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Translation

GS-ET-39 “Principles of testing and certification of Coordinate measuring machines”

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These Principles of testing serve as verification that the requirements of the German Product Safety Act (ProdSG) and, as such, the 9th provision of the ProdSG has been complied with.

These principles will be revised and supplemented periodically in consideration of knowledge gained in the area of occupational safety and the state of technological progress.

The most recent edition shall always be binding for tests conducted by the Electrical engineering testing and certification body of the Energy, textile & electrical media products department.

This is the English translation of the German test principle. The German original version is obligatory.

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1 General

1.1 Scope

These Principles of testing apply to Coordinate measuring machines that are not operated by human force. They also apply to Coordinate measuring machines, on which the drive system for the axes is supported by human force.

These Principles of testing do not include any requirements for hand-operated Coordinate measuring machines.

1.2 Testing and certification process

The testing and certification process will be initiated upon signing of the contract by the contractual partners. The technical documentation set forth in Section 3.2 is to be submitted together with the contract.

In principle, a complete and functional Coordinate measuring machine must be made available at the time type testing is performed.

In principle, the testing of the Coordinate measuring machine by the Test laboratory will be performed at the applicant's or manufacturer's facilities. Only under exceptional circumstances will testing be performed at the operator's facilities.

1.3 EC/EU Directives and standards

The directives and standards listed below were taken into consideration, among others, while preparing these Principles of testing:

2006/42/EC	Directive 2006/42/EC of the European Parliament and of the Council from 17 May 2006 on machinery and amending Directive 95/16/EC (revised version) ["Machinery directive"]
2014/35/EU	Directive 2014/35/EU of the European Parliament and of the Council from 26 February 2014 on the harmonization of the laws of the Member States regarding the provision in the market place of electrical equipment designed for use within certain voltage limits (revised version) ["Low-voltage directive"]
2014/30/EU	Directive 2014/30/EU of the European Parliament and of the Council from 26 February 2014 on the harmonization of the laws of the Member States regarding Electromagnetic compatibility (revised version) ["EMC directive"]

Normative documents:

Preliminary remarks: With regard to undated references within the context of testing, the edition of the standard listed in the Official Journal of the European Union that relates to the Machinery Directive (MD) or the Low-voltage directive (LVD) is to be used.

DIN EN ISO 12100	Safety of machinery – General principles for design − Risk assessment and risk reduction
DIN ISO/TR 14121-2:2013-02	Safety of machinery −Risk assessment − Part 2: Practical guidance and examples of methods
DIN EN 60204-1	Safety of machinery - Electrical equipment of machines - Part 1: General requirements
DIN EN 61010-1-1	Electrical equipment for measurement, control and laboratory use Part 1: General requirements
DIN EN ISO 13849-1	Safety of machinery -Safety-related parts of control systems −Part 1: General principles for design
DIN EN ISO 13849-2	Safety of machinery; Safety-related parts of control systems; Part 2: Validation
DIN EN ISO 13857	Safety of machinery - Safety distances to prevent hazard zones from being reached by upper and lower limbs
DIN EN ISO 13854	Safety of machinery – Minimum gaps to avoid crushing parts of the human body
DIN EN ISO 13850	Safety of machinery – Emergency-Stop - General principles for design
DIN EN 62477-1	Safety requirements for power electronic converter systems and equipment
GS-ET-07	Wireless control equipment subject to machinery safety requirements

2 Terms and abbreviations

2.1 Coordinate measuring machine

A Coordinate measuring machine is a machine/measuring device used for determining the spatial coordinates of points on the surface of an object. Processing of the data compiled by linking the points from multiple measurements will result in the various geometric parameters and properties of the measured object

2.2 MD: Machinery Directive

Directive 2006/42/EC of the European Parliament and of the Council from 17 May 2006 on machinery and amending Directive 95/16/EC.

2.3 LVD: Low voltage directive

Directive 2014/35/EU of the European Parliament and of the Council from 26 February 2014 on the harmonisation of the laws of the Member States regarding the provision in the market place of electrical equipment designed for use within certain voltage limits.

2.4 Official Journal of the European Union

List of the respective EU Directive harmonized standards.

2.5 Measuring machine danger zone

The area within which the moving parts on the measuring machine or the measuring head can be physically accessed.

2.6 ESPE: Electro-sensitive protective equipment

Electro-sensitive protective equipment includes light barriers and curtains, laser scanners, camera systems, passive infrared systems, etc.

2.7 SRCF:

Safety related control function (safety function)

A function within the control system, whose failure or loss will lead to an immediate increase in the level of risk/the risks.

2.8 Type testing

Tests performed on a test object/test piece are subjected to certain assumptions in order to verify that defined requirements have been complied with.

2.9 Effective area

That section of the probe where measurements are made (measurement range)

2.10 PL: Performance Level

Discrete level that specifies the capacity of the safety-related parts of a control system to perform a safety function under foreseeable conditions.

3. Test conditions

3.1 General

Insofar as it has not been set forth in the individual test sections, the tests are to be performed at an ambient temperature from 15°C to 35°C and a at relative humidity of not greater than 75%.

All values required for testing must be maintained with such precision that ensuing test results will not be influenced by more than ± 5%.

In principle, all tests will be performed on a single test object, in the condition intended for delivery, which must pass all relevant tests.

3.2 Documents to be submitted

The following technical documentation is required for testing:

- Operating instructions including technical specifications
- Sales literature
- Installation and setup instructions
- Circuit diagrams (electrical, pneumatic, hydraulic)
- Engineering drawings , 3D models
- Parts lists with material or standards specifications, as well as a list of individual circuit board components
- Circuit board layout
- Software documentation (safety-relevant)
- Product and safety data sheet for the hydraulic fluid, if applicable
- Calculation verification for the pressure-volume product on the basis of the Pressure Equipment Directive, if applicable
- Calculation verification for max. energy, if applicable
- PAH client information - Self-disclosure

3.3 Test objects to be provided

A complete and functional machine, configured with all possible options, is to be made available for testing.

4. Requirements and tests

4.1 General requirements

4.1.1 External materials and properties

The materials used for manufacturing the machine or the products used during its operation must not impair the safety or endanger the health of persons. Parts that may come in contact with the operator's skin during usage must not contain of any dangerous substances.

Test: Testing is performed according to the German AfPS GS 2019:01 PAK.

4.1.2 Electromagnetic compatibility

Coordinate measuring machines must be designed in such a manner that the protection requirements in the EMC Directive are complied with.

Test: Testing in accordance with DIN EN 61000-6-2 (immunity to interference) and DIN EN 61000-6-4, Class A (interference emission) for use in an industrial environment.

If the intended proper use of the machine is limited to a controlled environment with respect to disturbance variables (e.g. measuring room, measuring laboratory), then the reduced interference immunity requirements according to DIN EN 61326-1, Table 2 may be suitable. Usage restrictions must be specified in the Operating instructions.

4.1.3 Foreseeable application (foreseeable faulty application)

The product must not impair the safety or endanger the health of persons when used under reasonably foreseeable conditions.

Test: Visual inspection, check inscriptions/markings and review Operating instructions.

4.1.4 Stability criteria

The machine must be designed and built in such a manner that the prescribed stability criteria is warranted during operation or when it is out of service, during all phases of transport, installation or disassembly, as well as with any foreseeable parts failure or during testing according to the Operating instructions. This also applies to any foreseeable faulty application (maximum loading on just one corner of the measuring plate with a 3-point support).

Test: Visual inspection, check inscriptions/markings and review Operating instructions.

4.1.5 Hazard due to uncontrolled motion

When a machine component has been stopped, any motion away from its rest position must be prevented, no matter what the cause except for actuation of the control device, or the motion must not be hazardous to persons.

4.1.6 Noise

The machine must be designed and built in such a manner that the risks associated with airborne noise emissions, particularly those at the source, are reduced to the extent possible by technical progress and by the means available for reducing noise.

Information and instructions regarding the use of PPE (ear protection) must be included in the Operating instructions for noise emission levels greater than 80 dB(A).

Test: Measurement and evaluation of the emission value, if applicable.

4.1.7 Radiated emission

All function-related emissions of non-ionising radiation must be limited during setup, operation and servicing to the extent that they will have no harmful effects on humans.

Test: Measurement and evaluation of the magnetic, electrical or electromagnetic field strength, if applicable. Application of warning notices with references included in the Operating instructions.

4.1.8 External radiation

The machine must be designed and built in such a manner that its function will not be impaired due to external radiation.

Test: Testing of immunity to interference according to Section 4.1.2

4.1.9 Laser radiation

The following is to be considered when laser equipment is used:

- Laser equipment used in machinery must be designed and built in such a manner that it will not inadvertently emit radiation. Sales literature
- Laser equipment used in machinery must be shielded in such a manner that damage to health will not be suffered due to exposure to effective radiation, to reflected or scattered radiation, or to secondary radiation.

Test: Measurement and classification of the laser Radiation according to DIN EN 60825-1, if applicable.

4.1.10 Risk of being trapped in a machine

The machine must be designed, built or equipped in such a manner that it is not possible for a person to become trapped inside.

The machine must be designed, built or equipped in such a manner that it is not possible for a person to become trapped inside.

Test: Testing for accessibility and the possibility of opening the access doors from the inside (emergency release).

4.1.11 Risk of slipping, tripping and falling

Those sections of a machine where persons could be present or manoeuvring must be designed and built in such a manner that the potential for slipping, tripping or falling onto or from them is prevented.

Test: Visual inspection of the floor covering on the accessible sections of the machine.

4.1.12. Servicing and maintenance of the machine

Isolating the energy sources

The machine must be equipped with devices that make it possible to isolate each individual source of energy (e.g. electrical supply, compressed air, etc.). These devices must be clearly identified. They must be lockable in order to ensure that re-engagement will not cause a hazard for persons.

Where a plug and socket combination are used for disconnecting the mains, and which are under the direct control of the person performing the work, then a locking device for the OFF position need not be provided.

Isolating devices may also be included in the operating company’s installation (plug-in devices for the electrical supply or compressed air).

Test: Visual inspection

4.2 Inscriptions and marking

The following minimum information must be discernible, clearly legible and permanently applied:

- Company name and full address of the manufacturer and representatives, if applicable
- Machine designation
- CE markings
- Design series or type designation
- Nominal voltage, number of external conductors and frequency (for AC supply), as well as full load current for each power supply
- Nominal operating pressure, if applicable
- Serial number, if applicable
- Year of manufacture, meaning the year in which the production process was completed.

Test: Check for plausibility and completeness and the information and wipe test according to DIN EN 61010-1, Sec. 5.3

4.3 Operating instructions and Sales literature

4.3.1 Operating instructions

Each measuring machine must be accompanied by Operating instructions in German and be comprehensible to a level realistically expected of the user. It must contain all the information necessary for handling, servicing and assembly of the device.

The language version(s), for which the manufacturer assumes responsibility, shall be annotated „Original Operating Instructions“. Each additional translation shall be annotated „Translation of the Original Operating Instructions“.

The following information must be incorporated:

a) General information

- Manufacturer`s/authorised representative`s company name and complete address
- Machine designation/description
- Design series or type designation
- EC Declaration of Conformity (original or rendering of the content)
- Information regarding the service and maintenance work that may be performed by the operator.
- Maximum operating pressure
- General specifications for the electrical power supply
- Information related to pneumatic and hydraulic energy, if applicable

b) Description of the measuring machine

- List of the technical specifications (including nominal voltage, nominal power consumption, (network configuration, maximum operating pressure, weight specification)
- Description of the actuating and reporting equipment

c) Instructions regarding proper usage

- Information regarding the scope of application
- Description of initial commissioning
- Description of intended proper usage
- Description of foreseeable faulty applications
- Instruction regarding admissible temperature and environmental influences when using the device
- Instruction regarding isolating for energy sources
- Instruction regarding proper handling during assembly and loosening of tool inserts and other removable components
- Correlation of the tool inserts to the working heads and to the material being processed
- Instruction regarding the approved replacement of parts by the user
- Instruction regarding safety-relevant actions in the event of a malfunction, such as information related to residual risks.
- Information regarding storage, transport and handling (incl. specification of weight)
- Information regarding airborne noise emission
- Information regarding the release of non-ionising radiation (magnetic fields, electrical fields, electromagnetic fields) in the event the exposure limit values or triggering thresholds (also those for implant carriers!) in Directive 2013/35/EU Annex II, Annex III can be exceeded
- Information regarding classification of the laser equipment being used

Test: Check the Operating instructions for completeness of the requirements mentioned above

4.3.1 Malfunction during installation and setup

The failure during installation or re-installation of a component that could potentially pose a risk must be made impossible through its design and construction, or prevented by posting a notice on the component, itself, and/or on its enclosure.

The same notice must be applied to all moving parts and/or on their enclosures if knowledge of the direction of motion is necessary for avoiding the risk.

Additional information regarding these risks should be included in the Operating instructions, if deemed necessary.

If a faulty connection can cause a risk, then this must be made impossible through construction of the connecting component, or made impossible by posting a notice on the parts being connected and, if applicable, on the means of connection.

Test: Check the installation and setup instructions

4.3.2 Sales literature

In a sales brochure is available, it must not contradict the Operating instructions with regard to the protection of safety and health. If performance characteristics are described in the sales literature, these must agree with the specifications in the Operating instructions.

Test: Review the sales literature for consistency with the Operating instructions

4.4 Hydraulic equipment

The hydraulic equipment must comply with the requirements of DIN EN ISO 4413.

Test: Review of the data sheets and check the applicable requirements according to DIN EN ISO 4413

4.5 Pneumatic equipment

If a Coordinate measuring machine is outfitted with pneumatic equipment, the applicable requirements from DIN EN ISO 4414 must be taken into consideration.

Test: Review of the data sheets and check the applicable requirements according to DIN EN ISO 4414

4.6 Electrical equipment and electrical hazards

Compliance with the protection requirements set forth in the MD, Annex 1, Sec. 1.5.1 must be verified in accordance with DIN EN 60204-1.

Test: Testing of the electrical equipment in accordance with the applicable requirements of DIN EN 60204-1

Note: Configuration of the electrical equipment with reference to the over-voltage category must be in accordance with DIN EN 60664-1.

In principle, power supply units that comply with the requirements of DIN EN 62368-1 are already configured for Over-voltage category II.

4.6.1 SRCF (safety related control function) requirements

The safety-relevant functions listed in the Annex are exemplary for the potential safety functions provided in Coordinate measuring machine controllers or through external equipment.

The Plr required for the respective SRCF can be determined with reference to DIN EN ISO 13849-1, Annex A.

Test: Validation of the safety functions in accordance with DIN EN ISO 13849-2

4.6.2 Interface for safety stop

Each Coordinate measuring machine designed for integration into a production system must be configured with potential connections for external protective equipment, such as light curtains or guard door interlock switching.

This interface can be designated, for example, as a safety stop input. In addition to the Emergency-Stop input, it must be physically available, for example, through additional connecting terminals.

The stop-reaction of the Coordinate measuring machine in the event of a safety stop must occur in stop category 0 or 1, corresponding to DIN EN 60204-1. Stop category 2 can also be used if the stoppage is reliably monitored.

The Performance Level and MTTFD (or PFHD) must be specified in the Operating instructions for both interfaces.

Test: Check for intended proper usage, check for the presence of the interfaces and for the required information in the Operating instructions

4.6.3 Emergency-Stop

Coordinate measuring machines must be configured with one or more Emergency-Stop devices, through which all hazardous motion and conditions can be stopped.

The SRCF in the Emergency-Stop circuit (e.g. for hazardous motion) must perform at least to PLc.

Emergency-Stop devices must be designed in accordance with DIN EN ISO 13850 and be easily accessible. As a minimum, they must be provided for at every operating station and on every control console.

The machine must not restart immediately upon release of the Emergency-Stop command device. Restart should be initiated only after actuation of a separate starting device.

Test: Testing of the Emergency-Stop device for function and compliance with the requirements according to DIN EN ISO 13850 and DIN EN ISO 13849-1/-2

4.6.4 Movable separating guards

Movable separating guards must be locked in conjunction with any hazardous motion. This means that the hazardous motion must be reduced to less than 250 mm/s, considering the maximum energy specified in Section 4.7.1,

and must be reliably monitored as soon as a guard is opened. The speed reduction must take place before the moving parts (in the operating area) can be accessed by persons.

Compliance with a safety distance to the operating area can be dispensed with if the measuring machine’s axes exhibit a sufficiently small overrun value (< 50 mm).

Test: Measurement of force progression using a force measuring device possessing a spring constant of 25 N/mm. Force progression: 450 N (peak), 150 N after 0.75 s, 0 N after 5 s.

Check the prescribed maximum axis speed and overrun traverse; check the energy calculation verification for plausibility; determine the suitability of the protective equipment.

4.6.5 Electro-sensitive protective equipment (ESPE)

Electro-sensitive protective equipment includes light barriers and curtains, laser scanners, camera systems, passive infrared systems, ultrasonic systems, etc.

Any hazardous motion must be reduced to less than 250 mm/s, considering the maximum energy specified in Section 4.7.1,

and must be reliably monitored as soon as it is addressed by the ESPE.

In principle, safety distances for the electro-sensitive protective equipment must be configured to correspond with DIN EN ISO 13855. A walking/grabbing speed is established at 1.6 m/s in accordance with DIN EN ISO 13855.

Compliance with a safety distance to the operating area can be dispensed with if the measuring machine's traversing axes possess a sufficiently small overrun value (< 50 mm).

Test: Measurement of force progression using a force measuring device possessing a spring constant of 25 N/mm. Force progression: 450 N (peak), 150 N after 0.75 s, 0 N after 5 s.

Check the prescribed maximum axis speed and overrun traverse; check the energy calculation verification for plausibility; determine the suitability of the protective equipment.

4.6.6 Protective guards with rear access; Acknowledgement

Coordinate measuring machines may be accessible. In addition to actively limiting the force-/energy if access is possible, measures must be taken to prevent motion at speeds greater than 150 mm/s in the measuring machine as long as persons are present in the danger area. This applies to the same extent to access doors protected by electro-sensitive protective equipment (e.g. light curtains, laser scanners) as well as to movable separating guards (e.g. protective doors).

In principle, danger zones within the Coordinate measuring machine must be visible. For this reason, an acknowledgement button is sufficient for resetting the signal from the protective equipment, such protective doors and light curtains, and for releasing motion at the maximum possible speed.

Test: Measurement of force progression using a force measuring device possessing a spring constant of 25 N/mm. Force progression: 450 N (peak), 150 N after 0.75 s, 0 N after 5 s.

Check the prescribed maximum axis speed; check the energy calculation verification for plausibility; determine the suitability of the protective equipment.

For acknowledgement, the following applies:

The acknowledgement button must be installed at a location outside of the protective equipment.

- It must be not be accessible from inside.
- A clear view of any hazardous motion and the danger zone from wher the acknowledgement button is located must be warranted.
- Signal evaluation must ensure that the jamming of, or the conscious fixing of the button are recognized.
- Operating instructions for the Coordinate measuring machine must include information alerting the person actuating the acknowledgement buttons or viewing window may be required in order to facilitate the visibility of the danger one during acknowledgement.

Test: Visual inspection and assessment of the acknowledgement button signal evaluation.

4.6.7 Protective guards without rear access

Acknowledgement devices can be dispensed with if the working space is so small that the presence of persons going unnoticed is not possible. Motion can be released at the maximum possible speed upon closure of the protective door contacts or release of the ESPE.

The size of a danger zone without acknowledgement devices should not exceed the following dimensions:

- Max. measuring plate: 1000 mm x 2000 mm
- Height of the measuring plate above the floor: min. 600 mm

Potential gaps between the ESPE and the danger zone (e.g. measuring plate) must not be greater than 75 mm so that persons cannot access the space in between.

Test: Measure the height of the measuring plate

4.7 Mechanical hazards associated with moving parts

The degree of the hazards associated with moving parts must not exceed a justifiable level. If it is not possible to comply with this stipulation, measures must be taken to reduce any potential risk.

4.7.1 Traversing speed; Energy

The maximum energy of 4 J must not be exceeded on machines where physical contact can be made with any moving part that poses a risk of crushing, shearing or collision. Separating and/or non-separating protective equipment must be used where higher levels of energy exist.

If protective equipment is used, it should be configured to reduce the maximum speed to 250 mm/s when actuated. If the maximum energy level of 4 J is exceeded in the process, then the speed should be further reduced to an appropriate value, whereby the energy level of 4 J must not be exceeded. This calls for the reliable monitoring of speed at each axis with a PLc being realized as a minimum.

With regard to limiting the energy level, the dynamic peak force of 450 N must not be exceeded. A static energy level F > 150 N is not permitted after a time duration of 0.75 s. This static energy must sink to a level of 0 N after a total time duration of max. 5 s.

Test: Measurement of force progression using a force measuring device possessing a spring constant of 25 N/mm. Force progression: 450 N (peak), 150 N after 0.75 s, 0 N after 5 s.

Check the prescribed maximum axis speed; check the required Performance Level; check the energy calculation verification for plausibility.

4.7.2 Overrun traverse, run-down time

The greatest resulting overrun traverse on accessible moving machine components must not exceed 50 mm, while the motion must come to a stop at the latest 500 ms after actuating the “Stop command”. The overrun traverse must not exceed 100 mm in the event of a power failure.

Test: Measurement or calculation of the overrun traverse and the run-down time

4.7.3 Risk of breakage; End stops

The various machine components and their interconnections must be able to withstand the loads they are subjected to during machine operation.

The materials used must exhibit suitable strength and resistance, particularly with respect to material fatigue, ageing, corrosion and wear, corresponding to the intended operating environment foreseen by the manufacturer. End stops must be configured in such a manner that they can accept the kinetic energy loads on the respective axis at the greatest speed occurrence, even in the event of a malfunction.

Test: Verification through calculation

4.7.4 Risks associated with falling objects or sinking of the vertical axis

Precautions must be taken to prevent any risks associated with falling objects or machine parts, as well as with objects that could fall from or be thrown from the machine.

Precautions must also be taken to prevent any inadvertent sinking of the vertical axis.

Test: Visual inspection, handling or functional testing of the braking system

4.7.5 Risks associated with surfaces, edges or corners

Where function allows, machine components which can be physically accessed should not have any sharp corners, edges or abrasive surfaces that can cause injury.

Test: Visual inspection and handling of corner and edge surfaces

4.8 Operator interface

4.8.1 Starting and stopping the drive unit

Manually actuated control elements must be available for starting and stopping the drive unit.

Test: Visual inspection and handling check

4.8.2 Unintentional actuation

Actuating elements (e.g. control console) used to initiate a motion must be protected against unintentional activation.

If a time window is used for deactivation of an actuating element, then the time frame must be maximum 60 s in length, after which the actuating element must be disabled.

A subsequent release must be possible only through deliberate actuation.

Test: The test object in the disabled state is placed in every possible position on a horizontal surface.

The test has been passed when a hazardous motion has not been initiated during testing.

5 Routine testing by the manufacturer

The tests described in this section should serve to uncover any discernible safety-related changes in the materials or the production process. These tests are to be performed on each Coordinate measuring machine.

The manufacturer can select the test procedures best suited for its production process if the tests selected guarantee at least the same level of safety as represented by the tests listed in the following section.

Routine testing of the electrical equipment:

- Ensure the continuity of the protective conductor system,
- Measurement and assessment of the leakage current

Functional test:

- The function of all control elements is to be tested for conformity with the specifications in the Operating instructions
- All SRF must be checked for functionality;the effectiveness of force-limiting and speed-limiting measures taken (e.g. force and speed measurement) must be verified.
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The results of the routine and function testing must be documented

Test: Review of the test instructions and test protocol for routine testing

Annex I (informative)

Explanation of possible Safety Related Control Functions (SRCF)

SRCF1: Limitation and reliable monitoring of torque and force

With consideration given to the edge-geometry of all Coordinate measuring machine surfaces involved in the work process, the control-side monitoring and limitation of force or torque results in a reduction of the risk of being crushed between moving and stationary parts of the measuring machine or installation room.

It is not sufficient, for example, to measure and document the force merely in a normal state. Excessive forces or speeds must not occur, even in the event of a component failure, or a hardware or software error. As an alternative, reliable force limitation, for example, can also be realized through an inherently safe design (e.g. slip clutch).

SRCF2: Reliable monitoring of the speed

In order to ensure that the speed will not exceed its permissible limit when contact with a person occurs or is about to occur, the speed must be reliably monitored to guarantee the force is maintained upon contact.

SRCF3: Emergency-Stop

The Emergency-Stop safety function must at least correspond to the requirements for PLc, DIN EN ISO 13849-1.

SRCF4: Integration of signals from external interlocking devices or ESPE

Coordinate measuring machines must be configured with one or more inputs for connecting safety device interlocks or ESPE.

Exception: Coordinate measuring machines, whose design ensures that the specific limits for force or torque and the specified speed as set forth in Sec. 4.6. will not be exceeded.

As a minimum, PL c must be possible in order to use this signal for SRCF1 and SRCF2. This means, for example, that when an object is present in the laser scanner’s protective field, its maximum speed will be reduced and reliably monitored (SRCF2) in order to maintain this maximum speed. SRCF1 becomes active at the same time If the limit value for force or speed in this situation is exceeded, then one of the machine’s Emergency-Stop functions will be triggered via SRCF3.

Annex II (informative)

Recitals for the assessment of risks associated with moving parts

Recital 1

A risk assessment addressing potential hazard zones must be performed using the Risk matrix according to DIN ISO/TR 14121-2, Table 1. An estimation of the extent of damage based on historical data (accidents involving Coordinate measuring machines in the last 25 years) shows that there have not been any serious or catastrophic events resulting in damages associated with measuring machines due to traversing axis motion.

Even incidents resulting in „moderate“ damages could not be traced back to the measuring machine, as such, but rather to the measured objects. Realistically viewed and with respect to personal injury associated with the hazards of traversing motion, it can be assumed that the potential extent of damages borne by a measuring machine is „moderate“ (S2).

At speeds of up to 250 mm/s (DIN ISO/TR 14121-2, Sec. 6.3.2), it is possible to avoid injury by physical evasion (A1).

At speeds greater than 250 mm/s, the avoidance of injury by physical evasion is no longer possible (A2).

For the machine operator, it is assumed that the duration/frequency of exposure to hazards in the effective area of the measuring head is „frequent“, because the „Teach-In“ process requires more than 15 min. of physical presence within the machine’s danger zone per work shift (F2).

Outside the effective area of the measuring head, it is assumed that the duration/frequency is „seldom“ (F1).

The probability of a hazardous occurrence in both cases is assumed to be „moderate (negligible)“ (O2/O1).

Based on DIN ISO/TR 14121-2, Fig. 3, an estimation of the risk to the operator associated with a machine's traversing motion results in:

Automatic mode: S2-F1-O2-A1 => Risk index 2 (negligible risk). The probability of a damaging occurrence is „remotely conceivable“.

“Teach-In mode“ (within the effective area of the measuring head): S2-F2-O2-A1 => Risk index 4 (moderate risk).

The probability of a damaging occurrence is „unlikely“.

For a non-operator of the machine, it is assumed that the duration/frequency of exposure to hazards is „seldom“, because this group of people does not normally access the machine’s effective operating area and has no reason to be present in that area for more than 15 min. (F1).

The probability of a hazardous occurrence for a non-operator is assumed to be „moderate“ (O2).

Based on DIN ISO/TR 14121-2, Fig. 3, an estimation of the risk to the non-operator associated with a machine's traversing motion results in:

S2-F1-O2-A1 => Risk index 2 (negligible risk).

The probability of a damaging occurrence is „unlikely“.

The probability of a cumulative damaging occurrence while working on a Coordinate measuring machine is „remotely conceivable“, refer to DIN ISO/TR 14121-2, Sec. 6.2.2.4.

Recital 2

Force-time limit values are considered on the basis of DIN EN 12453 “Industrial, commercial and garage doors and gates - Safety in use of power operated doors - Requirements and test methods“. The limit values for the max. motion energy of 4 J has also been adopted for Coordinate measuring machines on the basis of DIN EN 12453