

Automation - Functional Safety

Inspection Report

**Report about the inspection of
the safety function "Safe Torque Off" (STO)
within the DX4 series drive of
ESTUN AUTOMATION CO., LTD.**

**Report-No.: 968/INS 314.00/20
Date: 2020-08-10**

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within the DX4 series drive of ESTUN AUTOMATION CO., LTD.**

Report-No.:	968/INS 314.00/20
Date:	2020-08-10
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Inspection scope:	Drives with integrated safety function “Safe Torque Off” (STO) Types: DX4 series
Customer/Manufacturer:	ESTUN AUTOMATION CO., LTD. No .155 Jiang Jun Road South, Jiang Ning Development Zone Nanjing 211100 P.R. China
Customer-Order-No./Date:	244051379 dated 2020-05-03
Inspection Body:	TÜV Rheinland Industrie Service GmbH Automation - Functional Safety Am Grauen Stein 51105 Köln Germany
Inspection Body Quotation-No./Date:	244051379 dated 2020-05-03
Inspection Body Order -No./Date:	190126662 dated 2020-06-03
Inspector(s):	Yunxi Zhang (responsible for project) Xiaoyi Hu
Location:	TÜV Rheinland (China) Ltd. Unit 707, AVIC Bldg.No.10B, Central Road East 3rd Ring Road, Chaoyang District Beijing 100022 P.R. China
Inspection duration:	May 2020 - August 2020

The inspection results are exclusively related to the test samples. This inspection report must not be copied **in an abridged version** without the written permission of the Inspection Body.

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1. **Scope**

This report documents the inspection of the safety function “Safe Torque Off” (STO) within the DX4 series drives. This variant bases on the previously certified ED3S series drives, which are further brought on the market. Both variants shall jointly be listed on an updated certificate.

This report contains the essential safety engineering aspects, that were inspected during the inspection and identifies the various inspection steps that were performed to provide evidence that the inspection object complies with the safety-relevant requirements of the product specification and the relevant standards.

2. **Inspection requirements and applied standards**

- [N1] INS FSP1
Inspection Program for Functional Safety related compliant items, components, devices, systems in the machinery and plant safety including safety components according to the European Machinery Directive
- [N2] EN 61800-5-2:2017
Adjustable speed electrical power drive systems
Part 5-2: Safety requirements - Functional
- [N3] EN 61800-5-1:2007 + A1:2017
Adjustable speed electrical power drive systems
Part 5-1: Safety requirements - Electrical, thermal and energy
- [N4] EN IEC 61800-3:2018
Adjustable speed electrical power drive systems
Part 3: EMC requirements and specific test methods
- [N5] EN ISO 13849-1:2015
Safety of Machinery - Safety Related Parts of Control Systems
Part 1: General principles for design
- [N6] EN 62061:2005 + AC:2010 + A1:2013 + A2:2015
Safety of machinery - Functional safety of safety-related electrical, electronic and programmable electronic control systems
- [N7] IEC 61508:2010, parts 1 - 7
Functional safety of electrical/electronic/programmable electronic safety-related systems
- [N8] EN 60204-1:2018 (in extracts)
Safety of machinery - Electrical equipment of machines
Part 1: General requirements
- [N9] IEC 61326-3-1:2017
Electrical equipment for measurement, control and laboratory use - EMC requirements
Part 3-1: Immunity requirements for safety-related systems and for equipment intended to perform safety-related functions (functional safety) - General industrial applications

3. **Identification of the inspection object**

3.1. **Description of the inspection object**

The safety function “STO” within the previously certified ED3S series drives is covered by the previous assessment report [R1]. The safety function “STO” within the DX4 series drives as the subject of this inspection is considered a variant of those.

The DX4 drive series consist of the following product types and their revisions (see [T2]):

Product Types ¹⁾	Hardware Rev.	Software Rev. ²⁾
DX4-1A5AJA	V100B3-TRIO	V100B6 / CRC32: 0xB4C89B95
DX4-1A5A##-*	V100B3-TRIO	V100B6 / CRC32: 0xB4C89B95
DX4-101AJA	V100B3-TRIO	V100B6 / CRC32: 0xB4C89B95
DX4-101A##-*	V100B3-TRIO	V100B6 / CRC32: 0xB4C89B95
DX4-102AJA	V100B3-TRIO	V100B6 / CRC32: 0xB4C89B95
DX4-102A##-*	V100B3-TRIO	V100B6 / CRC32: 0xB4C89B95
DX4-104AJA	V100B3-TRIO	V100B6 / CRC32: 0xB4C89B95
DX4-104A##-*	V100B3-TRIO	V100B6 / CRC32: 0xB4C89B95
DX4-108AJA	V100B3-TRIO	V100B6 / CRC32: 0x58D75603
DX4-108A##-*	V100B3-TRIO	V100B6 / CRC32: 0x58D75603
DX4-110AJA	V100B3-TRIO	V100B6 / CRC32: 0x58D75603
DX4-110A##-*	V100B3-TRIO	V100B6 / CRC32: 0x58D75603
DX4-115AJA	V100B3-TRIO	V100B6 / CRC32: 0x58D75603
DX4-115A##-*	V100B3-TRIO	V100B6 / CRC32: 0x58D75603
DX4-120AJA	V100B3-TRIO	V100B6 / CRC32: 0x13EC7171
DX4-120A##-*	V100B3-TRIO	V100B6 / CRC32: 0x13EC7171
DX4-130AJA	V100B3-TRIO	V100B6 / CRC32: 0x13EC7171
DX4-130A##-*	V100B3-TRIO	V100B6 / CRC32: 0x13EC7171

Table 3-1: Product Type Codes and Revisions covered by the Inspection

Note ¹⁾: For type code, refer to document [U1]
 # stands for A-Z to indicate encoder software edition;
 * n/a to indicate ESTUN's general client;
 0 ... 9 or A ... Z or any other form to indicate ESTUN's specific client number.

Note ²⁾: Software is not considered part of the safety function "STO", but performs only part of the diagnostic function on the STO circuitry. The whole DX4 series of products use the same source code, but different frame sizes use different compiler switch options. Therefore, the CRCs for different frame sizes differ, although they have the same revision number.

3.2. Documents provided by the manufacturer

Among other documents as detailed in [D1], the following most relevant documents have been taken into account during the inspection:

No.	Document	Rev.	Date
[D1]	Document list 05_DL_ESTUN_V1.9_2020-07-23.xlsx	1.9	2020-07-23
[D2]	Modification impact analysis report 26a_DX4_Change_Impact_Analysis_V1.2_2020-07-23.docx	1.2	2020-07-23
[D3]	Circuit schematics 20a_DX4_SCH-C_ESTUN_V1.0_2020-06-29.pdf	1.0	2020-06-29

No.	Document	Rev.	Date
[D4]	FMEA on component level 10b_FMEA_ESTUN_V1.4_2020-07-23.xlsx	1.4	2020-07-23
[D5]	Environmental (incl. EMC, mechanical) test plan 08_EMC TE_ESTUN_V2.1_2020-07-23.xlsx	2.1	2020-07-23
[D6]	EMC test report 21h_DX4 CE-EMC test report.pdf	-/-	2020-06-08
	21j_DX4 STO-EMC report.pdf	-/-	2020-06-08
[D7]	Electrical safety and environmental test report 21i_DX4 CE-LVD test report.pdf	-/-	2020-06-04
[D8]	Integration and validation test plan and report 13a_DX4 FTR_ESTUN_V1.0_2020-06-29.xlsx	1.0	2020-06-29
[D9]	Requirements traceability 24_ Requirement Traceability _V1.2_2020-07-23.xls	1.2	2020-07-23

Table 3-2: Documents provided by the manufacturer

Besides the above listed documents, the manufacturer has provided the following user manuals:

No.	Document	Rev.	Date
[U1]	Safety manual 09a_DX4 SM_ESTUN_V1.3_2020-07-10.doc	1.3	2020-07-10
[U2]	Product manual or user manual 23a_DX4 PM_ESTUN_V1.1_2020-07-10.docx	1.1	2020-07-10

Table 3-3: User manual provided by the manufacturer

3.3. Documents compiled by Inspection Body

The following table shows the main documents, compiled by the Inspection Body:

No.	Document	Rev.	Date
[T1]	List of Open Points (LOP) 2020-08-04_LOP-ESTUN_STO-update1.xlsx	-/-	2020-08-04
[T2]	Revision Release List 01_205_5728_01_20_RL_2020_08_17.docx	-/-	2020-08-10

Table 3-4: Documents compiled by the Inspection Body

3.4. Previous reports and certificates

No.	Report No.	Date	Certificate	Date
[R1]	968/FSP 1903.00/19	2019-09-20	01/205/5728.00/19	2019-09-20

Table 3-5: Previous reports and certificates

4. Inspection procedure and inspection results

4.1. Inspection procedure

This inspection considers a modification of the safety function “STO” within the previously certified ED3S series drives [R1]. The belonging certificate shall be updated to cover both the ED3S and the DX4 series drive variants. For this project, the following points have been covered:

- Inspection and review of modification impact analysis against each modification
- Inspection and review of the updated design documents, and corresponding repeated system integration and validation tests
- Inspection and review of electrical safety tests
- Inspection and review of environmental (ENV) tests
- Inspection and review of electromagnetic compatibility (EMC) tests
- Inspections and review of the updated user documentation

The following subchapters provide inspection results regarding the above listed topics.

4.2. Inspection results

4.2.1. Inspection of modification impact analysis

The modification impact analysis report [D2] provided by the manufacturer covers the following aspects:

- Reasons for each modification
- Contents of each modification itself
- Impact analysis against each modification

According to the modification impact analysis report [D2], the main changes are as following:

- Some safety related discrete components are replaced at the DX4, but the safety related circuits keep unchanged in comparison to the solution at the ED3S.
- Some non-safety related hardware and software changes, in order to reduce the DX4 hardware cost.

The the following conclusions have been drawn in the modification impact analysis report [D2]:

- Required system integration and validation tests shall be repeated (see chapter 4.2.2).
- All the electrical safety and environmental tests (except shock tests) shall be repeated (see chapter 4.2.3).
- EMC tests shall be repeated (see chapter 4.2.4).
- The user documentation shall be updated (see chapter 4.2.5).

Result: The inspection of the modification impact analysis confirmed that all relevant aspects on the modification are sufficiently covered regarding the requirements of the applicable standards.

4.2.2. Inspection of system integration and validation tests

According to the results of the modification impact analysis report [D2], the manufacturer carried out some necessary re-verification and re-validation tests (including also some Fault-Insertion-Test) on the DX4 series drives.

The integration and validation test plan and report [D8] contains the corresponding test results, which have been reviewed by the Inspection Body, see [T1]. As the test cases are the same as those of the previously certified ED3S products, covering all the functions and performance of STO; the system integration and validation tests were not witnessed by the inspection body. The inspection was only based on a review the validation test plan and report [D8].

Result: All required re-verification and re-validation tests of the safety function STO have been successfully passed, and are accepted by the Inspection Body.

4.2.3. Inspection of electrical safety and environmental tests

The basis for the inspection of electrical safety and environmental tests is formed by [N3]. These tests were carried out by the accredited test laboratory TÜV Rheinland (Shanghai) Co., Ltd. The corresponding test results were documented in the electrical safety and environmental test report [D7], which has been reviewed by the Inspection Body, see [T1].

According to the modification impact analysis report [D2], a re-execution of the vibration and shock tests as required by EN 61800-5-2:2017 was not considered necessary, since the mechanical structure design of the DX4 series drives is similar to the previously certified ED3S series drives.

Result: All necessary electrical safety and environmental tests have been passed successfully and are accepted by the Inspection Body based on the accreditation of the TÜV Rheinland (Shanghai) Co., Ltd. test laboratory.

4.2.4. Inspection of electromagnetic compatibility (EMC) tests

The EMC tests were carried out based on the requirements defined in [N4] for standard industrial levels, and based on the requirements defined in [N1] and [N9] for increased immunity levels. All tests have been performed in the accredited test laboratory TÜV Rheinland (Shanghai) Co., Ltd. The corresponding test results were documented in [D6], which has been reviewed by the Inspection Body, see [T1].

Result: All the repeated EMC tests have been passed successfully and are accepted by Inspection Body based on the accreditation of the TÜV Rheinland (Shanghai) Co., Ltd. test laboratory.

4.2.5. Inspection of the documentation for the user

New separate safety manual [U1] and product manual [U2] were created for the DX4 series drives. The ED3S series drives continue to use their own original safety manual and product manual. The manuals [U1] and [U2] have been reviewed according to the applicable requirements of [N7], part 2, annex D. Open items have been discussed and clarified together with the manufacturer (see [T1]).

Result: The new safety manual and product manual for DX4 series drive cover all relevant aspects for a safe use of the product. All relevant information for identification and safe use is in its appropriate place.

5. Summary

Based on the inspection performed, it is concluded that the "STO" safety function within the DX4 series drives listed in chapter 3.1 meets the requirements of PL e / Cat. 4 according to EN ISO 13849-1 and SIL 3 according to EN 61800-5-2 / IEC 61508, as well as for SIL CL 3 according to EN 62061.

Taking into account the notes in the associated product manual [U1] and the safety manual [U2], the safety function "STO" within the DX4 series drives can therefore be used in applications up to these levels.

The safety function "STO" in the ED3S series drives as well as the associated Product and Safety Manual has not been modified with respect to [R1] and therefore continues to meet the above-mentioned requirements.

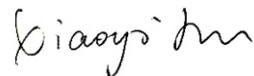
This inspection does not substitute the validation at application level, which is mandatory before commissioning a machine.

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