C1. Active harmonic filter - routine tests

Standard Approach

For active harmonic filters, the main framework should be established according to the product's panel/system structure: Power electronics safety: IEC/EN 62477-1 may be used as the safety standard 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 should be considered. IEC 61439-1 covers general definitions, service conditions, structural requirements, technical characteristics and verification rules for low-voltage switchgear and controlgear assemblies. Harmonic and power quality measurement: IEC 61000-4-7 should be used for the harmonic/interharmonic measurement method, and IEC 61000-4-30 for measurement and interpretation of power quality parameters. IEC 61000-4-7 covers measurement instruments and methods for spectral components superimposed on the fundamental frequency in 50/60 Hz systems; IEC 61000-4-30 defines power quality measurement methods in AC 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 should be used for specific 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 active harmonic filter	Panel, power modules, busbars, fuses, contactor/switch, fans, filter boards, CT inputs, HMI and control board layout are checked.

2 Panel/enclosure earth continuity

Main standard	IEC/EN 61439-1; IEC 60204-1 as supporting reference for machine/panel applications
Construction / method standard	Low-resistance PE continuity measurement
For active harmonic filter	Enclosure, cover, mounting plate, fan body, screen connections, PE busbar and door grounding are checked.

3 Insulation resistance - power circuit/enclosure

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 active harmonic filter	Measured between AC input, DC busbar, IGBT/power module outputs and power busbars versus enclosure/PE. To avoid damage to electronic boards, connections should be separated according to the manufacturer procedure or a suitable test level should be selected.

4 Insulation resistance - control circuit/enclosure

Main standard	IEC/EN 62477-1; IEC/EN 61439-1
Construction / method standard	Manufacturer procedure; check with limited voltage in sensitive electronic circuits
For active harmonic filter	The control circuit, auxiliary supply, HMI, communication and low-voltage boards are evaluated separately. High megger voltage should not be applied directly to electronic boards.

5 Dielectric withstand / hipot

Main standard	IEC/EN 62477-1; IEC/EN 61439-1
Construction / method standard	AC/DC withstand test; manufacturer procedure
For active harmonic filter	The test configuration should be determined so that electronic boards, SPD, EMI filters and power modules are not damaged. If necessary, boards are separated and the main insulation between power circuit and enclosure is tested.

6 Auxiliary supply check

Main standard	IEC/EN 62477-1; IEC/EN 61439-1
Construction / method standard	Auxiliary AC/DC supply voltage, SMPS outputs and fuse check
For active harmonic filter	24 V DC, 12 V DC, control supply, fan supply and board supplies are measured. If low/high supply alarm exists, function check is performed.

7 Fan and cooling system test

Main standard	IEC/EN 62477-1; IEC/EN 61439-1
Construction / method standard	Fan direction, air flow, thermostat/PWM fan control and fan alarm test
For active harmonic filter	Since thermal reliability is critical in power electronics, fan direction, air duct, filter clogging, fan alarm and temperature sensor are checked together. The OMSAN glossary states that thermal design is decisive in long-life product design.

8 Current transformer direction/polarity check

Main standard	IEC/EN 62477-1; IEC 61000-4-30 as supporting reference on the measurement side
Construction / method standard	CT polarity test, phase matching, load direction and measurement verification
For active harmonic filter	CT direction is critical for the active harmonic filter to operate correctly. If the CT is connected in reverse, the device may increase distortion instead of suppressing harmonics or may perform incorrect compensation.

9 Current transformer ratio check

Main standard	IEC/EN 62477-1; customer specification
Construction / method standard	CT primary/secondary ratio, parameter and measurement comparison
For active harmonic filter	The CT ratio on the HMI, the CT label on site and the test measurement must be consistent. If ratios such as 100/5, 300/5, 1000/5 are entered incorrectly, the compensation current will be wrong.

10 Phase sequence and voltage detection check

Main standard	IEC/EN 62477-1; IEC/EN 61439-1
Construction / method standard	L1-L2-L3 phase sequence, phase-neutral/phase-phase voltage measurement
For active harmonic filter	It is checked that the device detects the grid phases correctly and that the phase sequence is correct.

11 Display / HMI function test

Main standard	IEC/EN 62477-1
Construction / method standard	Menu, measurement screen, alarm history, parameter input-output check
For active harmonic filter	THDi, THDv, current, voltage, power factor, active/reactive power, device status, alarm and temperature screens are checked.

12 Communication test - RS485 / Modbus

Main standard	IEC/EN 62477-1; Modbus manufacturer document for protocol
Construction / method standard	Address, baud rate, parity, register read-write test
For active harmonic filter	If Modbus RTU is available, RS485 A/B polarity, address and communication stability are checked.

13 Communication test - Ethernet / Modbus TCP, if available

Main standard	IEC/EN 62477-1; customer specification for system network
Construction / method standard	IP address, port, register access, remote monitoring test
For active harmonic filter	Ethernet connection, IP setting, web interface or SCADA register readings are checked.

14 Harmonic detection test

Main standard	IEC 61000-4-7; IEC 61000-4-30
Construction / method standard	Verification of 2nd-50th harmonic measurement with a harmonic-producing load or test signal
For active harmonic filter	It is verified that the device detects the harmonic spectrum correctly. The measuring instrument should comply with IEC 61000-4-7; power quality parameters should be reported with the IEC 61000-4-30 approach.

15 Compensation current injection function test

Main standard	IEC/EN 62477-1; IEC 61000-4-7 / 4-30 for performance
Construction / method standard	THDi and harmonic current comparison with device off/on under non-linear load
For active harmonic filter	It is observed that the active filter reduces harmonic current by injecting opposite-phase current. This is the main function test of the product.

16 Reactive power support function - if available

Main standard	IEC/EN 62477-1; IEC 61000-4-30 for power quality measurement
Construction / method standard	cos phi, Q, compensation mode and target power factor check
For active harmonic filter	If the device provides reactive power support, target cos phi, capacitive/inductive mode and limit values are verified.

17 Alarm and fault contacts test

Main standard	IEC/EN 62477-1; IEC/EN 61439-1
Construction / method standard	Digital output, relay contact, alarm simulation
For active harmonic filter	Contacts such as general fault, running, fan fault, overtemperature, overcurrent, low/high voltage are tested.

18 Overtemperature simulation

Main standard	IEC/EN 62477-1
Construction / method standard	Sensor simulation, temperature set value or software test mode
For active harmonic filter	Overtemperature alarm, derating, trip and fan speed control are verified.

19 Fan fault simulation

Main standard	IEC/EN 62477-1
Construction / method standard	Fan stop, tach signal interruption or alarm input simulation
For active harmonic filter	Alarm, output limiting or trip behavior is verified in case of fan fault.

20 Overload / current limiting check

Main standard	IEC/EN 62477-1
Construction / method standard	Limit check with test load or software simulation
For active harmonic filter	It is verified that the device provides safe limiting, alarm or trip when nominal compensation current is exceeded.

21 Parameter save check

Main standard	IEC/EN 62477-1
Construction / method standard	Preservation of parameters after power off/on
For active harmonic filter	CT ratio, operating mode, target cos phi, harmonic selection, alarm limits and communication settings should be preserved after power is restored.

22 Factory setting check

Main standard	IEC/EN 62477-1; customer specification
Construction / method standard	Parameter list, software version, serial number and default setting comparison
For active harmonic filter	Before shipment, it should be reported that the device leaves the factory with the correct software/firmware, correct power class and correct factory parameters.

23 Protection device check

Main standard	IEC/EN 61439-1; IEC/EN 62477-1
Construction / method standard	Fuse, MCB/MCCB, SPD, contactor, pre-charge circuit check
For active harmonic filter	Panel protection devices, selectivity and short-circuit withstand information should comply with the technical file.

24 Label and warning check

Main standard	IEC/EN 61439-1; IEC/EN 62477-1
Construction / method standard	Label, terminal marking, warning label and wiring diagram check
For active harmonic filter	Voltage, current, phase, frequency, compensation current, connection type, IP, serial number, CE, warnings and CT wiring diagram are checked.

2. Optional / Special Tests

1 THDi reduction performance test

Main standard	IEC 61000-4-7; IEC 61000-4-30
Construction / method standard	THDi comparison with AHF off/on under non-linear load
When is it recommended?	This is the test that best demonstrates the product sales claim. Initial THDi, THDi after filtering, load level, dominant harmonics and device compensation current should be written in the test report.

2 2nd-50th harmonic suppression verification

Main standard	IEC 61000-4-7
Construction / method standard	Harmonic spectrum measurement; individual harmonic percentages and RMS values
When is it recommended?	If the page claims 2nd-50th harmonic suppression, at least selected harmonics or the full spectrum can be shown in the report.

3 Reactive power compensation test

Main standard	IEC 61000-4-30
Construction / method standard	Measurement with target cos phi or Q set value
When is it recommended?	If the device performs both harmonic and reactive power compensation, this should be a separate report line from harmonic reduction.

4 Dynamic load change response time test

Main standard	IEC/EN 62477-1; IEC 61000-4-30 as supporting reference for measurement
Construction / method standard	Response time measurement with oscilloscope/power analyzer during sudden load change
When is it recommended?	Recommended for rapidly changing loads such as welding machines, elevators, cranes, presses and drive groups.

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 against fast switching pulses in industrial panel environments.

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 surface and user-accessible points
When is it recommended?	Important in applications where the operator interacts with the HMI/panel cover.

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 communication, CT cables 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 in dense industrial EMC environments.

10 Conducted emission test

Main standard	IEC 61000-6-4; CISPR 11/32 as supporting references according to product/panel specification
Construction / method standard	Conducted emission measurement at supply port
When is it recommended?	Since the active harmonic filter contains power electronics, the conducted emission it feeds back to the grid should be evaluated.

11 Radiated emission test

Main standard	IEC 61000-6-4; CISPR 11/32 as supporting references
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 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 continuous high compensation current, hot panel rooms, high-IP enclosures or fan-cooled designs.

13 Harmonic spectrum report

Main standard	IEC 61000-4-7; IEC 61000-4-30
Construction / method standard	THDi, THDv, individual harmonics and RMS values before/after AHF
When is it recommended?	A very strong document for commissioning or customer acceptance testing.

14 Site-specific simulation test

Main standard	IEC 61000-4-7 / 4-30; IEC/EN 62477-1
Construction / method standard	Laboratory simulation based on customer load profile, CT ratio, transformer power and harmonic analysis report
When is it recommended?	Recommended as a pre-shipment acceptance test for critical facilities when the load profile is known.

15 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.

16 Short-term overload test

Main standard	IEC/EN 62477-1; customer specification
Construction / method standard	Compensation current limit test at a specified duration and current level
When is it recommended?	The overload protection and derating behavior of the device are verified.

17 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.

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Thermal camera test

Main standard	IEC/EN 62477-1 thermal safety approach
Construction / method standard	IR thermography at nominal or high compensation current
When is it recommended?	Hot spots are searched for at IGBT modules, DC busbar, fan area, reactor/filter, fuse, contactor, terminal and busbar connections.

3. Lines Recommended to Add to the Test Report

Report line	Recommended content
Product type	Active harmonic filter
Rated values	Voltage, frequency, phase, compensation current, panel IP class
Main standard approach	IEC/EN 62477-1, IEC/EN 61439-1/2, IEC 61000-4-7, IEC 61000-4-30, IEC 61000-6-2/6-4
Earth 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
HMI / communication	HMI function, RS485/Modbus/Ethernet test result
Harmonic detection	Detected THDi, THDv, individual harmonics
Compensation function	Injected current, device mode, target harmonics
THDi performance	THDi before / after filtering and load level
Reactive power support	If available, target cos phi, measured cos phi, Q value
Protection functions	Fan fault, overtemperature, overload, low/high voltage alarm
Parameters	Firmware, factory settings, CT ratio, communication settings
EMC tests	EFT/burst, surge, ESD, conducted/radiated emission, immunity
Thermal tests	Thermal equilibrium, fan test, thermal camera result