

2005-02-25



TÜV Rheinland Group

Automation, Software and Information Technology

**Report about the type approval
of the Frequency AC Drive PowerFlex 700S
with the safety function “Safe standstill”**

**Report-No.: 968/EZ 189.00/05
Date: 2005-02-25**

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Pages: 8

Test object: Adjustable Frequency AC Drive PowerFlex 700S
Frame 1/2/3/4/5/6 240 V, 400 V, 480 V
and corresponding dc input voltage ratings
Frame 5/6 600 V, 690 V
and corresponding dc input voltage ratings

Customer: Rockwell Automation
6400 West Enterprise Drive
USA-Mequon, WI 53092
United States of America

Manufacturer: Rockwell Automation
6400 West Enterprise Drive
USA-Mequon, WI 53092
United States of America

Order-No./Date: 3029029 dated 2004-02-25

Test Institute: TÜV Industrie Service GmbH
Automation, Software and Information Technology
Competence Center Safeguards and Safety Components
Am Grauen Stein
D-51105 Köln

TÜV-Offer-No./Date: 968/26/04 dated 2004-02-16

TÜV-Order-No./Date: 9105491 dated 2004-03-01

Inspector: Dipl.-Ing. Thomas Steffens

Test Locations: See Test Institute

Test period: September 2003 until January 2005

The test results are exclusively related to the test samples.

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1. **Scope**

In this document the type approval of the Adjustable Frequency AC Drive Powerflex 700S is documented and the results of the approval are revealed.

On this way the comprehensible proof shall be established, that the device under test meets the functional and safety related requirements of the product specification and fulfils the requirements of the relevant standards.

Furthermore it shall be established that the safety function "Safe standstill" of the Powerflex 700S meets the functional and safety related requirements of Safety category 3 according to EN 954-1.

2. **Standards as basis for the requirements and tests**

- [1] EN 954-1:1996
Safety of machinery - Safety-related parts of control systems
Part 1: General principles for design
- [2] EN ISO 13849-2:2003
Safety of machinery - Safety-related parts of control systems -
Part 2: Validation
- [3] EN 60204-1:1997
Safety of machinery - Electrical equipment of machines
Part 1: General requirements
- [4] EN 50178:1997
Electronic equipment for the use in power installations
- [5] EN 61800-3:1996 & A11:2000
Adjustable speed electrical power drive systems -
Part 3: EMC product standard including specific test methods

3. **Identification of the device under test**

3.1 **Technical data**

All technical data of the devices under test can be found in the belonging instruction sheets and the documents listed below.

3.2 **Documents**

- User Manual "Safe Off Option for PowerFlex 700S AC Drives", Draft 5, 2004-09-22, 20 pages, Rockwell
- PowerFlex 700S2:Safe Off Functional Verification Test Report ,Revision 1.0, 2004-09-16, 7 pages, Rockwell
- PowerFlex 700S2:Safe Off Fault Insertion Test Report, 2004-10-01, 10 pages, Rockwell
- PF700S FMEA Analysis of Safety Circuit , 1122262, 2004-11-30, 7 pages, Rockwell
- Schematic "PHASE II ENCODER OPTION BOARD SCHEMATIC DIAGRAM PF 700S SERIES B", 319830-2,Revision 03, 2004-04-16, 2 pages, Rockwell

- Schematic "SCH,PF 700S,MAIN CNTRL BD", 96419654, Revision A01, 07/2004, 46 pages, Rockwell
- SRS for PF700S Safe Off Control, 1122305, 2004-07-06, 5 pages, Rockwell
- Summary Report of TÜV Rheinland of North America (TRNA) No.: P30461464.001, dated 2005-01-05, 10 pages
- Summary of TRNA Report No.: 30472368.002 dated 2005-01-28, 43 pages

3.3 Test sample, test set-up

The judgement of the realized safety function "Safe standstill" has been carried out based on the provided documents and partly in common reviews together with the developer.

All other mentioned tests, carried out by Rockwell or by TRNA, were performed on representative models.

The test sample will be kept by Rockwell Automation.

4. Test and test results

4.1 Description and judgement of the safety structure

The frequency AC Drive PowerFlex 700S provides the safety function "Safe standstill". The safety function "Safe standstill" has to fulfil the requirements for safety category 3 according to EN 954-1, that means no single fault results in a loss of the safety function. For this safety function the power supply to the motor or driven machine must be safely interrupted. A monitoring of the standstill position is not required.

The safety function "Safe standstill" of the PF 700S provides only a coast-to-stop capability. In application where coasting to a standstill may result in a hazard additional protective measures, as the use of mechanical brakes, are required.

The principle safety structure is shown in the drawing below.

The Enable Health Signal is monitored by the μC and a hardware enable circuit warning will be generated by the μC in case that U91 does not work properly. Another method for the fault detection is to monitor the current sensor. It is possible to link the warning messages to digital outputs for external evaluation. The procedure is described in the belonging user manual.

In the event of a failure combination of a simultaneous short of two IGBTs, a one-time movement of max. 180° for a 2-pole motor can occur.

4.2 Results of the functional and safety analyses

In common reviews together with the developer the safety of design of the Hardware has been discussed and analysed. Based on the reviews a failure mode and effect analysis (FMEA) has been performed by Rockwell for providing the evidence, that no single fault results in the loss of the safety function. The FMEA has been verified by the Test Institute by a theoretical analysis and selected parts of the FMEA by practical tests. The practical tests have been carried out by Rockwell witnessed by an inspector of TÜV Rheinland of North America, Inc. (TRNA).

Following conditions have to be considered:

- Both safety inputs have to be used independent to each other.
- Due to the fact that a short circuit between the external wiring of the safety inputs will not be revealed by the system. The wiring has to be performed in such a way, that a fault exclusion acc. to ISO 13849-2 for the failures "short-circuits" is allowed. This is possible for example, when the cable is protected against external damage by cable ducting or armouring.
- The correct function of the safety function has to be tested in a periodic maintenance interval. The time period of this interval depends on the safety analysis of the system where the PF 700S is installed.
- The possibility of small movement of the motor resulting from simultaneous IGBT failures shall be taken into account during the hazard analysis of the application.
- Additional measures to keep the motor in the standstill position must be foreseen, if external forces may have an impact on the motor position.

The requirements for the safety function "Safe standstill" are fulfilled according to EN 954-1 category 3.

All the required information for a safe use are contents of the user manual.

4.3 Electrical safety

The TRNA has performed the electrical safety certification according to EU Low Voltage Directive (LVD) and to EN 50178. The results are documented in the summary report-no.: 30371439.002 dated 2004-02-20. They confirm, that the PF700S fulfils requirements according to the EU Low Voltage Directive (LVD) and to EN 50178.

The results are accepted by the Test Institute.

4.4 Environmental tests

The environmental tests according to EN 50178 have been carried out. The results of these tests are documented in the same summary report-no.: 30371439.002 dated 2004-02-20. They confirm, that the requirements according to EN 50178 are fulfilled.

The results are accepted by the Test Institute.

4.5 EMC/EMI contemplation

The EMC testing was performed on the PF700S at two test locations: Rockwell Automation, 6400 West Enterprise Drive, USA-Mequon WI, 53092 and LS Compliance Inc., W66 N220 Commerce Ct., Cedarburg WI 53012.

The EMC testing was performed for the following types of the PF700S drives:

Allen Bradley PowerFlex 700S AC Drive

Frame 0/1/2/3/4/5/6-240 V, 400 V, 480 V and corresponding DC input voltage ratings

Frame 5/6 - 600 V, 690 V and corresponding DC input voltage ratings

All EMC tests were witnessed by an expert of TÜV Rheinland of North America.

The results of the EMC tests are documented in the summary report-no.: P30461464.001 dated 2005-01-05. They confirm, that the requirements for EMC according to EN 61800-3 are fulfilled.

The results are accepted by the Test Institute.

5. Summary

The type approval of the Frequency AC Drive Powerflex 700S, manufactured by Rockwell Automation, Inc., came to the result, that the requirements of the applicable standards, which are listed in clause 2, are met.

Furthermore the inspection of the safety function "Safe standstill" of the frequency AC Drive Powerflex 700S came to result, that the safety function fulfils the requirements for safety category 3 according to EN 954-1 under the following prerequisites:

- Both safety inputs have to be used independent to each other.
- Due to the fact that a short circuit between the external wiring of the safety inputs will not be revealed by the system. The wiring has to be performed in such a way, that a fault exclusion acc. to ISO 13849-2 for the failures "short-circuits" is allowed. This is possible for example, when the cable is protected against external damage by cable ducting or armouring.
- The correct function of the safety function has to be tested in a periodic maintenance interval. The time period of this interval depends on the safety analysis of the system where the PF 700S is installed.
- The possibility of small movement of the motor resulting from simultaneous IGBT failures shall be taken into account during the hazard analysis of the application.
- Additional measures to keep the motor in the standstill position must be foreseen, if external forces may have an impact on the motor position.

The above listed conditions and the user manuals must be considered.

Cologne, 2005-02-25
ASI/Kst 968 stf-nie

The expert

A handwritten signature in blue ink, appearing to read 'Steffens'.

Dipl.-Ing. Thomas Steffens
Report-No.: 968/EZ 189.00/05