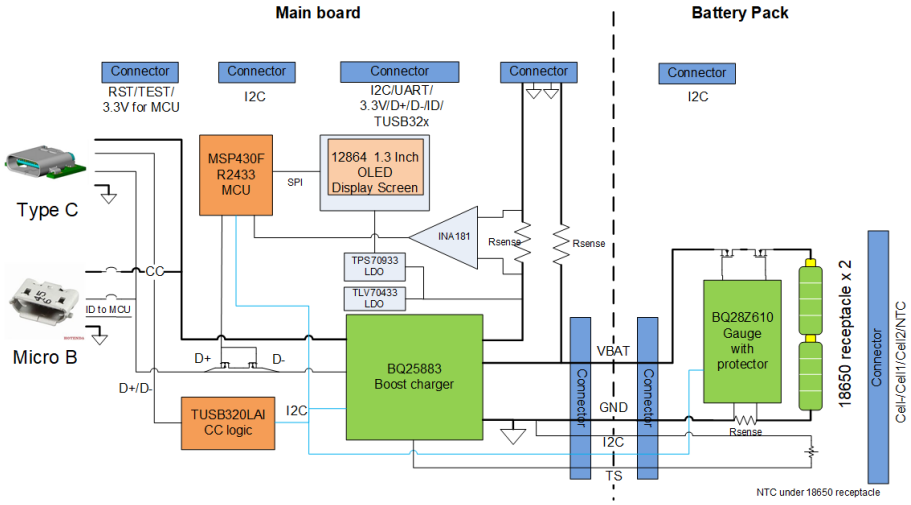
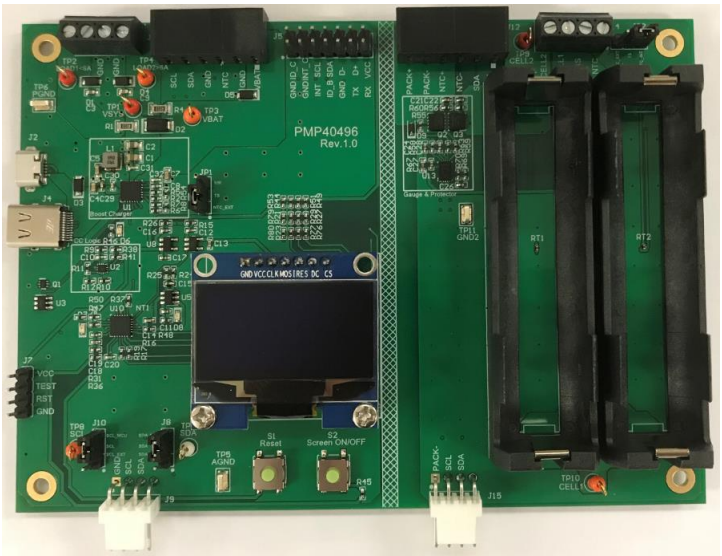
Test Report: PMP40496

2-Cell Boost Charge System Reference Design With 5-V USB

Description

This 5-V USB, 2-cell battery boost charger system reference design includes a charger system and a 2-cell battery holder with a gauge that can be connected by a cable or work independently. The key components of the charger system include the BQ25883 boost charger, TUSB320LAI Type-C CC logic, MSP430FR2433 microcontroller (MCU), OLED display, USB Type-C and Micro B connecters. The battery gauge is BQ28Z610, which combined with the internal ADC of BQ25883, display the charge and battery parameters. This design can be connected to your own system via a signal connector J5, making it a plug-in turnkey solution. The design is suitable for portable electronics applications, such as POS, *Bluetooth*® speakers and portable printers.





1 Test Prerequisites

1.1 Voltage and Current Requirements

Table 1. Voltage and Current Requirements

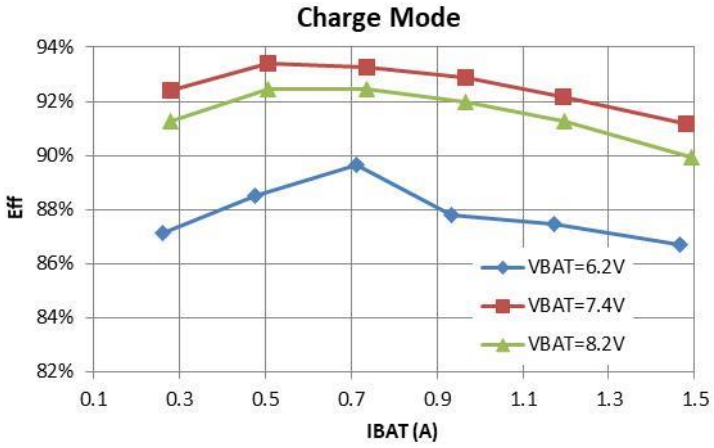
PARAMETER	SPECIFICATIONS
Input Voltage	4.5~5.5 Vdc
Battery Voltage	6~8.4 Vdc
Maximum Input Current	3 A
Output Voltage	5 Vdc
Maximum Output Current	1.5 A

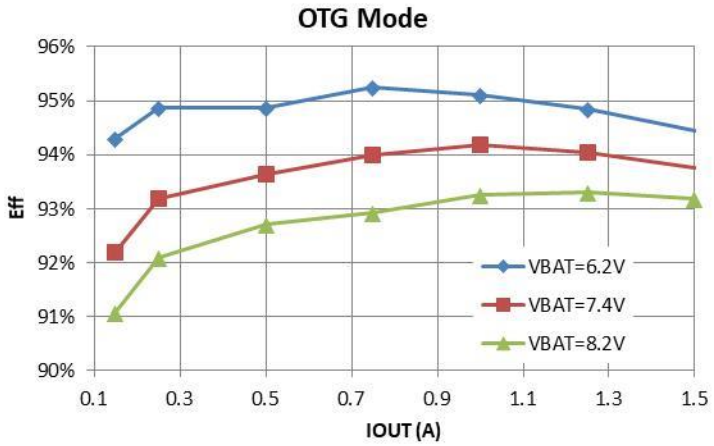
1.2 Required Equipment

- Multi-meter (current): Fluke 287C
- Multi-meter (voltage): Fluke 287C
- DC Source: Chroma 62006P-100-25
- Battery Simulator: ASunDar ASD906A
- E-Load: Chroma 63105A module
- Oscilloscope: Tektronix DPO3054
- Electrical Thermography: Fluke TiS55

2 Testing and Results

2.1 Efficiency Graphs





2.2 Efficiency Data

Charge Mode (Test w/o BQ28Z610 part)

V_{IN}/V	I_{IN}/A	V_{BAT}/V	I_{BAT}/A	loss/W	Eff/%
5.000	0.375	6.200	0.263	0.241	**87.16%**
5.001	0.667	6.200	0.476	0.383	**88.51%**
5.000	0.986	6.200	0.713	0.510	**89.66%**
4.999	1.320	6.200	0.935	0.804	**87.81%**
4.997	1.664	6.200	1.173	1.044	**87.45%**
4.999	2.096	6.200	1.466	1.392	**86.72%**
5.005	0.447	7.400	0.279	0.170	**92.41%**
5.002	0.803	7.400	0.507	0.265	**93.39%**
4.999	1.172	7.400	0.739	0.394	**93.27%**
5.005	1.541	7.400	0.968	0.549	**92.88%**
4.999	1.919	7.400	1.195	0.750	**92.19%**
4.998	2.406	7.400	1.481	1.064	**91.15%**

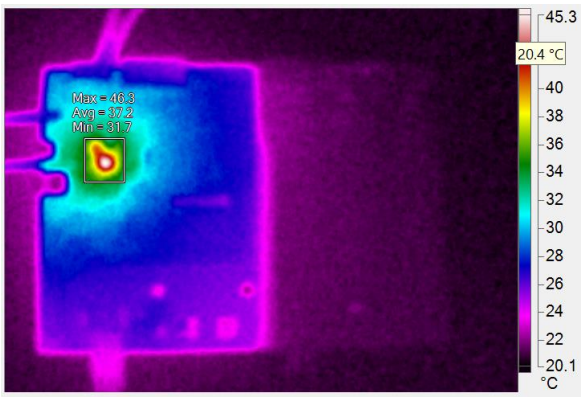
5.001	0.501	8.200	0.279	0.218	**91.28%**
5.005	0.898	8.200	0.507	0.339	**92.45%**
4.999	1.309	8.200	0.738	0.493	**92.47%**
5.002	1.724	8.200	0.967	0.691	**91.98%**
5.004	2.148	8.200	1.197	0.938	**91.28%**
5.005	2.719	8.200	1.492	1.369	**89.94%**

OTG Mode (Test w/o BQ28Z610 part)

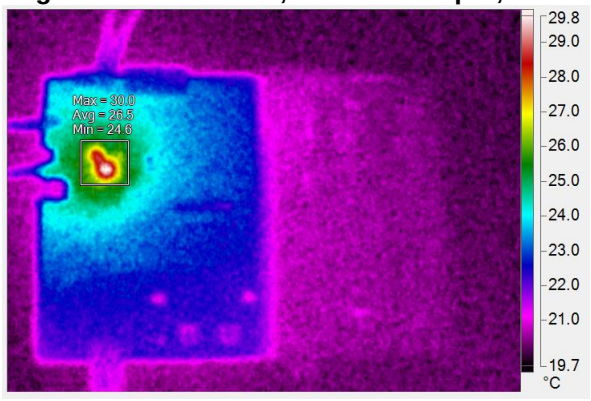
V_{BAT}/V	I_{BAT}/A	V_{OUT}/V	I_{OUT}/A	loss/W	Eff/%
6.200	0.129	5.027	0.150	0.046	**94.30%**
6.200	0.213	5.009	0.250	0.068	**94.88%**
6.200	0.423	4.976	0.500	0.135	**94.87%**
6.200	0.631	4.970	0.749	0.186	**95.25%**
6.200	0.841	4.963	1.000	0.255	**95.10%**
6.200	1.054	4.957	1.250	0.337	**94.84%**
6.200	1.269	4.952	1.501	0.438	**94.44%**
7.400	0.111	5.039	0.150	0.064	**92.18%**
7.400	0.182	5.028	0.250	0.092	**93.18%**
7.400	0.359	4.969	0.501	0.169	**93.64%**
7.400	0.535	4.969	0.749	0.238	**94.00%**
7.400	0.712	4.962	1.000	0.307	**94.17%**
7.400	0.891	4.957	1.250	0.392	**94.05%**
7.400	1.071	4.951	1.501	0.494	**93.76%**
8.400	0.099	5.054	0.150	0.074	**91.06%**
8.400	0.163	5.046	0.250	0.108	**92.10%**
8.400	0.322	5.006	0.501	0.197	**92.70%**
8.400	0.477	4.967	0.750	0.284	**92.92%**
8.400	0.633	4.961	1.000	0.359	**93.26%**
8.400	0.791	4.957	1.251	0.445	**93.30%**
8.400	0.949	4.951	1.500	0.542	**93.19%**

2.3 Thermal Images

Charge Mode Ta=22.4°C, 5V input, VBAT=8.2V, charging current 1.5A

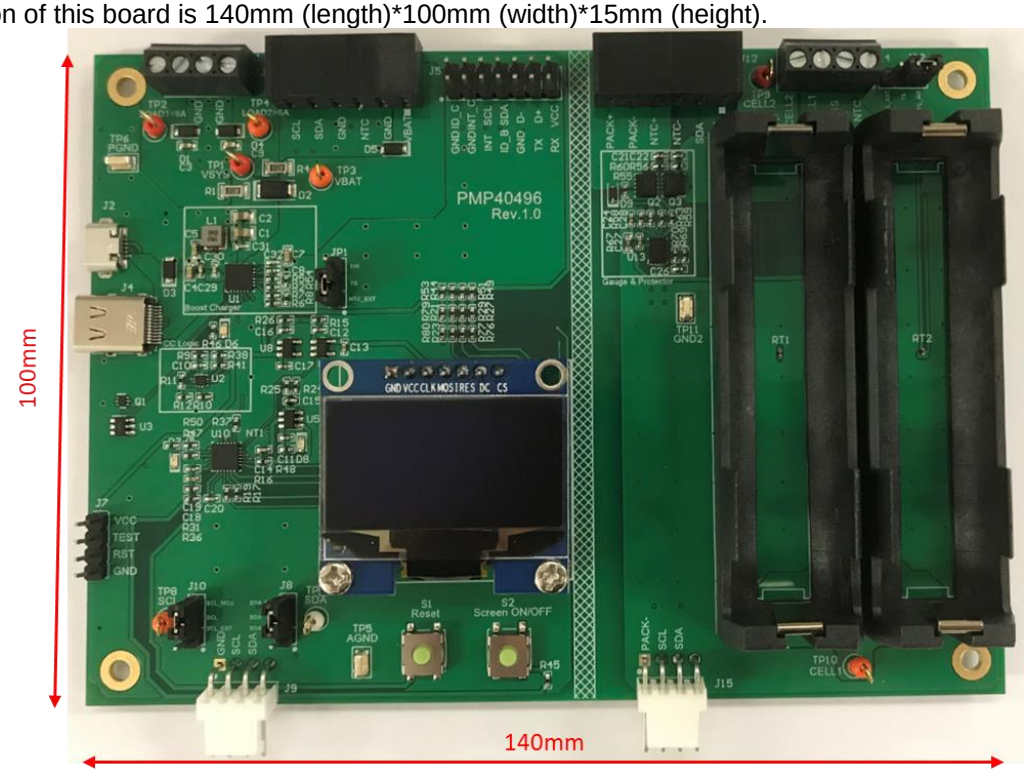


Discharge Mode Ta=22.4°C, 5.1V1.5A output, VBAT=8.4V



2.4 Dimensions

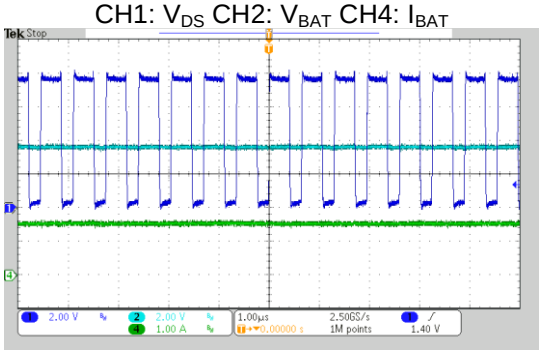
The dimension of this board is 140mm (length)*100mm (width)*15mm (height).



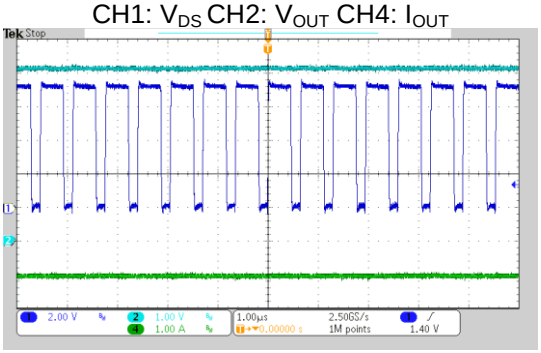
3 Waveforms

3.1 Switching

Charge mode, 5V/3A in, V_{BAT}=7.4V
CH1: V_{DS} CH2: V_{BAT} CH4: I_{BAT}

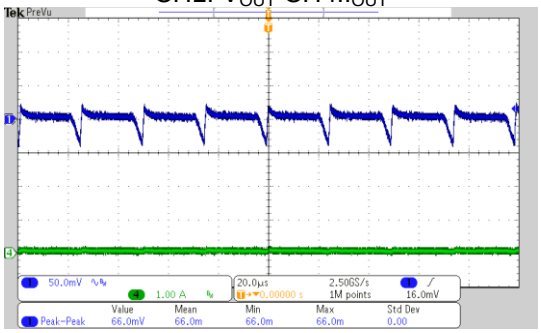


OTG mode, V_{BAT}=7.4V, 1.5A output
CH1: V_{DS} CH2: V_{OUT} CH4: I_{OUT}

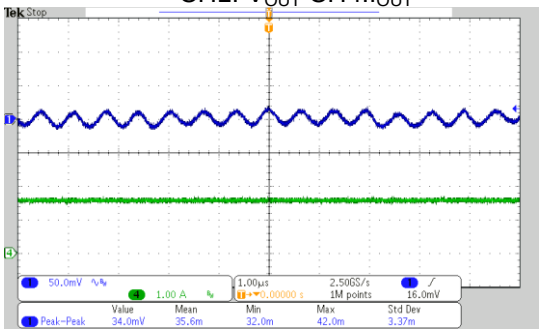


3.2 Output Voltage Ripple

OTG mode, No Load
CH1: V_{OUT} CH4:I_{OUT}

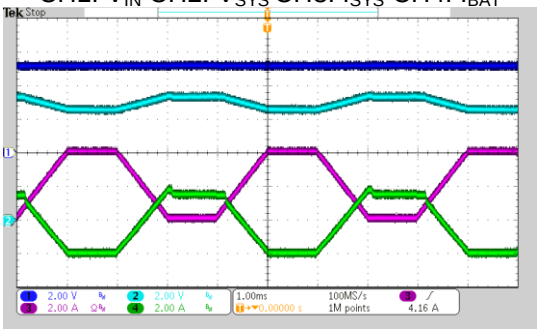


OTG mode, 1.5A output
CH1: V_{OUT} CH4:I_{OUT}



3.3 DPM Response

Charge mode, 5V/3A in, V_{BAT}=7.4V I_{SYS} increase from 0A to 4A
CH1: V_{IN} CH2: V_{SYS} CH3: I_{SYS} CH4: I_{BAT}

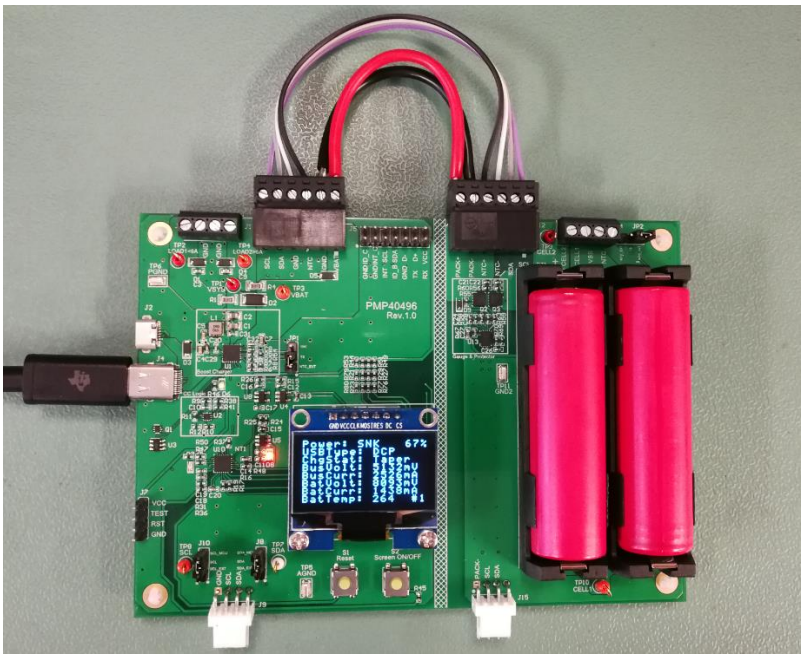


3.4 USB Connection Pattern

	Device/Host type	Device/Host	Cable	Charging/Discharging Spec.
Type-C	DFP	30W notebook PD2.0 adapter	Type-C to Type-C	5V 3A(BUS) charging
		45W notebook PD3.0 adapter	Type-C to Type-C	5V 3A(BUS) charging
		15W 5V3A Type-C adapter	Type-C to Type-C	5V 3A(BUS) charging
		7.5W 5V1.5A Type-C adapter	Type-C to Type-C	5V 1.5A(BUS) charging
	DFP Type-A BC1.2	5V2A DCP Type-A adapter	Type-A to Type-C	5V 2A(BUS) charging
		9V2A DCP Type-A adapter	Type-A to Type-C	5V 3A(BUS) charging
		5V0.5A PC Type-A port(SDP)	Type-A to Type-C	5V 0.5A(BUS) charging
		5V1.5A PC Type-A port(CDP) (A U disk paralleled at Type-C port)	Type-A to Type-C	5V 1.5A(BUS) charging
	DRP	30W power Bank PD2.0 (DRP)	Type-C to Type-C	5V 3A(BUS) charging
		45W power Bank PD3.0 (DRP)	Type-C to Type-C	5V 3A(BUS) charging
		Notebook PD2.0 port (DRP)	Type-C to Type-C	5V 3A(BUS) charging
		Huawei P10 enable OTG	Type-C to Type-C	5V 0.5A(BUS) charging
	UFP	Huawei Nova 2	Type-C to Type-C	5V 1.5A(BUS) discharging
		Huawei P10	Type-C to Type-C	5V 1.5A(BUS) discharging
		Huawei Honor 8	Type-C to Type-C	5V 1.5A(BUS) discharging
		Samsung S9+	Type-C to Type-C	5V 1.5A(BUS) discharging
		Google Pixel 2	Type-C to Type-C	5V 1.5A(BUS) discharging
	UFP Micro-B	30W Power Bank Micro-B Port	type-C to Micro-B	5V 2A(BUS) discharging
Micro-B	Type-A	5V2A DCP Type-A adapter	Type-A to Micro-B	5V 2A(BUS) charging
		5V/2A/4.5A SCP Type-A adapter	Type-A to Micro-B	5V 2A(BUS) charging
		9V2A DCP QC2.0 Type-A adapter	Type-A to Micro-B	5V 3A(BUS) charging
		5V0.5A PC Type-A port(SDP)	Type-A to Micro-B	5V 0.5A(BUS) charging
		5V1.5A PC Type-A port(CDP) (A U disk paralleled at Micro-B port)	Type-A to Micro-B	5V 1.5A(BUS) charging
	Type-C	30W Type-C PD2.0 adapter	Type-C to Micro-B	5V 0.5A(BUS) charging
		15W 5V3A Type-C adapter	Type-C to Micro-B	5V 3A(BUS) charging
	Micro-B	Micro-B Power Bank, 5V2A	OTG cable + Type-A to Micro-B USB2.0	5V 2A(BUS) discharging

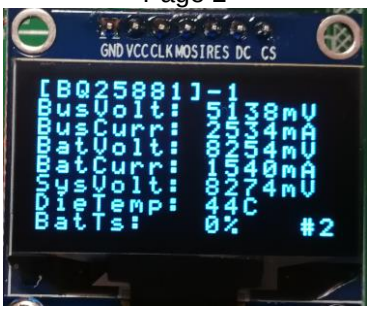
3.5 OLED Display

When adapter plugged in, the OLED displays the charging and battery parameters, and turns off after adapter removed automatically. There are 6 pages on the screen, a short press on S2 turns the pages to view status of BQ25883, BQ28Z610 and TUSB320LAI, and a long press turns off the display. If the charger part is evaluated alone, the screen displays charging parameters but no gauge information.

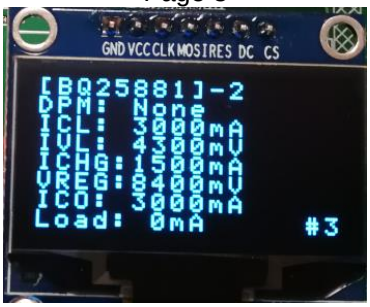


Page 1

Page 2



Page 3



Page 4

Page 5

Page 6

3.6 Quick Start Guide

1. Put two 18650 batteries into battery holders BT1 and BT2. Other types of batteries also can be used via J14.
2. Connect charger part and battery pack part via J11 and J12.
3. Plug in an adapter at Type-C or Micro B port, the board works and displays charging parameter.
4. The board can be connected to external system via J5.
5. There are 4 shunts on J8, J10, JP1 and JP2. Shunts on J8 and J10 are to choose the I2C connection, defaulted to MCU on the board, if customers want to control by external system, please shunt to EXT. JP1 is defaulted to 10K resistor, and can be shunted to NTC_ EXT to detect the temperature of battery pack. JP2 is defaulted to NTC under battery holder, and also can be shunted to external NTC via J14.
6. The battery pack can be used to do learning cycle of some specific battery for higher accuracy gauge. Customers can get the steps from ***How to Complete a Successful Learning Cycle for the bq28z610/bq78z100***.

IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATASHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES “AS IS” AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, or other requirements. These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI’s products are provided subject to TI’s Terms of Sale (https:www.ti.com/legal/termsofsale.html) or other applicable terms available either on ti.com or provided in conjunction with such TI products. TI’s provision of these resources does not expand or otherwise alter TI’s applicable warranties or warranty disclaimers for TI products.

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