# NCV840XXF Evaluation Board User's Manual

# NCV840XXFEVB

The NCV840XXF Evaluation Board has been designed to enable a complete functional and parametric evaluation of the NCV840XXF single channel high-side driver. This evaluation board has been constructed to easily interface with different test systems and equipment though power terminals and test points located throughout the board. A variant of the evaluation board also has the option to integrate an Arduino Nano and use independent software routines to evaluate capabilities of the NCV840XXF device in a convenient user-friendly manner.

This document gives a detailed description of the NCV840XXF Evaluation Board (TSSOP-14 EP Package) with the bill of materials, board schematic, and a layout overview of the board. The document also provides details on operational aspects of the board and recommended external connections.

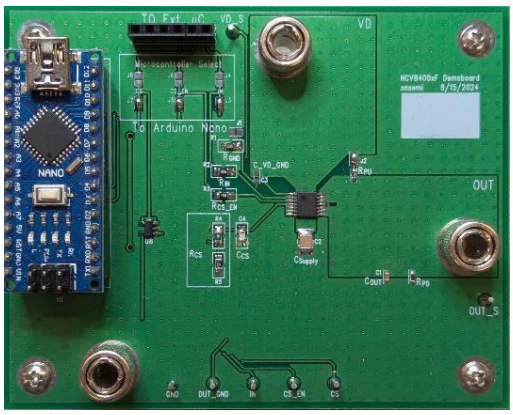
This document should be used with the NCV840XXF datasheet available on www.onsemi.com or the product preview provided with engineering samples. The evaluation board, in general, follows the application diagram, however the datasheet contains full technical details about the NCV840XXF specification, features, protections, diagnostics and other operations.

### Features

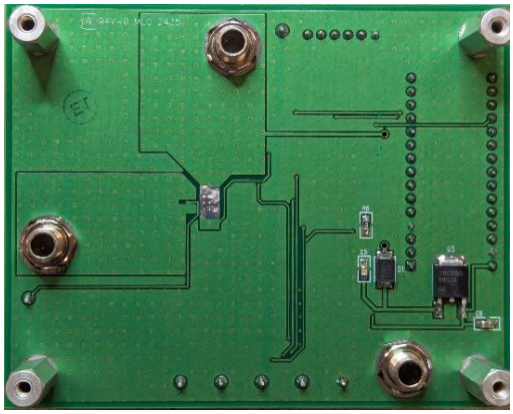
- Power Terminals and Test Points for Drain and OUT Connections
- Test Points for all Logic Pins
- Protection Resistors on GND and Digital Inputs
- Optional Onboard 5 V Regulator
- Optional Connector to External Microcontroller
- Open Load Diagnosis Circuit
- Arduino Nano Integration
- Additional Demonstration Software

### Typical Applications

- Power Distribution
- Switch Capacitive, Resistive, and Inductive Loads
- Automotive / Industrial




(Front Side)



(Back Side)

**Figure 1. Evaluation Board**

### ORDERING INFORMATION

| Device |
|---|
| NCV840XXFNTGEVB |
| NCV840XXFTGEVB |

XX represents IC version populated when ordering.

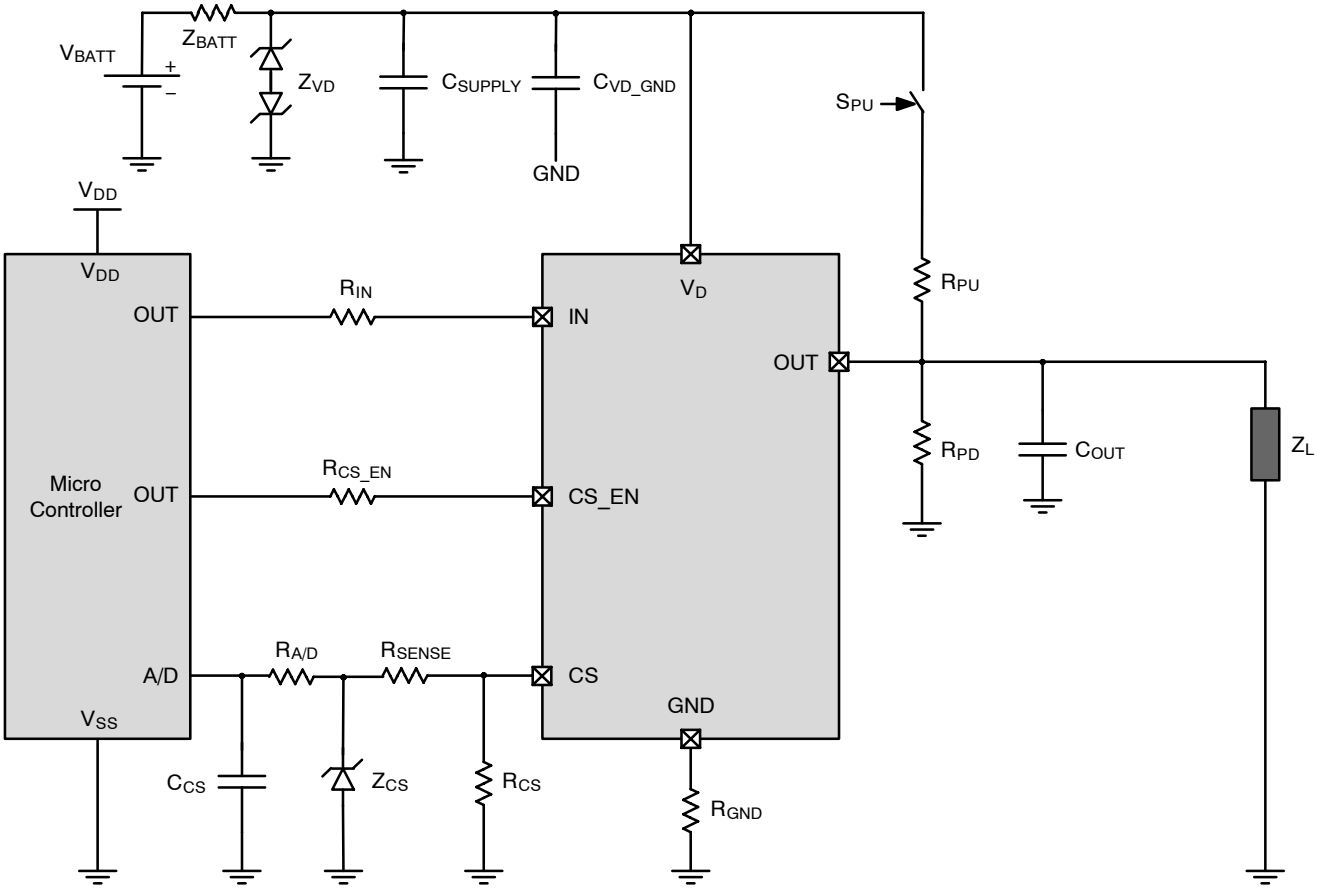



**Figure 2. Recommended Application Diagram**

**Table 1. RECOMMENDED EXTERNAL COMPONENTS**

| Reference | Value | Description |
|---|---|---|
| $R_{IN}$ | 4.7 kΩ | Provides protection of the micro controller during overvoltage and reverse polarity. Ensures the channel is OFF during loss of GND. |
| $R_{CS\_EN}$ | 4.7 kΩ | Provides protection of the micro controller during overvoltage and reverse polarity. Ensures the channel is OFF during loss of GND. |
| $R_{CS}$ | 1.2 kΩ | Current Sense resistor. |
| $R_{SENSE}$ | 4.7 kΩ | Provides protection against overvoltage, reverse polarity, and loss of GND. The value of this resistor should be selected with the micro controller specification. |
| $C_{CS}$ | 100 pF | Current Sense signal filtering. |
| $R_{A/D}$ | 4.7 kΩ | Current Sense signal filtering. |
| $Z_{CS}$ | 10 V Zener Diode | Provides protection micro controller during overvoltage at CS. Should be selected with the micro controller specification. |
| $R_{PU}$ | 1.5 kΩ | Polarizes the NCV840XXF output during OFF state open load diagnosis. |
| $R_{PD}$ | 47 kΩ | Output polarization. Improves the NCV840XXF immunity to electromagnetic noise and also used for short to $V_{BATT}$ detection. |
| $S_{PU}$ | BC807 | Switches the battery voltage for OFF state open load diagnostic. |
| $R_{GND}$ | 47 Ω | Provides protection during over-voltage. |
| $Z_{VD\_Ext}$ | 30 V Zener Diode | Provides protection of the device during overvoltage. |
| $C_{SUPPLY}$ | 100 nF | Filtering of voltage spikes on the battery line. |
| $C_{VD\_GND}$ | 47 nF | Provides drain voltage stability during fast transients such as overload. |
| $C_{OUT}$ | 10 nF | Protection during ESD and BCI on output. |

## ELECTRICAL SPECIFICATIONS

**Table 2. MAXIMUM RATINGS** (Note 1)

| Rating | Symbol | Min | Max | Unit |
|---|---|---|---|---|
| **SUPPLY VOLTAGE** | | | | |
| Steady State Supply Voltage – NCV840XXFNTGEVB | $V_D$ | 6 | 18 | V |
| Steady State Supply Voltage – NCV840XXFTGEVB | | −0.3 | 18 | |
| Max Supply Voltage for Transient Operations (Note 1) | | | 28 | V |
| **CONNECTIONS TO DIGITAL INPUT PINS: IN, CS_EN** | | | | |
| Maximum Current Capability | $I_{TP\_DIG\_IN}$ | $-I_{DIG\_IN\_MAX}$ (Note 2) | $I_{DIG\_IN\_MAX}$ (Note 2) | mA |
| Maximum Voltage Capability | $V_{TP\_DIG\_IN}$ | −0.3 | $V_{DIG\_IN\_MAX}$ (Note 2) | V |
| **CONNECTIONS TO CURRENT SENSE OUTPUT** | | | | |
| Current at Current Sense Output | $I_{TP\_CS\_MAX}$ | −25 | $I_{CS\_Fault\_ILIM}$ (Note 2) | mA |
| Voltage at Current Sense Output | $V_{TP\_CS\_MAX}$ | −0.3 | $V_D$ | V |
| **OUTPUT CONNECTION** | | | | |
| Drain-Source Voltage at Power Transistor | $V_{DS\_MAX}$ | | $Z_{CL}$ | V |
| Max Output Current – Steady State | $I_{OUT\_MAX}$ | | 15 (Note 3) | A |
| Max Output Current – Transient | $I_{OUT\_MAX\_TRAN}$ | | $I_{LIM}$ | A |
| **CONNECTIONS TO DEVICE GROUND** | | | | |
| Current through GND Pin | $I_{TP\_GND}$ | $-I_{GND}$ (Note 2) | $I_{GND}$ (Note 2) | mA |
| **OPERATING TEMPERATURE** | | | | |
| Operating Ambient Temperature – NCV840XXFNTGEVB | $T_{AMB}$ | −40 | 85 (Note 4) | °C |
| Operating Ambient Temperature – NCV840XXFTGEVB | | −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.

1. For transient application only. Extended operation at absolute maximum voltage may affect device reliability.
2. Refer to product datasheet.
3. Limited by max rating of power terminal connector.
4. Limited by operation capability of Arduino-Nano.

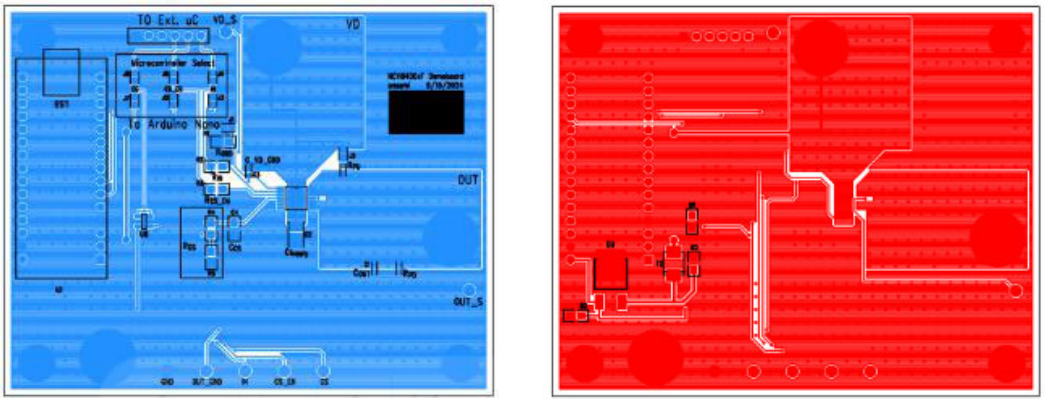



**Figure 3. Board Layout (on Left) Top Layer, (on Right) Bottom Layer**

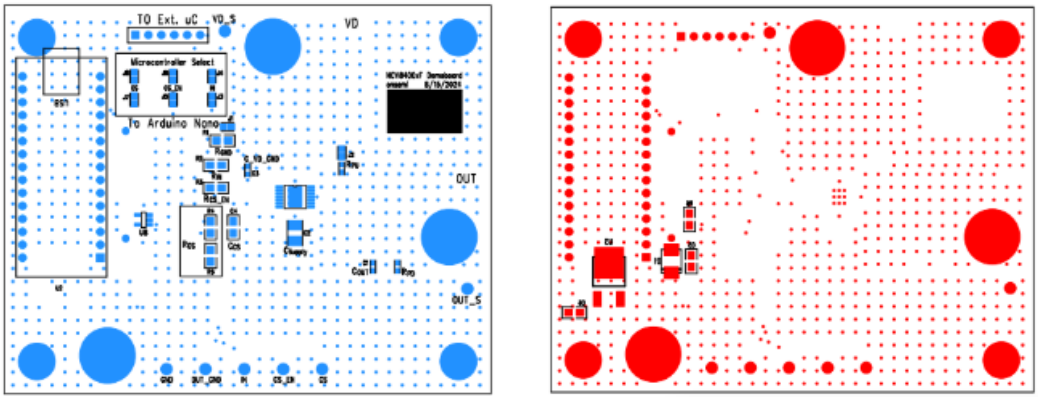



**Figure 4. Board Layout without Traces (on Left) Top Layer, (on Right) Bottom Layer**

**Table 3. JUMPER DEFINITIONS**

| Jumper | Purpose | Default Connection |
|---|---|---|
| J1 | To connect device GND pin to GND plane | NP |
| J2 | To connect Pull Up resistor from OUT to VD for OSOL diagnosis | P |
| J3, J5, J7 | To connect IN, CS_EN and CS respectively to Arduino Nano I/O | P: NCV840XXFNTGEVB<br>NP: NCV840XXFTGEVB |
| J4, J6, J8 | To connect IN, CS_EN and CS respectively to external microcontroller | NP |

## Schematic

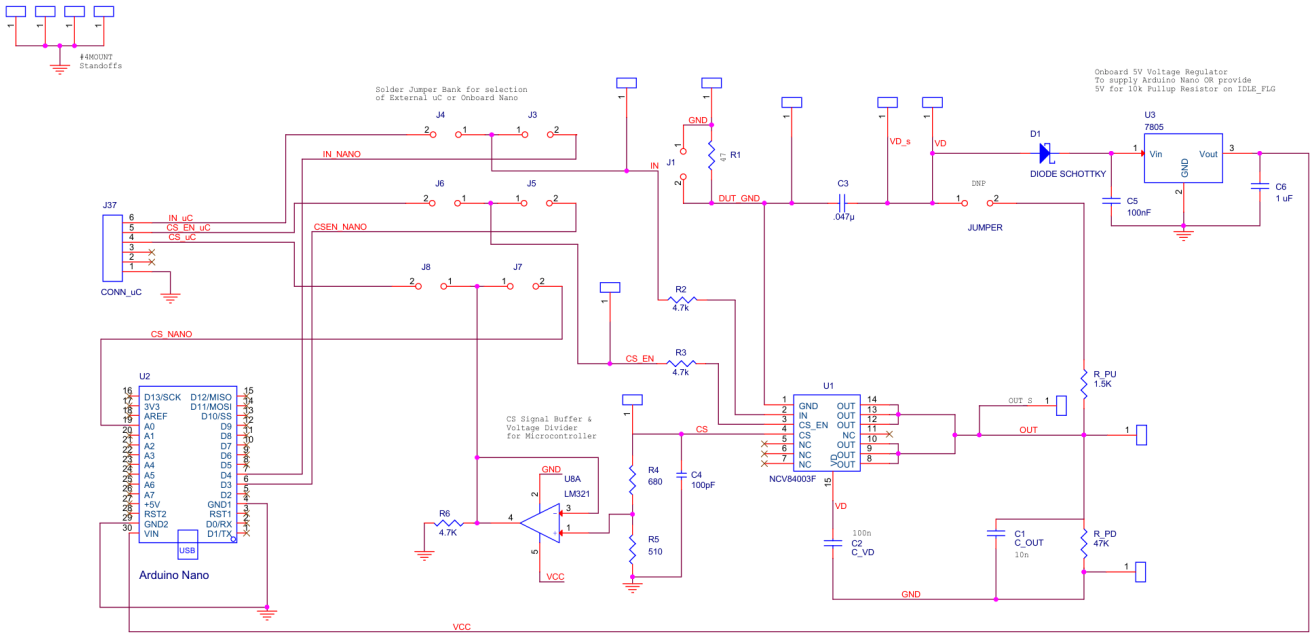



**Figure 5. EVB Schematic**

## BOARD OPERATION

### Supply

The EVB is required to be supplied via the connection VD as highlighted in Figure 6. This input serves as the supply (drain connection) for NCV840XXF as well as for other optional active circuits on the board including the regulator MC7805 that in turn powers an on-board voltage buffer and the Arduino nano. The board is designed to ensure that the performance of the device can be evaluated in the specified nominal operating voltage range. Further, transient operations such as jump start (and associated overcurrent limit), load dump etc. can also be evaluated on the board. At supply voltages lower than 6 V, the regulator can fail to provide sufficient output voltage for Arduino and the buffer. While evaluating for low voltage operations such as under-voltage shutdown and recovery times, it is therefore, recommended to use individual test points for driving logic inputs (Refer Digital Inputs section). It should be noted that the buffer output will not be available at low battery voltages. The drain pin on the device is connected to filter capacitor and an optional capacitor to device GND (as specified per BOM) for eliminating any unexpected fast transients that may affect device response.

### Output

The output terminal can be connected to the desired load per application. While connecting to the output, the cable length and impedance should be noted as it may impact the protection mechanisms such as peak current levels observed in overcurrent detection, or the current slew off time after an over-load detection. The board can also be used to switch inductive loads within the maximum rated capability of the device. It should also be noted that the maximum steady state output current is limited by the capability of the power connectors and is specified in the electrical characteristics of this reference document. The test point can be used to monitor voltage at this node using DC multimeters/ oscilloscope. As with supply connection, output has a filter capacitor populated on board (as specified per BOM) to eliminate high frequency noise. Further, referring to Figure 6, the output node is connected to VD through a pull-up resistance $R_{PU}$ and to GND through a pull-down resistor $R_{PD}$ (as specified per BOM) to diagnose off-state open load and short circuit to battery respectively (Refer to product datasheet for details).

### Ground Network

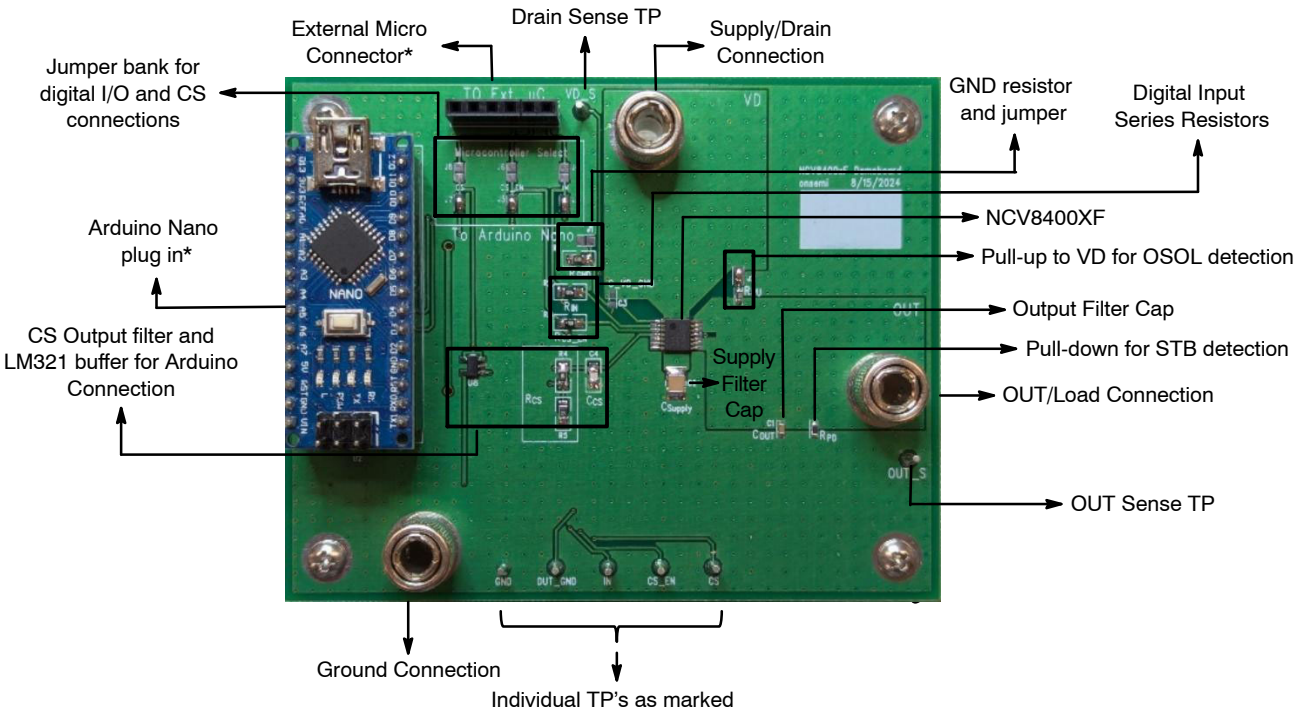
The device needs to be always supplied with a ground connection for it to function as desired. The device response in case of a loss of device or load GND condition is explained in the product datasheet. The evaluation board has a protection resistor connected to the ground pin to protect and limit the current across the internal ESD's and clamps in case of transient over-voltage events. The test point at GND pin can be used to monitor the ground potential, or to measure the ground current.

### Digital Inputs

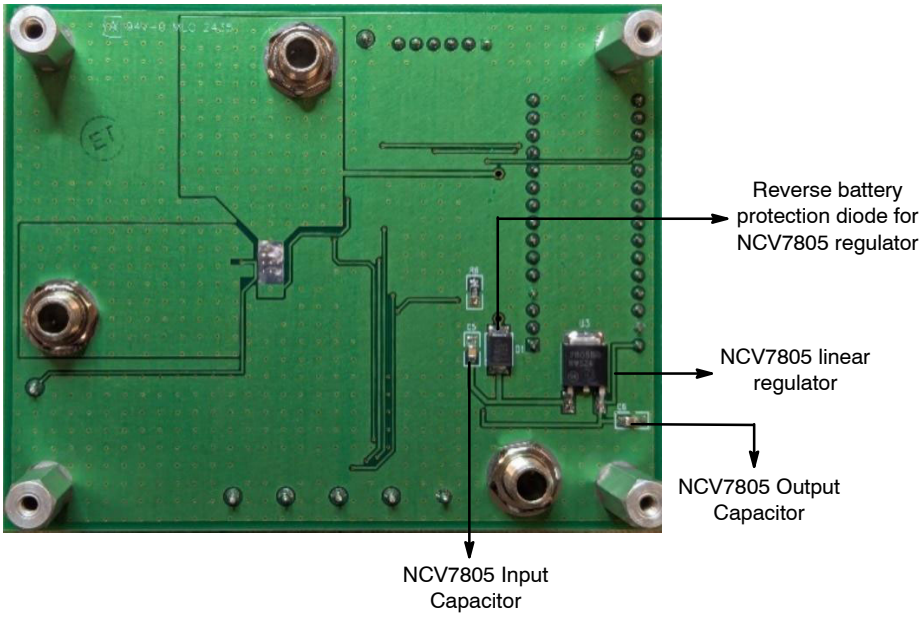
The digital inputs (IN and CS_EN) are provided with the option to be driven externally via individual test points or using a plug-in connector to an external microcontroller. Further, there is an optional socket (only on NCV840XXFNTGEVB version) to plug in an on-board Arduino that can drive the digital inputs using the provided software. The user can also load the Arduino with their own software routines to drive the pins as they desire in the application or to observe mode transitions as specified in product datasheet. It should be noted that if evaluation at high ambient temperatures is desired then external test points on NCV840XXFTGEVB should be connected to wires that can withstand temperature. When using an external test point, a 3.3 V/5 V compatible logic input can be interfaced to these pins. Jumpers J3–J4 and J5–J6 can be used to connect on-board Arduino or external microcontroller to IN and CS_EN respectively (Refer Table 3 for details). The digital inputs are interfaced to the device with series protection resistors that limit the current through logic ESD's in case of transient over-voltage events.

### Current Sense Output

The current sense output is connected to a network of resistors and a filter capacitor (values per the BOM specified). The output voltage on the resistor network can be measured directly on the dedicated test point (Refer Figure 6), or the jumpers J7–J8 can be used to route this signal to on-board Arduino/external microcontroller connector (as explained in Table 3). The current sense output going to this jumper bank is attenuated via the potential divider at the CS pin. This is done to protect the Arduino/micro inputs from getting damaged at high CS output voltages. In addition, the EVB also consists of a buffer (LM321) to prevent CS pin loading before connecting it to Arduino input. While monitoring the CS output voltage for load current estimation/diagnosis, the required CS operation voltage and normal/fault CS output current levels must be considered as specified per the product datasheet. Further, when processing/digitizing CS voltage through Arduino or microcontroller, the on-board attenuation must be accounted for as explained in Operational Guidelines.




**a) Annotated EVB Top Side**




**b) Annotated EVB Bottom Side**

**Figure 6. Annotated EVB**

## OPERATIONAL GUIDELINES

The test procedure below will demonstrate the general functionality of the NCV840XXF evaluation boards:

1. Connect a DC input voltage at VD connector within the recommended operating limits as specified. The power supply should be capable of handling the load inrush and steady state power requirements. If required, external bulk capacitors can be connected to the power supply. DO NOT switch on power in this step.
2. Connect the desired load per application to the OUT connector.
3. Configure the digital input driving connections to either on-board Arduino or use the external microcontroller connector interface (on NCV840XXFNTGEVB). Alternatively, individual test points can also be connected (on NCV840XXFTGEVB) to external pulse signal generators/DC power supplies compatible with CMOS logic levels. The voltage and temperature limitations of these alternatives have been presented in the sections above.
4. While using Arduino, the provided software code can be used, or the user can program the Arduino as desired.
5. The oscilloscope probes, if desired, can be connected to the test points to monitor signal transitions.
6. It is recommended to apply the pulsed sequence on digital inputs (if using one) and observing the same on oscilloscope for verification before switching on the power supply at VD. This ensures that the applied pulse duration, signal sequence, PWM/duty cycle (if required) etc. on IN and CS_EN is as desired by the user.
7. Finally, the power supply can be switched on and user can observe/monitor output voltage, load current, current sense output and other signals as desired.

The current sense signal as an input to LM321 buffer is voltage-divided per the equation below:

$$V_{CS\_Attn} = (R5 / (R4 + R5)) \times V_{CS} = (510 / (510 + 680)) \times V_{CS} = 0.428 \times V_{CS} \text{ (values per specified BOM)} \quad \text{(eq. 1)}$$

So, for a maximum current sense output current of 10 mA (Refer to $I_{CS\_Fault\_ILIM}$ and $I_{CS\_SAT}$ specifications per datasheet), $V_{CS}$ input going into LM321 can be calculated as: $V_{CS\_Attn}$ = 0.428 x 10 mA x 1190 Ω = 5.1 V. This signal attenuation protects the Arduino/microcontroller input from high voltage levels and must be accounted for while doing digitization/processing of the current sense signal using Arduino or external microcontroller.

## EVALUATION BOARD GRAPHICAL USER INTERFACE

A User Interface and Arduino sketch are paired with the evaluation board.

The GUI will be disabled until a connection to the Arduino is established. To connect:

1. Refresh the COM ports with the ‘Refresh COM Ports’ button.
2. Select the correct COM port with the dropdown.
3. Click ‘Connect to Arduino’.

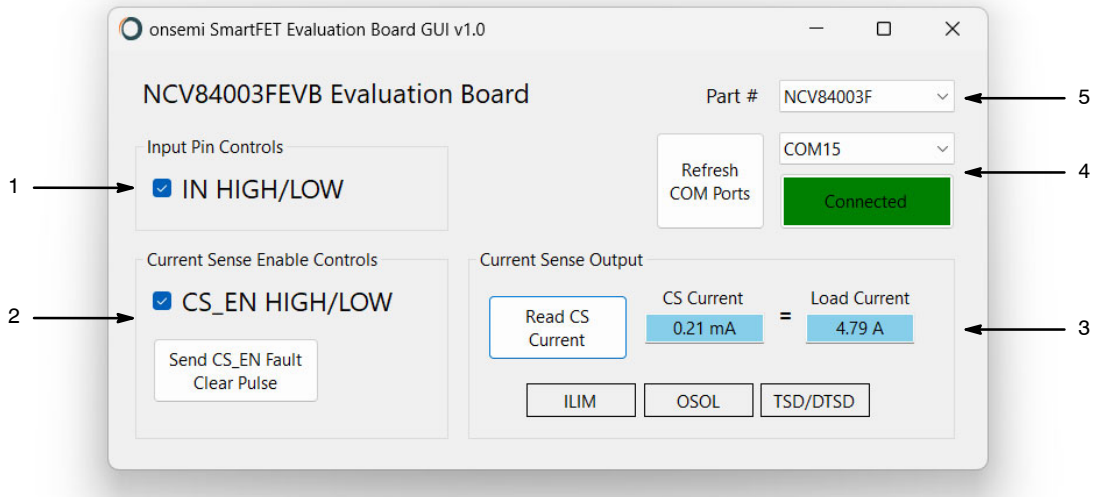



**Figure 7. Evaluation Board GUI Usage**

1. *Input Pin Controls*: Check/uncheck the box to control the IN pin. The startup mode will be highlighted depending on the state of the CS_EN pin.
2. *Current Sense Enable Controls*: Check/uncheck the box to control the CS_EN pin. If the IN pin is HIGH, the GUI will allow a Fault Clear Pulse via the CS_EN pin. A Status Readback or Configuration Readback Pulse will be available depending on the state of the IN pin.
3. *Current Sense Output*: The output of the CS pin is displayed in this section. If the CS_EN pin is high, the GUI will enable the ‘Read CS Current’ button. If a fault is flagged on the CS Pin, one of the fault indicators will turn red. If a Config Readback Pulse is sent, the resistor settings will be updated here.
4. *Arduino COM Port Controls*: The ‘Connect to Arduino’ button will change to ‘Connected’ or ‘Disconnected’ if the status of the Arduino serial connection is changed. Click the button to change the status.
5. *Part Number Dropdown*: This dropdown will change the CS Ratio used in the ‘Current Sense Output’ section.

## BILL OF MATERIALS (BOM)

### Table 4. BILL OF MATERIALS FOR THE NCV840XXFNTGEVB

| Designator (Main Board) | Quantity | Description | Value | Tolerance | Footprint | Manufacturer | Manufacturer Part Number | Subst. Allowed | Lead Free |
|---|---|---|---|---|---|---|---|---|---|
| Rpu | 1 | 1.5 kOhms ±1% 0.125W, 1/8W Chip Resistor 0603 | 1.5 kOhms | ±1% | 0603 | Stackpole Electronics | RNCP0603TFD1K50 | Yes | Yes |
| Rpd | 1 | 47 kOhms ±1% 0.125W, 1/8W Chip Resistor 0603 | 47 kOhms | ±1% | 0603 | Panasonic | ERJ-H3EF4702V | Yes | Yes |
| R4 | 1 | RES SMD 680 OHM 5% 1/8W 0805 | 680 Ohms | ±5% | 0805 | Panasonic | ERJ-6GEYJ681V | Yes | Yes |
| R5 | 1 | RES 510 OHM 5% 1/8W 0805 | 510 Ohms | ±5% | 0805 | Stackpole Electronics | RMCF0805JT510R | Yes | Yes |
| R2, R3, R6 | 3 | 4.7 kOhms ±1% 0.125W, 1/8W Chip Resistor 0805 | 4.7 kOhms | ±1% | 0805 | Yageo | RC0805FR-074K7L | Yes | Yes |
| R1 (Rgnd) | 1 | 47 Ohms ±1% 0.125W, 1/8W Chip Resistor 0805 | 47 Ohms | ±1% | 0805 | Stackpole Electronics | RMCF0805FT47R0 | Yes | Yes |
| J1, J4, J6, J8 | DNP | 0 Ohms Jumper Chip Resistor 0603 | 0 Ohms | ±5% | 0603 | Stackpole Electronics | RMCF0603ZT0R00 | Yes | Yes |
| J2, J3, J5, J7 | 4 | 0 Ohms Jumper Chip Resistor 0603 | 0 Ohms | ±5% | 0603 | Stackpole Electronics | RMCF0603ZT0R00 | Yes | Yes |
| C2 (Csupply) | 1 | 100nF ±10% 50V Ceramic Capacitor X5R 1210 | 100 nF | ±10% | 1210 | KEMET | C1210C104K5RACTU | Yes | Yes |
| C4 (Ccs) | 1 | 100pF ±5% 50V Ceramic Capacitor X7R 0805 | 100 pF | ±5% | 0805 | Yageo | CC0603JRNPO9BN101 | Yes | Yes |
| C3 (C_VD_GND) | 1 | 47nF ±10% 50V Ceramic Capacitor X7R 0603 | 47 nF | ±10% | 0603 | Walsin Technology | 0603B473K500CT | Yes | Yes |
| C1 (Cout) | 1 | 10nF 50V Ceramic Cap 0603 | 10 nF | ±5% | 0603 | KEMET | C0603C103J5RACTU | Yes | Yes |
| C6 | 1 | 1uF 50V Ceramic Cap 0805 | 1 uF | ±10% | 0805 | Samsung Electro-Mechanics | CL21B105KBFNNNE | Yes | Yes |
| C5 | 1 | 330nF 50V Ceramic Cap 0805 | 330 nF | ±10% | 0805 | TDK Corporation | CGA4J2X7R1H334K125DA | Yes | Yes |
| U3 | 1 | Linear Voltage Regulator IC Positive Fixed 1 Output 1A DPAK | Linear Voltage Regulator | N/A | DPAK3_SMD | **onsemi** | MC7805BDTG | No | Yes |
| D1 | 1 | Diode Schottky 50V 2A Surface Mount DO-214AA (SMB) | 50V, 2A | N/A | SMB_DIODE | **onsemi** | SS25 | No | Yes |
| U8 | 1 | IC OPAMP GP 1 CIRCUIT 5TSOP | GP OP AMP | N/A | TSOP-5 | **onsemi** | LM321SN3T1G | No | Yes |
| U1 | 1 | Self-Protected Very Low IQ High Side Driver with Analog Current Sense | N/A | N/A | TSSOP 14EP | **onsemi** | NCV840XXFPAR2G | No | Yes |
| VD, OUT, GND | 3 | CONN BIND POST KNURLED | Connector Header Connector | N/A | BANANA | Cinch Connectivity Solutions | 111-2223-001 | Yes | Yes |
| U2 (Arduino and Headers) | 2 | CONN HDR 15POS 0.1 TIN PCB | Connector Header Connector | N/A | ARDUINONANO | Sullins Connector Solutions | PPTC151LFBN-RC | Yes | Yes |
| | 1 | Arduino Nano Every Microcontroller | ucontroller | N/A | | Arduino | ABX00028 | No | Yes |
| | 1 | CBL USB2.0 A PLUG-MIN A PLUG 6′ | N/A | N/A | | Stewart Connector | SC-2ANK006F | Yes | Yes |
| J37 (“TO Ext. uC” 6 pos Header) | 1 | CONN HDR 6POS 0.1 TIN PCB | Connector Header Connector | N/A | JP6 | Sullins Connector Solutions | PPTC061LFBN-RC | Yes | Yes |
| (Board Standoffs) TP84, TP85, TP86, TP87 | 4 | HEX STANDOFF #4-40 ALUMINUM 3/4″ | N/A | N/A | #4MOUNT | Keystone Electronics | 2204 | Yes | Yes |
| | 4 | Machine Screw Pan Phillips #4-40 x 1/4″ | | | | | 9900 | Yes | Yes |
| GND, IN, CS_EN, CS, DUT_GND, OUT_S, VD_S | 7 | Test Point | N/A | N/A | TP | Vector Electronics | K31C/M | Yes | Yes |

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| Designator (Main Board) | Quantity | Description | Value | Tolerance | Footprint | Manufacturer | Manufacturer Part Number | Subst. Allowed | Lead Free |
|---|---|---|---|---|---|---|---|---|---|
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| R5 | 1 | RES 510 OHM 5% 1/8W 0805 | 510 Ohms | ±5% | 0805 | Stackpole Electronics | RMCF0805JT510R | Yes | Yes |
| R2, R3, R6 | 3 | 4.7 kOhms ±1% 0.125W, 1/8W Chip Resistor 0805 | 4.7 kOhms | ±1% | 0805 | Yageo | RC0805FR-074K7L | Yes | Yes |
| R1 (Rgnd) | 1 | 47 Ohms ±1% 0.125W, 1/8W Chip Resistor 0805 | 47 Ohms | ±1% | 0805 | Stackpole Electronics | RMCF0805FT47R0 | Yes | Yes |
| J1, J3, J4, J5, J6, J7, J8 | DNP | 0 Ohms Jumper Chip Resistor 0603 | 0 Ohms | ±5% | 0603 | Stackpole Electronics | RMCF0603ZT0R00 | Yes | Yes |
| J2 | 1 | 0 Ohms Jumper Chip Resistor 0603 | 0 Ohms | ±5% | 0603 | Stackpole Electronics | RMCF0603ZT0R00 | Yes | Yes |
| C2 (Csupply) | 1 | 100nF ±10% 50V Ceramic Capacitor X5R 1210 | 100 nF | ±10% | 1210 | KEMET | C1210C104K5RACTU | Yes | Yes |
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| C3 (C_VD_GND) | 1 | 47nF ±10% 50V Ceramic Capacitor X7R 0603 | 47 nF | ±10% | 0603 | Walsin Technology | 0603B473K500CT | Yes | Yes |
| C1 (Cout) | 1 | 10nF 50V Ceramic Cap 0603 | 10 nF | ±5% | 0603 | KEMET | C0603C103J5RACTU | Yes | Yes |
| C6 | 1 | 1uF 50V Ceramic Cap 0805 | 1 uF | ±10% | 0805 | Samsung Electro-Mechanics | CL21B105KBFNNNE | Yes | Yes |
| C5 | 1 | 330nF 50V Ceramic Cap 0805 | 330 nF | ±10% | 0805 | TDK Corporation | CGA4J2X7R1H334K125DA | Yes | Yes |
| U3 | 1 | Linear Voltage Regulator IC Positive Fixed 1 Output 1A DPAK | Linear Voltage Regulator | N/A | DPAK3_SMD | **onsemi** | MC7805BDTG | No | Yes |
| D1 | 1 | Diode Schottky 50V 2A Surface Mount DO-214AA (SMB) | 50V, 2A | N/A | SMB_DIODE | **onsemi** | SS25 | No | Yes |
| U8 | 1 | IC OPAMP GP 1 CIRCUIT 5TSOP | GP OP AMP | N/A | TSOP-5 | **onsemi** | LM321SN3T1G | No | Yes |
| U1 | 1 | Self-Protected Very Low IQ High Side Driver with Analog Current Sense | N/A | N/A | TSSOP14EP | **onsemi** | NCV840XXFPAR2G | No | Yes |
| VD, OUT, GND | 3 | CONN BIND POST KNURLED | Connector Header Connector | N/A | BANANA | Cinch Connectivity Solutions | 111-2223-001 | Yes | Yes |
| U2 (Arduino and Headers) | DNP | CONN HDR 15POS 0.1 TIN PCB | Connector Header Connector | N/A | ARDUINONANO | Sullins Connector Solutions | PPTC151LFBN-RC | Yes | Yes |
| | DNP | Arduino Nano Every Microcontroller | ucontroller | N/A | | Arduino | ABX00028 | No | Yes |
| | DNP | CBL USB2.0 A PLUG-MIN A PLUG 6′ | N/A | N/A | | Stewart Connector | SC-2ANK006F | Yes | Yes |
| J37 (“TO Ext. uC” 6 pos Header) | DNP | CONN HDR 6POS 0.1 TIN PCB | Connector Header Connector | N/A | JP6 | Sullins Connector Solutions | PPTC061LFBN-RC | Yes | Yes |
| (Board Standoffs) TP84, TP85, TP86, TP87 | 4 | HEX STANDOFF #4-40 ALUMINUM 3/4″ | N/A | N/A | #4MOUNT | Keystone Electronics | 2204 | Yes | Yes |
| | 4 | Machine Screw Pan Phillips #4-40 x 1/4″ | | | | | 9900 | Yes | Yes |
| GND, IN, CS_EN, CS, DUT_GND, OUT_S, VD_S | 7 | Test Point | N/A | N/A | TP | Vector Electronics | K31C/M | Yes | Yes |

## REVISION HISTORY

| Revision | Description of Changes | Date |
|---|---|---|
| 0 | Initial document release. | 4/28/2026 |
| 1 | Edit orderable part numbers throughout document, one value edit table 1, text edits board operation section, replace tables 4 and 5 | 6/10/2026 |

## ADDITIONAL INFORMATION

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