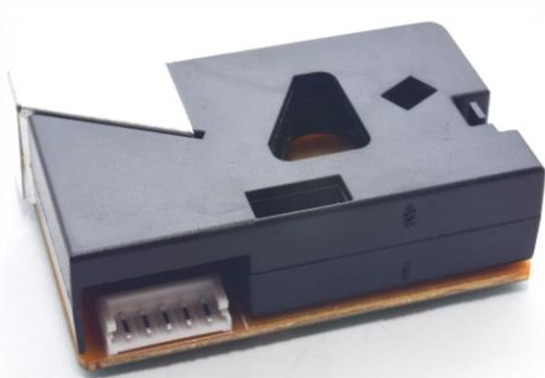


MDSM Particle Sensor Application Note

[For Air Purifier]



1. Structure and Principle of MDSM Particle Sensor

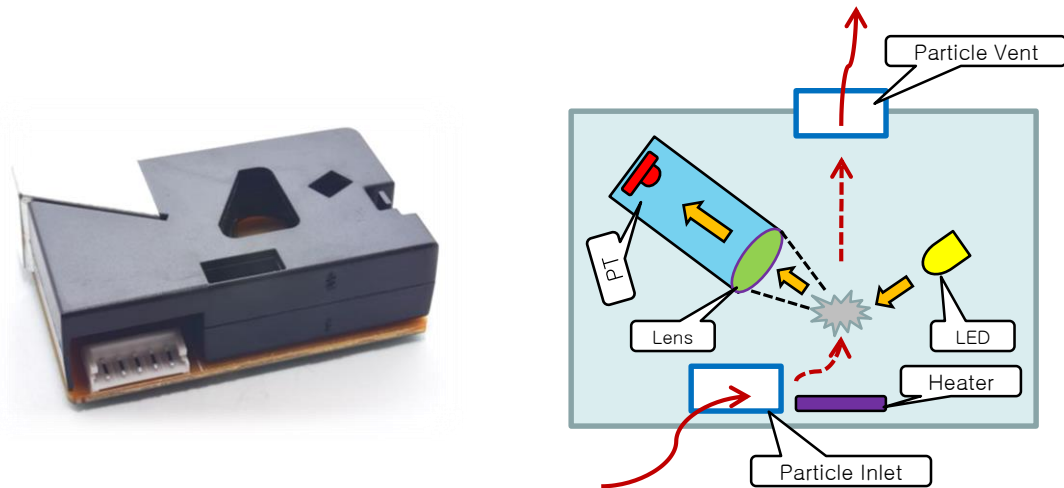


Fig 1. Block Diagram

1) Structure

As above Block Diagram, MDSM501 consists of IR(infrared ray) LED, Photo TR(PT) which recognizes the IR as a signal, and condensation lens to maximize the reflected IR light by floating particles. Also, There is a heater to move up the in-flowed particles. In addition, for the smooth air flow, there are particle inlet at the bottom and particle vent at the top of the sensor.

红外线LED,光电三极管识别红外信号,镜子最大化反射的红外光,加热器提升进入的颗粒为了增加流动性,有出口和入口

2) Principle

When the in-flowed particles from outside passes by the measuring point with heated updraft, the light from infrared LED is scattered by floating particles, and Photo TR(PT) recognizes it. The light from Photo TR(PT) is transformed into PWM signal through amplification, filtering and MCU.

2. Application method and cautions

1) How and Where to install

- Place the particle sensor inside an application to minimize any influences of external diffuse light. 避免外部的散射光

- Block every parts except for particle inlet and vent. Particularly, block the lens cleaning window with dustproof and antistatic materials.

堵死每个位置除了出入口.特别注意要用防尘和防静电材料堵住镜子清洁窗

- If possible, place the particle sensor on the location where the airflow from inlet, vent and fan least affects and where other products' IR remote signal least affects. (Please refer to the picture below)

(Please avoid placing the particle sensor on **RED** part of below picture)

传感器要避免放置在红色区域,不要靠近风口,排气口,风扇,红外信号.

- Use a partition or so to protect the sensor from an unwanted influence by airflow from air inlet.

用一个隔离器将空气入口的气流和传感器隔开

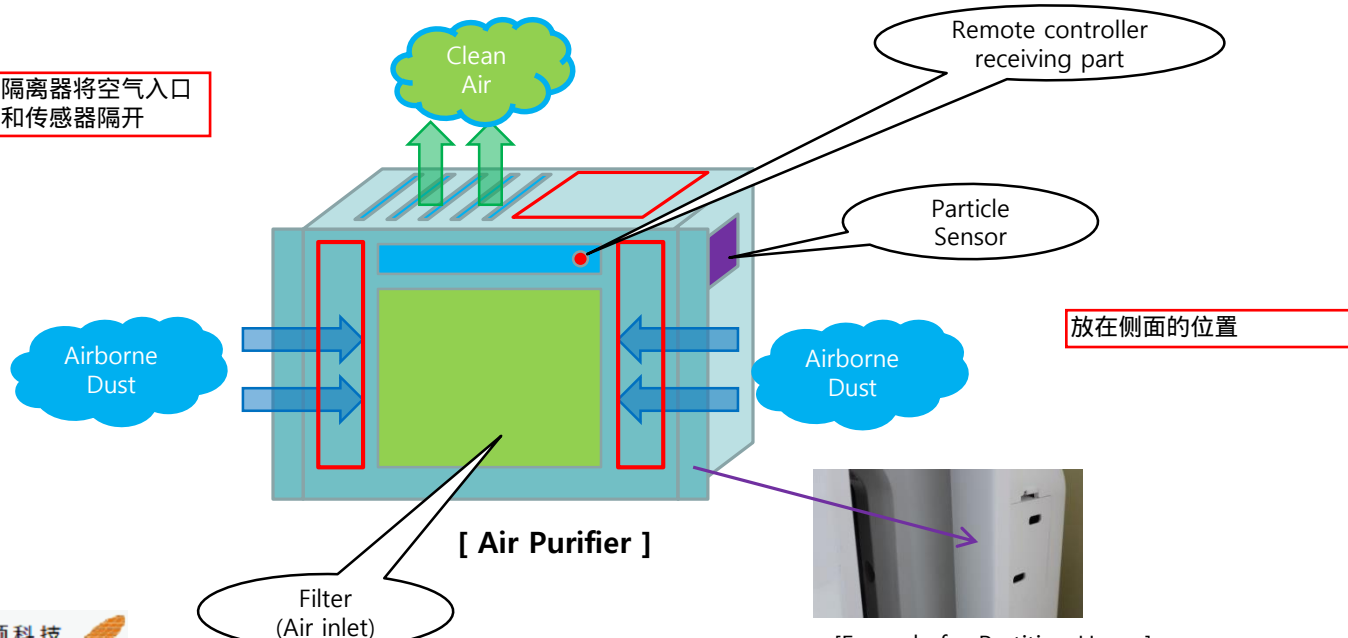


Fig 2. Example for Air Purifier

[Example for Partition Usage]

- Make a private cover for maintenance of particle sensor.
- Also, block the lens cleaning window with a foam to protect particle inflow and to shade.

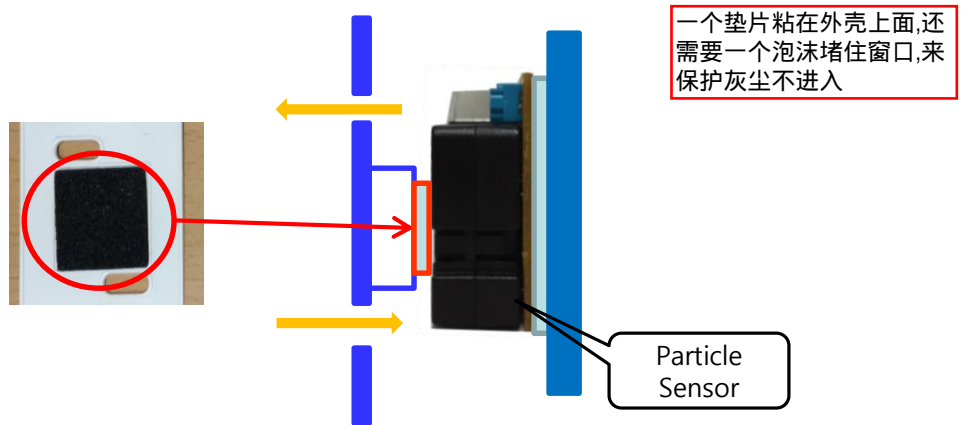


Fig 3. Example 1 for Air purifier Inside

- Place the particle sensor at least 10mm away from outside.

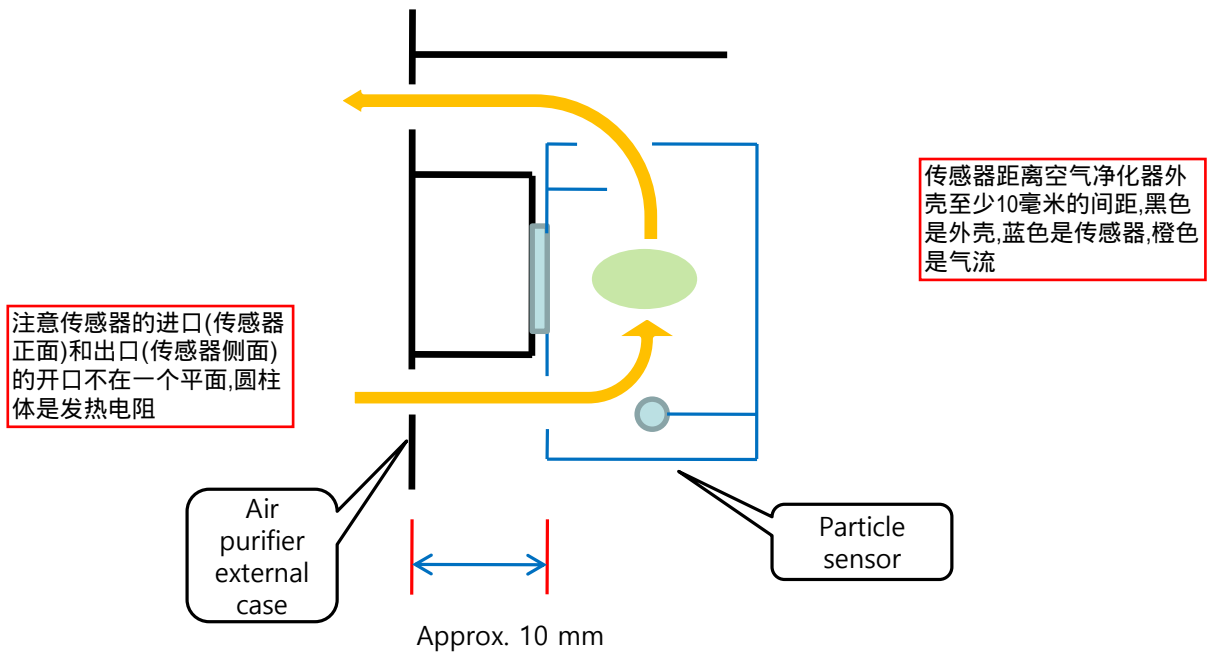


Fig 4. Example 2 for Air purifier inside

- The characteristic of particle sensor might be affected by external vibration, therefore, attach a foam at the back of the sensor to absorb any shock.
(A foam may be installed on a wall or at the back of particle sensor)

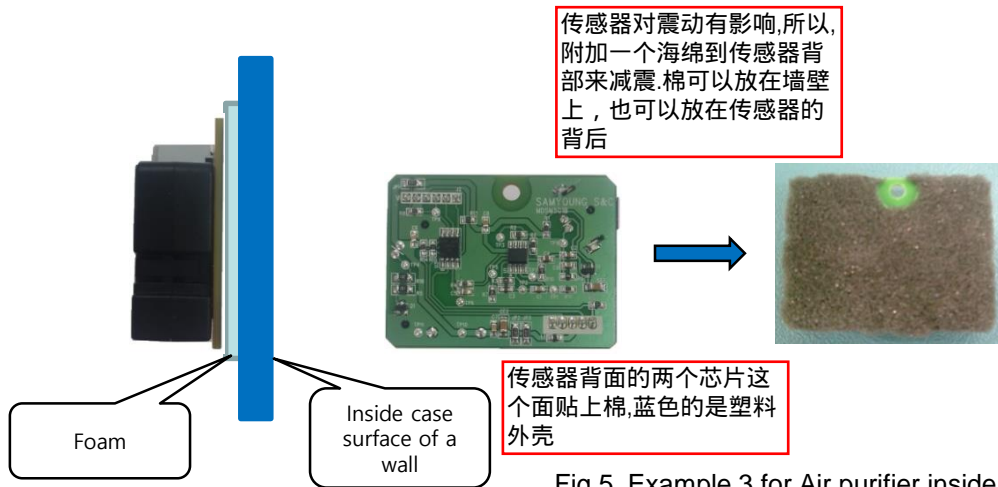


Fig 5. Example 3 for Air purifier inside

- Harness(Lead wire) should be kept as short as possible.
The thickness of Harness should be at least AWG24 or more.

引线越短越好,线的厚度至少AWG24或者以上

- The sensor should be installed on a height of 30cm or more from the ground where an application is placed.

传感器在实地安装的时候至少离地30厘米以上

2) Cautions

(1) Particle sensor is manufactured for home appliances, so please do not use particle sensor for medical/fire control instrument and any other purposes that are required particular safety and reliability.

家电设备的应用,不能用于
医疗,火警的控制仪器涉及
到安全和可靠性

(2) Particle sensor generates updraft airflow inside a case with the use of self-heating of heater's resistance, therefore, place the sensor on air purifier right angled (± 10 degree or less).

传感器在腔体内部通过加
热器阻抗来自己加热产生
一个上升的气流,那么放置
传感器的角度小于10度

(3) Scattered updraft airflow can affect the characteristic of the sensor, therefore, do not directly expose the air current around the sensor to motor fan's blades.

(4) Scattered updraft airflow affected by the vibration of fan motor or any others can affect the characteristic of the sensor, therefore, attaching a foam on PCB for absorption is recommended.

漫跑的上升的气流受空气
马达的振动影响,或者其
它。所以附加一个棉到
PCB用于吸振是必要的

(5) Do avoid using organic solvent or detergent when cleaning lens because particle sensor uses plastic lens, and do not scratch the surface of the lens with rigid materials. The surface of lens should be kept clean by tap water, distilled water, and soft and dry cotton swab.

有机溶剂和清洁剂来清洁镜头,因为灰尘传
感器使用的是塑料镜头,不要用硬材料刮伤
镜头的表面。用自来水清洁,蒸馏水和软的
干棉花棒

(6) Adjustment and examination of particle sensor is conducted with the lens cleaning window sealed, therefore, shield the lens cleaning window while using. If fail to shield the light, external light may cause noise.

传感器的调整和测试是通
过密封的镜头窗完成的,所
以,在使用的时候,需要
屏蔽镜头窗。假如没有屏
蔽的光的话,外部的光会
形成噪声

(7) Power supply to particle sensor should maintain ripple 30mV below at the connector position. Especially, when display LED is lighting dynamically, you should be careful of wiring route in order not to exceed ripple 30mV.

传感器处于插头的位置的供电浪涌控制在30mV.特别是LED处于强烈亮度的时候,所以走线要注意不要超过此值

(8) Low Ratio of particle sensor is based on sampling time: 60 sec. If you change the sampling time, values of Low Ratio may differ temporarily.

低比例的灰尘传感器采样时间是60秒.假如你改变了采样时间,低比例的值会临时地变化一下

(9) The output of Low Ratio can be varied (An error of $\pm 1\%$) depending on the spatial distribution of particles, therefore, be mindful when designing level display of particle quantity.

低比例的输出会有1%的误差变化,取决于灰尘的空间分布,所以,当设计显示浓度水平的时候,注意这个灰尘的数量

3. Cleaning particle sensor

1) Clean the lens regularly

经常清洗镜头

1恶劣环境3个月清洗一次，或者6个月一次

2假如传感器污染了或者监测功能降级，我们建议你频繁清理传感器

3假如你不频繁清理，传感器精度降低

- We recommend that you clean the lens once in 3 months in harsh environment. Otherwise, once in 6 months is recommended.

- We recommend that you clean particle sensor frequently if the sensor is polluted or its detecting function is decreased.

- If you do not clean regularly, the sensor's accuracy may decrease.

2) How to clean

- Clean the lens carefully through the lens cleaning window in a bright environment.

- If it is hard to remove dirt on the lens, use a wet cotton swab to clean and then clean again with a dry cotton swab.

3) Cautions

- Do not put alcohol, detergent or etc. other than water on a cotton swab(It can cause heat of lens).

不要用酒精，清洁剂清洁，否则镜头会热。用水即可。

- Must put a cover on after cleaning.

清洁完之后需要盖上盖子

4. Low Ratio Calculating and Applying methods

1) Low Ratio Calculation

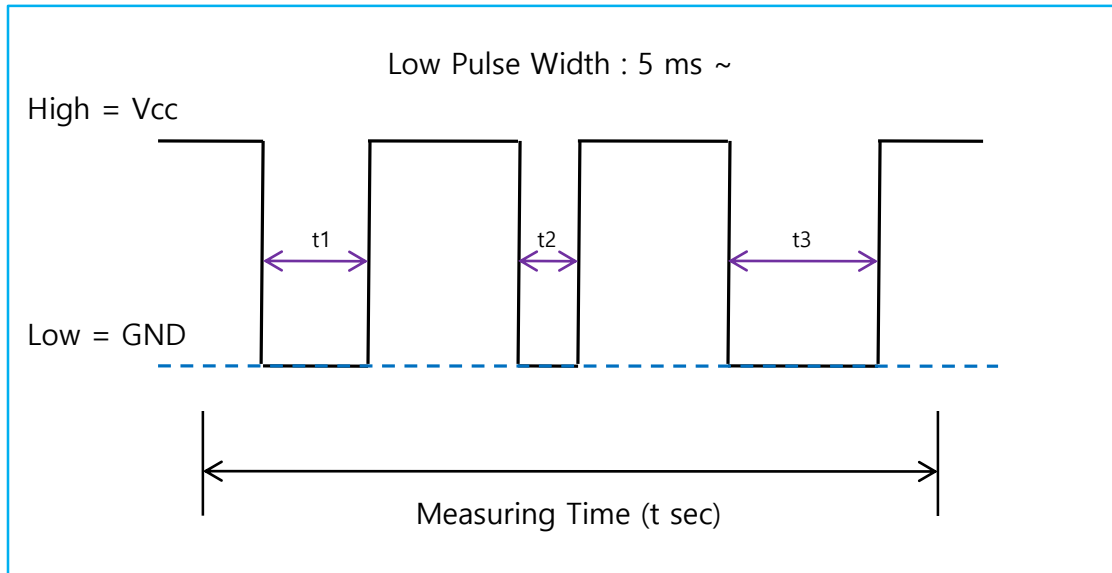


Fig 6. Calculation for particle amount

$$\text{Low Ratio (\%)} = (t1 + t2 + t3) / t \times 100$$

(Change a sum of Low signals occurred in measurement time(60sec) to percent)

[Remark] Noise Filtering

1. Noise Filtering

Cut-off less than 5ms pulse to minimize noise, and calculate accumulated integral time. (60sec).

The measurement accuracy is proportional to accumulated integral time.

2. Stabilization Time

After turning the power on, an initial stabilization time takes approx. 1minute. The data process will be proceeded afterward.

稳定时间需要1分钟,然后
就可以处理数据了

2) Low Ratio Calculation Example

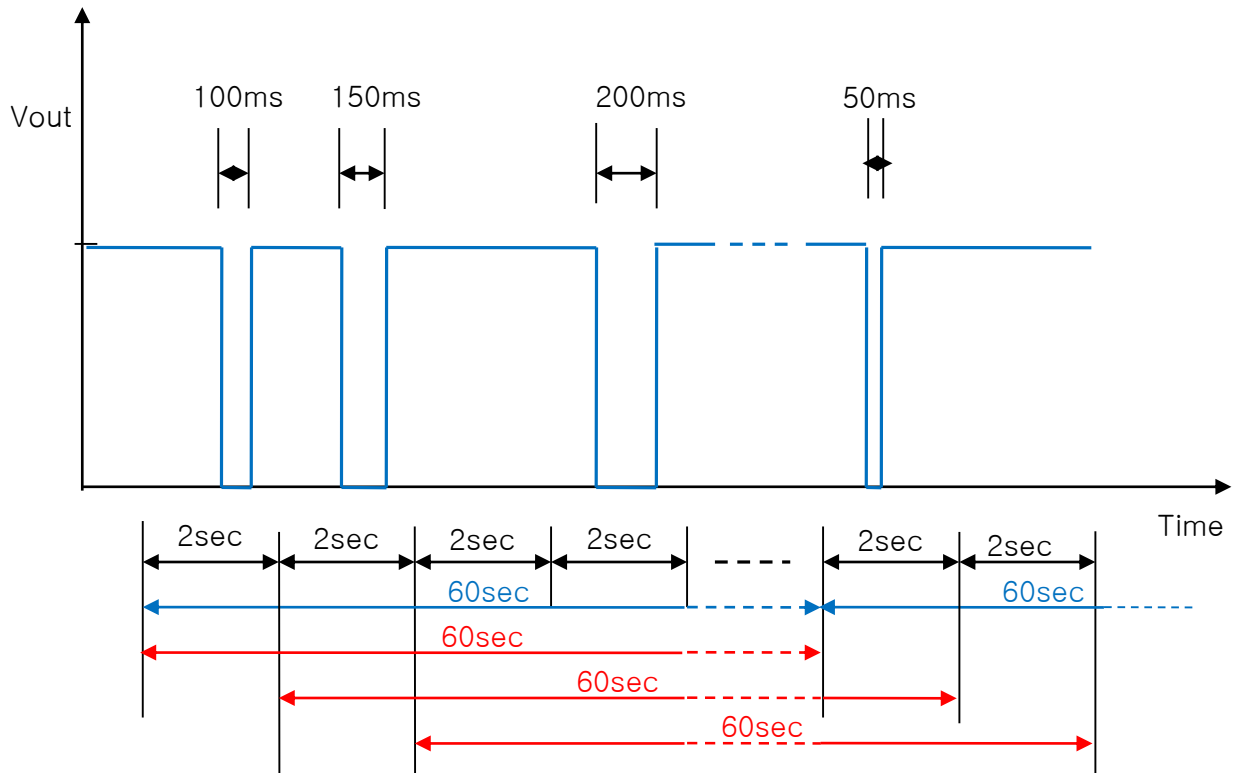


Fig 7. Example for Low Ratio Calculation Method

[When sampling with arithmetic in every 2sec]

Low Ratio changes drastically; a sequence of 5% \rightarrow 7.5% \rightarrow 0.0% \rightarrow 10.0% \rightarrow ..., the response is fast, but reaction is too sensitive that the sensor may be affected by momentary signals

[When Sampling with arithmetic in every 60sec]

Low Ratio is 7.5%, and it can protect the sensor from noise and momentary signals. However, reliability of the sensor will decrease due to slow response

[Sampling with every 2sec and arithmetic in every 60sec] - Recommend

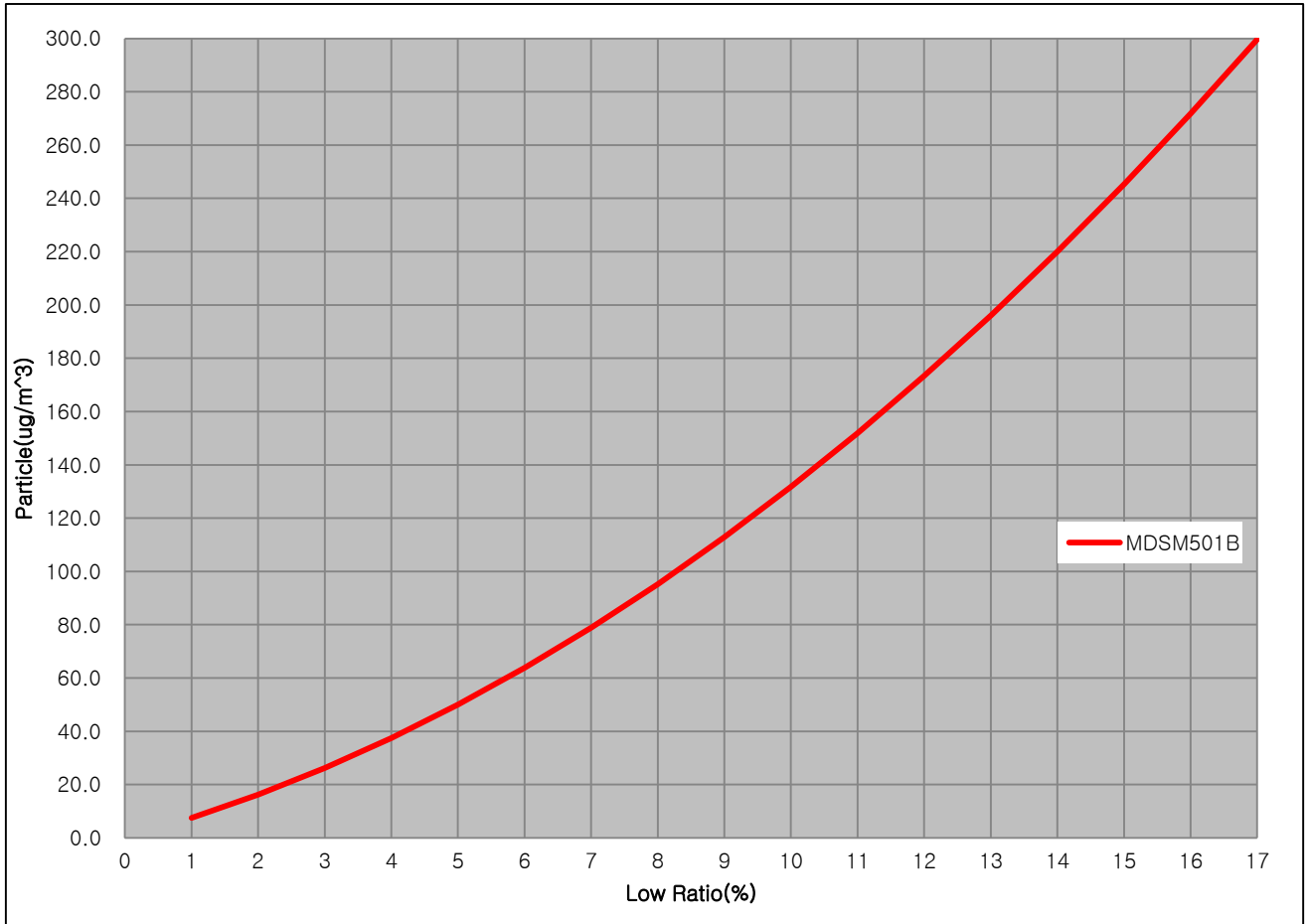
Low ratio is 7.5% \rightarrow 6.7% \rightarrow ..., it protects the sensor from noise and momentary signals and shows fast response

60秒采样和计算可以保护传感器的噪声和瞬间信号,但是由于慢响应会导致可靠性降低.

推荐两秒采样一次,数学计算一分钟一次,就可以保护噪声和瞬间信号,且快速响应

低比率到ug的换算公式

3) Low Ratio to $\mu\text{g}/\text{m}^3$ (PM2.5) Conversion



Concentration Conversion based on Low Ratio(%)

$$\mu\text{g}/\text{m}^3 = Ax^2 + Bx$$

A : 0.6352

B : 6.825

x : Low Ratio(%)

5. Description of Optimization 如何校正来达到出厂状态

Optimization is to complement decreased abilities of old or polluted sensor. It recovers the sensor back to an initial condition. If the sensor's ability or accuracy remarkably goes down while using, follow the instruction below to optimize.

5-1. Input signal to Optimization Function Pin (Opt. Pin No. 1)

Approve active high (5V) signal to Opt (Pin.1) input signal pin.

Particle sensor has Pull down resistor inside (10kΩ), the normal status is LOW(GND).

After inputting signal to the sensor, the optimization function gets started.

At the moment, the active high (5V) signal should be kept more than min. 1ms.

输入信号到功能脚1:输入5V高电平信号到脚1,传感器内置有下拉电阻10Kohm,常规状态是低。输入信号之后,优化功能就开始了。这个高电平信号至少要保持1毫秒

5-2. Waiting for Optimization Function

15秒可以完成校正,在此过程中需要隔离冲击,振动和闪射光。校正的是候不要断电,可能会产生自动输入新的数值到MCU的EEPROM

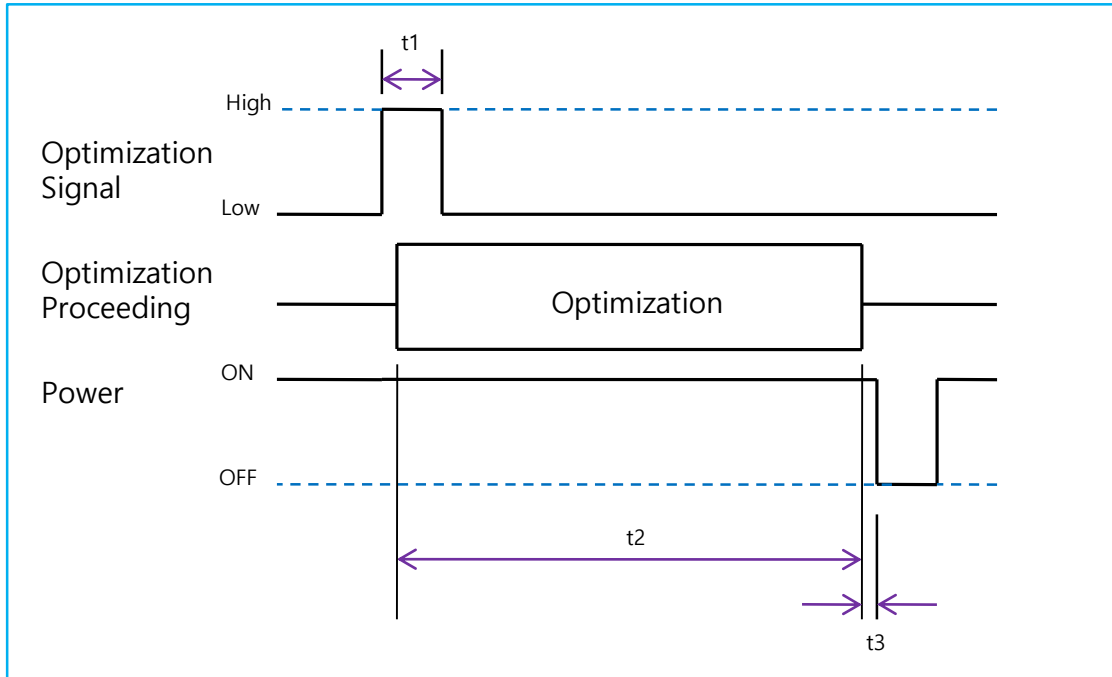
The optimization function time takes approximately max. 15sec, and during the operation, keep the sensor away from any external impact, vibration or scattering lights.

Furthermore, do not turn off the power during the operation; it may cause automatically inputting new values to the EEPROM of MCU.

校正完之后,关闭电源,重启计入操作模式

5-3. Resetting after Optimization

After optimization, please turn off the power and restart for stable sensor operation.



| | Description | Min | Max | Unit |
|----|--------------------------------|-----|-----|------|
| t1 | Optimization Signal Input Time | 1 | - | ms |
| t2 | Optimization Proceeding Time | - | 15 | sec |
| t3 | Switch Off after Optimization | 0.1 | - | ms |

Fig 7. Handling Optimization

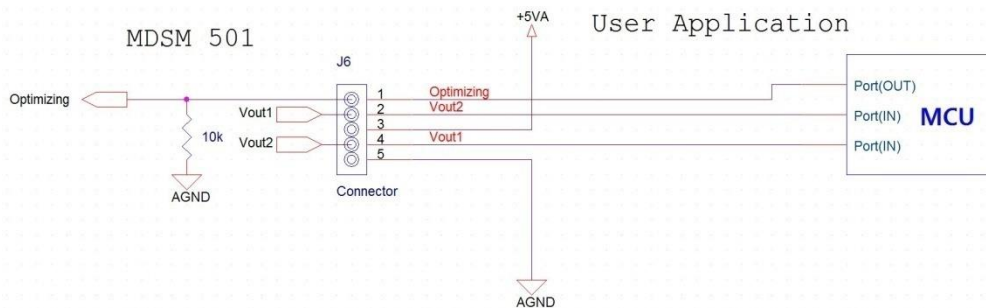


Fig 8. Circuit of Optimization

Revision History

| Date | Version | Page | Change |
|------------|---------|------|---|
| 2015-07-06 | 1.3 | 11 | Low Ratio to $\mu\text{g}/\text{m}^3$ (PM2.5) formula changed |
| 2015-09-17 | 1.4 | 11 | Low Ratio to $\mu\text{g}/\text{m}^3$ (PM2.5) formula changed |