InstaSine

i-PFC
Static Var Generators

Step-less Solution to Step-Up Your Power Factor

Capacitor-less | Step-less | Modular | 3-Level Technology |Lead/Lag PF Correction | Resonance Free | Small Footprint | Cloud Connectivity

PRODUCT BROCHURE 2020-2021

About InstaSine:

❖ Founded by IIT Delhi alumni with over 30 years of combined first hand R&D experience in the areas of Power Electronics and Power Quality.

❖ Two of the founders hold doctoral degrees in electrical engineering from worlds renowned universities abroad.

❖ More than 100 international research findings and articles from InstaSine's core members have been published so far. Out of which, more than 40 are in prestigious *IEEE* Journals and Transactions.

❖ All the founders have collaborative research experience at Massachusetts Institute of Technology (MIT), Cambridge, USA.

❖ In the span of four years of its inception, InstaSine has become the synonym for *the most reliable and trusted power quality solutions provider in India*.

What is an *i-PFC*?

i-PFC (Inverter based Power Factor Correction) is trademark name for the Static Var Generators (SVG) being developed and manufactured at InstaSine.

Making use of advanced controllability of 3-Phase 3-Level IGBT based voltage source inverter architecture, *i-PFC* SVG does precise power factor and unbalance correction without the need of any passive power factor correction capacitors.

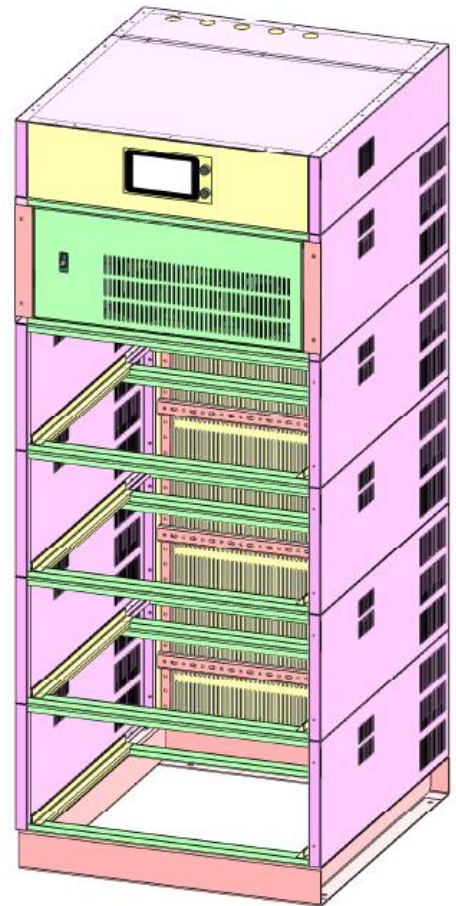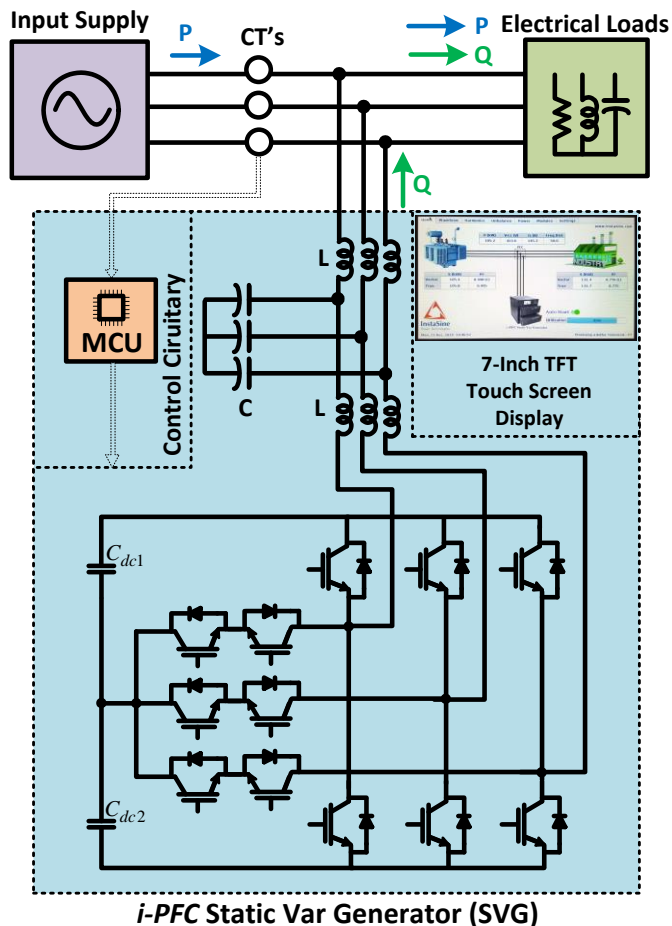## Working Principle of *i-PFC* SVG*:*

Excitation control of synchronous machine had been the classical method for power factor control in low and medium voltage systems. In which, a grid connected synchronous machine, acting as a voltage source with series reactance, produces leading VAR (behaving as a capacitor) when over excited, and lagging VAR (behaves as an inductor) when under excited. By controlling its excitation voltage, reactive power output of the synchronous machine can be controlled in a step-less manner in either direction.

The *i-PFC* SVG also act as controlled voltage source with series reactance, principally similar to the grid-connected synchronous machine, however, without any rotating part(s). Internal architecture of *i-PFC* SVG can be seen in the schematic diagram below.

The reactive power output of the *i-PFC* SVG is precisely controlled to the reference value by adjusting waveshape, magnitude and phase angles of the internal AC voltage (with the use of appropriate Pulse Width Modulation technique). The real-time reference value of the reactive power output of the *i-PFC* SVG is precisely calculated in real-time as per the target power factor entered by the user, and voltage and current values.

The *i-PFC* SVGs are powered with a sophisticated Artificial Neural Network based control algorithm to achieve set power factor within 20 milli seconds, while always working in the background for real-time loss minimization, to achieve improved energy efficiency.

The *i-PFC* SVGs are designed in stackable modular configuration for increased resilience, reliability and redundancy. A robust CAN Bus communication between the *i-PFC* SVG Modules and Master Display Module enables equal load sharing between all the active modules.

i-PFC Static Var Generator (SVG)

Advancements of Benefits of *i-PFC* SVGs*:*

➢ Step-less reactive power compensation (No over/under-compensations)

➢ Bi-directional Reactive Power Compensation (Compensates both inductive and capacitive reactive power of the loads)

➢ Compatible with LT or HT Side current sensing, with all groups of transformer configurations

➢ HT side power factor correction from LT side CT sensing using the InstaSine's smart-sense technology

➢ Near unity power factor correction at all load conditions

➢ Faster dynamic response time (<100 micro seconds)

➢ Shortest Power factor correction time (<20 milli seconds)

➢ Low kVAR capacity dependency on grid voltage fluctuations

➢ No harmonic resonances/amplifications

➢ Relatively maintenance free

➢ Compatible with power supply from Grid/DG/Co-gen/Solar power plants

➢ Works under high voltage THD (THDv) up to 15%, without causing harmonic resonance

➢ No capacitor explosion risk and no accidents and/or risk of safety

➢ Advanced technology and easy to use HMI monitor, with built-in real-time oscilloscope and power quality analyzer functionalities

➢ Minimal footprint, save more than 70% of space compared with traditional capacitor banks

➢ "Connect-Monitor-Control" from anywhere using internet through Cloud connectivity

➢ Modular architecture for enhanced resilience, reliability and redundancy

Technical Specifications of *i-PFC* SVG Module:

Operating Conditions:	
System voltage (RMS)	350-480V
System frequency (Hz)	50 ± 5%
Operating temperature range	0 to 45º C (Non-condensing)

Product Specifications:	
Semiconductor devices	IGBTs (3-Level Topology)
Maximum Reactive Power Output @ 480V	125kVAR
Step-less compensation range	-100kVAR to +125kVAR
Rated RMS current output	150A
i-Sine AHF configuration	3P3W
Power Factor Correction	Yes
Load Current Balancing	Yes, Negative Sequence
CT Requirement	3CTs with 1A or 5A Secondary
CT Position	Load Side / Source Side
Internal Thermal Losses	<2%
Color	Black
Integrated Short-Circuit Protection	Yes
Dimensions in mm (WxDxH)	800 x 890 x 330

Control and Paralleling:	
Controller	ARM based MCU
Control method	Adaptive Artificial Neural Network based
Dynamic Response Time	100 micro seconds
Correction Time	10 milli seconds
Parallel Operation	Upto 50 modules per CT set
Parallel Communication	CAN Bus/Mini-USB
Paralleling Options	Master-Slave / Multi-Master
Noise Level	<65dB

System Integration:	
Stackable upto 5 *i*-PFC modules in each floor mounting 5 rack system.	
CT Connections between modules	Daisy Chain Type
Display	*7" TFT Touch-Screen Display*
Software for PC Interface	InstaView
Cloud Connectivity	Yes
Master Module Dimensions in mm (WxDxH)	800 x 890 x 200

Technical/Performance Comparison - APFC vs APFC+SVG vs Full *i-PFC* SVG:

Functionality/Problems Associated	APFC ** (Detuned/Not Detuned)	Hybrid ## (APFC+SVG/AHF)	Full *i-PFC* SVG
Step-less correction	Not Possible	Possible	Possible
Precisely controlled inverter architecture benefit *i-PFC* SVGs with step-less reactive power compensation, making them free from over/under compensations. This makes them the ideal solution for maintaining power factors above 0.99 at all times.			
Bidirectional Correction	Not Possible	Part Range	Full Range
i-PFC SVGs and only active/SVG part of hybrid solutions, are capable to compensate both inductive and capacitive reactive loads.			
Capacitor switching and resultant Voltage surges	High	High	Nil
Full inverter based *i-PFC* SVGs are free from frequent mechanical operations such as contactor opening and closing (also, free from capacitor charging/discharging). In APFC and hybrid solutions such frequent capacitor switching creates voltage dips/spikes at PCC. These surges may trigger the malfunctioning of sensitive systems connected to the same LT network.			
Response time from 0-100% Output	Slow (>Few Seconds)	Slow (>Few Seconds)	Fastest (< 20 Milli Seconds)
During the load changes, *i-PFC* SVGs can ramp up from 0 to 100% and ramp down from 100% to 0% capacity in less than 20 milli seconds, without causing any transients. Such a feature is most needed at places where frequent start-stop of processes or motors are involved. Hybrid solutions might take few tens of seconds in ramping up and ramping down due to time lags in calculation and switching of corresponding capacitor banks. This hinders their performance in achieving power factors very close to unity.			
Harmonic Amplification Chances	High	High	Nil
The *i*-PFC SVGs cause near-zero current harmonic injection while performing the power factor correction, even if the voltage THD level goes to 15%. Detuned APFC and hybrid solutions cause resonance/amplification of current harmonics which are below their resonance frequencies. And, are highly sensitive to input voltage harmonics. In case of input voltage harmonics above 2-3%, the passive part of APFC panels tend to draw corresponding current harmonics in addition to plant current harmonics. Which is unwanted in true kVAH based tariff structure.			
Voltage Dependency of kVAR Capacity	High	High	Low
kVAR capacity of *i*-PFC SVG is proportional to grid voltage. Detuned APFC and passive part of hybrid solutions kVAR capacities are proportional to square of the voltage. Means, minor voltage fluctuations result in large reactive power swings.			
PF and Unbalance correction with 1-Phase and 2-Phase loads	Not possible	Partly possible	Possible
Capability to use the 100% capacity for negative sequence correction, make *i-PFC* SVGs to be the only contender power factor correction in the presence of large single-phase and two-phase loads.			
Maintenance Requirements	Very High	Very High	Low
Having no frequent mechanical operations in *i*-PFC SVGs make them relatively maintenance free. In detuned APFC or hybrid solutions, there is always a risk of capacitor and/or contactor explosion due to the constant mechanical switching, which is a safety risk.			
Footprint	Large	Medium	Small
i-PFC SVG's minimal footprint saves more than 70% space, compared to the conventional APFC and/or hybrid solutions.			

**APFC: automatic power factor correction panels (including detuned and/or non-detuned)
APFC+SVG: Hybrid solution are the combination of APFC along with a part rated SVG or AHF.

Prominent Clients of InstaSine:

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