

# B4. Sine filters - routine tests

## Standard Approach

Because sine filters are not standalone "transformers" but are often drive output filters consisting of reactor + capacitor + connection/protection elements, the main framework should be established as follows:

Reactor section: IEC/EN 60076-6 - Reactors. This standard covers series reactors, filter/tuning reactors, smoothing reactors and similar reactor types.

Small LV reactor safety: IEC/EN 61558-1 and, where applicable, IEC/EN 61558-2-20.

System verification together with the drive: IEC 61800-3 is used for EMC requirements and test methods; IEC 61800-5-1 is used for electrical, thermal, fire, mechanical and energy safety requirements in drive systems.

Harmonic / THD / power quality measurements: IEC 61000-4-7 is used for harmonic and interharmonic measurement; IEC 61000-4-30 is used for power quality measurement methods.

## 1. Routine Tests

1

### Reactor winding resistance

<b>Main standard</b>	IEC/EN 60076-6; IEC/EN 61558-1 / 61558-2-20 for small LV reactors
<b>Construction / method standard</b>	DC resistance measurement; manufacturer routine test procedure
<b>Description for sine filter</b>	Each phase winding is measured separately. The resistance difference between phases is evaluated in terms of incorrect winding, contact resistance, loose connection or conductor cross-section difference.

2

### Inductance measurement

<b>Main standard</b>	IEC/EN 60076-6
<b>Construction / method standard</b>	Measurement with an LCR meter, AC test setup or power analyzer
<b>Description for sine filter</b>	This is the basic parameter of the sine filter. The inductance value, together with the capacitor group, determines the cut-off frequency and PWM suppression performance.

3

### Phase-based inductance balance

<b>Main standard</b>	IEC/EN 60076-6
<b>Construction / method standard</b>	L1-L2-L3 measurement under the same frequency and test condition
<b>Description for sine filter</b>	In a three-phase sine filter, phase inductances must be balanced. Phase difference may cause imbalance in motor phase voltages and additional heating.

4

### Capacitance measurement if a capacitor group exists

<b>Main standard</b>	IEC 60831-1 for the capacitor; IEC 61800-3 auxiliary for the system filter
<b>Construction / method standard</b>	Capacitance meter or suitable AC measurement method
<b>Description for sine filter</b>	The cut-off frequency of the LC filter is directly dependent on the capacitor value. The capacitance value and tolerance of each phase must be reported separately.

5

**Capacitor phase balance**

<b>Main standard</b>	IEC 60831-1; customer specification
<b>Construction / method standard</b>	Comparison of the capacitance of each phase
<b>Description for sine filter</b>	C difference between phases may disturb the output waveform and phase voltage balance. It is especially important in three-phase motor supply.

6

**LC connection verification**

<b>Main standard</b>	IEC/EN 60076-6; IEC 61800-5-1 system safety approach
<b>Construction / method standard</b>	Connection diagram, continuity, terminal and component direction check
<b>Description for sine filter</b>	It is checked that reactors and capacitors are connected to the correct phase and in the correct sequence. Incorrect LC connection may create resonance, overcurrent or drive failure risk.

7

**Cut-off frequency / design frequency verification**

<b>Main standard</b>	IEC/EN 60076-6; IEC 61800-3 auxiliary
<b>Construction / method standard</b>	Calculation based on measured L and C; frequency response test if required
<b>Description for sine filter</b>	In a sine filter, measuring only L and C is not enough; the cut-off/design frequency calculated from these values must also be written in the report. The cut-off frequency must be selected compatibly with the drive switching frequency.

8

**Resonance risk check**

<b>Main standard</b>	IEC/EN 60076-6; IEC 61800-3 on the system side
<b>Construction / method standard</b>	LC calculation check, drive switching frequency and motor cable length evaluation
<b>Description for sine filter</b>	The OMSAN technical document states that resonance risk in LCL filters must be considered in the design.

9

**Insulation resistance**

<b>Main standard</b>	IEC/EN 60076-6; IEC/EN 61558-1 / 61558-2-20
<b>Construction / method standard</b>	Insulation resistance measurement; IEC 61557-2 as an auxiliary reference in practical measurement
<b>Description for sine filter</b>	Winding-to-frame, phase-to-phase and capacitor circuit-to-frame insulation are measured according to the design. Since there is high dv/dt at the PWM output, insulation quality must be critical.

10

**Dielectric withstand / hipot**

<b>Main standard</b>	IEC/EN 60076-6; IEC/EN 61558-1; IEC 61800-5-1 auxiliary for the drive system
<b>Construction / method standard</b>	AC withstand test; test level according to product voltage and customer specification
<b>Description for sine filter</b>	The main insulation of reactor winding-to-frame, phase-to-phase and capacitor circuit-to-frame is verified.

<b>11</b>	<b>Inter-layer winding insulation check</b>	
	<b>Main standard</b>	IEC/EN 60076-6; manufacturer procedure
	<b>Construction / method standard</b>	Surge winding test, induced voltage or special impulse check
	<b>Description for sine filter</b>	Since fast voltage edges exist at the drive output, inter-layer insulation must be evaluated more critically than in a classical 50 Hz application.
<b>12</b>	<b>Phase balance</b>	
	<b>Main standard</b>	IEC/EN 60076-6; IEC 61800-3 system approach
	<b>Construction / method standard</b>	Phase-based comparison of R, L, C and, if required, output voltage
	<b>Description for sine filter</b>	In a sine filter, phase balance must be checked not only with resistance but also together with L and C values.
<b>13</b>	<b>Loss measurement</b>	
	<b>Main standard</b>	IEC/EN 60076-6
	<b>Construction / method standard</b>	I <sup>2</sup> R calculation from DC resistance; total loss measurement under AC/PWM load
	<b>Description for sine filter</b>	Reactor copper loss, core loss and capacitor losses determine the thermal design. The OMSAN glossary describes total loss as the sum of copper, core and stray losses.
<b>14</b>	<b>Fan function test - if present</b>	
	<b>Main standard</b>	IEC/EN 60076-6; IEC 61800-5-1 system safety auxiliary
	<b>Construction / method standard</b>	Fan direction, supply, activation and alarm check
	<b>Description for sine filter</b>	In fan-cooled filters, airflow is critical for filter life and temperature rise.
<b>15</b>	<b>Thermal sensor / thermostat function test - if present</b>	
	<b>Main standard</b>	IEC/EN 60076-6; IEC/EN 61558-1
	<b>Construction / method standard</b>	PTC/PT100/thermostat continuity, resistance or contact test
	<b>Description for sine filter</b>	Sensor leads, alarm/trip contact and terminal numbers are checked.
<b>16</b>	<b>Terminal check</b>	
	<b>Main standard</b>	IEC/EN 60076-6; IEC 61800-5-1 auxiliary
	<b>Construction / method standard</b>	Terminal marking, torque, continuity and insulation distance check
	<b>Description for sine filter</b>	Drive input, motor output, PE, screen, fan and thermal leads must be clearly separated.

17

**Connection diagram check**

<b>Main standard</b>	IEC/EN 60076-6; IEC 61800-5-1
<b>Construction / method standard</b>	Cross-check of nameplate, connection diagram and production connection
<b>Description for sine filter</b>	The LC structure, phase sequence, PE connection, capacitor connection and, if present, discharge resistor must be compatible with the diagram.

18

**Frame-ground / PE continuity**

<b>Main standard</b>	IEC/EN 61558-1; IEC 60204-1 auxiliary in panel/machine application
<b>Construction / method standard</b>	Low-resistance continuity measurement
<b>Description for sine filter</b>	Continuity is checked between frame, cover, mounting foot, screen connection and PE terminal.

19

**Mechanical tightness and vibration visual check**

<b>Main standard</b>	IEC/EN 60076-6; IEC 60076-10 / IEC 60068-2-6 if numerical testing is required
<b>Construction / method standard</b>	Visual inspection, torque check, core/winding/capacitor fixing check
<b>Description for sine filter</b>	PWM-induced electromagnetic forces and harmonic components may create mechanical vibration. The OMSAN document lists winding symmetry, mechanical fixing, low contact resistance, noise and vibration control among the points to be considered in production.

20

**Nameplate check**

<b>Main standard</b>	IEC/EN 60076-6; IEC 61800-5-1 system approach
<b>Construction / method standard</b>	Cross-check of nameplate, technical datasheet and test report
<b>Description for sine filter</b>	Current, voltage, frequency, inductance, capacitance, cut-off frequency, drive switching frequency range, motor cable length, insulation class and connection information are checked.

**2. Optional / Special Tests**

1

**Waveform test with drive**

<b>Main standard</b>	IEC 61800-3; IEC 61800-5-1; IEC/EN 60076-6 for the reactor
<b>Construction / method standard</b>	Oscilloscope measurement with actual drive + filter + motor/equivalent load
<b>When is it recommended?</b>	This is the actual performance test of the sine filter. The output waveform is compared with/without reactor or with/without filter.

2

**Output voltage THD measurement**

<b>Main standard</b>	IEC 61000-4-7; IEC 61000-4-30
<b>Construction / method standard</b>	Measurement of THDv, harmonic components and RMS voltage at motor terminals with a power analyzer
<b>When is it recommended?</b>	Since the sine filter claims to bring the waveform closer to sinusoidal form, this is one of the strongest report lines. IEC 61000-4-7 gives the harmonic/interharmonic measurement instrument and method, and IEC 61000-4-30 gives power quality measurement methods.

3

**dv/dt measurement**

<b>Main standard</b>	IEC 61800-3; IEC 61800-5-1
<b>Construction / method standard</b>	Measurement at drive output and motor end with oscilloscope and suitable high-voltage/differential probe
<b>When is it recommended?</b>	It is very valuable for showing motor insulation stress. The OMSAN glossary states that dv/dt may be stressful for motor windings and cable insulation in PWM-output drives.

4

**Motor cable length simulation**

<b>Main standard</b>	IEC 61800-3; IEC 61800-5-1
<b>Construction / method standard</b>	Measurement of motor-end voltage peaks and waveform with a defined cable length or equivalent RLC model
<b>When is it recommended?</b>	In long motor cables, voltage reflection may create peak voltage; the OMSAN glossary states that this effect is important for motor insulation.

5

**EMC pre-compliance test**

<b>Main standard</b>	IEC 61800-3
<b>Construction / method standard</b>	Conducted emission, radiated emission, cabling/shielding and filtered-unfiltered comparison
<b>When is it recommended?</b>	A sine filter contributes to reducing EMI effects; however, it does not replace an EMI filter by itself. The OMSAN glossary states that reactors may indirectly contribute to reducing EMI levels, but do not replace an EMI filter on their own.

6

**Temperature rise test**

<b>Main standard</b>	IEC/EN 60076-6; IEC/EN 61558-2-20 for small LV reactors; IEC 61800-5-1 auxiliary in system
<b>Construction / method standard</b>	Steady-state temperature measurement at rated RMS current or real PWM load profile
<b>When is it recommended?</b>	Recommended in enclosed panels, high ambient temperature, long-term full load, high switching frequency or high RMS current.

7

**Sound level test**

<b>Main standard</b>	IEC/EN 60076-10
<b>Construction / method standard</b>	Sound pressure or sound intensity method
<b>When is it recommended?</b>	Recommended for indoor, hospital, office, HVAC, pump room and noise-sensitive applications.

8

**Thermal camera test**

<b>Main standard</b>	IEC/EN 60076-6 thermal performance approach
<b>Construction / method standard</b>	IR thermography at rated load or real drive operation
<b>When is it recommended?</b>	Hot spots are checked at reactor winding, capacitor group, terminals, busbars, fan region and frame connections.

<b>9</b>	<b>Magnetic linearity / saturation test</b>	
	<b>Main standard</b>	IEC/EN 60076-6
	<b>Construction / method standard</b>	Derivation of the L-I curve at different current points
	<b>When is it recommended?</b>	Recommended for iron-core filters if high RMS current or transient is expected. In saturation, inductance decreases and filtering performance deteriorates.

<b>10</b>	<b>Capacitor discharge check</b>	
	<b>Main standard</b>	IEC 61800-5-1; capacitor standard and customer specification
	<b>Construction / method standard</b>	Measurement of the time for capacitor voltage to fall to a safe level after power is disconnected
	<b>When is it recommended?</b>	Important for maintenance safety in sine filters containing capacitor groups.

<b>11</b>	<b>Drive-motor system function test</b>	
	<b>Main standard</b>	IEC 61800-3; IEC 61800-5-1
	<b>Construction / method standard</b>	Operation test with actual drive, target motor, cable and load condition
	<b>When is it recommended?</b>	If the customer drive, motor cable length and switching frequency are known, this is the most accurate performance verification.

<b>12</b>	<b>IP test - for enclosed products</b>	
	<b>Main standard</b>	IEC/EN 60529
	<b>Construction / method standard</b>	IEC 60529
	<b>When is it recommended?</b>	Applied if an enclosure declaration such as IP20, IP23, IP54 or IP55 exists for the enclosed sine filter.

<b>13</b>	<b>Vibration test</b>	
	<b>Main standard</b>	IEC 60068-2-6; customer specification in special application
	<b>Construction / method standard</b>	Sinusoidal vibration test
	<b>When is it recommended?</b>	Recommended for machine-mounted, pump/compressor, marine, railway or high-vibration facilities.

### 3. Lines Recommended to Be Added to the Test Report

Report line	Recommended content
Product type	Sine filter / drive output sine filter
Rated values	Voltage, current, frequency, number of phases
Drive compatibility	Drive voltage, switching frequency range, motor cable length limit
Reactor value	Phase-based winding resistance and inductance
Capacitor value	Phase-based capacitance and tolerance
LC verification	Connection diagram, phase sequence, series/parallel structure
Cut-off / design frequency	Frequency calculated from measured L-C values
Phase balance	R, L, C phase deviations
Insulation / hipot	Winding-to-frame, phase-to-phase, capacitor circuit-to-frame
Loss / temperature	Loss measurement, temperature rise result if available
Protection functions	Fan, thermal sensor, thermostat, capacitor discharge check
Performance test	THDv, dv/dt, motor-end peak voltage, waveform screenshot
EMC note	Pre-compliance or system evaluation according to IEC 61800-3
Nameplate check	Current, voltage, L, C, cut-off frequency, insulation class, connection, PE