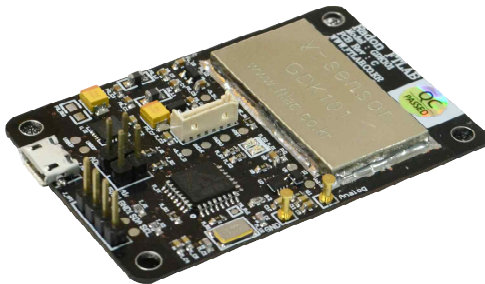


GDK101 ver1.5

Gamma Radiation Sensor Module



Features

- Solid state sensor : sensitive PIN Photodiode 10pc
- Sensitivity : 12cpm/ μ Sv/h
- Measurement Range : 0.01 ~ 200 μ Sv/h
- Linearity error : \pm 5% up to 100 μ Sv/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 200 μ Sv/h, for the measurement of our environmental condition with various IoT solutions. The uncertainty of sensing value is below \pm 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 | I ² C data I/O 3.3V |
| 6 | SCL | I ² C clock 3.3V |

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

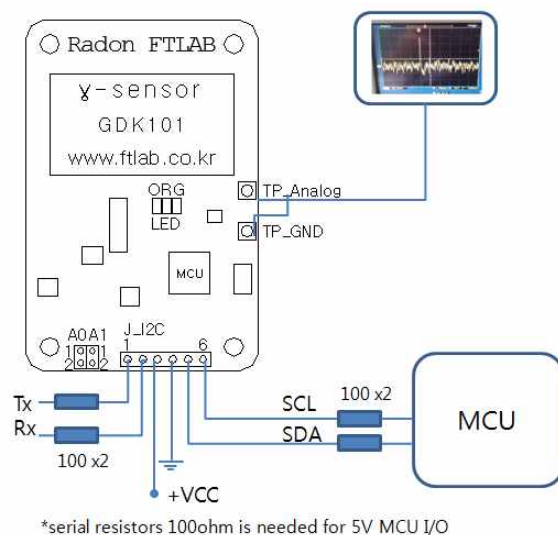


Fig 1. typical application circuit

GDK101 ver1.5 **Gamma Radiation Sensor Module****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 | T _s | -20 ~ 85 | °C |
| Maximum soldering temperature | T _{max} | 250 (40sec) | °C |
| ESD rating | | ±2 | kV |

RECOMMENDED OPERATING CONDITIONS

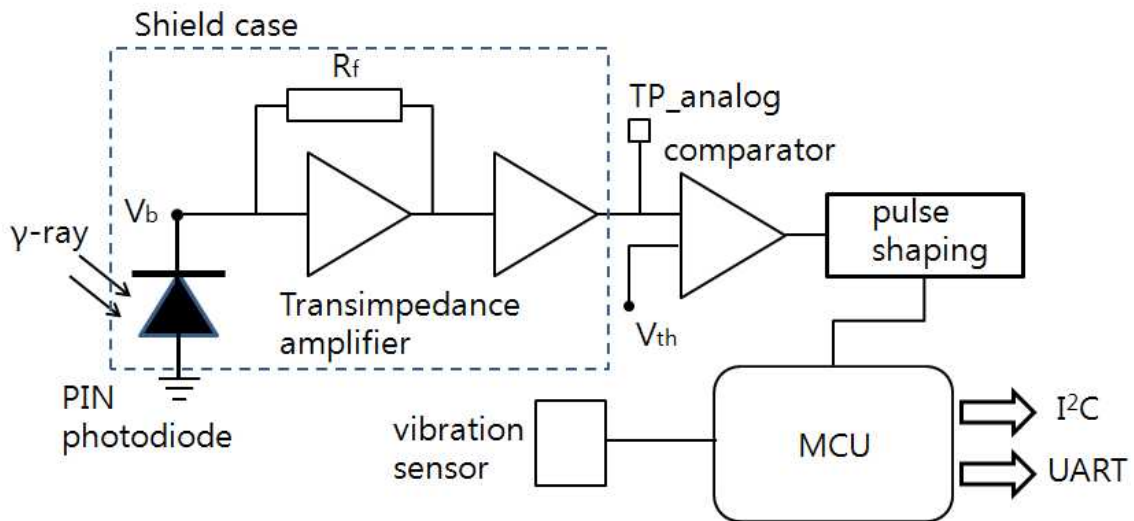
| Parameter | Symbol | Min | Typ | Max | Unit |
|-----------------------|----------------|-----|---------|-----|------|
| Supply voltage | Vcc | 4.0 | 5.0 | 6.0 | V |
| Operating temperature | T _a | -10 | 25 | 65 | °C |
| Operating humidity | RH | | 0 to 65 | 90 | % |

ELECTRICAL CHARACTERISTICS(T_a=25°C, Vcc=5V)

| Parameter | Symbol | conditions | Min | Typ | Max | Unit |
|---------------------------------------|-----------------|----------------------------------|------|-------|------|-----------|
| internal supply voltage | V _{dd} | through LDO | 3.28 | 3.30 | 3.32 | V |
| current consumption | I _{cc} | I ² C 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 _{IO} | | 2.7 | 3.0 | 3.3 | V |

GDK101 ver1.5 Gamma Radiation Sensor Module

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 ± 0.5 sec.
- * Internal supply voltage, Vdd is 3.3V by two LDO, for analog and digital part.

FUNCTIONAL CHARACTERISTICS*

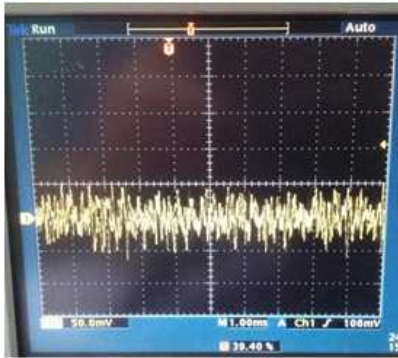
(Ta=25°C, Vcc=5V)

| Parameter | Symbol | conditions | Min | Typ | Max | Unit |
|-------------------|----------------|-------------------------------|---------|----------|----------|-----------------|
| measurement range | | 10min average | 0.01 | - | 200 | μ Sv/h |
| Sensitivity | K | full range | 11.5 | 12 | 12.5 | cpm/ μ Sv/h |
| uncertainty | δ | 1min average at 20 μ Sv/h | ± 5 | ± 10 | ± 15 | % |
| Linearity error | ϵ | 10 ~ 100 μ Sv/h | ± 3 | ± 5 | ± 8 | % |
| minimum error | δ_{min} | background test | - | 0.05 | - | μ Sv/h |

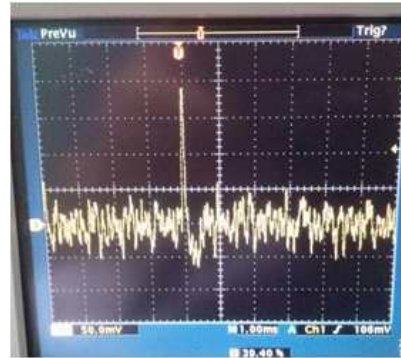
* All the test were carried out from the standard radiation test laboratory using Cs137 radiation source

GDK101 ver1.5 Gamma Radiation Sensor Module

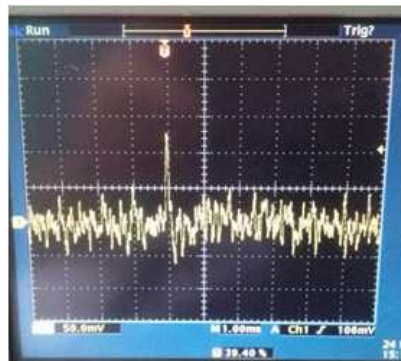
TYPICAL ANALOG OUTPUT CHARACTERISTICS



Base noise level V_n , typically $\pm 50\text{mV}$ (1ms/div, 50mV/div)



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

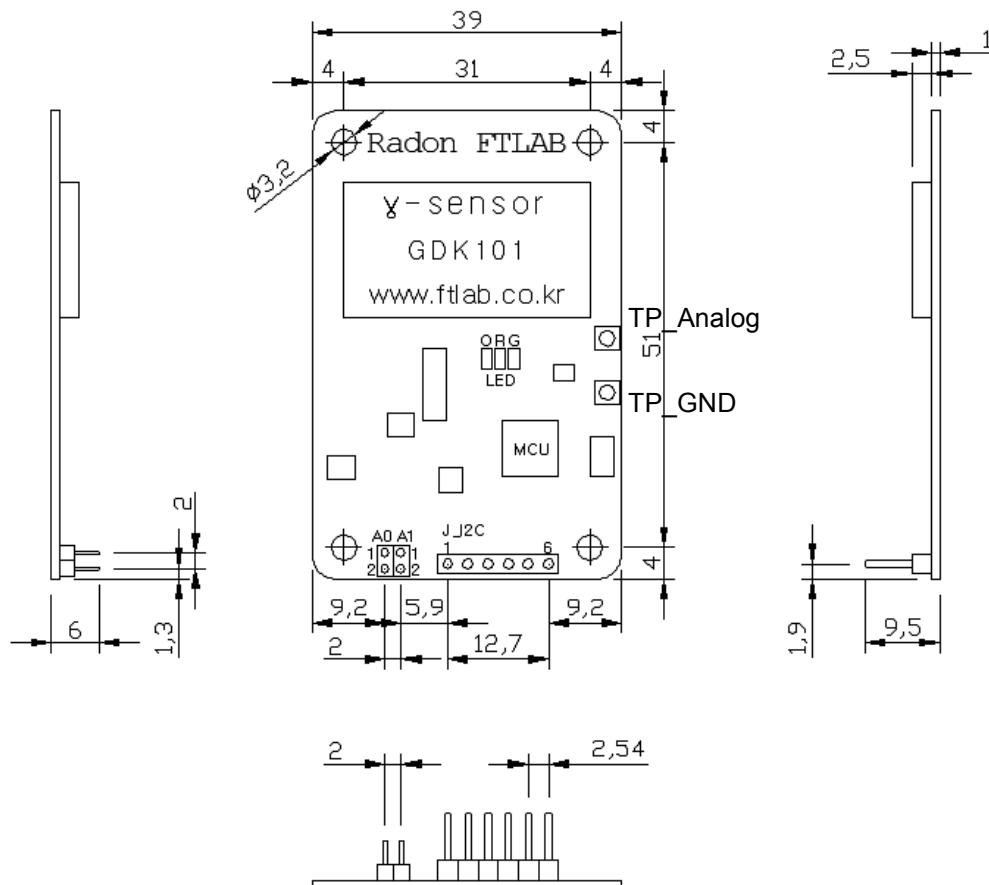


Typical gamma detection signal waveform 2 (1ms/div, 50mV/div)

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

GDK101 ver1.5 Gamma Radiation Sensor Module

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) |

GDK101 ver1.5 Gamma Radiation Sensor Module

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 ² C data I/O |
| 6 | SCL | I ² C clock |

Address Pin Descriptions

| Name | Function | Description |
|------|-------------------------------|--------------|
| A0 | I ² C address bit0 | open is high |
| A1 | I ² C 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 $\pm 50\text{mV}$ |
| TP_GND | Ground pin for oscilloscope probe |

GDK101 ver1.5 Gamma Radiation Sensor Module

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) <code>␣M:1.24<CR><LF> ;1.24 uSv/h</code> |
| 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 | " <code>␣</code> " |
| 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) |

GDK101 ver1.5 Gamma Radiation Sensor Module

Example

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

GDK101 ver1.5 Gamma Radiation Sensor Module

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)

GDK101 ver1.5 Gamma Radiation Sensor Module

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.