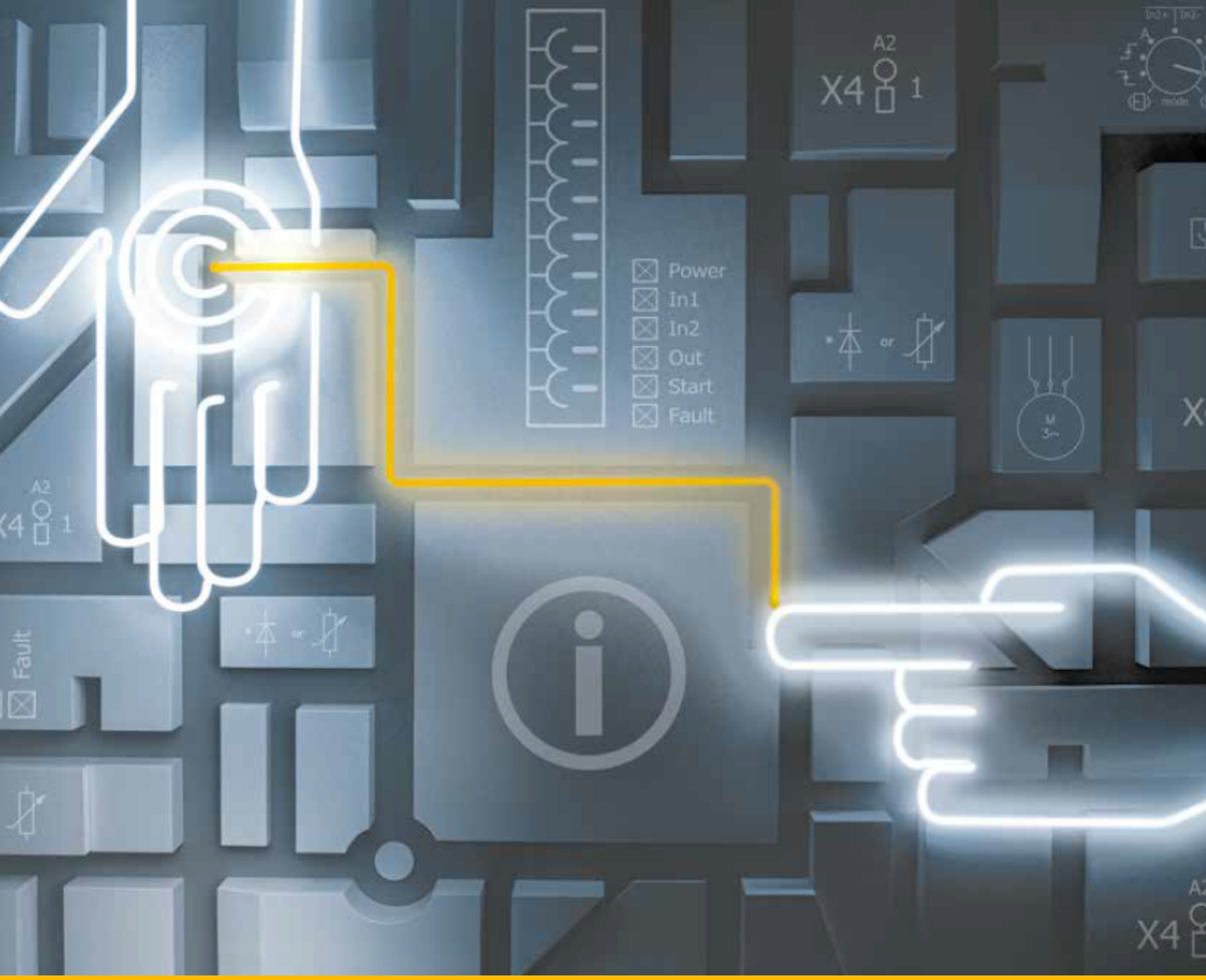


PSENvip IPM

PILZ
THE SPIRIT OF SAFETY

Operating Manual-1004948-EN-03




This document is the original document.

Where unavoidable, for reasons of readability, the masculine form has been selected when formulating this document. We do assure you that all persons are regarded without discrimination and on an equal basis.

1 Introduction 6
1.1 Validity of the documentation 6
1.2 Using the documentation 6
1.3 Definition of symbols 7

2 Overview 8
2.1 Device features 8
2.2 Front view 8

3 Safety 10
3.1 Additional documents that apply 10
3.2 Intended use 10
3.2.1 Third-party manufacturer licence information 10
3.3 Use of qualified personnel 10
3.4 EMCD 11
3.5 Warranty and liability 11
3.6 Safety during commissioning, installation and operation 11

4 Security 12
4.1 Implemented security measures 13
4.2 Required security measures 14

5 Function description 16
5.1 Block diagram 16
5.2 Functional overview 17
5.3 Service button 19
5.4 Bending angle measurement 20
5.4.1 Measuring accuracy and boundary conditions 21
5.4.2 Multiple measurement with averaging 26
5.4.2.1 Configure measurement time (MeasureTime) 26
5.4.2.2 Configure number of images (NumberImages) 27
5.4.2.3 Configure averaging of raw images (ImageAverage) 28
5.4.2.4 Configure averaging of angle values (StatisticMode) 28
5.4.3 Measurement algorithm 29
5.5 Communication 30
5.5.1 Control commands and responses 30
5.5.1.1 Start measurement mode – AMSStart (Command ID 3) 30
5.5.1.2 Request single angle – AMSGetAngle (Command ID 4) 32
5.5.1.3 Stop measurement mode – AMSStop (Command ID 0) 34
5.5.1.4 Change parameter – AMSConfigWrite (Command ID 1) 35
5.5.1.5 Read parameter – AMSConfigRead (Command ID 2) 37
5.5.2 Protocol 38
5.5.2.1 Global header 38
5.5.2.2 Header for requests to the Server (AMS) 39
5.5.2.3 Header for standard responses from the Server (AMS) 40
5.5.2.4 Header when receiving measurement data 41
5.5.3 Scenarios and procedures 45
5.5.3.1 Measurements in "Single measurements” measurement mode 45

5.5.3.2 Measurements in "Continuous mode" measurement mode 46
5.5.3.3 Single measurement with preparation 47
5.6 Configuration 48
5.6.1 Configuration file 48
5.6.2 Structure of the configuration file 49
5.6.3 Configuration parameters 52
5.6.3.1 Configurable configuration parameters 52
5.6.3.2 Syntax rules for configurable configuration parameters 66
5.6.3.3 Read-only configuration parameters 67

6 Installation 70
6.1 Install add-on module 70
6.2 Dimensions 70

7 Interfaces 71
7.1 Connector pin assignment X1, X2 (Ethernet) 71
7.2 Connector pin assignment X3 71
7.3 Connector pin assignment X4 (module supply) 71
7.4 USB port X5 72

8 Wiring 73
8.1 Connect module supply 73
8.2 Connect add-on module to the network 74

9 Commissioning 75
9.1 Network configurations 75
9.2 Initial commissioning 77
9.2.1 Position tool 78
9.2.2 Configuration during commissioning 79
9.2.3 Test in continuous measurement mode (continuous mode) 79

10 Operation 80
10.1 Measurement mode with single measurements 80
10.2 LED indicators 81

11 Diagnostics and troubleshooting 83
11.1 Error codes 83
11.1.1 General error codes 83
11.1.2 Error codes for angle measurement system (AMS) 83
11.1.3 Error codes for PSENvip 85
11.1.4 Error codes for bending angle measurement 86
11.1.5 Error codes for warnings regarding the bending angle measurement 87
11.2 Diagnostic and operating server 89
11.2.1 Call up diagnostic and operating server 91
11.2.2 Download the diagnostic file 91
11.2.3 Save raw images for measured value analysis 92
11.2.3.1 Activate and deactivate memory function via the web application 98
11.2.3.2 Activate and deactivate memory function via ImageSave 99

11.2.3.3 Delete saved raw images 100
11.2.3.4 Add offset value to the measurement result 100

12 Change 102
12.1 Recovery server 102
12.2 Activate recovery mode 103
12.3 Call up recovery server 104
12.4 Run firmware update or recovery update 105
12.5 Reset add-on module to factory settings 107
12.6 Set date and time 108
12.7 Reboot 109

13 Maintenance and testing 110

14 Decommissioning 111

15 Technical details 112

16 Supplementary data 115
16.1 Network data 115

17 Order reference 116

18 EC declaration of conformity 117

19 UKCA-Declaration of Conformity 118

1 Introduction

This operating manual contains information about the intended operation of the PSENvip IPM. The PSENvip IPM is an add-on module for standard applications, which is used to evaluate raw images from the PSENvip productive version.

This operating manual is aimed at press brake manufacturers, operators, planning and maintenance staff, who use the PSENvip IPM add-on module with the PSENvip productive version.

This operating manual is not an instruction manual for the press brake that is safeguarded using the PSENvip. Please refer to the press brake operating manual for this information.

1.1 Validity of the documentation

This documentation is valid for the product PSENvip IPM from Version 1.2. It is valid until new documentation is published.

The current documentation is available in the download area of the Pilz homepage (www.pilz.de -> Downloads).

1.2 Using the documentation

This document is intended for instruction. Only install and commission the product if you have read and understood this document. The document should be retained for future reference.

1.3 Definition of symbols

Information that is particularly important is identified as follows:

DANGER!

This warning must be heeded! It warns of a hazardous situation that poses an immediate threat of serious injury and death and indicates preventive measures that can be taken.

WARNING!

This warning must be heeded! It warns of a hazardous situation that could lead to serious injury and death and indicates preventive measures that can be taken.

CAUTION!

This refers to a hazard that can lead to a less serious or minor injury plus material damage, and also provides information on preventive measures that can be taken.

NOTICE

This describes a situation in which the product or devices could be damaged and also provides information on preventive measures that can be taken. It also highlights areas within the text that are of particular importance.

INFORMATION

This gives advice on applications and provides information on special features.

2 Overview

2.1 Device features

- Add-on module for use with the **PSENvip productive version** consisting of
  - Transmitter PSENvip E
  - Receiver PSENvip R/PSENvip R LR
  - Special module PSSu K F FAU P
- Add-on module used to evaluate raw images provided by the PSENvip productive version.
- Evaluation function for calculating the bending angle of bent metal sheets.
- Web server provided for diagnostics and firmware update.

2.2 Front view

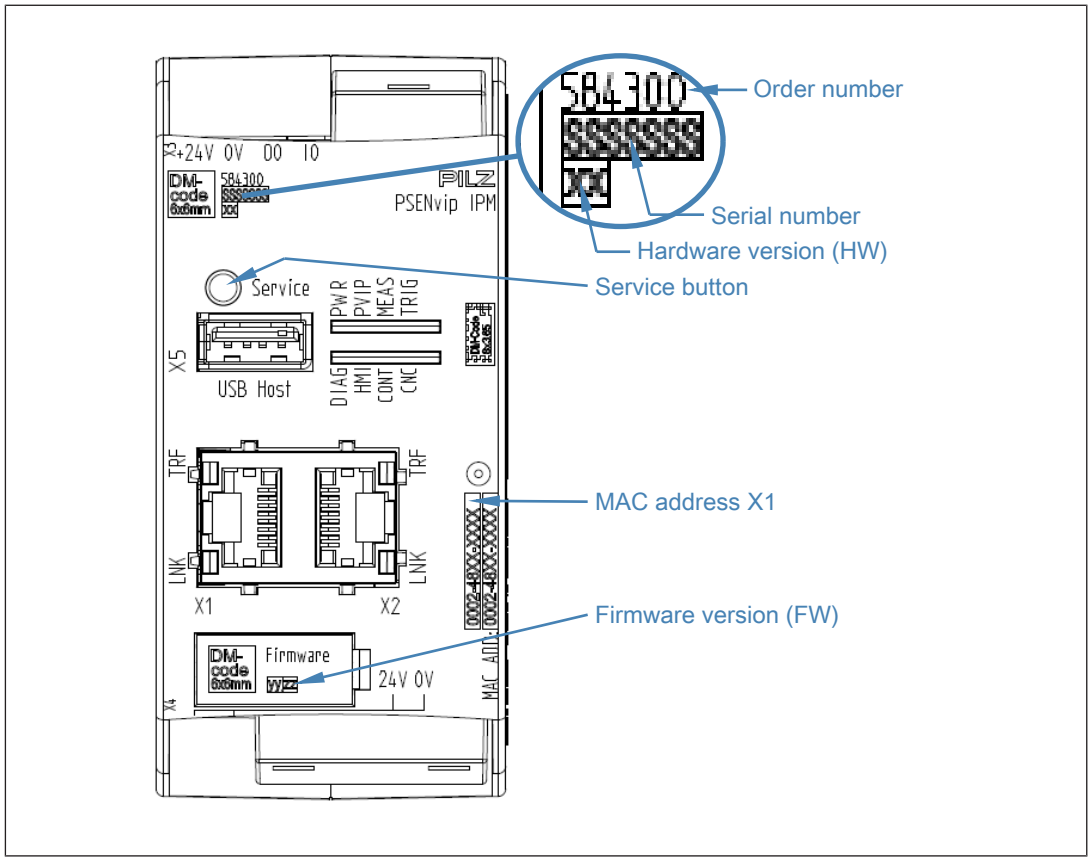


Fig.: Add-on module PSENvip IPM

Legend

Connections

X1	Ethernet port for connection to PSENvip (productive version) and press controller (CNC/HMI)
X2	*<No function>*
X3	*<No function>*

X4	24 V (A1), 0 V (A2) Module Supply
X5	USB port for USB memory to save images for diagnostic purposes
LEDs	
DIAG	Diagnostic messages
PWR	Operating state
HMI	Status of connection between human-machine interface (HMI) and add-on module
PVIP	Status of connection to PSENvip
CONT	Continuous measurement mode
MEAS	Measurement mode
CNC	*<No function>*
TRIG	*<No function>*

3 Safety

3.1 Additional documents that apply

Refer to the safety guidelines in the operating manuals for the relevant products.

You should also refer to the operating manual "PSENvip R/PSENvip R LR, PSENvip E".

3.2 Intended use

The product is intended for use with the PSENvip productive version:

- PSENvip R/PSENvip R LR from hardware version 2 and software version 2.2
- Special module PSSu K F FAU P from hardware version 3 and software version 2.2

The product may be used to evaluate raw images (e.g. bending angle measurement).

The product may only be used for **non-safety-related** functions.

3.2.1 Third-party manufacturer licence information

The product contains open source software, whose terms of use could further limit the product's application area. It is essential that you observe the third-party manufacturer licence information.

You can obtain the licence information by starting the web application of the PSENvip IPM, going to the start page and clicking on the ***Download*** button in the ***Device information*** field under ***Open Source License information***.

3.3 Use of qualified personnel

The products may only be assembled, installed, programmed, commissioned, operated, decommissioned and maintained by persons who are competent to do so.

A competent person is a qualified and knowledgeable person who, because of their training, experience and current professional activity, has the specialist knowledge required. In order to inspect, assess and handle products, devices, systems, plant and machinery, this person must be familiar with the state of the art and the applicable national, European and international laws, directives and standards.

It is the company's responsibility only to employ personnel who

- Are familiar with the basic regulations concerning health and safety / accident prevention,
- Have read and understood the information provided in the section entitled Safety
- Have a good knowledge of the generic and specialist standards applicable to the specific application.

3.4 EMCD

The product is designed for use in an industrial environment.

The product may cause interference if installed in other environments. If installed in other environments, measures should be taken to comply with the applicable standards and directives for the respective installation site with regard to interference.

3.5 Warranty and liability

All claims to warranty and liability will be rendered invalid if

- The product was used contrary to the purpose for which it is intended,
- Damage can be attributed to not having followed the guidelines in the manual,
- Operating personnel are not suitably qualified,
- Any type of modification has been made (e.g. exchanging components on the PCB boards, soldering work etc.).

3.6 Safety during commissioning, installation and operation

You must refer to the safety guidelines provided under "Installation", "Commissioning" and "Operation".

4 Security

The term "security" refers to information security in plants, systems, machines and networks. This includes protection from external attacks (remote access) as well as protection from attacks from insiders. Measures are taken that protect the integrity and confidentiality of sensitive data and guarantee plant/machine availability. So all measures that concern the integrity, availability, confidentiality and authenticity of data fall under the term "security" (see also the IEC 62443 series of standards).

Planning and implementation

Securing plants, systems, machines and networks against cyberthreats requires a holistic industrial security concept that is state of the art and is continuously developed further.
All plants, systems, machinery and networks that require protecting must be assessed individually. The assessment must take into account organisational as well as technical measures. If necessary, seek advice from Pilz Customer Support.
Planning and implementation should be carried out in accordance with a defined security process. For example, your security process should take the following into account:

- Note the regulatory specifications and requirements from the locally applicable safety and application standards with regard to protection from manipulation.
- Perform a risk analysis (e.g. in accordance with IEC 62443-3-2) and then plan the resulting security measures carefully.
- Where possible, counter the security risks using a multi-layered concept (e.g. defence-in-depth concept).
- Name the necessary security measures and document them.
- Check the security measures after implementation.
- Carry out a new risk analysis after every change and adapt the security measures if necessary.
- It is advisable to review the security measures regularly, for example annually.

Defence-in-depth concept

In accordance with IEC 62443-4-1, the defence-in-depth concept is an approach in which multiple layers of independent security methods are used.

The defence-in-depth concept is based on the following rationale:

- Every protective measure can be overcome, and probably will be overcome.
- A multi-layer structure (e.g. onion model) implements several concerted and coordinated measures.
- Due to independent defence mechanisms in each layer, successful exploitation of a weakness in one layer is prevented, or made more difficult, by a measure in another layer.
- Generally with the defence-in-depth concept, an attack is made more difficult because the attacker has to circumvent different, independent security measures, one after the other.

The standard series IEC 62443 distinguishes between the following three areas of responsibility:

- Manufacturer
- System integrator

- Operator

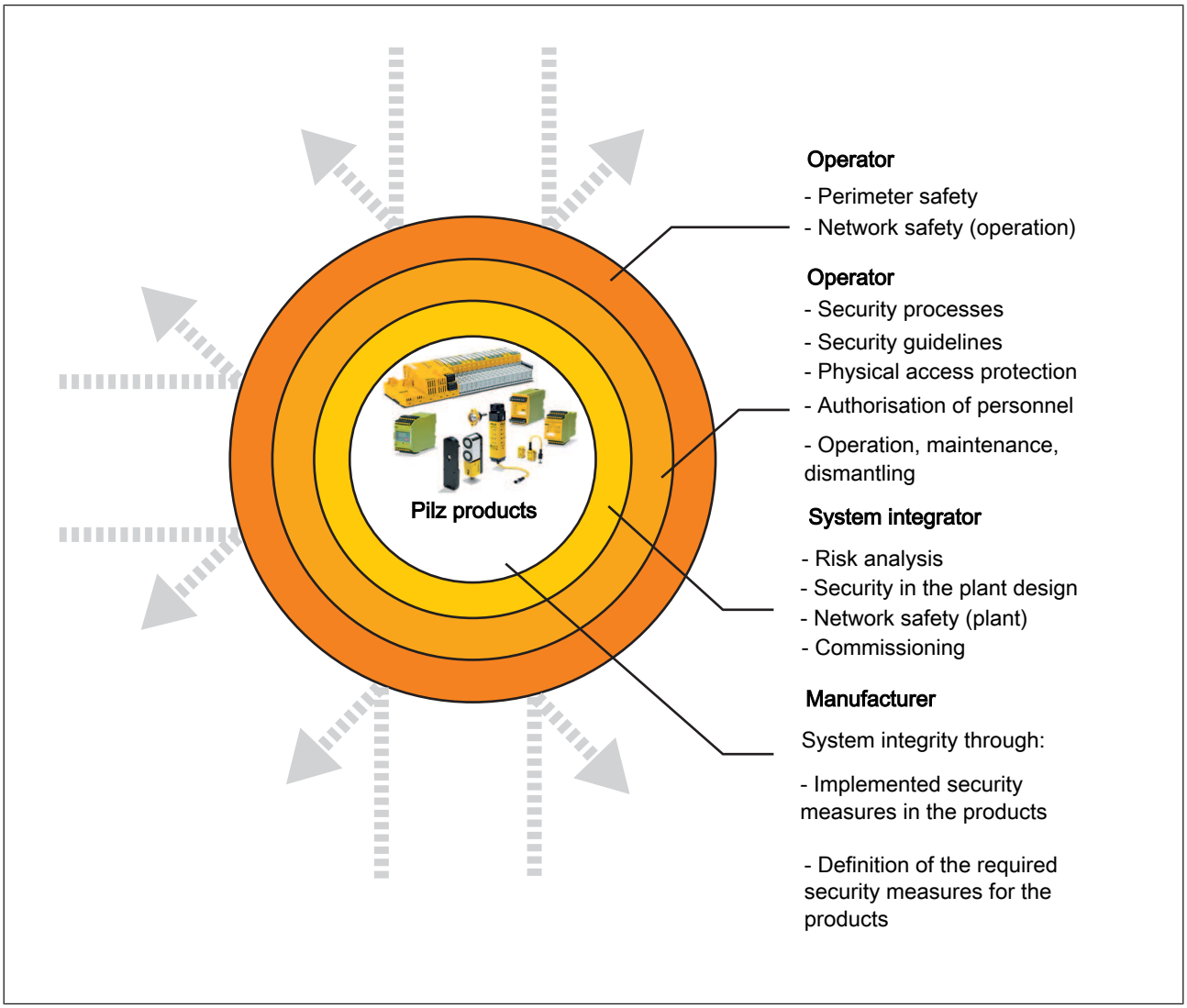


Fig.: Roles and responsibilities in the defence-in-depth onion model

Security incident management

Should the product have a security vulnerability, this will be published in a security advisory. You'll find the security advisories under www.pilz.com/security. You can also report any security problems there.

4.1 Implemented security measures

- The product firmware is certified. As a result, only official, tested firmware can be loaded via a firmware update.
- No firmware downgrades are allowed. This prevents outdated firmware with vulnerabilities from being loaded onto the product.

4.2 Required security measures

- Note the network data [115] for risk analysis and the security measures.
- The product is not protected from physical manipulation or from reading of memory contents during physical access. Use appropriate measures to ensure that there is no physical access by unauthorised persons. You should also use security seals so that you can detect any manipulation of the product or interfaces. Installation inside a lockable control cabinet is recommended as a minimum measure.
- Protect the product from unauthorised data exchange via the network by using a firewall or providing other appropriate measures. Only allow the data exchange that's required for the application. Any data exchange that is not required for the application must be prevented by the firewall.
- Make sure that the product is in a closed, secured network. The safety controller from the automation system PSS 4000 and the special module PSSu K F FAU P can also be operated in this network.
- Logical separation between the network adapters on the HMI (dual homed host) can be used as an alternative to operation in a closed, secured network. Make sure that protective separation of the networks is guaranteed through the HMI.
- An external computer that accesses the product for diagnostic purposes or firmware updates, for example, must be protected from attacks by a firewall or other suitable measures. We recommend that a virus scanner is used on this computer and is updated regularly.
- If necessary, protect the configuration computer and the product from unauthorised use by assigning passwords and taking further measures if required. We also recommend that the user logged on to this configuration computer does not have administrator rights.
- Only assign strong passwords and handle the passwords carefully. Be guided by generally accepted guidelines such as NIST 800-63b for example.
- As soon as possible, install firmware updates that Pilz provides for the product.
- Before disposal, the product must be safely decommissioned. To do this, all the data must be deleted from the device.
  - Set the configuration back to its default settings or delete the configuration.
  - Switch off the product.

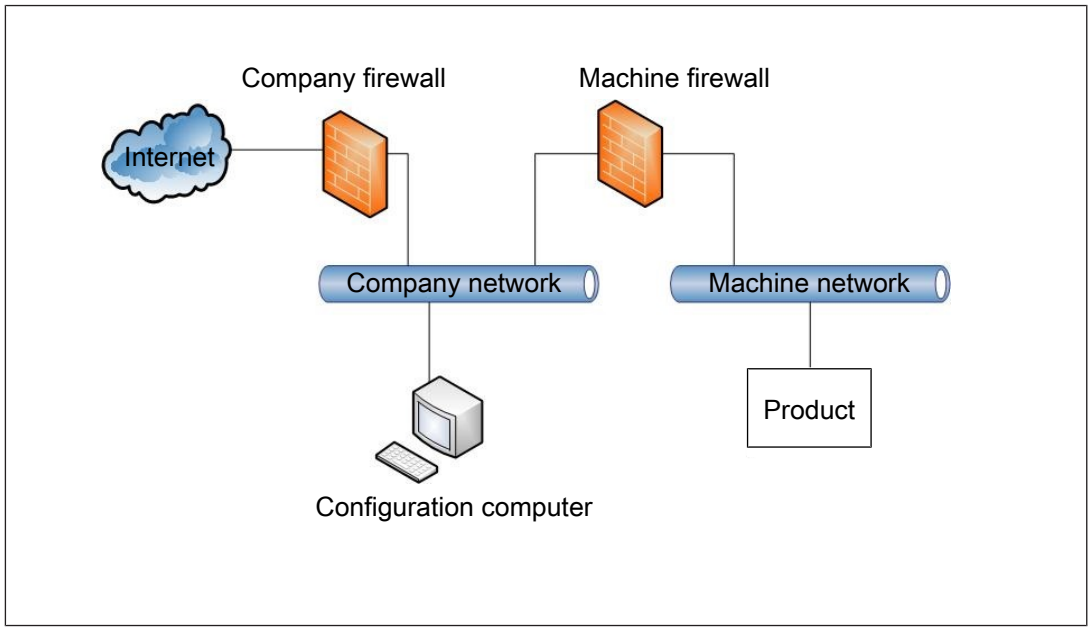
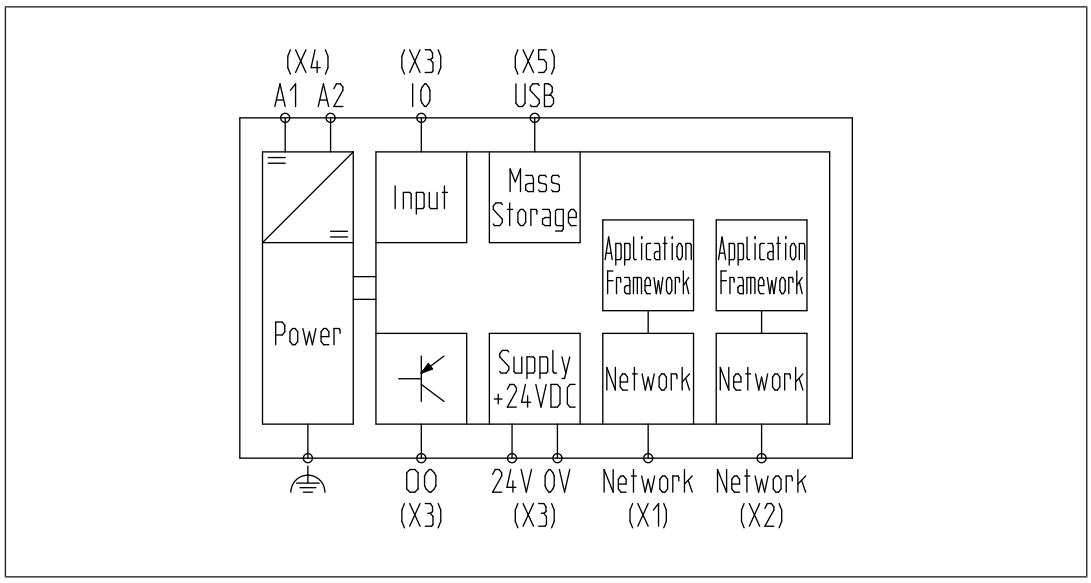


Fig.: Example network topology

5 Function description

5.1 Block diagram



Note:

X2	*<No function>*
X3	*<No function>*

5.2 Functional overview

The functional overview contains information about the interaction between the various devices and the data flow between the press controller (HMI, CNC), the add-on module PSENvip IPM with the "Angle Measurement System" (AMS) software application and the PSENvip productive version (receiver PSENvip R/PSENvip R LR, transmitter PSENvip E and special module PSSu K F FAU P).

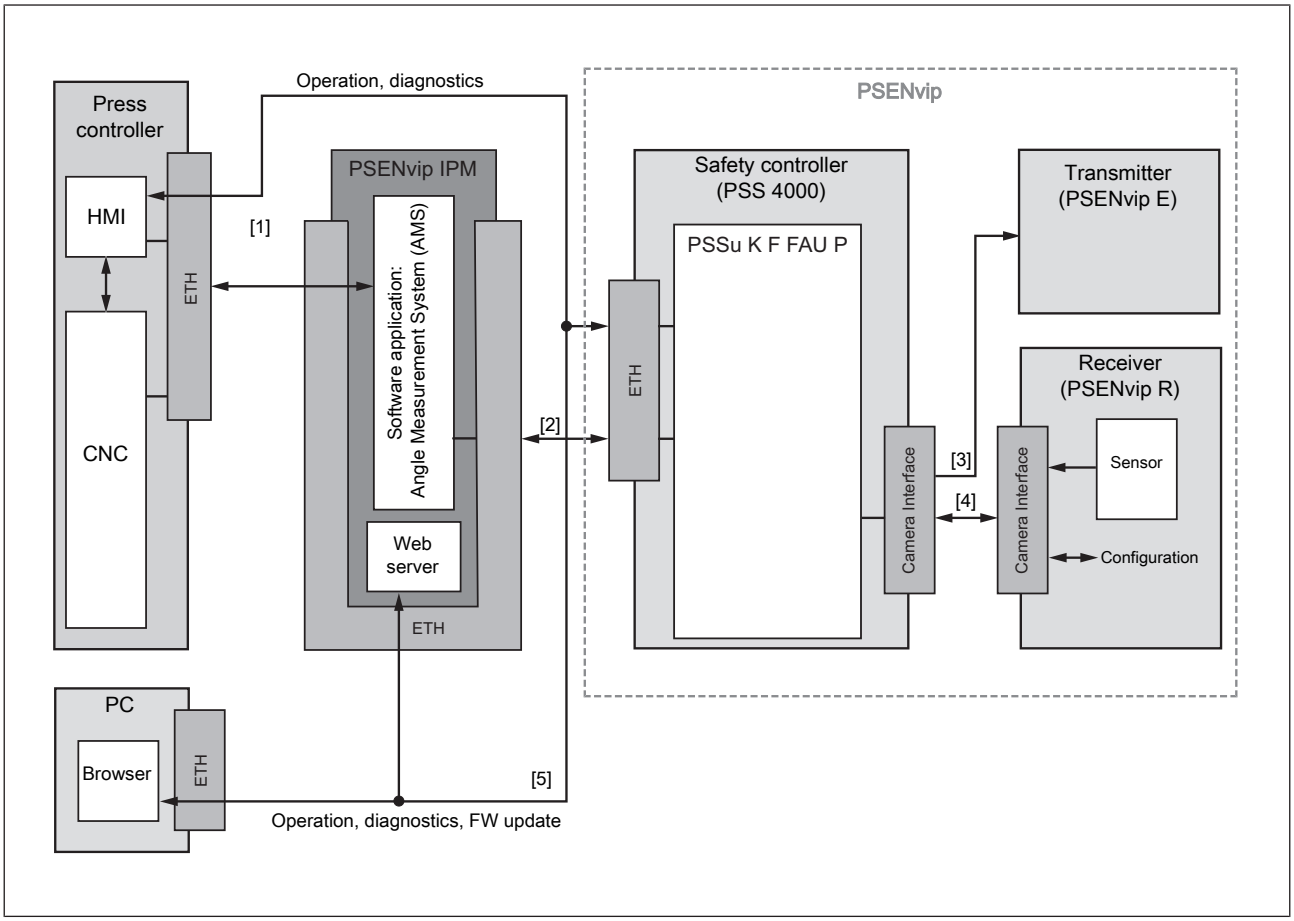


Fig.: Functional overview with data flow

Legend

[1] Connection via the Ethernet port to
- Transfer the determined angle values and image data from the AMS to the press controller (HMI or CNC)
- Transfer commands from the press controller (HMI or CNC) to the AMS
- Read the current configuration data of the add-on module

[2] Connection via the Ethernet port to
- Transfer configuration data and commands to the special module PSSu K F FAU P
- Transfer image data (raw images from the sensor) to the AMS

[3] Interface to control the transmitter

[4] Interface to
- Transfer image data (raw images from the sensor)
- Transfer configuration data and commands

[5] Connection via the Ethernet port for access to the web server of the PSENvip IPM for:

- Diagnostics and operation via the press controller (HMI) or an external PC
- Firmware updates via an external PC

5.3 Service button

The service button is recessed slightly into the housing to prevent the service button from being operated unintentionally.

The service button can be used to start the add-on module in recovery mode (see Activate recovery mode [📖 103]). Various service functions are available in recovery mode (e.g. run firmware update or firmware recovery). Further information is available under Recovery server [📖 102].

5.4 Bending angle measurement

Bending angle measurement (Angle Measurement System (AMS)) is the main function of the add-on module PSENvip IPM. This software application takes the raw images provided by the PSENvip and determines the bending angle of the metal sheets after bending.

- The application is started automatically when the add-on module is switched on.
- The application contains a TCP Server with API. The press controller (CNC, HMI) can communicate with the application via the API (e.g. request measurement and receive angle value).
- The application establishes an Ethernet connection to the special module PSSu K FAU P and uses this connection to communicate with the PSENvip. PSENvip must switch to a special measurement mode for this measurement.
- The raw image from the receiver PSENvip R/PSENvip R LR is used to determine the bending angle. Due to its alignment parallel to the upper beam, the receiver supplies an exact side profile view of the bent metal sheet.
- The algorithms of the application for bending angle measurement use the image to detect the sheet's edge points and in turn the position of the straight lines of the sheet legs. This data is then used to determine the angle.
- The detected edge points and angle are output using the configuration parameter "DataMode=SHEETPROFILEANGLE". They can then be visualised or analysed by the press controller (HMI) or a test client.

5.4.1 Measuring accuracy and boundary conditions

Measuring accuracy

As is customary with measuring devices, the measuring accuracy of the bending angle measurement and/or measurement uncertainty of the bending angle measurement is indicated through the confidence interval and error limits.

All information regarding measurement uncertainty refers to a confidence interval of 2σ; i.e. 95 % of all measurement results are within the stated range and therefore 5 % are outside the stated range.

If all factors that adversely affect measurement uncertainty are excluded, the following measurement uncertainties are achieved during bending angle measurement:

When bending flat metal sheets	Measurement uncertainty: +/- 0.3°
When bending boxes	Measurement uncertainty: +/- 0.6°

The measurements with the PSENvip IPM are made directly after the bending process, while still in the press brake. As a result the measurement results are not falsified, as can happen due to handling of the material and/or the measurement equipment. For example, by pressing thin metal sheets together or due to misfeeds.

Boundary conditions

NOTICE

Adverse effects on measuring accuracy

Although measurements that deviate from the specified boundary conditions are possible, in such cases the measuring accuracy may be adversely affected.

Comply with the specified boundary conditions to achieve optimum measuring accuracy.

Bending angle measurement is at its optimum in applications that comply with the following boundary conditions:

Measuring range	50° … 160°
Distance between sheet and receiver	0.1 m … 1.5 m
Adjustment of receiver	▸ For an optimum measurement result, the receiver must be adjusted to the centre. With this adjustment, both legs are of sufficient length. ▸ The tool should be adjusted within the lower area of the vertical tolerance range.
Sheet leg length	Leg lengths of greater than/equal to 25 mm are supported for both legs. This is the straight part of the leg, without the radius.
Sheet thickness	1 mm … 3 mm

No impact on measuring accuracy

The achievable measuring accuracy is not affected by the following factors:

- Metal sheet material
- Reflective metal sheet, residues or contamination on the metal sheets
- Foiled metal sheet
- Type of metal sheet, e.g. perforated sheets, textured sheets

Positive impact on measuring accuracy

The following factors improve the achievable measuring accuracy:

- Multiple measurement and averaging.
  Multiple measurement can be configured, which reduces the scattering of measured values and eliminates individual outliers.
- Correct configuration of the bending parameters.
  The measurement algorithm refers to the sheet thickness stored in the bending parameters, for example.

Negative impact on measuring accuracy

The following factors adversely affect the achievable measuring accuracy:

- Sheet thickness

  The thicker the sheet, the greater the bending radius. A larger bending radius reduces the area of the straight leg that can be evaluated and therefore the measuring accuracy. The deterioration in measuring accuracy mainly occurs on sheets from a thickness of > 4 mm.
- Straightness of the sheet legs

  If the sheet legs are not straight but slightly bent, this will adversely affect the measuring accuracy.
- Multiple angles

  Where there are multiple bends and the distance between the legs is less than 30 mm, the raw image will contain multiple angles. This will adversely affect the measuring accuracy.
- Sheet lengths and torsions in the sheet

  On longer metal sheets, torsions may arise within the sheet. This produces a "thicker" sheet with fuzzy edges in plan view; i.e. the angle value depends on which side is measured.
- Tilting of the metal sheet

  When the metal sheet is no longer clamped by the upper tool, this can cause the sheet to tilt. Tilting of the sheet can adversely affect measuring accuracy. It is particularly problematic if the sheet covers a wide area on the upper tool or die. Than can occur mainly on acute angles or large angle upper tools.

  Please note: If there is a danger that a leg is positioned at the upper tool, "AUTO" must be configured as the measurement algorithm.
- Adjustment of the PSENvip receiver

For optimum measurement results, the receiver PSENvip R/PSENvip R LR must be adjusted to the centre. If the tool is adjusted far inside the tolerance range, that will have a positive impact on measuring accuracy. Adjustment at the upper end of the tolerance range should be avoided.

- Box shaping

  When box shaping, the legs of the angle to be measured are wholly or partially concealed on one side.

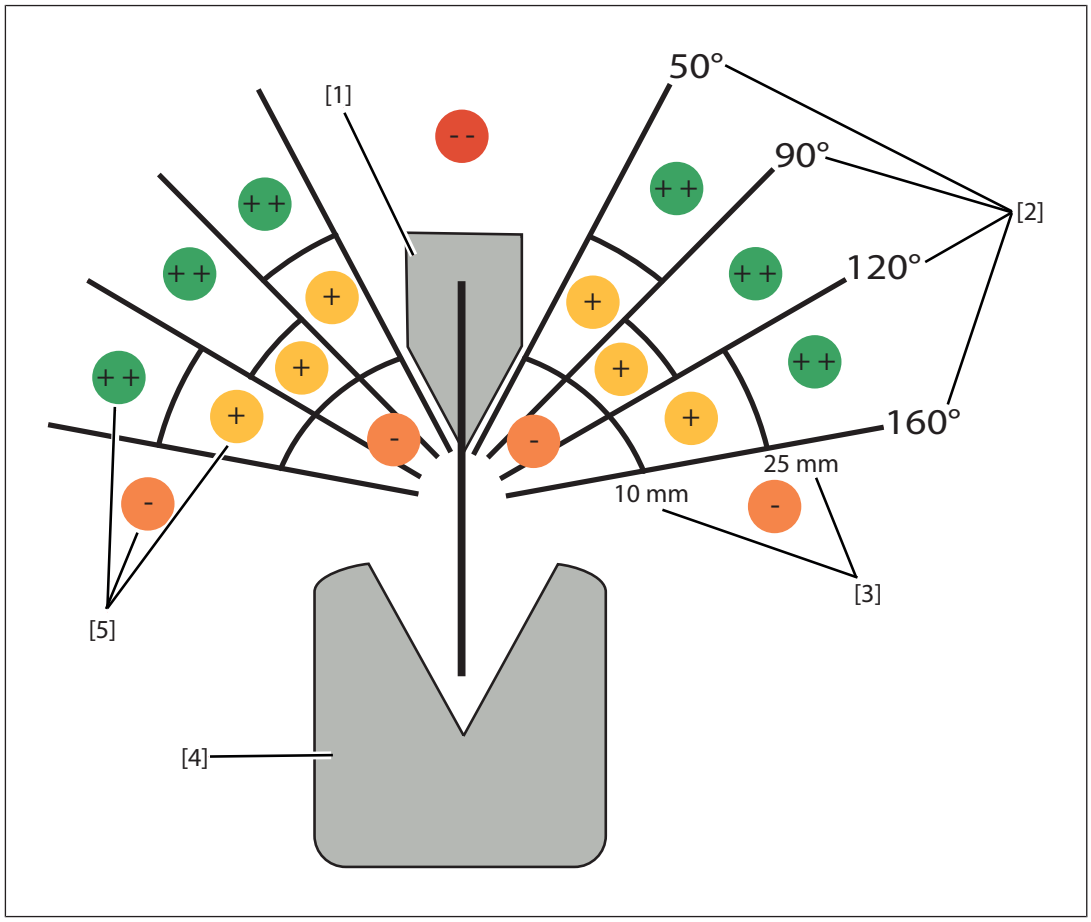
- Used tool shape (upper or lower tool)

  After the bending process, if the sheet is positioned at the upper or lower tool, the area of the leg that can be evaluated is reduced. This reduces the measuring accuracy.

- Time of measurement

  When setting the time of measurement, care must be taken to ensure that the springback from the metal sheet is fully completed. If the time of measurement is too late, the metal sheet may tilt.

The named factors may have little or great impact on measuring accuracy, or none at all. For this reason, no reliable information can be provided regarding which factors increase measurement uncertainty. In any case, with a combination of factors you can expect a significant increase in measurement uncertainty.



Legend

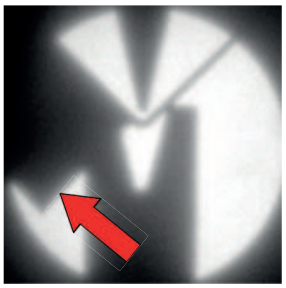
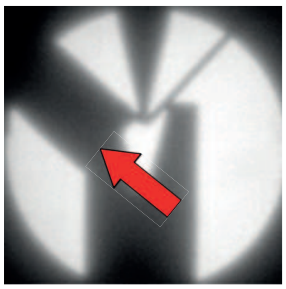
1 Upper tool
2 Bending angle ranges
3 Sheet leg length
4 Lower tool
5 Pictograms for measurement uncertainty:
- Good measurement conditions, measurement uncertainty ±0.3 °
- Acceptable measurement conditions, measurement uncertainty ±0.5 °
- Poor measurement conditions, no information regarding measurement uncertainty
- No measurements possible

Angle measurement when box forming

When box forming,

- the legs of the angle to be measured are wholly or partially concealed.
- it is necessary to distinguish whether a box is to be bent upwards or downwards.

Due to the geometries of the upper and lower tool, the situation may arise where a box with short legs (<18 mm) that is bent downwards will result in optical "merging". As a result, measurement of the angle is only possible to a very limited extent, if at all. This problem occurs in particular when measuring in "Auto" mode. When measuring in "PARTIAL_BOX_LOWER" mode, even these angles can be measured well.

30 mm box leg length: ▸ In "Auto" mode, the angle is measured reliably.	
18 mm box leg length: ▸ In "Auto" mode, angle measurement can result in a mismeasurement. ▸ In "PARTIAL_BOX_LOWER" mode, the angle is measured reliably.	
≤10 mm box leg length: ▸ The angle cannot be measured reliably.	

5.4.2 Multiple measurement with averaging

The measurement uncertainty of the bending angle measurement can be reduced via multiple measurement and averaging of the individual results.

Please note that multiple measurements increase the measurement time.

NOTICE

Performance characteristics of multiple measurement with averaging

A multiple measurement can reduce scattering of measured values and eliminate individual measurement outliers.

Please note that a multiple measurement cannot reduce systematic measurement errors caused by the physical structure of the system, the algorithms or problematic boundary conditions.

Multiple measurement can be configured via configuration parameters (see Configurable configuration parameters [📖 52]) and activated using the command AMSConfigWrite (see Change parameter – AMSConfigWrite (Command ID 1) [📖 35]).

5.4.2.1 Configure measurement time (MeasureTime)

The MeasureTime parameter can be used to establish the approximate measurement time in milliseconds (see "[AMS] section: Measurement system parameters (AMS)" under Configurable configuration parameters [📖 52]). Based on the configured measurement time, the measurement system automatically calculates the number of images that have to be averaged.

▶ Configure MeasureTime parameter

– MeasureTime = 0 (UNDEFINED, default setting)

  MeasureTime = 0 cannot be configured by the user. The value is set by the measurement system when the NumberImages parameter is configured.

– Value range for MeasureTime

  A value in the range from 1 … 2000 ms can be configured for MeasureTime.

Please note:

– Only a rough time frame is configured via MeasureTime. The actual measurement time may deviate from the configured value by +/- 50 ms. There may also be larger deviations if averaging over raw images is configured via the parameter ImageAverage.

– MeasureTime can be used as an alternative to the parameter NumberImages.

– Either NumberImages or MeasureTime may be configured. The measurement system will then set the other parameter to 0 (UNDEFINED). The configuration will not be applied if the user has configured both NumberImages and MeasureTime (PARAMETER_ERROR 1002).

- Functional characteristics when MeasureTime >0

  The measurement system typically needs 35 ms to calculate an image with RequestType=CONTINUOUS and 50 ms with RequestType=SW. The measurement system uses this provisional value to determine the number of images required for the configured measurement time and then averages these over this number of measured values. While averaging takes place, the measurement system calculates the actual measurement time and adapts the number of images dynamically.

- Provision of extended measurement data for angle

  The parameter DataMode=EXTENDED_ANGLE is used to provide the number of images used when averaging, as well as the precise measurement time (see Header when receiving measurement data [📖 41]).

5.4.2.2 Configure number of images (NumberImages)

The NumberImages parameter can be used to establish the number of images that are to be averaged.

- Configure NumberImages parameter
  - NumberImages = 1 (default setting)

    With this configuration the angle is calculated from a single image, without averaging.
  - Value range for NumberImages

    A value in the range from 1 … 100 can be configured for NumberImages.

  Please note:
  - NumberImages can be used as an alternative to the parameter MeasureTime.
  - Either NumberImages or MeasureTime may be configured. The measurement system will then set the other parameter to 0 (UNDEFINED). The configuration will not be applied if the user has configured both NumberImages and MeasureTime (PARAMETER_ERROR 1002).
  - Typically the measurement time for an image is 35 ms with RequestType=CONTINUOUS and 50 ms with RequestType=SW. This typical value can be used to provide an approximate calculation of the total measurement time including averaging.
  - If both NumberImages and ImageAverage are to be configured, then NumberImages must be an integer multiple of ImageAverage. If not the configuration will be rejected and will not be applied (VALUE_ERROR 1003).
- Provision of extended measurement data for angle

  The parameter DataMode=EXTENDED_ANGLE is used to provide the number of images used when averaging, as well as the precise measurement time (see Header when receiving measurement data [📖 41]).

5.4.2.3 Configure averaging of raw images (ImageAverage)

The parameter ImageAverage can be used to establish that the measurement system will initially average a configurable number of raw images in order to calculate an angle from the overall image obtained in this way.

- Configure parameter ImageAverage
  - ImageAverage = 1 (default setting)

    With this configuration an angle value is calculated from each raw image, without averaging.
  - Value range for ImageAverage

    A value from 1 … 10 can be configured for ImageAverage.
    Alternatively the parameter can be assigned the value "AUTO". With this configuration, the number of raw images that the measurement system uses for averaging corresponds approximately to the number of angle values that is then used to average the angle values.
  - If both NumberImages and ImageAverage are to be configured, then NumberImages must be an integer multiple of ImageAverage. If not the configuration will be rejected and will not be applied (VALUE_ERROR 1003).
- If MeasureTime is configured in addition to ImageAverage, the actual measurement time may turn out to be greater than is documented as the deviation for MeasureTime (see Configure measurement time (MeasureTime) [📖 26]). The time units are increased due to averaging of the raw images.
- Averaging of the raw images may only be carried out when it is guaranteed that the position of the bent sheet is stable and constant; i.e. averaging of raw images may not be carried out with manual feed, with the hand on the metal sheet.
- Provision of extended measurement data for angle

  The parameter DataMode=EXTENDED_ANGLE is used to provide the precise measurement time and, in the case of ImageAverage=AUTO, also the number of raw images (see Header when receiving measurement data [📖 41]).

5.4.2.4 Configure averaging of angle values (StatisticMode)

While averaging of raw images can be configured as an option, averaging of the angle values always takes place when a value greater than 1 is configured for NumberImages; i.e. averaging of the angle values always takes place when more than 1 image is available for averaging.

The StatisticMode parameter can be used to establish the type of averaging.

- StatisticMode=AVERAGE (default setting)

  The arithmetic mean is calculated.
- StatisticMode=MEDIAN

  The average is calculated using the median method.

5.4.3 Measurement algorithm

The standard measurement algorithm detects both metal sheet edges and uses these to calculate the sheet straight lines and the bending angle. It normally supplies the best angle values. However, with box bending the standard measurement algorithm does not supply a measured value or does not supply the best measured value.

Configure measurement algorithm (SheetDetectFront and SheetDetectBack)

The parameters SheetDetectFront and SheetDetectBack can be used to establish the measurement algorithm. The measurement algorithm for the front and back sheet legs must be configured separately.

- SheetDetectFront and SheetDetectBack=AUTO (default setting)

  The AMS automatically determines the measurement algorithm that supplies the best angle value.

- SheetDetectFront and SheetDetectBack=SHEET

  This configuration should only be used if both legs are clearly recognisable. If both legs are clearly recognisable, the "SHEET" configuration can potentially deliver better measurement results. Also, the measurement time can be reduced in comparison with the "AUTO" configuration.

- Provision of extended measurement data for angle

  The parameter DataMode=EXTENDED_ANGLE is used to provide the measurement algorithm that is used (see Header when receiving measurement data [📖 41]).

5.5 Communication

5.5.1 Control commands and responses

5.5.1.1 Start measurement mode – AMSStart (Command ID 3)

Description

The command is sent by a press controller (HMI, CNC). This command causes both the "Angle Measurement System" (AMS) application and PSENvip to switch to measurement mode. In measurement mode, measurement data is provided continuously; another trigger is not required. This measurement mode is also called "continuous mode".
Measurement mode is only halted by the stop command. Single angles cannot be requested with the start command. The command AMSGetAngle is available to request a single angle.

Note:

- This command is only permitted when there is no measurement active on the AMS and PSENvip is monitoring the protected field (protected field mode), otherwise an error is returned in the standard response (acknowledgement).
- The current configuration parameters stored on the AMS are used for the bending angle measurement.
- It is the task of the press controller (HMI, CNC) to trigger measurement mode on the AMS and PSENvip at the right time.
- When the PSENvip switches to measurement mode, the OSSD signal is switched off. In this case the fast shutdown outputs are also switched off ("0"). If the press is in rapid traverse when the start command is given, this will lead to an emergency stop.

Command ID

The command ID 3 is transferred in the request header
(see Header for requests to the Server (AMS) [📖 39]).

Parameters

None

Feedback

- Standard response as acknowledgement with error code

  (see Header for standard responses from the Server (AMS) [📖 40])

  The error codes that can be returned in the header are found under Error codes [📖 83].
- AMSMeasurement responses with measurement data
  (see Header when receiving measurement data [📖 41])

Mode of operation and procedure

- To start the measurement, the press controller (HMI, CNC) sends the command AMSStart to the AMS.

- The AMS switches to measurement mode.
  - The AMS starts measurement mode on the PSENvip.
  - The OSSD signals and fast shutdown outputs switch to "0".
- As a reaction to the start command, the AMS sends the result to the press controller in the standard response.
- "Continuous mode" measurement mode: The AMS constantly requests image data from the PSENvip and uses it to calculate the bending angle.

  "SW" measurement mode: The AMS requests image data from the PSENvip after a command "AMSGetAngle" and uses it to calculate the bending angle.
- In the AMSMeasurement responses the AMS delivers to the press controller (HMI, CNC)
  - the angle values
  - The image data, provided this has been configured at the "DataMode" configuration parameter

5.5.1.2 Request single angle – AMSGetAngle (Command ID 4)

Description

The command is sent by a press controller (HMI, CNC). This command is used to request a single angle value. This command causes both the "Angle Measurement System" (AMS) application and PSENvip to switch to measurement mode. A single angle value is provided. Measurement mode is then ended immediately on both the AMS and PSENvip.

Note:

- The command is permitted in the following cases:
  - no measurement is active on the AMS and PSENvip is monitoring the protected field (protected field mode).
  - a measurement that was started with AMSStart and Request Type=SW is active on the AMS.
- The current configuration parameters stored on the AMS are used for the bending angle measurement.
- It is the task of the press controller (HMI, CNC) to trigger measurement mode on the AMS and PSENvip at the right time.
- When the PSENvip switches to measurement mode, the OSSD signal is switched off. In this case the fast shutdown outputs are also switched off ("0"). If the press is in rapid traverse when the start command is given, this will lead to an emergency stop.

Command ID

The command ID 4 is transferred in the request header
(see Header for requests to the Server (AMS) [📖 39]).

Parameters

None

Feedback

- Standard response as acknowledgement
  (see Header for standard responses from the Server (AMS) [📖 40])
  The error codes that can be returned in the header are found under Error codes [📖 83].
- AMSMeasurement response with angle value
  (see Header when receiving measurement data [📖 41])

Mode of operation and procedure: No measurement active

- To request a single angle, the press controller (HMI, CNC) sends the command AMSGetAngle to the AMS.
- The AMS switches to measurement mode in "single mode".
  - The AMS starts measurement mode on the PSENvip.
  - The OSSD signals and fast shutdown outputs switch to "0".
- As a reaction to the start command, the AMS sends the result to the press controller (HMI, CNC) in the standard response.

- The AMS requests an image from the PSENvip and uses it to calculate the bending angle.
- The AMS delivers the angle value to the press controller (HMI, CNC) in the AMSMeasurement response. Image data is also sent in the AMSMeasurement response, depending on the configuration of the "DataMode" configuration parameter.
- The AMS then ends measurement mode automatically.
  - The AMS ends measurement mode on the PSENvip.
  - If the protected field is clear the OSSD signals switch back to "1" and enable rapid traverse.
- The ending of measurement mode is **not** reported via the standard response.

Mode of operation and procedure: Measurement active

- The measurement was started with AMSStart and RequestType=SW.
- The AMS delivers the angle value to the press controller (HMI, CNC) in the AMSMeasurement response. Image data is also sent in the AMSMeasurement response, depending on the configuration of the "DataMode" configuration parameter.
- Measurement mode is not ended automatically. Further measurements with AMSGetAngle are possible.

  To end measurement mode, the command AMSStop must be sent explicitly.
  - The AMS ends measurement mode on the PSENvip.
  - If the protected field is clear the OSSD signals switch back to "1" and enable rapid traverse.

5.5.1.3 Stop measurement mode – AMSStop (Command ID 0)

Description

The command is sent by a press controller (HMI, CNC). The stop command causes both the "Angle Measurement System" (AMS) application and PSENvip to end measurement mode. PSENvip switches back to monitoring mode.

Note:

- This command is only permitted when the AMS and PSENvip are in measurement mode.

Command ID

The command ID 0 is transferred in the request header
(see Header for requests to the Server (AMS) [39]).

Parameters

None

Feedback

Standard response as acknowledgement with error code

The error codes that can be returned in the header are found under Error codes [83].

If PSENvip is not in measurement mode but the press controller (HMI, CNC) still sends a stop command, then no error is entered in the response telegram; i.e. the error code "0" (no error present) is returned in the standard response.

Mode of operation and procedure

- To stop measurement mode, the press controller (HMI, CNC) sends the command AMSStop to the AMS.
- The AMS ends its measurement mode.
  - The AMS ends measurement mode on the PSENvip.
  - If the protected field is clear the OSSD signals switch back to "1" and enable rapid traverse.
- The ending of measurement mode is reported via the standard response.

5.5.1.4 Change parameter – AMSConfigWrite (Command ID 1)

Description

The command is sent by a press controller (HMI, CNC). This command is used to transfer a data set containing configuration parameters to the "Angle Measurement System" (AMS) application; i.e. with this command the AMS can be configured dependent on the application. As configuration parameters are adapted dependent on the application, bending angle measurement can be controlled and optimised (e.g. measurement mode, measuring accuracy, speed).

Note:

- The write command can be used to adapt the configurable configuration parameters that deviate from the standard configuration dependent on the application.
  - A command can be used either to transfer all configuration parameters or also a subset of these parameters. It is generally only necessary to transfer the configuration parameters that are to be changed.
  - Configuration parameters that are not changed using the command AMSConfigWrite retain their current value; i.e. configuration parameters that have never been modified contain the default value that was stored in the original configuration file.
- It is only possible to change the configuration using AMSConfigWrite when no measurement is active. A configuration change can reasonably be made at the following times:
  - Before starting the first measurement with AMSStart or AMSGetAngle or
  - Between two measurement processes, i.e.:

    A configuration change can be made after a measurement that was started using AMSStart (continuous mode) is stopped using AMSStop. A configuration change can also be made between 2 AMSGetAngle commands.
- The changed AMS connection parameters ([COMMON] section + Parameter "Adapter...") are not applied until the PSENvip IPM is next restarted (switch supply voltage off and on again). So configuration of this parameter is only effective when Save=YES.

Temporary and permanent configuration

There are two types of configuration change. The type of configuration change is influenced by the "Save" configuration parameter from the [COMMON] section.

- Temporary configuration (***Save=NO***)

  If the voltage supply to the AMS is switched off and back on again (restart), the standard configuration will be used again.
- Permanent configuration (***Save=YES***)

  The new configuration parameters are saved in the configuration file and are used as the new standard configuration.

The "Save" parameter is not available in the standard configuration file. This is synonymous with ***Save=NO***.

Command ID

The command ID 1 is transferred in the request header (see Header for requests to the Server (AMS) [📖 39]).

Parameters

A description of the configuration parameters can be found under Configurable configuration parameters [52].
The configuration parameters are transferred in the request bytes as ASCII strings. It is necessary to comply with the syntax rules (see Syntax rules for configurable configuration parameters [66]).

Feedback

Standard response as acknowledgement with error code

The error codes that can be returned in the header are found under Error codes [83].

5.5.1.5 Read parameter – AMSConfigRead (Command ID 2)

Description

The command is sent by a press controller (HMI, CNC). This command is used to request the whole current configuration (see Configurable configuration parameters [📖 52] and Read-only configuration parameters [📖 67]).

Note:

- It is only possible to request the configuration using AMSConfigRead when no measurement is active. A configuration request can reasonably be made at the following times:
  - Before starting the first measurement with AMSStart or AMSGetAngle or
  - Between two measurement processes, i.e.:

    A configuration request can be made after a measurement that was started using AMSStart (continuous mode) is stopped using AMSStop. A configuration request can also be made between 2 AMSGetAngle commands.

Command ID

The command ID 2 is transferred in the request header
(see Header for requests to the Server (AMS) [📖 39]).

Parameters

None

Feedback

Standard response as acknowledgement with error code

The error codes that can be returned in the header are found under Error codes [📖 83].

In addition to the header bytes, the standard response also contains all the current configuration parameters from the configuration file (see Header for standard responses from the Server (AMS) [📖 40]).

5.5.2 Protocol

Communication is in accordance with the Client-Server principle. The press controller (HMI, CNC) is the Client. The "Angle Measurement System" (AMS) application is the Server. Communication is always established through the Client.

5.5.2.1 Global header

The global header precedes each data packet.

Structure of the global header

Data length (byte)	Data type	Description	
4	U32	Synchronisation bytes 0xAA0F55F0	Header bytes
4	U32	Counter	
4	U32	Data length <*n*> in bytes (without global header)	
		- - - END OF GLOBAL HEADER - - -	
<*n*>	U8	Data bytes	

- Synchronisation bytes

  The synchronisation bytes are used to simplify detection of the header.

- Counter

  The counter is used to detect any missing data packets. It is increased by 1 with each telegram. Client and Server increase their counters independently from each other when transmitting. The counter is reset to "0" by the following actions (counter reset):

  – Stop command

  – Ethernet connection to the Client (press controller) is disconnected

- Data length

  The data length of the "Data bytes" data area is stated in this field. The data length of the header is not included in the calculation.

- Data bytes

  The data packets containing commands and responses/results are sent in this data area.

5.5.2.2 Header for requests to the Server (AMS)

This header is placed in front when the Client (press controller) sends a request to the Server (AMS).

Structure of the header

Data length (byte)	Data type	Description	
4	U32	Command ID	Header bytes
4	U32	Host ID	
4	U32	Request length <*n*> in bytes (without request header)	
		- - - END OF REQUEST HEADER - - -	
<*n*>	U8	Request bytes	

- Command ID

  The command ID contains the command.

  Possible command IDs:

  0 Stop measurement mode – AMSStop
  1 Change configuration data – AMSConfigWrite
  2 Read configuration data – AMSConfigRead
  3 Start measurement mode – AMSStart
  4 Request single angle – AMSGetAngle

- Host ID

  The Host ID is any value that is returned in the response from the Server (AMS). With the Host ID, enquiries and responses can be clearly assigned. Different Host IDs can be allocated to various Clients.

- Request length

  The data length of the "Request Bytes" data area is stated in this field. The data length of the header is not included in the calculation.

- Request bytes

  The data associated with the command is transferred in this data area. At the moment, only the command AMSConfigWrite contains additional data. Then the data area contains the configuration data that is to be changed. You must comply with the syntax rules under Syntax rules for configurable configuration parameters [📖 66].

5.5.2.3 Header for standard responses from the Server (AMS)

The Server (AMS) sends a response telegram to each command from the Client (press controller).

If the standard response telegram is only used to acknowledge the request, then only the response header is sent, repeating the Command ID, Host ID and error code.

If the standard response telegram is used to respond to the read command, then the current configuration data will be sent in addition to the header bytes.

If data is requested via a command, then this will be returned in the response data area in addition to the header bytes, provided it does not involve measured values.

Structure of header

Data length (byte)	Data type	Description	
4	U32	Command ID	Header bytes
4	U32	Host ID replay	
4	U32	Error code	
4	U32	Response length <*n*> in bytes (without request header)	
		- - - END OF RESPONSE HEADER - - -	
<*n*>	U8	<*Response-Bytes*>	

- Command ID

  The command ID contains the command.
  The Command ID corresponds to the Command ID of the associated request (mirroring of Command ID).

- Host ID replay

  The Host ID replay corresponds to the Host ID of the associated request (mirroring of Host ID).

- Error code

  If the enquiry is incorrect or could not be carried out, then an error code is returned in this field (see Error codes [📖 83]). The error code "0" means that the action was successful and no error is present.

- Response length

  The data length of the "Return values" data area is stated in this data area. The data length of the header is not included in the calculation.

- Response bytes

  A command's response data is returned in this data area. At the moment, data is only requested through the command AMSConfigRead. In this case the data area contains the current configuration data.

5.5.2.4 Header when receiving measurement data

If measurement data is requested, then initially the standard response telegram is returned as acknowledgement (see Header for standard responses from the Server (AMS) [📖 40]). The measurement data itself is contained in an additional response telegram, the measured value telegram. The measured value telegram contains the special AMSMeasurement header and the data area containing the measurement data.

The Client (press controller) receives a measured value telegram in the following cases:

- A single angle is requested using the command AMSGetAngle
- Measurement is started in continuous mode using the start command

  Measured value telegrams containing measurement data are sent constantly.

Structure of AMSMeasurement Header

Data length (byte)	Data type	Description	
4	U32	Command ID (1000)	Header bytes
4	U32	Data mode	
4	U32	Sensor result counter	
8	U64	Image time stamp after sensor boot [ms]	
4	U32	Error code	
4	U32	Result length <*n*> in bytes (without response header)	
		- - - END OF RESULT HEADER - - -	
<*n*>	U8	<*Measurement-Bytes*>	

- Command ID

  The Command ID of the response telegram is always 1000. The ID identifies data packets containing measurement results.

- Data mode

  The results that the AMS will return are defined in the "Data mode" data area. The content of Data mode is established/switched via the write command AMSConfigWrite (see Configurable configuration parameters [📖 52]).

  Possible contents of the "Data Mode" field and what it means:

  1 The measurement data area contains a grayscale image (DataMode=GRAYPIC). Information under "Measurement data for grayscale image and black & white image".
  2 The measurement data area contains a back & white image (DataMode=BINARYPIC). Information under "Measurement data for grayscale image and black & white image".
  3 The measurement data area only contains the angle value (DataMode=ANGLE). Information under "Measurement data for angle values".

4 The measurement data area contains the sheet profile in the form of straight lines and reference points (DataMode=SHEETPROFILEANGLE).
Information under "Measurement data for sheet profile with straight lines and angles".

5 When DataMode=EXTENDED_ANGLE, the measurement data area contains the following:

- Number of images used when averaging
- Precise measurement time
- Measurement algorithms used

Information under "Extended measurement data for angles".

- Sensor result counter

  The counter is used to detect any missing data packets. It is increased by 1 with each measured value telegram. The counter is reset to "0" by the following actions (counter reset):

  – Stop command

  – Ethernet connection to the Client (press controller) is disconnected

- Image time stamp after sensor boot

  At the moment the time stamp always contains the value "0".

- Error code

  Should an error occur during measurement, then an error code is displayed in this field (see Error codes [📖 83]). The error code "0" means that the action was successful and no error is present.

Measurement data for grayscale image and black & white image

If the "Data mode" data area contains the value 1 (GRAYPIC) or 2 (BINARYPIC), then the following data will be sent in the data area for the return values:

Data length (byte)	Data type	Description
4	Float	Measured angle
4	U32	Width
4	U32	Height
*<Width * Height * SizeOf(U8)>* For *SizeOf(U8)*: Value = 1 applies	U8	Image ▸ Image transfer as binary stream – 1 byte per pixel, – X*Y pixel – Line-by-line transfer with start position top left ▸ Image orientation corresponds to the view of the web server ▸ View from left into the protection zone, the operator side is on the right

Measurement data for angles

If the "Data mode" data area contains the value 3 (ANGLE), then the following data will be sent in the data area for the return values.

Data length (byte)	Data type	Description
4	Float	Measured angle

Measurement data for sheet profile with straight lines and angles

If the "Data mode" data area contains the value 4 (SHEETPROFILEANGLE), then the following data will be sent in the data area for the return values:

Data length (byte)	Data type	Description
4	Float	Measured angle
4	Float	CX 1; x-value of a sheet profile point of straight line 1
4	Float	CY 1; y-value of a sheet profile point of straight line 1
4	Float	m 1; gradient of straight line 1
4	Float	CX 2; x-value of a sheet profile point of straight line 2
4	Float	CY 2; y-value of a sheet profile point of straight line 2
4	Float	m 2; gradient of straight line 2
4	U32	Number of sheet profile points
*<Number Of Points * 2 * SizeOf(float)>* For *SizeOf(Float)*: Value = 4 applies	Float	x/y-position of sheet profile points 1 and 2 (sheet profile points (x, y))

Extended measurement data for angles

If the "Data mode" data area contains the value 5 (EXTENDED_ANGLE), then the following data will be sent in the data area for the return values:

Data length (byte)	Data type	Description
4	Float	Measured angle
4	U32	Total number of images used when averaging (NumberImages)
4	U32	Number of images used when averaging prior to each calculation (ImageAverage)
4	U32	Number of angles used when averaging (NumberAngles)
4	U32	Measurement time in ms (MeasureTime)

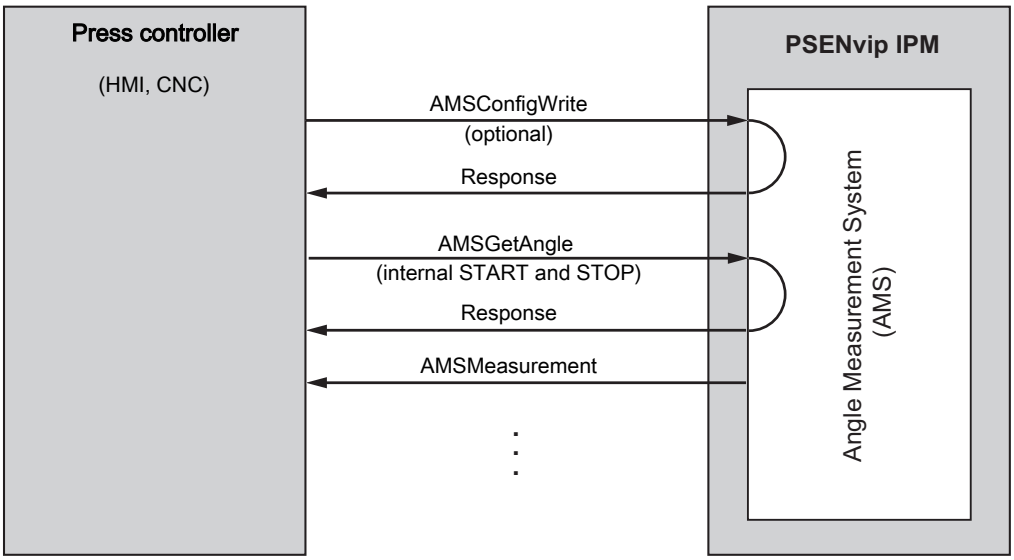
Data length (byte)	Data type	Description
4	U32	Measurement algorithm used (SheetDetectionFront) ▸ 1: SHEET ▸ 2: BOX ▸ 3: PARTIAL_BOX
4	U32	Measurement algorithm used (SheetDetectionBack) ▸ 1: SHEET ▸ 2: BOX ▸ 3: PARTIAL_BOX

5.5.3 Scenarios and procedures

5.5.3.1 Measurements in "Single measurements” measurement mode

"Single measurements” measurement mode is used for normal mode (production mode). A single measurement is triggered by the press controller (HMI, CNC). After a single angle is requested using the command AMSGetAngle, the AMS returns a single angle value and measurement mode is then stopped.

Triggering a single measurement initiates the following procedure:

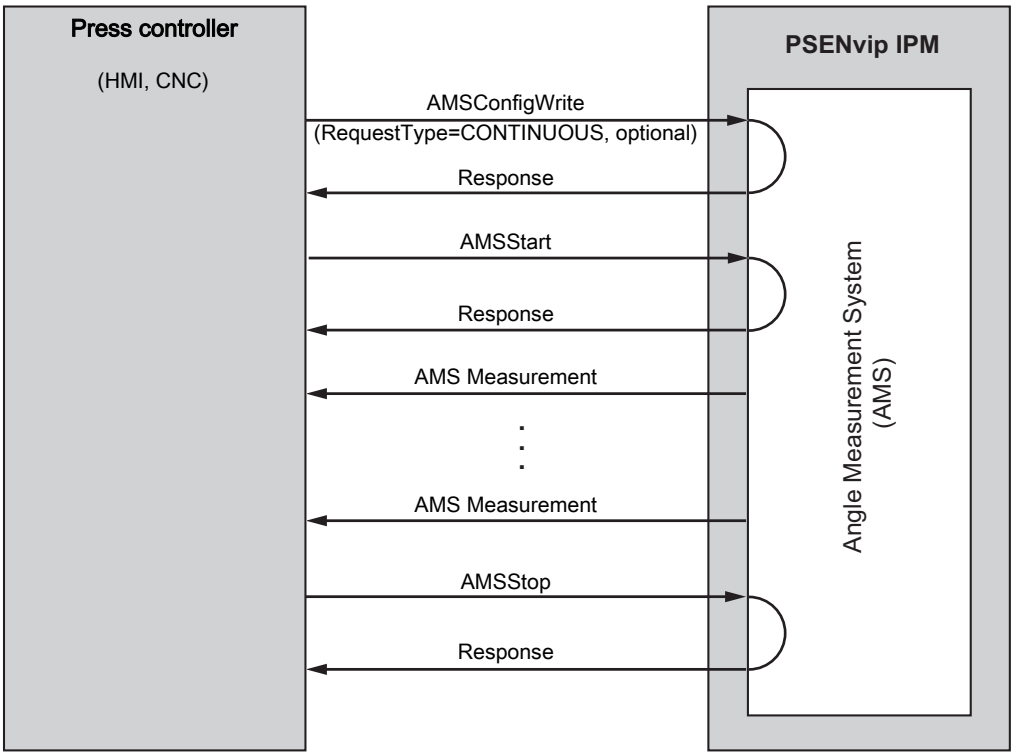


Further information is available under Request single angle – AMSGetAngle (Command ID 4) [📖 32].

5.5.3.2 Measurements in "Continuous mode" measurement mode

It is preferable to use "Continuous mode" measurement mode to test the configuration parameters and settings during commissioning. Continuous mode is triggered via the press controller (HMI, CNC). Once measurement mode is started (AMSStart command), the AMS provides measurement data continuously. Measurement mode is only halted by the stop command (AMSStop).

Triggering continuous mode initiates the following procedure:



Further information is available under Start measurement mode – AMSStart (Command ID 3) [📖 30].

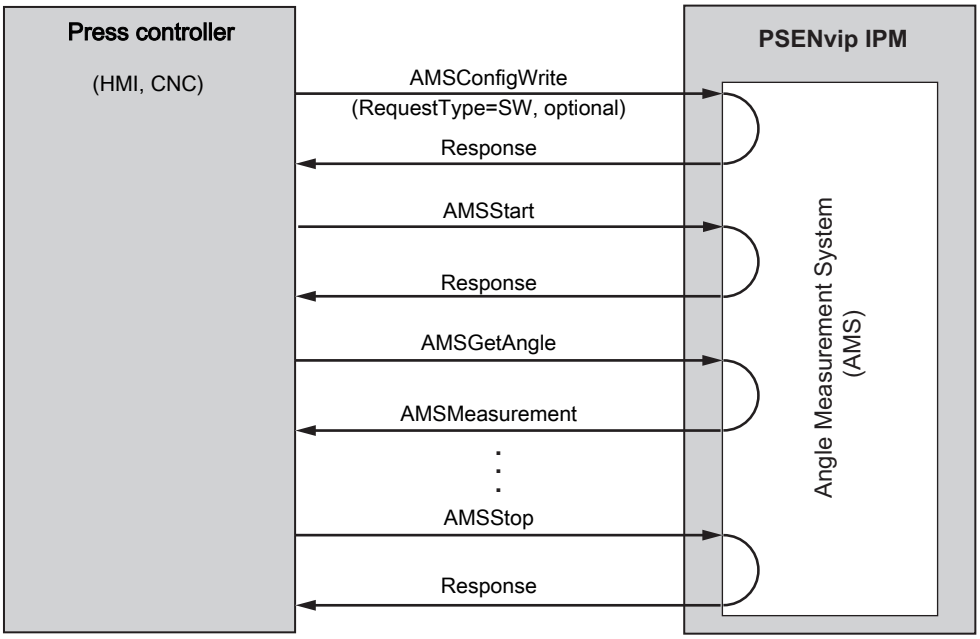
5.5.3.3 Single measurement with preparation

"Single measurements with preparation" measurement mode can also be used in normal mode (production mode). A single measurement is first prepared by the press controller (HMI, CNC) using AMSStart and then requested using AMSGetAngle.

Preparation for the measurement (AMSStart) can already start during the bending process. That way you can reduce the time between the request (AMSGetAngle) and the measurement result being available. Further single measurements can be taken if necessary.

After a single angle or multiple single angles are requested, measurement with AMSStop must be stopped explicitly.

In the case of single measurements with preparation, the following procedure is initiated:



Further information is available under Start measurement mode – AMSStart (Command ID 3) [📖 30] and Request single angle – AMSGetAngle (Command ID 4) [📖 32].

5.6 Configuration

5.6.1 Configuration file

The standard configuration data can be found in a configuration file. It is read in when the "Angle Measurement System" (AMS) application is started. The initial start is made using the configuration parameter's default values.

The configuration file contains Configurable configuration parameters [52] and non-configurable configuration parameters. Non-configurable configuration parameters are called Read-only configuration parameters [67].

The configurable configuration parameters can be changed via the press controller, using the write command (see Change parameter – AMSConfigWrite (Command ID 1) [35]). This is not possible for the read-only configuration parameters. If the changed configuration parameters are saved, then the configuration file will contain standard configuration data in which the values of various configuration parameters no longer correspond to the default values.

All the current configuration parameters at the time can be read via the press controller, using the read command (Read parameter – AMSConfigRead (Command ID 2) [37]). Both the configurable and the read-only configuration parameters are read.

If the configuration file is unavailable, defective or corrupt, the configuration file will be reconstructed using the default values from the configuration parameters. This also occurs when the module is reset to the factory settings in recovery mode (see Activate recovery mode [103] and Reset add-on module to factory settings [107]).

5.6.2 Structure of the configuration file

The configuration file contains the configuration parameters. The following applies for the configuration parameters:

- The configuration parameters are grouped into sections. A section appears as a heading with the "Parameter" addendum and is underlined using the equals sign (=).
- Each configuration parameter is on a separate line.
- When reading
  - **Numeric parameters**, the value range (minimum, maximum) is provided along with the parameter
  - **Selection parameters** the selection options are listed
  - **Physical variables**, the unit is also stated in brackets

Principle structure

```
[<SectionX> Parameter]
======================
Parameter1=Value1
Parameter2=Value2
…
[<SectionY> Parameter]
======================
Parameter1=Value1
Parameter2=Value2
…
[<SectionZ> Parameter]
======================
Parameter1=Value1
Parameter2=Value2
…
Parameter6=Value, Min=Value_1, Max=Value_2 [Unit]
…
```

Reading the configuration parameters using the command ConfigRead

When reading the configuration parameters you will obtain the following list with configuration parameters, for example:

Application Data:

==========

ApplicationId: 1000

ApplicationName: AMS

ApplicationBuild: 1.2.0.0

ApplicationBuildDate: 26.05.2024

ApplicationSoftwareVersion: 0x1020000

Common Parameter:

==========

ConfigVersion: 5

AdapterProtocolVersion: 2

AdapterType: 584110

AdapterIP: 192.168.0.13

AdapterInterface: 0

AdapterPort: 1096

ClientSoftwareVersion: 0

AMS Parameter:

==========

DataMode: ANGLE, [ANGLE, GRAYPIC, BINARYPIC, SHEETPROFILEANGLE, EXTENDED_ANGLE]

UpperToolAngle: 30.00, Min = 20, Max = 120 [Degrees]

UpperToolRadius: 1.00, Min = 1, Max = 10 [mm]

BottomToolAngle: 30.00, Min = 30, Max = 120 [Degrees]

BottomToolWidth: 25.00, Min = 8, Max = 100 [mm]

BottomToolOpening: 12.00, Min = 5, Max = 100 [mm]

SheetThickness: 2.00, Min = 0.50, Max = 12 [mm]

SheetTolerance: 1.00, Min = 0.10, Max = 3 [mm]

SheetLengthLeft: 30.00, Min = 10 [mm]

SheetLengthRight: 30.00, Min = 10 [mm]

SheetDistance: 500.00, Min = 0, Max = 2000 [mm]

SheetDetectFront: SHEET, [SHEET, BOX_UPPER, PARTIAL_BOX_UPPER, BOX_LOWER, PARTIAL_BOX_LOWER, AUTO]

SheetDetectBack: SHEET, [SHEET, BOX_UPPER, PARTIAL_BOX_UPPER, BOX_LOWER, PARTIAL_BOX_LOWER, AUTO]

MeasureTime: UNDEFINED, Min = 1, Max = 2000 [ms]

NumberImages: 1, Min = 1, Max = 100

ImageAverage: 1, Min = 1, Max = 10, [AUTO]

StatisticMode: AVERAGE, [AVERAGE, MEDIAN]

ImageSave: YES, [NO, YES]

AngleOffset: 0.00, Min = -2.5, Max = 2.5

PSENvip Parameter:

==========

PSENvipProtocolVersion: 1

PSENvipIP: 192.168.0.3

PSENvipPort: 8080

PSENvipProtocol: UDP

ImageType: GRAYSCALE

RequestType: SW, [SW, CONTINUOUS]

TransmitterMode: HIGH

StartX: 0, Max = 94 [Pixel]

StartY: 0, Max = 94 [Pixel]

SizeX: 154, Min = 60, Max (Start + Size) = 154 [Pixel]

SizeY: 154, Min = 60, Max (Start + Size) = 154 [Pixel]

YINC: 1

BufferSize: 2

ToolTopX: 68

ToolTopY: 52

FAUSoftwareVersion: 0x2040000

ReceiverSoftwareVersion: 0x2040000

5.6.3 Configuration parameters

5.6.3.1 Configurable configuration parameters

The configurable configuration parameters are grouped into sections.

Using the write command

The configurable configuration parameters can be changed using the write command (see Change parameter – AMSConfigWrite (Command ID 1) [📖 35]). It is necessary to comply with the structure and syntax rules. Further information is available under Syntax rules for configurable configuration parameters [📖 66].

Using the read command

- The configurable configuration parameters and read-only configuration parameters can be read as ASCII strings using the read command.
- When reading numeric parameters with a value range, the value range (minimum, maximum) is provided along with the value of the parameter.
- When reading parameters with a clearly defined set of values (e.g. DataMode,) the potential values are provided along with the value of the parameter.
- When physical variables are read, the unit is provided in square brackets.

General configuration guidelines

- Fixed parameters should be set once during initial commissioning for example. This occurs with the parameter "Save=YES".
- Temporary or changing parameters (e.g. sheet thickness) should be set before each measurement. This ensures that the correct parameters are used for the measurement. This must occur without the "Save" parameter or with the parameter "Save=NO".

Parameters of the FLOAT data type

Note the following when configuring parameters of the FLOAT data type

- Accuracy of the decimal places = 2 digits
- It is possible to configure values with more than 2 decimal places.
- If values with more than 2 decimal places are configured, then the values will be rounded to 2 decimal places.

NOTICE

Premature failure due to frequent write access

If an AMSConfigWrite with "Save=YES" is performed before every measurement, very frequent write access to the Flash memory will result. This can cause the add-on module to fail prematurely.

Make sure that temporary or changing parameters are set without the "Save" parameter or with the "Save=NO" parameter.

- Alternatively, temporary or changing parameters can be set when changing the bending program. In this case the setting can be made with the "Save=YES" parameter. This will mean that the settings are still active even after the add-on module is restarted.

- If the settings are made without the "Save" parameter or with the "Save=NO" parameter, the settings will need to be repeated after the add-on module is restarted.

Section [COMMON]: General parameters for the whole application

[COMMON]		
Parameter	**Value**	**Note**
Save	NO (Default value)	Temporary configuration The configured parameters are **not** applied to the configuration file. When the add-on module is restarted, the standard configuration will be used again.
	YES	Permanent configuration With ***Save=YES***, the transferred parameters are applied to the configuration file and then the configuration is saved permanently. If parameters have already been transferred with ***Save=NO***, then these will also be saved permanently.
	Please note: The parameter can only be used in conjunction with the write command AMSConfigWrite. It is not part of the configuration file and is not displayed when the configuration data is read using AMSConfigRead. If changed parameters are to be saved permanently, then ***Save=YES*** must be transferred with each write command.	
	Example: `Save=YES`	
AdapterProtocolVersion	*<32-Bit-Unsigned>*	Parameter used to configure the version of the protocol used between the press controller (HMI, CNC) and the add-on module: - The parameter is used to check compatibility. - Start value: 1 - The press controller (HMI, CNC) sends the version in the configuration command (AMSConfigWrite), the add-on module checks the version and sends a version error (error code 1001) if there is incompatibility. - Configuration of the parameter is optional. If the parameter is not configured, the version cannot be checked.
	Example: `AdapterProtocolVersion=2`	

[COMMON]		
Parameter	**Value**	**Note**
ClientSoftwareVersion	*<32-Bit-Unsigned>*	Parameter used to configure the software version of the press controller (HMI, CNC). ▸ The parameter is used to check compatibility ▸ The press controller (HMI, CNC) sends the version in the configuration command (AMSConfigWrite), the add-on module checks the version and if necessary can provide the version-dependent functionality. The add-on module sends a version error (error code 1001) if there is incompatibility. ▸ Configuration of the parameter is optional. If the parameter is not configured, the version cannot be checked.
	Example: `ClientSoftwareVersion=1`	
AdapterPort	1096	Port via which the press controller (HMI, CNC) can communicate with the AMS.
	Example: `AdapterPort=1096`	

Section [PSENVIP]: Parameters for PSENvip control and image request

[PSENVIP]		
Parameter	**Value**	**Note**
PSENvipIP	192.168.0.3 (default IP address)	IP address of the special module PSSu K F FAU P Format: xxx.xxx.xxx.xxx
	Example: `PSENvipIP=192.168.0.3`	
RequestType	Type of request and provision of measurement data through the add-on module PSENvip IPM and of image data through PSENvip The parameter only affects the AMSStart command. Internally the parameter is converted to SW (single angle and single image request) through the command AMSGetAngle.	
	CONTINUOUS (Default setting)	Provision of angles and measurement data through the add-on module and of image data through PSENvip is continuous
	SW	Request for measurement data from single measurements with AMSGetAngle The required number of images is provided through PSENvip and the add-on module provides an angle as well as measurement data.

	Example - Configuration with AMSConfigWrite:
	`RequestType=CONTINUOUS`
	Example - Read with AMSConfigRead:
	`RequestType: CONTINUOUS, [SW, CONTINUOUS]`	

StartX *<See [1]>*	Value range: 0 … 94 Default value: 0	Image range that is to be transferred and evaluated: ▸ x-value of start coordinate (position: left) ▸ To obtain a full image, StartX=0 and StartY=0 must be configured.

	Example - Configuration with AMSConfigWrite:
	`StartX=10`
	Example - Read with AMSConfigRead:
	`StartX: 10, Max=94 [Pixel]`	

StartY *<See [1]>*	Value range: 0 … 94 Default value: 0	Image range that is to be transferred and evaluated: ▸ y-value of start coordinate (position: top) ▸ To obtain a full image, StartX=0 and StartY=0 must be configured.

	Example - Configuration with AMSConfigWrite:
	`StartY=10`
	Example - Read with AMSConfigRead:
	`StartY: 10, Max=94 [Pixel]`	

<table>
<tr><th colspan="3">[PSENVIP]</th></tr>
<tr><th>Parameter</th><th>Value</th><th>Note</th></tr>
<tr><td rowspan="2">SizeX
<See [1]></td><td>Value range: 60 … 154
Default value: 154</td><td>Image range that is to be transferred and evaluated:
Number of pixels in x-direction, related to the configured start coordinate x (StartX)
Please note:
▸ StartX + SizeX must be less than/equal to 154
▸ To obtain a full image, SizeX=154 and SizeY=154 must be configured.</td></tr>
<tr><td colspan="2">Example - Configuration with AMSConfigWrite:
<code>SizeX=100</code>
Example - Read with AMSConfigRead:
<code>SizeX: 100, Min=60, Max(Start+Size)=154 [Pixel]</code></td></tr>
<tr><td rowspan="2">SizeY
<See [1]></td><td>Value range: 60 … 154
Default value: 154</td><td>Image range that is to be transferred and evaluated:
Number of pixels in y-direction, related to the configured start coordinate y (StartY)
Please note:
▸ StartY + SizeY must be less than/equal to 154
▸ To obtain a full image, SizeX=154 and SizeY=154 must be configured.</td></tr>
<tr><td colspan="2">Example - Configuration with AMSConfigWrite:
<code>SizeY=90</code>
Example - Read with AMSConfigRead:
<code>SizeY: 90, Min=60, Max(Start+Size)=154 [Pixel]</code></td></tr>
</table>

[1]

You can limit the image range via the parameter StartX, SizeX, StartY und SizeY. That you way you can speed up the measurement a little.
Please note: Use of the parameter requires a certain basic understanding of the measurement process. We recommend that you only use the parameter in consultation with Pilz.

Section [AMS]: Parameters for the measurement system (AMS)

<table>
<tr><th colspan="3">[AMS]</th></tr>
<tr><th>Parameter</th><th>Value</th><th>Note</th></tr>
<tr><td rowspan="8">DataMode</td><td colspan="2">This parameter is used to establish which measurement results will be provided.</td></tr>
<tr><td>ANGLE
(Default setting)</td><td>Measurement data: angle value only</td></tr>
<tr><td>GRAYPIC</td><td>Measured data: grayscale image and angle value</td></tr>
<tr><td>BINARYPIC</td><td>Measured data: black white image and angle value</td></tr>
<tr><td>SHEETPROFILEANGLE</td><td>Measured data: sheet profile and angle value</td></tr>
<tr><td>EXTENDED_ANGLE</td><td>Measured data: Angle value with averaging and algorithm information</td></tr>
<tr><td colspan="2">Example - Configuration with AMSConfigWrite:
<code>DataMode=ANGLE</code>
Example - Read with AMSConfigRead:
<code>DataMode: ANGLE [ANGLE, GRAYPIC, BINARYPIC, SHEETPROFILEANGLE, EXTENDED_ANGLE]</code></td></tr>
<tr><td rowspan="2">SheetThickness</td><td>Value range: 0.5 … 12
Default setting: 2.00</td><td>Sheet thickness
▸ Data type: Float
▸ Unit: mm
Please note:
▸ The sheet thickness is known in the press controller's bending program. SheetThickness must be configured by the press controller each time the bending program is changed or before every measurement.
▸ A value with more than 2 decimal places can be entered for the sheet thickness. However, in this case the value will be rounded internally.</td></tr>
<tr><td colspan="2">Example - Configuration with AMSConfigWrite:
<code>SheetTickness=2</code>
Example - Read with AMSConfigRead:
<code>SheetThickness: 2.00, Min=0.50, Max=12 [mm]</code></td></tr>
</table>

<table>
<tr><th colspan="3">[AMS]</th></tr>
<tr><th>Parameter</th><th>Value</th><th>Note</th></tr>
<tr><td rowspan="2">SheetTolerance</td><td>Value range: 0.1 … 3
Default setting: 1.00</td><td>Sheet thickness tolerance
▸ Data type: Float
▸ Unit: mm
Please note:
▸ The tolerance must not be greater than the sheet thickness (SheetThickness).
▸ The tolerance influences the sheet detection. Reducing the tolerance can increase the measuring accuracy. However, by reducing the tolerance there is a risk that no sheet will be detected and therefore no angle, or a completely incorrect angle, will be determined.</td></tr>
<tr><td colspan="2">Example - Configuration with AMSConfigWrite:
<code>SheetTolerance=0.1</code>
Example - Read with AMSConfigRead:
<code>SheetTolerance: 1.00, Min=0.10, Max=3 [mm]</code></td></tr>
</table>

<table>
<tr><th colspan="3">[AMS]</th></tr>
<tr><th>Parameter</th><th>Value</th><th>Note</th></tr>
<tr><td rowspan="2">MeasureTime</td><td>Value range: 1 … 2000
Default setting:
0 (UNDEFINED)</td><td>Measurement time for multiple measurement with averaging of several images
▸ Data type: U32
▸ Unit: ms
Please note:
▸ Only a rough time frame is configured via MeasureTime. The actual measurement time may deviate from the configured value by +/- 50 ms.
▸ If ImageAverage is configured in addition to MeasureTime, the actual measurement time may turn out to be greater than is documented as the deviation for MeasureTime.
▸ The parameter can be used as an alternative to the NumberImages parameter. NumberImages and MeasureTime influence each other; i.e. if one of the parameters is changed, then the other parameter is changed to "0" (UNDEFINED).
▸ MeasureTime=0: The angle is determined in accordance with the configuration of "NumberImages".
▸ Either NumberImages or MeasureTime may be configured. The measurement system will then determine the other parameter. The configuration will not be applied if the user has configured both NumberImages and MeasureTime (PARAMETER_ERROR 1002).</td></tr>
<tr><td colspan="2">Example - Configuration with AMSConfigWrite:
<code>MeasureTime=500</code>
Example - Read with AMSConfigRead:
<code>MeasureTime: 500, Min=0, Max=2000 [ms]</code></td></tr>
</table>

<table>
<tr><th colspan="3">[AMS]</th></tr>
<tr><th>Parameter</th><th>Value</th><th>Note</th></tr>
<tr><td rowspan="2">NumberImages</td><td>Value range: 1 … 100
Default setting: 1</td><td>Number of images to be used for averaging with multiple measurement
▸ Data type: U32
Please note:
▸ With the configuration NumberImage=1, the angle is calculated from a single image, without averaging.
▸ The parameter can be used as an alternative to the MeasureTime parameter. NumberImages and MeasureTime influence each other; i.e. if one of the parameters is changed, then the other parameter is changed to "0" (UNDEFINED).
▸ NumberImages=0: The angle is determined in accordance with the configuration of "MeasureTime".
▸ Either NumberImages or MeasureTime may be configured. The measurement system will then determine the other parameter. The configuration will not be applied if the user has configured both NumberImages and MeasureTime (PARAMETER_ERROR 1002).
▸ If both NumberImages and ImageAverage are to be configured, NumberImages must be an integer multiple of ImageAverage. If not the configuration will be rejected and will not be applied (VALUE_ERROR 1003).</td></tr>
<tr><td colspan="2">Example - Configuration with AMSConfigWrite:
<code>NumberImages=10</code>
Example - Read with AMSConfigRead:
<code>NumberImages: 10, Min=1, Max=100</code></td></tr>
</table>

<table>
<tr><th colspan="3">[AMS]</th></tr>
<tr><th>Parameter</th><th>Value</th><th>Note</th></tr>
<tr><td rowspan="2">ImageAverage</td><td>Value range: 1 … 10 or AUTO
Default setting: 1</td><td>Number of raw images to be averaged before the angle is calculated
Data type: U32
▸ ImageAverage=1:
An angle value is calculated from each raw image.
▸ ImageAverage=AUTO:
The number of raw images that are averaged before the angle value is calculated corresponds approximately to the number of angle values that is then used to average the angle values.
Please note:
▸ If both NumberImages and ImageAverage are to be configured, then NumberImages must be an integer multiple of ImageAverage. If not the configuration will be rejected and will not be applied (VALUE_ERROR 1003).
▸ If MeasureTime is configured in addition to ImageAverage, the actual measurement time may turn out to be greater than is documented as the deviation for MeasureTime.</td></tr>
<tr><td colspan="2">Example - Configuration with AMSConfigWrite:
<code>ImageAverage=4</code>
Example - Read with AMSConfigRead:
<code>ImageAverage: 4, Min=1, Max=10, [AUTO]</code></td></tr>
<tr><td rowspan="4">StatisticMode</td><td colspan="2">Averaging procedure for the angle values</td></tr>
<tr><td>AVERAGE
(Default setting)</td><td>Averaging of angle values using arithmetic mean formation</td></tr>
<tr><td>MEDIAN</td><td>Averaging of angle values using median method</td></tr>
<tr><td colspan="2">Example - Configuration with AMSConfigWrite:
<code>StatisticMode=MEDIAN</code>
Example - Read with AMSConfigRead:
<code>StatisticMode: MEDIAN, [AVERAGE, MEDIAN]</code></td></tr>
</table>

[AMS]		
Parameter	**Value**	**Note**
SheetDetectFront	Detection of front sheet edge	
	AUTO (Default setting)	The AMS automatically determines the algorithm that supplies the best angle value.
	SHEET	Two-sided sheet edge detection This configuration should only be used if both legs are clearly recognisable.
	BOX_UPPER	On the front leg, a box is bent upwards.
	PARTIAL_BOX_UPPER	On the front leg, a small box (<20 mm) is bent upwards.
	BOX_LOWER	On the front leg, a box is bent downwards.
	PARTIAL_BOX_LOWER	On the front leg, a small box (<20 mm) is bent downwards.

	Example - Configuration with AMSConfigWrite:
	`SheetDetectFront=AUTO`
	Example - Read with AMSConfigRead:
	`SheetDetectFront: AUTO, [SHEET, AUTO]`	

SheetDetectBack	Back sheet edge detection	
	AUTO (Default setting)	The AMS automatically determines the algorithm that supplies the best angle value.
	SHEET	Two-sided sheet edge detection This configuration should only be used if both legs are clearly recognisable.
	BOX_UPPER	On the back leg, a box is bent upwards.
	PARTIAL_BOX_UPPER	On the back leg, a small box (<20 mm) is bent upwards.
	BOX_LOWER	On the back leg, a box is bent downwards.
	PARTIAL_BOX_LOWER	On the back leg, a small box (<20 mm) is bent downwards.

	Example - Configuration with AMSConfigWrite:
	`SheetDetectBack=AUTO`
	Example - Read with AMSConfigRead:
	`SheetDetectFront: AUTO, [SHEET, AUTO]`	

[AMS]		
Parameter	**Value**	**Note**
ImageSave	Raw images from measurements (image series) are saved in non-retentive memory (RAM)	
	NO (Default setting)	Raw images are not saved
	YES	Raw images are saved in RAM

	Example - Configuration with AMSConfigWrite:
	`ImageSave=YES`
	Example - Read with AMSConfigRead:
	`ImageSave: YES, [NO, YES]`	

UpperToolAngle  *<Change without impact>*	Value range: 30 … 120 Default setting: 30.00	Upper tool angle ▸ Data type: Float ▸ Unit: Degree

	Example - Configuration with AMSConfigWrite:
	`UpperToolAngle=50`
	Example - Read with AMSConfigRead:
	`UpperToolAngle: 30.00, MIN=20, MAX=120 [Degrees]`	

UpperToolRadius  *<Change without impact>*	Value range: 1 … 10 Default setting: 1.00	Upper tool radius on the bending line ▸ Data type: Float ▸ Unit: mm

	Example - Configuration with AMSConfigWrite:
	`UpperToolRadius=4`
	Example - Read with AMSConfigRead:
	`UpperToolRadius: 1.00, Min=1, Max=10 [mm]`	

BottomToolAngle  *<Change without impact>*	Value range: 30 … 120 Default setting: 90.00	Lower tool angle ▸ Data type: Float ▸ Unit: Degree

	Example - Configuration with AMSConfigWrite:
	`BottomToolAngle=100`
	Example - Read with AMSConfigRead:
	`BottomToolAngle: 90.00, Min=30, Max=120 [Degrees]`	

[AMS]		
Parameter	**Value**	**Note**
BottomToolWidth  <*Change without impact*>	Value range: 8 … 100 Default setting: 25.00	Lower tool width ▸ Data type: Float ▸ Unit: mm

	Example - Configuration with AMSConfigWrite:
	`BottomToolWidth=50`
	Example - Read with AMSConfigRead:
	`BottomToolWidth: 25.00, Min=8, Max=100 [mm]`	

BottomToolOpening  <*Change without impact*>	Value range: 5 … 100 Default setting: 12.00	Width of lower tool opening ▸ Data type: Float ▸ Unit: mm

	Example - Configuration with AMSConfigWrite:
	`BottomToolOpening=50`
	Example - Read with AMSConfigRead:
	`BottomToolOpening: 12.00, Min=5, Max=100 [mm]`	

SheetLengthLeft  <*Change without impact*>	Minimum value: 10 Default setting: 30.00	Left sheet leg length ▸ Data type: Float ▸ Unit: mm

	Example - Configuration with AMSConfigWrite:
	`SheetLengthLeft=50`
	Example - Read with AMSConfigRead:
	`SheetLengthLeft: 30.00, Min=10 [mm]`	

SheetLengthRight  <*Change without impact*>	Minimum value: 10 Default setting: 30.00	Right sheet leg length ▸ Data type: Float ▸ Unit: mm

	Example - Configuration with AMSConfigWrite:
	`SheetLengthRight=50`
	Example - Read with AMSConfigRead:
	`SheetLengthRight: 30.00, Min=10 [mm]`	

SheetDistance  <*Change without impact*>	Value range: 0 … 2000 Default setting: 500.00	Distance between sheet and receiver ▸ Data type: Float ▸ Unit: mm

	Example - Configuration with AMSConfigWrite:
	`SheetDistance=250`
	Example - Read with AMSConfigRead:
	`SheetDistance: 500.00, Min=0, Max=2000 [mm]`	

[AMS]		
Parameter	**Value**	**Note**
AngleOffset	Value range: -2.5 … +2.5 V Default setting: 0	Offset value for adapting the measured values to a specific machine configuration Data type: Float Unit: DEGREE Please note: ▸ Before the result is transferred to the press HMI, the entered offset value is added to the measured value.

	Example - Configuration with AMSConfigWrite:
	`AngleOffset=1.5`
	Example - Read with AMSConfigRead:
	`AngleOffset: 1.50, Min=-2.50, Max=2.50 [°]`	

5.6.3.2 Syntax rules for configurable configuration parameters

For both configuration using the write command and reading using the read command, the configuration parameters are transferred as ASCII strings.

Syntax rules

- The configuration parameters are grouped into sections.
  - A section name starts with "[" and ends with "]".
  - Spaces are not permitted within the square brackets.
  - Each section name is on a separate line.
  - Each configuration with the write command must start with a section name.
- The parameter definitions for a section must come after the section name and before the section name of another section.
  - Each parameter definition is on a separate line.
  - Between the parameter and value there is an "=" without spaces.
- Each line (section name and parameter definition) ends with a line feed character. This also applies to the final parameter definition.
  Permitted strings for the line feed:
  - "\n" (Linux)
  - "\r\n" (Windows)
- Blank lines to improve clarity are permitted. However, they must not contain spaces.

Principle structure and syntax

```
[Section1]\r\n
Parameter1=Value1\r\n
Parameter2=Value2\r\n
...
[Section2]\r\n
Parameter1=Value1\r\n
Parameter2=Value2\r\n
…
```

Example

```
[AMS]\r\n
SheetThickness=2\r\n
SheetTolerance=0.5\r\n
\r\n
[PSENvip]\r\n
SizeY=154\r\n
\r\n
[Common]\r\n
Save=YES\r\n
```

5.6.3.3 Read-only configuration parameters

When the read command AMSConfigRead is used, the read-only configuration parameters and the configurable configuration parameters are read as ASCII strings. The tables below are divided into sections and contain the read-only configuration parameters.

Section [Application Parameter]: Identification parameters for the measurement system (AMS)

[Application Data]		
Parameter	**Value**	**Description**
ApplicationId	1000	Application's unique ID Meaning: 1000: "Angle Measurement System "(AMS) application
	Example: `ApplicationId: 1000`	
ApplicationName	AMS	Name of application
	Example: `ApplicationName: AMS`	
ApplicationBuild	1.1.0.0	Build number
	Example: `ApplicationBuild: 1.1.0.0`	
ApplicationBuildDate	31.10.2019	Build creation date
	Example: `ApplicationBuildDate: 31.10.2019`	
ApplicationSoftwareVersion	0x1010000	Software version number
	Example: `ApplicationSoftwareVersion: 0x1010000`	

Section [COMMON Parameter]: General parameters for the whole application

[COMMON parameter]		
Parameter	**Value**	**Description**
ConfigVersion	5	Configuration data version
	Example: `ConfigVersion: 5`	
AdapterType	584110	Identifier for the communication adapter Note: The stated adapter type indicates the communication adapter from Bystronic.
	Example: `AdapterType: 584110`	

[COMMON parameter]		
Parameter	**Value**	**Description**
AdapterIP	192.168.0.13	IP address of the PSENvip IPM
	Example: `AdapterIP: 192.168.0.13`	
AdapterInterface	0	Interface that the press controller (HMI, CNC) uses to communicate with the AMS
	Example: `AdapterInterface: 0`	

Section [PSENvip parameters]: Parameters for PSENvip control and image request

[PSENvip Parameters]		
Parameter	**Value**	**Description**
PSENvipProtocolVersion	1	Version number of the communication protocol used for communication between the add-on module and PSENvip.
	Example: `PSENvipProtocolVersion: 1`	
PSENvipPort	8080	Port for connection to the PSENvip
	Example: `PSENvipPort: 8080`	
PSENvipProtocol	UDP	UDP is used as the communication protocol between PSENvip and the add-on module (AMS).
	Example: `PSENvipProtocol: UDP`	
	Example: `RequestType: CONTINUOUS`	
ImageType	GRAYSCALE	Grayscale image
	Example: `ImageType: GRAYSCALE`	
TransmitterMode	HIGH	High transmitter intensity
	Example: `TransmitterMode: HIGH`	
ToolTopX	<*Value*>	x-coordinate of the tool point detected in the PSENvip
	Example: `ToolTopX: 68`	

[PSENvip Parameters]		
Parameter	**Value**	**Description**
ToolTopY	*<Value>*	y-coordinate of the tool point detected in the PSENvip
	Example: `ToolTopY: 52`	
YINC	1	Column increment 1: Each image column is provided
	Example: `YINC: 1`	
BufferSize	2	Number of images that are buffered on the PSENvip
	Example: `BufferSize: 2`	
FAUSoftwareVersion	0x2020000	Software version of the special module PSSu K F FAU P
	Example: `FAUSoftwareVersion: 0x2020000`	
ReceiveSoftwareVersion	0x2020000	Software version of the PSENvip R (receiver)
	Example: `ReceiveSoftwareVersion: 0x2020000`	

6 Installation

6.1 Install add-on module

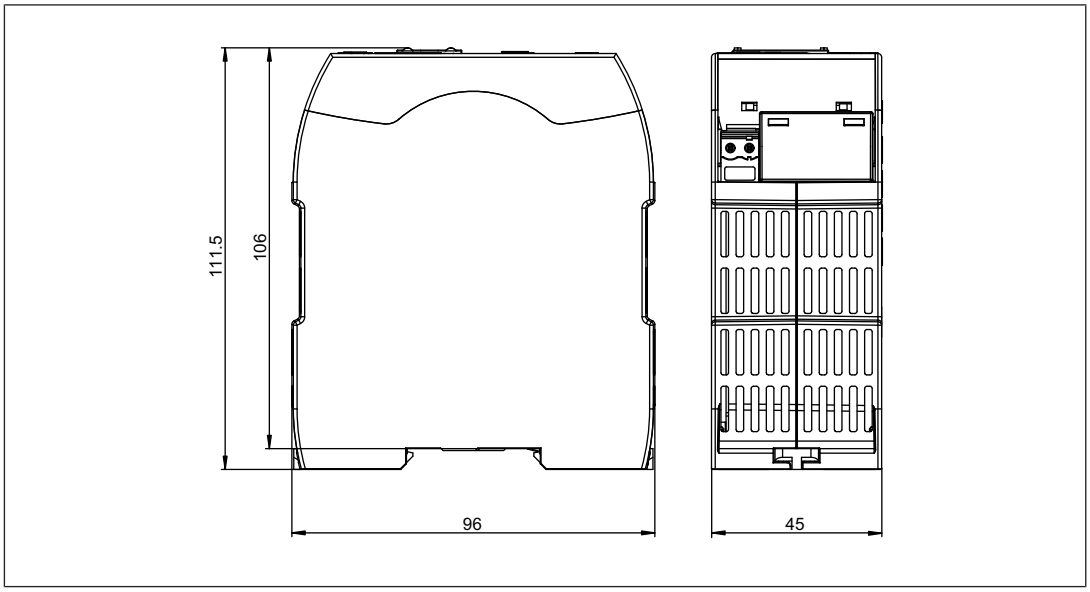
- Install the add-on module in an environment that guarantees a protection type of at least IP54 for the add-on module.
- Install the add-on module on to a horizontal mounting rail.
  The venting slots must face upward and downward. Other mounting positions could destroy the add-on module.
- Use the locking elements on the rear of the add-on module to attach it to a mounting rail. Connect the add-on module to the mounting rail in an upright position, so that the earthing springs on the add-on module are pressed on to the mounting rail.
- The ambient temperature of the add-on module must not exceed the figure stated in the technical details, otherwise air conditioning is required.
- To comply with EMC requirements, the mounting rail must have a low impedance connection to the central earth point (e.g. earth bar).

NOTICE

Damage due to electrostatic discharge!

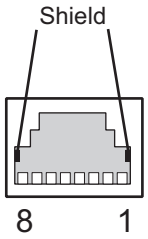
Electrostatic discharge can damage components.
Ensure against discharge before touching the product, e.g. by touching an earthed, conductive surface or by wearing an earthed armband.

6.2 Dimensions



7 Interfaces

7.1 Connector pin assignment X1, X2 (Ethernet)

X1, X2	Assignment	
RJ45 female connector	1: TD+	
	2: TD-	
	3: RD+	
	4: n.c.	
	5: n.c.	
	6: RD-	
	7: n.c.	
	8: n.c.	

▶ n.c. = not connected

INFORMATION

The X2 interface has no function.

7.2 Connector pin assignment X3

INFORMATION

The X3 interface has no function.

7.3 Connector pin assignment X4 (module supply)

X4	Assignment	
Socket, 2-pin	+24V	Module supply (supply voltage for the add-on module)
	0V	Module supply

7.4 USB port X5

The add-on module has a USB connection. You can use this to connect a USB memory to save the raw images.

Use of a USB extension cable is not permitted and is deemed improper use.

CAUTION!

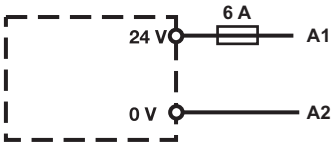
Risk of burns!

With ambient temperatures >45 °C, a surface temperature of above 70 °C can arise when a USB memory is connected!

Take protective measures to prevent intended and unintended contact with an inserted USB memory (e.g. only leave the USB memory inserted briefly, never leave the USB memory inserted during productive mode).

8 Wiring

8.1 Connect module supply

Connector	Function	
X4	Module supply to supply the add-on module	

Module supply properties

- Polarity protection
- Overvoltage protection

Prerequisites

- Compliance with the information stated under Technical details [📖 112].
- Copper wire is used, which can withstand 75° C.

Procedure

- Connect the supply voltage for the module supply and protect the supply voltage as follows:
  - Circuit breaker, characteristic C - 6 A

    or
  - Blow-out fuse, slow, 6 A

Guidelines for UL approval

UL Markings

- The external circuits intended to be connected to this device shall be galv. separated from mains supply or hazardous live voltage by reinforced or double insulation and meet the requirements of PELV (Class III) circuit of UL/CSA/IEC 61010-1, 2-201.
- The modules have to be build-in the final safety enclosure, which has adequate rigidity according to UL 61010-1, 61010-2-201 and meets the requirements with respect to spread of fire.

8.2 Connect add-on module to the network

The add-on module has two RJ45 sockets for connecting to Ethernet.

Use the Ethernet interfaces X1 and X2 as follows:

- Ethernet interface X1
  - Connect the add-on module to the Ethernet interfaces on the PSENvip (productive version) and the press controller (CNC, HMI).
- Ethernet interface X2
  - *No function*

NOTICE

Please note the security requirements under Security [📖 12].

9 Commissioning

9.1 Network configurations

Please note the following network configurations for the various Ethernet connections on the add-on module PSENvip IPM:

IP address	Port	Comment
192.168.0.13	- - -	Unchangeable IP address of the add-on module, for communication of the press controller (HMI, CNC) or a PC with the ▸ TCP Server for the "Angle Measurement System" (AMS) application ▸ Diagnostic Server ▸ Recovery Server
	1096	Pre-configured port of the TCP Server for the "Angle Measurement System" (AMS) application on the add-on module ▸ Communication with the AMS must be via this port. ▸ The port can be changed via the command AMSConfigWrite (AdapterPort parameter). Note that the configuration must be made with the parameter Save=YES. ▸ The change will not take effect until the add-on module has been restarted.
192.168.0.3	- - -	The IP address of the PSENvip is pre-configured with this IP address in the add-on module. ▸ To enable the add-on module to communicate with the special module PSSu K F FAU P, this IP address must match the IP address configured in PAS4000 for the special module PSSu K F FAU P. ▸ The IP address of the PSENvip can be changed via the command AMSConfigWrite (parameter PSENvipIP).
	8080	Unchangeable port for UDP communication between add-on module and PSENvip

INFORMATION

For communication via Ethernet please note:

- The network configuration and any installed firewall must allow communication via the stated IP addresses and ports.
- Protocol version 1 is used for communication with the TCP Server. If the protocol is developed further, compatibility must be taken into account.

NOTICE

Note the information and requirements stated under Security [12] and Network data [115].

9.2 Initial commissioning

The prerequisite for commissioning the add-on module PSENvip IPM is a functioning PSENvip system. You'll find a description of the required actions and inspections in the operating manual "PSENvip R/PSENvip R LR, PSENvip E".

These include:

- Align transmitter and receiver
- Perform the adjustment
- Use the test piece to test the function of the safeguard

INFORMATION

Position the tool

Note the different recommendations for positioning the tool under Position tool [78].

9.2.1 Position tool

Prerequisites

- You have installed the PSENvip (transmitter and receiver) and carried out the electrical wiring correctly. You have noted and complied with the requirements for installation and wiring in the operating manual "PSENvip R/PSENvip R LR; PSENvip E".
- You have fitted an upper tool to the right and left-hand edge of the press brake.
- You have installed the PSENvip IPM (see Installation [70]) and carried out the electrical wiring (see Wiring [73]) correctly.
- The press controller (HMI, CNC) or the test client (PC) is connected to the special module PSSu K F FAU P via the Ethernet interface and the web interface (PSENvip) is available to adjust the tool.

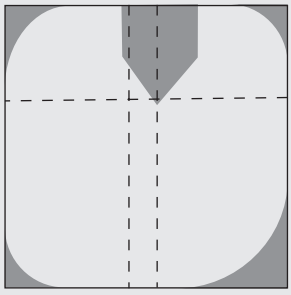
Procedure

- Note the requirements stated under "Commissioning" in the operating manual "PSENvip R/PSENvip R LR; PSENvip E".
- Switch to the ***Adjustment*** page on the web interface and adjust the transmitter, receiver and tool.

INFORMATION

Contrary to the details in the operating manual "PSENvip R/PSENvip R LR; PSENvip E", alignment to the right-hand bending line (tool centre) is recommended for the "Angle Measurement System" (AMS) application. The distance from the bending line to the front segments of the protected field is >15 mm.

Example:



This alignment increases the measuring accuracy for the bending angle measurement. Note that in this case, the maximum tool width for tool classes 1 and 2 is reduced.

- Switch to the ***Tool Change*** page in the web interface and confirm the tool class.

9.2.2 Configuration during commissioning

If the pre-defined network parameters do not match the network parameters for the overall system, the network parameters will first need to be aligned. Note the information under Network configurations [📖 75].

The basic configuration parameters must be set once during initial commissioning. Then they must be permanently saved using the write command AMSConfigWrite and the setting "Save=YES" (see Configurable configuration parameters [📖 52]). The changes will not take effect until the add-on module has been restarted.

If other basic configuration parameters are to be changed, this must also take place in the commissioning phase using the command AMSConfigWrite and the setting "Save=YES".

NOTICE

Changing configurable configuration parameters

Note that good knowledge of the bending angle measurement procedure is needed to change the factory-set configuration parameters.

We recommend that you only change the configurable configuration parameters in consultation with Pilz.

9.2.3 Test in continuous measurement mode (continuous mode)

It is preferable to use continuous mode when testing the configuration parameters and settings during commissioning. In this measurement mode, measurement data is provided continuously once measurement has started (command AMSStart). Information about the procedure is available under Measurements in "Continuous mode" measurement mode [📖 46].

10 Operation

CAUTION!

Risk of burns!

With ambient temperatures >45 °C, a surface temperature of above 70 °C can arise when a USB memory is connected!

Take protective measures to prevent intended and unintended contact with an inserted USB memory (e.g. only leave the USB memory inserted briefly, never leave the USB memory inserted during productive mode).

10.1 Measurement mode with single measurements

In normal mode (production mode), the "single measurements" measurement mode is used. In this measurement mode, when a single angle is requested (command AMSGet-Angle), a single angle value is returned and then measurement mode is stopped. Information about the procedure is available under Measurements in "Single measurements" measurement mode [📖 45].

10.2 LED indicators

Legend

 LED on

 LED flashes

● LED off

DIAG

Colour	State	Meaning
- - -	●	Add-on module is not ready for operation
Green		No error present
Red		Module error
Red		Add-on module is working with test firmware

PWR

Colour	State	Meaning
- - -	●	No supply voltage
Green		Supply voltage present, add-on module is ready for operation
Red		Add-on module is in recovery mode

LEDs for normal mode (production mode)

The meaning of the following LEDs applies exclusively for normal mode (production mode). The meaning of the LEDs does not apply in recovery mode.

HMI

Colour	State	Meaning
- - -	●	No connection between press controller (HMI, CNC) and add-on module
Green		The press controller (HMI, CNC) has established a communication connection with the add-on module

PVIP

Colour	State	Meaning
- - -	●	No communication connection with the PSENvip
Green		The add-on module has established a communication connection with the PSENvip

CONT

Colour	State	Meaning
- - -	●	The measurement system (AMS) is not in "Continuous mode" measurement mode.
Green	☼	The measurement system (AMS) has been started using the start command AMSStart and is in "Continuous mode" measurement mode.

MEAS

Colour	State	Meaning
- - -	●	The measurement system (AMS) is not in measurement mode.
Green	☼	The measurement system (AMS) is in measurement mode.

CNC

Colour	State	Meaning
- - -	●	*<No function>*

TRIG

Colour	State	Meaning
- - -	●	*<No function>*

TRF

Colour	State	Meaning
- - -	●	No data traffic
Yellow	◐	Data traffic present

LNK

Colour	State	Meaning
- - -	●	No network connection
Green	☼	Network connection exists

11 Diagnostics and troubleshooting

11.1 Error codes

11.1.1 General error codes

Code	Error text in the log file	Meaning
0	Success	No error present
1	Error	The application is registering a general internal error.

11.1.2 Error codes for angle measurement system (AMS)

The following error messages can occur when the press controller prompts the AMS to perform an action.

Code	Error text in the log file	Meaning
1000	Appl_State_Error	The AMS is in the wrong state to execute the command. ▸ One of the commands AMSStart, AMSGetAngle, AMSConfigWrite or AMSConfigRead was sent, although measurement mode is active. ▸ Note: If the command AMSStop is sent although measurement mode is inactive, this does not lead to an error (error code 0).
1001	Version_Error	The software version of the press controller (HMI) and add-on module is incompatible.
1002	Parameter_Error	The Client transferred an incorrect parameter (e.g. in the command AMSConfigWrite): ▸ Unknown parameter ▸ Syntax error
1003	Value_Error	The Client transferred an incorrect value (e.g. in the command AMSConfigWrite): ▸ Unknown value for a parameter
1004	Out_Of_Range	The Client transferred a value outside of the defined range (e.g. in the command AMSConfigWrite): ▸ The value of the parameter is outside the permitted value range.

Code	Error text in the log file	Meaning
1005	Protocol_Error	The press controller has violated the requirements defined in the communication protocol headers. Examples: ▸ Data format is not supported ▸ Data length is not supported
1006	Protocol_Version_Error	The protocol version of the add-on module is not compatible with the protocol version of the press controller (HMI).
1007	Command_Error	The press controller received an incorrect command: ▸ Unknown command
1008	Session_Abort	The add-on module aborted a measurement session established using the start command.

11.1.3 Error codes for PSENvip

Code	Error text in the log file	Meaning
1100	PSENvip_Error	PSENvip registers a general internal error
1101	PSENvip_Connect_Error	Could not establish a connection to the PSENvip: ▸ No Ethernet connection (connection cable not plugged in) ▸ Wrong IP address or wrong port ▸ Special module PSSu K F FAU P is inactive or the firmware version of the special module is too low (< 2.2)
1102	PSENvip_Session_Abort	▸ A measurement session established using START was aborted via PSENvip. ▸ Missing heartbeat ▸ Lost connection
1103	PSENvip_Comm_Error	Communication error between add-on module and PSENvip: ▸ Cannot transfer data Possible reasons: ▸ Data transfer interrupted or disrupted ▸ Data corrupted
1104	PSENvip_Version_Error	PSENvip does not support the required action or measurement: ▸ The firmware version of the PSENvip is too low (< 2.2) ▸ The protocol or software versions of PSENvip and the add-on module are incompatible.
1105	PSENvip_Receiver_Version_Error	The PSENvip receiver does not support the required action or measurement: ▸ The firmware version of the receiver is too low (< 2.2)
1106	PSENvip_State_Error	PSENvip must be in a RUN state: ▸ PSENvip is in STOP, standby or adjustment mode ▸ The PSS 4000 user program on the safety controller will not be processed.

11.1.4 Error codes for bending angle measurement

The "Angle Measurement System" (AMS) application returns these error codes in the AMS-Measurement header of the response telegram, provided an angle could be defined (see Header when receiving measurement data [📖 41]).

Note that even if there are errors in the bending angle measurement, an angle can still be calculated to some extent. In this case the AMS returns the measured value telegram despite the bending angle error. Both the error code and the measured angle plus any image that may have been requested are returned. If an angle value can no longer be calculated, the standard telegram containing the relevant error code is sent.

NOTICE

Invalid angle value

If one of the bending angle errors is detected during bending angle measurement and an angle value has been calculated, then the AMS sends a measured value telegram containing the error code and angle value.

If an angle value from this type of measured value telegram is processed further, it can lead to problems on the press controller.

Make sure that the angle value from this type of measured value telegram is not processed further.

NOTICE

Invalid image data

If one of the bending angle errors is detected during bending angle measurement and image data has been requested, then the AMS sends a measured value telegram containing the error code and the image data.

If the image data from this type of measured value telegram is processed further, it can lead to problems on the press controller.

Make sure that the image data from this type of measured value telegram is exclusively used for fault diagnostics.

Code	Error text in the log file	Meaning
1200	Measure_Error	The measurement algorithm is registering a general internal error.
1201	Image_Format_Error	The format of the image data is incorrect: ▸ The data format is violated
1202	Image_Structure_Error	The image contains incorrect structures: ▸ Sender group is not recognised ▸ Sheet is not recognised

11.1.5 Error codes for warnings regarding the bending angle measurement

An angle can still be calculated when there are warnings regarding the bending angle measurement, so the AMS sends the measured value telegram despite the warning. Both the warning itself and the measured angle plus any image that may have been requested are reported back (see Header when receiving measurement data [📖 41]).

NOTICE

Measurement inaccuracies

When a warning occurs, the angle value may not be as accurate as expected or other irregularities may be present.

Decide whether the measurement can be trusted, depending on the application.

Code	Message text in the log file	Meaning
1300	Image_Format_Warning	Incorrect image format suspected: ▸ Incorrect image size ▸ Line breaks in the image
1301	Image_Not_Current_Warning	An outdated image was used for the bending angle measurement: ▸ Sequencing error
1302	Bad_Pixel_Warning	The image contains too many bad pixels (bad pixel cluster): ▸ Sensor error (can lead to interfering contours)
1303	Image_Intensity_Warning	The intensity is outside the expected range: ▸ Image is too bright or too dark ▸ Image has to little or too much contrast
1304	Image_Structure_Warning	The expected structures were not recognised: ▸ Tool contours ▸ Sheet thickness
1305	Sheet_Fit_Warning	Straight line detection is problematic: ▸ There are too few points present to determine straight lines (e.g. short legs, interfering contours) ▸ The image points detected do not form straight lines (e.g. radius too large, interfering contours, optical interference, distorted image) Note: Problems with straight line detection can adversely affect measuring accuracy.

Code	Message text in the log file	Meaning
1306	Angle_Warning	The feasibility check is registering a suspicious angle value.

11.2 Diagnostic and operating server

The add-on module PSENvip IPM provides a diagnostic and operating server for a variety of information and actions. A web browser can be used to access the web application of the diagnostic and operating server.

The following start page appears when the web application is launched and no USB memory is inserted:

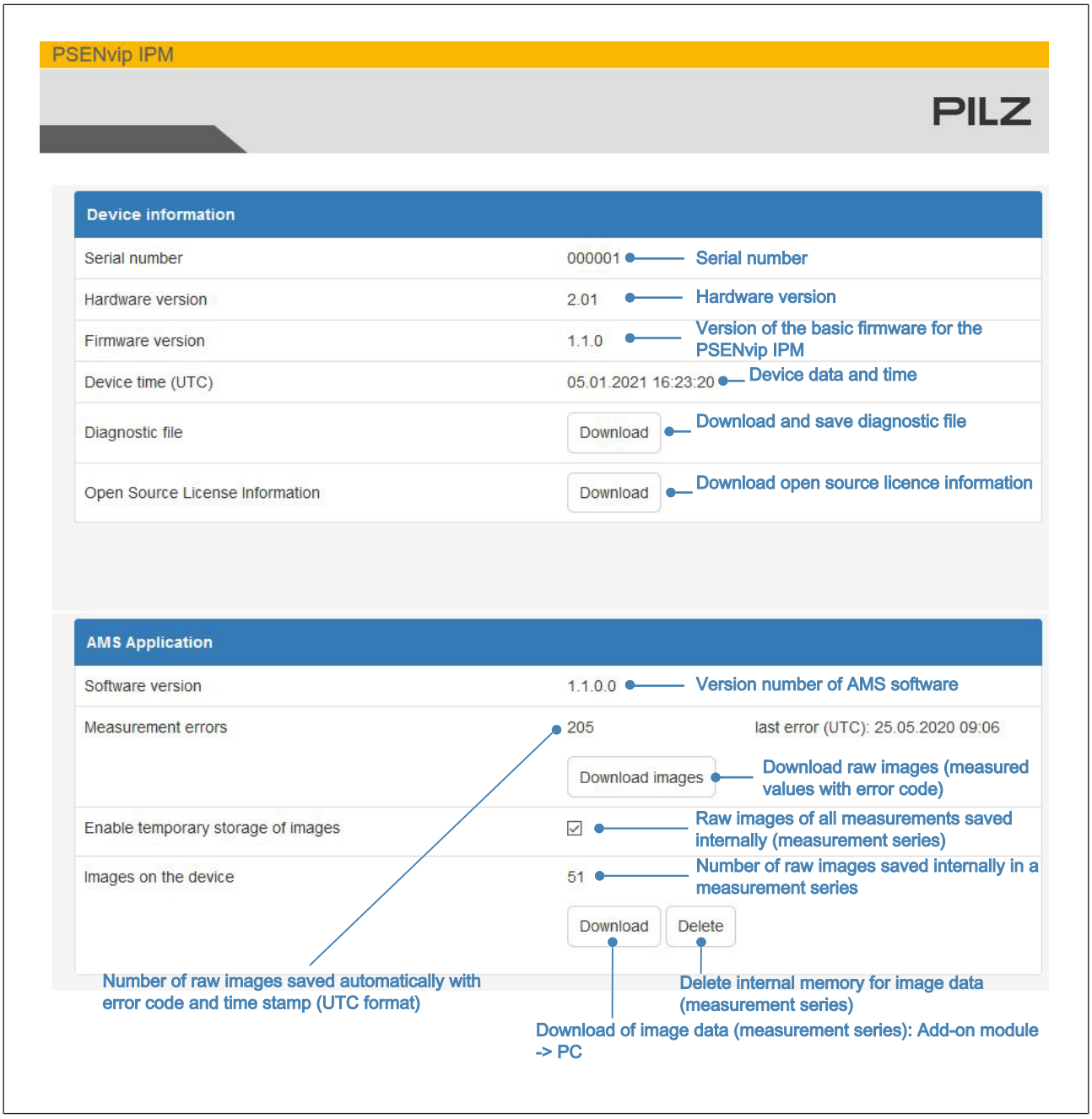


Fig.: Start page of the web application for the diagnostic and operating server (without USB memory)

The following start page appears when the web application is launched and a USB memory is inserted:

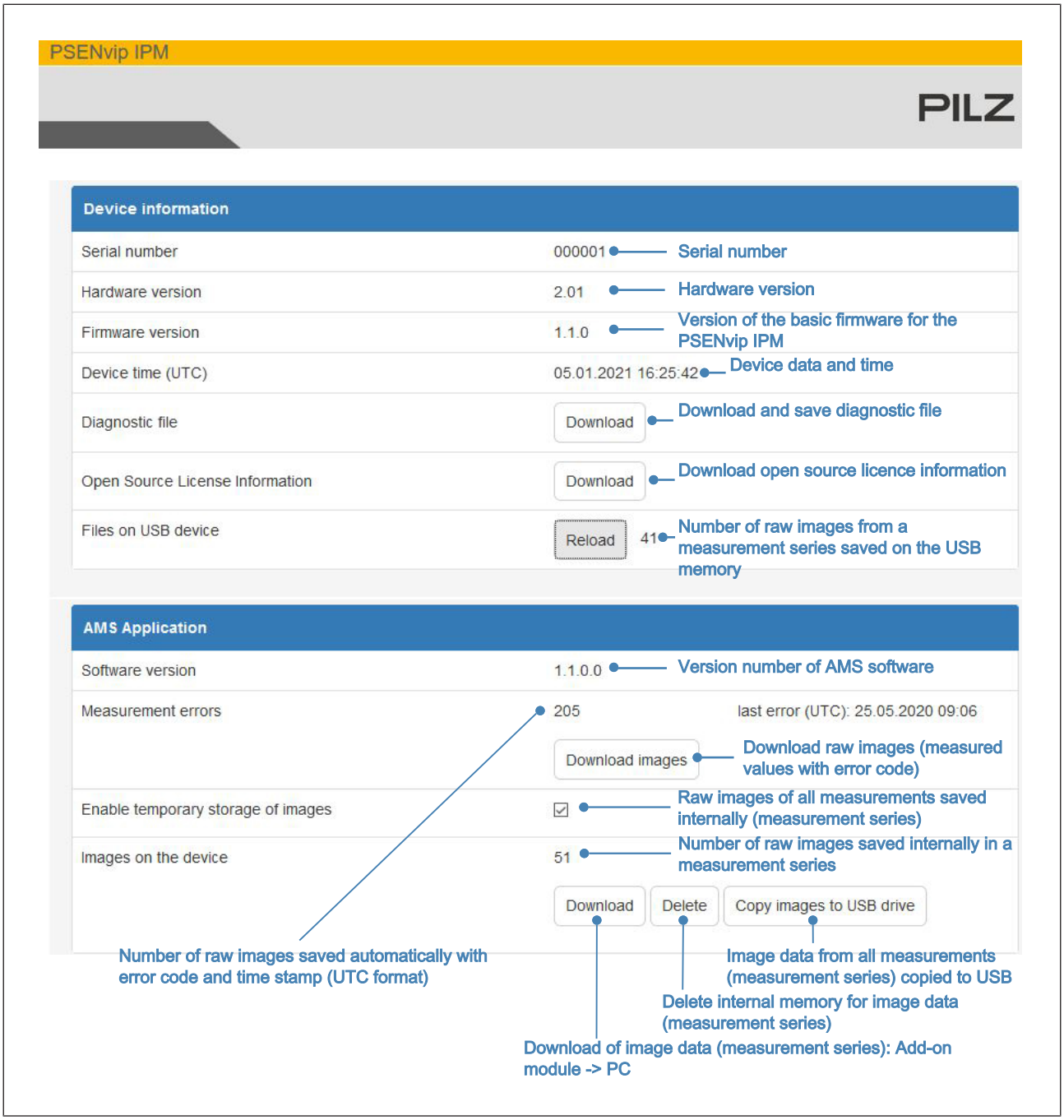


Fig.: Start page of the web application for the diagnostic and operating server (with USB memory)

Further information is available under

- Call up diagnostic and operating server [📖 91]
- Download the diagnostic file [📖 91]
- Save raw images for measured value analysis [📖 92]

11.2.1 Call up diagnostic and operating server

The press controller (HMI) or an external PC can use a web browser to call up the web application for the diagnostic and operating server on the add-on module PSENvip IPM. The IP address of the add-on module must be entered in the web browser. The IP address of the add-on module is 192.168.0.13 and cannot be changed.

Prerequisites

- Press controller (HMI) or PC with web browser (e.g. Internet Explorer)
- If you are using an external PC, connect this to the add-on module via the ETH interface X1.

Procedure

- Start the browser.
- Enter the IP address of the add-on module in the browser.

  IP address: 192.168.0.13

  The start page is displayed.
- Carry out the required actions.
- Close the browser.

11.2.2 Download the diagnostic file

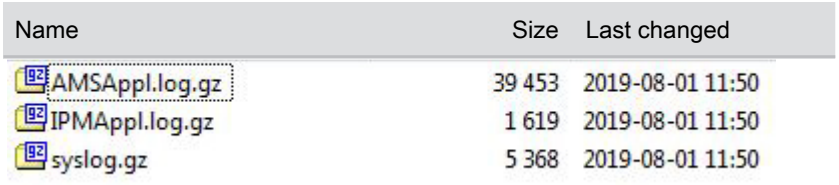
The "Angle Measurement System" (AMS) application provides a diagnostic file for diagnostic purposes. The diagnostic and operating server can be used to access the file.

Procedure

- Start the web application of the diagnostic and operating server.

  (see Call up diagnostic and operating server [📖 91])
- In the ***Device information*** field under ***Diagnostic file***, click on the download button The diagnostic file is downloaded.
  - The diagnostic file is available in compressed form (zip file).
  - The zip file contains the following files in compressed form (gz files):
    - Diagnostic file for the AMS (AMSAppl.log.gz)
    - Diagnostic file for the IPM (IPMAppl.log.gz)
    - Diagnostic file for the base system (syslog.gz)

    Example:



Name	Size	Last changed
AMSAppl.log.gz	39 453	2019-08-01 11:50
IPMAppl.log.gz	1 619	2019-08-01 11:50
syslog.gz	5 368	2019-08-01 11:50

- Make the diagnostic files available to Pilz for further examination.

11.2.3 Save raw images for measured value analysis

The memory function for raw images is used for measured value analysis. In this way, raw images of implausible measured values can be made available to Pilz for diagnostic purposes.

Automatic saving of raw images internally (measured values with error code)

Raw images with error code are automatically saved on the add-on module. Automatic saving cannot be deactivated. A separate non-volatile memory is available on the add-on module for these raw images.
Note: The raw images of measured values with error code are initially saved in non-retentive memory (add-on module's RAM). A few minutes pass before they are moved to non-volatile memory.

A raw file with image data and an ini file with the corresponding settings are generated and saved for each raw image with error code. The raw file contains the pure pixel data of the raw image with 8-bit resolution without header. Both file names contain the same time stamp.

- Structure of the file name for the raw file:

  *yyyymmdd_hhmmss_µs*_Angle_*ffff*_*0xeeee*.error.raw

  – *yyyymmdd_hhmmss_µs*: Time stamp in µs resolution

  – *ffff*: Measured angle value

  – *0xeeee*: Error code in hex format

- Structure of the file name for the ini file:

  yyyymmdd_hhmmss_µs.error.ini

  – *yyyymmdd_hhmmss_µs*: Time stamp in µs resolution for the respective raw image

Raw images of all measurements saved internally (measurement series)

The memory function for raw images from a measurement series is controlled and managed via the diagnostic and operating server (see Activate and deactivate memory function via the web application [📖 98]). Alternatively, this memory function can also be activated and deactivated via the command AMSConfigWrite (Activate and deactivate memory function via ImageSave [📖 99]).

With this memory method, a raw file is generated for the raw image of each measured angle. It is then saved in the add-on module in non-retentive memory (RAM). The raw file contains the pure pixel data of the raw image with 8-bit resolution without header.

An ini file is also generated and saved. The ini file contains the settings for the current measurement. As the ini file is overwritten with the settings of each raw image that is newly saved, only measurement series with identical settings make sense; i.e. the ini file is regarded as a shared file for a measurement series, so that the settings for measurements can be understood.

- Structure of the file name for the raw file:

  *yyyymmdd_hhmmss_µs*_Angle_*ffff*.raw

  – *yyyymmdd_hhmmss_µs*: Time stamp in µs resolution

  – *ffff*: Measured angle value

- File name for the ini file: test.ini

NOTICE

Measurement time extended by the internal storage of raw images

Please note that saving the raw images means the bending angle measurement takes slightly longer.

NOTICE

Measurement time extended by the USB memory

Connecting a USB memory extends the measurement time. To keep the adverse affects to a minimum, make sure that the following requirements are met:

- Only use fast USB memory.
- Only connect the USB memory to the add-on module when copying or saving.

INFORMATION

Additional guidelines for USB memory

- If the web application is launched with the USB memory inserted, additional elements and buttons will be available on the start page (see Diagnostic and operating server [89]).
- The display on the start page is not automatically refreshed when the USB memory is inserted or removed. Refresh the display manually using the "Reload" button.

Prerequisites

- The web application of the diagnostic and operating server has been launched (see Call up diagnostic and operating server [91]).
- If necessary: Save image data on a USB memory:
  - The USB memory is formatted with FAT32.
  - The USB memory is connected to the add-on module while downloading or copying.

Procedure

- Activate internal saving for the raw data of all measurements (measurement series)

  Activate the memory function via one of the options documented.

- Perform measurements

  Perform measurements using AMSStart or AMSGetAngle.

  The number of images saved in the RAM is displayed on the web application's start page under ***Images on the device***.
  Note: As long as the images of measurements with error code have not yet been moved to non-volatile memory, then these images will also be included in that number.
  Note: The display in the web application of the diagnostic and operating server is not refreshed automatically.

  – Click on ***Reload*** in the footer to refresh the display

- Save image data

  After a measurement series, the raw images saved internally can either be saved on the connected PC, on the press controller (CNC, HMI) or on a USB memory.

  – Save image data on the PC or press controller (CNC, HMI)

    In the web application, go to the ***Images on the device*** field and click on the ***Download*** button.

    A zip file is generated containing all the image data. By default it is saved in the download area of the connected PC; i.e. the zip file contains all the raw images saved from a measurement series.

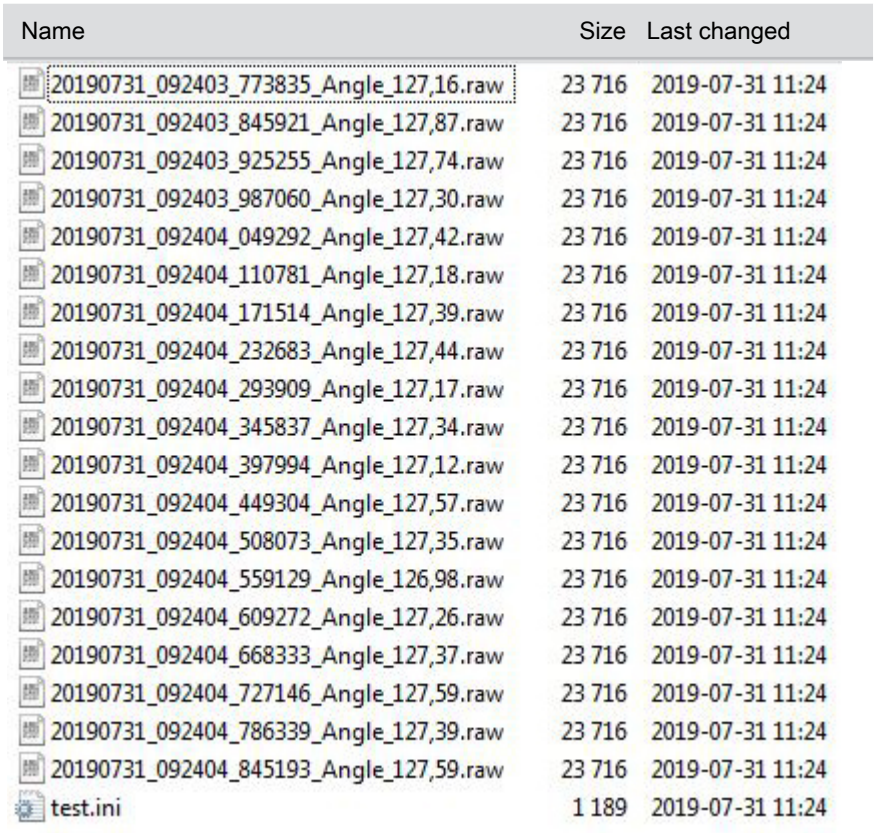
  – Save image data on the USB memory

    In the web application, go to the ***Images on the device*** field and click on the ***Copy images to USB drive*** button.

    A zip file is generated containing all the image data and is saved in the root directory of the connected USB memory; i.e. the zip file contains all the raw images saved from a measurement series.

  Note: If the raw images from incorrect measurements, including the corresponding configuration files, have not yet been moved to non-volatile memory at the time the data is saved, then these files will also be included in the zip file.

Example:



Name	Size	Last changed
20190731_092403_773835_Angle_127,16.raw	23 716	2019-07-31 11:24
20190731_092403_845921_Angle_127,87.raw	23 716	2019-07-31 11:24
20190731_092403_925255_Angle_127,74.raw	23 716	2019-07-31 11:24
20190731_092403_987060_Angle_127,30.raw	23 716	2019-07-31 11:24
20190731_092404_049292_Angle_127,42.raw	23 716	2019-07-31 11:24
20190731_092404_110781_Angle_127,18.raw	23 716	2019-07-31 11:24
20190731_092404_171514_Angle_127,39.raw	23 716	2019-07-31 11:24
20190731_092404_232683_Angle_127,44.raw	23 716	2019-07-31 11:24
20190731_092404_293909_Angle_127,17.raw	23 716	2019-07-31 11:24
20190731_092404_345837_Angle_127,34.raw	23 716	2019-07-31 11:24
20190731_092404_397994_Angle_127,12.raw	23 716	2019-07-31 11:24
20190731_092404_449304_Angle_127,57.raw	23 716	2019-07-31 11:24
20190731_092404_508073_Angle_127,35.raw	23 716	2019-07-31 11:24
20190731_092404_559129_Angle_126,98.raw	23 716	2019-07-31 11:24
20190731_092404_609272_Angle_127,26.raw	23 716	2019-07-31 11:24
20190731_092404_668333_Angle_127,37.raw	23 716	2019-07-31 11:24
20190731_092404_727146_Angle_127,59.raw	23 716	2019-07-31 11:24
20190731_092404_786339_Angle_127,39.raw	23 716	2019-07-31 11:24
20190731_092404_845193_Angle_127,59.raw	23 716	2019-07-31 11:24
test.ini	1 189	2019-07-31 11:24

- Save raw images from measurements with error code

  In the web application, go to the ***Measurement errors*** field and click on the ***Download images*** button.

  A zip file is generated containing all the image data from incorrect measurements. By default it is saved in the download area of the connected PC; i.e. the zip file contains all the raw images saved automatically from measurements with error code, including the corresponding configuration files.
  Note: The zip file contains the data in compressed form (gz files).

Example:

Name	Size	Last changed
20190731_085918_838299.error.ini.gz	639	2019-07-31 11:00
20190731_085918_838299_Angle_0,00_0x2103.error.raw.gz	11 491	2019-07-31 11:00
20190731_085918_912191.error.ini.gz	639	2019-07-31 11:00
20190731_085918_912191_Angle_0,00_0x2103.error.raw.gz	11 505	2019-07-31 11:00
20190731_085918_992493.error.ini.gz	639	2019-07-31 11:00
20190731_085918_992493_Angle_0,00_0x2103.error.raw.gz	11 437	2019-07-31 11:00
20190731_085919_046052.error.ini.gz	639	2019-07-31 11:00
20190731_085919_046052_Angle_0,00_0x2103.error.raw.gz	11 496	2019-07-31 11:00
20190731_085919_076481.error.ini.gz	639	2019-07-31 11:00
20190731_085919_076481_Angle_0,00_0x2103.error.raw.gz	11 469	2019-07-31 11:00
20190731_085919_112811.error.ini.gz	639	2019-07-31 11:00
20190731_085919_112811_Angle_0,00_0x2103.error.raw.gz	11 519	2019-07-31 11:00
20190731_085919_151817.error.ini.gz	639	2019-07-31 11:00
20190731_085919_151817_Angle_0,00_0x2103.error.raw.gz	11 447	2019-07-31 11:00
20190731_085919_191157.error.ini.gz	639	2019-07-31 11:00
20190731_085919_191157_Angle_0,00_0x2103.error.raw.gz	11 484	2019-07-31 11:00
20190731_085919_223947.error.ini.gz	639	2019-07-31 11:00
20190731_085919_223947_Angle_0,00_0x2103.error.raw.gz	11 465	2019-07-31 11:00
20190731_085919_279869.error.ini.gz	639	2019-07-31 11:00
20190731_085919_279869_Angle_0,00_0x2103.error.raw.gz	11 499	2019-07-31 11:00
20190731_085919_338183.error.ini.gz	639	2019-07-31 11:00
20190731_085919_338183_Angle_0,00_0x2103.error.raw.gz	11 448	2019-07-31 11:00
20190731_085919_388210.error.ini.gz	639	2019-07-31 11:00
20190731_085919_388210_Angle_0,00_0x2103.error.raw.gz	11 531	2019-07-31 11:00
20190731_085919_428520.error.ini.gz	639	2019-07-31 11:00
20190731_085919_428520_Angle_0,00_0x2103.error.raw.gz	11 511	2019-07-31 11:00
20190731_085919_459319.error.ini.gz	639	2019-07-31 11:00
20190731_085919_459319_Angle_0,00_0x2103.error.raw.gz	11 478	2019-07-31 11:00

- Make the saved data available to Pilz for further analysis.
- If necessary: Evaluate information in the web application

  With the help of the information in the ***AMS Application*** field you can see approximately how many images can still be saved.

  Check the following information in the ***AMS Application*** field:

  – ***Images on the device*** – *<Number of raw images saved from a measurement series>*

    The memory holds approx. 3500 raw images and is written as a ring memory.

  – ***Measurement errors*** – *<Number of raw images saved automatically with error code and time stamp (UTC format)>*

    The memory holds approx. 200… 250 raw images and configuration files and is written as a ring memory.
- If necessary: delete raw images

  Delete the raw images saved internally once these have been downloaded or are no longer required (see Delete saved raw images [📖 100]).

Note: A large number of saved images will slow down the diagnostic and operating server.

- Deactivate memory function for raw images

  Deactivate the saving of raw images if you no longer need the function (see Activate and deactivate memory function via the web application [📖 98] and Activate and deactivate memory function via ImageSave [📖 99]).

11.2.3.1 Activate and deactivate memory function via the web application

Prerequisites

- The web application of the diagnostic and operating server has been launched (see Call up diagnostic and operating server [📖 91]).

Activate memory function

- Select ***Enable temporary storage of images*** in the ***AMS Application*** field.

  The activation is maintained until either it is deactivated or the add-on module is restarted (switch supply voltage off and on again).

Deactivate memory function

- Deselect ***Enable temporary storage of images*** in the ***AMS Application*** field or restart the add-on module (switch supply voltage off and on again).

  Note: In the event of a restart, any raw images that are in the add-on module's non-retentive memory (RAM) will be lost. These are the raw images that originate from a measurement series, including the ini file "test.ini".

NOTICE

Deactivate memory function for raw images

Storing the raw images increases the measurement time. For this reason the memory function should be deactivated as soon as recording of the raw images for measured value analysis is complete.

Make sure that the memory function is deactivated again once the data is saved.

11.2.3.2 Activate and deactivate memory function via ImageSave

Activate memory function for raw images

- Activate the memory function by using the command AMSConfigWrite with configuration ImageSave=YES.

  The activation is maintained until the memory function is deactivated with ImageSave=NO or the add-on module is restarted (switch supply voltage off and on again).

NOTICE

Permanently activate memory function for raw images

The memory function can be permanently activated through the command AMSConfigWrite with configuration ImageSave=YES and Save=YES. We recommend that you do not use permanent activation of the memory function as it extends the measurement time and uses memory space.

Make sure that the memory function is only permanently activated during measured value analysis and is deactivated again once the data is saved.

Deactivate memory function for raw images

- Deactivate the memory function by using the command AMSConfigWrite with configuration ImageSave=NO or by restarting the add-on module (switch supply voltage off and on again).

  Note: In the event of a restart, any raw images that are in the add-on module's non-retentive memory will be lost. These are the raw images that originate from a measurement series, including the ini file "test.ini".

NOTICE

Permanently deactivate memory function for raw images

If you have used the command AMSConfigWrite with configuration ImageSave=YES and Save=YES to permanently activate the memory function, you will need to use the command AMSConfigWrite with configuration ImageSave=NO and Save=YES to permanently deactivate it.

11.2.3.3 Delete saved raw images

With the saved raw images a distinction is made between raw images that originate from a measurement series and raw images that are saved automatically (raw images with error code). While raw images with error code are saved in non-volatile internal memory, raw images from image series are saved in non-retentive internal memory (add-on module's RAM).

Delete raw images from non-retentive memory (RAM)

The memory space available on the add-on module is designed for approx. 3500 raw images. If the memory is full, no more raw images will be saved. The memory on the add-on module must be deleted before further images can be saved.

- Either go to ***Images on the device*** in the web application of the diagnostic and operating server and click on the ***Delete*** button or restart the add-on module (switch supply voltage off and on again).

  Any raw images originating from measurement series will be deleted from internal, non-retentive memory (RAM). Raw images from measurements with error code are maintained if they are in non-volatile memory.

INFORMATION

The raw images should be saved when each measurement series is completed and then deleted form the internal memory.

NOTICE

Delete raw images from measurement series

Raw images saved internally are not deleted when raw images are downloaded or by copying the raw images to a USB memory.

Raw images from measurement series can only be deleted in the web application of the diagnostic and operating server or by restarting the add-on module.

11.2.3.4 Add offset value to the measurement result

Specific machine configurations can mean that the angle values measured by PSENvip IPM show a systematic deviation compared with other measurement methods. So to ensure that the tolerance range does not have to be enlarged, the systematic deviation can be countered using the "AngleOffset" parameter. This parameter does not impact the result of the actual angle measurement by PSENvip IPM.

When the pre-production series on the press is completed and the systematic deviation is known, the relevant offset value can be assigned to the "AngleOffset" parameter. Before the angle value is transferred to the press controller (HMI), the offset value and the value calculated by PSENvip IPM are automatically added.

If different configuration files are used, then the corresponding offset values for the different angle measurements can also be stored.

Example:

Offset value stored for the "AngleOffset" parameter	-2.2°
Angle value calculated by PSENvip IPM	+90.0°
Added angle value, which is transferred to the press controller (HMI)	= **87.8**°

If different configuration files are used, then the corresponding offset values for the different angle measurements can also be stored.

12 Change

12.1 Recovery server

The add-on module PSENvip IPM provides a recovery server for a variety of information and actions. A web browser can be used to access the web application of the recovery server. To enable access to the recovery server via the web application, the add-on module must be in recovery mode (see Activate recovery mode [103]).

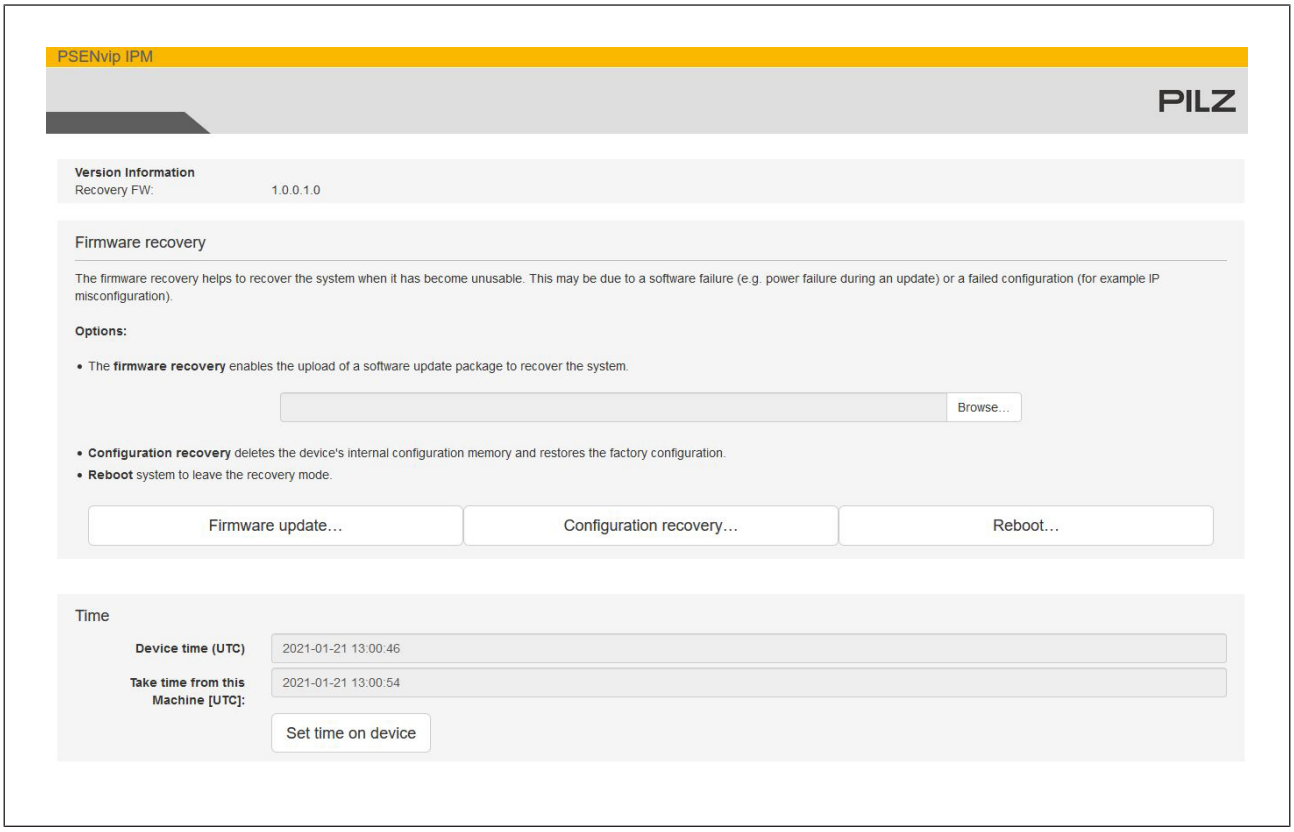


Fig.: Start page of the web application for the recovery server

The following information is available on the start page:

- Firmware version of the recovery image

  You'll find the firmware version in the ***Version Information*** field under ***Recovery FW***.

You can perform the following actions on the start page:

- Run firmware update or recovery update (see Run firmware update or recovery update [105]).
- Run configuration recovery; i.e. reset the configuration parameters of the add-on module and AMS to the factory settings (see Reset add-on module to factory settings [107])
- Reboot the add-on module; i.e. switch from recovery mode to operating mode (see Reboot [109]).
- Set add-on module's date and time (see Set date and time [108])

12.2 Activate recovery mode

In order to use the web application of the recovery server, recovery mode must first be activated on the add-on modulePSENvip IPM.
The press controller (HMI) or an external PC can then use a web browser to call up the web application of the recovery server on the add-on module. The IP address of the add-on module must be entered in the web browser. The IP address of the add-on module is 192.168.0.13 and cannot be changed.

Procedure

- Switch on the supply voltage to the add-on module and at the same time press the service button.
- Keep the service button pressed down until the "PWR" LED lights up red.
  The add-on module is in recovery mode.

12.3 Call up recovery server

In order to use the web application of the recovery server, recovery mode must first be activated on the add-on modulePSENvip IPM.
The press controller (HMI) or an external PC can then use a web browser to call up the web application of the recovery server on the add-on module. The IP address of the add-on module must be entered in the web browser. The IP address of the add-on module is 192.168.0.13 and cannot be changed.

Prerequisites

- Press controller (HMI) or PC with web browser (e.g. Internet Explorer)
- If you are using an external PC, connect this to the add-on module via the ETH interface X1.
- Recovery mode on the add-on module is activated (see Activate recovery mode [📖 103]).

Procedure

- Start the browser.
- Enter the IP address of the add-on module in the browser.

  IP address: 192.168.0.13

  The start page is displayed.
- Carry out the required actions.
- You have several options for switching from recovery mode back to operating mode:
  - Click on the ***Reboot*** button

    or
  - Restart the add-on module. To do this, switch the supply voltage off and then on again.

12.4 Run firmware update or recovery update

A firmware update or recovery update can only be run when the add-on module is in recovery mode.

Prerequisites

- You have a firmware package or a recovery package from Pilz (fw file).
- The firmware or recovery image has a valid (Pilz) certificate for authentication.
- The version of the firmware package or recovery package is the same or higher than the current version. For security reasons it is not possible to downgrade to an older version.

Procedure

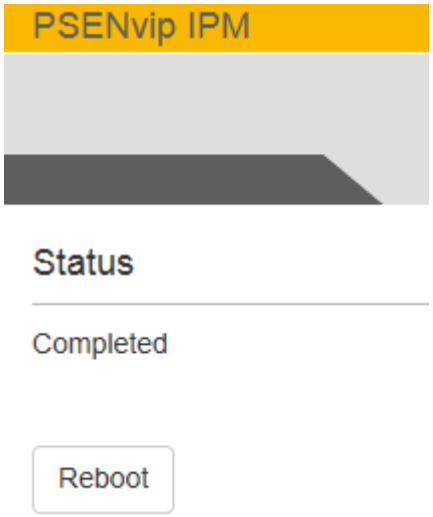
- Activate recovery mode on the add-on module.

  (see Activate recovery mode [📖 103]).
- Call up the recovery server.

  (see Call up recovery server [📖 104]).
- Click on the ***Browse*** button on the start page and navigate to the firmware package or recovery package (fw file).
- Click on the ***Firmware update*** button and confirm your selection.

  The firmware update or recovery update will only be run if authentication was successful (asymmetric encryption mode).

  The firmware update or recovery update is complete when the ***Completed*** status is displayed.



- Click on the ***Reboot*** button to complete the action and switch from recovery mode back to operating mode.

Note: After returning to operating mode, the display in the web application of the diagnostic and operating server is not refreshed automatically. The web application must be called up again to refresh the display.

Check firmware version

You can check whether the new firmware version is active:

- Call up the web application again to obtain a refreshed display (IP address of the add-on module see Call up diagnostic and operating server [📖 91]).

- Check the following details on the web application's start page:
  - ***Firmware version*** in the ***Device information*** field
  - ***Software version*** in the ***AMS Application*** field

Failure of the supply voltage during a firmware update

If the supply voltage fails during the firmware update, then the add-on module will not start when the supply voltage is switched back on as it no longer has an operating image.

Procedure

- Restart the add-on module in recovery mode.
- Run a firmware update again (see above).
- Then switch to operating mode (see above).

Failure of the supply voltage during a recovery update

NOTICE

Module destroyed due to failure of the supply voltage

If the supply voltage is interrupted or switched off during a recovery update, the add-on module may be destroyed as a result.

Make sure that the supply voltage is reliable and never switch off the supply voltage while running a recovery update.

12.5 Reset add-on module to factory settings

When the add-on module is in recovery mode, the configuration parameters of the add-on module and the AMS can be reset to the factory settings.

NOTICE

Loss of saved raw images of measurements with error code

All the saved raw images from measurements with error code are deleted when you reset the add-on module to the factory settings.

If necessary, save the raw images from measurements with error code before resetting the add-on module to its factory settings.

Procedure

- Activate recovery mode on the add-on module.
  (see Activate recovery mode [📖 103]).
- Call up the recovery server.
  (see Call up recovery server [📖 104]).
- Click on the ***Configuration recovery*** button to reset the configuration parameters to their factory settings and confirm the security prompt.
  The process may take several minutes.
- Click on the ***Reboot*** button to complete the action and switch from recovery mode back to operating mode.

Note: After returning to operating mode, the display in the web application of the diagnostic and operating server is not refreshed automatically. The web application must be called up again to refresh the display.

12.6 Set date and time

The data and time can be set when the add-on module is in recovery mode.

Procedure

- Activate recovery mode on the add-on module.
  (see Activate recovery mode [📖 103]).
- Call up the recovery server.
  (see Call up recovery server [📖 104]).
- Set the date and time for the add-on module.
- Click on the ***Set time on device*** button to apply the settings.
- Click on the ***Reboot*** button to complete the action and switch from recovery mode back to operating mode.

Note: After returning to operating mode, the display in the web application of the diagnostic and operating server is not refreshed automatically. The web application must be called up again to refresh the display.

Check settings

You can check whether the settings for date and time have been applied:

- Call up the web application of the diagnostic and operating server again to obtain a refreshed display (IP address of the add-on module see Call up diagnostic and operating server [📖 91]).
- Check the settings.
  Note: The time is displayed in UTC format.

12.7 Reboot

The add-on module can be rebooted in recovery mode.

Procedure

- Click on the ***Reboot*** button on the recovery server's start page.

  The add-on module is rebooted. The add-on module will then start in operating mode.

Note: After returning to operating mode, the display in the web application of the diagnostic and operating server is not refreshed automatically. The web application must be called up again to refresh the display.

13 Maintenance and testing

It is not necessary to perform maintenance work on the product in normal operation. Please return any faulty products to Pilz.

14 Decommissioning

- When decommissioning, please comply with local regulations regarding the disposal of electronic devices, such as the Electrical and Electronic Equipment Act.
- Reset the configuration to the factory settings (see Required security measures [📖 14]).

15 Technical details

General	
Certifications	**CE, UKCA, cULus Listed**
Application range	**Standard**
Electrical data	
Supply voltage	
for	**Module supply**
Voltage	**24 V**
Kind	**DC**
Voltage tolerance	**-30 %/+25 %**
Output of external power supply (DC)	**5,5 W**
Supply voltage	
for	**Periphery supply**
Voltage	**24 V**
Kind	**DC**
Voltage tolerance	**-30 %/+25 %**
Output of external power supply (DC)	**60 W**
Max. power dissipation of module	**5,5 W**
Status indicator	**LED**
Inputs	
Quantity	**1**
Voltage at inputs	**24 V DC**
Input type in accordance with EN 61131-2	**3**
Input current at rated voltage	**10 mA**
Semiconductor outputs	
Quantity	**1**
Current	**2 A**
External supply voltage	**24 V**
Voltage tolerance	**-30 %/+25 %**
Utilisation category in accordance with EN 60947-1	**DC-12**
Utilisation category in accordance with UL 61010-2-201	**DC General use, DC Resistance**
USB interface	
Number of USB Hosts	**1**
Max. voltage	**5 V**
Max. current	**500 mA**
Ethernet interface	
Quantity	**2**
IP address, factory setting	**192.168.0.13**
Connection type	**RJ45**
Transmission rate	**10 MBit/s, 100 MBit/s**
Environmental data	
Climatic suitability	**EN 60068-2-1, EN 60068-2-14, EN 60068-2-2, EN 60068-2-30, EN 60068-2-78**

Environmental data	
Ambient temperature	
in accordance with the standard	**EN 60068-2-14**
Temperature range	**0 - 60 °C**
Storage temperature	
in accordance with the standard	**EN 60068-2-1/-2**
Temperature range	**-25 - 70 °C**
Climatic suitability	
in accordance with the standard	**EN 60068-2-30, EN 60068-2-78**
Humidity	**93 % r. h. at 40 °C**
Condensation during operation	**Not permitted**
Max. operating height above SL	**2000 m**
EMC	**EN 61000-4-2, EN 61000-4-3, EN 61000-4-4, EN 61000-4-5, EN 61000-4-6, EN 61000-6-4, EN 61131-2**
Vibration	
in accordance with the standard	**EN 60068-2-6**
Frequency	**5 - 8,4 Hz, 8,4 - 150 Hz**
Amplitude	**3,5 mm**
Acceleration	**1g**
Shock stress	
in accordance with the standard	**EN 60068-2-27**
Acceleration	**15g**
Duration	**11 ms**
Airgap creepage	
in accordance with the standard	**EN 61131-2**
Overvoltage category	**II**
Pollution degree	**2**
Rated insulation voltage	**30 V**
Protection type	
in accordance with the standard	**EN 60529**
Housing	**IP20 (not evaluated by UL)**
Terminals	**IP20 (not evaluated by UL)**
Mounting area (e.g. control cabinet)	**IP54**
Potential isolation	
Potential isolation between	**Periphery supply and module supply**
Type of potential isolation	**Basic insulation**
Rated surge voltage	**500 V**
Mechanical data	
Mounting position	**vertical**
DIN rail	
Top hat rail	**35 x 7,5 EN 50022**
Recess width	**27 mm**
Material	
Bottom	**PC**
Front	**PC**

Mechanical data	
Connection type	**Spring-loaded terminal, screw terminal**
Mounting type	**plug-in**
Conductor cross section with screw terminals	
1 core flexible	**0,25 - 2,5 mm², 24 - 12 AWG**
2 core with the same cross section, flexible without crimp connectors or with TWIN crimp connectors	**0,2 - 1,5 mm², 24 - 16 AWG**
Torque setting with screw terminals	**0,5 Nm**
Conductor cross section with spring-loaded terminals: Flexible with/without crimp connector	**0,2 - 2,5 mm², 24 - 12 AWG**
Spring-loaded terminals: Terminal points per connection	**2**
Stripping length with spring-loaded terminals	**9 mm**
Dimensions	
Height	**96 mm**
Width	**45 mm**
Depth	**111,5 mm**
Weight	**170 g**

Where standards are undated, the 2017-06 latest editions shall apply.

16 Supplementary data

16.1 Network data

Protocol	Direction [*]	Transport protocol	Port no.	Can be deactivated	Time-critical	Description
HTTP	In	TCP	80	No	Yes	**Web server in recovery mode** Firmware update
HTTP	In	TCP	8081	No	Yes	**Web server in operating mode** Diagnostics
Proprietary	In	TCP	0 …65535 (default:1096)	No	Yes	**TCP server for bending angle measurement**
Proprietary	Out	UDP/TCP	8080	No	Yes	**Connection to PSENvip**

[*]

in: The communication partner starts communication with the product.

out: The product starts communication with the communication partner.

17 Order reference

Product type	Features	Order no.
PSENvip IPM Set 1	Add-on module for bending angle measurement for PSENvip2 systems, consisting of receiver (PSENvip R, PSENvip LR), transmitter (PSENvip E) and special module PSSu K FAU P	584300

18 EC declaration of conformity

This product/these products meet the requirements of the directive 2006/42/EC on machinery of the European Parliament and of the Council. The complete EC Declaration of Conformity is available on the Internet at www.pilz.com/downloads.
Representative: Pilz GmbH & Co. KG, Felix-Wankel-Str. 2, 73760 Ostfildern, Germany

19 UKCA-Declaration of Conformity

This product(s) complies with following UK legislation: Supply of Machinery (Safety) Regulation 2008.
The complete UKCA Declaration of Conformity is available on the Internet at www.pilz.com/downloads.

Representative: Pilz Automation Technology, Pilz House, Little Colliers Field, Corby, Northamptonshire, NN18 8TJ United Kingdom, eMail: mail@pilz.co.uk

Support

Technical support is available from Pilz round the clock.

Americas
Brazil
+55 11 97569-2804
Canada
+1 888 315 7459
Mexico
+52 55 5572 1300
USA (toll-free)
+1 877-PILZUSA (745-9872)

Asia
China
+86 400-088-3566
Japan
+81 45 471-2281
South Korea
+82 31 778 3300

Australia and Oceania
Australia
+61 3 95600621
New Zealand
+64 9 6345350

Europe
Austria
+43 1 7986263-444
Belgium, Luxembourg
+32 9 3217570
France
+33 3 88104003
Germany
+49 711 3409-444
Ireland
+353 21 4804983
Italy, Malta
+39 0362 1826711
Scandinavia
+45 74436332
Spain
+34 938497433
Switzerland
+41 62 88979-32
The Netherlands
+31 347 320477
Türkiye
+90 216 5775552
United Kingdom
+44 1536 462203

You can reach our international hotline on:
+49 711 3409-222
support@pilz.com

Pilz develops environmentally-friendly products using ecological materials and energy-saving technologies. Offices and production facilities are ecologically designed, environmentally-aware and energy-saving. So Pilz offers sustainability, plus the security of using energy-efficient products and environmentally-friendly solutions.

BLUEcoMPETENCE Alliance Member
Partner of the Engineering Industry Sustainability Initiative

German Standards
BRAND OF THE CENTURY 2022

Quality Management ISO 9001:2015 REG. NO. 2462
Environmental Management ISO 14001 REG. NO. 2462
Energy Management ISO 50001 REG. NO. 2462

We are represented internationally. Please refer to our homepage www.pilz.com for further details or contact our headquarters.

Headquarters: Pilz GmbH & Co. KG, Felix-Wankel-Straße 2, 73760 Ostfildern, Germany
Telephone: +49 711 3409-0, E-Mail: info@pilz.com, Internet: www.pilz.com

PILZ
THE SPIRIT OF SAFETY

1004948-EN-03, 2024-06 Printed in Germany