NCP45491IMNGEVB

NCP45491 Evaluation Board User's Manual

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EVAL BOARD USER'S MANUAL

Introduction

This user's manual provides detailed information regarding the configuration and use of the NCP45491IMNGEVB Evaluation board. The evaluation board serves as a demonstration of NCP45491 general functionality for single chip mode featuring power monitoring of 4 channels. The evaluation board also provides a means of quick prototyping for specific applications.

Features

- NCP45491
- Connectors for 4 High Current Supplies and Loads
- Configuration Options for Shunt Current and Gain Settings
- Appropriate Test Loops for Easy Evaluations

QUICK START

Recommended Equipment

Before beginning, the following equipment is needed:

- 4 DC Power Supplies (2 capable of at least 7 V, 2 capable of at least 13 V to support current evaluation board setup)
- 4 DC Loads (up to at least 2 A)
- Function Generator
- Oscilloscope
- Digital Multi−meter
- SMA to BNC Cables Recommended for Connection to DIFF_OUTN, DIFF_OUTP, and MUX_SEL

Board Setup

The assembled evaluation board targets Bus Voltages and Shunt Currents shown in Tables 1 and 2. VBUS1 ties to both channel 1 and channel 3 bus voltage inputs. VBUS2 ties to both channel 2 and channel 4 bus voltage inputs. Refer to the schematic and layout diagrams found in Appendix A and Appendix B respectively as needed.

Table 1. BUS VOLTAGE SETUP

Channel	Target Bus Voltage	Bus Divider
1 (VBUS1)	12 V	1/60 V/V
2 (VBUS2)	6 V	1/30 V/V
3 (VBUS1)	12 V	1/60 V/V
4 (VBUS2)	6 V	1/30 V/V

Table 2. SHUNT CURRENT SETUP

Channel	Shunt Current	Shunt Gain
Load 1	0.5 A	400 mV/A
Load 2	5 A	40 mV/A
Load 3	0.5 A	400 mV/A
Load 4	5 A	40 mV/A

The specific resistor configuration populated on the board facilitate these gain settings. The nominal differential amplifier gain is 2 V/V. Therefore, the expected differential output for any channels voltage or current can be calculated as follows:

- For Bus Voltage:

$$\text{Diff Output} = \text{Bus Voltage} \cdot \frac{R4}{R4 + R3} \cdot 2 \qquad \text{(eq. 1)}$$

- For Load Current:

  Diff Output = Load Current * Channel Shunt Gain * 2

$$\text{Diff Output} = I_{Load} \cdot \frac{R2 + R_{sense}}{R1} \cdot 2 \qquad \text{(eq. 2)}$$

These gain settings can be adjusted by changing the bus divider resistors, and the shunt current network resistors as desired.

Board Connections & Jumper Settings

The following board to bench equipment connections are required for demonstration of 4 channel power monitoring. Make all board connections with supplies and loads disabled. Take adequate precautions when working with high current and high voltage applications. Table 3 below defines all default board connections and their purpose.

Table 3. EVALUATION BOARD DEFAULT CONNECTIONS

Connection	Connect To…	Purpose
VBUS1 (banana)	12 V supply	Provides channel 1 and channel 3 bus voltages
VBUS2 (banana)	6 V supply	Provides channel 2 and channel 4 bus voltages
LOAD1 & GND (banana)	0.5 A load current (24 Ω 1W resistor)	Provides channel 1 load current
LOAD2 & GND (banana)	2 A load current (3 Ω 12 W resistor)	Provides channel 2 load current
LOAD3 & GND (banana)	0.5 A load (24 Ω 1W resistor)	Provides channel 3
LOAD4 & GND (banana)	2 A load current (3 Ω 12 W resistor)	Provides channel 4 load current
VCC & GND	3.3 V	Provides NCP45491 supply
MUX_SEL (sma)	3.3 V to 0 V signal generator	Channel mux select input
EN (sma/header)	3.3 V to 0 V signal generator or tied to GND	NCP45491 enable input. Active low
DIFF_OUT_P (sma)	Oscilloscope	Differential output (positive)
DIFF_OUT_N (sma)	Oscilloscope	Differential output (negative)

NOTES:
1. All connections to the board have an accompanying ground connection. Use all ground connections with the evaluation board being the center of a star ground to avoid ground loops.
2. Connect to DIFF_OUT* signals with either 2 SMA to BNC cables to an oscilloscope (where the subtraction of the 2 signals give the differential voltage), or connect to the DIFF_OUT* test loops with a twisted pair or differential probe. Connecting in this manner will mitigate noise via EMI.
3. SH_INx inputs need to be driven to a voltage between VCC and 26 V, even for unused channels. Jumpers 1, 2, 5, and 8 provide a means to connect unused channels to VCC. If a channel is not in use, the jumper should be switched to the VCC position and the SH_Ox jumper should be removed to float the SH_Ox pin.

Table 4 below defines all default jumper connections and their purpose.

Table 4. DEFAULT JUMPER DEFINITION

Jumper	Default Setting	Function
J1	Shorted [1,2]	Connects channel 1 bus voltage. [2,3] connection sets bus voltage to 3.3 V
J2	Shorted [1,2]	Connects channel 1 bus voltage. [2,3] connection sets bus voltage to 3.3 V
J5	Shorted [1,2]	Connects channel 1 bus voltage. [2,3] connection sets bus voltage to 3.3 V
J8	Shorted [1,2]	Connects channel 1 bus voltage. [2,3] connection sets bus voltage to 3.3 V
J3	Shorted	SH_O2
J4	Shorted	SH_O1
J6	Shorted	SH_O3
J7	Shorted	SH_O4
J20	Shorted [1,2]	SKIP input connection
J21	Open	MODE_SEL input connection
J10	Open	SMD jumper that can be shorted to tie EN to GND

Testing Procedure

The NCP45491IMNGEVB comes fully assembled and tested. Follow the steps below to verify board operation. Refer to the schematic and layout diagrams found in Appendix A and Appendix B respectively as needed.

1. Apply power to VBUS inputs (6 V and 12 V supply).
2. Apply load currents for all channels.
3. Apply 3.3 V VCC power.
4. Apply MUX_SEL signal. (Square wave 50% duty cycle, 100 kHz or faster, VCC to 0 V)
   a. 8 cycles will read out voltage and current data for all 4 channels.
   b. Continuous cycles on MUX_SEL will read out bus voltage and current data continuously, repeating channels 1−4.
5. Observe the following:
   a. 1.3 V on BG_REF_OUT
   b. 650 mV on CM_REF_IN
   c. 170 mV on BS_REF
   d. Bus voltages and currents represented on DIFF_OUTP and DIFF_OUTN with oscilloscope.

PCB Layout

Care must be taken in PCB layout regarding a few specific nodes for proper operation of the NCP45491. Connections to the external sense resistor for each channel must be treated as a 4 wire Kelvin connection. The SH_IN_Nx and the SH_IN_Px (connected through R1) must connect directly to the sense resistor leads for each respective channel. These should also be large traces to avoid error in the shunt current measurement. See Appendix C for the example layout of the evaluation board.

APPENDIX A – EVALUATION BOARD SCHEMATIC

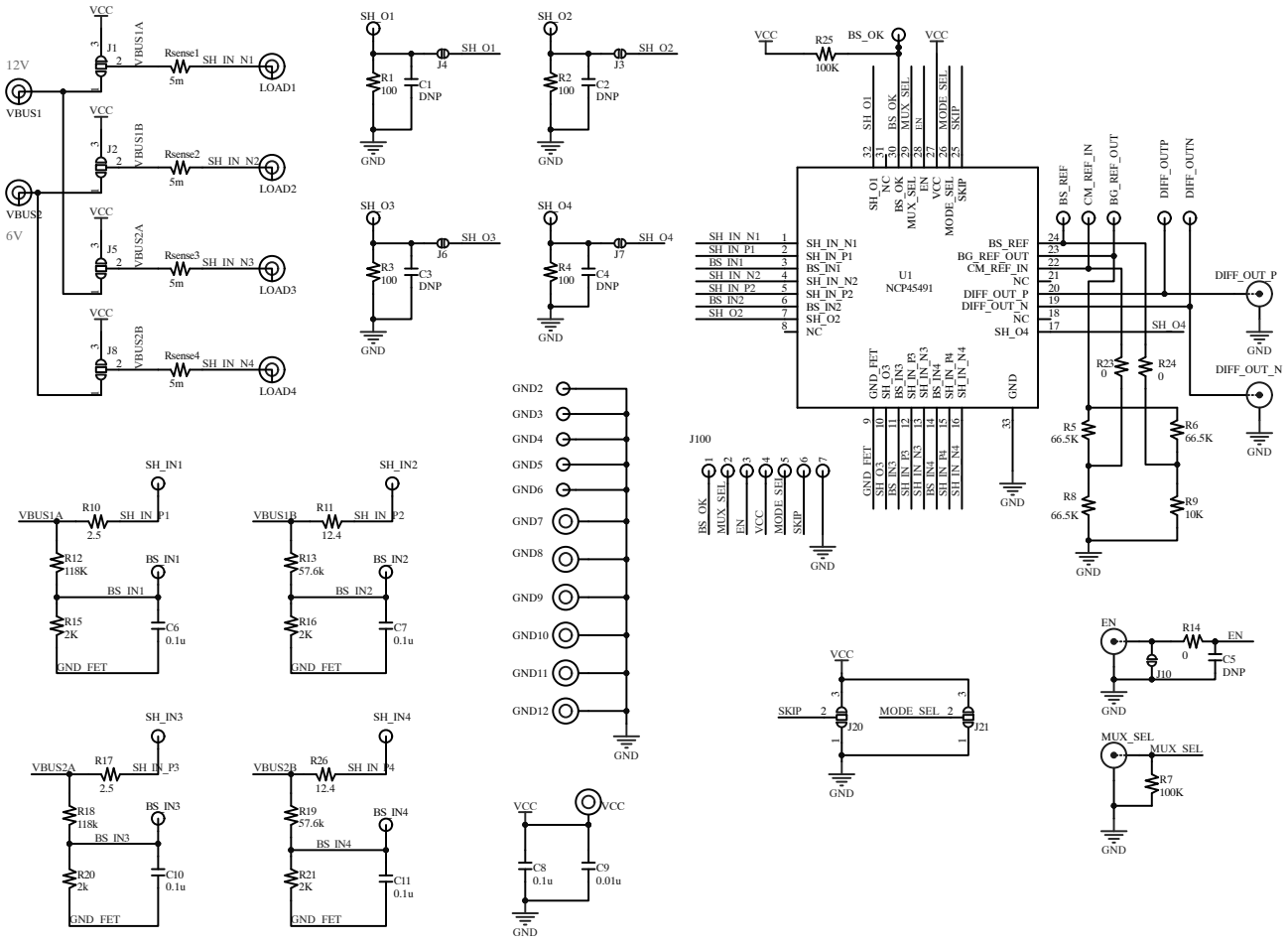

Figure 1. NCP45491 Evaluation Board Schematic

APPENDIX B – BILL OF MATERIALS

Table 5. BILL OF MATERIALS

Designator	Footprint	Value	Quantity	Digikey P/N
BG_REF_OUT, BS_IN1, BS_IN2, BS_IN3, BS_IN4, BS_OK, BS_REF, CM_REF_IN, DIFF_OUTN, DIFF_OUTP, GND2, GND3, GND4, GND5, GND6, SH_IN1, SH_IN2, SH_IN3, SH_IN4, SH_O1, SH_O2, SH_O3, SH_O4	Test_Point	Test loop	23	36−5009−ND
C1, C2, C3, C4, C5	SMD_0805	No placement	5	N/A
C6, C7, C8, C10, C11	SMD_0805	0.1 μF	5	490−8049−1−ND
C9	SMD_0805	0.01 μF	1	1276−1015−2−ND
DIFF_OUT_N, DIFF_OUT_P, EN, MUX_SEL	SMB_V−RJ45	SMB/SMA Strai	4	WM5543−ND
GND7, GND8, GND9, GND10, GND11, GND12, LOAD1, LOAD2, LOAD3, LOAD4, VBUS1, VBUS2, VCC	Bannana_Connec	Banana Con	13	J587−ND
J1, J2, J5, J8, J20, J21	10th″ header	3 pins	6	732−5316−ND
J3, J4, J6, J7, J10, J100	10th″ header	10″ header	6	732−5315−ND
R12, R18	SMD_1206	118 kΩ	2	P118KFCT−ND
R15, R20, R16, R21	SMD_1206	2 kΩ	4	P2.0KBCCT−ND
Rsense1, Rsense2, Rsense3, Rsense4	SMD_1206	5 mΩ	4	RHM.005ALCT−ND
R1, R2, R3, R4	SMD_1206	100 Ω	4	P100BCCT−ND
R5, R6, R8	SMD_1206	66.5 kΩ	3	311−66.5KFRCT−ND
R9	SMD_1206	10 kΩ	1	RNCP1206FTD10K0CT−ND
R14, R23, R24	SMD_1206	0 Ω	3	HCJ1206ZT0R00CT−ND
R7, R25	SMD_1206	100 kΩ	2	RHM100KICT−ND
R13, R19	SMD_1206	57.6 kΩ	2	P57.6KAACT−ND
R11, R26	SMD_1206	12.4 Ω	2	311−12/4FRCT−ND
R10, R17	SMD_1206	2.5 Ω	2	541−2.49UCT−ND
U1	NCP45491	N/A	1	NCP45491

APPENDIX C – NCP45491 EVALUATION BOARD LAYOUT

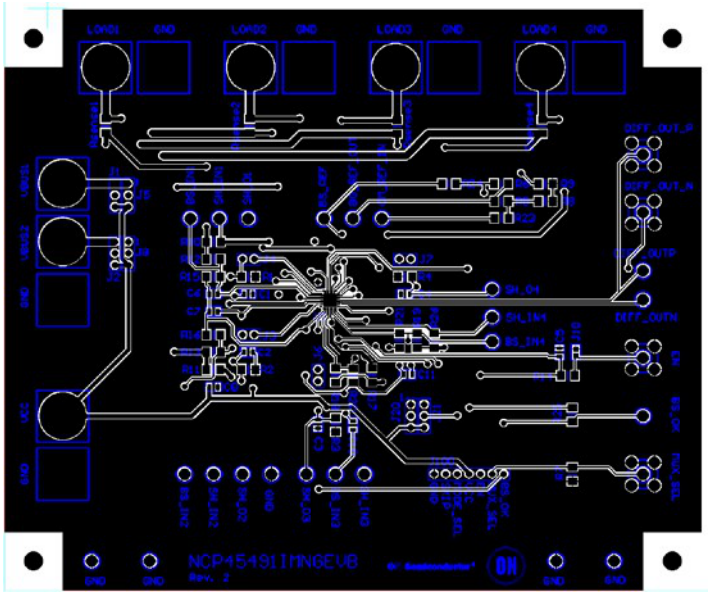

Figure 2. PCB Front (Top Metallization)

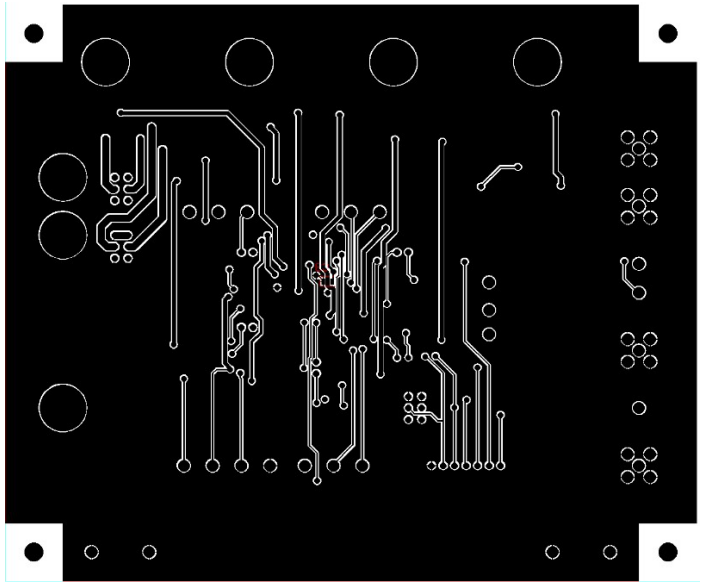

Figure 3. PCB Backside (Bottom Metallization)

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