NCV887103 340 kHz Automotive SEPIC Reference Design

TND6344/D

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REFERENCE DESIGN

Overview

This reference design describes the operation and performance of the NCV887103 automotive boost/SEPIC controller with a NVTFS5C478NL 40 V single N−channel FET. The design demonstrates the NCV887103 controller capabilities as well as a complete designed for an automotive pre−regulator for broad range of applications.

It is intended for the power supply designer to adopt the circuit directly into a typical system design, making only minimal component changes based on system requirements.

The design is meant to be a complete solution, but it also provides access to key features of the NCV887103. These include peak current mode control with internal slope compensation, 1.2 V ±2% reference voltage, fixed frequency operation, wide input voltage range, input undervoltage lockout, internal soft−start, low IQ in sleep mode, cycle−by−cycle current limit protection, hiccup−mode overcurrent protection, hiccup−mode short−circuit protection and thermal shutdown.

Key Features

- Complete Automotive Reference Design
- Non−synchronous SEPIC Controller with an Input Voltage Range of 6.0 V to 16.0 V, Handles Peaks up to 40 V
- 340 kHz Switching Frequency for Maximum Efficiency
- ON Semiconductor NCV887103 Adjustable Output Automotive Non−synchronous SEPIC Controller and NVTFS5C478NL 40 V Single N−channel FET
- Small Form Factor PCB with Two Layers

Specifications

Table 1. SPECIFICATIONS TABLE

Device	NCV887103
Application	Automotive Rear Lighting SEPIC Application
Input Voltage	6.0 V to 16.0 Vdc
Output Power	Up to 10 W
Topology	SEPIC
Isolation	Non−Isolated
Output Voltage	11.5 V
Output Current	0.9 A

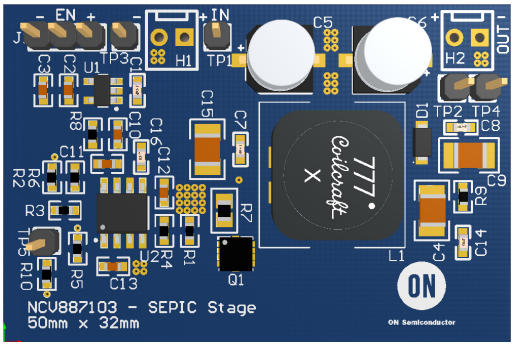

Figure 1. Reference Design PCB Print

SCHEMATICS

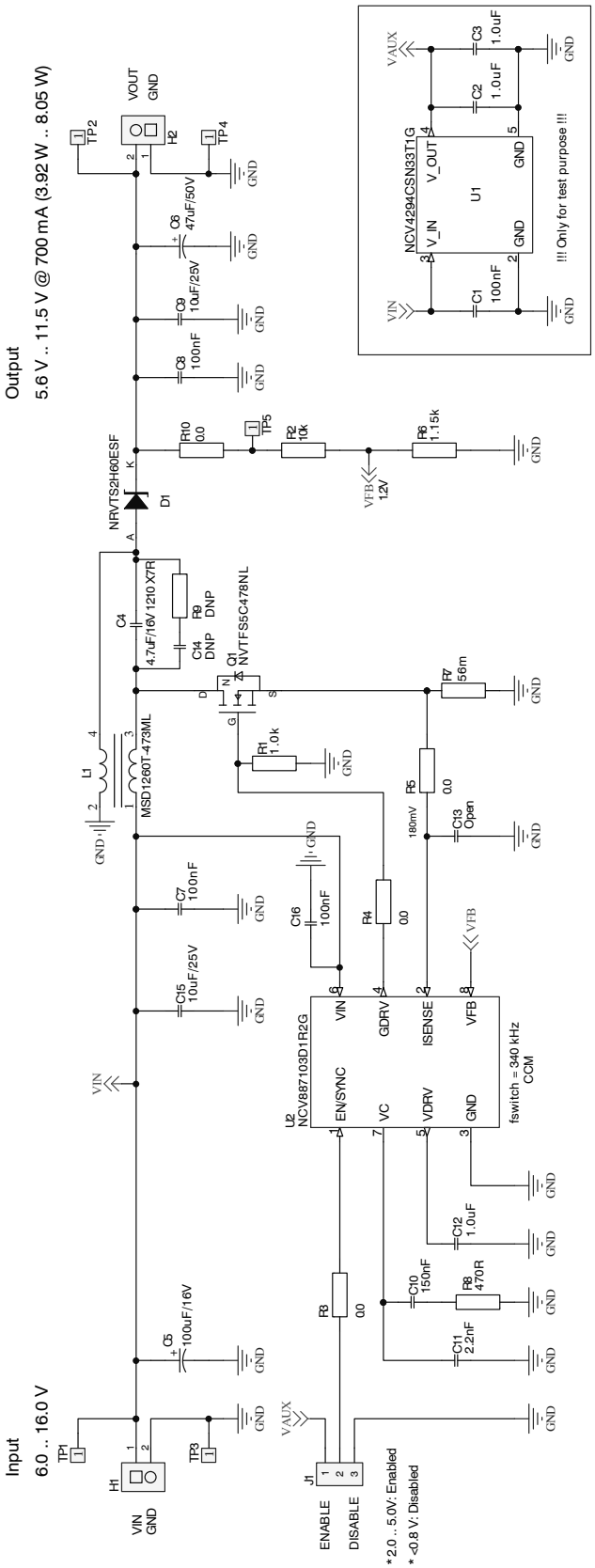

Figure 2. NCV887103 SEPIC Schematic

BOARD LAYOUT

Figure 3 and 4 show the top and bottom assembly and the two layers of the PCB. The PCB is 50 mm x 32 mm (length x width).

The power stage is located only at one side of the PCB with short traces and minimized numbers of vias in order to reduce parasitic influences.

The power GND and analog GND are only connected at the IC GND pad to separate both ground planes.

Five test pins allow the measurement of the in− and output, the phase and gain margin.

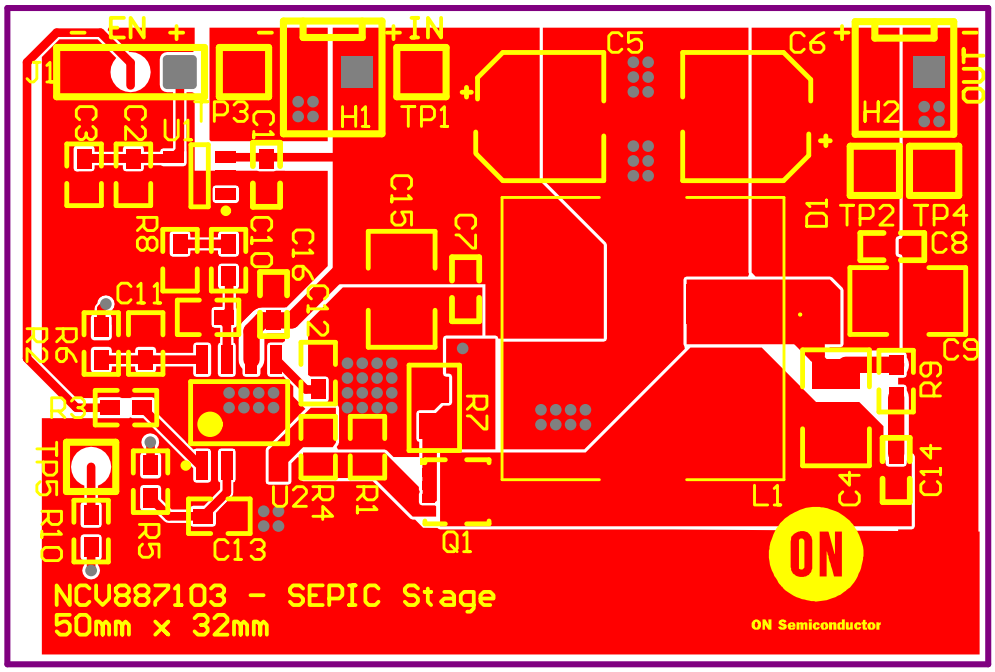

Figure 3. Top Layer with Assemble Drawing

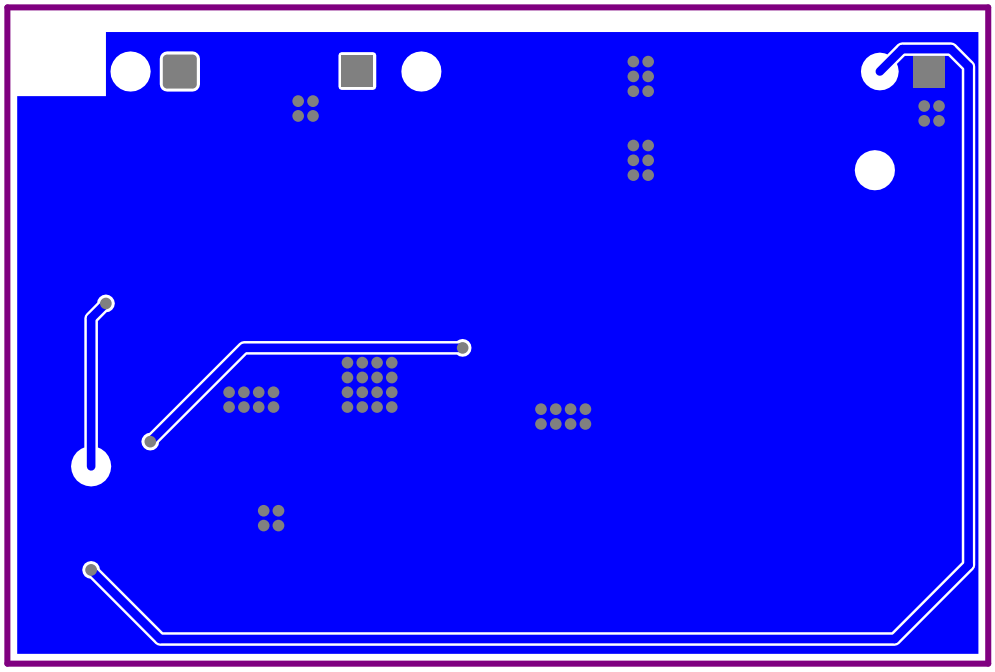

Figure 4. Bottom Layer with Assemble Drawing

PERFORMANCE SUMMARY

Efficiency

The efficiency for continuous mode is shown in Figure 5.

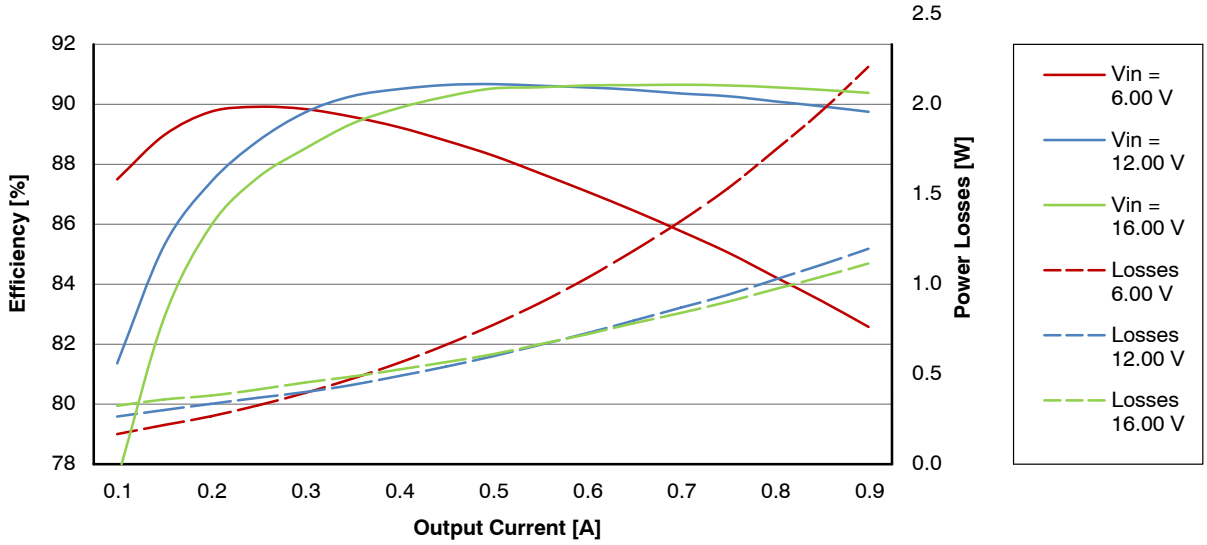

Figure 5. Efficiency for 6.0, 12.0 and 16.0 V Input Voltage

Transient Response

The response to a load step from 0.3 A to 0.6 A and vice versa at 12.0 V input voltage is shown in Figure 6.

- Channel 1: Output current, load step 0.3 to 0.6 A 0.2 A/div, 1 ms/div
- Channel 2: Output voltage, approx. −200 mV (−1.7 %) undershoot, approx. +200 mV (1.7%) overshoot 200 mV/div, 1 ms/div, AC coupled

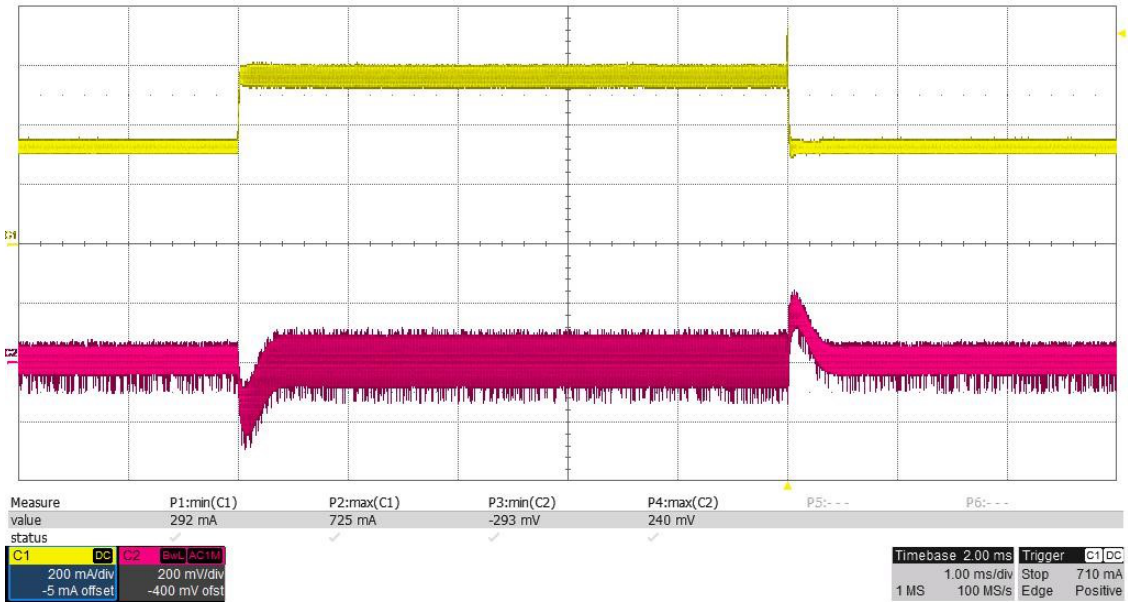

Figure 6. Transient Response on 0.3 A Load Step

Frequency Response

The frequency response at 12.0 V input voltage and 0.8 A load is shown in Figure 7.

The purpose of R10 (see Figure 2) is to provide access to measure the gain and phase of the PCB with the bode analyzer. Both pins of the analyzer are connected to TP2 and TP5 using a load of 50 Ω for R10.

- Trace 1:
  - 3.26 kHz bandwidth
  - −11.9 dB gain margin
- Trace 2:
  - 74° phase margin

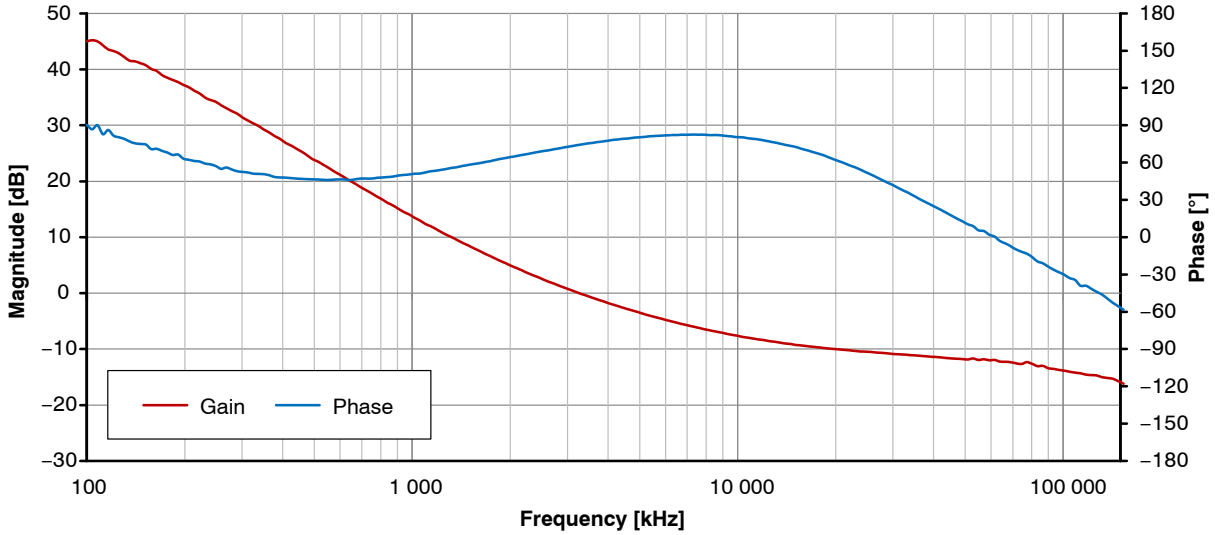

Figure 7. Frequency Response at 0.8 A Load

Table 2. FREQUENCY RESPONSE AT 0.8 A LOAD

	Bandwidth [kHz]	Gain Margin [dB]	Phase Margin [°]
V_{IN} = 6 V	2.01	−8.5	52
V_{IN} = 12 V	3.26	−11.9	74
V_{IN} = 16 V	3.73	−11.5	81

BILL OF MATERIALS (BOM)

Table 3. BILL OF MATERIALS

Designator	Qty.	Value	Part Number	Manufacturer	Description	Package
C1, C7, C8, C16	4	100 nF	GCM188R71H104KA57D	Murata	CAP, CERM, 100 nF, 50 V, ±10%, X7R, 0603	0603
C2, C3, C12	3	1 μF	GRT188R61H105KE13D	Murata	CAP, CERM, 1 μF, 50 V, ±10%, X7R, 0603	0603
C4	1	4.7 μF	GCM31CR71E475KA55K	Murata	CAP, CERM, 4.7 μF, 25 V, ±10%, X7R, 1210	1210
C5	1	100 μF	UCM1E1010MCL1GS	Nichicon	CAP, Electrolyte, 100 μF, 25 V, ±20%, SMD	D6.3 x L5.8 mm
C6	1	47 μF	GYB1H330MCQ1GS	Nichicon	CAP, Hybrid, 33 μF, 50 V, 100 μF, 50 V, ±20%, SMD	D6.3 x L7.7 mm
C9, C15	2	10 μF	GCM32ER71E106KA57K	Murata	CAP, CERM, 10 μF, 25 V, ±10%, X7R, 1210	1210
C10	1	150 nF	GCM188R71H154KA64D	Murata	CAP, CERM, 150 nF, 50 V, ±10%, X7R, 0603	0603
C11	1	2.2 nF	GCN188R71H222KA37D	Murata	CAP, CERM, 2.2 nF, 50 V, ±10%, X7R, 0603	0603
C13	1	DNP				
C14	1	DNP				
D1	1	60 V	NRVTS2H60ESF	ON Semiconductor	Diode, Schottky, 60 V, 2 A, AEC−Q101, SOD−123FL	SOD−123FL
H1, H2	2					
J1	1		61330311121	Wurth Elektronik	Header, 2.54 mm, 3x1, Gold, TH	Header, 2.54 mm, 3x1, TH
L1	1	47 μH	MSD1260T−473NL	Coilcraft	Inductor, Coupled, Composite, 47 μH, 3.4 A, 12.3 x 12.3 mm, SMD	12.3 x 12.3
Q1	1	40 V	NVTFS5C478NL	ON Semiconductor	MOSFET, 1−CH, N−CH, 40 V, 26 A, μ8FL 3x3	u8FL
R1	1	1 kΩ	CRCW06031K00FKEA	Vishay−Dale	RES, 1 kΩ, 1%, 0.1 W, 0603	0603
R2	1	10 kΩ	CRCW060310K0FKEA	Vishay−Dale	RES, 10 kΩ, 1%, 0.1 W, 0603	0603
R3, R4, R5, R10	4	0 Ω	CRCW06030000Z0EA	Vishay−Dale	RES, 0 Ω, 5%, 0.1 W, 0603	0603
R6	1	1.15 kΩ	CRCW060331K15FKEA	Vishay−Dale	RES, 1.15 kΩ, 1%, 0.1 W, 0603	0603
R7	1	56 mΩ	ERJ−6BWJR056V	Panasonic	RES, 56 mΩ, 5%, 0.5 W, 0805	0805
R8	1	470 Ω	CRCW0603470RFKEA	Vishay−Dale	RES, 470 Ω, 1%, 0.1 W, 0603	0603
R9	1	DNP				
TP1, TP2, TP3, TP4, TP5	5		5000	Keystone	Test Point, Miniature, Red, TH	Red Miniature Testpoint
U1	1		NCV4294CSN33T1G	ON Semiconductor	LDO Regulator, 30 mA, Ultra−Low Dropout	TSOP−5
U2	1		NCV887103D1R2G	ON Semiconductor	Automotive Grade Non−Synchronous Boost Controller	SOIC−8

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