NCV7471B5V1GEVB, NCV7471C5V1GEVB, NCV7471C5V2GEVB

NCV7471 System Basis Chip Evaluation Board User's Manual

ON Semiconductor®

EVAL BOARD USER'S MANUAL

Introduction

This document describes the NCV7471 EVB board for the ON Semiconductor NCV7471 System basis chip with a high−speed CAN and two LIN transceivers with boost−buck converter and low−drop voltage regulator. The functionality and major parameters can be evaluated with the NCV7471 EVB board.

NCV7471 is a System Basis Chip (SBC) integrating functions typically found in automotive Electronic Control Units (ECUs) in the body domain. NCV7471 provides and monitors the low−voltage power supplies for the application microcontroller and other loads, monitors the application software via a watchdog and includes high−speed CAN and LIN transceivers allowing the ECU to host multiple communication nodes or to act as a gateway unit. The on−chip state controller ensures safe power−up sequence and supports low−power modes with a configurable set of features including wakeup from the communication buses or by a local digital signal WU. The status of several NCV7471 internal blocks can be read by the microcontroller through the serial peripheral interface or can be used to generate an interrupt request.

Evaluation Board Features

- One−row Pin Header, Providing the Circuit Signals, Enables Easy Insertion of the Evaluation Board into a more Complex Application Setup
- Oscilloscope Test−points on All Important Signals
- Reverse Protection and Decoupling on the Main (Battery) Supply
- All the Necessary VOUT Converter External Components – Assembly Options Available
- Decoupling on VOUT Converter and VOUT2 Regulator Outputs
- Additional Pull−up Resistors on the Open−drain Digital Outputs (RSTN, INTN, UVN_VOUT)
- Filtering Circuit on the Switch−monitoring WAKE Input
- On−board Local Wakeup Switch
- CAN/LIN−bus Terminations
- Good Thermal Connection of the Circuit's Exposed Pad to the Bottom Ground Plane
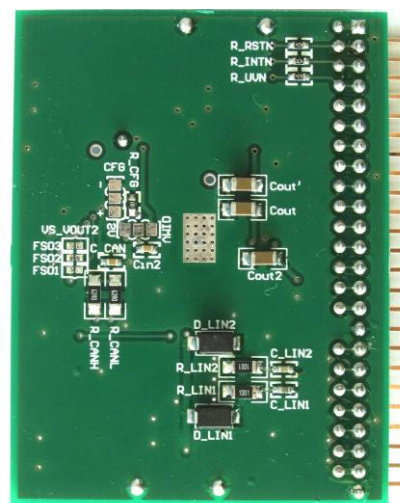- Basic Standalone Functionality using Software Development Mode

Figure 1. Evaluation Board Photo

SCHEMATIC

Complete schematic with all the assembly options are shown in Figure 2. Depending on VOUT maximum current and minimum battery operation voltage, few assembly options are available. Values of components may be customized according to specific requirements.
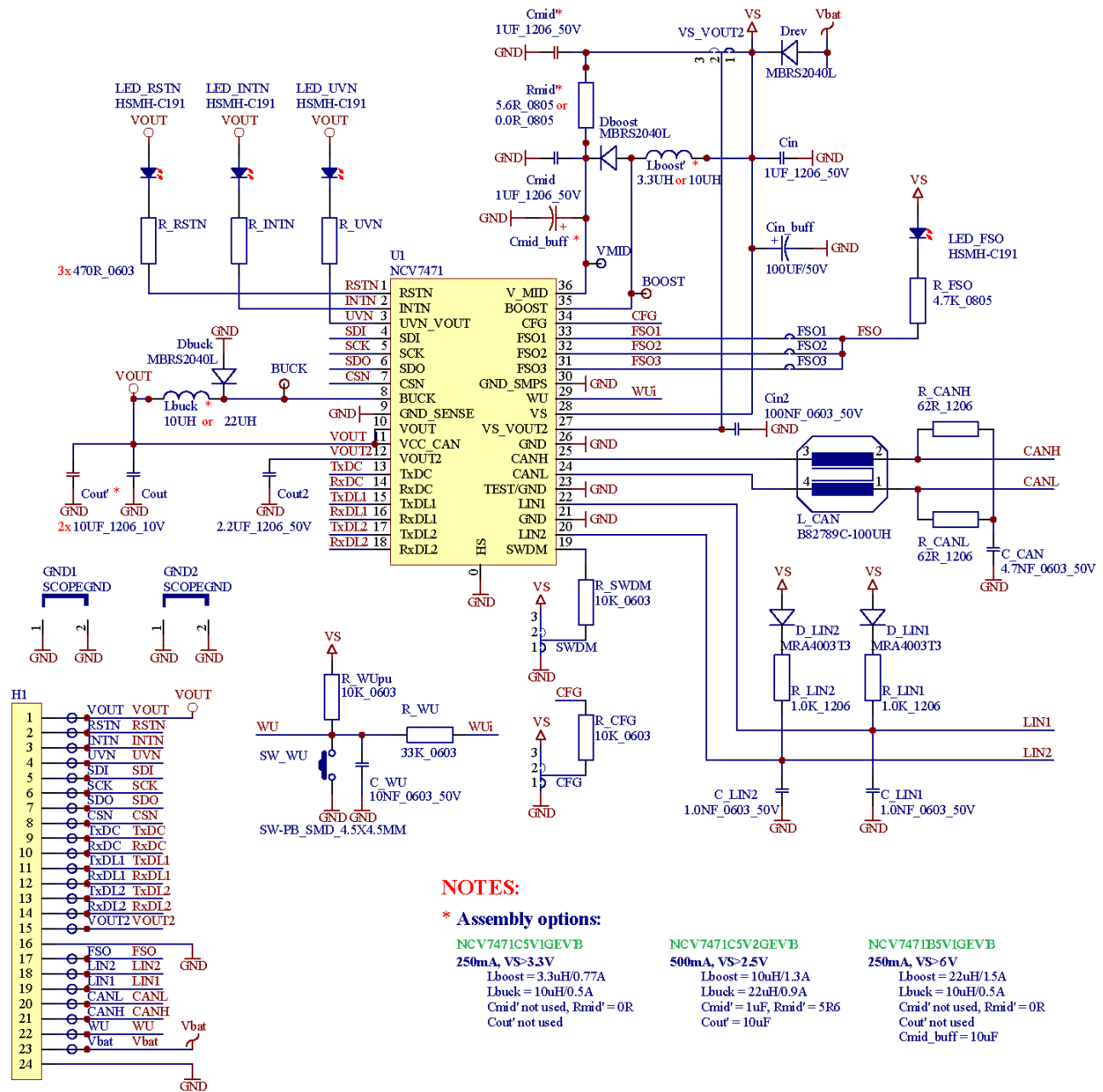

Figure 2. NCV7471 Evaluation Board Schematic

NCV7471B5V1GEVB, NCV7471C5V1GEVB, NCV7471C5V2GEVB

Table 1. ABSOLUTE MAXIMUM RATINGS

Rating	Pins	Min	Max	Unit
Supply voltage	Vbat	−40	40	V
VOUT output voltage	VOUT	−0.3	6	V
VOUT output current	VOUT	0	internally limited	mA
VOUT2 output voltage	VOUT2	−1	40	V
VOUT2 output current	VOUT2	0	internally limited	mA
Digital inputs voltage	RSTN, INTN, UVN, SDI, SCK, CSN, TxDC, TxDL1/2	−0.3	6	V
Digital outputs voltage	SDO, RxDC, RxDL1/2	−0.3	VOUT+0.3	V
Fail−safe pin output voltage	FSO	−0.3	40	V
LIN bus lines voltage	LIN1, LIN2	−45	45	V
CAN bus lines voltage	CANH, CANL	−50	50	V
Wake−up input voltage	WU	−40	40	V
NCV7471 junction temperature		−40	+170	°C
Board temperature		−40	+125	°C

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

Table 2. RECOMMENDED BOARD OPERATING CONDITIONS

Rating	Pins	Min	Max	Unit
Supply voltage (Vbat)	Vbat NCV7471B5V1GEVB NCV7471C5V1GEVB NCV7471C5V2GEVB	 6.6 3.8 3.0	28	V
Supply voltage (VS)	VS (board internal node) NCV7471B5V1GEVB NCV7471C5V1GEVB NCV7471C5V2GEVB	 6.0 3.3 2.5	28	V
VOUT output voltage	VOUT	4.9	5.1	V
VOUT output current	VOUT NCV7471B5V1GEVB NCV7471C5V1GEVB NCV7471C5V2GEVB	0	 250 250 500	mA
VOUT2 output voltage	VOUT2	4.9	5.1	V
VOUT2 output current	VOUT2	0	50	mA
Digital inputs voltage	RSTN, INTN, UVN, SDI, SCK, CSN, TxDC, TxDL1/2	0	VOUT	V
Digital outputs voltage	SDO, RxDC, RxDL1/2	0	VOUT	V
FSO pin output voltage	FSO	0	VS	V
LIN bus lines voltage	LIN1, LIN2	0	VBAT	V
CAN bus lines voltage	CANH, CANL	0	5	V
Wake−up input voltage	WU	0	VBAT	V
NCV7471 junction temperature		−40	+150	°C
Board temperature		−40	+105	°C

Functional operation above the stresses listed in the Recommended Operating Ranges is not implied. Extended exposure to stresses beyond the Recommended Operating Ranges limits may affect device reliability.
*See assembly options

OPERATIONAL GUIDELINES

NCV7471 is complex SCB device, which needs external MCU, connected through H1 connector, to control all functions and settings. However, with basic function of the converter, LIN and CAN operation, NCV7471 may work in so called Software Development Mode (SWDM). To configure NCV7471 into this mode, SWDM pin has to be tight to VS. Details about board configuration can be found in the following chapter.

Behavior of NCV7174 in Software Development mode is following:

- Buck converter is active, delivering +5 V on VOUT.
- Boost converter may be disabled/enabled by connecting CFG pin to GND/VS ("−"/"+" positions of CFG soldering strap)
- VOUT2 LDO is disabled by default

- CAN transceiver is configured into LIN Normal mode – receiver and transmitter are enabled.
- LIN1/2 transceiver is configured into LIN Normal mode – receiver and transmitter are enabled.
- Watchdog does not need to be served, the device remains in Normal mode, until it is changed via SPI command.
- RSTN, INTN, VOUT_UVN, FSO1−3 provide their standard functionality, except of RSTN and FSO1−3 pins, which are not active due to not−serving the watchdog.

Board Configuration

The NCV7471 evaluation board provides few hardware configuration options, using soldering straps. Their functions are described in the table below.

Table 3. SOLDERING STRAPS FUNCTIONS

Solder Strap	Position	Function
SWDM	"−" or not connected (GND)	Normal operation mode with external MCU connected (Watchdog service needed)
	"+" (VS)	Software Development Mode (Watchdog does not need to be served, CAN and LIN1/2 enabled in Normal mode by default)
CFG	"−" or not connected (GND)	**SWDM = GND**: Config2/4 (Fail−safe mode entered after 1st/2nd watchdog service failure) **SWDM = VS**: Boost stage disabled
	"+" (VS)	**SWDM = GND**: Config1/3 (Fail−safe mode not entered after 1st/2nd watchdog service failure) **SWDM = VS**: Boost stage enabled
VS_VOUT2	VS	Input of VOUT2 LDO regulator connected to VS
	VMID	Input of VOUT2 LDO regulator connected to V_MID
FSO1−3	FSO1	FSO constantly Low at failure
	FSO2	FSO Low for 50%, frequency of 1.25 Hz at failure
	FSO3	FSO Low for 20%, frequency of 100 Hz at failure

Special care has to be taken for Standby or Sleep mode quiescent consumption measurements. Both SWDM and CFG pins have internal pull−down resistors (typ. 100 kΩ), which influence input supply current if they are connected to VS (typically Software Development Mode with Boost stage enabled). To measure pure NCV7471 consumption, these pins should stay Low (GND) or may be pulled up by external voltage source.

Four on−board LEDs indicate faulty states of the board, as described in the Table 4.

Table 4. LED FUNCTIONS

LED Name	Function
LED_RSTN	Indicates activation of RSTN pin due to the following reasons: • Sleep/Fail−safe mode (LED_RSTN off due to missing VOUT supply), • Reset mode (internal or external activation) (5 ms on)
LED_INTN	Indicates activation of INTN pin due to the following reasons: • Sleep/Fail−safe mode (LED_INTN off due to missing VOUT supply), • Wake−up event (CAN, LIN1/2, WU, Timer) − configurable via SPI • Interrupt request − has to be enabled via SPI (1 ms on, 5 ms off)
LED_UVN	Indicates activation of VOUT_UVN pin due to the following reasons: • Sleep/Fail−safe mode (LED_UVN off due to missing VOUT supply), • Undervoltage on VOUT pin (VOUT < 4.65 V)
LED_FSO	FSOx pin active due to failure condition (depends on CFG and SPI configuration): • Thermal Shutdown • Fatal VOUT failure • RSTN clamped Low / High • Watchdog failure (ignored if SWDM is High) • SPI control bit FSO_ON is set

External Board Connections

Configuration with and without the control MCU is shown in the figures below. SWDM and CFG soldering straps need to be configured to work correctly in both setups.

For basic evaluation, the board may operate without external control in the Software Development Mode (Figure 3). If full functionality is needed, an external microcontroller has to be attached to the board (Figure 4).
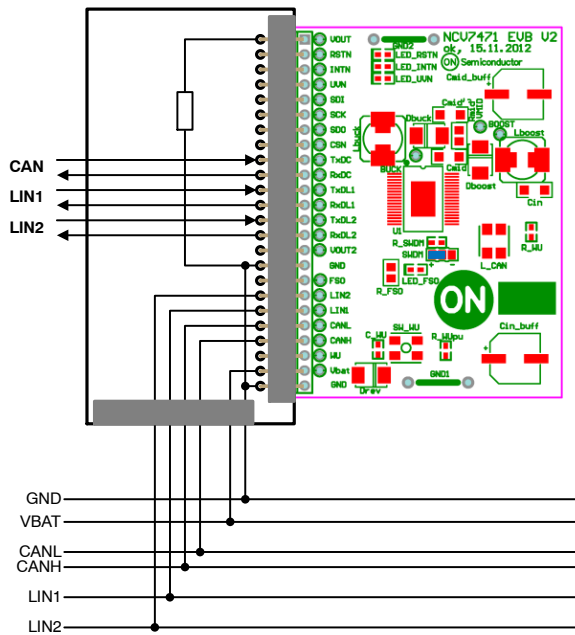
Figure 3. Standalone NCV7471 Evaluation Setup (Software Development Mode used, limited functionality)
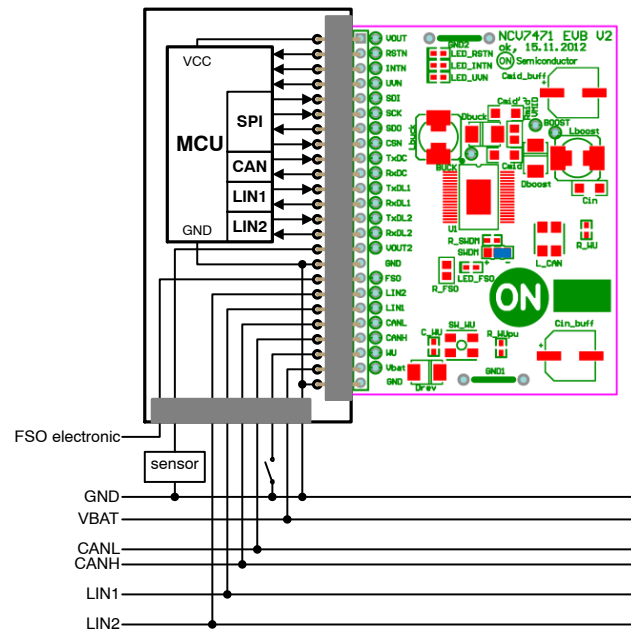
Figure 4. NCV 7471 Full Evaluation Setup

FUNCTIONAL DESCRIPTION

VS Supply Input

VS pin of NCV7471 is typically connected to the car battery through a reverse−protection diode and can be exposed to all relevant automotive disturbances (ISO7637 pulses, system ESD ...). VS supplies mainly the integrated LIN transceivers.

VOUT DC/DC Converter

The main application low−voltage supply is provided by an integrated boost−buck DC/DC converter, delivering a 5 V output VOUT. The converter can work in two modes:

- **Buck−only mode** is the default mode of the VOUT power−supply. In this mode, the boosting part of the converter is never activated and the resulting VOUT voltage can be only lower than the input line voltage. Buck−only mode is applied during the initial power−up (after the VS connection), wakeup from Sleep−mode and also recovery from the Fail−safe mode, as well as in the Software Development Mode with CFG pin at Low level.

- **Boost−buck mode** ensures that the correct VOUT voltage is generated even if the input line voltage falls below the required VOUT level. This mode can be requested through the corresponding SPI control register. If selected, the boost−buck mode is used during Reset, Start−up, Normal, Standby, and Flash modes. It is also preserved during VOUT under−voltage recovery through Power−up mode. In SW Development configuration, boost−buck mode can be additionally enabled by High level on CFG pin. No SPI communication is therefore necessary to select the DC/DC mode in SW Development (see Table 5).

Table 5. CONTROL OF DC/DC CONVERTER MODES
("X" means "Don't care")

Device Configuration	SPI bit en-BOOST	CFG Pin Signal	Applied DC/DC Mode
Config 1, 2, 3, 4	Low	X	**Buck−Only**
	High		**Boost−Buck**
SW Development	Low	Low	**Buck−Only**
		High	**Boost−Buck**
	High	X	**Boost−Buck**

By default, the converter works with a fixed switching frequency 485 kHz nominal. Through the SPI settings, a switching frequency modulation can be applied with fixed modulation frequency of 10 kHz and three SPI−selectable modulation depth values – 10%, 20% or 30% of the nominal frequency.

VOUT level is monitored by an under−voltage detector with multiple thresholds:

- Comparison with selectable threshold *VOUT_RESx*. By default, the lowest threshold (typ. 3.1 V) applies for the state machine control and the activation of the RSTN signal (LED_RSTN on). This reset threshold can be changed via SPI to any of the four programmable values.

- A second monitoring signal – UVN_VOUT (LED_UVN on) – is generated based on comparison of the VOUT level with the highest monitoring level (typ. 4.65 V).

- VOUT is compared with a fixed threshold *VOUT_FAIL* (typ. 2 V). If VOUT stays below *VOUT_FAIL* level for longer than *t_VOUT_powerup* (typ. 1.5 s), a VOUT short−circuit is detected and Fail−safe mode is entered (LED_FSO on, if connected).

Both UVN_VOUT and RSTN pins provide an open drain output with integrated pull−up resistor. The split between reset−generating level VOUT_RESx and an under−voltage indication allows coping with VOUT dips in case of high loads coinciding with low input line voltages.

VOUT2 Low−drop Regulator

An integrated low−drop regulator provides a second 5 V supply VOUT2 to external loads, typically sensors. The regulator's input is taken from a dedicated pin VS_VOUT2, which does not feature an explicit under−voltage monitoring. VS_VOUT2 would be typically connected to the VS pin or might be taken from other nodes like, e.g., the DC/DC converter's auxiliary node V_MID. "VS_VOUT2" soldering strap allows connecting VOUT2 LDO input supply to the VS or the V_MID point.

After a power−up or a reset event, as well as in Sleep mode, VOUT2 regulator is switched off. In Start−up, Normal, Standby and Flash modes, it can be freely activated or deactivated via SPI control register.

Operating States

NCV7471 provides five static operating modes and three transition states – see Figure 5. Mode setting is done via SPI registers. Additional details of the NCV7471 operation and parameters can be found in the corresponding NCV7471/D datasheet at www.onsemi.com.

Figure 5. NCV7471 State Diagram

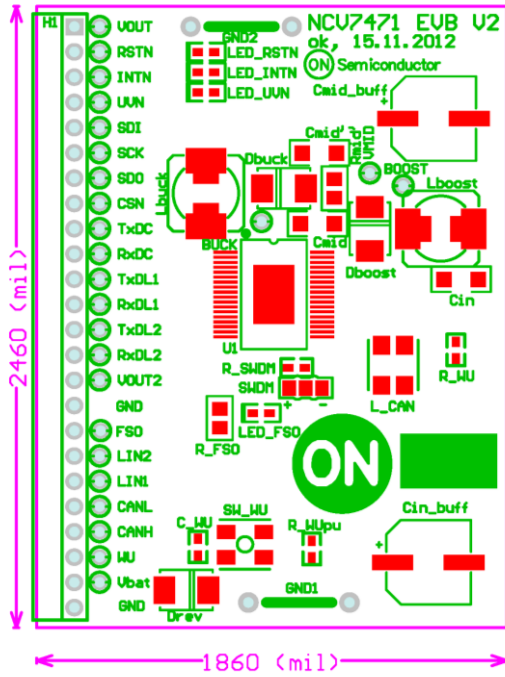# PCB DRAWINGS

Assembly Drawings

Figure 6. NCV7471 EVB PCB Top Assembly Drawing
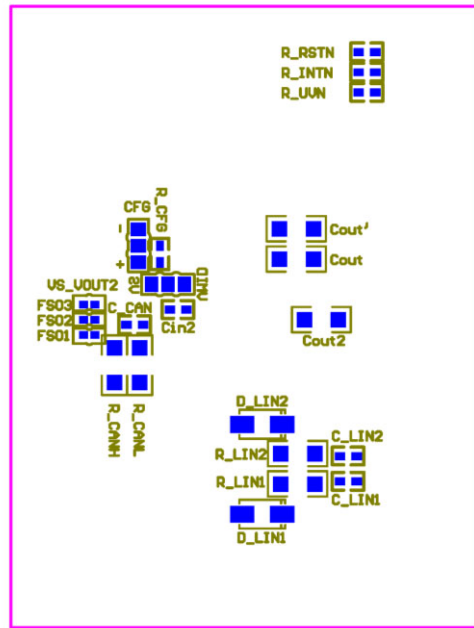

Figure 7. NCV7471 EVB PCB Bottom Assembly
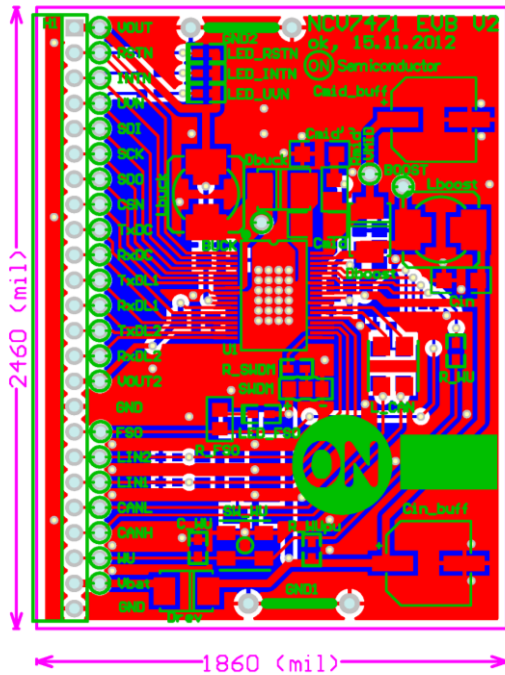Drawing (bottom view)

Composite Drawings

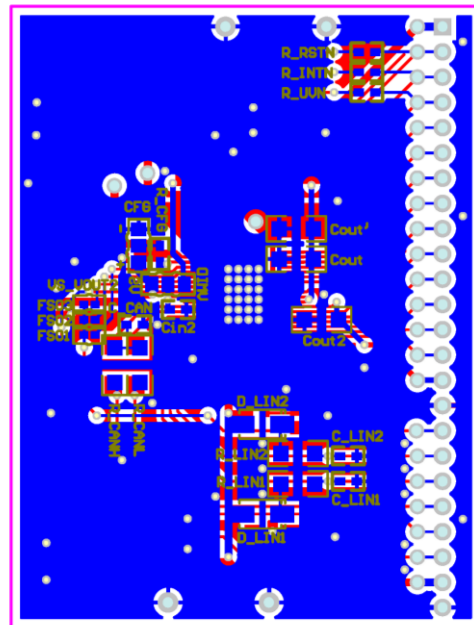Figure 8. NCV7471 EVB PCB Top Composite Drawing

Figure 9. NCV7471 EVB PCB Bottom Composite
Drawing (bottom view)

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