

# D1. Servo regulators - single-phase / three-phase

## Standard Approach

For servo regulators, instead of a narrow IEC standard such as a standalone 'servo regulator standard', a standards matrix should be used according to the product structure: Panel/enclosure structure: IEC/EN 61439-1 and IEC/EN 61439-2 according to the applicable panel structure. IEC 61439-1 covers general definitions, service conditions, structural requirements, technical characteristics and verification rules for low-voltage switchgear and controlgear assemblies. Integrated use in machine/OEM panels: IEC/EN 60204-1 may be used as a supporting reference; this standard covers general requirements for electrical equipment and systems of machines. EMC immunity/emission: In industrial environments, IEC 61000-6-2 may be used for immunity and IEC 61000-6-4 for emission. Voltage dips, short interruptions and voltage variations: IEC 61000-4-11 defines immunity test methods for voltage dips, short interruptions and voltage variations in equipment connected to low-voltage supply networks. If an enclosure/IP declaration exists: IEC 60529 is used; this standard classifies the degrees of protection provided by enclosures against dust/liquid ingress and access to hazardous parts by means of the IP code.

## Routine tests

### 1. Routine Tests

Visual and mechanical inspection		
1	Main standard	IEC/EN 61439-1; IEC/EN 60204-1 as supporting reference
	Construction / method standard	Visual inspection, assembly check, cable routing, torque and label check
	For servo regulator	Panel, variac, servo motor, control board, contactor/relay, fuse/circuit breaker, terminal, fan, indicator and wiring are checked.

  

Variac mechanical inspection - brush surface		
2	Main standard	IEC/EN 61439-1; manufacturer procedure
	Construction / method standard	Visual inspection, contact surface, spring pressure and trace check
	For servo regulator	There should be no burn marks, excessive wear, contamination or contact defect on the brush surface. It directly affects output stability in a servo regulator.

  

Variac travel path check		
3	Main standard	IEC/EN 61439-1; manufacturer procedure
	Construction / method standard	Manual/automatic movement check
	For servo regulator	The brush/variatic arm should move from minimum to maximum without sticking. Friction, jamming and play should be checked.

<b>4</b>	<b>Limit switch check</b>	
	Main standard	IEC/EN 60204-1; IEC/EN 61439-1
	Construction / method standard	Limit switch function test
	For servo regulator	The variac should stop at the lower/upper mechanical limit. If the limit switch does not operate, the motor may force the variac and mechanical damage may occur.
<b>5</b>	<b>Mechanical oscillation / backlash check</b>	
	Main standard	IEC/EN 61439-1; manufacturer procedure
	Construction / method standard	Observation during movement, backlash and vibration check
	For servo regulator	If there is oscillation, backlash or excessive vibration during servo movement, regulation instability may occur.
<b>6</b>	<b>Servo motor direction and movement test</b>	
	Main standard	IEC/EN 60204-1; IEC/EN 61439-1
	Construction / method standard	Motor direction check under low/high input scenarios
	For servo regulator	It is verified that the motor moves in the boost direction when the input is low and in the buck direction when the input is high. It is tested separately according to single-phase/three-phase control logic.
<b>7</b>	<b>Control board supply test</b>	
	Main standard	IEC/EN 61439-1; IEC/EN 60204-1
	Construction / method standard	Auxiliary supply, board voltages, fuse and relay check
	For servo regulator	Control board AC/DC supply voltage, sensor inputs, relay outputs and on-board indicators are checked.
<b>8</b>	<b>Input voltage range test - minimum input</b>	
	Main standard	IEC/EN 61439-1; IEC 61000-4-11 as supporting reference
	Construction / method standard	Minimum input voltage is applied with an adjustable source/variatic
	For servo regulator	At the catalog minimum input, the regulator should be able to bring the output to the target value or the limit/protection behavior should operate correctly.
<b>9</b>	<b>Input voltage range test - nominal input</b>	
	Main standard	IEC/EN 61439-1
	Construction / method standard	Operating test at nominal mains voltage
	For servo regulator	For single-phase products, the 220/230 V output target is generally verified; for three-phase products, the 380/400 V target is verified.

<b>10</b>	<b>Input voltage range test - maximum input</b>	
	Main standard	IEC/EN 61439-1; IEC 61000-4-11 as supporting reference
	Construction / method standard	Maximum input voltage is applied
	For servo regulator	The regulator output should remain within tolerance or the overvoltage protection should operate correctly.
<b>11</b>	<b>Output regulation test - single-phase</b>	
	Main standard	IEC/EN 61439-1; manufacturer specification
	Construction / method standard	Output measurement at minimum/nominal/maximum input
	For servo regulator	In a single-phase product, the target is verified as 220/230 V. The acceptance tolerance should be given according to the product document.
<b>12</b>	<b>Output regulation test - three-phase</b>	
	Main standard	IEC/EN 61439-1; manufacturer specification
	Construction / method standard	L-L and, if available, L-N output measurement
	For servo regulator	In a three-phase product, the 380/400 V target is checked for phase-to-phase and, if available, phase-to-neutral outputs.
<b>13</b>	<b>Regulation tolerance check</b>	
	Main standard	IEC/EN 61439-1; customer/product document
	Construction / method standard	Comparison of measured output with catalog tolerance
	For servo regulator	For example, +/-1%, +/-2% or the tolerance given in the product data sheet should be clearly written in the report.
<b>14</b>	<b>Regulation speed / response test</b>	
	Main standard	IEC/EN 61439-1; IEC 61000-4-11 as supporting reference
	Construction / method standard	The time for the output to reach the target is measured by applying an input voltage step
	For servo regulator	OMSAN quality documentation specifically lists regulation speed tests for regulators. Input step, initial/final output voltage and recovery time should be reported.
<b>15</b>	<b>Phase-independent regulation test - three-phase</b>	
	Main standard	IEC/EN 61439-1
	Construction / method standard	Output measurement by applying different input conditions or unbalanced load to each phase
	For servo regulator	If the three-phase servo regulator has a phase-independent structure, it should be verified that each phase regulates separately. This feature should not be declared for common-regulation types.

<b>16</b>	<b>Phase sequence check</b>	
	Main standard	IEC/EN 61439-1; IEC/EN 60204-1 as supporting reference
	Construction / method standard	Check with phase sequence relay or phase sequence meter
	For servo regulator	L1-L2-L3 input and output sequence is verified. It is critical for motor and machine supplies.
<b>17</b>	<b>Phase loss / phase protection test</b>	
	Main standard	IEC/EN 61439-1; IEC/EN 60204-1 as supporting reference
	Construction / method standard	Protection behavior is observed by interrupting one phase
	For servo regulator	In the event of phase loss, alarm, output cut-off, contactor drop-out or protection function is verified according to the product design.
<b>18</b>	<b>Undervoltage protection test</b>	
	Main standard	IEC/EN 61439-1; IEC 61000-4-11 as supporting reference
	Construction / method standard	Input/output voltage is reduced below the threshold
	For servo regulator	Undervoltage alarm, output cut-off or delayed restart function is checked.
<b>19</b>	<b>Overvoltage protection test</b>	
	Main standard	IEC/EN 61439-1; IEC 61000-4-11 as supporting reference
	Construction / method standard	Input/output voltage is increased above the threshold
	For servo regulator	At overvoltage, output cut-off, alarm and restart behavior are verified.
<b>20</b>	<b>Overcurrent protection test</b>	
	Main standard	IEC/EN 61439-1; IEC/EN 60204-1 as supporting reference
	Construction / method standard	Current threshold check with adjustable load or simulation
	For servo regulator	Circuit breaker, fuse, electronic protection or alarm function is verified at overcurrent. A safe test method should be preferred without applying an actual short circuit.
<b>21</b>	<b>Short-circuit protection function check</b>	
	Main standard	IEC/EN 61439-1; IEC/EN 60204-1
	Construction / method standard	Protection device selection, simulation or low-energy controlled test
	For servo regulator	Since short-circuit tests are high risk, routine testing generally includes function/simulation and verification of the protection device.

<b>22</b>	<b>Bypass function test - if available</b>	
	Main standard	IEC/EN 61439-1; IEC/EN 60204-1
	Construction / method standard	Manual/automatic bypass transfer test
	For servo regulator	It is verified that the regulator is taken out of service and the mains is bypassed to the load. During bypass, phase sequence, output continuity and interlock should be checked.
<b>23</b>	<b>Input-output measuring instruments / display verification</b>	
	Main standard	IEC/EN 61439-1
	Construction / method standard	Comparison with reference multimeter/power analyzer
	For servo regulator	Panel voltmeter, ammeter, display and control board measurements are compared with the reference instrument.
<b>24</b>	<b>Insulation resistance</b>	
	Main standard	IEC/EN 61439-1; IEC/EN 60204-1 as supporting reference
	Construction / method standard	Insulation resistance measurement; IEC 61557-2 as practical measurement reference
	For servo regulator	Power circuit-enclosure, input-output circuit-enclosure and control circuit-enclosure are measured. The manufacturer procedure should be followed so that electronic boards are not damaged.
<b>25</b>	<b>Dielectric withstand / hipot</b>	
	Main standard	IEC/EN 61439-1; IEC/EN 60204-1 as supporting reference
	Construction / method standard	AC withstand test; separation of electronic equipment according to manufacturer procedure
	For servo regulator	The main insulation between the power circuit and enclosure is verified. Control board, display, measuring circuit and electronic components should not be directly exposed to high test voltage.
<b>26</b>	<b>PE continuity</b>	
	Main standard	IEC/EN 61439-1; IEC/EN 60204-1
	Construction / method standard	Low-resistance continuity measurement
	For servo regulator	Continuity is checked between the enclosure, door, mounting plate, variac chassis, fan body, door grounding braid and PE busbar.
<b>27</b>	<b>Fan function test</b>	
	Main standard	IEC/EN 61439-1
	Construction / method standard	Fan direction, air flow, thermostat or control board activation test
	For servo regulator	In fan-cooled products, air flow, filter clogging and fan alarm, if available, are checked.

<b>28</b>	<b>Thermal protection test</b>	
	Main standard	IEC/EN 61439-1; IEC/EN 60204-1 as supporting reference
	Construction / method standard	Thermostat/PTC/PT100 contact or resistance check
	For servo regulator	If there is a temperature sensor in the variac, transformer, power element or panel interior, the alarm/trip function is verified.

<b>29</b>	<b>Operation under load test</b>	
	Main standard	IEC/EN 61439-1; customer specification
	Construction / method standard	Loading at a specified percentage of nominal load
	For servo regulator	Output stability, current, sound, servo movement and temperature are observed at least at a specified load percentage. For high powers, a staged load test may be applied depending on factory infrastructure.

<b>30</b>	<b>Sound, vibration and heating observation</b>	
	Main standard	IEC/EN 61439-1; IEC 60076-10 for sound and IEC 60068-2-6 for vibration as supporting references
	Construction / method standard	Listening/observation under load; numerical measurement if required
	For servo regulator	Variac brush noise, servo motor vibration, fan noise, transformer hum and connection heating are checked. IEC 60068-2-6 is used to evaluate the mechanical strength of equipment under sinusoidal vibration.

<b>31</b>	<b>Label check</b>	
	Main standard	IEC/EN 61439-1
	Construction / method standard	Cross-check of label, technical data sheet and test report
	For servo regulator	Input range, output voltage, power/kVA, current, phase, frequency, tolerance, regulation speed, IP, serial number and CE are checked.

<b>32</b>	<b>User manual and wiring diagram check</b>	
	Main standard	IEC/EN 61439-1; IEC/EN 60204-1 as supporting reference
	Construction / method standard	Document, terminal marking, warning and wiring diagram check
	For servo regulator	Input/output, neutral, PE, bypass, alarm contact, fan/thermal connections and phase sequence should be clearly provided.

## 2. Optional / Special Tests

<b>1</b>	<b>Full load test</b>	
	Main standard	IEC/EN 61439-1; customer specification
	Construction / method standard	Output voltage, current, temperature and regulation check at nominal load
	When is it recommended?	Recommended for high power, critical loads, export or customer acceptance testing.

<b>2</b>	<b>Long-term burn-in test</b>	
	Main standard	IEC/EN 61439-1; customer specification
	Construction / method standard	Hourly operation at specified load; monitoring voltage, temperature, fan and servo behavior
	When is it recommended?	Useful for observing the reliability of the electronic board, servo mechanism and fan-cooling.
<b>3</b>	<b>Temperature rise test</b>	
	Main standard	IEC/EN 61439-1; IEC/EN 60204-1 as supporting reference
	Construction / method standard	Steady-state temperature measurement at nominal or specified load
	When is it recommended?	Recommended for enclosed cabinets, high ambient temperature, continuous full load and high-kVA regulators.
<b>4</b>	<b>Sudden voltage change response test</b>	
	Main standard	IEC 61000-4-11; IEC/EN 61439-1
	Construction / method standard	The recovery time of the output is measured by suddenly decreasing/increasing the input voltage
	When is it recommended?	Shows the real performance of the servo regulator. Input step, output deviation and recovery time should be reported.
<b>5</b>	<b>Unbalanced load test - three-phase</b>	
	Main standard	IEC/EN 61439-1
	Construction / method standard	Phase output voltages are measured by applying different loads to the phases
	When is it recommended?	Especially recommended if phase-independent regulation is claimed in three-phase regulators.
<b>6</b>	<b>Harmonic distortion test</b>	
	Main standard	IEC 61000-4-7; IEC 61000-4-30
	Construction / method standard	Input/output THDv and, if necessary, THDi measurement
	When is it recommended?	Recommended for UPS, CNC, medical device, sensitive electronics or non-linear loads.
<b>7</b>	<b>Short-term overload test</b>	
	Main standard	IEC/EN 61439-1; customer specification
	Construction / method standard	Loading with specified current and duration; protection and temperature monitoring
	When is it recommended?	Recommended for motors, compressors, CNC or loads drawing high starting current.
<b>8</b>	<b>Sound level test</b>	
	Main standard	IEC 60076-10 as supporting reference
	Construction / method standard	Sound pressure or sound intensity measurement
	When is it recommended?	Recommended for hospitals, offices, laboratories, indoor areas and quiet technical rooms.

<b>9</b>	<b>Thermal camera test</b>	
	Main standard	IEC/EN 61439-1 thermal verification approach
	Construction / method standard	IR thermography under load
	When is it recommended?	Hot spots are searched for at the variac brush surface, busbars, terminals, switch, contactor, transformer, servo motor and fan area.
<b>10</b>	<b>Operation test with generator supply</b>	
	Main standard	IEC/EN 61439-1; IEC 61000-4-30 as supporting reference
	Construction / method standard	Operation under frequency/voltage fluctuation with generator or generator simulator
	When is it recommended?	Recommended for construction sites, industrial plants or generator-backed systems.
<b>11</b>	<b>Sensitive load simulation such as UPS / CNC / medical device</b>	
	Main standard	IEC/EN 61439-1; IEC 61000-4-30 for power quality measurement
	Construction / method standard	Voltage stability, transition, harmonic and protection behavior check with real or equivalent load
	When is it recommended?	Recommended because output fluctuation, regulation speed and protection thresholds are critical for sensitive loads.
<b>12</b>	<b>EMC immunity test</b>	
	Main standard	IEC 61000-6-2; IEC 61000-4-2, -4, -5, -6, -11 for special tests
	Construction / method standard	ESD, EFT/burst, surge, RF immunity and voltage dip tests
	When is it recommended?	Can be applied for CE/EMC file or customer specification in regulators containing electronic control board and display. IEC 61000-4-5 defines surge immunity tests against transient overvoltages caused by switching and lightning.
<b>13</b>	<b>EMC emission test</b>	
	Main standard	IEC 61000-6-4; CISPR 11 / CISPR 32 as supporting references if required
	Construction / method standard	Conducted/radiated emission measurement
	When is it recommended?	May be evaluated for industrial EMC conformity due to servo motor, control board, relay/contactor and electronic display.
<b>14</b>	<b>IP test - enclosed products</b>	
	Main standard	IEC 60529
	Construction / method standard	Dust/water and access protection test according to IP code
	When is it recommended?	Applied if an enclosure declaration such as IP20, IP21, IP31, IP54 exists.

### 3. Lines Recommended to Add to the Test Report

Report line	Recommended content
Product type	Single-phase / three-phase servo regulator
Rated values	kVA, input voltage range, output voltage, frequency, current

Report line	Recommended content
Regulation accuracy	Output voltage and tolerance at min/nominal/max input
Regulation speed	Input step, output deviation, recovery time
Variac check	Brush surface, travel path, limit switch, mechanical oscillation
Servo motor test	Direction, movement, stop at limit, stable position
Protection functions	Phase loss, phase sequence, low/high voltage, overcurrent, short-circuit function check
Bypass	Manual/automatic bypass, interlock and output continuity
Display verification	Comparison of panel instruments with reference measuring device
Insulation / hipot	Power circuit-enclosure; electronic board protection note
PE continuity	Enclosure, door, mounting plate, variac chassis, PE busbar
Load test	Load percentage, output voltage, current, temperature and observation
Fan/thermal protection	Fan direction, air flow, thermostat/PTC/PT100 result
Label/document	Label, wiring diagram, user manual, warnings