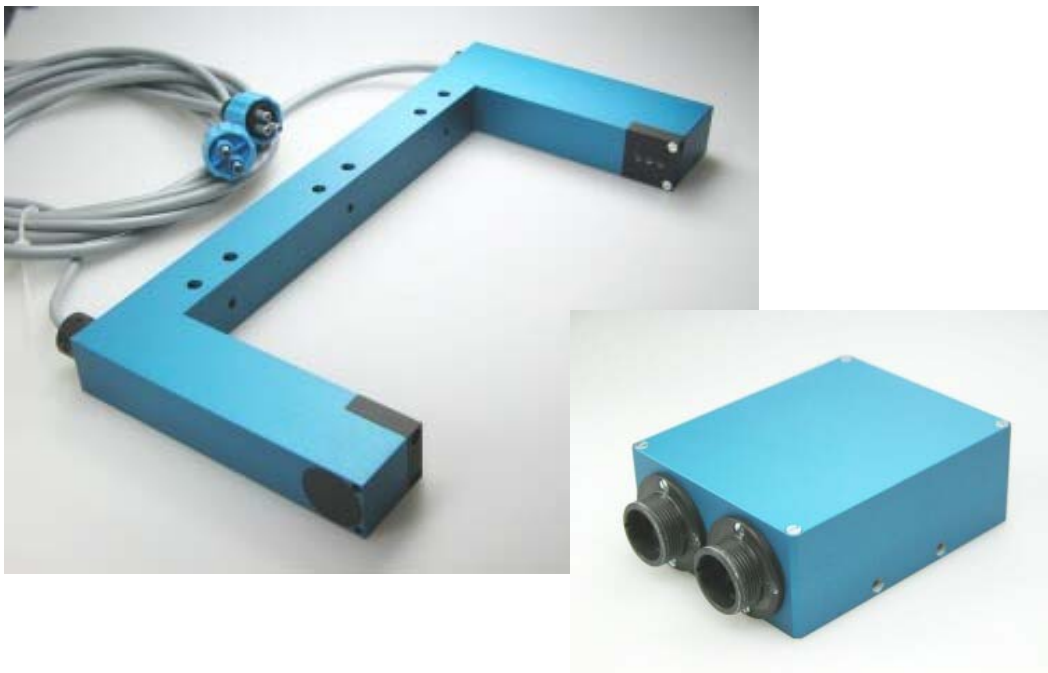# Manual
Software SI-JET2-Scope V3.1
(PC-Software for Microsoft® Windows® Vista, XP, 2000, NT® 4.0, Me, 98, 95)

for the spray jet monitoring sensor SI-JET2

This manual describes the installation of the PC software for the SI-JET2 sensor. As a support for commissioning of the spray jet sensor this manual explains the functional elements of the graphic Windows® user interface.

The SI-JET2 spray jet sensor detects the radiation that is transmitted by the measuring object. It uses a red-light LED with adjustable transmission power as a light source. An integrated 3-fold receiver for the LEFT, CENTRE, and RIGHT component of the light transmitted by the measuring object is employed as a receiver.

The current density and symmetry are taught to the sensor through an external input IN0. As a maximum 31 states can be taught.

Density and symmetry are detected continuously. The respective detected status is provided at the outputs as a binary code (OUTMODE=BINARY) or directly (OUTMODE=DIRECT). The detected adjustment is at the same time visualised by way of 5 LEDs at the housing of the SI-JET2 control unit.

Through the RS232 interface parameters and measured values can be exchanged between the PC and the SI-JET2 sensor. All the parameters for density and symmetry detection can be stored in the non-volatile EEPROM of the SI-JET2 sensor. When parameterization is finished the color sensor continues to operate with the current parameters in "stand alone" mode without a PC.

SI-JET2 spray jet sensors are available as single-channel, dual-channel, or triple-channel systems with red-light LED or laser. In a single-channel system all three receivers for the left, center, and right component that are visualised on the user interface assume the value of the center channel. In a dual-channel system the center component is formed from the mean value of the left and right channel.
The programming software is used to set the number of existing channels.

0. Contents

Shortcuts:

SEND   F9
GET   F10
GO   F11
STOP   F12

1.   Measured variables

In this manual, the following measured variables are used for explaining the measurement principle and for representing formulas. The designations also are identical to those on the PC user interface.

CH_L   Current value of channel left
CH_C   Current value of channel centre
CH_R   Current value of channel right
MAX_CHL   Maximum value of channel left during the last 60 seconds
MAX_CHC   Maximum value of channel centre during the last 60 seconds
MAX_CHR   Maximum value of channel right during the last 60 seconds
DENSITY   Current calculated density
SYM1   Current calculated symmetry 1
SYM2   Current calculated symmetry 2

D   Taught value for density in Teach Table
DTO   Tolerance value for density in Teach Table
S1   Taught value for symmetry 1 in Teach Table
S1TO   Tolerance value for symmetry 1 in Teach Table
S2   Taught value for symmetry 2 in Teach Table
S2TO   Tolerance value for symmetry 2 in Teach Table

2. Measuring principle

The following three measurands are picked up and monitored in the production process by the SI-JET2 spray jet monitoring system:

- Spray jet density (hereinafter referred to as density).
- Symmetry 1 (the two outer channels are put into proportion to each other).
- Symmetry 2 (Symmetry 1 is put into proportion to the centre channel).

Depending on the evaluation mode, density and symmetry are calculated as follows.

2.1 Evaluation modes

EVALUATION MODE ABSOLUTE:

$$DENSITY = \frac{CH\_L + CH\_C + CH\_R}{3} \qquad SYM1 = \frac{CH\_L}{CH\_L + CH\_R} * 1000$$

$$SYM2 = \frac{CH\_C}{CH\_C + \dfrac{CH\_L + CH\_R}{2}} * 1000$$

EVALUATION MODE RELATIVE:

$$CHL\_N = 4096 - \frac{CH\_L}{MAX\_CHL} * 4096 \qquad CHC\_N = 4096 - \frac{CH\_C}{MAX\_CHC} * 4096 \qquad CHR\_N = 4096 - \frac{CH\_R}{MAX\_CHR} * 4096$$

$$DENSITY = CHC\_N \qquad SYM1 = \frac{CHL\_N}{CHL\_N + CHR\_N} * 1000$$

$$SYM2 = \frac{CHC\_N}{CHC\_N + \dfrac{CHL\_N + CHR\_N}{2}} * 1000$$

2.2 TEACH process

The teach process can be performed either with the parameterisation software, by way of the teach input (IN0 PIN3 green at the cab-las8/SPS cable), or by means of the switch at the housing.
When teaching is performed through the IN0 input, the tolerance values for density and symmetry must first be stored once in the EEPROM of the control unit with the help of the parameterisation software.
Before input IN0 is activated, the status to be taught must be present at the sensor front-end, i.e. spraying must first be switched on, and then IN0 must be set to +24V.
The current status is taught to as many rows in the Teach Table as have been selected under MAXVEC-No. classification is performed by way of different set tolerances.

3. Installation of the SI-JET2-Scope V3.1 software

Hardware requirements for successful installation of the SI-JET2-Scope software:

- IBM PC AT or compatible
- VGA graphics
- Microsoft® Windows® Vista, XP, Me, 2000, 98, NT® 4.0 or 95
- Serial RS232 interface at the PC
- Microsoft-compatible mouse
- Cable for the RS232 interface
- CD-ROM drive
- Approx. 5 MB of free hard disk space

The SI-JET2-Scope software can only be installed under Windows. Windows must therefore be started first, if it is not yet running.

Please install the software as described below:

1. The software can be installed directly from the installation CD-ROM. To install the software, start the SETUP program in the INSTALL folder of the CD-ROM.

2. The installation program displays a dialog and suggests to install the software in the C:\"FILENAME" directory on the hard disk. You may accept this suggestion with **OK** or [**ENTER**], or you may change the path as desired. Installation is then performed automatically.

3. During the installation process a new program group for the software is created in the Windows Program Manager. In the program group an icon for starting the software is created automatically. When installation is successfully completed the installation program displays "Setup OK".

4. After successful installation the software can be started with a left mouse button double-click on the icon.
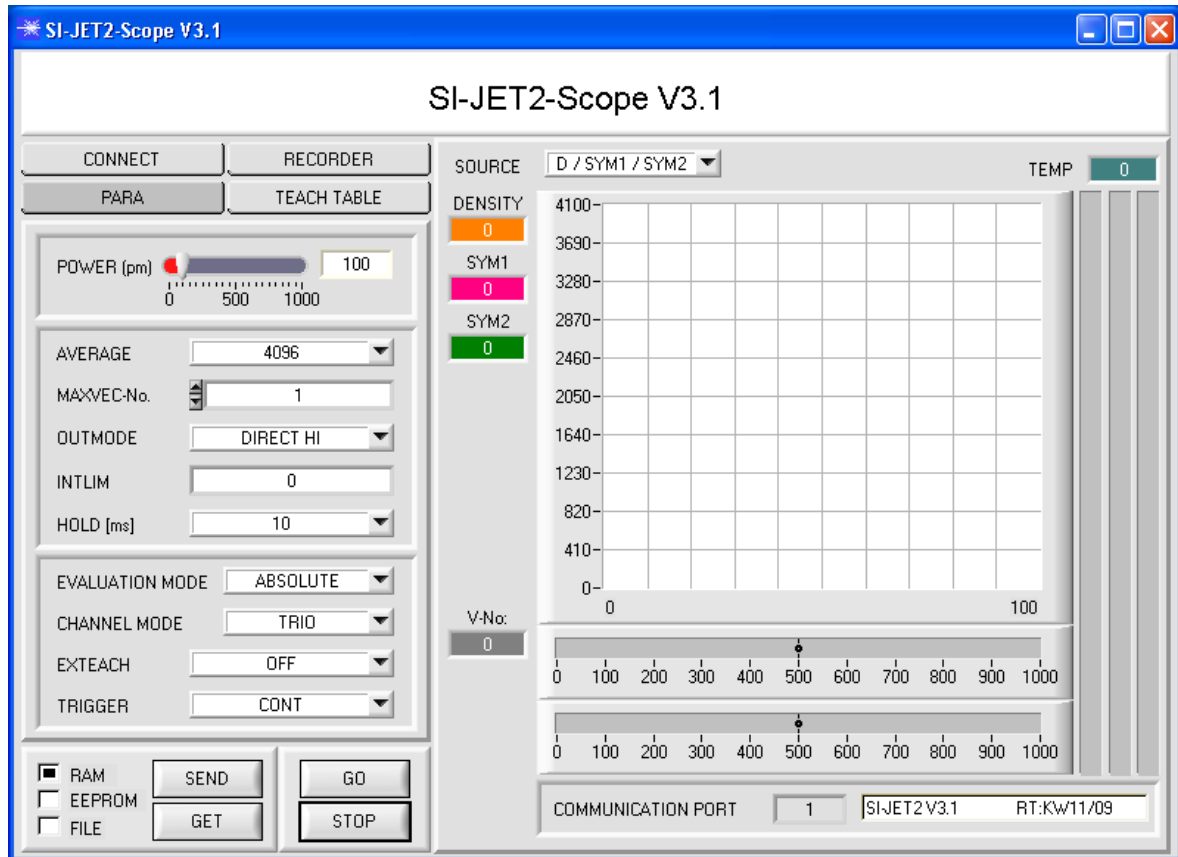
Windows® is a trademark of the Microsoft Corp.
VGA™ is a trademark of the International Business Machines Corp.

4. Operation of the SI-JET2-Scope V3.1 software

Please read this chapter first before you start to adjust and parameterise the SI-JET2 sensor.

Pressing the right mouse button on an individual element will call up a short help text.

When the SI-JET2-Scope software is started, the following window appears on the Windows interface:

4.1   Tab CONNECT

CONNECT:
Pressing the CONNECT tab opens a window for selecting and configuring the interface.

The COMMUNICATION PROTOCOL function field is used for selecting either an RS232 or a TCP/IP protocol.
If RS232 is selected, a port from 1 to 256 can be selected with SELECT COM PORT, depending on which port the sensor is connected to.
If an adaptor is used, the COMPORT number can be determined by way of the hardware manager in the system control panel.
If the sensor should communicate through a local area network, an RS232 to Ethernet adaptor will be needed. This adapter makes it possible to establish a connection to the sensor with the TCP/IP protocol.
The network adaptors that are available from us are based on the Lantronix XPort module. For parameterising these adapters (assigning of an IP address, setting of the Baud rate of 19200) please download the "DeviceInstaller" software that is provided free of charge by Lantronix at http://www.lantronix.com/. DeviceInstaller is based on Microsoft's ".NET" framework. Detailed operating instructions for the "DeviceInstaller" software also are available from Lantronix.
In order to establish a connection to the adaptor, its IP address or HOST name must be entered in the field INSERT IP ADRESS (xxx.xxx.xxx.xxx) OR HOST NAME. The DROP DOWN menu (down arrow) shows the last 10 IP addresses that were used. An address from this list can be directly selected by clicking on the respective item. The DROP DOWN list is saved and is thus always available when the software is closed.
The PORT NUMBER for the XPort-based network adaptors is 10001. This port number must not be changed.
When you press the TRY TO CONNECT button, the software tries to establish a connection with the set parameters. The communication status is shown in the display field. If the sensor answers with its FIRMWARE ID, the set connection type can be accepted by pressing ACCEPT SETTINGS. You will then be returned to the main panel. If you get a CONNECTION FAILURE message, the software could not establish a connection to the sensor. In this case please check if the interface cable is correctly connected, if the sensor is supplied with power, and if the set parameters are correct. Pressing DISCARD SETTINGS exits the COMMUNICATION SETTINGS panel with the parameters that were set before the panel was started.
If a connection has been accepted by pressing ACCEPT SETTINGS, the software starts automatically with these settings when called the next time.

⚠ ATTENTION !	The stable function of the interface is a basic prerequisite for measured value transfer from the PC to the SI-COLO4 color sensor. Due to the limited data transfer rate through the serial RS232 interface (19200 bit/s) only slow changes of the raw signals at the sensor front end can be observed in the graphic output window of the PC. For maintaining maximum switching frequency at the sensor data communication with the PC must be stopped (press the STOP button).

2.2 Tab PARA, button SEND, GET, GO, STOP

PARA:
Pressing the PARA tab opens a window for setting the sensor parameters.

ATTENTION!
A change of the parameter function groups only becomes effective at the sensor after actuation of the SEND button in the MEM function field!

SEND [F9]:
When the SEND button is clicked (or shortcut key button F9 is pressed), all the currently set parameters are transferred between PC and sensor. The target of the respective parameter transfer is determined by the selected button (RAM, EEPROM, or FILE).

GET [F10]:
The currently set values can be interrogated from the sensor by clicking on the GET button (or with shortcut key button F10). The source of data exchange is determined by the selected button (RAM, EEPROM, or FILE).

RAM:
After a click on the SEND button the current parameters are written into the RAM memory of the sensor, or they are read from the RAM by clicking on the GET button, i.e. these parameters are lost when the voltage at the sensor is switched off.

EEPROM:
After a click on the SEND button the current parameters are written into the non-volatile memory of the EEPROM in the sensor, or they are read from the EEPROM by clicking on the GET button, i.e. the parameters in the internal EEPROM are stored when the voltage at the sensor is switched off.

FILE:
After pressing SEND, the current parameters can be written to a selectable file on the hard disk. With GET parameters can be read from such a file. When the SEND or GET button is pressed, a dialog box opens for selecting the desired file.

GO [F11]:
A click on this button (or with shortcut key button F11) starts data transfer from the sensor to the PC through the serial RS232 interface.
SOURCE is used to select which signals should be shown in the displays and graphs.

STOP [F12]:
A click on this button (or with shortcut key button F12) stops data transfer from the sensor to the PC through the serial RS232 interface.

EVALUATION MODE:
The SI-JET2 can be operated with two different evaluation modes.

ABSOLUTE:
The absolute status of the three channels CH_L, CH_C, and CH_R is used for evaluation.

RELATIVE:
The current status of the three channels CH_L, CH_C, and CH_R relative to their maximum values in the last 60 seconds is used for evaluation.
See 4.5 and 4.6!

CHANNEL MODE:
The SI-JET2 can be operated with different frontends. A differentiation is made here between a "single-channel", "dual-channel" and "triple-channel system". The number of channels can be set with **CHANNEL MODE**.

MONO:
Only the center channel **CH_C** is available. **CH_L** and **CH_R** are set to the same value as **CH_C.**

DUO:
Only the channels **CH_L** and **CH_R** are available. **CH_C** is set to **(CH_L+CH_R)/2**.

TRIO:
All three channels CH_L, CH_C and CH_R are available.

No.	TEACH TABLE					
	D	DTO	S1	S1TO	S2	S2TO
0	1	100	1	20	1	20
1	1	200	1	40	1	40
2	1	300	1	60	1	60
3	1	400	1	80	1	80
4	1	1	1	1	1	1
5	1	1	1	1	1	1

EXTERN TEACH:
When EXTERN TEACH is activated, the currently present gloss degree or normalized vector (depending on EVALMODE) can be written to the TEACH TABLE by way of the external IN0 input or the TEACH button. The currently present line vector is automatically taken over, starting with line 0, in as many lines as is set in MAXVEC-No..

The advantage is that the user does not have to start the parameterisation software for this purpose.

Please note that when this evaluation mode is selected, the tolerances must at the beginning be stored once to the EEPROM.

Furthermore, the MAXVEC-No. also must be set first, and must also be stored in the EEPROM.

ATTENTION!
When the EXTERN TEACH mode is activated, external triggering with EXT1 and EXT2 is not possible, because the sensor only has one input. The TRIGGER function field will no longer be active.

TRIGGER:
This function field serves for setting the trigger mode at the SI-JET2 sensor.

CONT:
Continuous gloss value detection (no trigger event required).

EXT1:
Evaluation is started through the external trigger input (IN0 pin3 green of cable cab-las8/SPS) or through clicking the TEACH button. A trigger event is recognized as long as +24V is present at the IN0 input (HIGH active).
After the trigger input goes to LOW again, the state (V-No.:) that was last detected will be held at the outputs.

EXT2:
Same behaviour as in EXT1 mode, with the difference that an error state (V-No.: = 255) will be output after the trigger input goes to LOW again.

PLEASE NOTE!
External teaching is not possible when the TRIGGER mode is activated, because the sensor only has one input.
The EXTEACH function field will be inactive.

POWER:
In this function field the intensity of the transmitter unit can be adjusted by using the slider or by entering a value in the edit box. A value of 1000 means full intensity at the transmitter unit, a value of 0 stands for the lowest transmitter intensity adjustment!
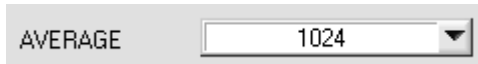
AVERAGE:
This function field is used for adjusting the number of scanning values (measurement values) over which the raw signals measured at the receivers are averaged. A higher AVERAGE default value reduces noise of the raw signals at the receiver unit and there will be a decrease of the maximal available switching frequency of the SI-JET2 spray jet sensor.

MAXVEC-No.:
This function field serves for setting the number of spray states to be checked.
In BINARY mode the maximum number of spray states to be checked is 31. In DIRECT HI or DIRECT LO mode the maximum number of spray states to be checked is 5 (No. 0,1,2,3,4). The numerical value set here determines the currently possible scanning rate of the sensor. The less the spray states to be checked, the faster the operation of the SI-JET2 spray jet sensor.
The numerical value set here refers to the number of rows (starting with row 0) in the → TEACH TABLE
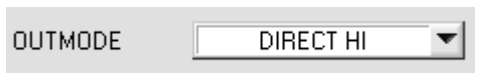
OUTMODE:
This group of buttons offers the method of how to control the 5 digital outputs.

BINARY:
If in this row-by-row comparison the current spray state corresponds with the teach-in parameters entered in the TEACH TABLE, this "hit" in the TEACH TABLE is displayed as a vector number (V-No.) and is sent to the digital outputs (OUT0 ... OUT4) as a **bit pattern**.
The maximum number of spray states to be taught is 31.

DIRECT:
In this mode the maximum number of spray states to be taught is 5.
If in this row-by-row comparison the current parameters correspond with the teach-in parameters entered in the TEACH TABLE, this "hit" in the TEACH TABLE is displayed as a vector number (V-No.) and is sent **directly** to the digital outputs (OUT0 ... OUT04).I

DIRECT HI:
If **DIRECT HI** is activated and if a line vector (V-no.: 0…4) is detected in the TEACH TABLE, the special digital output (OUT0 … OUT4) is set to HI. If no line vector was detected, the digital outputs are in LO status (no LED is lighting).

DIRECT LO:
If **DIRECT LO** is activated and if a line vector (V-no.: 0…4) is detected in the TEACH TABLE, the special digital output (OUT0 … OUT4) is set to LO, while the other ones are set to HI. If no line vector was detected, the digital outputs are in HI status (all LEDs are lighting).

INTLIM:
This edit box is used for setting an intensity limit. Evaluation is stopped, if the current intensity INT arriving at the receiver unit falls below this limit, and ERROR STATE (V-No.: =255) is output.

HOLD:
The SI-JET sensor operates with minimum scanning times in the magnitude of less than 150µs. This is why most of the PLCs that are connected to the digital outputs OUT0 … OUT4 have difficulties with the safe detection of the resulting short switching state changes. For the digital outputs of the SI-JET2 sensor pulse lengthening of up to 100 ms can be set by selecting the corresponding HOLD value.

4.3 Tab TEACH TABLE

Pressing the GO button starts the data transfer from the sensor to the PC. The respective CH_L, CH_C and CH_R components are indicated in the bars beside the graph. The calculated DENSITY, SYM1 and SYM2 values are visualised in the displays.
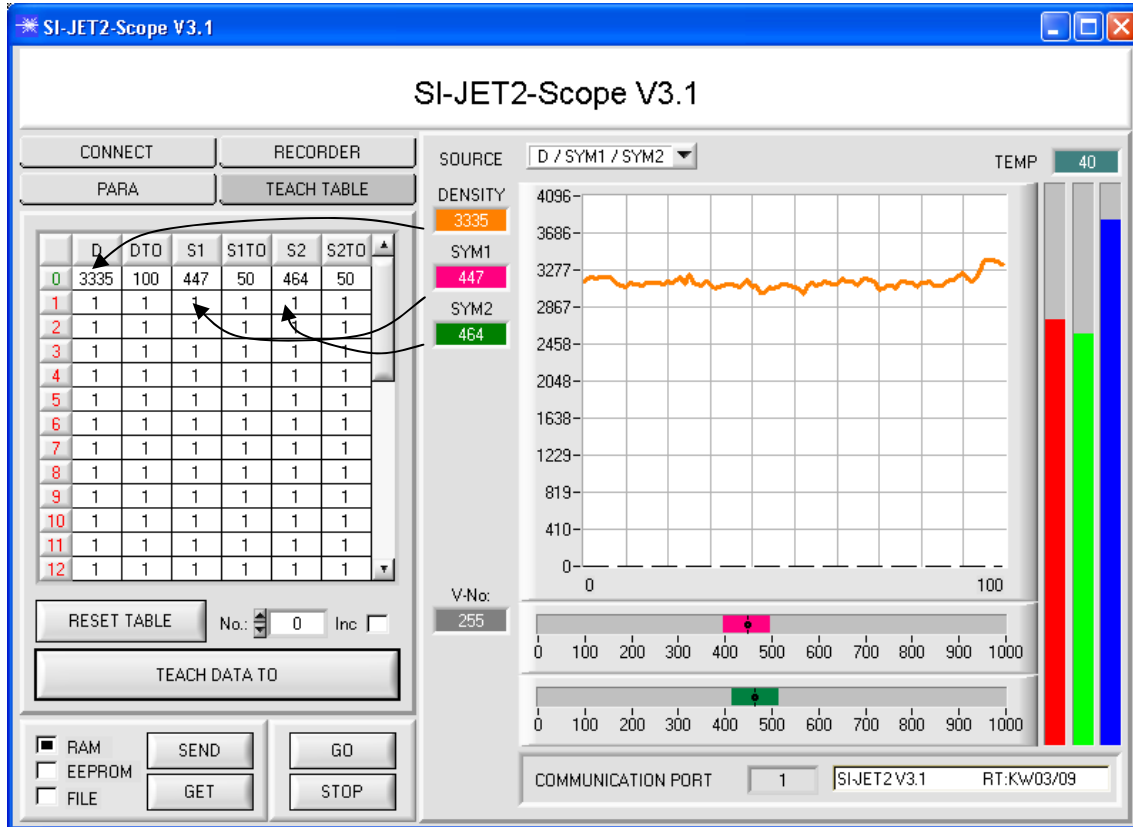
DENSITY 0 Current calculated density

SYM1 0 Current calculated symmetry 1

SYM2 0 Current calculated symmetry 2

CH_L 0 Current value of channel left

CH_C 0 Current value of channel centre

CH_R 0 Current value of channel right

MAX_CHL 0 Maximum value of channel left during the last 60 seconds

MAX_CHC 0 Maximum value of channel centre during the last 60 seconds

MAX_CHR 0 Maximum value of channel right during the last 60 seconds

TEMP 0 This display shows the current temperature that is measured in the sensor housing.

V-No: 255 **V-No.:**
This numerical value output field displays the currently detected vector number in accordance with the entry in the TEACH TABLE. The currently detected vector number is sent to the digital outputs OUT0 … OUT4 as a corresponding bit pattern.

Please note:	The above-mentioned 5 output fields are only updated when data transfer between PC and SI-JET2 sensor is active (GO button pressed).

	D	DTO	S1	S1TO	S2	S2TO
0	3335	100	447	50	464	50
1	1	1	1	1	1	1
2	1	1	1	1	1	1
3	1	1	1	1	1	1
4	1	1	1	1	1	1
5	1	1	1	1	1	1
6	1	1	1	1	1	1
7	1	1	1	1	1	1
8	1	1	1	1	1	1
9	1	1	1	1	1	1
10	1	1	1	1	1	1
11	1	1	1	1	1	1
12	1	1	1	1	1	1

RESET TABLE   No.: 0   Inc □

TEACH DATA TO

■ RAM   SEND   GO
□ EEPROM
□ FILE   GET   STOP

TEACH TABLE:
A click on the TEACH TABLE tab opens a view where vectors can be taught to the TEACH TABLE.

Please note: The sensor must be informed about the teach vectors by pressing SEND.

After a left mouse button double click (or a click on shortcut key button F2) on the respective field the default values can be changed by entering numerical values with the PC keyboard.

The TEACH TABLE is organized in rows, i.e. the individual parameters for the teach-in vectors are arranged side by side in the respective row.

The sensor is able to check up to 31 teach-in vectors. The number of the respective teach-in vector is given in the left column of the table.

Only the green rows are used for evaluation in the sensor. The number of rows to be inspected is set with MAXVEC-No.

When **TEACH DATA TO** is pressed, the currently displayed data for DENSITY, SYM1, and SYM2 are transferred to the row in the TEACH TABLE that is selected under **No.:**
A DENSITY Tolerance (DTO), a SYM1 Tolerance (S1TO), and a SYM2 Tolerance (S2TO) also are set. If necessary, these tolerances, as well as the teach values, can be changed as described above.
No.: also is used to select which SYM1 or SYM2 tolerance window is shown in the respective graphs for the Symmetrie1 or for Symmetrie2.

When **Inc:** is activated, and the **TEACH DATA TO** button is pressed, the No.: input field is automatically incremented (increased) by 1, i.e. the next row in the TEACH TABLE is selected

A click on the **RESET TABLE** button resets the TEACH TABLE (RESET value = 1)

4.4 Tab RECORDER

The SI-JET2-Scope software features a data recorder that allows the saving of CH_L, CH_C, CH_R, DENSITY, SYM1, SYM2, V-No: and TEMP. The recorded file is saved to the hard disk of the PC and can then be evaluated with a spreadsheet program.

The file that is created has ten columns and as many rows as data frames were recorded.

The following steps describe how data frames are recorded with the recorder:
Please note:
Recording depends on the EVALUATION MODE that is chosen. Several EVALUATION MODES do not need certain data, therefore these data will be set to 0, i.e. for these data the value 0 will be recorded.

Step 1:
When the RECORDER button is pressed, the following window will be displayed:
When the SHOW GRAPH button is pressed, a panel will be displayed that allows the user to monitor the different signals.
The individual signals can be activated from the SIGNAL drop-down menu.

RECORD MODE   AUTO LIMITED

RECORD-TIME INTERVAL [sec]   1

RECORD VALUES (MAX 50 000)   1000

TOTAL RECORD TIME (days hours min sec)

| 0 | 0 | 16 | 40 |

RECORDED	REMAINING
0	1000

START RECORD   STOP RECORD

ID

SELECT RECORD FILE   SHOW GRAPH

Filename
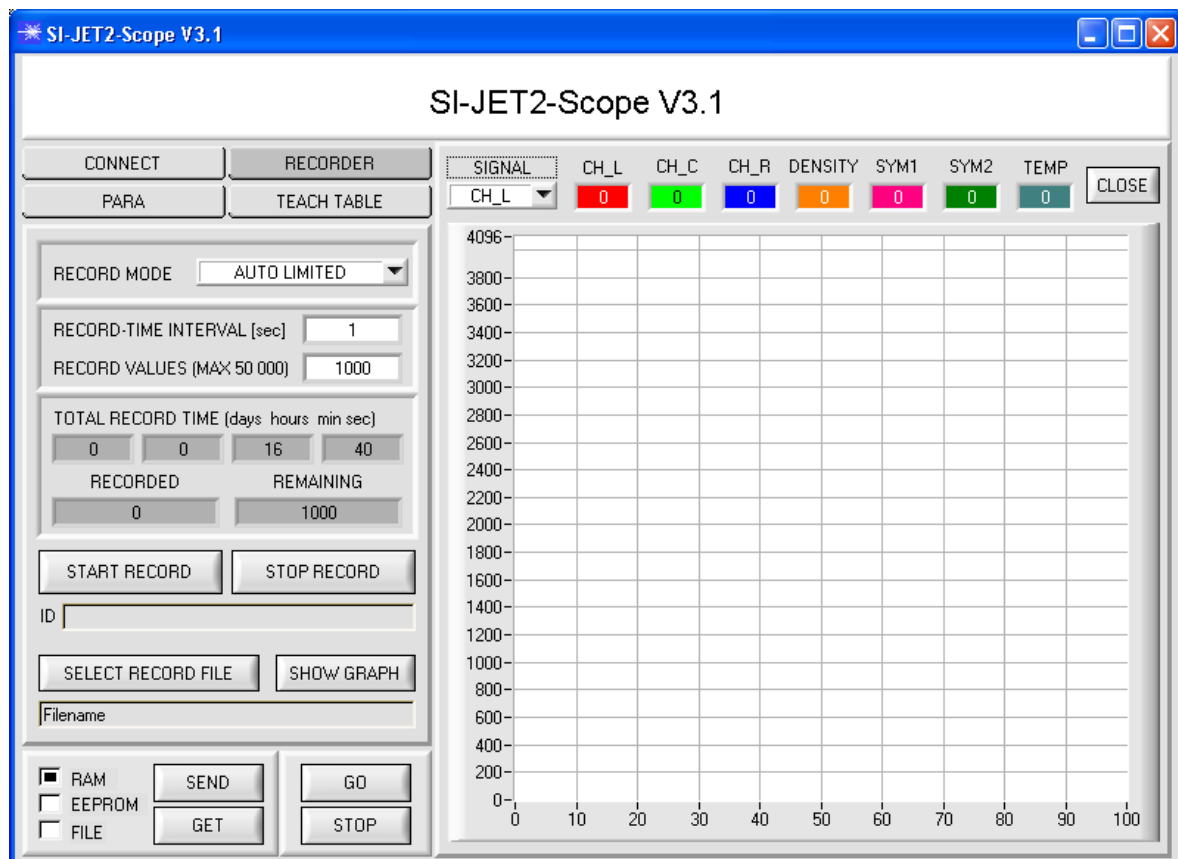
Step 2:
If you want to automatically record several data frames, please select **AUTO LIMITED** under **RECORD MORE**.
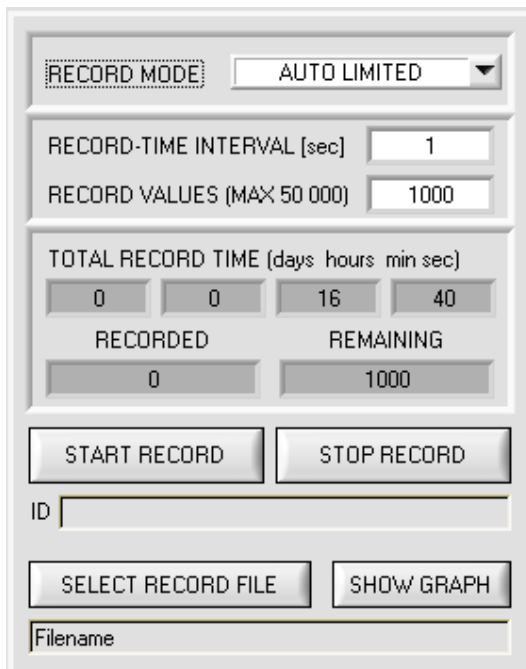Enter a time interval for recording under **RECORD-TIME INTERVAL [sec]**, in this example: 1, i.e. a new value is called from the sensor every second).
Then enter the maximum number of values you wish to record in the **RECORD VALUES [MAX 50 000]** field.
Please note: Recording can also be stopped earlier by clicking **STOP RECORD**, the data recorded so far will not be lost.

The **TOTAL RECORD TIME** field indicates how long recording will take (in days, hours, minutes, and seconds) if all data are recorded.

Step 3:
By pressing the button **SELECT RECORD FILE** a file can be selected in which the data frame will be stored.
If you select an already existing file name, you will be asked whether you want to overwrite the existing file or not.

Step 4:
Pressing the START RECORD button starts automatic data recording.

The recorder starts to record data, and the button **START RECORD** is red to indicate that recording is active.
The respective data frames are shown in the display windows.

In the two display fields **RECORDED** and **REMAINING** you can check how many data frames have been recorded, and how many frames remain to be recorded.

Please note:
During recording the two input fields RECORD-TIME INTERVAL and RECORD VALUES [MAX 50 000] are inactive.

Step 5:
When as many data frames as set under **RECORD VALUES [MAX 50 000]** have been recorded, or when the **STOP AUTO RECORD** button is pressed, a pop-up window will appear which confirms that the file is stored.

If you want to record an unlimited number of data, select the **AUTO UNLIMITED** function under **RECORD MORE**. Then select the desired recording interval and press **START RECORD**.

If you want to record data "manually", select the **MANUAL RECORDING** function under **RECORD MORE**.
You can start reading data from the sensor by pressing the **GO** button. These data are visualised in the display window. Pressing the **CAPTURE DATA FRAME** button saves a data frame in the file that was selected under **SELECT RECORD FILE**. The **RECORDED** field shows the sum of the frames already recorded.

If **AUTO TRIGGERED** is selected under **RECORD MORE**, and **TRIGGER** = **EXT1** or **EXT2** is selected, the sensor will automatically send a data frame after each drop of the trigger when **START RECORD** is pressed. This data frame is captured and recorded by the recorder.
Pressing the **STOP RECORD** button terminates the automatic sending function of the sensor again.

Please note:
When you press START RECORD, the file that is selected under SELECT RECORD FILE will be deleted. With RECORD FRAME MANUALLY, the file will be created if it does not already exist. If the file already exists, the data are added to the existing file.

4.5 EVALUATION MODE ABSOLUTE
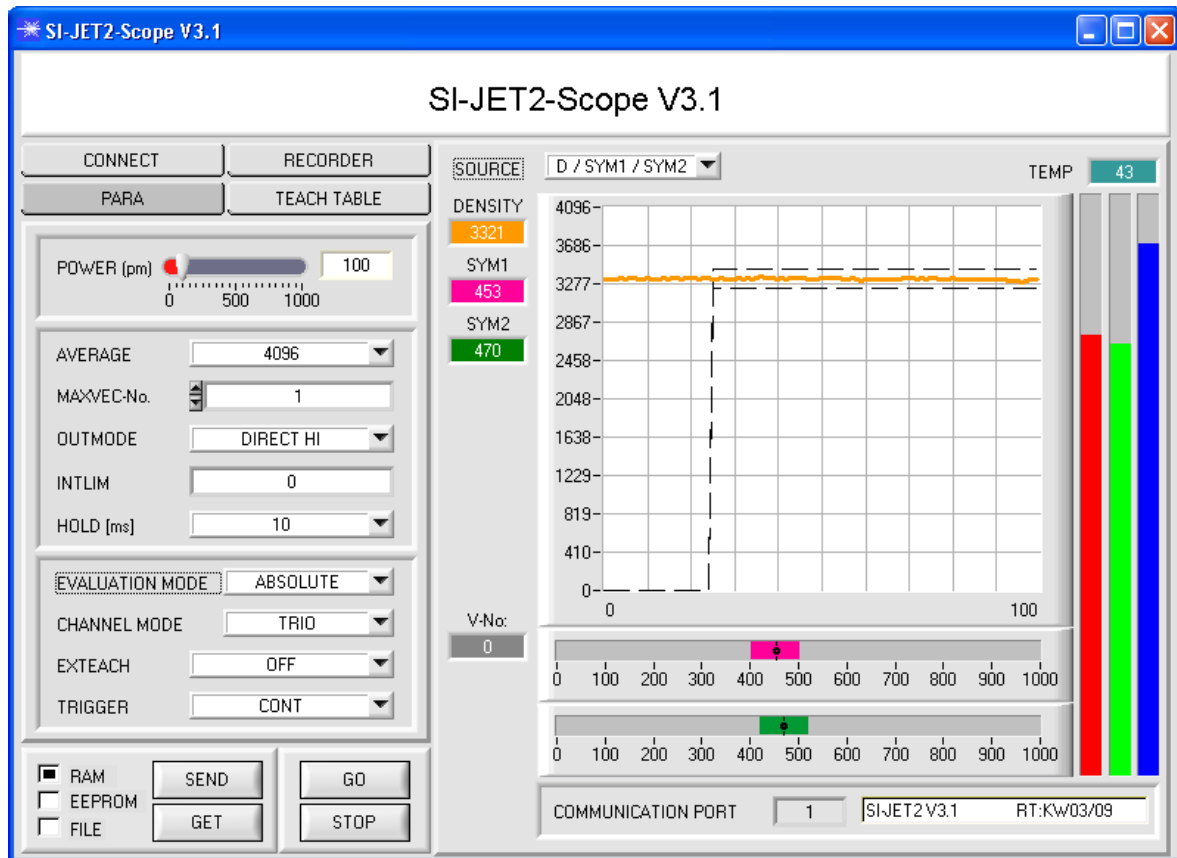
In EVALUATION MODE ABSOLUTE all three channels CH_L, CH_C, and CH_R are used for calculating density, symmetry 1, and symmetry 2:

$$DENSITY = \frac{CH\_L + CH\_C + CH\_R}{3}$$

$$SYM1 = \frac{CH\_L}{CH\_L + CH\_R} * 1000$$

$$SYM2 = \frac{CH\_C}{CH\_C + \frac{CH\_L + CH\_R}{2}} * 1000$$

The current values for DENSITY, SYM1, and SYM2 are shown in displays on the PC user interface.
CH_L, CH_C, and CH_R in addition are visualised in the form of bars at the right side of the graph.
SOURCE is used to select the signal that should be visualised in the graph.

For teaching, the tab TEACH TABLE must be pressed.
When TEACH TABLE has been pressed, the setting parameters will disappear and the TEACH TABLE will be displayed. The sensor can be taught a total of 31 TEACH vectors.

When the GO button is pressed, the DENSITY, SYM!, and SYM2 data that are currently calculated in the sensor are shown on the PC user interface.
When the TEACH DATA TO button is pressed, the data are written to the line in the TEACH TABLE that is selected under No.:.

DTO is used for setting a plus/minus tolerance for the taught density. The value can be changed by the user. For this purpose the corresponding cell in the TEACH TABLE must be selected either with a double-click or with function key F2.
The higher the value of DTO, the more insensitive the sensor will be.
S1TO and S2TO are used for setting a plus/minus tolerance for the taught symmetry1 and symmetry2.

Once a vector has been taught, the information is transferred to the sensor by pressing the SEND button.
When the SEND button is pressed, the sensor stops data polling.
In order to check whether the sensor has adopted the teach vector, the GO button must be pressed again.
The currently detected line is displayed under V-No:.
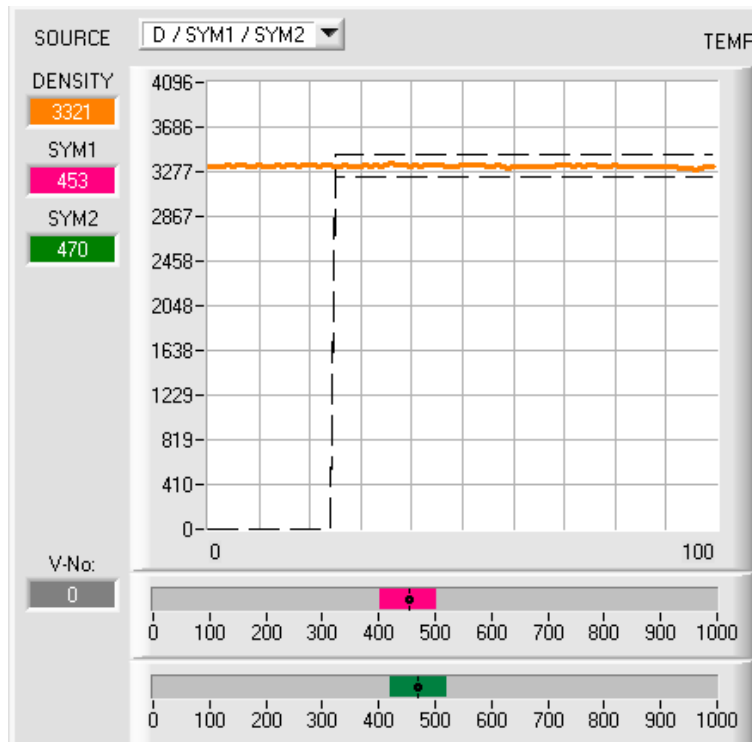
When D / SYM1 / SYM2 is selected under SOURCE, the currently determined values for density, symmetry 1, and symmetry 2 as well as the tolerance windows that were selected under No.: are displayed.

Please note!
The value range for density is 0 … 4096.
The value range for SYM1 and SYM2 is 0 … 1000.

4.6   EVALUATION MODE RELATIVE
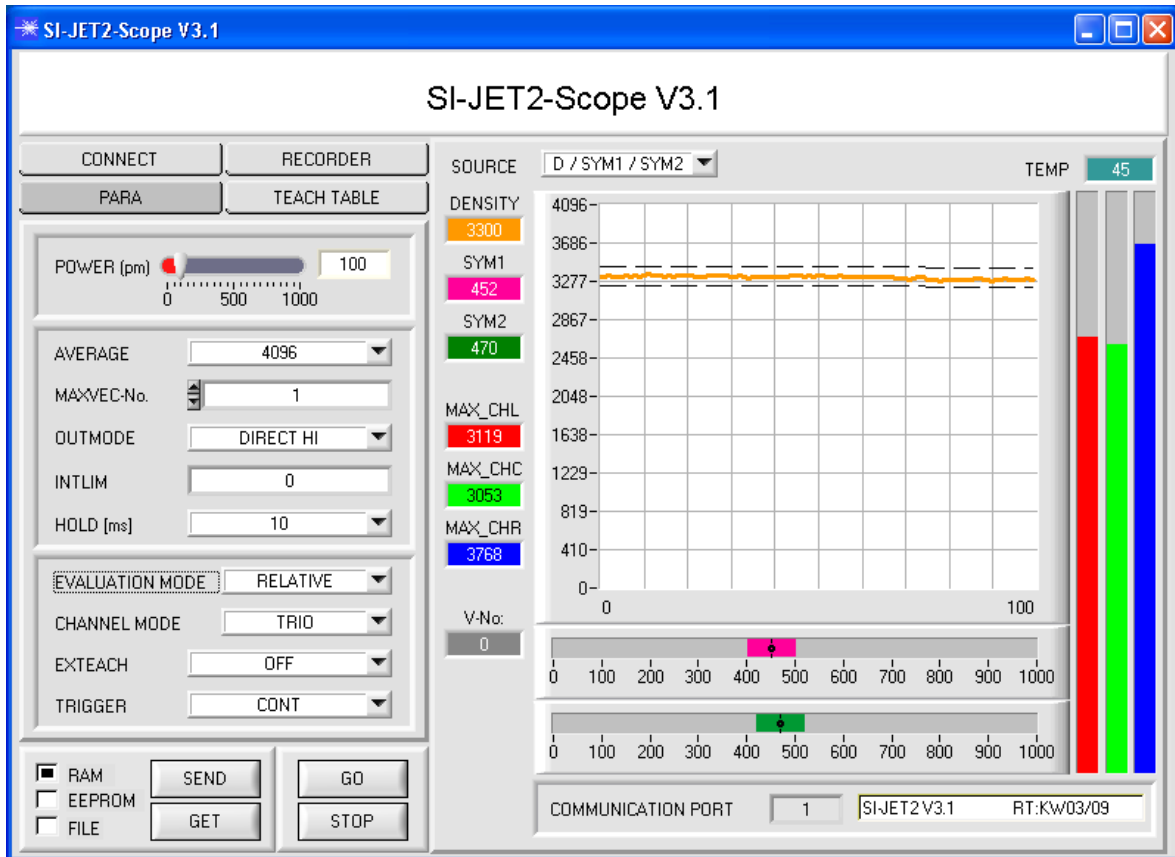
In EVALUATION MODE RELATIVE all three channels CH_L, CH_C, and CH_R are standardised in relation to their respective maximum values during the last 60 seconds. These standardised values are then used for determining density, symmetry 1, and symmetry 2. The advantage of this evaluation mode is that the standardisation to the respective maximum value to a large extent compensates possible dirtying of the sensor.

It is important in this evaluation mode that within 60 seconds the sensor must be free for at least 2 continuous seconds so that the respective maximum values can be determined.

The actual evaluation of DENSITY, SYM1, and SYM2 is then performed as in evaluation mode ABSOLUTE.

$$CHL\_N = 4096 - \frac{CH\_L}{MAX\_CHL} * 4096 \qquad CHC\_N = 4096 - \frac{CH\_C}{MAX\_CHC} * 4096 \qquad CHR\_N = 4096 - \frac{CH\_R}{MAX\_CHR} * 4096$$

$$DENSITY = CHC\_N \qquad\qquad SYM1 = \frac{CHL\_N}{CHL\_N + CHR\_N} * 1000$$

$$SYM2 = \frac{CHC\_N}{CHC\_N + \frac{CHL\_N + CHR\_N}{2}} * 1000$$

5. Function of the LED display

LED display:	
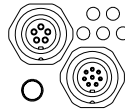
BINARY

The line vector is visualised by way of 5 yellow LEDs at the housing of the SI-JET2 sensor. At the same time in the binary mode (OUTMODE BINARY) the line vector indicated on the LED display is output as 5-bit binary information at the digital outputs OUT0 to OUT4 of the 8-pole SI-JET2/PLC female connector.

The SI-JET2 sensor is able to process a maximum of 31 line vectors (0 ... 30) in accordance with the corresponding lines in the TEACH TABLE. An "error" or a "not detected" is displayed by the lighting of all LED (OUT0 ... OUT4) digital outputs are set to HIGH-level).

Error or
not detected
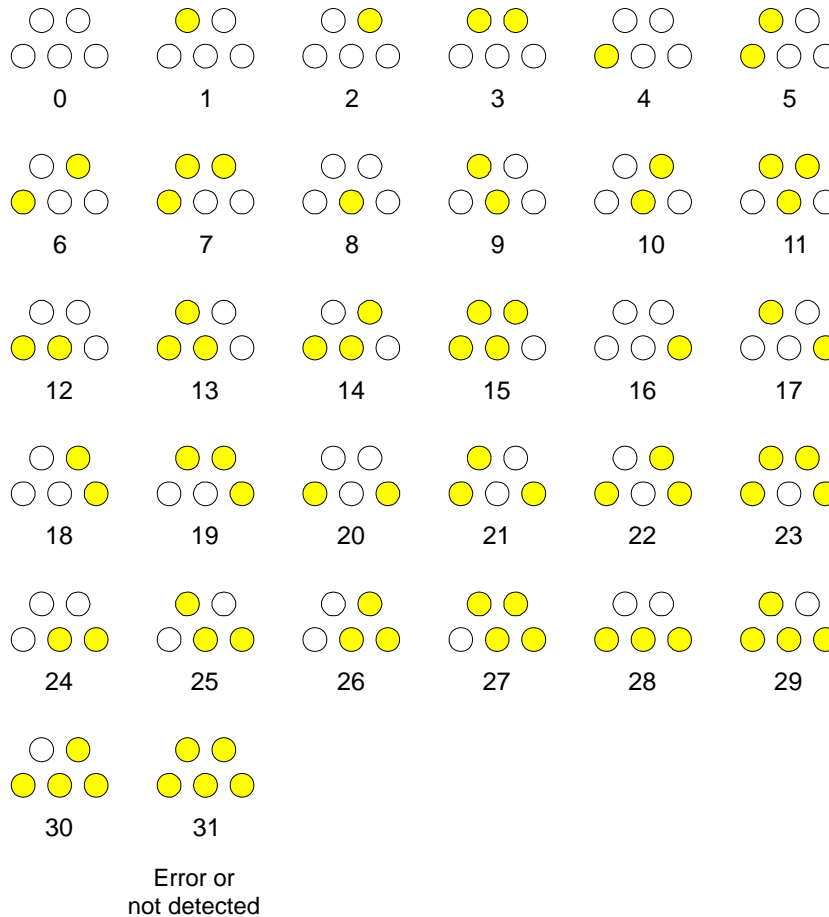
DIRECT

In the DIRECT mode (OUTMODE DIRECT HI or OUTMODE DIRECT LO) the maximum numbers of line vectors to be taught is 5 (no. 0, 1, 2, 3,4).

DIRECT HI:

If DIRECT HI is activated, the special digital output is set to HI while the other 4 are set to LO.
If no line vector was detected, all digital outputs are set to LOW (no LED is lighting).

0   1   2   3   4

(no line vector detected)
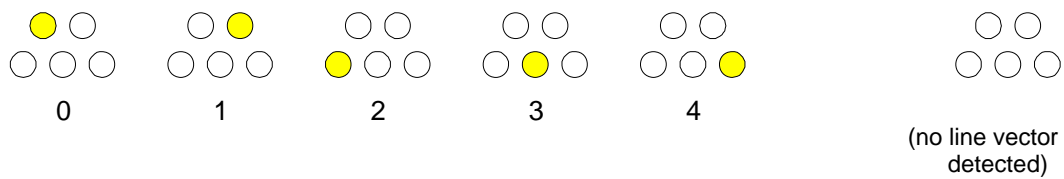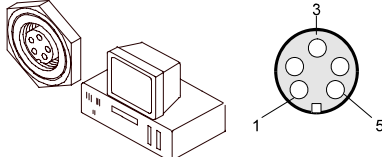
DIRECT LO:

If DIRECT LO is activated, the special digital output is set to LO, while the other 4 are set to HI.
If no line vector was detected, all digital outputs are set to HIGH (all LED are lighting).

0   1   2   3   4

(no line vector detected)
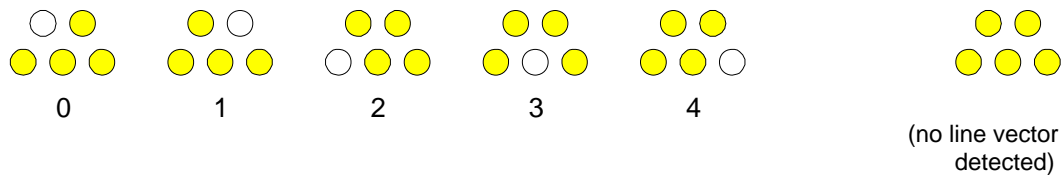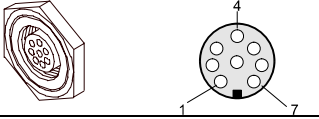
6. Connector assignment of the SI-JET2 system

Connection of SI-JET2 to PC:

<table>
<tr><td colspan="3" align="center">5-pole fem. connector (type Binder 712)
<i>SI-JET2/PC-RS232</i></td></tr>
<tr><td>Pin No.:</td><td></td><td align="center">Assignment:</td></tr>
<tr><td>1</td><td></td><td align="center">0V (GND)</td></tr>
<tr><td>2</td><td></td><td align="center">TxD</td></tr>
<tr><td>3</td><td></td><td align="center">RxD</td></tr>
<tr><td>4</td><td></td><td align="center">Not connected</td></tr>
<tr><td>5</td><td></td><td align="center">Not connected</td></tr>
</table>

Connection of SI-JET2 to PLC:

<table>
<tr><td colspan="3" align="center">8-pole fem. connector (type Binder 712)
<i>SI-JET2/SPS</i></td></tr>
<tr><td>Pin No.:</td><td>Color:</td><td align="center">Assignment:</td></tr>
<tr><td>1</td><td>white</td><td align="center">0V (GND)</td></tr>
<tr><td>2</td><td>brown</td><td align="center">+12VDC .. +30VDC</td></tr>
<tr><td>3</td><td>green</td><td align="center">IN0</td></tr>
<tr><td>4</td><td>yellow</td><td align="center">OUT0 (Digital 0: Type 0 … 1V, Digital 1: Type +Ub – 10%)</td></tr>
<tr><td>5</td><td>grey</td><td align="center">OUT1 (Digital 0: Type 0 … 1V, Digital 1: Type +Ub – 10%)</td></tr>
<tr><td>6</td><td>pink</td><td align="center">OUT2 (Digital 0: Type 0 … 1V, Digital 1: Type +Ub – 10%)</td></tr>
<tr><td>7</td><td>blue</td><td align="center">OUT3 (Digital 0: Type 0 … 1V, Digital 1: Type +Ub – 10%)</td></tr>
<tr><td>8</td><td>red</td><td align="center">OUT4 (Digital 0: Type 0 … 1V, Digital 1: Type +Ub – 10%)</td></tr>
</table>

7. RS232 communication protocol

RS232 communication protocol PC ⇔ SI-JET2 Sensor (SI-JET2-Scope V3.1)
- Standard RS232 serial interface without hardware-handshake - 3-wire: GND, TX0, RX0 - Speed: 19200 baud, 8 data-bits, no parity-bit, 1 stop-bit in binary mode, us (unsigned), MSB (most significant byte) first. The control device (PC or PLC) has to send a data frame of 18 words to the SI JET2 hardware. All bytes must be transmitted in binary format (us, MSB). The meaning of the parameters is described in the software manual. Info: 1 word = 2 bytes <u>Method:</u> The hardware is permanently reading (polling) the incoming byte at the RS232 connection. If the incoming word is 0x0055 (synch-word), then the 2. word (order-word) is read in, after this, 16 words (parameters) will be read. After reading in the completely data frame, the SI JET2 hardware executes the order which is coded at the 2. word (order-word).

		Format of the data frame:	
Word No.	*Format*	**Meaning**	**Comment:**
1	Word	sync-word = 0x0055	hex-code 0x0055, binary: 0000 0000 0101 0101, synchronisation word
2	Word	**ORDER NUMBER**	order word
3	Word	POWER	LED intensity (0 ... 1000) Attention intensity in thousendth!
4	Word	CHANNEL MODE	Channel mode MONO, DUO or TRIO coded to (0,1,2)
5	Word	AVERAGE	Signal averaging 1,2,4,8,16,32,64,128,256,512,1024,2048,4096,8192,16384 or 32768
6	Word	EVALUATION MODE	Evaluation mode ABSOLUTE or RELATIVE coded to (0,1)
7	Word	HOLD[ms]	Hold time 0,1,2,3,5,10,50 or 100ms coded to (0,1,2,3,5,10,50 or 100)
8	Word	INTLIM	Lower intensity limit (0 ... 4095)
9	Word	MAXVEC-No.	Number of the vectors (1,2,3,…,31)
10	Word	OUTMODE	Function of the digital output (0=direct/HI, 1=binary, 2=direct/LO)
11	Word	TRIGGER	Trigger mode CONT, EXT1, EXT2 (0,1,2)
12	Word	EXTERN TEACH	Extern Teach OFF or ON coded to (0,1)
13-18	Word	Free	Must be sent as dummy (e.g. 6 value 0)

Value	ORDER NUMBER (parameter byte no. 2)	
0	nop	no operation
1	Save parameter from PC into RAM	Cf. Example 1
2	Save one selectable row of TEACH TABLE into RAM	Cf. Example 2
3	Send parameter from RAM to PC	Cf. Example 3
4	Send one selectable Row of TEACH TABLE from RAM to PC	Cf. Example 4
5	Send data from RAM to PC	Cf. Example 5
6	Save parameter from RAM to EEPROM	Cf. Example 6
7	Send connection OK to PC	Cf. Example 8
8	Load Parameter from EEPROM to RAM	Cf. Example 7
19	Same as order 5 if TRIGGER=0 If TRIGGER = 1 or 2 only triggered values are transmitted	Cf. Example 5
20	Send line ok = 0x0055, 0x0014, 0x00AA, 11 Dummies to PC	Cf. Example 9

Example 1: DATA FRAME with ORDER NUMBER = 1:

ORDER NUMBER (second word = 1): WRITE parameters from PC into RAM of the SI JET2!

The completely data frame = 18 words must be sent to the SI JET2 hardware in binary form (sync-word / order-word / 16 parameter words).

DATA FRAME PC → SI JET2 (18 WORDS)

0x0055	SYNC.-WORD
1	ORDER-WORD
200	POWER
2	CHANNEL MODE
1024	AVERAGE
0	EVALUATION MODE
10	HOLD[ms]
10	INTLIM
5	MAXVEC-No.
0	OUTMODE
0	TRIGGER
0	EXTER TEACH
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY

DATA FRAME SI JET2 → PC (18 WORDS)

0x00AA	SYNC.-WORD
1	ORDER-WORD
200	POWER
2	CHANNEL MODE
1024	AVERAGE
0	EVALUATION MODE
10	HOLD[ms]
10	INTLIM
5	MAXVEC-No.
0	OUTMODE
0	TRIGGER
0	EXTER TEACH
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY

Example 2: DATA FRAME with ORDER NUMBER = 2:

ORDER NUMBER (second word = **2**): **WRITE one selectable row (vector) of TEACH TABLE into RAM of the SI JET2!**

The completely data frame = 18 words must be sent to the SI JET2 hardware in binary form (sync-word / order-word / ROW-NO / 4 parameter words = vector, 11 dummies).

Fill unused words of the TEACH VECTOR by value word=1 in binary form.

DATA FRAME PC → SI JET2 (18 WORDS)

0x0055	SYNC-WORD
2	ORDER-WORD
0	ROW-No. (0…30)
2000	D
100	DTO
500	S1
30	S1TO
400	S2
25	S2TO
1	DUMMY
1	DUMMY
1	DUMMY
1	DUMMY
1	DUMMY
1	DUMMY
1	DUMMY
1	DUMMY
1	DUMMY

DATA FRAME SI JET2 → PC (18 WORDS)

0x00AA	SYNC-WORD
2	ORDER-WORD
0	ROW-No. (0…30)
2000	D
100	DTO
500	S1
30	S1TO
400	S2
25	S2TO
1	DUMMY
1	DUMMY
1	DUMMY
1	DUMMY
1	DUMMY
1	DUMMY
1	DUMMY
1	DUMMY
1	DUMMY

Example 3: DATA FRAME with ORDER NUMBER = 3:

ORDER NUMBER (second word = 3): READ parameters out of SI JET2-RAM memory!
The same frame as example 1 must be sent to the SI JET2 hardware except of the order word that must be **3**.
The values for the parameters must be sent as Dummies.
The complete DATA FRAME which is responded by the SI JET2 hardware is 18 words.

DATA FRAME PC → SI JET2 (18 WORDS)
DATA FRAME SI JET2 → PC (18 WORDS)

0x00AA	SYNC-WORD
3	ORDER-WORD
200	POWER
2	CHANNEL MODE
1024	AVERAGE
0	EVALUATION MODE
10	HOLD[ms]
10	INTLIM
5	MAXVEC-No.
0	OUTMODE
0	TRIGGER
0	EXTER TEACH
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY

Example 4: DATA FRAME with ORDER NUMBER = 4:

ORDER NUMBER (second word = 4): READ one selectable row (vector) from RAM of the SI JET2!
The same frame as example 2 must be sent to the SI JET2 hardware except of the order word that must be **4**.
The values for the parameters must be sent as Dummies.
The complete DATA FRAME which is responded by the SI JET2 hardware is 18 words.

DATA FRAME PC → SI JET2 (18 WORDS)
DATA FRAME SI JET2 → PC (18 WORDS)

0x00AA	SYNC-WORD
4	ORDER-WORD
0	ROW-No. (0…30)
2000	D
100	DTO
500	S1
30	S1TO
400	S2
25	S2TO
1	DUMMY
1	DUMMY
1	DUMMY
1	DUMMY
1	DUMMY
1	DUMMY
1	DUMMY
1	DUMMY
1	DUMMY

Example 5: DATA FRAME with ORDER NUMBER = 5:

ORDER NUMBER (second word = 5): READ SI JET2 RAW DATA
Parameters must be sent for a constant parameter frame as dummies.
At order word **5** they do not affect the RAM or EEPROM.
ORDER NUMBER = 19 is similar. but if TRIGGER = 1 or 2 only triggered values are transmitted.

DATA FRAME PC → SI JET2 (18 WORDS)

0x0055	SYNC-WORD
5	ORDER-WORD
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY

DATA FRAME SI JET2 → PC (18 WORDS)

0x00AA
5
CH_L
CH_C
CH_R
DENSITY
SYM1
SYM2
V-No:
TEMP
MAX_CHL
MAX_CHC
MAX_CHR
DUMMY
DUMMY
DUMMY
DUMMY
DUMMY

Example 6: DATA FRAME with ORDER NUMBER = 6:

ORDER NUMBER (second word = 6): SAVE parameters from RAM to EEPROM of the SI JET2!
The complete data frame = 18 words must be sent to the SI JET2 hardware in binary form (sync-word / order-word / 16 parameter words).

DATA FRAME PC → SI JET2 (18 WORDS)

0x0055	SYNC-WORD
6	ORDER-WORD
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY

After sending this data frame, the sensor saves all the parameters and teach vectors from its RAM (volatile memory) to its EEPROM (non volatile memory).
ATTENTION: The right parameters and teach vectors must be in the RAM of the sensor. To save the parameters and teach vectors into RAM see **Example1** and **Example2.**

After completing the sensor writes back an echo of the same frame.

DATA FRAME SI JET2 → PC (18 WORDS)

0x00AA	SYNC-WORD
6	ORDER-WORD
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY

Example 7: DATA FRAME with ORDER NUMBER = 8:

ORDER NUMBER (second word = 8): Load parameters from EEPROM to RAM of the SI JET2!

The complete data frame = 18 words must be sent to the SI JET2 hardware in binary form (sync-word / order-word / 16 parameter words).

DATA FRAME PC → SI JET2 (18 WORDS)

0x0055	SYNC-WORD
8	ORDER-WORD
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY

After sending this data frame, the sensor loads all the parameters and teach vectors from its EEPROM (non volatile memory) to its RAM (volatile memory).
ATTENTION: The EEPROM parameters must be load first to the RAM to read it from the sensor. To get the parameters and teach vectors from RAM see **Example3** and **Example4.**

After completing the sensor writes back an echo of the same frame.

DATA FRAME SI JET2 → PC (18 WORDS)

0x00AA	SYNC-WORD
8	ORDER-WORD
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY

Example 8: DATA FRAME with ORDER NUMBER = 7:

ORDER NUMBER (second word = 7): SEND CONNECTION OK from the SI JET2 to PC!
Cf. example 1:
Send the same DATA FRAME but with ORDER NUMBER 7 to the sensor.
The sensor will reply with 18 words which tell the version of the sensor.

Example 9: DATA FRAME with ORDER NUMBER = 20:

ORDER NUMBER (second word = 20): SEND LINE OK from the SI JET2 to PC!
Cf. example 1:
Send the same DATA FRAME but with ORDER NUMBER 20 to the sensor.
The sensor will reply with the same18 words but with SYNC-WORD=0x00AA which tell that there is a connection.