

Guide for handling the safe brake test (SBT)

SINAMICS / Safety Integrated / Safe Brake Test

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1 Introduction

1.1 Preliminary remark

This guideline for handling the SBT diagnostics function (safe brake test) of the SINAMICS S120 drive does not address the general parameterization and/or commissioning of the Safety Integrated Functions or the SBT diagnostics function. Detailed information on this topic is provided in the Safety Integrated Function Manual \3\ or generally in the Siemens Industry Online Support \1\.

The interrelationships between the Safety Integrated SBT function and the SINAMICS drive control and notes and/or information, which influence performing an SBT, are provided in this document.

Note The guidelines do not provide any guarantee that when following all of the specified steps and notes that the safe brake test SBT can be performed under all circumstances without any problems or restrictions.

1.2 Requirement



WARNING The safe brake test SBT is a diagnostics function that complies with the requirements relating to Category 2 according to EN ISO 13849-1.

In order to use SBT, the requirements listed in the Safety Integrated Function Manual \3\ must be fulfilled.

The main points include:

- Control mode: Closed-loop speed control with encoder
- Safety Integrated Extended Functions with encoder have been enabled.
- For motor holding brakes connected to SINAMICS the following applies:
  - Safe Brake Control (SBC) must be activated
  - Brake configuration "Brake as in sequence control"

Preconditions for working with the guidelines

- Basic commissioning must have been completed for the drive and where relevant the control
- The drive must be in a status where it can be traversed/operated using external signals or the control panel.
- If the Safety Integrated Extended Functions of the SINAMICS S120 are controlled via PROFIsafe, then this part on the control side must have been commissioned.
- The SBT has been parameterized and its control has been set up.
  The required steps are not described in these guidelines.

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Note

A sound understanding of SINAMICS S120 configuration, and specifically

Safety Integrated Functions, are basic requirements.



WARNING

Risk of injury due to moving machine axes
When performing the commissioning steps and the measurements the drive being considered must be traversed/operated.

Only appropriately trained and qualified personnel are permitted to carry out work as laid down in these guidelines taking into account general safety rules and regulations. It is not permissible that the plant/machine is in productive operation.

1.3 Version overview

This document refers to using the SINAMICS S120 with Control Unit CU320-2 or CU310-2
SINAMICS S120 FW V5.2 and the STARTDRIVE engineering system were used to create the document.
Alternatively, the SCOUT or STARTER engineering tool can be used.

The document refers to firmware version V5.2. When working with older firmware versions, it is possible that not all of the parameters mentioned are available. Further, it is possible that measurement variables (traces) are represented in other units.

Note

If you cannot perform the specified steps using a previous version,

then it is recommended that you upgrade to V5.2.

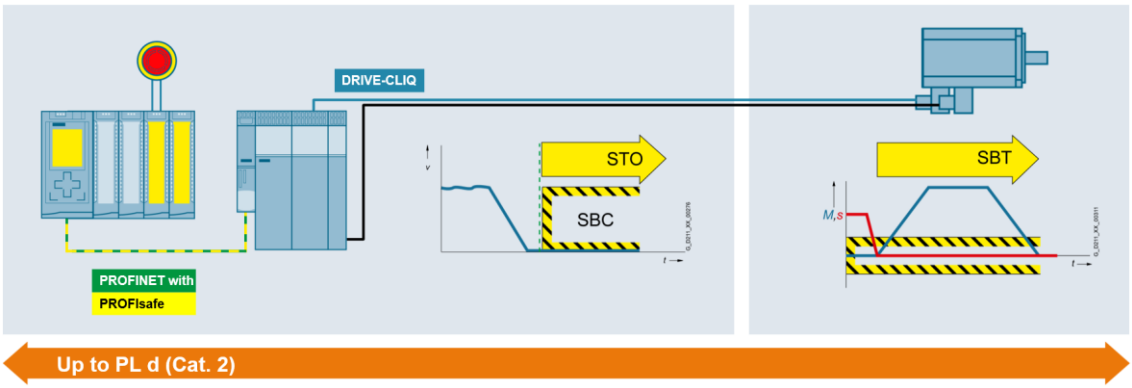
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2 The Safe Brake Test (SBT)

2.1 Standards-related issues

If the risk assessment of the machine indicates that there is a risk for persons, e.g. as a result of gravitational force, then control-related measures can play a role in minimizing the risk, for example, SBT.

Fig. 2-1: SBT overview



The Safe Brake Test (SBT) is suitable as diagnostics function for a brake that is controlled in a safety-relevant fashion (e.g. via SBC). With one brake in a Category 2 application according to ISO 13849-1 and with 2 brakes in a Category 3 application, a Performance Level of up to Category PL d can be achieved with an adequate test rate.

An application example for the calculation is provided under \5\

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2.2 Settings

NOTICE	**The machine manufacturer (OEM) must define more detailed setting values for the Safe Brake Test - for example, ramp times, duration and magnitude of the test torque to be generated - in the risk assessment.**

More detailed information can be taken from the information sheets of the DGUV, in this case, the wood and metal area \4\ or DIN EN ISO 16090-1.

SBT parameter settings in SINAMICS:

To perform the safe brake test (SBT), users must specify the necessary SBT parameters according to the particular application.
For the SBT parameters that are not changed, a check must also be made that the parameters associated with the factory settings shown in the following Fig. 2-2: SBT screen form with default parameter values match the application being considered.

The following should be specified and/or checked:

1. SBT selection method

   Select SBT: Here, you define how SBT is controlled, e.g. via the Safety Control Channel (SCC) (p10203)

2. Selecting the brake to be tested

   Brake 1: Select the brake type of brake 1, e.g. "Motor holding brake" (p10202[0])

   Brake 2: Select the brake type of brake 2, e.g. "Inhibit" when testing only one motor holding brake (p10202[1])

3. Test parameters for sequence 1 of brake 1 or brake 2

   Test duration: Test duration with full test torque (p10211)

   Holding torque: Brake holding torque (p10209)

   Factor: Factor for the SBT test torque (p10210)

   (Test torque = holding torque * factor)

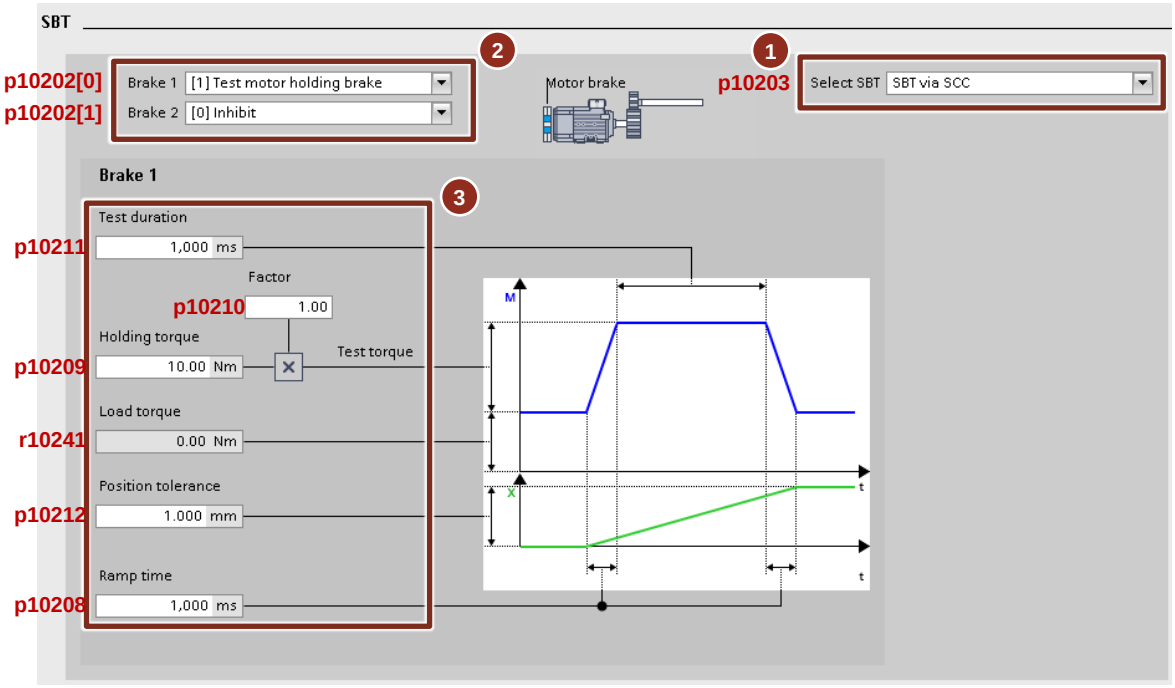
   Load torque: Displays the static load torque determined when initializing. (r10241) (display parameter)

   Position tolerance: Position deviation to be tolerated during the SBT (p10212) (default 1mm for axis type p9502 = linear axis or 1 for p9502 = rotary axis)

   Ramp time: Ramp time to establish the test torque and reduce it back down to zero (p10208)

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Fig. 2-2: SBT screen form with default parameter values



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WARNING

Performing the SBT with insufficient test torque

The holding torque in parameter p10209 must be specified as a holding torque effective on the motor side of the brake to be tested.

When using an external brake, e.g. with connection via a gearbox, the holding torque must therefore be converted to the motor side.

Otherwise, the SBT may be performed with a test-/holding torque that is too large or too small, depending on the connection.

NOTICE

Damage to the motor holding brake as a result of an incorrect setting

Brake wear increases if the opening and closing times of the motor holding brake are incorrectly set.
This can damage the brake.

When using an internal brake, set the switching times in parameters p1216 ("Motor holding brake opening time") and p1217 ("Motor holding brake closing time").

When using an external brake, you are only permitted to close it when

requested by signal r10234.6 = 1. Following this, you are permitted to set the signal p10230.5 = 1 ("External brake closed").

WARNING

Inadequate braking effect or premature loss of the braking effect

Only use the brake for the intended purpose as specified by the manufacturer.

2.3 Function description

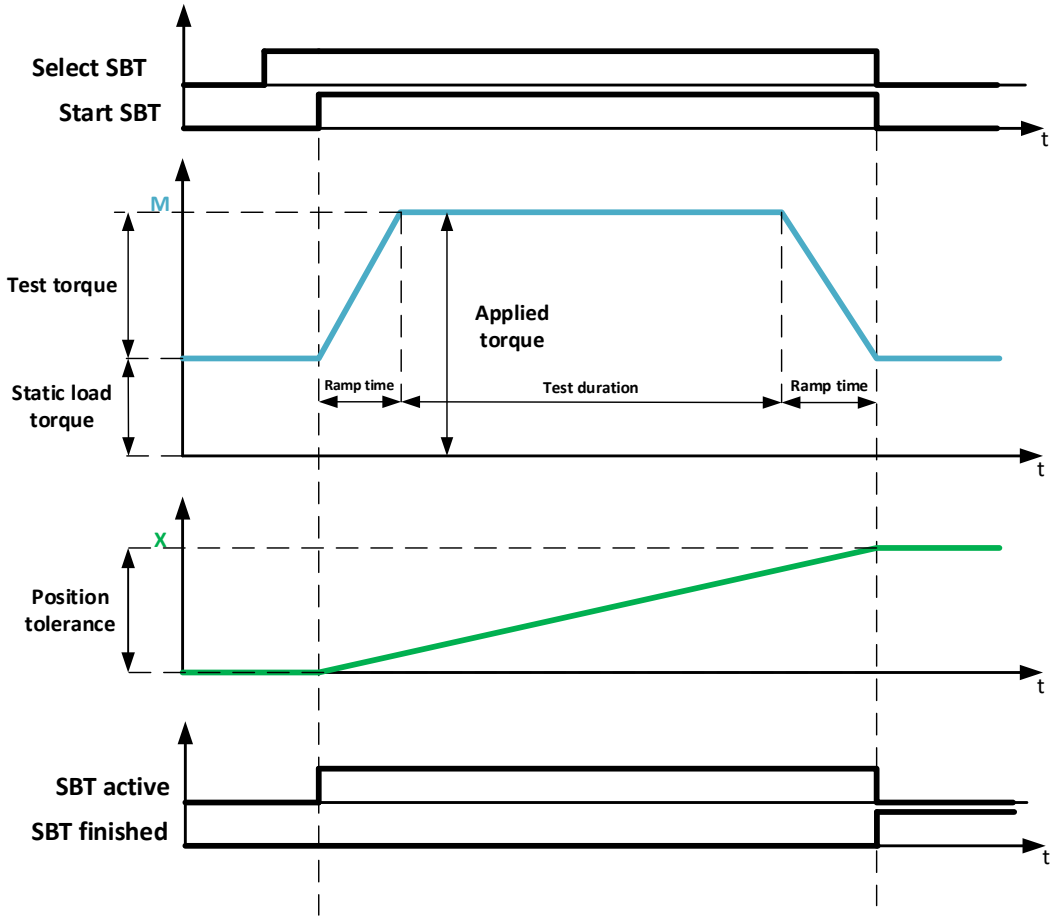
The SBT tests the selected brake according to the selected and parameterized values by establishing a test torque against the closed brake. During the test, the drive is monitored to detect any position change therefore identifying an inadequate braking effect (brake performance). This is then displayed using an appropriate fault message. In the case of a fault, the drive remains in the closed-loop controlled mode.

Description of the safe brake test function based on a motor holding brake:

- Parameterize the test sequence
- Set the pulse enable and open the brake
  - Speed actual value <1% of n_{Max} when selecting SBT
- Select SBT
  - The torque to be established for the SBT is automatically determined (test torque ± determined a static load torque, depending on the selected test direction)
- Wait for feedback signal r10231.0=1 select brake and test sequence
- Start SBT
  - The brake automatically closes
  - The test torque against the closed brake is established (along a defined ramp)
  - The actual speed < 10 % of n_{Max} is monitored
  - The actual torque is monitored to identify deviations < ±20 % of the test torque
  - Position monitoring < parameterized tolerance
  - Test was successful: Measured angle ≤ maximum angle that can be tolerated
  - Test was unsuccessful: Measured angle > maximum angle that can be tolerated
  - The test torque is reduced to zero
  - The brake is automatically opened, the drive remains in closed-loop control
- SBT terminated

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Fig. 2-3: SBT sequence diagram



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2.4 Restrictions/interaction with other drive functions

EPOS

In conjunction with the basic positioner (EPOS) of the SINAMICS, "Tracking operation" must be activated (r2683.0) before carrying out the safe brake test. Failure to do so will result in position monitoring errors of the EPOS, which prevent the SBT from being performed.

Technology object

Regarding the interaction of the technology object with the SBT diagnostics function, technology alarm 550 triggered by SBT must be subsequently acknowledged.

Version V4.0 of the SIMATIC – LDrvSafe library, listed under \8\, provides a block "LDrvSafe_SafeBrakeTest" that covers the interaction of the SBT with a technology object.

SIMOTION

In conjunction with a SIMOTION control, the SBT is called using system function _executeAxisSafetySbt().

Alternatively, parameter r10234(S_ZSW3B) must be evaluated and used to control the Safety Control Channel control word 3B (S_STW3B). Parameter r10234.1 specifies to the SIMOTION that it is not permissible that position monitoring or traversing motion is active during the brake test.

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3 Influencing factors

The subsequent chapter describes individual functions, which in unfavorable constellations can prevent SBT from being successfully performed or can cause sporadic fault-related interruptions of the SBT with alarm A01784(bitxx).

3.1 Torque ripple/accuracy

Factors that effect the drive torque directly influence the safe brake test and the result.

Influencing factors are:

- Effects on the motor module (temperature, operation outside the rated operating range, stationary/rotating measurement)
- Closed-loop control-related settings (control mode, gain factors)

During the brake test, the test torque applied is compared with the setpoint test torque with a tolerance range of ± 20%. If the tolerance range is exited during an active brake test as a result of one of the factors listed above, then the brake test is canceled and alarm A01784 (bit 26) is output.

If the torque manifests inaccuracies or any discontinuity, then this could mean that the torque actually output at the motor shaft does not match the torque calculated by the drive. This means that when carrying out the brake test, the brake holding torque can be exceeded, and therefore the brake test canceled with fault (A01784 (bit 6) or A01784 (bit 23)). In addition, the effects of the subsequently listed points, for example the brake tolerances specified in 3.4 can have a negative impact and worsen the fault profile.

Solution approach:

The following points should be checked for SBT problems caused as a result of the torque:

- The motor model data match the motor being considered (cable length, equivalent circuit diagram)
- Motor data identification and rotating measurement were performed (check with r3925)
- During the SBT, the motor operating range lies within the rated motor operating range or can the operating range of the SBT be shifted into the rated motor operating range? See Chapter 3.2
- The drive is optimized from a closed-loop control perspective, analysis of the control response at standstill, see Chapter 3.7
- The motor temperature is sensed using a temperature sensor (e.g. KTY or PT1000) to ensure that the motor temperature is precisely measured. Through the motor model, the temperature influences the resulting drive torque.

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3.2 Motor type/model

The motor type being used can also be an influencing factor when it comes to problems when performing the SBT.

From experience, it can be expected that induction motors manifest non-linear effects (e.g. the influence of temperature), which are even more pronounced when operated in the range above the rated operating data of the induction motor. This influences the SINAMICS motor model, which can have a negative impact on the torque accuracy described in Chapter 3.1. It is therefore urgently recommended that when performing the SBT, commissioning has been completed and there is a precise motor model available.
When operating induction motors in the overload range, high cogging torques can occur, which can unfavorably impact the SBT test torque.

Solution approach:

The stationary and rotating measurements are performed when commissioning the drive. This is an absolute necessity, especially for third-party induction motors or motors that are commissioned based on their rating plate data.

Every motor should be commissioned based on its individual data (equivalent circuit diagram data), as transferring equivalent circuit diagram data from one motor to other motors results in significant tolerances.

This is why it is recommended that also for series commissioning the motor model of the individual drives is checked and the stationary and rotating measurements are performed again as in addition to design differences, scatter in the motor data must be taken into consideration as a result of production-related tolerances.

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3.3 Mechanical design

The mechanical design is also a potential influencing factor, which can sporadically result in brake test faults.

The safe brake test can be unsuccessful if the mechanical design has some play (backlash), e.g. if there is a gearbox located between the motor and external brake or if a soft coupling is involved.
The resulting fault profile is diverse, and can be manifested in the form of speed and torque deviations as well as position violations. (A01784 (bit 6); A01784 (bit 23)).

Solution approach:

In this case, the cause of fault is generally as a result of the inherent principle. As a consequence, adapting the SBT parameters or avoiding play (backlash) arising from the process can resolve the issue.

On the parameter side, adapting the ramp times for establishing the test torque and reducing it to zero or adapting the position tolerance can help counteract any play (backlash) that exists. From a process-related perspective, the play (backlash) can be avoided by moving the axis to take up any play before starting the brake test, for example.

3.4 Mechanical properties

The mechanical attributes of the design is also a potential influencing factor, which can sporadically result in brake test faults. This means that the tolerances and characteristic data of the main components used for the brake test should be known and taken into account when setting the parameters for the brake test.

The mechanical brake attributes are especially important for the brake test. For example, any tolerances of the brake torque and the brake opening and closing times should be taken into account. Otherwise, faults can occur when performing the brake test with widely ranging fault profiles. This can be manifested in the form of speed deviations as well as position violations (A01784 (bit 6); A01784 (bit 23)).

Solution approach:

Here, the cause of the fault is the inherent principle, which means that the problem can be counteracted by correctly setting SBT parameters or the drive parameters.

On the parameter side, the test torque must be adapted to take into consideration any tolerances of the brake, and the correct brake opening and closing times must be set.

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3.5 Brake type and brake control

Depending on the type and control of the mechanical brake being used, the specific properties of this must be taken into consideration in the parameter settings. For brakes that are not directly controlled via the SINAMICS, longer brake opening and closing times can be expected as a result of the intermediate components used. The principle of operation of the brake also influences brake opening and closing times. For example, for hydraulically controlled brakes, the hydraulic pressure must be established up to a specific value before the brake develops its full braking force.

Solution approach:

Here, the cause of the fault is the inherent principle, which means that the problem can be counteracted by correctly setting SBT parameters or the drive parameters.

On the parameter side, brake opening and closing times must be adapted to the brake being tested

3.6 Available braking torque of the brake

The following factors must be taken into consideration for the brake, which have an influence on the holding torque/braking torque of the brake:

- Correct braking torque
  When parameterizing the resulting test torque of the SBT, the static braking torque (M_4) of the brake should be taken into consideration, which reflects the braking torque of the closed brake at standstill. Manufacturer's data on possible negative tolerances of the M_4 torque must be taken into account when parameterizing the test torque.
- Position of the brake in the drive train
  When using external brakes, i.e. brakes which are not directly attached to the motor, it should be noted that the holding torque entered in parameter p10209 refers to the holding torque effective on the motor side.
  If there are transmission ratio effects present in the drive train between the motor and the brake, e.g. gears, the holding torque entered in p10209 must be related to the motor side. Otherwise, the brake will not be tested with the correct test torque during the SBT.
- Run-in the brake
  If the manufacturer specifies that the brake lining must be run-in, then this must be carried out in accordance with these specifications in order to achieve the specified braking torque and tolerances.
- Activating the friction surface
  As a result of dirt or due to being used statically as motor holding brake (the brake is opened and closed at standstill), it is possible that the friction surfaces glaze over, therefore reducing the static braking torque. Reactivate the friction surfaces of the brake as specified by the brake manufacturer.

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3.7 Controller optimization

An unsuitable speed controller setting can have a negative impact when performing the SBT. The axis can start to oscillate, which can manifest itself in speed and torque deviations as well as position violations (A01784 (bit 6); A01784 (bit 23) or A01784 (bit 26)).

This behavior can be especially seen for speed controllers that have been set very fast to achieve a high dynamic response. For the SBT, the control response must also be assessed at standstill. It is not permissible that oscillation occurs or that the system oscillates around a speed of 0.

Solution approach:

The speed controller settings of the drive must be set appropriately. In addition to manual optimization, the speed controller can be optimized as part of the rotating measurement. For servo control drive types, auto tuning procedures are available - such as One-Button-Tuning and online tuning.

Under certain circumstances, for example as a result of the underlying process, it is necessary to operate with an optimized, very high dynamic response. This results in problems for the closed-loop control at standstill and also for the SBT. Here it is possible to use other suitable controller settings for the SBT, e.g. using speed controller adaptation or using a separate data set when performing the SBT.

A corresponding speed controller setting can also cause resonance with the brake. In this case, the motor works against the closed brake when the brake is opened or closed, which leads to unnecessary wear of the brake.
The brake resonance is often also noticeable acoustically, but the drive can also be examined for resonance using the trace measurement function.
The trace can be used to parameterize band stops and to reoptimize the speed controller.

Background information and details about brake resonance can be found in the application examples under \9\ and \10\.

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3.8 Dependencies relating to a specific firmware version

Note Changing the SBT speed actual value monitoring from 1% to 10% (referred to p1082) with firmware ≥V5.1.

When using firmware versions <V5.1, under certain circumstances, e.g. for a mechanical system with gearbox play or unfavorable controller settings, the Safe Brake Test is interrupted as rotary motion is identified and fault F01784 with fault information bit 6 is output.
Up to firmware V5.1, the fault threshold of the actual speed during the brake test was 1% referred to the maximum speed p1082, which, depending on the parameterization, possibly only permitted a low tolerance.

With firmware V5.1, the fault threshold was increased to 10% referred to the maximum speed p1082 to increase the degree of ruggedness of the SBT. Position monitoring parameterized with p10212 remains effective unchanged, which means that the adapted speed threshold results in a more rugged SBT response.

Solution approach:

The following points should be checked for a safe brake test canceled as a result of F01784 bit 6:

- Analyze the speed characteristic during the SBT using the trace function to determine the speed resulting from the rotary motion.
  If the resulting speed is <10% → It makes sense to update the firmware
  Otherwise, the rotary motion should first be reduced by adapting the appropriate parameters or as a result of the application itself.
- When using a FW < V5.1, check whether the firmware can be upgraded to ≥ V5.1. When doing this, the Safety Integrated license concept, changed as of V5.1, should be taken into consideration (Extended and Advanced Functions).
- If a firmware update is not being considered, or if the rotary motion cannot be reduced, then the speed actual value can be smoothed, see FAQ \6\.

  Alternatively, before starting the SBT, the maximum speed in parameter p1082 can be changed to a higher value by switching over a DDS.

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4 Analysis and procedure for SBT faults

For faults while an SBT is being performed, in addition to a trace recording, the following troubleshooting steps have proven to be helpful in the field:

4.1 Checklist for SBT faults

- Check the firmware release being used
  - For firmware-related faults and errors, check for a possible firmware update, see Chapter 3.8

- Check the brake linings for:
  - Wear → Maintain/replace the brake
  - Glazing over/dirt → Clean the brake by applying it/clean it

- Carefully check that the drive was correctly commissioned:
  - Stationary/rotating measurement carried out
  - Drive optimization completed

- Check the motor load
  (recommendation: test torque ≤ rated motor torque):
  - Reduce the torque demand placed on the motor, possibly using the test direction and additional load

- Check that the parameterized test torque
  - matches the data and tolerances of the brake (test torque ≤ M4 holding torque)
  - Matches the application (e.g. for vertical axes, test torque = 1.3 * max. load torque)

- Take into account mechanical effects in the tolerance settings
  - Determine any play/backlash
  - Determine any torsion/twisting between the brake and encoder and take into account in the tolerance settings p10212[x] or p10222[x]

- Specify the test torque as relative torque referred to the maximum load torque
  - Determine the static torque and the resulting torque at the maximum load torque indicated in SINAMICS in parameter r0080
  - Relative test torque (p10209) = static load torque * test factor

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4.2 Analysis using trace

It is recommended that the following drive parameters are recorded and traced. It is recommended that the traces are recorded in the fastest possible clock cycle; here it is possibly necessary to distribute individual parameters across to traces

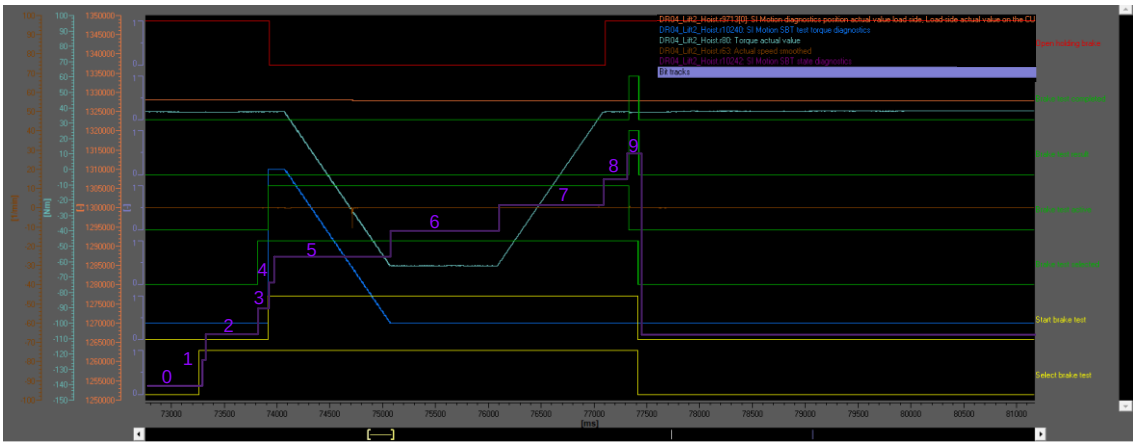
Trace parameters:

- r0080 actual torque value
- r0063 actual speed value
- r10242 SI Motion SBT status diagnostics
- r9713[0] SI Motion diagnostics position actual value load side
- r10240SI Motion SBT test torque diagnostics
- r10231 SI Motion SBT control word diagnostics
- r10234 SI Safety Info Channel status word S_ZSW3B

A correctly performed safety-related brake test is shown in the following diagram with a test torque of 100 Nm and a static load torque of 40 Nm.

Using the existing static load and the negative test direction of the SBT, with an actual applied test torque of -60 Nm, a brake test can be performed with a test torque of -100 Nm.

Fig. 4-1: Trace SBT without fault



The actual status of the brake test is displayed in parameter r10242 and can be evaluated for diagnostics.

0: Brake test inactive, wait until SBT is selected
1: Setpoint input, drive
2: Determine the load
3: Brake test is initialized, wait for test sequence to start
4: Start test sequence
5: Close the brake, establish the test torque
6: Brake test active, wait until the test has been completed
7: Reduce test torque to zero
8: Wait for the brake to open
9: Brake test successfully completed, wait until start is deselected
10: Change to brake test initialized - fault acknowledgment
11: Brake test canceled, torque is reduced to zero
12: Brake test canceled, wait for the brake to open
13: Brake test exited with fault, wait for acknowledgment

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14: Brake opening timer expired
15: Fault when initializing the brake test, wait for acknowledgment
16: Change to brake test inactive, acknowledgment active

4.2.1 Fault A01784 (bit 6)

For fault A01784 (bit 6) (the actual speed (r0063) of the axis is too high), signal r0063 or r10242 in the trace should be analyzed in more detail.
Using signal r10242 = 13, it can be evaluated at which instant in time the brake test was canceled and the response of the associated actual speed can be analyzed in r0063. It should be checked to whether the response indicated in r0063 can be assigned one of the factors described in Chapter 3. A possible fault cause can be identified depending on when the position was violated during the course of the SBT.
If the fault occurred when the SBT was started (r10242 = 4 or start of 5), then the cause is frequently due to factors described in Chapter 3.3; 3.4 or 3.5, for example, play (backlash) or the brake closing time.
If the fault occurred when the test torque was reached (r10242 = 6), then this is generally associated with fault A01784 (bit 23) and this fault should then be evaluated.

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4.2.2 Fault A01784 (bit 23)

For fault A01784 (bit 23) (with the brake closed, the permissible position range of the axis was violated (p10212/p10222)) then in the trace it can be seen that the tolerance range is exceeded in signal r9713; at the same time, signal r10242 changes to value 13.
At the time that the fault occurred, the trace must be investigated for the influencing factors as cause that are specified in Chapter 3. The fault cause can be identified depending on when the position was violated during the course of the SBT.
If the fault occurred when the SBT was started (r10242 = 4 or start of 5), then the cause is frequently due to factors described in Chapter 3.3; 3.4 or 3.5, for example, play (backlash) or the brake closing time. An excessively narrow tolerance range for the particular application would also manifest itself in this way, e.g. caused by torsion.
If the fault occurred when the test torque was reached (r10242 = 6 or transition 5 to 6) in addition to a worn brake, the influences listed in Chapter 3.1 or 3.2 could also cause this fault. It is recommended that the steps listed at the beginning of Chapter 4 are checked.

4.2.3 Fault A01784 (bit 26)

For fault A01784 (bit 26) (during the active brake test, the test torque had exited its tolerance range (20 %)) in the trace it can be seen that the tolerance range is exceeded in signal r0080 and at the same time, signal r10242 changes to a value of 13.
The trace must now be investigated for the influencing factors specified in Chapter 3 as possible cause. However, the probable fault cause can be identified depending on when the position was violated during the course of the SBT.
If the fault occurred when the SBT was started (r10242 = 4 or start of 5), then the cause is frequently due to factors described in Chapter 3.3; 3.4 or 3.5, for example, play (backlash) or the brake closing time.
If the fault occurred when the test torque was reached (r10242 = 6 or transition 5 to 6) in addition to a worn brake, the influences listed in Chapter 3.1 or 3.2 could also cause this fault. It is recommended that the steps listed at the beginning of Chapter 4 are checked to identify the possible cause of the fault.

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5 Optional contents

5.1 SBT for gantry axes or in a master-slave grouping

For axis groupings, for example gantry axes, then it should be checked as to whether the SBT of the SINAMICS can be used. Criteria that influence performing the SBT or the ability to perform the SBT must be taken into consideration. The risk assessment of the machine manufacturer (OEM) must also be taken into consideration and a specific test concept should be drawn up.

The following should be clarified as reference points:

- On which axes must Safety Integrated and the SBT be activated
- How many brakes are being used, and how are these loaded
- Evaluate the axis coupling whether, for example, tests of individual brakes/axes or common tests can be performed without causing any damage (mechanical distortion)

Information on these topics is available under the following Siemens Industry Online Support entry page from the SINUMERIK environment \7\; however, also for pure SINAMICS applications.

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6 References

This list does not claim to be complete and merely reflects a selection of suitable literature.

Table 6-1: References

	Subject
\1\	Siemens Industry Online Support https://support.industry.siemens.com
\2\	Download page of the article https://support.industry.siemens.com/cs/ww/en/view/109782484
\3\	SINAMICS S120 Safety Integrated Function Manual https://support.industry.siemens.com/cs/ww/en/view/109781722
\4\	DGUV division information sheet gravity-loaded axes vertical axes https://publikationen.dguv.de/widgets/pdf/download/article/4334
\5\	SINUMERIK 840D sl Safety Functions: Calculation examples for an axis subject to gravitational force https://support.industry.siemens.com/cs/ww/en/view/69870640
\6\	FAQ SINAMICS S120: Safe brake test (SBT) canceled with alarm (A1784, bit 6) https://support.industry.siemens.com/cs/ww/en/view/109751811
\7\	General condition when using a brake test in axis groups https://support.industry.siemens.com/cs/ww/en/view/109751498
\8\	SIMATIC - Failsafe library LDrvSafe to control the Safety Integrated functions of the SINAMICS drive family https://support.industry.siemens.com/cs/ww/en/view/109485794
\9\	SIMOTICS with engine brake: Determination and suppression of brake resonance https://support.industry.siemens.com/cs/ww/en/view/109804856
\10\	SINAMICS S: Eliminating resonance noise at a closed motor holding brake for S120 https://support.industry.siemens.com/cs/ww/en/view/66607874

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7 Contact

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8 History

Table 8-1 History

Version	Date	Change
V1.0	06/2021	First Edition
V1.1	02/2022	Classification „restricted“; added note test torque on motor side; link update; added information about brake resonance

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