LANGER
EMV-Technik

User manual

OSE set
Optical Signal Acquisition

The OSE system transmits digital signals
from devices and installations without disturbing the DUT.

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1 Declaration of Conformity

Manufacturer:
Langer EMV-Technik GmbH

Nöthnitzer Hang 31
01728 Bannewitz
Germany

Langer EMV-Technik GmbH herewith declares that the

OSE 450 set, Optical Fiber Probe 4-Channel, 50 Mbps including **OE 450** Optical Receiver and **S25** Optical Sensor
OSE 150-2 set, Optical Fiber Probe 2-Channel, 50 Mbps including 2x **OE 150** Optical Receiver and 2x **S25** Optical Sensor
OSE 150-1 set, Optical Fiber Probe 1-Channel, 50 Mbps including **OE 150** Optical Receiver and **S25** Optical Sensor

conforms with the following relevant regulations:

- EMC Directive 2014/30/EU
- Low-Voltage Directive 2014/35/EU
- Restriction of certain Hazardous Substances 2011/65/EU

The following applicable standards were used to implement the requirements specified by the a forementioned directives:

- DIN EN IEC 61000-6-1:2019-11 (EMC immunity)
- DIN EN IEC 61000-6-3:2022-06 (EMC emission)
- DIN EN 61010-1:2020-03 (Safety)
- DIN EN IEC 63000:2019-05 (Restriction of hazardous substances)

Name of the person authorized to compile the technical

Katja Langer

Bannewitz, 2025-09-08

Signature:

K. Langer, Managing Director

2 Mode of operation

The OSE sets contain small transducers (optical sensors) which convert digital electrical signals into light signals. These light signals are transmitted to an optical receiver via an optical fibre where they are converted back into digital electrical signals.

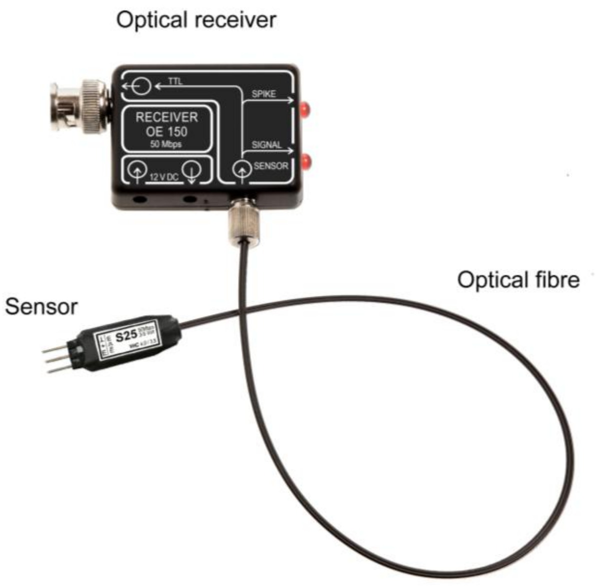


Figure 1: Sensor, optical fibre and optical receiver are combined into a probe head

These optical sensors also contain pulse stretchers. These stretches short input pulses that cannot be transmitted directly due to the limited bandwidth of the optical fibre cable to a transmissible pulse width.
This set-up allows for potential-free signal monitoring. Thus, it is particularly suitable for measurments during EMC Tests (burst, ESD, RF coupling) and on power lines (also high voltage).

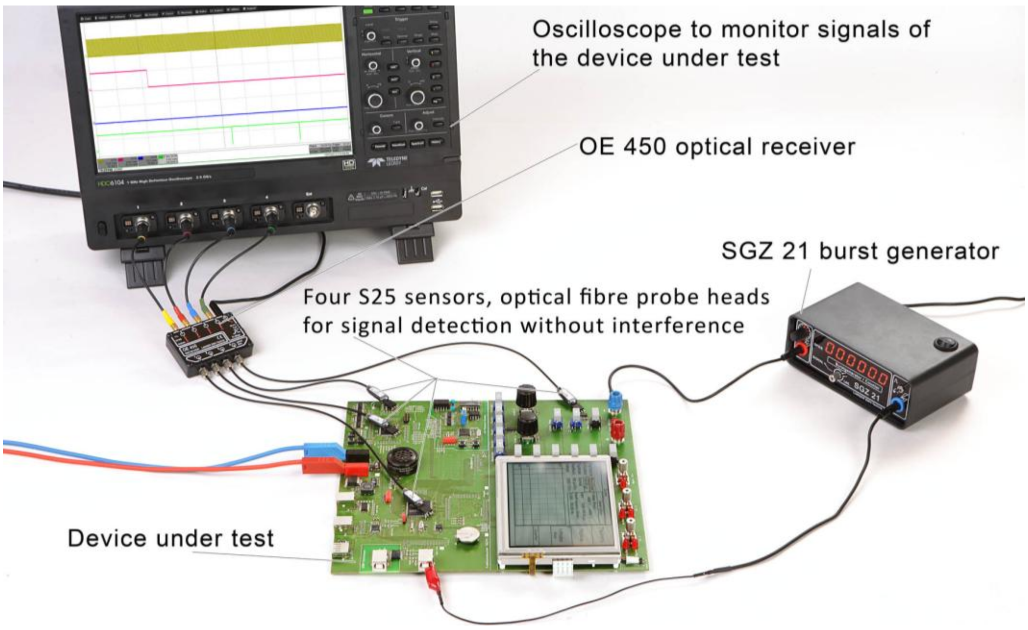


Figure 2: S25 sensor integrated in the DUT

3 Description of components

3.1 EMC sensor

Type S25 sensor	Transfer rate	Operating voltage
	DC-50 Mbps	3 – 5 Volt
Table 1		

3.1.1 Connection of the sensor to the DUT

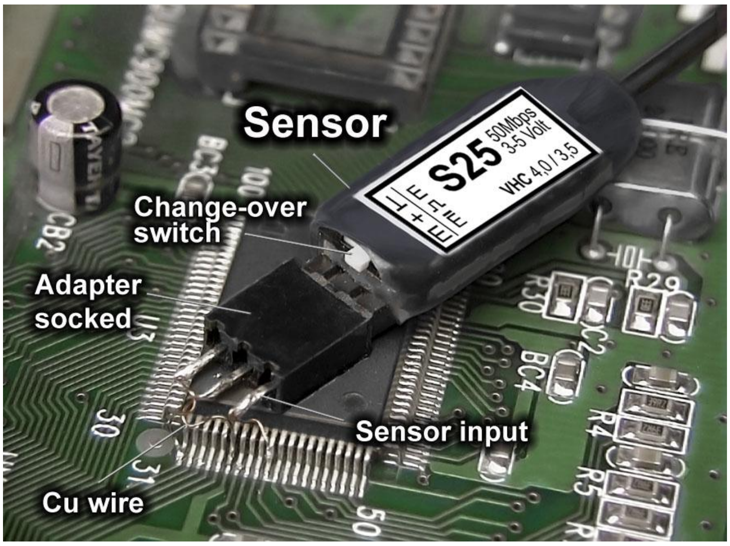


Figure 3 **S25 sensor connected to the DUT**

The sensor must be supplied from the DUT (device under test). The sensor is connected to the DUT via an adapter socket (included in the scope of delivery), which has to be fixed to the module in a suitable place with super glue or double-sided adhesive tape and connected with enamelled copper wire (included in the scope of delivery). The optical fibre is then simply plugged into the output of the sensor.

3.1.2 Level changing

The sensor has a change-over switch to negate the output signal of the sensor:

Switch position E	High logic level corresponds to "light on"
Switch position E transverse	High logic level corresponds to "light off"

This function makes it easier to trigger external devices such as a burst generator through the DUT.

3.1.3 Pulse stretching

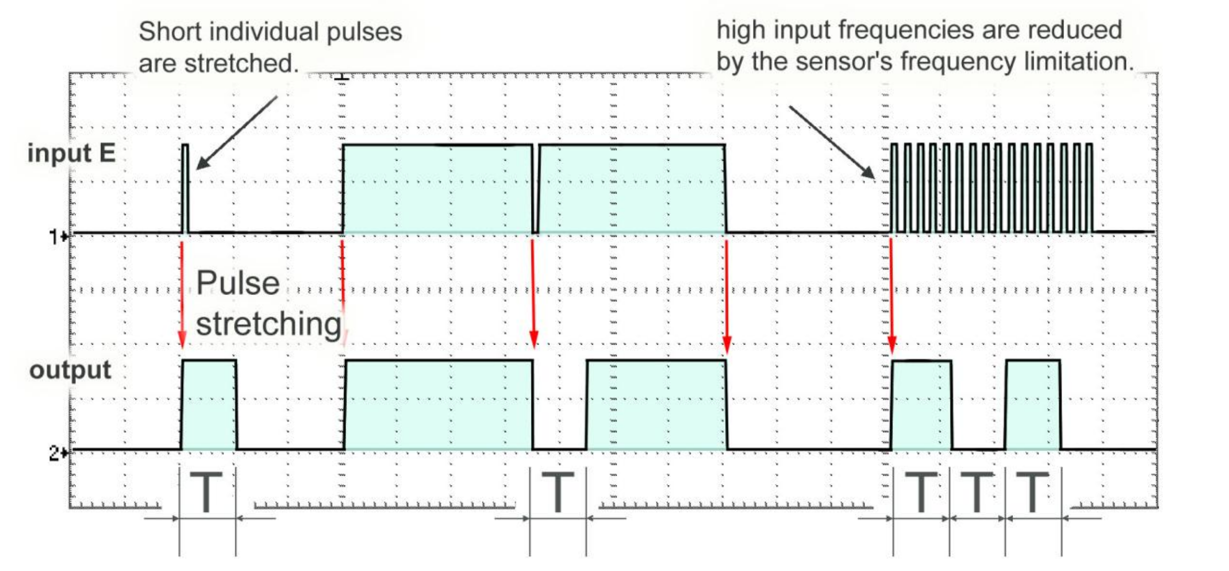


Figure 4: Pulse stretching

Very narrow input pulses are stretched to a transmissible width (approx. 20 ns) for transmission via synthetic optical fibre cable. Thus, it is possible to detect burst or ESD pulses that directly couple in the line connected to the sensor input.
If a narrow disturbance pulse (shorter than 20 ns) is detected, it will always be transmitted as a 20 ns long pulse.

3.1.4 Frequency limitation

Since pulse stretching operates with both positive (rest position "low") and negative (rest position "high") pulses, this results in a frequency limitation: individual input pulses are omitted if the input signal exceeds the system's threshold frequency – a pulse number near the maximum transfer rate is output. This ensures that pulses are indicated at the output whenever pulses occur at the input.

3.1.5 Susceptibility and disturbance threshold

Due to the different behaviour of their dynamic input switching threshold, ICs have a different susceptibility to fast transient disturbances. Two IC susceptibility characteristics have been defined in order to be able to handle these properties:

E(20) susceptibility:
The E(20) susceptibility definition is based on the 20 volts point of an IC input's dynamic input characteristic. The reciprocal of the pulse width (τ) at the 20 volts point (tail time constant of a test pulse) is defined as the E(20) susceptibility:

E(20) = 1/τ (20 Volt)

The respective unit of measurement is 1/ns. The susceptibility is between 0.5 and 6 for conventional IC families where ICs with a susceptibility of 0.5 are insensitive and those with a susceptibility of 6 highly sensitive.

The E(20) susceptibility value alone is often insufficient for wider disturbance pulses (>10 ns).

Disturbance threshold:
The disturbance threshold (switching threshold) at a pulse width (τ) of 12 ns on the dynamic input characteristic is defined as an additional parameter:

U(12) = u (12 ns)

The respective unit of measurement is volt. The threshold is between 1.5 and 8 volts for conventional IC families where ICs with a threshold of 1.5 volts are sensitive and those with a threshold of 8 volts insensitive.

All parameters are printed on the sensor.

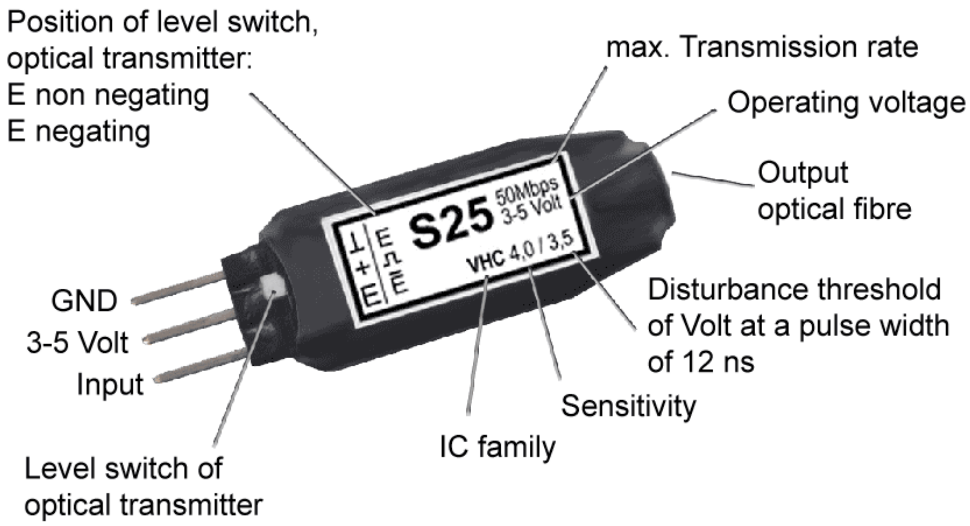


Figure 5: S25 sensor

3.2 Optical receivers

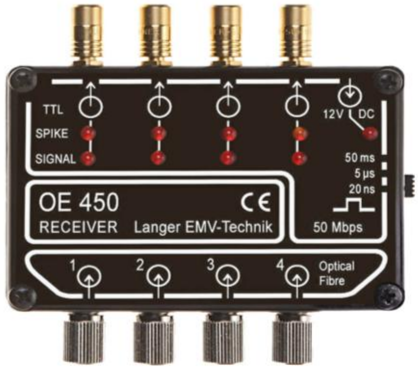
Type	OE 150	OE 450
		
Transfer rate	DC-50 Mbps	DC-50 Mbps
Pulse stretching	Pulse stretching to 50 ms can be activated	Pulse stretching from 20 ns to 5 µs or 50 ms can be activated
Suitable for	S25 sensor	S25 sensor

Table 2

The optical receivers have one or four inputs for optical fibres with a diameter of 2.2 mm. To connect the optical fibre, loosen the knurled nut, push the optical fibre into the receiver all the way and slightly tighten the knurled nut.

3.2.1 Supply

The receiver is supplied with 12V DC via the enclosed plug-in power supply unit. The OE 150 optical receiver has two sockets marked with 12V DC. These are directly connected with each other. Thus, a second receiver can be supplied via a connecting cable (included in the scope of delivery of the OSE 150-2 set).

3.2.2 Anzeige

All optical receivers have two LEDs for each optical fibre input to monitor the respective signal (**Table 3**).

"SIGNAL" LED	The signal is displayed directly. The pulse control factor can be roughly inferred from the LED's brightness with cyclic signals.
"SPIKE" LED	The signal is displayed. In addition, pulse stretching is integrated which stretches short pulses not visible for the eye to approximately 50 ms. Thus, even the shortest pulses (depending on the connected sensor) are clearly recognizable.

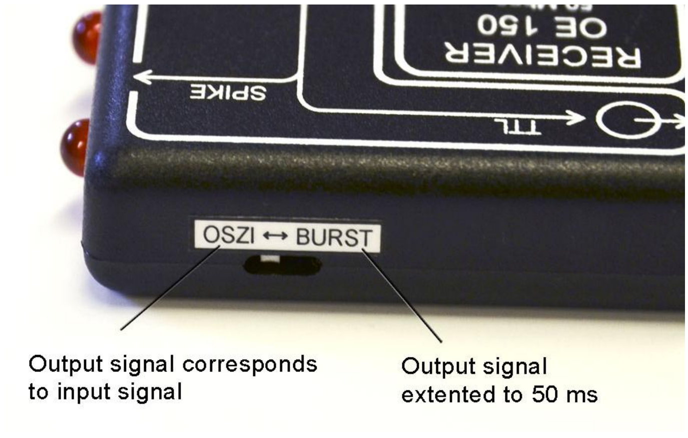
Table 3

3.2.3 Outputs

All optical receivers have outputs (BNC plugs) to connect to an oscilloscope, a counter or similar. The signal of the connected sensor is sent at TTL level.

A pulse stretcher can be activated on each output to facilitate signal evaluation or triggering of external devices.

3.2.4 OE 150 receiver



Switch position "Burst": The wide signals of the sensor are stretched to approxi. 50 ms (for controlling devices with slow inputs such as burst generators).

Switch position "Oszi": The optical input signals are directly switched to the TTL output. Signals can be evaluated with an oscilloscope, for example, in this switch position.

Figure 6: Pulse stretcher on the OE 150

3.2.5 OE 450 receiver

A sliding switch is located on the right-hand side of the receiver to switch the pulse stretching to 20 ns, 5 µs or 50 ms. The setting affects all four outputs.

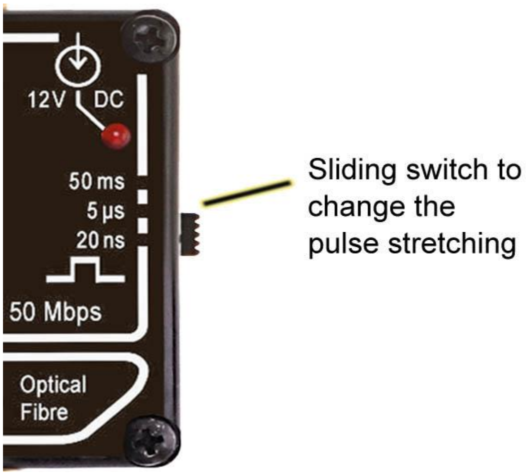


Figure 7 Switching of the pulse stretching on the OE 450

With pulse stretching activated, the individual pulses of a burst event are combined in one 50 ms signal and output via the BNC socket. This pulse stretching prevents devices with high dynamics (counter) from detecting individual pulses of the burst event (a pulse package of a duration of 15 ms is counted as one burst).
Evaluation instruments that have inputs with low dynamics are unable to detect any 20 - 200 ns signals of the sensor. Pulse lengthening is necessary und is carried out in the OE 150 receiver at the "burst" switch position.

4 Measuring methods

4.1 Signal monitoring during EMC tests

The sensor detects logic signals in the DUT's electronic circuit.

Recording signals: The output of the optical receiver is connected to the input of an oscilloscope or a logic analyzer to record the signals. Both the frequency limitation of the sensors and the pulse stretching set on the optical receivers has to be taken into consideration.

Status display of constant signals: Under certain circumstances it is sufficient to observe the "Spike" LED of the optical receiver with constant signals (e.g. RESET). Disturbance pulses – even very short ones – are stretched to around 50 ms and are clearly recognizable.

Counting cyclic signals: The useful signal detected by the sensor must have a constant frequency. Disturbance signals cause an increase in frequency. The signals are counted using a frequency counter.

4.2 Disturbance immunity measurement with optical sensor S25

Different device and housing variants as well as the effect of EMC measures can be evaluated through disturbance immunity measurements with the optical sensor S25. This method is ideal for DUTs where the effect of the interference is not immediately recognizable because, for example

- there is no display to observe a malfunction,
- values that are not displayed are changed in the memory,
- DUT parameters are changed.

4.2.1 Procedure

The disturbance threshold of the DUT is replaced by an artificial disturbance threshold for the measurement. This disturbance threshold is formed by a conducting track (reference conducting track located in the DUT) and a reference IC with a known IC susceptibility (EMC S25 sensor). The advantage: the S25 sensor has a time constant disturbance threshold – i.e. each ESD pulse or each individual burst spike which exceeds the artificial threshold is displayed. Delays or static effects caused by the firmware are excluded.

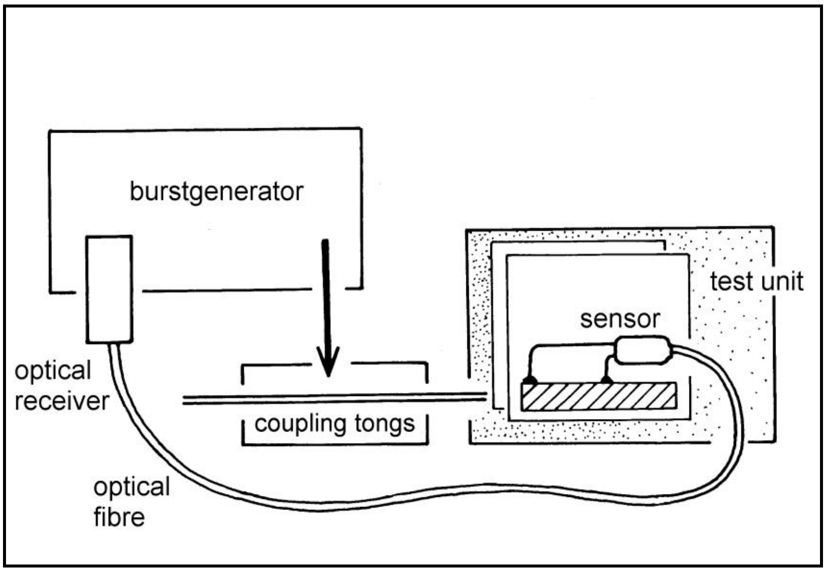


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Figure 8: Setup for disturbance immunity measurement with optical sensor S25

Disturbance voltage is applied or disturbance current is fed to the DUT through a disturbance generator. Both the sensor and the DUT's electronic circuit are subjected to disturbances. The disturbance voltage is increased according to a ramp function. If the disturbance voltage coupled into the reference conducting track exceeds the sensor's disturbance threshold, the sensor emits a light signal on the optical output which is used for evaluation or for switching the generator off. The disturbance current value associated with the resprective arrangement can be read at the generator.

Changes to the DUT design and modifications to EMC measures can be evaluated by measurements and comparison (Fig. 8).

Attention: The sliding switch of the optical receiver has to be set to "Burst" if the optical receiver is plugged into the "Stop" input of the disturbance generator.

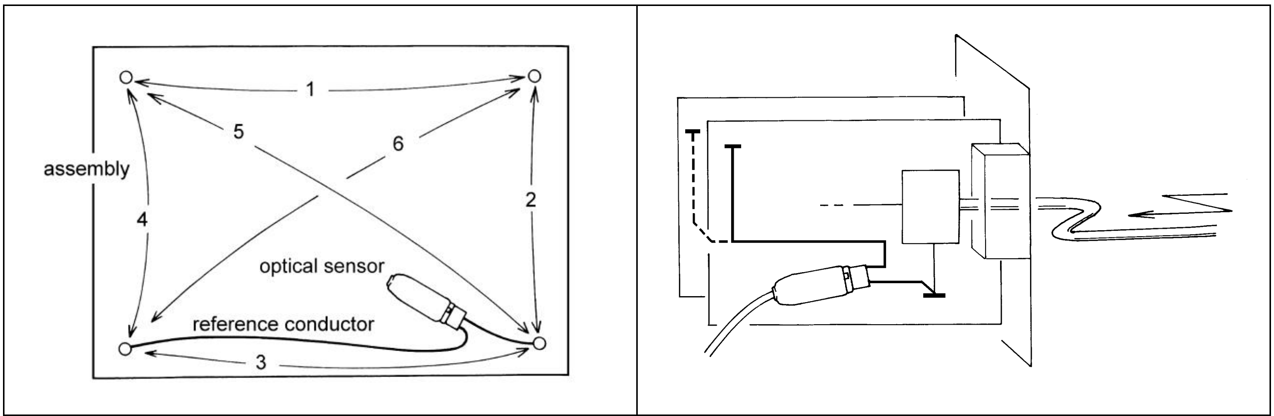

Figure 9: Routing examples of the reference conducting track

4.2.2 Dimensioning the reference conductor

Low-resistance reference conducting track: This reference conducting track simulates a disturbance voltage pick-off for the arrangement: "push–pull output – conducting track – IC input". Disturbance voltage is picked off via GND in modules with this arrangement.
Instead of the push-pull output the reference conducting track is connected directly to GND. The EMC sensor's GND connector is the second reference point of the disturbance current pick-off (the reference conducting track can also be connected to the supply voltage).

High-resistance reference conducting track: This variant simulates the disturbance behaviour of the "open collector output - pull-up resistor – conducting track – IC input" arrangement.
The reference conducting track remains open on one side, or it is connected to a pull-up resistor. This arrangement is particularly suitable for detecting disturbance-relevant electrical fields. The effect of pull-up resistors can be simulated with an adjusting controller (e.g. 10 k).

<u>Attention!</u> **Touching the sensor input with the generator switched-on and high-resistance arrangements can destroy the sensor.**

4.2.3 Routing the reference conducting track

Two strategies are possible.

Worst-case arrangement: The reference conducting track (low-resistance) is routed across the diagonals or along the edges of the electronic system to pick off a maximum disturbance voltage (**Fig. 10**). Routing can be implemented on one module or across several modules. The disturbance voltage is generally picked off via the GND system. The reference disturbance threshold need not correspond with the DUT's disturbance threshold for relative evaluations of EMC measures. The procedure is more convenient if the reference disturbance threshold is lower than the DUT's disturbance threshold. This can be realised by a relatively long pick-off distance.

Device-conform arrangement: The reference conducting track is routed along critical signal connections. Routing can be done along the bus system of a micro-computer, for example (**Fig. 10**). The position of the reference conducting track can be corrected based on comparative measurements.

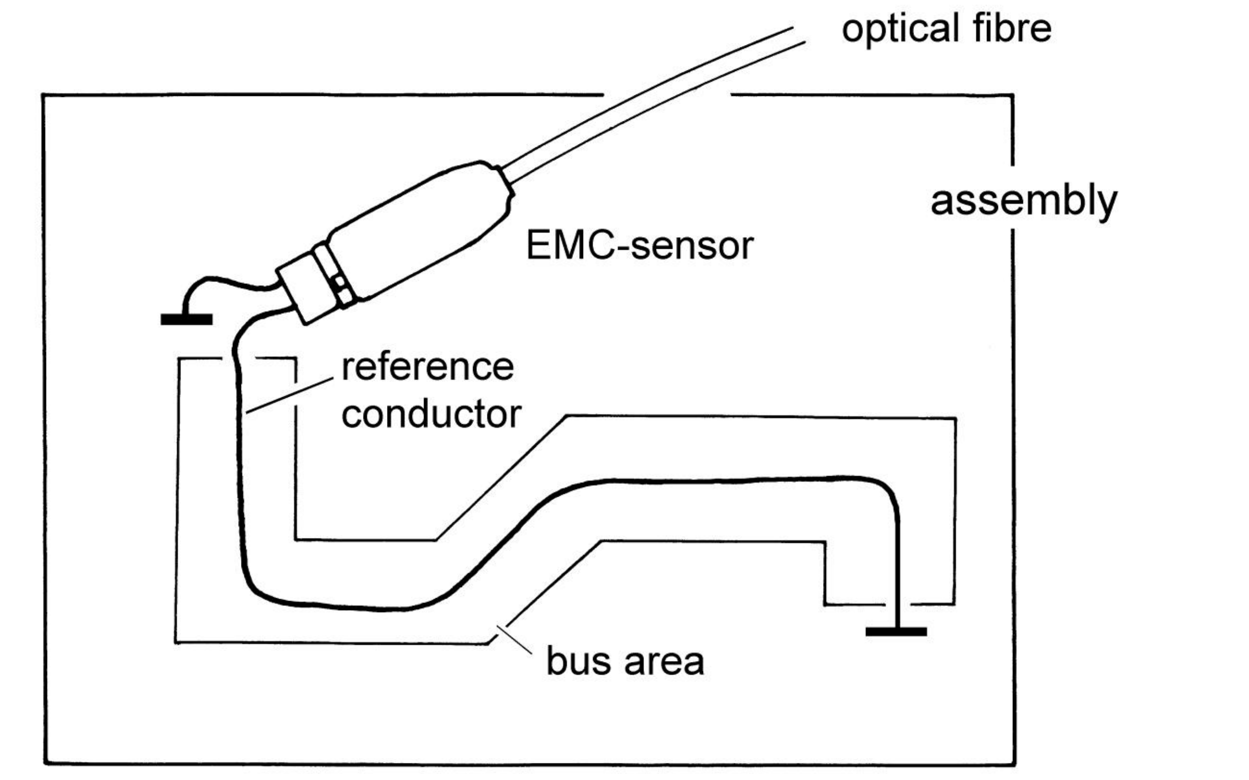

Figure 10: Routing the reference conducting track along bus systems

5 Practical tips and examples

5.1 Avoiding measuring errors

The sensor is connected via a three-pole adapter socket. The connections from the adapter socket to the monitored line or to GND and to voltage (e.g. with enamelled copper wire of approximately 0.2 mm diameter) must be as short as possible to avoid faulty measurements.
Requirements are not so strict on modules with a sturdy GND system (mainly multilayer GND planes with few apertures). Slightly longer lines (a few centimeters) are permissible here if the lines are routed close to the module and are therefore protected by the GND plane.

5.2 Example: disturbance immunity measurements on interfaces

Design and EMC measures which should prevent interference to interface signals are evaluated. For this purpose, an S25 sensor is connected in parallel to the input of the interface IC. The sensor and the interface IC presumably have a different susceptibility to the disturbance. As both susceptibilities are constant, however, it can be assumed that an improvement which was proven with the sensor is also applicable to the interface IC. It is possible to evaluate, for example:

- cable shielding type: aluminum foil, copper braiding, lead wire, density of the braided screen
- screen connection to GND, PE
- type of screen connection: stranded wire, sheet-metal segments, clamps, "water-tight" connection
- design of shielding discharge paths in the housing area: bolts, spacers, metal sheets
- plug-and-socket connectors: structural design, assignment
- shielding plates, foils, lacquer
- suppressor circuits: component selection, layout design, discharge paths

The line should be operated without a useful signal if the signal level of the interface deviates from the TTL level. It is possible, for example, to take measurements with the DUT switched off. (The sensor is supplied from a battery, for example, in this case.)

5.3 Example: monitoring watchdog and RESET signals

A DUT reacts to a burst test with a fault pattern which gives rise to the assumption that a RESET was triggered on the controller. An optical sensor is connected directly to the RESET line from the monitoring IC to the controller at the output of the monitoring IC to determine the cause. Observe the "Spike" LED and the "Signal" LED of the OE 110 optical receiver whilst performing the test.

If signals are clearly recognizable on both the "Signal" *and* the "Spike" LED, the monitoring IC is triggered by the disturbance events and it generates a RESET pulse of approximately 100 ms which is clearly visible on the LEDs. There has been a direct interference of the RESET line if 100 ms pulses are *only* recognizable on the "Spike" LED since it is not possible to recognize the pulses, which are very short in this case, with the naked eye.

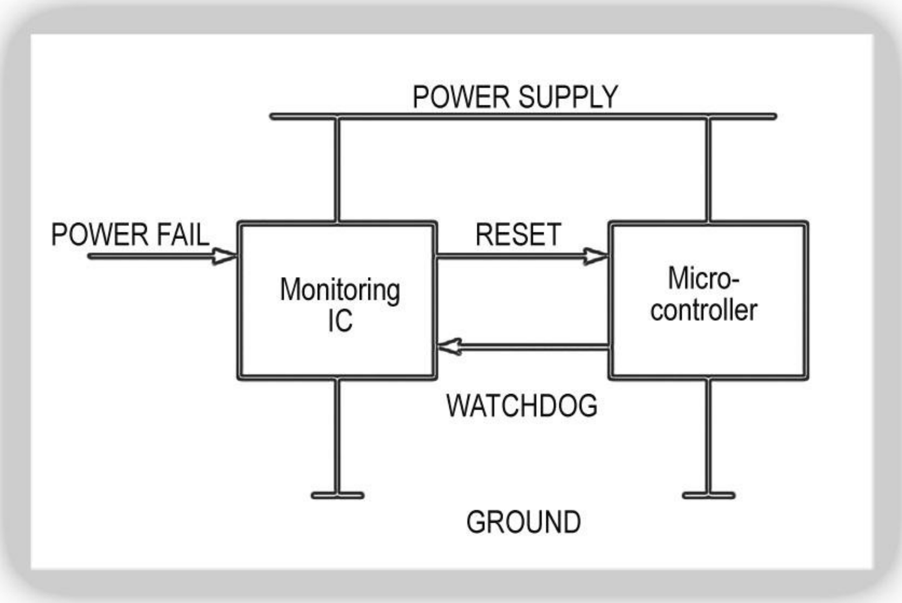

Figure 11: Monitoring IC and microcontroller can cause a RESET

A signal pattern as in **Figure 12** results if two sensors and an oscilloscope are used.
The cyclic watchdog pulses are clearly recognizable on channel 2. Channel 1 shows the RESET signal: the narrow pulses are caused by direct coupling into the RESET line but do not trigger a RESET. The watchdog signal shows that the controller is still running.
Only the pulse with a width of approx. 160 ms triggers a RESET. Since such a wide pulse cannot be caused directly by the disturbance an interference must have occurred on the monitoring IC.

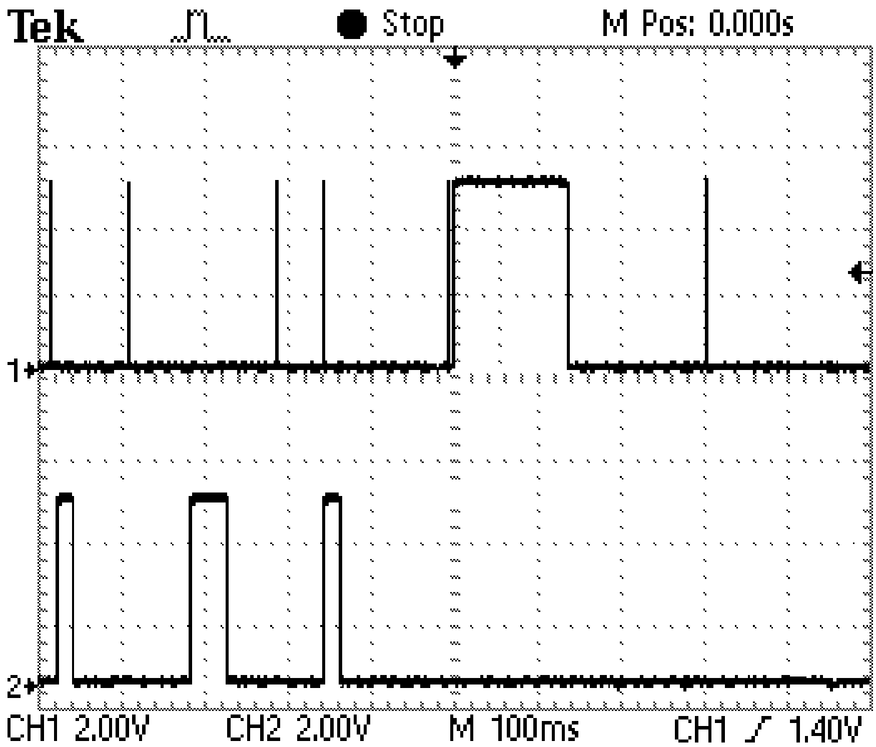

Figure 12: RESET and watchdog signal

5.4 Example: locating EMC weak points on an I/O module / microprocessor

Serial data transfer between a microprocessor and a remote I/O module can be disturbed by burst, ESD or radiated or conducted RF emissions. Appropriate test generators can be connected to the DUT for simulation purposes.

The relevant signals such as RDY, DAT, CLOCK etc. are detected by a sensor and transmitted to a memory oscilloscope for evaluation. The sensor can be connected to different points along the signal path such as the microprocessor pin, plug-and-socket connector, beginning of the cable, end of the cable, opto-coupler input, opto-coupler output, driver input, driver output or I/O circuit pin. The location of the disturbance attack can determined by scanning the signal path step-by-step and evaluating the signals.
Correlations between signals can be established if several sensors are used (e.g. handshake signals).

6 Safety instructions

When using a product from Langer EMV-Technik GmbH, please observe the following safety instructions to protect yourself from electric shock or the risk of injuries.

Read and follow the instructions in the user manual and keep it in a safe place for later reference. The device may only be used by personnel who are qualified in the field of EMC and who are fit to work with and possibly be influenced by disturbance voltages and (electric and magnetic) burst fields.

- Read the operating and safety instructions for all devices used in the set-up.
- Never use any damaged or defective devices.
- Carry out a visual check before using a measurement set-up with a Langer EMV-Technik GmbH product. Replace any damaged connecting cables before using the product.
- Never leave a product from Langer EMV-Technik GmbH unattended whilst it is in operation.
- The Langer EMV-Technik GmbH product may only be used for its intended purpose.
  Any other use is forbidden.
- People with a pacemaker are not allowed to work with this device.
- The test set-up should always be operated via a filtered power supply.

- **Attention! Functional near fields and interference emissions may occur when the probe is operated. The user is responsible for taking appropriate precautions to prevent any interference with the correct function of products outside the operational EMC environment (in particular through interference emissions.**

- This can be achieved by:

  - observing an appropriate safety distance
  - using of shielded or shielding rooms

- The disturbances that are injected into the modules can destroy the device under test (latch-up) if their intensity is too high. Protect the device under test by:

  - increasing the disturbance gradually and stopping when a functional fault occurs
  - interrupting the power supply to the device under test in the event of a latch-up.

Attention! Make sure that internal functional faults are visible from outside. The device under test may be destroyed due to an increase in the injection intensity if the faults are not visible from outside. Take the following precautions if necessary:

- monitor the representative signals in the device under test
- use a special test software
- monitor visible reaction of the device under test to inputs
  (reaction test of the device under test).

We cannot assume any liability for the destruction of devices under test!

7 Warranty

Langer EMV-Technik GmbH will remedy any fault due to defective material or defective manufacture, either by repair or by delivery of spare parts, during the statutory warranty period.

This warranty is only granted on condition that:

- the information and instructions in the user manual have been followed.

The warranty will be forfeited if:

- an unauthorized repair is performed on the product,
- the product is modified,
- the product is not used for its intended purpose.

8 Technical data

8.1 EMC sensor

Sensor type	**S25**
Transfer rate	DC-50 Mbps
Voltage supply	3 - 5 volts
Current input	30 mA
Dimensions	(34 x 10 x 6) mm
Optical fibre cable connection	∅ 2.2 mm

8.2 Optical receivers

Receiver type	**OE 450**	**OE 150**
Transfer rate	DC-50 Mbps	DC-50 Mbps
Current input	< 100 mA	< 80 mA
Voltage supply	12 V via external power supply unit	12 V via external power supply unit
Pulse stretching	5 µs / 20 ns / 50 ms adjustable	50 ms adjustable
Optical input	4x optical fibre cable ∅ 2.2 mm	optical fibre cable ∅ 2.2 mm
Output	4x BNC plug, 5 V HCMOS	BNC plug, 5 V HCMOS

9 Scope of delivery

9.1 OSE 450 set (4 channels) DC-50 Mbps

Pos.	Designation	Type	Quantity
01	Optical receiver	OE 450	1
02	Sensors*	S25	4
03	Plug-in power supply unit	12 V / 270 mA	1
04	Optical fibre cable	6 m	4
05	Adapter socket	3-pole	8
06	Enamelled Cu wire 0.15 mm	reel	1
07	Transport case with foam insert	(338 x 260 x 57) mm	1
08	Short description	Laminate	1
09	User manual		1

* Further sensors are available on request and can be added to the set.

Figure 13 **Case OSE 450 set (4 channels)**

9.2 OSE 150-1 set (1 channel) DC-50 Mbps

Pos.	Designation	Type	Quantity
01	Optical receiver	***OE 150***	1
02	Sensor*	***S25***	1
03	Plug-in power supply unit	12 V / 270 mA	1
04	Optical fibre	1.5 m	1
05	Adapter socket	3-pole	3
06	Enamelled Cu wire 0.15 mm	reel	1
07	Transport case with foam insert	(240 x 185 x 50) mm	1
08	Short description	Laminate	1
09	User manual		1

* Further sensors are available on request and can be added to the set.

Figure 14 Case OSE 150-1 set (1 channel)

9.3 OSE 150-2 set (2 channels) DC-50 Mbps

Pos.	Designation	Type	Quantity
01	Optical receivers	***OE 150***	2
02	Sensors*	***S25***	2
03	Power split cable	20 cm	1
04	Plug-in power supply unit	12 V / 270 mA	1
05	Optical fibre	6 m	2
06	Adapter socket	3-pole	6
07	Enamelled Cu wire 0.15 mm	reel	1
08	Transport case with foam insert	(338 x 260 x 57) mm	1
09	Short description	Laminate	1
10	Operating instructions		1

* Further sensors are available on request and can be added to the set.

Figure 15 Case OSE 150-2 set (2 channels)

10 Information on Recycling and Disposal

In accordance with the WEEE Directive 2012/19/EU (Waste of Electrical and Electronic Equipment), the following must be observed:

At the end of its service life, this product should be taken to a suitable disposal facility for recycling and disposal. Do not dispose of with household waste.

11 Customer service

Please contact us if you have any questions, comments or suggestions.

<u>You can contact us:</u>

Monday – Friday
8:00 Uhr bis 15 Uhr (CET)

<u>Contact us at:</u>

Address: Langer EMV-Technik GmbH
Nöthnitzer Hang 31
01728 Bannewitz
Germany

Internet: https://www.langer-emv.com/
E-mail: mail@langer-emv.de
Phone: +49 (0) 351-430093-0
Fax: +49 (0) 351-430093-22

<u>Calibration</u>

We recommend having the product calibrated every two years by the manufacturer Langer EMV-Technik GmbH or by a certified distributor.