STEVAL-L9800 evaluation board user manual

Introduction

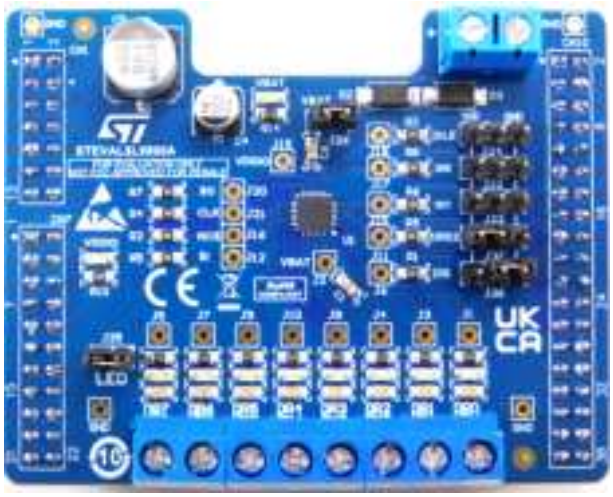
The STEVAL-L9800 is a tool designed to evaluate the L9800 smart power device, designed by STMicroelectronics in advanced BCD technology. The L9800 is an 8-channel IC with eight LS drivers designed for automotive applications (LEDs and relays) and compatible with resistive, inductive, and capacitive loads. The device offers advanced diagnostic and protection functionalities such as short to GND, open load, overcurrent, and overtemperature detection. The 8 output channels can be driven by SPI or by 2 dedicated parallel inputs that can be associated to different output thanks to a programmable internal multiplexer. Limp home functionality is also featured, which allows the use of 2 selected drivers in specific fault conditions, such as SPI fault, microcontroller fault, or supply UV. Daisy chain compatibility even with 8-bit SPI is available. The device is able to ensure operation in cranking scenarios down to VBATT = 3 V and very low quiescent current in the SLEEP condition.

A serial peripheral interface (SPI) is used for control and configuration of the loads and the device. Status feedback of all diagnostic functions is also provided.

There are two input pins available for direct control and PWM: these are connected to two defined outputs by default, but additional or different output mapping can be controlled by SPI. Thanks to the expansion connectors, the STEVAL-L9800 allows the complete control of L9800 communication interface (SPI) and parallel input/output.

The evaluation platform may also be controlled through a graphical user interface (GUI) on the AEK-MCU-C1MLIT1 hardware interface.

Figure 1. STEVAL-L9800 board



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1 Hardware description

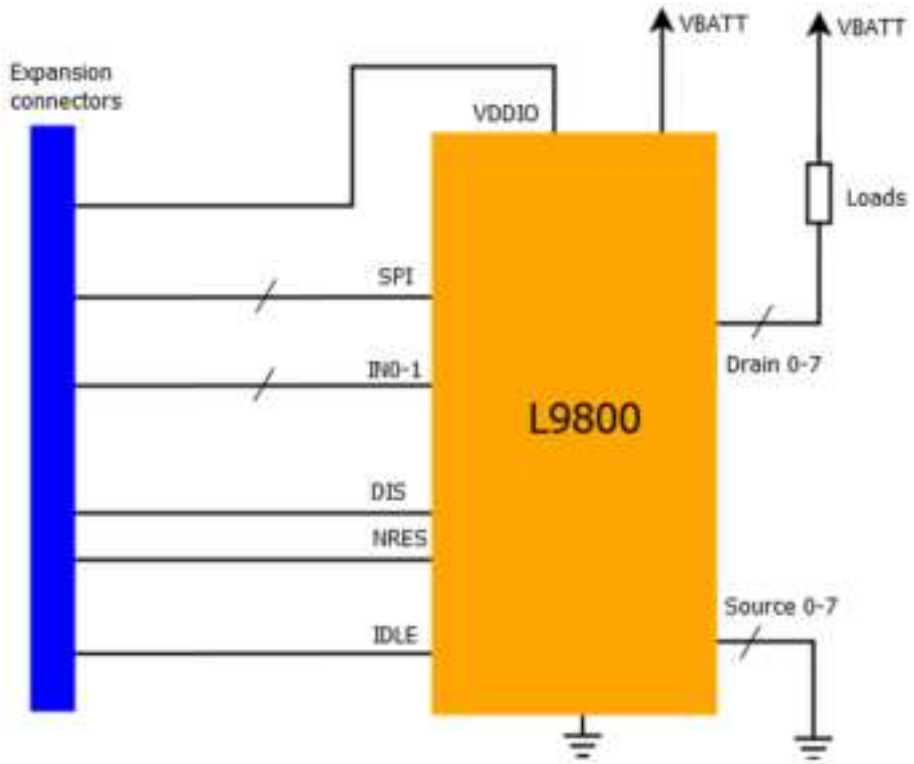
The STEVAL-L9800 is intended as a tool to evaluate all the functionalities of L9800. An optimized BOM has been dimensioned considering the real automotive application range.

The main board characteristics are the following:

- Operative input voltage: 3 - 28 V (for VBATT pin)
- Operative input voltage: 3 - 5 V (for VDDIO pin)
- 8 LS drivers up to 0.5 A each
- Configurable inputs (using jumpers):
  - IN0/IN1
  - IDLE
  - NRES
  - DIS
- SPI communication interface
- 70 x 55 mm 4-layer PCB

1.1 Block diagram

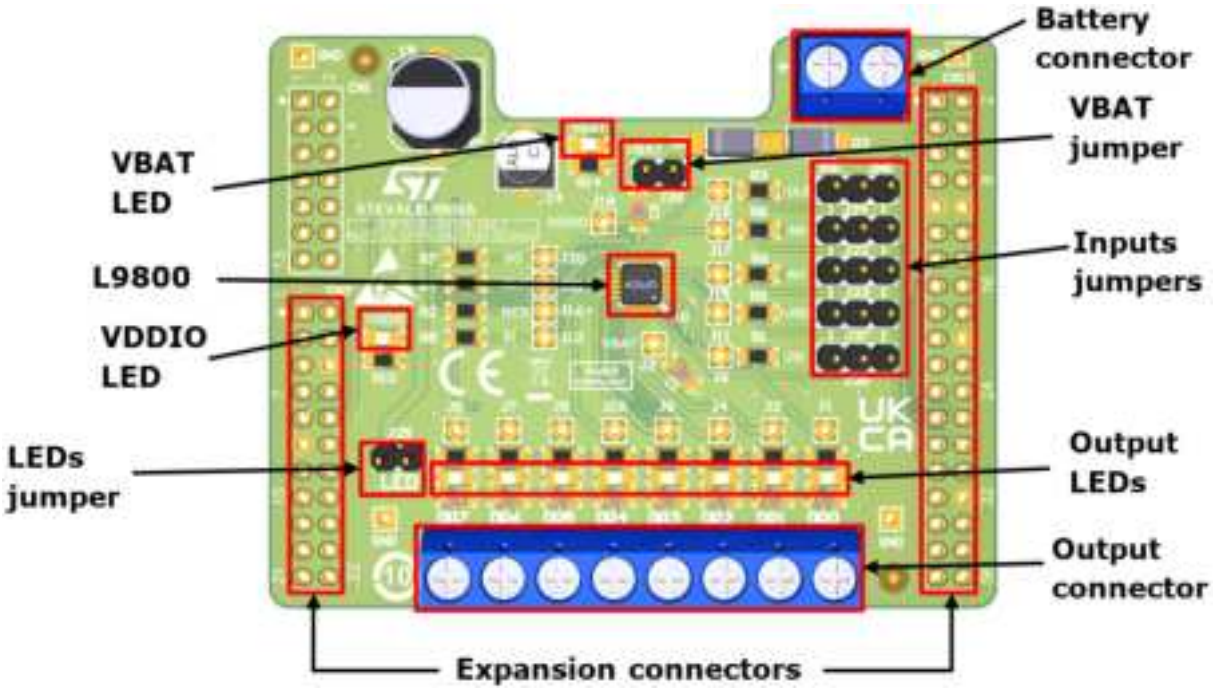
Figure 2. **STEVAL-L9800 block diagram**



2 Board description

2.1 Evaluation board main components and connectors

Figure 3. **Evaluation board main components and connectors**



2.2 Connectors

Table 1. **Evaluation board connectors and switches**

Name	Description	Type
CN7	Expansion connector Pin 5: L9800 SPI clock Pin 6,11: GND Pin 9: L9800 VDDIO All the other pins are unconnected	11 x 2 Header
CN10	Expansion connector Pin 4: L9800 NRES Pin 6: L9800 SPI Chip Select Pin 9,10,20,32: GND Pin 14: L9800 IDLE Pin 19: L9800 DIS Pin 24: L9800 SPI input Pin 26: L9800 IN1 Pin 28: L9800 IN0 Pin 29: L9800 SPI output All the other pins are unconnected	19 x 2 Header

Name	Description	Type
J13	Main battery connector Pin 1: L9800 VBATT Pin 2: GND	2 x Screw connector
J14	Output connector Pin 1: drain 0 Pin 2: drain 1 Pin 3: drain 2 Pin 4: drain 3 Pin 5: drain 4 Pin 6: drain 5 Pin 7: drain 6 Pin 8: drain 7	8 x Screw connector

2.3 Jumper configurations

Table 2. Evaluation board jumper configuration

Name	Description	Default configuration
J22	IN0 switch Closed in position 1-2 → IN0 = 5V Closed in position 2-3 → IN0 = 0V Open → IN0 driven by GUI	OPEN
J23	IN1 switch Closed in position 1-2 → IN1 = 5V Closed in position 2-3 → IN1 = 0V Open → IN1 pin floating	OPEN
J24	IDLE switch Closed in position 1-2 → IDLE = 5V Closed in position 2-3 → IDLE = 0V Open → IDLE driven by GUI	OPEN
J25	Output LEDs switch Closed → Output LEDs active Open → Output LEDs inactive ***NB:*** This jumper must be left open in case of open load diagnosis	CLOSED
J26	Device Vbatt jumper Closed → Vbatt device pin connected to main battery Open → Vbatt device pin floating	CLOSED
J36	DIS switch Closed in position 1-2 → DIS = 5V Closed in position 2-3 → DIS = 0V Open → DIS pin floating	CLOSED (position 2-3)
J37	NRES switch Closed in position 1-2 → NRES = 5V Closed in position 2-3 → NRES = 0V Open → NRES pin floating	CLOSED (position 1-2)

3 Getting started

3.1 Minimum setup

In order to operate the STEVAL-L9800, the following equipment is necessary:

- VBATT power supply 3 - 28 V current capability up to 8 A
- VDDIO power supply 3 - 5 V (only if AEK-MCU-C1MLIT1 is not used)
- Loads: LED, relay, lamp with a rating of 12 V, 0.5 A
- Optional: AEK-MCU-C1MLIT1 and STEVAL-L9800 GUI

For AEK-MCU-C1MLIT1 board usage, please refer to the relevant user manual.

3.2 Startup

Follow the steps below before using the board, :

Step 1. Configure the power supply to desired voltage level and limit the current to n x 1 A where n is the number of connected loads.

Step 2. Switch power supplies on and check that VBATT LED and VDDIO LED are switched on (if the VDDIO pin is supplied by the AEK-MCU-C1MLIT1 board, the VDDIO LED will switch on when USB cable is plugged into the PC).

Step 3. Control IDLE input and SPI settings according to the L9800 datasheet.

Step 4. Check IN0 and IN1 according to your setup.

Step 5. Check that the output LEDs switch on correctly when the associated output is switched on.

3.3 Usage example

In this section, a usage example is described, according to the configuration provided in the following table.

Table 3. Example configuration

Channel	Configuration	Load
CH0	Solenoid actuator	IN0
CH1	Main Relay	SPI
CH2	LED	LED PWM generator
CH3	Resistive Load	GEN PWM generator
CH4	Relay	SPI
CH5	Bulb lamp	IN1
CH6	(unconnected)	SPI
CH7	(shorted to GND)	SPI

Startup phase:

Step 1. Power up the system

With the load configuration given in Table 3, if J25 (LEDs jumper) is closed, the output LED of CH7 will switch on since drain 7 is shorted to GND.

Step 2. IN0 = 0, IN1 = 0, IDLE = 0. The device is in **sleep** mode

Step 3. IN0 = 0, IN1 = 0, IDLE = 1. The device is in **idle** mode

Step 4. SPI initial configuration:

- **MAP_IN0: 0x9C04** (associate IN0 to CH0, frame counter = 0)
- **MAP_IN1: 0xA081** (associate IN1 to CH5, frame counter = 1)
- **CFG_1: 0x8802** (LED PWM generator freq = 122.5 Hz, frame counter = 0)
- **CFG_2: 0x8C01** (GEN PWM generator freq = 122.5 Hz, no adjustment, frame counter = 1)
- **PWM_LED_DC: 0xB000** (PWM LED duty cycle = 0%, frame counter = 0)
- **PWM_GEN_DC: 0xAC03** (PWM GEN duty cycle = 0%, frame counter = 1)
- **MAP_PWM: 0xA430** (CH2-CH3 driven by internal PWM generators, frame counter = 0)
- **PWM_SEL: 0xA813** (CH2 driven by PWM LED & CH3 driven by PWM GEN, frame counter = 1)
- **BIM: 0x9080** (activate bulb inrush mode on CH5, Frame counter = 0)
- **CFG_1: 0x8901** (put device in **active** mode, frame counter = 1)
- **STA_1:0x4402** (read Status register 1, expected results POR = 1, VDD_UV = 0, VS_UV = 0 MODE = 11: active mode, frame counter = 0)

The implemented SPI protocol provides the answer to a command frame only with the next transmission triggered by the MCU; so, for example, the expected result of this STA_1 read, will be the SDO value of the next STA_0 read.

- **STA_0:0x4001** (read Status register 0, expected results OUT_ON_ERR = 0, OUT_OFF_ERR = 0, frame counter = 1)

Step 5. OFF diagnosis:

Before sending the next SPI command, remove jumper J25, otherwise the OUTPUT LED is seen as a load for CH6, masking the open load diagnosis.

- **DIAG_OFF_EN: 0xB7FE** (enable OFF diagnosis on all channels to detect open load or short circuit to GND, frame counter = 0)
- **STA_0: 0x4001** (read Status register 0: expected result DIS = 0, NRES = 1, IDLE = 1, IN1 = 0, IN0 = 0, OUT_ON_ERR = 0, OUT_OFF_ERR = 1, frame counter = 1)
- **DIAG_OPL_OFF: 0x4C00** (read open load in OFF diagnostic: expected results OUT6 = 1 because unconnected, frame counter = 0)
- **DIAG_SHG: 0x5401** (read short to GND diagnostic: expected results OUT7 = 1 because shorted to GND, frame counter = 0)

After OFF diagnosis completion, jumpers J25 can be closed, so there will be visual feedback at channels switched on.

Step 6. Switch on the loads

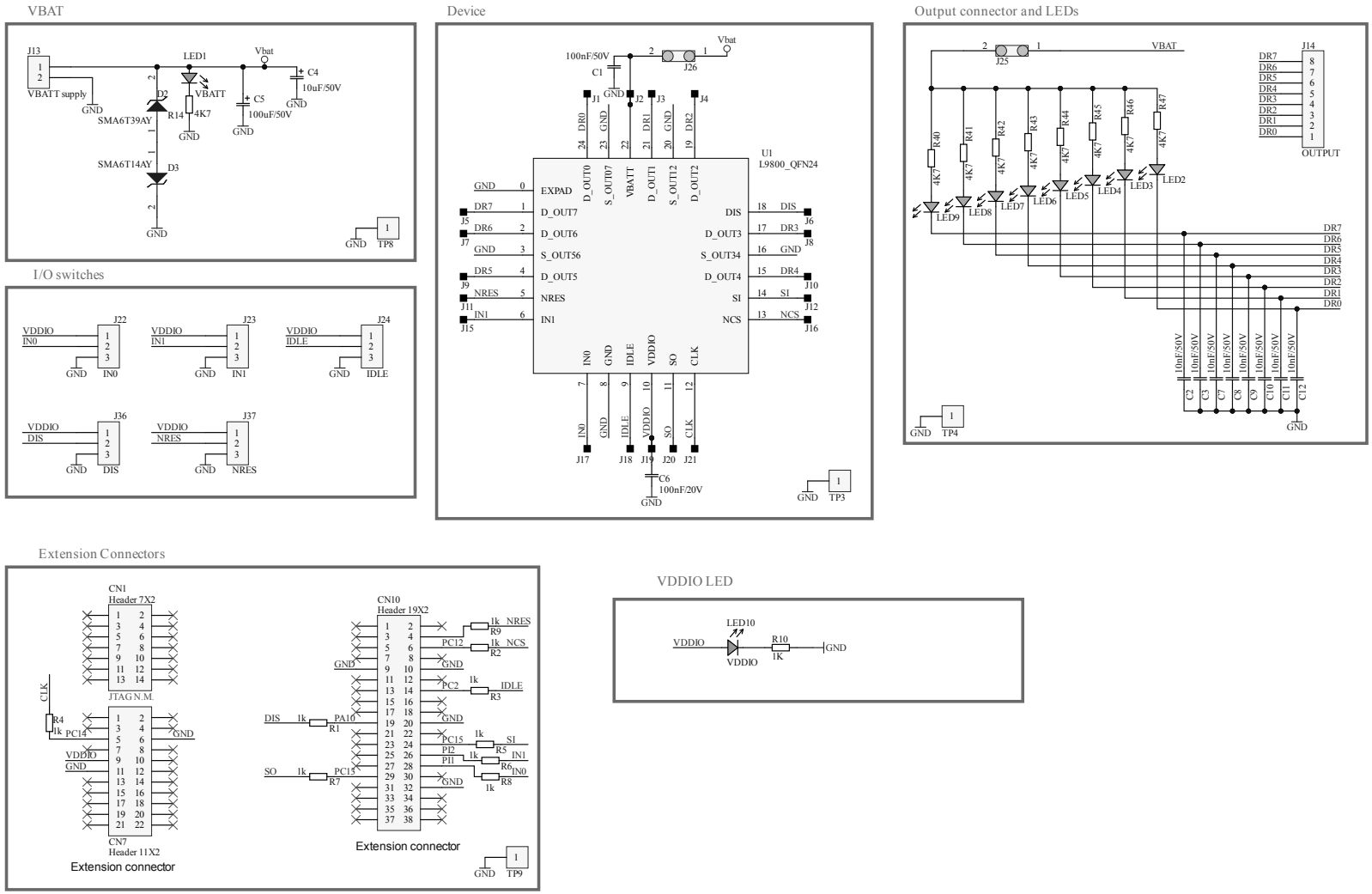
- IN0 =1, IN1 = 1 (switch on CH0 & CH5, through J22-J23)
- **PWM_SPI: 0x9B48** (all SPI driven channels are switched on, frame counter = 0)
- **PWM_GEN_DC: 0xAFFF** (configure PWM GEN duty cycle at 100 %, the expected effect is CH3 fully on, frame counter = 1)
- **PWM_LED_DC: 0XB3FD** (configure PWM LED duty cycle at 100 %, the expected effect is CH2 fully on, frame counter = 0)

Step 7. ON diagnosis

- **STA_0: 0x4001** (read Status register 0: expected result DIS = 0, NRES = 1, IDLE = 1, IN1 = 1, IN0 = 1, OUT_ON_ERR = 1, OUT_OFF_ERR = 0, frame counter = 1)
- **DIAG_OVC_OVT:0x4802** (read the overcurrent and overtemperature diagnosis, expected results OUT5 = 1 since a bulb lamp has been used; refer to the L9800 datasheet for further details. Frame counter = 0)
- **DIAG_OVC_OVT_RLW: 0XBFFD** (clear all the overcurrent and overtemperature diagnosis, expected result reading DIAG_OVC_OVT again – all the diagnosis has been cleared. Frame counter = 1)

4 Schematic diagrams

Figure 4. STEVAL-L9800 evaluation board schematic



5 PCB layout

Figure 5. **Assembly top**

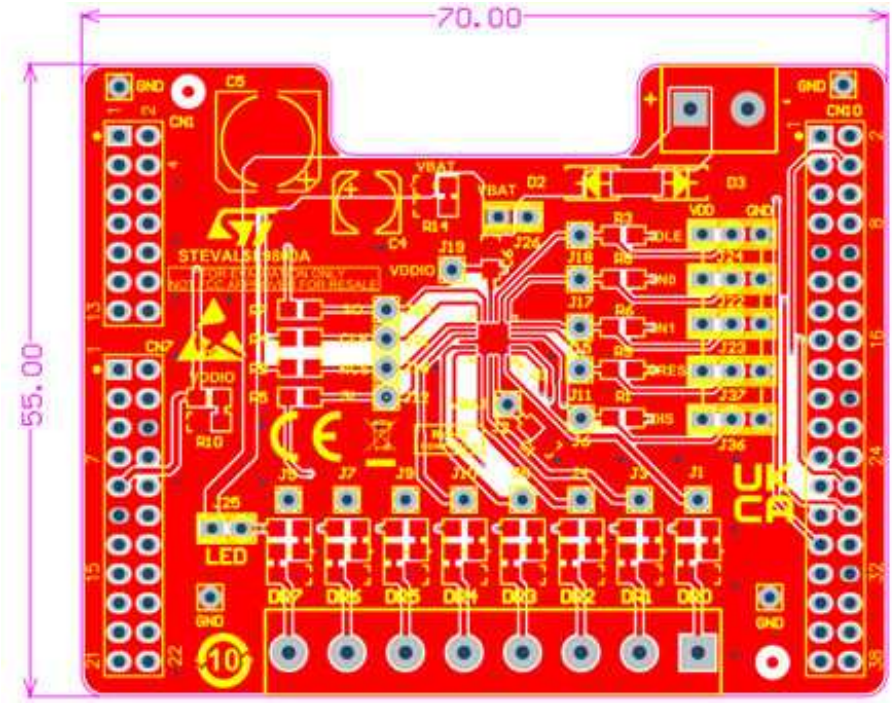


Figure 6. **Inner 1**

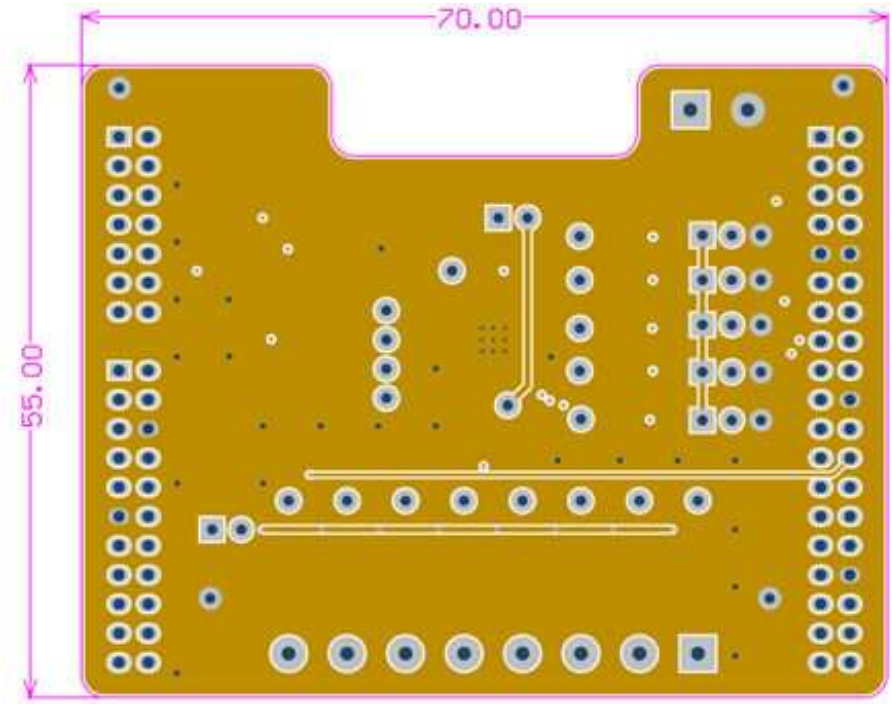


Figure 7. **Inner 2**

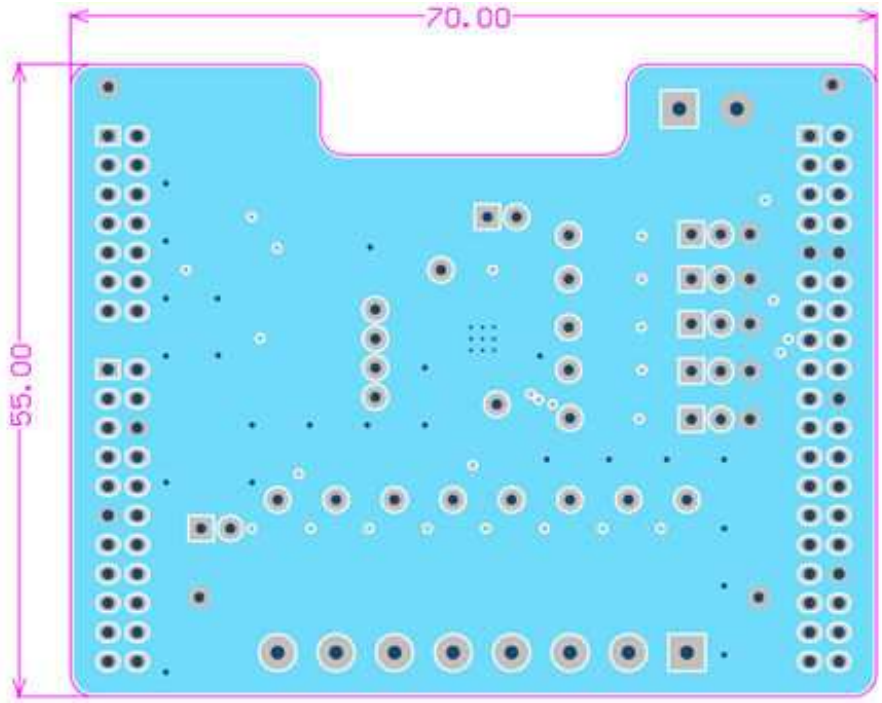
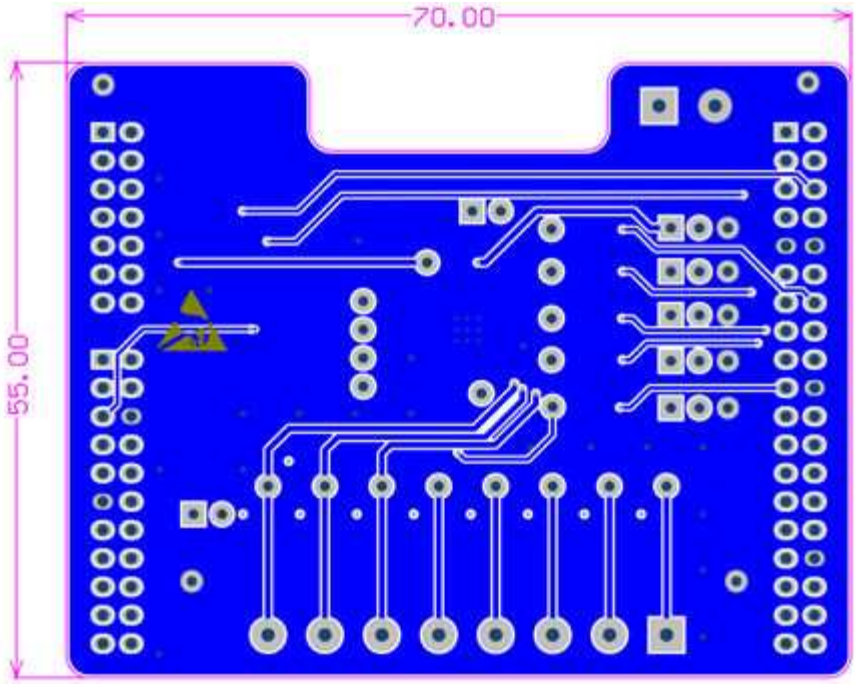


Figure 8. **Assembly bottom**



6 Bill of materials

Table 4. **STEVAL-L9800 bill of materials**

Item	Q.ty	Ref.	Part/value	Description	Manufacturer	Order code
1	2	C1,C6	100nF	multilayer ceramic capacitor	WALSIN	MT21B104K500CT
2	8	C2, C3, C7, C8, C9, C10, C11, C12	10nF	multilayer ceramic capacitor	WALSIN	MT21B103K500CT
3	1	C4	10uF	Aluminum Electrolytic Capacitor	WURTH ELEKTRONIK	865080642006
4	1	C5	100uF	Aluminum Electrolytic Capacitor	WURTH ELEKTRONIK	865080653016
5	2	LED1,LED10		Green Led	MULTICOMP PRO	MP005923
6	8	LED2, LED3, LED4, LED5, LED6, LED7, LED8, LED9		Orange Led	MULTICOMP PRO	MP007090
7	10	R1, R2, R3, R4, R5, R6, R7, R8, R9, R10	1K	Resistor	MULTICOMP PRO	MCWR08X1001FTL
8	9	R14, R40, R41, R42, R43, R44, R45, R46, R47	4K7	Resistor	MULTICOMP PRO	MCWR08X4701FTL
9	5	J22, J23, J24, J36, J37		Male strip connector, straight, board to board, 2.54 mm, 1 line, 3 connections	HARWIN	M20-9990345
10	2	J25, J26		Male strip connector, straight, board to board, 2.54 mm, 1 line, 2 connections	HARWIN	M20-9990245
11	1	D2	SMA6T39AY, SMA	TVS diode, SMA6TY Transil, unidirectional	ST	SMA6T39AY
12	1	D3	SMA6T14AY, SMA	TVS diode, SMA6TY Transil, unidirectional	ST	SMA6T14AY
13	1	J13		C.S. Clamps straight step 5 MM	ELCART	05/10000-00
14	1	J14		Clamps wire to board, 5 mm, 8 Vie, 28 AWG, 12 AWG, with screws	AMPHENOL ANYTEK	VI0801550000G
15	1	CN1		PCB Preci-Dip connections, 14 via, 2 line, step 2.54mm	Preci Dip	803-87-014-10-001101
16	1	CN7		PCB Preci-Dip connections, 22 via, 2 line, step 2.54mm	Preci Dip	803-87-022-10-001101
17	1	CN10		PCB Preci-Dip connections, 20 via, 2 line, step 2.54mm	Preci Dip	803-87-020-10-001101
18	1	CN10		PCB Preci-Dip connections, 18 via, 2 lile, step 2.54mm	Preci Dip	803-87-018-10-001101
19	1	U1	L9800-TR, TFQFN24	8 channels low side driver	ST	L9800-TR

7 Board versions

Table 5. **STEVAL-L9800 versions**

Finished good	Schematic diagrams	Bill of materials
STEVAL$L9800A (1)	STEVAL$L9800A schematic diagrams	STEVAL$L9800A bill of materials

1. *This code identifies the STEVAL-L9800 evaluation board first version.*

8 Regulatory compliance information

Notice for US Federal Communication Commission (FCC)

For evaluation only; not FCC approved for resale

FCC NOTICE - This kit is designed to allow:

(1) Product developers to evaluate electronic components, circuitry, or software associated with the kit to determine

whether to incorporate such items in a finished product and

(2) Software developers to write software applications for use with the end product.

This kit is not a finished product and when assembled may not be resold or otherwise marketed unless all required FCC equipment authorizations are first obtained. Operation is subject to the condition that this product not cause harmful interference to licensed radio stations and that this product accept harmful interference. Unless the assembled kit is designed to operate under part 15, part 18 or part 95 of this chapter, the operator of the kit must operate under the authority of an FCC license holder or must secure an experimental authorization under part 5 of this chapter 3.1.2.

Notice for Innovation, Science and Economic Development Canada (ISED)

For evaluation purposes only. This kit generates, uses, and can radiate radio frequency energy and has not been tested for compliance with the limits of computing devices pursuant to Industry Canada (IC) rules.

À des fins d'évaluation uniquement. Ce kit génère, utilise et peut émettre de l'énergie radiofréquence et n'a pas été testé pour sa conformité aux limites des appareils informatiques conformément aux règles d'Industrie Canada (IC).

Notice for the European Union

This device is in conformity with the essential requirements of the Directive 2014/30/EU (EMC) and of the Directive 2015/863/EU (RoHS).

Notice for the United Kingdom

This device is in compliance with the UK Electromagnetic Compatibility Regulations 2016 (UK S.I. 2016 No. 1091) and with the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations 2012 (UK S.I. 2012 No. 3032).

9 Reference documents

Table 6. **Reference documents**

Doc name	Revision	Title
DS14041	1	L9800 datasheet

Revision history

Table 7. **Document revision history**

Date	Version	Changes
27-May-2025	1	Initial release.

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