

OVERVIEW

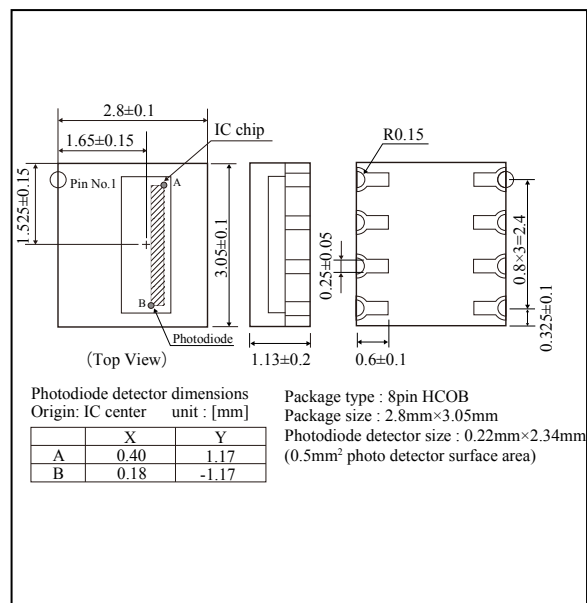
The SM3321A is an image sensor IC with a built-in single element photodiode of 0.5mm^2 . The IC can detect range of light wave from visible to infrared in itself. It is a superior sensor with noise immunity to integrate photodetection circuits which consist of photodiodes and operational amplifiers. The gain of amplifiers in SM3321A is settable by setting external terminals, so that it can detect range of light wave from visible to infrared with high sensitivity.

FEATURES

- High-sensitivity preamplifier for visible to infrared detection using a single IC
- Gain setting and output control function by pin terminal setting (GS0, GS1, GS2, OEN)
- Transimpedance range: $2\text{M}\Omega$ to $48\text{M}\Omega$
- Photodiode detector size: $0.22\text{mm} \times 2.34\text{mm}$ (0.5mm^2 photodetector surface area)
- Anti-reflection film coating with little sensitivity changing by wavelength
- Supply voltage range: 3.0 to 5.5V (single supply)
- Current consumption: 1.0mA (typ)@ $V_{\text{DD}}=5\text{V}$, no load
- Operating temperature range: -40 to $+85^\circ\text{C}$
- Package: 8 pin HCOB

PACKAGE DIMENSIONS

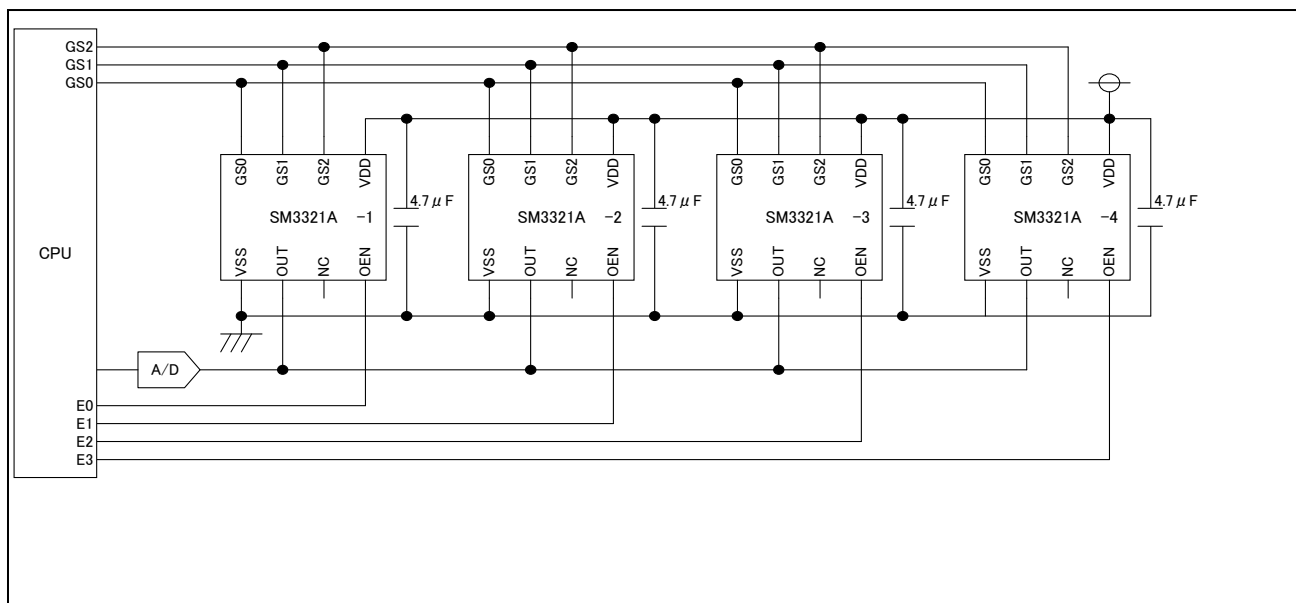
(Unit: mm)



ORDERING INFORMATION

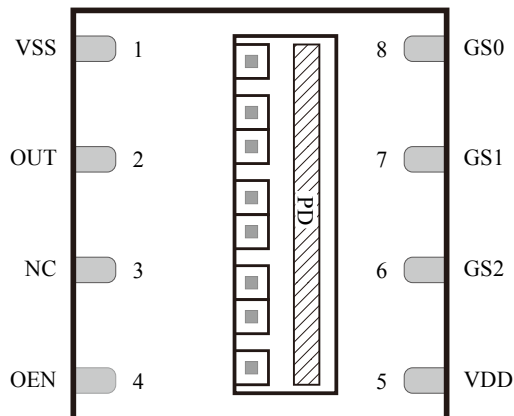
Device	Package
SM3321A	8 pin HCOB

TYPICAL APPLICATION CIRCUIT



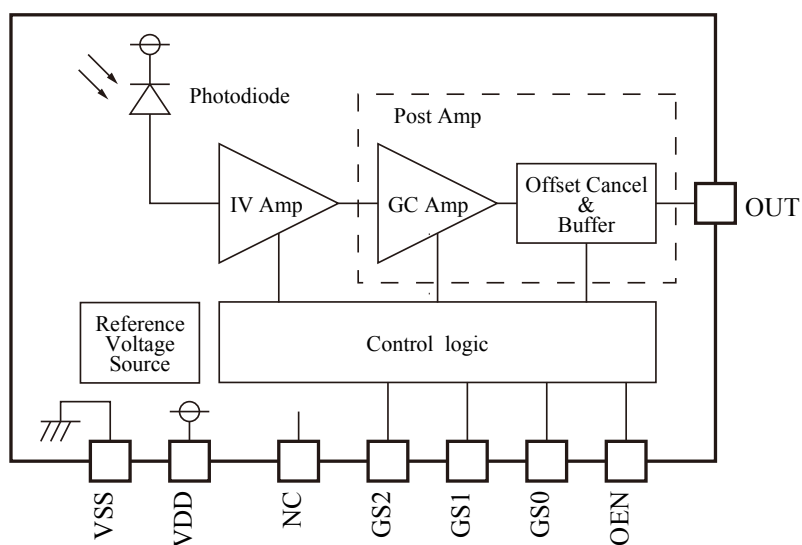
PINOUT

(Top view)

**PIN DESCRIPTION**

No.	Name	I/O	Function
1	VSS	S	Ground
2	OUT	O	Analog output
3	NC	-	Open circuit or VSS level (LOW)
4	OEN	I_{PU}	Output enable control input Output enabled when LOW.
5	VDD	S	Supply voltage
6	GS2	I	Transimpedance (I/V) amplifier resistance control input H: VDD level; L: VSS level
7	GS1	I	Post-amplifier gain control input H: VDD level; L: VSS level
8	GS0	I	Post-amplifier gain control input H: VDD level; L: VSS level

*. S: Power supply, O: Output, I: Input, I_{PU} : Input with pull-up resistance

BLOCK DIAGRAM

SPECIFICATIONS

Absolute Maximum Ratings

$V_{SS}=0V$

Parameter	Symbol	Condition	Rating	Unit
Supply voltage ^{*1}	V_{DD}	Voltage between VDD and VSS	-0.3 to +7.0	V
Input voltage ^{*1*2}	V_{IN}	OEN, GS0, GS1, GS2 pins	-0.3 to $V_{DD}+0.3$	V
Output voltage ^{*1*2}	V_{OUT}	OUT pin	-0.3 to $V_{DD}+0.3$	V
Storage temperature ^{*3}	T_{STG}		-55 to +90	°C

*1. This parameter rating is the values that must never exceed even for a moment. This product may suffer breakdown if this parameter rating is exceeded.

Operation and characteristics are guaranteed only when the product is operated at recommended operating conditions.

*2. V_{DD} is a V_{DD} value of recommended operating conditions.

*3. When stored in nitrogen or vacuum atmosphere applied to IC itself only (excluding packaging materials).

Recommended Operating Conditions

Recommended operating conditions guarantee the electrical characteristic.

$V_{SS}=0V$

Parameter	Symbol	Condition	Rating			Unit
			MIN	TYP	MAX	
Supply voltage	V_{DD}	Voltage between VDD and VSS	3.0	5.0	5.5	V
OUT output load ^{*1}	C_L	OUT pin			80	pF
Operating temperature	T_a		-40		85	°C

*1. The output load of the OUT output presumes capacitive load only. For current load, an error in the output voltage occurs, so the outputs must be used under high-impedance conditions.

Note. Since it may influence the reliability if it is used out of range of recommended operating conditions, this product should be used within this range.

Electrical Characteristics

DC Characteristics

Reference circuit with recommended operating conditions, unless otherwise specified.

Parameter	Symbol	Condition	Rating			Unit
			MIN	TYP	MAX	
Current consumption	I_{DD}	OEN= V_{DD} input, OUT output no load		1	2	mA
Input voltage 1	V_{IH1}	GS0, GS1, GS2, OEN pins	$0.7V_{DD}$			V
	V_{IL1}				$0.3V_{DD}$	
Input current 1	I_{IH1}	GS0, GS1, GS2 pins $V_{IH}=V_{DD}$ applied voltage			1	μA
	I_{IL1}	GS0, GS1, GS2 pins $V_{IL}=0V$ applied voltage	-1			
Input current 2	I_{IH2}	OEN pin, $V_{DD}=5.0V$, $V_{IH}=V_{DD}$ applied voltage			1	μA
	I_{IL2}	OEN pin, $V_{DD}=5.0V$, $V_{IL}=0V$ applied voltage	-40	-20	-5	
OUT output voltage	V_{OH}		$0.9V_{DD}$			V
	V_{OL}				0.05	
Output impedance	Z_O	OUT pin ^{*2}		0.4	1	k Ω

*1. The output impedance Z_O is given by the following equation, where V_{I0} is the output voltage for 10k Ω load resistance and V_0 is the output voltage with no load.

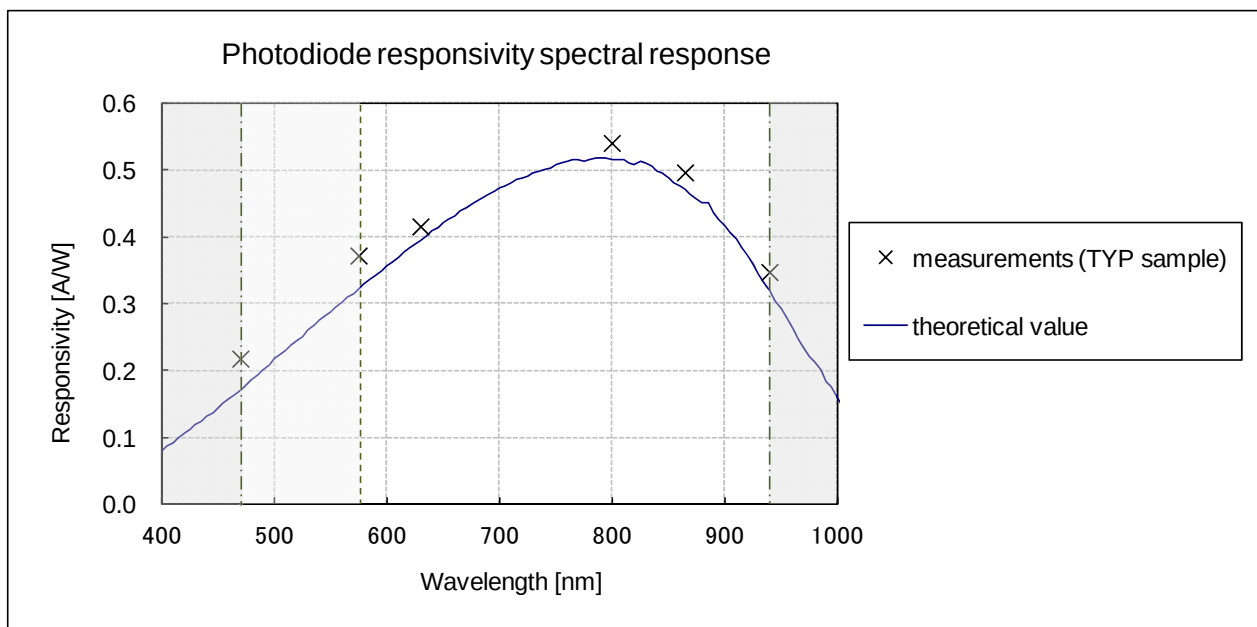
$$Z_O = (V_0/V_{I0} - 1) \times 10 \quad [k\Omega]$$

Photodiode Characteristics

Ta=25°C, Reference circuit with recommended operating conditions, unless otherwise specified

Parameter	Symbol	Conditions	Rating			
			MIN	TYP	MAX	Unit
Spectral range of responsivity 1	λ_1	S=50% of S ₄	570		940	nm
Spectral range of responsivity 2	λ_2	S=30% of S ₄	470		570	nm
Photodiode responsivity 1 ^{*1}	S ₁	470nm		0.22		A/W
Photodiode responsivity 2 ^{*1}	S ₂	570nm		0.37		A/W
Photodiode responsivity 3 ^{*1}	S ₃	630nm		0.42		A/W
Photodiode responsivity 4 ^{*1}	S ₄	865nm		0.50		A/W
Photodiode responsivity 5 ^{*1}	S ₅	940nm		0.35		A/W

*1. Typical characteristics determined on actual device



Photodiode spectral responsivity

Analog Electrical Characteristics

Reference circuit with recommended operating conditions, unless otherwise specified

Parameter	Symbol	Conditions	Rating			Unit
			MIN	TYP	MAX	
Pre-amplifier transimpedance	R_{ti}	GS2=0V input	0.4	0.5	0.6	MΩ
		GS2= V_{DD} input	2.4	3	3.6	MΩ
Post-amplifier gain differential	G_{diff}	Gain differential relative to GS[2:0] gain settings	-1		1	dB
Dark voltage	V_{OD1}	$V_{DD}=5.0V$, $T_a=25^{\circ}C$			20	mV
	V_{OD2}	$V_{DD}=5.0V$, $T_a=85^{\circ}C$			50	mV

AC Characteristics

Reference circuit with recommended operating conditions, unless otherwise specified

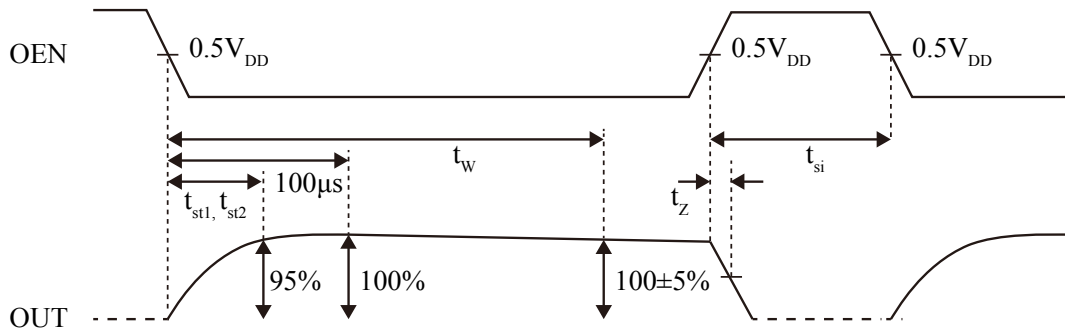
Parameter	Symbol	Conditions	MIN	TYP	MAX	Unit
Settling time1	t_{st1}	80pF OUT output load, Time for output to reach 95% amplitude ^{*1} GS2=0V (Transimpedance: 2MΩ, 3.2 MΩ, 5 MΩ, 8 MΩ)		5	10	μs
Settling time2	t_{st2}	80pF OUT output load, Time for output to reach 95% amplitude ^{*1} GS2= V_{DD} (Transimpedance: 12MΩ, 19.2 MΩ, 30 MΩ, 48 MΩ)		18	30	μs
Output voltage stabilization time ^{*2}	t_w	≤ 5% output variation ^{*1}			1000	μs
Output disable time ^{*3}	t_z	OUT		0.1		μs
Interface wait time	t_{si}	—	10			μs
Input capacitance ^{*4}	C_i	OEN, GS0, GS1, GS2		3		pF
Output capacitance ^{*4}	C_o	OUT		3.5		pF

*1. OUT output presumed to reach reference value 100μs after output enable.

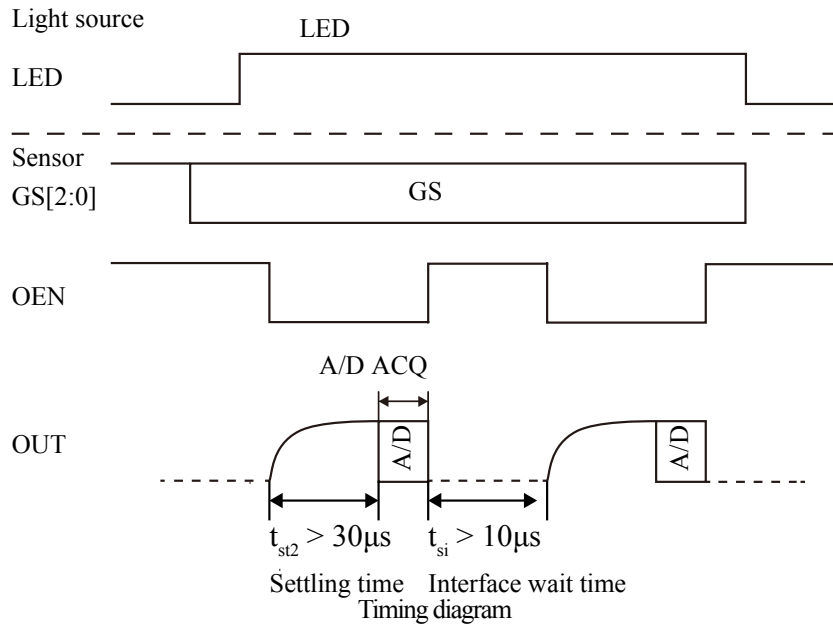
*2. An output voltage error may occur if the output hold time does not satisfy rated value.

*3. Design value, provided as a guide for the output control time.

*4. Design value, representing the capacitance per terminal. Provided as a guide for when designing circuit boards.



AC characteristics



FUNCTIONAL DESCRIPTION

Transimpedance Setting

The I/V amplifier impedance and post-amplifier gain can be selected using GS0, GS1, and GS2 input state control. Selecting the I/V amplifier impedance and post-amplifier gain also determines the transimpedance setting.

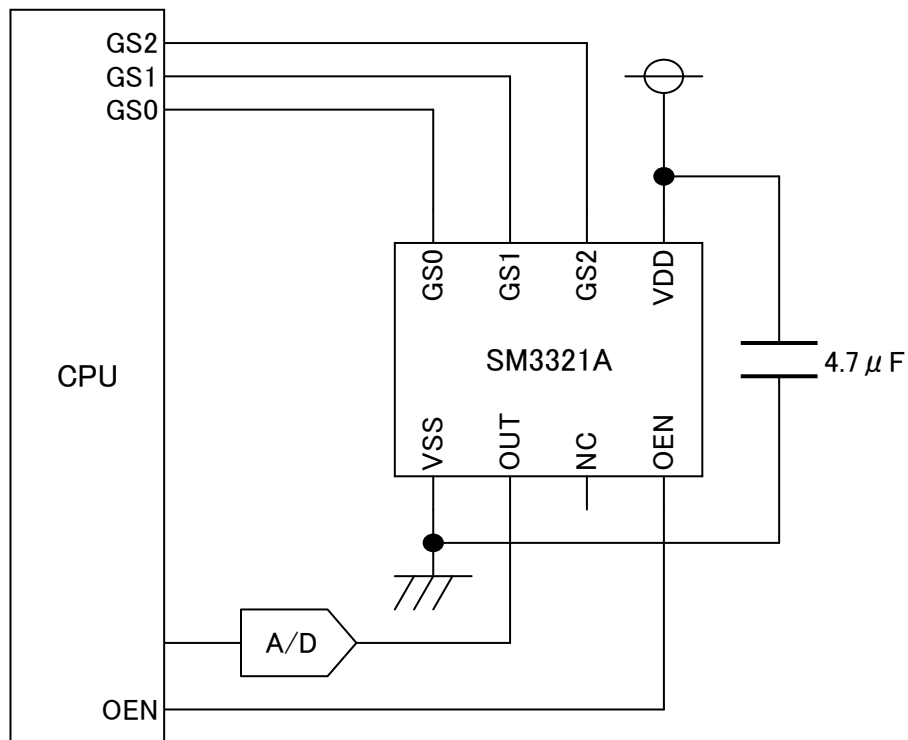
Input			Conditions		Transimpedance
GS2	GS1	GS0	I/V amplifier resistance	Post-amplifier gain	
L	L	L	0.5M Ω	12dB	2.0M Ω
L	L	H		16dB	3.2M Ω
L	H	L		20dB	5.0M Ω
L	H	H		24dB	8.0M Ω
H	L	L	3M Ω	12dB	12M Ω
H	L	H		16dB	19.2M Ω
H	H	L		20dB	30M Ω
H	H	H		24dB	48M Ω

OUT Output Setting

The OUT output can be controlled using the OEN input.

OEN input	OUT output
L	Output enabled
H	Hi-Z

REFERENCE CIRCUIT



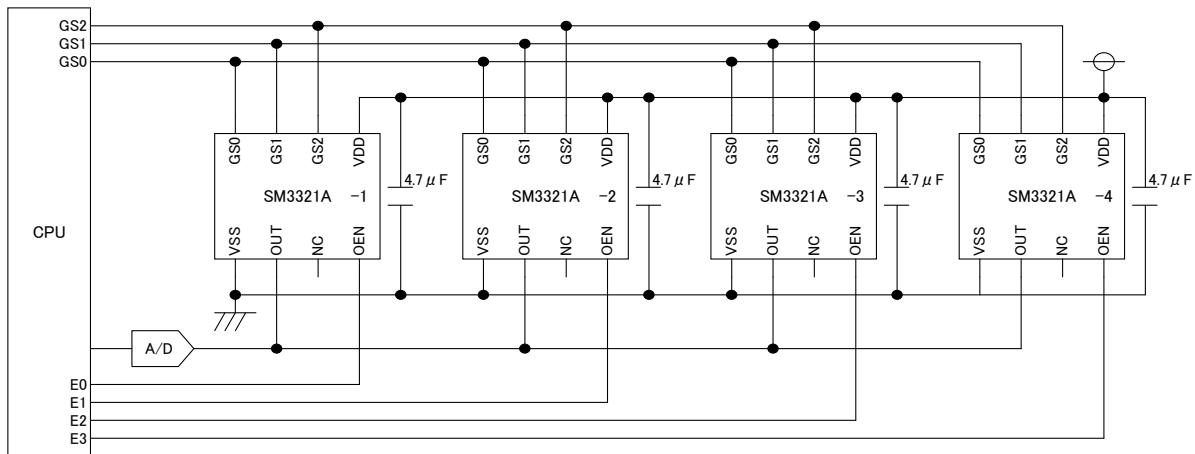
Connect a laminated ceramic capacitor of 4.7 μ F or larger as close as possible to the supply voltage terminals.
The normal value for each electrical characteristics parameter is measured using the reference circuit.

TYPICAL APPLICATION CIRCUIT

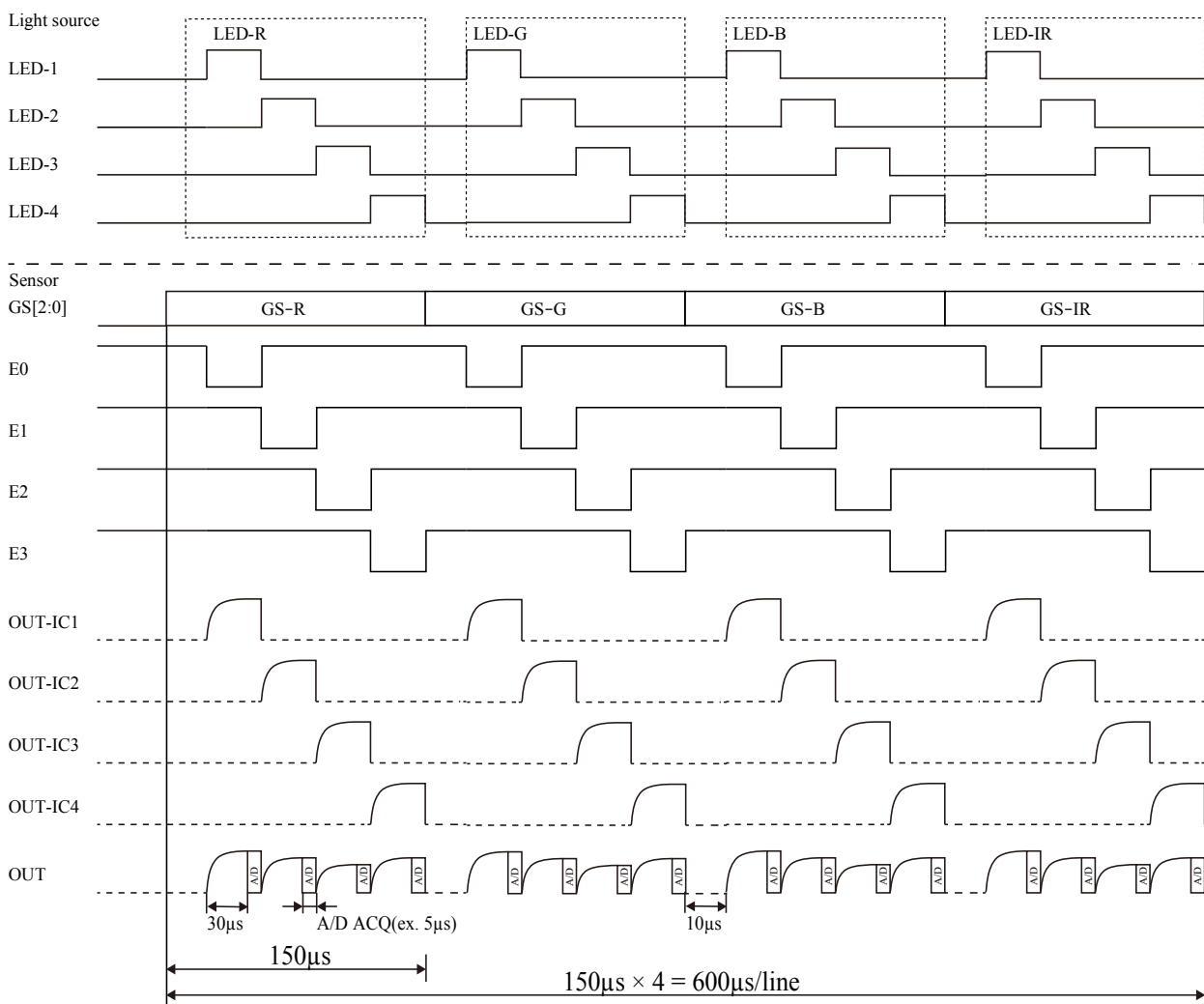
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Application Circuit Example

4-device application



4-device application timing diagram



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