EVM User's Guide: BQ25770EVM BQ25773EVM

BQ2577xEVM Evaluation Module

Description

The BQ25770EVM or BQ25773EVM evaluation module (EVM) is a complete high-power high-efficiency battery charger using SMBus or I^{2}C-controlled NVDC dual phase buck boost charge controller BQ25770 or BQ25773. The input voltage range is from 3.5 V to 40 V, with a programmable output of 2–5 cells and a charge current range of 0 A to 16.3 A. This BQ2577xEVM allows the users to evaluate the function and performance of the BQ2577x with step-by-step instructions. The BQ2577xEVM also serves as a reference design with complete schematic, layout and Bill of Materials (BOM).

Get Started

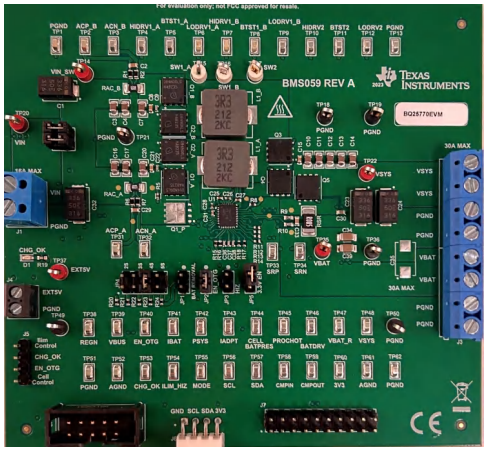
1. Order the BQ2577xEVM from ti.com.[1]
2. Download the latest BQStudio GUI.
3. Follow this step-by-step user guide.

Features

- Supports 3.5- to 40-V input source
  - 3.5- to 40-V, 0- to 8.2-A input operating range and 2–5 cell battery configuration
  - Supports USB 2.0, USB 3.0, USB 3.1 (USB Type-C®) and USB-C PD
  - Supports USB OTG with 3- to 28-V adjustable output
  - Supports Fast Role Swap (FRS) feature for USB_PD
- Narrow VDC (NVDC) power path management
  - Battery supplements the system when the adapter is fully-loaded
- 600-kHz or 800-kHz switching frequency for low profile inductor
- SMBus (BQ25770) or I^{2}C (BQ25773) port for best system performance and status reporting
- Power and current monitor for CPU throttling
- Safety
  - Thermal regulation and thermal shutdown
  - Input, system and battery overvoltage protection
  - Input, MOSFET and inductor overcurrent protection
- Supports Vmin Active Protection (VAP) mode for Intel® platform
- Charge status outputs for LED or host processor
- Test points available for key signals with easy probe hook-up
- Jumpers available for easy-to-change reconfiguration

Applications

- Standard notebook PC, Chromebook
- Appliances: battery charger, oxygen concentrator



[1] This EVM kit does not include the EV2400 interface device; the EV2400 must be ordered separately to evaluate the BQ2577x EVM.

1 Evaluation Module Overview

1.1 Introduction

The BQ2577xEVM evaluation module is designed for evaluating an SMBus or I^2C-controlled buck boost charger BQ2577x. The input voltage range is from 3.5 V to 40 V, with a programmable output of 2–5 cells and a charge current range of 0 to 16.3 A.

1.2 Kit Contents

The evaluation kit includes a full power BQ2577xEVM. This EVM kit does not include the EV2400 interface device; the EV2400 must be ordered separately to evaluate the BQ2577x EVM.

1.3 Specification

Table 1-1. Recommended Operating Conditions

Symbol	Description	MIN	TYP	MAX	Unit
Supply voltage, V_{IN}	Input voltage from AC adapter input	3.5		40	V
Battery voltage, V_{BAT}	Voltage applied at VBAT terminal	0		23	V
Supply current, I_{AC}	Maximum input current from AC adapter input (RAC=10 mΩ)	0		8.2	A
Output current, I_{out}	System current or charge current	0		16.3	A
Operating junction temperature range, T_J		0		125	°C

1.4 Device Information

The BQ2577x is a synchronous NVDC buck-boost battery charge controller to charge a 2- to 5-cell battery from a wide range of input sources including USB adapters, extended power range (EPR) USB-C Power Delivery (PD) sources, standard power range (SPR) USB-C Power Delivery (PD) sources and traditional adapters. The BQ2577x offers a low component count, high efficiency device for space constrained, 2- to 5-cell battery charging applications.

2 Hardware

2.1 General Description

The NVDC configuration allows the system to be regulated at the battery voltage, but does not drop below the system minimum voltage. The system keeps operating even when the battery is completely discharged or removed. When load power exceeds the input source rating, the battery supplement mode prevents the input source from being overloaded.

During power up, the charger sets the converter to buck, boost, or buck-boost configuration based on the input source and battery conditions. During the charging cycle, the charger automatically transits among buck, boost, and buck-boost configuration without host control.

The BQ2577x monitors adapter current, battery current, and system power. The flexibly programmed $\overline{\text{PROCHOT}}$ output goes directly to the CPU for throttle back, when needed.

For more details, please see the *BQ25770: 40-V, SMBus 2- to 5-Cell Narrow VDC Dual Phase Buck-Boost Battery Charge Controller With System Power Monitor and Processor Hot Monitor* or *BQ25773: 40-V, I2C 2- to 5-Cell Narrow VDC Dual Phase Buck-Boost Battery Charge Controller With System Power Monitor and Processor Hot Monitor* data sheet.

Table 2-1 lists the I/O descriptions.

Table 2-1. I/O Description

Jack	Description
J1–VIN	Input: positive terminal
J1–PGND	Input: negative terminal (ground terminal)
J2-VSYS	Connected to system output
J2-PGND	Ground
J3-VBAT	Connected to battery pack output
J3-PGND	Ground
J4-EXT5V	Connected to external 5 V supply
J4-PGND	Ground
J5-ILIM_HIZ	External converter disable
J5-CHRG_OK	CHRG_OK output
J5-ENZ_OTG	External OTG disable pin
J5-CELL_control	External battery removal control; logic high to pull the CELL pin down
J6–3V3	Onboard 3.3-V output
J6–SDA	SMBUS or I^2C SDA
J6-SCL	SMBUS or I^2C SCL
J6-GND	Ground
J8–SDA	SMBUS or I^2C SDA
J8-SCL	SMBUS or I^2C SCL
J8-GND	Ground

Table 2-2 displays the controls and key parameters settings.

Table 2-2. Controls and Key Parameters Setting

Jumper	Description	Factory Setting
JP1	Jumper on: Bat removal Jumper off: Cell setting by JP4	Not installed
JP2	Jumper on: Forward Mode Jumper off: OTG Mode	Installed
JP3	For input current setting: Jumper on: Enter HiZ mode. Jumper off: Allow pre-bias EXTLIM	Not installed
JP4	CELL setting: 2S: JP4(1-2), measure CELL pin voltage 2 V 3S: JP4(3-4), measure CELL pin voltage 2.75 V 4S: JP4(5-6), measure CELL pin voltage 3.76 V 5S: JP4(7-8), measure CELL pin voltage 5 V	4S setting: JP4(5-6)
JP5	Jumper on: Onboard 3.3V LDO enabled Jumper off: Disconnect onboard 3.3V LDO	Installed
JP6	Bypass inrush control circuit JP6 on: Bypass input FETs Q9 /inrush control disabled JP6 off: CHRG_OK controls Q9/inrush control enabled	Installed JP6(1-2), JP6(3-4)

2.2 Definitions

This procedure details how to configure the BMS059 evaluation board. For the test procedure, the following naming conventions are followed. Refer to the BMS059 schematic for details.

VXXX:	External voltage supply name (VIN, VSYS, VBAT).
LOADy:	External load name (LOADy).
V(TPyyy):	Voltage at internal test point TPyyy. For example, V(TP12) means the voltage at TP12.
V(Jxx):	Voltage at jack terminal Jxx.
V(TP(XXX)):	Voltage at test point “XXX”. For example, V(ACDET) means the voltage at the test point which is marked as “ACDET”.
V(XXX, YYY):	Voltage across point XXX and YYY.
I(JXX(YYY)):	Current going out from the YYY terminal of jack XX.
Jxx(BBB):	Terminal or pin BBB of jack xx.
JPxx ON :	Internal jumper JPxx terminals are shorted.
JPxx OFF:	Internal jumper JPxx terminals are open.
JPxx (-YY-) ON:	Internal jumper JPxx adjacent terminals marked as “YY” are shorted.
Measure: → A,B	Check specified parameters A, B. If measured values are not within specified limits, the device under test has failed.
Observe → A,B	Observe if A, B occurs. If A or B does not occur, the device under test has failed.

Assembly drawings have locations for jumpers, test points, and individual components.

2.3 Equipment

The following list of equipment is required for EVM testing:

1. **Power Supplies**: A power supply capable of supplying 40 V at 20 A is required.
2. **Load #1**: A 40-V, 20-A system DC electronic load.
3. **Load #2** : A Kepco load: BOP36-6M, DC 0 to ±36 V, 0 to ±6 A (or higher), or equivalent.
4. **Meters**: Six Fluke 75 multimeters (three voltage meters and three current meters), or equivalent.
5. **Computer**: A computer with at least one USB port and a USB cable.
6. **EV2400 Communication Kit**
7. **Software**: Download and properly install bqStudio from https://www.ti.com/tool/BQSTUDIO.

2.4 Equipment Setup

The test setup for BMS059 is shown in Figure 2-1. Please refer to the test setup and follow below guidelines.

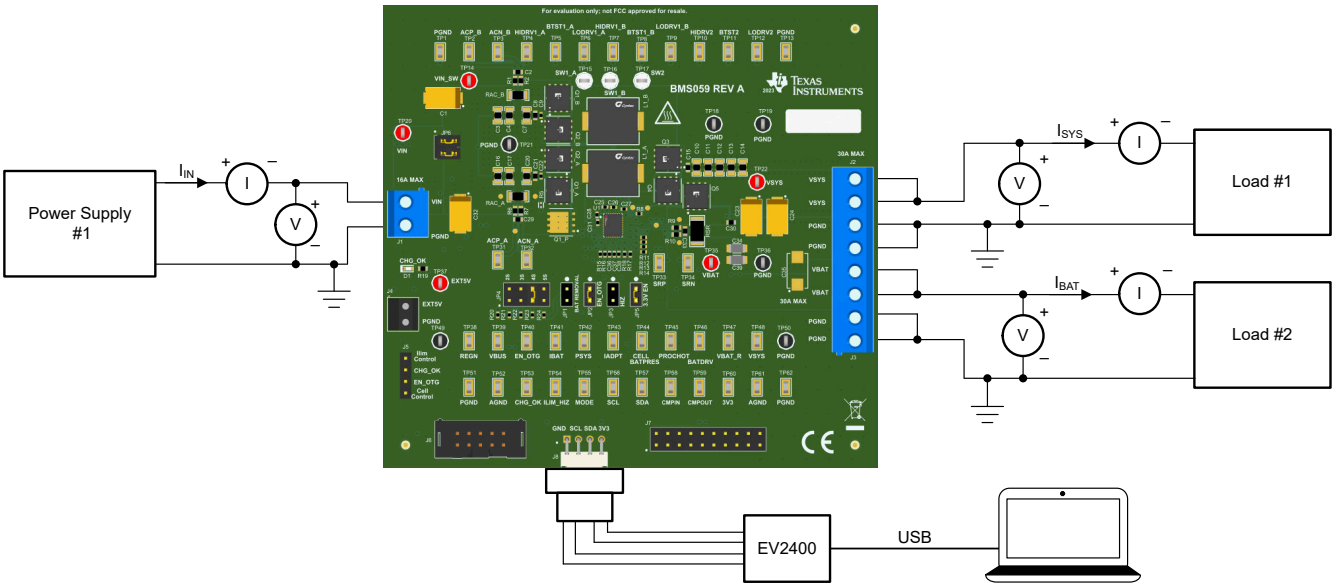


Figure 2-1. Test Setup for BMS059 (BQ2577x EVM)

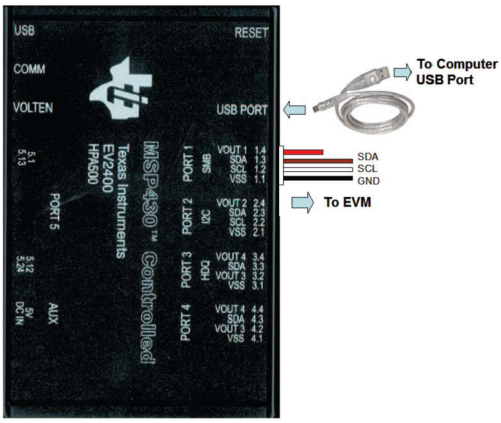
Use the following guidelines to set up the equipment:

1. Set power supply #1 for 20-V DC, 9-A current limit and then turn off the supply.
2. Connect the output of power supply #1 in series with a current meter to J1 (VIN and PGND).
3. Connect a voltage meter across J1 (VIN) and J1 (PGND).
4. Connect load #1 in series with a current meter to J2 (VSYS and PGND).
   Connect a voltage meter across J2 (VSYS and PGND).
   Set 2 A at the constant current mode. Turn off load #1.
5. Connect Load #2 in series with a current meter to J3 (VBAT and PGND).
   Connect a voltage meter across J3 (VBAT and PGND).
   Set 15 V at KEPCO load output. Turn off load #2.

Note

Add a 47-µF capacitor on the BAT pin when testing without a real battery.

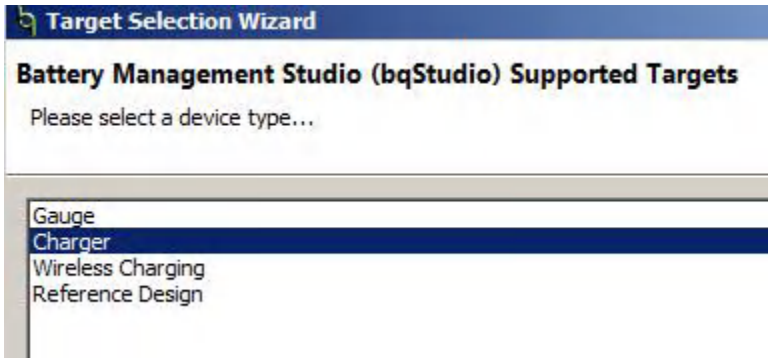
Connect J8 to the EV2400. Connect J8 to the SMBus PORT 1 (BQ25770) or I^{2}C PORT 2 (BQ25773) on the EV2400. Figure 2-2 shows the connections.



The figure shows the SMBus version EVM connection. If the user is using the BQ25773EVM, then move the connector to the I^{2}C port.

Figure 2-2. EV2400 Connections

1. Install jumpers as indicated in Table 2-2.
2. Turn on the computer and power supply #1. Open the bqStudio software.
   a. Select *Charger* and click the *Next* button.



   b. For SMBus BQ25770, select “Charger_1_00_BQ25770.bqz” on the *Select a Target Page*. For I^{2}C BQ25773, select “Charger_1_00_BQ25773.bqz” on the *Select a Target Page*.

c. After selecting the target device, click the *Read Register* button and the interface in Figure 2-3 is presented.

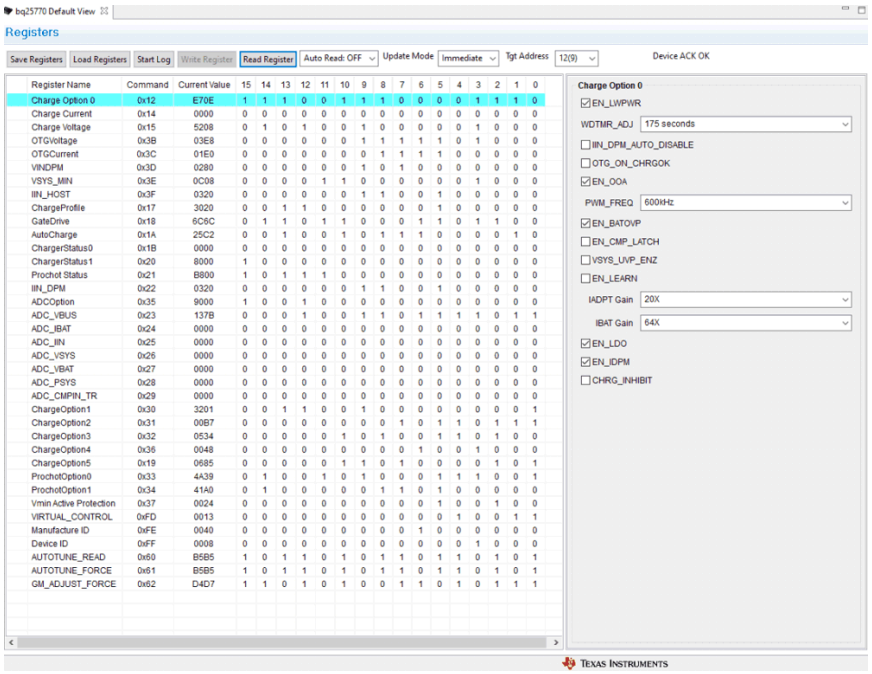


Figure 2-3. Main Window of the BQ2577x Evaluation Software

2.5 Procedure

2.5.1 Charge Function

To evaluate the charge function, please follow below step-by-step instructions:

1. Make sure the Equipment Setup steps are followed.
2. Set the power supply #1 to 20 V, 9 A current limit, then turn on the power supply.
3. Set the load #2 to 15 V, then turn on load #2 (VBAT load).
4. Set the load #1 to 2 A, then turn on load #1 (VSYS load).
5. Confirm the *Tgt Address* is *12(9)* for BQ25770 or *D6(6B)* for BQ25773 in BQStudio.
6. Disable Watchdog timer.
   Write “870E” to charge option 0 register 0x12H (BQ25770) or 0x00H (BQ25773).
   Measure → V(J1(V_{IN})) = 20 V ±0.5 V
   Measure → V(TP53(CHRG_OK)) = 3 V to 4.5 V
   Measure → V(TP38(REGN)) = 5 V ±1 V
   Measure → V(TP54(ILIM_HIZ)) = 3 V
7. Set inductor L/DCR time constant in AUTOTUNE_FORCE register.
   Write “A8A8” to 0x61 register.
8. Set inductor DCR in GM_ADJUST_FORCE register.
   Write “B2B3” to 0x62 register.
9. Set Charge Voltage Register.
   Write “41A0” (16.8V) to charge voltage register 0x15H(BQ25770) or 0x04H (BQ25773).
10. Set Charge Current Register.
    Write “0800”(2048mA) to charge current register 0x14H (BQ25770) or 0x02H (BQ25773).
11. Measure → V(J2(SYS)) = 15 V ±0.5 V
    Measure → V(J3(VBAT)) = 15 V ±0.5 V
    Measure → I(J3(VBAT)) = 2 A ±0.5 A.

2.5.2 OTG Function

To evaluate the OTG function, please follow below step-by-step instructions:

1. Use load #2 as a battery source, set to 15 V or connect a 15-V power supply to J3.
2. Disconnect the power supply #1 from J1. (The connection must be physically removed from the board).
3. Connect load #1 to the J1.
4. Set inductor L/DCR time constant in AUTOTUNE_FORCE register.
   Write “A8A8” to 0x61 register.
5. Set inductor DCR in GM_ADJUST_FORCE register.
   Write “B2B3” to 0x62 register.
6. Write “03E8” (5000mV) to the OTG voltage register.
7. Write “01E0”(3000mA) to the OTG current register.
8. Remove JP2 to enable the OTG function.
9. Check *EN_OTG* bit in *Charge Option 3* ON (EN_OTG=1). See Figure 2-4.
10. Set load #1 to 2 A, then turn on the load.
    Measure → V(J1(V_{IN})) = 5 V ±1 V
    Measure → I(J1(V_{IN})) = 2 A ±0.5 A

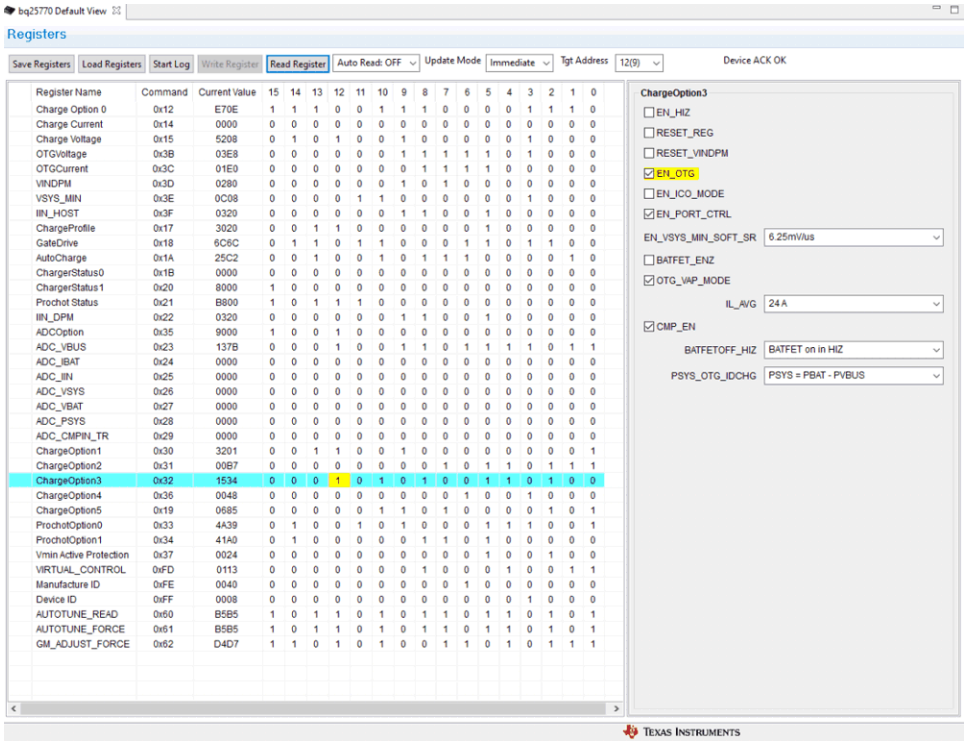
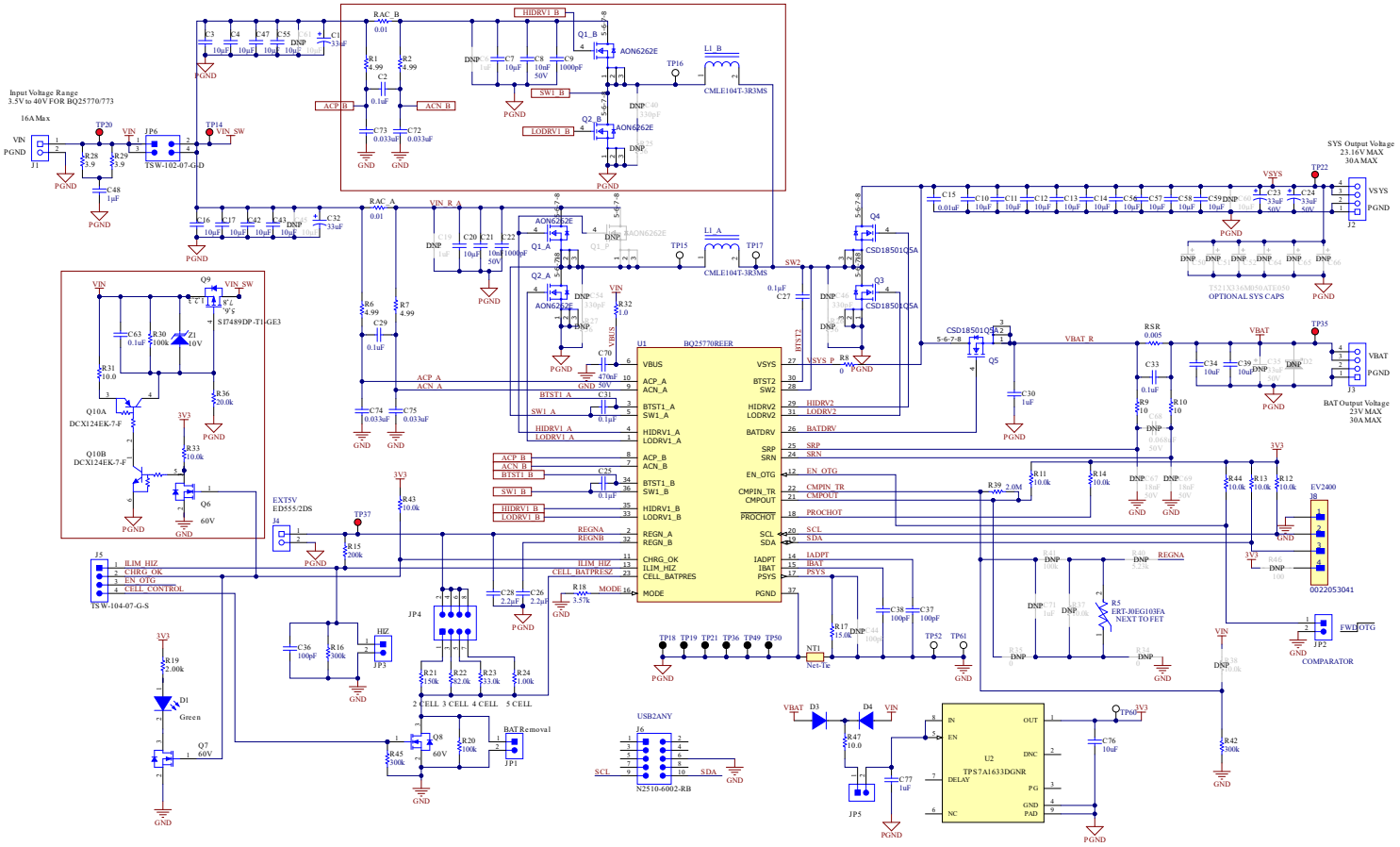


Figure 2-4. Check EN_OTG bit in Charge Option 3 register

3 Hardware Design Files

3.1 Schematic

Figure 3-1 shows the EVM schematic.



1. U1 is BQ25770 for BQ25770EVM, while BQ25773 for BQ25773EVM. 2. DNP means "Do Not Populate".

Figure 3-1. BQ2577x EVM Schematic

3.2 PCB Layout

Figure 3-2 through Figure 3-9 illustrate the board assembly and layout images.

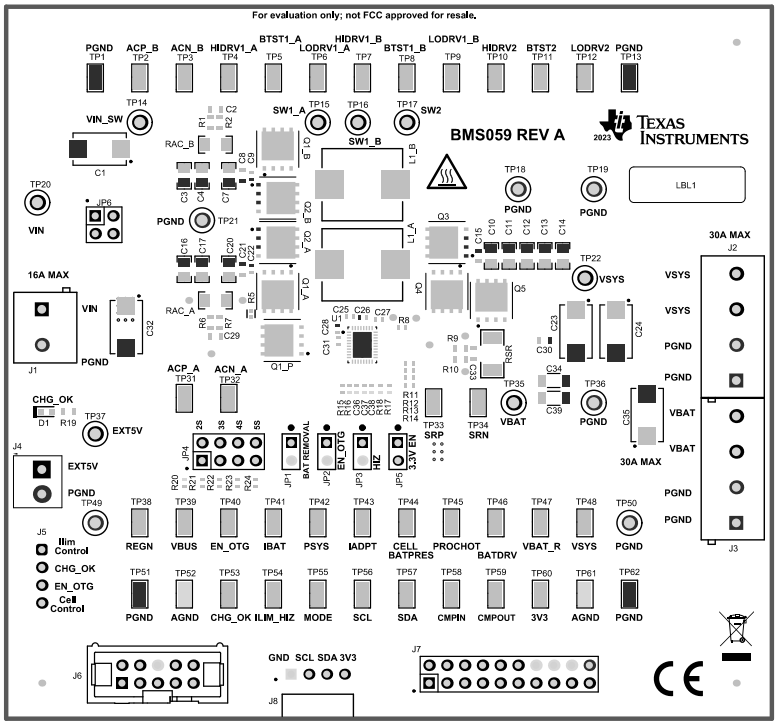


Figure 3-2. Top Assembly

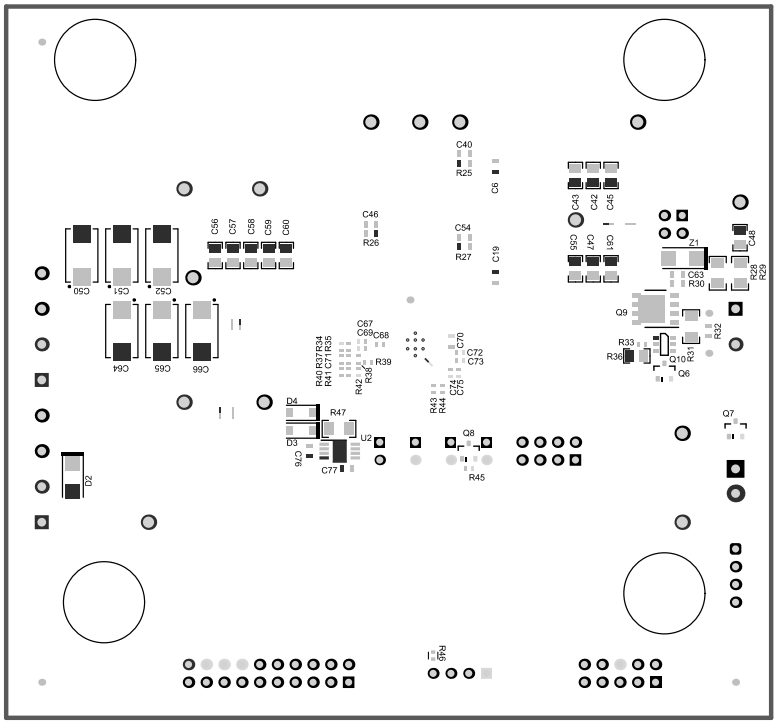


Figure 3-3. Bottom Assembly

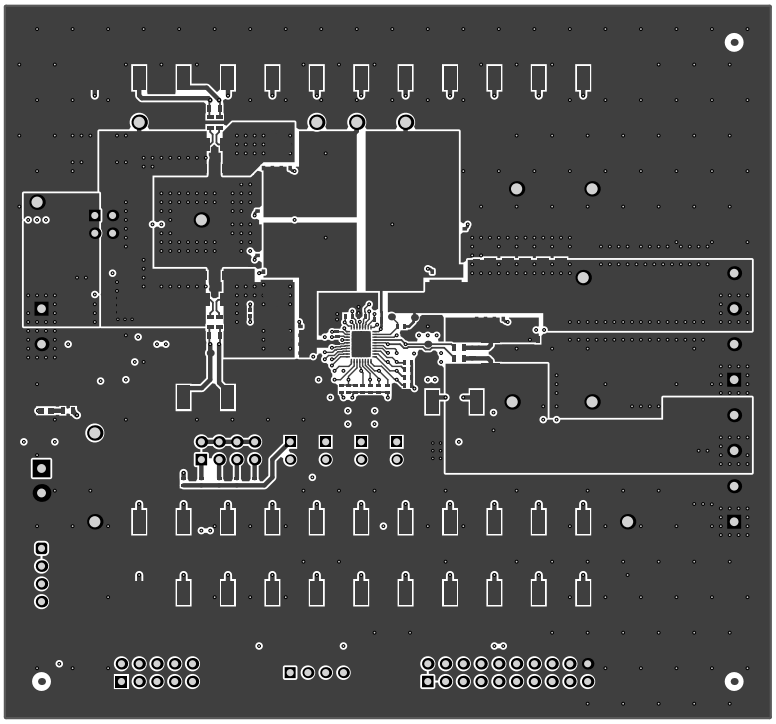


Figure 3-4. PCB Layer 1

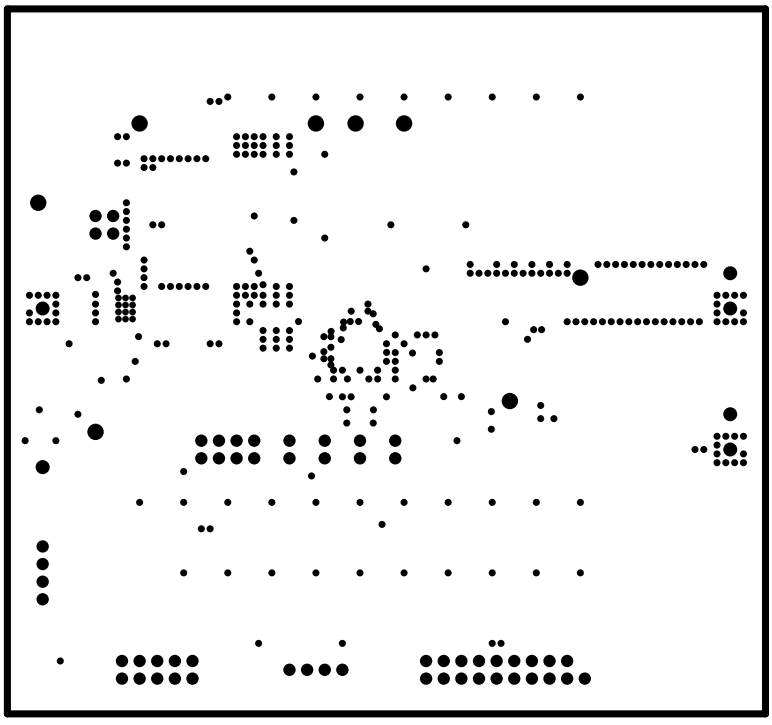


Figure 3-5. PCB Layer 2 (Negative)

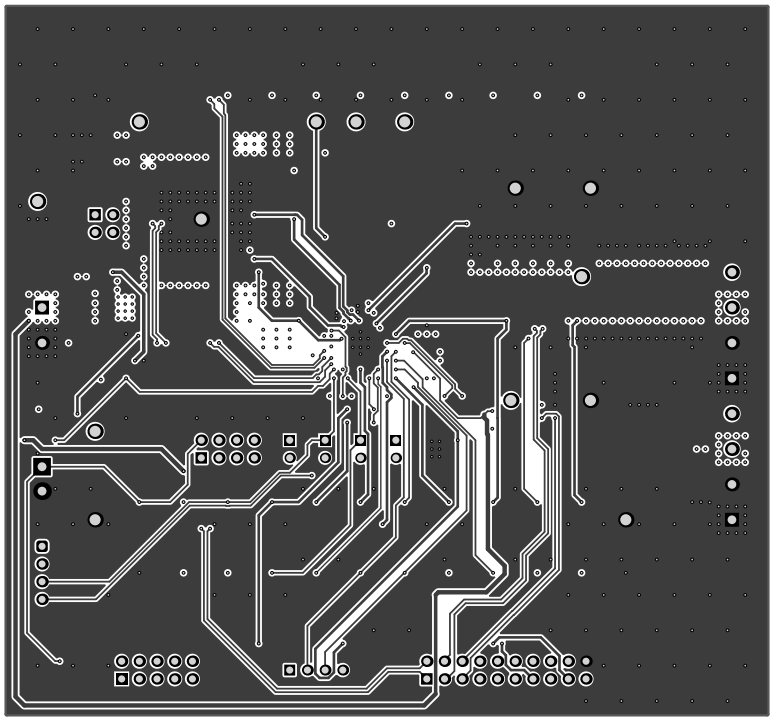


Figure 3-6. PCB Layer 3

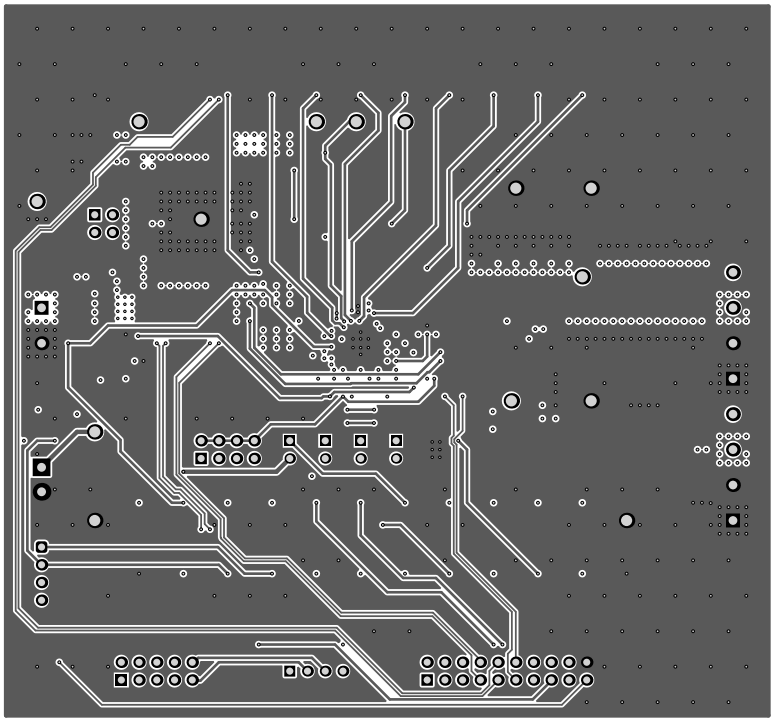


Figure 3-7. PCB Layer 4

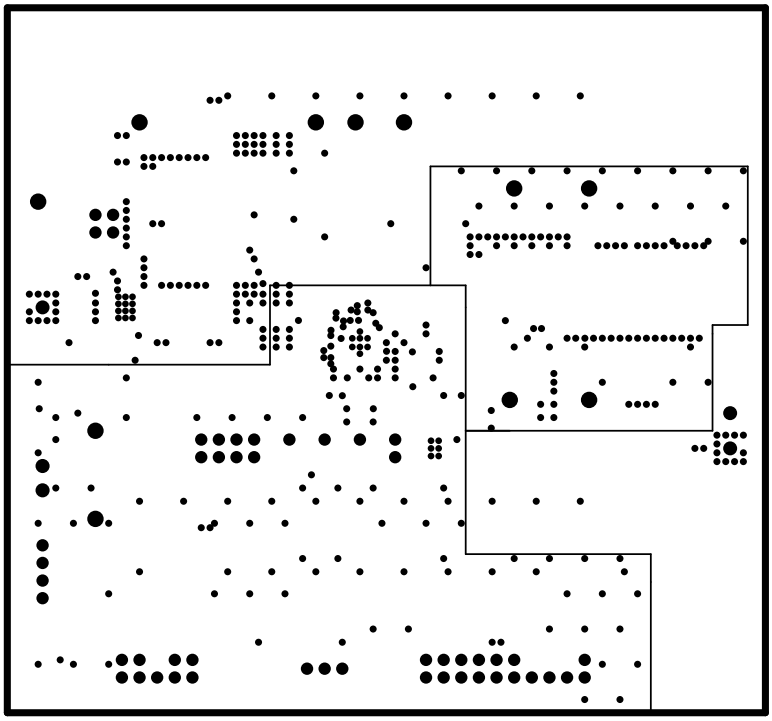


Figure 3-8. PCB Layer 5 (Negative)

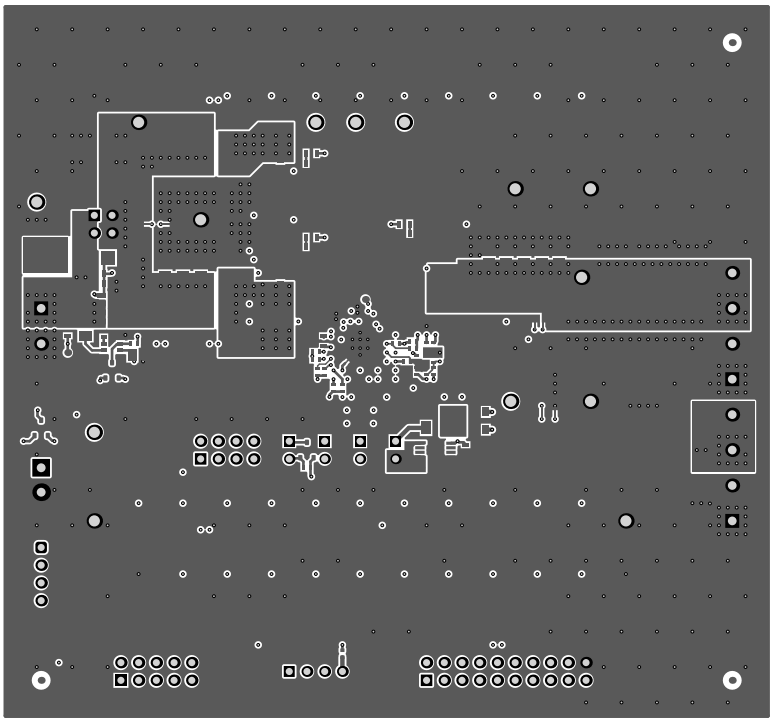


Figure 3-9. PCB Layer 6

3.3 Bill of Materials

Table 3-1 lists the BQ2577x EVM bill of materials.

Table 3-1. BQ2577x EVM Bill of Materials

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer
!PCB1	1		Printed Circuit Board		BMS059	Any
C1, C23, C24, C32	4	33uF	CAP, Tantalum Polymer, 33 uF, 50 V, +/- 20%, 0.05 ohm, 7343-43 SMD	7343-43	T521X336M050ATE050	Kemet
C2, C29, C33, C63	4	0.1uF	CAP, CERM, 0.1 uF, 50 V, +/- 10%, X7R, AEC-Q200 Grade 1, 0603	603	CGA3E2X7R1H104K080AA	TDK
C3, C4, C7, C10, C11, C12, C13, C14, C16, C17, C20, C42, C43, C47, C55, C56, C57, C58, C59	19	10uF	CAP, CERM, 10 µF, 50 V,+/- 10%, JB, 0805	805	GRM21BR61H106KE43L	muRata
C8, C15, C21	3	0.01uF	CAP, CERM, 0.01 uF, 50 V, +/- 5%, X7R, 0603	603	C0603C103J5RACTU	Kemet
C9, C22	2	1000 pF	CAP, CERM, 1000 pF, 50 V,+/- 5%, X7R, 0402	402	04025C102JAT2A	AVX
C25, C27, C31	3	0.1uF	CAP, CERM, 0.1 µF, 25 V,+/- 10%, X7R, AEC-Q200 Grade 1, 0402	402	CGA2B3X7R1E104K050BB	TDK
C26, C28	2	2.2uF	CAP, CERM, 2.2 µF, 25 V,+/- 20%, X5R, 0402	402	GRM155R61E225ME15D	MuRata
C30, C77	2	1uF	CAP, CERM, 1 uF, 50 V, +/- 10%, X5R, 0603	603	C1608X5R1H105K080AB	TDK
C34, C39	2	10uF	CAP, CERM, 10 uF, 35 V, +/- 10%, X7R, 1206_190	1206_190	GMK316AB7106KL-TR	Taiyo Yuden
C36, C37, C38	3	100 pF	CAP, CERM, 100 pF, 50 V, +/- 5%, C0G/NP0, 0402	402	GRM1555C1H101JA01D	MuRata
C48	1	1uF	CAP, CERM, 1 µF, 50 V,+/- 10%, X7R, AEC-Q200 Grade 1, 0805	805	GCM21BR71H105KA03K	MuRata
C70	1	0.47uF	CAP, CERM, 0.47 uF, 50 V, +/- 20%, X7R, AEC-Q200 Grade 1, 0603	603	CGA3E3X7R1H474M080AE	TDK
C72, C73, C74, C75	4	0.033uF	CAP, CERM, 0.033 uF, 50 V, +/- 10%, X7R, AEC-Q200 Grade 1, 0402	402	CGA2B3X7R1H333K050BB	TDK
C76	1	10uF	CAP, CERM, 10 uF, 35 V, +/- 20%, X5R, 0603	603	GRM188R6YA106MA73D	Murata
D1	1	Green	LED, Green, SMD	1.6x0.8x0.8mm	LTST-C190GKT	Lite-On
D3, D4	2	100 V	Diode, Switching, 100 V, 0.3 A, AEC-Q101, SOD-123	SOD-123	1N4148WQ-7-F	Diodes Inc.
H1, H2, H3, H4	4		Bumpon, Hemisphere, 0.44 X 0.20, Clear	Transparent Bumpon	SJ-5303 (CLEAR)	3M
J1	1		Terminal Block, 5.08 mm, 2x1, Brass, TH	2x1 5.08 mm Terminal Block	ED120/2DS	On-Shore Technology
J2, J3	2		Terminal Block, 5.08 mm, 4x1, Brass, TH	4x1 5.08 mm Terminal Block	ED120/4DS	On-Shore Technology
J4	1		Terminal Block, 3.5mm Pitch, 2x1, TH	7.0x8.2x6.5mm	ED555/2DS	On-Shore Technology
J5	1		Header, 100mil, 4x1, Gold, TH	4x1 Header	TSW-104-07-G-S	Samtec

Table 3-1. BQ2577x EVM Bill of Materials (continued)

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer
J6	1		Header (shrouded), 100mil, 5x2, High-Temperature, Gold, TH	5x2 Shrouded header	N2510-6002-RB	3M
J7	1		Header, 100mil, 10x2, Gold, TH	10x2 Header	TSW-110-07-G-D	Samtec
J8	1		Connector Header Through Hole, Right Angle 4 position 0.100" (2.54mm)	HDR4	22053041	Molex
JP1, JP2, JP3, JP5	4		Header, 100mil, 2x1, Gold, TH	Header, 2x1, 100mil	5-146261-1	TE Connectivity
JP4	1		Header, 100mil, 4x2, Gold, TH	4x2 Header	TSW-104-07-G-D	Samtec
JP6	1		Header, 100mil, 2x2, Gold, TH	2x2 Header	TSW-102-07-G-D	Samtec
L1_A, L1_B	2		3.3µH Shielded Wirewound Inductor 13 A 9mOhm Max 10x10x4mm	Inductor	CMLE104T-3R3MS (SRP1040VA-3R3M)	Cyntec (Bourns)
LBL1	1		Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll	PCB Label 0.650 x 0.200 inch	THT-14-423-10	Brady
Q1_A, Q1_B, Q2_A, Q2_B	4		AOS, N-Channel 60 V Surface Mount 8-DFN (5x6)	DFN8	AON6262E	Alpha & Omega Semiconductor
Q3, Q4, Q5	3		40-V, N channel NexFET™ power MOSFET, single SON 5 mm x 6 mm, 3.2 mOhm	DFN8	CSD18501Q5A	Texas Instruments
Q6, Q7, Q8	3	60 V	MOSFET, N-CH, 60 V, 0.26 A, SOT-23	SOT-23	2N7002ET1G	ON Semiconductor
Q9	1	-100V	MOSFET, P-CH, -100 V, -28 A, PowerPAK SO-8	PowerPAK SO-8	SI7489DP-T1-GE3	Vishay-Semiconductor
Q10	1	50 V	Transistor, NPN/PNP Pair, 50 V, 0.05 A, SC-74R	SC-74R	DCX124EK-7-F	Diodes Inc.
R1, R2, R6, R7	4	4.99	RES, 4.99, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	603	CRCW06034R99FKEA	Vishay-Dale
R5	1		THERMISTOR NTC 10KOHM 3380K 0402	402	ERT-J0EG103FA	Panasonic Electronic
R8	1	0	RES, 0, 5%, 0.063 W, 0402	402	RC0402JR-070RL	Yageo America
R9, R10	2	10	RES, 10, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	603	CRCW060310R0JNEA	Vishay-Dale
R11, R12, R13, R14, R33, R43, R44	7	10.0k	RES, 10.0 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	402	CRCW040210K0FKED	Vishay-Dale
R15	1	200k	RES, 200 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	402	CRCW0402200KFKED	Vishay-Dale
R16, R42, R45	3	300k	RES, 300 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	402	CRCW0402300KFKED	Vishay-Dale
R17	1	15.0k	RES, 15.0 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	402	CRCW040215K0FKED	Vishay-Dale
R18	1	3.57k	RES, 3.57 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	402	CRCW04023K57FKED	Vishay-Dale
R19	1	2.00k	RES, 2.00 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	603	CRCW06032K00FKEA	Vishay-Dale
R20	1	100k	RES, 100 k, 1%, 0.0625 W, 0402	402	RC0402FR-07100KL	Yageo America
R21	1	150k	RES, 150 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	402	CRCW0402150KFKED	Vishay-Dale

Table 3-1. BQ2577x EVM Bill of Materials (continued)

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer
R22	1	82.0k	RES, 82.0 k, 1%, 0.063 W, 0402	402	RC0402FR-0782KL	Yageo America
R23	1	33.0k	RES, 33.0 k, 1%, 0.063 W, 0402	402	RC0402FR-0733KL	Yageo America
R24	1	1.00k	RES, 1.00 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	402	CRCW04021K00FKED	Vishay-Dale
R28, R29	2	3.9	RES, 3.9, 5%, 0.25 W, AEC-Q200 Grade 0, 1206	1206	CRCW12063R90JNEA	Vishay-Dale
R30	1	100k	RES, 100 k, 1%, 0.1 W, 0603	603	RC0603FR-07100KL	Yageo
R31, R47	2	10	RES, 10.0, 1%, 0.25 W, AEC-Q200 Grade 0, 1206	1206	ERJ-8ENF10R0V	Panasonic
R32	1	1	RES, 1.0, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	603	CRCW06031R00JNEA	Vishay-Dale
R36	1	20.0k	RES, 20.0 k, 1%, 0.125 W, AEC-Q200 Grade 0, 0805	805	CRCW080520K0FKEA	Vishay-Dale
R39	1	2.0Meg	RES, 2.0 M, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	402	CRCW04022M00JNED	Vishay-Dale
RAC_A, RAC_B	2	0.01	RES, 0.01, 1%, 1 W, 1206	1206	WSLP1206R0100FEA	Vishay-Dale
RSR	1	0.005	RES, 0.005, 1%, 1.5 W, 2010	2010	CSNL2010FT5L00	Stackpole Electronics Inc
SH-JP2, SH-JP4, SH-JP5, SH-JP6, SH-JP7	5	1x2	Shunt, 100mil, Gold plated, Black	Shunt	SNT-100-BK-G	Samtec
TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP8, TP9, TP10, TP11, TP12, TP13, TP31, TP32, TP33, TP34, TP38, TP39, TP40, TP41, TP42, TP43, TP44, TP45, TP46, TP47, TP48, TP51, TP52, TP53, TP54, TP55, TP56, TP57, TP58, TP59, TP60, TP61, TP62	40		Test Point, Miniature, SMT	Testpoint_Keystone_ Miniature	5015	Keystone Electronics
TP14, TP20, TP22, TP35, TP37	5		Test Point, Multipurpose, Red, TH	Red Multipurpose Testpoint	5010	Keystone Electronics
TP15, TP16, TP17	3		Test Point, Multipurpose, White, TH	White Multipurpose Testpoint	5012	Keystone Electronics
TP18, TP19, TP21, TP36, TP49, TP50	6		Test Point, Multipurpose, Black, TH	Black Multipurpose Testpoint	5011	Keystone Electronics
U1	1		SMBus 2- to 5-Cell Narrow VDC Dual Phase Buck-Boost Battery Charge Controller With System Power Monitor and Processor Hot Monitor	WQFN36	BQ25770REER (BQ25773REER)	Texas Instruments
U2	1		60 V, 5uA IQ Low-Dropout 100 mA Linear Regulator with Enable and Power Good, DGN0008C (VSSOP-8)	DGN0008C	TPS7A1633DGNR	Texas Instruments

Table 3-1. BQ2577x EVM Bill of Materials (continued)

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer
Z1	1	10 V	Diode, TVS, Uni, 10 V, 17 Vc, 400 W, 23.5 A, SMA	SMA	SMAJ10A	Littelfuse
C6, C19	0	1uF	CAP, CERM, 1 uF, 50 V, +/- 10%, X5R, 0603	603	C1608X5R1H105K080AB	TDK
C35, C50, C51, C52, C64, C65, C66	0	33uF	CAP, Tantalum Polymer, 33 uF, 50 V, +/- 20%, 0.05 ohm, 7343-43 SMD	7343-43	T521X336M050ATE050	Kemet
C40, C46, C54	0	330 pF	CAP, CERM, 330 pF, 50 V, +/- 10%, X7R, 0603	603	GRM188R71H331KA01D	MuRata
C44	0	100 pF	CAP, CERM, 100 pF, 50 V, +/- 5%, C0G/NP0, 0402	402	GRM1555C1H101JA01D	MuRata
C45, C60, C61	0	10uF	CAP, CERM, 10 µF, 50 V,+/- 10%, JB, 0805	805	GRM21BR61H106KE43L	muRata
C67, C69	0	0.018uF	CAP, CERM, 0.018 uF, 50 V, +/- 10%, X7R, 0402	402	GRM155R71H183KA12D	MuRata
C68	0	0.068uF	CAP, CERM, 0.068 uF, 50 V, +/- 10%, X7R, AEC-Q200 Grade 1, 0402	402	CGA2B3X7R1H683K050BB	TDK
C71	0	1uF	CAP, CERM, 1 uF, 35 V, +/- 20%, X5R, 0402	402	GRM155R6YA105ME11D	MuRata
D2	0	40 V	Diode, Schottky, 40 V, 2 A, SMA	SMA	B240A-13-F	Diodes Inc.
Q1_P	0		AOS, N-Channel 60 V Surface Mount 8-DFN (5x6)	DFN8	AON6262E	Alpha & Omega Semiconductor
R25, R26, R27	0	56	RES, 56, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	603	CRCW060356R0JNEA	Vishay-Dale
R34, R35	0	0	RES, 0, 5%, 0.063 W, 0402	402	RC0402JR-070RL	Yageo America
R37, R38	0	10.0k	RES, 10.0 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	402	CRCW040210K0FKED	Vishay-Dale
R40	0	5.23k	RES, 5.23 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	402	CRCW04025K23FKED	Vishay-Dale
R41	0	100k	RES, 100 k, 1%, 0.0625 W, 0402	402	RC0402FR-07100KL	Yageo America
R46	0	100	100 ±5% 0.063W, 1/16W Chip Resistor 0402 (1005 Metric) Moisture Resistant Thick Film	402	RC0402JR-13100RL	Yageo
SH-JP1, SH-JP3	0	1x2	Shunt, 100mil, Gold plated, Black	Shunt	SNT-100-BK-G	Samtec

4 Additional Information

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STANDARD TERMS FOR EVALUATION MODULES

1. *Delivery:* TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, and/or documentation which may be provided together or separately (collectively, an “EVM” or “EVMs”) to the User (“User”) in accordance with the terms set forth herein. User's acceptance of the EVM is expressly subject to the following terms.

   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 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 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 a nonconforming EVM if (a) the nonconformity was 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, (b) the nonconformity resulted from User's design, specifications or instructions for such EVMs or improper system design, or (c) User has not paid on time. Testing and other quality control techniques are used to the extent TI deems necessary. TI does not test all parameters of each EVM. User's claims against TI under this Section 2 are void if User fails to notify TI of any apparent defects in the EVMs within ten (10) business days after delivery, or of any hidden defects with ten (10) business days after the defect has been detected.

   2.3 TI's sole liability shall be at its option to repair or replace EVMs that fail to conform to the warranty set forth above, 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.

WARNING

Evaluation Kits 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 shall operate the Evaluation Kit within TI’s recommended guidelines and any applicable legal or environmental requirements as well as reasonable and customary safeguards. Failure to set up and/or operate the Evaluation Kit within TI’s recommended guidelines may result in personal injury or death or property damage. Proper set up entails following TI’s instructions for electrical ratings of interface circuits such as input, output and electrical loads.

NOTE:

EXPOSURE TO ELECTROSTATIC DISCHARGE (ESD) MAY CAUSE DEGREDATION OR FAILURE OF THE EVALUATION KIT; TI RECOMMENDS STORAGE OF THE EVALUATION KIT IN A PROTECTIVE ESD BAG.

3 *Regulatory Notices:*

3.1 *United States*

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

FCC NOTICE: 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 or RSS-247*

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-exempt RSSs. 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。

https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-delivered-in-japan.html

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 to follow the instructions set forth by Radio Law of Japan, which includes, but is not limited to, the instructions below with respect to EVMs (which for the avoidance of doubt are stated strictly for convenience and should be verified by User):

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。
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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。https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-for-power-line-communication.html

3.4 *European Union*

3.4.1 *For EVMs subject to EU Directive 2014/30/EU (Electromagnetic Compatibility Directive)*:

This is a class A product intended for use in environments other than domestic environments that are connected to a low-voltage power-supply network that supplies buildings used for domestic purposes. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

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 MATERIALS PROVIDED WITH THE EVM (INCLUDING, BUT NOT LIMITED TO, REFERENCE DESIGNS 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 EPIDEMIC FAILURE WARRANTY OR 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.

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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. 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 OR THE USE OF THE EVMS , 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 TWELVE (12) MONTHS AFTER THE EVENT THAT GAVE RISE TO THE CAUSE OF ACTION HAS OCCURRED.

   8.2 *Specific Limitations.* IN NO EVENT SHALL TI'S AGGREGATE LIABILITY FROM ANY USE OF AN EVM PROVIDED HEREUNDER, INCLUDING FROM ANY WARRANTY, INDEMITY OR OTHER OBLIGATION ARISING OUT OF OR IN CONNECTION WITH THESE TERMS, , EXCEED THE TOTAL AMOUNT PAID TO TI BY USER FOR THE PARTICULAR EVM(S) AT ISSUE DURING THE PRIOR TWELVE (12) MONTHS WITH RESPECT TO WHICH LOSSES OR DAMAGES ARE CLAIMED. THE EXISTENCE OF MORE THAN ONE CLAIM SHALL NOT ENLARGE OR EXTEND THIS LIMIT.

9. *Return Policy.* Except as otherwise provided, TI does not offer any refunds, returns, or exchanges. Furthermore, no return of EVM(s) will be accepted if the package has been opened and no return of the EVM(s) will be accepted if they are damaged or otherwise not in a resalable condition. If User feels it has been incorrectly charged for the EVM(s) it ordered or that delivery violates the applicable order, User should contact TI. All refunds will be made in full within thirty (30) working days from the return of the components(s), excluding any postage or packaging costs.

10. *Governing Law:* These terms and conditions shall be governed by and interpreted in accordance with the laws of the State of Texas, without reference to conflict-of-laws principles. User agrees that non-exclusive jurisdiction for any dispute arising out of or relating to these terms and conditions lies within courts located in the State of Texas and consents to venue in Dallas County, Texas. Notwithstanding the foregoing, any judgment may be enforced in any United States or foreign court, and TI may seek injunctive relief in any United States or foreign court.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265

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Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265