AN010: MINIMISING SYSTEM POWER CONSUMPTION WHEN USING A COZIR®-BLINK CO_2 SENSOR

ABSTRACT

The CozIR®-Blink is an ultra-low power NDIR CO_2 sensor using state-of-the-art solid-state LED optical technology. The CozIR®-Blink uniquely allows users to reduce the power consumption of CO_2 measurements to unprecedented levels by allowing the sensor to be power cycled, where the sensor is only powered-up for the duration of the measurement, and then powered down again to save power for battery powered or wireless interface applications.

The CozIR-Blink can be configured so power consumption is reduced down to microwatts per measurement. In such cases, it is important to consider not only how the sensor is powered-down, but also potential leakage paths from surrounding circuitry.

It is critical to ensure there are no current leakage paths, especially when the CozIR®-Blink is connected to a shared communications interface like an I^2C bus. The purpose of this application note is to explain how to connect a Gas Sensing CozIR®-Blink CO_2 sensor to a host controller system and ensure there are no current leakage paths when the sensor is powered-off and not in use.

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BASIC PRINCIPLES

The CozIR-Blink senor has two digital interface options, either I^2C or UART. The interface is selected by reading the I2C_ENABLE pin at switch on. If this pin is logic low (tied to ground), the I^2C interface is selected. When the pin is logic high or not connected (pin has internal weak pull up), the UART interface is enabled. Only one interface type can be selected. The sensor needs to be switched off to enable the interface to be changed.

In a typical battery-controlled CO_2 measurement system using the CozIR®-Blink, it is important to isolate the sensor from the rest of the active circuitry when it is powered down. The communications interface on the CozIR-Blink is implemented using a microcontroller general purpose I/O port. Most microcontroller GPIO port pins have a similar structure with protection diodes to protect the internal circuitry from over voltage damage.

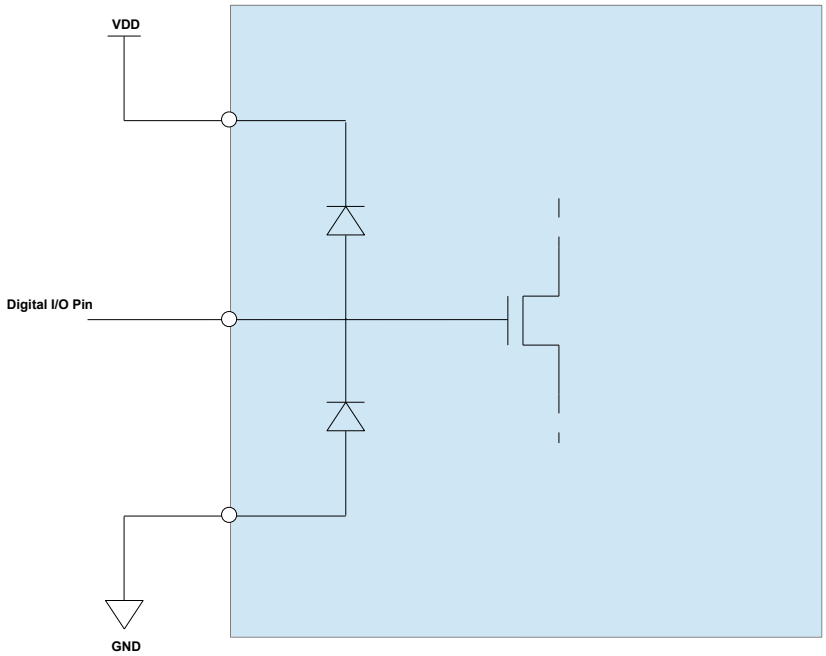

Figure 1: GPIO protection diodes

Figure 1 shows how the protection diodes are configured on a typical MCU GPIO pin. They are used to protect the microprocessor from voltages outside the operating range of the device. If the voltage at the GPIO input pin goes above VDD, the GPIO protection diode is forward biased and conducts. This scenario is a real possibility when the communications bus is still active but where the CozIR®-Blink is powered down and VDD is at 0V.

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This means that power can be directed from the GPIO port pin to VDD and can potentially power up the sensor processor. The following pages detail how to overcome this issue.

CONNECTING WITH THE UART INTERFACE

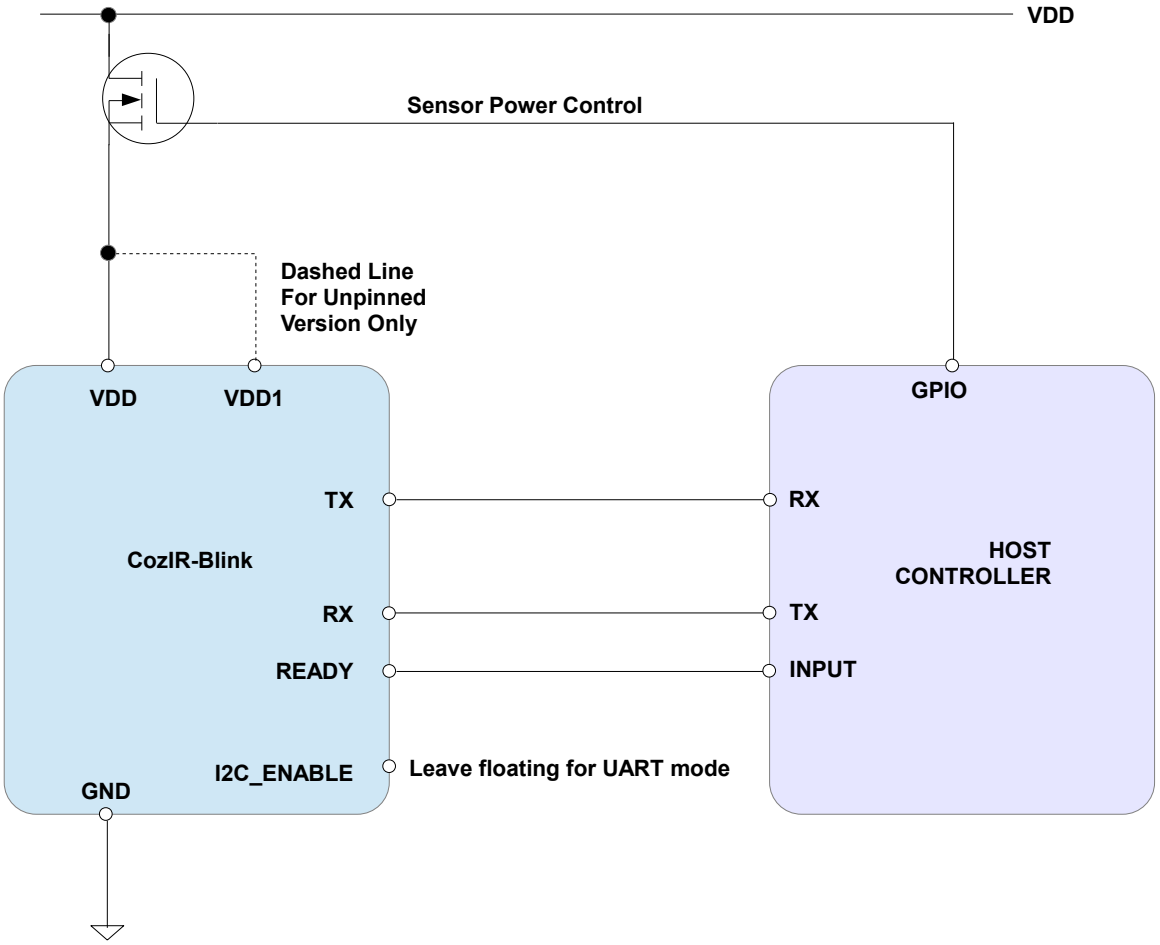

Figure 2: UART connection

Figure 2 shows the minimal connection for the CozIR®-Blink sensor in UART mode to allow the sensor to be completely turned off.

When the sensor is switched off, it is possible that power can leak from the host controller. To avoid this, it may be necessary to configure the Rx, Tx and Input pins of the host controller as high impedance or ensure they are not able to supply power. This may require the host controller to reconfigure the pin functions differently when the sensor is not in use.

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CONNECTING TO AN I²C BUS

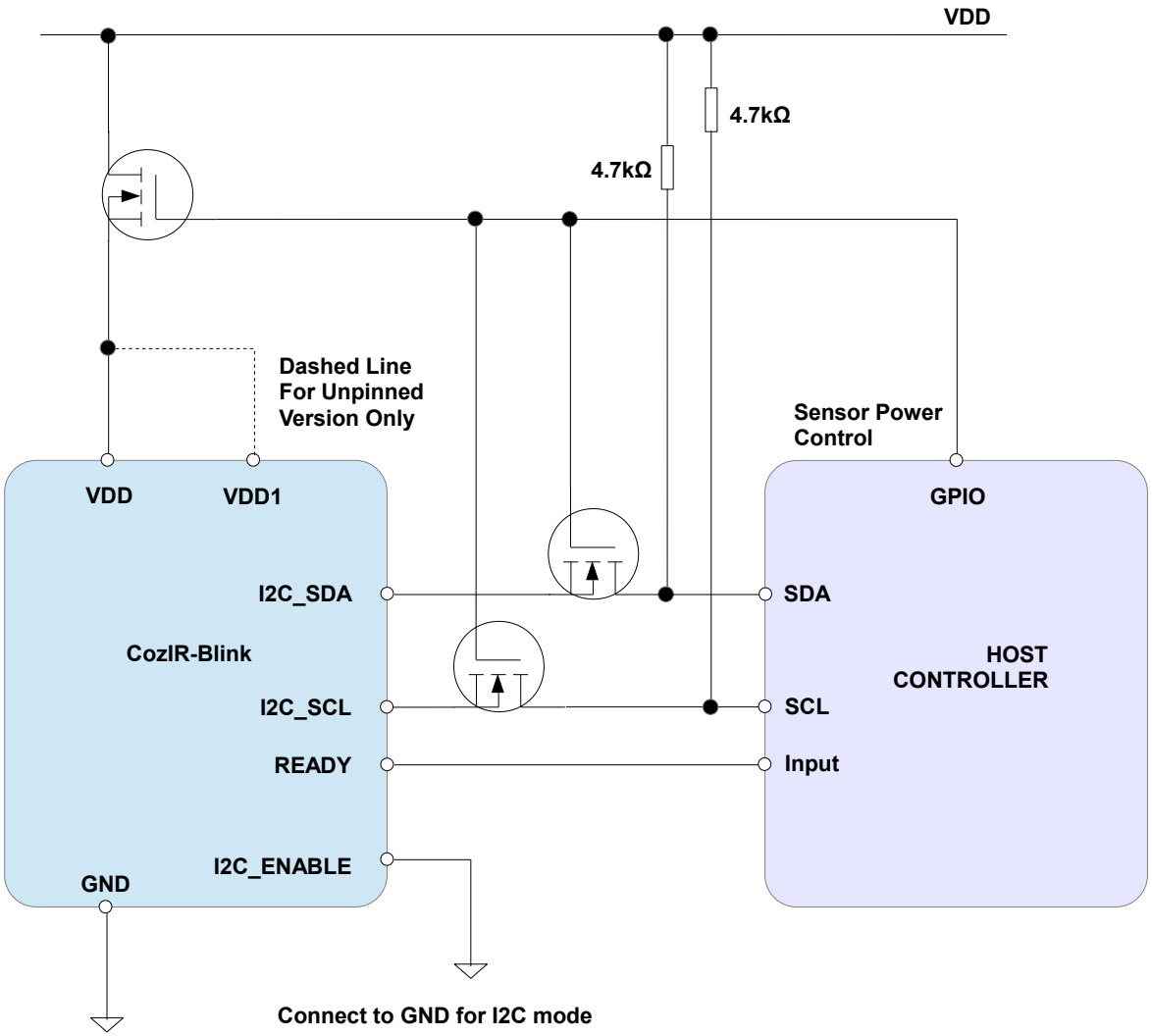

Figure 3: I²C with shared bus

When communicating with the CozIR®-Blink sensor using the I²C, there are two minimal circuit configurations depending on how the sensor is used within the overall.

Figure 3 shows what is required to isolate the CozIR®-Blink when it is powered off and there are other devices on the I²C bus. If the I²C lines are not isolated, the activity on the bus will cause the protection diodes on the sensor interface to conduct, and current will leak via the I²C pull up resistors into the sensor. This will waste power and also potentially corrupt I²C communications with other devices in

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the system. While the sensor is powered off and the I²C bus is isolated, the I²C host controller can continue communicating with other devices and sensors in the system.

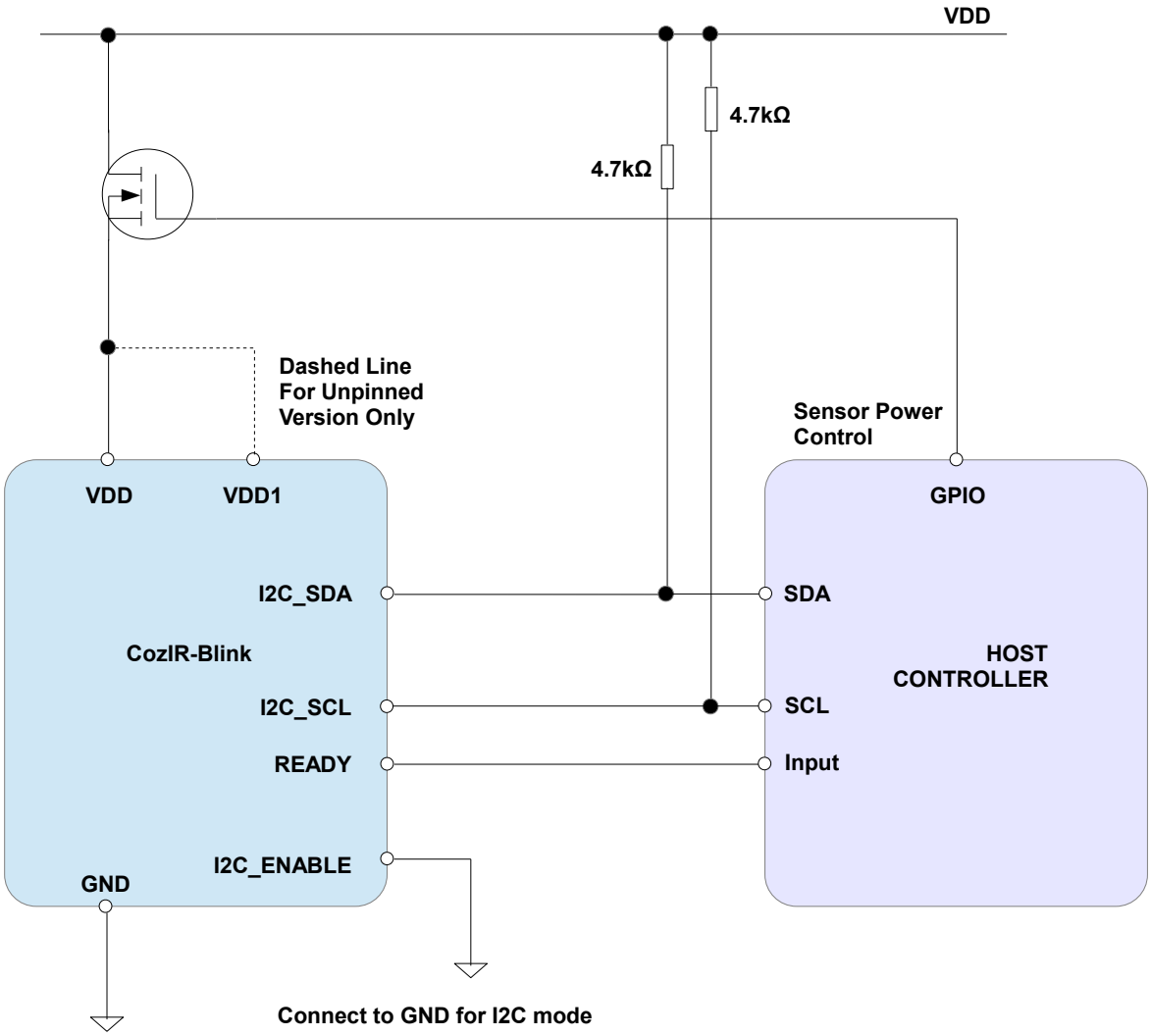

Figure 4 I²C with dedicated bus

Figure 4 is a potential option to reduce component count, but the CozIR®-Blink sensor must be the only device on the I²C bus. In this configuration, the I²C pullup resistors are only enabled when the sensor is powered up. Depending on the I²C function of the host controller system, it may also need to be disabled when the sensor is powered off. If the data and clock lines are low, this may result in continual I²C service interrupt requests.

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CHOICE OF SWITCH

It is important to choose the correct type of switching MOSFET designed for high efficiency power management applications. Suitable devices have a low R_{DS} ON resistance and low OFF leakage current.

POWER-OFF TIMING

The CozIR®-Blink is designed to be configured once, and then left to operate autonomously. The CozIR®-Blink was designed to be powered off as soon as the measurement is read from the sensor. However, if the configuration settings are modified or if other functions are enabled after a reading is taken, sufficient time must be allowed for the data changes to be written into flash memory on the sensor before powering it down. The period between changing a setting on the sensor and a safe shut down is specified in the data sheet.

CONCLUSION

The CozIR®-Blink is designed for applications where ultra-low power consumption is paramount. To minimise power consumption, the CozIR®-Blink is designed to be turned off when not taking CO_2 measurements.

When designing a circuit to switch the sensor power on and off, it is important to consider if there are any residual current leakage paths that may consume power, particularly when the sensor is being used on a shared bus system. Even though this residual current leakage may be small in absolute terms, it can seriously impact the overall system power budget of the CozIR®-Blink measuring system unless appropriate steps are taken to properly isolate the sensor.

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REVISION HISTORY

DATE	RELEASE	DESCRIPTION OF CHANGES	PAGES
27/08/2021	1.0	First revision	All