User's Guide
SLVUBN4–February 2019

Using the TLC694x VQFN Evaluation Module

This user's guide describes operational use of the TLC694x VQFN package evaluation module (BOOSTXL-TLC6948EVM) as a reference for engineering demonstration and evaluation of the TLC694x 16-channel, 32-, 48-multiplexing, 16-bit ES-PWM constant-current LED driver. Included in this user's guide are setup instructions, a schematic diagram, printed circuit board (PCB) layout, and a bill of materials (BOM).

Contents

1 Introduction 2
1.1 Features 2
1.2 Applications 2
2 Test Setup and Results 3
2.1 BOOSTXL-TLC6948EVM Board 3
2.2 Connectors 3
2.3 Test Points 3
2.4 Jumpers 3
3 Test Setup 4
4 Board Layout 5
5 Schematic and Bill of Materials 6
5.1 Schematic 6
5.2 Bill of Materials 7

List of Figures

1 BOOSTXL-TLC6948EVM Board 3
2 BOOSTXL-TLC6948EVM Layout 5
3 BOOSTXL-TLC6948EVM Schematic 6

List of Tables

1 Jumpers J2–J4 4
2 Jumpers J7–J9 4
3 BOOSTXL-TLC6948EVM Parameters 4
4 BOOSTXL-TLC6948EVM Bill of Materials 9

Trademarks

LaunchPad is a trademark of Texas Instruments.
All other trademarks are the property of their respective owners.

Copyright © 2019, Texas Instruments Incorporated

1 Introduction

1.1 Features

The TLC694x device is a 16-channel, constant-current-sink LED driver. Each channel has an individually-adjustable 65,536 steps of PWM grayscale control. The maximum constant-current value of all 16 channels is set by a single external resistor with 7-bit (128 steps) global brightness control from 0.3 mA to 25 mA. The BOOSTXL-TLC6948EVM uses three TLC6946 VQFN package devices to drive 16 RGB LEDs, each device controlling one color. Moreover, the EVM provides the function to verify the LED-open detection (LOD) and IREF resistor short protection (ISP).

1.2 Applications

The BOOSTXL-TLC6948EVM can be used as a basic function evaluation module for the following applications:

- Mono-color, multi-color, full-color LED displays
- High-refresh-rate LED video displays
- High-density, fine-pitch LED matrix boards
- LED sign boards, message boards
- Variable message signs (VMS)

Copyright © 2019, Texas Instruments Incorporated

2 Test Setup and Results

This section describes the BOOSTXL-TLC6948EVM connectors, test points, and jumpers.

2.1 BOOSTXL-TLC6948EVM Board

Figure 1 displays the EVM board.

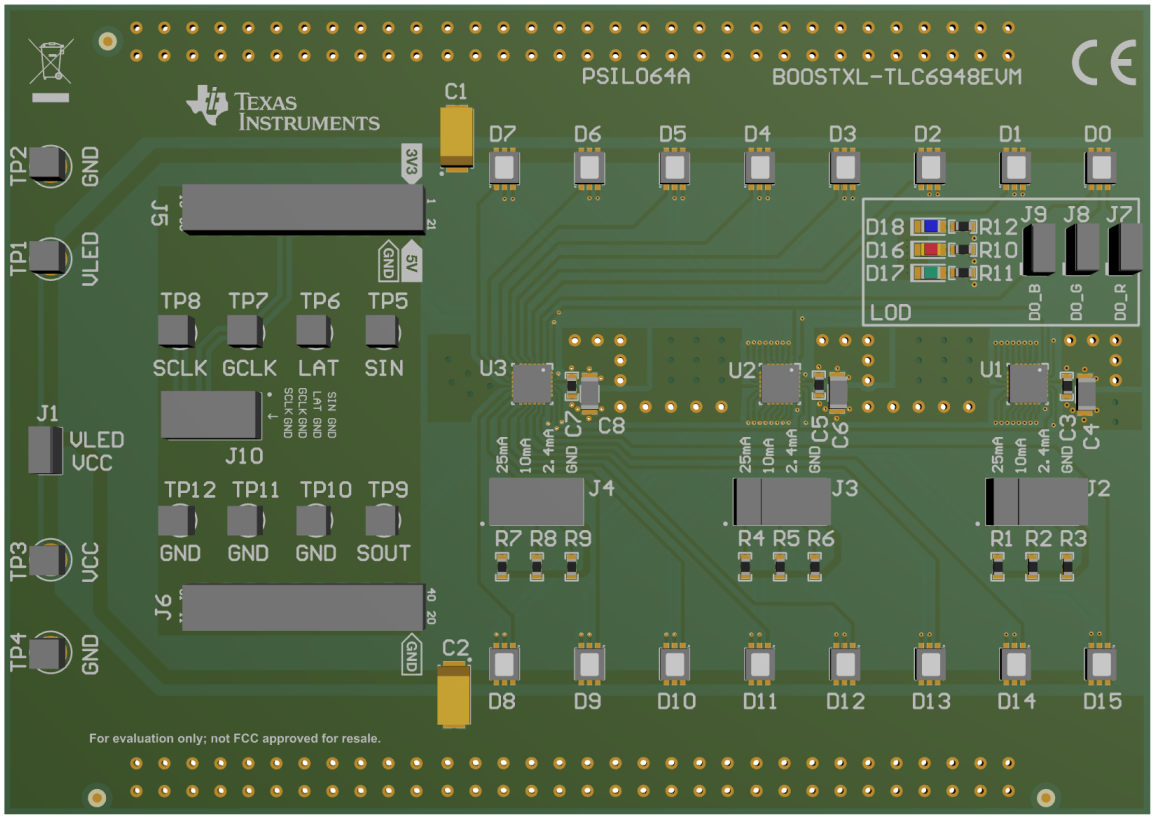


Figure 1. BOOSTXL-TLC6948EVM Board

2.2 Connectors

The EVM has the following connectors:

- TP1 (VLED): Input power supply for VLED
- TP3 (VCC): Input power supply for VCC
- TP2 or TP4 (GND): Supply ground

2.3 Test Points

All the signal pins on the TLC694x device have test points on the EVM, helping users to observe the waveform on the pins, including SCLK, GCLK, LAT, SIN, and SOUT. The EVM also offers extra GND test points for connections.

2.4 Jumpers

2.4.1 VCC and VLED Connection Jumpers – J1

Jumper J1 is used to connect VCC and VLED. With a shunt, the EVM uses the same power supply for VCC and VLED.

Copyright © 2019, Texas Instruments Incorporated

2.4.2 IREF Set Jumpers - J2, J3, and J4

Jumpers J2, J3, and J4 are used to select different maximum constant-output sink current or ISP function verification. Table 1 contains the definitions for jumpers J2 to J4.

Table 1. Jumpers J2–J4

JUMPER POSITION	WITH SHUNT FUNCTION
25 mA	Set maximum constant-output sink current to 25 mA
10 mA	Set maximum constant-output sink current to 10 mA
2.4 mA	Set maximum constant-output sink current to 2.4 mA
GND	Connect IREF with GND to verify IREF Resistor Short Protection (ISP)

2.4.3 Signal Input Jumpers - J5, J6, and J10

This BOOSTXL-TLC6948EVM provides BoosterPack connector J5 and J6 to connect with the MSP-EXP432P401R LaunchPad™ for a quick software start.

To use other controllers or data generator, the signals can be input through J10.

2.4.4 LOD Function Verification Jumpers – J7, J8, and J9

Jumpers J7–J9 are used to verify the LED-Open Detection (LOD) function. Using the MSP-EXP432P401R LaunchPad to drive the EVM, D16–D18 can work as indicators for LOD. If using other controllers or data generator, the LOD data can be read from SOUT (TP9). Table 2 contains the definitions for jumpers J7–J9.

Table 2. Jumpers J7–J9

DESIGNATOR	ATTACHED FUNCTION	WITHOUT SHUNT RESULT
J7	LOD for LED D0 Red	LED D0 red is open and D16 turns ON if using MSP-EXP432P401R LaunchPad configuration
J8	LOD for LED D0 Green	LED D0 green is open and D17 turns ON if using MSP-EXP432P401R LaunchPad configuration
J9	LOD for LED D0 Blue	LED D0 blue is open and D18 turns ON if using MSP-EXP432P401R LaunchPad configuration

3 Test Setup

Table 3 shows the typical parameters for the BOOSTXL-TLC6948EVM. Table 3 contains the BOOSTXL-TLC6948EVM parameters.

Table 3. BOOSTXL-TLC6948EVM Parameters

PARAMETER	VALUE
Input voltage for VCC	3 V to 5.5 V
Input voltage for VLED	17 V maximum
Input Current for VLED	1.2-A maximum

Follow these steps for the EVM test setup:

1. Using J1 to select whether using the same power supply for VCC, VLED. Set the voltage of the DC power supply for VCC and VLED and set the current limit to 1.5 A.
2. Connect the positive and negative outputs of the power supply to connectors VCC, VLED, and GND on the EVM board.
3. Select the positions of J2–J4 and make sure J7 to J9 have shunts.
4. Connect the MSP-EXP432P401R LaunchPad with the EVM through J5 and J6.

Copyright © 2019, Texas Instruments Incorporated

5. Power up the VCC and VLED and send the signal to change LED status and check LOD and ISP functions.

4 Board Layout

Figure 2 illustrates the EVM board layout.

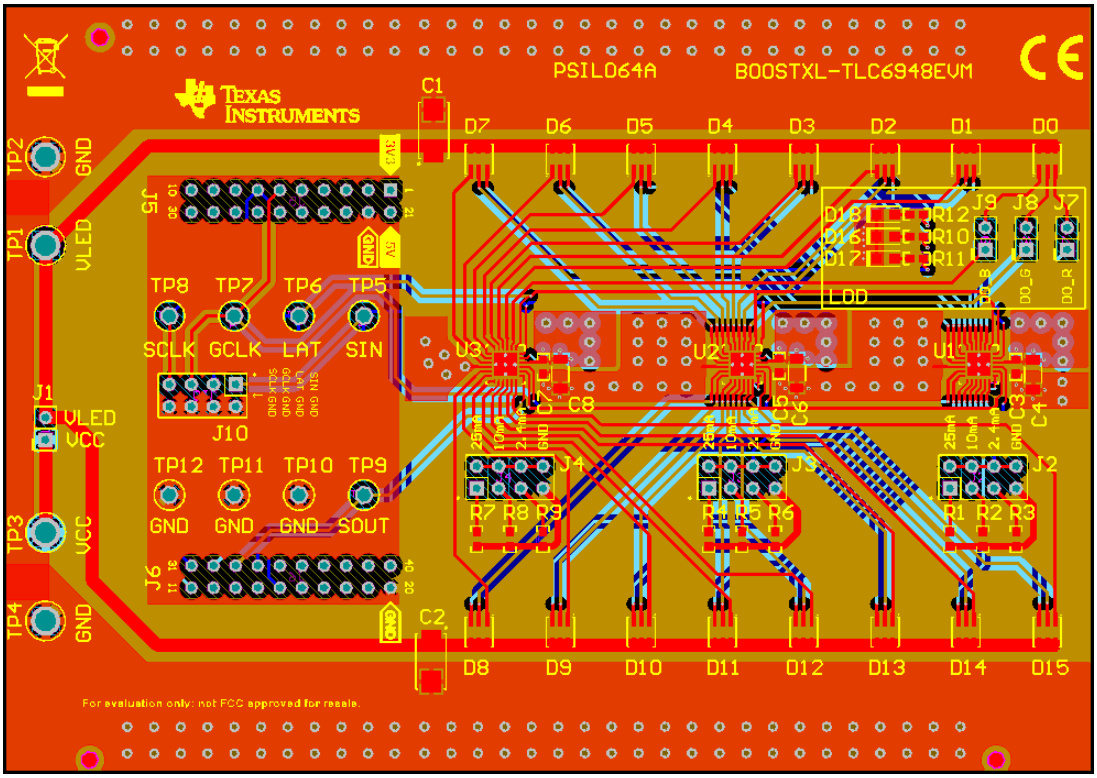


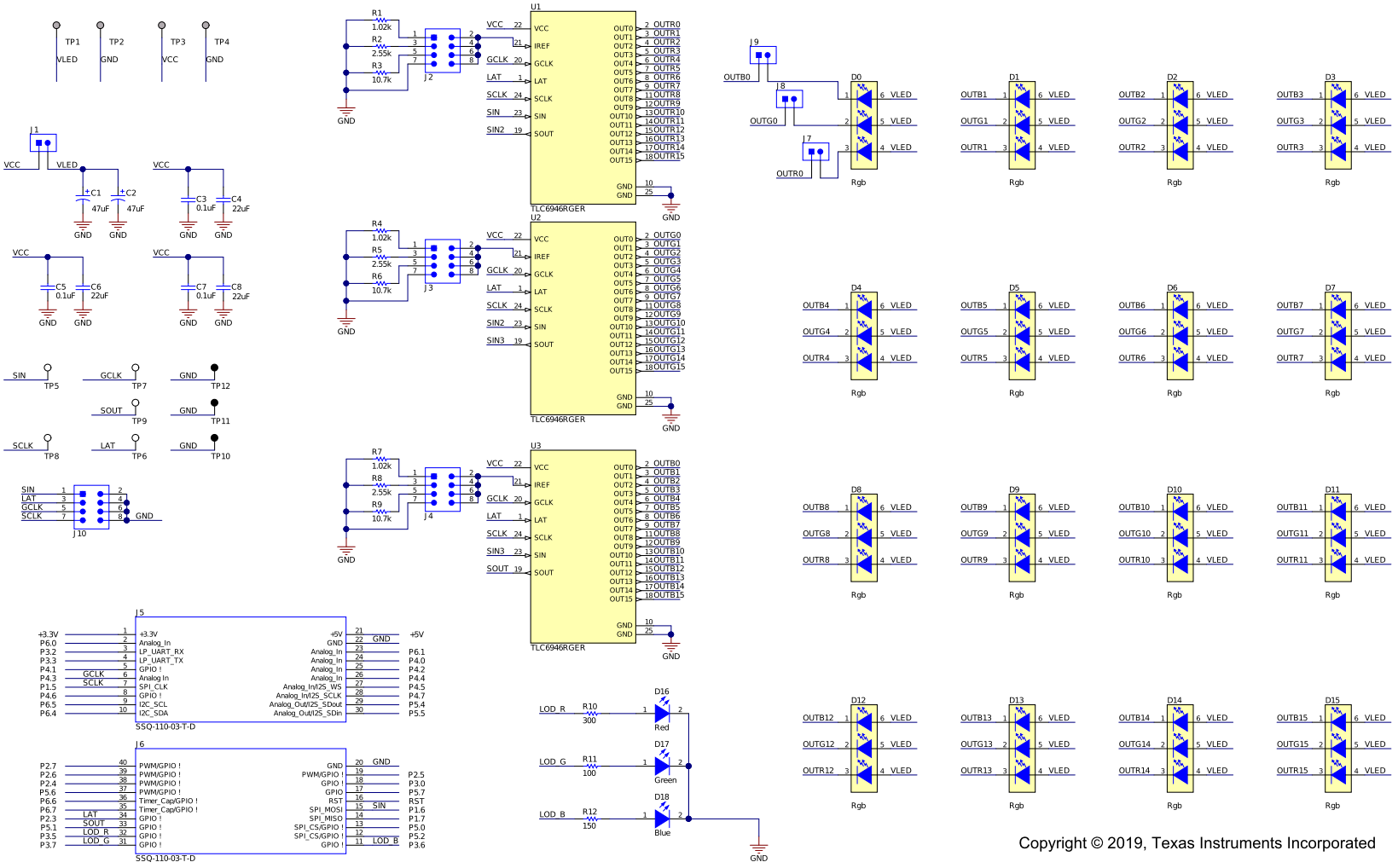
Figure 2. BOOSTXL-TLC6948EVM Layout

Copyright © 2019, Texas Instruments Incorporated

5 Schematic and Bill of Materials

5.1 Schematic

Figure 3 shows the EVM schematic.



Copyright © 2019, Texas Instruments Incorporated

Figure 3. BOOSTXL-TLC6948EVM Schematic

Copyright © 2019, Texas Instruments Incorporated

5.2 Bill of Materials

Copyright © 2019, Texas Instruments Incorporated

Table 4 lists the BOOSTXL-TLC6948EVM BOM.

Copyright © 2019, Texas Instruments Incorporated

Table 4. BOOSTXL-TLC6948EVM Bill of Materials

Item No.	Designator	QTY	Value	Part Number	Manufacturer	Description	Package Reference
1	C1, C2	2	47uF	593D476X9020E2TE3	Vishay-Sprague	CAP, TA, 47 µF, 20 V, +/- 10%, 0.15 ohm, SMD	7343-43
2	C3, C6, C8	3	22uF	1206YD226MAT2A	AVX	CAP, CERM, 22 µF, 16 V,+/- 20%, X5R, 1206	1206
3	C4, C5, C7	3	0.1uF	0603ZC104KAT2A	AVX	CAP, CERM, 0.1 µF, 10 V,+/- 10%, X7R, 0603	0603
4	D0, D1, D2, D3, D4, D5, D6, D7, D8, D9, D10, D11, D12, D13, D14, D15	16	Rgb	ASMT-YTC2-0AA02	Avago	LED, RGB, SMD	LED, 3x2x3.6 mm
5	D16	1	Red	LTST-C170KRKT	Lite-On	LED, Red, SMD	Red 0805 LED
6	D17	1	Green	LTST-C170KGKT	Lite-On	LED, Green, SMD	LED_0805
7	D18	1	Blue	LTST-C170TBKT	Lite-On	LED, Blue, SMD	LED_0805
8	J1, J7, J8, J9	4		TSW-102-07-G-S	Samtec	Header, 100mil, 2x1, Gold, TH	2x1 Header
9	J2, J3, J4, J10	4		TSW-104-07-G-D	Samtec	Header, 100mil, 4x2, Gold, TH	4x2 Header
10	J5, J6	2		SSQ-110-03-T-D	Samtec	Receptacle, 2.54mm, 10x2, Tin, TH	10x2 Receptacle
11	R1, R4, R7	3	1.02k	RT0603DRE071K02L	Yageo America	RES, 1.02 k, 0.5%, 0.1 W, 0603	0603
12	R2, R5, R8	3	2.55k	RT0603BRD072K55L	Yageo America	RES, 2.55 k, 0.1%, 0.1 W, 0603	0603
13	R3, R6, R9	3	10.7k	RT0603BRD0710K7L	Yageo America	RES, 10.7 k, 0.1%, 0.1 W, 0603	0603
14	R10	1	300	CRCW0603300RJNEA	Vishay-Dale	RES, 300, 5%, 0.1 W, 0603	0603
15	R11	1	100	CRCW0603100RFKEA	Vishay-Dale	RES, 100, 1%, 0.1 W, 0603	0603
16	R12	1	150	CRCW0603150RJNEA	Vishay-Dale	RES, 150, 5%, 0.1 W, 0603	0603
17	SH-J1, SH-J2, SH-J3, SH-J4, SH-J7, SH-J8, SH-J9	7	1x2	SPC02SYAN	Sullins Connector Solutions	Shunt, 100mil, Flash Gold, Black	Closed Top 100mil Shunt
18	TP1, TP2, TP3, TP4	4	Double	1502-2	Keystone	Terminal, Turret, TH, Double	Keystone1502-2
19	TP5, TP6, TP7, TP8, TP9	5		5012	Keystone	Test Point, Multipurpose, White, TH	White Multipurpose Testpoint
20	TP10, TP11, TP12	3		5011	Keystone	Test Point, Multipurpose, Black, TH	Black Multipurpose Testpoint
21	U1, U2, U3	3		TLC6946REGR	Texas Instruments	16-Channel 32-Multiplexing 16-Bit ES-PWM Constant-Current LED Driver, REG0024A (VQFN-24)	REG0024A

Copyright © 2019, Texas Instruments Incorporated

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 (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
Copyright © 2019, Texas Instruments Incorporated

Copyright © 2019, Texas Instruments Incorporated

IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATA SHEETS), 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, regulatory 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 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.

TI objects to and rejects any additional or different terms you may have proposed.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2022, Texas Instruments Incorporated