TECHNICAL DESCRIPTION

Laser Scanner Interface
LSI 101

SICK
optic
electronic

Reg. No. 19462-2

Table of Contents

This technical description contains all the information necessary for project planning setting up the LSI. You will find in it the information you need for mechanical mounting, electrical installation and programming of the LSI.

The description covers the following LSI types:
– LSI 101-11X (certified for personal protection to IEC/EN 61496-1)
  The last digit of the type designation (X: 2 to 4) corresponds to the maximum number of sensors allowed

Also refer to the technical description of the PLS laser scanner, which contains additional essential information on planning and installing the LSI system

Along with this technical description you are also provided with an instruction manual, containing important information for day-to-day use of the LSI.

Keep the technical description and the instruction manual readily to hand at all times.

Essential sections you should read:

Conditions of Use: ... Section 2

Supply package,
Mounting and connecting up the LSI: ... Sections 6 to 8

Entry into the user software ... Sections 9.1 to 9.3

1 Approvals and Certificates

EC Declaration of Conformity

Under the terms of EC Machine Directive 89/392/EEC, Appendix II C

We hereby declare that the devices (see page 2)

of the product family PLS101-312 / 316 with LSI101

are safety components for a machine constructed as per the EC directive 89/392/EEC art. 1 para. 2. This declaration will lose its validity if any modification to a device used in the plant is made without prior consultation.

We employ a quality system certified by the DQS (German Quality Assurance Society), No. 19 462-01, as per ISO 9001 and have therefore observed the regulations in accordance with module H as well as the following EC directives and EN standards during development and production:

1. ***EC directives***	EC machine directive 89/392/EEC, as per 91/368/EEC,93/68/EEC,93/44/EEC EC EMC directive 89/336/EEC as per 92/31/EEC, 93/68/EEC, 93/465/EEC		
2. ***Harmonized standards and preliminary standards used***	DIN EN 954-1	Safety-related components of controllers	Ed. 97-03
	EN 50082-2	Immunity, indust.	Ed. 96-02
	EN 50081-2	Emitted interference, indust.	Ed. 94-03
	IEC 61496-1	Safety of mach., active opto-electronic protective devices (AOPD)	Ed. 98-06
	DIN V VDE 0801	Basic principles for computers in systems with	Ed. 90-01
	DIN V VDE 0801/A1	safety functions	Ed. 94-10
	DIN 40839 T1	Electromagnetic compatibility in road vehicles	Ed. 92-10
	DIN 40839 T3 (Entw.)	Electromagnetic compatibility in road vehicles	Ed. 91-12
3. ***Test result***	IEC 61496-1	BWS type 3 (BWS-E)	

Conformance of a type sample belonging to the above-mentioned product family with the regulations from the EC machine directive has been certified by:

Address of notified authority (Germany)	Berufsgenossenschaftliches Institut für Arbeitssicherheit (BIA) Alte Heerstr. 111 D-53757 Sankt Augustin
EC type sample test No.	981092 dated 1998-07-02

The CE mark was affixed to the appliance in conformance with directive 89/336/EEC.

Waldkirch/Br., 1998-07-06

ppa. Windau
(Head of Sales & Marketing Division Safety Systems)

ppa. Dr. Bauer
(Head of Development)

The declaration certifies conformance with the listed directives, but does not guarantee product characteristics. The safety instructions contained in the product documentation must be observed.

Mat. No.: 9 051 802
Page 3, engl.
Update no.: see page 2

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2 Conditions of Use

The LSI is a device designed to protect people and property. It is intended to monitor hazardous areas in enclosed spaces in conjunction with one or more PLS laser scanners.
Observe the instructions relating to permitted use. SICK cannot be held liable for damage arising from use of the LSI other than stipulated.

- Be sure to follow the instructions given in the technical description of the PLS laser scanner! It contains important information on safe operation of the LSI system.
- Install the LSI in a dry location and protect the unit against dirt and damage (IP 54 switch cabinet).
- Route all wires and connecting cables such that they are protected against damage.
- Ensure that the connected controller and all other devices also have the necessary safety integrity. Make sure that the controller guarantees prompt switching between the monitoring cases. Note that there may already be someone in the protective field when the switch occurs. Safe protection is guaranteed only by prompt switching (that is, before the danger arises for the person at this point).
- Make sure that the input circuitry matches the expected ambient conditions, in order to prevent interference and resulting errors in monitoring case switching.
- Make sure that the response time of the LSI system is adequate in every monitoring case to protect the hazardous area (the response time of the LSI depends on the multiple evaluation, and is pre-set in the PLS/LSI user software).
- Make sure that no obstacles in the monitoring area can obstruct the fields of vision of the connected PLS units or cause shadows.
  Where there are unavoidable areas of shadow, check whether they present any risk. Take precautions as necessary.
- Keep the monitoring area free of smoke, fog, steam and other air pollution. The functioning of the LSI system may otherwise be impaired, and error shutdowns may occur.
- In mounting, installation and use of the LSI, observe the standards and regulations applicable in your country. The appendix presents a summary of the most important regulations.
- For programming of the monitoring areas and monitoring cases, take note of the description of the PLS/LSI user software in section 9. This describes how to connect the LSI to a PC and how to work with the user software.
- If you deploy the LSI for vehicle protection, note that it can only be used on vehicles with an electric motor.
  When using the LSI on materials handling equipment in narrow aisles be sure to follow the instructions given in the technical description of the relevant PLS.
  If using the LSI with PLS type 101-316, note that the response time of the LSI is not programmable, but is fixed at 270 ms.
- The LSI must be disposed of in a proper and environmentally friendly manner at the end of its useful service life.

3 How the LSI Works

Principle of Operation

The SICK LSI (Laser Scanner Interface) is an electronic component with which you can interconnect one or more PLS laser scanners to form one system and control them flexibly according to the specific application. The LSI system is thus able to monitor complex hazardous areas on a machine or vehicle.

Sensors, monitoring areas and monitoring cases

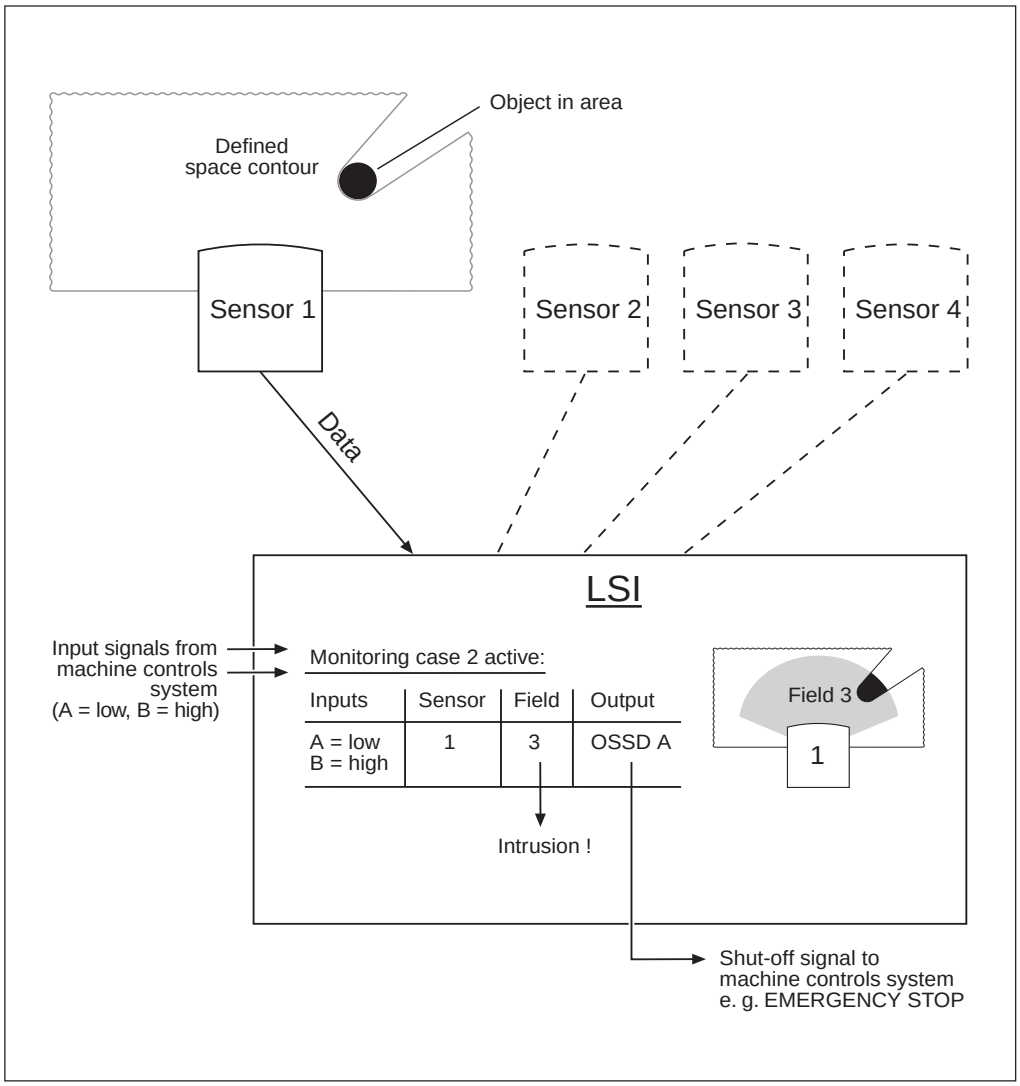
The LSI receives from the machine controls system certain input signals, e.g. input A = low, input B = high. These signals activate in the LSI one of the monitoring cases you configure using the PLS/LSI user software.

The definition of each individual monitoring case stipulates which monitoring area (consisting of a protective field and warning field) is to be monitored on which of the connected sensors.

The active sensor, e.g. sensor 1, transmits the space contour it "sees" to the LSI. The LSI compares the data received from the sensor with the contour of the defined monitoring area.

As soon as the LSI detects an object in the monitoring area, it switches off the output configured for that case. In the example, there is an object in protective field 3 and the LSI shuts off the defined output OSSD A. This output signal is transmitted to the machine controls system where it triggers a response, e. g. EMERGENCY STOP.

Based on the monitoring cases, the LSI system can react flexibly to various input signals and view various monitoring areas on the sensors, according to application requirements. Up to two sensors can be active at any one time under the same input conditions (simultaneous monitoring cases).



Evaluation of a monitoring case in the LSI (simplified block diagram)

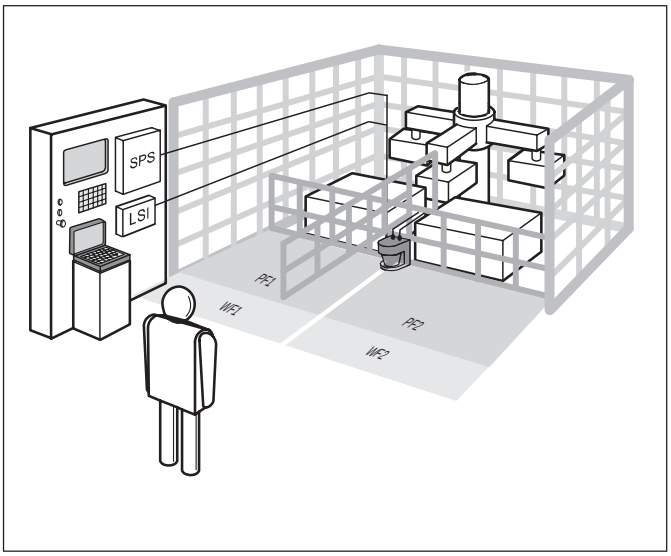
4 Fields of Application - What the LSI Can Do

These pages provide an overview of the key fields of application of the LSI.

Area protection

On hazardous stationary machinery the LSI, in conjunction with one or more PLS units, ensures that the machine (or its hazardous movement) is shut down as soon as someone enters the hazardous area. This is done by means of flexibly programmable monitoring areas, each comprising a protective field and a warning field, which are assigned to the connected sensors for monitoring purposes. In the same way the LSI can protect the interiors of large machines.

You can define various monitoring cases to match the active protective fields to the situation on the machine and to monitor different hazardous areas depending on the applicatio, such as in different production phases.



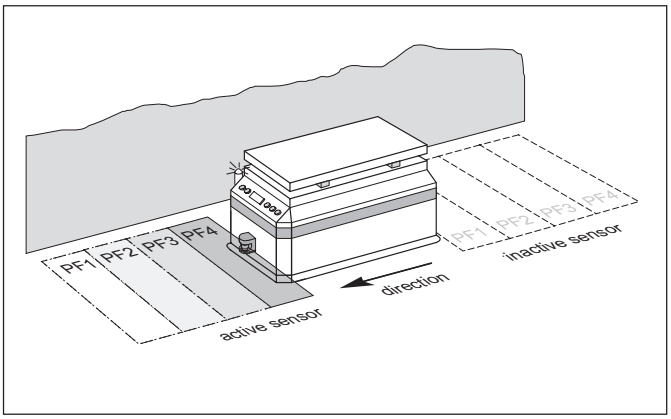
Machining center with changing load positions

Vehicle protection

You can deploy the LSI on vehicles, such as driverless transport systems (DTS), forklifts and shunting cars, to safeguard a vehicle's path - on its way through a production hall for example. The LSI with its connected sensors ensures that the vehicle decelerates and stops if a person or obstacle is standing in the way. You can protect both manually controlled vehicles and driverless transport systems (DTS).

Several monitoring cases - defined by you - provide diverse monitoring of various hazardous areas, such as when the vehicle is moving forward and when reversing.

You can also record the speed of the vehicle by means of incremental encoder, and so adapt monitoring areas of differing sizes dynamically to the vehicle speed.



Driverless transport system with direction detector and speed-sensitive protective field switchover

5 LSI System Planning

5.1 General planning information

Sensors:

You can connect up to four sensors to the LSI. All connected sensors must be of the same type (e.g. four PLS 101-312).

These are currently types PLS 1XX-3XX, or any type for which this is expressly permitted in the technical description.

Monitoring areas:

You can define up to eight monitoring areas. Each monitoring area consists of a protective field and a warning field.

To define the size of the monitoring area, follow the instructions given in the technical description of the PLS. It gives dimensioned examples for static and dynamic applications.

For the PLS system with LSI, the minimum response time is 190 ms (except if you combine the LSI with PLS type 101-316 for vehicle protection, in which case note that the response time of the LSI is not programmable, but is fixed at 270 ms).

Monitoring cases:

To view the monitoring areas on the connected sensors, you can set up to 15 monitoring cases.
At each time point a maximum of two monitoring cases may be active at any one time (simultaneous monitoring cases).

Safety and signaling outputs:

The LSI has two independent safety output pairs OSSD (output load per OSSD channel max. 250 mA ≤ 100 nF; restart effective from 0.2 to 5 seconds).
If necessary, you can perform contactor monitoring on any of the safety outputs (EDM, permitted tolerance max. 200 ms).

The warning field and signalling output load is 100 mA.

Inputs:

The LSI has the following inputs:
- Four binary inputs (A to D) with a maximum of 80 ms time difference (antivalent)
- Two incremental encoder inputs (inputs C and D)
- Two restart inputs
- Two EDM inputs (contactor monitoring)

5.2 Mobile protection: For on-board vehicle use

With the aid of incremental sensors, you can adapt the size of the monitored area to the speed of the vehicle.

Note:
The two incremental encoders must be mounted such that one continues to work safely and fault-free in the event of failure of the other. In this, failure of the incremental encoders must be prevented by design, mechanical and electrical means.
Also make sure that the systematic influences (such as temperature, shaft breakage, slip) are not able to influence the speed recording of both incremental encoders at the same time.

The incremental encoders must meet the following requirements:
– Type: two-channel rotary encoder with 90° phase offset
– Supply voltage: 24 V DC
– Outputs: push/pull
– Protection IP54 or higher
– Shielded cable
– Max. pulse frequency: 100 kHz

Determine the number of pulses each incremental encoder delivers per centimetre covered by your vehicle, running in a straight line. You will need these figures to configure using the PLS/LSI user software (see section 9.7 and the calculation example in the appendix, section 11.1).

Calculating the protective field depth on the vehicle:

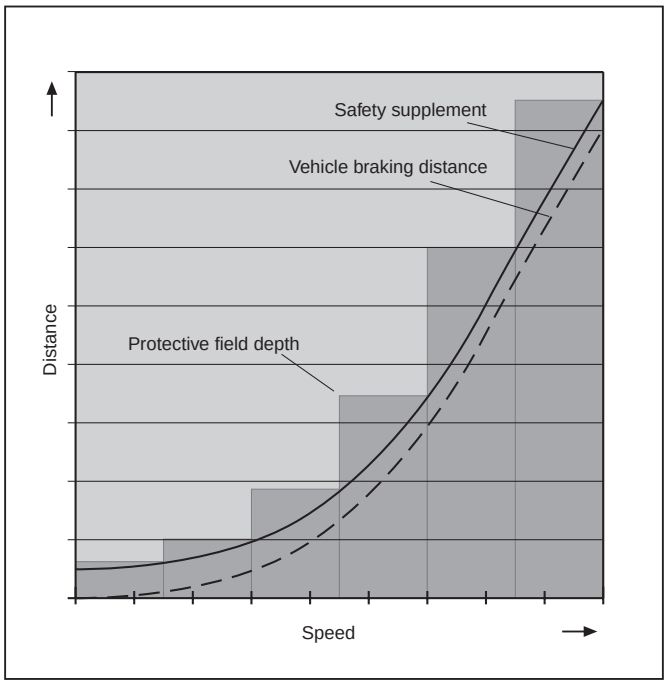
When calculating the required protective field depth on a vehicle you must take into account that the braking distance increase is not linear, but quadratic, as the speed increases (see diagram).

Note:
For precise information on the required protective field depth and on the necessary safety supplements refer to the technical description of the PLS.

- Define the required speed range for your application.
- Calculate the longest braking distance for each speed range (i.e. the braking distance for the upper speed limit).
- Add to that distance the necessary safety supplements (see technical description of PLS).

This will give you the required protective field depth for each speed range.

- Configure the protective fields using the PLS/LSI user software, as described in section 9.7.



The braking distance of the vehicle plus the safety supplement produces the required protective field depth

6 Supply Package

You receive:
- the LSI
- a connection set as per order (see below)
  (e.g. connection set A: one PLS supply plug, one PLS interface plug, one screw-in interface connector for connection of the PLS to the LSI)
- a top-hat rail fixture (mounted)
- 2 brackets for wall mounting
- instruction manual
- technical description

Note:
The LSI is not supplied with user software.
The PLS/LSI user software as from version 03.20 is used to program a single PLS or a LSI system. It is supplied with the PLS (on a 3.5” floppy disk).

Available connection sets:

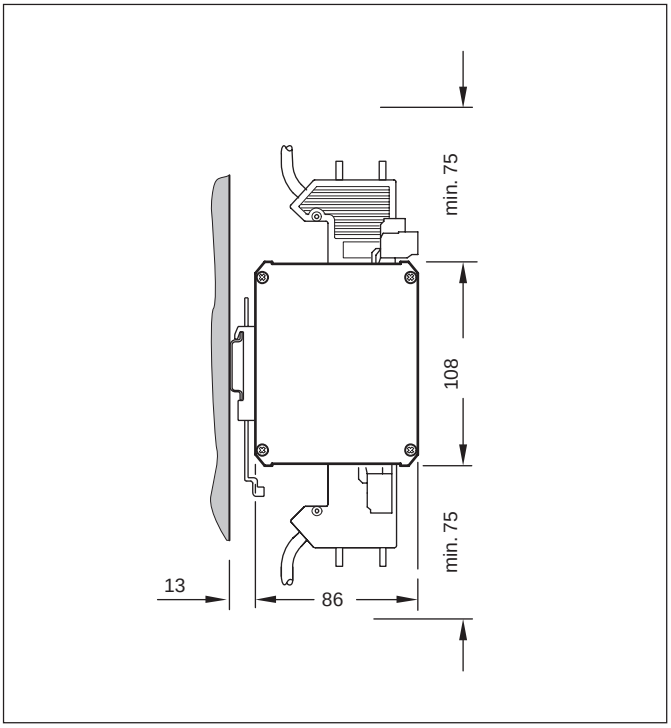
Connection set A 1 PLS supply plug 1 PLS interface plug 1 screw-in interface connector for sensor connection to LSI excluding cable	2 019 065
Connection set B As connection set A, with 3 m cable	2 019 066
Connection set C As connection set A, with 5 m cable	2 019 067
Connection set D As connection set A, with 10 m cable	2 019 068
Connection set E As connection set A, with 15 m cable	2 019 069
Connection set F As connection set A, with 20 m cable	2 019 070

7 Mounting the LSI

The LSI is shipped fitted with a top-hat rail fixture. A wall mounting bracket is also supplied.
If you secure the LSI by the wall bracket, vibration problems can be avoided.

Mounting the LSI on a top-hat rail:

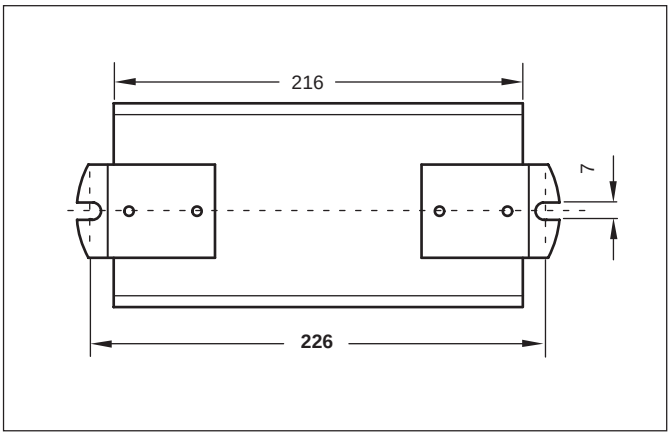
- Mount the LSI as shown in the diagram, with a TS 35 top-hat rail.



Mounting the LSI with a top-hat rail (All dimensions in mm)

Mounting the LSI on a wall:

- Unscrew the top-hat rail fixture.
- Attach the supplied wall bracket to the LSI as shown in the diagram.
- Mount the LSI on the wall using M6 screws.



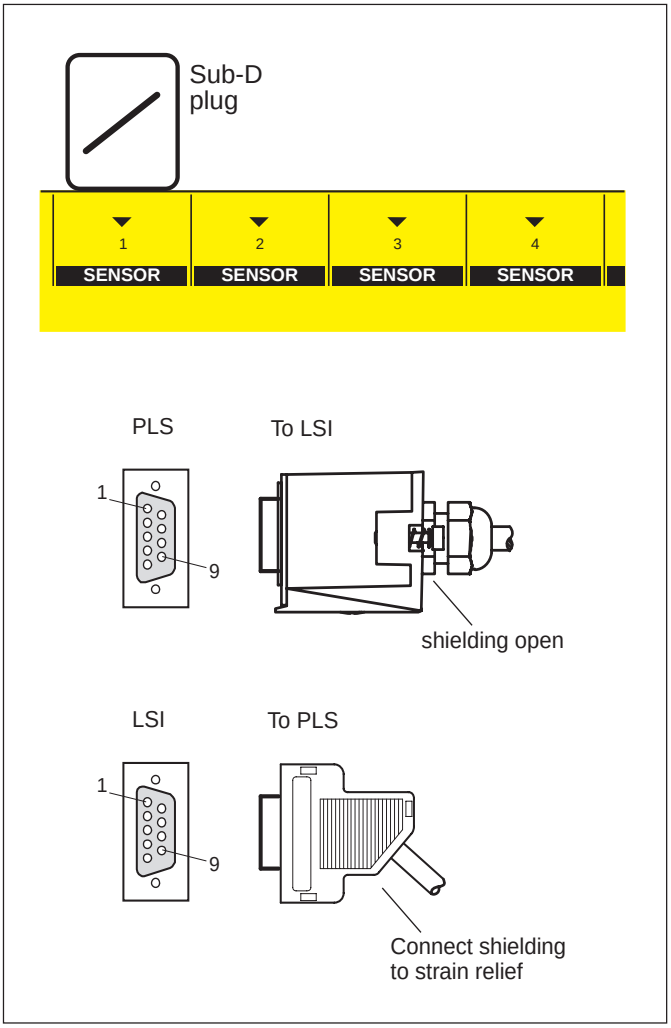
Mounting the LSI on a wall (all dimensions in mm)

8 Connecting Up the LSI

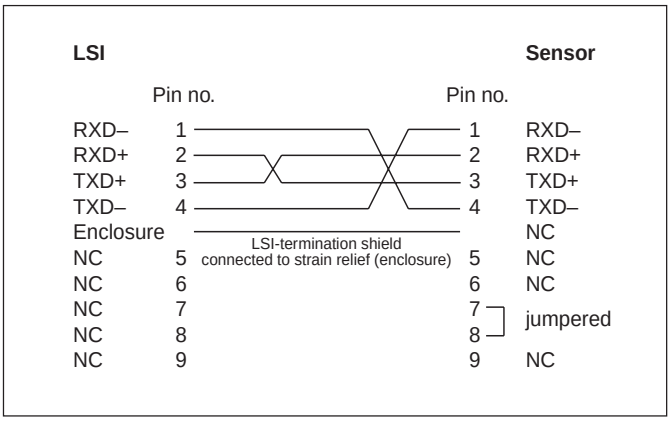
8.1 Wiring up the LSI and PLS

Notes:
Also refer to the connection diagram in the appendix. For the requirements to be met by the cables used, refer to section 4.3 of the instruction manual, under ”Cable requirements”.

- Connect the LSI ”Power Out +” and ”Power Out -” terminals to the power terminals on the PLS.
  Use 4-pin socket connector strips.
- Connect the LSI communication terminals (e.g. ”Sensor 1”) to the PLS interface.
- Connect the LSI-termination shielding to the strain relief. The PLS-termination shielding is not contacted. Follow the pin assignment.



Connecting PLS to LSI



Pin assignment of the interface connector in RS422 mode

8.2 Connecting the LSI to the controller and power

Notes:
Lay all wires and connecting cables such that they are protected against damage.

If you are using the PLS to protect hazardous areas: make sure that the connected controller and all other devices also have the necessary safety integrity.

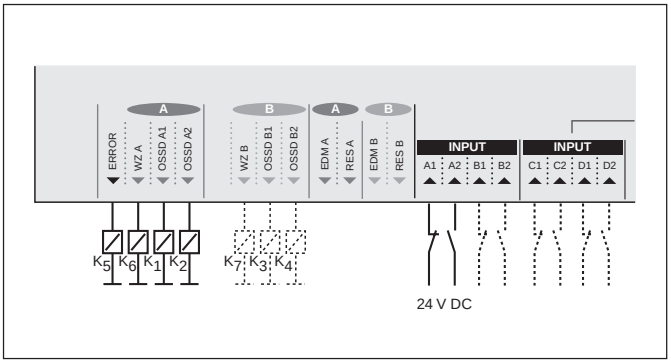
Perform a function check of the connected input controller if you have not executed a monitoring case switchover for a lengthy period of time. For this check you have the following options:
– Specific intrusion in the active protective field after monitoring case switchover
(look out also for simultaneous monitoring cases!)
– Monitoring by means of the I/O monitor (see section 9.10).

Also refer to the connection diagram in the appendix.

Label the connectors to avoid incorrect connection.

Connecting LSI inputs:

- Connect the inputs (A, B, C, D) of the LSI to the controller, as shown in the connection sketch. Use 4-pin socket connector strips (the WAGO connector supplied is an aid to wiring).
Notes:
Each input requires two signals, which must always be inverse to each other (maximum permissible tolerance: 80 ms).
If using incremental encoders, inputs C and D are occupied and unavailable for use.



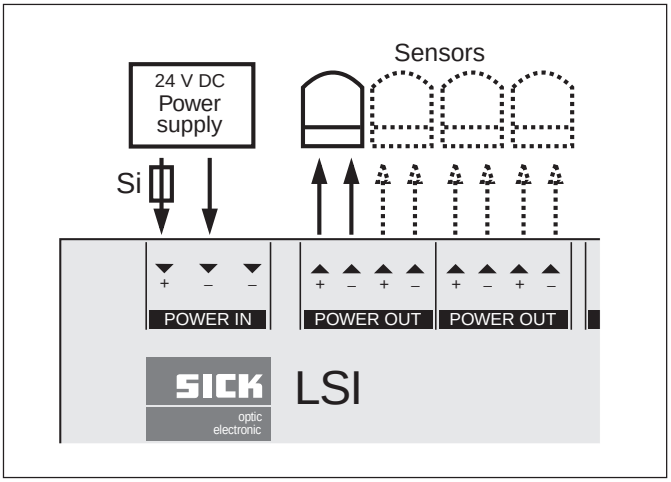
Connecting LSI inputs and outputs

Connecting LSI outputs:

- Connect the outputs to the controller, as shown in the connection sketch.
Use 4-pin socket connector strips.
Notes:
Note that in safety-related controllers for K1 to K4 you must use relays or (auxiliary) contactors with positively-driven contacts, taking account of appropriate protective measures (circuitry).

Connecting LSI to power supply:

- Connect the LSI supply via a suitably rated fuse to the power supply, e.g. a 24 V DC power supply unit (transformer, regulated with safe isolation to EN 60742, see technical data in appendix).
  Use 3-pin socket connector strips.

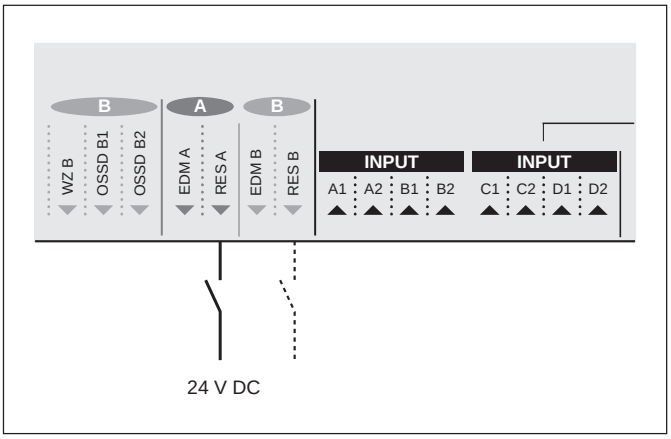


Connecting LSI to power supply

Connecting restart buttons as required:

- Connect the restart buttons (normally open) to inputs "RES A" and "RES B".
  Use 4-pin socket connector strips.

Notes:
Outside the switch cabinet "Restart A" and "Restart B" must be routed in separate cables.
When fitting the restart button, note that the button must be mounted such that, when the button is pressed, the hazardous area is fully visible.

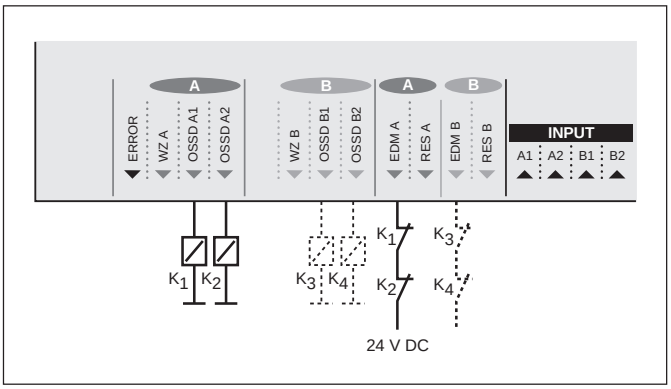


Connecting restart buttons

Connecting a contactor monitor as required:

- Connect the break contacts of the contactors to inputs "EDM A" and "EDM B", as shown in the diagram (K1 to K4 are contacts of the elements directly controlling hazardous movement).
  Use 4-pin socket connector strips.

Note:
Contactor monitoring is activated 200 ms after a switchover. In the static state the outputs are tested cyclically every 5 seconds.



Connecting a contactor monitor

Connecting incremental encoders as required:

- Connect two incremental encoders to inputs ”Speed Input C” and ”Speed Input D”.
  Use 9-pin metallized sub-D plugs.

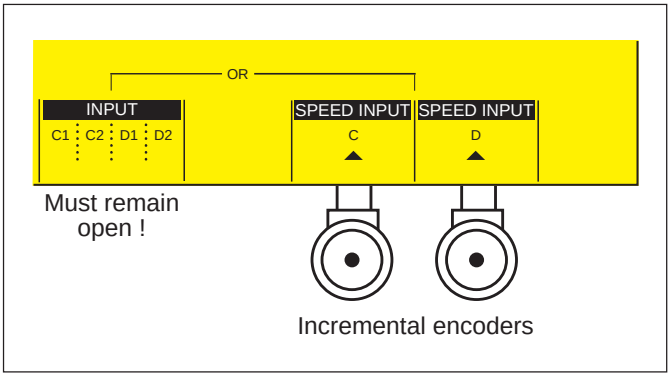
Notes:
If using incremental encoders, inputs C and D are occupied and unavailable for you to use.

The incremental encoders must meet the following requirements:
– Type: two-channel rotary encoder with 90° phase offset
– Supply voltage: 24 V DC
– Outputs: push/pull
– Protection IP54
– Shielded cables
– Max. pulse frequency 100 kHz

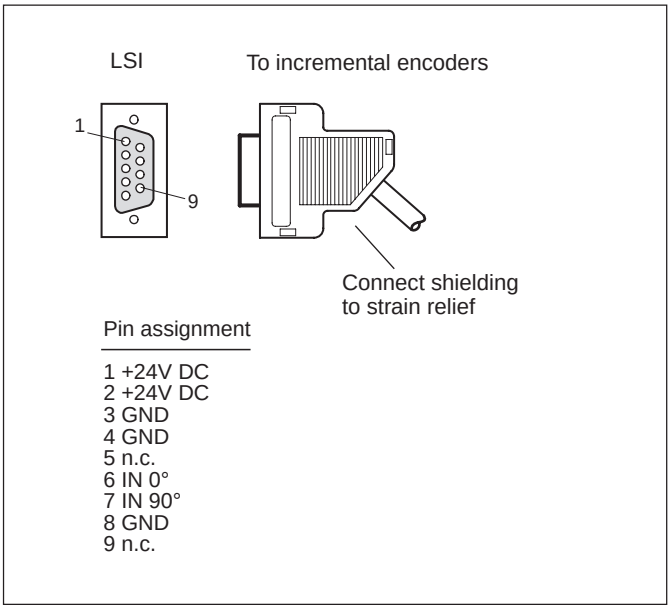
Make sure each incremental encoder delivers at least 50 pulses per centimeter covered by your vehicle (for configuration of the incremental sensors see section 9.7 and the calculation example in the appendix).

- Connect the shielding to the strain relief, as shown in the diagram. Follow the pin assignment.

Note:
You will find various examples of connection and configuration options for the LSI in section 11.1.



Connecting incremental encoders



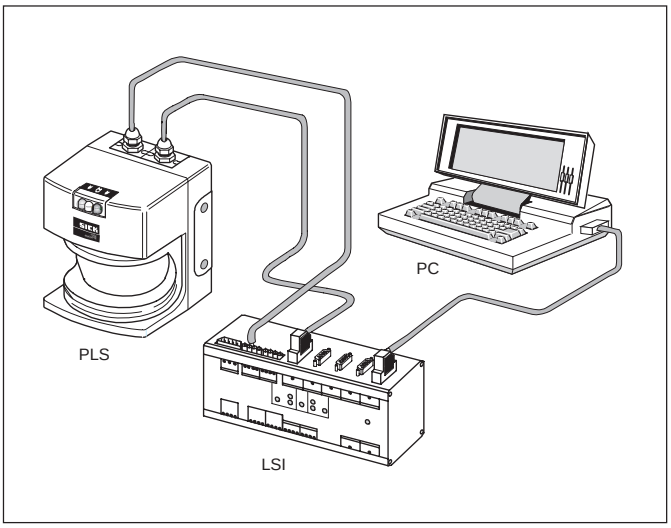
Shielding and pin assignment

8.3 Connecting the LSI to a PC

To configure your LSI system or change settings, you must temporarily connect the PC to the LSI. For this, the LSI is fitted with a switchable interface which permits you to connect the PC and LSI quickly and easily.

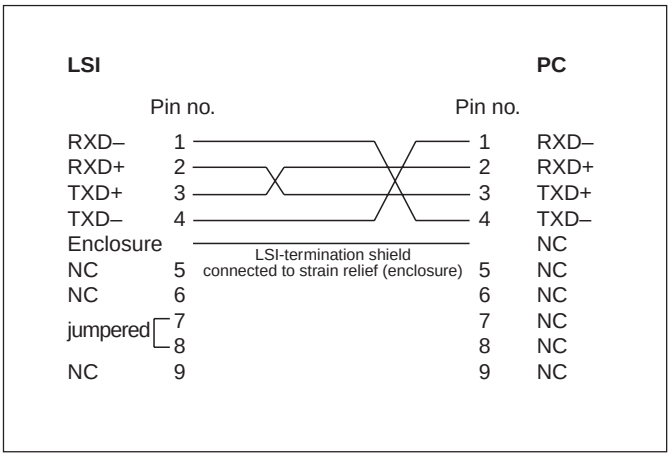
- Connect the LSI RS 232 interface (”COM” port) to a free serial port on the PC. Use a RS 232/RS 422 interface cable (see appendix, ”Accessories”).

You can now configure your LSI system.



Connecting LSI to a PC

Notes:
The LSI RS 232 interface is set up for connection to a PC. If required, you can reprogram it as a RS 422 interface by jumpering pins 7 and 8. The ”RS422” LED on the LSI then lights up to indicate the fact.
The pin assignment of a RS 422 interface is not standardized. Compare the pin assignment of the connecting cable with the one on the PC (see diagram) and adapt it accordingly.



Pin assignment of the interface connector in RS422 mode

9 Programming the LSI - User Software

9.1 Installing the PLS/LSI user software

Note:
The PLS/LSI user software as from version 03.20 can be used to program a single PLS or a LSI system. If you have already installed the user software for a PLS application on your PC you do not need to install new software. You can begin programming immediately.

If you have older PLS/LSI user software installed on your PC which you want to continue using, specify a different program directory/folder when installing the new PLS/LSI software.

System requirements

– min. 80486 processor
– min. 4 MB RAM
– min. 4 MB available hard disk capacity
– MS-Windows™ (version 3.11 or higher) or Windows 95™
– Color monitor recommended (not monochrome monitor)

When installing your PLS/LSI user software you are guided by the installation program. You only need to start the installation program:

- Boot your PC.
- Insert the PLS/LSI program disk in your PC's floppy drive.
- **Under MS-Windows**:
  Choose **File-Run** from the File Manager.
  Under Windows 95:
  Choose **Run** from the Start menu.
- Select and run "Install.exe".
- As necessary, enter the program directory/folder where you want the new PLS/LSI user software to be installed.
- Follow the on-screen instructions.

When the installation is finished a message box appears telling you that the setup has been completed successfully.

The PLS/LSI user software is now installed. You can run it any time by clicking on its icon.

9.2 What To Do

Notes:
When the program starts you are automatically logged on as the machine operator. As such, you can poll data but cannot transmit any.
To be able to transmit configuration data and monitoring areas to the LSI, you must log on as an "Authorized Client". How to log on is described in section 9.3.

Make sure that the LSI and all PLS units are correctly connected as described in section 8.

On the status bar at the bottom of the screen there is a color key for on-screen indication of protective fields and warning fields.

Essential steps

In creating a new configuration you are guided by the PLS/LSI user software. It guides you automatically through the following steps:

- **Configure hardware:**
  You log the sensors on and define whether you are using the LSI for area protection or for protection on a vehicle. You also define the inputs and outputs as well as the restart behavior of the outputs.
- **Define monitoring area:**
  You define the areas to be monitored by the LSI. If you wish, you can also determine the shape and size of the protective fields and warning fields here.
  You can define up to eight monitoring areas.
- **Define monitoring cases:**
  For each monitoring case (max. 15) you link a sensor to a monitoring area and define the input conditions under which the monitoring case is activated. Here you also determine which output is to be switched in the event of intrusion into the protective field.
  You can also define a specific order of switching between the monitoring cases.
- **Send configuration to LSI:**
  You now transmit all the configuration settings you have made to the LSI. You must be logged on as an "Authorized Client" to be able to do this.
- **Edit monitoring areas:**
  Here, if you wish, you have the chance to alter the shape and size of the protective fields and warning fields.
- **Send monitoring areas to LSI:**
  Finally you transmit the protective fields and warning fields to the LSI. For this too, you must be logged on as an "Authorized Client".

When you have completed these steps the LSI system is ready for operation.

Note:
Change the logon password, to protect your LSI system against manipulation (see section 9.13).
Log the configuration data stored in the LSI, and back up the configuration on the hard disk or on a floppy (see section 9.12).

Other options

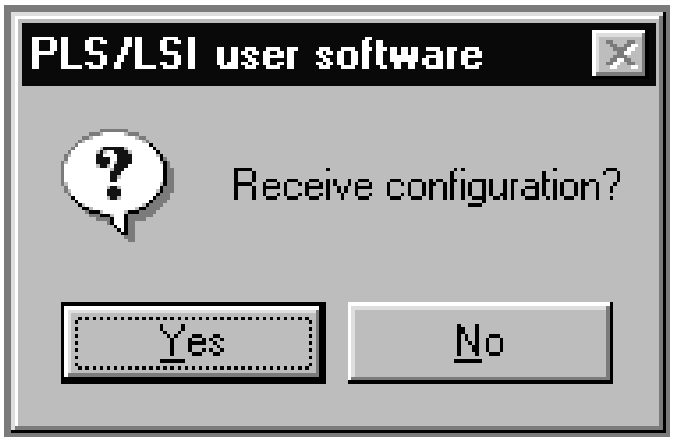
In addition to the essential steps, you can use a number of other options when configuring your LSI system.

- **Edit fields:**
  To edit the protective and warnings fields the PLS/LSI user software provides you with a number of useful edit functions.
- **Teach-in and check protective field:**
  In the teach-in process the active sensor runs over the space contour and the LSI generates a protective field on that basis. You can influence the extent of the protective field by running a target board over it, for example. You have to check learned protective fields.
  You can also edit a learned protective field subsequently, just like any other segmented field (function not available for use of LSI with PLS 101-316).
- **Adapt protective fields to speed:**
  When using the LSI on a vehicle, you can switch between protective fields of different shapes and sizes depending on the speed of the vehicle. In this way you can adapt the monitoring area flexibly to the environment and speed of the vehicle. You need to connect incremental sensors to the LSI for this.
- **Simulate monitoring cases:**
  You can check the settings of the monitoring cases by simulating the input conditions on PC. In this way you can check whether sensors and fields are correctly assigned in every monitoring case.
- **Monitor protective fields:**
  You can monitor the protective fields and warning fields in operation using a connected PC. You can also store the defined space contours of the sensors as a check.
- **Monitor inputs and outputs:**
  You can monitor and log the switching states of the LSI inputs and outputs with the I/O monitor. You can save the data obtained to an ASCII file for subsequent evaluation.
- **Check settings:**
  You can view, check and print all configuration settings in a page view.
- **Receive and store configuration:**
  You can receive and print the configuration data stored in the LSI. You can save any configuration to the hard disk or to a floppy.
- **Change password:**
  To protect your LSI against manipulation, you should change the logon password.
- **Change screen view:**
  You can zoom, unzoom or move the screen view, for example.
- **Interrogate fault memory (system diagnosis):**
  For troubleshooting purposes you can interrogate the fault memory of the LSI and the connected sensors.

9.3 Entry: The initial configuration

The LSI is shipped with certain pre-configured settings. This section describes how you can adapt those settings to your application.

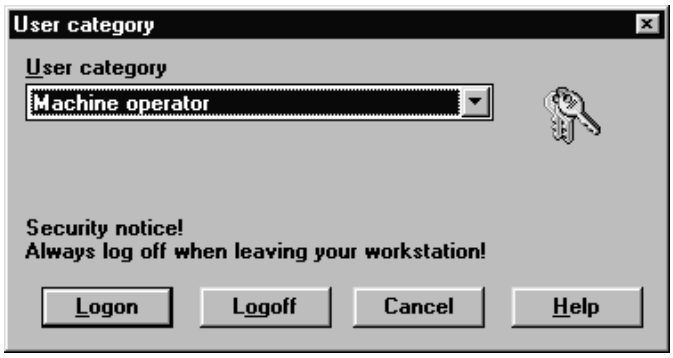
- Switch on your LSI system (it takes a few seconds to start up).
- Start the user software.



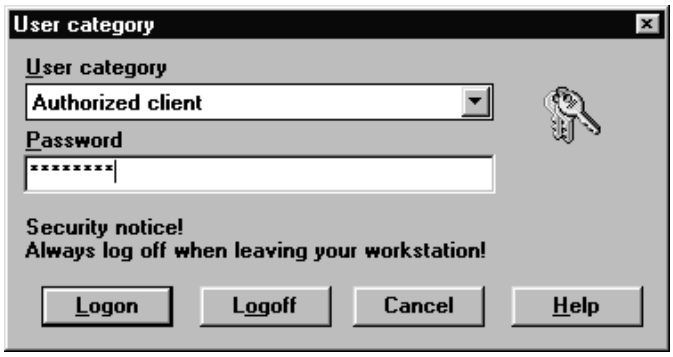
The following dialog box appears:

- Click on ”Yes”.

The PC receives the pre-configured settings and displays them on-screen.



This dialog box appears.
To be able later to send the configuration and monitoring areas to the LSI, you must log on as an ”Authorized Client”.



- Choose ”Authorized Client” from the category list.
- Enter the password ”SICK_PLS” and click on ”Logon”.

You are now logged on as an ”Authorized Client” (see status bar at bottom of screen).

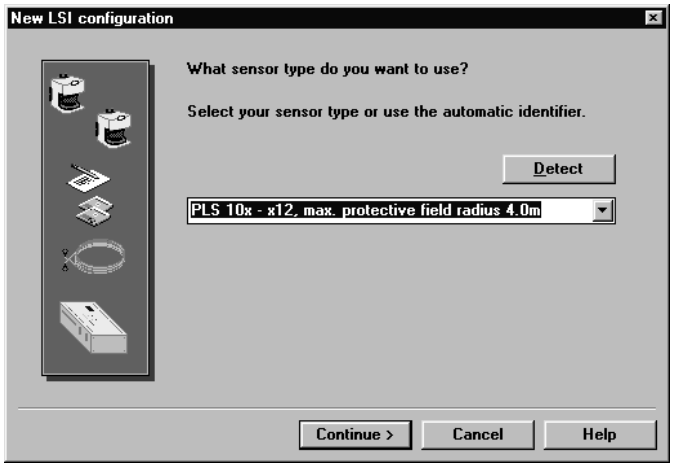
Note:
Always log off when leaving your workstation! This will prevent unauthorized persons from manipulating your LSI system.

Configure hardware

You can edit the received configuration or create a new configuration.

To create a new configuration:

- From the menu choose **File - New** and click on "LSI Configuration".
- Click on "OK".



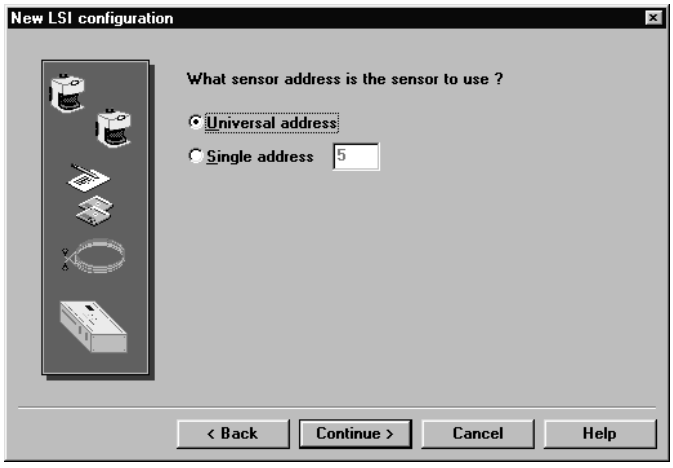
This dialog box appears. This is where you set the sensor type you want to work with.

- Select your sensor type or have the sensor detected automatically by clicking on "Detect".
- Click on "Continue".

The further steps and dialog boxes are the same as those described below for "Edit Configuration".

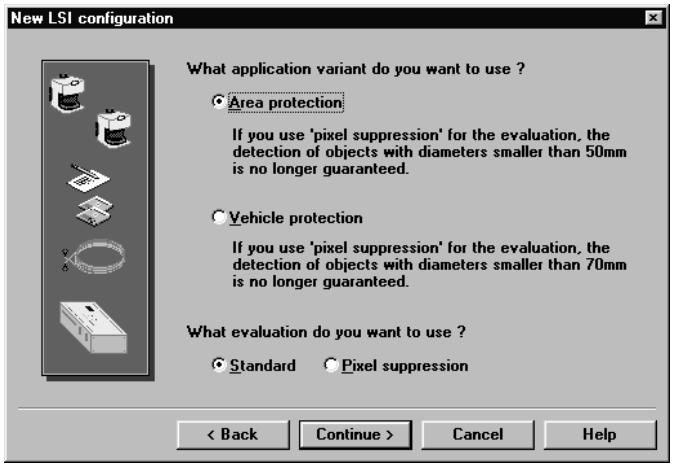
To edit the received configuration:

- From the menu choose **LSI - Configuration - Edit.**
- Or choose the "Edit Configuration" button from the toolbar.



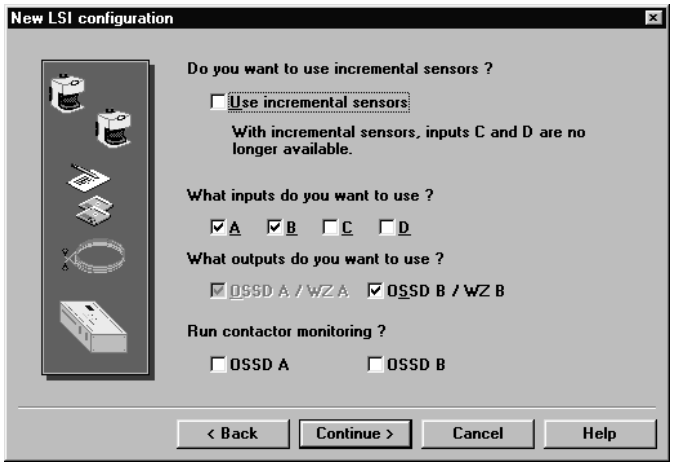
This dialog box appears. This is where you set the address under which the LSI and the sensors are to be addressed.

- Select whether you want to use a universal or single address.
  Universal address (zero):
  This is the recommended setting. If you set "Universal address", the stored configuration can be transferred at a later time to any other LSI.
  Single address (between 5 and 126):
  If you set "Single address" you assign the LSI the address specified here for transferring the configuration. It is then only possible to reload a configuration at a later time if the address specified here and the one stored in the LSI match. This makes sense when you want to ensure that a configuration saved as a file can only be transmitted to specific LSI units.
- Click on "Continue".



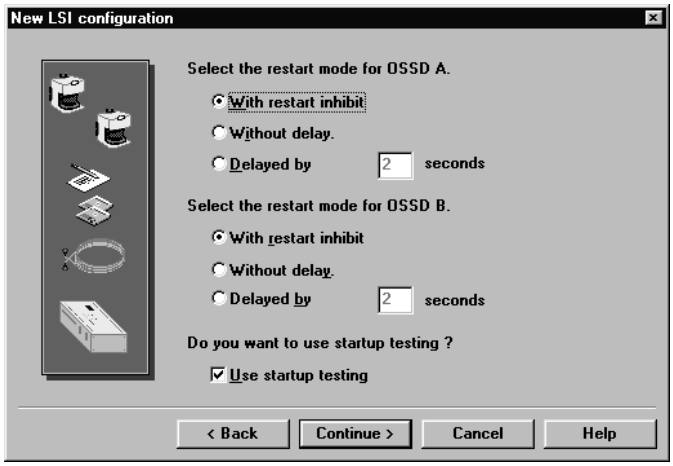
This dialog box appears. This is where you set field of application of your LSI system.

- Select whether you want to use the LSI for area protection or vehicle protection (e.g. DTS - Driverless Transport Systems).
- Select the evaluation you want to use.
  Standard:
  Standard evaluation.
  Pixel suppression:
  With this setting objects detected by just one pixel per scan are ignored. This can be useful in preventing error shutdowns.
- Click on "Continue".



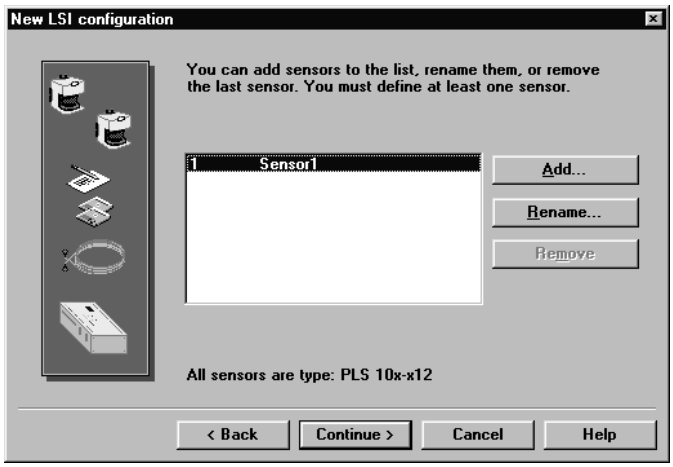
This dialog box appears. This is where you set which inputs and outputs you want to use.

- Check the checkbox to indicate whether you have connected incremental sensors. You can use incremental sensors when using the LSI to protect a vehicle (see section 9.7).
- Check the checkboxes for the inputs and outputs you want to use.
- Check the checkbox to indicate whether you want contactor monitoring on the outputs used. How to connect the contactor monitor is described in section 8.2.
- Click on ”Continue”.



This dialog box appears. This is where you set the restart behavior of the outputs and the startup testing.

- Select how the LSI is to restart after a protective field infringement.
  With restart inhibit:
  The system only restarts after a protective field infringement or a reset when the protective field is free and the restart button is pressed.
  Without delay:
  The system restarts immediately after the pre-set response time (multiple evaluation) as soon as the protective field is free.
  Delayed by n seconds:
  The system only restarts when the time set here has elapsed after the protective field has become free again.
- Check the checkbox for whether you want startup testing. If you select this option, you must intentionally interrupt the protective field one time after switching on the system. Only then is the system ready for operation.
  (How to perform startup testing is described in section 11.2).
- Click on ”Continue”.



This dialog box appears. This is where you log on the sensors to be used. One sensor is logged on already when the system is shipped.

To log on other sensors:

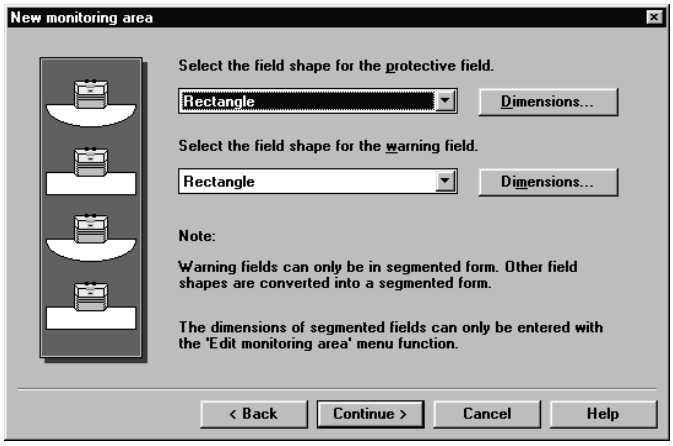
- Click on ”Add”.
- Enter a name for the sensor and click on ”OK”. The sensor is logged on.
- Click on ”Continue”.

Define monitoring areas

This dialog box appears. This is where you define the monitoring areas to be used.
One monitoring area is entered already when the system is shipped.

To define other monitoring areas:

- Click on ”Add”.
- Enter a name for the monitoring area and click on ”Continue”.



This dialog box appears.

- Select the shape of the protective field and warning field. You can define the sizes of the fields now or later. If you want to define them now, click on ”Dimensions” and enter the dimensions you want.

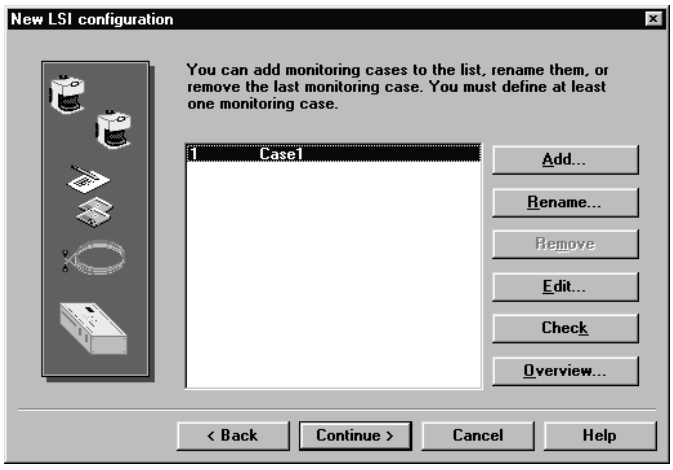
Note:
You will find more details on editing the protective fields and warning fields in section 9.5.

- Click on ”Continue”.
- Click on ”OK” to confirm the settings.

The monitoring area is defined.

- Click on ”Continue”.

Define monitoring cases



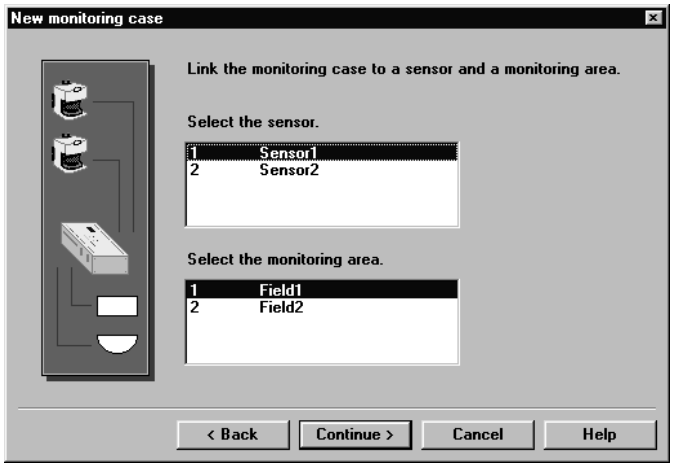
This dialog box appears. This is where you define the monitoring cases to be used.
One monitoring case is defined already when the system is shipped, although you can change its settings as you wish.

To change the monitoring case:

- Click on ”Edit” and change the settings as you need them.

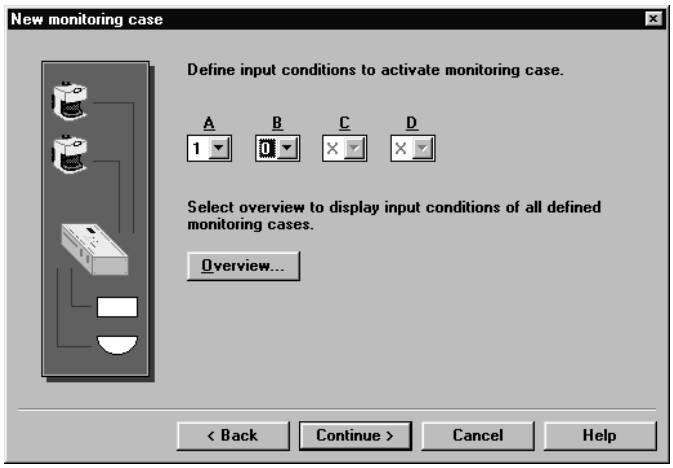
To define other monitoring cases:

- Click on ”Add”.
- Enter a name for the monitoring case and click on ”Continue”.



This dialog box appears.

- Select the sensor to be active in this monitoring case.
- Select the monitoring area you want monitored on the selected sensor.
- Click on ”Continue”.

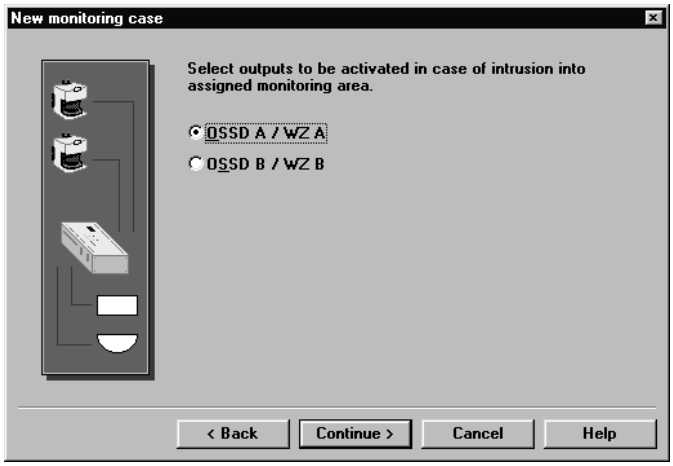


This dialog box appears.

- For the available inputs, define the input information on which the monitoring case is to be activated:
  X = low or high
  0 = low
  1 = high

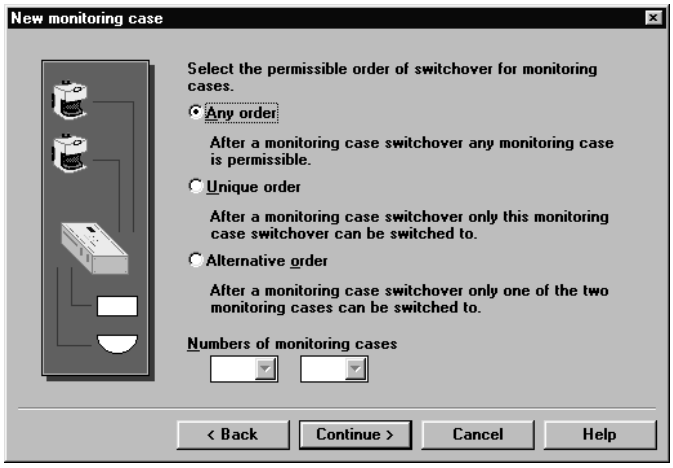
Note:
Each input comprises two signals, which must always be inverse to each other, e.g. for input A signals A_1 and A_2:
– Input A low: $A_1 = 1$ and $A_2 = 0$
– Input A high: $A_1 = 0$ and $A_2 = 1$
In this, the value set in the dialog box always corresponds to the signal level of the assigned input A_2 or B_2, C_2, D_2. (For cabling of inputs see section 8.2).

- Click on ”Continue”.



This dialog box appears.

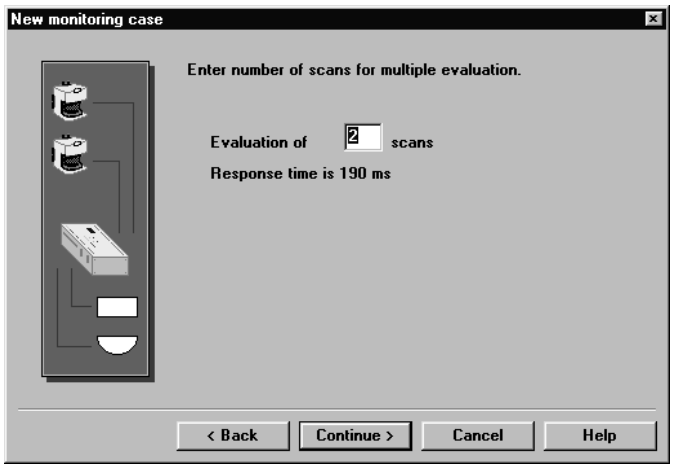
- Select the output to be switched in this monitoring case when there is an object in the protective field.
- Click on ”Continue”.



This dialog box appears.
This is where you set the order in which the monitoring cases are to be activated in succession.

Note:
You can change this setting subsequently. For more details on this, and on switching between several different monitoring cases, refer to section 9.4 under ”Define additional monitoring case”.

- Select ”Any order”, for example.
- Click on ”Continue”.



This dialog box appears. This is where you set how often (that is, in how many consecutive scans) the sensor must detect a foreign body in the protective field before the configured outputs are shut off (between 2 and 16 scans are possible).
(If you combine the LSI with PLS type 101-316 for vehicle protection, the response time of the LSI is not programmable, but is fixed at 270 ms).

- Enter the desired number of scans.
  Note:
  For safety reasons, always select the lowest possible setting! If you increase the setting the system will become more stable, but will also respond more slowly. The current response time is shown in the box.
- Click on ”Continue” and confirm with ”OK”.

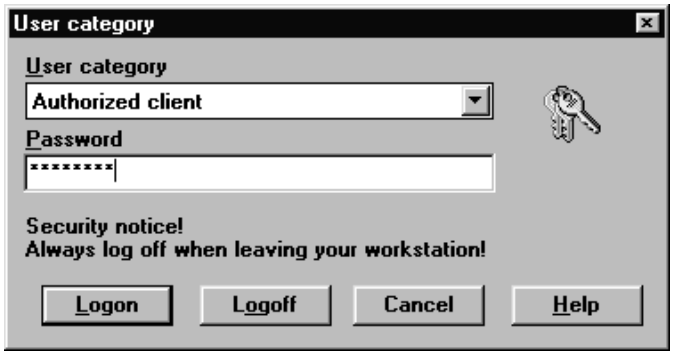
The monitoring case is thereby defined.

- Click on ”Continue”.
- Click on ”OK” to accept the configuration.

The configuration is defined. You can now transmit the settings to the LSI, as described in the following subsection.

Send configuration to LSI

- Make sure you are logged on as an ”Authorized Client” (see status bar at bottom of screen).
- If you are not logged on as an ”Authorized Client”, choose **LSI - User Category** from the menu, or click on the ”Logon/ Logoff User Category” button on the toolbar.

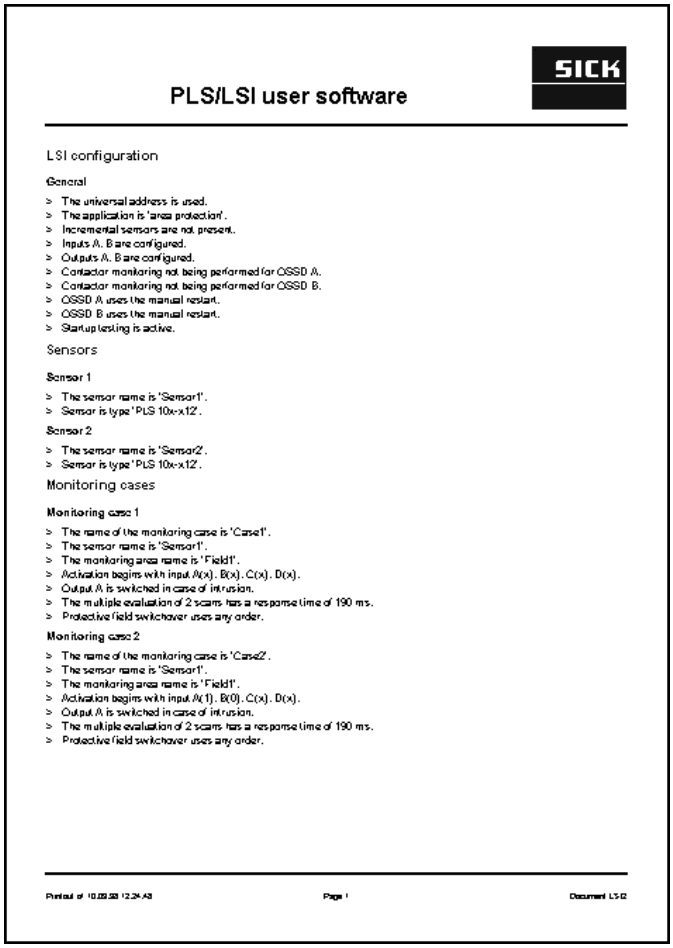


This dialog box appears.

- Choose ”Authorized Client” from the list of user categories.
- Enter the password ”SICK_PLS” and click on ”Logon”.

You are now logged on and can send data to the LSI.

- From the menu choose **LSI - Configuration - Send to LSI** from the menu,
  or click on the ”Send Configuration” button on the toolbar.



The screen displays an overview of the configuration settings for you to check through once again.

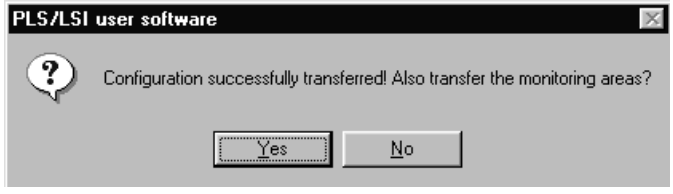
To correct settings:

- Click on ”Cancel” to close the overview and change the settings.

To confirm settings:

- Click on ”Confirm”.

The configuration data are sent to the LSI and stored there.



This dialog box appears.

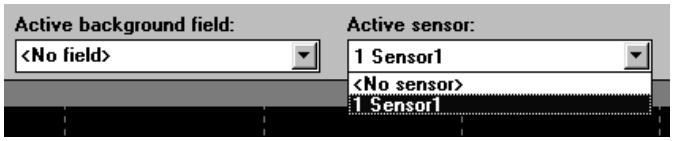
- If you want to transmit the monitoring areas unchanged, click on ”Yes”. You can then skip the next section, ”Edit monitoring area”.
- If you want to alter the shape and size of the monitoring areas, click on ”No”. You can then edit the protective and warning fields, as described in the following section.

Edit monitoring area

The screen displays the protective field you have defined. You can edit the size of all protective fields and warning fields after defining them.

- From the menu choose **Monitoring Area - Edit**, or click on the ”Edit Monitoring Area” button on the toolbar.

- From the ”Active Field” list select the protective field or warning field you want to edit.
- From the ”Active Background Field” list select the protective field or warning field that you want to see in the background for comparison purposes.



- From the ”Active Sensor” list select the sensor whose current defined space contour you want to see in the background for comparison purposes.

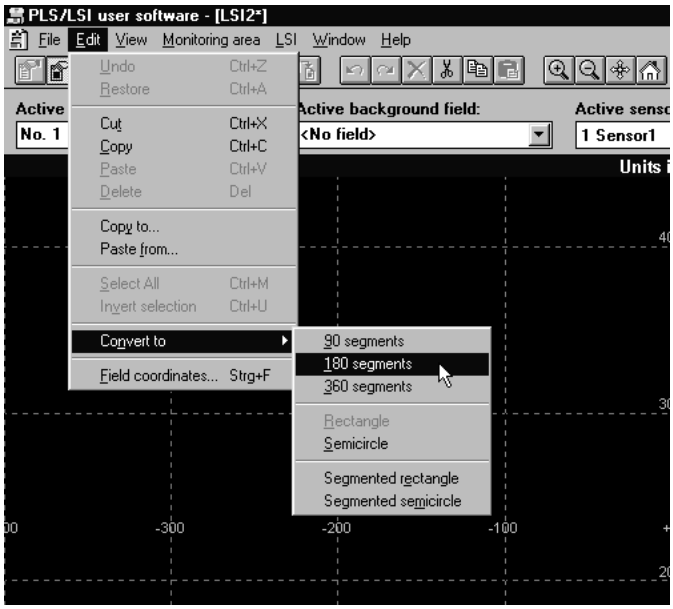
The selected fields and the space contour of the selected sensor are shown on-screen.

On the status bar at the bottom of the screen there is a color key for on-screen indication of protective fields and warning fields.

Note:
The space contour of the active sensor serves only as an aid to defining the protective and warning fields. The sensor you select here has no influence on the link between monitoring areas and sensors in the monitoring cases.

Convert field shape:

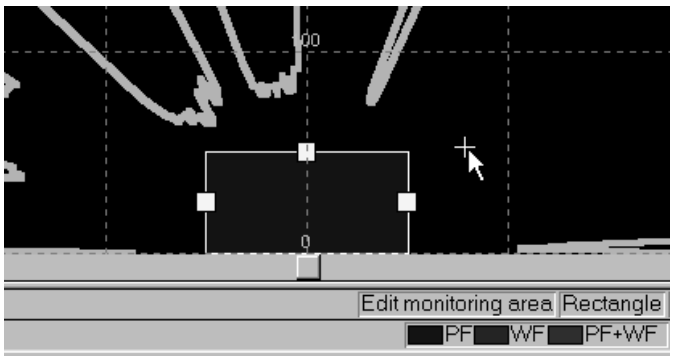
- To convert a field into a different shape, choose **Edit - Convert Into** from the menu.



Various field shapes are available to choose from:
– Segmented field: You can select various resolutions. The more segments a field has, the higher is its resolution. You can define the coordinates for each segment individually.
– Rectangle: This is the default. Newly defined fields are always this shape, unless you select a different setting. You can adjust the height of the rectangle and the width at the right and left.
– Semicircle: Here you define the radius.
– Segmented rectangle/semicircle: You define a rectangle or semicircle and select the desired resolution (number of segments). The field is automatically converted into a segmented field with the corresponding dimensions.

Notes:
Warning fields are always segmented fields. If you have defined a warning field as a rectangle or semicircle, it is automatically converted into a segmented field with the appropriate dimensions.
When you convert a field or change the resolution of a segmented field, the shape of the field may change minimally.

The following sections set out only the basic means of defining the sizes of the various field shapes. For more information on editing fields, refer to section 9.5.



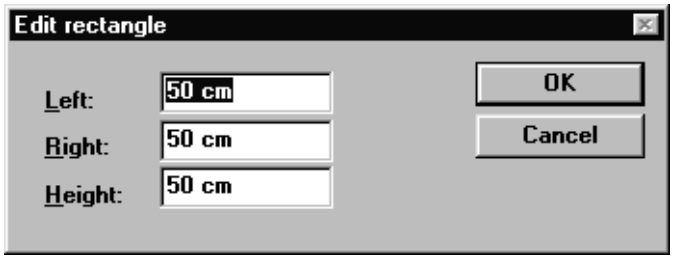
Define rectangular field:

- To set or move a corner point:
  Double-click on the desired position with the mouse.

Note:
In the example a rectangular grid pattern was chosen for the screen view. You can switch between circular and rectangular grid patterns. For more details refer to section 9.14.

... or:

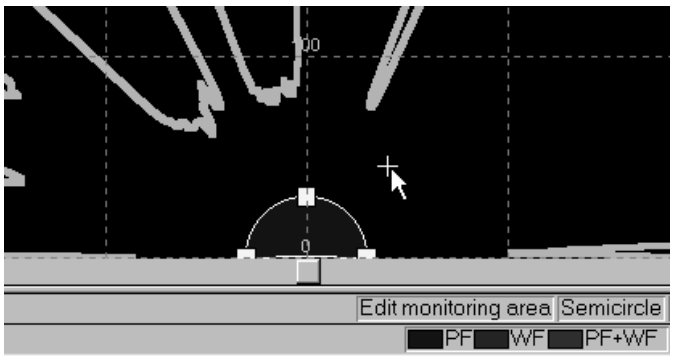
- From the menu choose **Edit - Field Coordinates** .



This dialog box appears, showing the dimensions of the rectangle.

- Enter the dimensions you want.
- Confirm with ”OK”.

The dimensions of the rectangle are changed accordingly.



Define semicircle:

- Double-click with the mouse on the desired position to define the radius of the field.

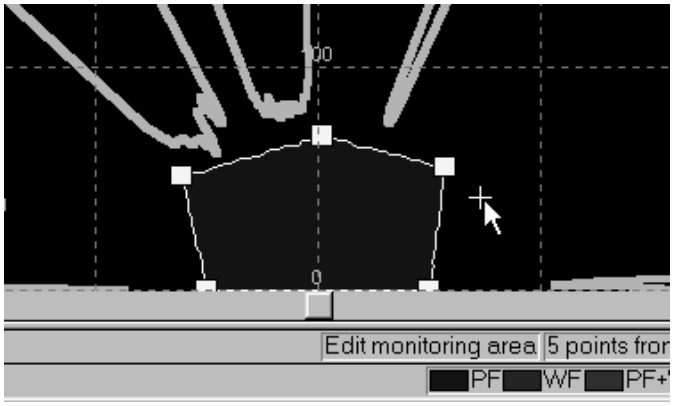
... or:

- From the menu choose **Edit - Field Coordinates** .

This dialog box appears, showing the radius of the semicircle.

- Enter the dimension you want.
- Confirm with ”OK”.

The radius of the semicircle is changed accordingly.

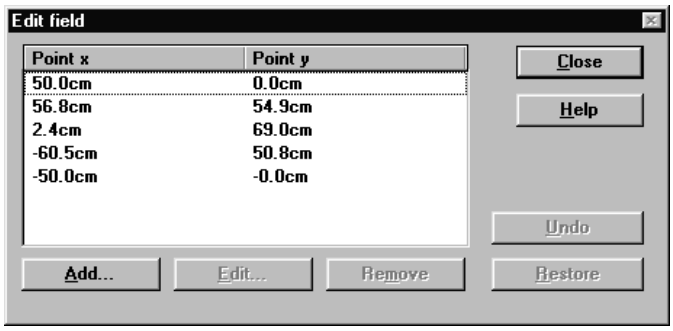


Define segmented field:

- To set a point with the mouse:
  Double-click on the desired position.
- To move a point with the mouse:
  Select the point and drag it to the desired position.
- To delete a point:
  Select the point and click on the ”Delete” button on the toolbar.

... or:

- From the menu choose **Edit - Field Coordinates** .



This dialog box appears, showing the coordinates of all defined points. You can add any points to the list, or you can select a point and edit it or remove it.

- To set a point:
  Click on the ”Add” button and enter your desired coordinates in the dialog box.
- To move a point:
  Select the point in the list and click on the ”Edit” button. Enter your desired coordinates in the dialog box.
- To delete a point:
  Select the point in the list and click on the ”Remove” button.

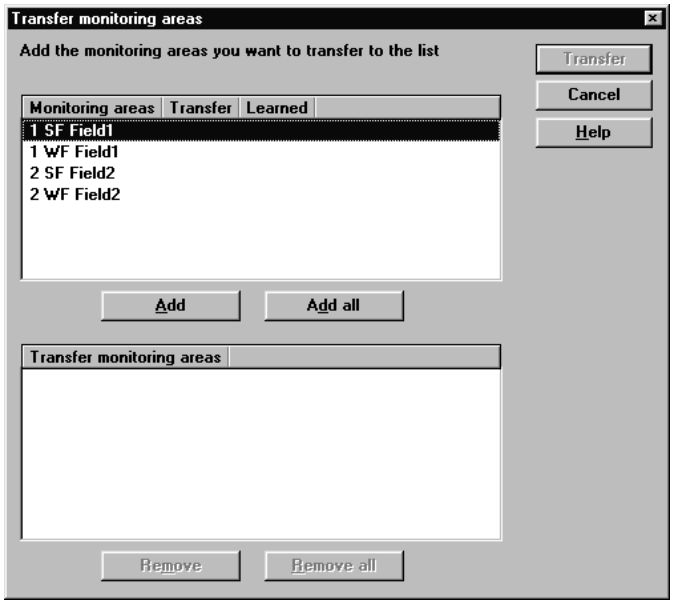
Note:
You can also select a point with the mouse before choosing **Edit - Field Coordinates**. The coordinates of the point in question are then already highlighted in the list.

- When you have defined the protective and warning fields as you want, deactivate the **Monitoring Area - Edit** menu function, or deactivate the ”Edit Monitoring Area” button on the toolbar.

Note:
After programming, check on the plant or vehicle that the monitoring areas are the correct size and shape! You can do this by intruding intentionally into the monitoring areas.
Only start up the plant or vehicle when you are sure the monitoring areas are operating effectively!

Send monitoring area to LSI

- From the menu choose **Monitoring Area - Send to LSI**, or click on the ”Send Monitoring Area” button on the toolbar.

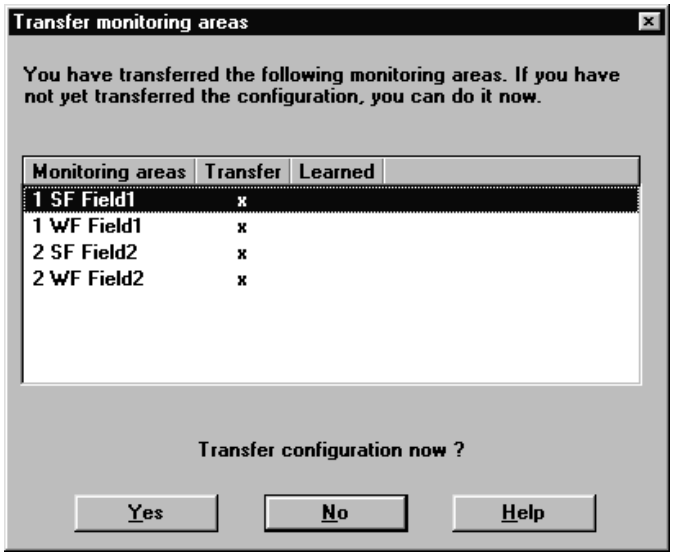


This dialog box appears.

- Click on ”Add All”, or - if you only want to transmit individual fields - select the fields you want from the list at the top and click on ”Add”.

The fields are entered in the list at the bottom.

- Click on ”Send” and confirm for each individual field.



This dialog box appears. The transmitted fields are now marked with asterisks in the list.

- Check that all protective fields and warning fields are marked with an asterisk, and so have been transmitted correctly.
- If you already sent the configuration before, you can click on ”No”.
  If you have not yet sent the configuration, click on ”Yes” and transmit it as previously described under ”Send configuration to LSI”.

When you have transmitted the configuration and all monitoring areas, the system is ready for operation.

Note:
When leaving your workstation log off by way of the **LSI - User Category** menu function!

Also change the ”Authorized Client” logon password. Make a note of the new password at a location accessible only to authorized persons. This will prevent unauthorized persons from manipulating the LSI system (how to change the password is described in section 9.13).

9.4 Expand configuration

This section shows you how you can expand your configuration to meet specific requirements.
You can add sensors and monitoring areas, and work with additional monitoring cases.
You can also change the inputs and outputs, as well as the address, application variant and restart settings.

Note on the following subsections:
There are two basic means of expanding the standard application, depending on the user category under which you have logged on:

– As an ”Authorized Client” you are automatically guided through all steps, as when creating a new configuration (see section 9.3).
– As ”SICK Service”, you can only call up and change specific settings. The following subsections describe this method. Consequently, you do not need to work through this entire section, but can go to the specific subsections relevant to your application.

Log on additional sensors

- From the menu choose **LSI - Configuration - Edit.**
- Or choose the ”Edit Configuration” button from the toolbar.
- Select the ”Sensors” tab in the ”LSI Configuration” dialog box.
- Click on ”Add”.
- Log on all sensors connected to your LSI in sequence, and name them as you wish. You can log on up to four sensors.

Define additional monitoring areas

- From the menu choose **LSI - Configuration - Edit.**
- Or choose the ”Edit Configuration” button from the toolbar.
- Select the ”Monitoring Areas” tab in the ”LSI Configuration” dialog box.
- Click on ”Add”.
- Log on all the monitoring areas you need and name them as you wish.
- Define the shape and size of the desired protective and warning fields as described in section 9.3.

Define additional monitoring cases

- From the menu choose **LSI - Monitoring Cases - Edit**.

This dialog box appears.

Overview of all monitoring cases:

- Click on ”Overview” to view all defined monitoring cases, their input and output definitions and the active sensors and monitoring areas. Here you can keep a continuous check on your settings.

Check plausibility:

- Click on ”Check”. During configuration you can check here that the monitoring cases are plausible in their current settings. This can help to reveal any conflicts or errors.

To create a new monitoring case:

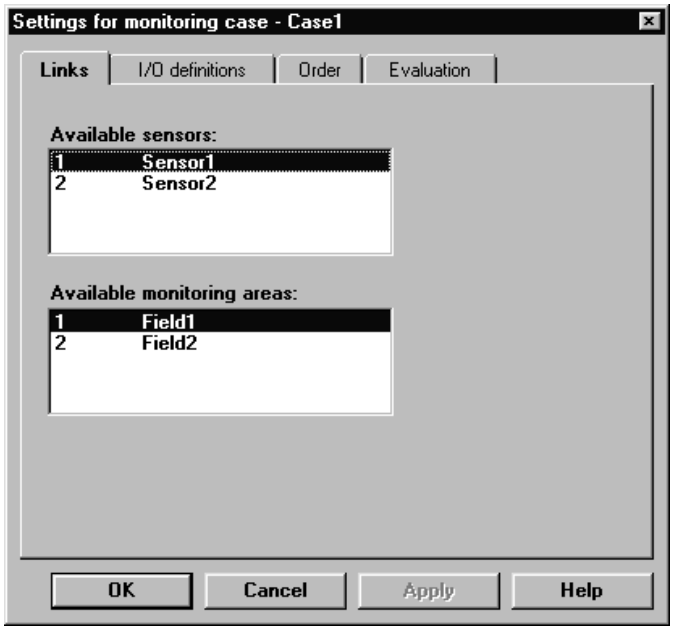
- Click on ”Add”. A series of dialog boxes appears in which you can enter the settings you want, as described in section 9.3. (All settings can be changed subsequently).

To delete a monitoring case:

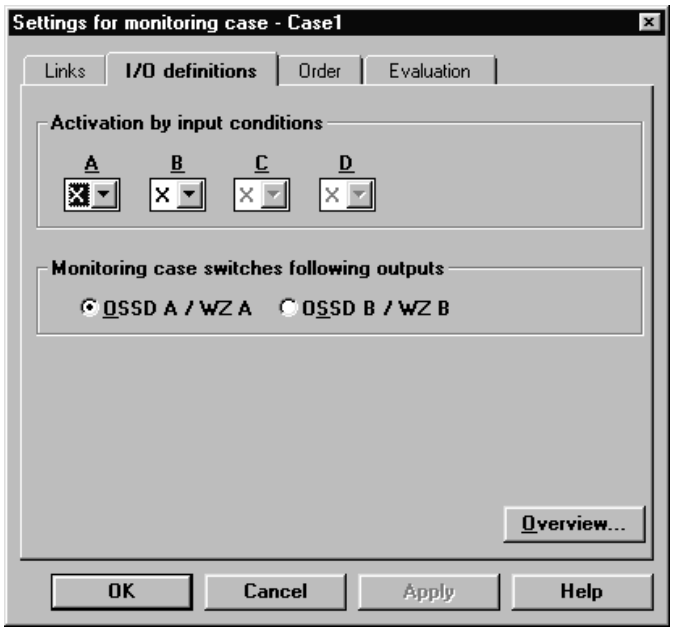
- Select the case you want to delete from the list and click on ”Remove”.

To change a monitoring case:

- Select the case you want to change in the list and click on ”Edit”. You can then make the changes on the tab as described in the following:



"Links" tab:
This is where you define which monitoring area (comprising a protective field and a warning field) is to be monitored on which sensor.

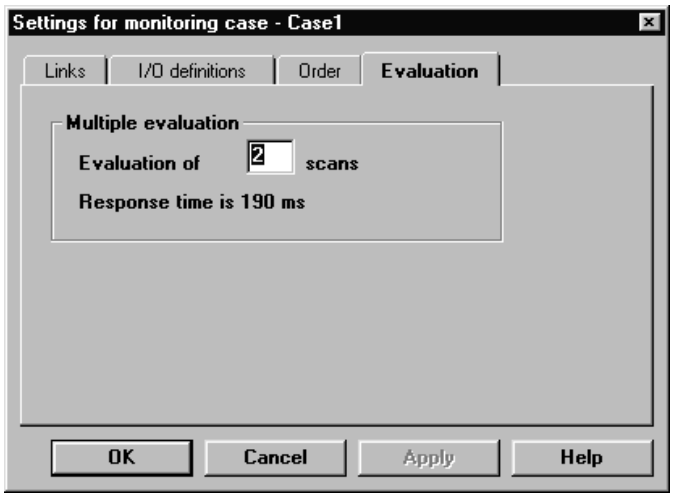


"I/O Definitions" tab:
This is where you define the input information on which the monitoring case is to be activated:
X = low or high
0 = low
1 = high

You also set which input is to be switched in the event of intrusion into the protective field.

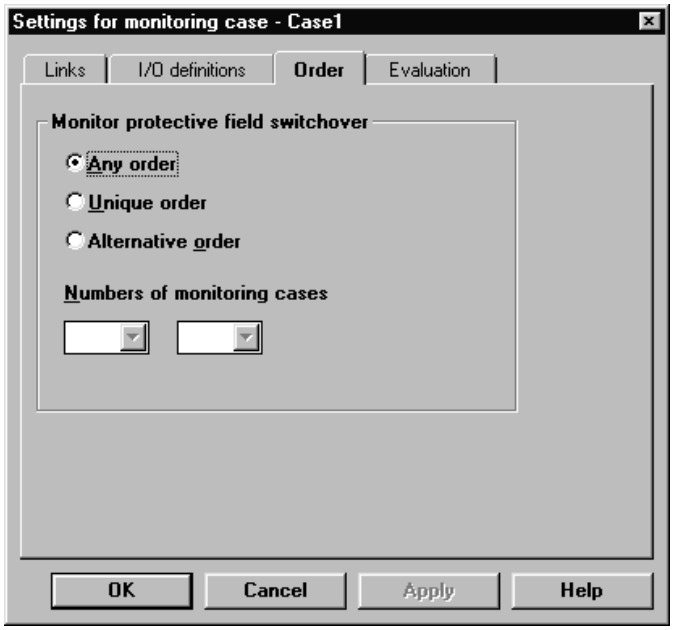
Note:
Each input comprises two signals, which must always be inverse to each other, e.g. for input A signals A_1 and A_2:
– Input A low: $A_1 = 1$ and $A_2 = 0$
– Input A high: $A_1 = 0$ and $A_2 = 1$

In this, the value set in the dialog box always corresponds to the signal level of the assigned input A_2, or B_2, C_2, D_2. (For cabling of inputs see section 8.2).



"Evaluation" tab:
This is where you set how often (that is, in how many consecutive scans) the sensor must detect a foreign body in the protective field before the configured outputs are shut off (between 2 and 16 scans are possible).
This sets the response time of the LSI.

Note:
If you combine the LSI with PLS type 101-316 for vehicle protection, the response time of the LSI is not programmable, but is fixed at 270 ms.

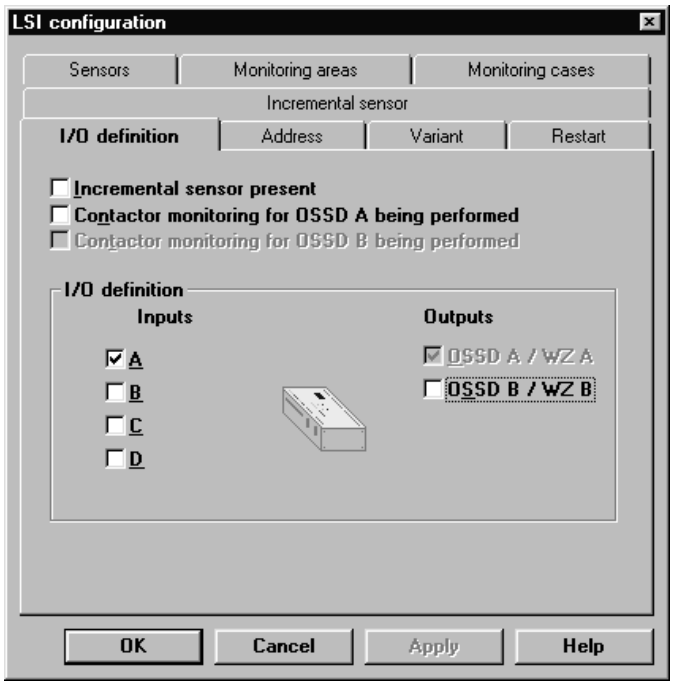


”Order” tab:
This is where you set the order in which the monitoring cases are to be activated in succession.

– Any order: After the current monitoring case any other monitoring case can be activated.
– Unique order: After the current monitoring case only the monitoring case you selected from the list at the bottom can be activated.
– Alternative order: After the current monitoring case only one of the two monitoring cases you selected from the list at the bottom can be activated.

Note on unique and alternative orders:
In programming the order, make sure only one input changes its state during switchover.
Example of order:

	A	B
1.	0	0
2.	1	0
3.	1	1
4.	0	1



Change inputs and outputs

- From the menu choose **LSI - Configuration - Edit.**
- Or choose the ”Edit Configuration” button from the toolbar.
- Select the ”I/O Definitions” tab in the ”LSI Configuration” dialog box.
- Check the checkbox to indicate whether you have connected incremental sensors. You can use incremental sensors when using the LSI to protect a vehicle (see section 9.7).
- Check the checkboxes for the inputs and outputs you want to use.
- Check the checkbox to indicate whether you want contactor monitoring on the outputs used.

Change address

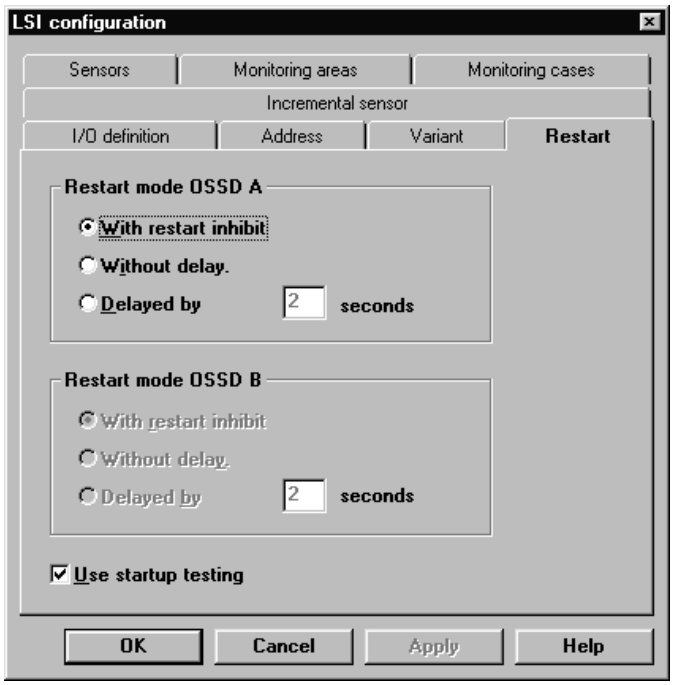
You can define whether the LSI is addressed via a universal address or a single address.

- From the menu choose **LSI - Configuration - Edit**.
- Or choose the ”Edit Configuration” button from the toolbar.
- Select the ”Address” tab in the ”LSI Configuration” dialog box.
- Select whether you want to use a universal or single address.
  Universal address (zero, recommended setting):
  If you set ”Universal address”, the stored configuration can be transferred at a later time to any other LSI.
  Single address (between 5 and 126):
  If you set ”Single address” you assign the LSI the address specified here for transferring the configuration. It is then only possible to reload a configuration at a later time if the address specified here and the one stored in the LSI match. This makes sense when you want to ensure that a configuration saved as a file can only be transmitted to specific LSI units.

Change application variant

You can also subsequently define the field of application of the LSI system.

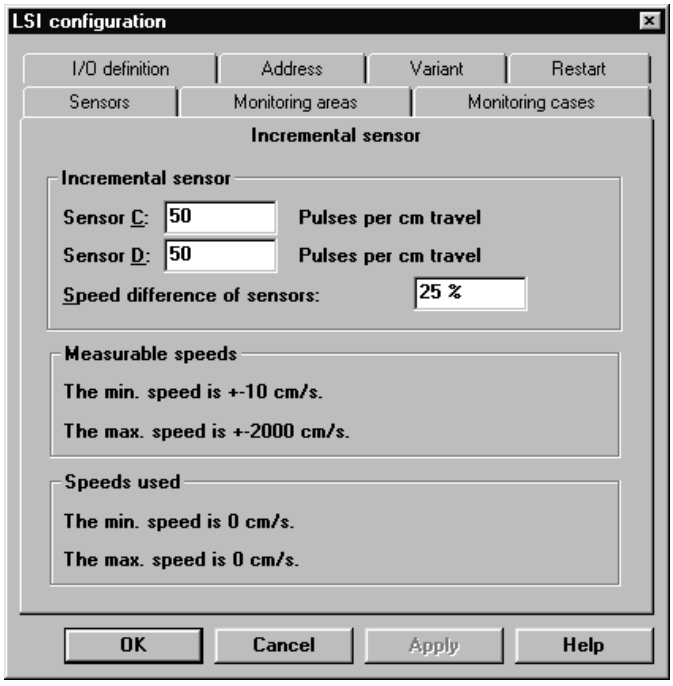
- From the menu choose **LSI - Configuration - Edit**.
- Or choose the ”Edit Configuration” button from the toolbar.
- Select the ”Variant” tab in the ”LSI Configuration” dialog box.
- Select whether you want to use the LSI for area protection or vehicle protection (e.g. DTS - Driverless Transport Systems).
- Select the evaluation you want to use.
  Standard:
  Standard evaluation.
  Pixel suppression:
  With this setting objects detected by just one pixel per scan are ignored. This can be useful in preventing error shutdowns.



Change restart behavior

You can change the settings for restart behavior and startup testing.

- From the menu choose **LSI - Configuration - Edit**.
- Or choose the ”Edit Configuration” button from the toolbar.
- Select the ”Restart” tab in the ”LSI Configuration” dialog box.
- Select for outputs OSSD A and B how the LSI is to restart after a protective field infringement.
  With restart inhibit:
  The system only restarts after a protective field infringement or a reset when the protective field is free and the restart button is pressed.
  Without delay:
  The system restarts immediately after the pre-set response time (multiple evaluation) as soon as the protective field is free.
  Delayed by n seconds:
  The system only restarts when the time set here has elapsed after the protective field has become free again.
- Check the checkbox for whether you want startup testing. If you select this option, you must intentionally interrupt the protective field one time after switching on the system. Only then is the system ready for operation. (How to perform startup testing is described in section 11.2).



Configure incremental sensors

If you want to evaluate the speed data when protecting a vehicle, enter the data of the incremental sensors here. For this, you must have checked the ”Incremental sensors present” checkbox on the ”I/O Definition” tab. (For precise information on evaluation of the speed data of a vehicle refer to section 9.7).

- From the menu choose **LSI - Configuration - Edit**.
- Or choose the ”Edit Configuration” button from the toolbar.
- Select the ”Incremental Sensors” tab in the ”LSI Configuration” dialog box.
- Enter the number of pulses per cm travel for the incremental sensors C and D used.
- Enter the max. speed difference between incremental sensors C and D in percent.

Note:
The maximum possible speed of the vehicle is displayed in the box.
The minimum recordable speed is ± 10 cm/s.
For technical reasons, and to provide greater availability, lower speeds are ignored, or interpreted as 0 cm/s.

9.5 Edit/dimension fields

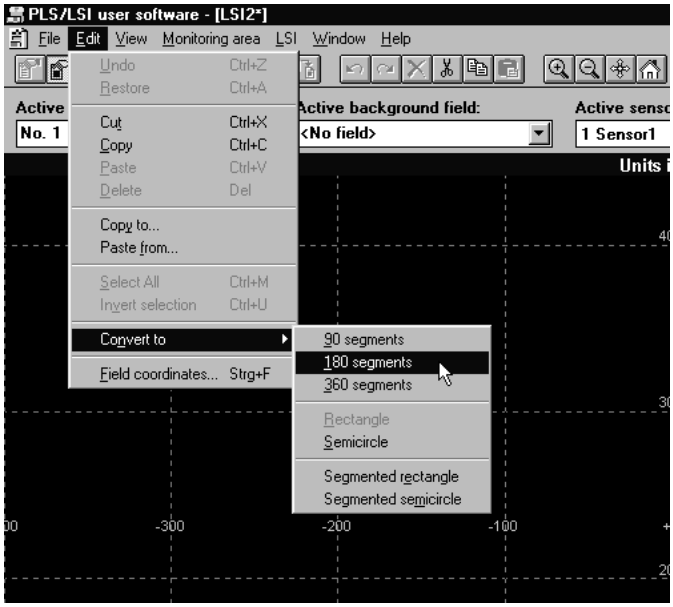
Section 9.3 describes the basic way to edit a protective field or warning field. You can use rectangular, semicircular or multiply-segmented fields. You can draw the fields using the mouse or type in their coordinates.

This section describes additional options of defining the size and shape of the protective and warning fields for your application. Various edit functions will assist you in drawing up the fields.

On the status bar at the bottom of the screen there is a color key for on-screen indication of protective fields and warning fields.

Notes:
Protective fields require the addition of supplements, due for example to the measuring error of the PLS. There are also special dimensioning rules, e.g. for use of the system on materials handling equipment in narrow aisles. Also refer to the technical description of the PLS.
After programming, check on the plant or vehicle that all monitoring areas are the correct size and shape! You can do this by intruding intentionally into the monitoring areas.
Only start up the plant or vehicle when you are sure all monitoring areas are operating effectively!

Convert fields

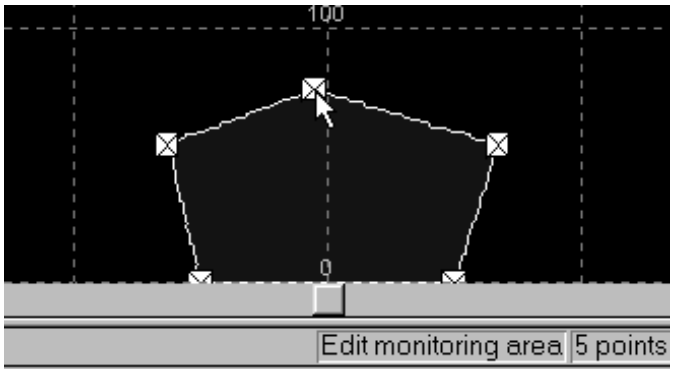


You can convert a field into a different shape - for example, a rectangular field into a segmented field.

- From the menu choose **Edit - Convert Into**.

Various field shapes are available to choose from:
– Segmented field: You can select various resolutions. The more segments a field has, the higher is its resolution. You can define the coordinates for each segment individually.
– Rectangle: This is the default. Newly defined fields are always this shape, unless you select a different setting. You can adjust the height of the rectangle and the width at the right and left.
– Semicircle: Here you define the radius.
– Segmented rectangle/semicircle: You define a rectangle or semicircle and select the desired resolution (number of segments). The field is automatically converted into a segmented field with the corresponding dimensions.

Note:
Warning fields are always segmented fields. If you have defined a warning field as a rectangle or semicircle, it is automatically converted into a segmented field with the appropriate dimensions.



Change scale of segmented field

When you have defined a segmented field you can enlarge or reduce it in scale.

- Choose **Edit - Select All** to select all the points in the field.
- Pick up one of the points with the mouse and drag the field to the size you want.

Each point is dragged on a measuring ray of the sensor away from or toward the zero as appropriate.

Copy and paste fields

You can copy fields to the clipboard and paste them at a different location, for example when you need several similar protective fields or warning fields. But you cannot mix field types: you can only paste a protective field back in as a protective field, and a warning field as a warning field.

- From the menu choose **Edit - Copy** to copy the current field to the clipboard.
- From the ”Active Field” list select another field of the same type (protective field or warning field).
- Choose **Edit - Paste** to paste the field from the clipboard.

You can then edit the field you have just pasted as normal.

Save individual fields

You can save individual fields as files so they are available to be used in other configurations.

- Choose **Edit - Copy To** and save the current field under the desired file name on the hard disk or on a floppy.
- To insert the stored field at the desired location, such as in another configuration, choose **Edit - Paste From** and enter the file name and storage location.

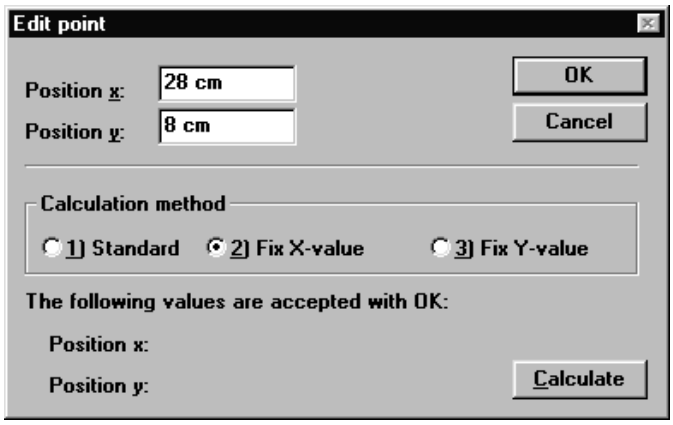
The field is inserted. You can then edit the field as normal.

Fix coordinates

When editing a segmented field you can fix one of the coordinates of a point. This may be necessary when the coordinate in question must not be changed, such as when configuring a protective field for a narrow alley.

- From the menu choose **Edit - Field Coordinates** .
- In the list select the point whose position you want to change and click on ”Edit”.

This dialog box appears.



- Enter the coordinates you want for x and y.
- Select which coordinate must not deviate from the entered value, for example ”Fix X-value”, and click on ”Calculate”.

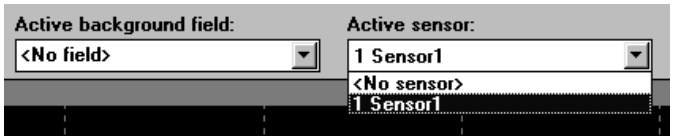
The next closest point on a measuring ray with the desired coordinates is calculated.

- The calculated coordinates are displayed. To accept them, click on ”OK”.

9.6 Teach-in protective field

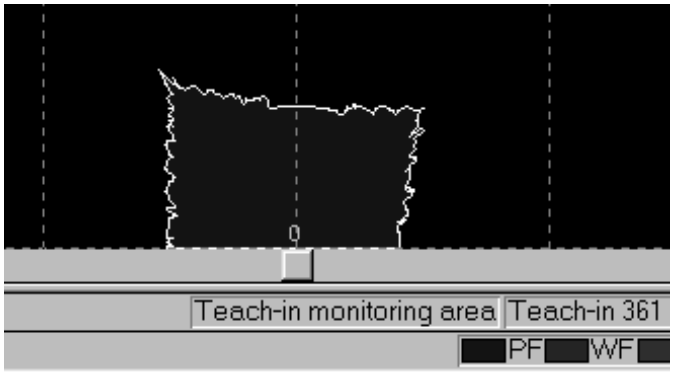
You can teach in protective fields. In the teach-in process the active sensor runs over the space contour and the LSI generates a protective field on that basis. You can influence the extent of the protective field by running a target board over it, for example. You have to check learned protective fields.
You can also edit a learned protective field subsequently, just like any other segmented field (function not available for use of LSI with PLS 101-316).

- From the ”Active Field” list select the protective field you want to edit.



- From the ”Active Sensor” list select the sensor from which you want to receive data.

- From the menu choose **Monitoring Area - Teach-in**.
- Or click on the ”Teach-in Monitoring Area” button on the toolbar.



The active sensor scans its surroundings and shows you the results. The contour you see on-screen is the largest possible extent of the protective field (the precise contour of the protective field is based on the ambient contours).

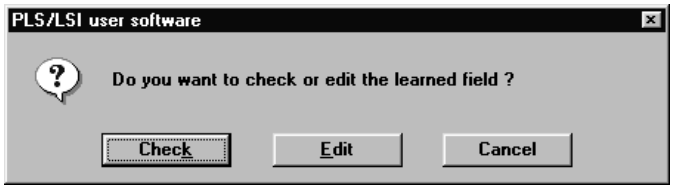
- If you want to reduce the size of the learned contour, run a target (e.g. a piece of cardboard, at least 10 x 10 cm in size) slowly along the edge of your desired protective field.

The contour of the protective field is reduced at the relevant point. On the screen you can track how the protective field takes on the taught-in contour.

Note:

To prevent fixed obstacles in the scanning plane subsequently producing false signals, 13 cm (= max. measuring error of PLS) is automatically deducted from the learned contour. Take this into account as appropriate when running over the protective field.
Also note that the teach-in process may result in an additional error of 4.5 cm.

- To terminate teach-in, deactivate the ”Teach-in Monitoring Area” button.

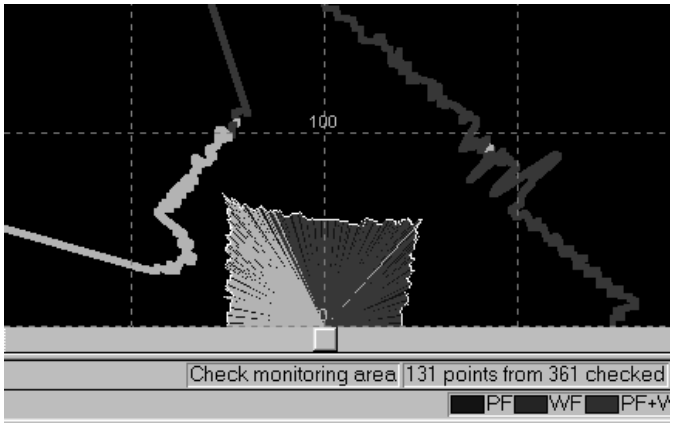


This dialog box appears. You now have three options:
– You can use the taught-in protective field.
– You can edit it as a segmented field.
– Or you can check it and then activate it in the LSI.

Reject protective field:
- Click on ”Cancel”. The taught-in protective field is rejected and the old field retained.

Edit protective field:
- Click on ”Edit”. You can then edit the taught-in protective field like a segmented field and then transmit it to the LSI.

Check protective field:
- Click on ”Check”:



The taught-in protective field is shown on-screen. The space contour of the sensor is displayed for comparison purposes.

- Infringe the protective field intentionally and run over the contour until you reach all 361 points and all measuring rays. It is important to do this inwards, in a corridor up to around 70 cm from the edge of the protective field.

The status bar indicates the number of checked points.

As soon as you have checked all points, this dialog box automatically appears.

If you want to cancel the check beforehand:

- Deactivate the **Monitoring Area - Teach-In** menu function, or deactivate the ”Teach-In Monitoring Area” button on the toolbar.
  The same dialog box appears.

- Click on ”Yes” to transfer the monitoring area into the LSI and confirm with ”OK”.

The taught-in protective field is now active in the LSI.

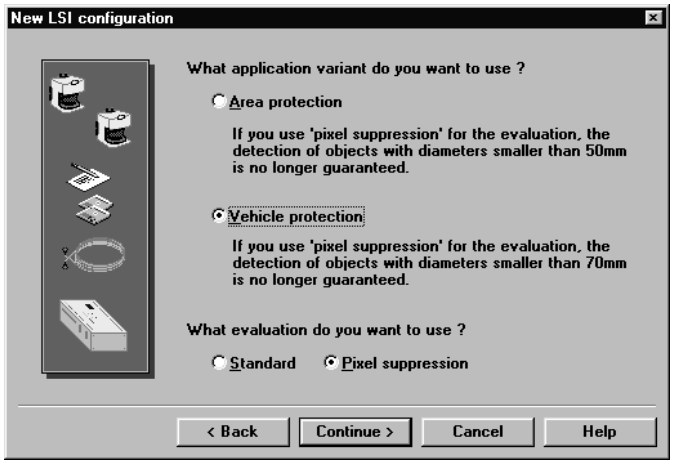
Note:
You can also edit the taught-in protective field subsequently and then transmit it as a segmented protective field to the LSI.

9.7 Adapt protective fields to speed

When using the LSI on a vehicle, you can switch between protective fields of different shapes and sizes depending on the speed of the vehicle. In this way you can adapt the monitoring area flexibly to the environment and speed of the vehicle.

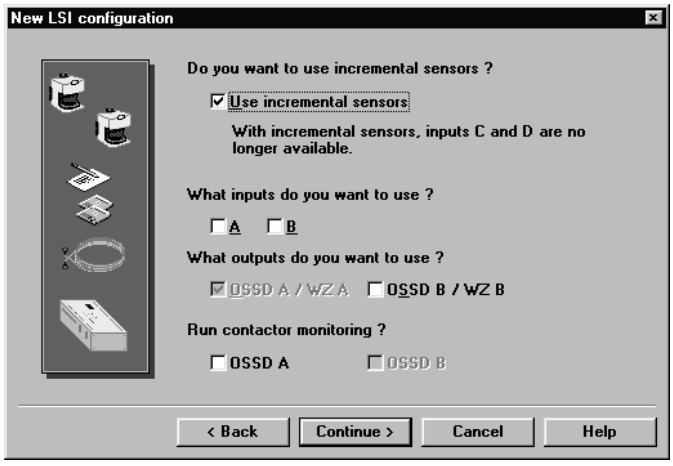
You need to connect incremental sensors to the LSI for this. The LSI receives the speed data from the incremental sensors and switches to a different monitoring case as required.

- Determine the number of pulses each incremental sensor delivers per centimeter covered by your vehicle (a calculation example for a typical application is given in the appendix, section 11.1).
- To enable to configuration to be transferred subsequently to the LSI, log on as an "Authorized Client" by choosing **LSI - User Category** from the menu.
- From the menu choose **File - New** and in the dialog boxes define a LSI configuration with the following settings:



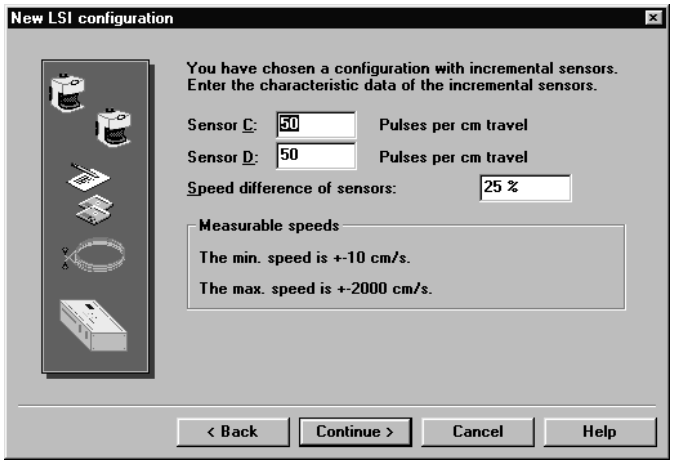
– Application variant: Vehicle protection

– Pixel suppression active: This is the recommended setting to avoid error shutdowns and to improve system availability.



– Use incremental sensors: As a result inputs C and D are automatically occupied and are no longer available for you to use.

– Activate inputs and outputs, and contactor monitoring, as required.
(In the example no other input is configured apart from the incremental sensors. Output OSSD A is connected to the brake system of the vehicle in this case.)

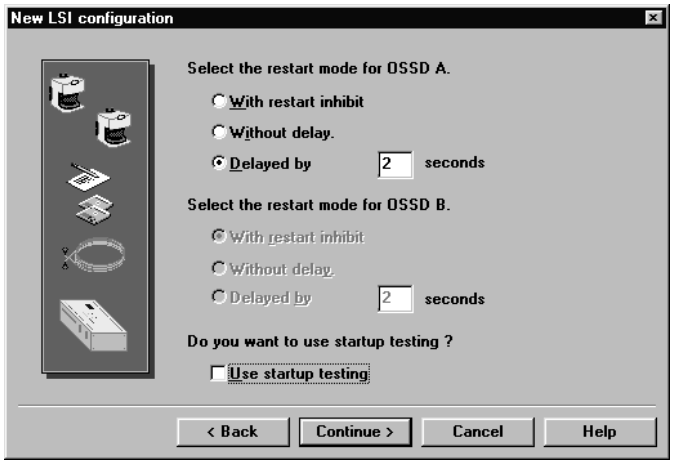


– Number of pulses of the incremental sensors per centimeter travel of your vehicle: Enter here the values you determined for your application
(a calculation example for a typical application is given in the appendix, section 11.1).

Note:
The maximum possible speed of the vehicle is displayed in the box.
The minimum recordable speed is ± 10 cm/s.
For technical reasons, and to provide greater availability, lower speeds are ignored, or interpreted as 0 cm/s.

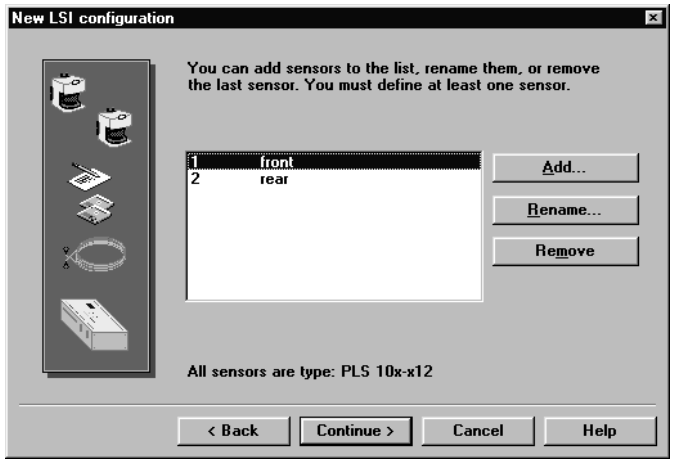
– Speed difference between the two incremental sensors: The recommended setting is 25 %. The values of the two incremental sensors must only deviate from each other by up to this amount.

Note:
The speed difference entered here may be exceeded for max. 20 seconds, e.g. for cornering. Activation of the protective field in such cases is always based on the higher of the two speed values. This guarantees maximum safety.



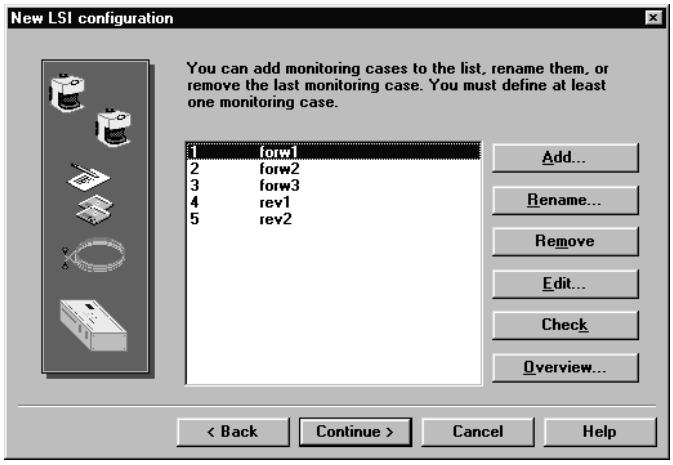
– Set the restart behavior for the outputs according to your needs.
(In this example delayed restart after two seconds is selected for the configured output OSSD A.)

– Startup testing off: This is the recommended setting.

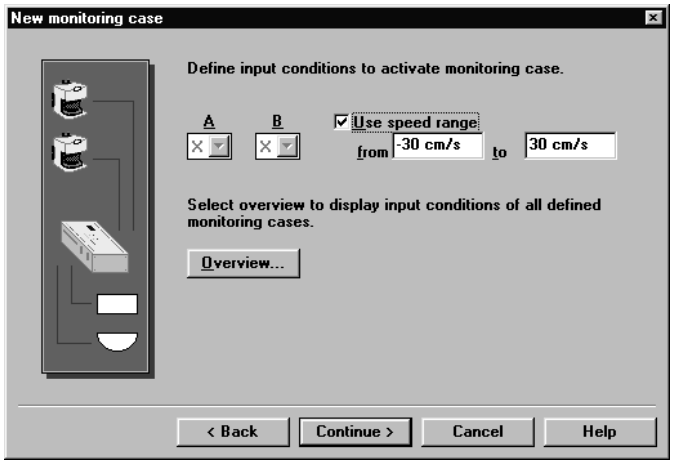


– Log on and name sensors:
(In the example the two sensors used are named according to their position on the vehicle: one sensor is mounted at the front, the other at the rear, to monitor forward and reverse movement of the vehicle.)

– Enter and name monitoring areas:
(In the example three monitoring areas are used, named according to their size.)



– Define monitoring cases: Click on ”Add” and make the settings you need for your application.
Enter a name for each monitoring case and assign sensors and monitoring areas as described in section 9.3 for the entry example.
(In the example five monitoring areas are defined: three for forward and two for reverse.)

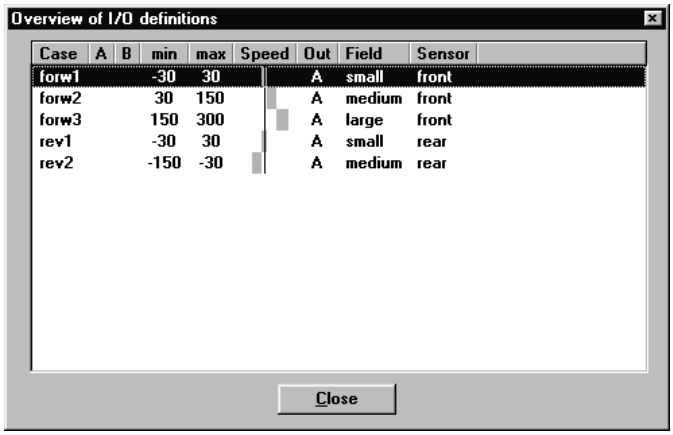


– Use speed range: Activate this option and enter the speed range in which the monitoring case is to be active.

Notes:
To avoid errors, make sure that a monitoring case is defined for every speed which may occur on the vehicle.

Speeds between -10 cm/s and +10 cm/s are interpreted as 0 cm/s, for technical reasons. You can therefore only enter values less than -10 cm/s or greater than +10 cm/s. To cover the range ±10 cm/s, enter speed ranges as follows for example:
– For forward: From -10 cm/s to + 150 cm/s
– For reverse: From -300 cm/s to + 10 cm/s
The negative value is always positioned at the left.

When defining speed ranges, note that a maximum of two monitoring cases can be active at any one time (simultaneous monitoring cases).



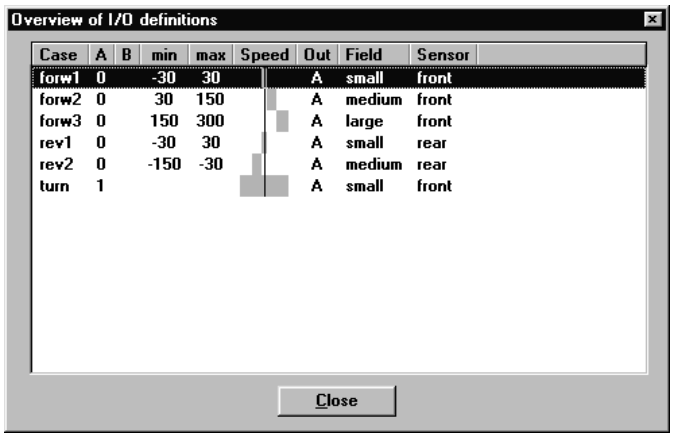
– As a check, click on ”Overview”. This will show you the monitoring cases with the associated sensors, fields and speed ranges.
(In the example five monitoring cases are defined: three for forward at different speeds, and two for reverse. The monitoring cases ”forw1” and ”rev1” are active simultaneously (simultaneous monitoring cases), and protect the vehicle in both directions at slow speeds.)

– Edit monitoring areas: Define the shape and size of the various protective and warning fields for your application, as described in sections 9.3 and 9.5.

Further tips and hints:
In section 11.1 you will find a number of examples of applications with further options for implementing your on-vehicle application in a configuration with incremental sensors.

Section 9.8 describes how you can simulate monitoring cases on PC to check the assignment of the sensors and fields at various speeds.

In section 9.10 you will find information on the ”I/O Monitor” menu function, with which you can receive and log the switching states of the inputs and outputs and of the incremental sensors from the LSI during operation.



A note about turning on-the-spot:
For turning on-the-spot, the directional information delivered by the two incremental sensors differs. Under normal circumstances this would cause the LSI system to shut down. You can enable turning on-the-spot by defining a ”Turn” monitoring case as follows:
– The ”Use speed range” option is deactivated for this monitoring case. The data of the incremental sensor are then not evaluated during turning. In the overview (see diagram) the entire speed range of the vehicle is then highlighted.
– Apart from the incremental sensors, one other input must be configured, e.g. input A, with the sole function of activating the ”Turn” monitoring case. This input must be set to ”0 = low” in all other monitoring cases.

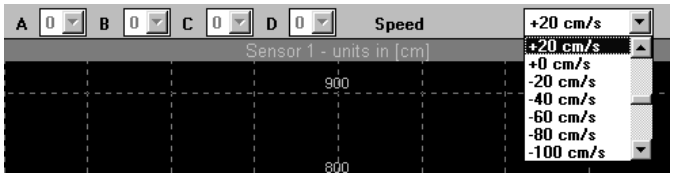
9.8 Simulate monitoring cases

You can check the settings of the monitoring cases by simulating the input conditions of each individual monitoring case on your PC. In this way you can check whether sensors and fields are correctly assigned in every monitoring case.

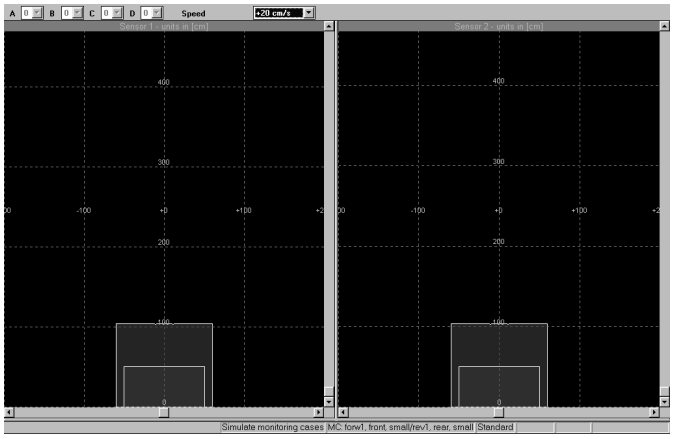
- From the menu choose **LSI - Monitoring Cases - Simulate**.
- Or choose the ”Simulate Monitoring Cases” button from the toolbar.

A dialog box appears displaying the logged-on sensors.

- For the available inputs (A, B, C, D) define the desired state:
  0 – low
  1 – high



- If you have connected incremental sensors, check the ”Speed” checkbox and enter the speed you want in the list.



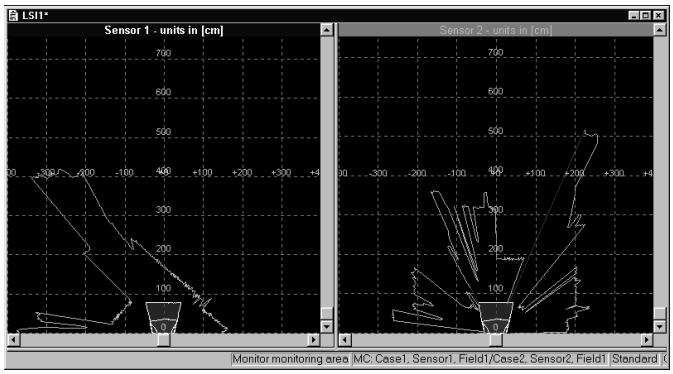
The dialog box shows the monitoring cases active under these input conditions: the active monitoring area appears in the window of the sensor to which it is assigned for the monitoring case in question.
In the example two sensors are present. Under the pre-set input conditions two monitoring cases are active at once (simultaneous monitoring case).

The names of the active monitoring cases are shown in the status bar at the bottom of the dialog box.

9.9 Monitor protective fields

You have the option of monitoring the space contour and the defined protective fields in operation, by means of a connected PC.

- From the menu choose **Monitoring Area - Monitor**.
- Or click on the ”Monitor Monitoring Area” button on the toolbar.

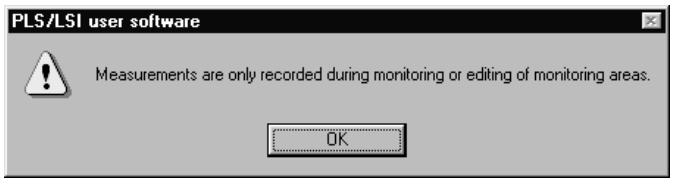


You see the active sensor with the active monitoring case on-screen.
(In the example two sensors are logged on and two monitoring cases active simultaneously).
On the status bar at the bottom of the screen there is a color key for on-screen indication of protective fields and warning fields.

Save space contour

You can receive and save the defined space contour of a sensor. In this way, when error shutdowns occur you can check at which point the protective field was infringed.

- From the menu choose **LSI - Tools - Measurements - Record Measurements**.
- Specify a file name under which the measured values are to be stored and click on ”OK”.



This dialog box appears.

- Click on ”OK”.
- From the menu choose **Monitoring Area - Monitor**.
- Or click on the ”Monitor Monitoring Area” button on the toolbar.

The measurements are recorded.

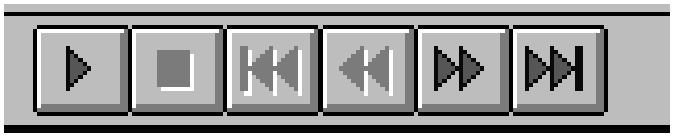
To terminate recording:

- Deactivate the **Monitoring Area - Monitor** menu function.
- From the menu choose **LSI - Tools - Measurements - Terminate Recording**.

To run through recorded measurements:

- From the menu choose **LSI - Tools - Measurements - Run Measurements**.
- Select the desired file and click on ”OK”.

The recorded measurements are run through. Where the space contour protrudes into the protective field it is represented in red.



On the toolbar you have six additional buttons with which you can control the recording process, as on a CD player.

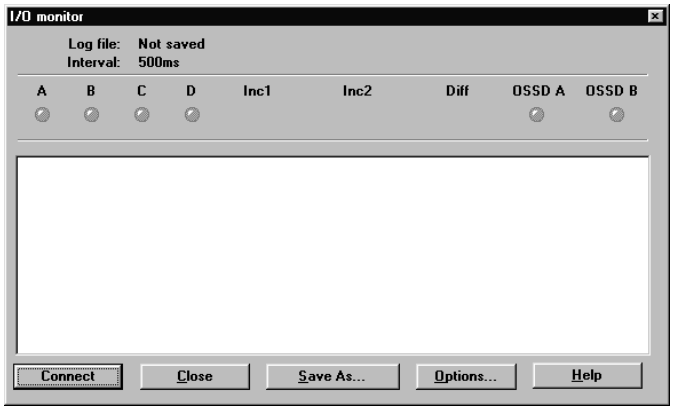
To terminate run-through:

- Deactivate the **LSI - Tools - Measurements - Run Measurements** menu function.

9.10 Monitor inputs and outputs

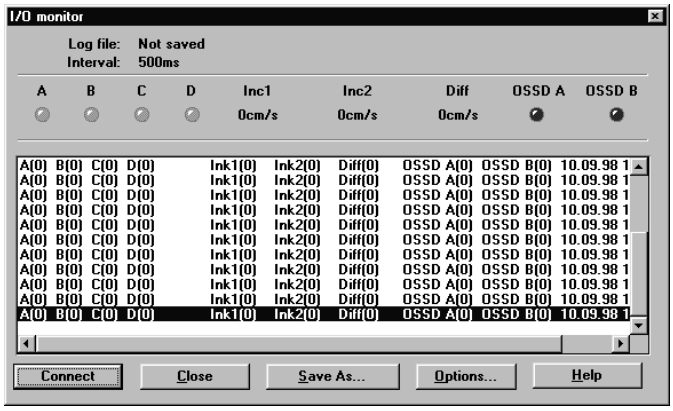
You can monitor and log the switching states of the LSI inputs and outputs. You can save the data obtained to an ASCII file for subsequent evaluation.

- From the menu choose **LSI - Tools - I/O Monitor**.



This dialog box appears.

- Click on ”Connect”.



The states of the inputs and outputs are displayed in the top section of the window, and at the same time are logged as ASCII text.

If you are using the LSI on a vehicle and have connected incremental sensors, here you can read-off and record the speed data and the speed difference between the two incremental sensors during operation for example.

To terminate recording:

- Click on ”Stop”. The connection to the LSI is cut and recording is terminated.

Change interval for recording:

- Click on ”Options” and set the interval as required.

Save data:

- Click on ”Save As” and save the gathered data to an ASCII file for subsequent evaluation.

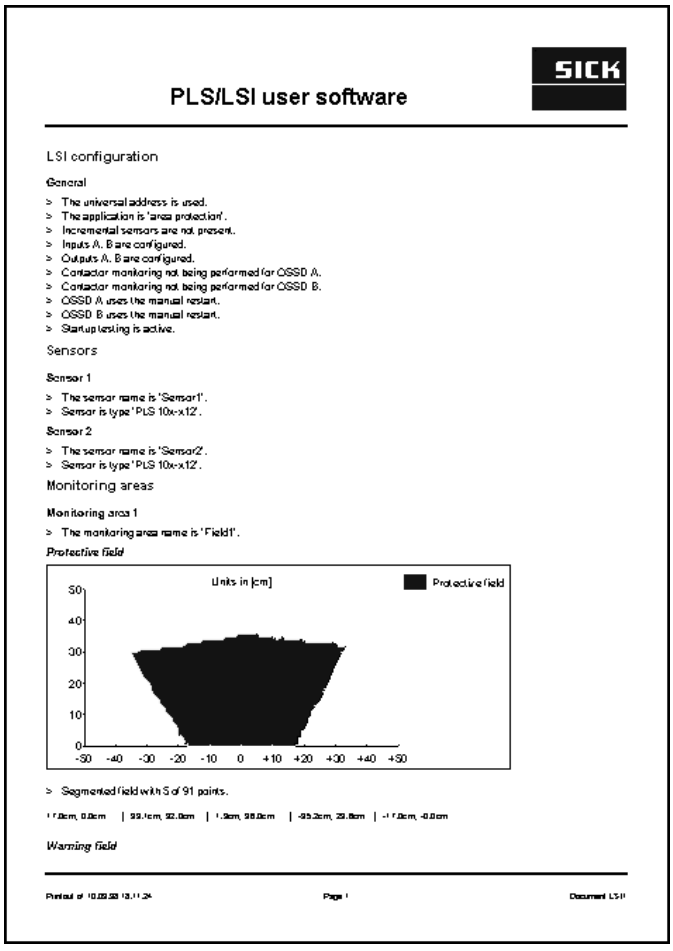
Terminate monitoring of inputs and outputs:

- Click on ”Close”.

9.11 Check settings

You can call up an overview at any time showing all the configuration and monitoring area settings. You can also print out the overview.

Note:
This page view does not show you the actual configuration active in the LSI, but only the settings you are currently editing on the PC. How to receive the active configuration from the LSI and print it is described in the next section.


PLS/LSI user software

LSI configuration

General

> The universal address is used.
> The application is 'area protection'.
> Incremental sensors are not present.
> Inputs A, B are configured.
> Outputs A, B are configured.
> Contactor monitoring not being performed for OSSD A.
> Contactor monitoring not being performed for OSSD B.
> OSSD A uses the manual restart.
> OSSD B uses the manual restart.
> Start up testing is active.

Sensors

Sensor 1

> The sensor name is 'Sensor1'.
> Sensor is type 'PLS 10x-x12'.

Sensor 2

> The sensor name is 'Sensor2'.
> Sensor is type 'PLS 10x-x12'.

Monitoring areas

Monitoring area 1

> The monitoring area name is 'Field1'.

Protective field

> Segmented field with 5 of 91 points.

Warning field

- From the menu choose **File - View**.

Several pages appear listing all the configuration settings in text and diagrams. You can check over your settings any time here.

Scroll through pages:

- Click on the ”Next” or ”Previous” button.

Change view:

Click on the ”One Page” / ”Two Pages” button.

Change size of screen view:

You can zoom the screen view in or out in two stages.

- Click on the ”Zoom In” or ”Zoom Out” button. The view is zoomed or unzoomed one stage.
- Or click on the place you want to zoom into. The view is zoomed one stage at the selected point.

Print page:

- Click on the ”Print” button.

9.12 Receive and store configuration

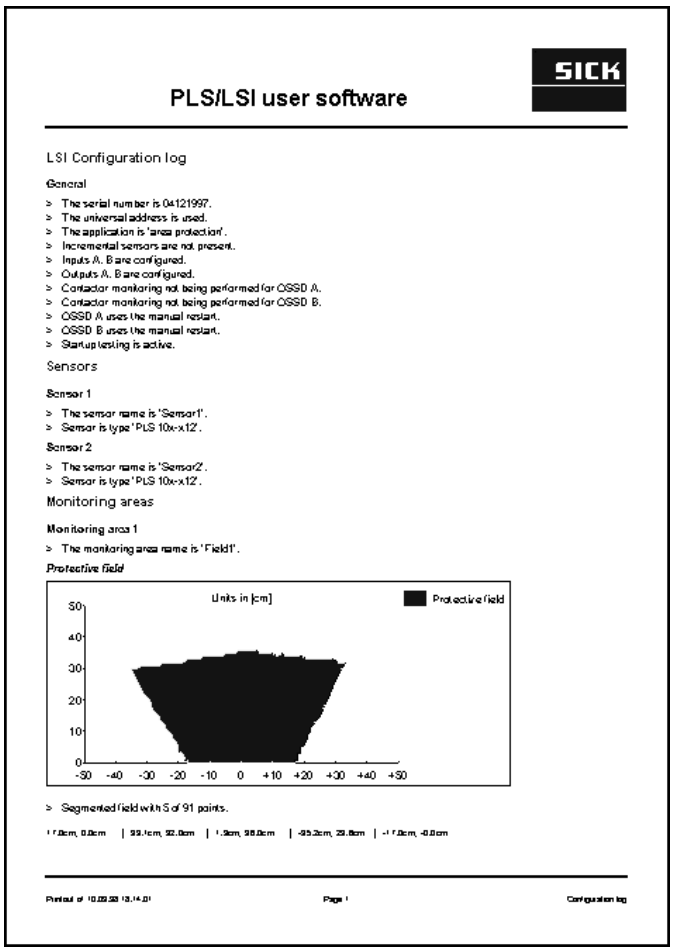
Receive configuration from LSI

You can receive and print or save the configuration data stored in the LSI.

- From the menu choose **LSI - Configuration - Configuration Log**.

The PC receives the current configuration from the LSI.

The screen displays an overview of all the configuration settings stored in the LSI.


PLS/LSI user software

LSI Configuration log

General

- The serial number is 04121997.
- The universal address is used.
- The application is 'area protection'.
- Incremental sensors are not present.
- Inputs A, B are configured.
- Outputs A, B are configured.
- Contactor monitoring not being performed for OSSD A.
- Contactor monitoring not being performed for OSSD B.
- OSSD A uses the manual restart.
- OSSD B uses the manual restart.
- Start up testing is active.

Sensors

Sensor 1

- The sensor name is 'Sensor1'.
- Sensor is type 'PLS 10x-x12'.

Sensor 2

- The sensor name is 'Sensor2'.
- Sensor is type 'PLS 10x-x12'.

Monitoring areas

Monitoring area 1

- The monitoring area name is 'Field1'.

Protective field

- Segmented field with 5 of 91 points.

Scroll through pages:

- Click on the ”Next” or ”Previous” button.

Change view:

Click on the ”One Page” / ”Two Pages” button.

Change size of screen view:

You can zoom the screen view in or out in two stages.

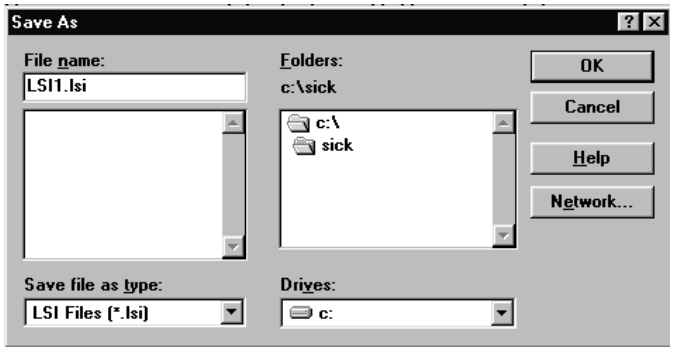
- Click on the ”Zoom In” or ”Zoom Out” button. The view is zoomed or unzoomed one stage.
- Or click on the place you want to zoom into. The view is zoomed one stage at the selected point.

Print log:

- Click on the ”Print” button.

Store configuration log

- Click on the ”Save” button.



This dialog box appears.

- Specify a file name under which the configuration log is to be stored and click on ”OK”.

You can call up the stored file again later to change the settings or transmit them to the LSI.

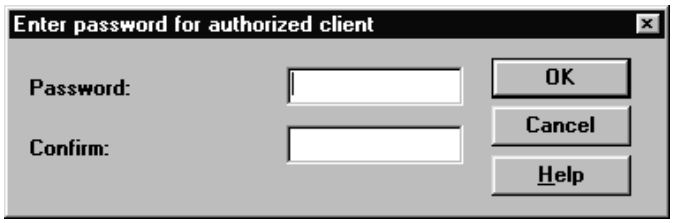
9.13 Change password

To be able to send configuration data and monitoring areas to the LSI, you must log on as an ”Authorized Client” or as ”SICK Service”. This requires a password (default: ”SICK_PLS”).

To protect your LSI system against manipulation, you should change the default password and keep it in a safe location accessible only to authorized persons.

To change the password:

- From the menu choose **LSI - User Category**, or click on the ”Logon/Logoff User Category” button on the toolbar.
- Log on as an ”Authorized Client”, using the old password (e.g. ”SICK_PLS”).
- Choose **LSI - Password - Change for Authorized Client**.



This dialog box appears.

- Type in the new password twice - once in each box. On-screen it is shown only as a series of asterisks.
- Confirm with ”OK”.

The new password is stored in the LSI.

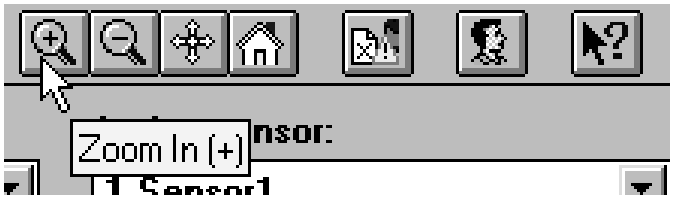
- Log off.
- Make a note of the new password at a location accessible only to authorized persons.

Note:
The new password takes immediate effect.
But please be sure to always log off before leaving your workstation! Only if you do so can the password protect your LSI system against manipulation.

9.14 Change screen view

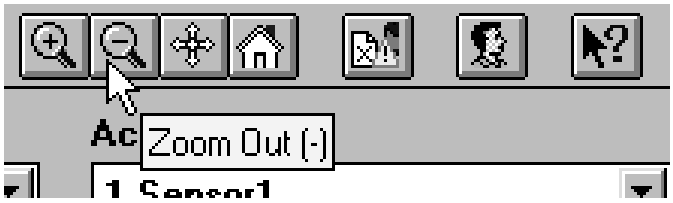
You can enlarge, reduce or move the fields on-screen to make them look as you want.
You can also choose between a circular and a rectangular background.

Enlarge or reduce view



- Click on the ”Zoom In” button on the toolbar.

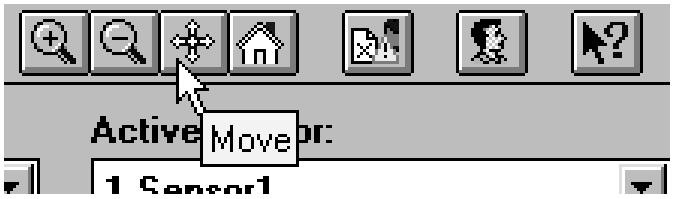
The zoomed segment is zoomed one stage further with every click of the mouse.



- Or click on the ”Zoom Out” button on the toolbar.

The zoomed segment is unzoomed one stage further with every click of the mouse.

Move view

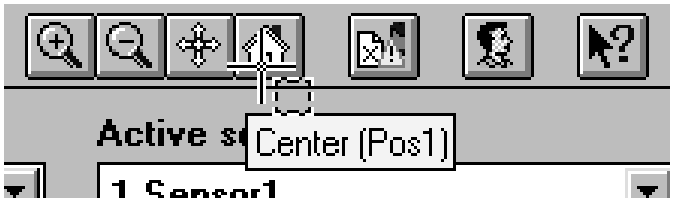


- Click on the ”Move” button on the toolbar. The cursor changes shape into a four-pointed arrow.
- Hold the mouse button pressed down and move the screen segment to where you want it.

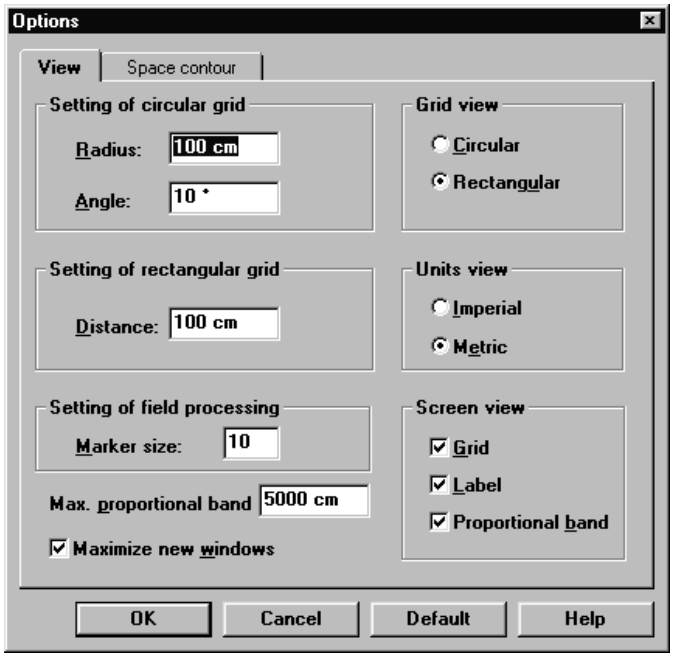
... or:

- Move the view using the scroll bars at the right and bottom of the screen.

Center view



- Click on the ”Center” button on the toolbar. The zero point is now back in the center of the screen.



Change grid pattern

You can switch between rectangular and circular grid patterns.

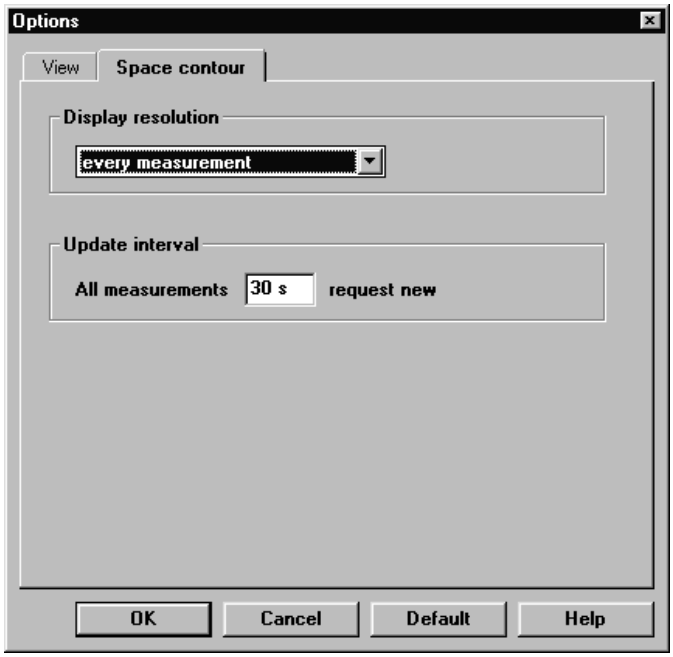
- From the menu choose **View - Options**.
- In the dialog box select the ”View” tab.
- Check the checkbox for rectangular or circular grid pattern.
- Set your desired grid width.
- Set the marker size you want to edit the fields with.
- Set your desired maximum visible area.
- Check the checkbox for metric or imperial units.
- Check the checkboxes to display the grid pattern, labels and visible area on-screen.

Restore defaults:

- Click on the ”Default” button. All values are reset to their defaults.

Confirm settings:

- Click on ”OK”.



Set displayed measurements

You can set how many measured values of the space contour are to be displayed in monitoring and editing of the fields.

Note:
The more measured values you display, the more accurate the display will be, but the slower it will be too.

- From the menu choose **View - Options**.
- Select the ”Space Contour” tab.
- Under ”Display resolution”, select how many measured values of the space contour you want to evaluate.
- Enter the time intervals at which new values are to be requested during editing.

9.15 Interrogate fault memory (system diagnosis)

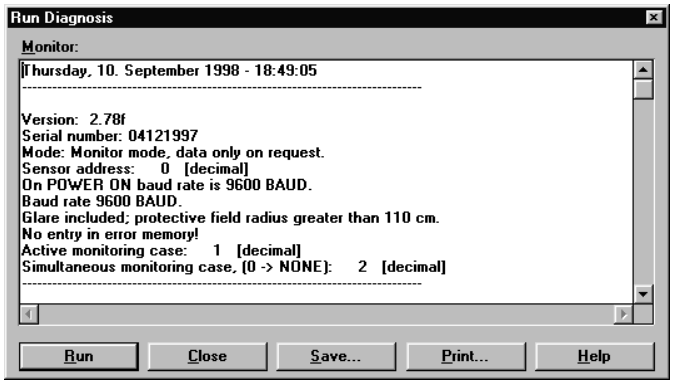
If your LSI is not functioning as you would like it, you can interrogate the fault memory of the LSI in a number of different steps to localize possible faults.

The fault table in section 10.2 will tell you what to do then to rectify the fault.

Initial fault diagnosis

As the first step you can carry out a simple diagnosis to localize faults.

- From the menu choose **LSI - Diagnosis**.



This dialog box appears.

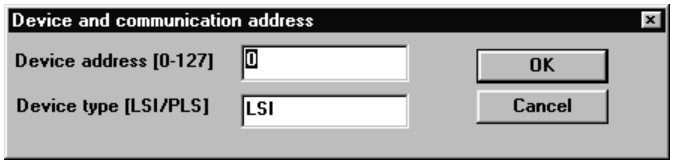
- Click on ”Run”.

The diagnosis is carried out and the window displays information on the current status of your LSI system.
The fault codes are given in the bottom section of the list display. To find out what the fault codes mean, and whether you can rectify the fault yourself, refer to the fault table in section 10.2.

If necessary you can also carry out a second diagnosis to get more detailed information. The more detailed diagnosis is described in the following.

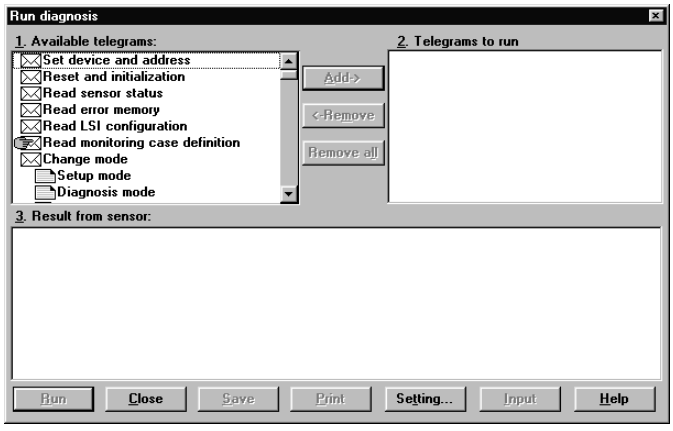
Interrogate LSI fault memory

- From the menu choose **LSI - SICK Diagnosis**.



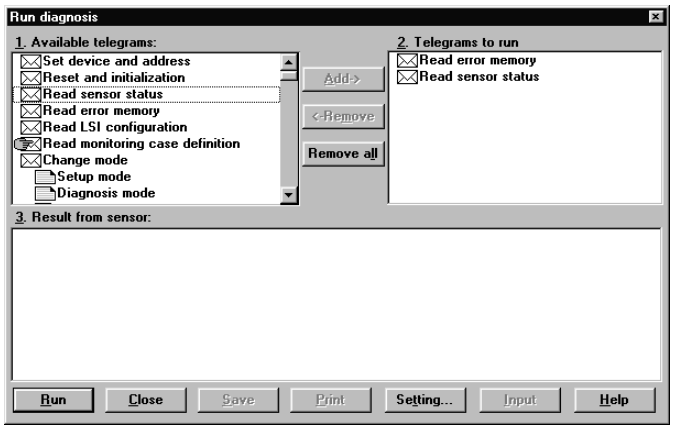
This dialog box appears.

- Make sure zero is entered as the device address and ”LSI” as the device type, and confirm with ”OK”.
  (This assumes the device address has not yet been changed. If you have assigned the LSI a different address, you must enter the changed address accordingly here.)



The ”Run Diagnosis” dialog box appears. In it you will find various telegrams with which you can execute additional commands and functions.

- In the list of available telegrams select the ”Read fault memory” telegram and click on ”Add”.
- Select the ”Read sensor status” telegram and click on ”Add”.



The two telegrams are now entered one under the other in the list of telegrams for diagnosis.

- Click on ”Run”.

The fault memory of the LSI and the sensor status are read, and the result log is displayed in the box at the bottom of the screen. You can find out what the listed fault codes mean from the fault table in section 10.2.

You can add supplementary information to the result log, print it, or save it as a file.

Enter supplementary information:
- Click on ”Input” and enter the text you want. Your text is then appended to the result log.

Print result log:
- Click on ”Print”.

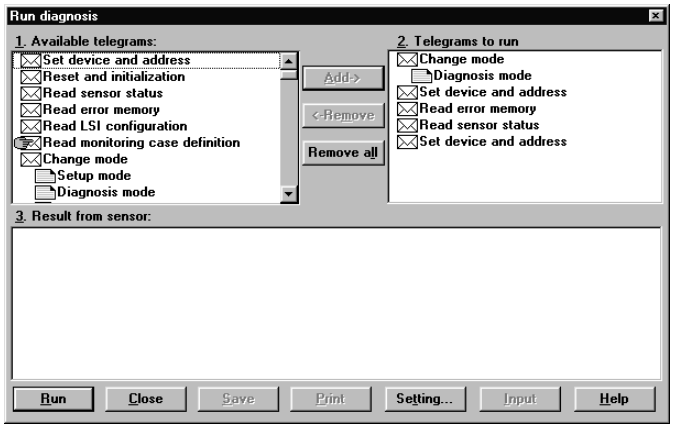
Save result log as file:
- Click on ”Save” and enter a file name and destination directory/folder.

Note:
When you have rectified the fault reset the LSI: choose **LSI - Initialize**.
Or execute the ”Reset and initialization” telegram in the SICK diagnosis.
The LSI system is then restarted.

Interrogate sensor fault memory

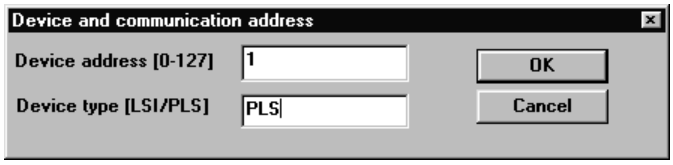
In some cases it may be necessary to interrogate the fault memory of a sensor directly.

- From the menu choose **LSI - Sick Diagnosis** and enter zero as the device address and ”LSI” as the device type, as described above. Click on ”OK”.



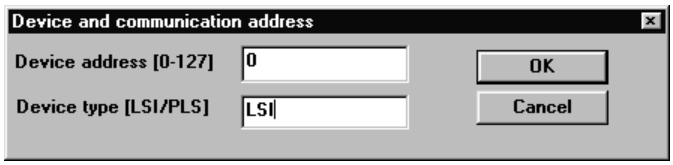
The ”Run Diagnosis” dialog box appears.

- Insert the following telegrams in sequence in the list of telegrams to be executed:
  - ”Switch mode: Diagnosis mode”
  - ”Set device and address”
  - ”Read fault memory”
  - ”Read sensor status”
  - ”Set device and address”
- Click on ”Run”.



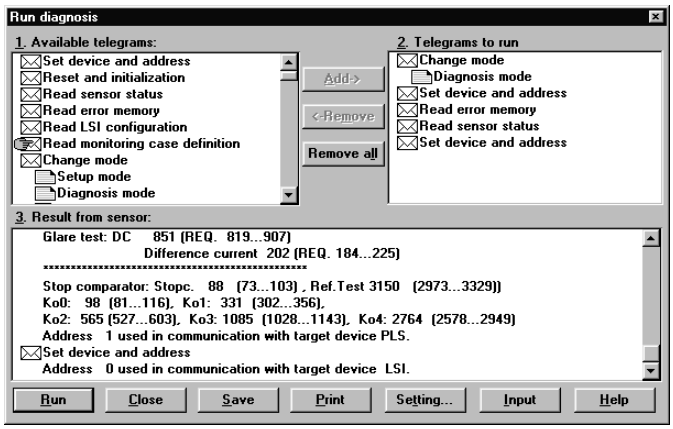
While the telegrams are being executed, a dialog box appears in which you need to enter the device address of the sensor:

- Enter the device address of the desired sensor (1 to 4) and ”PLS” as the device type.
- Click on ”OK”.



A second dialog box appears in which you need to enter the device address of the LSI:

- Enter the device address as zero and ”LSI” as the device type.
- Click on ”OK”.



The fault memory and the sensor status of the PLS are read, and the result log is displayed in the box at the bottom of the screen.
You can find out what the sensor fault codes mean from the technical description of the PLS.

- Rectify the fault and reset the LSI system as described below:

In case of PLS fault:

- Switch the power to the PLS off and then back on again. Then choose **LSI - Initialize** from the menu to reset the LSI system.

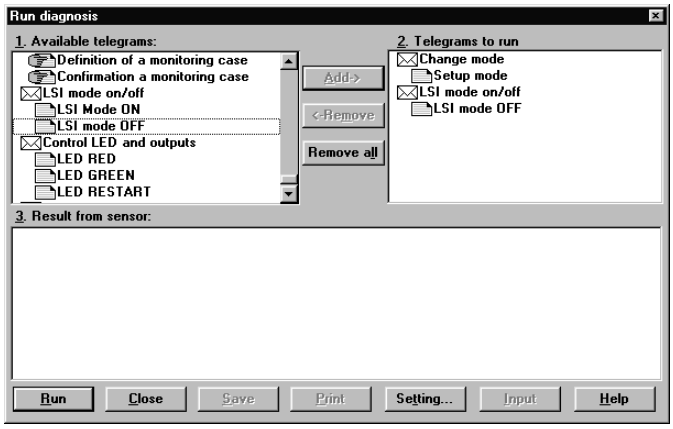
In case of LSI fault:

- Choose **LSI - Initialize** from the menu to reset the LSI system.
  Or execute the ”Reset and initialization” telegram in the SICK diagnosis. The LSI system is restarted.

Deconfigure sensor

A sensor which was connected up to a LSI system is programmed for operation on a LSI. Before disconnecting it from the LSI and to enable it to be used on its own, you must deconfigure it by means of the SICK diagnosis.

- From the menu choose **LSI - SICK Diagnosis** and enter zero as the device address and ”LSI” as the device type, as described above. Click on ”OK”.



The ”Run Diagnosis” dialog box appears.

- Insert the following telegrams in sequence in the list of telegrams to be executed:
  – ”Switch mode: Setup mode”
  – ”LSI mode on/off: LSI mode OFF”
- Click on ”Run”.

All connected sensors are deconfigured. You can disconnect them from the LSI and use them on their own.

Note:
If you want to use sensors without LSI, follow the instructions given in the technical description of the PLS.

10 Care and Maintenance

10.1 LEDs on the LSI

On the LSI and the PLSs there are light-emitting diodes (LEDs) which deliver important information on the functioning of your system. Here you can find out what the LEDs indicate.

LSI LEDs:

Status	OSSD (Green)	WEAK/ ERROR (Yellow)	RES (Yellow)	OSSD (Red)
Protective field free	≥◎≤			
Object in protective field				≥◎≤
Contamination warning *		≥◯≤ 1 Hz		
Contamination *		≥◎≤		≥◎≤
Fatal error **		≥◯≤ 4 Hz		≥◎≤
Startup testing				≥◎≤
Waiting for restart			≥◯≤ 1 Hz	≥◎≤

PLS LEDs:

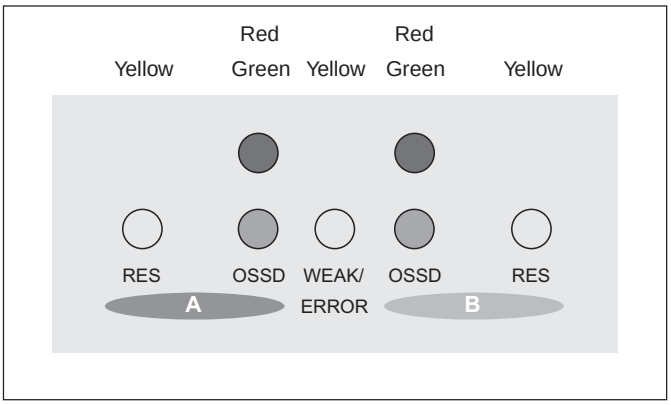
Status	Green	Yellow	Red
Protective field free	≥◎≤		
Object in protective field			≥◎≤
Contamination warning *		≥◯≤ 1 Hz	
Contamination *		≥◎≤	≥◎≤
Fatal error **		≥◯≤ 4 Hz	≥◎≤
Startup testing	≥◎≤		
Waiting for restart		≥◯≤ 1 Hz	≥◎≤

Output levels on LSI:

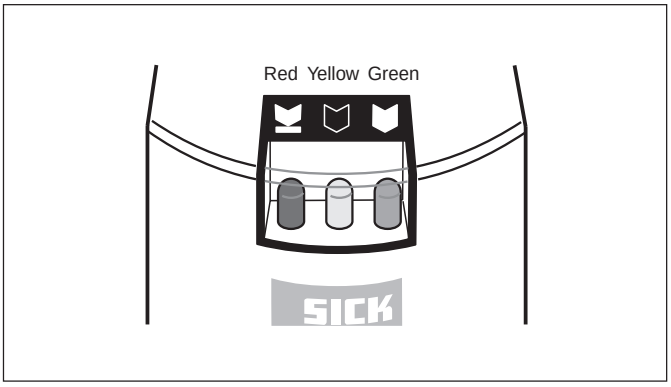
Status	Output OSSD	Output Warning field	Output ERROR
Protective field free	⌐¯		
Warning field free		⌐¯	
Object in protective field	¬_		
Object in warning field		¬_	
Contamination warning *			¬_
Contamination *	¬_	¬_	¬_
Fatal error **	¬_	¬_	¬⌐¬ 4 Hz
Startup testing	_		
Waiting for restart	_		

≥◎≤ = LED lit
≥◯≤ 1 Hz = LED flashing slowly
≥◯≤ 4 Hz = LED flashing rapidly
⌐¯ = Output switches to high
¬_ = Output switches to low
_ = Output constantly low
¬⌐¬ 4 Hz = Output switches between high and low

* Clean front screen of sensor with plastic cleaner and a soft cloth.
** System error: Carry out system diagnosis (see section 9.15).



LEDs on the LSI



LEDs on the PLS sensor

10.2 LSI fault table

From this table you can find out what the SICK diagnosis fault codes mean, and ascertain whether you can rectify the fault yourself. How to carry out SICK diagnosis is described in section 9.15.

Note:
If you get a fault code which you are unable to locate in this table, please contact the SICK Service Department.

10.3 SICK Service / Hotline

If you have any further queries, please contact your local Sick office.

Fault code:	Cause / What to do:
0	**System OK**
11 - 21	**Communication error between PLS and LSI:** Check communication line. Switch power off and back on again.
32 - 35	**Internal error:** Switch power off and back on again. Replace the LSI, or contact SICK Service.
41	**Sensor error:** Switch power off and back on again. Replace the PLS, or contact SICK Service.
43	**Sensor has no default password:** Contact SICK Service to configure the default password.
44	**Wrong sensor address:** Check wiring between LSI and sensors. Reconfigure LSI.
56	**Configuration error:** Check wiring between LSI and sensors.
57	**Internal error:** Switch power off and back on again. Replace the LSI, or contact SICK Service.
59	**Initialization error on channel 1:** Contact SICK Service.
60	**Initialization error on channel 2:** Contact SICK Service.
61, 63	**OSSD error:** Check output load. Switch power off and back on again. Replace the LSI, or contact SICK Service.
64 - 106	**Internal error:** Switch power off and back on again. Replace the LSI, or contact SICK Service.

Fault code:	Cause / What to do:
110	**Measurement telegram error sensor 1:** Check wiring between LSI and sensor 1. Interrogate sensor fault memory (see section 9.15) , or contact SICK Service.
111	**Measurement telegram error sensor 2:** Check wiring between LSI and sensor 2. Interrogate sensor fault memory (see section 9.15) , or contact SICK Service.
112	**Measurement telegram error sensor 3:** Check wiring between LSI and sensor 3. Interrogate sensor fault memory (see section 9.15) , or contact SICK Service.
113	**Measurement telegram error sensor 4:** Check wiring between LSI and sensor 4. Interrogate sensor fault memory (see section 9.15) , or contact SICK Service.
114	**Initialization error sensor 1:** Check wiring between LSI and sensor 1. Check that connected sensor type matches configured type. Reconfigure LSI, or contact SICK Service.
115	**Initialization error sensor 2:** Check wiring between LSI and sensor 2. Check that connected sensor type matches configured type. Reconfigure LSI, or contact SICK Service.
116	**Initialization error sensor 3:** Check wiring between LSI and sensor 3. Check that connected sensor type matches configured type. Reconfigure LSI, or contact SICK Service.
117	**Initialization error sensor 4:** Check wiring between LSI and sensor 4. Check that connected sensor type matches configured type. Reconfigure LSI, or contact SICK Service.
118	**Protective field configured too large:** Adapt size of protective field to sensor type.
120	**Contamination on sensor 1:** Check and clean front screen of sensor.
121	**Contamination on sensor 2:** Check and clean front screen of sensor.
122	**Contamination on sensor 3:** Check and clean front screen of sensor.
123	**Contamination on sensor 4:** Check and clean front screen of sensor.
140 - 143	**Internal error:** Switch power off and back on again. Replace the LSI, or contact SICK Service.

Fault code:	Cause / What to do:
144	**Initialization error on channel 1:** Contact SICK Service.
145	**Initialization error on channel 2:** Contact SICK Service.
160	**Internal error:** Switch power off and back on again. Replace the LSI, or contact SICK Service.
161	**Measurement tolerance of incremental encoders exceeded by more than 25%:** Check connections of incremental encoders.
162	**Directional values of incremental encoders different:** Check connections of incremental encoders.
163	**Undefined input combination:** Check configuration of input conditions.
164	**Internal error:** Switch power off and back on again. Replace the LSI, or contact SICK Service.
165	**Wrong order of monitoring case switching:** Check setting of order in configuration (see section 9.4).
180	**Error in sensor 1:** Switch power off and back on again. Interrogate sensor fault memory (see section 9.15). Replace the sensor, or contact SICK Service.
181	**Error in sensor 2:** Switch power off and back on again. Interrogate sensor fault memory (see section 9.15). Replace the sensor, or contact SICK Service.
182	**Error in sensor 3:** Switch power off and back on again. Interrogate sensor fault memory (see section 9.15). Replace the sensor, or contact SICK Service.
183	**Error in sensor 4:** Switch power off and back on again. Interrogate sensor fault memory (see section 9.15). Replace the sensor, or contact SICK Service.
200	**Same levels at input A:** Check input levels at input A1 and A2. Levels must be inverse to each other.
201	**Same levels at input B:** Check input levels at input B1 and B2. Levels must be inverse to each other.

Fault code:	Cause / What to do:
202	**Same levels at input C:** Check input levels at input C1 and C2. Levels must be inverse to each other.
203	**Same levels at input D:** Check input levels at input D1 and D2. Levels must be inverse to each other.
204	**Faulty operation of inputs:** Check operation.
206	**Incorrect operation of RES A:** Check level and time response of RES A.
208	**Incorrect operation of RES B:** Check level and time response of RES B.
209	**Input frequency of incremental encoders above 100 kHz:** Check configuration of incremental encoders.
240	**Contactor monitor EDM A still open:** Check contactor monitor EDM A.
242	**Contactor monitor EDM A closed when output active:** Check contactor monitor EDM A. Switch power off and back on again. Replace the LSI, or contact SICK Service.
243	**Contactor monitor EDM A open when output inactive:** Check contactor monitor EDM A. Switch power off and back on again. Replace the LSI, or contact SICK Service..
244	**Contactor monitor EDM B still open:** Check contactor monitor EDM B.
246	**Contactor monitor EDM B closed when output active:** Check contactor monitor EDM B. Switch power off and back on again. Replace the LSI, or contact SICK Service.
247	**Contactor monitor EDM B open when output inactive:** Check contactor monitor EDM B. Switch power off and back on again. Replace the LSI, or contact SICK Service.
248	**Object in protective field:** Check ambient conditions. Adapt LSI configuration to ambient conditions.
249	**Object in warning field:** Check ambient conditions. Adapt LSI configuration to ambient conditions.
250	**Internal error:** Switch power off and back on again. Replace the LSI, or contact SICK Service

11 Appendix

11.1 Application examples

Notes:
Also follow the instructions given in the technical description of the PLS.

The application examples presented on the following pages are intended only as an aid. You may need to incorporate additional protective measures.

A risk exists that personnel could be inside the protection field before it is monitored by the PLS. Ensure that fields are selected before any hazard is likely to arise.

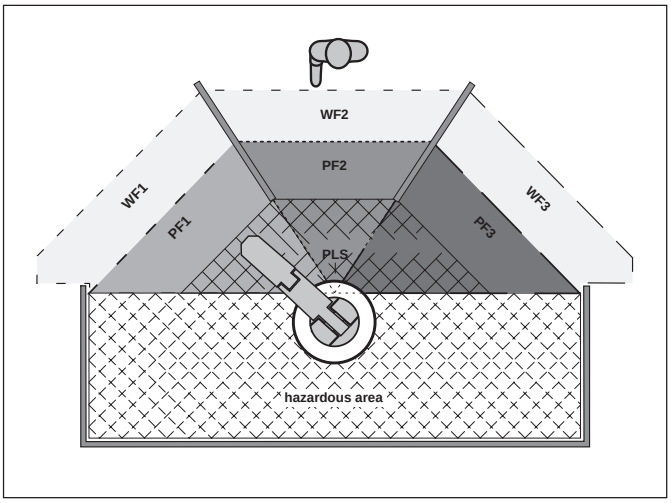
For area protection

Example 1: Machining centre with three load positions

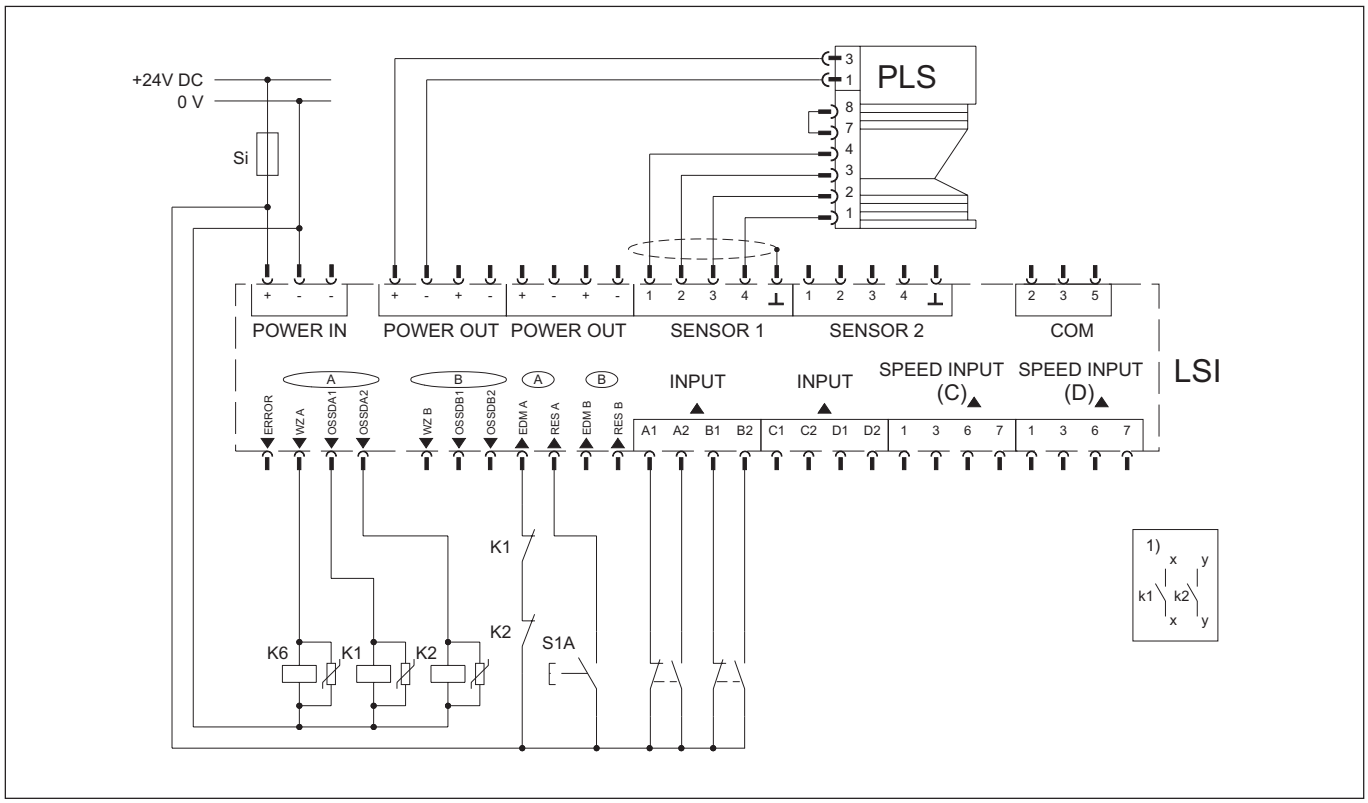
The LSI system is configured as follows:
- One PLS sensor connected
- Three monitoring areas defined (the protective and warning fields are shown in the diagram)
- One OSSD output and one warning field output configured
- Three monitoring cases configured, activated via the binary inputs
- Alternative order of monitoring cases

Note on the circuit diagram:
Use only relays with positively-driven contacts.
The protective elements switched in parallel with the contactors are for arc suppression.

1) Output circuits. These contacts are to be incorporated into the controller such that, when the output circuit is open, the hazardous state is controlled.
   In categories 3 and 4 to EN 954-1, they must be incorporated on two channels (x, y paths).



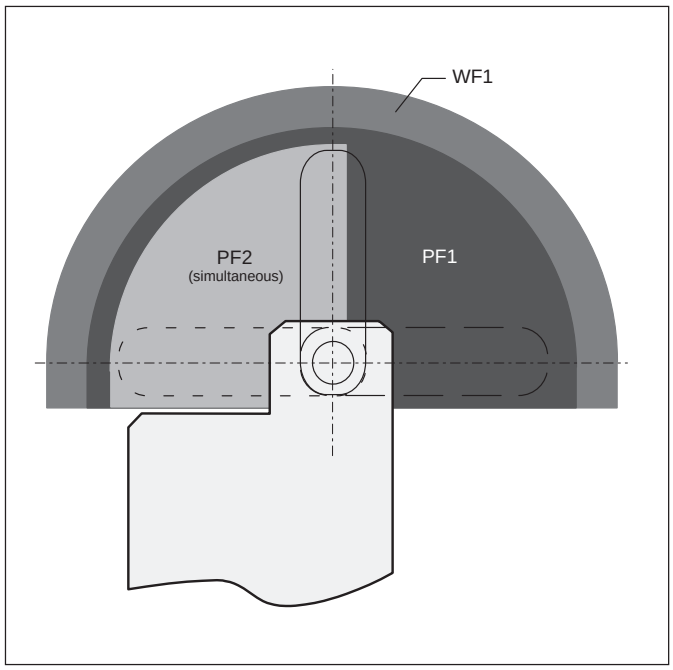
Example 1: Machining centre with three load positions



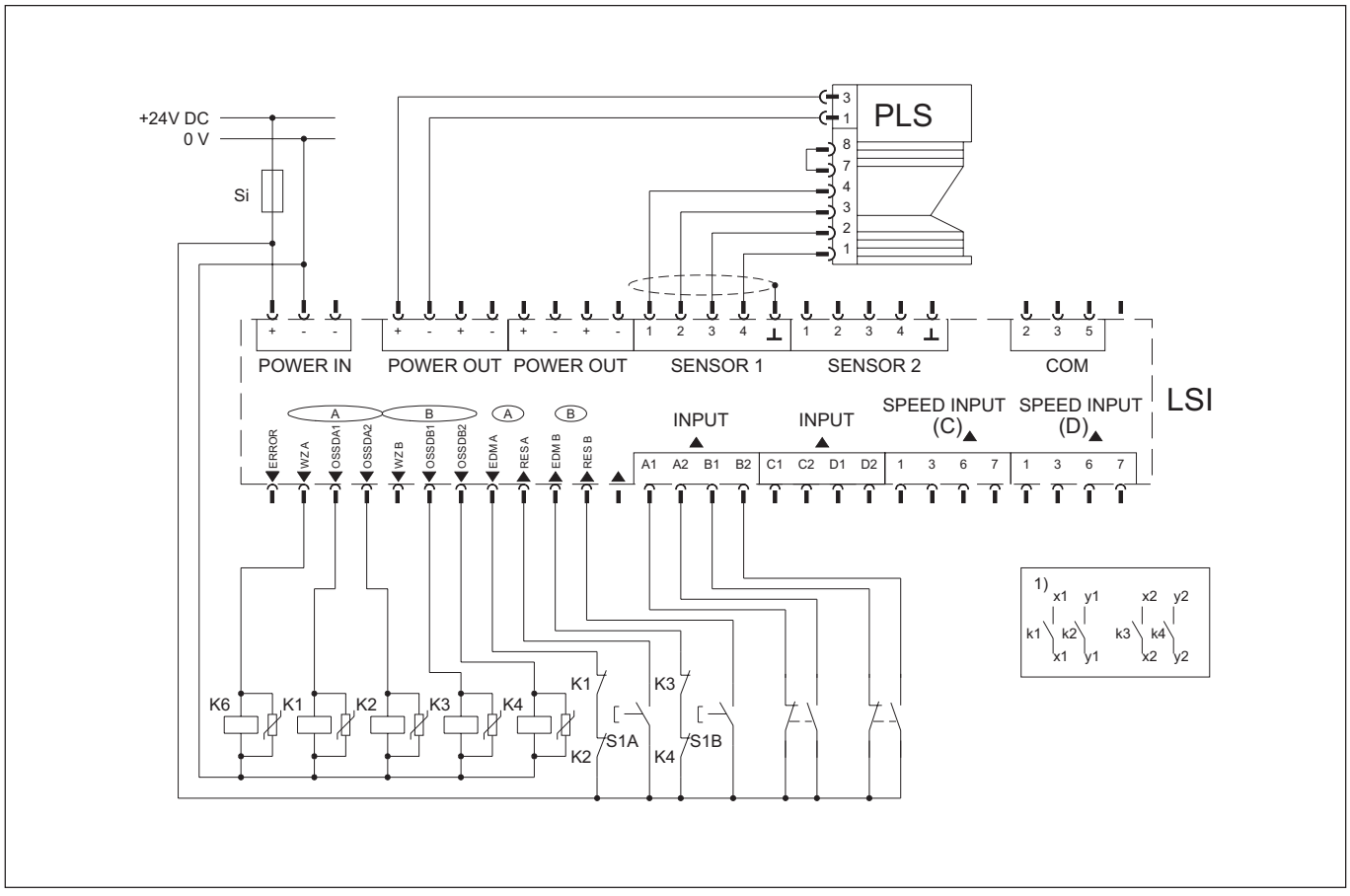
Example 2: Pipe bending machine

The LSI system is configured as follows:
– One PLS sensor connected
– Two protective fields (simultaneous) and one warning field defined
– Two OSSD outputs and one warning field output configured
– Three monitoring cases configured, activated via the binary inputs
– Any order of monitoring cases

Note on the circuit diagram:
Use only relays with positively-driven contacts.
The protective elements switched in parallel with the contactors are for arc suppression.
1) Output circuits. These contacts are to be incorporated into the controller such that, when the output circuit is open, the hazardous state is controlled.
In categories 3 and 4 to EN 954-1, they must be incorporated on two channels (x, y paths).



Example 2: Pipe bending machine



For vehicle protection

Example 3: Driverless Transport System (DTS), forward and reverse, with incremental encoders

Determine the number of pulses your incremental encoders deliver per centimetre covered by your vehicle.

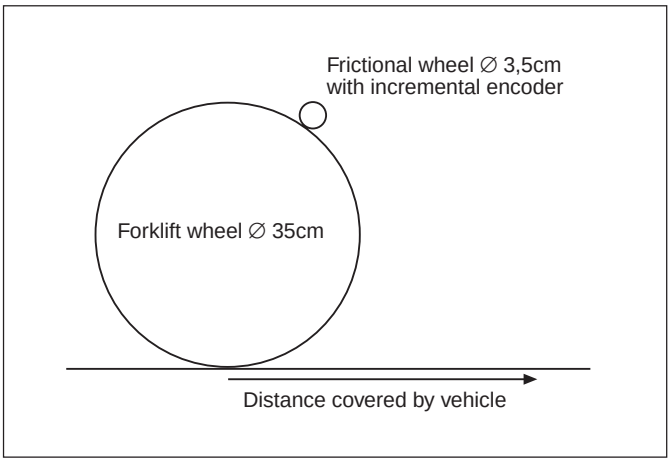
The result is dependent on the number of pulses the incremental encoder delivers per revolution and on the transmission ratio between the vehicle's running wheel and the frictional wheel on which the incremental encoder is mounted.

How to calculate the number of pulses per centimetre:

The running wheel of a forklift has a diameter of 35 cm.

The frictional wheel on which the incremental encoder is mounted has a diameter of 3.5 cm.

The incremental encoder used delivers 1000 pulses per revolution.



Calculation of pulses per centimetre

Circumference of
forklift wheel = d x π = 35 cm x π = 109.96 cm

One revolution of the forklift wheel corresponds to ten revolutions of the frictional wheel and thus to 10,000 pulses of the incremental encoder.

From this the number of pulses of the incremental encoder per centimetre covered by the vehicle is calculated as:

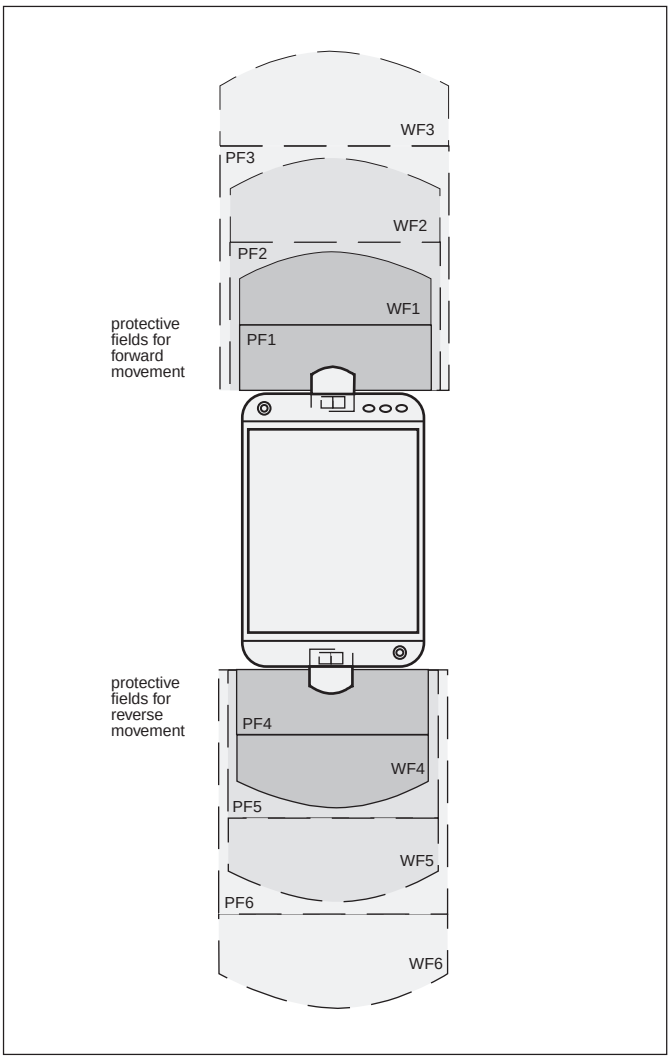
Pulses/cm = 10,000: 109.96 = 90.94

When configuring the incremental encoder in the PLS/LSI user software you must thus enter the rounded value "91" under "Pulses per centimetre".
The user software calculates from that figure the maximum permissible speed of the vehicle.

(How to configure the incremental encoders in the PLS/LSI user software is described in section 9.7).

The LSI system is configured as follows:
- Two PLS sensors connected
- Six monitoring areas defined (the protective and warning fields are configured in stages, as shown in the diagram)
- Two incremental encoders connected and configured
- Two OSSD outputs and two warning field outputs configured
- Six monitoring cases configured (three for forward, three for reverse)
- Any order of monitoring cases

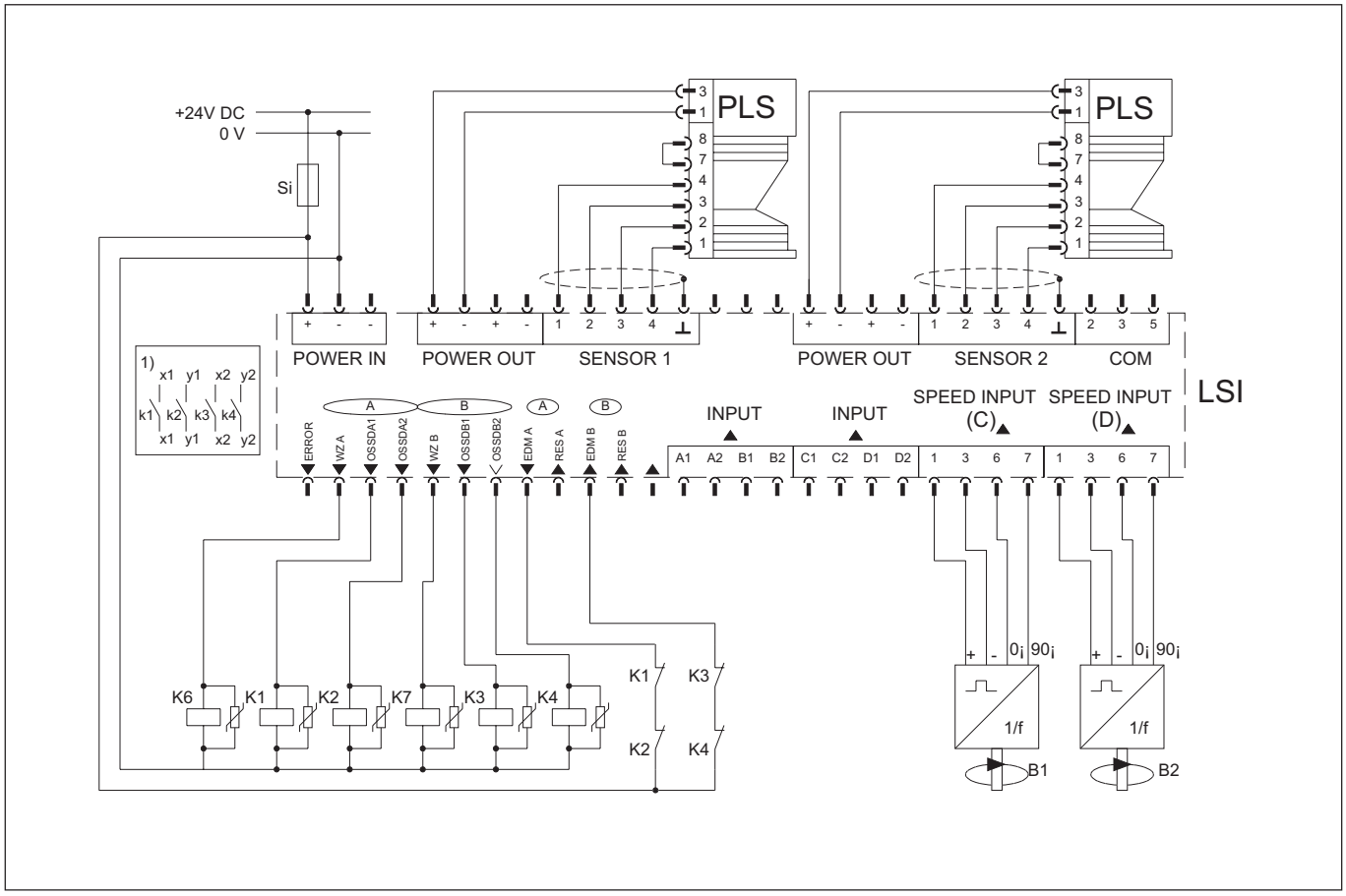
(The circuit diagrams relating to this example are on the next page.)



Example 3: Driverless Transport System (DTS), forward and reverse

Note on the circuit diagram:
Use only relays with positively-driven contacts.
The protective elements switched in parallel with the contactors are for arc suppression.

1) Output circuits. These contacts are to be incorporated into the controller such that, when the output circuit is open, the hazardous state is contolled.
   In categories 3 and 4 to EN 954-1, they must be incorporated on two channels (x, y paths).



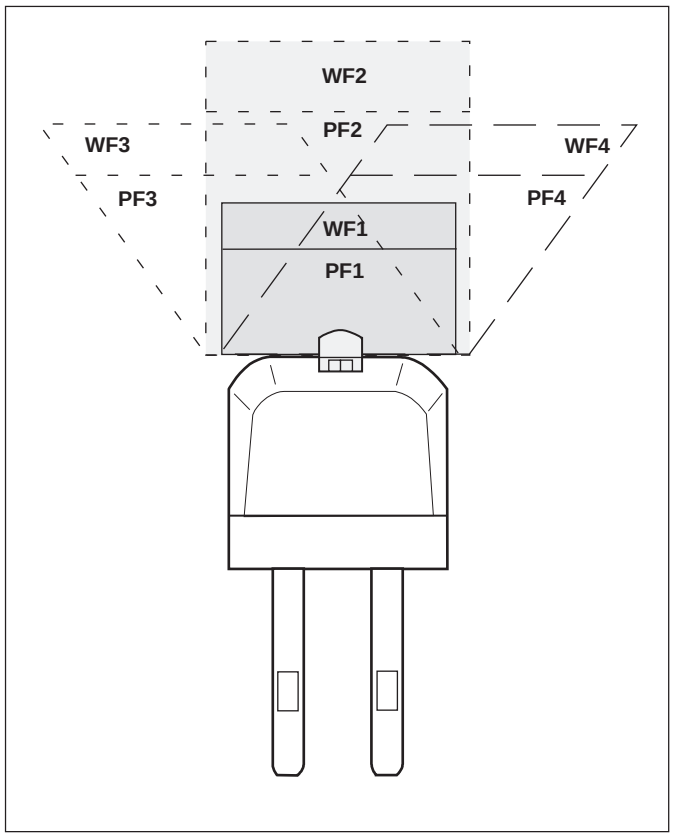
Example 4: Driverless Transport System (DTS), forward only, with incremental encoders

Determine the number of pulses your incremental encoders deliver per centimetre covered by your vehicle, as in example 3, and enter the values in the user software under "Pulses per centimetre"
(How to configure the incremental encoders in the PLS/LSI user software is described in section 9.7).

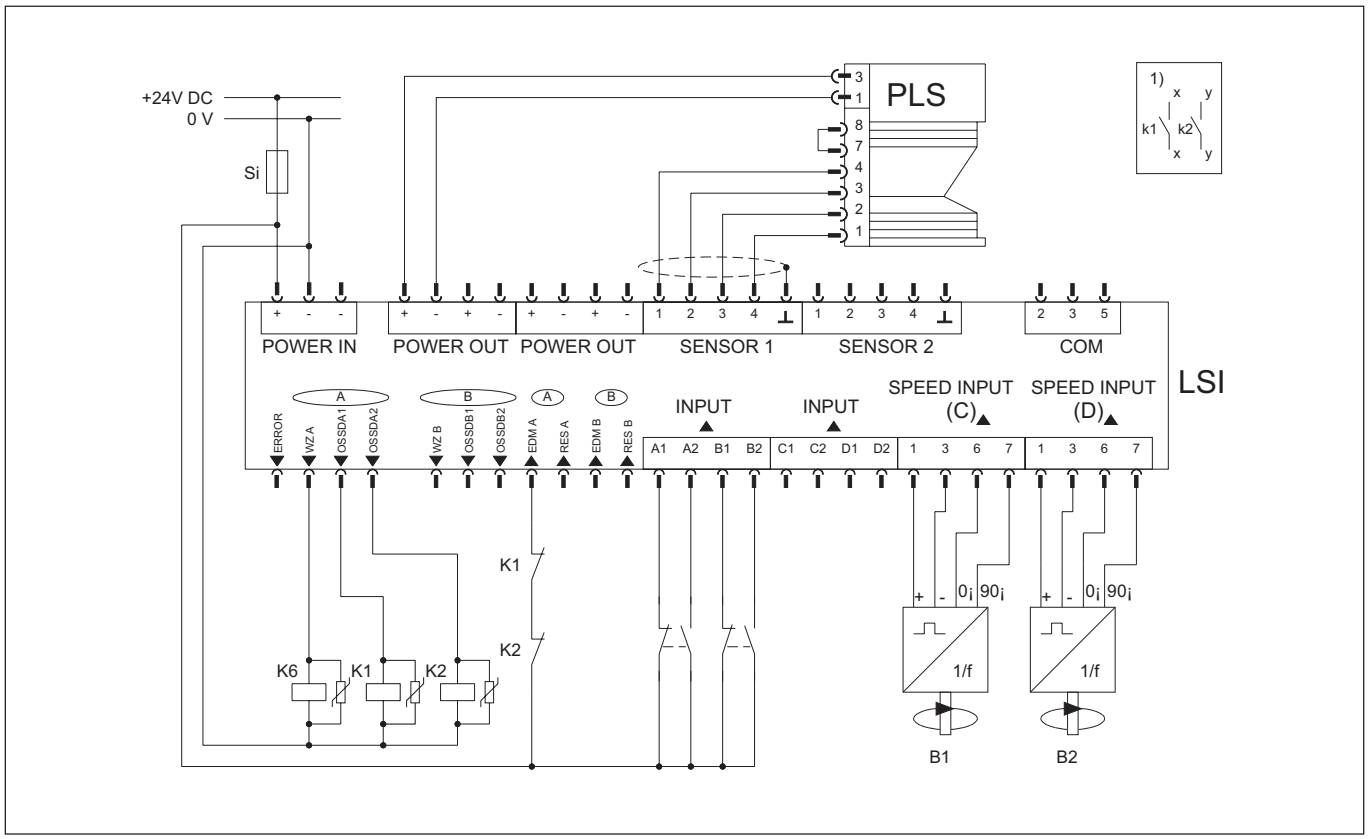
The LSI system is configured as follows:
- One PLS sensor connected
- Four monitoring areas defined (the protective and warning fields are shown in the diagram)
- One OSSD output and one warning field output configured
- Four monitoring cases configured (e.g. slow, fast, left, right)
- Two incremental encoders connected and configured
- The monitoring cases "slow" and "fast" are activated via the incremental encoders: monitoring cases "left" and "right" via the binary inputs
- Any order of monitoring cases

Note on the circuit diagram:
Use only relays with positively-driven contacts.
The protective elements switched in parallel with the contactors are for arc suppression.

1) Output circuits. These contacts are to be incorporated into the controller such that, when the output circuit is open, the hazardous state is canceled.
   In categories 3 and 4 to EN 954-1, they must be incorporated on two channels (x, y paths).



Example 4: Driverless Transport System (DTS), forward only



11.2 Startup testing and restart

Performing startup testing

You can set in the PLS/LSI user software whether you want to perform a startup test after your LSI system powers up. With the startup test you can check that the protective field evaluation you have stored in the LSI is working correctly.

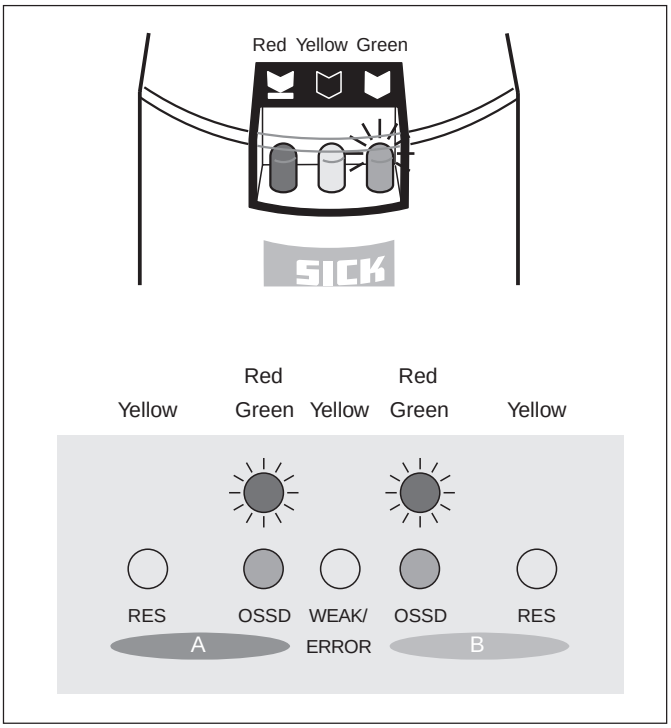
In the process you test only the sensor active on power-up and the monitoring area assigned to it. Which sensor and monitoring area is tested depends on which monitoring case is first active on power-up. As two monitoring cases can be active at any one time (simultaneous monitoring cases), you must test either one or two sensors in startup testing.

Only after startup testing are the configured outputs enabled, and the system ready for operation.
How to set up startup testing in the PLS/LSI user software is described in section 9.3.

How to perform startup testing:

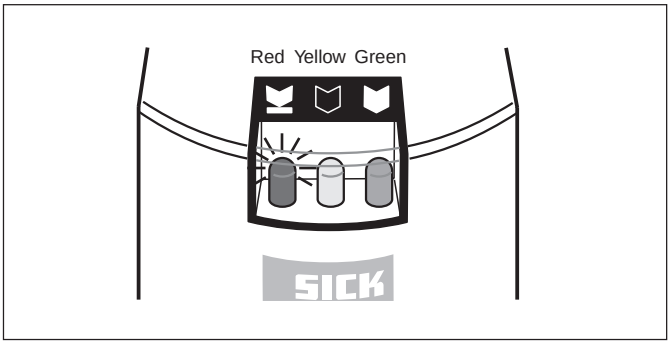
- Switch on your LSI system (allow a few seconds for start-up).

On the active sensor (where appropriate, on two sensors) the green LED lights up: the protective field active on power-up of the sensor is free.
On the LSI the red LEDs on the two outputs (OSSD A and OSSD B) light up: the outputs are deactivated.



- Intrude into the protective field of the active sensor so that the red LED on the sensor lights up.
- Move out of the protective field again.
- As appropriate, intrude into the protective field of the second active sensor and move out of it again.

Depending on which restart behavior you had configured in the PLS/LSI user software, the configured output (or both outputs) is enabled. The following subsection gives more detailed information on restart behavior.

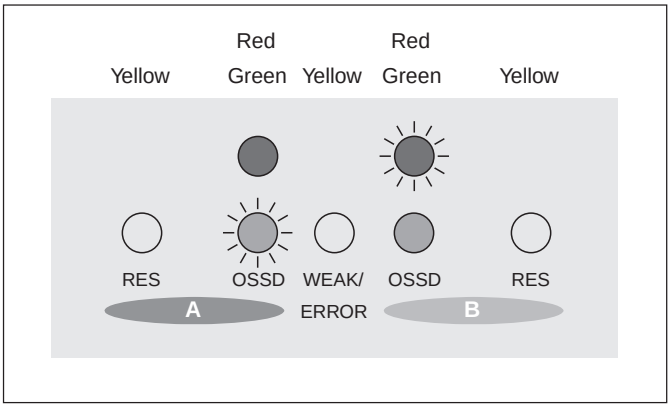


Restart after intrusion into protective field

You can program the following options in the PLS/LSI user software (see section 9.3):
– Without delay
– Delayed by n seconds
– With restart button

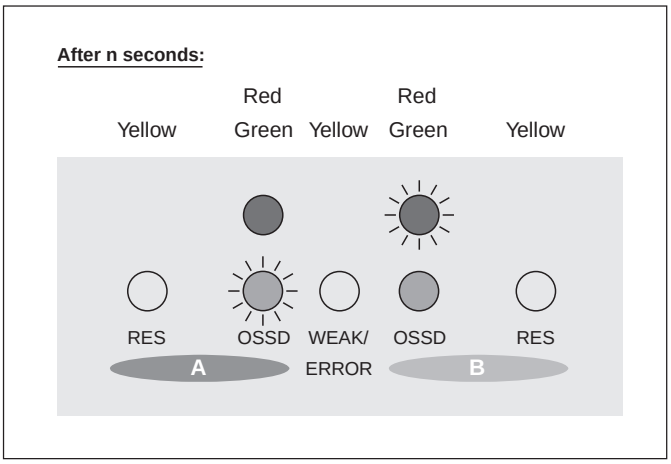
Restart ”without delay”

The LSI enables the output after the pre-set response time (scan rate) as soon as the protective field is free. The red LED on the configured output (OSSD A or B) goes out and the green LED lights up.



Restart ”delayed by n seconds”:

The LSI starts when the time ”n” set here has elapsed after the protective field has become free again. After that time the red LED on the configured output goes out and the green LED lights up. The output is then free.

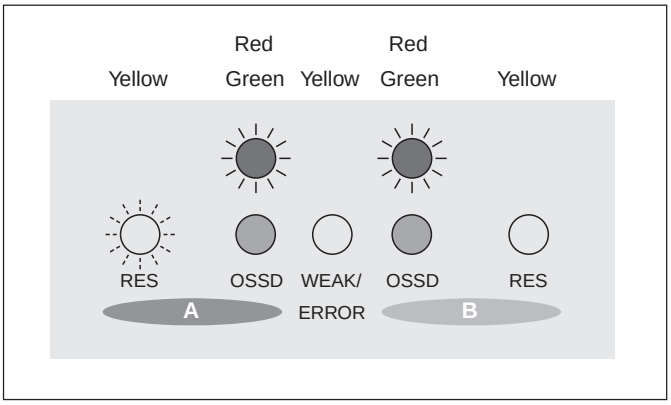


Restart ”with restart button”:

On the configured output the yellow ”Restart” LED flashes. You must then press the restart button. Only then is the output enabled.

Note:
When fitting the restart button, note that the button must be mounted such that, when the button is pressed, the hazardous area is fully visible.

The system is thus ready for operation.



11.3 Technical data

Here you will find the key technical data of the LSI.

Notes:
Please also take note of the technical data given in the technical description of the PLS.

The requirements for the cables used are set out in the instruction manual, section 4.3, under "Cable requirements".

Protective fields

Number	Max. 8
Range	See PLS technical description
Min. remission	1.8 % at 4 metres distance
Max. remission	Unlimited
Resolution	70 mm at 4 metres distance
Outputs	2 x independent, monitored semiconductor outputs, 2-channel, PNP high-active, 24 V / 250 mA, Load capacitance ≤100 nF Residual voltage (at 250 mA load) max. 3.4 V Max. switching frequency 12.5 Hz
Category:	Single-fault safe, Category 3 to EN 954-1 Type 3 to IEC/EN 61496-1

Warning fields

Number	Max. 8
Range	See PLS technical description
Outputs	2 x independent semiconductor outputs, PNP high-active, 24 V / 100 mA
Error output	1 x semiconductor output, PNP high-active, 24 V / 100 mA

Overall measuring range

Range	Max. 50 m (see PLS technical description)
Resolution	Distance: ± 50 mm Angle: 0.5°

General data

Weight	1.25 kg
Supply voltage	24 V DC / + 20% - 30% (via isolating transformer to EN 60 742)
Power consumption	< 15 W (excluding PLS and load) < 63 W (with 1 PLS and max. load) < 80 W (with 2 PLS and max. load) < 97 W (with 3 PLS and max. load) < 114 W (with 4 PLS and max. load)
Response time	Adjustable min. 190 ms (PLS with LSI) (except: PLS 101-316 with LSI in vehicle protection response time 270 ms, non-adjustable)
Enclosure rating	IP 20 (specification: built into cabinet with min. IP 54)
Protection class	Safety extra-low voltage, protection class 3
Interference immunity (EMC)	To IEC 61496-1 type 4 EN 50081-2 DIN 40839-1 and -3
Vibration resistance	5 g, 10 ... 55 Hz to IEC 60068-2-6
Shock resistance	10 g, 16 ms to IEC 60068-2-29
Operating temperature	0 ... +50 °C
Storage temperature	-25 ... +70 °C
Humidity class	F to DIN 40040
Dimensions (W x H x D)	216 mm x 108 mm x 86 mm (excluding terminals and plug)
PC interface	RS 232 or RS 422 9 600, 19 200, 38 400 Bd
Transmission range	RS 232: max. 15 metres RS 422: max. 100 metres

Inputs

Monitoring case switching	4 static binary inputs (A_1, A_2, B_1, B_2, C_1, C_2, D_1, D_2) to 24 V DC, 2-channel (antivalent)
or:	2 dynamic incremental encoder inputs (C, D) and 2 static binary inputs (A_1, A_2, B_1, B_2) to 24 V DC
Restart/Reset (RES)	1 input per OSSD pair (to 24 V DC)
Contactor monitoring (EDM)	1 input per OSSD pair (to 24 V DC)
Current consumption of inputs RES, EDM, A and B:	
Starting pulse current	From 16 mA to 32 mA (with time constant 100 µs)
Static input current	From 2.5 mA to 5 mA
Current consumption of inputs C, D and incremental encoders:	
Starting pulse current	From 16 mA to 32 mA (with time constant 0.5 µs)
Static input current	From 2.5 mA to 5 mA
Permissible time response of inputs:	
Restart/Reset (RES)	Valid actuation from > 200 ms to <5 s
Contactor monitor (EDM)	Contact switchover time < 200 ms
Binary inputs A, B, C, D	Switchover time < 80 ms
Incremental encoder inputs	f_{max} 100 kHz

11.4 Accessories

For mounting

Mounting kit (top-hat rail and bracket)	2 019 300

For connection to controller and PLS

Connection set A 1 PLS supply plug 1 PLS interface plug 1 screw-in interface connector for sensor connection to LSI excluding cable	2 019 065
Connection set B As connection set A, with 3 m cable	2 019 066
Connection set C As connection set A, with 5 m cable	2 019 067
Connection set D As connection set A, with 10 m cable	2 019 068
Connection set E As connection set A, with 15 m cable	2 019 069
Connection set F As connection set A, with 20 m cable	2 019 070
Terminal strip set WAGO connector set, 8-part	2 018 946
Sub D connector (RS 232/RS 422) Screw-in terminals, EMC protected	6 011 808
Sub D connector (RS 232/RS 422) Solder terminals, EMC protected	2 019 097

Power supply units

24 V, 2.5 A	DC	6 010 361
24 V, 4.0 A	DC	6 010 362
24 V, 10 A	DC	6 010 156

User documentation

LSI Technical Description, German, excluding floppy disc	8 008 309
LSI Technical Description, English, excluding floppy disc	8 008 310
LSI Technical Description, French, excluding floppy disc	8 008 311

11.5 Standards and regulations

The following lists the key standards and regulations applicable to the use of optoelectronic safety devices. Depending on field of application, additional regulations may be of importance for you. You can get information on other device-specific standards from local regulatory authorities, or from professional bodies.

Regarding the use and installation of safety devices:

Machinery directive 89 / 392 EEC

Safety of machines - Basic terms, general design guidelines (EN 292)

Safety requirements for automated manufacturing systems (VDI 2854)

Safety of machines - Electrical equipment on machines - Part 1: General requirements (EN 60204)

Safety of machines - Safety distances to prevent reaching hazardous areas with upper limbs (EN 294)

Safety requirements for robots (EN 775)

Safety rules for non-contact safety devices on power-driven machinery (ZH 1/597)

Safety of machines - Arrangement of safety devices with regard to approach speed of body parts (prEN 999)

Safety of machines - Risk assessment (prEN 1050)

Regarding construction and equipping of safety devices:

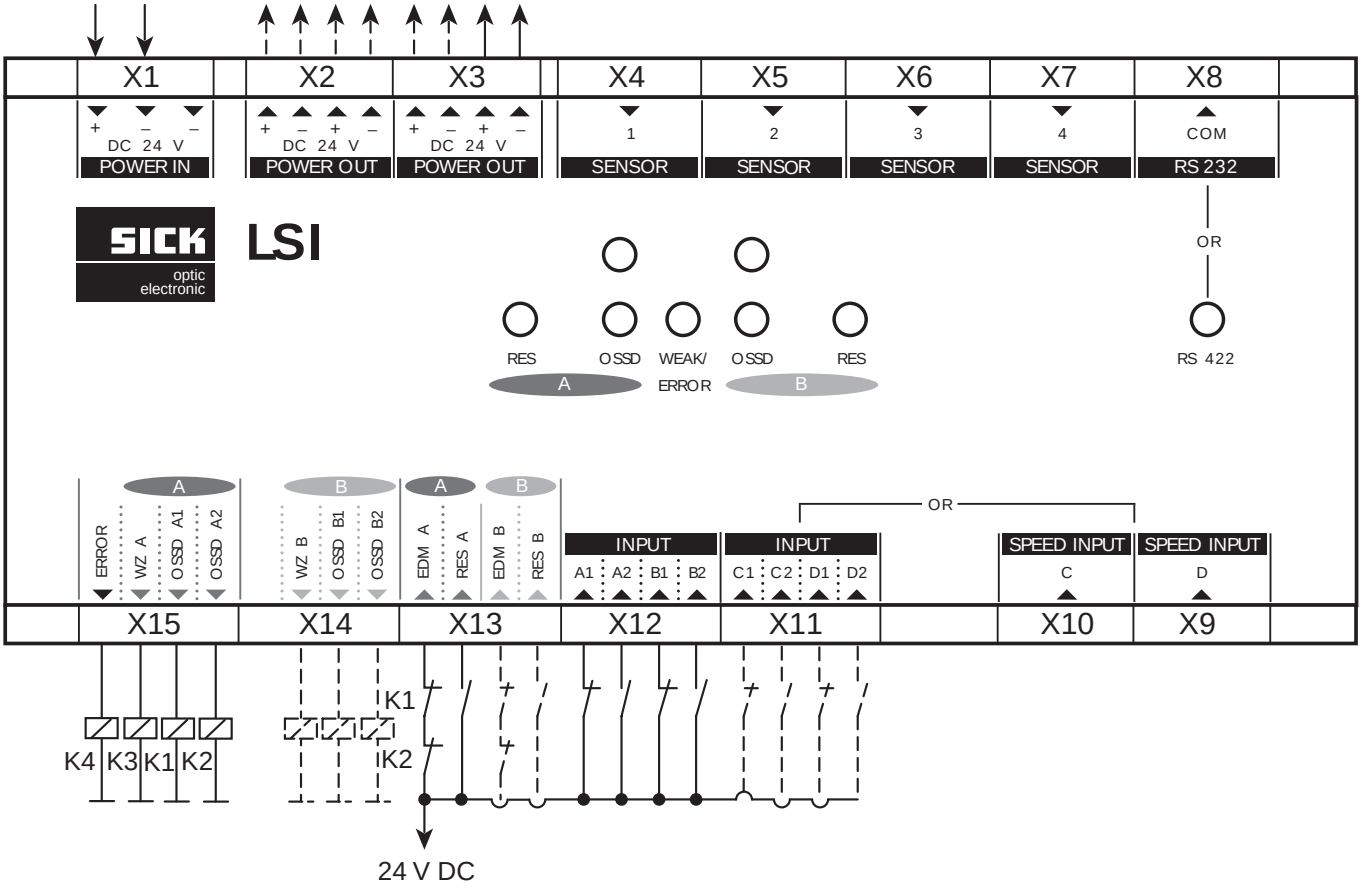
Safety of machines - Non-contact safety devices - Part 1: General requirements (IEC 61496-1 / DIN VDE 0113, part 201)

Safety of machines - Electrical equipment on machines - Part 1: General requirements (EN 60204)

Safety of machines - Safety-related components of controls - Part 1: General design guidelines (DIN EN 954)

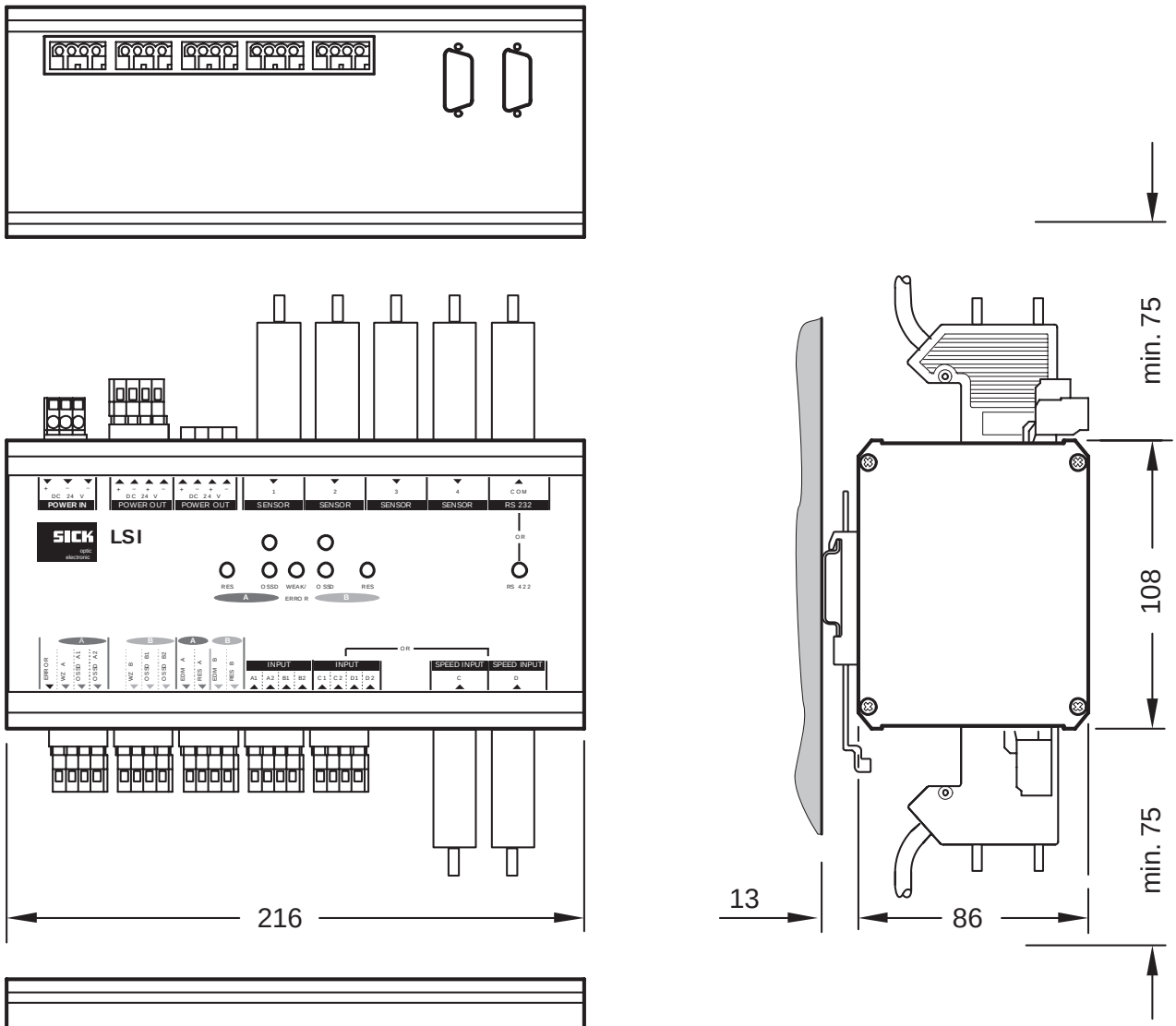
On these subjects please also order our brochure ”Safe machines with optoelectronic safety devices”.

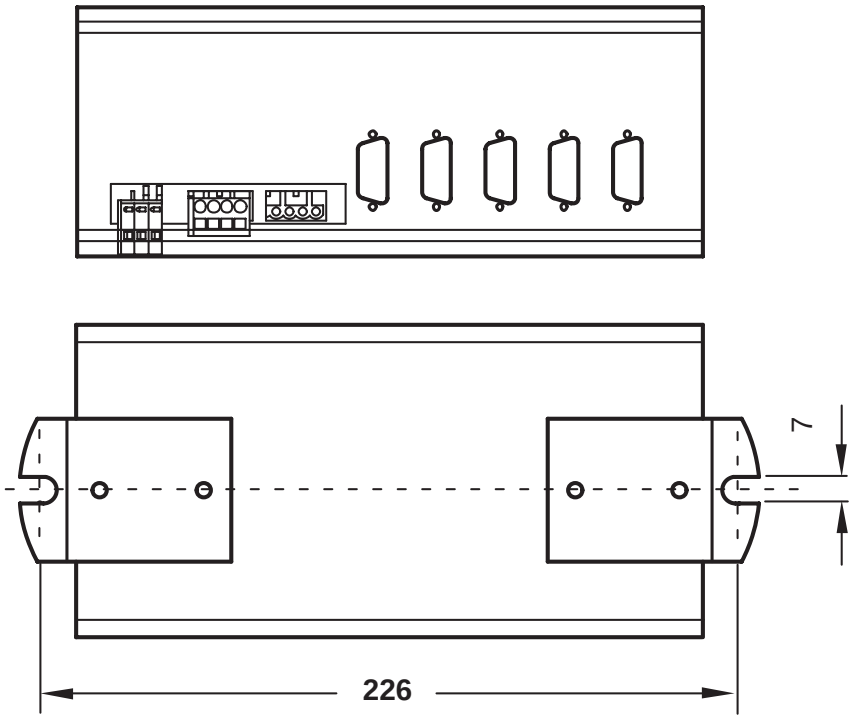
11.6 Connection diagram



11.7 Dimensional drawing

(All dimensions in mm)





12 Glossary

DTS

Driverless Transport System (industrial conveyors).

Incremental encoder

A component which generates electrical pulses proportional to a movement. From these pulses various physical variables can be derived (e.g. speed, distance, etc.).

I/O monitor

Function of the PLS/LSI user software with which the switching states of the LSI inputs and outputs are monitored and logged. The data obtained can be saved to an ASCII file for subsequent evaluation.

Measurement zone

The field of vision of the PLS is its measurement zone. It is heavily dependent on the remission of the object struck, but without special measures extends to around 15 metres. When using heavily reflective materials the maximum range of 50 metres is also achievable.
With the PLS the distance to objects can also be measured in order to display them on the PC (by way of the computer interface) or to carry out any other evaluations on a computer.

Monitoring area

A monitoring area consists of a protective field and a warning field. In the PLS/LSI user software up to eight monitoring areas can be defined in a configuration, assigned to the connected sensors according to the monitoring case.

Monitoring case, simultaneous

A maximum of two monitoring cases can be active at any one time, i.e. under the same input conditions, on a LSI.

Pixel suppression

When you select ”Pixel suppression”, objects detected by just one pixel per scan are ignored. This can be useful in preventing error shutdowns.

Protective field

In the range up to a radius of 4 metres, the PLS/LSI system offers eight sensor fields with single-fault fail-safe accident prevention functions in accordance with category 3 of EN 954 - for area protection, but also as a (non-tactile) bumper replacement.

Plausibility check

Function of the PLS/LSI user software with which you can check for errors in the definition of monitoring cases.

Speed difference

In vehicle protection, the speed of two axles - or running wheels - is recorded by incremental encoders. When the vehicle goes round a bend these two items of speed information may differ. In the PLS/LSI user software you can specify how large the maximum speed difference between the two incremental encoders may be before the system is shut down (default for speed difference: 25%).

Space contour

You can receive the defined contour of a sensor’s surroundings and save the measurements obtained. In this way, when error shutdowns occur you can check at which point the space contour protrudes into the protective field.

Warning field

The warning field is a sensor field with a radius up to 15 metres. It can be used to monitor larger areas and to trip simple switching functions (e.g. warning functions) or to switch a driverless transport system to slow running.