

NCV7718EVB, NCV7720EVB

NCV7718, NCV7720 Half-Bridge Drivers Evaluation Board User's Manual



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EVAL BOARD USER'S MANUAL

Description

The NCV7717-7720 evaluation board provides a convenient method to evaluate the NCV7718 and NCV7720 half-bridge drivers in a suitable application environment. A one board solution for all the drivers in the family is possible since all the devices share the same package and common pin-out structure. The evaluation board is intended to be used with the ON Semiconductor FlexMOS GUI installed on a personal computer (PC) and the USB to SPI interface adapter board for a master-slave communication between the target board and the PC. The evaluation boards allow flexible configuration of the various loads and each of the half-bridges can be individually controlled via the FlexMOS GUI. The evaluation board is populated with an adjustable LDO (NCV4276), so a 3.3 V or 5 V digital supply voltage (VCC) can be selected through the GUI. By means of a jumper the user can bypass the onboard regulator and use an external power supply. Furthermore the onboard LEDs provide visual indication of the board configuration. An external reverse battery circuitry is implemented on the evaluation board to protect the integrated driver in scenarios where the VBAT supply polarity is reversed. This feature can be disabled by slightly modifying the board.

Features

- One Hardware Solution for NCV7718 and NCV7720 Half-Bridge Drivers
- 0.55 A Peak Current
- High Side and Low Side Drivers Connected as Half-Bridge Configuration
- $R_{dson} = 1 \Omega$ (typ)
- 3.3 V or 5 V VCC Operation with an Onboard Adjustable Regulator
- Over Current and Over Temperature Protection
- Under Load Detection
- Dedicated GUI Interface for Device Control and Diagnostic



Figure 1. FlexMOS Evaluation Board Solution

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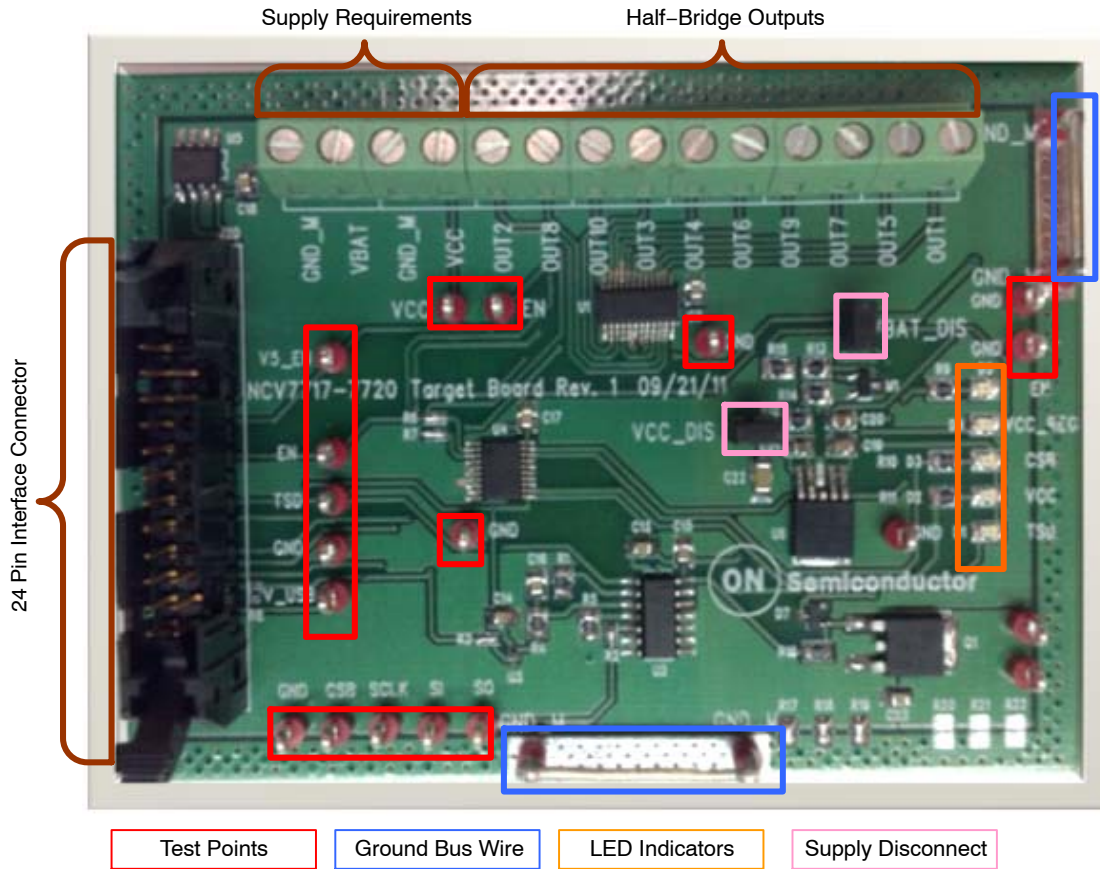


Figure 2. Evaluation Board

Table 1. ABSOLUTE MAXIMUM RATINGS

Rating	Value	Units
Main Supply Voltage (VBAT) Without Reverse Battery Protection Circuitry With Reverse Batter Protection Circuitry	-0.3 to 40 -60 to 40	V
External Digital Supply Voltage (VCC)	-0.3 to 5.5	V
Output Pins (OUTx) Without Reverse Battery Protection Circuitry With Reverse Batter Protection Circuitry	-0.3 to 40 -60 to 40	V
USB to SPI Interface Adapter Connector Pins	-0.5 to 5.5	V
Junction Temperature (NCV7718, NCV7720)	-40 to 150	°C
Ambient Temperature (Evaluation board)	-40 to 105	°C

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

Table 2. RECOMMENDED OPERATING CONDITIONS

Rating	Value		Units
	Min	Max	
External Digital Supply Voltage (VCC)	3.15	5.25	V
Main Supply Voltage (VBAT)	5.5	28	V
DC Output Current (Per Channel)		0.55	A
Junction Temperature	-40	125	°C

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Table 3. PIN FUNCTION DESCRIPTION

Connector	Pin Number	Terminal Name	Description
24 Pin Interface Connector	1	SCL	I2C Clock Line, 3.3 V Levels
	2	SDA	I2C Data Line, 3.3 V Levels
	3	GND	Ground
	4	GND	Ground
	5	PO7	General-Purpose Output 7
	6	PO6	General-Purpose Output 6
	7	PO5	General-Purpose Output 5
	8	PO4	General-Purpose Output 4, used for controlling the LDO reference
	9	PO3	General-Purpose Output 3
	10	PO2	General-Purpose Output 2
	11	PO1	General-Purpose Output 1, used for EN, Chip Enable
	12	PO0	General-Purpose Output 0
	13	GND	Ground
	14	GND	Ground
	15	PI1	General-Purpose Input 1, used for reading latched thermal shutdown (TSD) data
	16	PI0	General-Purpose Input 0
	17	VIO	3.3 V or 5 V for level translators
	18	PI2	General-Purpose Input 2
	19	SO	SPI data from slave to master
	20	SI	SPI data from master to slave
	21	SCLK	SPI clock from master to slave
	22	CSB	SPI slave chip select bar
	23	VTRGT	5 V Supply from slave to J1
	24	VCC_USB	5 V USB voltage from the USB to SPI adapter board to the demonstration board (100 mA max)
Supply Requirement		VBAT	Main Supply Voltage. Powers the NCV77xx drivers and the onboard LDO.
		GND_M	Module Ground
		VCC	Optional external digital supply (used only when the onboard LDO is disconnected via VCC_DIS jumper)
Half-Bridge Outputs (Note 1)		OUT1	Half Bridge Output 1
		OUT2	Half Bridge Output 2
		OUT3	Half Bridge Output 3
		OUT4	Half Bridge Output 4
		OUT5	Half Bridge Output 5
		OUT6	Half Bridge Output 6
		OUT7	Half Bridge Output 7
		OUT8	Half Bridge Output 8
		OUT9	Half Bridge Output 9
		OUT10	Half Bridge Output 10

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Table 3. PIN FUNCTION DESCRIPTION

Connector	Name	Description
Test Points	V5_EN	When this signal is high the LDO is programmed for 5 V output.
	EN	Enable signal for the integrated driver.
	TSD	Latched thermal information. (Note 2)
	CSB	Chip Select Bar signal produced by the master. CSB LED is illuminated when CSB transition to a low state.
	SCLK	Serial clock signal generated by the master.
	SI	Serial input data from the master.
	SO	Serial output data from the slave
	VCC	Digital Supply voltage.
	V_USB	Supply voltage from the USB port.
	GND	Chip Ground
LED Indicator	EN	EN LED is illuminated when the part is enabled.
	TSD	TSD LED is illuminated when part encountered a latched thermal shutdown. (Note 2)
	CSB	CSB LED is illuminated when CSB transition to a low state.
	VCC	VCC LED is illuminated when the LDO is regulating.
	VCC_REG	VCC_REG LED is illuminated when the regulated voltage is applied to the demonstration board.
Supply Disconnect	VBAT_DIS	VBAT_DIS jumper is used to disconnect the VBAT supply from the board. No power is delivered to the integrated driver or the LDO when the jumper is disconnected.
	VCC_DIS	VCC_DIS jumper is used to disconnect the VCC supply from the LDO to the board. When the jumper is disconnected the board can be powered from an external supply.

1. OUT7 – OUT10 are only available in NCV7720 devices.

2. SI is OR'ed with the TSD fault, so if the LSB bit (B0) is set high on the previous frame the TSD will be set high.

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OPERATIONAL GUIDELINES

The material necessary to successfully use the demonstration boards is given hereunder:

- PC running the latest Onsemi FlexMOS GUI
- USB cable Type A to Type B
- USB to SPI Interface Adapter with Ribbon Cable
- NCV7717-7720 Evaluation Board
- Power Supply
- Resistive, Inductive or Motor Load

An application example of a NCV7720 driving motor loads is given in Figure 3. The same concept can be applied

to the rest of the half-bridge integrated drivers in the family and for different load types.

Figure 3 shows the VCC_DIS and the VBAT_DIS jumpers inserted, so the digital supply and battery voltage is applied to the board. When VBAT voltage is applied to the board, the onboard regulator regulates the VCC voltage. By default the VCC is regulated to 3.3 V, but this can be adjusted to 5 V via the GUI. The onboard LED VCC_REG is illuminated when the regulator is active. If the VCC power is delivered to the board (VCC_DIS is closed) the VCC LED is also activated.

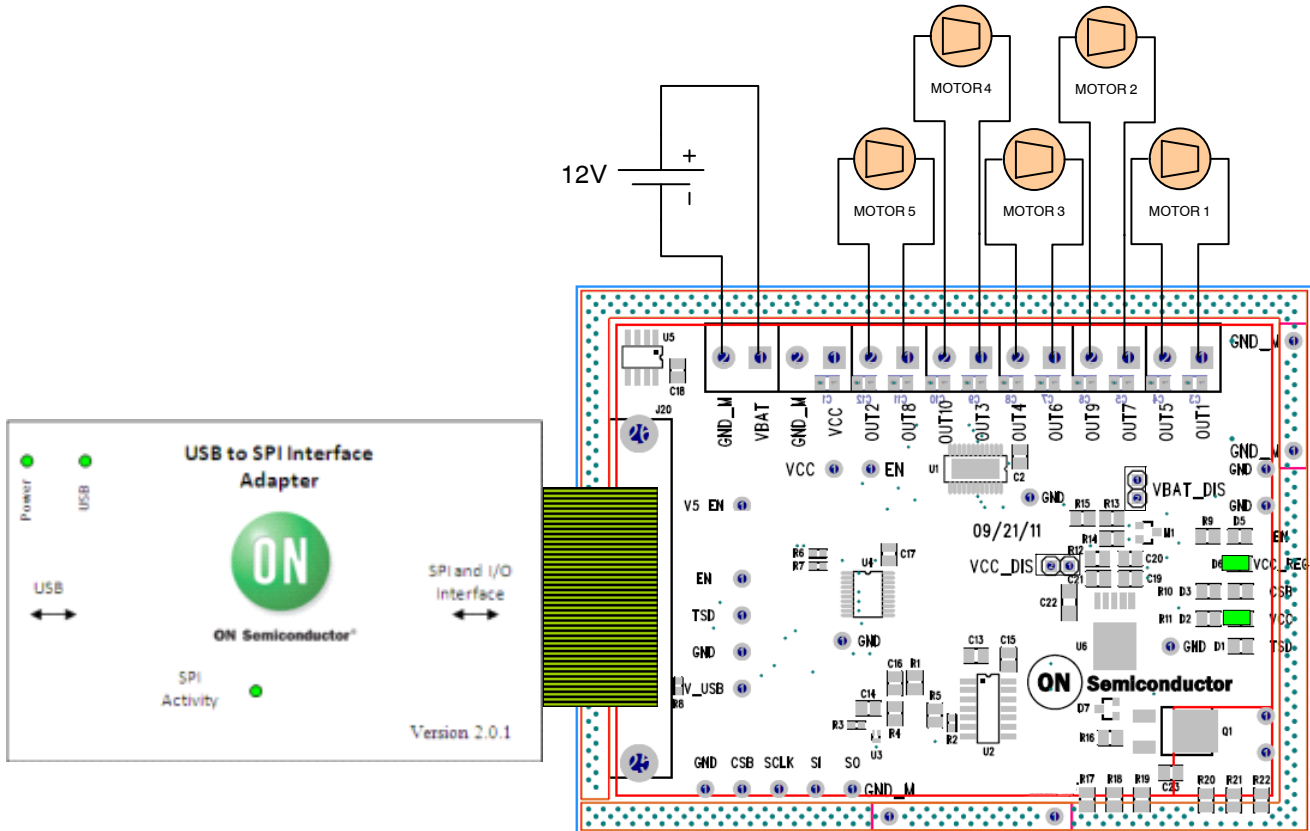


Figure 3. Application Example

Once the hardware is configured with the desired load and is interfaced with the USB to SPI adapter, the user can invoke the FlexMOS software. Once the software is launched the GUI should automatically identify the connected demonstration board and loads the appropriate GUI interface for the half-bridge driver. If the software doesn't recognize the connected demonstration board, manually select the device from the drop down box. If the device name doesn't appear in the drop down box, the latest version of the GUI needs to be installed on the PC.

A detailed description of the GUI functionality for the NCV7718 is provided in Figure 4.

The FlexMOS GUI is used to enable or disable the device and to control the half-bridge outputs. For the application example given in Figure 3, the motor 1 is driven in the forward direction by enabling the high side power MOSFET on OUT1 and the low side power MOSFET on OUT5. Conversely the current can be directed to flow in the reverse direction by enabling the low side power MOSFET on OUT1 and the high side power MOSFET on OUT5. The same methodology can be carried out for the subsequent motor operations by controlling their respective outputs.

Half-Bridge Control
Allows independent control of the half-bridges

Half-Bridge Status
Reports whether the half-bridge is in tri-state, LS or HS enabled.

Compiled SPI-Frame
Compiled SPI frame based on the Half-Bridge Control input

GUI update Mode
Manual: User must press "Update" button for any changes made to Half-Bridge Control to be take effect.
Auto: When the Half-Bridge Control is changed the "Update" button is automatically triggered.
Polling: The Half-Bridge Control is updated periodically at a predefined interval.

VCC Mode
Programs the onboard LDO for either 3.3V or 5V operation.

Status Info
Reports all global faults

SPI Traffic
Log of SPI command send and received.

Push Button Control
Update: Transmits the compiled SPI-Frame to the slave device
All LS ON: Selects LS ON for all the half-bridge outputs
All HS ON: Selects HS ON for all the half-bridge outputs
All OFF: Selects OFF for all the half-bridge outputs
TSD: Creates a CSB pulse with no clock to for latched thermal information.

Check Box Control
Enable Device: Enables or disables the integrated driver
Status Reset: Resets all latched faults
Under Load Shutdown: Enables or disables ULDCSC feature
Overvoltage Lockout: Enables or disabled OVLO feature

Figure 4. GUI Overview

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TYPICAL CHARACTERISTICS

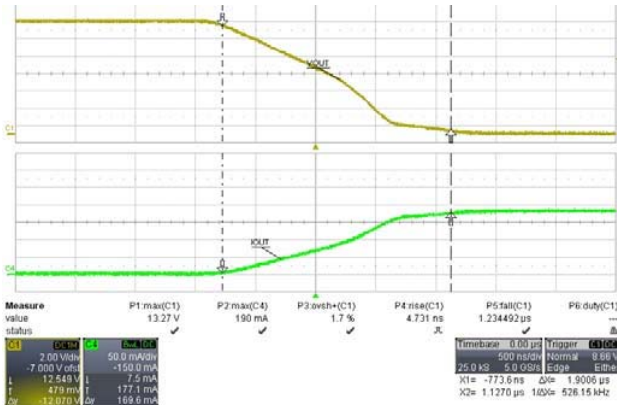


Figure 5. $V_{CC} = 3.3$ V, LS Configuration Switch Turn On Resistive Load

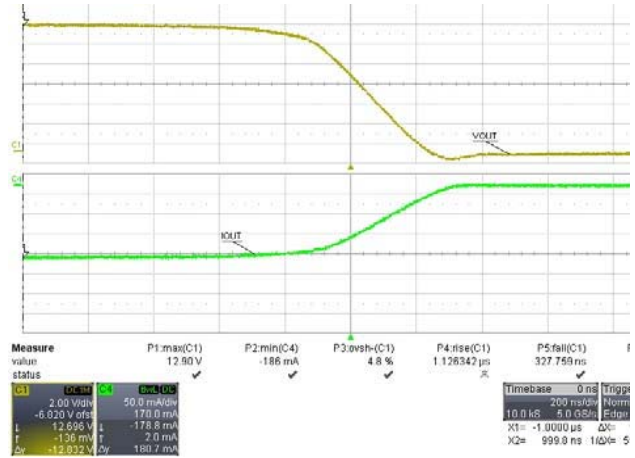


Figure 6. $V_{CC} = 3.3$ V, HS Configuration Switch Turn On Resistive Load

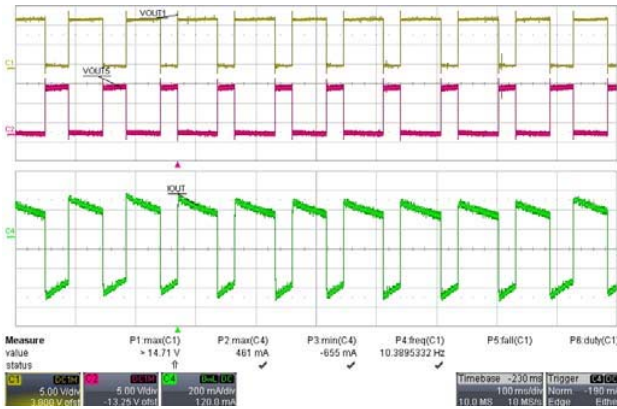


Figure 7. $V_{CC} = 3.3$ V, OUT1_OUT5 H-Bridge Configuration Forward, Reverse, Forward Loop with a Motor Load

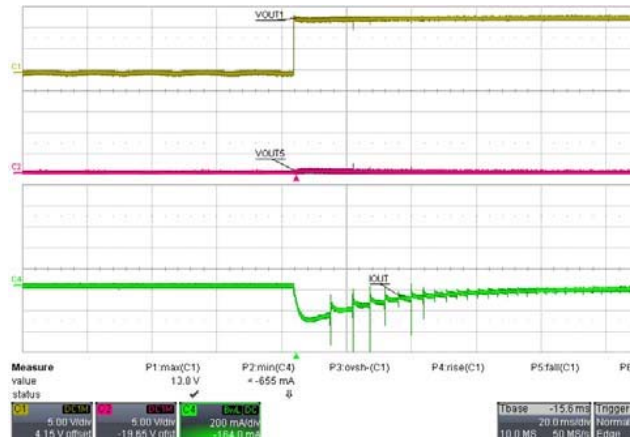


Figure 8. $V_{CC} = 3.3$ V HVAC Motor Forward

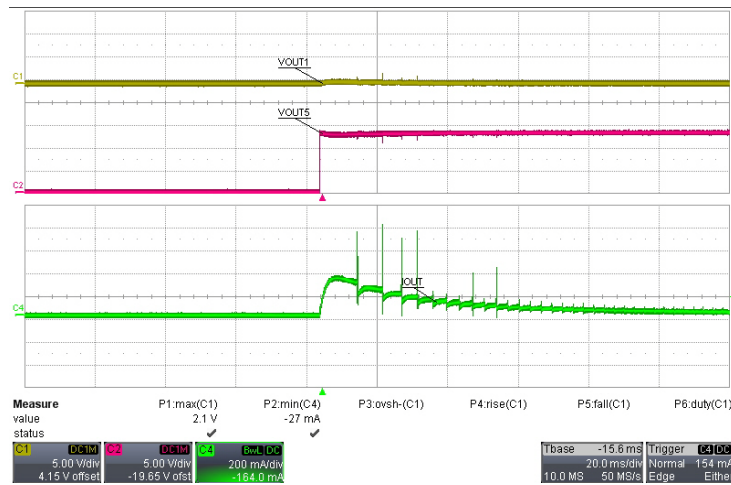
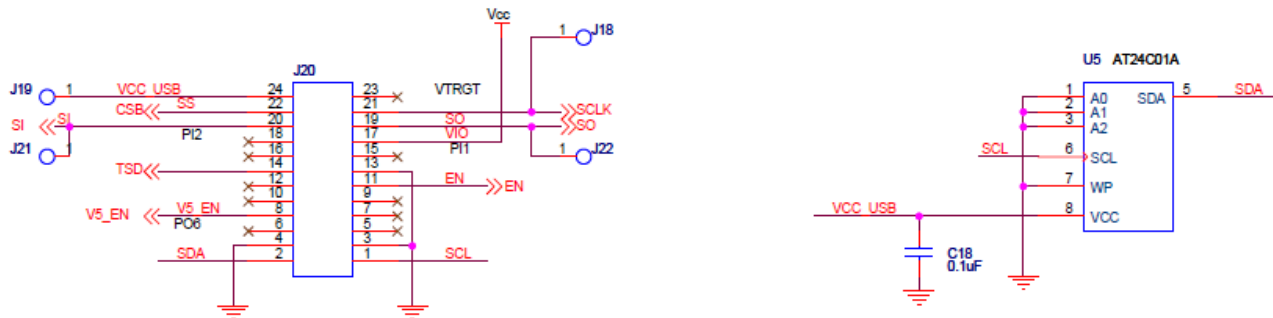
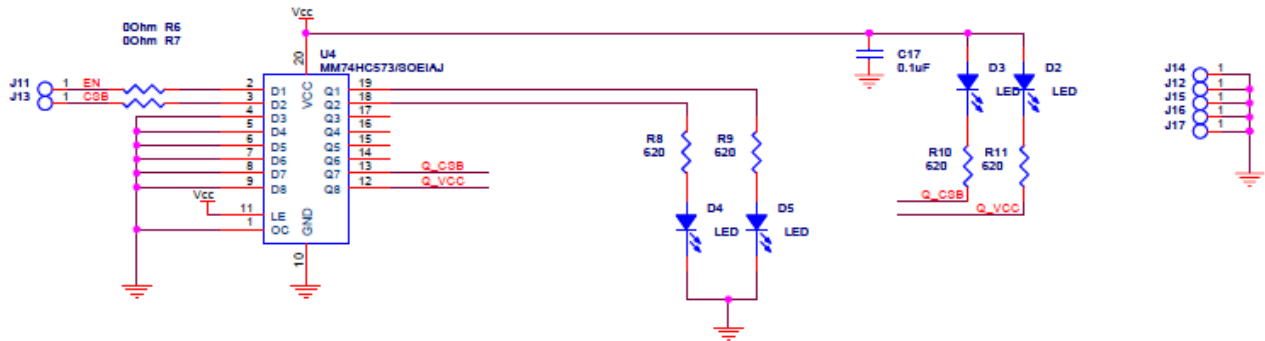
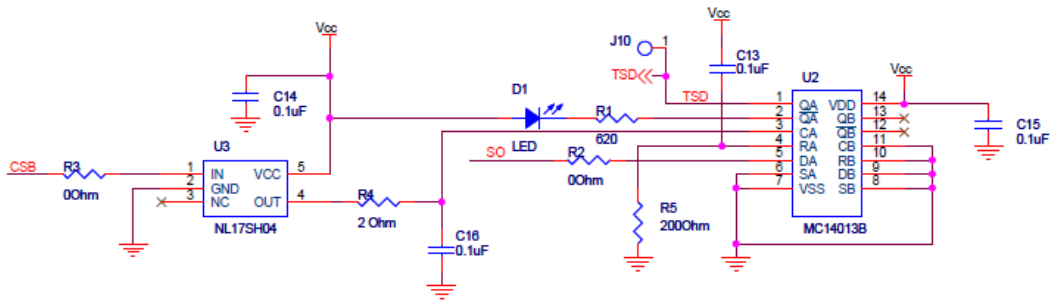
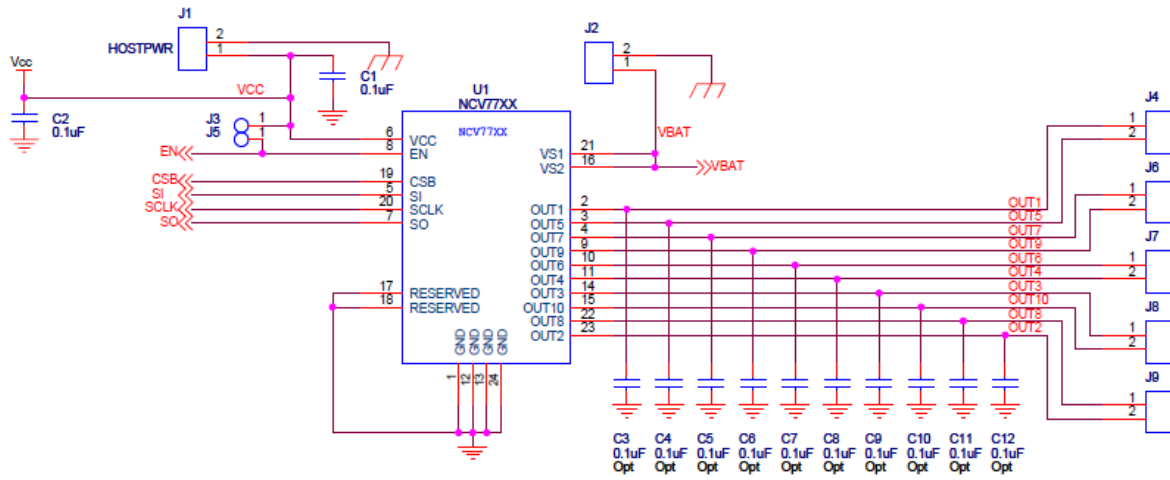


Figure 9. $V_{CC} = 3.3$ V HVAC Motor Reverse

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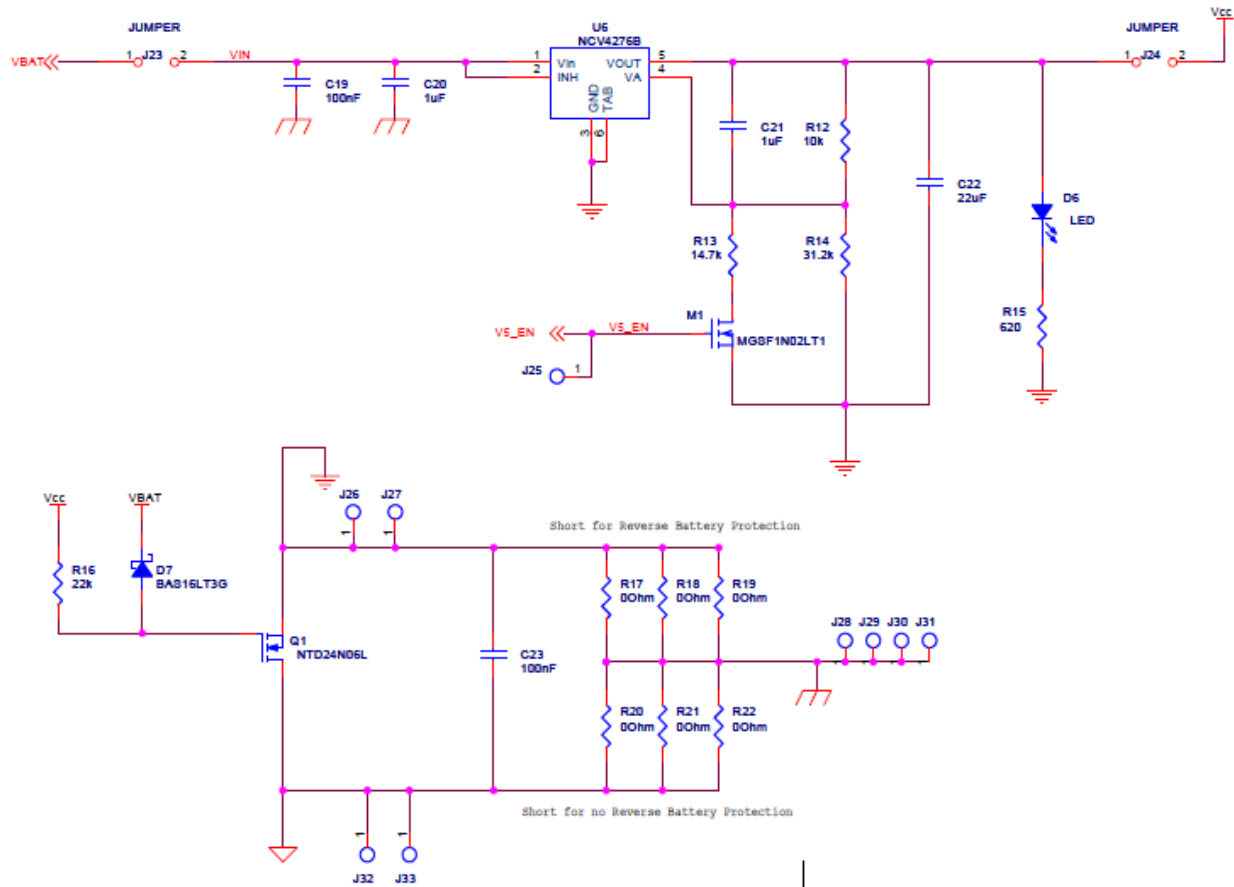


Figure 10. Evaluation Board Schematic

BILL OF MATERIAL

Table 4. BILL OF MATERIAL

Ref	Qty	Description	Value	Manufacturer	Manufacturer's Part Number
C1–C19, C23	20	CAP CER .1UF 50V 10% X7R 0805	0.1 uF	Murata Electronics North America	GRM21BR71H104KA01L
C20, C21	2	CAP CER 1UF 50V X7R 0805	1.0 uF	Murata Electronics North America	GRM21BR71H105KA12L
C22	1	CAP CER 22UF 16V X5R 1206	22 uF	Murata Electronics North America	GRM31CR61C226ME15L
D1–D6	6	LED GREEN CLEAR THIN 0805 SMD	N/A	Lite-On Inc	LTST-C171GKT
D7	1	DIODE SWITCH 75V 200MA SOT-23	N/A	ON Semiconductor	BAS16LT3G
J1, J2, J4, J6, J7, J8, J9	7	CONN TERM BLOCK 2POS 5.08MM PCB	N/A	Phoenix Contact	1729128
J3, J5, J10–J19, J21, J22, J25–J33	23	TEST POINT PC MULTI PURPOSE RED	N/A	Keystone Electronics	5010
J20	1	CONN HEADER VERT 24POS .100 GOLD	N/A	TE Connectivity	5499910-5
J23, J24	2	CONN HEADER 2POS .100 VERT GOLD	N/A	Molex Connector Corporation	22-28-4024

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Table 4. BILL OF MATERIAL

Ref	Qty	Description	Value	Manufacturer	Manufacturer's Part Number
M1	1	MOSFET N-CH 20V 750MA SOT23	20 V / 0.75 A	ON Semiconductor	MGSF1N02LT1G
Q1	1	MOSFET N-CH 60V 24A DPAK	60 V / 24 A	ON Semiconductor	NTD24N06LT4G
R1, R8, R9, R10, R11, R15	6	RES 620 OHM 1/8W 1% 0805 SMD	620	Vishay/Dale	CRCW0805620RFKEA
R2, R3, R6, R7	4	RES 0.0 OHM 1/10W 0603 SMD	0	Panasonic- ECG	ERJ-3GEY0R00V
R4	1	RES 2.00 OHM 1/8W 1% 0805 SMD	2	Vishay/Dale	CRCW08052R00FKEA
R5	1	RES 200 OHM 1/8W 1% 0805 SMD	200	Vishay/Dale	CRCW0805200RFKEA
R12	1	RES 10.0K OHM 1/8W 1% 0805 SMD	10.0 K	Vishay/Dale	CRCW080510K0FKEA
R13	1	RES 14.7K OHM 1/8W 1% 0805 SMD	14.7 K	Vishay/Dale	CRCW080514K7FKEA
R14	1	RES 30.9K OHM 1/8W 1% 0805 SMD	30.9 K	Vishay/Dale	CRCW080530K9FKEA
R16	1	RES 22.0K OHM 1/8W 1% 0805 SMD	22 K	Vishay/Dale	CRCW080522K0FKEA
R17–R22	6	RES 0.0 OHM 1/8W 0805 SMD	0	Vishay/Dale	CRCW08050000Z0EA
U1	1	Half-Bridge Driver	N/A	ON Semiconductor	NCV77XX
U2	1	IC FLIP-FLOP DUAL CMOS 14SOIC	N/A	ON Semiconductor	MC14013BDR2G
U3	1	Single Inverter	N/A	ON Semiconductor	NL17SH04P5T5G
U4	1	IC LATCH OCTAL D 3STATE 20-TSSOP	N/A	ON Semiconductor	MM74HC573MTC
U5	1	IC EEPROM 1KBIT 1MHZ 8SOIC	N/A	Atmel	AT24C01BN-SH-B
U6	1	IC REG LDO 400MA ADJ D-PAK	N/A	ON Semiconductor	NCV4276BDTADJRKG

EVALUATION BOARD FEATURES

Reverse Battery Protection

The reverse battery protection scheme is employed as shown in the bottom section of Figure 10.

An N-channel NTD24N06L MOSFET is used to isolate the chip ground of the integrated driver from the module ground. When proper VBAT voltage is applied to the gate, the MOSFET will be pulled up to the regulated VCC voltage. Thus turning on the MOSFET and connecting the module ground and the chip ground via a very low ohmic drop. Even when the LDO is not regulating (in absence of gate voltage to the MOSFET) there is a current path from VBAT to the module ground through the inherent body diode of the MOSFET. In cases where the polarity of the VBAT supply voltage is reversed the MOSFET will not conduct and the module ground will be disconnected from the chip ground.

The reverse battery protection can be disabled by depopulating resistors: R20, R21 and R22 and shorting the following resistors: R17, R18 and R19.

Latched Thermal Information

When the TSD button is pressed on the FlexMOS GUI, latched thermal shutdown information is monitored on the demonstration board through the TSD LED indicator (D1). Since the SI is OR'ed with the TSD fault it is important to understand that if the LSB bit (B0) is set high on the previous frame the TSD reporting should be ignored. This is because SI holds the value of B0 until the first SCLK rising edge and the TSD information is latched in before the first rising edge of SCLK.

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EVALUATION BOARD LAYOUT

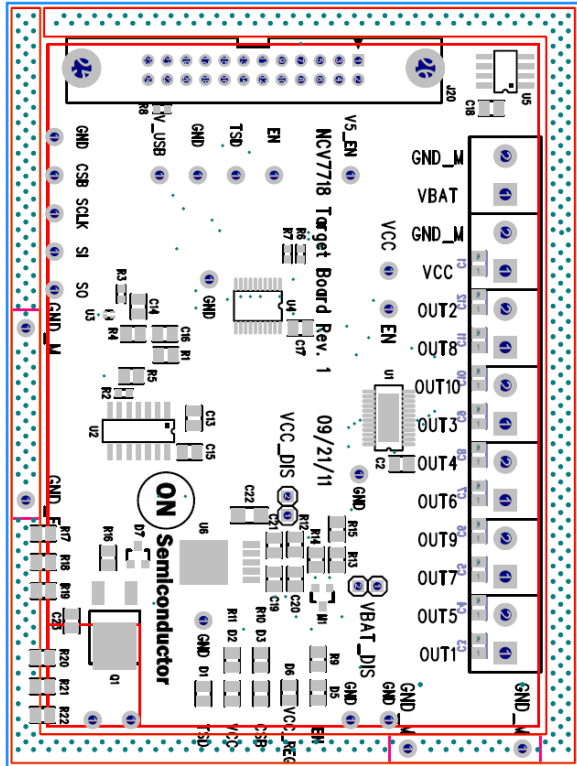


Figure 11. Silk Screen & Drill Holes

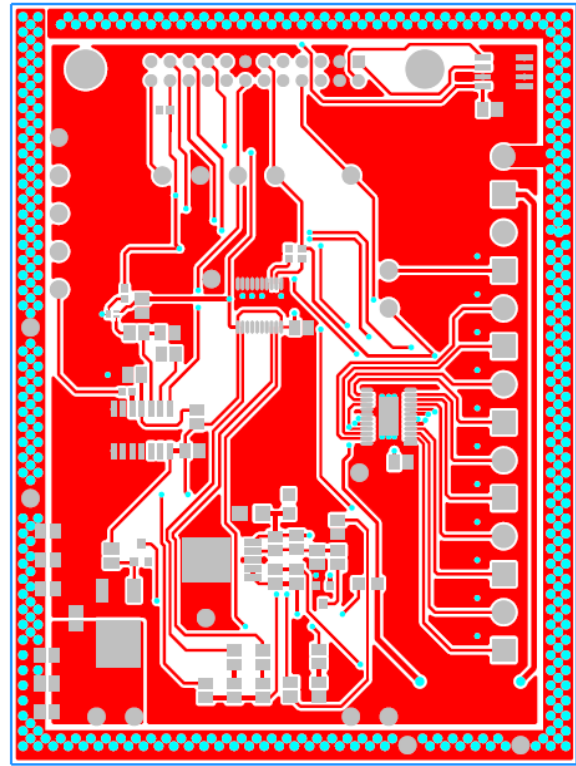


Figure 12. Top Copper

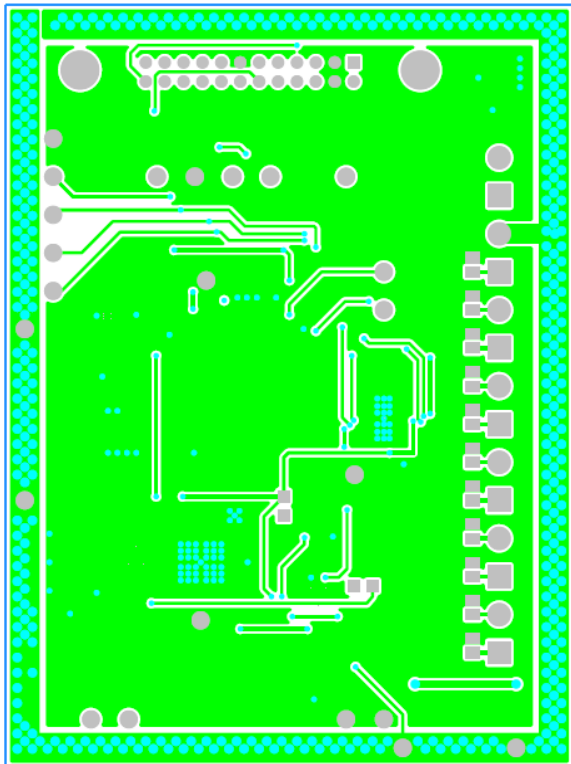


Figure 13. Bottom Copper

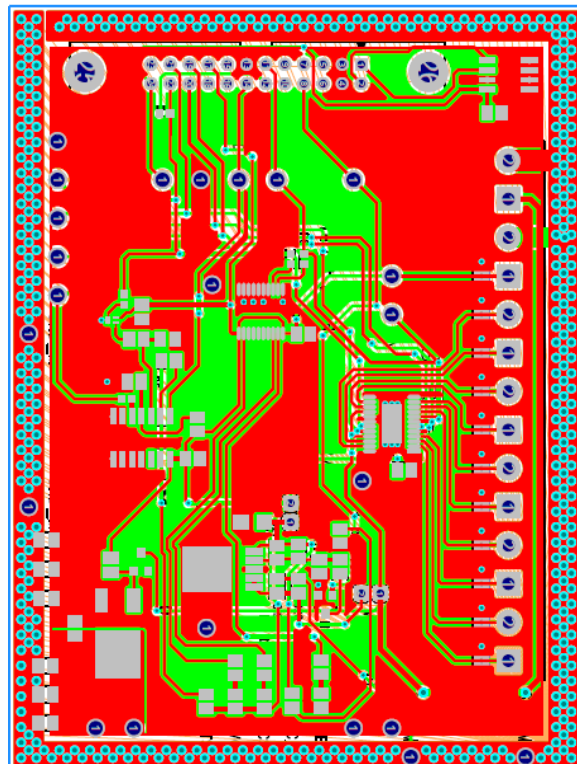



Figure 14. Board Composite

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