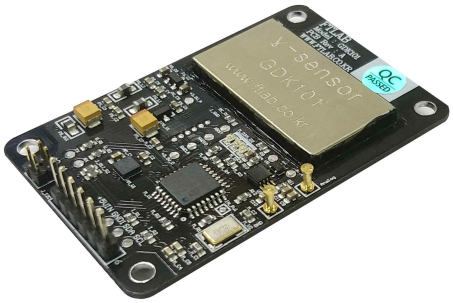
GDK101 ver1.6 Gamma Radiation Sensor Module



Features

- **Solid state sensor : sensitive PIN Photodiode 10pc**
- **Sensitivity : 12cpm/μSv/h**
- **Measurement Range : 0.01 ~ 99.99μSv/h**
- **Linearity error : ±5% up to 99.99μSv/h**
- **Calibration free**
- **Supply voltage & current : DC 4.0 ~ 6.0V, 10mA**
- **I²C and UART interface for MCU & Arduino**
- **Analog output port for analysis of detection pulse**
- **Built in vibration sensor for prevent error detection**

DESCRIPTION

The GDK101 is a solid state gamma radiation sensor module which has sensitive 10 PIN photodiodes and transimpedance amplifier circuit controlled by MCU. It is optimized for the low level gamma detection up to 99.99 μSv/h, for the measurement of our environmental condition with various IoT solutions. The uncertainty of sensing value is below ±10% by FTLAB's precision technology using international standard calibrated procedure. It's robustic design allow the long life time, more than 5 years without the need of maintenance. And the sensor module includes a internal MCU, it provide a smart analyzing function with built in a vibration sensor for recognition the error pulse caused by external mechanical shock. It also provides the I²C & UART interface for external microprocessor and Arduino. Also user can check the detecting waveform directly from the analog output port. It would be useful for verifying the energy spectrum analysis of gamma photons.

APPLICATION

Indoor radiation monitor
Radiation sensor for Arduino
Environmental radiation level monitor

Pin Descriptions

Pin No	name	Description
1	Tx	TTL out level 3.3V
2	Rx	TTL in level 3.3V
3	+5V	VCC input
4	GND	Ground
5	SDA	I²C data I/O 3.3V
6	SCL	I²C clock 3.3V

A0	address bit0	open is high
A1	address bit1	open is high

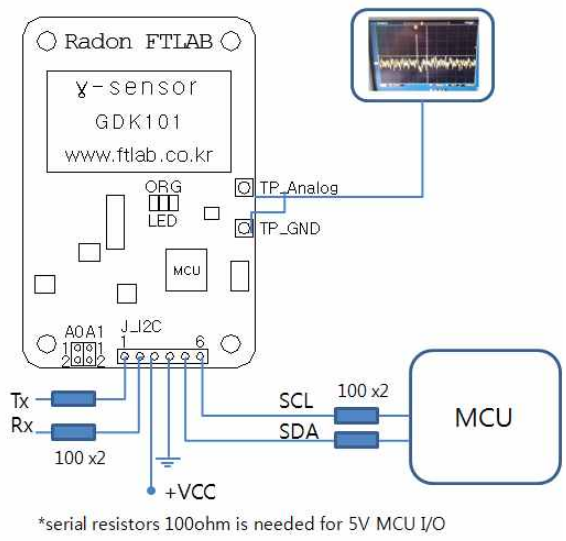


Fig 1. typical application circuit

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ABSOLUTE MAXIMUM RATING

Parameter	Symbol	Rating	unit
Supply voltage	Vcc	-0.3 to 7	V
I/O terminal voltage	V_IO	-0.3 to Vcc	V
Storage temperature	Ts	-20 ~ 85	ºC
Maximum soldering temperature	Tmax	250 (40sec)	ºC
ESD rating		±2	kV

RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	Min	Typ	Max	Unit
Supply voltage	Vcc	4.0	5.0	6.0	V
Operating temperature	Ta	-10	25	65	ºC
Operating humidity	RH		0 to 65	90	%

ELECTRICAL CHARACTERISTICS

(Ta=25ºC, Vcc=5V)

Parameter	Symbol	conditions	Min	Typ	Max	Unit
internal supply voltage	Vdd	through LDO	3.28	3.30	3.32	V
current consumption	I_{cc}	I^2C operating case	13	15	18	mA
Analog output peak	V_p	background test	100	150	1000	mV
Analog output pulse width	T_w	FWHM	50	100	200	μs
Base noise level of analog output	V_n		±40	±50	±70	mV
Threshold voltage for gamma detection	V_{th}	reference voltage for comparator	94	96	98	mV
Serial data clock	SCL			100		kHz
UART	Tx, Rx	MODBUS		19200		Baud rate
Level of Tx, Rx, SDA	$V_{I/O}$		2.7	3.0	3.3	V

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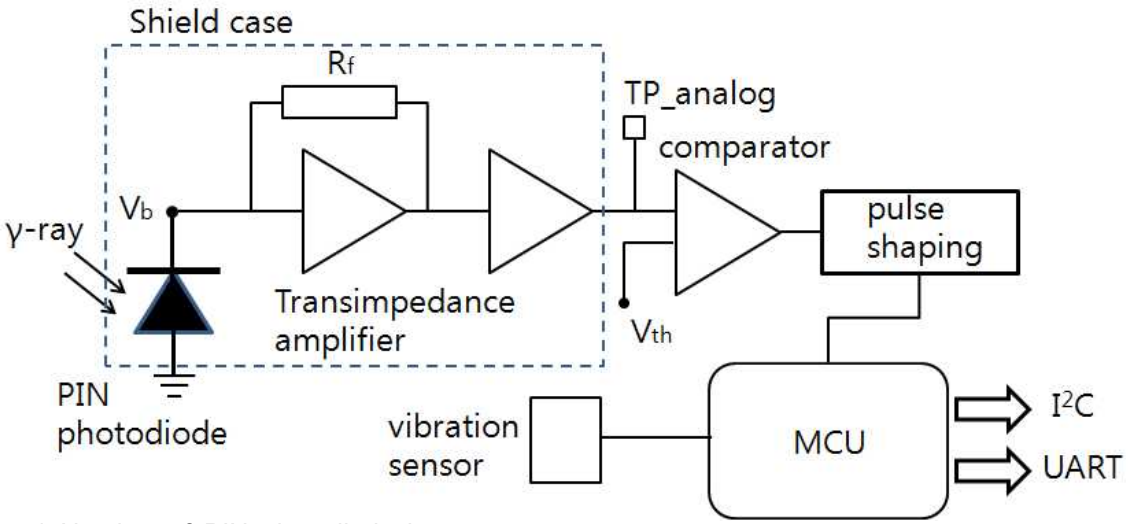
FUNCTIONAL BLOCK DIAGRAM



* Number of PIN photodiode is ten.
* Measurable radiations are Gamma ray and X-ray.
* When the vibration is detected, MCU cancel the detection signal during ±0.5sec.
* Internal supply voltage, Vdd is 3.3V by two LDO, for analog and digital part.

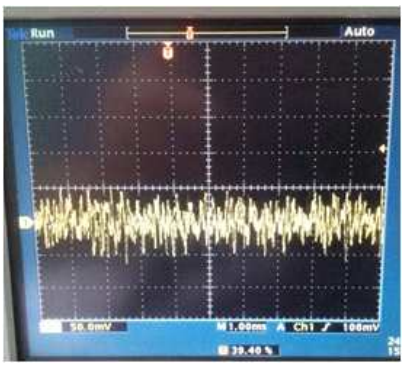
FUNCTIONAL CHARACTERISTICS*

(Ta=25ºC, Vcc=5V)

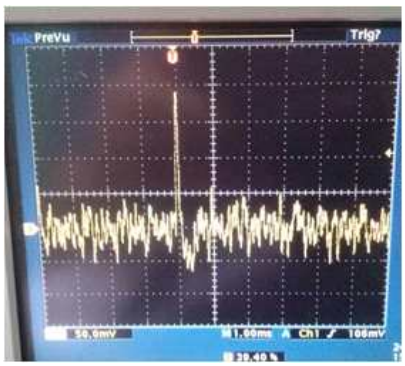
Parameter	Symbol	conditions	Min	Typ	Max	Unit
measurement range		10min average	0.01	-	99.99	μSv/h
Sensitivity	K	full range	11.5	12	12.5	cpm/μSv/h
uncertainty	δ	1min average at 20μSv/h	±5	±10	±15	%
Linearity error	ε	10 ~ 99.99μSv/h	±3	±5	±8	%
minimum error	δ_{min}	background test	-	0.05	-	μSv/h

* All the test were carried out from the standard radiation test laboratory using Cs137 radiation source

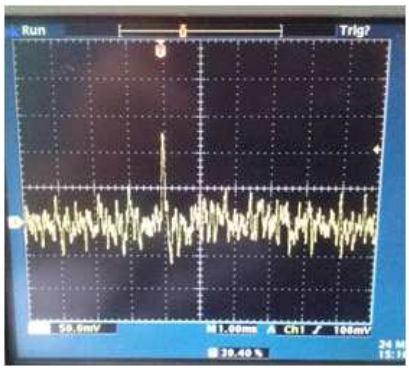
TYPICAL ANALOG OUTPUT CHARACTERISTICS



Base noise level V_n, typically ±50mV (1ms/div, 50mV/div)



Typical gamma detection signal waveform 1 (1ms/div, 50mV/div)



Typical gamma detection signal waveform 2 (1ms/div, 50mV/div)

* The threshold voltage for gamma detection, V_{th} is typically 96mV by considering the noise level.

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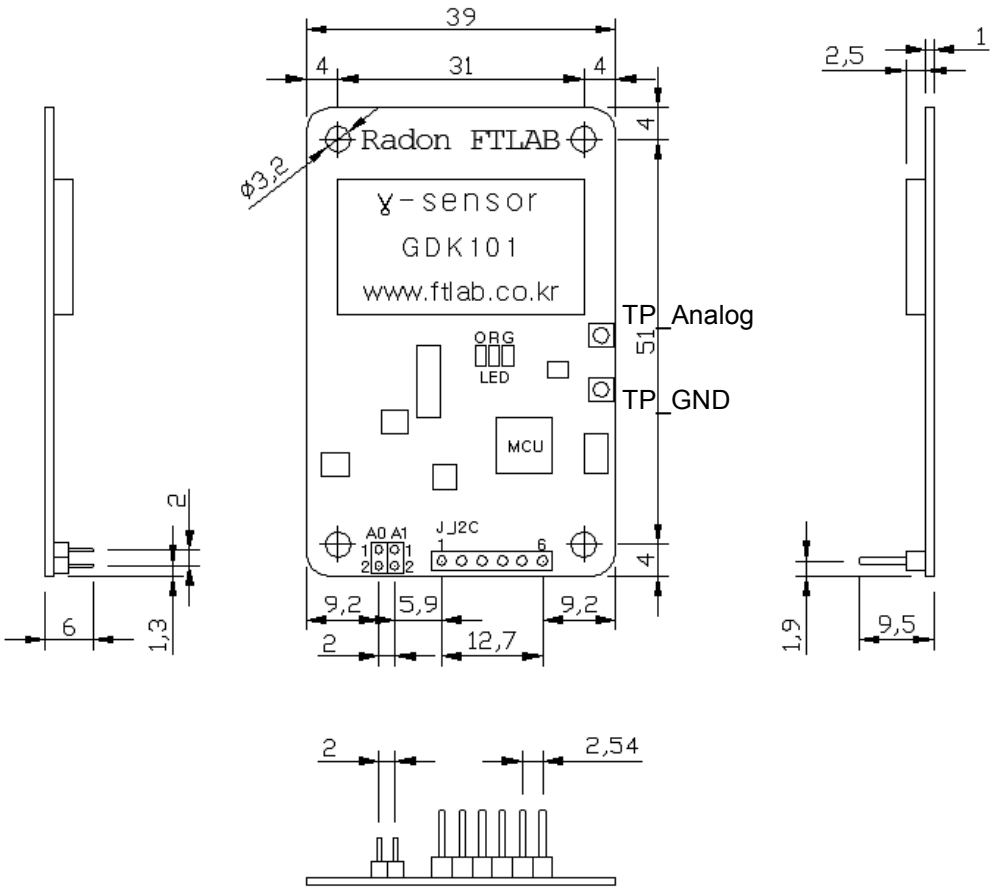
GENERAL PCB OVERVIEW



LED Descriptions

Color	Descriptions
Orange	Vibration sensing sign (detection canceled when this sign on)
Red	Gamma pulse detection sign
Green	MCU operating status (normal : flashing once per second)

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Main Pin (J_I2C) Descriptions

Pin No	Name	Description
1	Tx	TTL out level 3.3V
2	Rx	TTL in level 3.3V
3	+5V	VCC input
4	GND	Ground
5	SDA	I^2C data I/O
6	SCL	I^2C clock

Address Pin Descriptions

Name	Function	Description
A0	I^2C address bit0	open is high
A1	I^2C address bit1	open is high

Analog TP Descriptions

Name	Description
TP_Analog	The transimpedance amplifier output port. When the gamma ray is detected, an analog pulse is output from this pin, which has typically 100mV ~ 1000mV peak and 100us FWHM pulse width. Base noise level is normally ±50mV
TP_GND	Ground pin for oscilloscope probe

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UART INTERFACE (ASCII)

* GDK101 has two modes.

Mode	Description
Auto_send	When GDK101 is turned on, the GDK101 sends the Measured value(1min) to the host at every 1min automatically. ex) ┐M:1.24<CR><LF> ;1.24 uSv/h
Normal	If other request is sent from the host(except for 'R'), the GDK101 will be changed to Normal mode.(Should request comes in response.)

Packet Format

STX	Command	:	Data	CR	LF

Field	Length	Type	Description
STX	1 byte	Character	" ┐ "
Command	1 byte	Character	Select a command from the Command List.
:	1 byte	Character	This symbol separate the Command field and the Data field
Data	variable	Character string	'?' (when requesting to GDK101) Data bytes(when you receive a response from GDK101)
CR, LF	2 byte	Binary data	Used to identify the end of a packet

* Sample packet
  - Request : ┐D:?<CR><LF> ; 10min average value?
  - Response : ┐D:1.24<CR><LF> ; 1.24 uSv/h

Command List

Command	Meaning	Description
D	Measured value 10min	Return gamma value(10min avg, 1min update)
M	Measured value 1min	Return gamma value(1min avg, 1min update)
T	Measuring time	Return the current measuring time
S	Status	Return the current status
F	Firmware version	Return firmware version of GDK101
V	Vibration status	Return the current vibration status
R	Reset	Reset GDK101
U	Auto_send enable	Set Auto_send status(enable / disable)
A	All data	Return all data of GDK101(S+T+D+M)

Example

Packet		Meaning	
Request Response	┐ D:?<CR><LF> ┐ D:1.24<CR><LF>	Measured value (10min) is 1.24 uSv/h	Range 0.00 ~ 99.99 uSv/h
*Request Response	┐ M:?<CR><LF> or automatically ┐ M:1.24<CR><LF>	Measured value (1min) is 1.24 uSv/h	Range 0.00 ~ 99.99 uSv/h
Request Response	┐ T:?<CR><LF> ┐ T:124 13:44:53<CR><LF>	Measuring time is '124day 13hour 44min 53sec'	Type Day HH:mm:ss
Request Response	┐ S:?<CR><LF> ┐ S:1<CR><LF>	Status is '1'	Status 0: Power on ~ 10sec 1: 10sec to 10min 2: after 10min
Request Response	┐ F:?<CR><LF> ┐ F:v0.6<CR><LF>	GDK101 firmware version is 'v0.6'	-
Request Response	┐ V:?<CR><LF> ┐ V:1<CR><LF>	The current vibration status is 1	Status 0: No vibration 1: Detect vibration
Request Response	┐ R:1<CR><LF> ┐ R:1<CR><LF>	Reset success	-
Request Response	┐ U:1<CR><LF> no response	Auto_send is 'enable'	Status 1: Enable Other request send (except for 'R') : Disable
Request Response	┐ A:?<CR><LF> ┐ A:1/3 22:15:46/0.55/1.67<CR><LF>	1. Status is '1' 2. Measuring time is '3day 22hour 15min 46sec' 3. Measured value(10min) is 0.55 uSv/h 4. Measured value(1min) is 1.67 uSv/h	-

* If status of Auto_send is 'enable', the GDK101 send the Measured value(1min) to the host at every 1 min automatically. Default status of Auto_send is 'enable'.

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I²C INTERFACE

Command List

CMD	Description	Read data 1	Read data 2
0xA0	Reset	0 - Fail 1 - Pass	Not used
0xB0	Read the status and vibration status	0 - Power On ~ 10sec 1 - 10sec to 10min 2 - after 10 min	0 - Not detect vibrations 1 - Detect vibrations
0xB1	Read measuring time	Minutes of measuring time	Seconds of measuring time
0xB2	Read measured value (10min avg. / 1min update)	Integer of measured value	Decimal of measured value
0xB3	Read measured value (1min avg, / 1min update)	Integer of measured value	Decimal of measured value
0xB4	Read firmware version	Main of version	Sub of version

Read sequences

START	5-bit Address	2-bit User address	Write bit	Command	START	5-bit Address	2-bit User address	Read bit	Read data 1	Read data 2	STOP
	*default addr. + user addr.		0	CMD		default addr. + user addr.		1			
	1 byte			1 byte		1 byte			1 byte	1 byte	

* Default address is **0x18**.

* ex) **START** | 0x30 | 0xB2 | **START** | 0x31 | 0x01 | 0x15 | **STOP**

  a. 0x30 : Gamma sensor address and write bit. 0x18 shifted one bit to left and write bit is 0

  b. 0xB2 : Read measured value (10min avg. / 1min update) command

  c. 0x31 : Gamma sensor address and read bit. 0x18 shifted one bit to left and read bit is 1

  d. 0x01(Data 1) : Integer of measured value, $1_{(16)} = 1_{(10)}$

  e. 0x15(Data 2) : Decimal of measured value, $15_{(16)} = 21_{(10)}$

  -> Measured value is 1.21 (uSv/h)

** More informations refer to application note. (www.allsmartlab.com)

NOTE

1. Shield case and GND

Shield case printed model name is a metal cap for EMI shielding, which is connected with GND of module. Do not open this case.

2. Electric noise influence

If the module is located close to noise generator (ex. hair dryer, high voltage discharger, high power RF transceiver, etc.), the sensor output may be affected by leaded noise. On top of that noise from power supply line also may affect the sensor output. When designing the system, please consider the effect from noise.

3. Vibration influence

The sensor may be influenced its output signal by mechanical shock or oscillation. So this module was designed to measure in a stational condition, not moving. Before usage, please make sure that the device works normally in the application. And please do not remove the black sponge on the back side of PCB.

4. Incident light influence

There is a case that the sensor output may be affected when outer-light comes through the side of PCB or through between shield case and PCB. In order to avoid any influence from outer-light, please do not scratch on the side of PCB which is painted black.

5. When the module is moisturized, this product does not keep its proper function. Please design the application so that moisturization of the module does not happen.

6. Cleaning

When cleaning the module, please use proper electronic PCB cleaner.