

C2. Static Var Generator - SVG

Standard Approach

The main framework for SVG should be established as follows: Power electronics safety: IEC/EN 62477-1. This standard defines safety requirements for power electronic converter systems and equipment. If delivered as a panel/enclosure: IEC/EN 61439-1 and IEC/EN 61439-2 according to the applicable panel type. IEC 61439-1 covers general definitions, service conditions, structural requirements, technical characteristics and verification rules for low-voltage switchgear and controlgear assemblies. Power quality / PF / reactive power measurement: IEC 61000-4-30. This standard defines methods for measuring and interpreting power quality parameters in 50/60 Hz AC power systems. Harmonic measurement and THD effect: IEC 61000-4-7. This standard provides general guidance for measurement instruments and methods for harmonic and interharmonic components superimposed on the fundamental frequency in 50/60 Hz power systems. EMC immunity/emission: IEC 61000-6-2 for immunity and IEC 61000-6-4 for emission in industrial environments; the IEC 61000-4 series is used for specific tests. Routine tests

Routine tests

1. Routine Tests

1	Visual and mechanical inspection	
	Main standard	IEC/EN 61439-1; IEC/EN 62477-1
	Construction / method standard	Visual inspection, assembly, wiring, component, torque and label check
	For SVG	Panel, IGBT power modules, DC busbar, fans, filter elements, fuses, contactors, HMI, communication ports and control board layout are checked.
2	Panel/enclosure PE continuity	
	Main standard	IEC/EN 61439-1; IEC 60204-1 as supporting reference
	Construction / method standard	Low-resistance PE continuity measurement
	For SVG	Enclosure, door, mounting plate, PE busbar, fan body, screen connections and door grounding braid are checked.
3	Insulation resistance	
	Main standard	IEC/EN 62477-1; IEC/EN 61439-1
	Construction / method standard	Insulation resistance measurement; in practice IEC 61557-2 as supporting reference
	For SVG	Power circuit-enclosure, DC busbar-enclosure, auxiliary circuit-enclosure and control circuit-enclosure are evaluated separately. High megger voltage should not be applied directly to electronic boards; the manufacturer procedure should be followed.

4	Dielectric withstand / hipot	
	Main standard	IEC/EN 62477-1; IEC/EN 61439-1
	Construction / method standard	AC/DC withstand test; according to manufacturer procedure
	For SVG	The test configuration should be determined so that IGBT modules, driver boards, SPD, EMI filter and sensitive electronics are not damaged. If necessary, electronic boards are separated and the main insulation between power circuit and enclosure is tested.
5	Auxiliary supply test	
	Main standard	IEC/EN 62477-1; IEC/EN 61439-1
	Construction / method standard	AC/DC auxiliary supply, SMPS outputs, fuse and control voltage measurement
	For SVG	24 V DC, 12 V DC, fan supply, board supply, pre-charge circuit and control relays are verified.
6	HMI / display test	
	Main standard	IEC/EN 62477-1
	Construction / method standard	Menu, measurement screen, alarm history, parameter input-output check
	For SVG	Voltage, current, power factor, active/reactive power, module status, temperature, alarm and communication screens are checked.
7	Fan / cooling test	
	Main standard	IEC/EN 62477-1; IEC/EN 61439-1
	Construction / method standard	Fan direction, air flow, fan alarm, thermostat/PWM control
	For SVG	Thermal reliability of the IGBT and DC busbar is very critical in SVG. Fan direction, filter clogging, air duct, temperature sensor and fan fault alarm should be checked together.
8	CT direction and connection check	
	Main standard	IEC/EN 62477-1; IEC 61000-4-30 as supporting reference
	Construction / method standard	CT polarity test, phase matching, ratio and load direction check
	For SVG	CT direction is critical for the SVG to generate the correct capacitive/inductive current. Reverse CT connection may cause compensation to work in reverse or the power factor to deteriorate.
9	CT ratio parameter check	
	Main standard	IEC/EN 62477-1; customer specification
	Construction / method standard	Comparison of CT label, HMI parameter and measured current
	For SVG	CT ratio such as 300/5 or 1000/5 must match the HMI/PLC parameter. An incorrect ratio distorts the reactive power command and PF targeting.

10	Voltage and phase sequence detection check	
	Main standard	IEC/EN 62477-1; IEC/EN 61439-1
	Construction / method standard	L1-L2-L3 phase sequence, phase-phase/phase-neutral voltage measurement
	For SVG	It is verified that the device detects the grid phases correctly and that the measurement phases match the CT phases.
11	Reactive power measurement verification	
	Main standard	IEC 61000-4-30; IEC/EN 62477-1
	Construction / method standard	Comparison of Q, P, S and cos phi with a reference power analyzer
	For SVG	The reactive power value measured by the SVG is compared with a calibrated reference device. Measurement accuracy directly affects the decision for capacitive/inductive operation.
12	Capacitive mode function test	
	Main standard	IEC/EN 62477-1; IEC 61000-4-30 for measurement
	Construction / method standard	Generation of capacitive reactive current under inductive load and PF correction check
	For SVG	It is verified that the device can provide capacitive reactive power for compensating an inductive load.
13	Inductive mode function test	
	Main standard	IEC/EN 62477-1; IEC 61000-4-30 for measurement
	Construction / method standard	Generation of inductive reactive current under capacitive load or overcompensation scenario
	For SVG	It is verified that the SVG can provide inductive reactive power to balance a capacitive system. This is an important point that differentiates it from a classic capacitor bank.
14	Power factor targeting test	
	Main standard	IEC 61000-4-30; IEC/EN 62477-1
	Construction / method standard	Verification with reference analyzer by entering the target cos phi set value
	For SVG	For example, when the target is selected as 0.99, it is checked that the device generates Q according to the load change and brings the power factor close to the target.
15	Overload / current limiting check	
	Main standard	IEC/EN 62477-1
	Construction / method standard	Current limit check with software simulation or test load
	For SVG	When the device exceeds the nominal compensation current, it should show derating, limit, alarm or trip behavior.

16	Alarm, fault and protection functions	
	Main standard	IEC/EN 62477-1; IEC/EN 61439-1
	Construction / method standard	Digital input/output, relay contact, software simulation
	For SVG	Overtemperature, fan fault, phase loss, low/high voltage, DC bus fault, IGBT fault, overcurrent, communication fault and general fault contacts are tested.
17	Communication test	
	Main standard	IEC/EN 62477-1; customer communication specification
	Construction / method standard	RS485/Modbus RTU, Modbus TCP, Ethernet or other protocol test
	For SVG	Address, baud rate, parity, IP, register read-write, alarm information and remote monitoring are checked.
18	Parameter backup check	
	Main standard	IEC/EN 62477-1
	Construction / method standard	Preservation of parameters after power off/on
	For SVG	CT ratio, target PF, operating mode, alarm limits, communication settings and number of modules should be preserved after power is restored.
19	Factory setting check	
	Main standard	IEC/EN 62477-1; customer specification
	Construction / method standard	Comparison of parameter list, firmware, serial number, power class and default settings
	For SVG	Before shipment, the correct software version, correct nominal current/power class and correct factory parameters should be reported.
20	Pre-charge / DC busbar check	
	Main standard	IEC/EN 62477-1
	Construction / method standard	Pre-charge circuit, DC busbar voltage and discharge time check
	For SVG	In IGBT-based devices, the DC busbar and pre-charge circuit are important for safety. The time for DC busbar voltage to fall to a safe level after power-off may also be checked.
21	Label and wiring diagram check	
	Main standard	IEC/EN 61439-1; IEC/EN 62477-1
	Construction / method standard	Label, terminal marking, warning and wiring diagram check
	For SVG	Voltage, frequency, compensation current/kVAR, number of phases, IP, CE, serial number, CT connection direction, PE and communication connections are checked.

2. Optional / Special Tests

1	Dynamic response time test	
	Main standard	IEC/EN 62477-1; IEC 61000-4-30 as supporting reference
	Construction / method standard	Measurement of Q, cos phi, current and response time during sudden load change
	When is it recommended?	If the page claims a response of less than 15 ms, this is the most important performance test. Load step, initial/final PF, response time and overshoot/settling behavior should be reported.
2	Power factor correction performance test	
	Main standard	IEC 61000-4-30
	Construction / method standard	Comparison of cos phi, Q and current with SVG off/on
	When is it recommended?	Very strong for sales and acceptance testing. If the target is 0.99, initial PF, PF after compensation, load level and device Q output should be written.
3	Capacitive/inductive four-quadrant performance test	
	Main standard	IEC/EN 62477-1; IEC 61000-4-30
	Construction / method standard	+Q / -Q generation verification under different load conditions
	When is it recommended?	Recommended for SVGs that will operate in both inductive and capacitive facilities.
4	THD effect test	
	Main standard	IEC 61000-4-7; IEC 61000-4-30
	Construction / method standard	THDi/THDv and individual harmonic measurement with SVG on/off
	When is it recommended?	Although the main function of SVG is reactive power, the IGBT-based device may affect the grid waveform. THD effect and harmonic side effects may be reported.
5	EFT/burst immunity test	
	Main standard	IEC 61000-4-4; IEC 61000-6-2 for general immunity
	Construction / method standard	Application of EFT/burst to power, control and communication ports
	When is it recommended?	Recommended for immunity to fast switching pulses in industrial panel environments. IEC 61000-4-4 provides test procedures for electrical fast transient/burst immunity.
6	Surge immunity test	
	Main standard	IEC 61000-4-5; IEC 61000-6-2 for general immunity
	Construction / method standard	Application of surge to AC supply and suitable ports
	When is it recommended?	Recommended for mains pulses, lightning-induced transients and field durability.

7	ESD immunity test	
	Main standard	IEC 61000-4-2; IEC 61000-6-2 for general immunity
	Construction / method standard	ESD test on HMI, door, metal surfaces and user-accessible points
	When is it recommended?	IEC 61000-4-2 covers immunity requirements and test methods for electrical/electronic equipment exposed to electrostatic discharges from operators or nearby objects.
8	Conducted immunity / RF immunity	
	Main standard	IEC 61000-4-6; IEC 61000-6-2
	Construction / method standard	RF conducted immunity test on cable ports
	When is it recommended?	Recommended for panels with CT cables, communication and long control cables.
9	Radiated immunity	
	Main standard	IEC 61000-4-3; IEC 61000-6-2
	Construction / method standard	Function check under electromagnetic field
	When is it recommended?	Recommended for dense industrial EMC environments and CE/EMC documentation.
10	Conducted emission test	
	Main standard	IEC 61000-6-4; CISPR 11 / CISPR 32 as supporting references if required
	Construction / method standard	Conducted emission measurement at the supply port
	When is it recommended?	Conducted emission delivered to the grid should be evaluated because of the IGBT switching structure. IEC 61000-6-4 is the emission standard for industrial environments.
11	Radiated emission test	
	Main standard	IEC 61000-6-4; CISPR 11 / CISPR 32 as supporting references if required
	Construction / method standard	Radiated emission measurement around the panel
	When is it recommended?	Recommended if CE/EMC documentation, export or critical facility specification exists.
12	Thermal camera test	
	Main standard	IEC/EN 62477-1 thermal safety approach
	Construction / method standard	IR thermography at nominal or high Q output
	When is it recommended?	Hot spots are searched for at IGBT modules, DC busbar, fuse, contactor, fan area, reactor/filter, terminals and busbar connections.
13	Long-duration load / thermal equilibrium test	
	Main standard	IEC/EN 62477-1; IEC/EN 61439-1
	Construction / method standard	Operation at nominal compensation current until temperature becomes steady
	When is it recommended?	Recommended for enclosed panels, high IP enclosures, hot panel rooms or projects with continuous high-Q compensation.

14	Parallel module operation test	
	Main standard	IEC/EN 62477-1; IEC/EN 61439-1
	Construction / method standard	Load sharing, communication and fault behavior check in multiple SVG modules
	When is it recommended?	Recommended for modular SVG systems. When one module is disconnected, the behavior of the other modules and load sharing should be checked.
15	Voltage fluctuation test with grid simulator	
	Main standard	IEC/EN 62477-1; IEC 61000-4-30 for power quality measurement
	Construction / method standard	%Un variations, phase unbalance, frequency deviation and load change scenarios
	When is it recommended?	Recommended for weak grids, generator supply, fluctuating voltage or critical facility applications.
16	Site-specific load profile simulation	
	Main standard	IEC 61000-4-30; IEC/EN 62477-1
	Construction / method standard	Laboratory simulation according to customer load profile, transformer power, CT ratio and target PF
	When is it recommended?	Very valuable for project approval or FAT. Especially recommended for cranes, welding, presses, elevators, rapidly changing loads and facilities switching between capacitive/inductive states.
17	Remote monitoring / SCADA integration test	
	Main standard	IEC/EN 62477-1; customer communication specification
	Construction / method standard	Modbus register list, alarm monitoring, start/stop and parameter read test
	When is it recommended?	Recommended for projects to be delivered with an energy monitoring system.
18	IP test - enclosed products	
	Main standard	IEC/EN 60529
	Construction / method standard	Dust/water and access to hazardous parts test according to IP code
	When is it recommended?	Applied if an enclosure declaration such as IP31, IP42, IP54 exists.

3. Lines Recommended to Add to the Test Report

Report line	Recommended content
Product type	Static Var Generator - SVG
Rated values	Voltage, frequency, phase, compensation current/kVAr, panel IP class
Main standard approach	IEC/EN 62477-1, IEC/EN 61439-1/2, IEC 61000-4-30, IEC 61000-4-7, IEC 61000-6-2/6-4
PE continuity	Panel enclosure, door, PE busbar, screen connections
Insulation / dielectric	Power circuit-enclosure, control circuit-enclosure; electronic board protection note
CT check	CT ratio, direction, polarity, phase matching
Reactive power measurement	Comparison of Q, P, S and cos phi with reference analyzer
Capacitive mode	Generated capacitive Q, current and PF effect
Inductive mode	Generated inductive Q, current and PF effect
PF targeting	Target cos phi, measured cos phi, settling time

Report line	Recommended content
Dynamic response	Load step, response time, overshoot/settling behavior
Protection functions	Overtemperature, fan fault, overcurrent, DC busbar, phase loss, voltage fault
HMI / communication	Display, RS485/Modbus/Ethernet, SCADA register test
Parameters	Firmware, factory settings, CT ratio, target PF, communication settings
EMC tests	EFT/burst, surge, ESD, conducted/radiated immunity and emission
Thermal tests	Fan test, thermal equilibrium, thermal camera result
Parallel module test	Module sharing and module fault behavior, if available