EVM User's Guide: LP5814EVM LP5815EVM LP5814/5DRLEVM 3/4-Channel I²C RGB LED Driver Evaluation Module

Description

This user's guide describes the LP5814/4I/5/6/7 evaluation module, including LP5814DRLEVM and LP5815DRLEVM. This user's guide is used as a reference for engining evaluation. Included in this user's guide are hardware setup instructions, Graphical User Interface (GUI) installation, GUI guidance, schematic diagrams, print board (PCB) layout and bill of materials (BOM).

The LP5814DRLEVM helps deigners evaluate the functions of the LP5814, LP5814I and LP5816. The LP5815DRLEVM helps deigners evaluate the functions of the LP5815 and LP5817.

- LP5814 : 4-channel I²C interface RGBW LED driver with auto animation control.
- LP5815 : 3-channel I²C interface RGB LED driver with instant blinking and auto animation control.
- LP5814I : 4-channel I²C interface RGBW LED driver with auto animation control and instant blinking.
- LP5816 : 4-channel I²C interface RGBW LED driver.



• LP5817 : 3-channel I2C interface RGB LED driver.

The LP581x_RUKA Graphical User Interface (GUI) is provided to control all the family devices LP5814/4I/5/6/7 through the USB2ANY interface adapter.

Get Started

- 1. Request the LP5814DRLEVM or LP5815DRLEVM from ti.com .
- 2. Download the LP5814, LP5815, LP5816, LP5817 or LP5814I data sheet from ti.com.
- 3. Download the LP581x_RUKA GUI from ti.com.

Applications

- Portable and wearable electronics: e-cigarette, earbuds and charging case
- Gaming and home entertainment: smart speaker, RGB mouse, video doorbell
- Industrial HMI: EV charger, factory automation



LP5814DRLEVM Hardware Image



LP5815DRLEVM Hardware Image

1



1 Evaluation Module Overview

1.1 Introduction

This user's guide describes the characteristics, setup, and usage of the LP5814/5DRLEVM. The LP5814/5DRLEVM helps the user evaluate the features of the Texas Instruments Device.

The LP5814DRLEVM can be converted for testing the LP5816 or the LP5814I by replacing the factory-installed device (U1) with the LP5816 or the LP5814I device.

LP5815DRLEVM can be converted for testing the LP5817 by replacing the factory-installed device (U1) with the LP5817 device.

This document covers following topics:

- Hardware Setup
- Graphical User Interface (GUI) Instructions
- Schematic Diagram
- Printed-Circuit Board (PCB) Layout
- Bill of Materials (BOM)

1.2 Kit Contents

The LP5814/5 EVM kit includes the following materials and is illustrated in Figure 1-1.

- LP5814/LP5815 evaluation module
- USB2ANY interface adapter with ribbon cables and USB cable



Figure 1-1. LP5814/5DRLEVM Kit



Hardware

2 Hardware

2.1 Setup

This section describes how to set up the LP5814/5DRLEVM properly. Items from the following list are required to begin the evaluation.

- Computer
- LP5814DRLEVM or LP5815DRLEVM
- USB2ANY interface adapter

In the default jumper setting, the board can be evaluated by USB2ANY power directly and does not need an external power supply. Setup connection is demonstrated in Figure 2-1. The setup procedure is as follows:

- 1. Connect the USB2ANY with the LP5814/5DRLEVM through the ribbon cable.
- 2. Make sure all jumpers are properly set under the appropriate operating conditions. See more details in Jumper Information.
- 3. Plug the USB cable into the USB port on the computer.



Figure 2-1. Hardware Connection

2.2 Jumper Information

- 1. For the LP5814DRLEVM, the LP5814 is under the conditions below with the default jumpers setting.
 - The VCC of LP5814 is connected to the 3.3V of USB2ANY through the jumper J1.
 - The VLED, which provides the power supply for the RGB LED D1 and White LED D2, is connected to the 3.3V of USB2ANY through the jumper J2.



Figure 2-2. LP5814DRLEVM Default Jumpers Setting

- 2. For the LP5815DRLEVM, the LP5815 is under the conditions below with the default jumpers setting.
 - The VCC of LP5815 is connected to the 3.3V of USB2ANY through the jumper J2.

- The STAT of LP5815 is connected to GND through the jumper J3.
- The VLED, which provides the power supply for the RGB LED D1, is connected to the 3.3V of USB2ANY through the jumper J9.



Figure 2-3. LP5815DRLEVM Default Jumpers Setting



3 Software

3.1 Software Description

This section describes how to intsall the GUI and control the EVM through the GUI. Items from the following list are required to begin evaluating the LP5814/5DRLEVM.

LP581x_RUKA GUI software

3.2 Graphical User Interface (GUI) Installation

The LP581x_RUKA GUI software is downloaded from the link: LP581x_RUKA GUI.

On the Gallery page as shown in Figure 3-1, click the blank part of the panel to open the **online version** or click *download* button and select the platform to install the **offline version** to the user's computer.



Figure 3-1. GUI Download Page

For the offline version, after the download completed, extract the file and double click the exe application file to start the installation. Then follow the setup wizard to complete the installation, during which the license has to be accepted and all the default settings are kept. The installation takes about several ten minutes depends on the network speed.

Figure 3-2 appears to prompt that the offline version is installed successfully. Click the finish button to start the GUI evaluation.



Figure 3-2. Last Step of Installing GUI Successfully

3.3 Graphical User Interface (GUI) Guidance

The LP581x_RUKA GUI is a convenient tool to control and evaluate all functions of LP581x(4/4I/5/6/7) family.

5



3.3.1 Hardware Connection

Open the GUI software and plug the USB cable into the USB port of the computer. The Figure 3-3 on the left down corner of the GUI illustrates the hardware connection status.

Click the connection button to initiate the software connection to the EVM board through the USB2ANY. The connection status shows the connection result of the GUI and EVM board.

- Hardware Connected indicates the EVM is connected to the GUI successfully
- · Hardware not Connected indicates the EVM is not connected to the GUI successfully

Connectio ↓	n But	ton	
a	•	USB2ANY/OneDemo device	Hardware Connected.
1			1
Log Panel			Connection Status

Figure 3-3. Hardware Connection Status Bar

In case the USB2ANY tool has been used to evaluate other EVMs and updated to other firmware version (such as, 2.8.2.0), the firmware version is required to updated to the mapping version of the LP581x_RUKA GUI. After clicking the connection button, the firmware update window appears as shown in Figure 3-4. Follow the steps to complete the firmware update.

Update Firmware	Update Firmware
The device is using firmware version 2.8.2.0. Recommended firmware version is 3.0.4.0.	The device is using firmware version 2.8.2.0. Recommended firmware version is 3.0.4.0.
• Step 1: UPDATE Firmware	Step 1: UPDATE Firmware
Step 2: After firmware update succeeds, please click Finish	• Step 2: After firmware update succeeds, please click Finish
SKIP UPDATE	Update succeeded FINISH



In case the USB2ANY tool has never been used to evaluate any EVM, the following steps is needed before clicking the UPDATE button to update the firmware version of the USB2ANY to the mapping version of the GUI after clicking the connection button.

- 1. Unplug the USB cable (do not click the UPDATE button).
- 2. Press the BSL button inside USB2ANY, then plug in the USB cable.
- 3. Click UPDATE button.

3.3.2 Start Page

The Figure 3-5 is shown after opening the GUI, on which different device variants can be selected. The LP5814 is choosen by default. Choose the device that is mounted on the EVM connected to the GUI. Then click the *EXPLORE* button to start the evaluation.



Figure 3-5. Start Page

When LP5814, LP5816 or LP5817 is choosen on the *Start Page*, after clicking the *EXPLORE* button, the GUI jumps to the *Home Page*.

When LP5815 or LP5814I is choosen on the Start Page, after clicking the EXPLORE button, the instant blinking disable prompt window appears as shown in Figure 3-6.

- Click YES to set the INSTABLINK_DIS bit as 1.
- Click **NO** to keep the INSTABLINK_DIS bit as 0.

As for the LP5815, the STAT is shorted to the GND by default through the jumper **J3**. So the instant blinking function is disabled even though the INSTABLINK_DIS bit is 0. To have the instant blinking on the OUT0, the jumper **J3** should be removed.

Either click Yes or No, the GUI jumps to *Home Page*.

Explore			×
Do you want to disable	charge indicator mode?		
l	YES	NO	

Figure 3-6. Instant Blinking Disable

3.3.3 Hardware Setup Page

There are two tabs shown on the Figure 3-7.

7



- *Connect the EVM to Your PC* shows the cable connections between computer and USB2ANY tool and the EVM.
- Connect the Jumpers shows the default jumpers setting for the EVM.

Click *FINISH* to jump to the *Home Page*.



Figure 3-7. Hardware Setup Page

3.3.4 Home Page

8

On the left side of the Figure 3-8, there is *Hardware Steup* control. The I²C broadcast communication mode is selected by default. After clicking the *CONFIGURE & EDIT* button, the *Mode* selection control is enabled for input and the hardware is disconnected. *Independent* mode can be selected from the *Mode* pulldown menue. Then click *CONFIGURE & CONNECT* to initiate the hardware connection through the independent I²C communication mode.

On the right side of the Figure 3-8, there are two shortcuts that navigate to *LED Control Page* and *Register Map Page* through clicking the corresponding *START* button.





Figure 3-8. Home Page

3.3.5 LED Control Page

9

Software



Figure 3-9 provides controls for all the functions of the device. Following sections describe how to use the GUI to turn on the LED in manual mode and autonomous animation mode based on the LP5814DRLEVM.

LP58	Tx_RUKA File Options Tools Help	
	LED CONTROL UP5814 () Chip Enabled Interface : I2C Chip Address : 0x34	L IMPORT
∜o	CUSTOM	PRE-DEFINED
A	1 Mode Selection ② N	Manual Mode Configuration ③ Auto Mode Configuration
•	Select LED select individual or multiple LEDs to configure (Shift + select for multiple LED selections)	► START STOP II PAUSE
		Selected LEDs Select the required LEDs from LED Matrix
	Mode Selection	
	Enable LED Select Mode PVM Dimming Scale Disable v Manual v Linear v	Exable Fade Decimal Decimal 0 0
R G	 16221W//m/barm dwice, Marketen Connected 	NEXT

Figure 3-9. LED Control Page

3.3.5.1 Turn ON LED in Manual Mode

This section shows the steps to turn on the blue (OUT0) and green (OUT1) LEDs in manual mode.

- 1. Enbale chip through clicking *Chip Enabled* button as shown in Figure 3-10.
- 2. Select the blue LED (OUT0) and green LED (OUT1) to do the configuration through clicking the blue LED and green LED with *Shfit* keyboard button pushed.
- 3. Enable the selected blue LED and green LED through selecting the *Enable* item from the *Enable LED* pulldown menue. Set the selected blue LED and green LED in manual mode through selecting the *Manual* item from the *Select Mode* pulldown menue.



Figure 3-10. Chip Enable and Manual Mode Set

- 4. Click the *Device Configuration* button on the right side of the *LED Control* page to open the maximum current configure panel as shown in Figure 3-11. Set the MC (Maximum Current) for the selected blue LED and green LED through selecting the *25.5mA* or *51mA* item from the *Maximum Current* pulldown menue.
- 5. Click UPDATE button on the top right corner to make the configurations in above step 3 and step 4 take effect.

LED CONTROL	LP5814	Chip Enabled Interface : I	2C Chip Address	0x34							C DERET	UPDATE
		cu	STOM						×			
			1 Mode	Selection	- (2) Manu	ual Mode Configu	ation	() Auto Mode	Cor	Maximum Current	25.5mA	*
Select LED s	elect individual or multiple l	EDs to configure (Shift + select for	multiple LED selections							LED Fade Time	Os	*
				0UT 0		Select	ed LEDs ne required LEDs from	LED Matrix	DEVICE CONFIGURATION			
Mode Selection	n							<u></u>	-			
Enable LED Enable	~	Select Mode Manual	¥	PWM Dimming Scale Linear	~	Enable Fade Disable	~	Dot Current Hex				

Figure 3-11. Current Set and Update Command Send in Manual Mode

- 6. Set DC (Dot Current) value for the selected blue LED and green LED through entering the data in the *Dot Current* control as shown in Figure 3-11.
- Click the Manual Mode Configuration tab to open the manual PWM setting panel as shown in Figure 3-12. Set manual PWM value for the selected blue LED and green LED through entering the data in the Manual PWM control.

The selected blue LED and green LED are turned on after entering the PWM value.

	Charles Comp charles internace. 120 Chilp Address . 0234		± imr		- TICH ALL PLAGS		C Reset	C, OF DATE
	CUSTOM				PRE-DEF	FINED		
	Mode Selection	– 2 Manual Mode (Configuration	③ Auto Mode	e Configuration			
Select LED se	ect individual or multiple LEDs to configure (Shift + select for multiple LED selections)				1	► START	STOP	II PAUSE
	00/10		Selected LEDs Select the required LEDs fi	rom LED Matrix				
Manual Mode				_				
		Manual PWM Hex r	Decimal 255					



3.3.5.2 Turn On LED in Autonomous Mode

This section shows the steps to turn on the red LED (OUT2) and white LED (OUT3) LEDs in autonomous animation mode with the patterns as shown in Table 3-1 and .

LED	PATTERNS						
Red LED (OUT2)	Animation Mode, Blinking with 5Hz Frequency						
White LED (OUT3)	Animation Mode, Breathing with 1s Exponential Ramping Up and 1s Exponential Ramping Down						







- 1. Enbale chip through clicking *Chip Enabled* button as shown in Figure 3-15.
- 2. Select the red LED (OUT2) and white LED (OUT3) to do the configuration through clicking the red LED and white LED with *Shfit* keyboard button pushed.
- 3. Enable the selected red LED and white LED through selecting the *Enable* item from the *Enable LED* pulldown menue.

Set the selected red LED and white LED in autonomous animation mode through selecting the *Auto* item from the *Select Mode* pulldown menue.

Eanble exponential PWM dimming for the selected red LED and white LED through selecting the *Exponential* item from the *PWM Dimming Scale* pulldown menue.





Figure 3-15. Chip Enable and Auto Mode Set

- 4. Click the *Device Configuration* button on the right side of the *LED Control* page to open the maximum current configure panel as shown in Figure 3-16. Set the MC (Maximum Current) for the selected red LED and white LED through selecting the 25.5mA or 51mA item from the *Maximum Current* pulldown menue.
- 5. Click UPDATE button on the top right corner to make the configurations in above step 3 and step 4 take effect.
- 6. Set DC (Dot Current) value for the selected blue LED and green LED through entering the data in the *Dot Current* control as shown in Figure 3-16.

LED CO	ONTROL	LP581	4 ()	Chip Enabled In	terface : I2C	Chip Addres	s : 0x34) (<u>T</u> e	VPORT			N C PESET	
					CUST	м								×			
						1 Mod	le Selection	— (2) Mar	iual Mode Co	onfiguration –		3 Auto	Mode C	nc	Maximum Curre	nt 25.5mA	*
Selec	t LED sele	ect individual	or multiple LE	Ds to configure (Shift	+ select for mult	iple LED selectio	ns)								LED Fade Time	Os	*
							оит о оит т оит т оит т сист оит т сис			Selected LEDs Select the required LED 2	LEDs from L	.ED Matrix		DEVICE CONFIGURATION			
Mod	le Selection											1	/				
Enab Ena	ile LED ible		•	Select Mode Auto		~	PWM Dimming Scale Exponential	*	Enable Fade Disable	e	~	Dot Curr	Hex FF				

Figure 3-16. Current Set and Update Command Send in Auto Mode

7. Click the Auto Mode Configuration tab to open the patterns setting panel as shown in Figure 3-17.

Select engine 0 for selected red LED (OUT2) through selecting the *Engine0 is selected* item from the *OUT2 Engine Channel* pulldown menue.



Select engine 1 for selected white LED (OUT3) through selecting the *Engine1 is selected* item from the *OUT3 Engine Channel* pulldown menue

 Device Configura
2 LED Selected
BACK

Figure 3-17. Engine Select

8. Enbale engine 0 order 0 through clicking the toggle button besides the *Order 0* under *Engine 0* control panel. Select pattern 0 for engine 0 order 0 through selecting the *Pattern0 is selected* item from the pulldown menue under the *Order 0* as shown in Figure 3-18.

Enbale engine 1 order 0 through clicking the toggle button besides the *Order 0* under *Engine 1* control panel. Select pattern 1 for engine 1 order 0 through selecting the *Pattern1 is selected* item from the pulldown menue under the *Order 0* as shown in Figure 3-18.

i						
D CONTROL	LP5814 O Chip Enabled Inte	face : I2C Chip Address : 0x34		VIEW ALL FLAGS		
		CUSTOM		PRE-DEFINED		
		Mode Selection ——	— 🕑 Manual Mode Co	onfiguration ③ Auto Mod	le Configuration	
OUTO Engine Channel	OUT1 Engine Channel	OUT2 Engine Channel	OUT2 Engine Channel			
Engine0 is selected	✓ Engine0 is selected	✓ Engine0 is selected ✓	Engine1 is selected	~		
Engine 0			Repeat Time	0 times 🗸		
	Order 0 Drabled	Order 1 🔴 Disabl	ed	Order 2 (Disabled	Order 3 Disabled	
	Pattern() is selected	Pattern0 is selected	~	Pattern0 is selected	Pattern0 is selected	
Engine 1			Repeat Time	0 times 🗸		
	Order 0 Enabled	Order 1 💽 Disable	rd	Order 2 Olisabled	Order 3 Disabled	
	Pattern1 is selected	Pattern0 is selected	~	Pattern0 is selected	Pattern0 is selected	
Engine 2			Repeat Time	0 times 🗸		
	Order 0 Disabled	Order 1 💿 Disable	rd	Order 2 Oisabled	Order 3 Oisabled	
	Pattern0 is selected	Pattern0 is selected	~	Pattern0 is selected	Pattern0 is selected	
Engine 3			Repeat Time	0 times 👻		
	Order 0 Oisabled	Order 1 🚺 Disable	ed	Order 2 Disabled	Order 3 Disabled	
					BAG	CK UP

Figure 3-18. Engine Order Enable

Set the paramters of pattern 0 as the value shown in the Table 3-2 table.
 Set the paramters of pattern 1 as the value shown in the Table 3-3 table.



Enter the values under the PATTERN 0 and PATTERN 1 control panels as shown in Figure 3-19.

Table 3-2. PATTERN0 5Hz Blinking Parameters

Address	Register	Set Value	Description
1Ch	PATTERN0_PAUSE_TIME	00h	No pause time
1Dh	PATTERN0_REPEAT_TIME	0Fh	Infinite repeat times
1Eh	PATTERN0_PWM0	FFh	PATTERN0_PWM0 = FFh
1Fh	PATTERN0_PWM1	FFh	PATTERN0_PWM1 = FFh
20h	PATTERN0_PWM2	00h	PATTERN0_PWM2 = 0
21h	PATTERN0_PWM3	00h	PATTERN0_PWM3 = 0
22h	PATTERN0_PWM4	00h	PATTERN0_PWM4 = 0
23h	PATTERN0_SLOPER_TIME1	02h	PATTERN0_SLOPER_T1 = 0, PATTERN0_SLOPER_T0 = 0.1s
24h	PATTERN0_SLOPER_TIME2	02h	PATTERN0_SLOPER_T3 = 0, PATTERN0_SLOPER_T2 = 0.1s

Table 3-3. PATTERN1 Breathing Parameters

Address	Register	Set Value	Description
25h	PATTERN1_PAUSE_TIME	00h	No pause time
26h	PATTERN1_REPEAT_TIME	0Fh	Infinite repeat times
27h	PATTERN1_PWM0	00h	PATTERN1_PWM0 = 0
28h	PATTERN1_PWM1	FFh	PATTERN1_PWM1 = FFh
29h	PATTERN1_PWM2	FFh	PATTERN1_PWM2 = FFh
2Ah	PATTERN1_PWM3	00h	PATTERN1_PWM3 = 0
2Bh	PATTERN1_PWM4	00h	PATTERN1_PWM4 = 0
2Ch	PATTERN1_SLOPER_TIME1	4Bh	PATTERN1_SLOPER_T1 = 0.2s, PATTERN1_SLOPER_T0 = 1s
2Dh	PATTERN1_SLOPER_TIME2	4Bh	PATTERN1_SLOPER_T3 = 0.2s, PATTERN1_SLOPER_T2 = 1s





Figure 3-19. Pattern Parameters Set

10. Finally, send start command to start the configured patterns running on the red LED (OUT2) and white LED (OUT3) through clicking the START button as shown in Figure 3-20.

The selected red LED starts blinking in 5Hz frequency and selected white LED starts breathing up and down after sending start command.

x_RUKA File	Options Tools Help					
LED CONTROL	P5814 O Chip Enabled Interface : I2C C	hip Address : 0x34			VIEW ALL FLAGS	🔆 RESET 🗘 UPDATE
	CUSTO	И			PRE-DEFINED	
		Mode Selection	Manual Mode Cor	nfiguration 3 Auto Mod	e Configuration	
Select LED Select Indiv	vidual or multiple LEDs to configure (Shift + select for multiple	ELED selections)			► START	TOP
		OUT 0	S	elected LEDs		
		OUT 1	S	IFD 2 × IFD 3 ×		
		OUT 2				
		OUT 3				
AEU Configuration						2 LED Selected
Select Engine Channel OUT0 Engine Channel Engine0 is selected	OUT1 Engine Channel Channel Engine0 is selected	OUT2 Engine Channel Engine0 is selected	OUT3 Engine Channel Engine1 is selected	×		
Engine 0			Playback Time	0 times 🗸		
	Order 0 Enabled	Order 1 Disabled		Order 2 Disabled	Order 3 Oisabled	
	Pattern0 is selected 🗸	Pattern0 is selected	~	Pattern0 is selected 🗸 🗸	Pattern0 is selected	
Engine 1			Playback Time	0 times 🗸		BACK
12 4204 24 25000				1		





3.3.6 Enter and Exit Shutdown Mode

This section describes how to use the GUI to control the device enter and exit shutdown mode.

Click the *SHUTDOWN* button on the top right corner of the *LED Control Page* to open the *Shutdown Controls* panel as shown in Figure 3-21. There are two pairs of methods to control the device enter and exit shutdown mode as described in the device data sheet.

LP58	1x_RUKA File Options Tools Help								-	ð ×
	LED CONTROL UP5814 (1) Chip Enabled Interface : I2C	Chip Address : 0x34				VIEW ALL FLAGS	() SHUTDOWN	C RESET	C UPDATE	
∜o	CUSTO	мс				PRE-DEFI	ED	J		
÷		1 Mode Selection ———	2 Manual Mode C	onfiguration ———	③ Auto Mode	Configuration				
8	Select LED select individual or multiple LEDs to configure (SNR + select for multiple	ple LED selections)					▶ START	STOP	PAUSE	Iration
		Shutdown Controls				×				e Configu
			→ Send Shutdown Command C→ Toggle SDA 8 times	-] Pull down SCL as 100 ms						 ▲ Device
	Mode Selection									
R G	IISP2ANV/Depage device Landware Connected								NEXT	TRUMENTS

Figure 3-21. Shutdown Controls Open

1. Enter shurdown mode

Click the *Send Shutdown Command* button or *Pull down SCL as 100ms* button as shown in Figure 3-22 to make the device enter shutdown mode. After that, the clicked button is hidden for clicking protection and the button below it is enabled for clicking. Besdies that the hardware connection status as shown in Figure 3-3 shows the *Hardware not Connected*, as the I²C of the device is inactive in shutdown mode.

As for LP5815, STAT pin is required to be pulled down to make the device enter shutdown mode.





Figure 3-22. Enter Shutdown

2. Exit shutdown mode

Click the *Toggel SDA 8 times* button if *Send Shutdown Command* button is clicked in the step1 or Click the *Pull up SCL* button if *Pull down SCL as 100ms* button is clicked in the step1 as shown in Figure 3-23 to make the device exit shutdown mode. After clicking exit shutdown button, the GUI tries to connect to the device and shows the status on the hardware connection status bar.

LP58	1x_RUKA File Options Tools Help	_ 0 ×
	LED CONTROL UP5814 Chip Enabled Interface : I2C Chip Address : 0x34	L IMPORT T EXPORT VIEW ALL FLAGS US SHUTDOWN C RESET & UPDATE
∜o	сизтом	PRE-DEFINED
÷	Mode Selection —— (2) Manu	al Mode Configuration ③ Auto Mode Configuration
	Select LED select individual or multiple LEDs to configure (Shift + select for multiple LED selections)	START STOP
/	LID0	
	Shutdown Controls	Configure
		Deelco
	-D Con	utdown and 100 ms
	[E→ Togi ti	SDA 8 es
	Mode Selection	
	Enable LED Select Mode Disable Marcual	
		NEXT
🗐 G-2	Connecting to target	🗘 Texas Instruments





3.3.7 Read Flags

Click the VIEW ALL FLAGS button on the top right corner of the LED Control Page as shown in Figure 3-24 to open the *Flag Registers* panel, on which all the flags are shown. When chip is enabled, click *Clear TSD* button to clear TSD flag and click *Clear POR* button to clear POR flag.

LP58	1x_RUKA File Options Tools Help			_ 0 ×
	LED CONTROL UP5814 (U) Chip Enabled Interface : I2C	Chip Address : 0x34		C reset
∜o	CUST	М	PRE-DEFINED	
÷		1 Mode Selection ② Manual Mode Co	onfiguration ③ Auto Mode Configuration	
•	Select LED select individual or multiple LEDs to configure (Shift + select for multiple LEDs to configure (Shift + sele	iple LED selections)	► START	STOP PAUSE
/		LEDO		ation
		Flag Registers	×	Configur
		OUT3 Engine Busy	Clear TSD	▲ Device
		OUT2 Engine Busy	Clear POR	
		OUT1 Engine Busy	1	
		OUTO Engine Busy 🛛 🕒		
	Mode Selection Enable LED Select Mode	Engine Busy		
		TSD		
				Motor
<i> e</i>	USB2ANY/OneDemo device Hardware Connected.			TEXAS INSTRUMENTS

Figure 3-24. Read Flags



4 Hardware Design Files

4.1 Schematics

LP5814DRLEVM schematic is shown in Figure 4-1.



Figure 4-1. LP5814DRLEVM Schematic



LP5815DRLEVM schematic is shown in Figure 4-2.



Figure 4-2. LP5815DRLEVM Schematic



4.2 PCB Layouts

Figure 4-3 and Figure 4-4 show the top layer and bottom layer of the LP5814DRLEVM PCB layout.



Figure 4-3. LP5814DRLEVM PCB Top Layer



Figure 4-4. LP5814DRLEVM PCB Bottom Layer

Figure 4-5 and Figure 4-6 show the top layer and bottom layer of the LP5815DRLEVM PCB layout.





Figure 4-5. LP5815DRLEVM PCB Top Layer



Figure 4-6. LP5815DRLEVM PCB Bottom Layer



4.3 Bill of Materials (BOM)

Table 4-1 shows the bill of materials (BOM) of LP5814DRLEVM.

Table 4-1. LP5814DRLEVM BOM DESIGNATOR QUANTITY DESCRIPTION MANUFACTURER PART NUMBER C1 1 CAP, CERM, 1µF, 10V, +/- 10%, X7R, 0603 Taiyo Yuden LMK107B7105KA-T D1 1 LED, RGB, SMD Cree CLY6D-FKC-CK1N1D1BB7D3D3 D2 1 LED, Cool White, SMD Cree CLM3C-WKW-CWBYA453 J1, J2 2 Header, 100mil, 2x1, Gold, TH HTSW-102-07-G-S Samtec J3, J4, J5, J6, J7, 8 Header, 2.54mm, 1x1, Gold, TH Samtec TSW-101-08-G-S J8, J9, J10 R1, R2 2 RES, 4.7k, 5%, 0.1W, 0603 Vishay-Dale CRCW06034K70JNEA SH-J1, SH-J2 2 Shunt, 100mil, Gold plated, Black Samtec SNT-100-BK-G 1 5011 GND Test Point, Multipurpose, Black, TH Keystone VCC Test Point, Multipurpose, Red, TH 1 Keystone 5010 VLED 1 Test Point, Multipurpose, Yellow, TH Keystone 5014 Header(shrouded), 2.54mm, 15x2, Gold with Sullins Connector USB1 1 SBH11-PBPC-D05-RA-BK Tin tail, R/A, TH Solutions 4-Channel I2C Interface RGBW LED Driver U1 1 Texas Instruments LP5814DRLR with Auto Animation Control

Table 4-2 shows the bill of materials (BOM) of LP5815DRLEVM.

Table 4-2. LP5815DRLEVM BOM

DESIGNATOR QUANTITY		DESCRIPTION	MANUFACTURER	PART NUMBER
C1	1	CAP, CERM, 1µF, 10V, +/- 10%, X7R, 0603	Taiyo Yuden	LMK107B7105KA-T
D1	1	LED, RGB, SMD	Cree	CLY6D-FKC- CK1N1D1BB7D3D3
J2, J3, J9	3	Header, 100mil, 2x1, Gold, TH	Samtec	HTSW-102-07-G-S
J4, J5, J6, J7, J8, J10, J11	7	Header, 2.54mm, 1x1, Gold, TH	Samtec	TSW-101-08-G-S
R1, R2, R3	R1, R2, R3 3 RES, 4.7k, 5%, 0.1W, 0603		Vishay-Dale	CRCW06034K70JNEA
SH-J1, SH-J2, SH- J3	3 Shunt, 100mil, Gold plated, Black		Samtec	SNT-100-BK-G
GND	GND 1 Test Point, Multipurpose, Black, TH		Keystone	5011
VCC	VCC 1 Test Point, Multipurpose, Red, TH		Keystone	5010
VLED	VLED 1 Test Point, Multipurpose, Yellow, TH		Keystone	5014
USB1	1	Header(shrouded), 2.54mm, 15x2, Gold with Tin tail, R/A, TH	Sullins Connector Solutions	SBH11-PBPC-D05-RA-BK
U1	U1 1 3-Channel I2C Interface RGB LED Driver with Instant Blinking and Auto Animation Control		Texas Instruments	LP5815DRLR



5 Additional Information

5.1 Trademarks

All trademarks are the property of their respective owners.

STANDARD TERMS FOR EVALUATION MODULES

- 1. Delivery: TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, and/or documentation which may be provided together or separately (collectively, an "EVM" or "EVMs") to the User ("User") in accordance with the terms set forth herein. User's acceptance of the EVM is expressly subject to the following terms.
 - 1.1 EVMs are intended solely for product or software developers for use in a research and development setting to facilitate feasibility evaluation, experimentation, or scientific analysis of TI semiconductors products. EVMs have no direct function and are not finished products. EVMs shall not be directly or indirectly assembled as a part or subassembly in any finished product. For clarification, any software or software tools provided with the EVM ("Software") shall not be subject to the terms and conditions set forth herein but rather shall be subject to the applicable terms that accompany such Software
 - 1.2 EVMs are not intended for consumer or household use. EVMs may not be sold, sublicensed, leased, rented, loaned, assigned, or otherwise distributed for commercial purposes by Users, in whole or in part, or used in any finished product or production system.
- 2 Limited Warranty and Related Remedies/Disclaimers:
 - 2.1 These terms do not apply to Software. The warranty, if any, for Software is covered in the applicable Software License Agreement.
 - 2.2 TI warrants that the TI EVM will conform to TI's published specifications for ninety (90) days after the date TI delivers such EVM to User. Notwithstanding the foregoing, TI shall not be liable for a nonconforming EVM if (a) the nonconformity was caused by neglect, misuse or mistreatment by an entity other than TI, including improper installation or testing, or for any EVMs that have been altered or modified in any way by an entity other than TI, (b) the nonconformity resulted from User's design, specifications or instructions for such EVMs or improper system design, or (c) User has not paid on time. Testing and other quality control techniques are used to the extent TI deems necessary. TI does not test all parameters of each EVM. User's claims against TI under this Section 2 are void if User fails to notify TI of any apparent defects in the EVMs within ten (10) business days after delivery, or of any hidden defects with ten (10) business days after the defect has been detected.
 - 2.3 TI's sole liability shall be at its option to repair or replace EVMs that fail to conform to the warranty set forth above, or credit User's account for such EVM. TI's liability under this warranty shall be limited to EVMs that are returned during the warranty period to the address designated by TI and that are determined by TI not to conform to such warranty. If TI elects to repair or replace such EVM, TI shall have a reasonable time to repair such EVM or provide replacements. Repaired EVMs shall be warranted for the remainder of the original warranty period. Replaced EVMs shall be warranted for a new full ninety (90) day warranty period.

WARNING

Evaluation Kits are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems.

User shall operate the Evaluation Kit within TI's recommended guidelines and any applicable legal or environmental requirements as well as reasonable and customary safeguards. Failure to set up and/or operate the Evaluation Kit within TI's recommended guidelines may result in personal injury or death or property damage. Proper set up entails following TI's instructions for electrical ratings of interface circuits such as input, output and electrical loads.

NOTE:

EXPOSURE TO ELECTROSTATIC DISCHARGE (ESD) MAY CAUSE DEGREDATION OR FAILURE OF THE EVALUATION KIT; TI RECOMMENDS STORAGE OF THE EVALUATION KIT IN A PROTECTIVE ESD BAG.

3 Regulatory Notices:

3.1 United States

3.1.1 Notice applicable to EVMs not FCC-Approved:

FCC NOTICE: This kit is designed to allow product developers to evaluate electronic components, circuitry, or software associated with the kit to determine whether to incorporate such items in a finished product and software developers to write software applications for use with the end product. This kit is not a finished product and when assembled may not be resold or otherwise marketed unless all required FCC equipment authorizations are first obtained. Operation is subject to the condition that this product not cause harmful interference to licensed radio stations and that this product accept harmful interference. Unless the assembled kit is designed to operate under part 15, part 18 or part 95 of this chapter, the operator of the kit must operate under the authority of an FCC license holder or must secure an experimental authorization under part 5 of this chapter.

3.1.2 For EVMs annotated as FCC – FEDERAL COMMUNICATIONS COMMISSION Part 15 Compliant:

CAUTION

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

FCC Interference Statement for Class A EVM devices

NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

FCC Interference Statement for Class B EVM devices

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.
- 3.2 Canada

3.2.1 For EVMs issued with an Industry Canada Certificate of Conformance to RSS-210 or RSS-247

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-exempt RSSs. Operation is subject to the following two conditions:

(1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Concernant les EVMs avec appareils radio:

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Concerning EVMs Including Detachable Antennas:

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication. This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Concernant les EVMs avec antennes détachables

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante. Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans le manuel d'usage et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur

- 3.3 Japan
 - 3.3.1 Notice for EVMs delivered in Japan: Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page 日本国内に 輸入される評価用キット、ボードについては、次のところをご覧ください。

https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-delivered-in-japan.html

3.3.2 Notice for Users of EVMs Considered "Radio Frequency Products" in Japan: EVMs entering Japan may not be certified by TI as conforming to Technical Regulations of Radio Law of Japan.

If User uses EVMs in Japan, not certified to Technical Regulations of Radio Law of Japan, User is required to follow the instructions set forth by Radio Law of Japan, which includes, but is not limited to, the instructions below with respect to EVMs (which for the avoidance of doubt are stated strictly for convenience and should be verified by User):

- 1. Use EVMs in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry's Rule for Enforcement of Radio Law of Japan,
- 2. Use EVMs only after User obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or
- 3. Use of EVMs only after User obtains the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to EVMs. Also, do not transfer EVMs, unless User gives the same notice above to the transferee. Please note that if User does not follow the instructions above, User will be subject to penalties of Radio Law of Japan.

【無線電波を送信する製品の開発キットをお使いになる際の注意事項】 開発キットの中には技術基準適合証明を受けて

いないものがあります。 技術適合証明を受けていないもののご使用に際しては、電波法遵守のため、以下のいずれかの 措置を取っていただく必要がありますのでご注意ください。

- 1. 電波法施行規則第6条第1項第1号に基づく平成18年3月28日総務省告示第173号で定められた電波暗室等の試験設備でご使用 いただく。
- 2. 実験局の免許を取得後ご使用いただく。
- 3. 技術基準適合証明を取得後ご使用いただく。
- なお、本製品は、上記の「ご使用にあたっての注意」を譲渡先、移転先に通知しない限り、譲渡、移転できないものとします。 上記を遵守頂けない場合は、電波法の罰則が適用される可能性があることをご留意ください。 日本テキサス・イ

ンスツルメンツ株式会社

東京都新宿区西新宿6丁目24番1号

西新宿三井ビル

- 3.3.3 Notice for EVMs for Power Line Communication: Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_02.page 電力線搬送波通信についての開発キットをお使いになる際の注意事項については、次のところをご覧くださ い。https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-for-power-line-communication.html
- 3.4 European Union
 - 3.4.1 For EVMs subject to EU Directive 2014/30/EU (Electromagnetic Compatibility Directive):

This is a class A product intended for use in environments other than domestic environments that are connected to a low-voltage power-supply network that supplies buildings used for domestic purposes. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

4 EVM Use Restrictions and Warnings:

- 4.1 EVMS ARE NOT FOR USE IN FUNCTIONAL SAFETY AND/OR SAFETY CRITICAL EVALUATIONS, INCLUDING BUT NOT LIMITED TO EVALUATIONS OF LIFE SUPPORT APPLICATIONS.
- 4.2 User must read and apply the user guide and other available documentation provided by TI regarding the EVM prior to handling or using the EVM, including without limitation any warning or restriction notices. The notices contain important safety information related to, for example, temperatures and voltages.
- 4.3 Safety-Related Warnings and Restrictions:
 - 4.3.1 User shall operate the EVM within TI's recommended specifications and environmental considerations stated in the user guide, other available documentation provided by TI, and any other applicable requirements and employ reasonable and customary safeguards. Exceeding the specified performance ratings and specifications (including but not limited to input and output voltage, current, power, and environmental ranges) for the EVM may cause personal injury or death, or property damage. If there are questions concerning performance ratings and specifications, User should contact a TI field representative prior to connecting interface electronics including input power and intended loads. Any loads applied outside of the specified output range may also result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM user guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative. During normal operation, even with the inputs and outputs kept within the specified allowable ranges, some circuit components may have elevated case temperatures. These components include but are not limited to linear regulators, switching transistors, pass transistors, current sense resistors, and heat sinks, which can be identified using the information in the associated documentation. When working with the EVM, please be aware that the EVM may become very warm.
 - 4.3.2 EVMs are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems. User assumes all responsibility and liability for proper and safe handling and use of the EVM by User or its employees, affiliates, contractors or designees. User assumes all responsibility and inability to ensure that any interfaces (electronic and/or mechanical) between the EVM and any human body are designed with suitable isolation and means to safely limit accessible leakage currents to minimize the risk of electrical shock hazard. User assumes all responsibility and liability for any improper or unsafe handling or use of the EVM by User or its employees, affiliates, contractors or designees.
- 4.4 User assumes all responsibility and liability to determine whether the EVM is subject to any applicable international, federal, state, or local laws and regulations related to User's handling and use of the EVM and, if applicable, User assumes all responsibility and liability for compliance in all respects with such laws and regulations. User assumes all responsibility and liability for proper disposal and recycling of the EVM consistent with all applicable international, federal, state, and local requirements.
- 5. Accuracy of Information: To the extent TI provides information on the availability and function of EVMs, TI attempts to be as accurate as possible. However, TI does not warrant the accuracy of EVM descriptions, EVM availability or other information on its websites as accurate, complete, reliable, current, or error-free.
- 6. Disclaimers:
 - 6.1 EXCEPT AS SET FORTH ABOVE, EVMS AND ANY MATERIALS PROVIDED WITH THE EVM (INCLUDING, BUT NOT LIMITED TO, REFERENCE DESIGNS AND THE DESIGN OF THE EVM ITSELF) ARE PROVIDED "AS IS" AND "WITH ALL FAULTS." TI DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, REGARDING SUCH ITEMS, INCLUDING BUT NOT LIMITED TO ANY EPIDEMIC FAILURE WARRANTY OR IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF ANY THIRD PARTY PATENTS, COPYRIGHTS, TRADE SECRETS OR OTHER INTELLECTUAL PROPERTY RIGHTS.
 - 6.2 EXCEPT FOR THE LIMITED RIGHT TO USE THE EVM SET FORTH HEREIN, NOTHING IN THESE TERMS SHALL BE CONSTRUED AS GRANTING OR CONFERRING ANY RIGHTS BY LICENSE, PATENT, OR ANY OTHER INDUSTRIAL OR INTELLECTUAL PROPERTY RIGHT OF TI, ITS SUPPLIERS/LICENSORS OR ANY OTHER THIRD PARTY, TO USE THE EVM IN ANY FINISHED END-USER OR READY-TO-USE FINAL PRODUCT, OR FOR ANY INVENTION, DISCOVERY OR IMPROVEMENT, REGARDLESS OF WHEN MADE, CONCEIVED OR ACQUIRED.
- 7. USER'S INDEMNITY OBLIGATIONS AND REPRESENTATIONS. USER WILL DEFEND, INDEMNIFY AND HOLD TI, ITS LICENSORS AND THEIR REPRESENTATIVES HARMLESS FROM AND AGAINST ANY AND ALL CLAIMS, DAMAGES, LOSSES, EXPENSES, COSTS AND LIABILITIES (COLLECTIVELY, "CLAIMS") ARISING OUT OF OR IN CONNECTION WITH ANY HANDLING OR USE OF THE EVM THAT IS NOT IN ACCORDANCE WITH THESE TERMS. THIS OBLIGATION SHALL APPLY WHETHER CLAIMS ARISE UNDER STATUTE, REGULATION, OR THE LAW OF TORT, CONTRACT OR ANY OTHER LEGAL THEORY, AND EVEN IF THE EVM FAILS TO PERFORM AS DESCRIBED OR EXPECTED.

www.ti.com

- 8. Limitations on Damages and Liability:
 - 8.1 General Limitations. IN NO EVENT SHALL TI BE LIABLE FOR ANY SPECIAL, COLLATERAL, INDIRECT, PUNITIVE, INCIDENTAL, CONSEQUENTIAL, OR EXEMPLARY DAMAGES IN CONNECTION WITH OR ARISING OUT OF THESE TERMS OR THE USE OF THE EVMS, REGARDLESS OF WHETHER TI HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. EXCLUDED DAMAGES INCLUDE, BUT ARE NOT LIMITED TO, COST OF REMOVAL OR REINSTALLATION, ANCILLARY COSTS TO THE PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES, RETESTING, OUTSIDE COMPUTER TIME, LABOR COSTS, LOSS OF GOODWILL, LOSS OF PROFITS, LOSS OF SAVINGS, LOSS OF USE, LOSS OF DATA, OR BUSINESS INTERRUPTION. NO CLAIM, SUIT OR ACTION SHALL BE BROUGHT AGAINST TI MORE THAN TWELVE (12) MONTHS AFTER THE EVENT THAT GAVE RISE TO THE CAUSE OF ACTION HAS OCCURRED.
 - 8.2 Specific Limitations. IN NO EVENT SHALL TI'S AGGREGATE LIABILITY FROM ANY USE OF AN EVM PROVIDED HEREUNDER, INCLUDING FROM ANY WARRANTY, INDEMITY OR OTHER OBLIGATION ARISING OUT OF OR IN CONNECTION WITH THESE TERMS, EXCEED THE TOTAL AMOUNT PAID TO TI BY USER FOR THE PARTICULAR EVM(S) AT ISSUE DURING THE PRIOR TWELVE (12) MONTHS WITH RESPECT TO WHICH LOSSES OR DAMAGES ARE CLAIMED. THE EXISTENCE OF MORE THAN ONE CLAIM SHALL NOT ENLARGE OR EXTEND THIS LIMIT.
- 9. Return Policy. Except as otherwise provided, TI does not offer any refunds, returns, or exchanges. Furthermore, no return of EVM(s) will be accepted if the package has been opened and no return of the EVM(s) will be accepted if they are damaged or otherwise not in a resalable condition. If User feels it has been incorrectly charged for the EVM(s) it ordered or that delivery violates the applicable order, User should contact TI. All refunds will be made in full within thirty (30) working days from the return of the components(s), excluding any postage or packaging costs.
- 10. Governing Law: These terms and conditions shall be governed by and interpreted in accordance with the laws of the State of Texas, without reference to conflict-of-laws principles. User agrees that non-exclusive jurisdiction for any dispute arising out of or relating to these terms and conditions lies within courts located in the State of Texas and consents to venue in Dallas County, Texas. Notwithstanding the foregoing, any judgment may be enforced in any United States or foreign court, and TI may seek injunctive relief in any United States or foreign court.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265 Copyright © 2023, 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 © 2025, Texas Instruments Incorporated