User manual for DEV_KIT_NGC1081

About this document

Scope and purpose

This document describes the evaluation kit for **Infineon's NGC1081 microcontroller**, which supports near-field communication (NFC). The kit has all the necessary components to enable the user to quickly start sensing the world via NFC in active and/or passive mode. The required settings for both modes, for programming and debugging, are covered in this document.

Intended audience

This document aims to help developers make use of the NGC1081 in NFC sensing applications. It can also serve as a demo for customers when used to sense different parameters at the same time.

Reference board/kit

Product(s) embedded on a PCB with a focus on specific applications and defined use cases that may include software. PCB and auxiliary circuits are optimized for the requirements of the target application.

Note: Boards do not necessarily meet safety, EMI and quality standards (for example UL, CE).

Figure 1 A photo of the Evaluation board EVAL_NGC1081

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Safety precautions

Note: *Please note the following warnings regarding the hazards associated with development systems.*

Table 1 Safety precautions

	**Caution:** *A drive that is incorrectly applied or installed can lead to component damage or reduction in product lifetime. Wiring or application errors such as undersizing the motor, supplying an incorrect or inadequate AC supply, or excessive ambient temperatures may result in system malfunction.*

Table of contents

1 The board at a glance

This development kit is a tool for engineers who want to use NGC1081 as a solution for sensing the world via NFC and energy harvesting. NGC1081 is an NFC tag-side controller, which combines in one device the functions of energy harvesting, NFC, sensing unit and motor control. NGC1081 is based on a 32-bit Arm® Cortex®-M0 processor core operating at a CPU frequency of 28 MHz. Standard peripheral modules such as UART, I^2C, SPI and 32 kHz RTC are included. The user manual reference number is UM_2302_PL39_2304_090250.

1.1 Scope of supply

The development kit consists of the evaluation board EVAL_NGC1081, packages of firmware, demo cell phone app, and a USB-A to micro-USB cable for power supply. With the QR code printed on the shipping box, it is possible to register the board at **http://www.infineon.com** to get access to all related documents and code examples. The following packages will be available after registration:

- Standalone temperature-sensing firmware (with additional sensing examples using Shield 2GO (S2GO) sensors)
- Firmware development SDK (without source code)
- Mobile application demo for Android (without source code)
- Evaluation board schematic, PCB layout files, Gerber files, and bill of materials (BOM)

1.2 Main features

- Arm® Cortex®-M0 controller
- ISO14443-A NFC interface
- 60 kB non-volatile memory (NVM), 16 kB RAM
- Boot ROM
- 12-bit SAR ADC/10-bit DAC
- Integrated temperature sensor
- Integrated H-bridge
- Energy harvesting
- 128-bit AES accelerator
- True random number generator
- Chip UID, I^2C, SPI and UART

1.3 Board parameters and technical data

Table 2 Operational conditions and parameters

Parameter	Symbol	Min.	Typ.	Max.	Unit	Note
Board power supply	VCC_{board}		5		V	Through micro-USB
IC power supply	VCC_{IC}	2.8	3	3.6[*]	V	Stepped down on the board, or connected externally
GPIOs as outputs, high level	GPIO0 to GPIO15	2.2		2.5	V	Load 2 mA
GPIOs as outputs, low level	GPIO0 to GPIO15			0.2	V	Load 2 mA
GPIOs as inputs, high level	GPIO0 to GPIO15	1.75		3.6	V	

Parameter	Symbol	Min.	Typ.	Max.	Unit	Note
GPIOs as inputs, low level	GPIO0 to GPIO15	0		0.7	V	
Wake-up threshold, high level	WAKEUP	2.3			V	
Wake-up threshold, low level	WAKEUP			0.8	V	
Voltage at VCC_HB	VCC_HB			3.3	V	Avoid low-ohmic load on VCC_HB over extended period of time (several seconds)
Current between MA and MB	I_HB			250	mA	
Analog input	AN_IN0 to AN_IN3	0		1.8	V	
Analog outputs	AN_OUT	0		1.7	V	

[*] The maximum external voltage should not exceed the selected clamping voltage of NGC1081 – **see the datasheet** for the possible values of the clamping voltage.

2 System and functional description

The EVAL_NGC1081 has been developed to operate in two different modes. It can operate either in active mode (by external wired power supply) or passive mode (by harvesting energy from the NFC antenna and without any external wired power supply). Additionally, there is debugging mode, which is slightly different from active mode.

2.1 Operating in active mode

As already mentioned, the EVAL_NGC1081 needs external power supply in active mode, between 3.0 V and 3.6 V, precisely.

2.1.1 Steps to power up the board in active mode

First, remove any reader device in the NFC antenna field, to avoid two conflicting power sources, then use one of the two options below.

- Option 1: plug in a micro-USB and switch the S1 switch on.

  The voltage from the micro-USB will then get stepped down internally to the recommended 3.3 V operating voltage (additionally, please check the jumper connections in **Table 3**).
- Option 2: switch off the S1 switch, connect a direct 3.3 V to the pins marked with the 3.3 V label, and also connect the ground to the pins marked with the GND label (additionally, please check the jumper connections in **Table 3**).

2.1.2 Jumper connections in active mode

Table 3 Jumper connections in active mode

Jumper	Connection	Condition
JP8	Connected	–
JP10	Connected	When wake-up pin is not in use
JP5	Connect pins 2 to 3	When using half-bridge
All other jumpers may be connected or not depending on the application.		

2.1.3 Potential applications in active mode

Active mode is an option in applications that require long time sensing. In that case, the board will be programmed via NFC and supplied by an external wired power supply. Data sensed by the board can be read via NFC at the end.

Potential applications:

- Temperature logger
- Smart thermostat
- CO_2 logger
- General environment parameter logging

2.2 Operation in passive mode

In passive mode, the EVAL_NGC1081 not only communicates with the reader device (e.g., smartphone), but also harvests energy from it.

2.2.1 Steps to power up the board in passive mode

- Check jumper connections in **Table 4**.
- Make sure the capacitor on VCC_CB is soldered (C9 = 1 µF (recommended value)).
- When planning to use the half-bridge, solder C2, C11, or C12 if needed for harvesting energy (as shown in **Figure 2**).

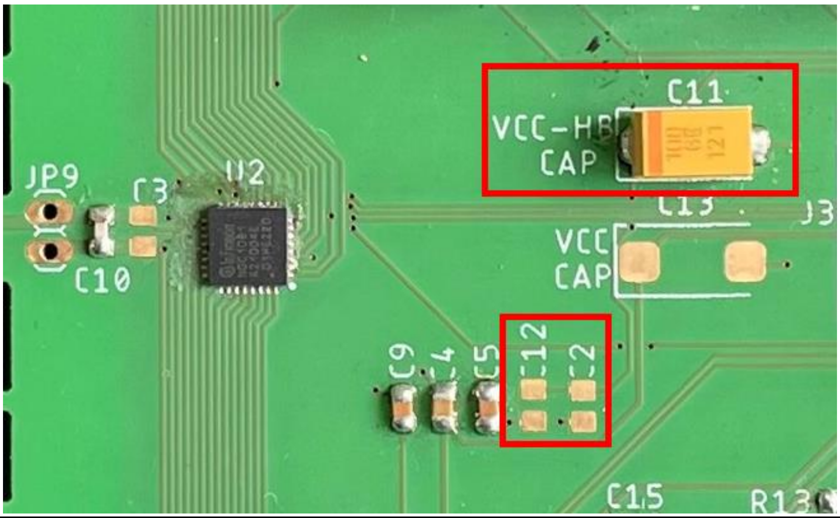


Figure 2 Capacitors for storing harvested energy to use the MA pin as an output power source

2.2.2 Jumper connections in passive mode

Table 4 Jumper connections in passive mode

Jumper	Connection	Condition
JP8	Disconnected	–
JP10	Connected	When wake-up pin is not in use
JP5	Connect pins 1 to 2	When using half-bridge
All other jumpers may be connected or not depending on the application.		

2.2.3 Potential applications in passive mode

Sensing the world in passive mode is practical, as it doesn't require batteries. All you need is a reader device (e.g., smartphone), which most people have.

Potential applications are usually those that require one-time sensing or one-time motor movement, such as:

- Temperature and humidity sensing
- Tire pressure sensing
- CO_2 sensingSmart lock applications

3 System design

3.1 Schematics

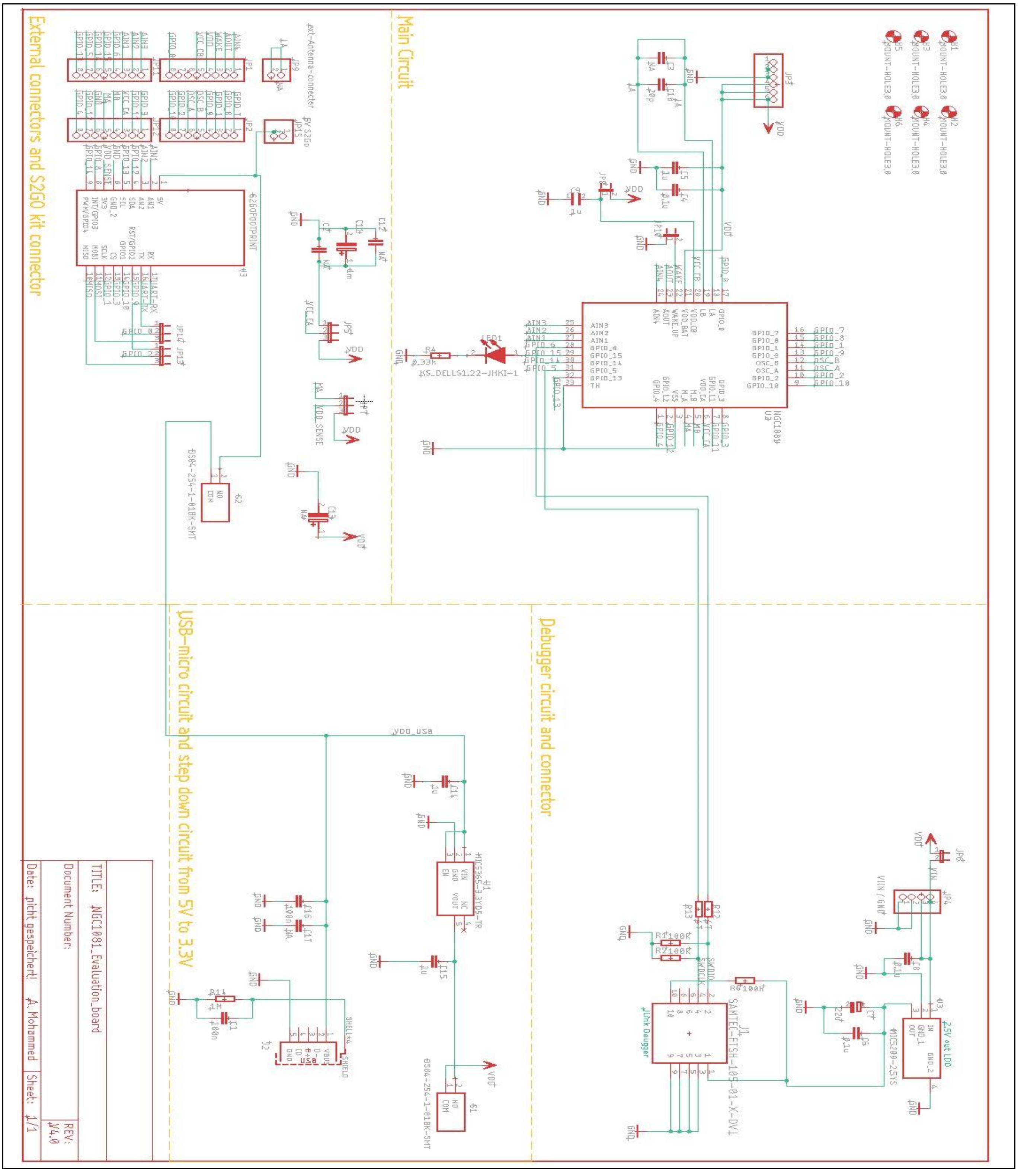


Figure 3 EVAL_ NGC1081 schematics

3.2 Layout

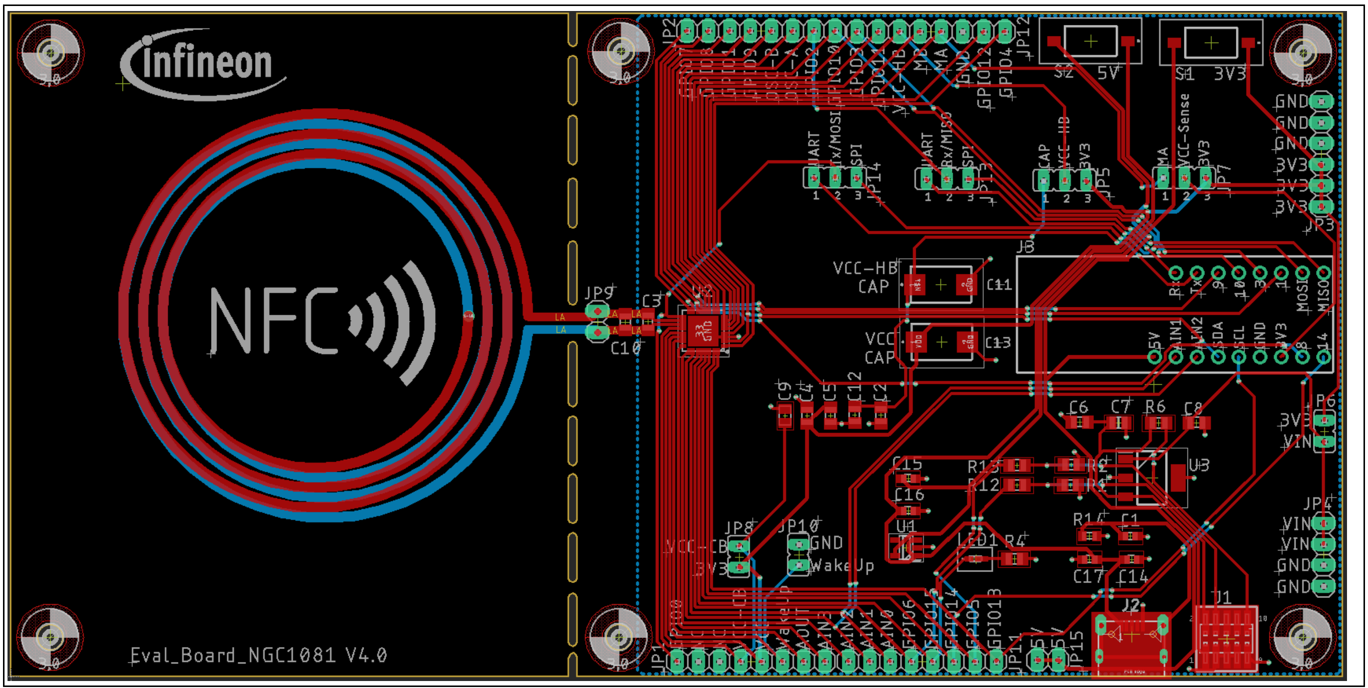


Figure 4 **EVAL_NGC1081 layout (top layer)**

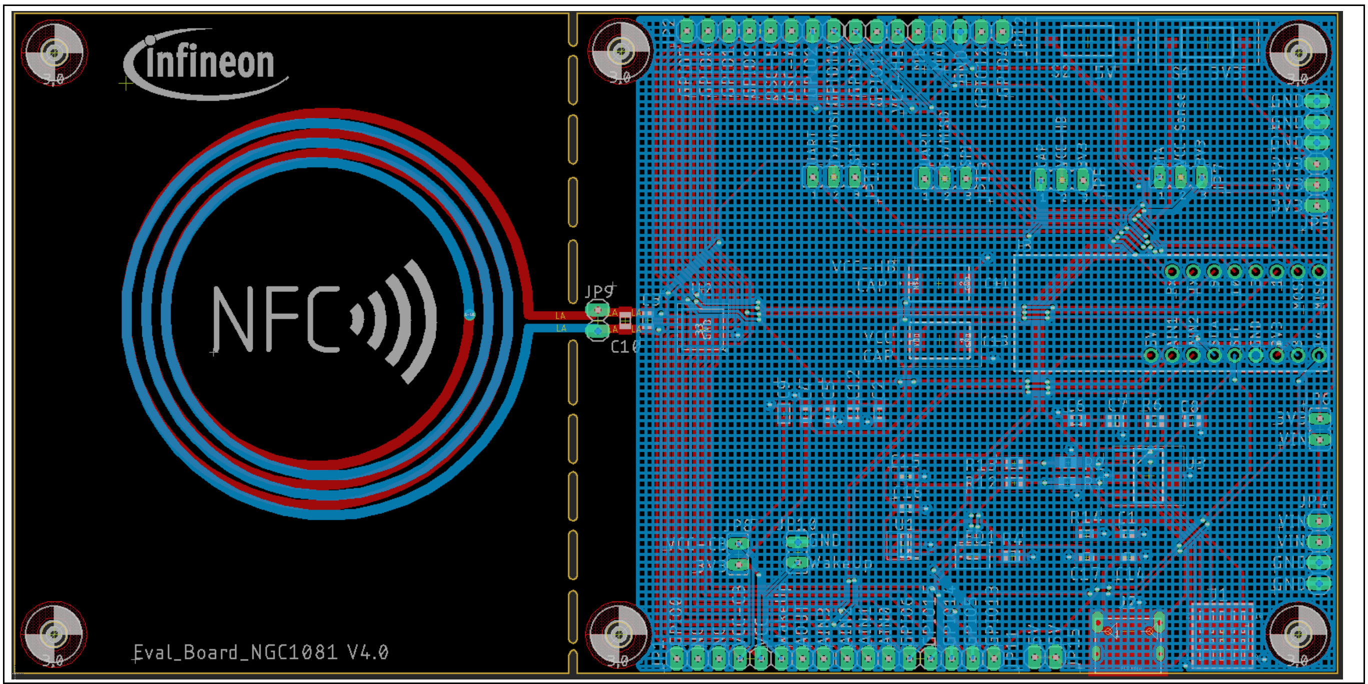


Figure 5 **EVAL_NGC1081 layout (bottom layer)**

3.3 Bill of materials

Table 5 EVAL_NGC1081 BOM

Serial no.	Part ref.	Value	Package	Description
1	U1	MIC5365-3.3YD5-TR	SOT95P280X100-5N	LDO with 3.3 V output
2	U2	NGC1081	QFN32_NGC1081	Infineon tag-side microcontroller
3	U3	MIC5209-2.5YS	SOT230P700X180-4N	LDO with 2.5 V output
4, 5	C1, C16	100 nF	C0603	Ceramic/X7R
6, 7, 8	C2, C3, C12	N/A	C0805K	N/A, ceramic/X7R
9, 10, 11	C4, C6, C8	0.1 µF, 10%, 6.3 V	C0805K	Ceramic/X7R
12, 13	C5, C9	1 µF, 10%, 6.3 V	C0805K	Ceramic/X7R
14	C7	22 µF, 10% or 20%, 6.3 V	Tantalum capacitor, 0805	TLJR226M010R3800
15	C10	20 pF, 10%, 6.3 V	C0805K	Ceramic/X7R
16	C11	1 mF, 10%, 6.3 V	Tantalum capacitor, 2917	399-18864-1-ND
17	C13	N/A	Tantalum capacitor, 2917	N/A, 399-18864-1-ND
18, 19	C14, C15	1 µF, 10%, 6.3 V	C0603	Ceramic/X7R
20	C17	N/A	C0603	N/A, ceramic/X7R
21, 22, 23	R1, R2, R6	100 kΩ, 5%	R0805	5%
24	R4	0.33 kΩ	R0805	5%
25, 26	R12, R13	47 Ω	R0805	5%
27	R14	1 MΩ	R0603	5%
28	LED1	KS_DELLS1.22-JHKI-1	KSDELLS122JHKI1	SMD super red top LED E 1608 mm
39, 30	S1, S2	DS04-254-1-01BK-SMT	DS04254101BKSMT	Voltage switches to circuit
31	J1	SAMTEC-FTSH-105-01-X-DVJ	SAMTEC-FTSH-105-01-X-DV	Debugger connector
32	J2	Micro-USB B, USB 2.0	Position surface mount	Input voltage micro-USB
33	J3	Print socket, board-to-board, 2.54 mm, 8 contacts (female)	2212S-08SG-85	
		Print socket, board-to-board, 2.54 mm, 9 contacts (female)	2212S-10SG-85	Only 9 pins, not 10
34, 35, 36, 37	JP1, JP2, JP11, JP12	1X08 (male), 2.54 mm	TSW-108-14-G-S	2.54 mm pitch
38	JP3	1X06 (male), 2.54 mm	TSW-106-14-G-S	2.54 mm pitch
39	JP4	1X04 (male), 2.54 mm	TSW-104-14-G-S	2.54 mm pitch

Serial no.	Part ref.	Value	Package	Description
40, 41, 42, 43	JP5, JP7, JP13, JP14	1X03 (male), 2.54 mm	TSW-103-14-G-S	2.54 mm pitch
44, 45, 46, 47	JP6, JP8, JP10, JP15	1X02 (male), 2.54 mm	TSW-102-14-G-S	2.54 mm pitch
48	JP9	1X02 (male), 2.54 mm	TSW-102-14-G-S	N/A, 2.54 mm pitch

3.4 Connector and switch details

Table 6 EVAL_NGC1081 connector and switch descriptions

Pin	Function
JP1	NGC1081 pins (1)
JP2	NGC1081 pins (2)
JP3	3V3 and GND pins
JP4	V_{IN} (power supply for debugger) and GND pins
JP5	VCC_HB (half-bridge) connection options: 1 to 2: connect to external capacitor (passive mode) 2 to 3: connect to 3V3 (active mode)
JP6	(Optional) connection between the debugger power supply and 3V3
JP7	Power supply for the S2GO (V_{CC} sense) options: 1 to 2: MA (half-bridge motor pin) 2 to 3: 3V3 (connect only in active mode)
JP8	VCC_CB connection with 3V3: Connected in active mode Disconnected in passive mode
JP9	(Optional) pinouts for external an antenna
JP10	(Recommended) connected when wake-up pin is not in use
JP11	NGC1081 pins (3)
JP12	NGC1081 pins (4)
JP13, JP14	UART and SPI connection between NGC1081 and S2GO
JP15	5 V pinouts connected to the S2GO sensors
J1	Debugger connector
J2	Micro-USB connector
J3	S2GO sensors connector
S1	Switches 3V3 from USB to the whole circuit
S2	Switches 5 V from USB to the S2GO sensors and JP15

4 System in operation

To sense the world using NGC1081, you can use the internal temperature sensor or any of the other peripherals (I^2C, SPI, UART ...) that the NGC1081 supports to sense using external sensors.

For an easy trial of different sensors, the EVAL_NGC1081 supports the S2GO boards.

4.1 Shield 2GO

The S2GO kits are different boards. Each has a different sensor, but all have the same pinning. This makes trying different sensors using the EVAL_NGC1081 possible with minimal effort. **Figure 7** shows the pinning of the S2GO.

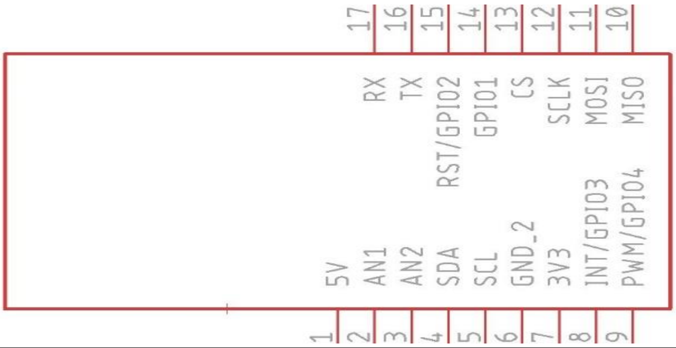


Figure 7 Pinning of S2GO

The S2GO used in the default firmware is the SHIELD_PASCO2_SENSOR, as shown in **Figure 8**.

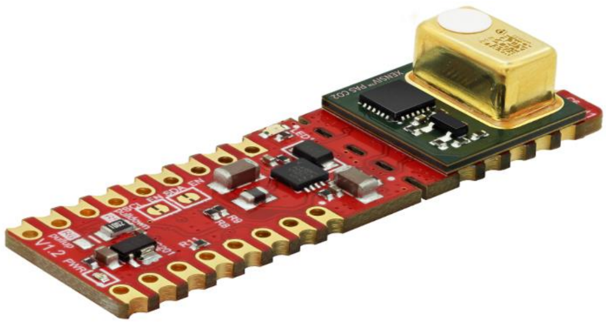


Figure 8 SHIELD_PASCO2_SENSOR

This shield has the XENSIV™ PAS CO2 sensor on it. This is a real carbon dioxide (CO_2) sensor in an unprecedented small form factor.

4.2 Firmware

The default firmware on the EVAL_NGC1081 already makes one of two measurements:

1. If the SHIELD_PASCO2_SENSOR is present, the NGC1081 will make a connection with it, configure it and read the CO_2 (only available in active mode).

   In order to have a correct measurement and not burn the sensor:

   - Turn on S1 (3V3), then right after it S2 (5 V).

2. If the SHIELD_PASCO2_SENSOR is not available, the NGC1081 will use the internal sensor to make a temperature measurement (available in active and/or in passive mode).

After going through one of the two options, the NGC1081 sends the results over UART. The results can be read using the Android app supplied with the board. Below is the flow chart of the firmware.

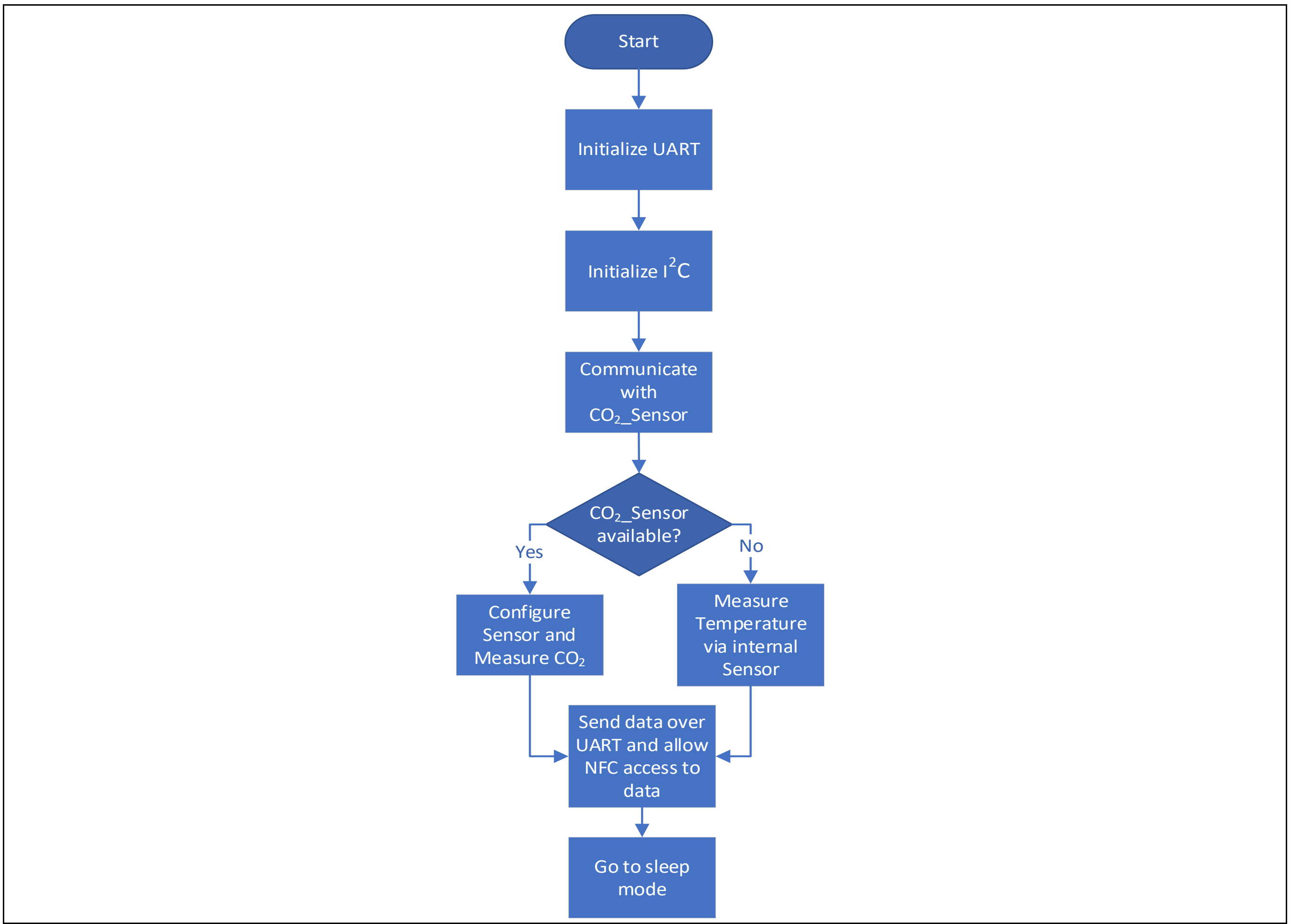


Figure 9 **Firmware flow chart**

4.2.1 Steps to measure CO_2

1. Plug the micro-USB into J2 for power supply.
2. Make sure the following jumpers are connected correctly:
   a. JP8 connected
   b. JP7 connected between 2 and 3
3. Connect the Rx UART cable to GPIO2 (Tx of the NGC1081).
4. Place the SHIELD_PASCO2_SENSOR on J3.
5. Switch S1 on, then right after switch S2 on.

These steps are labeled on the board in **Figure 10**.

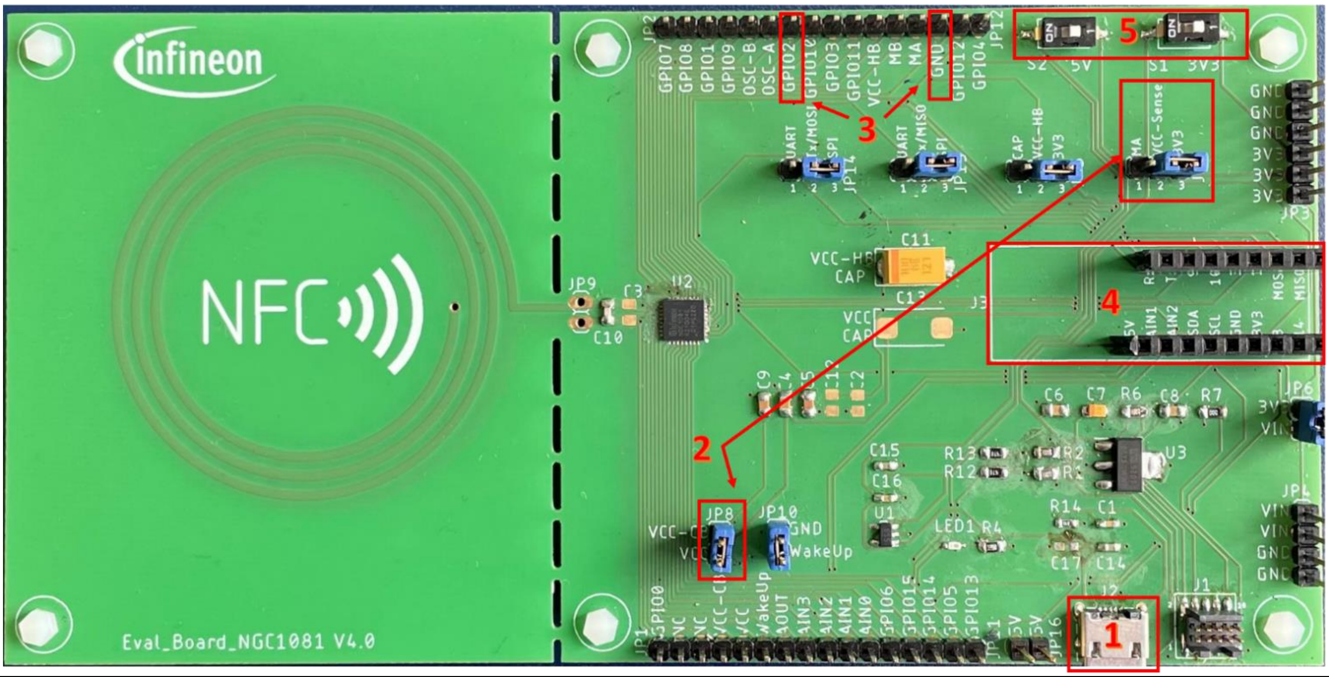


Figure 10 **CO_2 measurement steps labeled on the EVAL_NGC1081 with the SHIELD_PASCO2_SENSOR**

After less than 2 s the result will already be shown on the UART terminal.

6. Additionally, if the phone is placed where the NFC antenna is, the result of the measurement will also be shown in the app.

Note: *Every phone has its NFC antenna in a different place (usually on the back of the phone). The performance is best when the phone's NFC antenna is placed in the middle of the EVAL_NGC1081 antenna.*

The figures below show a screenshot of both the phone and the UART terminal.

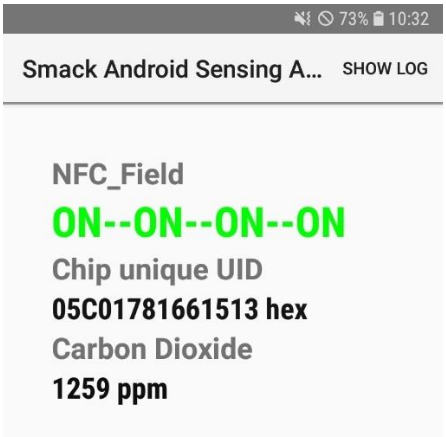
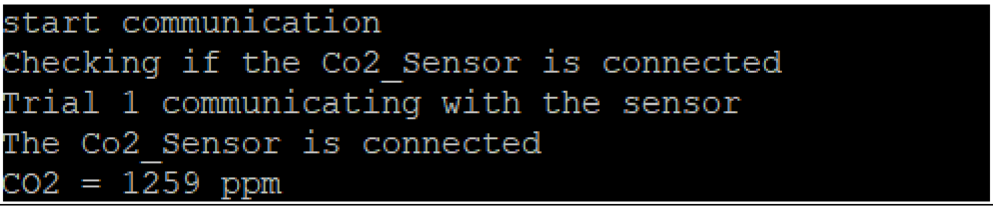


Figure 11 **Screenshot of the result on the app after CO_2 measurement**



```
start communication
Checking if the Co2_Sensor is connected
Trial 1 communicating with the sensor
The Co2_Sensor is connected
CO2 = 1259 ppm
```

Figure 12 **Screenshot of the result on the UART terminal after CO_2 measurement**

4.2.2 Steps to measure temperature

For temperature measurement there are two options – either measuring in active mode, or measuring in passive mode.

4.2.2.1 Active mode temperature measurement

1. Plug the micro-USB into J2 for power supply.
2. Make sure the following jumper is connected correctly:
   a. JP8 connected
3. Connect the Rx UART cable to GPIO2 (Tx of the NGC1081).
4. Switch S1 on.

Figure 13 shows the steps mentioned above on the board.

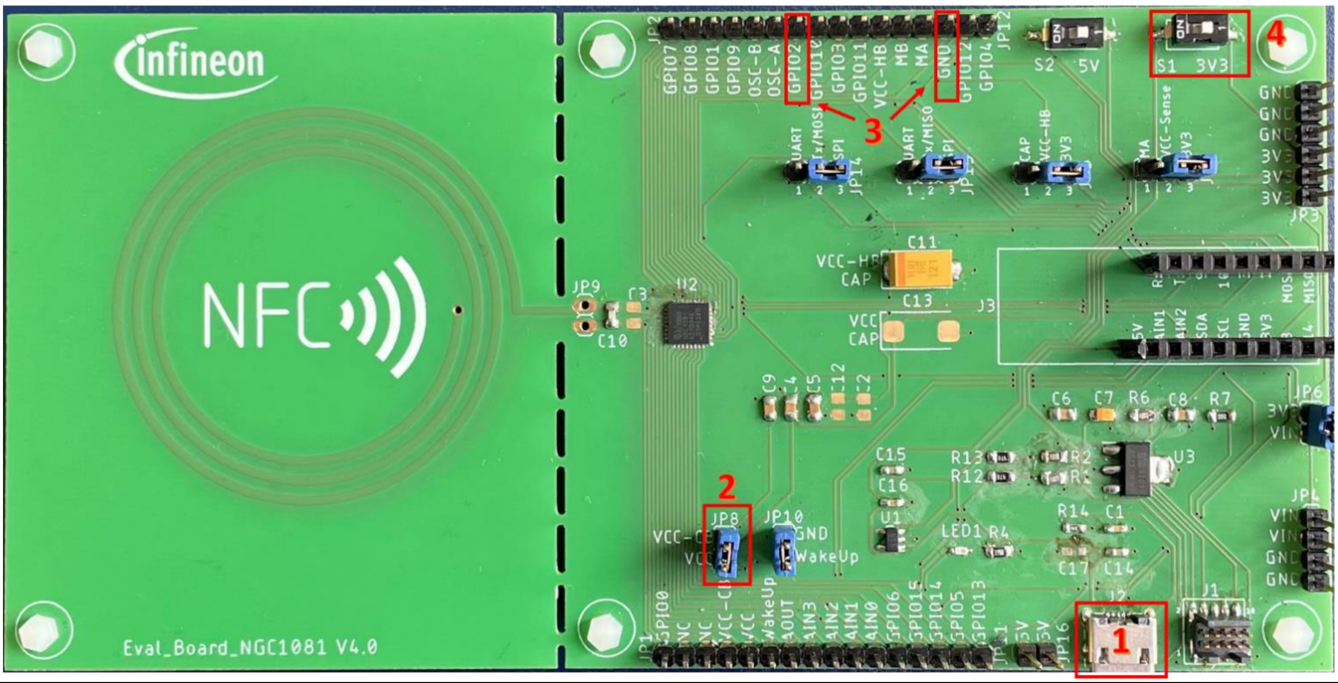


Figure 13 **Temperature measurement steps labeled on the EVAL_NGC1081**

5. After around 2 s the result will already be shown on the terminal.
6. Additionally, if the phone is placed where the NFC antenna is, the result of the measurement will also be shown in the app.

The figures below show the results of temperature measurements.

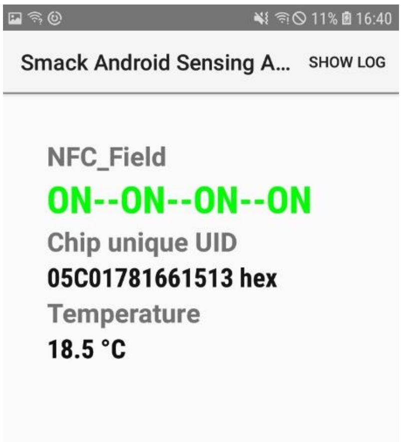


Figure 14 **Screenshot of the result on the app terminal after temperature measurement**

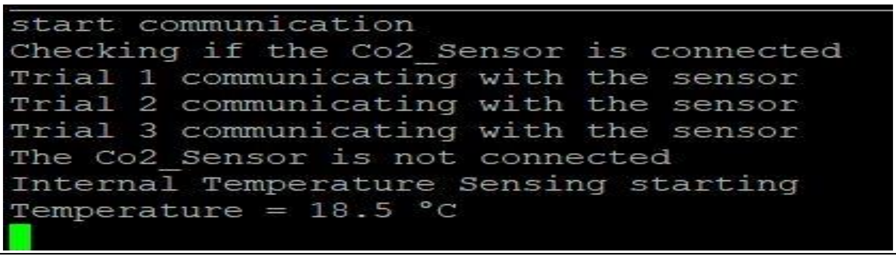


Figure 15 **Screenshot of the result on the UART terminal after temperature measurement**

4.2.2.2 Passive mode temperature measurement

For passive mode temperature measurement, there are just two steps:

1. Make sure JP8 is not connected.
2. Place the phone where the EVAL_NGC1081 antenna is, for roughly 2 s.

The result should look similar to that shown in **Figure 14** and **Figure 15**.

Appendices

A Debugger connection

NGC1081 IC supports Arm® SWD and TAG debug ports for firmware programming. **Figure 16** shows the connection of the debugger to the device. Two signals of the SWD debug port – SWDCLK and SWDIO – are connected with the pull-down resistors of 100 kΩ. Series termination resistors of 47 Ω on the SWCLK and SWDIO lines are strongly recommended. As shown in **Figure 16** and **Figure 17**, if JP6 is connected, the system will be supplied by V_{DD} (3.3 V); debugging/flashing is only done in active mode. As GPIO outputs of the device have a "high" level (2.2 V to 2.5 V) instead of the 3 V range, a low-dropout (LDO) regulator with the 2.5 V output is used to generate the required level for the V_{Tref} signal of the debugger. Nine-pin debugger SWD/JTAG pinout is shown in **Figure 18**.

As a debugger tool, micro trace for Cortex-M from Lauterbach or Segger J-LINK JTAG debuggers can be used. Both debuggers have a 20-pin header, therefore a 20-pin to 10-pin adapter is required. Please be aware that a debugger is not included in the development kit and must be ordered separately.

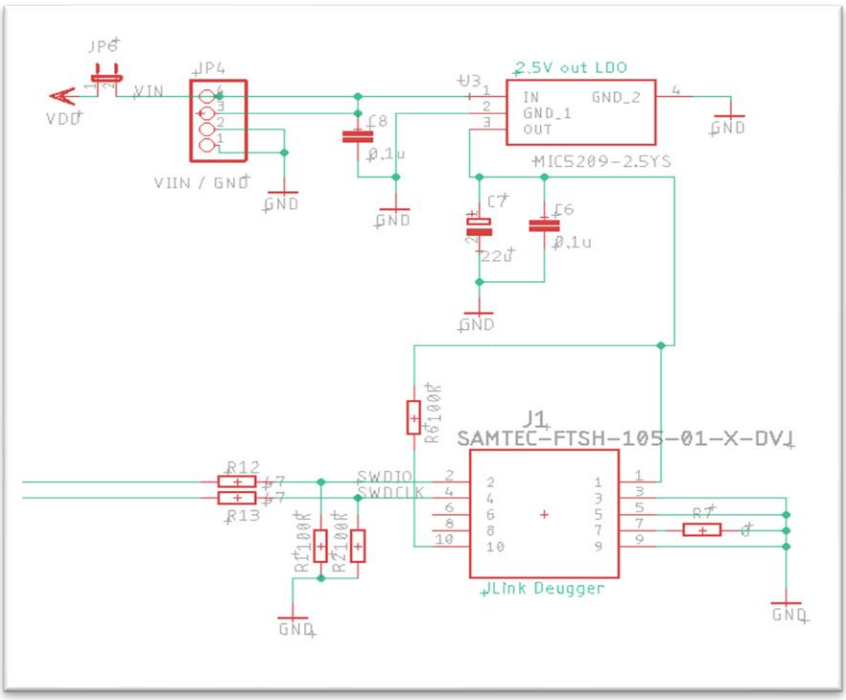


Figure 16 Schematics of the debugger part

Figure 17 **rConnection of USB and debugger to the NGC1081**

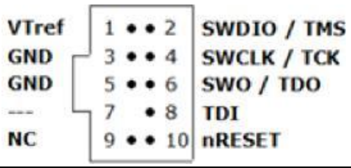


Figure 18 **Ten pin descriptions of the JTAG**

B NFC antenna

The evaluation kit offers an antenna as part of the evaluation board. An additional finished antenna design can be downloaded from the NGC1081 product web page. It is also possible to remove the antenna on the PCB and use an external antenna by connecting it to JP9. NFC readers operate in the 13.56 MHz high-frequency band. The typical value of the internal capacity between terminals LA and LB of NGC1081 is given in the datasheet, and it is 23.5 pF. For the antenna tuning (if necessary) capacitors C5 and C6 are laid out on the evaluation board.

Glossary

S2GO
Shield 2GO

EVAL_NGC1081
Evaluation board NGC1081

Revision history

Document revision	Date	Description of changes
V 1.0	2023-04-12	Initial release

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