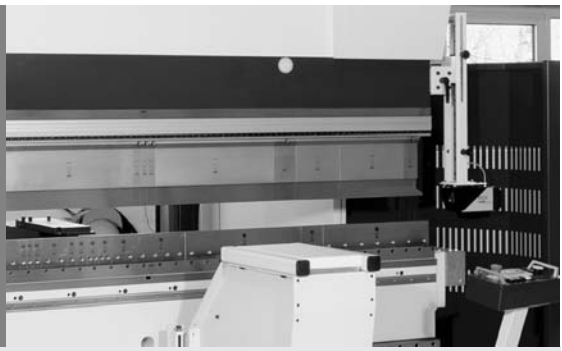
OPERATING INSTRUCTIONS

V4000 Press Brake sensor system



for protecting the press brake

GB

SICK
Sensor Intelligence.

QUALITY SYSTEM
certified by DQS according to
DIN EN ISO 9001 Reg. No. 462-03

Update

WARNING

Please take note of the following updates to this document!

Based on Machinery Directive 2006/42/EC, we have added the following supplementary data or change notices on our product to the following document.

Scope

This document is an original document.

Cited standards and directives

The standards and directives cited in these operating instructions might have changed. The following list indicates the standards and directives that might have been cited and their successive versions.

Kindly replace the standards and directives cited in these operating instructions with the successive versions listed in the table.

Previous standard or directive	Successive standard and directive
Machinery Directive 98/37/EC	Machinery Directive 2006/42/EC
Directive 93/68/EEC	Directive 93/68/EC
EMC directive 89/336/EEC	EMC directive 2004/108/EC
Low Voltage Directive 73/23/EC	Low Voltage Directive 2006/95/EC
DIN 40 050	EN 60 529
IEC 536:1976	EN 61 140
DIN EN 50 178:1998-04/ VDE 0160:1998-04	EN 50 178
EN 775	EN ISO 10 218-1
EN 292-1	EN ISO 12 100-1
EN 292-2	EN ISO 12 100-2
EN 954-1	EN ISO 13 849-1
EN 418	EN ISO 13 850
EN 999	EN 999+A1[1])
EN 294	EN ISO 13 857
EN 811	EN ISO 13 857
EN 1050	EN ISO 14 121-1
IEC 68, part 2-27 or IEC 68	EN 60 068-2-27
IEC 68, part 2-29	EN 60 068-2-27
IEC 68, part 2-6	EN 60 068-2-6
prEN 50 100-1	EN 61 496-1
ANSI B11.19-1990	ANSI B11.19:2003-04, Annex D

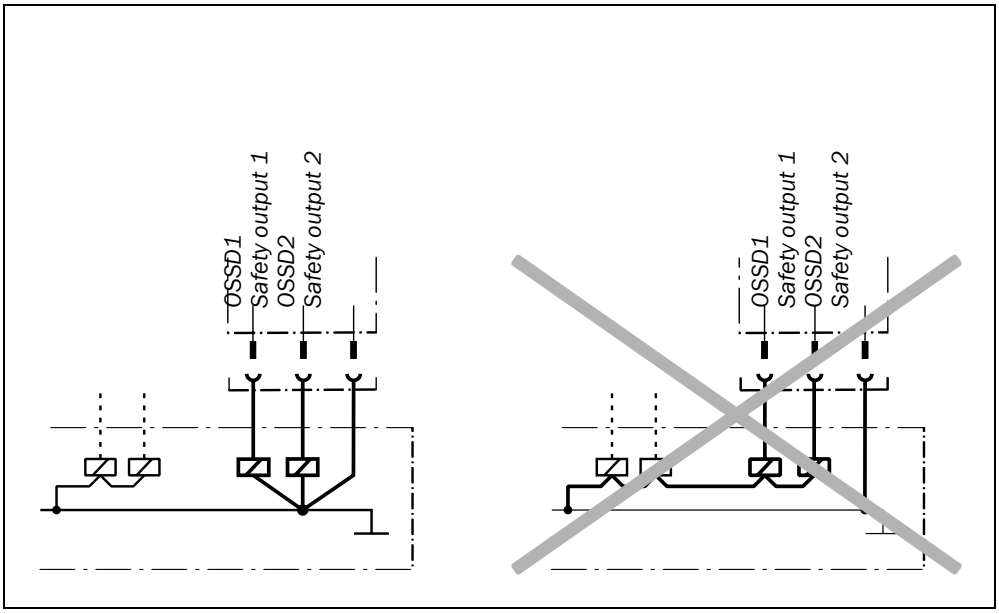
[1]) EN 999 will be replaced by EN ISO 13 855.

Electrical installation

WARNING

Prevent the formation of a potential difference between the load and the protective device!

➢ If you connect loads that are not reverse-polarity protected to the OSSDs or the safety outputs, you must connect the 0 V connections of these loads and those of the corresponding protective device individually and directly to the same 0 V terminal strip. This is the only way to ensure that, in the event of a defect, there can be no potential difference between the 0 V connections of the loads and those of the corresponding protective device.



Technical specifications

Safety-related parameters according to EN ISO 13849, EN 62061, IEC 61508:

V4000 PB: General system data	
Type	Type 4 (IEC 61496)
Safety Integrity Level[2)]	SIL3 (IEC 61508), SILCL3 (EN 62061)
Category	Category 4 (EN ISO 13849) Category 4 (EN 954[3)])
Performance Level[2)]	PL e (EN ISO 13849)
PFHd (mean probability of a dangerous failure per hour)	1.52×10^{-8}
T_M (mission time)	16.6 years (EN ISO 13849)

EC declaration of conformity

Note You can obtain the EC declaration of conformity with the standards used at: www.sick.com

2) For detailed information on the exact design of your machine/system, please contact your local SICK representative.
3) Only valid for the assumption of conformity until 28.12.2009. From then on it will only be permissible to use the successor EN ISO 13849.

Checklist for the manufacturer

SICK

Checklist for the manufacturer/installer for the installation of electro-sensitive protective equipment (ESPE)

Details about the points listed below must be present at least during initial commissioning – they are, however, dependent on the respective application, the specifications of which are to be controlled by the manufacturer/installer.

This checklist should be retained and kept with the machine documentation to serve as reference during recurring tests.

1.	Have the safety rules and regulations been observed in compliance with the directives/standards applicable to the machine?	Yes☐	No ☐
2.	Are the applied directives and standards listed in the declaration of conformity?	Yes☐	No ☐
3.	Does the protective device fulfil the required PL/SILCL and PFHd according to EN ISO 13 849-1/EN 62 061 and the type according to EN 61 496-1?	Yes☐	No ☐
4.	Is the access to the hazardous area/hazardous point only possible through the protective field of the ESPE?	Yes☐	No ☐
5.	Have appropriate measures been taken to prevent (mechanical protection) or monitor unprotected presence in the hazardous area when protecting a hazardous area/hazardous point and have these been secured against removal?	Yes☐	No ☐
6.	Are additional mechanical protective measures fitted and secured against manipulation which prevent reaching under, over or around the ESPE?	Yes☐	No ☐
7.	Has the maximum stopping and/or stopping/run-down time of the machine been measured, specified and documented (at the machine and/or in the machine documentation)?	Yes☐	No ☐
8.	Has the ESPE been mounted such that the required safety distance from the nearest hazardous point has been achieved?	Yes☐	No ☐
9.	Are the ESPE devices correctly mounted and secured against manipulation after adjustment?	Yes☐	No ☐
10.	Are the required protective measures against electric shock in effect (protection class)?	Yes☐	No ☐
11.	Is the control switch for resetting the protective device (ESPE) or restarting the machine present and correctly installed?	Yes☐	No ☐
12.	Are the outputs of the ESPE (OSSDs, AS-Interface Safety at Work) integrated in compliance with the required PL/SILCL according to EN ISO 13 849/EN 62 061 and does the integration comply with the circuit diagrams?	Yes☐	No ☐
13.	Has the protective function been checked in compliance with the test notes of this documentation?	Yes☐	No ☐
14.	Are the given protective functions effective at every setting of the operating mode selector switch?	Yes☐	No ☐
15.	Are the switching elements activated by the ESPE, e.g. contactors, valves, monitored?	Yes☐	No ☐
16.	Is the ESPE effective over the entire period of the dangerous state?	Yes☐	No ☐
17.	Once initiated, will a dangerous state be stopped when switching the ESPE on or off and when changing the operating mode, or when switching to another protective device?	Yes☐	No ☐
18.	Has an information label for the daily check been attached so that it is easily visible for the operator?	Yes☐	No ☐
19.	Have you made sure that the protective device itself when mounted is not a source of danger during machine operation (for example, catching between the device and parts of the machine)?	Yes☐	No ☐

This checklist does not replace the initial commissioning, nor the regular inspection by qualified safety personnel.

Contents

Contents

1 About this document

Read this chapter carefully before working with the operating instructions and the V4000 Press Brake system.

For "V4000 Press Brake system" we shall use the abbreviation "V4000 PB" from now on.

1.1 Function of this document

These operating instructions are intended for *the technical personnel of the machine manufacturer* or the *machine operator* in regards to safe mounting, electrical installation, configuration, commissioning, operation and diagnostics of the V4000 PB sensor.

These operating instructions do *not* provide instructions for operating machines on which the V4000 PB is, or will be, integrated. Information of this kind will be found in the operating instructions for the machine.

1.2 Target groups

These operating instructions are intended for *manufacturers, operators and the users* of press brakes which are to be protected by a V4000 PB. It also addresses people who integrate the V4000 PB into a machine, initialise its use, or who check the unit.

1.3 Scope

Note These operating instructions apply for the V4000 PB with the following type label entry in the *Operating Instructions* field: 8 010 501. This document is part of SICK part number 8 010 501 (V4000 Press Brake sensor system in all available languages).

You will require a CDS (Configuration & Diagnostic Software) version 3.0 or greater for the configuration and diagnostics of this system. To determine the software version, select the **Module info** item from the **?** menu in the menu bar.

1.4 Depth of information

These operating instructions contain information on the V4000 PB regarding the following subjects:

- Mounting
- Electrical installation
- Configuration and commissioning
- Operation, care and maintenance
- Error diagnostics and remedying
- Technical data and order numbers
- Conformity and approval

Planning and using protective devices such as the V4000 PB sensor also require specific technical skills which are not detailed in these operating instructions.

When operating the V4000 PB sensor, the national, local and statutory rules and regulations must be observed.

General information on health and safety using opto-electronic protective devices is contained in the brochure "Safe Machines with Opto-Electronic Protective Devices".

Note We also refer you to the SICK homepage on the Internet at

http://www.sick.com

Here you will find:

- These operating instructions in different languages for viewing and printing
- The EC Declaration of Conformity

1.5 Abbreviations

ANSI American National Standards Institute

BWS Electro-sensitive protective equipment (ESPE) (e. g. V4000 PB)

CDS SICK Configuration & Diagnostic Software = software for configuring and diagnosing the V4000 PB system

EDM External device monitoring

ESPE Electro-sensitive protective equipment

HMI Human machine interface

LD Laser diode

LED Light-emitting diode

MP Mute point

NC Numerical control

OMO Overall machine overrun

ORT Overall response time

OSSD Output signal switching device = signal output of the protective device to the controller used for switching off the movement which is the source of danger

PBDC Programmed bottom dead centre

PBI Press brake interface

PTDC Programmed top dead centre

PP Pinch point

SP Switch-over point (from v_p to v_{slow})

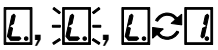
SPLC Safety programmable logic control

V4000 PB V4000 Press Brake (sensor system)

1.6 Symbols used

Recommendation Recommendations are designed to provide some assistance for your decision-making process regarding application of a certain function or technical measure.

Note Notes provide special information about the device.



Display indicators show the status of the 7-segment display of the receiver:

- F. Constant display of the letter F
- F. Flashing display of the letter F
- F. 2. Alternating display of F and 2

● Yellow, ☀ Yellow, ○ Yellow

LED symbols describe the state of an LED:

- ● The LED is illuminated constantly.
- ☀ The LED is flashing.
- ○ The LED is off.

■, □ ON or OFF state:

- ■ ON
- □ OFF

➢ **Action …** Instructions for taking action are shown by an arrow. Read carefully and follow the instructions for action.

WARNING

Warning!

A warning indicates concrete or potential dangers. They save you from harm.

Read warnings carefully and abide by them!

Software notes show the location in the CDS (Configuration & Diagnostic Software) where you can make the appropriate settings and adjustments. Go to the **View** menu, **Dialogue windows** of the CDS and activate the **item tabs** to view the named dialogue boxes as required. Otherwise use the software wizard to make the desired settings.

Sender and receiver

In drawings and diagrams, the ▶ symbol denotes the sender and the symbol ▶| the receiver.

The term "dangerous state"

In the drawings in these operating instructions, the dangerous state (standard term) of the machine is always represented as a movement of a machine part. In practical operation there may be a number of different dangerous states:

- Machine movements
- Electrical conductors
- Visible or invisible radiation
- A combination of several risks and hazards

Representation of the signals for teach-in, alignment mode and selection of protective volume mode

These operating instructions also describe the V4000 PB input and output signals. As a way of uniquely representing the signals for teach-in, alignment mode and selection of protective volume mode (input signals), tactile switching amplifiers (buttons, switches) are used. The signals can be generated at the inputs of the V4000 PB by, for example, foot switches, alignment buttons, teach-in buttons, selector switches and key-operated switches or by the corresponding switching elements on the HMI of the press controller.

2 On safety

This chapter deals with your own safety and the safety of the operators.

➢ Read this chapter carefully before working with the V4000 PB or with the machine protected by the V4000 PB.

2.1 Specialist personnel

The V4000 PB must be mounted, connected, commissioned and serviced only by specialist personnel. Specialist personnel are defined as persons who

- due to their technical training and experience possess sufficient knowledge in the field of safety equipment for making press brakes safe

and

- who have been instructed by the responsible machine operator in the operation of the machine and the current valid safety guidelines

and

- have sufficient familiarity with the relevant national industrial safety regulations, work safety regulations, directives and the generally recognised code of practice of the industry (for example, DIN standards, VDE specifications, technical codes of other EC member states) that they can judge whether the press brake is safe from the occupational safety point of view

and

- have access to and have read these operating instructions.

As a rule these will be specialist personnel, the manufacturer of the ESPE or even such persons who have been given the corresponding training by the ESPE manufacturer, who are mainly concerned with inspecting and testing ESPEs and have been commissioned by the ESPE operator in this regard.

2.2 Applications of the system

The V4000 PB is an ESPE (electro-sensitive protective equipment) device designed to protect the area beneath the die of press brakes at high closing speeds. As soon as an object enters the protective volume beneath the die, the ESPE issues the signal to the press controller to stop the fast closing movement and this system must then stop the closing movement.

The V4000 PB system consists of a sender and a receiver which are mounted on the press crosshead. The protective volume between the sender and the receiver moves with the press crosshead and thus ensures that the safeguarded area stays beneath the die.

The system is a *Type 4 ESPE* as defined by to IEC 61 496-1 and 2 and is therefore allowed for use with controls of safety category 4 in compliance with EN 954-1. It may be used in safety applications up to SIL 3 in accordance with IEC 61 508.

Use of the V4000 PB in the open air or explosion hazard areas is not permitted. The V4000 PB can only be used in normal industrial environments.

WARNING

Do not use the V4000 PB as a separating protective measure!

An opto-electronic protective device provides indirect protection, e.g., by switching off the power at the source of the hazard. It cannot provide protection neither from parts thrown out, nor from emitted radiation. Transparent objects are not detected.

Depending on its applications, mechanical protective devices may be needed in addition to the V4000 PB.

2.3 Correct use of the system

The V4000 PB system is intended to be used solely at a fixed location on press brakes and may only be used as defined by Section 2.2 "Applications of the system". It must be used only by specialist personnel and only on the machine where it has been mounted and initially commissioned by specialist personnel in accordance with these operating instructions.

SICK AG accepts no claims for liability if the equipment is used in any other way or if modifications are made to the device, even in the context of mounting and installation.

2.4 General protective notes and protective measures

WARNING

Protective notes

Please observe the following protective notes in order to ensure the correct and safe use of the V4000 PB.

- Warnings on the V4000 PB must be observed without fail.
- The V4000 PB meets the requirements of laser protection class 1 M. Do not look into the laser beam neither with the naked eye nor using optical equipment (such as binoculars).

Fig. 1: Warning regarding laser class 1M

- This device meets the norms: CDRH 21 CFR 1040.10, 1040.11 as well as DIN EN 60 825:2001. There the following note is required:”Caution – use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure!”
- The V4000 PB components must not be opened for maintenance work. Defective devices have to be sent back to the manufactorer.

- The national/international rules and regulations apply to the installation, commissioning and periodic technical inspections of the V4000 PB, in particular:
  - Machinery Directive 98/37/EC
  - Provision and use of Work Equipment Directive 89/655/EEC
  - The work safety regulations/safety rules
  - Relevant national health and safety regulations

  Manufacturers and operators of the machine on which the V4000 PB is used are responsible for obtaining and observing all applicable safety regulations and rules.
- The notices, in particular the test regulations (see Chapter 7 "Commissioning") of these operating instructions (e.g. on use, mounting, installation or integration into the existing machine controller) must be observed.
- The tests must be carried out by specialist personnel or specially qualified and authorised personnel and must be recorded and documented to ensure that the tests can be reconstructed and retraced at any time.
- The operating instructions must be made available to the operator of the machine where the V4000 PB is fitted. The machine operator is to be instructed in the use of the device by specialist personnel and must be instructed to read the operating instructions of the V4000 PB and of the machine.

2.5 Safety in operation

WARNING

Dangers which the V4000 PB does not protect against!

The different ways in which the press brake can be used in manufacturing means that indirect dangers may arise.
Please observe and comply with the following points in order to protect yourself against dangers during machine operation.

The V4000 PB safeguards the hazardous point beneath the die at high closing speeds (over 10 mm/s) or irrespective of the speed up to a gap of 6 mm. The maximum height of the protective volume up to the lower edge of the die is 26 mm.

Maximum protection is provided in standard protective volume mode.

In the case of box-bending or back-stop operation, use of a restricted protective volume is possible. With this kind of work, the reduced dimensions of the protective volume means that only limited protection against getting caught or crushed is possible.

If parts of the body are brought into the hazardous point within a box, they will only be detected behind the tolerance zone around the pressure axis. There is a danger of injury by being caught or crushed.

For a time interval of 100–150 ms (just before the gap height of 6 mm is reached) there is the possibility of an object which is moving into the space between the die and the workpiece being crushed.

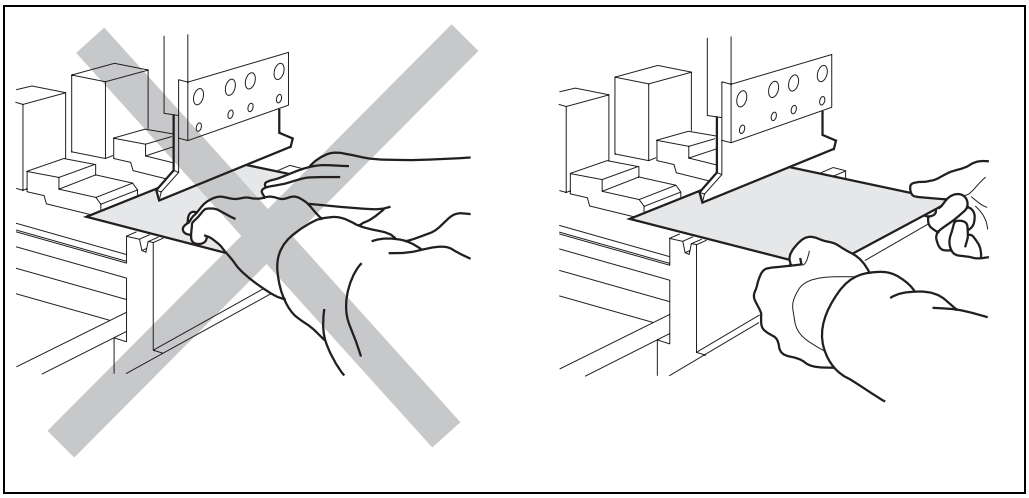
Correct handling of the workpiece

By handling the sheet properly you can avoid your hands or fingers being caught or crushed.

➢ Use gloves to prevent:

– Injuries caused by edges, corners and burr
– Residues and rust caused by sweat from the hands getting on dies and workpieces
– Deposits on the hands
– Slipping of smooth workpieces

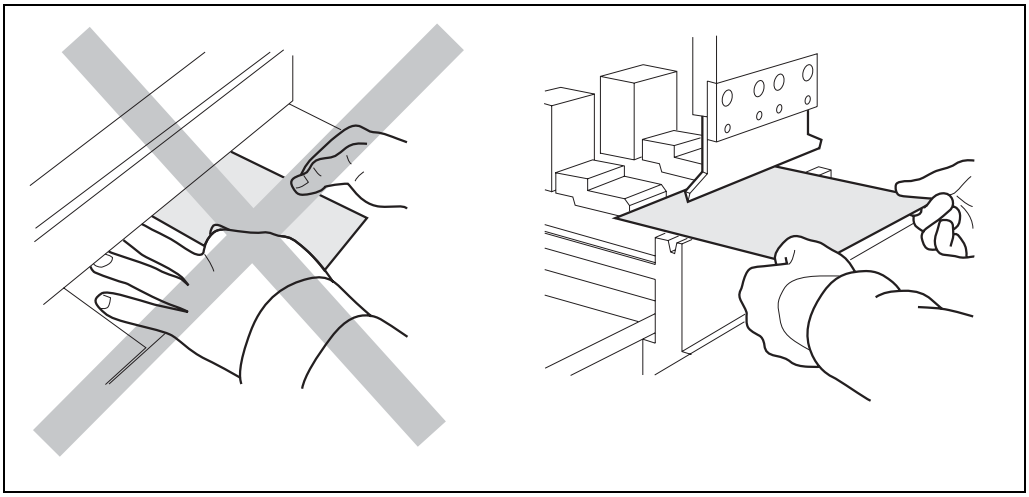
Fig. 2: Handling of the workpiece 1



➢ Hold the sheet by the left and right corners of the end facing you.

➢ Use both hands to hold the sheet firmly from below (thumb on top of the sheet, rest of hand underneath)

Fig. 3: Handling of the workpiece 2



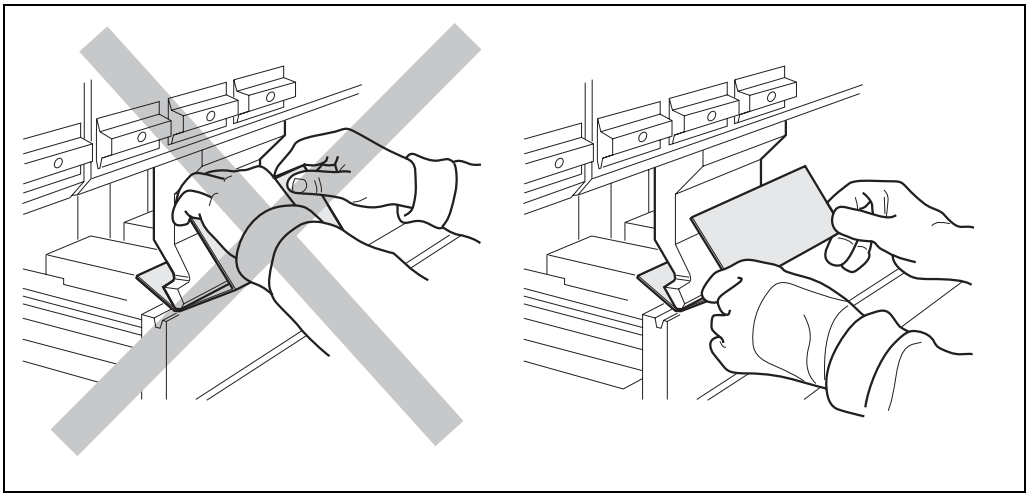
➢ When holding the sheet, be sure not to spread your fingers.

Note Spread fingers will interrupt the protective volume of the V4000 PB. The protective function of the V4000 PB will be triggered and the V4000 PB initiates a stop.

If the protective volume is limited (box-bending and back-stop operation) there will be an additional risk of getting your hand caught.

Correct handling of pre-flanged sheets

Fig. 4: Handling of pre-flanged sheets



Note If pre-flanged sheets are not handled correctly, your hands could get caught between the sheet and the die or press crosshead.

- ➢ Hold the pre-flanged sheet by the left and right edges between the thumbs and index fingers.
- ➢ Use both hands to hold the sheet firmly.

Correct handling with box-bending

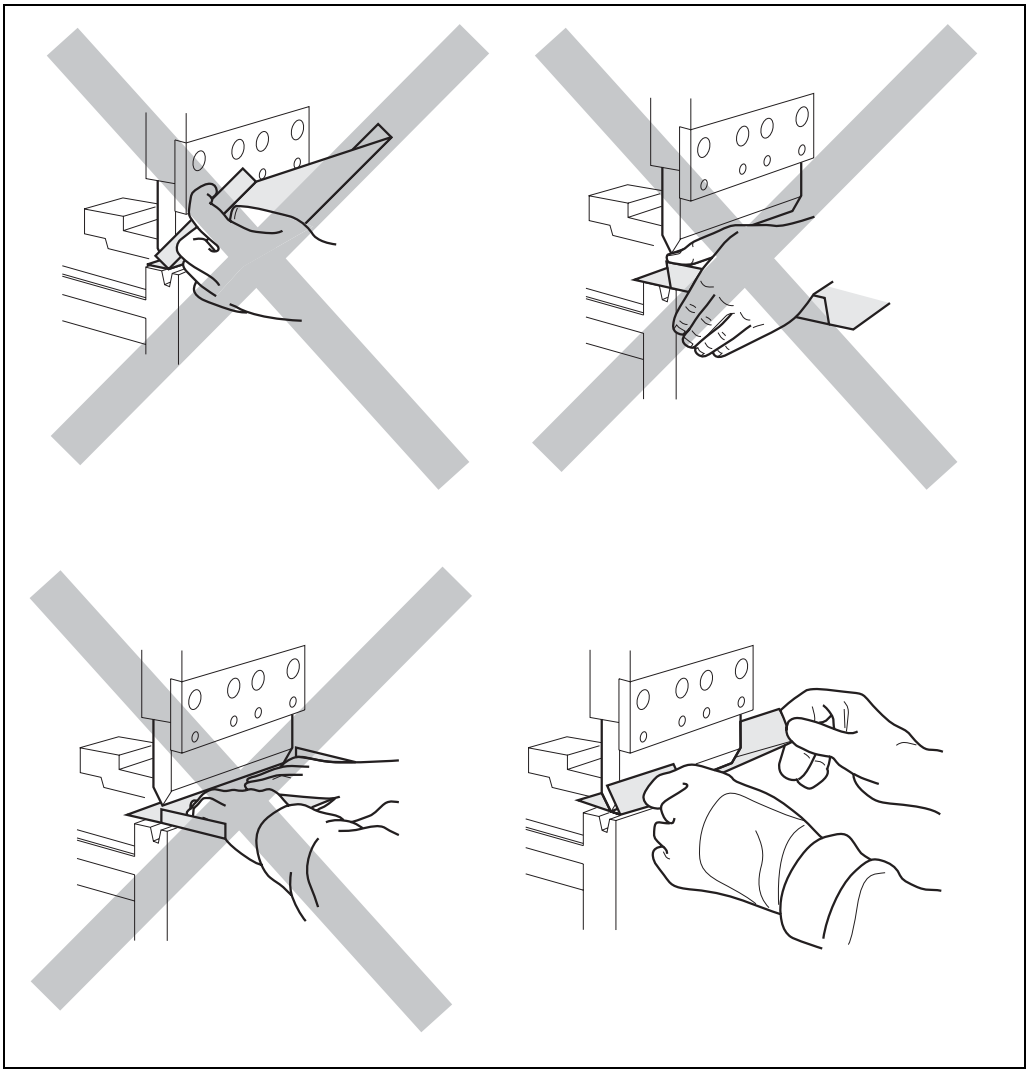


Fig. 5: Handling of box-shaped workpieces

Note In box-bending and back-stop modes the protective volume is limited and a tolerance zone around the pressure axis is hidden. If box-like workpieces are not handled correctly, your hands could get caught between the workpiece and the die or press crosshead.

- ➢ Do **not** hold the upper box walls by the edges or corners on the pressure axis.
- ➢ Hold box-shaped workpieces by their back part (closest to you) outside the hazardous point.

The V4000 PB cannot protect you against these dangers:

- Crushing your hands or fingers between the workpiece and the press crosshead as a result of handling the workpiece incorrectly during bending
- Crushing your fingers between the die and the workpiece as a result of handling the workpiece incorrectly
- The risk of injury from workpieces falling when the press brake is opened
- The risk of injury from large workpieces swinging upwards during bending
- When bending aids are used:
  Risk of injury due to the workpiece swinging up or down, or to the movement of the bending aids

- When automatically traversing rear stops are used:
  - Crushing your hands or fingers between the rear stops and the female die during traversing movements towards the operator
  - The operator being crushed by large workpieces being pushed at him by the rear stops
- Risk of injury in the rear space arising from automatically traversing stops, moving tools, workpieces or bending aids.

Note Access to the rear space or standing in the rear space must be prevented by means of the appropriate safety devices, such as a light grid.

Dangers arising from mounting of the V4000 PB

➢ When mounting the V4000 PB make sure that there will be no crushing or shearing points between the moving sender and receiver and other stationary machine parts or devices in the vicinity of the machine.

➢ If hazardous points cannot be avoided, they must be made safe by other protective measures or remedied by design changes.

2.6 Environmental protection

The V4000 PB has been designed to minimise environmental impact. It uses only a minimum of power and natural resources.

➢ At work, always act in an environmentally responsible manner.

2.6.1 Disposal

Disposal of unusable or irreparable devices should always occur in accordance with the applicable country-specific waste-disposal regulations
(e.g. European Waste Code 16 02 14).

Before you can turn over the devices for environmentally-friendly recycling, you must separate the different materials of the V4000 PB from one another.

➢ Separate the housing from the remaining components (especially the PCB).

➢ Press the front lens out of the lens holder.

➢ Send the separated components to the corresponding recycling centres (see Tab. 1).

Tab. 1: Overview of disposal by component

Component	Disposal
Product	
Housing	Metal recycling (aluminium)
Front lens	Glass recycling (used glass)
PCBs, cables, plugs and electrical connection pieces	Electronics recycling
Packaging	
Cardboard, paper	Paper/cardboard recycling
Polyethylene packaging	Plastic recycling

Note We would be pleased to be of assistance on the disposal of the V4000 PB. Contact your local SICK representative.

WARNING

Material separation may only be performed by specialist personnel!

Exercise care when disassembling the devices. The danger of injury is present.

3 Product description

This chapter provides information on the special features and properties of the V4000 PB.

It describes the safety concept, the range of use, the structure and operating principle of the device, configuration options and the various operating modes.

➢ Read this chapter before you mount, install and commission the V4000 PB.

3.1 Special features

- Sender/receiver system
- Response time 10 ms
- Unambiguous status information via LED and 7-segment display shown directly on the V4000 PB receiver
- All inputs and outputs of the system integrated in the receiver
- Simple combination of the V4000 PB system with alternative protective measures by means of bypass inputs and outputs
- No additional evaluation unit required in the control cabinet
- V4000 PB system uses the existing measurement guides of the press brake for determining speed, position and direction
- Optional operation via hardware input devices or via the outputs of the press brake controller (e.g. NC).
- The SICK CDS user interface provides ease of configuration and comprehensive expanded diagnostics of the V4000 PB system
- Reliable pinch-point monitoring even when workpiece surface has irregularities or unevenness

Automatic functions

- Determination and monitoring of the pinch point
- Monitoring of the relevant overall machine overrun of the press brake as a function of speed
- Monitoring of the slow closing speed (≤ 10 mm/s) from pinch point V4000 PB (can be configured)
- Dynamic adaptation of the switch-over point
- Position-dependent muting (6 mm above the pinch point)
- Speed-dependent muting (configurable)
- Checking of the die position to detect coarse maladjustment
- Detection of box wall in front and rear spaces

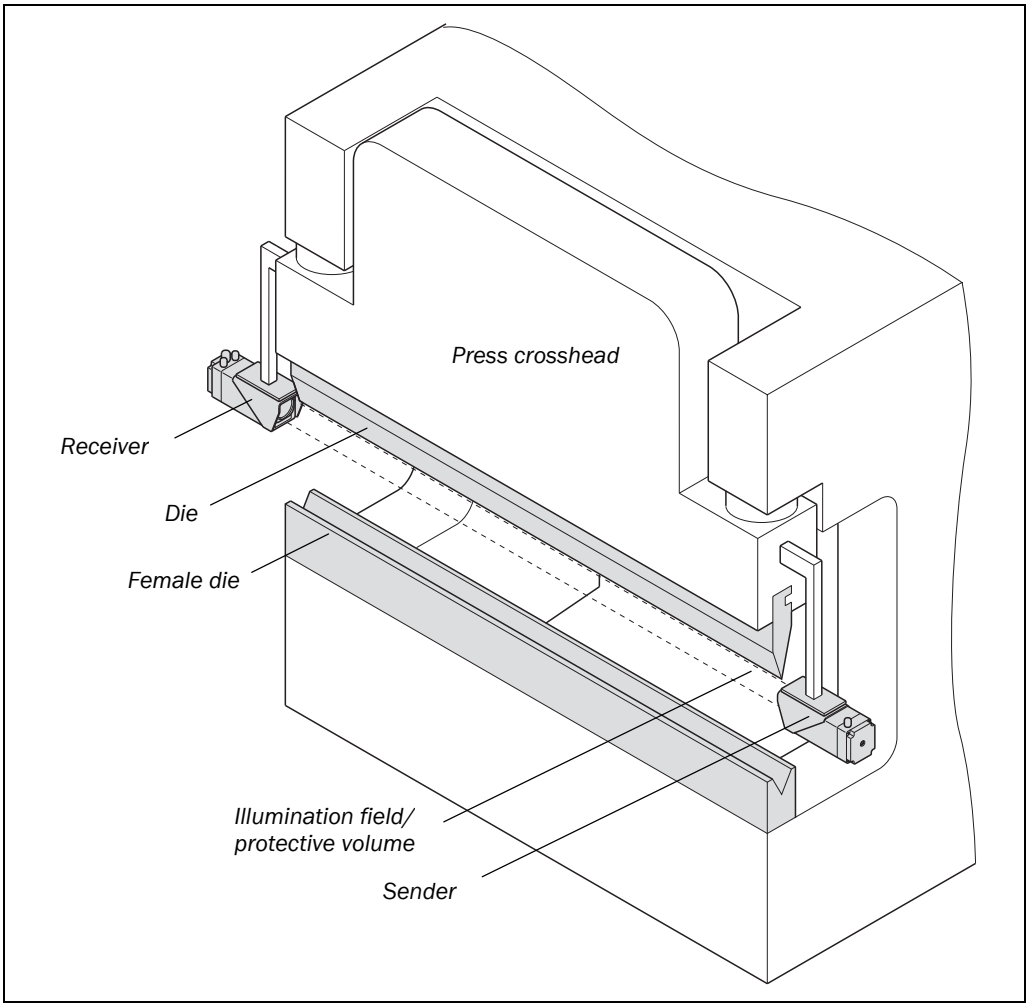
Protective operation

- 3 protective volume modes with adapted protective volume shape corresponding to bending task
- Loading of press hydraulics minimised by box and back-stop modes without emergency stop at box wall

3.2 Safety concept

3.2.1 Protection principle of the V4000 PB

Fig. 6: Press brake with V4000 PB



The V4000 PB consists of a sender and a receiver mounted on the press crosshead.

A light beam of light (illumination field) between sender and receiver forms a three-dimensional protective field (protective volume) beneath the die tip measuring 40 mm wide and 26 mm high. The protective volume follows the movement of the press crosshead and in this way provides a travelling safety zone beneath the die tip.

The V4000 PB has three different kinds of protective volume (standard, box and back-stop). These protective volumes differ in their dimensions and in their functions.

Should there be a partial or complete interruption of the protective volume by an object, the output signal switching devices (OSSDs) of the ESPE which are integrated in the receiver change over to the OFF state and generate a two-channel monitored switch-off signal to the press controller which then must stop the closing movement of the press crosshead with the die.

The evaluation and run concepts of the V4000 PB have been designed so that the ESPE constantly checks its internal expected position (which depends on the operating mode, the press crosshead position and the speed) against the actual external situation. Only when the expected position is identical to the actual circumstances will the OSSDs remain in the ON state. Any other result will put the OSSDs into the OFF state.

The V4000 PB safeguards the hazardous point beneath the die at high closing speeds (> 10 mm/s) and a pass-through gap height of more than 6 mm. If the gap height between the top of the workpiece and the die tip is 6 mm or less, the ESPE switches automatically into muting mode.

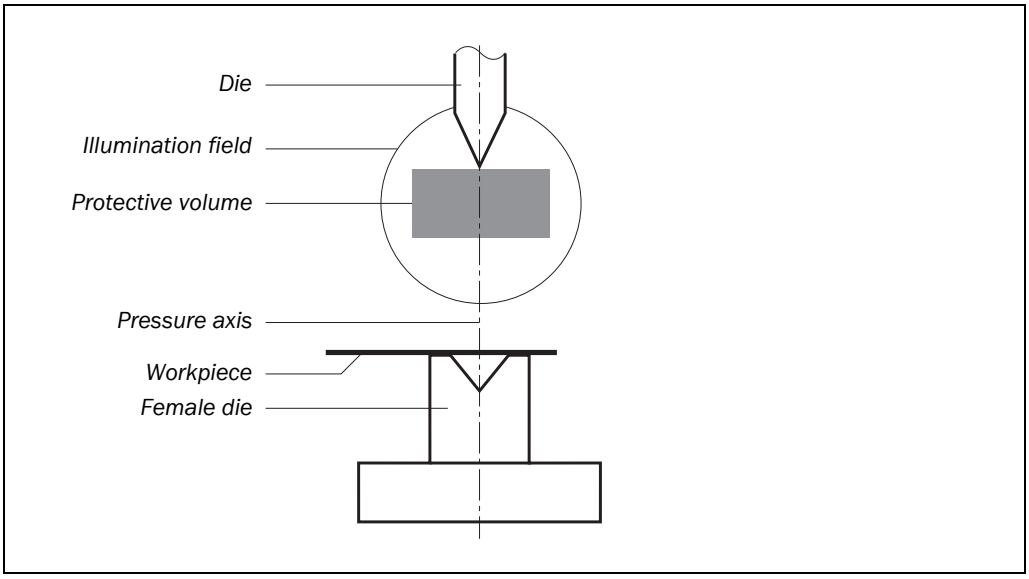
If the muting option is activated at a low closing speed (≤ 10 mm/s), the system will automatically go into muting mode even when the slow closing speed is reached. The speed is monitored continuously.

In the muting state, the protective volume is inactive and the OSSDs stay in the ON state.

Note Whether muting is permitted at the slow closing speed varies from country to country. This option is by default disabled in the configuration.

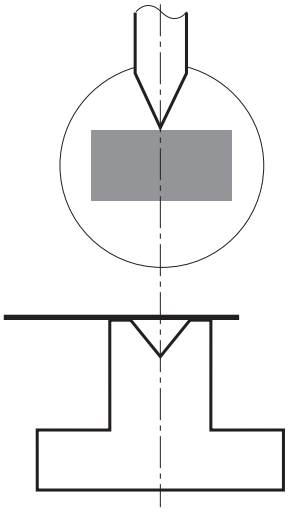
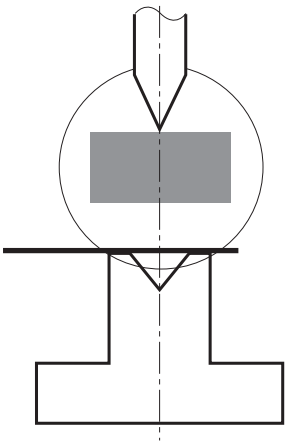
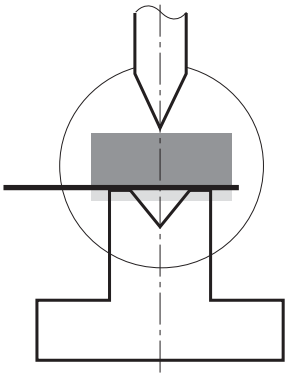
In the event of system errors (such as an error being detected when the hardware is tested) the V4000 PB switches into lock-out state.

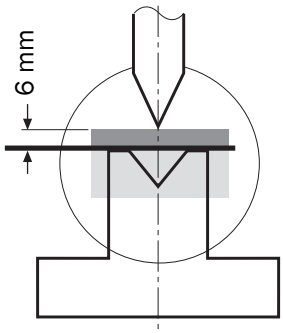
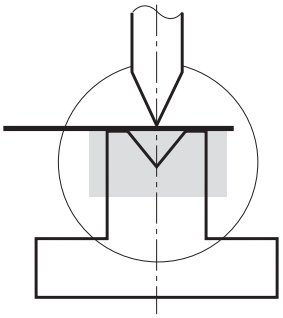
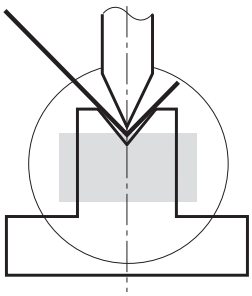
Fig. 7: Definitions



3.2.2 Protective volume during the operating cycle

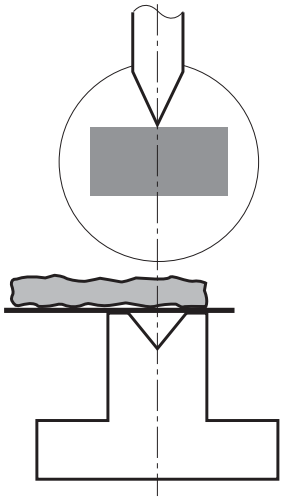
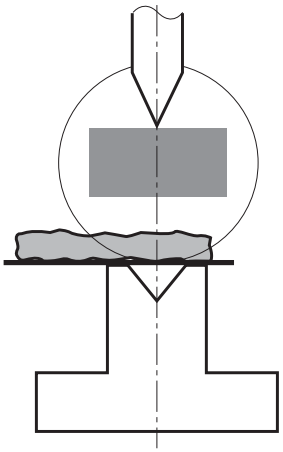
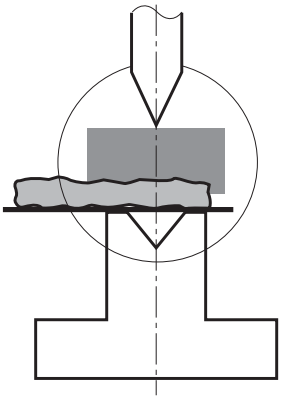
This sequence shows the protective volume during one operating cycle.

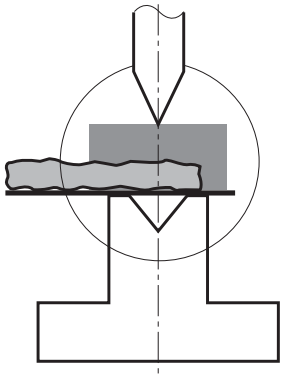
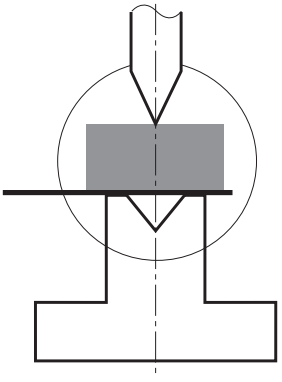
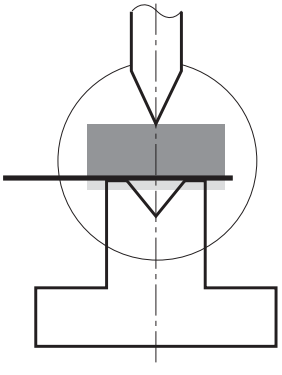
Step	① The die is at the programmed top dead centre. The operator gives the signal to start the closing movement (foot switch).	② The die descends at high speed (> 10 mm/s). The entire protective volume is active.	③ At the switch-over point the target speed is requested by the V4000 PB. The press controller initiates the braking procedure. The protective volume stays active in the gap opening.
Protective volume			

Step	④ The calculation of the switch-over point includes an additional 6 mm safety gap required to reach the target speed (v_{slow}). The protective volume becomes inactive.	⑤ The die contacts the workpiece (pinch point).	⑥ The die shapes the workpiece. The operating cycle ends at the programmed bottom dead centre. The die goes back up.
Protective volume			

3.2.3 Intrusion of the protective volume during the operating cycle

This sequence shows how the V4000 PB responds when there is an interruption to the protective volume.

Step	① The die is at the programmed top dead centre. There is a foreign object on the workpiece or female die. The operator gives the signal to start the closing movement (foot switch).	② The die descends at high speed (> 10 mm/s). The entire protective volume is active.	③ Part of the protective volume is interrupted by the object. The OSSDs go into the OFF state and generate a safe stop signal. The press controller must ensure the stop procedure is implemented.
Protective volume			

Step	④ The die continues to move in accordance with the overall machine overrun and stops at least 5 mm above the object.	⑤ The object is now removed. The protective volume is clear again.	⑥ The operator gives the signal once more to start the closing movement (foot switch). The closing movement starts and the operating cycle resumes.
Protective volume			

3.3 Range of use

The V4000 PB is an ESPE (electro-sensitive protective equipment) device designed to protect the area beneath the die of press brakes at high closing speeds, it provides hand and fingers protection.

The V4000 PB is suitable for stationary use in press brakes with a maximum distance of 7.5 m between the sender and the receiver.

The press brake must be designed to comply with the maximum stopping distance of 11 m.

This corresponds, for example, to a maximum overall machine overrun of 8.5 mm at a maximum closing speed of 300 mm/s (see also Section 3.5.13 "Monitoring of the slow closing speed vcrawl from the pinch point").

Requirements for use of the V4000 PB

Before the V4000 PB can carry out its protective functions the following conditions must be met:

- It must be possible to influence the control of the press brake by electrical means.
- The OSSDs of the V4000 PB must be incorporated into the press controller in such a way that when the OSSDs give the switch-off signal:

  – the dangerous state (high closing speed of > 10 mm/s) is stopped.

  or

  – the press, should the lock-out state occur, does not start up again.
- The V4000 PB must be mounted and configured in such a way that it can detect objects when they penetrate into the hazardous point.

3.4 Structure of the device

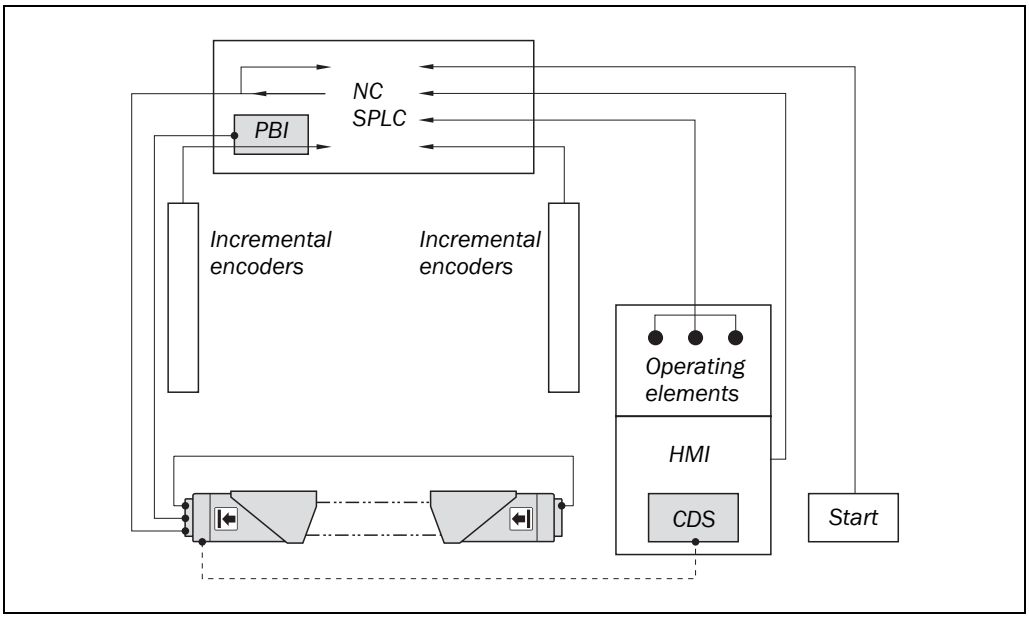
The V4000 PB comprises the following components:

- Sender
- Receiver with interfaces
- PBI with interfaces
- CDS (software for configuration and diagnostics of the V4000 PB sensor)

In addition the V4000 PB needs control signals from *external operating elements*.

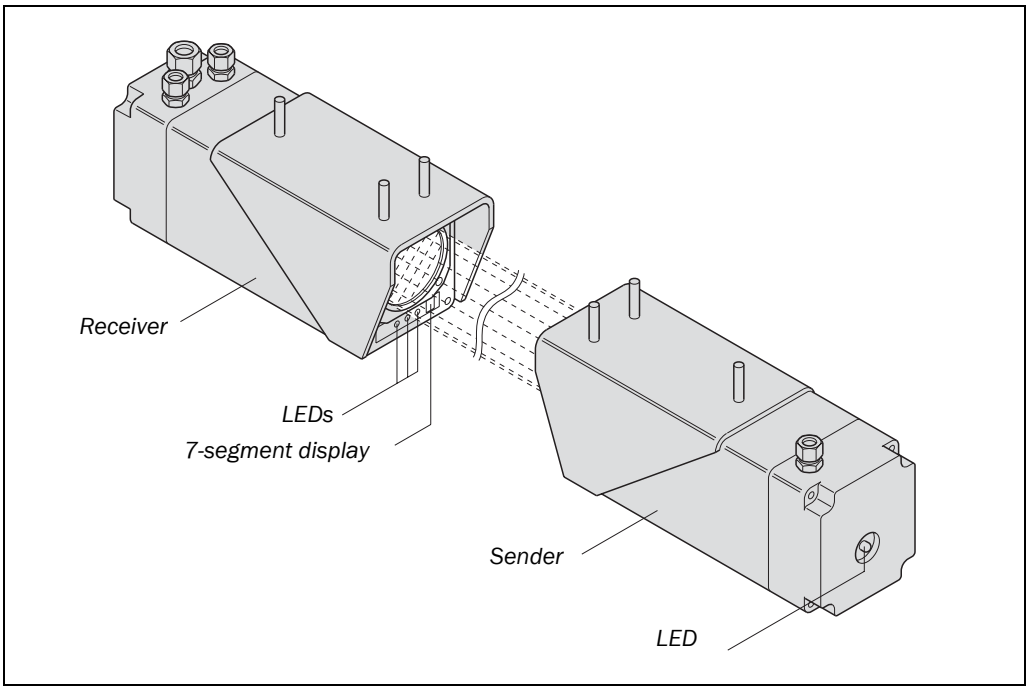
The sections which follow describe the individual components of the device.

Fig. 8: Components



3.4.1 Sender and receiver

Fig. 9: Sender and receiver



Sender and receiver are mounted on the press crosshead and follow the movements of the crosshead. At start-up and every time there is a change of tooling, they need to be precisely aligned to the length of the die used and to each other.

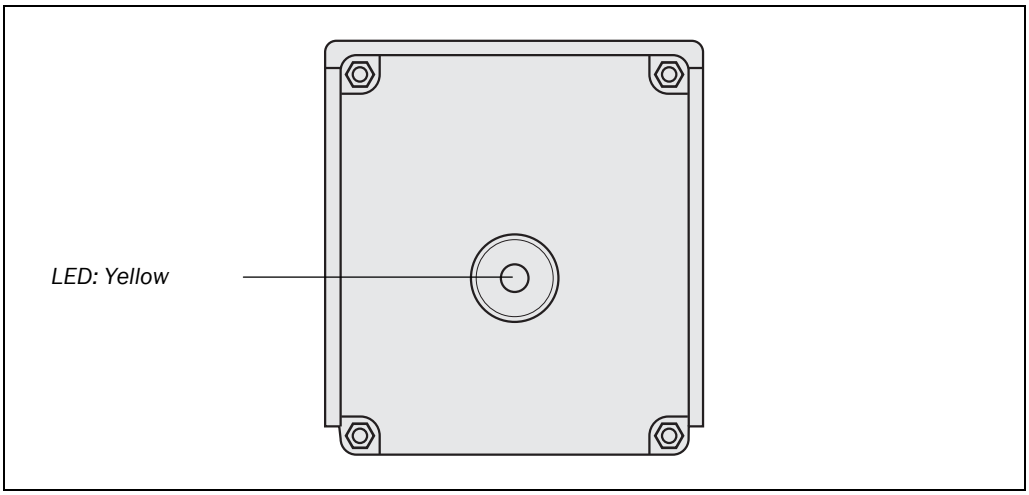
The laser diode in the sender emits light which is collected at the transmitting lens and given parallel alignment. The beam of light, which has a constant diameter of 58 mm (illumination field), travels along the lower side of the die to the receiver. In the receiver the light beam is mapped at the image detector.

The evaluation electronics with all relevant inputs and outputs is built into the receiver. Two output switching elements (OSSDs), which go into the OFF state when the sensor function is triggered, pass on the signal for stopping the closing movement (high closing speed > 10 mm/s).

3.4.2 Displays at the sender and receiver

Display at the sender

Fig. 10: Display at the sender



An LED on the sender displays the status.

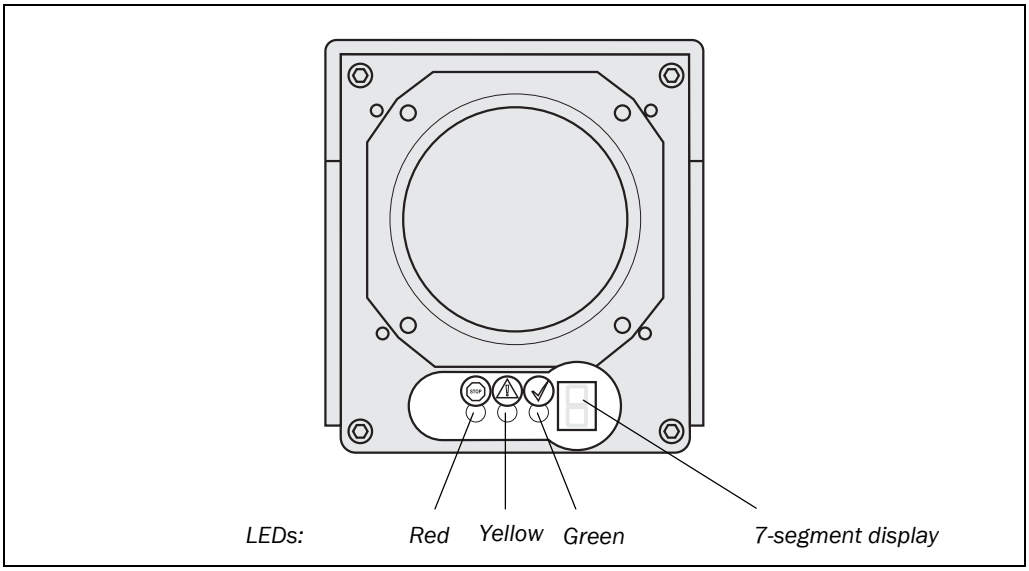
Tab. 2: Display at the sender

Display	Meaning
● **Yellow**	Power supply OK. The sender of the V4000 PB is switched on.

Displays at the receiver

The status of the system is displayed at the receiver by three LEDs and a 7-segment display.

Fig. 11: Displays at the receiver



The LEDs tell the operator whether an input is expected and whether the OSSDs are in the OFF or ON state.

The 7-segment display provides the operator with further information about the status of the V4000 PB.

Tab. 3: Key to the LEDs on the receiver display

Display	Meaning
☼● **Yellow** (10/90) (90/10)	• Operator action (input) is required (On % / Off % at 1 Hz) – Alignment mode – Teach-in request
● **Yellow**	• In production operation: Operator action (input) required – In standard mode (release foot switch) – In back-stop mode (first operation of the foot switch expected) – In box mode (first operation of the foot switch expected) • During configuration: CDS connected and Configuration operating mode selected
● **Red**	• System sending signals to switch off the machine (OSSDs in the OFF state) • Additional states in which the red LED is illuminated: – Self-test (system initialisation) – Configuration – Box mode – Back-stop mode – Lock-out state – Alignment mode
● **Green**	System free (OSSDs in the ON state)

Tab. 4: Key to the 7-segment display on the receiver

Display	Meaning
E.	System error. The device is defective. Replace the receiver.
.	Muting state
-	Switch on. This is followed by self-testing of the V4000 PB (system initialisation).
n.	Standard mode
a.	Box mode
t.	Back-stop mode
Other displays	All of the other displays are error messages, displays within alignment mode or displays during the self-test (system initialisation).

Note **Further explanations of the 7-segment display** will be found in the following sections:

- Displays during system initialisation when the machine is switched on (see Section 8.1 "Switching the machine on")
- Displays within alignment mode (see Section 7.2 "Aligning sender and receiver")
- Error displays within lock-out state (see Section 9.2 "Error displays of the LEDs")

3.4.3 Interfaces at the receiver

The receiver of the V4000 PB has the following interfaces:

- Digital interface
- Serial interfaces for configuration and diagnostics
- Interface for connecting the sender
- Interface for connecting the PBI

Digital interface

The digital interface receives signals from the press controller or from external operating elements and passes them on to the receiver; it also passes signals from the receiver on to the press controller.

Tab. 5: Inputs and outputs at the digital interface

Number	Inputs and outputs with safety relevance	Function
2	Actively tested semiconductor switching outputs (OSSDs)	For the switch-off signal to the press controller which must stop the closing movement of the press crosshead with the die
2	Inputs	For the gated signal for starting the closing movement
Number	**Standard inputs and outputs**	**Function**
2	Pulsed outputs	For the bypass signal
2	Inputs	For the bypass signal
1	Input	For external device monitoring (EDM)
1	Output	For the target speed request to the press controller
1	Input	For activating alignment mode
1	Input	For activating teach-in mode
3	Inputs	For selecting the protective volume mode (standard, box, back-stop) within protective operation
1	Output	For the signal to the press controller that teach-in is being requested

Serial interface for configuration and diagnosis

The PC is connected to the receiver via the serial RS-232 interface for configuration of the V4000 PB and for extended diagnostics with the SICK CDS Software in the event of servicing. For a permanent connection of the PC (CDS) to the receiver an RS-422 interface is available for extended diagnostics. A switch allows you to switch between the two interfaces (see Section 6.1 "Delivery state").

Interface for connecting the sender

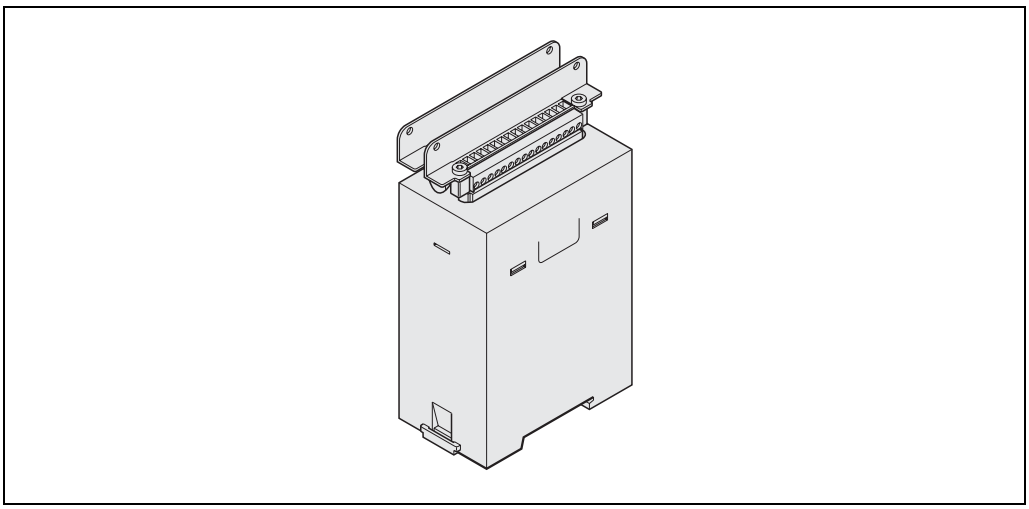
To allow control of the sender function by the receiver, the sender and the receiver are electronically connected to the receiver via a signal line.

Interfaces for connecting the PBI

The receiver is provided with an interface for data transmission (incremental pulses of the measurement guide) from the PBI.

3.4.4 PBI (press brake interface)

Fig. 12: PBI (press brake interface)



The incremental measurement guides of the press controller register the movement of the press crosshead. The speed and direction of movement of the press crosshead and the overall machine overrun are calculated by the V4000 PB from the signals of one measurement guide and from other measured data (such as time).

The measurement guide is connected to the V4000 PB via the PBI in the control cabinet. At the interface with the press controller the PBI taps onto the signals of the measurement guide, decouples them and passes them on to the receiver.

Position detection must be checked to ensure it is working properly. The V4000 PB monitors whether the signals (increments) from the measurement guide have a logical order – in other words, whether they can be interpreted unambiguously as upward or downward movement or standstill.

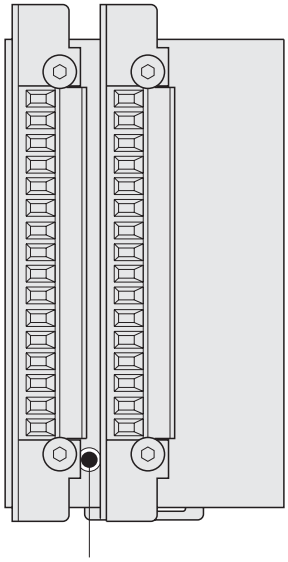
Example

If a start signal for the closing movement is detected by the safety-relevant inputs, it will be assumed that the press brake is moving after a period of delay (start-up delay). If there is no movement – in other words, the signals from the PBI cannot be unambiguously interpreted as movement – the V4000 PB assumes that there is a fault in position detection, switches the OSSDs into the OFF state, and goes into lock-out state.

The system will not change into the muting state unless the measurement system is delivering correct information which agrees with the expected values.

Display at the PBI

Fig. 13: Display at the PBI



LED: Yellow

Tab. 6: Display at the PBI

Display	Meaning
● **Yellow**	Power supply OK.

Interface at the PBI

The PBI of the V4000 PB has been designed for two-channel, incremental, linear measurement guides with an RS- 422 interface. All signals of the measurement guide are looped through.

3.4.5 CDS (Configuration & Diagnostics Software)

The V4000 PB is configured and diagnosed with the CDS software (Configuration & Diagnostics Software) running on Windows 98 and later operating systems.

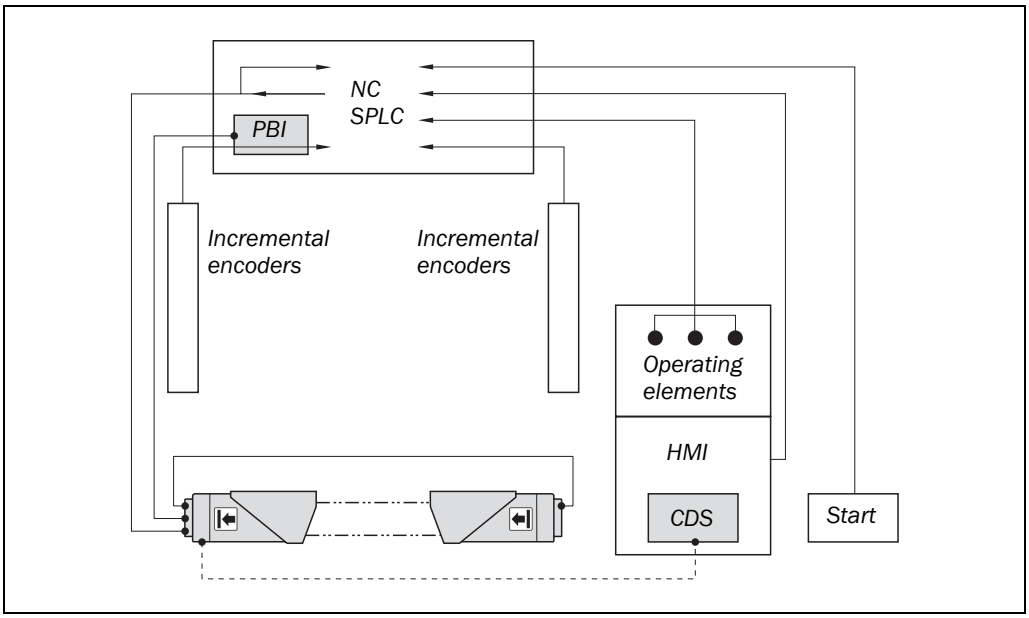
Note For more information see the Sections 3.5 "Possible device configurations" and 9.4 "Extended diagnostics via CDS".

System configuration: version A

In the case of press brakes with PC control and a Windows user interface, the CDS for configuration or diagnostics of the V4000 PB can be integrated into the control system.

Note Permanent – on-line - diagnostics and operation must be implemented solely via the RS-422 interface.

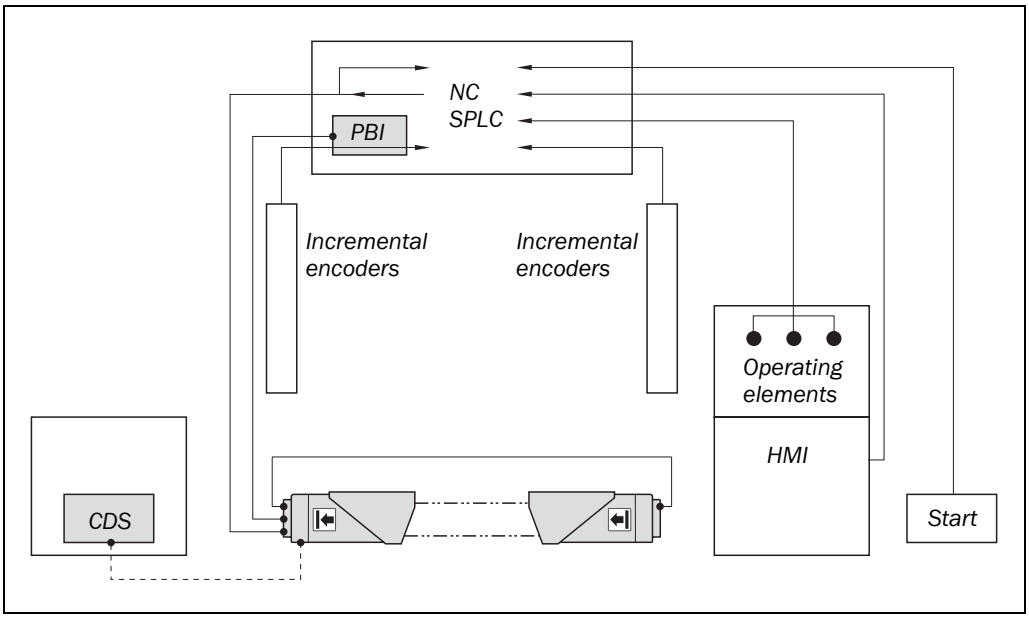
Fig. 14: System configuration with PC control



System configuration: version B

In the case of press brakes without PC control or a Windows user interface, the CDS for configuring the V4000 PB must be connected to the receiver. A permanent connection with the CDS is not necessary.

Fig. 15: System configuration without PC control



3.4.6 External operating elements

For controlling the V4000 PB external signals are required. The V4000 PB has the corresponding signal inputs for:

- Starting the closing or opening movements of the press brake
- Requesting alignment mode
- Requesting or confirming teach-in
- Selecting the protective volume mode (standard, box, back-stop)
- Requesting bypass mode

The signals are generated either by operating elements such as buttons or selector switches or by the outputs of the press controller (e.g. NC).

Note How these various possibilities are actually implemented (for example, foot switch, alignment button, teach-in button, selector switch and key-operated switch, or corresponding switching elements on the MMI of the press controller) falls within the area of responsibility of the user.

Recommendation All switching elements should be large and sturdy. It must be possible to operate them reliably and simply while wearing gloves.

3.5 Possible system configurations

This section describes the parameters and functions of the V4000 PB which can be configured via CDS.

WARNING

Check the V4000 PB after making changes!

After making any change to the configuration you must check the effectiveness of the V4000 PB (function and configuration data).

When starting to configure the V4000 PB, you may save the configuration using an application name with a maximum of 22 characters. You should use unique designations with an evident relation to the concrete application name – such as "Machine name XYZ".

V4000 PB device symbol, context menu **Configuration draft, Edit, Basic settings** tab

Tab. 7: Configurable parameters and functions

Basic settings	**Description in Section**
Source of the operator signals	3.5.1
Baud rate of communication interface	3.5.2
Application name	3.5.3
Repetition interval of power-up cycle	3.5.4
Mounting of receiver	3.5.5
Position-sensing system Increments per mm stroke Measurement direction during closing movement	3.5.7
Speed-dependent muting	3.5.6
External device monitoring	3.5.8
Standstill time for determining the top dead centre	3.5.16
Start delay for closing movement	3.5.17
Time for standstill detection	3.5.18
Braking distance	
Default value for braking distance	3.5.9
Travel for determining braking distance	3.5.10
Braking offset	3.5.11
Target speed v_{slow}	3.5.12
Monitoring of the slow closing speed v_{crawl} from the pinch point	3.5.13
Overall machine overrun	
Max. overall machine overrun	3.5.14
Travel for determining overall machine overrun	3.5.15
Maximum closing speed	3.5.14
Inputs	
Settling times for standard inputs	3.5.19
Settling times for safety-relevant inputs	
Discrepancy time for safety-relevant inputs	3.5.20
Discrepancy time for protective volume selection	
Maximum duration of 1st operation (confirmation of reduced protective volume)	3.5.21
Start signal ***Time for pause between 1st and 2nd operation***	
Outputs	
Minimum state time for standard inputs	3.5.22
Minimum switch-off time of safety-relevant outputs	3.5.23
Bypass	
Bypass	3.5.24
Discrepancy time for bypass inputs	3.5.20

3.5.1 Source of the operator signals

With the CDS the V4000 PB can be configured to accept operator signals (alignment, teach-in, reset, and selection of the protective mode) either from the CDS software or from external touch elements such as buttons or selector switches. Use of CDS to provide these operator signals requires a dedicated permanent (on-line) communication interface between the V4000 PB and CDS via a RS-232 port.

Another method for providing operator signals to the V4000 PB is via the HMI of the numerical control. These signals could be collected via touch buttons connected to the NC interface or via software buttons on the HMI console.

Note Signals of the operating elements of the CDS overwrite signals of the external operating elements. There could be inconsistencies between the system state and the state of the V4000 PB.

V4000 PB device symbol, context menu **Configuration draft, Edit, Basic settings** tab

3.5.2 Baud rate communication interface

By means of the CDS the baud rate (transmission rate) can be set at the serial interface for configuration (between V4000 PB and connected PC). The setting will depend on how powerful the PC is.

V4000 PB device symbol, context menu **Configuration draft, Edit, Basic settings** tab

3.5.3 Application name

When starting to configure the V4000 PB, you may save an application name with a maximum of 22 characters.

Here you should use unique designations with an evident relation to the concrete application name – such as "Machine name XYZ".

V4000 PB device symbol, context menu **Configuration draft, Edit, Basic settings** tab

3.5.4 Repetition interval of power-up cycle

The V4000 PB has an internal time monitor for certain functions. The time monitor should ensure a regular check is made in the case of uninterrupted operation. The start times are saved and compared with the current state. If the time for a particular function has elapsed, a corresponding operator action will be requested.

Following an interruption to the supply voltage all times will be reset to zero.

The V4000 PB monitors the time since the last power-up cycle and requests a new power-up cycle if the configured value (≤ 24 h) is exceeded.

V4000 PB device symbol, context menu **Configuration draft, Edit, Basic settings** tab

3.5.5 Mounting of receiver

In back-stop mode, the active protective volume segment as seen from the operator side is behind the pressure axis.

In order to place the active protective volume correctly, it is necessary to specify during configuration on which side of the press brake (as seen from the operator side) the receiver is mounted.

V4000 PB device symbol, context menu **Configuration draft, Edit, Basic settings** tab

3.5.6 Speed-dependent muting

Any one of the following conditions will result in automatic muting of the V4000 PB (inactivation of the protective volume):

- Gap size ≤ 6 mm above the taught-in pinch point
- Upward movement

In addition a closing movement at a low closing speed v_{crawl} (≤ 10 mm/s) will also cause the system to go automatically into muting mode provided this option has been enabled during configuration.

The closing speed is continually monitored. If the slow closing speed v_{crawl} is exceeded in the muting state, muting will be deactivated and the protective volume activated.

With automatic muting at the slow closing speed v_{crawl} it is possible for the press brake to close at slow closing speed despite an interruption of the protective volume.

If slow closing speed v_{crawl} has not yet been reached when the protective volume is interrupted, the press will be stopped. After this the press brake can be closed at slow closing speed via the press controller and a new start signal.

If slow closing speed has already been reached when the protective volume is interrupted, a new start signal will not be needed.

Note If a slow closing speed (≤ 10 mm/s) is permitted by the applicable regulations as the sole protective measure, the option may be activated by the machine setter. In ANSI standard B11.3 "Safety Requirements for Power Press Brakes" the slow closing speed (≤ 10 mm/s) is not specified as the sole protective measure!

V4000 PB device symbol, context menu **Configuration draft, Edit, Basic settings** tab

3.5.7 Position-sensing system

The measurement guides (incremental encoders) of the press controller register the position of the press crosshead.

Increments per mm stroke

The V4000 PB requires the resolution of the incremental encoder [INC/mm] in order to calculate the speed and direction of movement of the press crosshead and the overall machine overrun from the signals of one measurement guide and from other measured data (such as time).

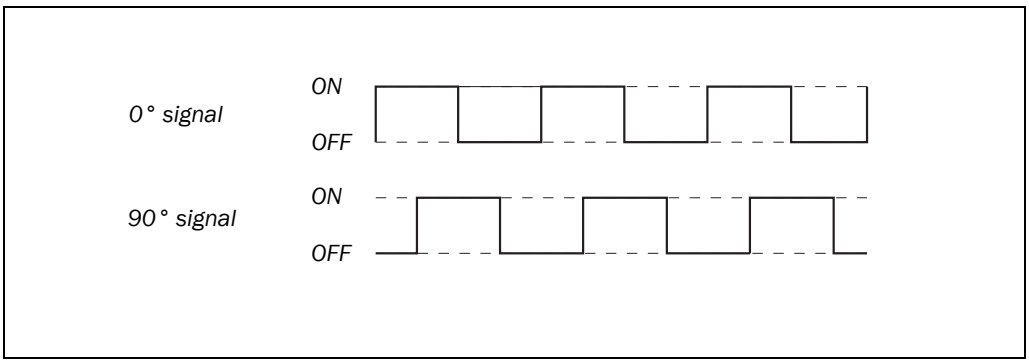
The incremental encoder must support two channels with at least 45 INC/mm and a maximum of 300 INC/mm at a closing speed of 300 mm/s. The recommendation is 50 INC/mm.

The specifications of the encoder manufacturer can differ from those for the V4000 PB. If, for example, pulses/mm or a resolution of 10 μm is specified, these have to be converted into increments/mm.

Measurement direction during closing movement

The 0° and the 90° signal of the incremental encoder are phase-shifted. During a closing movement (positive sign) the V4000 PB expects the 0° signal to be leading.

Fig. 16: Incremental encoder signals



Note When connecting the incremental encoder channels, make sure that they do not swapped or interchanged as this would lead to the direction of movement being misinterpreted. If a measurement guide is replaced, you will need to check the configuration and input the resolution of the new measurement guide into the configuration.

V4000 PB device symbol, context menu **Configuration draft, Edit, Basic settings** tab

3.5.8 External device monitoring (EDM)

The EDM checks if the contacts actually de-energise when the protective device responds.

If an external device monitor is present, external device monitoring must be activated in the CDS. The V4000 PB will then check the contacts every time the protective volume is interrupted and before the press brake restarts.

The external device monitor can tell whether a contact is welded or whether a contact/ relay has not de-energised due to a different mechanical fault. If, due to the failure of a contactor, the system cannot go into a safe operating state the OSSDs will go into the OFF state, the V4000 PB changes to lock-out state and a reset becomes necessary.

V4000 PB device symbol, context menu **Configuration draft, Edit, Basic settings** tab

3.5.9 Default value for braking distance

Note The Braking distance tab only has to be configured if the press brake supports two speeds (v_p and v_{slow}) and V_{slow} is connected.
During the power-up cycle, the braking distance (transition from the high closing speed to the target speed v_{slow}) is also determined.

From the braking distance and the pinch point (which was determined during teach-in) the positions for the switch-over and muting points are calculated.

The CDS includes a default value of 30 mm for the braking distance which may not, under any circumstances, be exceeded by the measured braking distance.

V4000 PB device symbol, context menu **Configuration draft, Edit, Braking distance** tab

3.5.10 Travel for determining the braking distance

During the power-up cycle, the braking distance (transition from the high closing speed to the target speed v_{slow}) is also determined. The travel for determing the braking distance is the distance the press requires to accelerate to the high closing speed and then brake down again to the target speed v_{slow}.

The CDS includes a set value of 30 mm for the travel for determining the braking distance.

V4000 PB device symbol, context menu **Configuration draft, Edit, Braking distance** tab

3.5.11 Braking offset

During braking to the target speed v_{slow}, vibrations in the V4000 PB and braking distance fluctuations may occur.

The design of the V4000 PB specifies that the vibration tolerance of the V4000 PB for gap sizes from 6 mm to 26 mm increases from ±4 mm to ±7 mm.

With the braking offset the gap size at which the target speed v_{slow} is reached is increased.

Tab. 8: Braking offset

Braking offset	**Gap at v_{slow}**	**Availability with braking distance fluctuations**	**Remark**
6 mm	6 mm	± 4 mm	Maximum productivity
26 mm	26 mm	± 7 mm	Maximum availability

The braking offset is added to the braking distance calculated from the power-up cycle:

- With a braking offset of 6 mm the target speed v_{slow} is reached at the muting point (6 mm above the pinch point).
- If a braking offset of more than 6 mm is selected, the switch-over point will be shifted upwards.
  The V4000 PB requests the target speed v_{slow} before the calculated switch-over point.
  The press brakes earlier and thus reaches the target speed v_{slow} before the muting point.

V4000 PB device symbol, context menu **Configuration draft, Edit, Braking distance** tab

3.5.12 Target speed v_{slow} for determining the braking distance

In the determination of the braking distance, the target speed v_{slow} is the speed which the press must reach after the braking procedure.

The CDS specifies a set value of 10 mm/s for the target speed.

V4000 PB device symbol, context menu **Configuration draft, Edit, Braking distance** tab

3.5.13 Monitoring of the slow closing speed v_{crawl} from the pinch point

The slow closing speed (v_{crawl}) is monitored from the pinch point at bending processes where the V4000 PB cannot be active (for example within a box).

If v_{crawl} ($\leq$ 10 mm/s) is exceeded, a stop command is output to the downstream control system and the V4000 PB changes to the lock-out state.

V4000 PB device symbol, context menu **Configuration draft, Edit, Braking distance** tab

3.5.14 Maximum closing speed and maximum overall machine overrun

Maximum closing speed

The following values are defined for the closing speed:

- v_{max} = maximum closing speed (depends on machine design), held in the configuration
- v_P = high closing speed which is reached in the current operating cycle and is measured by the V4000 PB

During configuration the maximum closing speed of the press is input as the maximum closing speed v_{max}. This speed must not be exceeded in any operating cycle.

The press crosshead travels at high closing speed (>10 mm/s) up to the switch-over point. The high closing speed v_p is continually monitored.

Should the press brake exceed the high closing speed of the last power-up cycle a new power-up cycle will be needed. During the power-up cycle, the high closing speed v_p and the overall machine overrun D (as a function of the high closing speed) are determined. The high closing speed must be less than or equal to the configured maximum closing speed.

Note The configured maximum closing speed in combination with the configured maximum overall machine overrun must not exceed the stopping distance of the V4000 PB and will therefore need to be checked during configuration.

V4000 PB device symbol, context menu **Configuration draft, Edit, Overall machine overrun** tab

Maximum overall machine overrun

The following values are defined for the overall machine overrun:

- D_{max} = maximum overall machine overrun (depends on machine design), held in the configuration
- D = overall machine overrun which is reached with the current emergency stop and is measured by the V4000 PB

During configuration the maximum overall machine overrun of the press is input as the maximum overall machine overrun D_{max}. This overall machine overrun must not be exceeded in any emergency stop.

During the closing movement of the press, and after an emergency stop, the press brake will continue to run for a distance (overall machine overrun D) which is less than the maximum machine overrun D_{max}.

If the distance exceed the maximum machine overrun, D_{max}, the V4000 PB will require a new power-up cycle.

During the power-up cycle, the high closing speed v_p and the overall machine overrun D (as a function of the high closing speed) are determined.

At every emergency stop the overall machine overrun is measured. Should the overall machine overrun measured exceed the value of the overall machine overrun of the last power-up cycle the V4000 PB will switch into its lock-out state.

To cancel the lock-out state, a reset and a new power-up cycle are necessary. The overall machine overrun is determined and at the next emergency stop is available as a well-founded value for the overall machine overrun.

Note The configured maximum overall machine overrun in combination with the configured maximum closing speed must not exceed the stopping distance of the V4000 PB and will therefore need to be checked during configuration.

V4000 PB device symbol, context menu **Configuration draft, Edit, Overall machine overrun** tab

Stopping distance

The stopping distance is a system parameter from the V4000 PB and the press brake which is defined in the design of the V4000 PB.

The stopping distance S describes the maximum path distance that the press brake covers in the time between the sensor function activation and the press being at a standstill.

The following condition applies: $S = T_1 * v_{max} + D_{max}$

$S \leq 11$ mm

The response time T_1 of the V4000 PB is constant. The parameters maximum overall machine overrun D_{max} and maximum high closing speed v_{max} can be adjusted with regard to the stopping distance.

A press brake with a large overall machine overrun can be equipped with the V4000 PB if its maximum closing speed is limited by making modifications to the hydraulics system (such as orifice plates). A very high closing speed is only possible when combined with a short overall machine overrun.

Note The maximum overall machine overrun and the maximum closing speed must be configured during installation so that they satisfy the condition of the stopping distance.

3.5.15 Travel for determining the overall machine overrun

During the power-up cycle, the overall machine overrun following an emergency stop (transition from the high closing speed to standstill) is also determined. The travel for determining the overall machine overrun is the distance the press requires to accelerate to the high closing speed.

The CDS includes a default value of 30 mm for the maximum travel for determining the overall machine overrun.

V4000 PB device symbol, context menu **Configuration draft, Edit, Overall machine overrun** tab

3.5.16 Standstill time for determining the top dead centre

The V4000 PB recognises when the opening movement of the press has ended in the operating cycle – in other words, when the top dead centre has been reached.

Should the press crosshead make no further upward movement for a specific, configured period of time (standstill time), the V4000 PB will assume that the top dead centre has been reached.

Note Detection of the top dead centres is only necessary during the power-up cycle. The top dead centre is not monitored and not reaching it is permitted during production operation.

V4000 PB device symbol, context menu **Configuration draft, Edit, Basic settings** tab

3.5.17 Start delay for closing movement

If a start signal for the closing movement is detected by the safety-relevant inputs, it will be assumed that the press brake is moving after a period of delay. If there is no movement – in other words, the signals from the PBI cannot be unambiguously interpreted as movement – the V4000 PB assumes that there is a fault in position detection.

The time delay between the start signal to the V4000 PB for the closing movement and the actual movement of the press brake depends on the switching times of the individual components of the press.

V4000 PB device symbol, context menu **Configuration draft, Edit, Basic settings** tab

3.5.18 Time for standstill detection

The V4000 PB detects when the press is at a standstill.

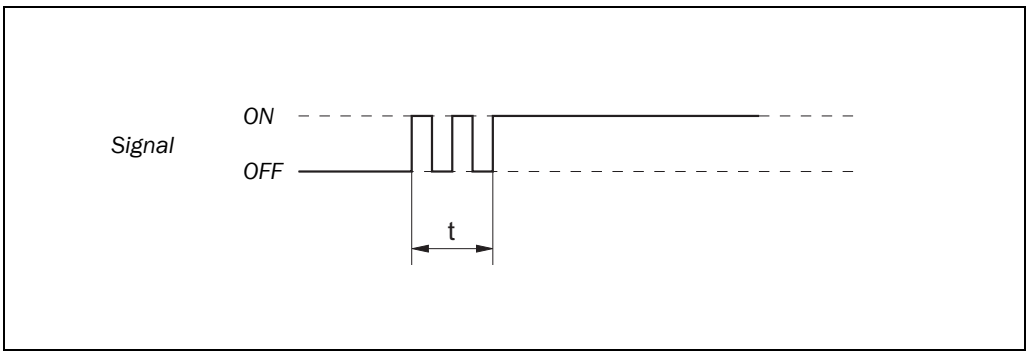
Should the press crosshead make no further change in position for a specific, configured period of time (standstill time), the V4000 PB will assume that the press is at a standstill.

V4000 PB device symbol, context menu **Configuration draft, Edit, Basic settings** tab

3.5.19 Settling times for inputs

When a switch is switched on or off, there will be an undefined state for a brief period. The signal goes back and forth between the ON and OFF states until a defined state is reached.

Fig. 17: Settling times



An undefined state will result in an error following logic checking by the V4000 PB and will thus initiate the lock-out state.

To prevent this from happening, a time period (the settling time) is configured via the CDS for which the V4000 PB will ignore the undefined state.

Settling times can be configured for the following inputs and outputs:

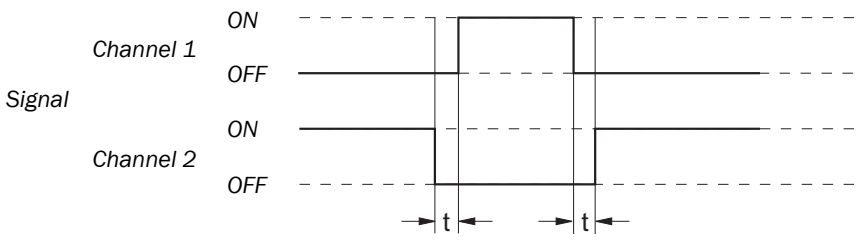
- Standard inputs
- Safety-relevant inputs

V4000 PB device symbol, context menu **Configuration draft, Edit, Inputs** tab

3.5.20 Discrepancy times for inputs

Two-channel inputs supply two complementary signals. Here the switching-off operation has ended somewhat earlier than the switching-on operation. This results for a brief period in an undefined state.

Fig. 18: Discrepancy times



An undefined state will result in an error following logic checking by the V4000 PB and will thus initiate the lock-out state.

To prevent this from happening, a time period (the discrepancy time) is configured via the CDS for which the V4000 PB will ignore the undefined state.

Discrepancy times can be configured for the following inputs and outputs:

- Safety-relevant inputs
- Inputs for selecting the protective volume mode
- Bypass input

V4000 PB device symbol, context menu **Configuration draft, Edit, Inputs** or **Bypass** tab

3.5.21 Start signal at reduced protective volume

Two different settings can be selected here:

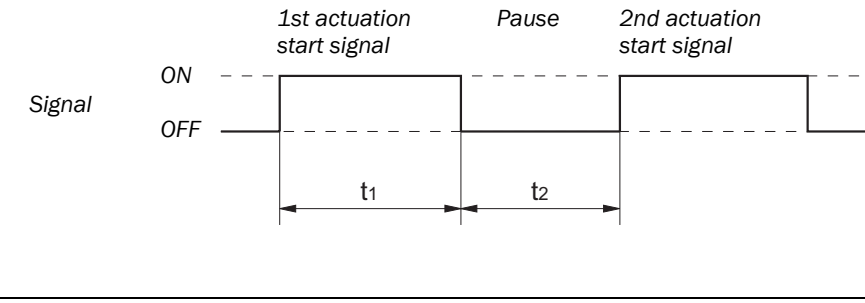
- Double-click (default setting)
- Deselect double-click

Double-click (default setting)

In the case of the box and back-stop protective volume modes, the start signal for the closing movement must be given twice. This is intended to draw the operator's attention to the fact that he is working in a special mode in which only limited protection is provided by the reduced protective volume.

Via the CDS you can configure the **maximum duration of the first start signal** (how long the operator must operate the corresponding operating element) and **the pause between the first and second start signal**.

Fig. 19: Start signal (double-click)



Deselect double-click

At this setting the operator only has to trigger the start signal once (for example by operating the foot switch once).

Note If you deselect the double-click, ensure that the operator has to select the Standard protective field volume mode once briefly after a work interruption of more than 10 minutes, before continuing in the desired protective field volume mode.

V4000 PB device symbol, context menu **Configuration draft, Edit, Inputs** tab

3.5.22 Minimum state time for standard outputs

The time after which a digital output signal changes from the OFF to the ON state, or vice versa, can be configured via the CDS so that the signal can be registered by the systems connected to the V4000 PB. The minimum configurable state time is 0 ms while the maximum configurable state time is 1000 ms.

V4000 PB device symbol, context menu **Configuration draft, Edit, Outputs** tab

3.5.23 Minimum switch-off time for safety-relevant outputs

The time for which the signal of the OSSD outputs remains at minimum in the OFF state (after an interruption of the protective volume, for example), can be configured via the CDS so that the signal can be registered by the systems connected to the V4000 PB.

The minimum configurable switch-off time is 100 ms while the maximum configurable switch-off time is 1000 ms.

V4000 PB device symbol, context menu **Configuration draft, Edit, Outputs** tab

3.5.24 Bypass

In bypass mode the press brake can be operated without the V4000 PB protective device being activated.

To activate bypass mode, the bypass function is enabled in the configuration and the outputs of the bypass function at the receiver connected with its inputs.

In bypass mode the OSSDs are in the ON state and all displays on the receiver are switched off. The V4000 PB does not generate any output signals (request for target speed, request for teach-in).

The bypass is deactivated by breaking the electrical connection between output and input. After the bypass mode is deactivated, the V4000 PB changes to the restart interlock and requests a new power-up cycle.

Note The operator is responsible for the use and perfect functioning of additional safety devices which ensure the safe operation of the press brake (for example, the use of robots for handling materials).

V4000 PB device symbol, context menu **Configuration draft, Edit, Bypass** tab

3.6 Protective operation

In protective operation the V4000 PB safeguards the hazardous point beneath the die during the operating cycle at high closing speed (>10 mm/s).

Operating states within protective operation

The following operating states are available within protective operation:

- Power-up cycle
- Teach-in
- Production operation

The following is true for all operating states:

- The protective volume is active and is monitored for interruption.
- The position, direction of movement, speed and overall machine overrun are monitored and evaluated.

Protective volume modes in protective operation

Within protective operation there are also three protective volume modes available which make it possible to adjust the protective volume to best suit the current bending job:

- Standard mode
- Box mode
- Back-stop mode

3.6.1 Power-up cycle

In the power-up cycle the overall machine overrun at high closing speed and, if possible, the braking distance (the transition from high closing speed to target speed) are determined for monitoring during press operation. Following this the teach-in procedure is carried out.

- During the power-up cycle the protective volume is active.
- The power-up cycle is requested by the V4000 PB after every switch-on or reset of the V4000 PB.
- At least once every 24 hours (in the case of continuous press operation) the V4000 PB system automatically requests the power-up cycle.
- The operator confirms the power-up cycle by giving the teach-in signal via the press controller or external operating elements.

3.6.2 Teach-in

During teach-in the pinch point (which depends on the thickness of the material or the relative position of the top surface of the workpiece) is determined. The die contacts the workpiece at the pinch point. From the pinch point the positions for the switch-over and muting points are calculated.

- During teach-in the protective volume is active.
- The operator or the V4000 PB system can request teach-in.
- The pinch point is monitored during each stroke of the press. The V4000 PB detects when the position of the pinch point does not correspond to the value last determined. The system then requests teach-in which the operator must confirm via the controller or an external operating element.

Note V4000 PB calculates from the pinch point all safety-relevant parameters (switch-over and muting points). For this reason, following a change of material the safety-relevant parameters will no longer apply.

This means that you will need to carry out the teach-in procedure every time the workpiece material changes.

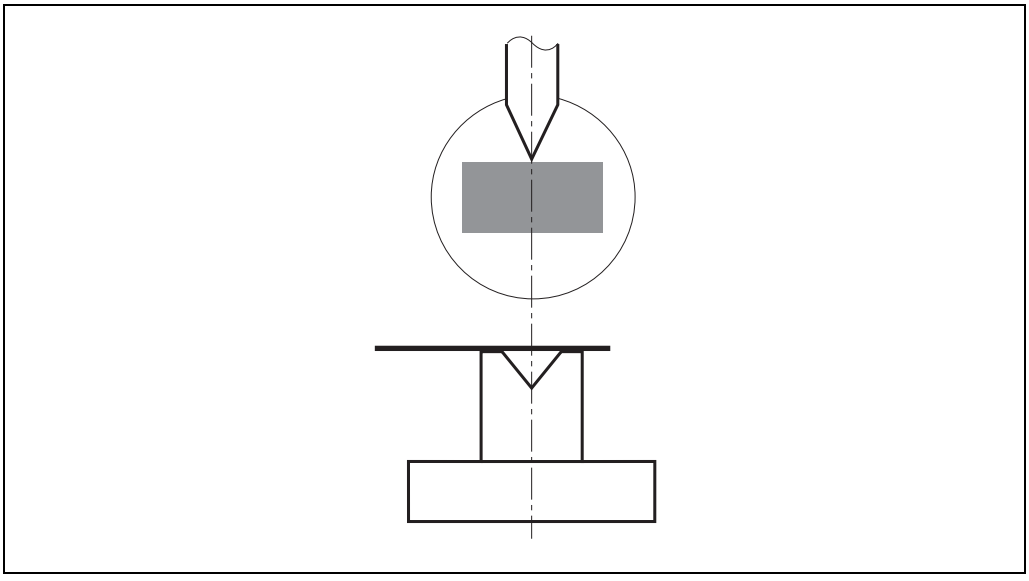
3.6.3 Protective volume modes in protective operation

Standard mode

Standard mode is used when flat workpieces are to be bent and it is not expected that at high closing speed the protective volume will be interrupted by the shape of the workpiece.

In standard mode the entire protective volume is monitored for interruption.

Fig. 20: Protective volume in standard mode



Box mode

WARNING

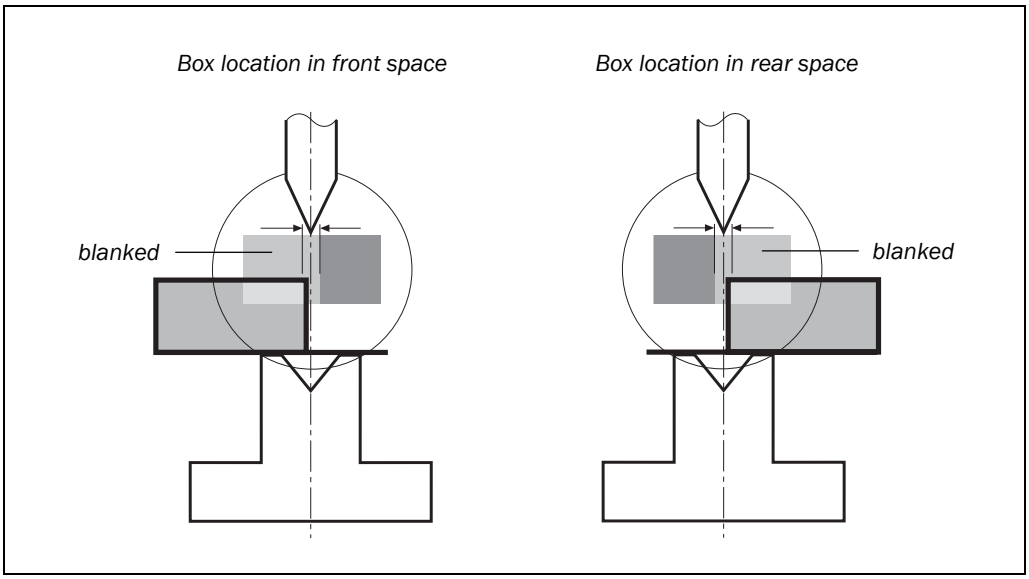
Catching or crushing of fingers or hands is possible due to the protective volume being partially blanked and also in the tolerance zone at the pressure axis!

The partial blanking of the protective volume means that objects within the tolerance zone will not be detected.

➢ Make sure that the workpiece is handled correctly (see Section 2.5 "Safety in operation").

Box mode is used when the workpiece needs to be bent several times (as when boxes or trays are being made, for example) and it is expected that at high closing speed the protective volume will be interrupted by the shape of the workpiece.

Fig. 21: Reduced protective volume in box mode



Note

Box mode may be used in either of **two variants**:

Variant A

Up until the time when the protective volume is interrupted by the top of the box the entire protective volume is checked for interruption (as in standard mode).

In the case of the protective volume being interrupted from one side, either in front of or behind the pressure axis, this interruption will automatically be interpreted as the box wall. In box mode the corresponding segment of the protective volume and a tolerance zone (positioned centrally on the pressure axis) will be blanked automatically and the closing movement will not be stopped.

If the protective volume is interrupted in both segments (in front of and behind the pressure axis), this will initiate a stop signal which must stop the movement of the press crosshead.

Since in box-bending the side walls of the box can project behind the pressure axis, the tolerance zone at the pressure axis is blanked.

Variant B

The press brake is closed at high closing speed leaving but a gap. As in standard mode the entire protective volume is monitored. The operator stops the movement of the press crosshead.

The box is then slid into the gap. The corresponding segment of the protective volume is blanked automatically.

A new starting pulse finishes the operating cycle.

Recommendation If possible use Variant B of box mode for bending boxes since the operating cycle is mostly carried out in standard mode.

Note If the press brake is closed leaving a gap of [6 mm before the box is inserted into the gap, work can be carried out in standard mode.

Back-stop mode

WARNING

Catching or crushing of fingers or hands due to the protective volume being partially blanked and also in the tolerance zone at the pressure axis!

The partial blanking of the protective volume means that objects within the tolerance zone will not be detected.

➢ Make sure that the workpiece is handled correctly (see Section 2.5 "Safety in operation").

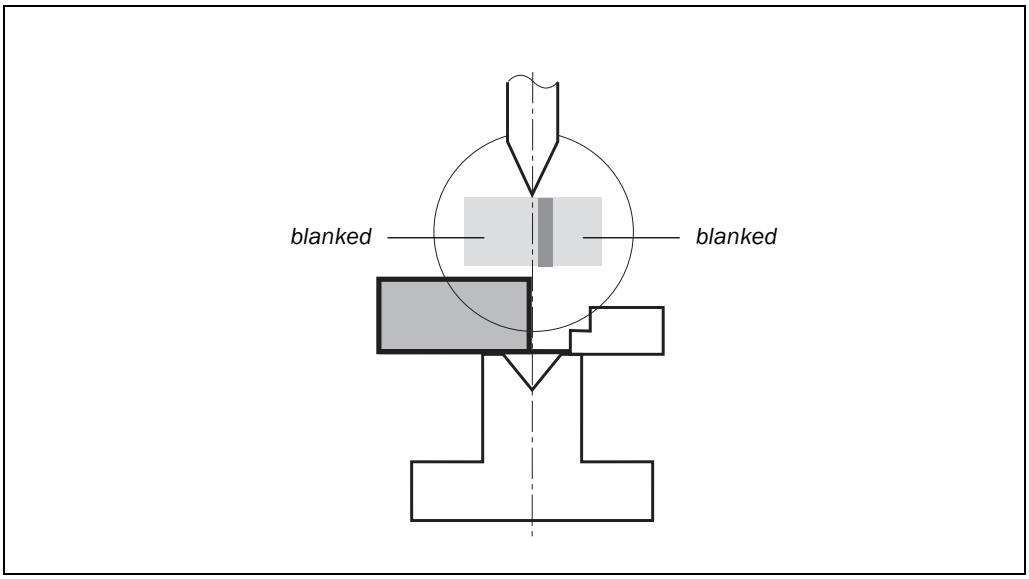
Back-stop mode is used during bending of very short legs or flanges when the rear stops have to be moved up very close to or even onto the female die with the result that the protective volume is interrupted by the rear stop at high closing speed.

Boxes can also be bent in back-stop mode.

In back-stop mode, the protective volume segment on the operator side is blanked completely and the part behind the pressure axis blanked partially.

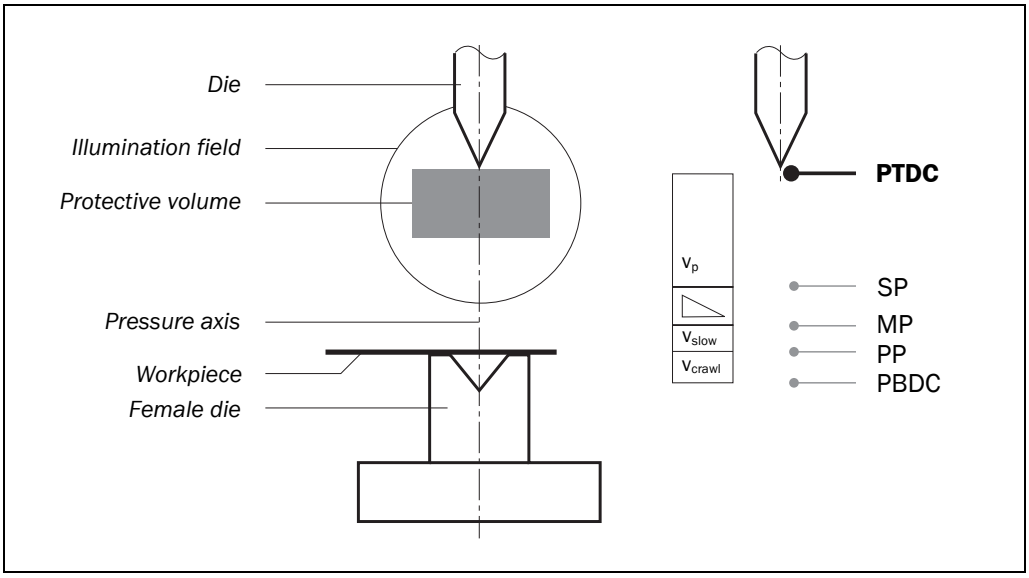
The side on which the receiver is mounted is defined via the CDS and this ensures that the correct protective volume segment is blanked.

Fig. 22: Reduced protective volume in back-stop mode



3.7 System sequences in protective operation

Fig. 23: Definitions



v_p	***High closing speed > 10 mm/s***
v_{slow}	***Target speed following braking***
v_{crawl}	***Slow closing speed ≤ 10 mm/s (after the pinch point)***
◺	***Braking from v_P to v_{slow}***
PTDC	***Programmed top dead centre of the press***
SP	***Switch point = V4000 PB switch-over point – request for target speed v_{slow}***
MP	***Mute point – protective volume inactive***
PP	***Pinch point***
PBDC	***Programmed bottom dead centre of the press***

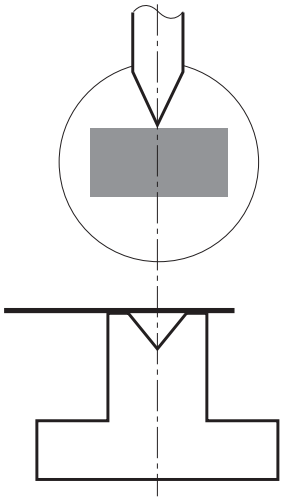
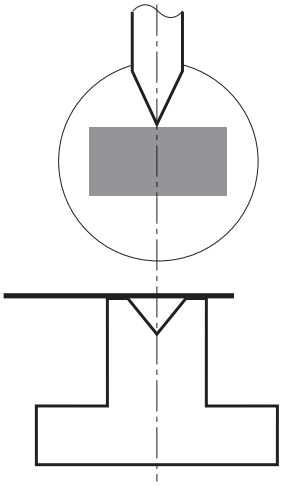
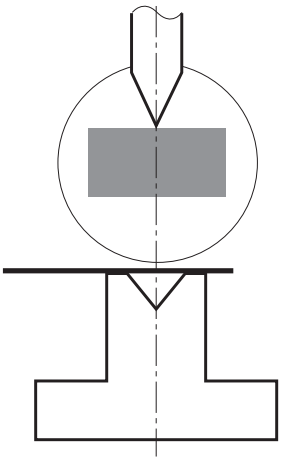
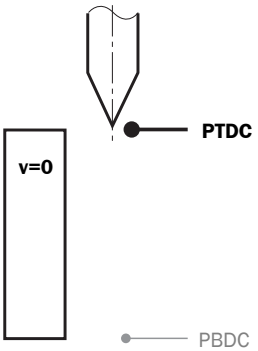
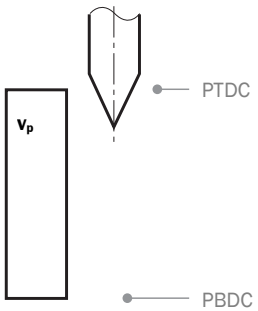
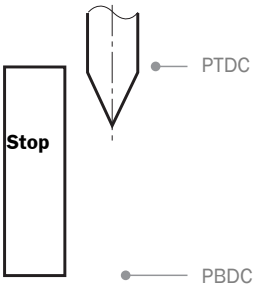
From the system sequences you can see how the protective volume adapts itself during the operating cycle and how it reacts if necessary. The machine movement, closing speed, and the states and signals are shown in parallel. The protective volume is located below the tip of the die.

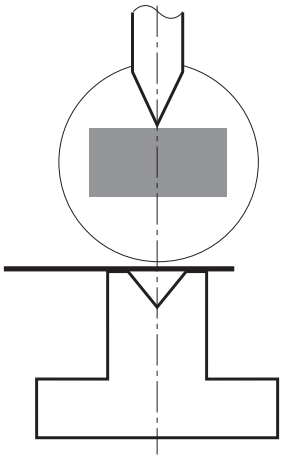
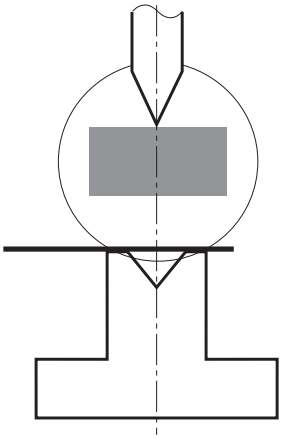
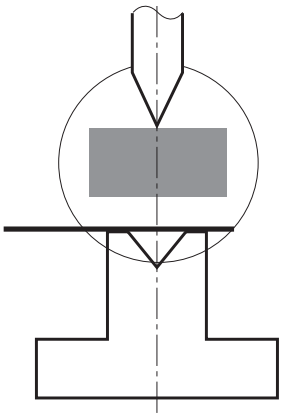
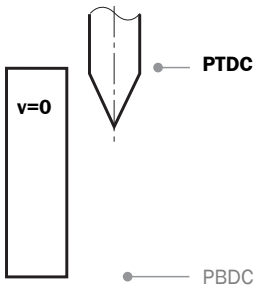
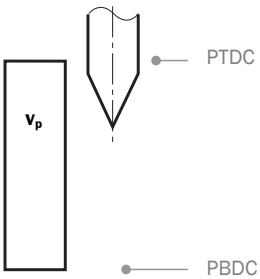
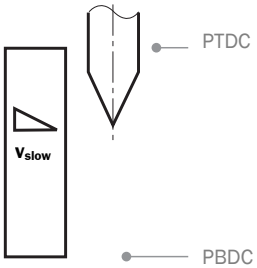
A requirement for the following sequences is that v_{slow} is supported by the press controller.

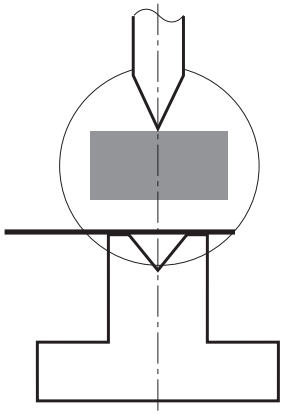
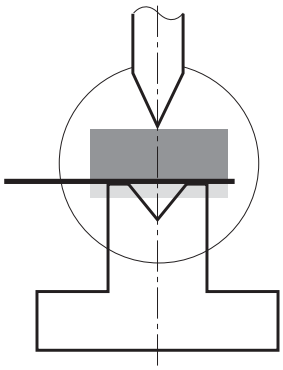
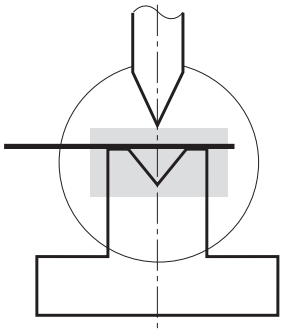
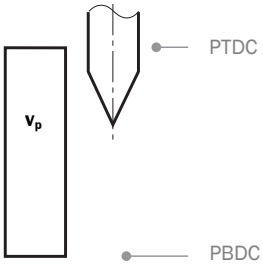
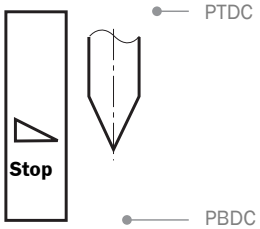
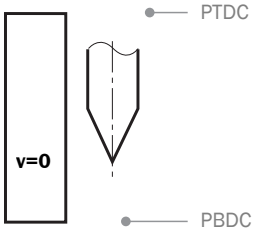
Note The time context and the behaviour of the input and output signals are dealt with in Section 13.1 "Detailed system sequences in protective operation").

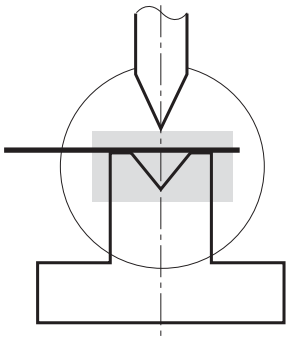
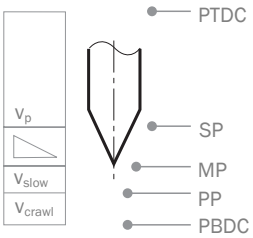
3.7.1 Power-up cycle in standard mode

Start condition: the system starts, carries out the self-test and waits for acknowledgement from the operator for the request signal for teach-in.

Step	① The die is at any point in the operating cycle. The operator gives the signal for teach-in (teach-in button).	② The operator gives the signal to start the closing movement (foot switch). The die descends at maximum closing speed. v_p is measured.	③ After about 20 mm the OSSDs go into the OFF state and generate a safe stop signal. The high closing speed must be stopped. The V4000 PB determines the overall machine overrun.
Protective volume			
Speed; machine movement			
System state	● Red ◐ Yellow ○ Green	○ Red ○ Yellow ● Green	● Red ○ Yellow ○ Green
7-segment display	1.	1.	1.
Start signal for closing movement	□	■	■
Request signal V_{slow}	□	□	□
OSSD	□	■	□
Request signal for teach-in	■	□	□

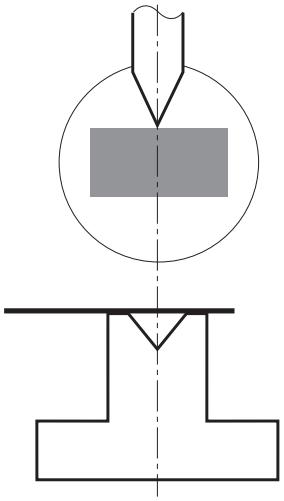
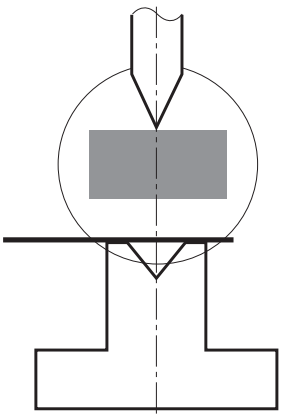
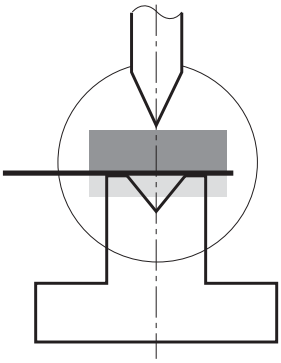
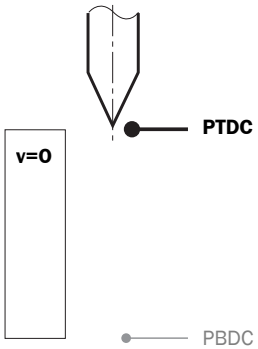
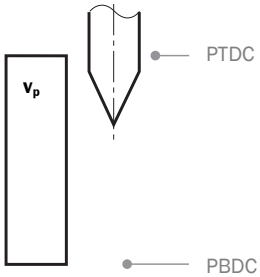
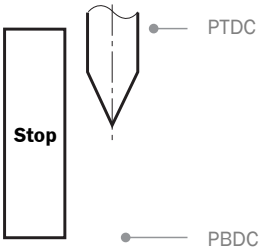
Step	④ The overall machine overrun of the press brake is determined. The overall machine overrun must not exceed the configured value.	⑤ The operator gives the signal once more to start the closing movement (foot switch). The die descends at maximum closing speed v_P.	⑥ The target speed v_{slow} is requested by the V4000 PB. The press controller starts the braking procedure. When v_{slow} is reached the braking distance is calculated.
Protective volume			
Speed; machine movement			
System state	● Red ○ Yellow ○ Green	○ Red ○ Yellow ● Green	○ Red ○ Yellow ● Green
7-segment display	1.	1.	1.
Start signal for closing movement	■	■	■
Request signal v_{slow}	□	□	■
OSSD	□	■	■
Request signal for teach-in	□	□	□

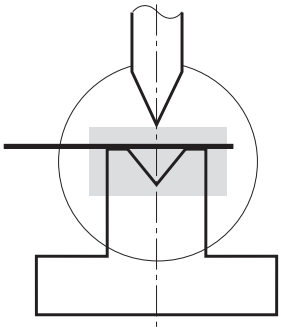
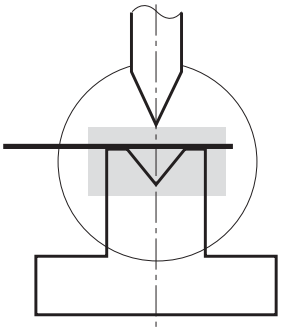
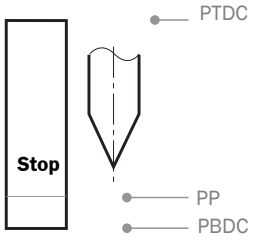
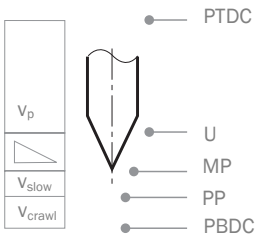
Step	⑦ The request signal for v_{slow} is cancelled. The die accelerates to the high closing speed v_P.	⑧ The workpiece interrupts the protective volume. The OSSDs go into the OFF state and generate a safe stop signal. From this the pinch point **PP** (workpiece surface) is obtained.	⑨ The die must stop at least 5 mm above the workpiece. The positions for the switch-over and muting points are calculated. The operator cancels the start signal (foot switch).
Protective volume			
Speed; machine movement			
System state	○ Red ○ Yellow ● Green	● Red ○ Yellow ○ Green	○ Red ○ Yellow ● Green
7-segment display			
Start signal for closing movement	■	■	□
Request signal v_{slow}	□	□	□
OSSD	■	□	■
Request signal for teach-in	□	□	□

Step	⑩ The operator gives the signal once more to start the closing movement (foot switch). The operating cycle resumes on the basis of this position. The protective volume is muted as soon as the gap is ≤ 6 mm and the V4000 PB has reached the muting point **MP**. The V4000 PB has updated the parameters and the first bending without discarding of material can be made after giving a new start signal.
Protective volume	
Speed; machine movement	
System state	○ Red ○ Yellow ● Green
7-segment display	
Start signal for closing movement	□
Request signal v_{slow}	■
OSSD	■
Request signal for teach-in	□

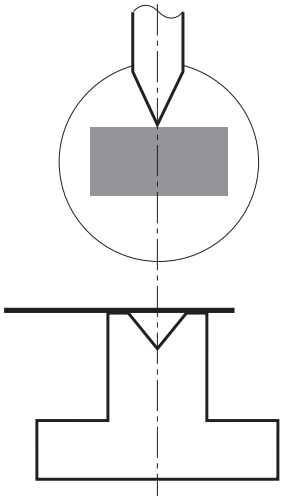
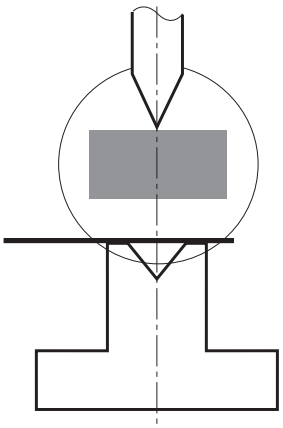
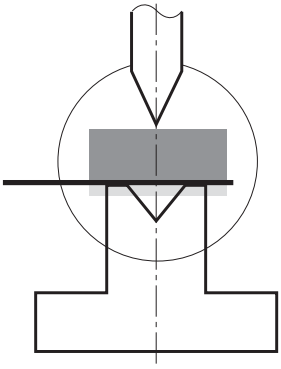
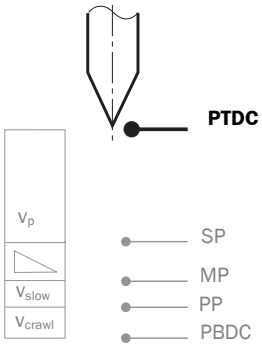
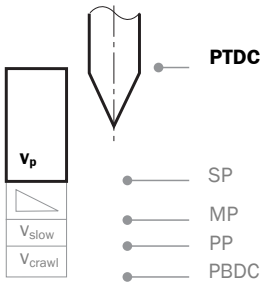
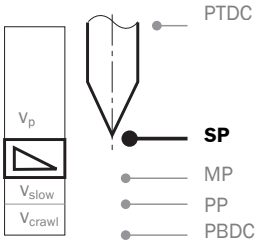
3.7.2 Teach-in

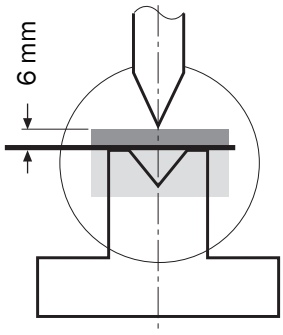
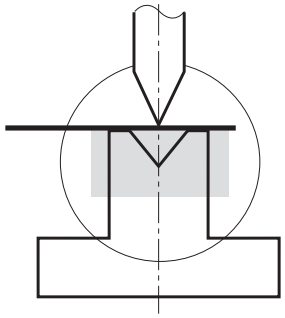
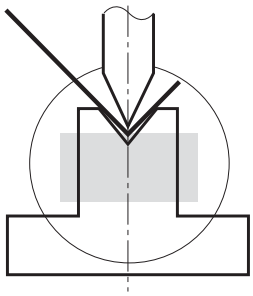
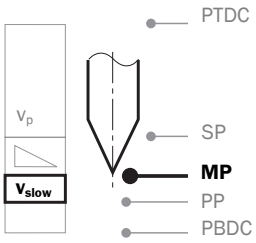
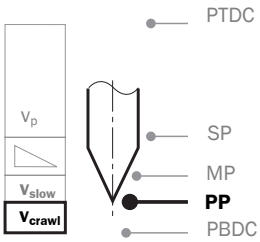
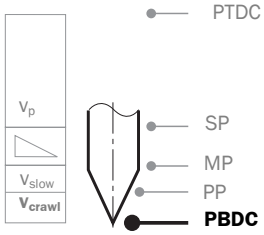
Start condition: press is wide open

Step	① The die is at any point in the operating cycle. The operator gives the signal for teach-in (teach-in button). The protective volume is active.	② The operator gives the signal to start the closing movement (foot switch). The die descends at high closing speed v_P. The entire protective volume is active.	③ The workpiece interrupts the protective volume. The OSSDs go into the OFF state and generate a safe stop signal. From this the pinch point **PP** (workpiece surface) is obtained.
Protective volume			
Speed; machine movement			
System state	● Red ◐ Yellow ○ Green	○ Red ○ Yellow ● Green	● Red ○ Yellow ○ Green
7-segment display	1.	1.	1.
Start signal for closing movement	□	■	■
Request signal v_{slow}	□	□	□
OSSD	□	■	□
Request signal for teach-in	■	□	□

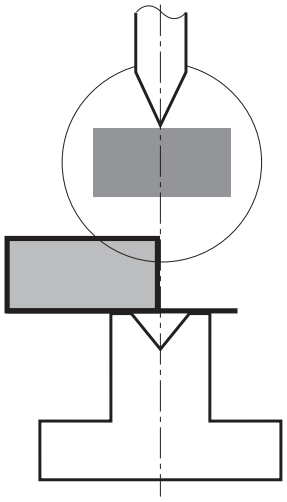
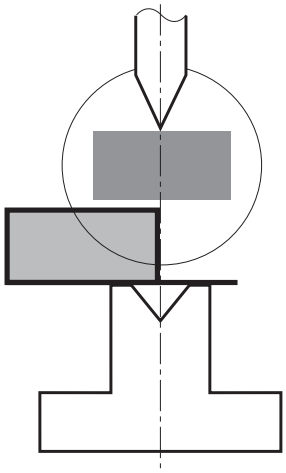
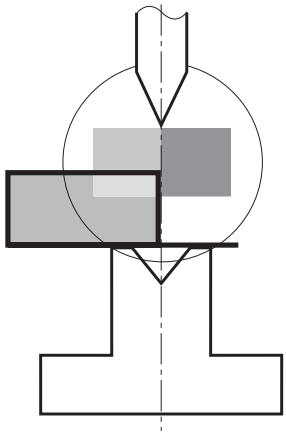
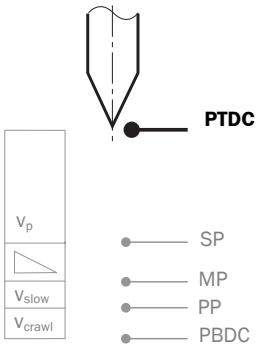
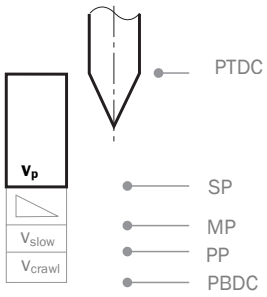
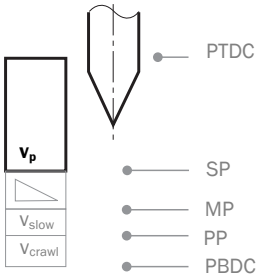
Step	④ The die must stop at least 5 mm above the workpiece surface. The positions for the switch-over and muting points are calculated.	⑤ The operator gives the signal once more to start the closing movement (foot switch). The operating cycle resumes on the basis of this position. The protective volume is muted as soon as the gap is ≤ 6 mm and the V4000 PB has reached the muting point **MP**. The first bending without discarding of material can be completed.
Protective volume		
Speed; machine movement		
System state	● Red ○ Yellow ○ Green	○ Red ○ Yellow ● Green
7-segment display		
Start signal for closing movement	☐	■
Request signal v_{slow}	☐	☐
OSSD	☐	■
Request signal for teach-in	☐	☐

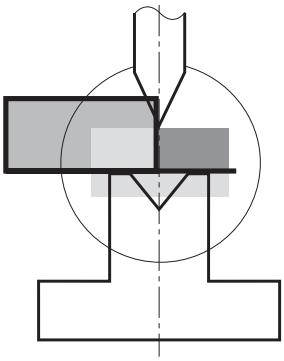
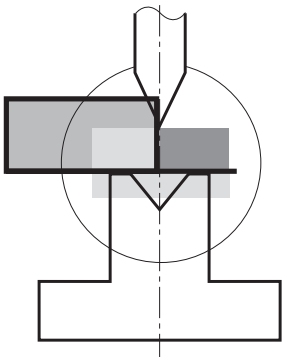
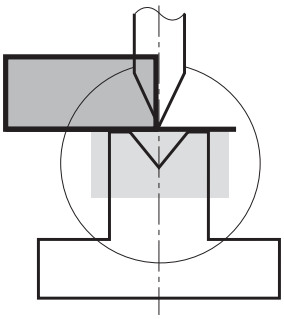
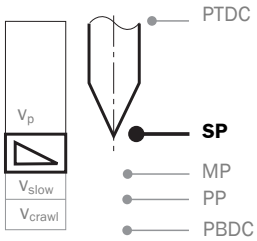
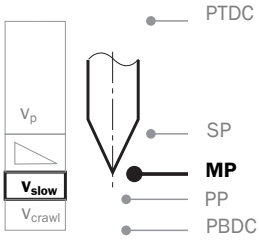
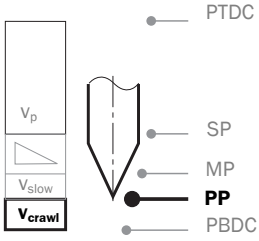
3.7.3 Operating cycle in standard mode

Step	① The die is at the programmed top dead centre **PTDC**. The operator gives the signal to start the closing movement (foot switch).	② The die descends at high closing speed (≤ v_P). The entire protective volume is active.	③ At the switch-over point **SP** the target speed is requested by the V4000 PB. The press controller starts the braking procedure. The protective volume stays active in the gap opening.
Protective volume			
Speed; machine movement			
System state	○ Red ○ Yellow ● Green	○ Red ○ Yellow ● Green	○ Red ○ Yellow ● Green
7-segment display	1.	1.	1.
Start signal for closing movement	■	■	■
Request signal v_{slow}	□	□	■
OSSD	■	■	■

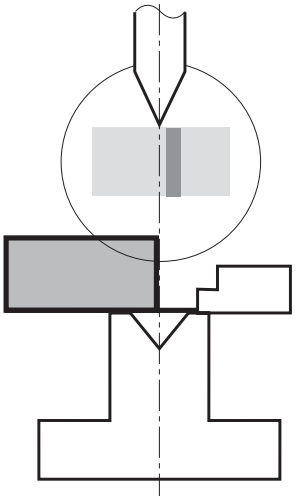
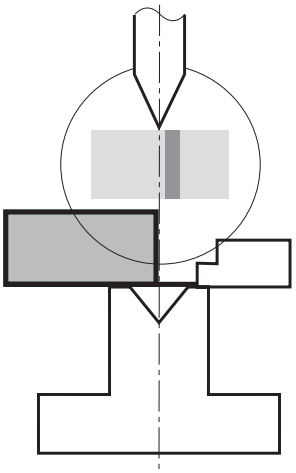
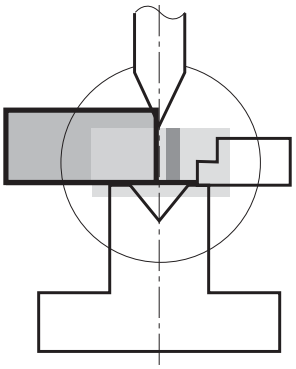
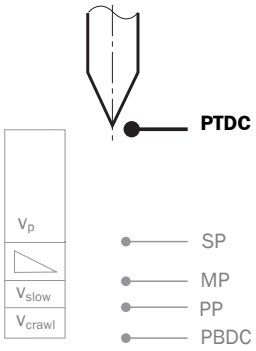
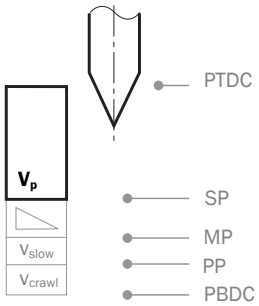
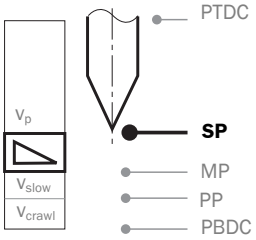
Step	④ At the muting point **MP** the gap size is 6 mm and the target speed has been reached. The protective volume becomes inactive.	⑤ The die contacts the workpiece at the pinch point **PP**.	⑥ The die shapes the workpiece. The operating cycle ends at the programmed bottom dead centre **PBDC** and the die goes back-up.
Protective volume			
Speed; machine movement			
System state	○ Red ○ Yellow ● Green	○ Red ○ Yellow ● Green	○ Red ○ Yellow ● Green
7-segment display	☐	☐	☐
Start signal for closing movement	■	■	■
Request signal v_{slow}	■	■	■
OSSD	■	■	■

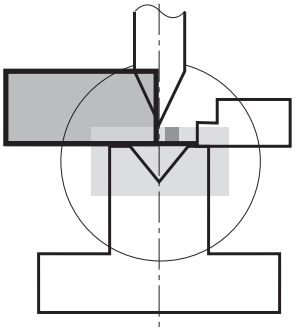
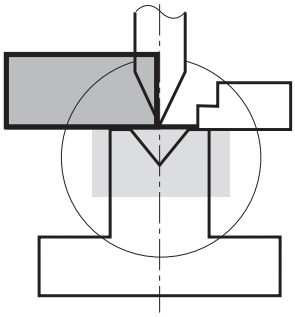
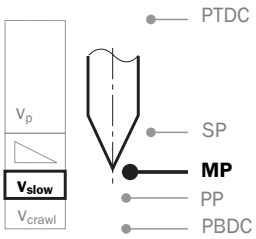
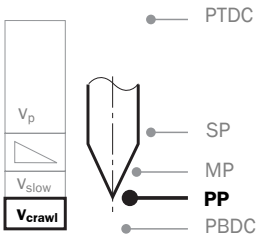
3.7.4 Operating cycle in box mode

Step	① The die is at the programmed top dead centre **PTDC**. The operator gives the signal to start the closing movement (e.g. double-click with the foot switch).	② The die descends at high closing speed (≤ v_P). The entire protective volume is active.	③ If the box projects into the protective volume in front of the pressure axis, the protective volume in front of the pressure axis will be automatically blanked. The die continues to descend at maximum speed v_p. The part of the protective volume behind the pressure axis remains active.
Protective volume			
Speed; machine movement			
System state	(If double-click is deselected, V4000 PB is green.) ● Red ● Yellow ○ Green	○ Red ○ Yellow ● Green	○ Red ○ Yellow ● Green
7-segment display	0.	0.	0.
Start signal for closing movement	■	■	■
Request signal v_{slow}	□	□	□
OSSD	□	■	■

Step	④ At the switch-over point **SP** the target speed is requested by V4000 PB. The press controller starts the braking procedure. The protective volume segment remains active in the gap opening behind the pressure axis.	⑤ At the muting point **MP** the gap size is 6 mm and the target speed has been reached. The protective volume becomes inactive.	⑥ The die contacts the workpiece at the pinch point **PP**. The bending process is the same as with standard mode.
Protective volume			
Speed; machine movement			
System state	○ Red ○ Yellow ● Green	○ Red ○ Yellow ● Green	○ Red ○ Yellow ● Green
7-segment display			
Start signal for closing movement	■	■	■
Request signal v_{slow}	■	■	■
OSSD	■	■	■

3.7.5 Operating cycle in back-stop mode

Step	① The die is at the programmed top dead centre **PTDC**. The operator gives the signal to start the closing movement (e.g. double-click with the foot switch).	② The die descends at high closing speed (≤ v_P). A reduced protective volume segment behind the pressure axis is active.	③ At the switch-over point **SP** the target speed is requested by the V4000 PB. The press controller starts the braking procedure. The protective volume segment stays active in the gap opening.
Protective volume			
Speed; machine movement			
System state	(If double-click is deselected, V4000 PB is green.) ● Red ● Yellow ○ Green	○ Red ○ Yellow ● Green	○ Red ○ Yellow ● Green
7-segment display	1.	1.	1.
Start signal for closing movement	■	■	■
Request signal v_{slow}	□	□	■
OSSD	□	■	■

Step	④ At the muting point **MP** the gap size is 6 mm and the target speed has been reached. The protective volume becomes inactive.	⑤ The die contacts the workpiece at the pinch point **PP**. The bending process is the same as with standard mode.
Protective volume		
Speed; machine movement		
System state	○ Red ○ Yellow ● Green	○ Red ○ Yellow ● Green
7-segment display		
Start signal for closing movement	■	■
Request signal v_{slow}	■	■
OSSD	■	■

3.8 Alignment mode

The alignment operating mode helps the operator in aligning the sender and the receiver.

When commissioning and every time there is a change of tooling, the sender and receiver need to be mechanically aligned with respect to each other beneath the die and with respect to the die tip.

The operator uses the alignment masks and the 7-segment display to align the sender and receiver exactly to each other and determines the optimum alignment of the protective volume to the die (see also Section 7.2 "Aligning sender and receiver").

The following applies to alignment mode:

- The protective volume is not active.
- The OSSDs are in the OFF state.
- The operator has no protection from the V4000 PB.

Note In alignment mode the laser is visible. The V4000 PB meets the requirements of laser protection class 1 M. There is no hazard for the operator.

➢ Do not look into the laser beam using optical equipment (such as binoculars).

4 Mounting

This chapter describes the preparation and completion of the mounting of the V4000 PB.

The following steps are necessary after mounting:

- Electrical installation (Chapter 5)
- Configuration of the V4000 PB (Chapter 6)
- Aligning sender and receiver (Section 7.2)

4.1 Steps for mounting

WARNING

Pay particular attention to the following points during mounting:

- ➢ Mount the V4000 PB so that it is protected against moisture, contamination and damage.
- ➢ Ensure that the viewing field of the front lenses is not restricted.
- ➢ In the case of machines with high vibration levels, use a screw-locking compound to ensure mounting screws do not work themselves loose.
- ➢ Check the mounting screws regularly to ensure they are still tight.

Note The sender and the receiver are mounted on the press crosshead in the same way.

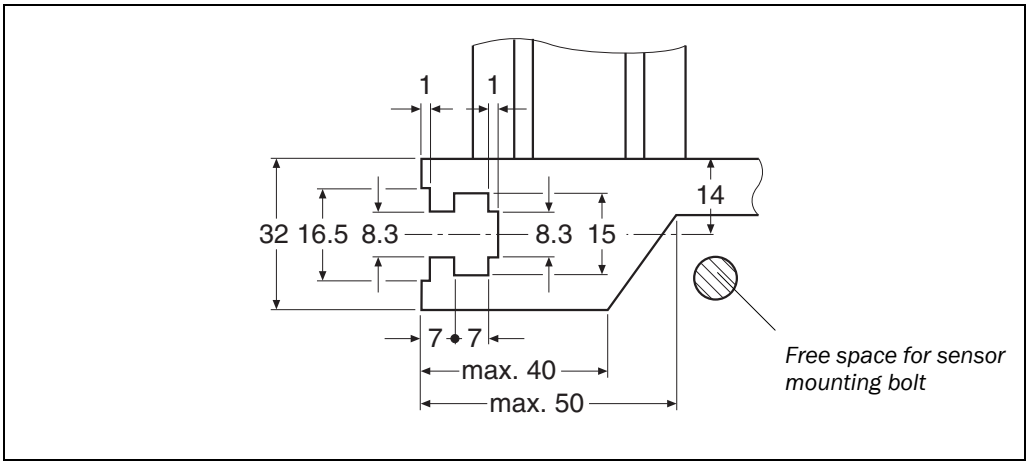
4.1.1 Mounting the sender or receiver using SICK mounting kit 1

Preparation of the bracket on the press crosshead:

The SICK mounting kit 1 consists of an alignment plate with a sliding nut.

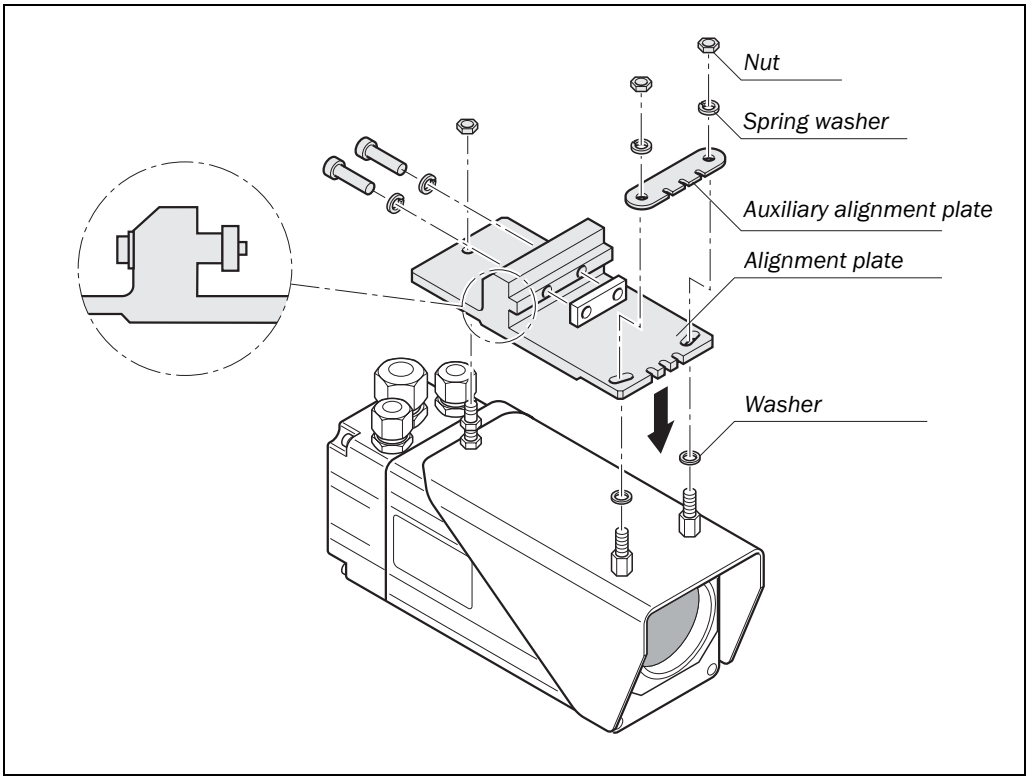
Your bracket on the press crosshead must have a corresponding groove (for dimensions, see Fig. 24). The groove must be at least 100 mm long. In addition a free space must be left for the front mounting bolt of the sender or receiver.

Fig. 24: Groove for accommodating the sliding nut



Mounting your V4000 PB with the SICK mounting kit 1:

Fig. 25: Mounting using SICK mounting kit 1



Note When installing mounting kit 1 make sure the supplied spring washers, plain washers, nuts and auxiliary alignment plate are positioned correctly.

- Fasten the alignment plate to the sender or receiver.
- Slide the alignment plate with the sender or receiver into the groove prepared for it in your bracket.

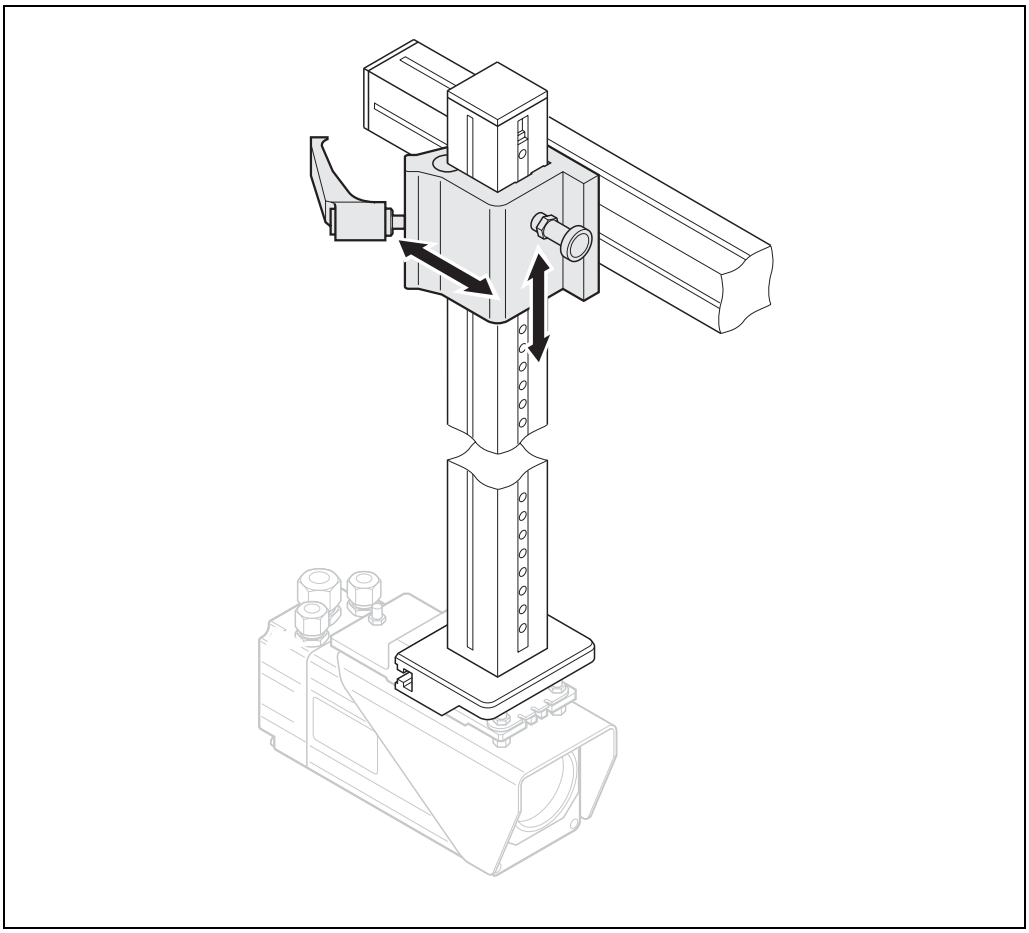
Note In back-stop mode, the active protective volume segment as seen from the operator side is behind the pressure axis. This is why you will need to specify via the CDS in the configuration on which side of the press brake the receiver is mounted.

4.1.2 Mounting the sender or receiver using SICK mounting kit 2

SICK mounting kit 2 consists of a device adapter with a groove for mounting the sliding nut (SICK mounting kit 1) and a retaining arm which is mounted on the press crosshead. The retaining arm has a rapid adjustment device for the vertical axis and an adjustment lever in the direction of the press crosshead.

Latching marks can be provided on the vertical profile of the retaining arm to allow rapid adjustment of the V4000 PB for frequent tool changes.

Fig. 26: SICK mounting kit 2



➢ Before mounting SICK mounting kit 2, please read the mounting instructions (SICK Art. No. 8010988) which are supplied with the kit.

4.1.3 Sticker: Information for daily inspection

➢ Once mounting is completed, you will need to attach the self-adhesive information note supplied entitled "**Information for daily inspection**".

– Use only the information label in the language which the operators of the machine speak and understand.

– Affix the information label such that it is easily visible by the operators during operation. After attaching additional objects and equipment, the information label must not be concealed from view.

5 Electrical installation

WARNING

Switch off the machine!

The machine could start unintentionally during electrical installation work.

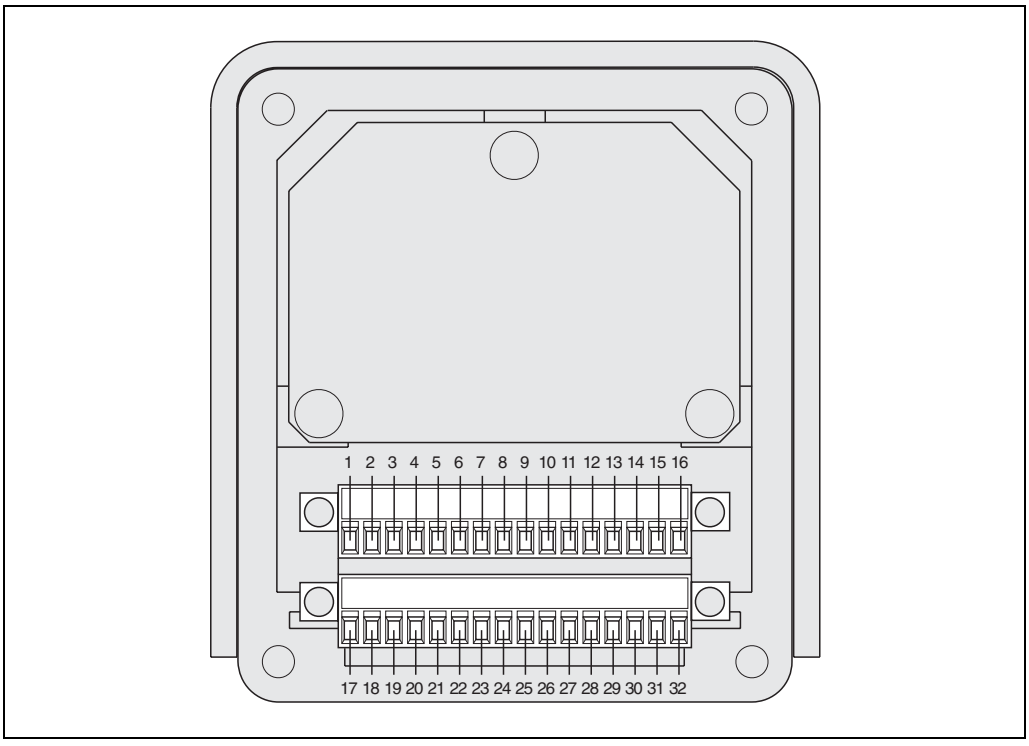
➢ Ensure that the entire system is de-energised during the electrical installation.

Note

- To ensure the specified electromagnetic compatibility (EMC), functional earthing (FE) must be connected.
- The external voltage supply of the devices must be capable of buffering brief mains voltage failures of 20 ms as specified in EN 60 204. Suitable power supplies are available as accessories from SICK (Siemens type series 6 EP 1).
- Make sure the V4000 PB is protected by the appropriate fusing. The electrical data you will need in order to ascertain the fuse ratings will be found in Chapter 10 "Technical data" in Table 30 on Page 102.

5.1 Connecting the receiver

Fig. 27: Pin assignments of digital interface



Tab. 9: Pin assignment of digital interface

Pin	Signal	Function
1	OSSD2	OSSD2 (switching output 2), 0.5 A
2	OSSD1	OSSD1 (switching output 1), 0.5 A
3	EDM	Input, external device monitoring (EDM) (optional)
4	START	Safe 24 V input, gated signal for starting the closing movement
5	NSTART	Safe 24 V input, complementary, gated signal for starting the closing movement
6	BYPASS_OUT1	Pulsed output (bypass signal) (optional)
7	VSLOW_REQ	Output, request signal for target speed (optional)
8	BYPASS_OUT2	Pulsed output (bypass signal) (optional)
9	TEACH_REQ	Output, request signal for teach-in mode
10	BYPASS_IN1	Input, bypass signal (optional)
11	TEACH_BUTTON	Input, signal for teach-in mode
12	BYPASS_IN2	Input, bypass signal (optional)
13	ADJ_BUTTON	Input, signal for alignment mode
14	DMODE3	Input, signal for back-stop protective volume mode
15	DMODE2	Input, signal for box protective volume mode
16	DMODE1	Input, signal for standard protective volume mode
17	NC	Reserved
18	GND	0 V DC input (voltage supply)
19	+24V	24 V DC input (voltage supply)
20	24V_SENDER	24 V DC output (sender voltage supply) 200 mA
21	GND	0 V DC input (sender voltage supply)
22	SEND-	Output, for differential signal to the sender
23	SEND+	Output, for differential signal to the sender
24	ENCO1+	Input, signal from PBI
25	ENCO1–	Input, signal from PBI
26	ENCO2+	Input, signal from PBI
27	ENCO2–	Input, signal from PBI
28	ENCO_GND	0 V DC input
29	TXD_232 / 422_TXD–	Output, connection for serial configuration interface RS-232 / RS-422 (double assignment, can be set via switch S)
30	RXD_232 / 422_TXD+	Output, connection for serial configuration interface RS-232 / RS-422 (double assignment, can be set via switch S)
31	GND / 422_RXD–	Input, connection for serial configuration interface RS-232 / RS-422 (double assignment, can be set via switch S)
32	422_RXD+	Input, connection for serial configuration interface RS-422 (optional)

Fig. 28: Connection diagram for receiver

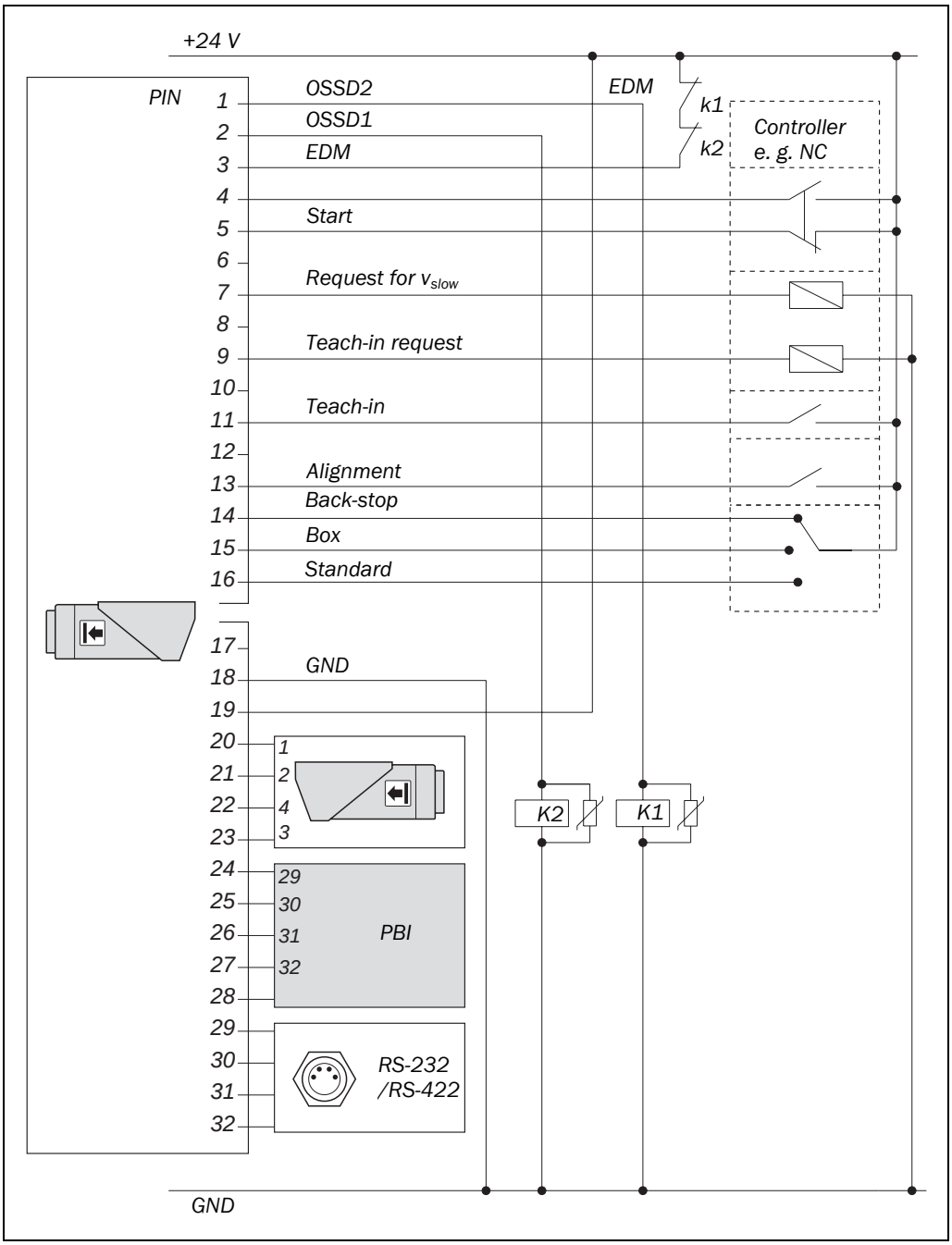
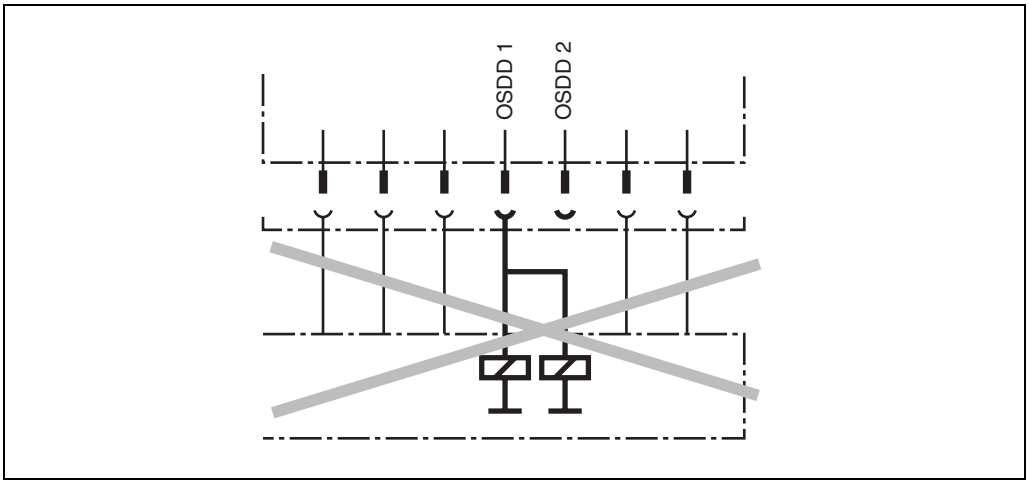


Fig. 29: OSSDs connection

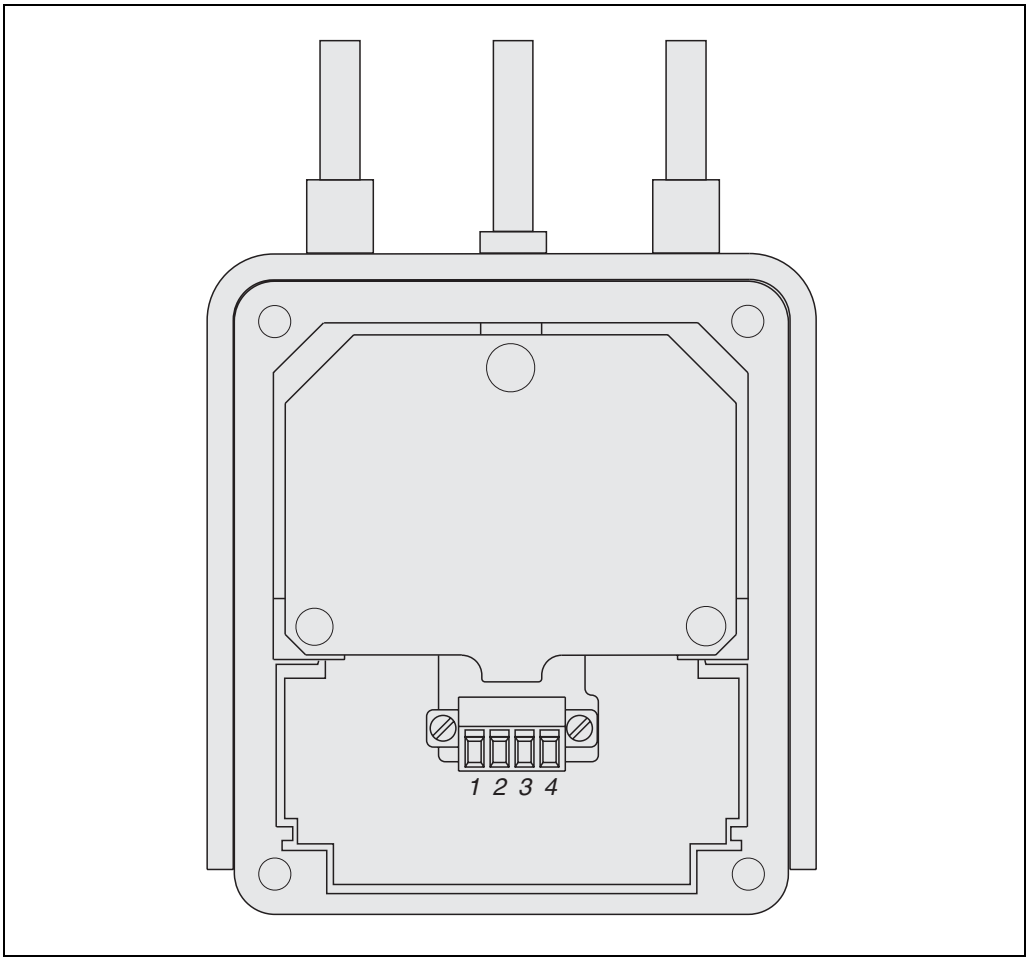


Note The machine controller must process the signals from OSSD1 and OSSD2 separately. OSSD1 and OSSD2 must not be connected together.

➢ To ensure signal integrity connect OSSD1 and OSSD2 separately to the machine controller (see also Fig. 28).

5.2 Connecting the sender

Fig. 30: Pin assignments of the sender



Tab. 10: Pin assignments of the sender

Pin	Signal	Function
1	+24V	24 V DC input (voltage supply)
2	GND	0 V DC input (voltage supply)
3	SEND+	Input, signal from receiver
4	SEND–	Input, signal from receiver

5.3 Making up the connections for receiver and sender

➢ Always use EMC-type cable glands for all through-holes.

The following cable glands are supplied:

Tab. 11: Cable glands

Cable gland	**Cable diameter**
Receiver wiring space (3 through-holes)	
M20	7–12 mm
M16 (x 2)	3–7 mm
Sender wiring space (1 through-holes)	
M16	3–7 mm

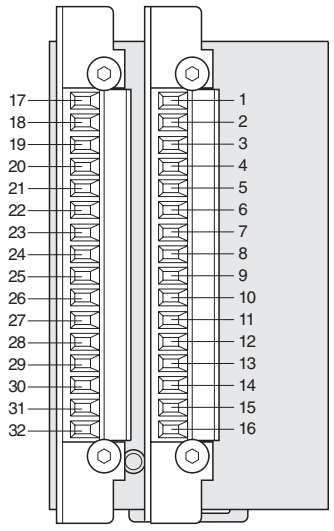
➢ Use the following cable cross-sections for the individual connections:

Tab. 12: Cable cross-sections

Cable	**Recommended cable**	**Screened**	**Usable as trailing cable**	**Other requirements**
Receiver to control cabinet (M20)	18 wires, 0.34 - 0.5 mm²	Yes	Yes	–
Receiver to sender (M16)	4 wires, 0.34 mm²	Yes	No	2 twisted pairs for RS-422
Receiver to PBI (M16)	4 wires, 0.34 mm²	Yes	Yes	2 twisted pairs for RS-422

5.4 Connecting the PBI

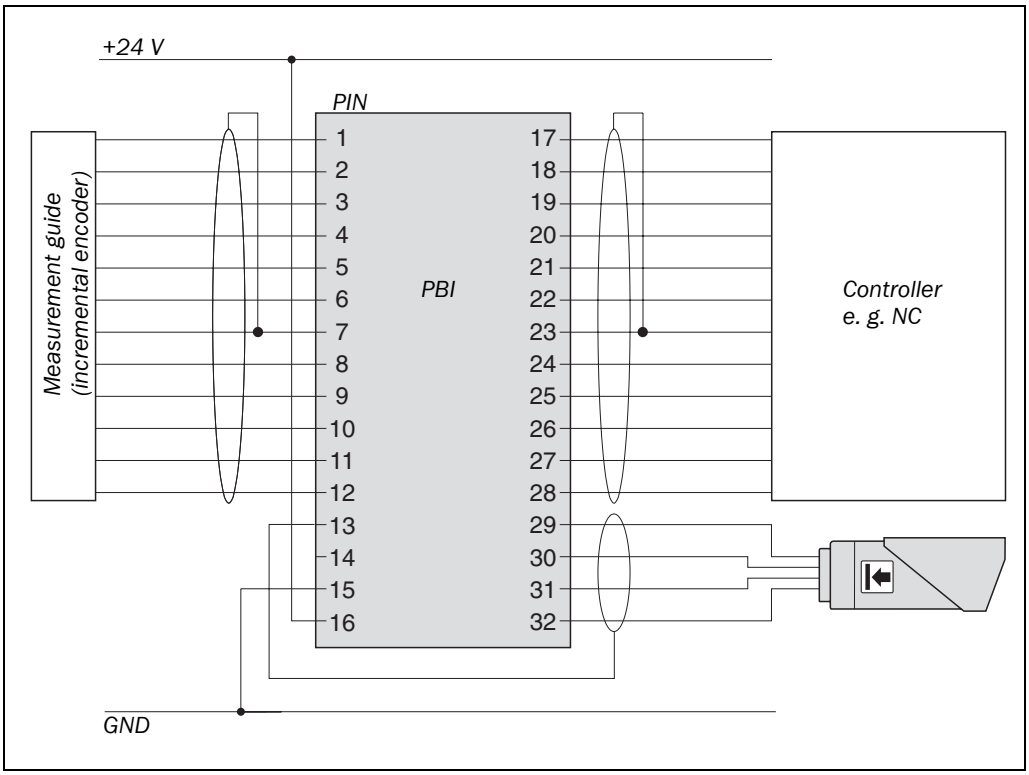
Fig. 31: Pin assignments of the PBI



Tab. 13: Pin assignments of the PBI

Pin	Signal	Function
1	UA0+	Input (RS-422), reference mark (optional)
2	UA0–	Input (RS-422), reference mark (optional)
3	UA1+	Input (RS-422), 0° signal from incremental encoder
4	UA1–	Input (RS-422), 0° signal from incremental encoder
5	UA2+	Input (RS-422), 90° signal from incremental encoder
6	UA2–	Input (RS-422), 90° signal from incremental encoder
7	Shield	Shield
8	UP_5V	5 V DC output (voltage supply for incremental encoder)
9	UN_0V	0 V DC output (voltage supply for incremental encoder)
10	Sense_5V	5 V DC input (for measurement of voltage supply at incremental encoder) (optional)
11	Sense_0V	0 V DC input (for measurement of voltage supply at incremental encoder) (optional)
12	UAS	Input, error signal from incremental encoder (optional)
13	Shield	Shield
14	+5V_Opt.	5 V DC output (optional voltage supply for incremental encoder), 0.15 A (optional)
15	GND	0 V DC input (voltage supply)
16	+24V	24 V DC input (voltage supply), 0.5 A
17	UA0+	Output (RS-422), reference mark (optional)
18	UA0–	Output (RS-422), reference mark (optional)
19	UA1+	Output (RS-422), signal to numerical control
20	UA1–	Output (RS-422), signal to numerical control
21	UA2+	Output (RS-422), signal to numerical control
22	UA2–	Output (RS-422), signal to numerical control
23	Shield	Cable shield
24	UP_5V	5 V DC input (voltage supply from numerical control for incremental encoder)
25	UN_0V	0 V DC input (voltage supply from numerical control for incremental encoder)
26	Sense_5V	5 V DC output (for measurement of supply voltage at incremental encoder) (optional)
27	Sense_0V	0 V DC output (for measurement of supply voltage at incremental encoder) (optional)
28	UAS	Output, error signal from the incremental encoder to numerical control (optional)
29	ENCO1+	Output (RS-422), signal to the receiver
30	ENCO1–	Output (RS-422), signal to the receiver
31	ENCO2+	Output (RS-422), signal to the receiver
32	ENCO2–	Output (RS-422), signal to the receiver

Fig. 32: PBI connection diagram



5.5 External device monitoring (EDM)

The EDM checks if the contacts actually de-energise when the protective device responds. If, after an attempted reset, the EDM does not detect a response from the switching amplifier within 300 ms, the EDM will deactivate the OSSD switching outputs again.

External device monitoring is implemented in such a way that there is positive closing of both N/C contacts (k1, k2) when the contact elements (K1, K2) reach their de-energised position after the protective device has responded. 24 V is then applied at the input of the EDM (see Fig. 28). If 24 V is not present after the response of the protective device , this means one of the contact elements is faulty and the external device monitoring prevents the machine starting up again.

Notes

- Contacts or relays monitored by EDM must be positively driven.
- If you connect the contact elements to be monitored to the EDM input, then you must activate the option EDM in the CDS (Configuration & Diagnostic Software). If you fail to do so, after the V4000 PB is switched on the 7-segment display will show 8.
- If you later deselect the EDM option, pin 6 of the system plug must not remain connected to 24 V.

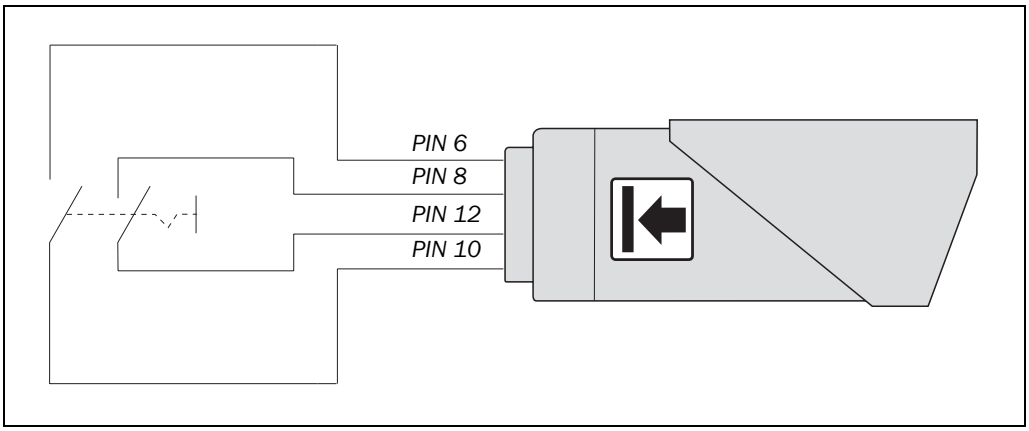
5.6 Bypass

In bypass mode the press brake can be operated without an activated V4000 PB protective device. In bypass mode the OSSDs are in the ON state and all displays on the receiver are switched off. The V4000 PB does not generate any output signals (target-speed request, teach-in request).

To activate bypass mode, the bypass function should be enabled in the configuration and the outputs of the bypass function at the receiver connected with its inputs.

The bypass is disabled by interrupting the electrical connection. When bypass mode is disabled, the V4000 PB goes into restart interlock and requests a power-up cycle.

Fig. 33: Bypass connection diagram



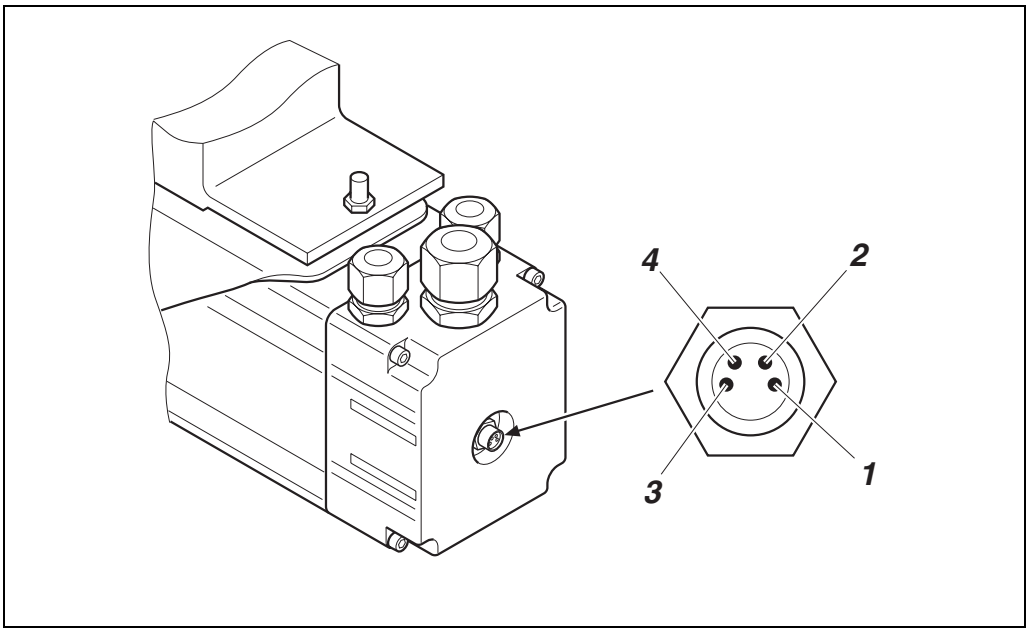
Notes

If you connect the bypass, you must activate the bypass function in the CDS (Configuration & Diagnostic Software). Should implausible states of the two input signals occur, the 7-segment display will show the error message c.8.

The operator is responsible for the use and perfect functioning of additional safety devices which ensure the safe operation of the press brake (such as using robots for material handling).

5.7 Configuration connection (serial interface)

Fig. 34: Pin assignments for configuration interface



Switch S in position RS-422 (see Section 6.1)

Tab. 14: Pin assignment of permanent configuration connection with RS-422

Pin	Colour	Meaning	PC-side RS-422
1	Brown	422 RxD+	Pin 3 (TxD+)
2	White	422 TxD+	Pin 2 (RxD+)
3	Blue	422 RxD–	Pin 4 (TxD–)
4	Black	422 TxD–	Pin 1 (RxD–)

Switch S in position RS-232, default (see Section 6.1)

Tab. 15: Pin assignments of temporary configuration connection with RS-232

Pin	Colour	Meaning	PC-side RS-232 SubD
1	Brown	–	NC
2	White	RxD	Pin 3
3	Blue	0 V DC (voltage supply)	Pin 5
4	Black	TxD	Pin 2

Notes

The following instructions only apply when the V4000 PB is connected temporarily with a PC.

- Connect the connecting cable to the configuration connection of the receiver.
- When configuration is finished, remove the connecting cable from the configuration connection.

6 Configuration

6.1 Delivery state

The V4000 PB is delivered in a state which is safe.

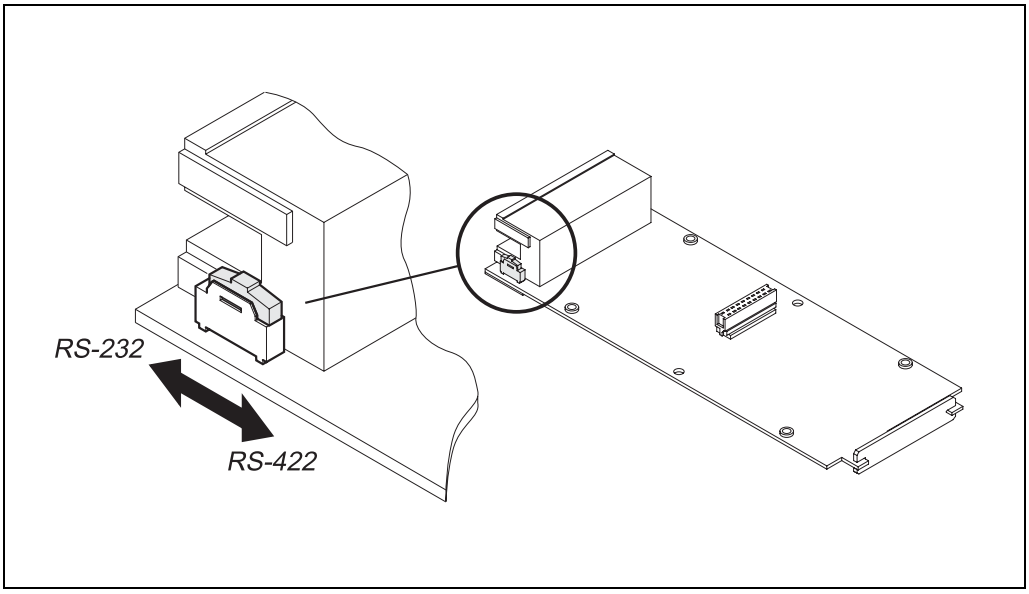
- The V4000 PB is in the **Waiting for configuration** device mode.
- The switching outputs (OSSDs) are in the OFF state.
- The 7-segment display shows 6.

Notes The maximum overall machine overrun and the maximum closing speed must be configured at installation such that they satisfy the condition of the stopping distance.

You can change this configuration with CDS.

The serial interface for configuration is switched to RS-232. In the case of a permanent – on-line – connection, the interface will need to be changed over to RS-422 with the switch S. The RS-422 interface must be supported on the PC or controller side and connected properly.

Fig. 35: Switch setting



6.2 Configuration preparations

To configure the V4000 PB you will need:

- CDS (Configuration & Diagnostic Software) on CD
- User manual for the CDS on CD
- A PC or notebook running Windows 9x / NT 4 / 2000 Professional / XP and with an RS-232 serial interface (the PC or notebook is not supplied)
- Connecting cable for connecting the PC and the V4000 PB (SICK part no. 6 021 195)

How to prepare the configuration:

➢ Ensure that the V4000 PB is properly mounted and connected electrically.

➢ Plan all the necessary settings (operating modes etc.).

➢ To configure the device, please read the user manual for the CDS (Configuration & Diagnostic Software) and use the on-line help function of the program.

Notes Should the V4000 PB need to have repairs done by SICK, the configuration will be restored to its original state.

➢ For this reason you should back up your configuration on a separate data medium.

7 Commissioning

WARNING

Do not commission without a check by specialist personnel!

- Before you operate a system protected by the V4000 PB for the first time, make sure that the system is first checked and released by specialist personnel.
- To this regard please read the notes in Chapter 2 "On safety" on Page 9.

Notes After replacing single components of the safety system a commissioning has to be done.

7.1 Test notes

The purpose of the tests described below is to confirm the safety requirements specified in the national and international rules and regulations, especially in the Machinery Directive and the Use of Work Equipment Directive (EC Conformity).

These tests are also intended as a way of detecting whether protection is being affected by sources of extraneous light or by other unusual environmental influences.

It is therefore essential that these tests be carried out.

7.2 Aligning sender and receiver

7.2.1 Initial alignment

Sender and receiver must be aligned exactly with respect to each other and with respect to the die of the press brake in order to ensure the safety function of the sensor. This is done with the alignment masks in alignment mode.

How to prepare for initial alignment:

- Ensure that the V4000 PB is properly mounted and connected electrically.
- Ensure that the press is fitted with at least one die segment.
- Switch on the power supply to the V4000 PB.

Recommendation To increase the accuracy of initial alignment, the press crosshead should be fitted with one die segment at the right-hand edge and one at the left.

Notes The laser is visible in alignment mode. The V4000 PB meets the requirements of laser protection class 1M. The operator is not at any risk.

- Do not look into the laser beam with optical devices (such as a binoculars).

Fig. 36: Die segments

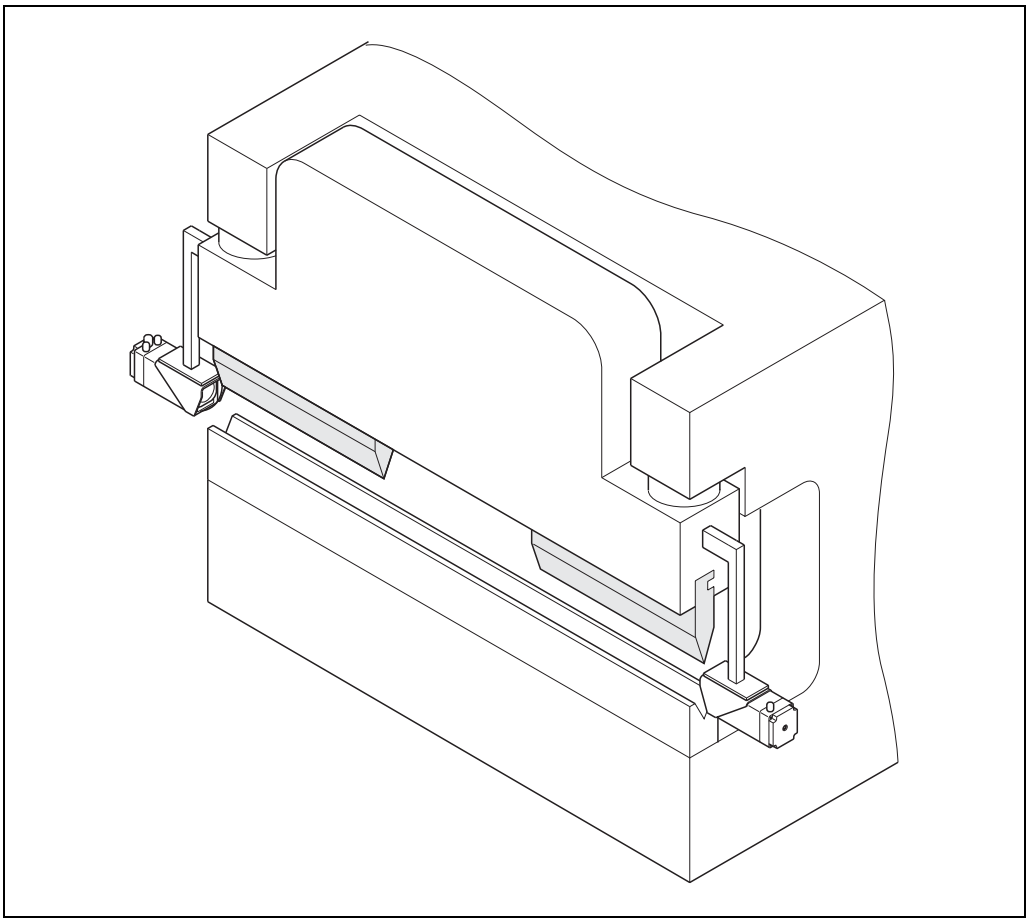
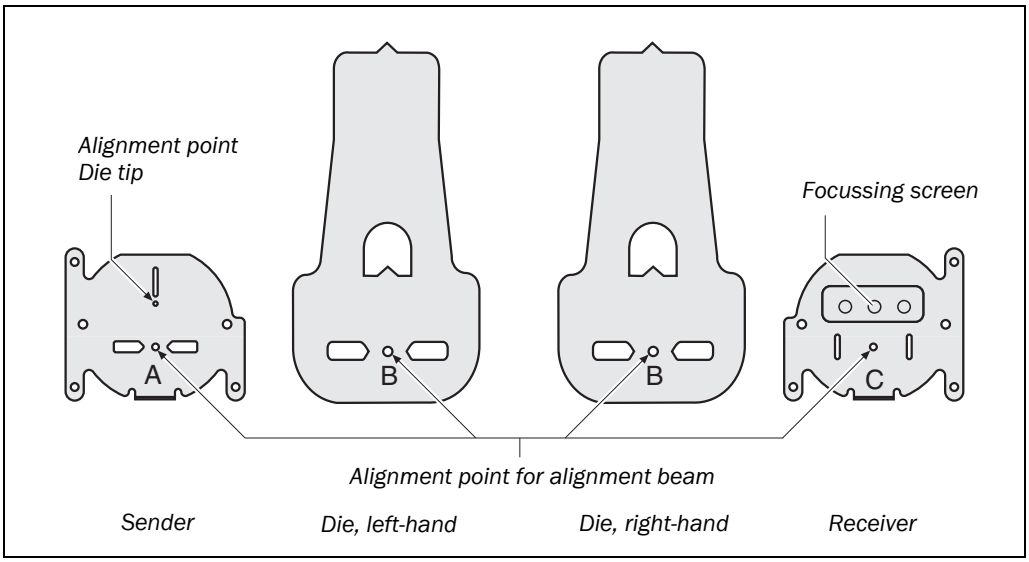


Fig. 37: Alignment masks

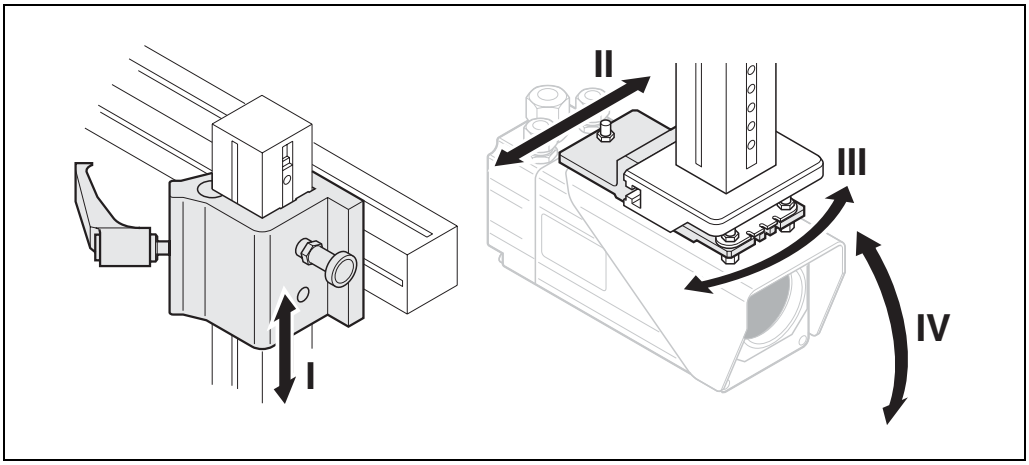


Notes Four alignment masks and the values appearing on the 7-segment display will help you align the sender and receiver.

The alignment beam must in each case pass through the hole (alignment point) in the masks.

The sender and receiver can be adjusted in four directions.

Fig. 38: Adjustment directions



Tab. 16: Adjustment directions

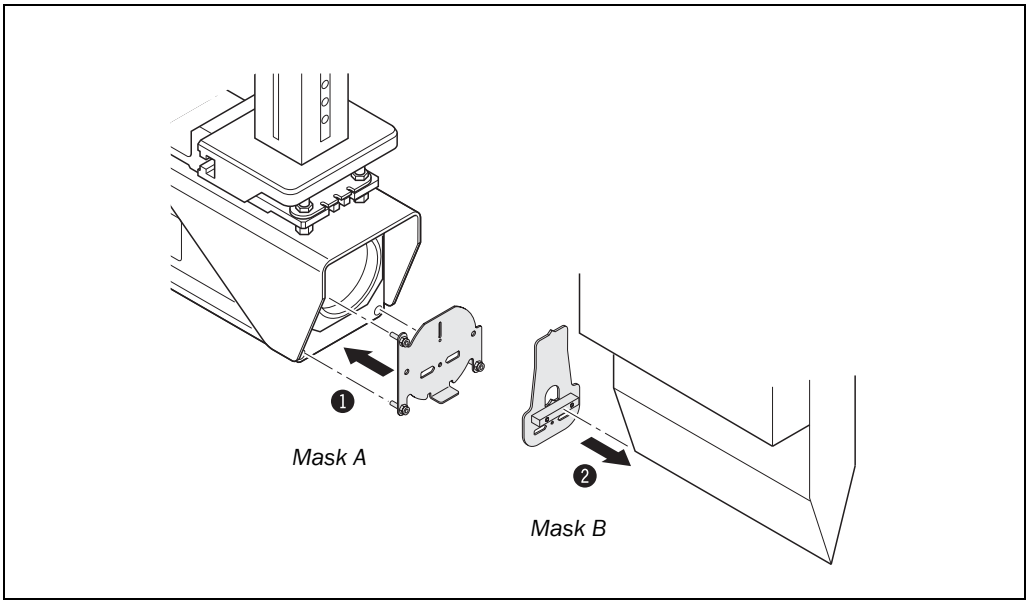
Direction	Meaning
I	Adjustment in the vertical direction on the retaining arm
II	Adjustment in the horizontal direction via the grooved guide in the alignment plate
III	Rotation of the sender on the horizontal plane in the slots of the alignment plate
IV	Rotation of the sender on the vertical plane by adjusting the screw on the rear pin

Alignment of the sender

➢ Use the corresponding operating element to access alignment mode.

Notes If there is no alignment point saved, alignment mode will be requested automatically after switching on.

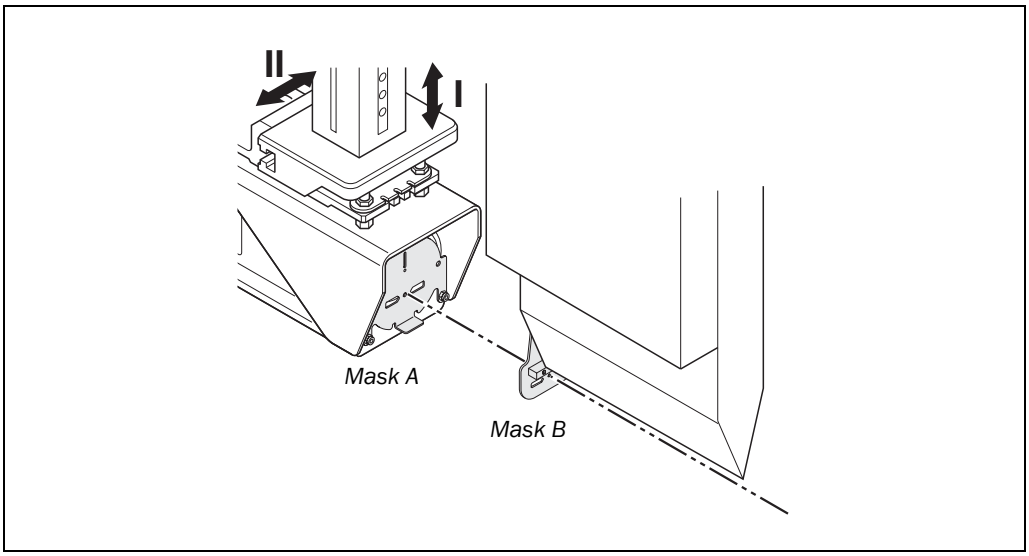
Fig. 39: Fitting masks A and B



➢ Affix mask **A** in front of the front lens on the sender housing.

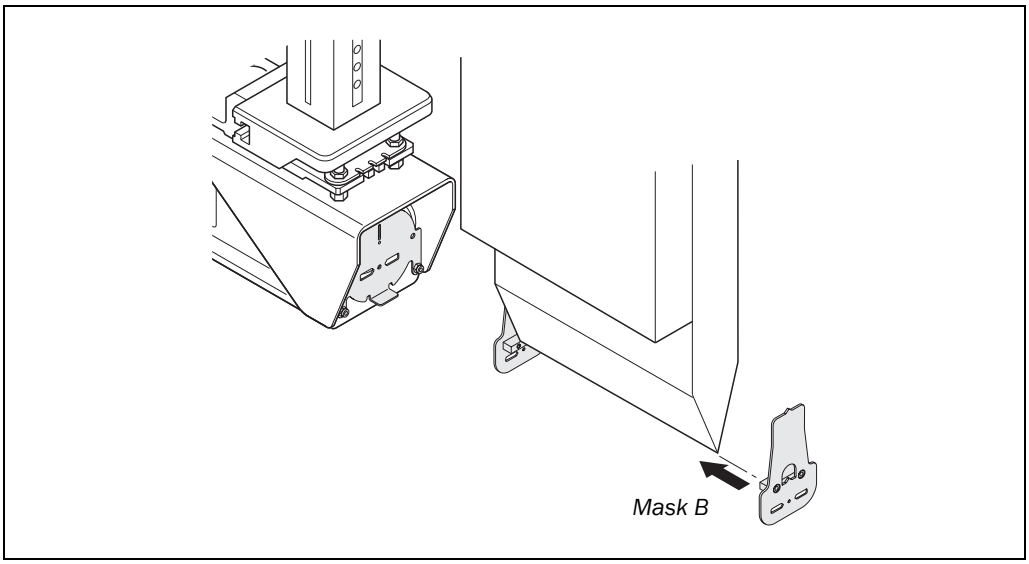
➢ On the sender side attach mask **B** to the die. Make sure that the die tip coincides with the bottom edge of the half-moon-shaped cut-out and that it is on the longitudinal axis which is marked on the mask.

Fig. 40: Alignment in directions I and II



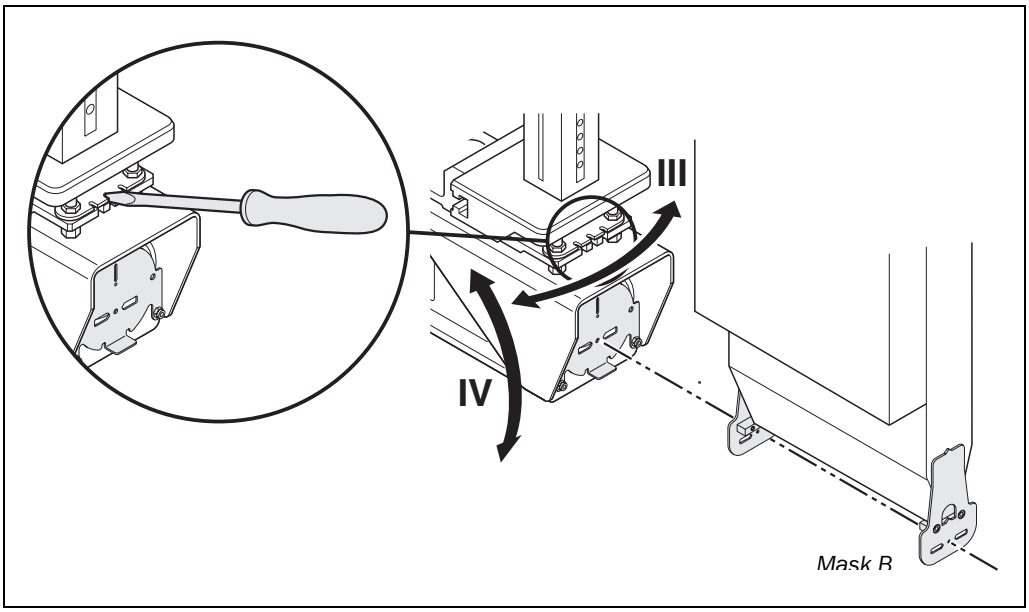
➢ Move the sender bracket in directions I and II until the alignment beam goes through the hole in mask **B**.

Fig. 41: Fitting mask B



➢ On the receiver side attach the second mask **B** to the die. Make sure that the die tip coincides with the bottom edge of the half-moon-shaped cut-out and that it is on the longitudinal axis which is marked on the mask.

Fig. 42: Alignment in directions III and IV



➢ Move the sender bracket in directions III and IV until the alignment beam goes through the hole of the second mask **B**.

Adjustment in direction III

With the aid of a steel plate with three notches (auxiliary alignment plate) which is mounted between the front bolts and three notches in the alignment plate, the sender can be rotated on the horizontal plane ±3° out of its central position. Here the sender rotates in the slots in the alignment plate – in other words, the sensor is turned on the rear bolts and relative to the alignment plate.

Notes When aligning the sender, make sure that the nuts of the bolts on which the alignment plate is mounted are only tightened up handtight. The spring washers will provide the necessary tension.

➢ Insert the blade of a screwdriver (blade 4) into the middle notch of the alignment plate or steel plate.

➢ Turn the screwdriver blade slowly clockwise or anti-clockwise in the middle notch until the alignment beam goes through the hole in the second mask **B**.

➢ You can use the left-hand or right-hand notch to turn the sender even further clockwise or anti-clockwise if this is necessary.

Notes Make sure that the alignment beam goes through both **B** masks. You may need to make realignment adjustments in directions I and II and in directions III and IV.

➢ Fix the sender brackets in place.

Alignment of the receiver

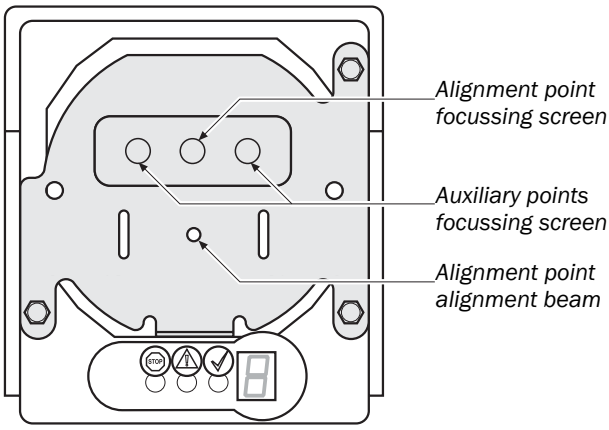
WARNING

Risk of injury if incorrectly aligned!

Incorrect alignment of the V4000 PB can result in serious injuries.

➢ After every alignment operation, carry out a function check.

Fig. 43: Alignment of the receiver



➢ Affix mask **C** in front of the front lens on the receiver housing.

➢ Move the receiver bracket in directions I and II until the alignment beam goes through the hole in the mask.

➢ Move the receiver bracket in directions III and IV until the three target points (alignment point and two auxiliary points) coincide with the collecting zone on the focussing screen.

➢ Use the 7-segment display to carry out fine alignment.

Notes The CDS provides a graphic representation of the alignment state of the receiver. You can also carry out fine alignment with the aid of the CDS display.

Tab. 17: Display during alignment of sender and receiver

Display	Meaning	Action
0	Image detector not illuminated	➢ Check the connection of the sender. ➢ Check the rough alignment of the sender and receiver and correct if necessary. ➢ Check the masks. They may have been mixed up or fitted at an angle.
=	Invalid pattern	➢ Move the sender bracket in directions I and II until the alignment point is in the target zone.
1	Alignment point or all points on left outside the target zone	
¯	Alignment point or all points above the target zone	
7	Alignment point or all points on right above the target zone	
r	Alignment point or all points on left above the target zone	
1	Alignment point or all points on right outside the target zone	

Display	Meaning	Action
_	Alignment point or all points below the target zone	➢ Move the sender bracket in directions I and II until the alignment point is in the target zone.
L	Alignment point or all points on left below the target zone	
J	Alignment point or all points on right below the target zone	
,'	Alignment point in the target zone, position of the auxiliary points at alignment point out of tolerance (clockwise rotation)	➢ Move the sender bracket in directions III and IV until the alignment point is in the target zone and the auxiliary points in tolerance.
',	Alignment point in the target zone, position of the auxiliary points at alignment point out of tolerance (anti-clockwise rotation)	
II	Alignment point or all points horizontally outside tolerance	
E	Distance between the auxiliary points outside tolerance	➢ Check the masks. ➢ Replace the device (internal mis-justment).
F	An attempt has been made to save an invalid alignment point.	➢ Cancel the "Save alignment point" request and continue with alignment.
-	Alignment point in the target range, auxiliary points in tolerance	➢ For at least 1 second request alignment mode in order to save the alignment point.

➢ Once the sender and receiver are in the right position (7-segment display -) fasten down the receiver brackets.

➢ For at least one second request alignment mode.

The alignment point will be saved.

When the request for alignment mode is cancelled, the V4000 PB will be reset.

When the self-test (system initialisation) is completed, the V4000 PB calls for a power-up cycle.

➢ Remove all masks.

➢ Press the teach-in button.

The request for the power-up cycle is acknowledged and the cycle carried out (see Section 8.4 "Carrying out a power-up cycle").

➢ Carry out the function check using the test piece (see Section 7.3 "Function check").

7.2.2 Alignment following a tooling change

Notes Alignment may have to be readjusted after a tool change.

Recommendation If you are working with only a few dies of different lengths, it is worth setting up latching marks (defined, vertical bracket positions or markings on the bracket).

How to prepare for alignment following a tool change:

- Ensure that sender and receiver are correctly aligned at first alignment.
- Switch on the power supply to the V4000 PB.

Tracking without latching marks (checking and initial setting-up of latching marks)

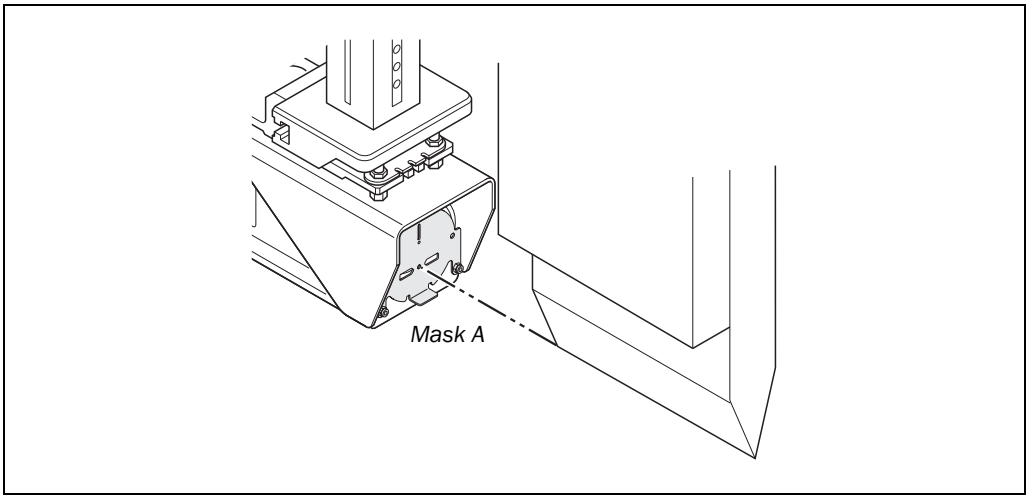
WARNING

Risk of injury if incorrectly aligned!

Incorrect alignment of the V4000 PB can result in serious injuries.

- After every alignment operation, carry out a function check.

Fig. 44: Tracking without latching marks



- Press the alignment mode button (signal for alignment mode).
- Affix mask **A** in front of the front lens on the sender housing.
- Move the sender bracket in direction I until the die tip alignment point is intersected by the lower edge of the die.
- Move the receiver bracket in direction I until the correct position is confirmed via the 7-segment display (alignment tolerance ± 6 mm).
- Once the sender and receiver are in the right position (7-segment display ⊟), hold down the button for alignment mode for at least one second.

The alignment point will be saved.

When the signal for alignment mode is cancelled, the V4000 PB will be reset.

When the self-test (system initialisation) is completed, the V4000 PB calls for a power-up cycle.

- Remove mask **A**.
- Press the power-up cycle button.

The request for the power-up cycle is acknowledged and the cycle carried out (see Section 8.4 "Carrying out a power-up cycle").

- Carry out the function check using the test piece (see Section 7.3 "Function check").

Tracking with latching marks

WARNING

Risk of injury if incorrectly aligned!

Incorrect alignment of the V4000 PB can result in serious injuries.

➢ After every alignment operation, carry out a function check.

➢ Align the sender and receiver on the brackets (manufacturer's brackets) vertically, that is, in direction I.

➢ Carry out the function check using the test piece (see Section 7.3 "Function check").

➢ Initiate a reset by pressing the alignment and teach-in buttons simultaneously.

When the self-test (system initialisation) is completed, the V4000 PB calls for a power-up cycle.

➢ Press the power-up cycle button.

The request for the power-up cycle is acknowledged and the cycle carried out (see Section 8.4 "Carrying out a power-up cycle").

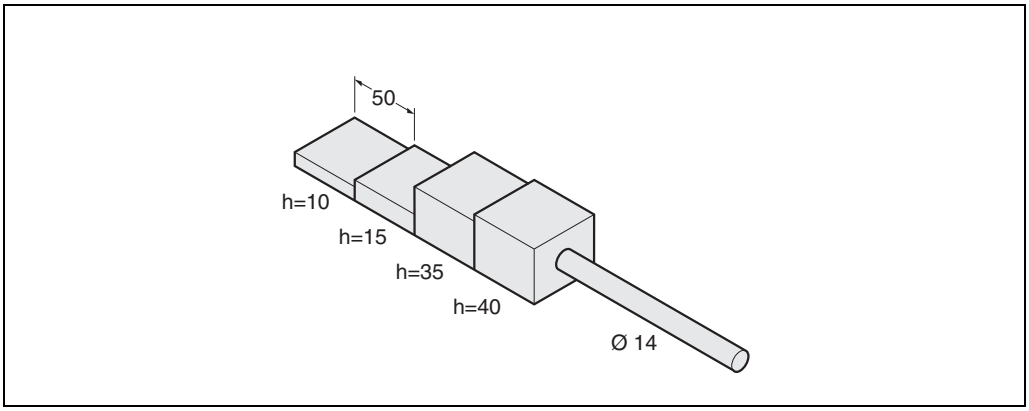
➢ Carry out the function check using the test piece (see Section 7.3 "Function check").

7.3 Function check

During the function check the following aspects are checked:

- Protective function with the test rod (objects larger than 14 mm)
- Distance from the tool
- Emergency stop properties
- Overall machine overrun

Fig. 45: Test piece



How to prepare for the function check:

➢ Ensure that the press is fitted with a die which extends for its full working length.

➢ Ensure that sender and receiver have been correctly aligned at first alignment.

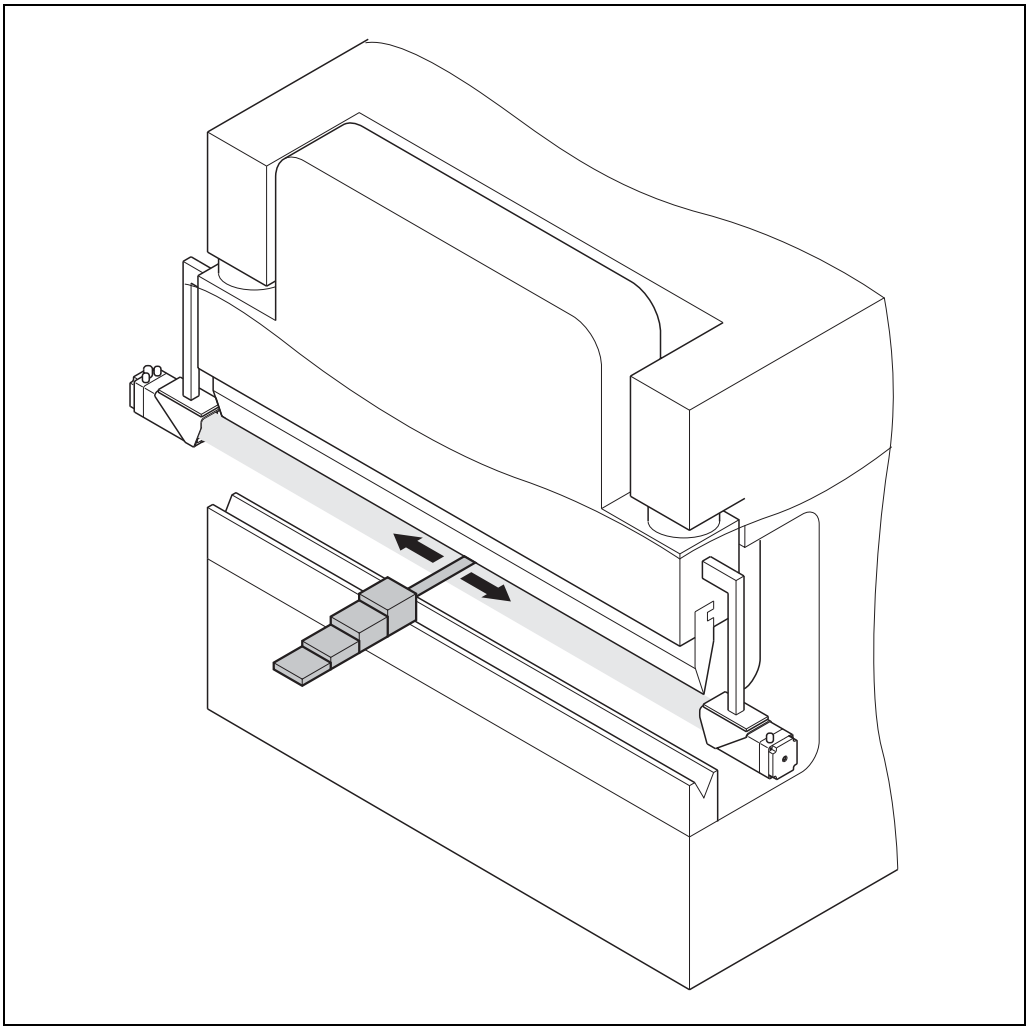
➢ Switch on the power supply to the V4000 PB.

➢ Select standard mode (see Section 8.2 "Selecting protective volume mode").

➢ Carry out a power-up cycle (see Section 8.4 "Carrying out a power-up cycle").

Function check with the test rod (handle of the test piece)

Fig. 46: Function check with test rod



➢ Slowly pass the rod (the handle of the test piece) along the die tip for the full extent of the protective volume.

The rod must be detected over the whole extent of the protective volume beneath the die tip.

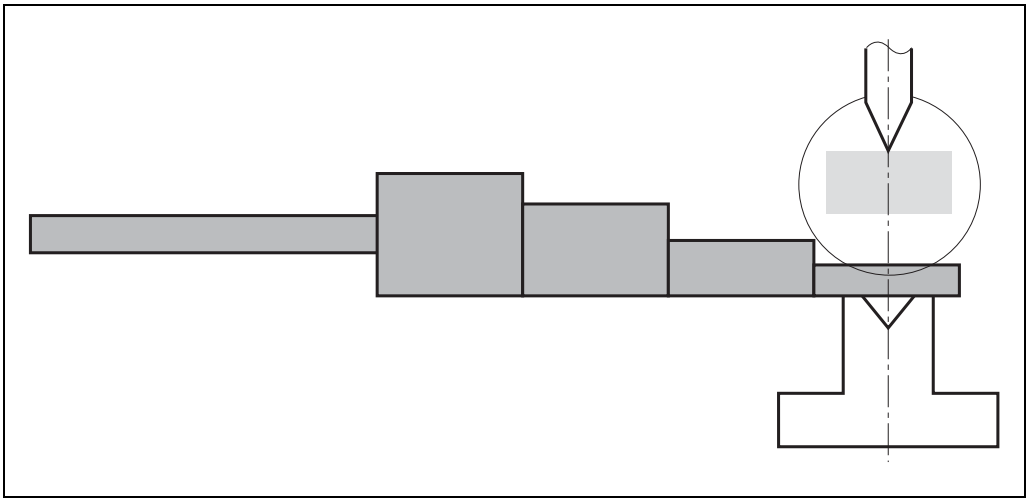
During this test, the red LED on the receiver must stay on the whole time.

Function check with the test piece

Notes

The pinch point must be known from teach-in.

Fig. 47: Function check with test piece (10 mm)

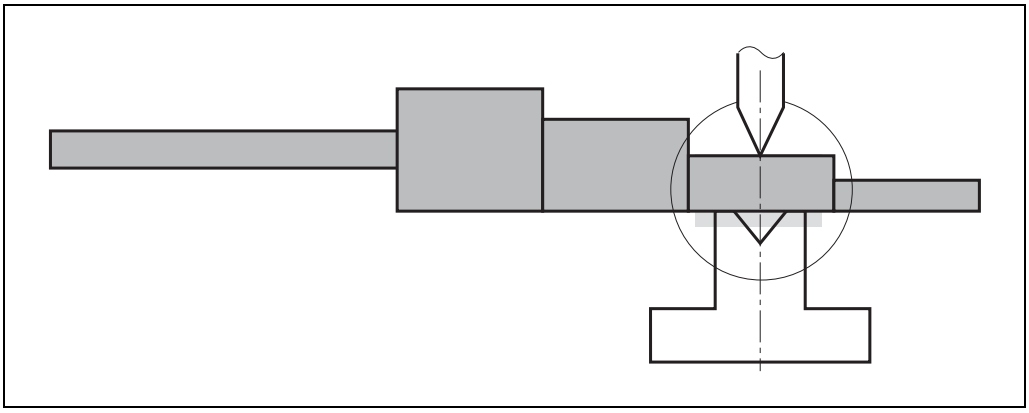


- Place the section of the test piece having a height of 10 mm on the female die or on the workpiece so that the section lies in the middle of the pressure axis.
- Start the closing movement with the maximum closing speed.

The protective volume is interrupted by the test piece and the closing movement stopped by the OFF state of the V4000 PB.

After the closing movement has stopped, the die tip must not be touching the test piece.

Fig. 48: Function check with test piece (15 mm)



It must then be possible to push the following section (having a height of 15 mm) into the remaining gap.

- Check whether the following section having a height of 15 mm can be pushed into the remaining gap.
- Carry out the test on the outer left- and outer right-hand side and in the centre of the press.
- In order to increase security, repeat the test with the 35mm-high section (40 mm for checking the gap).

7.4 Regular checks of the protective device by specialist personnel

Regular checks will ensure that any changes to the machine or manipulation of the protective device after commissioning are detected.

- Check the system at the inspection intervals specified in the national rules and regulations.
- If major modifications have been made to the machine or the protective device, or if the V4000 PB has been modified or repaired, the system must be checked again as specified in the checklist in the annex (see Section 13.3 "Manufacturer's checklist").

Tab. 18: Regular checks

Check	Daily	Annually/after commissioning	Following a tool change
Alignment		x	x
Protective function with test rod	x	x	x
Emergency stop properties of the entire system	x	x	x
Overall machine overrun		x	
Configuration data		x	
Number of repetitions	**1**	**10**	**1**

7.5 Daily checks of the protective device by authorised commissioned persons

The effectiveness of the protective device must be checked daily or prior to the start of work by a specialist or by authorised commissioned persons, using the correct test rod. The check must furthermore be carried out at each tool change.

WARNING

Do not operate the machine if errors or faults are found during the checks!

If any of the following conditions is not fulfilled, no work may be carried out at the machine.

- In this case have the installation of the V4000 Press Brake checked by specialist personnel.

Visual inspection of the protective device

- Check the protective device (mounting, housing, electrical connection, optics) for damage or wear.
- Switch the machine on and check whether at least one LED at the receiver of the V4000 Press Brake (LED below the receiver lens) lights up permanently.

Checking the protective volume

- Check whether the red LED at the receiver of the V4000 Press Brake lights up when the protective volume is interrupted with the test rod (handle of the test piece) below the die tip. Carry out the test along the entire protective volume below the die tip.
- Carry out a power-up cycle using a workpiece.

➢ Carry out the following test **on the left and right side of the female die and in the centre of the female die**.

– Place the section of the test piece having a height of 10 mm on the workpiece so that the section lies in the middle of the pressure axis.

– Start the closing movement with the maximum closing speed.

– After the press has stopped, check whether the following section having a height of 15 mm can be pushed into the remaining gap.

➢ In order to increase security, repeat the test with the section of the test piece having a height of 35 mm and check whether the following section having a height of 40 mm can be pushed into the remaining gap after the press has stopped. Also carry out this test **on the left and right side of the female die and in the centre of the female die**.

8 Operation

WARNING

Nuisance shutdowns due to air contamination!

The functioning of the V4000 PB can be affected by air contamination and nuisance shutdowns may be the result.

➢ Keep the area around the V4000 PB free of smoke, fumes, steam and other types of air contamination (particularly contamination of the lenses, such as by oil).

How to prepare for operation:

➢ Carry out the daily check (see Section 7.5 "Daily checks of the protective device by authorised commissioned persons").

8.1 Switching the machine on

Display sequence during switch-on

After the system is switched on, the sender and receiver carry out a self-test (system initialisation). The 7-segment display indicates the device status during the self-test.

The display values have the following meaning:

Tab. 19: Displays during the power-up cycle

Display	Meaning
	Switch on. This is followed by the self-test of the V4000 PB.
	Testing the 7-segment display. All segments are activated sequentially.
	It has not (yet) been possible to complete the self-test successfully.
	The input states do not (yet) correspond to the values expected.
	V4000 PB requires configuration.
Other display	• Protective volume mode: see Section 8.2 "Selecting protective volume mode" • Device error: see Section 9.3 "Error displays of the 7-segment display"

8.2 Selecting protective volume mode

➢ Use the selector switch to select protective volume mode (standard, box or back-stop mode).

Depending on which protective volume mode you have selected you will see the following displays on the 7-segment display:

Tab. 20: Protective volume mode displays

Display	Meaning
	Standard mode
	Box mode
	Back-stop mode

➢ If the selector switch is pointing to box or back-stop, switch the selector switch to standard protective volume mode first and then to the protective volume mode you want.

Note The protective volume mode you have selected will be available thereafter with every start signal.

In the case of the box or back-stop protective volume modes, the start signal for the closing movement can be triggered either by double-clicking or by a single action. If single triggering is used, non-operation is time-monitored. The operator will then be warned that the machine is working in a special mode in which there is only limited protection due to a reduction in the protective volume.

8.3 Resetting

A V4000 PB reset corresponds to a switch-on. After the reset, there will be a self-test and a power-up cycle.

➢ Make a reset by pressing simultaneously the buttons for alignment mode and for teach-in.

8.4 Carrying out a power-up cycle

Following machine switch-on and system initialisation the V4000 PB requests teach-in mode. A power-up cycle will be requested if the V4000 PB has, during operation, detected a time-out since the last power-up cycle, or the V4000 PB has been reset.

The power-up cycle cannot be carried out unless the standard protective volume mode has been previously selected, if only for a brief period. After this the power-up cycle can be carried out in any protective volume mode.

Tab. 21: Carrying out a power-up cycle, for example in standard mode

Action	Result	LED display
➢ If necessary, open the press.	The press is open.	● Red ☀ Yellow (90/10)
➢ Press the teach-in button.	The request for the power-up cycle is acknowledged.	● Green
➢ Insert the workpiece.	–	● Green

Action	Result	LED display
➢ Press the foot switch (start signal for the closing movement).	• The press closes at high closing speed. • The V4000 PB switches the OSSDs off. • The high closing speed is stopped. • The overall machine overrun is checked.	● Green ● Red
➢ Release the foot switch (this cancels the start signal).	–	● Green
➢ Press the foot switch again (start signal for the closing movement).	• The V4000 PB requests the target speed from the press controller (only if v_{slow} is connected). • The press controller starts the braking procedure. • The V4000 PB detects and accepts the target speed. • The braking distance is determined once the target speed has been reached. • The V4000 PB cancels the request for target speed. • The press controller can accelerate up to the high closing speed. • The workpiece interrupts the protective volume. • The press stops. • The pinch point is determined. • The overall machine overrun is checked.	● Green ● Red
➢ Release the foot switch (this cancels the start signal).		● Green
➢ Press the foot switch again (start signal for the closing movement).	The press finishes the operating cycle.	● Green
➢ Carry out the function check (see Section 7.3).	The press is now ready for operation.	● Green

8.5 Carrying out teach-in

Note From the pinch point the V4000 PB calculates all safety-relevant parameters (switch-over point and muting point). For this reason the safety-relevant parameters cease to apply after a change of material.

➢ This means you should carry out teach-in every time a material is changed.

Teach-in cannot be carried out unless the standard protective volume mode has been previously selected. Once this has been done, teach-in can be carried out in any protective volume mode.

Recommendation If the V4000 PB does not detect the pinch point or does so only after a repeated request for teach-in, use the magnetic plate supplied to cover the female die opening beneath the workpiece.

The magnetic plate should be flush with the top surface of the female die. It must not project above the level of the workpiece surface.

Tab. 22: Carrying out teach-in, for example in standard mode

Action	Result	LED display
➢ Select standard protective volume mode.	–	
➢ Press the teach-in button.	–	
➢ If necessary, open the press.	The press is open.	● Green
➢ Insert the workpiece.	–	● Green
➢ Press the foot switch (start signal for the closing movement).	• The press controller accelerates up to the high closing speed. • The workpiece interrupts the protective volume. • The press stops. • The pinch point is determined. • The overall machine overrun is checked.	● Green ● Red
➢ Release the foot switch (this cancels the start signal).		● Green
➢ Press the foot switch again (start signal for the closing movement).	• The press finishes the operating cycle. • The press is now ready for operation.	● Green

8.6 Bending in standard mode

➢ Select standard protective volume mode (7-segment display).

➢ If the sheet thickness of the workpiece has changed, carry out teach-in (see Section 8.5 "Carrying out teach-in").

➢ Insert the workpiece.

➢ Press the foot switch (start signal for the closing movement).

The press carries out the operating cycle.

8.7 Bending in box mode

WARNING

Catching or crushing of fingers or hands due to partial blanking of the protective volume and also within the tolerance zone at the pressure axis!

Due to partial blanking of the protective volume, objects in the tolerance zone will not be detected.

➢ Make sure the workpiece is handled correctly (see Section 2.5 "Safety in operation").

➢ Select box protective volume mode (7-segment display).

➢ If the sheet thickness of the workpiece has changed, carry out teach-in (see Section 8.5 "Carrying out teach-in").

8.8 Bending in back-stop mode

WARNING

Catching or crushing of fingers or hands due to partial blanking of the protective volume and also within the tolerance zone!

Due to partial blanking of the protective volume, objects in the tolerance zone will not be detected.

➢ Make sure the workpiece is handled correctly (see Section 2.5 "Safety in operation").

➢ Select back-stop protective volume mode (7-segment display).

➢ If the sheet thickness of the workpiece has changed, carry out teach-in (see Section 8.5 "Carrying out teach-in").

8.9 Changing the sheet thickness

If the sheet thickness of the workpiece changes you will need to carry out teach-in again (see Section 8.5 "Carrying out teach-in").

8.10 Tool changing

The following steps may be necessary after a tool change:

- Alignment following a tool change (see Section 7.2.2)
- Standard protective volume mode (see Section 8.2)
- Carrying out a power-up cycle (see Section 8.4)
- Function check with the test piece (see Section 7.3)

8.11 Care and maintenance

WARNING

Hazardous radiation exposure by the laser beam during disassembling!

The V4000 PB is maintenance-free. The V4000 PB does not contain any repairable components.

➢ Do not attempt to disassemble the V4000 PB for repair.

➢ Return a defective unit to the manufacturer.

Notes

The front lenses of the sender and receiver should not be cleaned unless they are dirty.

To avoid damage to the V4000 PB do not use aggressive or abrasive cleaning agents.

Cleaning the front lenses:

➢ Use a clean brush to remove dust from the front lens.

➢ Spray the lens with glass cleaning liquid containing alcohol so that the front lens is wetted but no droplets form on the lens.

➢ To remove hard particles of grit or the like from the lens, carefully dab away the liquid with the SICK lens cloth (SICK part no. 4 003 353).

➢ Spray the front lens again and with a dry part of the cloth wipe off the lens. Do not apply pressure to remove the liquid since hard particles could then scratch the lens.

➢ After cleaning, check the positions of the sender and receiver to ensure the safety function of the sensor is still present. If necessary, re-align the sender and receiver (see Section 7.2 "Aligning sender and receiver").

➢ Carry out a function check (see Section 7.3 "Function check").

9 Diagnostics

This chapter describes how to identify and remedy errors and malfunctions of the V4000 PB.

9.1 Response to errors and malfunctions

WARNING

Cease operation if there is malfunctioning or other operational problems!

➢ Stop the machine if you cannot clearly identify or allocate the error and if you cannot safely remedy the malfunction.

Lock-out state

With certain errors or an erroneous configuration, the system can go into the lock-out state.

To put the device back into operation, carry out the following steps:

➢ Correct the source of the problem as described in Section 9.2 "Error displays of the LEDs" and 9.3 "Error displays of the 7-segment display".

➢ Switch the V4000 PB power supply off and back on again:

– Either make a reset by pressing simultaneously the buttons for alignment mode and for teach-in.

– Or switch the machine off and back on again.

9.2 Error displays of the LEDs

This section explains what the LED error displays mean and how you can respond.

Error displays of the sender LED

Tab. 23: Error displays of the sender LED

Display	Possible cause	Remedying the error
○ **Yellow**	No operating voltage, or voltage too low.	➢ Check the voltage supply and switch it on if necessary.

Error displays of the receiver LEDs

Tab. 24: Error displays of the receiver LEDs

Display	Possible cause	Remedying the error
○ **Red** and ○ **Green**	The bypass function has been selected.	➢ Check to see whether the bypass function has been selected (configuration). ➢ Check whether there is adequate operating voltage

9.3 Error displays of the 7-segment display

This section explains the meaning of the error displays of the 7-segment display and how you can respond.

Tab. 25: Error displays of the 7-segment display

Display	Possible cause	Remedying the error
4	Erroneous input signals	➢ Check the input signals, foot switch and the protective volume mode selector switch.
6	Configuration incomplete	The display goes off automatically once the configuration has been successfully transferred. If the 6 does not disappear: ➢ Check the configuration of the system using the CDS (Configuration & Diagnostic Software). ➢ Re-transfer the corrected configuration to the system.
8	EDM error (switch-on)	➢ Check the contactors and their wiring, eliminate any wiring errors, if necessary. ➢ Check the voltage level at the EDM input. ➢ Check to see whether the EDM configuration is correct.
8 (flashing)	EDM error	➢ Check the contactors and their wiring, eliminate any wiring errors, if necessary. ➢ Check the voltage level at the EDM input. ➢ Check to see whether the EDM configuration is correct. ➢ Due to an EDM error, the device is in the lock-out state. Carry out a reset.
E↻1	System error	➢ Have the receiver replaced.
F↻1	Overcurrent at switching output 1	➢ Check the contactor. Replace, if necessary. ➢ Check the wiring for a short-circuit to 0 V.
F↻2	Short-circuit at switching output 1	➢ Check the wiring for a short-circuit to 24 V.
F↻3	Short-circuit at switching output 1	➢ Check the wiring for a short-circuit to 0 V.
F↻4	Overcurrent at switching output 2	➢ Check the contactor. Replace, if necessary. ➢ Check the wiring for a short-circuit to 0 V.
F↻5	Short-circuit at switching output 2	➢ Check the wiring for a short-circuit to 24 V.
F↻6	Short-circuit at switching output 2	➢ Check the wiring for a short-circuit to 0 V.
F↻7	Short-circuit between switching outputs 1 and 2	➢ Check the wiring and rectify the error.
F↻9	Internal error	➢ Check the OSSD load. ➢ Have the receiver replaced.

Display	Possible cause	Remedying the error
c↻4	Discrepancy time is longer than configured	➢ Re-configure the discrepancy time accordingly.
c↻6	No protective volume mode selected, or several	➢ Check the connection and the function of the protective volume mode selector switch. ➢ Re-configure the discrepancy time accordingly. ➢ Check for a short-circuit in the connection of the selector switch on the switching amplifier.
c↻8	Bypass input signals are implausible	This message cannot appear unless the bypass has been activated in the configuration. ➢ Check the bypass wiring, eliminating any wiring errors or short-circuits, if necessary.
d↻5	Incremental encoder signal is implausible	➢ Check the configuration. ➢ Check the incremental encoder. ➢ Check the wiring.
i↻2	Dazzle	➢ Cut out outside light from an external light source, if necessary. ➢ Check the wiring from the sender or receiver, eliminating any wiring errors, if necessary.
A↻1	The maximum closing speed taught in during the power-up cycle has been exceeded	➢ Carry out a power-up cycle.
A↻2	The maximum closing speed specified in the configuration has been exceeded	➢ Reconfigure the maximum closing speed accordingly. ➢ Check to see whether the incremental encoder signals have got mixed up, eliminating the wiring error, if necessary. There may be a error in the press brake (see press brake operating instructions).
A↻3	The overall machine overrun specified in the configuration has been exceeded	➢ Reconfigure the overall machine overrun accordingly. ➢ Check to see whether the incremental encoder signals have got mixed up, eliminating the wiring error, if necessary. There may be an error in the press brake (see press brake operating instructions).
A↻6	The press is closing although the foot switch has not been operated The press is closing although the OSSDs have been deactivated	There may be an error in the press brake (see press brake operating instructions).
L↻2	Invalid configuration of the EDM	➢ Verify that the machine-side EDM is connected.

Display	Possible cause	Remedying the error
L↻9	Under or over-voltage in the 24 V voltage supply	➢ Check the voltage supply.

Notes If you cannot remedy an error with the aid of the LED or 7-segment display error displays, you can carry out extended diagnostics via the CDS or you can contact your local SICK branch.

9.4 Extended diagnostics via CDS

The CDS software supplied with the device (Configuration & Diagnostic Software) includes extended diagnostics options. If you cannot identify what kind of error is occurring or if you have serviceability problems, the CDS allows you to locate the error more accurately. Detailed information to be found

- in the on-line help function of the CDS (Configuration & Diagnostic Software)
- in the user manual for the CDS

Conduct extended diagnostics of the V4000 PB as follows:

➢ Connect the PC or notebook in which CDS has been installed to the receiver of the V4000 PB.

➢ Carry out diagnostics at the V4000 PB receiver.
Device symbol **V4000 PB**, **Receiver**, context menu **Diagnostics**, **Show**.

9.5 SICK support

If you cannot correct an error using the information in this section, please contact your local SICK branch.

Write the branch's telephone number in the box below so it is readily accessible to you or anyone else. The telephone number is given on the last page of these operating instructions.

Telephone number of your SICK branch

Notes Following repair work by SICK you will find that the configuration of your V4000 PB will have been reset to its original state.

➢ Back your configuration up to a separate data medium first.

10 Technical data

10.1 Device data sheet

10.1.1 V4000 PB technical data

General specifications

Tab. 26: V4000 PB general specifications

	Minimum	Typical	Maximum
Laser protection class	Laser class 1M (21 CFR 1040.10 and 1040.11, IEC 60825-1:2001)		
Enclosure rating	IP 54 (EN 60529)		
Protection class according to DIN VDE 0106, DIN EN 50178	III		
Type according to IEC 61496	4		
Can be used in accordance with IEC 61 508 up to SIL	3		
Operating temperature range	0 °C		+50 °C
Storage temperature range	–25 °C		+70 °C max. 24 h
Humidity (taking operating temperature range into account)	IEC/EN 61496-1, Sections 5.1.2 and 5.4.2		
Air humidity (non-condensing)	***15 %***		***95 %***
Vibrations	IEC/EN 61496-1, Sections 5.1.2 and 5.4.4.1		
Frequency range	10 Hz		100 Hz
Tuning	1 octave/min		
Amplitude	0.35 mm or. 5 g		
Number of attempts	20 per axis, 3 axes without dwell time at resonant frequencies		
Shock resistance			
Individual shock	15 g, 11 ms according to EN 60068-2-27		
Repetitive shock	10 g, 16 ms according to IEC/EN 61496-1, Sections 5.1.2 and 5.4.4.2		

Tab. 27: V4000 PB general specifications (cont'd)

	Minimum	Typical	Maximum
Sender	Pulsed laser diode		
Wavelength		635 nm	
Divergence of collimated beam		0.1 mrad	
Pulse output power		5 mW	
Light exit surface		Ø 58 mm	
Light source	Laser diode		
Laser class	1M		
Type of cable to connect	with braided copper shield		
Surge impedance		100 Ω	
Cable cross-section	0.25 mm²		0.6 mm²
Housing			
Material	Aluminium		
Colour	RAL 1021 (rape yellow)		
V4000 PB dimensions (receiver/sender)[1)]			
Height			100 mm
Width			90 mm
Length			250 mm
Total weight for sender or receiver with alignment plate		2.6 kg	

Ambient conditions – explosion protection

No explosion protection is provided for the V4000 PB. The corresponding conditions do not usually occur with press brakes and the environment where they are used.

Extraneous light

The extraneous light requirements in IEC61496-2 Section 5.4.6 and also the corresponding function tests per IEC IEC61496-1 Section 5.2.3 apply to the V4000 PB.

1) Without cable threads projecting when system plug fitted.

General system data

Tab. 28: V4000 PB general system data

	Minimum	Typical	Maximum
Protective volume height	6 mm	26 mm	
Protective volume width	3,2 mm	40 mm	
Resolution	10 mm below		14 mm above
Lateral penetration depth required	5 mm[2)]		
Response time T_1			10 ms
Stopping distance S			11 mm
Distance between sender and receiver	0 m		7.5 m
Overall machine overrun of the press after OSSD opens (when v_{max} = 300 mm/s)			8 mm
Slow closing speed of the press (v_{slow}; v_{10})			10 mm/s
Maximum closing speed of the press (v_{max})			300 mm/s
Switch-on time		3 s	5 s

Electrical specifications

Tab. 29: V4000 PB electrical specifications

	Minimum	Typical	Maximum
Electrical connection	Plug-in adapter box with screw-terminal connections		
Screw terminal technical data			
Cross-section of flexible wire[3)]	0.14 mm²		1.0 mm²
American Wire Gauge (AWG)	26		16
Stripped length of wire		5 mm	
Screw tightening torque	0.22 Nm		0.25 Nm
Cable length with power supply tolerance of ±20%			
With cable cross-section 0.34 mm²			20 m
Cable length with power supply tolerance of ±10%			
With cable cross-section 0.34 mm²			25 m
Cable length with power supply tolerance of ±5%			
With cable cross-section 0.34 mm²			30 m

2) + 6.6 mm in box or back-stop mode with protective volume on operator side
3) Wire end ferrules are not required

Tab. 30: V4000 PB electrical specifications (cont'd)

	Minimum	Typical	Maximum
Supply voltage (SELV) The external voltage supply must be capable of buffering brief mains failures of 20 ms as specified in EN 60 204. Suitable power supplies are available as accessories from SICK (Siemens series 6 EP 1).	19.2 V	24 V	28.8 V
Permissible residual ripple			±5 %
Starting current[4)]			0.5 A
Operating current at 24 V without fan-out			0.2 A
Operating current with maximum fan-out			2 A
Power consumption without fan-out			5 W
Power consumption with maximum fan-out			45 W
Digital control inputs for input devices – Teach-in – Alignment – Protective volume mode selector switch – EDM			
Input resistance at HIGH		2 kΩ	
Voltage for HIGH	11 V	24 V	28.8 V
Voltage for LOW	–3 V	0 V	5 V
Input capacitance		100 nF	
Static input current	4 mA		15 mA
Digital control input pairs for input devices – Start / start (complementary) – Bypass / bypass (complementary)			
Input resistance at HIGH		2 kΩ	
Voltage for HIGH	11 V	24 V	28.8 V
Voltage for LOW	–3 V	0 V	5 V
Input capacitance		100 nF	
Static input current	4 mA		15 mA

4) Starting currents of the input capacitors are not taken into account.

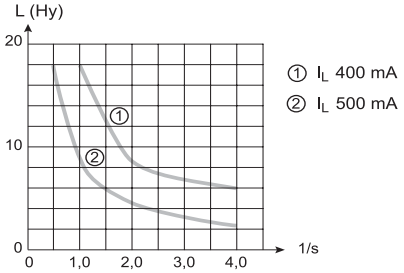
Tab. 31: V4000 PB electrical specifications (cont'd)

	Minimum	Typical	Maximum
OSSDs			
Switching output pairs	2 PNP semiconductors, short-circuit protected[5], cross-circuit monitored		
Switching voltage ON state at 500 mA	U_V – 2.7 V		U_V
Switching voltage OFF state	0 V	0 V	3.5 V
Source switching current	6 mA	0.2 A	0.5 A
Leakage current[6)]			250 µA
Load inductance[7)]			2.2 H
Load capacity			2.2 µF at 50 Ω
Switching sequence (without switchover)	Depends on load inductance		
Permissible line resistance[8)]			2.5 Ω
Test pulse width[9)]		150 µs	200 µs
Test frequency	80 ms	100 ms	120 ms
Minimum configurable switch-off time of the OSSDs	100 ms	100 ms	1000 ms
Skew with switching on OSSDs between OSSD2 and OSSD1		2 ms	10 ms
Signalling outputs for – Teach-in request – Request for target speed v_{slow}			
Switching voltage HIGH at 200 mA	U_V – 3.3 V		U_V
Source switching current			200 mA
Current limiting (after 5 ms at 25 °C)	400 mA		500 mA
ON delay		1.4 ms	2 ms
OFF delay		0.7 ms	2 ms

5) Applies to voltages in the range between U_V and 0 V.

6) In the event of a fault (interruption of the 0 V line), the leakage current flows maximally in the OSSD line. The downstream control element must identify this condition as LOW. An EPLC (error-proof programmable logic controller) must identify this condition.

7) The maximum rated load inductance is higher with lower switching sequence.



8) Make sure you limit the individual line core resistance to the downstream control element to this value to ensure that a short-circuit between the outputs is sure to be detected. (In addition, note EN 60 204-1)

9) When active, the outputs are tested cyclically (brief LOW). When selecting the downstream control elements, make sure that the test pulses do not result in deactivation.

Tab. 32: V4000 PB electrical specifications (cont'd)

	Minimum	Typical	Maximum
Configuration and diagnostics interface			
Interface type	RS232 (proprietary)		
Transfer speed	9600 baud 19200 baud 38400 baud 57600 baud		
Cable length at 9600 baud and 0.25 mm² cables			15 m
Galvanised decoupling	No		
Output TxD HIGH	5 V		15 V
Output TxD LOW	–15 V		–5 V
Voltage range RxD	–15 V		15 V
Operating point RxD LOW	–15 V		0.4 V
Operating point RxD HIGH	2.4 V		15 V
Short-circuit current at TxD	–60 mA		60 mA
Maximum voltage level at RxD	–15 V		15 V
Maximum voltage level at TxD	–11 V		11 V
Data interface			
Interface type	RS-422 (proprietary)		
Transfer speed (selectable)	9600 baud 19200 baud 38400 baud 57600 baud		
Cable length at 57.6 kbps and 0.25 mm² cables			15 m
Galvanised decoupling	Yes		
Differential output voltage at sender (between TxD+ and TxD–) with 50 Ω load	±2 V		±5 V
Differential input threshold at receiver (between RxD+ and RxD–)	±0.2 V		
Short-circuit current at TxD+, TxD–	–30 mA		–150 mA
Maximum voltage level at TxD+, TxD–	–7 V		+7 V
Maximum voltage level at RxD+, RxD–	–7 V		+7 V
Terminating resistor		100 Ω	
Type of cable to connect	Stranded in pairs with braided copper shield		
Surge impedance of the cable to be connected		100 Ω	
Cable cross-section of the cable to be connected	0.25 mm²		0.6 mm²

10.1.2 Technical data for PBI (press brake interface)

Tab. 33: PBI technical data

	Minimum	Typical	Maximum
Enclosure rating	IP20		
Supply voltage	19.2 V	24 V	28.8 V
Residual ripple			±5 %
Power consumption			7.5 W
Data interface – input			
Interface type	RS-422		
Galvanised decoupling	No		
Maximum voltage level	–7 V		+7 V
Input current			1 mA
Differential threshold voltage	–200 mV	–125 mV	–50 mV
Input voltage – hysteresis		25 mV	
Terminating resistor		100 Ω	
Pulse frequency			160 kHz
Number of pulses per mm			640
Data interface – output			
Interface type	RS-422		
Galvanised decoupling	No		
Maximum voltage level	–7 V		+7 V
Differential output voltage with 100 Ω load	2 V	3.1 V	
Short-circuit current	–30 mA		–150 mA
Type of cable to connect	Stranded in pairs with braided copper shield		
Surge impedance		100 Ω	
Cable cross-section	0.25 mm²		0.6 mm²
Dimensions			
Height			90 mm
Width			45 mm
Depth			130 mm
Total weight		0.1 kg	

10.1.3 Incremental encoder technical data

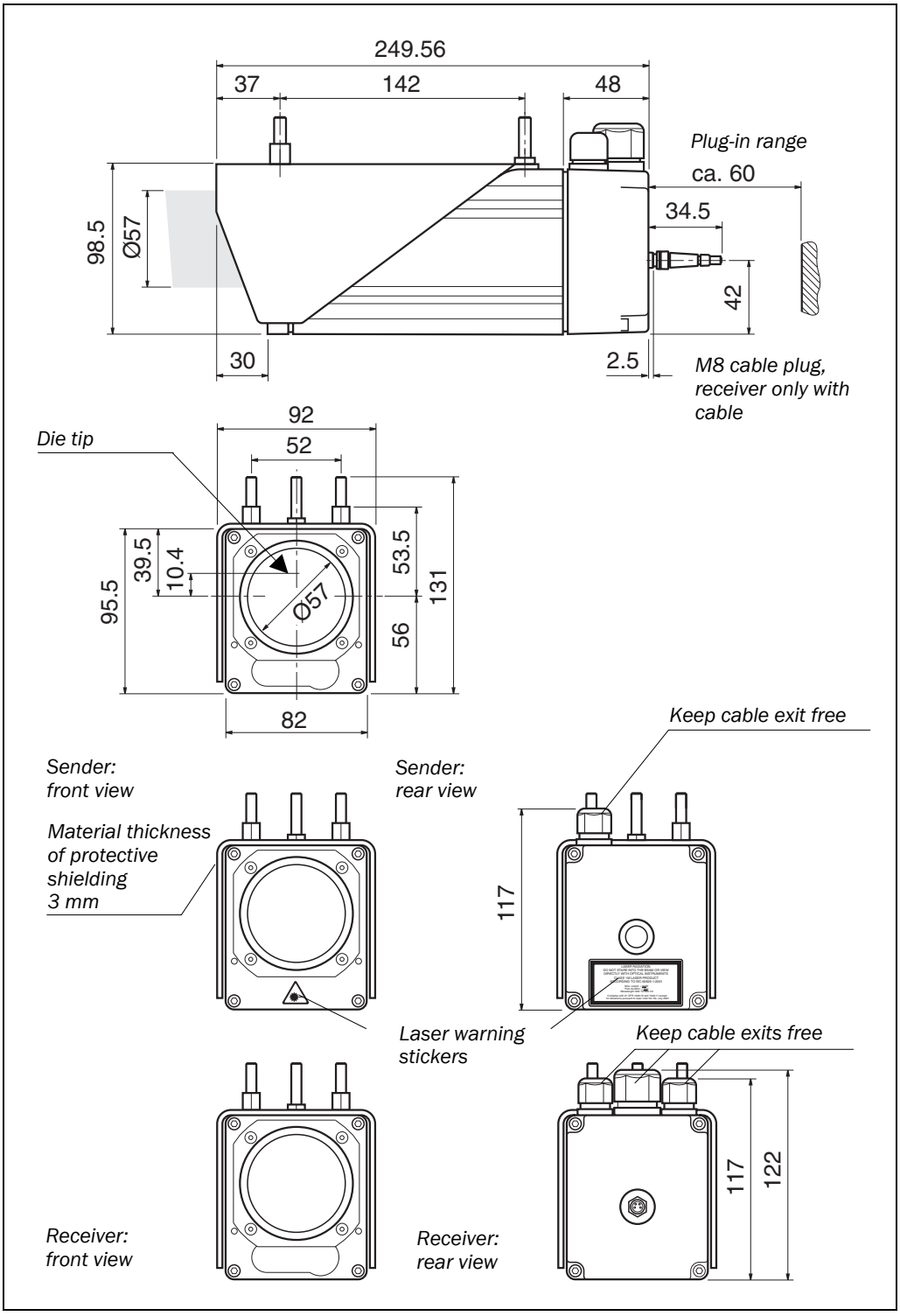
Tab. 34: Technical data of decodable incremental encoders

	Minimum	Typical	Maximum
Decodable incremental encoder	Two-channel encoder with 90° phase shift		
Incremental encoder outputs required	Digital (RS-422)		
Galvanised decoupling	No		
Maximum voltage level	–7 V		+7 V
Pulse frequency			75 kHz
Terminating resistor		100 Ω	
Increments per mm	45	50	300
Cable length (shielded)			10 m

10.2 Dimensional drawings

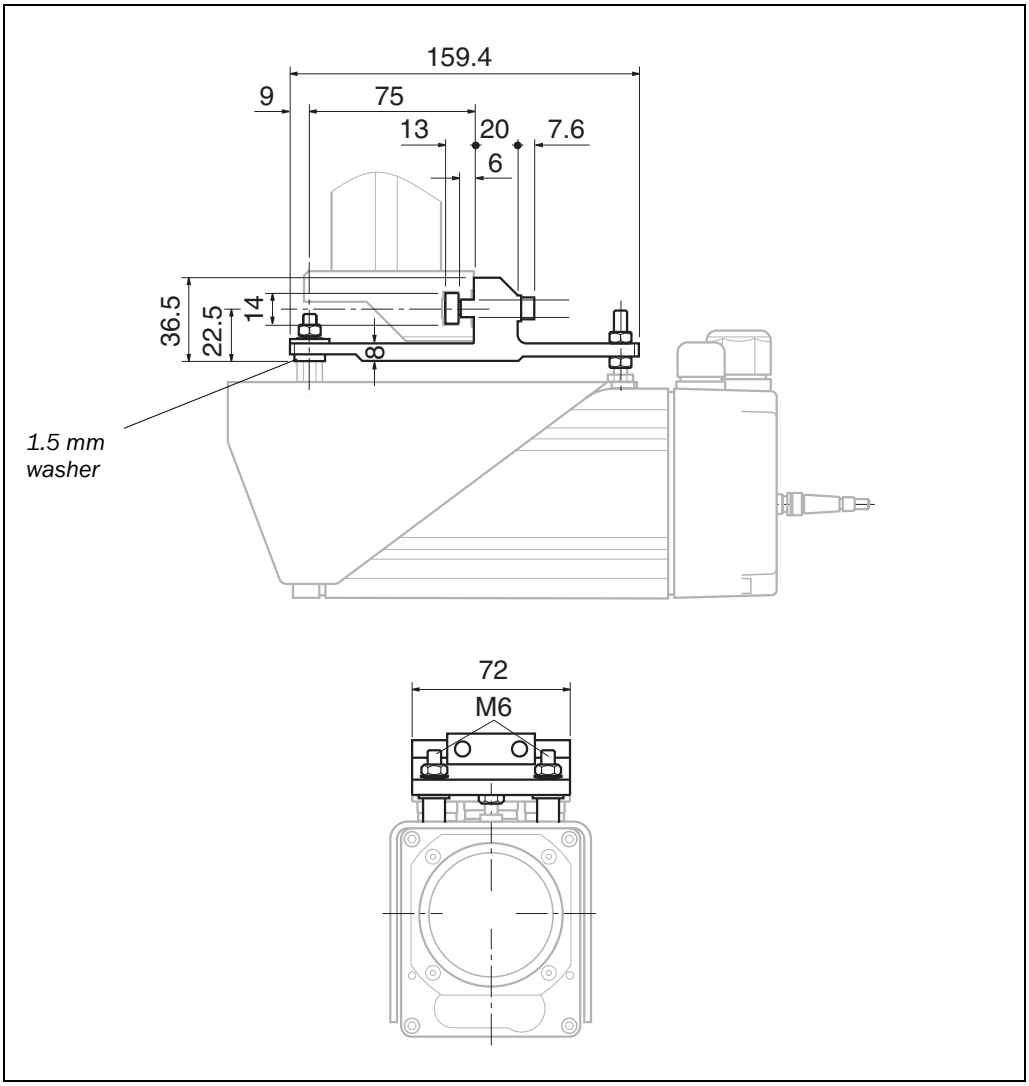
10.2.1 Sender and receiver

Fig. 49: Dimensional drawings: sender and receiver



10.2.2 SICK mounting kit 1

Fig. 50: Dimensional drawing: SICK mounting kit 1



11 Ordering information

11.1 Scope of delivery

- V4000 PB sender

or

- V4000 PB receiver
- Test piece
- Set of masks
- Operating instructions and CDS on CD
- Sticker: Information for **daily inspection**
- Magnetic plate for edge covering

11.2 Available systems

Tab. 35: System part numbers

Device type	Part	Part no.
V4000 PB	V4000 PB sender	1 025 765
	V4000 PB receiver	1 025 766

11.3 Accessories

Tab. 36: Accessories part numbers

Part	Description	Part no.
V4000 PB plug		
Set of spares: V4000 PB receiver plug x 2	16-pin	2 032 052
PBI (press brake interface)		
PBI (press brake interface)		1 026 798
PBI plug		
Set of spares: PBI plug x 2	16-pin, with extractor for PBI	2 032 051
Mounting kits		
Mounting kit 1: Alignment plate x 2		2 031 126
Mounting kit 2: Retaining arm x 2		2 031 745
RS232 service cables	Connecting cable. Connects V4000 PB and serial interface of the PC M8*4-pin / D-Sub / 9-pin (DIN 41642)	
Service cable, 2 m		6 021 195
Service cable, 8 m		2 027 649

Part	Description	Part no.
Connecting cables (shielded) for self-configuration	**Yard ware**	
4-pin, sender-receiver, usable as trailing cable, 0.34 mm^2		6 029 221
4-pin, receiver-PBI, 0.34 mm^2		6 029 222
18-pin, receiver-control cabinet, usable as trailing cable, 0.34 mm^2		6 029 223
24 V DC, 2.5 A power supply		6 010 361
Documentation		
CDS (Configuration & Diagnostic Software) on CD incl. on-line documentation and		2 032 314
Operating instructions in all available languages		8 010 501
Set of masks		
Receiver mask, sender mask, press crosshead masks		2 030 829
Miscellaneous		
Plastics cleaning agent	Plastics cleaning and care agent, antistatic, 1 litre	5 600 006
Lens cloth	Cloth for cleaning front lens	4 003 353
Test piece	Test piece for external device monitoring	4 040 724
Magnetic plate	Magnetic plate for covering female die opening beneath the workpiece	4 040 736

12 Glossary

Alignment mode Operating mode for aligning the protective volume, requested via the corresponding button.

This mode supports the operator in aligning the sender to the die and the receiver to the sender following a tooling change.

Blanking Local deactivation of parts of the protective volume (protective volume segment).

Braking distance Distance covered by the press brake braking down from the high closing speed to the target speed v_{slow} during a normal braking procedure.

Braking offset The braking offset is added to the braking distance calculated from the power-up cycle. The gap size when the target speed v_{slow} is reached is increased by the braking offset (see also Section 3.5.9).

Bypass In bypass mode the press brake can be operated without an activated V4000 PB protective device.

Bypass mode Operating mode of the V4000 PB.

Closing movement The die is lowered down the pressure axis onto the female die or onto the metal sheet lying on it.

Die Top tool or male tool of the press brake.

External device monitoring (EDM) Device which monitors the relays or contactors addressed by the protective device.

Female die Bottom forming tool of the press brake.

Hazard point The area beneath the die in which hazards or dangers could occur for the operator.

High closing speed v_P closing speed of the press ($v > 10$ mm/s).

Illumination field Illuminated area beneath the die which is demarcated by the optically clear area of the lens.

Image sensor Optical image sensor. Consists of a large number of light-sensitive image elements (pixels) arranged in a tightly-packed array on a silicon backing element.

Incremental encoder Sensor for position-sensing which supplies individual increments during a movement (rotation / offset).

Lock-out state With certain errors or an erroneous configuration, the system will go into the lock-out state.

Maximum closing speed The highest closing speed of the press brake which depends on the individual machine design.

Muting Bridging, time-limited suppression of the protection function of the V4000 PB.

Muting point Point on the pressure axis from which the protective function of the V4000 PB is bridged in order to finish the operating cycle without the protective device responding. The muting point is located at a gap size of ≤ 6 mm.

Operating cycle Movements of the press crosshead of the press brake from the starting position of the cycle (in most cases the top dead centre) to the bottom dead centre and back to the starting position of the cycle. The operating cycle includes all procedures or operations which are carried out during this movement.

Operating mode Protective operation, alignment mode, configuration, bypass mode.

Operating state In protective operation the following operating states are available: power-up cycle, teach-in, production mode.

OSSDs Output switching elements of the V4000 PB. These elements are electronically monitored.

Overall machine overrun Distance required, after the stop signal is issued, to stop the hazardous movement.

Overall response time Time between the stop signal (opening of the OSSDs) and when the press brake is at a standstill.

Pinch point Point on the pressure axis at which the die contacts the sheet metal before bending. Reference point of the V4000 PB for determining the muting point and switch-over point.

Power-up cycle Determining the overall machine overrun, the braking distance, complete run following commissioning or a restart of the V4000 PB. This could be, for example, after restoration of the power supply, or after a reset with teach-in.

Pressure axis Line along which the workpiece is formed between the male and female dies.

Programmed top dead centre The top dead centre in the operating cycle which is programmed in the press controller.

Programmed bottom dead centre The bottom dead centre in the operating cycle which is programmed in the press controller.

Protective volume The protective volume safeguards the hazardous area beneath the die. As soon as the V4000 PB detects an object in the protective volume, it switches the OSSDs into the OFF state and thus causes the closing movement to stop. The area within which the defined test piece is detected by the V4000 PB.

Protective volume mode In protective operation the following protective volume modes are available: standard mode, box mode, back-stop mode. In box and back-stop modes parts of the protective volume are blanked.

Protective volume segment Part of the protective volume.

Protective operation Operating mode of the V4000 PB.
The protective volume is active and there is monitoring for interruption. Position, direction of movement, speed and overall machine overrun are monitored and evaluated (see also Section 3.6).

Rear space The other side of the press brake opposite to the operator, behind the pressure axis.

Request signal for teach-in Digital output signal to the press controller.

Request signal for alignment mode Digital output signal to the press controller.

Request signal v_{slow} Digital output signal to the press controller.

Resolution The smallest size of object which can be detected by the protective device and which is guaranteed by the manufacturer.

Reset After the V4000 PB resets, there will be a full system start.

Response time The maximum time between the occurrence of an event which causes the V4000 PB to respond and the OSSDs reaching the OFF state.

Restart interlock Device which inhibits automatic starting of the machine. Switch-over point.

Slow closing speed v_{crawl} closing speed of the press ($v \leq 10$ mm/s).

Start signal for closing movement Gated signal from the press controller to the inputs of the V4000 PB and which is followed by a movement of the press crosshead.

Stopping distance The stopping distance is a system parameter from the V4000 PB and the press brake which is defined in the design of the V4000 PB. The stopping distance S describes the maximum path section which the press brake covers in the time between the sensor function responding and the press coming to a standstill

Switch-over point Switch-over point is the position on downward motion of the press when the speed begins to change from v_{max} to v_{slow}.

Target speed v_{slow} closing speed which the press must have reached following the braking procedure.

Teach-in Determining the pinch point on the surface of the workpiece.

Test piece Standardised test piece with rod and body sections and used for triggering the sensor function of the V4000 PB during the function check.

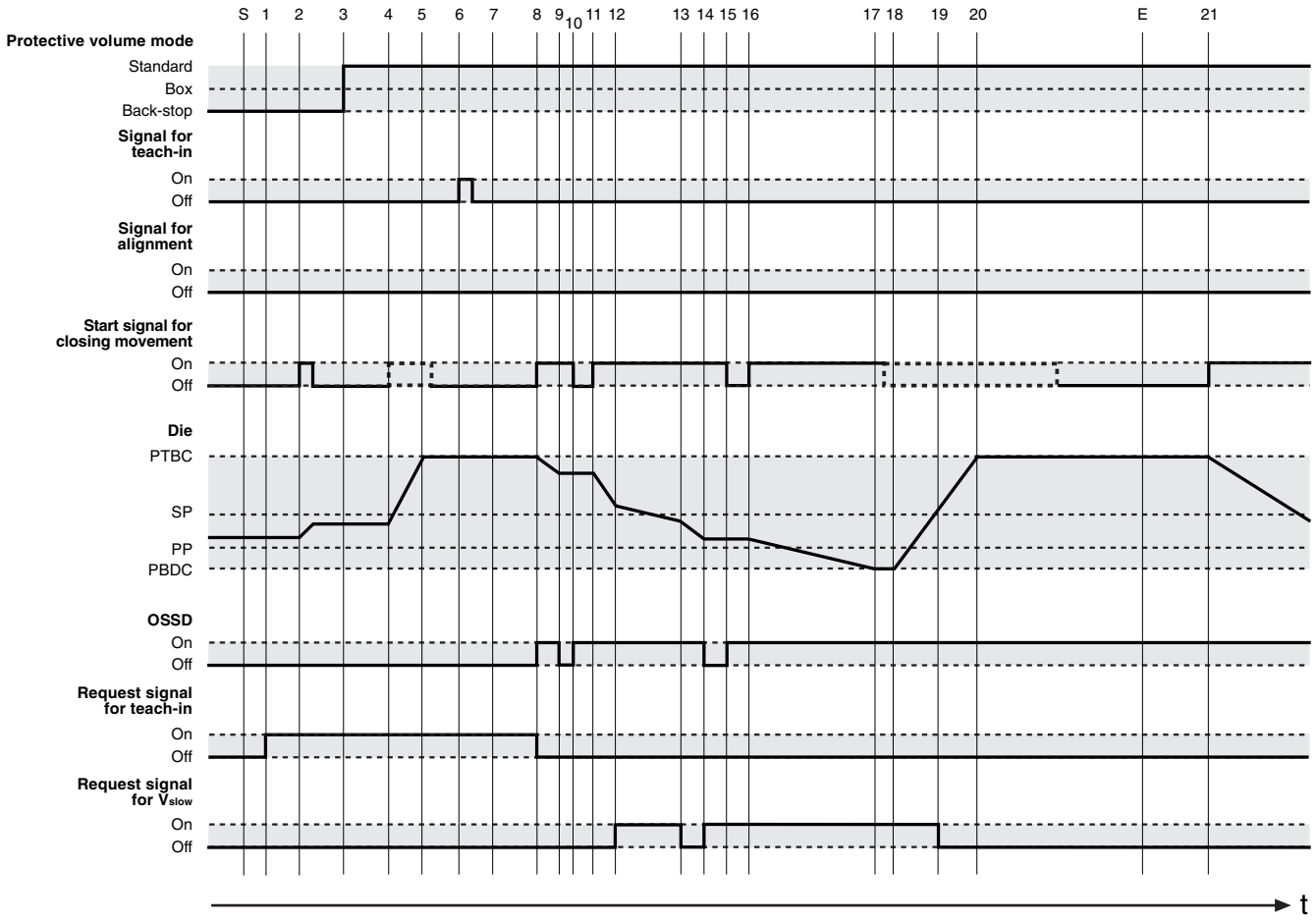
13 Annex

13.1 Detailed system sequences in protective operation

This section provides charts of the operating modes and changes over time in the machine movement, tool speed, states and signals.

Details of the individual signals may be found in the descriptions of the interfaces.

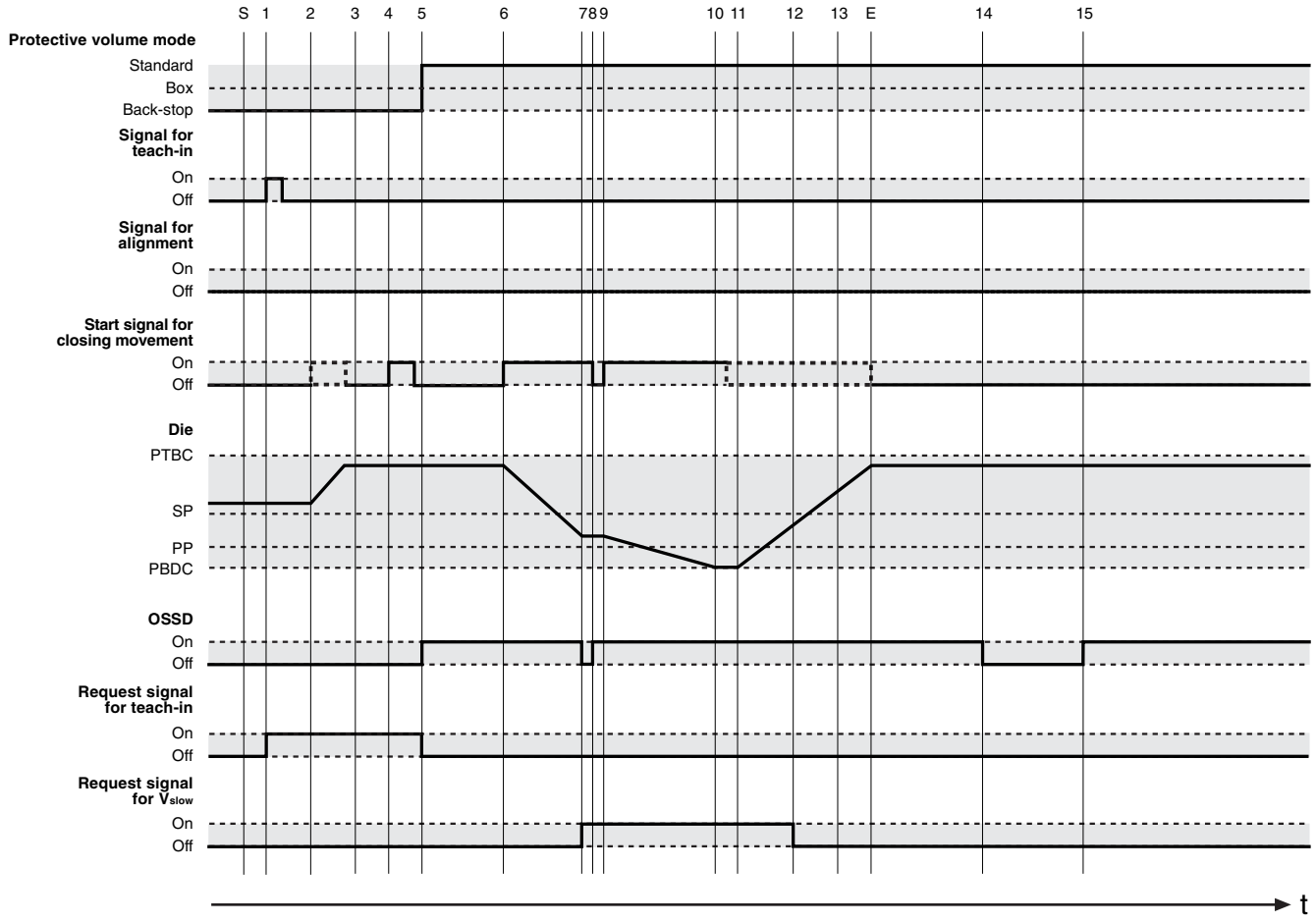
13.1.1 Power-up cycle



Tab. 37: Power-up cycle sequence

t	Description
S	The die is at any position in the operating cycle. The OSSDs are closed. The protective volume is active. Protective volume mode: standard
1	V4000 PB detects a time-out since the last power-up cycle.
2	The movement stops and the die stops and any position.
3	The operator gives the start signal for the fast closing movement. The start signal has no effect on the V4000 PB.
4	The press controller or if applicable the operator gives the start signal for opening the press.
5	The opening movement is finished.
6	If standard has been selected, the operator does not need to specifically select the protective volume mode.
7	The operator confirms the teach-in request.
8	The V4000 PB detects the end of the opening movement.
9	The operator gives the start signal for the fast closing movement.
10	The V4000 PB switches the OSSDs off. The fast closing movement is aborted. The overall machine overrun is checked.
11	The operator cancels the start signal for the fast closing movement.
12	The operator gives once more the start signal for the fast closing movement.
13	The V4000 PB requests the target speed.
14	The V4000 PB detects and accepts the target speed. The V4000 PB cancels the target speed request.
15	The closing movement is stopped above the pinch point and the overall machine overrun checked.
16	The operator cancels the start signal for the fast closing movement.
17	The operator gives once more the start signal for the closing movement.
18	The press finishes the closing movement.
19	The press controller or if applicable the operator gives the start signal for opening the press.
20	The protective volume is clear.
21	Upon failure to reach the switch-over point the V4000 PB cancels the request for slow speed.
22	The opening movement is finished.
E	End of the opening movement.

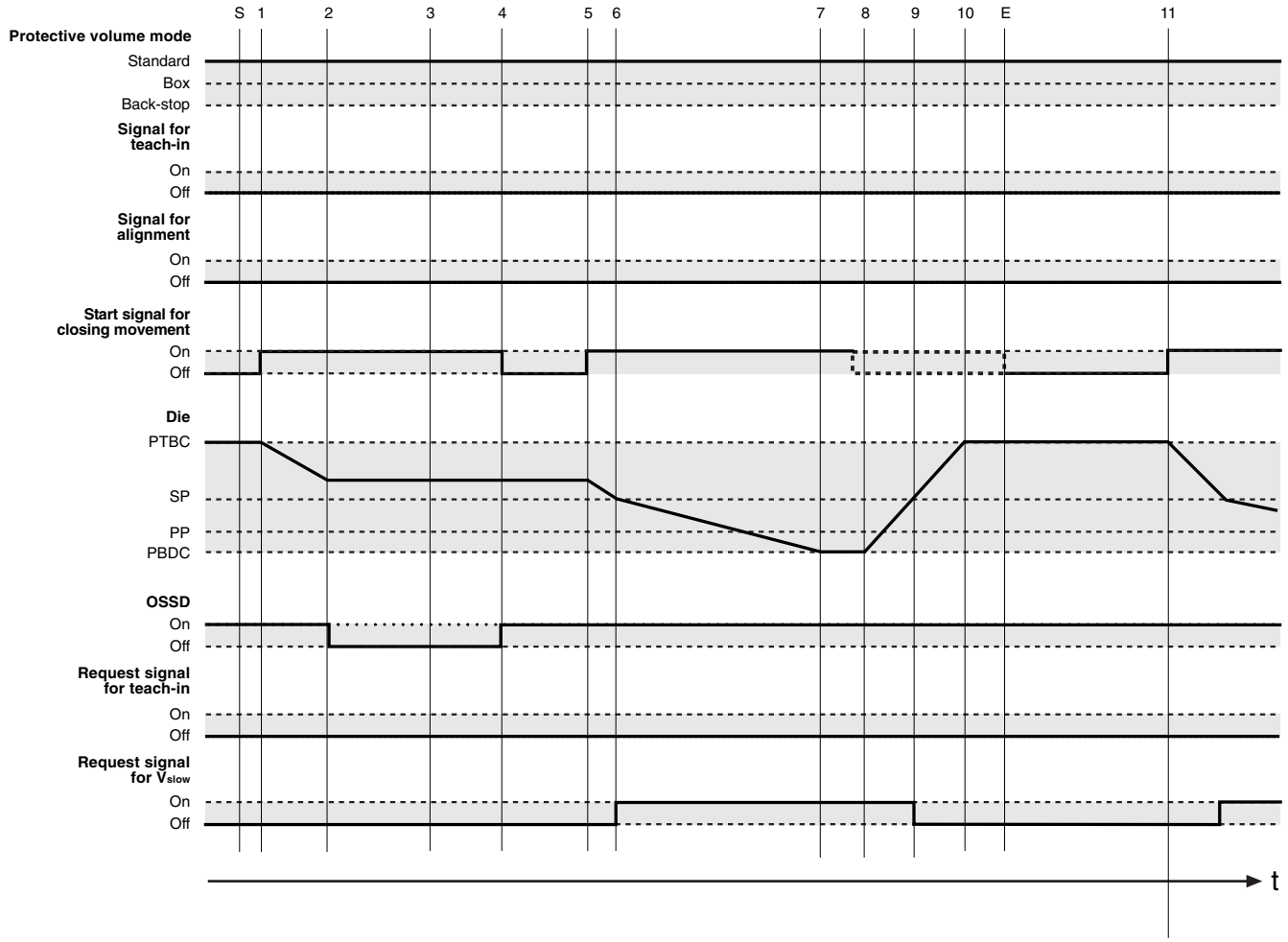
13.1.2 Teach-in



Tab. 38: Teach-in request sequence

t	Description
S	The die is at any position in the operating cycle. The OSSDs are closed or open. Protective volume mode: any.
1	The operator makes a teach-in request.
2	The press controller or if applicable the operator gives the start signal for opening the press.
3	The V4000 PB detects the end of the opening movement.
4	The operator gives the start signal for the fast closing movement. The start signal has no effect on the V4000 PB.
5	The operator selects the protective volume mode. If the following conditions are met, the OSSDs are switched on: • Die above the muting point • Standard selected as protective volume mode at least briefly • No start signal for the fast closing movement.
6	The operator gives the start signal for the fast closing movement.
7	The closing movement is stopped above the pinch point and the overall machine overrun checked.
8	The operator cancels the start signal.
9	The operator gives the start signal for the closing movement.
10	The press finishes the closing movement.
11	The press controller or if applicable the operator gives the start signal for opening the press.
12	Upon passing the switch-over point the V4000 PB cancels the request for slow speed.
13	The opening movement is finished.
E	Teach-in is completed.
14	Function test by interrupting the active protective volume.
15	Function test finished.

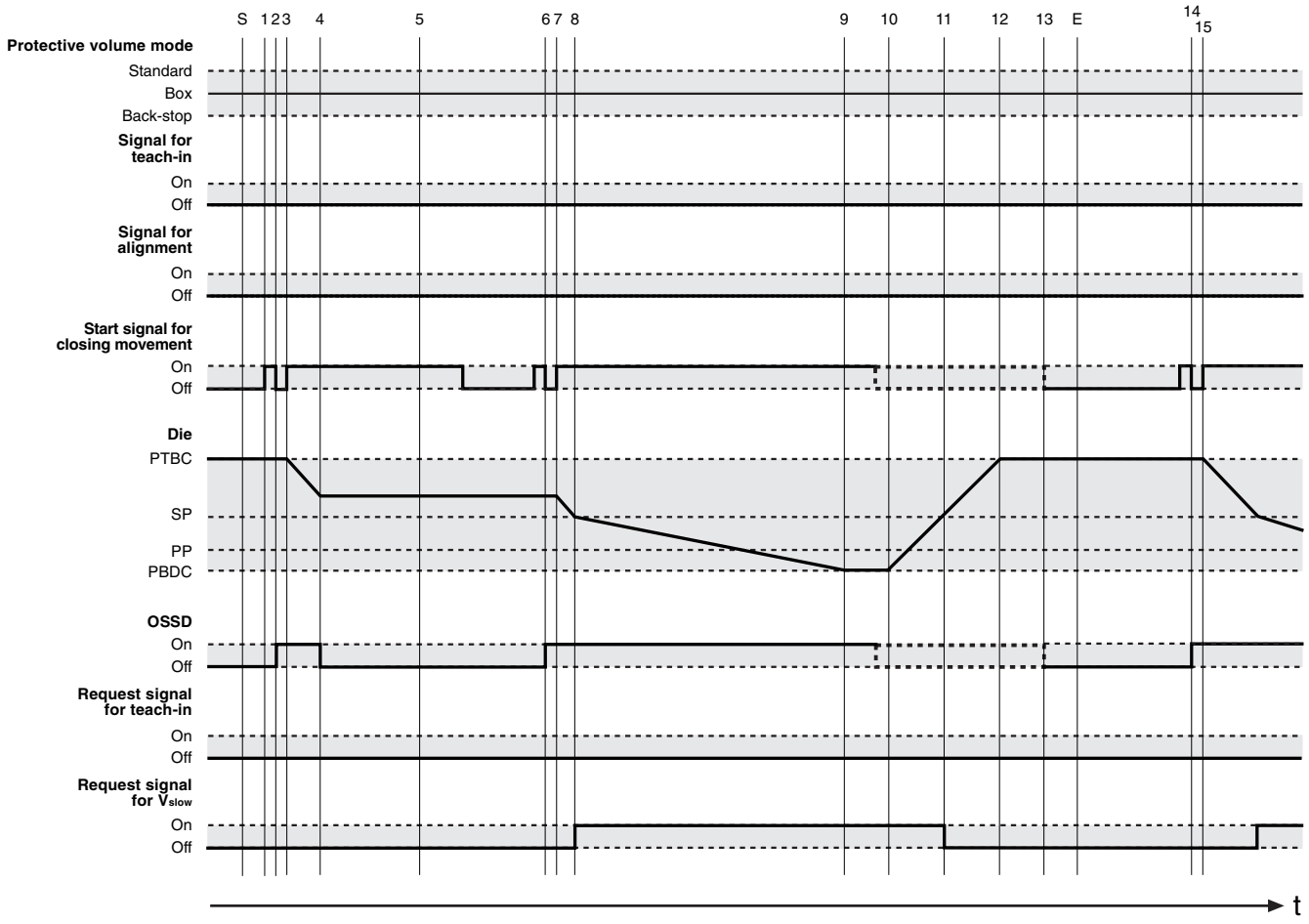
13.1.3 Standard mode



Tab. 39: Standard mode sequence

t	Description
S	The die is at the top dead centre. The OSSDs are closed. The protective volume is active. Protective volume mode: standard
1	The operator gives the start signal for the fast closing movement.
2	An object interrupts the protective volume.
3	The object is removed from the protective volume. The protective volume is clear again.
4	The operator cancels the start signal for the fast closing movement.
5	The operator gives once more the start signal for the fast closing movement.
6	The V4000 PB requests the target speed.
7	The press finishes the closing movement.
8	The press controller or if applicable the operator gives the start signal for opening the press.
9	Upon passing the switch-over point the V4000 PB cancels the request for slow speed.
10	The opening movement is finished.
E	The operating cycle is completed.
11	A new operating cycle is started.

13.1.4 Box or back-stop mode with interruption of the protective volume



Tab. 40: Box or back-stop mode sequence

t	Description
S	The die is at the top dead centre. The OSSDs are closed. The protective volume is active. Protective volume mode: box or back-stop
1	The operator confirms box or back-stop as the protective volume mode.
2	The operator cancels the protective volume mode confirmation.
3	The operator gives the start signal for the fast closing movement.
4	An object interrupts the protective volume.
5	The object is removed from the protective volume. The protective volume is clear again.
6	The operator cancels the start signal for the fast closing movement.
7	The operator gives once more the start signal for the fast closing movement.
8	The V4000 PB requests the target speed.
9	The press finishes the closing movement.
10	The press controller or if applicable the operator gives the start signal for opening the press.
11	Upon passing the switch-over point the V4000 PB cancels the request for slow speed.
12	The opening movement is finished.
13	Upon the start request disappearing the OSSDs are switched off.
E	The operating cycle is completed.
14	The operator cancels, if applicable, the start signal for opening the press.
15	A new operating cycle is started.

13.2 Declaration of Conformity

SICK

EC Declaration of conformity

en

Ident-No. : 9093200

The undersigned, representing the following manufacturer

SICK AG
Industrial Safety Systems
Sebastian-Kneipp-Straße 1
79183 Waldkirch
Germany

herewith declares that the product

V4000 press brake

is in conformity with the provisions of the following EC directive(s) (including all applicable amendments), and that the standards and/or technical specifications referenced overleaf have been applied.

Waldkirch, 21.10.09

ppa. Dr.Plasberg
(Manager Research and Development
Industrial Safety Systems)

i.V. Knobloch
(Manager Production
Industrial Safety Systems)

Further testing certificates on request.

SICK

EC Declaration of conformity

en

Ident-No. : 9093202

The undersigned, representing the following manufacturer

SICK AG
Industrial Safety Systems
Sebastian-Kneipp-Straße 1
79183 Waldkirch
Germany

herewith declares that the product

PBI

is in conformity with the provisions of the following EC directive(s) (including all applicable amendments), and that the standards and/or technical specifications referenced overleaf have been applied.

Waldkirch, 22.10.04

ppa. Dr.Plasberg
(Manager Research and Development
Industrial Safety Systems)

i.V. Knobloch
(Manager Production
Industrial Safety Systems)

Further testing certificates on request.

13.3 Manufacturer's checklist

SICK

Checklist for the manufacturer or installer
for the installation of electro-sensitive protective equipment (ESPE)

The specifications for the following items listed must be available at least for the initial commissioning but depending on the application, whose requirements the manufacturer or installer must check.

This checklist should be retained/stored with the machine documentation so that you can use it as a reference for periodical tests.

1.	Have the safety rules and regulations been observed in compliance with the directives/standards applicable to the machine?	Yes ☐	No ☐
2.	Are the applied directives and standards listed in the declaration of conformity?	Yes ☐	No ☐
3.	Does the protective device comply with the required control category?	Yes ☐	No ☐
4.	Have the ESPE devices been fastened in place properly and once aligned, secured against moving?	Yes ☐	No ☐
5.	Are the required protective measures against electric shock in effect (protection class)?	Yes ☐	No ☐
6.	Are the outputs of the ESPE (OSSDs) integrated in compliance with the required control category and does the integration correspond to the circuit diagrams?	Yes ☐	No ☐
7.	Has the protective function been checked in compliance with the test notes in this documentation?	Yes ☐	No ☐
8.	Are the given protective functions effective at every setting of the operating mode selector switch?	Yes ☐	No ☐
9.	Are the switching elements activated by the ESPE, e.g. contactors, valves monitored?	Yes ☐	No ☐
10.	Is the ESPE effective over the entire period of the dangerous state?	Yes ☐	No ☐
11.	Once initiated, will a dangerous state be stopped when switching the ESPE on or off and when changing the operating mode, or when switching to another protective device?	Yes ☐	No ☐
12.	Is the information label concerning daily inspections posted so that the operator can see it easily?	Yes ☐	No ☐
13.	Have you made sure that the protective device itself when mounted is not a source of danger during machine operation (for example, catching between the device and parts of the machine)?	Yes ☐	No ☐

This checklist does not replace initial commissioning and regular tests by specialist personnel.

13.4 List of tables

13.5 List of illustrations

13.6 Index

T

W

8010505/TL63/2009-11-27 · TL/FM · Printed in Germany (yyyy-mm) · Subject to change without notice · The specified product features and technical data do not represent any guarantee · A4 sw in134

Australia
Phone +61 3 9497 4100
1800 33 48 02 – tollfree
E-Mail sales@sick.com.au

Belgium/Luxembourg
Phone +32 (0)2 466 55 66
E-Mail info@sick.be

Brasil
Phone +55 11 3215-4900
E-Mail sac@sick.com.br

Ceská Republika
Phone +420 2 57 91 18 50
E-Mail sick@sick.cz

China
Phone +852-2763 6966
E-Mail ghk@sick.com.hk

Danmark
Phone +45 45 82 64 00
E-Mail sick@sick.dk

Deutschland
Phone +49 211 5301-301
E-Mail kundenservice@sick.de

España
Phone +34 93 480 31 00
E-Mail info@sick.es

France
Phone +33 1 64 62 35 00
E-Mail info@sick.fr

Great Britain
Phone +44 (0)1727 831121
E-Mail info@sick.co.uk

India
Phone +91–22–4033 8333
E-Mail info@sick-india.com

Israel
Phone +972-4-999-0590
E-Mail info@sick-sensors.com

Italia
Phone +39 02 27 43 41
E-Mail info@sick.it

Japan
Phone +81 (0)3 3358 1341
E-Mail support@sick.jp

Nederlands
Phone +31 (0)30 229 25 44
E-Mail info@sick.nl

Norge
Phone +47 67 81 50 00
E-Mail austefjord@sick.no

Österreich
Phone +43 (0)22 36 62 28 8-0
E-Mail office@sick.at

Polska
Phone +48 22 837 40 50
E-Mail info@sick.pl

Republic of Korea
Phone +82-2 786 6321/4
E-Mail kang@sickkorea.net

Republika Slovenija
Phone +386 (0)1-47 69 990
E-Mail office@sick.si

România
Phone +40 356 171 120
E-Mail office@sick.ro

Russia
Phone +7 495 775 05 34
E-Mail info@sick-automation.ru

Schweiz
Phone +41 41 619 29 39
E-Mail contact@sick.ch

Singapore
Phone +65 6744 3732
E-Mail admin@sicksgp.com.sg

Suomi
Phone +358-9-25 15 800
E-Mail sick@sick.fi

Sverige
Phone +46 10 110 10 00
E-Mail info@sick.se

Taiwan
Phone +886 2 2375-6288
E-Mail sales@sick.com.tw

Türkiye
Phone +90 216 587 74 00
E-Mail info@sick.com.tr

United Arab Emirates
Phone +971 4 8865 878
E-Mail info@sick.ae

USA/Canada/México
Phone +1(952) 941-6780
1 800-325-7425 – tollfree
E-Mail info@sickusa.com

More representatives and agencies
in all major industrial nations at
www.sick.com

SICK
Sensor Intelligence.