

Ethernet POWERLINK

Certification Test Procedure

Version 1.2.5

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(B&R Industrial Automation GmbH)

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B&R Industrial Automation GmbH

POWERLINK-Office
B&R Straße 1
5142 Eggelsberg
Austria

powerlink.office@br-automation.com
www.br-automation.com/en/technologies/powerlink/

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Pre. 2 History

Vers.	Date	Author / Filename		short description
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0.0.2	2014-02-10	David Puffer	B&R	Structural changes, minor corrections
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Pre. 6 Definitions and Abbreviations

Pre. 6.1 Definitions

Pre. 6.2 Abbreviations

MN	Managing Node
CN	Controlled Node
DUT	Device Under Test
AS	Automation Studio
SD	SafeDESIGNER
SL	B&R SafeLOGIC

Pre. 7 References

- [1] EPSG Draft Standard 301 (EPSC DS 301), Ethernet POWERLINK, Communication Profile Specification
- [2] EPSG Draft Standard 310 (EPSC DS 310), Ethernet POWERLINK, Conformance Test Specification

1 Introduction

1.1 General

EPSC DS 310 specifies the mandatory test cases for certification of POWERLINK CNs.

A major number of these test cases is being covered by the conformance test software "openCONFORMANCE". The latest version of this program valid for certification is always available for download on the POWERLINK portal of the B&R website.

The remaining test cases are being conducted using a B&R X20 CPU as POWERLINK MN and B&R Automation Studio.

This document specifies the technical procedure of a POWERLINK Certification, covering the usage of openCONFORMANCE and the execution of test cases using the B&R X20 POWERLINK MN.

A device passing all test cases of openCONFORMANCE, as well as all test cases being conducted with the B&R X20 CPU as POWERLINK MN, passes the POWERLINK certification.

1.2 Different device types


For some tests, test execution is depending on the DUT's device type and is therefore differing from the approach of standard POWERLINK CNs. For this reason, this document contains related information on requirements and additional or differing test procedures for modular POWERLINK devices and openSAFETY over POWERLINK devices.

The following sub sections provide further information on the device types and the denotation of related information throughout the document.

An overview of differences in test execution for affected tests is given in table Tab. 3, p. 28.


1.2.1 Information for modular devices

When testing a modular device, related denoted information has to be considered:

 Information referring to modular POWERLINK devices is denoted with this dedicated border style.

1.2.2 Information for openSAFETY devices

When testing an openSAFETY over POWERLINK device, related denoted information has to be considered:

 Information referring to openSAFETY devices is denoted with this dedicated border style.
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For testing openSAFETY over POWERLINK devices, general know-how regarding commissioning and operating safety devices with the B&R system is required. If tests require a B&R SafeLOGIC, make sure that each device is used in the SafeDESIGNER program.

2 openCONFORMANCE

2.1 Requirements

2.1.1 Hardware

Hardware	No. of items	Description
PC with Ethernet-Interface	1	Standard PC (desktop or laptop) with Ethernet interface. Ideally, this PC has a second Ethernet interface to enable the capture of network traces in certain error scenarios.
B&R 0AC808.9-1	1	Ethernet hub

Tab. 1 Hardware req. for openCONFORMANCE tests

2.1.2 Software

- Windows 10(x32/x64)
- openCONFORMANCE. The latest valid version relevant for certification is available on the POWERLINK portal of the B&R website (all-in-one ZIP package).

2.2 Test setup

Connect the Ethernet interface of the PC and the DUT to the hub using standard CAT5 cables.

2.3 Test execution

1. Prior to executing openCONFORMANCE, remove the TCP/IP protocol binding from the network interface that will be used by openCONFORMANCE. Close all other programs and run openCONFORMANCE.exe in the main directory or using the shortcut in the start menu as user "Administrator".
2. Import the XDD file using the menu "File – Import XDD file".
3. Set your network-interface and the POWERLINK-Cycletime under "Edit" -> "Preferences".
4. Upon successfully importing the XDD, select (checkbox), execute ("Run Test") and generate a test report ("File" -> "Generate test report") for each of the following testgroups/test cases **separately**:
 - a. Bootup-Tests
 - b. SDO-Tests
 - c. NMT-State Tests
 - d. OD-Tests excluding Testcase_3_2_9_T1
 - e. Testcase_3_2_9_T1
 - f. Error-Behavior
 - g. Extension-Compatibility
5. This will result in 7 test reports being generated, each being opened when the generation is done.
6. A DUT has successfully passed the openCONFORMANCE tests, if all test reports contain an "Overall Testresult: PASSED" under the "Test-Statistics" section.

3 Additional certification tests with a B&R system

3.1 Requirements

3.1.1 Hardware

Hardware	No. of items	Description
PC with 2 Ethernet interfaces	1	Standard PC (desktop or laptop) with 2 Ethernet interfaces. One interface is used as a connection to the B&R X20 MN, another one for connecting to the hub in order to enable network traces.
24V power supply	1	24V power supply
B&R X20CPx68x	1	MN
B&R X20CPx68x	1	iCN
B&R X20BB80	4	X20 bus controller backplane
B&R X20BM11	6	X20 bus modules
B&R X20BC0083	3	POWERLINK bus controller
B&R X20ET8819	1	Ethernet analyzer
B&R X20PS9400	4	X20 power supply
B&R X20DI9371	3	X20 digital input module
B&R X20DO9322	3	X20 digital output module
B&R X20TB12	10	X20 terminal block
B&R 0AC808.9-1	1	Ethernet hub
CF card	2	CF cards
Additional required HW when testing an openSAFETY device		
B&R X20SL8100	1	X20 SafeLOGIC
B&R X20MK1000.000.000	1	SafeKEY 20 SN Base

Tab. 2 Hardware req. for B&R X20 system tests

3.1.2 Software

- Automation Studio 4.4 or higher
- SafeDESIGNER 4.3.3.7 or higher
- Automation Runtime B4.44 or higher
- Wireshark 2.0 or higher + Ethernet Analyzer Plugin for B&R X20ET8819

3.2 Test setup

The test setup may vary depending on the test case being conducted (most test cases do not require a second B&R X20 CPU to be present as iCN).

Basic setup: Connect one PC Ethernet interface to the standard Ethernet interface of the B&R X20 CPU (for Automation Studio project transfer), connect the second one to the hub (to enable network traces during test execution). In order to avoid distortions by the tracing PC, disable all network protocols on the PC's second Ethernet interface.

Connect the POWERLINK interfaces of both, the B&R X20 CPU and the DUT to the hub.

Create an Automation Studio project, select the available B&R X20 CPU and then import the DUT's XDD file using "Tools – Manage 3rd party devices – Import Fieldbus Device".

An openSAFETY device typically has two device description files (*.XDD, *.XOSDD). During device import, select the *.XOSDD file before the *.XDD file.

For a modular device, import the head *.XDD (bus coupler) and the related child *.XDD (modules) files.

Insert the imported DUT by searching the DUT in the “Hardware Catalog” and dragging it into the “System Designer” or the “Physical View” under the POWERLINK interface or by selecting the POWERLINK interface and double-clicking the DUT in the “Hardware Catalog”.

For testing an openSAFETY device, also insert an X20SL8100 SafeLOGIC and set “module supervised” in I/O Configuration to “off”.

Set up a minimum SafeDESIGNER project, where the SafeModuleOK channels of all openSAFETY devices are used. This allows easier verification and to check correct (safety packet) routing functionality inside the device.

The “Safe Data Duration” has to be set accordingly. For example, setting a “Safe Data Duration” of 200 milliseconds, respectively 200000 µs, should be big enough for all related test cases below.

Download the project to the PLC. Download the safety project to the SL and acknowledge device and firmware changes.

3.3 Test execution

The execution of some tests is depending on the DUT’s device type. Where applicable, specifically marked paragraphs cover information on differing or additional required procedures. A related summary can also be found in Tab. 3, p. 28.

3.3.1 PDO test

3.3.1.1 General

This test verifies the mapping of objects to the PDO frames PollRequest and PollResponse. Both directions are tested.

openSAFETY over POWERLINK devices have dedicated channels (TPDO and RPDO) for openSAFETY communication, which are enabled by default in Automation Studio and cannot be deactivated. Safe output channels are not visible in Automation Studio.

In case the head station of a modular device does not have mappable objects by itself, related child modules shall be attached (physically and in the AS project) in order to activate input/output channels.

3.3.1.2 PDO1

Map an input object (TPDO-mappable object of the DUT) by enabling a “read” channel in the I/O Configuration page (Parameter group “Channels”) of the DUT. The selected object should be manually changeable on the DUT (e.g. ActualPositionValue on an encoder).

The object must be named by the applicant engineer.

For a modular device, attach an input module or map an input object by enabling a “read” channel.

Download the project to the PLC and verify a changing signal in monitor mode of AS.

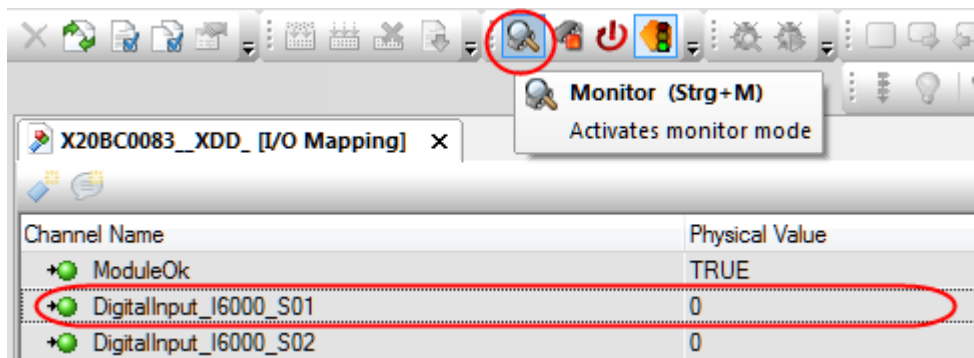


Fig. 1 Activation of monitor mode and observing the signal change

If no input object is available, this test is not applicable.

If the device only offers openSAFETY-related channels, the device has to be booted up successfully by the SL to observe safe signal changes in AS. An according signal should be manually changeable on the DUT (e.g. SafeActualPositionValue on an encoder).

The object must be named by the applicant engineer.

Download the project to the PLC and verify a changing signal in monitor mode of AS.

If the device does not have safe channels in input direction, verify with the SafeDESIGNER that the SafeLOGIC is in "Run" and SafeModuleOK of the DUT is set (true).

3.3.1.3 PDO2

Map an output object (RPDO-mappable object of the DUT) by enabling a "write" channel in the "I/O Configuration page" (Parameter group "Channels") of the DUT. The selected object should trigger a visible action on the DUT (e.g. DigitalOutput indicated by a LED).

The object must be named by the applicant engineer.

For a modular device, attach an output module or map an output object by enabling a "write" channel.

Download the project to the PLC and verify a changing signal on the DUT in monitor mode (force) of AS.

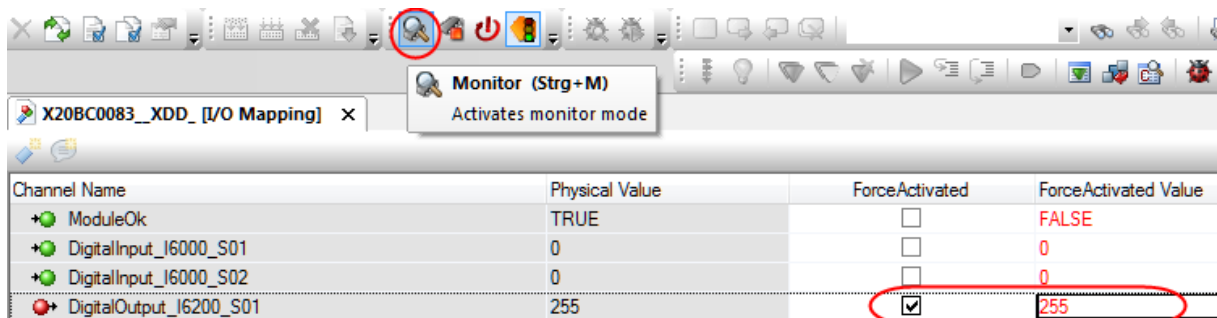


Fig. 2 Activation of monitor mode and forcing of values

If no output object is available, this test is not applicable.

If the device only offers openSAFETY-related channels, the device has to be booted up by the SL. An according safe signal should trigger a visible action on the DUT (e.g. SafeDigitalOutput indicated by a LED).

The object must be named by the applicant engineer.

Verify a changing signal on the DUT in SL debug mode with activated variable status (overwrite) with SD.

If the device does not have safe channels in output direction, verify with the SafeDESIGNER that the SafeLOGIC is in "Run" and SafeModuleOK of the DUT is set (true).

3.3.2 Multiplex test

3.3.2.1 General

This test verifies the feature “Multiplexing” on the DUT. It is only applicable if the DUT’s XDD file declares the feature `DLLCNFeatureMultiplex=“true”`.

3.3.2.2 MUX1

Enable Multiplexing in the DUT’s I/O Configuration page and download the project to the PLC. Verify in the network trace that the DUT is behaving correctly (responding to the PReq that is only sent every n^{th} cycle). The value n is given by the parameter “Multiplexing prescale” in the POWERLINK Configuration of the PLC.

Use two different numbers for n to approve this test, e.g. 3 and 5.

Also force the multiplexed cycle on the DUT’s I/O Configuration page to the first, middle and last multiplexed cycle.

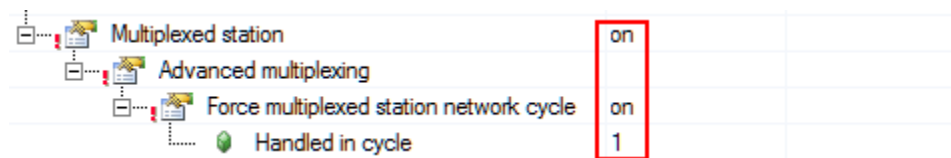


Fig. 3 Forcing a specific multiplexed cycle

3.3.3 Cycle time test

3.3.3.1 General

This test verifies the reduced, minimum and maximum cycle time of the DUT.

When testing an openSAFETY device, disconnect the SafeLOGIC from the hub for this test.

3.3.3.2 CycleTime1

No configuration in AS is necessary for the reduced cycle time test. The value is automatically imported from the XDD file.

Download the project and restart the PLC. Check that the DUT boots up to CS_PRE_OPERATIONAL_2 or higher, e.g. by a Wireshark trace.

3.3.3.3 CycleTime2

Configure the minimum cycle time possible by the DUT (feature “NMTCycleTimeMin” in the XDD) and the MN in the MN POWERLINK interface configuration. Verify that the DUT boots up to CS_OPERATIONAL and stays operational for at least 1000 cycles, e.g. by a Wireshark trace.



Fig. 4 Setting the minimum cycle time in the MN POWERLINK interface configuration

3.3.3.4 CycleTime3

Configure the maximum cycle time possible by the DUT (feature “NMTCycleTimeMax” in the XDD) and the MN in the MN’s POWERLINK interface configuration. Verify that the DUT boots up to CS_OPERATIONAL and stays operational for at least 1000 cycles, e.g. by a Wireshark trace.



POWERLINK parameters		
Activate POWERLINK communication	on	
Device name	<InterfaceAddress>	
Host names		
Cycle time	40000	μs
Multiplexing prescale	8	

Fig. 5 Setting the maximum cycle time in the MN POWERLINK interface configuration

3.3.4 Data load test

3.3.4.1 General

This test verifies the minimum and maximum possible load of synchronous data mapped to a PDO frame. If a DUT only supports static mapping, DataLoad1 and DataLoad2 are not applicable.

openSAFETY over POWERLINK devices have dedicated channels (TPDO and RPDO) for openSAFETY communication which are enabled by default in Automation Studio and cannot be deactivated. Safe output channels are not visible in Automation Studio.

The SafeLOGIC has to be connected for this test.

3.3.4.2 DataLoad1

Set all channels in the “I/O Configuration Page” (Parameter group “Channels”) of the DUT to “none”.



Fig. 6 Deactivation of all channels, no data points except ModuleOk

For a modular device, remove all attached modules from the head station and deactivate all channels.

Verify that the DUT boots up to CS_OPERATIONAL and stays operational for at least 1000 cycles, e.g. by a Wireshark trace.

This test is not applicable for an openSAFETY device.

3.3.4.3 DataLoad2

Activate one channel (in each direction) in the “I/O Configuration Page” (Parameter group “Channels”) of the DUT. The channel with the smallest data size should be selected.

For a modular device, attach an input and an output module or activate one channel in each direction.

The safety channels of an openSAFETY device are enabled by default, therefore no channels have to be activated manually.

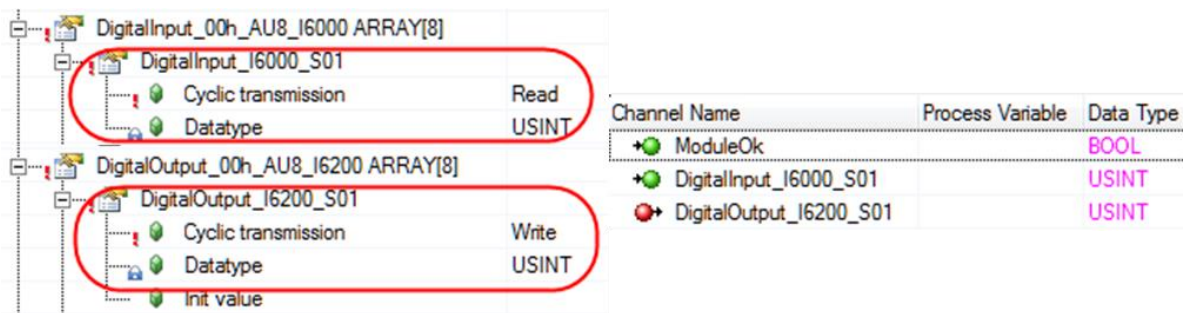


Fig. 7 Activation of one channel in each direction with the smallest data size

Verify that the DUT boots up to CS_OPERATIONAL and stays operational for at least 1000 cycles, e.g. by a Wireshark trace.

3.3.4.4 DataLoad3

Activate the maximum number of channels (in each direction) in the “I/O Configuration Page” (Parameter group “Channels”) of the DUT. Channels with larger data sizes should be used.

For a modular device, attach several input and output modules and/or activate the maximum number of channels in each direction.

For an openSAFETY device, activate further channels additionally to those already enabled by default.

Channel Name	Process Variable	Data Type
+● ModuleOk		BOOL
+● MOD_NetworkStatus_AU64_I20B0_S01		OCTET[8]
+● MOD_NetworkStatus_AU64_I20B0_S02		OCTET[8]
+● MOD_NetworkStatus_AU64_I20B0_S03		OCTET[8]
+● MOD_NetworkStatus_AU64_I20B0_S04		OCTET[8]
●→ AnalogueOutput_I6411_S01		INT
●→ AnalogueOutput_I6411_S02		INT
●→ AnalogueOutput_I6411_S03		INT
●→ AnalogueOutput_I6411_S04		INT

Fig. 8 Activated maximum number of channels in each direction with biggest data sizes

Verify that the DUT boots up to CS_OPERATIONAL and stays operational for at least 1000 cycles.

3.3.5 Cross traffic test

3.3.5.1 General

This test verifies the ability of the DUT to read PollResponse frames of one or several other CNs in the network.

Read out the value of the feature “PDORPDOChannels” in the DUT’s XDD file. If this value is 1, none of the cross-traffic tests are applicable. If this value is 2, CrossTraffic1 and CrossTraffic2 are applicable. For any higher value, also CrossTraffic3 is applicable.

For a modular device, attach as many output modules to the head station, as needed to have three different objects mapped. Configure cross-traffic on these modules, so that those objects will be used.

For an openSAFETY over POWERLINK device, one RPDO object is mapped by default to the PRes of the SafeLOGIC and is used for openSAFETY communication. In general, a working cross-traffic functionality can be assumed, if PDO tests have been successful.

When the device does not have non-safe output channels, or the value of “PDORPDOChannels” is below 3, none of the cross-traffic tests are applicable.

If this value is 3, CrossTraffic1 and CrossTraffic2 are applicable. For any higher value, also CrossTraffic3 is applicable. The SafeLOGIC is required to be connected for this tests.

3.3.5.2 CrossTraffic1 (PReq + PResMN)

The test is carried out via an iCN configuration. Cf. also the Automation Studio help:

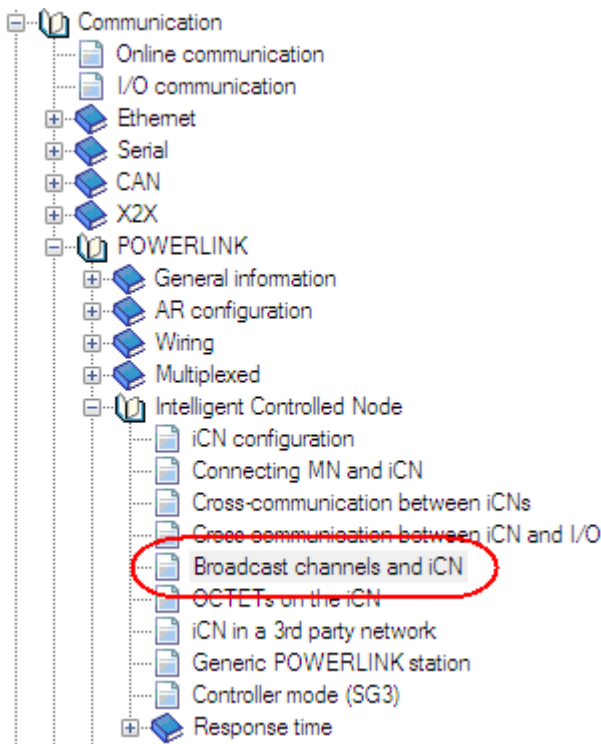


Fig. 9 AS help, iCNs and broadcast channels

1. Create a configuration for the MN in the AS project.
2. Add the DUT to the MN configuration and choose two objects (RPDO-mappable objects): one will be used for direct communication (i.e. PReq from MN) and one will be used for the cross-traffic test (i.e. PRes from MN). These objects should trigger visible actions on the DUT (e.g. DigitalOutput indicated by a LED). They must be named by the applicant engineer.
3. Activate the mapping of the two objects by setting the according channels to "Write" in the I/O Configuration page of the DUT.
4. Open the POWERLINK Configuration of the MN and create one broadcast channel with the same data type as the DUT's object for cross-traffic:

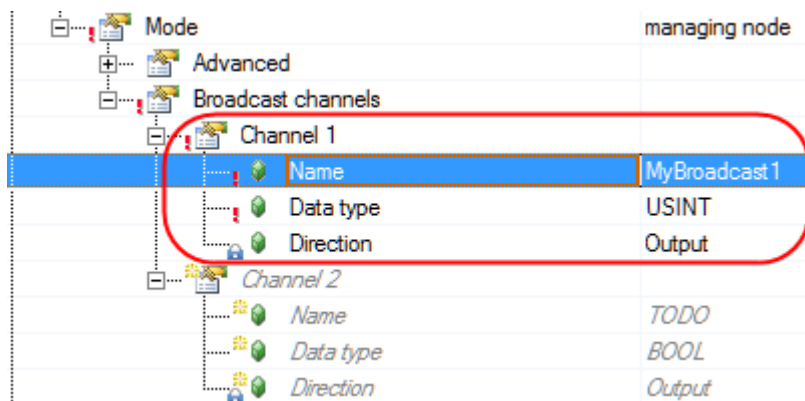


Fig. 10 Configuring broadcast channels

5. Open the I/O Mapping page of the DUT and choose the created broadcast channel in the channel's list:

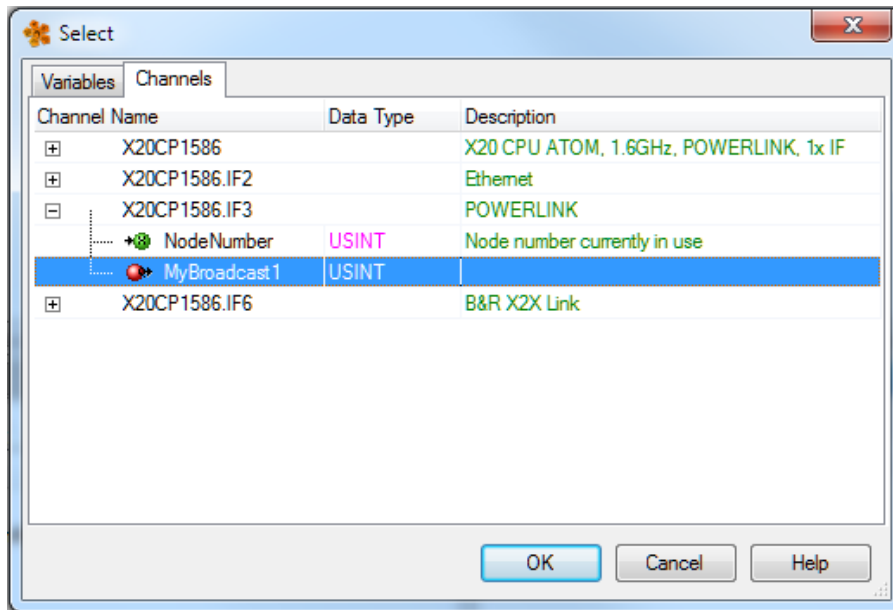


Fig. 11 Mapping a broadcast channel

- Download the project to the PLC.
- Activate monitor mode and test the objects by forcing values. For the directly mapped object (PReq from MN) open the I/O Mapping page of the DUT, force a value and verify the reaction on the DUT. For the cross-traffic-mapped object (PRes from MN), open the POWERLINK I/O Mapping page of the MN, force a value on the broadcast channel and verify the reaction on the DUT.

3.3.5.3 CrossTraffic2 (PReq + PRes iCN)

- Create a new configuration for the MN in the AS project.
- Add the DUT to the MN configuration and choose two objects (RPDO-mappable objects): one will be used for direct communication (i.e. PReq from MN) and one will be used for the cross-traffic test (i.e. PRes from iCN). These objects should trigger visible actions on the DUT (e.g. DigitalOutput indicated by a LED). They must be named by the applicant engineer.
- Activate the mapping of the two objects by setting the according channels to "Write" in the I/O Configuration of the DUT.
- Create a Configuration for the iCN in the same project:

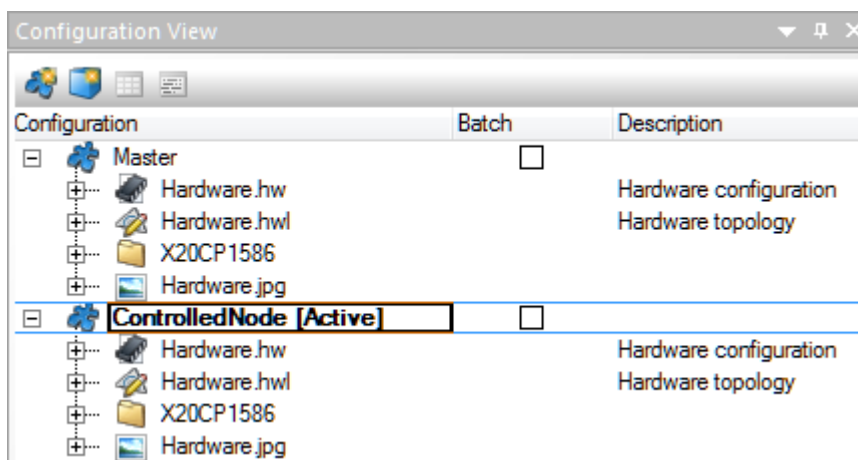


Fig. 12 An iCN configuration

- Open the POWERLINK Configuration

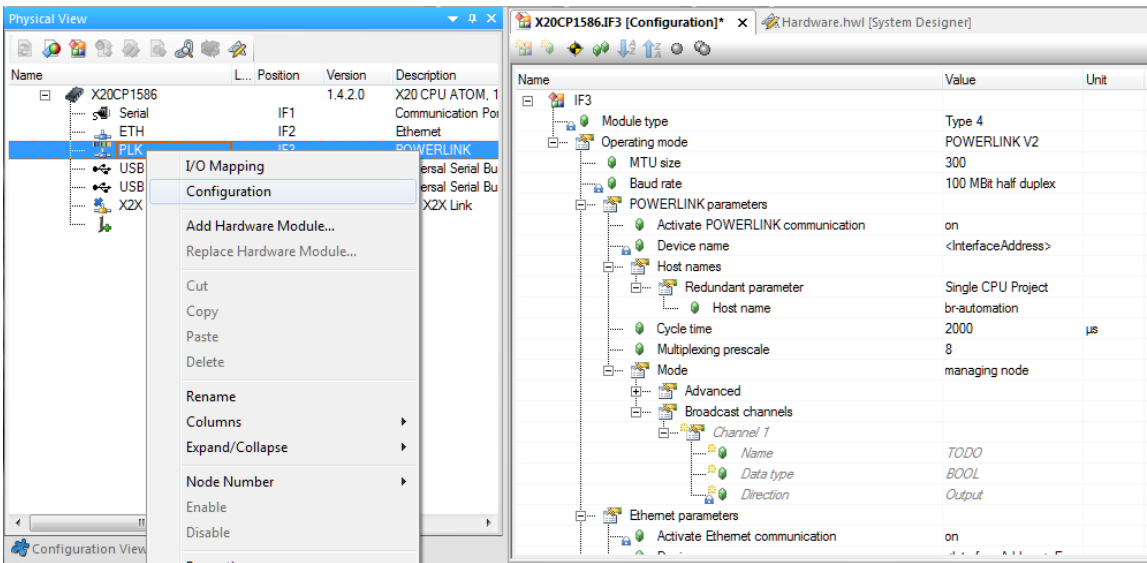


Fig. 13 Opening POWERLINK Configuration

6. Change the “Mode” from “managing node” to “controlled node” and set a node number (1-239):

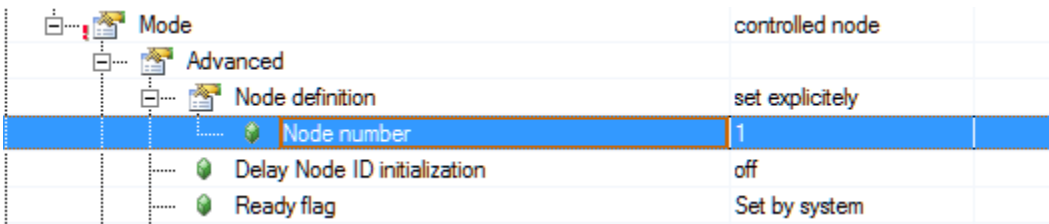


Fig. 14 Changing "Mode" and Node number of a node

7. Create an output channel on the iCN which will be read as cross-traffic by the DUT. The data type of the channel has to match exactly the data type of the corresponding input object on the DUT selected in step 2.

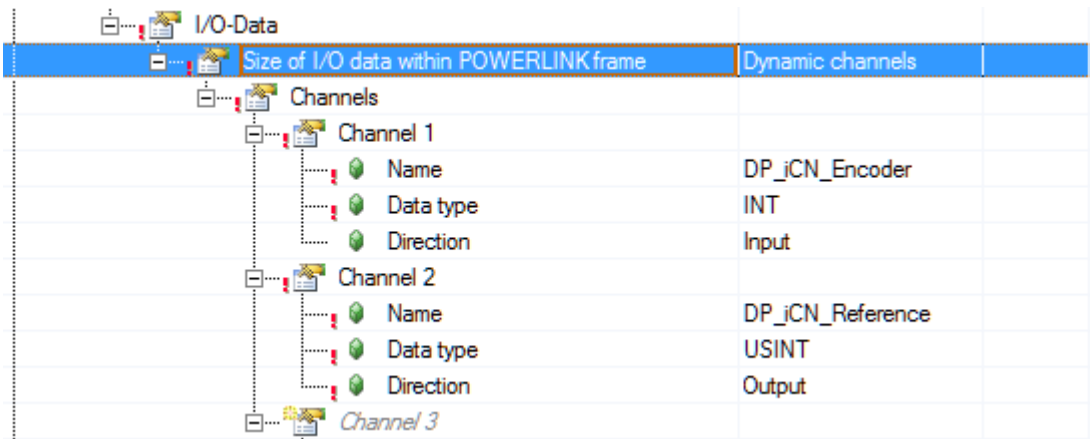


Fig. 15 Creating a broadcast channel

8. Change back to the MN Configuration.
9. Open the POWERLINK Interface and insert a POWERLINK V2 iCN. Set the same node number as defined in the iCN Configuration.

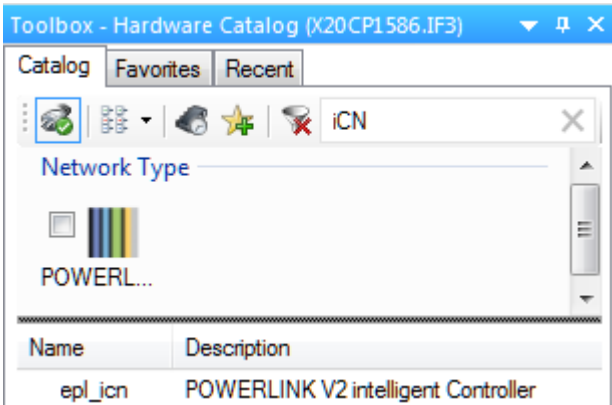


Fig. 16 Inserting an iCN

10. Open the “Configuration” of the iCN and select the corresponding “Configuration name” and “Interface name”:

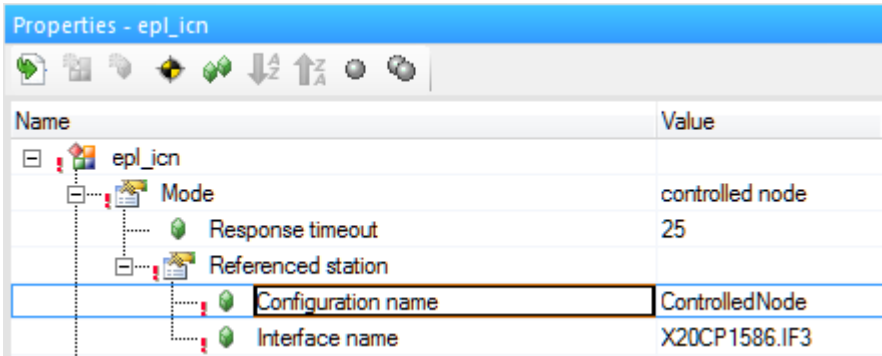


Fig. 17 Select configuration and interface name for iCN device

11. Open the I/O Mapping of the DUT and connect the output channel of the iCN (created in step 7) with the DUT’s input channel selected in step 2:

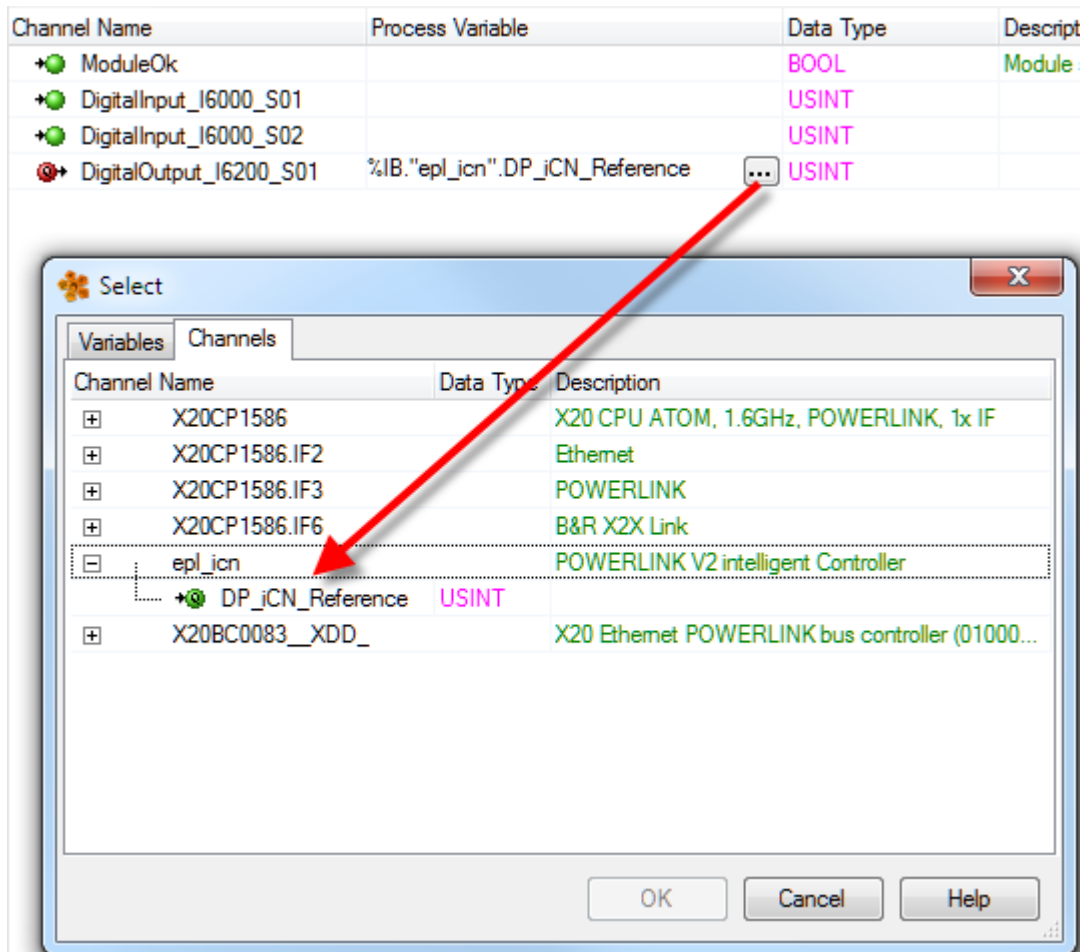


Fig. 18 Connecting a broadcast channel

12. Set the iCN Configuration active, go online on the iCN CPU and download the project.
13. Set the MN Configuration active, go online on the MN CPU and download the project.
14. Activate monitor mode and test the objects by forcing values. For the directly-mapped object (PReq from MN) open the I/O Mapping page of the DUT, force a value and verify the reaction on the DUT.
15. For the cross-traffic-mapped object (PRes from iCN), set the iCN Configuration active, go online on the iCN CPU and activate the monitor mode.
16. Open the POWERLINK I/O Mapping page of the iCN, force a value on the output channel and verify the reaction on the DUT.

3.3.5.4 CrossTraffic3 (PReq + PResMN + PRes iCN)

The CrossTraffic3 test combines both, CrossTraffic1 and CrossTraffic2 at the same time. Therefore, three RPDO-mappable objects must be available and named by the applicant engineer:

- One object is mapped to the PReq of the MN
- One object is mapped to the PRes of the MN
- One object is mapped to the PRes of the iCN

Carry out the test by verifying a reaction on the DUT after forcing all three objects.

3.3.6 Advanced extension compatibility test

3.3.6.1 General

The extension compatibility tests shall ensure that the DUT is able to cope with existing and possible future extensions of the POWERLINK protocol.

3.3.6.2 ExtensionCompatibility1 (PRes Chaining test)

Create a new project, add the DUT and add three Bus Controllers as Chained Stations:

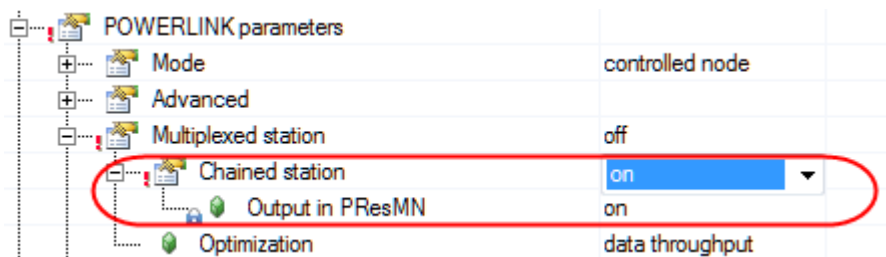


Fig. 19 Activating PollResponse-Chaining for a CN

Verify that the DUT boots up to CS_OPERATIONAL and stays operational for at least 1000 cycles, e.g. by a Wireshark trace.

3.3.6.3 ExtensionCompatibility2 (Multi ASnd test)

This test shall verify that a device not supporting Multi-ASnd ignores unknown POWERLINK message types (e.g. the Alnv frame), and that it can cope with more than one ASnd frame in the asynchronous phase at low cycletimes.

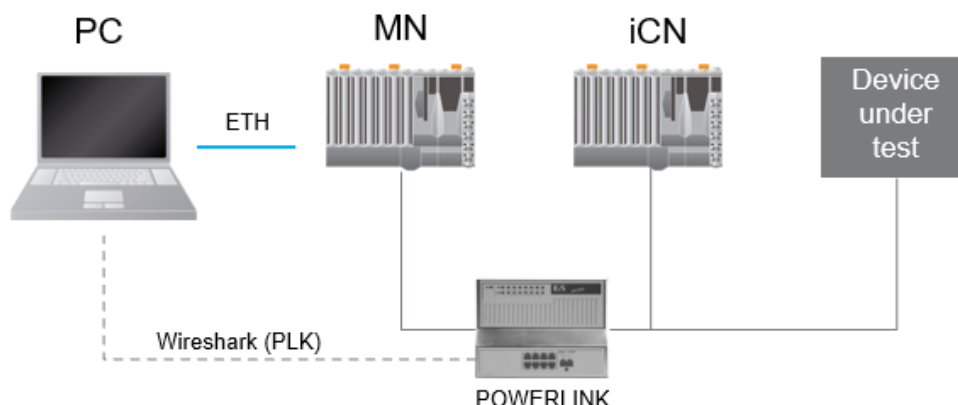
The test setup contains a B&R X20 POWERLINK MN, a B&R X20 POWERLINK iCN and the DUT. Both, the MN and the iCN are permanently sending ASnd frames to the DUT, causing Alnv frames and up to two ASnd frames in the asynchronous phase on the network.

The pre-configured attached AS project to run this test executes the tasks for sending the ASnd frames on both, MN and iCN.

This section outlines the procedure for conducting the MultiASnd test using the predefined B&R project. The process involves the following steps:

Setup:

Connect the Managing Node (MN) the Controlled Node (iCN) and the device under test to a standard ethernet hub. Use the built-in POWERLINK ports for connection, no special hardware is required. Also connect the MN to a PC via an Ethernet port.



Configuration:

1. Open the project file.
2. Adjust CPU settings in Configurations 1 and 2 to align with the specifications of your setup, ensuring compatibility with your specific CPU type.
3. Set up online settings on the MN's Ethernet interface (Configuration 1).

4. Import and assign Node Number 1 to the device under test, and Node Number 2 to the iCN.
5. Download Configuration 1 to the MN and Configuration 2 to the iCN.

Execution:

1. Start Wireshark and connect to the POWERLINK network.
2. Select MN configuration and establish an online connection to the MN.
3. Activate monitor mode (Strg + M).
4. Open iCN's I/O Mapping (Physical view -> rightclick on epl_icn -> I/O mapping) and activate the 'floodAsnd_enable' channel.
5. In the Logical View, right click on the program 'FloodASnd' and open its watch.
6. Add variables and set 'enable' to true.

Verification:

Monitor the results in Wireshark. Verify that at least two asynchronous slots are being used in each cycle throughout the test. Also check that the DUT boots up to CS_OPERATIONAL and stays operational for at least 1000 cycles

3.3.7 Timeout test

3.3.7.1 General

These tests shall ensure that the DUT is able to operate within the timing parameters given in its XDD file.

3.3.7.2 Timeout1

The DUT shall respond to a PReq within the PRes response time (object 0x1F98/3) given in the XDD file. Read out the value of this object, divide it by 1000 (convert ns to μ s) and set it in the I/O Configuration page of the DUT. Configure the MN with the minimum possible cycle time (feature "NMTCycleTimeMin").

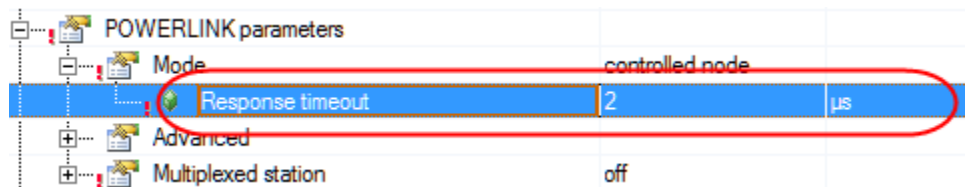
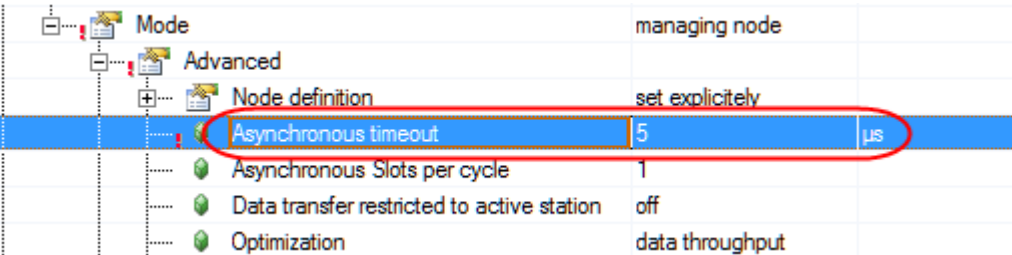


Fig. 20 Setting the PRes timeout for a CN

Verify that the DUT boots up to CS_OPERATIONAL and stays operational for at least 1000 cycles, e.g. by a Wireshark trace.

3.3.7.3 Timeout2

The DUT shall respond to an SoA within the SoA response time (object 0x1F98/6) given in the XDD file. Read out the value of this object, divide it by 1000 (convert ns to μ s) and set it in the POWERLINK I/O Configuration page of the MN. For values less than 5 μ s, the setting must be 5 μ s. Configure the MN with the minimum possible cycle time (feature "NMTCycleTimeMin").



Mode	managing node
Advanced	
Node definition	set explicitly
Asynchronous timeout	5 us
Asynchronous Slots per cycle	1
Data transfer restricted to active station	off
Optimization	data throughput

Fig. 21 Setting the async. slot timeout on the MN

Verify that the DUT boots up to CS_OPERATIONAL and stays operational for at least 1000 cycles, e.g. by a Wireshark trace.

3.3.7.4 Timeout3

In this test the DUT shall respond to a PReq after the time “SoC to first PReq” has elapsed. This value is given in the XDD file via the feature “NMTCNSoC2PReq” and is automatically used by Automation Studio.

Use the DUT as the only device besides the MN in the network. Verify that the DUT boots up to CS_OPERATIONAL and stays operational for at least 1000 cycles, e.g. by a Wireshark trace.

Configure the MN with the minimum possible cycle time (feature “NMTCycleTimeMin”).

4 Appendix

4.1 Test execution differences based on device types

The following table summarizes the differences in the test execution based on the DUT's device type.

Note: If a modular head station or an openSAFETY over POWERLINK device implements related channels / mappable objects additionally to their device dedicated functionality, the test execution for a POWERLINK CN can be used instead of the device specific one.

Test	Device type			
	Standard CN	Modular CN	openSAFETY over POWERLINK CN	Modular CN with safety modules only
PDO1	activate an input channel	attach an input module	use SL	use SL, attach a safe module
PDO2	activate an output channel	attach an output module	use SL	use SL, attach a safe module
DataLoad1	deactivate all channels	remove all attached modules	not applicable	remove all attached modules
DataLoad2	activate a channel in each direction	attach an input and an output module	use SL	use SL, attach a safe module
DataLoad3	activate max channels in each direction	attach big (max) number of modules (in, out); activate additional channels, if applicable	use SL; activate additional channels, if applicable	use SL, attach a big (max) number of safe modules; activate additional channels, if applicable
CrossTraffic			general cross traffic functionality OK, if PDO test was successful	
CrossTraffic1	standard	standard, use multiple output modules	standard, only applicable, if "PDORPDOChannels" >= 3 and output channels existing	
CrossTraffic2	standard	standard, use multiple output modules	standard, only applicable, if "PDORPDOChannels" >= 3 and output channels existing	
CrossTraffic3	standard	standard, use multiple output modules	standard, only applicable, if "PDORPDOChannels" >= 4 and output channels existing	

Tab. 3 Differences in test execution with different device types