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Driver circuit for CMOS linear image sensor

C16605

Compact circuit suitable for incorporation into spectrometers, etc.

The C16605 is a driver circuit developed for Hamamatsu CMOS linear image sensor S11639-01, etc. By connecting the C16605 to a PC through the USB 2.0 interface, you can control the C16605 from the PC and capture 16-bit digital output numeric data, converted from the sensor's analog video signal, into the PC. The C16605 consists of a sensor board that drives the sensor and an interface board that drives the sensor board and performs data communication with the PC. The two boards are connected via a flexible cable. The sensor board is compact, making it easy to be installed in optical systems. The interface board has external trigger I/O through-holes that can be used to synchronize with external devices by soldering pins or a cable. This product comes with application software (DcIc-USB) that runs on Microsoft® Windows® 10 (32-bit, 64-bit). It can be used to easily control the C16605 from the PC. The product also includes a DLL that the user can use to create original C16605 control programs.

Features

- **Built-in 16-bit A/D converter**
- **Compact sensor board: Easy to install in optical systems**
- **Interface: USB 2.0**
- **External synchronization operation capable**
- **Single power supply: USB bus powered (DC +5 V)**

Applications

- **Spectrometers**
- **CMOS linear image sensor S11639-01, etc. control and data acquisition**

Note: Microsoft and Windows are either registered trademarks or trademarks of Microsoft Corporation in the United States and/or other countries.

The C16605 is compatible with the following CMOS linear image sensors. Note that the C16605 does not include a sensor.

■ Directly mountable CMOS linear image sensors

Type no.	Number of pixels	Number of effective pixels	Pixel size (µm)	Image size [mm (H) × mm (V)]	Package
S16528-1024-11	1024	1002	28 × 200	28.672 × 0.200	LCP (liquid crystal polymer)
S13828		1024	28 × 84	28.672 × 0.084	
S16514-2048-11	2048	2002	14 × 200	28.672 × 0.200	
S11639-01		2048		28.672 × 0.200	
S11639-11		2004		28.056 × 0.200	
S15739-1024	1024	1024	14 × 200	14.336 × 0.200	
S15796-2048	2048	2048	7 × 200	14.366 × 0.200	
S13496	4096	4096	7 × 200	28.672 × 0.200	
S13496-11		4008	7 × 200	28.056 × 0.200	
S16596-4096-11		4008	7 × 200	28.672 × 0.200	
S12706		4096	7 × 7	28.672 × 0.007	

■ CMOS linear image sensors to be connected using a conversion board*1

The following sensors cannot be directly mounted on the C16605. A conversion board is required for connection to the C16605. Contact us for detailed information.

Type no.	Number of pixels	Number of effective pixels	Pixel size (µm)	Image size [mm (H) × mm (V)]	Package
S11639-21	2048	2048	14 × 200	28.672 × 0.200	Surface mount type ceramic
S15739-1024-20	1024	1024		14.336 × 0.200	
S14739-20	256	256		3.585 × 0.200	
S13014	512	512		7.168 × 0.200	Ceramic
S13014-10					Surface mount type ceramic
S13496-20	4096	4096	7 × 200	28.672 × 0.200	Surface mount type ceramic
S15796-1024-20	1024	1024		7.168 × 0.200	
S15796-2048-20	2048	2048		14.366 × 0.200	
S15796-1024	1024	1024		7.168 × 0.200	LCP

*1: Hamamatsu conversion board is not covered by warranty. It is usable for operation check purposes only.

Structure

Parameter	Specification	Unit
Output type	Digital	-
A/D resolution	16	bit
Interface	USB 2.0	-

Absolute maximum ratings

Parameter	Symbol	Condition	Value	Unit
Supply voltage	Vdd	Ta=25 °C	0 to +6.0	V
Input signal voltage*2	Vi	Ta=25 °C	0 to +Vdd	V
Operating temperature	Topr	No dew condensation*3	0 to +50	°C
Storage temperature	Tstg	No dew condensation*3	-20 to +70	°C

*2: Trigger input

*3: When there is a temperature difference between a product and the surrounding area in high humidity environments, dew condensation may occur on the product surface. Dew condensation on the product may cause deterioration in characteristics and reliability.

Note: Exceeding the absolute maximum ratings even momentarily may cause a drop in product quality. Always be sure to use the product within the absolute maximum ratings.

Electrical characteristics (Ta=25 °C)

Parameter		Symbol	Condition	Min.	Typ.	Max.	Unit
Readout frequency		fop		-	10	-	MHz
Conversion gain		Gc	Gain=1	-	31	-	µV/ADU
Trigger output voltage	High level	-	Vdd=+5 V	3.8	-	Vdd	V
	Low level			-	-	0.6	V
Trigger input voltage	High level	-	Vdd=+5 V	+3.5	-	Vdd	V
	Low level			-	-	1.5	V
Current consumption		Ic		-	300	500	mA
High start pulse period*4 *5		thp(ST)		10	-	tpi(ST) - 200	clocks*6

*4: thp(ST) < tpi(ST)

*5: A maximum value exists when the synchronization mode is internal mode, external edge mode, or external gate mode.

*6: 1 clock = 1/fop

Electrical and optical characteristics (Ta=25 °C)

■ When S16528-1024-11 (1024 pixels) is mounted

Parameter	Symbol	Min.	Typ.	Max.	Unit
Readout noise	Nread	-	20	-	ADU rms
Saturation output	Dsat	-	56000	65535	ADU
Dynamic range*7	DR	-	2800	-	-
Line rate*8	-	-	-	6.6	kHz
Start pulse period*9 *10	tpi(ST)	1500	-	4294967295	clocks*11

■ When S13828 (1024 pixels) is mounted

Parameter	Symbol	Min.	Typ.	Max.	Unit
Readout noise	Nread	-	20	-	ADU rms
Saturation output	Dsat	-	56000	65535	ADU
Dynamic range*7	DR	-	2800	-	-
Line rate*8	-	-	-	6.6	kHz
Start pulse period*9 *10	tpi(ST)	1500	-	4294967295	clocks*11

■ When S16514-2048-11 (2048 pixels) is mounted

Parameter	Symbol	Min.	Typ.	Max.	Unit
Readout noise	Nread	-	20	-	ADU rms
Saturation output	Dsat	-	56000	65535	ADU
Dynamic range*7	DR	-	2800	-	-
Line rate*8	-	-	-	4	kHz
Start pulse period*9 *10	tpi(ST)	2500	-	4294967295	clocks*11

■ When S11639-01/-11/-21 (2048 pixels) is mounted

Parameter	Symbol	Min.	Typ.	Max.	Unit
Readout noise	Nread	-	20	-	ADU rms
Saturation output	Dsat	-	56000	65535	ADU
Dynamic range*7	DR	-	4000	-	-
Line rate*8	-	-	-	4	kHz
Start pulse period*9 *10	tpi(ST)	2500	-	4294967295	clocks*11

■ When S15739-1024/-1024-20 (1024 pixels) is mounted

Parameter	Symbol	Min.	Typ.	Max.	Unit
Readout noise	Nread	-	20	-	ADU rms
Saturation output	Dsat	-	56000	65535	ADU
Dynamic range*7	DR	-	4000	-	-
Line rate*8	-	-	-	6.6	kHz
Start pulse period*9 *10	tpi(ST)	1500	-	4294967295	clocks*11

*7: DR = Dsat/Nread
*8: Theoretical line rate value determined by the internal operation timing of the driver circuit. This is different from the line rate defined in the sensor specifications. This value is also different from the overall processing rate (system rate) of acquiring data into the PC via the USB 2.0 port.
*9: thp(ST) < tpi(ST)
*10: A maximum value exists when the synchronization mode is internal mode or external gate mode.
*11: 1 clock = 1/fop

■ When S15796-1024/-1024-20 (1024 pixels) is mounted

Parameter	Symbol	Min.	Typ.	Max.	Unit
Readout noise	Nread	-	20	-	ADU rms
Saturation output	Dsat	-	56000	65535	ADU
Dynamic range*12	DR	-	4000	-	-
Line rate*13	-	-	-	6.6	kHz
Start pulse period*14 *15	tpi(ST)	1500	-	4294967295	clocks*16

■ When S15796-2048/-2048-20 (2048 pixels) is mounted

Parameter	Symbol	Min.	Typ.	Max.	Unit
Readout noise	Nread	-	20	-	ADU rms
Saturation output	Dsat	-	56000	65535	ADU
Dynamic range*12	DR	-	4000	-	-
Line rate*13	-	-	-	4	kHz
Start pulse period*14 *15	tpi(ST)	2500	-	4294967295	clocks*16

■ When S13496/-11/-20 (4096 pixels) is mounted

Parameter	Symbol	Min.	Typ.	Max.	Unit
Readout noise	Nread	-	20	-	ADU rms
Saturation output	Dsat	-	58300	65535	ADU
Dynamic range*12	DR	-	3600	-	-
Line rate*13	-	-	-	2.2	kHz
Start pulse period*14 *15	tpi(ST)	4500	-	4294967295	clocks*16

■ When S16596-4096-11 (4096 pixels) is mounted

Parameter	Symbol	Min.	Typ.	Max.	Unit
Readout noise	Nread	-	20	-	ADU rms
Saturation output	Dsat	-	56000	65535	ADU
Dynamic range*12	DR	-	2800	-	-
Line rate*13	-	-	-	4	kHz
Start pulse period*14 *15	tpi(ST)	4500	-	4294967295	clocks*16

■ When S12706 (4096 pixels) is mounted

Parameter	Symbol	Min.	Typ.	Max.	Unit
Readout noise	Nread	-	33	-	ADU rms
Saturation output	Dsat	-	55700	65535	ADU
Dynamic range*12	DR	-	1700	-	-
Line rate*13	-	-	-	2.2	kHz
Start pulse period*14 *15	tpi(ST)	4500	-	4294967295	clocks*16

■ When S14739-20 (256 pixels) is mounted

Parameter	Symbol	Min.	Typ.	Max.	Unit
Readout noise	Nread	-	20	-	ADU rms
Saturation output	Dsat	-	56000	65535	ADU
Dynamic range*12	DR	-	2800	-	-
Line rate*13	-	-	-	13	kHz
Start pulse period*14 *15	tpi(ST)	750	-	4294967295	clocks*16

*12: DR = Dsat/Nread
*13: Theoretical line rate value determined by the internal operation timing of the driver circuit. This is different from the line rate defined in the sensor specifications. This value is also different from the overall processing rate (system rate) of acquiring data into the PC via the USB 2.0 port.
*14: thp(ST) < tpi(ST)
*15: A maximum value exists when the synchronization mode is internal mode or external gate mode.
*16: 1 clock = 1/fop

■ When S13014/-10 (512 pixels) is mounted

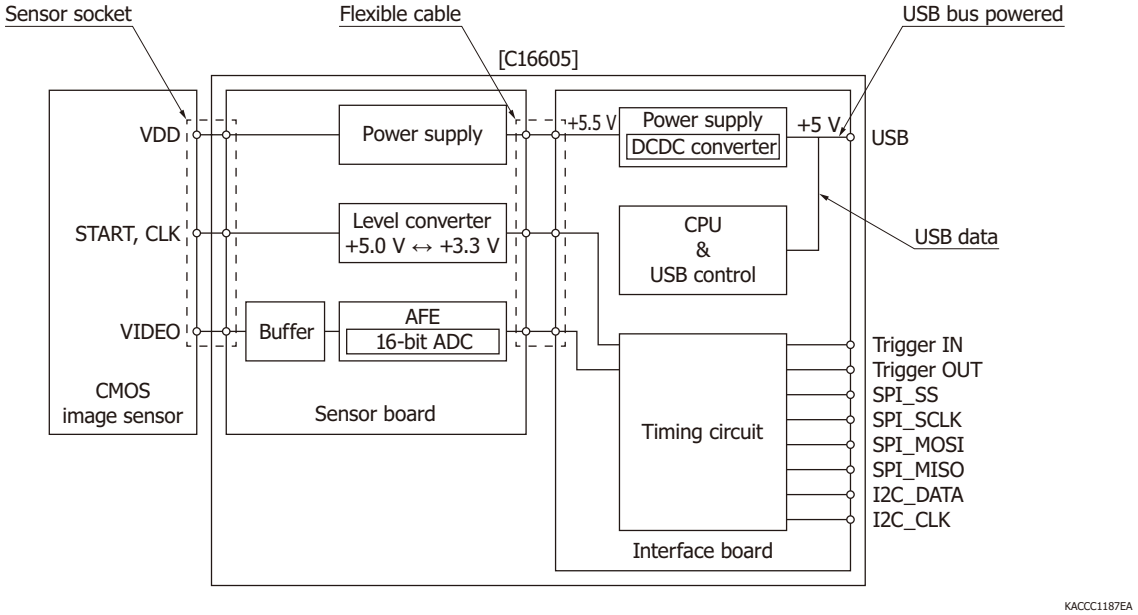
Parameter	Symbol	Min.	Typ.	Max.	Unit
Readout noise	Nread	-	20	-	ADU rms
Saturation output	Dsat	-	56000	65535	ADU
Dynamic range*17	DR	-	2800	-	-
Line rate*18	-	-	-	10	kHz
Start pulse period*19 *20	tpi(ST)	1000	-	4294967295	clocks*21

*17: DR = Dsat/Nread
*18: Theoretical line rate value determined by the internal operation timing of the driver circuit. This is different from the line rate defined in the sensor specifications. This value is also different from the overall processing rate (system rate) of acquiring data into the PC via the USB 2.0 port.
*19: thp(ST) < tpi(ST)
*20: A maximum value exists when the synchronization mode is internal mode or external gate mode.
*21: 1 clock = 1/fop

Function

Function	Description
Trigger mode change	The following trigger modes are available.For the detailed timing of each mode, see "Trigger mode" in "Timing chart" (P.7). · Internal mode · External edge mode · External level mode · External gate mode
Gain adjustment	The gain can be set in the range of 1 to 6.The set gain is calculated by the following equation. The default gain is 1. $\text{Gain} = \frac{6}{1 + 5\left(\frac{63 - G}{63}\right)}$ G: 6-bit value ranging from 0 to 63
Offset adjustment	The offset can be set in the range of -255 to +255. The offset increment per step is approximately 1.2 mV. The offset is set by writing a 9-bit value to the C16605 internal register. If the most significant bit (MSB) of the 9-bit value is zero, the offset is positive. In the case of 1, the offset is negative. The bit values other than the MSB are the magnitude of the offset. Note that because the offset circuit is arranged before the amplifier stage, the actual offset is equal to the offset value set above × gain.
Integration time change	The sensor integration time is changed by changing the high period of the ST pulse.
Start pulse period change	A maximum value exists for internal mode or external gate mode.

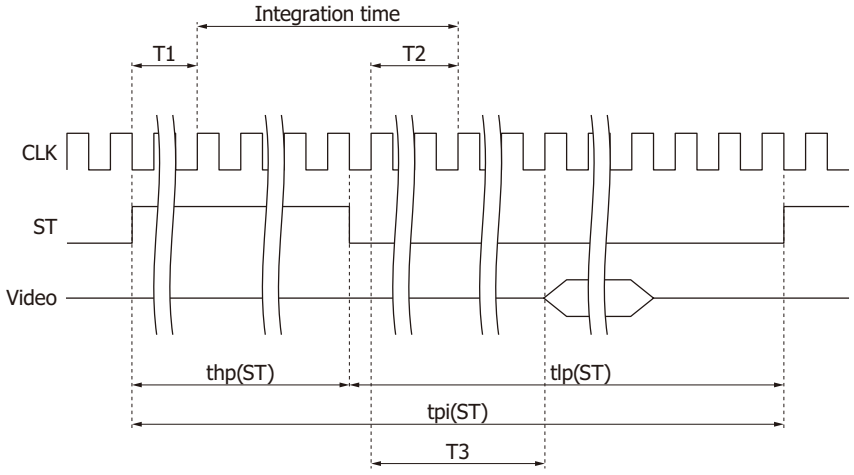
Block diagram



Timing chart

Sensor drive timing

The two parameters that can be changed in the sensor drive timing are the ST pulse width thp(ST) and the line period tpi(ST). For the thp(ST) and tpi(ST) settable ranges in internal mode, external edge mode, and external gate mode (explained later), see "Electrical characteristics" (P.2, 3). The timings of T1, T2, and T3 when the S11639-01 is connected are as follows.



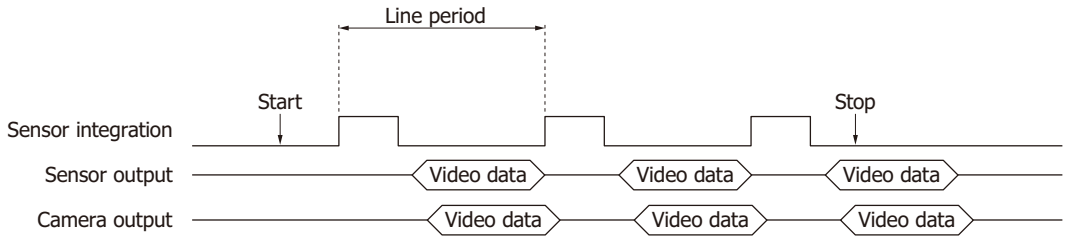
T1=4CLK
T2=52CLK
T3=87CLK
(1CLK=0.1 μs)
Integration time = thp(ST) + 48CLK

The following condition must be met.
tpi(ST) > thp(ST)

Trigger mode

Internal mode

When a Start command is received from the PC, the C16605 starts sensor integration and outputs acquired image data to PC.



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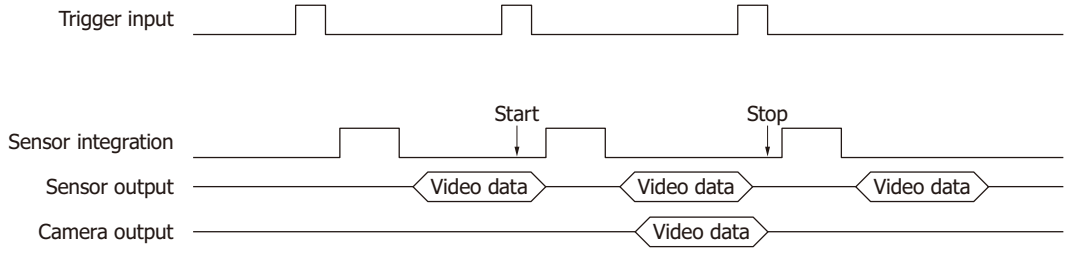
External edge mode

The sensor integration control is performed in synchronization with the edges of an external input trigger signal. When the circuit receives an external trigger after having received a Start command, the C16605 sends the image data output from the sensor to the PC.



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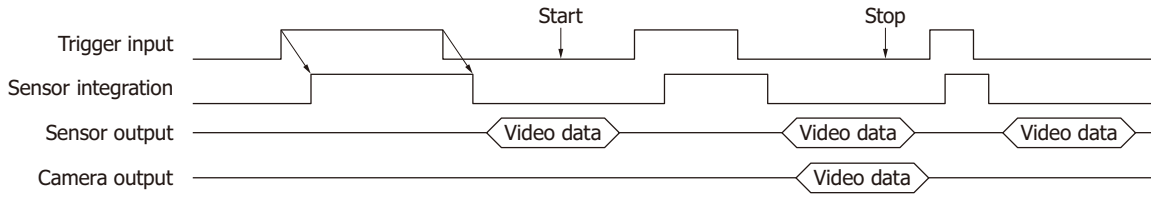
External level mode

Integration time and line transmission period are controlled using an external trigger signal.



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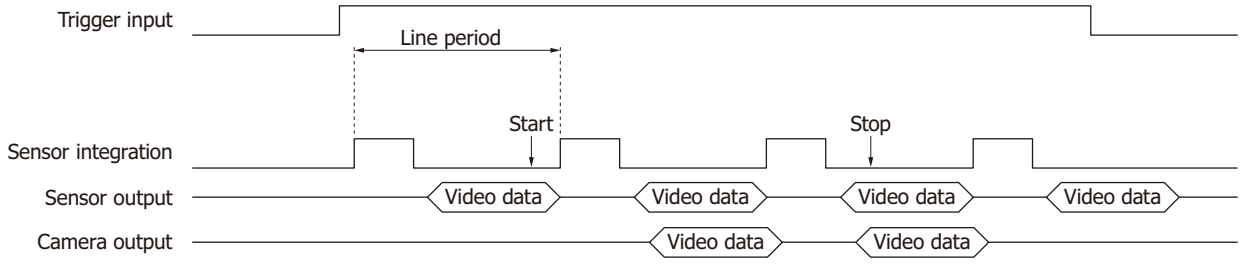
External gate mode

Integration is performed only while the external trigger is valid.



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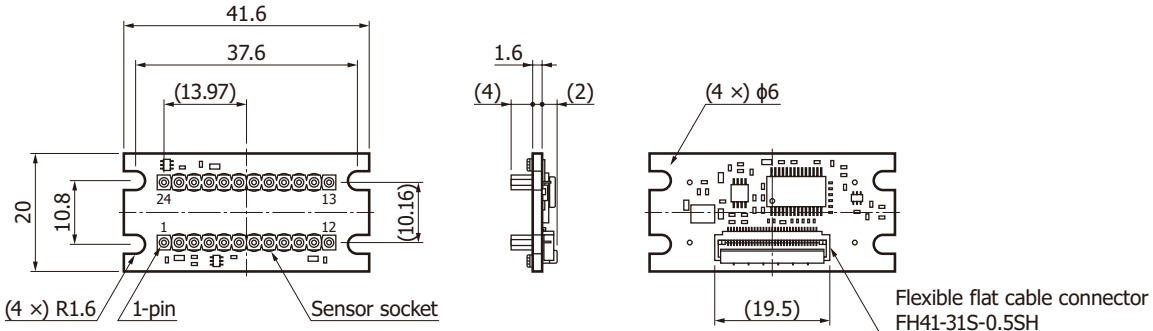
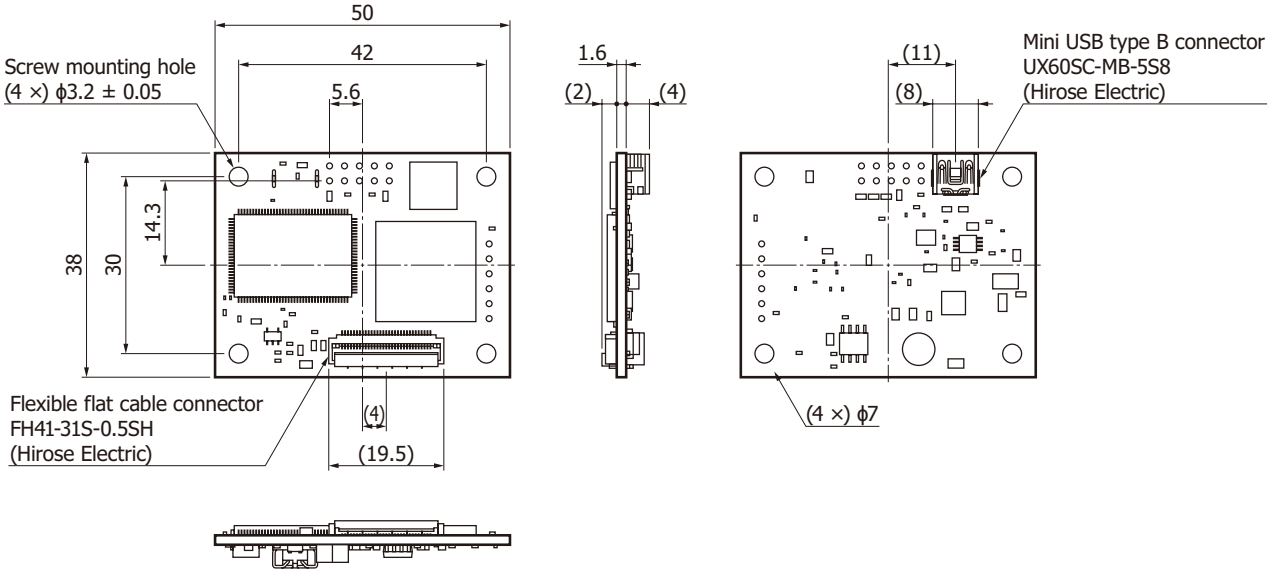
Dimensional outline (unit: mm)

■ Sensor board



Tolerance: ±0.2

■ Interface board



Tolerance: ±0.2

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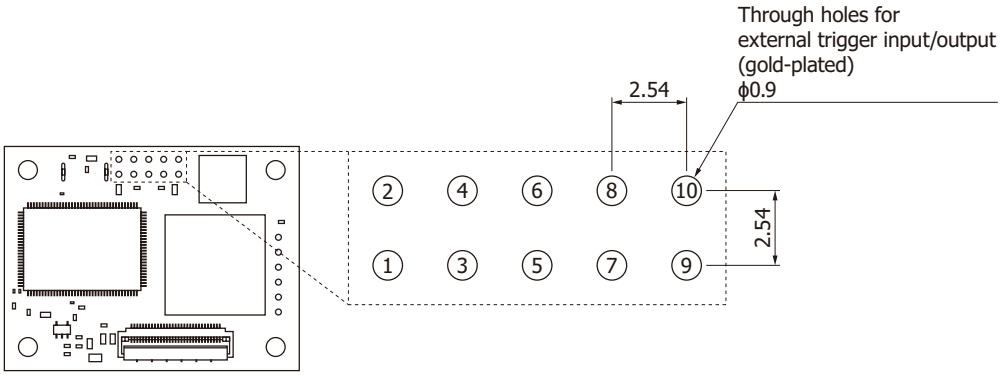
Weight: Approx. 20 g (including the flexible cable but not the sensor)

Pin connections of through holes for external trigger input/output (unit: mm)



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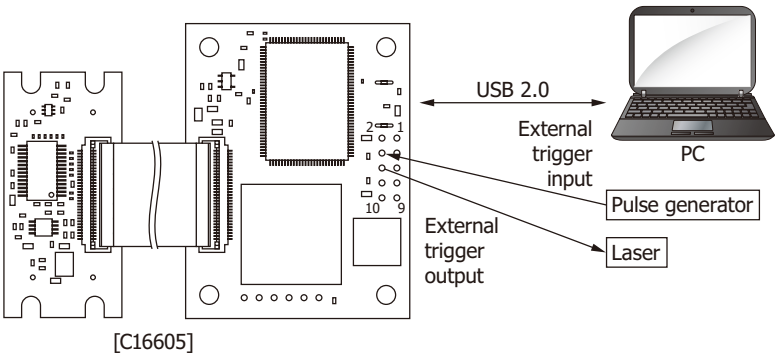
Pin no.	Symbol	Input/output	Description
1	PowerGND	-	GND*22
2	+5R0V_EXT	-	+5 V power supply*23
3	Trigger_In	Input	Trigger input terminal
4	SPI_SS	Input	SPI communication slave select (SS) terminal
5	Trigger_Out	Output	Trigger output terminal
6	SPI_SCLK	Input	SPI communication clock (SCLK) terminal
7	I2C_DATA	Input, output	I²C communication data terminal
8	SPI_MOSI	Input	SPI communication master data output (MOSI) terminal
9	I2C_CLK	Input	I²C communication clock terminal
10	SPI_MISO	Output	SPI communication master data input (MISO) terminal

*22: It is connected to the GND of the interface board. Used as a GND for digital signals.
*23: It is used when supplying power directly from an external source without using USB bus power.

Connection example



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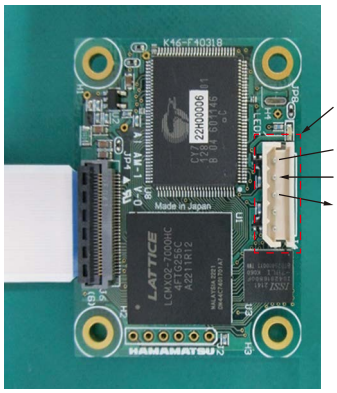
Soldering to through-holes for external trigger input/output

Pins and cables are required to be soldered to the through-holes for external trigger input/output in order to synchronize with external devices. Before soldering, make sure to read the following "Image sensors precautions | 3. Soldering."
https://www.hamamatsu.com/content/dam/hamamatsu-photonics/sites/documents/99_SALES_LIBRARY/ssd/image_sensor_KXX-A12018-ENG.pdf

■ Mounting example of a connector for external trigger input/output



Accessories

· CD-ROM (includes instruction manual, application software, and DLL file)
· Flexible cable for connecting the sensor board and interface board (length: 100 mm)

Related information

www.hamamatsu.com/sp/ssd/doc_en.html

■ Precautions
· Disclaimer
· Image sensors

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Cat. No. KACC1329E03 May 2024 DN