A 12-V/1-A Isolated Flyback Converter with Primary Side Regulation without Auxiliary Winding for Automotive Applications Evaluation Board User's Manual

NCV12711FLOATGEVB

SPECIFICATION

Devices	Applications	Input Voltage	Output Power	Topology	Board Size
NCV12711	Automotive	4.5 – 38 V dc	12 W	Current−Mode Flyback	97 x 41 x 15 mm
Output Spec.	**Turn On Time**	**Efficiency**	**Operating Temperature**	**Cooling**	**Standby Power**
12 V/1 A	< 100 ms	Peaks to 86 % @ full load	0 – 50°C	Open Frame in Still Air	See the tables on page 7

DESCRIPTION

This evaluation board user's manual provides elementary information about a primary side regulated flyback converter NCV12711FLOATGEVB without auxiliary winding built with the NCV12711 operated in current−mode control at 100 kHz. This control circuit offers many features to build an energy−efficient converter with all the needed protections like cycle−by−cycle current limit with a 250−mV sense voltage, over−current protection (OCP) and over−voltage protection (OVP) on the VCC pin. The controller drives an N−channel MOSFET as with any classical flyback converter at a user−adjustable switching frequency. The secondary side hosts a low−V_f diode for efficient rectification in continuous conduction mode (CCM).

The primary−side section drives a transformer whose primary inductance is 8 μH. The current is sensed via two paralleled 40−mΩ resistors which limit the maximum output current to a safe value in fault condition. The board is rated to 12 W of continuous output power in free air at the lowest input voltage. This level is delivered down to a 4.5−V input. The converter is able to deliver output power up to 4−V input, which is the turn−off level adjusted by an UVLO resistor divider. At higher input voltages, the board may deliver more power but thermal runaway may happen and the board temperature must be monitored.

The regulation is ensured directly on the primary winding, avoiding the use of an optocoupler and also an auxiliary winding. The primary winding is first filtered via R_{14}/C_{21} which help lowering the leakage inductance peak naturally present in the transformer voltage. Then diode D_2 with capacitor C_{14} provide adequate rectification to build a clean dc voltage as an image of the output voltage.

In order to perform the regulation on the primary winding, the controller is arranged in a floating high−side configuration. In this way, the MOSFET is placed between the input voltage and the transformer. The primary winding is thus directly connected to the negative terminal of the power supply.

The NCV12711 operates in self−supply mode. Due to the reflected voltage from secondary to primary side, the input voltage is limited to 38 V in order to maintain the VIN pin voltage below the 45−V maximum rating.

The internal operational amplifier coupled to external components ensures the realization of a type 2 compensator. Using the simulation model or a bench measurement, components values were adjusted to crossover above 1 kHz. The maximum crossover is limited by the right−half−plane−zero (RHPZ) which degrades the phase response at the lowest input voltage and the largest output current. The board is equipped with two connectors letting you easily connect the network analyzers probes for a convenient measurement.

A simple front−end filter limits the amount of parasitic noise going back to the source and it must be properly damped to avoid interaction with the downstream converter. C5 is providing that function with its equivalent series resistance (ESR).

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Key Features of NCV12711

- Internal 20–mA current source for lossless start–up sequence and self–supply operation
- Smooth start–up sequence with frequency sweep
- Internal operational amplifier with precise 2.5–V reference voltage
- Current–mode control operation
- Short circuit protection
- Over voltage protection
- Input Voltage UVLO with Hysteresis
- Shutdown threshold for external disable
- 0% duty ratio mode for low standby power
- Single Resistor Programmable Oscillator
- User–Adjustable Soft–Start Ramp

BOARD PICTURES

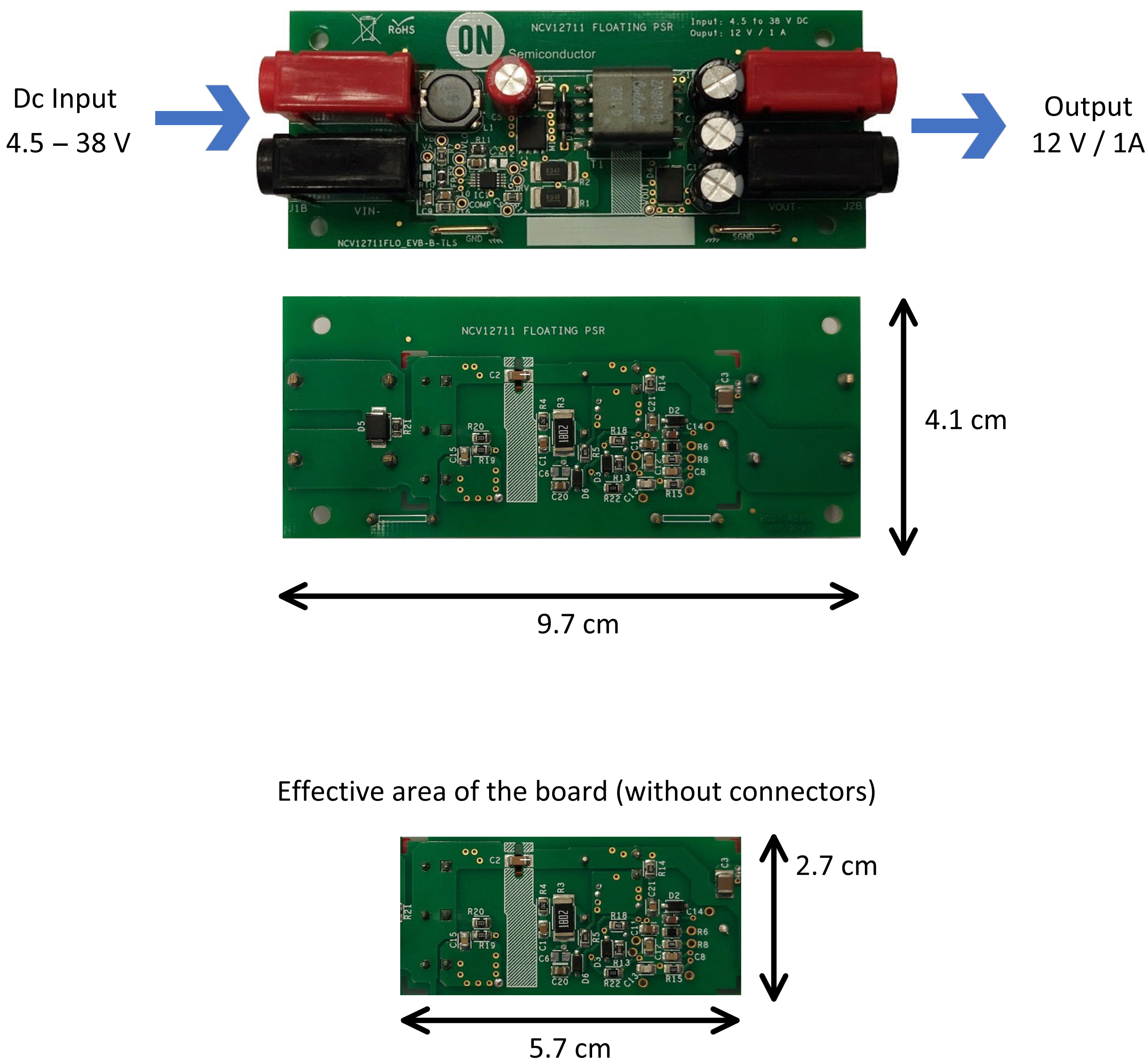


Figure 1. Top/Bottom Photo of the NCV12711FLOATGEVB Evaluation Board

EVALUATION BOARD SCHEMATIC DIAGRAM

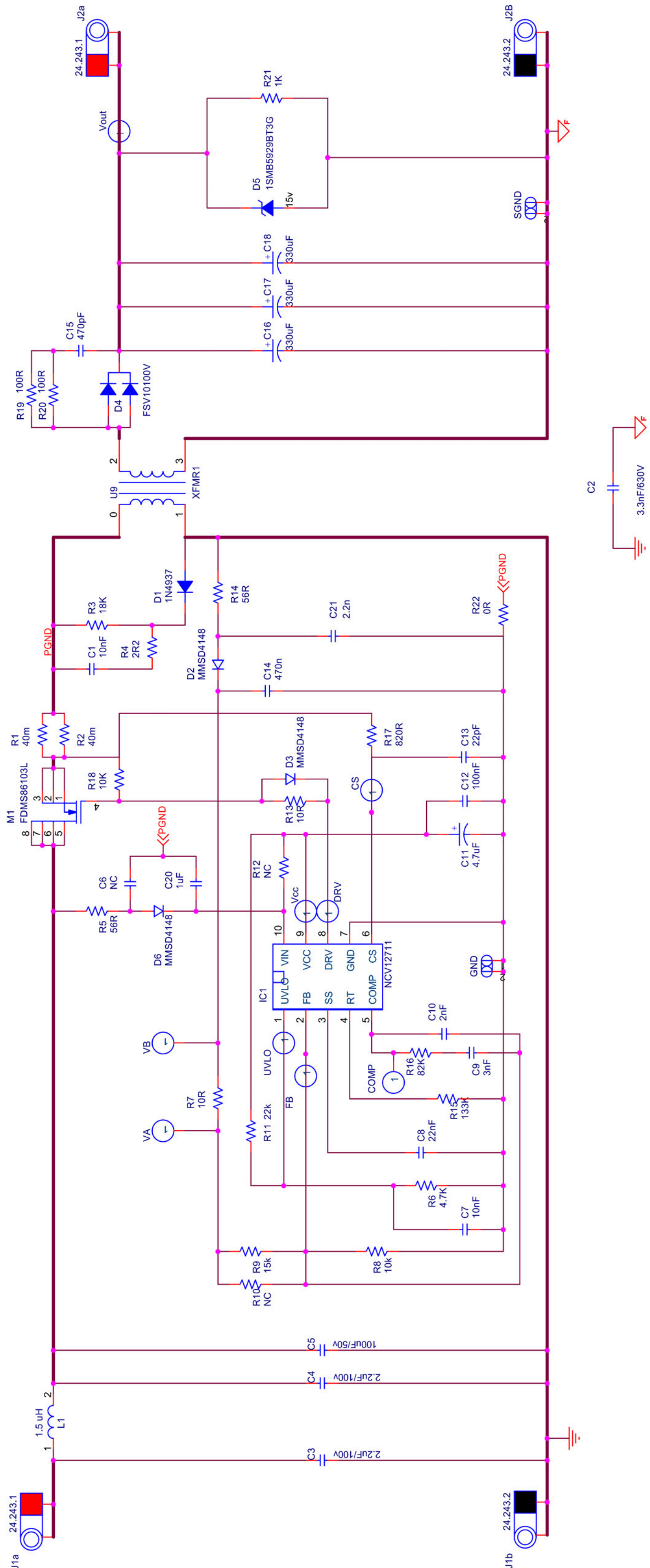
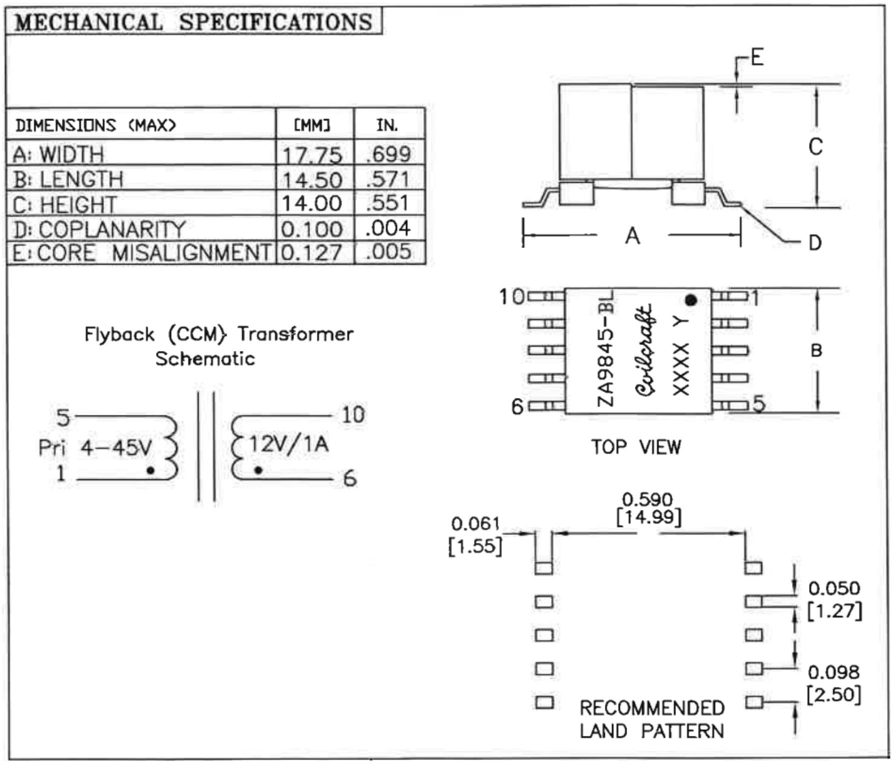


Figure 2. Schematic of the NCV12711FLOATGEVB Evaluation Board

MAGNETICS DATA

ZA9845−BL from Coilcraft:



MECHANICAL SPECIFICATIONS

DIMENSIONS (MAX)	[MM]	IN.
A: WIDTH	17.75	.699
B: LENGTH	14.50	.571
C: HEIGHT	14.00	.551
D: COPLANARITY	0.100	.004
E: CORE MISALIGNMENT	0.127	.005

Figure 3. Mechanical Specifications

ELECTRICAL SPECIFICATIONS "ALL ELECTRICAL SPECIFICATIONS @ 25°C"

INDUCTANCE(uH) (CSC)
300KHZ, 0.1 VRMS, 0/11ADC

PINS	MIN	MAX
1−5(0A)	7.6	8.4
1−5(11A)	7.0	

DC RESISTANCE (OHMS)

PINS		MAX
1−5		.044
6−10		.265

HI POT(1mA)
(VRMS, Applied for 1 minute)

VOLTAGE:	FROM PINS	TO PINS
1500	1	10
750	ALL PINS	CORE

LEAKAGE INDCTANCE(uH)
300KHZ, 0.1 VRMS, 0ADC

PINS	SHORT PINS	MAX
1−5	6−10	0.110

TRL
Apply 0.05 Vrms, 30 KHZ to pins 1−5

MEASURE PINS:	MIN	MAX
6−10	1.940	2.060

Figure 4. Electrical Specifications

TEST DATA

Startup Time

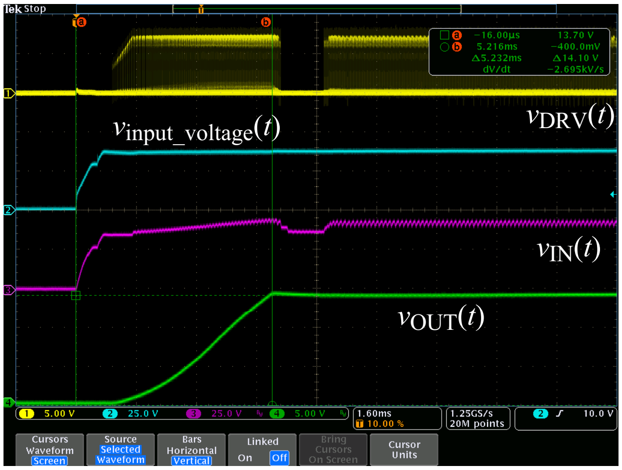


Figure 5. Self-supplied, V_{IN} = 38 V, I_{OUT} = 0 A, $t_{startup}$ = 5.2 ms

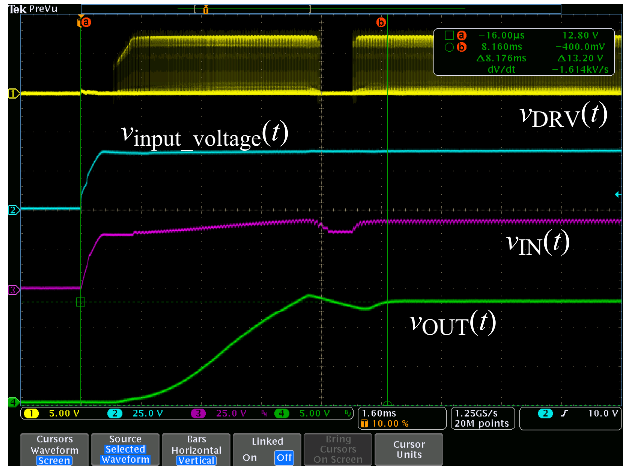


Figure 6. Self-supplied, V_{IN} = 38 V, I_{OUT} = 1 A, $t_{startup}$ = 8 ms

Steady-state Operation

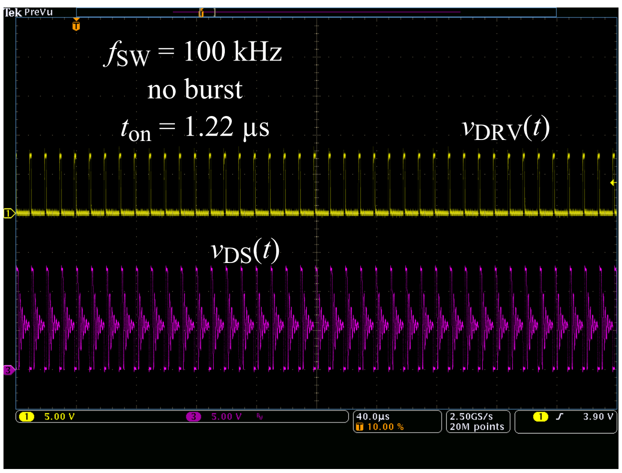


Figure 7. V_{IN} = 5.5 V, I_{OUT} = 0 A

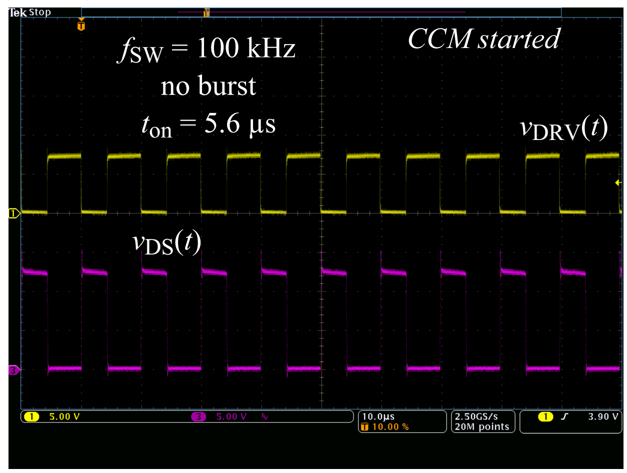


Figure 8. V_{IN} = 5.5 V, I_{OUT} = 0.35 A

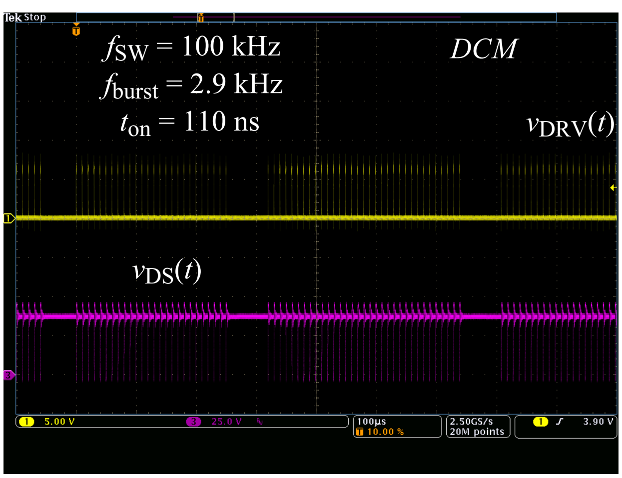


Figure 9. V_{IN} = 38 V, I_{OUT} = 0 A

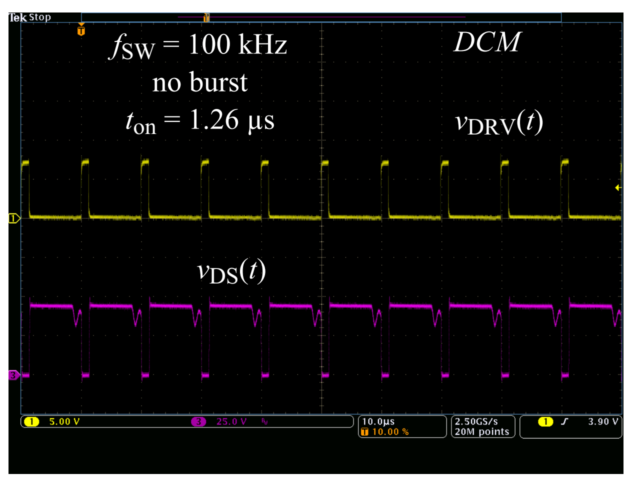


Figure 10. V_{IN} = 38 V, I_{OUT} = 1 A

Load Transient Response

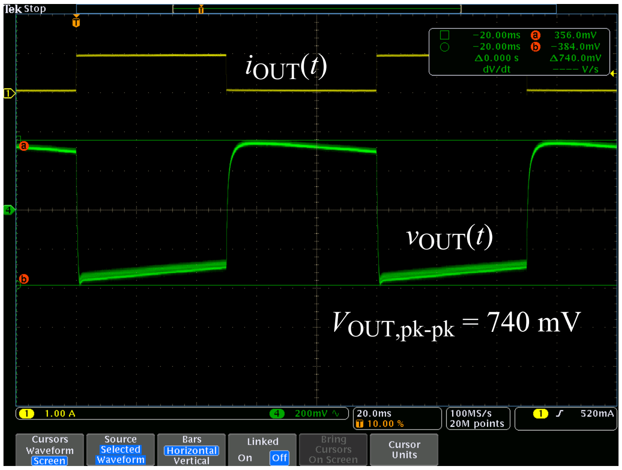


Figure 11. V_{IN} = 25 V, I_{OUT} = from 0.1 A to 1 A, slew rate 0.5 A/μs

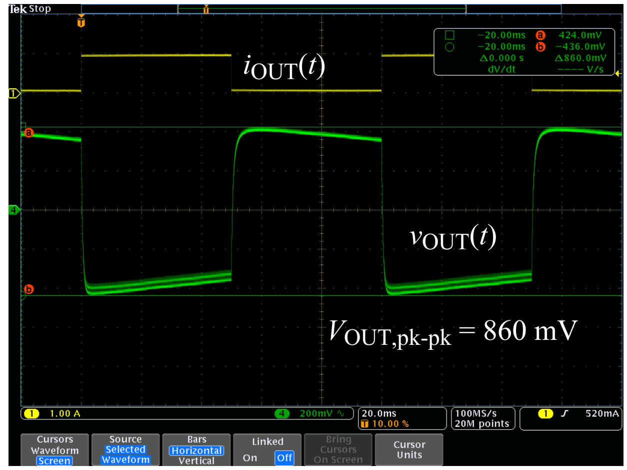


Figure 12. V_{IN} = 5.5 V, I_{OUT} = from 0.1 A to 1 A, slew rate 0.5 A/μs

Output Voltage Ripple

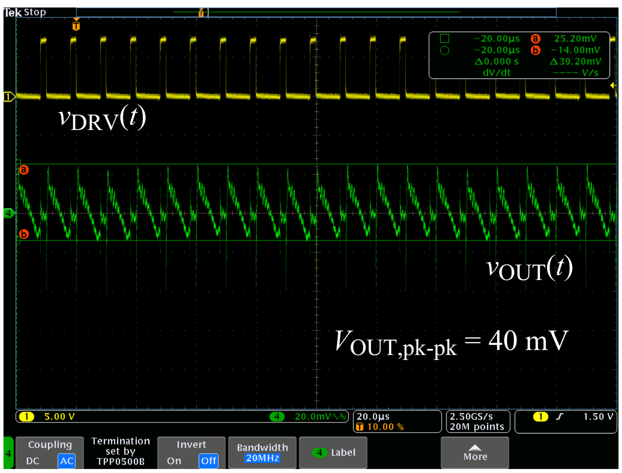


Figure 13. V_{IN} = 25 V, I_{OUT} = 1 A

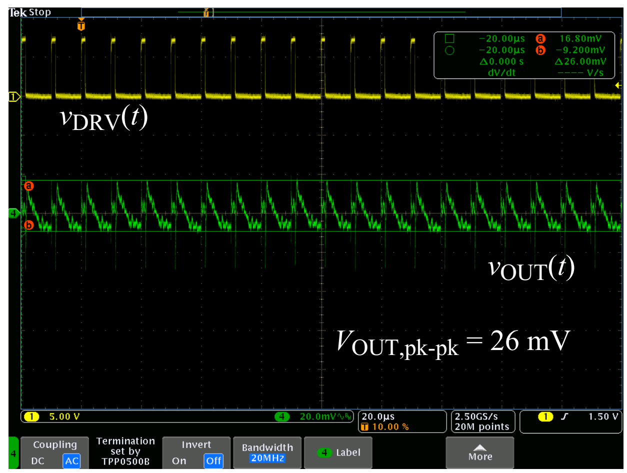


Figure 14. V_{IN} = 25 V, I_{OUT} = 0.5 A

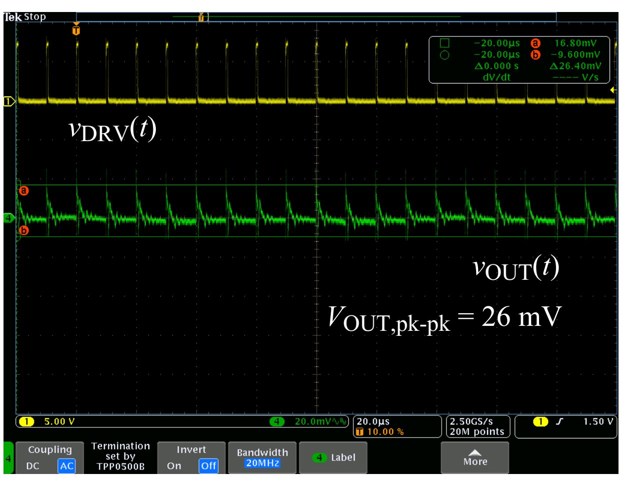


Figure 15. V_{IN} = 25 V, I_{OUT} = 0.1 A

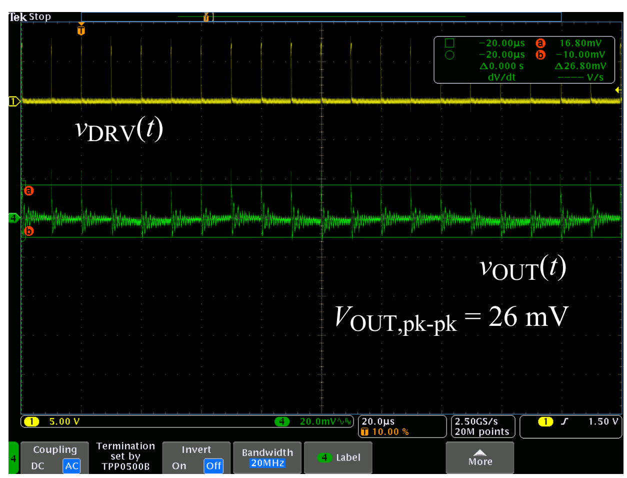


Figure 16. V_{IN} = 25 V, I_{OUT} = 0 A

Drain−Source Voltage

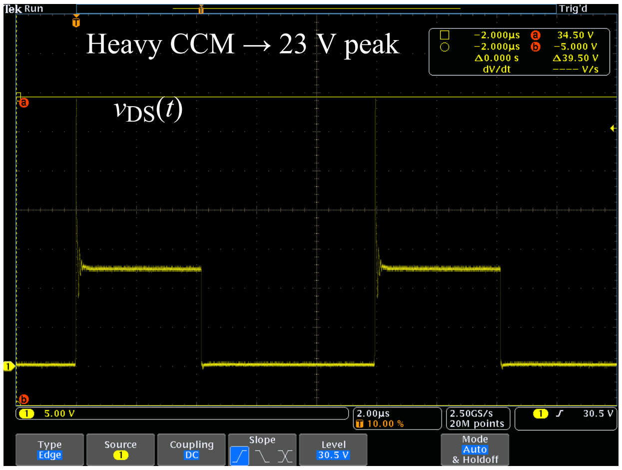


Figure 17. V_{IN} = 5.5 V, I_{OUT} = 1 A

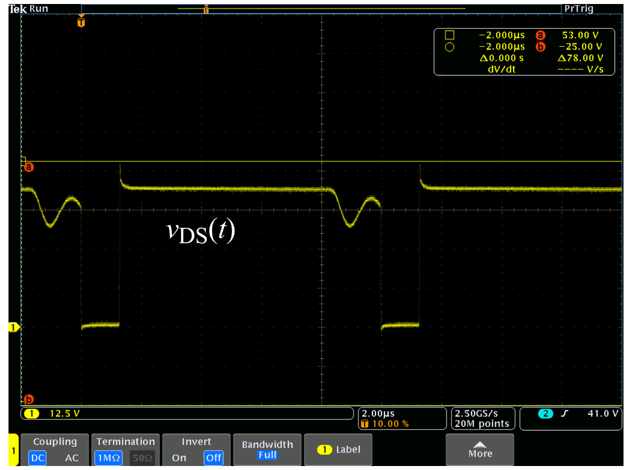


Figure 18. V_{IN} = 38 V, I_{OUT} = 1 A

Standby Data

Table 1. NO−LOAD INPUT POWER FOR THE BOARD WITHOUT CHANGES (WITH DUMMY LOAD R21 = 1K)

V_{IN} (V)	I_{IN} (mA)	P_{IN} (mW)	V_{OUT} (V)
4.5	74.3	333.4	14.2
12	36.9	406.7	14.3
24	27.9	669.6	14.3
38	24.0	910.1	14.3

Table 2. NO−LOAD INPUT POWER WHEN THE DUMMY LOAD IS REMOVED, OUTPUT IS LOADED BY 5 mA CURRENT SOURCE

V_{IN} (V)	I_{IN} (mA)	P_{IN} (mW)	V_{OUT} (V)
4.5	41.3	186.5	14.7
12	24.4	292.5	14.8
24	20.6	495.5	14.9
38	11.6	440.8	15.3

Efficiency Data

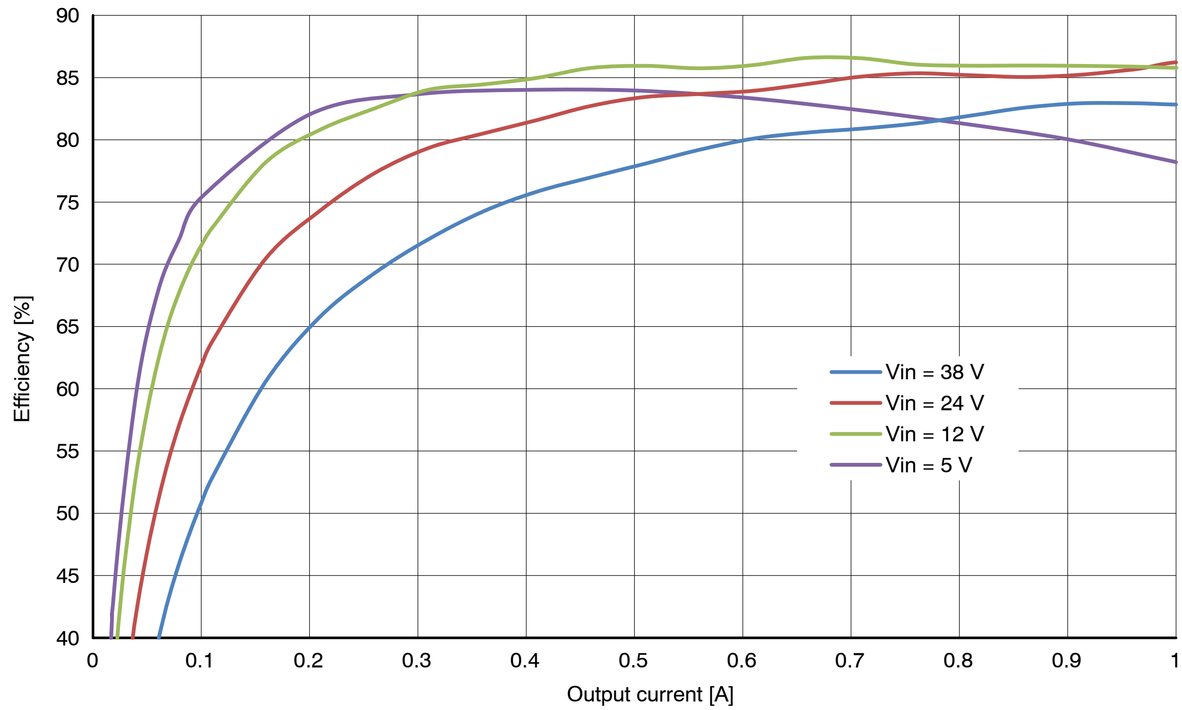


Figure 19. Efficiency vs. Output Current for Constant Input Voltage

Regulation Data

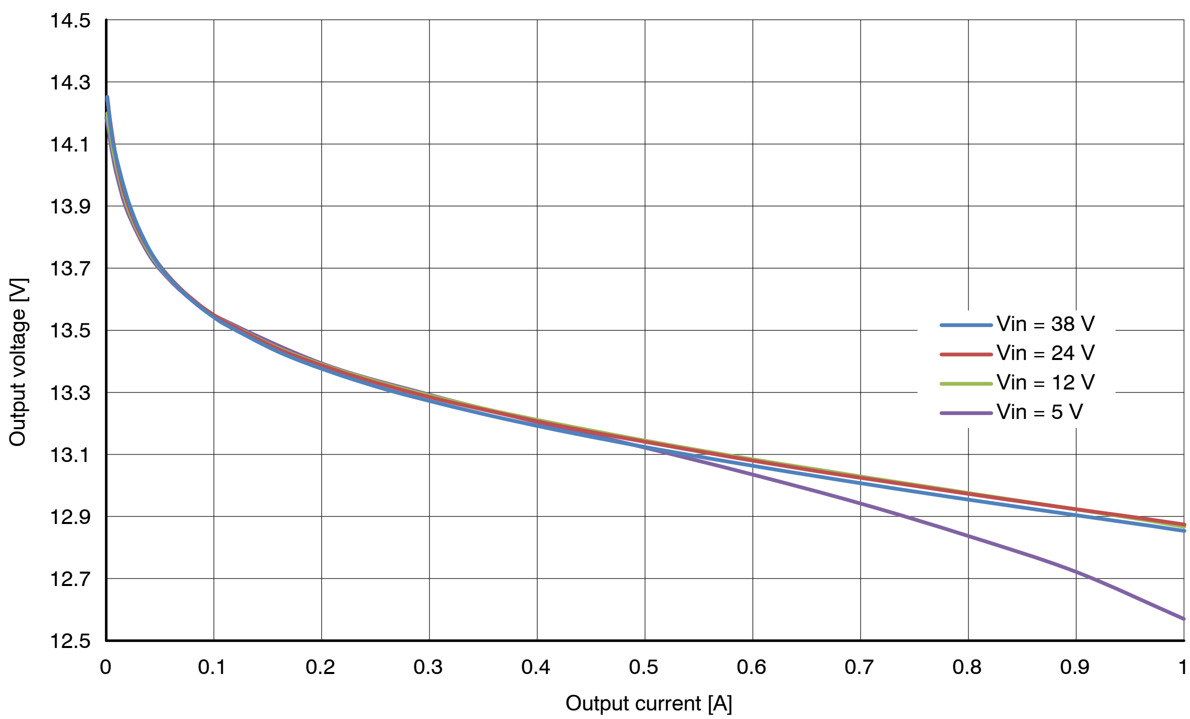


Figure 20. Output Voltage Variation for Constant Input Voltage

Table 3. BILL OF MATERIALS

Part No	Qty	Description	Value	Package	Manufacturer	Manufacturer Part Number
C1	1	Ceramic capacitor	10 nF / 100 V	0805	Generic	
C2	1	Ceramic capacitor	3.3 nF / 630 V	1206	Kemet	C1206C332KBRACTU
C3, C4	2	Ceramic capacitor	2.2 μF / 100 V	1210	Kemet	C1210C225M1RACTU
C5	1	Electrolytic Capacitor	100 μF / 50 V	TH	Rubycon	50ZL100MEFC8X11.5
C6	0	Ceramic capacitor	NU	0805	Generic	
C7	1	Ceramic capacitor	10 nF / 50 V	0805	Generic	
C8	1	Ceramic capacitor	22 nF / 50 V	0805	Generic	
C9	1	Ceramic capacitor	3.3 nF / 50 V	0805	Generic	
C10	1	Ceramic capacitor	2.2 nF / 50 V	0805	Generic	
C11	1	Ceramic capacitor	4.7 μF / 50 V	0805	Generic	
C12	1	Ceramic capacitor	100 nF / 50 V	0805	Generic	
C13	1	Ceramic capacitor	22 pF / 50 V	0805	Generic	
C14	1	Ceramic capacitor	470 nF / 50 V	0805	Generic	
C15	1	Ceramic capacitor, C0G	470 pF / 200 V	0805	Yageo	CC0805JRNPOABN471
C16, C17, C18	3	Electrolytic Capacitor	330 μF / 16 V	TH	Rubycon	16ZLG330MEFC8X11.5
C20	1	Ceramic capacitor	1 μF / 50 V	0805	Generic	
C21	1	Ceramic capacitor	2.2 nF / 50 V	0805	Generic	
D1	1	HV diode	1N4937	DO−41	**onsemi**	1N4937G
D2, D3, D6	3	switching diode	MMSD4148	SOD−123	**onsemi**	MMSD4148
D4	1	power diode	FSV10100V	TO−277	**onsemi**	FSV10100V
D5	1	Zener diode 15V/3W	1SMB5929BT3G	SMB−2	**onsemi**	1SMB5929BT3G
IC1	1	PWM Controller	NCV12711	MSOP−10	**onsemi**	NCV12711ADNR2G
J1a, J2a	2	Banana plug	–	–	multicomp	24.243.1
J1b, J2b	2	Banana plug	–	–	multicomp	24.243.2
L1	1	Inductor	1.5 μH	–	Coilcraft	MSS1038−152NL
M1	1	N−channel MOSFET	FDMS86103L	PQFN−8	**onsemi**	FDMS86103L
R1, R2	2	Resistor	40 mΩ	2512	Vishay	WSL2512R0400FEA
R3	1	Resistor	18 kΩ / 1 W	2512	Generic	
R4	1	Resistor	2.2 Ω / 0.5 W	0805	Generic	
R5, R14	2	Resistor	56 Ω	0805	Generic	
R6	1	Resistor	4.7 kΩ	0805	Generic	
R7, R13	2	Resistor	10 Ω	0805	Generic	
R8	1	Resistor	10 kΩ	0805	Generic	
R9	1	Resistor	15 kΩ	0805	Generic	
R10, R12	0	Resistor	NU	0805	Generic	
R11	1	Resistor	22 kΩ	0805	Generic	
R15	1	Resistor	133 kΩ	0805	Generic	
R16	1	Resistor	82 kΩ	0805	Generic	
R17	1	Resistor	820 Ω	0805	Generic	
R18	1	Resistor	10 kΩ	0805	Generic	
R19, R20	2	Resistor	100 Ω / 0.25 W	0805	Generic	
R21	1	Resistor	1 kΩ / 0.25 W	0805	Generic	
R22	1	Resistor	0 Ω	0805	Generic	
T1	1	Transformer	ZA9845–BL	–	Coilcraft	ZA9845–BL

NOTES:All parts are Lead−free
Ceramic capacitors are X7R type unless stated otherwise
TH = Through Hole

ADDITIONAL INFORMATION

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