LM5175 Synchronous 4-Switch Buck-Boost Converter

TI reference design number: PMP10698 REV A

Input: 9V to 42V DC
Output: Selectable 5V, 12V or 20V @ 5A

DC – DC Test Results
# Table of Contents

1. Test Specifications .................................................................................................................. 3
2. Circuit Description .................................................................................................................... 3
3. Board Photos ............................................................................................................................ 3
4. Efficiency .................................................................................................................................. 5
   4.1 12V Output Efficiency Results ............................................................................................. 5
   4.2 12V Output Efficiency Data .................................................................................................. 5
   4.3 20V Output Efficiency Results ............................................................................................. 7
   4.4 20V Output Efficiency Data .................................................................................................. 8
   4.5 5V Output Efficiency Results .............................................................................................. 10
   4.6 5V Output Efficiency Data .................................................................................................... 10
5. Thermal .................................................................................................................................... 13
   5.1 9V Input, 20V at 4A Output .................................................................................................. 13
   5.2 12V Input, 20V at 5A Output ............................................................................................... 13
   5.3 16V Input, 20V at 5A Output ............................................................................................... 14
   5.4 42V Input, 20V at 5A Output ............................................................................................... 14
6. Startup ...................................................................................................................................... 15
   6.1 Startup from EN .................................................................................................................... 15
7. Switching and Ripple Voltage .................................................................................................... 16
   7.1 9V Input ................................................................................................................................ 16
   7.2 12V Input .............................................................................................................................. 17
   7.3 16V Input .............................................................................................................................. 18
   7.4 42V Input ................................................................................................................................ 19
8. Output Voltage Control ............................................................................................................ 20
   8.1 5V to 12V Output .................................................................................................................. 20
   8.2 12V to 20V Output ................................................................................................................ 21
   8.3 5V to 20V Output .................................................................................................................. 22
9. Load Transient Response .......................................................................................................... 23
   9.1 9V Input ................................................................................................................................ 23
   9.2 12V Input ................................................................................................................................ 24
   9.3 16V Input ................................................................................................................................ 25
   9.4 42V Input ................................................................................................................................ 26
10. Frequency Response ............................................................................................................... 27
    10.1 9V Input .............................................................................................................................. 27
    10.2 12V Input ............................................................................................................................ 28
    10.3 16V Input ............................................................................................................................ 29
    10.4 42V Input ............................................................................................................................ 30
11. Short Circuit Tests ................................................................................................................... 31
    11.1 Output Short Circuit ........................................................................................................... 31
    11.2 Output Short Circuit Recovery .......................................................................................... 32
1 Test Specifications

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2 Circuit Description

PMP10698 is a synchronous 4-switch buck-boost converter which utilizes the LM5175 controller for USB type C applications. The output voltage can be selected for 5V, 12V or 20V at 5A using jumpers or open drain control switches. The LM5175 average current loop sets a maximum output current of 6.25A. Additional pulse-by-pulse current limiting is inherent in the current-mode controller. The board includes enable, synchronization and power good functions.

3 Board Photos

The design is built on PMP10624 Rev A printed circuit board. This is a 4-layer PCB with 1 oz. copper on external layers and 0.5 oz. copper on internal layers. PCB dimensions are 2.85 x 2.60 inch.
4 Efficiency

4.1 12V Output Efficiency Results

The output current is increased above the maximum value to test current limit.

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<th>Pin (W)</th>
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<th>Pdis (W)</th>
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#### 4.3 20V Output Efficiency Results

![PMP10698 20V Output Efficiency](image)
## 4.4 20V Output Efficiency Data

The output current is increased above the maximum value to test current limit.

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4.5 5V Output Efficiency Results

The output current is increased above the maximum value to test current limit.

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## Power Management Solutions

### Test Results

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- **Vin (V):** Voltage input
- **Iin (A):** Current input
- **Vout (V):** Voltage output
- **Iout (A):** Current output
- **Pin (W):** Input power
- **Pout (W):** Output power
- **Pdis (W):** Dissipated power
- **Efficiency (%):** Efficiency percentage

The table above shows the test results for different input voltages, currents, and efficiencies. Each row represents a test condition with the corresponding power values and efficiency percentage.
## PMP10698 Test Results

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5 Thermal

5.1 9V Input, 20V at 4A Output

5.2 12V Input, 20V at 5A Output
5.3 16V Input, 20V at 5A Output

5.4 42V Input, 20V at 5A Output
6 Startup

6.1 Startup from EN

---

EN VOUT IIN Startup 9Vin 12Vout 0A
EN VOUT IIN Startup 9Vin 12Vout 5A

EN VOUT IIN Startup 12Vin 12Vout 0A
EN VOUT IIN Startup 12Vin 12Vout 5A

EN VOUT IIN Startup 16Vin 12Vout 0A
EN VOUT IIN Startup 16Vin 12Vout 5A

---

Page 15 of 32
7 Switching and Ripple Voltage

7.1 9V Input

VOUT BUCKSW BOOSTSW Switching 9Vin 5Vout 5A

VOUT BUCKSW BOOSTSW Switching 9Vin 12Vout 5A 0.1uF

VOUT BUCKSW BOOSTSW Switching 9Vin 20Vout 0A 0.1uF
7.2 12V Input

VOUT BUCKSW BOOSTSW Switching 12Vin 5Vout 5A 0.1uF

VOUT BUCKSW BOOSTSW Switching 12Vin 12Vout 5A 0.1uF

VOUT BUCKSW BOOSTSW Switching 12Vin 20Vout 5A 0.1uF
7.3 16V Input

![Diagram of 16V Input test results](image-url)
7.4 42V Input

VOUT BUCKSW BOOSTSW Switching 42Vin 5Vout 5A 0.1uF

VOUT BUCKSW BOOSTSW Switching 42Vin 12Vout 5A 0.1uF

VOUT BUCKSW BOOSTSW Switching 42Vin 20Vout 5A 0.1uF
8 Output Voltage Control
All tests were performed at 12V input.

8.1 5V to 12V Output

---

CTL1 CTL2 VOUT Output Voltage Control 12Vin 5Vout to 12Vout 5A
CTL1 CTL2 VOUT Output Voltage Control 12Vin 5Vout to 12Vout 0A

CTL1 CTL2 VOUT Output Voltage Control 12Vin 12Vout to 5Vout 5A
CTL1 CTL2 VOUT Output Voltage Control 12Vin 12Vout to 5Vout 0A
8.2 12V to 20V Output
8.3 5V to 20V Output

CTL1 CTL2 VOUT Output Voltage Control 12Vin 5Vout to 20Vout 5A
CTL1 CTL2 VOUT Output Voltage Control 12Vin 5Vout to 20Vout 0A

CTL1 CTL2 VOUT Output Voltage Control 12Vin 20Vout to 5Vout 5A
CTL1 CTL2 VOUT Output Voltage Control 12Vin 20Vout to 5Vout 0A
9 Load Transient Response

9.1 9V Input

VOUT IOUT Transient Response 9Vin 5Vout 2.5A to 5A load step
VOUT IOUT Transient Response 9Vin 12Vout 2.5A to 5A load step
VOUT IOUT Transient Response 9Vin 20Vout 2.5A to 5A load step
9.2 12V Input

VOUT IOUT Transient Response 12Vin 5Vout 2.5A to 5A load step

VOUT IOUT Transient Response 12Vin 12Vout 2.5A to 5A load step

VOUT IOUT Transient Response 12Vin 20Vout 2.5A to 5A load step
9.3 16V Input

VOUT IOUT Transient Response 16Vin 5Vout 2.5A to 5A load step

VOUT IOUT Transient Response 16Vin 12Vout 2.5A to 5A load step

VOUT IOUT Transient Response 16Vin 20Vout 2.5A to 5A load step
9.4 42V Input

VOUT IOUT Transient Response 42Vin 5Vout 2.5A to 5A load step

VOUT IOUT Transient Response 42Vin 12Vout 2.5A to 5A load step

VOUT IOUT Transient Response 42Vin 20Vout 2.5A to 5A load step
10 Frequency Response

10.1 9V Input

Control Loop 9Vin 5Vout 5A CC load

Control Loop 9Vin 12Vout 5A CC load

Control Loop 9Vin 20Vout 5A CC load
10.2 12V Input

Control Loop 12Vin 5Vout 5A CC load

Control Loop 12Vin 12Vout 5A CC load

Control Loop 12Vin 20Vout 5A CC load
10.3 16V Input

Control Loop 16Vin 5Vout 5A CC load

Control Loop 16Vin 12Vout 5A CC load

Control Loop 16Vin 20Vout 5A CC load
10.4 42V Input

Control Loop 42Vin 5Vout 5A CC load

Control Loop 42Vin 12Vout 5A CC load

Control Loop 42Vin 20Vout 5A CC load
11 Short Circuit Tests

11.1 Output Short Circuit

![Graphs showing short circuit tests for different voltage inputs and currents.](image-url)
### 11.2 Output Short Circuit Recovery

- **PGOOD IOUT VOUT short circuit recovery 9Vin 12Vout 0A**
- **PGOOD IOUT VOUT short circuit recovery 9Vin 12Vout 5A**
- **PGOOD IOUT VOUT short circuit recovery 12Vin 12Vout 0A**
- **PGOOD IOUT VOUT short circuit recovery 12Vin 12Vout 5A**
- **PGOOD IOUT VOUT short circuit recovery 16Vin 12Vout 0A**
- **PGOOD IOUT VOUT short circuit recovery 16Vin 12Vout 5A**
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