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Report

on the

Certificate

M6A 023303 0009 Rev. 01

of the

Safety Component
KW series digital pulse inverter

Applicant

AMKmotion GmbH + Co KG

Gaußstraße 37-39
73230 Kirchheim unter Teck
Germany

Report No.: AK102558C

Version 1.1 of 2024-05-277

Testing Laboratory for Safety Components

TÜV SÜD Rail GmbH

Rail Automation
Barthstraße 16
D-80339 München

Certification Body

TÜV SÜD Product Service GmbH

Ridlerstraße 65
D-80339 München

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Modification History

Rev.	Status	Date	Author	Modification / Description
1.0	Replaced	2024-04-24	Moritz Mayer	Initial Version
1.1	Active	2024-05-27	Moritz Mayer	Added safety characteristics data in Chapter 5.1.1

Table 1: Modification history

1 Target of Evaluation (ToE)

In January 2022 AMKmotion GmbH + Co KG requested TÜV SÜD Rail GmbH to test and certify the KW series digital pulse inverter according to the standard listed in clause 4 of this report. The project number related to this Technical Report is 717524587.

The ToE is a product used in safety related applications. The KW series digital pulse inverter is a Safety Component approved for

- PL e, Cat. 4 according to ISO 13849-1

2 Scope of Testing

2.1 Test Specimen

KW series digital pulse inverter consists of compact power supply and compact inverter modules to control AMKmotion AC and DC motors in a power range from 1kVA up to 200kVA. A dangerous state, in this context rotation or restart of the motor can only occur, if power is supplied to the motor through U, V, W phases. For a rotary field to be generated in the motor, IGBT output stages must be enabled in a meaningful way by the motor-controller. Only in this case the motor can rotate.

The output stage is controlled by the KW controller card KW-Rxx using 6 PWM command lines through optocouplers. The KW controller card only generates PWM control signals when the intermediate circuit voltage is present, the controller enable signal RF and the output stage enable EF, EF2 are set.

At standstill of the motor (RF = 0), the higher-level control system triggers the drive interlock by resetting the input signal EF, EF2. The enable signals EFL (lower switches) or EFH (upper switches) prevent the optocouplers from being energized. The acknowledgement signals QEF or QES can be read back by the higher-level control system.

2.2 Nomenclature and Identification of KW series digital pulse inverter

The KW series digital pulse inverter tested is identified by the nomenclature as follows:

Safety Component digital inverter: Compact inverter module with integrated EF safety function: protection against motor restart

- Compact inverter module with Coldplate: KW y, KW yy, KW yyy, KWD y (y, yy, yyy = rated power (kVA))
- Compact inverter module with integrated air cooling: KW y-F, KWD y-F (y = rated power (kVA))
- Special models: KW 100-S3 and KW 150-S12
- In combination with optional KW controller: KW-Rxx und KW-RxxP (xx = model)

The KW series digital pulse inverter tested is identified by hardware as follows:

Typ	Part-No.	Revision (current)	Revision min. (Option 1)	Remark
KW 2	46304	3.29	3.00	
KW 3	46756	3.26	3.01	
KW 5	46303	3.27	3.00	
KW 8	46754	3.28	3.02	
KW 10	46262	3.27	3.00	

	51072	4.02	4.00	
KW 20	46263 51076	3.28 4.02	3.00 4.00	
KW 40	47158	3.29	3.00	
KW 60	47134	3.29	3.00	
KW 70-S9	47750	3.29	3.00	
KW 100	47149 47994	4.07 5.02	3.01 5.00	
KW 100-S3	47150	4.07	4.00	
KW 150	47436	1.11	1.05	
KW150-S12	47920	1.11	1.05	
KW 200	47437	1.11	1.05	
KWD 1	46773	3.29	3.00	
KWD 2	46774 51214	3.29 3.29	3.00 3.29	alternative to 46774
KWD 5	46763	3.28	3.04	

Table 2: HW Identification of KW series digital pulse inverter with Coldplate

Type	Part-No.	Revision current	Revision min. (Option 1)	Remark
KW 2-F	47108	3.29	3.00	
KW 4-F	47190	3.27	3.22	
KW 6-F	47191	3.28	3.23	
KW 9-F	47123	3.27	3.22	
KWD 1-F	47112	3.29	3.00	
KWD 2-F	47113	3.29	3.00	
KWD 4-F	47114	3.28	3.23	

Table 3: HW Identification of KW series digital pulse inverter with integrated air cooling

Type	Part-No.	Revision current	Revision min. (Option 1)	Bemerkung

KW-R03	46459	2.09	2.00	
KW-R03P	46501	2.09	2.00	
KW-R04	46502	2.09	2.00	
KW-R06	47127	1.20	1.01	
KW-R16	47382	1.17	1.01	
KW-R24	47708	1.09	1.00	
KW-R24R	47928	1.09	1.04	
KW-R25	47709	1.10	1.00	
KW-R26	47710	1.10	1.00	
KW-R35	51196	1.02	--	
KW-R36	51195	1.02	--	

Table 4: HW Identification of KW series controller card (not part of certification scope)

Option 1: Monitoring of WIF, EFL, EFH Signals (internal signals)

Hardware: Digital inverter: This option can be used with devices KW(D) xxx with min HW revision see Table 3 and Table 4

Controller card: This option can be used with controller cards with minimum HW revision see Table 5

Software: Controller card: this option can be used with controller cards with minimum SW revision see Table 6

Type	min SW revision	Date (Year/Week)	Remarks
KW-R03, -R04	from V3.04	2003/41	--
KW-R03P	from V5.05	2004/03	--
KW-R05/06	from V1.06	2010/42	--
KW-R2x	from V2.02	2014/23	--
KW-R3x	from V1.00	2023/xx	--

Table 5: Minimum SW revision of controller card for Option 1

Note: support for “Option 1” can be checked through ID 34055 by super-oriented controller (ID34055 = 4: system supports option 1 – monitoring of internal signals by KW-Rxx controller, ID34055 = 2: system does not support option1)

3 Certification Requirements

The certification of the KW series digital pulse inverter is according to the regulations and standards listed in clause 4 of this document. This certifies the successful completion of the following test segments.

I. Functional Safety including
   - Functional safety management (FSM) and safety lifecycle
   - Applied safety development process
   - Analysis of the product structure / architecture (Block-Diagram-FMEA)
   - Analysis of the hardware (FMEDA on component or block level, quantitative analysis)
   - Analysis of the software
   - Verification and validation procedures/activities
   - Fault simulations and software tests
   - Approval of fault avoidance measures
   - Functional tests

II. Electrical Safety

III. Susceptibility to environmental errors including
   - Climate and temperature
   - IP degree of protection
   - Mechanical effects

IV. Electromagnetic compatibility (EMC)
   - Immunity

V. Safety information in the product documentation (safety manual, user manual, installation and operating instructions).

VI. Product-Related Quality Assurance in Manufacture and Product Development

3.1 Certification Documentation

The detailed technical evaluation is documented in the most recent version of the Technical Report:

Document No.	Description	Project No.
AK102299T	Technical Report	717524587
Safety related requirements, conditions and restrictions can be found in the following user documentation		
PDK_028932_KEKW_Hardware	Gerätebeschreibung Servoumrichter KE/KW Kompakteinspeisungen KE, KES, KEN Kompaktwechselrichter KW, KWD	717524587

Table 6: Technical Report

Based on the specified purpose of use of the KW series digital pulse inverter in safety critical process applications, the certification is based on the set of standards listed in clause 4 of this document. The issuance of the certificate states compliance with these references unless specifically noted otherwise.

4 Standards and Guidelines

The regulations and guidelines which form the basis of the type testing are listed below.

4.1 Guidelines and Directives

No.	Reference	Description
/N1/	2006/42/EC	Directive 2006/24/EC of the European Parliament and of the Council of 2006-05-17 on machinery

Table 8: Guidelines and directives

4.2 Functional Safety

No.	Reference	Description
/N2/	EN ISO 13849-1:2015	Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 1: General requirements
/N3/	EN ISO 13849-1:2023	Safety of machinery - Safety-related parts of control systems Part 1: General principles for design

Table 9: Basic safety standards

No.	Reference	Description
/N4/	EN 61800-5-2:2017	Adjustable speed electrical power drive systems - Part 5-2: Safety requirements – Functional

Table 10: Associated safety standards

No.	Reference	Description
Remark:	*The following standards were approved by other testing services.*	
/N5/	EN 61800-3:2018	Adjustable speed electrical power drive systems - Part 3: EMC requirements and specific test methods

Table 11: Other product related standards

4.3 Electrical Safety

Remark: The following standards were approved by other testing services.

No.	Reference	Description
/N6/	EN 61800-5-1:2007/A11:2021	Adjustable speed electrical power drive systems - Part 5-1: Safety requirements - Electrical, thermal and energy

No.	Reference	Description
/N7/	EN 50178:1997 (applicable parts)	Electronic equipment for use in power installations

Table 12: Electrical safety standards

4.4 Environmental Testing

Remark: The following standards were approved by other testing services.

No.	Reference	Description
/N8/	EN 61800-5-1:2007/A11:2021	Adjustable speed electrical power drive systems - Part 5-1: Safety requirements - Electrical, thermal and energy
/N9/	EN 60068-2-6:2008	Environmental testing - Part 2-6: Tests - Test Fc: Vibration (sinusoidal))
/N10/	EN 60068-2-27:2009	Environmental testing - Part 2: Tests - Test Ea and guidance: Shock (IEC 60068-2-27:2008)

Table 13: Environmental testing standards

4.5 Electromagnetic Compatibility

Remark: The following standards were approved by other testing services.

No.	Reference	Description
/N11/	EN 61800-5-2:2017	Adjustable speed electrical power drive systems - Part 5-2: Safety requirements – Functional
/N12/	EN 61000-6-2:2019	Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - Immunity standard for industrial environment
/N13/	EN 61800-3:2018	Adjustable speed electrical power drive systems - Part 3: EMC requirements and specific test methods

Table 14: Electromagnetic compatibility standards

4.6 Safety Information in the Product Documentation (safety manual, operating instructions, labelling)

No.	Reference	Description
/N14/	EN ISO 13849-1:2015	Safety of machinery – Safety-related parts of control systems – Part 1: General principles for design
/N15/	EN ISO 13849-1:2023	Safety of machinery – Safety-related parts of control systems – Part 1: General principles for design

Table 15: Safety information standards

4.7 Quality Management System

No.	Reference	Description
[M1]	QMS	Quality Management System TÜV SÜD Rail GmbH
	TR_RA_P_04.50	Test Program Functional Safety TR_RA_P_04.51 Definition Scope of testing TR_RA_P_04.07 Product Modification TR_RA_P_04.52 Concept Phase & Safety Lifecycle TR_RA_P_04.53 Detail Phase Hardware TR_RA_P_04.54 Detail Phase Software TR_RA_P_04.55 Safety Manual TR_RA_P_04.56 Result of Testing
[M2]	D-PL-11190-08-00	DAkkS accreditation according to DIN EN ISO 17025:2018 / EN ISO/IEC 17025:2017

Table 16: Quality Management System

5 Results

5.1 Functional Safety

The tests performed and quality assurance measures implemented by the AMKmotion GmbH + Co KG have shown that the KW series digital pulse inverter complies with the testing criteria specified in clause 4 subject to the conditions defined in clause 6 and is suitable for safety-related use in applications up to

- category 4 PL e according to ISO 13849-1.

5.1.1 Probabilistic Data

The probabilistic data for EF safety function of the KW series digital pulse inverter is given in the table below:

	Product Values	**Remark**
PFH [h^{-1}]	< 10^{-7}	--
$MTTF_D$ [years]	>100	
Category	4	
PL	e	
DC [%]	99	
CCF [Points]	>65	

Table 17: Safety characteristics data of the KW series digital pulse inverter

6 Implementation Conditions and Restrictions

The use of the KW series digital pulse inverter shall comply with the current version of the safety parts of the user manual, and the following implementation and installation requirements have to be followed, if the KW series digital pulse inverter is used in safety-related installations.

- The guidelines and requirements specified in the user documentation shall be followed. Only modules certified for safety-related operation shall be used for safety-critical functions.
- Timing aspects like reaction times, test intervals or test execution times have to be considered by the implementation of the final Safety function.
- The power supply (24V) has to be isolated from the net via a transformer according to IEC 61558-2-6 that fulfils the requirements for double insulation of overvoltage category III.
- The KW series digital pulse inverter must be placed within a cabinet with at least IP54.
- The operating conditions like lifetime or operating temperature as specified in the user documentation shall be met.
- The maintenance and repair instructions described in the instruction manual of the KW series digital pulse inverter have to be followed.

7 Certificate Number

This report specifies technical details and implementation conditions required for the application of KW series digital pulse inverter to the certificate:

M6A 023303 0009 Rev. 01

Technical Certifier

Digital unterschrieben von Christian Dirmeier
Datum: 2024.05.28 08:08:32 +02'00'