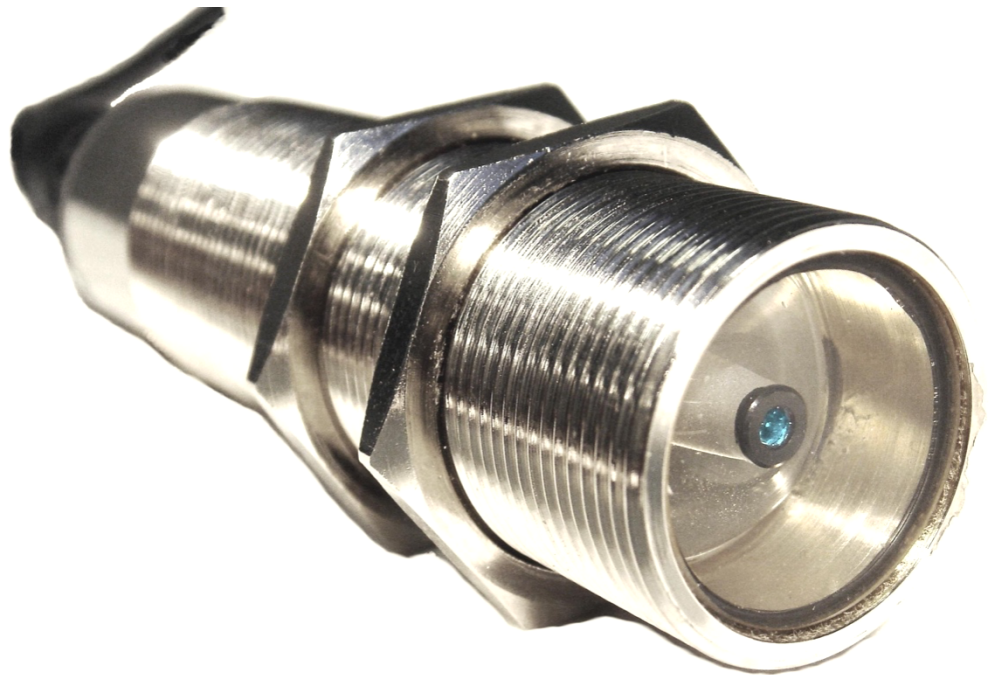




ColorMax™

Color sensor



Operating Instructions

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1. CAUTIONS AND WARNINGS

WARNING:

1. The ColorMax is not intended for use in personal safety applications.
2. The ColorMax is not an explosion-proof enclosure. Do not use in an environment where flammable materials are present.
3. The ColorMax sensor uses a high intensity, white LED, do not look directly into this light source.

IMPORTANT:

This product is an accessory or part of a system. Always read and follow the manufacturer's instructions for the equipment before connecting this product. Comply with all applicable codes and safety regulations. Failure to do so may result in damage, injury or death.

2. PRODUCT OVERVIEW

The ColorMax-1000 color sensors are designed to verify the presence of targets that can be differentiated by color. The sensor projects a high intensity white light onto a target. The sensor analyzes the reflected light for its constituent RGB (red, green, blue) values. If the readings of all of the three colors fall within the preprogrammed parameters, the sensor issues a discrete signal that indicates a color match. A wide variety of models provide color detection capabilities for the most demanding applications. High-speed discrete outputs provide a standard interface to factory automation systems. Models include 3 spot sizes, up to 15 color recognition channels and RGB analog outputs.

ColorMax Windows™ Application Program provides a comprehensive approach to sensor set-up, file management and real-time sample analysis and evaluation.

Easy to use

The ColorMax Application Program provides a familiar Windows™ environment creating an intuitive user interface. All essential sensor information is presented in one window including, sensor settings, color recognition channel data and real-time display of color data. Features such as drop and check boxes make selections and settings easy to change.

Flexibility

The ColorMax Application Program provides significant flexibility for set-up and operation. Features such color/color & luminosity modes, color recognition tolerance settings for each color component and separate NPN/PNP output selections are available for each color recognition channel.

Real-time display

Whenever the sensor is connected to the PC and the application program is running, the Current Reading section shows the color components of the signal and the Recognized Colors status. In the Color & Luminosity mode the bar graph provides a visual representation of each color component, red, green and blue as a target is placed in the sensor's viewing area. A numeric value is shown above the bar graph indicating the percent of full scale for each color component. In the Color only mode a pie chart indicates the proportion of each color component. This graphic display aids in set-up by showing the signal levels for the users samples, allowing distance and sensor angle to be easily optimized for reliable detection.

*Windows™ is a trademark of Microsoft Corporation
ColorMax™ is a trademark of EMX Industries, Inc.*

3. SPECIFICATIONS

| ColorMax SPECIFICATIONS | | CM1000-1-4 | CM1000-4-4 | CM1000-7-4 | CM1000-15 HEX4 | CM1000-4-RGB4 | CM1000-FLEX4 | CM1000-1-8 | CM1000-4-8 | CM1000-7-8 | CM1000-15 HEX8 | CM1000-4-RGB8 | CM1000-FLEX8 | CM1000-7-25 | CM1000-15 HEX25 | CM1000-4-RGB25 | CM1000-FLEX25 |
|------------------------------------|---|------------|------------|------------|----------------|---------------|--------------|------------|------------|------------|----------------|---------------|--------------|-------------|-----------------|----------------|---------------|
| Light source | White LED 400...700 nm | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| Spot dia. @ 50 mm | 4 mm | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| | 8 mm | | | | | | | ● | ● | ● | ● | ● | ● | | | | |
| | 25 mm | | | | | | | | | | | | | ● | ● | ● | ● |
| Receiver | RGB photodiode | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| Sensing range | 30 mm...100 mm | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| Recommended sensing distance | 50 mm | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| Color recognition channels | 1 | ● | | | | | | ● | | | | | | | | | |
| | 4 | | ● | | | ● | ● | | ● | | | | | | | ● | ● |
| | 7 | | | ● | | | | | | ● | | | ● | ● | | | |
| | 15 | | | | ● | | | | | | ● | ● | | | ● | | |
| Color recognition discrete outputs | 1 | ● | | | | | | ● | | | | | | | | | |
| | 4 | | ● | | | ● | ● | | ● | | | | | | ● | ● | ● |
| | 7 | | | ● | | | | | | ● | | | ● | ● | | | |
| | 15 (4 binary coded discrete outputs) | | | | ● | | | | | | ● | | | | ● | | |
| RGB analog outputs | Red (0-5V), Green (0-5V), Blue (0-5V) | | | | | ● | ● | | | | ● | | | | | ● | ● |
| Discrete outputs | Programmable NPN/PNP | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| Current (max.) | 100 ma | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| Voltage (max.) | Sensor V+ | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| Protection | Short-circuit, transient, EMI | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| Min. pulse duration (ms) | 0, 10, 20...100 | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| Response time (ms) | 0.330 | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| Switching frequency | 20 kHz | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| Controls | PC Application program | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| Communications | RS-232C/USB | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| Data logging | PC Application program | | | | | | ● | | | | | | | | | | ● |
| External trigger input | Sensor V+ (12...30 VDC @ 5 mA) | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| Data transmission | RS-232C/USB | | | | | | ● | | | | | | | | | | ● |
| Power | 12...30 VDC @ 100 mA (max.) | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| Protection | Reverse polarity, over current (PTC fuse) | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| Dimensions (length x dia.) | 120 mm x 30 mm (1.5" x 1.25") | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| Weight | 180 g (.4 lbs.) | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| Housing material | 316 stainless steel | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| Type of protection | IP67 | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| Operating temperature | -10...55°C | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| Storage temperature | -20...70°C | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| I/O connector | Circular M12, 12 pin, IP67 | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |

3.1. DISCRETE OUTPUT CHART FOR HEX MODELS

CM1000-15 HEX4, CM1000-15 HEX8, CM1000-15 HEX25

| CHANNEL MATCH | DISCRETE OUTPUTS | | | | | | |
|------------------|------------------|----------|----------|-----|-----|-----|-----|
| | C7 | C6 | C5 | C4 | C3 | C2 | C1 |
| None | not used | not used | not used | gnd | gnd | gnd | gnd |
| Channel 1 | not used | not used | not used | gnd | gnd | gnd | +V |
| Channel 2 | not used | not used | not used | gnd | gnd | +V | gnd |
| Channel 3 | not used | not used | not used | gnd | gnd | +V | +V |
| Channel 4 | not used | not used | not used | gnd | +V | gnd | gnd |
| Channel 5 | not used | not used | not used | gnd | +V | gnd | +V |
| Channel 6 | not used | not used | not used | gnd | +V | +V | gnd |
| Channel 7 | not used | not used | not used | gnd | +V | +V | +V |
| Channel 8 | not used | not used | not used | +V | gnd | gnd | gnd |
| Channel 9 | not used | not used | not used | +V | gnd | gnd | +V |
| Channel 10 | not used | not used | not used | +V | gnd | +V | gnd |
| Channel 11 | not used | not used | not used | +V | gnd | +V | +V |
| Channel 12 | not used | not used | not used | +V | +V | gnd | gnd |
| Channel 13 | not used | not used | not used | +V | +V | gnd | +V |
| Channel 14 | not used | not used | not used | +V | +V | +V | gnd |
| Channel 15 | not used | not used | not used | +V | +V | +V | +V |

3.2. RGB ANALOG OUTPUTS

CM1000-4-RGB4, CM1000-4-RGB8, CM1000-4-RGB25, CM1000-FLEX4, CM1000-FLEX8 and CM1000-FLEX25

ColorMax provides an analog output signal for each color component (red, green, blue). The signal resolution is 10-bit. The advantage of the analog outputs is that an external device can measure these signals and a PC can analyze this data. There are data acquisition systems and PC cards available to convert the analog signals to digital values in a PC or PLC environment. Once these analog signals are converted to digital values further processing and analysis can be performed allowing virtually unlimited number of colors to be recognized. The discrete output can only indicate to the user that a sample is within or outside it's tolerance range, the use of the analog outputs allow continuous monitoring of a process allowing corrective action to be taken prior to parts not meeting the pre-determined color selection criteria.

3.3. COLORMAX FLEX MODELS

CM1000-FLEX4, CM1000-FLEX8 and CM1000-FLEX25

The ColorMax FLEX models provide two methods collecting readings from the sensor, via the serial port, to external devices.

First, the sensor can be set to transmit a reading, or series of readings, under control of the External Trigger input line. The Application program is used to activate this feature. To utilize this feature, the Edge or Level trigger mode is selected in the Sensor Settings window (refer to section 9.1.2 Triggering and section 11 Sensor Data Transmission and Data Logging for further information). Data may be acquired using a terminal program on a PC.

Second, a data-logging feature is provided in the Application program allowing readings to be saved to a file for further analysis. Set-up and control of the data logging is performed under control of the Applications program (refer to section 9.1.2 Triggering and section 11 Sensor Data Transmission and Data Logging for further information).

4. QUICKSTART

This section provides step-by-step instruction on connection and set-up, allowing the user to become familiar with operation of the sensor.

1. Determine which communications port on the PC will be used to communicate with the sensor. [Install the ColorMax Application software](#) per instructions in the following section. When using the USB port on the PC for communication, install the associated drivers during the Application installation. (Software download link is on last page of this manual.)
2. Connect the sensor cable to the Color I/O per instructions in the CONNECTIONS section. Connect the 12V power supply as shown in the wiring diagram (observe polarity) and apply power.
3. The Red and Green LEDs will illuminate on initial power up. Depending on the sensor model number and discrete outputs available, various LEDs on the Color I/O will be illuminated. For unconnected or unavailable channels, both LEDs on the Color I/O will be illuminated.
4. Connect either the RS232 or the USB cable from the Color I/O to the appropriate PC port. When using the USB port, Windows© will detect the new hardware, and install the drivers. Upon completion launch the Application program by double-clicking the program icon.
5. If the correct COM port is selected, the Application program will show the sensor model number and serial number. If this information is not displayed, select a different COM port and press the reset button. Once communication with the sensor is established the Application window will show the sensor settings and current reading.
6. In the Sensor Settings column select Averaging 64, Free Run, Minimum Output Duration 0 and press the Send ColorMax Settings button. In the Current Reading frame, select the Color and Luminosity display mode.
7. Select several targets, solid color objects, paint samples, or other colored materials to evaluate. Place the sensor at approximately 2" from the target, if the target is glossy, tilt the sensor on a slight 15 to 20° angle (from perpendicular to the target). When positioning targets in front of the sensor maintain distance and angle by marking the surface in the test area.
8. Start with the lightest colored sample. Observe the RGB signals in the Current Reading section of the display. Generally, the one or more of the red, green or blue signals should be in the 20% to 80% of full scale range. If the signals are low, increase the illumination level. If any of the color signals are too high, decrease the illumination level to bring the highest color signal between 80% to 90% of full scale. To adjust the illumination level, move the slider to a new position and press the Send ColorMax Settings button.
9. After determining the appropriate illumination setting for the range of samples being evaluated a Color Recognition Channel may be programmed. In the Color Recognition Channel frame, select Channel 1 from the drop box, check Color and Luminosity mode, check the Recognition Enabled box, set the tolerances for each color to 20% using the Tolerance spin boxes. Select Match output High. After making these selections, verify that the target is properly positioned in the sensor light spot. Press the Teach ColorMax Channel button to program the selected channel to recognize the current target color.

Repeat this step by selecting the next Color Recognition channel, positioning the next target, then teaching the channel.

10. After teaching several channels, note the status of the LEDs on the Color I/O box and the indicators in the Recognized Colors frame in the Application program. Place target 1 into position in front of the sensor. Observe the Channel 1 LED on the Color I/O box moves from the NPN to the PNP column indicating recognition of the target color. Also note the indicator for Channel 1 in the Recognized Colors frame is on. Remove target 1 and observe Channel 1 LED on the Color I/O box returns to the NPN column and the Channel 1 indicator in the Recognized Colors frame is off. Repeat this process with the other targets to see the sensor outputs change state as each is recognized by a different channel.
11. When similar colors, or shades of the same color are used, it may be necessary to reduce the tolerance settings to differentiate between them. Tolerance settings for a previously programmed channel can be adjusted and resent to the sensor without reprogramming the channel by pressing the Send All ColorMax Channels button.

5. SOFTWARE INSTALLATION

Hardware requirements for ColorMax Application software installation and operation:

- Internet Connection
- IBM compatible PC
- Windows™ 9XXX or higher
- RS232 serial interface port (COM1/COM2) or USB port
- VGA graphics or higher monitor

Download, install, and run the ColorMax Software linked on the last page of this manual. (NOTE: You may need to whitelist the software if you have an anti-virus program.) Following installation of the Application software, a prompt to install the USB drivers necessary to use USB interface will appear, continue with the USB driver installation to use the USB port to communicate with the sensor. Upon successful installation, double-click on the desktop icon to start the program.

6. SENSOR INSTALLATION

The ColorMax is provided with 2 jam nuts allowing it to be easily mounted thru a 30mm clearance hole. The ColorMax bracket provides a 30mm clearance hole for the sensor and a pivot and slot for a #8 screw for mounting the bracket. The slotted hole allows the angle of the sensor to target to be easily adjusted.

To achieve optimum performance it is recommended that samples be evaluated prior to permanent installation of the sensor. During evaluation, sensor-to-target distance and sensor-to-target angle can easily be determined by placing samples into the sensor's field of view and observing the RGB color component signal levels. When possible, it is generally best to set the sensor at a target distance that results in a signal level of 80% to 90% using the lightest sample. If necessary the illumination level may be reduced to prevent the sensor from saturating on light colors.

7. COLOR I/O

The Color I/O board provides a means of connecting the sensor cable to other external devices. The I/O board provides a set of LEDs for each channel that indicate the status of the discrete outputs for verification of sensor operation and color recognition. Connections are provided for both serial, RS232 and USB port. Either

may be used as a connection to a PC for set-up and programming of the ColorMax sensor. The drivers for the USB port are installed during installation of the ColorMax Application Software.

The RS 232 connection consists of a modular jack (a phone style plug), cable and 9-pin adapter. To connect the RS232 port, plug one end of the interface cable (with the RJ11 phone plugs) into the RS232 jack on the Color I/O and the other end into the 9-pin adapter. Plug the adapter into the RS232 communications port on the PC. Place the slide switch on the Color I/O to “RS232”.

The USB connection consists of a USB B jack on the Color I/O and a USB interface cable. To connect the USB port, plug one end of the cable into the USB B jack on the Color I/O and the other end into the USB port on the PC. Place the slide switch on the Color I/O to “USB”

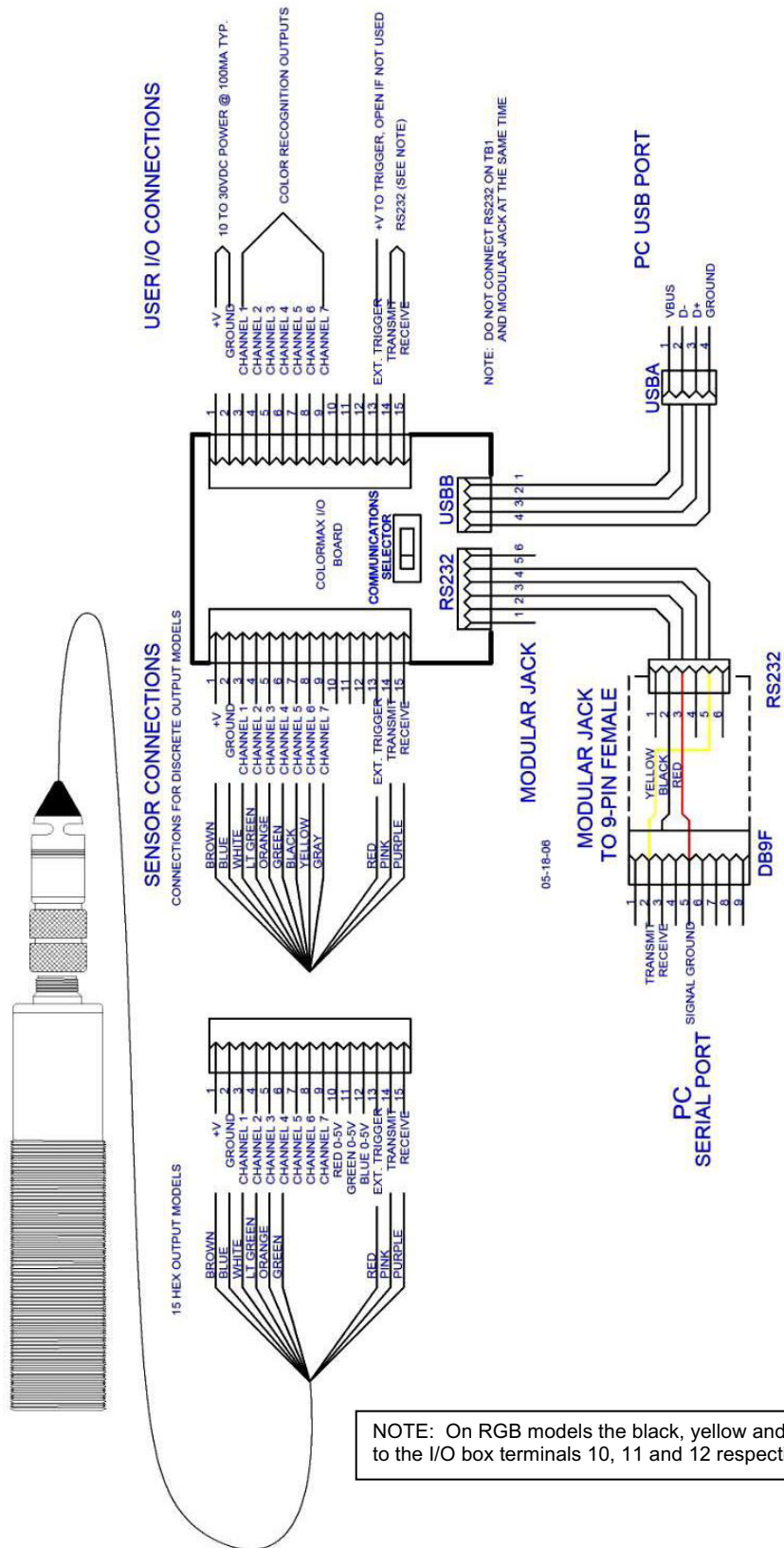
In addition to a power indicator LED, there are 2 LEDs associated with each channel. The LEDs are arranged in 2 columns, one labeled PNP and the other labeled NPN. The PNP LED indicates that a channel output is high, connected to sensor V+, while the NPN indicates that a channel output is low, connected to sensor ground. Operation of the discrete channel outputs is dependent on whether the Match output is set to high or low for a particular channel. Both PNP and NPN LEDs will be illuminated for channels that are not connected to the Color I/O board such as models ColorMax-1000-1 and ColorMax-1000-4.

It is not necessary for the Color I/O board to be used; all sensor connections may be routed directly to the appropriate devices such as a PLC.

8. CONNECTIONS

| Sensor pin no. | Wire color | CM1000-1-4 CM1000-1-8 | CM1000-4-4 CM1000-4-8 | CM1000-7-4 CM1000-7-8 | CM1000-15 HEX4 CM1000-15 HEX8 CM1000-15 HEX25 | CM1000-4-RGB4 CM1000-4-RGB8 CM1000-4-RGB25 CM1000-FLEX4 CM1000-FLEX8 CM1000-FLEX25 |
|----------------|------------|--------------------------|--------------------------|--------------------------|---|---|
| 1 | Pink | TX | TX | TX | TX | TX |
| 2 | Blue | GND | GND | GND | GND | GND |
| 3 | Brown | V+ | V+ | V+ | V+ | V+ |
| 4 | Red | ET | ET | ET | ET | ET |
| 5 | Green | nc | C4 | C4 | C4 | C4 |
| 6 | Black | nc | nc | C5 | nc | RD |
| 7 | Yellow | nc | nc | C6 | nc | GN |
| 8 | Gray | nc | nc | C7 | nc | BL |
| 9 | White | C1 | C1 | C1 | C1 | C1 |
| 10 | Orange | nc | C3 | C3 | C3 | C3 |
| 11 | Purple | RX | RX | RX | RX | RX |
| 12 | Lt. green | nc | C2 | C2 | C2 | C2 |

Note: Shield connection is not required, may be connected to earth ground



9. COLORMAX APPLICATION PROGRAM

ColorMax Application Program provides a comprehensive approach to sensor set-up, file management and real-time sample analysis. The ColorMax Application Program provides a familiar Windows™ environment creating an intuitive user interface. All essential sensor information is presented in one window including, sensor settings, color recognition channel data and real-time display of color data. Features such as drop and check boxes make selections and settings easy to change. After completing the installation procedure, double click the ColorMax icon to open the application. During initialization, the application software interrogates the ColorMax sensor to determine the serial number of the sensor and the specific sensor model. After reading the sensor model number, the application will reconfigure to the appropriate model by changing the number of channels indicated in the Recognized Colors section. Also, the general sensor settings and programmed colors, if any, are read.

Once a sensor is set-up and programmed to recognize various colors the sensor operates as a stand-alone device. It is not necessary to maintain a connection to the PC for normal operation.

The display window is segmented into four frames, Sensor Settings, Sensor Communications, Color Recognition Channels and Current Reading. Each will be described in detail in the following sections.

9.1. SENSOR SETTINGS

Sensor settings are parameters that apply to operation of the sensor. When a sensor is connected to the PC the application program reads these parameters and updates the display. When changes are made to these settings, the new settings must be downloaded to the sensor by selecting the Send ColorMax Settings button.

9.1.1. AVERAGING

Selections: 1,2,4,8,16,32,64

Default = 1

The Averaging drop box allows the user to select the number of measurements that are averaged to obtain a reading that is checked for a match to programmed channels. The higher the number of measurements that are averaged, the lower the variation in the reading allowing detection of subtle differences in color. The lower the number of measurements that are averaged, the faster a match can be detected. Ideally, the more averaging that can be accommodated within the speed constraints of the application, the more accurate and reliable the detection of recognized colors.

9.1.2. TRIGGERING

Selections: Free Run, Level, Edge

Default = Free Run

The triggering options include Free Run, Level and Edge. In general applications, Free Run is the most common. In Free Run mode, the sensor is measuring continuously, updating the discrete outputs whenever the target meets a programmed color criteria.

Level and Edge triggering require the use of the External Trigger input on the sensor I/O connector. Applying a voltage, 12-30VDC, not exceeding the sensor supply voltage, holds the input inactive. Opening this connection will activate the External Trigger input. When Level is selected, and the External Trigger input is active (no voltage applied), the sensor will continuously check for a color match and update the discrete outputs until the Trigger input is deactivated (voltage is applied). The discrete outputs will remain in the state that they are in when the Trigger input is deactivated. When Edge is selected, the sensors will check for a color match on the each falling edge of the External Trigger input and update the discrete outputs. The discrete outputs will remain in the state that they are in when the Trigger input is deactivated. The External Trigger input is generally used when a

separate proximity sensor detects the presence of a sample and signals the sensor to check with the pre-programmed color recognition channels to determine whether there is a match. Alternatively, the sensor can be operated in the Free Run mode, and a separate proximity sensor can be connected to the data acquisition system or PLC indicating a sample is present and the discrete output is valid.

9.1.3. MINIMUM OUTPUT DURATION (ms)

Selections: 0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100

Default = 0

The minimum output duration setting allows the user to increase the time that the discrete output(s) indicate a match. When “0” delay is selected and a color match occurs, the appropriate channel’s discrete output becomes active (i.e. changes state) as long as the match criteria is met. When a target is moving at high-speed, presence of the target may be too short for the polling cycle of the data acquisition system or PLC. In this case, increasing the minimum output duration lengthens discrete output signal, allowing it to remain active long enough for the acquisition system to read its input port.

9.1.4. ILLUMINATION (%)

Adjustment range = 0 - 100%

The ColorMax allows the user to optimize the sensitivity of the sensor by adjusting the illumination level to prevent the sensor from saturating. The illumination setting must be adjusted prior to teaching the color recognition channels. Changing this setting after teaching will affect channels selected for Color & Luminosity mode.

9.1.5. READ COLORMAX SETTINGS

The Read ColorMax Settings button causes the application program to read the current settings from the sensor and display them in the Sensor Settings section.

9.1.6. SEND COLORMAX SETTINGS

The Send ColorMax settings button causes the application program to send the selected settings to the sensor. When changes are made to the Sensor Settings section the Send ColorMax Settings button must be selected to transmit the settings to the sensor.

9.2. SENSOR COMMUNICATIONS

The Sensor Communications section provides user control of PC COM port selection and displays specific sensor information.

9.2.1. PORT

The user may select the appropriate PC COM port for sensor RS232 or USB communications.

Color Sensor I/O with USB Interface: Determining Windows™ COM port assignment

After installing Color Sensor Application Software and USB drivers connect the Color I/O interface board to the PC using the USB cable. Windows will complete the driver installation.

Verify that the RS232/USB switch on the Color I/O interface board is in the USB position. Connect the Color Sensor to the Color I/O and apply power to the system.

In order for communications between the sensor and the PC to be established, it is necessary that the appropriate COM port be selected in the Port drop box.

1. Launch the Application program. Observe the Communications Status box in the lower left corner of the Application window. If the message “Waiting for.....” is displayed, then an incorrect COM port is selected. Close the Application program.

2. To determine the COM port assignment select the Windows™ Control Panel, System Properties. Select the Hardware tab and the Device Manager. Scroll down the device list to Ports (COM & LPT) and expand the list (+). The Color Sensor port assignment will be shown in the list.
3. Close the Control Panel windows and launch the Application program. Select the appropriate COM port in the drop box and select the Reset button. Communications with the sensor are now established.

9.2.2. COMMUNICATION STATUS

The Communications status box shows the ColorMax model and the connection status, either *on line* indicating normal communication or *Communication lost* indicating a disruption in communications. After initiating a Teach command, while the sensor is executing the instruction, the status box indicates *Teaching Channel X...*

9.2.3. SERIAL NO.

The Serial Number box shows the serial number of the sensor currently connected.

9.3. COLOR RECOGNITION CHANNELS

The Color Recognition Channels section of the display window contains all color matching channel parameters. The number of color recognition channels is dependent on the ColorMax model and the application program configures for the appropriate model. All of the selections in this section are channel specific. For example, one channel can be programmed to output a high level when a match occurs while another channel can be programmed to output a low level when a match occurs. With the exception of the ColorMax-1000-15HEX models, Color Recognition Channels can be programmed to achieve multiple match outputs. For example, channel 1 can be programmed to 5% tolerance, channel 2 to 10% tolerance and channel 3 to 15% tolerance using the same sample. This allows the user to monitor variations in samples for further process analysis. The ColorMax-1000-15HEX models provide four discrete signals in a binary format and as such, only one output may be active at a time.

9.3.1. CHANNEL

The channel drop box shows the number of channels available for color recognition. Select the appropriate channel prior to changing the associated parameters. Note that the number of color recognition channels is dependent on the ColorMax model.

9.3.2. RECOGNITION MODE

There are two color recognition modes; Color & Luminosity and Color only. The Color only mode compares the proportion of each color component in the signal, checking to determine that the proportions are within the allowable tolerance to detect a match. This allows for greater variation in sensor-to-target distance than the Color & Luminosity mode. The Color & Luminosity mode evaluates each color component, the luminosity level of each and compares them to the programmed values within the allowable tolerance. The ColorMax allows users to select color and color & luminosity modes on an individual channel basis. Color and luminosity provides the highest precision while Color only is better suited in applications where target flutter is present.

9.3.3. RECOGNITION ENABLED

The Recognition Enabled check box allows the user to enable or disable a particular channel without altering the programmed color recognition settings. A single channel or multiple channels can be temporarily disabled causing the sensor suspend checking of that channel for a color match. To disable a channel, uncheck the Recognition Enabled box and select the Send All ColorMax channels button.

9.3.4. COLOR %

The RED, GREEN and BLUE Color (%) boxes show the values programmed into the selected channel. If the channel was programmed in the Color & Luminosity mode, these values represent a percent of full scale for each color component. If the channel was programmed in the Color only mode, these values represent the proportion of each color component in the composite signal (i.e. the sum of the color components = 100%).

9.3.5. TOLERANCE %

The Tolerance spin boxes are used to set the tolerance for each color component individually. When the colors of the samples are significantly different, for example, red, brown, yellow, then the tolerance setting may be set to a higher value. When the colors of the samples are very similar, for example similar intensities of the same hue (i.e. color), then tighter tolerance settings are necessary for reliable differentiation. For applications that require tight tolerance settings (<2%), allow the sensor to warm-up for 30 minutes prior to use.

9.3.6. MANUAL

The Manual button opens a Manual Entry window that allows previously determined Color (%) and Tolerance (%) values to be entered by the user. This function is only available when the Recognition Mode for the selected channel is set to Color and Luminosity.

After entering the desired values, select the OK button to store the values or cancel to exit without changes.



The image shows a 'Manual Entry' dialog box with a title bar containing a color icon and a close button. The dialog is titled 'Manual Entry' and contains a section labeled 'Color & Luminosity'. Inside this section, there are two rows of input fields. The first row is labeled 'Color (%)' and contains three spin boxes with values 64.1, 44.5, and 40.9, corresponding to RED, GREEN, and BLUE respectively. The second row is labeled 'Tolerance (%)' and contains three spin boxes with values 10.0, 8.8, and 23.2, also corresponding to RED, GREEN, and BLUE. At the bottom of the dialog are two buttons: 'OK' and 'Cancel'.

| | RED | GREEN | BLUE |
|---------------|------|-------|------|
| Color (%) | 64.1 | 44.5 | 40.9 |
| Tolerance (%) | 10.0 | 8.8 | 23.2 |

9.3.7. LUMINOSITY (%)

The Luminosity box shows the average of the red, green and blue color % for the selected channel when in the Color & Luminosity Recognition Mode. When Color only is selected the Luminosity box is blank.

9.3.8. MATCH OUTPUT

The Match output setting allows the operator to select either High or Low output on the associated discrete output when a match occurs. By selecting High the output will pull to sensor V+ and by selecting Low the output will pull to sensor ground. Whenever a channel is in a non-match condition the output will pull to the opposite state.

9.3.9. MULTI-SAMPLE TEACH CHANNEL

The Multi-Sample Teach Channel button opens a window that allows multiple samples or multiple points on a sample to be measured. These measurements are analyzed and the appropriate settings that allow a match for all of the samples are calculated and are shown in the Result frame. Up to 10 measurements may be made. Select the OK button to store the values or cancel to exit without changes.

Multi-Sample Teach

| | RED | GREEN | BLUE |
|-------|------|-------|------|
| Teach | 44.1 | 40.1 | 46.6 |
| Teach | 44.1 | 40.1 | 46.7 |
| Teach | 44.1 | 40.1 | 46.7 |
| Teach | 44.1 | 40.1 | 46.7 |
| Teach | 40.8 | 37.0 | 42.8 |
| Teach | 40.8 | 37.0 | 42.9 |
| Teach | | | |
| Teach | | | |
| Teach | | | |
| Teach | | | |

| Result | RED | GREEN | BLUE |
|---------------|------|-------|------|
| Color (%) | 42.5 | 38.6 | 44.8 |
| Tolerance (%) | 4.7 | 4.8 | 5.1 |

OK Cancel

9.3.10. TEACH COLORMAX CHANNEL

The Teach ColorMax Channel button initiates a sequence of sampling the input signals resulting in current values, tolerances and other specific channel parameters to be stored in the sensor. Executing the teach function applies only to the selected channel. While the teach function is performed by the sensor for several seconds all user selections in the application program are temporarily disabled.

9.3.11. READ ALL COLORMAX CHANNELS

The Read All ColorMax Channels button allows the application to load previously programmed settings from a sensor into the application program for review, modification or saving to a file. Reading the channels from the sensor into the application will overwrite any current settings and parameters in the Color Recognition section of the display window.

9.3.12. SEND ALL COLORMAX CHANNELS

The Send All ColorMax Channels button sends all the settings and parameters for all channels to the sensor. This function is useful when recalling a saved file to re-programming the sensor.

9.4. CURRENT READING

The Current Reading section of the display shows current information received from the sensor. This allows the user to place samples in the viewing area of the sensor and observe the levels of the red, green

and blue components. The Current Reading display is useful in initial set-up for determining optimum sensor-to-target distance, sensor-target angle and relative reflected intensity of multiple samples prior to beginning the teaching sequence.

9.4.1. DISPLAY MODE

The Display Mode allows the user to select Color & Luminosity, resulting in a bar graph display of current reading, or Color only, resulting in a pie chart representation of current reading.

- *Color and luminosity*
The Color & Luminosity selection shows a bar graph of the red, green and blue components. The numeric value in the display boxes above the bar graph show the percent of full scale for each color component. Indicators on the chart show 20% and 80% of full scale.
- *Color only*
The Color only selection shows a pie chart of the red, green and blue components representing the proportion of each color component in the reflected signal. The numeric value in the display boxes above the bar graph show the proportion of each color component in the current reading.

9.4.2. RECOGNIZED COLORS

The Recognized Colors section shows the current status of the programmed color recognition channels and coincides with the current state of the discrete outputs. The number of color recognition channels is dependent on the ColorMax model. This section will automatically configure to display the appropriate number of channels. When a channel match occurs, the indicator will change to blue and the output state box will indicate either high or low as specified by the Match output selection for that channel. The ColorMax-1000-15HEX models provide four discrete signals in a binary format and as such, only one color recognition channel output may be active at a time.

10. PROGRAMMING COLOR RECOGNITION CHANNELS

To program ColorMax sensor to recognize user samples double-click on the ColorMax icon to open the Windows™ Application Program. The following description illustrates a typical set-up of the Color Recognition Channels. Some of the settings suggested may be adjusted based on the specific requirements of a particular application.

1. Acquire samples of all colors that will be programmed into the color recognition channels. For optimum operation select a target distance that is best suited for the range of colors being detected. When using shiny/glossy targets, set the sensor on a 20° to 25° angle to prevent direct reflection.
2. Set sensor averaging to a lower value, 1, 2, 4 or 8 for higher speed applications or 16, 32 or 64 for higher precision applications.
3. Select the appropriate mode; free run, level or edge triggered depending on the application requirements.
4. Set the illumination level to 100%.
5. Press the Send ColorMax Settings button to send the settings to the sensor.
6. To determine which sample provides the highest signal level, place the sample that appears to be the lightest in the sensor field of view.

7. Observe the signal level for each color component. Generally, best results are achieved by setting the sensor-to-target distance to obtain a signal level near 80% as indicated in the Current Reading frame in the Application window. Check the remaining samples to verify that the signal levels for each of the color components are below the full scale, 100%, level.
8. If the required sensor-to-target distance is such that the lightest sample, with the highest signal level, saturates one or more color channels, it is necessary to reduce the illumination setting. In the Sensor Settings frame, lower the illumination and press the Send ColorMax Settings button. Repeat this adjustment until the color levels are near 80% as indicated in the Current Reading frame. Note that any change in the illumination setting after teaching of one or more Color Recognition Channels may require re-teaching of these channels for reliable operation.
9. Once the sensor-to-target distance and illumination level have been established the Color Recognition channels may be programmed.
 - Select a channel in the Channel pull-down list.
 - Select the Recognition Mode, Color & Luminosity or Color Only.
 - Select the Recognition Enabled check box.
 - Set the tolerance levels for each color component in text box below each color value. Generally, a tolerance of 5% to 10% is suitable for color recognition when the target colors are visually different. In cases where the colors are very similar, it may be necessary to use lower tolerance settings.
 - Select the Match output to be high or low.
10. Place the target in the sensor field of view and press the Teach ColorMax Channel button. The sensor will determine the RGB for the samples and store them for the selected channel.
11. Repeat this process with each of the samples, selecting a different Color Recognition Channel for each. Once all of the samples have been programmed into a channel, place each sample, one at a time in the sensors field of view and verify that the correct channel indicates a match while the other channels do not indicate a match.

11. SENSOR DATA TRANSMISSION AND DATA LOGGING

This section applies to ColorMax FLEX models only

The ColorMax FLEX models provide two methods collecting readings from the sensor, via the serial port, to external devices.

11.1. USING THE EXTERNAL TRIGGER TO TRANSMIT DATA

First, the sensor can be set to transmit a reading, or series of readings, under control of the External Trigger input line. The Application program is used to activate this feature. To utilize this feature, the Edge or Level trigger mode is selected in the Sensor Settings window (refer to section 9.1.2 Triggering for further information). When the external triggering function is used on a ColorMax FLEX model, the sensor will transmit a set of readings via the serial port when the External Trigger input is active (refer to section 12.1.3 External Triggering for description of hardware operation). If the sensor is set for edge trigger, one set of readings will be transmitted with each high to low transition of the External Trigger input. If the sensor is set for level trigger, readings will be transmitted continuously while the External Trigger input line is low.

NOTE: When using the Application program, always disable the external triggering by placing it high (V+).

ASCII data may be acquired using a terminal program on a PC. The COM port settings are 9600 BAUD, 7 data bits, even parity, 1 stop bit, and flow control is set to none. The maximum data rate is approximately 40 measurements per second.

DATA FORMAT: !d,aaaa,bbbb,cccc,d
 !d = command acknowledgement
 a = Red reading, % full-scale (Hexadecimal value)
 b = Green reading, % full-scale (Hexadecimal value)
 c = Blue reading, % full-scale (Hexadecimal value)
 d = recognized color(s) (0-based bitmapped)

EXAMPLE:
!d,9FB5,8F41,90EF,05

CONVERSION OF HEXADECIMAL VALUE TO % FULL SCALE VALUE

| | | | |
|--------------|--------|--------|--------|
| Hexadecimal | 9FB5 | 8F41 | 90EF |
| Decimal | 40885 | 36673 | 37103 |
| % full scale | 40.885 | 36.673 | 37.103 |

RECOGNIZED COLOR(S)

| ASCII Characters | DB7 | DB6 | DB5 | DB4 | DB3 | DB2 | DB1 | DB0 |
|------------------|-----|-----|-----|-----|-----|-----|-----|-----|
| 00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 05 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| 23 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 |

NOTE: 1 indicates recognized color
 0 indicated unrecognized color

11.2. USING DATA LOGGING IN THE APPLICATION PROGRAM

Second, a data-logging feature is provided allowing readings to be saved to a CSV (comma-separated-variable) file for further analysis. Each set of readings is time/date stamped. Set-up and control of the data logging is performed under control of the Applications program. Communications with the sensor via the Application program occurs 3 - 4 times per second.

Data log format: 9:10:58,39.6,36.7,37.7,1
 Time stamp, red % full-scale, green % full-scale, blue % full-scale, recognized color
 recognized color(s) (0-based bitmapped) (refer to table in section 11.1)

1. Select the OPTIONS menu item and then select DATA LOGGING, SETTINGS.
2. Select one of the following modes:

CONTINUOUS LOGGING

Logs data to the file continuously at a rate of 3 - 4 readings per second.

LOG ON MATCH

Logs data to the file when a channel match occurs. One or more channels may match.

LOG ON INTERVAL

Logs data to the file at the specified interval.

3. Select the filename and file location.

4. Select OPTIONS, DATA LOGGING, START to begin logging data to a file. A message at the bottom of the Application screen indicates logging is in process.
5. Select OPTIONS, DATA LOGGING, STOP to terminate logging.

The log file may be opened in a text editor or spreadsheet for further analysis. A sample log file is shown below:

| | | | | |
|---------|------|------|------|---|
| 9:10:58 | 39.6 | 36.7 | 37.7 | 1 |
| 9:11:21 | 37.4 | 34.6 | 35.1 | 1 |
| 9:11:25 | 39.6 | 36.6 | 37.5 | 1 |
| 9:11:29 | 39.5 | 36.6 | 37.6 | 1 |
| 9:11:30 | 39.4 | 36.5 | 37.5 | 1 |
| 9:11:33 | 39.8 | 36.8 | 37.9 | 1 |

12. INPUT/OUTPUT SIGNAL DESCRIPTIONS

12.1. DISCRETE OUTPUTS

The discrete output(s) are a PNP/NPN configuration allowing the user to provide a load on this output that is either pulled high to sensor V+ or low to ground. This output is typically connected to a PLC. The output remains active as long as the target meets the criteria for a color match. In high-speed applications it may be useful to use the Minimum Output Duration feature to lengthen the signal duration to meet acquisition requirements of the PLC.

12.2. ANALOG OUTPUTS

ColorMax provides an analog output signal for each color component (red, blue, green). The analog outputs are 0-5V with 5mV resolution (10-bit). Any standard analog input channels typically available on a PLC may monitor these outputs. The analog output signals are useful in applications where simply detecting a color match is insufficient. For example, constant real-time monitoring of individual red, green and blue color components in process allows minor fluctuations or trends to be detected permitting corrective action to be taken prior to parts not meeting the color criteria.

12.3. EXTERNAL TRIGGER

The triggering options include Free Run, Level and Edge. Level and Edge triggering require the use of the External Trigger input on the sensor I/O connector. Applying sensor supply voltage, 12-30VDC, not exceeding the sensor supply voltage, de-activates the External Trigger input. When Level is selected, and the External Trigger input is active (open-0V), the sensor will continuously check for a color match and update the discrete outputs until the Trigger input is deactivated (returns to sensor supply voltage). The discrete outputs will remain in the state that they are in when the Trigger input is deactivated. When Edge is selected, the sensor will check for a color match on the each falling edge of the External Trigger input and update the discrete outputs. The discrete outputs will remain in the state that they are in when the Trigger input is deactivated and remain in that state until the next trigger event.

The External Trigger input is generally used when a separate proximity sensor detects the presence of a sample and signals the sensor to check with the pre-programmed color recognition channels to determine whether there is a match. Alternatively, the sensor can be operated in the Free Run mode, and a separate proximity sensor can be connected to the data acquisition system or PLC indicating a sample is present and the sensor's discrete output is valid.

ColorMax CM1000-FLEX models provide a feature that allows the External Trigger input to initiate the transmission of a reading or series of readings via the sensor's serial interface (refer to section 9.1.2 Triggering and section 11 Sensor Data Transmission and Data Logging for further information).

13. APPLICATION NOTES

SENSOR RANGE

Range is dependent on target color(s). Darker colors absorb more light and consequently return less signal than lighter colors, therefore, may require shorter sensor-to-target distance.

SPOT SIZE

In most applications, the target color should be contained within the illuminated area. For example, a target that is only partially in the illuminated area will cause the sensor to include color signal from the surrounding area, which may affect the ability to reliably recognize the target color. The spot size is generally dependant on the application. The advantage of a larger spot is that the measurement is averaged over a larger area, allowing the sensor to ignore slight variations. For example, a textured surface such as carpet or a multi-colored object that does not have a uniform color should be viewed over a larger area to minimize variations in readings. A smaller spot size is necessary in applications where the target is relatively small, such as a registration mark, a pill or other small object. Best results are achieved when the target color is completely within the illuminated area.

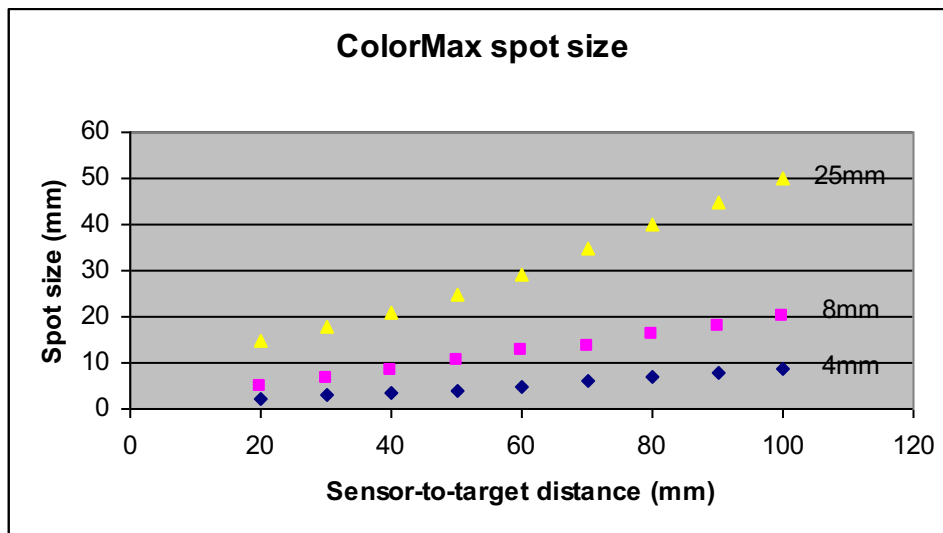
GLOSSY SAMPLES

When sensing color variations on shiny, glossy, highly reflective surfaces, it is recommended that the sensor be positioned at a 15-20° from perpendicular to the sample surface. This is helpful in avoiding direct reflection of the sensor light source back into the sensor lens.

TOLERANCE SETTINGS

When signal levels are low (ex. Dark colors), low tolerance settings in the range of .5 to 5% will result in very high detection sensitivity. Small variation in color may result in a sample not meeting the color recognition criteria. Generally, at low signal levels, relaxing the tolerance results in more reliable operation. For applications that require tight tolerance settings (<2%), allow the sensor to warm-up for 30 minutes prior to use.

ColorMax SPOT SIZE CHART



ORDERING INFORMATION

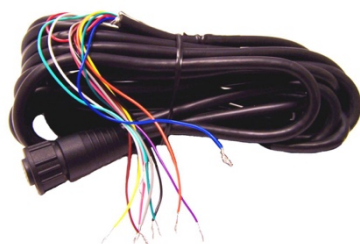
| | |
|----------------|--|
| CM1000-1-4 | Color sensor, one discrete output, 4mm spot |
| CM1000-4-4 | Color sensor, four discrete outputs, 4mm spot |
| CM1000-7-4 | Color sensor, seven discrete outputs, 4mm spot |
| CM1000-15HEX4 | Color sensor, fifteen encoded discrete outputs, 4mm spot |
| CM1000-4-RGB4 | Color sensor, four discrete outputs, RGB outputs, 4mm spot |
| CM1000-FLEX4 | Color sensor, four discrete outputs, RGB outputs, data transmission, 4mm spot |
| | |
| CM1000-1-8 | Color sensor, one discrete output, 8mm spot |
| CM1000-4-8 | Color sensor, four discrete outputs, 8mm spot |
| CM1000-7-8 | Color sensor, seven discrete outputs, 8mm spot |
| CM1000-15HEX8 | Color sensor, fifteen encoded discrete outputs, 8mm spot |
| CM1000-4-RGB8 | Color sensor, four discrete outputs, RGB outputs, 8mm spot |
| CM1000-FLEX8 | Color sensor, four discrete outputs, RGB outputs, data transmission, 8mm spot |
| | |
| CM1000-7-25 | Color sensor, seven discrete outputs, 25mm spot |
| CM1000-15HEX25 | Color sensor, fifteen encoded discrete outputs, 25mm spot |
| CM1000-4-RGB25 | Color sensor, four discrete outputs, RGB outputs, 25mm spot |
| CM1000-FLEX25 | Color sensor, four discrete outputs, RGB outputs, data transmission, 25mm spot |

ACCESSORIES

ColorMax ACCESSORIES

CM1000-KIT2 includes the following parts:

| | |
|---------------|--|
| M12-12-5 | Interface cable assembly, 12 conductor |
| 80-M30X1.5HEX | Jam nut, M30 x 1.5 mm hex |
| CM1000-I/O2 | ColorMax I/O board, terminals, status LEDs |
| M30-SS-BRKT | Mounting bracket, stainless steel |
| 240-56857 | Power supply, 12 V @ 300 mA |
| 15-046-0003 | Adapter, RJ-11 to DB9-M |
| 32-1024 | USB cable |
| 32-H1642-07 | Phone cord, RJ-11 |



Interface cable assembly, 12 conductor



Jam nut, M30 x 1.5 mm hex



Mounting bracket, stainless steel



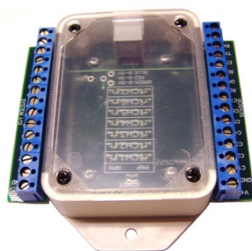
Power supply, 12 V @ 300 mA



Adapter, RJ-11 to DB9-M



Phone cord, RJ-11



ColorMax I/O board



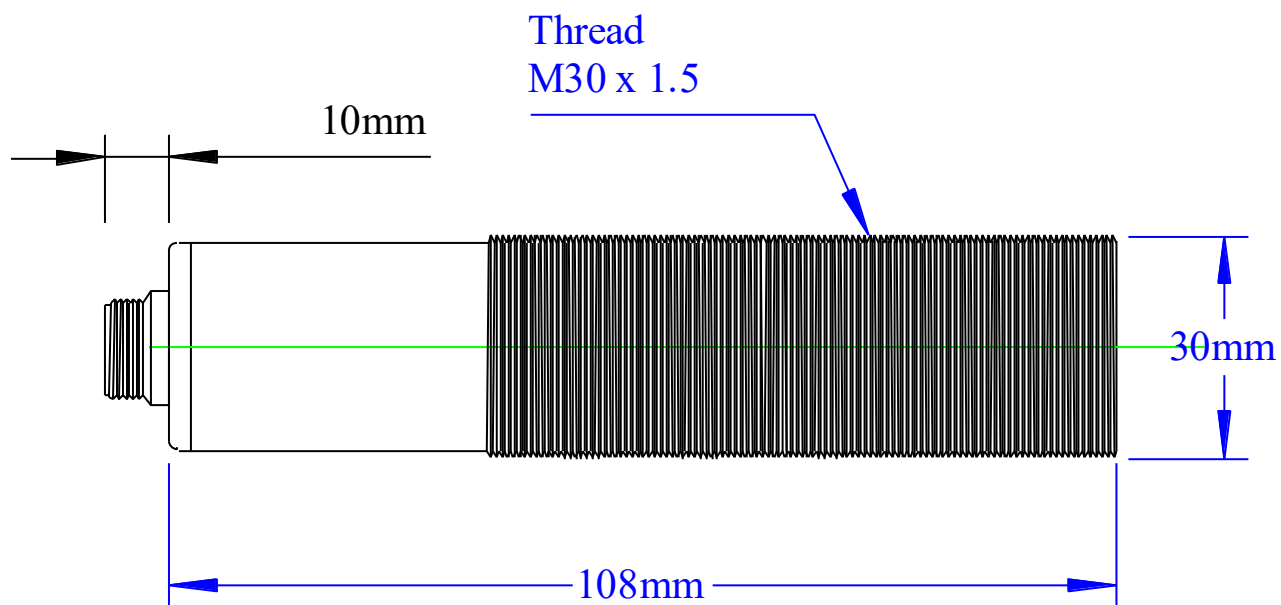
USB cable

CERTIFICATIONS: CE, CSA, ETL



Electrical Equipment for Measurement, Control and Laboratory
Conforms to – ANSI/UL STD: 61010-1
Certified to CAN/CSA STD: C22.2 No. 61010-1

ColorMax CASE DIMENSIONAL OUTLINE



EMX Industries Incorporated warrants all products to be free of defects in materials and workmanship for a period of two years under normal use and service from the date of sale to our customer. This warranty does not cover normal wear and tear, abuse, misuse, overloading, altered products, damage caused by incorrect connections, lightning damage, or use other than intended design.

There is no warranty of merchantability. There are no warranties expressed or implied or any affirmation of fact or representation except as set forth herein.

EMX Industries Inc. sole responsibility and liability, and the purchaser's exclusive remedy shall be limited to the repair or replacement at EMX Industries option of a part or parts found not conforming to the warranty. In no event shall EMX Industries Inc. be liable for damages, including but not limited to damages resulting from non-conformity, defect in material or workmanship.

Effective date: January 1st, 2002





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