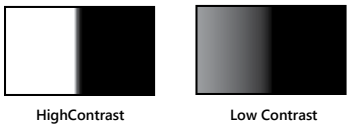
Machine Vision Lighting Overview

Generic lighting products are designed to provide basic illumination. However, lights designed for use as part of machine vision systems are designed with high-quality LEDs to provide consistent and uniform light across the desired field of view. Here are some considerations that should be kept in mind when designing an optimized machine vision lighting system.

Goals for Machine Vision Lighting

Contrast

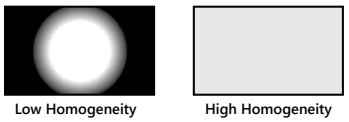
Maximizing contrast is the ultimate goal for any machine vision lighting system. If high contrast can be obtained, then detection is going to be a lot easier. In fact, maximizing contrast is the reason that most camera vision applications are monochrome. Contrast in monochrome images makes image processing easier.



To achieve the best contrast, the user must have a balance between homogeneity and brightness.

Homogeneity

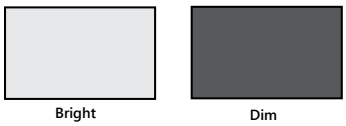
Homogeneity can be thought of as uniformity. The light needs to illuminate the whole field of view uniformly. Hot spots or dark spots remove contrast from specific regions of the field of view and can adversely impact vision accuracy, while a homogenous (uniform) field of illumination can greatly enhance accuracy.



Brightness

Brightness, which is essential in creating contrast, is important in machine vision systems.

By increasing the brightness, system designers can create more robust systems using shorter exposure times. As an added benefit, this will also reduce motion blur.



It is true that if you put more current through an LED, it will get brighter. But one of the worst things for an LED's lifespan is over-current. Even though more current means a brighter LED, that brightness comes at a cost, for the brighter the LED gets the more heat is generated and the more its lifespan is reduced. In other words, the lifespan of an LED is directly related to the current through the LED.

The manufacturers of our machine vision lights have taken great care in selecting the brightest and highest quality LEDs. They have also carefully engineered these lights to maximize light output and LED lifespan in order to deliver a product that will work consistently well for a long period of time. For instance, in order to achieve higher brightness, some of our lights can be strobed with higher current. In these lights, built-in microprocessors manage strobe duration to maximize brightness without adversely impacting life expectancy of the LEDs.

Dealing With Ambient Light

One of the hardest things to design out of a machine vision application is interference with your controlled lighting coming from unwanted ambient light in the location where the system will be used. Ambient light varies greatly from location to location, so designers must keep potential ambient light impacts in mind when designing machine vision lighting systems.

A common misconception is that ambient light comes only from overhead. However, the truth is that ambient light can come from several sources. Among the conditions which can impact ambient lighting are sunlight through a window, the reflection off of a reflective surface, or even a shadow.

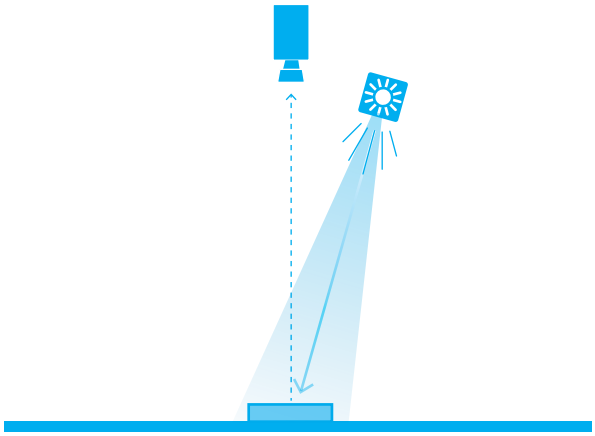
There are situations in which building a shroud around the inspection area is the most appropriate way to deal with ambient light. In other situations, the best way to deal with it is to increase the brightness of the light source.

Another solution to deal with ambient light is to use a specific color (wavelength) of light along with a corresponding filter to only allow that color of light to pass through to the camera. For example, when using a red light (625nm), you can use a 625nm bandpass filter to block out unwanted ambient light of other wavelengths.

Machine Vision Lighting Overview, continued

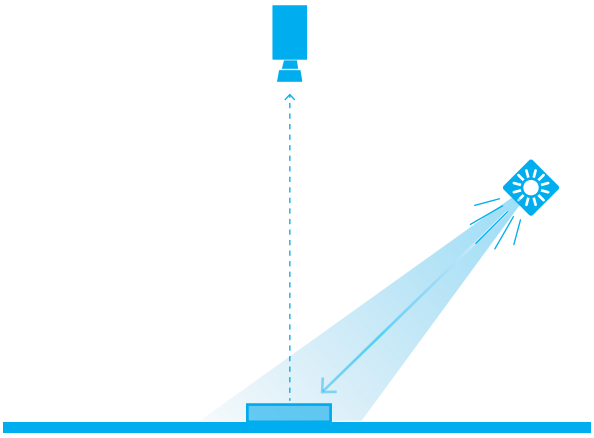
Lighting Principles

Effective machine vision lighting relies on several factors, including what is known as the "angle of incidence." Angle of incidence is defined as the angle at which the light strikes the object being illuminated. This angle is measured from an imaginary line between the camera and the light source, The examples below illustrate how different lighting angles can be used in various applications.



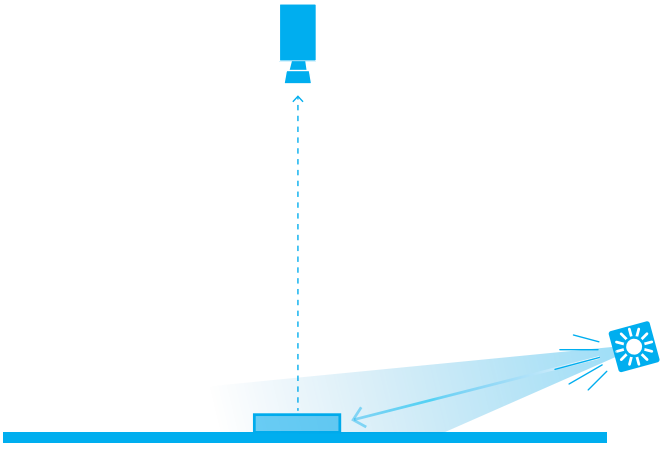
Bright field

- Usually, the angle of incidence is between 0 and 30 degrees.
- Bright field is the easiest type of lighting principle for humans to understand, because this is how we generally see the world. However, this type of lighting system may not be well suited for use where shiny parts are involved.
- Diffusers or polarizers might be needed to decrease the unintended direct reflections.



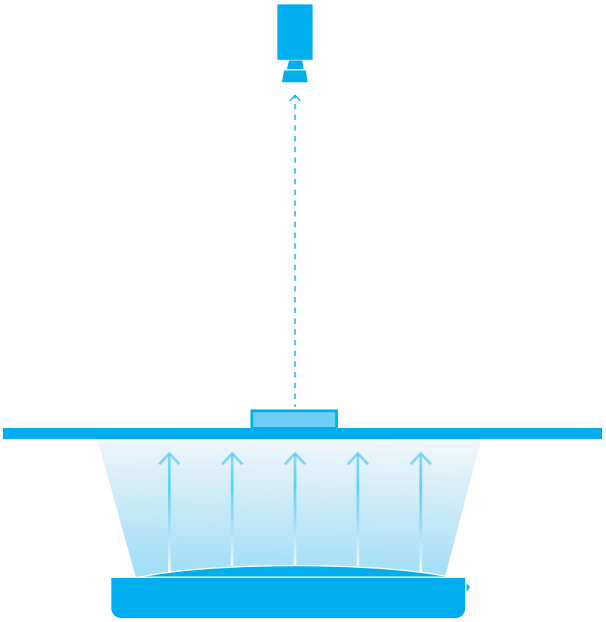
Low angle

- Usually, the angle of incidence is between 30 and 80 degrees.
- The lighting source is placed between the dark field and the bright field so that the user can take advantage of both illumination methods.
- Good for engravings



Dark field

- Usually, the angle of incidence is between 80 and 90 degrees
- This lighting configuration will generally bring high contrast to the edges. For parts that are not shiny, a narrow beam angle is usually best. For shiny parts, a diffused light source usually works best.
- Applications include edge detection and measurement.



Backlight

- The light source is placed behind the object.
- When using this method, it is important that the light is bigger than the field of view.
- Backlighting light sources should be highly diffused and offer high homogeneity.
- Backlighting makes it possible to see a silhouette.

WenglorTPL Vision Lighting M-EBAR Lights

WenglorTPL M-EBAR (Modular Essential Bar) Lights, which feature high-power LEDs, come in various sizes and are available with either white or infrared lights to help create the best contrast for image processing. These linear lights are extremely versatile and can be used to create different types of lighting (for example, bright field, dark field, or dome effect) suited to various automation and robotics applications. Designed with flexibility in mind, WenglorTPL bar lights simplify the product selection process and make for easy integration.

WenglorTPL's award-winning Modular Essential Bar Light illumination provides universal solutions for pick-and-place, logistics, packaging and traceability applications. These bar lights can be combined with WenglorTPL's Angle Changers to suit almost any machine vision application.

Features

- **Illumination angle can be customized to suit almost any application with the addition of angle changers**
- Ultra narrow lens delivers ±7° illumination
- Robust aluminum body
- IP65
- Non-removable M4 nut included on back of bar
- Built-in overdrive protection safeguards against damage from overcurrent

OPT2401

WenglorTPL White M-EBAR Selection Guide

Part Number	Price	Color of Light	Light Temperature	Length of Light	Overdrive	Mode of Operation	Drawings
OPT2400	$;05[10:	White	5800K	125mm [4.92 in]	Yes	Continuous or strobe	PDF
OPT2401	$;05[11:			250mm [9.84 in]			PDF
OPT2402	$;05[12:			375mm [14.76 in]			PDF
OPT2403	$;05[13:			500mm [19.69 in]			PDF

OPT2406

WenglorTPL Infrared M-EBAR Selection Guide

Part Number	Price	Color of Light	Wavelength	Length of Light	Overdrive	Mode of Operation	Drawings
OPT2404	$;05[14:	Infrared	850nm	125mm [4.92 in]	Yes	Continuous or strobe	PDF
OPT2405	$;05[17:			250mm [9.84 in]			PDF
OPT2406	$;05[18:			375mm [14.76 in]			PDF
OPT2407	$;05[19:			500mm [19.69 in]			PDF

WenglorTPL Vision Bar Clamp Selection Guide

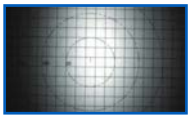
Part Number	Price	Description	Material	Drawing
OPT2432	$;5[20:	Bar clamp	Aluminum	PDF

OPT2432

Angle Changers

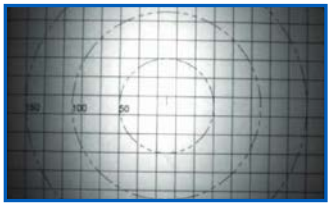
WenglorTPL bar lights can be used as-is in a wide range of applications. However, the addition of an angle changer accessory can greatly enhance the versatility of the overall lighting system by changing the angle of the illumination and thus allowing a single light to be used in multiple applications.

Angle changers are easy to install on the Wenglor bar lights and do not have any impact on the IP rating. Installation takes just seconds and is simply a matter of clipping them into the light's aluminum frame.

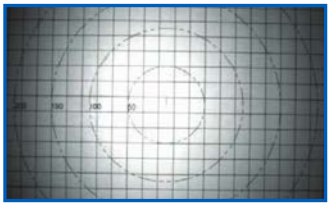


M-EBAR without angle changer

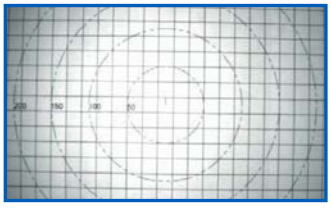
Result when using different angle changers



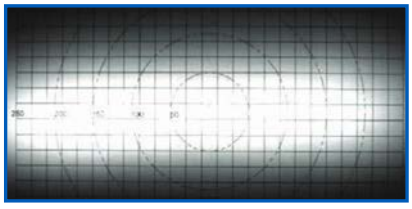
With Narrow Angle Changer



With Medium Angle Changer



With Wide Angle Changer



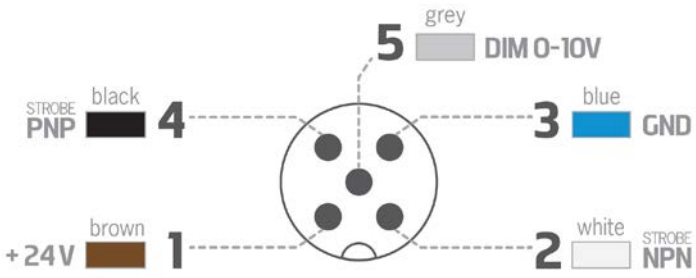
With Line Light Angle Changer

WenglorTPL Vision Lighting
M-EBAR Lights

wenglor TPL

M-EBAR General Specifications				
	125mm [4.92 in]	***250mm [9.84 in]***	***375mm [14.76 in]***	***500mm [19.69 in]***
Electronics				
Functioning Mode	Continuous or strobe			
Strobe Input	PNP: From 5 to 24V for 100% ON. From 0 to 1V for 100% OFF NPN: Less than 1V for 100% ON. Above 2V for 100% OFF. Max 20V			
Overdrive	Yes			
Strobe Conditions (ON time, duty cycle)	LEDs are supplied with 240% maximum current. After 30ms, LED are supplied at 100% level.			
Maximum Rising Time	15µs			
Maximum Falling Time	15µs			
Connection	M12 5-pole connector			
Consumption CW Mode	0.3 A	0.6 A	0.9 A	1.2 A
Consumption Strobe Mode	1.2 A	2.4 A	3.6A	4.8 A
Minimum Functioning Voltage	20V at the light input			
Normal Functioning Voltage	24V at the light input (±10%)			
Maximum Functioning Voltage	30V at the light input			
Maximum Consumption Strobe and Dimming Signal	10mA			
Maximum Strobe Duty Cycle	20%			
Dimming	Pin 5 (M12 5-pole connector): 0-10 V = 100-30% respectively			
Operating Temperature	-10°C to 40°C [14°F to 104°F]			
Operating Maximum Humidity	80% without condensation			
Maximum Temperature Variation in 24 Hours	10°C [18°F] over 24 hours			
Optics				
Color	White (5800k) Infrared (850nm)			
Mechanics				
Weight	0.8 lb [380g]	1.4 lb [630g]	2.1 lb [950g]	2.6 lb [1.20 kg]
Materials	Aluminum and fiberglass-reinforced ABS			
Mounting	2 M4 nuts (non-removable) installed in T slot in rear of bar light			4 M4 nuts (non-removable) installed in T slot in rear of bar light
Environment				
Storage Temperature	-20°C to 60°C / 80% humidity without condensation No thermal shock (maximum temperature variation 10C in 24 hours)			
IP Protection	IP65			

Connections



Strobe PNP	
1	+24V
2	Not connected
3	Ground
4	PNP-signal
5	Dim 0-10 V

Strobe NPN	
1	+24V
2	NPN-signal
3	Ground
4	Not connected
5	Dim 0-10 V

Continuous Mode			
1	+24V		+24V
2	Not connected		Ground
3	Ground	OR	Ground
4	+24V		Not connected
5	Dim 0-10 V		Dim 0-10 V

WenglorTPL Vision Lighting Angle Changers for M-EBAR

WenglorTPL Angle Changers are inserts for the modular essential bar light that make it easy for you to change illumination angles as needed to meet changing application demands.

OPT2408 OPT2409-2 OPT2410-4

Features

- Quickly and easily change illumination angles as your project evolves.
- No need to dismantle the product to adjust the illumination angle. All you need to do is to swap Angle Changers.
- Angle Changers do not have an impact on the IP rating of the bar light.
- Allows for rapid feasibility testing.
- Quickly and easily identify the best illumination solution with different angle changer combinations.

WenglorTPL M-EBAR Angle Changers Selection Guide

Part Number	Price	Angle Type	Angle	Quantity in Package	Drawings
OPT2408	$;5[15:	Narrow	±10°	1	PDF
OPT2408-2	$;5[16:			2	PDF
OPT2408-4	$;05[1a:			4	PDF
OPT2409	$;5[1b:	Medium	±17°	1	PDF
OPT2409-2	$;5[1c:			2	PDF
OPT2409-4	$;05[1d:			4	PDF
OPT2410	$;5[1e:	Wide	±25°	1	PDF
OPT2410-2	$;;5[1f:			2	PDF
OPT2410-4	$;05[1g:			4	PDF
OPT2411	$;5[1h:	Line light	±9° x ±16°	1	PDF
OPT2412	$;-5[1i:	Polarized narrow	±10°	1	PDF
OPT2413	$;-5[1j:	Polarized medium	±17°	1	PDF
OPT2414	$;5[1k:	Polarized wide	±25°	1	PDF
OPT2415	$;-5[1l:	Polarized line light	±9° x ±16°	1	PDF
OPT2416	$;5[1n:	Polarized	None	1	PDF
OPT2417	$;5[1o:	Transparent	None	1	PDF
OPT2417-2	$;5[1p:			2	PDF
OPT2417-4	$;5[1q:			4	PDF

Number of Angle Changers Needed

Length of Bar Light	Quantity of Angle Changers Required
125mm [4.92 in]	1
250mm [9.84 in]	2
375mm [14.76 in]	3
500mm [19.69 in]	4

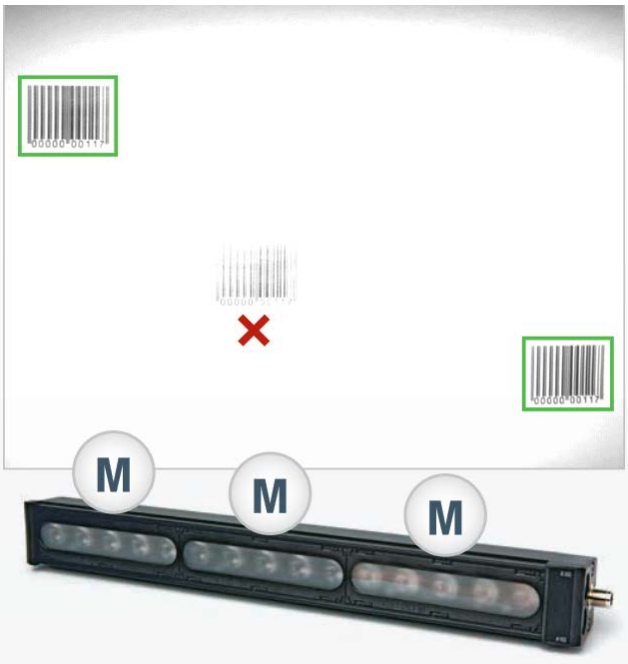
Angle Changer Installation

WenglorTPL Vision Lighting Angle Change Inserts For M-EBAR

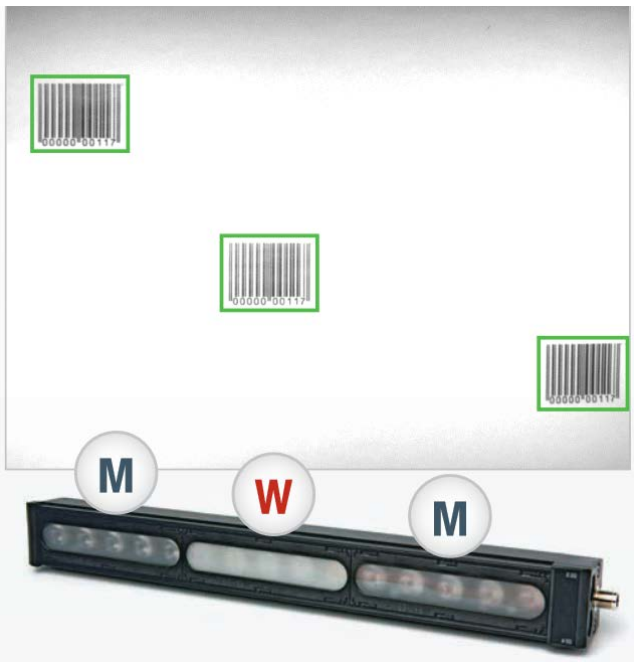
Application Example

Hot spots are often a problem in machine vision lighting, and WenglorTPL Angle Changers provide an excellent solution to help you deal with hot spots by utilizing different angle changers on the same bar light.

OPT2402 light bar with 3 medium-angle Angle Changers (OPT2409)



OPT2402 light bar with 2 medium-angle Angle Changers (OPT2409) and 1 wide-angle Angle Changer (OPT2410)



Example

- 2000mm working distance
- 1300 x 900 field of view
- Four OPT2403 light bars with angle changers

Angle changers marked at each 125mm as Narrow, Medium or Wide by N, M, or W

Schematic views show a plan of the system from behind the camera