ColorSight™ True Color Sensor RS-485 Communications

USER MANUAL

45CLR

Important User Information

In no event will Rockwell Automation, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, Rockwell Automation, Inc. cannot assume responsibility or liability for actual use based on the examples and diagrams. No patent liability is assumed by Rockwell Automation, Inc. with respect to use of information, circuits, equipment, or software described in this manual.

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Throughout this manual, when necessary, we use notes to make you aware of safety considerations.

WARNING	Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.
IMPORTANT	Identifies information that is critical for successful application and understanding of the product.
ATTENTION	Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you identify a hazard, avoid a hazard, and recognize the consequences.
SHOCK HAZARD	Labels may be on or inside the equipment (for example, drive or motor) to alert people that dangerous voltage may be present.
BURN HAZARD	Labels may be on or inside the equipment (for example, drive or motor) to alert people that surfaces may reach dangerous temperatures.

We recommend that you save this user manual for future use. The following symbols are used in this manual for clarification.

i	This symbol indicates supplemental sections of the text which contain useful tips.
Ⓔ	Identifies features and functions that are only available with EtherNet/IP models. These features and functions are not available on the standard MultiSight models.

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Typical Applications

The ColorSight with RS-485 communications is a self-contained true color sensor with one discrete output channel, allowing for the concurrent detection of up to five internally stored colors and the ability to communicate true RGB values for remote processing of additional colors. The colors to be sensed are taught quickly and easily with the touch of a button on the sensor or through the remote teach function of the sensor or by interfacing with an Allen-Bradley MicroLogix™ PLC. Typical applications are:

- Sorting of packages
- Paint color matching
- Verification of item packaging by color
- Multiple color yarn detection
- Detection of color mark on metal sheet for cutting purposes

Requirements of Use

The ColorSight can be programmed to internally detect and store multiple colors in up to five different color channels using the local teach button. Upon recognition of the taught colors, a single discrete output will be active as long as one of the five color channels is being detected. For additional application flexibility, the RS-485 interface allows the user to program the sensor remotely and obtain true RGB information for additional processing of colors using an external control device such as an Allen-Bradley MicroLogix PLC. Basic knowledge of the MicroLogix and RSLogix platform is essential to use the RS-485 communications interface.

The Connected Components Building Blocks from Rockwell Automation provides additional information to quickly and easily implement common control tasks in your machine design by using Rockwell Automation's components. The Simple Color Sensing Connected Components Building Block contains information on how to interface the ColorSight to a MicroLogix 1400 and also includes PanelView component sample screens for a complete color sensing solution. For more information, please visit www.rockwellautomation.com/go/connected.

Performance Features

- Self-contained color detection sensor
- Wide sensing range tolerance
- Three available spot sizes (4 mm round, 2 x 2 mm, 1 x 5 mm)
- Internally match up to five color channels (one discrete output)
- Communicate true RGB information for remote processing of additional colors using the RS-485 communications interface
- Adjustable tolerance and intensity for high precision to general color matching
- Remote teach and color scan capability
- Optional pulse stretching (50 ms)
- Teach button lock and sensor disable option
- Programmable normally open or normally closed output

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Installation Instructions

Position the 45CLR sensor so that the distance from the object to the sensor will be within the sensing range. Extremely shiny or reflective surfaces can distort the color detection. The sensor should be mounted at an angle of 10…30° and the movement of the objects to be sensed should be perpendicular to the position of the sensor as shown below.
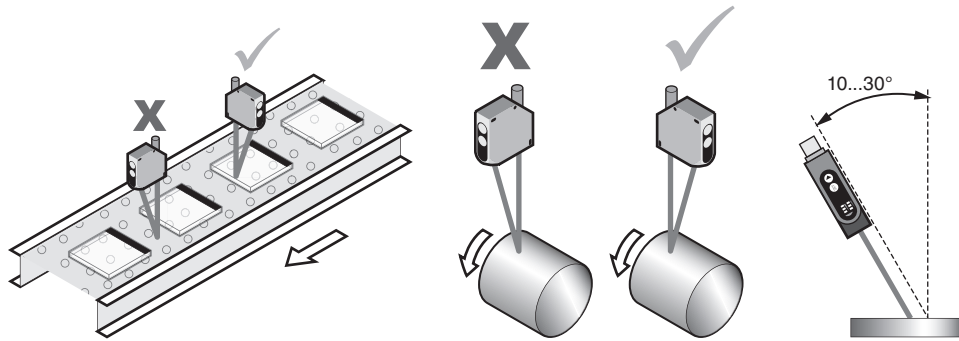
Mounting

Securely mount the sensor on a firm, stable surface or support for reliable operation. A mounting which is subjected to excessive vibration or shifting may cause intermittent operation. The following mounting brackets are available for installation convenience and sensor protection. Once securely mounted, the sensor can be wired per the attached wiring diagrams.

Dimensions [mm (in.)]

45BPD-BKT1
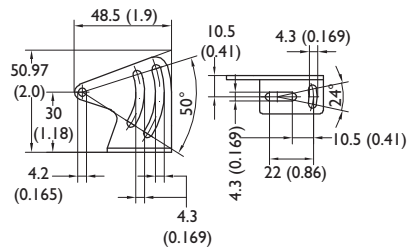
45BPD-BKT2
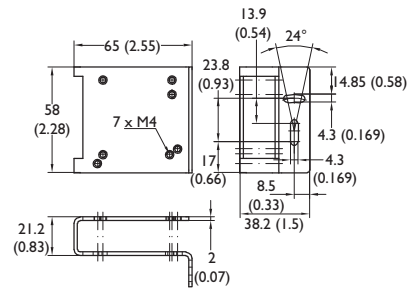
Electrical Installation

ATTENTION 	The electrical installation of the ColorSight must be carried out by a qualified electrician. When installing the ColorSight disconnect all electrical components from the power supply. The wiring shown in this section reflects the sensor connection to an 889D-F8AB-2 8-pin micro (M12) QD cordset. When using the RS-485 interface, Rockwell Automation recommends the 48MS-CS-2 8-pin micro (M12) QD shielded cordset for superior noise immunity.
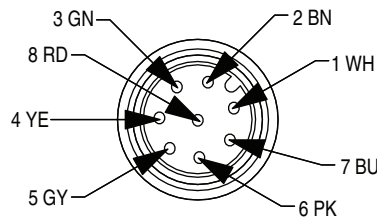
Sensor M12 Male ❶
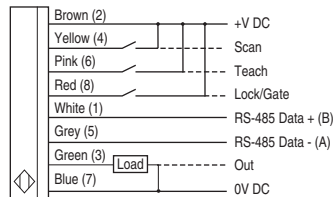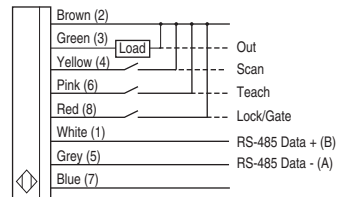
PNP   **NPN**

❶ Wire colors shows correspond to the 889D-F8AB-2 cordset.

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Pin	Color	Connection	Description
1	White (WH)	RS-485 Data + (B)	RS-485
2	Brown (BN)	V+ DC	V+ 12…28V DC supply voltage
3	Green (GN)	OUT	Discrete output
4	Yellow (YE)	SCAN	Remote scan
5	Grey (GY)	RS-485 Data - (A)	RS-485
6	Pink (PK)	TEACH	Remote teach
7	Blue (BU)	0V DC	V- 0V DC
8	Red (RD)	LOCK/GATE	Teach button lock/gate

WARNING

The RS-485 interface pinout (Pin 1 and Pin 5) must not be connected to the supply voltage (+V DC). Permanent damage to the unit will occur.

User Interface
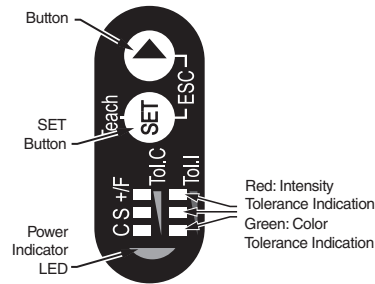
Push Button Functions

Buttons	Description	Functions
SET	SET Button	• Enter teach mode • Confirm menu selection
▶	Continue Button	• Select menu option
SET ▶ ESC	ESC Buttons	• Exit teach mode without saving any changes while pushing both buttons simultaneously

IMPORTANT	The SET button has to be pressed for more than three seconds to enter teach mode. Once this mode is active, the user has approximately 20 seconds to input the desired configuration parameters. If no key is pushed during that time the sensor will return to run mode.

LED	Color	Description
⬡	Green	Sensor is ready to operate
C	Yellow	**Color status indication**. In run mode, a solid ON yellow LED (if sensor color output is configured as normally open; solid OFF if sensor color output is configured as normally closed) indicates that a taught color has been detected and the sensor output is active. In teach mode, a single yellow blinking LED indicates that the sensor is learning one color. A yellow blinking LED combined with a blinking +/F indicates that the sensor is ready to learn additional colors.
S	Yellow	**Color scan indication**. This LED does not have any function while operating in run mode. In teach mode, a blinking LED indicates that the sensor is ready to scan colors to store on channel 1. A blinking LED combined with a blinking +/F indicates that the sensor is ready to scan additional colors.
+/F	Yellow	**Teach or scan additional colors**. This LED does not have any function while operating in run mode. While in teach mode, a blinking yellow LED indicates that the sensor is ready to teach or scan additional colors when combined with the C (color teach) or S (color scan) functions.
+/F	Green	**Special Functions**. This LED does not have any function while operating in run mode. In teach mode, a blinking green LED indicates that the special function menu has been selected
Tol. C	Green	**Tolerance Levels**. This LED does not have any function while operating in run mode. In teach mode, the sensor is ready to set the desired color tolerance levels. (4 levels)
Tol. I	Red	**Intensity Levels**. This LED does not have any function while operating in run mode. In teach mode, the sensor is ready to set the desired intensity tolerance levels. (4 levels)
Tol. I	Red Blinking	Special functions are indicated by this LED combination

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Factory Default Settings

Function	Default Setting
Single Channel Teach (C menu function)	Neutral White (90%)
Multiple Channel Teach (C+ menu function)	Neutral White (90%) for all channels
Single Channel Scan (S menu function)	Neutral White (90%)
Multiple Channel Scan (S+ menu function)	Neutral White (90%) for all channels
Pulse Stretching	OFF
Programmable N.O. or N.C. output	Normally Open
Teach button lock and gate input (lock/gate)	Gate
RS-485 Interface sensor address	1

ATTENTION	A neutral white (90%) color target will trigger the sensor output while the unit is operating under the factory default settings.
⚠	All programmed settings are internally stored and will not be lost if power is removed from the unit.

ColorSight Setup

The ColorSight is set up using the push buttons (SET and ▶) with the LED indicators on the top of the sensor. The built-in RS-485 interface allows the user to program the sensor remotely and obtain true RGB information for additional processing of colors using an external control device such as an Allen-Bradley MicroLogix PLC. There are four ways to program the sensor when using the push buttons:

Single Channel Teach (C menu function)

To teach the ColorSight to detect a single color using one channel:

1. Place the color target within the sensing range.

2. Enter teach mode by pushing SET for three seconds until the (C) yellow LED indicator starts blinking as shown below:

□ Off
▨ Blinking
▪ On

3. Press and release SET until the color tolerance LEDs (green) turn on.
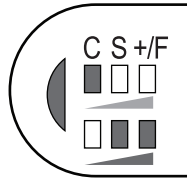
4. The default color tolerance is medium high (see page 15 for color tolerance information). To adjust the color tolerance press ▶ several times until the desired tolerance is displayed.

5. Press and release SET. Note that the intensity tolerance LEDs (red) turn on. Press ▶ to adjust the tolerance to the desired level. Push SET to confirm. The white detection beam and the tolerance LEDs briefly turn off and then back on to indicate that the teach sequence has been completed.

6. The sensor is now ready to operate (yellow LED (C) is on when the target is present). White LED detection beam is also ON during normal operation.
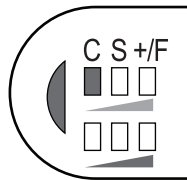
Multiple Channel Teach (C+ menu function)

To teach the ColorSight to detect multiple individual colors using multiple channels:

1.   Place the color target within the sensing range.

2. Enter teach mode by pushing SET for three seconds until the (C) yellow LED indicator starts blinking.

☐ Off
▨ Blinking
▩ On

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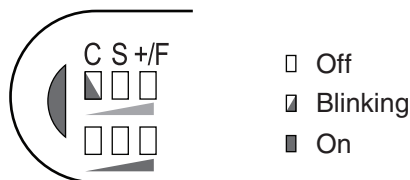
3. Push and release ▶. Note that the C and +/F LEDs are blinking simultaneously.

C S +/F

☐ Off
◪ Blinking
◼ On
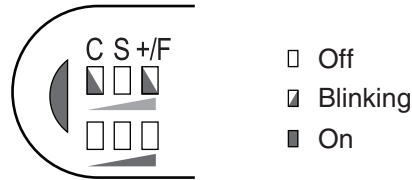
4. Press and release SET. Note that the color tolerance LEDs (green) turn on. Press ▶ to adjust the tolerance to the desired level. Push SET to confirm (for more information on tolerance settings, see page 15).

5. Press and release SET. Note that the intensity tolerance LEDs (red) turn on. Press ▶ to adjust the tolerance to the desired level. Push SET to confirm. Note that the white detection beam and the tolerance LEDs briefly turns off and then back on to indicate that the teach sequence has been completed.

6. The sensor is now ready to operate (yellow LED (C) is on when the target is present). White LED detection beam is also on during normal operation.

C S +/F
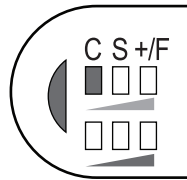
Repeat instructions to teach additional channels.

IMPORTANT	A maximum of four additional color channels can be programmed by using the multiple channel teach feature. All previously taught colors are internally stored with the respective color and intensity tolerances programmed during the teach process.
	If more than five channels are taught using this feature, the first programmed channel is replaced by the last programmed color (first in/first out memory).
	The discrete output will turn on if the sensor detects the taught colors of any of the five channels.

Single Channel Scan (S menu function)

The single channel scan feature enables you to teach and detect objects with various colors and individual multiple colors to a single channel. To teach the sensor:

1. Place the color target within the sensing range.

2. Enter teach mode by pushing SET for three seconds until the (C) yellow LED indicator starts blinking.


    ☐ Off
    ◩ Blinking
    ◼ On

3. Push the ▶ button two times until the yellow LED (S) indicator starts blinking.

    ☐ Off
    ◩ Blinking
    ◼ On

4. Push and hold SET while the yellow LED (S) is blinking. Continue to hold SET while moving the object to scan all colors with the sensor's white light spot. When you are finished scanning the object, release the SET button. Note that the white detection beam briefly turns off and then back on to indicate that the teach sequence has been completed.

5. The sensor is now ready to operate (yellow LED (C) is on when the target is present). White LED detection beam is also ON during normal operation.

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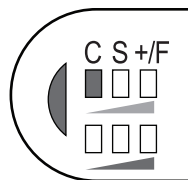
Multiple Channel Scan (S+ menu function)

The multiple channel scan feature enables you to teach and detect objects with various colors and individual multiple colors to up to four additional channels. To teach the sensor:

1. Place the color target within the sensing range.

2. Enter teach mode by pushing SET for three seconds until the (C) yellow LED indicator starts blinking.

C S +/F

☐ Off
▨ Blinking
▪ On
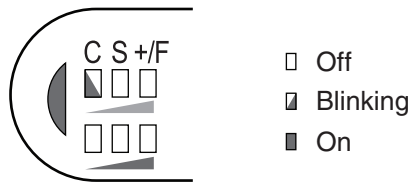
3. Push the ▶ button three times until the yellow LEDs (S and +/F) indicators start blinking.

C S +/F

☐ Off
▨ Blinking
▪ On

4. Push and hold SET while the yellow LED (S) and the yellow LED (+/F) are blinking. Continue to hold SET while moving the object to scan all colors by the sensor white light spot. When you are finished scanning the object, release the SET button. Note that the white detection beam briefly turns off and then back on to indicate that the teach sequence has been completed.

5. The sensor is now ready to operate (yellow LED (C) is on when the target is present). White LED detection beam is also ON during normal operation.

C S +/F
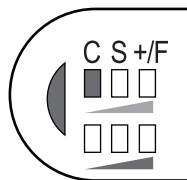
Repeat instructions to teach additional channels.

IMPORTANT	A maximum of four additional color channels can be programmed by using the multiple channel scan feature. All previously scanned colors are internally stored without any color or intensity tolerance settings during the teach process.
	If more than five channels are taught using this feature, the first programmed channel is replaced by the last programmed color (first in/first out memory).
	The discrete output will turn on if the sensor defects the taught colors of any of the five channels.

Remote Teach Input (TEACH)

The remote teach input (see wiring diagram on page 6) can be used to program a single color to channel 1. To remotely teach a color:

1. Place the color target within the sensing range.

2. Set TEACH (pink wire) to high (+V DC) for more than three seconds. The color is taught during the signal transition from high to low.

3. The sensor is now ready to operate (yellow LED (C) is on when the target is present). White LED detection beam is also ON during normal operation.

IMPORTANT	Only channel 1 can be programmed when using the TEACH pin. After the teach process has been completed, the color is stored using the last programmed color tolerance and intensity tolerance settings.

Remote Scan Input (SCAN)

The remote scan input (see wiring diagram on page 6) can be used to teach and detect objects with various colors and individual multiple colors to a channel 1. To remotely teach a color:

1. Place the color target within the sensing range.

2. Set SCAN (yellow wire) to high (+V DC) for more than three seconds to start the color scan sequence. The target color region will be scanned as long as SCAN is high. The color is taught during the signal transition from high to low.

3. The sensor is now ready to operate (yellow LED (C) is on when the target is present). White LED detection beam is also ON during normal operation.

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IMPORTANT	Only channel 1 can be programmed when using the SCAN pin. All previously scanned colors are internally stored without any color tolerance or intensity tolerance settings during the teach process

LOCK/GATE Input

The LOCK/GATE pin provides a dual function input connection that allows the user to lock the sensor keypad and avoid undesired reprogramming of the unit. This input can also be used to inhibit the operation and output of the ColorSight and it is very useful when combined with a trigger sensor that will signal the sensor when to start the color evaluation process.

For key lock setting: When the pin is high (+V DC) the button keypad is locked

When the pin is low (0V DC) or open the button keypad is unlocked.

For trigger setting: When the pin is high (+V DC) the sensor is disabled

When the pin is low (0V DC) or open, the sensor is running.

Color Tolerance Levels (Green tolerance LEDs)

After an object has been taught, move the object manually within the sensing range or positions that can occur in your application. Check that the programmed channel is effectively detecting the color. If the color is not being detected reliably, adjust the tolerance one level higher (wide tolerance) or one level lower (tight tolerance). By repeating this procedure, the optimal tolerance level can be determined.

Adjusting the tolerance levels on the ColorSight enables the user to define the amount of variation in color (ratio of Red, Green, Blue components) the sensor will detect. Up to four color tolerance levels can be selected as shown in the chart below.

| Tight | Medium Low | Medium High (factory default) | Wide |
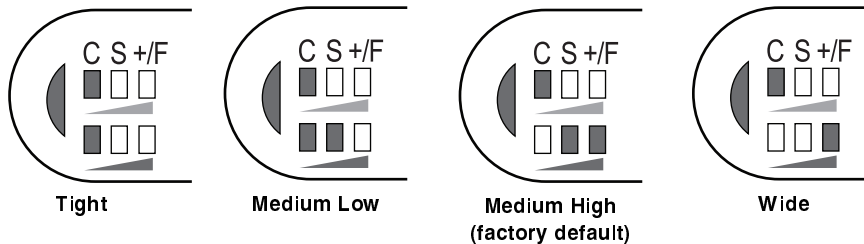
Intensity Tolerance Levels (Red tolerance LEDs)

Adjusting the intensity tolerance levels on the ColorSight enables the user to define the greyscale variation of color (light or dark ratio) the sensor will detect. Up to four intensity tolerance levels can be selected as shown on the chart below.

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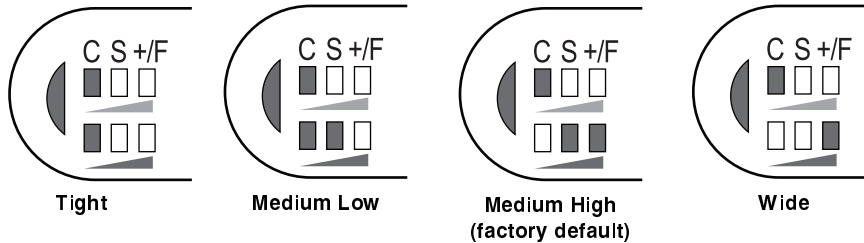
| Tight | Medium Low | Medium High (factory default) | Wide |

| **INFORMATION** | For high precision color detection, a tight setting for color and intensity tolerance is recommended. |

Special Functions

Restore Factory Settings

To configure the sensor to the manufacturer's default settings:

1. Enter teach mode by pressing SET for three seconds until the C LED (yellow) starts blinking.

2. Push the ▶ button four times until the +/F LED (green) indicator starts blinking.

3. Push and release SET to confirm. Note that all three intensity tolerance LEDs (red) are now blinking as shown below. This indicates that the selected option will reset the sensor to the manufacturer's default settings.

| **ATTENTION** ⚠ | After entering the special functions factory default option (steps 1 through 3), if all three intensity tolerance LEDs (red) and the +/F LED (green) are blinking, the sensor has already been programmed with the factory default settings. |
| | Note that a neutral white (90%) target will be detected by the sensor upon resetting the unit to factory default settings. |

☐ Off
◨ Blinking
■ On
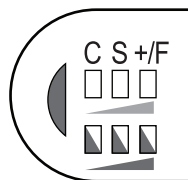
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4. Push and release SET. Note that all three intensity tolerance LEDs (red) and the +/F LED (green) are now blinking alternatively as shown below. This indicates that the sensor has been reset to factory default values.

C S +/F

☐ Off
▨ Blinking
▦ On
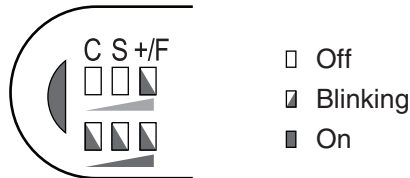
5. Push the ▶ button four times until all the intensity LEDs (red) are OFF.

6. Push and release SET to confirm.

7. The sensor is now ready to operate. White LED detection beam is ON during normal operation.

Pulse Stretching

The ColorSight allows the user to configure a 50 ms output pulse stretch for applications where the sensor may be interfaced to slower response devices. To program this feature:

1. Enter teach mode by pressing SET for three seconds until the C LED (yellow) starts blinking.

2. Push the ▶ button four times until the +/F LED (green) indicator starts blinking.

3. Push and release SET to confirm. Note that all three intensity tolerance LEDs (red) are now blinking as shown below.

C S +/F

☐ Off
▨ Blinking
▦ On

4. Push the ▶ button once. Note that a single intensity tolerance LED (red) is flashing as shown below. This indicates that the selected option inserts a 50 ms pulse stretching delay in the sensor's output.

☐	Off
◨	Blinking
▨	On
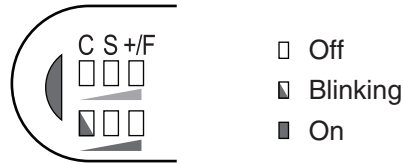
⚠ ATTENTION	After entering the special functions pulse stretching option (steps 1 through 4), if a low intensity tolerance LED (red) and the +/F LED (green) are blinking, the sensor has already been programmed for pulse stretching.

5. Push and release SET. Note that a single intensity tolerance LED (red) and the +/F LED (green) are now blinking alternatively as shown below. This indicates that the sensor has been successfully programmed to insert a 50 ms pulse stretching delay.

☐	Off
◨	Blinking
▨	On
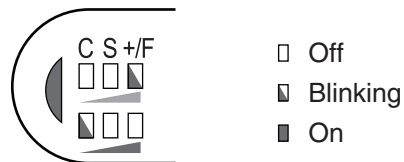
6. Push the ▶ button three times until all the intensity tolerance LEDs (red) are OFF.

7. Push and release SET to confirm.

8. The sensor is now ready to operate. White LED detection beam is ON during normal operation.

Output Mode

The ColorSight output can be configured to operate as a normally open (NO) or normally closed (NC) output device. To program the sensor:

1. Enter teach mode by pressing SET for three seconds until the C LED (yellow) starts blinking.

2. Push the ▶ button four times until the +/F LED (green) indicator starts blinking.

3. Push and release SET to confirm. Note that all three intensity tolerance LEDs (red) are now blinking as shown below.

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C S +/F

☐ Off
◨ Blinking
■ On
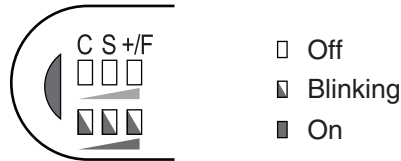
4.   Push the ► button twice. Note that two intensity tolerance LEDs (red) are blinking as shown below. This indicates that the selected option configures the sensor's output mode.

C S +/F

☐ Off
◨ Blinking
■ On

ATTENTION ⚠	After entering the special functions output mode option (steps 1 through 4), if two intensity tolerance LEDs (red) and the +/F LED (green) are blinking, the sensor output has already been programmed to operate as N.C. Push SET to turn this feature off.

5.   Push and release SET. Note that two intensity tolerance LEDs (red) and the +/F LED (green) are now blinking alternatively as shown below. This indicates that the sensor output has been successfully programmed to operate as N.C.

C S +/F

☐ Off
◨ Blinking
■ Steady

6.   Push the ► button two times until all the intensity tolerance LEDs (red) are OFF.

7.   Push and release SET to confirm.

8.   The sensor is now ready to operate with a N.C. output. White LED detection beam is ON during normal operation. Note that the C indicator will be on without any target present and off when a programmed color is detected.

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LOCK/GATE

The LOCK/GATE pin provides a dual function input connection that allows the user to lock the sensor keypad and avoid undesired reprogramming of the unit. This input can also be used to inhibit the operation and output of the ColorSight and it is very useful when combined with a trigger sensor that will signal the sensor when to start the color evaluation process. To change the settings for this feature:

1. Enter teach mode by pressing SET for three seconds until the C LED (yellow) starts blinking.

2. Push the ► button four times until the +/F LED (green) indicator starts blinking.

3. Push and release SET to confirm. Note that all three intensity tolerance LEDs (red) are now blinking as shown below. If the sensor is currently operating in factory default settings the +/F LED (green) will also flash alternatively.

☐ Off
◩ Blinking
◼ On
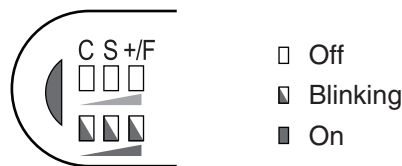
4. Push the ► button three times. Note that a single high intensity tolerance LED (red) and the +/F LED (green) are now blinking alternatively as shown below. This indicates that the selected option configures pin 8 as a gate input (default settings). If the operator wants pin 8 to operate as a teach button lock, continue on to step 5. If the operator wants pin 8 to operate as a GATE proceed to step 6.

Gate   Teach Button Lock
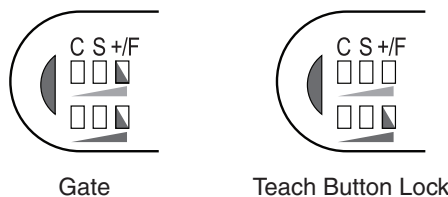
5. Push and release SET. Note that a single high intensity tolerance LED (red) is now blinking as shown below. This indicates that the selected option configures pin 8 as a Key Lock input.

☐ Off
◩ Blinking
◼ On

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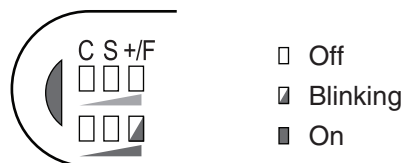
6.   Push the ▶ button until all the intensity tolerance LEDs (red) are OFF.

7.   Push and release SET to confirm.

8.   The sensor is now ready to operate. White LED detection beam is ON during normal operation.

ColorSight RS-485 Communications Interface

The ColorSight is equipped with a RS-485 serial communications interface for bidirectional transmission of color values and setting of sensor functions. This capability allows the user to:

•   Teach multiple colors and store them as color vectors in a control system such as an Allen-Bradley MicroLogix PLC
•   Internally match up to five color channels
•   Communicate true RGB information for remote processing of additional colors
•   Address multiple sensors connected to the RS-485 communication interface

Basic Parameters

	Fixed Settings	Adjustable Settings
Protocol	RS-485, half-duplex	
Data Transfer Rate		4800/9600(*)/19200/34800
Stop Bits	1	
Parity	No	
Bits/Byte	8	
Access method	Master/Slave (sensor acts as a slave)	
Sensor Address		1

(*) Factory Default

IMPORTANT	The sensor only sends data when requested. The user can assign an address number to the sensor ranging from 1...127 (Factory default is one).
	The sensor response time after a command has been received from a master device is typically 500 µS.
	If multiple sensors are connected via the RS-485 communications interface, a 120 ohm terminating resistor is recommended to reduce noise interference and provide reliable communications between the master and the slave RS-485 devices.

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Data Message Structure

Each byte consists of a selection bit (D7) and 7 data or address bits (D6 to D0)

D7	D6	D5	D4	D3	D2	D1	D0
Selection Bit	7 Data/Address Bits						

General Message Structure

A complete telegram, from both the master and the slave, consists of at least 4 bytes and has the following structure:

	Master	Reply Sensor
1st Byte	Address 1 (to 127) corresponds with 129 (to 255), as the selection bit of the 1st byte (D7) =1	
2nd Byte	Length of telegram, number of all bytes (4 to 127), D7=0	
3rd Byte	Command (see "Overview of master commands") D7=0	Reply (see reply telegram, below) D7=0
4th byte to (n-1) byte	Parameter (see parameter bytes, below) D7=0	
N byte (last Byte)	Check sum exclusive OR of byte 1 and byte n-1, D7 =0	

The 1st byte always included the sensor address. In addition, it is characterized by the selection bit (D7 = 1). This means that this byte is decimal: always „address +128". The selection bit is not set (D7=0) with any other bytes. When the master sends a byte with a set selection bit, a new data transfer cycle is started, regardless of whether the previous cycle has been completed.

The command message (3rd byte) from the master can adopt the values listed in the "Command Message Overview."

The slave response message (3rd byte) can only adopt the following values:

Decimal	Hex	Description
89	0x59	The received command has been executed
78	0x4E	The received command cannot be executed. Possible causes: Checksum or incorrect parameter

The 12 bit and 7 bit data is transferred in the parameter bytes (4th byte to (n-1) bytes). The following formats are used:

7 bit data byte:

D7	D6	D5	D4	D3	D2	D1	D0
0	Data bits						

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12 bit data:

D7	D6	D5	D4	D3	D2	D1	D0	D7	D6	D5	D4	D3	D2	D1	D0
0	0	Data Item						0	0	Data Item					

12 bit data with output detection (Q1 is in bit D6, byte i+1) and data valid (DV in bit D6 byte i):

D7	D6	D5	D4	D3	D2	D1	D0	D7	D6	D5	D4	D3	D2	D1	D0
0	DV	Data Item						0	Q1	Data Item					

Command Message Overview

Decimal	Hex	ASCII	Description
83	0x53	S	**Store settings**. This command permanently stores all data and parameter settings in the sensor. The information is retained even if power is removed.
118	0x76	v	**Read software version**. This command provides the latest firmware version information.
87	0x57	W	**Factory default settings**. Resets all configurations including sensor address to factory default.
76	0x4C	L	**Change sensor address**. Transfer new address to sensor.
86	0x56	V	**Keypad Lock/Unlock**. This command immediately locks and unlocks the user keypad. It is not necessary to connect pin 8. To unlock the keypad the command message would need to be retransmitted.
98	0x62	b	**Configure special functions**. The command programs the normally open (NO) or normally closed (NC) output modes and the 50 ms output pulse stretch.
99	0x63	c	**Read color channels**. Up to 5 colors /color scans can be stored in separate channels within the sensor. Upon receiving the master (controller) message, the sensor provides information on the color channels that were detected in the last detection cycle.
63	0x3F	?	**Read all configuration settings**. The sensor transfers all configuration settings to the master device (parameters and color channel information)
65	0x41	A	**Read color vector**. Reads current measured color value (color vector). The sensor sends the color vector and the output status in the last 12 bits of data.
105	0x69	i	**Transfer color matrix**. This command programs the 5 color channels.
88	0x58	X	**Single Channel Teach and Single Channel Scan**. This command performs a single channel teach or a single channel scan. The process consists of a command sequence that must be executed.
73	0x49	I	**Tolerance settings**. This command programs the color and intensity tolerance settings. The command can only be used when combined with single channel teach sequence.
66	0x42	B	**Set data transfer rate**. Programs the data transfer rate. Possible baud rates are 4800,9600,19200 and 38400 baud.

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Command Message Examples

The following section provides examples describing the communications between the master (controller) and slave (sensor) command sequences.

Store Settings

This command permanently stores all data and parameter settings in the sensor. The information is retained even after the supply power has been removed.

Master Command Message	Decimal: 83; Hexadecimal: 0x53
Parameter	No parameters are sent for this command

Sensor Response Message	Decimal: 89; Hexadecimal: 0x59
Parameter	No parameters are sent for this command

In the example below, the sensor has an address value of 1.

Master Command Message

	Designation	Decimal	Hex.
1st byte	Address	129	0x81
2nd byte	Length	4	0x04
3rd byte	Command	83	0x53
4th byte	Check sum	86	0x56

Sensor Response Message

	Designation	Decimal	Hex.
1st byte	Address	129	0x81
2nd byte	Length	4	0x04
3rd byte	Response	89	0x59
4th byte	Check sum	92	0x0C

Read Software Version

This command provides the latest sensor firmware version information.

Master Command Message	Decimal: 118; Hexadecimal: 0x76
Parameter	No parameters are sent for this command

Sensor Response Message	Decimal: 89; Hexadecimal: 0x59
Parameter	Main version 7 bit data byte, secondary version 7 bit data byte

The example describes the communication between a controller and a ColorSight with an internal address of 1 running on a 3.5 firmware version.

Master Command Message

	Designation	Decimal	Hex.
1st byte	Address	129	0x81
2nd byte	Length	4	0x04
3rd byte	Command	118	0x76
4th byte	Check sum	115	0x73

Sensor Response Message

	Designation	Decimal	Hex.
1st byte	Address	129	0x81
2nd byte	Length	6	0x06
3rd byte	Response	89	0x59
4th byte	Main version	3	0x03
5th byte	Secondary version	5	0x05
6th byte	Check sum	88	0x58

Restore Factory Default Settings

This command resets all configurations including sensor address to factory default values.

Master Command Message	Decimal: 87; Hexadecimal: 0x57
Parameter	No parameters are sent for this command

Sensor Response Message	Decimal: 89; Hexadecimal: 0x59
Parameter	No parameters are sent for this command

In this example the master is resetting the sensor to its default values. The sensor has an address value of 1.

Master Command Message

	Designation	Decimal	Hex.
1st byte	Address	129	0x81
2nd byte	Length	4	0x04
3rd byte	Command	87	0x57
4th byte	Check sum	83	0x52

Sensor Response Message

	Designation	Decimal	Hex.
1st byte	Address	129	0x81
2nd byte	Length	4	0x04
3rd byte	Response	89	0x59
4th byte	Check sum	92	0x5C

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Change Sensor Address

This command assigns a new address to the sensor.

Master Command Message	Decimal: 76; Hexadecimal: 0x4C
Parameter	New sensor address

Sensor Response Message	Decimal: 89; Hexadecimal: 0x59
Parameter	No parameters are sent for this command

In the example below, the sensor has an address value of 1; the controller (master) will assign a new address value of 122. The sensor responds to the old address. After the response is received, all commands will need to be issued to the new sensor address.

Master Command Message

	Designation	Decimal	Hex.
1st byte	Address	129	0x81
2nd byte	Length	5	0x05
3rd byte	Command	76	0x4C
4th byte	New Address	122	0x7A
5th byte	Check sum	50	0x32

Sensor Response Message

	Designation	Decimal	Hex.
1st byte	Address	129	0x81
2nd byte	Length	4	0x04
3rd byte	Response	89	0x59
4th byte	Check sum	92	0x5C

Keypad Lock/Unlock

This command immediately locks and unlocks the user keypad. It is not necessary to connect pin 8. To unlock the keypad the command message would need to be retransmitted.

Master Command Message	Decimal: 86; Hexadecimal: 0x56
Parameter	Bit 0: 0 unlock keypad;1 lock keypad

Sensor Response Message	Decimal: 89; Hexadecimal: 0x59
Parameter	No parameters are sent for this command

In the example below, the sensor has an address value of 1 and the controller (master) transmits the command to lock the keypad.

Master Command Message

	Designation	Decimal	Hex.
1st byte	Address	129	0x81
2nd byte	Length	5	0x05
3rd byte	Command	6	0x4C
4th byte	New Address	1	0x7A
5th byte	Check sum	83	0x32

Sensor Response Message

	Designation	Decimal	Hex.
1st byte	Address	129	0x81
2nd byte	Length	4	0x04
3rd byte	Response	89	0x59
4th byte	Check sum	92	0x5C

Configure Special Functions (N.O./N.C. and drop-out delay time)

This command activates the functions that are specified in the parameter values.

Master Command Message	Decimal: 98; Hexadecimal: 0x62
Parameter	Bit 0: 1 (NC), 0 (NO) Bit 2: 1 (50 ms pulse stretch active), 0 (50 ms pulse stretch inactive)
Sensor Response Message	Decimal: 89; Hexadecimal: 0x59
Parameter	No parameters are sent for this command

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In the example below, the sensor has an address value of 1 and the controller (master) transmits the command to change the output to NC and activate the 50 ms pulse stretching feature.

Master Command Message

	Designation	Decimal	Hex.
1st byte	Address	129	0x81
2nd byte	Length	6	0x06
3rd byte	Command	98	0x62
4th byte	Function	0	0x00
5th byte		5	0x05
6th byte	Check sum	96	0x60

Sensor Response Message

	Designation	Decimal	Hex.
1st byte	Address	129	0x81
2nd byte	Length	4	0x04
3rd byte	Response	89	0x59
4th byte	Check sum	92	0x5C

Read Color Channel

The sensor sends the color channels that were detected in the last measuring cycle.

Master Command Message	Decimal: 99; Hexadecimal: 0x63
Parameter	No parameters are sent for this command

Sensor Response Message	Decimal: 89; Hexadecimal: 0x59
Parameter	Signal status:
	Bit 0: channel 1 detected
	Bit 1: channel 2 detected
	Bit 2: channel 3 detected
	Bit 3: channel 4 detected
	Bit 4: channel 5 detected

In this example, the sensor has an address value of 1 and has detected the colors programmed on channel 3 and 5.

Master Command Message

	Designation	Decimal	Hex.
1st byte	Address	129	0x81
2nd byte	Length	4	0x04
3rd byte	Command	99	0x63
4th byte	Check sum	102	0x66

Sensor Response Message

	Designation	Decimal	Hex.
1st byte	Address	129	0x81
2nd byte	Length	5	0x05
3rd byte	Response	89	0x59
4th byte	Color Channel	20	0x14
5th byte	Check sum	73	0x49

Read All Configuration Settings

The sensor transfers all the configuration settings. The first two bytes provide information on the configuration status for the special functions (See Configure Special functions page "Configure Special Functions (N.O./N.C. and drop-out delay time)" on page 28). The color and intensity information can be a value ranging from 0 to 1023. The RGB (Red, Green, Blue) color components total a value of 1023. The blue color component is not provided by the sensor but can be calculated from subtracting the red and green components from 1023. The color tolerance is an absolute value between 0 and 1023 and the intensity is a relative value provided in percentage between 0% and 100%.

Master Command Message	Decimal: 63; Hexadecimal: 0x3F
Parameter	No parameters are sent for this command

Sensor Response Message	Decimal: 89; Hexadecimal: 0x59
Parameter	Special Functions (NO/NC, 50 ms pulse stretch) [12 bit data message]
	Red color information for channel 1 [12 bit data message]
	Green color information for channel 1 [12 bit data message]
	Intensity information for channel 1 [12 bit data message]
	Color tolerance for channel 1 [12 bit data message]
	Channel 2 to channel 5 information is displayed similar to channel 1

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In this example, the sensor has an address value of 1, operating as a NO output with a 50 ms pulse stretch and the keypad locked. Channel 1 has the following values (120 | 240 | 411) (red | green | intensity) with a color tolerance value of 48 and an intensity tolerance of 25%. The additional channel information (Channels 2-5) are not listed in this example.

Master Command Message

	Designation	Decimal	Hex.
1st byte	Address	129	0x81
2nd byte	Length	4	0x04
3rd byte	Command	63	0x3F
4th byte	Check sum	58	0x3A

Sensor Response Message

	Designation	Decimal	Hex.
1st byte	Address	129	0x81
2nd byte	Length	56	0x38
3rd byte	Response	89	0x59
4th byte	Special Functions Status	4	0x04
5th byte		1	0x01
6th byte	Red color component channel 1	1	0x01
7th byte		56	0x38
8th byte	Green color component channel 1	3	0x03
9th byte		48	0x30
10th byte	Intensity component channel 1	6	0x06
11th byte		27	0x5B
12th byte	Color tolerance channel 1	0	0x00
13th byte		48	0x30
14th byte	Intensity tolerance channel 1	0	0x00
15th byte	Check sum	25	0x25
16th -55th byte	Channel 2 to Channel 5 information	---	---
56th byte	Check sum	XOR (1-55)	---

Read Color Vector

When this command is executed the sensor transmits the current measured color value (color vector) and the output status in the last 12 bit data message.

Master Command Message	Decimal: 65; Hexadecimal: 0x41
Parameter	No parameters are sent for this command

Sensor Response Message	Decimal: 89; Hexadecimal: 0x59
Parameter	Red component [12 bit data message]
	Green component [12 bit data message]
	Intensity [12 bit data message]

In this example the sensor has an address value of 1. The color vector information contains the following values: (120|240|411) (red/green/intensity) and the output and DV are set.

Master Command Message

	Designation	Decimal	Hex.
1st byte	Address	129	0x81
2nd byte	Length	4	0x04
3rd byte	Command	65	0x41
4th byte	Check sum	68	0x44

Sensor Response Message

	Designation	Decimal	Hex.
1st byte	Address	129	0x81
2nd byte	Length	10	0x0A
3rd byte	Response	89	0x59
4th byte	Red component	1	0x01
5th byte		56	0x38
6th byte	Green component	3	0x03
7th byte		48	0x30
8th byte		70	0x46
9th byte	Intensity	91	0x5B
10th byte	Check sum	69	0x45

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Write Color Matrix

This command programs all 5 color channels information (color, intensity, tolerance) to the sensor.

Master Command Message	Decimal: 105; Hexadecimal: 0x69
	Red component channel 1 [12 bit data message]
	Green component channel 1 [12 bit data message]
	Intensity channel 1[12 bit data message]
Parameter	Color tolerance channel 1 [12 bit data message]
	Intensity tolerance channel 1 [12 bit data message]
	Channel 2 to channel 5 information is displayed similar to channel 1
Sensor Response Message	Decimal: 89; Hexadecimal: 0x59
Parameter	No parameters are sent for this command

In the example, the sensor has an address value of 1. Channel 1 is programmed with the color vector (120 I240 I411) (red Igreen Iintensity) with a color tolerance of 48 and the intensity tolerance at 25%. The additional channel information (Channels 2-5) are not listed in this example.

Master Command Message

	Designation	Decimal	Hex.
1st byte	Address	129	81
2nd byte	Length	54	0x36
3rd byte	Command	105	69
4th byte	Red color component channel 1	1	01
5th byte		56	0x38
6th byte	Green color component channel 1	3	0x03
7th byte		48	0x30
8th byte	Intensity component channel 1	6	0x06
9th byte		27	0x1B
10th byte	Color tolerance channel 1	0	0x00
11th byte		48	0x30
12th byte	Intensity tolerance channel 1	0	0x00
13th byte		25	0x19
16th -53rd byte	Channel 2 to Channel 5 information	--	--
54th byte	Check sum	XOR (1-53)	--

Sensor Response Message

	Designation	Decimal	Hex.
1st byte	Address	129	0x81
2nd byte	Length	4	0x04
3rd byte	Response	89	0x59
4th byte	Check sum	92	0x5C

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Single Channel Teach and Single Channel Scan

This command initiates a single channel color teach or single channel color scan.

Master Command Message	Decimal: 88; Hexadecimal: 0x58
Parameter	Bit 0: 1 – Start single channel teach; 0 – End teach process
	Bit 0: 1 – Start single channel scan; 0 – End teach process

Sensor Response Message	Decimal: 89; Hexadecimal: 0x59
Parameter	No parameters are sent for this command

In order to successfully teach a single channel using this command the following programming sequence must be followed:

Single Channel Teach:

Set bit 0 to a value of 1 (Bit 0 = 1) to start the teach process (command 0x58). The sensor learns the color that is present in the detection area for approximately 2 ms. The next command can be transmitted after this period has passed.

As an optional parameter, the new tolerance values can be set by using the command Set Tolerance (command 0x49). The keypad can also be used to program this tolerance values. If no tolerance has been programmed, the last selected tolerance is used.

Set bit 0 to a value of 0 (Bit 0 = 0) to complete the teach cycle.

Single Channel Scan:

Set bit 1 to a value of 1 (Bit 1 = 1) to start the scanning process (command 0x58).This command initiates the scan process.

Set bit 1 to a value of 0 (Bit 1 = 0) to finalize the scan process. The minimum duration of a color scan is 2 ms. If a command to finalize the scan is issued before the 2 ms, the scan sequence will be aborted.

IMPORTANT	Tolerance levels cannot be configured when programming the sensor using the single channel scan.

Start Teach

Master Command Message

	Designation	Decimal	Hex.
1st byte	Address	129	0x81
2nd byte	Length	5	0x05
3rd byte	Command	88	0x58
4th byte	Start Teach	1	0x01
5th byte	Check sum	93	0x5D

Sensor Response Message

	Designation	Decimal	Hex.
1st byte	Address	129	0x81
2nd byte	Length	4	0x04
3rd byte	Response	89	0x59
4th byte	Check sum	92	0x5C

Stop Teach

Master Command Message

	Designation	Decimal	Hex.
1st byte	Address	129	0x81
2nd byte	Length	5	0x05
3rd byte	Command	88	0x58
4th byte	Start Teach	0	0x00
5th byte	Check sum	92	0x5C

Sensor Response Message

	Designation	Decimal	Hex.
1st byte	Address	129	0x81
2nd byte	Length	4	0x04
3rd byte	Response	89	0x59
4th byte	Check sum	92	0x5C

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Set Tolerance

This command programs the tolerance levels for the sensor. The values for this message are expressed as a relative value provided in percentage between 0% (0) and 100% (4).

Master Command Message	Decimal: 73; Hexadecimal: 0x49
Parameter	Bit 0 and 1: binary coded levels 1 to 4 (0 to 3)
	Bit 2 and 3: binary coded levels 1 to 4 (0 to 3)

Binary Coded Level	Tolerance
0	12%
1	25%
2	38%
3	50%

Sensor Response Message	Decimal: 89; Hexadecimal: 0x59
Parameter	No parameters are sent for this command

IMPORTANT This command can only be used in conjunction with the single channel teach process (see page 35). The programmed tolerance levels are used as preset values for future teach procedures unless the values are reprogrammed.

In this example, the sensor with an address value of 1 is programmed a color tolerance level of 3 (38%) and an intensity tolerance level of 4 (50%).

Master Command Message

	Designation	Decimal	Hex.
1st byte	Address	129	0x81
2nd byte	Length	5	0x05
3rd byte	Command	73	0x49
4th byte	Set tolerance	14	0x0E
5th byte	Check sum	67	0x43

Sensor Response Message

	Designation	Decimal	Hex.
1st byte	Address	129	0x81
2nd byte	Length	4	0x04
3rd byte	Response	89	0x59
4th byte	Check sum	92	0x5C

Set Data Transfer Rate

This command configures the data transfer rate between the master (controller) and the sensor interface.

Master Command Message	Decimal: 66; Hexadecimal: 0x42
Parameter	Bit 0: 4800 baud
	Bit 1: 9600 baud
	Bit 2: 19200 baud
	Bit 3: 38400 baud

Sensor Response Message	Decimal: 89; Hexadecimal: 0x59
Parameter	No parameters are sent for this command

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In this example, the sensor has an address value of 1 and the data transfer rate is set at 19200 baud.

Master Command Message

	Designation	Decimal	Hex.
1st byte	Address	129	0x81
2nd byte	Length	5	0x05
3rd byte	Command	66	0x42
4th byte	Set baud rate	2	0x02
5th byte	Check sum	68	0x44

Sensor Response Message

	Designation	Decimal	Hex.
1st byte	Address	129	0x81
2nd byte	Length	4	0x04
3rd byte	Response	89	0x59
4th byte	Check sum	92	0x5C

Maintenance

Clean the ColorSight with a clean dry cloth. Do not use solvents. Do not use sharp objects. Care should be taken when cleaning the sensor face to avoid scratches.

Appendix

Technical Data

Environmental	
Certifications	cULus and CE marked for all applicable directives
Operating Environment	IP67
Operating Temperature [C(F)]	-10°…+55°(14°…+131°)
Vibration	10… 55 Hz, 1mm amplitude, meets or exceeds IEC 60947-5-2
Shock	30 g with 1ms pulse duration, meets or exceeds IEC 60947-5-2
Optical	
Sensing Mode	True color (Diffuse)
Sensing Range [mm (in.)]	45CLR-5L*S1-D8: 12 … 32 mm (0.47 … 1.26)
	45CLR-5L*S2-D8: 15 … 30 mm (0.59 … 1.18)
	45CLR-5L*S3-D8: 18 … 22 mm (0.70 … 0.86)
Sensing Range Tolerance	45CLR-5L*S1-D8: ± 6 mm
	45CLR-5L*S2-D8: ± 5 mm
	45CLR-5L*S3-D8: ± 2 mm
Spot Size [mm (in.)] @ 22 mm	45CLR-5L*S1-D8: 4 (0.15) round
	45CLR-5L*S2-D8: 2 x 2 (0.07x0.07)
	45CLR-5L*S3-D8: 5 x 1 (0.19 x 0.86)
Light Source	White LED
Adjustments	Push buttons
Electrical	
Voltage	12…28V DC
Current Consumption	40 mA max @ 24V DC
Sensor Protection	Overload, short circuit, reverse polarity, false pulse, transient noise
Power On Delay	300 ms
Output	
Response Time	1 ms
Output Type	1 PNP or 1 NPN output by catalog number
Output Mode	Light operate (NO) or Dark Operate (NC)
Output Features	Optional 50 ms off delay (pulse stretch)
Output Current	100 mA @ 28V DC max
Output Leakage Current	0.1 mA max

*   Replace with P for PNP models or N for NPN models.

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Technical Data (continued)

LOCK/GATE Input	
Response Time	10 ms min.
Trigger Mode is Active	Input = +V DC
Trigger Mode is Inactive	Input = 0V DC or open
Keypad Lock is Active	Input = +V DC
Keypad Lock is Inactive	Input = 0V DC or open
TEACH Input (Remote Teach)	
Response Time	2 ms min.
Start Teach	Input = +V DC for more than 3 seconds
Normal Operation	Input = 0V DC or open
SCAN Input (Remote Scan)	
Response Time	2 ms min.
Start Scan	Input > 12 … 28V DC for more than 3 seconds
Normal Operation	Input < 3V or open
Communications Interface	
Communications Protocol	RS-485 Half Duplex. 1 stop bit, no parity
Selectable Baud Rates	4800
	9600
	19200
	38400
Mechanical	
Housing Material	ABS
Lens Material	PMMA
Connection Types	8-pin DC micro (M12) QD
Supplied Accessories	None
Optional Accessories	Mounting brackets, cordsets

Dimensions   [mm (in.)]
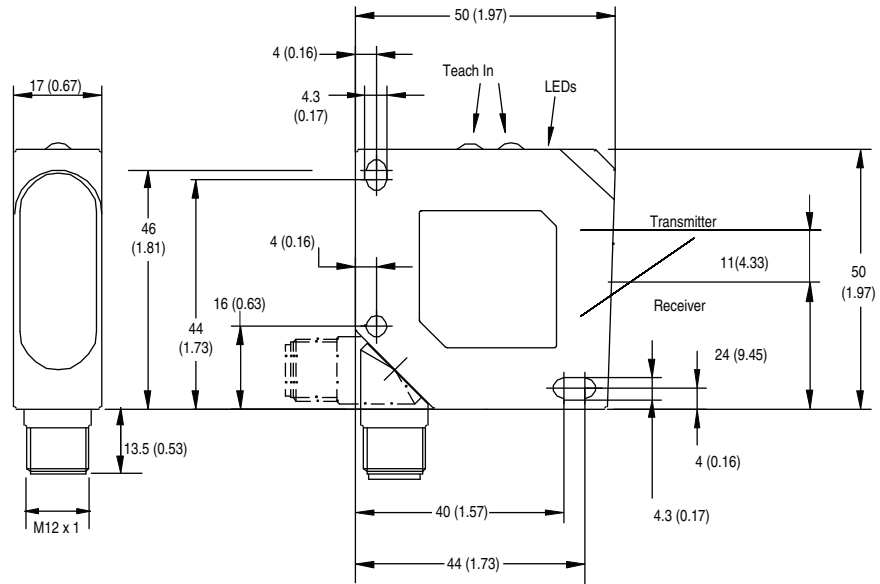
Accessories

Cat. No.	Description
45BPD-BKT1	Mounting Bracket
45BPD-BKT2	Protective Mounting Bracket
889D-F8AB-2	Female, 8-pin micro (M12) QD unshielded cordset (2 meter)
48MS-CS-2	Female, 8-pin micro (M12) QD shielded cordset (2 meter)

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