Using the UCD3138A64OEVM-662

User's Guide

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Using the UCD3138A64OEVM-662

Power Management

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1 Introduction

The UCD3138A64OEVM-662 EVM offers an easy to use test platform for stand-alone evaluation of UCD3138A64 digital controller optimized for isolated power applications. Featuring an 80-pin socket and a comprehensive set of test points, the EVM allows hardware and firmware engineers to manipulate signals on the different pins of the device individually and study open loop operation. The EVM also offers the flexibility to realize simple closed loop control configurations (eg. using RC circuits to filter PWM output signals and regulate a DC voltage in closed loop control). Hardware ports available to communicate with the device include PMBus and UART. The EVM accepts up to 5V DC input and an on-board 3.3V LDO can be used to bias the device. Alternately, using jumpers, the device can be biased using the PMBus communication pins.

NOTE: In order to download firmware and program the UCD3138A64 device in UCD3138A64OEVM-662, a separate EVM from Texas Instruments known as the USB-TO-GPIO Adapter is required. The USB-TO-GPIO Adapter is NOT supplied with UCD3138A64OEVM-662 and must be purchased separately. The USB-TO-GPIO Adapter serves as a communication interface adaptor or a bridge between a host PC and the UCD3138A64 via a standard type-A to mini-B USB cable. The USB-TO-GPIO Adapter is listed below in the related products section.

2 Description

UCD3138A64OEVM-662 is an EVM board to facilitate evaluation on UCD3138A64PFC digital power controller. This EVM provides hardware needed to evaluate UCD3138A64 80-pin device. All pins of UCD3138A64PFC are accessible through header connections, including all GPIO pins, ADC12 pins, front end pins, DPWM pins, and Fault pins, etc. Particularly, the board has terminal of PMBus, UART DB-9 RS232, and JTAG. All headers can be jumped to configure for a particular interested evaluation need.

2.1 Typical Applications

- UCD3138A64 function evaluation
- Firmware debug
- Hardware design assistance

2.2 Features

- Test points for easy access to all pins of UCD3138A64 80-pin digital controller
- Socket for easy removal/replacement of the device
- All GPIO and ADC12 pins accessible (with on-board RC filters on each pin)
- Capability to adapt EVM for various evaluation targets using jumpers
- Hardware terminals: PMBus, UART, and Logic Analyzer
- Includes On-board SPI and I2C accessible EEPROMs for additional memory storage
- External 5.0V supply input with onboard 3.3V LDO to bias the device (option to bias device using PMBus port)
- LED indicators
- Rich test points to facilitate the IC evaluation, system design and circuit and firmware debugging
- Board with jumpers to make flexible configuration to adapt various evaluation target

3 Specifications

Table 1. UCD3138A64OEVM-662 Specifications

Parameter	Notes & Conditions	Min	Nom	Max	Units
Connector J21					
J21-4	Port to use on board 3.3V to bias external circuit	3.25	3.30	3.45	VDC
J21-3	External +5.0V to board	4.90	5.00	5.10	VDC
J21-2	External +3.3V to board	3.27	3.30	3.33	VDC
J21-1	Digital ground DGND				
Connector J26					
UART	Female DB-9, RS232	Standard			
Connector J27					
JTAG	Standard JTAG communication connection	Standard			
Connector J28					
PMBus connector	Port of connection to USB-to-GPIO, Jump across J56 (2&3) and J57 (2&3) to enable communication to UCD3138A64 device. For pin definition, refer to TI standard USB-to-GPIO document SLLU093	Standard			
Operation Environment					
Operating Temperature Range	Natural Convection		25		°C
MECHANICAL CHARACTERSTICS					
Dimensions	Width		4.0		in
	Length		6.0		in
	Highest Component Height		0.512		in
Firmware for Testing					
Filename	PWR662_HelloWorld.x0				

4 Schematics

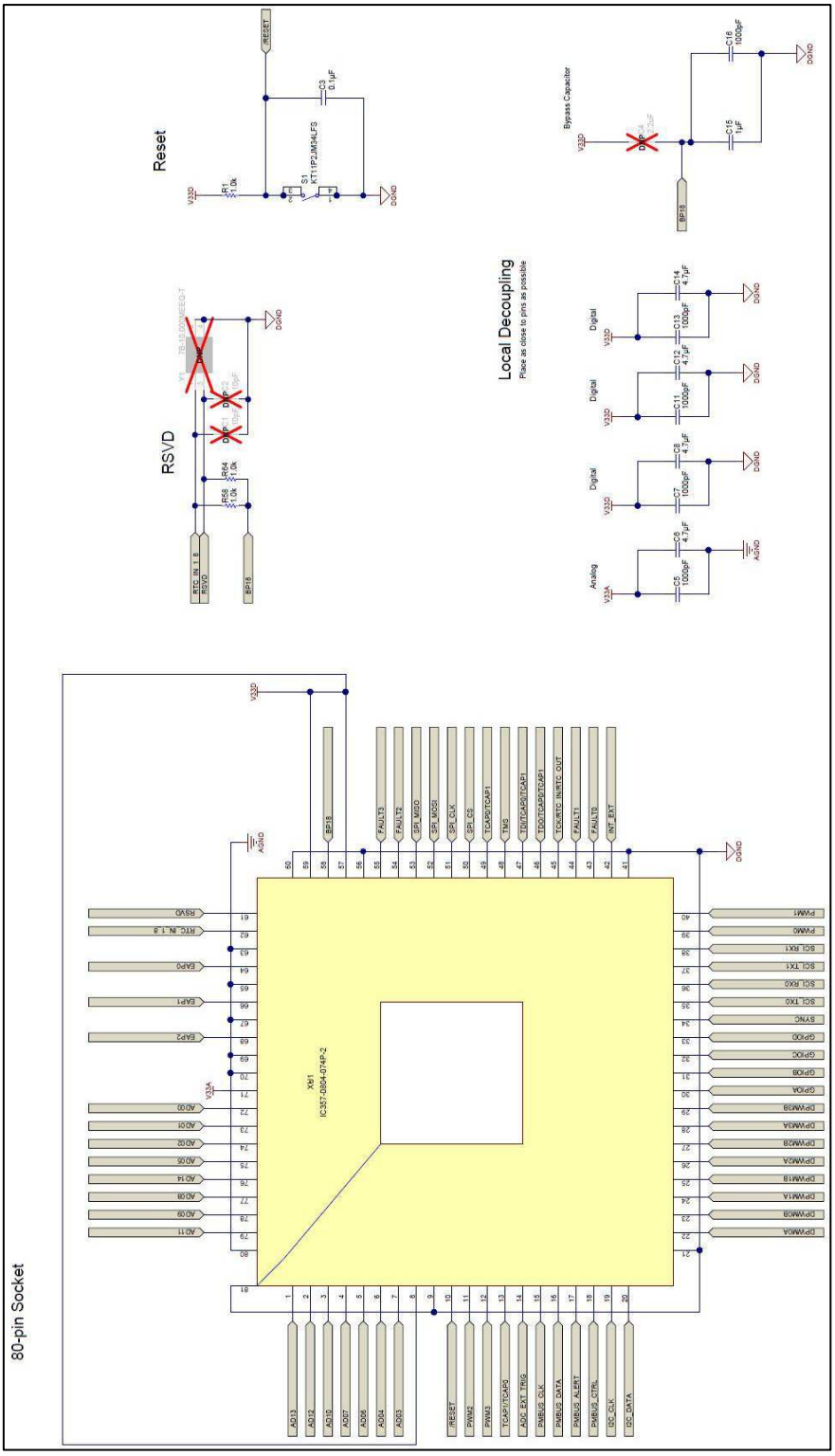

Figure 1. UCD3138A64OEVM-662 Schematics (Socket) 1 of 10

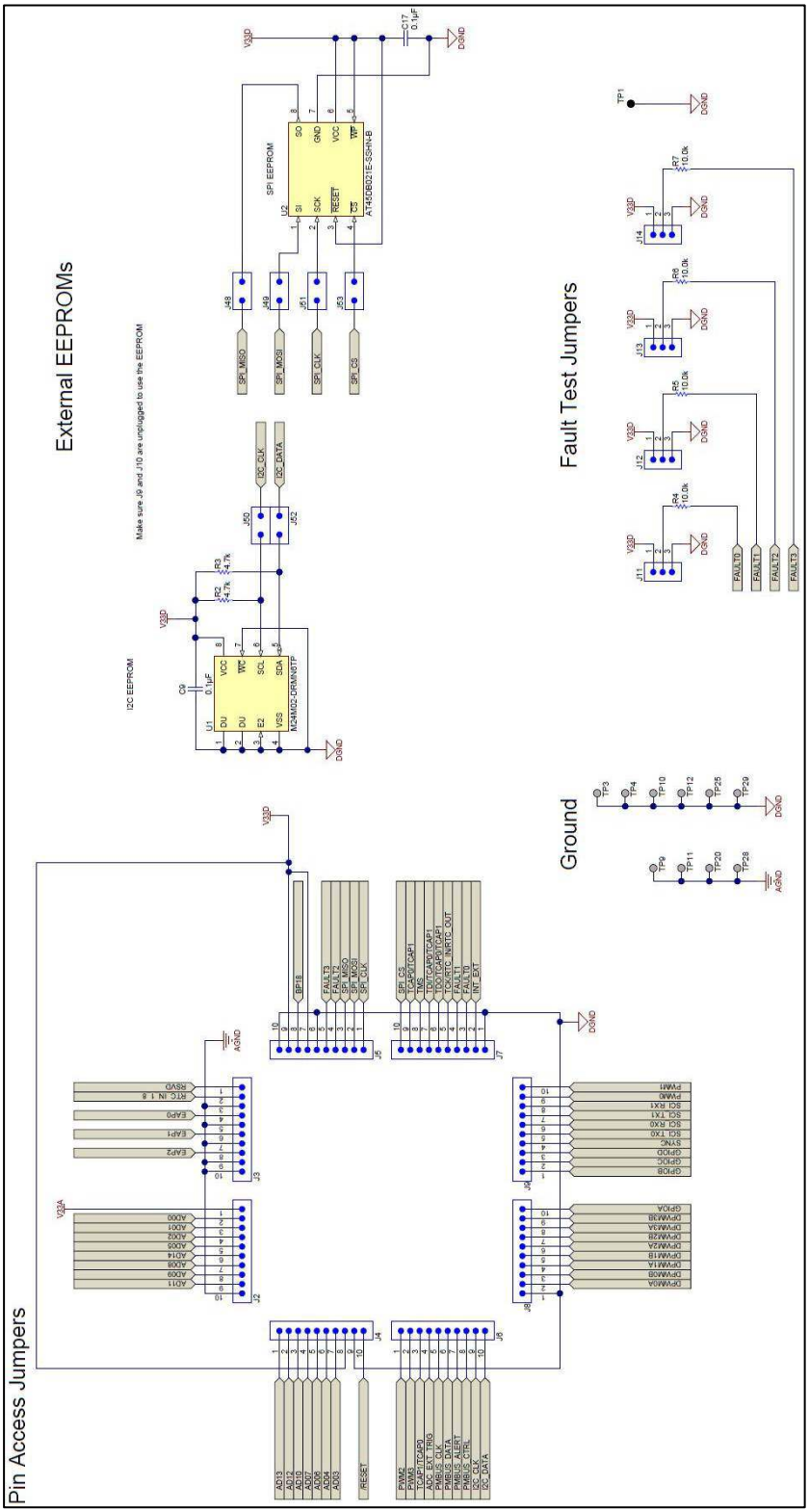

Figure 2. UCD3138A64OEVM-662 Schematics (Headers) 2 of 10

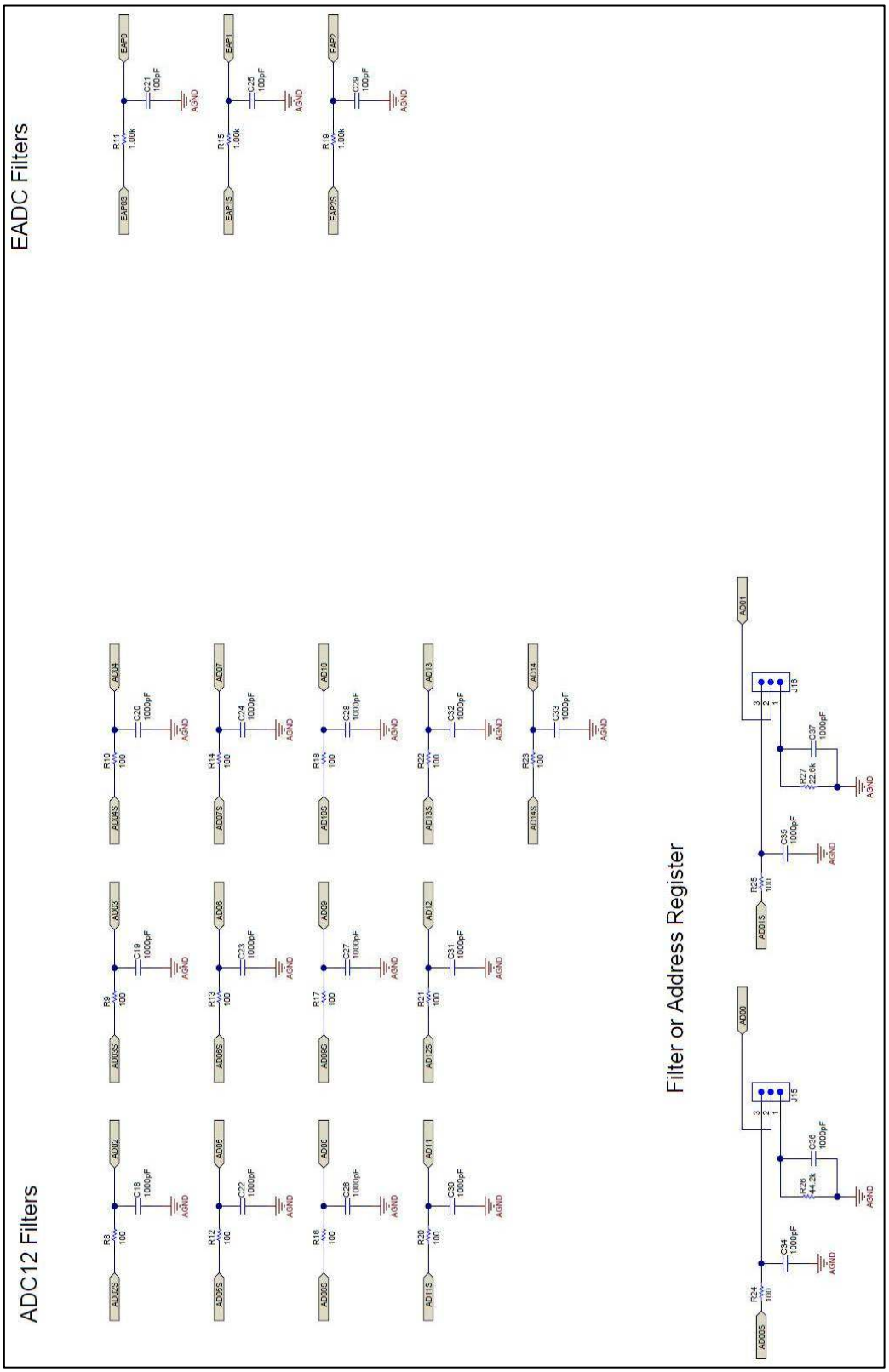

Figure 3. UCD3138A64OEVM-662 Schematics (Filters) 3 of 10

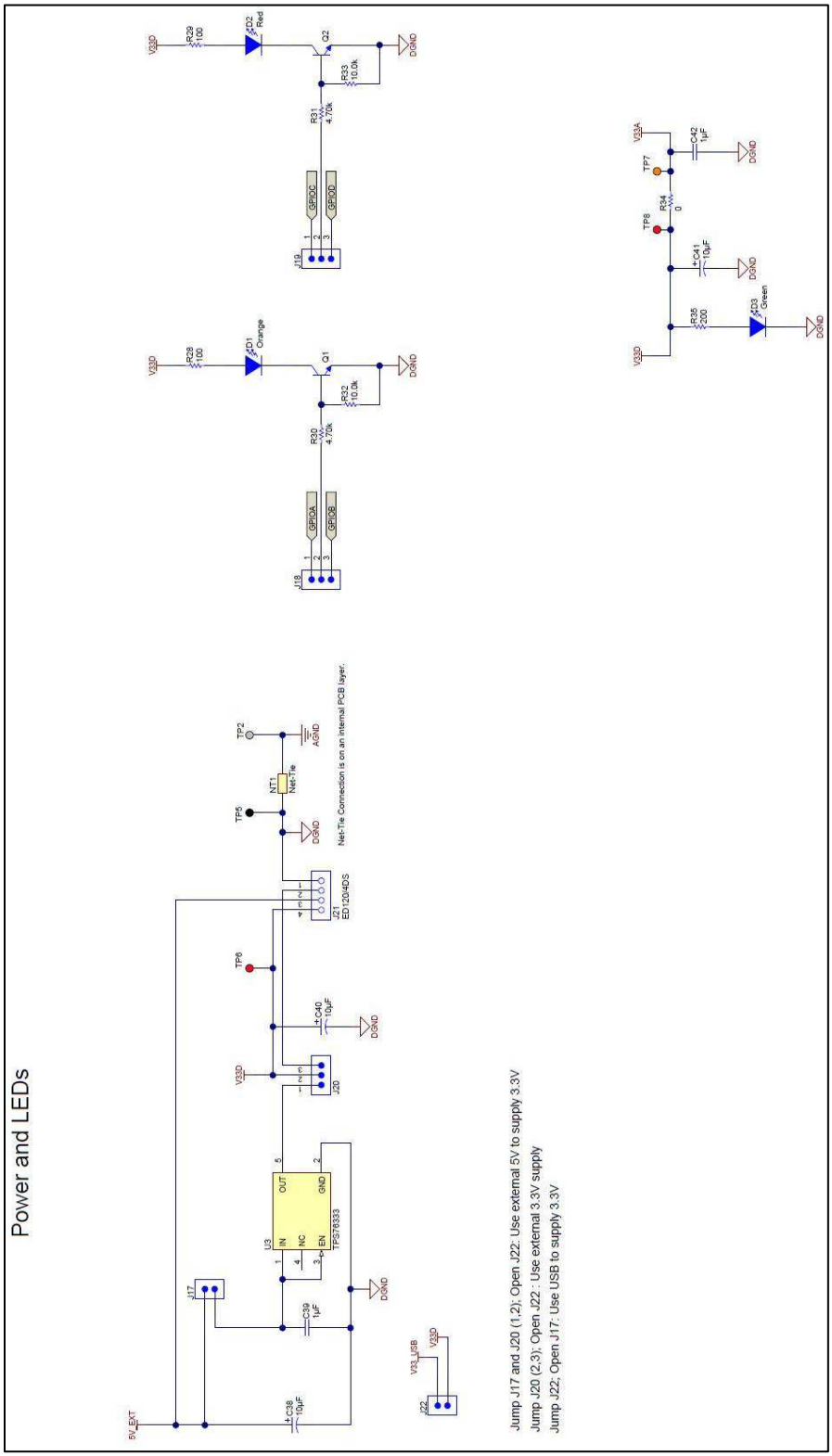

Figure 4. UCD3138A64OEVM-662 Schematics (Bias and LEDs) 4 of 10

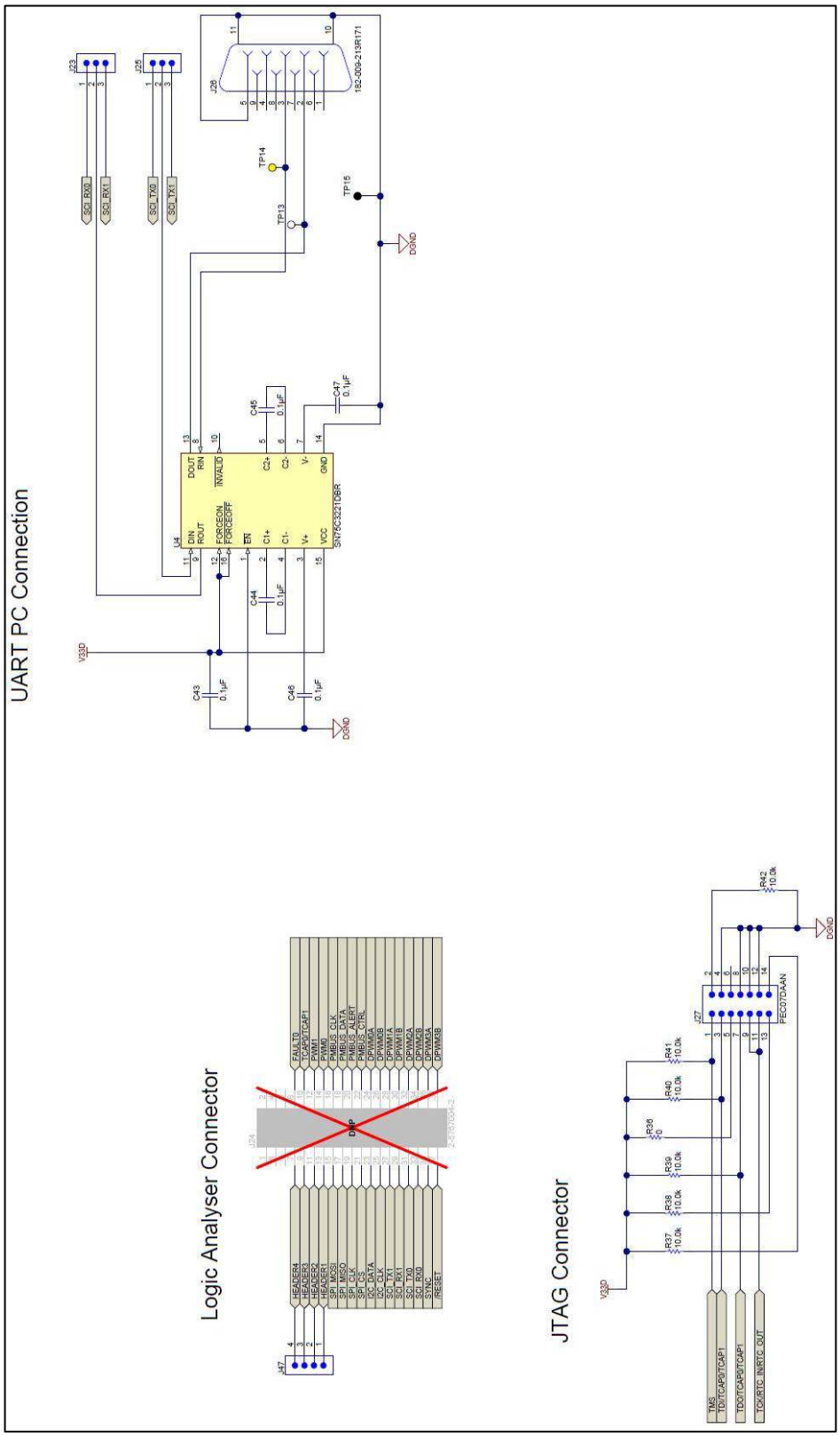

Figure 5. UCD3138A64OEVM-662 Schematics (UART and JTAG) 5 of 10

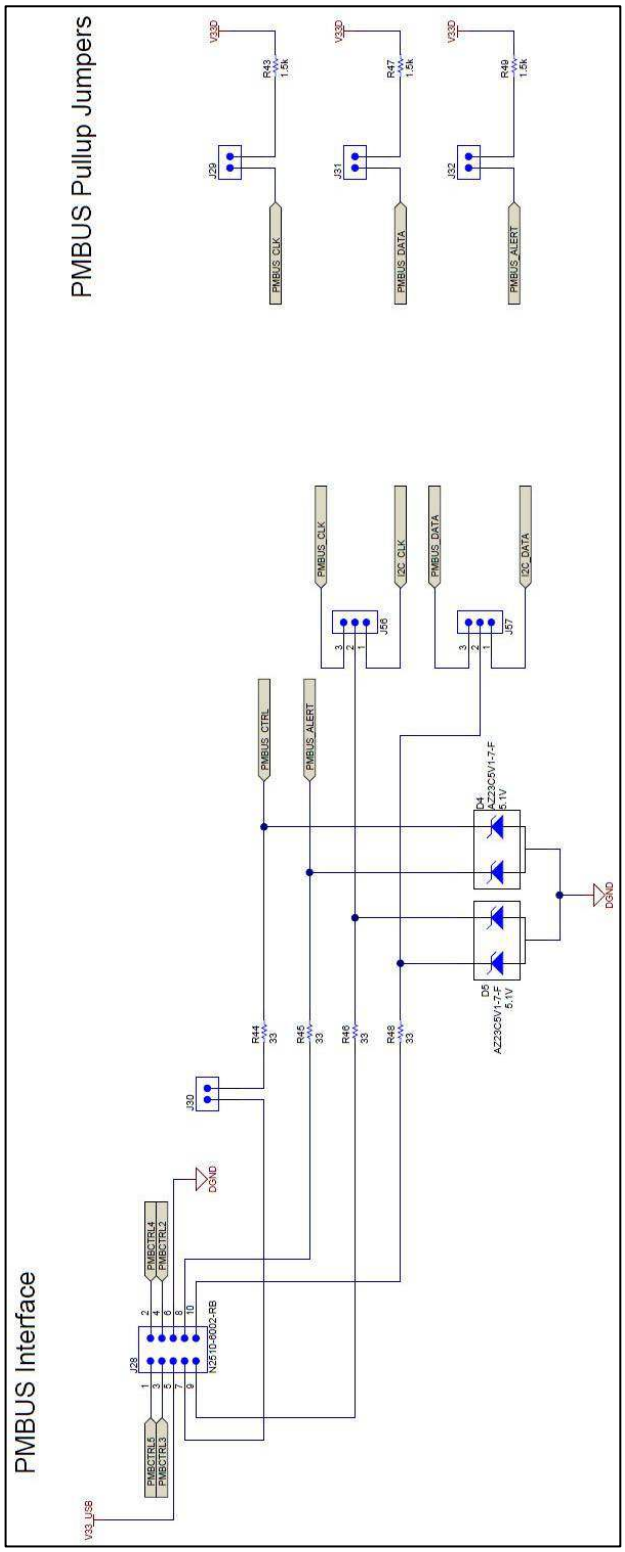

Figure 6. UCD3138A64OEVM-662 Schematics (PMBus) 6 of 10

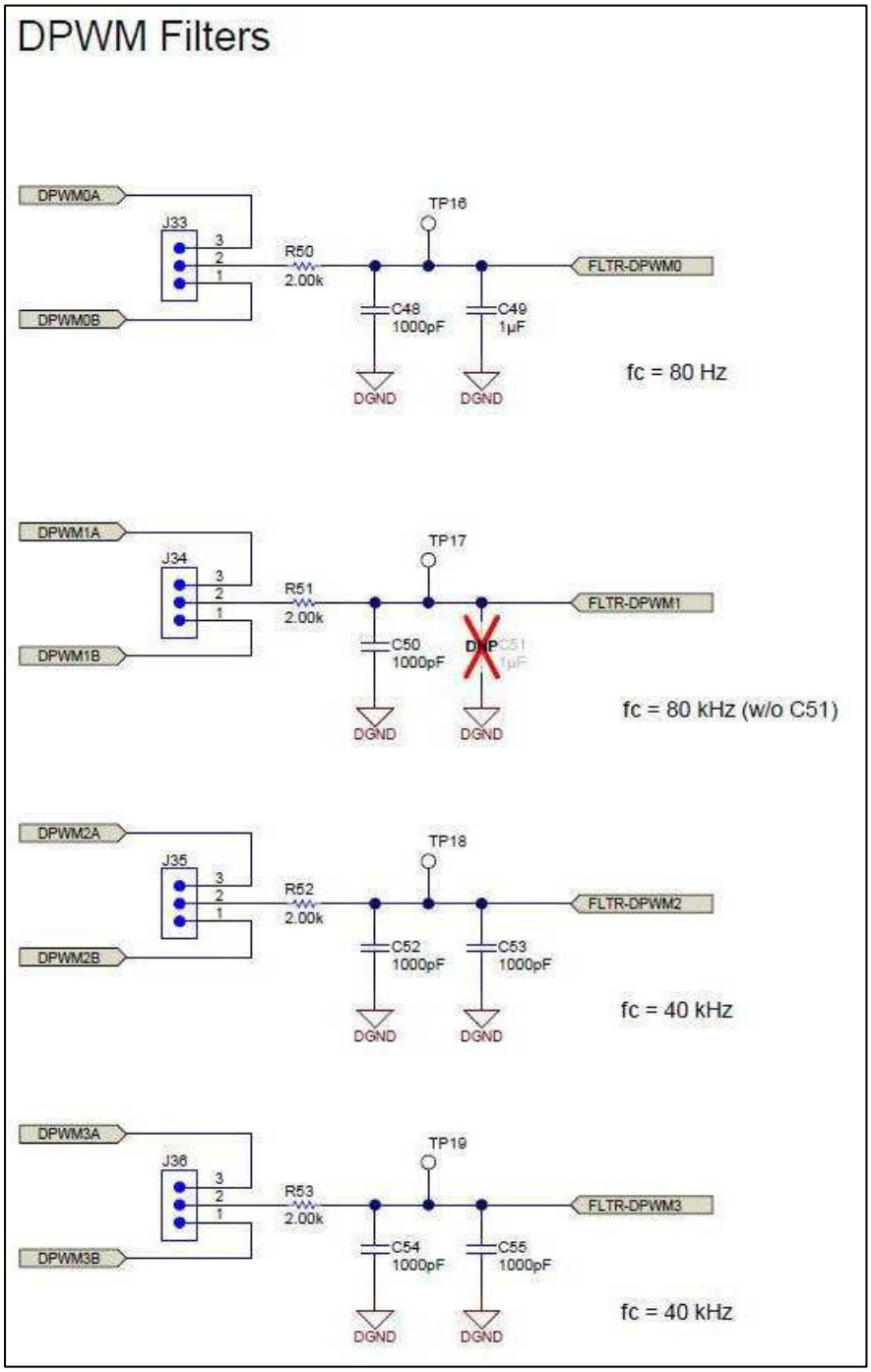

Figure 7. UCD3138A64OEVM-662 Schematics (DPWM) 7 of 10

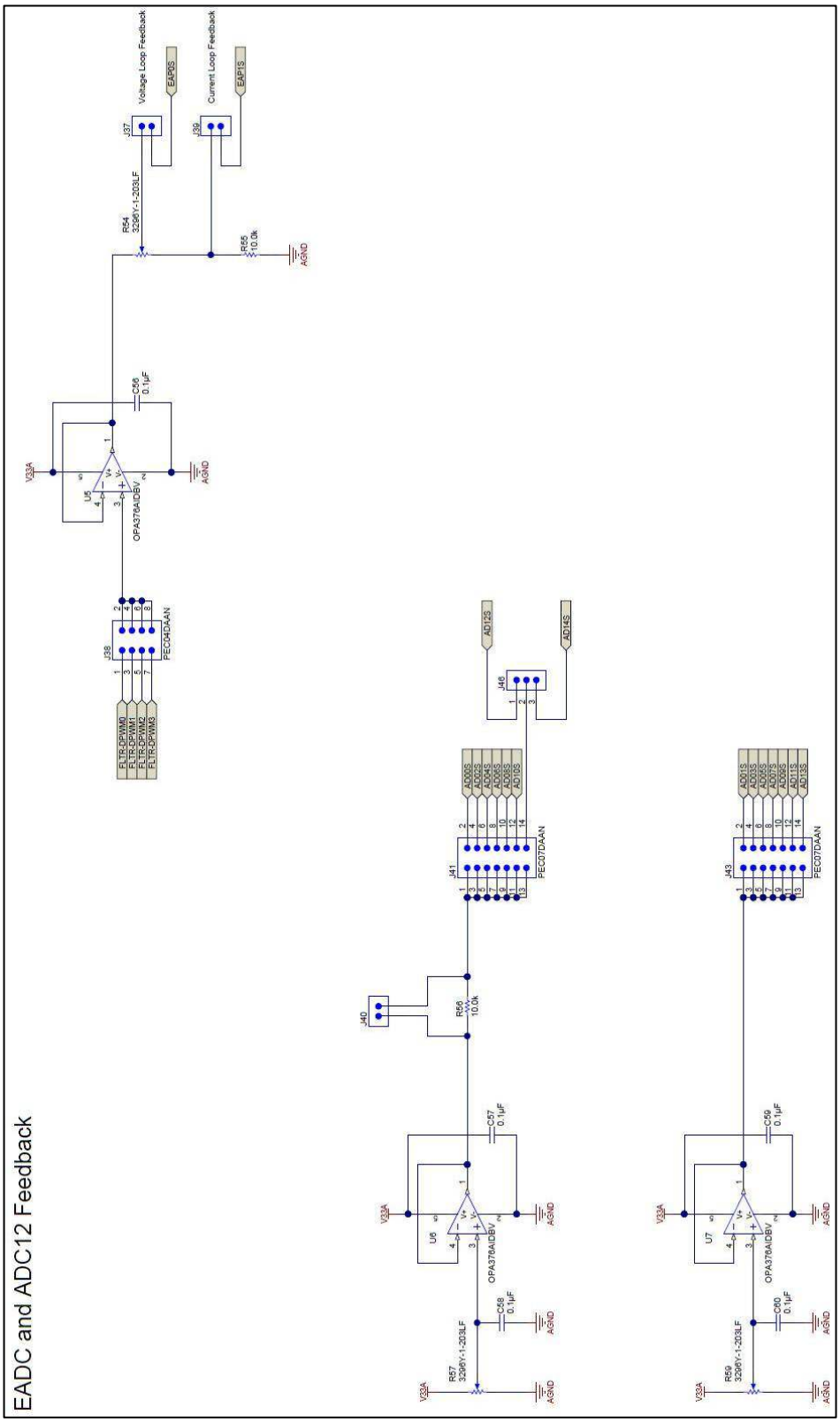

Figure 8. UCD3138A64OEVM-662 Schematics (EADC and ADC12) 8 of 10

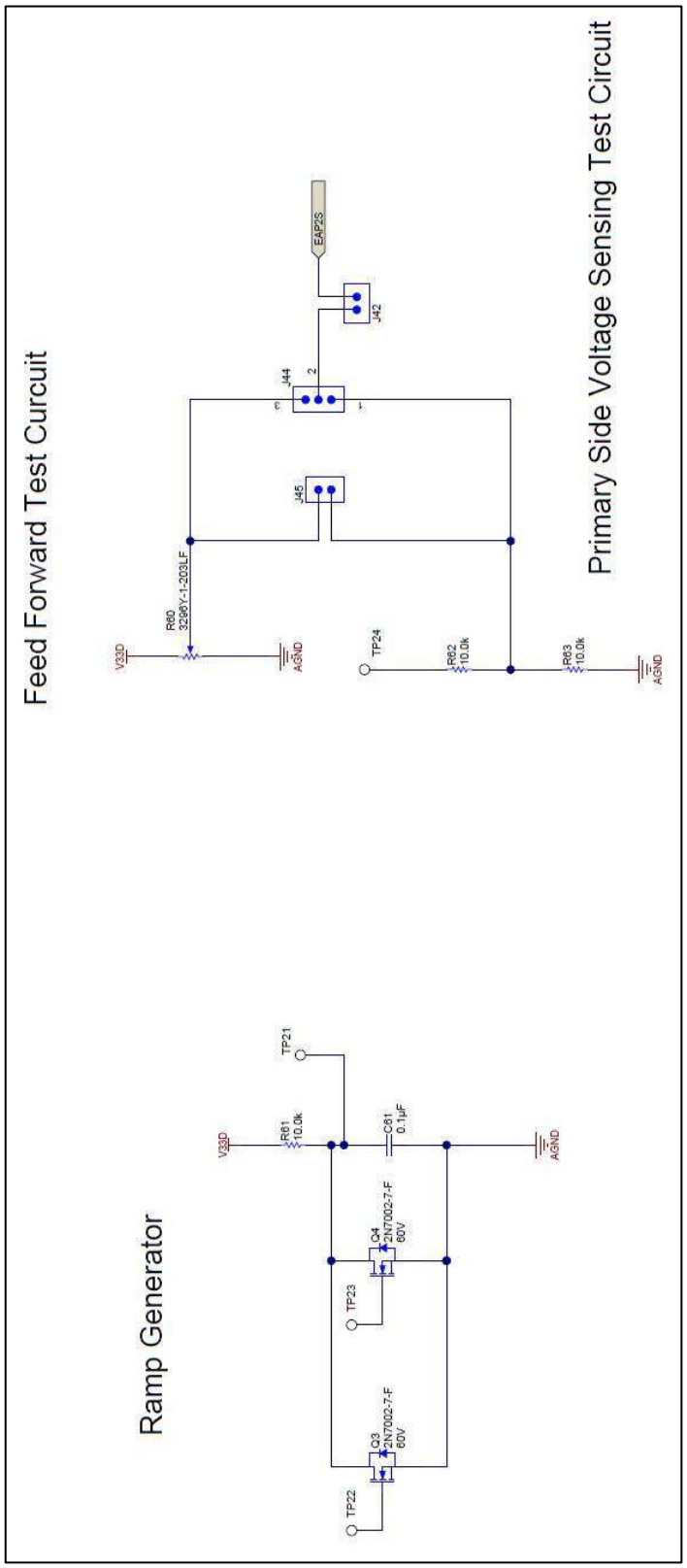

Figure 9. UCD3138A64OEVM-662 Schematics (Misc) 9 of 10

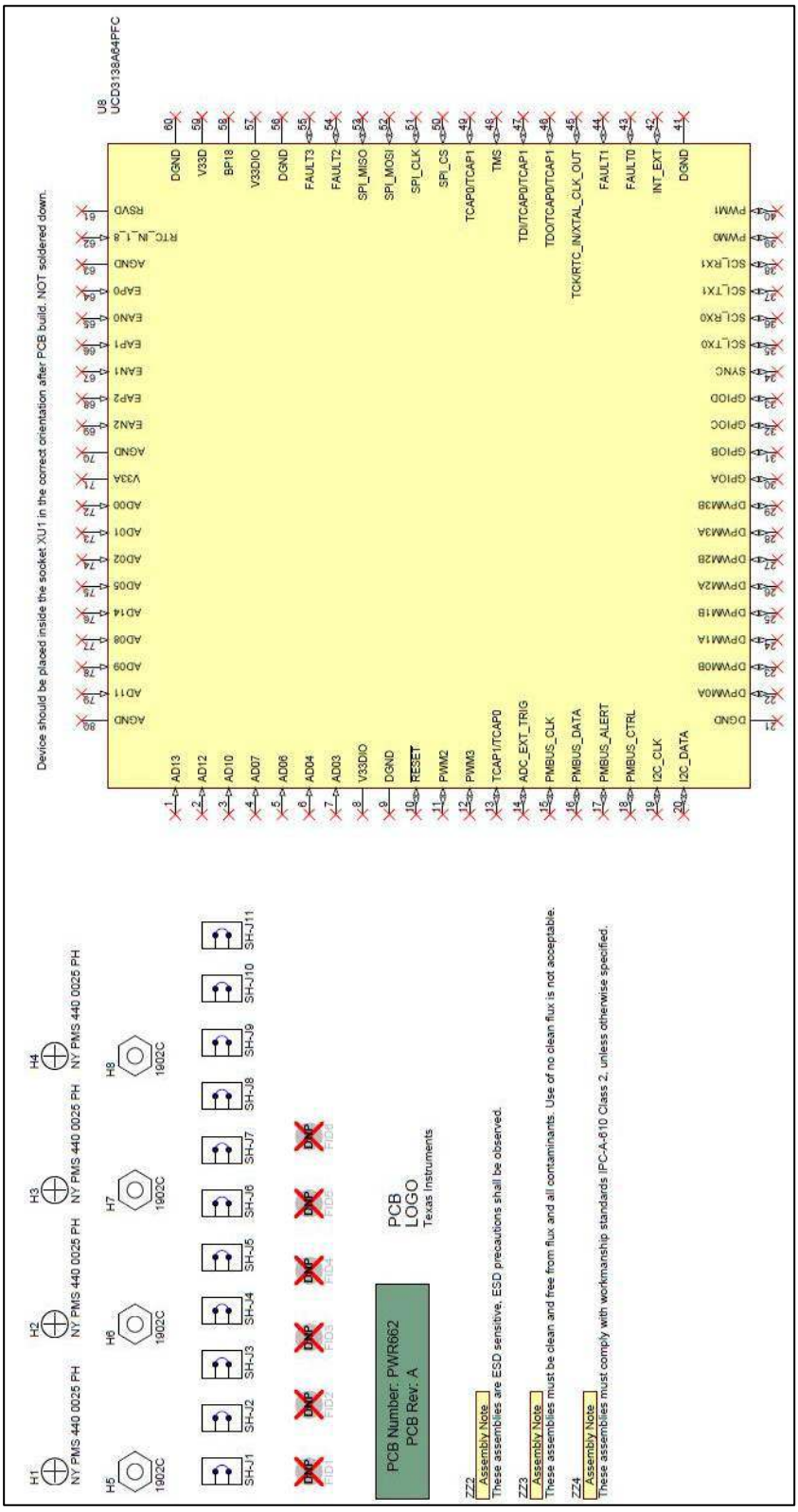

Figure 10. UCD3138A64OEVM-662 Schematics (Hardware) 10 of 10

5 Test Equipment

5.1 PC Computer

5.1.1 Operating System

Microsoft Windows XP (32-bit), or Vista (32-bit), or Windows 7 (32-bit).

5.2 USB-to-GPIO Interface Adapter

This adapter is to establish the communication between the control card UCC3138A64OEVM-662 and the PC computer through the PMBus and the **GUI**, ***Texas Instruments Fusion Digital Power Designer***.

5.2.1 USB-to-GPIO Interface Adapter (HPA172)

Accessories including:

a) USB interface adapter (HPA172)
b) USB cable, 5 pin B Mini Male to Type A Male.
c) Ribbon cable, socket to socket, 10 pin, 2 headers, polarized.

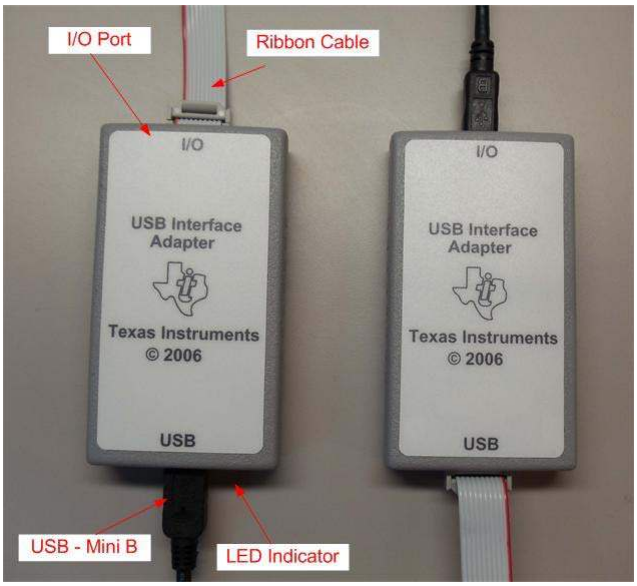

Figure 11. USB-to-GPIO Interface Adapter (HPA172) Outlook.

5.3 Oscilloscope

An oscilloscope of analog or digital type is capable of 200MHz bandwidth with Tektronix P6138 or equivalent oscilloscope probe.

6 Equipment Setup

6.1 GUI (Graphical User Interface)

6.1.1 File for Installation

The GUI installation file is TI-Fusion-Digital-Power-Designer-Version-1.9.54.exe or newer version. Obtain the latest version of GUI from http://www.ti.com/tool/fusion_digital_power_designer.

6.1.2 Installation

Double click and launch the **.exe** file to start the installation. Click **Next** on the subsequent dialog windows. When present, click **I accept the agreement** after reading it, then click **Install**. After the installation, click **Finish** to exit setup, then click **Exit Program**.

6.1.3 Launch UCD3138 Device GUI

The GUI for UCD3138A64OEVM-662 board is launched with the following steps:

Click the Windows **Start** → click **All Programs** → click **Texas Instruments Fusion Digital Power Designer** → click **Device GUIs** → click **UCD3xxx and UCD9xxx Device GUI**.

6.2 Hardware Setup

6.2.1 Setup Overview

Figure 11 shows the connection between UCD3138A64OEVM-662 and the PC computer through USB-to-GPIO Interface Adapter.

USB Adapter Connection

a) Connect one end of the ribbon cable to the EVM, and connect the other end to the USB interface adapter

b) Connect the Mini connector of the USB cable to the USB interface adapter, and connect the other end to the USB port of the PC computer.

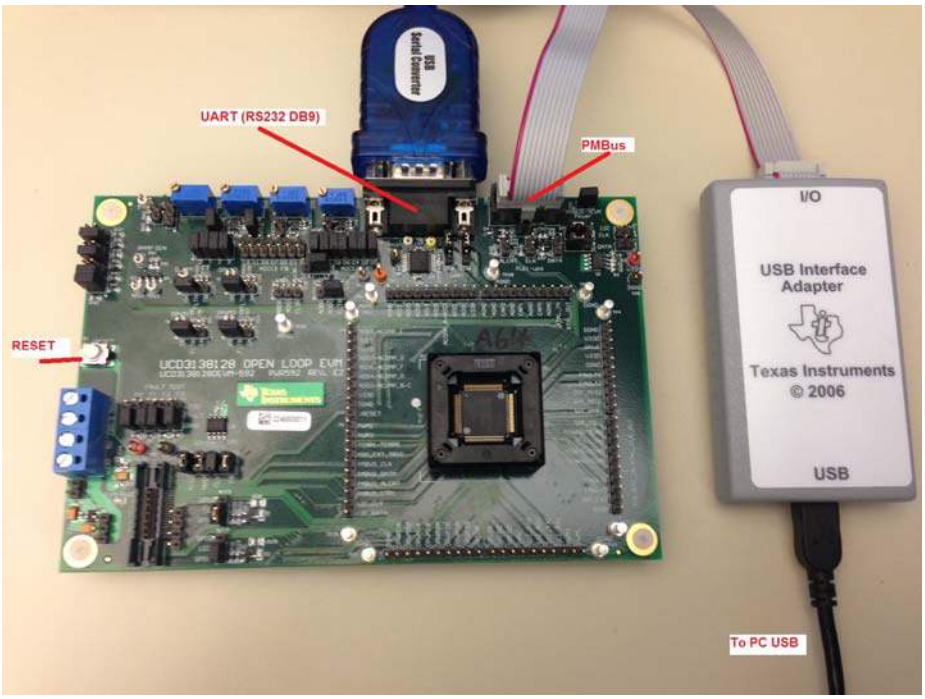

Figure 12. UCD3138A64OEVM-662 Test Connections

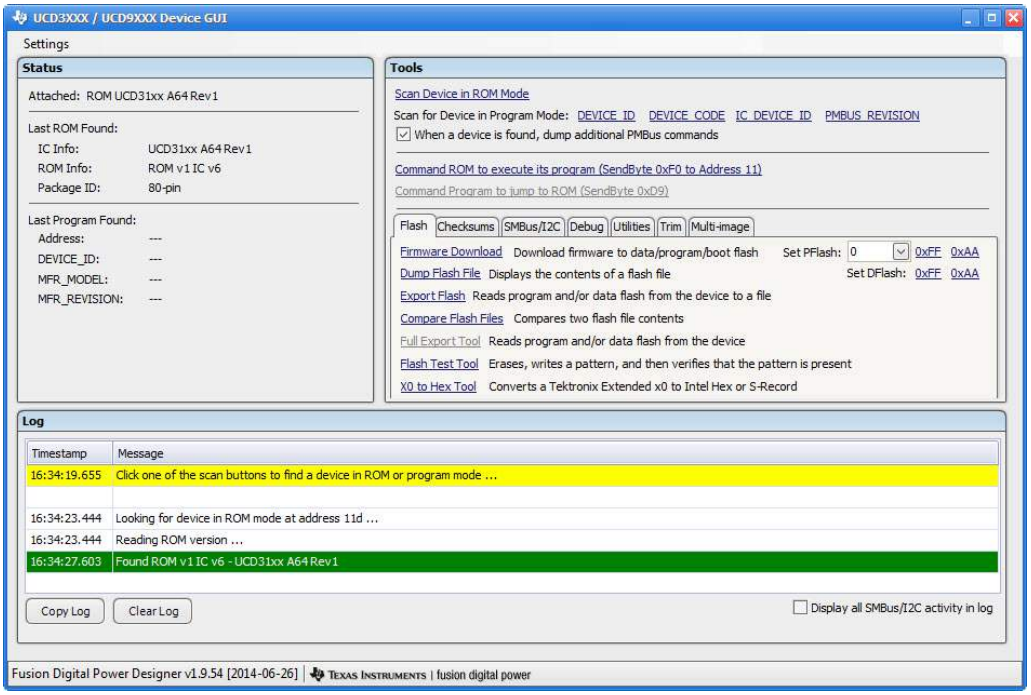

Figure 13. UCD31xx Device GUI

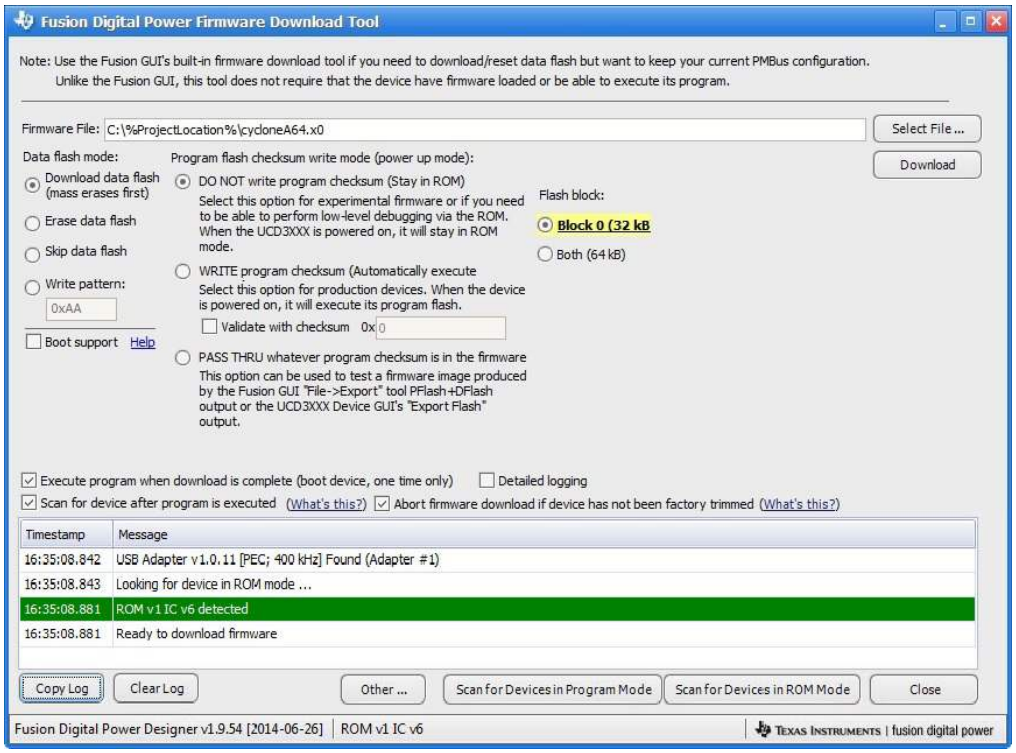

Figure 14. Firmware code downloading

6.3 List of Test Points

Table 2. The functions of each test point

Test Points	Name	Description
TP1, TP3, TP4, TP5, TP10, TP12, TP15, TP25, TP28, TP29	DGND	Digital Ground (for less sensitive / noisy signals)
TP2, TP9, TP11, TP20	AGND	Analog Ground (for more sensitive / less noisy signals)
TP6, TP8	V33D	Digital 3.3VDC
TP7	V33A	Analog 3.3VDC
TP13	UART J26-2	UART Transmitting
TP14	UART J26-3	UART Receiving
TP16	FLTR_DPWM0	DPWM0 Front End Connection
TP17	FLTR_DPWM1	DPWM1 Front End Connection
TP18	FLTR_DPWM2	DPWM2 Front End Connection
TP19	FLTR_DPWM3	DPWM3 Front End Connection
TP21	Q3 and Q4 Drain	Ramp generator
TP22	Q3 gate	Ramp generator
TP23	Q4 gate	Ramp generator
TP24	FFC_adj	Feed Forward Control Adjustment
J2, J3, J4, J5, J6, J7, J8, J9	Device Pins	UCD3138A84 Pinout Headers
J11, J12, J13, J14	Fault Connections	Place jumper to choose to pull corresponding Fault pin to V33D, DGND, or neither
J15	AD00 ADDR / FLTR	Place jumper to choose to filter AD00, or use it to create an address, or neither
J16	AD01 ADDR / FLTR	Place jumper to choose to filter AD01, or use it to create an address, or neither
J17, J20, J21, J22		Board Bias Power Management
J18	LED D1	Place jumper to choose connection to either GPIOA, GPIOB, or neither.
J19	LED D2	Place jumper to choose connection to either GPIOA, GPIOB, or neither.
J23	UART RX	Place jumper to use UART connector to communicate with UART Module 0, or Module 1, of the UCD3138A64
J24	Logic Analyzer	Logic Analyzer connector, not populated
J25	UART TX	Place jumper to use UART connector to communicate with UART Module 0, or Module 1, of the UCD3138A64
J26	UART	UART Connector, DB-9, Female, RS232
J27	JTAG	JTAG Connector Header
J28	PMBus	PMBus Connector
J29	PMBus CLK	Enables board side Pull-up Resistor. Jump to add 1.5kΩ Pull-up resistor to PMBus Clocking line
J30	PMBus CTRL	Place jumper to connect PMBus Control Line
J31	PMBus DATA	Enables board side Pull-up Resistor. Jump to add 1.5kΩ Pull-up resistor to PMBus Data line
J32	PMBus ALERT	Enables board side Pull-up Resistor. Jump to add 1.5kΩ Pull-up resistor to PMBus ALERT line

J33	DPWM0 Filter	DPWM Filter. Place Jumper to choose to filter DPWM0A or DPWM0B in accordance with the schematic.
J34	DPWM1 Filter	DPWM Filter. Place Jumper to choose to filter DPWM1A or DPWM1B in accordance with the schematic.
J35	DPWM2 Filter	DPWM Filter. Place Jumper to choose to filter DPWM2A or DPWM2B in accordance with the schematic.
J36	DPWM3 Filter	DPWM Filter. Place Jumper to choose to filter DPWM3A or DPWM3B in accordance with the schematic.
J37, J38, J39	EADC and DPWM	Place Jumpers to connect chosen filtered DPWM(s) to EAP0S/EAP1S
J40, J41, J43, J46	ADC12	Place Jumpers to obtain intermediate voltage on select ADC12 pins.
J42	FFCS	Feed Forward Control Selection
J44, J45	FFC	Voltage Feed Forward Test Circuit
J47	Logic Connector Header	Used to connect select signals to logic connector header.
J48, J49, J51, J53	SPI EEPROM	Place jumpers to connect SPI EEPROM to SPI MISO, MOSI, CLK, and CS pins of UCD3138A64 device.
J50, J52	I2C EEPROM	Place jumpers to connect I2C EEPROM to I2C CLK and DATA pins of UCD3138A64 device.
J56, J57	PMBus / I2C	Place jumpers to choose the PMBus connector's connection to the UCD3138A64 device. Connect to I2C pins, or PMBus pins.
S1	/RESET	Push button to reset UCD3138A64.

7 Test Procedure

7.1 Connection Test

1. Connect one end of the USB cable to the PC computer and the other end to the USB interface adapter, HPA172. The LED on HPA172 should light up.
2. Connect HPA172 to PWR662 PMBus connector **J28** with the ribbon cable. Jump across **J22**, **J56(2&3)**, and **J57(2&3).** LED **D3** on PWR662 should light up.
3. Launch the GUI by the steps described in **5.1.3**. Wait until the window in **Figure 13** is shown.
4. Click "Scan Device in ROM Mode", then wait and check **Figure 13** on its "Log" and confirm "**Found ROM v1 IC v6 – UCD31xx A64 Rev 1**". If "Found ROM" not shown, Click "**Device ID**" then click "**Command Program to jump to ROM** (sendByte0xD9) and then click "**Scan Device in ROM Mode**" again.

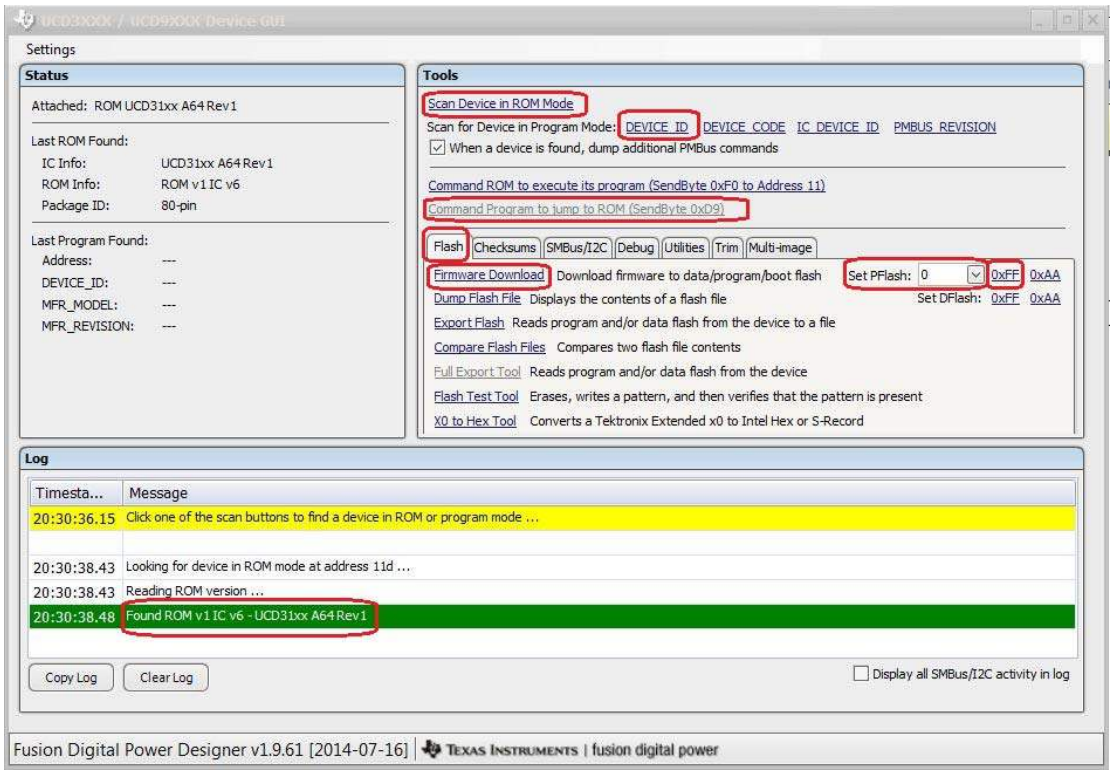

Figure 15 Using the UCD3xxx / UCD9xxx Device GUI Main Window

7.2 ADC12 Input Setup

5. Connect a voltmeter with its positive terminal to **J41-1** and return terminal to **TP25**.
6. Adjust **R57** to make the voltage meter read 250mV +/- 0.1mV
7. Move the voltmeter positive terminal to **J43-1**.
8. Adjust **R59** to make the voltmeter read 250mV +/- 0.1mV
9. Remove **J22**, and move the voltmeter positive terminal to **J39 pin 1**, and the negative terminal to **J37 pin 1**. Set the voltmeter to resistance, and tune the potentiometer R54, until the resistance is 4.07kohm +/- 0.1kohm.
10. Remove the voltmeter probes, and re-connect the jumper across **J22**.

7.3 Communication Terminal using RS232 Serial Port

11. Set up Communication Terminal port settings as shown in **Figure 16**. Then save this setup as “Test_UCD3138A64OEVM-662”. The detail how to set up UART terminal communication is addressed in **Appendix B**.
12. Connect RS232 Serial Port (UART) with DB9 male to PWR662 **J26** and DB9 female to PC. Jump across **J23(2&3)** and **J25(2&3)**.
13. Launch saved terminal.

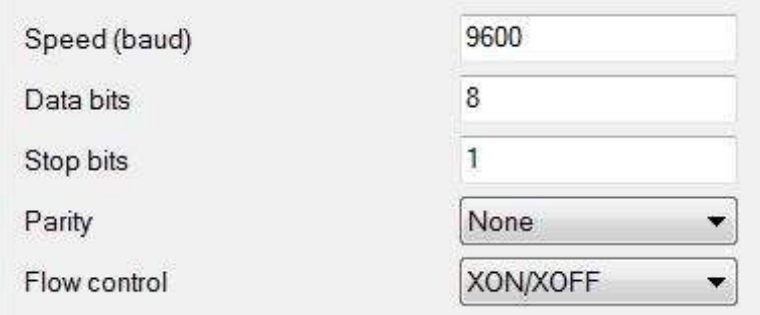

Figure 16 Terminal Communication Settings

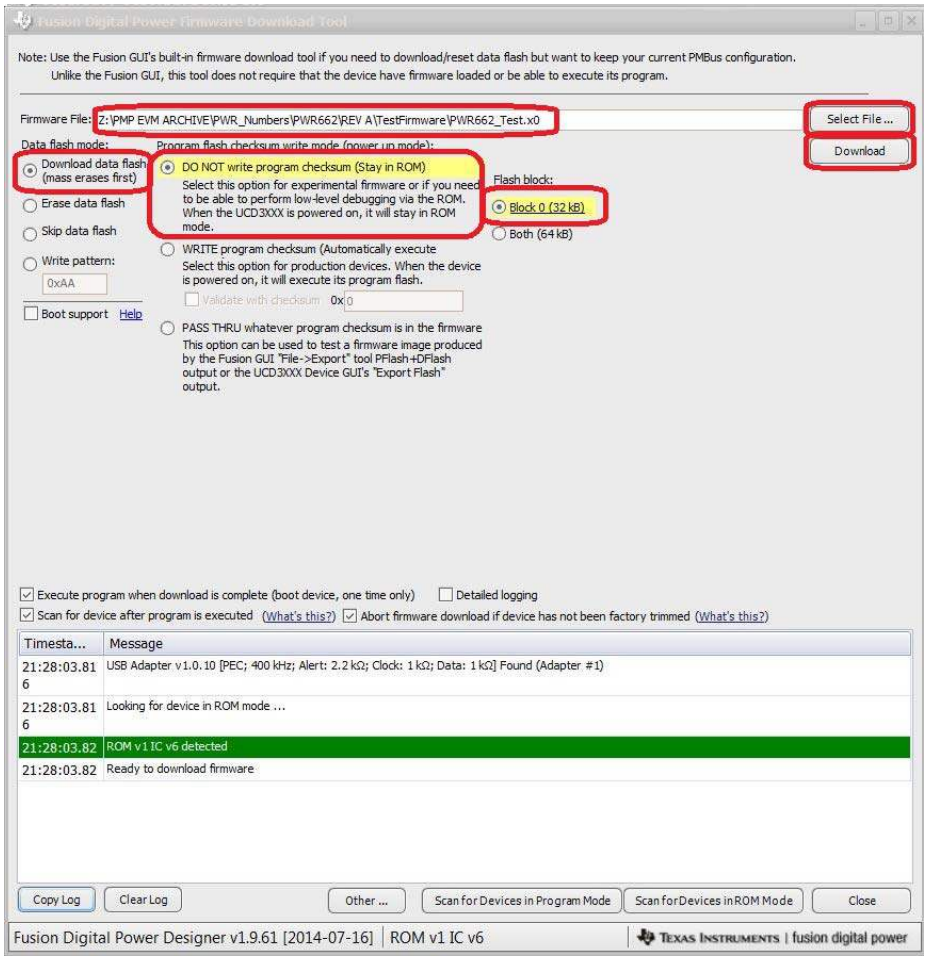

Figure 17: Download the Firmware

7.4 Setup-A Test

14. Place jumpers on the following Headers:
    - **J18(1&2)** and **J19(1&2)**
    - **J27(11&13)**
    - **J11(1&2)**, **J12(1&2)**, **J13(1&2)**, and **J14(1&2)**.

- **J16(1&2)**, **J46(2&3)**, **J43(1&2)(3&4)(5&6)(7&8)(9&10)(11&12)(13&14)**, **J41(13&14)**
- **J48, J49**, **J51**, and **J53**
- **J50**
- **J38(1&2)(3&4)(5&6)(7&8)**, **J37**, **J39**, **J33(2&3)**, **J34(2&3)**, **J35(2&3)**, and **J36(2&3)**

15. Using clip wires, short **PWM0,1,2,3**, **TCAP0**, **TCAP1**, **INT_EXT**, **SYNC**, and **ADC_EXT_TRIG** to **V33D**. That is, **J6pins1,2,3,4**, **J9pins4,9,10**, and **J7pins2,9** must all be shorted together and connected to **TP6**.
16. On the GUI shown in **Figure 15**, click Firmware Download, then a new window should come up as in **Figure 17**. On this new window,
    a) Check “Download data flash”, “DO NOT write program checksum”, and “Block 0 (32kB)” as shown in **Figure 17**
    b) Click “Select file” and find “PWR662_Test.x0”. Click “Download”.
    c) When asked, “Do you want to continue with the firmware download?”, click “Yes” to continue.
17. After finishing the program download, the PWR662 board starts self-test automatically. The test status is reported by the Hyper Terminal, shown in **Figure 18**. With Setup-A, Tests A1-A8 should pass.
18. Check LED **D1** and **D2**. Both should light up.
19. Click “Close” to close the Firmware Download window shown in **Figure 17**.

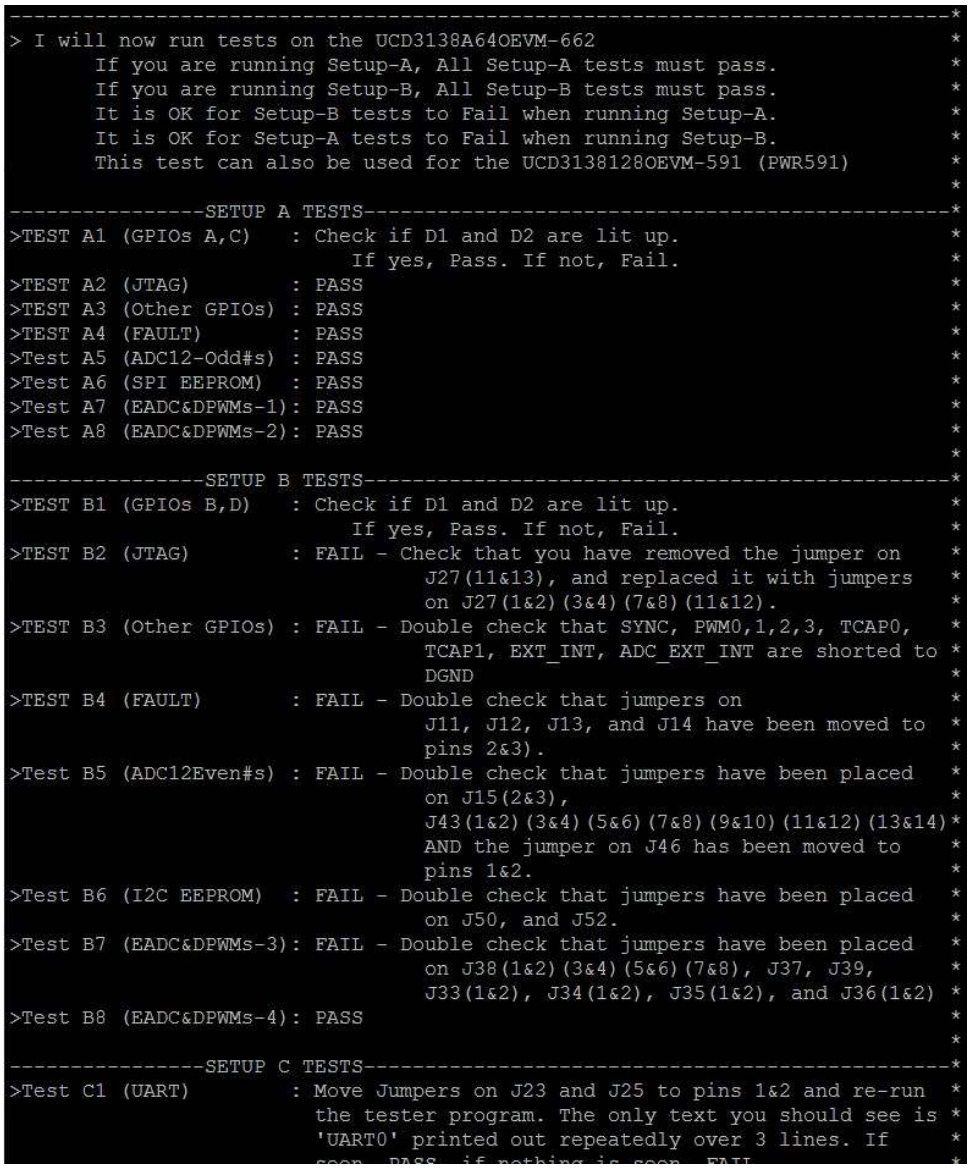

Figure 18: Setup-A Test Result

7.5 Equipment Shutdown

a. Exit the GUI and UART

b. Disconnect the cables.

8 EVM Assembly Drawing and PCB layout

The following figures (Figure 17 through Figure 22) show the design of the UCD3138A64OEVM-662 printed circuit board. PCB dimensions: L x W = 6.0 x 4.0 in, PCB material: FR4 or compatible, four layers and 1oz copper on each layer.

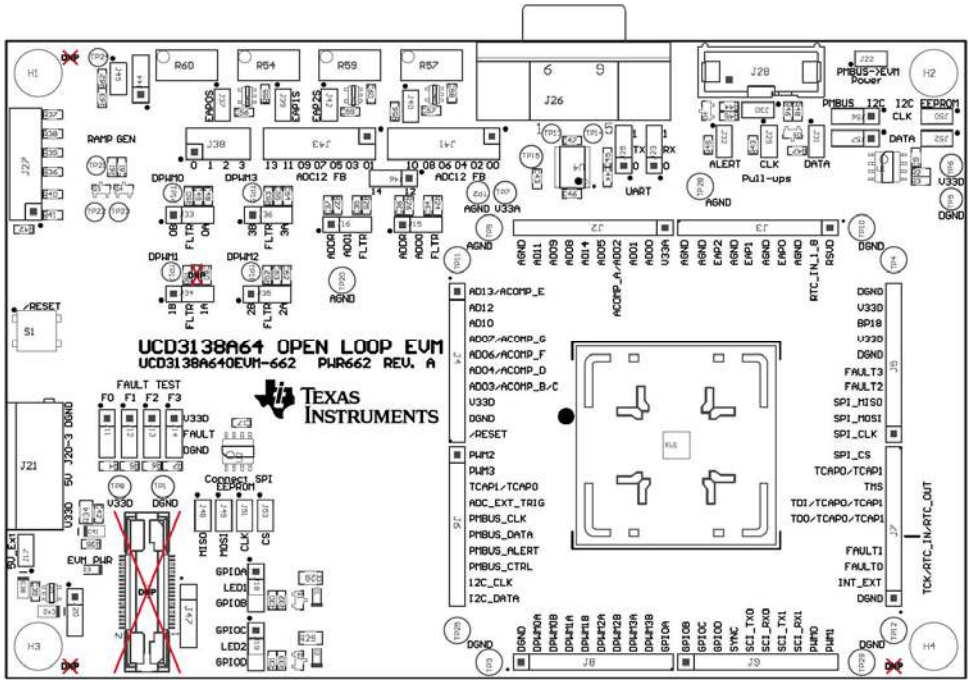

Figure 15. UCD3138A64OEVM-662 Top Layer Assembly Drawing (Top view)

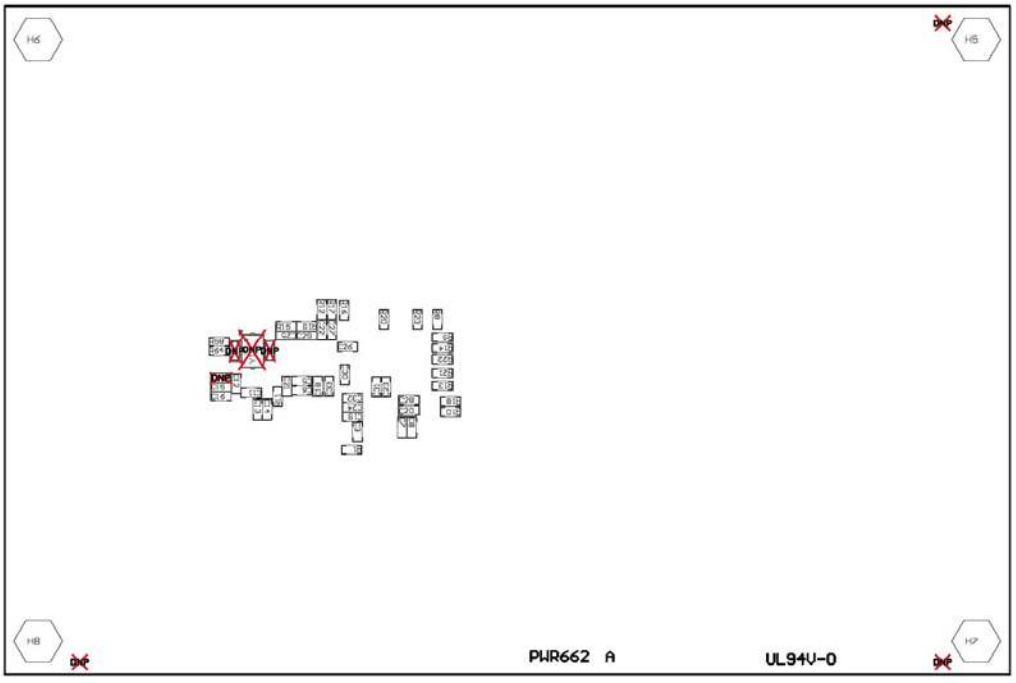

Figure 16. UCD3138A64OEVM-662 Bottom Assembly Drawing (Bottom view)

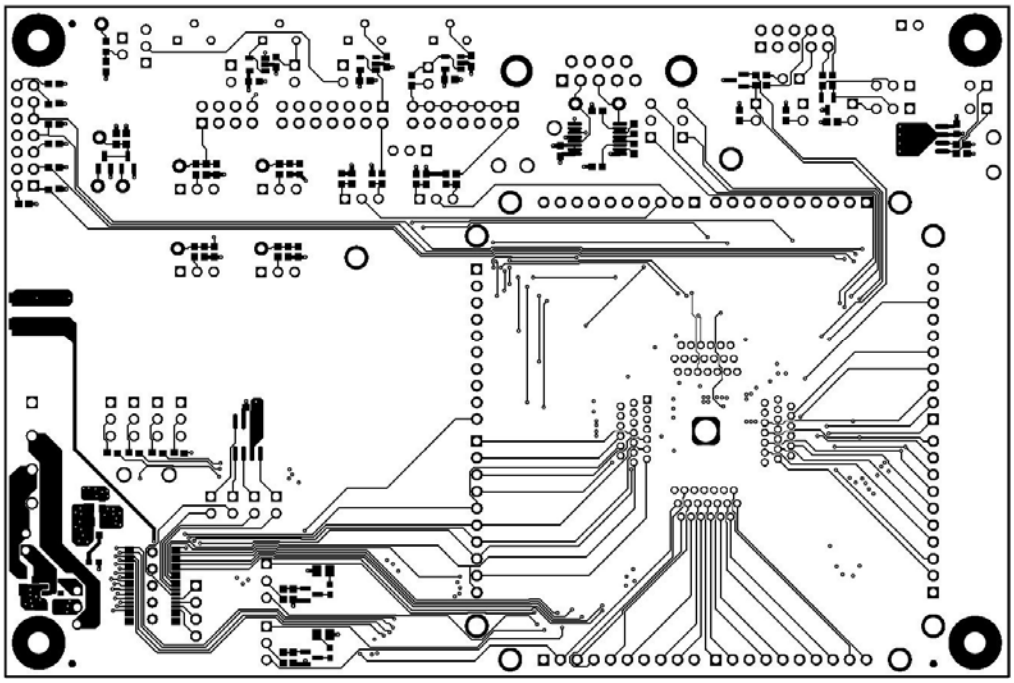

Figure 17. UCD3138A64OEVM-662 Top Copper (Top View)

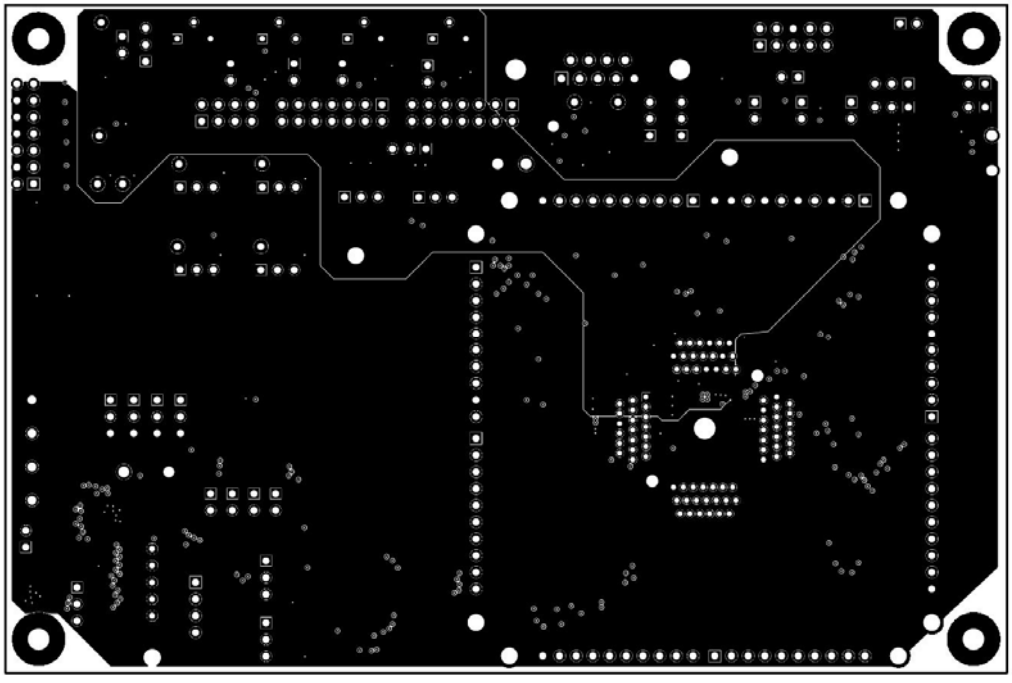

Figure 18. UCD3138A64OEVM-662 Internal Layer 1 (Top View)

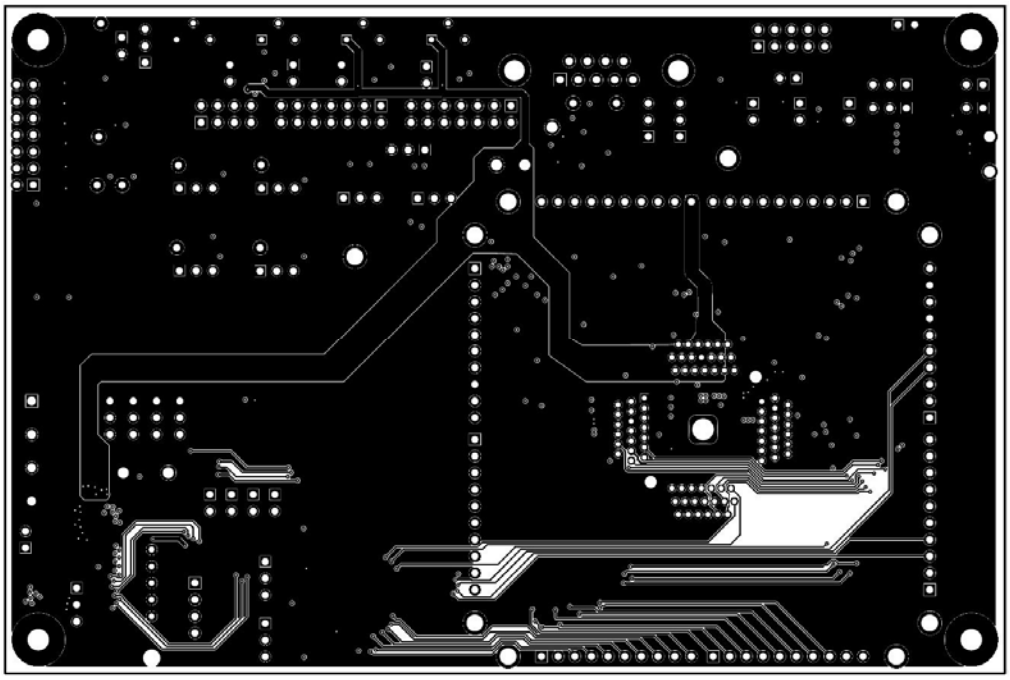

Figure 19. UCD3138A64OEVM-662 Internal Layer 2 (Top View)

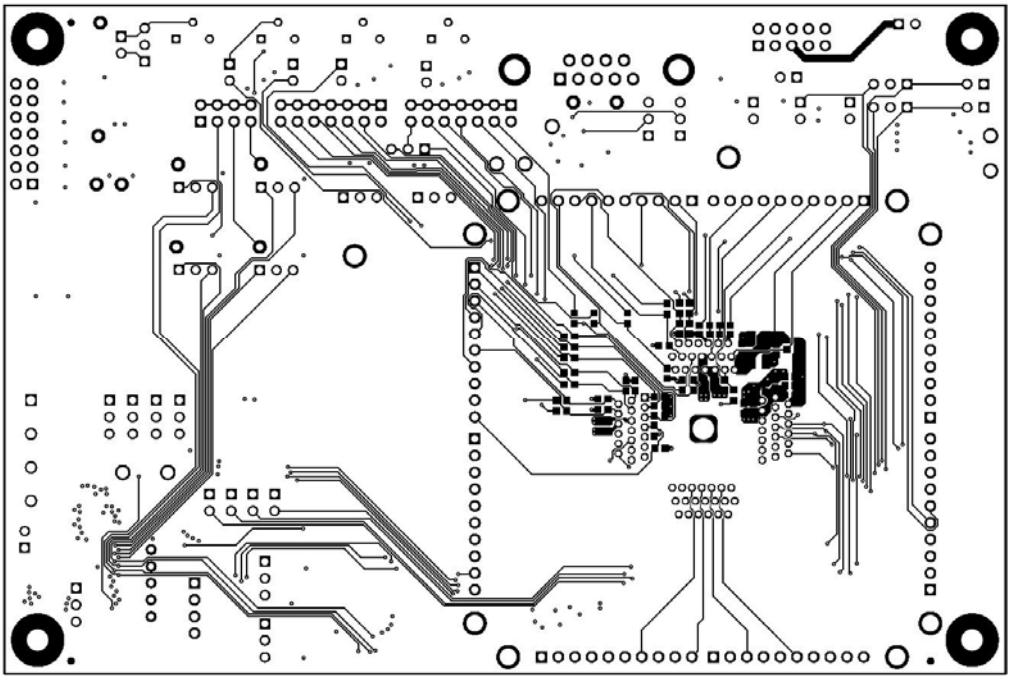

Figure 20. UCD3138A64OEVM-662 Bottom Copper (Top View)

9 Bill of Materials

Table 3. The EVM components list according to the schematics shown in Figure 1 to 10

RefDes	QTY	Value	Description	Size	Part Number	MFR
!PCB	1		Printed Circuit Board		PWR662	Any
C3	1	0.1uF	CAP, CERM, 0.1uF, 16V, +/-10%, X7R, 0603	0603	C0603C104K4RACTU	Kemet
C5, C7, C11, C13, C16, C36, C37	7	1000pF	CAP, CERM, 1000pF, 50V, +/-5%, C0G/NP0, 0603	0603	C0603C102J5GAC	Kemet
C6, C8, C12, C14	4	4.7uF	CAP, CERM, 4.7uF, 16V, +/-10%, X5R, 0603	0603	GRM188R61C475KAAJ	MuRata
C9	1	0.1uF	CAP, CERM, 0.1uF, 25V, +/-10%, X5R, 0603	0603	GRM188R61E104KA01D	MuRata
C15, C39, C42, C49	4	1uF	CAP, CERM, 1uF, 16V, +/-10%, X7R, 0603	0603	GRM188R71C105KA12D	MuRata
C17	1	0.1uF	CAP, CERM, 0.1uF, 25V, +/-10%, X7R, 0603	0603	GRM188R71E104KA01D	MuRata
C18, C19, C20, C22, C23, C24, C26, C27, C28, C30, C31, C32, C33, C34, C35	15	1000pF	CAP, CERM, 1000pF, 50V, +/-10%, X7R, 0603	0603	GRM188R71H102KA01D	MuRata
C21, C25, C29	3	100pF	CAP, CERM, 100pF, 50V, +/-5%, C0G/NP0, 0603	0603	GRM1885C1H101JA01D	MuRata
C38, C40, C41	3	10uF	CAP, TA, 10uF, 10V, +/-20%, 3.4 ohm, SMD	3216-18	293D106X0010A2TE3	Vishay-Sprague
C43, C44, C45, C46, C47, C56, C57, C58, C59, C60, C61	11	0.1uF	CAP, CERM, 0.1uF, 16V, +/-10%, X7R, 0603	0603	GRM188R71C104KA01D	MuRata
C48, C50, C52, C53, C54, C55	6	1000pF	CAP, CERM, 1000pF, 50V, +/-10%, X7R, 0603	0603	C0603C102K5RACTU	Kemet
D1	1	Orange	LED, Orange, SMD	1.6x0.8x0.8 mm	LTST-C190KFKT	Lite-On
D2	1	Red	LED, Red, SMD	Red LED, 1.6x0.8x0.8 mm	LTST-C190CKT	Lite-On
D3	1	Green	LED, Green, SMD	1.6x0.8x0.8 mm	LTST-C190GKT	Lite-On
D4, D5	2	5.1V	Diode, Zener, 5.1V, 300mW, SOT-23	SOT-23	AZ23C5V1-7-F	Diodes Inc.
H1, H2, H3, H4	4		Machine Screw, Round, #4-40 x 1/4, Nylon, Philips panhead	Screw	NY PMS 440 0025 PH	B&F Fastener Supply
H5, H6, H7, H8	4		Standoff, Hex, 0.5"L #4-40 Nylon	Standoff	1902C	Keystone
J2, J3, J4, J5, J6, J7, J8, J9	8		Header, TH, 100mil, 10x1, Gold plated, 230 mil above insulator	10x1 Header	TSW-110-07-G-S	Samtec

J11, J12, J13, J14, J15, J16, J18, J19, J20, J23, J25, J33, J34, J35, J36, J44, J46, J56, J57	19		Header, 100mil, 3x1, Tin plated, TH	Header, 3 PIN, 100mil, Tin	PEC03SAAN	Sullins Connector Solutions
J17, J22, J29, J30, J31, J32, J37, J39, J40, J42, J45, J48, J49, J50, J51, J52, J53	17		Header, 100mil, 2x1, Tin plated, TH	Header, 2 PIN, 100mil, Tin	PEC02SAAN	Sullins Connector Solutions
J21	1		TERMINAL BLOCK 5.08MM VERT 4POS, TH	TERM_BLK, 4pos, 5.08mm	ED120/4DS	On-Shore Technology
J26	1		CONN DB9 FEMALE R/A SOLDER TH	D-SUB 9 PIN	182-009-213R171	NorComp
J27, J41, J43	3		Header, 100mil, 7x2, Tin plated, TH	Header, 7x2, 100mil, Tin	PEC07DAAN	Sullins Connector Solutions
J28	1		Header (shrouded), 100mil, 5x2, High-Temperature, Gold, TH	5x2 Shrouded header	N2510-6002-RB	3M
J38	1		Header, 100mil, 4x2, Tin plated, TH	Header, 4x2, 100mil, Tin	PEC04DAAN	Sullins Connector Solutions
J47	1		Header, TH, 100mil, 4x1, Gold plated, 230 mil above insulator	4x1 Header	TSW-104-07-G-S	Samtec
NT1	1		Single point connection between nets.			
Q1, Q2	2	0.2V	Transistor, NPN, 40V, 0.2A, SOT-23	SOT-23	MMBT3904	Fairchild Semiconductor
Q3, Q4	2	60V	MOSFET, N-CH, 60V, 0.17A, SOT-23	SOT-23	2N7002-7-F	Diodes Inc.
R1, R58, R64	3	1.0k	RES, 1.0k ohm, 5%, 0.1W, 0603	0603	CRCW06031K00JNEA	Vishay-Dale
R2, R3	2	4.7k	RES, 4.7k ohm, 5%, 0.1W, 0603	0603	CRCW06034K70JNEA	Vishay-Dale
R4, R5, R6, R7, R32, R33, R37, R38, R39, R40, R41, R42, R55, R56, R61, R62, R63	17	10.0k	RES, 10.0k ohm, 1%, 0.1W, 0603	0603	CRCW060310K0FKEA	Vishay-Dale
R8, R9, R10, R12, R13, R14, R16, R17, R18, R20, R21, R22, R23, R24, R25	15	100	RES, 100 ohm, 1%, 0.1W, 0603	0603	CRCW0603100RFKEA	Vishay-Dale
R11, R15, R19	3	1.00k	RES, 1.00k ohm, 1%, 0.1W, 0603	0603	CRCW06031K00FKEA	Vishay-Dale
R26	1	44.2k	RES, 44.2k ohm, 1%, 0.1W, 0603	0603	CRCW060344K2FKEA	Vishay-Dale
R27	1	22.6k	RES, 22.6k ohm, 1%, 0.1W, 0603	0603	CRCW060322K6FKEA	Vishay-Dale
R28, R29	2	100	RES, 100 ohm, 1%, 0.125W, 0805	0805	CRCW0805100RFKEA	Vishay-Dale
R30, R31	2	4.70k	RES, 4.70k ohm, 1%, 0.1W, 0603	0603	RC0603FR-074K7L	Yageo America
R34	1	0	RES, 0 ohm, 5%, 0.333W, 0805	0805	CRCW08050000Z0EAHP	Vishay-Dale

R35	1	200	RES, 200 ohm, 5%, 0.1W, 0603	0603	CRCW0603200RJNEA	Vishay-Dale
R36	1	0	RES, 0 ohm, 5%, 0.1W, 0603	0603	CRCW06030000Z0EA	Vishay-Dale
R43, R47, R49	3	1.5k	RES, 1.5k ohm, 5%, 0.1W, 0603	0603	CRCW06031K50JNEA	Vishay-Dale
R44, R45, R46, R48	4	33	RES, 33 ohm, 5%, 0.1W, 0603	0603	CRCW060333R0JNEA	Vishay-Dale
R50, R51, R52, R53	4	2.00k	RES, 2.00k ohm, 1%, 0.1W, 0603	0603	CRCW06032K00FKEA	Vishay-Dale
R54, R57, R59, R60	4	20k ohm	TRIMMER, 20K, 0.5W, TH	9.5x10x4.8 mm	3296Y-1-203LF	Bourns
S1	1		Switch, Tactile, SPST-NO, 1VA, 32V, SMT	Switch, 6.3x5.36x6.6 mm, SMT	KT11P2JM34LFS	C&K Components
SH-J1, SH-J2, SH-J3, SH-J4, SH-J5, SH-J6, SH-J7, SH-J8, SH-J9, SH-J10, SH-J11	11	1x2	Shunt, 100mil, Flash Gold, Black	Closed Top 100mil Shunt	SPC02SYAN	Sullins Connector Solutions
TP1, TP5, TP15	3	Black	Test Point, Multipurpose, Black, TH	Black Multipurpose Testpoint	5011	Keystone
TP2	1	Grey	Test Point, Multipurpose, Grey, TH	Grey Multipurpose Testpoint	5128	Keystone
TP3, TP4, TP9, TP10, TP11, TP12, TP20, TP25, TP28, TP29	10	Triple	Terminal, Turret, TH, Triple	Keystone1598-2	1598-2	Keystone
TP6, TP8	2	Red	Test Point, Multipurpose, Red, TH	Red Multipurpose Testpoint	5010	Keystone
TP7	1	Orange	Test Point, Multipurpose, Orange, TH	Orange Multipurpose Testpoint	5013	Keystone
TP13, TP16, TP17, TP18, TP19, TP21, TP22, TP23, TP24	9	White	Test Point, Miniature, White, TH	White Miniature Testpoint	5002	Keystone
TP14	1	Yellow	Test Point, Miniature, Yellow, TH	Yellow Miniature Testpoint	5004	Keystone
U1	1		IC, EEPROM, 2MBIT, 1MHZ, 8SOIC	SOIC-8	M24M02-DRMN6TP	STMicroelectronics
U2	1		2-Mbit DataFlash (with Extra 64-Kbits), 1.65V Minimum SPI Serial Flash Memory, SOIC-8	SOIC-8	AT45DB021E-SSHN-B	Adesto Technologies
U3	1		LOW-POWER 150-mA LOW-DROPOUT LINEAR REGULATOR, DBV0005A	DBV0005A	TPS76333DBV	Texas Instruments
U4	1		3-V to 5.5-V Single-Channel RS-232 Compatible Line Driver / Receiver, 0	DB0016A	SN75C3221DBR	Texas Instruments

			to 70 degC, 16-Pin SSOP (DB), Green (RoHS & no Sb/Br)			
U5, U6, U7	3		Low-Noise, Low Quiescent Current, Precision Operational Amplifier e-trim Series, DBV0005A	DBV0005A	OPA376AIDBV	Texas Instruments
U8	1		UCD3138A64PFC, PFC0080	PFC0080A	UCD3138A64PFC	Texas Instruments
XU1	1		Socket, QFN-80, 0.5mm pitch, TH	29X16.5X29 mm	IC357-0804-074P-2	Yamaichi Electronics
C1, C2	0	10pF	CAP, CERM, 10pF, 50V, +/-5%, C0G/NP0, 0603	0603	C0603C100J5GACTU	Kemet
C4	0	2.2uF	CAP, CERM, 2.2uF, 10V, +/-10%, X7R, 0603	0603	GRM188R71A225KE15D	MuRata
C51	0	1uF	CAP, CERM, 1uF, 16V, +/-10%, X7R, 0603	0603	GRM188R71C105KA12D	MuRata
FID1, FID2, FID3, FID4, FID5, FID6	0		Fiducial mark. There is nothing to buy or mount.	Fiducial	N/A	N/A
J24	0		CONN RECEPT 38POS .025 VERT SMD	1000x250x2 72 mil	2-5767004-2	TE Connectivity
Y1	0		Crystal, 10.000MHz, 10pF, SMD	5x0.9x3.2m m	7B-10.000MEEQ-T	TXC Corporation

Appendix A. Using Code Composer Studio v5.5

In this appendix, the basic steps of how to use Code Composer Studio v5.5 to compile firmware for UCD3138 family of devices is described. A design flow is described while detailed steps for firmware code creation, and firmware debugging along with hardware are obviously beyond the scope of this user's guide and this appendix.

A.1 Importing a CCSv5 project

Upon running CCSv5.5 for the first time, the **Workspace Launcher** window will appear as shown in **Figure A1**: CCSv5.5 Workspace Launcher. It is left to the user do decide whether or not to use a workspace, where it is located, and/or to check the box that says **Use this as the default and do not ask again**. For this guide, a workspace will not be used, so click **OK**.

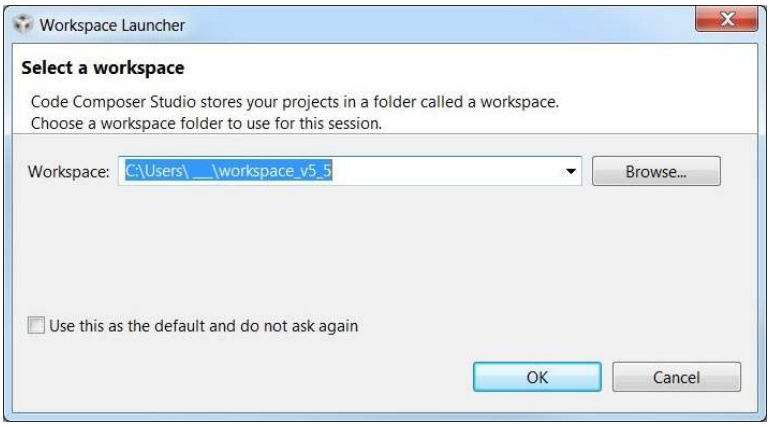

Figure A1: CCSv5.5 Workspace Launcher

When the main window opens, click **Project** in the top navigation menu, then choose **Import Existing CCS Eclipse Project** as shown in window as shown in **Figure A2**: Import Existing CCS Eclipse Project.

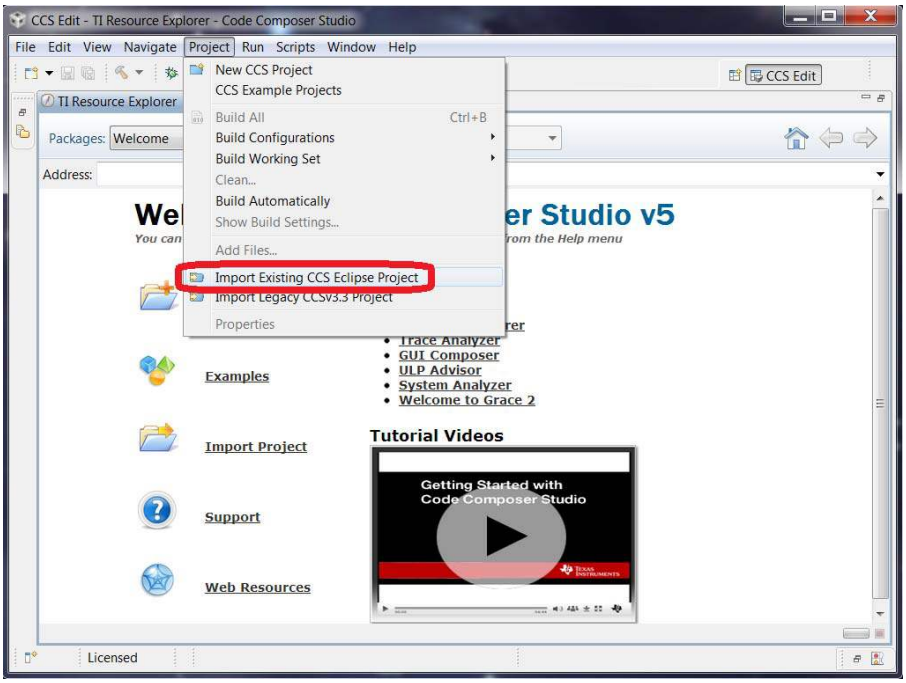

Figure A2: Import Existing CCS Eclipse Project

This will open the window shown in **Figure A3**: Importing a CCSv5.5 project. Under **Select-search directory**, click **Browse**, navigate to the target project, and click **OK**. For this example, the project is called **Training_CCSv5.5** and is located in a folder called **Training_CCS5v5**. Check the box next to the discovered project, and do not check **Copy projects into workspace**, or **Automatically import referenced projects**. Click **Finish**.

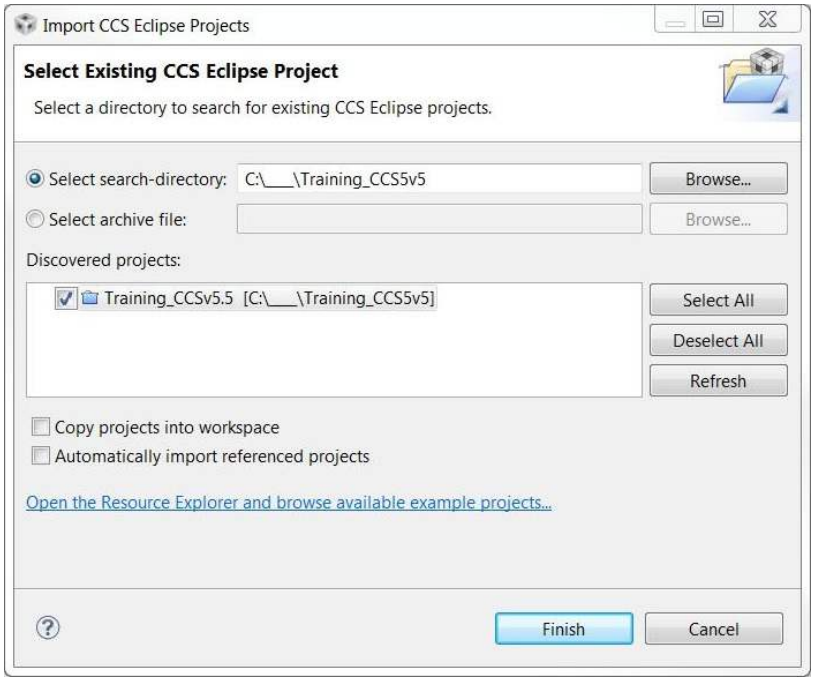

Figure A3: Importing a CCSv5.5 project

The project should be imported into CCSv5.5 and should be shown in the **Project Explorer** as shown in **Figure A4**: Project Explorer. At this point, files in the project can be edited as required.

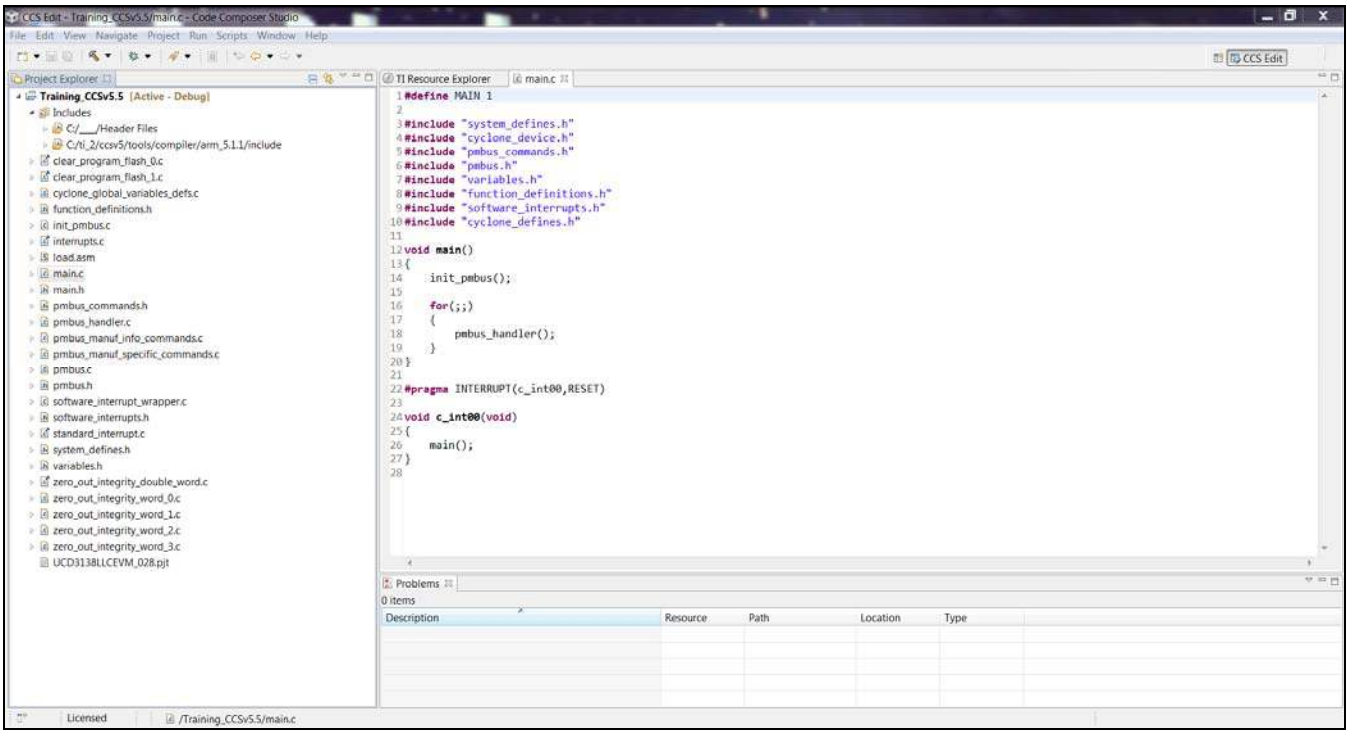

Figure A4: Project Explorer

A.2 Build/Compile a Project using Code Composer Studio v5.5

For the UCD3138 family of devices, compiling a project produces an **Intel-hex** (**.x0**) firmware file that can be downloaded to, and run on the UCD3138 or related target device using the **UCD3XXX** / **UCD9XXX Device GUI** (part of the Fusion Design Online software from TI).

After finished editing the project files, Right-Click on the project in the Project explorer, and choose **Build Project**.

Note: If this is the first time building a UCD3138 or related project, and Cygwin is also installed on the PC that is performing the compilation, the instructions in Section 3.3 of the Application Note entitled "Converting UCD3138 Firmware Project from Code Composer Studio Version 3.3 to 5.2" must be followed. Mainly, the C:\CYGWIN or other similarly named directory must be renamed **temporarily** during this first build. This will allow the new ARM library to be built properly. After this first build, the CYGWIN directory can be rolled back to its original name, and future builds can compile successfully.

Builds may take up to a minute to compile, or longer for a first time build. **Figure A5**: Successful Build of UCD3138 Related Source Code shows the state of a successful build:

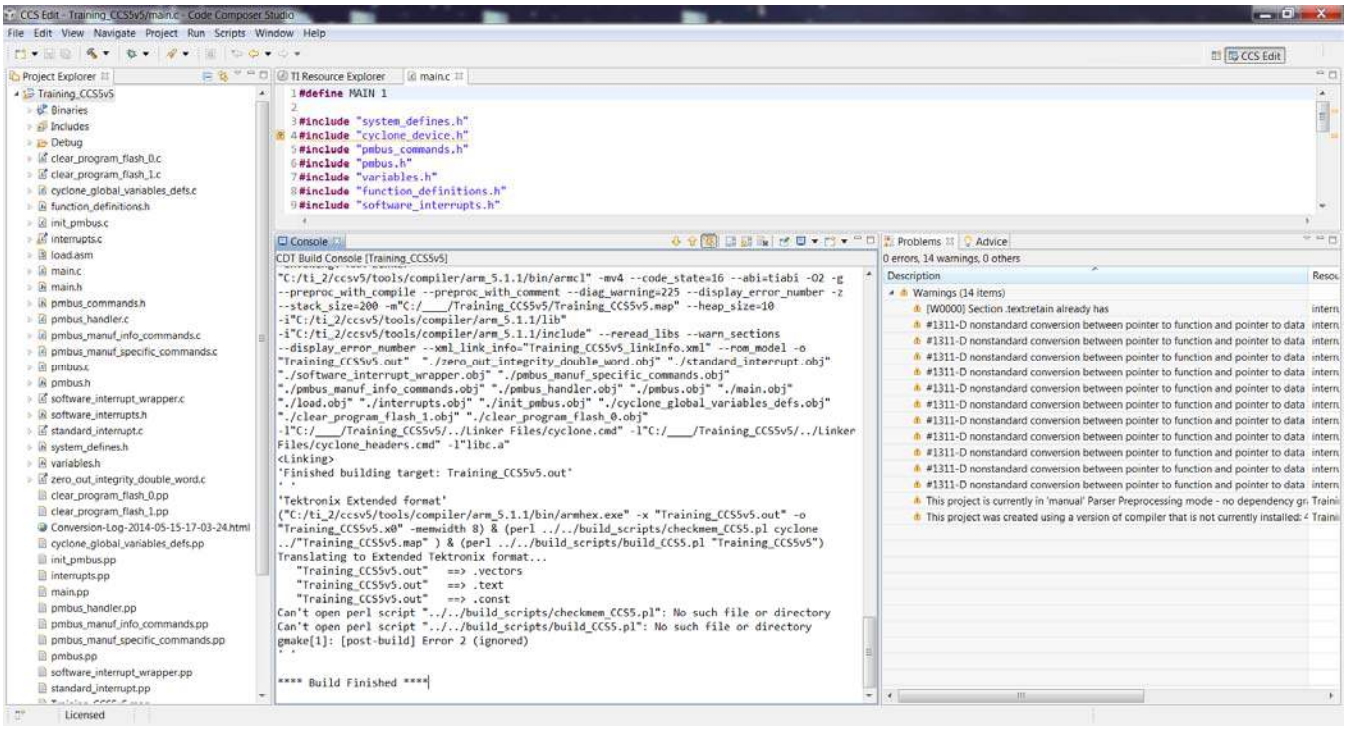

Figure A5: Successful Build of UCD3138 Related Source Code

When the build has finished, the **.x0** file should be created and will be placed in the project directory's **debug** folder. The filename that prefaces the **.x0** will be the name of the project that was built (i.e. a project named **Training_CCS5v5** will create **Training_CCS5v5.x0** as its firmware file). However, it must be noted that the project name must have no spaces, otherwise the **.x0** file will not be generated.

This **.x0** file can be and run on the UCD3138 target device using the **UCD3XXX** / **UCD9XXX Device GUI**.

Appendix B. Setting up PuTTY

PuTTY is an open source Telnet and SSH terminal software that can be downloaded from www.putty.org. Download and run the putty.exe installation file. Follow the installation prompts making sure to allow the program to install to the default directory.

Step 1

In Windows, launch from its installed directory using the start menu (Start→Programs→PuTTY→PuTTY)

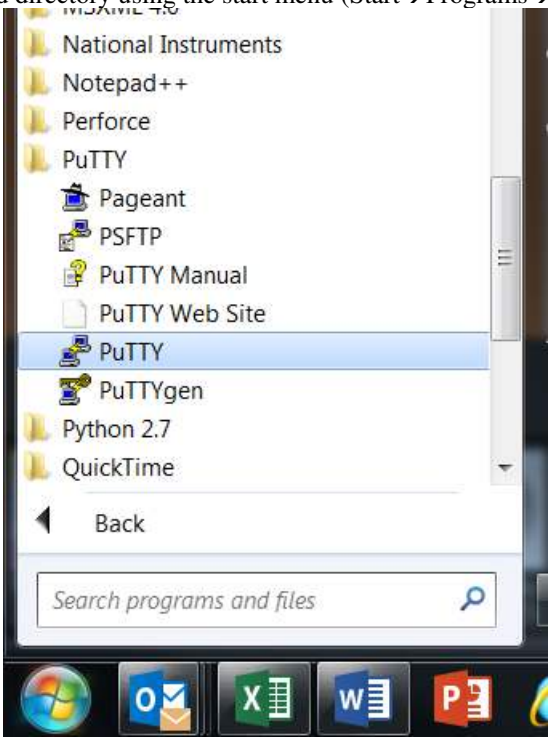

Figure B1: Starting Putty

Step 2

On the main **Session** category, click the **Serial** radio button.

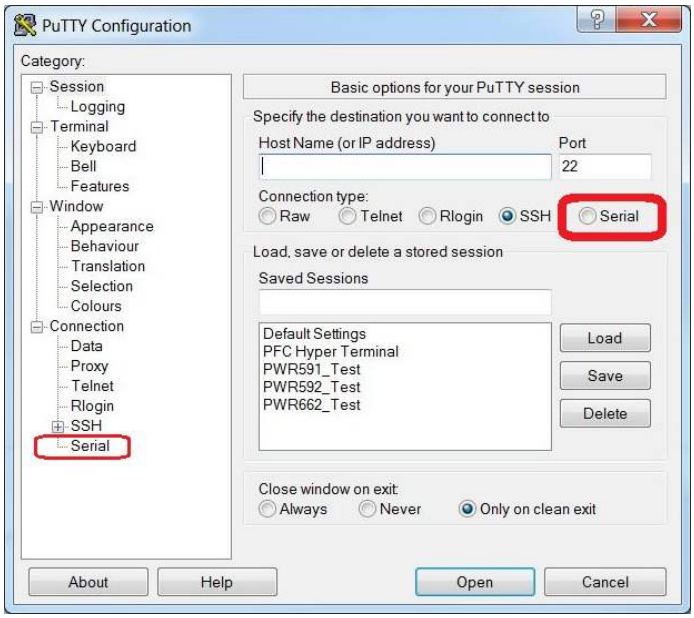

Figure B2 Step 2

Step 3

Under the **Connection** category, click **Serial** as highlighted in the figure from Step 2. Configure the information as shown in the image below. However, instead of COM1, use the serial line in which the Device Under Test (DUT) is connected on the PC. Baud = **9600**, Data bits = **8**, Stop bits = **1**, Parity = **None**, and Flow Control = **XON/XOFF**.

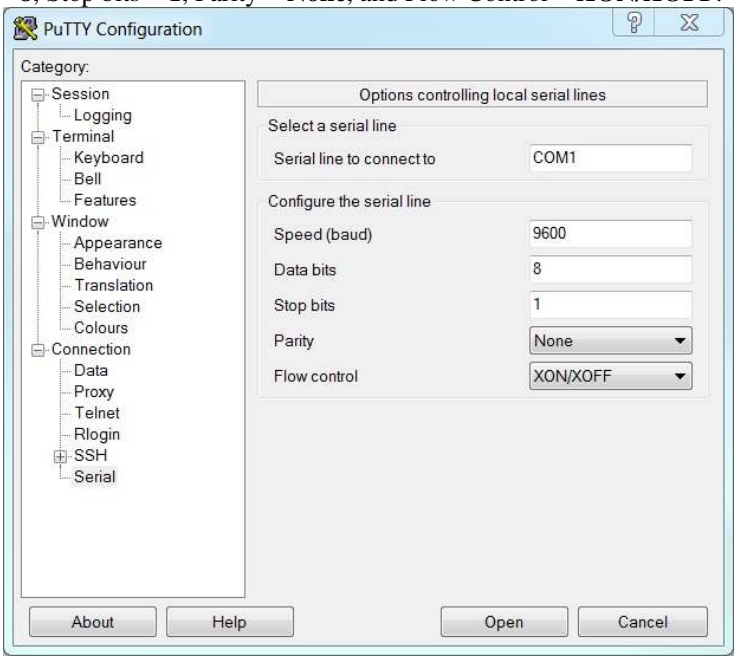

Figure B3 Step 3

Step 4

Click back to the main **Session** category, and enter in a save name for this configuration such as PWR662_Test as shown below. Click **Save**. This will save the session configuration so that upon closing and re-opening PuTTY, just click on the saved session name, and choose **Load**.

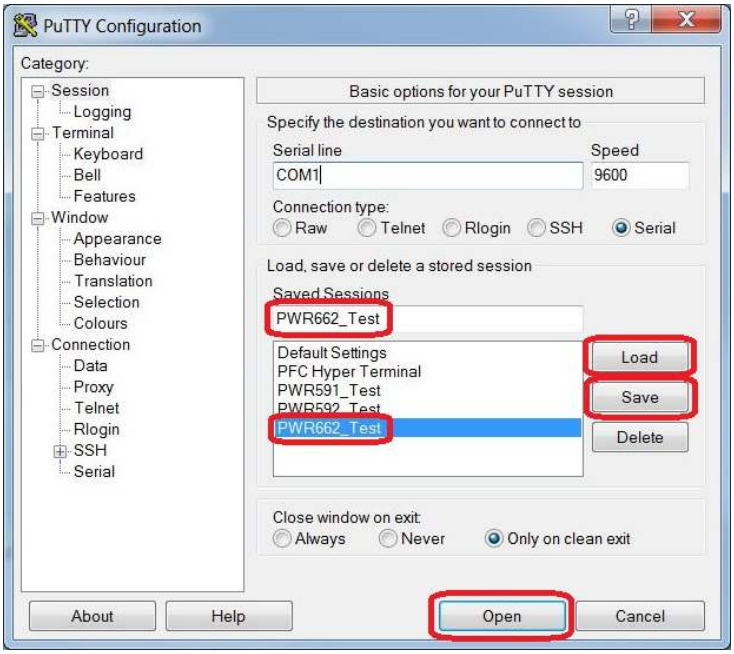

Figure B4 Step 4

Step 5

Click **Open** to open the serial terminal session with the DUT.

References

1. *UCD3138A64 Data Manual* (SLUSBZ8)
2. *UCD3138 Monitoring and Communications Programmer's Manual* (SLUU996)
3. *UCD3138 Digital Power Peripherals Programmer's Manual* (SLUU995)
4. *UCD3138 ARM and Digital System Programmer's Manual* (SLUU994)
5. *Fusion Digital Power Designer GUI for Isolated Power Applications User Guide* (for UCD3138, UCD3138064, UCD3138A64 applications) (SLUA676)
6. *Code Composer Studio v5 Wiki*, Texas Instruments, http://processors.wiki.ti.com/index.php/Category:Code_Composer_Studio_v5
7. *Converting UCD3138 Firmware Project from Code Composer Studio Version 3.3 to 5.2* (SLUA679)
8. *UCD3138A64 Programmer's Manual* (SLUUB54)
9. *UCD3138 Datasheet,* SLUSAP2, 2012
10. *UCD3138CC64EVM-030 Evaluation Module and User's Guide, SLUU886, 2012*

EVALUATION BOARD/KIT/MODULE (EVM) WARNINGS, RESTRICTIONS AND DISCLAIMER

For Feasibility Evaluation Only, in Laboratory/Development Environments. The EVM is not a complete product. It is intended solely for use for preliminary feasibility evaluation in laboratory / development environments by technically qualified electronics experts who are familiar with the dangers and application risks associated with handling electrical / mechanical components, systems and subsystems. It should not be used as all or part of a production unit.

Your Sole Responsibility and Risk. You acknowledge, represent and agree that:

1. You have unique knowledge concerning Federal, State and local regulatory requirements (including but not limited to Food and Drug Administration regulations, if applicable) which relate to your products and which relate to your use (and/or that of your employees, affiliates, contractors or designees) of the EVM for evaluation, testing and other purposes.
2. You have full and exclusive responsibility to assure the safety and compliance of your products with all such laws and other applicable regulatory requirements, and also to assure the safety of any activities to be conducted by you and/or your employees, affiliates, contractors or designees, using the EVM. Further, you are responsible to assure 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.
3. Since the EVM is not a completed product, it may not meet all applicable regulatory and safety compliance standards (such as UL, CSA, VDE, CE, RoHS and WEEE) which may normally be associated with similar items. You assume full responsibility to determine and/or assure compliance with any such standards and related certifications as may be applicable. You will employ reasonable safeguards to ensure that your use of the EVM will not result in any property damage, injury or death, even if the EVM should fail to perform as described or expected.

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Safety-Critical or Life-Critical Applications. If you intend to evaluate TI components for possible use in safety-critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, such as devices which are classified as FDA Class III or similar classification, then you must specifically notify TI of such intent and enter into a separate Assurance and Indemnity Agreement.

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1. *Delivery:* TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, or documentation (collectively, an “EVM” or “EVMs”) to the User (“User”) in accordance with the terms and conditions set forth herein. Acceptance of the EVM is expressly subject to the following terms and conditions.

   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 and conditions 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 and conditions 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 any defects that are 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. Moreover, TI shall not be liable for any defects that result from User's design, specifications or instructions for such EVMs. Testing and other quality control techniques are used to the extent TI deems necessary or as mandated by government requirements. TI does not test all parameters of each EVM.

   2.3 If any EVM fails to conform to the warranty set forth above, TI's sole liability shall be at its option to repair or replace such EVM, 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.

3 *Regulatory Notices:*

   3.1 *United States*

      3.1.1 *Notice applicable to EVMs not FCC-Approved:*

      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*

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-exempt RSS standard(s). 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。
http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page

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 by Radio Law of Japan to follow the instructions below with respect to EVMs:

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.

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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。
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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

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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 liability 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 WRITTEN DESIGN MATERIALS PROVIDED WITH THE EVM (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 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 AND CONDITIONS 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 MADE, CONCEIVED OR ACQUIRED PRIOR TO OR AFTER DELIVERY OF THE EVM.

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 AND CONDITIONS. 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.

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 ANDCONDITIONS OR THE USE OF THE EVMS PROVIDED HEREUNDER, 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 ONE YEAR AFTER THE RELATED CAUSE OF ACTION HAS OCCURRED.

   8.2 *Specific Limitations.* IN NO EVENT SHALL TI'S AGGREGATE LIABILITY FROM ANY WARRANTY OR OTHER OBLIGATION ARISING OUT OF OR IN CONNECTION WITH THESE TERMS AND CONDITIONS, OR ANY USE OF ANY TI EVM PROVIDED HEREUNDER, EXCEED THE TOTAL AMOUNT PAID TO TI FOR THE PARTICULAR UNITS SOLD UNDER THESE TERMS AND CONDITIONS WITH RESPECT TO WHICH LOSSES OR DAMAGES ARE CLAIMED. THE EXISTENCE OF MORE THAN ONE CLAIM AGAINST THE PARTICULAR UNITS SOLD TO USER UNDER THESE TERMS AND CONDITIONS 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

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In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI’s goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or “enhanced plastic” are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have ***not*** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

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