THE DATASHEET OF

BQ25898EVM-730

bq25898, bq25898D, and bq25898C PWR730 Evaluation Modules

This user's guide provides detailed testing instructions for the bq25898, bq25898D, and bq25898C evaluation modules. Also included are descriptions of the necessary equipment, equipment setup, and procedures. Section 4 contains the printed-circuit board layouts, schematic, and the bill of materials (BOM).

Throughout this user's guide, the abbreviations EVM, bq25898xEVM, and the term evaluation module are synonymous with the bq25898, bq25898D, and bq25898C evaluation modules, unless otherwise noted. Also, the abbreviation bq25898x refers to any of the three devices – bq25898, bq25898D, and bq25898C, unless otherwise noted.

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1 Introduction

1.1 EVM Features

The device data sheets, listed in Table 1, provide detailed features and operation.

Table 1. Device Data Sheets

Device	Datasheet	EVM Label	Variant
bq25898	SLUSCA6	bq25898EVM-730	001
bq25898D	SLUSCA6	bq25898DEVM-730	002
bq25898C	SLUSCH6	bq25898CEVM-730	003

The bq25898x evaluation module (EVM) is a complete charger module for evaluating an I^{2}C-controlled single NVDC-1 charge using the bq25898x device.

This EVM does not include the USB-TO-GPIO or EV2300/EV2400 interface board. To evaluate the EVM, a USB-TO-GPIO interface board must be ordered separately.

1.2 I/O Descriptions

Table 2 lists the jumper connections available on this EVM.

Table 2. PWR730 EVM Connections

Jack	Description
J1–VBUS	Input: positive terminal
J1–GND	Input: negative terminal (ground terminal)
J2–PMID	PMID pin connection, power bank output
J2–GND	Ground and power bank output negative terminal
J3–SYS	Connected to system
J3–GND	Ground
J4–BAT	Connected to battery pack
J4–BATSEN	Connected to battery pack for voltage sensing
J4–GND	Ground
J5	Input mini-USB port
J6	Output mini-USB port
J7	USB-TO-GPIO connector
J8	I^{2}C 4-pin connector
J9–VOK	VOK output
J9–GND	Ground

Table 3 lists the EVM jumper connections.

Table 3. EVM Jumper Connections and Shunt Installation

Jack	Description	bq25898 Setting	bq25898D Setting	bq25898C Setting
JP1	Input current setting	short PSEL to LOW	Not installed	Short PSEL to LOW
JP2	D–/PG pin selection	short to PG	short to D–	Short to PG
JP3	DSEL/VOK selection	Short to VOK	Short to DSEL	Not installed
JP4	STAT, PG, CE, INT, OTG pins internal pullup source (VSYS or BAT)	Short to VSYS	Short to VSYS	Short to VSYS
JP5	D+/D– connections for input current limit setting	Not installed	Not installed	Not installed
JP6	Pulldown option for INT and OTG	Not installed	Not installed	Installed
JP7	$\overline{\text{CE}}$ pin setting: pull low to enable the charge	Not Installed	Not Installed	Not Installed
JP8	TS pin to GND	Not Installed	Not Installed	Installed
JP9	TS resistor divider pullup source (REGN) connection	Installed	Installed	N/A
JP10	Internal 10 k to GND to TS pin	Installed	Installed	N/A
JP11	ILIM pin to GND	Not Installed	Not Installed	Installed
JP12	Short BATSEN pin to BAT pin	Installed	Installed	Installed

Table 4 lists the recommended operating conditions for this EVM.

Table 4. Recommended Operating Conditions

Symbol	Description	MIN	TYP	MAX	Unit
Supply voltage, V_{VBUS}	Input voltage from AC adapter	3.9		14	V
Battery voltage, V_{BAT} 0, 3.7, 4.4 V	Voltage applied at V_{BAT} terminal	0		4.5	V
IBAT	Fast charging current			3 or 4	A
	Discharging current through internal MOSFET	9			A
Supply current, I_{IN}	Maximum input current from AC adapter input	0		3.25	A

2 Test Summary

2.1 Equipment

This section includes a list of supplies required to perform tests on this EVM:

1. **Power Supplies**
   Power supply #1 (PS#1): a power supply capable of supplying 5 V at 1 A is required. While this part can handle larger voltage and current, it is not necessary for this procedure.
2. **Load #1** (4-quadrant supply, constant voltage < 4.5 V)
   A 0–20 V/0–5 A, > 30-W system, dc electronic load and setting as constant voltage load mode
   or
   Kepco load: BOP 20–5 M, DC 0 to ±20 V, 0 to ±5 A (or higher)
3. **Load #2** Use with *Boost Mode*
   PMID to GND load, 10 Ω, 5 W, or greater
4. **Meters**
   Six Fluke 75 multimeters, (equivalent or better)
   or
   Four equivalent voltage meters and two equivalent current meters, the current meters must be capable of measuring 5-A current.
5. **Computer**
   A computer with at least one USB port and a USB cable. The bq25898xEVM evaluation software must be properly installed.
6. **USB-to-GPIO Communication Kit**
   EV2300/EV2400 USB-based PC interface board
7. **Software**
   Download bqStudio from www.ti.com
   Double click the *Battery Management Studio-1.3.20_Build2-Setup* installation file, follow the installation steps. The software supports the Microsoft® Windows® XP and Windows 7 operating systems.

2.2 Equipment Setup

Use the following steps for equipment setup:

1. Set PS#1 for 5-V DC, 1-A current limit and then turn off the supply.
2. Connect the output of PS#1 in series with a current meter (multimeter) to J1 (VBUS and GND).
3. Connect a voltage meter across TP2 (VBUS) and TP14 (PGND).
4. Turn on the load, set to constant voltage mode and output to 2.5 V. Turn off (disable) load. Connect the load in series with a current meter (multimeter), ground side, to J4 (BAT and GND) as shown in Figure 2.
5. Connect a voltage meter across TP18 (BAT) and TP22(GND).
6. Connect the EV2300/2400 USB interface board to the computer with a USB cable and from I^2C port to J8 with the 4-pin cable. The connections are shown in Figure 1.

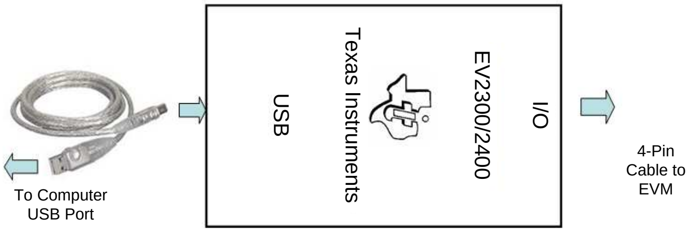
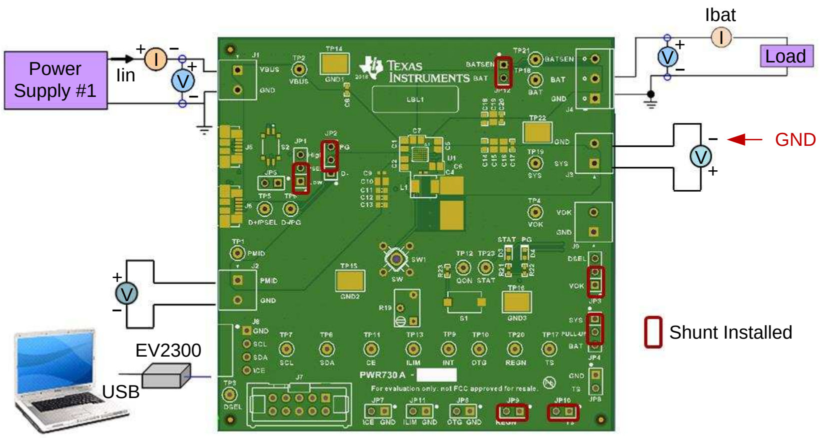
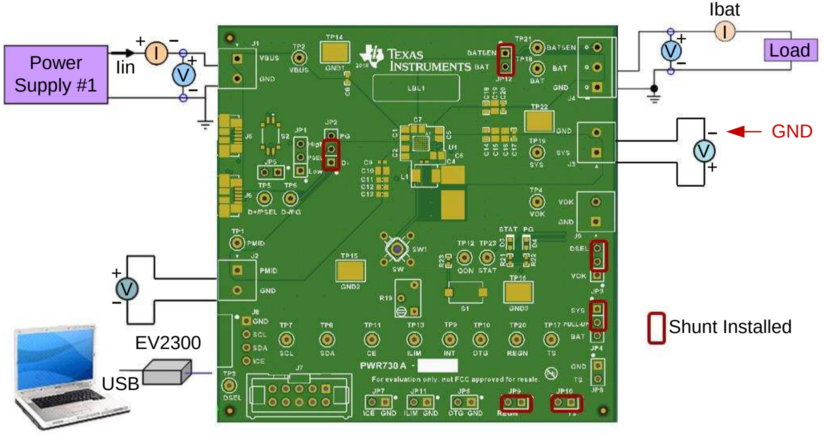


Figure 1. Connections of the EV2300 Kit

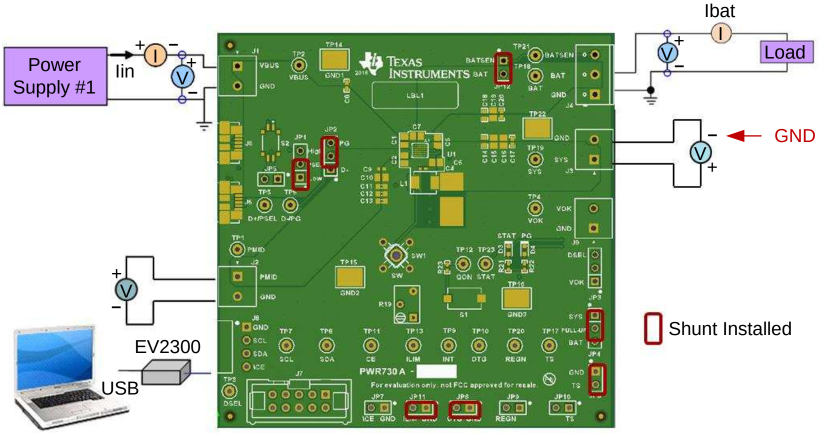
7. Install shunts as shown in Table 3, or as shown in Figure 2.



bq25898



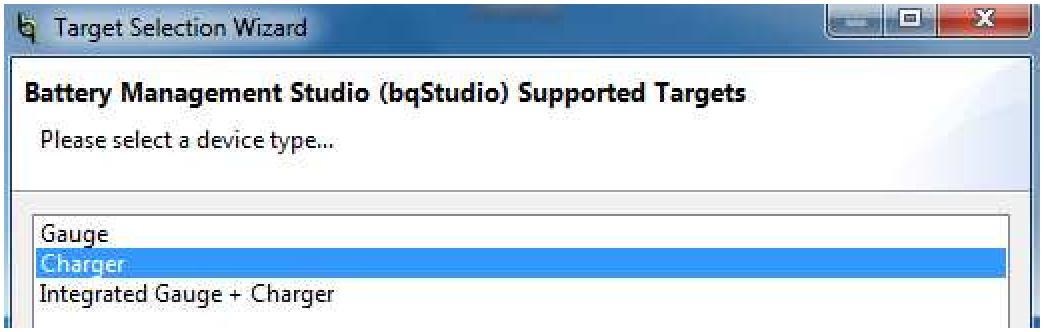
bq25898D



bq25898C

Figure 2. Original Test Setup for bq25898X

8. Turn on the computer. Launch *Battery Management Studio* (bqStudio). Select *Charge* and bq25898 (or bq25898D, bq25898C, accordingly) evaluation software. The main window of the software is shown in Figure 3.



Battery Management Studio (bqStudio) Supported Targets

Please select a device type...

Gauge
Charger
Integrated Gauge + Charger

Figure 3. Selection Window of the bqStudio Evaluation Software

2.3 Test Procedure

2.3.1 Current Settings

Use the following list when setting the current:

1. Make sure the *Equipment Setup* steps are followed.
   ILIM Setting: Set the potentiometer to its lowest value for maximum input current by connecting an ohmmeter between point TP9 and ground. Turn the screw on the potentiometer counterclockwise until the resistance drops to its lowest point (this should be in the range of 40 Ω to 60 Ω, the value of R1).
2. Launch the **bq25898x** EVM GUI software, if not already done.
3. Turn on PS#1.
   Measure → Vsys (TP19(SYS), T22(GND)) = 4.20 ±0.3 V

NOTE: #1. bq25898C reads Vsys = 3.7 ±0.3 V

#2. Completely disconnect Load#1 from the BAT pin, if different voltage value is seen.

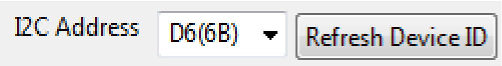
2.3.2 Charge Voltage and Current Regulation of V_{IN} and Device ID Verification

Follow the steps and verify the outputs and IC for the EVM.

2.3.3 Communication Verification

Use the following steps to ensure proper device communication:

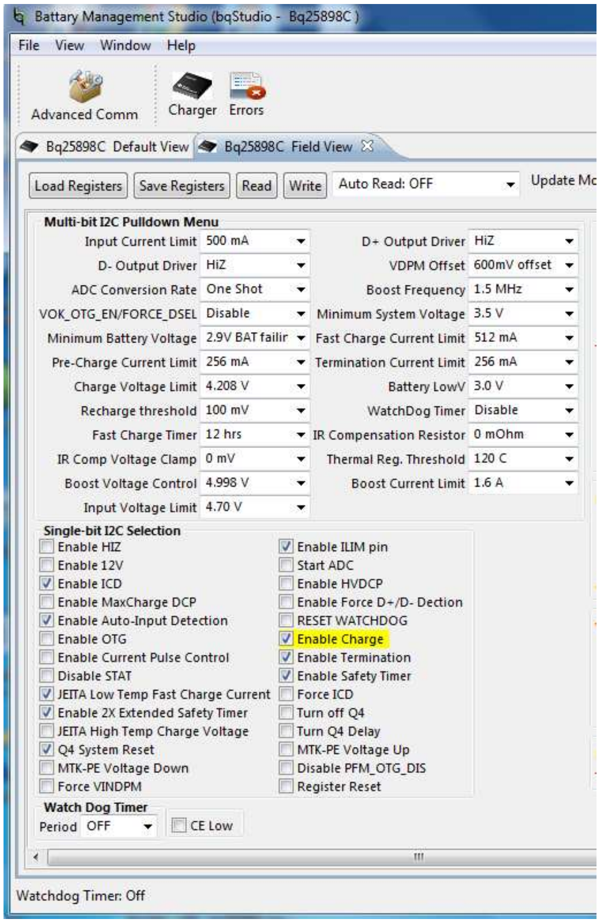
1. In the EVM software, specify device *I2C Address* as 6A for bq25898D, and 6B for bq25898/C.



I2C Address D6(6B)

2. Click the **Read** button.

3. In the EVM software, make the following changes as necessary:
    - Select *Disabled* for the *Watchdog Timer*.
    - Set *Input Voltage Limit* to 4.2.
    - Set *Input Current Limit* to 500 mA.
    - Set *Charge Voltage Limit* to 4.208 V.
    - Set *Fast Charge Current* ICHG to 512 mA.
    - Set *Pre-Charge Current* to 256 mA.
    - Deselect *Enable Termination* (see Figure 4).



Multi-bit I2C Pulldown Menu

Input Current Limit	500 mA	D+ Output Driver	HiZ
D- Output Driver	HiZ	VDPM Offset	600mV offset
ADC Conversion Rate	One Shot	Boost Frequency	1.5 MHz
VOK_OTG_EN/FORCE_DSEL	Disable	Minimum System Voltage	3.5 V
Minimum Battery Voltage	2.9V BAT failir	Fast Charge Current Limit	512 mA
Pre-Charge Current Limit	256 mA	Termination Current Limit	256 mA
Charge Voltage Limit	4.208 V	Battery LowV	3.0 V
Recharge threshold	100 mV	WatchDog Timer	Disable
Fast Charge Timer	12 hrs	IR Compensation Resistor	0 mOhm
IR Comp Voltage Clamp	0 mV	Thermal Reg. Threshold	120 C
Boost Voltage Control	4.998 V	Boost Current Limit	1.6 A
Input Voltage Limit	4.70 V		

Single-bit I2C Selection

☐ Enable HIZ
☐ Enable 12V
☑ Enable ICD
☐ Enable MaxCharge DCP
☑ Enable Auto-Input Detection
☐ Enable OTG
☐ Enable Current Pulse Control
☐ Disable STAT
☑ JEITA Low Temp Fast Charge Current
☑ Enable 2X Extended Safety Timer
☐ JEITA High Temp Charge Voltage
☑ Q4 System Reset
☐ MTK-PE Voltage Down
☐ Force VINDPM

☑ Enable ILIM pin
☐ Start ADC
☐ Enable HVDCP
☐ Enable Force D+/D- Dection
☐ RESET WATCHDOG
☑ Enable Charge
☑ Enable Termination
☑ Enable Safety Timer
☐ Force ICD
☐ Turn off Q4
☐ Turn Q4 Delay
☐ MTK-PE Voltage Up
☐ Disable PFM_OTG_DIS
☐ Register Reset

Watch Dog Timer

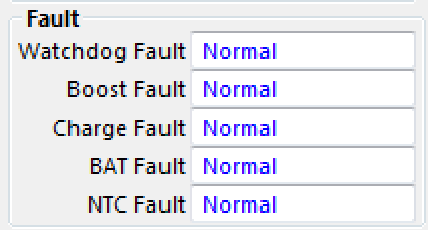
Period OFF

☐ CE Low

Watchdog Timer: Off

Figure 4. Setup Window of the bqStudio Evaluation Software

4. Click the **Read** button twice.
    - Observe → Everything is ‘Normal’ in the *Fault* box.



Fault

Watchdog Fault	Normal
Boost Fault	Normal
Charge Fault	Normal
BAT Fault	Normal
NTC Fault	Normal

Figure 5. Status Report From Window of the bqStudio Evaluation Software

5. Observe → D3 (STAT) is on.
6. Observe → D4 (/PG) is on (except on bq25898D).

2.3.4 Charger Mode Verification

Use the following steps to verify the charger mode:

1. Enable Load #1 from Section 2.2, step 4. Measure the voltage across J3 and J4 as follows:
   - Measure → V(TP19(SYS), TP22(GND)) = 3.7 V ±0.3 V
   - Measure → V(TP18(BAT), TP22(GND)) = 2.5 V ±0.1 V
   - Measure → IBAT = 256 mA ±200 mA (= pre-charge current)
2. Change load to 3.7 V.
   - Measure → V(TP19(SYS), TP22(GND)) = 3.8 V ±0.3 V
   - Measure → V(TP18(BAT), TP22(GND)) = 3.7 V ±0.1 V
   - Measure → IBAT = 500 mA ±200 mA (= fast charge current)
3. In the software, set *Fast Charge Current Limit* to 1024 mA.

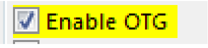
Fast Charge Current Limit 1.024 A

   - Measure → Iin = 500 mA ±200 mA (= input current limit)
4. Turn off and disconnect load #1.
5. Turn off and disconnect power supply #1.

2.3.5 Boost Mode Verification

Use the following steps to verify *Boost Mode*:

1. If the constant voltage load connected from BAT+ to GND is not a four-quadrant supply (sources current), remove the load and use the power source disconnected in step one. Set the power sourcee to 3.7 V and 2-A current limit and connect between BAT+ and GND.
2. Apply 10 Ω (5 W or greater) across J2 PMID(+) to GND(–).
3. Uncheck the *OTG Low* box in the GUI.
4. Check the *Enable OTG* option in the GUI.



☑ Enable OTG

5. Verify V_{PMID} to GND on J2
   - Measure → V_{PMID} = 5.0V ±0.2 V
6. Turn off and disconnect the power supply.
7. Remove 10-Ω resistor at PMID.

NOTE: Skip this test for bq25898C.

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3 PCB Layout Guideline

Minimize the switching node rise and fall times for minimum switching loss. Proper layout of the components, minimizing high-frequency current path loop, is important to prevent electrical and magnetic field radiation and high-frequency resonant problems. This PCB layout priority list must be followed in the order presented for proper layout:

1. Place the input capacitor as close as possible to the PMID pin and GND pin connections and use the shortest copper trace connection or GND plane.
2. Put the output capacitor near the inductor and the IC.
3. Place decoupling capacitors next to the IC pins and make trace connection as short as possible.
4. Place the inductor input terminal as close as possible to the SW pin. Minimize the copper area of this trace to lower electrical and magnetic field radiation but make the trace wide enough to carry the charging current. Do not use multiple layers in parallel for this connection. Minimize parasitic capacitance from this area to any other trace or plane.
5. Connect all grounds together to reduce PCB size and improve thermal dissipation.
6. Avoid ground planes in parallel with high frequency traces in other layers

See the EVM design for the recommended component placement with trace and via locations.

4 Board Layout, Schematic, and Bill of Materials

4.1 Board Layout

Figure 6 through Figure 11 illustrate the EVM board layouts.

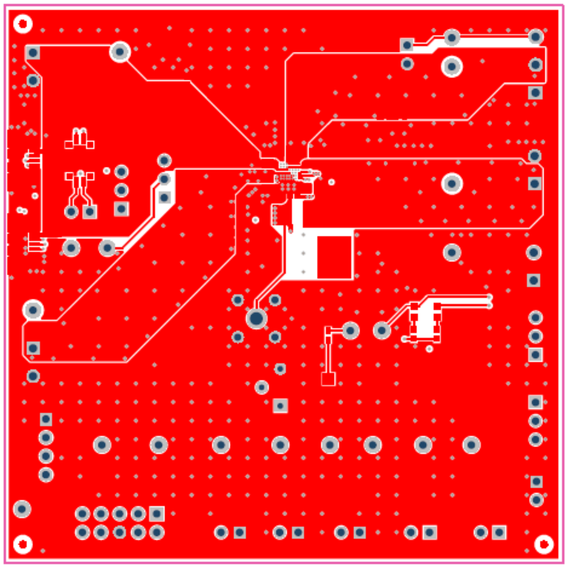

Figure 6. bq25898EVM-730 Top Layer

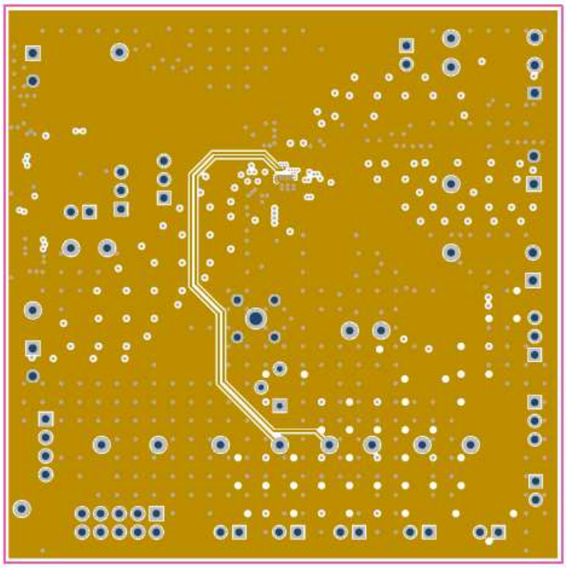

Figure 7. bq25898EVM-730 Mid Layer 1

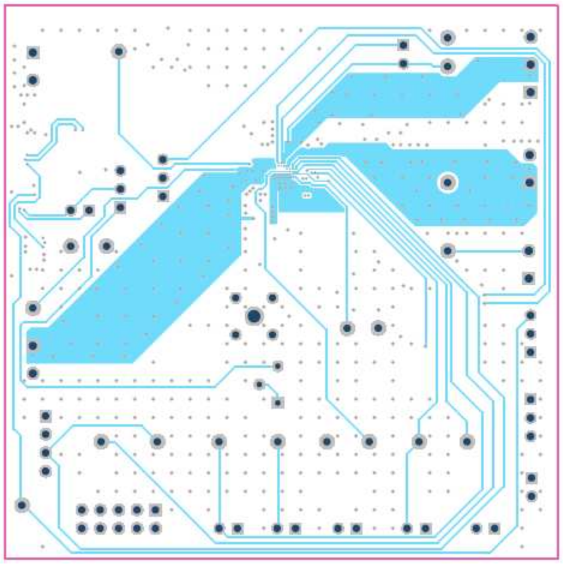

Figure 8. bq25898EVM-730 Mid Layer 2

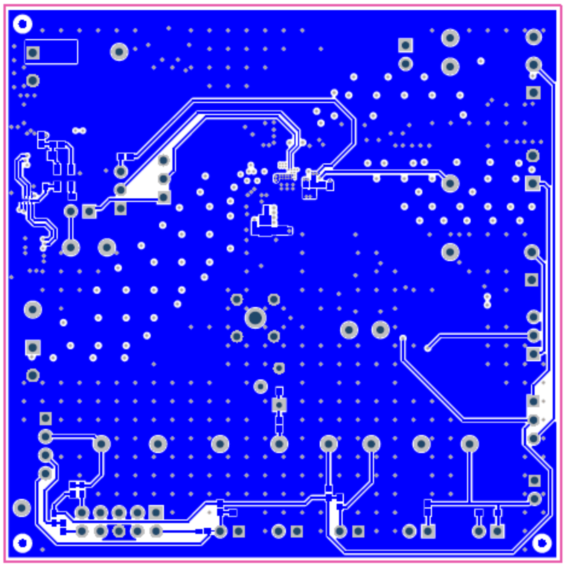

Figure 9. bq25898EVM-730 Bottom Layer

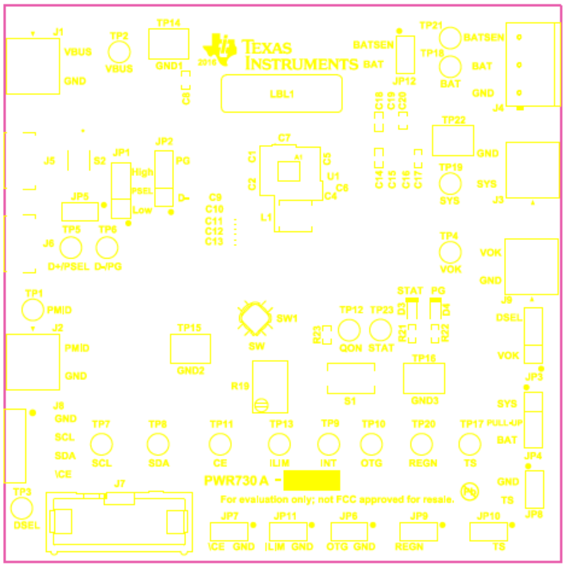

Figure 10. bq25898EVM-730 Top Layer Assembly

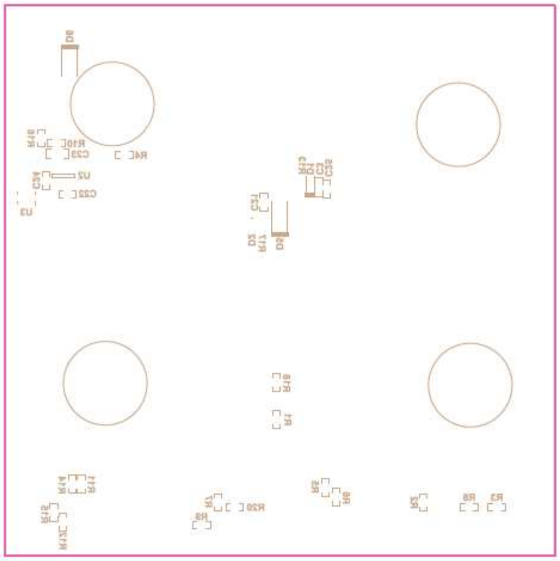

Figure 11. bq25898EVM-730 Bottom Layer Assembly

4.2 Schematic

Figure 12, Figure 13, and Figure 14 illustrate the schematics of the three EVM variants.

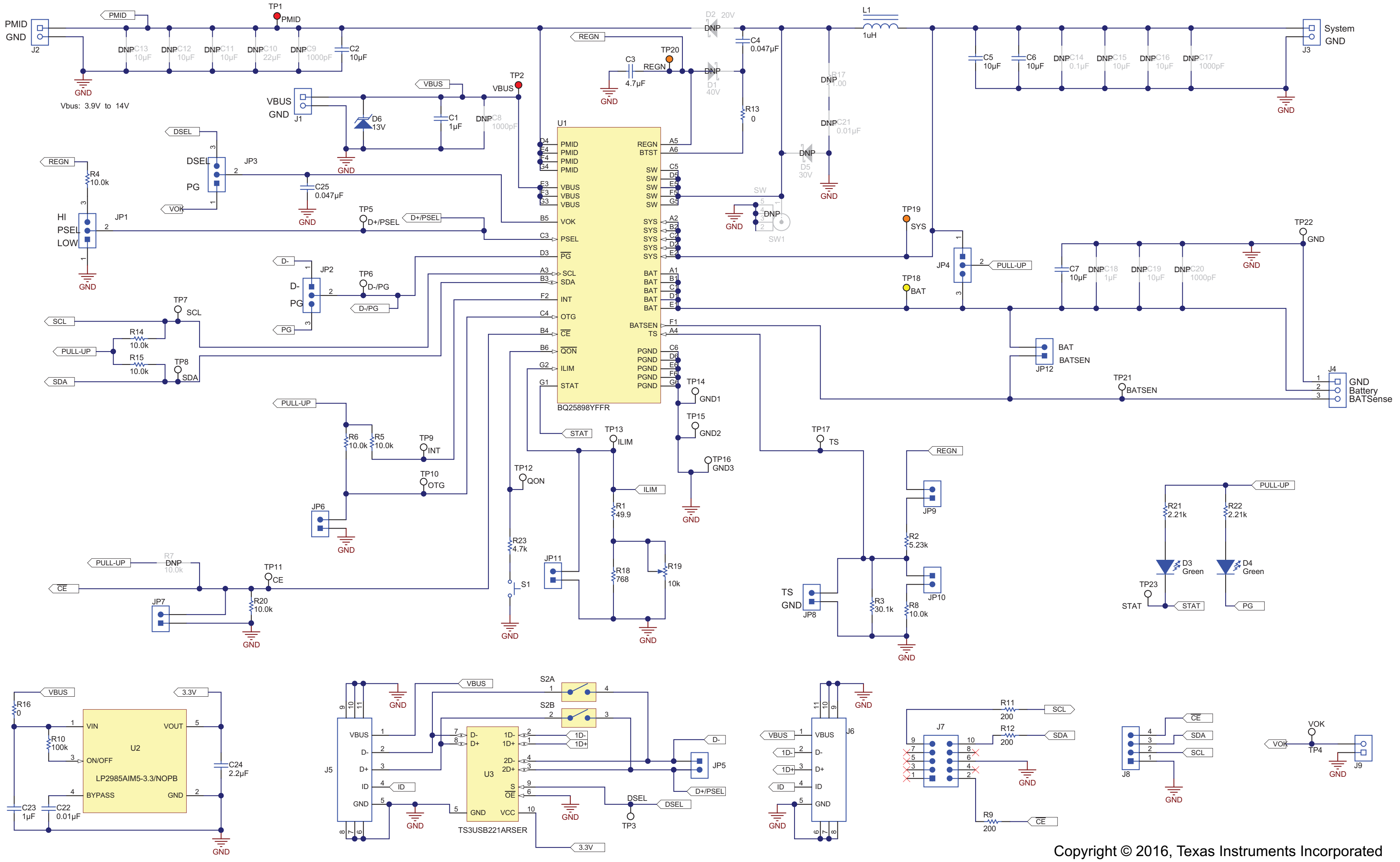

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Figure 12. bq25898EVM-730-001 Schematic

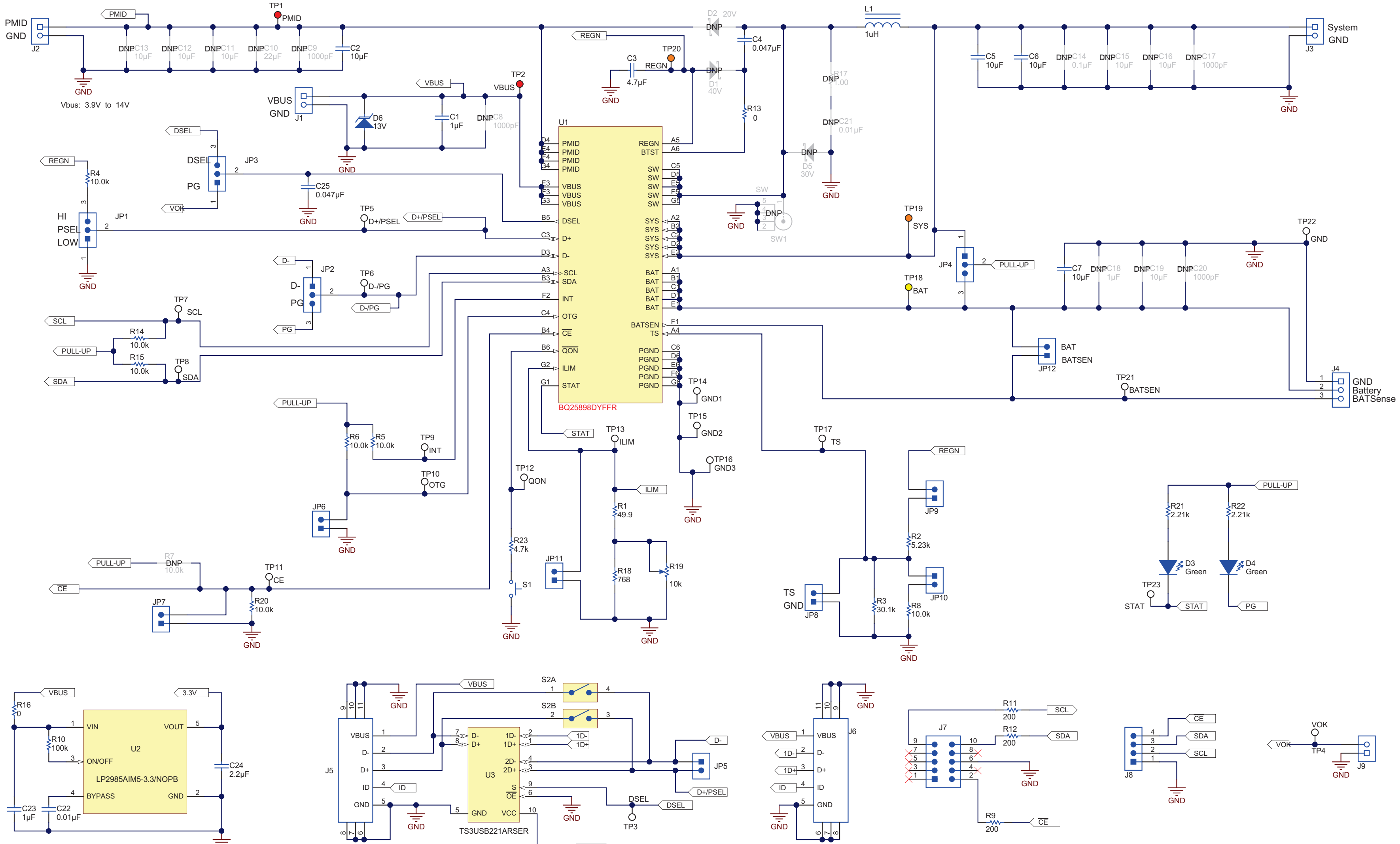

Figure 13. bq25898DEVM-730-002 Schematic

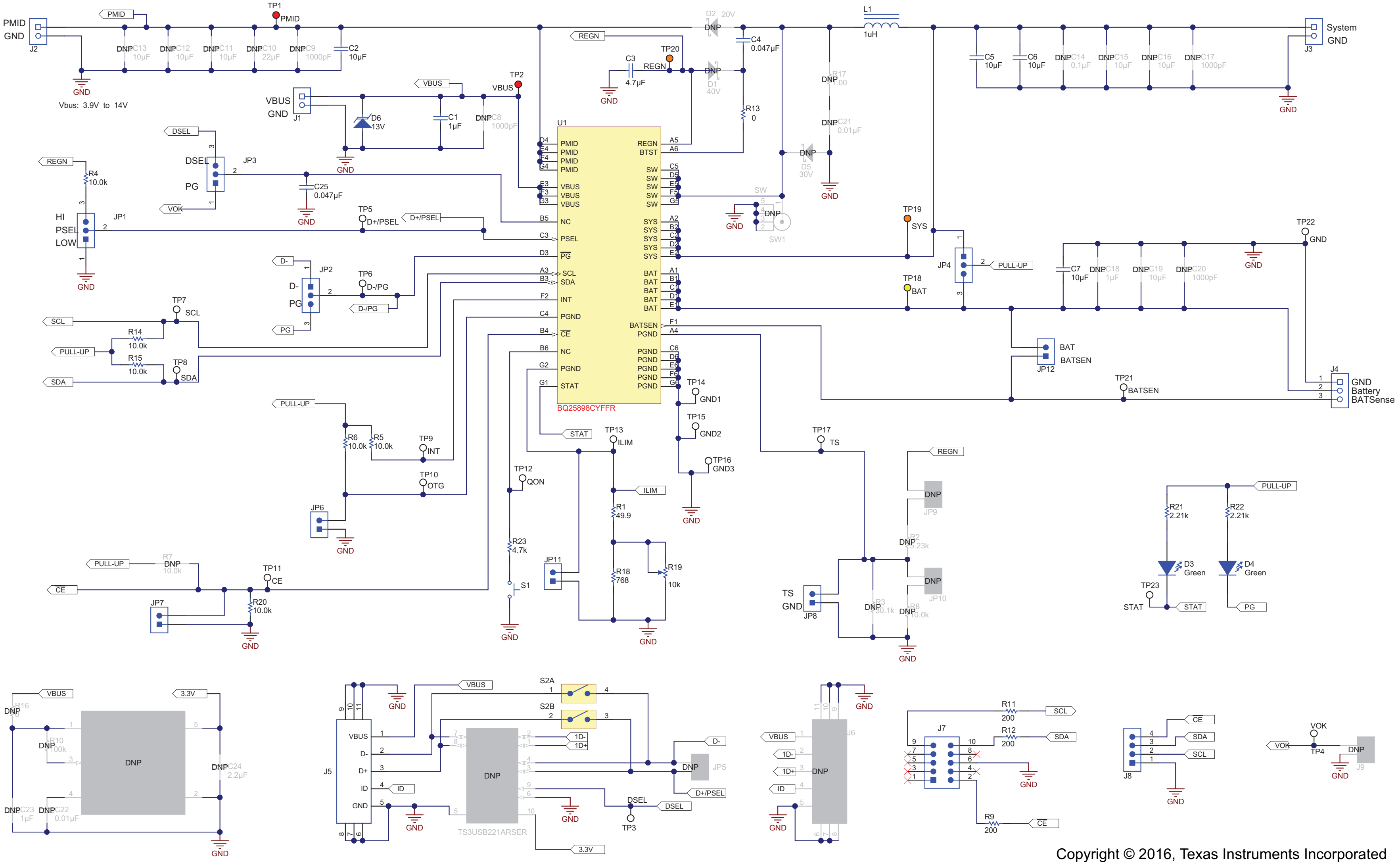

Figure 14. bq25898CEVM-730-003 Schematic

4.3 Bill of Materials

Table 5, Table 6, and Table 7 list the bill of materials for the three EVM variants.

Table 5. bq25898EVM-730-001 Bill of Materials

Designator	Description	Manufacturer	Part Number	Qty
!PCB	Printed Circuit Board	Any	PWR730	1
C1	CAP, CERM, 1 µF, 25 V, +/- 10%, X7R, 0805	Murata	GRM219R71E105KA88D	1
C2	CAP, CERM, 10uF, 25V, +/-10%, X5R, 0805	TDK	C2012X5R1E106K125AB	1
C3	CAP, CERM, 4.7uF, 16V, +/-10%, X5R, 0603	Murata	GRM188R61C475KAAJ	1
C4, C25	CAP, CERM, 0.047uF, 25V, +/-10%, X7R, 0402	Murata	GRM155R71E473KA88D	2
C5, C6, C7	CAP, CERM, 10 µF, 10 V, +/- 10%, X7R, 0805	Murata	GRM21BR71A106KE51L	3
C22	CAP, CERM, 0.01uF, 25V, +/-10%, X7R, 0402	TDK	C1005X7R1E103K	1
C23	CAP, CERM, 1uF, 25V, +/-10%, X7R, 0603	TDK	C1608X7R1E105K080AB	1
C24	CAP, CERM, 2.2uF, 10V, +/-10%, X5R, 0402	TDK	C1005X5R1A225K050BC	1
D3, D4	LED, Green, SMD	Lite-On	LTST-C190GKT	2
D6	Diode, TVS, Uni, 13 V, W, SOD-123W	NXP Semiconductor	PTVS13VS1UR,115	1
H1, H2, H3, H4	Bumpon, Hemisphere, 0.44 X 0.20, Clear	3M	SJ-5303 (CLEAR)	4
J1, J2, J3, J9	Conn Term Block, 2POS, 3.81mm, TH	Phoenix Contact	1727010	4
J4	Terminal Block Receptacle, 3x1, 3.81mm, R/A, TH	Phoenix Contact	1727023	1
J5, J6	Connector, Receptacle, Micro-USB Type B, R/A, Bottom Mount SMT	Molex	0473460001	2
J7	Header (shrouded), 100mil, 5x2, High-Temperature, Gold, TH	3M	N2510-6002-RB	1
J8	Header, 100mil, 4x1, R/A, TH	Molex	22-05-3041	1
JP1, JP2, JP3, JP4	Header, 100mil, 3x1, Tin plated, TH	Sullins Connector Solutions	PEC03SAAN	4
JP5, JP6, JP7, JP8, JP9, JP10, JP11, JP12	Header, 100mil, 2x1, Tin plated, TH	Sullins Connector Solutions	PEC02SAAN	8
L1	Inductor, Wirewound, 1 µH, 4 A, 0.041 ohm, SMD	Wurth Elektronik	74437321010	1
LBL1	Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll	Brady	THT-14-423-10	1
R1	RES, 49.9, 1%, 0.063 W, 0402	Vishay-Dale	CRCW040249R9FKED	1
R2	RES, 5.23k ohm, 1%, 0.063W, 0402	Vishay-Dale	CRCW04025K23FKED	1
R3	RES, 30.1k ohm, 1%, 0.063W, 0402	Vishay-Dale	CRCW040230K1FKED	1
R4, R5, R6, R8, R14, R15, R20	RES, 10.0k ohm, 1%, 0.063W, 0402	Vishay-Dale	CRCW040210K0FKED	7
R9, R11, R12	RES, 200 ohm, 1%, 0.063W, 0402	Vishay-Dale	CRCW0402200RFKED	3
R10	RES, 100k ohm, 1%, 0.063W, 0402	Vishay-Dale	CRCW0402100KFKED	1
R13, R16	RES, 0 ohm, 5%, 0.063W, 0402	Vishay-Dale	CRCW04020000Z0ED	2
R18	RES, 768 ohm, 1%, 0.063W, 0402	Vishay-Dale	CRCW0402768RFKED	1
R19	Trimmer, 10k ohm, 0.25W, TH	Bourns	3266W-1-103LF	1
R21, R22	RES, 2.21k ohm, 1%, 0.063W, 0402	Vishay-Dale	CRCW04022K21FKED	2
R23	RES, 4.7k ohm, 5%, 0.063W, 0402	Vishay-Dale	CRCW04024K70JNED	1
S1	Switch, Normally open, 2.3N force, 200k operations, SMD	C and K Components	KSR221GLFS	1
S2	DIP Switch, SPST, 2Pos, Slide, SMT	Copal Electronics	CVS-02TB	1
SH-JP1, SH-JP2, SH-JP3, SH-JP4, SH-JP5, SH-JP6, SH-JP7, SH-JP8, SH-JP9, SH-JP10, SH-JP11, SH-JP12	Shunt, 100mil, Gold plated, Black	3M	969102-0000-DA	12
SW1	Compact Probe Tip Circuit Board Test Points, TH, 25 per	Tektronix	131-5031-00	1
TP1, TP2	Test Point, Miniature, Red, TH	Keystone	5000	2
TP3, TP4, TP5, TP6, TP7, TP8, TP9, TP10, TP11, TP12, TP13, TP17, TP21, TP23	Test Point, Miniature, White, TH	Keystone	5002	14
TP14, TP15, TP16, TP22	Test Point, Compact, SMT	Keystone	5016	4
TP18	Test Point, Miniature, Yellow, TH	Keystone	5004	1
TP19, TP20	Test Point, Miniature, Orange, TH	Keystone	5003	2
U1	I2C Controlled 4A Single Cell NVDC Power Path Management with MaxChargeTM High Voltage Adapter Support, YFF0042-C01	Texas Instruments	BQ25898YFFR	1
U2	Micropower 150 mA Low-Noise Ultra Low-Dropout Regulator in SOT-23 Package, DBV0005A	Texas Instruments	LP2985AIM5-3.3/NOPB	1
U3	ESD Protected,High-Speed USB 2.0 (480-Mbps) 1:2 Multiplexer / Demultiplexer Switch, 1:2 Mux / Demux, 6 ohm RON, 2.5 to 3.3V, -40 to 85 degC, 10-Pin UQFN (RSE), Green (RoHS & no Sb/Br)	Texas Instruments	TS3USB221ARSER	1

Table 6. Bill of Materials bq25898DEVM-730-002 BOM

Designator	Description	Manufacturer	Part Number	Qty
!PCB	Printed Circuit Board	Any	PWR730	1
C1	CAP, CERM, 1 µF, 25 V, +/- 10%, X7R, 0805	Murata	GRM219R71E105KA88D	1
C2	CAP, CERM, 10uF, 25V, +/-10%, X5R, 0805	TDK	C2012X5R1E106K125AB	1
C3	CAP, CERM, 4.7uF, 16V, +/-10%, X5R, 0603	Murata	GRM188R61C475KAAJ	1
C4, C25	CAP, CERM, 0.047uF, 25V, +/-10%, X7R, 0402	Murata	GRM155R71E473KA88D	2
C5, C6, C7	CAP, CERM, 10 µF, 10 V, +/- 10%, X7R, 0805	Murata	GRM21BR71A106KE51L	3
C22	CAP, CERM, 0.01uF, 25V, +/-10%, X7R, 0402	TDK	C1005X7R1E103K	1
C23	CAP, CERM, 1uF, 25V, +/-10%, X7R, 0603	TDK	C1608X7R1E105K080AB	1
C24	CAP, CERM, 2.2uF, 10V, +/-10%, X5R, 0402	TDK	C1005X5R1A225K050BC	1
D3, D4	LED, Green, SMD	Lite-On	LTST-C190GKT	2
D6	Diode, TVS, Uni, 13 V, W, SOD-123W	NXP Semiconductor	PTVS13VS1UR,115	1
H1, H2, H3, H4	Bumpon, Hemisphere, 0.44 X 0.20, Clear	3M	SJ-5303 (CLEAR)	4
J1, J2, J3, J9	Conn Term Block, 2POS, 3.81mm, TH	Phoenix Contact	1727010	4
J4	Terminal Block Receptacle, 3x1, 3.81mm, R/A, TH	Phoenix Contact	1727023	1
J5, J6	Connector, Receptacle, Micro-USB Type B, R/A, Bottom Mount SMT	Molex	0473460001	2
J7	Header (shrouded), 100mil, 5x2, High-Temperature, Gold, TH	3M	N2510-6002-RB	1
J8	Header, 100mil, 4x1, R/A, TH	Molex	22-05-3041	1
JP1, JP2, JP3, JP4	Header, 100mil, 3x1, Tin plated, TH	Sullins Connector Solutions	PEC03SAAN	4
JP5, JP6, JP7, JP8, JP9, JP10, JP11, JP12	Header, 100mil, 2x1, Tin plated, TH	Sullins Connector Solutions	PEC02SAAN	8
L1	Inductor, Wirewound, 1 µH, 4 A, 0.041 ohm, SMD	Wurth Elektronik	74437321010	1
LBL1	Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll	Brady	THT-14-423-10	1
R1	RES, 49.9, 1%, 0.063 W, 0402	Vishay-Dale	CRCW040249R9FKED	1
R2	RES, 5.23k ohm, 1%, 0.063W, 0402	Vishay-Dale	CRCW04025K23FKED	1
R3	RES, 30.1k ohm, 1%, 0.063W, 0402	Vishay-Dale	CRCW040230K1FKED	1
R4, R5, R6, R8, R14, R15, R20	RES, 10.0k ohm, 1%, 0.063W, 0402	Vishay-Dale	CRCW040210K0FKED	7
R9, R11, R12	RES, 200 ohm, 1%, 0.063W, 0402	Vishay-Dale	CRCW0402200RFKED	3
R10	RES, 100k ohm, 1%, 0.063W, 0402	Vishay-Dale	CRCW0402100KFKED	1
R13, R16	RES, 0 ohm, 5%, 0.063W, 0402	Vishay-Dale	CRCW04020000Z0ED	2
R18	RES, 768 ohm, 1%, 0.063W, 0402	Vishay-Dale	CRCW0402768RFKED	1
R19	Trimmer, 10k ohm, 0.25W, TH	Bourns	3266W-1-103LF	1
R21, R22	RES, 2.21k ohm, 1%, 0.063W, 0402	Vishay-Dale	CRCW04022K21FKED	2
R23	RES, 4.7k ohm, 5%, 0.063W, 0402	Vishay-Dale	CRCW04024K70JNED	1
S1	Switch, Normally open, 2.3N force, 200k operations, SMD	C and K Components	KSR221GLFS	1
S2	DIP Switch, SPST, 2Pos, Slide, SMT	Copal Electronics	CVS-02TB	1
SH-JP1, SH-JP2, SH-JP3, SH-JP4, SH-JP5, SH-JP6, SH-JP7, SH-JP8, SH-JP9, SH-JP10, SH-JP11, SH-JP12	Shunt, 100mil, Gold plated, Black	3M	969102-0000-DA	12
SW1	Compact Probe Tip Circuit Board Test Points, TH, 25 per	Tektronix	131-5031-00	1
TP1, TP2	Test Point, Miniature, Red, TH	Keystone	5000	2
TP3, TP4, TP5, TP6, TP7, TP8, TP9, TP10, TP11, TP12, TP13, TP17, TP21, TP23	Test Point, Miniature, White, TH	Keystone	5002	14
TP14, TP15, TP16, TP22	Test Point, Compact, SMT	Keystone	5016	4
TP18	Test Point, Miniature, Yellow, TH	Keystone	5004	1
TP19, TP20	Test Point, Miniature, Orange, TH	Keystone	5003	2
U1	I2C Controlled 4A Single Cell NVDC Power Path Management with MaxChargeTM High Voltage Adapter Support, YFF0042AHAC	Texas Instruments	BQ25898DYFFR	1
U2	Micropower 150 mA Low-Noise Ultra Low-Dropout Regulator in SOT-23 Package, DBV0005A	Texas Instruments	LP2985AIM5-3.3/NOPB	1
U3	ESD Protected,High-Speed USB 2.0 (480-Mbps) 1:2 Multiplexer / Demultiplexer Switch, 1:2 Mux / Demux, 6 ohm RON, 2.5 to 3.3V, -40 to 85 degC, 10-Pin UQFN (RSE), Green (RoHS & no Sb/Br)	Texas Instruments	TS3USB221ARSER	1

Table 7. Bill of Materials bq25898CEVM-730-003 BOM

Designator	Description	Manufacturer	Part Number	Qty
!PCB	Printed Circuit Board	Any	PWR730	1
C1	CAP, CERM, 1 µF, 25 V, +/- 10%, X7R, 0805	Murata	GRM219R71E105KA88D	1
C2	CAP, CERM, 10uF, 25V, +/-10%, X5R, 0805	TDK	C2012X5R1E106K125AB	1
C3	CAP, CERM, 4.7uF, 16V, +/-10%, X5R, 0603	Murata	GRM188R61C475KAAJ	1
C4, C25	CAP, CERM, 0.047uF, 25V, +/-10%, X7R, 0402	Murata	GRM155R71E473KA88D	2
C5, C6, C7	CAP, CERM, 10 µF, 10 V, +/- 10%, X7R, 0805	Murata	GRM21BR71A106KE51L	3
D3, D4	LED, Green, SMD	Lite-On	LTST-C190GKT	2
D6	Diode, TVS, Uni, 13 V, W, SOD-123W	NXP Semiconductor	PTVS13VS1UR,115	1
H1, H2, H3, H4	Bumpon, Hemisphere, 0.44 X 0.20, Clear	3M	SJ-5303 (CLEAR)	4
J1, J2, J3	Conn Term Block, 2POS, 3.81mm, TH	Phoenix Contact	1727010	3
J4	Terminal Block Receptacle, 3x1, 3.81mm, R/A, TH	Phoenix Contact	1727023	1
J5	Connector, Receptacle, Micro-USB Type B, R/A, Bottom Mount SMT	Molex	0473460001	1
J7	Header (shrouded), 100mil, 5x2, High-Temperature, Gold, TH	3M	N2510-6002-RB	1
J8	Header, 100mil, 4x1, R/A, TH	Molex	22-05-3041	1
JP1, JP2, JP3, JP4	Header, 100mil, 3x1, Tin plated, TH	Sullins Connector Solutions	PEC03SAAN	4
JP6, JP7, JP8, JP11, JP12	Header, 100mil, 2x1, Tin plated, TH	Sullins Connector Solutions	PEC02SAAN	5
L1	Inductor, Wirewound, 1 µH, 4 A, 0.041 ohm, SMD	Wurth Elektronik	74437321010	1
LBL1	Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll	Brady	THT-14-423-10	1
R1	RES, 49.9, 1%, 0.063 W, 0402	Vishay-Dale	CRCW040249R9FKED	1
R4, R5, R6, R14, R15, R20	RES, 10.0k ohm, 1%, 0.063W, 0402	Vishay-Dale	CRCW040210K0FKED	6
R9, R11, R12	RES, 200 ohm, 1%, 0.063W, 0402	Vishay-Dale	CRCW0402200RFKED	3
R13	RES, 0 ohm, 5%, 0.063W, 0402	Vishay-Dale	CRCW04020000Z0ED	1
R18	RES, 768 ohm, 1%, 0.063W, 0402	Vishay-Dale	CRCW0402768RFKED	1
R19	Trimmer, 10k ohm, 0.25W, TH	Bourns	3266W-1-103LF	1
R21, R22	RES, 2.21k ohm, 1%, 0.063W, 0402	Vishay-Dale	CRCW04022K21FKED	2
R23	RES, 4.7k ohm, 5%, 0.063W, 0402	Vishay-Dale	CRCW04024K70JNED	1
S1	Switch, Normally open, 2.3N force, 200k operations, SMD	C and K Components	KSR221GLFS	1
S2	DIP Switch, SPST, 2Pos, Slide, SMT	Copal Electronics	CVS-02TB	1
SH-JP1, SH-JP2, SH-JP3, SH-JP4, SH-JP5, SH-JP6, SH-JP7, SH-JP8, SH-JP9, SH-JP10, SH-JP11, SH-JP12	Shunt, 100mil, Gold plated, Black	3M	969102-0000-DA	12
SW1	Compact Probe Tip Circuit Board Test Points, TH, 25 per	Tektronix	131-5031-00	1
TP1, TP2	Test Point, Miniature, Red, TH	Keystone	5000	2
TP3, TP4, TP5, TP6, TP7, TP8, TP9, TP10, TP11, TP12, TP13, TP17, TP21, TP23	Test Point, Miniature, White, TH	Keystone	5002	14
TP14, TP15, TP16, TP22	Test Point, Compact, SMT	Keystone	5016	4
TP18	Test Point, Miniature, Yellow, TH	Keystone	5004	1
TP19, TP20	Test Point, Miniature, Orange, TH	Keystone	5003	2
U1	I2C Controlled 4A Single Cell NVDC Power Path Management with MaxChargeTM High Voltage Adapter Support, YFF0042-C01	Texas Instruments	BQ25898CYFFR	1

STANDARD TERMS AND CONDITIONS FOR EVALUATION MODULES

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.

【無線電波を送信する製品の開発キットをお使いになる際の注意事項】 開発キットの中には技術基準適合証明を受けていないものがあります。 技術適合証明を受けていないもののご使用に際しては、電波法遵守のため、以下のいずれかの措置を取っていただく必要がありますのでご注意ください。

1. 電波法施行規則第6条第1項第1号に基づく平成18年3月28日総務省告示第173号で定められた電波暗室等の試験設備でご使用いただく。
2. 実験局の免許を取得後ご使用いただく。
3. 技術基準適合証明を取得後ご使用いただく。

なお、本製品は、上記の「ご使用にあたっての注意」を譲渡先、移転先に通知しない限り、譲渡、移転できないものとします。

上記を遵守頂けない場合は、電波法の罰則が適用される可能性があることをご留意ください。 日本テキサス･ インスツルメンツ株式会社
東京都新宿区西新宿６丁目２４番１号
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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
電力線搬送波通信についての開発キットをお使いになる際の注意事項については、次のところをご覧ください。http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_02.page

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.

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