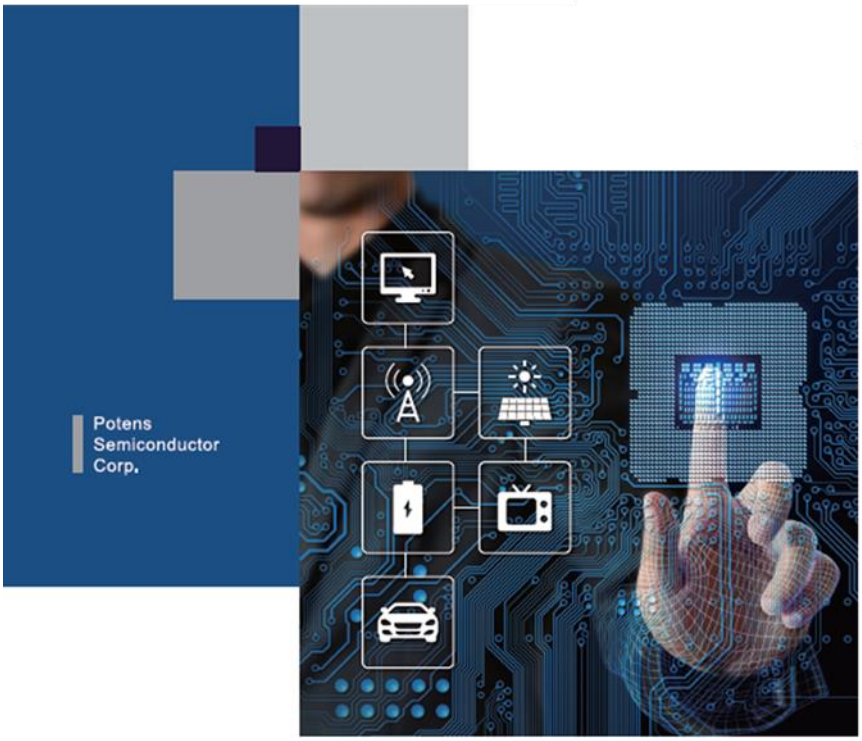
Application Information

Buck Converter Evaluation Board with NCP81278



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1. Introduction

This document provides the features, operations, board setup procedure, and buck converter design parameters and basic information to designing with the buck converter design (DK2-24) using the NCP81278 DC/DC controller and the 30V MOSFET(PDC3809RC) from Potens Semiconductor Corp[1] [2].

1.1 Circuit Diagram

The NCP81278 is the PWM control IC for the buck converter. Fig. 1 shows the power stage circuit, control and feedback circuit for the boost converter. The main circuit is including power inductor(22uF, TMPA1003-R22MN-D), input/output capacitor, MOSFET and NCP81278. For this evaluation board, the input voltage is 12V, the output voltage is 15V, and the output current is 5A and the switching frequency is ~400 kHz [3].

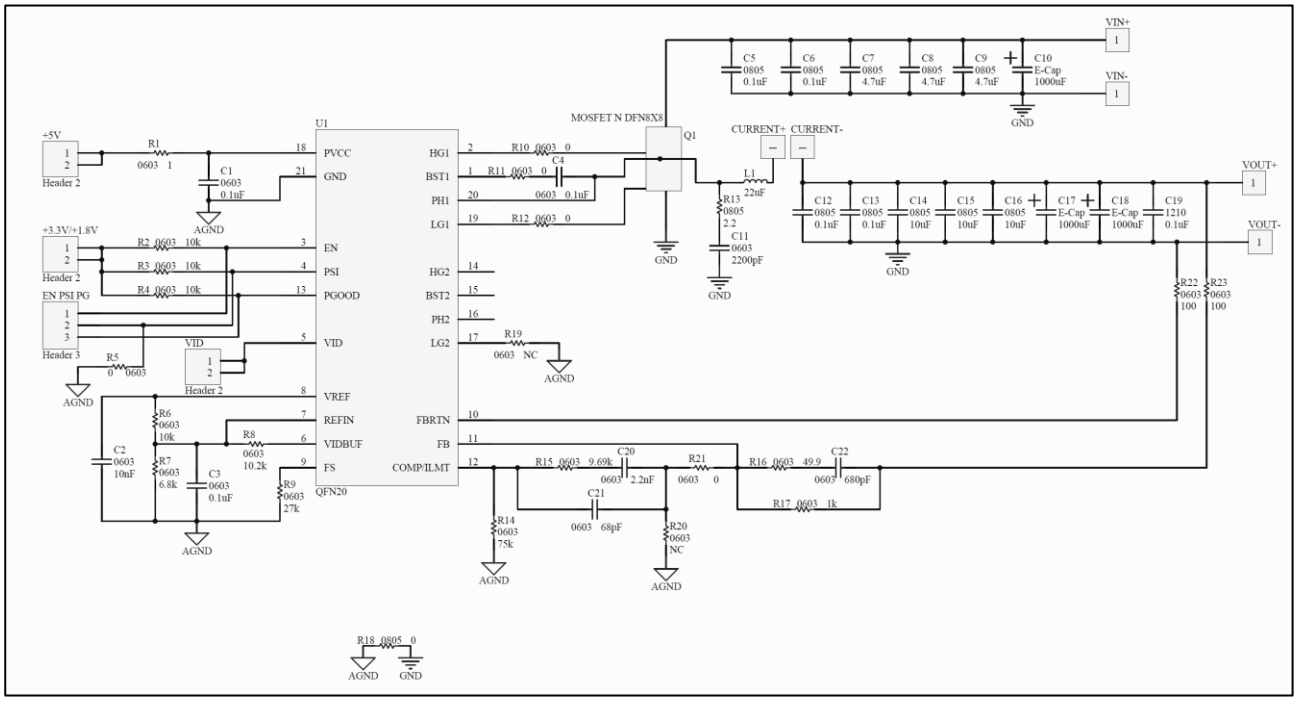

Fig. 1 The circuit diagram of DK2-24 buck evaluation board

1.2 Specifications

Table 1 is the main parameters of the DK2-24 evaluation board.

1.3 Evaluation Board

Figure 2 shows the top side of the DK2-24 evaluation board.

Table 1. DK3-24evaluation board specifications

Parameter	Value
Input voltage	3.6 V dc to 24 Vdc
Output voltage	Up to 2 Vdc
Output current	20A
Total output power	40W

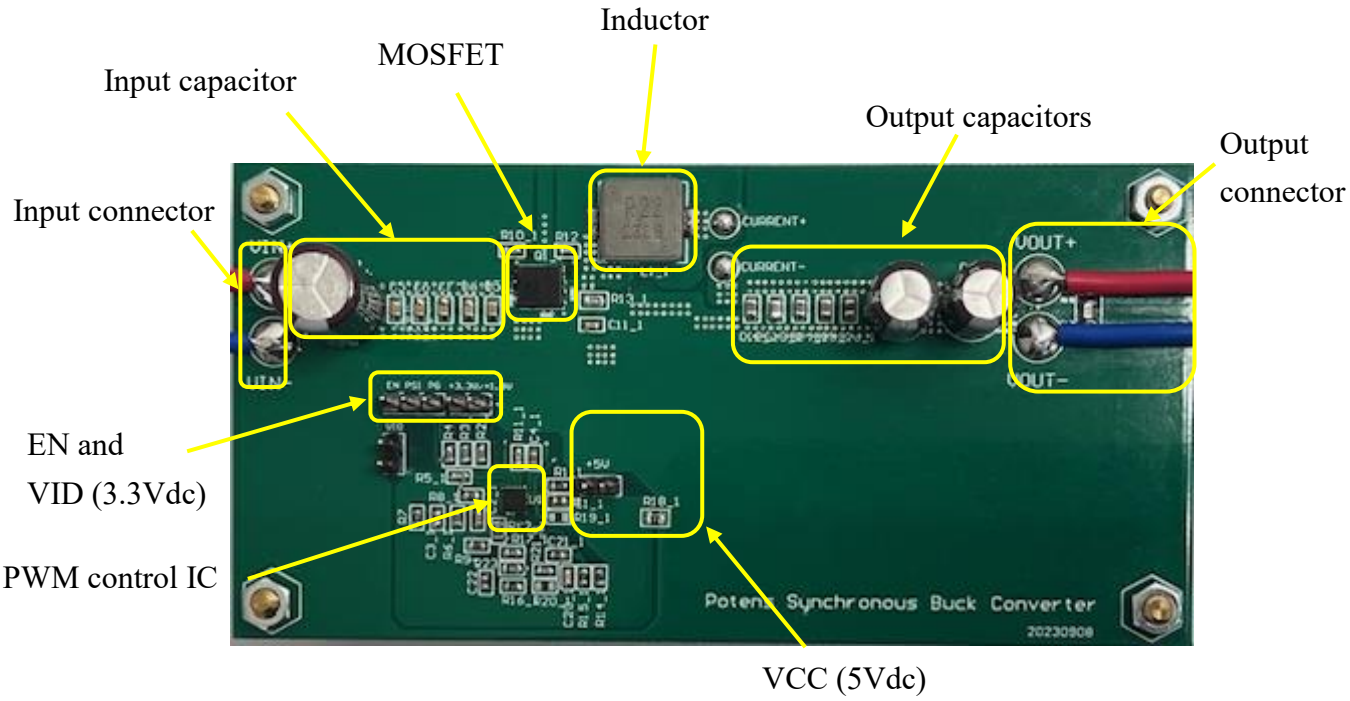

Fig. 2 the top side of the DK2-24 buck converter evaluation board

1.4 Test Setup

The evaluation board test setup is as follows:

Step 1. Input connector connects to DC source (Ex: voltage setting:19.5Vdc)

Step 2. Output connector connects to DC load

Step 3. Power on the DC source (5Vdc)

Step 4. Adjust output loading (0A~20A)

2. Design Considerations

From the volt-second balance principle, the duty cycle of input and output voltage relation for boost convert design is derived as below:

$$V_{OUT} = D \ V_{IN} \tag{1}$$

where V_{OUT} is output voltage, V_{IN} is input voltage and D is duty cycle. Let the converter operates in continuous current mode for the low ripple current requirement. The duty cycle for input voltage is 19.5V and output voltage is 0.8V is derived as:

$$0.8V = D \times 19.5\text{V} \ \Rightarrow \ D = 0.04 \tag{2}$$

The switching frequency is set as 500kHz. The frequency adjust resistor R_{14} can be derived by table(switching frequency Programmed at FS Pin):

$$R_{14} = \ 75k\Omega \tag{3}$$

Assumes operation in continuous conduction mode, the power inductor selection is shown as:

$$L > \ \frac{D \times V_{IN}}{2 \times I_{OUT} \times f_S} \tag{4}$$

The output current is 5A. Hence, the power inductor selection is as following:

$$L > \ \frac{0.04 \times 19.5}{2 \times 20 \times 500k} \ \Rightarrow \ \text{L} > 15\mu\text{H} \tag{5}$$

Choosing 22μH for the minimum current ripple of the power inductor, the current ripple can be derived as

$$\Delta i_L > \ \frac{D \times V_{IN}}{2 \times L \times f_S} \ \Rightarrow \ \Delta i_L > \ \frac{0.04 \times 19.5}{2 \times 22u \times 500k} \ \Rightarrow \ \Delta i_L > 3.5A \tag{6}$$

The output voltage is set by resistor divider (R_6 and R_7) and we choose $R_6 = 10k$ and $R_7 = 6.8k$ for the 0.8V output voltage, the output voltage relation can be derived as

$$V_{OUT} = 2 \times \left(\frac{R_7}{R_6 + R_7}\right) \ \Rightarrow \ V_{OUT} = 2 \times \left(\frac{6.8k}{10k + 6.8k}\right) = 0.8V \tag{7}$$

3. Test Results

The test equipment and experimental results of the DK2-24 buck evaluation board applying PWM control IC NCP81278 are shown as following subsection.

3.1 Test Equipment

The table 3 shows the test equipment.

Table 3. List of the test equipment

Test equipment	Model
DC Power Supply	ITECH IT6874A
Electronic load	ITECH IT8700
Power meter	YOKOGAWA WT310
Oscilloscope	Angilent DSO-X 6004A

3.2 Test waveforms

Fig. 3 shows the steady state waveforms at 2A load and the switching frequency is ~500kHz. Channel 1 is output voltage and Channel 4 is inductor current.

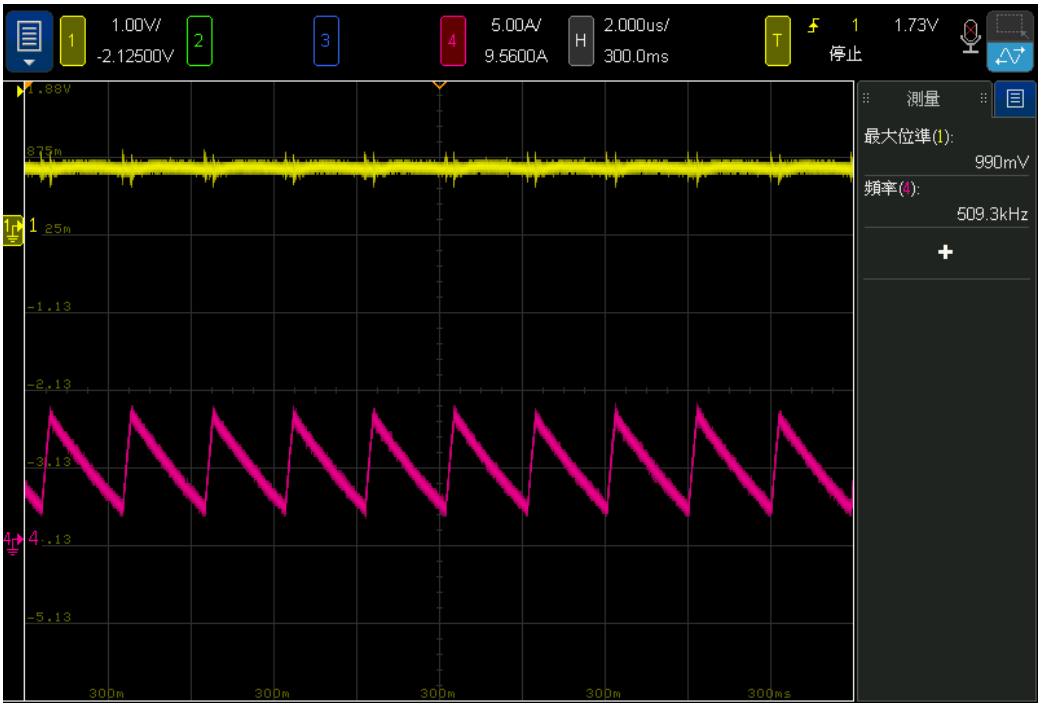

Fig. 3 The steady state waveforms

4. Reference

[1] ON-semi Semiconductor, “Compact 2-Phase Synchronous Buck Controller with Integrated Gate Drivers and PWM VID Interface High Efficiency DC/DC Controller,” NCP81278 datasheet.

[2] Potens Semiconductor, “30V N-channel Asymmetric Dual MOSFET,” PDC3809RC datasheet. https://www.potens-semi.com/upload/product/PDC3809RC.pdf.

[3] TAI-TECH Advanced Electronics, “Hi-current Power Inductor,” TMPA1003S-R22MN-D datasheet. https://www.tai-tech.com.tw/product?mcls=1551832438&cls=1490671070&cls2=1490671070&cls3=1490672466&pid=1566546846

5. Appendix

The bill of materials for the DK2-24 evaluation board is shown in Table 4.

Table 4. Bill of materials

Location	Description	Quantity
C1, C3, C4, C6, C11	Capacitor 0.1uF 0603	5
C2	Capacitor 10nF 0603	1
C5, C10	Capacitor 2200pF 0603	2
C7, C8	Capacitor 10uF 0805	2
C9	E-Cap, 220uF/25V	3
C9, C14, C15	E-Cap. 1500uF/6.3V	3
C12, C13	Capacitor 22uF 0805	2
C16	Capacitor 2.2nF 0603	1
C17	Capacitor 68pF 0603	1
C18	Capacitor 680pF 0603	1
L1	Choke 22uF, TMPA1003S-22MN-D	1
Q1	PDC3809RC	3
R1	Resistor 1 0603	1
R2, R3, R4, R6	Resistor 10k 0603	4
R5, R10, R11, R12	Resistor 0 0603	4
R7	Resistor 6.8k 0603	1
R8	Resistor 10k 0603	1
R9	Resistor 27k 0603	1
R13	Resistor 2.2 0805	1
R14	Resistor 75k 0603	1
R15	Resistor 9.69k 0603	1
R16	Resistor 49.9 0603	1
R17	Resistor 1k 0603	1
R18	Resistor 0 0805	1
U1	PWM IC, NCP81278	1