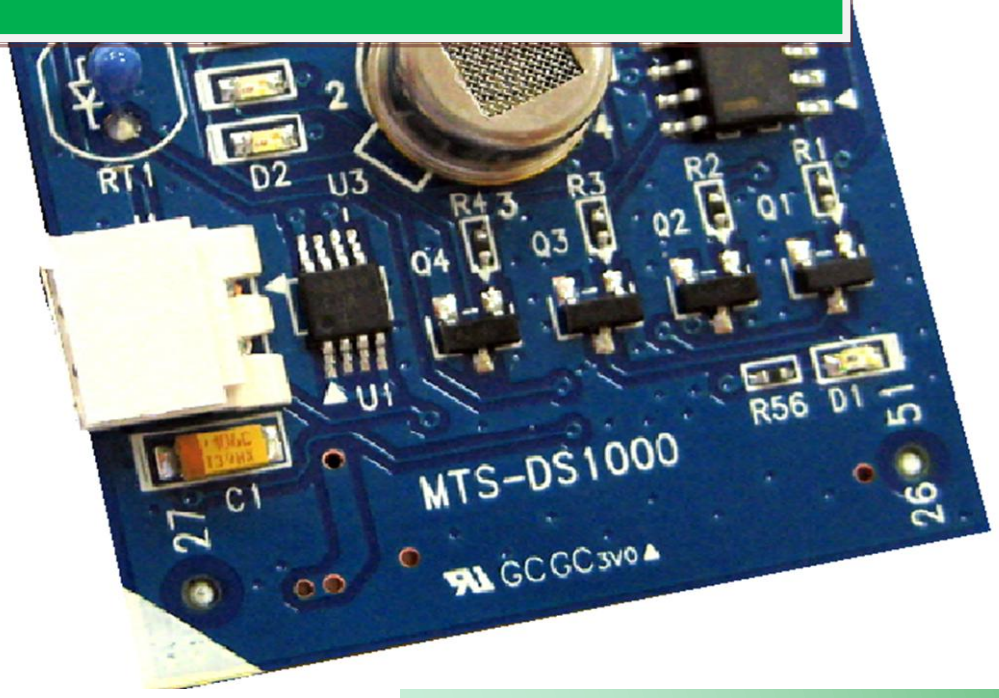
DS1000
DATASHEET



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1. INTRODUCTION

The DS1000 is an attachable sensor board that is compatible with all the CMXXXX series of WSN Motes that have the 51-pin connector. It includes the following sensors:

- CO
- CO2
- Temperature

DS1000's main field of application is environment monitoring, as it can give real time information on the air temperature and gases concentration due to CO level as well as CO2. The DS1000 can be useful in environment monitoring applications , where the air quality and the pollutants concentration have to be analysed as well as fire detection systems or safety-related applications.

Figure 1: DS1000

2. DS1000 COMPONENT LAYOUT

2.1 LIST OF COMPONENTS

Model	Brand	Description	Picture
GS-02A	NIDS Co®	Temperature & Humidity Sensor	
SH-300-DC	SOHA TECH®	Light Sensor (visible range)	
LM324	Texas Iinstruments®	Operational Amplifiers Array	
MAX4644	MAXIM®	CMOS analog switch	
NTC-103F397F	Samkyung Ceramics	NTC thermistor	
DF9B-51S-1V	Hirosi®	51-pin Connector	

2.2 DS1000 DESCRIPTION

The DS1000 board has the following layout:

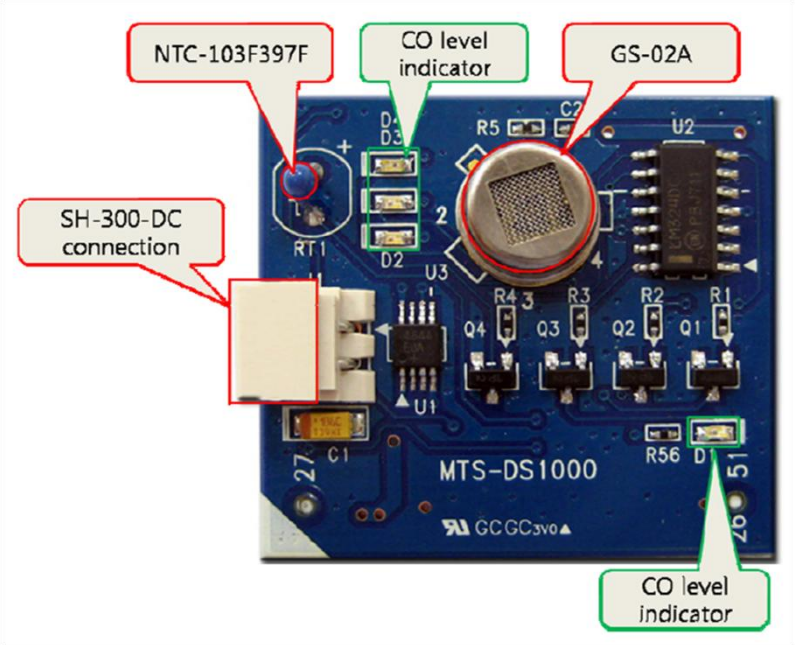


Figure 2: DS1000 Component Layout

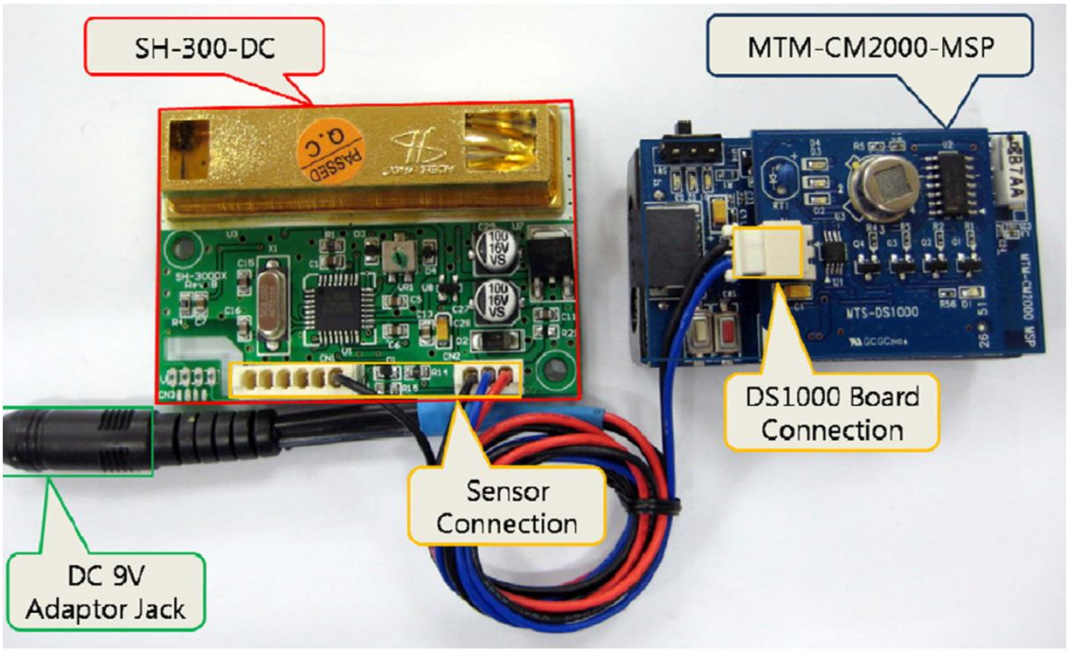


Figure 3 DS1000 Connections

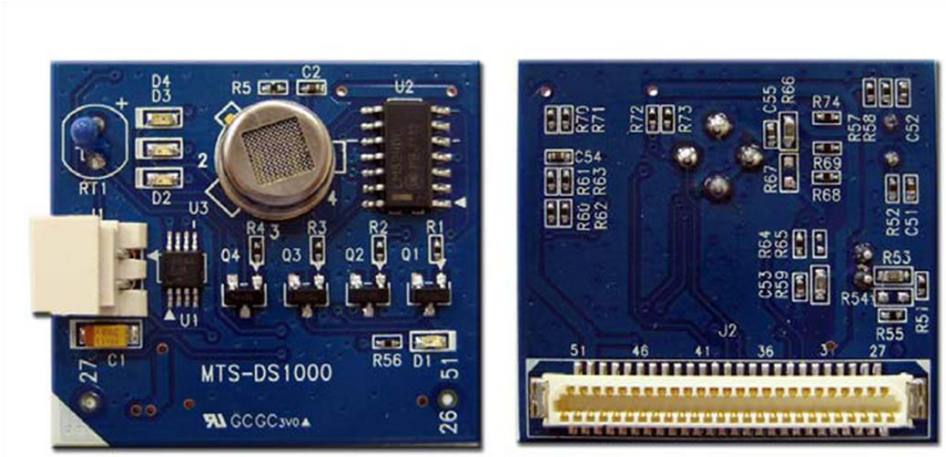
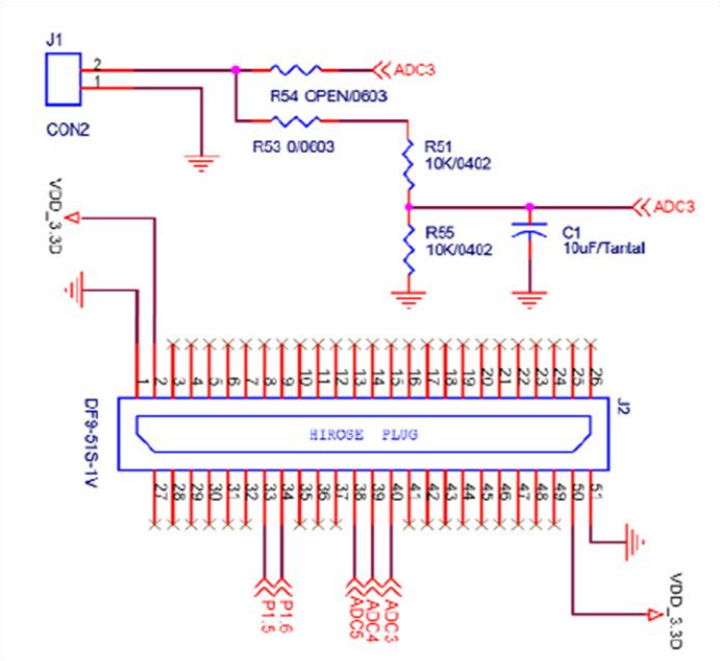
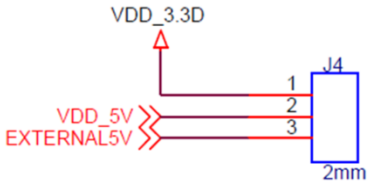


Figure 4: Top & Bottom description

2.3 DS1000 PINOUT





Pin NO	J1
1	GND
2	CO output (ADC3)
Pin NO	J2
1,51	GND
2,50	VDD_3.3
33	P1.5 ('1' ON/ '0' OFF CO sensor)
34	P1.6 ('1' ON/ '0' OFF Temp sensor)
38	ADC5/GS-02A
39	ADC4/NTC
40	ADC3/SH-300

Figure 5: 51 pin Connector Pinout (DF9B-51S-1V)

3. SENSOR SPECIFICATION

The DS1000 is composed by the following sensors: CO, CO2 and dust.

3.1 CO sensor - NIDS® GS-02A

Gas sensor GS-02A can detect and measure CO concentrations.

Key features:

The main features are:

- Low Power consumption
- Broad measuring range
- High sensitivity
- Low response time
- ESD protection
- High durability

Figure 6: NIDS® GS-02A Sensor

The following table shows the operating conditions:

Parameter	Symbol	Typ	Min	Max	Unit
Heating Power,	P_H	83	78	88	mW
Heating Voltage,	V_H	2.5	-	-	V
Heating Current,	I_H	34	-	-	mA
Heating Resistance at nominal power,	R_H	74	66	82	Ω

Figure 7. Operation conditions

The sensor response has the following response:

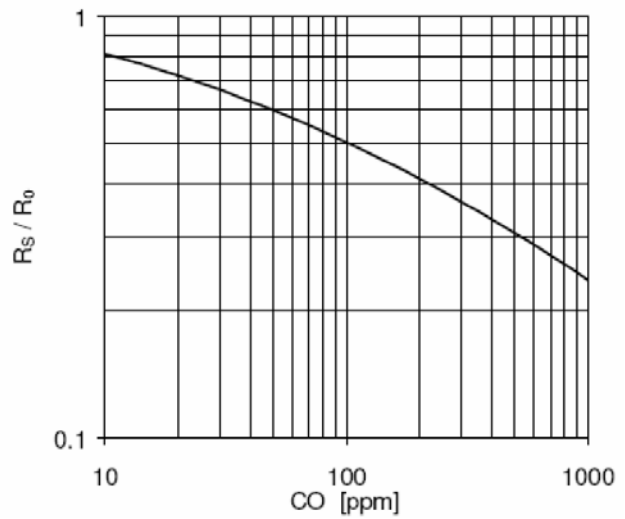


Figure 8. Bode diagram response

Conversion formulas:

GS-02A is connected 12Bit ADC of reference voltage 2.5V.
Vref (Reference voltage) is 2.5V and then V (Raw voltage) is adc_value /4096*2.5

RS = (RL * Vcc) / Vs - RL; RS : Sensor resistance
RL : Load resistance (20,000 Ω)
VCC : supplied voltage (about 3V)
VS : V(Raw voltage)
Sensitivity = RS / R0 ; R0 : about 880,000 Ω

As above characteristics of sensor response graph, CO concentration(ppm) is different value conditionally.

Case 1: If sensitivity is above 0.8, and then CO concentration(ppm) is:
=> **ppm = below 10ppm.**
Case 2: If sensitivity is above 0.5 and below 0.8, and then CO concentration is :
=> **ppm = (-300*Sensitivity) + 250.**

Case 3: If sensitivity is below 0.5 and equal, and then CO concentration is :
=> **ppm = (-3600*Sensitivity) + 1900**.

See GS-02A datasheet for more details.

3.2 CO2 sensor - SOHA TECH® SH-300-DC(CO_2)

The SH-300-DH measure air CO2 concentration.

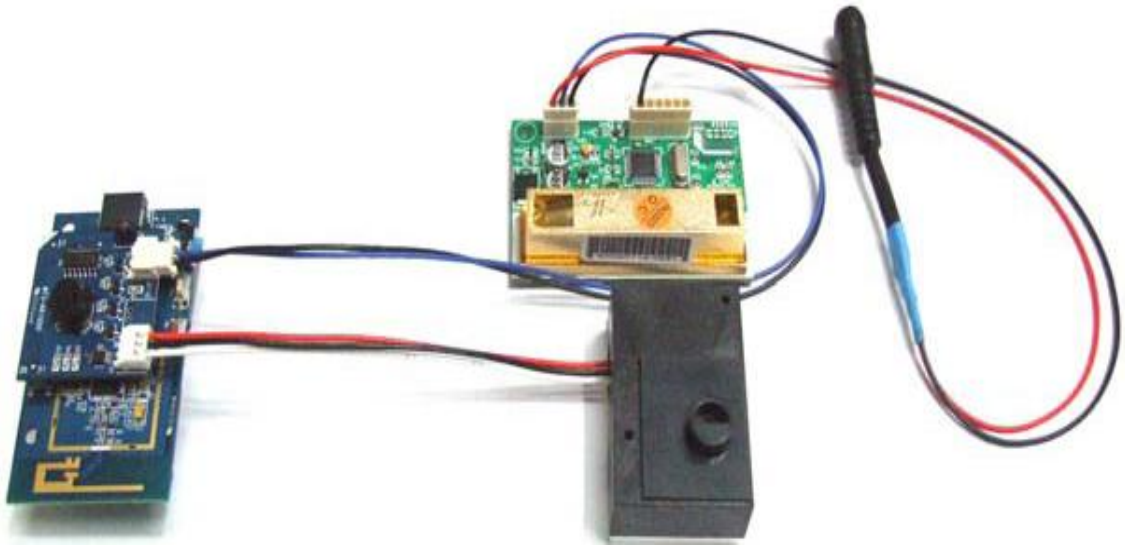


Figure 8. SH-300-DC connected to a DS1000+CM4000

Key features:

The main features are:

- Operating theory : NDIR
- Response time : 0 ~ 80% < 30 sec
- Warm-up Time @ 25℃ : < 90
- Interval of updating signal : 2.0 sec
- Accuracy : ± 2% ppm (0 ~ 3000 PPM) @ 10~ 50℃
- Measurement range : 0~3,000ppm
- Storage temperature range : -40 ~ +70℃
- Operating temperature range : 0~50℃
- Operating humidity range : 0~95% RH (Non condensing)

Electrical and Mechanical specification

- **Input voltage : 7~12V (9v Power adapter included in the purchase)**
- Power consumption : Low 25mA(@5VDC), peak 150mA
- Dimension : 18×65×45 (D×W×H) mm

Signal Outputs

- Analog Outputs : 0~3V, 0~3,000ppm comparison output [CN2]
- UART : Default 9600 bps (@9600 ~ 115200 Baud) [CN1]

Installation Method

- It has to be installed in vertical or horizontal directions.
- It is needed to keep the sensor directly expose to the gases flow.

CO2 concentration – Conversion table of output voltage

Output (V)	Concentration (ppm)	Output (V)	Concentration (ppm)	Output (V)	Concentration (ppm)
0	0				
0.1	100	1.1	1100	2.1	2100
0.2	200	1.2	1200	2.2	2200
0.3	300	1.3	1300	2.3	2300
0.4	400	1.4	1400	2.4	2400
0.5	500	1.5	1500	2.5	2500
0.6	600	1.6	1600	2.6	2600
0.7	700	1.7	1700	2.7	2700
0.8	800	1.8	1800	2.8	2800
0.9	900	1.9	1900	2.9	2900
1.0	1000	2.0	2000	3.0	3000

Figure 9. Conversion factors

Conversion formulas:

SH-300-DC is connected 12Bit ADC (Vref=2.5V); V(Raw voltage) is adc_value/4096*2.5;
=> **CO2 concentration(ppm) = V(Raw voltage) * (3000 / 3) - 200**
See GS-02A datasheet for more details.

3.3 Temperature sensor. Samkyung Ceramics , NTC-103F397F

Thermistor NTC-103F397F actuates as a temperature sensor sensitive to resistance changes. It is simple and compact and operates with high accuracy and feasibility

Key features:

- Resistance (25 ℃): 10kΩ ± 1% (25
- β (25 ℃ / 85 ℃) * 2: 3970 ± 1% (25 ℃ and 85 ℃)
- heat dissipation constant: 3.5mW / ℃
- t(seg) $_{T=63,2\%}$ = 15 sec max
- operation consume: 45mW
- Temperature range: -50 ~ 120 ℃

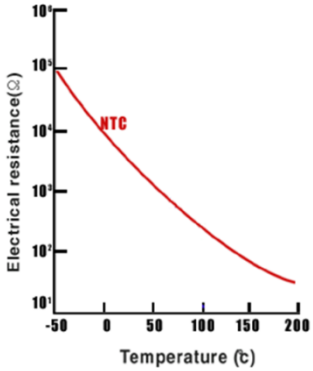


Figure 10. Electrical sensor resistance related to temperature changes.

NTC 103 F 397 F				
TEMP. (℃)	RESISTANCE (kΩ) min.	center	max.	TEMP. (℃)
-40	318.580	333.282	348.627	-40
-35	230.926	240.799	251.068	-35
-30	169.167	175.846	182.770	-30
-25	125.187	129.735	134.434	-25
-20	93.546	96.659	99.866	-20
-15	70.557	72.697	74.895	-15
-10	53.695	55.171	56.683	-10
-5	41.214	42.234	43.275	-5
0	31.894	32.600	33.317	0
5	24.877	25.364	25.857	5
10	19.551	19.885	20.222	10
15	15.477	15.704	15.933	15
20	12.337	12.489	12.642	20
25	9.900	10.000	10.100	25
30	7.960	8.058	8.156	30
35	6.441	6.534	6.627	35
40	5.243	5.329	5.417	40
45	4.293	4.372	4.453	45
50	3.534	3.606	3.680	50
55	2.925	2.991	3.057	55
60	2.433	2.492	2.553	60
65	2.034	2.087	2.142	65
70	1.709	1.756	1.805	70
75	1.442	1.485	1.528	75
80	1.222	1.260	1.300	80
85	1.040	1.075	1.110	85
90	0.889	0.920	0.951	90
95	0.763	0.790	0.819	95
100	0.657	0.682	0.707	100
105	0.568	0.590	0.613	105
110	0.493	0.513	0.533	110
115	0.429	0.447	0.465	115
120	0.374	0.391	0.408	120
	β(25/85)=3970°k±1%			

Figure 11. Thermistor Thermal coefficient

$$R_T = R_o e^{\beta\left(\frac{1}{T}-\frac{1}{T_o}\right)} \rightarrow \ln\left(\frac{R_T}{R_o}\right) = \beta\left(\frac{1}{T}-\frac{1}{T_o}\right)$$

RT [Ω]: Load resistance
R0 [Ω]: T0 [K] resistance
T [K]: 25 +273.15 = 298.15 [K]
$\beta_{3000\ [K]} << \beta_{5000\ [K]}$

Conversion formulas:

Vref (Reference voltage) = 2.5
V (Raw voltage) = adc_value / 4096 * 2.5
adc_value = Vin * RT / (RT + R0)

- Vin = 3V, RT = 10KΩ, R0 = Thermistor resistance

$$\ln\left(\frac{R_T}{R_o}\right) = \beta\left(\frac{1}{T} - \frac{1}{T_o}\right)$$

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