User's Guide
SLUUB62A–August 2014–Revised March 2015

bq24296M and bq24298 EVM (PWR655) User's Guide

This user's guide describes the characteristics, operation, and use of the PWR655 bq24296MEVM and bq24298EVM (EVM). This document details the equipment required, equipment setup, testing procedures, schematics, PCB assembly and layout drawings, and bill of materials (BOM).

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1 Introduction

1.1 EVM Features

For detailed features and operation, refer to Table 1 for a list of devices and their data sheets.

Table 1. Device Data Sheets

Device	Document
bq24296M	SLUSBU3
bq24298	SLUSC59

The bq24296M and bq24298 evaluation modules (EVM) are complete charger modules for evaluating an I^2C-controlled single NVDC-1 charge using the bq24296M and bq24298 devices.

This EVM doesn't include the USB-to-GPIO 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. 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/Power bank output negative terminal
J3–SYS	Connected to system
J3–GND	Ground
J4–BAT+	Connected to battery pack
J4–GND	Ground
J6–INT	INT pin connection
J6– $\overline{OTG}$	$\overline{OTG}$ pin connection
J6–$\overline{CE}$	$\overline{CE}$ pin connection
J6–GND	Ground
J7	USB-to-GPIO connector (USB interface adapter connector – EV2300 or EV2400)
J8	External TS1 pin connection
J8	Ground
J9	External TS2 pin connection
J9	Ground

Table 3 lists the controls and key parameter settings for this EVM.

Table 3. Jumper Connections

Jack	Description	Factory Setting
JP1	For bq24296M and bq24298 input current setting: PSEL LOW: Adaptor input PSEL HIGH: USB input	bq24296M and bq24298: Short PSEL to LOW
JP2	D-/$\overline{PG}$ pin selection	bq24296M and bq24298: Short D–/$\overline{PG}$ to $\overline{PG}$
JP3	TS2 or QON selector	bq24296M and bq24298: Select QON Installed
JP4	TS2 pin setting	Not installed
JP5	D+/D– connections for bq24296M input current limit setting	Not installed
JP6	USB current limit selection pin during buck mode and PSEL is high (JP1-High)/Enable pin during boost mode. In buck mode: $\overline{OTG}$ = High, I_{IN} limit = 500 mA; $\overline{OTG}$ = Low, I_{IN} limit = 100 mA. The boost mode is activated when the REG01[5:4] = 10 and $\overline{OTG}$ pin is HIGH.	Not installed
JP7	$\overline{CE}$ pin setting: pull low to enable the charge	Not Installed: (GUI also can pull $\overline{CE}$ low)
JP8	STAT, $\overline{PG}$, $\overline{CE}$, INT, $\overline{OTG}$ pin internal pull-up source (VSYS) jumper	bq24296M and bq24298: Installed
JP9	TS1 Resistor Divider pull-up source (REGN)	bq24296M and bq24298: Installed
JP10	Internal 10 kΩ from TS1 to ground	bq24296M and bq24298: Short TS2 and TS2-I
JP11	TS2 Connection	Not 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_{IN}	Input voltage from AC adapter	3.9	5	6.2	VDC
Battery voltage, V_{BAT}	Voltage applied at V_{BAT} terminal	0	3.7	4.4	V
I_{BAT}	Fast charging current			3	A
	Discharging current through internal MOSFET			5.5	A
Supply current, I_{AC}	Maximum input current from AC adapter input	0		3	A
Output current, I_{SYS}	Output current (SYS)	0		3.5	A
Operating junction temperature range, T_J		0		125	°C

2 Test Summary

Section 2.1 through Section 2.3 explains the equipment, equipment setup, and test procedure.

2.1 Equipment

2.1.1 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.

2.1.2 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 20–5M, DC 0 to ±20 V, 0 to ±5 A (or higher).

or:

Real single-cell battery.

2.1.3 Load #2 – Use with Boost Mode

PMID to GND load, 10 Ω, 5 W or greater.

2.1.4 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.

2.1.5 Computer

A computer with at least one USB port and a USB cable. The Battery Management Studio (bqStudio) (SLUC525) must be properly installed.

2.1.6 USB-to-GPIO Communication Kit (EV2300 or EV2400 - USB Interface Adapter)

2.1.7 Software

Download the bqStudio software and double-click on the file. Follow the installation steps. The software supports the Microsoft® Windows® XP and Windows 7 operating systems.

Microsoft, Windows are registered trademarks of Microsoft Corporation.

2.2 Equipment Setup

Use the following steps to setup the equipment:

Step 1. Set PS #1 for 5-V DC, 1-A current limit and then turn off the supply.

Step 2. Connect the output of PS #1 in series with a current meter (multimeter) to J1 (V_{BUS} and GND).

Step 3. Connect a voltage meter across J1 (V_{BUS}) and J1 (GND).

Step 4. Turn on the Load, set to constant voltage mode and output to 2.5 V. Turn off (disable) Load. Connect Load in series with a current meter (multimeter), ground side, to J4 (BAT+ and GND) as shown in Figure 2.

Step 5. Connect a voltage meter across J4 (BAT+ and GND).

Step 6. Connect the USB interface adapt to the computer and connect SDA, SCL, and GND to TP12(SDA), TP13(SCL), and TP8 (AGND) on the EVM, respectively. Figure 1 shows the connections.

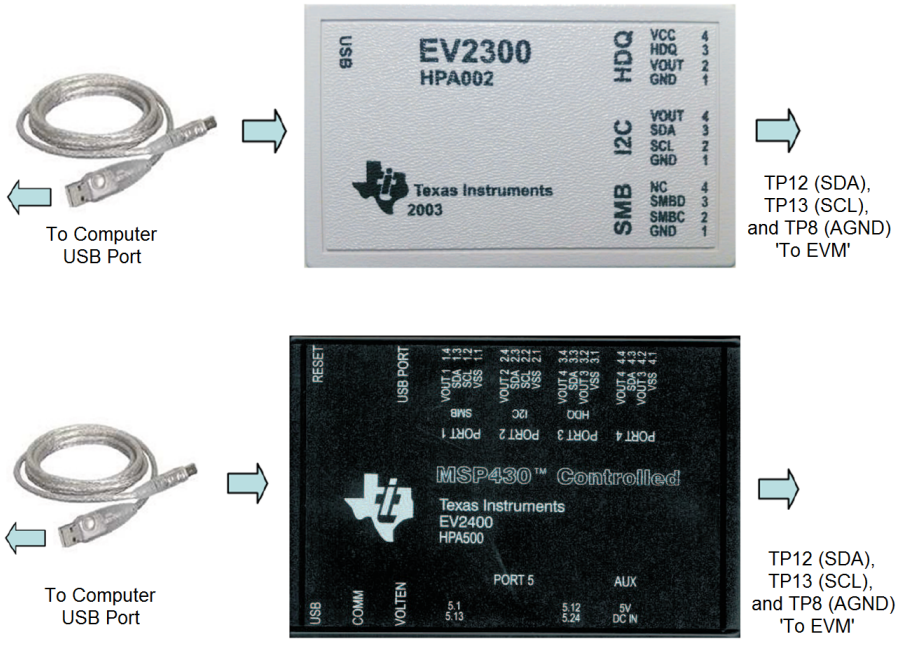


Figure 1. Connections of the EV2300 or EV2400 Kit

Step 7. Figure 2 illustrates the shunt installation.

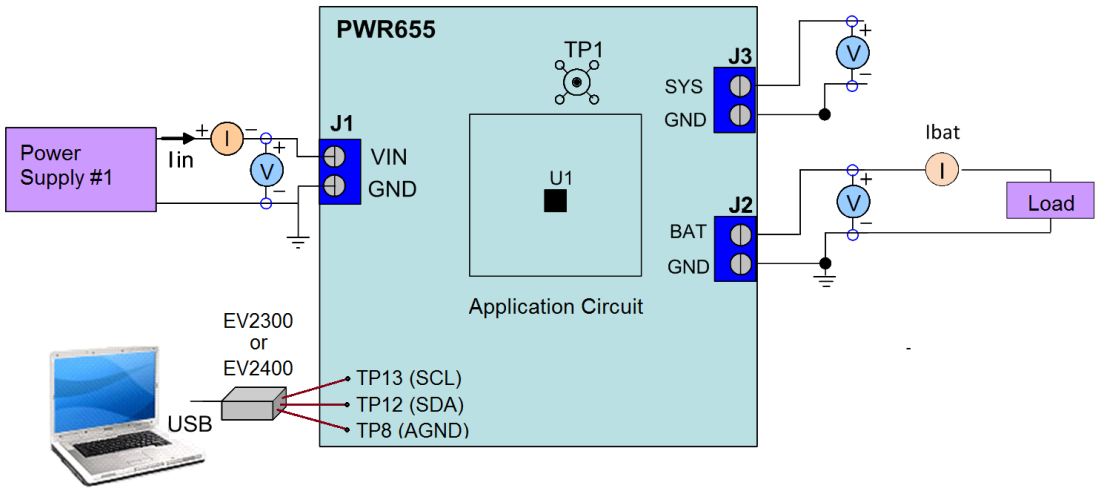


Figure 2. Original Test Setup for PWR655

8. Turn on the computer. Launch the evaluation software. The main windows of the bq24296M and bq24298 software are shown in Figure 3 and Figure 4, respectively.

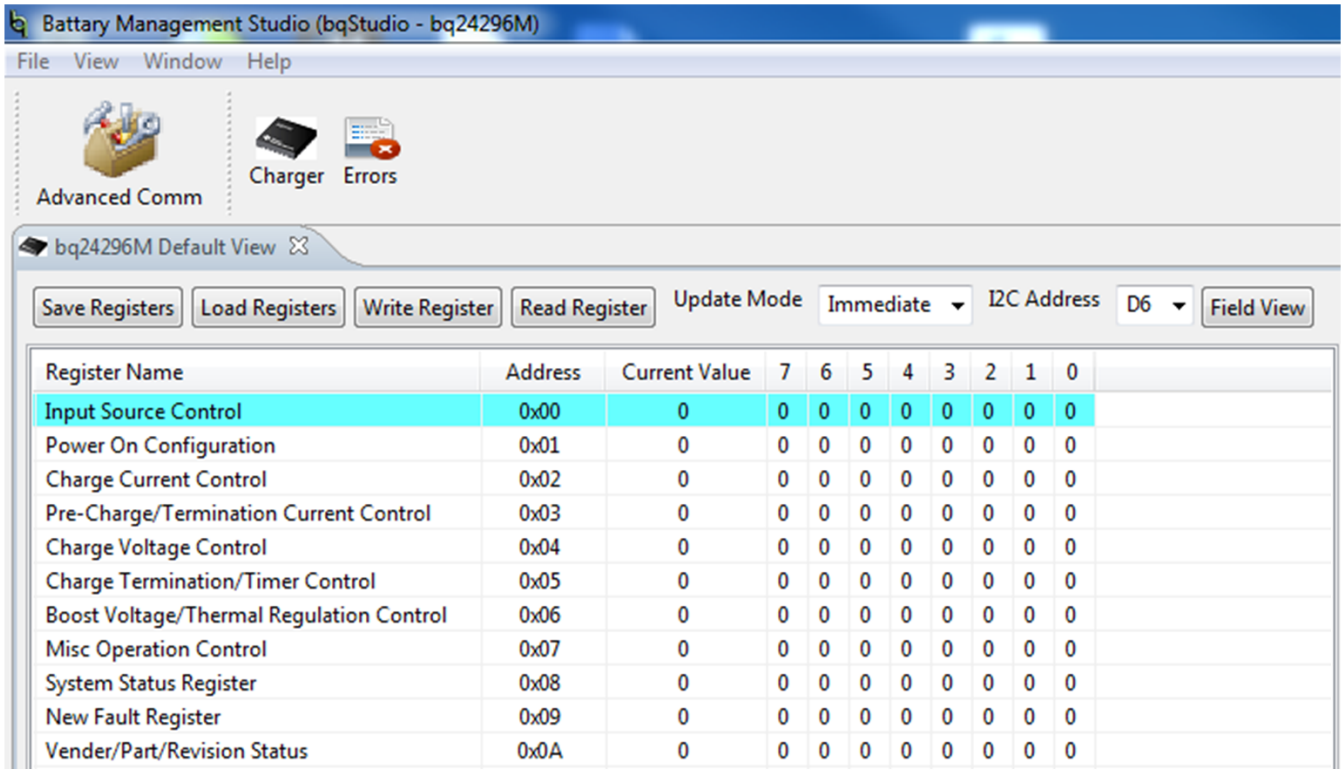


Figure 3. Main Window of the bq24296M Evaluation Software

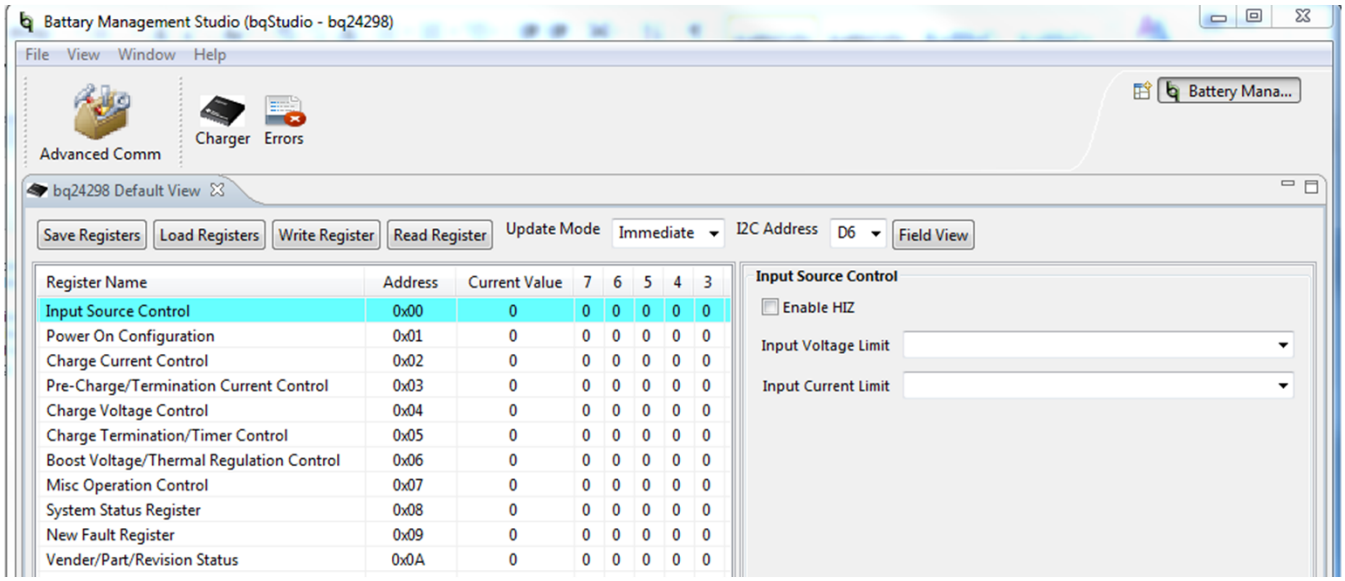


Figure 4. Main Window of the bq24298 Evaluation Software

2.3 Test Procedure

2.3.1 Current Settings

1. Make sure equipment setup steps are followed.
   ILIM Setting: Set the potentiometer to its lowest value for max 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 125 Ω to 175 Ω, the value of R7)
2. Launch the GUI software, if not already done
3. Turn on PS #1
   Measure → V (J3(SYS), J3(GND)) = 4.10 ±300 mV

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

Follow steps 1–7 and verify the outputs and IC for the EVM:

Step 1. Software setup (all of Step 1 is done in the GUI)

(a) Device address: bq24296M and bq24298

(b) Click the **Read** button

(c) Select *Disabled for I2C Watchdog Timer Limit*

(d) Set *Input Voltage Limit* to 4.2 V

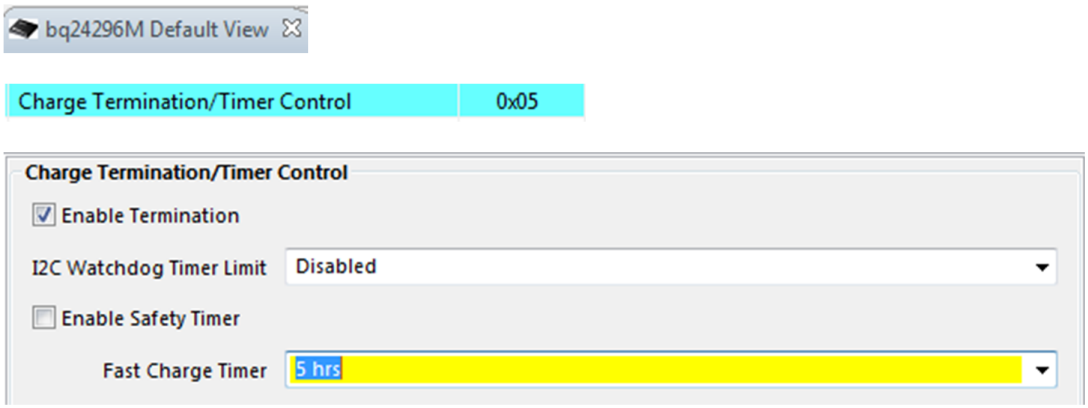
(e) Set *Input Current Limit* to 500 mA

(f) Set *Charge Voltage Limit* to 4.208 V

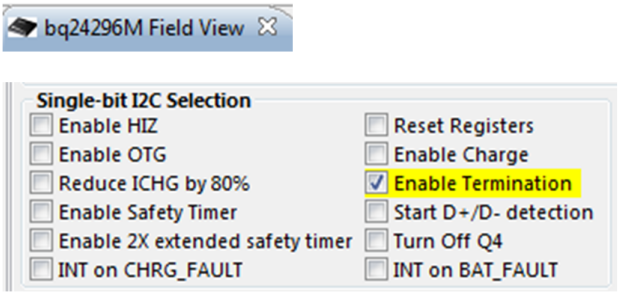
(g) Set *Fast Charge Current*, ICHG to 512 mA

(h) Set *Pre-Charge Current* to 256 mA

(i) Deselect *Enable Termination* (see the following images)



or



(j)

Click the **Read** button twice
Observe → Everything normal at *FAULT* box
Observe → D3 (STAT) is on
Observe → D4 ($\overline{PG}$) is on

Step 2. Enable Load #1 from Section 2.2, step 4. Measure the voltage across J3 and J4 as follows:
Measure → V(J3(SYS), J3(GND)) = 3.65 V ±300 mV
Measure → V(J4(BAT), J4(GND)) = 2.5 V ±200 mV

Step 3. Increase the constant voltage load to 3.7 V_{DC}
Measure → V(J3(SYS), J3(GND)) = 3.75 V ±200 mV
Measure → IBAT = 500 mA ±200 mA
Measure → V(J4(BAT), J4(GND)) = 3.7 V ±200 mV

Step 4. In the software, set *Fast Charge Current*, ICHG to 1024 mA
Measure → I_{IN} = 500 mA ±200 mA

Step 5. Verify scope measurements (See Figure 5 – 500 ns/div)
C1 (AC coupled 20 mV/div): Vac_PMID (TP2 to GND) – Ripple excluding high frequency spikes < 10 mV
C2 (5 V/div): Vdc_SW (TP1) – Frequency between 1.25 MHz and 1.5 MHz, duty cycle between 73% and 81%
C3 (AC coupled, 20 mV/div): Vac_VSYS (TP4 to GND) – Excluding high frequency spikes < 15 mV

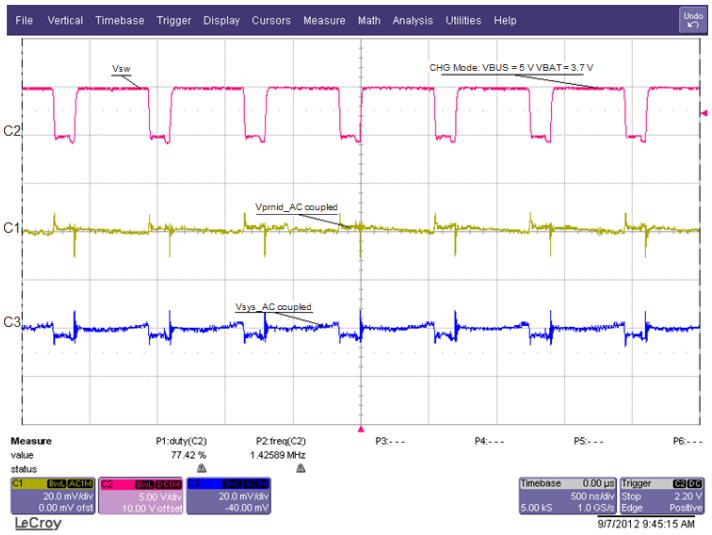


Figure 5. CHG Mode Ripple and Duty Cycle: V_{BUS} = 5 V, V_{BAT} = 3.7 V

6. Switch to Boost mode
   (a) Turn off and disconnect PS #1
   (b) 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 to 3.7 V and 2-A current limit and connect between BAT+ and GND
   (c) Apply 10 Ω (5 W or greater) across J2 (PMID(+) to GND(–)
   (d) Uncheck the *OTG Low* box in the GUI
   (e) Check the *Enable OTG* option in the GUI
   (f) Verify V_{PMID} to GND on J2 is between 4.9 V and 5.3 V
   (g) Verify scope measurement (see Figure 6):
   C1 (AC coupled 20 mV/div): Vac_PMID (TP2 to GND) – Ripple excluding high frequency spikes
   C2 (5 V/div): Vdc_SW (TP1) – Frequency between 1.2 MHz and 1.7 MHz, duty cycle between 67% and 74%

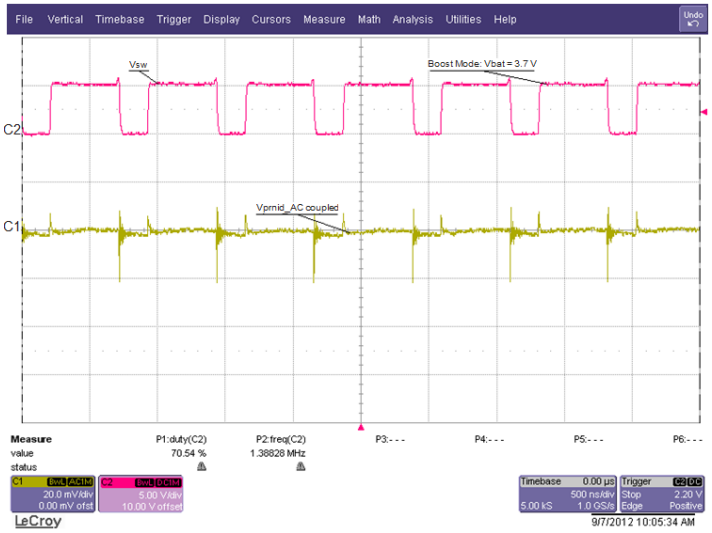


Figure 6. Boost Mode Ripple and Duty Cycle: V_{BAT} = 3.7 V

Step 6. Verify Device ID JEITA shown in software matches Table 5.

Table 5. Device ID JEITA Settings

Assembly Number	EVM Part Number	Device ID	JEITA
PWR655-001	bq24296EVM-655	bq24296M	Disabled
PWR655-002	bq24298EVM-655	bq24298	Disabled

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 and GND pin connections and use the shortest possible copper trace connection or GND plane.
2. Place the inductor input terminal as close to the SW pin as possible. 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.
3. Put an output capacitor near to the inductor and the IC. Tie ground connections to the IC ground with a short copper trace connection or GND plane.
4. Route analog ground separately from power ground. Connect analog ground and connect power ground separately. Connect analog ground and power ground together using power pad as the single ground connection point or use a 0-Ω resistor to tie analog ground to power ground.
5. Use a single ground connection to tie the charger power ground to the charger analog ground just beneath the IC. Use ground copper pour but avoid power pins to reduce inductive and capacitive noise coupling.
6. Place decoupling capacitors next to the IC pins and make the trace connection as short as possible.
7. It is critical that the exposed power pad on the backside of the IC package be soldered to the PCB ground. Ensure that there are sufficient thermal vias directly under the IC, connecting to the ground plane on the other layers.
8. The via size and number should be enough for a given current path.

See the EVM design for the recommended component placement with trace and via locations. For the QFN information, refer to *Quad Flatpack No-Lead Logic Packages* (SCBA017) and *QFN/SON PCB Attachment* (SLUA271).

4 Board Layout, Schematic, and Bill of Materials

This section contains the board layouts, schematics, and BOMs.

4.1 Board Layout

Figure 7 through Figure 10 illustrate the board layouts for this EVM.

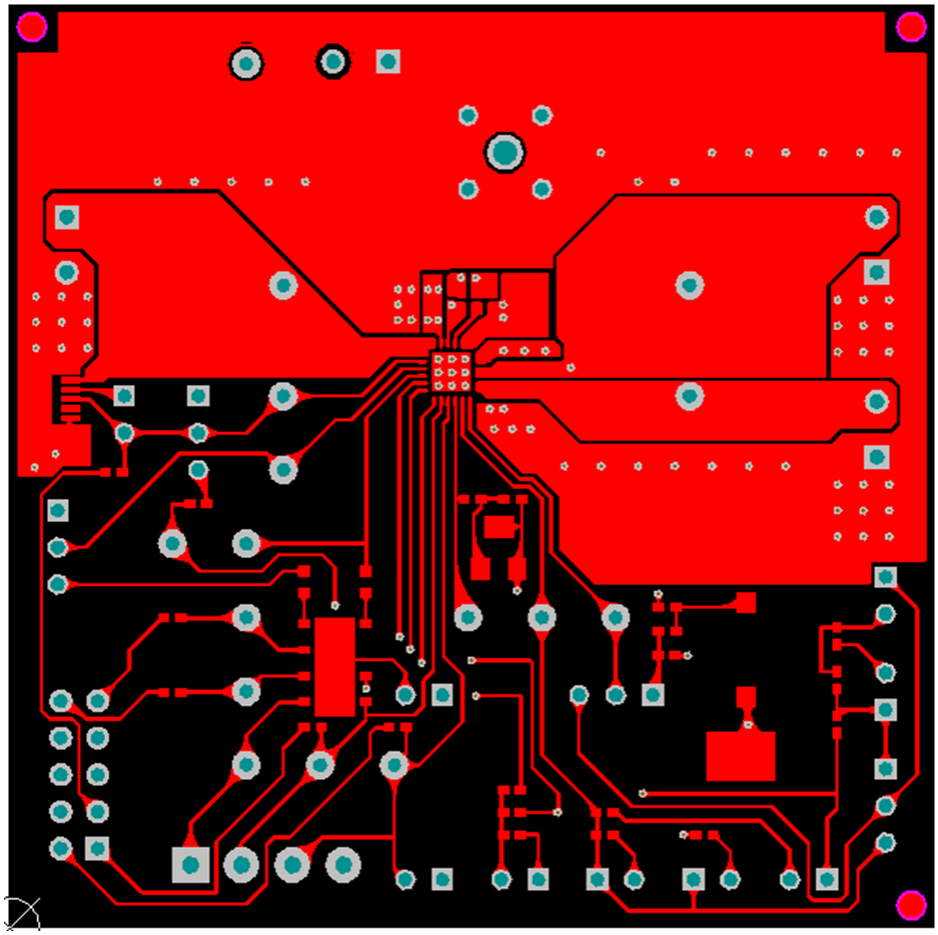


Figure 7. PWR655 EVM Top Layer

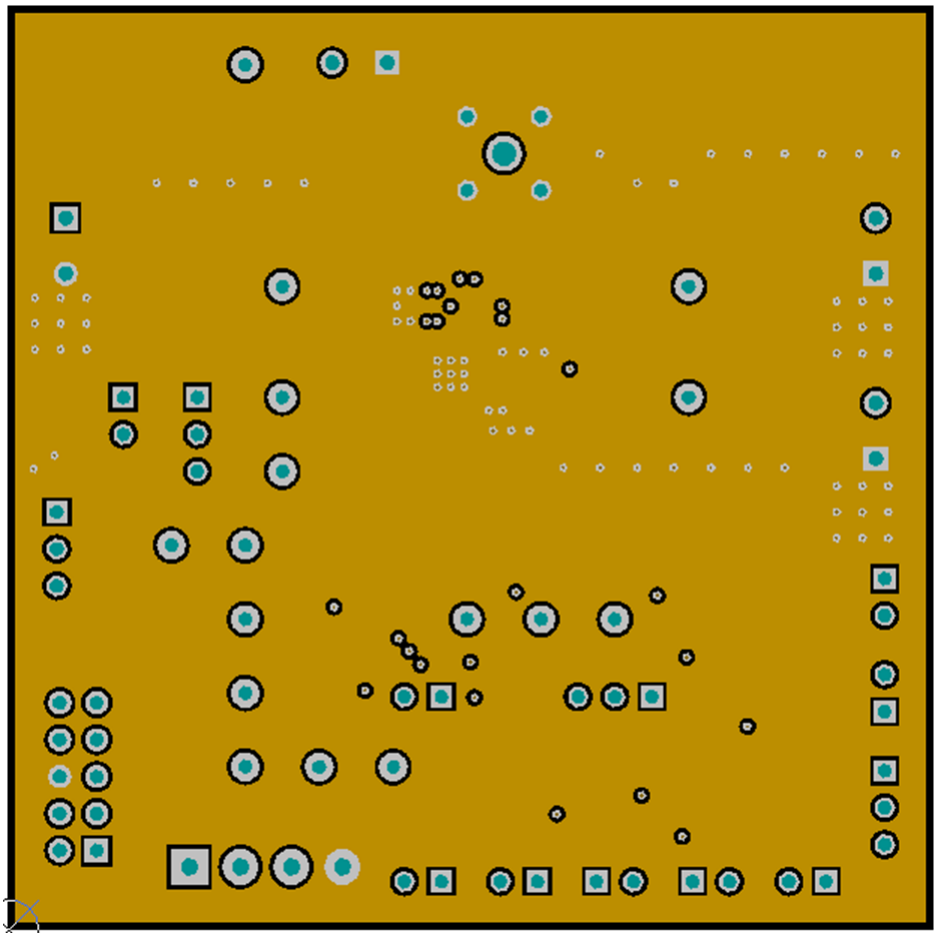


Figure 8. PWR655 EVM Second Layer

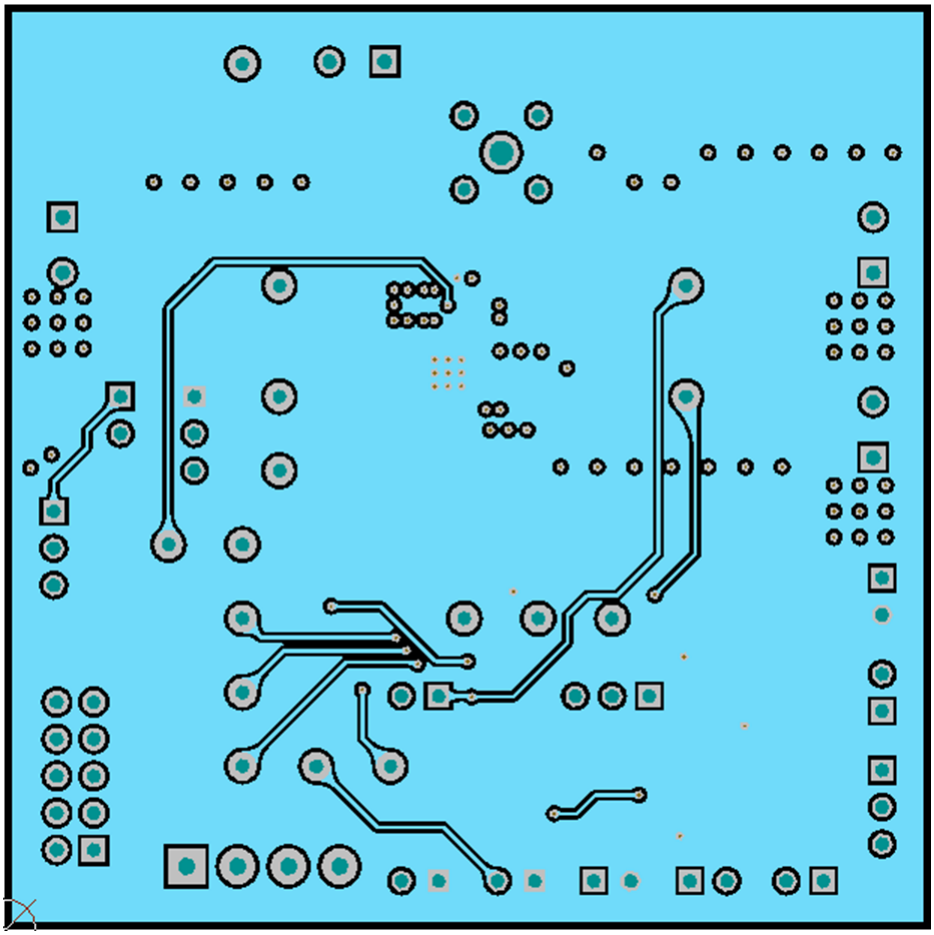


Figure 9. PWR655 EVM Third Layer

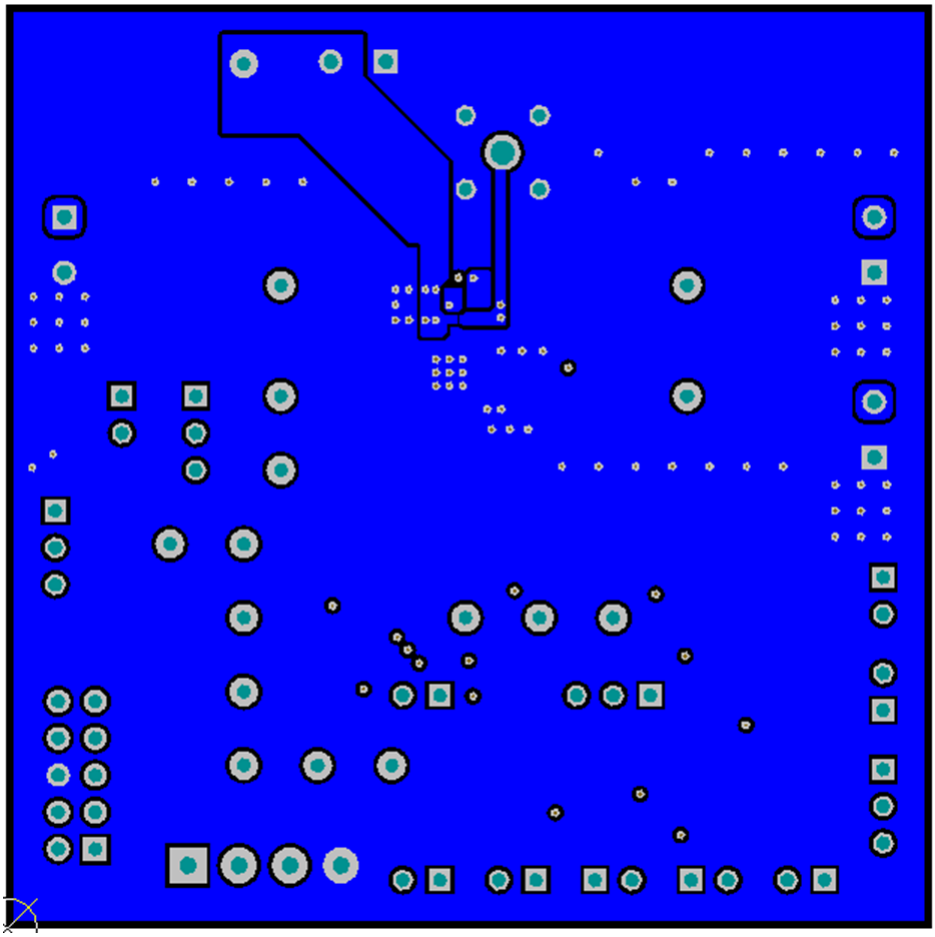


Figure 10. PWR655 EVM Bottom Layer

4.2 Schematics

This section includes the bq24296M and bq24298 schematics.

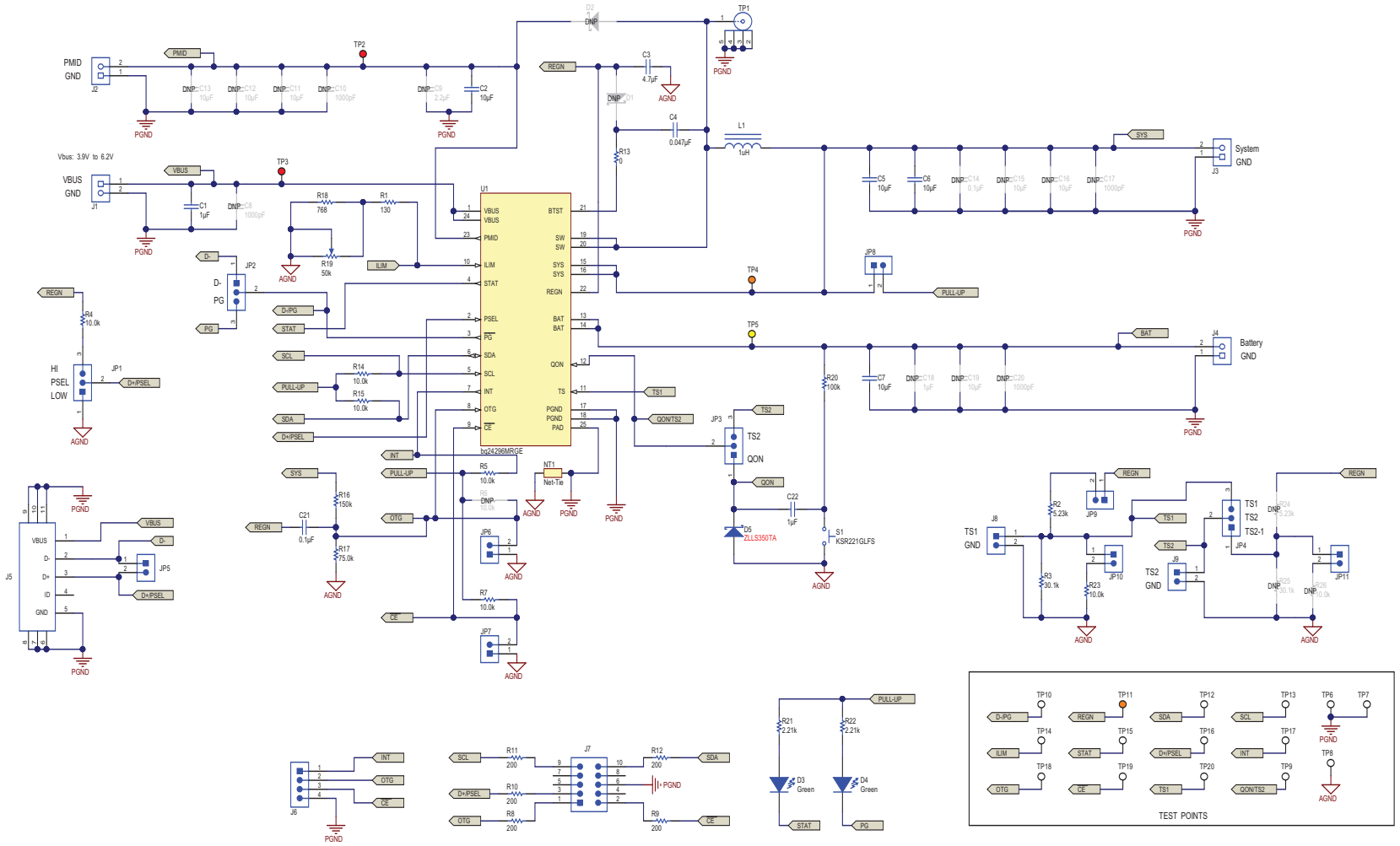


Figure 11. bq24296M Schematic

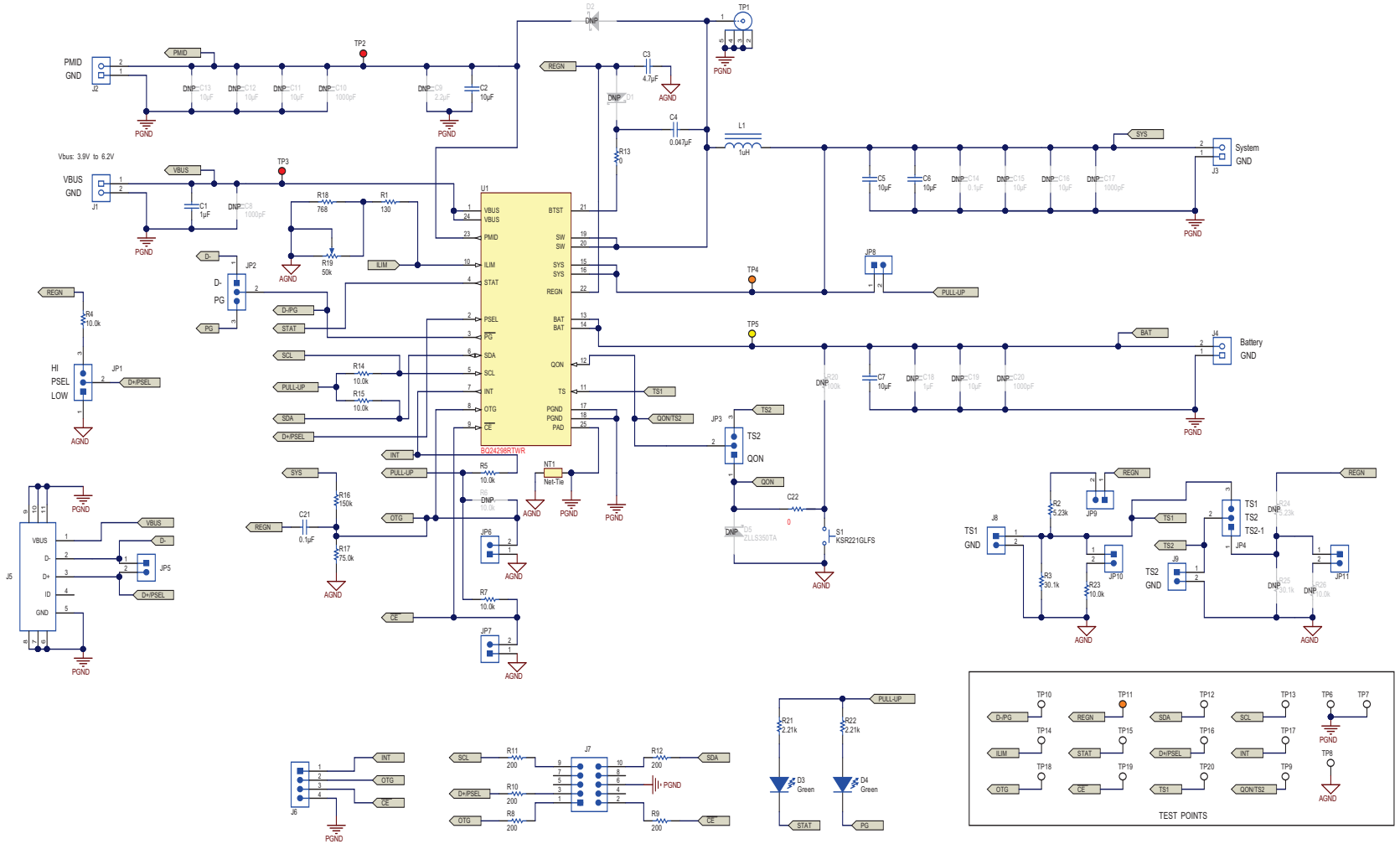


Figure 12. bq24298 Schematic

4.3 Bill of Materials

This section includes the bq24296M and bq24298 BOMs.

Table 6. bq24296M Bill of Materials

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer
PCB	1		Printed Circuit Board		PWR655	Any
C1	1	1uF	CAP, CERM, 1uF, 25V, ±10%, X7R, 0603	0603	C1608X7R1E105K080AB	TDK
C2	1	10uF	CAP, CERM, 10uF, 25V, ±10%, X5R, 0805	0805	C2012X5R1E106K125AB	TDK
C3	1	4.7uF	CAP, CERM, 4.7uF, 10V, ±20%, X5R, 0402	0402	GRM155R61A475M	MuRata
C4	1	0.047uF	CAP, CERM, 0.047uF, 25V, ±10%, X7R, 0402	0402	GRM155R71E473KA88D	MuRata
C5, C6, C7, C15, C16, C19	6	10uF	CAP, CERM, 10uF, 10V, ±20%, X5R, 0603	0603	C1608X5R1A106M	TDK
C21	1	0.1uF	CAP, CERM, 0.1uF, 10V, ±10%, X7R, 0402	0402	GRM155R71A104KA01D	MuRata
C22	1	1uF	CAP, CERM, 1uF, 10V, ±10%, X5R, 0402	0402	GRM155R61A105KE15D	MuRata
D3, D4	2	Green	LED, Green, SMD	1.6x0.8x0.8mm	LTST-C190GKT	Lite-On
D5	1	40V	Diode, Schottky, 40V, 0.38A, SOD-523	SOD-523	ZLLS350TA	Diodes Inc.
H1, H2, H3, H4	4		Bumpon, Cylindrical, 0.312 X 0.200, Black	Black Bumpon	SJ61A1	3M
J1, J2, J3, J4	4	2x1	Conn Term Block, 2POS, 3.81mm, TH	2POS Terminal Block	1727010	Phoenix Contact
J5	1		Connector, Receptacle, Micro-USB Type B, R/A, Bottom Mount SMT	7.5x2.45x5mm	0473460001	Molex
J6	1		Terminal Block, 6A, 3.5mm Pitch, 4-Pos, TH	14x8.2x6.5mm	ED555/4DS	On-Shore Technology
J7	1		Header (shrouded), 100mil, 5x2, High-Temperature, Gold, TH	5x2 Shrouded header	N2510-6002-RB	3M
J8, J9, JP5, JP6, JP7, JP8, JP9, JP10, JP11	9		Header, 100mil, 2x1, Tin plated, TH	Header, 2 PIN, 100mil, Tin	PEC02SAAN	Sullins Connector Solutions
JP1, JP2, JP3, JP4	4		Header, 100mil, 3x1, Tin plated, TH	Header, 3 PIN, 100mil, Tin	PEC03SAAN	Sullins Connector Solutions
L1	1	1uH	Inductor, Flat Wire, Powdered Iron, 1uH, 4.8A, 0.0336 ohm, SMD	4.7x1.2x4.0mm	SRP4012-1R0M	Bourns
LBL1	1		Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll	PCB Label 0.650"H x 0.200"W	THT-14-423-10	Brady
R1	1	130	RES, 130 ohm, 1%, 0.063W, 0402	0402	CRCW0402130RFKED	Vishay-Dale
R2	1	5.23k	RES, 5.23k ohm, 1%, 0.063W, 0402	0402	CRCW04025K23FKED	Vishay-Dale
R3	1	30.1k	RES, 30.1k ohm, 1%, 0.063W, 0402	0402	CRCW040230K1FKED	Vishay-Dale
R4, R5, R7, R14, R15, R23	6	10.0k	RES, 10.0k ohm, 1%, 0.063W, 0402	0402	CRCW040210K0FKED	Vishay-Dale
R8, R9, R10, R11, R12	5	200	RES, 200 ohm, 1%, 0.063W, 0402	0402	CRCW0402200RFKED	Vishay-Dale
R13	1	0	RES, 0 ohm, 5%, 0.063W, 0402	0402	CRCW04020000Z0ED	Vishay-Dale
R16	1	150k	RES, 150k ohm, 1%, 0.063W, 0402	0402	CRCW0402150KFKED	Vishay-Dale
R17	1	75.0k	RES, 75.0k ohm, 1%, 0.063W, 0402	0402	CRCW040275K0FKED	Vishay-Dale
R18	1	768	RES, 768 ohm, 1%, 0.063W, 0402	0402	CRCW0402768RFKED	Vishay-Dale
R19	1	50k	Trimmer, 50k, 0.25W, SMT	4.8x5.3x3.5mm	3214W-1-503E	Bourns
R20	1	100k	RES, 100k ohm, 1%, 0.063W, 0402	0402	CRCW0402100KFKED	Vishay-Dale
R21, R22	2	2.21k	RES, 2.21k ohm, 1%, 0.063W, 0402	0402	CRCW04022K21FKED	Vishay-Dale
S1	1		Switch, Normally open, 2.3N force, 200k operations, SMD	KSR	KSR221GLFS	C and K Components
TP1	1		Compact Probe Tip Circuit Board Test Points, TH, 25 per	TH Scope Probe	131-5031-00	Tektronix
TP2, TP3	2	Red	Test Point, Miniature, Red, TH	Red Miniature Testpoint	5000	Keystone
TP4, TP11	2	Orange	Test Point, Miniature, Orange, TH	Orange Miniature Testpoint	5003	Keystone
TP5	1	Yellow	Test Point, Miniature, Yellow, TH	Yellow Miniature Testpoint	5004	Keystone

Table 6. bq24296M Bill of Materials (continued)

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer
TP6, TP7, TP8	3	SMT	Test Point, Compact, SMT	Testpoint_Keystone_Compact	5016	Keystone
TP9, TP10, TP12, TP13, TP14, TP15, TP16, TP17, TP18, TP19, TP20	11	White	Test Point, Miniature, White, TH	White Miniature Testpoint	5002	Keystone
U1	1		I2C Controlled 3A Single Cell USB Charger With Narrow VDC Power Path Management and Adjustable Voltage USB OTG, RGE0024H	RGE0024H	bq24296MRGE	Texas Instruments
C8, C10, C17, C20	0	1000pF	CAP, CERM, 1000pF, 25V, ±5%, C0G/NP0, 0402	0402	C1005C0G1E102J	TDK
C9	0	2.2uF	CAP, CERM, 2.2uF, 25V, ±10%, X5R, 0402	0402	C1005X5R1E225K050BC	TDK
C11, C12, C13	0	10uF	CAP, CERM, 10uF, 25V, ±20%, X5R, 0603	0603	GRM188R61E106MA73	MuRata
C14	0	0.1uF	CAP, CERM, 0.1uF, 10V, ±10%, X5R, 0402	0402	GRM155R61A104KA01D	MuRata
C18	0	1uF	CAP, CERM, 1uF, 10V, ±10%, X5R, 0402	0402	GRM155R61A105KE15D	MuRata
D1	0	40V	Diode, Schottky, 40V, 0.38A, SOD-523	SOD-523	ZLLS350TA	Diodes Inc.
D2	0	20V	Diode, Schottky, 20V, 1A, 1.4x0.6x0.31mm	1.4x0.6x0.31mm	NSR10F20NXT5G	ON Semiconductor
FID1, FID2, FID3	0		Fiducial mark. There is nothing to buy or mount.	Fiducial	N/A	N/A
R6, R26	0	10.0k	RES, 10.0k ohm, 1%, 0.063W, 0402	0402	CRCW040210K0FKED	Vishay-Dale
R24	0	5.23k	RES, 5.23k ohm, 1%, 0.063W, 0402	0402	CRCW04025K23FKED	Vishay-Dale
R25	0	30.1k	RES, 30.1k ohm, 1%, 0.063W, 0402	0402	CRCW040230K1FKED	Vishay-Dale

Table 7. bq24298 Bill of Materials(1)

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer	Alternate Part Number	Alternate Manufacturer
PCB	1		Printed Circuit Board		PWR655	Any	-	-
C1	1	1uF	CAP, CERM, 1uF, 25V, +/-10%, X7R, 0603	0603	C1608X7R1E105K080AB	TDK		
C2	1	10uF	CAP, CERM, 10uF, 25V, +/-10%, X5R, 0805	0805	C2012X5R1E106K125AB	TDK		
C3	1	4.7uF	CAP, CERM, 4.7uF, 16V, +/-10%, X5R, 0603	0603	GRM188R61C475KAAJ	MuRata		
C4	1	0.047uF	CAP, CERM, 0.047uF, 25V, +/-10%, X7R, 0402	0402	GRM155R71E473KA88D	MuRata		
C5, C6, C7	3	10uF	CAP, CERM, 10uF, 10V, +/-20%, X5R, 0603	0603	C1608X5R1A106M	TDK		
C21	1	0.1uF	CAP, CERM, 0.1uF, 10V, +/-10%, X7R, 0402	0402	GRM155R71A104KA01D	MuRata		
C22	1	0	RES, 0, 5%, 0.063 W, 0402	0402	CRCW04020000Z0ED	Vishay-Dale		
D3, D4	2	Green	LED, Green, SMD	1.6x0.8x0.8mm	LTST-C190GKT	Lite-On		
H1, H2, H3, H4	4		Bumpon, Cylindrical, 0.312 X 0.200, Black	Black Bumpon	SJ61A1	3M		
J1, J2, J3, J4	4	2x1	Conn Term Block, 2POS, 3.81mm, TH	2POS Terminal Block	1727010	Phoenix Contact		
J5	1		Connector, Receptacle, Micro-USB Type B, R/A, Bottom Mount SMT	7.5x2.45x5mm	0473460001	Molex		
J6	1		Terminal Block, 6A, 3.5mm Pitch, 4-Pos, TH	14x8.2x6.5mm	ED555/4DS	On-Shore Technology		
J7	1		Header (shrouded), 100mil, 5x2, High-Temperature, Gold, TH	5x2 Shrouded header	N2510-6002-RB	3M		
J8, J9, JP5, JP6, JP7, JP8, JP9, JP10, JP11	9		Header, 100mil, 2x1, Tin plated, TH	Header, 2 PIN, 100mil, Tin	PEC02SAAN	Sullins Connector Solutions		
JP1, JP2, JP3, JP4	4		Header, 100mil, 3x1, Tin plated, TH	Header, 3 PIN, 100mil, Tin	PEC03SAAN	Sullins Connector Solutions		
L1	1	1uH	Inductor, Flat Wire, Powdered Iron, 1uH, 4.8A, 0.0336 ohm, SMD	4.7x1.2x4.0mm	SRP4012-1R0M	Bourns		
LBL1	1		Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll	PCB Label 0.650"H x 0.200"W	THT-14-423-10	Brady	-	-
R1	1	130	RES, 130 ohm, 1%, 0.063W, 0402	0402	CRCW0402130RFKED	Vishay-Dale		
R2	1	5.23k	RES, 5.23k ohm, 1%, 0.063W, 0402	0402	CRCW04025K23FKED	Vishay-Dale		
R3	1	30.1k	RES, 30.1k ohm, 1%, 0.063W, 0402	0402	CRCW040230K1FKED	Vishay-Dale		
R4, R5, R7, R14, R15, R23	6	10.0k	RES, 10.0k ohm, 1%, 0.063W, 0402	0402	CRCW040210K0FKED	Vishay-Dale		
R8, R9, R10, R11, R12	5	200	RES, 200 ohm, 1%, 0.063W, 0402	0402	CRCW0402200RFKED	Vishay-Dale		
R13	1	0	RES, 0 ohm, 5%, 0.063W, 0402	0402	CRCW04020000Z0ED	Vishay-Dale		
R16	1	150k	RES, 150k ohm, 1%, 0.063W, 0402	0402	CRCW0402150KFKED	Vishay-Dale		
R17	1	75.0k	RES, 75.0k ohm, 1%, 0.063W, 0402	0402	CRCW040275K0FKED	Vishay-Dale		
R18	1	768	RES, 768 ohm, 1%, 0.063W, 0402	0402	CRCW0402768RFKED	Vishay-Dale		
R19	1	50k	Trimmer, 50k, 0.25W, SMT	4.8x5.3x3.5mm	3214W-1-503E	Bourns		
R21, R22	2	2.21k	RES, 2.21k ohm, 1%, 0.063W, 0402	0402	CRCW04022K21FKED	Vishay-Dale		
S1	1		Switch, Normally open, 2.3N force, 200k operations, SMD	KSR	KSR221GLFS	C and K Components		
SH-JP1, SH-JP2, SH-JP3, SH-JP8, SH-JP9, SH-JP10	6	1x2	Shunt, 100mil, Gold plated, Black	Shunt	969102-0000-DA	3M	SNT-100-BK-G	Samtec

(1) Unless otherwise noted in the Alternate Part Number and/or Alternate Manufacturer columns, all parts may be substituted with equivalents.

Table 7. bq24298 Bill of Materials[(1)] (continued)

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer	Alternate Part Number	Alternate Manufacturer
TP1	1		Compact Probe Tip Circuit Board Test Points, TH, 25 per	TH Scope Probe	131-5031-00	Tektronix		
TP2, TP3	2	Red	Test Point, Miniature, Red, TH	Red Miniature Testpoint	5000	Keystone		
TP4, TP11	2	Orange	Test Point, Miniature, Orange, TH	Orange Miniature Testpoint	5003	Keystone		
TP5	1	Yellow	Test Point, Miniature, Yellow, TH	Yellow Miniature Testpoint	5004	Keystone		
TP6, TP7, TP8	3	SMT	Test Point, Compact, SMT	Testpoint_Keystone_Compact	5016	Keystone		
TP9, TP10, TP12, TP13, TP14, TP15, TP16, TP17, TP18, TP19, TP20	11	White	Test Point, Miniature, White, TH	White Miniature Testpoint	5002	Keystone		
U1	1		I2C Controlled 3A Single Cell USB Charger With Narrow VDC Power Path Management and Adjustable Voltage USB OTG, RTW0024H	RTW0024H	BQ24298RTWR	Texas Instruments	BQ24298RTWT	Texas Instruments
C8, C10, C17, C20	0	1000pF	CAP, CERM, 1000pF, 25V, +/-5%, C0G/NP0, 0402	0402	C1005C0G1E102J	TDK		
C9	0	2.2uF	CAP, CERM, 2.2uF, 25V, +/-10%, X5R, 0402	0402	C1005X5R1E225K050BC	TDK		
C11, C12, C13	0	10uF	CAP, CERM, 10uF, 25V, +/-20%, X5R, 0603	0603	GRM188R61E106MA73	MuRata		
C14	0	0.1uF	CAP, CERM, 0.1uF, 10V, +/-10%, X5R, 0402	0402	GRM155R61A104KA01D	MuRata		
C15, C16, C19	0	10uF	CAP, CERM, 10uF, 10V, +/-20%, X5R, 0603	0603	C1608X5R1A106M	TDK		
C18	0	1uF	CAP, CERM, 1uF, 10V, +/-10%, X5R, 0402	0402	GRM155R61A105KE15D	MuRata		
D1, D5	0	40V	Diode, Schottky, 40V, 0.38A, SOD-523	SOD-523	ZLLS350TA	Diodes Inc.		
D2	0	20V	Diode, Schottky, 20V, 1A, 1.4x0.6x0.31mm	1.4x0.6x0.31mm	NSR10F20NXT5G	ON Semiconductor		
FID1, FID2, FID3	0		Fiducial mark. There is nothing to buy or mount.	Fiducial	N/A	N/A		
R6, R26	0	10.0k	RES, 10.0k ohm, 1%, 0.063W, 0402	0402	CRCW040210K0FKED	Vishay-Dale		
R20	0	100k	RES, 100k ohm, 1%, 0.063W, 0402	0402	CRCW0402100KFKED	Vishay-Dale		
R24	0	5.23k	RES, 5.23k ohm, 1%, 0.063W, 0402	0402	CRCW04025K23FKED	Vishay-Dale		
R25	0	30.1k	RES, 30.1k ohm, 1%, 0.063W, 0402	0402	CRCW040230K1FKED	Vishay-Dale		

Revision History

Changes from Original (August 2014) to A Revision	Page
• Added bq24298 EVM information globally to this user guide.	1
• Changed HPA172 to *EV2300 or EV2400* globally.	2
• Changed *bq2429x evaluation software* to *bqStudio* in the entire document.	4
• Deleted bq24296MEVM label from *Original Test Setup for PWR655* image.	5
• Changed *Main Window of the bq24296M Evaluation Software* to update the GUI image for bqStudio.	6
• Added *Main Window of the bq24298 Evaluation Software*.	6

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

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

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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.

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