CS64A
Color Sensors

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(Address updated)

Contents

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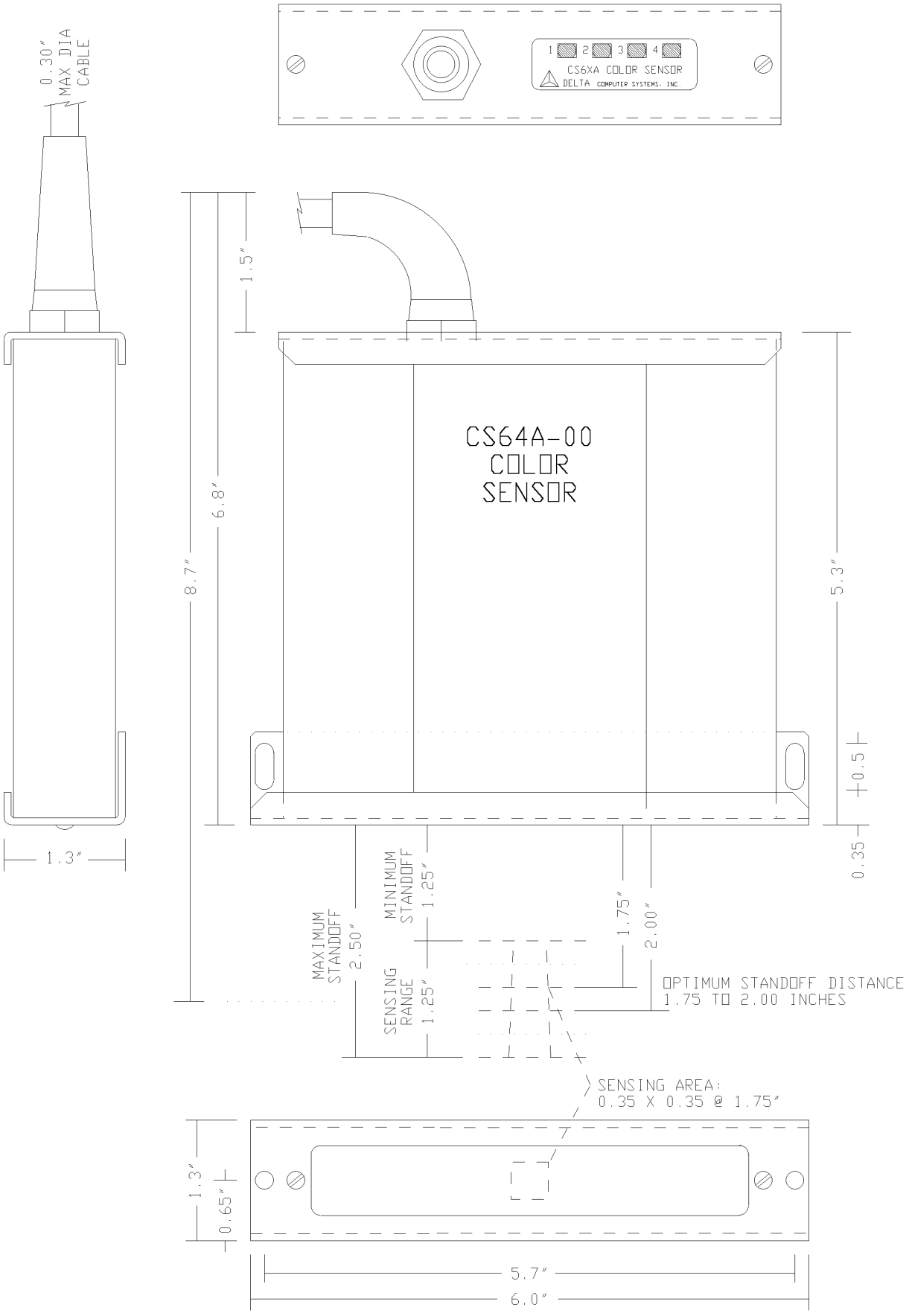

0.30″
MAX DIA
CABLE
1 2 3 4
CS6XA COLOR SENSOR
DELTA COMPUTER SYSTEMS, INC.
1.5″
8.7″
6.8″
CS64A-00
COLOR
SENSOR
5.3″
0.5
0.35
1.3″
MAXIMUM
STANDOFF
2.50″
MINIMUM
STANDOFF
1.25″
SENSING
RANGE
1.25″
1.75″
2.00″
OPTIMUM STANDOFF DISTANCE
1.75 TO 2.00 INCHES
SENSING AREA:
0.35 X 0.35 @ 1.75″
1.3″
0.65″
5.7″
6.0″

1. Specifications

Model	CS64A-00	CS64A-02	CS64A-04-BNR
Sensor-to-Object Standoff Distance	1.75 to 2.0" *(45-50mm)* optimum	4.75 to 5.0" *(120-125mm)* optimum	3.75 to 4.0" *(95-100mm)* optimum
Sensor-to-Object Sensing Range	1.25" *(32mm)*: 1.25 to 2.5" sensor-to-object	1.25" *(32mm)*: 4.25 to 5.0 sensor-to-object	2.75" *(70mm)*: 3.0 to 5.75 sensor-to-object
Sensing Area	0.35" *(9mm)* square @ 1.75" *(45mm)*	0.7" *(18mm)* square @ 4.75" *(120mm)*	0.48" *(12mm)* square @ 3.75" *(95mm)*
Response Time	62us to read all 4 colors		47us to read all 3 colors
Output Update Rate	< 1 millisecond		
Analog Outputs	Four, 0 to 10V at 5mA max		Three, 0-10V, 5mA max
Color 1	470nm Blue		470nm Blue
Color 2	880nm Near-Infrared		880nm Near-Infrared
Color 3	660nm Red		660nm Red
Color 4	570nm Green		N/A
Calibration	9.5V and 100% ratios (Red/NIR, Blue/NIR, and Green/NIR) with >99% diffuse reflection		9.5V and 100% ratios (Red/NIR, Blue/NIR)
At Standoff Distance	1.75" *(45mm)*	4.75" *(120mm)*	3.75" *(95mm)*
Ratio Variation with Sensing Distance	0.6% max per 0.25" *(6mm)* change in sensor-to-object distance (<2% max over sensing range)		
Temperature Stability	Ratios 0.1%/C typical		
Supply Voltage	+24VDC ±5%		
Current Consumption	100mA maximum		
Enclosure	Dust tight; 6.0 x 5.3 x 1.3" *(153 x 135 x 33mm)* excluding strain relief;1.25 lb *(2.75 kg)*		
Environment	+10 to +40C operating; -25 to +85C storage; 0 to 90% humidity, non-condensing		

1.1 Ordering Information

CS64A-00 1.75 to 2.0 inch *(45 to 50mm)* nominal standoff distance

CS64A-02 4.75 to 5.0 inch *(120 to 125mm)* nominal standoff distance

CS64A-04-BNR 3.00 to 5.75 inch *(75 to 145mm)* working distance, Blue, NIR, and Red

Other color sensors are available with standoff distances to 6", update rates to 50 microseconds as well as other color combinations and options. Contact Delta or your local Delta color sensor distributor for more information, or visit our web page at www.deltacompsys.com.

6/27/2001 DELTA Computer Systems, Inc. (360) 254-8688

Introduction

The CS64A color sensor contains a light generation system to illuminate the object to be sensed, and a light receiving system to read the diffuse reflected light from the object.

The light generation system consists of four sets of light emitting diode (LED) light sources—a total of 28 LEDs. The CS64A determines color by turning on just one set of LEDs (one color) at a time and analyzing the light captured by it's precision silicon photodiode.

The CS64A color sensor reads four different wavelengths--Blue, Near-infrared (NIR), Red, and Green. Reflected energy in each of the color ranges appears as a 0-10V signal on the corresponding four analog outputs, making the CS64A compatible with any PLC, PC, or system having 0-10V analog inputs.

Using the ratios of Red/NIR, Blue/NIR and Green/NIR, it is possible to distinguish between a wide range of colors. Very similar colors typically have a 10% difference in at least one ratio, while some colors may have ratio differences 70% or more.

The CS64A was developed specifically for on-line color sensing applications, including:

- Distinguish between objects to ensure the correct color object is being processed on your automated production line, such as vehicle headliners, door and body panels, and seats
- Sort objects by color
- Monitor color variations of materials during manufacture such as carpets and ceramic tile
- Detect presence of metal coatings or wood varnish
- Monitor color quality of granular foods such as sugar
- Detect paint marks where bar coding is impractical
- Detect over- or under-cooked baked goods

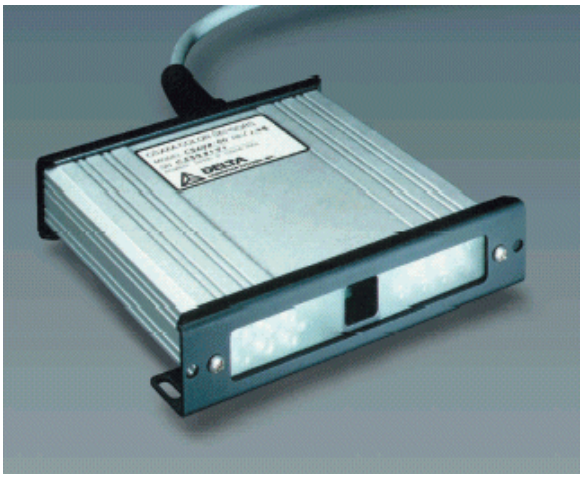
The diffuse LED lighting and large sensing area make the CS64A relatively immune to material grain direction and similar variations. The CS64A-00's long standoff distance of 1.75 to 2" and sensor-to-target distance variation tolerance of 1.25 to 2.5" are important benefits in many applications as well. The CS64A-02 has an extended standoff distance of 4.75-5.00" while the CS64A-04-BNR has a very wide working range of 2.75" (3.00 to 5.75" sensor-to-object).

Each of the CS64A's four 0-10V analog outputs has an adjustment potentiometer and an indicator LED. The indicator LEDs come on when the output reaches about 2 volts and the indicator LED intensity increase with amplitude.

The high-intensity LEDs in the CS64A's lighting system have a typical life of 100,000 hours. (Actual intensity is 64 times higher than it appears since the LEDs are pulsed at a low duty cycle).

The intensity of all LEDs varies with temperature due to the properties of the semiconductor materials used. The CS64A sensors use feedback circuitry to maintain amplitudes over a wide range of temperature and to compensate for light loss due to normal LED aging. This feedback along with the long life of the LEDs, greatly reduces the need for recalibration.

1.2 Primary Features



- Superior color detection on a wide range of materials
- Versatile analog outputs allow unlimited sorting and show data trends
- Long sensing range and standoff distance
- Four color ranges are sensed—from blue to near-infrared
- Near-infrared differentiates between materials such as leather, vinyl, and cloth
- Robust LED lighting system—no light bulbs to burn out
- Feedback compensation for LED aging
- Fast, one millisecond update rate

For more information on Delta's growing lines of color sensors, motion controllers, and other industrial products, visit our web site at:

www.deltacompsys.com

2. Mounting the CS64A

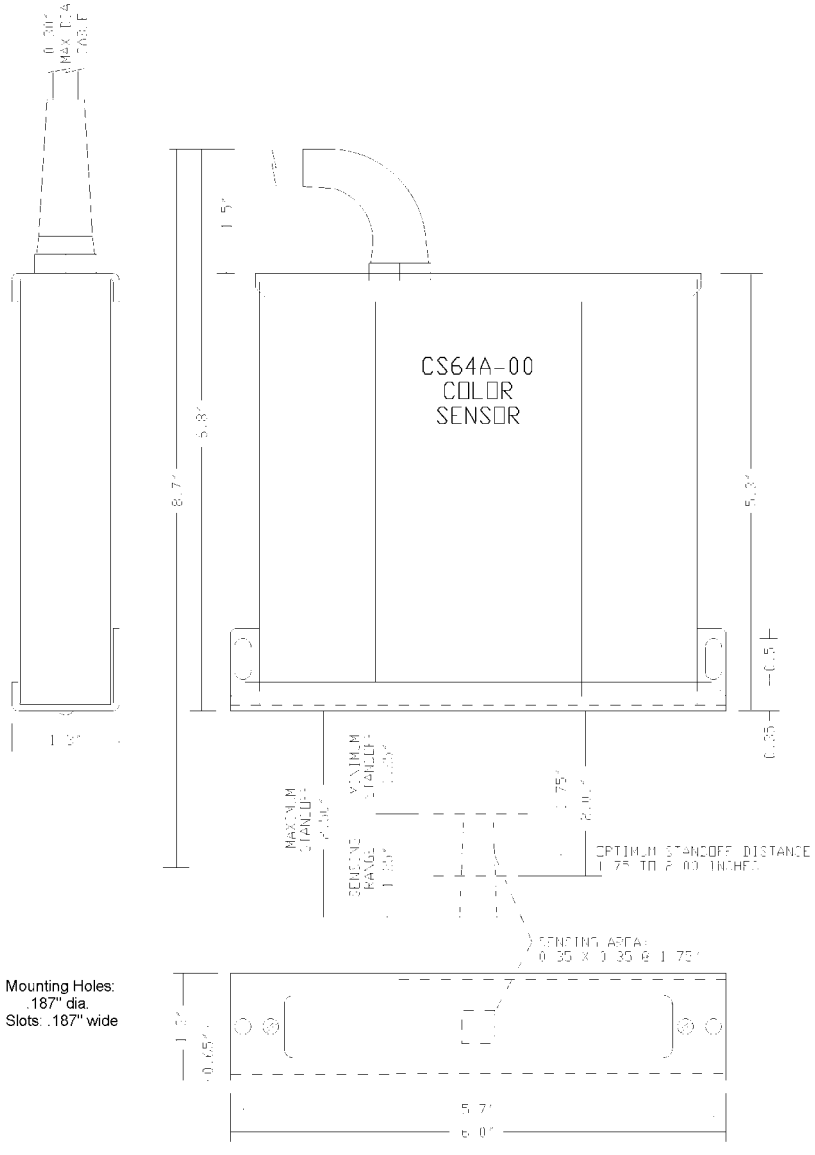
In general, the sensing area should be as dark as possible (especially if small differences in color are to be detected). Any light that is in the sensing area that is not generated by the CS64A is a source of error. The Blue and Green colors are more sensitive to extraneous light than are the Red and NIR colors since these LEDs are less intense.

Small amounts of constant light can sometimes be tolerated, but bright pulsing lights (such as fluorescent) and sunlight should never be allowed to shine into the sensing area. Direct sunlight can also cause overheating (or damage if it shines through the lens).

The CS64A-00 should be mounted such that the bottom is 1.75 to 2 inches from the average target object position. The sensing range will be +-1/2 inch allowing for sensor to object movement. (See Specifications for standoff and range for other models).

The CS64A's lighting system is much more intense than it appears because of the low duty cycle of its light emitting diodes (LEDs). However, in most applications it is desirable to keep extraneous light out of the sensing area. This area includes not only the area that is directly read by the sensor (0.35" square for the CS64A-00), but also the immediate surrounding surfaces since light will reflect into the direct sensing area. The optimum type of light block depends on the application and the environment.

If it is possible that the CS64A could be bumped hard enough to cause damage, it should be mounted such that it is protected. To minimize electrical noise, the CS64A enclosure should be grounded.



If the sensor is used in a wet or corrosive area, order the OEM package. This package allows the CS64A to be mounted inside a NEMA 4X enclosure. For convenience, a window kit is also available.

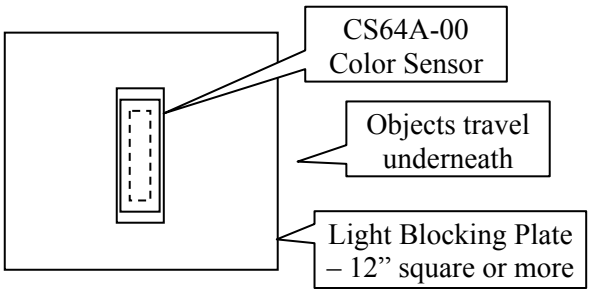
2.1 Moving Line Applications

In cases where the product moves under the sensor as on an assembly line, it is usually important not to overly restrict headroom (distance from sensor to the target object).

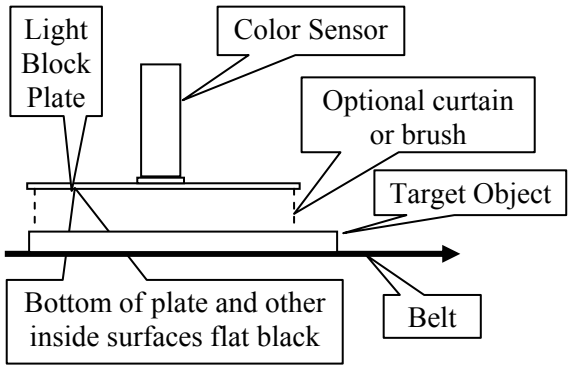
2.1.1 Adequate space and moderate light levels (normal factory lighting, no direct sunlight)

It is usually adequate to use a plate mounted above the line at a distance approximately equal to the sensor standoff distance (~2" for the CS64A-00). This plate should be 12" square or more with the CS64A mounted in the center. The bottom side of the plate should be painted with a good quality optically flat black paint such as Krylon 1602 Ultra Flat Black. This plate will prevent extraneous light from being reflected into the sensing area.

Top View: CS64A with Light Block Plate



Side View: CS64A with Light Block Plate



2.1.2 Limited space and high or varying light levels

If there is not enough room for a large flat plate, or if a usable size plate is inadequate, a curtain or brush can be used to block additional light. Ideally, a plate of the largest practical dimensions would still be used, with the curtains or brushes mounted on the edges. The bottom edge should just clear the normal travel of the objects. The curtains and brushes should be of dark materials. If the curtain or brush is close to the direct sensing area (within 2"), it should be tested to make sure that it does not reflect in the visible or near-infrared regions (see manual for information on how to test with the CS64A).

2.2 Fixed Applications

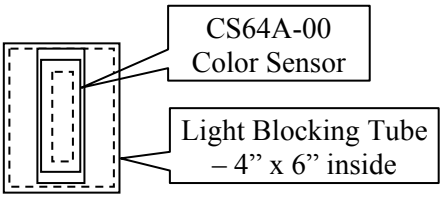
In cases where the product is clamped into a fixture, sensor-to-target distance restrictions are usually less important.

2.2.1 Fixed applications with very tight control of sensor-to-target distances

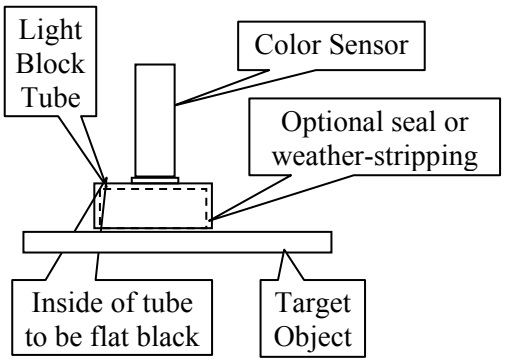
In these applications, a rectangular tube of an inflexible material such as sheet metal can be used between the sensor and object. If necessary, weather-stripping can be used on the bottom edge to completely block out light without marring the objects. Again, it is preferable that the tube be as large as practical (ID: 4" x 6" or more) to minimize internal reflections and that the interior painted optically flat black. If space is very limited, the

inside dimensions of the rectangular could be a small as 3/4" by 4", although 1" x 4 ½" would be preferable. Flat black surfaces are especially important with these smaller inside dimensions.

Top View: CS64A with Light Block Tube



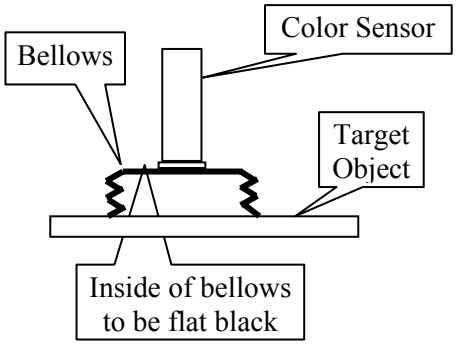
Side View: CS64A with Light Block Tube



2.2.2 Fixed applications where it is necessary to accommodate variations in sensor-to-target distances

In some applications, the standoff distance will vary, if not during the normal sensing time, then during loading or unloading of the objects. In these applications the tube must be of a very flexible material. A brush can be used, as can deep weather-stripping or a bellows for maximum accommodation.

Side View: CS64A with Bellows



As with rigid tubes, it is preferable that the bellows be as large as practical (ID: 4" x 6") to minimize internal reflections. The inside of the bellows should be optically flat black. It is not always practical to paint flexible devices, so it is important to ensure that the material itself is black. Flat or matte finishes are preferable over gloss finishes, especially in bellows with small inside dimensions.

If space allows, flexible polyurethane bellows are available from McMaster-Carr with inside dimensions of 6 5/8" square or 4" square. (Outside dimensions are 8 5/8" and 6", respectively). McMaster-Carr also carries a wide variety of brushes and vinyl weather-stripping, door gaskets, and rubber wear strips.

3. Wiring the CS64A

The CS64A requires a 24Vdc power source capable of supplying 100mA. It should be a linear power supply and not be used to supply other loads. A 250mA fast blow fuse should be used between the power supply and the sensor.

The power supply voltage must be maintained within 5% (22.8 to 25.2V) at the sensor. A P6KE30A Transzorb protects against overvoltage and reverse voltage. This device limits the working voltage to a maximum of 25.6 volts. On the other hand, voltages below 5% may cause the light intensity to be reduced and calibration to be lost.

Delta recommends connecting the CS64A's 24V power supply common to the CS64A's enclosure (as shipped), so the power supply should be isolated and not connected to ground at any other point.

A five pair, shielded, 0.3" max OD cable, (Alpha 5475C or Consolidated 5775) will fit the CS64A strain relief and will be adequate for most environments up to about 20 feet. For longer distances or noisy environments, heavier gauge wire and better shielding may be required.

The analog output wire pairs should be connected to differential inputs for best noise performance.

The CS64A uses 45 degree terminal blocks that are accessed by removing the top cover. Insert the cable through the strain relief before connecting to the terminal blocks.

Block	Terminal	Signal
TB1	+24	Power Supply Positive
TB1	CMN	Circuit Common (PS and Outputs)
TB1	CMN	Circuit Common (PS and Outputs)
TB1	GND	Enclosure Ground*
TB2	1	Blue: Color 1 Output
TB2	2	NIR: Color 2 Output
TB2	3	Red: Color 3 Output
TB2	4	Green: Color 4 Output

**The CS64A is shipped with a jumper wire between the GND and CMN terminals, connecting the circuit common to enclosure ground. This is the recommended grounding for lowest electrical noise. To isolate the circuit common from ground, remove this jumper.*

4. Adjustment

The CS64A-00 is factory calibrated to read Spectralon as 9.50V on all four colors (100% ratios) at 1.75” standoff. (Refer to specification table for standoff distance for other models). Spectralon has >99% reflectance over the visible/NIR spectrum. (The 9.50V setting ensures that the outputs do not exceed 10V over the full sensing range). You can either maintain this calibration or match the calibration to your application.

In any case, you should define a calibration standard using either a white calibration standard material or the lightest material that the sensor will see. Make the calibration piece large (preferably about 4” square) for ease of alignment. The calibration material must be opaque in the visible and NIR ranges. If this is not possible, bond a piece of opaque material (e.g. flat black aluminum plate) to the reverse side of the calibration piece.

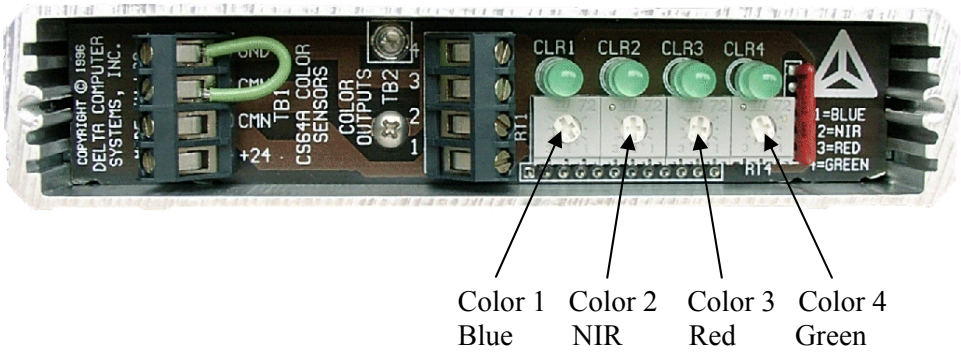
Either adjust to specified values using the standard or record the factory values for future reference. Refer to Section 7 for recalibration period recommendations.

Tip: If you decide to establish your own calibration standard, you should do so before setting up ratio thresholds for your application. Otherwise, if you change the relative amplitudes of the CS64A color outputs, you will need to change your ratio thresholds as well.

For best results, adjust the gain with the CS64A at normal operating temperature and in a normal mounting position, etc. Let it warm up for 15 minutes or more.

To calibrate the CS64A, place your calibration material under the sensor at the normal standoff distance (1.75" for CS64A-00) and adjust for each output to read 8.5 volts (9.0 volts for very white material).

If possible, for maximum convenience, adjust the gains in software, or in the analog circuitry to which the CS64A is connected, rather than using the pots inside the CS64A. If you choose to use the pots in the CS64A, they are located as shown below.



5. Sample Quick Test

You can do a quick test using the CS64A simply by wiring the +24V power, placing the samples one at a time at the standoff distance (1.75 to 2 inches from the bottom of the CS64A-00), recording the analog readings, and calculating the ratios on a calculator:

	Measure					Calculate		
	Sample	NIR	Red	Green	Blue	Red/NIR	Grn/NIR	Blu/NIR
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								

Differences in the Red/NIR, Green/NIR and Blue/NIR ratios are used to differentiate between colors.

Usually, the amplitudes cannot be used directly since they vary with distance, dirt, etc.

Occasionally, it is necessary to use the NIR amplitude to differentiate between shades of the same color (light and dark gray, for example). If the NIR amplitude is used, be sure that:

1. The sensor to target distance is tightly controlled,
2. The sensor window is kept clean and/or
3. There is sufficient variation in the NIR amplitude—10% is usually adequate for very clean and controlled conditions, while more difference will allow for more distance variation.

6. Threshold Setting

To differentiate between colors, set up thresholds on the Red/NIR, Green/NIR, and Blue/NIR ratios.

If a sample is different from every other sample in one of the ratios, a set of thresholds (upper and lower) on that ratio can sort that color from all of the others.

Since the Red and NIR colors are the strongest, it is often advantageous to use the Red/NIR to sort as many of the samples as possible, setting secondary thresholds on the Blue/NIR and Green/NIR ratios as needed to sort the remaining samples. You may not need to use all of the ratios, often one or two will be enough for a given set of samples.

The larger the ratio difference between samples, the better the system will work. The minimum difference required for reliable operation depends on the variability of the colors, the presentation, and the ambient conditions. The presentation of the samples includes variations in the distance from the CS64A to the samples, the angle of the samples, etc. Ambient conditions include extraneous light, temperature, etc.

Generally a ratio difference of 10% or more will provide good result. If there is a ratio difference in more than one ratio, the differences can be combined before checking against thresholds.

As explained in the previous section, the amplitudes typically cannot be used directly since they vary with distance, dirt, etc.

Sometimes, however, it is necessary to use thresholds on the NIR amplitude to differentiate between shades of the same color. If the NIR amplitude is used:

1. The sensor to target distance must be constant,
2. The sensor window must be kept clean and/or
3. There must be sufficient variation in the NIR amplitude.

For very clean and controlled conditions, a 10% difference in the NIR amplitude may be adequate, while more difference will allow for more distance variation and more dirt buildup on the sensor window.

Of course, in your program, you will want to make the thresholds variables so they can be adjusted if required.

7. Characteristics

7.1 Temperature

The feedback circuitry automatically compensates for the normal LED intensity variation with temperature yielding a typical stability of 0.1%/C for the Red/NIR, Blue/NIR, and Green/NIR ratios (0.3%/C maximum). In the most critical applications, the CS64A should be maintained at a constant temperature since the LED color varies slightly with temperature.

7.2 Edge Effects

The CS64A-00 sees an area of about 0.35 x 0.35 inches. When material is entering or leaving the sensing area, the color can appear wrong for a variety of static and dynamic conditions. For best results, read the analog outputs and compute the color only when the CS64A sees the intended material over the entire viewing area.

7.3 Angle of CS64A to Material

The most consistent readings are obtained if the material is perpendicular to the CS64A in both planes. If angle differences cannot be avoided, it is preferable to have the angle the narrow way and the standoff at the longer end of the recommended range (2 inches for CS64A-00). In some cases when dealing with shiny materials, angling the sensor slightly with respect to the target may produce more consistent readings. Concave surfaces should be avoided if possible.

7.4 Distance Performance

The amplitudes of the signals reach the maximum value close to the CS64A (about 1.5" for CS64A-00) and then decrease with distance. The ratios of Red/NIR, Green/NIR and Blue/NIR are adjusted to be constant within the specified tolerance over the specified working range of the sensor. As the sample is moved further from the CS64A, the ratios will gradually become less consistent. This effect, along with the decrease in signal amplitude, limits the usable range of the CS64A. In applications where the differences in samples are large, the CS64A-00 may work well out to 3" or more.

7.5 General Information

The term "color" actually implies visible light--wavelengths from about 400nm (violet) to about 750nm (deep red), although in this document any wavelength that can be seen by the CS64A is referred to as a color.

With high intensity blue LEDs (450nm) and several visible wavelengths up to 700nm available, DELTA's sensors can be made to see practically the entire visible color spectrum. But the capability does not stop there; the precision photodiode in the sensors can see into the near infrared up to about 1,000nm, and LEDs are readily available in this region as well.

NIR LEDs are used in the CS64A-00 and similar general purpose color sensors to provide a baseline value that is relatively constant for a given type of material regardless of color. This "divisor color" compensates for distance variations.

The NIR spectrum can be valuable in special applications. For example, the ratio of two different NIR colors can be used to detect certain types of glue, while ignoring visible color variations. Contact Delta for more information on these applications.

8. Recalibration

The LEDs have a typical operating life of 100,000 hours or about 10 years of continuous operation.

The intensity of LEDs varies with temperature and aging due to the properties of the semiconductor materials used. The CS64A sensors use feedback circuitry to maintain amplitudes over a wide range of temperature and to compensate for LED aging.

The automatic compensation will not eliminate 100% of the variation, so calibration should be checked regularly. The recalibration period depends on the application. In many cases, every three to six months or more may suffice, while in very critical applications, it may be necessary to check every week or every shift.

To check, place the calibration material in the sensing area at the typical sensing distance and monitor the outputs with a voltmeter or your data acquisition system.

Typically, if any change is needed, you will only need to change one or two gains slightly. (See Adjustments section for details). If other adjustments seem to be needed, make certain that you have the proper calibration material and the sensor window and sensing area are clean before adjusting.

Unless you are using narrow thresholds on the NIR amplitudes, we do not recommend readjusting all outputs to compensate for small variations in amplitude. Calculate the ratios, and adjust only to compensate for intensity degradations that affect the ratios.

If practical, we recommend that either a provision be made for adjusting the gains in software, or that gain adjustment capabilities be built into the analog circuitry to which the CS64A is connected. The gain adjust pots on the CS64A can be used if no other adjustment point is available.

9. Maintenance

Cleaning: Under normal conditions, the CS64A requires little or no maintenance other than keeping the window and sensing area clean. Use only water and cleaning materials compatible with polycarbonate, such as isopropyl alcohol.

In dusty conditions, an automated air nozzle can be used to help keep the window clean.

The ratio calculations will compensate for signal strength degradation down to about 75% of normal signal. Beyond that, performance will start to suffer. Once the window and viewing area are cleaned, the ratio calculations will automatically readjust to the clean conditions.

If the window becomes scratched or damaged, it should be replaced. Order from Delta: Part No: CS64A-Window.

10. Frequently Asked Questions

Q. How many different colors can the CS64A detect?

A. Unlike many color sensors, the CS64A does not limit the number of sorting outputs. The CS64A, when used with a host PLC or computer with math capabilities, can sort into virtually unlimited categories.

Q. What if my materials are textured?

A. The CS64A has been very successful in handling a variety of textured, grainy, and other difficult surfaces where other color sensors give inconsistent readings.

Q. Can the CS64A work with patterned materials?

A. The CS64A-00 reads the average color within its sensing area of approximately 9mm (0.35") square. If the pattern is smaller than this area, the CS64A-00 will provide consistent readings from the sample. For larger patterns, contact Delta for special CS64A versions with larger sensing areas.

Q. Can the CS64A distinguish between hues of the same color (e.g. light red and dark red)?

A. Yes, in most cases. If the colors are exactly the same hue, then all of the ratios (Red/NIR, Blue/NIR, and Green/NIR) will be the same, however the amplitude of the signals will vary. Generally it is best to use the NIR amplitude to differentiate between lighter and darker versions of the same colors sine the NIR is the strongest light and less susceptible to electrical and optical noise. The use of small differences in amplitudes requires consistent sensor-to-target distance and a reasonably clean environment.

Q. Is it true that the CS64A can distinguish between different materials of the same color?

A. It depends on the materials. For example, with carpet, vinyl and leather, the CS64A was able to separate all three colors in each material type, and also all of the material types from each other for a total of nine unique categories.

Q. What if I can't position the sensor close to the sample?

A. The CS64A-02 handles a sensor-to-object range of 110-125mm (4.25-5") standoff distance as compared to the 35-60mm (1.25-2.5") of the CS64A-00. If a wide variation in sensor-to-object distance is needed, the CS64A-04-BNR operates from 75-145mm (3-5.75").

Q. How can I verify that the CS64A will work with my samples?

A. Delta will test your samples for you and send a report showing the performance of the CS64A on your samples and recommendations for your application. There is no charge for this testing on new applications. Demonstration units are also available to qualified customers.

Q. What outputs are available from the CS64A?

A. The CS64A outputs four 0-10V analog voltages proportional to the diffuse reflected light in four color ranges: Red, Blue, Green, and Near-infrared (NIR). Special versions may have less than four outputs, and/or different color combinations. A 12-bit A-D converter has adequate resolution to handle these signals. In additional to allowing almost unlimited sorting, the analog outputs also allow color variation trends to be seen.

Q. How is sorting typically done?

A. In PLC sorting applications, the host system typically reads the four 0-10V signals and sets thresholds on the Red/NIR, Blue/NIR, Green/NIR ratios and NIR amplitude readings as needed. (Usually not all four are required in a given application). Using ratios compensates for most variations caused by sensor-to-target distance changes and dust on the sensor window.

Q. Does the CS64A require special lighting?

A. No additional lighting is required. The CS64A is completely self-contained with its own lighting system using high intensity light-emitting diodes (LEDs). No external light is needed and for maximum consistency, ambient light should be blocked from the sensing area.

Q. What are the power requirements for the CS64A?

A. The CS64A is rated for 24Vdc ±5% and 100mA maximum. Typical current draw is about 40mA. Although the power supply is not critical, for best noise performance a dedicated, linear supply is recommended. A dedicated supply also allows the circuit common and case ground to be connected inside the sensor, which often results in lowest electrical noise.

Q. Does the CS64A require any other inputs?

A. No. The CS64A "free-runs" and outputs are updated at a 1ms rate. Filtering minimizes glitches, so it is not necessary to synchronize the A-D to the sensor.

Q. Can I use the CS64A in a washdown environment?

A. The standard enclosure for the CS64A is dust-tight. For wet environments, any model of the CS64A can be ordered with a special package that allows it to be mounted into a sealed enclosure of your choice (specify –OEM at the end of the part number). An optional window kit is available as well.

Q. Does the CS64A have a color sensitivity specification (e.g. delta E (with CIELAB or CIEXYZ coordinates) that is common with spectrophotometers)?

A. Since on-line applications vary so widely, this specification would be of limited value. Instead, Delta will test your samples for you and send a report showing the performance of the CS64A on your samples and recommendations for your application. (No charge on new applications). Demo units are also available to qualified customers.

Q. How sensitive is the CS64A to changes in angle of the object?

A. The sensitivity to angles varies from very insensitive on matte surfaces to quite sensitive on gloss surfaces. This effect can be minimized with proper orientation of the sensor to the object. If possible, the varying angle should be oriented with the small dimension of the CS64A.

Q. How about curved surfaces?

A. Again, this is more critical on glossy surfaces and, if possible, the curve should be oriented with the small dimension of the CS64A. Concave, glossy surfaces should be avoided if possible as they can cause direct reflections.

Q. I would like to have the sensor “look” through a slot. What materials/paints would be good to look through?

A. Ideally, the inside surface of the slot should be optically flat black. In most cases, this can be easily achieved by painting with a high quality, flat black paint such as Krylon

1602 Ultra-flat black. Some materials and finishes may provide acceptable performance without painting. They may not be obvious, however black anodized aluminum reflects in the near-infrared spectrum, for example, and should not be used without painting. The CS64A can be used to test materials—look for very low readings on all four outputs. A slot is a good way to eliminate ambient light, and soft weather-stripping or brush can be used to seal the bottom if required.

Q. What is the minimum size that I can make the slot that the CS64A looks through?

A. If space is tight, you can reduce the slot to about 5/8 x 3 inches providing the sensor is centered well. A better solution might be to angle the sides of the hole so the dimension closest to the sensor is 3/4 by 3 1/2 inches and tapers down to about 1/2 x 2 inches.

Q. Can I use the CS64A pointing up?

A. The CS64A can be mounted in any orientation. With the sensor pointing up, it is important to watch dust build-up on the sensing window. Using ratios dramatically reduces the sensitivity to dust and other environmental factors.

Q. How often should the calibration be checked?

A. As with all similar instruments, the calibration of the CS64A should be checked periodically. The CS64A uses special compensation circuitry to greatly reduce the time and temperature drift inherent with the LEDs. The required frequency of recalibration depends on the required precision, and could be as often as once a week, or as infrequent as once a quarter or more. It is generally most convenient to do the calibration in software in the host system, in which case it can be highly automated if desired.

Q. Is it necessary to use a special material to verify calibration of the CS64A?

A. No. As explained in the CS64A manual, the user can use virtually any stable material as a calibration standard. The CS64A is factory calibrated to read Spectralon (>99% diffuse reflective over the visible and NIR range) as 9.50V volts at 1.75" standoff distance. If you wish to maintain the factory calibration, Spectralon is available from Labsphere (www.labshpere.com). They sell this material in a convenient 2" diameter disk: SRS-99-020 99% 2.38D x 0.60H. If you place this disk 1.75" from the bottom of the sensor, block out all ambient light, and adjust all four outputs to 9.5V, you will duplicate factory calibration. (You can adjust either at the sensor or through software).

Q. If a color sensor is disconnected and not used for a several months and then reconnected and powered will it require calibration?

A. It should not change significantly over time just sitting on the shelf if it is protected from dirt, etc. However, we would recommend recalibrating until it can be verified that it is not necessary in your application. Thanks to the feedback compensation, the CS64A stabilizes within a few minutes of powering on.

Q. I left a demo unit running overnight and am getting slightly different readings. Why is this?

A. Our demo units probably do not meet the specifications for temperature and time drift. On demo units, we verify basic functionality and recalibrate before shipping, but we do not check drift. Production units have low temperature and time drift. Although all LEDs experience intensity changes with both temperature and time, the CS64A uses special circuitry to dramatically reduce this variation. If all readings are going down, this could also be due to dust on the sensing window or an increase in distance from sensor to target material. Using ratios automatically compensate for these changes. Although any

color sensor will require periodic calibration checks, this can typically be done at widely spaced intervals with the CS64A. The drift of demo units is not representative of the performance of production units.

Q. What are the limitations to the detection of colors?

A. The measurement consistency varies from application to application. Here are the various error sources associated with any color sensor, including the CS64A.

Sample color variations: Often colors vary from sample to sample. Dark objects tend to display the largest amount of variations. If possible, check multiple samples over time to verify consistency before setting up the thresholds.

Presentation variations: The largest variation in multiple readings of the same object is typically differences in the orientation of the object to the sensor. Not only does the distance from the object to the sensor effect the readings, but so does the angle of the object. The least sensitive objects are those with a matte or other non-glossy finish and with a flat to slightly convex surface. The most difficult objects have a gloss finish and a concave surface. The CS64A-00 handles these types of variation better than most color sensors, in fact spectrophotometers often require contact measurements which eliminate distance variations but also make them unsuitable for most on-line applications. Small sensor-to-object variations (~1/4") typically only cause a few tenths of a percent variation in ratios of the CS64A's readings--see spec sheet for worst case specs. Angle variations are not specified and are dependent on glossiness of the object.

Environment: Dust collecting on the CS64A's window reduces signal strength. Use of ratios eliminates errors from uniformly distributed dust, but eventually the loss of signal strength will impact performance.

Noise: Electrical and optical noise is typically the next largest variation from reading-to-reading of the same object. Noise is greater for green and blue since the green and blue LEDs are less intense, and less for NIR and red. Optical noise is primarily caused by changing ambient light conditions. Extraneous light in the sensing area is an error signal and should be eliminated as much as possible. Low levels of constant light may be tolerable, while sunlight is almost never tolerable. For lowest electrical noise, we recommend connecting the CS64A analog outputs to differential inputs using shielded twisted pair wires and a dedicated power supply, which allows the circuit common, and case ground to be connected inside the sensor. This noise can also be effectively eliminated in many applications simply by averaging multiple readings.

Temperature: Output voltage variation with temperature is specified and 100% tested. The LED color also drifts slightly with temperature, but this is insignificant in most applications.

Time: There is a certain amount of reading variation over time, typically a few tenths of a percent per week or less. This can be dealt with by recalibrating more often in critical applications.

11. Troubleshooting

The CS64A's output indicator LEDs provide helpful troubleshooting information.

The green LEDs come on when the output voltage reaches approximately 2 volts and gradually increase in intensity as the output voltage increases, so they should be at least slightly on for all but very dark objects.

If the green indicator LEDs are off (or very dim), when light colored material is in the normal sensing area, check for:

1. Dirt buildup on the window
2. Incorrect sensor to target distance
3. Problems with power supply or wiring

12. Support

Delta offers extensive telephone support on all of its products, both before and after the sale. Delta offers testing of samples using color sensors or spectrometer. To have samples tested, send them to:

Delta Computer Systems, Inc.
1818 SE 17th Street
Battle Ground, WA 98604

Attn: Color Sample Testing

(360) 254-8688
FAX (360) 254-5435

On new applications, this testing is typically done at no charge. If required, training and field support can be provided on a time and expense basis.

13. Repairs

If a CS64A needs repair, call Delta to receive an RMA number before returning unit. Including a brief description of the problem will help to speed the repair time.

14. Warranty

The Products shall be free from defects in materials and workmanship under normal and proper use and service for a period of one (1) year from the date of shipment by DELTA.

The obligation of DELTA under this warranty shall be limited to repairing or replacing the Product or any part thereof, which, in the opinion of DELTA, shall be proved defective in materials or workmanship under normal use and service during the warranty period.

Defective Products shall be returned, postage prepaid, to DELTA at the address set forth in Section 12.

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