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ISO/TC 188 / SC

Title

Small craft

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English title

Small craft — Electrical/electronic control system for steering, shift and throttle

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Introductory note

This draft has been prepared by WG 5 and is now submitted for formal adoption as an active work item for TC 188 as well as a Committee Draft for approval to be circulated for enquiry as DIS.

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Small craft — Electrical/electronic control system for steering, shift and throttle

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 25197 was prepared by Technical Committee ISO/TC 188, *Small crafts*.

Small craft — Electrical/electronic control system for steering, shift and throttle

1 Scope

This International Standard establishes the requirements for design, construction and testing of electrical/electronic steering, shift and throttle and dynamic position control systems on small craft of up to 24 m length of hull.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 8846:1990, *Small craft — Electrical devices — Protection against ignition of surrounding flammable gases.*

ISO 8848, *Small craft — Remote steering systems*

ISO 10133, *Small craft — Electrical systems — Extra-low-voltage-dc. installations*

ISO 10592:1994, *Small craft — Hydraulic steering systems*

ISO 13297, *Small craft— Electrical Systems — Alternating current installations*

ISO 16750-2:2006 *Road vehicles — Environmental conditions and testing for electrical and electronic equipment — Part 2: Electrical loads*

ISO 16750-3:2006 *Road vehicles — Environmental conditions and testing for electrical and electronic equipment — Part 3: Mechanical loads*

ISO 16750-4:2006 *Road vehicles — Environmental conditions and testing for electrical and electronic equipment — Part 4: Climatic loads*

IEC 60533:1999*, Electrical and electronic installations in ships – electromagnetic compatibility*

IEC 61000-4-5, *Electromagnetic compatibility (EMC) - Part 4-5: Testing and measurement techniques - Surge immunity test*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
electric/electronic steering system
all components including CPU (Control processing Unit) and cable harnesses from the manual steering input device up to and including the device (actuator or electrical motor) regulating the rudder or propulsion unit angle

NOTE It includes joystick and components i.e. GPS antennas for dynamic positioning if installed.

3.2
ignition-protected equipment
electrical equipment designed and tested for use in explosive atmosphere without igniting surrounding flammable gases

3.3
accessible
capable of being reached for inspection, removal or maintenance without removal of permanent structure of the craft

3.4
readily accessible
capable of being reached without the use of tools

3.5
system voltage
voltage supplied to the distribution panel board (switchboard) from the power source

3.6
nominal voltage(s)
those commonly used voltages such as 12, 24, or 36 volts DC

3.7
manoeuvring speed
craft speed below 10 knots

3.8
cruising speed
craft speed at 10 knots or above

3.9
axis X
direction of a craft fore or aft; longitudinally

3.10
axis Y
direction of a craft port or starboard; transversely

3.11
axis Z
axis normal to the X-Y plane

3.12
dynamic positioning system
a computer controlled system to automatically maintain a craft's position and heading by using her own propellers with or without the assistance of bow or stern thrusters

3.13
control lever
a user input device for the control of thrust and propulsion.

3.14
steering helm
a user input device for the control of steering.

3.15
joystick
a user input device the simultaneous control of thrust, steering and propulsion.

3.16
helm station
A location from which steering, propulsion or thrust can be achieved.

3.17
multiple helm station(s)
more than one location in the boat from which steering, propulsion or thrust may be achieved

3.18
command station
the helm station location that is in active control

3.19
portable steering helm
a steering helm, not permanently affixed to the craft's structure

3.20
propulsion
the component or components of thrust that permit a craft's movement in any direction.

NOTE Examples of propulsion generating devices include outboards, stern drives, pod drives, jet drives, inboards and thrusters

3.21
radio frequency (RF)
the range of electromagnetic waves with a frequency or wavelength suitable for utilization in radio communication

3.22
actuator
an electro-mechanical, electro-pneumatic, and/or electro-hydraulic device that converts an electrical signal into a mechanical displacement

3.23
thrust
propulsive force from craft's main propulsion system or bow or stern thrusters or a combination thereof in order to move or rotate the craft

3.24
wireless
a means of communication, monitoring and/or control through the use of electromagnetic, acoustical or optical transmission through atmospheric space

3.25
damp area
An area where moisture is either permanently present or intermittent present e.g. bilge, head, galley

3.26
wet area
an area exposed to weather

3.27
EUT
equipment under test

3.28
performance criteria
the functional status of an EUT during and after test

4 General requirements

4.1 All electronic/electrical components shall be designed to withstand a reverse connection of voltage to the power leads (+ volts to ground and ground to + volts). This shall not render the component inoperable when subsequently connected to the power correctly.

4.2 All electronic/electrical components shall be designed with reverse polarity protection from internal surges.

4.3 D.C. systems shall comply with ISO 10133.

4.4 A.C. systems shall comply with ISO 13297.

4.5 The system shall be energized whenever the propulsion engine(s) are running.

4.6 The system shall be fully operational within one second after being turned on (powered)

4.7 A single engine installed steering system shall have built in redundancy accomplished by electronic/electric or mechanical means.

4.8 Multi installed engine steering systems shall be redundant by means of independency (fuel, mechanical, electrical) from each other.

4.9 Each helm station shall have visual indication when active.

4.10 Each helm station shall by visible and audible means alert the operator when system enters fail safe mode.

4.11 The sound pressure of an audible alarm 1 meter from the command station shall be at least 75 dB (A) but not greater than 85 dB (A), systems incorporating a mute feature must maintain the visual alert as long as the failure is present.

4.12 Instructions for proper installation and use of the steering system shall be made available by the manufacturer.

4.13 Operational characteristics, instructions and warnings for proper use shall be described in the owner's manual and/or in on-product labelling.

4.14 During normal operation, engine(s) shall only start in neutral.

4.15 The steering and shift and throttle actuator shall react on a physical input command within 0, 5 seconds.

4.16 Steering Wheels, larger than 20 cm diameter, shall comply with the requirements of ISO 8848.

4.17 Hydraulic systems shall comply with the requirements of ISO 10592.

4.18 Electrical components intended to be installed in petrol engine or petrol tank compartments shall be ignition-protected in accordance with ISO 8846.

5 Control head

5.1 Cruising or maneuvering mode shall be indicated. Transition from maneuvering mode and cruising mode shall only be accomplished by an input from the operator and shall not change modes without additional operator input.

5.2 Control head operation can be available for both cruising speed and maneuvering mode operation.

5.3 Control head position shall return neutral X, Y and Z axis, when operator releases his/her grip. See Figure 1.

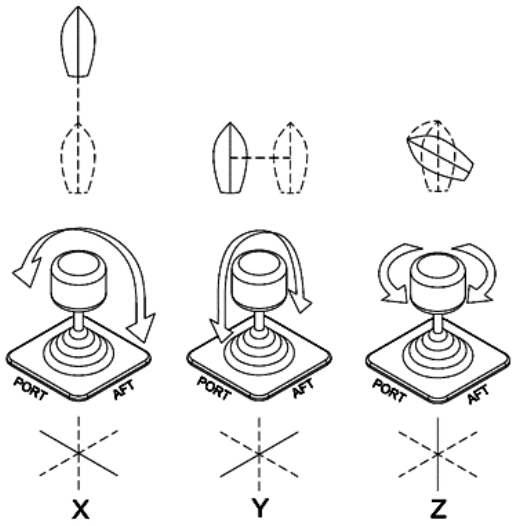

Figure 1 — X, Y & X commands

5.4 For operation other than maneuvering, control head engine throttle control need not return to a low RPM or idle state when released.

5.5 Releasing control head in maneuvering mode to neutral position shall result in disengaged transmission and idling engine(s).

5.6 The craft shall move in the same direction as the orientation of the control head relative to the craft.

5.7 If the control head includes a rotation function, the control head activation clockwise shall result in rotating the craft clockwise. Control head activation counter clockwise shall rotate the craft counter clockwise.

6 Command station transfer

6.1 Transfer of command from one station to another shall be completed at the helm station intended to be active.

7 Wireless helm stations

7.1 Wireless helm stations shall have restrictions for use only during manoeuvring speed.

7.2 Loss of radio contact or malfunction of the wireless helm station system shall result in disengaged transmission and idling engine(s). The operator shall be notified of the loss of communications and the system shall not prevent transfer to another helm station.

7.3 A warning label shall be posted at the helm station and in the owner's manual to advise operator of the following hazards.

— keep proper lookout;

— hold on to prevent falling, boat may move suddenly;

— read owner's manual for safe use of the system.

7.4 The wireless device shall be designed to operate only while on board the craft.

7.5 The wireless device shall only control the boat of origin.

7.6 The wireless device shall have indication of the electrical charge status. The device shall prevent activation when the charge is insufficient to maintain a reliable connection for 15 minutes.

7.7 The wireless device shall notify the operator when the device is 15 minutes from insufficient charge deactivation.

7.8 Wireless systems shall meet the requirements of relevant radio and telecommunications legislation.

8 Dynamic positioning system

8.1 The dynamic positioning system shall only be possible to activate manually.

8.2 Crafts equipped with dynamic positioning system shall have a display screen at the main helm station for visual indication of warnings according to 8.3 and the GPS precision value.

8.3 The following warnings shall be displayed at engine start up:

— boat is considered under way;

— keep proper lookout;

— stay out of water, propellers are spinning;

— hold on to prevent falling, boat may move suddenly;

— read owner's manual for safe use of the system.

8.4 Activating shall only be possible after acknowledgement of warnings displayed.

8.5 Activating shall only be possible if the GPS precision value is within factory set limits.

8.6 If dynamic positioning (autonomous) mode is activated and the GPS precision value is out of factory set limits at any time, the control system shall alert the operator visually and audibly of such prior to disengagement of the feature.

8.7 Maximum allowable envelope/radius and heading deviation shall be factory set, not adjustable by the operator.

8.8 Maximum engine speed for dynamic positioning shall be factory set, not adjustable by the operator.

8.9 Helm stations not equipped with display screen shall be labelled with the same warnings as in 8.3.

9 Failure modes and responses

9.1 Loss of operation

9.1.1 In the event of a command station malfunction in a multiple command station system, the system shall:

— not prevent transfer to, or operation from, other command stations and

— alert the operator visually and audibly that the failed command station is not working.

9.1.2 In the event of loss of steering control affecting only one engine in a multi-engine installation, the system shall still be capable of steering the boat.

9.1.3 In the event of a command station failure, the operator shall be notified, and the system shall return to neutral.

NOTE System performance may be at a reduced level

9.2 Loss of Computer Command Logic

9.2.1 The system shall notify the operator of a command logic loss or malfunction in its computer command logic.

10 Test requirements

10.1 General test requirements

10.1.1 At least three consecutive samples of each electronic and electromechanical component, as sold, shall be tested to verify compliance with this standard.

10.2 Steering

10.2.1 The complete system (mechanical and electric/electronic components) shall be designed to withstand the load tests defined in this section. A new system may be used for each test. For clarification purposes, a cycle is defined to be the command from an input device sufficient to cause the steering system to move the output device(s) starting from hard over to opposite hard over and back to original starting position. A malfunction of any type constitutes a failure.

10.2.2 The steering helm shall comply with ISO 10592, Clause 9.4.

10.2.3 *Durability test* – The steering actuator shall withstand a 100,000 cycle load test when the output device(s) is subjected to a resistance load equal to the maximum load declared by the manufacturer. In all test cases, the system shall be configured as it is intended to be used in a boat application. The minimum cycle rate shall be six cycles per minute.

10.2.4 *High load test* – The steering actuator withstand a force equal to 2 times the force used in 10.2.3.

10.2.5 Conduct these tests at +77°C and 120% of nominal voltage.

10.2.6 Conduct these tests at -18°C and 120% of nominal voltage.

10.2.7 Following these tests the steering actuator shall continue to operate without failure within the original parameters specified by the manufacturer. Failure includes loose parts, cracks, wear outside of tolerance or impaired function.

10.3 Joystick

10.3.1 The joystick device shall be designed to withstand a 100,000 cyclic 80% of stroke test in each X, Y and Z direction. A malfunction of any type, electrical or mechanical, constitutes a failure.

10.3.2 The joystick when fully moved in the +X and –X direction to the point of its end stop, shall be capable of withstanding a force of 350N as applied tangentially to the arc of the throw. See Figure 2.

10.3.3 The joystick when fully moved in the +Y and –Y direction to the point of its end stop, shall be capable of withstanding a force of 350N as applied tangentially to the arc of the throw. See Figure 2.

10.3.4 The joystick when fully twisted in the +Z and –Z direction shall be capable of withstanding a torque of 1 Nm. See Figure 3.

10.3.5 Following these tests the system shall continue to operate without failure within the original parameters specified by the manufacturer. Failure includes loose parts, cracks, wear outside of tolerance or impaired function.

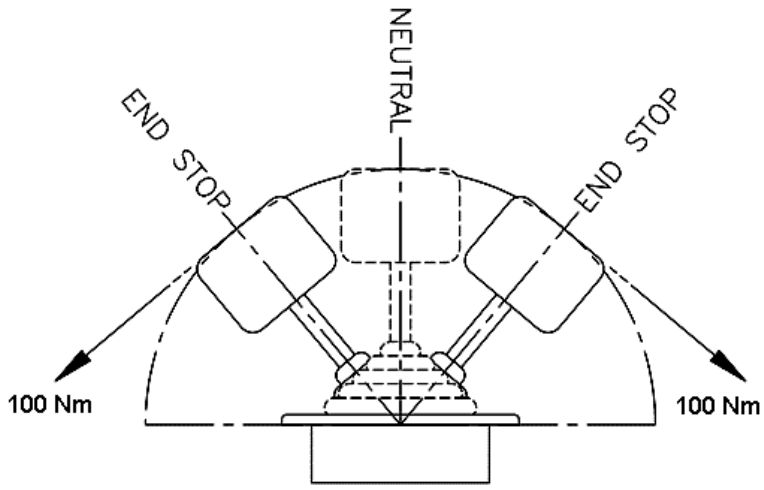

Figure 2 — Extreme Travel Test, X & Y Movements

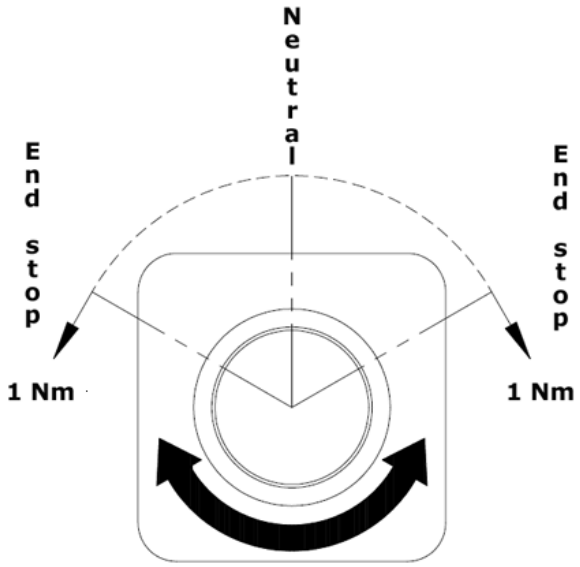

Figure 3 — Extreme Travel Test, Z Rotation

10.4 Control lever, single or combined, shift and throttle

10.4.1 The system shall be designed to withstand the load tests defined in this section. A new system may be used for each test. For clarification purposes, a cycle is defined to be the command from an input device sufficient to cause the propulsion control system to move the output device(s) as follows:

— neutral/idle to ahead/idle (full stroke of the shift output device to ahead), and

— ahead/idle to ahead/full RPM (full stroke of the throttle output device), and

— ahead/full RPM to ahead/idle, and

— ahead/idle to neutral/idle, and

— neutral/idle to astern/idle (full stroke of shift output device to astern), and

— astern/idle to astern/full RPM (full stroke of throttle output device), and

— astern/full RPM to astern/idle, and

— astern/idle to neutral/idle.

10.4.2 The system shall withstand a 75 000 cycle load test when subjected to the loads defined below. The shift output device shall actuate a minimum 111 N shift load each time it moves from neutral to the ahead or astern position. An increasing load of a minimum of 22 N at idle to a minimum of 111 N at full stroke shall be applied to the throttle output device.

10.4.3 Conduct this test at +77°C and 120% of nominal voltage.

10.4.4 Conduct this test at -18°C and 120% of nominal voltage.

10.4.5 The system shall withstand a 50 000 cycle load test when subjected to the following:

10.4.6 The shift output device shall be subjected to a load of a minimum of 67 N, from neutral to near full stroke, with an over stroke load of a minimum of 178 N applied to the shift device within the last 20% of the shift stroke, i.e., the shift load will change from a minimum of 67 N, at 80% of the full shift stroke to a minimum of 178 N at full stroke.

10.4.7 The load can either ramp up to a minimum of 178 N, or be applied as a step function. An increasing load of 22 N at idle to a minimum of 111 N at full stroke shall be applied to the throttle output device.

10.4.8 Conduct this test at +77°C and 120% of nominal voltage.

10.4.9 Conduct this test at -18°C and 120%of nominal voltage.

10.4.10 In all test cases, the system shall be configured as it is intended to be used in a boat application. The minimum cycle rate shall be 6 cycles per minute.

10.4.11 Following these tests the systems shall continue to operate without failure within the original parameters specified by the manufacturer. Failure includes loose parts, cracks, wear outside of tolerance or impaired function.

10.5 Environmental test requirements

10.5.1 Components shall be tested at a temperature based on their intended installation according to Table 1

Table 1 – Environmental tests vs. Location

Temps (+/- 2C)	Interior	Machinery	Damp	Wet
Salt Mist		See 10.6	See 10.6	See 10.6
Vibration Test	X	X	X	X
Damp Heat - Cyclic	30°C	50°C	50°C	50°C
Damp Heat – Steady state	30°C	50°C	50°C	50°C
High Temperature Storage	30°C	50°C	50°C	50°C
High Temperature Operation	70°C	70°C	70°C	70°C
Low Temperature Test - Operation	-15°C	-15°C	-25°C	-25°C
Low Temperature Test - Storage	-40°C	-40°C	-40°C	-40°C
IP Rating	54	55	56	67

10.6 Salt mist test

10.6.1 Insulation resistance test shall be carried out before and after, damp heat test, cold test and salt mist test.

10.6.2 The salt solution shall be prepared by dissolving the compounds listed below in distilled water and making up the volume of the solution to one litre. The quantities of the salts in the solution are to be within 10 percent of those shown in Table 2 below.

Table 2 – Salt Mist Solution

Sodium chloride	NaCl	26.5 grams
Magnesium chloride	MgCl2	2.4 grams
Magnesium sulphate	MgSo4	3.3 grams
Calcium chloride	CaCl2	1.1 grams
Potassium chloride	KCl	0.73 grams
Sodium bicarbonate	NaHCo3	0.20 grams
Sodium Bromide	NaBr	0.28 grams

10.6.3 The test chamber parameters are configured as follows:

a) Salt solution shall be sprayed into the atmosphere surrounding the EUT in the chamber in the form of a fine mist at approximately one per cent of the volume of the chamber per hour.

b) To avoid contamination, salt solution dripping from the walls and ceiling of the test chamber and from the EUT shall not be recycled for re-spraying.

10.6.4 Salt mist - Cyclic

a) The spraying shall continue for 2 hours, after which the EUT is to be maintained as follows:

   1) Temperature: 35°C ± 2°C.

   2) Relative humidity: 90% to 95%

   3) Duration: 7 days

   4) This procedure shall be repeated four times in succession, following which the test chamber temperature and humidity shall be reduced to ambient conditions.

b) On completion of Salt mist tests, the complete system shall be subjected to one cycle of performance test without delay, as described in 10.2, or 10.4, where applicable, to assure the system functions without failure, or impaired function within the original parameters specified by the manufacturer. The EUT shall be examined to ensure that any deterioration or corrosion is superficial in nature.

10.6.5 Salt mist - Continuous

a) The spraying shall continue for 300 hours.

b) On completion of Salt mist tests, the complete system shall be subjected to one cycle of performance test without delay, as described in 10.2, or 10.4, where applicable, to assure the system functions without failure, or impaired function within the original parameters specified by the manufacturer. The EUT shall be examined to ensure that any deterioration or corrosion is superficial in nature.

10.7 Damp heat - Cyclic

10.7.1 Test shall be carried out acc to ISO 16750-4:2006 with the following deviations:

a) Number of cycles shall be four (4);

b) On completion of the Damp heat test, the system shall be subjected to one cycle of performance test without delay, as described in 10.2 or 10.4, where applicable, to assure the system functions without failure, or impaired function within the original parameters specified by the manufacturer..

10.8 Damp heat – Steady State

10.8.1 Test shall be carried out according to ISO 16750-4.

10.8.2 On completion of the Damp heat test, the system shall be subjected to one cycle of performance test, as described in 10.2 or 10.4, where applicable, to assure the system functions without failure, or impaired function within the original parameters specified by the manufacturer..

10.9 High Temperature Test - Operation

10.9.1 Tests and performance criteria shall be according to ISO 16750-4.

10.9.2 The test chamber parameters are configured as follows:

— Temperature: Raised from the initial ambient temperature to temperature T_{max} indicated in Table 1

— Duration:48 hours.

10.9.3 On completion of the High Temperature test, the system shall be subjected to one cycle of performance test, as described in 10.2 or 10.4, where applicable, to assure the system functions without failure, or impaired function within the original parameters specified by the manufacturer.

10.10 High Temperature Test - Storage

10.10.1 Tests and performance criteria shall be according to ISO 16750-4.

10.10.2 On completion of the High Temperature test, the system shall be subjected to one cycle of performance test, as described in 10.2, 10.3 or 10.4, where applicable, to assure the system functions without failure, or impaired function within the original parameters specified by the manufacturer.

10.11 Low Temperature Test - Operation

10.11.1 The test procedure shall be carried out in accordance to ISO 16750-4 and the test chamber parameters are configured as follows:

— Temperature: Lowered from the initial ambient temperature to Table 1 and maintained within ± 2°C.

— Duration: 16 hours.

10.11.2 On completion of the Low Temperature test, the system shall be subjected to one cycle of performance test, as described in 10.2 or 10.4, where applicable, to assure the system functions without failure, or impaired function within the original parameters specified by the manufacturer.

10.12 Low Temperature Test - Storage

10.12.1 The test procedure shall be carried out in accordance to ISO 16750-4 and the test chamber parameters are configured as follows:

— Temperature: Lowered from the initial ambient temperature to Table 1 and maintained within ± 2°C

— Duration: 72 hours.

10.12.2 On completion of the Low Temperature test, the system shall be subjected to one cycle of performance test, as described in 10.2 or 10.4, where applicable, to assure the system functions without failure, or impaired function within the original parameters specified by the manufacturer.

10.13 Vibration tests and requirements

10.13.1 Equipment mounted on engines, reverse gears, or drives shall be tested in accordance to ISO 16750-3:2006, Clause 4.1.2.6.

NOTE: The same test profile shall be used for components mounted on reverse gears or drives not rigidly attached to the engine since the contribution of propeller induced vibrations are considered relatively high in comparison with engine induced vibrations.

The EUT must meet, as a minimum, performance criterion A

10.13.2 Equipment mounted or located in locations not covered in 10.13.1 shall be tested to a) or c) below. The EUT must meet, as a minimum, performance criterion A

NOTE: The same system must be used to complete all testing under 10.13.2. A system shall be subjected to one cycle as described in section 10.2.1 to ensure that the system functions prior to the test.

a) Random Vibration - The system shall be subjected to a random vibration, at 0.0284 g^2/Hz, from 20 Hz to 2000 Hz, applied along the three mutual perpendicular axes. Test duration shall be eight hours for each axis.

b) On completion of the Random vibration test, the system shall be subjected to one cycle, as described in 10.2, or 10.4, where applicable, to assure the system functions without failure, or impaired function within the original parameters specified by the manufacturer. .

c) Resonant Vibration - In order to identify the major resonant frequencies, major sub-assemblies shall be subjected to a swept sine vibration along the three mutually perpendicular axes from 20 Hz to 2000 Hz at 1g zero-peak amplitude with a sweep rate of one octave per minute. Once the resonant frequency for the individual major subassembly is known, it shall be vibrated for 10 million cycles or two hours, whichever is greater, at the maximum displacement frequency (resonant frequency) at a one (1)g zero-peak amplitude for each axis for off engine mounted units, and at four (4)g's zero-peak amplitude for each axis for engine mounted units.

d) On completion of the resonant vibration test, the system shall be subjected to one cycle, as described in 10.2 or 10.4, where applicable, to assure the system functions without failure, or impaired function within the original parameters specified by the manufacturer..

10.14 Shock testing

10.14.1 The system shall be shock tested with an acceleration of 1000 m/s^2 and duration 6 ms. Number of shocks shall be 3/direction (18 in total). Any system malfunction shall be considered as a failure.

10.15 Free fall

10.15.1 All components in the system, control unit, electrical actuators, transmitters, etc. shall withstand a freefall test from a height of 1 meter with impact on a concrete floor. By the use of 3 samples, all 6 directions shall be tested, see Figure 4. Any system malfunction shall be considered as a failure.

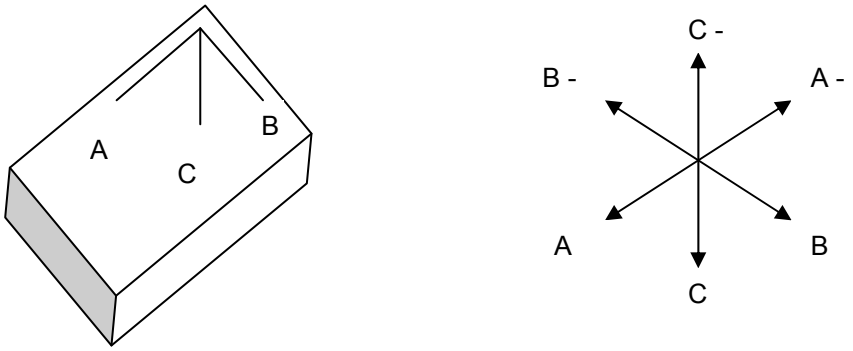

Figure 4 — Principal description of freefall directions

10.16 UV testing

10.16.1 If required, resistance to solar radiation shall be ensured by the choice of a suitable material Such testing to be followed by salt mist and reduced cycle mechanical testing]

10.17 Electromagnetic Compatibility (EMC)

10.17.1 Electromagnetic interference tests

10.17.1.1 Electronic equipment shall be subjected to the specified electromagnetic interference tests for:

— immunity to conducted low frequency interference;

— immunity to conducted high frequency interference;

— immunity to radiated radio frequency fields;

— immunity to fast, low energy transients - bursts (on power, control and signal lines);

— immunity to slow high energy transients (surges);

— immunity to electrostatic discharge (ESD);

— radiated emissions;

— compass safe distance.

10.17.2 EMC Performance Criteria

10.17.2.1 Test results shall be evaluated according to the Performance Criteria stated under each specific test.

Performance Criterion A: (For continuous phenomena): The EUT shall continue to operate as intended during and after the test. No degradation of performance or loss of function is allowed as defined in the technical specification published by the manufacturer.

Performance Criterion B: (For transient phenomena): The EUT shall continue to operate as intended after the tests. No degradation of performance or loss of function is allowed as defined in the technical specification published by the manufacturer. During the test, degradation or loss of function or performance, which is self recoverable, is, however, allowed but no change of actual operating state or stored data is allowed.

Performance Criterion C: (For interruption of operation): Temporary degradation or loss of function or performance is allowed during and after the test provided function is self recoverable, or can be restored by

the operation of the controls as defined in the technical specification published by the manufacturer. No corruption or loss of stored data is allowed.

10.17.3 Immunity to Conducted Low Frequency interference.

10.17.3.1 Tests shall be carried out acc to IEC 60533.

10.17.3.2 The EUT must meet, as a minimum, performance criterion A.

10.17.4 Immunity to Conducted High Frequency Interference.

10.17.4.1 The test shall be carried out as described in IEC 60533 applied to:

— power lines AC/DC

— signal/control lines

— I/O ports

10.17.4.2 The EUT must meet, as a minimum, performance criterion A.

10.17.5 Immunity to Radiated Radio Frequency Fields.

10.17.5.1 The test shall be carried out as described in IEC 60533:1999 with the following test parameters:

Frequency range:	80MHz – 2 GHz
Modulation:	1000 Hz ±10%; or 400 Hz ±10% where an input signal at a modulation frequency of 1000 Hz Is necessary.
Field strength:	30 V/m shall be applied to the whole frequency range

10.17.5.2 The EUT shall be housed in the enclosure shown in the manufacturers published specification or be tested in open rack configuration.

10.17.5.3 The test shall be carried out with the generating antenna facing each of the six sides of the EUT (x-y-z orientation).

10.17.5.4 The EUT must meet, as a minimum, performance criterion A

10.18 Immunity to Fast, Low Energy Transients (Bursts)

10.18.1 The test shall be carried out as described in Standard IEC 60533:1999 with the following test parameters:

Wave shape of the pulse output into 50Ω Amplitude (peak):	a) 2 kV line/ground, power lines b) 1kV line/ground, control and signal lines.
Pulse repetition rate:	5kHz at 1kV and at 2kV.
Duration / polarity:	5 minutes for positive and negative polarity pulses.

10.18.2 Input/output lines of the EUT shall be connected to appropriate devices. The type of cabling shall be as specified in the manufacturer's data sheet

10.18.3 The EUT must meet, as a minimum, performance criterion A when tested at 1kV and performance criteria B when tested at 2kV

10.19 Immunity to Slow High Energy Transients (Surges)

10.19.1 The test shall be carried out as described in IEC 60533:1999 using the specified 1.2/50μs - 8/20μs combination wave pulse generator with following test parameters:

Pulse rise time:	1.2μs (between 10% and 90% value)
Amplitude (peak):	1kV line/ground, 0.5kV line/line
Repetition rate:	≥ 1 pulse/min
No. of pulses:	5 positive and negative polarity pulses
Application:	Continuous

10.19.2 All input/output lines of the EUT shall be connected to appropriate devices. The test signal shall be applied to power lines using the coupling method specified in IEC 61000-4-5.

10.19.3 The EUT must meet, as a minimum, performance criterion B

10.20 Immunity to Electrostatic Discharge (ESD)

10.20.1 The test shall be carried out in accordance with IEC 60533:1999 with following test parameters:

Pulse interval:	1 second
No. of pulses:	10 for positive and negative polarity pulse

10.20.2 The EUT must meet, as a minimum, performance criterion A

10.21 Power supply variation

10.21.1 The test shall be carried out in accordance with IEC 60533.

10.21.2 The EUT must meet, as a minimum, performance criterion A

10.22 Radiated Emissions

10.22.1 The test shall generally be carried out as described in IEC 60533, with limits for bridge and deck zone (Clause 6.2.1)

10.23 Conducted Emissions

10.23.1 The test shall generally be carried out as described in IEC 60533, with limits for bridge and deck zone (Clause 6.2.1)

10.24 Compass safe distance

10.24.1 The test shall be performed according to EN 60945:2002, Clause 9, with following modifications. The test shall be performed at maximum load on the EUT, and the worst case direction shall be used.

10.25 Insulation Resistance

10.25.1 The test shall be carried out in accordance with ISO 16750-2:2006, Clause 4.12

Table 4 — Test voltage and insulation resistance requirements

Rated supply voltage	Test voltage (d.c.)	Minimum insulation resistance	
		Before test	After test
Up to 65 V	2 x supply voltage minimum 24 V	10 MΩ	1 MΩ
Over 65 V	500 V	100 MΩ	10 MΩ

10.25.2 Certain components, such as filters, surge arrestors, variable resistors etc. may be required to be disconnected for this test.

11 Labelling

11.1 Helm stations not equipped with electronic display shall on craft with installed dynamic positioning system be labelled with the following warnings:

— boat is considered under way;

— keep proper lookout;

— propellers are spinning, swimming is dangerous;

— boat may move suddenly, hold on to prevent falling;

— read owner's manual for safe use of the system;

Annex A
(informative)

Electrical compliance

IEC 60092-507[1)] has been identified as an alternative compliance option to ISO 10133 and ISO 13297.

1) IEC 60092-507, Electrical installations in ships - Part 507: Small vessels