LM5122EVM-2PH Evaluation Module

User's Guide

Literature Number: SNVU205
APRIL 2013
## Contents

1. Introduction .......................................................................................................................... 4
2. Features and Electrical Performance .................................................................................... 4
3. Test Points ............................................................................................................................. 4
   3.1 Test Points ....................................................................................................................... 4
4. Test Equipment ....................................................................................................................... 5
   4.1 Power Supply .................................................................................................................. 5
   4.2 Electronic Load ................................................................................................................ 5
   4.3 Meters .............................................................................................................................. 5
   4.4 Oscilloscope .................................................................................................................... 5
5. Test Setup and Procedure ...................................................................................................... 5
   5.1 Precaution & Wire Gauge .............................................................................................. 5
   5.2 Test Setup ...................................................................................................................... 6
   5.3 Quick Test Procedure ..................................................................................................... 6
6. Performance Curves ............................................................................................................... 6
   6.1 Efficiency ......................................................................................................................... 6
   6.2 Load Transient ................................................................................................................. 7
   6.3 Interleaving ..................................................................................................................... 7
   6.4 Light Load Operations ..................................................................................................... 8
   6.5 Startup ............................................................................................................................ 9
   6.6 Loop Response ............................................................................................................... 9
7. Schematic ............................................................................................................................... 10
8. Layout .................................................................................................................................... 12
9. Bill of Materials ..................................................................................................................... 15
List of Figures

1 Connection Diagram ........................................................................................................ 5
2 Efficiency .......................................................................................................................... 6
3 Load Transient .................................................................................................................. 7
4 Interleaving ....................................................................................................................... 7
5 Pulse Skip ........................................................................................................................... 8
6 Skip Cycle ........................................................................................................................... 8
7 Forced PWM ...................................................................................................................... 8
8 Startup ................................................................................................................................ 9
9 Loop Response .................................................................................................................. 9
10 Schematic (Power Block) .................................................................................................. 10
11 Schematic (Control Block) .............................................................................................. 11
12 Top Silk (Top View) ......................................................................................................... 12
13 Bottom Silk (X-Ray View) .............................................................................................. 12
14 Top Copper (Top View) .................................................................................................... 13
15 Mid1 Copper (X-Ray View) ............................................................................................. 13
16 Mid2 Copper (X-Ray View) ............................................................................................. 14
17 Bottom Copper (X-Ray View) .......................................................................................... 14

List of Tables

1 Electrical Performance Specifications .................................................................................. 4
2 Pin Descriptions .................................................................................................................. 4
3 Bill of Materials ................................................................................................................... 15
1 Introduction
The LM5122EVM-2PH evaluation module (EVM) provides the design engineer with a fully functional dual phase synchronous boost converter to evaluate the Texas Instruments LM5122 synchronous boost controller device. The EVM provides 28 V output at up to 7 A current from a 9 V to 20 V input. The EVM is designed to start up from a single power supply without any additional bias voltage.

2 Features and Electrical Performance
• 9 V to 20 V input voltage range
• 28 V target output voltage
• Up to 7 A output current
• 250 kHz typical switching frequency
• Dual phase interleaved operation

Table 1. Electrical Performance Specifications

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>TEST CONDITIONS</th>
<th>MIN</th>
<th>TYP</th>
<th>MAX</th>
<th>UNITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Characteristics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input Voltage</td>
<td></td>
<td>9</td>
<td>12</td>
<td>20</td>
<td>V</td>
</tr>
<tr>
<td>Input Current</td>
<td>( V_{SUPPLY} ) ( = 12 ) ( \text{V} ), ( I_{LOAD} ) ( = 7 ) ( \text{A} )</td>
<td>17</td>
<td></td>
<td></td>
<td>A</td>
</tr>
<tr>
<td>Output Characteristics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output Voltage</td>
<td>( I_{LOAD} ) ( = 7 ) ( \text{A} )</td>
<td>27.02</td>
<td>28</td>
<td>28.98</td>
<td>V</td>
</tr>
<tr>
<td>Output Current</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>A</td>
</tr>
<tr>
<td>System Characteristics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Switching Frequency</td>
<td></td>
<td></td>
<td>250</td>
<td></td>
<td>kHz</td>
</tr>
<tr>
<td>Full Load Efficiency</td>
<td>( V_{SUPPLY} ) ( = 12 ) ( \text{V} )</td>
<td></td>
<td></td>
<td>96%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( V_{SUPPLY} ) ( = 20 ) ( \text{V} )</td>
<td></td>
<td></td>
<td>98%</td>
<td></td>
</tr>
</tbody>
</table>

3 Test Points
3.1 Test Points

Table 2. Pin Descriptions

<table>
<thead>
<tr>
<th>PIN NAME</th>
<th>DESCRIPTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>TP7, TP8</td>
<td>Power Ground</td>
</tr>
<tr>
<td>TP5, TP9, TP10</td>
<td>Analog Ground</td>
</tr>
<tr>
<td>TP6</td>
<td>UVLO</td>
</tr>
<tr>
<td>J1#1</td>
<td>External Synchronization Pulse Positive Input</td>
</tr>
<tr>
<td>J1#2</td>
<td>External Synchronization Pulse Negative Input</td>
</tr>
</tbody>
</table>
4 Test Equipment

4.1 Power Supply
Power Supply should be capable of 20 V / 25 A, current monitoring and remote sensing.

4.2 Electronic Load
Electronic load should be capable of 32 V / 7 A. Use Constant Current (CC) mode.

4.3 Meters
One current meter is required to measure input current accurately. Maximum current rating of the meter should be carefully considered. Input current can be as high as 25 A at full load current and minimum input voltage. Output voltage is monitored by a voltage meter which should be capable of monitoring up to 32 V.

4.4 Oscilloscope
Oscilloscope and 10x probe with at least 20 MHz bandwidth are required.

5 Test Setup and Procedure

5.1 Precaution & Wire Gauge
Prolonged operation with low input voltage at full power will cause heating of the MOSFETs. A fan with a minimum of 200LFM should be always provided.

Wire gauge for the input power supply should be 6-8 AWG minimum and no longer than 1 foot each for VIN and GND. Wire gauge for the output electronic load should be 12 AWG minimum and no longer than 1 foot each for VOUT and GND.
5.2 **Test Setup**

5.2.1 **Power Supply**
Connect the power supply’s positive terminal (+) to ‘A’ terminal of ampere meter and negative terminal (-) to TP4 GND. Connect the power supply’s positive remote sense terminal to TP2 VIN and negative remote sense terminal to TP4 GND.

5.2.2 **Meter**
Connect ‘COM’ terminal of ampere meter to TP2 VIN. Double check ‘A’ terminal is connected to the power supply’s positive terminal.

Voltage meter is used to measure output voltage. Connect positive terminal (V) of the voltage meter to TP1 VOUT and negative terminal (COM) of the voltage meter to TP3 GND.

5.2.3 **Load**
Connect electronic load’s positive terminal (+) to TP1 VOUT and negative terminal (-) to TP3 GND.

5.3 **Quick Test Procedure**

5.3.1 **Startup**
- Set load current to 0 A and turn the load on
- Set power supply current limit to 25 A
- Turn on the power supply and increase voltage slowly up to 20 V
- Increase load current slowly up to 7 A

5.3.2 **Shutdown**
- Turn off the load
- Decrease the input voltage down to 0 V
- Turn on the load and discharge output capacitor

6 **Performance Curves**

The following curves are presented for reference, the actual field data may differ from these curves. Actual performance data can be affected by measurement techniques, equipment setting and environmental variables.

6.1 **Efficiency**

![Efficiency Graph](image-url)

**Figure 2. Efficiency**
6.2 Load Transient

\[ V_{\text{SUPPLY}} = 12 \text{ V}, \text{ 3.5 A to 7 A and 7 A to 3.5 A load transient} \]

C1: \( V_{\text{OUT}} \)

Figure 3. Load Transient

6.3 Interleaving

\[ V_{\text{SUPPLY}} = 12 \text{ V} \]

C1: SW1, C2: SW2

Figure 4. Interleaving
6.4 Light Load Operations

Forced PWM (FPWM) and Skip Cycle mode can be configured by controlling MODE pin voltage.

\[ V_{\text{SUPPLY}} = 12 \, \text{V}, \, I_{\text{LOAD}} = 0 \, \text{A} \]

C1: SW1

---

**Figure 5. Pulse Skip**

C1: SW1

**Figure 6. Skip Cycle**

C1: SW1

**Figure 7. Forced PWM**
6.5  Startup

\[ V_{\text{SUPPLY}} = 12 \text{ V, } I_{\text{LOAD}} = 0 \text{ A} \]

C1: \( V_{\text{OUT}} \), C2: SS, C4: \( V_{\text{SUPPLY}} \)

![Figure 8. Startup](image)

6.6  Loop Response

![Figure 9. Loop Response](image)
Figure 10. Schematic (Power Block)
Figure 11. Schematic (Control Block)
8 Layout

The LM5122 2-phase EVM has been designed using a 4-layer board. Most of components are on the top to allow the user to easily view, probe, and evaluate the LM5122 device.

Figure 12. Top Silk (Top View)

Figure 13. Bottom Silk (X-Ray View)
Figure 14. Top Copper (Top View)

Figure 15. Mid1 Copper (X-Ray View)
Figure 16. Mid2 Copper (X-Ray View)

Figure 17. Bottom Copper (X-Ray View)
# Bill of Materials

The EVM components are listed according to the schematic shown in Figure 10 and Figure 11.

## Table 3. Bill of Materials

<table>
<thead>
<tr>
<th>REFERENCE DESIGNATOR</th>
<th>DESCRIPTION</th>
<th>MANUFACTURER</th>
<th>PART NUMBER</th>
<th>QTY</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1, C13</td>
<td>CAP, CER, 470 pF, 100 V, +/-5%, C0G, 0805</td>
<td>MURATA</td>
<td>GRM2165C2A471JA01D</td>
<td>2</td>
</tr>
<tr>
<td>C2, C3, C12, C14, C15</td>
<td>CAP CER 3.3 uF 50 V 10% X7R 1206</td>
<td>TDK</td>
<td>C3216X7R1H335K160AC</td>
<td>5</td>
</tr>
<tr>
<td>C4, C5, C6, C16, C17, C18</td>
<td>CAP CER 10 uF 35 V 10% X7R 1206</td>
<td>Taiyo Yuden</td>
<td>GMK316AB7106KL</td>
<td>6</td>
</tr>
<tr>
<td>C7</td>
<td>CAP, CER, 1 uF, 50 V, +/-10%, X7R, 0805</td>
<td>MURATA</td>
<td>GRM218R71H051KA12L</td>
<td>1</td>
</tr>
<tr>
<td>C8, C9, C10, C11</td>
<td>CAP ALUM 330 uF 35 V 20% SMD</td>
<td>Panasonic</td>
<td>EEE-FP1V331AP</td>
<td>4</td>
</tr>
<tr>
<td>C19, C20, C29</td>
<td>CAP, CER, 0.1 uF, 25 V, +/-10%, X7R, 0603</td>
<td>MURATA</td>
<td>GRM188R71E041KA01D</td>
<td>3</td>
</tr>
<tr>
<td>C21, C22, C25, C26</td>
<td>CAP, CER, 100 pF, 50 V, +/-5%, C0G/NP0, 0603</td>
<td>MURATA</td>
<td>GRM1885C1H011KA01D</td>
<td>4</td>
</tr>
<tr>
<td>C23, C24</td>
<td>CAP, CER, 4.7 uF, 16 V, +/-10%, X7R, 0805</td>
<td>MURATA</td>
<td>GRM218R71C475KA73L</td>
<td>2</td>
</tr>
<tr>
<td>C27, C28, C30</td>
<td>CAP, CER, 0.47 uF, 25 V, +/-10%, X7R, 0603</td>
<td>MURATA</td>
<td>GRM188R71E474KA12D</td>
<td>3</td>
</tr>
<tr>
<td>C31</td>
<td>CAP, CER, 330 pF, 50 V, +/-10%, X7R, 0603</td>
<td>KEMET</td>
<td>C0603C331K5RACTU</td>
<td>1</td>
</tr>
<tr>
<td>C32</td>
<td>CAP, CER, 0.022 uF, 50 V, +/-10%, X7R, 0603</td>
<td>KEMET</td>
<td>C0603C223K5RACTU</td>
<td>1</td>
</tr>
<tr>
<td>R1, R7</td>
<td>RES 8.2 Ω 3/4W 5% 2010 SMD</td>
<td>Vishay</td>
<td>CRCW20108R20JNEF</td>
<td>2</td>
</tr>
<tr>
<td>R2, R8</td>
<td>RES, 0.004 Ω, 3 W, 1%, 3015, WIDE</td>
<td>Susumu</td>
<td>KRL7638-C-R004-F-T1</td>
<td>2</td>
</tr>
<tr>
<td>R3, R4, R9, R10</td>
<td>RES, 100 Ω, 1%, 0.1 W, 0603</td>
<td>Vishay</td>
<td>CRCW0603100RFKEA</td>
<td>4</td>
</tr>
<tr>
<td>R5, R6, R11, R12, R15, R16, R26, R28, R35, R36</td>
<td>RES, 0 Ω, 5%, 0.1 W, 0603</td>
<td>Panasonic</td>
<td>ERJ-3GEY900V</td>
<td>10</td>
</tr>
<tr>
<td>R19, R33</td>
<td>RES, 49.9k Ω, 1%, 0.1 W, 0603</td>
<td>Vishay</td>
<td>CRCW060349K9FKEA</td>
<td>2</td>
</tr>
<tr>
<td>R20, R21</td>
<td>RES, 3.3 Ω, 5%, 0.1 W, 0603</td>
<td>Vishay</td>
<td>CRCW060339J30JNEA</td>
<td>2</td>
</tr>
<tr>
<td>R24</td>
<td>RES, 8.06k Ω, 1%, 0.1 W, 0603</td>
<td>Vishay</td>
<td>CRCW06038K06FKEA</td>
<td>1</td>
</tr>
<tr>
<td>R25, R27</td>
<td>RES, 78.7k Ω, 1%, 0.1 W, 0603</td>
<td>Vishay</td>
<td>CRCW060378K7FKEA</td>
<td>2</td>
</tr>
<tr>
<td>R29</td>
<td>RES, 36.5k Ω, 1%, 0.1 W, 0603</td>
<td>Vishay</td>
<td>CRCW060336K5FKEA</td>
<td>1</td>
</tr>
<tr>
<td>R31</td>
<td>RES, 59.0k Ω, 1%, 0.1 W, 0603</td>
<td>Vishay</td>
<td>CRCW060359K0FKEA</td>
<td>1</td>
</tr>
<tr>
<td>R32</td>
<td>RES, 2.26k Ω, 1%, 0.1 W, 0603</td>
<td>Vishay</td>
<td>CRCW06032K26FKEA</td>
<td>1</td>
</tr>
<tr>
<td>R34</td>
<td>RES, 576 Ω, 1%, 0.125 W, 0805</td>
<td>Vishay</td>
<td>CRCW0805576RFKEA</td>
<td>1</td>
</tr>
<tr>
<td>D1, D2</td>
<td>Diode, Schottky, 60 V, 1 A, SOD-123F</td>
<td>NXP</td>
<td>PMEG6010CEH</td>
<td>2</td>
</tr>
<tr>
<td>Q1, Q2, Q3, Q4</td>
<td>MOSFET N-CH 40 V 100 A LFPAK</td>
<td>Texas Instruments</td>
<td>CSD18501Q5A</td>
<td>ALT</td>
</tr>
<tr>
<td>H1, H2, H5, H8</td>
<td>Machine Screw, Round, #4-40 Nylon</td>
<td>B&amp;F</td>
<td>NYP M4 0025 PH</td>
<td>4</td>
</tr>
<tr>
<td>J1</td>
<td>Header, TH, 100mil, 2x1, Gold plated</td>
<td>SAMTEC</td>
<td>TSW-102-07-G-S</td>
<td>1</td>
</tr>
<tr>
<td>U1, U2</td>
<td>Synchronous Boost Controller</td>
<td>Texas Instruments</td>
<td>LM5122MH</td>
<td>2</td>
</tr>
</tbody>
</table>
IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as “components”) are sold subject to TI’s terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its components to the specifications applicable at the time of sale, in accordance with the warranty in TI’s terms and conditions of sale of semiconductor products. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by applicable law, testing of all parameters of each component is not necessarily performed.

TI assumes no liability for applications assistance or the design of Buyers’ products. Buyers are responsible for their products and applications using TI components. To minimize the risks associated with Buyers’ products and applications, Buyers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of significant portions of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI components or services with statements different from or beyond the parameters stated by TI for that component or service voids all express and any implied warranties for the associated TI component or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in safety-critical applications.

In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI’s goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or “enhanced plastic” are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have not been so designated is solely at the Buyer’s risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

Products

- Audio: www.ti.com/audio
- Amplifiers: amplifier.ti.com
- Data Converters: dataconverter.ti.com
- DLP® Products: www.dlp.com
- DSP: dsp.ti.com
- Clocks and Timers: www.ti.com/clocks
- Interface: interface.ti.com
- Logic: logic.ti.com
- Power Mgmt: power.ti.com
- Microcontrollers: microcontroller.ti.com
- RFID: www.ti-rfid.com
- OMAP Applications Processors: www.ti.com/omap
- Wireless Connectivity: www.ti.com/wirelessconnectivity

Applications

- Automotive and Transportation: www.ti.com/automotive
- Communications and Telecom: www.ti.com/communications
- Computers and Peripherals: www.ti.com/computers
- Consumer Electronics: www.ti.com/consumer-electronics
- Industrial: www.ti.com/industrial
- Medical: www.ti.com/medical
- Energy and Lighting: www.ti.com/energy
- Security: www.ti.com/security
- Space, Avionics and Defense: www.ti.com/space-avionics-defense
- Video and Imaging: www.ti.com/video
- TI E2E Community: e2e.ti.com

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265

Copyright © 2013, Texas Instruments Incorporated