I²C Load Switch GUI and EVM Board

User's Guide



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I²C Load GUI and EVM Board

The I²C Load Switch EVM Board contains two quad channel load switch devices that are ultra-low resistance (R_{ON}) with I²C programmable slew rate, delay time, and QOD channel. The I²C Load switch EVM is available for both the TPS22993 and the TPS22994. Multiple I²C load switch EVM boards may be connected together and controlled via a single I²C master.

1 Description

The I²C Load Switch is a multi-channel low R_{ON} load switch with user selectable controlled turn on. The device contains four N-channel MOSFET devices that can operate over an input voltage range of 1.0 V to 3.6 V. The switch is controlled by I²C making it ideal for usage with processors that have limited GPIO available. The rise time of the I²C Load Switch device is internally controlled in order to avoid inrush current. The I²C Load Switch has five programmable slew rate options. The device also has adjustable ON-delay as well as selectable quick output discharge (QOD) resistance.

The device can operate in either GPIO or I²C mode. The default mode of operation is GPIO control through the ONx pins. The address pins can be tied high or low to assign seven unique addresses.

The I²C Load Switch is available in a space-saving WQFN package (0.4-mm pitch) and is characterized for operation over the free-air temperature range of -40°C to 85°C.

1.1 Typical Applications

- Ultrabooks[™]
- Notebooks and Netbooks
- Tablet PC

- Consumer Electronics
- Smartphones
- Servers

1.2 Features

- EVM contains two I²C Load Switch devices, for a total of 8 independently controlled channels
 - Additional I²C Load Switch EVMs can be daisy chained (up to 4 EVMs) to give a total of 28 channels that can be controlled independently via I²C
- I²C control interface allows user to use any I²C capable microcontroller for evaluation of the EVM
 - TI I²C capable microcontroller module (USB2ANY) included in EVM kit
 - Daisy chained EVMs can only be controlled through I²C mode. USB2ANY can control only 2 devices through GPIO on the board it is directly connected to. The GPIO control for these 2 devices is accessed through the U1 and U2 tabs regardless of I²C address.
- Status LEDs for each channel output allows for quick debug of setup
- VIN input voltage range: 1V to 3.6V
- VBIAS voltage range: 4.5V to 17.2V
 - Suitable for 2S/3S/4S Li-ion battery topologies
- TPS22993 is capable of up to 1.2 A continuous current per channel
- TPS22994 is capable of up to 1.0 A continuous current per channel

Electrical Performance Specifications

www.ti.com

2 Electrical Performance Specifications

For TPS22993 specifications refer to datasheet (SLVSCA3)

For TPS22994 specifications refer to datasheet (SLVSCL4)

3 Setup – System Requirements - Windows 7 or XP

(A) To install the software run the setup.application from the link below (<u>http://www.ti.com/tool/tps22993evm-033</u>) by right clicking and saying "Run as Administrator, see Figure 1.

Name			Date m	odified	Туре	Size
🍌 bin			9/11/20	014 3:09 PM	File folder	
🍌 license			9/11/20	014 3:09 PM	File folder	
🍌 supportfi	les		9/11/20	014 3:09 PM	File folder	
nidist.id			9/11/20	014 10:38 AM	ID File	1 KB
🚽 setup.exe			6/11/20	13 5:00 PM	Application	1,394 KB
setup.ini		Open		4 10:38 AM	Configuration sett	12 KB
	9	Run as administrator				
		Troubleshoot compatibility 7-Zip	,			
		Scan for Viruses				

Figure 1. Select Run Administrator When Executing the Installer

(B) You should see a pop up window asking you to install the software click "Yes" and then you should see the window in Figure 2 pop up and click "Next" and agree to the terms and conditions in the installer.

ad Switch GUI	
Destination Directory Select the primary installation directory.	
All software will be installed in the following location: different location, click the Browse button and selec	a
Directory for I2C Load Switch GUI	
Directory for I2C Load Switch GUI C:\Program Files (x86)\Texas Instruments\	Browse
	Browse

Figure 2. I²C Load Switch Application Installer

(C) You will see a Python installer begin, see Figure 3, let the installer complete and then click OK.



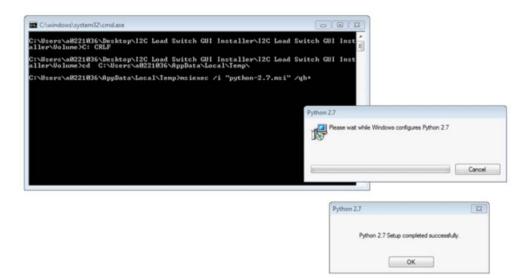


Figure 3. Python Installer

(D) Connect the USB cable to the USB2ANY and then to the computer and connect the ribbon cable to the EVM board. The setup should look like Figure 4 when you are done.

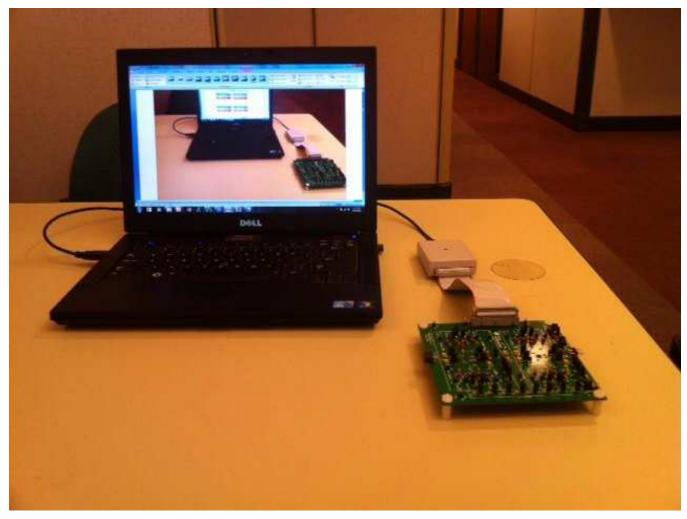


Figure 4. I²C Load Switch Board and USB2ANY Setup



4 Device GUI SW

CAUTION

Do not launch the I^2C Load Switch GUI Application without having the USBB2ANY plugged into the computer first.

- (A) Go to All Programs >>> Texas Instrument >> I²C Load Switch GUI to launch the application.
- (B) The I²C Load Switch GUI application window should pop on your screen, see Figure 5.
- (C) You are ready to begin using the software and the demo board.

then all	12C L	oad Switch Device	GUI		
ph Level Configuration HL U2 HL U2 HL U3	Switch ALL ^{~~} - PW Version 2.6.3.0		-	Go to Low Level Co	infiguration Go to Abo
HL US HL US	U1 U2 ADD31=06000 ADD31=06001 ADD	U3 U4 0.1 = 06010 ADD3.1 = 06011	U5 AD031 = 08100	4003.1 = 06101	U7 ADD31 = 06110
Low Level Certiquision About	U1 C0	ONFIG CON		in the second	
	CH1 Settings	CH2 Settings		UI MODE Settings	IT C FALLER FO
	CH1 GPIO MODE	CH2 GPIO MODE			
	IZC CH1 DISABLED	12C CH2 DISABLED		UL MODE 2 NO CHANNELS ENABLED	
	GPIO CH1 DISABLED	GPIO CH2 DISABLED		UL MODE 3 (NO CHANNELS ENABLED	
	U1 CH1 QOD U1 CH1 SLEW RATE U1 CH1 ON DELAY	UT CH2 QOD UT CH2 SLEW RATE UT CH2 ON DELAY		UL MODE 4 NO CHANNELS ENABLED	
	951 Ohm 460us/V 11us	951 Ohm 460us/V	llus	UL MODE S (NO CHANK	ELS ENGABLED
				UT MODE 6 (NO CHANN	IELS ENABLED
	CH3 Settings	CH4 Settings		UL MODE 7 (NO CHANN	ELS ENABLED
	CH3 GPIO MODE	CH4 GPIO MO	DE	UL MODE # () NO CHANE	VELS ENABLED
	I2C CH3 DISABLED	I2C CH4 DISAB	LED	UL MODE 9 1 NO CHUNK	ILS ENABLED
	GPIO CH3 DISABLED	GPIO CH4 DISA	BLED	UI MODE 15 (NO CHANE	JELS ENABLED
	U1 CH3 QOD U1 CH3 SLEW RATE U1 CH3 ON DELAN 9510hm 460us/V 13us	U1 CH4 QOD U1 CH4 SLEW RATE 951 Ohm 460us/V	U1 CH4 ON DELAT	UI MODE II (ND CHANN	
	·			UI MODE 12 ANO CHANE	IELS ENABLED

Figure 5. I²C Load Switch GUI Application Window

Device GUI SW



Device GUI SW

4.1 High Level Functionality

- (A) The HL U1 U7 Tabs contain high level controls that set the device to specific register settings. Each change in the control value results in a register write to the device.
- (B) There are 6 different controls for each channel on the device
 - CHx GPIO/I2C Mode
 - CHx I2C Disable/Enable
 - CHx GPIO Disable/Enable
 - CHx QOD resistance
 - CHx Turn On Slew Rate
 - CHx Turn On Delay Time
- (C) The GUI also provides Mode Register Controls for each device
- (D) The SwitchALL[™] control communicates with all devices simultaneously.
- (E) See Figure 6 showing the different controls (SwitchALL[™], Channel Controls, MODE Registers)

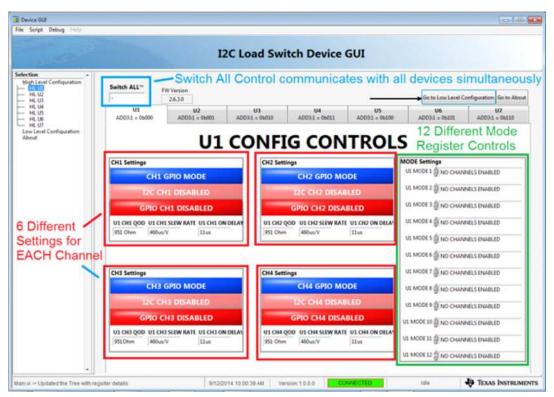


Figure 6. Description of the Different Control in the GUI



4.2 Select U1 – U7

- (A) You can navigate to the controls for U1 U7 in two different ways.
- (B) The first way is by clicking the device tab (U1, U2, U3, etc.).
- (C) The second way is by clicking the high level functions on the left side of the screen, see Figure 7.
- (D) Be sure that the I²C address is properly configured using jumper points JP7, JP9, JP11, JP20, JP22, and JP23. The configured address should correspond to the address appearing on the specific device tab.

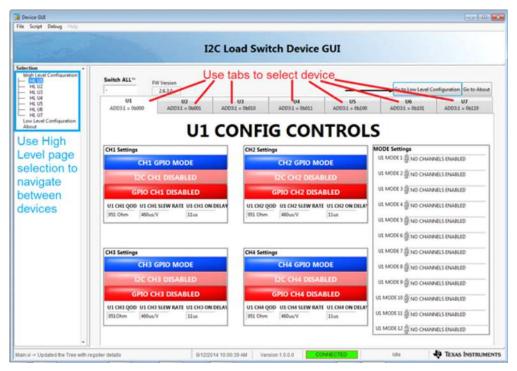


Figure 7. Ways to Select Device Control



4.3 GPIO Mode or *PC* Mode for Each Channel

- (A) The CHx GPIO Mode/I²C Mode Control will set the channel on that specific device to respond to either the GPIO Enable Pin or the I²C EN register bit. See Figure 8 showing CH1 and CH2 of U1 are set to the 2 different modes.
- (B) Also the disable/enable control for the alternate mode will become inactive to the user. In Figure 8, I²C CH1 Disable is pink which indicates this does not have an effect on the output of CH1 and this is the same for GPIO CH2 Disabled; the user will not be able to change the value on the high level page until the channel mode selection has been changed. Figure 8 shows the controls that are active and deactivated for CH1 and CH2.

	I2C Lo	ad Switch Device	GUI		
ntion digh Level Configuration Ht. U2 Ht. U2	Switch ALL** FW Version			Go to Low Level Cr	onliguration Go to About
HLUS HLUS	U1 U2 ADD31 = 06000 ADD31 = 06001 ADD1	U3 U4 3-1 = 05010 ADD3-1 = 05011	U5 A0031 = 06100	U6 AD031 = 06101	U7 AD031 = 06110
w Level Configuration bout	U1 CC	ONFIG CON	TROLS	5	
lode	CH1 Settings	CH2 Settings		MODE Settings	
	CH1 I2C MODE	CH2 GPIO MC	DE	UL MODE 1 NO CHANN	
	12C CH1 DISABLED	I2C CH2 DISA	ILED	UL MODE 2 NO CHANN	VELS ENABLED
	GPIO CH1 DISABLED	GPIO CH2 DISA	BLED	UL MODE 3 1 NO CHUNN	VELS ENABLED
	UI CHI QOD UI CHI SLEW RATE UI CHI ON DELAY	U1 CH2 QOD U1 CH2 SLEW RATE	(manufacture and states)	UL MODE 4 () NO CHANN	KELS ENABLED
/	951 Ohm 460us/V 11us	951 Ohm 460us/V	llus	UL MODE S ON CHANN	VELS ENABLED
tive Mode				UL MODE 6 () NO CHUNK	VELS ENABLED
LIVE MODE	CH3 Settings	CH4 Settings		UL MODE 7 NO CHUNK	HELS ENABLED
	CH3 GPIO MODE	CH4 GPIO MC	DE	UL MODE & NO CHUNK	HELS ENABLED
	I2C CH3 DISABLED	12C CH4 DISA	ILED	UL MODE 9 1 NO CHANN	VELS ENABLED
	GPIO CH3 DISABLED	GPIO CH4 DISA	BLED	UL MODE 10 D NO CHANN	
	UI CH3 QOD UI CH3 SLEW RATE UI CH3 ON DELAN 951 Ohm 460 us/V II us	UI CH4 QOD UI CH4 SLEW RATE 951 Chm 450us/V	E UT CHI ON DELAT	UI MODE 11 (NO CHUNK	
				UL MODE 12 NO CHUNN	VELS ENABLED

Figure 8. Set GPIO Mode or I²C Mode on Different Channels



4.4 SwitchALL™ Functionality and Mode Registers

- (A) To use the SwitchAll[™] function, the GUI CONFIG controls for all channels must be set to the I²C Mode, and the I²C communication must be enabled.
- (B) You can use the SwitchALL[™] functionality by configuring the Mode Register controls for each specific mode register on the two devices.
- (C) For example U1 MODE1 is configured to enable CH1 only and U2 MODE1 is configured to enable CH2 only, you must set these first before sending the SwitchALL[™] command, see Figure 9 and Figure 10.
- (D) Once you set the SwitchALL[™] control to MODE1 then SwitchALL[™] command will be sent to both devices and each device will respond according to how you have configured the MODE1 register for that device, see Figure 11.

cript Debug Hillp	I2C Los	ad Switch Device GUI			
High Level Configuration High Level Configuration High D High D High U2 - High U2	Switch ALL**	E1 - Set to CH1 Enabled, channels disabled	Ge to Low Level Configuration Ge to Ab		
L US L US L US		U3 U4 U5 = 06030 ADD31 = 06011 ADD31 = 0610	U6 U7 AD031 = 06101 AD031 = 06110		
ov Level Configuration bout	U1 C0	NFIG CONTROL			
	CH1 Settings	CH2 Settings	MODE Settings UL MODE 1 CHL ENABLED		
	CH1 I2C MODE	CH2 I2C MODE			
	12C CH1 ENABLED	I2C CH2 ENABLED	UL MODE 2 NO CHANNELS ENABLED		
	GPIO CH1 DISABLED	GPIO CH2 DISABLED	UL MODE 3 (INO CHANNELS ENABLED		
	U1 CH1 QOD U1 CH1 SLEW RATE U1 CH1 ON DELAY	U1 CH2 QOD U1 CH2 SLEW RATE U1 CH2 ON DELAY	UL MODE 4 DI NO CHANNELS ENABLED		
	951 Chm 460us/V 11us	951 Ohm 460us/V 11us	UL MODE 5 D NO CHANNELS ENABLED		
			UL MODE 6 D NO CHANNELS ENABLED		
	CH3 Settings	CH4 Settings	UL MODE 7 B NO CHUNNELS ENABLED		
	CH3 I2C MODE	CH4 IZC MODE	UL MODE 8 @ NO CHANNELS ENABLED		
	I2C CH3 ENABLED	12C CH4 ENABLED	UL MODE 9 D NO CHANNELS ENABLED		
	GPIO CH3 DISABLED	GPIO CH4 DISABLED	UL MODE 10 D NO CHANNELS ENABLED		
	UI CH3 QOD UI CH3 SLEW RATE UI CH3 ON DELAN 951.0hm 460us/V IIus	U1 CH4 QOD U1 CH4 SLEW RATE U1 CH4 ON DELA" 951 Chm 460us/V 11us	UL MODE 11 () NO CHANNELS ENABLED		
			UL MODE 12 2 NO CHANNELS ENABLED		

Figure 9. Set U1 Mode1 Register to CH1 Enabled

File Script Debug Hirlp	I2C Lo	ad Switch Device GUI		
Selection Selection	Switch ALL** PW Viersion 28.330 U1 28.330 U2 ADD3.1 = 06000 ADD3.1 = 06001 ADD3	DE1 - Set to CH2 Enables r channels disabled ⁰³ 1 = 0600 ADC31 = 0601 ADC31 = 0601	Go to Low Level Configuration Go to About U6 U7 AD031 = 06001 AD031 = 0610	
	U2 CC	ONFIG CONTROL		
	CH1 Settings CH1 12C MODE	CH2 Settings CH2 12C MODE	MODE Settings	
	I2C CH1 ENABLED	I2C CH2 ENABLED	UZ MODE Z () NO CHANNELS ENABLED	
	GPIO CH1 DISABLED	GPIO CH2 DISABLED	U2 MODE 3 () NO CHANNELS ENABLED	
	U2 CH1 QOD U2 CH1 SEEW RATE U2 CH1 ON DELAY 950 Chm 480us/V 11us	U2 CH2 QOD U2 CH2 SEEW RATE U2 CH2 ON DELA* 951 Ohm 460us/V 11us	UZ MODE 4 @ NO CHANNELS ENABLED	
			UZ MODE & NO CHANNELS ENABLED	
	CH3 Settings	CH4 Settings	UZ MODE 7 () NO CHANNELS ENABLED	
	CH3 I2C MODE	CH4 I2C MODE	U2 MODE 8 (INO CHANNELS ENABLED	
	I2C CH3 ENABLED	12C CH4 ENABLED	UZ MODE 9 DI NO CHANNELS ENABLED	
	GPIO CH3 DISABLED	GPIO CH4 DISABLED	LIZ MODE 10 DI NO CHANNELS ENABLED	
	U2 CH3 QOD U2 CH3 SLEW RATE U2 CH3 ON DELAY 951 Ohm 460us/V 11us	951 Ohm 460us/V 11us	U2 MODE 11 (NO CHANNELS ENABLED	

Figure 10. Set U2 Mode1 Register to CH2 Enabled

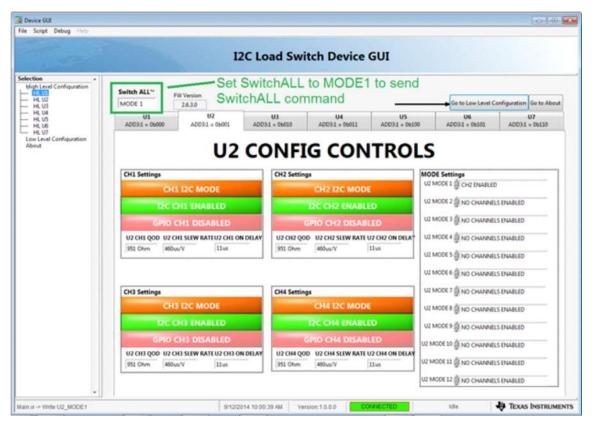


Figure 11. Set SwitchALL™ Control to MODE1 to Send SwitchALL™ Command



4.5 Scripting Functionality

- (A) Restart the Device GUI to insure the GUI starts with the known default values.
- (B) Go to the drop down menu Script >> Launch window as shown in Figure 12.
- (C) A Python scripting window should be launched named Untitled as shown in Figure 13.
- (D) Go to the drop down menu Script >> Start Recording, see Figure 14
- (E) The Python script should begin flashing green and additional text should show up in the window, see Figure 15.
- (F) You are now ready to record the actions in the I²C Load Switch GUI. Click on the U2 tab to select device U2. Click on CH1 GPIO Mode it should transition to CH1 I2C MODE, Click on I2C CH1 Disable and it should transition to I2C CH1 Enabled and turn Green, Click on U2 CH1 QOD and select 110 Ω , Click on U2 CH1 Slew Rate and select 250 μ s/V, and Click on U2 CH1 ON Delay and select 105 μ s.
- (G) Your GUI screen should look like Figure 16 after you have finished clicking the controls.
- (H) These steps should have been recorded in the Python script GUI, see Figure 17.
- (I) Go to the script drop down menu and select Stop Recording, see Figure 18. The Python window should now have the GUI.__del__() command added to the last of the script and the Python window should have stopped flashing green.
- (J) Open the Python window and go to File >> Save As, see Figure 19
- (K) Browse to the Desktop and put the file name as test_gui_script.py (to save the file, you must enter the .py file extension at the end of the file name, for example, test.py) and save it to the desktop, see Figure 20.
- (L) Go to the I²C Load Switch GUI and Select File>> Exit, see Figure 21 to exit the application.
- (M) Restart the application and go to Script >>> Launch Window.
- (N) In the Python window go to File >> Open>> and Browse to the test_gui_script.py file on the desktop, see Figure 22.
- (O) In the Python window go to Run >> Run Module, see Figure 23. The Python script should run and another python window should pop us saying Script Completed Successfully.
- (P) The I²C Load Switch GUI setting for U2 CH2 should now be updated to the setting from the recording after restarting the application and running the script, see Figure 24.

Device GUI SW

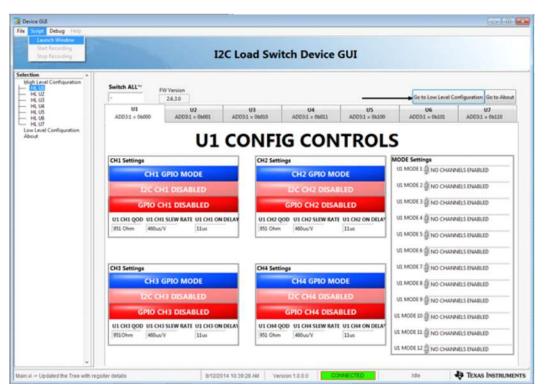


Figure 12. Launch Script Window

le Script Debug	Help			
	and the second			
	74 Untitled			
ection	File Edit Format Run Options Windows Help			
High Level Configu		-		
HL UZ				
HL US			Go to Low Level C	onfiguration Go to About
HL US		US	U6	U7
- HE US		1 = 06100	A003.1 = 06101	A0031 = 06110
HL UT				
4bout		OL	C	
		UL I	5	
			MODE Settings	1
			UI MODE I DI NO CHAN	AND C FRANK PA
			an inter i gino chur	PRES EPARALLY
			US MODE 2 NO CHAN	NELS ENABLED
			1	
			UL MODE 3 NO CHAN	NELS ENABLED
		ON DELAY	UI MODE 4 () NO CHUN	NELS ENABLED
			UE MODE 5 () NO CHAN	AND CONTRACT
		_	and a state of the state	HELD CREADLED
			UL MODE 6 NO CHUN	NELS ENABLED
			UL MODE 7 DI NO CHAN	NELS ENABLED
			in the second descent	
			UL MODE & NO CHUN	NELS ENABLED
			UL MODE 9 D ND CHAN	ANTI C FRIADI ED
			an and a gray crown	HELD EPERDLED
			UL MODE 19 AND CHAN	NELS ENABLED
		ON DELAY		
			UI MODE II () NO CHAN	NELS ENABLED
			UI MODE 12 A NO CHAN	
		Lm 1 Colt 0	OR MODE LA WIND CHAN	NELS ENGABLED

Figure 13. Python Script Window Pops Up

Launch Window							
Stat Recording Stop Recording		L	2C Load	Switch Device	GUI		
tion A Level Configuration	Switch ALL**	Version 263.0				Go to Low Level C	onfiguration Go to About
HL U4 HL U5 HL U6	U1 ADD31 = 06000	U2 AD031 = 06001	U3 AD031 = 060	19 AD031 = 06011	US A0031 = 06000	U6 AD03:1 = 06101	U7 ADD31 = 06110
ow Level Configuration labout		U1	CON	FIG CON	ITROLS	5	
	CH1 Settings			12 Settings		MODE Settings	
	CH1 G	PIO MODE		CH2 GPIO M	ODE	US MODE 1 (NO CHAN	
	12C CH1 DISABLED			IZC CH2 DISABLED		US MODE 2 1 NO CHANNELS ENVILLED	
	GPIO CH	1 DISABLED		GPIO CH2 DIS/	ABLED	US MODE 3 (NO CHAN	NELS ENABLED
	UI CHI QOD UI CHI	SLEW RATE UI CHI O	N DELAY	1 CH2 QOD U1 CH2 SLEW RAT	TE US CH2 ON DELAY	US MODE 4 NO CHAN	NELS ENABLED
	951 Ohm 460us/V	1145	9	51 Ohm 460us/V	11us	US MODE 5 D NO CHAN	NELS ENLIGED
						US MODE 6 D NO CHAN	
	CH3 Settings		0	14 Settings		US MODE 7 (NO CHAN	NELS EN4ABLED
	СНЗ С	PIO MODE		CH4 GPIO M	ODE	US MODE # NO CHAN	NELS ENABLED
	12C CH	3 DISABLED		I2C CH4 DISA	BLED	UT MODE 9 NO CHAN	NELS ENABLED
	GPIO CH	13 DISABLED		GPIO CH4 DIS/	ABLED	US MODE 10 NO CHAN	NELS ENABLED
	U1 CH3 QOD U1 CH3 9510hm 450us/	SLEW RATE UI CH3 OF	factor and a second	1 CH4 QOD U1 CH4 SLEW RAT	TE UI CH4 ON DELAY	UL MODE 11 (NO CHAN	NELS ENABLED
				Server Million		US MODE 12 10 NO CHAN	NELS ENABLED

Figure 14. Select Start Recording

7% *Untitled*	- • •
<u>File Edit Format Run Options Windows H</u> elp	
GUI_Module=import('TPS2299X')	<u> </u>
GUI=GUI_Module.Device_GUI("TPS2299X.exe")	
	Ln: 4 Col: 0



Script Debug Help	I2C Lo	ad Switch Device GU	I		
tion gh Level Configuration HL U2 HL U2 HL U3	Switch ALL** FW Version - 2630		-	Go to Low Level C	onliguration Go to About
HL US HL US	U1 U2 ADD31=06000 ADD31=06001 ADD3	U3 U4 1 = 06010 ADD31 = 06011 A	U5 0031 = 06100	U6 AD031 = 06101	6/7 AD031 = 06110
	CH1 Settings	CH2 Settings		MODE Settings	
	CH1 Settings CH1 I2C MODE	CH2 Settings CH2 GPIO MODE	U2 M	OUL 1 () NO CHANNEL	
	GPIO CH1 ENABLED	I2C CH2 DISABLED GPIO CH2 DISABLED			
	U2 CH1 QOD U2 CH1 SLEW RATEU2 CH1 ON DELAY	U2 CH2 QOD U2 CH2 SLEW RATE U2 CH	2 ON DELA" U2 M	DOE 4 () NO CHANNES	SENABLED
	110 Ohm 250us/V 105us	951 Ohm 460us/V 11us		DOE 5 () NO CHANNEL	
	CH3 Settings	CH4 Settings		COE 6 () NO CHANNEL	
	CH3 GPIO MODE	CH4 GPIO MODE		OCE 8 () NO CHANNEL	
	I2C CH3 DISABLED	I2C CH4 DISABLED GPIO CH4 DISABLED		COE 9 () NO CHANNEL	11 (1 (1 (1 (1 (1 (1 (1 (1 (1 (1 (1 (1 (
	U2 CH3 QOD U2 CH3 SLEW RATE U2 CH3 ON DELAY	U2 CH4 QOD U2 CH4 SLEW RATE U2 CH	4 ON DELAY	CE 10 () NO CHANNEL	
	951 Chun 460us/V 11us	951 Ohm 460us/V 11us		DE 12 () NO CHANNEL	

Figure 16. GUI Screen after Clicking U2 CH1 Controls

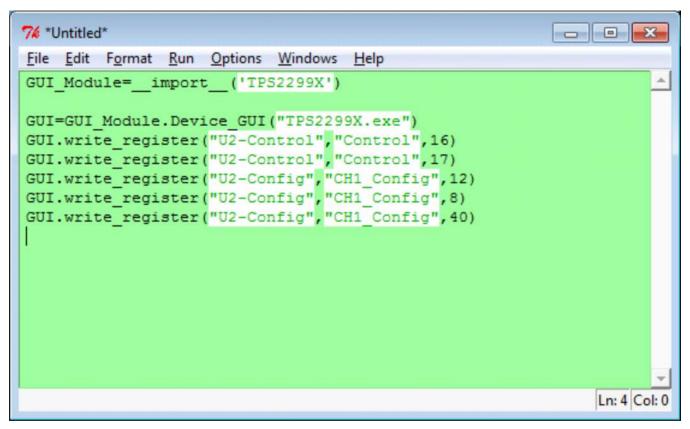


Figure 17. Python Script Window after Recording after Clicking U2 CH1 Controls

Screet Debug Histor Launch Window Start Recording Step Recording	I2C Lo	ad Switch Device	GUI		
tion * oh Level Configuration * HL U2 HL U3	Switch ALL** FW Version			Go to Low Level C	onfiguration Go to About
HL UA HL U5 HL U6	U1 U2 AD031 = 06000 AD031 = 06001 AD031	U3 U4 1 = 05010 ADD3:1 = 05011	US ADD31 = 06000	U5 ADD31 = 06101	U7 ADD31 × 06110
	CH1 Settings	CH2 Settings	MO	DE Settings	
	CH1 IZC MODE	CH2 GPIO MOD	E U21	NODE 1 () NO CHANNEL	S ENABLED
	I2C CH1 ENABLED	I2C CH2 DISABLE	D	MODE 2 NO CHANNEL	S EN44BLED
	GPIO CH1 DISABLED	GPIO CH2 DISABL	ED U2	UZ MODE 3 () NO CHANNELS ENIABLED	
	110 Ohm 250us/V 105us	U2 CH2 QOD U2 CH2 SLEW RATE U 951 Chm 460us/V 3	lut	NODE 4 () NO CHANNEL	
				NODE 5 NO CHANNEL	8080103440100
				NODE 6 () NO CHANNEL	
	CH3 Settings CH3 GPIO MODE	CH4 Settings CH4 GPIO MOD		NODE 7 () NO CHANNEL	
	12C CH3 DISABLED	12C CH4 DISABLE		NODE B () NO CHANNEL	22-23-02
	GPIO CH3 DISABLED	GPIO CH4 DISABL		NODE 9 🗿 NO CHANNEL	
	U2 CH3 QOD U2 CH3 SLEW RATE U2 CH3 ON DELAY	U2 CH4 QOD U2 CH4 SLEW RATE U	2 CH4 ON DELAY	ODE 13 () NO CHANNEL	
	951 Ohm 460us/V 11us	951.0hm 450us/V [1	19.405	ODE 12 () NO CHANNEL	
			(va)	South grid Crosent	2 DANGEED

Figure 18. Python Script Window Stop Recording

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Save	Ctrl+S		
Save <u>A</u> s	Ctrl+Shift+S		
Save Copy As	Alt+Shift+S		
Prin <u>t</u> Window	Ctrl+P		
<u>Close</u>	Alt+F4		
Exit	Ctrl+Q		

Figure 19. Save Python Script Window



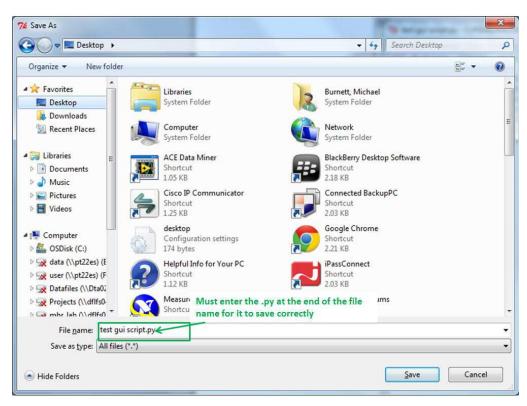


Figure 20. Must Enter the .py at the End of the File Name to Save the Python File Correctly

retion a		Load Switch Device GUI	
Righ Level Configuration HE U2 HE U3	Switch ALL** PW Version - 2630	-	Ge to Low Level Configuration Ge to Abo
HLUA HLU5 HLU6	U1 U2 ADD31 = 0x000 ADD31 = 0x001		US U6 U7 + 06100 ADD31 + 06201 ADD31 + 06210
lbeut		CONFIG CONTR	
	CH1 Settings	CH2 Settings	MODE Settings U2 MODE 1 (I) NO CHANNELS ENABLED
	CH1 12C MODE	CH2 GPIO MODE	UZ MODE Z ŚŚ NO CHANINELS INAMIJED
	IZC CH1 ENABLED	12C CH2 DISABLED	
	GPIO CH1 DISABLED	GPIO CH2 DISABLED	U2 MODE 3 @ NO CHANNELS ENABLED
	U2 CHE QOD U2 CHE SLEW RATEU2 CHE ON D	designed and an and a second s	DELA" SZ MODE 4 DI NO CHANNELS ENABLED
	110 Ohm 250us/V 105vs	951 Ohm 460us/V 11us	UZ MODE 5 @ NO CHANNELS ENABLED
			UZ MODE 6 () NO CHANNELS ENABLED
	CH3 Settings	CH4 Settings	UZ MODE 7 ((NO CHANNELS ENABLED
	CH3 GPIO MODE	CH4 GPIO MODE	122 MODE 8 (1) NO CHARMELS ENABLED
	I2C CH3 DISABLED	I2C CH4 DISABLED	UZ MODE 9 () NO CHANNELS ENABLED
	GPIO CH3 DISABLED	GPIO CH4 DISABLED	U2 MODE 17 B NO CHUNNELS ENABLED
	U2 CH3 QOD U2 CH3 SLEW RATE U2 CH3 ON D 951 Chm. 460us/V 11us	ELAY U2 CH4 QOD U2 CH4 SLEW RATE U2 CH4 ON 1 951 Chm 460us/V 11us	

Figure 21. Select Exit on the Device GUI



Hit US Sere Coll-S Sere Solut Coll Solut Coll-S Sere Solut Coll Solut	svice GUI Script Debug Help			0 8
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ht Levi Configuration He U2 He U3 He U3 He U3 He U3 He U3 He U3 He U3 He U3 He U4 He U3 He U5 He U5				
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U1 CH 951CH In 1 Cel 0				O NO CHANNELS ENABLED
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				Let 1 Col 0

Figure 22. Open Test_gui_script.py File

	74 test gui script.py - C:\Users\a0221036\Desktop\test gui script.py	
Selection High Level Configuration HL U2 HL U2 HL U3 HL U4 HL U5 HL U5 HL U7 Low Level Configuration About	<pre>File Edit Format Run Options Windows Help GUI_Module=_i Python Shell GUI=GUI_Module GUI.write_regi Run Module Alt+X pntrol",16) GUI.write_register("U2=Config","CH1_Config",12) GUI.write_register("U2=Config","CH1_Config",8) GUI.write_register("U2=Config","CH1_Config",40) GUIdel()</pre>	



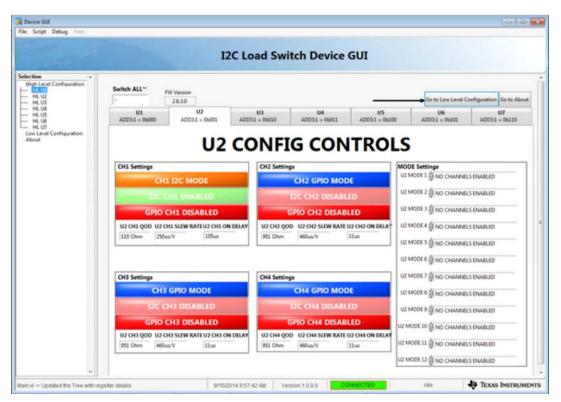


Figure 24. U2 Settings after Executing the Module and Running the Script



5 Schematics and Layouts

5.1 Schematics

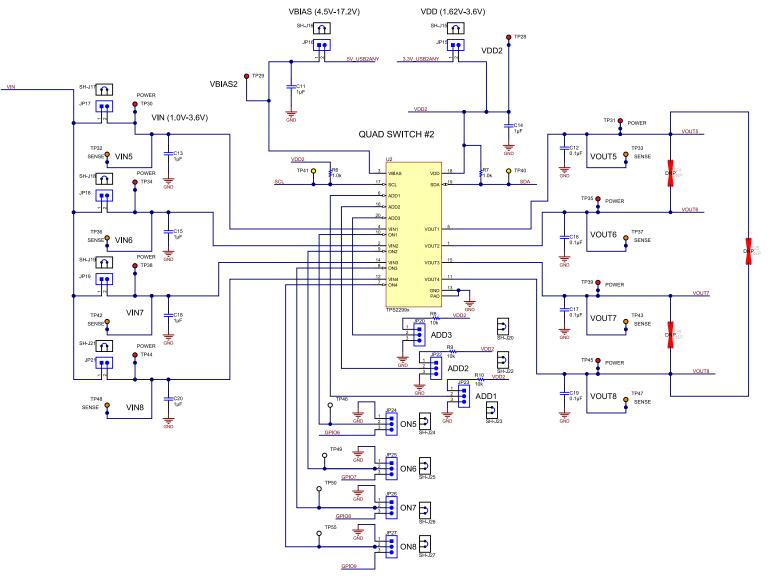


Figure 25. I²C Load Switch EVM Board Schematic (1 of 3)



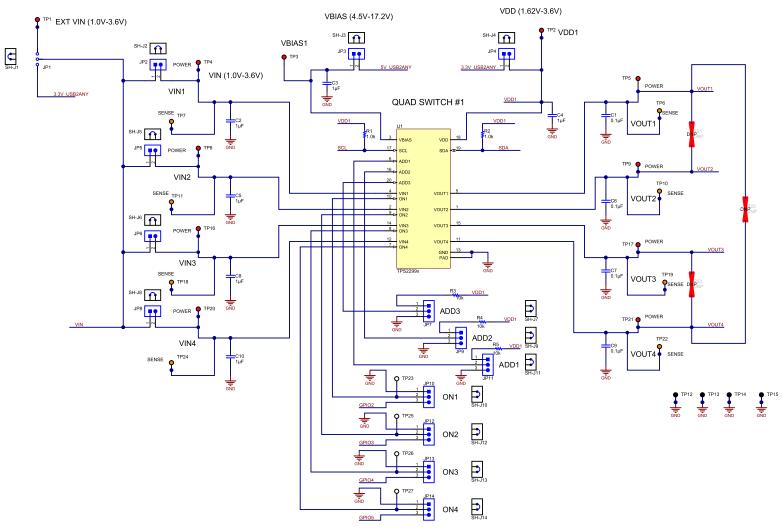
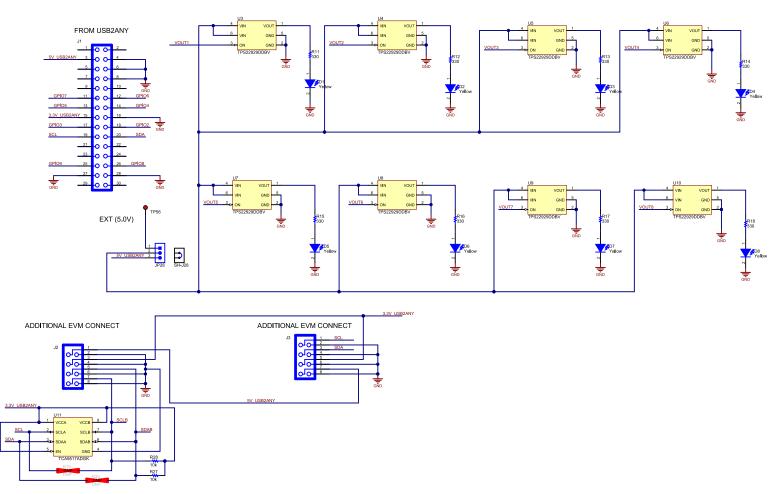


Figure 26. I²C Load Switch EVM Board Schematic (2 of 3)









Schematics and Layouts

5.2 Layouts

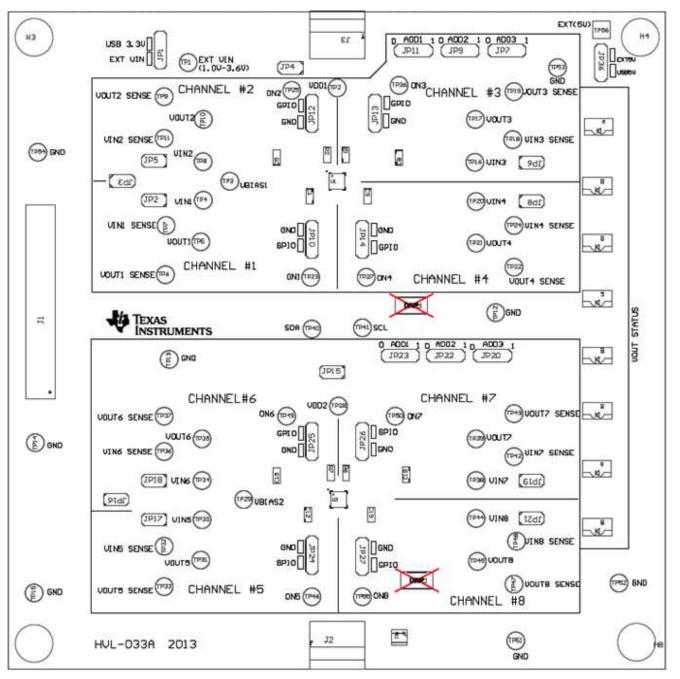


Figure 28. I²C Load Switch EVM Board Top Assembly





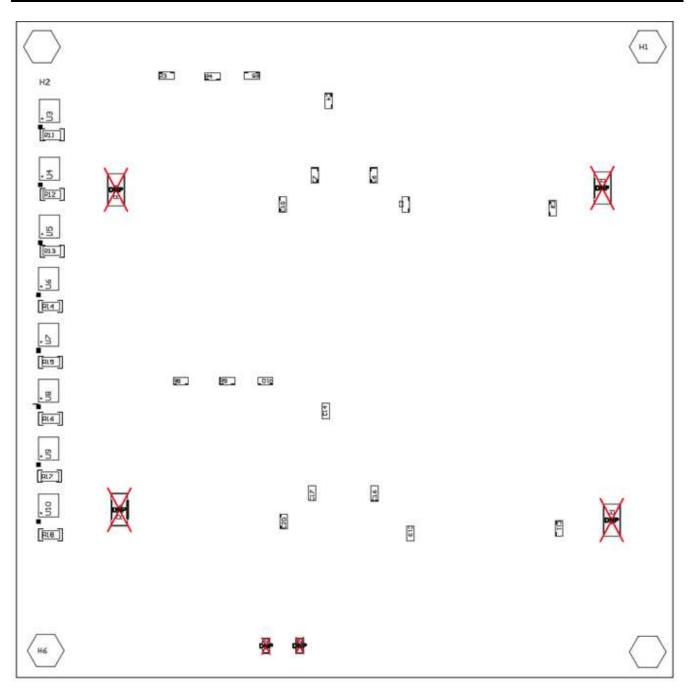


Figure 29. I²C Load Switch EVM Board Bottom Assembly



Schematics and Layouts

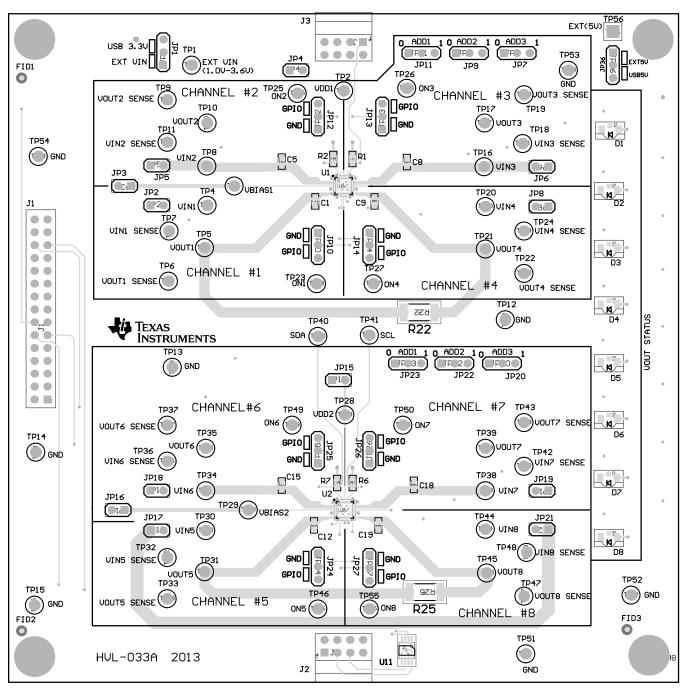


Figure 30. I²C Load Switch EVM Board Top Side (Minus GND Pour)



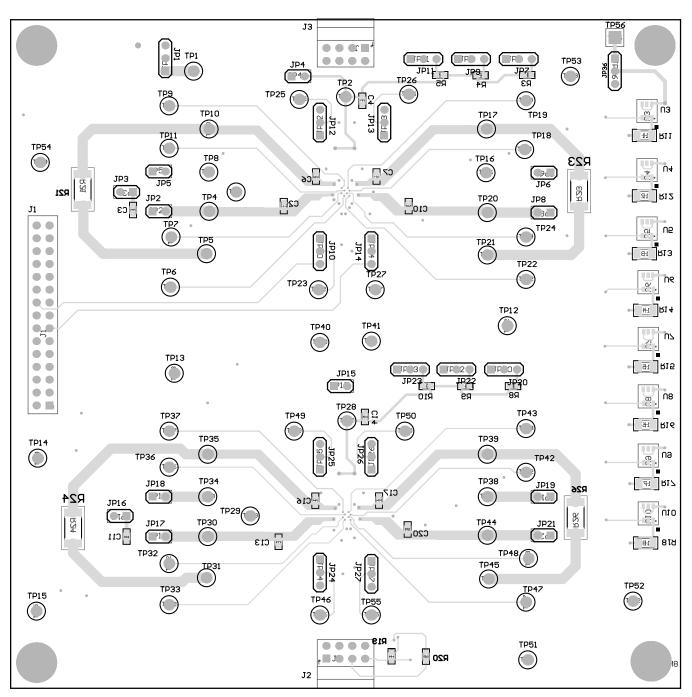


Figure 31. I²C Load Switch EVM Board Bottom Side (Minus GND Pour)



6 EVM Setup

Use Table 1 to connect to the EVM. Two operating modes will be explained further in Section 6.2 and Section 6.3. A valid voltage level for VIN, VDD, and VBIAS must be present for proper switch operation.

6.1 List of Test Points and Jumpers

Test Points	Name	Description	Default Setting
J1	USB2ANY Cable	Connects the USB2ANY to the EVM	Connected
J2	AUX EVM Bottom	Allows for an additional EVM connected to the EVM in use	Not Connected
J3	AUX EVM Top	Allows for an additional EVM connected to the EVM in use	Not Connected
JP1	EXT VIN /USB	Connects 3p3V USB2ANY or EXTPOWER VIN to VIN1-8 Jumpers	Short to USB 3.3 V
JP2	VIN1	Connects voltage to VIN1	Short
JP3	VBIAS1 /USB	Connects 5V USB2ANY voltage to VBIAS1	Short
JP4	VDD1	Connects 3.3V USB2ANY voltage to VDD1	Short
JP5	VIN2	Connects voltage to VIN2	Short
JP6	VIN3	Connects voltage to VIN3	Short
JP7	ADD3	Connects SWITCH1 ADD3 to GND or VDD1 (thru 10K ohms)	Short JP7 to 0
JP8	VIN4	Connects voltage to VIN4	Short
JP9	ADD2	Connects SWITCH1 ADD2 to GND or VDD1 (thru 10K ohms)	Short JP9 to 0
JP10	ON1	Connects SWITCH1 ON1 to GND or GPIO2	Short JP10 pin2 to 3
JP11	ADD1	Connects SWITCH1 ADD1 to GND or VDD1 (thru 10K ohms)	Short JP11 to 0
JP12	ON2	Connects SWITCH1 ON2 to GND or GPIO3	Short JP12 pin2 to 3
JP13	ON3	Connects SWITCH1 ON3 to GND or GPIO4	Short JP13 pin2 to 3
JP14	ON4	Connects SWITCH1 ON4 to GND or GPIO5	Short JP14 pin2 to 3
JP15	VDD2	Connects 3.3V USB2ANY voltage to VDD2	Short
JP16	VBIAS2 /USB	Connects 5V USB2ANY voltage to VBIAS2	Short
JP17	VIN5	Connects voltage to VIN5	Short
JP18	VIN6	Connects voltage to VIN6	Short
JP19	VIN7	Connects voltage to VIN7	Short
JP20	ADD3	Connects SWITCH2 ADD3 to GND or VDD1 (thru 10K ohms)	Short JP20 to 0
JP21	VIN8	Connects voltage to VIN8	Short
JP22	ADD2	Connects SWITCH2 ADD2 to GND or VDD1 (thru 10K ohms)	Short JP22 to 0
JP23	ADD1	Connects SWITCH2 ADD1 to GND or VDD1 (thru 10K ohms)	Short JP23 to 1
JP24	ON5	Connects SWITCH2 ON1 to GND or GPIO6	Short JP24 pin2 to 3
JP25	ON6	Connects SWITCH2 ON2 to GND or GPIO7	Short JP25 pin2 to 3
JP26	ON7	Connects SWITCH2 ON3 to GND or GPIO8	Short JP26 pin2 to 3
JP36	EXT 5.0V	Connects voltage for LED from switch	Short to USB5V
TP1	EXT VIN	Connection point foe EXT VIN input	
TP2	VDD1	Connection point to VDD1	
TP3	VBIAS1	Connection point to VBIAS1	
TP4	VIN1	Connection point to VIN1	
TP5	VOUT1	Connection point to VOUT1	
TP6	VOUT1 SENSE	Connection point to VOUT1 SENSE	
TP7	VIN2 SENSE	Connection point to VIN2 SENSE	
TP8	VIN2	Connection point to VIN2	
TP9	VOUT2	Connection point to VOUT2	
TP10	VOUT2 SENSE	Connection point to VOUT2 SENSE	
TP11	VIN2 SENSE	Connection point to VIN2 SENSE	
TP16	VIN3	Connection point to VIN3	
TP12-15	GND	Connection point to AGND	
TP17	VOUT3	Connection point to VOUT3	

Table 1. Functions of Test Points and Jumpers

TEXAS INSTRUMENTS

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Test Points	Name	Description	Default Setting
TP18	VIN3 SENSE	Connection point to VIN3 SENSE	
TP19	VOUT3 SENSE	Connection point to VOUT3 SENSE	
TP20	VIN4	Connection point to VIN4	
TP21	VOUT4	Connection point to VOUT4	
TP22	VOUT4 SENSE	Connection point to VOUT4 SENSE	
TP23	ON1	Connection point to ON1	
TP24	VIN4	Connection point to VIN4	
TP25	ON2	Connection point to ON2	
TP26	ON3	Connection point to ON3	
TP27	ON4	Connection point to ON4	
TP28	VDD2	Connection point to VDD2	
TP29	VBIAS2	Connection point to VBIAS2	
TP30	VIN5	Connection point to VIN5	
TP31	VOUT5	Connection point to VOUT5	
TP32	VIN2 SENSE	Connection point to VIN2 SENSE	
TP33	VOUT5 SENSE	Connection point to VOUT5 SENSE	
TP34	VIN6	Connection point to VIN6	
TP35	VOUT6	Connection point to VOUT6	
TP36	VIN6 SENSE	Connection point to VIN6 SENSE	
TP37	VOUT6 SENSE	Connection point to VOUT5 SENSE	
TP38	VIN7	Connection point to VIN7	
TP39	VOUT7	Connection point to VOUT7	
TP40	SDA	Connection point to SDA	
TP41	SCL	Connection point to SCL	
TP42	VIN7 SENSE	Connection point to VIN7 SENSE	
TP43	VOUT7 SENSE	Connection point to VOUT7 SENSE	
TP44	VIN8	Connection point to VIN8	
TP45	VOUT8	Connection point to VOUT8	
TP46	ON5	Connection point to ON5	
TP47	VOUT8 SENSE	Connection point to VOUT8 SENSE	
TP48	VIN8 SENSE	Connection point to VIN8 SENSE	
TP49	ON6	Connection point to ON6	
TP50	ON7	Connection point to ON7	
TP55	ON8	Connection point to ON8	
TP51-54	GND	Connection point to AGND	

Table 1. Functions of Test Points and Jumpers (continued)

6.2 EVM USB Powered Mode

When the jumpers are placed in the default setting described in Table 1. The USB2ANY module will supply all necessary power (VIN, VDD, VBIAS, and VLED) for both U1 and U2 load switches. The functionality of the load switches Trise, Tfall, Ton, and QOD can be programmed using the GUI commands and viewed by connecting a scope to the desired switch output. When powering the I²C Load Switch in the USB powered mode the user may **NOT** place excessive loads on the switch outputs. The USB2ANY power sources are limited to 500 mA.



6.3 EVM External Powered Mode

External Power Sources can be connected directly to VIN, VDD, VBIAS, and VLED. To connect externally to VIN move JP1 shunt to pin1 to pin2 position, and connect power source to TP1. (VIN operating voltage levels are from 1.0V to 3.6V). When connecting VDD1 externally, remove JP4 shunt and connect power source to TP2, for VDD2 remove shunt from JP15 and connect voltage to TP28. (VDD operating range is 1.62 to 3.6 V). To connect directly to VBIAS1 remove JP3 shunt and connect power source to TP3. For VBIAS2 remove shunt from JP16 and connect power source to TP29. (VBIAS operating voltage levels are from 4.5 to 17.2 V). External voltage can be applied for the LED's place JP36 shunt on pin1 to 2 and connect voltage source to TP56. (VLED = 4 V - 5 V). By connecting an external power source to the VIN inputs the 1.2 A VOUT max continuous current limit may be exercised.

7 Load Switch Performance

The I²C Load Switch enables the user to set different slew rate, delay the turn on time, and control the output discharge (or) turn off rate as desired using simple I²C commands. Examples of this flexibility are shown in the sections below. Each switch channel is configurable independent of the other switch channels.

Each switch channel is configurable independent of the other switch channels. Examples of this flexibility are shown in the following plots using these test conditions:

- VIN = 2.6 V
- VBIAS = 7.2 V
- CIN = 1 μF
- COUT = 0.1 μF
- Rload = 10 Ω
- Temp = Room ($\sim 25^{\circ}$ C)





Figure 32. Programmable Slew Rate Control





Figure 33. Programmable Turn on Delay Time



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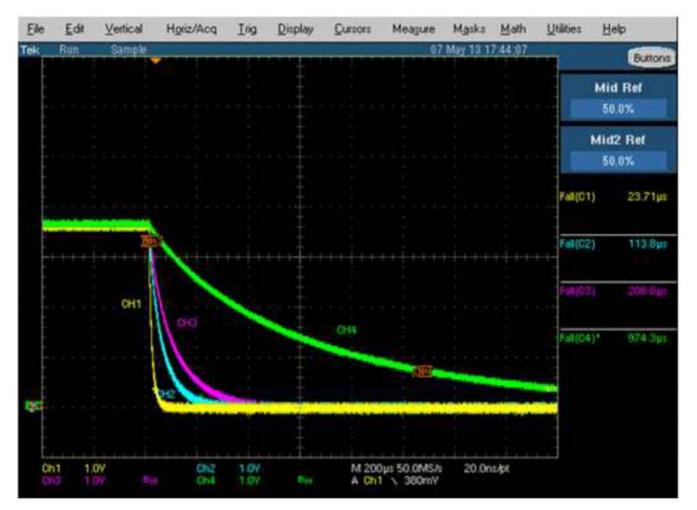
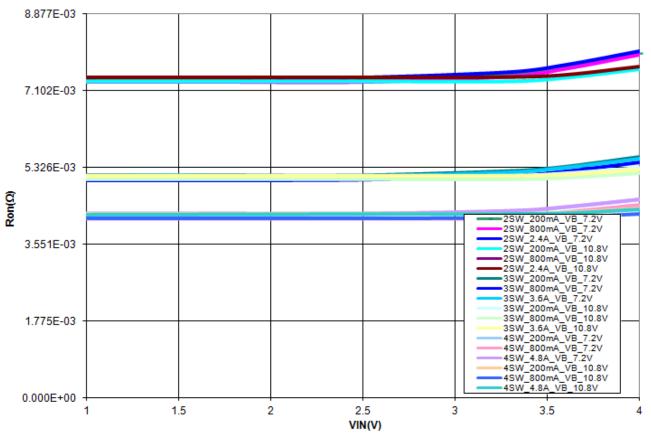


Figure 34. Programmable Output Discharge (Fall Time Control)



7.1 Switch Parallel Configuration Mode

Shorting resistors may be placed on the switch outputs to connect them in a parallel configuration; these resistors are not populated when shipped. Placing a 0 Ω 2512 1W size resistor across R21 pads connects switch1 VOUT1 and VOUT2 in parallel, R22 connects VOUT1 and VOUT4 and R23 connects VOUT3 and VOUT4. Switch2 connects in the same manner using R24, R25, and R26. When connecting switches in parallel the continuous current drawn through the device may be increased, and the On resistance (Ron) across the parallel switch configuration is decreased. Figure 30 shows switch performance examples of the TPS22993 in parallel configuration.



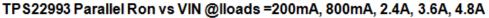


Figure 35. TPS22993 All Four Switches Connected in Parallel Configuration



Revision History

Changes from B Revision (September 2014) to C Revision				
•	Updated Functions of Test Points and Jumpers table.	28		
•	Updated Functions of Test Points and Jumpers table.	29		

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

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