

PROFIBUS



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**Draft
Technical Guideline**

**Test Specifications for
PROFIBUS-DP Slaves
acc. to DIN (E) 19 245 Part 3**

Edition: August 1994

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Issued by:
PROFIBUS Nutzerorganisation e.V.
Haid-und-Neu-Str. 7
D-76131 Karlsruhe
Phone: ++ 49 721 / 96 58 590
Fax: ++ 49 721 / 96 58 589
e-mail: PROFIBUS_International@compuserve.com
<http://www.profibus.com>

Developed by the working group Decentralized Periphery (DP) of
PROFIBUS Nutzerorganisation e. V. in co-operation with the test
laboratories of PNO.

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A - Certification to Verify PROFIBUS DP Functionality

At the date of publication of this document, the following PROFIBUS-DP test laboratories are established. Further test laboratories are under approval.

Please contact your local PROFIBUS user organization to get the latest information.

PROFIBUS Schnittstellencenter	Forschungszentrum Informatik	PROFIBUS Interface Center
AUT 7 B1-T2 Siemensstr.2 D-90766 Fürth	Haid-und-Neu-Straße 10-14 D-76131 Karlsruhe	3000 Bill Garland Road Johnson City, TN 37605-1255
Tel: +49 911/750-9179 Fax: +49 911/750-9222	Tel: +49 721/ 9654 - 800 Fax: +49 721/ 9654 - 809	Tel: +1 423/641-2576 Fax: +1 423/461-2016

The certification application is submitted in writing by the applicant to one of the PROFIBUS test laboratories. The application must include the following:

1. Name and address of the applicant
2. The technical documentation, including:
 - a general description of the device's structure
 - descriptions and explanations necessary for understanding how the device works
 - manufacturer's declaration stating that the device conforms to the safety and EMC requirements for its area of use (VDE 0160, IEC 80x)
 - for slaves and masters (class 1), the device data base file (DDB-File) according to DIN E 19245 Part 3, as well as a copy of the manufacturer identifier form issued by the PROFIBUS User Organization, the exact type name, and the hardware, software and firmware versions.

The application will be stamped with the date of arrival and will be processed within two weeks of this date. After the application is processed, the applicant will receive written approval of a test date, as well as an indication of how long the test will last. From the beginning of the application process to the test date, a maximum waiting time of 8 weeks is possible. On the approved test date, the applicant, hereafter referred to as the customer, and the representative end product for planned production, hereafter referred to as the test item, are to be made available free of cost to the testing laboratory. The test item must be representative of the production series and the test must be able to be carried **out without modifying hardware or software**.

After passing the tests, the test item will be integrated into the test system in the testing laboratory to show test reproducibility. The test item will be operated according to its regular use. The testing laboratory will make sure that the test item is inaccessible to all unauthorized personnel (all persons excluding the testing laboratory personnel).

The testing laboratory

- Will execute the appropriate tests to determine whether the test item conforms with PROFIBUS DP specifications, especially concerning its functional behaviour.
- Will write up a test report with the name and address of the applicant, test results, any conditions for the test validity and necessary input for definite identification of the test item. Important technical documentation will be attached to the report as an appendix.
- The test results and documents are to be available to the applicant and the testing lab.
- The testing laboratory is obligated to keep all test results and documents confidential.
- The documents received from the applicant and the test report will be kept in a separate lockable cabinet for 3 years. Only testing laboratory personnel have access to this cabinet.
- The testing laboratory will make sure that the test procedure complies with the specifications given by the PROFIBUS User Organization.
- The testing laboratory will commit itself to adapting the test procedure to the demands, if needed, and after consulting the PROFIBUS User Organization.
- If a certified product demonstrates faulty behaviour in a system and this is proved in the testing laboratory, the certificate is cancelled within a period of 6 months.

B - Test

The scope of the test includes a hardware test (Part 1), a bus transmission test (Part 2), a function test (Part 3) and an interoperability test (Part 4).

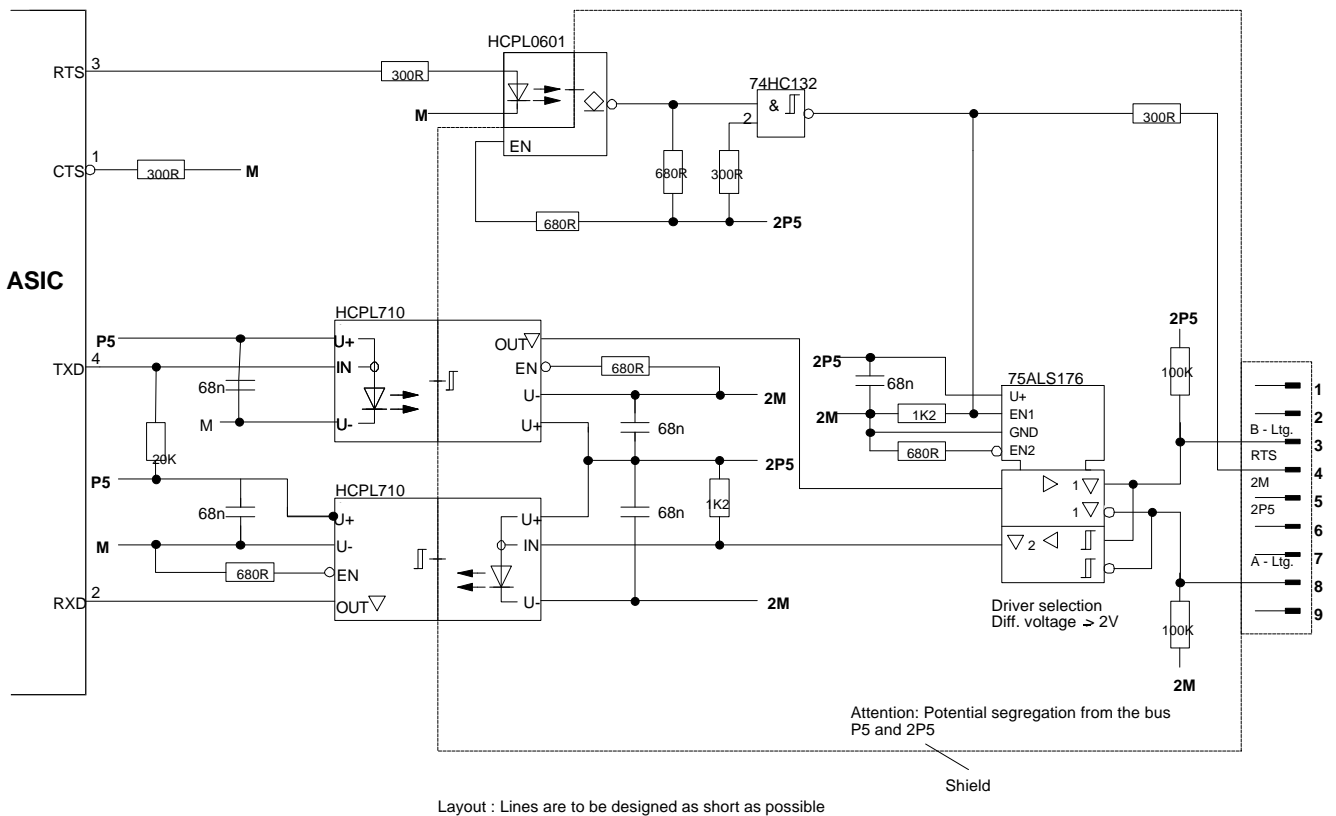
1. Hardware Testing

Necessary Documentation:

A circuit diagram of the bus interfaces is necessary, i.e. from ASIC or processor (for software solutions) to the bus connector.

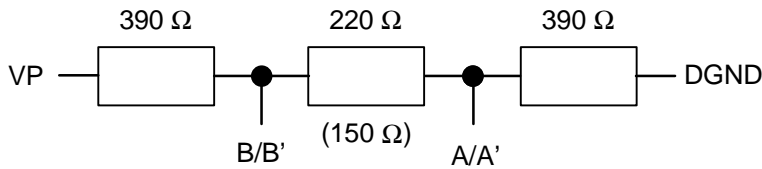
The customer is to supply the corresponding electrical diagrams in neat, legible form with clear identification of the product to be tested. The documents will be labeled with the date, a test stamp and the name of the test item and will then be archived. The documents will be kept confidential.

Sample circuit diagram



The following tests are performed using the circuit diagram and measurements:

a. Line terminators according to DIN E 19245 Part 3 (Section 6.3):



As an alternative, but with shortened cables, the standard also allows the values of the termination resistors as comply with DIN 19245 Part 1 (in parentheses).

b. Compatibility of the bus interface according to DIN E 19245 Part 3 (Section 6.4):

pin number	RS 485	signal	
1		shield*	shield or protective ground
2		M24*	ground 24V output voltage
3	B/B'	RxD/TxD-P	received/transmitted data - P
4		CNTR-P**	repeater control signal - P
5	C/C'	DGND	data reference potential output
6		VP	power supply voltage output
7		P24V*	+24V output voltage
8	A/A'	RxD/TxD-N	received/transmitted data - N
9		CNTR-N**	repeater control signal - N
* signals are optional			
** signals are optional; preferably RS 485 signal level			

If a 9-pin D-Sub plug is used on the test item, the pin numbers have to correspond to DIN E 19245 Part 3.

(If another plug is selected, it must at least include the mandatory signals (RxD/TxD-P, RxD/TxD-N, VP, DGND).

When optional signals are used, they must also comply with DIN E 19245 Part 3 and should agree with the description in the DDB-File.

c. RS 485 circuitry

The test item is driven at its maximum transmission speed with the maximum length of cable (e.g., 1.5 MBaud / 200 m).

The differential voltage and the line level (operation level and idle level with terminating resistor) are tested.

2. Bus Transmission (Slave Functionality)

a. Control interval monitoring according to DIN E 19245 Part 3 (Section 7.4)

It is checked whether the watchdog value set by the master is adhered to.
 Can the test item achieve watchdog times within the range of 10 ms to 650 s?
 Measurements are taken with various set times (3 arbitrary values in the allowable range).
 Allowable tolerance = +/- 10 ms and +/- 10 % of the set time.

b. TSDR according to DIN E 19245 Part 3 (Section 7.8)

An oscillograph is used to check whether the test item adheres to the demanded min and max. TSDR according to DIN E 19245 Part 3 at the available Baud rates.
 Adhering to the max. TSDR must agree with the entry in the DDB-File.

Baudrate (kBaud)	to 187,5kBaud	500kBaud	1500kBaud
min. T _{SDR} (tBit)	11	11	11
max. T _{SDR} (tBit)	60	100	150

c. Addressing

Addressability is tested in the range 0-126.
 EEPROM modules must allow the address 126 to be set in order to allow addressing with a master (class 2).
 Test parameters: The test item is operated under various addresses.

d. Manufacturer identifier according to DIN E 19245 Part 3 (Section 14.3)

The manufacturer identifier must be securely stored in the test item and should not be changeable when the test item is operated in its intended fashion. The manufacturer identifier must be the same as the entry in the DDB-File and in the application of the test laboratory.

e. Transmission speeds

It is tested whether data is correctly transmitted at the supported Baud rates, depending on the entry in the DDB-File. The master does the parameterization, the slave must recognize the set Baud rates and accept bus communication.
 The cyclic bus communication is recorded with an oscillograph or bus monitor and is checked for correctness.

f. Operation in mixed networks

The test item must be able to operate on a bus with PROFIBUS FMS and DP stations. The construction and the bus parameter settings must be explained in the product description. The slave must start with the following default times according to DIN E 19245 Part 3 (Section A1).

Baudrate/kBit/s	9,6	19,2	93,75	187,5	500	1500
Min T _{SDR} (TBit)	11	11	11	11	11	11

g. Composite (mixed) Devices as FMS and DP Slave

If the test item can be used as a combi-slave, it is tested in mixed operation. The slave must start with the following default times according to DIN E 19245 Part 3 (Section A2.2).

Baudrate/kBit/s	9,6	19,2	93,75	187,5	500	1500
Min T _{SDR} (TBit)	30	60	125	250	255	255

A hybrid device must be able to start with DP parameters as well as with FMS parameters.

h. Consistency

If the test item can transmit consistent data, this will also be checked.

3. Function Testing

The function test distinguishes between single-chip and processor-interface solutions (with and without ASIC). Parts of the test can be skipped for single-chip solutions if the chip in question has already been approved (More information concerning this can be obtained from the PROFIBUS User Organization or testing laboratory.). This refers to the test sequences of the state transitions.

a. Bus interruption at the test item (bus connector unplugged)

All other slaves must still be addressable (bus looped through).

Is bus interruption detected on the slave (with control interval monitoring) and does the slave switch to a defined state?

Does the test item automatically take on cyclical bus communication once the error has been removed?

b. Bus cable short-circuited on test item

The A, B cables are short-circuited, the A, B cable against the shield, DGND and VP.

The cables A, B are interchanged.

Are the outputs switched to a defined state?

Does the test item automatically take on cyclical bus communication once the error has been removed?

c. Power supply voltage at test item off/on

Does the test item automatically take on cyclical bus communication once the supply voltage has been turned on?

d. Network turned off at master

Do the test item outputs switch to a defined state (evaluation of clear data)?

e. Network turned on at master

Does the test item automatically take on cyclical bus communication once the network has been turned on?

f. Master parameterization (with and without control interval monitoring)

How does the test item behave when the bus is interrupted?

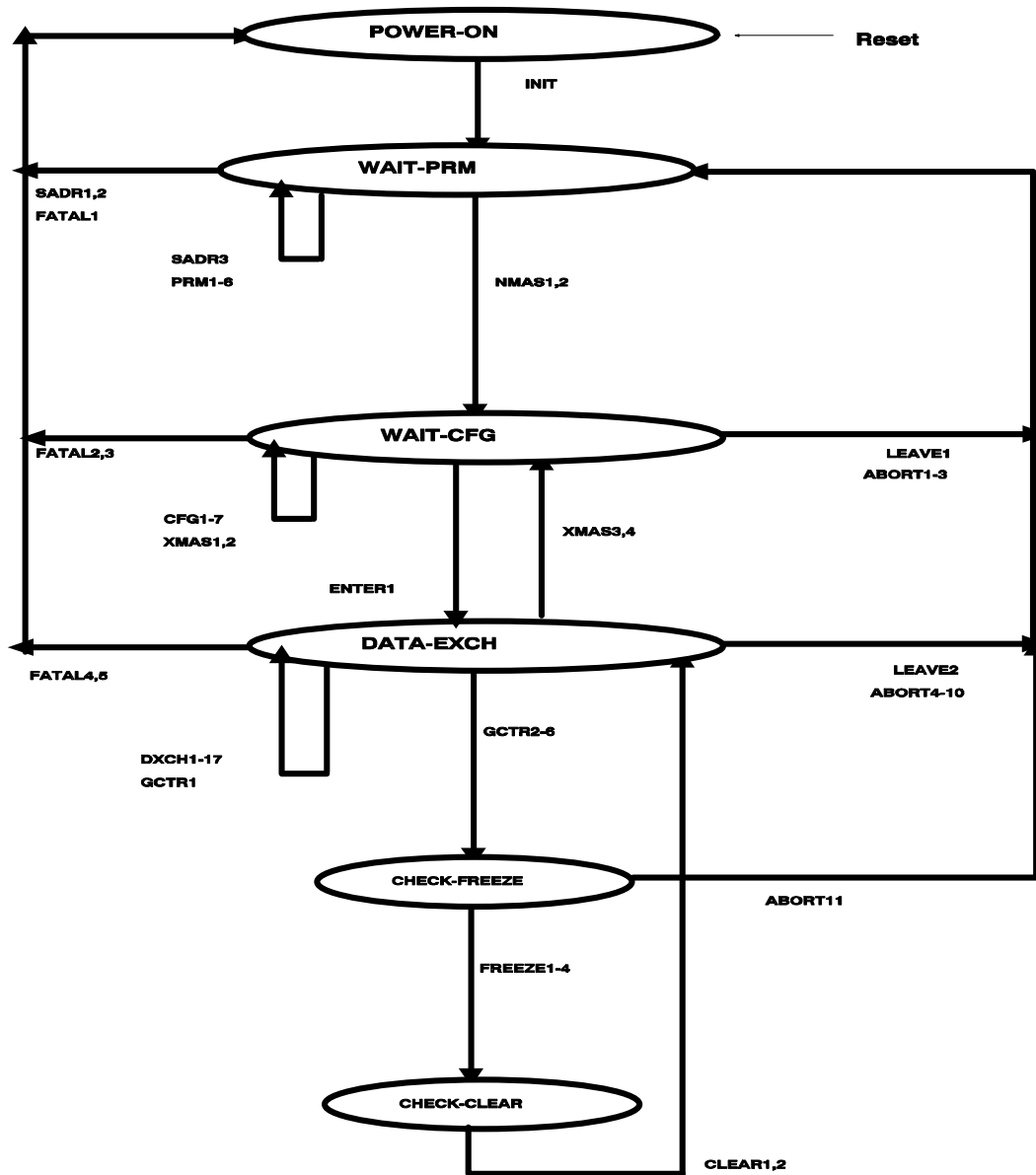
g. Master (class 2) takes control during operation

Can the test item be controlled by a master (class 2)?

h. State transitions

(see state transitions according to DIN E 19245 Part 3 Section 12.7.1.2)
 The state transitions of the user interface are checked using a test program.

General overview of the user interface state transitions for a DP slave



Additional, frames with invalid lengths are checked (configuration with incorrect length, parameterization with incorrect user data length, Global_Control with length #2 and Set_Slave_Address with length < 4, incorrect configuration).
 In the state Wait_PRM and Wait_CFG, the services Global_Control, RD_Input, RD_Output and Data Exchange must be denied.

i. Optional Services

If optional services are supported, they must be executed according to the standard.

-Freeze-

-Sync-

These services must be executed immediately after receipt and the group selection must be recognized.

When these services are activated, the corresponding function bit must be set in the slave diagnostic.

The test is carried out by reading the slave diagnostic information.

j. Evaluation of the Diagnostic Function

Every slave must provide the octets 1-6 according to the standard. Different error states are created to test the functionality.

If the slave uses external diagnostic data, they must agree with the corresponding entry in the DDB-File and the predefined format described in the standard.

The diagnosability of the test item must be defined in the product description. External diagnostic is tested using the product description and the bus monitor. The test item must allow external diagnostic to be triggered.

4. Interoperability

a. Load Test

The test item's operation at the maximum sampling frequency on the DP bus is tested. The maximum sampling frequency is reached when the test item is operated as a single station at its highest allowable Baud rate and a short evaluation program in the master is run on PROFIBUS DP.

Can the test item follow this sampling frequency? How does it react? The master must make the Min_Slave_Interval time comply with the entry in the DDB-File (IDLE 1).

b. Functional Test

The test item is integrated into a test system and is tested on its interoperability with multifunctional devices in this system. The evaluation program in the master documents the slave's functionality.

- The test item is allocated by a DP master (class 1). An evaluation program for cyclic services and slave diagnostic is created in the master. The evaluation program also takes possible error states into account caused by the additional slaves.
- During the cyclic operation, the test item will be controlled by a master (class 2).
- Mixed operation (FMS communication) is also involved in the test system.

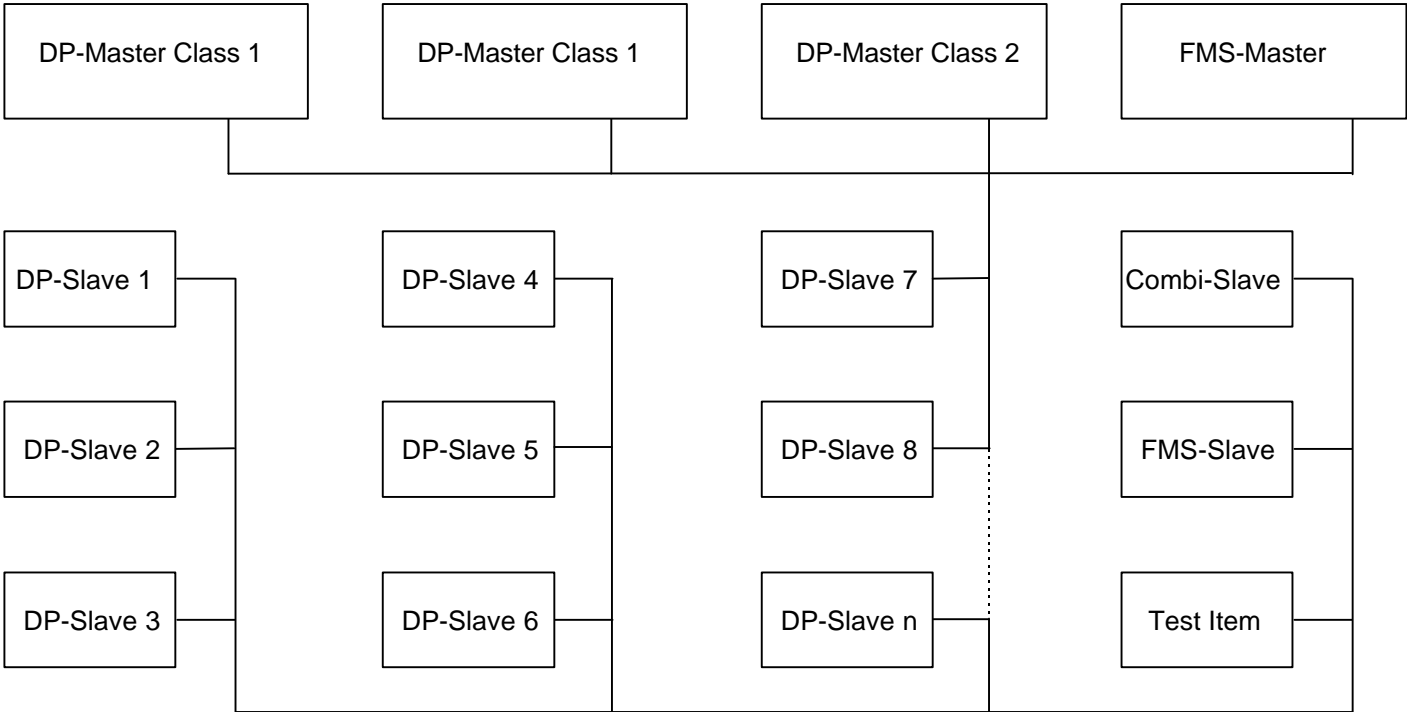
The interoperability test can be carried out in four stages:

- 1- Pure DP mono-master system just with test item
- 2- Pure DP mono-master system with at least 10 slaves
- 3- DP multi-master system with at least 10 slaves
- 4- Mixed operation consisting of stage 3 and FMS components

The individual stages are reached by reconstructing and reparameterizing the overall system.

General System Structure

test system structure (number of slaves is variable; minimum of 9 slaves + test piece)



c. Electromagnetic Compatibility

If a prototype test report for the product (see Appendix) concerning EMC measurement was supplied with the test item, no EMC test will be carried out.

For test items not having a corresponding measurement protocol, the following measurements will be carried out:

The EMC test is carried out with the maximum Baud rate.

Interference on test item's power supply lines

The interference on the supply lines (at least 2 kV) is coupled over the network according to IEC 801-4.

Data: burst = +/- 2 kV, burst frequency = 2.5 kHz, burst duration = 15 ms, disturbance duration = 1 min.

Interference on the test item's signal lines (I/O)

The interference on the signal line and bus line (at least 1 kV) is generated over coupling clamps according to IEC 801-4.

Data: burst = +/- 1 kV, burst frequency = 5 kHz, burst duration = 15 ms, interference duration = 1 min.

Test for susceptibility to static electricity discharge

All user-accessible parts will be tested with a 4 kV contact discharge according to IEC 801-2 TC65.

With all EMC tests, only the incorrect operation with reference to the bus interface will be considered. Other possible errors in the product's function will not be considered. Test item disturbance problems may not have a negative effect on the function of the overall system, including other connected stations and master components.

Inspection Report

Inspection Report

Nr.X

Slave on PROFIBUS DP

Page / Enclosure
/

File Identifier

Department

Responsible Party

Signature

Date
09.02.99

Customer:

Company:

Technical Contact Person :

Tel:

Product Identification :

Application : *e.g. DP slave component for valve blocks*

Hardware version :

Software version :

Manufacturer Identifier :

DDB-File :

Solution used:

Processor

ASIC with Processor

Single Chip

Identification :

Summary:

Remarks concerning test process and test item:

Test report

Example

According to the specified test areas:

1. Hardware

Bus Termination

- electrical data comply with the demands
- bus termination external
- electrical data do not comply with the demands
- further remarks: *Remarks recorded in Italics*

PROFIBUS DP Plug

- standard 9-pin SUB D
- nonstandard, but includes all mandatory signals and sufficient description
Description of the implementation:
- nonstandard and

RS 485

- requirements fulfilled
- requirements not fulfilled sufficiently

Component Use

- electrical data comply with the demands
- electrical data do not comply with the demands

2. Bus Transmission

Control Interval Monitoring

- adjustable in entire available range
- limited in the range of:

TSDR

- requirements fulfilled
- recorded timing behaviour does not conform with PROFIBUS DP:

Addressing the Test Item under PROFIBUS DP

- test item can be addressed by Master Class 2
- test item can be addressed in the entire available range
- limited addressability: *The device under test can only be addressed in the range 1-99.*

Manufacturer Identifier

- as issued
- limitations:

Transmission Speeds

- can be operated with the following PROFIBUS DP transmission rates:
9,6; 19,2; 187,5; 500; 1500kBaud
- restricted operability

Mixed Network

- no errors in operation detected
- errors in operation when:

Mixed Operation

- test item is designed for the mixed operation
- no errors in operation detected
- the test item could be further operated on DP when FMS operation was disturbed or interrupted
- the test item could **not** be further operated on DP when FMS operation was disturbed or interrupted
- the test item could be further operated on FMS when DP operation was disturbed or interrupted
- the test item could **not** be further operated on FMS when DP operation was disturbed or interrupted
- errors in operation when:

Consistency

- consistency not adjustable on test item
- consistency is supported correctly
- errors in operation when:

3. Function Testing

Bus Interruption

- correct behaviour
- special behaviour when:
 - acceptable
 - not acceptable in this form

Short Circuit

- correct behaviour
- special behaviour when:
 - acceptable
 - not acceptable in this form

Supply Voltage

- correct behaviour
- special behaviour when:
 - acceptable
 - not acceptable in this form

Network on/off at Master

- correct behaviour
- special behaviour when:
 - acceptable
 - not acceptable in this form

With and without Control Interval Monitoring

- correct behaviour
- special behaviour when:
 - acceptable
 - not acceptable in this form

Master Class 2

- correct behaviour
- special behaviour when:
 - acceptable
 - not acceptable

State Transitions

- nothing unusual in operation could be detected
- special behaviour when:
 - acceptable
 - not acceptable in this way

Optional Services

- optional services sync and freeze are not supported and are correctly carried out
- sync is supported and is correctly carried out
- freeze is supported and is correctly carried out
- errors in operation when:

Diagnostic

- mandatory diagnostic is carried out correctly
- external diagnostic not used
- external diagnostic complies with the standard
- special behaviour when:

4. Interoperability

Load Test

- load test complies with specifications
- special behaviour when:

Functional Test

- no restrictions could be determined
- restrictions when:

EMC

- correct prototype test report available
- test item only failed occasionally during EMC testing
- bus failure when interference on test product power supply line
- bus failure when interference on test product signal line (I/O)
- bus failure when susceptibility to static electricity discharge was tested
- no failure

5. Supplementary Hints and other Restrictions

Here, verbal descriptions of the following functions are reported:

- any errors or special behaviour with reference to the respective test area
- other test product peculiarities
- remarks concerning manufacturer explanations
- remarks concerning documentation comprehension

6. Test Apparatus and Equipment Used

Here, the test apparatus is documented, all versions of test software and any abnormalities. This documentation guarantees the test's reproducibility for 3 years.

Version Testsystem PC :

Hardware version :

Software version :

Version master class 1 :

Hardware state :

Firmware state :

Version master class 2 :

Hardware state :

Firmware state :

Version FMS master :

Hardware state :

Software state :

List of used slaves :

Type specifications sorted according to increasing station number:

.....

7. Enclosures

The only enclosures are the measurement reports or recordings which are to inform the customer or PROFIBUS User Organization about abnormal behaviour.

All recordings are stored in the testing laboratory in two separate places accessible only by testing laboratory personnel. The customer and PROFIBUS User Organization can receive all recordings on demand.

Appendix: Prototype Test Report

Prototype Test

Test No ...

**Noise Immunity against Highly Transient Burst Disturbances
according to
IEC 801, Part 4 (1988)**

Project:	
Test Item:	
Responsible Party:	
Tester:	
Test Location:	
Time Range:	

Test Requirements/Results					
Coupling to	Requirement		Requirement fulfilled?		Achieved Immunity
	Level	Test Voltage kV	yes	no	Test Voltage kV
Current supply lines			<input type="checkbox"/>	<input type="checkbox"/>	
Data and signal lines			<input type="checkbox"/>	<input type="checkbox"/>	

<p>Result :</p> <p>Test requirements are <input type="checkbox"/> fulfilled <input type="checkbox"/> not fulfilled</p> <p>Every single requirement must be met.</p>

Remarks:

Enclosures:

 Date

 Tester's Signature

Prototype Test

Test No ...

Immunity against Electrostatic Discharge (ESD) according to IEC 801, Part 2 (1991)

Project:	
Test Item:	
Responsible Party:	
Tester:	
Test Location:	
Time Range:	

Test Requirements/Results:						
Type of discharge	Requirement		Requirement fulfilled?			Achieved Immunity
	Level	Test Voltage kV	yes	no		Test Voltage kV
Contact discharge			<input type="checkbox"/>	<input type="checkbox"/>		
Air discharge			<input type="checkbox"/>	<input type="checkbox"/>		
HCP			<input type="checkbox"/>	<input type="checkbox"/>		
VCP			<input type="checkbox"/>	<input type="checkbox"/>		

Result:

Test requirements are fulfilled
 not fulfilled

Every single requirement must be met.

Remarks:

Enclosures:

_____ Date

_____ Tester's Signature

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PROFIBUS Nutzerorganisation e.V.
Haid-und-Neu-Str. 7
D-76131 Karlsruhe
Phone: ++ 49 721 / 96 58 590
Fax: ++ 49 721 / 96 58 589
e-mail: PROFIBUS_International@compuserve.com
<http://www.profibus.com>