

# FUSB15201DV Dual-Port Source USB Type-C PD Controller Evaluation Board User's Manual

## EVBUM2810/D

### Introduction

The FUSB15201DV evaluation board, in conjunction with firmware and software, provides a platform to evaluate a full dual-port Type-C/PD system. The FUSB15201DV integrates an ARM<sup>®</sup> Cortex-M0+ processor with customized peripherals and supports a fully standalone application with only a power supply.

### Description

The FUSB15201DV Evaluation kit is designed to support the full features of dual-port Type-C/PD Source applications for FUSB15201DV or FUSB15201P with a single battery (typ 13.5 V) or power supply, primarily targeting automotive charger applications.

The Evaluation kit is designed to control two individual VBUS outputs from the NCV81599, a buck/boost DC-DC power converter. All components are AEC qualified.

This manual provides information about the evaluation board's interconnection, hardware setting, communication to PC, and detailed information of the board design data.

### Key EVB Features

- 120 W, Configurable up to 200 W
- > 94% Efficiency
- Solution Size: 1.7" x 1.9" (20.8cm<sup>2</sup>) / 1.7" x 1.5" (16.5 cm<sup>2</sup>) Active Area
- Power Density: 5.77 W/cm<sup>2</sup> or 7.27 W/cm<sup>2</sup>
- Highest Board Temperature: 98.061°C at 22°C Ambient at Full Load
- VBUS Output Current Sense
- VBAT Reverse Current Protection

### FUSB15201DV Features

- ARM Cortex-M0+ Processor
- 132 KB Flash Memory / 6 KB SRAM
- Integrated VCONN Switch for E-Marked Cables
- Supports Low Power Mode (Idle/ Sleep)
- BC1.2 (SDP, DCP, CDP)/ Apple Divider Mode
- 10 bit ADC for Voltage and General Purpose
- Over Voltage / Over Temperature Protection
- I2C Master/Slave
- SWD Interface for Debugging
- Temperature Sensing using NTC

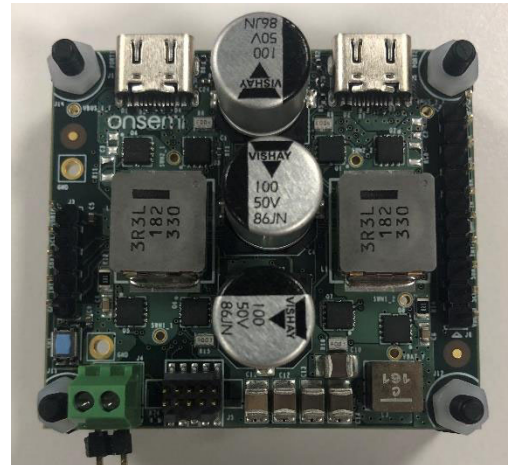


Figure 1. FUSB15201DV Evaluation Board

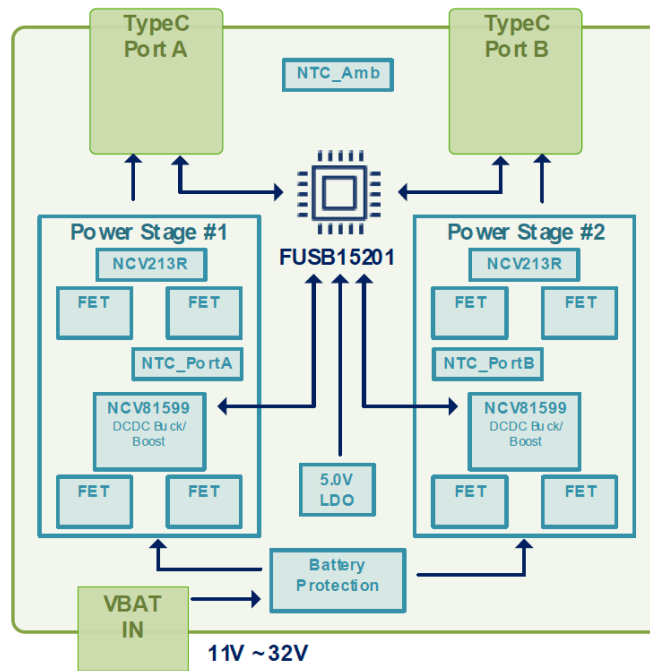


Figure 2. Concept

This Evaluation board is designed to provide a ready-to-use solution for a dual-port Type-C/PD Charging port application. All components are appropriately selected from automotive qualified devices and capable of operating up to 125°C.

## DETAILED DESCRIPTION OF EACH BLOCK

### Power Stage

All power components are selected to drive output power up to 100 W per port (20 V / 5 A) if thermal performance is under control. Due to the limited PCB size and the space between each heat dissipating component, the initial firmware will provide support for up to 60 W per port (120 W = 2 x 60 W) under control of the hottest board spot to lower than 100°C.

In case higher output power is desired, it is recommended to perform re-sizing of the PCB design with thicker copper planes (>2 oz) for the top and bottom layers and to maintain

enough space between heat dissipating components (FET switches). This board is designed to fit into an application that has limited space, reflecting customer demand for charging ports in automotive cabin areas.

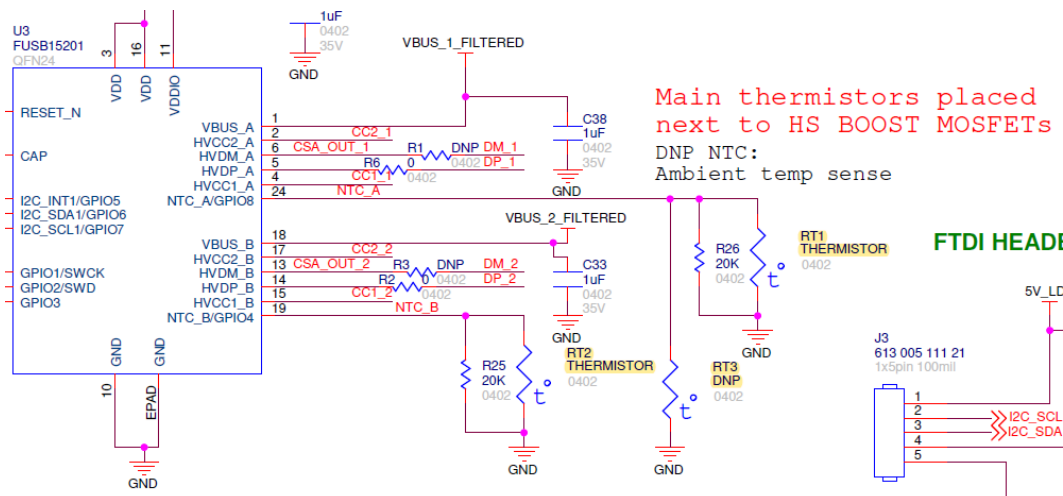
### DC-DC Converter

NCV81599 is used as DC to DC converter controller with NVTFS5C460NL and NVTFS5C471NL for FET switches for Buck and Boost mode respectively. Power Inductor (3.3 µH, ETQP6M3R3YLC) is selected for driving output current up to 5.0 A.

In the Unattached state, FUSB15201DV controls EN\_1/EN\_2 to logic Low which maintains the NCV81599 power-off state for minimizing power consumption. In this state, NCV81599 has no I2C register accessibility. All register values in NCV81599 will reset upon EN\_x returning to logic High.

Each NCV81599 ADDR pin is set to a different I2C slave address.

## Temperature Sensing



**Figure 3.**

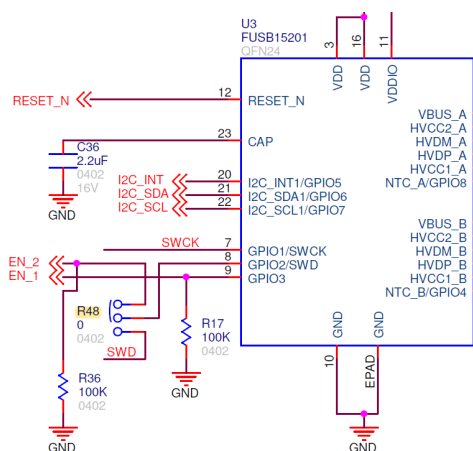
NTCs (RT1/ RT2) are initially populated nearby the area where the hi-side boost mode FETs (Q1 and Q3) are located. Temperature-read data from these spots indicate the hottest temperatures on the entire board area.

If ambient temperature is a higher concern than the FET switch, depopulate RT1 and RT2 and populate RT3 (not populated by default). RT3 is placed at the center between the two Type-C ports, and the temperature reading value will indicate ambient board temperature between these two Type-C ports.

## Output VBUS Current Sense

Current sense amplifiers (NCV213R) with 3 mΩ sense resistors are in the circuit for filtered VBUS current measurement. The amplified voltage (x50) goes to CSA\_OUT\_1/2 for ADC reading. (3m x 5.0 A x 50 = 750 mV @ 5.0 A loading)

## J-Link Interconnect



**Figure 4.**

GPIO2/SWD is being shared between EN\_2, which enables NCV81599, and SWD for J-Link debug or download. A 3-pad 0  $\Omega$  option (R48) sets the connection to EN\_2 by default, so FUSB15201DV can enable or disable NCV81599. When it is desired to connect to the SWD interface using J-Link, move the 0  $\Omega$  connection to SWD, then return the connection to EN\_2 when the firmware download is complete.

Firmware enables use of SWD for connection to a J-Link debugger if R48 is configured to SWD. Note that if a sink is attached to Port 2, firmware will disable SWD.

### Input/Output Voltage Measurement

VBAT\_F, VBUS\_1\_F and VBUS\_2\_F are routed at the point of source/load as sensing input/output voltage. These can be used for accurate voltage measurement with minimum impact of voltage change by trace impedance, which can be used for efficiency measurements.

## Legacy BC1.2 Charging Port Support

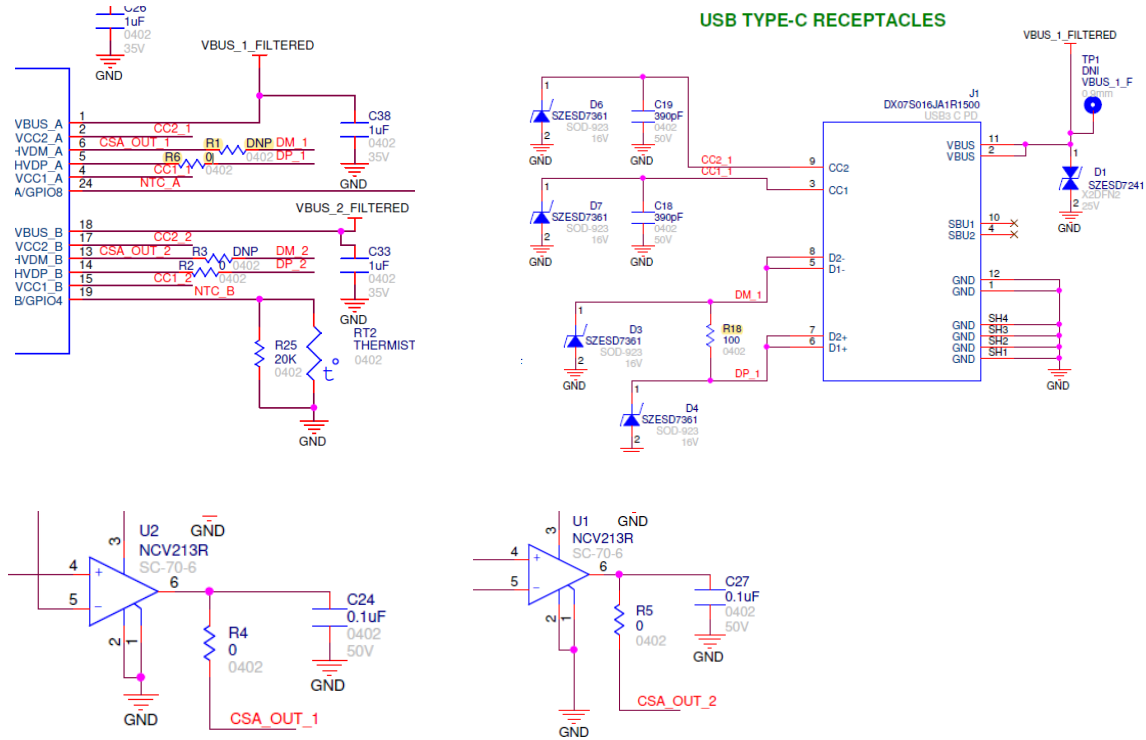


Figure 5.

FUSB15201DV is capable of supporting legacy charging port (Battery Charging 1.2 and voltage divider mode) through a built-in voltage/resistor divider.

The built-in circuit uses HVDP/DM pins for mimicking a legacy charging port. This evaluation board uses the HVDP pin for moisture sensing and the HVDM pin for CSA (Current Sense Amplifier) monitoring by default. An external 0  $\Omega$  resistor is placed between HVDP and HVDM for DCP (Dedicated Charging Port) configuration.

- Configuration for DCP with Moisture sensing on HVDP and CSA monitor on HVDM (Default):

- ♦ R1 (PortA) & R3 (PortB): Not Populated
- ♦ R18 (PortA) & R7 (PortB): 100  $\Omega$  (~200  $\Omega$ )
- ♦ R4 (PortA) & R5 (PortB): 0  $\Omega$
- Configuration for BC1.2 charging port (CDP/DCP) or voltage divider mode:
  - ♦ R1 (PortA) & R3 (PortB): 0  $\Omega$
  - ♦ R18 (PortA) & R7 (PortB): Not populated.
  - ♦ R4 (PortA) & R5 (PortB): Not populated.

CC/ VBUS Plot upon Accessory Plug-in

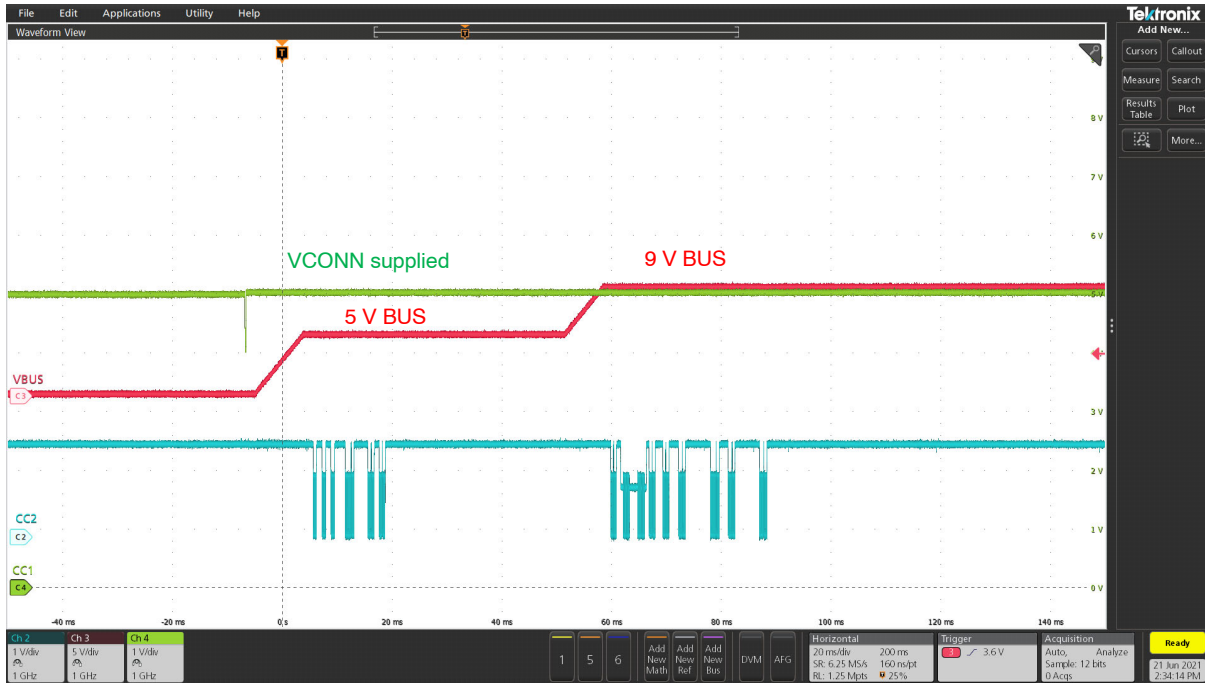


Figure 6. Sink Request 9 V PDO, CC = CC2, VCONN = CC1

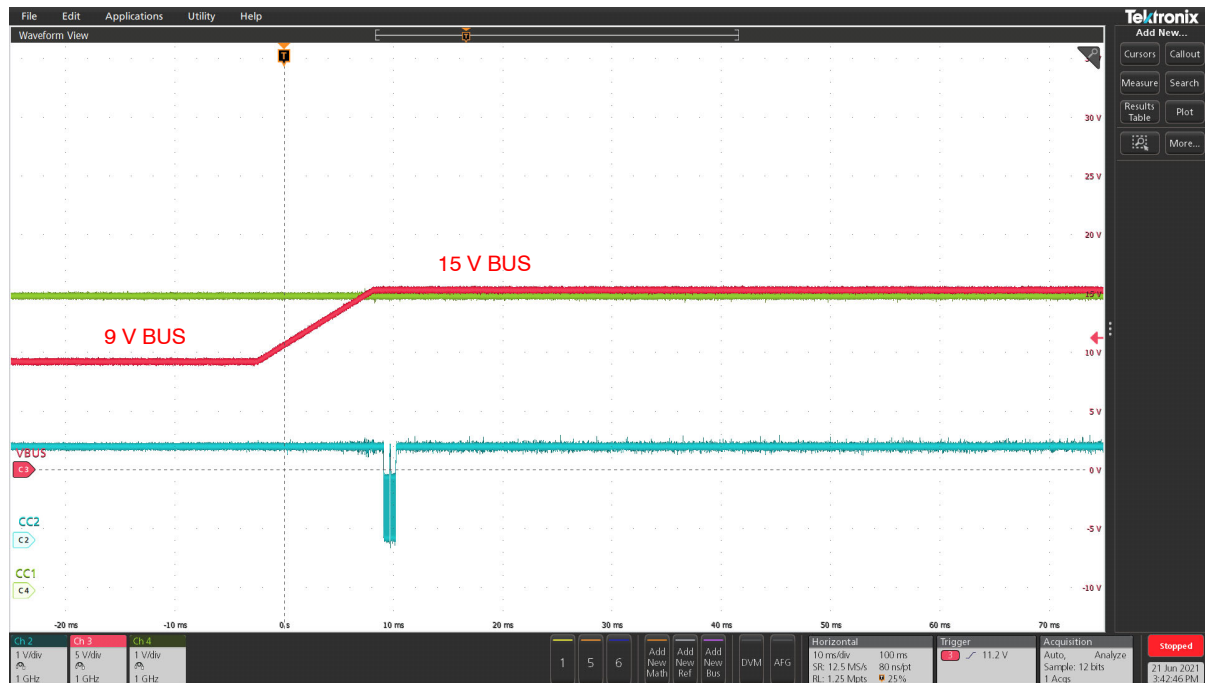


Figure 7. Sink Request 15 V PDO, CC = CC2, VCONN = CC1

# EVBUM2810/D



Figure 8. Sink Request 20 V PDO, CC = CC2, VCONN = CC1

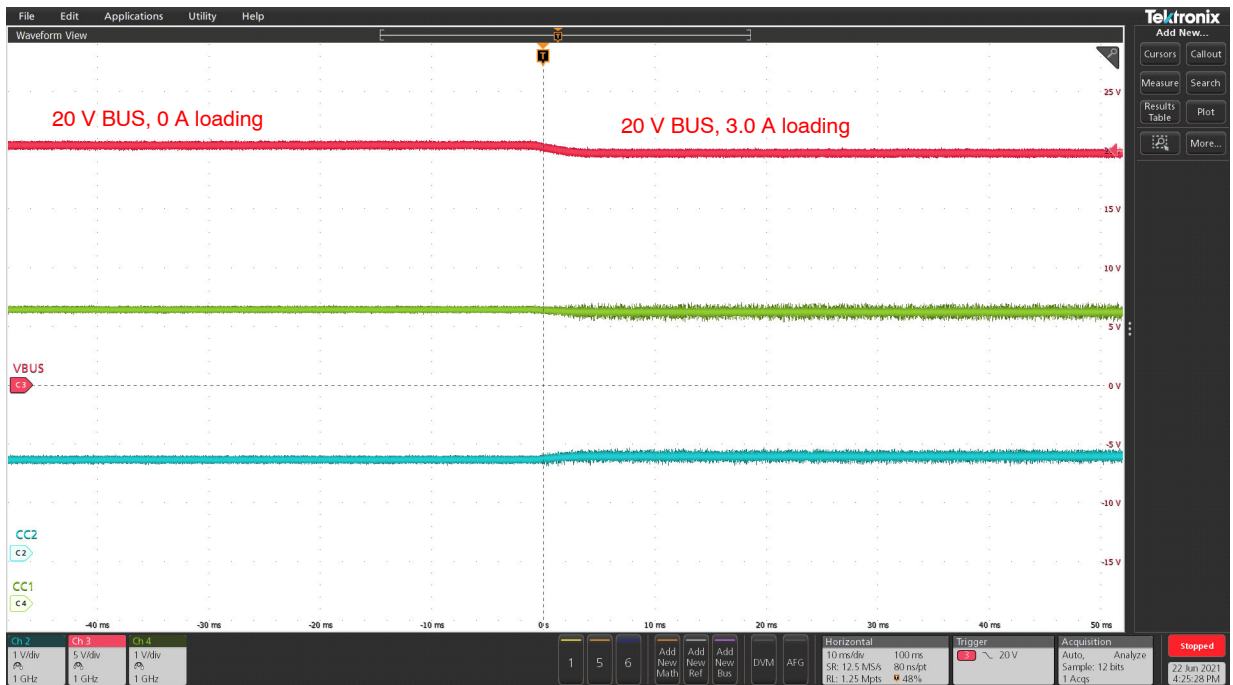


Figure 9. Loading 0 A to 3.0 A @ VBUS = 20 V

## onsemi DEVICE LINKS

Device	Description
<a href="#">SZESD7241</a>	ESD Protection Diode Ultra Low Capacitance
<a href="#">SZESD7361</a>	ESD Protection Diode
<a href="#">SZMM3Z18VT1G</a>	Generic SOD-323 Zener Diode
<a href="#">NVTFS5C471NL</a>	Generic u8FL DFN-5 N-Channel Power MOSFET
<a href="#">NVTFS5C460NL</a>	Generic u8FL DFN-5 N-Channel Power MOSFET
<a href="#">NVMFS5A140PLZ</a>	Generic SO8-FL DFN-5 P-Channel Power MOSFET
<a href="#">NCV213R</a>	Current-Shunt Monitor, Voltage Output, Bi-Directional Zero-Drift, Gain = 50V/V
<a href="#">FUSB15201DV</a>	Dual Port USB Type-C & PD Controller
<a href="#">NCV81599</a>	4 Switch Buck-Boost
<a href="#">NCV8730BMTW500</a>	LDO Regulator, 150 mA, 38 V max input, 1 A IQ, with PG Automotive

## Other References

FUSB15201DV Flash Programming Guide [UM70093/D].

FUSB15201DV Software Programming Guide [UM70092/D].



**onsemi**, **onsemi**, and other names, marks, and brands are registered and/or common law trademarks of Semiconductor Components Industries, LLC dba "**onsemi**" or its affiliates and/or subsidiaries in the United States and/or other countries. **onsemi** owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of **onsemi**'s product/patent coverage may be accessed at [www.onsemi.com/site/pdf/Patent-Marking.pdf](http://www.onsemi.com/site/pdf/Patent-Marking.pdf). **onsemi** is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner.

The evaluation board/kit (research and development board/kit) (hereinafter the "board") is not a finished product and is not available for sale to consumers. The board is only intended for research, development, demonstration and evaluation purposes and will only be used in laboratory/development areas by persons with an engineering/technical training and familiar with the risks associated with handling electrical/mechanical components, systems and subsystems. This person assumes full responsibility/liability for proper and safe handling. Any other use, resale or redistribution for any other purpose is strictly prohibited.

**THE BOARD IS PROVIDED BY ONSEMI TO YOU "AS IS" AND WITHOUT ANY REPRESENTATIONS OR WARRANTIES WHATSOEVER. WITHOUT LIMITING THE FOREGOING, ONSEMI (AND ITS LICENSORS/SUPPLIERS) HEREBY DISCLAIMS ANY AND ALL REPRESENTATIONS AND WARRANTIES IN RELATION TO THE BOARD, ANY MODIFICATIONS, OR THIS AGREEMENT, WHETHER EXPRESS, IMPLIED, STATUTORY OR OTHERWISE, INCLUDING WITHOUT LIMITATION ANY AND ALL REPRESENTATIONS AND WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, TITLE, NON-INFRINGEMENT, AND THOSE ARISING FROM A COURSE OF DEALING, TRADE USAGE, TRADE CUSTOM OR TRADE PRACTICE.**

**onsemi** reserves the right to make changes without further notice to any board.

You are responsible for determining whether the board will be suitable for your intended use or application or will achieve your intended results. Prior to using or distributing any systems that have been evaluated, designed or tested using the board, you agree to test and validate your design to confirm the functionality for your application. Any technical, applications or design information or advice, quality characterization, reliability data or other services provided by **onsemi** shall not constitute any representation or warranty by **onsemi**, and no additional obligations or liabilities shall arise from **onsemi** having provided such information or services.

**onsemi** products including the boards are not designed, intended, or authorized for use in life support systems, or any FDA Class 3 medical devices or medical devices with a similar or equivalent classification in a foreign jurisdiction, or any devices intended for implantation in the human body. You agree to indemnify, defend and hold harmless **onsemi**, its directors, officers, employees, representatives, agents, subsidiaries, affiliates, distributors, and assigns, against any and all liabilities, losses, costs, damages, judgments, and expenses, arising out of any claim, demand, investigation, lawsuit, regulatory action or cause of action arising out of or associated with any unauthorized use, even if such claim alleges that **onsemi** was negligent regarding the design or manufacture of any products and/or the board.

This evaluation board/kit does not fall within the scope of the European Union directives regarding electromagnetic compatibility, restricted substances (RoHS), recycling (WEEE), FCC, CE or UL, and may not meet the technical requirements of these or other related directives.

**FCC WARNING** – This evaluation board/kit is intended for use for engineering development, demonstration, or evaluation purposes only and is not considered by **onsemi** to be a finished end product fit for general consumer use. It may generate, use, or radiate radio frequency energy and has not been tested for compliance with the limits of computing devices pursuant to part 15 of FCC rules, which are designed to provide reasonable protection against radio frequency interference. Operation of this equipment may cause interference with radio communications, in which case the user shall be responsible, at its expense, to take whatever measures may be required to correct this interference.

**onsemi** does not convey any license under its patent rights nor the rights of others.

**LIMITATIONS OF LIABILITY:** **onsemi** shall not be liable for any special, consequential, incidental, indirect or punitive damages, including, but not limited to the costs of requalification, delay, loss of profits or goodwill, arising out of or in connection with the board, even if **onsemi** is advised of the possibility of such damages. In no event shall **onsemi**'s aggregate liability from any obligation arising out of or in connection with the board, under any theory of liability, exceed the purchase price paid for the board, if any.

The board is provided to you subject to the license and other terms per **onsemi**'s standard terms and conditions of sale. For more information and documentation, please visit [www.onsemi.com](http://www.onsemi.com).

## ADDITIONAL INFORMATION

### TECHNICAL PUBLICATIONS:

Technical Library: [www.onsemi.com/design/resources/technical-documentation](http://www.onsemi.com/design/resources/technical-documentation)  
onsemi Website: [www.onsemi.com](http://www.onsemi.com)

ONLINE SUPPORT: [www.onsemi.com/support](http://www.onsemi.com/support)

For additional information, please contact your local Sales Representative at [www.onsemi.com/support/sales](http://www.onsemi.com/support/sales)