Air Quality System I - Basic Operation of SCD41 CO_2, Humidity and Temperature Sensor

Prof. Short

Sources

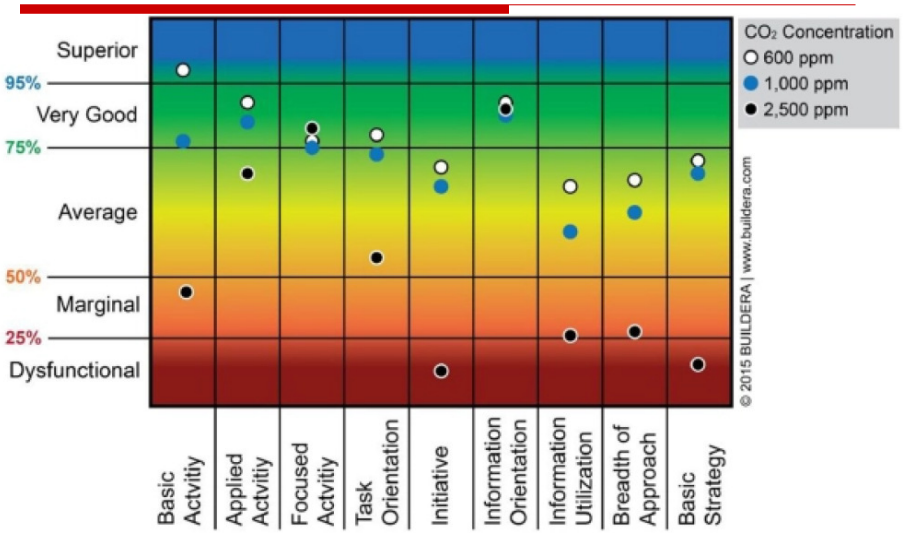
- The figures in this lecture and some text are taken from the following two references:
  - Sensirion SCD40/41 Miniature CO2 Sensor Data Sheet
  - Product Flyer SCD4x.
  - Sensirion Indoor Air Quality Brochure.

Laboratory 10 Tasks

- Task 1: Hardware Interface of SCD41 to AVR128DB48.
- Task 2: Basic Operation of the SCD41, Function Partitioning, Definitions, and Reading Measured CO_2, Temperature, and Humidity Values.
- Task 3: LCD Display of Formatted CO_2, Temperature, and Humidity Using a Multifile implementation.

SCD41 Miniature CO2 Sensor

Impact of CO2 on human decision-making performance



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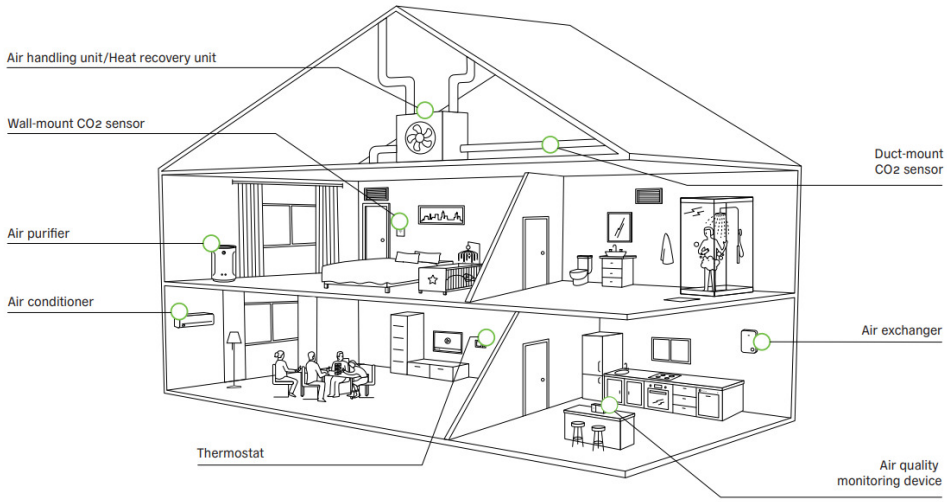
Commercial and Residential HVAC Applications



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NDIR vs. Photoacoustic Sensing Technology

Features	Typical NDIR CO_2 Sensor	SCD4x CO_2, RH + T Sensor
High selectivity	✓	✓
Small size	✗	✓
Additional sensor outputs	✗	✓
Cost-effective assembly	✗	✓
Mechanical robustness	✗	✓
Cost-effective BOM	✗	✓

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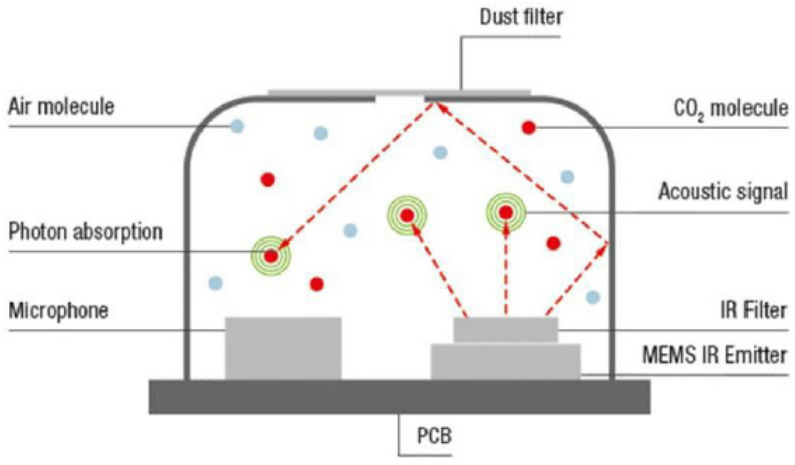
Photo Acoustic Sensing of CO_2



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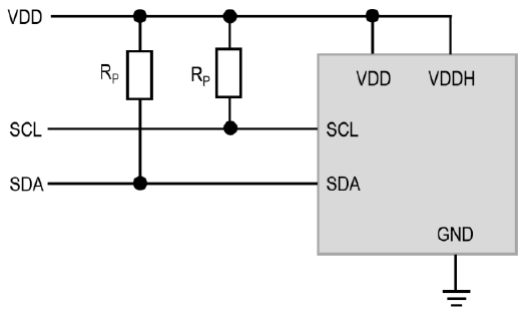
Task 1: Hardware Interface of SCD41 to AVR128DB48

- Your schematic should be based on the block diagram from the data sheet that follows.
- You must also carry out a logic level and current compatibility analysis and provide it with your prelab.

Data Sheet Schematic



SCD41 Electrical Specifications

Parameter	Symbol	Conditions	Min.	Typical	Max.	Units
Supply voltage DC	V_{DD}		2.4	3.3 or 5.0	5.5	V
Voltage ripple peak to peak	V_{RPP}				30	mV
Peak supply current[6]		V_{DD} = 3.3 V		175	205	mA
		V_{DD} = 5 V		115	137	mA
Average supply current for periodic measurement, periodic measurement	I_{DD}	V_{DD} = 3.3 V		15	18	mA
		V_{DD} = 5 V		11	13	mA
Average supply current for periodic measurement, low power periodic measurement	I_{DD}	V_{DD} = 3.3 V		3.2	3.5	mA
		V_{DD} = 5 V		2.8	3	mA
Average supply current for periodic single shot measurement, 1 measurement / 5 minutes (SCD41 only)[7]	I_{DD}	V_{DD} = 3.3 V		0.45	0.5	mA
		V_{DD} = 5 V		0.36	0.4	mA
Input high level voltage	V_{IH}		0.7 x V_{DD}		1 x V_{DD}	-
Input low level voltage	V_{IL}				0.3 x V_{DD}	-
Output low level voltage	V_{OL}	3 mA sink current			0.66	V

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Task 2: Basic Operation of the SCD41, Function Partitioning, etc.

- You need to read the data sheet so that you understand the basic operation of the SCD41.
- You will need to define a minimal set of functions that allow you operate the SCD41 and write those functions and their headers.
- The command sequence types and corresponding I2C transactions are shown on the diagram that follows.
- The minimal set of commands that you need to implement are highlighted in blue on the SCD4x Command Overview slides that follow.

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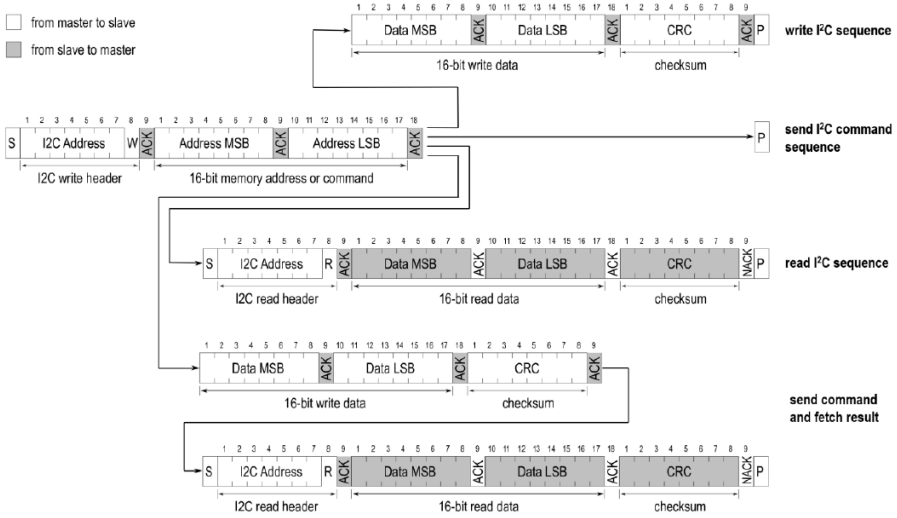
Task 2: Basic Operation of the SCD41, Function Partitioning, etc.

- You can display the measurement results in the watch window of Studio 7.

Command Sequence Types



SCD4x Command Overview

Domain	Command	Hex. Code	I²C sequence type (see chapter 3.3)	Execution	
				time [ms]	During meas.*
Basic Commands Chapter 3.5	start_periodic_measurement	0x21b1	send command	-	no
	read_measurement	0xec05	read	1	yes
	stop_periodic_measurement	0x3f86	send command	500	yes
On-chip output signal compensation Chapter 3.6	set_temperature_offset	0x241d	write	1	no
	get_temperature_offset	0x2318	read	1	no
	set_sensor_altitude	0x2427	write	1	no
	get_sensor_altitude	0x2322	read	1	no
	set_ambient_pressure	0xe000	write	1	yes

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SCD4x Command Overview (cont.)

Field calibration Chapter 3.7	perform_forced_recalibration	0x362f	send command and fetch result	400	no
	set_automatic_self_calibration_enabled	0x2416	write	1	no
	get_automatic_self_calibration_enabled	0x2313	read	1	no
Low power Chapter 3.8	start_low_power_periodic_measurement	0x21ac	send command	-	no
	get_data_ready_status	0xe4b8	read	1	yes
Advanced features Chapter 3.9	persist_settings	0x3615	send command	800	no
	get_serial_number	0x3682	read	1	no
	perform_self_test	0x3639	read	10000	no
	perform_factory_reset	0x3632	send command	1200	no
	reinit	0x3646	send command	20	no
Low power single shot (SCD41 only) Chapter 3.10	measure_single_shot	0x219d	send command	5000	no
	measure_single_shot_rht_only	0x2196	send command	50	no

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Task 3: LCD Display of Formatted Measurements