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## Design Note – DN06047/D

# High Voltage HB-LED Driver

| Device | Application | Input Voltage | Output Current | Topology | I/O Isolation |
|---|---|---|---|---|---|
| NCP1034 | LED Driver | 20-58 V | <60 W | BUCK | NONE |

| Other Specifications | | | | |
|---|---|---|---|---|
| | Output 1 | Output 2 | Output 3 | Output 4 |
| Output Voltage | 2-46 V | N/A | N/A | N/A |
| Nominal Output Voltage | 36 V | N/A | N/A | N/A |
| Nominal Input Voltage | 48 V | N/A | N/A | N/A |
| Current Ripple | <30 mA | N/A | N/A | N/A |
| Output Current | 1.3 A | N/A | N/A | N/A |
| Operation frequency | 400 kHz | N/A | N/A | N/A |

| Efficiency | 92% |
|---|---|

## Circuit Description

This circuit is intended for driving high power LEDs, such as the Cree XLAMP™ series, Lumileds Luxeon™ Rebel and K2 and OSRAM, Golden and Platinum Dragon™ as well as the OSTAR™. Typical application is for example street lighting. It is designed for wide input and output voltage range. An optional dimming PWM input is included. The circuit is based on NCP1034 operation at 400 kHz in a non-isolated configuration.

## Key Features

- Buck mode
- Wide input and output operation voltage
- Precise line and load regulation
- Dimming capability
- High operation frequency
- Minimal output current ripple
- Output short circuit protection
- Synchronization capability
- Ceramic capacitors only

## Schematic

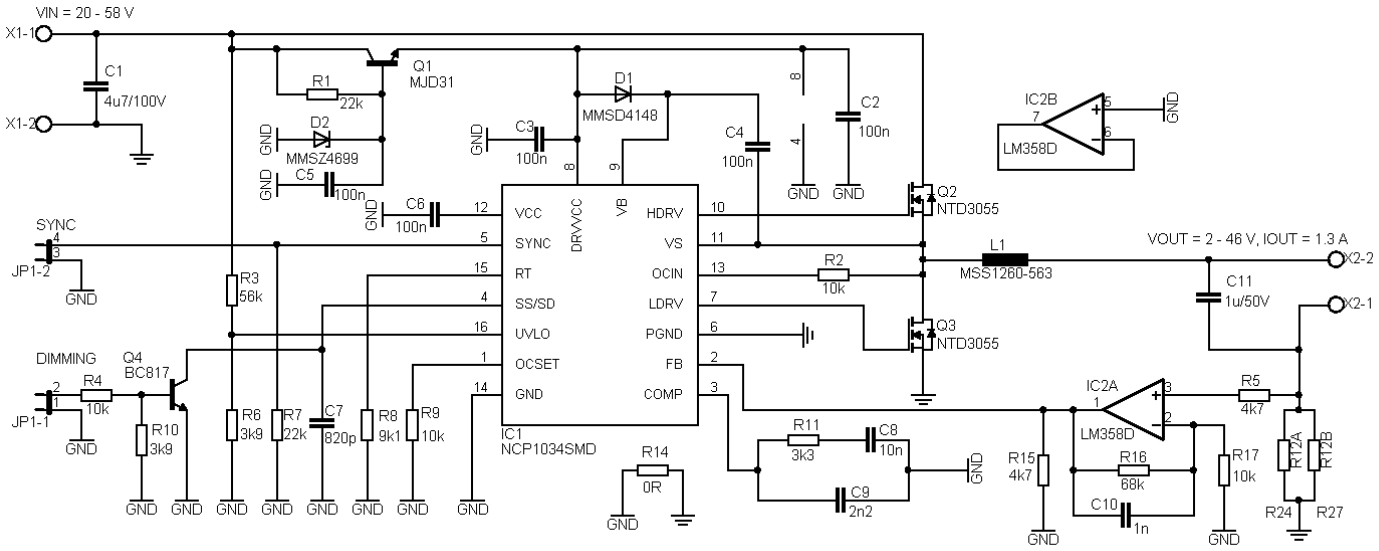


**Figure 1 –** LED driver schematic

## Design Notes

The LED driver is based on typical NCP1034 application except for the feedback path. The feedback voltage is sensed at the current sense resistors in series with the LED string. An Op Amp is used to amplify the voltage drop on current sense resistors. The voltage drop is only 0.16 V against the internal 1.25 V feedback voltage. This results in a reduced power loss from 1.6 W to only 0.2 W at nominal load. The output current can be set by sensing resistors R12A and R12B and by Op Amp gain set resistors R16 and R17.

IC's and Op Amp supply voltage is stabilized by Q1, D2, R1 and C5 circuit. If the input voltage range is narrower then Q1 can be replaced by R1 with higher power loss. Automatic calculation of this and other parameters can be found on web at the following link http://www.onsemi.com/pub/Collateral/NCP1034%20DESIGN%20WORKSHEET.XLS .

The dimming signal can be connected to JP1-1. Up to 300 Hz dimming frequency is acceptable. Higher frequency increases the power loss and increases the offset dimming characteristic. The dimming signal can have an amplitude of 0 – 5 V.

External synchronization signal or another NCP1034 can be connected to JP1-2 to decrease EMI.

# Measurements

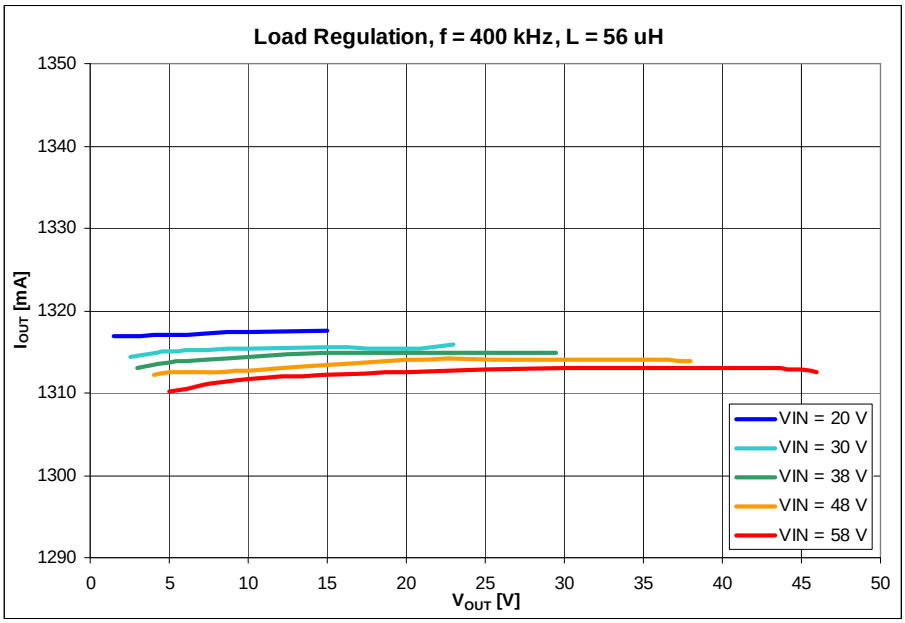


**Figure 2** – Load regulation

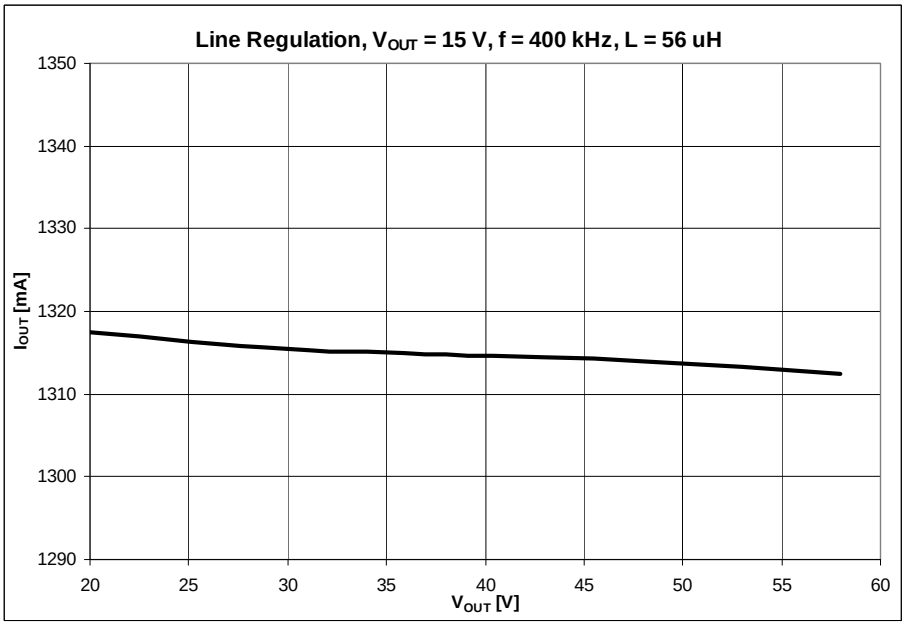


**Figure 3** – Line regulation

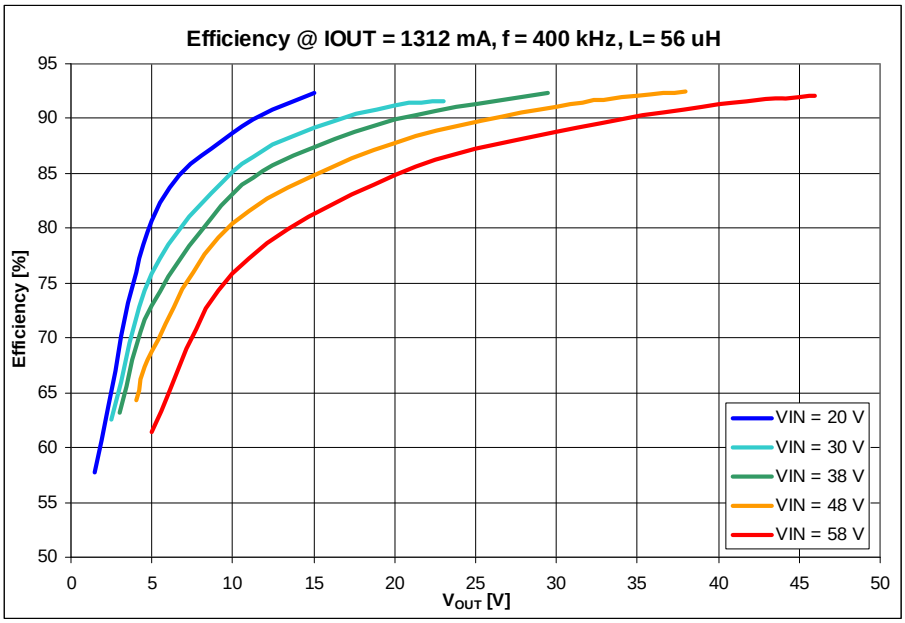


**Figure 4** - Efficiency

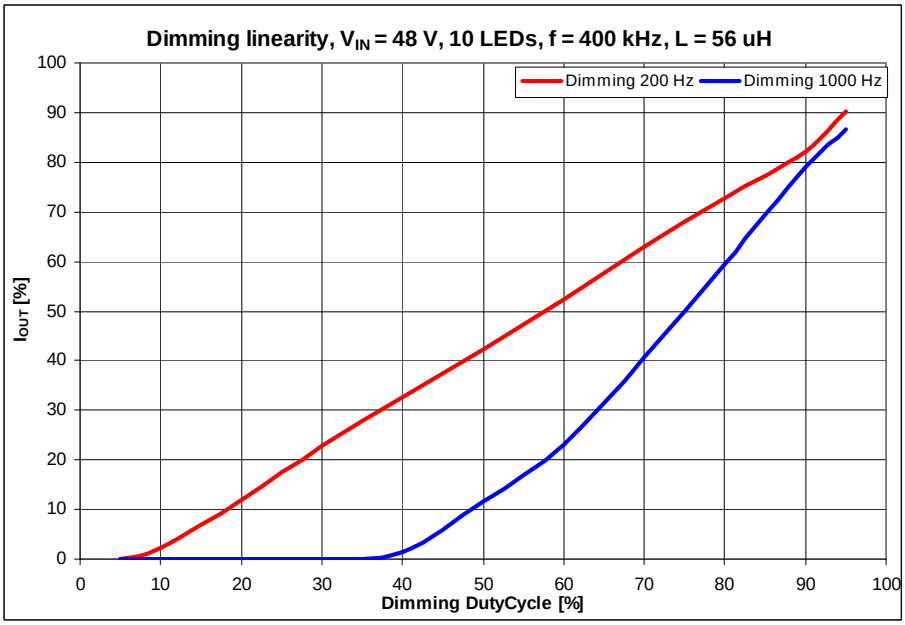


**Figure 5** – Dimming linearity

**CH1 – Output Voltage**
**CH2 – Bridge**
**CH4 – Inductor Current 200mA/div**

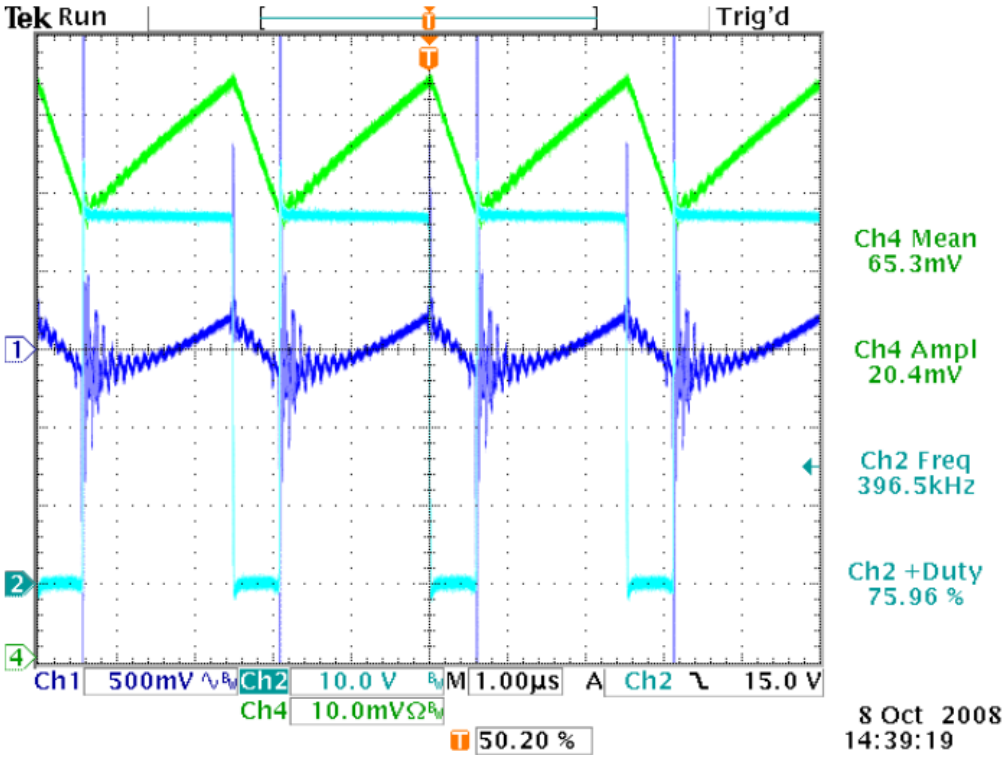


**Figure 6 –** Inductor current 10 LEDs, $V_{IN}$ = 48 V

**CH4 – Output capacitor current 100mA/div**

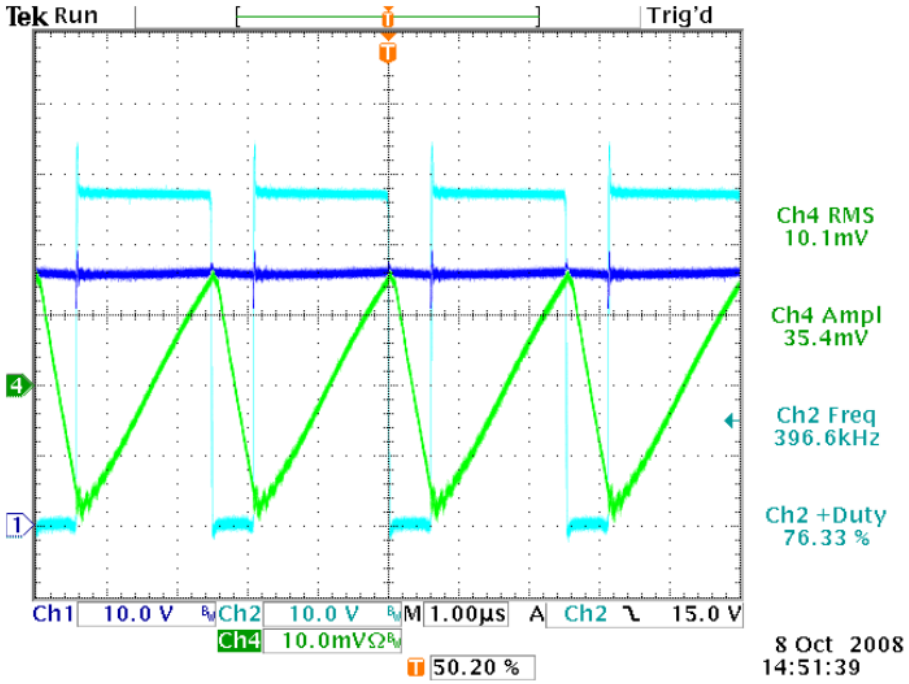


**Figure 7 –** Output capacitor current 10 LEDs, $V_{IN}$ = 48 V

**CH4 – Output current 10mA/div**

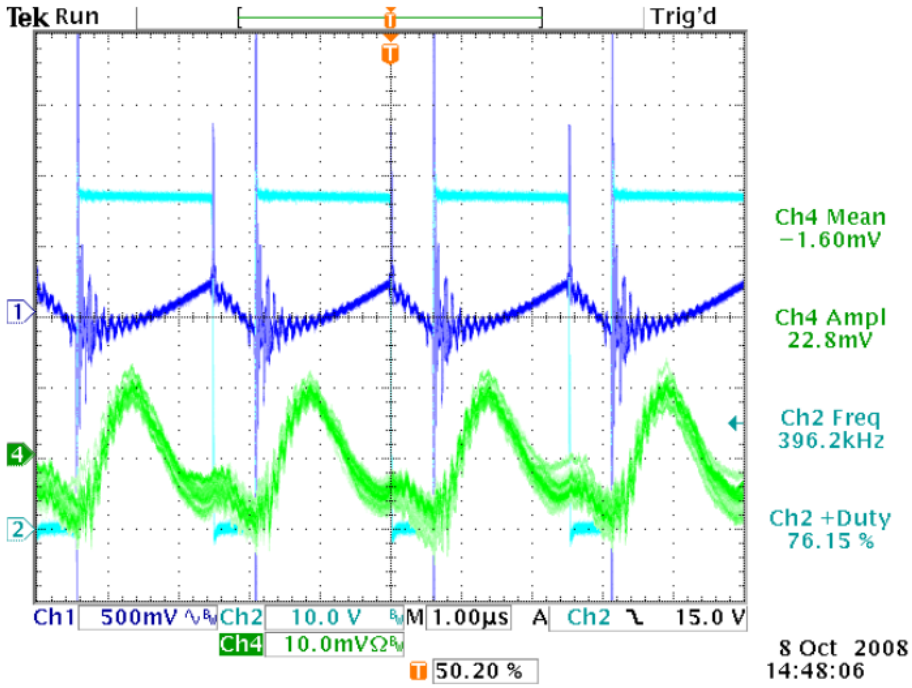


**Figure 8 –** Output current ripple 10 LEDs, $V_{IN}$ = 48 V

**CH3 – Dimming input signal (high level – output disable)**
**CH4 – Output current 200mA/div**

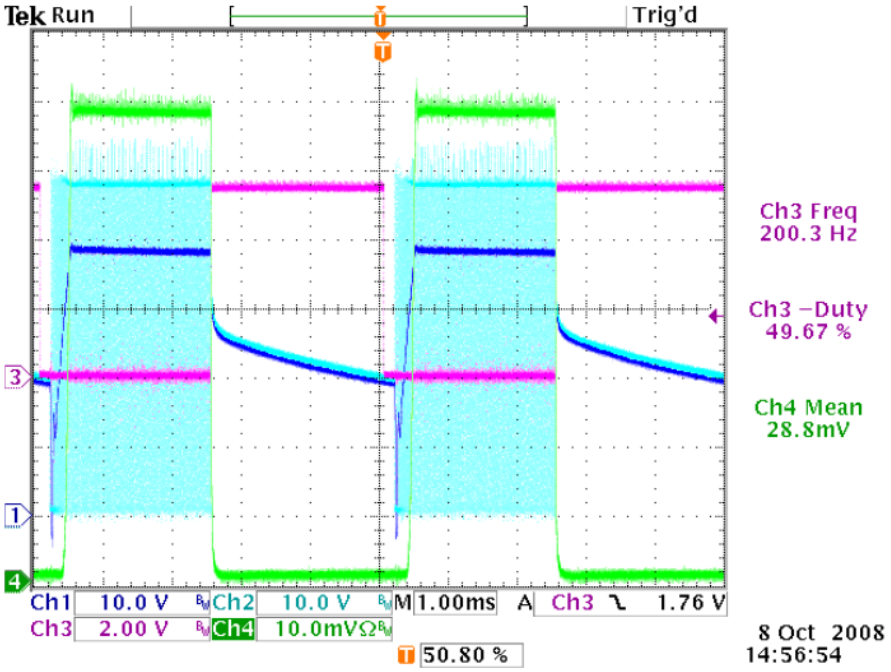


**Figure 9** – Dimming 200 Hz, 10 LEDs, $V_{IN}$ = 48 V

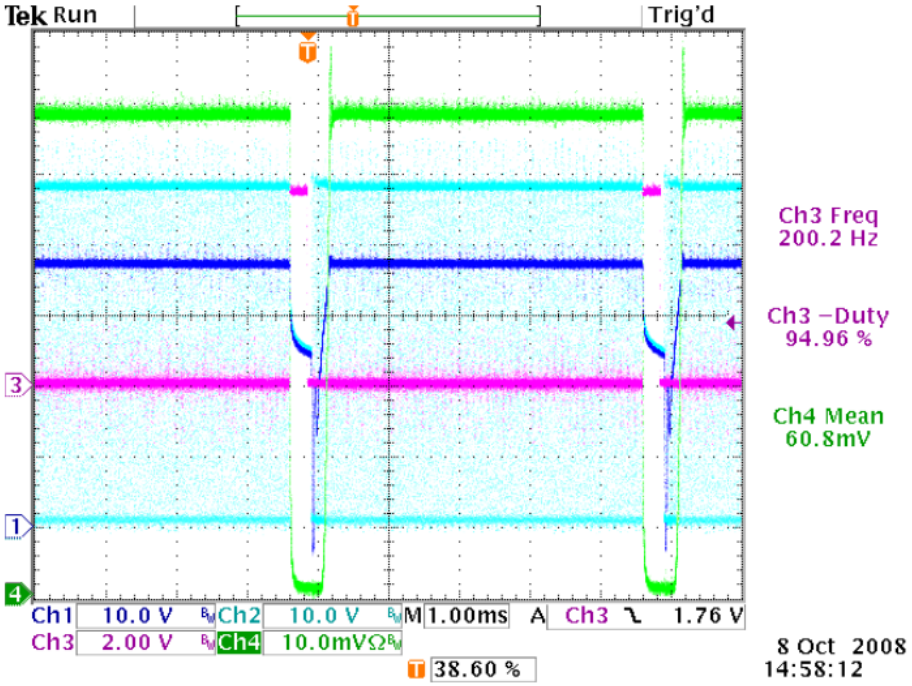


**Figure 10** – Dimming 200Hz high duty cycle, 10 LEDs, $V_{IN}$ = 48 V

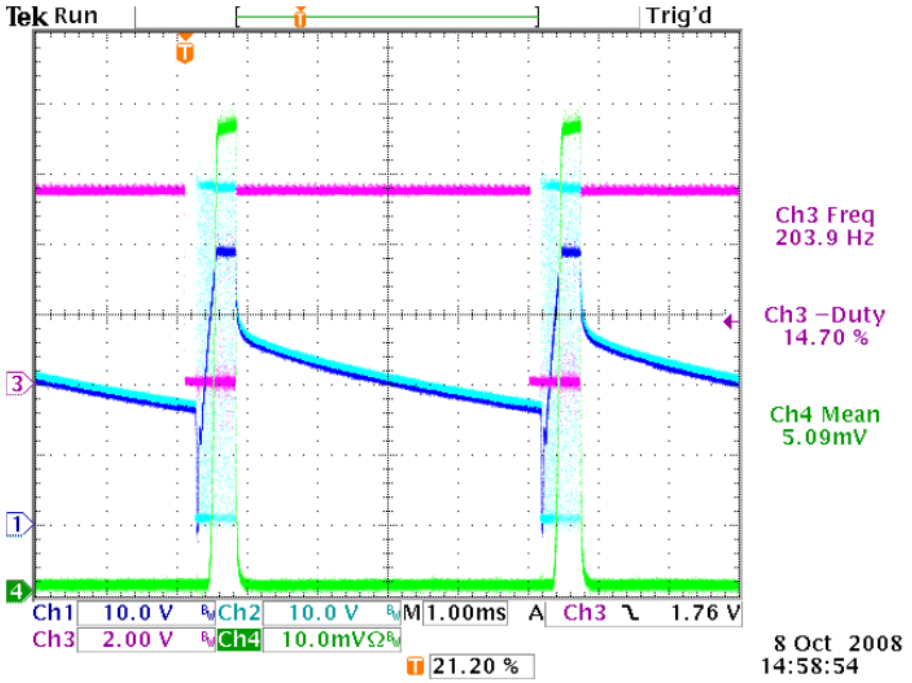


**Figure 11** – Dimming 200Hz low duty cycle, 10 LEDs, $V_{IN}$ = 48 V

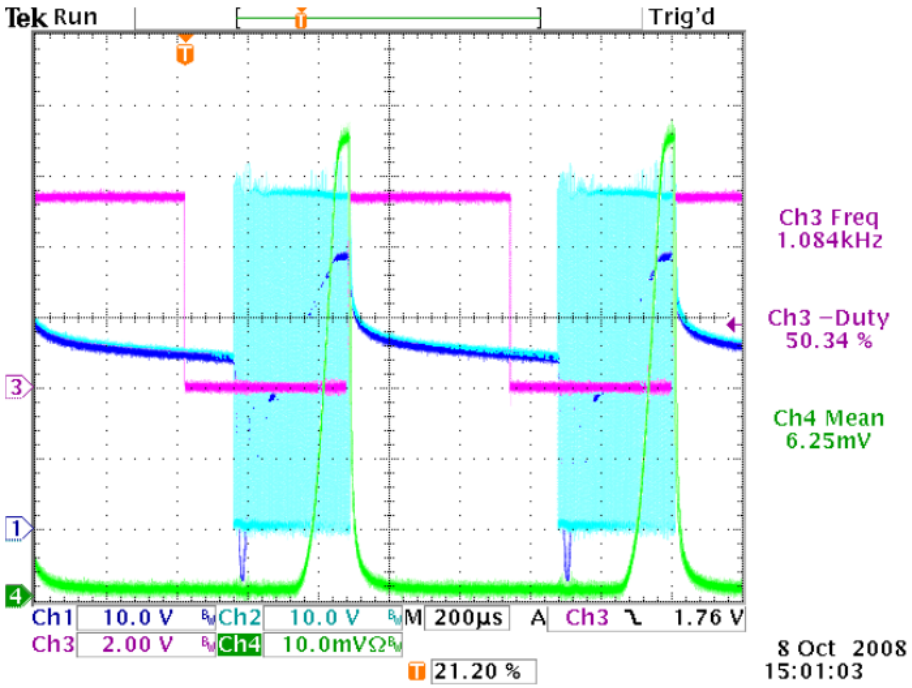


**Figure 12** – Dimming 1000 Hz, 10 LEDs, $V_{IN}$ = 48 V

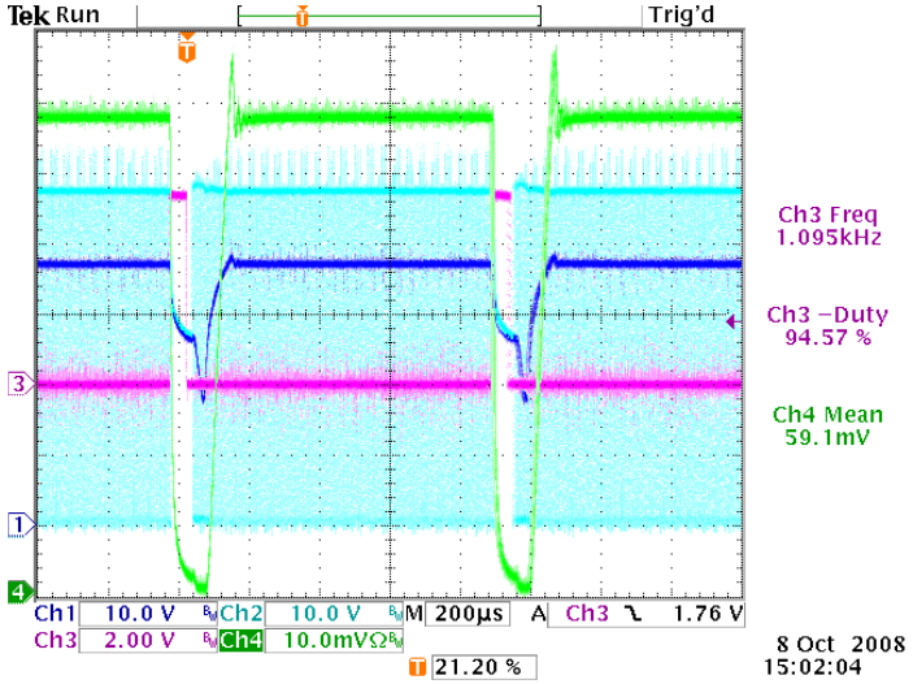


**Figure 13** – Dimming 1000Hz high duty cycle, 10 LEDs, $V_{IN}$ = 48 V

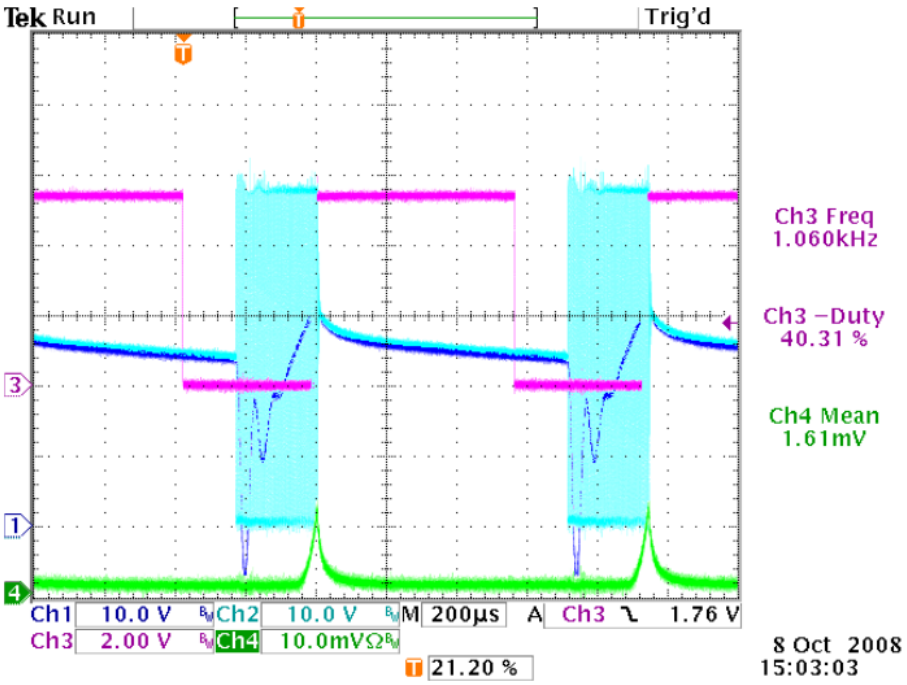


**Figure 14** – Dimming 1000Hz low duty cycle, 10 LEDs, $V_{IN}$ = 48 V

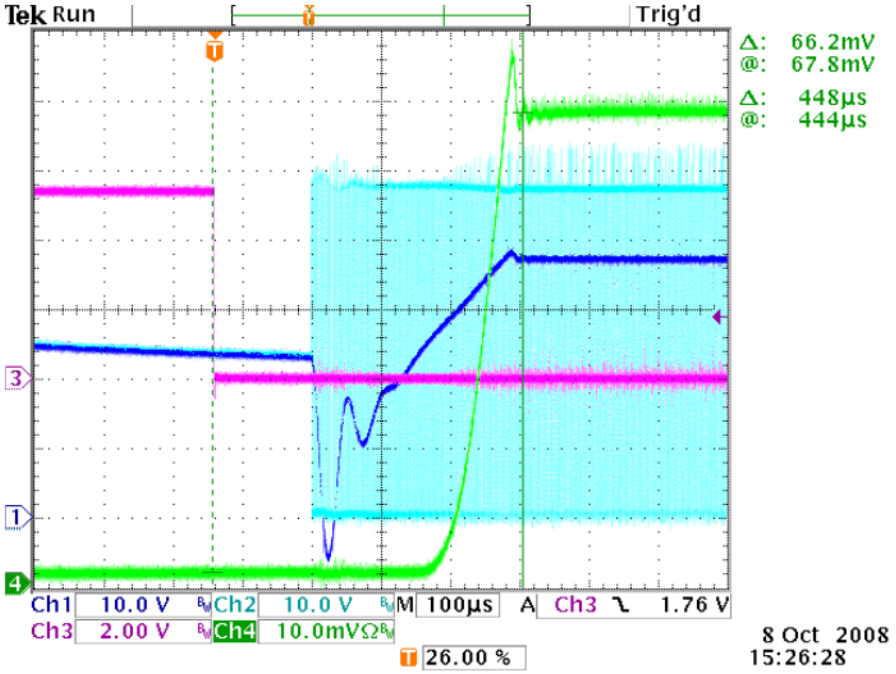


**Figure 15** – Switch-on delay 10 LEDs, $V_{IN}$ = 48 V

**Table 1 –** Bill of materials

| Designator | Qty. | Description | Value | Tol. | Footprint | Manufacturer | Manufacturer Part Number | Subst. Allowed | Lead Free | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | |
| R14 | 1 | Resistor | 0R | 1% | 1206 | Vishay | CRCW12060000Z0EA | Yes | Yes | |
| R11 | 1 | Resistor | 3k3 | 1% | 1206 | Vishay | CRCW12063K30FKEA | Yes | Yes | |
| R6, R10 | 2 | Resistor | 3k9 | 1% | 1206 | Vishay | CRCW12063K90FKEA | Yes | Yes | |
| R5, R15 | 2 | Resistor | 4k7 | 1% | 1206 | Vishay | CRCW12064K70FKEA | Yes | Yes | |
| R8 | 1 | Resistor | 9k1 | 1% | 1206 | Vishay | CRCW12069K10FKEA | Yes | Yes | |
| R2, R4, R9, R17 | 4 | Resistor | 10k | 1% | 1206 | Vishay | CRCW120610K0FKEA | Yes | Yes | |
| R1, R7 | 2 | Resistor | 22k | 1% | 1206 | Vishay | CRCW120622K0FKEA | Yes | Yes | |
| R3 | 1 | Resistor | 56k | 1% | 1206 | Vishay | CRCW120656K0FKEA | Yes | Yes | |
| R16 | 1 | Resistor | 68k | 1% | 1206 | Vishay | CRCW120668K0FKEA | Yes | Yes | |
| R12A | 1 | Resistor | R24 | 1% | 1206 | Rohm | MCR18EZHFLR240 | Yes | Yes | |
| R12B | 1 | Resistor | R27 | 1% | 1206 | Rohm | MCR18EZHFLR270 | Yes | Yes | |
| C10 | 1 | Ceramic Capacitor | 1n | 10% | 1206 | Kemet | C1206C102K5RACTU | Yes | Yes | |
| C9 | 1 | Ceramic Capacitor | 2n2 | 10% | 1206 | Kemet | C1206C222K5RACTU | Yes | Yes | |
| C8 | 1 | Ceramic Capacitor | 10n | 10% | 1206 | Kemet | C1206C103K5RACTU | Yes | Yes | |
| C7 | 1 | Ceramic Capacitor | 820p | 10% | 1206 | Kemet | C1206C821K5RACTU | Yes | Yes | |
| C2, C3, C4, C5, C6 | 5 | Ceramic Capacitor | 100n | 10% | 1206 | Kemet | C1206F104K1RACTU | Yes | Yes | |
| C11 | 1 | Ceramic Capacitor | 1u/50V | 10% | 1206 | TDK | C3216X7R1H105K | Yes | Yes | |
| C1 | 1 | Ceramic Capacitor | 4u7/100V | 10% | 1812 | United Chemi-Con | KTS101B475K43N0T00 | Yes | Yes | |
| L1 | 1 | Inductor SMD | 56u | 10% | 13x13 | Coilcraft | MSS1260-563 | Yes | Yes | |
| D1 | 1 | Switching Diode | MMSD4148 | - | SOD123 | ON Semiconductor | MMSD4148T1G | Yes | Yes | |
| D2 | 1 | Zener Diode 12V | MMSZ4699 | - | SOD123 | ON Semiconductor | MMSZ4699T1G | Yes | Yes | |
| Q1 | 1 | NPN Tranzistor | MJD31 | - | DPAK | ON Semiconductor | MJD31T4G | Yes | Yes | |
| Q2, Q3 | 1 | Power N-MOSFET | NTD3055 | - | DPAK | ON Semiconductor | NTD3055-150G | Yes | Yes | |
| Q4 | 1 | Small NPN Tranzistor | BC817 | - | SOT-23 | ON Semiconductor | BC81740LT1G | Yes | Yes | |
| IC2 | 1 | Dual OPAMP | LM358 | - | SOIC8 | ON Semiconductor | LM358DR2G | No | Yes | |
| IC1 | 1 | Synchronous PWM buck controler | NCP1034 | - | SOIC16 | ON Semiconductor | NCP1034DR2G | No | Yes | |



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