PRIMES

Operating Instructions

Translation of the original instructions

PowerMeasuringModule PMM

Hardware- and software interfaces

PROFINET® | PROFIBUS® | Parallel | DeviceNet™ | EtherNet/IP™ | EtherCAT®

Revision 01/2020 EN

IMPORTANT!

READ CAREFULLY BEFORE USE.

KEEP FOR FUTURE USE.

Table of contents

1 Basic safety instructions 8

2 Symbol explanations 10

3 Conditions at the installation site 10

4 Introduction 11

4.1 System description 11
4.2 Measuring principle 11
4.2.1 Number of measuring cycles 12
4.2.2 Calculation of the exposure time 13
4.3 Overview of the PowerMeasuringModule PMM types 14
4.3.1 Differentiation by interface and absorber type 14
4.3.2 Differentiation by the interface and the possibility to measure pulsed lasers 14
4.3.3 Differentiation by the interface and a reduced thermalization time 14
4.3.4 Differentiation by the interface, the possibility to measure pulsed lasers and a reduced thermalization time 15
4.3.5 Devices with UL marking 15

5 Transport 16

6 Installation 16

6.1 Installation into the laser system 16
6.2 Installation position and fastening 17
6.3 Removal from the laser system 17

7 Electrical connectors and displays 18

7.1 PROFINET®/ PROFINET® Fiber optics 18
7.1.1 Data connector 18
7.1.2 Power supply 18
7.1.3 Status LEDs 18
7.2 PROFIBUS® 19
7.2.1 Bus connector 19
7.2.2 Power supply 19
7.2.3 Status LEDs 20
7.3 Parallel interface 20
7.3.1 Power supply 20
7.3.2 Input, 4-Channel 21
7.3.3 Output, 16-Channel 21
7.4 DeviceNet™ 22
7.4.1 Connectors 22
7.4.2 Control LEDs 23
7.5 EtherNet/IP™ 23
7.5.1 Data connectors (Port 1/Port 2) 23
7.5.2 Power supply (Power) 24
7.5.3 Control LEDs 24
7.6 EtherCAT® 25
7.6.1 Data plug (Port 1/Port 2) 25
7.6.2 Power supply 25
7.6.3 Control LEDs 26

8 Measurement 27

8.1 General flow diagram of a PowerMeasuringModule PMM measurement 27
8.2 PLC Control program sequence of the PowerMeasuringModule PMM 29
8.3 Internal conditions 29
8.4 Shutter conditions 30

9 Measurement cycle details 31

9.1 Preparing the measurement 31
9.1.1 Opening the shutter 31
9.1.2 Determination of the exposure time 31
9.2 Execution of the power measurement 32
9.3 Evaluation of the power measurement 33
9.3.1 Without exposure time control 33
9.3.2 With exposure time control 33
9.4 Time-optimized measuring procedure 34
9.5 Measuring procedure parallel-interface 35

10 Interface description 36

10.1 Bus interfaces 36
10.1.1 PROFINET® 36
10.1.2 PROFIBUS® 36
10.1.3 Parallel 36
10.1.4 DeviceNet™ 36
10.1.5 EtherNet/IP™ 36
10.1.6 EtherCAT® 36

11 Programming model 37

11.1 Registry settings 37
11.2 Configuration data 38
11.3 Variables 39
11.4 Status 39
11.5 Commands 40

12 Integration in PROFINET® or PROFIBUS® 41

12.1 GSDML file (PROFINET®) 41
12.2 GSD file (PROFIBUS®) 42
12.2.1 Setting the PROFIBUS® address 42

13 Integration in DeviceNet™ or EtherNet/IP™ 44

13.1 Hardware/Software 44
13.1.1 Hardware 44
13.1.2 Software 44
13.2 Data model 45
13.3 PowerMeasuringModule PMM with DeviceNet™ 45
13.3.1 Setting the DeviceNet™ address and the baud rate 47
13.3.2 Integrating DeviceNet™ scanner into DeviceNet™ 47
13.3.3 Importing EDS file 48
13.3.4 Bus configuration with RSNetWorx 49
13.3.5 Debugging 52
13.4 PowerMeasuringModule PMM with EtherNet/IP™ 55
13.4.1 Module configuration 55
13.4.2 Setting the IP address 55
13.4.3 Setting the IP address via a web browser 56
13.4.4 Module definition 58

14 Connection in the EtherCAT® 61

14.1 Connect the PMM into the device tree 61
14.2 Process data mapping 62

15 Maintenance and service 66

15.1 Protective window replacement 66
15.1.1 Safety instructions 66
15.1.2 Dismounting/Mounting 67
15.2 Exchangeable cassette (Option) 68
15.2.1 Taking out the exchangeable cassette 68
15.2.2 Inserting of an exchangeable cassette 69
15.2.3 Exchanging the protective glass of the exchangeable cassette 69

16 Measures for the product disposal 70

17 Technical data 71

18 Dimensions 74

19 Declaration of Incorporation of Partly Completed Machinery 75

20 Manufacturer's Declaration 76

21 Appendix 77

21.1 Add-On Instruction of the RSLogix 5000 Control Software 77
21.2 Example for a Connection to a Siemens PLC via PROFIBUS® 78

PRIMES - The Company

PRIMES manufactures measuring devices used to analyze laser beams. These devices are employed for the diagnostics of high-power lasers ranging from CO_2 lasers and solid-state lasers to diode lasers. A wavelength range from infrared through to near UV is covered, offering a wide variety of measuring devices to determine the following beam parameters:

- Laser power
- Beam dimensions and position of an unfocused beam
- Beam dimensions and position of a focused beam
- Beam quality factor M^2

PRIMES is responsible for both the development, production, and calibration of the measuring devices. This guarantees optimum quality, excellent service, and a short reaction time, providing the basis for us to meet all of our customers' requirements quickly and reliably.

PRIMES GmbH
Max-Planck-Str. 2
64319 Pfungstadt
Germany

Tel +49 6157 9878-0
info@primes.de
www.primes.de

1 Basic safety instructions

Intended Use

The PowerMeasuringModule PMM is a partly completed machine and exclusively intended for measurements carried out in or near the optical path of high power lasers. Please mind and adhere to the specifications and limit values given in chapter 17 „Technical data“ on page 71. Other forms of usage are improper. The information contained in this operating manual must be strictly observed to ensure proper use of the device.

Using the device for unspecified use is strictly prohibited by the manufacturer. By usage other than intended the device can be damaged or destroyed. This poses an increased health hazard up to fatal injuries. When operating the device, it must be ensured that there are no potential hazards to human health.

The device itself does not emit any laser radiation. During the measurement, however, the laser beam is guided onto the device which causes reflected radiation (**laser class 4**). That is why the applying safety regulations are to be observed and necessary protective measures need to be taken.

Observing applicable safety regulations

Startup is only permitted once it has been ensured that the entire machine into which the PRIMES PowerMeasuringModule PMM is installed meets the requirements of the EC Directive 2006/42/EC and laser beam protection regulations, including DIN EN ISO 12254, DIN EN 60825 and TROS laser beam (technical regulations for the occupational safety ordinance for artificial optical radiation) as well as the corresponding implementation regulations.

Necessary safety measures

If people are present within the danger zone of visible or invisible laser radiation, for example near laser systems that are only partly covered, open beam guidance systems, or laser processing areas, the following safety measures must be implemented:

- Please wear **safety goggles** adapted to the power, power density, laser wave length and operating mode of the laser beam source in use.
- Depending on the laser source, it may be necessary to wear suitable **protective clothing** or **protective gloves**.
- Protect yourself from direct laser radiation, scattered radiation, and beams generated from laser radiation (by using appropriate shielding walls, for example, or by weakening the radiation to a harmless level).
- Use beam guidance or beam absorber elements that do not emit any hazardous substances when they come in to contact with laser radiation and that can withstand the beam sufficiently.
- Install safety switches and/or emergency safety mechanisms that enable immediate closure of the laser shutter.
- Ensure that the device is mounted securely to prevent any movement of the device relative to the beam axis and thus reduce the risk of scattered radiation. This in the only way to ensure optimum performance during the measurement.

Employing qualified personnel

The device may only be operated by qualified personnel. The qualified personnel must have been instructed in the installation and operation of the device and must have a basic understanding of working with high-power lasers, beam guiding systems and focusing units.

Conversions and modifications

The device must not be modified, neither constructionally nor safety-related, without our explicit permission. The device must not be opened e.g. to carry out unauthorized repairs. Modifications of any kind will result in the exclusion of our liability for resulting damages.

Liability disclaimer

The manufacturer and the distributor of the measuring devices do not claim liability for damages or injuries of any kind resulting from an improper use or handling of the devices or the associated software. Neither the manufacturer nor the distributor can be held liable by the buyer or the user for damages to people, material or financial losses due to a direct or indirect use of the measuring devices.

2 Symbol explanations

The following symbols and signal words indicate possible residual risks:

⚠ DANGER

Means that death or serious physical injuries **will** occur if necessary safety precautions are not taken.

⚠ WARNING

Means that death or serious physical injuries **may** occur if necessary safety precautions are not taken.

⚠ CAUTION

Means that minor physical injury **may** occur if necessary safety precautions are not taken.

NOTICE

Means that property damage **may** occur if necessary safety precautions are not taken.

The following symbols indicating requirements and possible dangers are used on the device:

Do not grab inside!

Read and observe the operating instructions and safety guidelines before startup!

Further symbols that are not safety-related:

i Here you can find useful information and helpful tips.

CE With the CE designation, the manufacturer guarantees that its product meets the requirements of the relevant EC guidelines.

▶ Call for action

3 Conditions at the installation site

- The device must not be operated in a condensing atmosphere.
- The ambient air must be free of organic gases.
- Protect the device from splashes of water and dust.
- Operate the device in closed rooms only.

4 Introduction

4.1 System description

The PowerMeasuringModule PMM is a laser power measuring device for the determination of laser power in the processing zone of a production environment. To avoid contamination of the absorber, the inlet is protected by a shutter and a safety window. Furthermore, a field bus interface enables an easy integration into the industrial control.

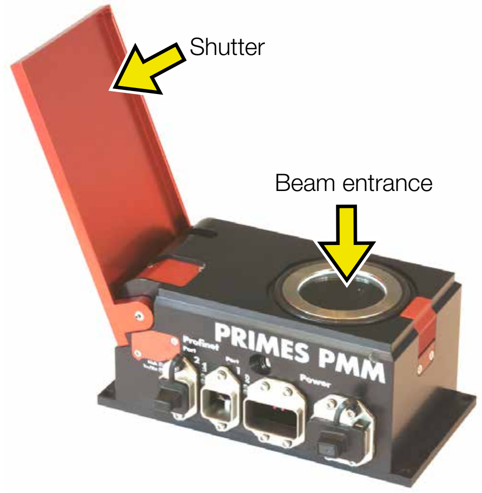


Fig. 4.1: PowerMeasuringModule PMM with opened shutter

4.2 Measuring principle

The device measures the laser power according to the ballistic principle. The absorber of the device is irradiated with the laser for a short period of time. The temperature of the absorber is measured between the beginning and end of the irradiation. Based on the temperature rise and the thermal properties of the absorber, the microprocessor-based electronics are able to calculate the laser power with high accuracy.

With the help of the known thermal capacity and the temperature rise of the absorber, as well as the given or measured exposure time, the laser power can be calculated as follows:

$$P = \Delta Q / \Delta t$$

P	=	Laser power
ΔQ	=	Variation of energy content in the absorber resulting from irradiation with the laser beam.
Δt	=	Irradiation time (laser beam) of the absorber. The time period is programmed at the laser.

The variation of energy content is calculated as follows:

$$\Delta Q = (T_{end} - T_{start}) \cdot c_p \cdot m$$

T_{end}	=	temperature – end of irradiation
T_{start}	=	temperature – start of irradiation
c_p	=	specific thermal capacity of test piece
m	=	mass of absorber

4.2.1 Number of measuring cycles

With a start temperature of 20 °C, the absorber can absorb a heat quantity (= energy) of approx. 3 200 joule. We recommend an energy input between 400 J and 1 000 J per measuring cycle in order to achieve the highest measuring accuracy possible.The measuring cycles can be carried out until the admissible final temperature is reached.
The nominal measuring frequency at 400 joule is 1 cycle/min, at 3 200 joule it is 1 cycle/10 min.

NOTICE

Damaging/destroying the device

The maximum absorber temperature must not be exceeded.

- **Before a measurement, make sure not to exceed the maximum test piece temperature (see Tab. 4.1 on page 12).**

With an assumed laser power of 8 kW and 4 kW, the following numbers of measurements are possible:

Laser power in Watt	Exposure tim in ms	Possible number of measurements
8 000	100	4
	200	2
	400	1
4 000	100	8
	200	4
	400	2

Tab. 4.1: Possible number of measurements

The absorber cools down by itself by means of thermal conduction.

4.2.2 Calculation of the exposure time

The selection of a certain exposure time is based on three different criteria:

1. The minimum irradiated energy should amount to at least 10 % of the total capacity of the absorber (Variable: “Max. Capacity”). This requirement ensures an acceptable measurement accuracy.
2. In case of a repeated power measurement within a short period of time, a maximum of 50 % of the residual absorber capacity of the test piece must be used. (Variable: “Remaining Capacity”)
3. The irradiated energy may not exceed the “Remaining capacity”, otherwise the absorber will be overheated during the measurement.

With the following formula the exposure time can be determinated:

Δ t = Remaining capacity / Laser power		
Δ t	=	Exposure time
Remaining capacity	=	Capacity after first irradiation
Laser power	=	Total power of the laser beam

A constant exposure time ensures a best possible performance and repeatability.

Even with absorbers at room temperature the remaining capacity does not reach the "Maximum capacity". This is due the fact that the “Maximum capacity“ refers to an absorber temperature of 0 °C.

Example

- MaxCapacity = 4 000 Joules
- Remaining capacity = 3 000 Joules
- Minimum energy = 400 Joules
- Laser power = 8 000 Watts

▶ selected: 100 milliseconds

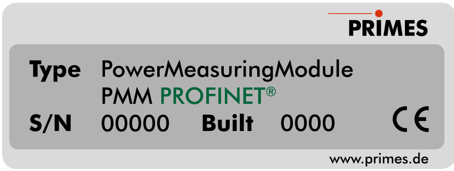
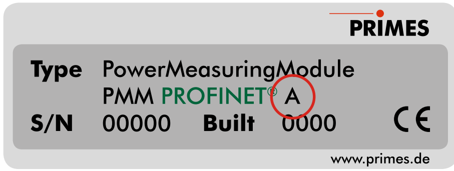
The exposure time of 100 ms leads to an irradiation of 800 Joule. This means, the minimum amount of energy of 400 Joules is clearly exceeded. Furthermore, this exposure time enables two more power measurements, that can be carried out immediately.

When it comes to pulsed laser radiation a correct exposure time measurement up to a pulse frequency of 1 kHz and a duty cycle of 50 % is possible. In case of on/off times shorter than 500 µs a correct exposure time measurement is not possible. However, the irradiated energy is still measured correctly.

4.3 Overview of the PowerMeasuringModule PMM types

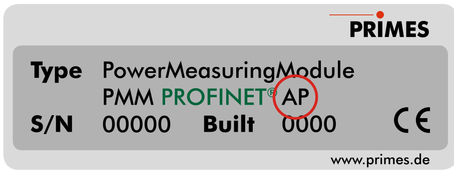
The different versions of the PowerMeasuringModule PMM types can be found on the identification plate. The devices differ in the interface, the absorber type (standard or advanced absorber), the possibility to measure pulsed lasers and the reduced speed of the thermalization time. In addition, devices with UL marking are available.

4.3.1 Differentiation by interface and absorber type

Interface	Standard absorber	**Advanced absorber** When a A marking is made, an advanced absorber is built into the device.
PROFINET® PROFINET® LWL PROFIBUS® Parallel DeviceNet™ EtherNet/IP™ EtherCAT®		

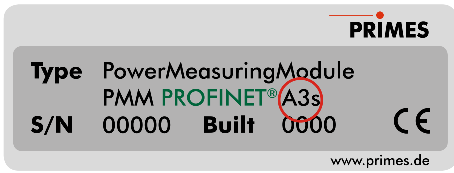
Tab. 4.2: Differentiation by interface and absorber type using the PMM PROFINET® as an example

4.3.2 Differentiation by the interface and the possibility to measure pulsed lasers

Interface	Standard absorber	**Advanced absorber** With the AP marking, pulsed lasers can also be measured.
PROFINET® PROFINET® LWL PROFIBUS® Further interfaces on request	—	

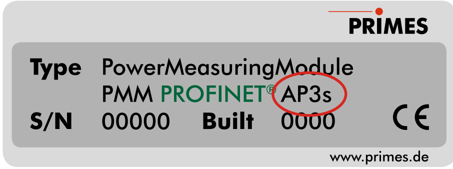
Tab. 4.3: Differentiation through the interface and the possibility to measure pulsed lasers using the PMM PROFINET® as an example

4.3.3 Differentiation by the interface and a reduced thermalization time

Interface	Standard absorber	**Advanced absorber** With the A3s marking, the device is designed for a reduced thermalization time.
PROFINET® PROFINET® LWL PROFIBUS® Parallel DeviceNet™ EtherNet/IP™ EtherCAT®	—	

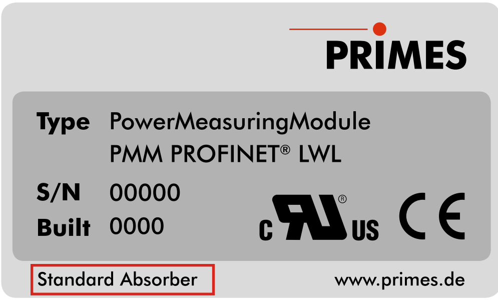
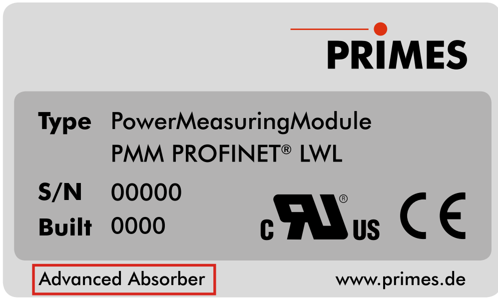
Tab. 4.4: Differentiation by the interface and a reduced thermalization time using the PMM PROFINET® as an example

4.3.4 Differentiation by the interface, the possibility to measure pulsed lasers and a reduced thermalization time

Interface	Standard absorber	Advanced absorber With the AP3s marking, pulsed lasers can also be measured and the device is designed for a reduced thermalization time.
PROFINET® PROFINET® LWL PROFIBUS® Further interfaces on request	—	

Tab. 4.5: Differentiation through the interface, the possibility to measure pulsed lasers and a reduced thermalization time using the PMM PROFINET® as an example

4.3.5 Devices with UL marking

Interface	Standard absorber When the PMM PROFINET® LWL with UL marking has the designation standard absorber a standard absorber is built into the device.	Advanced absorber When the PMM PROFINET® LWL with UL marking has the designation advanced absorber an advanced absorber is built into the device.
PROFINET® LWL		

Tab. 4.6: Unterscheidung durch die Schnittstelle und den Absorbertyp am PROFINET® LWL mit UL-Kennzeichnung

5 Transport

NOTICE

Damaging/destroying the device

Optical components may be damaged if the device is subjected to hard shocks or is allowed to fall.

- **Handle the device carefully when transporting or installing it.**
- **Only transport the device in the original PRIMES transport box.**

6 Installation

6.1 Installation into the laser system

The PowerMeasuringModule PMM is intended for the installation into a laser system. Therefore neither constructive nor safety-related modifications may be made to the PowerMeasuringModule PMM unless we have given our explicit written consent. In case of any modifications, we do not accept any liability for resulting damages.

Please keep the following points in mind when installing the device:

1. First of all, the laser source has to be turned off.
2. Ensure that the moving parts, e.g. robot arms, etc. are at a standstill and that they cannot be set in motion unintentionally.
3. Stability: Please mount the measuring device securely in order to prevent a relative movement to the beam axis, reducing a danger posed by scattered radiation.

DANGER

Serious eye or skin injury due to laser radiation

If the device is moved from its calibrated position, increased scattered or directed reflection of the laser beam occurs during measuring operation (laser class 4).

- **When mounting the device, please ensure that it cannot be moved, neither due to an unintended push or a pull on the cables and hoses.**

4. Mounting space: Please note that the shutter of the PowerMeasuringModule PMM is opened and closed during operation. A complete opening of the shutter has to be ensured. Please make sure that there is enough space to prevent a collision of the shutter with other parts of the machine as well as to exclude a hazard for the operating personnel by crushing.

6.2 Installation position and fastening

The PowerMeasuringModule PMM can be mounted both horizontally and vertically. Due to the danger of contamination we recommend a vertical mounting with a horizontal beam incidence. The connectors should point downwards and unused sockets should be closed by means of the supplied covering caps.
An "overhead“ mounting position should be avoided because then the shutter does not close properly.

There are four holes Ø 6.6 mm for the fixture on a customer specific mounting (please see Fig. 6.1 on page 17). Please mount the housing with 4 screws M6. We recommend screws of the strength class 8.8 and a tightening torque of 35 N·m.

Please ensure a good thermal conductivity of the mounting surface, especially during measurement procedures with high measurement cycles (please see chapter 4.2.1 on page 12), in order to ensure a fast heat dissipation.

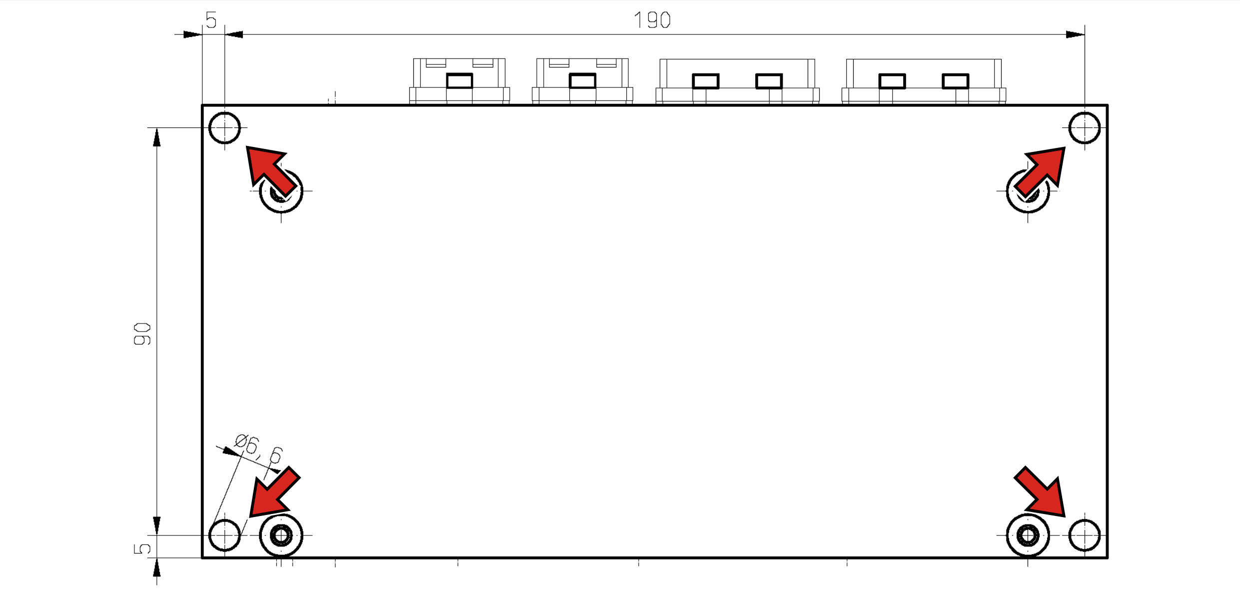


Fig. 6.1: Mounting holes, view underside

6.3 Removal from the laser system

1. First of all, the laser source has to be turned off.
2. Turn off the voltage supply.
3. Ensure that moving parts, e.g. robot arms, etc. are at a standstill and that they cannot be set in motion unintentionally.
4. Close the shutter
5. Remove all connection cables and remove the device.

7 Electrical connectors and displays

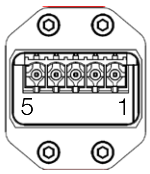
7.1 PROFINET®/ PROFINET® Fiber optics

7.1.1 Data connector

The PROFINET® connectors are AIDA compatible RJ45 connectors. Both RJ45 connectors are connected internally via an integrated switch. There are two status LED's on the left side of the connector. The green LED (Tx/Rx) glows as soon as the physical connection has been established. The yellow LED glows during data transfer.
The fiber version has SCRJ connectors (e. g.: Phoenix Contact, Article-No. 1402172; Type FOC-PN-B-1000/...).

7.1.2 Power supply

The power supply is realized via the AIDA compatible connectors. Both connectors are connected internally 1:1. The power consumption of the PowerMeasuringModule PMM is below 250 mA, which is covered by the sensor supply.

Power device connector (top view plug-in side)	Pin	Function
	1	Sensor power supply 24 V
	2	GND Sensor power supply
	3	Actor power supply 24 V
	4	GND Actor power supply
	5	FE (functional earth)

Tab. 7.1: Pin assignment power supply

7.1.3 Status LEDs

There are two status LED's on the left side of the power supply. The yellow LED glows constantly if there is no physical connection to the bus. The LED flashes when there is a connection but no data transfer.
The upper green LED glows during a DCP cycle via the bus.

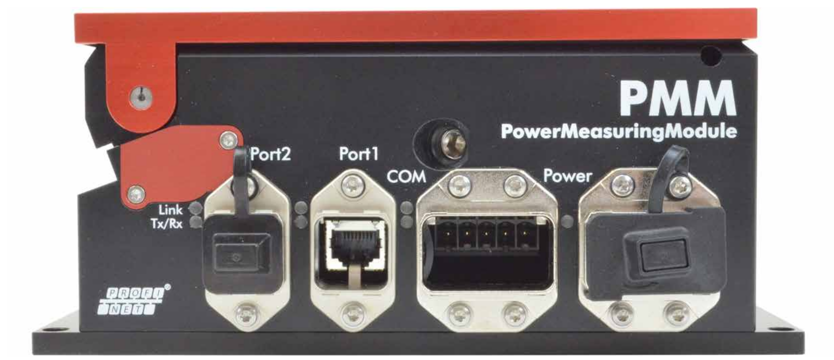


Fig. 7.1: PowerMeasuringModule PMM PROFINET®

LED Indication

PROFINET® Port 1	PROFINET® Port 2	Status
Link (green)	Link (green)	DCP-signal bus transfer (green)
Tx/Rx (yellow)	Tx/Rx (yellow)	Communication • Constant - no connection • Flashing - no data transfer

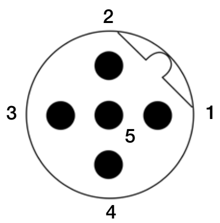
Tab. 7.2: LED Indication

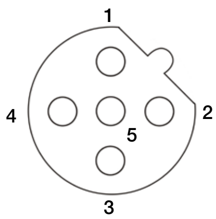
Regarding the fiber version, the LEDs "Link" and "Tx/Rx" have no function.

7.2 PROFIBUS®

7.2.1 Bus connector

The plug connector for PROFIBUS® is a 5-pole, B-coded M12 connector.

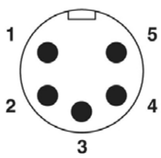
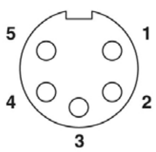
Plug assignment (top view plug-in side)	Pin	Function
	1	Not connected
	2	Signal A
	3	Not connected
	4	Signal B
	5	Not connected

Socket assignment (top view plug-in side)	Pin	Function
	1	5 V
	2	Signal A
	3	ISOGND
	4	Signal B
	5	Not connected

Tab. 7.3: PROFIBUS® connector

7.2.2 Power supply

The power supply uses 7/8"- connectors. Both connectors are internally connected 1:1. The PowerMeasuringModule PMM has a power requirement below 250 mA which is covered by the sensor supply.

Assignment (top view plug-in side)	Pin	Funktion
 Plug  Socket	1	GND Actor
	2	GND Sensor
	3	FE (functional earth)
	4	Sensor supply 24 V
	5	Actor supply 24 V

Tab. 7.4: Power supply connector

7.2.3 Status LEDs

On the left of the power supply connector there are two LEDs indicating the status of the PowerMeasuringModule PMM. The yellow LED “stop” flashes when there is no physical connection between the measuring device and the bus. The LED glows when there is a connection but no data exchange.

The green LED “Run” glows during communication with the bus.

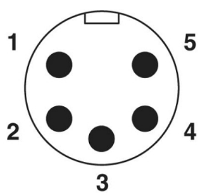
Fig. 7.2: PowerMeasuringModule PMM PROFIBUS®

7.3 Parallel interface

The PowerMeasuringModule PMM Parallel has a parallel interface with 4 inputs (In) and 16 outputs (Out).

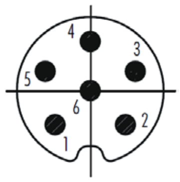
Fig. 7.3: PowerMeasuringModule PMM Parallel

7.3.1 Power supply

Plug assignment (top view)	Pin	Funktion
	1	0 V
	2	Not connected
	3	Not connected
	4	Sensor supply 24 V; 0.5 A
	5	Actor supply, not connected

Tab. 7.5: Connector for power supply (PhönixContact SACC-E-MINMS-5CON-PG13/0,5)

7.3.2 Input, 4-Channel



Plug assignment (top view)	Pin	Name	Funktion
	1	Bit 0	Shutter opening
	2	Bit 1	Shutter closing
	3	Bit 2	Start measurement
	4	Bit 3	Reset
	5		Not connected
	6		Ground

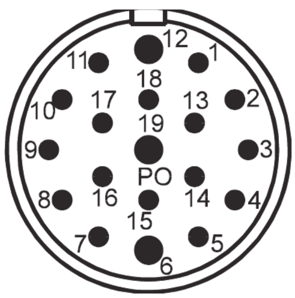
Tab. 7.6: Connector 4-Channel-Input (Binder; M12-plug-connector, 5-pole, series 713/763)

The inputs are electrically isolated by means of an opto coupler.

7.3.3 Output, 16-Channel

The outputs 1 to 17 have two functions, depending on the setting of bit 15. In case of bit 15 = 1 (measurement finished) the 14 lines below are used for displaying the power (Watt) as binary code.
In case of bit 15=0 those lines provide status information.

After a change of edge of bit 15, the measured value bits should be taken over a few milliseconds later to avoid runtime problems of the individual bits.



Plug assignment (top view plug-in side)	Pin	Name	Function	
			Bit15=0	Bit 15=1
	1	Bit 0	Shutter is open	Power Bit 0
	2	Bit 1	Shutter is closed	Power Bit 1
	3	Bit 2	Shutter is moving	Power Bit 2
	4	Bit 3	Shutter time error	Power Bit 3
	5	Bit 4	Irradiation time 100 ms	Power Bit 4
	6	-	GND[1)]	
	7	Bit 5	Irradiation time 200 ms	Power Bit 5
	8	Bit 6	Irradiation time 400 ms	Power Bit 6
	9	Bit 7	Irradiation time 800 ms	Power Bit 7
	10	Bit 8	Irradiation time 1,600 ms	Power Bit 8
	11	Bit 9	Confirmation command closing	Power Bit 9
	12	-	GND	
	13	Bit 10	Confirmation start measurement	Power Bit 10
	14	Bit 11	Absorber too warm	Power Bit 11
	15	Bit 12	System not in operation	Power Bit 12
	16	Bit 13	Measurement in process, Pulse received	Power Bit 13
	17	Bit 14	System waiting for pulse	Power Bit 14
	18	Bit 15	Measurement finished	
	19	-	Supply voltage (24 VDC)	

1) Is connected with pin 1 in the power supply (see Tab. 7.5 on page 20).

Tab. 7.7: 16 channel output connector (LQ-Mechatronik, connector M23 Sig-A, 16+3-E STI-CR9,0-13,2)

The output driver is supplied with 24 V via Pin 19. The maximum current load of all outputs is 2 Amperes. A single output can have a load of 500 mA. The outputs are not electrically isolated.

7.4 DeviceNet™

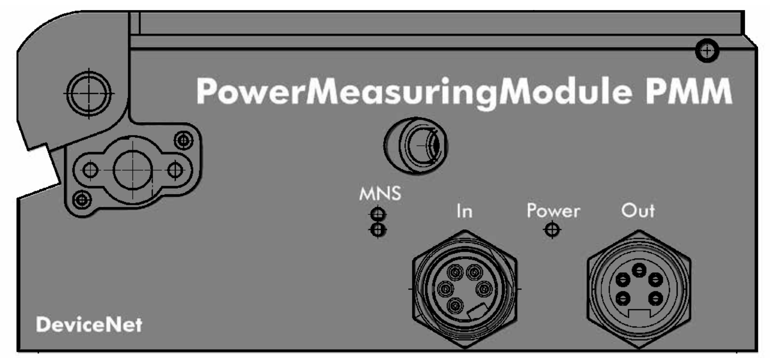
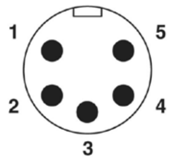
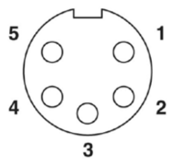


Fig. 7.4: PowerMeasuringModule PMM DeviceNet™

7.4.1 Connectors

The connectors for DeviceNet™ are 5-pin, 7/8“-connectors.

Pin assignment In (view from plug-in side)	Pin	Function
	1	Drain
	2	V+ (24 V)
	3	V– (GND)
	4	CAN_H
	5	CAN_L

Pin assignment Out (view from plug-in side)	Pin	Function
	1	Drain
	2	V+ (24 V)
	3	V– (GND)
	4	CAN_H
	5	CAN_L

Tab. 7.8: Connectors DeviceNet™

7.4.2 Control LEDs

LED	Color	Mode	Meaning
MNS (Module/Network Status)			
	Green	On	A device is online and has established one or more connections.
	Green	Flashing	Device is online and has not established a connection.
	Red	On	Critical connection error; Device has detected a network error: double MAC-ID or severe error in CAN-network (CAN-Bus-Off).
	Red	Flashing	Connection monitoring time has expired.
	Grün Red	Green/Red/Off	Start-up self-test: green on for 0.25 s, then red on for 0.25 s, then off.
	—	Off	After start-up of the device and during the check for a double MAC-ID.
Power			
	Green	On	Supply voltage is connected.

Tab. 7.9: Control LEDs

7.5 EtherNet/IP™

7.5.1 Data connectors (Port 1/Port 2)

The EtherNet/IP connectors are AIDA compatible RJ45 connectors. Both RJ45 connectors are connected internally via an integrated switch. There are two status LED’s on the left side of the connector. The green LED (Link) glows as soon as the physical connection has been established. The yellow LED (Act) glows during data transmission.

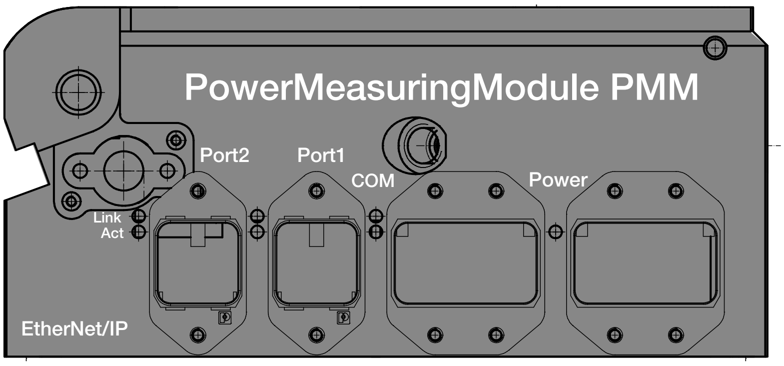
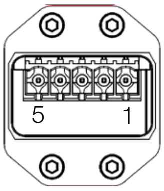


Fig. 7.5: PowerMeasuringModule PMM EtherNet/IP™

7.5.2 Power supply (Power)

The power supply is realized via the AIDA compatible connectors. Both connectors are connected internally 1:1. The power consumption of the PowerMeasuringModule PMM is below 250 mA, which is covered by the sensor supply.

Power-Device connector (view from plug-in side)		
	Pin	**Function**
	1	Sensor power supply 24 V
	2	GND Sensor power supply
	3	Actor power supply 24 V
	4	GND Actor power supply
	5	FE (functional earth)

Tab. 7.10: Pin assignment power supply

7.5.3 Control LEDs

LED	Color	Mode	Meaning
Link			
	Green	On	Connection established with Ethernet.
		Off	No connection established with Ethernet.
Act			
	Yellow	Flashing	The device sends/receives Ethernet Frames.
COM			
	Green	On	**PMM, PMM A, PMM A3s only – Connected:** If the device has at least one connection (including the message router).
	–	Off	**PMM AP und PMM AP3s only – Connected:** If the device has at least one connection (including the message router).
	Green	Flashing	**No connections**: If the device has no existing connections but has received an IP address, the network status display flashes green.
	Red	On	**Double IP**: If the device realizes that an IP address is already in use, the network status display glows red.
	Red	Flashing	**Time out of the connection:** If one or more connections with the device have reached the time out, the network status display flashes red. This status will not terminate until all connections, that have timed-out, have been restored or until the device has been reset.
	Red Green	Flashing	**Self-test**: When the device is carrying out a self-test, the network status display flashes green/red.
	–	Off	**Not turned on, no IP address:** If the device does not have an IP address (or is turned off), the network status display is off. .
Power			
	Green	On	The supply voltage is connected.

Tab. 7.11: Control LEDs

7.6 EtherCAT®

7.6.1 Data plug (Port 1/Port 2)

The EtherCAT® plug connectors are AIDA-compatible RJ45 plug connectors. The two RJ45 sockets are connected with each other internally via an integrated switched. Port 1 is the input (in) and Port2 is the output (out). There is one L/A LED (link/activity) located next to each socket on the left.

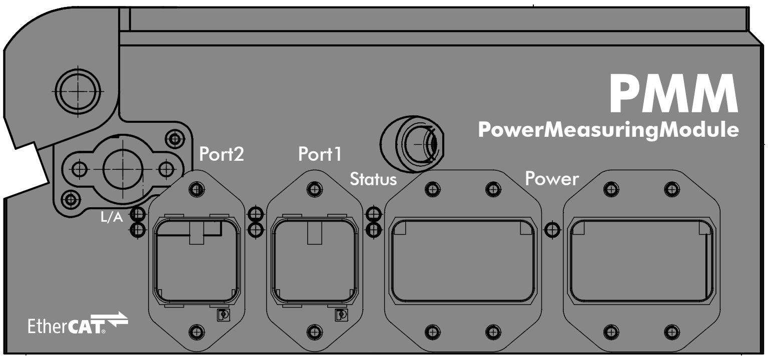
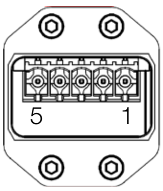


Fig. 7.6: PowerMeasuringModule PMM- EtherCAT®

7.6.2 Power supply

The power supply is realized via the AIDA compatible connectors. Both connectors are connected internally 1:1. The power consumption of the PowerMeasuringModule PMM is below 100 mA, which is covered by the sensor supply.

Power device connector (top view plug-in side)	Pin	Function
	1	Sensor power supply 24 V
	2	GND Sensor power supply
	3	Actor power supply 24 V
	4	GND Actor power supply
	5	FE (functional earth)

Tab. 7.12: Pin assignment power supply

7.6.3 Control LEDs

LED	Color	Mode	Meaning
L/A			
	Green	On	There is a connection to the EtherCAT®.
	Green	Flashing	The device sends/receives Ethernet frames.
	Green	Off	The device has no connection to the EtherCAT®.
Status			
	Green	On	The device is in OPERATIONAL mode.[1]
	Green	Flashing	The device is in PRE-OPERATIONAL mode.[2]
	Green	Simple flash	The device is in SAFEOPERATIONAL mode.[3]
	Green	Off	The device is in INIT mode. [4]
	Red	Flashing	Invalid configuration: General configuration error: Possible cause: A status change specified by the master isn't possible, because of the register or object settings.
	Red	Simple flash	Local error: The slave device application has an EtherCATStats Changed autonomously. Possible cause 1: A host watchdog timeout has occurred. Possible cause 2: Synchronization error, the device switches automatically after safe operational.
	Red	Double flash	Process data watchdog timeout: A process data watchdog timeout has occurred. Possible cause: Sync manager watchdog timeout
Power			
	Green	On	The supply voltage is applied.

Tab. 7.13: Control LEDs

1 Inputs and outputs are valid and the final mode has been achieved.

2 Communication with the application layer already runs through the mailbox, but the process data still isn't being communicated. Additional parameters now need to be configured. This includes the mapping of process data and the setup of the SyncManager and FMMU. The safe operational state can then be queried.

3 Communication of process data will start, but only the input values are valid at the start. Outputs are left in a so-called safe state. This will change as soon as the master sends valid output values and requests operational state.

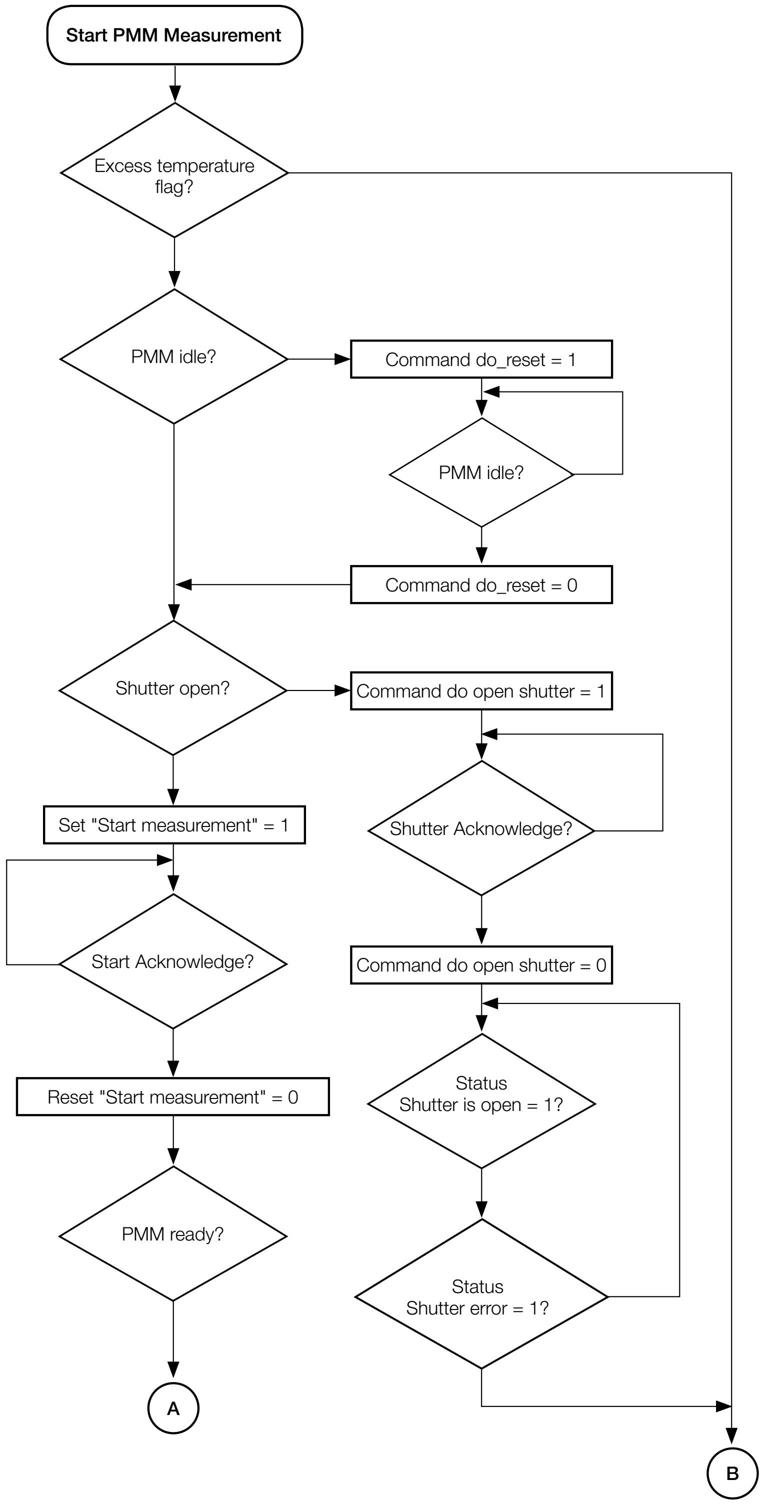
4 There is no communication on the application layer, but the master has already accessed the DL information register. Here the master at least has to configure the DL address register and channels for the mailbox of the SyncManager.

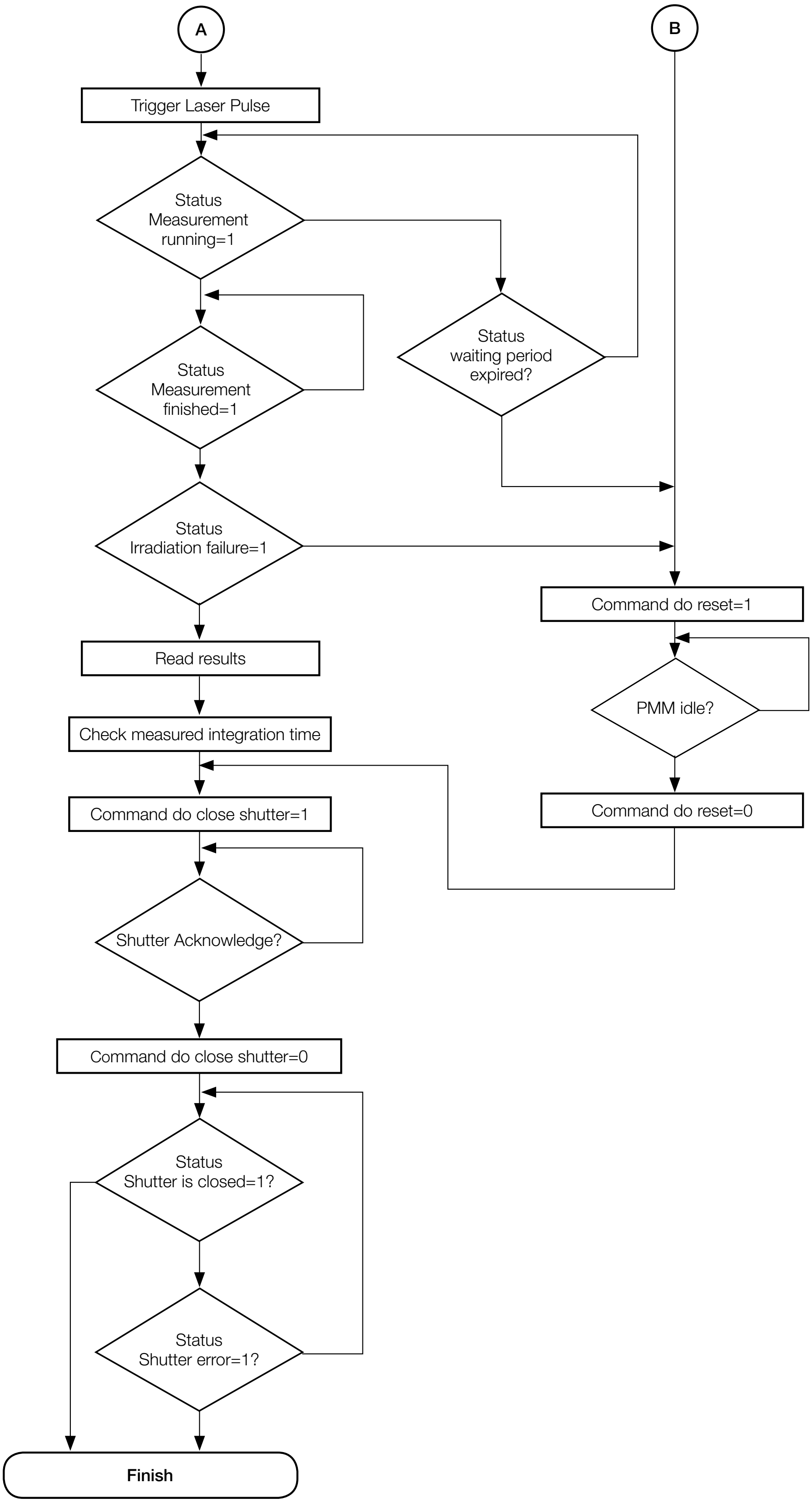
LED states	Description
On	The indication is steadily lit up.
Off	The indication is not lit up.
Flashing	The indication is turned on or off in phases, with a frequency of 2.5 Hz: On for 200 ms, followed by off for 200 ms.
Simple flash	The indication shows a short flash (200 ms), followed by a long off phase (1 000 ms).
Double flash	The indication shows a series of two short flashes (200 ms each), punctuated by a brief off phase (200 ms). The series ends with a long off phase (1 000 ms).

Tab. 7.14: LED states

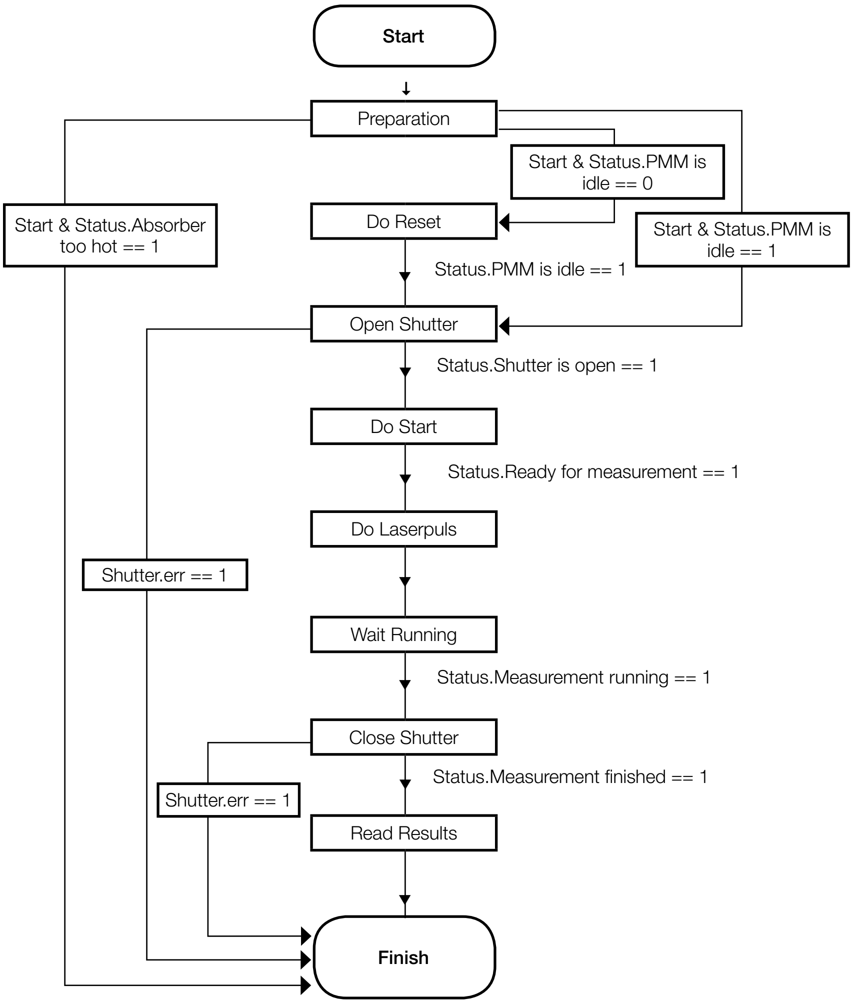
8 Measurement

8.1 General flow diagram of a PowerMeasuringModule PMM measurement

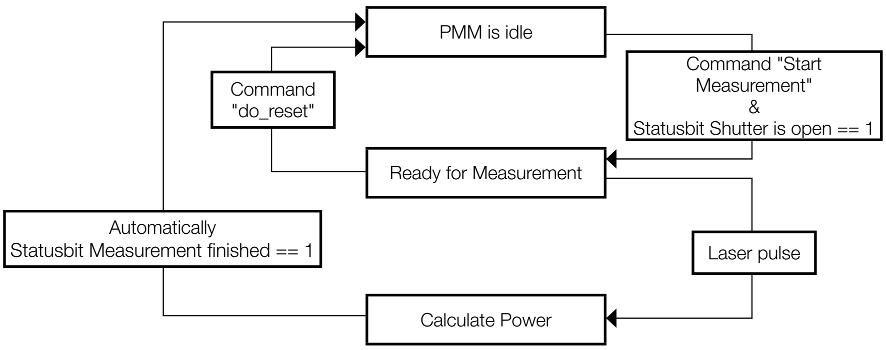



A
B
Trigger Laser Pulse
Status
Measurement
running=1
Status
waiting period
expired?
Status
Measurement
finished=1
Status
Irradiation failure=1
Command do reset=1
PMM idle?
Command do reset=0
Read results
Check measured integration time
Command do close shutter=1
Shutter Acknowledge?
Command do close shutter=0
Status
Shutter is closed=1?
Status
Shutter error=1?
Finish

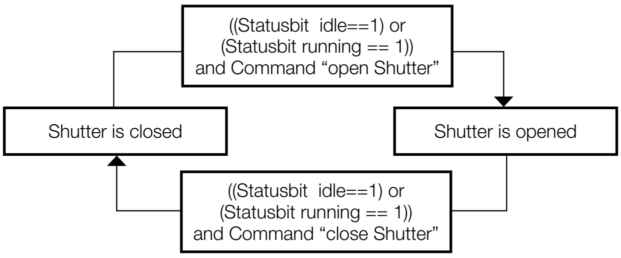
8.2 PLC Control program sequence of the PowerMeasuringModule PMM



8.3 Internal conditions



8.4 Shutter conditions



9 Measurement cycle details

The power measurement cycle includes three steps:

1. Preparing the measurement
2. Executing the power measurement
3. Evaluating the power measurement

The details of these steps are discussed below:

9.1 Preparing the measurement

The readyness of the device is subject to three conditions:

1. An open shutter
2. The absorber still has the capacity to absorb the energy of a measurement
3. No other measurement cycle is activated

9.1.1 Opening the shutter

The shutter is opened by a gear motor with a friction clutch. The bit "open shutter" in the command byte issues the command to open the shutter. The gear motor requires less than 5 seconds to open the shutter completely. As soon as the shutter has reached the open position the "shutter open"- bit changes to the value 1 in the "Status 1" byte. The command bit "open shutter" can then be deactivated. Closing the shutter is done in the same way.

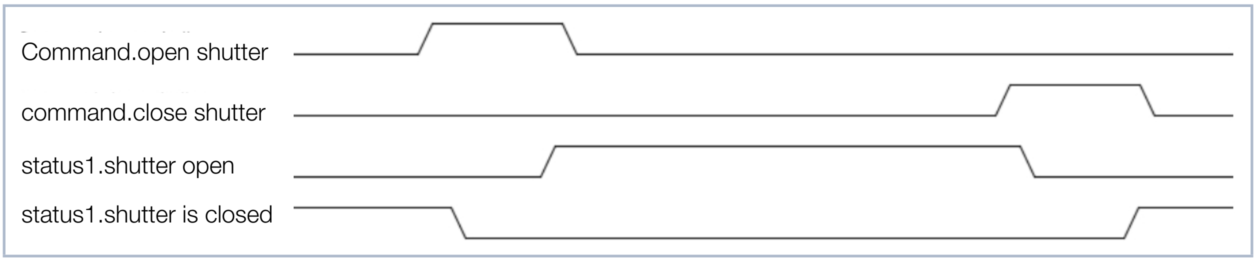


Fig. 9.1: Shutter control timing diagram

Step 2 requires a delay time. This delay time is typically below 1 minute until the absorber has cooled down and is ready for the next measurement cycle. With regard to step 3 there is an automatic reset after every measurement cycle.

9.1.2 Determination of the exposure time

The exposure time is to be determined according to the regulations stated in the chapter „4.2.2 Calculation of the exposure time" on page 13.

9.2 Execution of the power measurement

The device is ready as soon as the shutter is open. To initialize the device for the measurement the external control system must set the “start” bit in the “Command” byte (please see Fig. 9.2 on page 32).

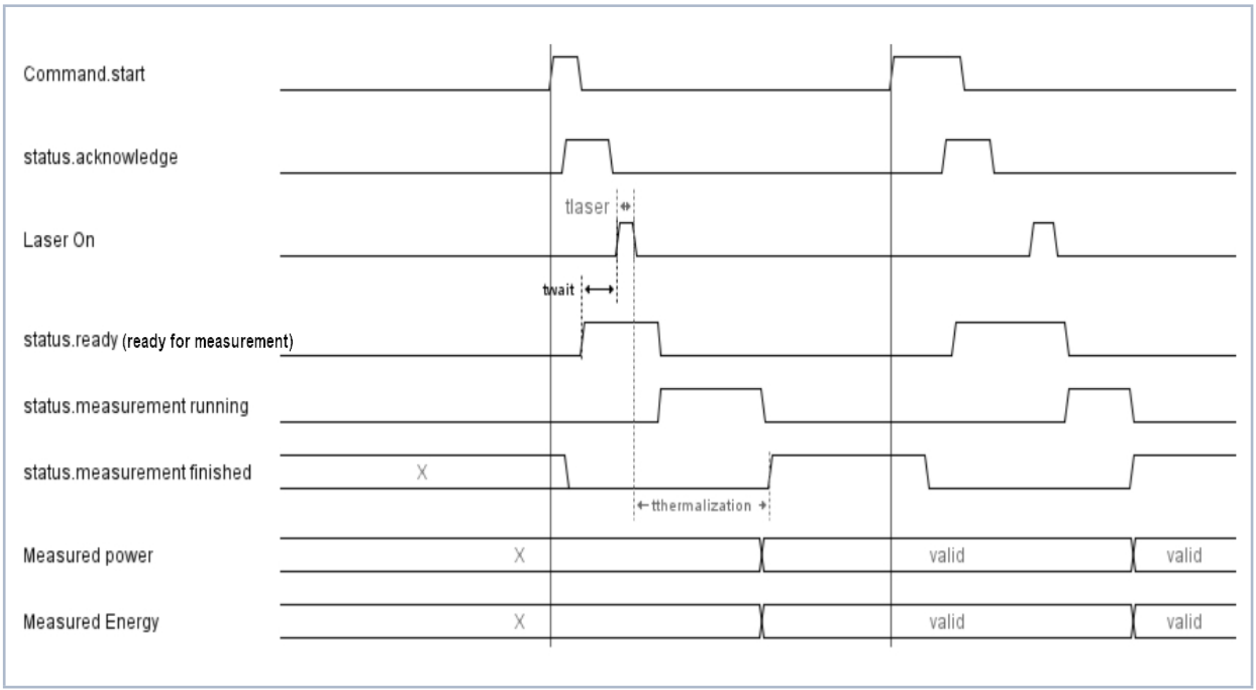


Fig. 9.2: Timing diagram of the measurement cycle

The instrument answers the starting command with an “Acknowledge” in status byte 1. As soon as the device is ready for measurement the “Ready” bit is set in the status byte 1. Please check status byte1. Bit 0 is "1" before starting the laser pulse.
Then the laser can irradiate the absorber for the specified time. The PowerMeasuring Module remains in this mode for an unlimited period of time. If the shutter is closed, the “ready” status is deleted.

After the laser pulse with the desired duration, the measuring device can identify the laser pulse due to the temperature rise of the absorber. The bit “ready” is deleted and the thermalization period of the absorber is displayed by the bit “running” in the status byte.
At the end of the thermalization phase (approx. 10 seconds for standard devices and 3 seconds for devices with reduced thermalization time - type A3s), the measurement result is calculated and the "measurement finished" bit is set. The results of the measurement can be displayed now.

If the measuring procedure is supposed to be aborted without a measurement and the shutter is supposed to be closed again, a reset has to be carried out (Do_reset; set bit 7 in the command byte, please see Tab. 11.2 on page 38).

9.3 Evaluation of the power measurement

The evaluation of a measurement depends upon whether or not the measuring device is equipped with an integrated exposure time measurement. The "read-only" value "Pulse duration measurement available" shows whether the exposure time measurement is included.
In case of a measurement cycle without an exposure time detection, it must be ensured that the exposure time the laser has been programmed to is definitely adhered to.
After finishing the measurement cycle the variable “measured energy” shows the readable irradiated laser energy.

9.3.1 Without exposure time control

To determine the laser power, the measured energy must be divided by the exposure time that has been set.

Example: 785.4 Joules, exposure time 100 ms equals a laser power of 7 854 W.

9.3.2 With exposure time control

With an integrated exposure time control, the power can be directly evaluated by the device, as the device itself can determine all the necessary values.

If a new measurement is launched before the end of the thermalization the “ready” bit does not appear before the thermalization has been completed.

9.4 Time-optimized measuring procedure

When integrating the PowerMeasuringModule PMM into a robotic production line, the cycle time is supposed to be as short as possible. In order to reduce the duration of the measurement, the robot downtime can be reduced to the mere exposure time.

Measuring procedure:

1. Robot moves towards the measuring device, at the same time the shutter opens.
2. The shutter is open, start measurement.
3. Robot has reached the right position.
4. Laser pulse is activated.
5. Laser pulse is finished.
6. Robot can move away again.
7. Wait for the signal "Measurement completed".

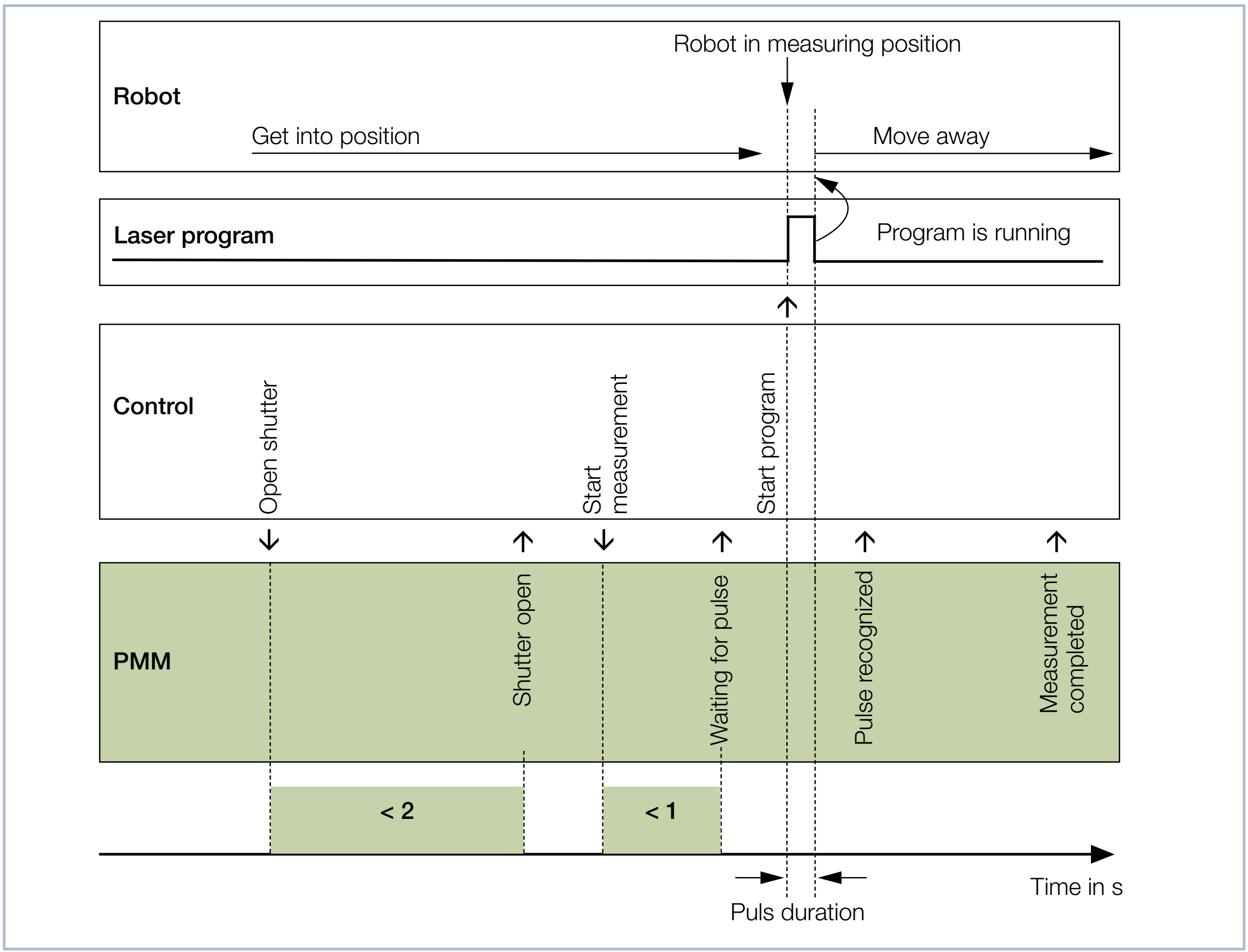


Fig. 9.3: Time-optimized measuring procedure

9.5 Measuring procedure parallel-interface

The measuring procedure of the PowerMeasuringModule PMM Parallel is identical to the procedures of the PowerMeasuringModule PMM PROFINET®/ PROFIBUS®. Due to a limited range of information, only the status bits as well as the result of the measurement are transmitted via the interfaces.

1. **Resetting the device**
   Please check whether bit 15=1. If so, please reset the device with a reset pulse of at least 200 ms. Then the bit “measurement completed” is 0. The status of the device can then be read at the output lines.

2. **Opening the shutter**
   Measurements may only be carried out with an open shutter! Please set the signal “open shutter” (entrance, bit 0). This signal has to be reset to 0 again after the signal “confirmation shutter-commando” is set. The open shutter is displayed by the bit "shutter open".

3. **Checking the temperature of the absorber**
   If the temperature of the absorber is too high, bit 11=1. This bit is only set if several measurements have been carried out in succession. This bit is reset within one minute due to thermal conduction.

4. **Starting the measurement**

NOTICE

Damaging/destroying the device

The maximum absorber temperature must not be exceeded.

▶ **When programming the laser system, please ensure that no measurement can be started, as long as the absorber is too warm (bit 11 = 1, see step 3.).**

Only start the measurement when the shutter is open and the temperature of the absorber is not too high. Set the signal “start measurement”. The bit “start measurement” has to be reset, as soon as the bit “confirmation start commando” is set. With the signal “system is waiting for laser pulse” (bit 14) the PowerMeasuringModule PMM indicates that it is ready for operation.

5. **Activating the laser pulse**
   The pulse energy should not exceed 25 % of the capacity of the absorber. In case of the current version of the PowerMeasuringModule PMM, the capacity is about 3 000 Joules. The shot should therefore contain about 750 Joules. For a laser power of 4 000 Watts, the pulse length should be 750/4 000 = 0.185 seconds. The exposure time does not need to be communicated to the device, as the exposure time is measured by the system itself. After the laser pulse has been activated it only takes a few 100 milliseconds before the bit “measurement running” is set to 1.

6. **Waiting for the measurement result**
   Ten seconds after the activation of the signal “measurement running” the bit is reset and the bit “measurement completed” is set to 1. Simultaneously, the bits 0 to 14 show the measurement result in binary form.

10 Interface description

Interface	Number of interfaces	
	Data	Power supply 24 V; max. 1 A power input
PROFINET®	2	2
PROFIBUS®	2	2
Parallel	2	1
DeviceNet™	1	1
EtherNet/IP™	2	2
EtherCAT®	2	2

Tab. 10.1: Interface overview

To install the PowerMeasuringModule PMM with PROFIBUS®, PROFINET® and EtherNet/IP™ interface in a serial bus system, there are two connectors for both the bus interface and the power supply.

10.1 Bus interfaces

As the PowerMeasuringModule PMM is available with different interfaces it is also available with different connectors. The data structure as well as the signals that are used to communicate via the different interfaces are identical. The software prepared for the PowerMeasuringModule PMM PROFIBUS® on a PLC can also be used for the PowerMeasuringModule PMM PROFINET®.

10.1.1 PROFINET®

The PowerMeasuringModule PMM has two PROFINET® interfaces connected via an integrated switch. For these interfaces AIDA compatible panel jacks are employed, IE-series 14; supplier: Weidmueller (optional fiber connectors; AVAGO TECHNOLOGIES; manufacturer's designation: AFBR-5978Z - TRANSCEIVER 10/100, SC-RJ).

10.1.2 PROFIBUS®

The PowerMeasuringModule PMM has two PROFIBUS® interfaces. The second panel jack acts as a power supply for the termination resistor.

10.1.3 Parallel

The PowerMeasuringModule PMM Parallel has an interface with 4 inputs (In) and 16 outputs (Out).

10.1.4 DeviceNet™

The PowerMeasuringModule PMM has two DeviceNet™ interfaces - 5-pin 7/8" connectors (plug / socket) - via which it is also supplied with voltage.
Suitable connector (female): Phoenix Contact 1521384
Suitable connector (male): Phoenix Contact 1521668

10.1.5 EtherNet/IP™

The PowerMeasuringModule PMM has two EtherNet/IP™ interfaces which are connected via an integrated switch. These interfaces are suitable for AIDA-compatible panel jacks (Weidmüller, IE-series 14).

10.1.6 EtherCAT®

The PowerMeasuringModule PMM has two EtherCAT® interfaces connected with each other via an integrated switch. These interfaces consist of AID-compatible mounted sockets from the Weidmüller company, IE Series 14 (optional fiber optic cable plug connector; AVAGO TECHNOLOGIES; manufacturer designation of the device socket: AFBR-5978Z - TRANSCEIVER 10/100, SC-RJ). The PMM is connected via an Ethernet patch cable or CAT5e quality crossover cable.

11 Programming model

The data, exchanged by the PowerMeasuringModule PMM via the upstream PLC field bus can be split into four parts:

1. Configuration data (read only, byte 12-35)
2. Variable (read only, byte 40-77)
3. Status (read only, byte 10-11)
4. Command (write only, byte 11)

In the registers, the data is available in the following format:

Field bus	Format
PROFINET®, PROFIBUS®	Motorola-Format, Big Endian
Devicenet™, Ethernet/IP™	Intel-Format, Little Endian

Tab. 11.1: Formats

11.1 Registry settings

Fixed value (ReadOnly)			Unit	Length	Type		Address
	MaxCapacity	4.000.000	1/1000 Joule	4 byte	lword		2 (MSB) - 5 (LSB)
	Minimum energy	400.000	1/1000 Joule	4 byte	lword		6-9
	Minimum irradiation time	1	ms	2 byte	word		10-11
	Maximum irradiation time	1000	ms	2 byte	word		12-13
	Maximum power	8000	Watt	2 byte	word		14-15
	Minimum absorber temperature	0	°C	2 byte	word		16-17
	Maximum absorber temperature	130	°C	2 byte	word		18-19
	Pulse duration Measurement avail.	0 / 1		2 byte	word		Byte 21:Bit 0
	Typ		-	2 byte	word		22-23
	Release		-	2 byte	word		24-25
Variable (read only)						Actualisation rate	
	Remaining capacity		1/1000 Joule	4 byte	lword	> 5 Hz	26 (MSB)-29 (LSB)
	Absorber temperature		1/1000 °C	4 byte	lword	> 5 Hz	30-33
	Housing 1 temperature		1/1000 °C	4 byte	lword	per measuring cycle	34-37
	Housing 2 temperature		1/1000 °C	4 byte	lword	per measuring cycle	38-41
	Housing 3 temperature		1/1000 °C	4 byte	lword	per measuring cycle	42-45
	Measured Energy		1/1000 Joule	4 byte	lword	per measuring cycle	46-49
	Measured Power		1/1000 Watt	4 byte	lword	per measuring cycle	50-53
	Measured irradiation time		Mikrosecond	4 byte	lword	per measuring cycle	54-57
Only for devices with AP/AP3s marking on the identification plate	Ontime		Mikrosecond	4 byte	lword	per measuring cycle	66-69 [1]
	Offtime		Mikrosecond	4 byte	lword	per measuring cycle	70-73
	Count of pulses		-	4 byte	lword	per measuring cycle	74-77
1) Gap due to bus system							
Status	Statusbyte (read only)			2 byte			
	Ready for Measurement		statusbyte1.Bit 0		Bool	> 5 Hz	Byte 0: Bit 0
	Measurement running		statusbyte1.Bit 1		Bool	> 5 Hz	0:1

Fixed value (ReadOnly)			Unit	Length	Type		Address
	Measurement finished		statusbyte1.Bit 2		Bool	> 5 Hz	0:2
	Absorber too hot		statusbyte1.Bit 3		Bool	> 5 Hz	0:3
	PMM is idle		statusbyte1.Bit 4		Bool	> 5 Hz	0:4
	Irradiation failure		statusbyte1.Bit 5		Bool	> 5 Hz	0:5
	Start acknowledged		statusbyte1.Bit 6		Bool	> 5 Hz	0:6
	Shutter acknowledged		statusbyte1.Bit 7		Bool	> 5 Hz	0:7
	Shutter is open		statusbyte2.Bit 0		Bool	> 5 Hz	Byte 1:0
	Shutter is closed		statusbyte2.Bit 1		Bool	> 5 Hz	1:1
	Shutter is moving		statusbyte2.Bit 2		Bool	> 5 Hz	1:2
	Shutter timeout		statusbyte2.Bit 3		Bool	> 5 Hz	1:3
	Shutter-Fehler Winkelsensor		statusbyte2.Bit 4		Bool	> 5 Hz	1:4
							1:5
Command							
	Commandbyte (write only)			1 byte		Set to default	
	Start measurement		Commandbyte Bit 0		Bool		0:0
	do open shutter		Commandbyte Bit 1		Bool		0:1
	do close shutter		Commandbyte Bit 2		Bool		0:2
	do_reset		Commandbyte Bit 7		Bool		0:7

Tab. 11.2: Registry settings overview

11.2 Configuration data

The configuration data includes all parameters that are factory set and that inform about the possibilities the device offers.

MaxCapacity	Max. energy (= thermal capacity) the absorber can absorb starting with 20 °C up to the max. temperature. This value is given for information only and is not needed for any calculations.
Minimum irradiation time	Is given for information only and is not needed for any calculations
Maximum irradiation time	Should not be exceeded, as the determination of the energy content of the absorber would then show inaccuracies.
Maximum power	Shows the max. laser beam power, the absorber can be irradiated with. In case the power is exceeded, the absorber can be damaged.
Minimum energy	The laser has to generate a sufficient increase in temperature for a measurement with the desired accuracy. To achieve this, a minimum amount of energy is needed. This value is given by the formula: $t_{Irradiation}$ > **Minimum energy /** P_{Laser}
Minimum absorber temperature	The minimum temperature of the absorber currently has no importance for this measurement system.
Maximum absorber temperature	No measurements can be carried out if the absorber temperature lies above the “max. absorber temp.” as the absorber would overheat otherwise.
Pulse duration Measurement avail.	This constant shows whether the integrated pulse duration measurement is available.

Tab. 11.3: Overview configuration data

11.3 Variables

The data generated during the measurement is stored in the variables. The measured temperatures are updated faster than one Hertz and the measured energy, power and exposure time are updated once in every measurement cycle.

Remaining capacity	Shows the remaining thermal capacity of the absorber. Do not use more energy for the next measurement than specified in this variable. When exceeding the amount of energy, the absorber is overheated. (From 70 °C absorber temperature: remaining capacity = 0)
Absorber temperature	The current temperature of the absorber. This value is for information only.
Housing 1 temperature	The current temperature of the housing. This value is for information only.
Housing 2 temperature	The current temperature of the housing. This value is for information only.
Housing 3 temperature	The current temperature of the housing. This value is for information only.
Measured Energy	Shows the energy content of the last laser beam measurement. In case of measurements without the measuring of the pulse duration, the laser power is to be determined from this (measuring) value.
Measured Power	Shows the power of the last laser beam measurement. This value is only valid if the device has an integrated exposure time measurement.
Measured irradiation time	Shows the exposure time during the last measurement. This value is only valid if the device has an integrated exposure time measurement.

Tab. 11.4: Overview variables

11.4 Status

The current status is shown in the status bits. The status bits are organized in 2 status bytes:

Ready for Measurement	The device is ready for a laser pulse.
Measurement running	The laser has emitted a pulse onto the power measuring device and is now evaluating the measurement.
Measurement finished	The measurement cycle is finished, the measurement results are provided in the corresponding registers.
Absorber too hot	The absorber is too hot for a further measurement. It has to cool down until the temperature is below the maximum absorber temperature. **Hint:** The bit indicating an excess temperature only displays that no further measurements are possible at this moment. An active bit after the measurement does not display an error and is reset within a minute.
PMM is idle	The PowerMeasuringModule PMM is in its initial state and is waiting for instructions
Irradiation failure	The measurement of the exposure time has detected an interruption of the laser power during the laser pulse. This bit is for information only.
Start acknowledge	The “start measurement” signal has been identified and can now be deactivated. The measurement standby is activated.
Shutter acknowledge	The “open shutter” and “close shutter” signal is identified and can now be deactivated.
Shutter is open	The shutter of the device is open.
Shutter is closed	The shutter of the device is closed.
Shutter is moving	The shutter of the device is moving.

Shutter timeout	The shutter has moved but has not reached the desired position within 5 seconds. This flag is deleted with the "Reset" command as well as a new "Open/Close"-shutter command.
Shutter error angle sensor	The angle sensor to determine the angle of the shutter is defective.

Tab. 11.5: Overview status

11.5 Commands

Commands are sent to the device via four command bits. However, only one bit may be activated and transferred at a time.

Start measurement	The start measurement bit launches the new measurement cycle. The start command is only issued if all status requirements are met. The instrument shows the incoming command via the „acknowledge-bit“ as the current status. Then, the „start-measurement-bit“ can be deactivated again.
Do open shutter	Activating the „open-shutter-bit“ leads to the opening of the shutter. This function can be observed via the status bits. As soon as the shutter is open, the bit can be deactivated again.
Do close shutter	Activating the „close-shutter-bit“ leads to the closure of the shutter. This function can be observed via the status bits. As soon as the shutter is closed, the bit can be deactivated again
Do_reset	Activating this bit will set the instrument to the initial state. The “idle-bit” is activated

Tab. 11.6: Overview commands

12 Integration in PROFINET® or PROFIBUS®

12.1 GSDML file (PROFINET®)

The registration of any PowerMeasuringModule PMM with the bus master occurs by means of the GSDML file. Within the GSDML file all parameters and variables are summarized in blocks (e.g. status, results). The contents of the single blocks are specified in the table Tab. 11.2 on page 38.

The software also includes a PowerMeasuringModule PMM image as a bitmap in the format 70 x 40 pixel, which is required for a symbolic depiction. The name of the file is “PMMpix.bmp”.

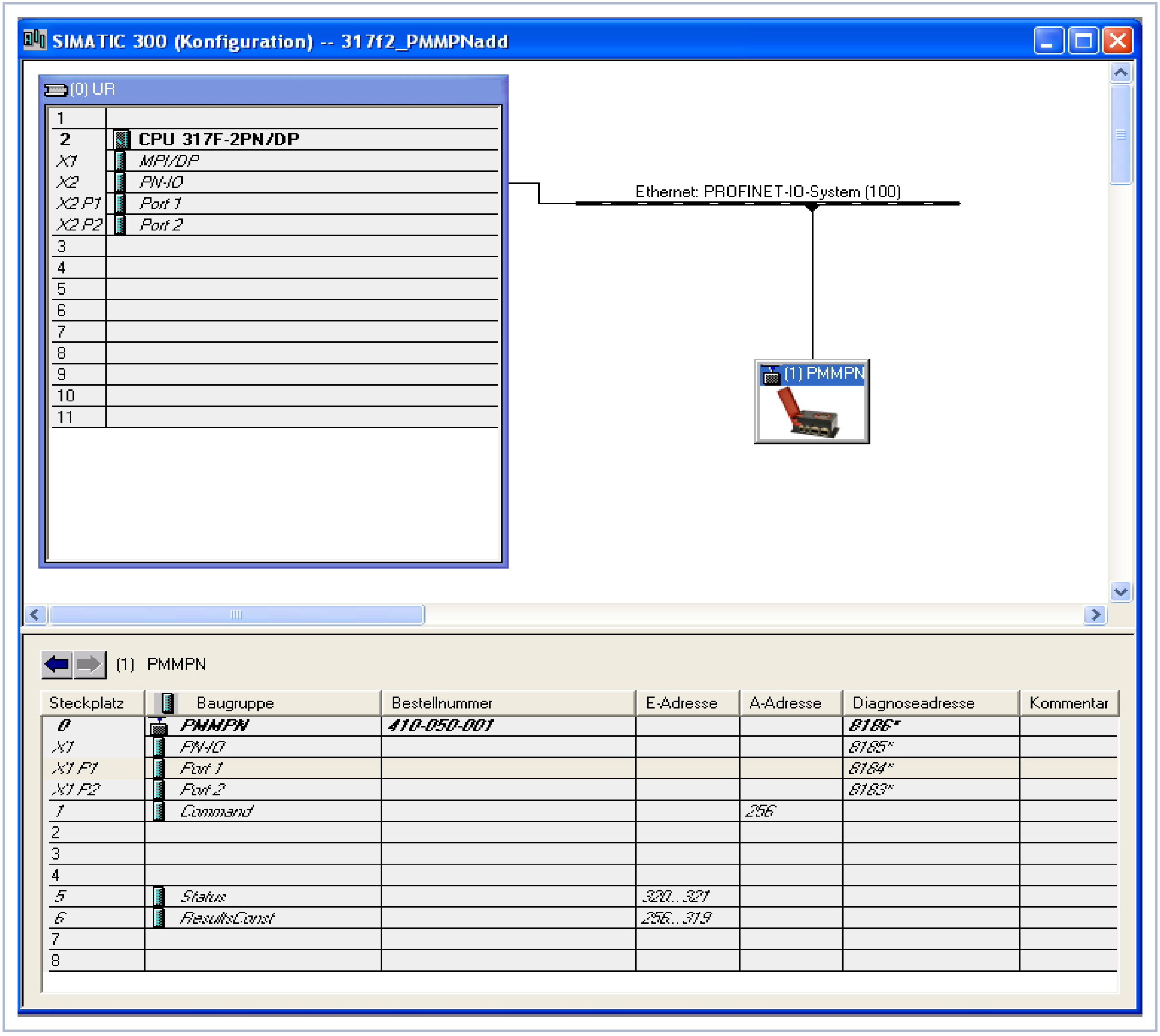


Fig. 12.1: Installed GSDML file

12.2 GSD file (PROFIBUS®)

The GSD-file for the PowerMeasuringModule PMM ccan be found on the supplied data medium and is called "PRI_101.gsd". The address is factory set to 03.
For devices delivered from 03.2012 onwards, the PROFIBUS® address is adjustable from 1 to 99.

12.2.1 Setting the PROFIBUS® address

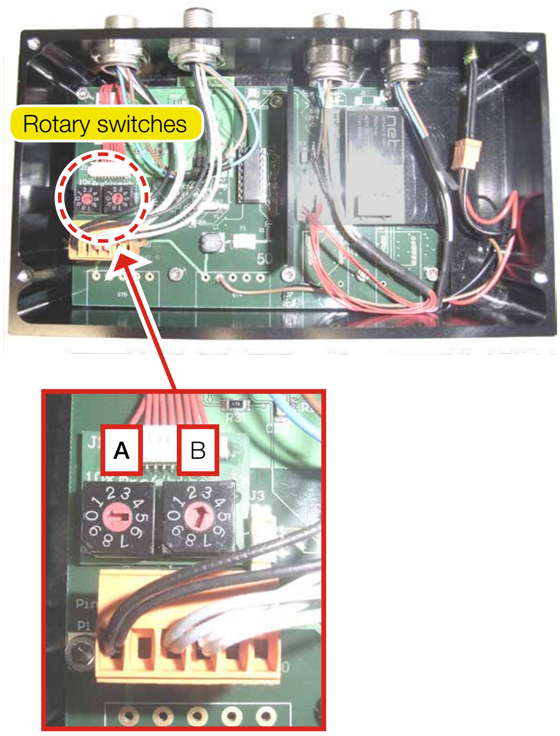
1. Please remove the base plate of the device (four hexagon socket screws a. f. 2.5 mm).

2. Please set the desired bus address by means of the rotary switches A and B. The arrow head of the rotary switch has to point to the respective figure.

Please note that the address consists of two digits. Switch A sets the first digit whereas switch B sets the second digit.

Example
The bus address is supposed to be 3.

Setting switch A=0
Setting switch B=3



The following screenshot shows the integration of the GSD file under SIMATIC STEP 7.

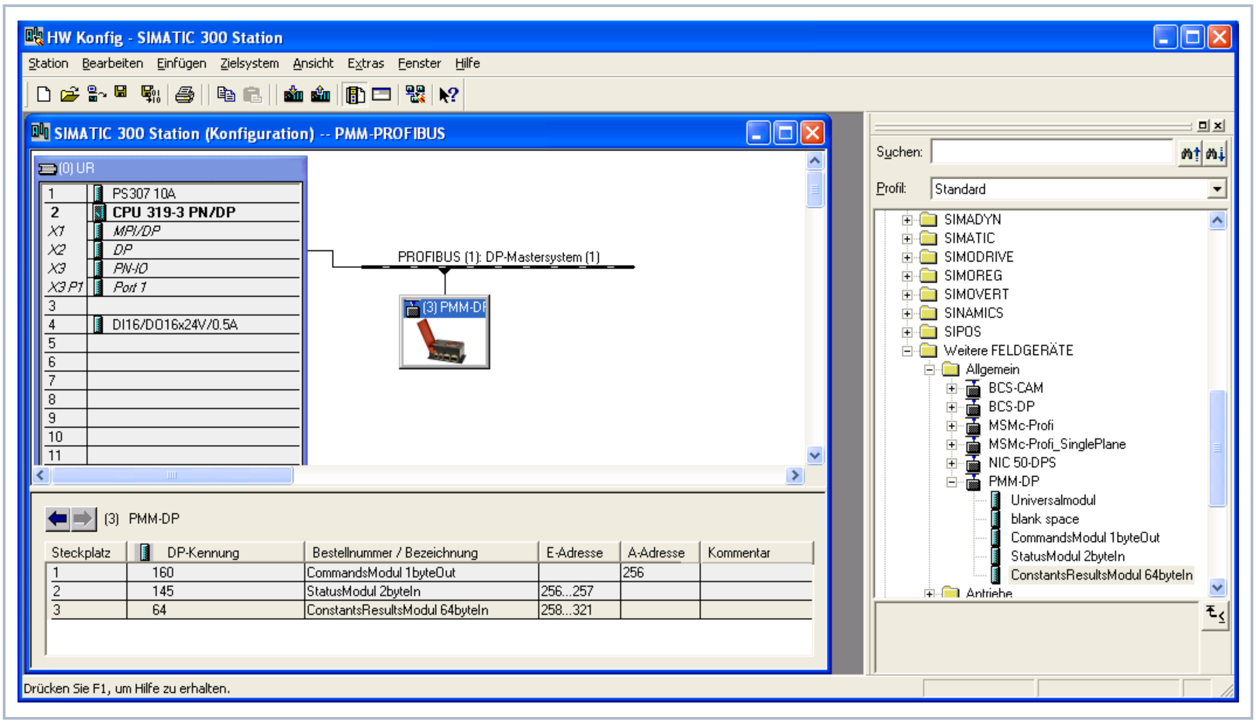
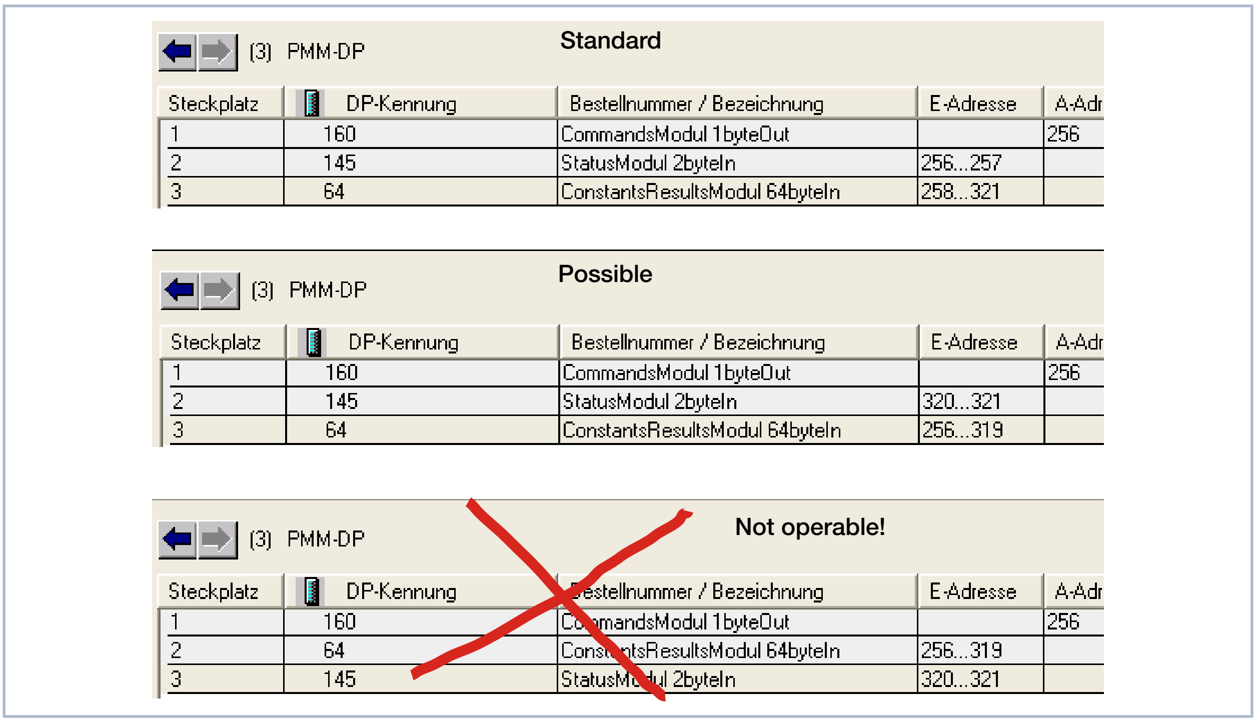


Fig. 12.2: GSD file under SIMATIC STEP 7

Please observe the correct order of the input and output modules in the configuration table.



(3) PMM-DP — **Standard**

Steckplatz	DP-Kennung	Bestellnummer / Bezeichnung	E-Adresse	A-Adr
1	160	CommandsModul 1byteOut		256
2	145	StatusModul 2byteIn	256...257	
3	64	ConstantsResultsModul 64byteIn	258...321	

(3) PMM-DP — **Possible**

Steckplatz	DP-Kennung	Bestellnummer / Bezeichnung	E-Adresse	A-Adr
1	160	CommandsModul 1byteOut		256
2	145	StatusModul 2byteIn	320...321	
3	64	ConstantsResultsModul 64byteIn	256...319	

(3) PMM-DP — **Not operable!**

Steckplatz	DP-Kennung	Bestellnummer / Bezeichnung	E-Adresse	A-Adr
1	160	CommandsModul 1byteOut		256
2	64	ConstantsResultsModul 64byteIn	256...319	
3	145	StatusModul 2byteIn	320...321	

Fig. 12.3: Order of the input and output modules in the configuration table

13 Integration in DeviceNet™ or EtherNet/IP™

DeviceNet™ was developed by Rockwell Automation and the user organization ODVATM (OpenDeviceNet™ Vendor Association) as an open field bus standard, based on the CAN protocol. DeviceNet™ is in accordance with the European standard EN 50325.
Just like ControlNet™ and EtherNet/IP™, DeviceNet™ is part of the family of CIP™-based networks. CIP™ (Common Industrial Protocol) forms the common application layer of these three industrial networks. DeviceNet™ is an object-oriented bus system which works according to the producer/consumer procedure. DeviceNet™-devices can be client (master) or server (slave) or both. Clients and server can be producer, consumer or both.

Based on DeviceNet™ the field bus EtherNet/IP™ was developed, which integrates the devices networked via EtherNet/IP™ seamlessly – automatically via mapping in the I/O tree of the RSLogix programming tools. As an option, the configuration software tool (RSNetWorx), known from DeviceNet™, can be used for the integration of further field devices into the network.

13.1 Hardware/Software

The descriptions in this manual refer to the application of the following hardware- and software components:

13.1.1 Hardware

- Allen-Bradley control, type 1769-L24ER-QB1B CompactLogix
- DeviceNet™ Scanner, type 1769-SDN/B

Allen-Bradley-Steuerung

DeviceNet™ Scanner

Fig. 13.1: Hardware

13.1.2 Software

- Rockwell Software RSLogix 5000 (for the control programming and configuration of EtherNet/IP™)
- Rockwell Software RSNetWorx (for the network configuration)
- Rockwell Software RSLinx

Detailed information regarding the used hardware can be found on the manufacturer’s homepage:

http://www.rockwellautomation.com/literature/

13.2 Data model

For the communication of the PowerMeasuringModule PMM with the field bus, a specific internal field bus module is used. The PowerMeasuringModule PMM is controlled by a command-byte, which encodes four commands. The PowerMeasuringModule PMM data are stored in an “Array of Byte”, which contains 66 elements. In the table of variables only entries up to byte 56 can be found. The remaining bytes contain information which is used for the calibration of the device.

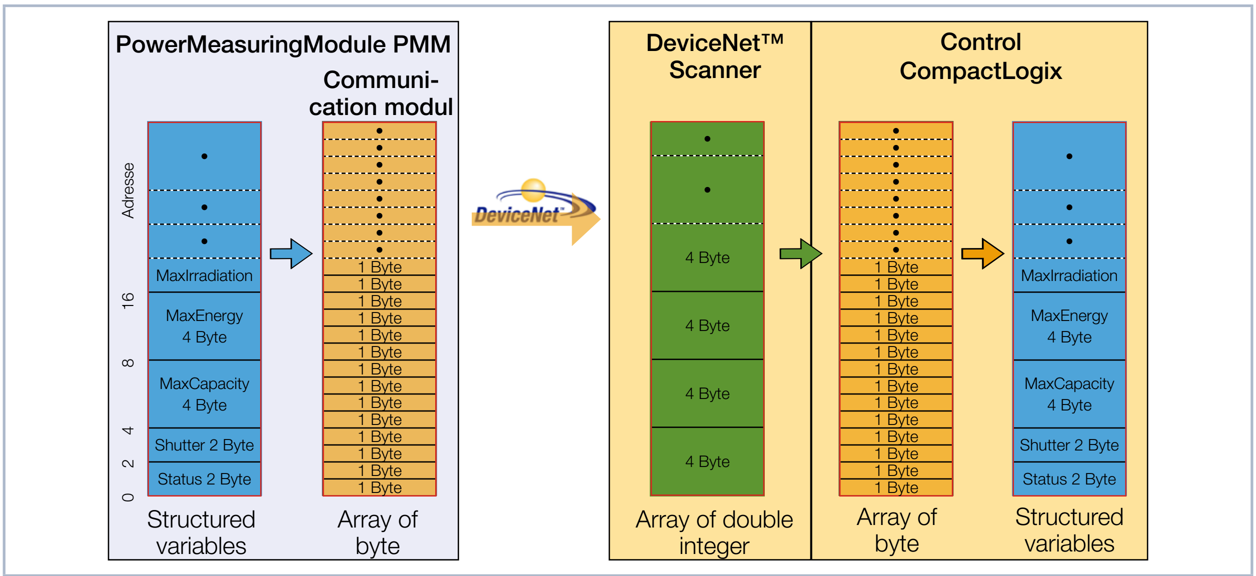


Fig. 13.2: Data structure between PowerMeasuringModule PMM and control

The PowerMeasuringModule PMM stores the data in the format 2 byte Integer and 4 byte Integer. With EtherNet/IP™ and DeviceNet™, the data is arranged in the “Little-Endian” format.
The field bus module used in the PowerMeasuringModule PMM generally only supports the “Array of bytes” and no tags, as defined by the CIP™ (Common Industrial Protocol). The variables of the PowerMeasuringModule PMM can therefore not be read directly from the bus.

13.3 PowerMeasuringModule PMM with DeviceNet™

With DeviceNet™, the data is transferred to the control via a scanner module. As an example, the data transfer of a CompactLogix 1769 by Allen Bradley is displayed here.
The measuring data of the PowerMeasuringModule PMM is written into the integrated communication module in the form of 2 byte Integer and 4 byte Integer. The communication module transfers this data as “Array of Byte” to the bus. Other data types are not supported.
The scanning module 1769-SDN stores the data as “Array of DINT” (4 byte Integer) in the area “local” of the control. The control does not contain direct commands which can carry out a type conversion. Therefore, the data is copied to the target variable in a two-step procedure.

1. Step:
   The data range of the type “Array of DINT” is copied to a variable range “Array of Byte” (see Fig. 13.3 on page 46, copy command A). By means of this copying process, data cannot only be copied with the start addresses modulo 4 (i.e. 0, 4, 8, 12, 16, 20, ...) but every start address is possible.

2. Step:
   The data is copied to the user-defined data types (see Fig. 13.3 on page 46, copy command B). The data is then available within the control.

The copying process is done with an add-on instruction (AOI) of the control software:

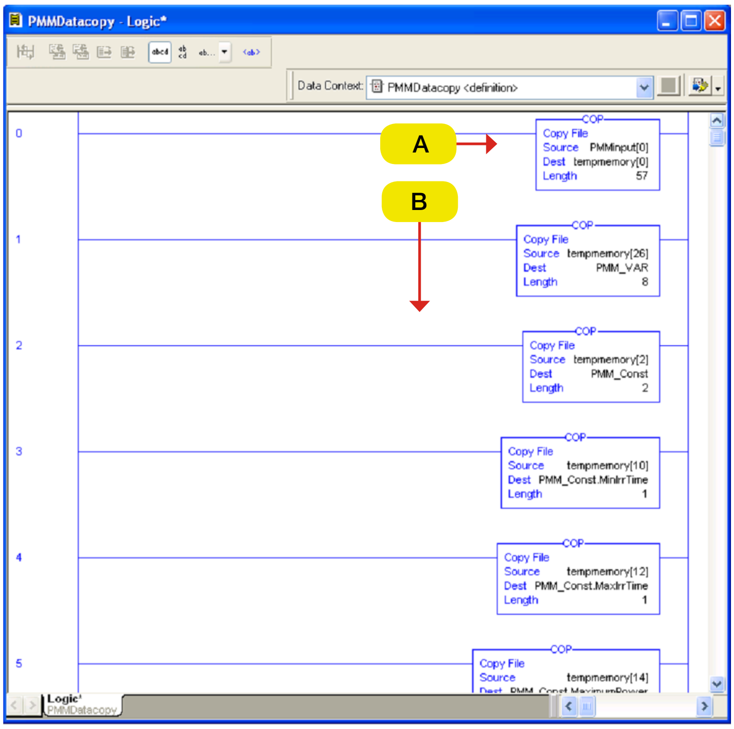


Fig. 13.3: Copy command in the contact plan logic routine

The entire copy instructions can be found in chapter „21 Appendix“ on page 77. The call up is displayed in Fig. 13.4 on page 46.

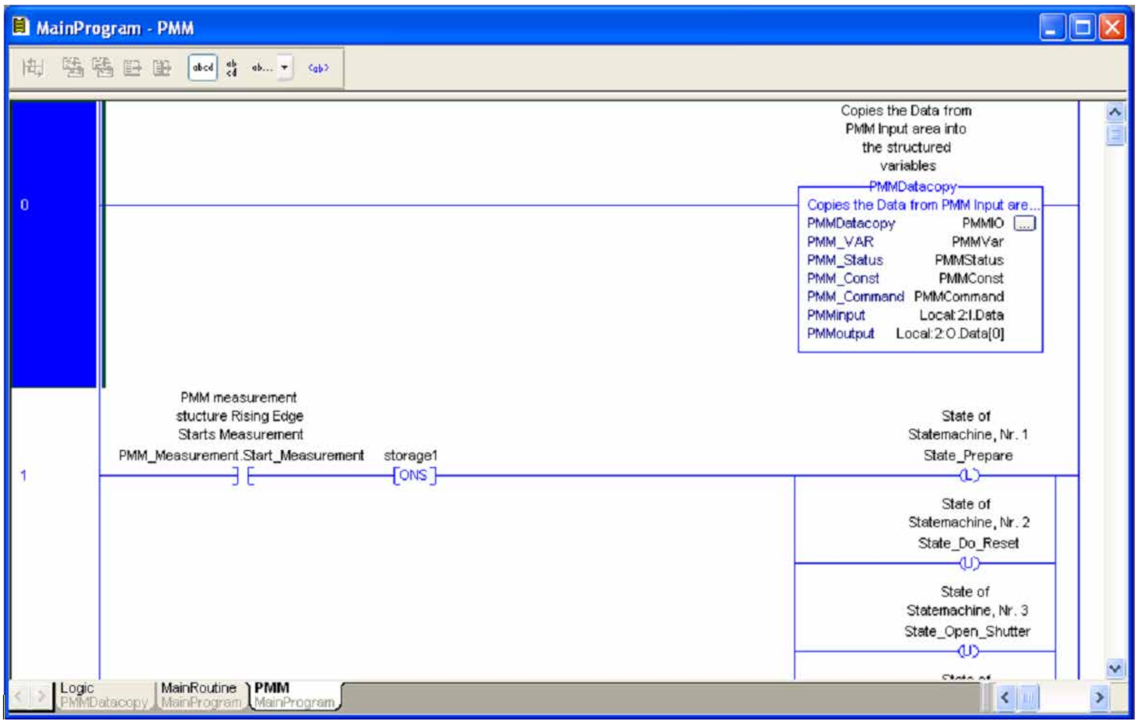


Fig. 13.4: Call up of the add on instruction “PMMDataCopy”

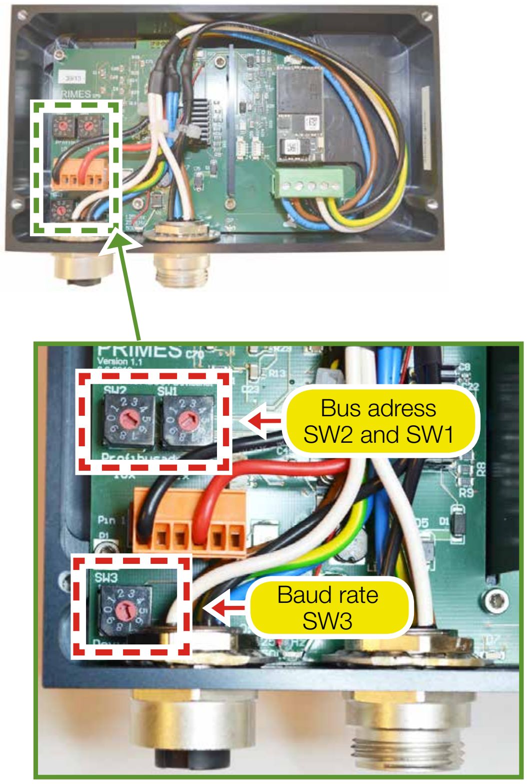
13.3.1 Setting the DeviceNet™ address and the baud rate

1. Remove the base plate of the device (four hexagon socket screws a. f. 2.5 mm).
2. Set the desired bus address by means of the rotary switches SW2 and SW1. The arrow head of the rotary switch has to point to the respective figure.

Please note that the address consists of two digits. Switch SW2 sets the first digit whereas switch SW1 sets the second digit.

Example
The bus address is supposed to be 14.

Setting switch SW2=1
Setting switch SW1=4

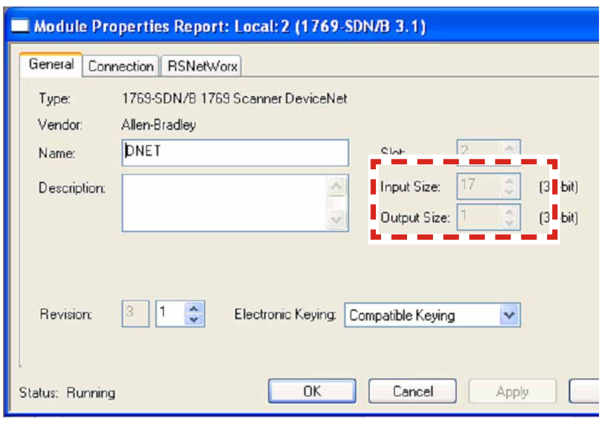


3. Set the desired baud rate by means of the rotary switch SW3 (factory settings 2 ≙ 500 kHz).
4. Mount the base plate of the device again.

Switch position SW3	Baud rate in kHz
0	125
1	250
2	500

13.3.2 Integrating DeviceNet™ scanner into DeviceNet™

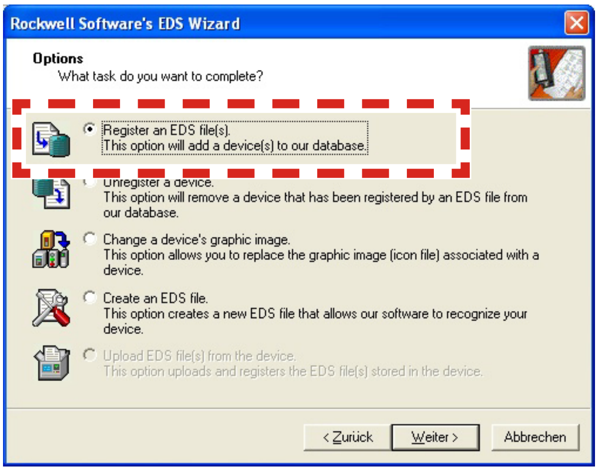
1. Click “I/O Configuration” in the directory tree of the hardware window and choose ***New Module…*** by clicking the right button.
2. Choose your scanner from the type list (here “1769-SDN/B Scanner DeviceNet™) and confirm by clicking ***OK***.
3. Enter 17 double words as an input parameter (equals 68 byte, 65 byte are required).



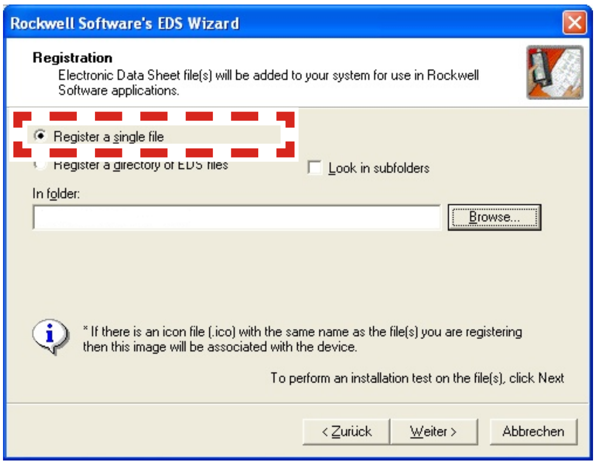
13.3.3 Importing EDS file

1. Insert the PRIMES CD into the drive of your computer.
2. Start the program RSNetWorx.

1. Start the EDS-Wizard:
2. Choose the menu ***Tools --> EDS Wizard***.
3. Choose the option ***Register an EDS File***.
4. Click ***Next***.

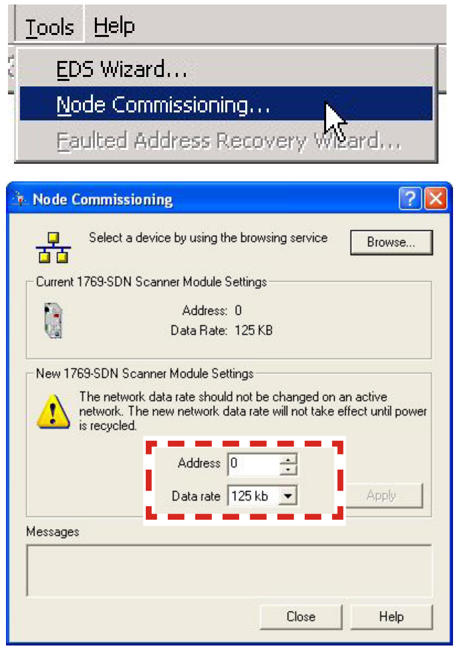


5. Choose the option ***Register a single file***.
6. Choose the EDS file "PMM_DNS.EDS" on the PRIMES-CD via ***Browse…*** and click ***Next***.
7. Confirm all upcoming dialogue windows by clicking ***Next*** or ***Complete***.



13.3.4 Bus configuration with RSNetWorx

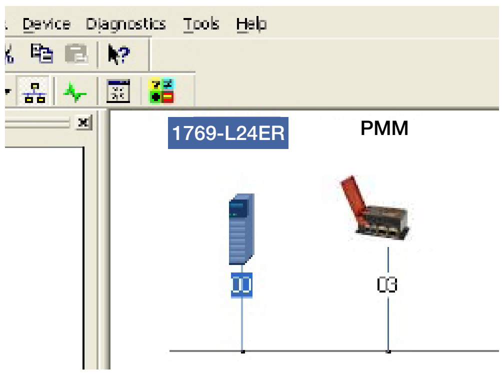
1. Start the program RSNetWorx.
2. Set the bus address and the baud rate in ***Tools --> Node Commissioning***.



3. Open the network (menu ***Network --> Online***).

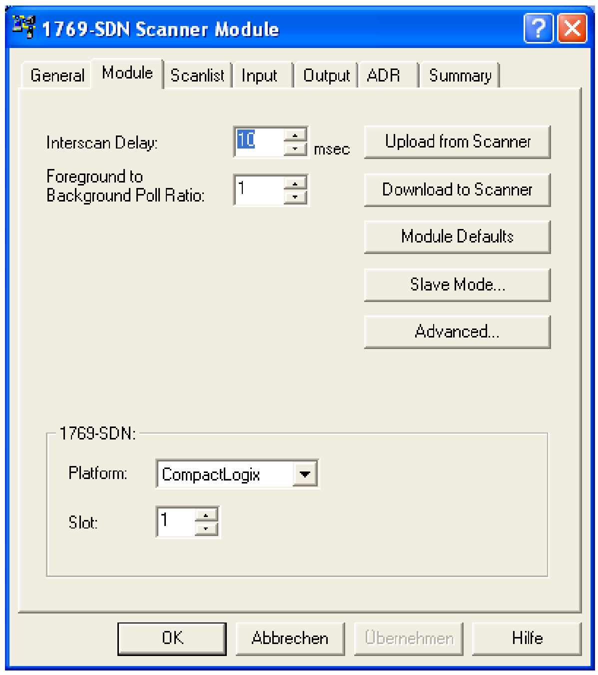
👁 The search process on the bus starts automatically. The found bus components are displayed.

4. Double-click the scanner symbol.



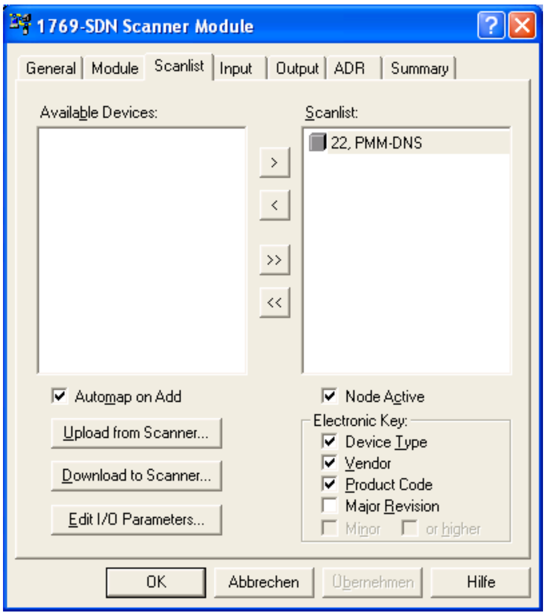
👁 The characteristics dialogue of the DeviceNet™ scanner appears.

5. Switch to the tab ***Scanlist***.

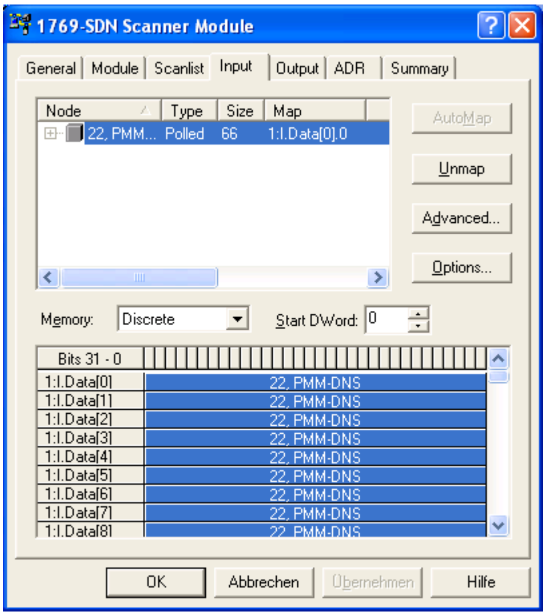


👁 The list of the nodes configured at the scanner appears.

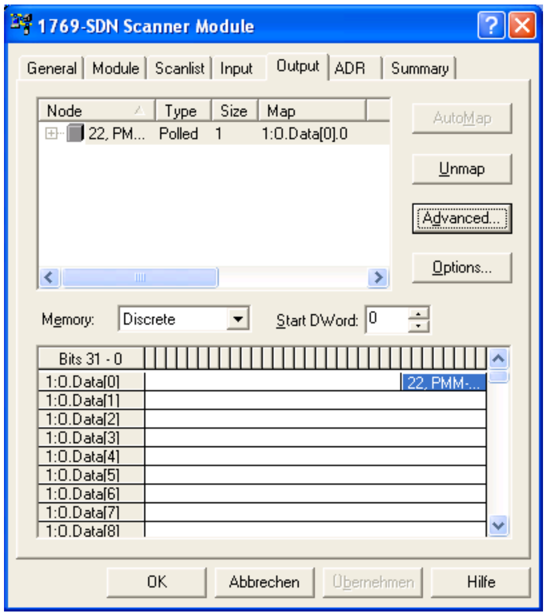
6. Move the PMM to the scan list on the right, using the button [>].



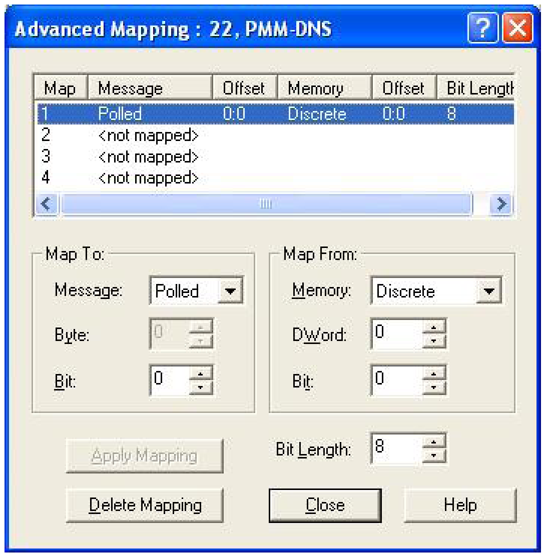
👁 The process data are mapped automatically by RSNetWorx. The addresses can be checked in the tabs input or output.



7. Click the button ***Advanced***.



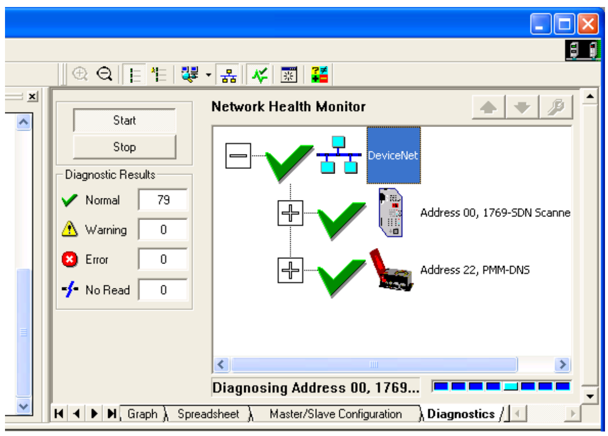
👁 It is essential that the command byte is mapped correctly (8 Bit).



8. Activate the devices via the menu ***Network ---> Online***.
9. Load the configuration via ***Download to Network*** into the scanner and the PMM.

10. Open the menu ***View --> Diagnostics***

👁 In this dialogue window the network condition is displayed. If all components are provided with a green tick, the field bus is ready for operation.



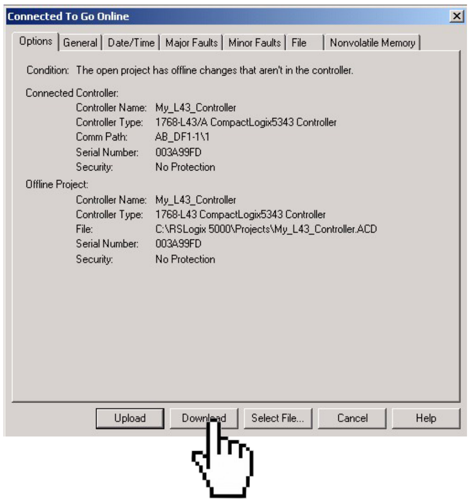
13.3.5 Debugging

After the configuration you can switch the system to the “Run Mode”. Therefore you first select “Go Online”. The software is then programmed into the system “via download” and then the “Run Mode” is set.

1. Select the control symbol and click ***Go Online***.

👁 The dialogue window ***Connect to Go Online*** is opened.

2. Click the button ***Download***.



3. Start the ***Run Mode***.

👁 The check boxes „Run Mode“, „Controller OK“ und „I/O OK“ have to be highlighted in green.

After the integration of the DeviceNet™ scanner and the PowerMeasuringModule PMM into the system, the data of the PowerMeasuringModule PMM are displayed in the data range of the scanner first (Fig. 13.5 on page 53):

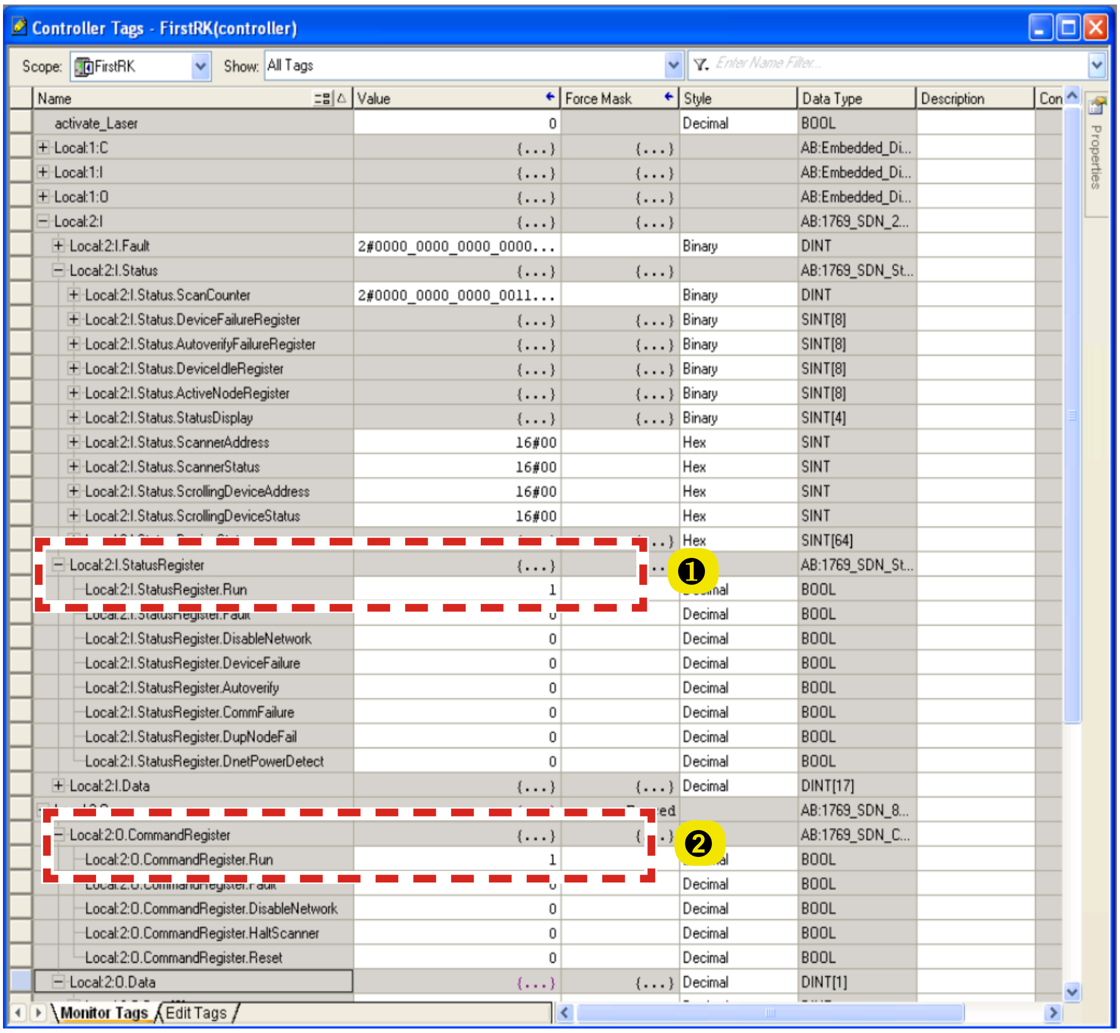
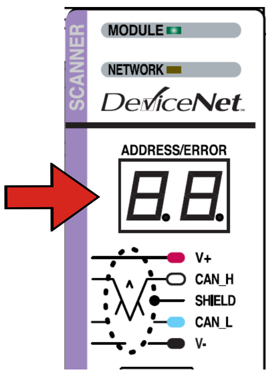


Fig. 13.5: Data range of the scanner

The entry „Local:2:O.CommandRegister.Run = 1“ (in Fig. 13.5 on page 53 --> ❷) sets the scanner into the RUN-Mode. Only then will data be transferred from the scanner to the PowerMeasuringModule PMM. The RUN-Mode of the scanner can be checked by means of the status register (in Fig. 13.5 on page 53 --> ❶„Local:2:I.StatusRegister.Run = 1“).

The two-digit segment display of the scanner bears the bus address of the scanner. If the bus address is 0, the display will depict “00”.
If run = 0, the bus address and the error code are displayed alternately. The error codes are listed in the manual of the scanner by Rockwell.



For a faultless functioning the display on the scanner must not show any error codes when in the RUN-Mode. During the communication with the PowerMeasuringModule PMM the values in the entry “Local:2:I.Data[7]" should change (absorber temperature). When opening and closing the shutter of the PowerMeasuringModule PMM manually, the bits in Local:2:I.Data[0] should change (see Fig. 13.6 on page 54).

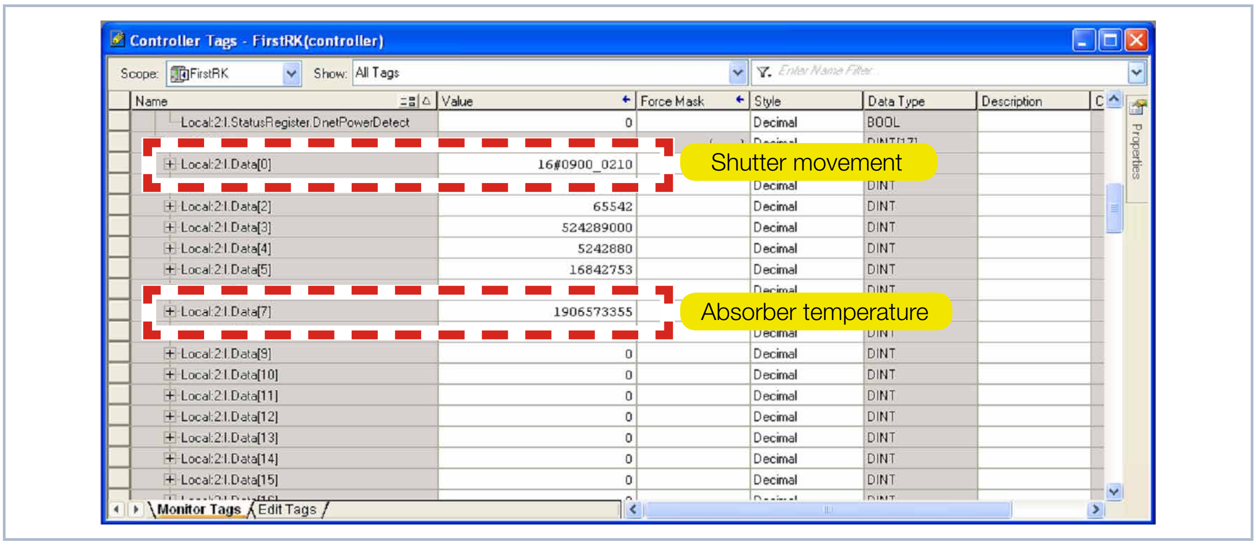


Fig. 13.6: Values for absorber temperature and shutter movement

As soon as the add-on command for copying of the data is carried out, the absorber temperature can be read out directly in the variable „PMMVar.AbsorberTemperature“ in a thousandth degree Celsius (Fig. 13.7 on page 54).

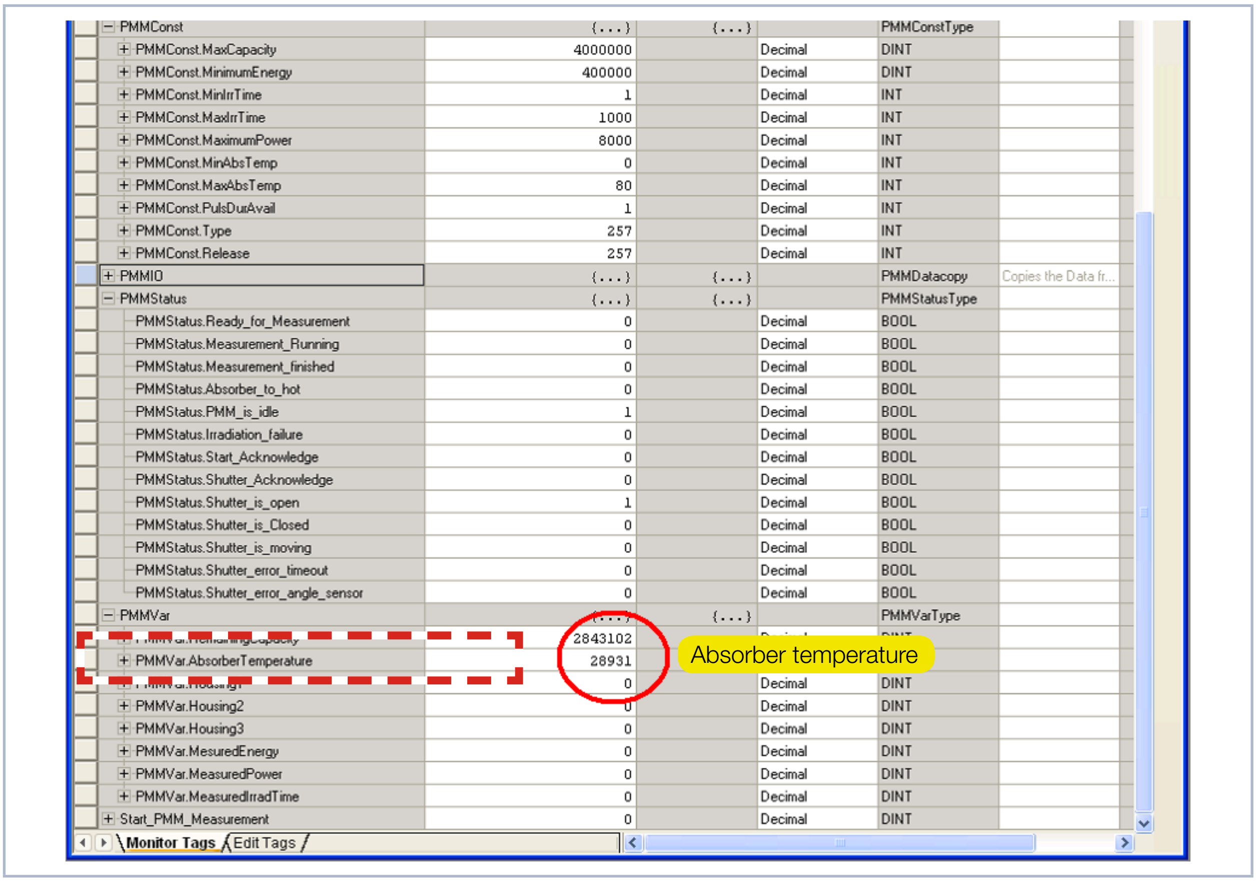


Fig. 13.7: Variable „absorber temperature“

13.4 PowerMeasuringModule PMM with EtherNet/IP™

The PowerMeasuringModule PMM is put into operation with EtherNet/IP™ according to the following scheme:

- Address assignment (automatically via DHCP or manually)
- Installation of the EDS-file
- Transfer of the data to the control unit

The EDS-file contains all identification- and communication parameters of the device. After the integration of the EDS-file (PRIMES-CD-Path: Tools/EDS Hardware Installation Tool) the PowerMeasuringModule PMM can be added as a new module.

13.4.1 Module configuration

Insert the PowerMeasuringModule PMM module by clicking the right button on ***Ethernet --> New Module*** . The name of the device can be chosen freely.

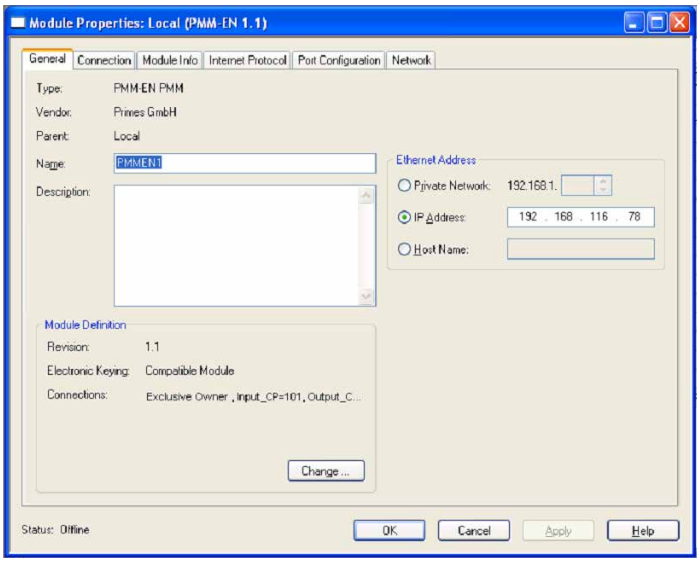


Fig. 13.8: Entering device name and IP-address

13.4.2 Setting the IP address

The IP address is set by means of two hexadecimal coding switches inside the device.

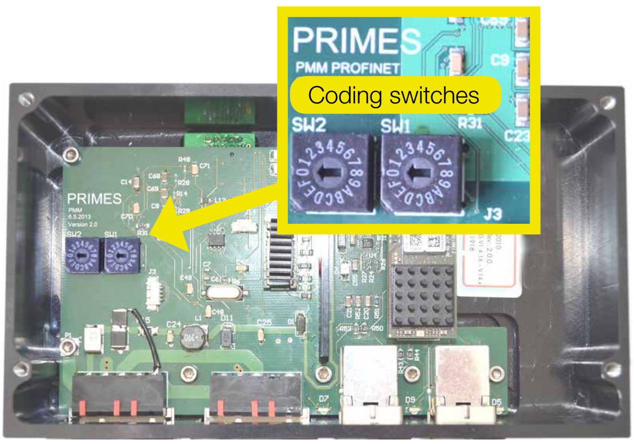


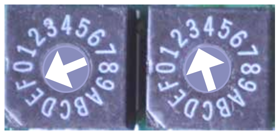
Fig. 13.9: Rotary switches for setting the IP address

If both rotary switches are set to 0, the address is assigned by DHCP. In case of addresses in the range of 1-254 (hexadecimal 0x01 to 0xFE), the address is set by means of the network segment 192.168.1.xxx. “xxx” stands for the preset number of the rotary switches.
If you set the rotary switch to 0xFF = 255, the programmed IP address is completely accepted.

Example:
The address 192.168.1.243 should be set.
243 (decimal) ≙ F3 (hexadecimal)

▶ Switch position: SW2=F; SW1=3

SW 2 SW 1

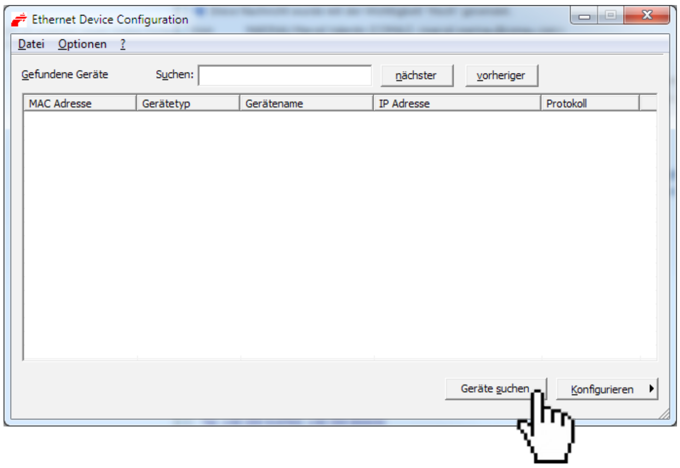


13.4.3 Setting the IP address via a web browser

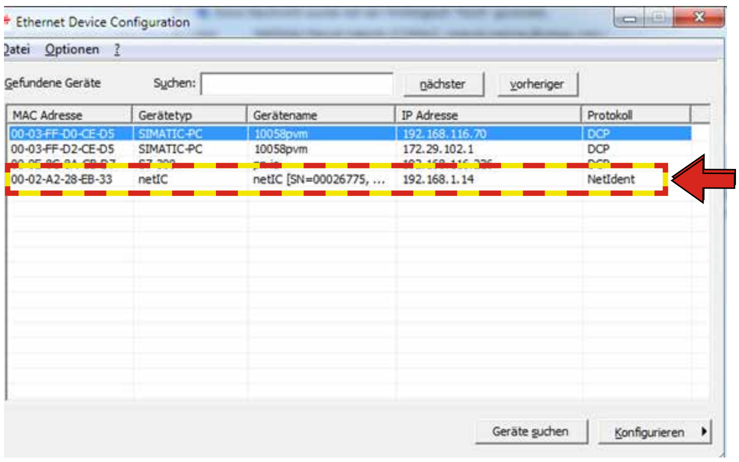
The first three bytes of the IP address can be set by means of your web browser via a web interface. The fourth (last) byte is set via the rotary switches and as described in chapter 13.4.2 on page 55.
In order to read out the current IP address of the PowerMeasuringModule PMM in the network, the program "EthernetDeviceConfiguration" is required. It can be found on the enclosed data medium.

The PowerMeasuringModule PMM has to be turned on.

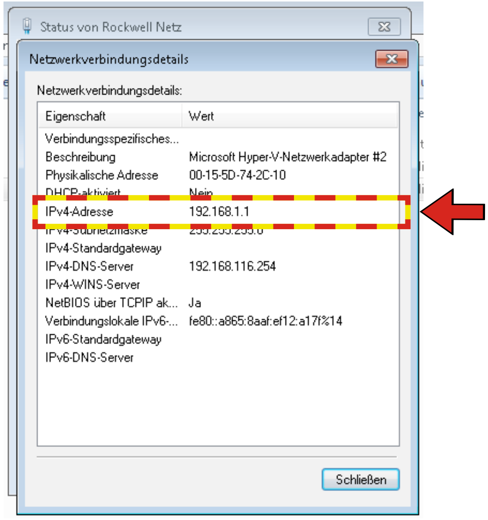
1. Start the program "EthernetDeviceConfiguration".
2. Click the ***Geräte suchen*** (Search Device) button.



The dialogue window is opened and the found devices are listed. The IP address of the PowerMeasuringModule PMM can be found in the line of the device type "***netIC***".



Please mind for the next steps, that the IP address of the network interface card of your PC has to be within the address range of the PMM.



3. Start your web browser.
4. Enter the IP address of the PMM in the address line.

If no connection can be established, this can have the following reason:

The communication software of the PMM is not up-to-date (version 1.5 is required).

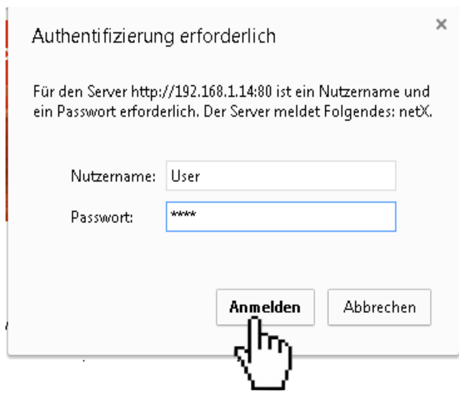
👁 The dialogue window of the web browser interface is opened.

5. Click ***Settings***.

👁 The registration window is opened.

Please mind the correct use of capital and small initial letters.

6. Enter the user name ***User***.
7. Enter the password ***User***.
8. Click the ***Anmelden = Register*** button.



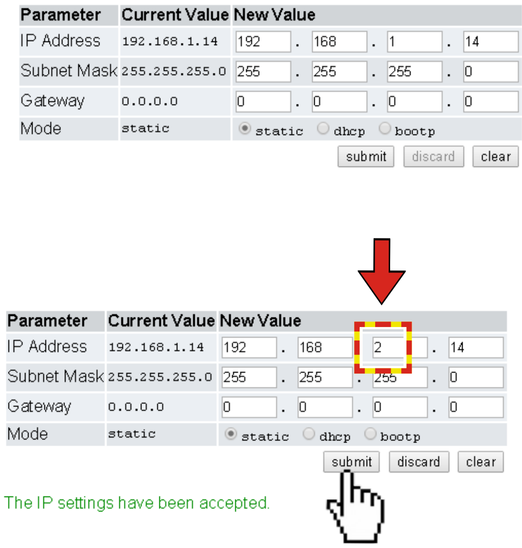
👁 The current IP address of the PMM is displayed.

9. Change the address according to your wishes.

Notice:
The ***Mode*** selection field must always be left ***static***!
Switching to ***dhcp*** or ***bootp*** leads to a loss of communication with the PowerMeasuringModule PMM.

10. Click the Submit button. The device address is transferred.
11. Please mind that the last byte of the IP address of the PMM is set by means of two rotary switches (see chapter 13.4.2 on page 55).

- The PMM is now reprogrammed.



12. Turn off the PMM and turn it on again so that the new address is taken over.
13. Reset the network interface card of your computer to the new address as well.
14. Check the communication with the PMM.

13.4.4 Module definition

With regard to the module definition the name “Exclusive Owner” is selected in the drop-down box (see Fig. 13.10 on page 58). The automatically entered data sizes of 66 for input and 1 for output are kept.

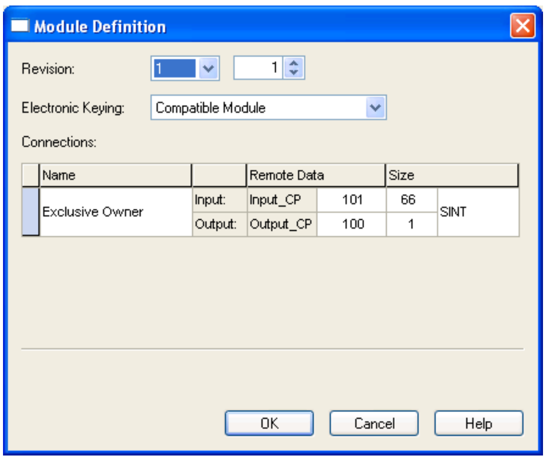


Fig. 13.10: Module Definition

After the confirmation of all entries, the module is created and appears in the list of Ethernet devices (see Fig. 13.11 on page 59).

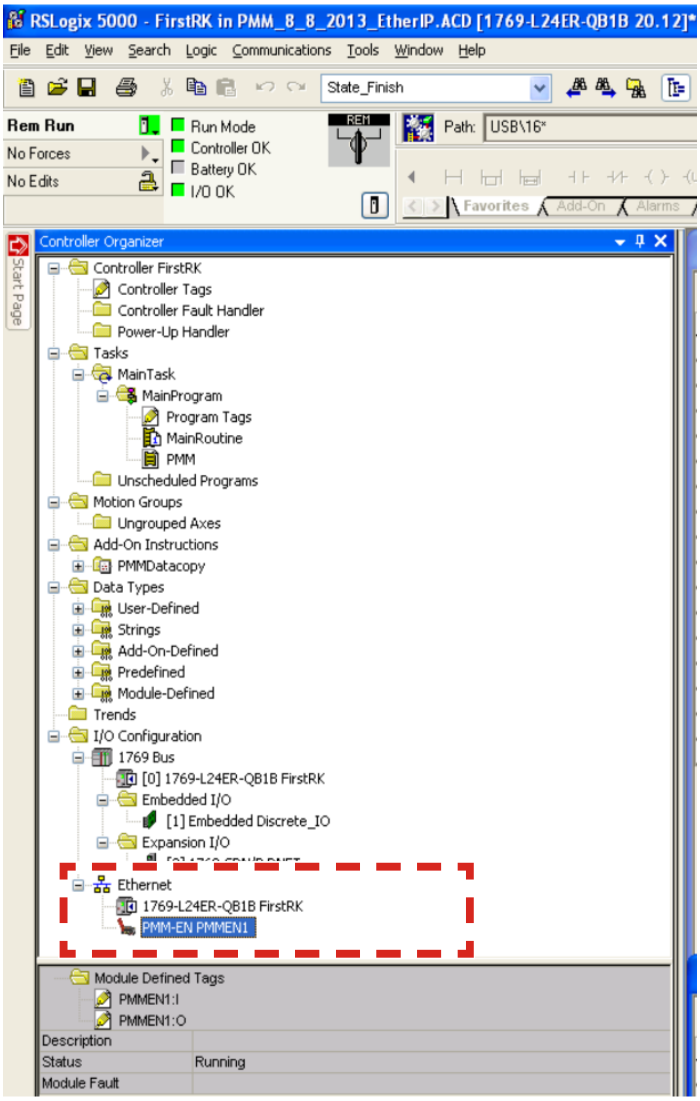


Fig. 13.11: Device list in the directory tree

As far as the controller tags are concerned, the PowerMeasuringModule PMM now has an entry in its I/O range. These data have the format Array of SINT, which means that a conversion of the data into the structural variables of the PowerMeasuringModule PMM has to be done (same procedure as for DeviceNet™). As soon as the control is in RUN Mode, the variables are constantly updated.

Fig. 13.12: RUN-Mode

The status of the shutter can be found in the variable: PMMEN1:I.Data[1] under “Value“ (see Fig. 13.13 on page 60). A “2” stands for a closed shutter. As soon as the shutter is opened manually, the value changes to “1”. This is a simple procedure in order to check the communication.

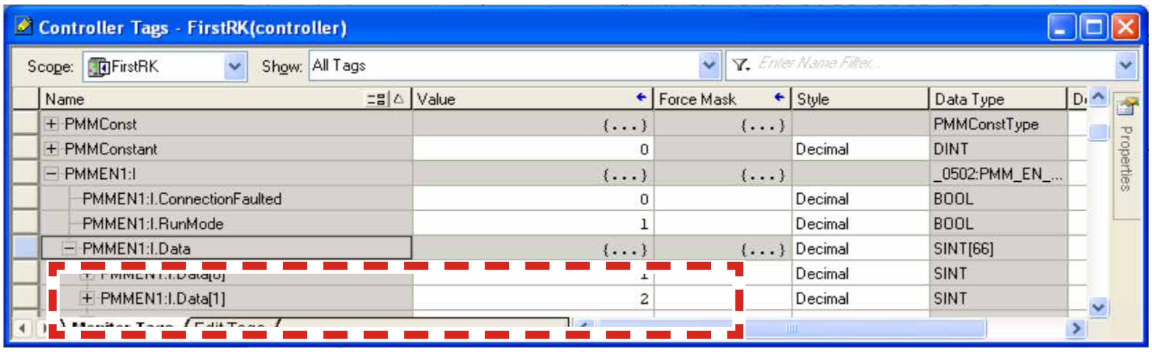


Fig. 13.13: Status of the shutter

As soon as the add-on instruction “PMMDataCopy” is included in the program, the PowerMeasuringModule PMM variables can be monitored directly (Fig. 13.14 on page 60).

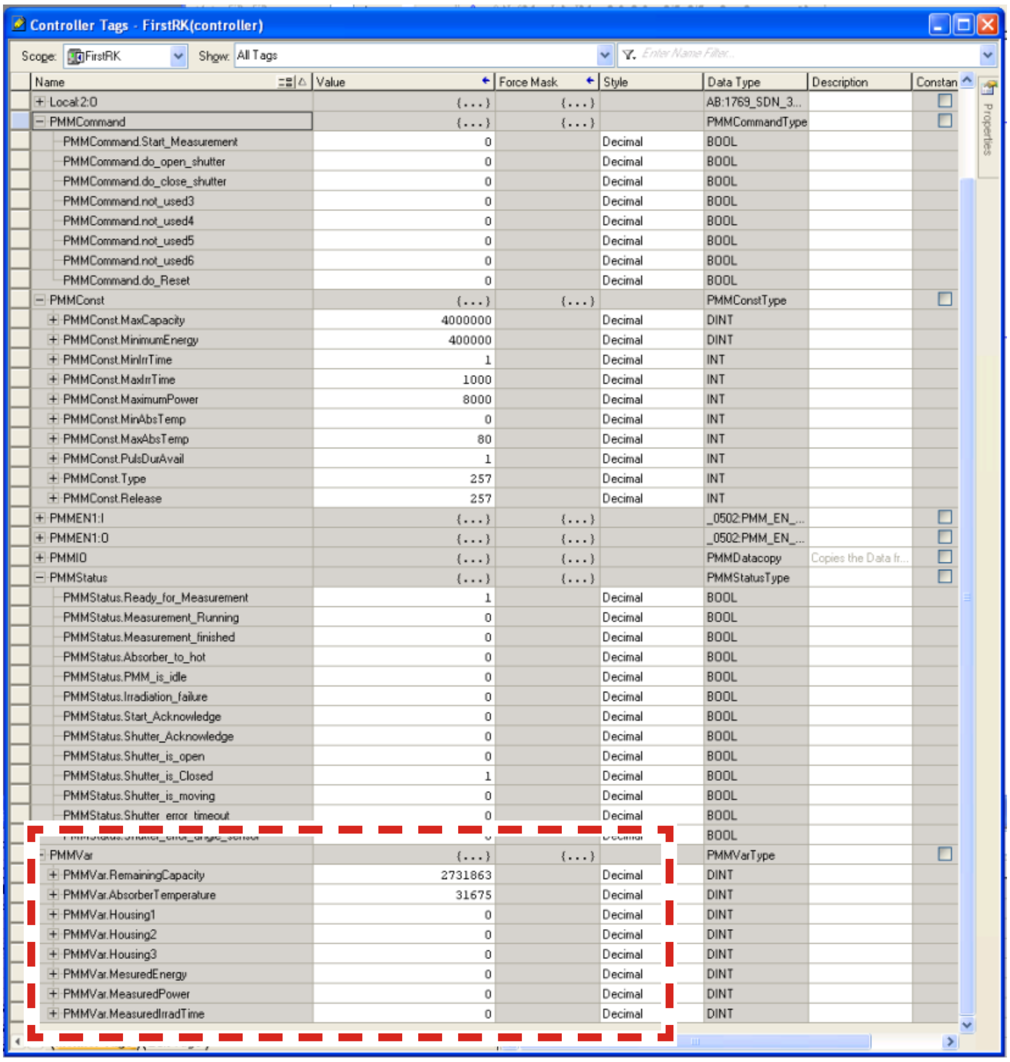


Fig. 13.14: PowerMeasuringModule PMM variables

14 Connection in the EtherCAT®

EtherCAT® stands for Ethernet for Control Automation Technology and is an Ethernet-based field bus. EtherCAT® is optimized for the recognized bus or line structures of field buses. Within this topology, the EtherCAT® slave participants are connected in a series. To make this possible, each EtherCAT® slave participant has an incoming and a continuing Ethernet connection.

The EtherCAT® network is configured in Windows® with the TwinCAT® automation software. The electronic data sheets of the connected EtherCAT® devices, the so-called ESI files (EtherCAT® Slave Information) are required for configuration. Each EtherCAT® device needs an individual ESI file made available by the respective device manufacturer.

TwinCAT® 3 contains all languages in accordance with IEC-61131-3. The program for the PMM is written in ST (Structured Text).

Requirements for connecting in EtherCAT®:

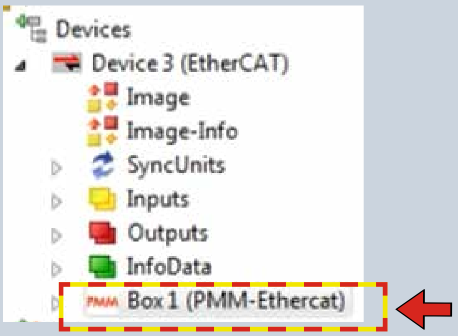
- The TwinCAT® software is installed on the PC (detailed installation instructions can be found on the manufacturer's (Beckhoff) website).
- The ESI file (the file ***PRIMES PMM ECS Vx.x.xml*** is located on the PRIMES USB stick) is copied in the TwinCAT directory (usually in the folder ***c:\TwinCAT\3.x\Config\Io\EtherCAT***).
- The PMM is connected via an Ethernet patch cable or CAT5e quality crossover cable.

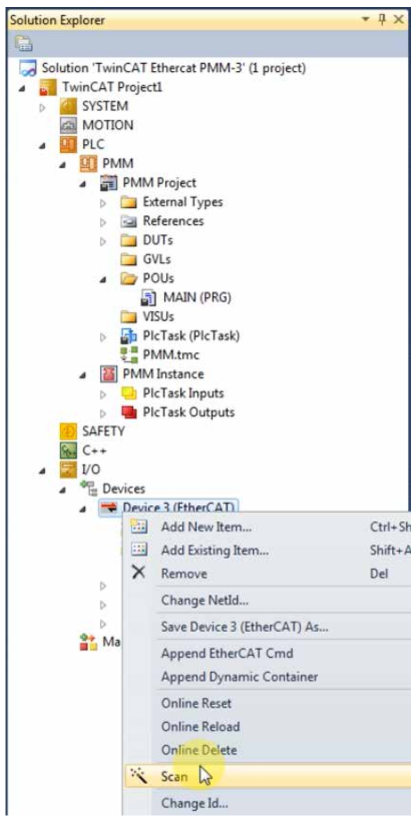
The following descriptions relate to the TwinCAT® Version 3.1. The TwinCAT® displays shown can be changed in keeping with the build version.

14.1 Connect the PMM into the device tree

1. Start the TwinCAT system manager.
2. Mark the project tree ***I/O --> Devices*** the device icon***Device (EtherCAT)*** and click on ***Scan*** in the context menu.

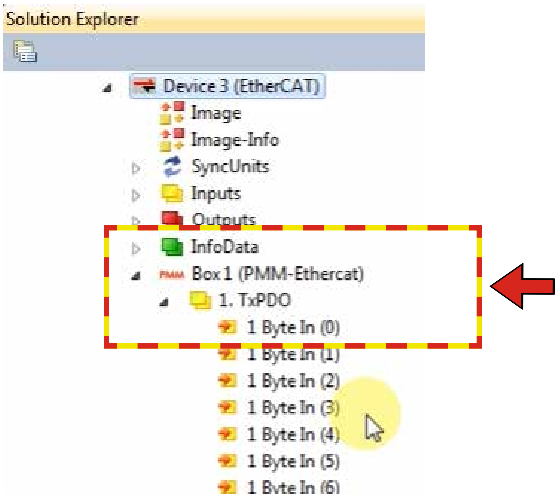
The PMM icon appears in the device tree.



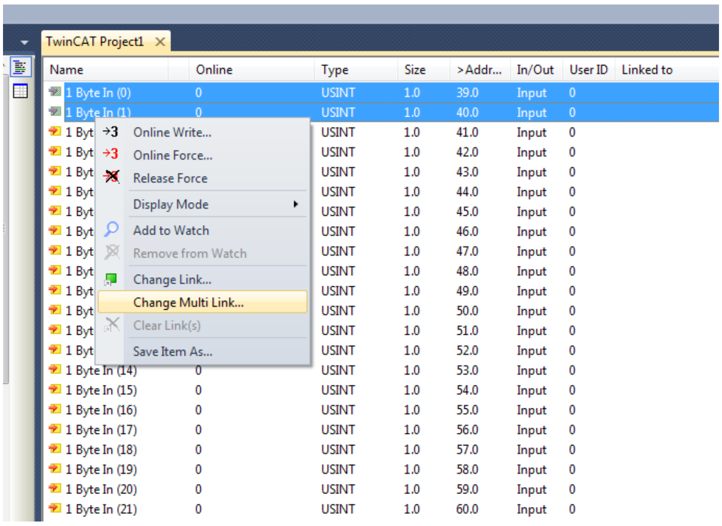


14.2 Process data mapping

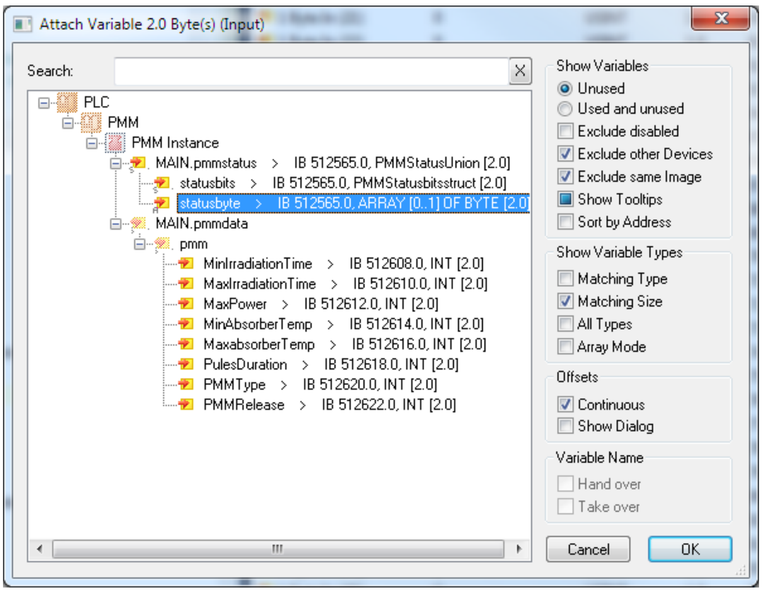
1. Open the ***PMM Ethercat box***.
2. Open the subdirectory for the input data ***TxPDO***.



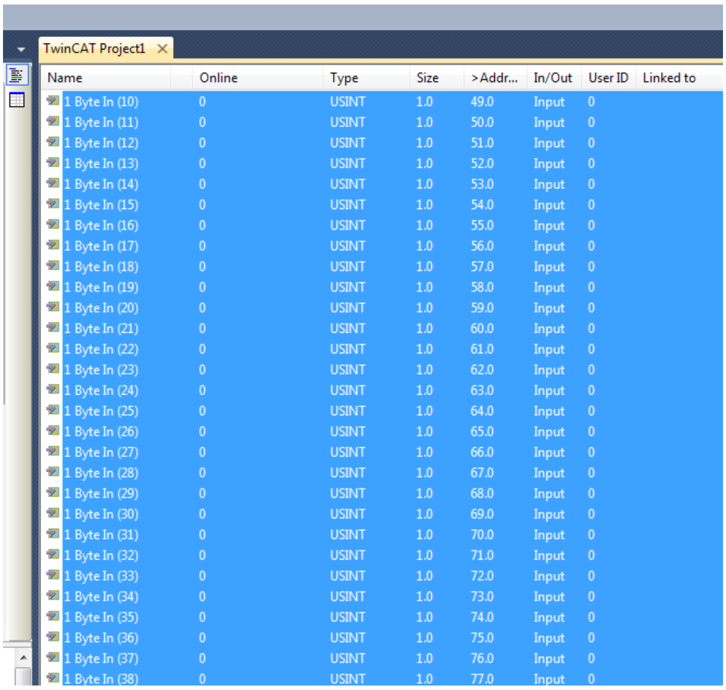
3. Mark the first two bytes (status bytes) in the project window and click on ***Change Multi Link...*** in the context menu.



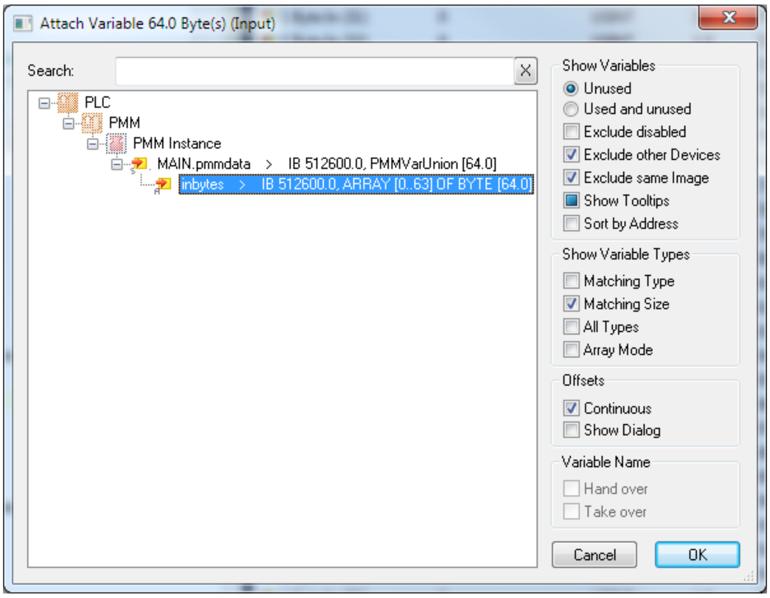
4. Mark the input ***Status byte*** and click on ***OK***.



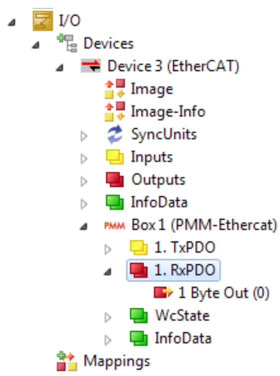
5. Mark all remaining bytes in the project window and click on ***Change Multi Link...*** In the context menu.



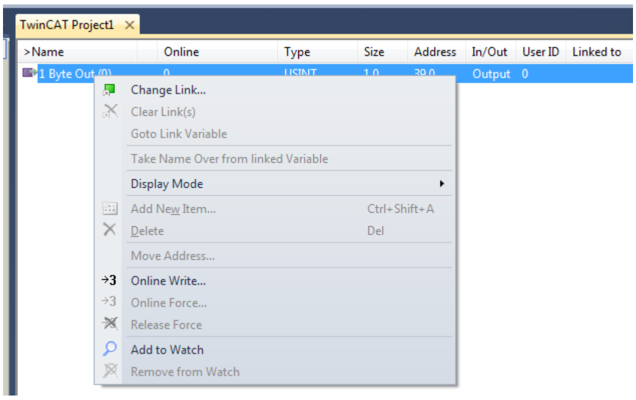
6. Mark the input ***In bytes*** and click on ***OK***.



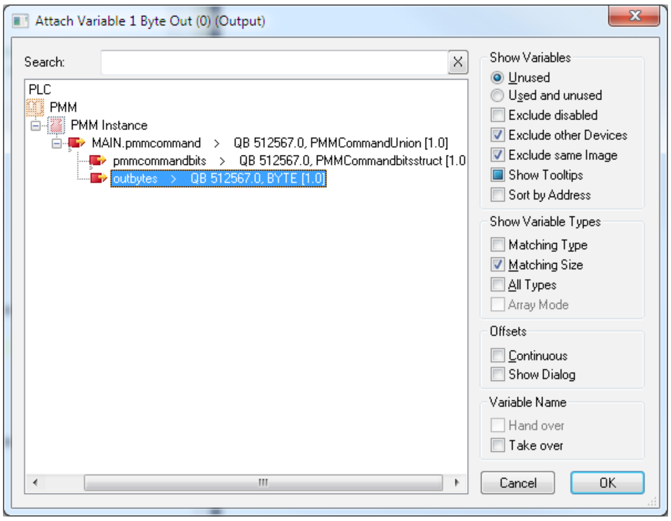
7. Open the subdirectory for the output data ***RxPDO***.



8. Mark the command byte in the project window and click on ***Change Link...*** in the context menu.



9. Mark the output ***Out bytes*** and click on ***OK***.



Once mapping has been completed, the variable groups and their current states can be displayed in the program window (main [online]).

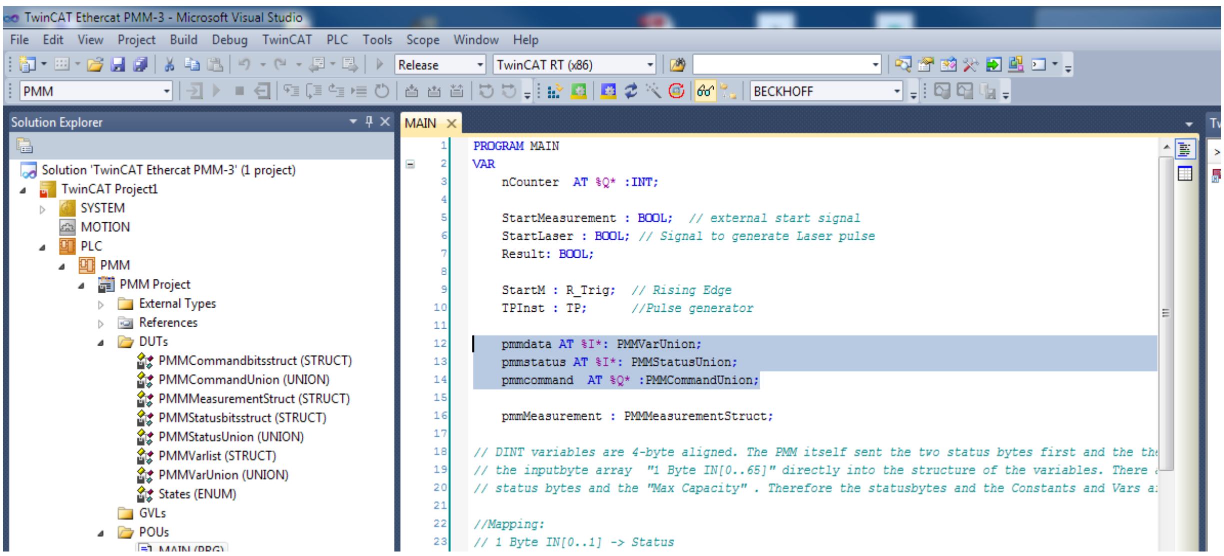


Fig. 14.1: Indication of the variable groups and their current states

Example: States of the status bits

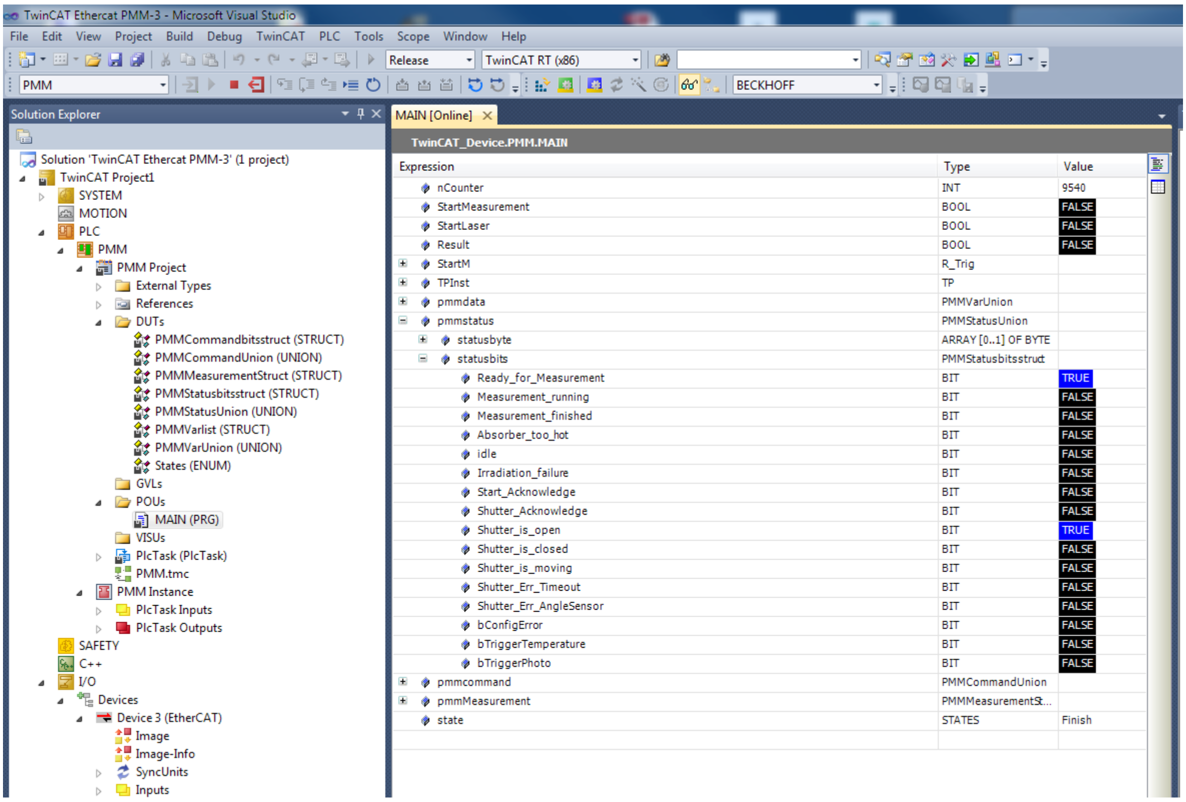


Fig. 14.2: States of the status bits

15 Maintenance and service

The operator is responsible for determining the maintenance intervals for the measuring device.
PRIMES recommends a maintenance interval of 12 months for inspection and validation or calibration.
If the device is used only sporadically, the maintenance interval can also be extended up to 24 months.

15.1 Protective window replacement

The protective window in the beam entrance is a wearing part and can be replaced if necessary. Low levels of contamination of the protective window can be carefully removed when cooled with Isopropanol (observe the manufacturer‘s safety instructions). In case of heavy, non-removable contamination or damage, the protective window must be replaced with a new one.

The protective window is coated with an antireflection coating and has low reflection values of less than 1 %. To avoid increased reflection values, use only original PRIMES protective windows.

Protective glass diameter	55 mm
Glass thickness	1.5 mm
Order number	410-070-021 (1 piece); 410-070-031 (10 pieces)

15.1.1 Safety instructions

CAUTION

Burns due to hot surface

After a measurement the absorber below the protective glass is hot. Unintentional contact during the protective glass exchange could lead to burns.

- **Do not exchange the protective glass directly after a measurement.**
- **Let the device cool down for an adequate period of time. The cooling period can vary depending on the laser power and the exposure time.**

NOTICE

Damage/Destruction of the protectice window due to burn-in

Contamination and fingerprints on the protective window can lead to damage or shattering or splintering of the protective window during measuring operation.

- **Only replace the protective window in a dust-free environment.**
- **Do not touch the protective window.**
- **When exchanging the protective window wear powder-free latex gloves.**

15.1.2 Dismounting/Mounting

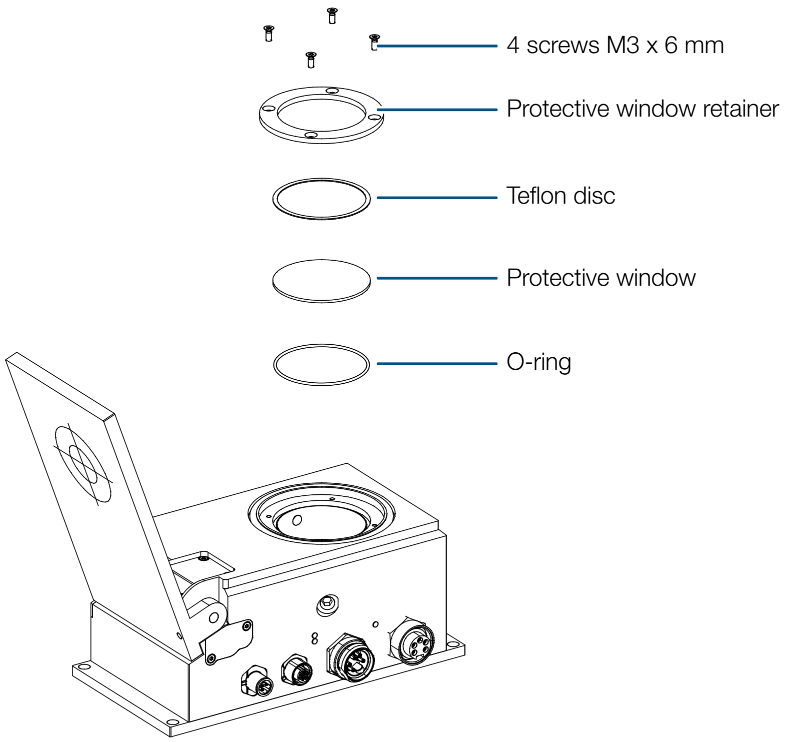


Fig. 15.1: Exploded view protective window mounting

1. Observe the safety instructions in „15.1.1 Safety instructions“ on page 66.
2. Remove the four screws at the protective window retainer (Torx TX 10; hexagon AF 2.0 for older versions).
3. Remove the protective window retainer.
4. Push down the protective window using a blunt object. Only touch its edge and take it out carefully (see Fig. 15.2 on page 67). In case the o-ring clings to the protective window, remove it and reinsert it into the aperture.
5. Carefully insert the new protective window.
6. Place the teflon disc on the protective window.
7. Place the protective window retainer on the protective window and fasten the screws.

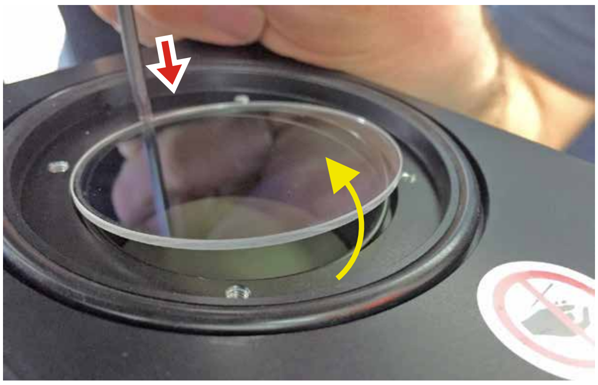


Fig. 15.2: How to lift the protective window

15.2 Exchangeable cassette (Option)

As an option, the PowerMeasuringModule PMM can be supplied with an exchangeable cassette. As far as this version is concerned, the protective glass is framed in a cassette, which can be exchanged easily and without any tools.

15.2.1 Taking out the exchangeable cassette

1. Observe the safety instructions in „15.1.1 Safety instructions“ on page 66.
2. Please turn off the laser and let the device cool down.
3. Please ensure that moving parts, e.g. robot arms are at a standstill and that they cannot be set in motion unintentionally.
4. Open the shutter.
5. Push the button of the cassette locking (the exchangeable cassette is automatically lifted by an ejector).
6. The exchangeable cassette can now be pulled out to the side of the housing.

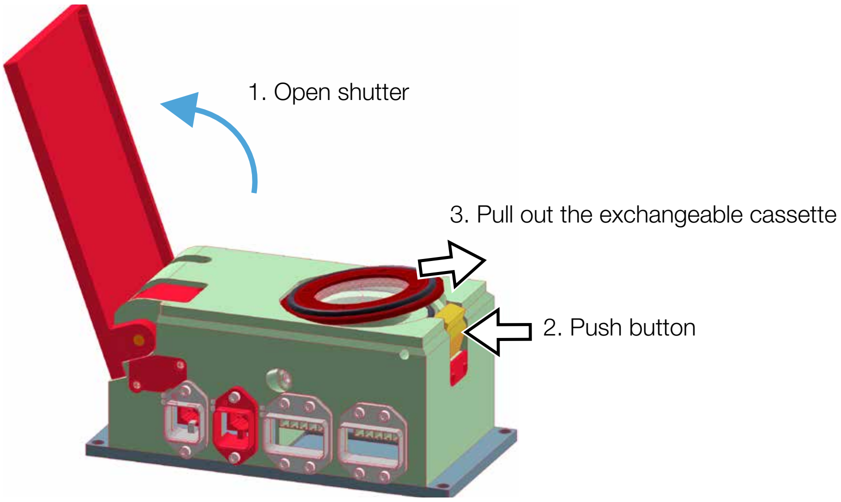


Fig. 15.3: Removing an exchangeable cassette

15.2.2 Inserting of an exchangeable cassette

1. Fit the new exchangeable cassette in the milling groove (with the gasket pointing upwards), see Fig. 15.4 on page 69.
2. Keep the button of the locking pressed while pushing the exchangeable cassette into the housing. As soon as you release the button, the exchangeable cassette is locked.

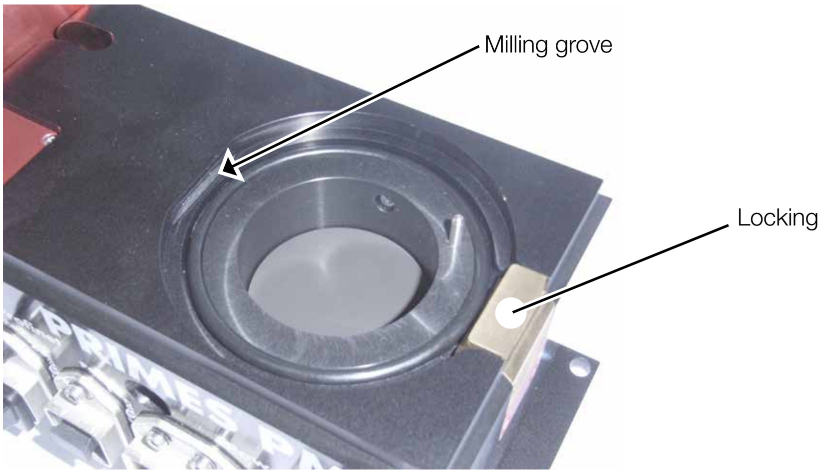


Fig. 15.4: Depiction of the exchangeable cassette

15.2.3 Exchanging the protective glass of the exchangeable cassette

The exchangeable cassette can be dismounted in order to the protective glass or to exchange it completely. The protective glass is held in the exchangeable cassette magnetically by means of a retaining ring. This retaining ring can be pushed out of the exchangeable cassette through a drilled hole in the housing. When reassembling, please ensure that the Teflon disc of the retaining ring points towards the protective glass.

In case of older devices, the retaining ring and the exchangeable cassette are screwed together.

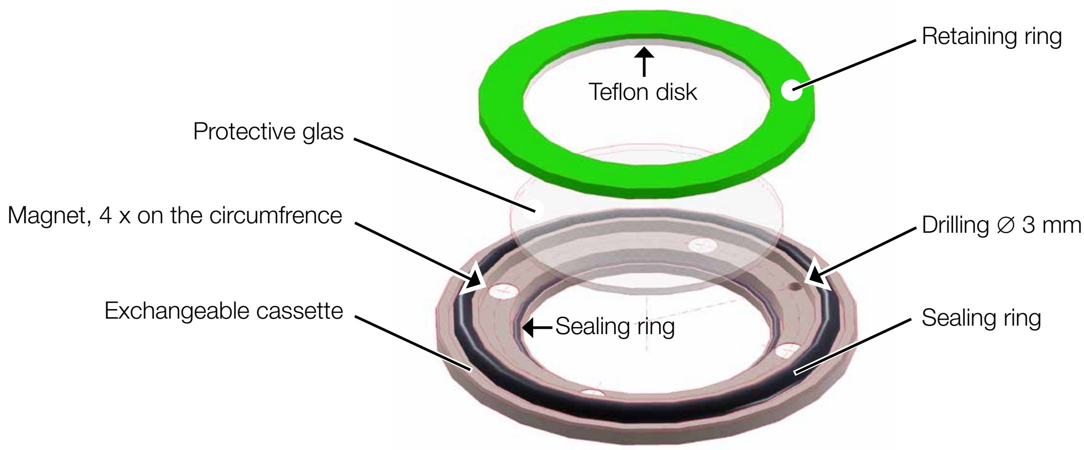


Fig. 15.5: Exploded view of an exchangeable cassette

16 Measures for the product disposal

According to the Electrical and Electronic Equipment Act (ElectroG) PRIMES is obliged to dispose PRIMES measuring devices manufactured after August 2005 free of charge. PRIMES is registered as a manufacturer with the EAR foundation (German register for electronic waste).
Registry number: WEEE-Reg. – Nr. DE65549202.

You are welcome to return PRIMES measuring devices that are to be disposed free of charge to our address (this service does not include shipping costs):

PRIMES GmbH
Max-Planck-Str. 2
64319 Pfungstadt
Germany

17 Technical data

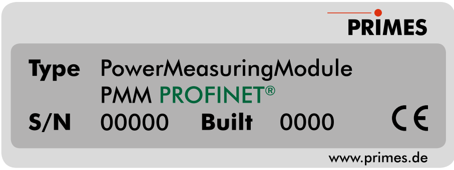
Measurement parameters		Standard absorber [1]	Advanced absorber [1]
Power range		400 – 6 000 W [2]	400 – 12 000 W [2]
Wavelength range		900 – 1 090 nm	
Max. beam diameter		30 mm	
Max. power density (peak) on the absorber (approx. 25 mm underneath the protective window) at beam diameters	> 10 mm	1.5 kW/cm²	4 kW/cm²
	10 – 3 mm	2.5 kW/cm²	5 kW/cm²
	3 – 1.5 mm	5 kW/cm²	10 kW/cm²
	< 1.5 mm	6 kW/cm²	12 kW/cm²
Irradiation time		0.1 – 1.0 s [2] (depending on laser power)	
Min. on/off times (duty cycle) for pulsed lasers		50 µs (e.g. max. 10 kHz at 50 % duty cycle)	
Max. laser rise time		100 µs	
Energy per measurement		50 – 3 000 J	
Recommended energy per measurement		300 – 500 J	
Total duration until measurement value output		< 15 s	
Total duration until measured value output for devices with reduced thermalization time (type A3s)		< 5 s	
Nominal measurement frequency		400 Joule: 1 cycle/min 3 200 Joule: 1 cycle/10 min	

[1] Please read the information on the identification plate to determine if your device is equipped with a standard or advanced absorber.

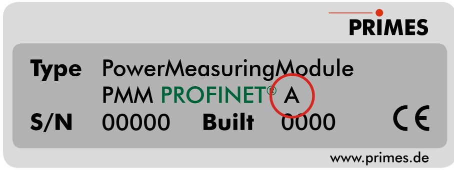
[2] The stated limit values are to be understood in correlation with the permitted maximum energy (E = P · t).

Device parameters	Standard absorber [1]	Advanced absorber [1]
Max. absorber temperature	120 °C	
Max. angle of incidence perpendicular to inlet aperture	± 5 °	
Max. centered tolerance	± 2.0 mm	
Measuring accuracy at angles of incidence up to 5 °	± 3 %	
Reproducibility	± 1 %	

[1)] Please read the information on the identification plate to determine if your device is equipped with a standard or an advanced absorber.
The identification plate shows as an example the PowerMeasuringModule PMM PROFINET®.

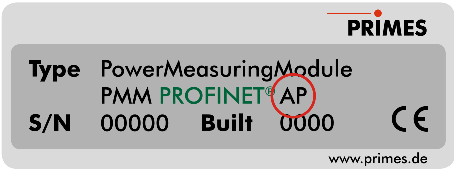


When a PMM PROFINET marking is made, a standard absorber is built into the device.



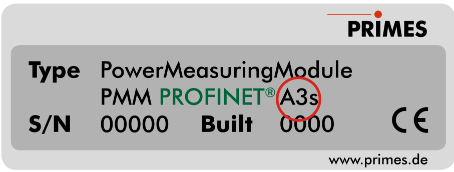
When a PMM PROFINET A marking is made, an advanced absorber is built into the device.

The configuration of your device with the possibility to measure pulsed lasers can be found on the identification plate.
The identification plate shows as an example the PowerMeasuringModule PMM PROFINET®.



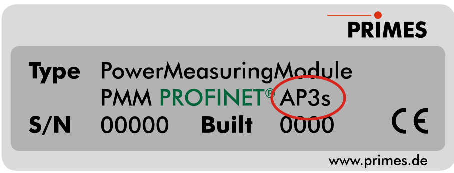
With the P marking, pulsed lasers can also be measured.
The device is equipped with an advanced absorber.

The configuration of your device with a reduced thermalization time can be found on the identification plate.
The identification plate shows as an example the PowerMeasuringModule PMM PROFINET®.



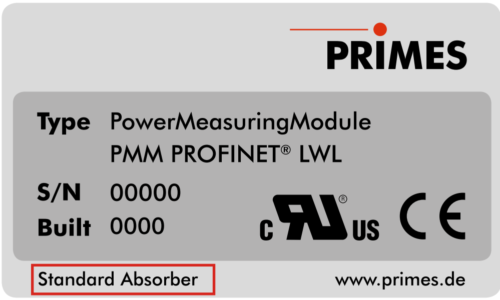
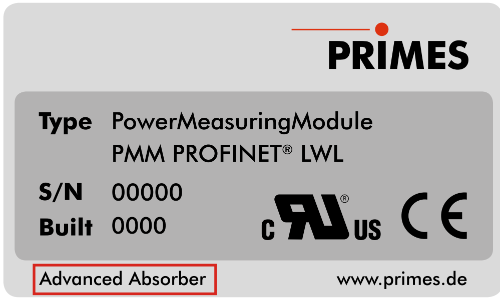
With the 3s marking, the device is designed for a reduced thermalization time.
The device is equipped with an advanced absorber.

The configuration of your device with the possibility to measure pulsed lasers and a reduced thermalization time can be found on the identification plate.
The identification plate shows as an example the PowerMeasuringModule PMM PROFINET®.



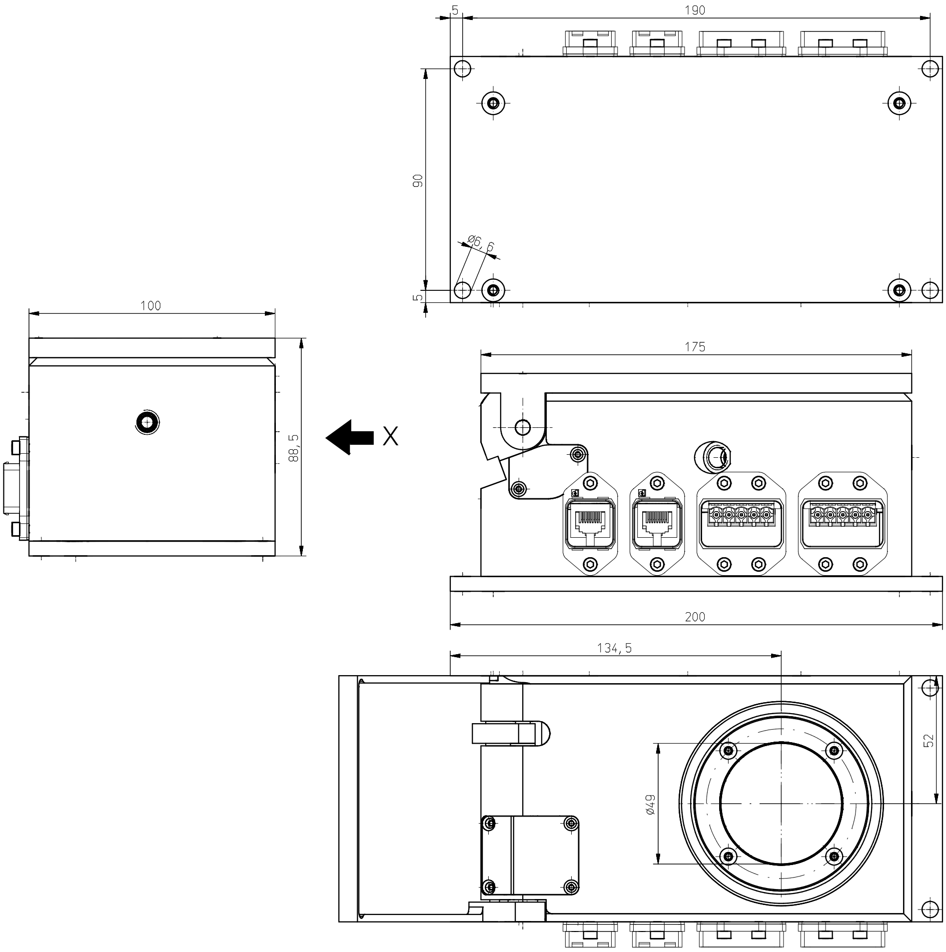
With the AP3s marking, pulsed lasers can also be measured and the device is designed for a reduced thermalization time. The device is equipped with an advanced absorber.

[1)] Please read the information on the identification plate to determine if your PMM PROFINET® LWL with UL marking is eqipped with a standard or advanced absorber.

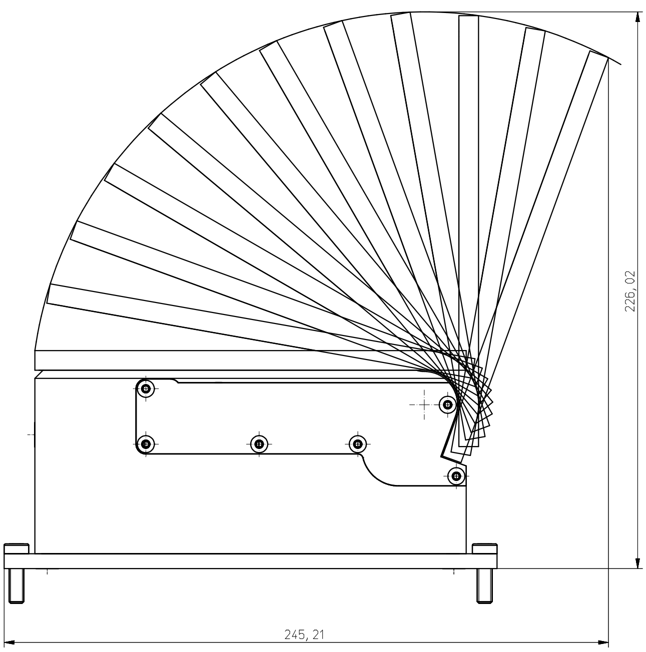
	
When the PMM PROFINET® LWL with UL marking has the designation standard absorber a standard absorber is built into the device.	When the PMM PROFINET® LWL with UL marking has the designation advanced absorber an advanced absorber is built into the device.

Supply data	
Power Supply, Limited energy, SELV DC IN DC OUT	 24 V DC ⎓ +25 % / -20 %; 250 mA 24 V DC ⎓ / max. 5 A
Kommunikation	
Interface (selectively)	PROFINET®/ PROFINET® Fiber optics PROFIBUS® Parallel DeviceNet™ EtherNet/IP™ EtherCAT®
Dimensions and weight	
Dimensions (LxWxH) • closed • open	 200 x 100 x 89 mm 246 x 100 x 227 mm
Weight (approx.)	2.2 kg
Umgebungsbedingungen	
Operating temperature range	15 – 40 °C
Storage temperature range	5 – 50 °C
Reference temperature	22 °C
Permissible relative humidity (non-condensing)	10 – 80 %
Pollution degree	3 (industrial environment)
Max. altitude of operation	3 000 m
Max. nonoperating altitude	12 000 m

18 Dimensions



View X



All dimensions in mm (general tolerance ISO 2768-v)

19 Declaration of Incorporation of Partly Completed Machinery

Original Declaration of Incorporation of Partly Completed Machinery

according to the Machinery Directive 2006/42/EC, Annex II B

The manufacturer: PRIMES GmbH, Max-Planck-Straße 2, 64319 Pfungstadt, Germany
hereby declares, that the partly completed machine with the designation:

PowerMeasuringModule (PMM)

Types: PMM

is in conformity with the following relevant EC Directives:

- Machinery Directive 2006/42/EC
- EMC Directive EMC 2014/30/EU
- Low voltage Directive 2014/35/EU
- Directive 2011/65/EC on the restriction of the use of certain hazardous substances (RoHS) in electrical and electronic equipment

Authorized for the documentation:
PRIMES GmbH, Max-Planck-Str. 2, 64319 Pfungstadt, Germany

The technical documentation according to Annex VII Part B of the Machinery Directive which belongs to the partly completed machinery was drawn up. The manufacturer obligates himself to provide the national authority in charge with technical documents in response to a duly substantiated request within an adequate period of time.

This partly completed machinery is intended for the integration into a laser system. An initial operation is strictly prohibited until it was ensured that the complete machine, into which the partly completed machinery was integrated, is in compliance with the requirements of the EC-Directive 2006/42/EC as well as the Laser Safety, e.g. the DIN EN ISO 12254, the DIN EN 60825 and TROS.

Pfungstadt, April 26, 2017

Dr. Reinhard Kramer, CEO

20 Manufacturer's Declaration

We, the PRIMES GmbH, declare under our sole responsibility that the device variant

PowerMeasuringModule PMM PROFINET LWL

meets the following requirements and standards:

- Guideline „Profinet Cabling and Interconnection Technology“, Version 2.00 March 2007
- PI-specification „Physical Layer Medium Dependent Sublayer on 650 nm Fiber Optics“ version 1.0 January 2008.
- IEC 61158-6-10/CD: 2010 Industrial Communication Networks – Fieldbus specification, Part 6-10: Application layer protocol specification – Type 10 elements (PROFINET).

21 Appendix

21.1 Add-On Instruction of the RSLogix 5000 Control Software

For more information, see the file "DeviceNet Project Report" on the enclosed data medium.

21.2 Example for a Connection to a Siemens PLC via PROFIBUS®