TOSHIBA

Leading Innovation

BU1203MC/MCF

Users Guide

Rev.1.20

December 25th 2015

Doc. No. 4300-0223

On the subject of this document

- **This document is to introduce the development source and technical source tackled by TOSHIBA TELI CORPORATION.**
- **This article information described in this document contains an under development source and subject to change without notice.**
- **Please read operation manual carefully before you use the product at the first time, and use it properly. Product specifications, operation manual and other related documents are available in our HP to download. Please keep these materials in your hand so that you can read them at any time.**

  http://www.toshiba-teli.co.jp/en/products/industrial/

- **Please refer our HP or contact our sales person for your enquiry and the latest information.**

Table of Contents

USB3 Vision Camera Product Range

USB3 Vision Camera Product range

Model name				Sensor	Optical Size	Output Resolution	Frame Rate
Mono chrome		Color					
BU030	Available	BU030C/CF	Available	ICX424A	1/3 inch	640(H) x 480(V)	125fps
BU031	Available			ICX414A	1/2 inch	640(H) x 480(V)	125fps
BU080	Available			ICX204A	1/3 inch	1,024(H) x 768(V)	40fps
BU130	Available	BU130C/CF	Available	ICX445A	1/3 inch	1,280(H) x 960(V)	30fps
BU132M	Q1/2016			EV76C560	1/1.8 inch	1,280(H) x 1,024(V)	60fps
BU205M	Available	BU205MC/MCF	Under study	CMV2000	2/3 inch	2,048(H) x 1,088(V)	170fps
BU238M	Available	BU238MC/MCF	Available	IMX174	1/1.2 inch	1,920(H) x 1,200(V)	165fps
BU302M	Q1/2016	BU302MC/MCF	Q1/2016	IMX252	1/1.8 inch	2,048(H) x 1,536(V)	120fps
BU406M	Available	BU406MC/MCF	Available	CMV4000	1 inch	2,048(H) x 2,048(V)	90fps
BU505M	New	BU505MC/MCF	Q1/2016	IMX250	2/3 inch	2,448(H) x 2,048(V)	75fps
DU657M	New	DU657MC	New	Own CMOS	1.1 inch	2,560(H) x 2,560(V)	TBD
DU806M	In plan	DU806MC/MCF	In plan	IMX255	1.0 inch	TBD	TBD
DU1207M	In plan	DU1207MC/MCF	In plan	IMX253	1.1 inch	TBD	TBD
BU602M	In plan	BU602MC/MCF	In plan	IMX178	1/1.8 inch	3,072(H) x 2,048(V)	TBD
		BU1203MC/MCF	**New**	**IMX226**	**1/1.7 inch**	**4,000(H) x 3,000(V)**	**30fps**

Note :
- This documents does not confirm product release schedule as information in development plan are included.
- Contact our persons in charge of sales for your enquiry.
- BU602, BU1203 : Rolling shutter type CMOS sensor

xxxC : without IR cut filter
xxxCF : with IR cut filter

Dec. 2015

Ordering information for B/D series camera

Image Sensor Type

None : CCD Sensor
M : CMOS Sensor

Interface

U : USB3.0
G : Gigabit Ethernet
C : Camera Link

Optical Filter Type

None : without IR cut filter
F : with IR cut filter
G : with dust-proof glass
L : with Optical low-pass filter
M : with Opt-LPF + IR cut filter

Model Signature

B : B (Standard) series
D : D (Deluxe) series

Lens Mount

None : C mount
BG205MC(F) only
-CS : CS mount

Color Type

None : Black/White(B/W)
C : Color

Total Pixel Numbers

03 : 0.3 mega pixels
08 : 0.8 mega pixels
13 : 1.3 mega pixels
20 : 2.0 mega pixels
23 : 2.3 mega pixels
30 : 3.0 mega pixels
40 : 4.0 mega pixels
50 : 5.0 mega pixels
60 : 6.0 mega pixels
65 : 6.5 mega pixels
80 : 8.0 mega pixels
120 : 12.0 mega pixels

Image Size

0.3 Mega Pixels Type
0 : 1/3 type
1 : 1/2 type
0.8 Mega Pixels Type
0 : 1/3 type
1.3 Mega Pixels Type
0 : 1/3 type
2 : 1/1.8 type
2.0 Mega Pixels Type
2 : 1/1.8 type
5 : 2/3 type
2.3 Mega Pixels Type
8 : 1/1.2 type
8L : 1/1.2 type, Low-fps
3.0 Mega Pixels Type
2 : 1/1.8 type
2L : 1/1.8 type, Low-fps
4.0 Mega Pixels Type
6 : 1.0 type
5.0 Mega Pixels Type
5 : 2/3 type
5L : 2/3 type, Low-fps
6.0 Mega Pixels Type
2 : 1/1.8 type
6.5 Mega Pixels Type
7 : 1.1 type
8.0 Mega Pixels Type
6 : 1.0 type
12.0 Mega Pixels Type
3 : 1/1.7 type
7 : 1.1 type

Rev.1.04

Advantage of BU1203MC/MCF

Advantage of BU1203MC/MCF

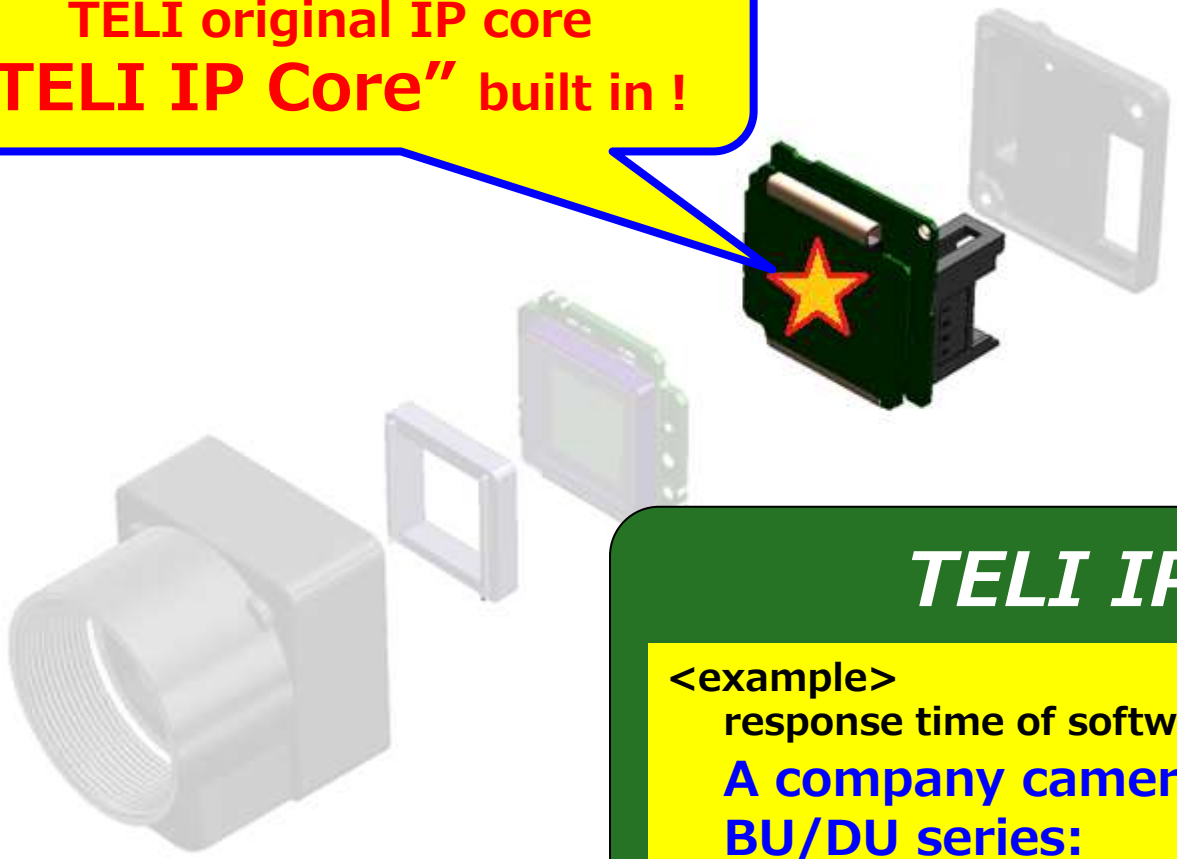
- **TELI original IP core**
  - High integration, by originally developed innovative technology, achieves super high speed response
- **Super high resolution, High sensitivity and High quality image**
  - Adopting Sony's IMX226(12.4M pixels) RS (Rolling Shutter) CMOS sensor STARVIS
  - Back side irradiation sensor achieves high sensitivity and better incident angle quality event with its compact pixel size
  - Less defect and noise with Sony quality
- **Advanced function**
  - Function with scalable, event notification and image buffer
- **Software**
  - Free supply of Software developing package "TeliCamSDK"
- **Quality warranty**
  - Full of 3 years warranty

* STARVIS or STARVIS logo might be trade mark of Sony Corporation.

Advantage of BU1203MC/MCF

■Extremely quick response by original IP

Newly developed
TELI original IP core
"TELI IP Core" built in !

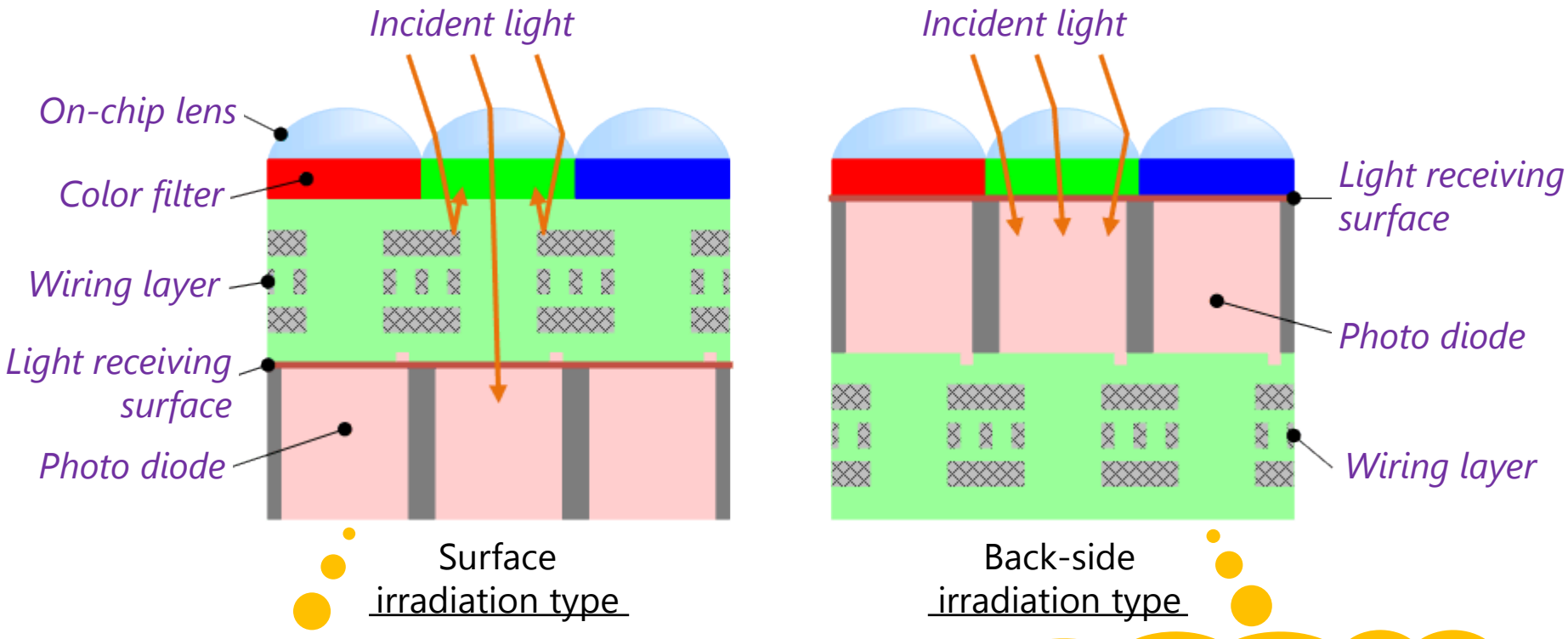


TELI IP Core

<example>
response time of software trigger
A company camera: 4msec
BU/DU series: ***5µsec*** (average)

Advantage of BU1203MC/MCF

■ **Structure difference between surface irradiation type sensor (conventional) and back side irradiation type sensor**



Incident light is hindered and reduced by wiring layer before it reaches photo diode. As a result, sensitivity is reduced.

Setting photo diode on front surface, then setting color filter and micro lens on it. As a result, sensitivity is well kept without hindrance of wiring layer.

Specification comparison

Specification Comparison (sensor)

Model	IMX226	IMX174	CMV2000	ICX274
Vendor	Sony	Sony	CMOSIS	Sony
Type	CMOS	CMOS	CMOS	CCD
Pixel Number	4,000(H)x3,000(V) / 4,096(H)x2,160(V)	1,920(H)×1,200(V)	2,048(H)×1,088(V)	1,600(H)×1,200(V)
	12M / 4K2K	WUXGA/2.3M	2M	UXGA/2M
Pixel Size	1.85(H)×1.85(V)µm 	5.86(H)×5.86(V)µm 	5.5(H)×5.5(V)µm 	4.4(H)×4.4(V)µm 
Image Size	7.40(H)×5.55(V)mm Diagonal: 9.25mm 	11.25(H)×7.03(V)mm Diagonal: 13.27mm 	11.26(H)×5.98(V)mm Diagonal: 12.75mm 	7.04(H)×5.28(V)mm Diagonal: 8.80mm 
Optical Format	Type 1/1.7	Type 1/1.2	Type 2/3 (1“)	Type 1/1.8
Aspect Ratio	4:3 / 17:9	16:10	2:1	4:3
Frame Rate	34.97fps / 29.97fps	164.5fps	350fps	15fps
DR	-	-	-	-
SNR	-	-	-	-

Specification Comparison

■ USB3.0 Camera Specification Comparison by GS/RS (1)

Specification items		BU series GS-CMOS type	BU1203MC/MCF RS-CMOS type
【1. Electric Spec】			
Color type		Mono	× : No setting
		Color without IR-cut filter (BU***MC)	Color without IR-cut filter (BU1203MC)
		Color with IR-cut filter (BU***MCF)	Color with IR-cut filter (BU1203MCF)
Interface		USB3.0	
Imaging Element		GS-CMOS	RS-CMOS
Electronic shutter type		Global shutter	Rolling Shutter (Global reset)
Synchronizing type		Internal or Bus synchronization	Internal
Image data format	Mono	Mono 8	mono 8
	Color	Bayer 8	Bayer 8
Scanning mode		Subject to sensor specification	
Frame rate		30fps	
【2. Power consumption】			
Power voltage		DC5V ± 5%(USB Port)	
Power consumption		Subject to sensor specification	
【3. Electronic shutter】			
Shutter type		Global shutter	Rolling Shutter / Global Reset
Shutter speed		*** s ～ *** s	43.28μs ~ 16s (Edge mode : 682μs～16s)
Shutter mode		Normal (MANU) / Random	Normal (MANU) / Random
Random trigger shutter		Hardware / Software	
Fixed mode		○ : Function available	○ : Function available
Pulse width mode		○ : Function available	○ : Function available
Bulk trigger		○ : Function available	× : No function
Sequential shutter		○ : Function available	× : No function
Overlapping trigger		○ : Function available	× : No function

Specification Comparison

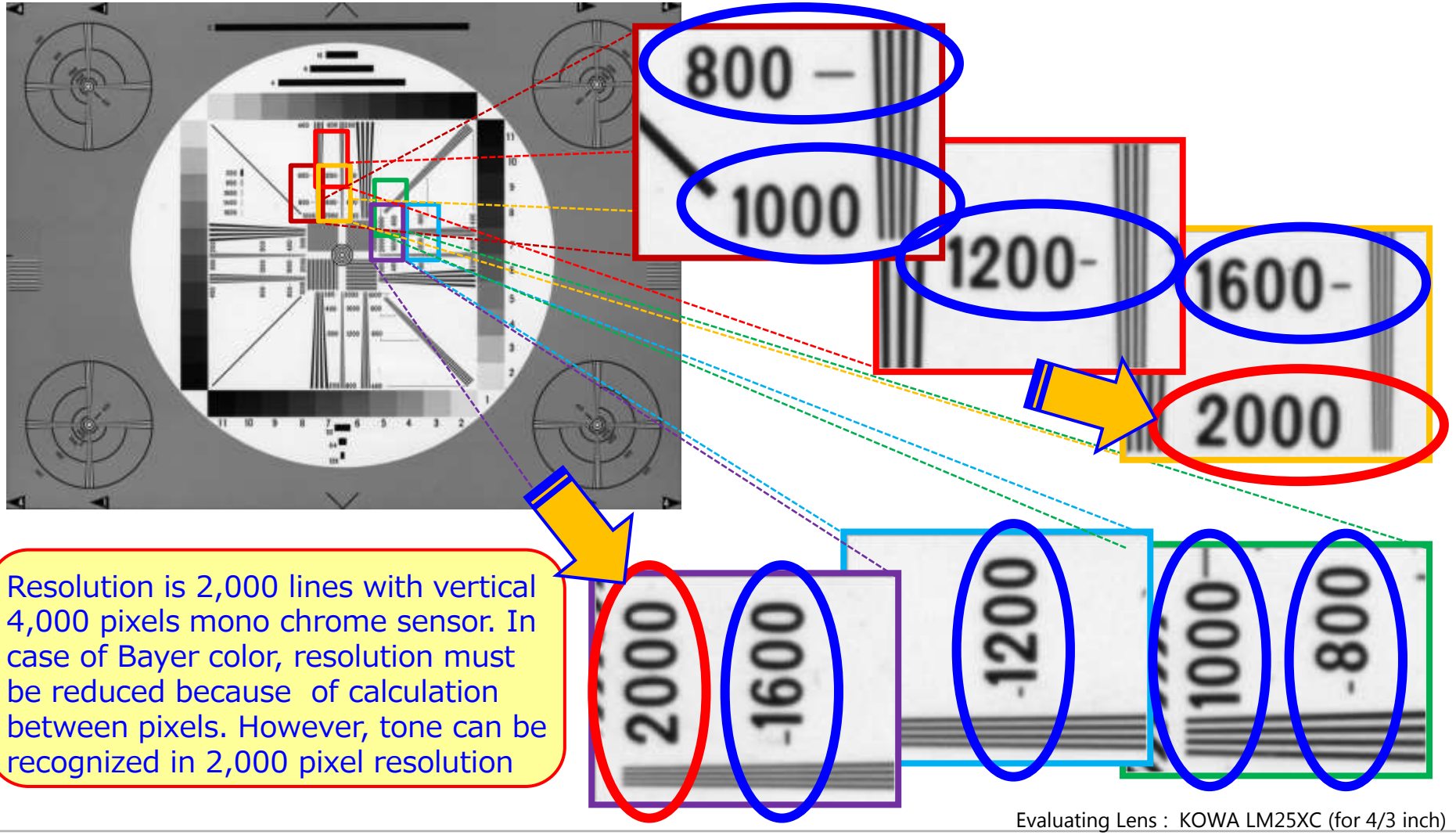
■ USB3.0 Camera Specification Comparison by GS/RS (2)

Specification items	BU series GS-CMOS type	BU1203MC/MCF RS-CMOS type
【4. Camera function】		
Offset	-25 to +25% (Default=0)	
Gain	MANU	MANU
White balance	MANU / ONCE	MANU / ONCE
Gamma correction	0.45 to 1.0	
LUT	10bit to 10bit	
【5. Mechanical･optical Spec		
All items	Common specification	
【6. Operational environmental conditions		
All items	Common specification	
【7. Product structure】		
All items	Common specification	
【8. Options】		
All items	Common specification	
【9. Complying Law･regulations】		
All items	Common specification	

Performance Comparison

Resolution of BU1203MC/MCF

Example of calculating Bayer output with software equivalent to mono- chrome output

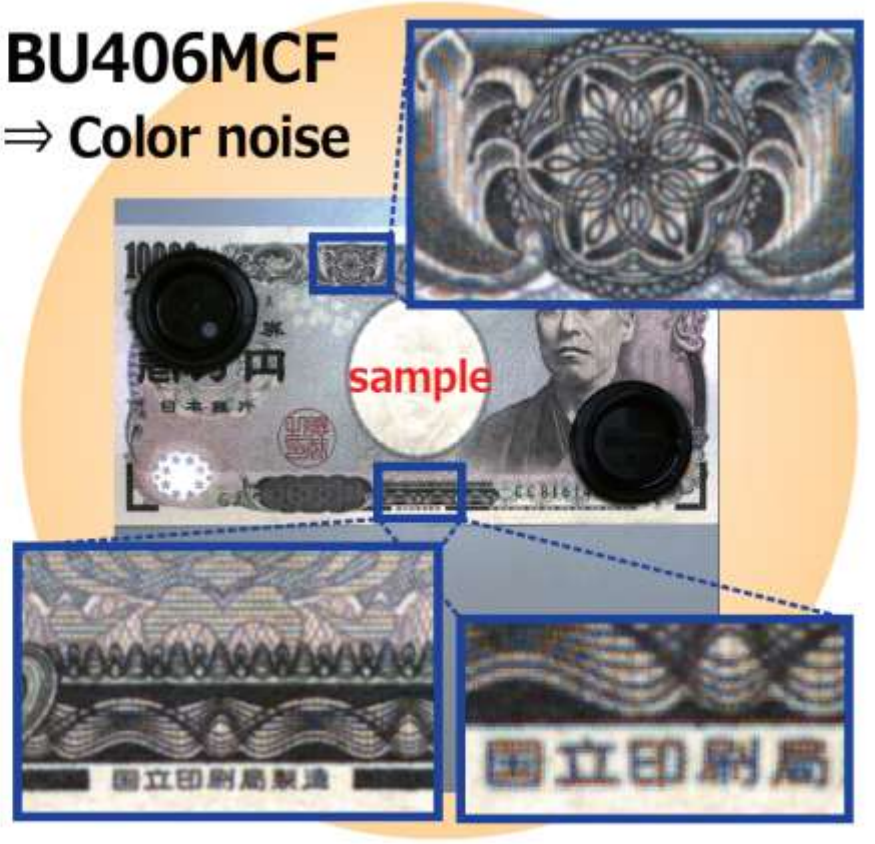


Resolution is 2,000 lines with vertical 4,000 pixels mono chrome sensor. In case of Bayer color, resolution must be reduced because of calculation between pixels. However, tone can be recognized in 2,000 pixel resolution

Evaluating Lens : KOWA LM25XC (for 4/3 inch)

Resolution comparison

Resolution comparison of BU1203MCF(12Mpix) & BU406MCF(4Mpix)

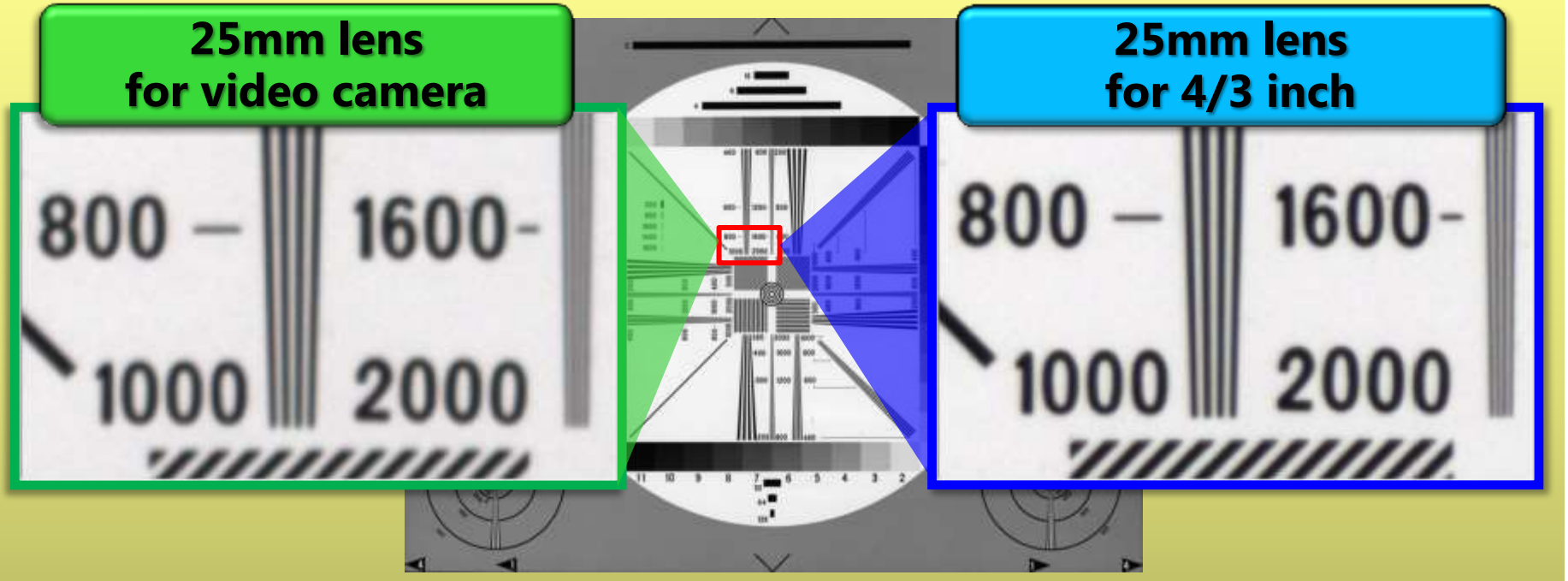


Comparing images of the same work size by BU1203MCF and BU406MCF camera with 4M-CMOS, apparently image by BU1208MCF has higher resolution due to its 2 times resolution

And, image by BU1203 does not obviously show color false peculiar to single sensor camera.

Example of resolution difference by lens

<Resolution Chart>



With lens for image sensor more than 1 inch, image is clear up to about 2,000 line pairs resolution. Even with video camera lens which is not for mega pixel, resolution in about 1,000 to 1,600 line pairs can be achieved.

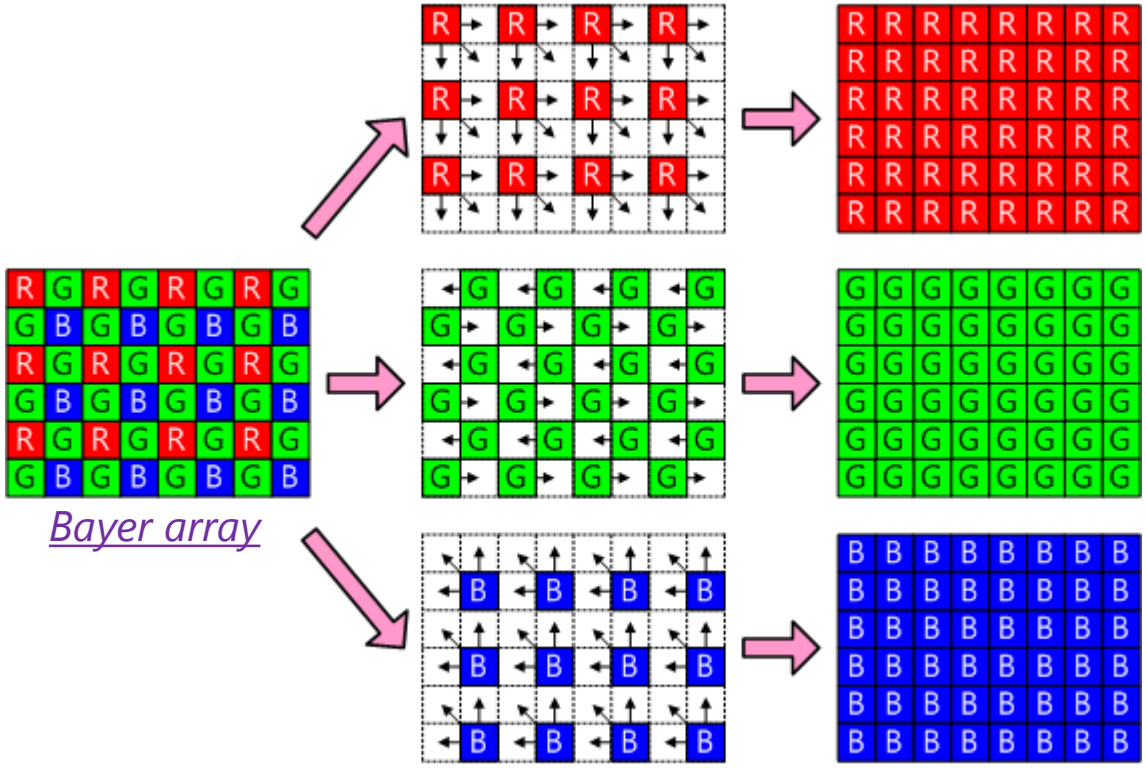
Advanced Function

Advanced Function (“MONO” output mode)

■ MONO output mode from color camera

Color camera generally output signal in RGB or RAW (Bayer). This function is to get output like mono chrome camera by calculating brightness from RGB.

① Conversion from Bayer to RGB (example)

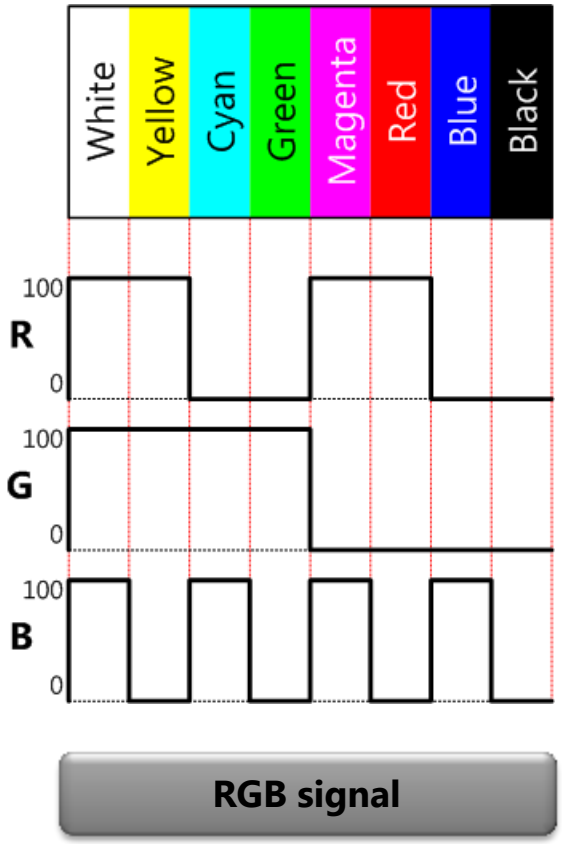


Among single plate color sensors, primary color RGB type sensor proceed through zigzag alignment (Bayer array) as chart shown in left.
A screen of RGB color can be output by interpolation on each RGB element
Left chart shows typical assignment method among various interpolation method.
Such as enhancing image quality by neighbor pixel calculation after RGB conversion, and interpolation by calculation with dynamic switching on detected brightness in horizontal and vertical.

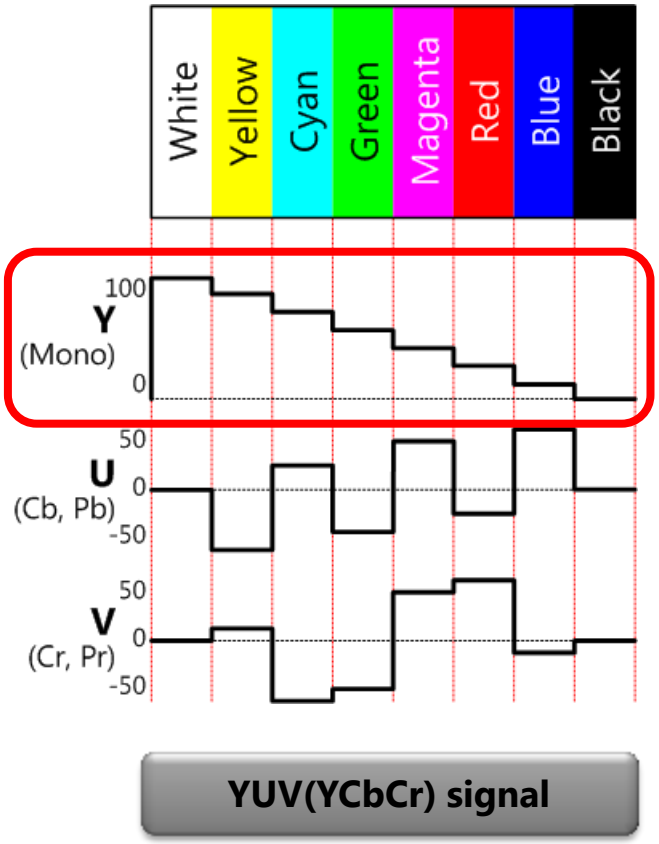
Advanced Function (“MONO” output mode)

② RGB to Y Conversion

Calculating brightness (Y) with RGB signal converted from Bayer signal, this camera outputs mono chrome signal as mono chrome camera.



RGB signal



YUV(YCbCr) signal

Brightness signal (Y) and chrominance signal (U/V) can be calculated from RGB signal.

General formulas are ;

Y=0.30R+0.59G+0.11B

U=-0.17R-0.33G+0.50B

V=0.50R-0.42G-0.08B

⇩

Output Y signal among above as mono chrome signal from camera.

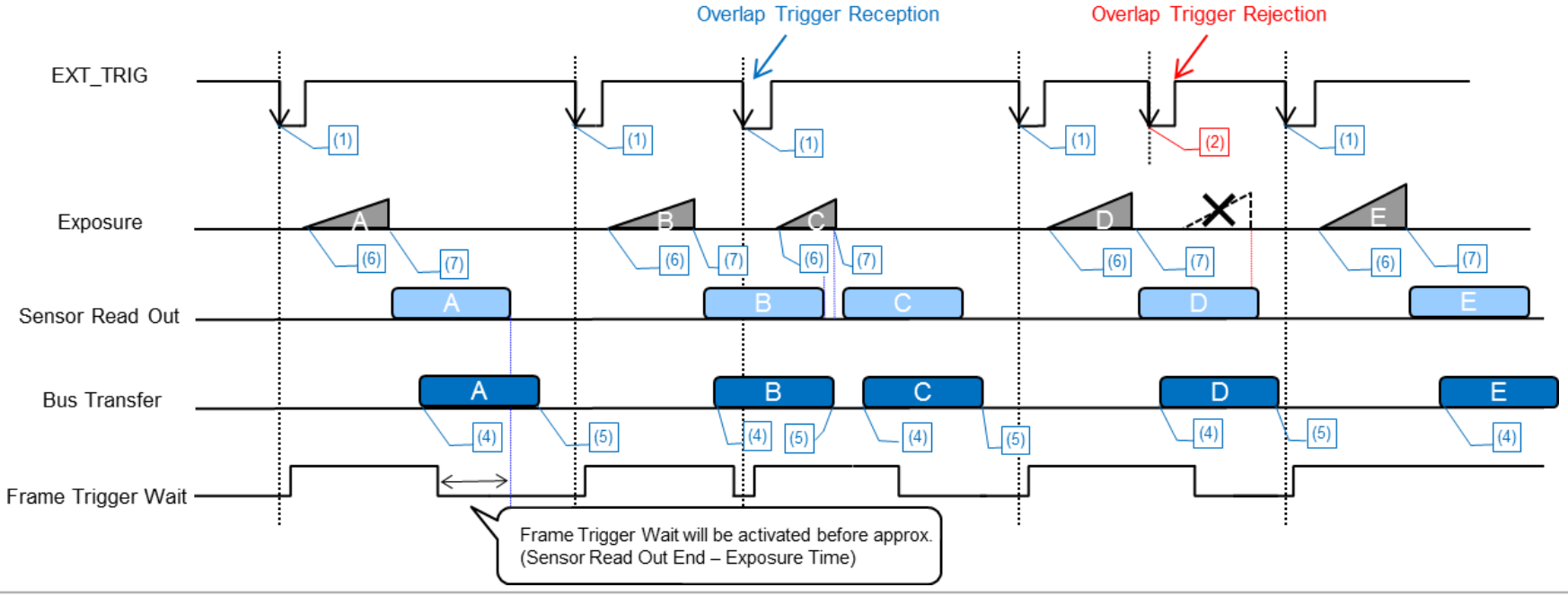
Might be Cb/Cr or Pb/Pr depend on calculation coefficient.

Advanced Function

■ Event notice function :

Camera status can be referred through USB3 by using event packet of USB3 Vision

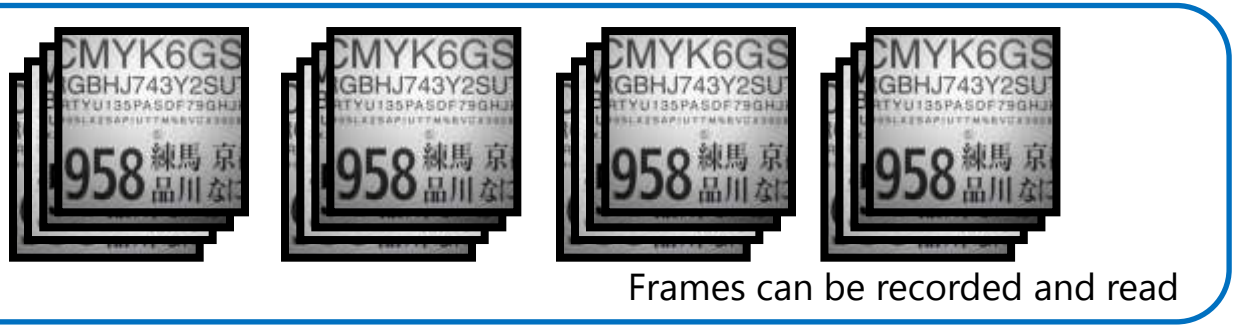
(1) Frame Trigger : Reception of Frame Start Trigger
(2) Frame Trigger Error : Rejection of Frame Start Trigger
(3) Frame Trigger Wait : Start of waiting for Frame Start Trigger
(4) Frame Transfer Start : Start of transferring Streaming data
(5) Frame Transfer End : End of Transferring Streaming data
(6) Exposure Start : Start of Exposure
(7) Exposure End : End of Exposure



Advanced Function

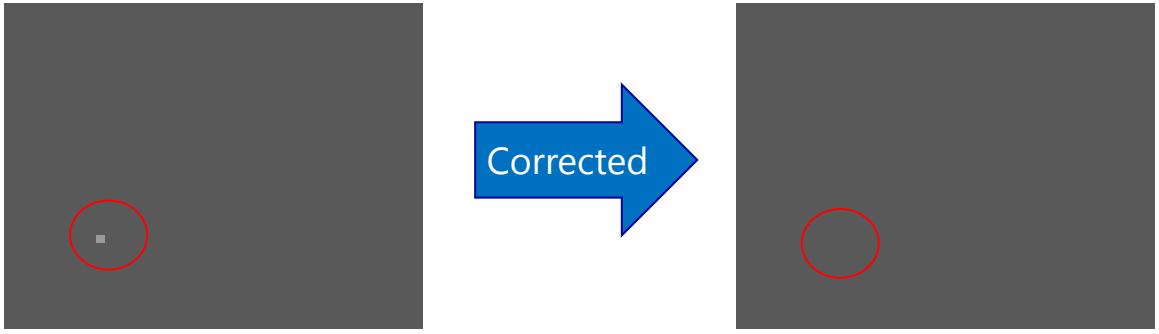
■ Image buffer :

As BU(CMOS) series have 64MB image buffer memory in it, recorded image data can be read from host PC at any time.



■ Correction function of pixel defect :

BU(CMOS) series have correction function of pixel defect. This function can be switched on and off depend on occasion.



Documents

Reference Documents

- **Specification sheet**
  (for BU1203MC/MCF)

- **Instruction manual**
  (for BU1203MC/MCF)

- **These documents are available in our HP to download;**

  http://www.toshiba-teli.co.jp/en/products/industrial/

[Appendix]
Explanation of Shutter function

Basic of electronic shutter (shutter, reset)

■ Shutter mode

- ➢ Assigning exposure time to sensor
  - ● **Global shutter**;
    - ✓ Shutter mode which takes image by exposure for all pixels (1 frame) in one time
    - ✓ Applied to CCD sensor and some of CMOS sensor
    - ✓ **Stable imaging for Motion picture and still picture**
  - ● **Rolling shutter**;
    - ✓ Shutter mode which has different exposure timing on each line. Most of CMOS sensors are applied.
    - ✓ Digital camera, mobile phone, smart phone, web camera, low cost monitor camera, mobile camera etc.
    - ✓ **Disadvantage of distortive image in motion picture**

■ Reset mode

- ➢ Action of clearing the **information (charge, electron)** in sensor before taking fresh image
  - ● **Global reset**;
    - ✓ A mode of reset which reset all pixels in one time
  - ● **Rolling reset**;
    - ✓ This resets on each line.

Sensor operation :

reset➡exposure➡
reset➡exposure➡・・・

Repeating above

Basic of electronic shutter (combination of shutter and reset)

1. Global shutter + global reset

- Complete **global shutter action**
- As scanning time is longer in lower part of image, black floating phenomenon might be caused by dark current effect. ＝This can be corrected as it is slight

2. Global shutter + rolling reset

- **Global shutter** mode can reduce an effect of time difference during reading by resetting on each line
- In some cases, effect of virtual global reset is achieved by high speed rolling reset

3. Rolling shutter + global reset

- As only resetting is done in one time, exposure time after reset varies on each line.
  ＝The lower part of image is the brighter as exposure time is longer.

4. Rolling shutter + rolling reset

- Complete **Rolling shutter** action
- Stable exposure process as both reset and shutter are rolling mode
- Easier to make low noise type sensor as structure of less pixel transistor number.
- As disadvantage, motion image shot under continuous light will be distortive.

Image comparison by shutter mode

■ Output comparison of rotating subject

Global shutter

- Complete image of moving subject

- Output image of moving subject is distortive

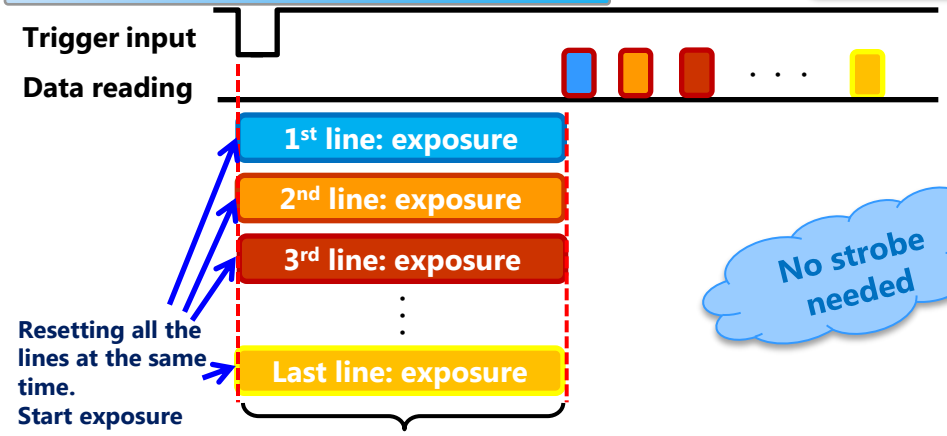
Rolling shutter

Shutter mode comparison 1

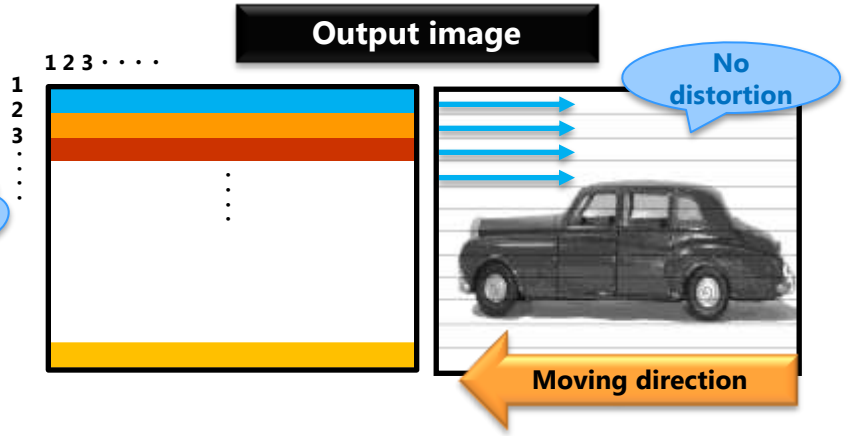
CMOSIS_4M

GS: Global shutter

Same exposure start time in each line. Hence no distortion of moving subject image under constant light.



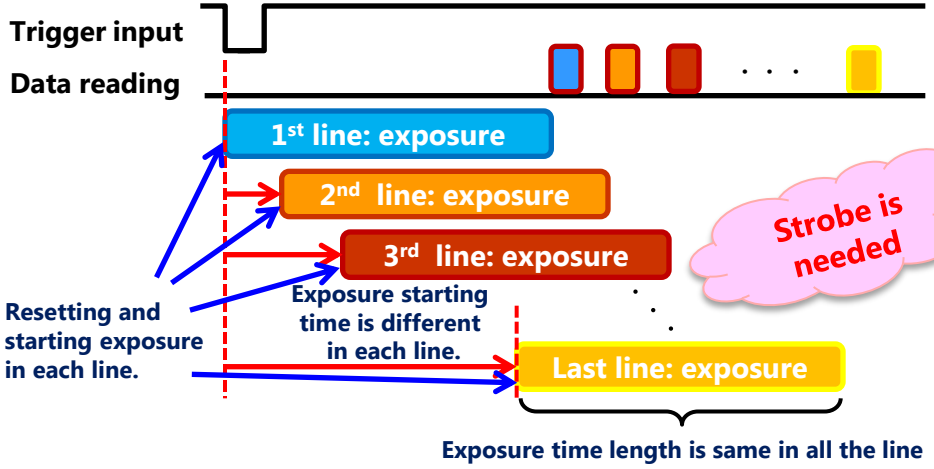
No strobe needed



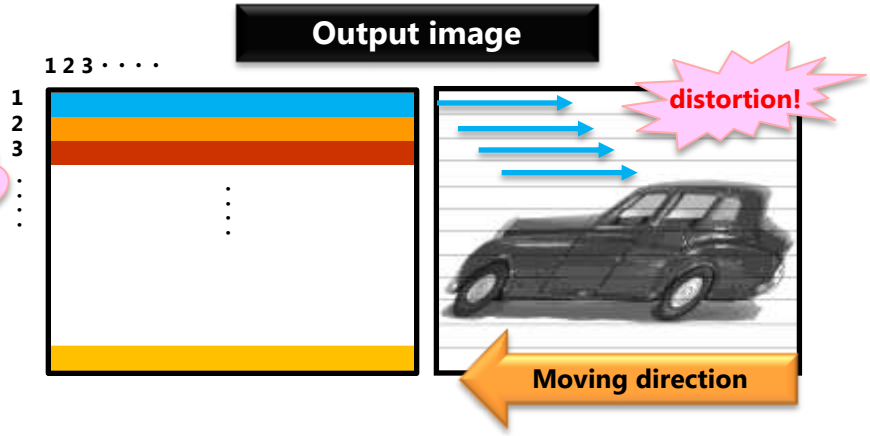
Aptina_5M

RS: Rolling shutter

Exposure start time is different in each line. Hence **"distortion" of moving subject image** is caused under constant light.



Strobe is needed



Shutter mode comparison 2

* data here are based on comparison test in our company. It may vary subject to circumstances.

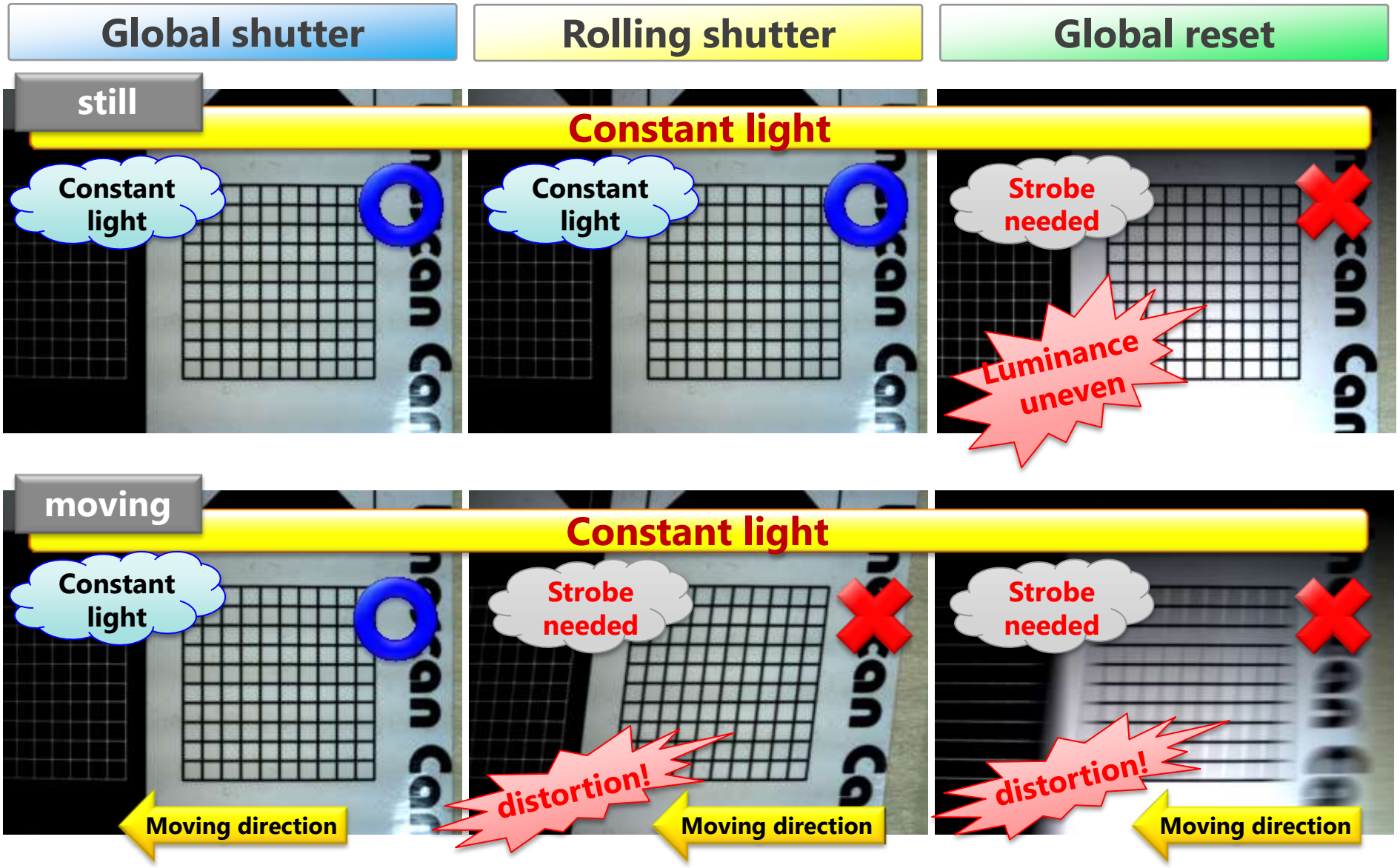
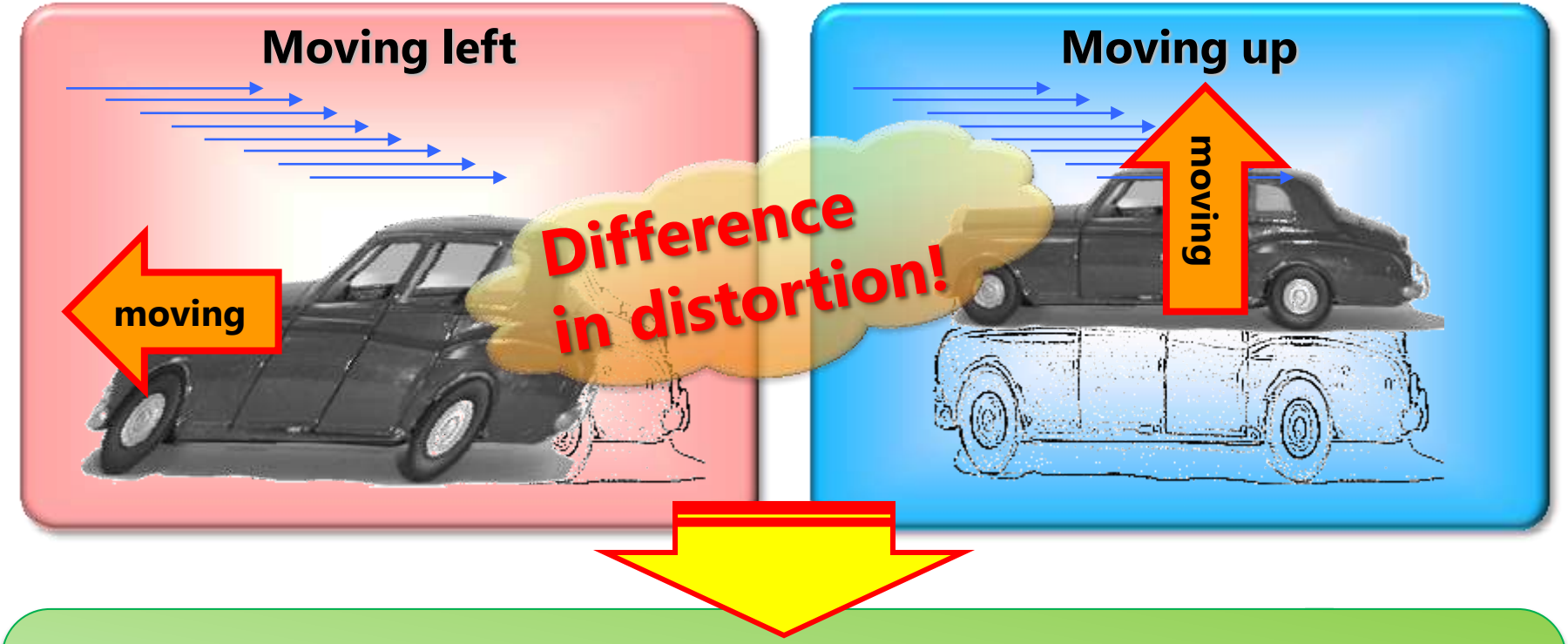


Image depend on moving direction of subject

■ Changing moving direction of subject in rolling shutter mode



- Changing camera angle against subject, distortion of image changes.
- In case of shooting subject in moving vertically with constant speed, image data without distortion can be gained by compensating constant enhancement in vertical.
  (* verification by actual camera is necessary. In case of global reset, problem might be caused as lower lins have fainting.)

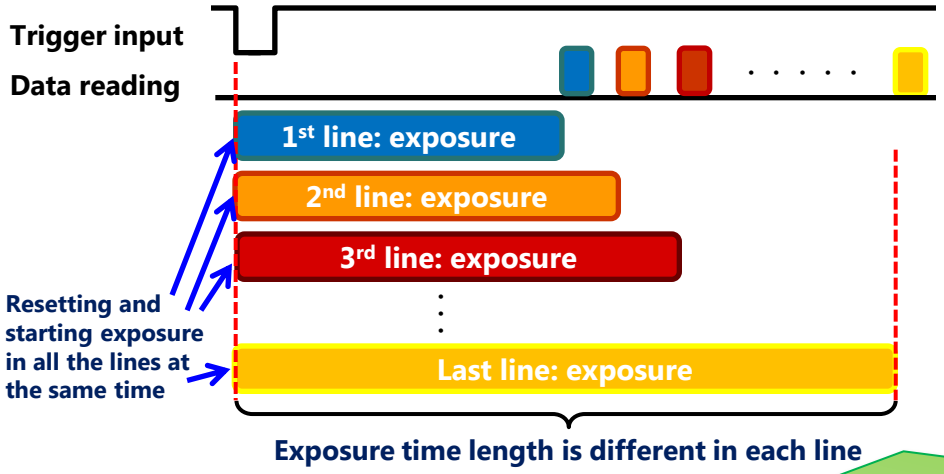
* Image

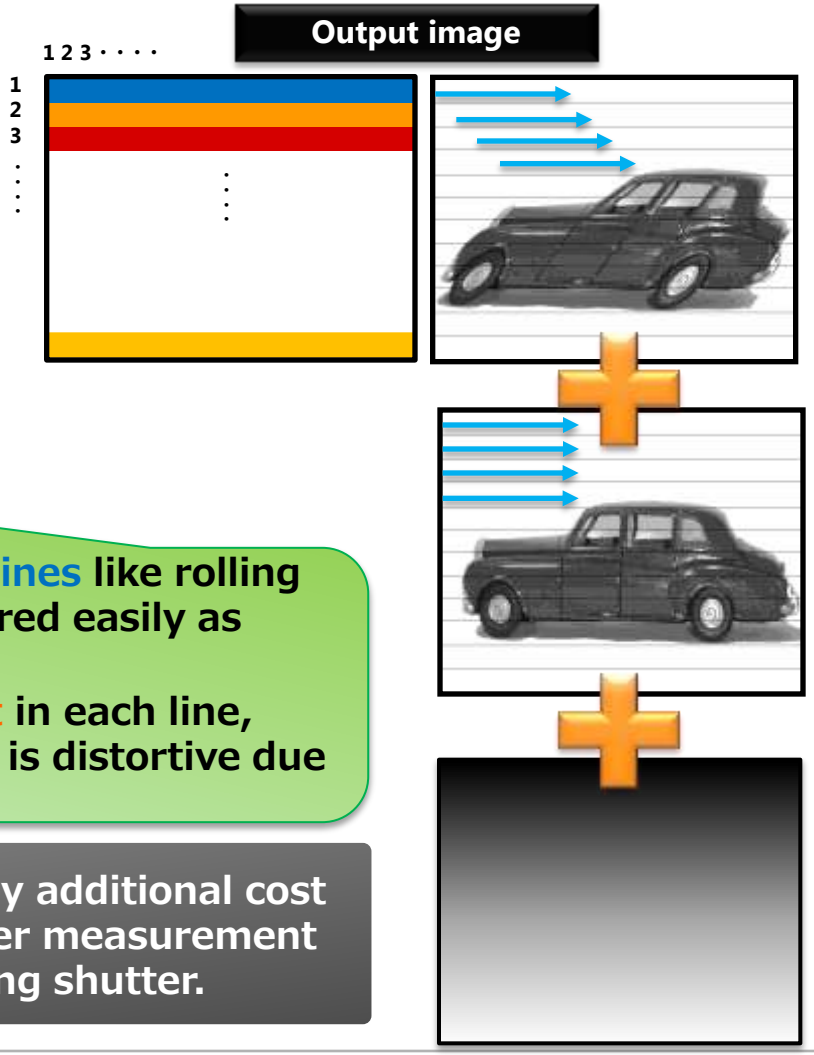
Shutter mode comparison 3

Aptina_5M

Global reset
(rolling shutter＋global reset)

Starting time of exposure is same in each line. However, exposure time length are longer in lower line. Hence **distortion and luminance difference in image** is caused under constant light.





As **no difference in exposure starting time in lines** like rolling shutter, exposure starting time can be measured easily as global shutter.
However, as **exposure ending time is different** in each line, image of moving subject under constant light is distortive due to luminance difference.

As a result, low cost advantage will be offset by additional cost of strobe. There is a certain advantage of easier measurement in exposure starting time comparing with rolling shutter.

vs. Global reset

* data here are based on comparison test in our company. It may vary subject to circumstances.

■ **Camera output comparison in shooting even luminance subject under constant light**

Global shutter Rolling shutter	Global reset (Rolling shutter＋Global reset)
	

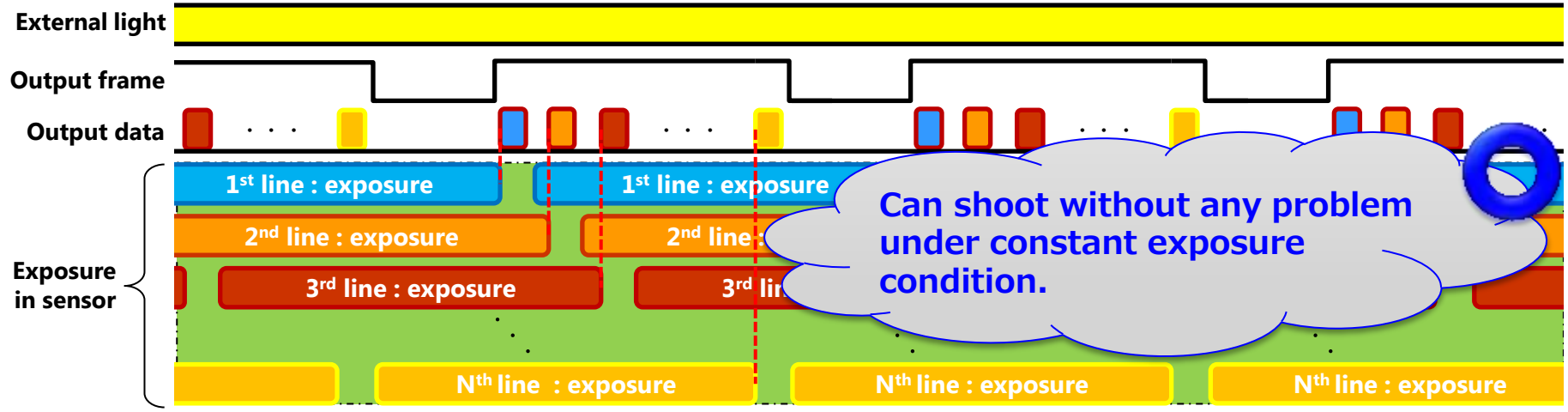
Under constant light, both of global shutter and rolling shutter can be used for shooting.

In case of global reset, the lower part becomes brighter due to duration time of output and exposure time.

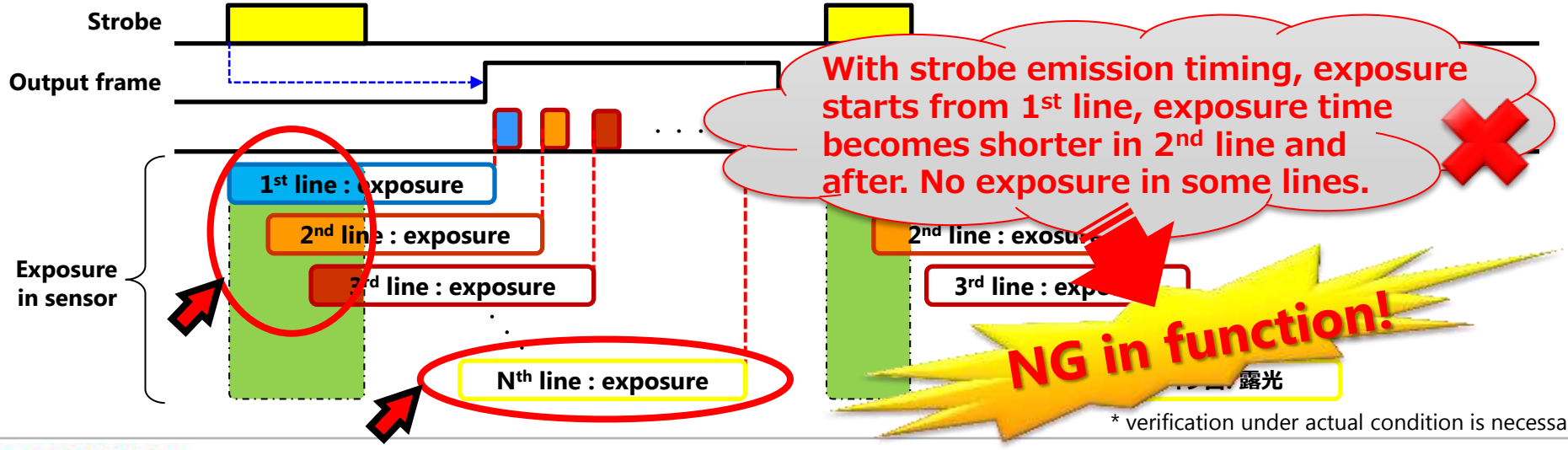
⇒ Proper light (strobe) is necessary

Basic timing of rolling shutter 1

① Shooting with constant light



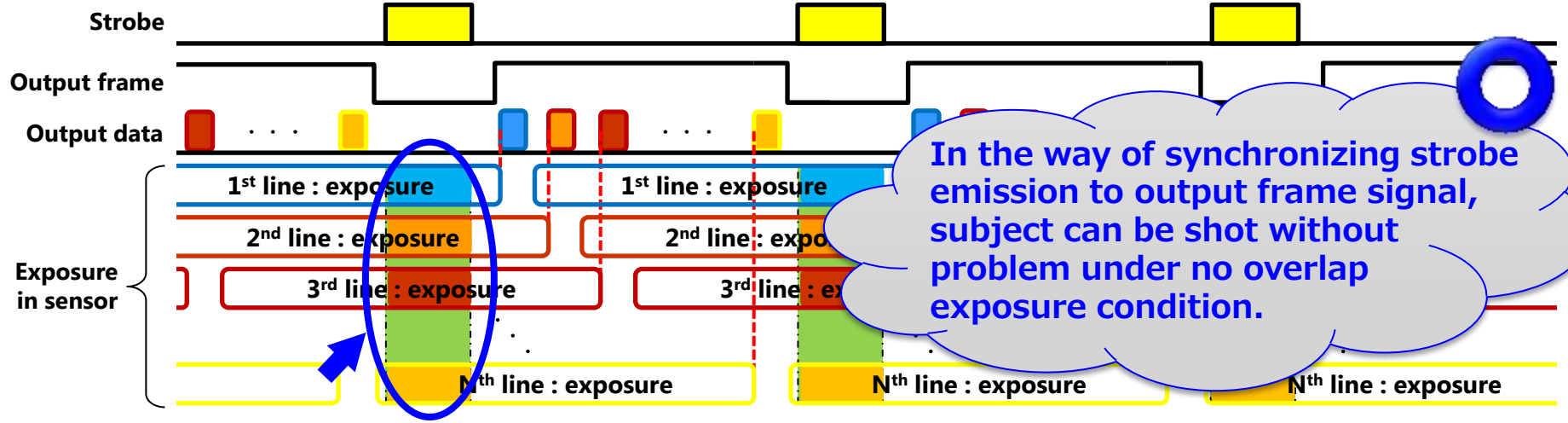
② Shooting in random trigger mode with strobe (no overlap)



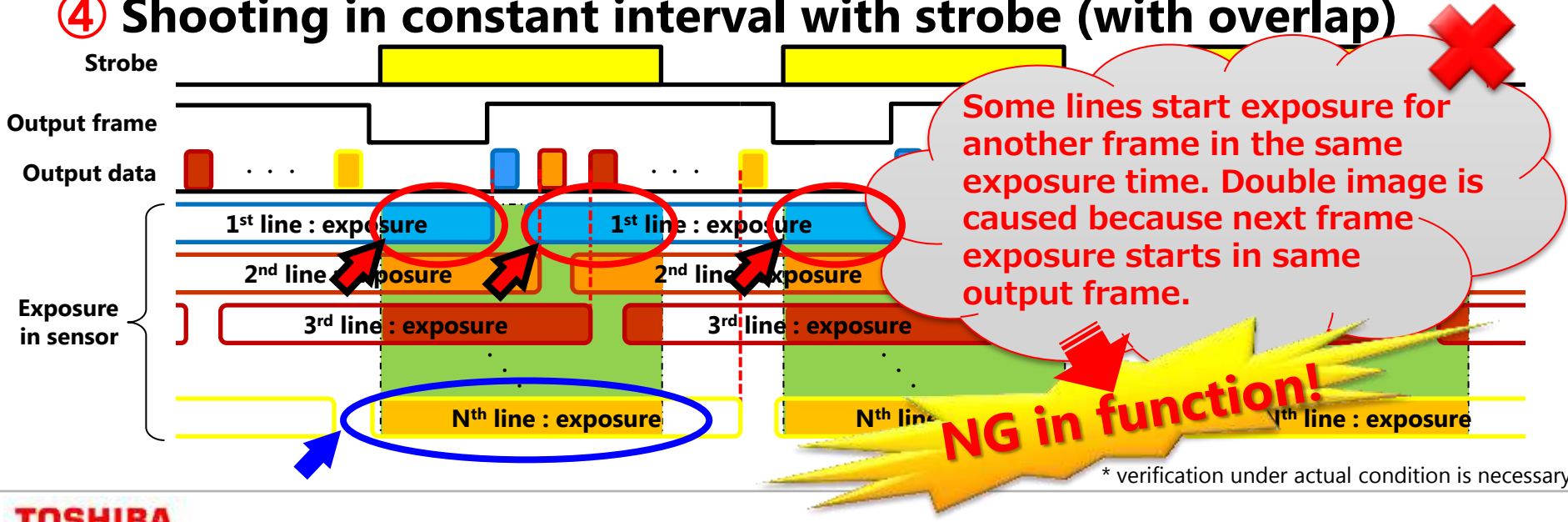
* verification under actual condition is necessary

Basic timing of rolling shutter 2

③ Shooting in constant interval with strobe (no overlap)



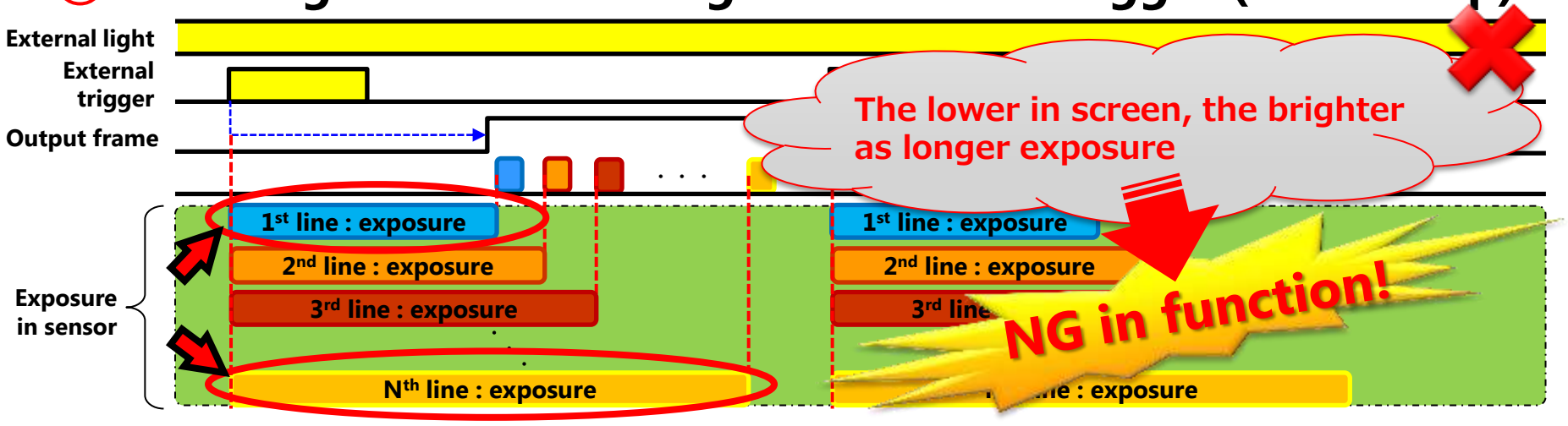
④ Shooting in constant interval with strobe (with overlap)



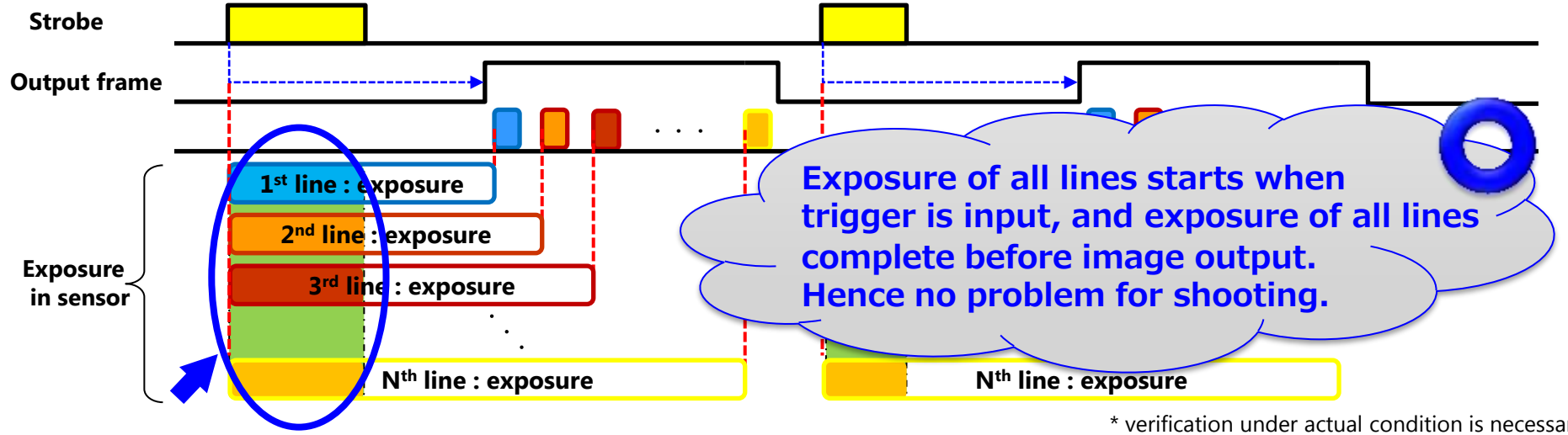
* verification under actual condition is necessary

Basic timing of global reset 1

⑤ Shooting with constant light at random trigger (no overlap)



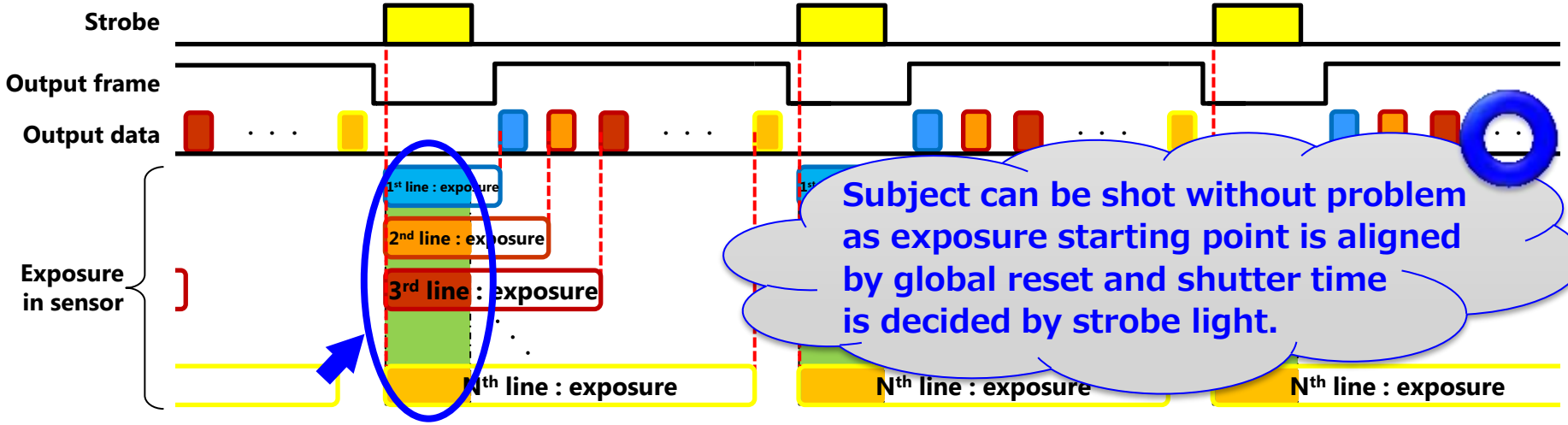
⑥ Shooting with strobe at random trigger (no overlap)



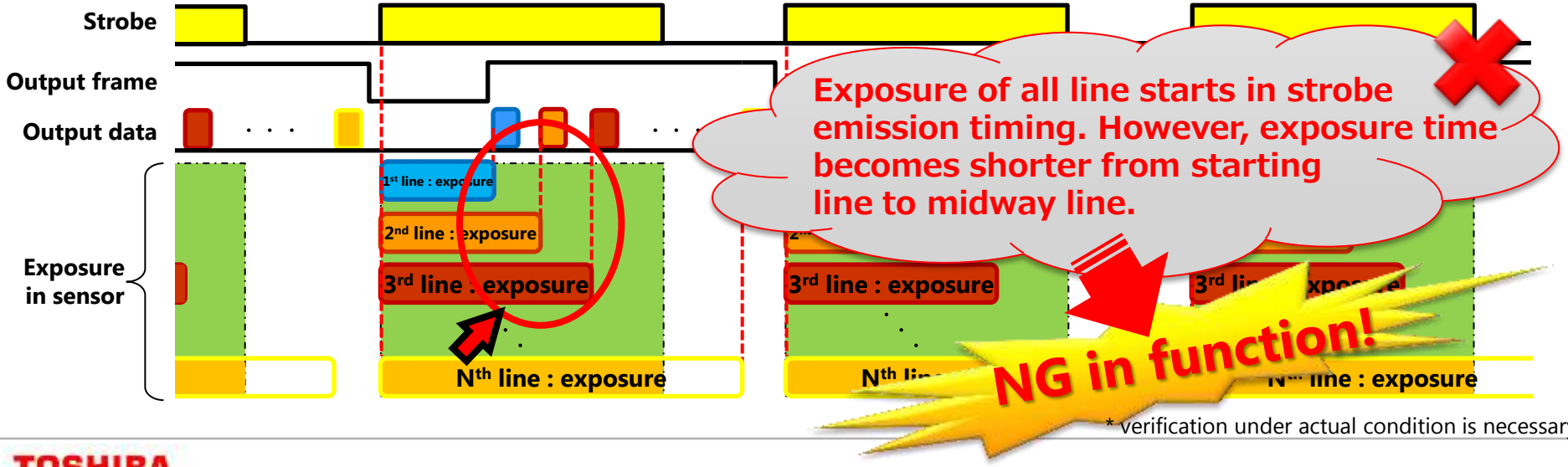
* verification under actual condition is necessary

Basic timing of global reset 2

⑦ Shooting in constant interval with strobe (no overlap)



⑧ Shooting in constant interval (with overlap)



* verification under actual condition is necessary

Summary of shutter action ~ still image

■ Shooting still subject with constant light

* verification in actual condition is necessary

Shutter mode	Shutter OFF Synchro in Camera, with overlap	Shutter ON Synchro in camera, without overlap	Random trigger	
			No overlap	With overlap
Global shutter (global shutter + global reset)	◎	◎	◎	○ Might be shutter scratch
Rolling shutter (rolling shutter + rolling reset)	◎ ①	◎ ①	(◎)	-
Global reset (rolling shutter + global reset)	× ⑤ V shading	× V shading	× V shading	(×) V shading

■ Shooting still subject with synchronized strobe

Shutter mode	Shutter OFF Synchro in camera, with overlap	Shutter ON Synchro. In camera, without overlap	Random trigger	
			No overlap	With overlap
Global shutter (global shutter + global reset)	◎ Almost nil in this case	◎	◎	○ Probably shutter
Rolling shutter (rolling shutter + rolling reset)	× ④ Double exposure	◎ ③	(×) ② Non exposure line	-
Global reset (rolling shutter + global reset)	× ⑤ V shading	◎ ⑦	◎ ⑥	(×) ⑧ V shading

* BU1203MCF

Summary of shutter action ~motion image

■ Shooting motion image with constant light

* verification in actual condition is necessary

Shutter mode	Shutter OFF Synchro. In camera, with overlap	Shutter ON Synchro. In camera, no overlap	Random trigger	
			No overlap	With overlap
Global shutter (global shutter + global reset)	◎	◎	◎	○ Might be shutter scratch
Rolling shutter (rolling shutter + rolling reset)	△ distortion	△ distortion	△ distortion	△ distortion
Global reset (rolling shutter + global reset)	× V shading, distortion, fading	× V shading, distortion, fading	× V shading, distortion, fading	× V shading, distortion, fading

■ Shooting motion image with synchronized strobe

Shutter mode	Shutter OFF Synchro. In camera, with overlap	Shutter ON Synchro. In camera, no overlap	Random trigger	
			No overlap	With overlap
Global shutter (global shutter + global reset)	◎	◎	◎	○ Might be shutter scratch
Rolling shutter (rolling shutter + rolling reset)	× Double exposure	△ distortion	× Unexposed line	× Double exposure
Global reset (rolling shutter + global reset)	× Unexposed line	◎	◎	× Unexposed line

* BU1203MCF

[Appendix]
Introduction of USB3.0/USB3 Vision

About USB3.0

■ Back ground of USB3.0

- USB was started to be used for PC peripherals such as mouse, keyboard, printer etc. in its early stage. And USB2.0 became majority which can be connected to mass storage like HDD.
- Gradually, USB is also used for sequential data transfer such as audio and video.
- As internet is getting more popular, USB3.0 became an interface which can handle more data. Official support to USB3.0 by Windows 8 also helps its popularity.
- Output data from camera is getting larger with higher speed than before in accordance with transition of CCD to CMOS sensor in it.
- USB3.0 is adopted as an interface which can handle these data. USB3.0 is expected as an interface for worldwide use by standardization of protocol as “USB3 Vision”.
- Industrial cameras with USB3.0 get ready to spread in the market with USB’s advantage of board less use and various availability of PC peripherals.

■ Transition of USB standard

- USB has been quite popular as multipurpose PC interface for about 20 years since USB1.0 in 1996.
- USB3.1 standard will start following the tremendous performance improvement of USB3.0.

Standard	USB1.0	USB2.0	USB3.0
Year	1996	2000	2008
Data rete	12Mbps	480Mbps	5Gbps
Max. current	500mA		900mA

USB3.0 interface(outline)

1

■ Bit rate : max. 5Gbps (Super Speed)

- Can transfer Uncompressed HDTV (1920x1080) image in 60fps

2

■ Cable length : No limit in standard (actual 5m)

- Length will be extended with cable quality and compensation device improvement
- Over 20m transfer by active optical cable (AOC)

8m is available with combination of system.

3

■ Number of axis : 9 lines

- 4 lines : USB2.0 signal
- 4 lines : for expanded super speed signal
- 1 line :GND

4

■ Communication mode : Full duplex

- Improved in communication efficiency against USB2.0 (half duplex)

5

■ Bus power source : max. 900mA

- Up to 4.5W with 5V supply

Image transfer of our USB3.0 camera is supported by USB3.0 standard

6

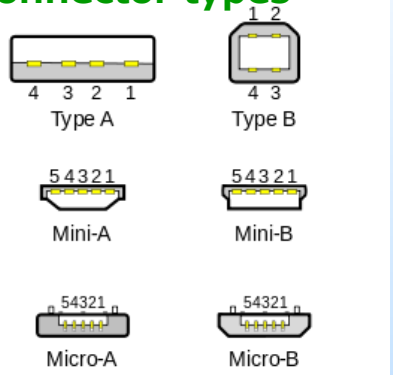
■ Lower compatibility

- USB3.0 device can be connected to USB2.0 port (works as USB2.0)
- USB2.0 device can be connected to USB3.0 port

Physical spec. of USB standard (reference)

USB2.0

Connector types



Pin array of standard USB connector

Pin	Function(Host side)	Function(Device side)
1	V_{BUS} (4.75 - 5.25 V)	V_{BUS} (4.4 - 5.25 V)
2	D−	D−
3	D+	D+
4	GND	GND

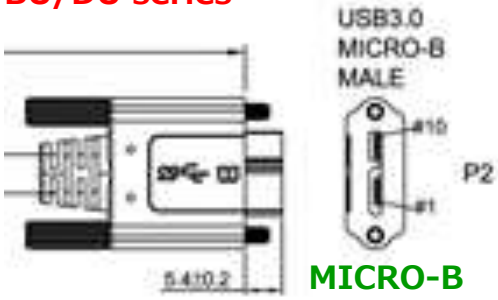
Pin array of mini-microUSB connector

Pin	Function(Host side)	Function(Device side)
1	V_{BUS} (4.75 - 5.25 V)	V_{BUS} (4.4 - 5.25 V)
2	D−	D−
3	D+	D+
4	ID	ID
5	GND	GND

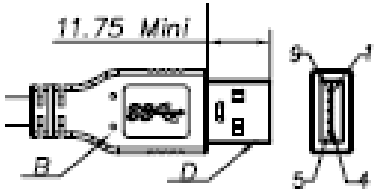
USB3.0

Connector types

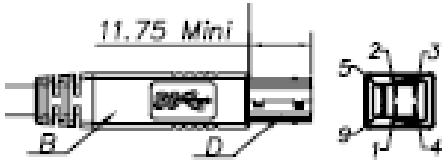
BU/DU series

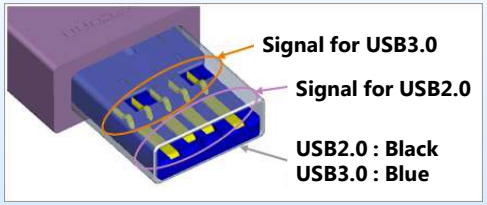


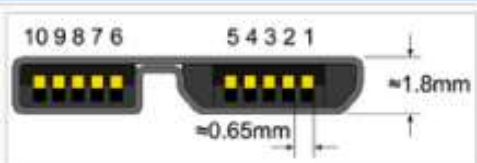
Standard -A



Standard -B







Micro socket for USB3.0

added connector with USB3.0 standard is arrayed beside USB2.0 micro connector.

No.1 : Power resource (VBUS)
No.2 : USB2.0 Differential pair (D-)
No.3 : USB2.0 Differential pair (D+)
No.4 : USB OTG ID
No.5 : GND
No.6 : USB3.0 Signal sending line (-)
No.7 : USB3.0 Signal sending line (+)
No.8 :
No.9 : USB3.0 Signal receiving line (-)
No.10 : USB3.0 Signal receiving line (+)

What's USB3 Vision ?

- **Machine vision standard**

  (IEEE1394 by IIDC, Gig-E by Gig-E Vision)
- **High band width of 5Gbps (440 MByte/s)**
- **Easy connection with Plug & Play**
- **Standardized software interface with GenICam™**
- **Much improved robust than USB2.0**

Comparison of major industrial interface

	USB3.0	Gigabit Ethernet	IEEE1394 (S800)	Camera Link	CoaXPress
Speed (band width)	<4Gbps (5Gbps Ø80%)	<1Gbps	655Mbps	2.04Gbps (Base Configuration)	5Gbps (6.125GbpsØ80%)
Unification of procedures	USB3 Vision (GenICam/IIDC)	GigEVision (GenICam)	IIDC	No standard	GenICam/ IIDC2
Multiple cameras	○	◎	◎	On FGB	On FGB
Simultaneous transfer	◎	○	◎	On FGB	On FGB
Bus power supply	Standard	PoE limited	Standard	PoCL limited	Standard
Easiness (non expert)	◎	○	◎	△	△
CPU load	Low	Slightly high	Very low	Very low	Very low
Connector size	◎	◎	○	△	◎
Connector reliability	○	○	◎	◎	◎
Maximum cable length	5m (no limit in standard)	<100m	4.5m (at first) (no limit in standard)	<10m	<100m

High bandwidth transfer

HIGH Bandwidth

- Taking advantage of high speed image sensor …USB3.0
- High bandwidth transfer by burst transfer …USB3.0

Sensor : Sony IMX174
Resolution : 1920 x 1200 (2.3MP)

GigEVision Camera	USB3 Vision Camera
Max. frame rate 50fps	Max. frame rate 165fps
Data rate 115MB/s	Data rate 380MB/s

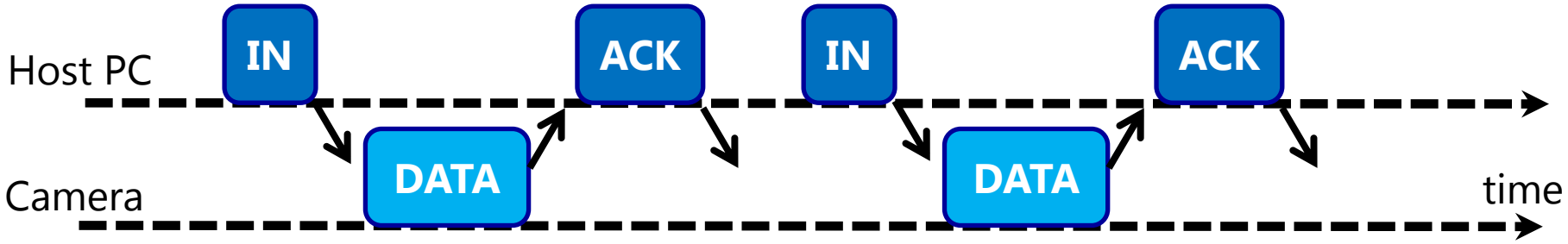
sensor : CMOSIS CMV4000
resolution : 2048 x 2048 (4.2MP)

GigEVision Camera	USB3 Vision Camera
Max. frame rate 25fps	Max. frame rate 90fps
Data rate 105MB/s	Data rate 377MB/s

Burst transfer compliancy

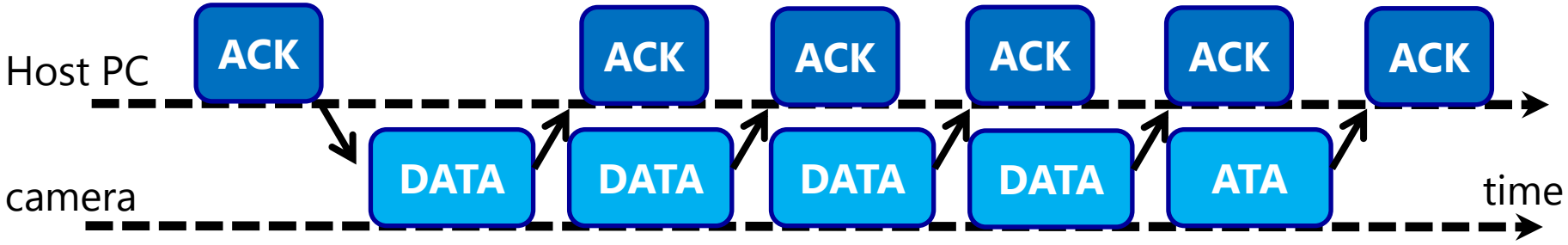
■USB2.0 : non compliancy to burst transfer

USB2.0 packet sequence cannot use bus band efficiently



■USB3.0 : compliancy to burst transfer

bus band can be used efficiently with burst transfer of USB3.0



Comparison of system cost

LOW COST

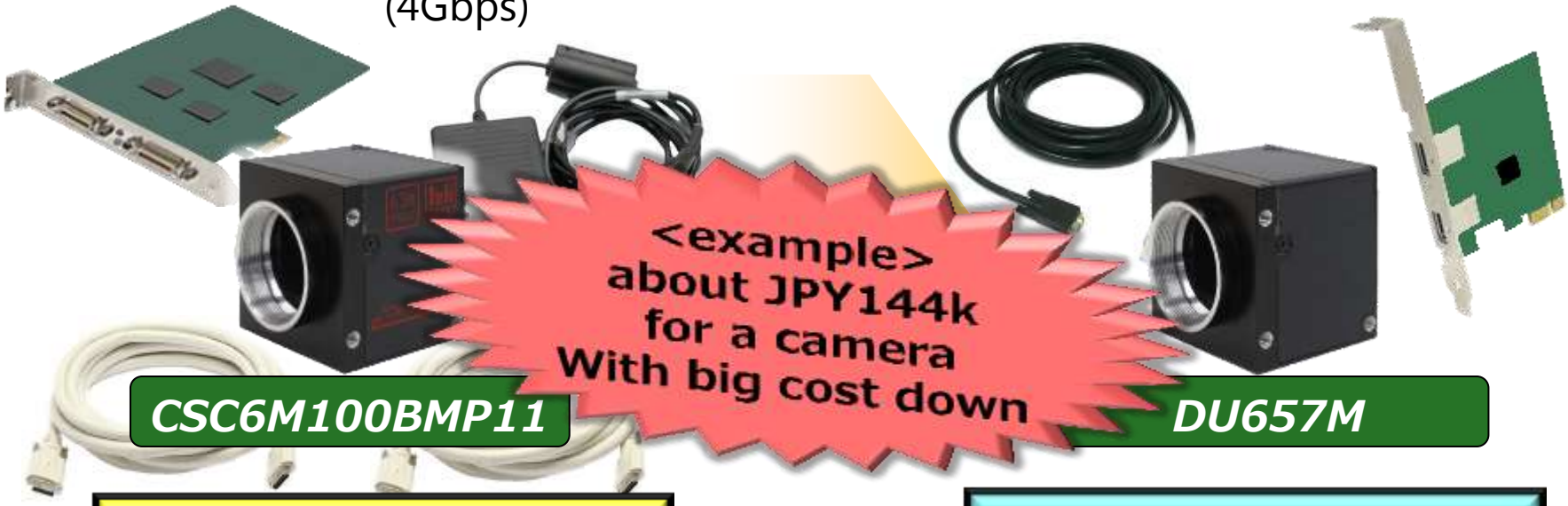
- Accessories with reasonable price…USB3.0
- No need of external power source…USB3.0

	USB3.0	GigE	1394.b	Camera Link
Frame Grabber	Low	Low	Medium	High
Cable	Low	Low	Medium	High
Power Supply	Bus	External / PoE	Bus	External / PoCL
Camera	Low	Medium	Medium	Low
4 Camera System Cost	**Low**	**Medium**	**Medium**	**High**

Applicable range of USB3.0

CameraLink
Medium Configuration
(4Gbps)

USB3.0
(4Gbps)



A camera (CL-FullConfig)
About JPY420k

camera (6.5M)	: JPY280k
board	: JPY100k
cable	: JPY30k
(power)	: JPY10k

A camera (USB3 Vision)
About JPY276k

camera (6.5M)	: JPY260k
board	: JPY8k
cable	: JPY8k

Big cost down by replacing Camera Link system with USB3.0 system!

High reliability

HIGH
Reliability

- Reliable data transfer is ensured ···USB3.0
- Packet format, Appropriate for DMA transfer ···USB3 Vision

Protocol Layer
data check by CRC
packet retransmission in protocol layer level

Link Layer
data check by CRC
packet retransmission in protocol layer level

Error protection of USB3.0 is much improved from USB2.0

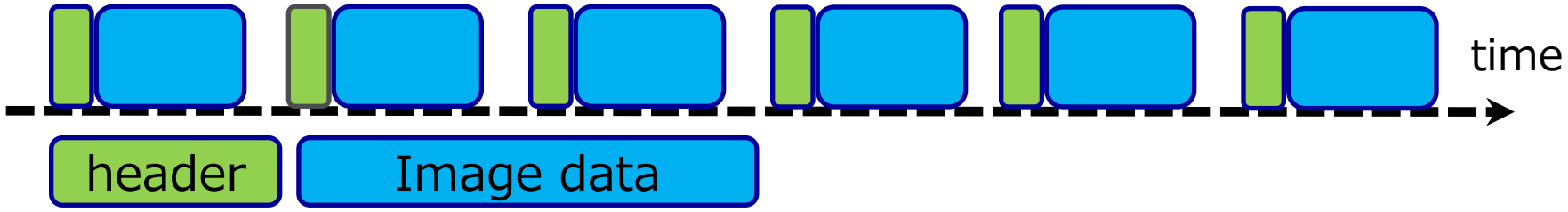
Physical Layer
bit error ratio in physical layer level is less than $1x10^{-12}$bits

USB3 Vision packet format

■UVC (USB Video Class) packet format

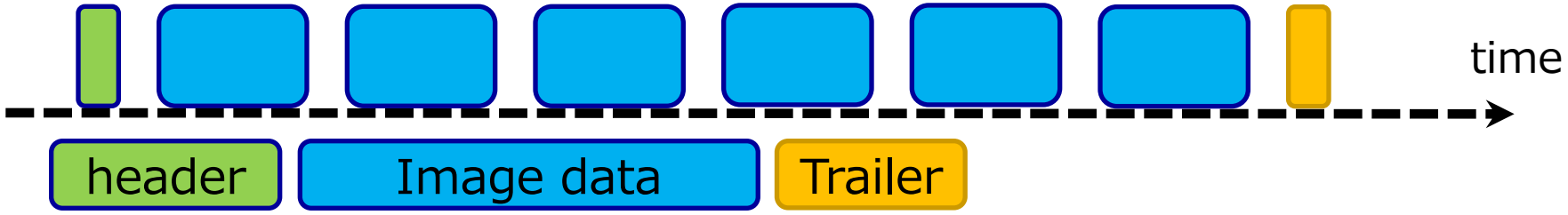
CPU analyzes header, and separate it from image data.

Over head is bigger, CPU process and communication becomes unstable.



■USB3 Vision packet format

CPU processing and communication is stable because of less CPU load as image data is deployed on memory at one time by DMA transfer.

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