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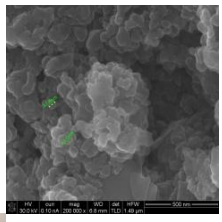
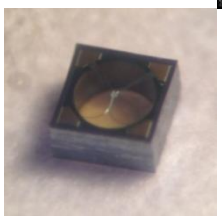
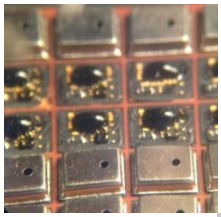
The TED1X is a compact and low-power MEMS gas sensor with ASIC for indoor air quality

The TED1X is metallic oxide semi-conductor type MEMS gas sensor for monitoring indoor air quality. It is a smallest, high sensitivity and ultra-low power multi-gas sensor with ASIC. Containing pre-installed software and specific algorithms is designed for detecting multi-gas and ambient temperature compensation. This sensor is consisted of nano-particle metal oxide sensing layer, micro heater, micro thickness membrane and Read-out IC. Those technologies provide high sensitivity, low-power consumption, fast response, small size and long-term stability.
TED110 is a multi-gas sensor for monitoring Carbon monoxide(CO), combustible gases and a volatile organic compounds(VOCs), and also can be used as an equivalent carbon dioxide(eCO_2) sensor. Humans are the source of VOCs, therefore the CO_2 concentration trend follows VOCs trend. That's why TED110 can detect eCO_2.







Advantages

Small SMP packaging (**3 x 3 x 1mm**) with ROIC
Self-Temperature compensation
Long-term stability
High sensitivity
Fast response time
Reasonable price
Low power consumption

Applications

Air pollution monitoring
Mobile smart device (phones, tablets, watches. etc)
Air quality monitoring (indoor, vehicle, parking, IoT etc.)
Ventilation (house, class room, industry and office etc.)
Gas leak detection
Breath checker
Air conditioner, Hood, Air cleaner, Boiler
Early fire detection

WISE®

Technical Details of Gas Sensor

Target gas : VOCs, CO, EtOH, CH_4, NO_2, Toluene, H_2S etc

Sensitivity (Rair/Rgas, 20ppm)

CO : 250%, EtOH: 2000%, CH_4: 120%, Toluene : 800%,

Detecting Range

Carbon Monoxide (CO): 1~1000ppm

Ethanol(C_2H_6OH; EtOH): 1~1000ppm

Methane (CH_4): 1~1000ppm

Toluene ($C_6H_5CH_3$): 1~1000ppm

Response time : 10sec

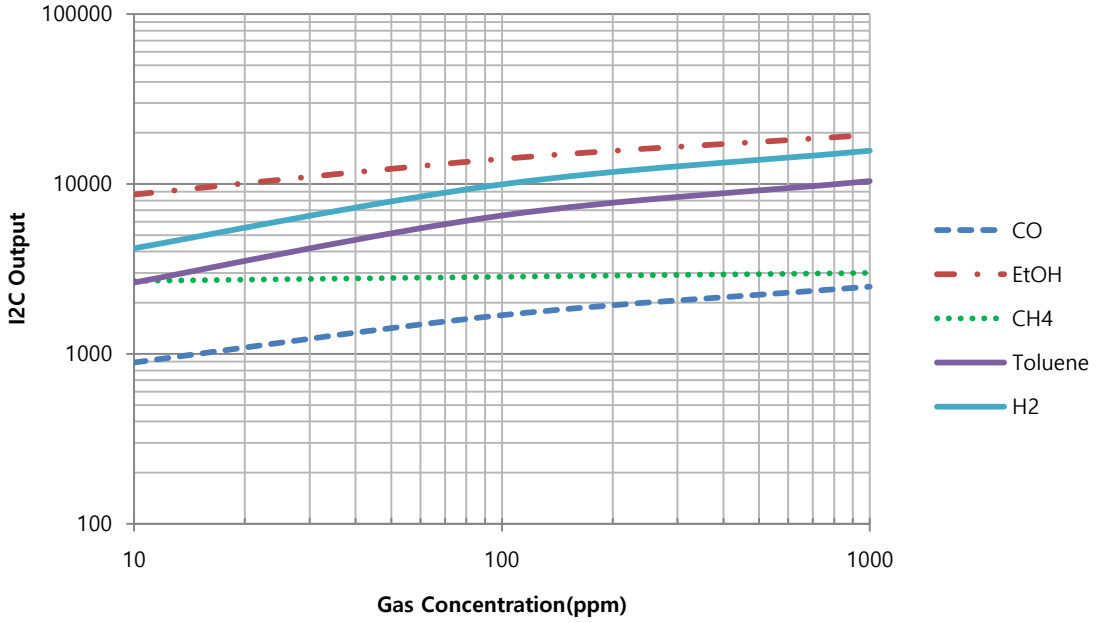
Die dimension: **0.55 x 0.55 x 0.3mm**

Package dimension: **3 x 3 x 1mm^3**

Output: **I2C Digital Output**

Sensitivity for Each Gas

Sensitivity is defined as the sensor's I2C output counts at 50%RH humidity and 25℃ ambient temperature. The following chart shows the sensitivity to VOCs in the best power mode of each gas.



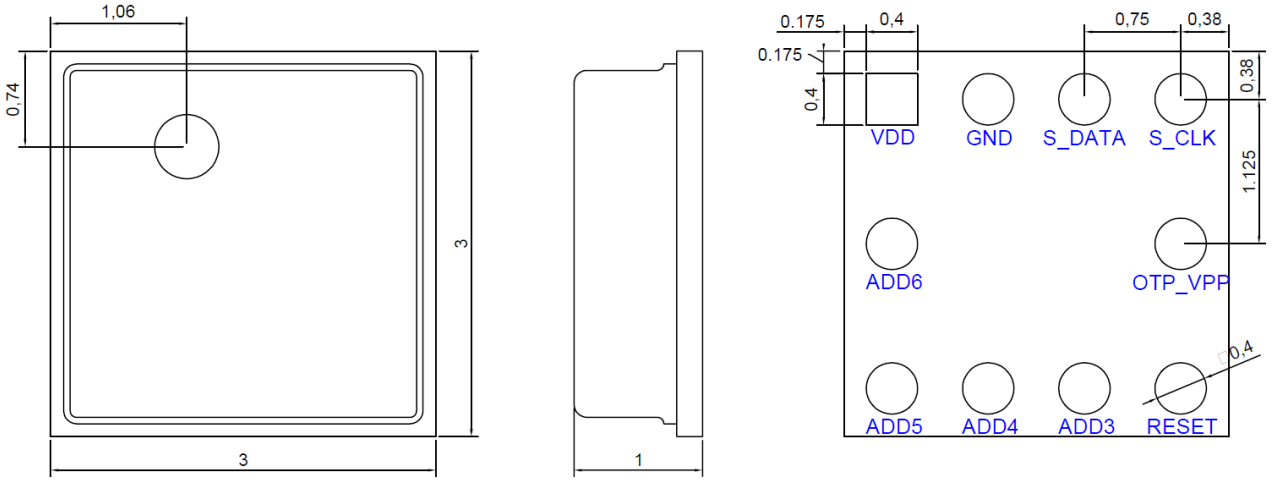
Electrical Characteristics

Parameter	Condition	Min	Typ	Max	Units
Supply Voltage			3.3		V
Maximum heater voltage(V_H)				1.3	V
Compensated ambient operating temperature		0		60	℃
Ambient operating humidity	Non-condensing	15		85	%RH
Storage temperature range		-40		125	℃
Average power consumption	10% duty cycle		3.9		mW
Peak power consumption			54		mW
Heater resistance	V_H =1V, 50%RH	51	60	69	Ω

Sensor resistance in clean air	V_H =1V, 50%RH	10		1000	kΩ
Life time	V_H =1V	>5			years

Package Outline Dimensions

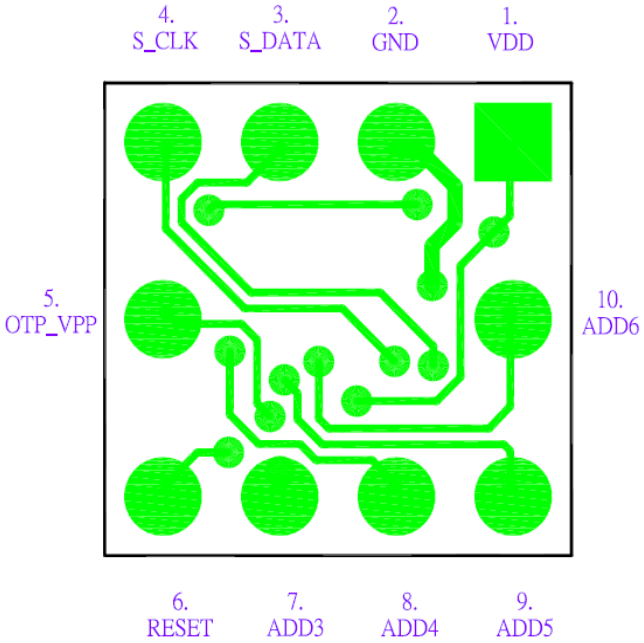
The package is compatible with SMD assembly process. This package should be protected by water. If you need a water proof package then we can supply a special package with membrane filter (option).



Top View Side View Bottom View

Pin Assignment

TED110 has 10 pins and it's description is as following table.



ROIC Top view

ROIC Pin Assign

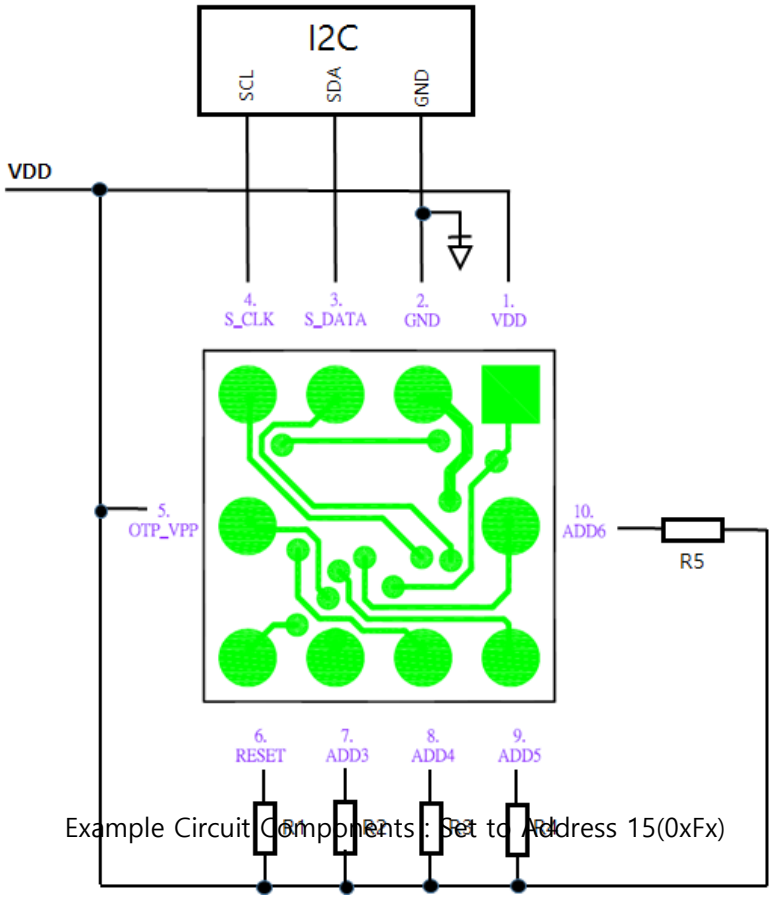
Pin Number	Name	Description	Input Voltage Min (V)	Input Voltage Max (V)
1	VDD	Analog power supply voltage	3	3.6
2	GND	Analog power supply ground	0	
3	S_DATA	I_2C Data Line	-	3.3
4	S_CLK	I_2C Clock Line	-	3.3
5	OTP_VPP	OTP driving power	3.3	
6	$\overline{\text{RESET}}$	ROIC reset pin	0 or 3.3	
7	ADD3	Sensor address setting pin	0 or 3.3	
8	ADD4	Sensor address setting pin	0 or 3.3	
9	ADD5	Sensor address setting pin	0 or 3.3	
10	ADD6	Sensor address setting pin	0 or 3.3	

Pin Function Description

Pin No.	Mnemonic	Function
1	VDD	ROIC Driving Power Input 3.3 V
2	GND	Common Ground VDD GND, I2C GND, OTP GND, RESET GND, ADDx GND
3	S_DATA	Data Line of I2C Communication
4	S_CLK	Clock Line of I2C Communication
5	OTP_VPP	OTP Driving Power ROIC Calibration Data is stored in OTP
6	$\overline{\text{RESET}}$	ROIC Hardware Reset Pin Reset at 0V
7	ADD3	Address Setting Pin I2C Address (0x1x ~ 0xFx) can be set by power input control to ADD3 ~ 6 Pin Input 0 V : Low signal Input 3.3 V : High signal Address MSB Pin : ADD3 Address LSB Pin : ADD6
8	ADD4	Same as ADD3
9	ADD5	Same as ADD3
10	ADD6	Same as ADD3

Circuit Component

Reference Diagram



Example Circuit Components : Set to Address 15(0xFx)

ROIC Pin Assign		
Component	**Value**	**Remarks**
R1	10KΩ	Pull-up resistor for $\overline{\text{RESET}}$
R2	10KΩ	Pull-up resistor for ADDRESS 3
R3	10KΩ	Pull-up resistor for ADDRESS 4
R4	10KΩ	Pull-up resistor for ADDRESS 5
R5	10KΩ	Pull-up resistor for ADDRESS 6

I2C Communication

According to the concept in IoT, ROIC provides I2C interface.

Address Setting At I2C ADD Part

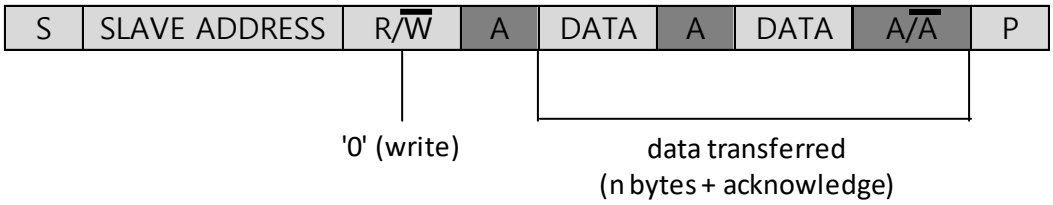
7	6	5	4	3	2	1	0
I2C_ADD6	I2C_ADD5	I2C_ADD4	I2C_ADD3	0	0	0	R/$\overline{W}$

Configuring Addresses on the I2C Protocol

I2C Address Setting

- — ROIC supports I2C Communication
- — To access ROIC set in circuit, you need to set address on I2C Protocol
- — Unlike general I2C address configuration, Bit 1 ~ 3 are not used
- — Bit 0 is set according to Read / Write purpose as in I2C standard
  - — 0 : Write signal
  - — 1 : Read signal

I2C Write Protocol



From Master to Slave
From Slave to Master

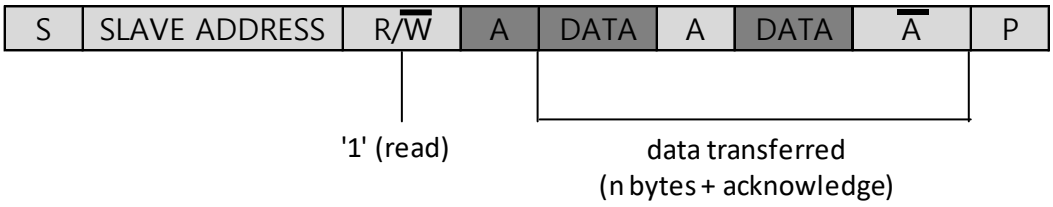
A = acknowledge (SDA LOW)
$\overline{A}$ = not acknowledge (SDA HIGH)
S = START condition
P = STOP condition

I2C Write Protocol

- — Follow the usual I2C protocol
- — Start signal transmission
- — I2C address transfer for write purposes
- — ACK check
- — Data transmission
  - — 1st Data: Call Start Register Address
  - — 2nd Data: Data to be stored in the register located consecutively starting from the corresponding register address

— Transmission of stop signal after completion of transmission

I2C Read Protocol



From Master to Slave
From Slave to Master

A = acknowledge (SDA LOW)
$\overline{A}$ = not acknowledge (SDA HIGH)
S = START condition
P = STOP condition

I2C Read Protocol

— Follow the usual I2C protocol
— Set register value to start reading
— Start signal transmission
— I2C address transfer for read purposes
— ACK check
— Read data sequentially
— ACK check every step
— NACK transmission
— STOP transmission

ROIC Register

ROIC has a register which is a data storage space.

ROIC Register Map

Register Address MSB	Register Address LSB	OTP Address MSB	OTP Address LSB	Read/ Write	Name	Description
56		56		RW	ANALOG_CNTL_0	[ ] [ ] [ ] [ ] FREQ<1:0> FREQ_DSP EN_OSC
69	68	-		RW	PWM_DATA	PWM Width = PWM_DATA / 32, 1 period = 1 second / 250kHz * 1024 cycle = 4ms
71	70	-		R	TEMPERATURE_OUTPUT	TEMPERATURE(℃) = TEMPERATURE_OUTPUT / 256
73	72	-		R	GAS_OUTPUT	GAS DENSITY(ppm) = GAS_OUTPUT / 256
75	74	-		R	IR_OUTPUT	IR(℃) = IR_OUTPUT / 128
76		-		R	STATUS	EN_IR EN_GAS EN_TEMP PEN OTP_RD OTP_WR PROG PTM
76		-		W	COMMAND	0 : initialize ROIC (OTP to Register) 1 : restart ROIC 6 : write data to OTP 7 : read data from OTP 8 : stop ROIC

ROIC Register Map

Register Map Description

— There are two kinds of storage devices in ROIC

— OTP

Calibration data is stored

Write once (impossible to write after)

Similar to ROM (Read Only Memory)

Nonvolatile Data

— Register

Storage space of ROIC internal calculation result

Initialization to copy OTP data to Register after inputting drive voltage to VDD

Similar to RAM (Random Access Memory)

Volatile Data

— Each register size is 8 bits (1 byte)

Register Function Description

Register	Function	Description
Register 56	FREQ	AFE Clock selection 2 bit configuration Requires 0x08 setting at ROIC Initialization (see. ROIC Initialize Sequence)
	FREQ_DSP	Digital Signal Process Clock selection

		1 bit configuration Requires high setting at ROIC Initialization
	EN_OSC	Internal VCO enable 1 bit configuration Requires high setting at ROIC Initialization
Register 68, 69	PWM Output	Used to keep the gas sensor at room temperature 2 bytes 16 bit Signed Integer used but negative is excluded. (0 ~ 32767)
Register 70, 71	Temperature Output	Temperature Sensor Output 2 bytes 16 bit Signed Integer (-32768 ~ 32767) / 256 = Current temperature (℃) R available (W not available)
Register 72, 73	Gas Output	Gas Sensor Output 2 bytes 16 bit Unsigned Integer (0 ~ 65535) R available (W not available)
Register 74, 75	IR Output	IR Sensor Output (Not supported) 2 bytes 16 bit Unsigned Integer (0 ~ 65535) R available (W not available)
Register 76	Write(Read)	cmd 0 : Copy OTP Data to Register cmd 1 : Restart ROIC cmd 6 : OTP Write Command cmd 7 : OTP Read Command cmd 8 : Stop ROIC

ROIC Initialize

Initialization is required to use ROIC after driving power input

Write the following data in the Register described below (Register No. 56, 76)

ROIC Initialize Sequence

Sequence No.	Register No.(Hex)	Register Data Hex Value	Function Hex Value
1	56 (0x38)	0x0B [ ][ ][ ][ ][1][0][1][1]	PREQ (AFE Clock selection) : 0x08 [ ][ ][ ][ ][1][0][ ][ ] PREQ_DSP (DSP Clock selection) : 0x02 [ ][ ][ ][ ][ ][ ][1][ ] EN_OSC (Internal VCO enable) : 0x01 [ ][ ][ ][ ][ ][ ][ ][1]
2	76 (0x4C)	0x00 [0][0][0][0][0][0][0][0]	Cmd 0 : 0x00 [0][0][0][0][0][0][0][0]