

# NCV898032LEDSEPGVB

## NCV898032 Automotive Grade High-Frequency SEPIC Controller LED Evaluation Board User's Manual



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### EVAL BOARD USER'S MANUAL

#### Description

This NCV898032 evaluation board provides a convenient way to evaluate a 2 MHz high-frequency current-mode control SEPIC converter design configured for an LED application. No additional components are required, other than dc supplies for the input and enable voltages. The topology uses two inductors. The design is configured to power a 360 mA four series LED string over the typical 6 V to 18 V automotive input voltage range.

#### Key Features

- 14 V/ 360mA Output
- 2 MHz Switching Frequency
- Input Undervoltage Lockout
- Internal Soft-Start
- Wide Input Voltage of 3.2 V to 40 V (36 V when Using LED OV Protection)
- Regulates Through Load Dump Conditions
- Hiccup-Mode Overcurrent Protection
- Automotive Grade



Figure 1. NCV898032LEDSEPGVB Evaluation Board

# NCV898032LEDSEPGEVB

**Table 1. EVALUATION BOARD TERMINALS**

Terminal	Function
VIN	Positive DC input voltage
GND	Common DC return
VOUT	Regulated DC output voltage
EN	Enable input

**Table 2. ABSOLUTE MAXIMUM RATINGS**

(Voltages are with respect to GND)

Rating	Value	Unit
DC supply voltage (VIN)	-0.3 to 40	V
DC supply voltage (EN)	-0.3 to 6	V
Junction temperature	-40 to 150	°C
Ambient temperature (demo board)	-40 to 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.

**Table 3. ELECTRICAL CHARACTERISTICS**

( $T_A = 25\text{ °C}$ ,  $3.2\text{ V} \leq V_{IN} \leq 40\text{ V}$ ,  $V_{EN} = 2\text{ V}$ ,  $V_{OUT} = 14\text{ V}$ ,  $0 \leq I_{OUT} \leq 360\text{ mA}$ , unless otherwise specified)

Characteristics	Conditions	Typical Value	Unit
<b>Switching</b>			
Switching Frequency	-	2	MHz
Soft-start Time	-	800	μs
<b>Current Limit</b>			
Cycle-by-cycle Current Limit (FET)	-	1.8	A
<b>Protections</b>			
Input Undervoltage Lockout (UVLO)	$V_{IN}$ decreasing	3.05*	V
Input Undervoltage Lockout (UVLO)	$V_{IN}$ increasing	150	mV
Thermal Shutdown	$T_A$ increasing	170	°C

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

\*See Note 3 from Operating Guidelines

# NCV898032LEDSEPGEV B

## Operational Guidelines

This evaluation board was designed for a 360 mA four series string OSRAM LUW H9GP.CE LED load connected between VOUT and VFB via connector J3 (J1 open). The evaluation board uses MOSFET Q2 (LED string model equivalent zener voltage) in series with resistors R2, R3, R4 (LED string model equivalent series AC resistance) as a 360 mA operating point model (J1 short, J3 open).

A different LED load may be emulated by varying the sum value of resistors R2, R3, R3 as well as Q2's regulation voltage operating point. LED current sense resistor R11 would need to be revised for an LED current other than 360 mA. Resulting modifications could necessitate revision of feedback loop compensation components.

This test procedure is to be used when the evaluation board LED simulator is used (J1–short, J3 open):

1. Connect a DC input voltage, within the 6 V to 40 V range, between VIN and GND.
  2. Connect a DC enable voltage, within the 2.0 V to 5.0 V range, between EN/SYNC and GND.
  3. The demo board feedback components were selected for continuous operation and rated to operate a 360 mA four series string OSRAM LUW H9GP.CE LED load at a minimum input voltage of 6 V.
- ◆ When regulating, output voltage may be expected to be ~12–14 V. **VFB shall be 200 mV ± 2%.**

- ◆ The NCV898032 IC–VIN has its operational voltage diode–ored between the converter output (14 V) and input voltages. As a result of D2 forward voltage drop between the external power source and IC–VIN, initiation of the NCV898032 controller PWM activity will occur at about 3.5 V ( $V_{UVLO}$  for VIN rising + VD2). The demo board is designed to regulate at the rated LED current for a minimum 6 V input voltage. Once energized, the output voltage supplies power to the IC when the battery voltage is below (approximately) 13 V.
- 4. The design may be configured to regulate the rated current for an input operating voltage of under 6 V by adjustment of current sense resistor R8 to a lower value. Feedback loop compensation may require adjustment.

## Separable LED Load Simulator

The evaluation board contains a separable LED simulator board. With removal of jumpers R20 and R21, the board is v–scored so that it may be easily removed for external connectivity during NCV898032 testing within a temperature chamber. With its removal and connectivity across J3, a specific application's LED load may be attached and evaluated. The new LED load would require adjustment of the LED current sense resistor R11 for a LED current other than 360 mA and could necessitate revision of feedback loop compensation components.

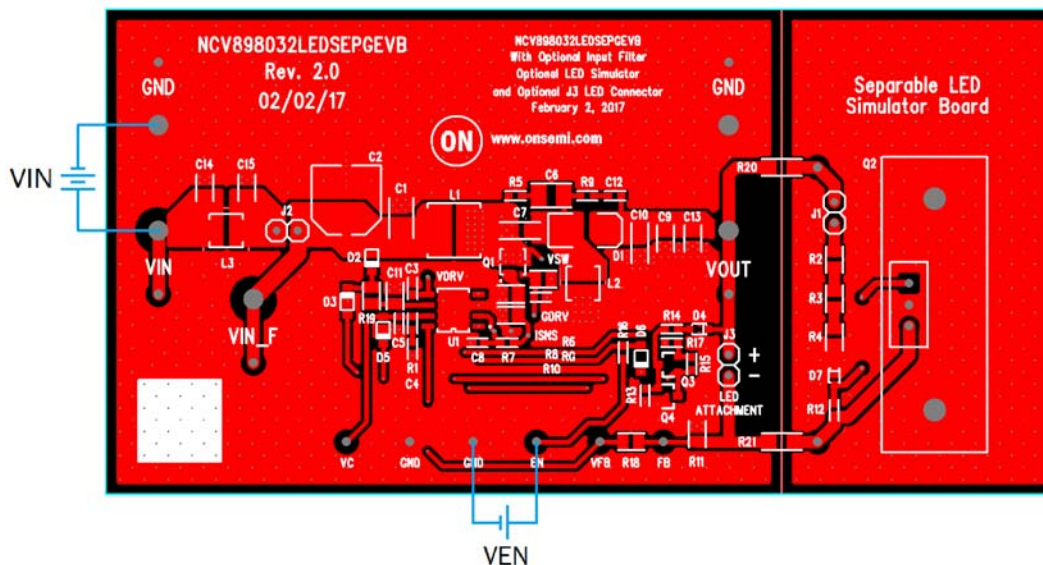


Figure 2. NCV898032LEDSEPGEV B PCB Connections

# NCV898032LEDSEPGEVB

## Typical Performance

### Start-up

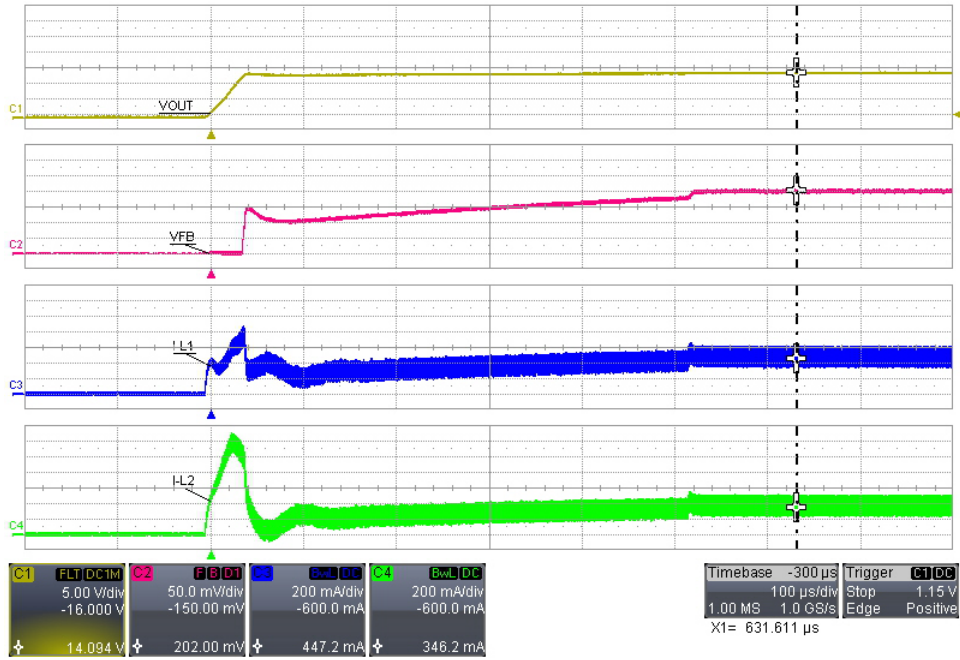


Figure 3. Typical Start-up with  $V_{IN} = 13.2$  V,  $I_{OUT} = 360$  mA

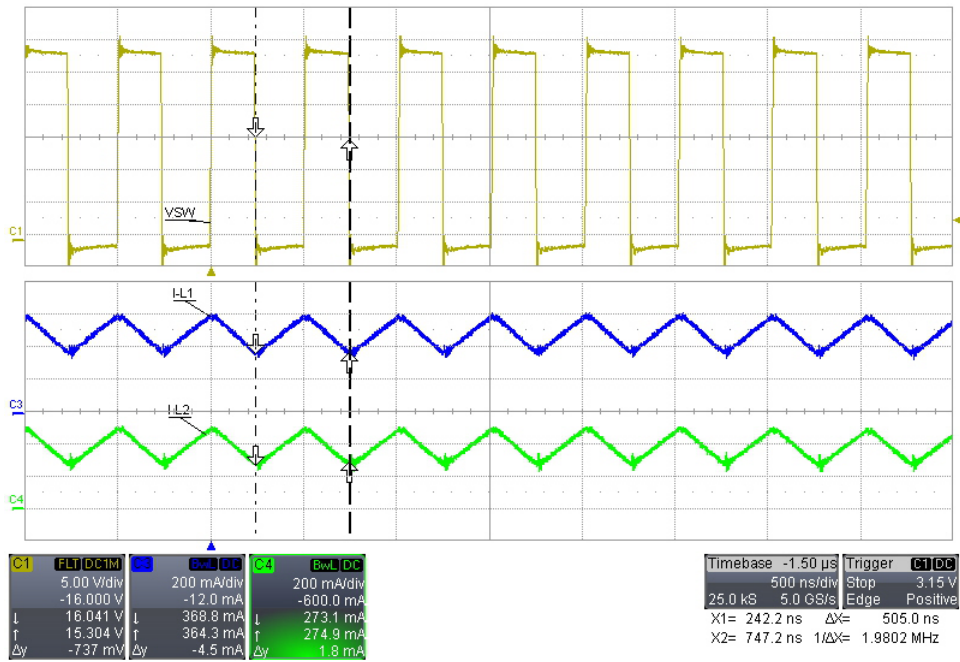


Figure 4. Operational Waveforms,  $V_{IN} = 13.2$  V,  $I_{OUT} = 360$  mA



# NCV898032LEDSEPEVB

**Table 4. BILL OF MATERIALS**

Reference Designator(s)	Qty	Description	Value	Tolerance	Footprint	Manufacturer	Manufacturer's Part Number	Substitution Allowed
C1, C6	1	CAP CER 4.7UF 50V X7R 1210	4.7uF	10%	1210	Kemet	C1210C475K5RACAU-TO	Yes
C2	1	CAP ALUM POLY 68UF 20% 50V SMD	68uF	20%	CAP_SMD_8P3	Panasonic Electronic Components	EEH-ZA1H680V	No
C3	1	CAP CER 1UF 16V X7R 0603	1uF	10%	603	Murata Electronics North America	GCM188R71C105KA64D	Yes
C4	1	CAP CER 10000PF 50V C0G 0603	10nF	5%	603	TDK Corporation	CGA3E2C0G1H103J080AA	Yes
C5, C8	2	CAP CER 100PF 50V C0G/NP0 0603	100pF	5%	603	Murata Electronics North America	GCM1885C1H101JA16D	Yes
C7	1	CAP CER 1UF 50V X7R 1206	1uF	10%	1206	TDK Corporation	CGA5L3X7R1H105K160AB	Yes
C9	DN-P	CAP CER 2.2UF 25V X7R 0805	2.2uF	10%	805	TDK Corporation	CGA4J3X7R1E225K125AD	Yes
C10	1	CAP CER 2.2UF 50V X7R 1206	2.2uF	10%	1206	Murata Electronics North America	GCM31CR71H225KA55L	Yes
C11, C15	2	CAP CER 1UF 50V X7R 0805	1uF	10%	805	Murata Electronics North America	GCM21BR71H105KA03L	Yes
C13, C14	2	CAP CER 0.1UF 50V X7R 0805	0.1uF	10%	805	Murata Electronics North America	GCM21BR71H104KA37K	Yes
C12	1	CAP CER 120PF 50V C0G/NP0 0603	120pF	5%	603	Murata Electronics North America	GCM1885C1H121JA16D	Yes
D1	1	DIODE SCHOTTKY 60V 3A SMA-FL	60V / 3A	N/A	SMA_DIODE	ON Semiconductor	NRVBAF360T3G	No
D2, D3	2	DIODE SCHOTTKY 40V 1A SOD123FL	40V / 1A	N/A	SOD_123	ON Semiconductor	NRVB140SFT1G	No
D4	1	DIODE ZENER 16.18V 200MW SOD323	16.18V	2%	SOD_323	ON Semiconductor	MM3Z16VST1G	Yes
D5, D6	2	DIODE GEN PURP 100V 200MA SOD123	100V	N/A	SOD-123	ON Semiconductor	MMSD4148T1G	Yes
D7	1	DIODE ZENER 12V 200MW SOD323	12V	2%	SOD_323	ON Semiconductor	MM3Z12VST1G	Yes
J1, J2, J3	3	CONN HEADER 2POS .100 VERT GOLD	N/A	N/A	JMP	Molex, LLC	22284023	Yes
	3	CONN JUMPER SHORTING GOLD	N/A	N/A		Sullins Connector Solutions	SSC02SYAN	Yes
L1	1	SMD Fixed Power Inductor 15uH 3.7A	15uH	20%	XAL60XX	Coilcraft	XAL5050-153ME	No
RSNB	1	RES SMD 9.1 OHM 1% 1/4W 1206	9.1	1%	1206	Stackpole Electronics Inc.	RMCF1206FT9R10	Yes
L2	1	SMD Fixed Power Inductor 15uH 2.8A	15uH	20%	XAL4030-472	Coilcraft	XAL4040-153ME	No
L3	1	SMD Fixed Power Inductor 1uH 8.7A	1uH	20%	XAL4030-472	Coilcraft	XAL4020-102ME	No
Q1	1	MOSFET N-CH 60V U8FL	60V / 7.8A	N/A	u8FL	ON Semiconductor	NVTF55C680NLWF-TAG	No

# NCV898032LEDSEPGVB

**Table 4. BILL OF MATERIALS** (continued)

Reference Designator(s)	Qty	Description	Value	Tolerance	Footprint	Manufacturer	Manufacturer's Part Number	Substitution Allowed
Q2	1	TRANS NPN 60V 10A TO220AB	60V / 10A	N/A	TO220_VE-RT	ON Semiconductor	D44H8G	No
	1	HEATSINK TO-220 POWER W/PINS BK	N/A	N/A		Aavid Thermalloy	531202B02500G	Yes
	1	THERM PAD TO-220 W/ADH HI-FLOW	N/A	N/A		Bergquist	HF115AC-0.0055-AC-54	Yes
	1	Stainless Steel Round Head 4-40 3/8" Screw	N/A	N/A		McMaster-Carr	95345A027 (pack of 50)	Yes
	1	Stainless Steel Lock-nut w/washer 4-40	N/A	N/A		McMaster-Carr	96278A005 (pack of 100)	Yes
Q3	1	TRANS PNP 40V 0.2A SOT23	40V / 0.2A	N/A	SOT23	ON Semiconductor	MMBT3906LT1G	Yes
Q4	1	TRANS NPN 40V 0.2A SOT23	40V / 0.2A	N/A	SOT23	ON Semiconductor	MMBT3904LT1G	Yes
R1	1	RES SMD 750 OHM 1% 1/10W 0603	750	1%	603	Vishay Dale	CR-CW0603750RFKEA	Yes
R2, R3, R4	3	RES SMD 1.13 OHM 1% 1/8W 0805	1.13	1%	805	Vishay Dale	CR-CW08051R13FKEA	Yes
R5	1	RES SMD 1.8 OHM 1% 1/10W 0603	1.8	1%	603	Vishay Dale	CR-CW06031R80FKEA	Yes
R6	1	RES SMD 0.0 OHM JUMPER 1/8W 0805	0	JUMPER	805	Vishay Dale	CRCW08050000Z0EA	Yes
R7	1	RES SMD 255 OHM 1% 1/10W 0603	255	1%	603	Vishay Dale	CR-CW0603255RFKEA	Yes
R8	1	RES SMD 0.11 OHM 1% 1/3W 0805	0.11	1%	805	Susumu	RL1220S-R11-F	No
R9	1	RES SMD 23.7 OHM 1% 1/10W 0603	23.7	1%	603	Vishay Dale	CR-CW060323R7FKEA	Yes
R10	1	RES SMD 0.11 OHM 1% 1/3W 0805	DNP	1%	805	Susumu	RL1220S-R11-F	No
R11	1	RES SMD 0.56 OHM 5% 1/8W 0805	0.56	5%	805	CTS Resistor Products	73L3R56J	No
R12, R14, R17	3	RES SMD 1K OHM 1% 1/10W 0603	1.00K	1%	603	Vishay Dale	CR-CW06031K00FKEA	Yes
R13	1	RES SMD 499 OHM 1% 1/10W 0603	499	1%	603	Vishay Dale	CR-CW0603499RFKEA	Yes
R15, R16	2	RES SMD 10K OHM 1% 1/10W 0603	10K	1%	603	Vishay Dale	CR-CW060310K0FKEA	Yes
R18, R19	2	RES SMD 10 OHM 1% 1/8W 0805	10	1%	805	Vishay Dale	RCA080510R0FKEA	Yes
R20, R21	2	1206 PROBE PAD	N/A	N/A	1206	TE Connectivity AMP Connectors	RCS-0C	Yes
RG	1		DNP	1%	603			
GDRV, ISNS, ISNS1, ISNS2, VDRV, VSW	6	CONN PC PIN CIRC 0.020DIA GOLD	N/A	N/A	SMALL_TP	Mill-Max Manufacturing Corp.	3128-2-00-15-00-00-08-0	Yes
EN, FB, GND1, GND2, GND3, GND4, LD1, LD2, VC, VFB, VIN1, VIN_F1, VOUT1	13	PIN INBOARD .042" HOLE 1000/PKG	N/A	N/A	TP	Vector Electronics	K24C/M	Yes
GND, GND5, VIN_UF, VIN_F, VOUT2	5	TERM TURRET SINGLE L=5.56MM	N/A	N/A	TURRET	Mill-Max Manufacturing Corp.	2501-2-00-44-00-00-07-0	Yes
FT1, FT2, FT3, FT4, FT5, FT6, FT7, FT8	8	BUMPER CYLINDRICAL 0.44" DIA BLK	N/A	N/A	Bottom Silkscreen Circle	3M	SJ-5003 (BLACK)	Yes
U1	1	2MHz Auto Grade Non-Sync Boost Controller	N/A	N/A	SOIC8_N_A-DJ	ON Semiconductor	NCV898032D1R2G	No

NOTE: All components are RoHS Compliant.

# NCV898032LEDSEPGEVB

## PCB Layout

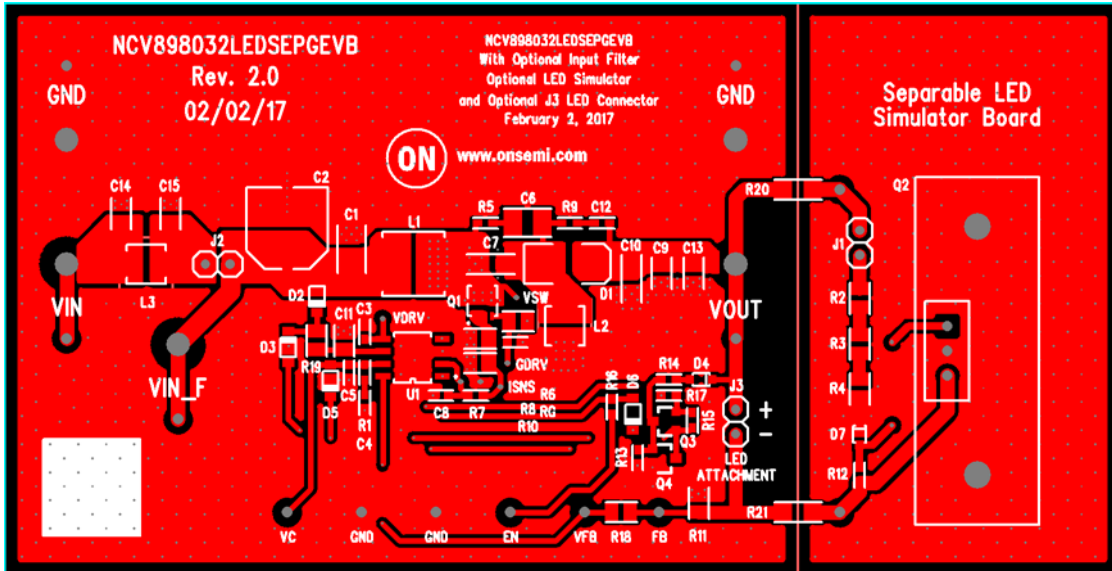


Figure 6. Top View

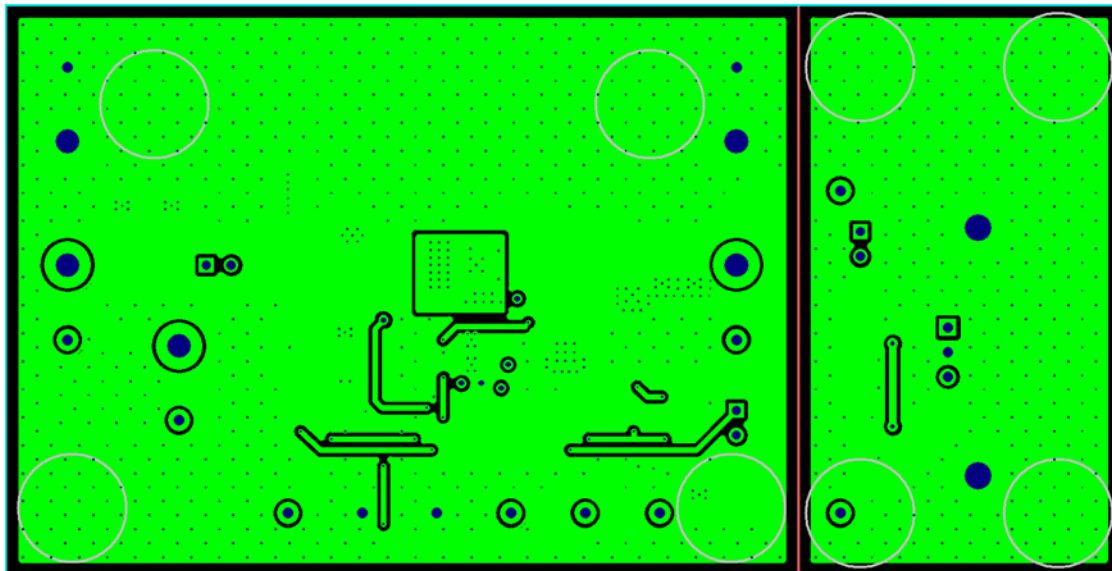


Figure 7. Bottom View



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