CCE4502 Evaluation Board

1. ABSTRACT

The CCE4502 evaluation board is designed to evaluate and demonstrate the CCE4502 IO-Link Device IC with integrated frame handler.

Contents

2. INTRODUCTION

The board is divided into three sections:

- **IO-Link Section**
  The IO-Link section contains all necessary periphery to use one CCE4502 in different modes (DC/DC buck converter mode or linear regulator mode) for IO-Link communication as well as several connectors.
- **Sensor Section**
  The sensor section contains three different sensors to provide a variety of signals and measurement capabilities (temperature sensor, color sensor and proximity switch).
- **MCU Section**
  The MCU section contains an LPC1347 32-bit ARM Cortex-M3 microcontroller from NXP to control the CCE4502 Device IC as well as the provided sensors.

For maximum flexibility, the sections can be used separately and independently from each other. This allows to evaluate the CCE4502 Device IC with any suitable sensor application and MCU or both.

The CCE4502 Evaluation Board is delivered with a CCE4502 in 3.3 V buck mode.
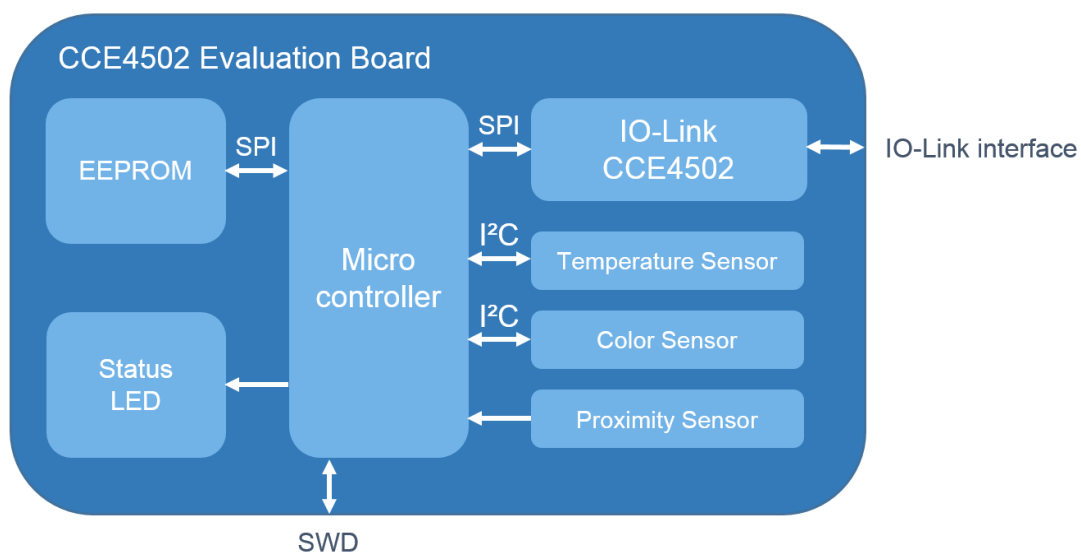

Figure 1: System Diagram

3. SYSTEM REQUIREMENTS

The CCE4502 Evaluation Board is ready to use with a preinstalled IO-Link Device Stack from IQ² Development (https://www.iq2-development.com) and TMG (https://www.tmgte.de/en/)

To get started, the following tools are required:

- Power Supply 24V (IO-Link Master)
- Debug probe (for programming via SWD)

4. FEATURE OVERVIEW

- ARM Cortex-M3 Microcontroller
- Programmable via SWD
- Reset Button
- Status LED indicator
- 8 Kbit EEPROM
- Additional on-board protection circuitry
- All pins accessible via pin-headers
  For microcontroller and IO-Link Device IC

- CCE4502 IO-Link Device IC
- M12 connector + terminal blocks
- Three on-board sensors
    - Temperature sensor
    - Color Sensor
    - Proximity sensor / switch
- Independent use of sections (IO-Link, Sensor, MCU)

5. GETTING STARTED

Programming via SWD

1. Connect debug probe to SWD connector (X1)
2. Set JP7 to connect C14
3. Power on the Evaluation Board (IO-Link interface L+ = 24V, L- = GND)
4. Start programming with your preferred SDK (Software Development Kit)

6. POWER SUPPLY

The Evaluation Board is supplied via the L+ voltage of the IO-Link interface which has to be 24 V. The IO-Link interface comprises L+, L-, CQ1 and DIO, and it can be accessed via an M12 connector or terminal clamps. The CCE4502 device is directly connected to the IO-Link interface and comprises three voltage regulators. Four SMAJ33A TVS diodes are used to provide additional protection against high voltage bursts.

In buck converter mode, a regulated voltage of 7 V is generated at port VHH. It is capable of supplying up to 50 mA for external devices. For using the buck converter mode, Pins 2 and 3 of jumper JP7 must be shorted.

At port VDD, a regulated voltage of 3.3 V is generated by a LDO regulator. This regulator supplies the digital I/O pads of the CCE4502, the MCU, the sensors, and the actuators. VDD can supply additional external components, but the overall combined external load of VHH and VDD must not exceed 50 mA. The current consumption of the MCU, the actuators and the sensors must be below this limit.

Port VDD5 is the output of an LDO regulator with a regulated voltage of 5 V. External components can be supplied by this port with a maximum load of 10 mA.

7. CCE4502

Interfaces

The SPI interface (SSX1, SCLK, MOSI, MISO and INTX) of the CCE4502 device grants access to all registers of the CCE4502. Therefore all features of both IO-Link channels CQ1 and DIO can be enabled. The interface allows access to internal supervisor circuitry, such as the overtemperature detection, overvoltage detection and the output overcurrent protection. Furthermore on-chip logic, for example framehandler and wakeup detection, can be used to ease the IO-Link communication. This reduces the computation overhead for the microcontroller.

Besides SPI, it is possible to control the outputs of CQ1 and DIO, and the input of CQ1 directly through the SIO ports of the CCE4502 device, that is, RXD1, TXD1, TXD2 and TXEN1. The device is factory programmed to use these ports on both channels, thus it is possible to omit the SPI. Note that when SPI is omitted, all IO-Link protocol handling has to be performed by the connected MCU. However, this allows using the CCE4502 as a simple level shifter from 3.3 V / 5 V logic signals to IO-Link compliant levels.

CLK_EXT Configuration

The CLK_EXT port is used as clock output port if port K1 is low and as clock input port if port K1 is high. In clock output mode, the clock of the calibrated internal oscillator is switched to CLK_EXT or CLK_EXT is floating, depending on the CLK_OUT register of the CCE4502. By default, CLK_OUT register is configured to disable the clock output. In clock input mode, the logic core is clocked by the signal applied externally to CLK_EXT.

8. SECTIONS OF THE CCE4502 EVALUATION BOARD

All sections can be used separately. The connection between the sections can be disconnected by cutting them open between the cutting marks (see Figure 2). Make sure not to break the evaluation board. To reestablish the connection, a pin header with 2.54 mm pitch can be used.
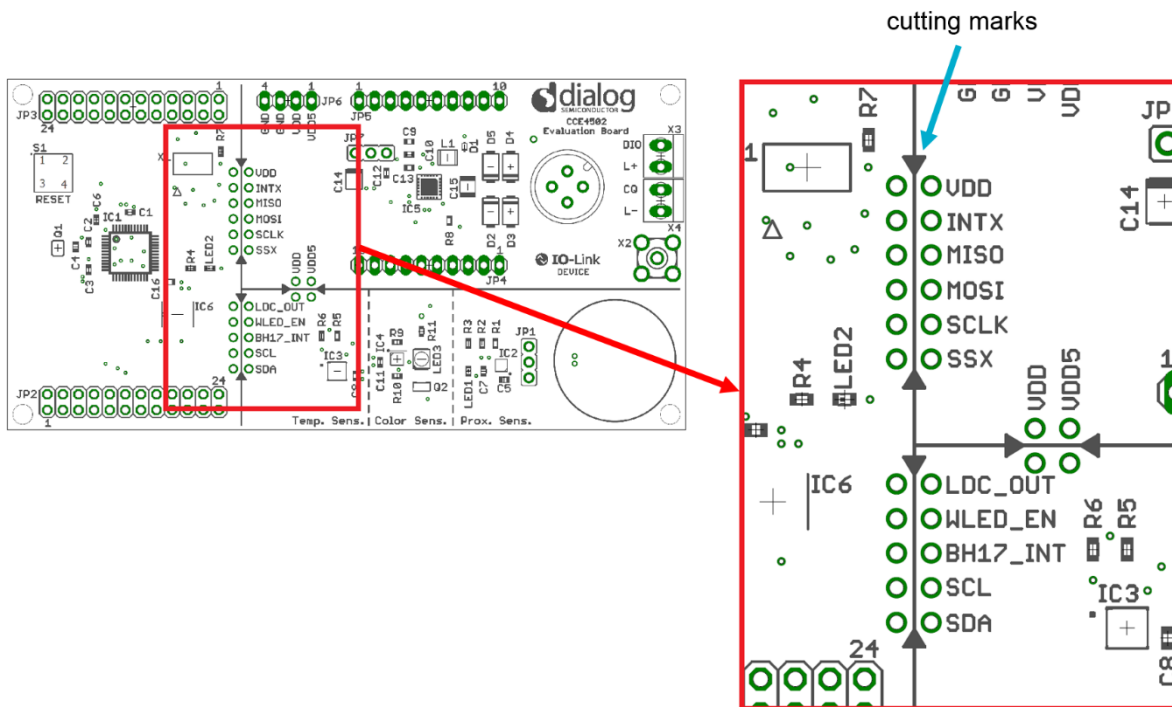

Figure 2: Cutting Marks

IO-Link Section

The IO-Link section contains the reference design for using the CCE4502. A variety of connectors including an M12 a-coded 4-pin connector are placed on the IO-Link section. JP7 is set according to the supply mode (Buck mode) and should not be changed.

SENSOR SECTION

The sensor section contains three sensors:

Temperature Sensor

Features of the temperature sensor:

- SI7055-A20-IM (Silicon Labs)
- I²C interface
- -40 °C to +125 °C (±0.5 °C)

Color Sensor

Features of the color sensor:

- BH1745NUC-E2 (ROHM)
- I²C interface
- 16 bit serial output RGBC

For successful measurements, activate LED3 (white LED) to illuminate the object to be measured. In order to get a better result, keep the object close to the sensor and reduce incident ambient light.

Proximity Sensor and Inductive Switch

Features of the proximity sensor and inductive switch:

- LDC0851HDSGR (Texas Instruments)
- Simple switching output

For successful measurements, the object held over the printed coils should be about the same size as the printed coils (for example a coin). The switching distance is about 5 mm. LED1 (red LED) signals a detected object.

MCU Section

All usable pins of the LPC1347 can be accessed via the connectors JP2 and JP3.

In case the on-board sensors are not used, the connection between the MCU section and the sensor section can be disconnected and the pins used for the sensor section can be used for any other purpose. Note that the pull-up resistors of the I²C communication are placed on the sensor section.

Connector X1 (JTAG) is used to program the LPC1347.

LED2 (green LED) is used as status LED and can be used for any purpose.

9. SCHEMATIC AND LAYOUT

Connectors

Figure 3 shows all connectors of the CCE4502 Evaluation Board. Via the connectors it is possible to access all pins of the MCU and the CCE4502 device IC (except LEXT and VDD1V8).
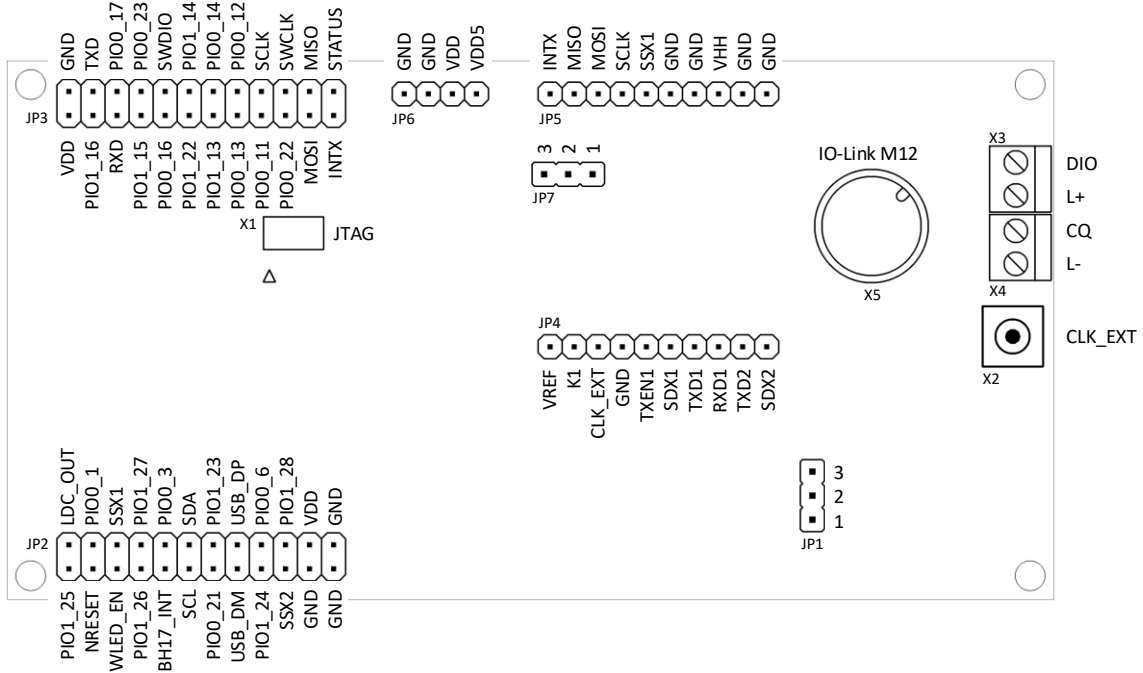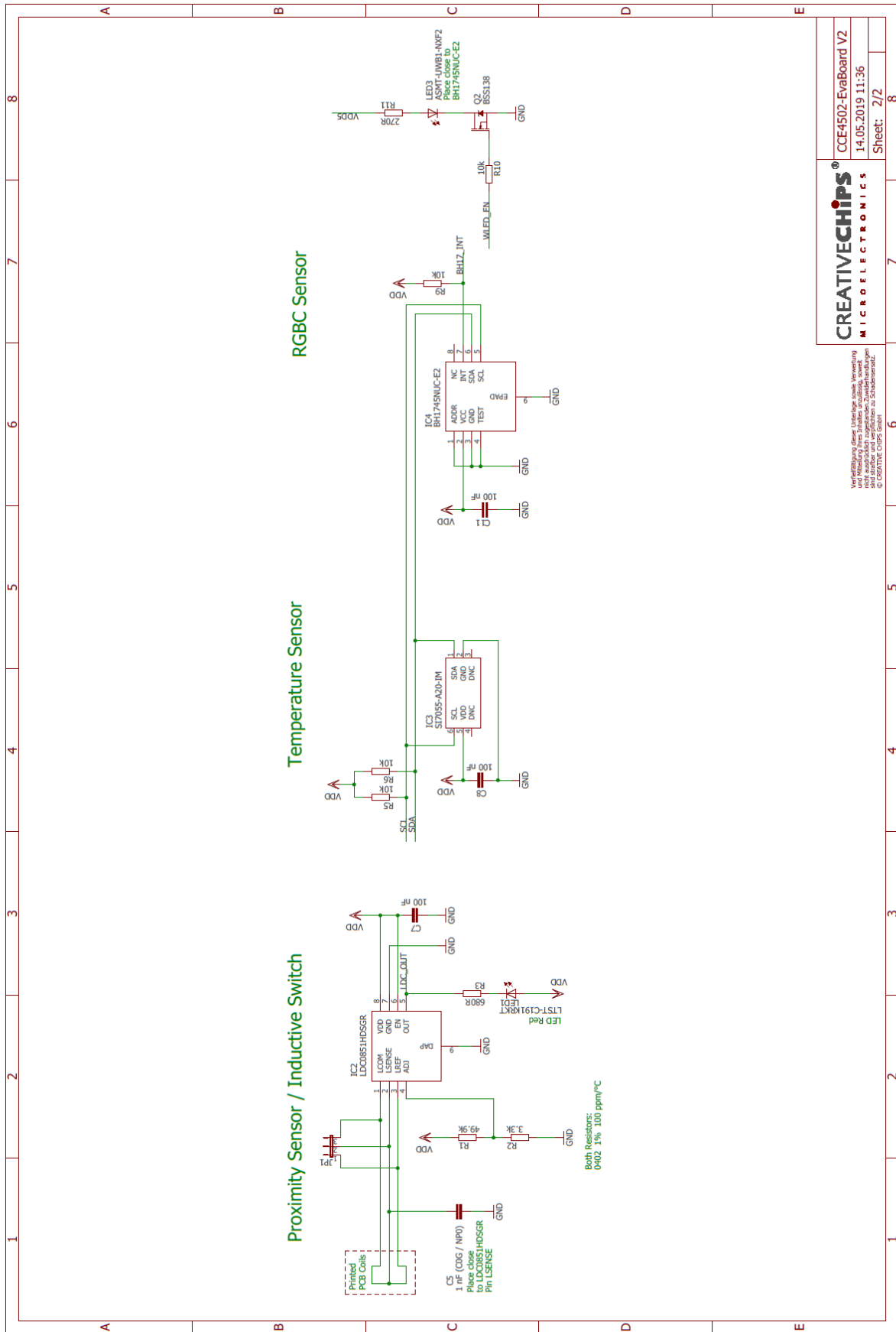

Figure 3: Connectors

Schematic

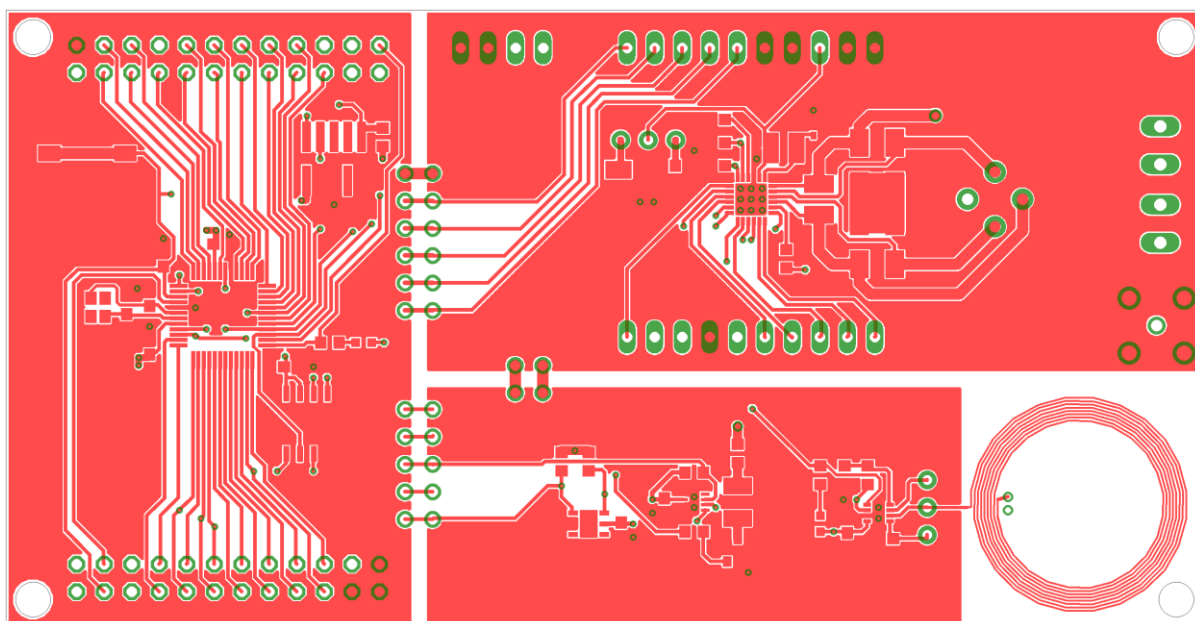**Figure 4: Schematic 1**

Figure 5: Schematic 2

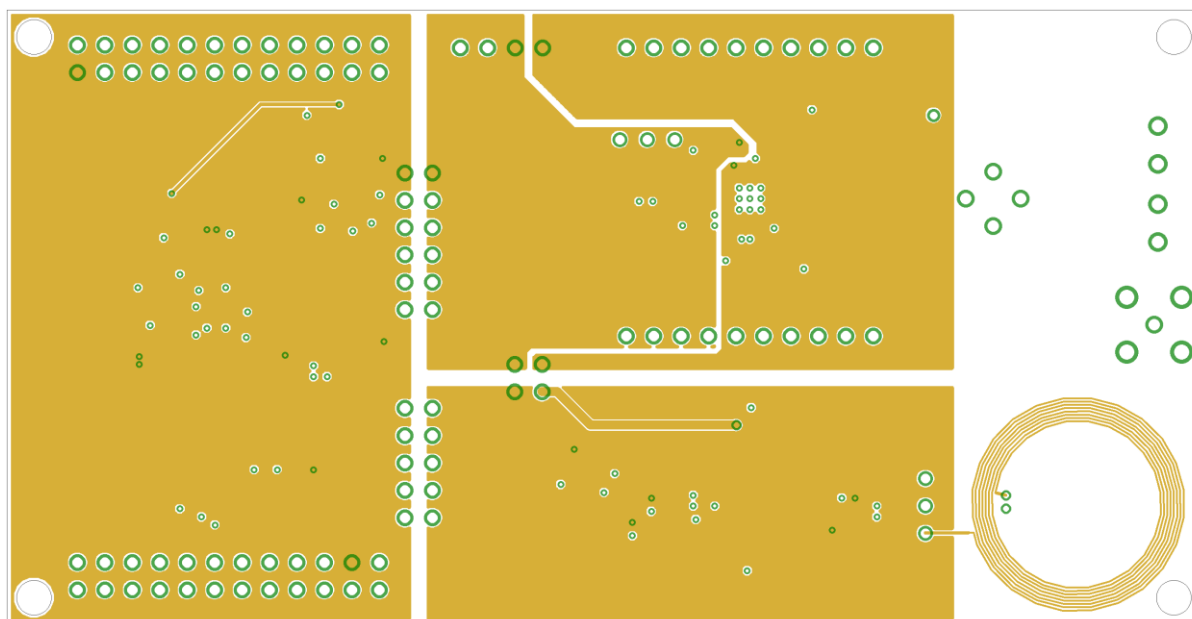# Layout

Figure 6: Layout TOP
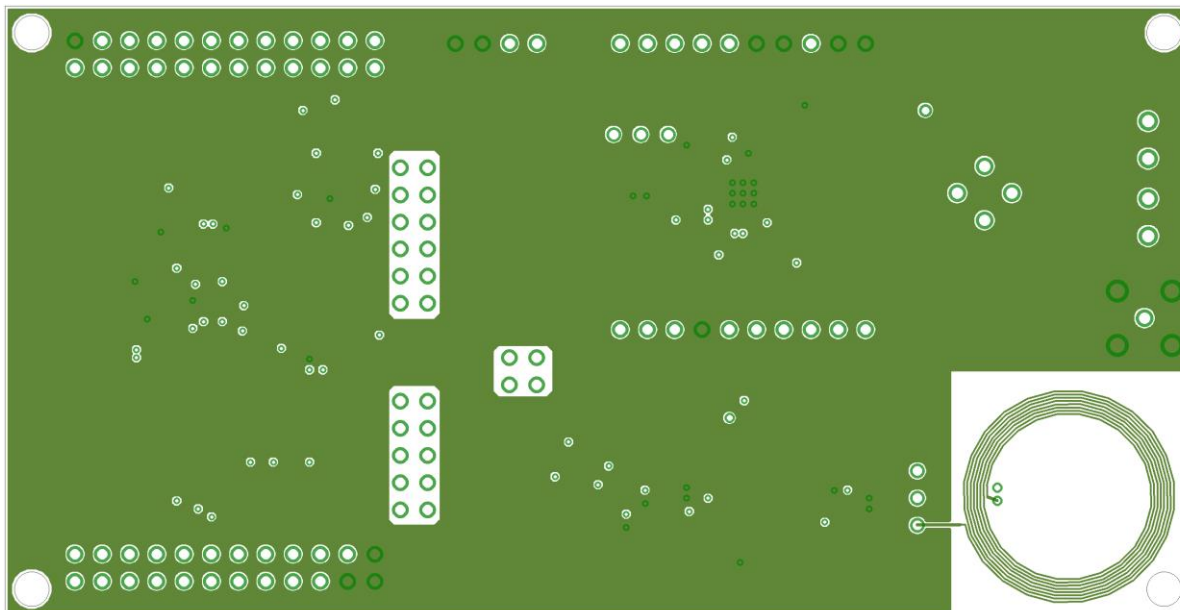

Figure 7: Layout MID 1
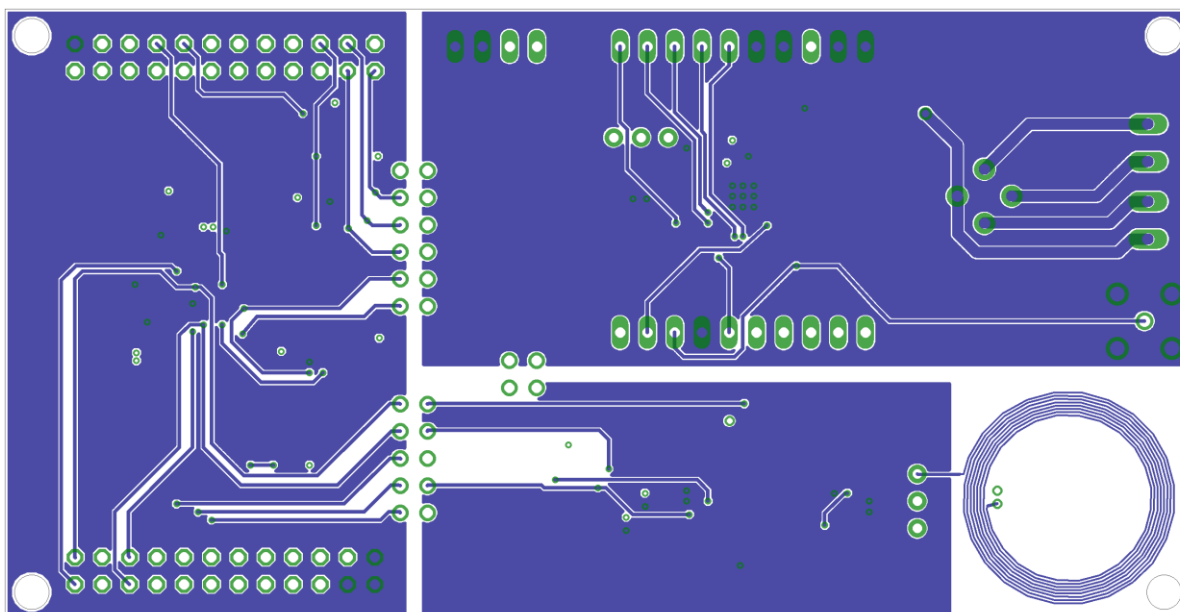
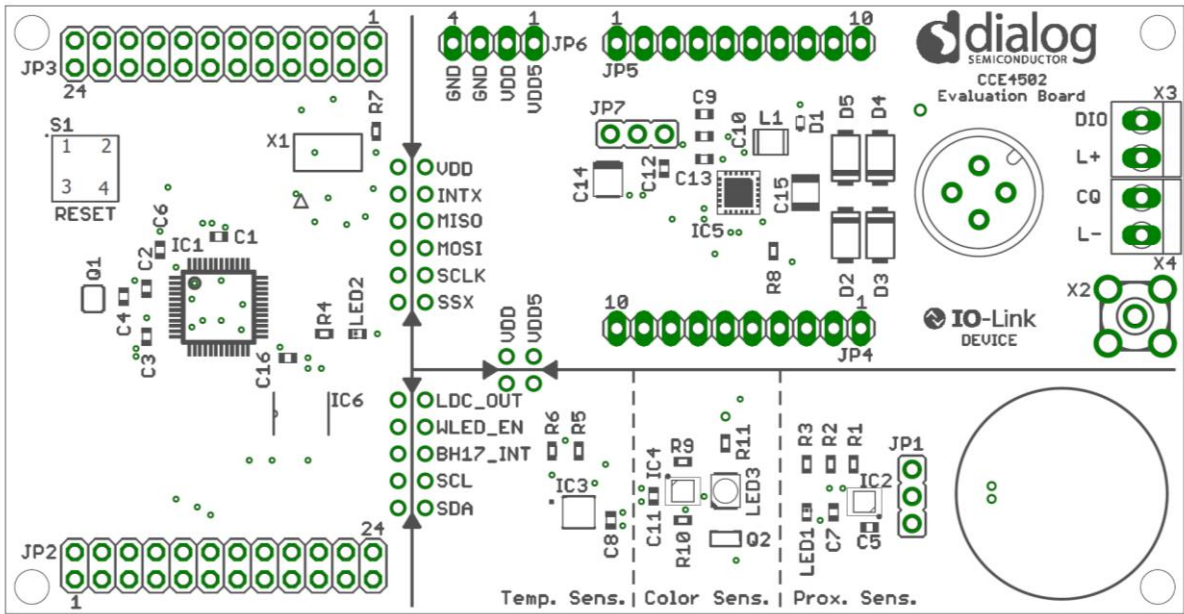**Figure 8: Layout MID 2**

Figure 9: Layout BOTTOM

Figure 10: Layout Assembly

10. BILL OF MATERIALS

Part	Value / Description	Manufacturer	Manufacturer Part Number
C1,C3,C6,C7,C8,C9,C11,C12,C13,C16	100 nF 50 V X7R 10 % 0603	Any	Any
C2,C4	18 pF 50 V C0G/NP0 5 % 0603	Any	Any
C5	1 nF 50 V C0G/NP0 5 % 0603	Any	Any
C10	470 nF 50 V X7R 10 % 0603	Any	Any
C14	22 µF 16 V 10 %	AVX	TPSB226K016R0600
C15	10 µF 50 V X7S 20 %	Taiyo Yuden	UMK325C7106MM-T
D1	BAT54KFILM	STMICROELECTRONICS	BAT54KFILM
D2,D3,D4,D5	SMAJ33A	Littelfuse Inc.	SMAJ33A
IC1	LPC1347 Microcontroller	NXP	LPC1347FBD48,151
IC2	Proximity Sensor	Texas Instruments	LDC0851HDSGR
IC3	Temperature Sensor	Silicon Labs	SI7055-A20-IM
IC4	Color Sensor	ROHM	BH1745NUC-E2
IC5	CCE4502-QFN24	Dialog Semiconductor	CCE4502QR4B3
IC6	EEPROM 8kbit	STMICROELECTRONICS	M95080-WMN6P
JP1,JP7	Pin Header 3-Pin 2.54 mm	Any	Any
JP2,JP3	Pin Header 24-Pin 2.54 mm	Any	Any
JP4,JP5	Pin Header 10-Pin 2.54 mm	Any	Any
JP6	Pin Header 4-Pin 2.54 mm	Any	Any
L1	22 µH	WURTH ELEKTRONIK	744032220
LED1	LED Red	Lite-On Inc.	LTST-C191KRKT
LED2	LED Green	Lite-On Inc.	LTST-C191KGKT
LED3	LED White	Broadcom Limited	ASMT-UWB1-NX3F2
Q1	12 MHz SMD Crystal	ABRACON	ABM8G-106-12.000MHZ-T
Q2	N-Channel MOSFET	ON SEMICONDUCTOR	BSS138
R1	49.9 k 50 V 100 mW 1 % 0603	Any	Any
R2	3.3 k 50 V 100 mW 1 % 0603	Any	Any
R3	680R 50 V 100 mW 1 % 0603	Any	Any
R4	560R 50 V 100 mW 1 % 0603	Any	Any
R5,R6,R7,R9,R10	10 k 50 V 100 mW 1 % 0603	Any	Any
R8	33R 50 V 100 mW 1 % 0603	Any	Any
R11	270R 50 V 100 mW 1 % 0603	Any	Any
S1	SMD Switch	Wurth Electronics Inc.	430481035816
X1	SMT Micro Header	SAMTEC	FTSH-105-01-F-DV-K
X2	SMB EB2-L174		
X3,X4	Wire-to-Board Connector	METZ CONNECT	31059102
X5	M12 Connector	binder	09-0431-212-04

11. REVISION HISTORY

Revision	Date	Description
1	03-Mar-2020	Initial version.
2	28-Jan-2022	Rebrand

12. REFERENCES

[1]   CCE4502, Datasheet, Dialog Semiconductor.

[2]   LPC1347FBD48,151, Datasheet, NXP.

[3]   IO-Link Interface and System Specification V1.1.2, IO-Link Community.

13. STATUS DEFINITIONS

Status	Definition
DRAFT	The content of this document is under review and subject to formal approval, which may result in modifications or additions.
APPROVED or unmarked	The content of this document has been approved for publication.

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