TPS65310AEVM and TPS65311EVM Evaluation Module

TI's TPS65310AEVM and TPS65311EVM evaluation modules (EVM) help engineers evaluate the operation and performance of the TPS65310A and TPS65311 power supply IC for safety applications. The devices offer configurability through the Serial Peripheral Interface (SPI).

The EVM contains either the TPS65310A or TPS65311 and some circuitry for basic operation. It has an on board USB-to-SPI interface but can also run without it or with a different SPI interface, for example, from an MCU supplied to the EVM.

Table 1. Device and Package Configurations

CONVERTER	IC	PACKAGE
IC1	TPS65310AQRVJQ1	S-PVQFN-N56

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1 Background

This document is written as a guide for both the TPS65310AEVM (EVM) and the TPS65311EVM (EVM). The TPS65310A-Q1 and TPS65311-Q1 devices have the same silicon and functionality but different EEPROM programming and a small number of other minor differences. The remainder of this document uses TPS6531xx when referring to the TPS65310A-Q1 and TPS65311-Q1. For illustration purposes, the TPS65310A is shown in the schematics and board layouts. The TPS6531xx is a power-management unit, meeting the requirements of DSP-controlled automotive systems (for example, Advanced Driver Assistance Systems). With its integration of commonly used features it helps to significantly reduce board space and system costs.

The device includes one high-voltage buck controller for pre-regulation, combined with two buck and one boost converter for post regulation. A further integrated LDO rounds up the power supply concept and offers a flexible system design with, in total, five independent voltage rails. The device offers two low-power states (LPM1 with buck controller active or LPM0 with all rails off) to reduce current consumption in case the system is constantly connected to the battery line. All outputs are protected against overload and overtemperature.

An external p-type metal-oxide-semiconductor (PMOS) makes the device capable of sustaining voltage transients up to 80 V (protection feature). This external PMOS is also used in safety-critical applications to protect the system in case one of the rails shows a malfunction (undervoltage, overvoltage, or overcurrent).

An internal Soft Start ensures a controlled start up for all supplies. Each power supply output has adjustable output voltage based on the external resistor network settings. The device has an integrated charge pump to provide overdrive voltage for the internal regulators. A reverse battery protection can be obtained by using the charge pump output to control an external NMOS transistor.

2 Setup

This section describes the jumpers and connectors on the EVM and how to properly connect, set up, and use the EVM.

2.1 Input/Output Connector Description

The connectors CON4(VBAT) and CON5(GND) are used to supply the EVM. The details about the connectors are shown in Table 2.

Table 2. Connectors

Connectors		
CON #	**Signals**	**Type**
1	LDO	OUTPUT
2	VREF	OUTPUT
3	GND	GND
4	VBAT	SUPPLY
5	GND	GND
6	VINPROT	internal SUPPLY
7	GND	GND
8	GND	GND
9	BUCK1	OUTPUT
10	VSUP5	internal SUPPLY
11	GND	GND
12	BOOST	OUTPUT
13	BUCK2	OUTPUT
14	GND	GND
15	GND	GND
16	BUCK3	OUTPUT

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2.2 Supply

The input voltage range for the converter is VBAT = 4.8 V to 36 V. It should be supplied to CON4(VBAT) respect to CON5(GND). VINPROT is the protected supply and generated EVM internally.

Table 3. EVM Supply Voltage

Parameter	Min	Typ	Max	Unit
VBAT	4.8	14	36	V

2.3 Jumper Setting

Configure the jumpers properly to operate the TPS6531xx. The recommended settings are shown in Table 4 and Table 5.

Table 4. EVM Jumper for Operation Without Using USB Interface and GUI Software

J#	Jumper Name	Description	Standard
J1	LED Driver	connect LED to LED driver	set
J2	VSUP4	connect supply LDO	set
J3	VSUP3	connect supply BUCK3	set
J4	VSUP2	connect supply BUCK2	set
J5	VSUP5	connect supply BOOST	set
J6	Select EXTSUP	select source external supply from BUCK1	set 1-2
J7	COMP3	compensation BUCK3	open
J8	COMP2	compensation BUCK2	open
J9	WAKE	Wake Up	open
J10	RESN	Reset	set 1-2
J11	PRESN	Reset	set 1-2
J12	IRQ	IRQ	set 1-2
J13	WD	Watchdog	set 1-2
J14	HSPWM	HSPWM signal	set 1-2
J15	CSN	CSN signal SPI	set 1-2
J16	SDO	SDO signal SPI	set 1-2
J17	SDI	SDI signal SPI	set 1-2
J18	SCLK	SCLK signal SPI	set 1-2
J19	VIO-VCC_555	Supply watchdog timer	set
J20	VIO-BUCK3	select VIO voltage from BUCK3	open
J21	VIO-VCC_USB	select VIO voltage from VCC_USB	open
J22	VIO-BOOST	select VIO voltage from BOOST	open
J23	VIO-BUCK2	select VIO voltage from BUCK2	set
J24	VIO-BUCK1	select VIO voltage from BUCK1	open

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Table 5. EVM Jumper for Operation with USB Interface and GUI Software

J#	Jumper Name	Description	Standard
J1	LED Driver	connect LED to LED driver	set
J2	VSUP4	connect supply LDO	set
J3	VSUP3	connect supply BUCK3	set
J4	VSUP2	connect supply BUCK2	set
J5	VSUP5	connect supply BOOST	set
J6	Select EXTSUP	select source external supply from BUCK1	set 1-2
J7	COMP3	compensation BUCK3	open
J8	COMP2	compensation BUCK2	open
J9	WAKE	Wake Up	open
J10	RESN	Reset	set 1-2
J11	PRESN	Reset	set 1-2
J12	IRQ	IRQ	set 1-2
J13	WD	Watchdog	set 1-2
J14	HSPWM	HSPWM signal	set 1-2
J15	CSN	CSN signal SPI	set 1-2
J16	SDO	SDO signal SPI	set 1-2
J17	SDI	SDI signal SPI	set 1-2
J18	SCLK	SCLK signal SPI	set 1-2
J19	VIO-VCC_555	Supply watchdog timer	set
J20	VIO-BUCK3	select VIO voltage from BUCK3	open
J21	VIO-VCC_USB	select VIO voltage from VCC_USB	set
J22	VIO-BOOST	select VIO voltage from BOOST	open
J23	VIO-BUCK2	select VIO voltage from BUCK2	open
J24	VIO-BUCK1	select VIO voltage from BUCK1	open

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2.4 Test Points

The test points are placed to measure different nodes on the board. Details are shown in Table 6.

Table 6. EVM Test Points

#	Test Point
1	HSSENSE
2	HSCTRL
3	GND
4	VBAT
5	GND
6	WAKE
7	VINPROT
8	PH1
9	GND
10	BUCK1
11	VSUP5
12	GND
13	BOOST
14	VT_REF
15	PH2
16	BUCK2
17	GND
18	PH3
19	BUCK3
20	BUCK20
21	GND
22	LDO
23	VT_REF
24	GND
25	GND
26	GND

2.5 BUCK1 Voltage Regulator

The BUCK1 regulator is a kind of pre-regulator operating in buck configuration using external NMOS transistors for the High-Side (HS) Switch and the Low-Side (LS) switch. HS and LS transistors are combined in one package. L1 is the inductance of Buck1, C16_1 to C16_4 are the output capacitors. The control loop is closed through the resistor divider, R19_2 and R19_1. In addition, the monitor resistor network, R19_2 and R17_0, are supporting the monitor function of the BUCK1 regulator. C18_0, C18_1, and R18 are the compensation network to stabilize the voltage regulator. R15 is the current shunt resistor to provide current feedback information. C104 is the blocking cap to stabilize the supply voltage of the HS and LS switching transistor. The BUCK1 voltage regulator is turned ON by default.

2.6 BUCK2 Voltage Regulator

The BUCK2 regulator is operating with internal HS and LS transistors. Lx is the coil and Cx the output caps. The output voltage can be adjusted with R1 and R2. R3 and R4 are the voltage dividers for the monitoring function. The compensation is done device internally and can be changed by setting jumper Jx. Cc is the bootstrap cap to provide the higher voltage for the HS gate driver. The BUCK2 voltage regulator is turned ON by default and can be turned OFF through SPI command, for example, by using the GUI software and unsetting BUCK2 EN.

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2.7 BUCK3 Voltage Regulator

The BUCK3 regulator is operating with internal HS and LS transistors. Lx is the coil and Cx the output caps. The output voltage can be adjusted with R1 and R2. R3 and R4 are the voltage dividers for the monitoring function. The compensation is done device internally and can be changed by setting jumper Jx. Cc is the bootstrap cap to provide the higher voltage for the HS gate driver. The BUCK3 voltage regulator is turned ON by default and can be turned OFF through SPI command, for example, by using the GUI software and unsetting BUCK3 EN.

2.8 BOOST Voltage Regulator

The BOOST voltage regulator is supplied out of BUCK1 voltage through the jumper J5. It is turned ON by default and can be turned OFF through SPI command, for example, by using the GUI software and unsetting BOOST EN.

2.9 LDO Voltage Regulator

The LDO voltage regulator is supplied out of BUCK1 through the jumper J2. It can be turned on with an SPI command, for example, by using the GUI software and setting LDO EN.

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3 GUI Software

The GUI software is intended to support a quick start of the TPS6531xx evaluation. The USB-to-SPI interface is needed to run the software. The USB cable to the PC can be connected to J10. After the initial start of the software, installing the Microsoft® .NET connection software may be necessary. The .NET software can be downloaded at www.microsoft.com.

The software provides a GUI interface for easy set-up and control of the TPS6531xx. Connecting the FTDI pins to the SPI pins is required to use the on board USB-to-SPI interface. Set the jumper shown in Table 4 if the EVM will be used without the GUI software or Table 5 if it will be used with the GUI software.

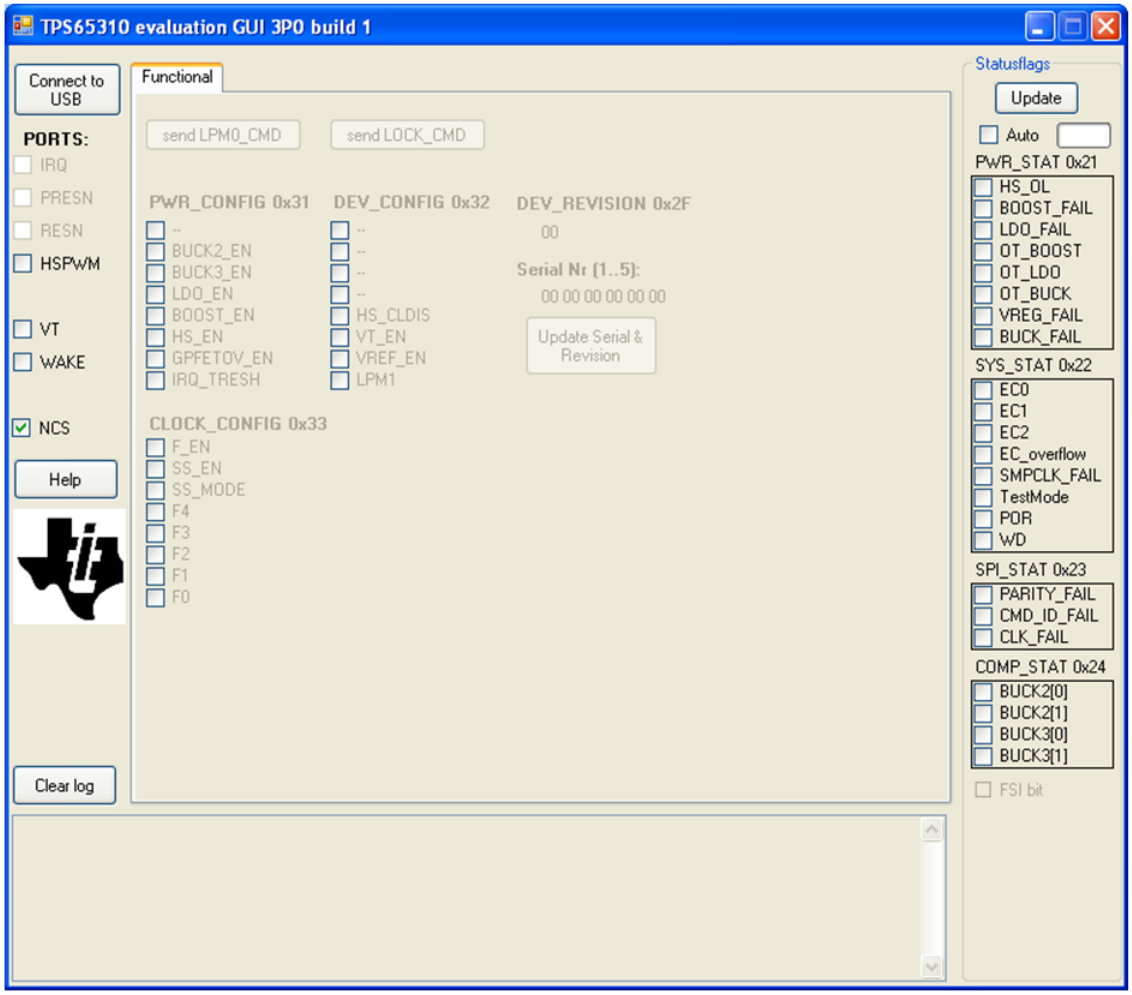


Figure 1. GUI-Software Start Screen

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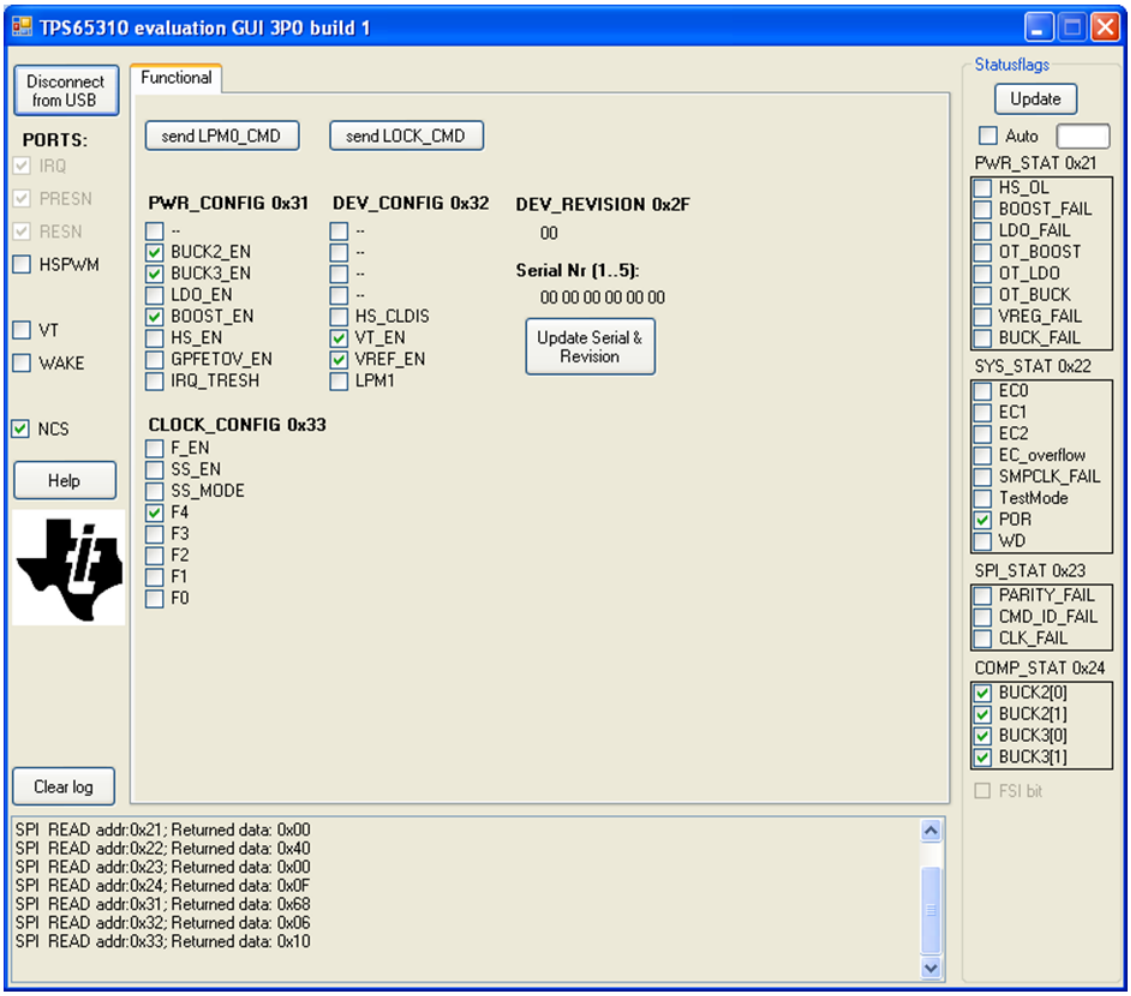


Figure 2. GUI Software Connected to USB

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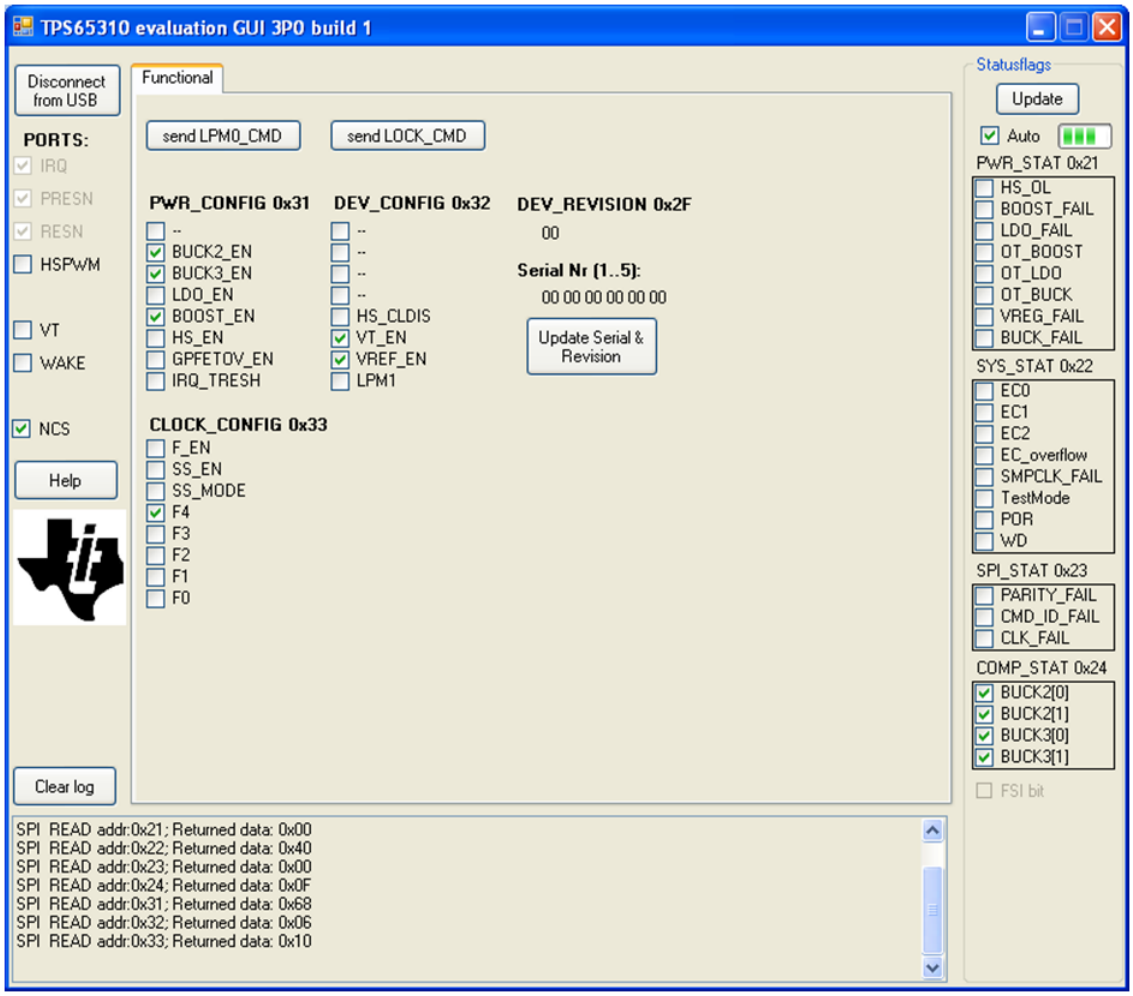


Figure 3. GUI Software Auto Update

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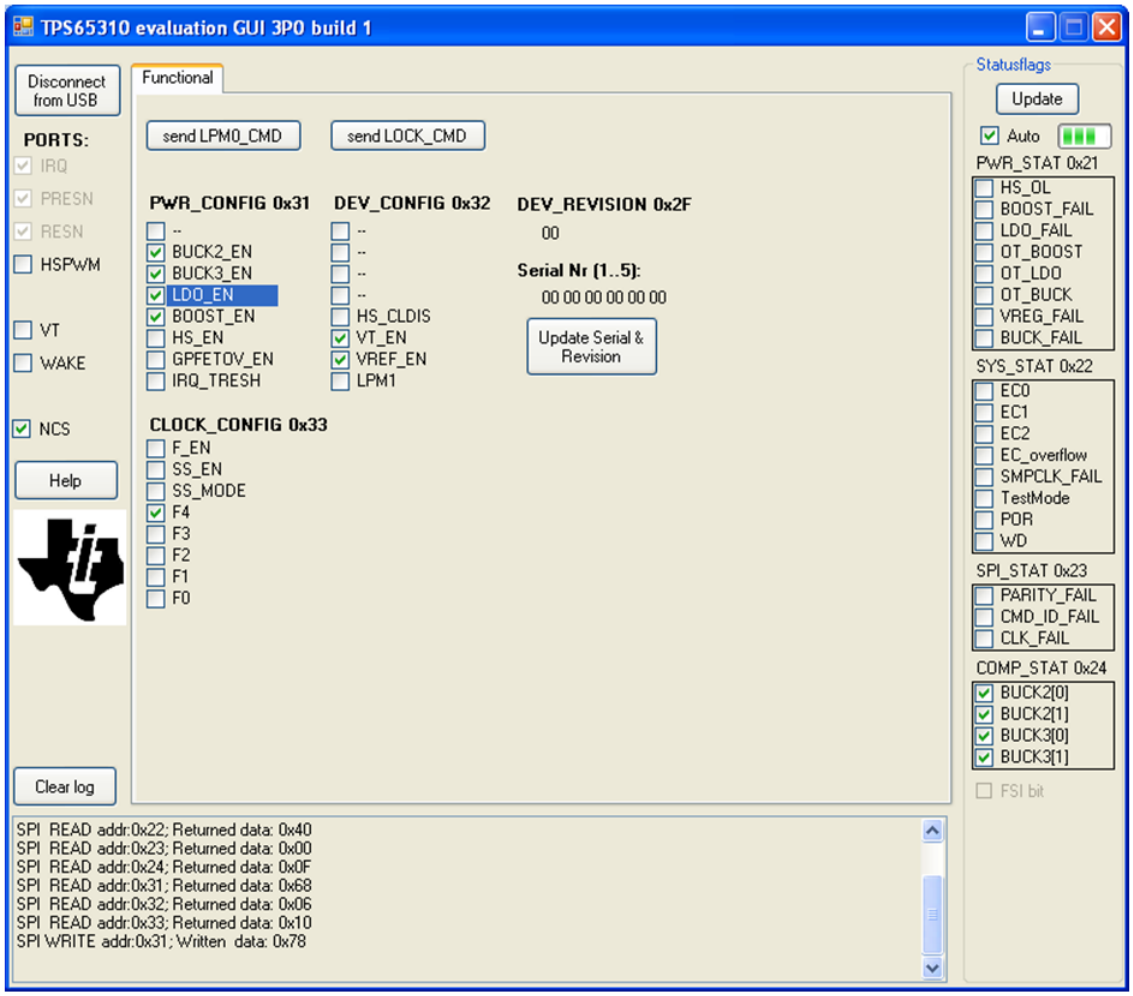


Figure 4. GUI Software LDO Turned ON

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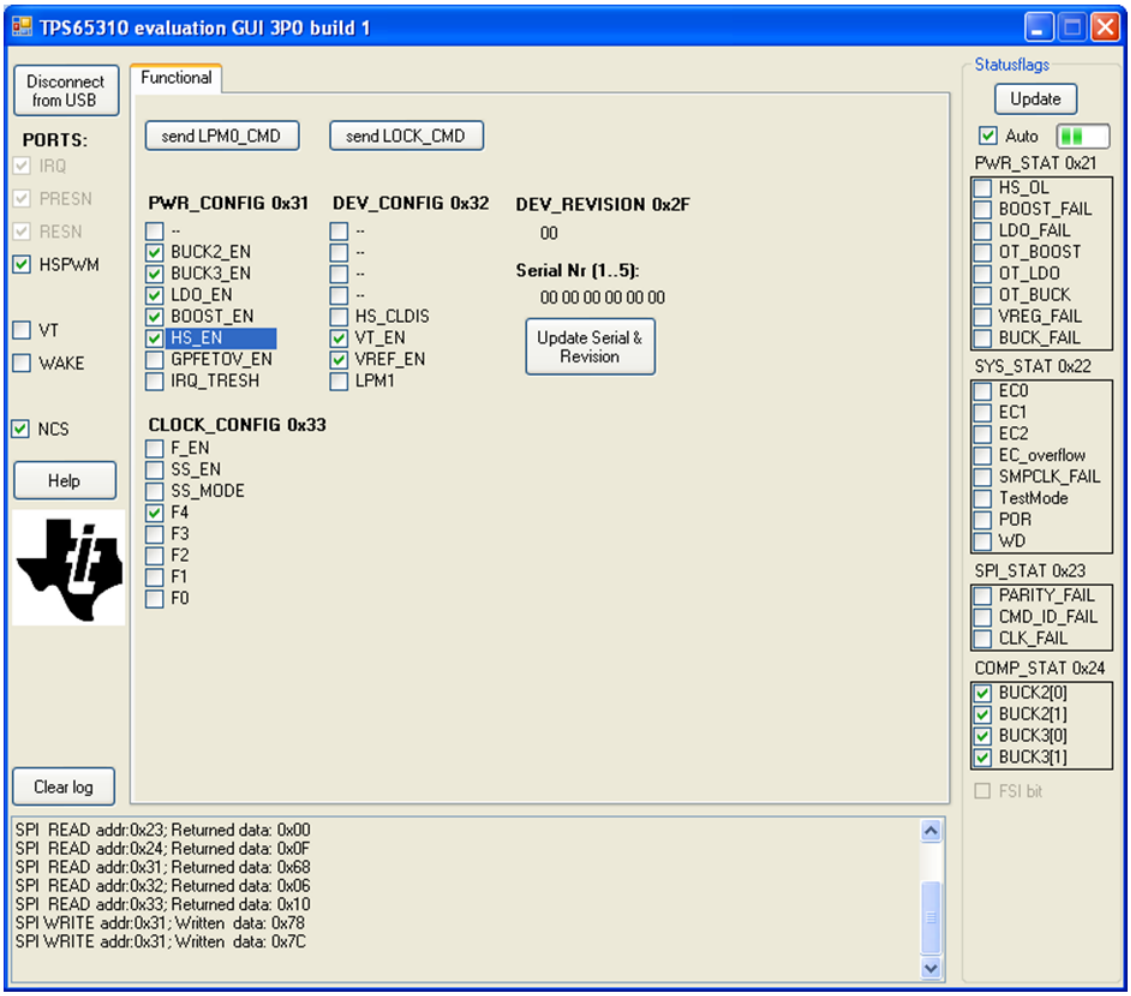


Figure 5. GUI Software HS EN ON and HS PWM ON

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4 EVM Schematic, PCB Layouts, and Bill of Materials

The following sections contain the schematic, board pictures, PCB layouts, and BOM for this EVM.

4.1 EVM Schematic

Figure 6 and Figure 7 are the schematics for this EVM.

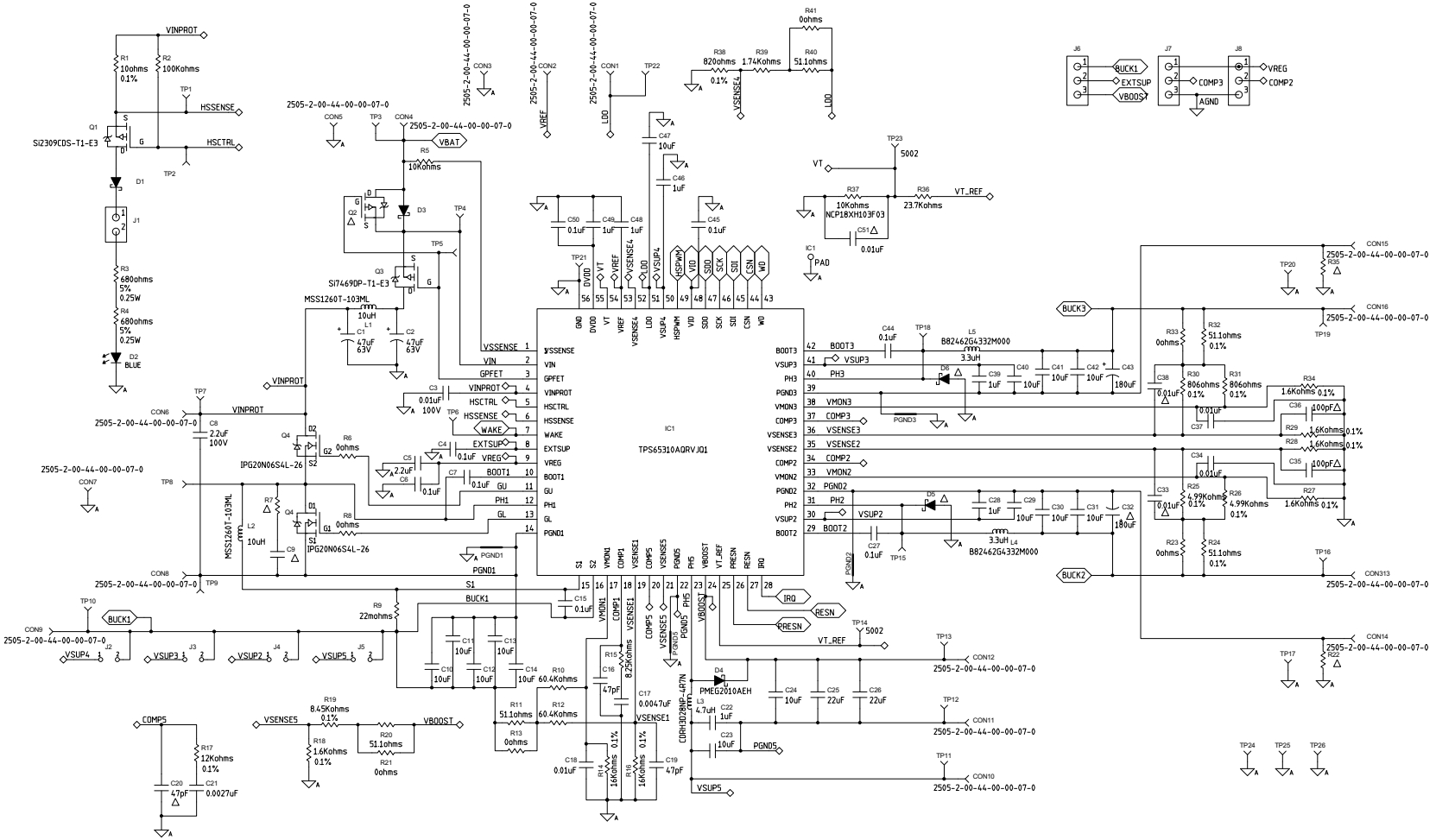


Figure 6. EVM Schematic (1 of 2)

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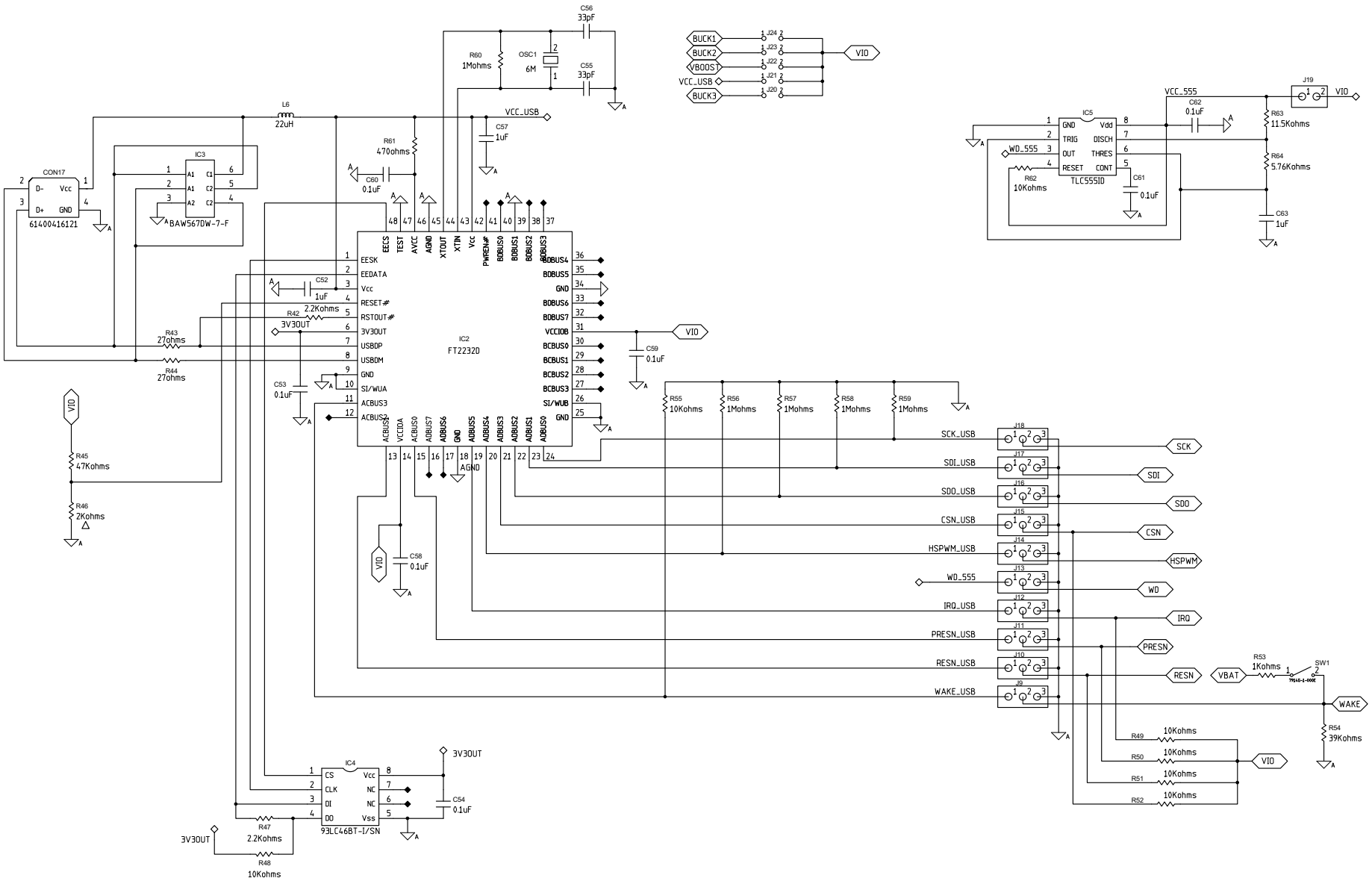


Figure 7. EVM Schematic (2 of 4)

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4.2 Board Picture

Figure 8 and Figure 9 are top and bottom picture of this EVM.

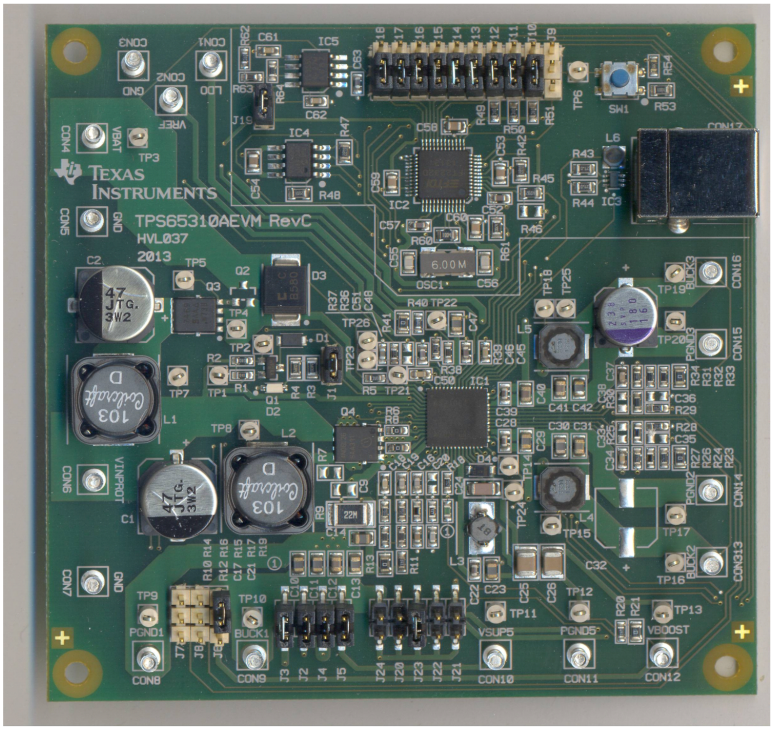


Figure 8. EVM Top View

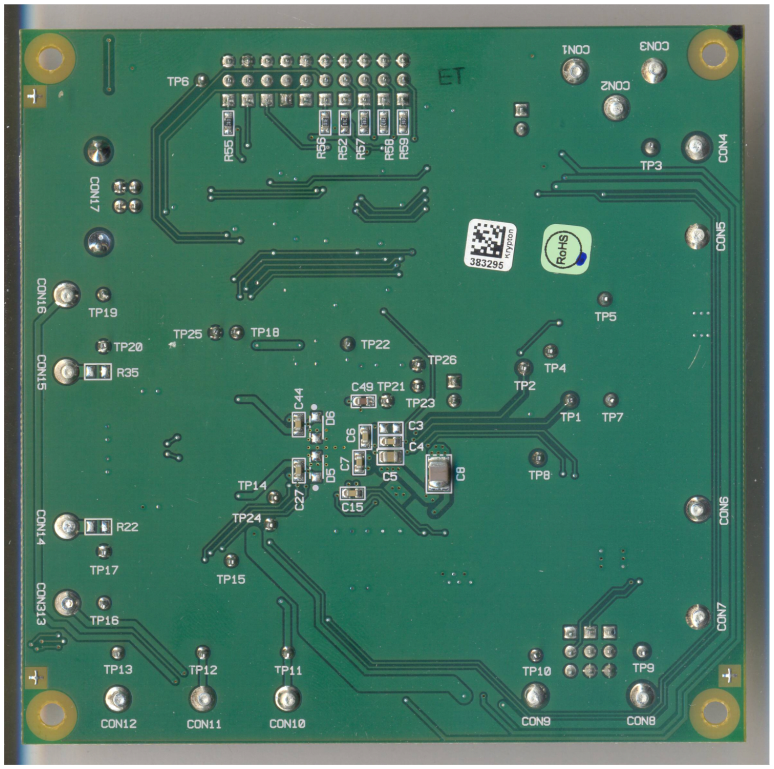


Figure 9. EVM Bottom View

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4.3 Board Assembly

Figure 10 and Figure 11 show the board layout for the EVM PCB. The EVM offers resistors, capacitors and jumpers to operate the TPS6531xx device. The TPS6531xx converter offers high efficiency, but does dissipate power. The PowerPAD™ package offers an exposed thermal pad to enhance thermal performance. This must be soldered to the copper landing on the PCB for optimal performance. The PCB provides 2 oz copper planes on the top and bottom to dissipate heat.

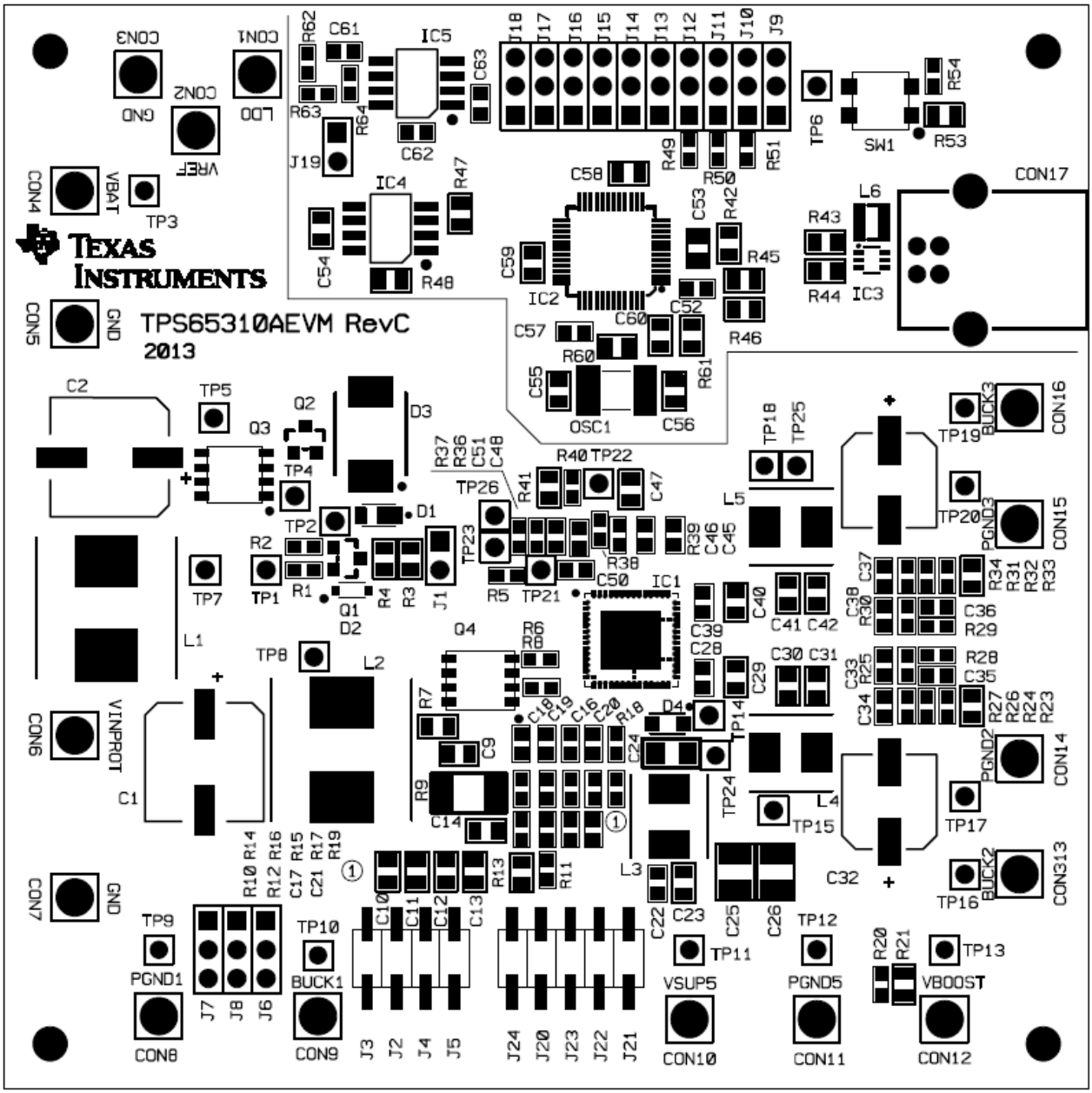


Figure 10. Top Assembly Layer

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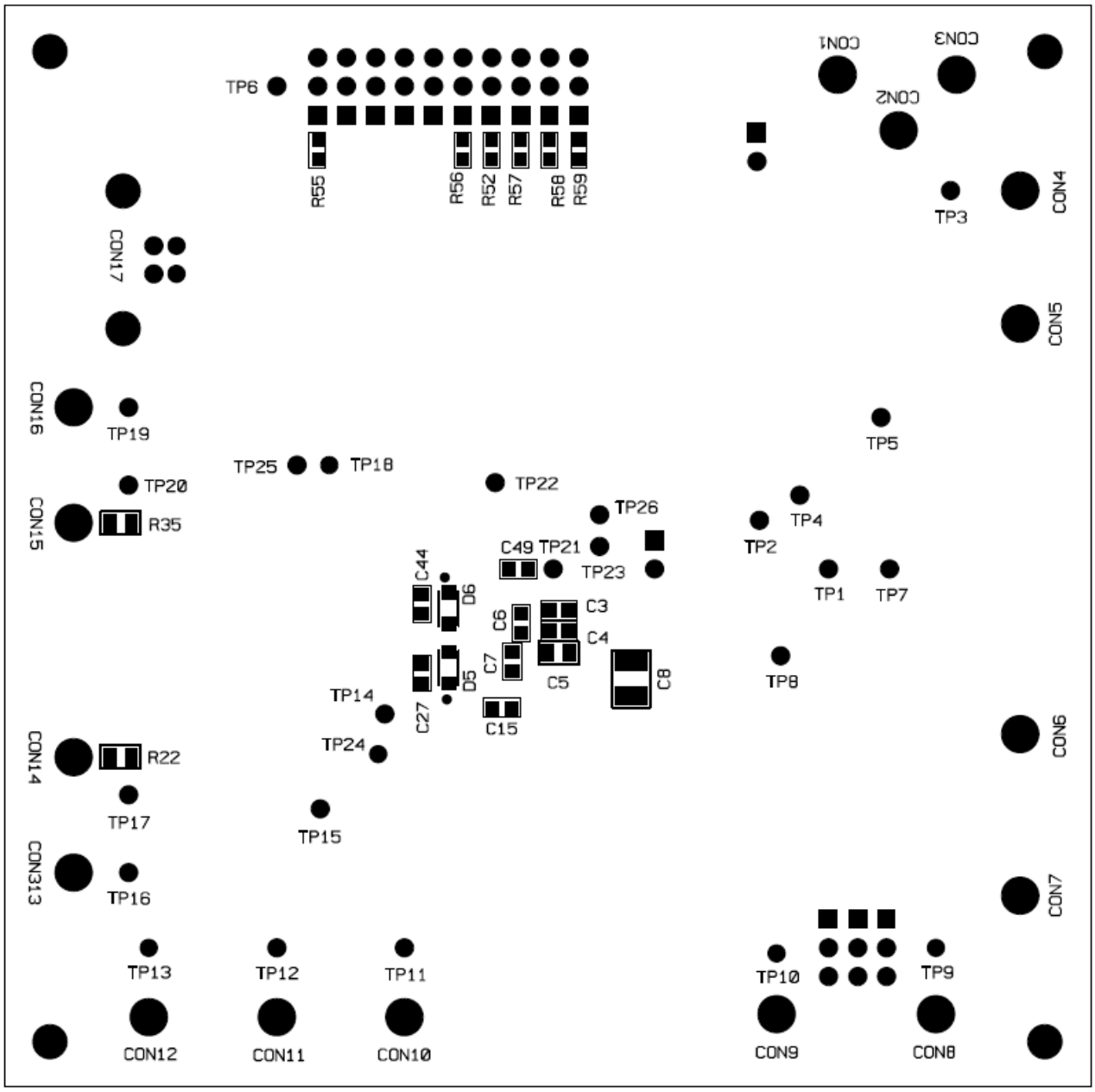


Figure 11. Bottom Assembly Layer

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4.4 Board Layout

The EVM is a 2-layer board. Details are shown in Figure 12 and Figure 13.

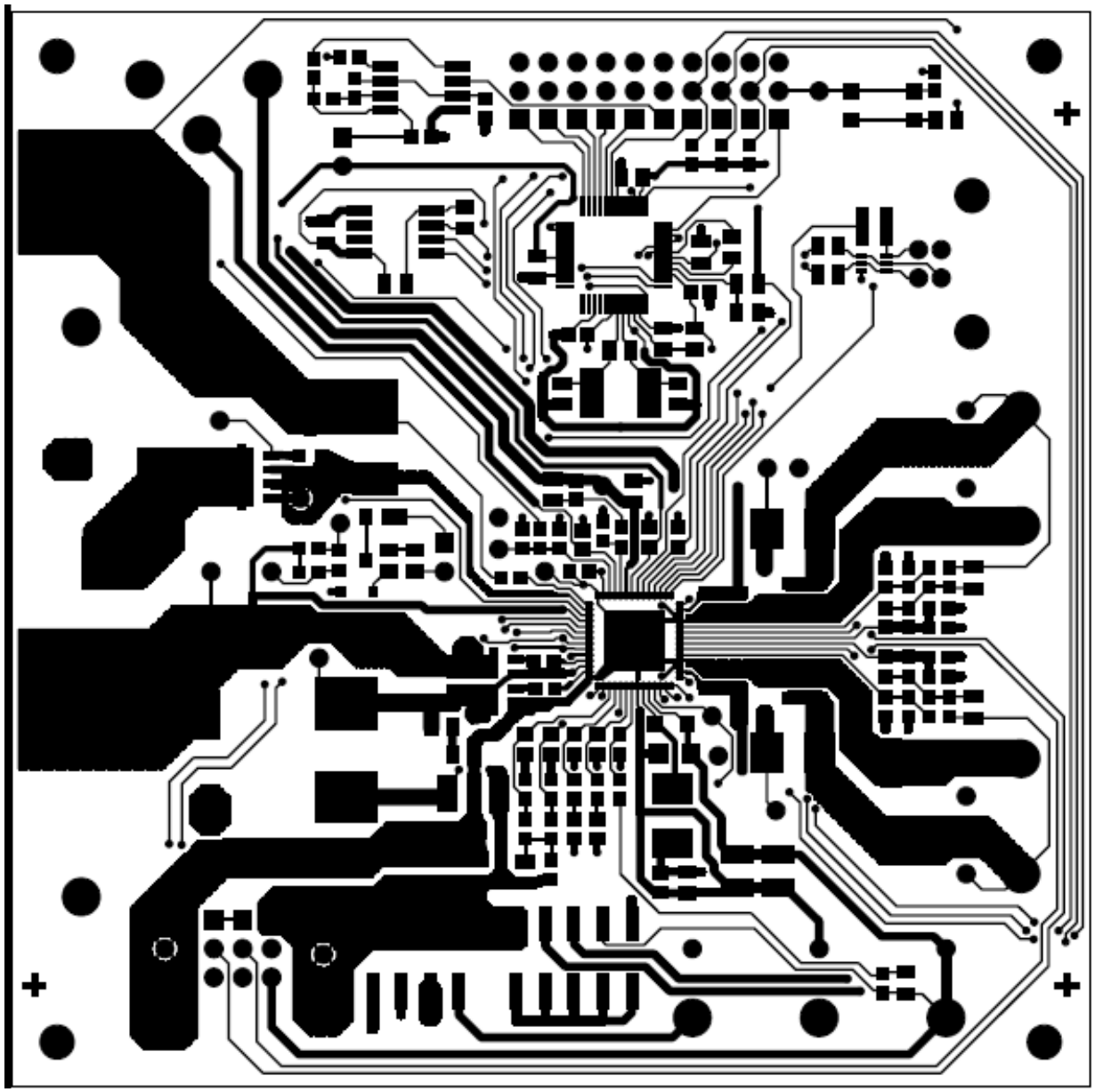


Figure 12. Top Layer Routing

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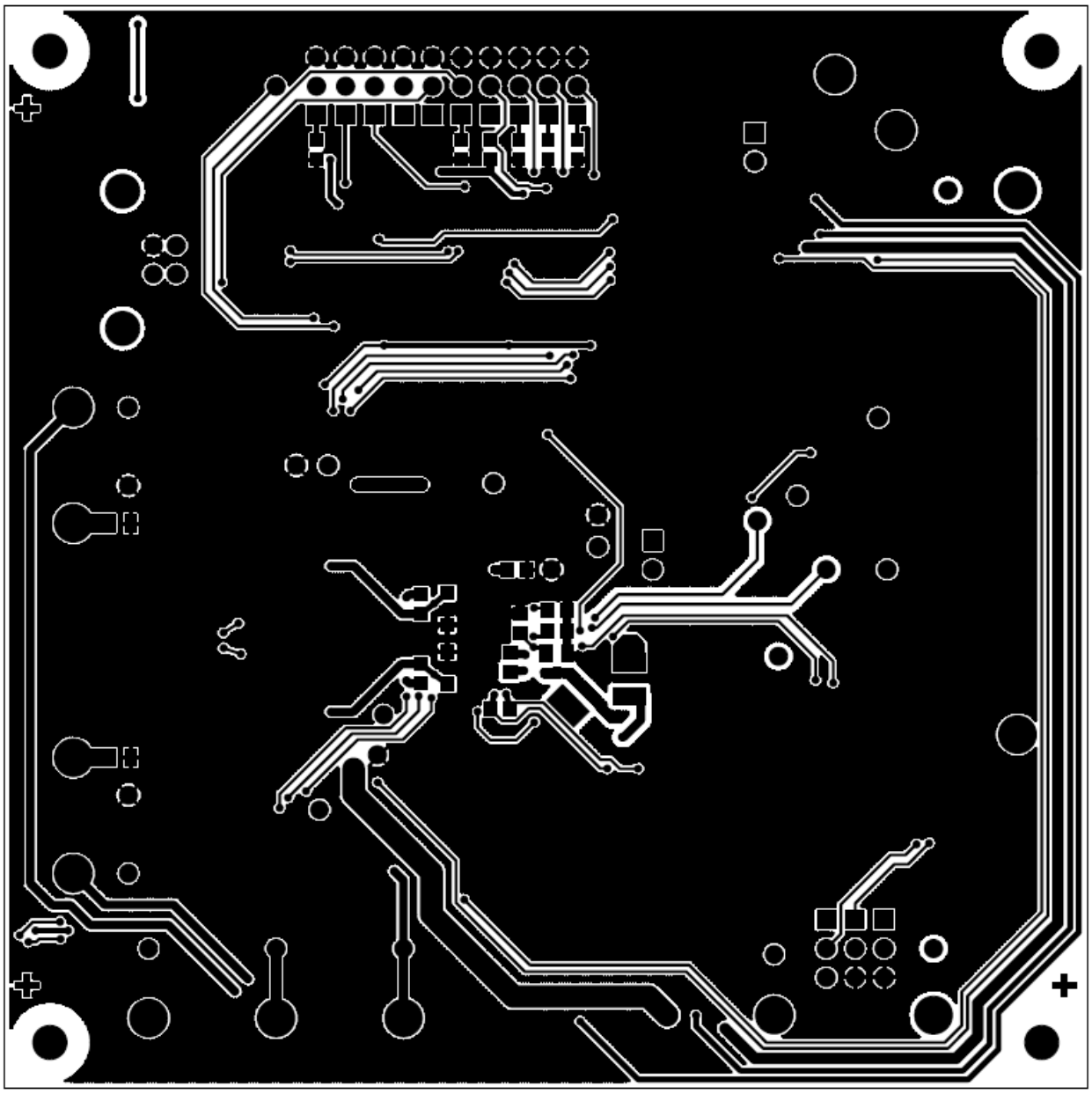


Figure 13. Layer2 Routing

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4.5 Bill of Materials

Table 7. Bill of Materials

ITEM	QTY	MFG	MFG PART#	REF DES	DESCRIPTION	VALUE or FUNCTION
	1	Any	HLV037	PCB	Printed Circuit Board	SIZE 95x95x1.5mm
1	0	UNINSTALLED	CAP_0603 (UN)	C20		UNINSTALLED CAP0603
2	0	UNINSTALLED	CAP_0805 (UN)	C9		UNINSTALLED CAP0805
3	2	SULLINS	PEC02SAAN	J1, J19		HEADER,THU,1x2,2.54mm
4	13	SULLINS	PEC03SAAN	J6, J7, J8, J9, J10, J11, J12, J13, J14, J15, J16, J17, J18		HEADER,THU,1x3,2.54mm
5	0	UNINSTALLED	RES_0805 (UN)	R7, R22, R35		UNINSTALLED RES0805
6	4		GND_SHORT	PGND1, PGND2, PGND3, PGND5	BOGUS PART NOT INSTALLED	NOT INSTALLED OR KITTED
7	1	AVX	06035C272JAT2A	C21	CAP,SMT,0603	CAPACITOR,SMT,0603,CERAMIC,0.0027uF,50V,5%,X7R
8	2	KEMET	C0603C101J5GAC	C35, C36	CAP,SMT,0603	CAPACITOR,SMT,0603,CERAMIC,100pF,50V,5%,COGR
9	3	KEMET	C0603C103J1RAC	C18, C34, C37	CAP,SMT,0603	CAPACITOR,SMT,0603,CERAMIC,0.01uF,100V,5%,X7R
10	0	KEMET	C0603C103J1RAC (UN)	C3, C33, C38, C51	CAP,SMT,0603	UNINSTALLED CAPACITOR, SMT, 0603, CER, 0.01uF,100V,5%,X7R
11	10	KEMET	C0603C104J3RAC	C4, C6, C7, C15, C27, C44, C45, C50, C61, C62	CAP,SMT,0603	CAPACITOR,SMT,0603,CERAMIC,0.1uF,25V,5%,X7R
12	9	KEMET	C0603C105K4PAC	C22, C28, C39, C46, C48, C49, C52, C57, C63	CAP,SMT,0603	CAPACITOR,SMT,0603,CERAMIC,1.0uF,16V,10%,X5R
13	2	KEMET	C0603C470J5GAC	C16, C19	CAP,SMT,0603	CAPACITOR,SMT,0603,CERAMIC,COG(NPO),50V,5%, 47pF
14	1	KEMET	C0603C472J5RAC	C17	CAP,SMT,0603	CAPACITOR,SMT,0603,CERAMIC,X7R,0.0047uF,50V,5%
15	5	KEMET	C0805C104K5RAC	C53, C54, C58, C59, C60	CAP,SMT,0805	CAPACITOR,SMT,0805,CERAMIC,0.1uF,50V,10%,X7R
16	2	KEMET	C0805C330J5GAC	C55, C56	CAP,SMT,0805	CAPACITOR,SMT,0805,CERAMIC,33pF,50V,5%,C0G(NP0)
17	13	MURATA	GRM21BR71A106KE51L	C10, C11, C12, C13, C14, C23, C29, C30, C31, C40, C41, C42, C47	CAP,SMT,0805	CAPACITOR,SMT,0805,CERAMIC,10uF,10V,10%,X7R
18	1	MURATA	GRM21BR71E225KA73L	C5	CAP,SMT,0805	CAPACITOR,SMT,0805,CERAMIC,2.2uF,25V,10%,X7R
19	1	MURATA	GRM31CR6YA106KA12L	C24	CAP,SMT,1206	CAPACITOR,SMT,1206,CER, 10uF,35V,10%,X5R
20	1	KEMET	C1210C225K1RAC	C8	CAP,SMT,1210	CAPACITOR,SMT,1210,CERAMIC,2.2uF,100V,10%,X7R
21	2	MURATA	GRM32ER61E226KE15L	C25, C26	CAP,SMT,1210	CAPACITOR,SMT,1210,CER, 22uF,25V,10%,X5R
22	1	VISHAY	94SVP187X0016E12	C43	CAP,SMT,ALUM	CAPACITOR,SMT,2P,ALUM,180uF,16V,20%,-55~105C,ESR-0.022ohm@100K
23	0	VISHAY	94SVP187X0016E12 (UN)	C32	CAP,SMT,ALUM	UNINSTALLED CAPACITOR, SMT, 2P, ALUM, 180uF, 16V, 20%ESR-0.022ohm@100K
24	2	PANASONIC	EEETG1J470P	C1, C2	CAPACITOR,SMT,ELEC	CAPACITOR,SMT,2P,ELEC,47uF,63V,20%,-40~125C
25	1	WUERTH	61400416121	CON17	CON,THU,4P	USB RECEPTACLE,TYPE B, RIGHT ANGLE
26	1	DIODES INC	DFLS1150	D1	DIODE,SMT	SCHOTTKEY BARRIER DIODE,SMT,1A, 150V
27	1	COMCHIP	CDBC580-G	D3	DIODE,SMT,2P	SCHOTTKY RECTIFIER,SMT,80V,5A
28	1	NXP	PMEG2010AEH	D4	DIODE,SMT,SOD123F	SCHOTTKY BARRIER DIODE,SMT,SOD123F,1A, 20V
29	0	NXP	PMEG2010AEH (UN)	D5, D6	DIODE,SMT,SOD123F	UNINSTALLED SCHOTTKEY BARRIER DIODE,SMT,SOD123F,1A, 20V
30	1	INFINEON	IPG20N06S4L-26	Q4	FET,SMT,P-PG-TDSON-8-4,N-CHANNEL	HEXFET,N-CHANNEL,POWER MOSFET,P-PG-TDSON-8-4
31	1	VISHAY	Si7469DP	Q3	FET,SMT,PowerPak SO8	P-CHANNEL,MOSFET,PowerPak SO8,-80V,-28A,0.029 RDS,83W
32	1	VISHAY	Si2309CDS	Q1	FET,SMT,SOT23-3	P-CHANNEL,MOSFET,SOT23-3,-60V,-1.6A,0.45 RDS,1.7W
33	0	VISHAY	Si2309CDS (UN)	Q2	FET,SMT,SOT23-3	UNINSTALLED P-CHANNEL,MOSFET,SOT23-3,-60V,-1.6A,0.45 RDS,1.7W

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Table 7. Bill of Materials (continued)

ITEM	QTY	MFG	MFG PART#	REF DES	DESCRIPTION	VALUE or FUNCTION
34	1	MICROCHIP	93LC46BT-I/SN	IC4	IC,SMT,8P	1K MICROWIRE COMPATIBLE SERIAL EEPROM,2.5~5.5V
35	1	FUTURE TECHNOLOGY DEVICES INT.	FT2232D	IC2	IC,SMT,LQFP-48	DUAL USB UART/ FIFO IC
36	1	TI	TPS65310AQRVJQ1	IC1	IC,SMT,QFN-56EP	DUT,SMT,QFN,56RTQ,0.5mmLS,8.15x8.15x1.0mm,THERMAL PAD
37	1	TI	TLC555ID	IC5	IC,SMT,SO-8	LinCMOS TIMER, SMT, 3V~15V
38	1	DIODES INC	BAW567DW-7-F	IC3	IC,SMT,SOT363-6	QUAD SURFACE MOUNT SWITCHING DIODE ARRAY
39	2	EPCOS	B82462G4332M000	L4, L5	INDUCTOR,SMT,2P	INDUCTOR,SMT,3.3uH,20%,2.3A
40	1	SUMIDA	CDRH3D28NP-3R3N	L3	INDUCTOR,SMT,2P	INDUCTOR,SMT,SHIELD, 3.3uH
41	2	COILCRAFT	MSS1260T-103ML	L1, L2	INDUCTOR,SMT,2P	INDUCTOR,SMT,10uH,20%,6.9A,SHIELD
42	1	WUERTH	744028220	L6	INDUCTOR,THU,2P	INDUCTOR,SMT,POWER CHOKE,22uH,400mA30%
43	9	FISCHER	SL 11 SMD 062	J2, J3, J4, J5, J20, J21, J22, J23, J24	JUMPER,SMD,2P,2.54	JUMPER,SMD,2P,2.54
44	1	OSRAM	LBY87S-L1M2-35	D2	LED,SMT,0805	SIDELED,SMT,0805,BLUE,3.4V
45	2	VISHAY	CRCW06030000Z0	R6, R8	RES,SMT,0603	RESISTOR,SMT,0603,0 OHM,1%,1/10W
46	1	VISHAY	CRCW0603100KF	R2	RES,SMT,0603	RESISTOR,SMT,0603,1%,1/10W,100K
47	7	VISHAY	CRCW060310K0F	R5, R49, R50, R51, R52, R55, R62	RES,SMT,0603	RESISTOR,SMT,0603,1%,1/10W,10.0K
48	1	VISHAY	CRCW060311K5F	R63	RES,SMT,0603	RESISTOR,SMT,0603,1%,1/10W,11.5K
49	1	VISHAY	CRCW06031K74F	R39	RES,SMT,0603	RESISTOR,SMT,0603,1%,1/10W,1.74K
50	4	VISHAY	CRCW06031M00F	R56, R57, R58, R59	RES,SMT,0603	RESISTOR,SMT,0603,1%,1/10W,1.00M
51	1	VISHAY	CRCW060323K7F	R36	RES,SMT,0603	RESISTOR,SMT,0603,1%,1/10W,23.7K
52	1	VISHAY	CRCW060339K0F	R54	RES,SMT,0603	RESISTOR,SMT,0603,1%,1/10W,39.0K
53	3	VISHAY	CRCW060351R1F	R11, R20, R40	RES,SMT,0603	RESISTOR,SMT,0603,1%,1/10W,51.1
54	1	VISHAY	CRCW06035K76F	R64	RES,SMT,0603	RESISTOR,SMT,0603,1%,1/10W,5.76K
55	2	VISHAY	CRCW060360K4F	R10, R12	RES,SMT,0603	RESISTOR,SMT,0603,1%,1/10W,60.4K
56	1	VISHAY	CRCW06038K25F	R15	RES,SMT,0603	RESISTOR,SMT,0603,1%,1/10W,8.25K
57	1	PANASONIC	ERA-3YEB123V	R17	RES,SMT,0603	RESISTOR,SMT,0603,12K,0.1%,1/16W
58	5	PANASONIC	ERA-3YEB162V	R18, R27, R28, R29, R34	RES,SMT,0603	RESISTOR,SMT,0603,1.6K,0.1%,1/16W
59	2	PANASONIC	ERA-3YEB163V	R14, R16	RES,SMT,0603	RESISTOR,SMT,0603,16.0K,0.1%,1/16W
60	1	PANASONIC	ERA-3YEB821V	R38	RES,SMT,0603	RESISTOR,SMT,0603,820 OHM,0.1%,1/16W
61	1	VISHAY	TNPW060310R0BE	R1	RES,SMT,0603	RESISTOR,SMT,0603,THIN FILM,10 OHM,0.1%,1/10W,25ppm
62	2	VISHAY	TNPW06034K99BE	R25, R26	RES,SMT,0603	RESISTOR,SMT,0603,THIN FILM,4.99K,0.1%,1/10W,25ppm
63	2	VISHAY	TNPW060351R1BE	R24, R32	RES,SMT,0603	RESISTOR,SMT,0603,THIN FILM,51.1 OHM,0.1%,1/10W
64	2	VISHAY	TNPW0603806RBE	R30, R31	RES,SMT,0603	RESISTOR,SMT,0603,THIN FILM,0.1%,1/10W, 806OHM
65	1	VISHAY	TNPW06038K45BE	R19	RES,SMT,0603	RESISTOR,SMT,0603,THIN FILM,8.45K,0.1%,1/10W
66	5	VISHAY	CRCW08050000Z	R13, R21, R23, R33, R41	RES,SMT,0805	RESISTOR,SMT,0805,THICK FILM,1/8W,0 OHM
67	1	VISHAY	CRCW080510K0F	R48	RES,SMT,0805	RESISTOR,SMT,0805,THICK FILM,1%,1/8W,10.0K
68	1	VISHAY	CRCW08051K00F	R53	RES,SMT,0805	RESISTOR,SMT,0805,THICK FILM,1%,1/8W,1.00K
69	1	VISHAY	CRCW08051M00F	R60	RES,SMT,0805	RESISTOR,SMT,0805,THICK FILM,1%,1/8W,1.0M
70	2	VISHAY	CRCW080527R0F	R43, R44	RES,SMT,0805	RESISTOR,SMT,0805,THICK FILM,1%,1/8W,27.0 OHM

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Table 7. Bill of Materials (continued)

ITEM	QTY	MFG	MFG PART#	REF DES	DESCRIPTION	VALUE or FUNCTION
71	0	VISHAY	CRCW08052K00F (UN)	R46	RES,SMT,0805	UNINSTALLED RESISTOR,SMT,0805,THICK FILM,1%,1/8W,2.00K
72	2	VISHAY	CRCW08052K20F	R42, R47	RES,SMT,0805	RESISTOR,SMT,0805,THICK FILM,1%,1/8W,2.20K
73	1	VISHAY	CRCW0805470RF	R61	RES,SMT,0805	RESISTOR,SMT,0805,THICK FILM,1%,1/8W,470 OHM
74	1	VISHAY	CRCW080547K0F	R45	RES,SMT,0805	RESISTOR,SMT,0805,THICK FILM,1%,1/8W,47.0K
75	2	PANASONIC	ERJ-P06J681V	R3, R4	RES,SMT,0805	RESISTOR,SMT,0805,THICK FILM,680 OHM,5%,1/4W
76	1	PANASONIC	ERJ-L12KF22MU	R9	RES,SMT,1812	RESISTOR,SMT,1812,0.022 OHM,0.5W,1%
77	1	ABRACON	AWSZT-6.00MGD-T	OSC1	RESONATOR,SMT,2P	RESONATOR,SMT,2P,CERAMIC,6.00 MHz
78	1	BOURNS	7914G-1-000E	SW1	SWITCH,SMT,4P	SWITCH, SMT, 4P, SPST, NO
79	16	BUERKLIN	12H6161	CON1, CON2, CON3, CON4, CON5, CON6, CON7, CON8, CON9, CON10, CON11, CON12, CON14, CON15, CON16, CON313	TESTPOINT,THU,1P	TEST POINTS,THU
80	26	KEYSTONE	5002	TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP8, TP9, TP10, TP11, TP12, TP13, TP14, TP15, TP16, TP17, TP18, TP19, TP20, TP21, TP22, TP23, TP24, TP25, TP26	TESTPOINT,THU,1P	TESTPOINT,THU,MINIATURE,0.1LS,120TL, WHITE
81	1	MURATA	NCP18XH103F03	R37	THERMISTOR,SMT,0603	THERMISTOR,SMT,0603,NTC,10K@25/C,1%
82	20	FISCHER	CAB 4 G S		2.54mm JUMPER	2.54mm JUMPER

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