

Dust sensor

Mar 2013

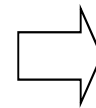
**System Device Division
Electronic Components and Devices Group
SHARP Corporation**

Dust sensor (Proposal)

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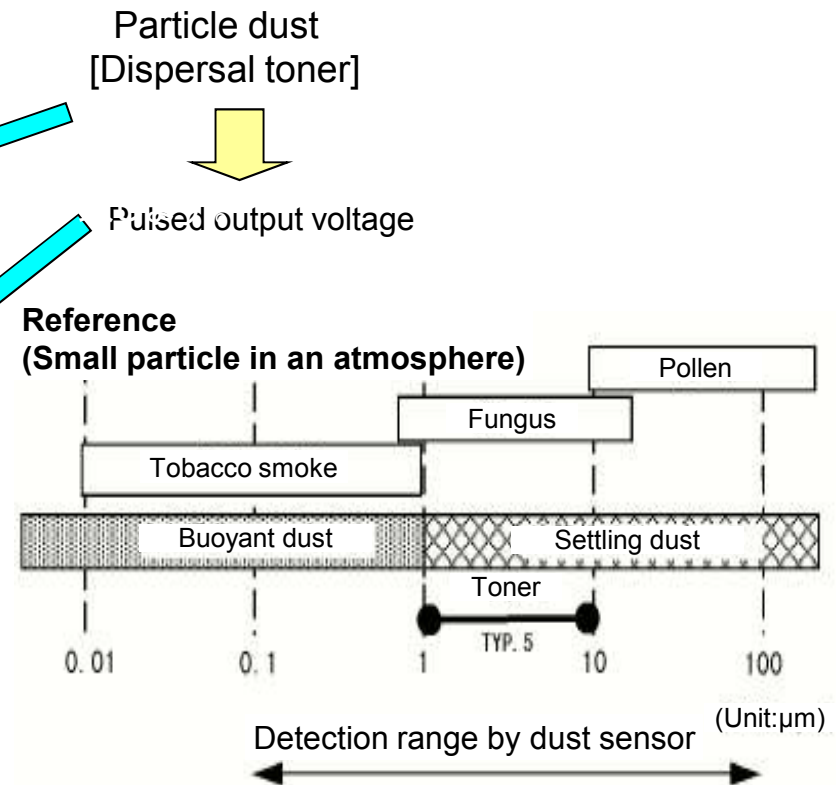
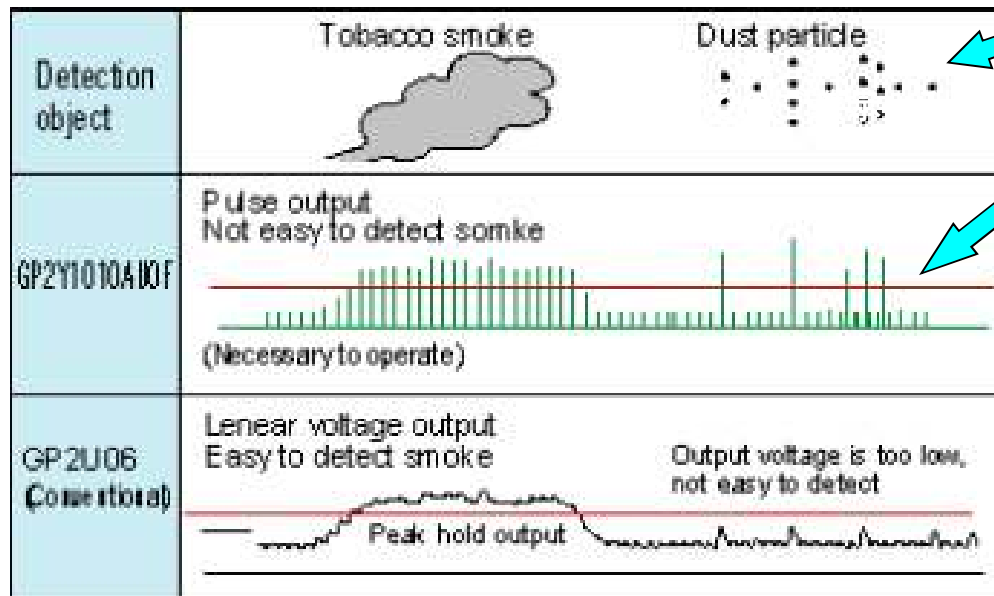
Application :

Detection of dispersal toner around drum of the copier



Display copier maintenance mode

Comparison of detection method



Dust Sensor Unit

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[GP2Y1010AU0F]

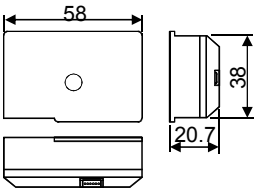
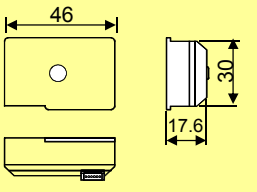
Features


- Compact type
(Compare to conventional model:47% reduction)
- Response to Operating supply voltage 5V
- Possible to detect sporadic cigarette smoke, house dust and toner
- Possible to distinguish cigarette smoke from house dust

Applications

- Air Cleaner
- Air-conditioner
- Copier
- Printer
(Laser Beam Printer)

Compare to Conventional Model

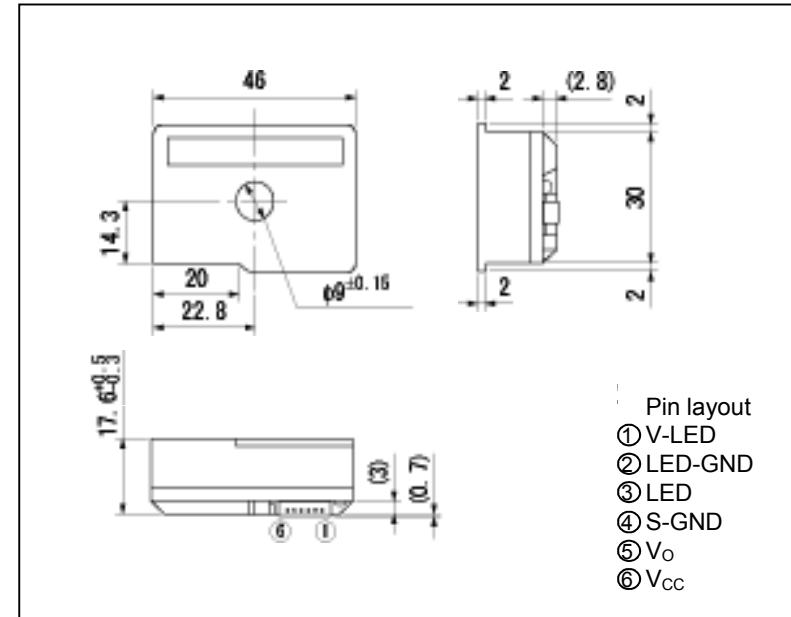
Model No.	GP2Y1002AU	GP2Y1010AU0F
Supply voltage	12 V	5 V
Detection sensitivity	1.2 V/(mg/m ³)	0.5 V/(mg/m ³)
Power consumption	TYP 132 mW	TYP 55 mW
Dimension	58 × 38 × 20.7 mm	46 × 30 × 17.6 mm
Outline drawing		
Capacity ratio	100	53

47% down 

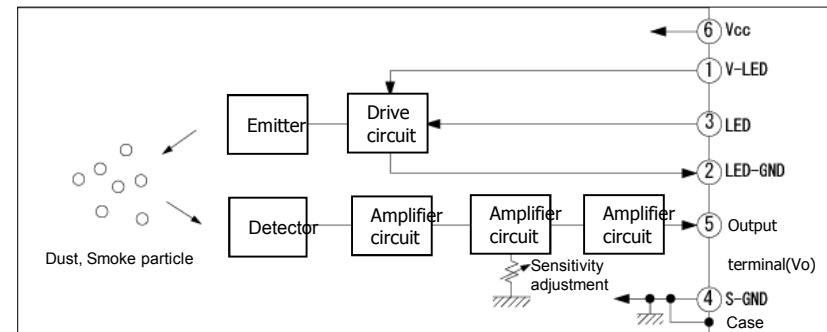
Specifications

Parameter	Symbol	Characteristics
Operating supply voltage	V _{CC}	5V ± 0.5V
Smoke detection sensitivity	K	TYP 0.5 V/(0.1 mg/m ³) ± 30 %
Output voltage at no dust	V _{OC}	MAX 1.2 V
Output voltage range	V _{OH}	MIN 3.4 V
Driving current for emitter	I _{LED}	MAX 20 mA
Current consumption	I _{CC}	MAX 20 mA

Outline Dimensions



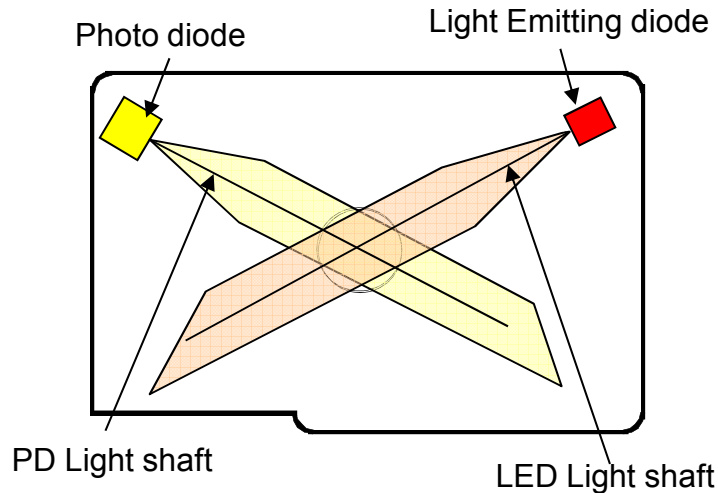
Block Diagram



Application of Dust Sensor Unit

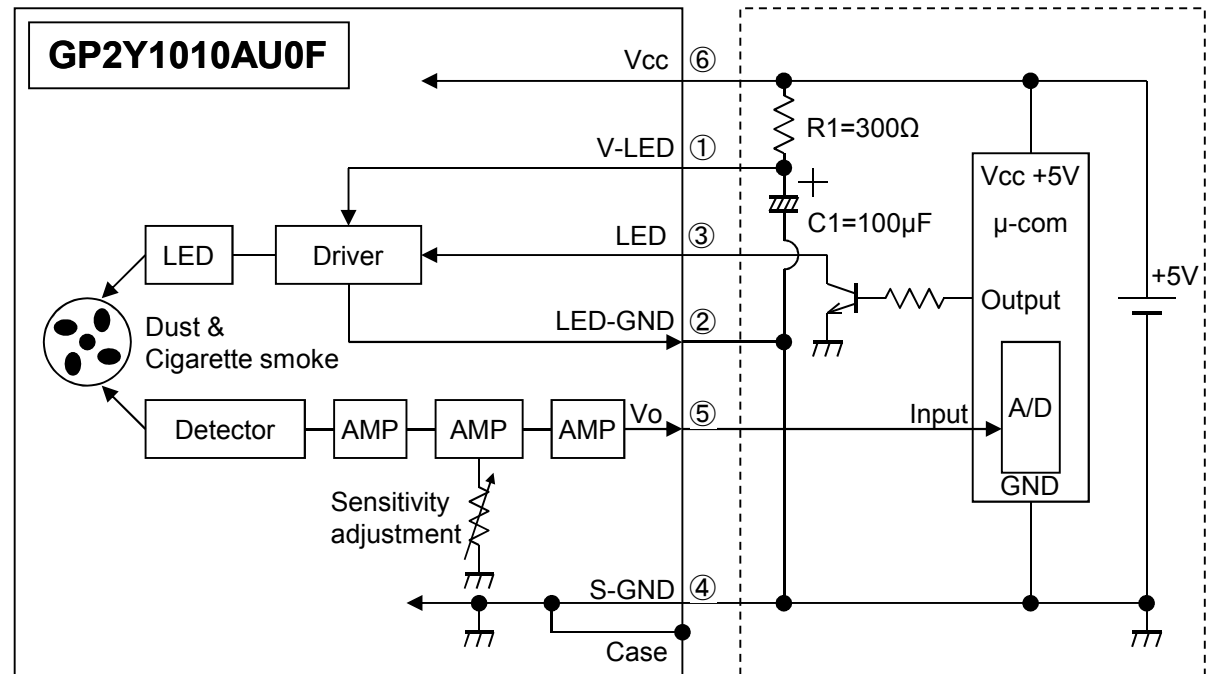
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•Structure

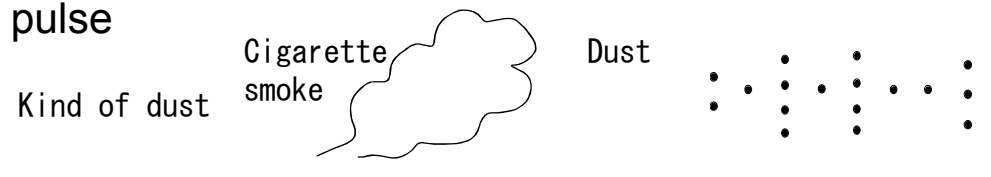


- The point where LED light shaft intersects PD light shaft is detection region.
- If there are airborne particles like tobacco smoke or house dust in the detection region, →Light reflected from these particles is directed to light-receiving element.

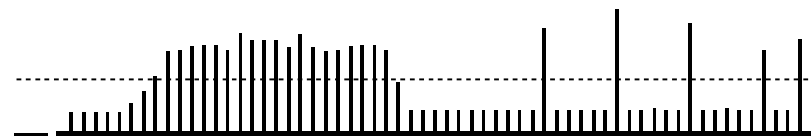
•Example of system connection



•Output pulse



GP2Y1010AU0F
Output pulse
(Pulse output)



How to design Dust Sensor

To begin with

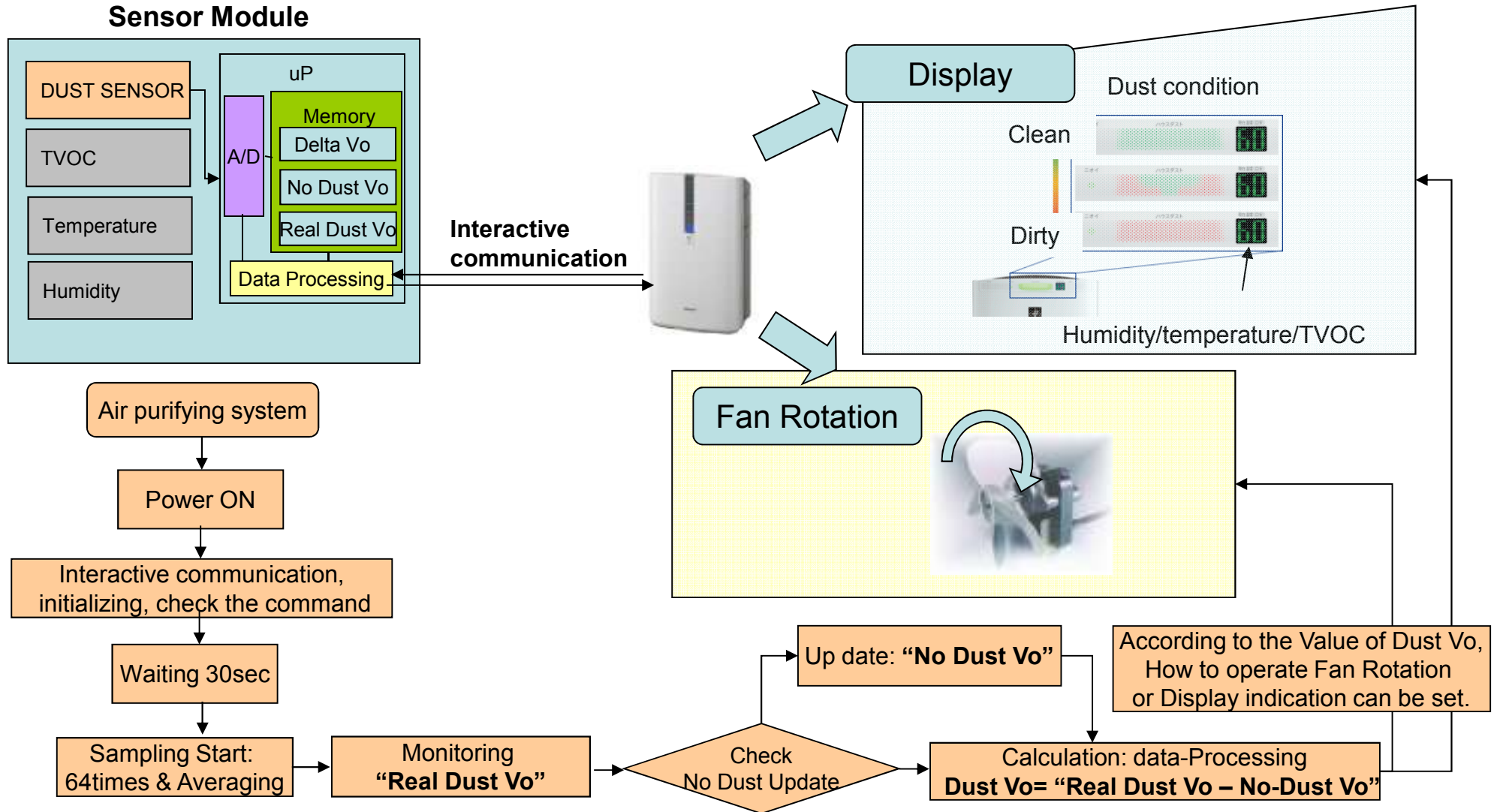
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- ◆ To make sure basic information of GP2Y1010AU0F
 - ◆ Refer to presentation of “ Dust Sensor “ total 14page w/o cover page
 - ◆ Circuit
 - ◆ Variation => Calibration
 - ◆ Mechanical Design Consideration
 - ◆ Power consumption
- ◆ Document
 - ◆ Spec
 - ◆ Application Note
 - ◆ Temperature Drift
 - ◆ Reliability

Standard Operation

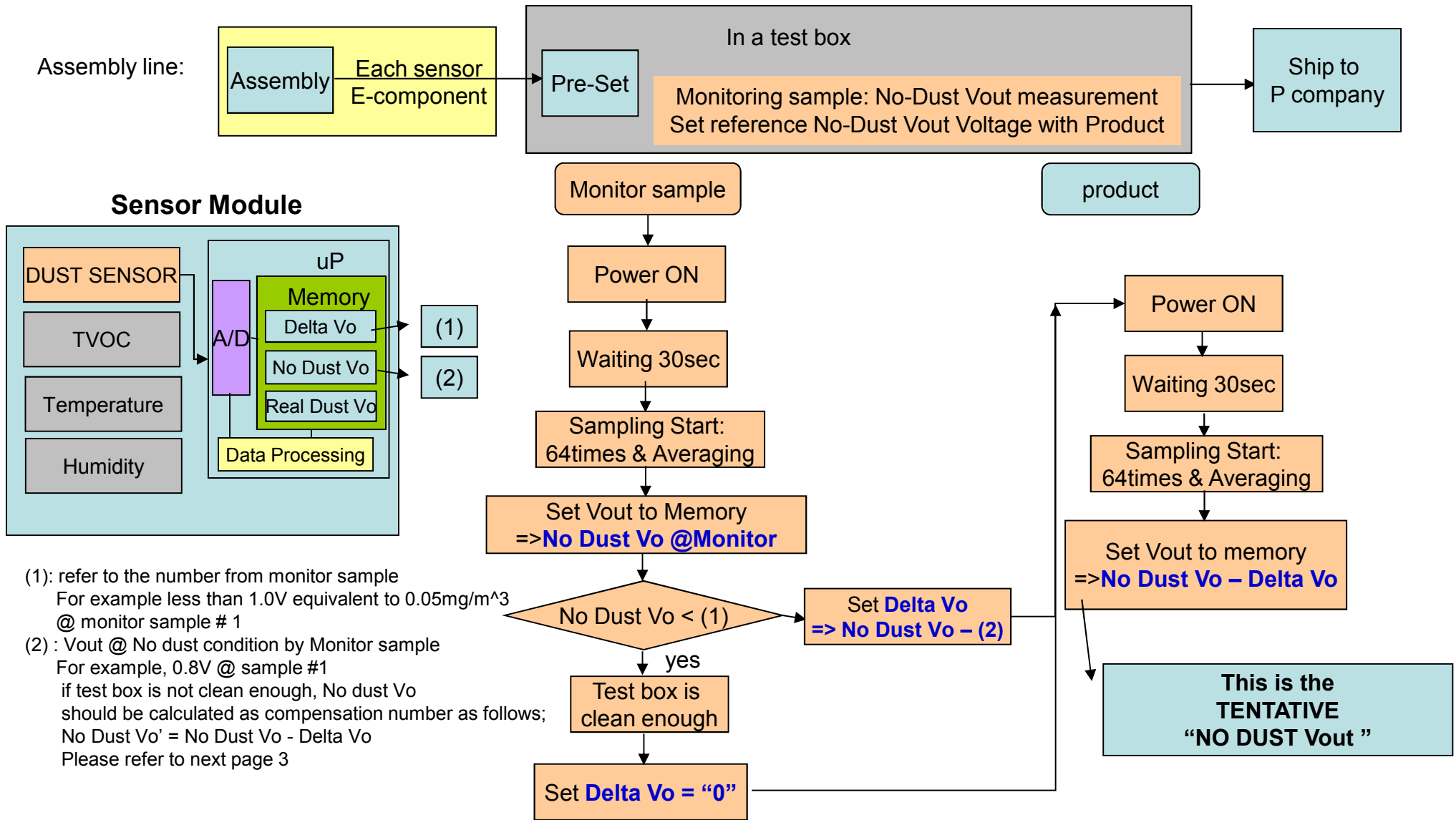
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Finish product: Air purifying system



No-Dust Condition: Set tentative No Dust Vout

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How to update ? No-Dust Vout

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When starting air purifying system as finish product, air cleaner,
“No-Dust Vout” should be updated accordingly as following conditions;

No Dust check when starting

- 1, When starting air purifying system like fan-rotation,
comparing Real Dust Vo with No Dust Vo(tentative one) which was set
before shipment.
if Real Vo < No Dust Vo => replace the Real Vo to No Dust Vo
=> Then this will be the latest No Dust Vo

More clean condition

- 2, When operating if find the cleaner condition such as Real Vo < No Dust Vo,
=> replace the Real Vo to No Dust Vo => Then this will be the latest No Dust Vo

Compensation of unexpected incident

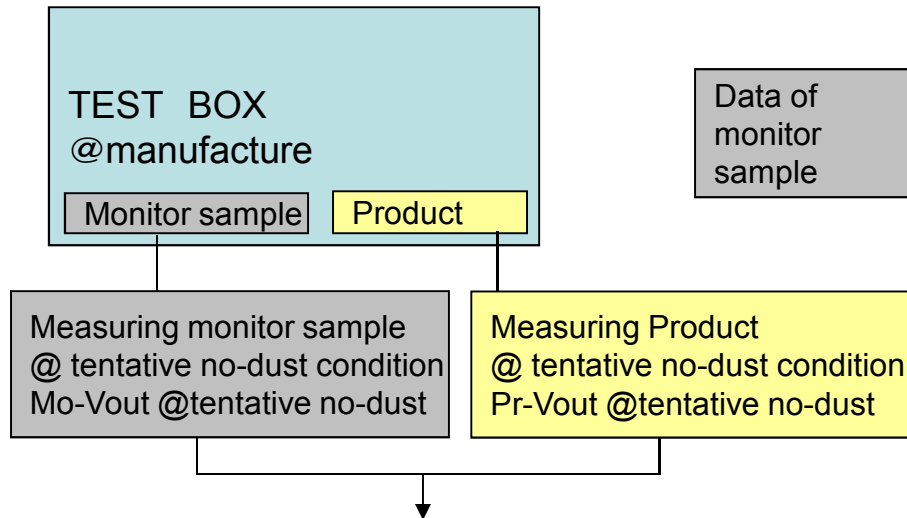
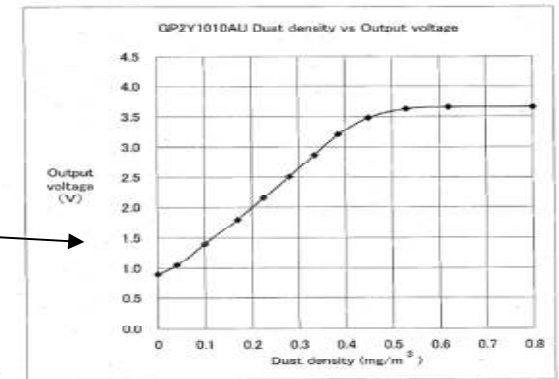
- 3, When operating if find steady Vo for long term,
=> replace the Real Vo to No Dust Vo => Then this will be the latest No Dust Vo

Proposal of calibration for no-dust condition

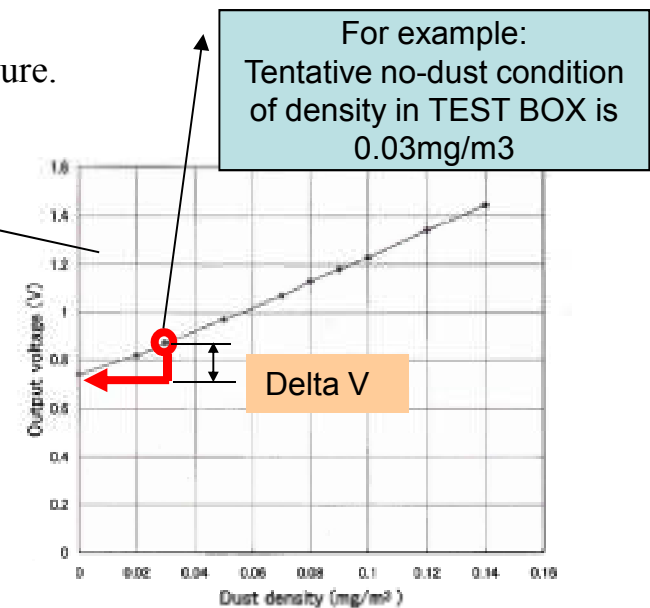
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- **process**

- Sharp makes monitor sample (3pcs)
 - Monitor sample has data of Vout vs. Dust density
 - Data should be shown low density condition such as 0 to 0.1mg/m³.
- Manufacture can use this monitor sample and set initial tentative no-dust condition
 - Monitoring the value of monitor sample and convert the Vout to initial tentative no-dust condition for mass production board of Manufacture.



Data of monitor sample



Convert Pr-Vout @ tentative no-dust condition to **Real no-dust Vout** by calibration as follows;

$$\text{Real No-Dust Vout} = \text{Pr-Vout @ tentative no dust} - \text{delta V}$$

Variation

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◆ Calibration

◆ No-Dust V_0

- ◆ Refresh/Update as latest cleaner condition
- ◆ Dust Density $V_0 = \text{Real-Dust } V_0 - \text{No-Dust } V_0$
 - ◆ Value of Dust Density can be used for set thresh level of starting fan rotation or segmentation of the Dust density level on Display

◆ Compensation

◆ Temperature Drift

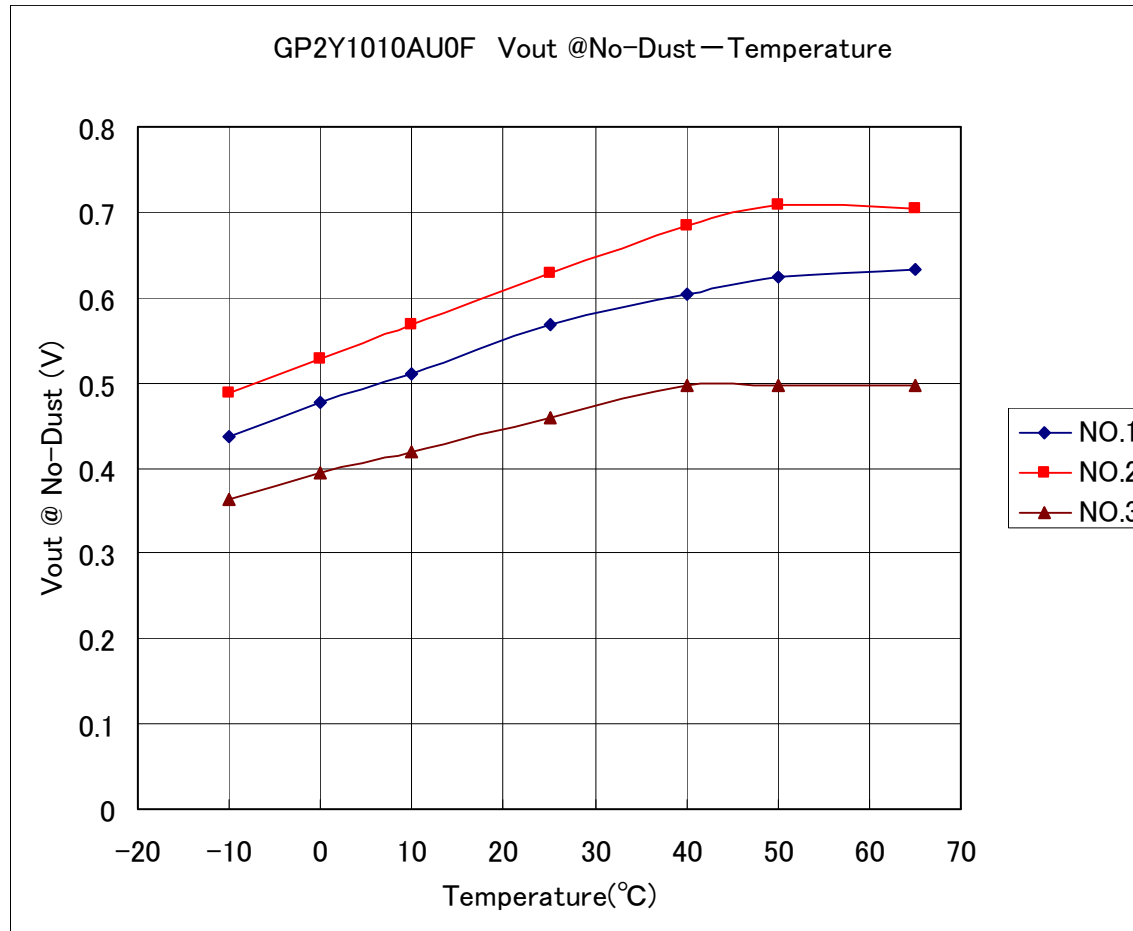
- ◆ Normalize the value for compensation: from 0 to 50 degree C
 - ◆ Please refer to attached graph of temperature drift

◆ Time Aging

- ◆ TBD
 - ◆ can be ignorable ?

Vout @ No-Dust condition vs. Temperature

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Impact of contamination for Sensor Output

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-Test concept

-To measure the impact of contamination for Sensor Output

-Test Method

-Take the date of K(Sensitivity) and Vout @ no-Dust for the sensor

-Set the sensor in the test box (W50 x H50 x D50cm).

-Smoke 1pcs of Cigarette completely and pour the smoke into the test box.

And keep the condition for 20 minutes. => It's the one cycle.

-Repeat above process for N times and take the date of K(Sensitivity) and Vout @ no-Dust for the sensor

Variation of Vout(sensitivity) (%) = (K(Sensitivity) after N times)/Initial K(Sensitivity)

Variation of Vout @ No-dust (%) = (Vout @ No-dust after N times/Initial Vout @ No-dust)

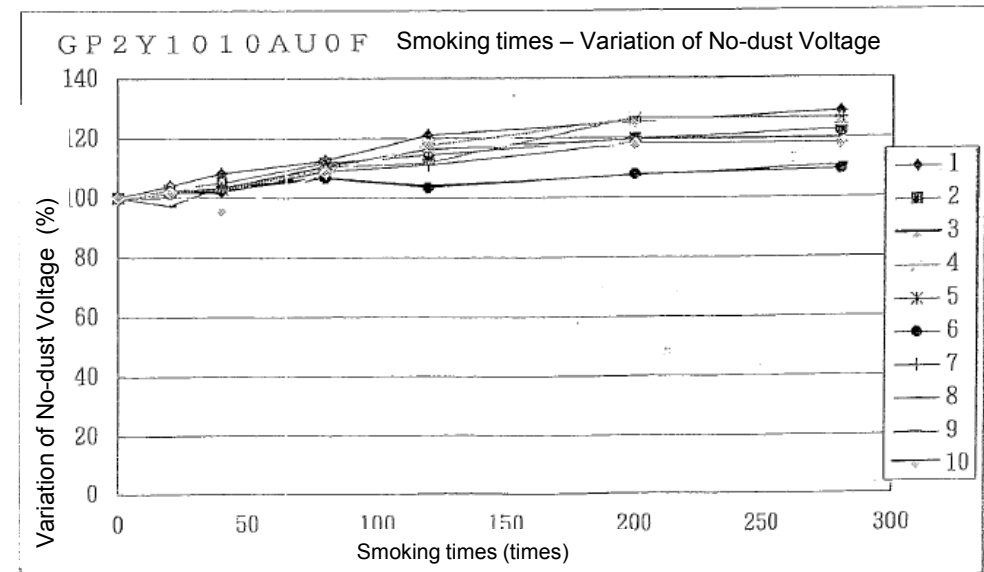
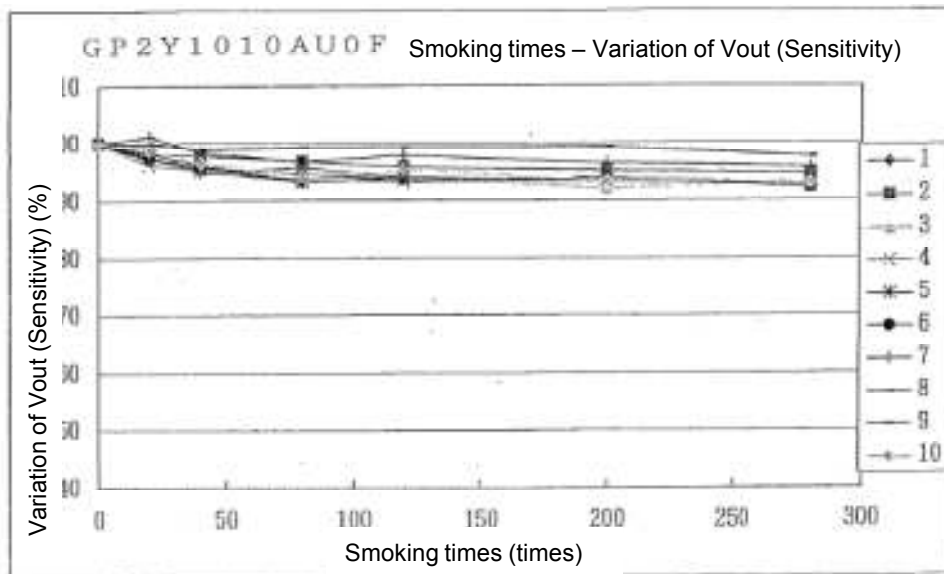
-Note

-This is acceleration test, so it can be equivalent to the real condition of smoking at room.

-Real condition of cigarette smoke = (Size of room) / (size of the test box) X (smoked cigarettes)

-For ex. Size of room(3.6m X 3.6m X 2.4m)/(0.5m X 0.5m X 0.5m) X 300= 74,649 pcs

It can be equivalent to 3,732 days with 20pcs smoking a day.



SHARP