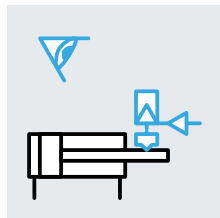


Safety Subfunctions Pneumatic

BT-s – Static Brake Test

Definitions



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- Specialist in electrical engineering
- Specialist for the programming of control systems and safety switching devices

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1 General

1.1 Objectives of this Document

- This document defines the diagnostic measure “static brake test (BT-s)” with results and describes possible measures. For practical implementation, additional notes are then given which should be observed depending on the application.

1.2 General Notes

- The given circuits are principle circuits which cannot be complete due to clarity and scope. It is a recommendation that does not exclude other possibilities.
- The abbreviations used for the safety sub-functions are based on the definitions in VDMA 24584 for pneumatics. The diagnostic measure “static brake test (BT-s)” is derived from the safety sub-function “safe brake monitoring (SBM)”. The background to this changed designation is that this diagnostic measure is not safe in the sense of a safety function and that no reliability requirements are normally necessary for diagnostic measures within the scope of ISO 13849.

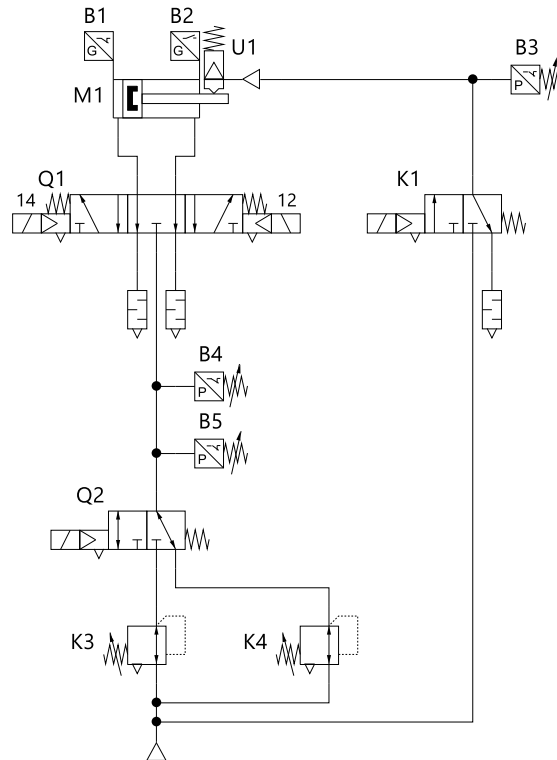
1.3 Definitions

- **Brake** (according to ISO 16092-2, 3.1)
Mechanism for slowing down, stopping and holding a power transmission element.
- **Clamping unit**
Mechanism for holding a power transmission element.

	position can be approached when requesting unlocking where there is no hazard. Important Note • Even with a positive result, it cannot be ruled out that the power transmission element of the drive does not move. The brake test only proves that at the time of the test the force is sufficient to hold the position.
Notes	• To apply the required holding force, a holding brake may perform a brief movement. • The static brake test leads to wear of the clamping unit. This should be taken into account when determining the frequency of the static brake test. • The axis with the clamping unit to be tested should be in a position where there is no obstacle or interfering contour in the range of movement.
Test intervals	• The static brake test should be carried out directly after switching on the machine, automatically at regular intervals during operation or before an assess in the hazardous area. • The following intervals are recommended for regular testing (basis ISO 16090-1): ○ Machines with manual loading and unloading in the hazardous area: Every 8 h or once per shift. ○ Machines with automatic loading and unloading in the hazardous area: Every 48 h
Test force	• The test force should be at least the maximum required force of the application with a safety factor. • The maximum required test force of the application depends on the requirements of the application. Possible values are for example ○ Recommended dimensioning: Maximum possible weight force of the load and the sum of the moving parts of the axis, incl. gripper. ○ Possible dimensioning: Maximum possible weight force of the load and the sum of the moving parts and the maximum force of the pneumatic drive. • Recommended safety factors are ○ With one clamping unit: $\eta = 1.3$ ○ In the case of two clamping units ▪ which are tested simultaneously: $\eta = 2$ ▪ which are tested one after the other: $\eta = 1$ Important note • The pressure required to generate the test force shall not exceed the maximum permissible pressure of the pneumatic components used.
Test duration	• Standards and other technical specifications, e.g., ISO 16090-1 and FBHM-5, specify test durations of 1–3 s. • Notes A distinction must be made between the following types of tests with regard to the test duration: ○ during commissioning; ○ during the functional test of the safety sub-function in normal operation; and ○ during periodic occupational safety inspections.

	○ During commissioning, the testing principle ➤ GS-IFA-M08 (only available in German) may be applied. During commissioning, the test is performed with a higher load and with the load applied for a longer period (GS-IFA-M08, 4.2.4.4), so that it can be assumed that the clamping unit will function as intended during the subsequent period. ○ During the functional test of the safety sub-function in normal operation, a higher load is applied for a short period to verify that the safety sub-function SB-f (friction-based blocking) functioned at the time of the functional test. For example, ISO 16090-1, Annex G, can be used for this purpose. ○ For periodic occupational safety inspections of safety functions, we recommend applying the testing principle ➤ GS-IFA-M08 (only available in German). Periodic inspections of safety functions are required by the Use of Work Equipment Directive 2009/104/EC, Article 5, and are also included in national implementations. During the periodic inspection, the test should likewise be performed with a higher load and with the load applied for a longer period, so that it can be assumed that the clamping unit will function as intended during the subsequent period. • Some clamping units may briefly jerk after 30...50 s when they are close to the wear limit, but may still be able to hold the load. It must be assessed on an application-specific basis whether this effect can occur and whether it poses a hazard.
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Carrying out the static brake test



Notes

- The pressure regulator (K3) should be protected from manipulation during normal operation so that the required test force is available for each static brake test.
- If a limit switch is used, it should be set so that the switching point is at the smallest possible distance from the end position, e.g. 1 mm. However, this must be determined depending on the application in order to obtain sufficient reliability of the normal machine function.
- Ideally, the end position should be monitored with an analogue position sensor. Depending on the operation of the clamping unit, it may move 0.1...0.3 mm when the test force is applied, unless otherwise specified by the manufacturer.

During initial commissioning

- The pressure is set at pressure regulator K3 to obtain the test force at the transmission element of the drive. The working pressure required for the application is set at pressure regulator K4.
- The pressure required for the test force is set at pressure switch B4 (plus measuring tolerance). This pressure switch monitors whether valve Q2 switches and whether the required pressure for the brake test is present.
- The pressure required for normal operation is set at pressure switch B5 (plus measurement tolerance). This pressure switch monitors whether valve Q2 is in normal position and whether the required pressure for normal operation is present.
- The following tests must be carried out and documented, e.g. measurement protocol, video.
 1. It must be proven by a force measurement that the pneumatic drive applies the test force for the clamping unit.
 2. It must be proven by a functional test that the pressure switch monitors the pressure that leads to the test force.

	3. A static function test must be carried out. Performing the static brake test • Check whether the pneumatic drive moves and reaches both end positions and the limit switches B1, B2 are actuated accordingly. • Move to an end position, for example the end position with limit switch B1. The valve Q1 remains actuated in the switching position 12. • Valve K1 is no longer actuated. The compressed air supply to the clamping unit is interrupted and exhausted. As a result, the locking unit goes into normal position and frictionally clamps the output element of the drive. • Valve Q2 is activated, moves to the switching position and switches the test pressure to port 1 of valve Q1. • The valve Q1 is controlled to the switching position 14, the drive is pressurised with the test pressure so that force acts on the friction surfaces of the clamping unit. The clamping unit prevents movement, i.e. the limit switch for monitoring the end position B1 must remain actuated. If the limit switch remains actuated, the test is successful; if there is a movement, the test has failed. • After the test, valve Q2 is no longer actuated, so that it switches to the normal position and the normal working pressure is again applied to port 1 of valve Q1. In normal operation • The function of valve K1 is monitored with pressure switch B3.
Diagnosis for clamping units	The static brake test is normally used as a diagnostic for clamping units to hold an output element of drives. • Diagnostic coverage DC=99% is not possible A diagnostic coverage of 99% requires direct monitoring of the effect on which the safety function is based. This means that the friction between the friction partners of the clamping unit must be monitored. This is not possible with a static brake test, so that a DC=99% cannot be achieved with frictionally engaged clamping units. • Diagnostic coverage DC=90% For a diagnostic coverage of DC=90%, a static function test must be carried out regularly or directly before any access in the hazardous area. In addition, the actuation of the control valve of the clamping unit should be monitored with a pressure switch or with a limit switch in the clamping unit.

3 Used Literature

3.1 Technical Specifications

- [1] FBHM-005: Gravity-Loaded Axes—Vertical Axes, dated August 17, 2021, accessed October 8, 2025, available at <https://publikationen.dguv.de/widgets/pdf/download/article/4333>
- [2] Testing Principle GS-IFA-M08—Principles for the Testing and Certification of Pneumatic Braking/Holding Devices with a Safety Function for Linear Actuators, dated October 2024, accessed October 8, 2025, available at https://www.dguv.de/medien/dguv-test-medien/pdf_zip_doc_ppt/pruefgrundsaeetze/ifa/gs-ifa-m08_2021-03.pdf

3.2 Standards

- [3] DIN EN ISO 4414:2011-04 – Pneumatic fluid power - General rules and safety requirements for systems and their components (ISO 4414:2010); German version EN ISO 4414:2010
- [4] ISO 5598:2020-01 – Fluid power systems and components - Vocabulary
- [5] DIN EN ISO 12100:2011-03 - Safety of machinery - General principles for design - Risk assessment and risk reduction (ISO 12100:2010); German version EN ISO 12100:2010
- [6] DIN EN ISO 13849-1:2016-06 – Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design (ISO 13849-1:2015); German version EN ISO 13849-1:2015
- [7] DIN EN ISO 13849-2:2013-02 – Safety of machinery - Safety-related parts of control systems - Part 2: Validation (ISO 13849-2:2012); German version EN ISO 13849-2:2012
- [8] DIN EN ISO 16090-1:2019-12 - Machine tools safety - Machining centres, Milling machines, Transfer machines - Part 1: Safety requirements (ISO 16090-1:2017); German version EN ISO 16090-1:2018
- [9] VDMA 24584:2020-10 – Safety functions of regulated and unregulated (fluid) mechanical systems; German Version
- [10] DIN EN 61508:2011-02 - Functional safety of electrical/electronic/programmable electronic safety-related systems (IEC 61508:2010); German version EN 61508:2010
- [11] DIN EN 61511:2019-02 - Functional safety - Safety instrumented systems for the process industry sector - (IEC 61511:2016); German version EN 61511:2017
- [12] DIN EN 62061:2016-05 - Safety of machinery - Functional safety of safety-related electrical, electronic and programmable electronic control systems (IEC 62061:2005 + A1:2012 + A2:2015); German version EN 62061:2005 + Cor.:2010 + A1:2013 + A2:2015

3.3 Legal Regulations

- [13] Machinery Directive: Directive 2006/42/EC of the European Parliament and of the Council of 17 May 2006 on machinery, and amending Directive 95/16/EC (recast)
- [14] Machinery Regulation: Regulation (EU) 2023/1230 of the European Parliament and of the Council of 14 June 2023 on machinery and repealing Directive 2006/42/EC
- [15] Use of Work Equipment: Directive 2009/104/EC of the European Parliament and of the Council of 16 September 2009 concerning the minimum safety and health requirements for the use of work equipment by workers at work (second individual Directive within the meaning of Article 16(1) of Directive 89/391/EEC)

4 Information about the Document

4.1 General Information

Document Number	100423
Diagnostic Function	BT-s – Static Brake Test - Definition

4.2 Revision History

Ver.	Date	Ed.	Chapter	Description of Change/Impact
1.10	2023-03-21	JKHL	All	Creation of the document
1.20	2026-08-26	JKHL	All	Update Layout, editorial revision
			Test duration	Updated

4.3 Approval/Release of the Document

Role	Signature
Release	

4.4 Period of Validity

Document is valid until 2031-08-25 or until one of the documents used or the required relevant base are changed.



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