

# NCV7535VMFD5C466GEVB

## NCV7535 SPI controlled H-bridge pre-driver Evaluation Board User's Manual



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### EVAL BOARD USER'S MANUAL

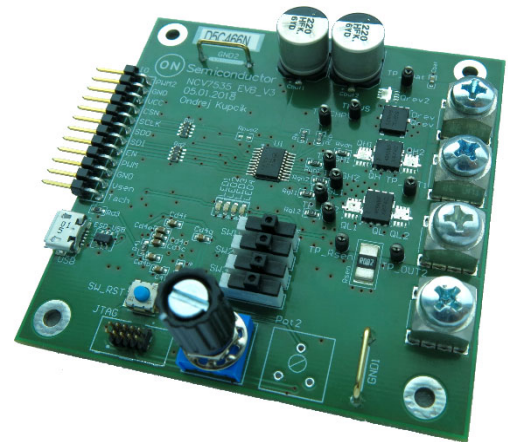
#### Introduction

This document describes the NCV7535 EVB board for the ON Semiconductor NCV7535 SPI controlled H-bridge and Dual-Half Bridge pre-driver. The functionality and major parameters can be evaluated with the NCV7535 EVB board.

The NCV7535 is a monolithic SPI controlled chip with enhanced feature set useful in automotive systems. Besides the SPI bus interface, the IC features an H-bridge pre-driver to control a DC-motor. This allows a highly integrated solution.

#### Evaluation Board Features

- N-MOSFET Reverse Protection and Decoupling on the Main (Battery) Supply (in Dual SO8FL or  $\mu$ 8FL Packages)
- On-Board + 5 V LDO
- MCU with USB Interface Controlling NCV7535
- One-Row Pin Header, Providing the Circuit Signals, Enables Easy Insertion of the Evaluation Board into a More Complex Application Setup.
- On-Board Current Sense Shunt Resistor and Current Amplifier
- Good Thermal Connection of the Power MOSFETs Allowing High Current Capability
- Oscilloscope Test-Points on All Important Signals
- M4 Screw Connectors for Power Signals (Battery, Ground, Outputs)
- Switches and Potentiometer for Standalone Mode Control
- LEDs for Diagnostics



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## SCHEMATIC

The evaluation board consists of two main blocks: NCV7535 application and control MCU including USB interface (see Figure 1).

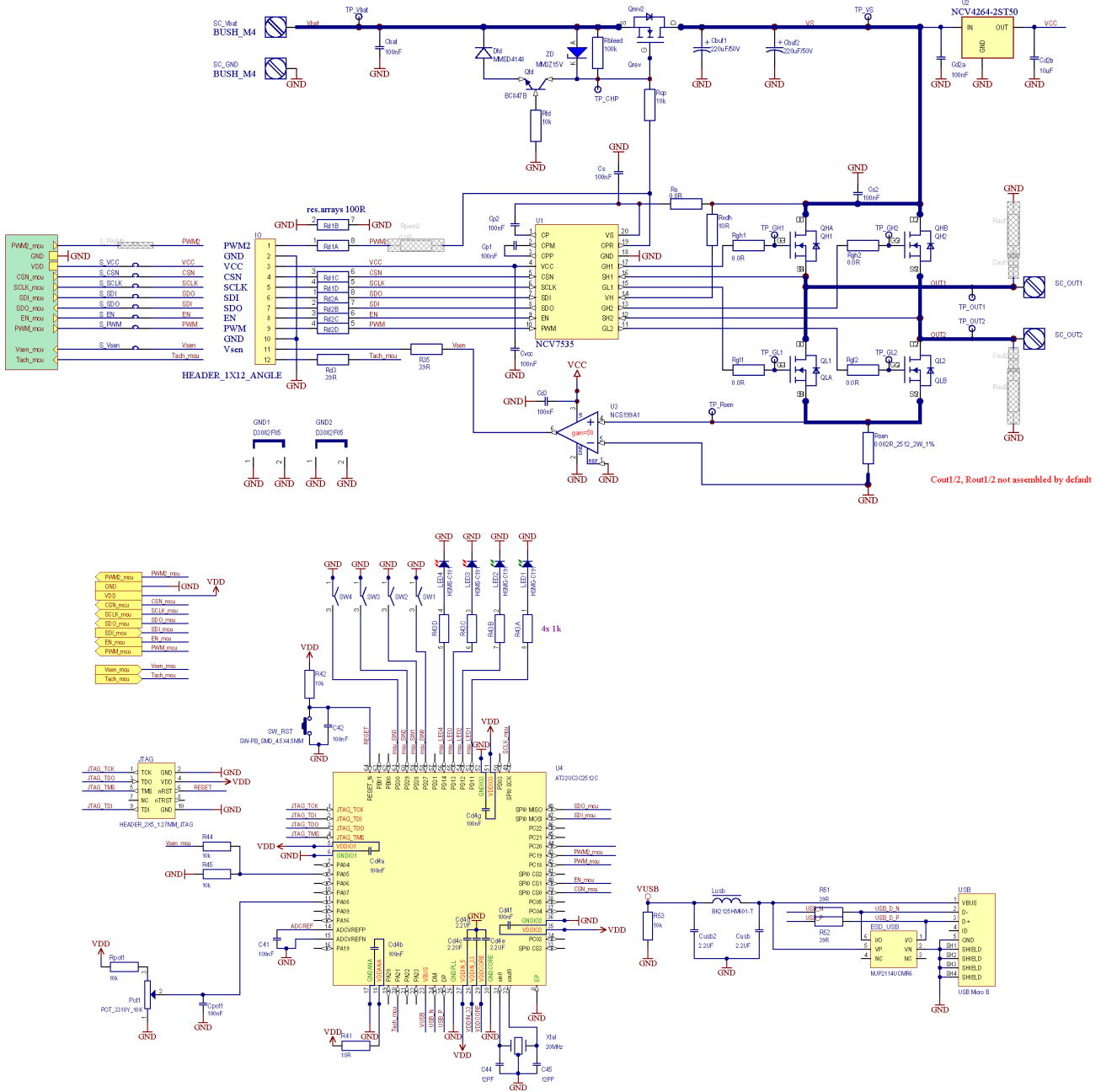


Figure 1. NCV7535 Evaluation Board Layout

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**Table 1. ABSOLUTE MAXIMUM RATINGS**

Rating	External Pin	Min	Max	Unit
Power Supply Voltage	Vbat	-40	40	V
Digital Supply voltage	VCC	-0.3	5.5	V
Digital Inputs/outputs voltage	CSN, SCLK, SDI, SDO, EN, PWM	-0.3	VCC+0.3	V
Current sense output voltage	Vsen	-0.3	VCC+0.3	
Current sense output current	Vsen	Internally Limited		A
H-bridge outputs DC voltage	OUT1,2	-0.3	Vbat+0.3	V
H-bridge outputs DC current	OUT1,2	-20	+20	A
NCV7535 junction temperature		-40	+150	°C
Qrev, QH1/2, QL1/2 junction temperature		-55	+175	°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	External Pin	Min	Max	Unit
Power Supply Voltage	Vbat	6	28	V
Digital Supply voltage	VCC	+5 V $\pm$ 2% (on-board supply)		V
Digital Inputs/outputs voltage	CSN, SCLK, SDI, SDO, EN, PWM	0	VCC	V
Current sense output voltage	Vsen	Generated internally		
Current sense output current	Vsen	Internally Limited		A
H-bridge outputs DC voltage	OUT1,2	0	Vbat	V
H-bridge outputs DC current	OUT1,2	Limited by max. junction/board temperature		A
NCV7535 junction temperature		-40	+150	°C
Qrev, QH1/2, QL1/2 junction temperature		-55	+175	°C
Board temperature		-40	+125	°C

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## OPERATIONAL GUIDELINES

NCV7535 is a monolithic SPI controlled H-bridge pre-driver for a DC-motor with enhanced feature set useful in automotive systems.

The evaluation board contains all the components necessary for NCV7535 application: a control MCU, USB interface, + 5 V LDO supply for VCC and current sense amplifier.

An external MCU can be connected through the IO connector to control all functions and settings of NCV7535.

## Board Configuration

The NCV7535 evaluation board allows several modes of operation:

- Standalone / full-demonstration using on-board MCU
  - ◆ MCU is controlled via micro USB connector “USB”
  - ◆ NCV7535 digital signals are still accessible via “IO” connector
- NCV7535 evaluation only; external control
  - ◆ External SPI control has to be connected via “IO” USB connector

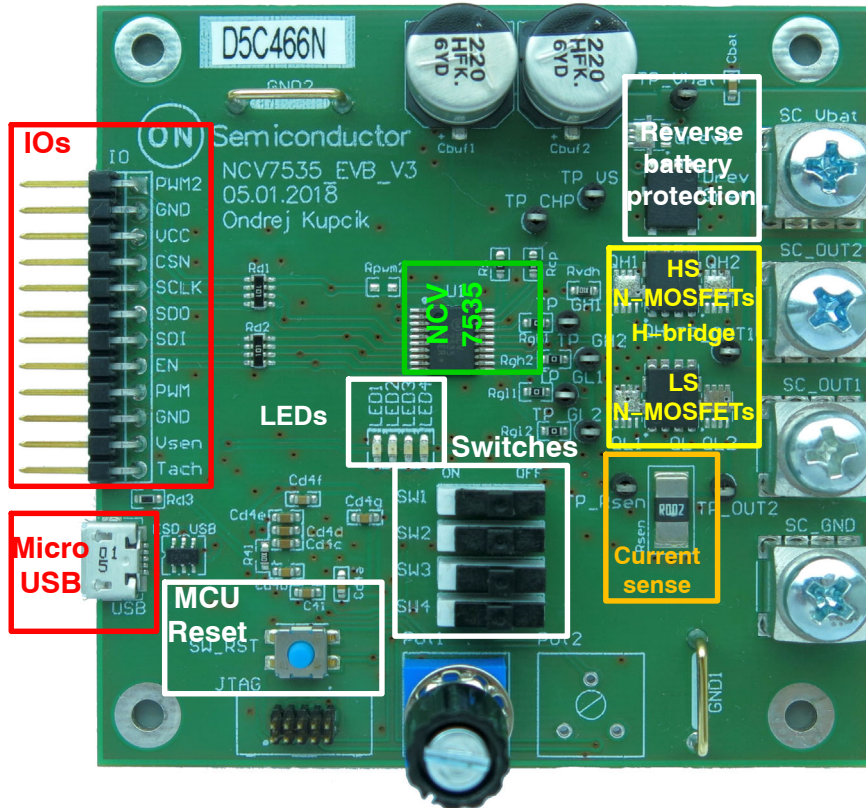


Figure 2. NCV7535 Evaluation Board Picture, top side

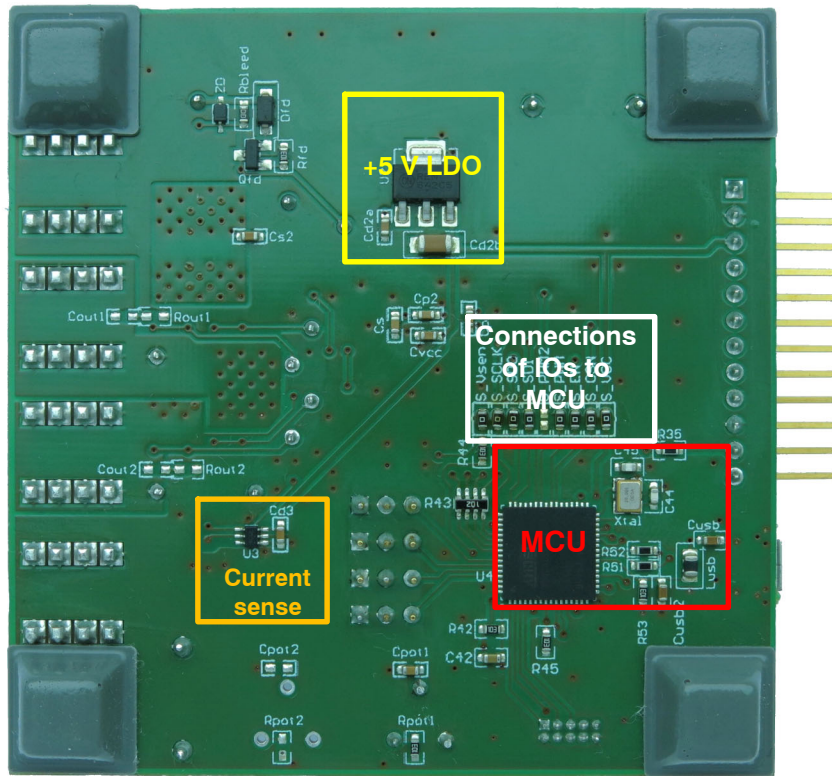


Figure 3. NCV7535 Evaluation Board Picture, bottom side

## FUNCTIONAL DESCRIPTION

### Power Supply

The output stage of NCV7535 pre-driver is supplied via VS pin. Normally, this pin is directly connected to the H-bridge supply. N-MOSFET Qrev ensures battery-reverse protection.

By default, H-bridge power supply is buffered by two 220  $\mu$ F capacitors covering high current peaks caused by the inrush current or PWM operation and absorbing energy stored in motor coils in case of the supply voltage disappears.

The NCV7535 supply (VS pin) can be optionally filtered using a non-zero value of Rs resistor.

### Current Sensing Amplifier

NCV7535 evaluation board contains a low-side sense resistor and operational amplifier for H-bridge current sensing.

The power MOSFETs as well as sensing resistor Rsen value are selected according to maximum application DC current. Higher current is possible for limited time as long as the junction and board temperatures are not exceeded.

The used dedicated current-sensing amplifier (NCS199A1) has a fixed gain of 50 and the output is referenced to GND.

The resulting A-V ratio (with Rsen = 2 m $\Omega$ ) is:

$$V_{sen} = 0.1 \times I_{out}$$

## GETTING STARTED

The board supports three ways of NCV7535 device control:

1. Standalone mode – PWM duty-cycle (motor speed) can be changed via on-board potentiometer. Additional device setting is available through on-board switches.
2. PC control – the user have full control over NCV7535 settings using PC connected to the board via USB.
3. External MCU control – external MCU controls the all the NCV7535 settings directly via SPI and PWM pin. The on-board MCU has to be disconnected from these signals (S\_xxx 0R resistors on the bottom side have to be disconnected).

### Standalone mode

1. Connect the load to “OUT1/2” bush connectors
2. Connect the main supply to “Vbat and “GND” bush connectors. The MCU starts in the Standalone mode automatically and NCV7535 is configured into the Active mode.
3. The motor speed (PWM duty-cycle) can be changed by “Pot1”
4. SW1-4 change additional H-bridge settings as listed in the table below.
5. LED1-4 indicate NCV7535 status

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**Table 3. Function of Switches**

Switch	Function	SW Left Position (“ON”)	SW Right Position (“OFF”)
SW1	Direction	LS1 + HS2	HS1 + LS2
SW2	Free-Wheeling (FWH)	High-Side	Low-Side
SW3	Free-Wheeling (FWA)	Active	Passive
SW4	Slopes (SRF), PWM frequency	Fast, 20 kHz	Slow, 200 Hz

**Table 4. Functions of LEDs**

LED	Function	Color
LED1	Indication of PC control mode	Green
LED2	Device ready (!NRDY bit)	Green
LED3	Failure (FLT bit)	Red
LED4	Indication of firmware flashing	Red

To enter the Standalone mode from PC controlled mode, the supply of the board needs to be dsiconnected or MCU reset by “SW\_RST” button.

**PC control mode**

1. Connect load to “OUT1/2” bush connectors.
2. Connect main supply to “Vbat” and “GND” bush connectors.
3. Connect the board by a Micro-USB connector to a PC, wait for drivers installation, if needed
4. Run NCV7535 EVB software.
5. In the startup frame select corresponding virtual COM port (you may need click the Refresh button several times).
6. Click “Connect” button.
7. The software should connect to the board. If the connection was successful, “Basic” window opens and the Standalone mode is left, which is indicated by LED1 on.
8. Several level of control abstractions are available through “Window” item in the menu bar.

9. “Board” window provides all application controls:
  - a. PWM generator inside the MCU (independent on NCV7535 configuration).
  - b. Analog-to-Digital converter inside the MCU for actual current measurement. Please note that actual current of a brushed motor may vary.
  - c. “Mode Control” allows access to EN pin and CONTROL\_0.MODE SPI bit of NCV7535
  - d. “Output Control” allows basic control of the H-bridge
  - e. “Configuration” allows changing the most important NCV7535 settings.
  - f. “Status” part combines diagnostic flags from STATUS\_0 SPI register and Global Status Bits.
10. “SPI Controller” window provides direct access to all NCV7535 SPI registers.
11. “SPI Raw” window provides direct SPI communication without any limitation and baud rate setting.
12. “Chip ID” window allows readout of NCV7535 ID Register.



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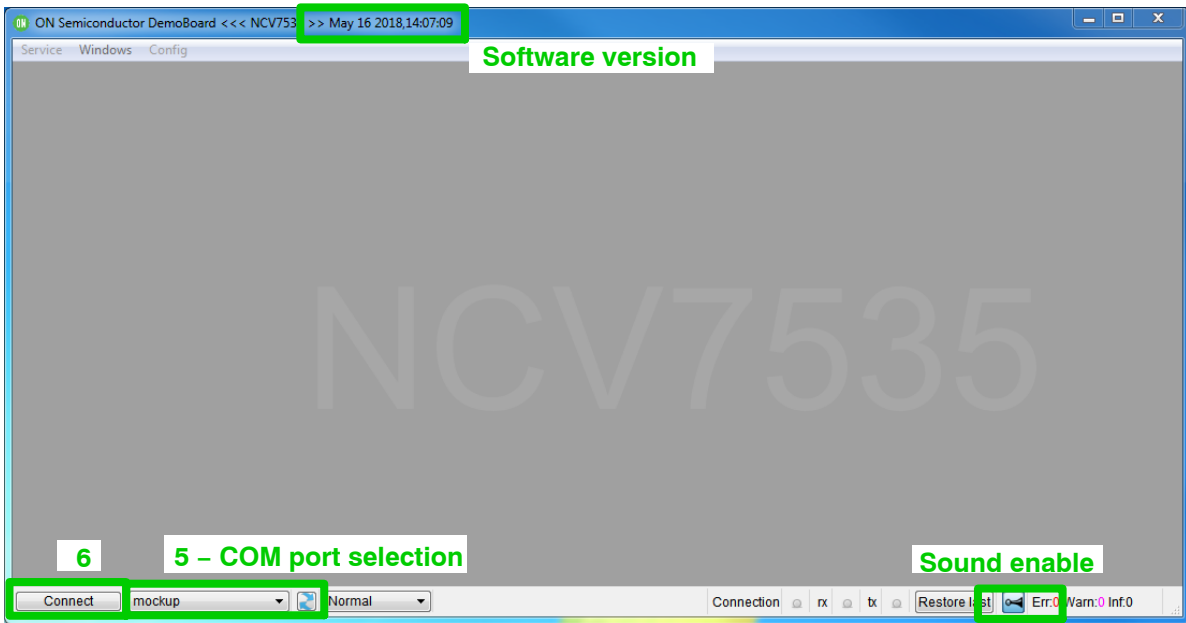


Figure 4. NCV7535 Controller Framework

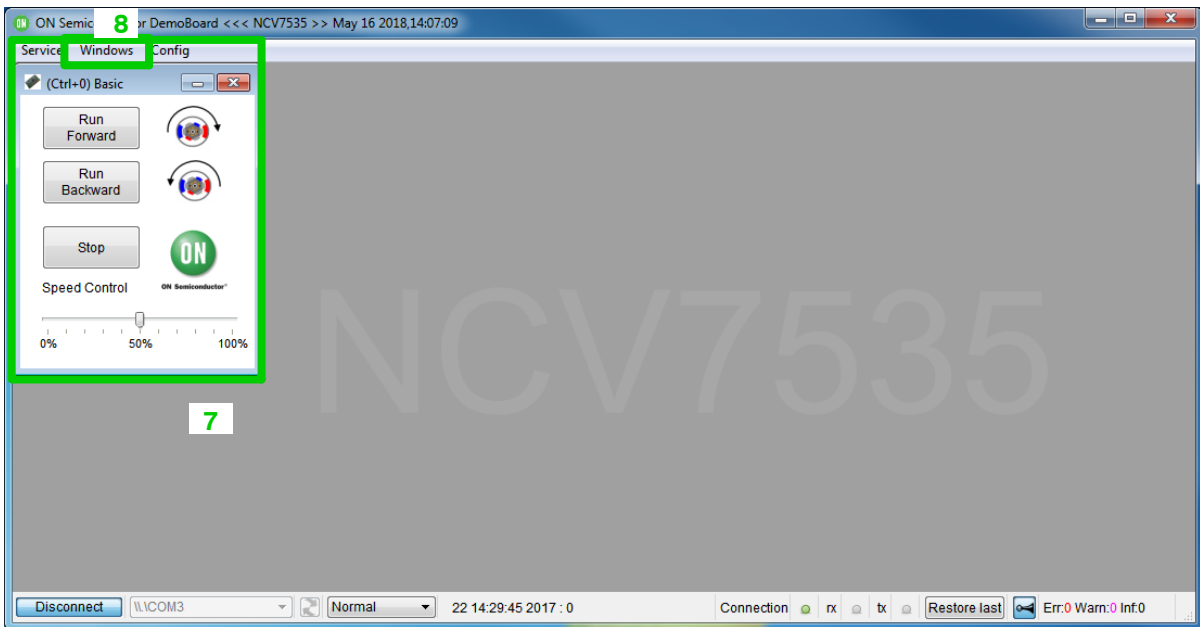


Figure 5. NCV7535 Controller Windows: Basic

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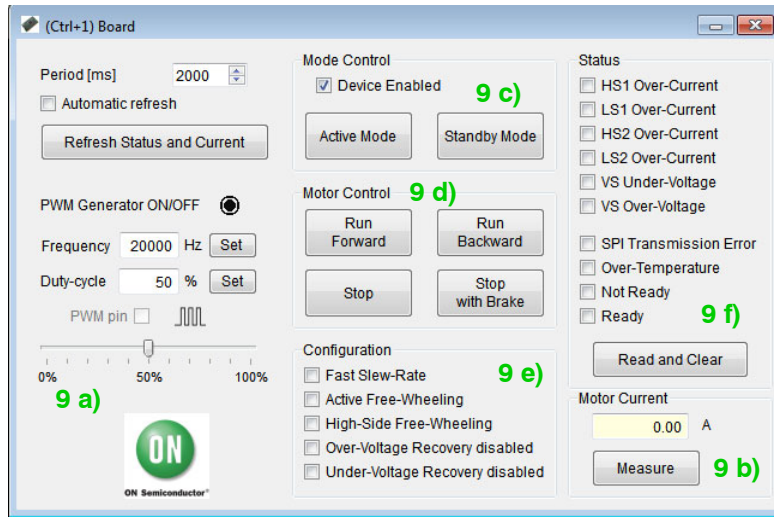


Figure 6. NCV7535 Controller Windows: Board

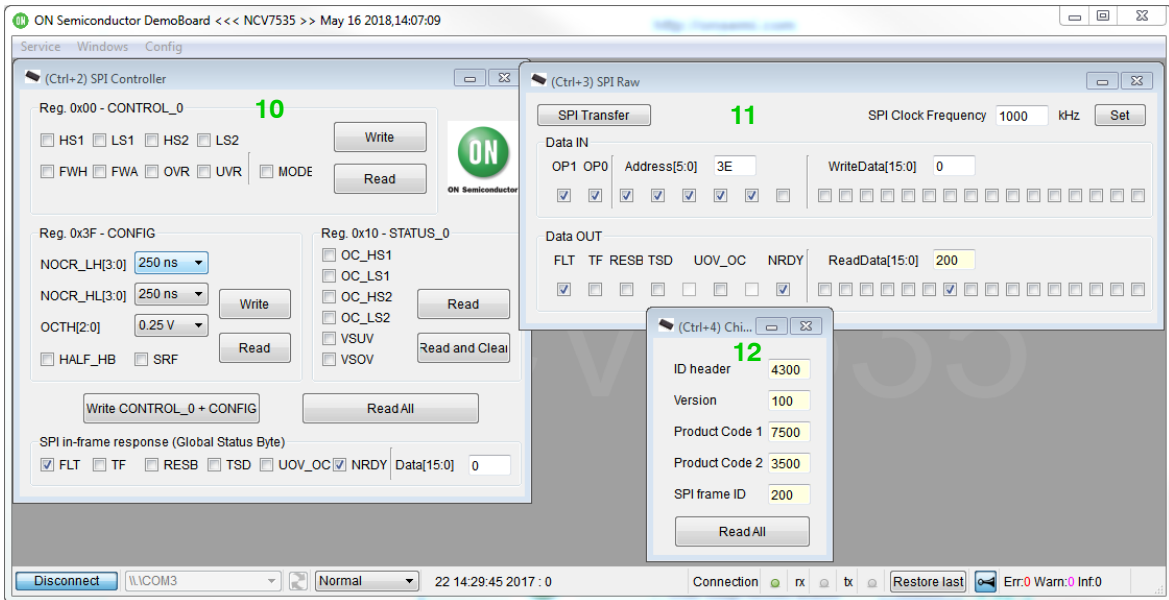


Figure 7. NCV7535 Controller Windows: SPI Controller, SPI Raw, Chip ID



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## PCB DRAWINGS

### Assembly Drawings

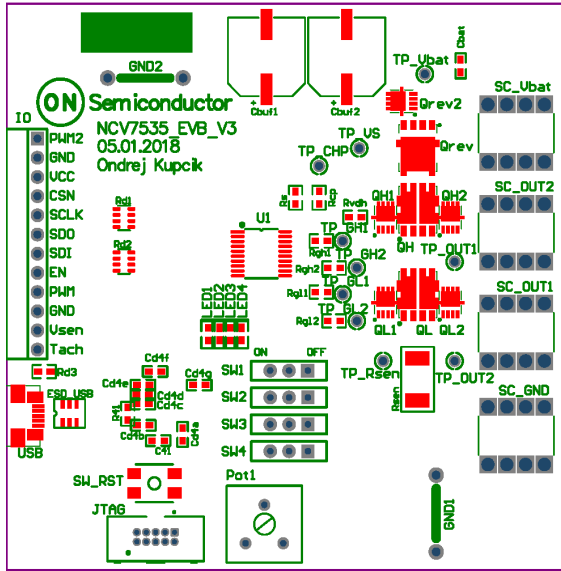


Figure 8. NCV7535 EVB PCB Top Assembly Drawing

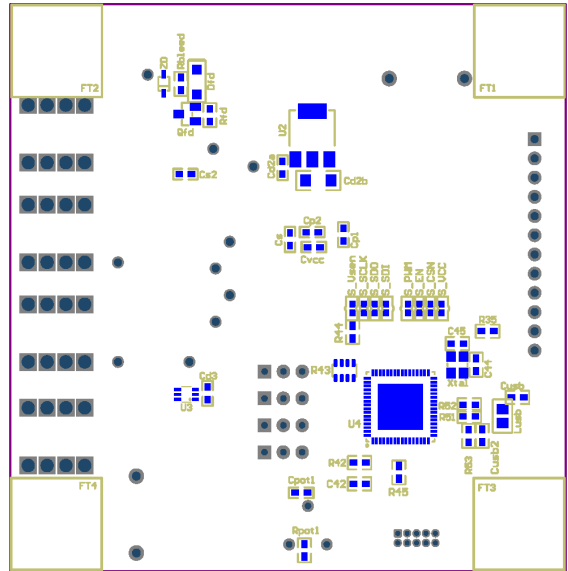


Figure 9. NCV7535 EVB PCB Bottom Assembly Drawing

### Composite Drawings

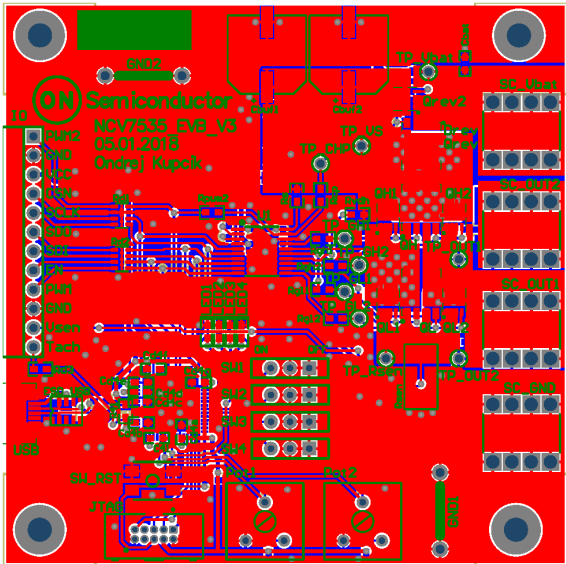


Figure 10. NCV7535 EVB PCB Top Composite Drawing

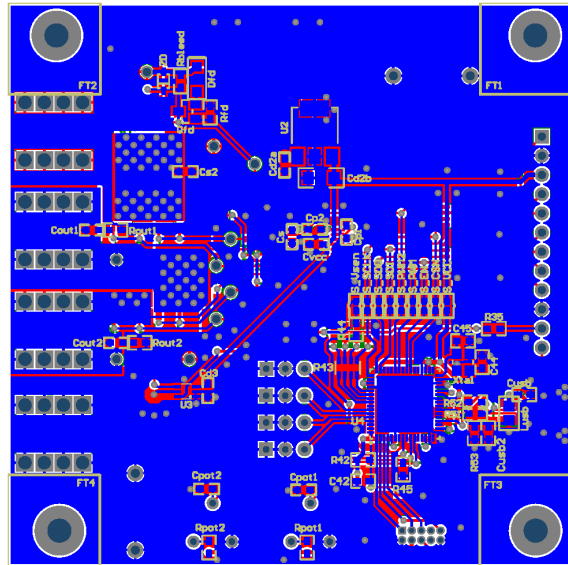


Figure 11. NCV7535 EVB PCB Bottom Composite Drawing

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