

Test Report

21-1-0062601T04a-C03



Number of pages: 15 **Date of Report:** 2022-Nov-02

Testing company: CETECOM GmbH
Im Teelbruch 116
45219 Essen Germany
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Fax: + 49 (0) 20 54 / 95 19-150 **Applicant:** KOSTAL Industrie Elektrik GmbH

Product: Frequency inverter
Model: Inveor MD / IV01 PW15 LP04 AP01 GH09 DK05 CO00

FCC ID: SX4INVEOR-M-BG-D **IC:** -

Testing has been carried out in accordance with:

FCC Regulations
Title 47 CFR, Chapter I
FCC Regualtions, Subchapter A
Subpart B: §15.107 & §15.109 (Class A limits)
and
ANSI C63.4-2014 chapter 7
ANSI C63.4-2014 chapter 8.2.3
ANSI C63.4-2014 chapter 8.3

Deviations, modifications or clarifications (if any) to above mentioned documents are written in each section under "Test method and limit".

Test Results: **The EUT complies with the requirements in respect of selected parameters subject to the test.**
The test results relate only to devices specified in this document
The current version of Test Report CETECOM_TR21-1-0062601T04a_C03 replaces the test report CETECOM_TR21-1-0062601T04a_C02 dated 2022-Sep-30. The replaced test report is herewith invalid.

Signatures:



Niels Jeß
Head of Compliance Testing
Authorization of test report

Andreas Ueberbach
Senior Test manager
Responsible of test report

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The listed attachments are separate documents.

1 General information

1.1 Disclaimer and Notes

The test results of this test report relate exclusively to the test item specified in this test report as specified in chapter 2.7. CETECOM does not assume responsibility for any conclusions and generalizations drawn from the test results with regard to other specimens or samples of the type of the equipment represented by the test item.

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This test report is electronically signed and valid without handwritten signature. For verification of the electronic signatures, the public keys can be requested at the testing laboratory.

The test report must always be reproduced in full; reproduction of an excerpt only is subject to written approval of the testing laboratory. The documentation of the testing performed on the tested devices is archived for 10 years at CETECOM.

Also we refer on special conditions which the applicant should fulfill according §2.927 to §2.948, special focus regarding modification of the equipment and availability of sample equipment for market surveillance tests.

1.2 Attestation

I declare that all measurements were performed by me or under my supervision and that all measurements have been performed and are correct to my best knowledge and belief to Industry Canada standards. All of the above requirements are met in accordance with enumerated standards.

1.3 Summary of Test Results

Test case	Reference in FCC <input checked="" type="checkbox"/>	Reference in ISED <input type="checkbox"/>	Reference in RSS-GEN <input type="checkbox"/>	Remark	Result
<u>AC-Power Lines Conducted Emissions</u>	§15.107	ICES-003, Issue 6	RSS Gen, Issue 5, Chapter 8.8	--	Passed
<u>Radiated field strength emissions 30 MHz – 1 GHz</u>	§15.109 §15.33 §15.35	ICES-003, Issue 6	RSS-Gen., Issue 5 Chapter 8.9, Chapter 7.3	--	Passed
Radiated field strength emissions above 1 GHz	§15.109 §15.33 §15.35	ICES-003, Issue 6	RSS-Gen., Issue 5 Chapter 8.9, Chapter 7.3	--	NP

PASSED

The EUT complies with the essential requirements in the standard.

FAILED

The EUT does not comply with the essential requirements in the standard.

NP

The test was not performed by the CETECOM Laboratory.

*The calculation of the measurement uncertainty shows compliance with the "maximum measurement uncertainties" of the tested standard and therefore for result evaluation the stated uncertainties will not be additionally added to the measured results.

1.4 Summary of Test Methods

Test case	Test method
AC-Power Lines Conducted Emissions	ANSI C63.4-2014 chapter 7
Radiated field strength emissions 30 MHz – 1 GHz	ANSI C63.4-2014 chapter 8.2.3
Radiated field strength emissions above 1 GHz	ANSI C63.4-2014 chapter 8.3

2 Administrative Data

2.1 Identification of the Testing Laboratory

Company name:	CETECOM GmbH
Address:	Im Teelbruch 116 45219 Essen - Kettwig Germany
Responsible for testing laboratory:	Volker Briddigkeit
Accreditation scope:	DAkkS Webpage
Test location:	CETECOM GmbH; Mündelheimer Weg 35; 40472 Düsseldorf

2.2 General limits for environmental conditions

Temperature:	22±2 °C
Relative. humidity:	45±15% rH

2.3 Test Laboratories sub-contracted

Company name:	
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2.4 Organizational Items

Responsible test manager:	Andreas Ueberbach
Receipt of EUT:	2021-May-28
Date(s) of test:	2021-May-28 – 2021-Jun-01
Version of template:	14.7

2.5 Applicant's details

Applicant's name:	KOSTAL Industrie Elektrik GmbH
Address:	Lange Eck 11 58099 Hagen North Rhine-Westphalia Germany
Contact Person:	Christian Alt
Contact Person's Email:	c.alt@kostal.com

2.6 Manufacturer's details

Manufacturer's name:	KOSTAL Industrie Elektrik GmbH
Address:	Lange Eck 11 58099 Hagen Germany

2.7 EUT: Type, S/N etc. and short descriptions used in this test report

Short description*)	PMT Sample No.	Product	Model	Type	S/N	HW status	SW status
EUT1	21-1-00626S04_C01	Frequency inverter	Inveor MD	IV01 PW15 LP04 AP01 GH09 DK05 CO00	90549UEJ0000R	none	3.96

*) EUT short description is used to simplify the identification of the EUT in this test report.

2.8 Auxiliary Equipment (AE): Type, S/N etc. and short descriptions

Short description*)	PMT Sample No.	Auxiliary Equipment	Type	S/N	HW status	SW status
AE1	21-1-00626S05_C01	Profinet Master	Siemens S7	-	-	-

*) AE short description is used to simplify the identification of the auxiliary equipment in this test report.

2.9 Connected cables

Short description*)	PMT Sample No.	Cable type	Connectors	Length
CAB1	21-1-00626S06_C01	unschielded cable	Fixed and CEE 16	3.0 m
CAB2	21-1-00626S07_C01	Adaptor	CEE 16 -> CEE 32	0.5 m
CAB3	none	Extension (CETECOM)	CEE 32	10 m
CAB4	21-1-00626S08_C01	unschielded cable	Fixed and CEE 16	1.10 m

*) CAB short description is used to simplify the identification of the connected cables in this test report.

2.10 Software

Short description*)	PMT Sample No.	Software	Type	S/N	HW status	SW status
-	-	-	-	-	-	-

*) SW short description is used to simplify the identification of the used software in this test report.

2.11 EUT set-ups

set-up no.*)	Combination of EUT and AE	Description
	EUT1 +AE1 + CAB1 + CAB2 + CAB3	Used for Radiated measurements
	EUT1 +AE1 + CAB4	Used for Conducted measurements

*) EUT set-up no. is used to simplify the identification of the EUT set-up in this test report.

2.12 EUT operation modes

EUT operating mode no.*)	Operating modes	Additional information
OP1	Operation with 10 Hz	-

*) EUT operating mode no. is used to simplify the test report.

3 Equipment under test (EUT)

3.1 General Data of Main EUT as Declared by Applicant

Product name	Inveor MD / IV01 PW15 LP04 AP01 GH09 DK05 CO00		
Kind of product	Frequency converter		
Firmware	<input checked="" type="checkbox"/> for normal use <input type="checkbox"/> Special version for test execution		
Power supply	<input checked="" type="checkbox"/> AC Mains	three Line (L1,L2,L3) 208V 60Hz	
	<input type="checkbox"/> DC Mains	- V DC via - Connector	
	<input type="checkbox"/> Battery	-	
Operational conditions	$T_{nom} = -^{\circ}\text{C}$	$T_{min} = -^{\circ}\text{C}$	$T_{max} = -^{\circ}\text{C}$
EUT sample type	Production		
Weight	--		
Size [LxWxH]	730 x 350 x 620 mm		
Interfaces/Ports	AC Input		
For further details refer Applicants Declaration & following technical documents			

3.2 Modifications on Test sample

Additions/deviations or exclusions	
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4 Measurements

4.1 AC-Power Lines Conducted Emissions

4.1.1 Description of the general test setup and methodology, see below example:

The radio frequency voltage conducted back into the AC power line in the frequency range 150 kHz to 30 MHz has to be investigated.

Compliance should be tested by measuring the radio frequency voltage between each power line and ground at the power terminals in the stated frequency range.

A 50 Ohm / 50 μ H line impedance stabilization network (LISN) is used coupling the interface to the measurement equipment.

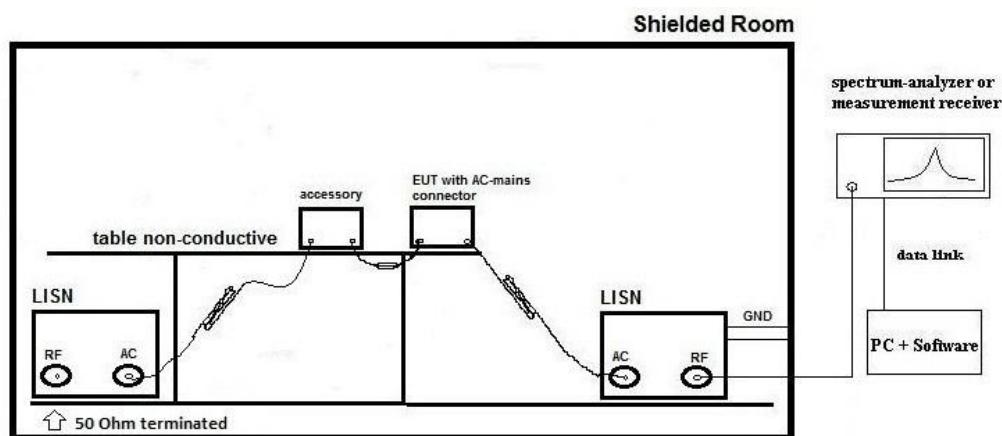
The EUT power input leads are connected through the LISN to the AC-power source. The LISN enclosure is electrically connected to the ground plane. The measuring instrument is connected to the coaxial output of the LISN.

Tabletop devices were set-up on an 80 cm height above reference ground plane, floor standing equipment 10 cm raised above ground plane.

Measurements have been performed on each phase line and neutral line of the devices AC-power lines.

The EUT was power supplied with 120 V/60 Hz. The EUT was tested in the defined operating mode and installed (connected) to accessory equipment according the general description of use given by the applicant.

Schematic:



Testing method:

The measurement is made according to relevant reference clauses:

(See Tables *Summary of Test Results* and *Summary of Test Methods* on page 5)

Exploratory, preliminary measurements

As a first step, determines the worst-case phase line (neutral or phase) as well as the most critical operating mode of the equipment. A complete frequency-sweep with PK-Detector is performed on each current-carrying conductor.

Final measurement on critical frequencies

For power phases and critical frequencies (Margin to AV- or QP limit lower than 3 dB) as a second step includes measurements with receivers detector set to Quasi-Peak and Average.

Formula:

$$V_C = V_R + C_L \quad (1)$$

$$M = L_T - V_C \quad (2)$$

V_C = measured Voltage –corrected value

V_R = Receiver reading

C_L = Cable loss

M = Margin

L_T = Limit

All units are dB-units, positive margin means value is below limit.

4.1.2 Measurement Location

Test site	225924 - Conducted Emission
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4.1.3 Limit

Frequency Range [MHz]	Class B <input type="checkbox"/>		Class A <input checked="" type="checkbox"/>	
	QUASI-Peak [dB μ V]	AVERAGE [dB μ V]	QUASI-Peak [dB μ V]	AVERAGE [dB μ V]
0.15 – 0.5	66 to 56*	56 to 46*	79	66
0.5 – 5	56	46	73	60
5 – 30	60	50	73	60

4.1.4 Result

Diagram	Mode	Power Line	Max [dB μ V]	Detector	Result
1.01	OP1	N	38.48	Average Critical Frequency only	OK
1.02	OP1	L1	61.49	Average	OK
1.03	OP1	L2	62.21	Average	OK
1.04	OP1	L3	60.93	Average	OK

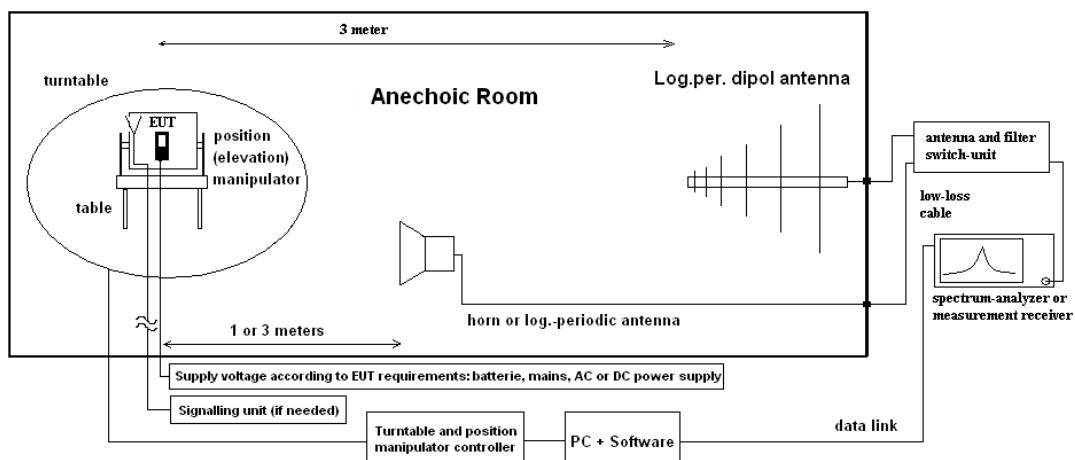
Remark: for more information and graphical plot see annex A1 CETECOM_TR21-1-0062601T4a

4.2 Radiated field strength emissions 30 MHz – 1 GHz

4.2.1 Description of the general test setup and methodology, see below example:

Evaluating the field emissions have to be done first by an exploratory emissions measurement and a final measurement for most critical frequencies. The tests are performed in a NSA-compliant semi anechoic room (SAR) recognized by the regulatory commissions.

Schematic:



Testing method:

The measurement is made according to relevant reference clauses:

(See Tables *Summary of Test Results* and *Summary of Test Methods* on page 5)

Exploratory, preliminary measurements

The EUT and its associated accessories are placed on a non-conductive position manipulator (tipping device) of 0.8 m height which is placed on the turntable. By rotating the turntable (range 0° to 360°, step 90°) and the EUT itself either on 3-orthogonal axis (portable equipment) or 2-orthogonal axis (defined operational position of EUT) the emission spectrum and its characteristics was recorded with an EMI-receiver, broadband antenna and software.

Measurement antenna: horizontal and vertical, heights: 1,0 m and 1,82 m as worst-case determined by an exploratory emission measurements. The results are documented in a diagram. Critical frequencies (low margin to limit) are saved within a table for further investigations. If various operating modes are supported, further investigations are made to find the worst-case of them. Also the interconnection cables and equipment position were varied in order to maximize the emissions.

Final measurement on critical frequencies

Based on the exploratory measurements, the most critical frequencies are re-measured by main-taining the EUT's worst-case operation mode, cable position, etc. either on 10m OATS or 3m semi-anechoic room.

First a frequency zoom around the critical frequency is done to locate the frequency more precisely. After this step, for all identified critical frequencies, the maximum peak was determined.

Following parameters were varied: the turntable angle continuously in the range 0 to 360 degree, the EUT itself either over 3-orthogonal axis (not defined usage position) or 2-orthogonal axis (defined usage position). The measurement antenna height between 1 m and 4 m.

On the determined worst-case position, a final measurement with necessary bandwidth and detector according standard has been carried out

Formula:

$$E_C = E_R + AF + C_L + D_F - G_A \quad (1)$$

$$M = L_T - E_C \quad (2)$$

AF = Antenna factor

C_L = Cable loss

D_F = Distance correction factor (if used)

E_C = Electrical field – corrected value

E_R = Receiver reading

G_A = Gain of pre-amplifier (if used)

L_T = Limit

M = Margin

All units are dB-units, positive margin means value is below limit.

4.2.2 Measurement Location

Test site	225911 - SAC5 - Radiated Emission <1GHz
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4.2.3 Limit

Frequency Range [MHz]	Class B <input type="checkbox"/> (3 meters)		Class A <input checked="" type="checkbox"/> (10 meters)		Detector	RBW [kHz]
	Limit [μV/m]	Limit [dBμV/m]	Limit [μV/m]	Limit [dBμV/m]		
30 - 88	100	40.0	90	39.0	Quasi peak	120
88 - 216	150	43.5	150	43.5	Quasi peak	120
216 - 960	200	46.0	210	46.4	Quasi peak	120
960 - 1000	500	54.0	300	49.5	Quasi peak	120

4.2.4 Result

Diagram	Channel	Mode	Maximum Level [dBμV/m] Frequency Range 30 – 1000 MHz	Result
3.01	--	OP1	19.96 (QP) at 81.18 MHz	OK

Remark: for more information and graphical plot see annex A1 **CETECOM_TR21-1-0062601T4a**

4.3 Results from external laboratory

None	-
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4.4 Opinions and interpretations

None	-
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4.5 List of abbreviations

None	-
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5 Equipment lists

ID	Description	Manufacturer	SerNo	Cal Date	Cal-Interval	Next Cal.
	225911 - SAC5 - Radiated Emission <1GHz					
25348	EMI Test Receiver ESR7	Rohde & Schwarz Messgerätebau GmbH	101600	09.08.2021	24M	09.08.2023
25352	Open Switch and control Platform OSP120	Rohde & Schwarz Messgerätebau GmbH	101542-rV	--	--	--
25358	Semi Anechoic Chamber SAC5	Albatross Projects GmbH	P27281-016	30.06.2016	120M	30.06.2026
25357	Ultra-broadband antenna HL562E	Rohde & Schwarz Messgerätebau GmbH	100824	13.09.2020	36M	13.09.2023
25309	Double-Ridged Horn Antenna HF 907	Rohde & Schwarz Messgerätebau GmbH	100333	02.08.2021	36M	12.08.2023
25417	Spectrum Analyser FSU 26	Rohde & Schwarz Messgerätebau GmbH	200413	16.10.2021	24M	16.10.2023
	225924 - Conducted Emission					
25370	EMI Test Receiver ESR7	Rohde & Schwarz Messgerätebau GmbH	101715	04.03.2021	24M	04.03.2023
25261	LISN 120/200 V ESH 2-Z5	Rohde & Schwarz Messgerätebau GmbH	871777/041	17.05.2022	24MY	17.05.2024
25341	Shielded Room Laboratory 1	Franconia	--	--	--	--

Tools used in 'P1M1'

6 Measurement Uncertainty valid for conducted/radiated measurements

The reported uncertainties are calculated based on the standard uncertainty multiplied with the appropriate coverage factor **k**, such that a confidence level of approximately 95% is achieved. For uncertainty determination, each component used in the concrete measurement set-up was taken in account and its contribution to the overall uncertainty according its statistical distribution calculated.

RF-Measurement	Reference	Frequency range	Calculated uncertainty based on a confidence level of 95%						Remarks	
Conducted emissions (U CISPR)	-	9 kHz - 150 kHz 150 kHz - 30 MHz	4.0 dB 3.6 dB						-	
Power Output radiated	-	30 MHz - 4 GHz	3.17 dB						Substitution method	
Power Output conducted	-	Set-up No.	Cel-C1	Cel-C2	BT1	W1	W2	--		
		9 kHz - 12.75 GHz	N/A	0.60	0.7	0.25	N/A	--	-	
		12.75 GHz - 26.5 GHz	N/A	0.82	--	N/A	N/A	--	-	
Conducted emissions on RF-port	-	9 kHz - 2.8 GHz	0.70	N/A	0.70	N/A	0.69	--	N/A - not applicable	
		2.8 GHz - 12.75 GHz	1.48	N/A	1.51	N/A	1.43	--		
		12.75 GHz - 18 GHz	1.81	N/A	1.83	N/A	1.77	--		
		18 GHz - 26.5 GHz	1.83	N/A	1.85	N/A	1.79	--		
Occupied bandwidth	-	9 kHz - 4 GHz	0.1272 ppm (Delta Marker)						Frequency error	
			1.0 dB						Power	
Emission bandwidth	-	9 kHz - 4 GHz	0.1272 ppm (Delta Marker)						Frequency error	
			See above: 0.70 dB						Power	
Frequency stability	-	9 kHz - 20 GHz	0.0636 ppm						-	
Radiated emissions Enclosure	-	150 kHz - 30 MHz	5.01dB						Magnetic field strength	
		30 MHz - 1 GHz	5.83 dB						Electrical Field strength	
		1 GHz - 18 GHz	4.91 dB							
		18-26.5 GHz	5.06 dB							

7 Versions of test reports (change history)

Version	Applied changes	Date of release
--	Initial release	2021-Jun-18
C01	Added FCC ID at cover page, updated table of annex at page 3. Updated chapter summary of test results. Updated product name at chapter 2.7. Updated product and model name and added FCC ID at cover pages for annex 1, annex 3 and annex 4.	2022-Nov-02
C02	Update Annex1, Equipment List and FCC Title	2022-Sep-26
C03	Update cal Date of Equipment List	2022-Nov-02

End Of Test Report