NHP

Selection Guide

Total Power Factor Correction (TPFC System – APF + SVG)

NHP Electrical Engineering Products

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Total Power Factor Correction (TPFC System – APF + SVG)

The Total Power Factor Correction (TPFC) system utilises the modular design of the Delta APF and SVG to combine displacement and distortion power factor correction in a single cabinet.

Whilst an APF does provide a level of power factor correction in addition to harmonic mitigation, it is generally not economically viable to solely rely upon a harmonic filter to correct significant reactive power at a site. The TPFC serves as an all-in-one solution to boost the true power factor of an electrical network.

There are five steps in selecting the right system for you.

This guide also includes CT and breaker cable selection guides which are critical components in the installation and operation of the system.

Step 1
How much reactive power (kVAr) and distortion power (A) compensation is required?

To determine the amount of compensation required for an existing site you will ideally have the following information:

- Existing power factor
- Total load kVA
- New target power factor
- Total harmonic current distortion (THID) in Amperes (A) under load conditions
- New target THID level in Amperes (A) under load conditions

Existing power factor and total load kVA may already be available via your electricity bill or can be requested from your energy retailer as part of your meter data. The THID is generally available on advanced energy meters or multi-function power meters. As the harmonics vary according to the load profile throughout the day/week, the measurements should be taken under different load conditions to get the compensation current.

The best way to determine the compensation size required for a TPFC system is to have a power quality audit conducted at the site. NHP's technical team can assist with sizing up an appropriate system in accordance with the project details and organize a power quality audit. A detailed report on site power quality is provided with suggested solutions.

For sites in the design and construction stage, required compensation can be calculated using tools such as PowerCad or other vendor tools. Please contact NHP for assistance with this.

Step 2
How much spare capacity is required?

As previously mentioned, the power quality on a site can change with the type and number of loads that are running. If you plan to expand your site, add equipment, or replace existing products, including slots for spare capacity would be beneficial as a future proof option.

Important Note

Even though high kVAr can be a burden on supply and electricity costs, inductive loads such as motors and welding equipment need some kVAr to maintain electromagnetic fields required to operate.

Step 3
3 wire or 4 wire?

The four-wire option is required when there is an imbalance in the network.

Network imbalance is when differing line voltages across phases occurs, caused by unbalanced loads and single phase and phase-to-phase connections. This information can be found on your energy meter or power quality audit report.

	Use	Applicable industry examples
3 Wire	For balanced networks	Mining
		Industrial
		Food and beverage
		Manufacturing
4 Wire	For an unbalanced network with a fully rated neutral wire	Commercial
		Office
		Education
		Shopping centers

Step 4
IP rating requirement?

The environment that the cabinet would be installed has a major impact on the IP rating. NHP offers options for IP30 or IP54 floor standing cabinets and an IP31 wall mount module. It is not recommended for any of the IP rated cabinets to be installed outdoors with direct sunlight or without cover for rain.

Step 5
Colour of cabinet

RAL7035 Light Grey or X15 Orange.

Ordering Guide

Modules

Module Type	Output	3 wire or 4 wire	Catalogue No.
APF	100A	3 Wire	PQ APFM 100 X G 3 F FC X 1A
SVG	100kVAr		PQ SVGM 100 X G 3 F FC X 1A
APF	100A	4 Wire	PQ APFM 100 X G 4 F FC X 1A
SVG	100kVAr		PQ SVGM 100 X G 4 F FC X 1A

Cabinet

Max. Number of Modules	IP rating	Colour	Catalogue No.
2	30	Grey	PQ SVGC 200 30 G X F FC X 1A
5			PQ SVGC 500 30 G X F FC X 1A
7			PQ SVGC 700 30 G X F FC X 1A
3	54		PQ SVGC 300 54 G X F FC X 1A
2	30	Orange	PQ SVGC 200 30 O X F FC X 1A
5			PQ SVGC 500 30 O X F FC X 1A
7			PQ SVGC 700 30 O X F FC X 1A
3	54		PQ SVGC 300 54 O X F FC X 1A

Note Draw type modules and cabinets are also available on a non-stocked basis. For selection, please contact NHP.

Ordering Examples

Example 1

To get a 200A and 300kVAr TPFC system, for a 4-wire installation, with an IP30 Grey cabinet and 20% spare capacity.

Order

2 x PQ APFM 100 X G 4 F FC X 1A,
3 x PQ SVGM 100 X G 4 F FC X 1A and
1 x PQ SVGC 700 30 G X F FC X 1A

Example 2

To get a 200A and 100kVAr TPFC system, for a 3-wire installation, with an IP54 Orange cabinet.

Order

2 x PQ APFM 100 X G 3 F FC X 1A,
1 x PQ SVGM 100 X G 3 F FC X 1A and
1 x PQ SVGC 300 54 O X F FC X 1A

Power Quality Commissioning Services

***FREE EXTENDED WARRANTY** for all NHP Power Quality systems when commissioned by NHP Service team*

- Standard 12-month warranty is provided with all NHP Power Quality systems
- Systems commissioned by NHP service team will receive an additional 12 months warranty

It is critical that your power quality system is installed, connected, and commissioned to ensure correct and reliable operation.

Common issues when equipment is not commissioned properly

- System performance compromised - inability to reach and maintain target power factor and reduce onsite harmonics. This can also impact your energy bills, particularly where kVA and kVAr tariffs are in place.
- Incorrect operation of power quality equipment with potential impact on other onsite equipment
- Reduced equipment operating life
- Void of equipment warranty

Please note

Commissioning outside metropolitan areas may incur "Additional Travel and Accommodation Cost".

Please contact service@nhp.com.au or 1300 NHP NHP

Cable and breaker Selection Guide

Appropriate cable and breaker selection are a vital part of ensuring the system will operate at its optimal capacity. Selection of each depends on the dominant power quality correction type of the TPFC. For example, for a system with more APF modules than SVG, use the APF cable and breaker selection table with total module quantity as a guide. Circuit breaker and cable size should be based on the maximum desired size of future expansion.

Example 1

A system with 200A and 100kVAr compensation, uses 3 power modules. Since APF is the dominant module type, we can select from the APF selection tables for a 300A APF system.

From the tables it is seen that a 500A breaker and a minimum conductor size of 120mm^2 is required for power and PE cables.

Example 2

A system with 200A and 200kVAr compensation, uses 4 power modules. Since there is no dominant module type, we can select from the SVG selection table for a 400kVAr SVG system.

From the table it is seen that an 800A breaker and a minimum conductor size of 2x185mm^2 is required power and PE cable.

Note: The cable sizes are a guide only, always refer to AS/NZS3008 for specific requirements. Individual de-rating based on method of installation, cable lengths, volt drop, ambient temperature and cable configuration must be allowed for when sizing cable.

APF Cable and breaker selection table

PM Quantity	APF Rated Current (A)	MCCB Rated Current (A)	Min. Conductor Size R/S/T/N Phases	Min. Conductor Size PE
1	100A	160A	$70mm^2$	$35mm^2$
2	200A	315A	$150mm^2$	$70mm^2$
3	300A	500A	$2x120mm^2$	$120mm^2$
4	400A	630A	$2x150mm^2$	$150mm^2$
5	500A	800A	$2x240mm^2$	$240mm^2$
6	600A	1000A (Suggesting 2*500A)	$2x300mm^2$	$300mm^2$
7	700A	1130A (Suggesting 500A+630A)	$2x300mm^2$	$300mm^2$

SVG Cable and breaker selection table

PM Quantity	SVG Capacity (kVAr)	SVG Rated Current (A) @400V	MCCB Rated Current (A)	Min. Conductor Size R/S/T/N Phases	Min. Conductor Size PE
1	100kVAr	150A	180A	$70mm^2$	$25mm^2$
2	200kVAr	300A	350A	$150mm^2$	$50mm^2$
3	300kVAr	450A	550A	$2x120mm^2$	$95mm^2$
4	400kVAr	600A	800A	$2x185mm^2$	$150mm^2$
5	500kVAr	750A	900A (Suggesting 400A+630A)	$2x240mm^2$	$185mm^2$
6	600kVAr	900A	1100A (Suggesting 550+550A)	$2x300mm^2$	$240mm^2$
7	700kVAr	1050A	1250A (Suggesting 630A+630A)	$2x300mm^2$	$240mm^2$

Note

For 3P3W TPFC, there are cooling fans in the cabinet, and rated voltage of these fans is AC220V, so a $1.5mm^2$ cable should be connected to 3P3W TPFC cabinet's Neutral terminal powering AC220V fans in the cabinet. For 3P4W TPFC, Neutral cable diameter should follow the guideline in the above table.

CT Selection Guide

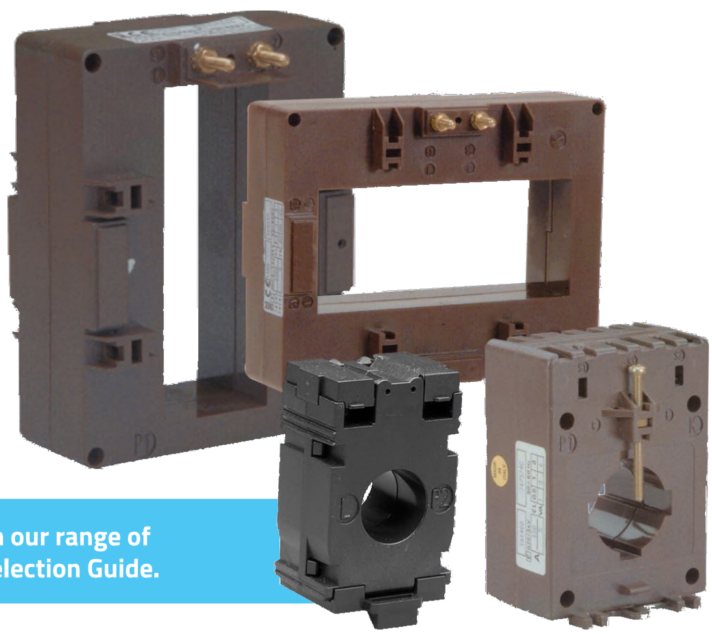
The correct CTs must be selected according to the electrical condition of the installation site. NHP can provide recommendations on the correct CT and wire size to suit your application.

Critical Installation Information

The placement of the CTs during the installation is critical to the operation of the system. This section outlines the placement options for different applications.

These guides are for the most common installations. Like the APF systems, the CT placements are the same for both balanced and unbalanced loads. For application where more than one TPFC unit is required, capacitor banks are present and any other variations to these scenarios outlined below please refer to the full CT selection and installation guide.

Note: The TPFC system follows the same CT placement as the APF systems. The cabinets are referred to as TPFC cabinets in the drawings for simplicity. When placing orders, the cabinets will be APF or SVG cabinets depending on the system type.



For more information on our range of CTs please use our CT Selection Guide.

External CT Connection Guide – Single TPFC System

1. Closed loop

In this scenario, 3 CTs shall be installed at grid side (R/S/T phases), and another 3 CTs shall be installed at TPFC input side. All the CTs P1 should be facing grid side with same CT ratio.

Refer to Figures 1-1 and 1-2 for single line diagram (SLD) and detailed connection.

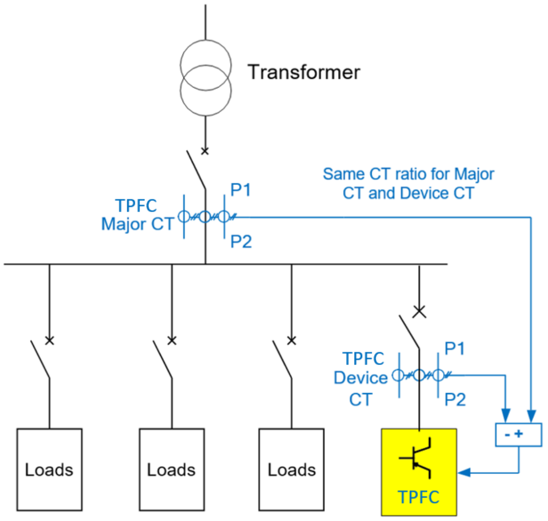


Figure 1-1
CT Connection for closed loop, without cap bank scenario – SLD

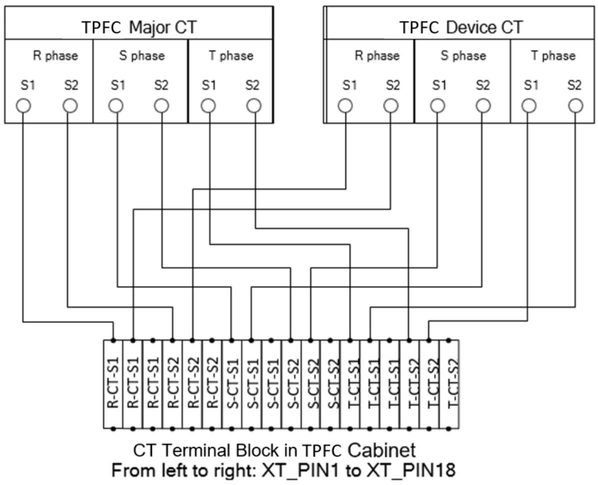


Figure 1-2
CT Connection for closed loop, without cap bank scenario – details

If CT connection is following this pattern, CT related parameters should be set according to following two tables for Touch Screen HMI.

Corresponding CT settings in Touch Screen HMI

Setting Location	Setting Value
CT Setting → CT Position	Load Side
CT Setting → CT Direction	Positive
CT Setting → CT Number	3-CT
CT Setting → 1-CT Location	No need to set
CT Setting → CT Ratio	Actual CT ratio

2. Open loop

In this scenario, 3 CTs shall be installed at the load side (R/S/T phases), P1 should be facing the grid side. Refer to Figures 2-1 and 2-2 for single line diagram (SLD) and detailed connection.

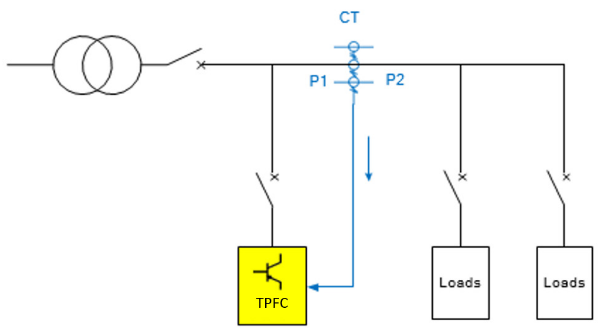


Figure 2 -1
CT Connection for open loop, without cap bank scenario – SLD

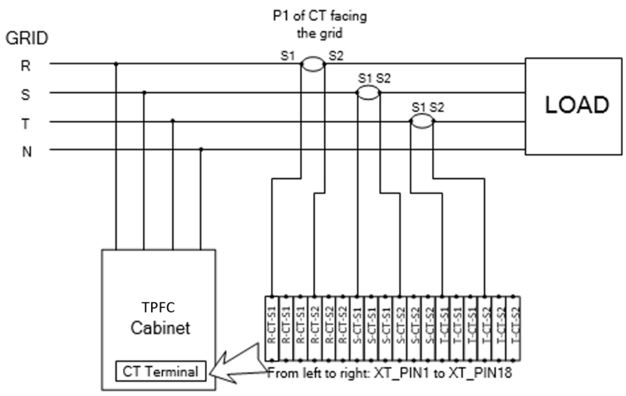


Figure 2-2
CT Connection for open loop, without cap bank scenario – details

If CT connection is following this pattern, CT related parameters should be set according to following tables for Touch Screen HMI.

Corresponding CT settings in Touch Screen HMI

Setting Location	Setting Value
CT Setting → CT Position	Load Side
CT Setting → CT Direction	Positive
CT Setting → CT Number	3-CT
CT Setting → 1-CT Location	No need to set
CT Setting → CT Ratio	Actual CT ratio

Technical specifications

<table>
<tr><th></th><th>Rated Voltage</th><th colspan="2">SVG AC 415 V</th><th colspan="3">APF AC 415V</th><th>APF AC 690V</th></tr>
<tr><td rowspan="19">Electrical Specification</td><td>Input Voltage Range</td><td colspan="5">AC 308V~480V</td><td>AC 432V~880V</td></tr>
<tr><td>Electric Connection</td><td colspan="5">3P3W / 3P4W</td><td>3P3W</td></tr>
<tr><td>Rated Frequency</td><td colspan="6">50(60)Hz ±10%</td></tr>
<tr><td>Input Voltage THD Range</td><td colspan="2"></td><td colspan="4">≤15%</td></tr>
<tr><td>Rated Capacity per Module</td><td>50kVAr</td><td>100kVAr</td><td>50Amp</td><td>75Amp</td><td>100Amp</td><td>100Amp</td></tr>
<tr><td>Rated Current per Cabinet</td><td colspan="2">50~700kVAr
(module combination)</td><td colspan="3">50~700Amp
(module combination)</td><td>100~500Amp
(module combination)</td></tr>
<tr><td>Redundancy</td><td colspan="2">Each module is an independent reactive compensation system</td><td colspan="4">Each module is an independent filtering system</td></tr>
<tr><td>Harmonic Elimination Range</td><td colspan="2">NA</td><td colspan="3">2nd ~ 50th order (selectable)</td><td>2nd ~ 31st order (selectable)</td></tr>
<tr><td>Harmonic Filtering Degree</td><td colspan="2">NA</td><td colspan="4">0 - 100% programmable per harmonic in Ampere value</td></tr>
<tr><td>Harmonic Filtering Performance</td><td colspan="2">NA</td><td colspan="4">Filter up to 98% harmonics at rated load, THDV<3%, THDi<5% after filtering</td></tr>
<tr><td>Reactive Power Compensation Capability</td><td colspan="6">Both inductive and capacitive reactive power</td></tr>
<tr><td>Reactive Power Compensation Performance</td><td colspan="2">Cosφ ≥ 0.99 after compensation (if the SVG capacity is sufficient)</td><td colspan="4">Cosφ ≥ 0.99 after compensatio (if the APF capacity is sufficient)</td></tr>
<tr><td>Imbalance Correction Capability</td><td colspan="6">Mitigate negative and zero sequence</td></tr>
<tr><td>Full Response Time</td><td colspan="6"><20ms</td></tr>
<tr><td>Instant Response Time</td><td colspan="6"><100us</td></tr>
<tr><td>Thermal Loss</td><td colspan="2">≤3% of SVG rated capacity</td><td colspan="4">≤3% of APF rated capacity (kVA)</td></tr>
<tr><td>Output Current Limitation</td><td colspan="6">Automatic (100% rated capacity)</td></tr>
<tr><td>Parallel Expansion (System)</td><td colspan="5">Up to 10 Cabinets in parallel (max. 7 modules per cabinet)</td><td>Up to 10 Cabinets in parallel (5 modules per cabinet)</td></tr>
<tr><td>MTBF</td><td colspan="6">>100,000 hours</td></tr>
<tr><td rowspan="4">Control Technology</td><td>Switching Frequency</td><td colspan="2">30kHz</td><td colspan="2">60kHz</td><td>30kHz</td><td>20kHz</td></tr>
<tr><td>Controller</td><td colspan="6">DSP control</td></tr>
<tr><td>Communication</td><td colspan="6">Modbus Protocol, RS232/485</td></tr>
<tr><td>Monitoring</td><td colspan="6">Via webserver</td></tr>
<tr><td rowspan="6">Physical Specifications</td><td>IP Grade of Cabinet</td><td colspan="6">IP30, IP54 available</td></tr>
<tr><td>Cooling method</td><td colspan="6">Intelligent forced air cooling</td></tr>
<tr><td>Noise Level</td><td colspan="2">< 60dB(A) @1m (Module)</td><td colspan="3">< 65dB(A) @1m (Module)</td><td>< 70dB(A) @1m (Module)</td></tr>
<tr><td>Dust Filter</td><td colspan="6">Optional</td></tr>
<tr><td>Weights (kg)</td><td>30</td><td>57</td><td>41</td><td colspan="2">63</td><td>78</td></tr>
<tr><td>Dimensions (WxHxD) mm</td><td>440 x 174 x 600</td><td>600 x 190 x 606</td><td>440 x 174 x 522</td><td colspan="2">605 x 220 x 728.2</td><td>606 x 270 x 728</td></tr>
<tr><td rowspan="3">Environmental Requirement</td><td>Ambient Temperature</td><td colspan="6">-10~50°C</td></tr>
<tr><td>Relative Humidity</td><td colspan="6">0~95%</td></tr>
<tr><td>Altitude</td><td colspan="6">≤1000m rated capacity, 1000~2000m(derating 1% per 100m)</td></tr>
</table>

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SALES 1300 NHP NHP
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SALES 0800 NHP NHP
sales@nhp-nz.com

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