

600-kHz Synchronous Switch-Mode Li-Ion and Li-Polymer Host-Controlled Battery Charger With Integrated MOSFETs

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1 Introduction

1.1 EVM Features

- Evaluation Module for bq24130
- Synchronous Switch-Mode Battery Charge, Host-Controlled Charger
- Integrated 20 V N-MOSFETs
- CELL pin setting up to 12.6 V Battery Voltage; 1, 2, or 3-cell with 4.2 V/cell
- Input Operating Range 5.5 V–17 V
- LED Indication for Charge Status
- Test Points for Key Signals Available for Testing Purpose—Easy Probe Hook-up
- Jumpers Available—Easy to Change Setting

1.2 General Description

The bq24130 is highly integrated host-controlled Li-ion and Li-polymer switch-mode battery charge controllers with two integrated N-channel power MOSFETs. It offers a constant-frequency synchronous PWM controller with high accuracy regulation of charge current and voltage. It also provides charge status monitoring.

The bq24130 automatically enters a low-quiescent current sleep mode when the input voltage falls below the battery voltage. The bq24130 charges one, two or three cell (selected by CELL pin), supporting up to 4A charge current. The bq24130 is available in a 20-pin, 3.5×4.5 mm² thin QFN package.

For details, see bq24130 data sheet ([SLUSAN2](#)).

1.3 I/O Description

Table 1. I/O Description

Jack	Description
J1 – VIN	Positive input
J1 – PGND	Negative input
J2 – VBAT	Connected to charger output
J2 – PGND	Ground
J3 – CMOD	Charge mode selection
J3 – $\overline{CE}$	Charge enable
J3-TS_EXT	Temperature qualification voltage Input

1.4 Control and Key Parameters Setting

Table 2. Control and Key Parameters Setting

Jack	Description	Factory Setting
JP1	Select external TS input or internal valid TS setting 1-2 : External TS input 2-3 : Internal valid TS setting	Jumper ON 1-2 (external TS)
JP2	The pull-up power source supplies the LED when JP5 ON. LED has no power source when JP5 OFF.	Jumper ON (LED power available)
JP3	CELL selection 2-3 : CELL-GND, 1CELL 2-1 : CELL-VREF, 3CELL OPEN: CELL- FLOAT, 2CELL	Jumper ON 2-1 (3 CELL)
JP4	Charge mode selection: ON: CMOD-GND for pre-charge set by ISET2 OFF: CMOD-VREF for fast charge set by ISET1	Jumper ON (Pre-charge setting)

Table 2. Control and Key Parameters Setting (continued)

Jack	Description	Factory Setting
JP5	Charger enable/disable setting. ISET is pulled to GND and the charger is disabled when JP5 OPEN; charger is enable when JP5 ON.	Jumper OPEN (disable charger)

1.5 Recommended Operating Conditions

Table 3. Recommended Operating Conditions

Symbol	Description	Min	Typ	Max	Unit	Notes
Supply voltage, V_{BUS}	Input voltage	5.5		17	V	
Battery voltage, V_{BAT}	Voltage applied at VBAT terminal of J2	0		12.6	V	
Supply current	Maximum input current	0		4	A	
Charge current, I_{CHRG}	Battery charge current	0	2	4	A	
Operating junction temperature range, T_J		0		125	°C	

The bq24130 EVM board requires a regulated supply approximately 1V minimum above the regulated voltage of the battery pack to a maximum input voltage of 17 VDC. The bq24130 uses CELL pin to select number of cells with a fixed 4.2V/cell. Connecting CELL to AGND gives 1 cell, floating CELL pin gives 2 cell configure, and connecting to VREF gives 3 cells configure. CELL pin adjusts internal resistor voltage divider from BAT pin to AGND pin for voltage feedback and regulate to internal 2.1V voltage reference.

CELL Pin	Voltage Regulation
AGND	4.2V
Floating	8.4V
VREF	12.6V

The default setting is 12.6V for BAT voltage.

A low-level signal on the CMOD pin forces the IC to charge at the pre-charge rate set on the ISET2 pin. A high-level signal forces charge at fast-charge rate as set by the ISET1 pin. If the battery reaches the voltage regulation level, the IC transitions to voltage regulation phase regardless of the status of the CMOD input.

The ISET1 input sets the maximum charging current. Battery current is sensed by current sensing resistor RSR connected between SRP and SRN. The full-scale differential voltage between SRP and SRN is **40mV max**. The equation for charge current is:

$$I_{CHARGE} = \frac{V_{ISET1}}{20 \times R_7} \quad (1)$$

The precharge current is determined by the voltage on the ISET2 pin according to the formula

$$I_{PRECHARGE} = \frac{V_{ISET2}}{100 \times R_7} \quad (2)$$

The default setting is 2ADC for fast charge current and 0.2ADC for pre-charge current.

2 Test Summary

2.1 Definitions

This procedure details how to configure the HPA624 evaluation board. On the test procedure the following naming conventions are followed.

VXX:	External voltage supply name (VIN, VBAT, VTS)
LOADW;	External load name (LOADR, LOADI)
V(TPyYy):	Voltage at internal test point TPyyy. For example, V(TP1) means the voltage at TP1.
V(Jxx):	Voltage at jack terminal Jxx.
V(TP(XXX)):	Voltage at test point "XXX". For example, V(REGN) means the voltage at the test point which is marked as "REGN".
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
Jxx ON:	Internal jumper Jxx terminals are shorted
Jxx OFF:	Internal jumper Jxx terminals are open
Jxx (-YY-) ON:	Internal jumper Jxx adjacent terminals marked as "YY" are shorted
Measure → A,B	Check specified parameters A, B. If measured values are not within specified limits the unit under test has failed.
Observe → A,B	Observe if A, B occur. If they do not occur, the unit under test has failed.

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

2.2 Safety

- Safety Glasses are to be worn.
- This test must be performed by qualified personnel trained in electronics theory and understand the risks and hazards of the assembly to be tested.
- ESD precautions must be followed while handling electronic assemblies while performing this test.
- Precautions should be observed to avoid touching areas of the assembly that may get hot or present a shock hazard during testing.

2.3 Quality

- Test data shall be made available upon request by Texas Instruments.

2.4 Apparel

- Electrostatic smock
- Electrostatic Gloves or finger cots
- Safety Glasses
- Ground ESD wrist strap

2.5 Equipment

- Power Supplies
Power Supply #1 (PS#1): a power supply capable of supplying 30-V at 5-A is required.
- Loads
LOAD #1 A 20V (or above), 3A (or above) electronic load that can operate at constant current and constant voltage mode.
- Meters
Five Fluke 75 multi-meters, (equivalent or better)

Or: Four equivalent voltage meters and three equivalent current meters.
The current meters must be capable of measuring 5A+ current.

2.6 Equipment Setup

- Set the power supply #1 (PS#1) for $16V \pm 200mV$, $2A \pm 0.1A$ current limit and then turn off supply.
- Connect the output of PS#1 in series with a current meter (multi-meter) to J1 (VIN, PGND).
- Connect a voltage meter across J1 (VIN, PGND).
- Connect Load #1 in series with a current meter to J2 (VBAT, PGND). Turn off Load #1.
- Connect a voltage meter across J2 (VBAT, PGND).
- Check all jumper shunts. JP1: connect 1-2 (External TS); JP2: ON; JP3: connect 1-2 (3-cell); JP4: ON; JP5: OPEN.

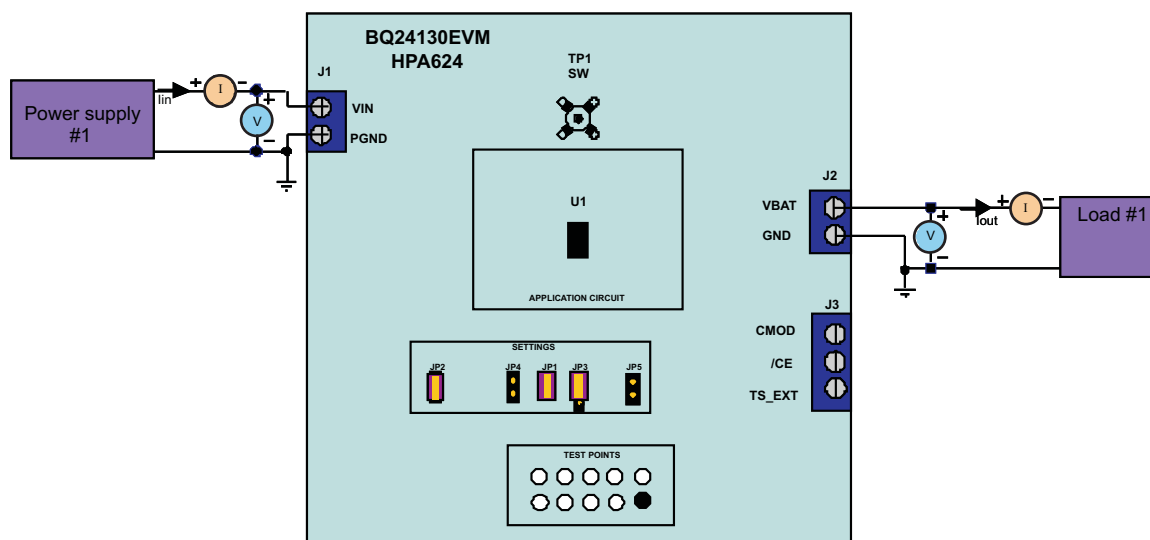


Figure 1. Original Test Setup for HPA624 (bq24130EVM)

2.7 Procedure

Make sure EQUIPMENT SETUP steps are followed.

1. Disconnect LOAD #1. Turn on PS#1

Measure → $V(J2(VBAT)) = 0.5V \pm 500mV$

Measure → $V(TP(VREF)) = 3.3V \pm 200mV$

Measure → $V(TP(REGN)) = 0.5V \pm 500mV$

2. Charger Enable

Connect 2-3 of JP1 (Internal TS); Short JP4 (Charger Enable)

Measure → $V(TP(VREF)) = 3.3V \pm 200mV$

Measure → $V(TP(REGN)) = 6V \pm 200mV$

Measure → $V(J2(VBAT)) = 12.6V \pm 200mV$

3. Charge Voltage Setting

Connect 2-3 of JP3

Measure → $V(J2(VBAT)) = 4.2V \pm 200mV$

Disconnect JP3

Measure → $V(J2(VBAT)) = 8.4V \pm 200mV$

4. Charge Current Regulation and Battery Temperature Qualification

Reconnect 1-2 of JP3

Reconnect LOAD#1. Turn on. Use the constant voltage mode. Set the output voltage to be 10V.

Measure → $I(J2(VBAT)) = 0.2A \pm 100mA$

Observe → D1 (STAT) ON

Open JP4 (set fast charge)

Measure → $I(J2(VBAT)) = 2A \pm 200mA$

Observe → D1 (STAT) ON

Open 2-3 of JP1 (external TS)

Measure → $I(J2(VBAT)) = 0A \pm 100mA$

Observe → D1 (STAT) BLINK

Connect 2-3 of JP1 (Internal TS)

Measure → $I(J2(VBAT)) = 2A \pm 200mA$

Observe → D1 (STAT) ON

5. Charge Voltage Regulation

Observe → $I(J2(VBAT))$ decreases from 2A while $V(J2(VBAT))$ becomes constant.

6. Test Complete

Turn off the power supply and remove all connections from the unit under test (UUT).

3 PCB Laout Guideline

1. It is critical that the exposed thermal pad on the backside of the BQ24130 package be soldered to the PCB ground. Make sure there are sufficient thermal vias right underneath the IC, connecting to the ground plane on the other layers.
2. The control stage and the power stage should be routed separately. At each layer, the signal ground and the power ground are connected only at the thermal pad.
3. Charge current sense resistor must be connected to SRP, SRN with a Kelvin contact. The area of this loop must be minimized. The decoupling capacitors for these pins should be placed as close to the IC as possible.
4. Decoupling capacitors for VREF, AVCC, REGN should make the interconnections to the IC as short as possible.
5. Decoupling capacitors for BAT must be placed close to the corresponding IC pins and make the interconnections to the IC as short as possible.
6. Decoupling capacitor(s) for the charger input must be placed very close to SW and PGND.
7. Take the EVM layout for design reference.

4 Bill of Materials, Board Layouts and Schematics

4.1 Bill of Materials

Table 4. Bill of Materials

Count	RefDes	Value	Description	Size	Part Number	MFR
1	C1	2.2 μ F	Capacitor, Ceramic, 25V, X7R, 10%	805	STD	STD
3	C11,C12, C17	0.1 μ F	Capacitor, Ceramic, 50V, X7R, 10%	603	STD	STD
0	C13	NONE	Capacitor, Ceramic, 50V, X7R, 10%	603	STD	STD
2	C14, C16	1.0 μ F	Capacitor, Ceramic, 16V, X7R, 10%	805	STD	STD
0	C15	NONE	Capacitor, Ceramic, 16V, X7R, 10%	805	STD	STD
2	C2, C3	4.7 μ F	Capacitor, Ceramic, 25V, X7R, 10%	805	STD	STD
2	C4, C10	1.0 μ F	Capacitor, Ceramic, 25V, X7R, 10%	805	STD	STD
0	C5	NONE	Capacitor, Ceramic, Low Inductance, 50V, X7R, 10%	603	STD	STD
1	C6	47 nF	Capacitor, Ceramic, 50V, X7R, 10%	603	STD	STD
2	C7, C8	10 μ F	Capacitor, Ceramic, 25V, X7R, 10%	1206	STD	STD
1	C9	1 μ F	Capacitor, Ceramic, 25V, X7R, 10%	805	STD	STD
1	D1	PDS1040	Diode, Schottky Barrier, 10A, 40V	Power DI 5	PDS1040-13	Diodes
1	D2	BAT54XV2T1G	Diode, Schottky, 10 mA, 30 V	SOD523	BAT54XV2T1G	On Semi
0	D3	B220A	Diode, Schottky, 20V, 2A	SMA	B220A-13-F	Diodes
1	D4	Green	Diode, LED, Green, 2.1V, 20mA, 6mcd	603	LTST-C190GKT	Lite On
0	D5	BAT54XV2T1G	Diode, Schottky, 10 mA, 30 V	SOD523	BAT54XV2T1G	On Semi
1	J1, J2	ED120/2DS	Terminal Block, 2-pin, 15-A, 5.1mm	0.40 x 0.35 inch	ED120/2DS	OST
1	J3	ED555/3DS	Terminal Block, 3-pin, 6-A, 3.5mm	0.41 x 0.25 inch	ED555/3DS	OST
3	JP2, JP4, JP5	PEC02SAAN	Header, 2 pin, 100mil spacing	0.100 inch x 2	PEC02SAAN	Sullins
2	JP1, JP3	PEC03SAAN	Header, 3 pin, 100mil spacing	0.100 inch x 3	PEC03SAAN	Sullins
1	L1	6.8uH	Inductor, SMT, 8A, 21milliohm	0.400 x 0.453 inch	HLP4040DZER6R8M01	Vishay
1	Q1	2N7002-7-F	MOSFET, N-ch, 60V, 115mA, 1.2Ohms	SOT23	2N7002-7-F	Diodes Inc
2	R10, R14	0	Resistor, Chip, 1/16W, 1%	603	STD	STD
1	R11	100	Resistor, Chip, 1/16W, 1%	603	STD	STD
1	R12	30.1k	Resistor, Chip, 1/16W, 1%	603	STD	STD
2	R13, R5	10k	Resistor, Chip, 1/16W, 1%	603	STD	STD
1	R15	232k	Resistor, Chip, 1/16W, 1%	603	STD	STD
1	R16	154k	Resistor, Chip, 1/16W, 1%	603	STD	STD

Table 4. Bill of Materials (continued)

Count	RefDes	Value	Description	Size	Part Number	MFR
2	R17, R18	100k	Resistor, Chip, 1/16W, 1%	603	STD	STD
1	R19	4.99k	Resistor, Chip, 1/16W, 1%	603	STD	STD
2	R2, R3	3.9	Resistor, Chip, 1/4W, 5%	1206	STD	STD
1	R20	32.4k	Resistor, Chip, 1/16W, 1%	603	STD	STD
1	R4	10	Resistor, Chip, 1/10W, 1%	805	STD	STD
0	R6	NONE	Resistor, Chip, 1/16W, 1%	805	STD	STD
1	R7	0.01	Resistor, Chip, 1/2 watt, 1.0%	1206	WSL1206R0100FEA	Vishay
1	R8	0	Resistor, Chip, 1/16W, 5%	603	STD	STD
1	R9	5.23k	Resistor, Chip, 1/16W, 1%	603	STD	STD
0	SH1	None	Short jumper			
1	TP	131-4244-00	Adaptor, 3.5-mm probe clip (or 131-5031-00)	0.200 inch	131-4244-00	Tektronix
1	TP1	VCC	Test Point, White, Thru Hole Color Keyed	0.100 x 0.100 inch	5002	Keystone
0	TP2, TP4, TP5	NONE	Test Point, White, Thru Hole Color Keyed	0.02 x 0.02 inch	STD	STD
1	TP3	VREF	Test Point, White, Thru Hole Color Keyed	0.100 x 0.100 inch	5002	Keystone
1	TP6	REGN	Test Point, White, Thru Hole Color Keyed	0.100 x 0.100 inch	5002	Keystone
1	TP7	TS	Test Point, White, Thru Hole Color Keyed	0.100 x 0.100 inch	5002	Keystone
1	TP8	GND	Test Point, Black, Thru Hole Color Keyed	0.100 x 0.100 inch	5001	Keystone
1	TP9	STAT	Test Point, White, Thru Hole Color Keyed	0.100 x 0.100 inch	5002	Keystone
1	TP10	CELL	Test Point, White, Thru Hole Color Keyed	0.100 x 0.100 inch	5002	Keystone
1	TP11	CMOD	Test Point, White, Thru Hole Color Keyed	0.100 x 0.100 inch	5002	Keystone
1	TP12	ISSET1	Test Point, White, Thru Hole Color Keyed	0.100 x 0.100 inch	5002	Keystone
1	TP13	ISSET2	Test Point, White, Thru Hole Color Keyed	0.100 x 0.100 inch	5002	Keystone
1	U1	BQ24130RHL	IC, 1.6-MHz High Efficiency Synchronous Switch-Mode Li-Ion and Li-Polymer Battery Charger	VQFN	BQ24130RHL	TI
1	—		PCB, 2.500 In X 2.500 In x 0.0062 In	2.500 In X 2.500 In	HPA624	Any
4		929950-00	Shorting jumper, 2-pin, 100mil spacing		929950-00	3M/ESD

- Notes: 1. These assemblies are ESD sensitive, ESD precautions shall be observed.
2. These assemblies must be clean and free from flux and all contaminants. Use of no clean flux is not acceptable.
3. These assemblies must comply with workmanship standards IPC-A-610 Class 2.
4. Ref designators marked with an asterisk (***) cannot be substituted. All other components can be substituted with equivalent MFG's components.

4.2 Board Layout

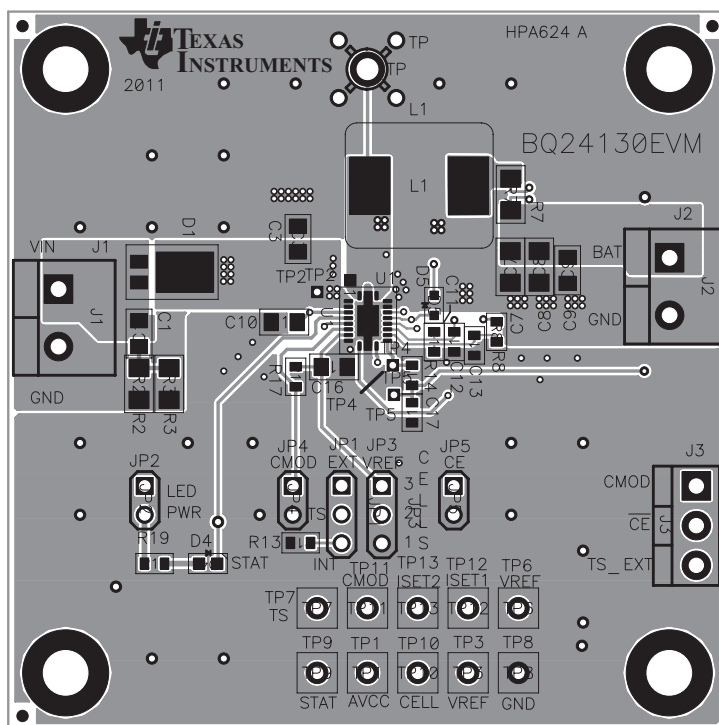


Figure 2. Top Assembly

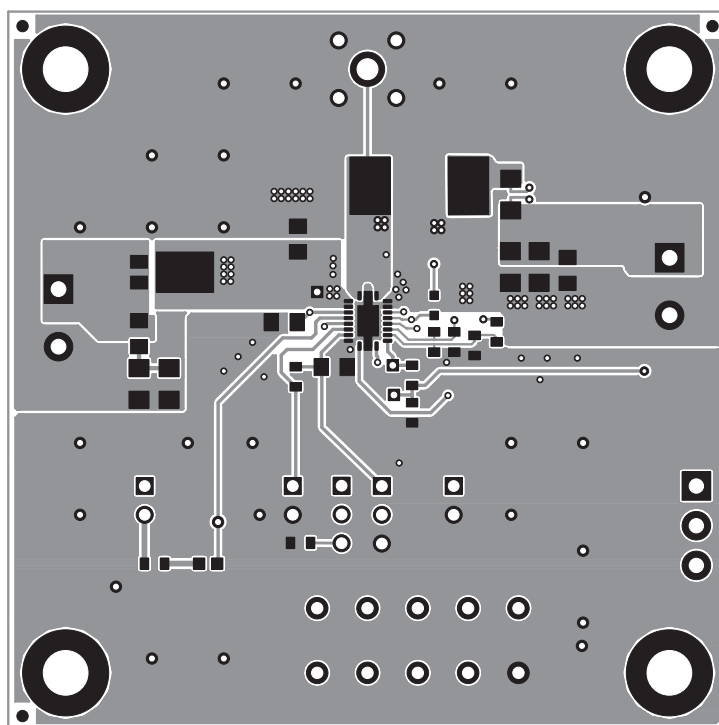


Figure 3. Top Layer

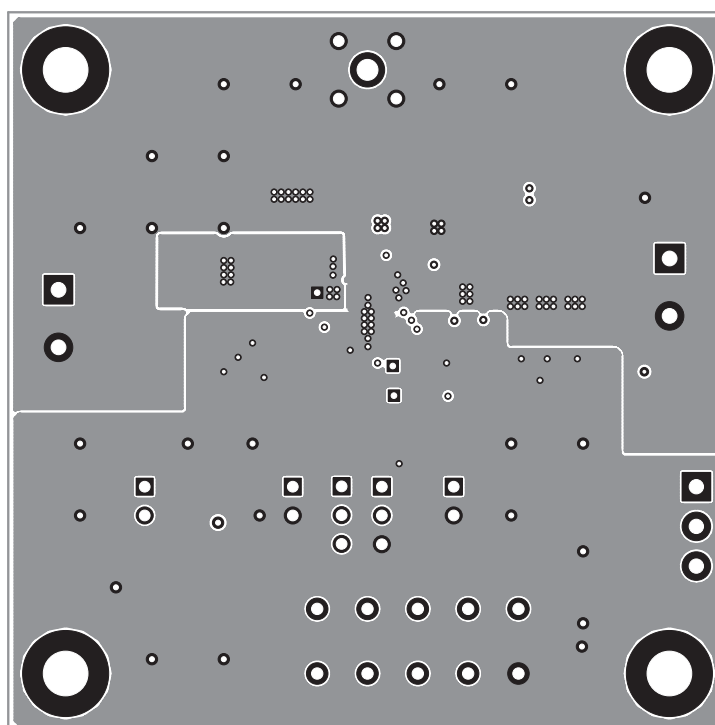


Figure 4. Second Layer

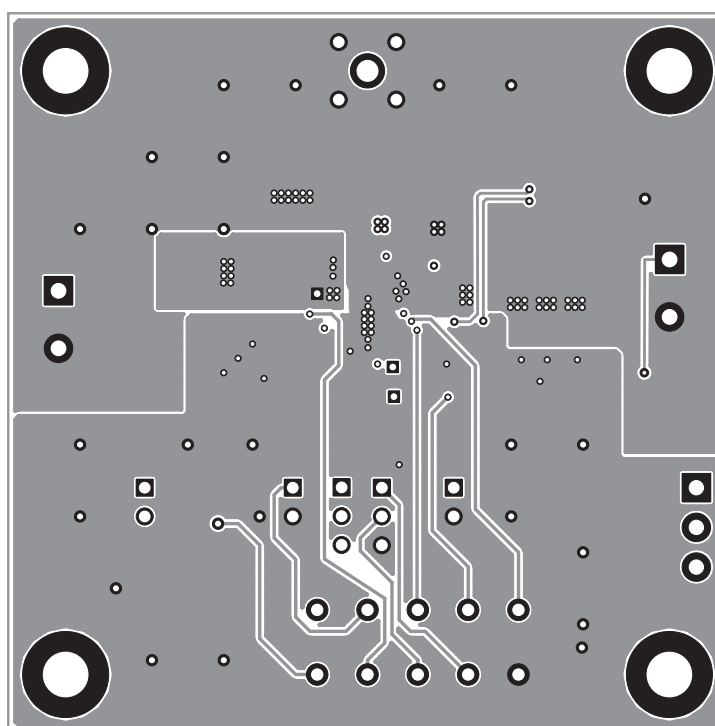


Figure 5. Third Layer

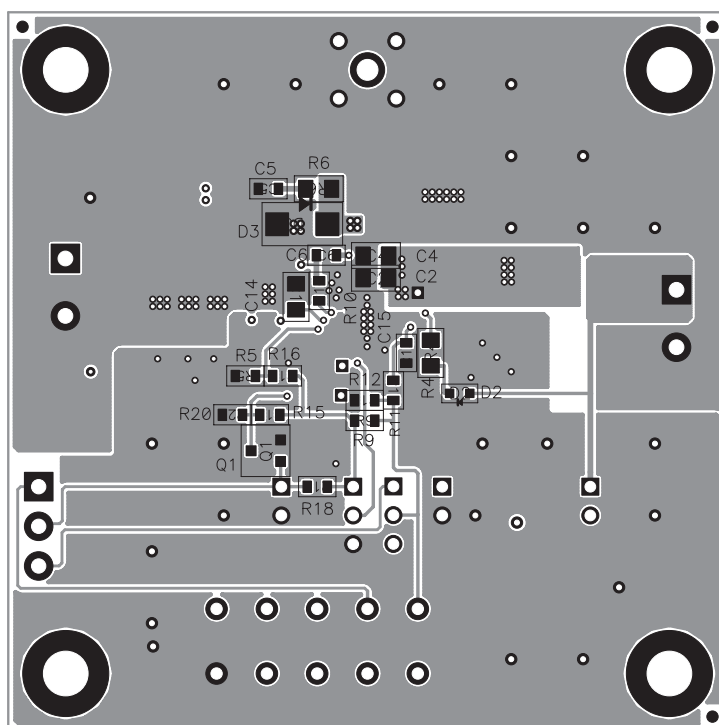


Figure 6. Bottom Assembly

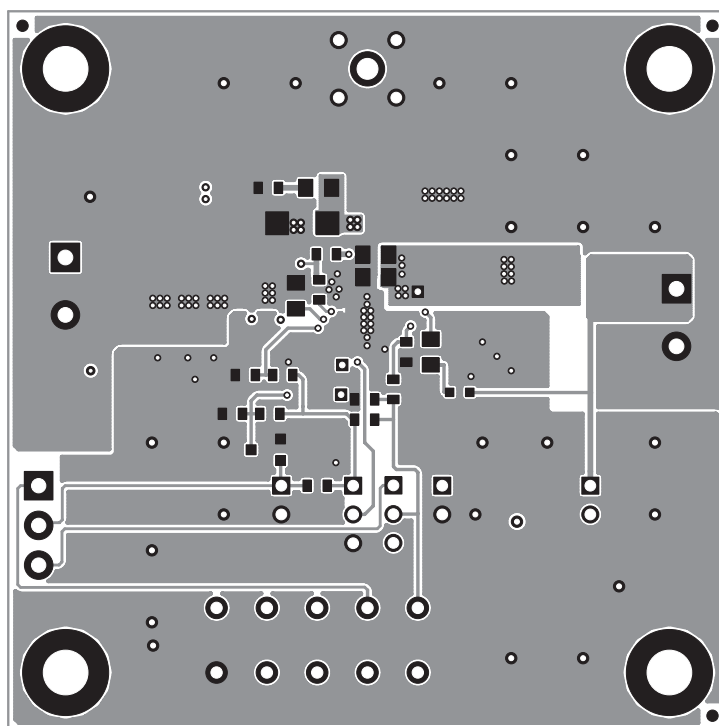


Figure 7. Bottom Layer

4.3 Schematic

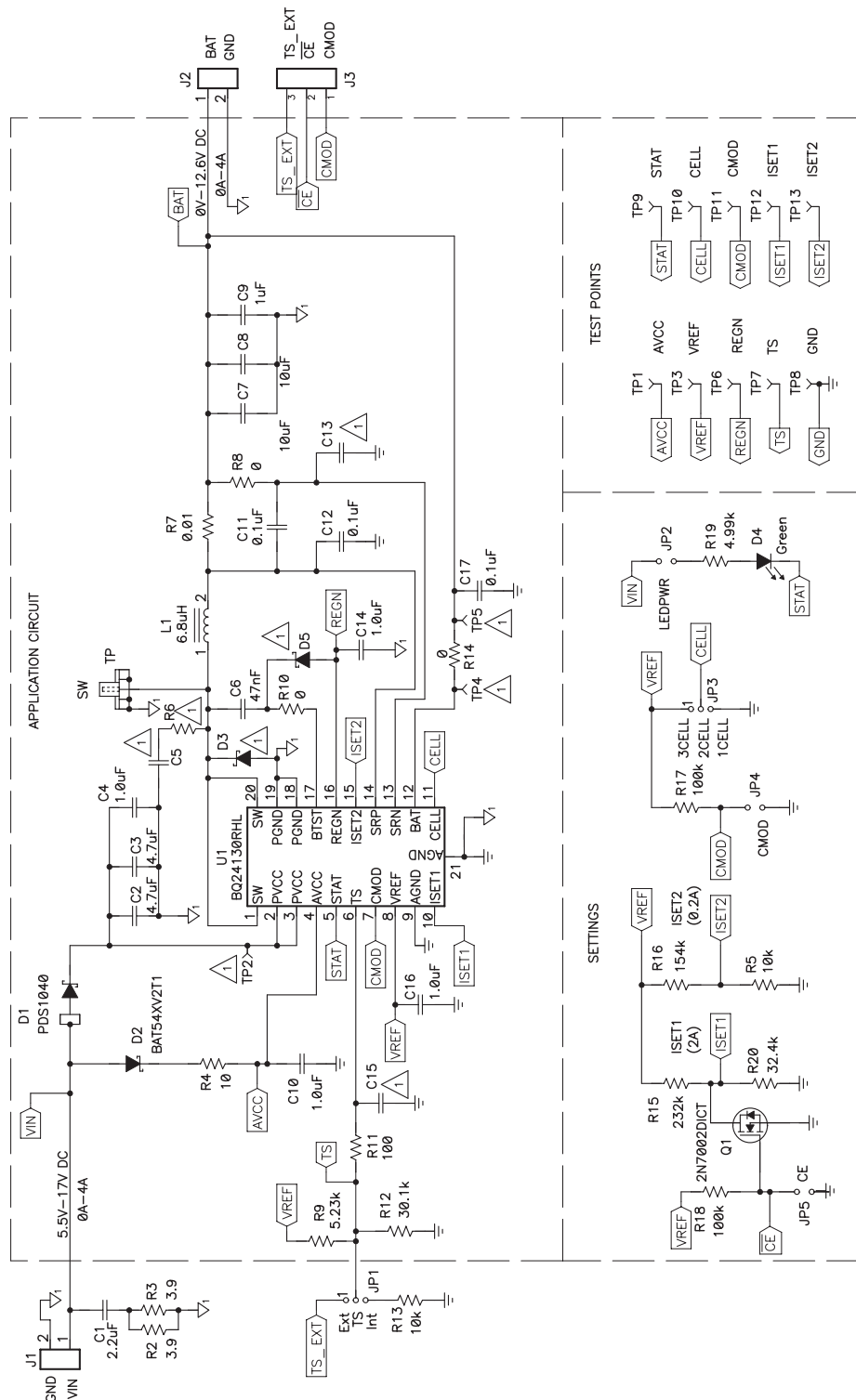


Figure 8. bq24130 EVM Schematic

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EVM Warnings and Restrictions

It is important to operate this EVM within the input voltage range of 18 V to 22 V and the output voltage range of 0 V to 18 V .

Exceeding the specified input range may cause unexpected operation and/or irreversible damage to the EVM. If there are questions concerning the input range, please contact a TI field representative prior to connecting the input power.

Applying loads outside of the specified output range may result in unintended operation and/or possible permanent damage to the EVM. Please consult the EVM User's 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, some circuit components may have case temperatures greater than 60°C. The EVM is designed to operate properly with certain components above 125°C as long as the input and output ranges are maintained. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors. These types of devices can be identified using the EVM schematic located in the EVM User's Guide. When placing measurement probes near these devices during operation, please be aware that these devices may be very warm to the touch.

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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 instructions, 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/sds/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.

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

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東京都新宿区西新宿 6 丁目 2 4 番 1 号
西新宿三井ビル

3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/sds/ti_ja/general/eStore/notice_02.page

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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.

6.2 EXCEPT FOR THE LIMITED RIGHT TO USE THE EVM SET FORTH HEREIN, NOTHING IN THESE TERMS 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, REGARDLESS OF WHEN MADE, CONCEIVED OR ACQUIRED.

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, INDEMNITY 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.

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