Leuze

IO-Link interface description

CRT648-L44

Color sensor

The Sensor People

We reserve the right to make technical changes
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1 IO-Link interface

The IO-Link interface is available in accordance with specification 1.1.4 (June 2024) on pin 4. You can easily, quickly and economically configure the devices via the IO-Link interface. Furthermore, the sensor transmits the process data via the IO-Link interface and makes diagnostic information available through it.

1.1 IO-Link identification

VendorID dec/hex	DeviceID dec/hex	Device
338/0x152	5302/0x0014B6	CRT648-60/L44-M12
	5303/0x0014B7	CRT648-150/L44-M12
	5304/0x0014B8	CRT648-32.G/L44-M12

Please refer to the respective product data sheet for the identification data of other IO-Link devices.

1.2 IO-Link process data

Device output data (PDIn – 48 bit data length) – Index 202: Process data profile = 0 (switching channel)

Bit offset	Data width in bits	Assignment	Meaning
24	12	Signal quality	Current signal quality Value range 0 … 100
16	1	Signal quality bit	0: Signal quality not OK 1: Signal quality OK
6	1	Q7	0: Switching output inactive 1: Switching output active
5	1	Q6	0: Switching output inactive 1: Switching output active
4	1	Q5	0: Switching output inactive 1: Switching output active
3	1	Q4	0: Switching output inactive 1: Switching output active
2	1	Q3	0: Switching output inactive 1: Switching output active
1	1	Q2	0: Switching output inactive 1: Switching output active
0	1	Q1	0: Switching output inactive 1: Switching output active

Byte 0	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**
	47	46	45	44	43	42	41	40

Byte 1	**x**	**x**	**x**	**x**	**Signal quality**			
	39	38	37	36	35	34	33	32

Byte 2	**Signal quality**							
	31	30	29	28	27	26	25	24

Byte 3	x	x	x	x	x	x	x	Quality Bit
	23	22	21	20	19	18	17	16

Byte 4	x	x	x	x	x	x	x	x
	15	14	13	12	11	10	9	8

Byte 5	x	Q7	Q6	Q5	Q4	Q3	Q2	Q1
	7	6	5	4	3	2	1	0

Device output data (PDIn – 48 bit data length) – Index 202: Process data profile = 1 (color values)

Bit offset	Data width in bits	Assignment	Meaning
0	12	Ratio red	Red ratio Value range 0 … 4095
12	12	Ratio green	Green ratio Value range 0 … 4095
24	12	Ratio blue	Blue ratio Value range 0 … 4095
36	12	Energy	Energy ratio Value range 0 … 4095

Byte 0	Energy							
	47	46	45	44	43	42	41	40

Byte 1	Energy				Ratio blue			
	39	38	37	36	35	34	33	32

Byte 2	Ratio blue							
	31	30	29	28	27	26	25	24

Byte 3	Ratio green							
	23	22	21	20	19	18	17	16

Byte 4	Ratio green				Ratio red			
	15	14	13	12	11	10	9	8

Byte 5	Ratio red							
	7	6	5	4	3	2	1	0

1.3 Device-specific IODD

At **www.leuze.com** in the download area for IO-Link sensors you will find the IODD zip file with all files required for the installation.

On the IODDfinder platform (https://ioddfinder.io-link.com/), a central cross-manufacturer database, you can also find the description files (IODDs) of the IO-Link sensors.

1.4 IO-Link parameters documentation

The complete description of the IO-Link parameters can be found in the *.html files. Double-click on a language variant in the directory containing the extracted files:

- German: *IODD*-de.html
- English: *IODD*-en.html

If the html file within the ZIP archive is opened, the image files are not displayed.

↳ Extract the ZIP file first.

1.5 Device-specific information

- This is a device of data storage class 1 (automatic DS), i.e., device exchange is possible without additional measures (such as teaching).
- In the PREOPERATE state, this device uses TYPE_1_2.

Fundamentals

- IO-Link Interface and System Specification Version 1.1.4 June 2024
- IO-Link Test Specification Version 1.1.4 June 2024

2 Functions configurable via IO-Link

PC configuration and visualization is performed conveniently with the USB-IO-Link Master SET MD12-US2-IL1.1 (part no. 50121098) and the *Sensor Studio* configuration and diagnosis software (in the download area of the sensor at **www.leuze.com**).

NOTICE

The system commands trigger an action in the device.

Parameter	Index	Sub-index	Data type, octets	Access	Value range	Default	Explanation
System command	2	0	UIntegerT, 1	WO	126, 127, 128, 129, 130, 131, 160, 161, 162, 169, 170, 171, 208, 209, 215, 216, 223		126: Locator Start 127: Locator Stop 128: Device Reset 129: Application Reset 130: Restore Factory Settings 131: Back-to-box 160: Emitter OFF 161: Emitter ON 162: Reset switching output 169: Trigger Input Pin 170: Trigger ON 171: Trigger OFF 208: Teach Apply 209: Single value teach 215: Color scan start 216: Color scan stop 223: Teach cancel

General configuration

Parameter	Index	Sub-index	Data type, octets	Access	Value range	Default	Explanation
Device Access Locks	12	0	UIntegerT, 2	RW	0, 8	0	0: Teach button not locked 8: Teach button locked
Application Specific Tag	24	0	String, max. 32	RW		***	Application-specific marking
Function Tag	25	0	String, max. 32	RW		***	Function identifier
Location Tag	26	0	String, max. 32	RW		***	Location indicator

Parameter	Index	Sub-index	Data type, octets	Access	Value range	Default	Explanation
Temperature	82	1	IntegerT, 1	RO			Current operating temperature
		2	IntegerT, 1	RO			Highest measured temperature since device restart
		3	IntegerT, 1	RO			Lowest measured temperature since device restart
		4	IntegerT, 1	RO			Highest measured temperature to date
		5	IntegerT, 1	RO			Lowest measured temperature to date
Operating data	88	1	UIntegerT, 4	RO			Non-volatile counting of completed operating hours
		2	UIntegerT, 4	RO			Object counter: This counts the switching events and can be read out as required. This function enables a simple validation of the process. As soon as the object counter has reached the maximum end value, the count process starts over again at 0.

Parameter	Index	Sub-index	Data type, octets	Access	Value range	Default	Explanation
Color C1 at output Q1	96	1	UIntegerT, 1	RW	0 … 8	3	Tolerance: Tolerance setting in 9 levels 0: Finest tolerance level 1: 2nd tolerance level 2: 3rd tolerance level 3: 4th tolerance level 4: 5th tolerance level 5: 6th tolerance level 6: 7th tolerance level 7: 8th tolerance level 8: Coarsest tolerance level
		2	UIntegerT, 1	RW	0, 1	0	Logic: 0: NO 1: NC
		3	UIntegerT, 1	RW	0, 1	0	Switching output function: 0: Switching output inactive 1: Switching output active
		4	UIntegerT, 1	RW	0, 1	1	Energy evaluation: The energy evaluation can be turned off. This may be helpful in applications with object distances larger 65 mm. From here on the energy decreases with increasing object distance. The color values remain the same. 0: Energy evaluation inactive 1: Energy evaluation active
		5	UIntegerT, 2	RW	0 … 65535	0	Counter: Specifies the number of detected objects after which the switching output should switch. Example for value 4: The switching output switches for every fourth object detected.
		6	UIntegerT, 2	RW	0 … 65535	0	Switch-on delay: Adjustable in 1 ms steps
		7	UIntegerT, 2	RW	0 … 65535	0	Switch-off delay: Adjustable in 1 ms steps
		8	UIntegerT, 2	RW	0 … 65535	0	Pulse stretching: Adjustable in 1 ms steps
		9	UIntegerT, 1	RW	0 … 2	0	Combining colors: 0: No combination 1: Combination with color C4 2: Exclude color C4

Parameter	Index	Sub-index	Data type, octets	Access	Value range	Default	Explanation
Color C2 at output Q2	97	1	UIntegerT, 1	RW	0 … 8	3	Tolerance: Tolerance setting in 9 levels 0: Finest tolerance level 1: 2nd tolerance level 2: 3rd tolerance level 3: 4th tolerance level 4: 5th tolerance level 5: 6th tolerance level 6: 7th tolerance level 7: 8th tolerance level 8: Coarsest tolerance level
		2	UIntegerT, 1	RW	0, 1	0	Logic: 0: NO 1: NC
		3	UIntegerT, 1	RW	0, 1	0	Switching output function: 0: Switching output inactive 1: Switching output active
		4	UIntegerT, 1	RW	0, 1	1	Energy evaluation: The energy evaluation can be turned off. This may be helpful in applications with object distances larger 65 mm. From here on the energy decreases with increasing object distance. The color values remain the same. 0: Energy evaluation inactive 1: Energy evaluation active
		5	UIntegerT, 2	RW	0 … 65535	0	Counter: Specifies the number of detected objects after which the switching output should switch. Example for value 4: The switching output switches for every fourth object detected.
		6	UIntegerT, 2	RW	0 … 65535	0	Switch-on delay: Adjustable in 1 ms steps
		7	UIntegerT, 2	RW	0 … 65535	0	Switch-off delay: Adjustable in 1 ms steps
		8	UIntegerT, 2	RW	0 … 65535	0	Pulse stretching: Adjustable in 1 ms steps
		9	UIntegerT, 1	RW	0 … 2	0	Combining colors: 0: No combination 1: Combination with color C5 2: Exclude color C5

Parameter	Index	Sub-index	Data type, octets	Access	Value range	Default	Explanation
Color C3 at output Q3	98	1	UIntegerT, 1	RW	0 … 8	3	Tolerance: Tolerance setting in 9 levels 0: Finest tolerance level 1: 2nd tolerance level 2: 3rd tolerance level 3: 4th tolerance level 4: 5th tolerance level 5: 6th tolerance level 6: 7th tolerance level 7: 8th tolerance level 8: Coarsest tolerance level
		2	UIntegerT, 1	RW	0, 1	0	Logic: 0: NO 1: NC
		3	UIntegerT, 1	RW	0, 1	0	Switching output function: 0: Switching output inactive 1: Switching output active
		4	UIntegerT, 1	RW	0, 1	1	Energy evaluation: The energy evaluation can be turned off. This may be helpful in applications with object distances larger 65 mm. From here on the energy decreases with increasing object distance. The color values remain the same. 0: Energy evaluation inactive 1: Energy evaluation active
		5	UIntegerT, 2	RW	0 … 65535	0	Counter: Specifies the number of detected objects after which the switching output should switch. Example for value 4: The switching output switches for every fourth object detected.
		6	UIntegerT, 2	RW	0 … 65535	0	Switch-on delay: Adjustable in 1 ms steps
		7	UIntegerT, 2	RW	0 … 65535	0	Switch-off delay: Adjustable in 1 ms steps
		8	UIntegerT, 2	RW	0 … 65535	0	Pulse stretching: Adjustable in 1 ms steps
		9	UIntegerT, 1	RW	0 … 2	0	Combining colors: 0: No combination 1: Combination with color C6 2: Exclude color C6

Parameter	Index	Sub-index	Data type, octets	Access	Value range	Default	Explanation
Color C4 at virtual output Q4	99	1	UIntegerT, 1	RW	0 … 8	3	Tolerance: Tolerance setting in 9 levels 0: Finest tolerance level 1: 2nd tolerance level 2: 3rd tolerance level 3: 4th tolerance level 4: 5th tolerance level 5: 6th tolerance level 6: 7th tolerance level 7: 8th tolerance level 8: Coarsest tolerance level
		2	UIntegerT, 1	RW	0, 1	0	Logic: 0: NO 1: NC
		3	UIntegerT, 1	RW	0, 1	0	Switching output function: 0: Switching output inactive 1: Switching output active
		4	UIntegerT, 1	RW	0, 1	1	Energy evaluation: The energy evaluation can be turned off. This may be helpful in applications with object distances larger 65 mm. From here on the energy decreases with increasing object distance. The color values remain the same. 0: Energy evaluation inactive 1: Energy evaluation active

Parameter	Index	Sub-index	Data type, octets	Access	Value range	Default	Explanation
Color C5 at virtual output Q5	100	1	UIntegerT, 1	RW	0 … 8	3	Tolerance: Tolerance setting in 9 levels 0: Finest tolerance level 1: 2nd tolerance level 2: 3rd tolerance level 3: 4th tolerance level 4: 5th tolerance level 5: 6th tolerance level 6: 7th tolerance level 7: 8th tolerance level 8: Coarsest tolerance level
		2	UIntegerT, 1	RW	0, 1	0	Logic: 0: NO 1: NC
		3	UIntegerT, 1	RW	0, 1	0	Switching output function: 0: Switching output inactive 1: Switching output active
		4	UIntegerT, 1	RW	0, 1	1	Energy evaluation: The energy evaluation can be turned off. This may be helpful in applications with object distances larger 65 mm. From here on the energy decreases with increasing object distance. The color values remain the same. 0: Energy evaluation inactive 1: Energy evaluation active

Parameter	Index	Sub-index	Data type, octets	Access	Value range	Default	Explanation
Color C6 at virtual output Q6	101	1	UIntegerT, 1	RW	0 … 8	3	Tolerance: Tolerance setting in 9 levels 0: Finest tolerance level 1: 2nd tolerance level 2: 3rd tolerance level 3: 4th tolerance level 4: 5th tolerance level 5: 6th tolerance level 6: 7th tolerance level 7: 8th tolerance level 8: Coarsest tolerance level
		2	UIntegerT, 1	RW	0, 1	0	Logic: 0: NO 1: NC
		3	UIntegerT, 1	RW	0, 1	0	Switching output function: 0: Switching output inactive 1: Switching output active
		4	UIntegerT, 1	RW	0, 1	1	Energy evaluation: The energy evaluation can be turned off. This may be helpful in applications with object distances larger 65 mm. From here on the energy decreases with increasing object distance. The color values remain the same. 0: Energy evaluation inactive 1: Energy evaluation active

Parameter	Index	Sub-index	Data type, octets	Access	Value range	Default	Explanation
Color C7 at virtual output Q7	102	1	UIntegerT, 1	RW	0 … 8	3	Tolerance: Tolerance setting in 9 levels 0: Finest tolerance level 1: 2nd tolerance level 2: 3rd tolerance level 3: 4th tolerance level 4: 5th tolerance level 5: 6th tolerance level 6: 7th tolerance level 7: 8th tolerance level 8: Coarsest tolerance level
		2	UIntegerT, 1	RW	0, 1	0	Logic: 0: NO 1: NC
		3	UIntegerT, 1	RW	0, 1	0	Switching output function: 0: Switching output inactive 1: Switching output active
		4	UIntegerT, 1	RW	0, 1	1	Energy evaluation: The energy evaluation can be turned off. This may be helpful in applications with object distances larger 65 mm. From here on the energy decreases with increasing object distance. The color values remain the same. 0: Energy evaluation inactive 1: Energy evaluation active
Color Tolerances C1	128	1	UIntegerT, 2	RW	0 … 4095	1365	Red ratio
		2	UIntegerT, 2	RW	0 … 4095	1365	Green ratio
		3	UIntegerT, 2	RW	0 … 4095	4095	Energy
		4	UIntegerT, 2	RW	0 … 4095	0	Red tolerance
		5	UIntegerT, 2	RW	0 … 4095	0	Green tolerance
		6	UIntegerT, 2	RW	0 … 4095	0	Energy tolerance
Color Tolerances C2	129	1	UIntegerT, 2	RW	0 … 4095	1365	Red ratio
		2	UIntegerT, 2	RW	0 … 4095	1365	Green ratio
		3	UIntegerT, 2	RW	0 … 4095	4095	Energy
		4	UIntegerT, 2	RW	0 … 4095	0	Red tolerance
		5	UIntegerT, 2	RW	0 … 4095	0	Green tolerance
		6	UIntegerT, 2	RW	0 … 4095	0	Energy tolerance

Parameter	Index	Sub-index	Data type, octets	Access	Value range	Default	Explanation
Color Tolerances C3	130	1	UIntegerT, 2	RW	0 … 4095	1365	Red ratio
		2	UIntegerT, 2	RW	0 … 4095	1365	Green ratio
		3	UIntegerT, 2	RW	0 … 4095	4095	Energy
		4	UIntegerT, 2	RW	0 … 4095	0	Red tolerance
		5	UIntegerT, 2	RW	0 … 4095	0	Green tolerance
		6	UIntegerT, 2	RW	0 … 4095	0	Energy tolerance
Color Tolerances C4	131	1	UIntegerT, 2	RW	0 … 4095	1365	Red ratio
		2	UIntegerT, 2	RW	0 … 4095	1365	Green ratio
		3	UIntegerT, 2	RW	0 … 4095	4095	Energy
		4	UIntegerT, 2	RW	0 … 4095	0	Red tolerance
		5	UIntegerT, 2	RW	0 … 4095	0	Green tolerance
		6	UIntegerT, 2	RW	0 … 4095	0	Energy tolerance
Color Tolerances C5	132	1	UIntegerT, 2	RW	0 … 4095	1365	Red ratio
		2	UIntegerT, 2	RW	0 … 4095	1365	Green ratio
		3	UIntegerT, 2	RW	0 … 4095	4095	Energy
		4	UIntegerT, 2	RW	0 … 4095	0	Red tolerance
		5	UIntegerT, 2	RW	0 … 4095	0	Green tolerance
		6	UIntegerT, 2	RW	0 … 4095	0	Energy tolerance
Color Tolerances C6	133	1	UIntegerT, 2	RW	0 … 4095	1365	Red ratio
		2	UIntegerT, 2	RW	0 … 4095	1365	Green ratio
		3	UIntegerT, 2	RW	0 … 4095	4095	Energy
		4	UIntegerT, 2	RW	0 … 4095	0	Red tolerance
		5	UIntegerT, 2	RW	0 … 4095	0	Green tolerance
		6	UIntegerT, 2	RW	0 … 4095	0	Energy tolerance
Color Tolerances C7	134	1	UIntegerT, 2	RW	0 … 4095	1365	Red ratio
		2	UIntegerT, 2	RW	0 … 4095	1365	Green ratio
		3	UIntegerT, 2	RW	0 … 4095	4095	Energy
		4	UIntegerT, 2	RW	0 … 4095	0	Red tolerance
		5	UIntegerT, 2	RW	0 … 4095	0	Green tolerance
		6	UIntegerT, 2	RW	0 … 4095	0	Energy tolerance

Parameter	Index	Sub-index	Data type, octets	Access	Value range	Default	Explanation
Function Q all	176	1	UIntegerT, 1	RW	0, 1	1	PNP/NPN changeover affects pin 2 and pin 5: 0: NPN 1: PNP
		2	UIntegerT, 1	RW	0 … 6	1	Setting the switching frequency: 0: 3 Hz 1: 30 Hz 2: 100 Hz 3: 300 Hz 4: 500 Hz 5: 1500 Hz (not for DeviceID 5304) 6: 3000 Hz (not for DeviceID 5304)
		3	UIntegerT, 1	RW	0, 1	0	Binary Out: Logically combines the switching outputs in order to be able to detect up to 7 (5-pin models) colors. Thereby: • Connected colors will be disconnected. • Always only one color switches. The priority is C1 > C2 > C3... • Smart functions are not available in this mode. All switching outputs will be set to N.O. 0: deactivated 1: activated

Parameter	Index	Sub-index	Data type, octets	Access	Value range	Default	Explanation
Detection mode	177	1	UIntegerT, 1	RW	0, 1	0	0: Color mode: Validates the taught color. • Required colors ≥ 1. • Application = color detection / color evaluation. • Is used when the false colors are not known. 1: Best fit: Switches the closest taught color. • Required colors ≥ 2. One channel of the sensor always switches. To avoid unintentional switching, it is recommended to teach in the background. • Application = Sorting of known objects. Is used when it should be distinguished between known colors. • C+ and C- is not possible in Best Fit mode. • Amart functions and N.O. / N.C. settings are deactivated in Best Fit mode. When returning to color mode they are restored. N.O. / N.C. settings can in Best Fit mode only be adjusted for all Q at once via Config Q all.
Signal quality level	196	1	UIntegerT, 1	RW	10 … 90	10	Threshold value at which reception quality the PD signal “Signal quality bit” should switch.

Parameter	Index	Sub-index	Data type, octets	Access	Value range	Default	Explanation
Teach-in status	204	1	UIntegerT, 4	RO	0 … 7		Teach event status: 0: No teach has yet taken place after PowerOn 1: Last teach successfully completed (SP or SP1) 2: Reserve 3: Last teach successfully completed (SP1 and SP2) 4: Teach waiting for input 5: Teach is currently running 7: Last teach returned error
		2	Boolean	RO	0, 1		SP1 signal teach-in ok: 0: Teach point 1 not OK 1: Teach point 1 OK
		3	Boolean	RO	0, 1		SP1 signal teach-in ok: 0: Teach point 2 not OK 1: Teach point 2 OK
		4	Boolean	RO	0, 1		SP2 signal teach-in ok: 0: Teach point 1 not OK 1: Teach point 1 OK
		5	Boolean	RO	0, 1		SP2 signal teach-in ok: 0: Teach point 2 not OK 1: Teach point 2 OK
Input	208	1	UIntegerT, 1	RW	0, 2, 3, 4	4	Configuration of the input pin: 0: Input is not active 2: Key lock active 3: Trigger 4: External teach
Display	224	1	UIntegerT, 1	RW	0, 1	1	Screen saver: Activates or deactivates the background lighting after a certain time. 0: Screen saver off 1: Screen saver on
		2	UIntegerT, 1	RW	0, 1	1	Rotate display: Rotate the orientation of the display by 180°. 0: Display readable from behind 1: Display readable from the front

3 Conversion formula

The color values are output as a numerical integer. The following formula is required to obtain the color or energy value as a percentage:

Example process data:

- Red ratio = PD Ratio Red * 0.02442002% Dec.2
- Red ratio = 2124 * 0.02442002% Dec.2
- Red ratio = 51.87%

Example index 128:

- Red ratio = Ratio red * 0.02442002% Dec.2
- Red ratio = 1365 * 0.02442002% Dec.2
- Red ratio = 33.33%