ON Semiconductor

Is Now

To learn more about onsemi™, please visit our website at
www.onsemi.com

NCV7381B0V2GEVB
NCV7381BGEVK

NCV7381B FlexRay® Transceiver Evaluation Board User's Manual

ON Semiconductor®

www.onsemi.com

EVAL BOARD USER'S MANUAL

INTRODUCTION

The NCV7381B0V2GEVB evaluation board and NCV7381BGEVK evaluation kit provides flexible and convenient platform to evaluate, characterize and verify the operation of the NCV7381BDP0R2G FlexRay transceivers.

DESCRIPTION

The NCV7381B is a single−channel FlexRay transceiver compliant with the FlexRay Electrical Physical Layer Specification Rev. 3.0.1, capable of communicating at speeds of up to 10 Mbit/s. It provides differential transmit and receive capability between a wired FlexRay communication medium on one side and a protocol controller and a host on the other side.

NCV7381B mode control functionality is optimized for nodes permanently connected to car battery.

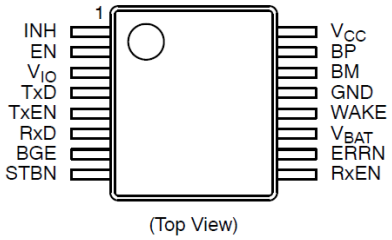
Additional details can be found in the NCV7381B datasheet.

The NCV7381B0V2GEVB Evaluation board is a reference design for stand−alone 2−channel FlexRay node. The board is intended to give designers easy, quick and convenient means for evaluation of NCV7381B FlexRay transceiver. The design incorporates complete node solution with possibility of modifications and small board size.

A set of two boards allows users to quickly start with the transceiver evaluation. The MCU is preprogrammed with simple mode control and FlexRay communication. The MCU firmware can be freely modified and reprogrammed if needed.

BOARD HARDWARE

The evaluation board consists of an MCU with integrated 2−channel FlexRay communication controller interconnected with two separate FlexRay transceivers (NCV7381B), two switchable voltage regulators and peripherals. The board is ready for various modifications of power supply concept and FlexRay bus termination, and allows for simple extension of the system by unused MCU pins. The USB interface provides connectivity with standard PC. The address of each board can be easily modified by address switch what allows for building complex FlexRay network without need of reprogramming the MCU. Implemented High Speed CAN interface can be used as a diagnostic interface in a network built from several nodes. For evaluation purposes the NCV7381B evaluation board is populated with several LEDs and most of the transceiver signals are easily accessible to oscilloscope probes.



NCV7381B Pin Connections

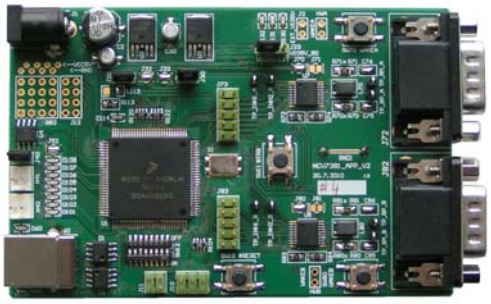


Figure 1. NCV7381B0V2GEVB Evaluation Board

GENERAL FEATURES

FlexRay Transceiver

- Two separate FlexRay channels with NCV7381B transceiver compliant with the FlexRay Electrical Physical Layer Specification Rev. 3.0.1
- Reconfigurable bus termination − End node/Middle node
- Common mode Choke and additional ESD protection footprint
- SUBD−9 connectors − FlexRay bus
- Local Wake−up switch

MCU

- 16-bit MC9S12XF family MCU with integrated FlexRay Communication Controller (Protocol Specification Rev. 2.1)
- Integrated CAN 2.0 A, B Controller
- Background Debug Module − single−wire communication with host development system
- 512 kB Flash
- 32 kB RAM
- 50 MHz maximum CPU bus frequency
- Relatively small 112−pin LQFP package

Peripherals

- Optical isolated USB interface (USB to UART converter)
- Additional CAN interface
- All NCV7381B digital I/O pins connected to test points − easy connection to Logic Analyzer
- 8 general purpose LEDs
- Address switch

Other

- Two Automotive Voltage regulators with Inhibit function (Input battery voltage up to 42 V)
- Power supplies voltage monitoring
- Instant 2−nodes FlexRay network with running communication by connecting two EVBs
- PC configuration software under development (available upon request)

PCB Layout

- The FlexRay transceiver, the ESD protection and the common mode choke are placed near to the FlexRay the ECU connector
- The FlexRay signal lines (BP, BM) are decoupled from disturbances on the ECU board
- The routing of the FlexRay lines (BP, BM, TxD and TxEN) is symmetric.
- The distance between the lines BP and BM resp. TxD and TxEN is minimized.

GETTING STARTED

The NCV7381BEVB board is fully assembled, pre−programmed and can be immediately used for evaluation. Only a few steps need be proceeded to get fully working simple FlexRay network.

Connect the evaluation boards as follows:

1. Set the boards to default configuration according to Jumpers and Default Configuration section.
2. Set a different board address on each board. One of the boards must be set with address 1 and is then considered to be a Master Board. The node address is configurable by address switch (SW12) − see Address Switch section for more details.
3. Connect the boards according to Figure 2.
4. Optionally connect an oscilloscope to any test−point as needed.
5. Once the power supply is applied, FlexRay communication is initialized automatically.

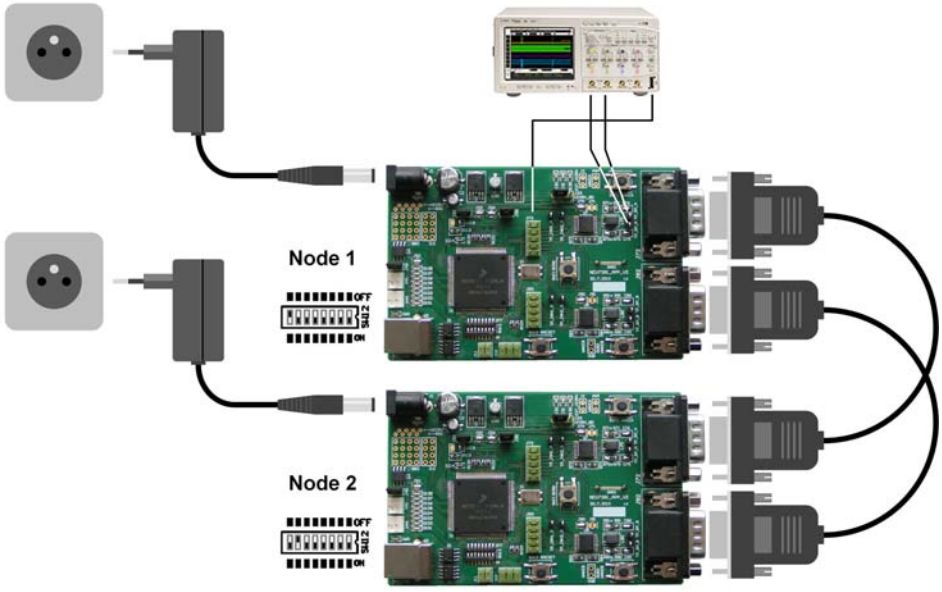


Figure 2. Getting started setup connection

Operating Modes

The nodes can operate in two different operating modes:

- Normal mode − all the nodes continuously communicate over the FlexRay bus
- Sleep mode − the communication is suspended. Both NCV7381B FlexRay transceivers are switched to low−power Sleep operating mode. The VCC and VIO power supplies are switched off by NCV7381B INH output and the transceivers are powered from VBAT supply input. MCU is not running and the board can be only woken−up with one of the Local Wake−up pushbutton switches (SW70, SW80). Indication LEDs are switched off.

Enter Sleep Mode Sequence

A transition to Sleep mode can be initiated by the node with address 1:

- Press and hold the Node1's #IRQ pushbutton switch for more than 5 seconds. The GO_TO_SLEEP signal is transmitted over the FlexRay bus. All the nodes then synchronously stop the communication and switch to Sleep mode.

Wake−up Sequence

The network operating in Sleep mode can be woken−up by any node:

- NCV7381B Local Wake−up function – Press the Local Wake−up pushbutton switch on any node connected to the network. The corresponding FlexRay transceiver is woken−up from Sleep mode and activates its INH output. Consequently the VCC and VIO supply voltage regulators are activated and the MCU resumes operation in Normal mode.
- NCV7381B Remote Wake−up function – Once the first node is active, it automatically wakes up the rest of the network by sending FlexRay Remote Wakeup Pattern over the bus. As soon as all the nodes are woken−up and initialized, the FlexRay communication is restarted.

LED Indication modes

Three LED indication modes are available – FlexRay communication indication, Status indication Channel A and B. Press and hold the pushbutton for approximately 2 seconds to cycle between the indication modes.

- FlexRay communication indication – each LED is assigned to one slot according to LED number. The LED is blinking if the respective slot in FlexRay communication is active.

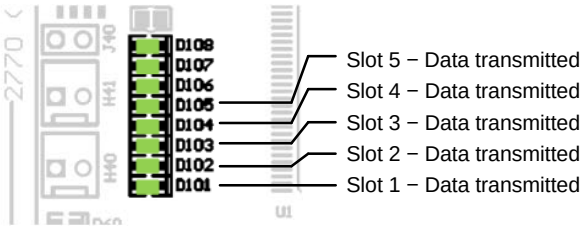


Figure 3. FlexRay communication indication

- FlexRay transceiver status indication − Channel A
- FlexRay transceiver status indication − Channel B
  - LED1 − Local Wake−Up status
  - LED2 − Remote Wake−up status
  - LED3 − TxEN Timeout status
  - LED4 − Bus Error status
  - LED5 − VIO Undervoltage status
  - LED6 − VCC Undervoltage status
  - LED7 − VBAT Undervoltage status
  - LED8 − Power−on status

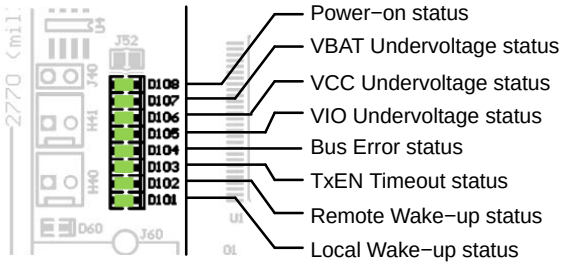
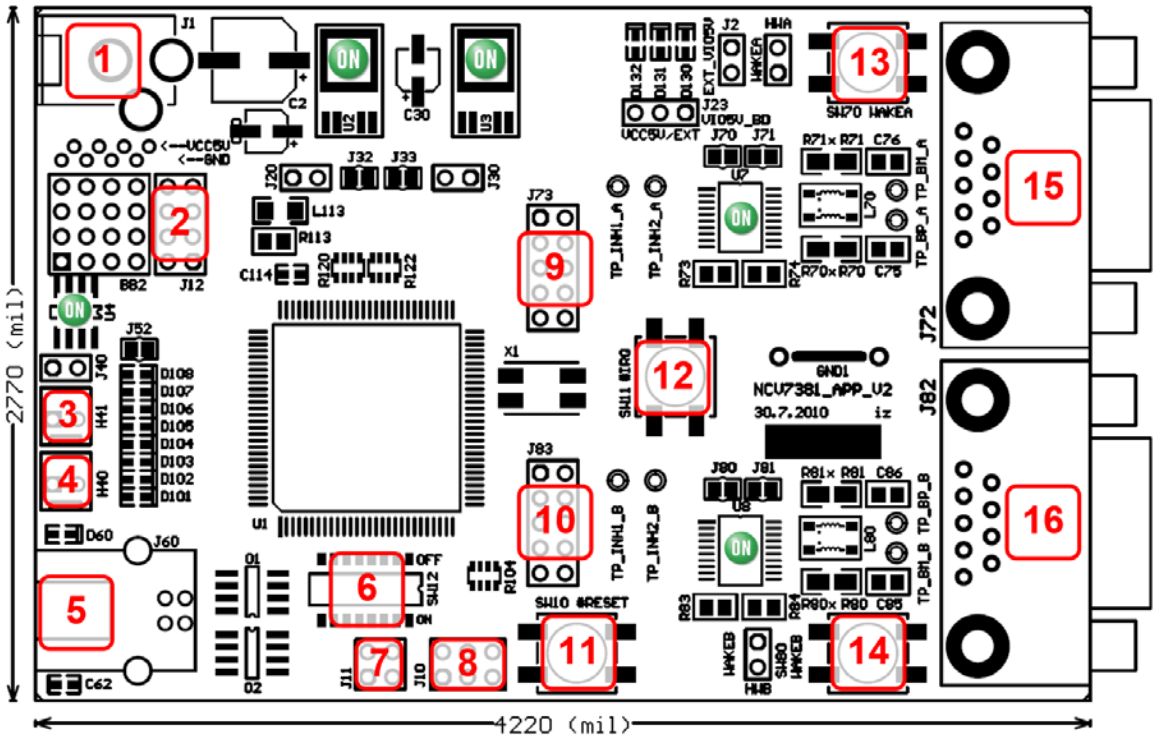


Figure 4. FlexRay transceiver status indication

In FlexRay transceiver status indication mode, press the pushbutton shortly to read−out the status register.

BOARD OVERVIEW



Legend:

1. Power supply input connector
2. Aux digital I/O connector
3. CAN backbone connector 1
4. CAN backbone connector 2
5. USB interface
6. Address DIP switch
7. FlexRay CC Strobe output signals
8. BDM Connector (MCU debugging interface)
9. FlexRay BD signals test points (Channel A)
10. FlexRay BD signals test points (Channel B)
11. MCU Reset pushbutton switch
12. MCU External interrupt pushbutton switch
13. BD Local Wake−up pushbutton switch (Channel A)
14. BD Local Wake−up pushbutton switch (Channel B)
15. FlexRay bus connector (Channel A)
16. FlexRay bus connector (Channel B)

Figure 5. Basic interface

Power Supply Input Connector

Power supply input socket. Plug diameter 2.1 mm, length 14 mm. Maximum input voltage 42 V (Limited by onboard voltage regulators).

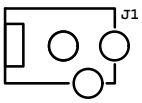


Figure 6. Power Supply Input Connector

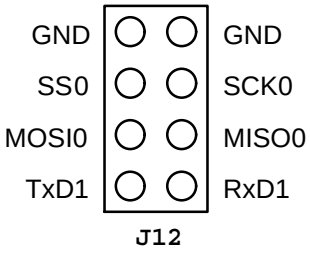


Figure 7. Aux Digital I/O Connector

Aux Digital I/O Connector

This pin header contains 6 auxiliary MCU signals – one SPI interface (4 pins) and one UART interface (2 pins). These signals can be also used as general input/output signals for debugging or other purposes.

CAN Backbone Connectors

CAN backbone network is a parallel connection of multiple boards. Each board contains two equivalent connectors in parallel, and thus whole network can be built using simple point−to−point twisted pair cables.

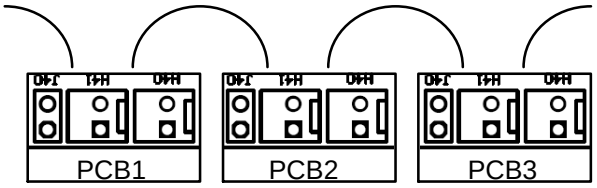


Figure 8. CAN Backbone Connectors

USB Interface

Standard B type USB socket is used for connection to PC. USB interface is bus powered and electrically isolated from the rest of the board, so it is not possible to supply this board via USB.

FlexRay CC Strobe Output Signals

The MCU FlexRay block provides a number of strobe signals for observing internal protocol timing related signals in the protocol engine.

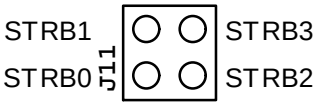


Figure 9. FlexRay CC Strobe Output Signals

These signals are connected to STRB pin header:

BDM Connector (MCU Debugging Interface)

The BDM module provides a single−wire communication with host development system (Programming and debugging interface).

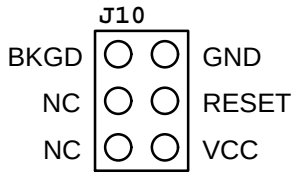


Figure 10. BDM Connector (MCU Debugging Interface)

FlexRay BD Digital Signals Test Points Headers

These headers are intended to be used as a test points for digital probes. Headers contain all FlexRay BD digital input and output signals.

Test points for both FlexRay channel A and channel B are placed on separated headers (J73 – channel A, J83 – channel B).

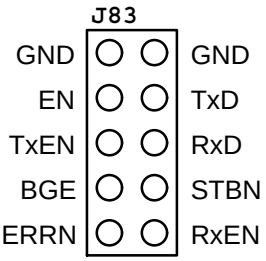


Figure 11. FlexRay BD Digital Signals Test Points Headers

FlexRay BD Analog Signals Test Points

Each FlexRay channel contains 4 analog test points:

- INH1 − Bus Driver Inhibit 1 output
- INH2 − Bus Driver Inhibit 2 output
- BP − FlexRay Bus Plus terminal
- BM − FlexRay Bus Minus terminal

FlexRay Bus Connectors

FlexRay EPL Specification [2] does not prescribe certain connectors for FlexRay systems. Commonly used 9−pin D−Sub connectors meet the defined constraints such as maximum contact resistance and connector impedance.

Table 1. FLEXRAY CONNECTOR

Pin #	Signal	Description	Connection	ESD Protection
1	−	Reserved	Not Connected	
2	FR_BM	BM Bus Line	BM	Yes (Optional)
3	FR_GND	Ground	GND	
4	−	Reserved	Not Connected	
5	−	Reserved	Not Connected	
6	−	Reserved	Not Connected	
7	FR_BP	BP Bus Line	BP	Yes (Optional)
8	−	Reserved	Not Connected	
9	(FR_VBAT)	Optional FR External Supply	Main Supply Line	Yes

Connector type: 9−pin D−Sub (DIN41652 or corresponding international standard), plug (male).

JUMPERS AND DEFAULT CONFIGURATION

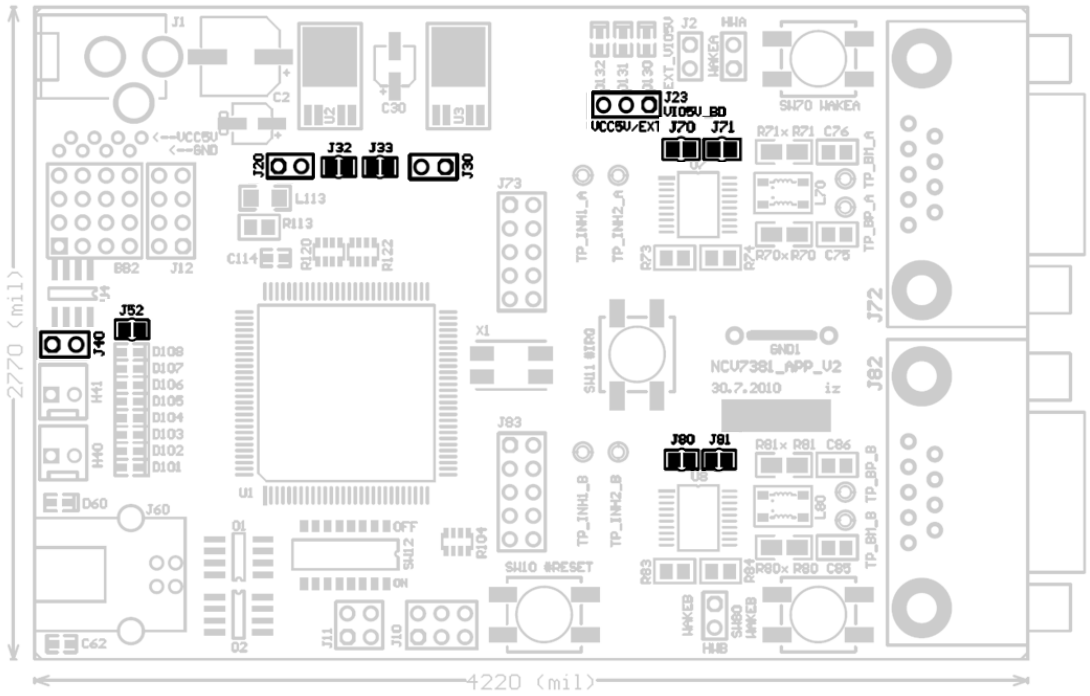


Figure 12. Jumpers and Soldering Straps

Table 2. 2−PIN JUMPER

		Open
		Closed

Table 3. 2−PIN JUMPER

1 2 3	
	Open
	Closed position 1−2
	Closed position 2−3

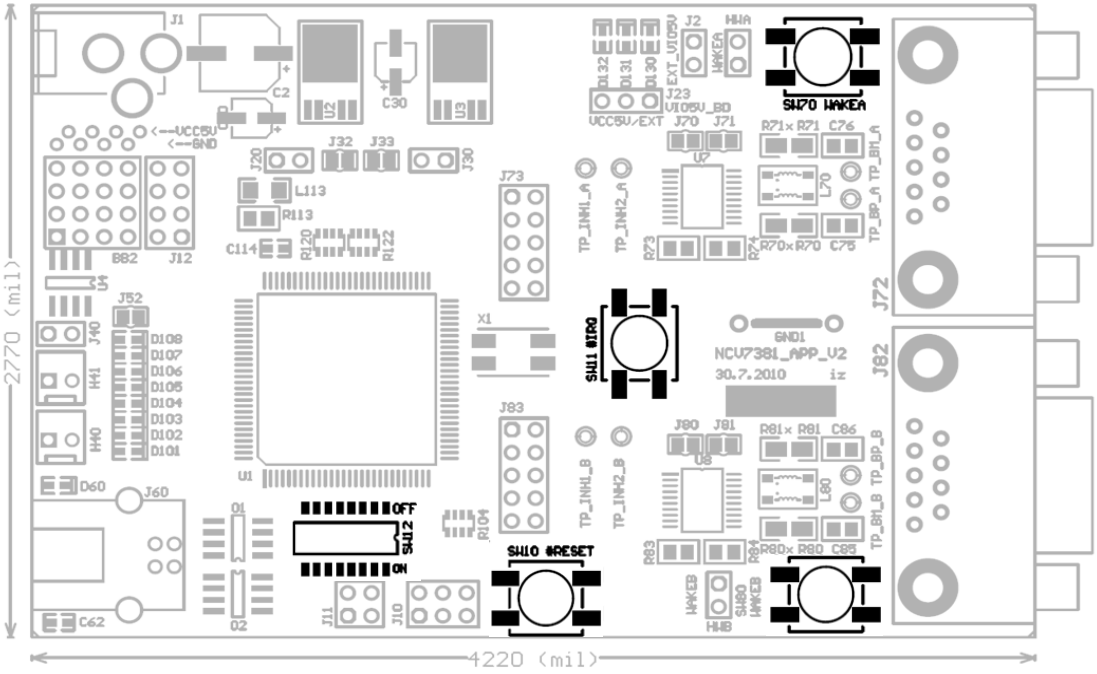
Table 4. JUMPERS CONFIGURATION

Jumper	Function	Configuration	Description	Default
J20	MCU VCC 5 V State	Open	Controlled by bd_INH1_x	Open
		Closed	Always On	
J23	BD VIO power supply selection	Open	BD VIO Disconnected	Closed 1−2
		Closed 1−2	BD VIO Connected to MCU VCC	
		Closed 2−3	BD VIO − External VIO power supply	
J30	BD VCC State	Open	Controlled by MCU	Closed
		Closed	Controlled by bd_INHx_x	
J32	BD VCC Inhibit source (Ch A)	Open	bd_INH2_A	Closed
		Closed	bd_INH1_A	
J33	BD VCC Inhibit source (Ch B)	Open	bd_INH2_B	Closed
		Closed	bd_INH1_B	
J40	CAN bus terminator	Open	Without Termination	Closed
		Closed	With 120 Ω Termination	

Table 4. JUMPERS CONFIGURATION (continued)

Jumper	Function	Configuration	Description	Default
J52	General purpose LED	Open	LEDs Disabled	Closed
		Closed	LEDs Enabled	
J70	Bus Driver VBAT supply (Ch A)	Open	BD VBAT Disconnected	Closed
		Closed	BD VBAT Connected	
J71	Bus Driver VBUF supply (Ch A)	Open	BD VBUF Disconnected	Open
		Closed	BD VBUF Connected to BD VCC	
J80	Bus Driver VBAT supply (Ch B)	Open	BD VBAT Disconnected	Closed
		Closed	BD VBAT Connected	
J81	Bus Driver VBUF supply (Ch B)	Open	BD VBUF Disconnected	Open
		Closed	BD VBUF Connected to BD VCC	

SWITCHES AND PUSHBUTTONS



- SW10 − MCU Reset pushbutton switch
- SW11 − MCU External interrupt pushbutton switch
- SW12 − 8−way DIP switch. The function depends on the MCU program. By default it is used for setting a node address.
- SW70 − FlexRay Transceiver Local Wake−up pushbutton switch (Channel A)
- SW80 − FlexRay Transceiver Local Wake−up pushbutton switch (Channel B)

Figure 13. Switches Description

Address Switch

This switch is used for setting a node address. Each board is programmed with the same firmware, therefore to distinguish individual nodes from each other and map the data to individual communication slots, every node in the network must be assigned a unique number.

LSB is situated on the left!

ON means the particular switch is closed and output is *Logical 0*!

OFF means the particular switch is open and output is *Logical 1*!

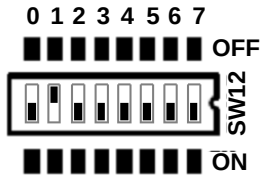


Figure 14. Address Configuration Switch

The switch configuration shown in this figure means binary 0b00000010 (Node address is set to 2).

MCU Reset Pushbutton Switch

This switch is used to generate an external reset event at the MCU reset pin.

MCU External Interrupt Pushbutton Switch

The MCU interrupt module supports one maskable interrupt input. This input is connected to SW11.

Local Wake−up Pushbutton Switch

The NCV7381B FlexRay transceiver supports Local Wake−up event detection. If a falling edge is recognized on WAKE pin, a local wake−up is detected. These switches (one for each FlexRay channel) can be used to generate a Local wake−up event that is normally generated by e.g. mechanical switch.

LEDs

Three power supply LEDs indicate proper function of the voltage regulators. In case the MCU and the NCV7381B transceivers I/O cells use the same power supply (as by default), the MCU VCC LED and BD VIO LED signalling is also the same.

The board contains a bank of eight general purpose LEDs (Green). Their function depends on the MCU program. There is also a USB indication LED which is used to indicate any ongoing USB data transmission.

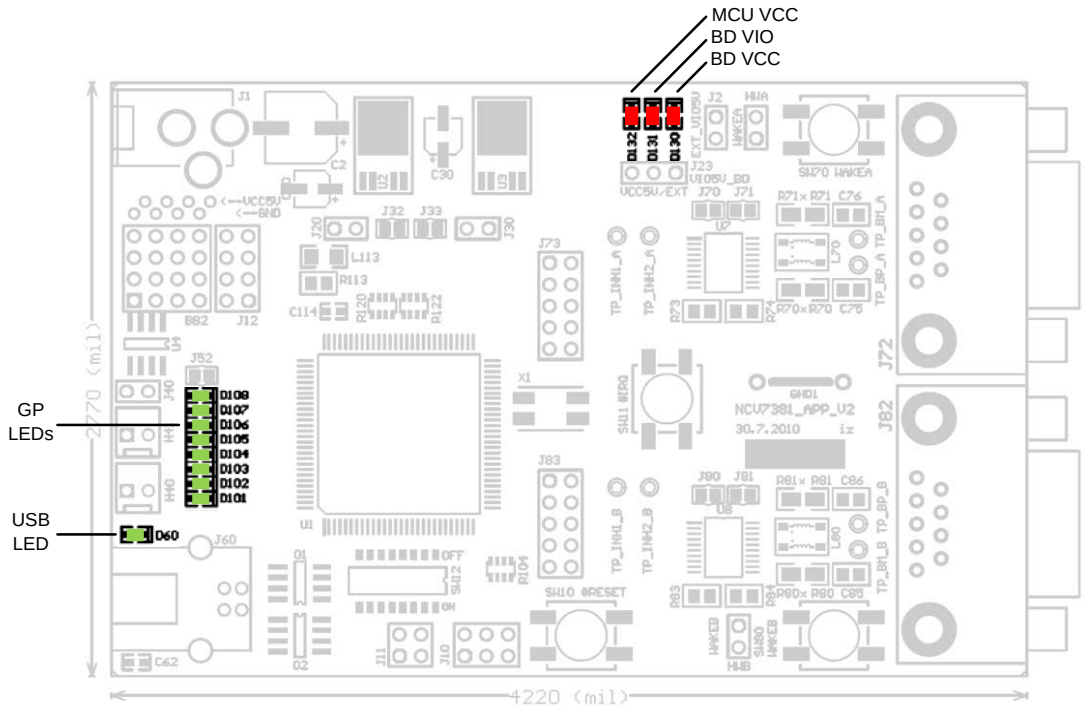


Figure 15. LEDs Description

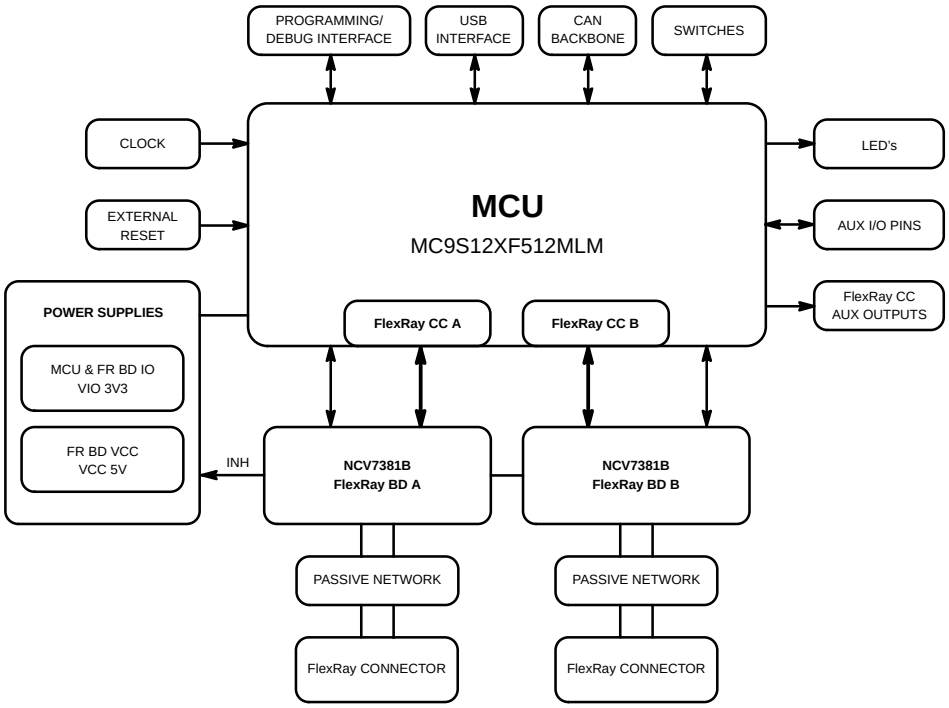


Figure 16. NCV7381B EVB Block Diagram

TYPICAL APPLICATION DIAGRAM

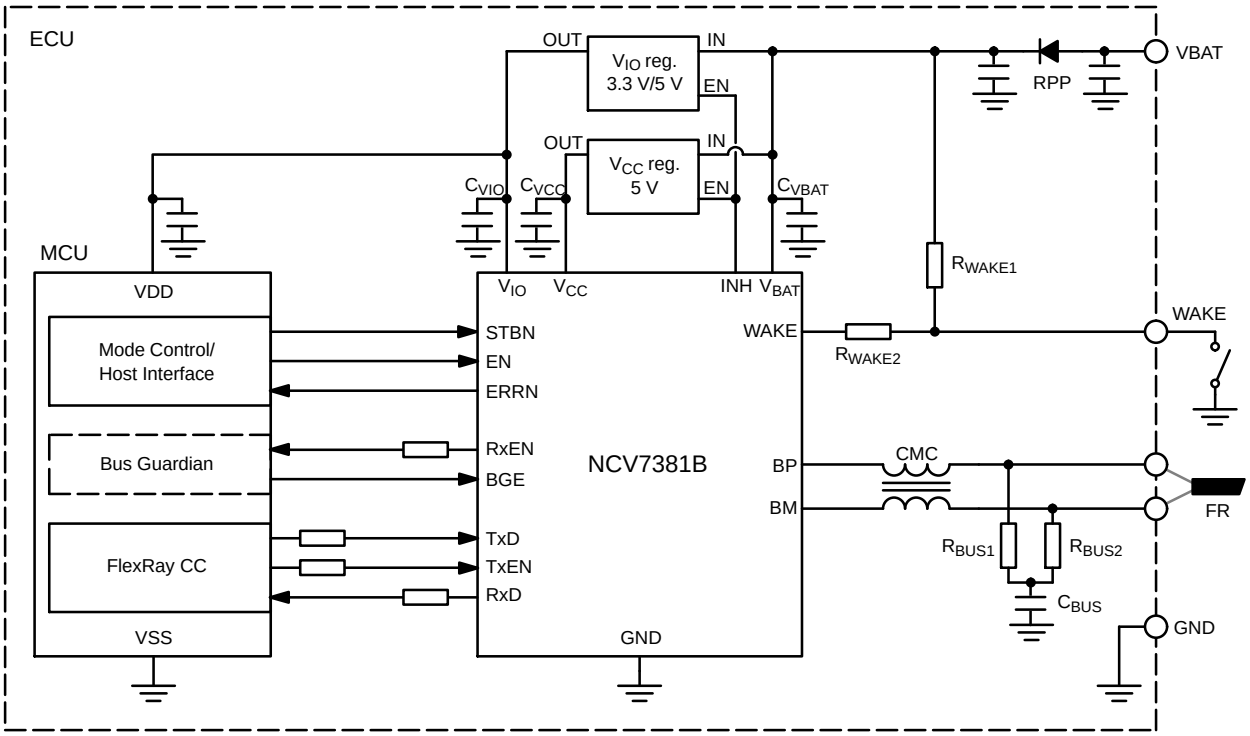


Figure 17. Typical Application Diagram

Table 5. RECOMMENDED EXTERNAL COMPONENTS FOR THE APPLICATION DIAGRAM

Component	Function	Min.	Typ.	Max.	Unit
C_{VBAT}	Decoupling capacitor on battery line, ceramic		100		nF
C_{VCC}	Decoupling capacitor on V_{CC} supply line, ceramic		100		nF
C_{VIO}	Decoupling capacitor on V_{IO} supply line, ceramic		100		nF
R_{WAKE1}	Pull−up resistor on WAKE pin		33		kΩ
R_{WAKE2}	Serial protection resistor on WAKE pin		3.3		kΩ
R_{BUS1}	Bus termination resistor (Note 1)		47.5		Ω
R_{BUS2}	Bus termination resistor (Note 1)		47.5		Ω
C_{BUS}	Common−mode stabilizing capacitor, ceramic (Note 2)		4.7		nF
CMC	Common−mode choke		100		μH

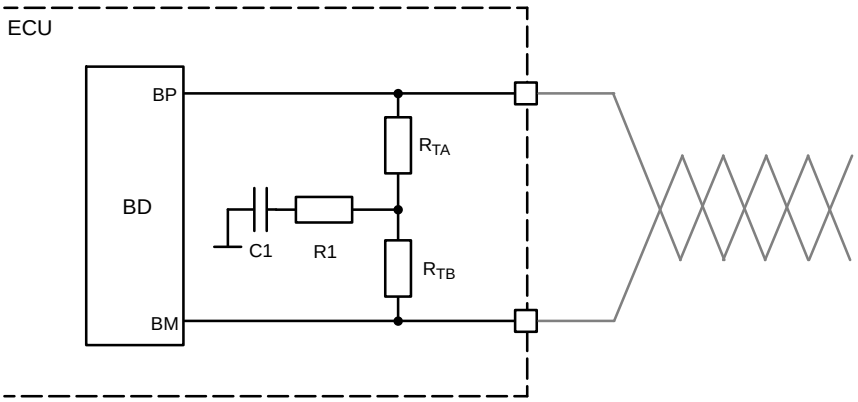
1. Tolerance ± 1%, type 0805
2. Tolerance ± 20%, type 0805

POWER SUPPLY

The evaluation board can be powered either via DC power supply input socket with plug diameter 2.1 mm and length 14 mm or by one of the FlexRay bus connectors (See the FlexRay Bus ConnectorsFlexRay bus connector (Channel A) section). Maximum input voltage (42 V) is limited by on−board voltage regulators input voltage range.

SPLIT TERMINATION

In order to achieve better EMC performance, it is recommended to make use of so−called split termination in all ECUs, where the termination resistance R_T is split into two equal parts R_{TA} and R_{TB} [2].



NOTE: The serial RC combination (R1, C1) at the center tap of the split termination provides a termination to GND for common mode signals. R1 is preferably omitted. Typical values are given in the following table.

Figure 18. ECU with split termination [2]

Table 6. TERMINATION PARAMETERS

Name	Description	Typ.	Unit
R1	Resistor	< 10	Ω
C1	Capacitor	4700	pF
$2 \times \lvert R_{TA}-R_{TB}\rvert/(R_{TA} + R_{TB})$	Matching of termination resistors	≤ 2	%

NOTES: For R_{TA} and R_{TB} the use of 1% tolerated resistors leads to a matching of 2%.
The better the matching of the split termination resistors R_{TA} and R_{TB}, the lower the electromagnetic emission.

Standard termination

Recommended bus split termination is shown in the Figure 19. Considering passive network, without active stars, proper termination should be applied at the two nodes that have the maximum electrical distance on the bus. The sum of termination resistors values should match the nominal cable impedance. At other nodes a high−ohmic split termination should be applied.

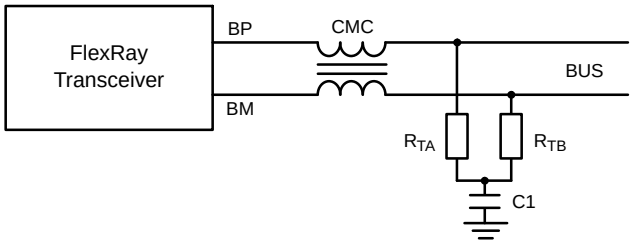


Figure 19. Basic Split Termination and Common Mode Choke Connection

Table 7. BASIC SPLIT TERMINATION PARAMETERS

Name	Description	Value		Unit
		End node	Middle node	
R_{TA}, R_{TB}	Termination resistors	47	1300	Ω
C1	Capacitor	4700	4700	pF

Custom Termination

In some cases a specific termination topology is required for middle modes. Such termination connection and typical values are shown in Figure 21 and Table 8.

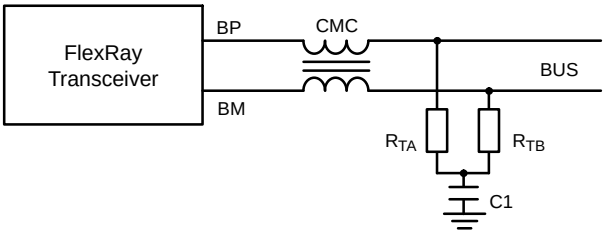


Figure 20. End Node Split Termination

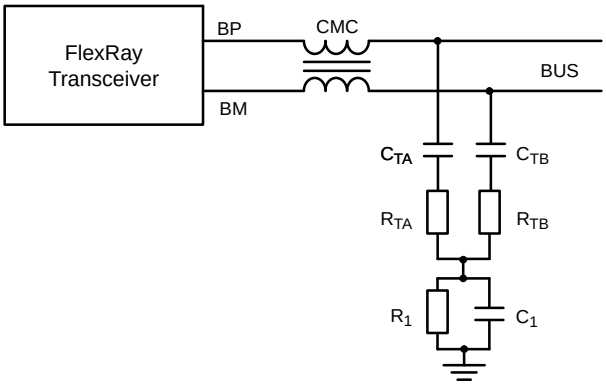


Figure 21. Middle Node Split Termination

Table 8. CUSTOM SPLIT TERMINATION PARAMETERS

Name	Description	Value		Unit
		End node	Middle node	
R_{TA}, R_{TB}	Termination resistors	47	24	Ω
C1	Capacitor	4700	4.7	pF
R1	Resistor	−	47	Ω
C_{TA}, C_{TB}	Termination capacitors	−	100	pF

COMMON MODE CHOKE

A common mode choke (CMC) is used to improve the emission and immunity performance. The function of the common mode choke is to force the current in both signal wires to be of the same strength, but opposite direction. Therefore, the choke represents high impedance for common mode signals. The parasitic stray inductance should be as low as possible in order to keep oscillations on the bus low. The common mode choke is placed between transceiver and split termination [2]. CMC requirements are listed in Table 9. Basic connection is shown in Figure 19.

Table 9. COMMON MODE CHOKE REQUIEREMENTS [2]

Name	Description	Typ.	Unit
R_{CMC}	Resistance per line	≤ 1	Ω
L_{CMC}	Main inductance	≥ 100	μH
L_{σ}	Stray inductance	< 1	μH

MCU PROGRAMMING INTERFACE

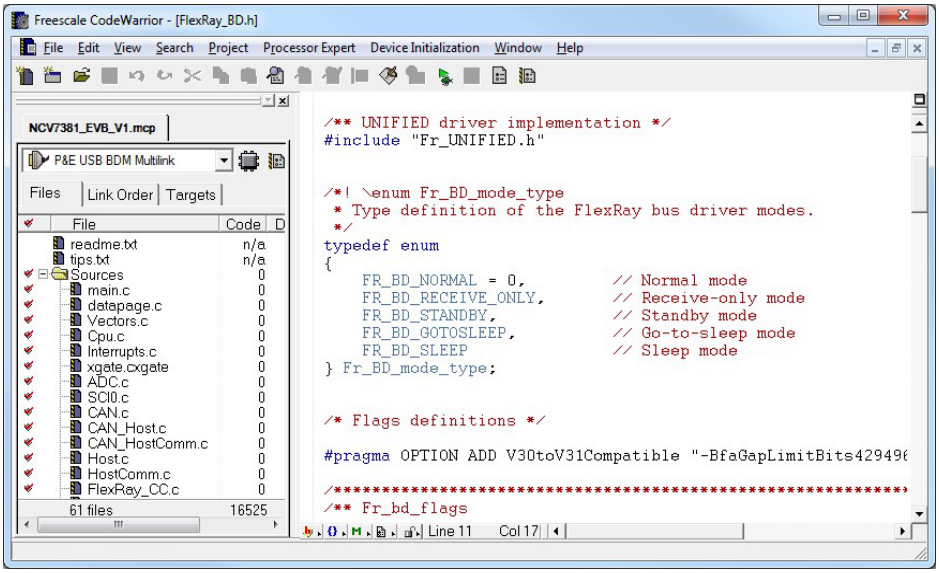
The NCV7381B0V2GEVB firmware can be freely reprogrammed using MCU programming and debugging interface (J10). The microcontroller can be programmed with PEmicro's USB Multilink BDM (Discontinued) or Universal module.

Figure 22. PEmicro USB Multilink BDM module (Discontinued)

Figure 23. PEmicro USB Multilink Universal Debug module

SOFTWARE DEVELOPMENT TOOL

Freescale CodeWarrior® Development Studio for HCS12(X) Microcontrollers (Classic IDE) v5.2 (http://www.nxp.com/) can be used for programming and debugging of the microcontroller firmware. The PEmicro USB Multilink interface is directly supported.



NOTE: The NCV7381B EVB firmware can be downloaded from ON Semiconductor web site (http://www.onsemi.com/).

Figure 24. CodeWarrior Development Studio

SCHEMATIC

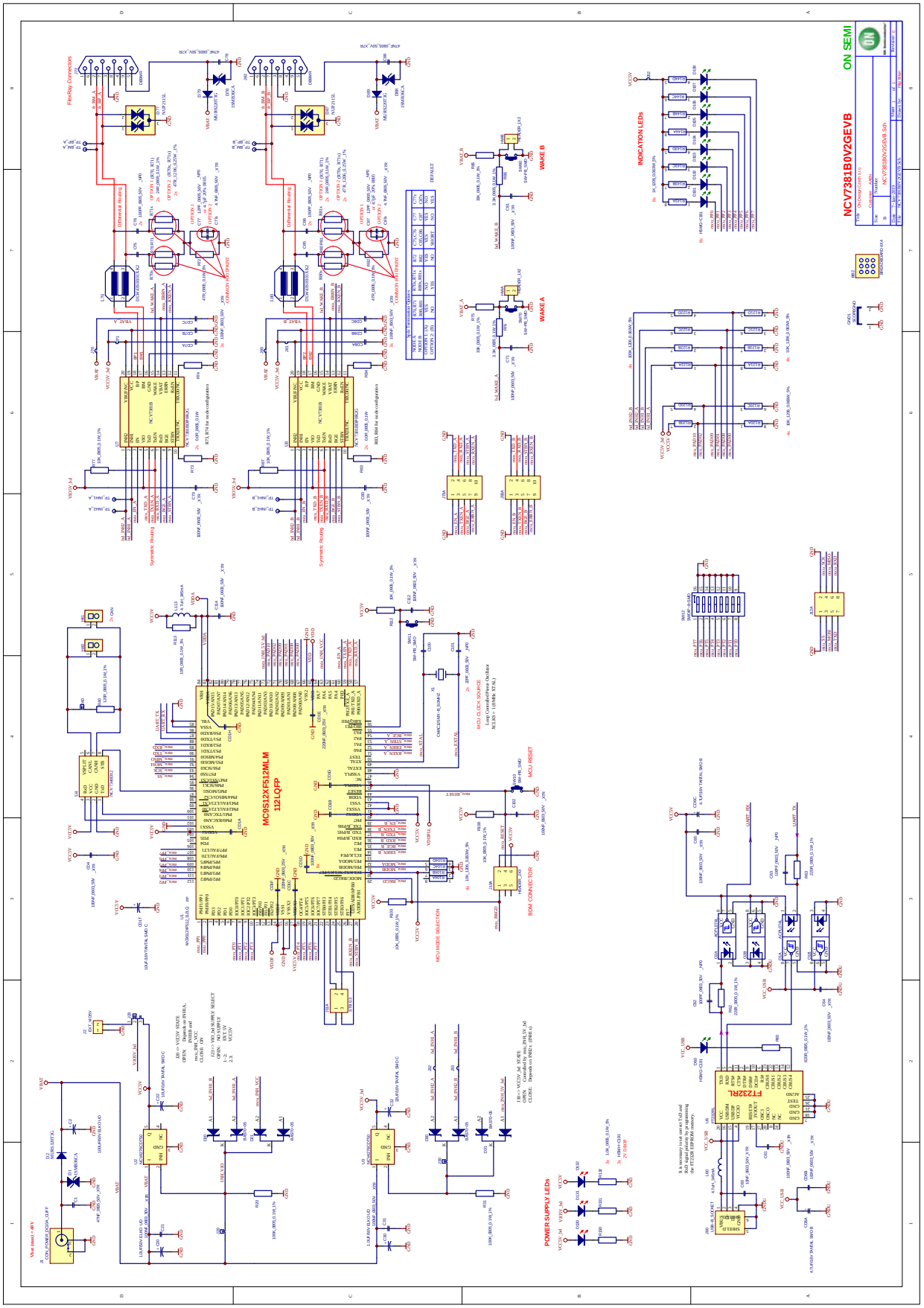


Figure 25. NCV7381B0V2GEVB Schematic

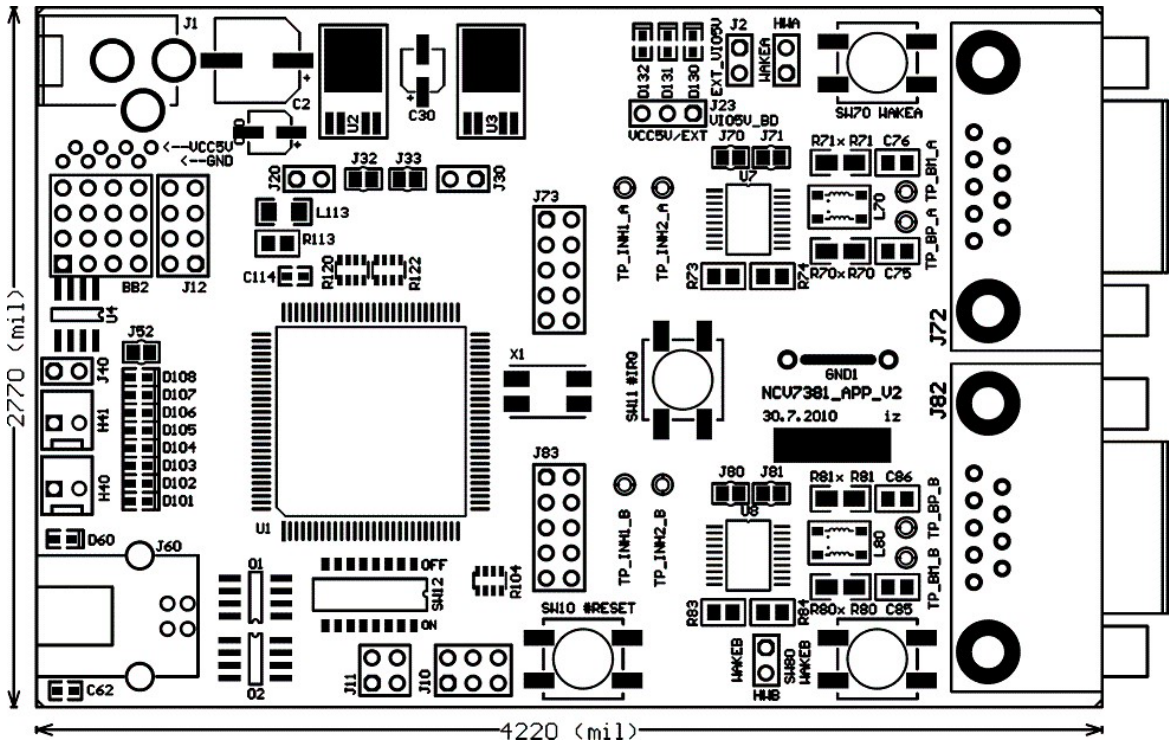


Figure 26. PCB Top Assembly Drawing

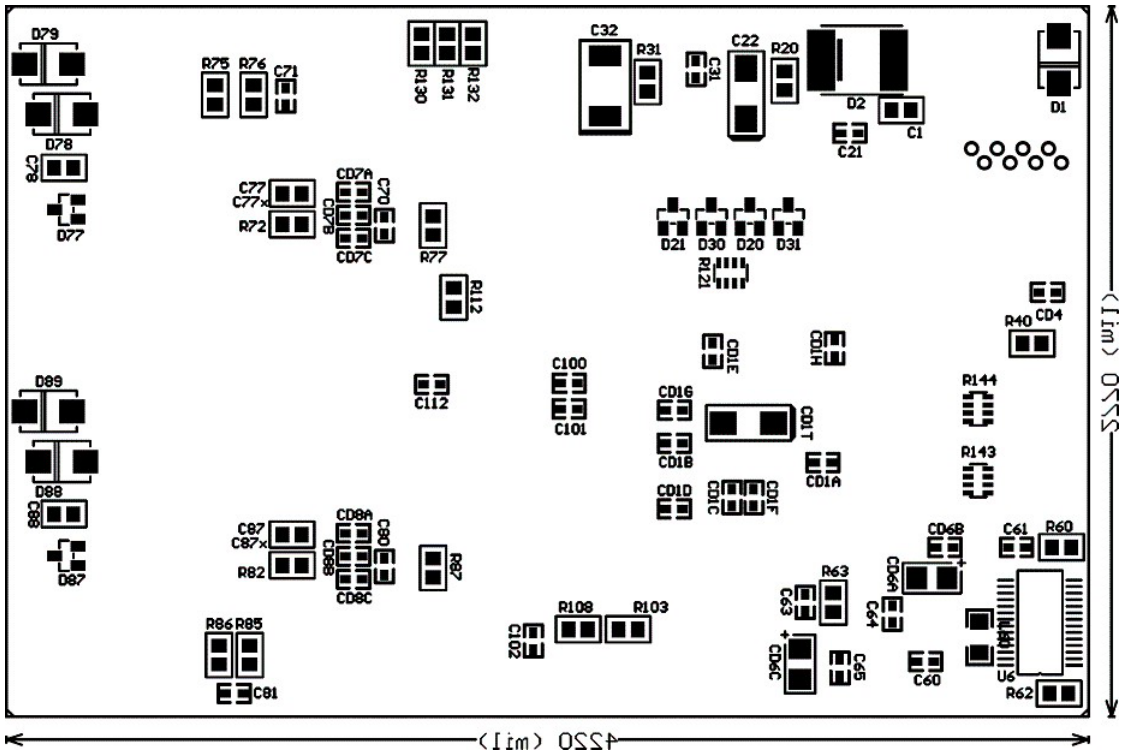


Figure 27. PCB Bottom Assembly Drawing

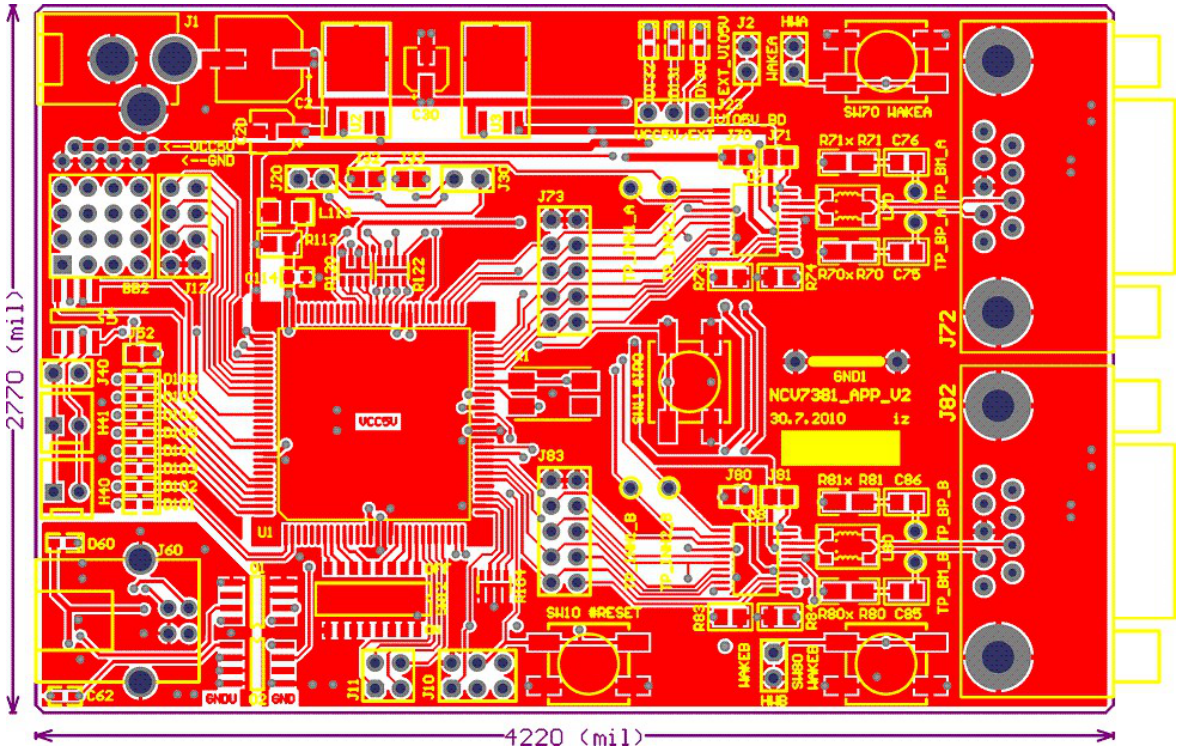


Figure 28. PCB Top Composite Drawing

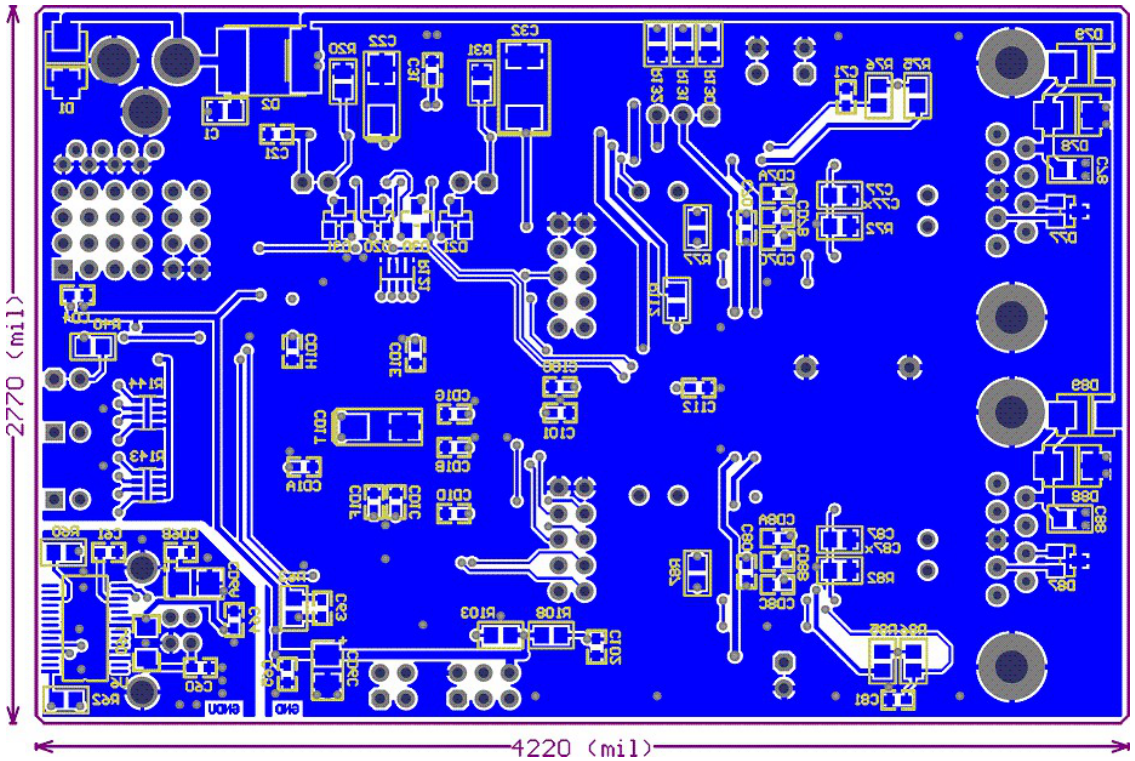


Figure 29. PCB Bottom Composite Drawing (Mirrored)

PCB GENERAL PARAMETERS

- Material: FR4
- CU Plating Thickness: 18 μm (0.5 oz)
- Surface Treatment: Au
- Solder Resist: Green, both sides

DIMENSIONS

- Length: 107.2 mm (4220 mil)
- Width: 70.4 mm (2770 mil)
- Thickness: 1.5 mm (60 mil)
- Minimum Clearance: 0.25 mm (9.842 mil)

REFERENCES

[1] ON Semiconductor. NCV7381B/D, Product Datasheet, Rev. 4, April 2018, www.onsemi.com

[2] FlexRay Consortium. FlexRay Communications System − Electrical Physical Layer Specification, V3.0.1., October 2010

[3] FlexRay Consortium. FlexRay Communications System − Physical Layer EMC Measurement Specification, V3.0.1., October 2010

PUBLICATION ORDERING INFORMATION

LITERATURE FULFILLMENT:
Literature Distribution Center for ON Semiconductor
19521 E. 32nd Pkwy, Aurora, Colorado 80011 USA
Phone: 303−675−2175 or 800−344−3860 Toll Free USA/Canada
Fax: 303−675−2176 or 800−344−3867 Toll Free USA/Canada
Email: orderlit@onsemi.com

N. American Technical Support: 800−282−9855 Toll Free USA/Canada
Europe, Middle East and Africa Technical Support:
Phone: 421 33 790 2910

ON Semiconductor Website: **www.onsemi.com**

Order Literature: http://www.onsemi.com/orderlit

For additional information, please contact your local Sales Representative