User’s Guide

PFM 200N100.1

PFM 200N200

Voltage Dips and Drops Interruptions

- **E-10** Brief Voltage Drop
- **E-13** Dropout Pin
- **E-14** Dropout Connector
- **E48-09** Short Interruptions

BMW QV65013
GMW3172
LV 124 (2013)
LV 148
Renault 36-00-808/--M
Nissan 28401 NDS02

The PFM 200N Series has been specially engineered for performing dropout pulses on battery and signal lines.

The PFM 200N contains a switch for battery voltage as well as additional switches for battery return lines from 100 mA up to 100 A or 200 A depending on the model. An additional set of 16 switches are provided for data and signal line switching from 100 µA to 2 A.

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Contents

1. Introduction

1.1. Overview

The PFM 200N Series has been specially engineered for testing virtually every known type of dropout pulses in automotive applications.

One special feature of this device is the capability of the generator to switch a load in parallel to the DUT during the dropout test.

For example, the PFM 200N series is for testing of E10 Short interruptions and E13 Pin Interruption for the following tests:
- OEM LV 124 Version 2.20 (2013-02)
- VW 80000 2013-06

Note: Due to changes in LV 124, the 2009 version of the standard is no longer supported by the PFM 200N100.1 and PFM 200N200.

Additional standards refer to LV 124 und LV 148:
- BMW GS 95024-2-1 (2010-01)
- BMW GS 95026
- LVA 320: 2014
- Mercedes-Benz MBN LV 124-1
- VW 82148

Another feature of the PFM200N100.1, as well as the PFM 200N200 is a very fast switching time for other dropout tests such as:
- BMW QV65013
- GMW3172

Finally, we the PFM 200N100.1 and PFM 200N200 fully support switching of BAT- lines for standards that require it, such as:
- Renault 36-00-808/--M
- Nissan 28401 NDS02

2. Safety

2.1. Safety Instructions

In order to guarantee your personal safety, and the safety of personnel in your surroundings, it is imperative that you read and understand the following safety instructions.

EM TEST devices are related to excess voltage category II.

Symbols on the device

	**DANGER**	Warning of voltages that might involve the risk of electric shock. Pay special attention to the User's Guide.
	**CAUTION**	Warns of a possibly dangerous situation. Careful attention should be made to avoid damage to the device, device under test or its surroundings
	**Note**	Important information about the operation of the device. Carefully read the User's Guide.
	**PE**	Protective Earth Connector

Mains Power
The mains power that is used shall not exceed 230V +15% between hot and neutral. The protective earth connection is made over the power cable and may not, under any circumstances, be removed.

Earthing of the Device and CDN
The device is earthed through the protective earth connection of the mains cable. Therefore, use only mains sockets where you are sure that the protective earth is correctly used. It is important to verify earthing before using the device. Any additional CDNs are to be earthed with the provided earth connectors.

Without a proper protective earth, conductive parts of the device may incur dangerous voltages. This may also affect components that appear to be isolated.

Use Only Tested Mains Cables
Use only the original mains cable or a cable with proper markings to ensure safe operation. Do not use damaged cables.

Use only Fuses of Specified Type
Solely for use with fuses that meet the specified type found on the mains connector or consult the User's Guide. Pay special attention to the type, voltage and current required.

Do not remove covers.
Do not use a device that is open. This is for your safety and the reproducibility of the test results.

☞ **Read this guide carefully before putting this device into operation.**

2.2. Care During Testing

All tests using high voltage or EMC generators are immunity tests for electrical devices. The device under test (DUTs) can react incorrectly which may lead to a dangerous situation. The user is responsible to take care to avoid the risk to man and material.

One must carefully follow all relevant international guidelines and requirements for the protection of people. This is especially important in unusual setups or where pulses may be coupled.

People at risk are prohibited from using the system; for example, people with pacemakers.

Long cables leading to the DUT can radiate and effect devices in the area, including devices that do not belong to the test setup. It is the user's responsibility to decide if and when the use of an area is acceptable for EMC testing.

Tests can lead to sparks. It is strictly forbidden to perform tests in areas where there exists a risk of explosion.

While the PFM 200N series produces no dangerous voltages, the very fast switching of inductive loads will result in large inductive kickback that can be dangerous to life. The output of the PFM 200N is equipped with a GDT (Gas Discharge Tube) that is designed to suppress voltage over 120V.

2.2.1. Switching Off

- The generator has **limited internal protection**.

  Switching off of the DUT is accomplished with an electronic switch that contains a current measurement that can be overloaded to 400 A when the DUT power is switched off.

CAUTION

In extreme cases, like when using an automotive battery into a short, can result in currents well over 400 A. In these cases, the electronic switch can no longer switch off.

Therefore, additional protection, like an inline fuse, is recommended to ensure safety when using an automotive battery.

The user must provide a breaker for the DUT. Special adapters with switching and breakers are available, but must be specified by the user.

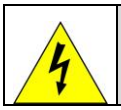
- To couple a disturbance on a data or signal line, the coupling method must first be carefully defined.
- If a data or signal line is not to have pulses coupled, the lines shall be removed entirely from the CDN!

2.2.2. Danger to the Device Under Test (DUT)

The pulses can lead to an unexpected condition of the DUT that results in a dangerous situation.

Therefore, the following conditions should be carefully observed:

- Stop the test when the DUT behaves abnormally.
- Due to an internal defect, high voltage components may make contact to the DUT housing.
- Cables and connectors can be overloaded by overvoltage.
- Internal destruction of components can lead to fire or explosion.
- Accidental operation of the DUT can cause dangerous situations.



DANGER Never approach a DUT during test!

2.2.3. Input Capacitance

In order to achieve the necessary switching time, the PFM 200N series contains capacitance at the battery input PF1. Ripple tests may not be performed when the PFM 200N is connected because the capacitive reactance of this buffer capacitor will cause the VDS 200Q or VDS 200N to go into current limit. The VDS 200Q series is prepared with a jumper to easily isolate the PFM 200N when it is not needed. It is strongly recommended to remove the PFM 200N from the test setup when it is not needed.

3. Package Contents and Putting Into Service

3.1. Basic Equipment PFM 200N100.1

- PFM 200N100.1 Generator
- Mains cable with country-appropriate connector
- 3 m Frame Bus cable
- Frame Bus Termination
- 2 sets of 2 m laboratory cables, 32A (red and black)
- Two pairs of 100A Multi Contact Sockets, 2 x 2 pairs
- 2 x PHOENIX, DFMC Adapters, 1.5 mm2, with a push-in locking connection
- User's Guide on a USB memory stick

Identical accessories are only delivered once for deliveries of multiple devices. Details may be found on the packing list which is final.

3.2. Basic Equipment PFM 200N200

- PFM 200N200 Generator
- Mains cable with country-appropriate connector
- 3 m Frame Bus cable
- Frame Bus Termination
- 2 mating connectors 200A
- 2 x PHOENIX, DFMC Adapters, 1.5 mm2, with a push-in locking connection
- User's Guide on a USB memory stick

Identical accessories are only delivered once for deliveries of multiple devices. Details may be found on the packing list which is final.

3.3. Accessories

- **User Software "AutoWave.control"**
  - Test, analyze and document under Windows
  - License for testing of most automotive standards
  - Report generator featuring export to text

Figure 3.1

- **Frame Bus Terminator**
  Terminating resistor for the Frame Bus interface


Figure 3.2

- **Printed-circuit board connector - DFMC**
  PHOENIX, DFMC Adapters, 1.5 mm2, with a push-in locking connection

  Poenix Contact
  Type: DFMC 1,5/16-ST-3,5-LR
  Order No: 1790629

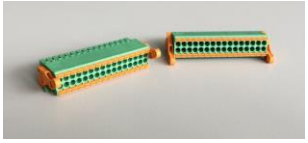


Figure 3.3

3.4. Optional Accessory CA LV124

Set for edge verification of the PFM 200N100.1 according to LV 124

- **Case for LV 124 Calibration**
  - Rugged plastic case for storing the calibration loads for the CA LV 124
  - 2 m BNC cable
  - 2 laboratory cables 0.5 m (black, red)
  - Calibration resistors for power and data lines

Figure 3.4

- **CA LV124-P1R** Calibration of Battery Lines
  1,0 Ω ± 1 %,
  U max.: 12 V
  P max.: 150 W

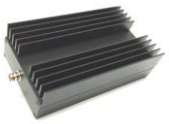


Figure 3.5

- **CA LV124-P100R** Calibration of Battery Lines
  100.0 Ω ± 1 %,
  U max.: 100 V
  P max.: 50 W

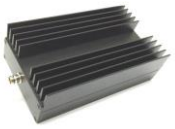


Figure 3.6

- **CA LV124-D1R** Calibration of Signal and Data Lines
  1.0 Ω ± 1 %
  U max.: 2.0 V
  P max.: 1 W, P Peak: 4W max.

Figure 3..7

- **CA LV124-D1000R** Calibration of Signal and Data Lines
  1000 Ω ± 1 %
  U max.: 40.0 V
  P max.: 1 W

Figure 3..8

3.5. Optional Accessory CA LV124.1

Set for edge verification of the PFM 200N200 according to LV 124

- **Case for LV 124.1 Calibration**
  - Rugged plastic case for storing the calibration loads for the CA LV 124
  - 2 m BNC cable
  - 2 laboratory cables 0.5 m (black, red)
  - Calibration resistors for power and data lines

- **CA LV124-P1R** Calibration of Battery Lines
  1,0 Ω ± 1 %,
  U max.: 12 V
  P max.: 150 W

- **CA LV124-P100R** Calibration of Battery Lines
  100.0 Ω ± 1 %,
  U max.: 100 V
  P max.: 50 W

- **CA LV124-D1R** Calibration of Signal and Data Lines
  1.0 Ω ± 1 %
  U max.: 2.0 V
  P max.: 1 W, P Peak: 4W max.

- **CA LV124-D1000R** Calibration of Signal and Data Lines
  1000 Ω ± 1 %
  U max.: 40.0 V
  P max.: 1 W

3.6. Optional Accessory CA LV148

Set for edge verification of the PFM 200N100.1 according to LV 148

- **Case for LV 148 Calibration**
  - Rugged plastic case for storing the calibration loads for the CA LV 124
  - 2 m BNC cable
  - 2 laboratory cables 0.5 m (black, red)
  - Calibration resistors for power and data lines

- **CA LV148-P10R** Calibration of Battery Lines
  10,0 Ω ± 1 %,
  U max.: 48 V
  P max.: 30 W

- **CA LV148-P1000R** Calibration of Battery Lines
  1000.0 Ω ± 1 %,
  U max.: 48 V
  P max.: 30 W

3.7. Optional Accessory CA LV148.1

Set for edge verification of the PFM 200N200 according to LV 148

- **Case for LV 148 Calibration**
  - Rugged plastic case for storing the calibration loads for the CA LV 124
  - 2 m BNC cable
  - 2 laboratory cables 0.5 m (black, red)
  - Calibration resistors for power and data lines

- **CA LV124-P10R** Calibration of Battery Lines
  10,0 Ω ± 1 %,
  U max.: 48 V
  P max.: 30 W

- **CA LV124-P1000R** Calibration of Battery Lines
  1000.0 Ω ± 1 %,
  U max.: 48 V
  P max.: 30 W

3.8. Installation

3.8.1. Unpacking

Before shipment, the device is carefully tested and packed on a one-way pallet. Every box is marked with a warning notice and packing list.

Before installation, check the contents the delivery contents for transport damage. Check that the packaging is in good condition and ensure that the device does not exhibit any mechanical damage. If this is the case, please immediately inform EM Test or their authorized representative before putting the device into operation.

Note: This guide uses the PFM 200N100.1 for illustrative purpose. Cases where the PFM 200N200 differs are listed separately.

3.8.2. Setup and Cabling the Test System

Control Cables

Figure 3.10 shows the typical usage of control cables for the test system:

- **AutoWave** Controls the PFM
- **PFM 200N100.1** Dropout simulator
- **VDS 200Nx** DC source for powering the DUT

AutoWave.control is required in order to operate the PFM 200N100.1. This software contains all the test routines for testing with the PFM 200N100.1

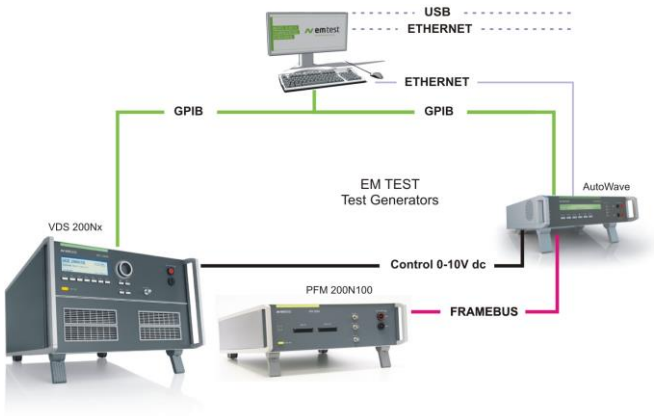


Figure 3.10: Control Cables

Cabling for the System

Figure 3.11 shows all connections necessary for the PFM 200N100.1, AutoWave und VDS:

Cable List:

Computer – AutoWave
GPIB / IEEE488 or
Ethernet

AutoWave - VDS200N100

IEEE 488	IEEE488
CH 1 BNC	0-10V BNC

AutoWave - PFM 200N100.1

Framebus OUT	Framebus IN	15 Pin D-Sub

VDS200Nx - PFM 200N100.1

DUT +	PF1 IN +	DUT power, 100A max.
DUT -	PF1 IN -	DUT power, 100A max.

PFM 200N100.1

Framebus OUT	Framebus Termination

Earth Connection: VDS 200Nx and PFM 200N

Mains power: to all devices (1ph / 3ph)

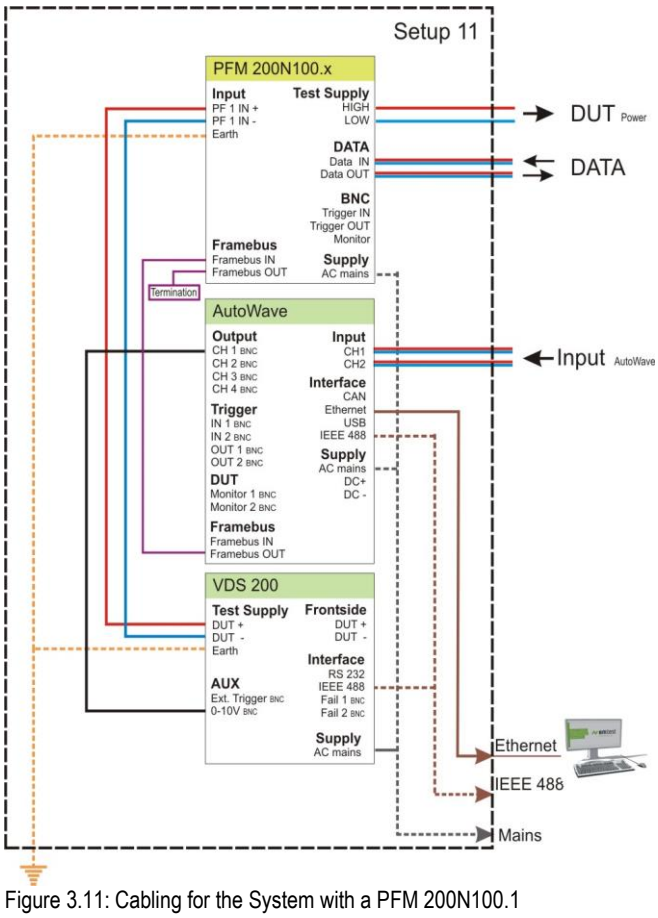


Figure 3.11: Cabling for the System with a PFM 200N100.1

3.8.3. Software Installation and Setup

To install the AutoWave.control, please consult the software user's guide.

After installation use the Hardware Configuration tool to setup the AutoWave.

A Select **Setup / Device** to open the System Configuration.

Figure 3.12

B System Configuration

Here you can setup the software for the correct system configuration.

1. Choose the selection **Select System Configuration** to open a typical configuration.
2. Select **System 7** or System 8 or the one that most accurately reflects your system.
3. Choose **OK** to close this window.

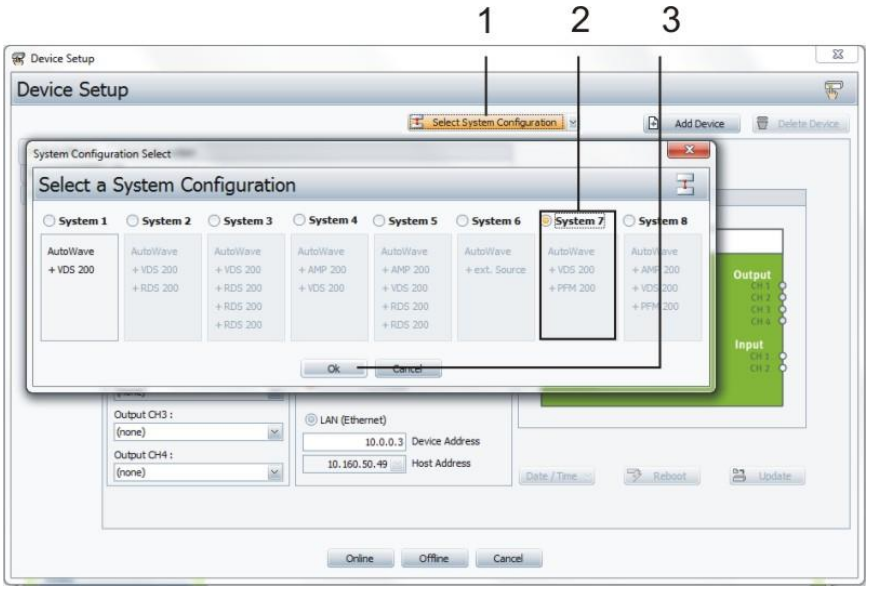


Figure 3.13: System Configuration for a Typical PFM 200N100.1 Setup

C Device Setup

Here is where you enter the details for the device.

1. First, select **AutoWave** as the device to be edited.
2. Enter the **Serial Number** in the list.
3. Enter the date from the delivered certification.
4. Select the **Interface** to the computer: GPIB or LAN.
5. Enter the details for the **VDS**.

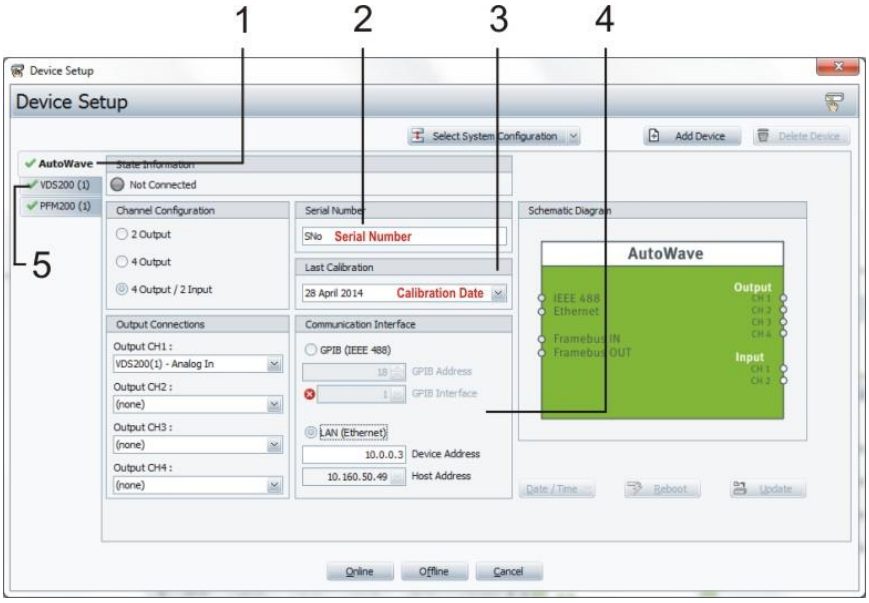


Figure 3.14: Device Setup for AutoWave

D PFM 200N Series Setup

Here is where you enter the details for the PFM 200N in the Software.

1 Select the **PFM 200N** to be edited.

2 Enter the calibration date for the PFM200N.

3 Enter the PFM 200N **Serial number** in the provided field.

4 Click Online to connect the system and the computer.

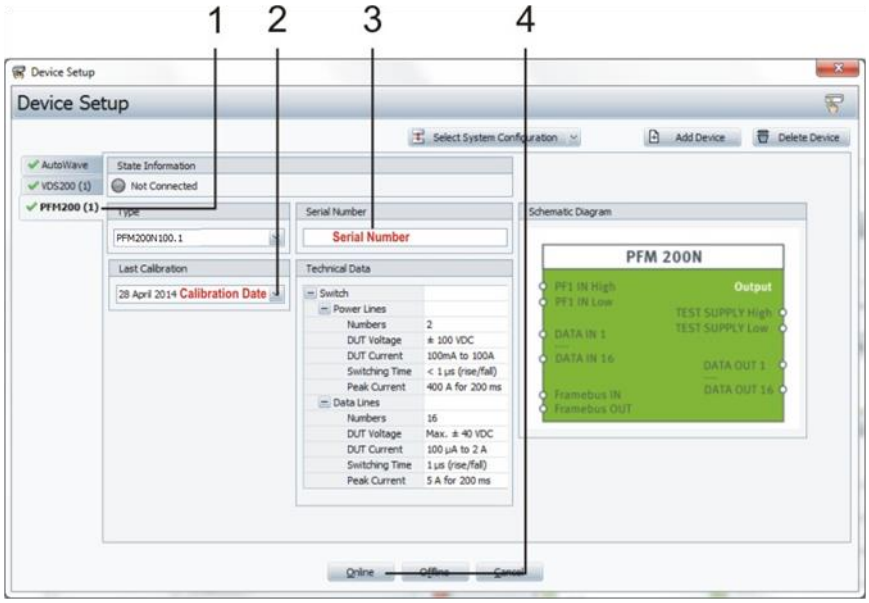


Figure 3.15: Device Setup for PFM 200N100.1

If you should encounter any problems during connection, please consult the AutoWave.control software user's guide. Here you'll find more information for the installation.

For further information about software, please consult:

- The user's guide for the AutoWave.control software
- The example applications in this guide

4. Functions and Operation of the PFM 200N

4.1. Front Panel Elements

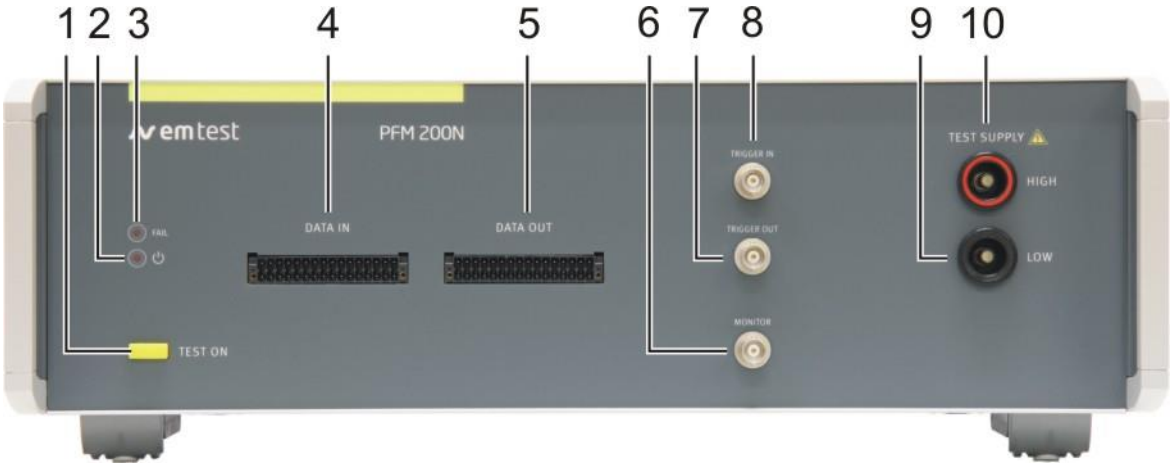


Figure 4.1

1 Test enable button "TEST ON”
2 LED Power ON
3 LED Fail
4 Data line inputs L1 – L16
5 Data line outputs L1 – L16
6 Monitor BNC port
7 Trigger OUT BNC port
8 Trigger IN BNC port
9 DUT Test Supply LOW
10 DUT Test Supply HIGH

1 Test Enable Button “TEST ON”
Pressing the "TEST ON" button enables testing. The LED serves also as an optical indication when the switch switches: the DUT power will be provided when the button is lit.

2 LED Power ON
This LED will light when the switch on the back of the device is switched on, indicating that the PFM is ready.

3 LED Fail
This LED will light when the PFM 200N detects an error. An error message will be displayed in a window in the AutoWave.control software.

4 Data Line Inputs L1 – L16
16 pin PHOENIX, DFMC connector with 1.5 mm2, push-in locking connections.
Upper row: switched channel L1 to L16 (input)
Bottom row: return lines for the upper L1 to L16 switches

5 Data Line Outputs L1 – L16
16 pin PHOENIX, DFMC connector with 1.5 mm2, push-in locking connections.
Upper row: switched channel L1 to L16 (output)
Bottom row: return lines for the upper L1 to L16 switches

6 Monitor
Monitoring output for the DUT voltage at the test supply output using a differential measurement
Ratio 1:20, Amplitude 10 Vpp, ± 5 V

7 Trigger OUT, Oscilloscope Trigger
BNC trigger output (12 V pos. edge) for external measurement devices

8 Trigger IN
Trigger input to control the trigger the switch.
Signal (5 V neg. edge), delay ca. 100 µs

9 DUT Test Supply LOW
DUT output LOW with 4 mm (male) / 6 mm (female) connectors

10 DUT Test Supply HIGH
Switch DUT voltage output LOW 4 mm (male) / 6 mm (female) connectors

4.2. Back Panel Elements

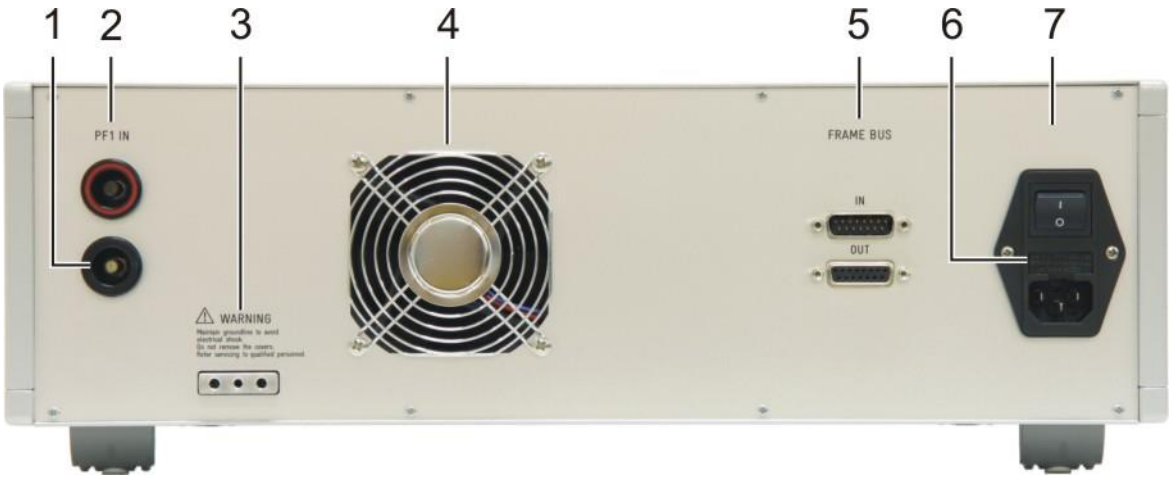


Figure 4.2

1 PF1 IN, DUT power input High
2 PF1 IN, DUT power input Low
3 Reference Earth
4 Cooling Fan
5 Frame Bus Interface
6 Mains Power Input and Fuse
7 Power Switch ON/OFF

1 PF1 IN, DUT Power Input Low (VDS)
Input connector 4 mm and 6 mm (PFM 200N100.1) or BVT 10 (PFM 200N200) for DC power for the DUT (Low). The generator must be connected to the reference earth of the test setup.

2 PF1 IN, DUT Power Input High (VDS)
Input connector 4 mm and 6 mm (PFM 200N100.1) or BVT 10 (PFM 200N200) for DC power for the DUT from an external source (High)
Max. DC Voltage ±100V
- 6 mm connector 100 A
- 4 mm connector 32 A max.

3 Reference Earth
Earth connector with an M5 screw terminal and 4mm banana connector. The generator must be connected to the reference earth in the test setup.

4 Cooling Fan
Cooling unit. At least 20cm around should be allowed for proper ventilation.

5 Frame Bus Interface
Interface for controlling the PFM 200N from an AutoWave. The output of the Frame Bus must be terminated with the Framebus Terminator part no. 101732.

6 Mains Input and Fuse
The mains input has an integrated filter and fuse for the generator using (2x 2 AT) fuses. The generator power supply is a universal power supply with a range of 100 V - 265 VAC, 50/60 Hz

7 Power Switch
Power ON/OFF Switch

4.3. Description of the Functions of the Device

4.3.1. Front

TRIGGER IN

Figure 4.3

Trigger IN

Trigger to start an event

The trigger signal starts an interrupt. The trigger can be set in the AutoWave software.

- Manual at Start
- Manual each Cycle
- Manual each Iteration

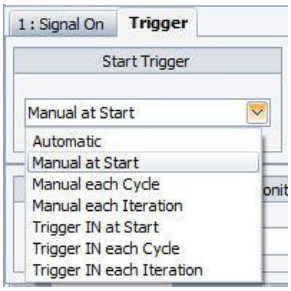


Figure 4.4 Trigger IN selection

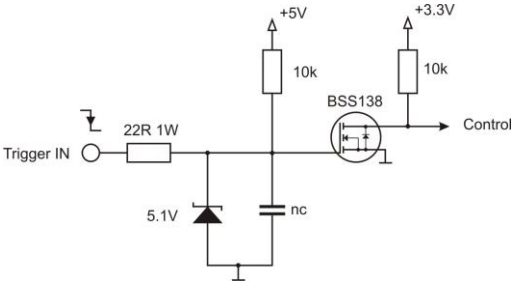


Figure 4.5 Schematic - Trigger IN

Signal: 5 V, neg. edge
Delay: 100 µs
Jitter:

TRIGGER OUT

Figure 4.6

Trigger OUT

Output signal synchronized with the internal switching control signal for an external oscilloscope

Signal: 12 V, pos. edge
Current: 100mA
Delay: same as the switch control signal
Jitter:

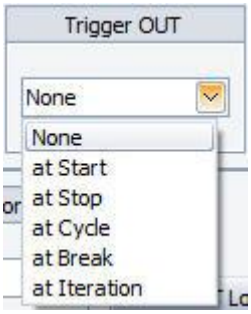


Figure 4.7 Trigger OUT selection

MONITOR

Figure 4.8

Monitor OUT

Allows monitoring of the output of the Test Supply
Measurement: differential measurement
Ratio: 1:20
Amplitude: 10 Vpp, ± 5 V
Accuracy: ± 5%
Bandwidth: 10 MHz

DUT Connections

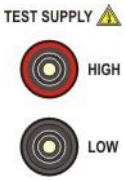


Figure 4.9

DUT Power

Current capabilities PFM 200N100.1:
4 mm male: max. 32 A
6 mm female: max. 100 A

Current capabilities PFM 200N200:
KBT10: max. 200 A
(Mating connectors provided)

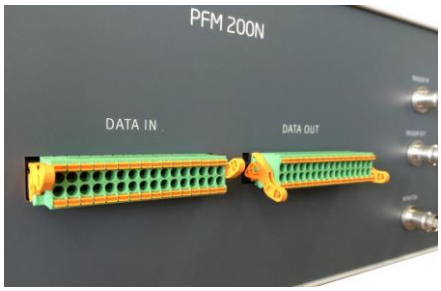


Figure 4.10

Data lines

The delivered connectors for the data lines are equipped with spring-cage connections

Position of the spring-cage connector:
Open: upper position
Closed: lower position

Manufacturer: PHOENIX CONTACT
Model: DFMC series
Order No: 1790629
Poles: 16
Contacts: 32

Note: Depending on the signal, impedance and frequency, a small amount of crosstalk may be experienced when using the data line switches.

4.3.2. Back

Figure 4.10

Input for DUT Power

Current capabilities PFM 200N100.1:
4 mm male: max. 32 A
6 mm female: max. 100 A

Current capabilities PFM 200N200:
KBT10: max. 200 A
(Mating connectors provided)

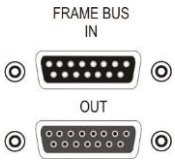


Figure 4.11

Frame Bus

Daisy Chain Bus with 15 pin Sub-D
male /female connector.

This interface is used to control various EM Test devices.

Figure 4.12

Power and Fusing

The main on/off switch of the PFM 200N series acts as the mains input and contains a mains filter and fusing.

Mains: 100V - 265V, 50/60 Hz
Fuse: 2 x 2 AT, 5 x 20mm

5. PFM 200N Dropout Simulator

The generator serves as the switching unit for dropout testing both power and signal lines required by various requirements.

5.1. Switch for DUT Battery Voltage

- Power Switch (S1P) for currents from 100 mA to 100 A (Inrush 400 A for 200 ms)
- Voltage ± 100 V DC
- Switching time < 1 µs (PFM 200N) < 200 ns (PFM 200N100.1 and PFM 200N200)
- Bidirectional switching capability
- Switch (S1N) on the ground line
- Integrated shorting-switch with < 100 mΩ during switch off (S2)
- Additional switchable impedances (R1…Rx), for predefined impedances of the on board power system

5.2. Switches for Data and Signal Lines

- Switch (S1 to S16) for currents from 100 µA to 2 A (Inrush 5 A for 200 ms)
- Bidirectional switching capability
- 16 switches for each sign or data lines
- Max. ± 40 VDC

The generator may **only** be used with AutoWave

5.3. Block Diagram PFM 200N

Battery Lines
Switch S1 and S2 from the standards LV 124 and LV 148 have a slightly different name in the PFM 200N Series and its associated software. Switch S2N in the PFM 200N, used to interrupt the ground line, is not found in the LV requirements, instead other standards.

	LV Std.	PFM / Software
Power Switch High	**S1**	**S1P**
Shorting Switch	**S2**	**S2**
Power Switch Low	--	S1N

Data and Signal Lines
There are two connectors on the PFM 200N, each with 16 inputs and outputs. The upper row is switched and the lower row is an unswitched return line.

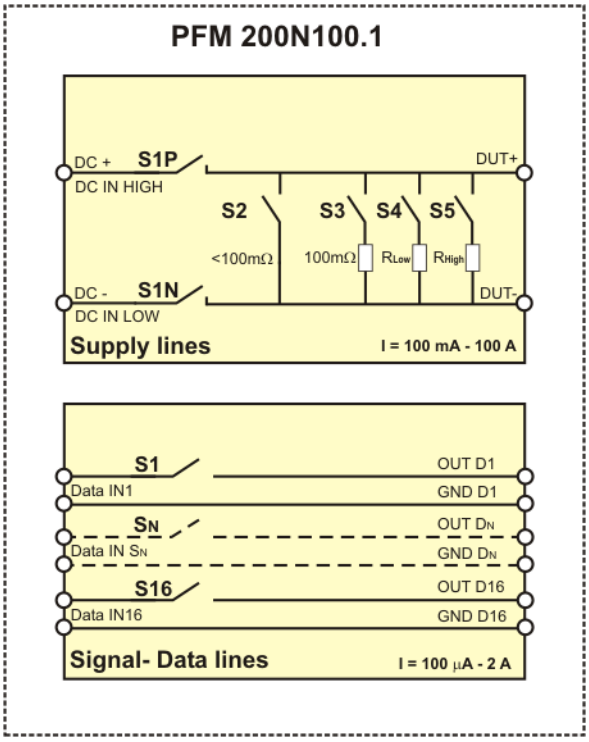


Figure 5.1: Block Diagram PFM 200N100.1 with descriptions corresponding to the AutoWave.control software

6. Testing according to LV 124 and LV 148 using the autowave.control Software

Tests according to E-10, E-13 and E-14 uses an AutoWave for control. The user must use AutoWave.control version 5.6.0 or newer.

6.1. Locating the Standard Tests for LV 124 and LV 148

LV 124 and LV 148 in the Standards Library
The standards LV 124 and LV 148 are found in the Standards Library under Automotive – OEM. Each standard contains various versions.

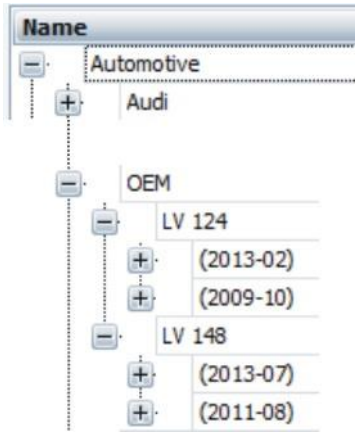


Figure 6.1: Standards list for LV 124 and LV 148

Selecting a Test
The user may choose the needed version and test routine. Tests that do not user EM Test equipment will not be found here. Each test step is listed individually.

The example in Figure 6.2 the selection of a test: LV 124(2013-02), E-10 Test Case 1 that includes a dropout from 100ms to 2s.

Preview
In the right window of AutoWave.control a preview of the selected test is displayed including some general information about the selected test.

The picture in the preview window shows the test run in a simplified way. The user has the possibility to check the voltage profile of the test run in a visual way.

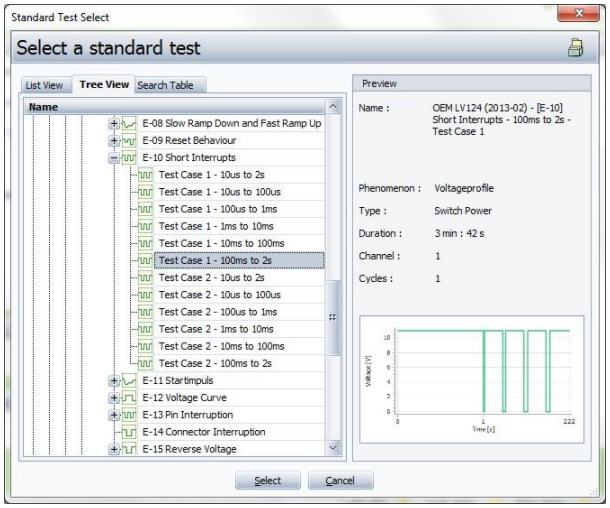


Figure 6.2: Standard List for LV 124 Test Case 1 & 2

More Information about the Preview Window

Name:	Standard name of the selected test
Phenomenon:	Type of test (Voltage profile)
Duration:	Duration of the entire test
Channel:	Channel (AutoWave output)
Cycles:	Number of Cycles

Standard Tests with Multiple Steps
The LV standards require for each DUT multiple sequences of tests in AutoWave.control

- **Individual** select each individually or
- **All Test Sequences Together** as shown in the test sequence is shown in Figure 6.3marked in grey.
  The first test step in the list contains a sequence of all 5 test steps.

Additional settings for the user of the software may be found in the AutoWave.control user's guide.

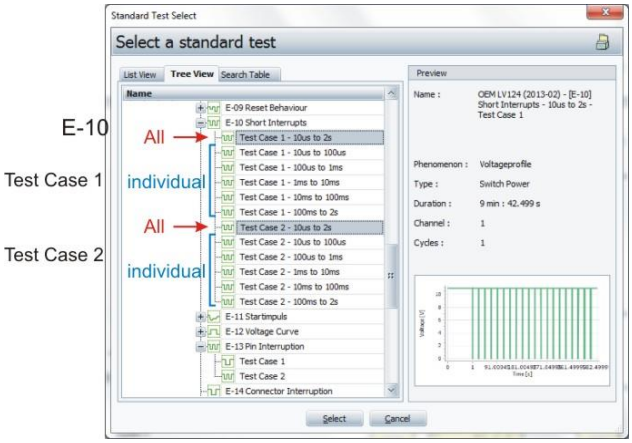


Figure 6.3 Selecting the Sequence for E-10

Choosing **Select** will select the test and load it in the test window.

6.2. SW Settings for the PFM 200N Switch

6.2.1. SW Settings Switch S1

Both S1N and S1P will interrupt the battery voltage from the DUT. The PFM 200N has the following settings for **Switched Line** (Figure 6.4) for dropout testing:

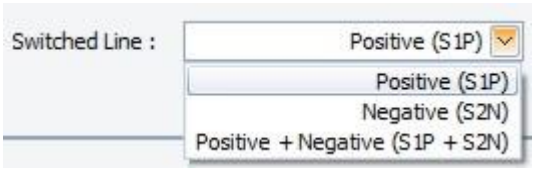


Figure 6.4: Switched Line Setting

Positive (S1P)
The switch in the positive line will be interrupted the positive supply voltage during the dropout test.

Negative (S1N)
The return line of the supply voltage will be interrupted during the dropout test. The DUT still has the positive supply voltage connected. Therefore, depending on switching, it is possible that the DUT stays powered on.

Positive (S1P) + Negative (S1N)
Both switches will be interrupted at the same time. The DUT is isolated during this time, but should still be connected to ground in any case.

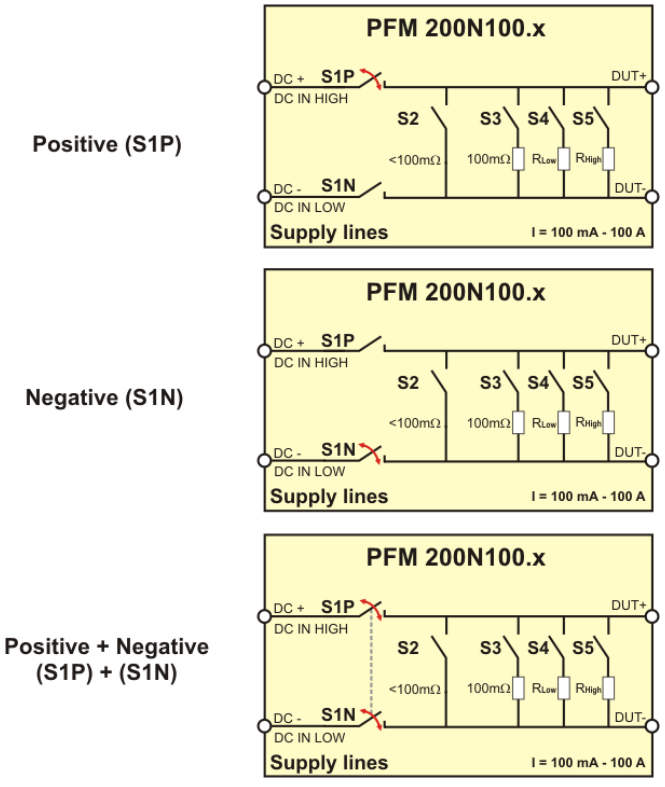


Figure 6.5: Switched Line Settings

6.2.2. SW Installation of Switch S2 – S5

During the interruption testing, the DUT may be discharged through other parallel devices on the supply. The PFM 200N can also switch these types of loads during the interruption.

The following **Switch Type** settings for are available in AutoWave.control under **Discharge Switches**(S2-S5):

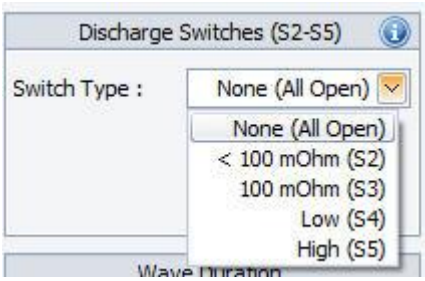


Figure 6.6: Switch Type Setting

None (All open): No loading during the interruption. All parallel switches stay open.

<100 mΩ (S2): The switch creates a direct short across the DUT. It will result in the shortest possible discharge time.

100 mΩ (S3): In series to switch (S3) is a 100 mΩ load. The DUT will be discharged with the impedance of the switch +100 mΩ.

Low (S4) Discharge of the DUT is performed through a low-impedance load

High (S5) Discharge of the DUT is performed through a high-impedance load

The various LV standards require a load impedance of <100 mΩ (S2) or 100 mΩ (S3)

7. E-10 Short Interrupts according to LV 124 (2013-02)

The test E10 consists of two test cases.

The tests simulate the condition where the component experiences short dropouts of various durations.

Block Diagram

Figure 7.1 shows the block diagram of how the test setup is arranged according to Figure 12 in the OEM standard LV 124.

Switch S1 interrupts the power supply to the DUT. Depending on the test case, switch S2, including the required <100 mΩ load, is activated.

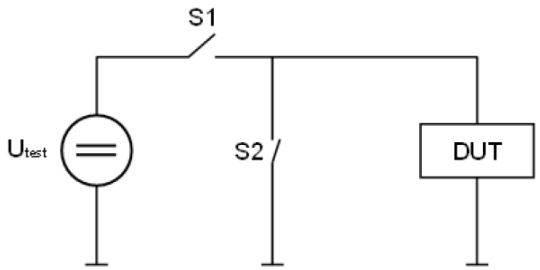


Figure 7.1: Block Diagram of E-10 Short Interruptions (LV 124)

EM TEST Solution for Testing of LV 124

Figure 7.2 shows a general test setup to test E-10 using EM Test Generators.

The PFM 200N has the integrated switches S1 and S2 switches. Switch S2 discharges the DUT with an impedance of <100 mΩ incl. switch.

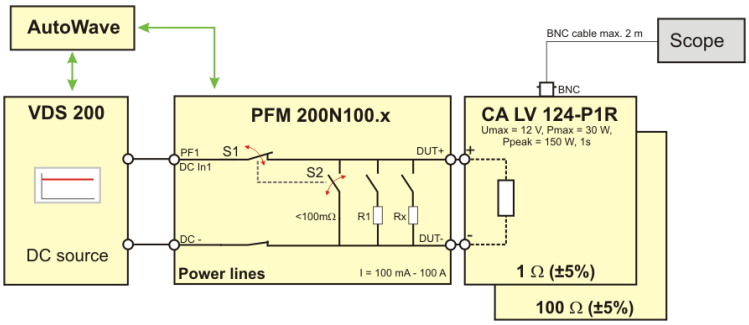


Figure 7.2: Test Setup Using EM TEST Generators

Test Sequence

DUT Operating Mode	Operating Mode II.c	
Vtest	11 V	
Z1	S1 closed	
Z2	S1 open	
t_r	≤ (0,1*t_1)	
t_f	≤ (0,1*t_1)	
Switch S1 is switched with the following sequence:	t1	Step
	10 µs to 100 µs	10 µs
	100 µs to 1 ms	100 µs
	1 ms to 10 ms	1 ms
	10 ms to 100 ms	10 ms
	100 ms to 2 s	100 ms
DUT On – Functional	> 10 s	
t2	The test voltage Vtest must be held at least until the DUT and the periphery have reached 100% operability.	
Number of Cycles	1	
Number of DUTs	At least 6	
Test case 1	S1 switched, S2 statically open	
Test case 2	S1 switched, S2 opposite S1	

Figure 7.3 shows Figure 11 from LV 124 (2013-02) with the state of change for switch S1 for E-10 Short interruptions

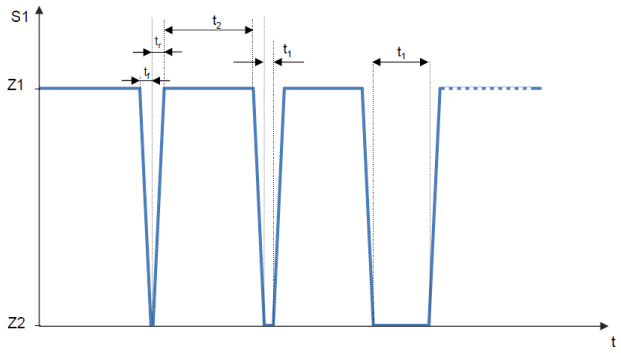


Figure 7.3: State change of switch S1, E-10 Short interruptions

7.1. Test Case 1 S1 Switched, S2 Statically Open

This test simulates the interruption of the power supply to the DUT.

The DUT will not be actively discharge after opening of switch S1.

The internal switch S2 of the PFM 200N stays open during the test.

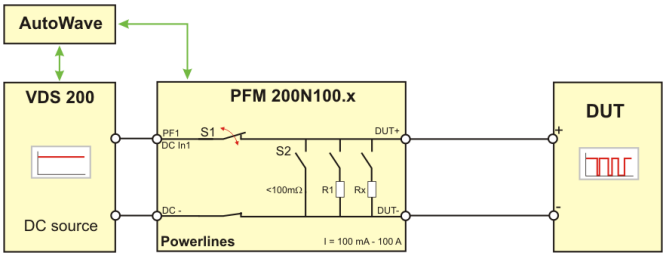


Figure 7.4: Test Setup of Test Case 1

The discharge of the DUT will mainly depend on the impedance of the DUT. The 1 µs falling of the voltage to 0 V at the DUT will only occur for DUTs with very low impedance for fast self-discharge and/or small input capacitance is present.

The time for the voltage drop, seen at the DUT, will depend on its impedance. If it is high-impedance and has a large input capacitance in the range of ten µF to mF as is common for decoupling capacitors then only a reduction in voltage at the DUT may be seen. Therefore, it is possible that the voltage may not fall to zero.

7.1.1. Testing with AutoWave.control Software

Select from the Standard Library the path

- **Open / Automotive / OEM / LV 124 / (2013-02) / 12V System / E-10 Short Interrupts**
- From the list, select Test Case 1 - tmin to tmax, for example, “Test Case 1 – 100ms to 2s“
- Open the file with **Select**

Figure 7.5 shows the test window for E-10 Test Case 1 with a sequence from 100ms to 2s for the interruptions

Sequence 1: One second 11.0 VDC

Sequence 2: Sequence with dropout tests from 100ms to 2s in 100ms steps

Checking the Settings:

1 DC Test Voltage = 11.0V

2 Switch Type: All PFM internal switches are open during the test.

3 Settings for the Test Sequence

4 Switches that will be interrupted to the DUT (only S1P)

Click **Start** to start the test.

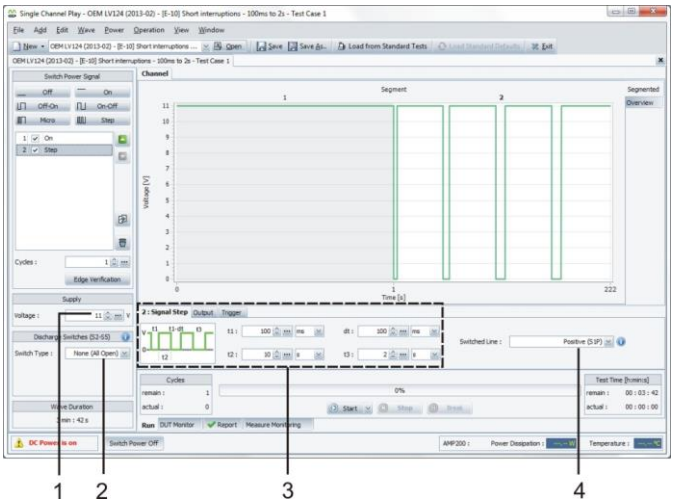


Figure 7.5: Test Window for the E-10 Test Case 1 Sequence

7.2. Test Case 2 S1 Switched, S2 Negated to S1

At the same as S1 switches open, S2 discharges the DUT in the µs range. Any capacitance present at the DUT input will be very quickly discharged. This is the most severe case for interruptions because the voltage stored is rapidly discharged.

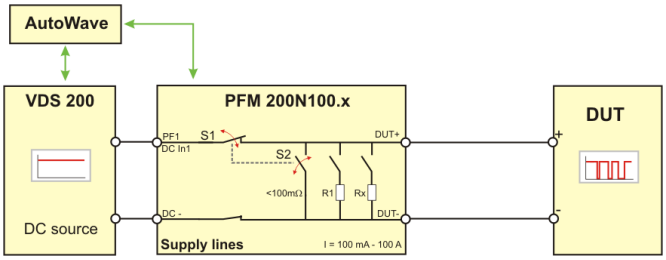


Figure 7.7: Test Setup for Test Case 2

Switch S2 is integrated in the PFM 200N and discharges the DUT through a low impedance of < < 100 mΩ (consisting of only the switch and associated interconnections).

7.2.1. Testing with the autowave.control Software

Select from the Standard Library the path

- Open / Automotive / OEM / LV 124 / (2013-02) / 12V System / E-10 Short Interrupts from the list, select Test Case 2 – tmin to tmax tmin to tmax, for example, “Test Case 2 – 10µs to 2s“ (all tests in one sequence)
- Open the file with **Select**

Figure 7.8 shows the test window for E-10 Test Case 2 with a sequence from 100ms to 2s for the interruptions.

Sequence 1: One second of 11.0 VDC

Sequence 2: Sequence with interruptions from 10µs to 90µs in 10µs steps

Sequence 3: Highlighted sequence with interruptions from 100µs to 900µs in 100µs steps

Sequence 4-6: Remaining sequences with interruptions from 1 ms to 2s with increasing step sizes

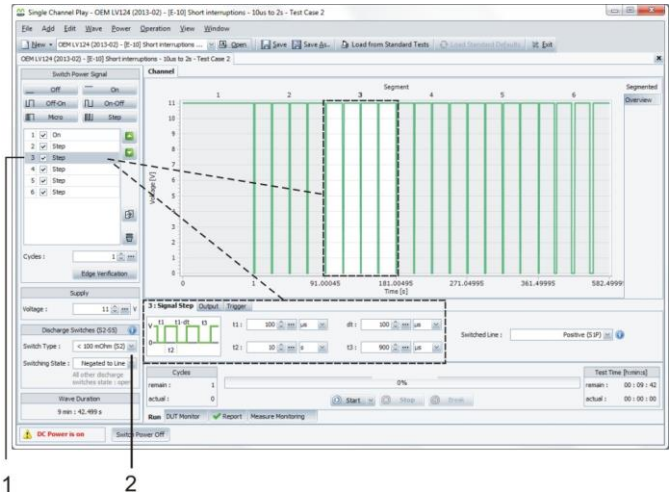


Figure 7.8: Test Window for E-10 Test Case 2

Checking the Settings:

1 Sequence 3 with the necessary settings and parameters

2 Discharge Switch <100mΩ (S2) that is negated to S1P. All other switches remain open.

7.3. Reference Measurement

One reference measurement each with 100 Ω (±5%) and 1 Ω (±5%) as a DUT substitute must be performed and documented. Verification of the edge steepness must be provided with this test setup. Low-inductance parts must be used as resistors.

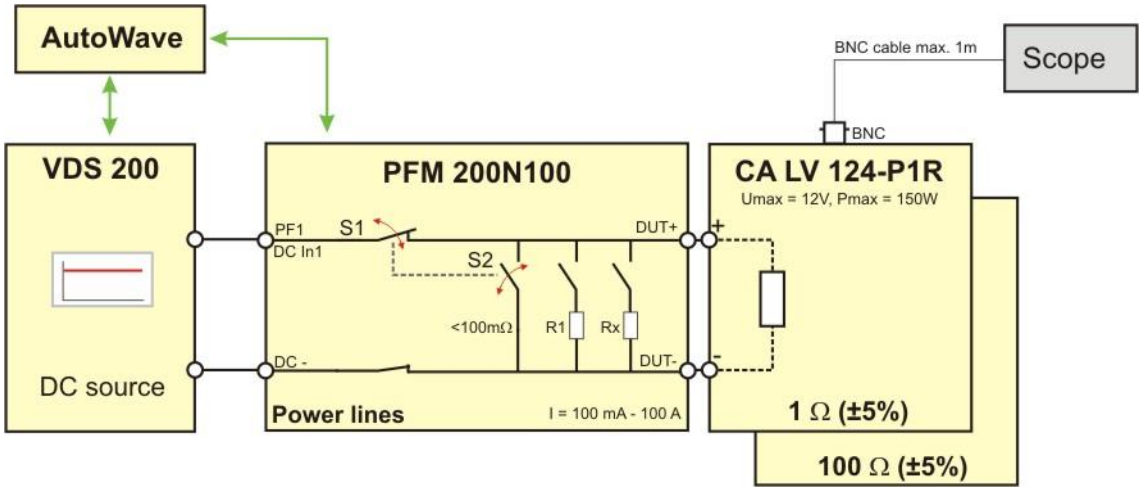


Figure 7.9: Setup for Reference Measurement with 1 Ω and 100 Ω

The verification resistors are rated for the following long-term power:

Resistor	Power at 11 V DC
100 Ω	1,21 W
1 Ω	121 W

CAUTION

Heating of the 1 Ω Reference Load

The 1 Ω reference load should be only connected to the PFM 200N after the test has been started. After the test, the resistor should be quickly removed from the PFM 20N100.1.

If 11V power is used for a long time, the 1 Ω reference load consumes 121 W and will begin to become warm. This warming can be severe and may result in burns when touched.

The verification test should only use a duty cycle of 1:10 so that the heating is only 1/10th as strong results in moderate heating (<45 ºC).

For safety, EM TEST recommends the use of the CA LV kits be connected only during the verification of PFM 200N.

7.3.1. Reference Measurement with the autowave.control Software

The reference measurement can be selected by selecting Edge Verification in the software.

There is a test window with where you can call up the settings for the reference measurement.

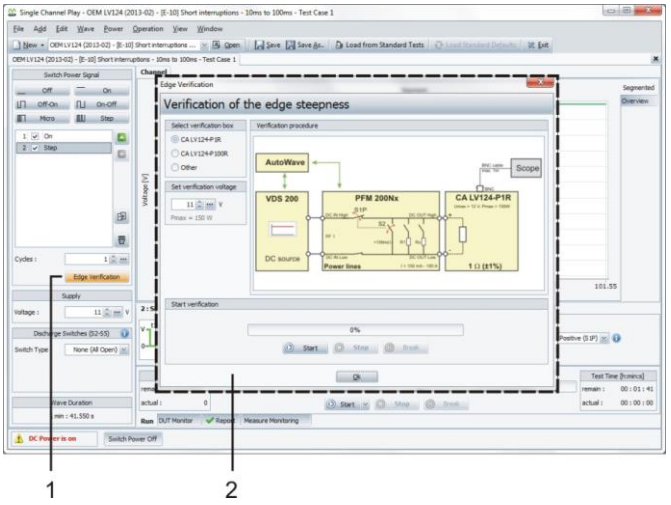


Figure 7.10: Test Window for Reference Measurement of the von Power Lines

1 Edge Verification
Choose this option to perform the reference measurement.

2 Test Window for the reference measurement

The load resistor must have the following characteristics to achieve the required pulse parameters:

- Low Inductive Component
- Shortest possible cables (a few cm) to the PFM output
- Probe must be as near as possible to the load resistor or, as with the CA LV kit, using a BNC connection directly on the load.

Window to Control the Reference Measurement

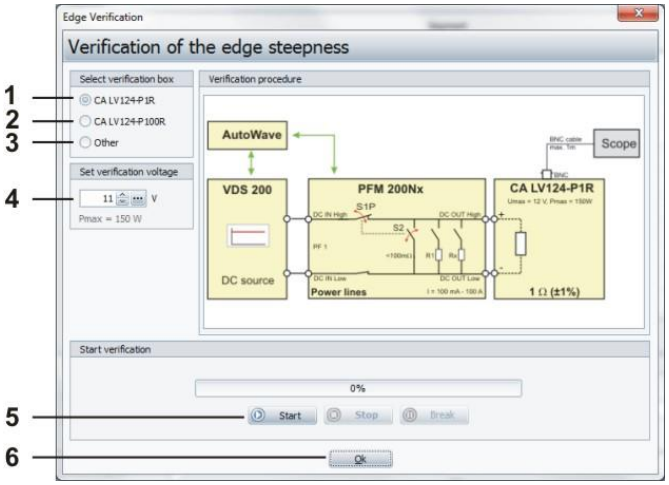


Figure 7.11: Reference Measurement Test Window

Select verification box
Select the calibration load when prompted

1 CA LV124-P1R or CA LV148-P10R

2 CA LV124-P100R or CA LV148-P1000R

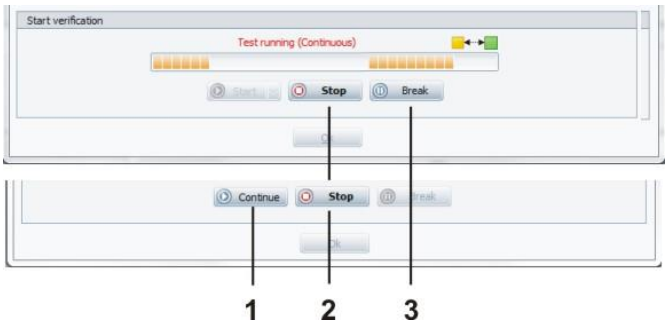
3 Other
Other load resistors

4 Set the Verification Voltage
The software sets the voltage when using the EM Test loads automatically. Carefully observe the power of the load resistors.

5 Start the Test

6 The **OK** closes the window

Continuous Verification



1 Continue
Continue the verification after a break

2 Break
Pause

3 Stop
Stops the verification

7.3.2. Test Setup for Reference Measurement

For the verification the power resistors are connected at the front side of the PFM 200N. Make sure to connect correct the HIGH and LOW terminals. Use low inductive resistance components.

CAUTION

Connecting the CA LV Loads

The **BNC Connection** of the connected CA LV kits must **be at the top.**

Mounting the incorrect orientation may result in a short between oscilloscope earth and the positive supply terminal!

Figure 7.13

Test Setup

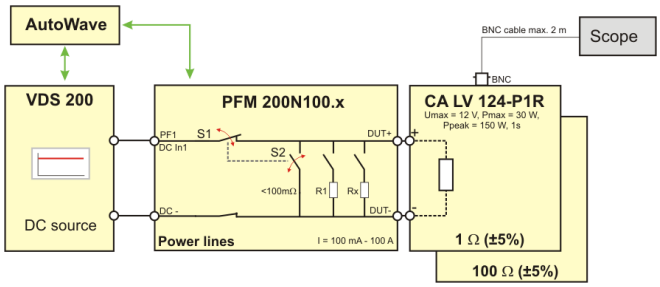


Figure 7.14: Test setup Verification Schematic

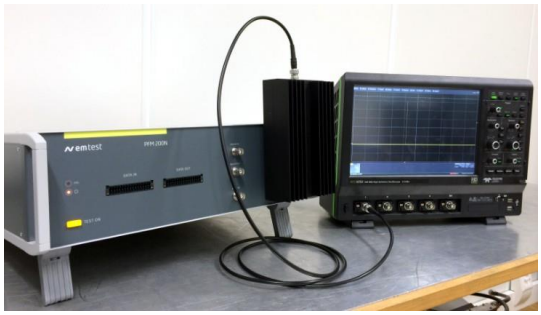


Figure 7.15: Example Verification setup with PFM 200N100.1, CA LV124-P1R and Scope

7.3.3. Example Reference Measurement

The rise time with a test load of 100 Ω (±5 %) and 1 Ω (±5 %) must be performed and documented.

Parameters	Value	Tolerance
Fall Time tf	<= 1 µs	<=0.1 x t1 (t1=10 µs)
Rise Time tr	<= 1 µs	<=0.1 x t1 (t1=10 µs)

Load resistor 1 Ω

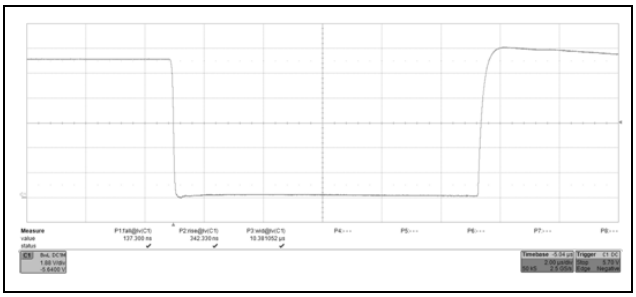


Figure 7.16: Reference measurement load 1 Ω

Typical results:

Rise Time tr: 342 ns
Fall Time tf: 137 ns

Load resistor 100 Ω

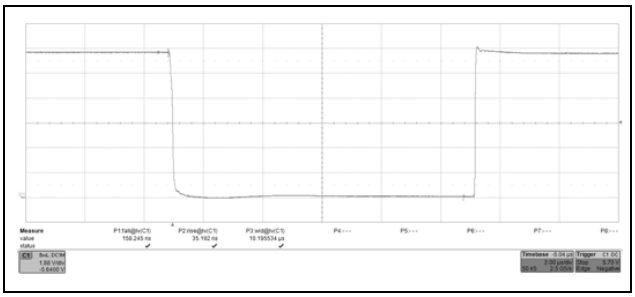


Figure 7.17: Reference measurement load 100 Ω

Typical results:

Rise Time tr: 35 ns
Fall Time tf: 158 ns

Note: The above measurements were achieved with the PFM 200N100.1. The PFM 200N200 contains a considerably larger switch and, therefore, exhibits correspondingly higher over and undershoot.

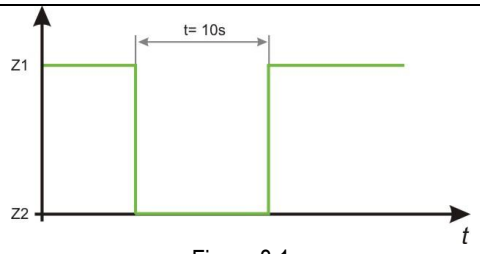
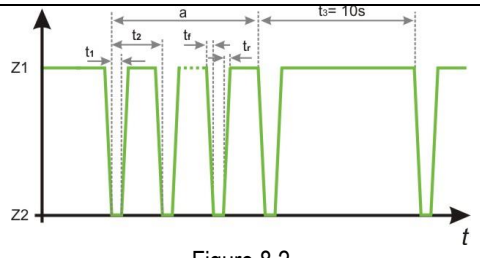
8. E-13 Pin Interruption according to LV 124 (2013-02)

This test simulates interruptions that may occur on individual pins. The test must be performed in two different operating states. Different pulse forms must be used, because the possible interruptions may differ greatly regarding their duration (from loose contacts to permanent interruption).

Test Sequence

The DUT is connected to a battery source. The test can be performed using a VDS 200N source controlled with AutoWave. The PFM 200N is used as the generator of the disturbances. The test is not for power lines (e.g. T.15, T.30, T.87, …) instead on signal or data lines as well as T.31 return lines.

Test parameters, E-13 Pin interruption

DUT operating mode	Operating mode II.a and II.c Must be performed for all relevant statuses of the voltage supply terminals (e.g., T.15, T.30, T.87) and their combinations.
Z1	Condition 1: pin connected
Z2	Condition 2: pin interrupted
t_r	≤ (0,1*t_1)
t_f	≤ (0,1*t_1)
Number of cycles	The following applies to the two test cases and the relevant terminal status: 3 cycles with operating mode II.a 3 cycles with operating mode II.c Each test must be evaluated separately.
Number of DUTs	At least 6
Test Case 1	 Figure 8.1
	Each pin must be removed for t = 10 s and then replaced (slow interval).
Test Case 2	 Figure 8.2
	Burst on each pin in order to simulate a loose contact
Number of pulses in the burst	4,000
a	Burst
t_1	0.1 ms
t_2	1 ms
t_3	10 s

Test Setup

Figure 9.3 shows the application of dropout simulations on signal and data lines up to 2 A, where up to 16 lines individually or simultaneously may be interrupted. The return lines of each pair can be individually tested.
For higher current, like with T.31 (battery minus) one may use S1N.

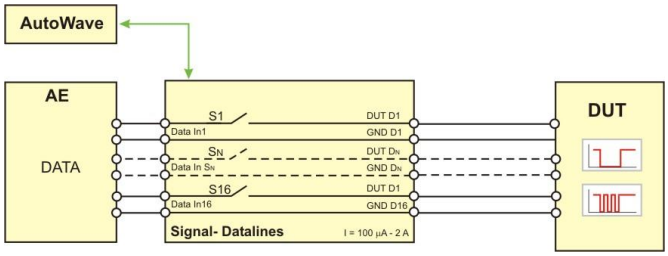


Figure 8.3: Pin Interruptions on Data Lines

8.1. Test Case 1 Slow Interval

Each pin must be disconnected for **10 s** and then reconnected (slow interval).

One could also perform this test manually with a switch. However, use of the PFM 200N offers the capability of exactly 10 s, down to ms accuracy, thus resulting in repeatable results.

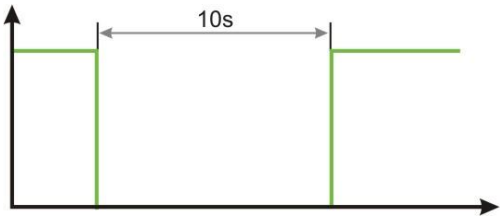


Figure 8.4: Test Pulse Test Case 1

8.1.1. Tests of Data Lines with the autowave.control Software

Note: LV 148 does not require testing of data/signal lines.

Select from the Standard Library the path

- **Open / Automotive / OEM / LV 124 / (2013-02) / 12V System / E-13 Pin Interruption**
- Select **"Test Case 1"** from the list
- Choose **Select** to open the file

Checking the Settings

- **Selecting the Number of Data Lines**
  Deselect the check box ☑ **(1)** for each sequence that is not necessary. (For example, the DUT has only 4 data lines)
- **Parameter for Cycles (3)**
  3 cycles for sequences 1 to 4
- **Parameter for the Dropout Test (3)**
  t1: 10s interruptions,
  t2: Should be long enough that the DUT and periphery has reached 100% operability.
  t3: 1 cycle per test run
- **Switch Selection**: Shows which data lines are active for the selected sequence **(3)**
- If a parameter is modified, **< Modified Standard >** at the top edge of the screen **(4)**
- **Save** the test if it is to be used again at a later time.
- Choose **Start** to start the test

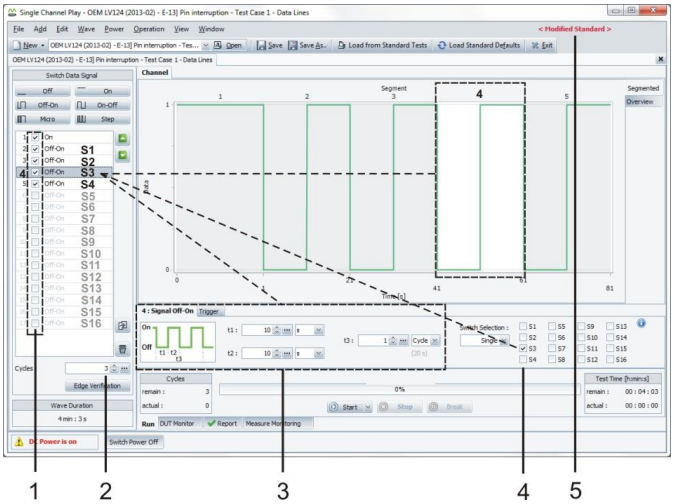


Figure 8.5: Test Window for E-13 Test Case 1 Showing a Modified Test

8.2. Test Case 2 Burst of Interruptions on Each Pin as a Simulation of a Loose Contact

This test simulates a packet of interruptions in order to simulate an intermittent contact.

a : Burst of 4000 Events
t1 : 0,1 ms
t2 : 1 ms
t3 : 10 s

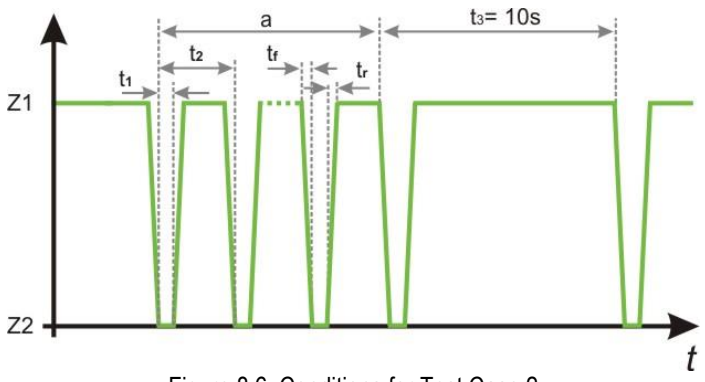


Figure 8.6: Conditions for Test Case 2

8.2.1. Testing Data Lines with the autowave.control Software

Note: LV 148 does not require testing of data/signal lines.

Select from the Standard Library the path

- **Open / Automotive / OEM / LV 124 / (2013-02) / 12V System / E-13 Pin Interruption**
- Select **"Test Case 2"** from the list
- Choose **Select** to open the file

Checking the Settings

- **Selecting the Number of Data Lines**
  Deselect the check box ☑ **(1)** for each sequence that is not necessary. (For example, the DUT has only 4 data lines)
- **Parameter for Cycles (3)**
  3 cycles for sequences 1 to 4
- **Parameter for the Dropout Test (3)**
  t1: 0.1ms interruption
  t2: 1.0ms repetition time for the interruption
  t3: 4000 Cycles
  t4: Should be long enough that the DUT and periphery has reached 100% operability
- **Switch Selection**: Shows which data liens are active for the selected sequence **(4)**
- If a parameter is modified, **< Modified Standard >** at the top edge of the screen **(5)**
- **Save** the test if it is to be used again at a later time.
- Choose **Start** to start the test

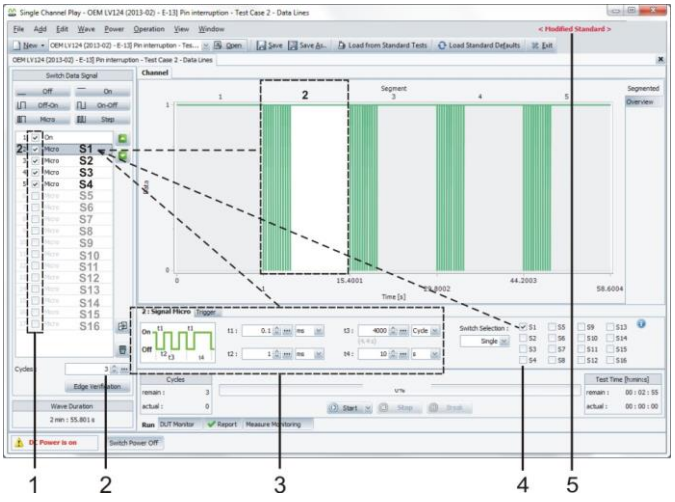


Figure 8.7: Test Window for E-13 Test Case 2 Showing a Modified Test

8.3. Reference Measurement

One reference measurement each with 1 kΩ (±5%) and 1 Ω (±5%) as a DUT substitute must be performed and documented. Verification of the edge steepness must be provided with this test setup. Low-inductance parts must be used as resistors.

LV 148 testing does not include signal/data line testing.

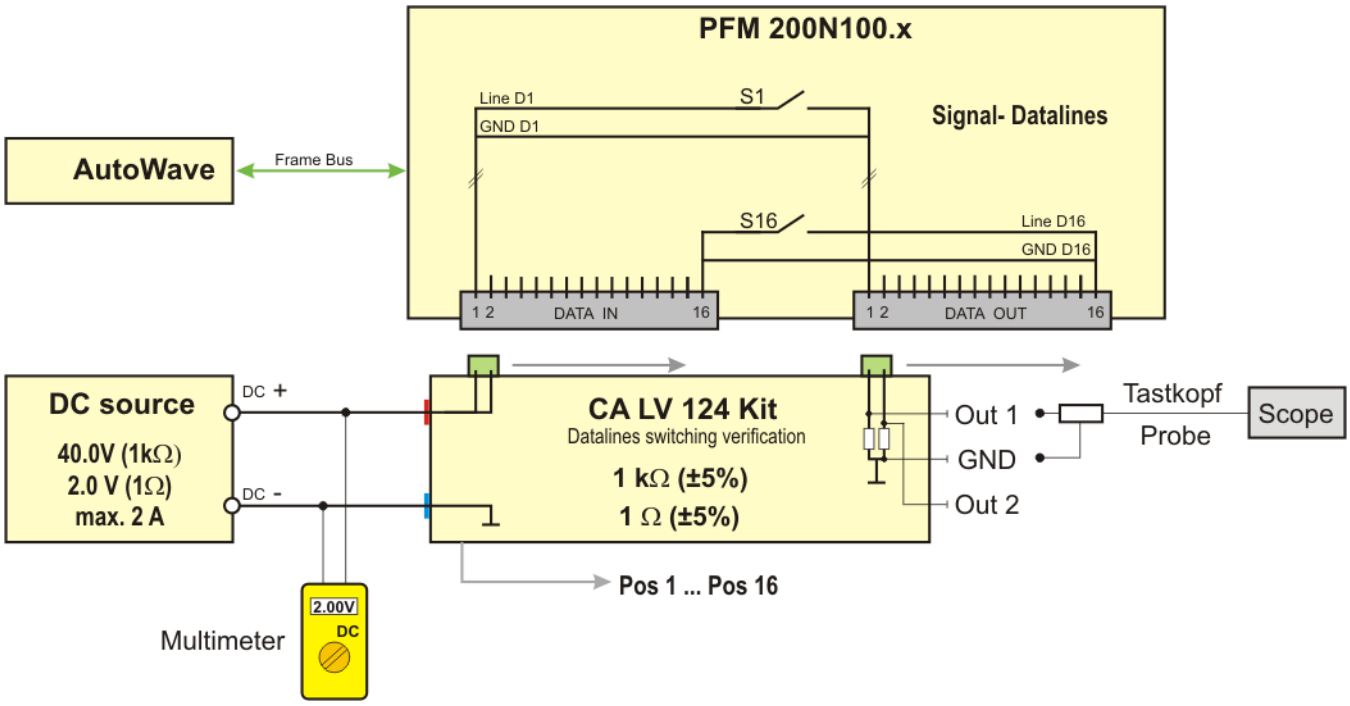


Figure 9.8: Test Setup for Reference Measurement using 1k Ω and 1 Ω

The test loads in the CA LV 124 Kit are specified for the following long-term power:

Resistance	Max. Voltage Umax.	Peak-Power at Umax.	Power
1 k Ω	40 V	1.6 W	1 W
1 Ω	2 V	4 W	1 W

In order to not exceed the power limit of the load resistors, the reference measurement must be programmed so that only one of the two data channels will be loaded at a time. The test procedure in AutoWave.control takes this into account.

CAUTION

During the reference measurement using the 1 Ω reference load, care shall be taken that at 2 V, the load resistor consumes 4 W already.

Therefore, the reference load shall only be connected once the test procedure has already started.

During long-term testing, care should be taken not to exceed 1 W.

8.3.1. Reference Measurement with autowave.control Software

The reference measurement can be selected by selecting **Edge Verification** in the software.

There is a test window with where you can call up the settings for the reference measurement.

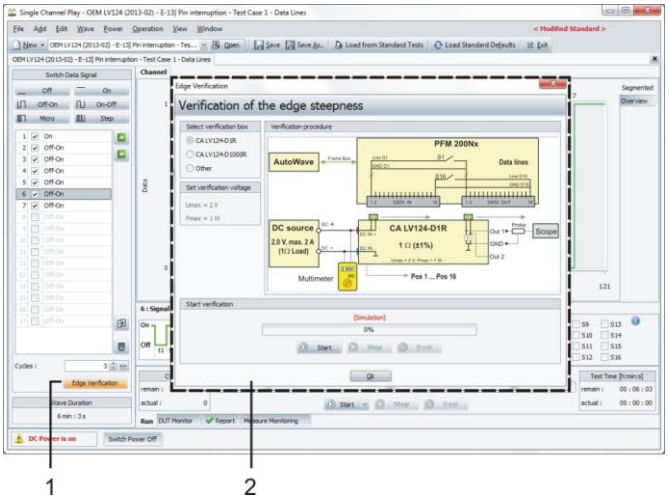


Figure 8.9: Test Window for Reference Measurement of Data Lines

1 **Edge Verification**
Choose this option to perform the reference measurement.

2 Test Window for the reference measurement

The load resistor must have the following characteristics to achieve the required pulse parameters:

- Low Inductive Component
- Shortest possible cables (a few cm) to the PFM output
- Probe must be as near as possible to the load resistor or, as with the CA LV 124-P, using a BNC connection directly on the load.

Window to Control the Reference Measurement

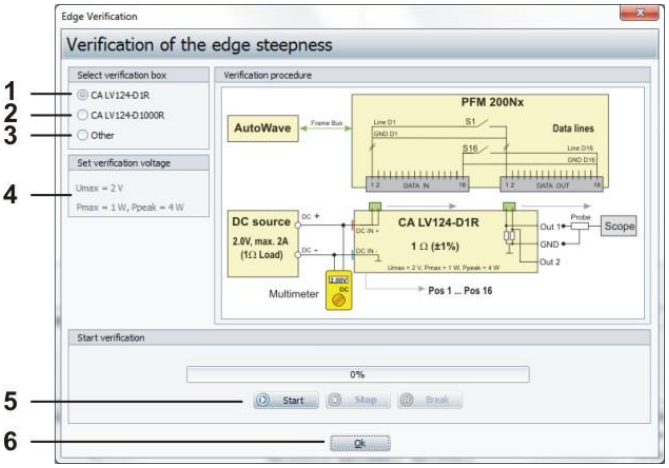


Figure 8.10: Reference Measurement Test Window

Select verification box
Select the calibration load

1 **CA LV124-D1R**
1 Ω load resistor for max. 2V

2 **CA LV124-D1000R**
1000 Ω load resistor for max. 40V

3 **Other**
Other load resistors

4 **Set the Verification Voltage**
Voltage setting for external dc sources. (manually setting). Carefully observe the power of the load resistors.

5 **Start the Test**

6 The **OK** closes the window

Continuous Verification

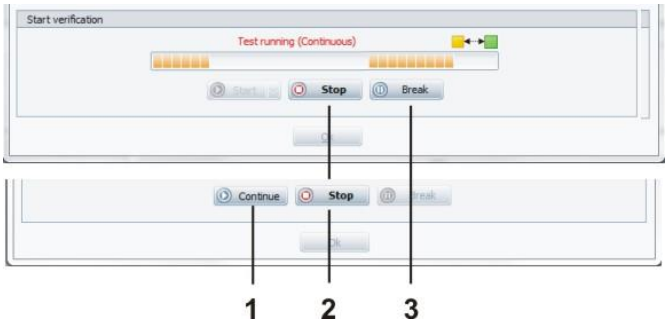


Figure 8.11: Operation Verification

1 **Continue**
Continue the verification after a break

2 **Break**
Pause

3 **Stop**
Stops the verification

8.3.2. Test setup for the Reference Measurement

Connect the load resistors at the two front-side plugs for of the PFM 200N for the verification. After each measurement shift the calibration load one pin forward to the right side.

WARNING

Setting for the external DC source for 1Ω load

Max Voltage: = 2.0 V

Current limit: = 2.0 A

Connect the load CA LV124-D1R after the test is started.

Figure 7.12

Test setup

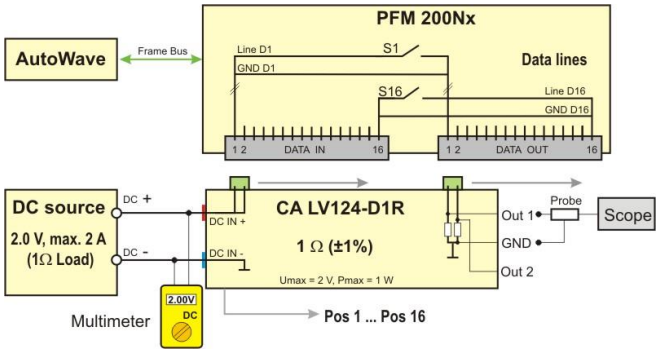


Figure 8.13: Test setup Verification schematic

Figure 8.14: Example calibration setup with PFM 200N100.1, CA LV124-D1R and Scope. Set the external voltage source to 2.00V with 2.0A current limit setting.

Test procedure

During the test, all even and odd I/O lines are switched alternately at the same time. With the test adapter is guaranteed that only one line is charged at each time.

REMARK: *EM TEST recommends connecting the probe first on output 1. After each measurement the load resistor is shifted by one position to the right. For the measurement of the I/O No. 16, the probe is switched to output 2.*

8.3.3. Example Reference Measurement

The voltage rise is to verify and to report with a DUT replacement of 1000 Ω (±5 %) and 1 Ω (±5 %).

Parameter	Value	Tolerance
Fall Time tf	<= 1 µs	<=0.1 x t1 (t1=100 µs)
Rise Time tr	<= 1 µs	<=0.1 x t1 (t1=100 µs)

Load resistance 1 Ω

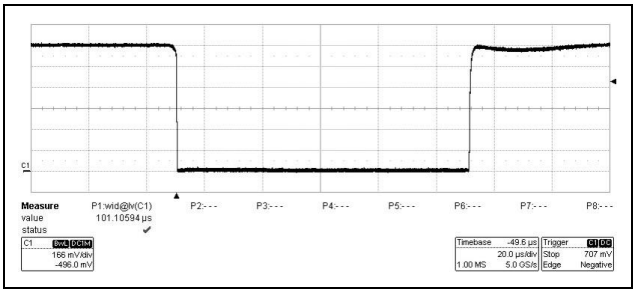


Figure 8.15: Reference measurement load 1 Ω

Load resistance 1000 Ω

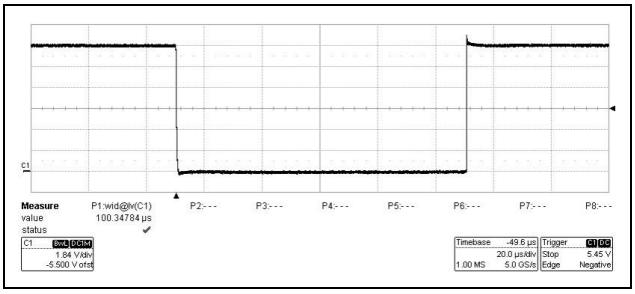


Figure 8.16: Reference measurement load 1000 Ω

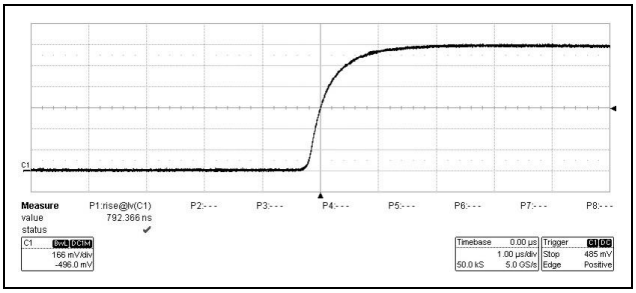


Figure 8.17: Reference measurement load 1 Ω

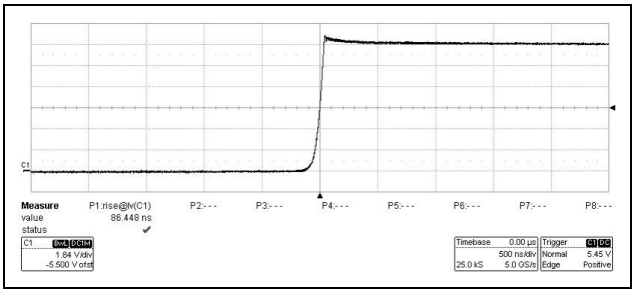


Figure 8.18: Reference measurement load 1000 Ω

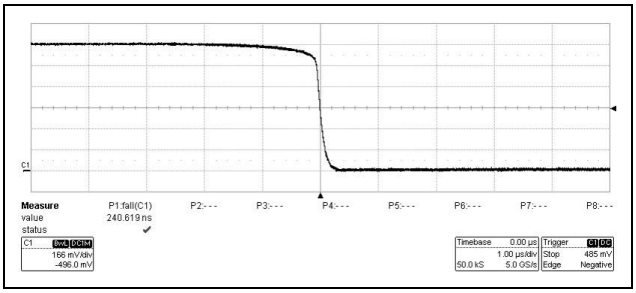


Figure 8.19: Reference measurement load 1 Ω

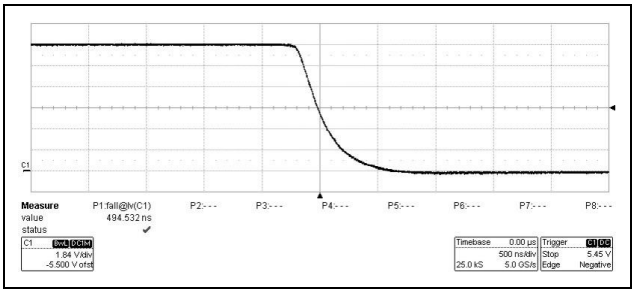


Figure 8.20: Reference measurement load 1000 Ω

Typical result:

Rise Time tr: 792 ns
Fall Time tf: 240 ns

Typical result:

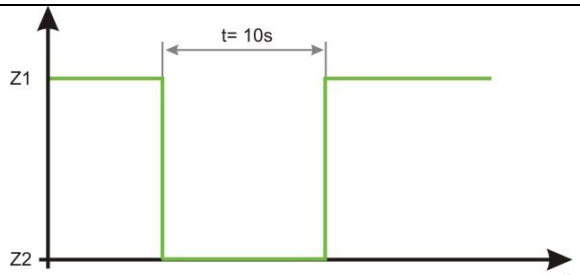
Rise Time tr: 87 ns
Fall Time tf: 495 ns

9. E-14 Connector Interruption

The line interruption of connectors is simulated.

Test Sequence

Each connector must be removed from the DUT for 10 s and then replaced. If the DUT has several connectors, each connector must be tested individually. The test sequence must be variable. In case that there are multiple connectors, every connector must be tested. The generator for this test is the PFM 200N with two power lines and 16 Signal or Data lines.

DUT Operating Mode	Operating mode II.a and II.c
Number of cycles	Each connector must be removed once.
Number of DUTs	At least 6
Test Case	 Figure 9.1
	Each connector must be removed from the DUT for 10 s and then replaced

9.1. Tests on Battery Lines

Image 11.2 shows the general setup for tests for which connector interruption tests must be performed.
The PFM 200N, especially when large currents are involved, provides the best safety for the user.

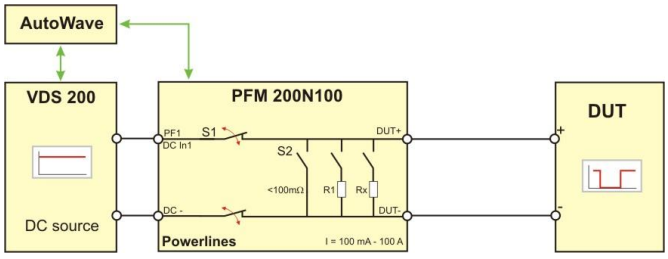


Image 9.2: Test Setup for Battery Lines

9.2. Tests on Data Lines

Image 11.3 shows an application whereby up to 16 data or signal lines may be interrupted simultaneously.

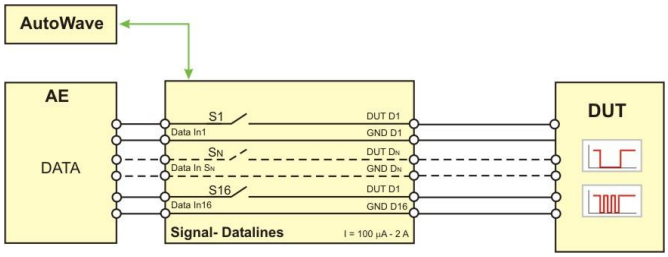


Image 9.3: Test Setup for Battery Lines

9.2.1. Tests on Data Lines with the AutoWave.control Software

Select from the Standard Library the path

- **Open / Automotive / OEM / LV 124 / (2013-02) / 12V System / E-14 Connector Interruption**
- Select **"E-14 Connector Interruption Data"** from the list
- Choose **Select** to open the file

Checking the Settings

- **Parameter for the Dropout Test (1)**
  t1: 10s interruption time
  t2: 1s switch on before the next interruption
  t3: 1 Cycle
- **Switch Selection (2)**:
  Shows that all data lines S1 to S16 together in the 2nd sequence will be opened. Switches that are not connected will also switch.
- Choose **Start** to start the test

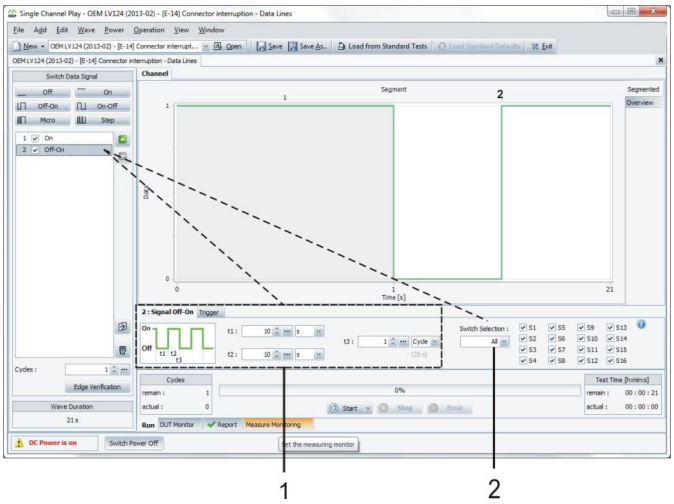


Figure 9.4: Test Window for E-14 Test Case 3

10. Technical Data

10.1. Switch for Power Lines

Electronic Switch	Two switches in circuit: - DC + Line - DC - Line (return line)
DUT Voltage	± 100 VDC
DUT Current	PFM 200N100.1:100 mA to 100 A, @ 25 °C PFM 200N200:100 mA to 200 A, @ 25 °C
Switching Behavior	Bidirectional
Switch Impedance	< 50 mΩ
Switching Time*	< 1 µs (rise/fall time) typ. 200 ns
Repetition Time*	10 µs - 1 h, (≥ 90% duty cycle)
Pulse Width td	1 µs; 2µs - 1 h
Inrush Current	400 A for 200 ms
Safety	Short-circuit safe to 400A

*Switching and repetition times may not combine to exceed 30kHz

10.2. Switches for Signal and Data Lines

Channels	16 independently switchable
DUT Voltage	Max. ± 40 VDC
DUT Current	100 µA to 2 A, per Channel, @ 25 °C
Switching Behavior	Bidirectional
Switch Impedance	< 500 mΩ
Switching Time	< 1 µs (rise/fall time)
Repetition Time	500 µs - 1 h
Pulse Width td	~1 µs; 2µs - 1 h
Bandwidth	50 MHz / 3 dB
Inrush Current	5 A for 200 ms
Safety	Short-circuit safe
Connector Type	2 x PHOENIX, DFMC Adapters, 1.5 mm2, with a push-in locking connection

10.3. Switchable Internal Loads for Battery Lines

Switching	Switching loads between lines (DC+ und DC-),
Shorting Switch S2	< 100 mΩ according to LV 124 (2013)
Internal Switch S3	100 mΩ
Internal Switch S4	Low
Internal Switch S5	High

10.4. Triggering

Trigger Output	BNC on the front panel, Automatic triggering of events, Trigger for Oscilloscope, 15 V negative edge
Trigger Input	BNC on the front panel, External triggering of events, Pull down

10.5. Safety

DC Input Protection	Max. Voltage ±100 V
Data Line Input Protection	Max. Voltage ±40 V
Over Temperature	NTC measurement on every connector
Over Current	Electronic protection on every switch
Current Measurement	Over current measurement at the output

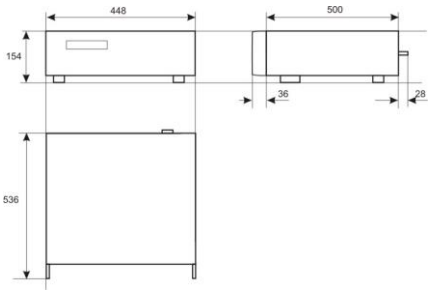
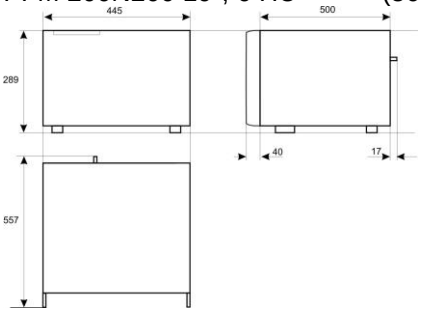
10.6. Interfaces

Framebus	
Function	Control Bus (Daisy Chain) through AutoWave
Master	AutoWave
Connector Type	15 pin D-Sub m/f
Monitor	
Output	DUT out, differential
Connector Type	BNC on the front panel
Voltage Ratio	20:1
Bandwidth	10 MHz

10.7. Bus Systems (data lines)

CAN Bus	- Low Speed Can 100 kbit
	- High Speed Can 500 kbit
LIN Bus	- LIN Bus 19200 Baud
FlexRay	- FlexRay 10 Mbit

10.8. General

Dimensions	PFM 200N100.1 19"/3 HU, 448 mm x 536 mm x 154 mm  PFM 200N200 19", 6 HU (500mm x 449mm x 267mm) 
Weight	PFM 200N100.1 12.6kg PFM 200N200 20 kg
Mains	100 V - 265 VAC, 50/60 Hz
Fuses	2 x 2 AT (5 x 20 mm)

10.9. Environmental

Operating Temperature	23 °C ±5 °C
Storage Temperature	10 °C to 35 °C
Relative Humidity	25 % to 75 %, non-condensing
Air Pressure	86 kPa (860 mbar) to 106 kPa (1,060 mbar)

11. Accessories for LV 124

11.1. CA LV Calibration Load

The calibration loads in the CA LV124 series are to be used for pulse verification of E-10 and E-13 according to LV 124: 2013-02. They consist of low-inductive resistors. The user connects the loads directly to the outputs of the battery or data lines. Two models are available.

11.1.1.CA LV Calibration loads

The calibration loads of the series CA LV124 and CA LV148 are suitable for the pulse verificationThey consist of low-inductance resistors. The user connects the calibration load directly to the power output or, in the case of the CA LV124 kits, I/O data plugs.

Technical Data CA LV 124 (for PFM 200N100.1) and CA LV124.1 (for PFM 200N200)

Use	**Battery Lines**		**Signal or Data Lines**	
	 Figure 11.2		 Figure 11.3	
Description	**CA LV124-P1R**	**CA LV124-P100R**	**CA LV124-D1R**	**CA LV124-D1000R**
Resistance	1 Ω	100 Ω	1 Ω	1.000 Ω
Accuracy	± 1 %	± 1 %	± 2 %	± 2 %
Max. Voltage	12 V	100 V	2 V	40 V
Power max.	30 W	30 W	1 W	1 W
Power peak	150 W, 1 s	100 W, 1 s	4 W, 1 s	4 W, 1 s
Dimensions	185 x 105 x 58 mm	185 x 105 x 58 mm	120 x 65 x 40 mm	120 x 65 x 40 mm
Weight	1.05 kg	0.90 kg	0.15 kg	0.15 kg

Technical Data CA LV 148 (for PFM 200N100.1) and CA LV148 (for PFM 200N200)

Use	**Battery Lines**	
Description	**CA LV148-P1000R**	**CA LV124-P10R**
Resistance	1000 Ω	10 Ω
Accuracy	± 1 %	± 1 %
Max. Voltage	48 V	48 V
Power max.	30 W	30 W
Power peak	150 W, 1 s	150 W, 1 s
Dimensions	185 x 105 x 58 mm	185 x 105 x 58 mm
Weight	1.05 kg	1.05 kg

12. Annex

12.1. Declaration of CE-Conformity

Manufacturer :	**AMETEK CTS GmbH**
Address:	Sternenhofstr. 15 CH 4153 Reinach Switzerland

declares, that under is sole responsibility, the product's listed below, including all their options, are conformity with the applicable CE directives listed below using the relevant section of the following EC standards and other normative documents.

Product's name:	PFM 200N100.1 PFM 200N200 CA LV124 CA LV124.1 CA LV148 CA LV148.1

Low Voltage Directive 2014/35/EU

Standard to which conformity is declared:

EN 61010-1 : 2011	Safety requirements for electrical equipment for measurement, control, and laboratory use.

EMC Directive 2014/30/EU

Standard(s) to which conformity is declared:

EN 61326-1 : 2013	Electrical equipment for measurement, control and laboratory use Class A
EN 61000-3-2 : 2014	Limits for harmonic current emissions
EN 61000-3-3 : 2013	Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems.

	European representative	Manufacturer
	AMETEK CTS Germany GmbH	AMETEK CTS GmbH
	Lünenerstr. 211	Sternenhofstr. 15
	D 59174 Kamen	CH 4153 Reinach
	Tel: +49 (0) 2307 / 26070-0	Tel: +41 61-7179191
	Fax: +49 (0)2307 / 17050	Fax: +41 61-7179199
By	A. Gerstner General manager	A. Burger Business Manager Conducted EMC
Place	Kamen, Germany	Reinach BL, Switzerland
Date	20. December 2016	25. February 2016

12.2. 100 A Connectors and Plugs 6mm (PFM 200N100.1)

Safety Connectors KBT6AR-N/...-S with latching and crimp connections

Model KBT6AR-N/...-S safety sockets are sockets with locking devices and for crimping onto highly flexible Cu conductor with cross-sections of 10mm2, 16mm2 or 25mm2.
This safety socket is suitable for mating with either safety flush-mounting plugs or plugs model KST6AR-N. Used together with a flush-mounting plug it acts as an appliance connector and with plugs as a coupler.

Figure 12.1

Sockets BP...AR-N with snap-in lock and crimp termination

Crimp termination for flexible and highly flexible Cu-cables class 6 (according to IEC 60228). MC recommends a hexagonal crimp. Indent crimping and soldering is also possible. Cables with compacted conductors need a special crimping sleeve.

IH6 + T6N

Figure 12.2

Safety branch adapter AZB6AR-N-S/6-4

Safety branch adapter with snap-in lock and ergonomic PA/TPE insulation that grips well. Mating plugs with suitable locking devices can be snap-locked into the socket. With one pick-off socket Ø 6mm and two safety sockets Ø 4mm for voltage tests up to 600V, CATIII.

Figure 12.3

Safety flush-mounting plugs ID/S6AR-N-B4S with snap-in lock and threaded stud

Model ID/S6AR-N-B4S safety flush-mounting plugs are insulated plugs designed for flush mounting in housings and panels. The plugs are designed to mate with sockets KBT6AR-N. The resulting plug connections are securable by means of snap-in lock. The plug ID/S6AR-N-B4S also mates with Ø 4mm MC Safety plugs, because the Ø 6mm plug has a Ø 4mm socket hole. The internal connection is made with an M6 threaded stud with nuts and washers. These safety flush-mounting plugs are also used to be connected with test leads according to the test accessories IEC/EN61010, (UL3111) and are UL recognized.

Figure 12.4

12.3. 200 A Connectors and Plugs (PFM 200N200)

2 x KBT10BV-AX/M25/50-70 Mating connectors
Red (C4 coded)
Black (C1 coded)

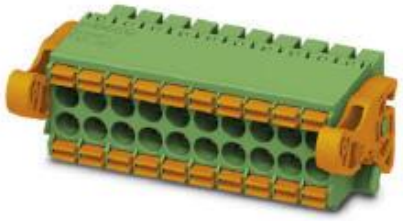
12.4. PHOENIX connector DFMC for Data lines

PHOENIX CONTACT

Extract from the online catalog

DFMC 1,5/16-ST-3,5-LR

Order No.: 1790629



http://eshop.phoenixcontact.co.uk/phoenix/treeViewClick.do?UID=1790629

Plug component, Nominal current: 8 A, Rated voltage (III/2): 160 V, Number of positions: 16, Pitch: 3.5 mm, Connection method: Spring-cage conn., Color: green, Contact surface: Tin

Commercial data	
EAN	4 046356 594684
Pack	50
Customs tariff	85366990
Gross weight in pieces	17.35 g
Country of Origin	DE
Catalog page information	Page 175 (CC-2011)

Product notes

WEEE/RoHS-compliant since: 08/07/2010

Please note that the data given here has been taken from the online catalog. For comprehensive information and data, please refer to the user documentation at http://www.download.phoenixcontact.com. The General Terms and Conditions of Use apply to Internet downloads.

Technical data

Dimensions / positions	
Length	27.75 mm
Height	13.25 mm
Pitch	3.5 mm
Dimension a	52.5 mm
Number of positions	16

For further information please refer to the PHOENIX CONTACT website

*https://www.**phoenixcontact**.com/*