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UV Sensor

GUVA-C32SM

FEATURES

- UVA sensing with 16-bit resolution
- Support UV index measurement (0~16)
- Programmable gain and integration time
- I^2C slave interface up to 400KHz
- Power management modes
- Shutdown current : 0.8uA typical
- Supply voltage of 2.2V to 3.6V
- 2.0mm×2.3mm×1.4mm ,4-pin COBpackage

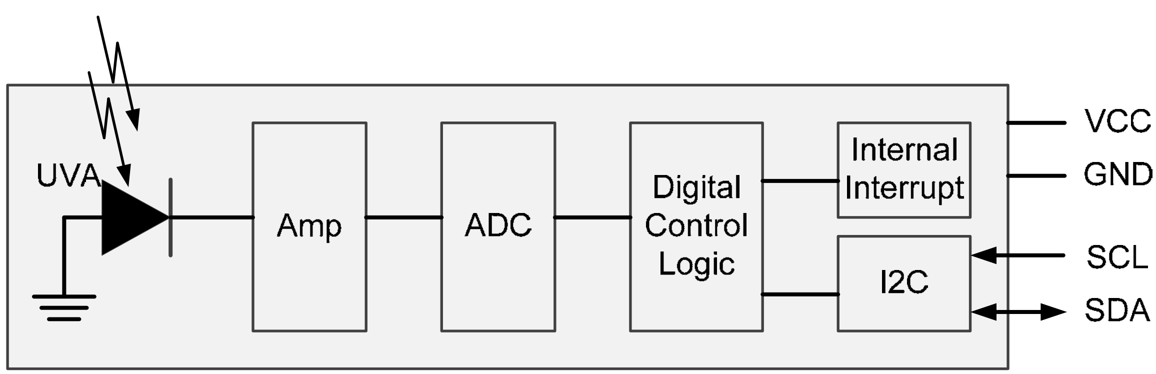
APPLICATIONS

Smartphone, Wearable devices, IoT, watch, weather station, bicycle navigation, gaming, accessary

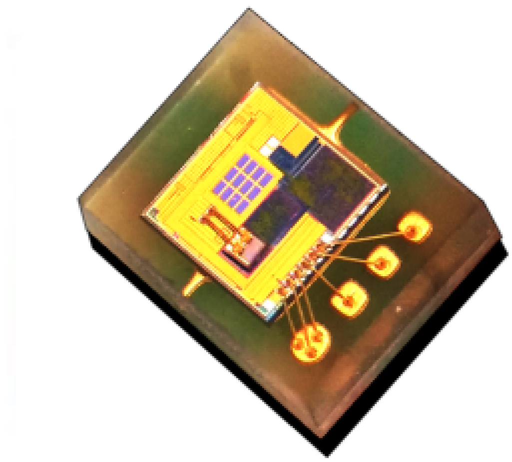
GENERAL DESCRIPTION

GUVA-C32SM supports integrated functions of ultraviolet light sensors such that can be easily configured and used in user applications.
GUVA-C32SM comprises photodiodes, amplifiers, ADC, digital control logic and I^2C interface circuit.GUVA-C32SM receives UVA and outputs digital count according to the intensity. Power consumption can be minimized by proper use of power management mode,.

FUNCTIONAL BLOCK DIAGRAM



GenUV Digital UV Sensor
2.0mm x 2.3mm SMD COB Packaging



Benefits:
- UV measurement only, visible is blocked
- 16 bit resolution
- Programmable gain and integration time
- Compact 2.0mm x 2.3mm SMD COB package

Applications:
- Cellphones
- Wearable Devices
- IoT
- Watches
- Weather Stations
- Bicycle Navigation
- Gaming Accessories

Table of Contents

1. SPECIFICATIONS

Unless otherwise noted, all the measurement results are based on T_A=25°C and V_{CC}=3.0V. Typical specifications are not guaranteed while all the minimum and maximum specifications are guaranteed.

Table 1.1Electricalcharacteristics

Symbol	Parameter	Condition	Min.	Typ.	Max.	Units
Functional						
V_{CC}	Power supply voltage		2.2	3.0	3.6	V
V_{OH}	High-level output voltage		1.22			V
V_{OL}	Low-level output voltage				0.4	V
V_{IH}	High-level input voltage		0.8 * V_{CC}			V
V_{IL}	Low-level input voltage				0.2 * V_{CC}	V
I_{DD}	Current consumption	Normal mode		150	160	µA
I_{DS}		Shutdown mode		0.8	1	
F_{I2C}	I^2C clock frequency		1		400	kHz
T_{ADC}	ADC conversion time	RES=011(100ms)	95	100	105	ms
ADC_f	Full scale ADC code	RES =011(100ms)			65535	LSB
ADC_d	ADC code for dark current	RES =011, RANGE_UVA = 011,		0	3	LSB
T_{OP}	Operating temperature		-30		85	°C
UVA						
	Wavelength		240		370	nm
I_{PH}	Photo Current	352nm UVA 4W Lamp,		23.94		nA
ADC_{UVA}	ADC code for UVA	352nm UVA 4W Lamp,		TBD		LSB

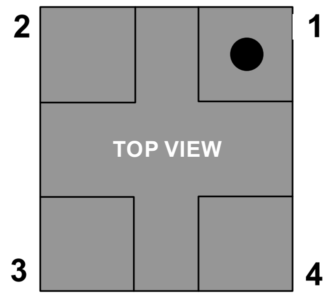
2. ABSOLUTE MAXIMUM RATINGS

Stresses above these listed absolute maximum ratings may cause permanent damage to the device. Exposure beyond specified electrical characteristics may affect the device reliability or cause malfunction.

Table 2.1Absolute Maximum ratings

Symbol	Parameter	Min	Max	Units
V_{CC}	Power supply voltage	-0.3	3.6	V
V_{IO}	Digital I/O signal voltage	-0.3	3.6	V
ESD	HBM		2	kV
	CDM		700	V
T_{OP}	Operating temperature	-30	+85	°C
T_{STORE}	Storage temperature range	-40	+85	°C
T_{SOLDER}	Soldering temperature (peak temperature duration: 10s)		260	°C

3. PIN CONFIGURATION AND DESCRIPTION



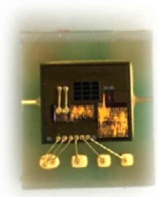
2mm x 2.3mm COB package (1.4mm thickness)

Figure 3.1 Pin configurations (Top view)

Table 3.1Pin description

Pin #	Name	I/O Type	Description
1	GND	Ground	Ground
2	SDA	Digital in/out	I^2C data line
3	SCL	Digital input	I^2C clock line
4	VCC	Supply	Supply voltage

4. PACKAGE INFORMATION



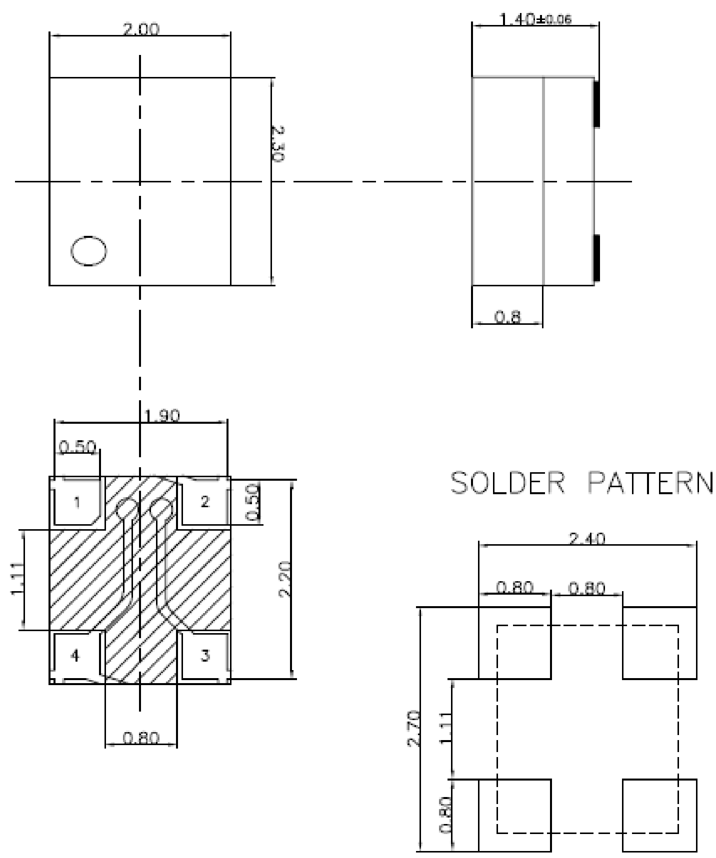


Figure 4.1 Package outline dimension

5. APPLICATION CIRCUITS

C_{VCC} is used to reduce the power supply noise, and also should be placed near pin 4. For the I^2C operation, SDA and SCL need pull-up resistors. The recommended component values are in Table 5.1.

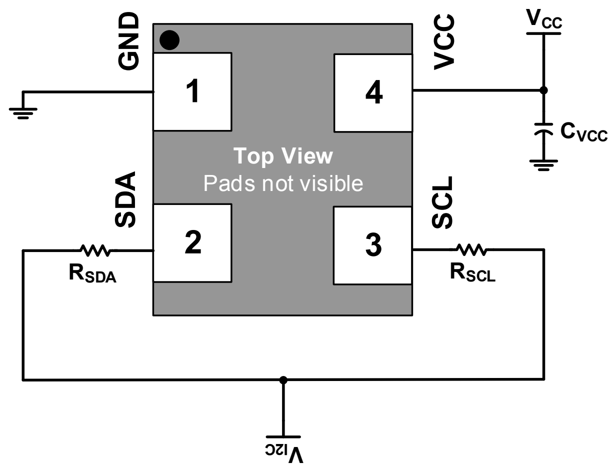


Figure 5.1 Application circuit

Table 5.1 Recommended values

Components	Recommended values
C_{VCC}	1uF
R_{SCL}	4.7kΩ
R_{SDA}	4.7kΩ

6. FUNCTIONAL DESCRIPTION

GUVA-C32SMis an integrated circuit of an UVAsensor and ROIC. It includes on-chip photodiodes, ADCs, amplifiers, comparators and I²C interface. The photo detectors senses the amount of incident light for the UVA. The current generated by photo detectors is converted and measured by ADC and changed to 16-bit resolution digital data. The measured data can be delivered to host CPU via I²C serial interface.GUVA-C32SMcaninternally generate the interrupt signal to reduce the burden of host CPU by informing the occurrence of specified events.

Communication with host CPU is accomplished through I²C serial interface. The fastest speed of the interface is 400kHz.

SYSTEM RESET

System reset circuit is shown in Figure6.1. When the system reset signal is generated, all the internal registers are initialized. System reset signal is generated from eitherPOR(power-on-reset) circuit or SoftReset signal. POR circuit releases reset signalwhen VDD signal rises to the specified voltage after powerup.TheSoftReset signal is generated when host CPU writes 0xA5 value to the register of address 0x0B.

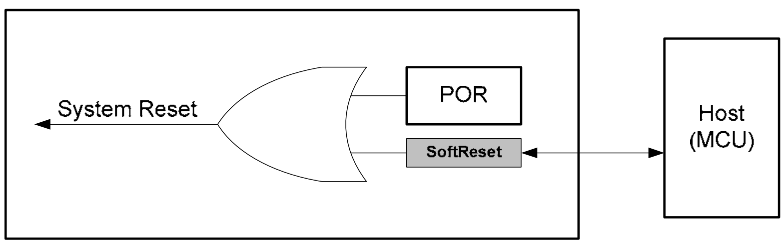


Figure6.1. System reset circuit

POWER MANAGEMENT MODES

GUVA-C32SM supports 4 power management modes to save power consumption;

- normal mode
- low-power mode
- auto-shutdown mode
- shutdown mode

As soon as power is up, GUVA-C32SM enters into shutdown mode. In normal mode, the amount of UVA isrepetitively measured according to the value of OPER field. In low-power mode,allthe other circuits except system management and host interface circuits are periodically deactivatedto save power consumption.

The power consumption is minimized in shutdown mode as all the circuits except host interface are disabled.In auto-shutdown mode, UVA sensing operation is executed just once and behave as shutdown mode afterwards. The power management mode can be selected by PMODE[1:0] field of MODE register at address 0x01.

UVA SENSINGOPERATIONS

In other modes except shutdown mode, the sensing operating can be set as follows;

In UVA operation, the photodiode for UVA is used to detect the amount of incident light. The measured data is output to UVA registers at address 0x15 and 0x16.

The sensing operations are selected by the value of OPER field of MODE register at address 0x01.

Figure 6.2 shows the possible sensing operations in the normal mode. Figure 6.3 shows the low-power and auto-shutdown mode operations. The sleep duration is controlled by SLP_PER[1:0] field of MODE_CTL register at address 0x0A.

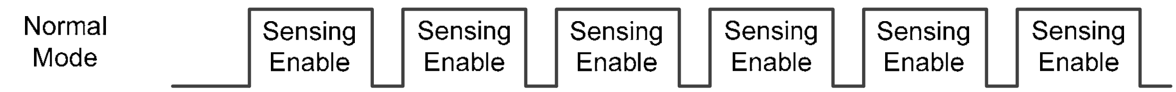


Figure6.2. Normal modeoperations

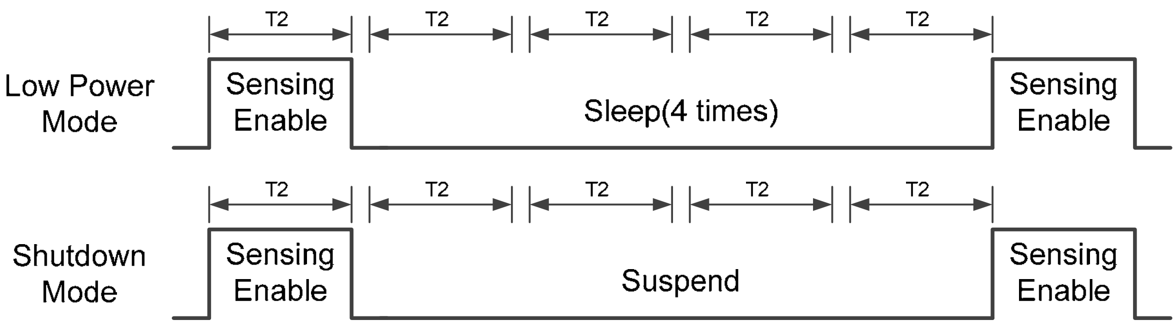


Figure 6.3.Low-power and shutdown mode operations

RESOLUTION AND RANGE

Resolution defines how finely the incident light can be measured. And it is proportional to ADC measuring time. If the ADC measuring time is increased by 2 times, the resolution can be increased by 1 bit.

The resolution for sensor is selected by RES[2:0] field of RES register at address 0x04. The default resolution is 16 bits and the measuring time is 100ms.

In sensing operation, if the resolution is over 16 bits, the upper 16 bits of the measured result is output as measured data.

Range controls the range of intensity of the incident light. In the case of incident light exceeding the full range(in other words, overflow), the maximum value of sensor is output as measured data. That is, the exact measured data can't be obtained. The range can be changed in order that the measured data is represented in the maximum value.

The range for sensor is selected by RANGE[2:0] field of RANGE register at address 0x05.

For example, the measurable range is to change x64 to x128, the measured data of x128 is represented as half value compared to that of x64 for the same incident light.

7. REGISTER MAP

There are 11 registers in GUVA-C32SM. Those registers can be accessed through I^2C interface from host CPU. The register map is shown in table 7.1.

All the reserved regieters are recommended NOT to be read and written and the reserved fields are recommended to be filled with '0',.

Addr (Hex)	Allias	Bit 7	6	5	4	3	2	1	0	Init (Hex)
0×00	CHIPID	CHIPID[7:0]								0×62
0×01	MODE	Reserved		UVA_EN		Reserved		POWER_MODE[1:0]		0×03
0×02	Reserved	Reserved								
0×03	Reserved	Reserved								
0×04	RES_UV	Reserved					RES_UV[2:0]			0×03
0×05	RANGE_UVA	Reserved					RANGE_UVA[2:0]			0×07
0×06	Reserved	Reserved								
0×07	Reserved	Reserved								
0×08	Reserved	Reserved								
0×09	Reserved	Reserved								
0×0A	MODE_CTL	SLEEP_PERIOD[3:0]				Reserved				
0×0B	SOFT_RESET	SOFT_RESET[7:0]								0×00
0×0C~0×14	Reserved	Reserved								
0×15	UVA_LSB	UVA[7:0]								ReadOnly
0×16	UVA_MSB	UVA[15:8]								ReadOnly
0×17	Reserved	Reserved								
0×18	Reserved	Reserved								
0×30	NVM_Read_ctrl	NVM Read Address[7:0]								
0×31	NVM_MSB	NVM(non-volatile memory)data output [15:8]								ReadOnly
0×32	NVM_LSB	NVM(non-volatile memory)data output [7:0]								ReadOnly

Table 7.1 Register map

Register 0x00 – CHIPID

D7	D6	D5	D4	D3	D2	D1	D0
CHIPID							

It stores CHIPID. The CHIPID always maintains '0x62'.

Register 0x01 – MODE

D7	D6	D5	D4	D3	D2	D1	D0
		OPER[1:0]				PMODE[1:0]	

This field controls UVA sensing operation. According to the value, UVA sensing operation can be enabled or disabled.

Table 7.2 Sensor Operations

OPER[1 :0]	Operations
00	No operation
01	UVAoperation
10, 11	Not used

PMODE[1:0]

This field controls the power management modes. Initial state is shutdown mode.

Table 7.3 Power management modes

PMODE	Power Management modes
00	Normal mode
01	Low-powermode
10	Auto shutdown mode
11	Shutdown mode

Register 0x04 – RES_UV

D7	D6	D5	D4	D3	D2	D1	D0
					RES_UV [2:0]		

RES_UV[2:0]

This field defines the measuring period of sensor operation. The default value is '011'.

Table 7.4Sensor resolution

RES_UV[2:0]	Resolution	Sensor measuring
000	16bits	800ms
001	16bits	400ms
010	16bits	200ms
011	**16bits**	**100ms**
100 ~111	-	Not used

Register 0x05 – RANGE_UVA

D7	D6	D5	D4	D3	D2	D1	D0
					RANGE_UVA [2:0]		

RANGE_UVA [2:0]

This field defines the range of UVA operation. The default value is '111'.

Table 7.5UVA range

RANGE_UVA[2:0]	Measurable
000	x1
001	x2
010	x4
011	x8
100	x16
101	x32
110	x64
111	**x128**

Register 0x0A – MODE_CTL

D7	D6	D5	D4	D3	D2	D1	D0
	SLP_PER[2:0]						

SLP_PER[2:0]

This field defines sleep duration in low-power mode. The sleep duration is based on measuring time of each operating mode.

Table 7.7Sleep duration

SLP_PER[2:0]	Sleep duration
000	2 times
001	4 times
010	8 times
011	16 times
100	32 times
101	64 times
110	128 times
111	256 times

Register 0xB – SOFT_RESET

D7	D6	D5	D4	D3	D2	D1	D0
SOFT_RESET							

SOFT_RESET[7:0]

If 0xA5 is written into this register, all the circuits and registers are initialized. Since it is auto-cleared, it always indicates 0x00 when host CPU reads it out.

It should be noted that applying SOFT_RESET should be done only when POWER_MODE='00'.

Register 0x15 – UVA_LSB

D7	D6	D5	D4	D3	D2	D1	D0
UVA[7:0]							

UVA [7:0]

UVA data lower 8 bits.

Register 0x16 – UVA_MSB

D7	D6	D5	D4	D3	D2	D1	D0
UVA[15:8]							

UVA[15:8]

UVA data upper 8 bits.

Register 0x30 – NVM Read Control

D7	D6	D5	D4	D3	D2	D1	D0
NVM address for read							

NMVaddress[7:0]

If NVM(non-volatile memory) address is written into this register,NVM gives out the memory content through NVM data output registers (register 0x31, 0x32)

Table 7.8NVM address for read

address	NVM READ ADDRESS
0x0A	offset
0X0B	A_Scale

Example) - Offset

//Read the value of NVM ADDRESS0x0A(offeset)

// ********* NVM Read Command************ //
`I2C_WRITE(`DEVADDR, 8'h30, **8'h0A**); // NVM ADDRESS
//As the data size of Offsetis 8bit, Offset data can be read out through NVM MSB register(0x31)
Offset = I2C_READ(`DEVADDR, 8'h31); // NVM DATA MSB [15:8]
// ******* NVM DataRead Command******** //
A_Scale_msb = I2C_READ(`DEVADDR, 8'h31); // NVM DATA MSB [15:8]

Example) – A_Scale

//Read the value of NVM ADDRESS 0x0B(A Scale)
// ********* NVM Read Command************ //
`I2C_WRITE(`DEVADDR, 8'h30, **8'h0B**); // NVM ADDRESS

//As the data size of A_Scale is 16bit,so through I2C need to read for a two times
// ******* NVM DataRead Command******** //
A_Scale_msb = I2C_READ(`DEVADDR, 8'h31); // NVM DATA MSB [15:8]
A_Scale_lsb = I2C_READ(`DEVADDR, 8'h32); // NVM DATA LSB [15:8]

Register 0x31 – NVM_MSB

D7	D6	D5	D4	D3	D2	D1	D0
NVM data[15:8]							

NVM data[15:8]

NVM data upper 8 bits.

Register 0x32 – NVM_LSB

D7	D6	D5	D4	D3	D2	D1	D0
NVM data[7:0]							

NVM data [7:0]

NVM data lower 8 bits.

8. I^{2}C INTERFACE

I^{2}C slave interface is implemented on the basis of "I^{2}C Specification UM10204 Rev. 03 (19 June 2007)". The 7-bit device address is "0111001", which can be modified by bonding option.

To explain the read/write operationsof I^{2}Cinterface,some abbreviations are introduced as follows.

Table 8.1Abbreviations

Abbr.	Operation
S	Start condition
Sr	Repeated start condition
P	Stop condition
ACKS	Acknowledged by slave
ACKM	Acknowledged by master
NACKS	Not acknowledged by slave
NACKM	Not acknowledged by master

In write operation, after host CPU sends start signal, first byte contains read/write mode and device addres information. MSB 7bits of first byte expresses device address and last bit indicates read ('1') or write ('0'). As soon as slave receives data, it needs to respond ACKS or NACKS. If host CPU receives ACKS, it sends the register address to GUVA-C32SM. Last transfer starts to send register data being written to its address. When the received information is NACKS, host CPU should finish the communication as sending stop condition. Likewise, host CPU sends stop condition after normal operation completion.

I^{2}C busrt write operation was implemented to send registers continuously. In figure8.2, the fourth and fifth bytes can be continuously sent to slave without stop condition. The register address increments automatically and I^{2}C slave receives data. The burst write does not finish until host CPU sends stop signal.

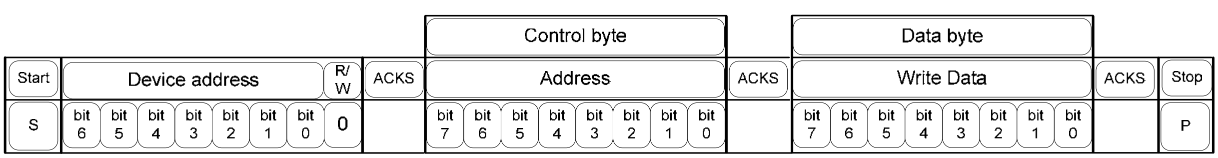


Figure 8.1I^{2}C single writeoperation

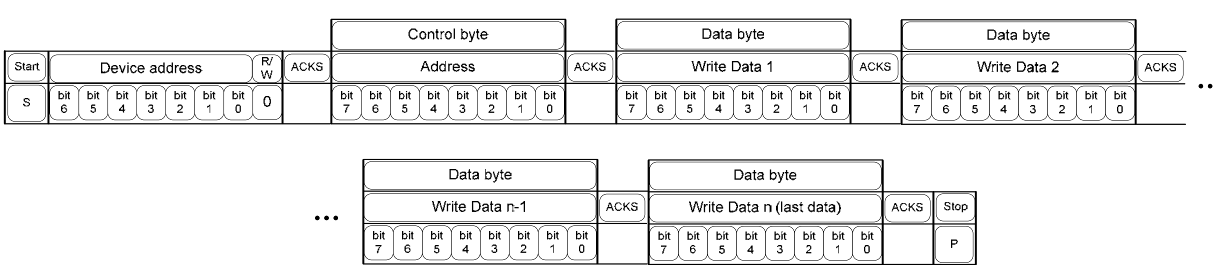


Figure8.2 I^{2}C burstwriteoperation

I^2C read operation consists of two stage. The first communication terminates when host CPU sendsstopcondition after the first byte transfer for device address setting and the second byte transfer for slave address setting is completed. Secondly, host CPU sends start condition again, device address and read mode '0' as the first byte for read operation. And then I^2C slave should send register data of the corresponding register address defined in the previous stage. For I^2C burst read operation, if host CPU sends SCL clock continuously, I^2C slave must send data in consecutively increasing address order. To terminate the communication, stop condition should be sent to I^2C slave.

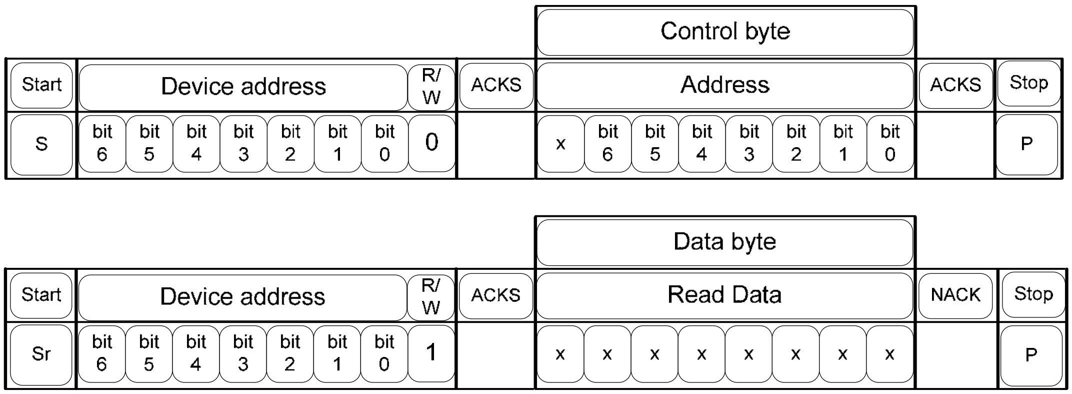


Figure 8.3 I^2C single readoperation

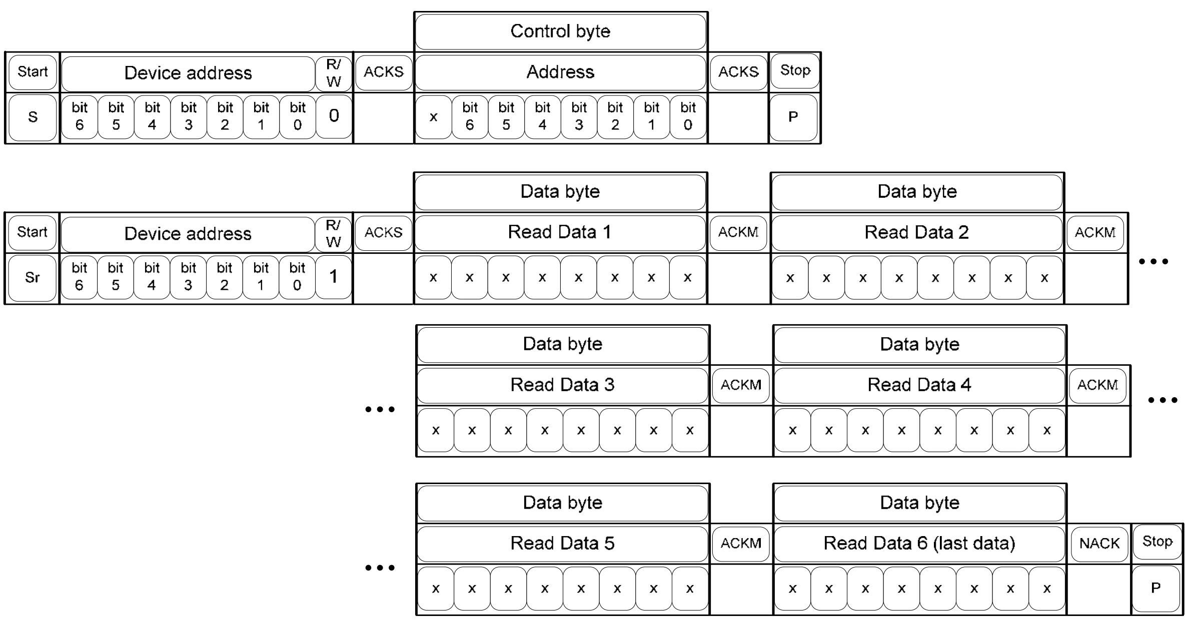


Figure 8.4I^2C burstreadoperation

The timing parameters and timing diagram for I²C operationsare shown in table 8.2 and figure8.5 as follows.

Table 8.2 I²C timing parameters

Symbol	Parameter	Condition	Min	Typ	Max	Units	Test
SCL Freq	SCL frequency				400	KHz	Q
T_F	Fall time				300	ns	Q
T_R	Rise time				1000	ns	Q
T_{HIGH}	SCL high time		0.6			µs	Q
T_{LOW}	SCL low time		1.3			µs	Q
T_{SUSTA}	Start condition setup time		0.6			µs	Q
T_{HDSTA}	Start condition hold time		0.6			µs	D
T_{HD}	Data hold time		0.0			µs	Q
T_{SU}	Data setup time		0.1			µs	Q
T_{SUSTO}	Stop condition setup time		0.6			µs	Q
T_{BUF}	Bus free time		1.3			µs	Q

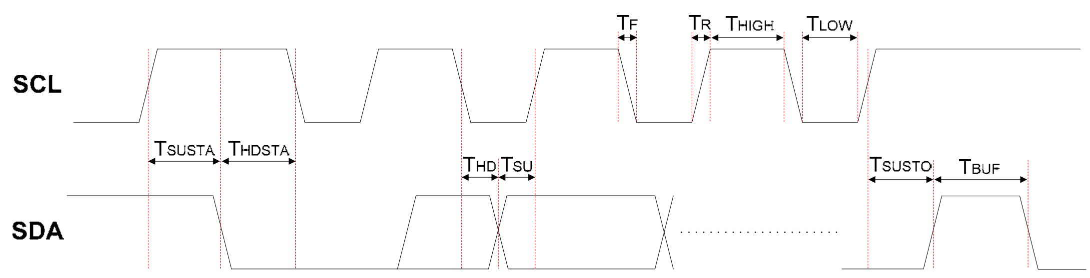


Figure 8.5 I²C timing diagram

9. TYPICAL CHARACTERISTICS

TBD

Figure9.1 Output data – UV Intensity Characteristics

TBD

Figure9.2Spectral Responsivility Characteristics

Document update history

Rev	Date	Change description
1	9-Sep-2015	Preliminary datasheet Release

Disclaimer

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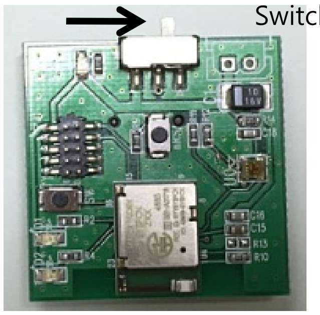
Instruction Manual
Demo Board

1. **Install "UVI_Checker_BLE.apk" file on you mobile phone. (Now only install in Android, and now developing Apple , Xiaomi app.)**

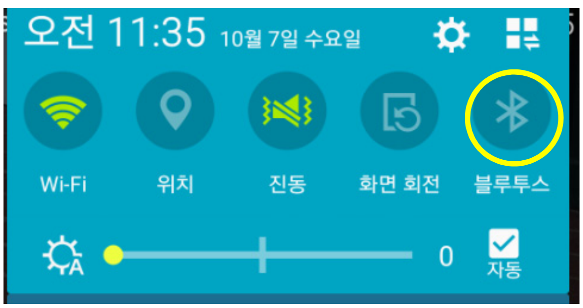
2. **Turn on Bluetooth on Demo Board**



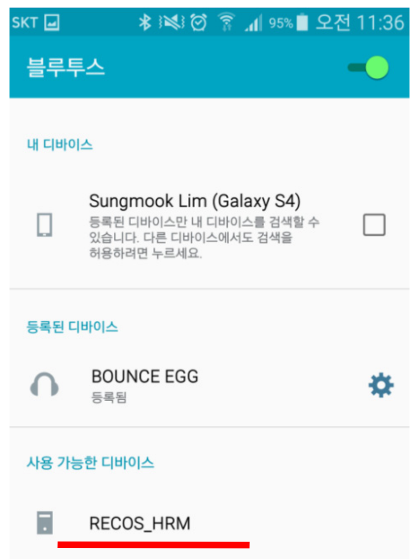
Switch off

Switch on

3.Turn on Bluetooth on your mobile phone. Click search button. When RECOS-HRM is searched on the phone, connect with phone.



Bluetooth on



4. **Start Smart UVI Checker BLE Application → Make Demo board face to sun or UV light and touch Smart UVI Checker app's measure button. → You can check UVI.**