Sensor for Heart Rate Monitor ICs

Optical Sensor for Heart Rate Monitor IC

BH1792GLC

General Description

BH1792GLC is optical sensor for heart rate monitor IC in which LED driver, green light and IR detection photo-diode are incorporated. This device drives LED and provides the intensity of light reflected from body.
LED brightness can be adjusted by LED driver current. The photodiode having the high sensitivity for green light and excellent wavelength selectivity achieves accurate pulse wave detection.

Key Specifications

- VCC Voltage Range: 2.5V to 3.6V
- Current Consumption: 200μA(Typ)
- Standby Mode Current: 0.8μA (Typ)
- Operating Temperature Range: -20°C to +85°C

Package

WLGA010V28

W(Typ) x D(Typ) x H(Max)

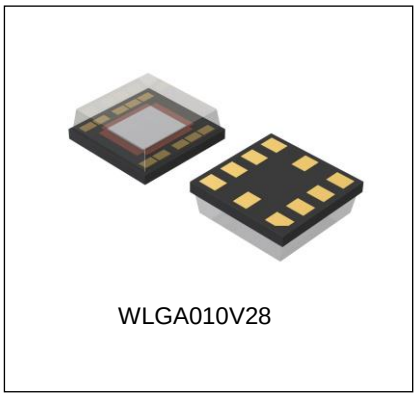
2.8mm x 2.8mm x 1.0mm

Features

- Build-in green photodiode with excellent wavelength selective green filter and IR curt filter.
- Built-in IR photodiode for touch detection.
- Correspond to high sampling frequency. (1024Hz)
- LED driver with current selection.
- I2C bus Interface(f/s mode support)
- Built-in FIFO

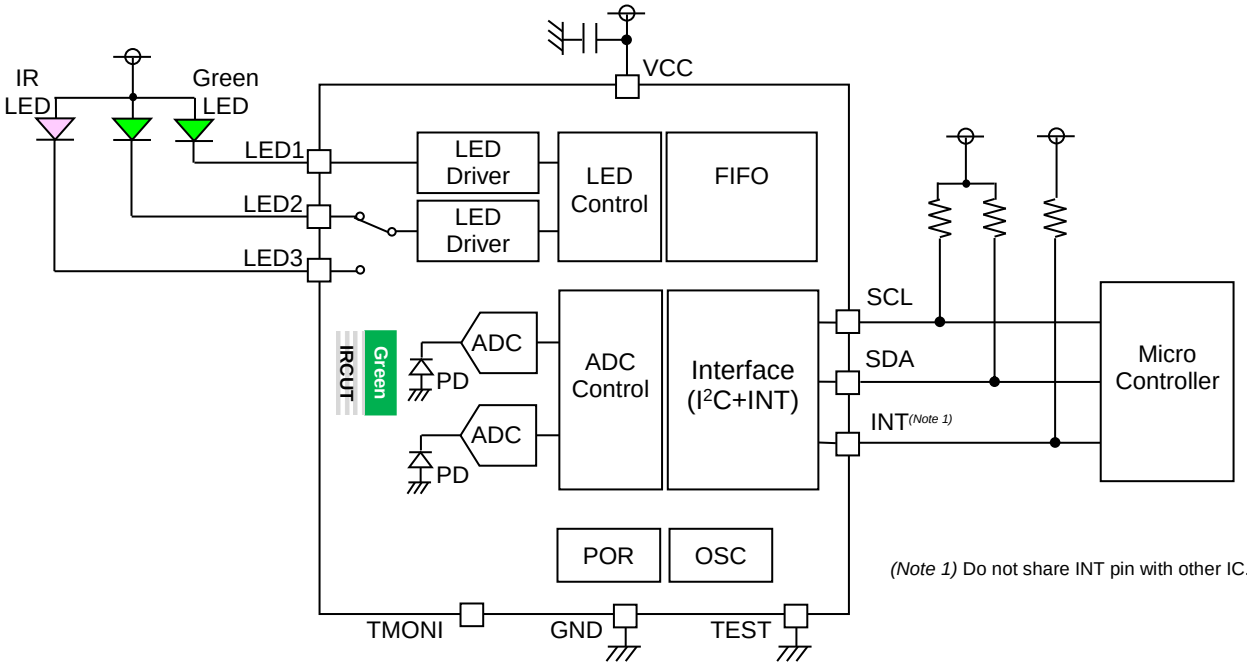
Applications

- Wearable device, smart phone, Tablet PC.



WLGA010V28

Typical Application Circuit

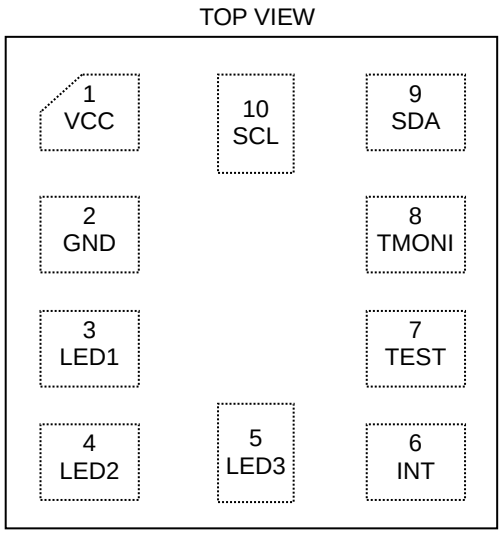


(Note 1) Do not share INT pin with other IC.

○Product structure : Silicon monolithic integrated circuit.
○This product does not include laser transmitter.
○This product includes Photo detector, (Photo Diode) inside of it.
○This product has no designed protection against radioactive rays.
○This product does not include optical load.

Contents

Pin Configuration

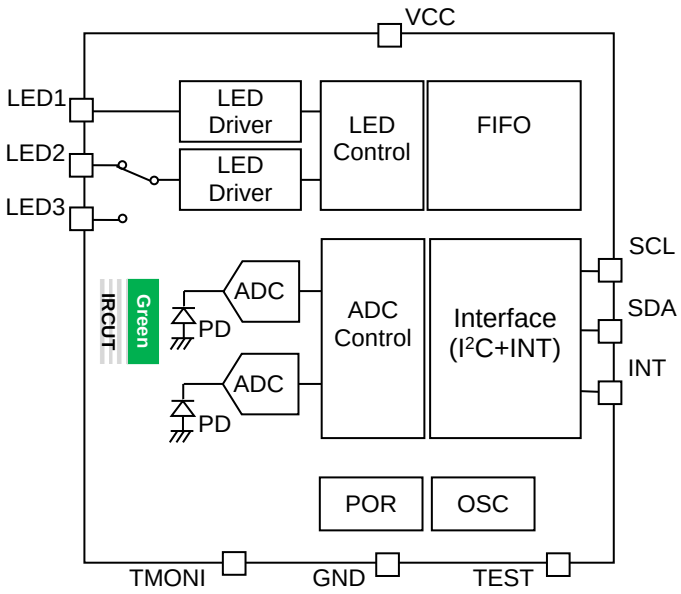


Pin Description

Pin No.	Pin Name	Function
1	VCC	Power supply*(Note 1)*
2	GND	Ground
3	LED1	LED1 driver output
4	LED2	LED2 driver output
5	LED3	LED3 driver output
6	INT	Interrupt*(Note 2)*
7	TEST	TEST pin (Connect to GND)
8	TMONI	TEST Monitor pin (open)
9	SDA	I^2C bus serial data
10	SCL	I^2C bus serial clock

(Note 1) Dispose a bypass capacitor as close as possible to the IC
(Note 2) Do not share INT pin with other IC

Block Diagram



Description of Blocks

- IRCUT
  This filter passes visible light and blocks infrared light.
- GREEN
  Green color pass filter
- PD
  Photodiodes (PD) convert light into current.
- LED Driver
  LED driver circuit
- ADC
  AD converter
- OSC
  Internal oscillator generates clock for internal logic.
- POR
  Power on reset
- Interface (I^2C+INT)
  I^2C bus and interrupt pin Interface block
- ADC control
  AD converter control block
- LED control
  LED driver control block
- FIFO
  FIFO circuit

Absolute Maximum Ratings (Ta=25°C)

Parameter	Symbol	Rating	Unit
Supply Voltage	V_{CC_MR}	4.5	V
Terminal input Voltage1*(Note 1)*	V_{IN_MR}	-0.3 to +4.5	V
Terminal input Voltage2*(Note 2)*	V_{LED_MR}	7	V
Storage Temperature Range	Tstg	-40 to +100	°C
Maximum Junction Temperature	Tjmax	100	°C

*(Note 1)*INT, SCL, SDA pins
*(Note 2)*LED1, LED2, LED3 pins

Caution1: *Operating the IC over the absolute maximum ratings may damage the IC. The damage can either be a short circuit between pins or an open circuit between pins and the internal circuitry. Therefore, it is important to consider circuit protection measures, such as adding a fuse, in case the IC is operated over the absolute maximum ratings.*

Caution2: *Should by any chance the maximum junction temperature rating be exceeded the rise in temperature of the chip may result in deterioration of the properties of the chip. In case of exceeding this absolute maximum rating, design a PCB boards with thermal resistance taken into consideration by increasing board size and copper area so as not to exceed the maximum junction temperature rating.*

Thermal Resistance*(Note1)*

Parameter	Symbol	Thermal Resistance (Typ)		Unit
		1s*(Note 3)*	2s2p*(Note 4)*	
WLGA010V28				
Junction to Ambient	θ_{JA}	319.5	182.1	°C/W
Junction – Top Characterization Parameter*(Note 2)*	Ψ_{JT}	102	65	°C/W

(Note 1) Based on JESD51-2A(Still-Air).
(Note 2) The thermal characterization parameter to report the difference between junction temperature and the temperature at the top center of the outside surface of the component package.
(Note 3) Using a PCB board based on JESD51-3.

Layer Number of Measurement Board	Material	Board Size
Single	FR-4	114.3mm x 76.2mm x 1.57mmt

Top	
Copper Pattern	Thickness
Footprints and Traces	70µm

(Note 4) Using a PCB board based on JESD51-7.

Layer Number of Measurement Board	Material	Board Size
4 Layers	FR-4	114.3mm x 76.2mm x 1.6mmt

Top		2 and 3 Internal Layers		Bottom	
Copper Pattern	Thickness	Copper Pattern	Thickness	Copper Pattern	Thickness
Footprints and Traces	70µm	74.2mm x 74.2mm	35µm	74.2mm x 74.2mm	70µm

Recommended Operating Conditions

Parameter	Symbol	Min	Typ	Max	Unit
Operating Temperature	Topr	-20	+25	+85	°C
Supply Voltage	V_{CC}	2.5	3.0	3.6	V
Terminal Input Voltage *(Note 1)*	V_{LED}	0.7	-	5.5	V

*(Note 1)*LED1, LED2, LED3 pins

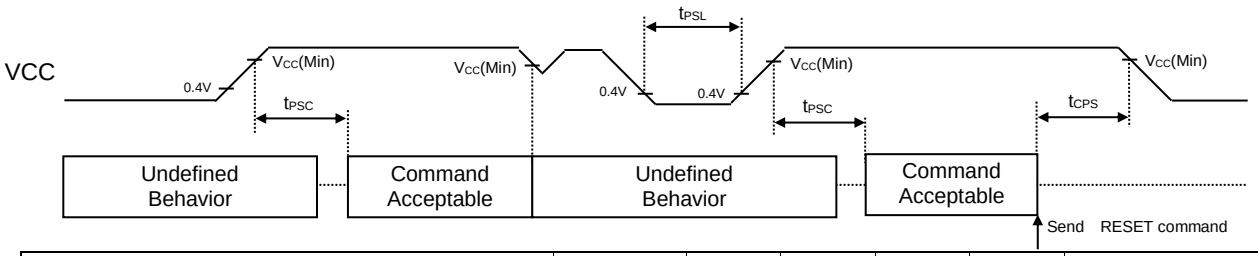
Electrical Characteristics
(Unless otherwise specified VCC=3.0V, Ta=25°C, MSR=000)

Parameter	Symbol	Min	Typ	Max	Unit	Conditions
Supply Current	I_{CC1}	-	200	400	µA	No LED emitting
Supply Current during LED current drive	I_{CC2}	-	1.4	3.0	mA	LED emitting
Standby Mode Current	I_{CC3}	-	0.8	1.5	µA	No input light
Green Data Count Value	D_{GREEN}	3000	5100	7200	count	EV=10uW/cm^2 *(Note 1)*
IR Data Count Value	D_{IR}	2500	4300	6000	count	EV=200uW/cm^2 *(Note 2)*
Dark Count Value (Green Data)	S_{GR_0}	-	-	200	count	No input light
Dark Count Value (IR Data)	S_{IR_0}	-	-	200	count	No input light
Synchronized Signal Interval	T_{sync}	-	1	-	s	
LED Emitting Time	t_{wILED}	-	300	400	µs	
LED Output Current	I_{LED}	1	2	3	mA	LED pin input voltage = 1.0V LED_CURRENT=2mA Mode
LED Off Leakage Current	I_{OFF}	-	0	1	µA	LED terminal voltage = 5.0V
OSC Cycle	t_{OSC}	-	0.5	0.67	µs	
L Input Voltage *(Note 3)*	V_{IL}	-	-	0.54	V	
H Input Voltage*(Note 3)*	V_{IH}	1.26	-	-	V	
L Input Current*(Note 3)*	V_{IL}	-10	-	-	µA	VIL=GND
H Input Current*(Note 3)*	V_{IH}	-	-	10	µA	VIH=VCC
L Output Voltage*(Note 4)*	V_{OL}	0	-	0.4	V	IL=3mA

(Note 1) Green LED is used as optical source.
(Note 2) IR LED is used as optical source.
(Note 3) SDA, SCL pins
(Note 4) SDA, INT pins

Power Sequence (Unless otherwise specified VCC=3.0V, Ta=25°C)

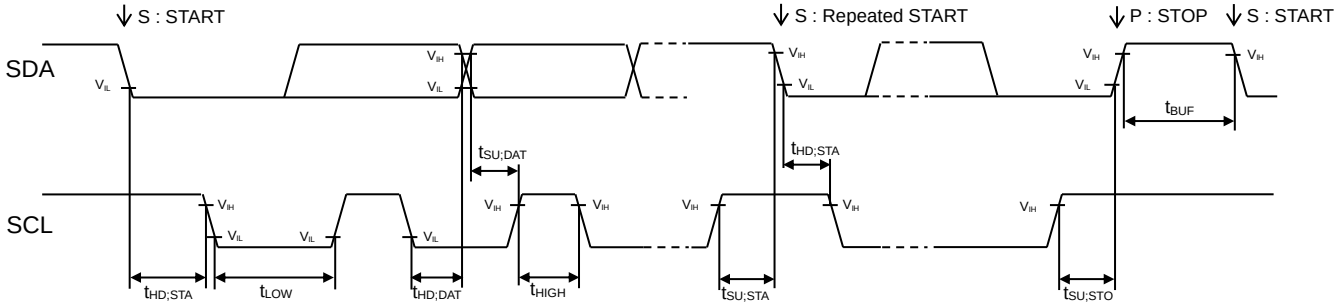
There is a Power on reset function which monitors VCC power.
All registers are reset by Power ON Reset function when power is supplied to VCC.



Parameter	Symbol	Min	Typ	Max	Unit	Conditions
Command input time after power-on	t_{PSC}	2	-	-	ms	
Power supply OFF time	t_{PSL}	1	-	-	ms	
Wait time from power down command	t_{CPS}	100	-	-	µs	

t_{PSC} after VCC power-on, command can be input.
Internal condition becomes undefined when VCC is lower than recommended operating voltage range. In this case power off VCC once and power-on again.
Please keep VCC Low (VCC<0.4V) more than t_{PSL} before VCC power-on.
Send RESET command before t_{CPS} from power-off VCC.

I²C Bus Timing Characteristics (Unless otherwise specified VCC=3.0V, Ta=25°C)



Parameter	Symbol	Min.	Typ.	Max.	Units	Conditions
SCL Clock frequency	f_{SCL}	0	-	400	kHz	
'L' Period of the SCL Clock	t_{LOW}	1.3	-	-	µs	
'H' Period of the SCL Clock	t_{HIGH}	0.6	-	-	µs	
Setup Time for Repeated START	$t_{SU;STA}$	0.6	-	-	µs	
Hold Time for START	$t_{HD;STA}$	0.6	-	-	µs	
Data Setup Time	$t_{SU;DAT}$	100	-	-	ns	
Data Hold Time	$t_{HD;DAT}$	0	-	-	µs	
Setup Time for STOP	$t_{SU;STO}$	0.6	-	-	µs	
Bus Free Time between STOP and START	t_{BUF}	1.3	-	-	µs	

I²C bus Communication

1. Write format

(1) Indicate register address

S	Slave Address	W 0	ACK	Register Address	ACK	P

(2) Write data after indicating register address

S	Slave Address	W 0	ACK	Register Address	ACK

Data specified at register address field	ACK	· · ·	ACK	Data specified at register address field + N	ACK	P

2. Read format

(1) Read data after indicating register address (Master issues restart condition)

S	Slave Address	W 0	ACK	Register Address	ACK

S	Slave Address	R 1	ACK	Data specified at register address field	ACK

Data specified at register address field + 1	ACK	· · ·	ACK	Data specified at register address field + N	NACK	P

(2) Read data from the specified register

S	Slave Address	R 1	ACK	Data specified at register address field	ACK

Data specified at register address field + 1	ACK	· · ·	ACK	Data specified at register address field + N	NACK	P

from master to slave from slave to master

Typical Performance Curves

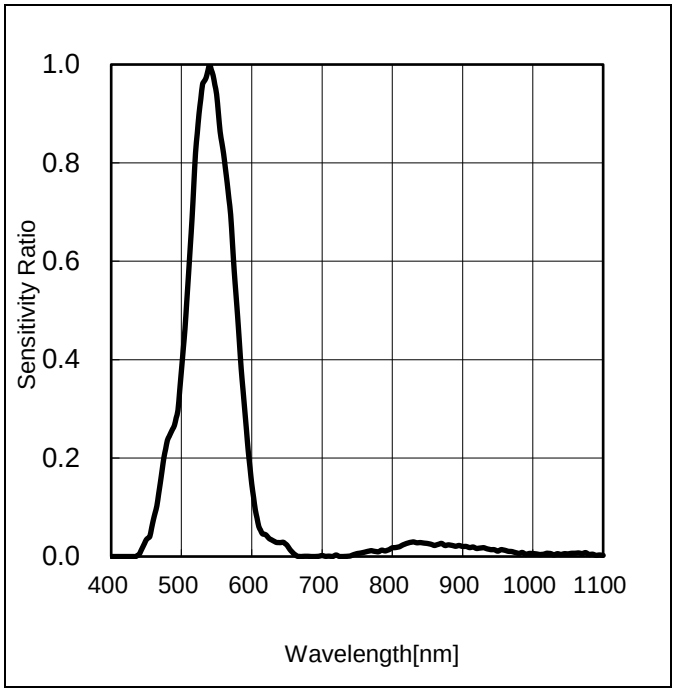


Figure 1. Sensitivity Ratio vs Wavelength
("Green Spectral Response")

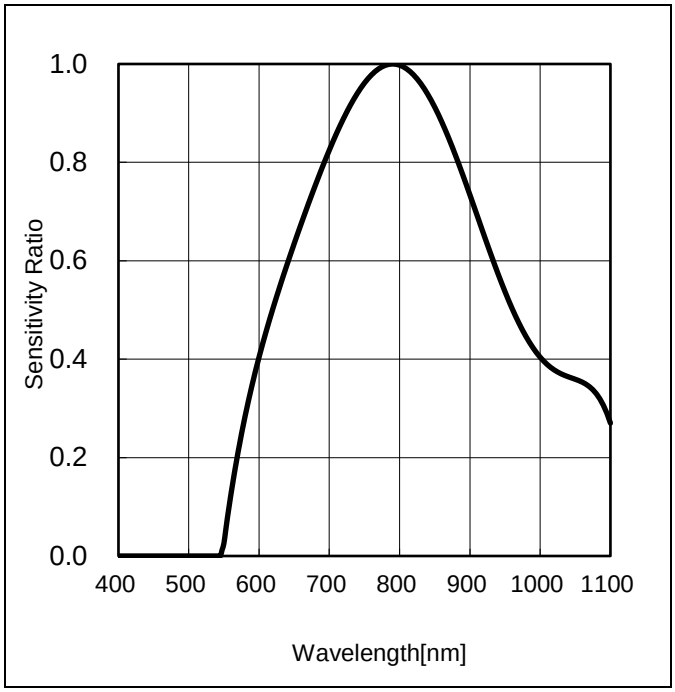


Figure 2. Sensitivity Ratio vs Wavelength
("IR Spectral Response")

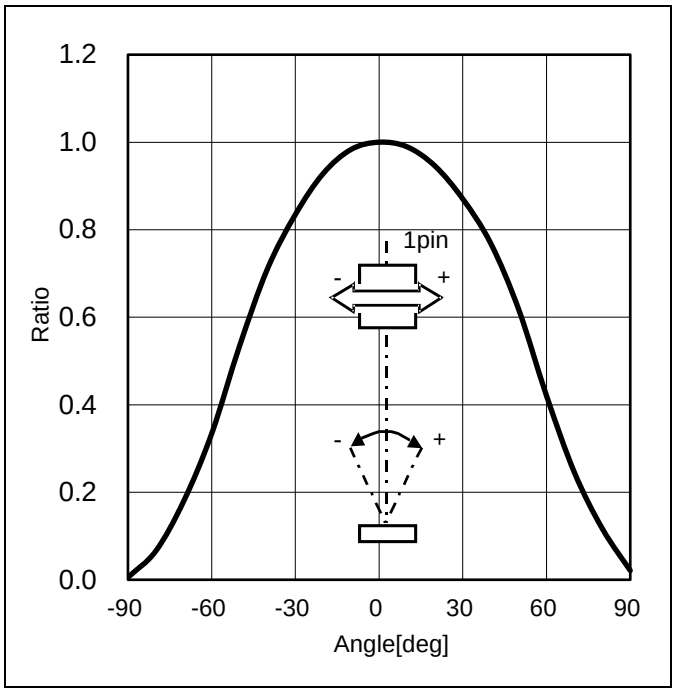


Figure 3. Green Ratio vs Angle
("Directional Characteristics 1")

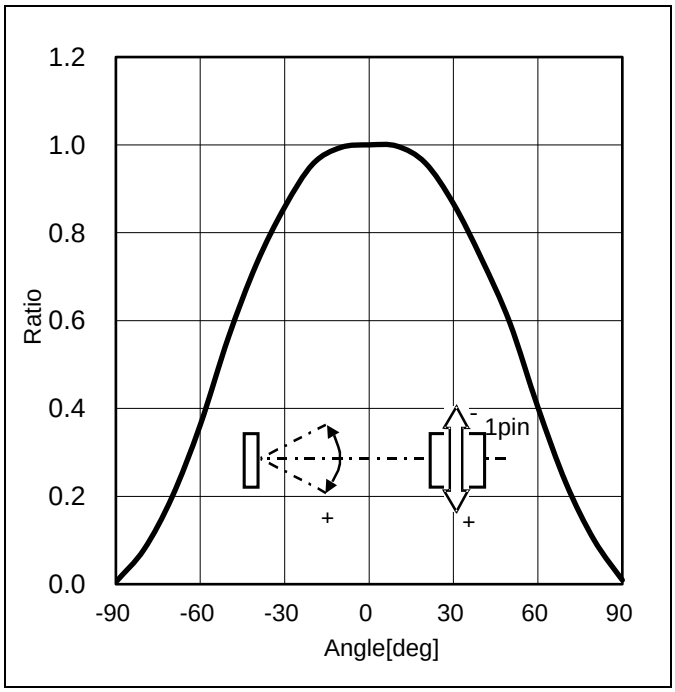


Figure 4. Green Ratio vs Angle
("Directional Characteristics 2")

Typical Performance Curves

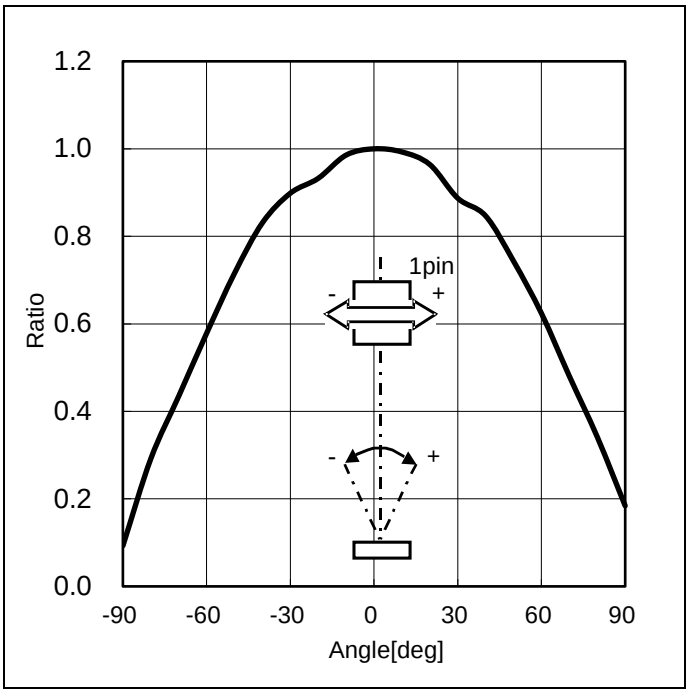


Figure 5. IR Ratio vs Angle
("Directional Characteristics 1")

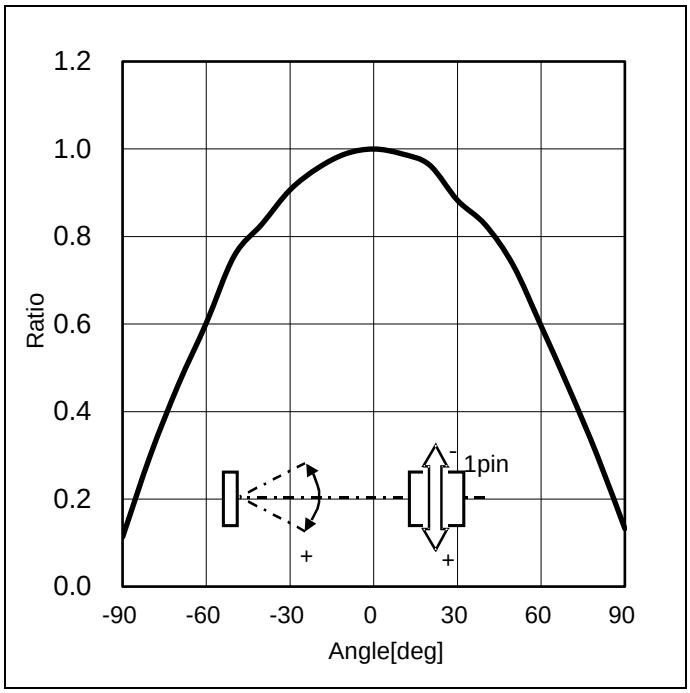


Figure 6. IR Ratio vs Angle
("Directional Characteristics 2")

I²C bus Slave address

Slave address is"1011011".

Register Map *(Note 1)*

Register Address	Register Name	R/W	D7	D6	D5	D4	D3	D2	D1	D0
0x0F	MANUFACTURER_ID	R	MANUFACTURER_ID [7:0]							
0x10	PART_ID	R	PART_ID[7:0]							
0x40	RESET	RW	SW RESET	0	0	0	0	0	0	0
0x41	MEAS_CONTROL1	RW	RDY	0	0	SEL_ ADC	0	MSR[2:0]		
0x42	MEAS_CONTROL2	RW	LED_EN1[1:0]		LED_CURRENT1[5:0]					
0x43	MEAS_CONTROL3	RW	LED_ EN2	0	LED_CURRENT2[5:0]					
0x44	MEAS_CONTROL4	RW	TH_IR[7:0]							
0x45		RW	TH_IR[15:8]							
0x46	MEAS_CONTROL5	RW	0	0	0	0	0	0	INT_SEL[1:0]	
0x47	MEAS_START	RW	0	0	0	0	0	0	0	MEAS_ ST
0x48	MEAS_SYNC	RW	0	0	0	0	0	0	0	MEAS_ SYNC
0x4B	FIFO_LEV	R	0	0	FIFO_LEV[5:0]					
0x4C	FIFODATA0	R	FIFODATA0 [7:0]							
0x4D		R	FIFODATA0 [15:8]							
0x4E	FIFODATA1	R	FIFODATA1 [7:0]							
0x4F		R	FIFODATA1 [15:8]							
0x50	IRDATA_LEDOFF	R	IRDATA_LEDOFF [7:0]							
0x51		R	IRDATA_LEDOFF [15:8]							
0x52	IRDATA_LEDON	R	IRDATA_LEDON [7:0]							
0x53		R	IRDATA_LEDON [15:8]							
0x54	GDATA_LEDOFF	R	GDATA_LEDOFF [7:0]							
0x55		R	GDATA_LEDOFF [15:8]							
0x56	GDATA_LEDON	R	GDATA_LEDON [7:0]							
0x57		R	GDATA_LEDON [15:8]							
0x58	INT_CLEAR	R	-	-	-	-	-	-	-	-

(Note 1) Do not write any commands to other addresses except above. Do not write '1' to the fields in which value is '0'in above table.

(0x0F) MANUFACTURER_ID

Fields	Function
MANUFACTURER_ID[7:0]	Manufacturer ID : 0xE0

(0x10) PART_ID

Fields	Function
PART_ID[7:0]	Part ID : 0x0E

(0x40) RESET

Fields	Function
SWRESET	Reset all registers when writing “1”. ”1” is not written in register. Read value is always” 0”.

default value 0x00

(0x41) MEAS_CONTROL1

Fields	Function
RDY	0 : Prohibited 1 : OSC block is active
SEL_ADC	Select channel of ADC measurement 0 : GREEN Measurement Mode LED1 and LED2 drivers are active. 1 : IR Measurement Mode Only in Non Synchronized Measurement Mode and Single Measurement Mode this mode can be used. LED3 driver is active.
MSR[2:0]	Select Measurement Mode

default value 0x00

< MSR >

Select measurement mode.

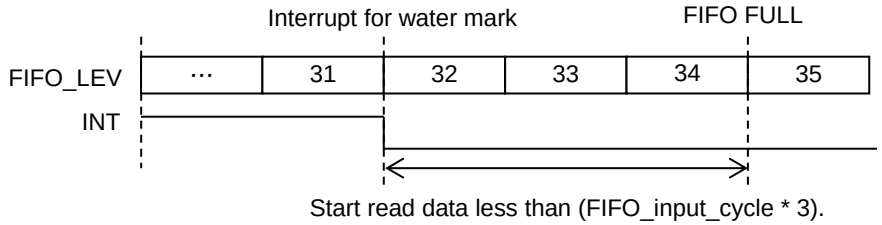
MSR	Measurement mode	LED Emitting Frequency	Output Data Rate	FIFO storing	FIFO_input_cycle[ms]	Measurement time after receiving MEAS_SYNC
000	32Hz Mode	128Hz setting	32Hz setting	Storing	$T_{sync}/32$	32
001	128Hz Mode	128Hz setting	128Hz setting	Storing	$T_{sync}/128$	128
010	64Hz Mode	256Hz setting	64Hz setting	Storing	$T_{sync}/64$	64
011	256Hz Mode	256Hz setting	256Hz setting	Storing	$T_{sync}/256$	256
100	Prohibited	-	-	-	-	-
101	1024Hz Mode	1024Hz setting	1024Hz setting	Storing	$T_{sync}/1024$	1024
110	Non Synchronized Measurement Mode	4Hz setting	4Hz setting	No storing	-	-
111	Single Measurement Mode	-	-	No storing	-	-

Synchronized Measurement Mode (MSR : 000 to 101)

Adjust LED emitting frequency and output data rate by synchronizing with MEAS_SYNC received interval. After receiving MEAS_SYNC, the measurements for a set number of times are performed. After finishing measurements for a set number of times, measurement stops until receiving MEAS_SYNC. When starting measurement, LED emission is operated with default frequency. And start synchronized operation after receiving next MEAS_SYNC. Use the measurement value of after starting synchronized operation

LED_CURRENT1and LED_CURRENT2 can be changed during measurement. The value becomes effective when receiving MEAS_SYNC. Send SWRESET first, in case of changing other registers above.

Measurement data is stored in FIFO. FIFO can store 35 samples. Refer to FIFODATA0 and FIFODATA1 for data to store in FIFO. It becomes FULL condition when the number of samples reaches 35, and stop storing samples in FIFO. Water Mark Interrupt occurs when the number of samples reaches 32 or more. Refer INT_SEL for setting interrupt output of INT pin. After the interruption, read FIFO data before it becomes FULL condition.



Non Synchronized Measurement Mode

Measurement starts after receiving MEAS_ST. LED_CURRENT1 and LED_CURRENT2 can be changed during measurement. New value becomes effective when receiving MEAS_ST. Send SWRESET first, in case of changing other registers above.

LED emitting frequency depends on OSC oscillation frequency.

LED emitting frequency: (499968 * t_{osc}) s

Single Measurement mode

Measurement starts after receiving MEAS_ST. Send SWRESET first, in case of changing registers. After finishing measurement, the measurement stops until receiving MEAS_ST.

(0x42) MEAS_CONTROL2

Fields	Function
LED_EN1[1:0]	Select the mode of LED driver
LED_CURRENT1[5:0]	Set the current of LED driver

default value 0x00

(0x43) MEAS_CONTROL3

Fields	Function
LED_EN2	Select the mode of LED driver
LED_CURRENT2[5:0]	Set the current of LED driver

default value 0x00

<LED_EN1/LED_EN2>

Select the mode of LED driver

LED_EN1[1:0]	LED_EN2	LED1	LED2	LED3	
00	x	Pulsed Light Emission	Pulsed Light Emission	Pulsed Light Emission	*(Note 1)*
01	x	ON	OFF	OFF	*(Note 2)*
10	0	OFF	ON	OFF	*(Note 2)*
10	1	OFF	OFF	ON	*(Note 2)*
11	0	ON	ON	OFF	*(Note 2)*
11	1	ON	OFF	ON	*(Note 2)*

(Note 1) LED driver is selected by SEL_ADC. Use for measurement.
(Note 2) This setting is for the operation check of LED.

<LED_CURRENT1>

Adjust the output current of LED1 and LED2 drivers.
New parameters becomes effective when receiving MEAS_ST.

LED_CURRENT1[5:0]	Current setting mode
0x00	Stop emission mode
0x01	1mA mode
0x02	2mA mode
0x03	3mA mode
…	…
0x09	9mA mode
0x0A	10mA mode
0x0B	11mA mode
…	…
0x3D	61mA mode
0x3E	62mA mode
0x3F	63mA mode

<LED_CURRENT2>

Adjust the output current of LED3 driver.
New parameters becomes effective when receiving MEAS_ST.

LED_CURRENT2[5:0]	Current setting mode
0x00	Stop emission mode
0x01	1mA mode
0x02	2mA mode
0x03	3mA mode
…	…
0x09	9mA mode
0x0A	10mA mode
0x0B	11mA mode
…	…
0x3D	61mA mode
0x3E	62mA mode
0x3F	63mA mode

(0x44/0x45) MEAS_CONTROL4

Fields	Function
TH_IR[15:0]	IR Interrupt Threshold Value

default value 0xFFFC

(0x46) MEAS_CONTROL5

Fields	Function
INT_SEL[1:0]	Select interrupt factor of INT pin INT pin outputs L when the interruption factor occurs. 00 : Disenable (No interrupt output) 01 : Water Mark interrupt of FIFO Interrupt when the stored sample number reaches 32 or more, and it's cleared when the number of sample falls below 32. 10 : IR threshold judgement interruption Use only in Non Synchronized Measurement Mode. Compare IRDATA_LEDON[15:4] and TH_IR[15:4] when updating data. Interruption occurs when IRDATA_LEDON[15:4] is TH_IR[15:4] or more. Interruption will be cleared when reading INT_CLEAR. 11 : Measurement completion interruption In Single Measurement Mode this is effective. Interrupt when the measurement finished. Interruption will be cleared when reading INT_CLEAR.

default value 0x00

(0x47) MEAS_START

Fields	Function
MEAS_ST	Flag of start measurement 0 : Prohibited 1 : Measurement start Starts measurement by writing "MEAS_ST=1" after setting up "RDY =1" (Non Synchronized Measurement Mode, Single Measurement Mode). When stop measurement, write "SWRESET=1" without writing "MEAS_ST=0". Restart measurement restart by writing "MEAS_ST=1", while it is in Single Measurement Mode.

default value 0x00

(0x48) MEAS_SYNC

Fields	Function
MEAS_SYNC	Input measurement synchronization signal 0 : Prohibited 1 : Input synchronization signal Starts measurement by writing "MEAS_SYNC=1" after setting up "MEAS_ST =1" (Synchronized Measurement Mode). Send MEAS_SYNC in every 1 second. Measurements set in "MSR" are performed within the interval of sending MEAS_SYNC. '1' can't be written in this register. Always '0' is read.

default value 0x00

(0x4B) FIFO_LEV

Fields	Function
FIFO_LEV[5:0]	Number of stored sample in FIFO FIFO_LEV=0x00 : FIFO Empty FIFO_LEV=0x23 : FIFO FULL

default value 0x00

(0x4C/0x4D) FIFODATA0

Fields	Function
FIFODATA0[15:0]	FIFO Output Data 0

default value 0x0000

(0x4E/0x4F) FIFODATA1

Fields	Function
FIFODATA1[15:0]	FIFO Output Data 1

default value 0x0000

Built-in 35 slot of FIFO.
FIFO store 4 byte data by 1 slot.
Measurement data stored in FIFO is determined by Measurement Mode.
Measurement data is stored in FIFO in every measurement.
Stop storing data in FIFO, after FIFO become FULL condition.

Measurement Mode	FIFODATA0	FIFODATA1
32Hz Mode	GDATA_LEDOFF	GDATA_LEDON
128Hz Mode	GDATA_LEDOFF	GDATA_LEDON
64Hz Mode	GDATA_LEDOFF	GDATA_LEDON
256Hz Mode	GDATA_LEDOFF	GDATA_LEDON
1024Hz Mode	No storing	GDATA_LEDON
Non Synchronized Measurement Mode	No storing	No storing
Single Measurement Mode	No storing	No storing

(0x50/0x51) IRDATA_LEDOFF

Fields	Function
IRDATA_LEDOFF[15:0]	IR Data Count Value during no LED emission.

default value 0x0000

(0x52/0x53) IRDATA_LEDON

Fields	Function
IRDATA_LEDON[15:0]	IR Data Count Value during LED emission – IR Data Count Value during no LED emission

default value 0x0000

(0x54/0x55) GDATA_LEDOFF

Fields	Function
GDATA_LEDOFF[15:0]	Green Data Count Value during no LED emission

default value 0x0000

(0x56/0x57) GDATA_LEDON

Fields	Function
GDATA_LEDON[15:0]	Green Data Count Value during LED emission

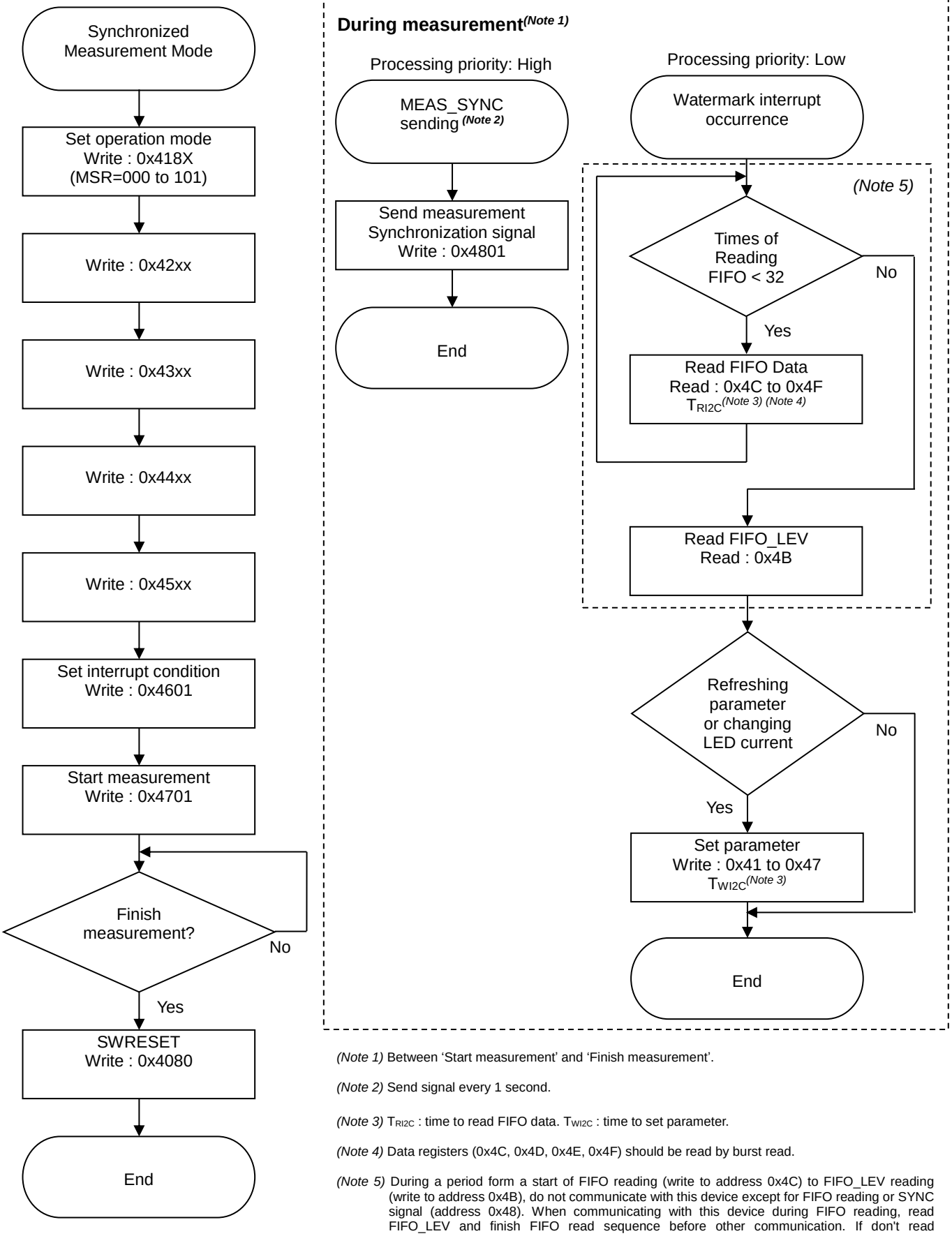
default value 0x0000

(0x58) INT_CLEAR

By reading INT_CLEAR, interruption of IR threshold judgement and measurement completion is cleared.

Control Sequence

<Synchronized Measurement Mode>



(Note 1) Between 'Start measurement' and 'Finish measurement'.

(Note 2) Send signal every 1 second.

(Note 3) T_{RI2C} : time to read FIFO data. T_{WI2C} : time to set parameter.

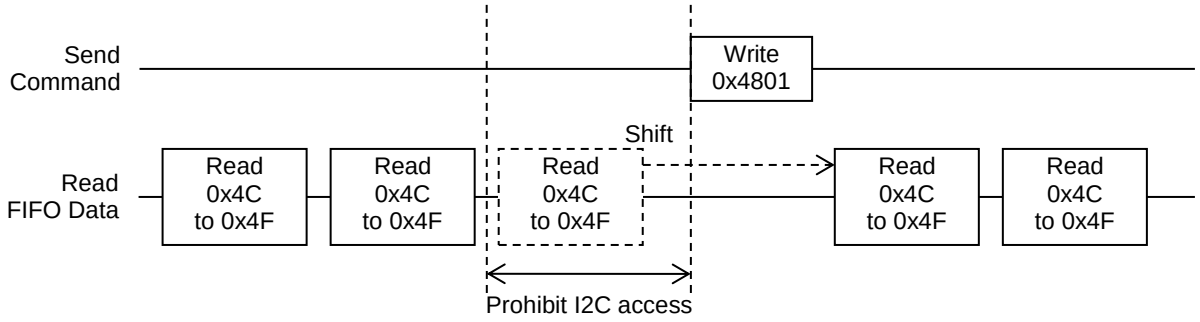
(Note 4) Data registers (0x4C, 0x4D, 0x4E, 0x4F) should be read by burst read.

(Note 5) During a period form a start of FIFO reading (write to address 0x4C) to FIFO_LEV reading (write to address 0x4B), do not communicate with this device except for FIFO reading or SYNC signal (address 0x48). When communicating with this device during FIFO reading, read FIFO_LEV and finish FIFO read sequence before other communication. If don't read FIFO_LEV before other communication, there is a possibility to lose FIFO data.

・MEAS_SYNC sending

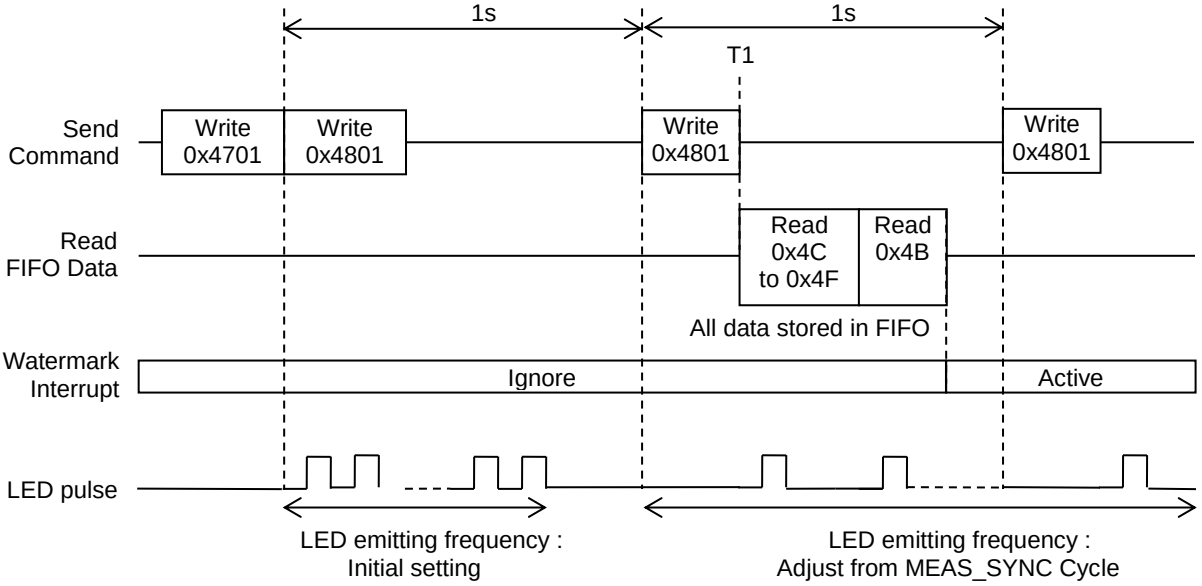
LED emitting frequency and output data rate depend on the interval of MEAS_SYNC.
Set the priority of 'MEAS_SYNC sending' higher than 'Watermark interrupt occurrence' to send MEAS_SYNC without delay. Since processing of 'MEAS_SYNC sending' and 'Watermark interrupt occurrence' is asynchronous, avoid conflicts of I2C Bus as below.

[Avoidance example]
Prohibit I2C access for a certain period of time just before 'MEAS_SYNC sending'.
Set the prohibit time longer than 'T_{RI2C}' and 'T_{WI2C}'.
And restart reading FIFO data before it becomes FULL condition.



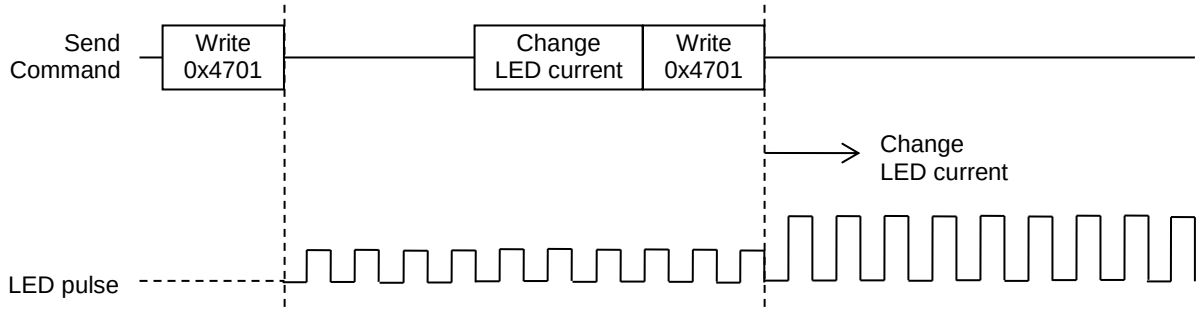
・Watermark interrupt

Since LED emitting frequency is initial setting until the device receives MEAS_SYNC twice, ignore watermark interrupt occurrence during initial setting and clear FIFO data just after sending 2nd MEAS_SYNC by reading all stored data immediately. After clearing FIFO data, treat watermark interrupt normally. At the timing of T1 after sending 2nd MEAS_SYNC 32 data are stored in FIFO. Pulse measurement starts just after MEAS_SYNC, and FIFO data should be read before FIFO reaches full. Regarding a period that FIFO becomes full, please refer to measurement mode of MSR register.

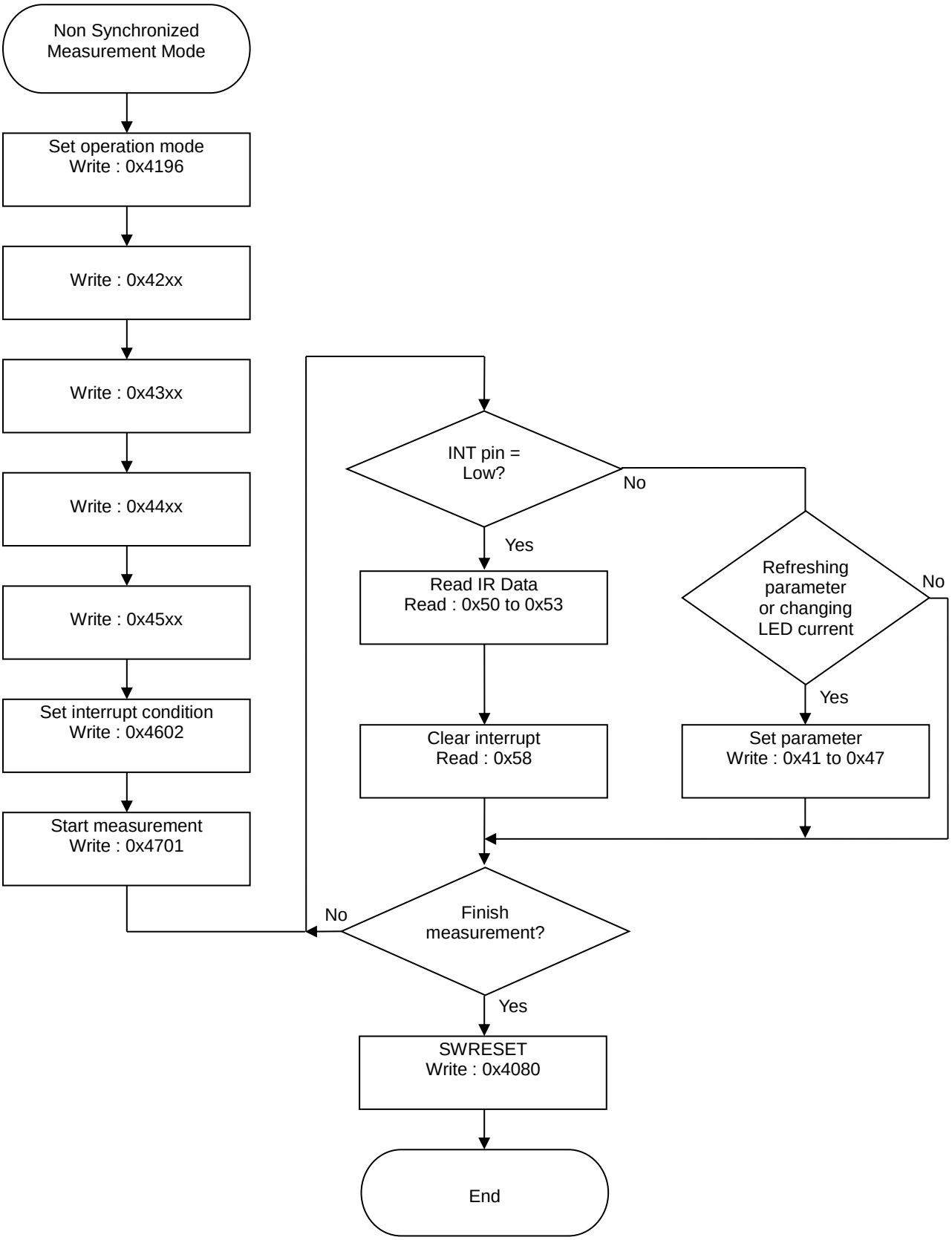


・Changing LED current

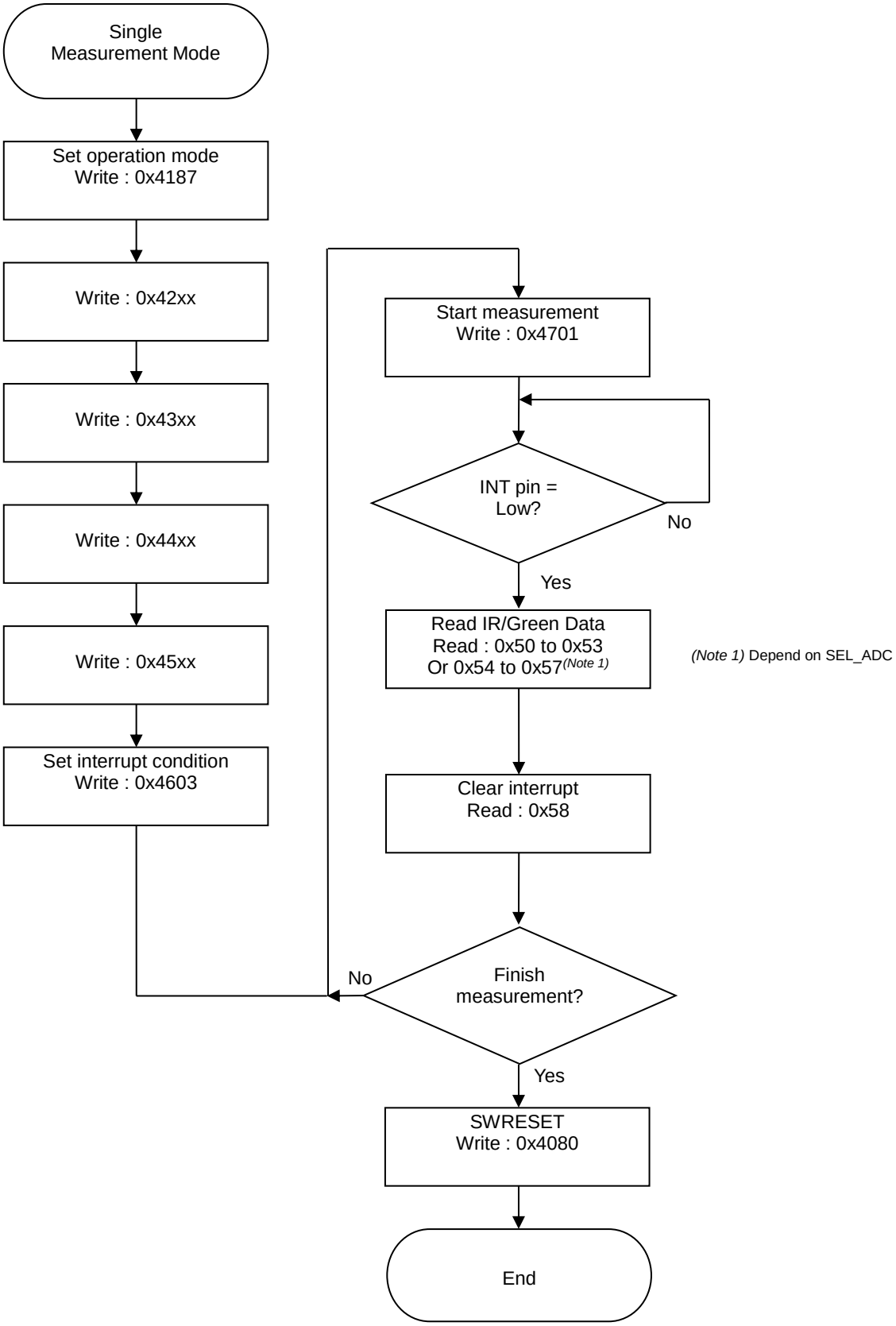
The updated LED current value is reflected after writing 'MEAS_ST = 1'.



<Non Synchronized Measurement Mode>

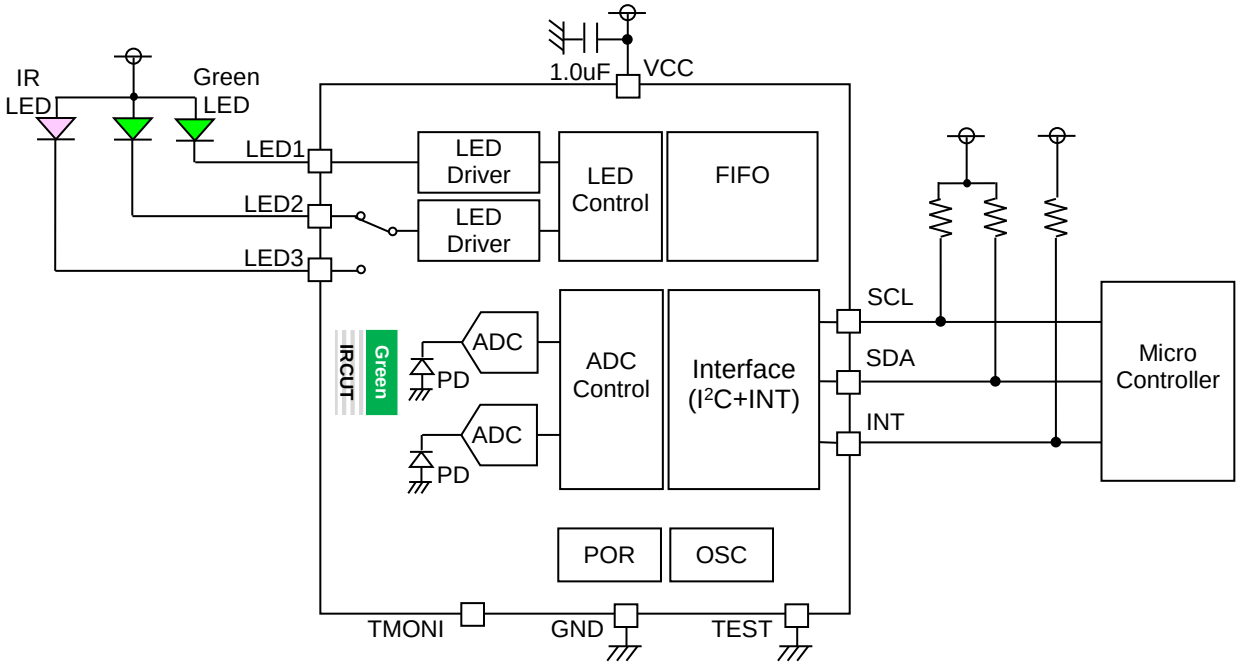


<Single Measurement Mode>

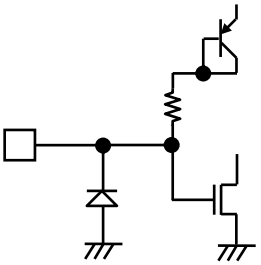
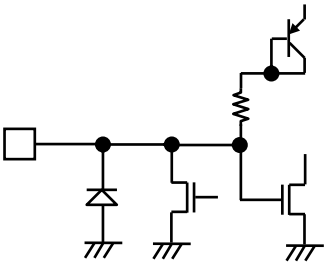
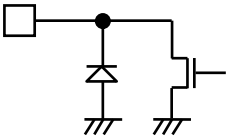
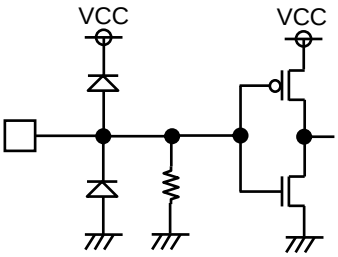
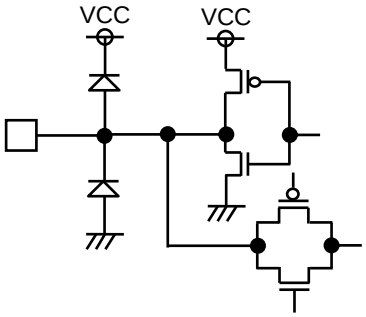


(Note 1) Depend on SEL_ADC

Application Example



I/O equivalent circuit

Pin Name	Equivalent Circuit Diagram	Pin Name	Equivalent Circuit Diagram
SCL		SDA	
LED1 LED2 LED3 INT		TEST	
TMONI			

Operational Notes

1. **Reverse Connection of Power Supply**
   Connecting the power supply in reverse polarity can damage the IC. Take precautions against reverse polarity when connecting the power supply, such as mounting an external diode between the power supply and the IC's power supply terminals.

2. **Power Supply Lines**
   Design the PCB layout pattern to provide low impedance supply lines. Furthermore, connect a capacitor to ground at all power supply pins. Consider the effect of temperature and aging on the capacitance value when using electrolytic capacitors.

3. **Ground Voltage**
   Ensure that no pins are at a voltage below that of the ground pin at any time, even during transient condition.

4. **Ground Wiring Pattern**
   When using both small-signal and large-current ground traces, the two ground traces should be routed separately but connected to a single ground at the reference point of the application board to avoid fluctuations in the small-signal ground caused by large currents. Also ensure that the ground traces of external components do not cause variations on the ground voltage. The ground lines must be as short and thick as possible to reduce line impedance.

5. **Recommended Operating Conditions**
   The function and operation of the IC are guaranteed within the range specified by the recommended operating conditions. The characteristic values are guaranteed only under the conditions of each item specified by the electrical characteristics.

6. **Inrush Current**
   When power is first supplied to the IC, it is possible that the internal logic may be unstable and inrush current may flow instantaneously due to the internal powering sequence and delays, especially if the IC has more than one power supply. Therefore, give special consideration to power coupling capacitance, power wiring, width of ground wiring, and routing of connections.

7. **Operation Under Strong Electromagnetic Field**
   Operating the IC in the presence of a strong electromagnetic field may cause the IC to malfunction.

8. **Testing on Application Boards**
   When testing the IC on an application board, connecting a capacitor directly to a low-impedance output pin may subject the IC to stress. Always discharge capacitors completely after each process or step. The IC's power supply should always be turned off completely before connecting or removing it from the test setup during the inspection process. To prevent damage from static discharge, ground the IC during assembly and use similar precautions during transport and storage.

9. **Inter-pin Short and Mounting Errors**
   Ensure that the direction and position are correct when mounting the IC on the PCB. Incorrect mounting may result in damaging the IC. Avoid nearby pins being shorted to each other especially to ground, power supply and output pin. Inter-pin shorts could be due to many reasons such as metal particles, water droplets (in very humid environment) and unintentional solder bridge deposited in between pins during assembly to name a few.

10. **Unused Input Terminals**
    Input pins of an IC are often connected to the gate of a MOS transistor. The gate has extremely high impedance and extremely low capacitance. If left unconnected, the electric field from the outside can easily charge it. The small charge acquired in this way is enough to produce a significant effect on the conduction through the transistor and cause unexpected operation of the IC. So unless otherwise specified, unused input pins should be connected to the power supply or ground line.

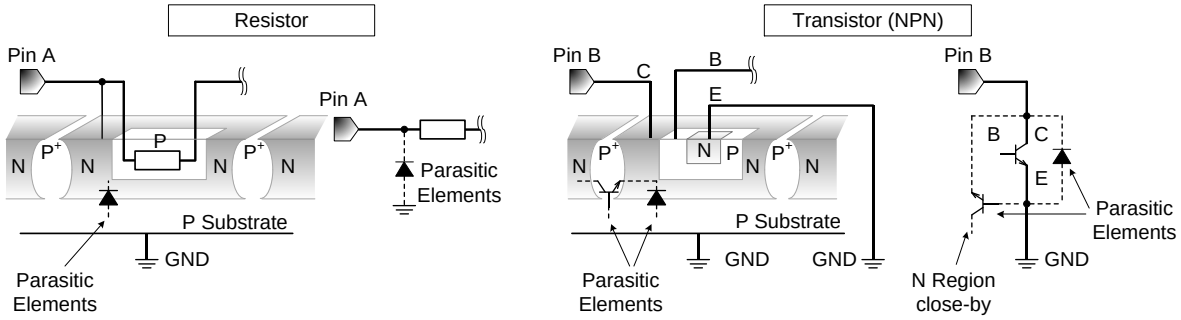
Operational Notes – continued

11. Regarding the Input Pin of the IC

This monolithic IC contains P+ isolation and P substrate layers between adjacent elements in order to keep them isolated. P-N junctions are formed at the intersection of the P layers with the N layers of other elements, creating a parasitic diode or transistor. For example (refer to figure below):

When GND > Pin A and GND > Pin B, the P-N junction operates as a parasitic diode.
When GND > Pin B, the P-N junction operates as a parasitic transistor.

Parasitic diodes inevitably occur in the structure of the IC. The operation of parasitic diodes can result in mutual interference among circuits, operational faults, or physical damage. Therefore, conditions that cause these diodes to operate, such as applying a voltage lower than the GND voltage to an input pin (and thus to the P substrate) should be avoided.



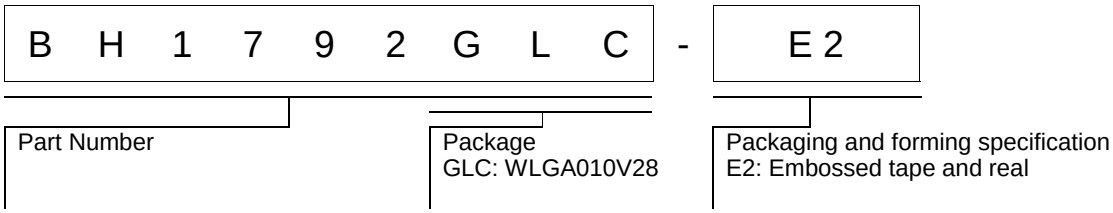
12. Ceramic Capacitor

When using a ceramic capacitor, determine the dielectric constant considering the change of capacitance with temperature and the decrease in nominal capacitance due to DC bias and others.

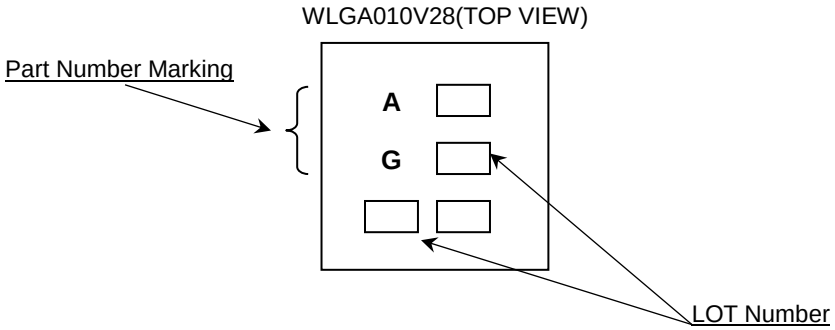
13. Area of Safe Operation (ASO)

Operate the IC such that the output voltage, output current, and the maximum junction temperature rating are all within the Area of Safe Operation (ASO).

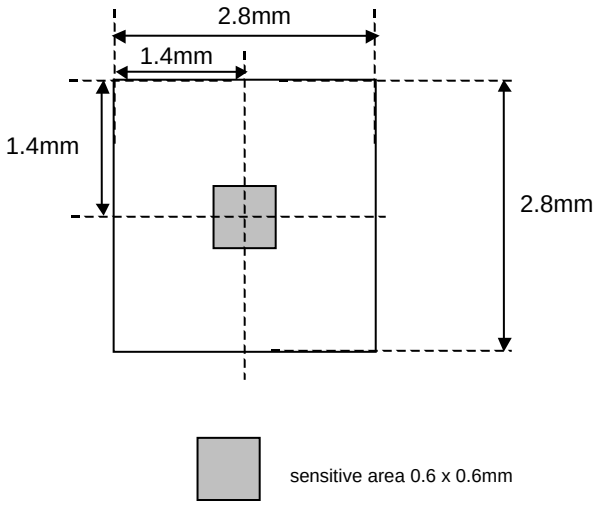
Ordering information



Marking Diagram

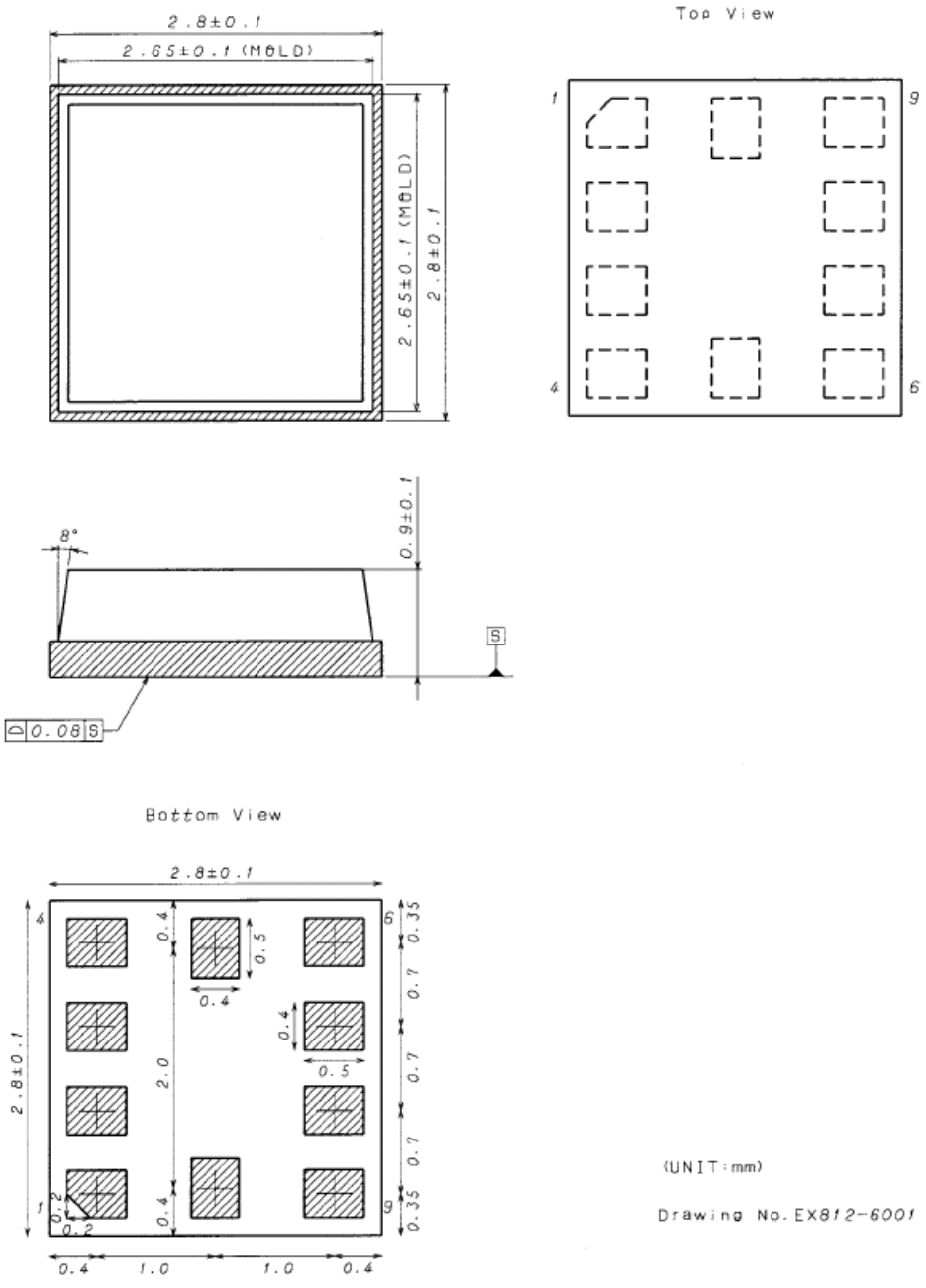


Optical design for the device



Physical Dimension and Packing Information

Package Name	WLGA010V28

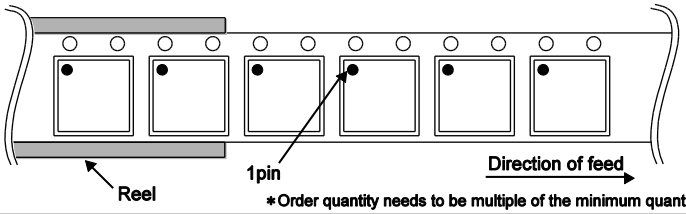


(UNIT:mm)

Drawing No. EX812-6001

<Tape and Reel information>

Tape	Embossed carrier tape (with dry pack)
Quantity	3000pcs
Direction of feed	E2 (The direction is the 1pin of product is at the upper left when you hold reel on the left hand and you pull out the tape on the right hand)



*Order quantity needs to be multiple of the minimum quantity.

Revision History

Date	Revision	Changes
03.Aug.2017	001	New Release
13.Dec.2017	002	P17 Modify the Synchronized Measurement Mode of Control Sequence. P18 Modify the Timing chart in the Watermark interrupt

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(Note1) Medical Equipment Classification of the Specific Applications

JAPAN	USA	EU	CHINA
CLASSⅢ	CLASSⅢ	CLASSⅡb	CLASSⅢ
CLASSⅣ		CLASSⅢ	

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   [e] Use of our Products in proximity to heat-producing components, plastic cords, or other flammable items
   [f] Sealing or coating our Products with resin or other coating materials
   [g] Use of our Products without cleaning residue of flux (even if you use no-clean type fluxes, cleaning residue of flux is recommended); or Washing our Products by using water or water-soluble cleaning agents for cleaning residue after soldering
   [h] Use of the Products in places subject to dew condensation

4. The Products are not subject to radiation-proof design.

5. Please verify and confirm characteristics of the final or mounted products in using the Products.

6. In particular, if a transient load (a large amount of load applied in a short period of time, such as pulse. is applied, confirmation of performance characteristics after on-board mounting is strongly recommended. Avoid applying power exceeding normal rated power; exceeding the power rating under steady-state loading condition may negatively affect product performance and reliability.

7. De-rate Power Dissipation depending on ambient temperature. When used in sealed area, confirm that it is the use in the range that does not exceed the maximum junction temperature.

8. Confirm that operation temperature is within the specified range described in the product specification.

9. ROHM shall not be in any way responsible or liable for failure induced under deviant condition from what is defined in this document.

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1. When a highly active halogenous (chlorine, bromine, etc.) flux is used, the residue of flux may negatively affect product performance and reliability.

2. In principle, the reflow soldering method must be used on a surface-mount products, the flow soldering method must be used on a through hole mount products. If the flow soldering method is preferred on a surface-mount products, please consult with the ROHM representative in advance.

For details, please refer to ROHM Mounting specification

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This Product is electrostatic sensitive product, which may be damaged due to electrostatic discharge. Please take proper caution in your manufacturing process and storage so that voltage exceeding the Products maximum rating will not be applied to Products. Please take special care under dry condition (e.g. Grounding of human body / equipment / solder iron, isolation from charged objects, setting of Ionizer, friction prevention and temperature / humidity control).

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   [a] the Products are exposed to sea winds or corrosive gases, including Cl2, H2S, NH3, SO2, and NO2
   [b] the temperature or humidity exceeds those recommended by ROHM
   [c] the Products are exposed to direct sunshine or condensation
   [d] the Products are exposed to high Electrostatic

2. Even under ROHM recommended storage condition, solderability of products out of recommended storage time period may be degraded. It is strongly recommended to confirm solderability before using Products of which storage time is exceeding the recommended storage time period.

3. Store / transport cartons in the correct direction, which is indicated on a carton with a symbol. Otherwise bent leads may occur due to excessive stress applied when dropping of a carton.

4. Use Products within the specified time after opening a humidity barrier bag. Baking is required before using Products of which storage time is exceeding the recommended storage time period.

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