

# NCV887601BSTGEVB

## NCV887601 Automotive Grade High-Frequency Start-Stop Boost Controller Evaluation Board User's Manual



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### EVAL BOARD USER'S MANUAL

#### Description

This NCV887601 evaluation board provides a convenient way to evaluate a high frequency boost controller designed to supply a minimum output voltage during Start-Stop vehicle battery voltage sags. The unit is in low  $I_q$  sleep-mode under normal battery operating condition and will wake-up when the monitored voltage drops below 7.3 V and begin regulating once 6.8 V is reached. Switching frequency is set to 440 kHz with a user selectable ROSC resistor. The evaluation board is rated 6.8 V / 3.6 A at a 2.6 V input voltage. Operation below 2.6 V is possible if output current is reduced.

#### Key Features

- Automatic enable below 7.3 V
- Boost Operation at 6.8 V
- 440 kHz Switching Frequency
- Input Undervoltage Lockout
- Wide Input Voltage of 2.6 V to 45 V
- Low Quiescent Current in Sleep Mode ( $<11 \mu\text{A}$  Typical)
- Cycle-by-Cycle Current Limit Protection
- Status Monitoring
- Automotive Grade

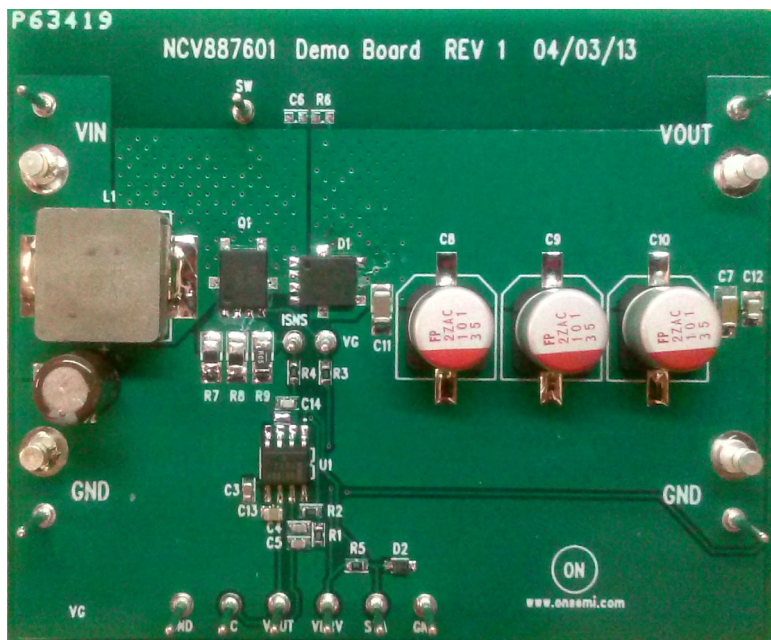


Figure 1. NCV887601 Start-Stop Evaluation Board

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**Table 1. EVALUATION BOARD TERMINALS**

| Terminal           | Function                                         |
|--------------------|--------------------------------------------------|
| VIN (large post)   | Positive DC input voltage (power)                |
| GND (large post)   | Common DC return (power)                         |
| VOOUT (large post) | Regulated DC output voltage (power)              |
| GND (small post)   | Common DC return, monitoring point               |
| VC (small post)    | Voltage compensation, monitoring point           |
| VOOUT (small post) | Regulated DC output voltage, monitoring point    |
| VDRV (small post)  | Driving voltage, monitoring point                |
| STA (small post)   | IC status, monitoring point                      |
| ISNS (small post)  | Current sense resistor voltage, monitoring point |
| VG (small post)    | MOSFET gate voltage, monitoring point            |
| SW (small post)    | MOSFET drain voltage, monitoring point           |

**Table 2. ABSOLUTE MAXIMUM RATINGS** (Voltages are with respect to GND)

| Rating                                 | Value        | Unit |
|----------------------------------------|--------------|------|
| DC supply voltage (VIN)                | -0.3 to 45 V | V    |
| DC supply voltage (EN, SYNC)           | -0.3 to 6 V  | V    |
| Junction Temperature                   | -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 3. ELECTRICAL CHARACTERISTICS**

( $T_A = 25^\circ\text{C}$ ,  $6\text{ V} \leq V_{IN} \leq V_{out\_LED}$ ,  $V_{EN} = 2\text{ V}$ , unless otherwise specified)

| Characteristics                    | Conditions                | Typical Value | Unit |
|------------------------------------|---------------------------|---------------|------|
| <b>Switching</b>                   |                           |               |      |
| Switching Frequency                | ROSC = 10.7 kΩ            | 440           | kHz  |
| User Selectable Frequency Range    | ROSC (refer to datasheet) | 170-500       | kHz  |
| <b>Current Limit</b>               |                           |               |      |
| Cycle-by-cycle Current Limit (FET) | -                         | 18            | A    |
| <b>Protections</b>                 |                           |               |      |
| Maximum Duty Cycle                 | -                         | 0.83          | -    |
| VOOUT Undervoltage Lockout (UVLO)  | VOOUT falling             | 3.6           | V    |
|                                    | VOOUT rising              | 4.0           |      |
| Thermal Shutdown                   | $T_A$ increasing          | 170           | °C   |

## Operational Guidelines

The evaluation board is rated to operate at full load for input voltage as low as 2.6 V at the input terminal under full power (less if output current is reduced). Start-Stop applications use reverse battery protection diodes in front of the boost converter (Figure 2), so the input source can operate down to 2.6 V plus a diode drop (i.e. ~3 V). On the cathode side of the reverse battery protection diode, electrolytic capacitors are used (e.g. 2 x 330  $\mu$ F) that serve three functions.

1. EMI filtering of the power supply input current.
2. Holdup energy to limit the Start-Stop operation dV/dt voltage sag to the boost supply.
3. When using a bench supply power source, the electrolytic capacitors decouple the power source from the boost demo board to prevent negative impedance oscillation\*.

\* The use of external electrolytic capacitors at the input of the evaluation board (short leads) is strongly recommended for bench testing.

## Notes:

1. The IC UVLO (undervoltage lockout) is 4.0 V for VOUT rising, 3.6 V for VOUT falling (0.4 V hysteresis). The STATUS pin is powered by the IC VDRV pin on the demo board (details available from the Figure 4 schematic) to eliminate leakage current during normal battery operation. The STATUS pin has a high impedance state when in sleep-mode. STATUS pin is in a low impedance state only when the IC is awake (VOUT decreasing is below 7.3 V) and not in UVLO.

2. Limit time spent with the power supply operating at minimum input voltage (equivalent to VIN = 2.6 V) to avoid overheating the power semiconductors.

## First Time Power-Up:

1. Connect a DC2 input voltage (15 A capable) set to a voltage of 12.0 V as shown in Figure 2. DC1 is not used in this test.
2. Connect a 3.6 A load on the output. If a load resistor is used, it is recommended to start from a DC2 input voltage of 8.5-9.0 V to avoid overstressing the PCB boost diode (D1, rated 4 A).
3. Decrease the DC input voltage until the PCB VIN voltage is less than that of the output. Verify that the unit is regulating at VOUT = 6.8 V.
4. Reduce the power source voltage until the PCB VIN = 2.6 V. Verify that the unit is regulating at VOUT = 6.8 V.

## Start-Stop Voltage Transient Test:

1. Connect both DC1 and DC2 input power supplies as illustrated in Figure 2. Adjust DC2 so that PCB VIN = 2.6 V for a 3.6 A load.
2. Connect a 3.6 A load on the output. If a load resistor is used, it is recommended to start from a DC1 input voltage of 8.5-9.0 V to avoid overstressing the PCB boost diode (D1, rated 4 A).
3. Monitor VOUT. Disconnect supply DC1. VOUT should have a response similar to that of Figure 3.

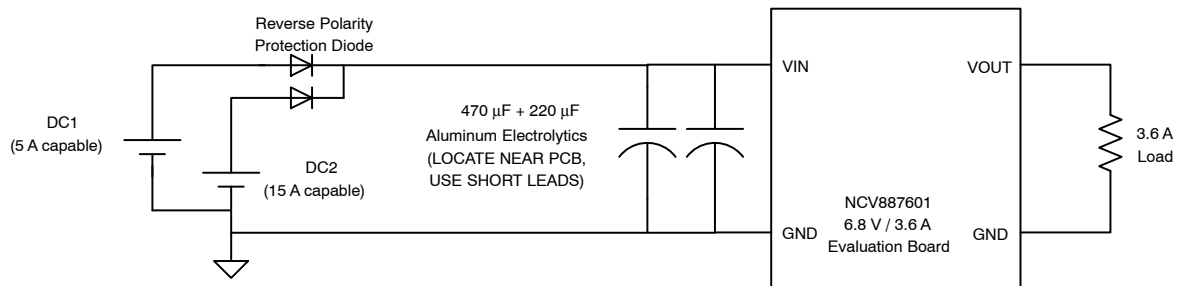


Figure 2. Evaluation Board Connections

## Typical Performance

DC1 is disabled, then re-enabled

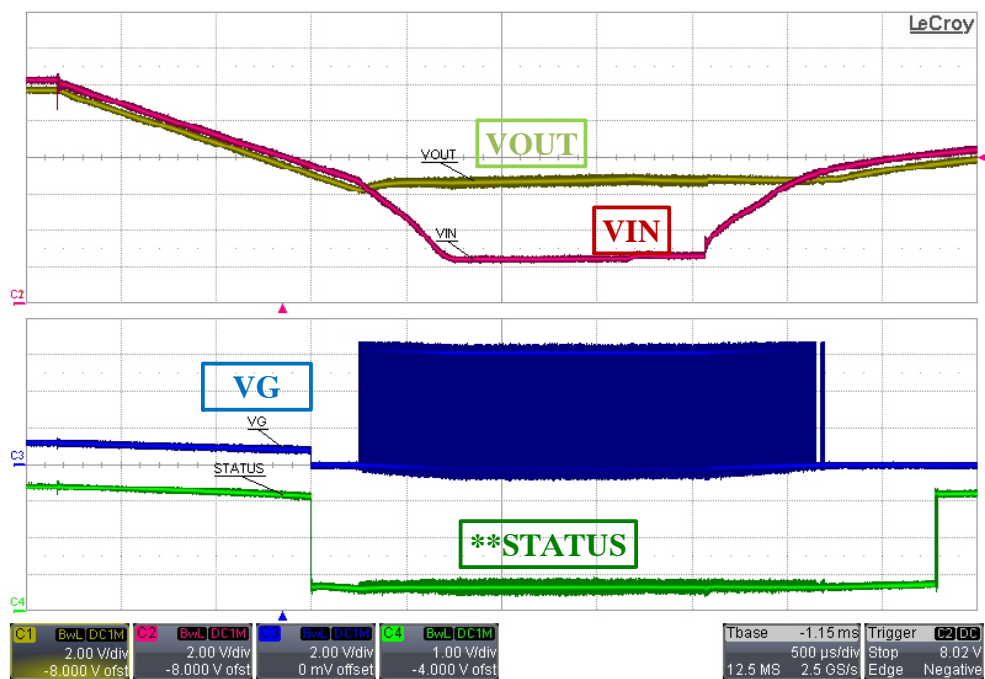
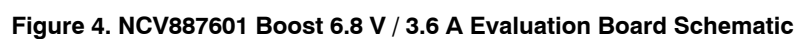


Figure 3. NCV887601 Evaluation Board Waveforms

- DC2 at VIN set to 2.6 V (after reverse polarity protection diode)
- VOUT = 6.8 V, IOUT = 3.6 A
- \*\*STATUS pin was powered using an external source

## SCHEMATIC



# NCV887601BSTGEVB

## BILL OF MATERIALS

**Table 4. BILL OF MATERIALS**

| Reference Designator(s) | QTY | Description                           | Value           | Tolerance | Manufacturer                     | Manufacturer's Part Number |
|-------------------------|-----|---------------------------------------|-----------------|-----------|----------------------------------|----------------------------|
| C1, C12                 | 2   | CAP CER 0.1UF 50V 10% X7R 0805        | 100 nF          | 10%       | Murata Electronics North America | GCM21BR71H104KA37L         |
| C2                      | 1   | CAP ALUM 56UF 50V 20% RADIAL          | 56 $\mu$ F      | 20%       | Chemi-Con                        | EKZE500ELL560MF11D         |
| C3                      | 1   | CAP CER 1UF 16V 10% X7R 0603          | 1 $\mu$ F       | 10%       | Murata Electronics North America | GCM188R71C105KA64D         |
| C4                      | 1   | CAP CER 470PF 50V 5% NP0 0603         | 470 pF          | 5%        | Murata Electronics North America | GCM1885C1H471JA16D         |
| C5                      | 1   | CAP CER 0.033UF 50V 10% X7R 0603      | 0.033 $\mu$ F   | 10%       | TDK Corporation                  | CGA3E2X7R1H333K080AA       |
| C6                      | 1   | CAP CER 3300PF 50V 5% NP0 0603        | 3300 pF         | 5%        | TDK Corporation                  | CGA3E2C0G1H332J080AA       |
| C7                      | 1   | CAP CER 4.7UF 50V 10% X7R 1206        | 4.7 $\mu$ F     | 10%       | Taiyo Yuden                      | UMK316AB7475KL-T           |
| C8, C9, C10             | 2   | CAP ALUM 100UF 35V 20% SMD            | 100 $\mu$ F     | 20%       | Nichicon                         | RHS1V101MCN1GS             |
| C11                     | 1   | CAP CER 1UF 50V 10% X7R 1206          | 1.0 $\mu$ F     | 10%       | Murata Electronics North America | GCM31MR71H105KA55L         |
| C13                     | 1   | CAP CER 1UF 50V 10% X7R 0805          | 1.0 $\mu$ F     | 10%       | TDK Corporation                  | CGA4J3X7R1H105K125AB       |
| C14                     | 1   | CAP CER 100PF 50V 5% NP0 0603         | 100 pF          | 5%        | Murata Electronics North America | GCM1885C1H101JA16D         |
| D1                      | 1   | 40 V, 4.0 A Schottky Rectifier SO8-FL | 40 V / 4 A      | N/A       | ON Semiconductor                 | NRVB440MFST1G              |
| D2                      | 1   | DIODE ZENER 3.3V 200MW SOD323         | 3.3 V / 200 mW  | N/A       | ON Semiconductor                 | MM3Z3V3ST1G                |
| L1                      | 1   | INDUCTOR POWER 2.2UH 22A SMD          | 2.2 $\mu$ H     | 20%       | Vishay Dale                      | IHLP5050FDER2R2M01         |
| Q1                      | 1   | N-Channel Power MOSFET 60V 61A SO-8FL | 60 V / 61 A     | N/A       | ON Semiconductor                 | NVMFS5844NL                |
| R1                      | 1   | RES 3.01K OHM 1/10W 1% 0603 SMD       | 3.01 K $\Omega$ | 1%        | Vishay Dale                      | CRCW06033K01FKEA           |
| R2                      | 1   | RES 10.7K OHM 1/10W 1% 0603 SMD       | 10.7 K $\Omega$ | 1%        | Vishay Dale                      | CRCW060310K7FKEA           |
| R3                      | 1   | RES 0.0 OHM 1/10W JUMP 0603 SMD       | 0               | Jumper    | Vishay Dale                      | CRCW06030000Z0EA           |
| R4                      | 1   | RES 845 OHM 1/10W 1% 0603 SMD         | 845 $\Omega$    | 1%        | Vishay Dale                      | CRCW0603845RFKEA           |
| R5                      | 1   | RES 9.10K OHM 1/10W 1% 0603 SMD       | 9.10 K $\Omega$ | 1%        | Vishay Dale                      | CRCW06039K10FKEA           |
| R6                      | 1   | RES 8.20 OHM 1/10W 1% 0603 SMD        | 8.2 $\Omega$    | 1%        | Vishay Dale                      | CRCW06038R20FKEA           |
| R8, R9                  | 2   | RES 0.022 OHM 1W 5% 1206 SMD          | 0.022 $\Omega$  | 5%        | Panasonic Electronic Components  | ERJ-8BWJR022V              |
| R7                      | DNP |                                       |                 |           |                                  |                            |
| TP1, 2, 3, 4            | 4   | TERM SOLDER TURRET .219" .109"L       | N/A             | N/A       | Mill-Max Manufacturing Corp.     | 2501-2-00-44-00-00-07-0    |
| TP5 thru TP17           | 13  | PIN INBOARD .042" HOLE 1000/PKG       | N/A             | N/A       | Vector Electronics               | K24C/M                     |
| U1                      | 1   | Automotive Non-Sync Boost Controller  | N/A             | N/A       | ON Semiconductor                 | NCV887601                  |

# NCV887601BSTGEVB

## PCB LAYOUT

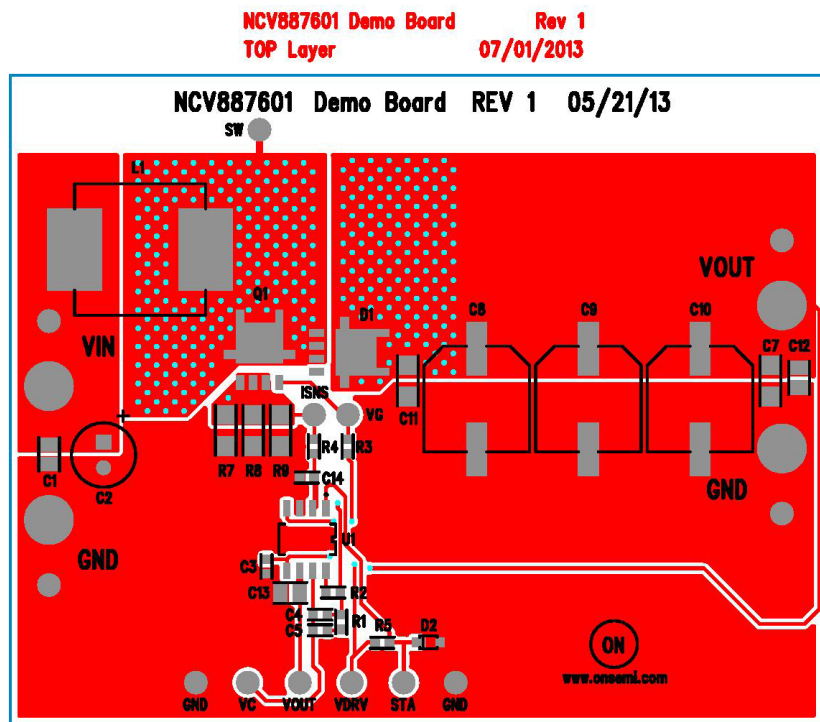


Figure 5. Top View (copper pour turned off)

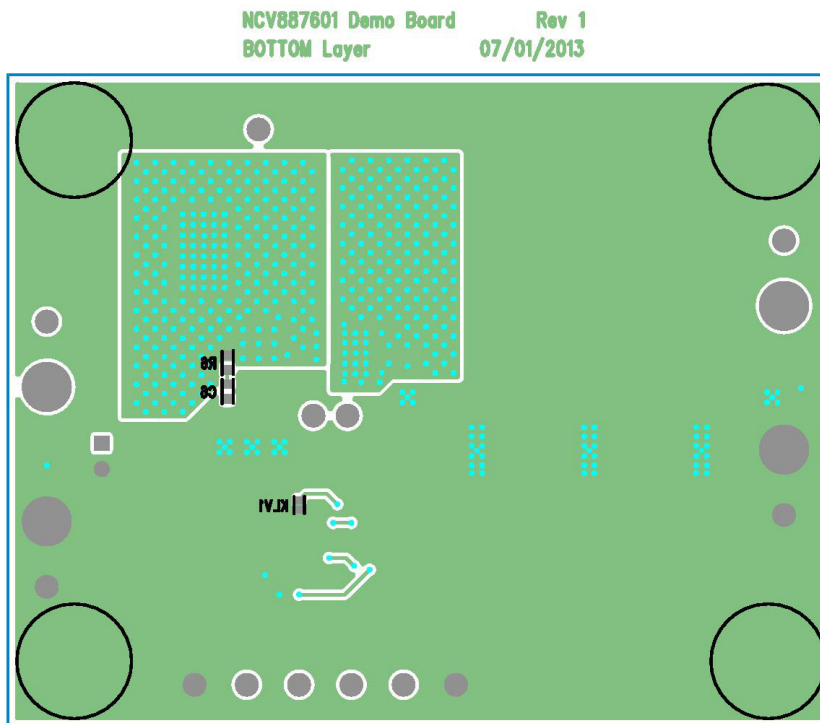


Figure 6. Bottom View (copper pour turned off)

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