TECHNICAL SPECIFICATIONS

TECHNICAL SPECIFICATIONS FOR THE SUPPLY, DELIVERY AND INSTALLATION OF A VARIABLE

Variable Active Harmonic Filter – ESD34

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1-GENERAL

1-1 INTRODUCTION

This document aims to specify the work for the design and supply of an Active Harmonic Filters (AHF). The Active Harmonic Filters shall be designed to limit harmonics levels at their point of connection to within harmonics limits specified herein. The system shall include all components, cabling, control equipment, operator interface, microprocessors, semi-condustors, fuses, circuit breakers and support system as required to provide a fully functional system. The Active Power Filter shall be fully rated, Hybrid (Passive + Active) Filters or pure Passive Filters (L-C circuit) are not acceptable

1-2 REFERENCE STANDARDS :

The propose filter should comply but not limited to the following standards :

(i) Reference Harmonic Standard : EN 61000-3-4, IEEE 519-1992
(ii) Design Standard : EN 60146
(iii) Safety Standard : UL508

1-3 DESIGN DESCRIPTIONS

1) The proposed filter shall consist of fast switching IGBT and other power semiconductors to generate the counter harmonic current waveform.

2) The harmonic current waveform detection, calculation and control aglorithums of the proposed filter shall utilise Digital Fourier Transform or better technology.

3) The proposed filter shall utilise fast speed Digital Signal Proccessor for internal command and control. Filters utilising Analogue type of control shall not be accepted.

4) Current limiting function to protect the semiconductors & IGBT is a must for the prosped filter.

5) The proposed filter shall not process overload risk. It should be able to continue operation even at its full rated capacity.

6) The proposed filter shall utilise one auxiliary current transducer (CTs) on each ‘Red’, ‘Yellow’ & ‘Blue’ phase for 3Phase 3 Wires System. The Active Power Filter must be able to accept and settable on site CT ratio suitable to read the maximum peak current of the power supply bus.

7) The proposed filter should have on-site expansion capability when the load increases. The filter should be able to parallel more than 8 systems of the same or different capacities (30A + 60A + 90A etc), to inject current according to the information received from one common set of auxiliary CT.

1-4 OPERATING CONDITIONS

1) Storage Temperature	:	- 20°C to 70°C
2) Operating Temperatue	:	0°C to 40°C
3) Relative Humidity	:	0 to 95% without condesation
4) Max. Operating Altitude	:	< 1000m without derating
5) Noise Emmission	:	<65 dBA measured 1 meter from the front of the APF
7) MTBF	:	> 100,000 hours

2-SYSTEM DESCRIPTIONS AND OPERATING PRINCIPALS

2-1 SYSTEM DESCRIPTIONS :

The proposed Filter should be modular in design and composed of Control Module and Power Modules for flexible on site upgrading and paralleling for maximum capacity.

A. Control Module shall consist of but not limited to:

(1) **Main Controller**
The control core utilising full Digital Signal Processing (DSP) to control the operation of Power Module.

(2) **Power Supply**
Provide DC power for the Control Module.

(3) **Voltage Detection Circuit**
Provide three phases AC main voltage signal for controller.

(4) **Current Detection Circuit**
Provide the Source or Load side current signal for controller to calculate harmonic and reactive current.

(5) **Control Panel**
Control and display the status of operation.

(6) **Communication Interface**
- (i) Standard Communication port
  - (a) RS232 port
  - (b) USB port
  - (c) 5 programmable Dry contacts output and 1 x input.
  - (d) Emergency Power Off (EPO).
- (ii) Options
  - (a) RS485 (Modbus Card)
  - (b) Ethernet Card for remote monitoring via TCP/IP.

B. Power Module shall consist of but not limited to:

(7) **Main Fuse**
For Over current protection.

(8) **Soft-start Module**
To limit the inrush current during start up and shut down to ≤ I-norminal

(9) **Electromagnetic Contactor Module**
To connect and disconnect the IGBT power converter from the power supply bus.

(10) **Link Inductor and Capacitor Module**
To act as a power transmission interface and protection between the IGBT power converter and the power supply bus.

(11) **Ripple Current Filter Module**

To absorb any residue low frequency ripple current from the IGBT power converter and prevent the ripple current from transmitting to the power supply bus. The Ripple Current Filter module shall consist of Over-Current protection fuse and over temperature detection sensor.

(12) **High Frequency Inductor**
To filter the high-frequency ripple current from IGBT power converter.

(13) **IGBT Power Converter Module**
The major function of the IGBT Power Converter Module is to convert the energy provided by the power supply bus to harmonic and reactive power compensated current, and re-generate a same equal amount of energy with opposite phase to the power supply bus to reduce harmonic current and improve the power factor.

(14) **DC Capacitor Module**
The DC Capacitor Module is made up of a specific numbers of similar rating DC capacitors connected electrically in parallel/series. The DC Capacitor Module stores the energy and maintains a constant DC voltage, which is controlled by the IGBT power converter.

2-1 OPERATING PRINCIPALS

The Propose filter should have the following basic operating principals :

1) The IGBT core circuit of the APF constanly sample the current waveform from the power line and monitor its harmonics spectrum and amplitude. The energy of the sampled waveform is than store in the DC Capacitor Bank, so as to produce a reverse waveform with the same amplitude and re-injected into the power line to attenuate the harmonics current which is present in the power line. This will result in a near perfect sinusoidal waveform returning to the power line.

2) The use of full Digital Signal Processor (DSP) to control the IGBT core circuit and processing of the collected data, enable the filter to have a fast respond to attenuate and compensate from the 2^{nd} to 51^{st} harmonics spectrum instantly without being affected by any sudden load change.

3) The filter should be able to attenuate the Total Current Harmonics Distortions (THDi) to an average ratio of 10 :1. Its performance should not be affected by the following situations :

   a) Line Impedence variations
   b) Line Frenquency variations
   c) Loads Variations

3-SYSTEM ELECTRICALCHARACTERISTIC

3-1 SYSTEM CAPACITY :

The proposed filter capacity should be at least 10% higher then the power supply bus harmonic current. The APF should be of easy upgradable modular design and is capable of mixed capacities parallelling should the power supply bus harmonic current increases.

3-2 ELECTRICAL DESCRIPTIONS

1) Operating Voltage	:	480V +10%, -20%
2) No. of Phase/Wires	:	3 Phases 3Wires
3) Frequency	:	50/60 Hz $\pm$ 3Hz autos sensing
4) Heat-Loss	:	<650W per module
5) Soft Start	:	≤ 10 sec
6) Compensated Harmonics	:	2^{nd} to 51^{st} order global, including even Orders harmonics. Minimum 12 harmonics orders selectable simultaneously
7) Attenuation Ratio	:	10 : 1 typical
8) Power Factor Compensation	:	selectable from 0.7 lagging to 0.7 leading
9) Respond Time	:	< 20 msec
10) Inrush Current	:	less than rated current
11) Current Limit	:	At full rated compensating current
12) Current Sensing	:	Open or Close Loop on site selectable
13) CT ratio setting	:	from 100/1A to 10,000/1A on site settable

3-3 Current Transducer (CTs)

The proposed filter should be capable of accepting both Open-Loop & Close-Loop CT configurations. Open Loop Configuration allows the CTs to install near to the Harmonics Load Side while Close-Loop Configuration allows the CTs to install near to the Mains Source Side. The flexibilities of allowing either configuration will enable ease of CT installation on various site conditions.

4-SYSTEM CONTROL AND MONITORING

The propose filter shall equiped with LCD control & display panel located at the front of the control module. The Panel should be silk-screen and consist of a Liquid Crystal Display (LCD). The LCD Screen should has illuminating back light for easy viewing under different luminating conditions.

The LCD Control & Display Panel shall consist of but not limited to the followings :

1. LCD Display Screen with LED status indicators.
2. Power On/Off Key Pad Switch
3. Alarm Mute/Reset Key Pad Switch
4. Power On Indicating LED
5. Filtering On Indicating LED
6. Full Correcting (Max. Capacity) Indicating LED
7. Error (Functional Abnormalities) Indicating LED
8. Confirmation/Enter Key
9. Directional Scrolling Key
10. Escape/Cancel Key

4-1 Display

The LCD Control & Panel should be able to display most of the essential electrical parameter readings at 1) Load Side, 2)Source Side & 3)Filter Side.

4-1-1 Parameters Display

These Parameter readings should consist but not limited to the followings :

KVA	: Apparent power
Freq	: System frequency
PF	: Power Factor
Vab ,Vbc, Vca	: Three phase line to line rms voltage
Ia, Ib, Ic	: Three phase line rms current
THDv	: Total harmonic voltage distortion
THDi	: Total harmonic current distortion

4-1-2 Waveform Display

The Control Panel should be able to display the following but not limited to the various electrical Waveforms.

Vab, Vbc, Vca	**:** Three phase line to line voltage.
Ia(L), Ib(L), Ic(L)	**:** Three phase line current of load side.
Ia(S), Ib(S), Ic(S)	**:** Three phase line current of source side.
Ia(F), Ib(F), Ic(F)	**:** Three phase line current of filter side.

The LCD screen shall be capable of displaying at least 2 waveforms simultaneously for comparisons of before and after filtering.

4-1-3 Harmonic Spectrum Display

The Control Panel should be able to display both Current & Voltage Harmonics Spectrum from 1st to 51st harmonics Orders.

4-1-4 Event Logs

The Control Panel should be able to capture up to 300 or more (first-in first-out basis) event logs of normal operation and alarms.

4-2 ALARM DESCRIPTIONS :

The proposed filter should have the capabilty to provide both audio & visual indications for the following (but not limited to) alarm conditions :

1) Over Temperature
2) Fan Fault
3) System Stop (By user operation)
4) Wrong Phase Sequence Connetion
5) DC Over-voltage
6) Power Supply / Input Power Faulty
7) System Emergency Stop

The filter shall equip with a Buzzer Command to enable/disable the buzzer alarms.

5 SYSTEM MECHANICAL DESCRIPTIONS

5-1 MECHANICAL DESIGN :

The proposed filter should be able to house in a standard 19 inch rack enclosure. The enclosure should made up of metal sheets of at least 2mm thickness.

The APF should be modular in design for easy installation and replacement.

The 19 inch rack enclosure should consist of MCCB/Isolating fuse switch for each filter system.

5-2 VENTILATION

The propose filter should utilise Force Air Cooling. The design of the ventilation fans should not require the use of dust filters. The Fans main function is to remove the heat generated by the system heat sink, and dissipate the heat via the ventilation lourves.

THE END

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