

NCP1034 Buck Converter Evaluation Board User's Manual



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EVAL BOARD USER'S MANUAL

Table 1. GENERAL PARAMETERS

| Device | Input Voltage | Output Voltage | Output Current | Voltage Ripple | Topology | I/O Isolation |
|---------|-----------------|----------------|----------------|----------------|----------|---------------|
| NCP1034 | 48 V $\pm 20\%$ | 5 V | 5 A | < 30 mV | Buck | None |

Description

This evaluation board user's manual describes high voltage, high power and high efficiency DC/DC buck converter featuring the NCP1034.

The NCP1034 is voltage mode PWM controller for a high voltage synchronous buck. The controller drives two external N-MOSFETs with programmable frequency up to 500 kHz for wide applications range. The IC is able to be synchronized by external signal or is able to synchronize other ICs that simplify design of system level filter. The output voltage can be set as low as 1.25 V. Besides system and drivers UVLO there is an external UVLO that can be set to user value. Over current protection uses low side MOSFET $R_{DS(on)}$ as sensing resistor, which has no impact on efficiency. Current limit protection uses a hiccup mode. These protections provide application additional security level.

Key Features

- High Input Voltage
- High Operation Frequency
- High Efficiency
- Low Output Voltage Ripple
- Ceramic Capacitors Only
- Over-current Protection
- Under-voltage Protection
- Start to Pre-biased Output
- Small Size

Connection Diagram

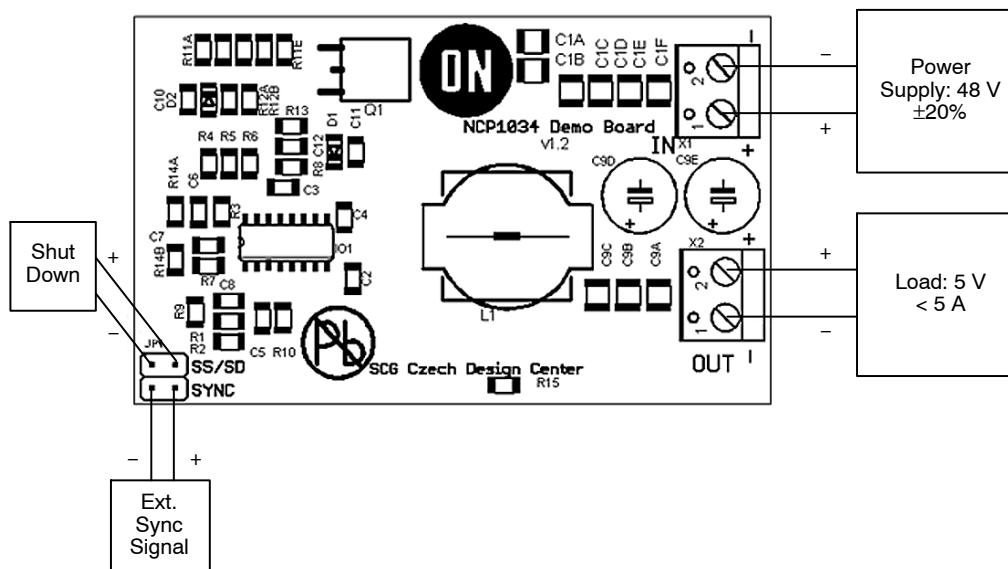


Figure 1. Connection Diagram

Schematic

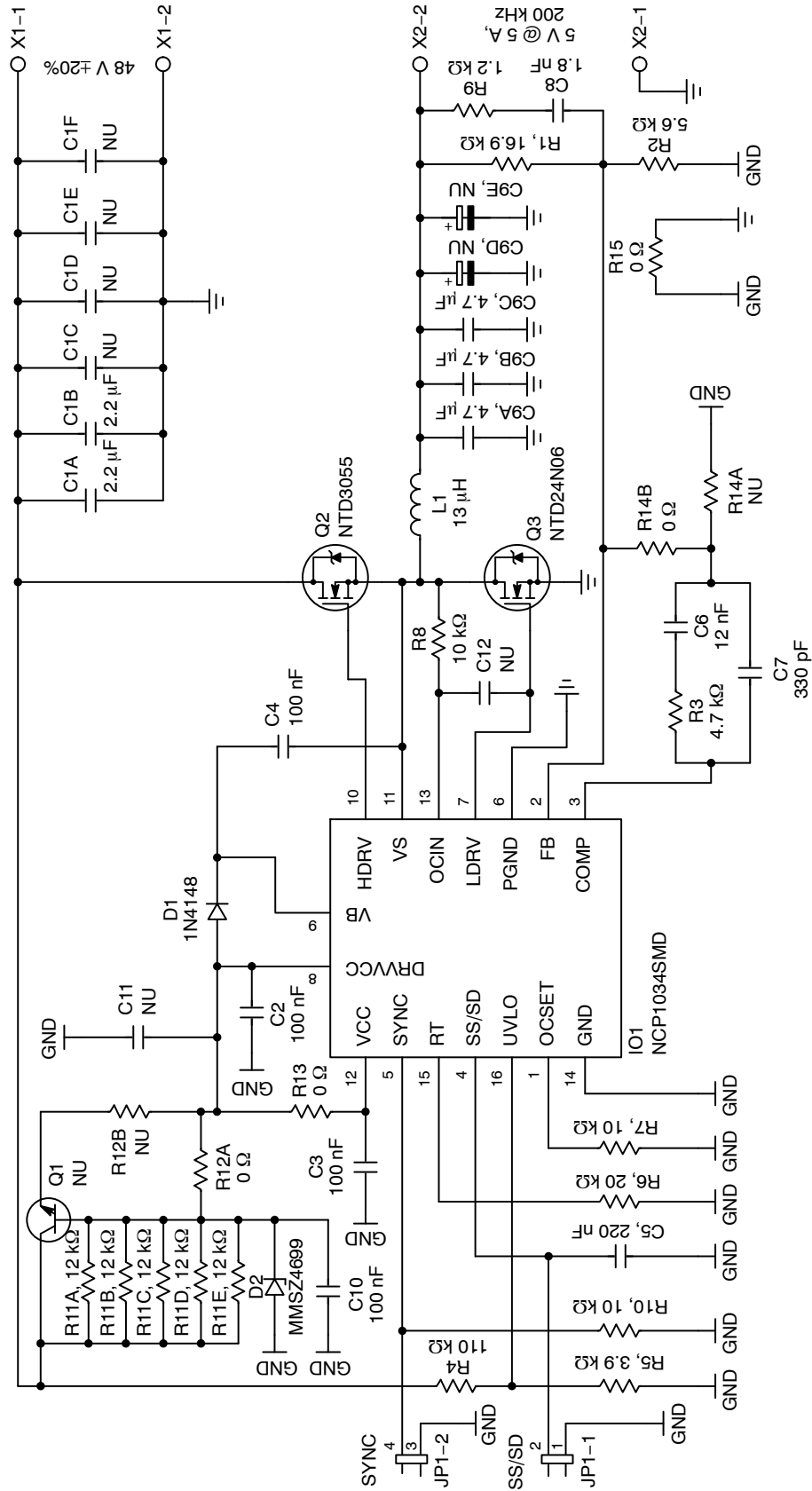


Figure 2. Schematic of the NCP1034 Demo Board

The demo board was designed as board with many options. There is linear regulator for powering the IC only with Zener diode or with high voltage transistor (R12A and R12B selected one of these regulators), compensation circuit of second or third type (R14A and R14B), ceramic or electrolytic output capacitors (C9A–C9E) and various input capacity (C1A–C1F). For additional filtering there are R13 and C11 which is not currently used. There are two headers pins for easy connection to external synchronization pulse source or to direct connection to the other NCP1034 demo board and the SS/SD pin that can be used to shut down the controller by connecting it to the ground.

Circuit Layout

Circuit is designed on two layer FR4 board with 72 μm copper cladding. Except connectors all components are

surface mounted types and almost all of them are on the top layer. On the bottom side there are power MOSFETs because it can be easy put on cooler (if demo board is used on prescribed operations conditions and at room temperature it is not needed).

Some components must be placed very carefully. Blocking capacitors C2, C3 and bootstrap capacitor C4 have to be placed close to the IC. Low side MOSFET's source have to be connected to the IC's power ground with minimum resistance and inductance of connection so two layers connection between them is needed. Feedback and compensation network should be near the IC to minimize noise on them. Using signal and power ground connected in one point near the output connector improves load regulation. Inductor and output capacitors are placed close to the MOSFETs and output connector.

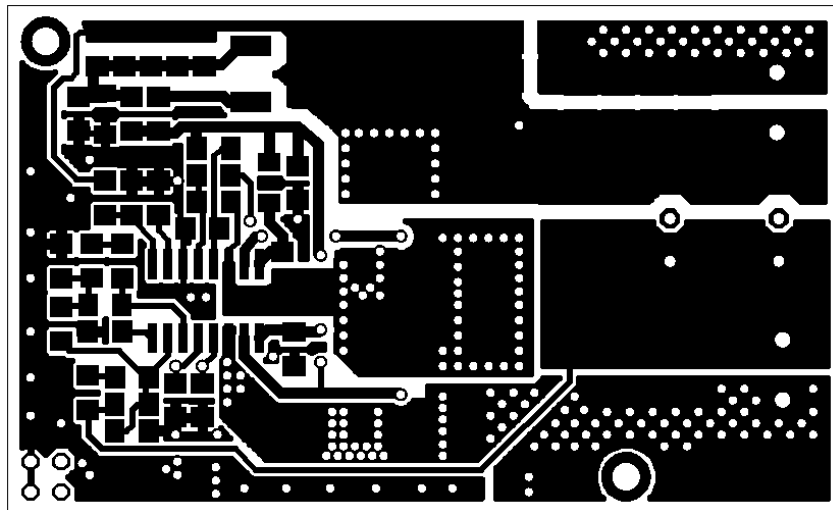


Figure 3. Top Layer

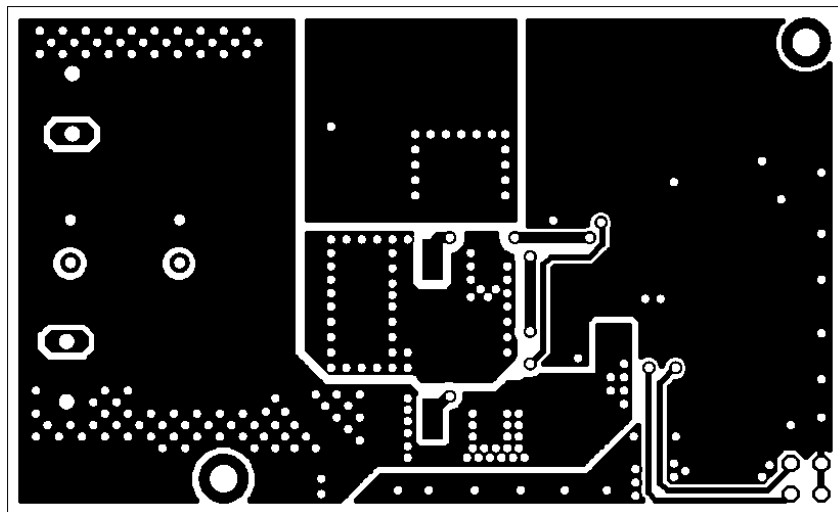


Figure 4. Bottom Layer

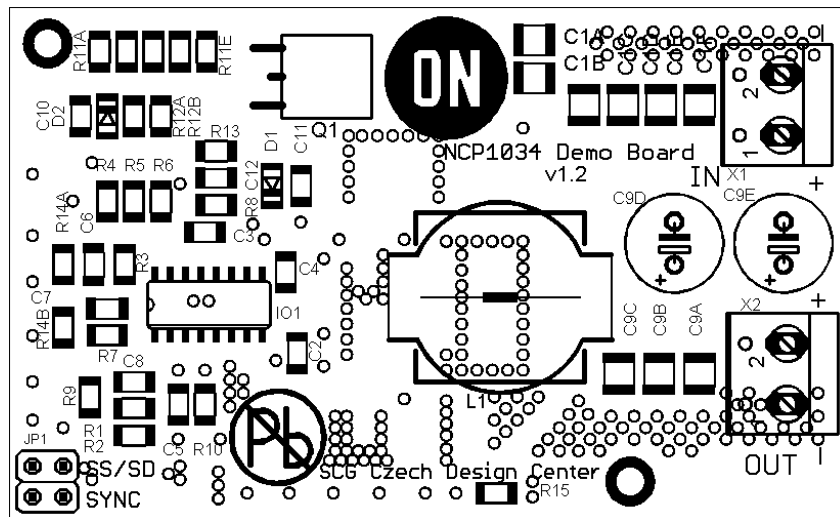


Figure 5. Top Side Components

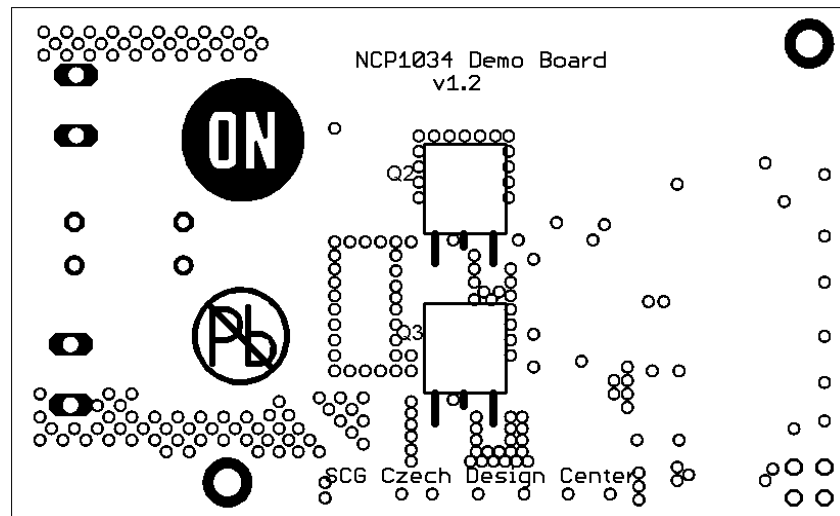


Figure 6. Bottom Side Components

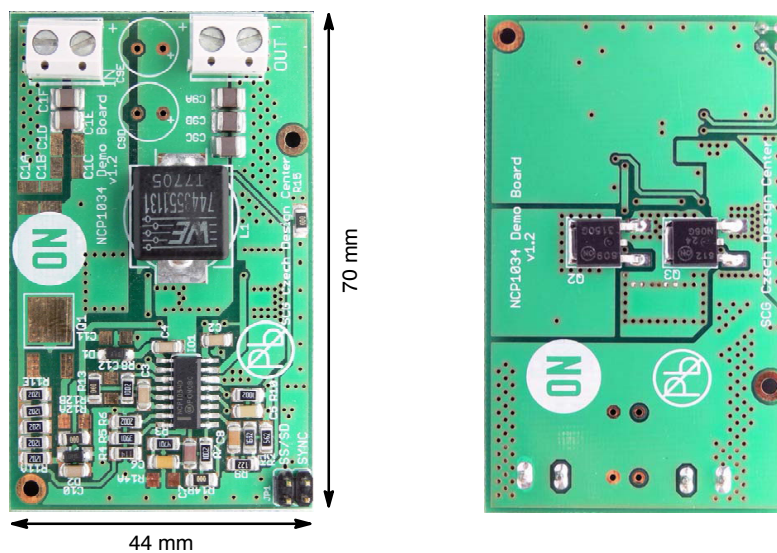


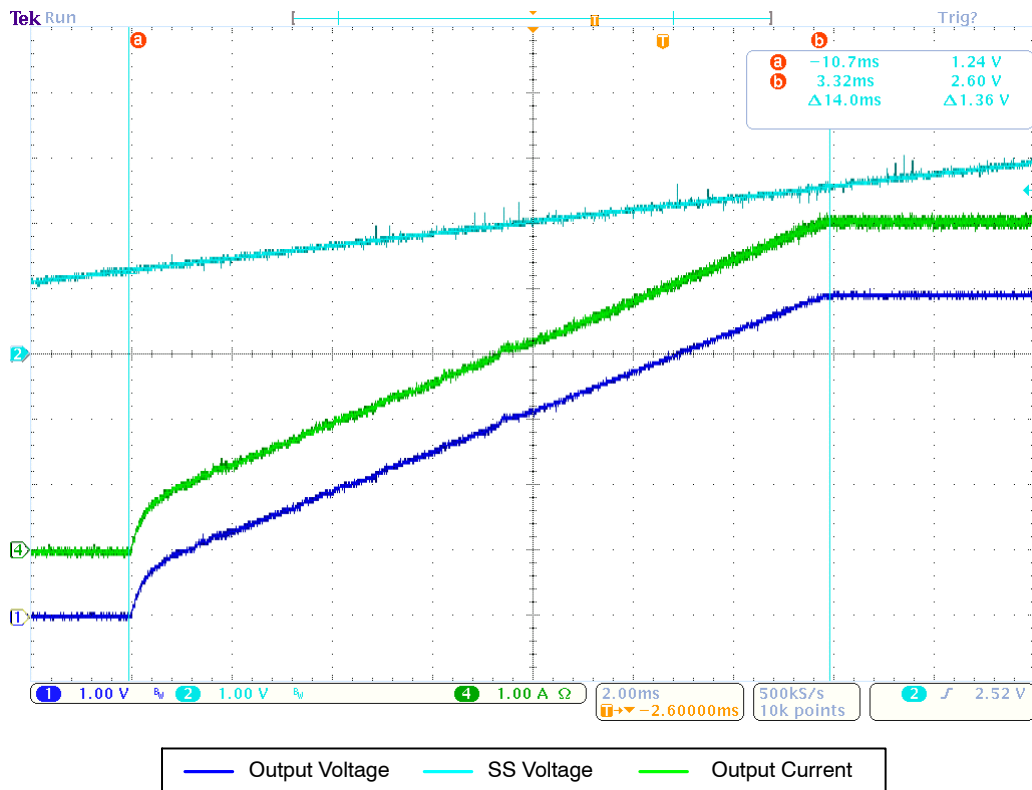
Figure 7. Demo Board Photos

Measurement

Table 2. OUTPUT PARAMETERS

| Characteristic | Typ | Unit |
|--|----------------|---------------------|
| Output Voltage | 5.02 | V |
| Maximum Output Current | 5 | A |
| Oscillator Frequency | 200 | kHz |
| Output Voltage Ripple $I_{OUT} = 0.1\text{ A}$ $I_{OUT} = 5\text{ A}$ | 16.5 20.5 | mV _{pk-pk} |
| Load Regulation $I_{OUT} = 0\text{--}5\text{ A}$, $V_{IN} = 48\text{ V}$ | -0.34 | mV/A |
| Line Regulation $V_{IN} = 38\text{--}58\text{ V}$ $I_{OUT} = 0.1\text{ A}$ $I_{OUT} = 5\text{ A}$ | 0.004 0.011 | % |

Start Up Sequence



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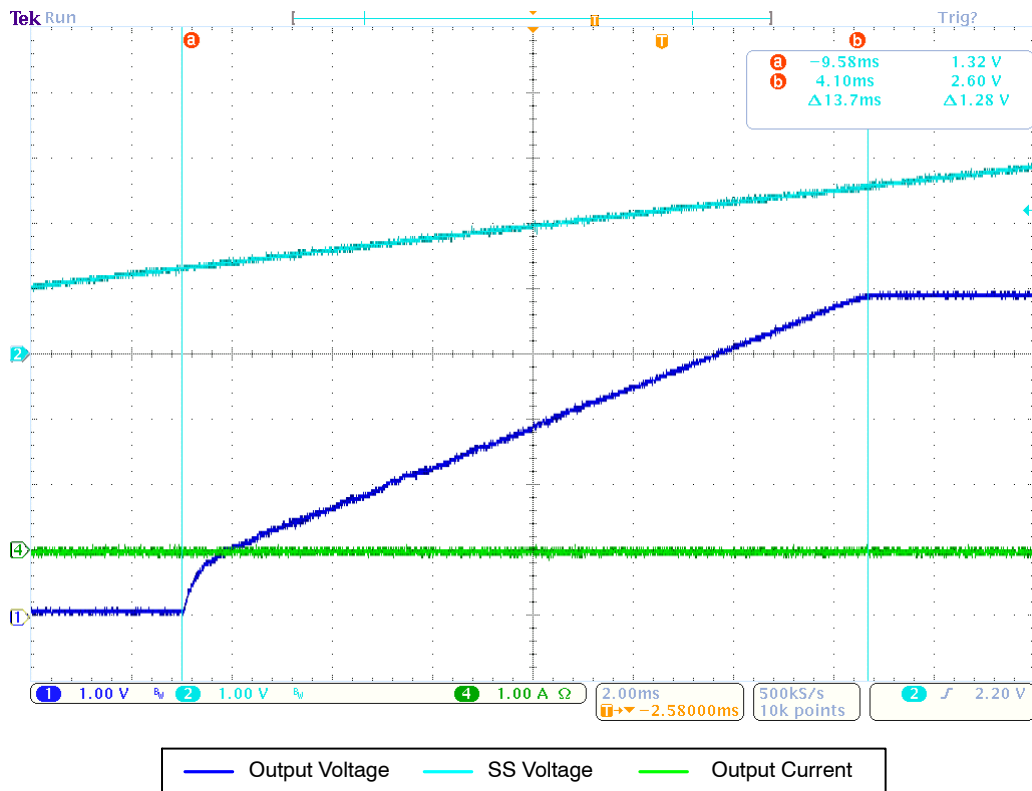


Figure 9. Start to Light Load

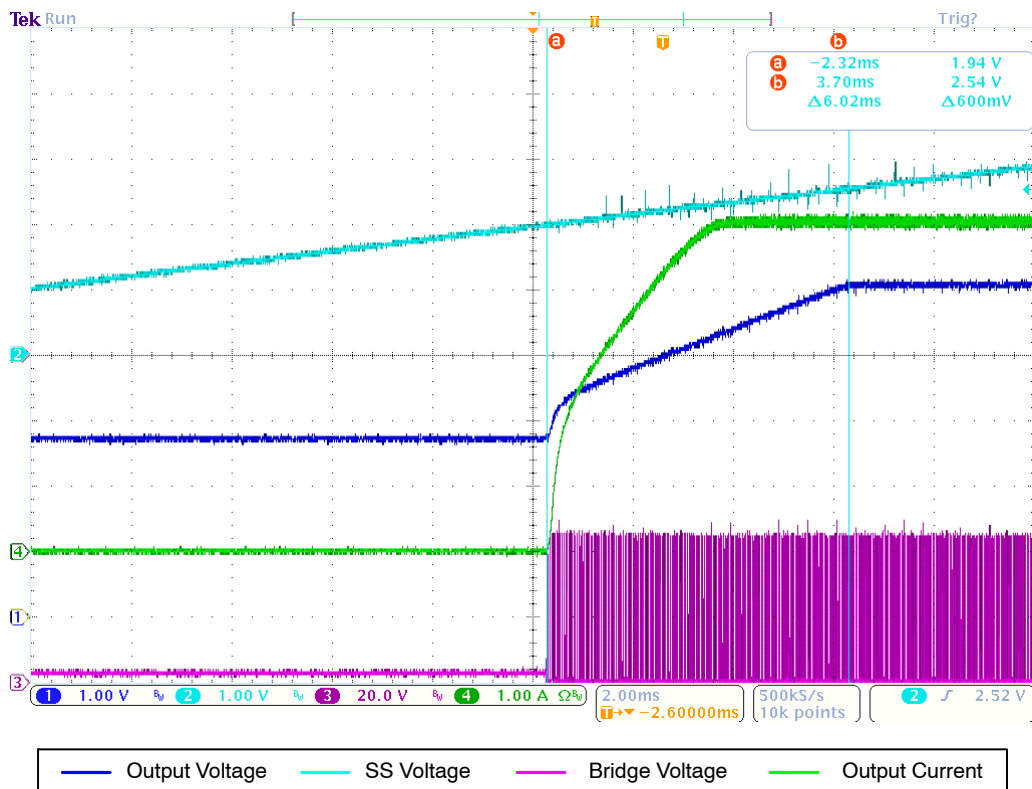


Figure 10. Start to Pre-Biased Output

Over-Current Protection

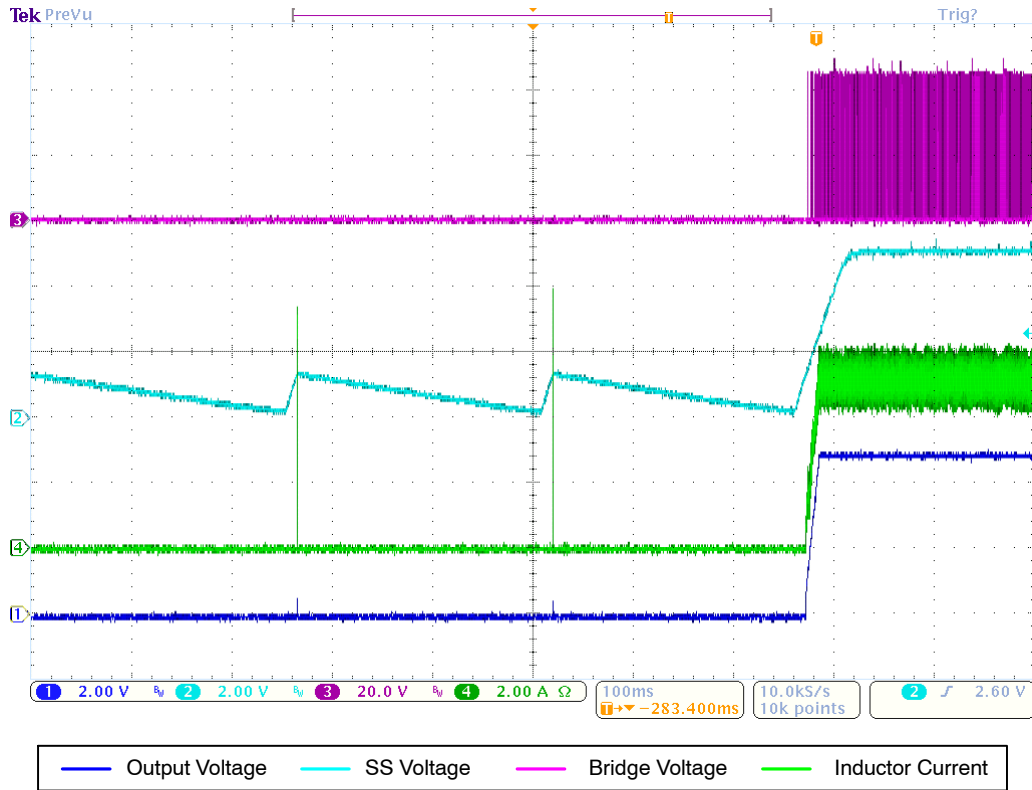


Figure 11. Shorted Output and Release

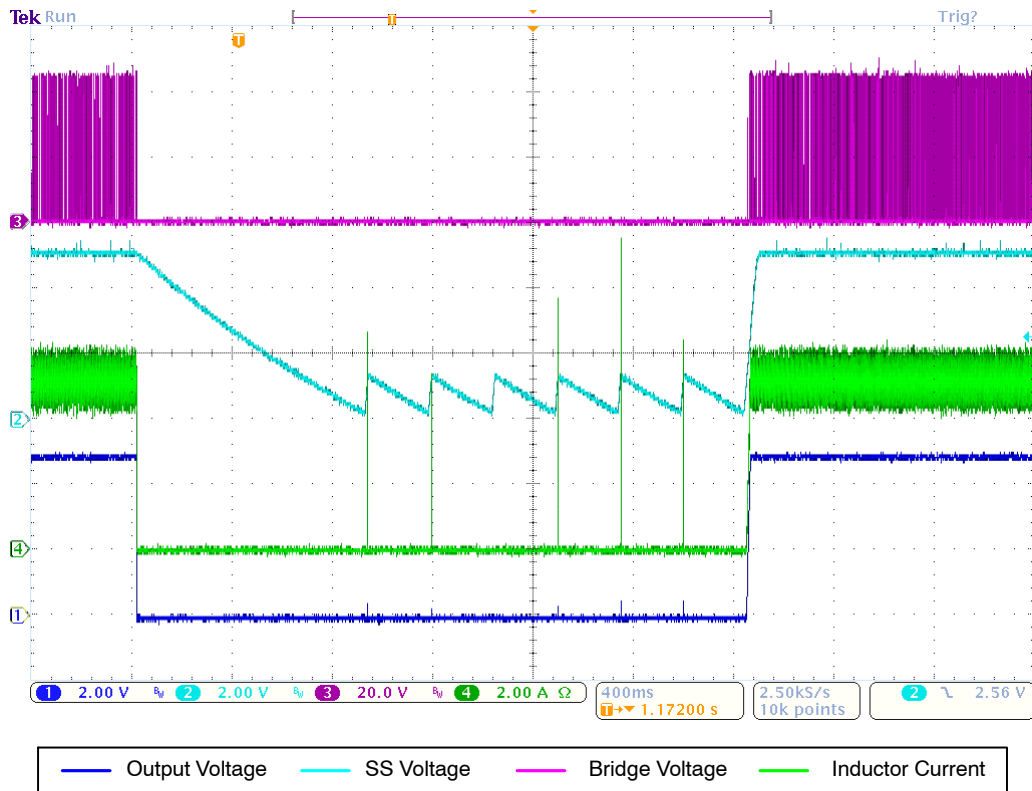


Figure 12. Overload from Nominal Load and Released

EVBUM2356/D

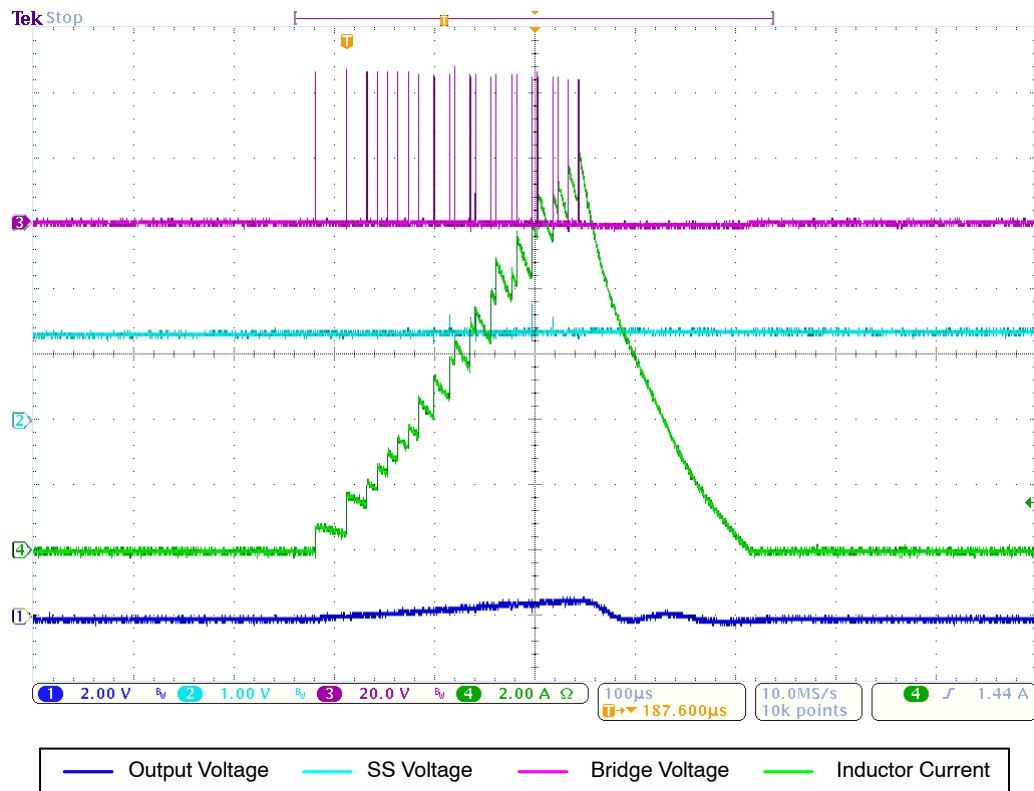


Figure 13. Hicup Pulse Detail

Shutdown

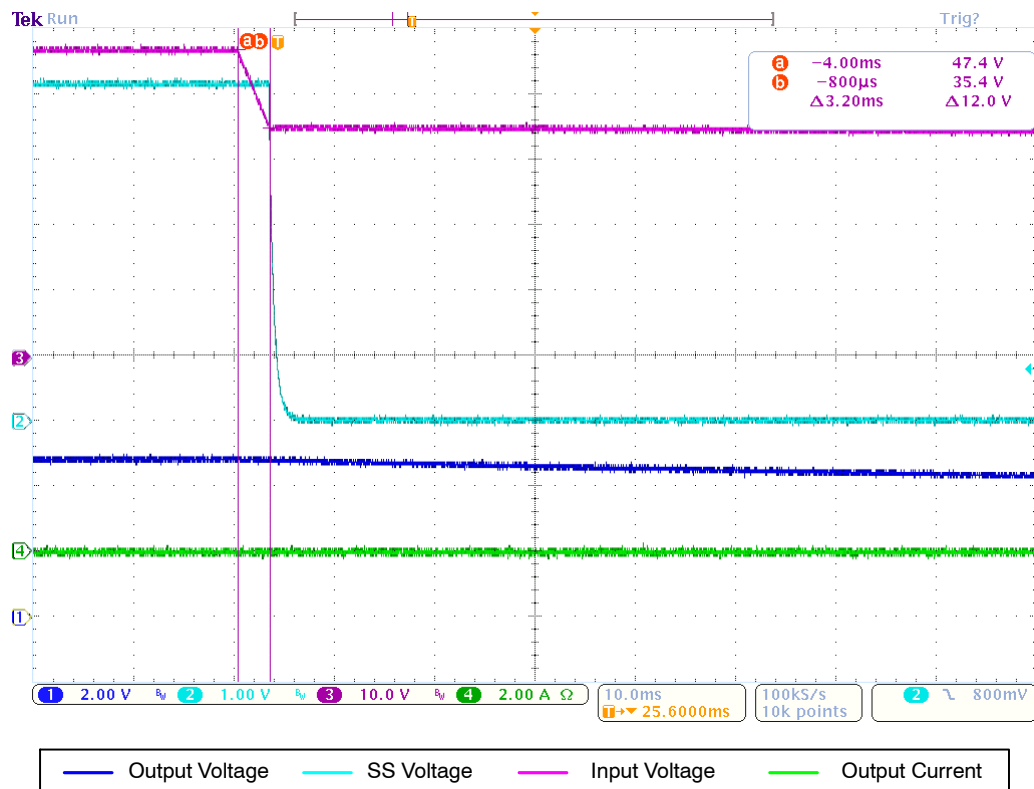


Figure 14. Switch Off Input Voltage to Light Load

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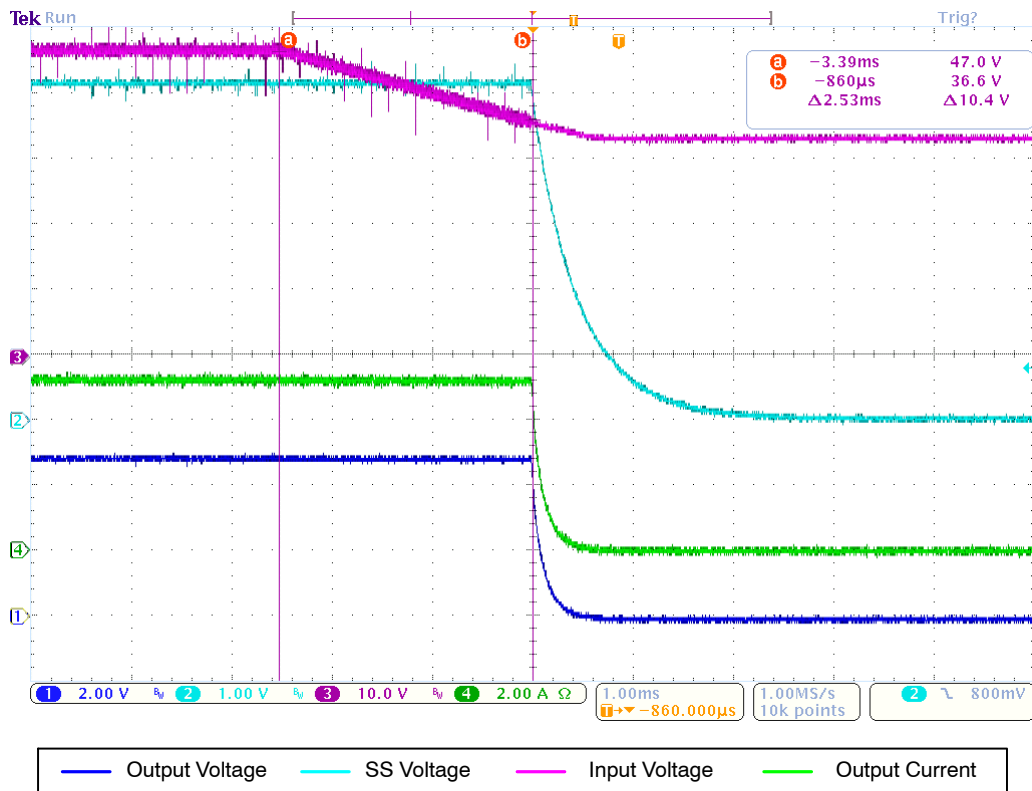


Figure 15. Switch Off Input Voltage to Nominal Load

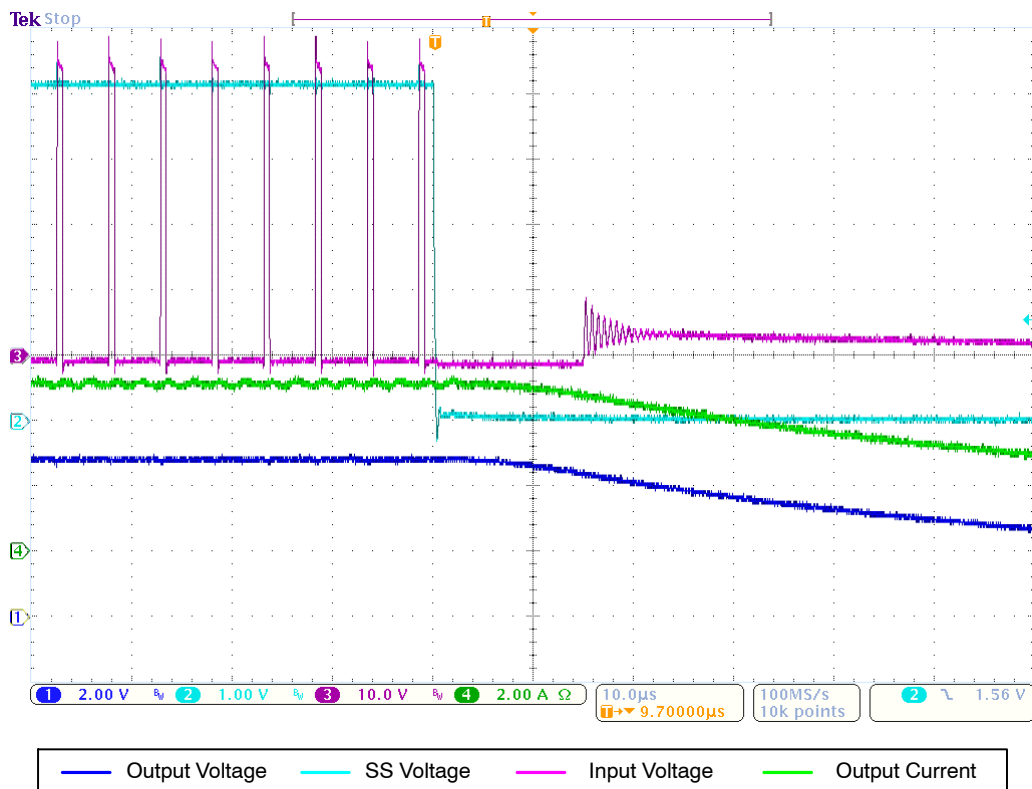


Figure 16. Shut Down through SS/SD Pin

Step Response and Output Voltage Ripple

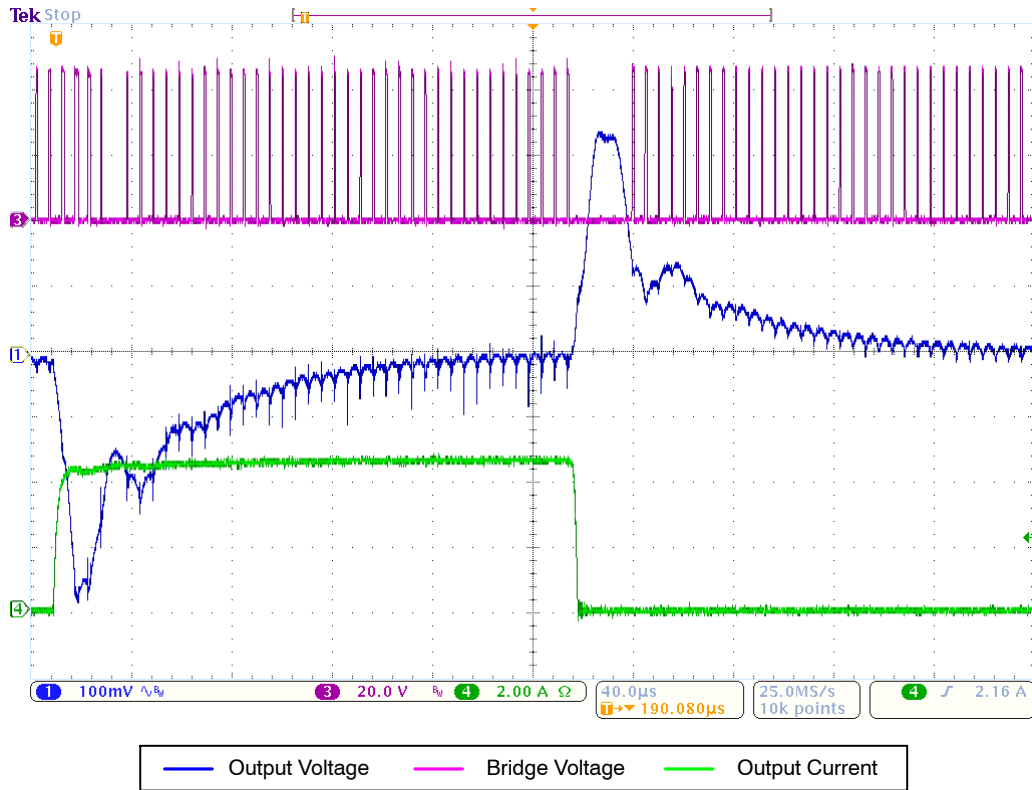


Figure 17. Load Step Response

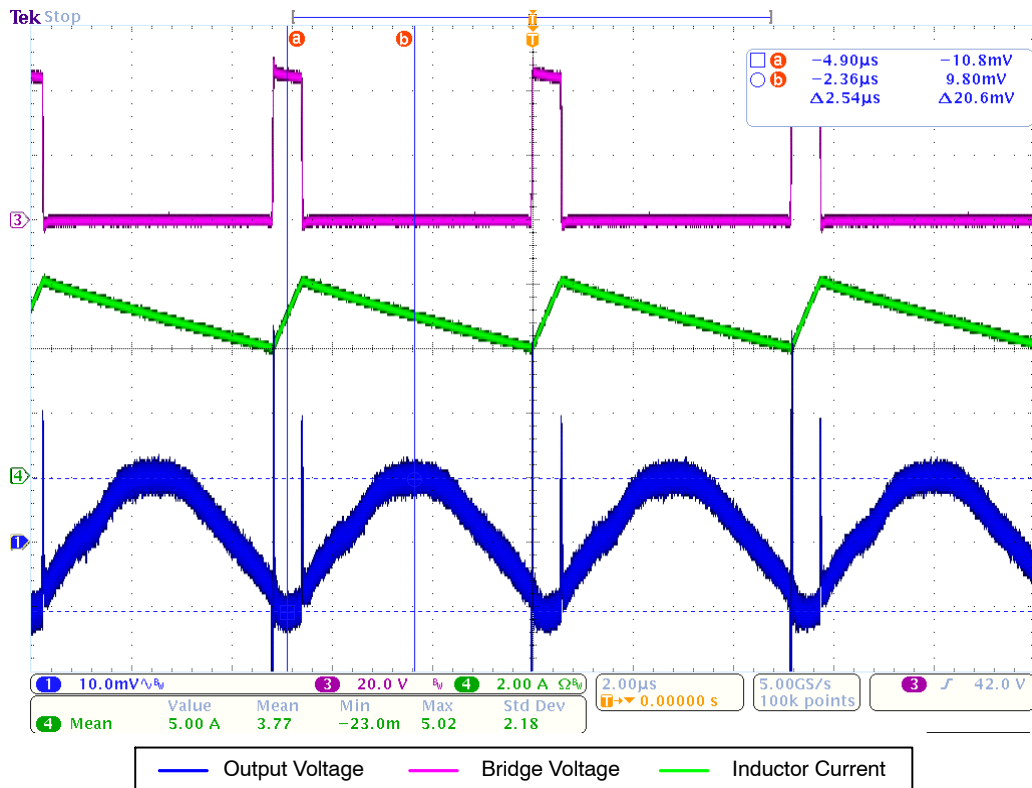


Figure 18. Output Voltage Ripple $I_{OUT} = 5\text{ A}$

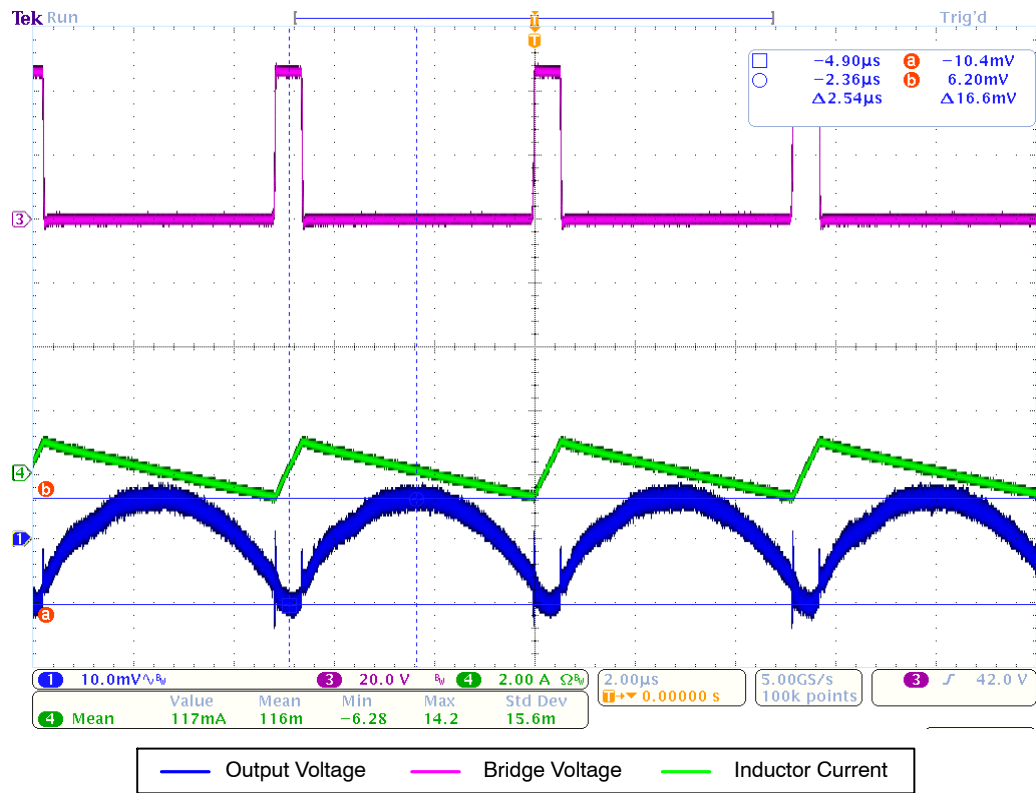


Figure 19. Output Voltage Ripple $I_{OUT} = 0.1 \text{ A}$

Synchronization

Two independent boards connected (or not) via Sync pin and ground.

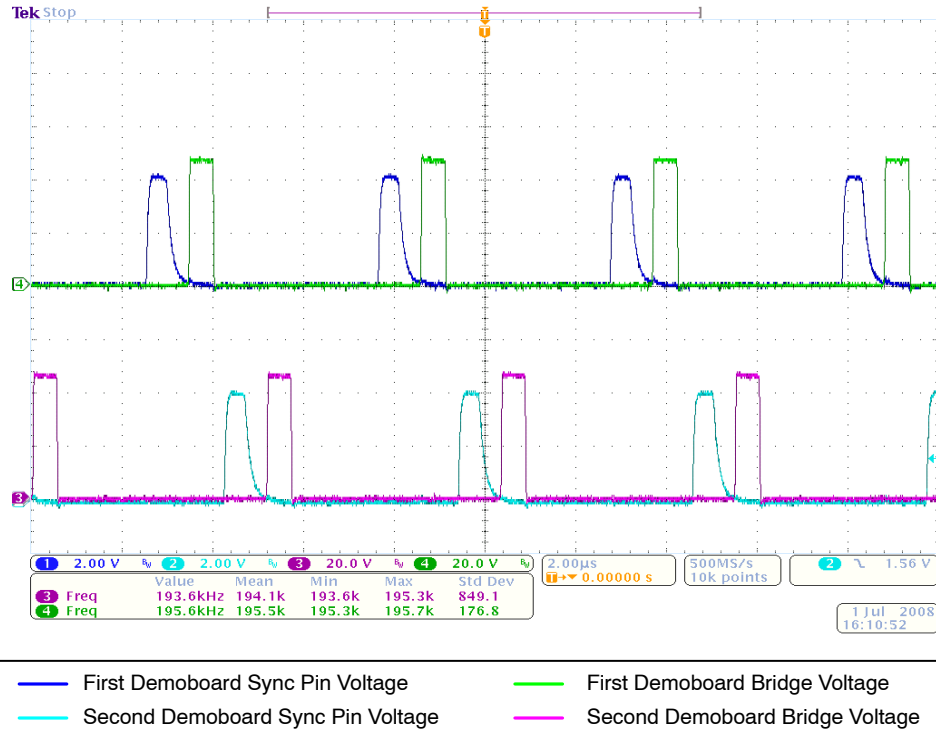


Figure 20. No Synchronization

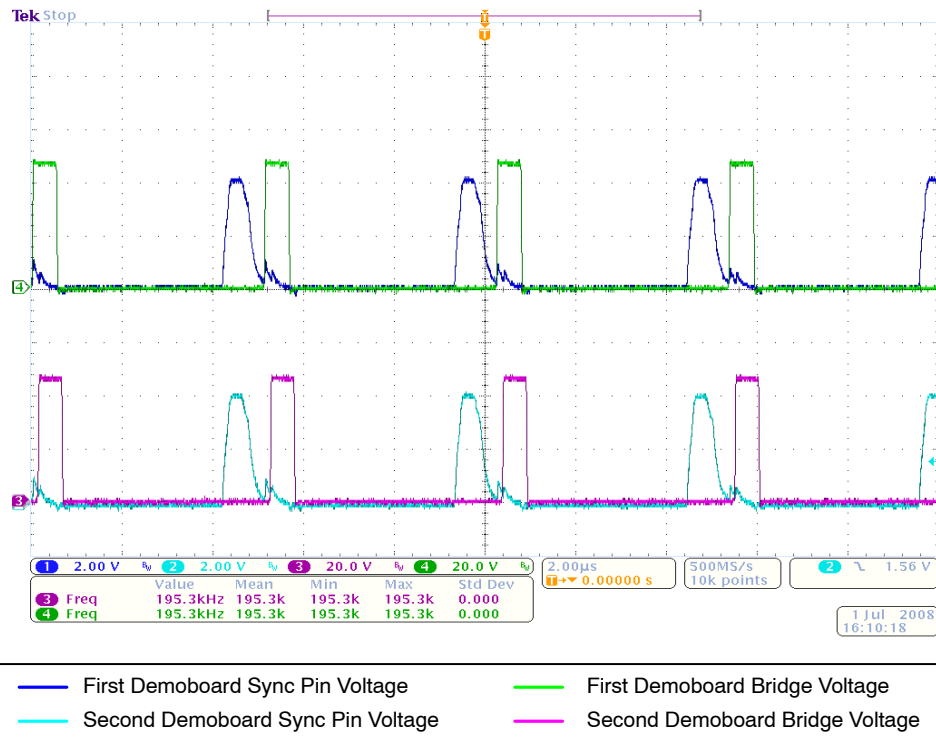


Figure 21. Synchronized – Sync Pins Connected

Line and Load Regulation

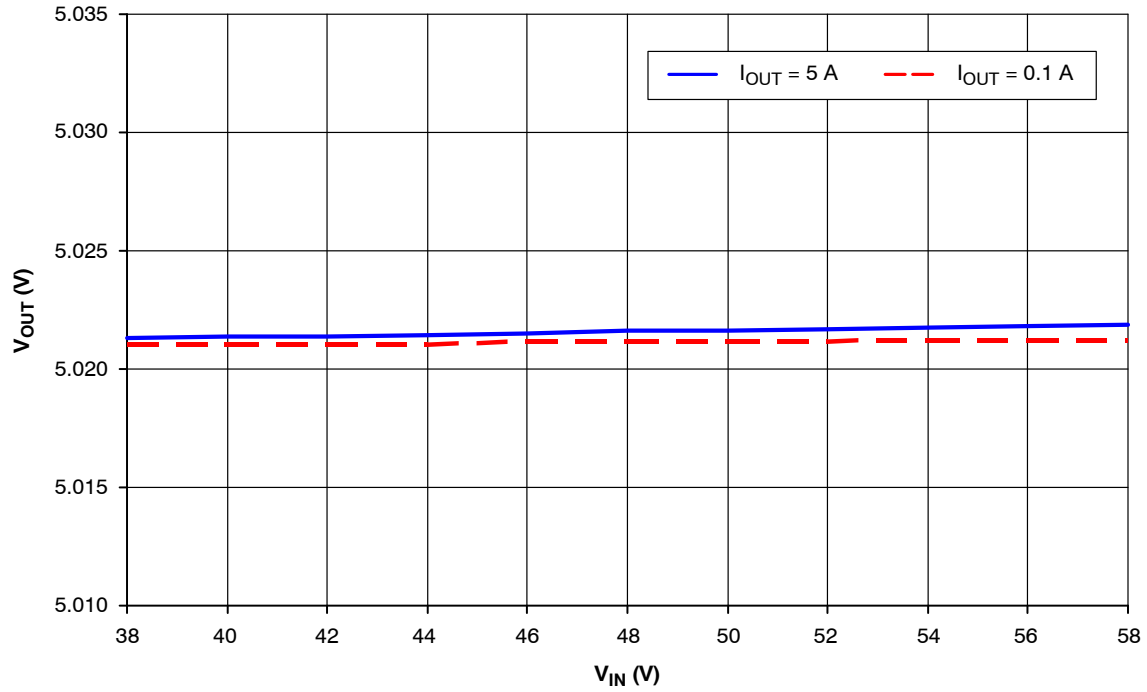


Figure 22. Line Regulation

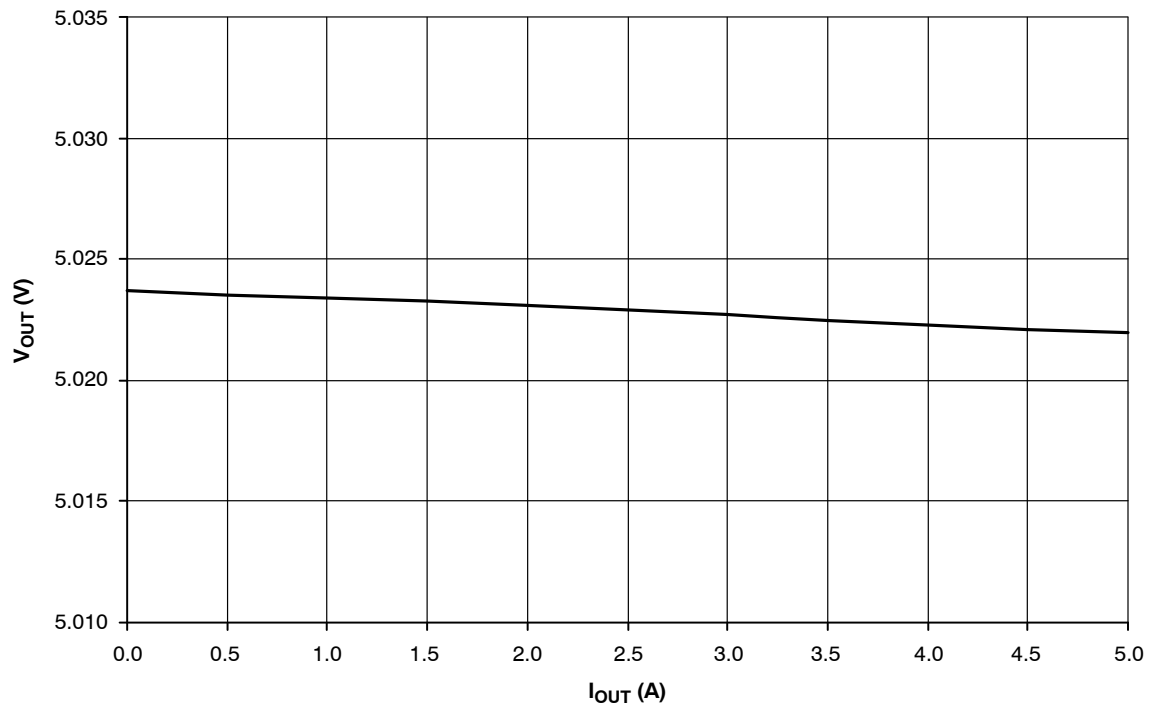


Figure 23. Load Regulation $V_{IN} = 48$ V

Efficiency

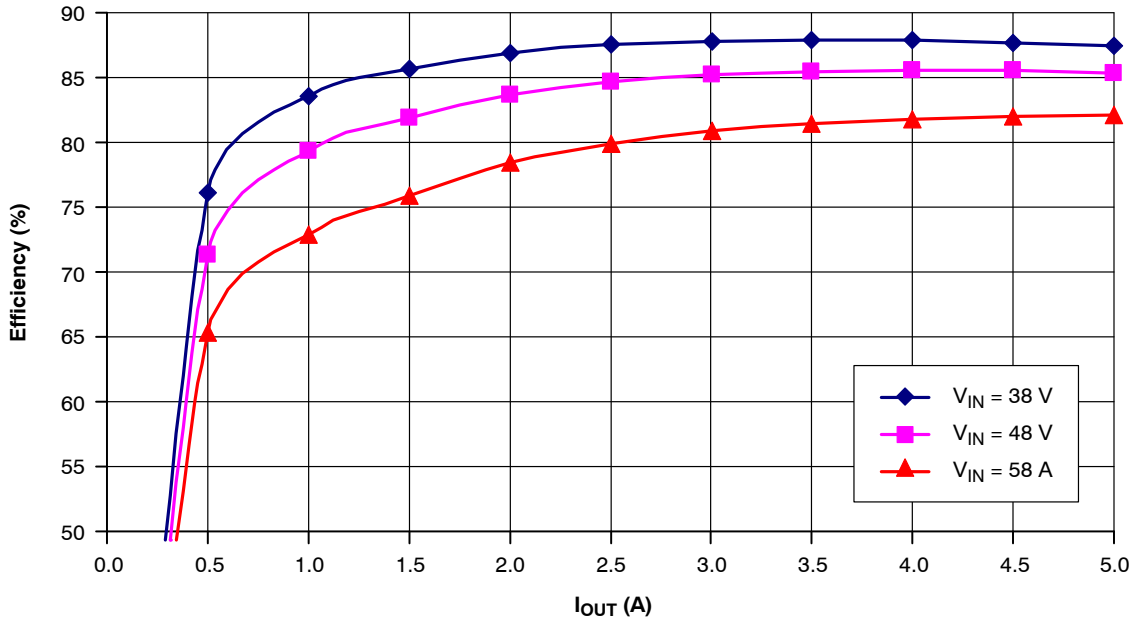


Figure 24. Efficiency

| | | Unit | |
|--------------------------------|-------|------|---|
| P _{ind, winding} | 0.32 | W | ← Inductor Winding Loss |
| P _{core} | 1.20 | W | ← Core Loss in Inductor. Available in Inductor Data Sheet |
| P _{static, IC} | 0.03 | W | ← Static Power Loss of the IC |
| P _{high_gate} | 0.02 | W | ← Power Loss of High Power Switch Gate Charge |
| P _{low_gate} | 0.06 | W | ← Power Loss of Low Power Switch Gate Charge |
| P _{dynam, IC} | 0.07 | W | ← Dynamic Power Loss of the IC |
| P _{high_switch, cond} | 0.32 | W | ← Conduction Loss of High Power Switcher |
| P _{low_switch, cond} | 0.72 | W | ← Conduction Loss of Low Power Switcher |
| P _{high_switch, sw} | 0.21 | W | ← Switching Loss of High Power Switcher |
| P _{low_switch, sw} | 0.00 | W | ← Switching Loss of Low Power Switcher |
| P _{low_switch, body} | 0.92 | W | ← Body Diode Recovery Charge Loss |
| P _{low_dead_time} | 0.11 | W | ← Body Diode Conduction Loss |
| P _{switch_capacit} | 0.07 | W | ← Switchers Capacitance Loss |
| P _{preregulator} | 0.31 | W | ← Power Loss of Linear Preregulator V _{IN} → V _{CC} |
| P _{loss, total} | 4.37 | W | ← Total Loss |
| P _{out} | 25.00 | W | ← Output Power |
| P _{in} | 29.37 | W | ← Input Power = Output Power + Total Loss |
| Effectivity | 85 | % | ← Efficiency of Converter (Est: ±5%) |

Figure 25. Power Loss Review from Spreadsheet

Bode Plot

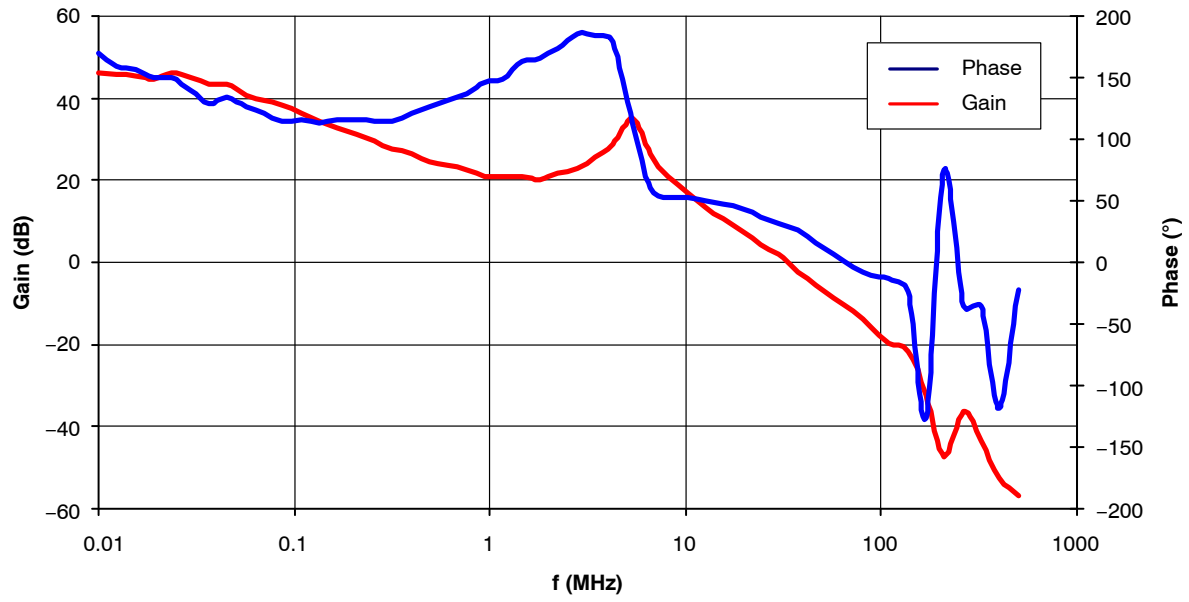


Figure 26. Bode Plot $V_{IN} = 48\text{ V}$, $I_{OUT} = 5\text{ A}$

Table 3. BILL OF MATERIALS FOR THE NCP1034 DEMOBOARD (Note 1)

| Parts | Qty | Description | Value | Tolerance | Footprint | Manufacturer | Manufacturer Part Number | Substitution Allowed |
|------------------------------------|-----|--|-------------------|-----------|-------------|------------------|--------------------------|----------------------|
| R9 | 1 | Resistor SMD | 1.2 k Ω | 1% | 1206 | Vishay | CRCW12061K20FKEA | Yes |
| R5 | 1 | Resistor SMD | 3.9 k Ω | 1% | 1206 | Vishay | CRCW12063K90FKEA | Yes |
| R3 | 1 | Resistor SMD | 4.7 k Ω | 1% | 1206 | Vishay | CRCW12064K70FKEA | Yes |
| R2 | 1 | Resistor SMD | 5.6 k Ω | 1% | 1206 | Vishay | CRCW12065K60FKEA | Yes |
| R1 | 1 | Resistor SMD | 16.9 k Ω | 1% | 1206 | Vishay | CRCW120616K9FKEA | Yes |
| R6 | 1 | Resistor SMD | 20 k Ω | 1% | 1206 | Vishay | CRCW120620K0FKEA | Yes |
| R11A, R11B, R11C, R11D, R11E | 5 | Resistor SMD | 12 k Ω | 1% | 1206 | Vishay | CRCW120612K0FKEA | Yes |
| R4 | 1 | Resistor SMD | 110 k Ω | 1% | 1206 | Vishay | CRCW1206110KFKEA | Yes |
| R7, R8, R10 | 3 | Resistor SMD | 10 k Ω | 1% | 1206 | Vishay | CRCW120610K0FKEA | Yes |
| R12A, R13, R14B, R15 | 4 | Resistor SMD | 0 Ω | 1% | 1206 | Vishay | CRCW120600R0FKEA | Yes |
| R12B, R14A | 2 | Resistor SMD | NU | – | 1206 | – | – | – |
| C8 | 1 | Ceramic Capacitor SMD | 1.8 nF | 10% | 1206 | Kemet | C1206C182K5RAC-TU | Yes |
| C6 | 1 | Ceramic Capacitor SMD | 12 nF | 10% | 1206 | Kemet | C1206C123K5RACTU | Yes |
| C5 | 1 | Ceramic Capacitor SMD | 220 nF | 10% | 1206 | Kemet | C1206C224K5RACTU | Yes |
| C7 | 1 | Ceramic Capacitor SMD | 330 pF | 10% | 1206 | Yageo | CC1206KRX7R9BB331 | Yes |
| C11, C12 | 2 | Ceramic Capacitor SMD | NU | – | 1206 | – | – | Yes |
| C2, C3, C4, C10 | 4 | Ceramic Capacitor SMD | 100 nF | 10% | 1206 | Kemet | C1206F104K1RACTU | Yes |
| C9A, C9B, C9C | 3 | Ceramic Capacitor SMD | 47 μ F/6.3 V | 20% | 1206 | Kemet | C1210C476M9PAC7800 | Yes |
| C1A, C1B | 2 | Ceramic Capacitor SMD | 2.2 μ F/100 V | 10% | 1206 | Murata | GRM32ER72A225KA35L | Yes |
| C1C, C1D, C1E, C1F | 4 | Ceramic Capacitor SMD | NU | – | 1206 | – | – | Yes |
| C9D, C9E | 2 | Electrolytic Capacitor | NU | – | 8x15 | – | – | Yes |
| L1 | 1 | Inductor SMD | 13 μ H | 20% | 13.2x12.8 | Würth | 7443551131 | Yes |
| D1 | 1 | Switching Diode | MMSD4148 | – | SOD–123 | ON Semiconductor | MMSD4148T1G | Yes |
| D2 | 1 | Zener Diode 500 mW 12 V | MMSZ4699 | – | SOD1–23 | ON Semiconductor | MMSZ4699T1G | Yes |
| Q1 | 1 | NPN Transistor | NU | – | DPAK | – | – | Yes |
| Q2 | 1 | Power N-MOSFET | NTD3055 | – | DPAK | ON Semiconductor | NTD3055-150G | Yes |
| Q3 | 1 | Power N-MOSFET | NTD24N06 | – | DPAK | ON Semiconductor | NTD24N06T4G | Yes |
| IO1 | 1 | High Voltage Synchronous PWM Buck Controller | NCP1034 | – | SOIC–16 | ON Semiconductor | NCP1034DR2G | No |
| X1 | 1 | Inlet Terminal Block | PCB 2 WAY | – | Pitch: 5 mm | Lumberg | KRM 02 | Yes |
| X2 | 1 | Outlet Terminal Block | PCB 2 WAY | – | Pitch: 5 mm | Lumberg | KRM 02 | Yes |

1. All parts are Pb-Free

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