

SAMSARA MACHINE VISION









### Introduction

Lighting is a critical factor for machine vision inspections. From selecting the best lighting options to configuring them in the most optimal setups, customizing lighting for your applications can help produce better results. Unlike everyday smartphone photography, which is optimized for the human eye, machine vision uses lighting to optimize how objects appear to the camera's sensors. The most successful machine vision applications use lighting that highlights features of interest while minimizing visual noise.

## Why Lighting Matters for Machine Vision

At a basic level, cameras contain sensors that capture incoming light as images. While most photos are typically captured for human review, machine vision applications look at images differently, and they typically perform best on high-contrast images. The central goals of lighting are to highlight features of interest and reduce the focus on the rest of the image.

Lighting is one of the most impactful yet customizable elements of machine vision. We've seen numerous customers succeed with our lighting solutions, and we've gathered some best practices to show how they can work for your product.

Two main considerations factor into lighting decisions:

- Setup environment There is an ideal lighting solution for any environment. Space constraints, levels of ambient lighting, support structures, conveyor speed, and other variables in the immediate inspection area influence what lighting products and configurations should be used.
- Object factors Shape, material, size, color, reflectivity, inspection elements, and other characteristics of the object inform decisions around lighting options.

## Lighting Options



All Samsara cameras feature built-in LEDs, and four additional standalone lighting options are available for even greater flexibility. Here are the types of lights we offer:

#### **Built-in light**

Twenty embedded LEDs on the VS2 cameras provide direct, high-contrast lighting. The brightness is easily adjustable through the Samsara dashboard.

#### **Bar light**

A versatile option that provides uniform lighting along a strip. Typically used to provide directional lighting.

#### **Ring light**

A bright circular light typically used to provide directional lighting.

#### **Dome light**

A hemisphere of light that provides soft illumination. Typically used to surround an object with uniform lighting.

#### Area light

A large rectangular light typically used for backlighting or directional lighting.

Below, we show you how each light can be used as well as common lighting arrangements.

## Lighting Configurations



#### **Bright Field Lighting**

One of the most common configurations, bright field lighting provides direct lighting onto an object, offering high contrast illumination.

Best for: reading text & barcodes on matte objects, label verification Compatible Samsar lights: built-in, bar, ring, area



#### **Dark Field Lighting**

Dark field lighting illuminates objects at shallow angles to accentuate edges, combat glare, or highlight surface features.

Best for: defining edges & shapes, highlighting surface
 features, finding defects on shiny objects
 Compatible Samsara lights: bar, area, ring



#### Backlighting

Uniform lighting placed behind objects of interest allow silhouettes, text, barcodes, and other features to achieve high contrast from transparent or translucent materials.

Best for: fill level inspection, label verification on transparent objects Compatible Samsara lights: area



#### **Dome Lighting**

Dome lights offer soft, diffuse lighting that eliminates shadows and glare.

Best for: finding defects & reading labels on small reflective objects Compatible Samsara lights: dome



#### **Ring Lighting**

Circular lighting reduces shadows by providing illumination from multiple angles. Ring lights offer versatility by offering either bright field lighting at longer distances or dark field lighting at shorter distances.

Best for: text and defect inspections on matte objects
Compatible Samsara lights: ring

### **Best Practices**

While your precise lighting needs will be highly unique to your use case, product characteristics, and inspection environment, it's possible that you'll encounter some standard troubleshooting scenarios, We've gathered some common challenges we've observed across various industries to highlight best practices on how to overcome them.

#### Minimize glare with side lighting



While unusual shapes, angles, and sizes require careful planning to properly accommodate, reflective products tend to be one of the most common lighting challenges. It just so happens that many industrial use cases feature products with highly reflective materials - glass, metals, plastics, and various coatings. Reflective surfaces will create glare from both direct and ambient light sources. Fortunately, there are ways to ensure the camera sees a clear image.

Most reflective products can be effectively handled using 1-2 side lights. These lights should be placed above and to the side of the product, with diffusers being applied where possible (Note: all Samsara lighting accessories come with built-in diffusers, though additional diffusers can certainly be utilized). If using a single side light, a reflector facing the light source will even out lighting across the product.

In the examples above, we show how an eyeshadow kit with a reflective plastic cover is captured in various lighting setups. Direct lighting creates glare that can interfere with inspection capabilities, while side lighting produces a clear image for inspection.

#### Use backlighting for transparent or translucent objects



Transparent glass and plastic products pose the unique challenge of background considerations. Because transparent objects allows light through, the background can influence both lighting of the product as well as readability of inspection elements. A reflective background could create glare, and a cluttered background could make text more difficult to read.

For the best results, we recommend utilizing backlighting to handle transparent products. A large area light placed in the background can hide small imperfections in the object while also illuminating inspection features. This works for use cases involving clear liquids as well, allowing fill level inspections to be easily performed.

In the examples above, we show how a transparent package of catheters is captured in various lighting setups. Direct lighting results in heavy glare that interferes with inspection performance, while backlighting allows for the catheters to be clearly and evenly illuminated.

#### **Optimize digital settings**



# Original (no lighting)



While physical lighting is a great way to highlight your products, digital settings can also enhance your inspections. From camera setting adjustments such as Exposure and Focus to post-processing filters that improve sharpness and lighting uniformity, the Samsara user dashboard allows you to perform image adjustments with real-time feedback. We will provide detailed, setting-by-setting explanations in the next lighting series blog post.

These filter options are especially useful in situations involving limited flexibility in customizing external lighting or significant, unavoidable ambient lighting that impacts inspection quality. The recommended adjustments will vary significantly by situation, but the general rule of thumb is to highlight features of interest whenever possible.

In the examples above, we show how a product affected by ambient lighting can be captured using various camera settings and image filters.



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