

Unintentional Uncoupling Tests VT TTL

Test report

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Table of Contents

Abbreviations and acronyms	4
1 Description of test case.....	5
1.1 Test schedule summary.....	5
2 Introduction and description of systems under test.....	5
2.1 Introduction Voith coupler	5
2.2 Description of test objects.....	5
2.2.1 VT_DAC4_003.....	6
2.2.2 VT_DAC4_004.....	9
3 Test description and results	15
3.1 Description of execution.....	15
3.2 Infrastructure.....	16
3.2.1 Wagons	16
3.2.1 Test-location	17
3.3 Measured and documented data	18
3.3.1 Measurement equipment on Shimmns_6025.....	19
3.3.2 Measurement equipment on Samms_1781	24
3.4 Criteria for a valid test execution.....	25
3.5 Evaluation	26
4 Results	26
4.1 Summary.....	26
4.2 Photo documentation	34
4.3 Further Abnormalities.....	36
5 Annex – Extract of Protocol.....	39

Abbreviations and acronyms

Abbreviation / Acronym	Description
BoB	Best of both
DAC	Digital automatic coupler
DBST	DB Systemtechnik GmbH
E-coupler	Electronic coupler of a digital automatic coupler
ERJU	Europe's Rail Joint Undertaking
HBK	Hottinger Brüel & Kjaer GmbH
HVLE	Havelländische Eisenbahn
IFB	Institut für Bahntechnik GmbH
KB	Knorr-Bremse
TTL	Train Test Lab
VT	Voith

1 Description of test case

The test case “Unintentional Uncoupling Tests VT” is a dynamic functionality test for proof of emergency brake function in case of a coupler brake of the coupler lug (bolt), which simulates unintentional uncoupling during train operation. The emergency brake function is guaranteed if the air valve stays open and the brake pipe vents.

The aim of the tests was to check whether the brake pipe is exhausted during unintentional uncoupling of two mating couplers. This is simulated by introducing a breaking point into the system. The coupling tests were executed in accordance with the requests of Voith. Impact tests are executed, during which the tension force after the impact needs to exceed 200 kN (braking force of braking points).

1.1 Test schedule summary

Date	Location	Action	from Test-Nr. ¹⁾
Prev. to 21.11.2023	HVLE Berlin-Spandau	Installation of couplers and measurement equipment	-
07.02.2024	HVLE Berlin-Spandau	Change of Coupler configurations to test configuration: #002 on Samms_1781 #002 on Shimmns_6025	-
08.02.2024	HVLE Berlin-Spandau	Unintentional Uncoupling Tests Change of Coupler configurations #002 during tests on Samms_1781 and Shimmns_6025	001-007

¹⁾ As tests with two wagons were executed, a wagon identifier was added in front of the test-number. For Shimmns_6025 this is “W1”, for Samms_1781 this is “W2”. Also an identifier for the coupler manufacturer (“VT”) was added. Example for this report: Name of test-nr. “002”: “VT_W1_002” and “VT_W2_002”.

2 Introduction and description of systems under test

The purpose of this chapter is to introduce the coupler and the systems to be tested.

2.1 Introduction Voith coupler

The description of the initial state of the Voith coupler will not be part of this report. For the test execution the couplers were adjusted. The steps are described in chapter 2.2.1 and 2.2.2.

Additionally, the pneumatic coupler was connected to the brake pipe.

2.2 Description of test objects

In the following, information on the tested couplers are given. In summary two couplers from Voith were used in the Train Test Lab.

The couplers are mounted on the following wagons:

- VT_DAC4_003 is mounted on Samms_1781
- VT_DAC4_004 is mounted on Shimmns_6025

3 Test description and results

3.1 Description of execution

In general, during the Unintentional Uncoupling Tests two DACs are coupled with a defined speed by a push-off operation. Therefore one standing wagon is positioned on a defined location on the track. A moving wagon is accelerated and pushed-off.

The moving wagon impacts on the standing wagon, the couplers impact on each other. The tension force results from reaction force after the coupling impact and it should be high enough that the coupling lock on VT_DAC4_004 brakes and the couplers separate.

The steps are described in more detail in the following chapters.

In advance to every test, the following steps need to be done:

1. Both Wagons are coupled and stand on a defined coupling position.
2. The loco fills the brake pipes of both wagons with 5 bar.
3. Wagons are uncoupled. It must be ensured that the uncoupling is executed as quick as possible to minimize pressure loss.
4. Both wagons need to be set up with the following:
 - Coupler centered
 - Coupler in status "ready to couple"
 - Brakes deactivated
 - Brake pipe filled with 5 bar
5. Moving wagon and loco move to start position. To brake the wagons after impact, brake shoes are used for both wagons.
6. The moving wagon is uncoupled from the loco. The pressure loss should be minimized.
7. The moving wagon is accelerated. As the moving wagon is slowed due to different influences after push-off, the speeds during the push-off operation are not defined and up to the loco driver. Only the impact speed is defined and should be around 10 km/h.
8. The moving wagon impacts on the standing wagon. Both wagons couple. Due to the resulting reaction force a tension force arises. If the tension force is around 200 kN the coupler bolt of Shimmns_6025 brakes and the wagons separate.
9. Both wagons move further and are braked by brake shoes.
10. After braking, the wagons are rebuild to the initial state and the wagons are coupled and pulled back to the couple position.

3.2 Infrastructure

3.2.1 Wagons

The couplers were installed on two different wagons, a Shimmns-ttu wagon ("Shimmns_6025", type 722, coil transport wagon) and a Samms wagon ("Samms_1781", type 489, flat wagon).

Both wagons were equipped with a measurement system by DBST (see chapter 3.3).

3.2.1.1 Shimmns_6025

Model: Shimmns-ttu

Type: 722

Description: Coil transport wagon

Number: 31 80 4675 602-5

Config:

Wagon	Config.	Date	Change
Shimmns_6025	#005	10.01.2023	Initial status Coupler A: VT_DAC4_004 Coupler B: Screw coupler Load state: empty

Loading:

Load state	Weight	Source / description / remark
empty	23.600 kg	Sources: - Wagon-inscription. Remarks: - Measurement system not included. - Screw coupler exchanged with DAC.

Photo documentation:



Figure 14: Shimmns_6025.

3.2.1.2 Samms_1781

Model: Samms

Type: 489

Description: Flat wagon

Number: 31 80 4852 178-1

Config:

Wagon	Config.	Date	Change
Samms_1781	#001	17.01.2024	Initial status Coupler A: DAC coupler from Knorr-Bremse Coupler B: VT_DAC4_003 Load state: empty

Loading:

Load state	Weight	Source / description / remark
empty	29.400 kg	Sources: - Wagon-inscription. Remarks: - Screw coupler exchanged with DAC.

Photo documentation:



Figure 15: Samms_1781.

3.2.1 Test-location

All tests were executed at the HVLE in Berlin-Spandau (Schönwalder Allee 51, GER-13587 Berlin). The installation of the measurement equipment took also place at the workshop of the HVLE in Berlin-Spandau. The tests were executed on track 3.

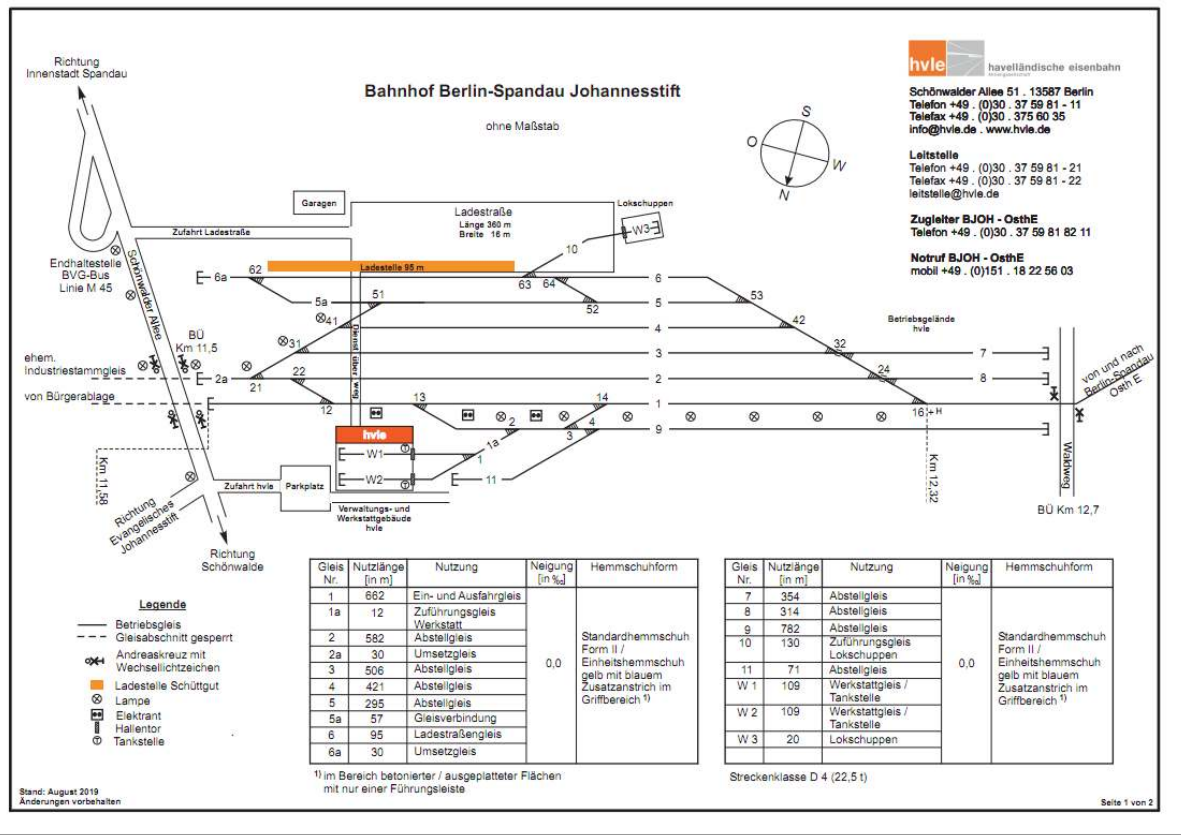


Figure 16: Track layout of the HVLE, location Berlin-Spandau [HVLE_TL].

3.3 Measured and documented data

The following data were documented or measured:

Documented in the protocol:

- Environmental inputs
- Initial status of couplers, wagons and track
- Moving / Standing wagon and coupler
- Type of actuation of coupler and actuated coupler
- Abnormalities and deviations from procedure

Documentation by photo:

- Photo documentation of the coupler

Measured by measurement systems:

- Force on the coupler
- Impact Speed
- Brake pipe pressure
- Displacement of coupler
- Connection of electrical contacts

Every test was recorded by the DBST on-wagon system on the moving wagon, the Shimmns_6025 (see chapter 3.3.1), and on the standing wagon, the Samms_1781 (see chapter 3.3.2).

3.3.1 Measurement equipment on Shimmns_6025

The first on-wagon measurement system was installed on the Shimmns_6025 wagon. It consisted of a Datalogger and two measuring amplifiers. Calibrated measurement chains were used to record the data of the on-board system. The location of installation of the sensors, signal names, identifiers and descriptions are shown in the following table:

Name	New unit	A = analogue D = digital	Description	Source / Installation	Connection	Range
Time		A	Time	Data-logger		
F_z		A	Force on coupler	DMS / strain gauges	Top and bottom inner side of coupler	-2.000 to 2.000 kN
S_x		A	Displacement (x-axis -> Sideways)	Wire sensor	On rack -> rights side of coupler	0 to 1.000 mm
S_y		A	Displacement (y-axis -> Up/Down)	Wire sensor	On rack -> above coupler	0 to 1.000 mm
S_z		A	Displacement (z-axis -> Forward/Backward)	Wire sensor	On rack -> behind coupler	0 to 1.000 mm
S_imp		A	Impulses (Distance)	Incremental Encoder	Pushed on left wheel	0-70.000.000
U_Pins_Data		A	Voltage throughput coupler over data-pins	Voltage sensor	See connection description	0 - 60 V
U_Pins_Power		A	Voltage throughput coupler over power-pins	Voltage sensor	See connection description	0 - 60 V
s	m	A	Distance	- calculated		
v	m/s	A	Speed	- calculated		
pBP	bar	A	Brake pipe pressure	Pressure Sensor	Control Valve	

3.3.1.1 Force on the coupler

The elongation force and compression force were measured with a full bridge strain gauge. The strain gauge was installed calibrated and calibrated by the DBST in Minden.



Figure 17: Strain gauge on the coupler VT_DAC4_004.

3.3.1.2 Displacement of the coupler

To measure the displacement of the coupler wire sensors were used in x-, y- and z-axis. Wire sensors with a high mechanical resistance were used to prevent vibrations. The sensors were aligned with the axis of movement to prevent high elongation during off-axis movement of the coupler. The zero position of the wire sensors is the straight aligned uncoupled position.



Figure 18: Wire sensor for forward/backward movement.



Figure 19: Wire sensor for vertical movement.



Figure 20: Wire sensor for horizontal movement.

3.3.1.3 Impact-speed

The speed of the coupler was measured with an incremental encoder. It measured the rotation of a wheel, pushed to the outer side of the wagon-wheel. The impulses of the encoder were transformed into a distance and then differentiated by the time. A mean-filter of 0.1 s was applied for the speed.

To calculate the distance from the given impulses, a calibration was done over a distance of 50 m.



Figure 21: Incremental encoder with wheel, attached to the wagon wheel.

3.3.1.4 Brake pipe pressure

The brake pipe pressure was measured with a pressure sensor, which was implemented in the brake pipe. The sensor was mounted in the control valve.



Figure 22: Pressure sensor mounted in control valve on Shimmns_6025.

3.3.1.5 Electrical connection

To measure the electrical connection of the coupler, a voltage was applied from the battery pack to the e-coupler of the moving wagon. A short circuit was set in the e-coupler on the standing wagon. The voltage was measured with the measurement system on the moving wagon. One voltage over all data-pins of the e-coupler and one voltage over the power-pins of the e-coupler were measured.

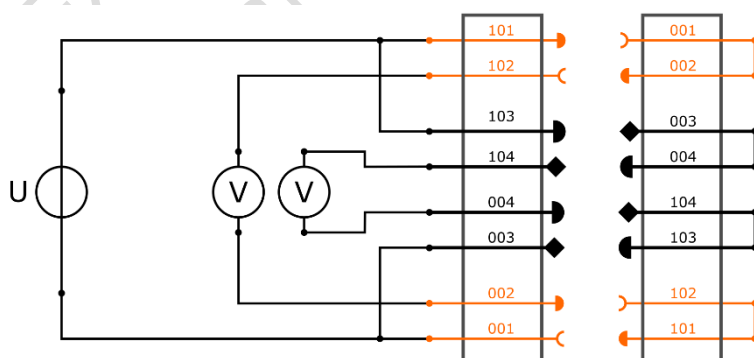


Figure 23: Circuit for voltage measurement over all pins.

3.3.1.6 Data acquisition

For Data acquisition a system by HBK was used, consisting of:

- Data logger: QuantumX CX22B-W (HBK)
- Measuring amplifiers: SomatXR MX480B-R (HBK)
- Data acquisition software: CatMan-Easy, Version 5.6.2 (HBK)

The data was measured with a frequency of 1.000 Hz. For power-supply a battery pack with 48 V was designed and installed by HVLE.

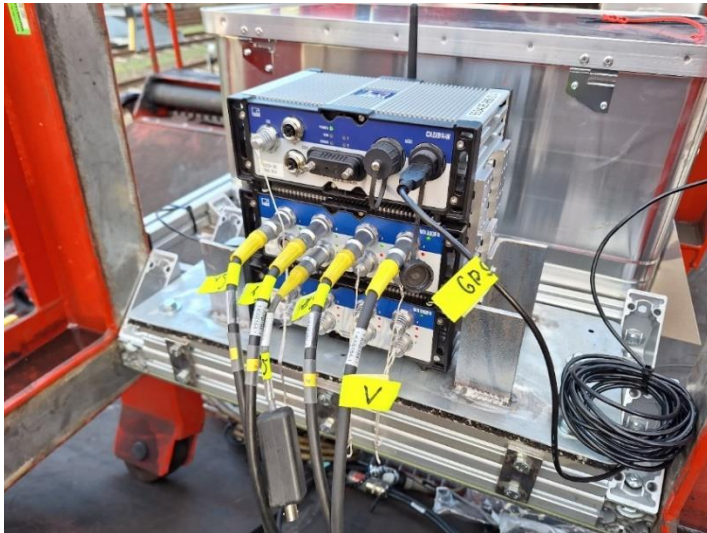


Figure 24: DBST on-wagon measurement system: Data-logger and measuring amplifiers.

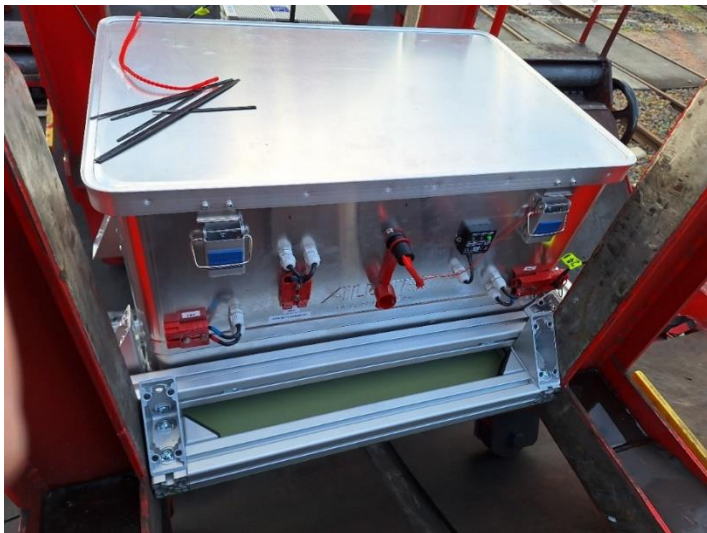


Figure 25: DBST on-wagon measurement system: Battery pack with different voltage outputs.

3.3.1.7 Data processing

Python-Scripts for editing and graphical presentation of the data were written by the TTL.

3.3.2 Measurement equipment on Samms_1781

The second on-wagon measurement system was installed on the Samms_1781 wagon. It consisted of a Datalogger and two measuring amplifiers. Calibrated measurement chains were used to record the data of the on-board system. The location of installation of the sensors, signal names, identifiers and descriptions are shown in the following table:

Name	New unit	A = analogue D = digital	Description	Source / Installation	Connection	Range
Time			Time	Data-logger		
pBP	bar		Brake pipe pressure	Pressure Sensor	Air coupling	

3.3.2.1 Brake pipe pressure

The brake pipe pressure was measured with a pressure sensor, which was implemented in the brake pipe. The sensor was mounted on one end of the air coupling.



Figure 26: Pressure sensor mounted on one end of air coupling on Samms_1781.

3.3.2.2 Data acquisition

For Data acquisition a system by HBK was used, consisting of:

- Data logger: QuantumX CX22B-W (HBK)
- Measuring amplifiers: SomatXR MX480B-R (HBK)
- Data acquisition software: CatMan-Easy, Version 5.6.2 (HBK)

The data was measured with a frequency of 1.000 Hz. For power-supply a battery pack with 48 V was designed and installed by HVLE.



Figure 27: DBST on-wagon measurement system: Data-logger and measuring amplifiers.



Figure 28: DBST on-wagon measurement system: Battery pack with different voltage outputs.

3.3.2.1 Data processing

Python-Scripts for editing and graphical presentation of the data were written by the TTL.

3.4 Criteria for a valid test execution

The test execution was defined as valid in case of:

- Velocity is high enough that the tension force is around 200 kN
- No relevant abnormalities and deviations from test procedure