

EU RO Mutual Recognition Technical Requirements

INVERTERS	Version	0.1
	Adoption Date:	1 January 2023
	Application Date:	1 July 2023
	Tier	9
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1. PRODUCT DESCRIPTION

1.a General description of the product

This Technical Requirement provides MR type approval requirements for static power inverters, that is power electronic devices that change direct current (DC) to alternating current (AC) at specified voltage and frequency.

1.b Application limitations†

- a) Restricted to inverters intended for on board non-essential services, where the rated power is less than 50 kVA and voltage less than 1000 VAC/ 1500 VDC;
- b) Not intended for propulsion, manoeuvring and emergency services and as a DC/AC converting equipment within a hybrid electrical power generation and distribution systems.
- c) Not intended for as parts of the motor controller which drive essential auxiliaries and exceed the output 7.5 kW;
- d) Onboard ships with exceptions as per SOLAS Ch. I, Reg. 3;
- e) Electrical components designed and constructed to operate satisfactorily under the environmental conditions on board as per IEC 60092-101:2018.

†The EU MR type approved product is generally not used as a stand-alone product but integrated as component in a sub-system or system. When a product is presented with an EU RO MR Type Approval Certificate for given application, its acceptability with regards to conditions defined in 1b, 1c and 1d of this Technical Requirement will be evaluated by the EU RO in charge of classing the ship or being in charge of the unit/system certification.

1.c Intended use

Any application within the limits set in 1.b.

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1.d System context

Electrical Power supply to the distribution system and consumers.

2. DESIGN EVALUATION

2.a Engineering evaluation requirements

2.a i. Technical Requirements

Construction

The design of semi-conductor inverters is to comply with the requirements of IEC 60146-1-1.

Semiconductors are to comply with the requirements of IEC 60146 (all parts).

For liquid-cooled inverters the following provisions are to be satisfied:

- liquid is to be non-toxic and of low flammability;
- drip trays or other suitable means are to be provided to contain any liquid leakages;
- a leakage detection is to be fitted providing visual and audible alarm;
- cooling liquids which are in contact with live unearthed parts of the assembly are to be non-conductive.
- the resistivity of the cooling fluid in direct contact with semiconductor or other current carrying parts is to be monitored and an alarm initiated if the resistivity is outside the specified limits.

Where forced cooling is used, the temperature of the heated cooling medium is to be monitored.

Prior the lower temperature limit value is reached an indication is to be given to the operator.

If the temperature exceeds the lower pre-set value an alarm is to be given and load is to be reduced to 50%. If the temperature continues to rise up to the second limit a second alarm is to be given and the shutdown of the inverter is to be activated.

Alarm is to be given for power supply failure and trip of unit. For IT systems alarm is to be given for earth fault.

Where forced (air or liquid) cooling is provided, it is to be so arranged that the inverters cannot be or remain loaded unless effective cooling is maintained.

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Alternatively, the load may be automatically reduced to a level commensurate with the cooling available.

Units are to be provided with appropriate measuring instruments. The maximum permissible values of parameters are to be marked on the scales of the measuring instruments.

To prevent condensation in semiconductor units having the dissipation power above 500 W, provision shall be made for heating so that their temperature is at least by 3 °C higher than that of the ambient air.

Piping is to be arranged to prevent harmful effects due to leakage or condensation and be installed preferably in the lower part of the assembly.

Inverter equipment is to be so arranged that the semiconductor devices, fuses, control and firing circuit boards may be readily removed from the equipment for repair or replacement.

In power semiconductor units, semiconductor elements of silicone type are to be used.

Inverters serving as power supply shall be able to supply a short circuit current sufficient for selective tripping of downstream protective device without suffering internal damage. Such selective tripping may be achieved by utilization of an automatic bypass.

Any regenerated power developed during the operation of inverter equipment is not to result in disturbances to the supply system voltage and frequency which exceeds the limits of the specified/required Quality of power supplies.

Protection

Semiconductor elements are to be protected against short-circuit by means of devices suitable for the point of installation in the network.

Protection devices fitted for inverter equipment protection are to ensure that, under fault conditions, the protective action of circuit breakers, fuses or control systems is such that there is no further damage to the inverter or the installation.

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Any capacitors are to be discharged to a voltage less than 60 V, or to a residual charge less than 50 μ C, within 5 seconds after the removal of power. If this requirement cannot be met, appropriate warning labels are to be placed on the assembly.

Overcurrent and overvoltage protection is to be installed to protect the inverter. When the semiconductor inverter is designed to work as an inverter supplying the network in transient periods, precautions necessary to limit the current are to be taken.

Semiconductor inverters are not to cause distortion in the voltage waveform of the power supply at levels exceeding the voltage waveform tolerances of all installed equipment and systems.

Inverter equipment, including any associated transformers, reactors, capacitors and filters, if provided, is to be so arranged that the harmonic distortion, and voltage spikes, introduced into the ship's electrical system are within the limits of quality of power supplies as specified/required or restricted to a lower level necessary to ensure that it causes no malfunction of equipment connected to the electrical installation.

Parallel operation with other power sources

For inverters arranged to operate in parallel with other power sources, load sharing is to be such that under normal operating conditions overloading of any unit does not occur and the combination of paralleled equipment is stable.

When inverter equipment has parallel circuits provisions are to be made to ensure that the load is distributed uniformly between the parallel paths.

Temperature rise

The permissible limit of temperature rise of the enclosure of the semiconductors is to be assessed on the basis of an ambient air temperature of 45°C or sea water temperature of 32°C for water-cooled elements, taking into account its specified maximum permissible temperature value.

The value of the maximum permissible temperature of the elements at the point where this can be measured (point of reference) is to be stated by the manufacturer.

The value of the mean rated current of the semiconductor element is to be stated by the manufacturer.

A temperature rise test, on one of each size and type of inverter equipment, and such other tests as may be necessary to demonstrate the suitability of the equipment for its intended duty.

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Insulation test

The test procedure is that specified in IEC Publication 60146-1-1:2010 item 7.2.

All the inverters are to be subjected to the tests stated in [2.b].

2.a.ii. Technical documents to be submitted

IMPORTANT: The English Language shall be used for all submitted documents.

The following technical documents are to be provided:

- Datasheet;
- Assembly layout;
- Test procedure and functional description;
- Test reports, giving information on the construction, type, serial number and all technical data relevant to the inverter, as well as the results of the tests required. In the case of inverters which are completely identical in rating and in all other constructional details, it will be acceptable for the rated current test and temperature rise measurement stipulated in [2.b] not to be repeated.
- Software quality plans to demonstrate that the provisions of ISO/IEC 90003 are incorporated. The plans are to define responsibilities for the lifecycle activities, including verification, validation, software module testing, integration with other components or systems and security policies to be applied.

2.b Type testing requirements

Type tests are to be carried out according to item 7 of IEC 60146-1-1:2010 on a prototype inverter.

The following type tests are to be carried out:

- 1) Examination of the technical documentation, as appropriate;
- 2) Visual inspection including check of earth continuity. A visual examination is to be made of the inverter to ensure, as far as practicable, that it complies with technical documentation;
- 3) Light load function test to verify all basic and auxiliary functions;
- 4) Rated current test;
- 5) Temperature rise measurement;
- 6) Insulation test (dielectric strength test and insulation resistance measurement). Test voltage according to Table 1.
- 7) High voltage test between semiconductor elements (live parts of accessories) charged with main circuit potential and earths is to be carried out;

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- 8) Protection of the inverter in case of failure of forced cooling system;
- 9) High voltage/lightning impulse test;
- 10) Capacitor discharge;
- 11) EMC test as per IACS UR E10;
- 12) Low temperature test for 16hours at agreed temperature;
- 13) Pressure test of cooling piping hoses (PT not less than 4 bar);
- 14) Examination of software for products that include programmable electronic systems;
- 15) The version of each type of installed software at the time of testing is to be identified.

Table 1: Test voltages for high voltage test on static inverters

$\frac{Um}{\sqrt{2}} = U$ [V] (1)	Test voltage [V]
$U \leq 60$	600
$60 < U \leq 90$	900
$90 < U$	$2 U + 1000$ (at least 2000)
(1) <i>Um</i> : highest crest value to be expected between any pair of terminals.	

The type test plan is to be agreed between the Manufacturer and the RO based on the characteristics of the product subject to testing.

Performance type tests according to the Manufacturer's specification shall be carried out. The type tests are intended to demonstrate the performance of the prototype according to the Manufacturer's specification.

The ability of the product to function as intended under the testing conditions specified in the latest revision of IACS UR E10 shall also be verified.

Tests shall be carried out in the presence of the EU RO Surveyor. In cases where the tests are conducted at Nationally Accredited Laboratories, the presence of the EU RO surveyor may be omitted†.

† For further clarification of witnessing of tests and sampling the test specimen(s), refer to paragraphs 6, 7 and 8 of the EU RO "Design Evaluation Scheme" procedure (Appendix V

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of EU RO Framework Document for the Mutual Recognition of Type Approval found on <https://www.euomr.org/technical-requirements>)

2.c Type testing requirement for certificate renewal

The manufacturer is to notify the RO of any modification or changes to the manufacturing specifications that may affect the MR TA to be renewed.

3. PRODUCTION REQUIREMENTS

The certificates of inverters routine tested are to contain the manufacturer's serial number of the inverter which has been type tested and the test result.

Routine tests are to be carried out according to item 7 of IEC 60146-1-1:2010.

The following routine tests are to be carried out by the Manufacturer on all inverters:

- a) Examination of the technical documentation, as appropriate, and visual inspection including check of earth continuity. A visual examination is to be made of the inverter to ensure, as far as practicable, that it complies with technical documentation.
- b) Light load function test to verify all basic and auxiliary functions
- c) Insulation test (dielectric strength test and insulation resistance measurement). Test voltage according to Table 1.
- d) Protection of the inverter in case of failure of forced cooling system.

Refer to EU RO "Product Quality Assurance (PQA)" procedure (Appendix VI of EU RO Framework Document for the Mutual Recognition of Type Approval) found on

<https://www.euomr.org/technical-requirements>

4. MARKING REQUIREMENTS

Manufacturers of the approved equipment are, in principle, to mark the product before shipment for identification of approved equipment and, in addition, at least the following items to be marked at the suitable place:

- a) Manufacturer's name or equivalent;
- b) Type No. or symbol;
- c) Serial No.;

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- d) Particulars and ratings;
- e) Date of manufacture.

5. TYPE APPROVAL CERTIFICATE CONTENT

The EU RO MR Type Approval Certificate shall contain the minimum information as defined in the “EU RO Framework Document for the Mutual Recognition of Type Approval” - see Appendix I EU RO MR Type Approval Certificate Information.

The following information is specifically applicable to products relevant to this Technical Requirement and shall be included on the EU RO MR Type Approval Certificate:

- a) Technical data according to IEC marking;
- b) Reference to approved technical documents (including approval date and revision);
- c) Application and limitations;
- d) Hardware, firmware (major version and minor version), software name as applicable, which have undergone the EU RO MR Type Approval process.

6. APPROVAL DATE AND REVISION NUMBER

Date	Revision	Comment
2021-07-01	0.0	Approved by EU RO MR Steering Committee
2023-01-01	0.1	Added para 9 Copyright (ref21030_)

7. BACKGROUND INFORMATION / REFERENCES

- a) EU RO Framework Document for the Mutual Recognition of Type Approval;
- b) IACS UR E10 Rev 7
- c) IEC 60146:2010

8. MAINTENANCE & CLARIFICATION OF TECHNICAL REQUIREMENTS

Anyone wishing to propose changes to this document or request clarification of technical issues should contact the EU RO MR Group Secretariat in the first instance:

Secretariat@euomr.org.

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Review and approval of change requests shall follow the EU RO MR Maintenance Process detailed in the EU RO Framework Document for the Mutual Recognition of Type Approval: <https://www.euomr.org/technical-requirements>

9. LEGAL PROVISIONS / COPYRIGHT

- a) Underlying legal provisions in accordance with EU RO Framework Document for the Mutual Recognition of Type Approval;
- b) Copyright © 2022. All EU RO MR Group rights reserved.

For a list of EU RO MR Group members please see <https://www.euomr.org/about-us>.

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