CCS

CREATING CUSTOMER SATISFACTION

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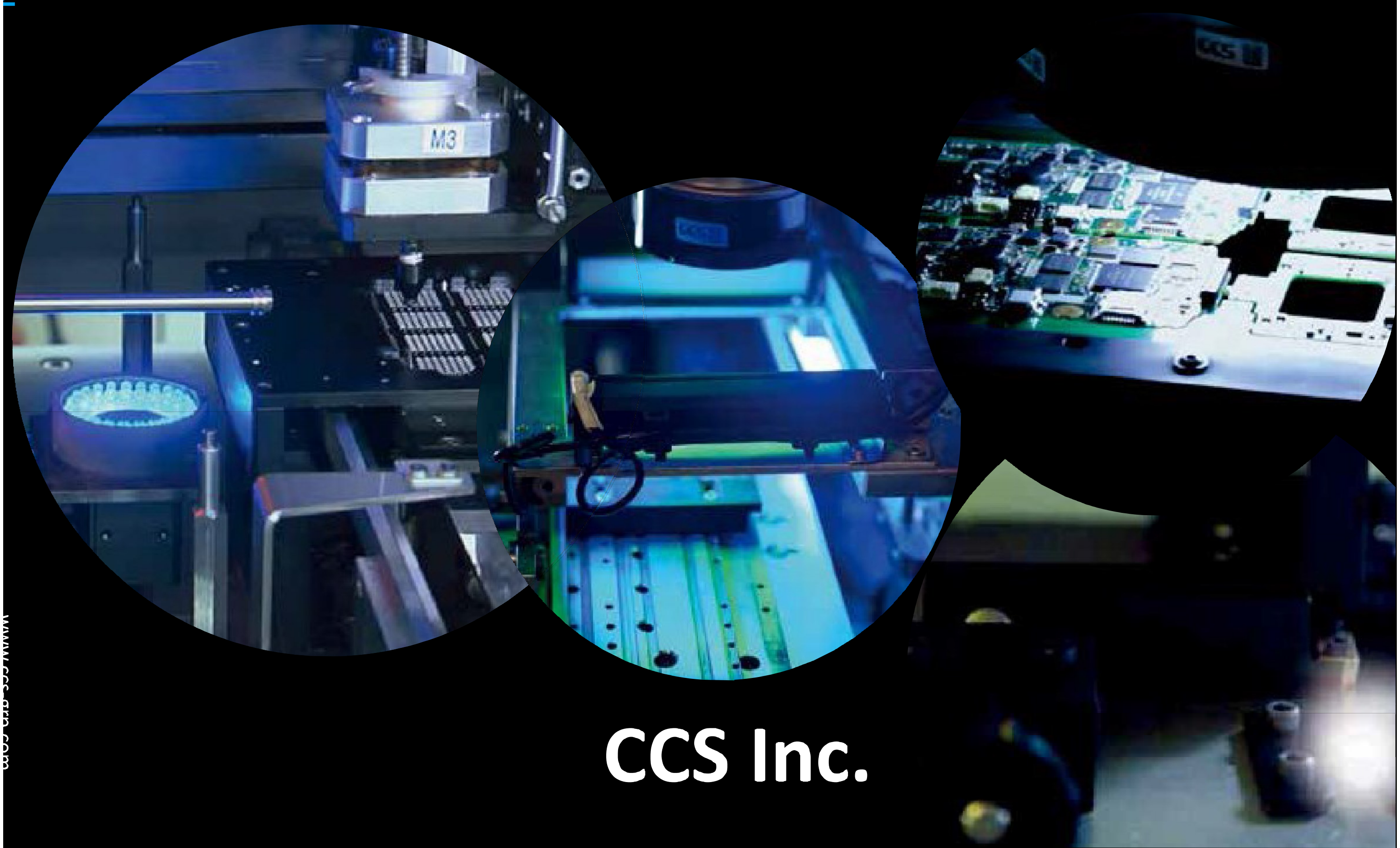
2015

LIGHTING SOLUTION

LED ILLUMINATOR FOR MACHINE VISION

WORLD CLASS LED LIGHTING TECHNOLOGY
LET OUR EXPERTISE WORK FOR YOU



CCS Inc.

2015 General Catalog of LED Lighting for Machine Vision Applications

LIGHTING SOLUTION

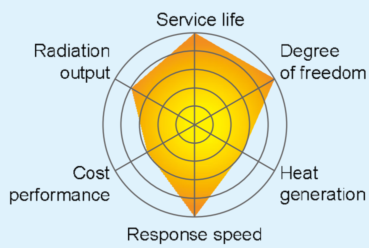
www.ccs-grp.com

LED Characteristics

- High degree of freedom in lighting design
- Long service life
- Fast response
- Selectable color
- Low total running cost

Comparison of Light Sources for Image Processing

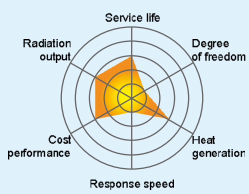
LED



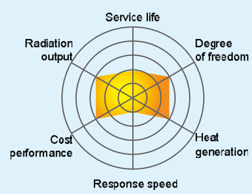
The characteristics of LED Lights are that they are compact, save energy, and have a long service life and a high degree of design freedom. Using LED Lights allows for lighting design that is optimal for various workpieces (samples).

Other main light sources

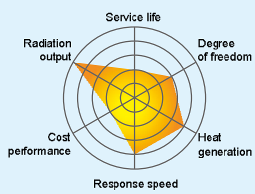
Fluorescent lamp



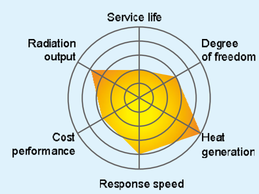
Halogen bulb



Xenon lamp



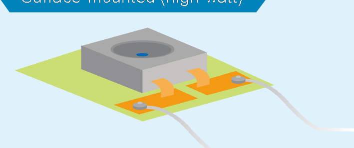
Metal halide



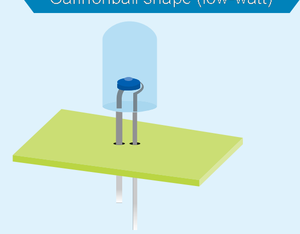
LED Type

Although the emitting principles are basically the same, they are available in the following types of shapes.

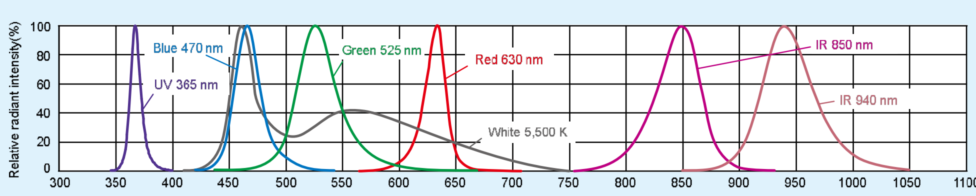
Surface mounted (high watt)



Cannonball shape (low-watt)



Light Spectrum (representative sample of the products in this catalog)



Skillful Use of LED Lights

The service life of LED Lights is shorter at high temperatures

Using LEDs at high temperatures for an extended period of time will cause them to deteriorate and the radiation output will decline. (The normal radiation output will not return even after they cool down.)

How to prevent LED deterioration and reduction in radiation output due to heat generated by LEDs

Avoid using at the maximum intensity

When used with a low Control Unit intensity value, the Light Unit is supplied with a lower amount of current, which therefore reduces the heat given off as well as LED deterioration. As a guideline, we recommend that you set the intensity value low at first and then turn it up gradually as the radiant output of the Light Unit decreases.

Turn on the light only when capturing images

LED Lights can withstand being turned on and off frequently. Turning on the Light Unit only when taking images using a strobe emitting or external signal input will reduce heat generation, provide a more stable radiation output, and increase the service life of the Light Unit.

Important Points of LED Lights

LED service life

Unlike a light bulb, an LED Light does not burn out suddenly but rather gradually deteriorates. Replace when captured images are dark and increasing the intensity value does not improve the conditions.

LED variations

LED Lights have different individual radiant quantities. There are also differences in the emitted color.

Wavelength shift

The LED emission spectrum varies due to ambient temperature and heat generated when energized. Temperature rising causes a shift towards the long-wavelength side.

Items You Must Check when Selecting a Light Unit

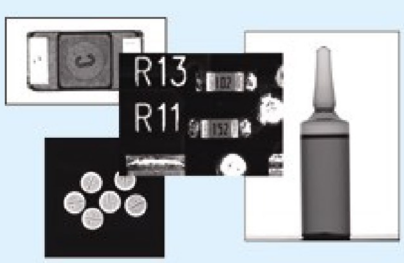
Workpiece (sample) shape, conditions, color and related items

Applications

External inspection	Part count inspection
Character recognition	Liquid volume inspection
Foreign material inspection	Detection inspection
Dimension measurement	Code recognition

Etc.

Large field of view (resolution)



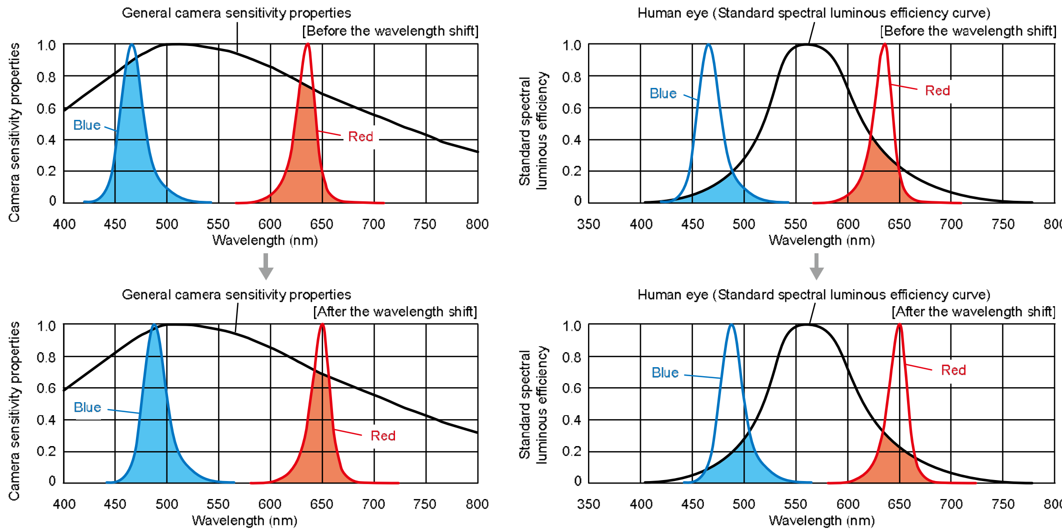
Installation conditions and ambient environment

- Production line conveyor speed
- Types of surrounding devices and similar items

- Separation of Light Units and workpiece

Changes in Brightness Due to Camera and the Human Eye

By only slightly shifting the wavelength of blue or red, the value for the human eye (illuminance and luminance) changes greatly.



Determining the Field of View of Coaxial Lighting

Figure 1 shows a cross-section of a Coaxial Light. Light from the LED is reflected using a half-mirror, so that the position of the emitting surface can be treated as if it were directly behind the mirror (See "Virtual emitting surface" in the figure). In this case, the distance from the emitting surface to the workpiece is LWD'.

The effective field of view of a Coaxial Light is determined by 1) the LWD (distance from the Light Unit to the workpiece) and 2) the WD (distance from the workpiece to the camera). Figure 2 shows how to determine the field of view "V" when the WD is held constant and the LWD (distance to the Light Unit) is varied. The following is an explanation of what the effective field of view will be when the virtual emitting surface is at positions A and B.

In the case of position A, if we assume that the workpiece is a reflecting surface, we can say that there is an emitting surface at A opposite to the workpiece (position A' of the LWD'a distance). Therefore, when the workpiece is viewed through the camera, it appears as if the emitting surface is at A', and thus the effective field of view is Va.

In the same way, in the case of B, the emitting surface is at B' and the effective field of view is Vb. Comparing Va to Vb, we find that Va, which has a shorter LWD, has a greater effective field of view. In this way, the effective field of view grows larger as the LWD becomes smaller.

What is the effective field of view?

For example, when reading characters engraved on a shiny piece of metal, if we assume that the virtual emitting surface is at position B, the effective field of view of Vb will be determined, in regards to the camera field of view V as shown in Figure 3 below, by the virtual emitting surface position B'. For this reason, only the letters CDEFG will be visible as dark letters against a light background, and the letters AB and HI, which appear dark against a dark background, will not be discernible. In this way, the effective field of view Vb is smaller than the field of view V.

Figure 1. Cross section of Coaxial Light

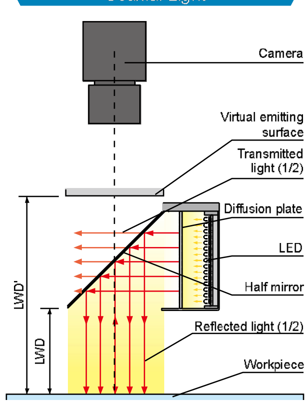


Figure 2. Determining the field of view by LWD

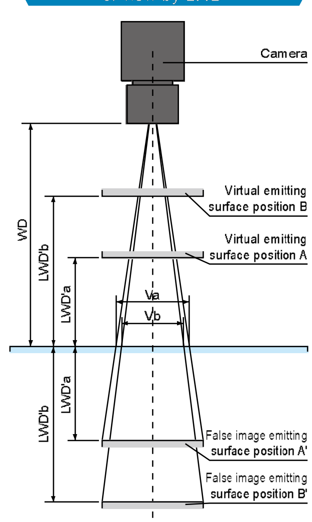
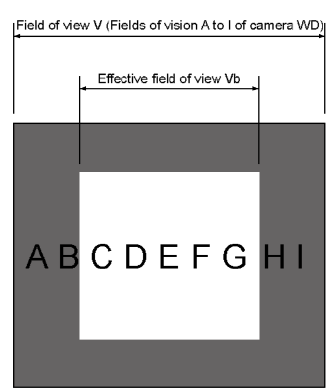


Figure 3. Field of view and effective field of view

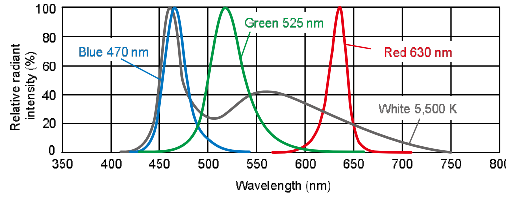


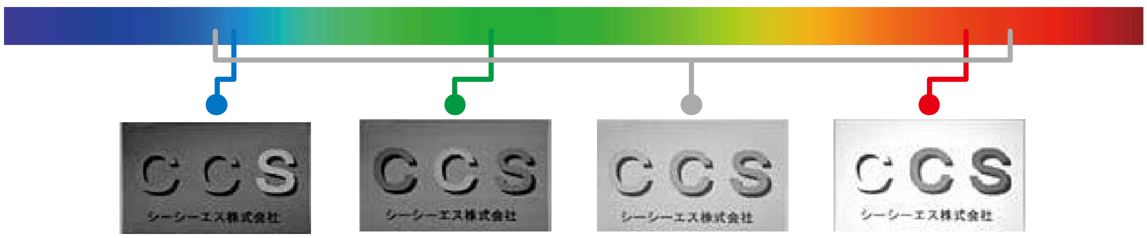
Objects Appear Differently Depending on the Emitted Color of a Light Unit

Imaged sample workpiece (printed card)

Background — Orange
Left-side C — Red
Center C — Green
S — Blue
Shadow and kana/kanji characters — Black

Light spectrum of colored LEDs (representative sample)





Imaging with Blue

When using blue lighting, parts that are the same color as the lighting become white and other colors become black.

Imaging with Green

Although, when using green lighting, there are some variations in color strength, green (same color as the lighting), as well as orange, yellow and blue all become white. The remaining red-colored area become black.

Imaging with White

As white lighting covers all three primary colors (red, blue and green), color brightness is even resulting in all colors appearing as gray with the same brightness. By comparing with other imaging, it is apparent that there is little strength of color. If using white lighting when imaging with a color camera or when imaging a multicolored workpiece, it is possible to perceive the particularities of the workpiece as their are no effects from color.

Imaging with Red

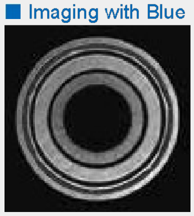
When using red lighting, parts that are the same color as the light (red) as well as orange and yellow become white and other colors (green and blue) become black. This is due to the property of the light expressed as, "Color reflects light of similar colors and absorbs light of complementary colors."

(Using a monochrome camera)

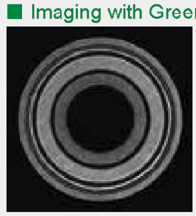
Example of workpieces which don't relate to the emitted color

Imaged sample workpiece
Metal (bearing)

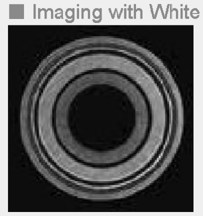
Imaging with Blue



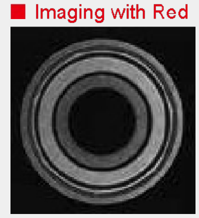
Imaging with Green



Imaging with White

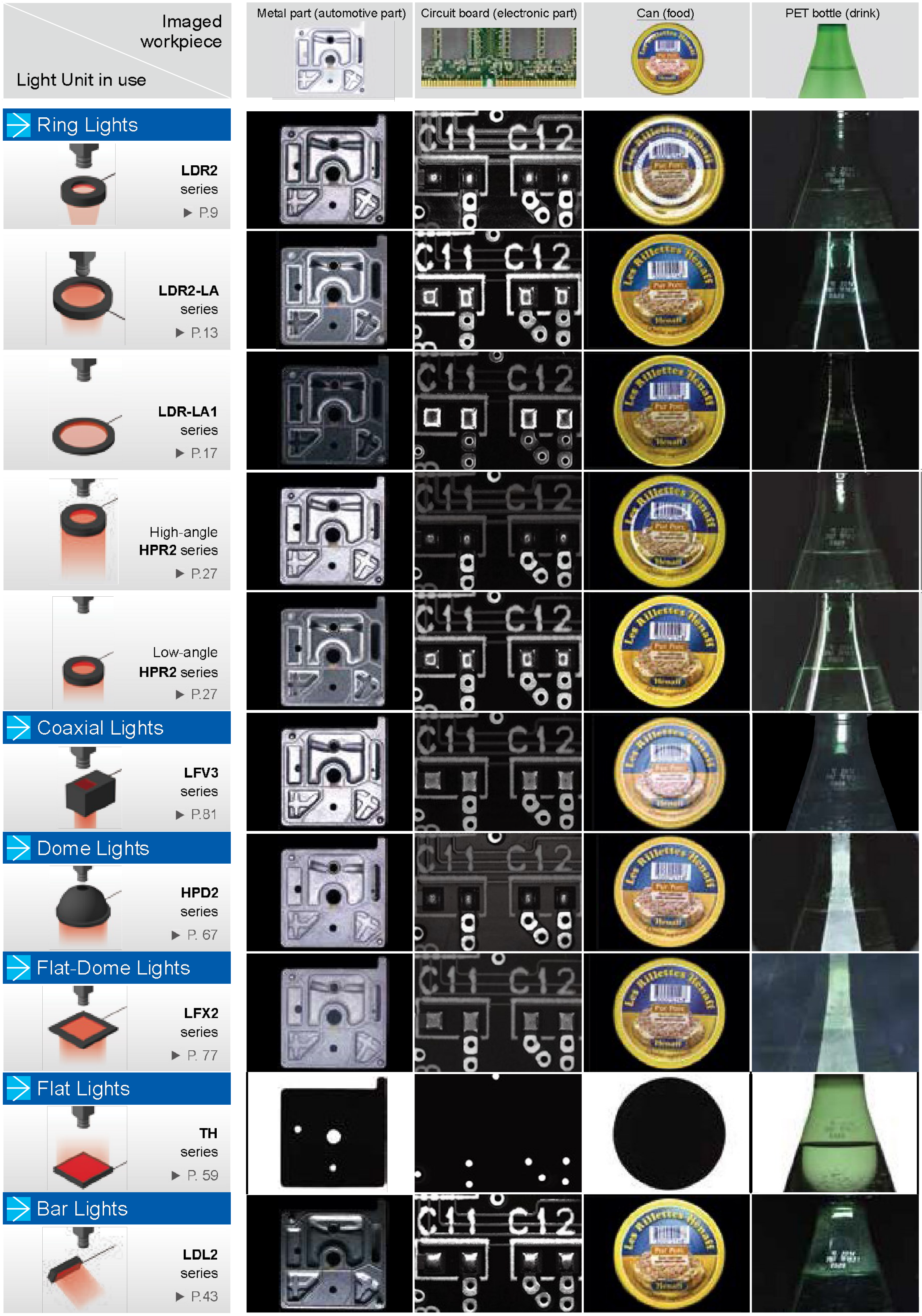


Imaging with Red



Imaging Differs Depending on the Combination of the Light Unit and Workpiece

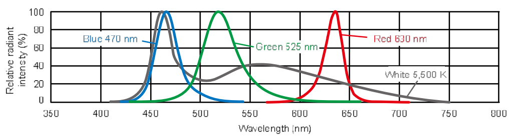
Light Unit in use	Series	Page
Ring Lights		
	LDR2 series	▶ P.9
	LDR2-LA series	▶ P.13
	LDR-LA1 series	▶ P.17
	High-angle **HPR2** series	▶ P.27
	Low-angle **HPR2** series	▶ P.27
Coaxial Lights		
	LFV3 series	▶ P.81
Dome Lights		
	HPD2 series	▶ P. 67
Flat-Dome Lights		
	LFX2 series	▶ P. 77
Flat Lights		
	TH series	▶ P. 59
Bar Lights		
	LDL2 series	▶ P.43



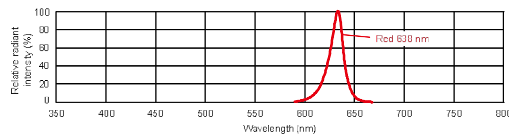
There are great differences in imaging results depending on the shape of the Light Unit, emitted color, illuminating method and similar conditions.
Please inquire with CCS so that we can use our vast knowledge and experience to help you with imaging.

LED Properties: Light Spectrum
(part not described on each product page)

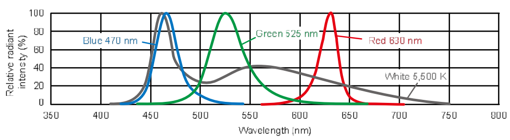
SQR series
Product Page ▶ P. 21



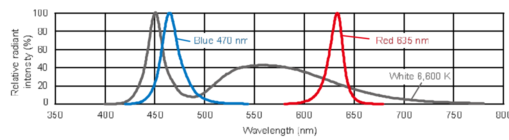
SQR-TP series
Product Page ▶ P. 22



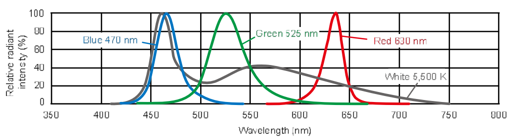
LFR series
Product Page ▶ P. 33



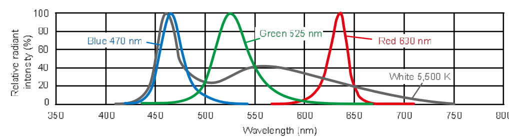
TH series
Product Page ▶ P. 59



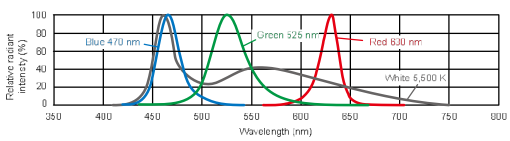
LFL series
Product Page ▶ P. 63



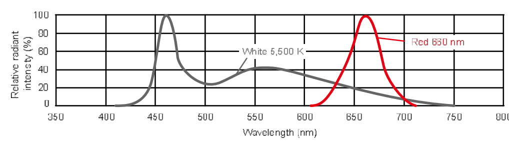
LAV series
Product Page ▶ P. 75



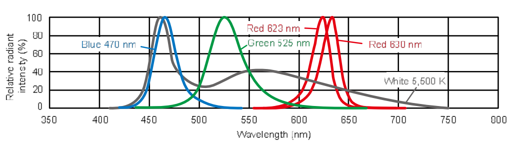
PDM series
Product Page ▶ P. 76



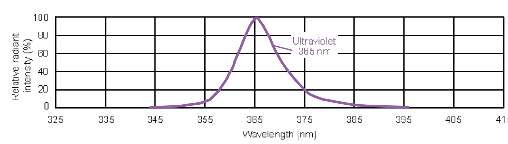
LFV2 series
Product Page ▶ P. 87



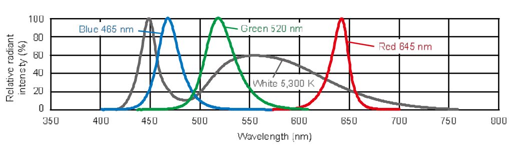
MSU series
Product Page ▶ P. 91



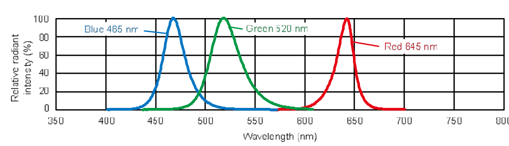
UV2 series
Product Page ▶ P. 95



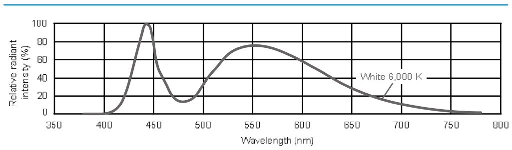
HLV2-22-NR-3W series
Product Page ▶ P. 119



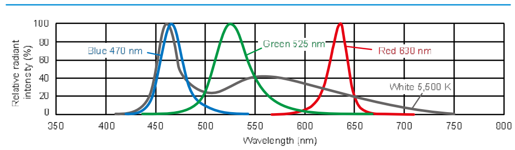
HLV2-3M-RGB-3W
Product Page ▶ P. 120



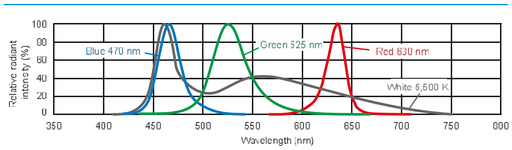
PFB2 series
Product Page ▶ P. 121



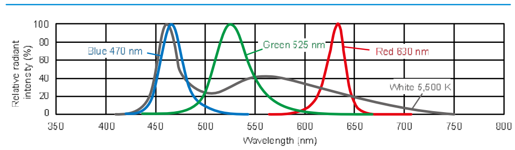
LV series
Product Page ▶ P. 115



LN/LN-HK series
Product Page ▶ P. 139

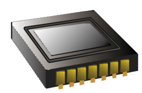
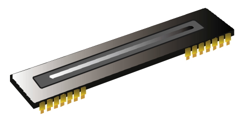


LNV series
Product Page ▶ P. 159



Basic line sensor camera knowledge

1 Differences between area sensor cameras and line sensor cameras

	Area sensor camera	Line sensor camera
Shape of imaging element		
Lens mount	C mount, F mount, etc.	F mount, M72 mount, etc.
Pixel expression	2M (1,600 × 1,200 pix)	8 K (8,192 pix)
Capture expression	Shutter speed 1/4,000 (250 μsec) 1/60 (16.67 msec)	Charge storage time 4,000 Hz (250 μsec) 1,000 Hz (1 msec)

Imaging methods for the area sensor camera and the line sensor camera (Conceptual image)

Make an image of the whole field of vision all at once.

Takes images in lines and makes them one picture.

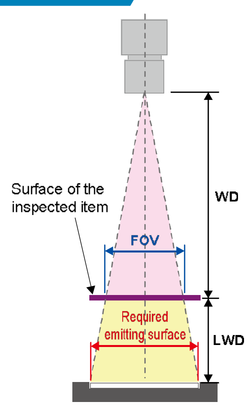
2 Pixel count for line cameras

Pixel count	Pixel size	Ratio of receiving surface area
2K(2,048)	14×14 μm	16
4K(4,096)	10×10 μm	8
8K(8,192)	7×7 μm	4
12K(12,228)	5×5 μm	2
16K(16,384)	3.5×3.5 μm	1

Note: Brightness varies based on the wavelength of the light source and the receiving sensitivity of the image sensor. Brightness does not necessarily correspond to the receiving surface area ratio.

3 How to find the required emitting surface when selecting a line sensor light

Setup examples



Information required when selecting the length of your light

(1) WD (Working distance):
Distance from the camera to the surface of the inspected item

(2) LWD (Light working distance):
Distance from the light to the surface of the inspected item

(3) FOV (Field of vision)

Calculate the require emitting surface using the items above

Solve Use the trigonometric ratio and calculate using the following procedure.

WD : FOV = (WD + LWD) : Required emitting surface

$$\text{Required emitting surface} = \frac{\text{FOV} \times (\text{WD} + \text{LWD})}{\text{WD}}$$

Note: The above is only valid for applications using direct light transmission or direct light reflection.
The emitting surface must be uniform. Select a light longer than the emitting surface you calculated.

When selecting a Digital Control Unit, be sure to consider high-frequency types as well. A Control Unit with a PWM frequency of 500 kHz can be made for custom orders. Please contact your CCS sales representative for details.

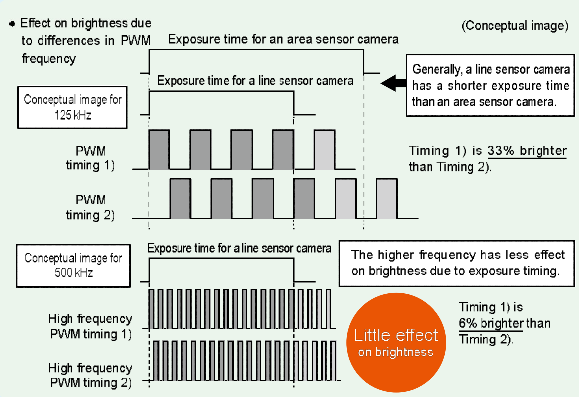
Introduction of the high-frequency Digital Control Unit (custom order)

PD3-10024-8 series

- PWM intensity control (500 kHz)
- 95 W capacity (EL connector: 1 channel)
- AC input
- 3 types of external control
  - Parallel communication
  - Ethernet communication
  - EIA-485 communication

PD3-10024-8-SI-500 (EIA-485 type)
PD3-10024-8-PI-500 (Parallel type)
PD3-10024-8-EI-500 (Ethernet communication) (TCP/IP UDP/IP)

See the PD3 series (standard) product page ►P.185



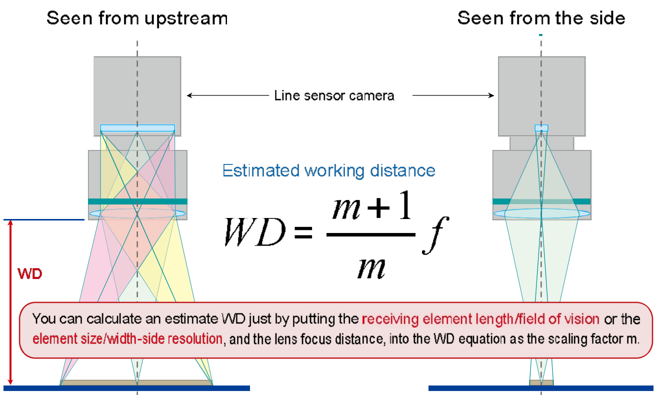
For details about PWM, refer to P.238 in the technical guide.

Setting optical and lighting conditions

1 How to find the working distance (WD) * Reference value

Optical system for the line sensor camera (Wide-side resolution)

It is necessary to calculate the working distance in advance.



Method for testing line sensor image input

When using a line sensor camera, calculate the working distance (WD), carrying speed, and scan rate before starting the test.

■ Example calculation with the following camera specs and conditoins

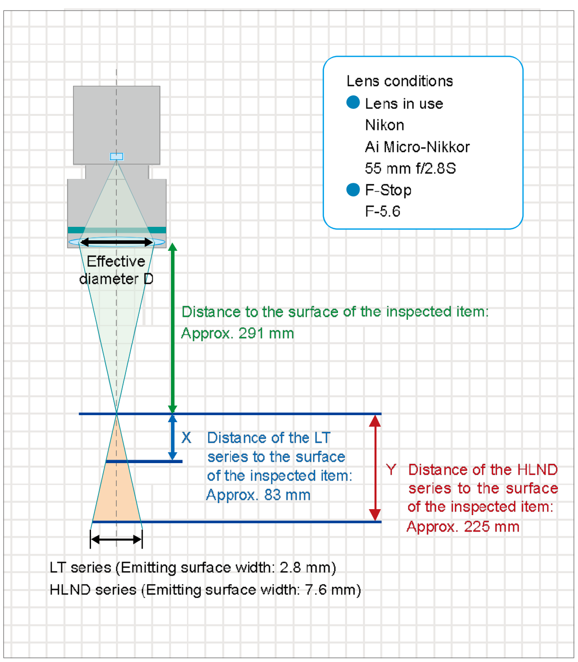
Pixel size: 7 µm × 7 µm (Pixel count: 8,192)

The scan rate and working distance when performing an image input test with the following conditions for a lens where focus distance f = 55 mm is calculated as follows:

Cond. 1 Carrying speed: 200 mm/sec
Cond. 2 Resolution: 30 µm (Carrying direction) × 30 µm (Lateral direction)

Scan rate = 0.03 mm ÷ 200 mm/sec = 0.00015 sec
= 150 µsec
Working distance = {(7/30 + 1) / (7/30)} × 55 mm
= Aprox. 291 mm

2 Relationship between the lens' effective diameter and the light's installation distance * Reference value



■ What is the effective diameter for the lens in the conditions on the left?

D = Lens focus distance ÷ F-stop = 55 ÷ 5.6 = 9.8

■ What is the longest distance where the most efficient brightness can be achieved for the emitting width (short side) of each light?

⇒Find it using similar relationships

1) If using the LT series

9. 8: 291 = 2. 8 : X
X = (291 x 2. 8) ÷ 9. 8 = Approx. 83 mm

2) If using the HLND series

9. 8: 291 = 7. 6 : Y
Y = (291 x 7. 6) ÷ 9. 8 = Approx. 225 mm

For both the above lights, if the light is farther than the distance above, it will be darker, but if the light is closer than the distance above, there will be virtually no change in the brightness. (However, this assumes that the inspected item is limited to something transparent where the illuminated light can be observed directly. This cannot be applied to an inspected item with a possibility for diffusion.) Also, if the lens in use or the F-stop changes, various conditions such as the effective diameter and WD change. Therefore, please consider this only as a reference value under certain conditions. Furthermore, the camera's pixel size is a large factor regarding brightness.

3 Comparison of the images for the area sensor camera and the line sensor camera

■ **Imaging sample (Metal bar)**

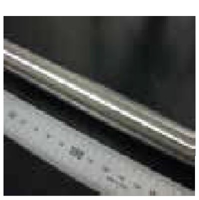
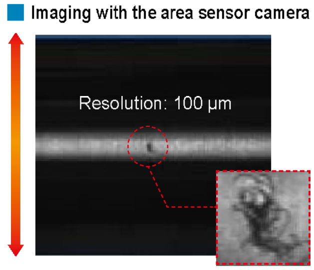


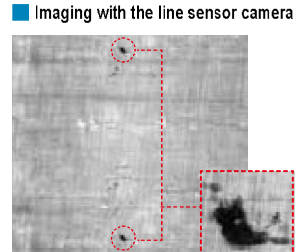
Image of scratches on a metal bar

- Sample size: Length 150 mm, Ø20 mm
- Resolution: 100 µm
- Pixels of the camera in use
  - Line camera: 8,192 pixels
  - Area camera: 300,000 pixels

■ **Imaging with the area sensor camera**



■ **Imaging with the line sensor camera**



(Image of revolving metal bar)

Maintenance and Inspection

LED Lights (Be careful not to touch the casing during or after use as the temperature is high and can cause burns.)

Use a dry soft cloth to wipe away any dust, grime or other foreign material from the emitting surface. If there is any oil or similar substance adhering, use a soft cloth that has been dampened with a neutral cleaner to wipe it off. Do not use thinner, benzene or any similar liquids. Doing so could result in discoloration and deformation.

Control Units for LED Lights (Always be sure that the Control Unit is turned off before cleaning.)

Use a dry soft cloth to wipe away any dust, grime or other foreign material from the electrodes. If there is any oil or similar substance adhering, use a soft cloth that has been dampened with a neutral cleaner to wipe it off. Do not use thinner, benzene or any similar liquids. Doing so could result in discoloration and deformation.

Options

Periodically inspect option parts such as polarization and diffusion plates as all of these are consumables. Replace any parts that show discoloration or deformation during inspection. CCS recommends maintaining extra option parts on-hand in order to be prepared for replacement.

Always be sure to consult the "Instruction Guide" when performing maintenance and inspection.

Operating and Storage Environments

These products are LED Lights that are mainly used for image processing and industrial inspection. Do not use these for other purposes. Always be sure to obey the following precautions.

Absolutely never use under the following conditions.

- Use under conditions or in an environment not described in the "Instruction Guide"
- Use for nuclear power control, railroads, aircraft, automobiles, combustion devices, medical equipment, home entertainment equipment, safety equipment. or any similar devices or equipment
- Use where it is thought that human life or property will be greatly affected, especially application where safety is required

Install in a location that satisfies the following conditions. An improper installation location can result in product malfunction.

- Low vibration and stable
- Water, oil, liquid, chemicals, steam or similar substances cannot contact or otherwise affect the product*
- Low level of dust and good ventilation
- No corrosive or flammable gases
- No sudden changes in temperature
- Far away from water lines, water heaters, humidifiers, air conditioners, heaters and similar equipment

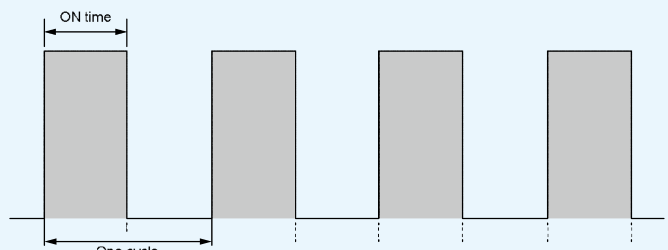
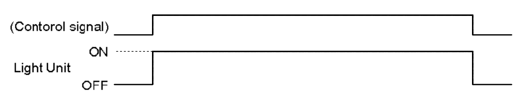
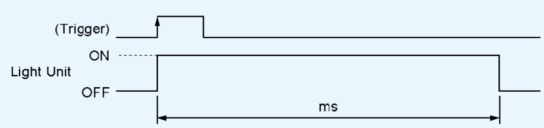
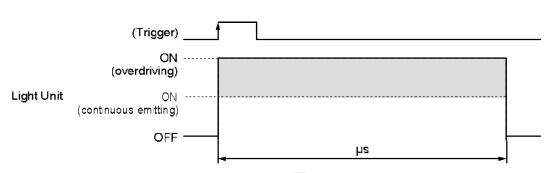
* Install IP-compatible products in a range that permits performance.

Use in the following environments.
An improper operating environment can result in product malfunction.

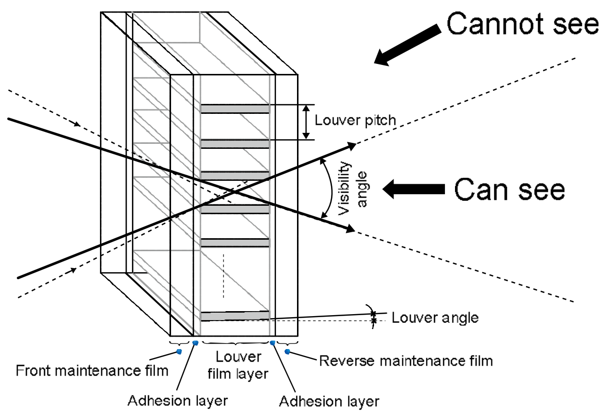
- Operating temperature: 0 to 40°C, Humidity: 20% to 85%RH (with no condensation)
- Storage temperature: -20 to 60°C, Humidity: 20% to 85%RH (with no condensation)

Operating and storage environments of products that are different from these are described on the corresponding product page.

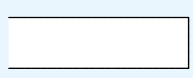
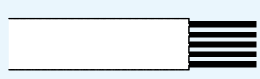
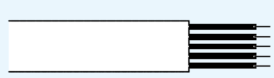
Explanation of Terminology

No.	Classification	Term	Explanation of Terminology
1	Control Unit	Digital control (Duty control)	This is a method of intensity control of the PD series. Intensity control is performed by varying the duty of the pulse on (proportion of time it is on (lit up) during a single pulse). With 8-bit control, you can perform 256-step linear intensity control. If using a high-speed shutter, you must be careful of frequency interference.
2	Control Unit	PWM control	PWM: An abbreviation of pulse width modulation, one pulse modulation method in which the period and amplitude are maintained at a constant, and only the pulse width is changed. Duty ratio: Expresses the amount of time a pulse wave is ON during a cycle as a ratio. Relational expression: Duty ratio = ON time/Period Products with this mark at the top of their product introduction page can be customized for a PWM frequency of 500 kHz.  E.g.: Duty ratio = 50/100 = 0.5 = 50%
3	Control Unit	External ON/OFF control (ON/OFF emitting)	 A method for emitting light for the time during which the ON signal of an ON/OFF signal is received.
4	Control Unit	Strobe emitting	"Strobe" refers to light being emitted for a specified amount of time in synchronization with a trigger signal. This additionally includes emitting light for a fixed amount of time after a delay has been applied for a fixed amount of time. 
5	Control Unit	Overdrive	"Overdrive" is a use method for emitting brighter light by applying a large current to an LED Light for a fixed amount of time. This current exceeds the current during continuous ON/OFF emitting. Products with this mark at the top of their product introduction page support overdrive. 

Explanation of Terminology

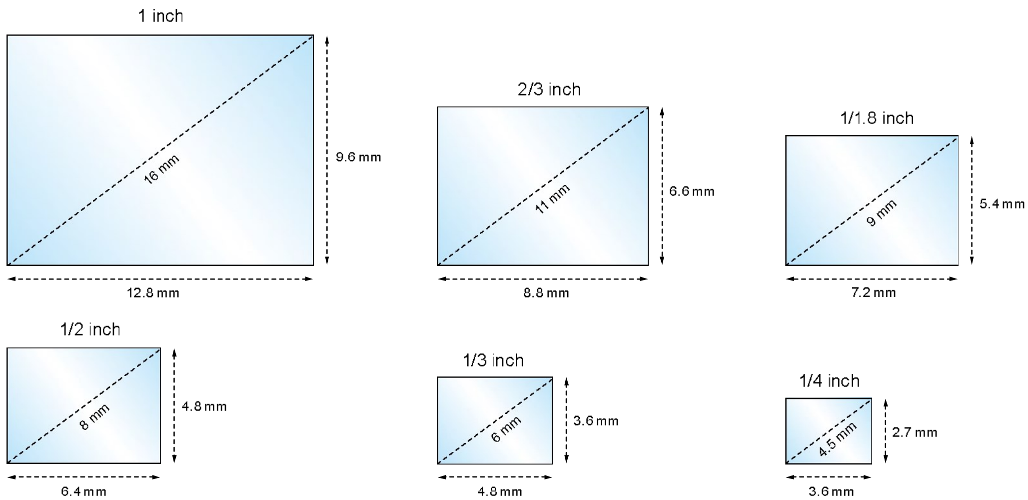
No.	Classification	Term	Explanation of Terminology
6	Options	Sharp cut filter	This filter sharply cuts off light of wavelengths that are less (or more) than the specified wavelength. At CCS, we mainly use these attached to the lens.
7	Options	Light control film	This plastic film is arranged as a minute louver with extremely small gaps. It functions to reduce the diffusion of light in a specific direction and improves parallelism.  **Basic structure of light controller film (cross-section)**
8	Other	LWD	The distance from the tip of the light source to the surface of the workpiece (sample). Abbreviation for light-work-distance. * Although this term is used in our website, catalogs and other materials with the above meaning, care must be paid if it is used for other publications as it is not a term that is officially defined by standards or a similar document.

Supplement

Category	Description		
About the cable condition	Cut off on one end		The cable end has the wiring cut off. This does not have loose wires.
	Loose wires		This has loose wires. (Flying lead)
	Conductor exposure		This has loose wires with exposed conductors.

Camera Image Sensor Size

These are examples of image sensor sizes for use with a camera of an image processing inspection system.



Field of Vision Chart

* These values are for reference. (Units: mm)

Refer to the field of vision chart for telecentric lenses (SE-65/SE-110): ► P.177

Refer to the field of vision chart for macro lenses (SE-16/SE-18): ► P.179

Optical magnification	Camera Image Sensor Size											
	2/3 inch			1/1.8 inch			1/2 inch			1/3 inch		
	Length	Width	Diagonal	Length	Width	Diagonal	Length	Width	Diagonal	Length	Width	Diagonal
0.1x	66.00	88.00	110.00	53.20	71.80	89.30	48.00	64.00	80.00	36.00	48.00	60.00
0.2x	33.00	44.00	55.00	26.60	35.90	44.65	24.00	32.00	40.00	18.00	24.00	30.00
0.3x	22.00	29.33	36.67	17.73	23.93	29.77	16.00	21.33	26.67	12.00	16.00	20.00
0.4x	16.50	22.00	27.50	13.30	17.95	22.33	12.00	16.00	20.00	9.00	12.00	15.00
0.5x	13.20	17.60	22.00	10.64	14.36	17.86	9.60	12.80	16.00	7.20	9.60	12.00
0.6x	11.00	14.67	18.33	8.87	11.97	14.88	8.00	10.67	13.33	6.00	8.00	10.00
0.7x	9.43	12.57	15.71	7.60	10.26	12.76	6.86	9.14	11.43	5.14	6.86	8.57
0.8x	8.25	11.00	13.75	6.65	8.98	11.16	6.00	8.00	10.00	4.50	6.00	7.50
0.9x	7.33	9.78	12.22	5.91	7.98	9.92	5.33	7.11	8.89	4.00	5.33	6.67
1x	6.60	8.80	11.00	5.32	7.18	8.93	4.80	6.40	8.00	3.60	4.80	6.00
1.5x	4.40	5.87	7.33	3.55	4.79	5.95	3.20	4.27	5.33	2.40	3.20	4.00
2x	3.30	4.40	5.50	2.66	3.59	4.47	2.40	3.20	4.00	1.80	2.40	3.00
3x	2.20	2.93	3.67	1.77	2.39	2.98	1.60	2.13	2.67	1.20	1.60	2.00
4x	1.65	2.20	2.75	1.33	1.80	2.23	1.20	1.60	2.00	0.90	1.20	1.50
5x	1.32	1.76	2.20	1.06	1.44	1.79	0.96	1.28	1.60	0.72	0.96	1.20
6x	1.10	1.47	1.83	0.89	1.20	1.49	0.80	1.07	1.33	0.60	0.80	1.00
7x	0.94	1.26	1.57	0.76	1.03	1.28	0.69	0.91	1.14	0.51	0.69	0.86
8x	0.83	1.10	1.38	0.67	0.90	1.12	0.60	0.80	1.00	0.45	0.60	0.75
9x	0.73	0.98	1.22	0.59	0.80	0.99	0.53	0.71	0.89	0.40	0.53	0.67
10x	0.66	0.88	1.10	0.53	0.72	0.89	0.48	0.64	0.80	0.36	0.48	0.60
12x	0.55	0.73	0.92	0.44	0.60	0.74	0.40	0.53	0.67	0.30	0.40	0.50