Product Reference Manual (V1.0)

Description

The BME688 Environmental 4-in-1 Sensor is a highly advanced and innovative compact module that seamlessly integrates temperature, humidity, barometric pressure, and gas sensing capabilities, encompassing a wide range of gases including volatile organic compounds (VOCs) and indoor air quality (IAQ) measurements, all within a single, convenient package.

Based on cutting-edge Bosch Sensortec technology, this device provides convenient digital I²C/SPI interfaces, allowing seamless integration with popular development platforms such as Arduino, ESP32, and Raspberry Pi, among others.

DevLab format compatibility.

Simplicity and compatibility are the primary objectives of the DevLab form factor. It offers a board layout that is compact and optimized for serial communication, which includes I²C and SPI interfaces.

This format enables the establishment of rapid and dependable connections via a Protocol I²C connector that is entirely compliant with the Qwiic and STEMMA standards.

This design guarantees efficient prototyping, accessibility, and simplicity of integration across a variety of devices and modules.
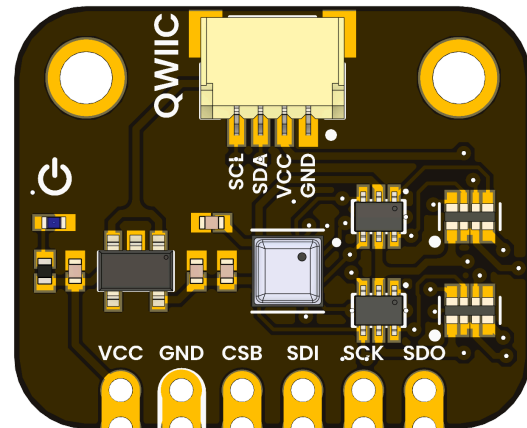
Key Features

- **Relative Humidity:** Accurately measures ambient moisture for precise environmental monitoring.
- **Barometric Pressure:** Detects atmospheric pressure changes to support dynamic weather tracking.
- **Excellent Temperature Stability:** Delivers consistent temperature readings even under varying conditions.
- **Gas Sensing:** Monitors a range of gases to help identify potential environmental hazards.
- **Power Consumption:** Optimized for low power usage, making it ideal for battery-ope**rated devices.**
- **Interfaces:** I²C and SPI

Hardware Features

- **Integrated Circuit:** Bosch **BME688** (Environmental & Gas Sensor)
- **Voltage Regulator:** 3.3 V onboard linear regulator
- **Level Shifters:** Bi-directional level translation compatible with **3.3 V and 5 V** logic systems
- **Pull-up Resistors:** Connected to **VCC** through level shifter for stable I²C communication
- **Header:** Standard **2.54 mm pitch** pin header for easy prototyping
- **I²C Distribution: JST-SH 1.00 mm** connector, **Qwiic/STEMMA QT** compatible for plug-and-play connectivity
- **SPI Distribution:** Standard pin header interface for **SPI** communication (MISO, MOSI, SCK, CS)

Software Support:

- **Arduino IDE:** The official [bme68x_library](#) provides high-level APIs for temperature, humidity, pressure, and gas measurements.
- **MicroPython / CircuitPython:** Bosch and community-developed drivers enable lightweight scripting and rapid prototyping.
- **PlatformIO / VS Code:** Professional development environment with multi-board build and deployment automation.
- **ESP-IDF (optional):** For advanced users requiring register-level access and AI data fusion.

Applications

- **Environmental Monitoring:** Real-time air quality, humidity, and pressure analysis in smart homes or industrial systems.
- **IoT Systems:** Integration in IoT nodes for continuous environmental data collection.
- **Weather Stations:** Accurate atmospheric tracking for DIY and research applications.
- **Smart Agriculture:** Air and soil condition analysis to improve crop growth and yield.
- **Wearable Devices:** Health and lifestyle monitoring based on environmental parameters.

CONTENTS

1 The Board

1.1 Accessories

- 1×6-pin 2.54 mm male header

2 Ratings

2.1 Recommended Operating Conditions

Symbol	Description	Min	Typ	Max	Unit
VCC	Input supply voltage (external input via VCC pin)	3.6	5.0	6.0	V
VIL	Low-level input voltage (I²C/SPI interface)	–0.3	–	0.99	V
VIH	High-level input voltage (I²C/SPI interface)	2.31	–	3.6	V
VOL	Low-level output voltage (at IOL = 3 mA)	–	–	0.4	V
VOH	High-level output voltage (at IOH = –3 mA)	2.4	–	3.3	V
ICC	Typical operating current (BME688 active mode)	–	12	18	mA
ISLEEP	Standby / sleep mode current	–	0.15	0.5	µA
RPU	I²C pull-up resistor to 3.3 V	4.7	–	10	kΩ
TOP	Operating temperature range	–40	–	+85	°C

3 Functional Overview

The DevLab BME688 Environmental Sensor Module is a compact device that incorporates a variety of sensing elements, including temperature, humidity, pressure, and gas detection. A shared digital interface (I²C/SPI) enables synchronized data acquisition, while each sensing function operates through independent internal circuits.

The BME688 core and logic-level converters are guaranteed constant power delivery by the integrated 3.3 V regulator, which facilitates compatibility with host systems that operate at 3.3 V and 5 V.

The host microcontroller can conduct real-time environmental monitoring or AI-based air-quality evaluation by accessing data from the sensor using standard digital commands.

Inside, the BME688 is equipped with MEMS sensors for pressure, temperature, and humidity, as well as a gas-sensing thermal element. The initial signal processing and temperature compensation are performed by the built-in microcontroller prior to the digital transmission of those results.

This architecture guarantees low power consumption, high measurement precision, and straightforward integration with embedded platforms like Raspberry Pi, Arduino, or ESP32.

3.2 Board Topology

Top   **Bottom**
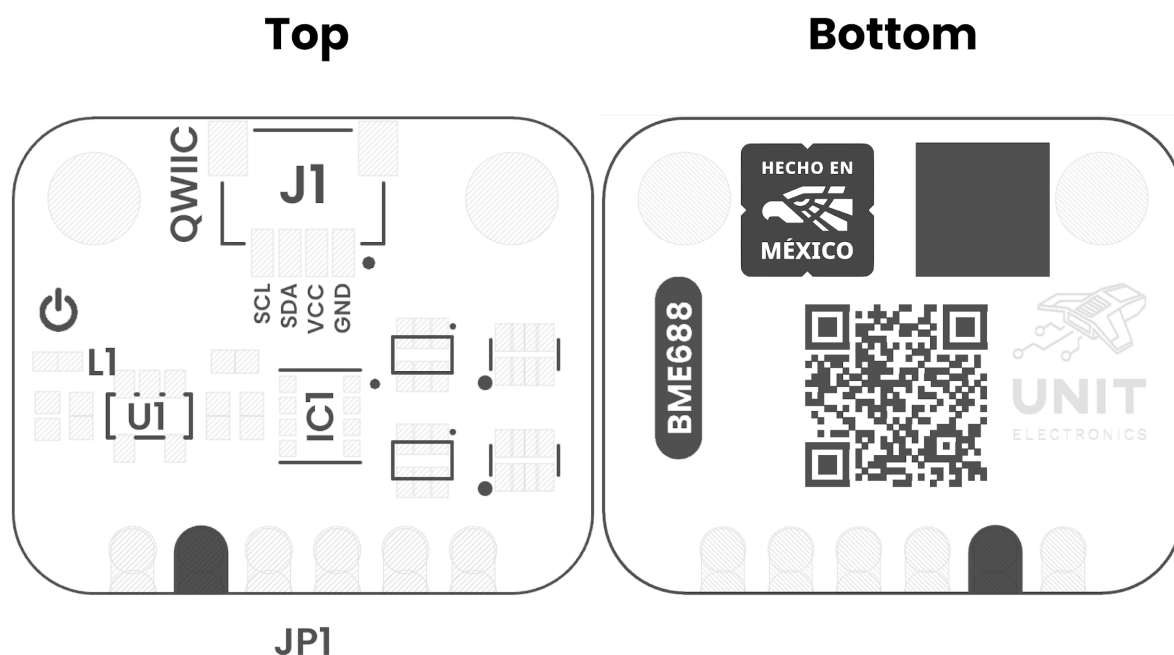
Views of Board Topology

Views of I2C BME688 Environmental 4-in-1 Sensor Topology

Table 3.2.1 - Components Overview

Ref.	Description
IC1	BME688 Environmental Sensor
L1	Power On LED
U1	AP2112K 3V3 Regulator
JP1	2.54 mm Castellated Holes
J1	QWIIC Connector (JST 1 mm pitch) for I2C

3.3 Bosch Sensortec BME688

The Bosch Sensortec BME688 digital environmental sensor combines gas, pressure, humidity, and temperature monitoring in a small 3.0 × 3.0 × 0.9 mm³ package. It is the first gas sensor that use AI to customize gas detection and analysis. Based on the BME680 platform, the BME688 gas scanner detects VOCs, VSCs, EtOH, CO, and H_2S at part-per-billion (ppb) levels. AI-based gas analysis allows the sensor to be taught for specific applications using BME AI-Studio software, enabling its adaptable performance in varied situations.

3.8 AP2112K Power Management System

The **AP2112K** low-dropout (LDO) regulator IC provide a **stable and efficient power delivery system** for the DevLab BME688 Environmental Sensor Module. The board accepts input voltages of **up to 6V via Vcc**, and delivers a **regulated 3.3V output** with a nominal current of **350 mA** and peak support up to **600 mA**, protected by internal thermal shutdown.

3.9 Power Tree

The power distribution architecture of the **DevLab BME688 Environmental Sensor Module** is designed for efficiency and stability. An external supply voltage (**V_INPUT**, 3.6 – 6.0 V) feeds the onboard **AP2112K-3.3 V regulator**, which provides a clean and regulated **3.3 V rail** for all internal circuit.

This regulated voltage powers three main sections of the board:

- The **BME688 sensor core**, ensuring precise and stable environmental measurements.
- The **Level Shifters**, which handle logic-level translation for compatibility with both 3.3 V and 5 V host systems.
- The **Power LED indicator**, which confirms correct operation and power presence.

A common **ground plane** (GND) connects all sections to ensure signal integrity and minimize noise across the sensor and interface lines.
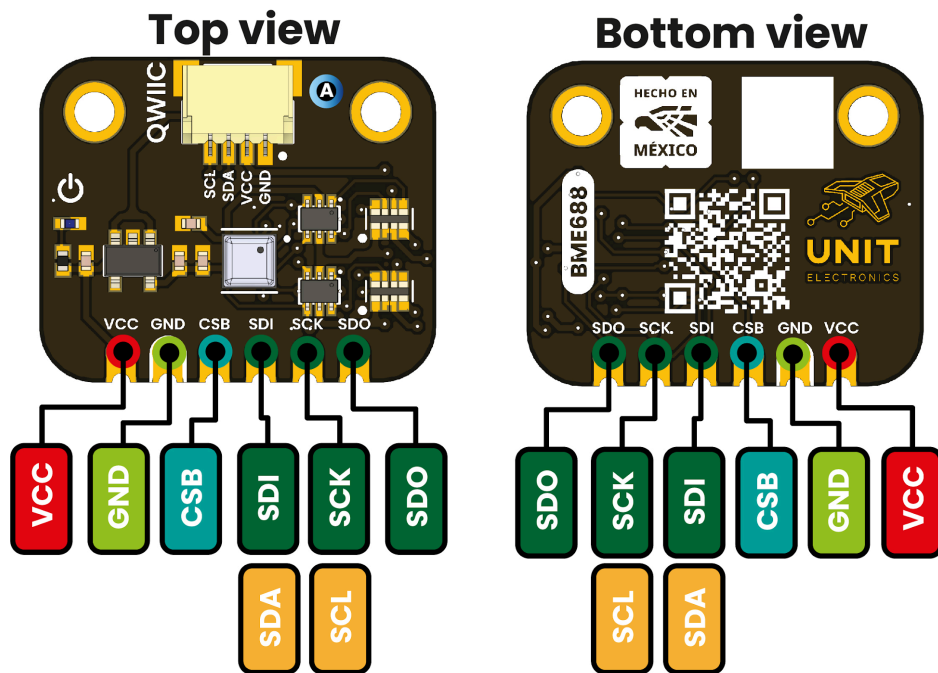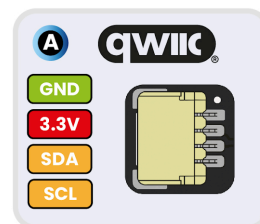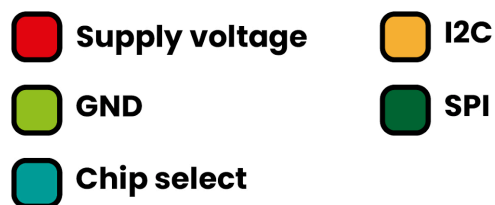
Power Tree
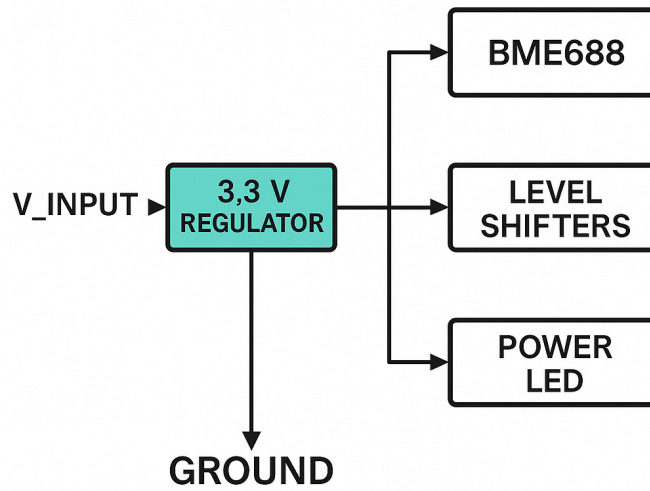
Power Tree

4 Connectors & Pinouts

4.1 General Pinout

PINOUT
UNIT BME688

Top view

Bottom view

Description:

	Supply voltage		I2C
	GND		SPI
	Chip select		

DevLab BME688 Environmental Sensor Module *General Pinout*

4.2 Pinout General Description

Pin Label	Function	Description
VCC	Power supply (3.3V or 5V)	Power supply for the sensor module. Max 6V.
GND	Ground	Ground reference for the module. Must be connected to the ground of the host system.
SDA/SDI	I²C data / SPI data in	**I²C:** Serial Data line for bidirectional communication. **SPI:** SDI (Serial Data In), used to send data from the microcontroller to the sensor.
SCL/SCK	I²C clock / SPI clock	**I²C:** Serial Clock line generated by the microcontroller. **SPI:** SCK (Serial Clock), clock line for SPI communication.
CSB	Chip select (SPI, active low)	Chip Select used for SPI communication (active low). For I²C operation, on this module, **the CSB pin is pulled HIGH by default through an onboard pull-up resistor**, so as long as it is not driven low, **the sensor remains configured for I²C communication**.
SDO	SPI data out	**SPI:** Serial Data Out from the sensor to the microcontroller. **I²C:** Sets the least significant bit of the I²C address (LOW = 0x76, HIGH = 0x77).

5 Board Operation

To begin using the BME688 environmental sensor with the Arduino IDE, you must first install the official **Bosch Sensortec BME68x library**, available through the Arduino Library Manager or the Bosch GitHub repository. This library provides a complete API that simplifies sensor initialization, configuration of operating modes, and retrieval of environmental data such as temperature, humidity, pressure, and gas resistance.
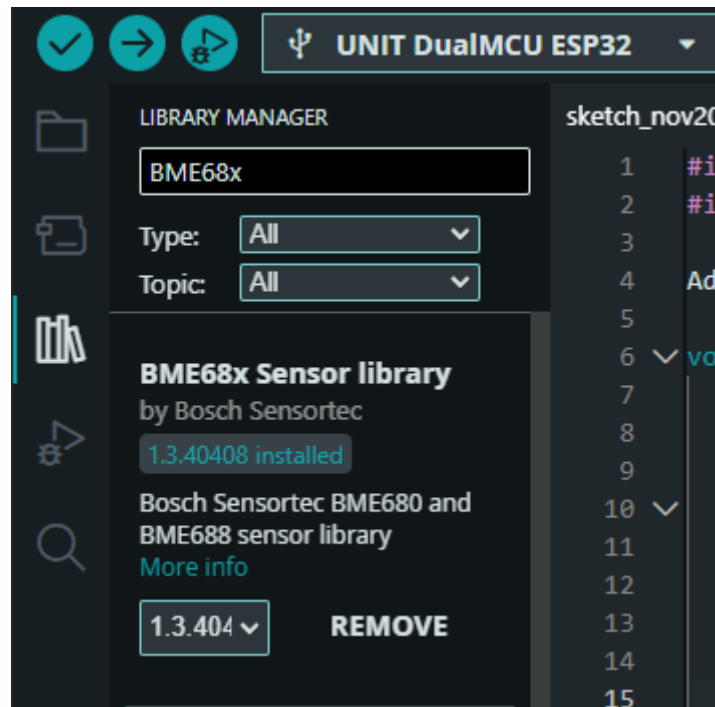
Once the library is installed, you can include it in your project and start communicating with the sensor through the I²C interface. The following example demonstrates the basic workflow: initializing the device, applying a standard configuration profile, performing a measurement, and printing the resulting data to the serial monitor. This minimal setup allows you to verify correct wiring, confirm sensor functionality, and ensure reliable communication with your development board.

```
#include <Arduino.h>
#include "bme68xLibrary.h"
#include <Wire.h>

#define SDA_PIN 21
#define SCL_PIN 22

Bme68x bme;

void setup() {
  Serial.begin(115200);
```

```
  while (!Serial) delay(10);

  Wire.begin(SDA_PIN, SCL_PIN);
  Wire.setClock(100000);  // 100 kHz

  bme.begin(0x77, Wire);

  // Verifica estado del sensor
  if (bme.checkStatus() == BME68X_ERROR) {
    Serial.println("Error: BME688 no detectado.");
    while (1);
  }

  Serial.println("Sensor BME688 inicializado correctamente.");

  bme.setTPH();  // Temp, Pressure, Humidity
  bme.setHeaterProf(300, 100);  // Heater: 300°C, 100 ms

  Serial.println("Time(ms), Temp(°C), Pressure(Pa), Humidity(%), Gas(Ω), Status");
}

void loop() {
  bme68xData data;

  bme.setOpMode(BME68X_FORCED_MODE);
  delayMicroseconds(bme.getMeasDur());

  if (bme.fetchData()) {
    bme.getData(data);

    Serial.print(millis()); Serial.print(", ");
    Serial.print(data.temperature); Serial.print(", ");
    Serial.print(data.pressure); Serial.print(", ");
    Serial.print(data.humidity); Serial.print(", ");
    Serial.print(data.gas_resistance); Serial.print(", ");
    Serial.println(data.status, HEX);
  }

  delay(100);
}
```

```
19:25:25.865 -> 108058, 29.84, 78234.41, 23.01, 368477.88, B0
19:25:26.036 -> 108205, 29.85, 78232.94, 23.01, 367288.38, B0
19:25:26.174 -> 108352, 29.84, 78234.05, 23.01, 367288.38, B0
19:25:26.314 -> 108499, 29.84, 78234.64, 23.02, 376055.81, B0
19:25:26.453 -> 108646, 29.84, 78234.64, 23.02, 367684.03, B0
19:25:26.581 -> 108793, 29.85, 78234.48, 23.01, 366893.59, B0
19:25:26.762 -> 108940, 29.84, 78233.57, 23.01, 375435.38, B0
19:25:26.874 -> 109087, 29.84, 78235.16, 23.01, 367684.03, B0
```

6 Mechanical Information
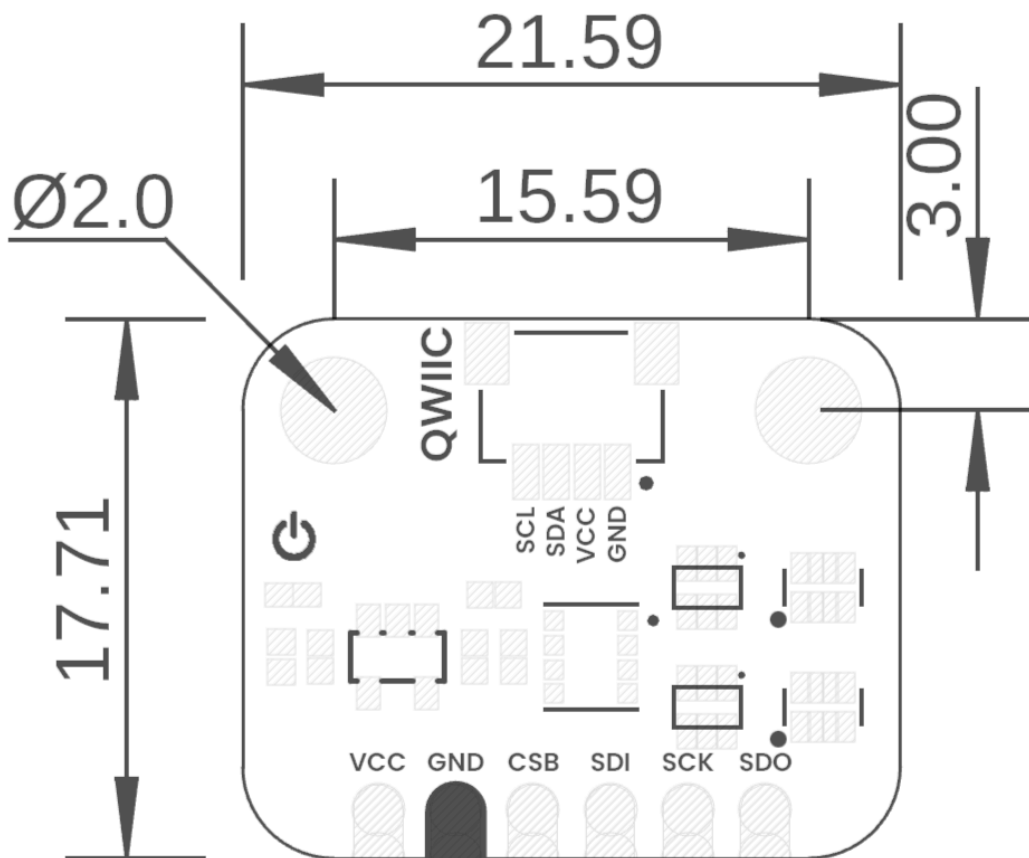
Mechanical dimensions in millimeters (mm)

Mechanical dimensions in millimeters

7 Company Information

Company name	UNIT Electronics
Company website	https://uelectronics.com/
Company Address	Salvador 19, Cuauhtémoc, 06000 Mexico City, CDMX

8 Reference Documentation

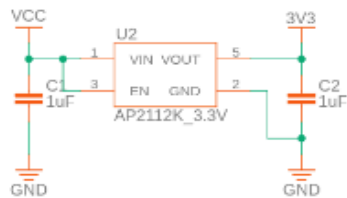| Ref	Link
Documentation	https://github.com/UNIT-Electronics-MX/unit_devlab_i2c_bme688_environmental_4_in_1_sensor
Bosch-BME68x-Library	https://github.com/boschsensortec/Bosch-BME68x-Library
Wiki	https://wiki.uelectronics.com/wiki/devlab-i2c-bme688-environmental-4-in-1
Thonny IDE	https://thonny.org/
Arduino IDE	https://www.arduino.cc/en/software
Visual Studio Code	https://code.visualstudio.com/download
BME688	https://www.bosch-sensortec.com/media/boschsensortec/downloads/datasheets/bst-bme688-ds000.pdf

9 Appendix

9.1 Schematic

(*https://github.com/UNIT-Electronics-MX/unit_devlab_i2c_bme688_environmental_4_in_1_sensor/blob/main/hardware/unit_sch_v_1_0_0_bme688_environmental_sensor_4_in_1.pdf*)
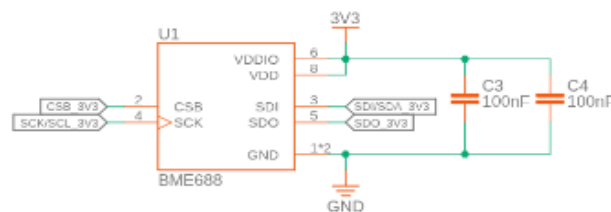
UNIT ELECTRONICS

Voltage Regulator

VCC — U2 — 3V3
VIN VOUT
EN GND
AP2112K_3.3V
C1 1uF
C2 1uF
GND

BME688

U1
VDDIO VDD — 3V3
CSB SDI
SCK SDO
GND
BME688
C3 100nF
C4 100nF
CSB_3V3
SCK/SCL_3V3
SDI/SDA_3V3
SDO_3V3
GND

JST

GND VCC — J2
SDI/SDA
SCK/SCL
SHIELD
GND

Power On LED

VCC — R1 51K — D1 Green — GND

Level Shifters

Q1 — BSS138AKDW
3V3 ... 3V3
CSB, SDI/SDA, CSB_3V3, SDI/SDA_3V3

Q2 — BSS138AKDW
3V3 ... 3V3
SCK/SCL, SDO, SCK/SCL_3V3, SDO_3V3

VCC 3V3 — RN1 10K
SDI/SDA_3V3, CSB, SDI/SDA, CSB_3V3

VCC 3V3 — RN2 10K
SDO_3V3, SCK/SCL, SDO, SCK/SCL_3V3

Header

GND VCC — J1
CSB
SDI/SDA
SCK/SCL
SDO

Mounting Holes

H1 H2