bq24730/31EVM (HPA111) for Multicell Synchronous Notebook Charger and System Power Selector

Contents

List of Figures

1 Introduction

1.1 bq24730/31EVM Features

- Evaluation module for both bq24730 and bq24731
- High-efficiency NMOS-NMOS synchronous buck charger with 300-kHz frequency
- Battery/adapter to system power selector function
- User-selectable 3-cell or 4-cell Li-ion battery voltage
- User-selectable 3-A or 4-A charge current
- AC adapter Current Limit 4.7 A
- Pin-programmable interface for control and status communications with host
- AC adapter operating range 17 V–24 V
- Charge and adapter overcurrent protection
- LED indication for control and status signals
- Test points for key signals available for testing purpose. Easy probe hook-up
- Jumpers available. Easy-to-change connections

1.2 General Description

The bq24730/31 evaluation module is a complete charger module for evaluating a multicell synchronous notebook charge and path selection solution using the bq24730/31 devices. It is designed to deliver up to 4 A of charge current to Li-ion or Li-polymer applications. The charge current can be reprogrammed by changing the current-setting resistance.

The bq24730/31 has a highly integrated battery charge controller designed to work with external host commands. The battery voltage, charge current, and other system parameters are pin-programmable.

The dynamic power management (DPM) function modifies the charge current depending on system load conditions, avoiding AC adapter overload.

High-accuracy, current-sense amplifiers enable accurate measurement of either the charge current or the AC adapter current, allowing termination of nonsmart packs and monitoring of overall system power.

The adapter isolation diode can be bypassed with an external MOSFET using a control signal provided by the bq24730/31, thus reducing overall power dissipation.

For details, see the bq24730/31 data sheet (SLUS695).

1.3 I/O Description

<table>
<tr><th colspan="2">Jack</th><th>Description</th></tr>
<tr><td colspan="2">J1–ACGD/TS</td><td>ACGOOD (pin 19) output for bq24730; TS (pin 19) output for bq24731</td></tr>
<tr><td colspan="2">J1–GND</td><td>Ground</td></tr>
<tr><td colspan="2">J1–VBAT</td><td>Connected to battery pack</td></tr>
<tr><td colspan="2">J1–VSYS</td><td>Connected to system</td></tr>
<tr><td colspan="2">J–POS</td><td>AC adapter, positive output</td></tr>
<tr><td colspan="2">J2–GND</td><td>AC adapter, negative output</td></tr>
<tr><td>J3–1</td><td rowspan="3">}DCG
}AC</td><td>R1 negative terminal connected to VBAT</td></tr>
<tr><td>J3–2</td><td>ACP (pin 4) output</td></tr>
<tr><td>J3–3</td><td>R2 positive terminal connected to Q2</td></tr>
<tr><td>J4–1</td><td rowspan="3">}DCG
}AC</td><td>DCG AC R1 positive terminal connected to L1</td></tr>
<tr><td>J–2</td><td>ACN (pin 3) output</td></tr>
<tr><td>J4–3</td><td>R2 negative terminal connected to PVCC</td></tr>
<tr><td colspan="2">J5–POS</td><td>External power supply, positive output</td></tr>
<tr><td colspan="2">J5–GND</td><td>External power supply, negative output</td></tr>
</table>

Jack		Description
J6–1	}SNS }CON	Gate of Q7
J6–2		BATDRV (pin 31) output
J6–3		Gate of Q28
J7–VREF		VREF5 (pin 15) output
J7–STAT		STAT (pin 33) output
J7–CHGEN		CHGEN (pin 1) output
J7–DPMDET		DPMDET (pin 9) output for bq24730
J7–ACGOOD/IADSLP		IADSLP (pin 17) output for bq24730; ACGOOD (pin 17) output for bq24731
J7–DGND/BATDET		DGND (pin 18) output for bq24730; BATDET (pin 18) output for bq24731
J7–LOWBAT		LOWBAT (pin 21) output
J7–CELLS		CELLS (pin 32) output
J7–ISELECT		Charge-current select signal (1 select 3A, 0 select 4A)
J7–IADAPT		IADAPT (pin 22) output
J7–IBAT		IBAT (pin 23) output
J7–GND		Ground
J8–VPUP		Pullup voltage source
J8–LED		LED pullup power line
J9–BYPASS		BYPASS (pin 8) output
J9–LED		LED drive
J10–VREF		IC reference voltage VREF5 (pin 15)
J10–VPUP		Pullup voltage source
J10–EXT		External power supply
J11–CHGEN		CHGEN (pin 1) output
J11–GND		Ground
J12–1	}731 }730	Connected to AC overcurrent limit-setting resistor (for bq24731)
J12–2		DPMDET (pin 9) output for bq24730; ACOCS (pin 9) output for bq24731
J12–3		Output terminal 4 of J7
J13–IADSLP		IADSLP (pin 17) output for bq24730
J13–GND		Ground
J14–CELLS		CELLS (pin 32) output
J14–VPUP		Pullup voltage source
J15–ISEL		Charge-current select signal (1 select 3A, 0 select 4A)
J15–GND		Ground
J16–ACDRV		ACDRV (pin 2) output
J16–LED		LED drive
J17–BATDRV		BATDRV (pin 24) output
J17–LED		LED drive
J18–1	}731 }730	ACGOOD (pin 19) output for bq24730
J18–2		Gate of Q32
J18–3		ACGOOD (pin 17) output for bq24731

1.4 Controls and Key Parameters Setting

JACK	DESCRIPTION	FACTORY SETTING	
		-001 (bq24730)	-002 (bq24731)
J3, J4	AC current amplifier input selection 1-2 (DCG) : Battery discharge current sense on R1 2-3 (AC) : AC adapter input current sense on R2	Jumper on 2-3 (AC)	Jumper on 2-3 (AC)
J6	Battery discharge path control 1-2 (SNS) : Battery discharge through sense resistor R1 when AC is removed 2-3 (CON) : Battery connected to VSYS directly when AC is removed	Jumper on 2-3 (CON)	Jumper on 2-3 (CON)
J8	The pullup power source supplies the LEDs when on. LED has no power source when off.	Jumper on	Jumper on
J9	The conduction of the bypass MOSFET is indicated by LED when on	Jumper on	Jumper on
J10	Pullup power source setting 1-2: Use external power supply as the pullup source 2-3: Use REF5 as the pullup source	Jumper on 1-2 (VPUP and EXT)	Jumper on 1-2 (VPUP and EXT)
J11	Enable charge process when on	Jumper off	Jumper off
J12	Pin 9 connection 1-2 (731) : connected to ACOCS setting resistor when using bq24731 2-3 (730) : connected to output terminal block when using bq24730	Jumper on 2-3 (730)	Jumper on 1-2 (731)
J13	Adapter current amplifier disabled when on (for bq24730 only)	Jumper on	Jumper off
J14	Select 4-cell voltage regulation when on	Jumper off	Jumper off
J15	Select 4-A charge current when on	Jumper off	Jumper off
J16	The conduction of the AC MOSFET is indicated by LED when on	Jumper on	Jumper on
J17	The conduction of the battery MOSFET is indicated by LED when on	Jumper on	Jumper on
J18	ACGOOD LED indication 1-2 (730) : connected to ACGOOD pin when using bq24730 2-3 (731) : connected to ACGOOD pin when using bq24731	Jumper on 1-2 (730)	Jumper on 2-3 (731)

1.5 Recommended Operating Conditions

			MIN	TYP	MAX	UNIT
V_{IN}	Supply voltage	Input voltage from AC adapter input	14	19.5	23	V
V_{BAT}	Battery voltage	Voltage applied at VBAT terminal of J8	7	9-16.8	20	V
I_{AC}	Supply current	Maximum input current from AC adapter input	0		4.5	A
I_{chrg}	Charge current	Battery charge current	2	3 or 4	6	A
T_J	Operating junction temperature range		0		125	°c

2 Test Summary

2.1 Definitions

This procedure details how to configure the HPA111 evaluation board. On the test procedure, the following naming conventions are followed. See the HPA111 schematic for details.

VXXX :	External voltage supply name (VADP, VBT, VSBT)
LOADW:	External load name (LOADR, LOADI)
V(TPyyy):	Voltage at HPA111 internal test point TPyyy. For example, V(TP12) means the voltage at TP12.
V(Jxx):	Voltage at HPA111 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
Jxx ON :	HPA111 internal jumper Jxx terminals are shorted
Jxx OFF:	HPA111 internal jumper Jxx terminals are open
Jxx (-YY-) ON:	HPA111 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 Equipment

2.2.1 Power Supplies

Power supply #1 (PS#1): a power supply capable of supplying 20 V at 5 A is required.
Power supply #2 (PS#2): a power supply capable of supplying 5 V at 1 A is required.
Power supply #3 (PS#3): a power supply capable of supplying 5 V at 1 A is required. (*for bq24731 EVM only*)

2.2.2 Electronic Load

A 30-V/5-A electronic load

2.2.3 Kepco Load

A Kepco bipolar operational power supply/amplifier (0 V ± 36 V, 0 A ± 12 A)

Note: the Kepco load is employed to emulate a battery pack. It can be replaced by any power supply with current-sinking capability.

2.2.4 Meters

Eight Fluke 75 (equivalent or better)
Or five equivalent voltage meters and three equivalent current meters. The current meters must be able to measure 5 A + current.

2.2.5 Oscilloscopes

An oscilloscope, a single voltage probe, and a single current probe are required.

2.3 Equipment Setup

1. Set the power supply #1 for 0 VDC ± 100 mVDC, at 5-A ± 0.1-A current limit and then turn off supply.
2. Connect the output of power supply #1 in series with a current meter (multimeter) to J2 (POS, GND).
3. Connect a voltage meter across J2 (POS, GND).
4. Set the power supply #2 for 3.3 VDC ± 100 mVDC, at 1-A ± 0.1-A current limit and then turn off supply.
5. Connect the output of the power supply #2 to J5 (POS, GND).
6. Set the Kepco load for 10 VDC ± 100 mVDC and then turn off.
7. Turn off the electronic load.
8. Connect a voltage meter across J1 (VBAT, GND).
9. Connect a voltage meter across J1 (VSYS, GND).
10. Turn on the oscilloscope.
11. Insert the voltage probe into TP47 (PH), and connect to the oscilloscope.
12. Hook up the current probe to the wire connected to L1, and connect to the oscilloscope. Set up the current probe in such a way that the current direction is from the floating pad to the big pad on the right side.
13. J3 (-AC-): ON, J4(-AC-): ON, J6 (-CON-): ON, J8: ON , J10 (VPUP, EXT): ON, J11: OFF, J14: OFF, J15: OFF, J9: ON, J16: ON, J17: ON.
14. (*For bq24730 only*) J12 (-730-): ON, J13: ON, J18 (-730-): ON.
15. (*For bq24731 only*) J12 (-731-): ON, J13: OFF, J18 (-731-): ON.
16. (*For bq24731 only*) Set the power supply #3 for 2.5 V ± 100 mVDC, at 1 A ± 0.1-A current limit and then turn off supply.
17. (*For bq24731 only*) Connect the output of the power supply #3 to J1 (ACGD/TS, GND).

After the preceding steps have been performed, the test setup for bq24730EVM looks like that shown in Figure 1. The test setup for bq24731EVM is shown in Figure 2.

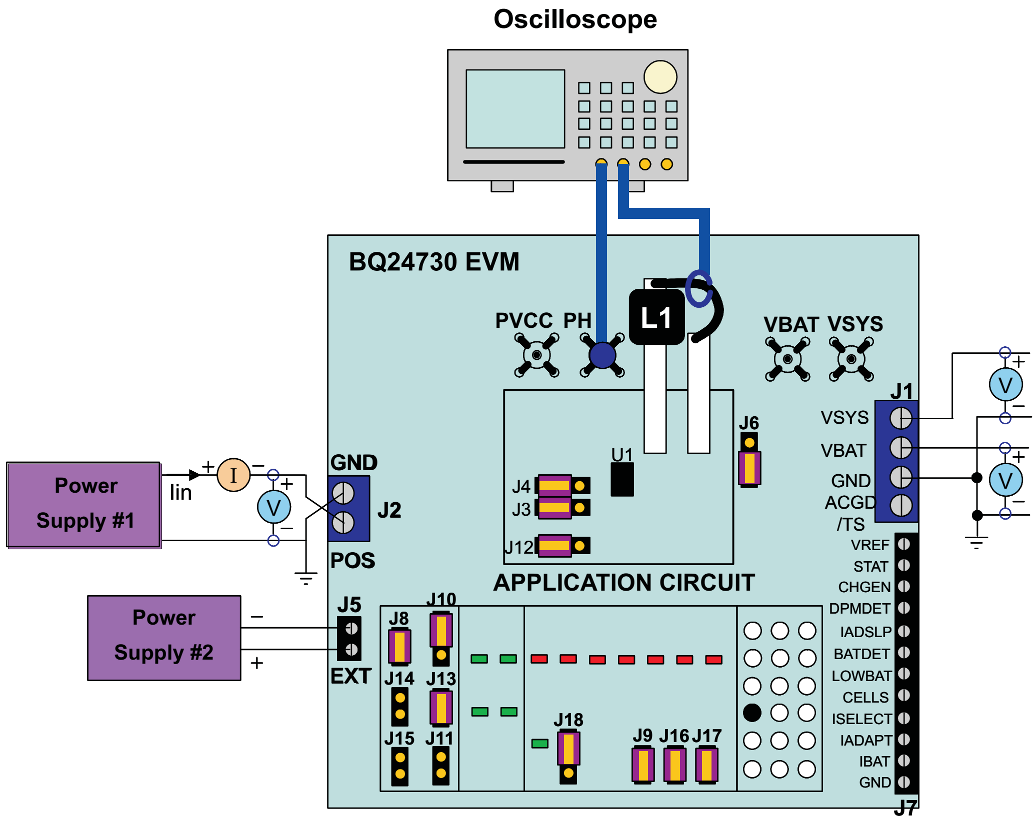


Figure 1. Original Test Setup for bq24730EVM

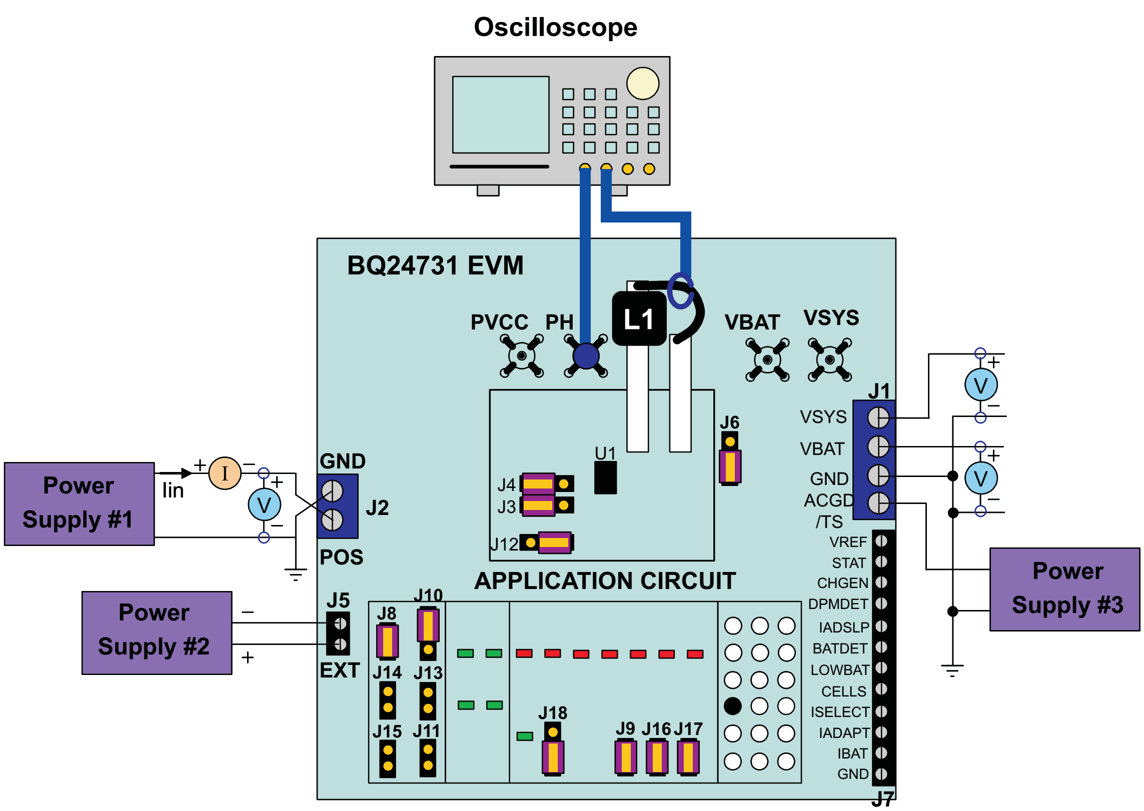


Figure 2. Original Test Setup for bq24731EVM

2.4 Procedure

2.4.1 AC Adapter Detection Threshold

1. Make sure the preceding *Equipment Setup* steps are followed. Turn on PS#2.
2. (*For bq24731 only*) Turn on PS#3.
3. Turn on PS#1.
   a. *Measure*→ V(J1(VSYS)) = 0 V ± 500 mV
   b. *Measure*→ V(TP(VREF5)) = 0 V ± 500 mV
4. Increase the output voltage of PS#1 until D9 (BYPASS) is on but do not exceed 20 V.
   a. Measure → V(TP(AIRDET)) = 1.2 V ± 0.1 V
   b. Measure → V(J2(POS)) = 17 V ± 1 V
   c. Measure → V(J1(VSYS)) = 17 V ± 1 V
   d. Measure → V(TP(VREF5)) = 5 V ± 500 mV
   e. Measure → V(TP51) = 6 V ± 300 mV
   f. Observe → D13 (ACSW) on, D12 (BAT LOW) on, D16 (BAT ON) on. (Note: ignore D16 when the EVM is for bq24370)
5. Increase the output voltage of PS#1 until D18 (ACGOOD) on but do not exceed 20 V.
   a. Measure → V(J2(POS)) = 17.5 V ± 1 V
   b. Measure → V(TP(ACDET)) = 2.4 V ± 0.1 V

2.4.2 Charge Parameters Settings

1. Increase the voltage of PS#1 until V(J2(POS)) = 19 V ± 0.1 V.
   a. Measure → V(J1(VBAT, GND)) = 0 V ± 1 V
   b. Install J11.
   c. Observe → D7 (CHG EN) on, D12 (BAT LOW) off, D10 (CHRGING) on.
   d. Measure → V(J1(VBAT)) = 12.6 V ± 200 mV
   e. Observe → Make sure the phase node voltage (PH) and the inductor current waveforms look like Figure 3.

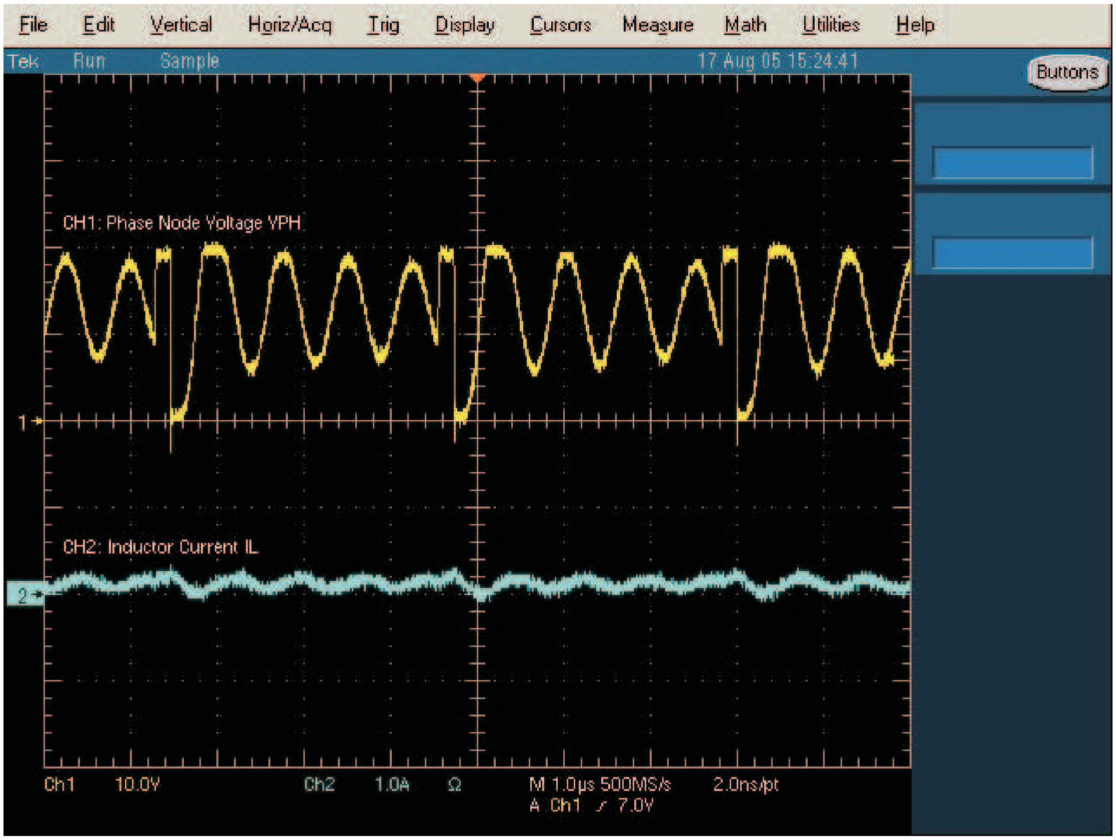


Figure 3. The Waveforms at No Load

2.4.3 Low Battery Voltage Detection

1. Uninstall J11 (disable the charging).
2. Connect the output of the Kepco load in series with a current meter (multimeter) to J1 (VBAT, GND). Make sure a voltage meter is connected across J1 (VBAT, GND). Turn on the Kepco load. Connect the output of the electronic load in series with a current meter (multimeter) to J1 (VSYS, GND). Make sure a voltage meter is connected across J1 (VSYS, GND). Turn on the power of the electronic load. Set the load current to 2 A ± 50 mA but disable the output. The setup is now like Figure 4 for bq24730 and like Figure 5 for bq24731. Make sure Ibat = 0 A ± 10 mA and Isys = 0 A ± 10 mA.

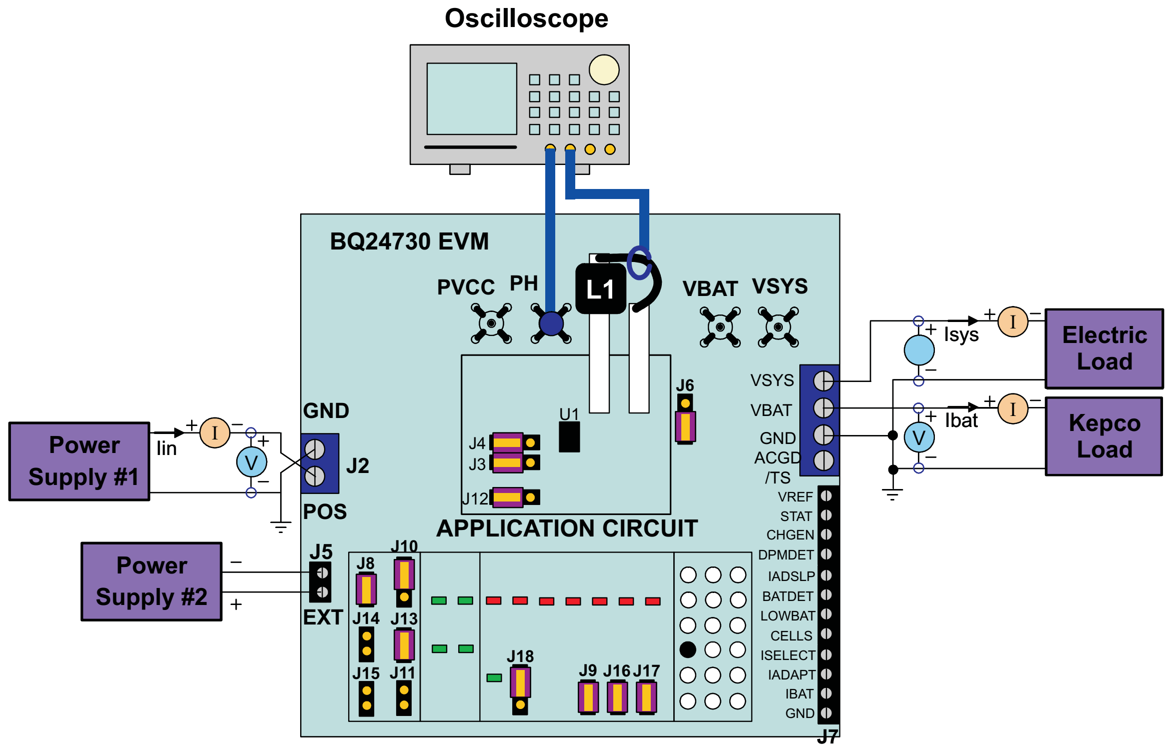


Figure 4. Test Setup for bq24730EVM

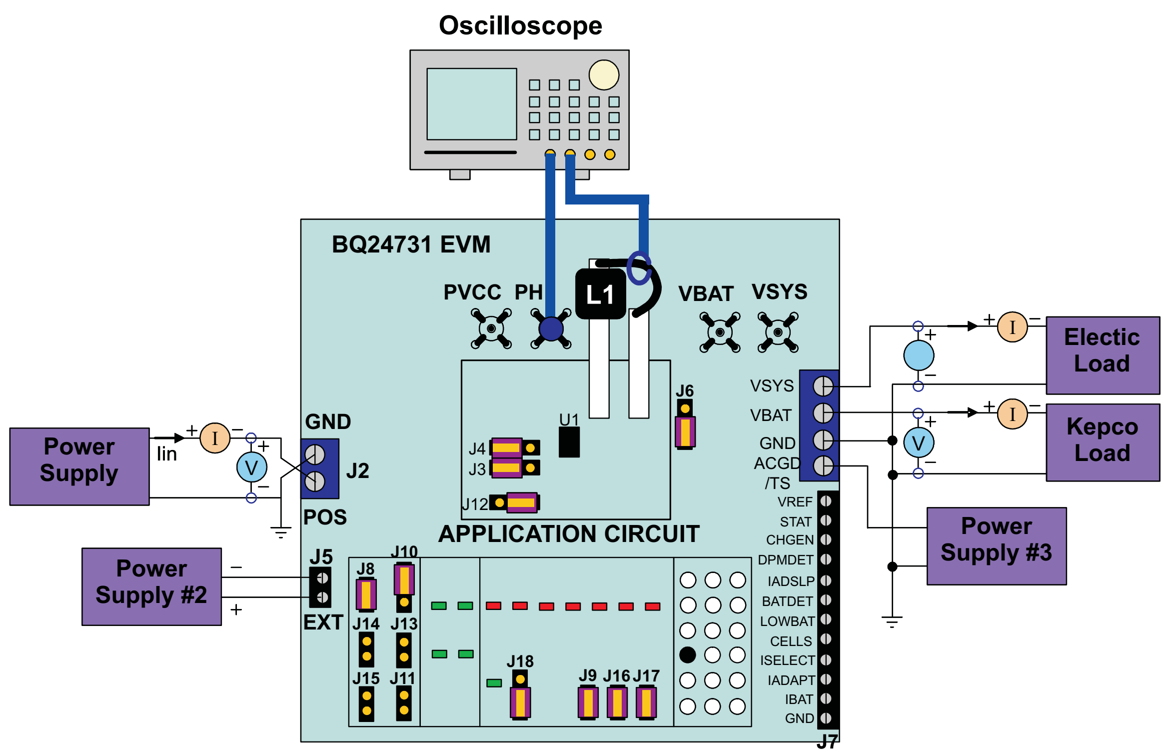


Figure 5. Test Setup for bq24731EVM

3. Slowly decrease the output voltage of the Kepco load until D12 (BAT LOW) is on.
   a. Measure → V(J1(VBAT)) = 9 V ± 200 mV
4. Slowly increase the output voltage of the Kepco load to 10 V ± 100 mVDC.

a. Observe → D12 (BAT LOW) off

2.4.4 Charge Current and AC Current Regulation (DPM)

1. Install J11 (enable the charging).
   a. Measure → Ibat = 3000 mA ± 200 mA
   b. Observe → Make sure the phase node voltage and the inductor current waveforms look like Figure 6.

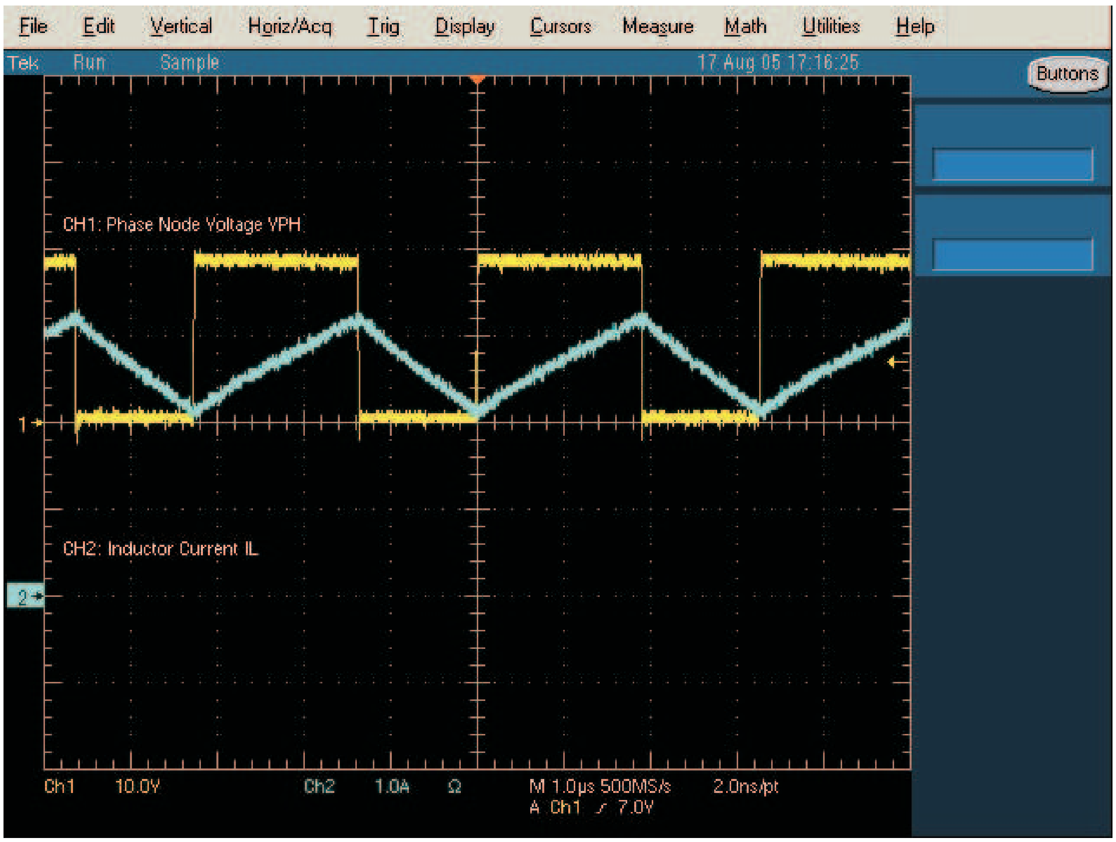


Figure 6. The Waveforms at Ibat = 3 A

2. 2.4.4.1 Install J15 (select Ichrg = 4 A).
   a. Observe → D11 (HIGH I) on
   b. Measure → Ibat = 4000 mA ± 300 mA
   c. Measure → Iin = 2300 mA ± 300 mA
   d. Measure → V(J7(IBAT)) = 800 mV ± 60 mV
   e. Measure → V(J7(IADAPT)) = 460 mV ± 60 mV
3. Enable the output of the electronic load.
   a. Measure → Isys = 2000 mA ± 200 mA, Ibat = 4000 mA ± 300 mA, Iin = 4300 mA ± 300 mA
4. Disable the output of the electronic load. Set the load current to 3 A ± 50 mA.
5. Enable the output of the electronic load.
   a. Observe → D8 (DPM ON) on
   b. Measure → Isys = 3000 mA ± 200 mA, Ibat = 2500 mA ± 300 mA, Iin = 4700 mA ± 400 mA
6. Turn off the electronic load.
   a. Measure → Isys = 0 A ± 100 mA, Ibat = 4000 mA ± 200 mA.

2.4.5 Charger Cut-Off by Thermistor (*bq24731 Only*)

1. Slowly increase the output voltage of PS#3 until Ibat = 0 A ± 10 mA.
   a. Measure → V(J1(ACGD/TS)) = 3.675 V ± 300 mV
2. Slowly decrease the output voltage of PS#3. Charge will resume. Continue to decrease the output voltage of PS#3 slowly until Ibat = 0 A ± 10 mA.
   a. Measure → V(J1(ACGD/TS)) = 1.465 V ± 300 mV
3. Slowly increase the output voltage of PS#3 to 2.5 V ± 100 mV.
   a. Measure → Ibat = 4000 mA ± 200 mA.

2.4.6 Voltage Regulation and Nonsynchronous Operation at Light Load

1. Slowly increase the output voltage of the Kepco load until Ibat = 300 mA ± 20 mA
   a. Measure → V(J1(VBAT, GND)) = 12.6 V ± 200 mV
   b. Observe → The inductor current waveform looks like that shown in Figure 7. The inductor current does not drop below 0 A.

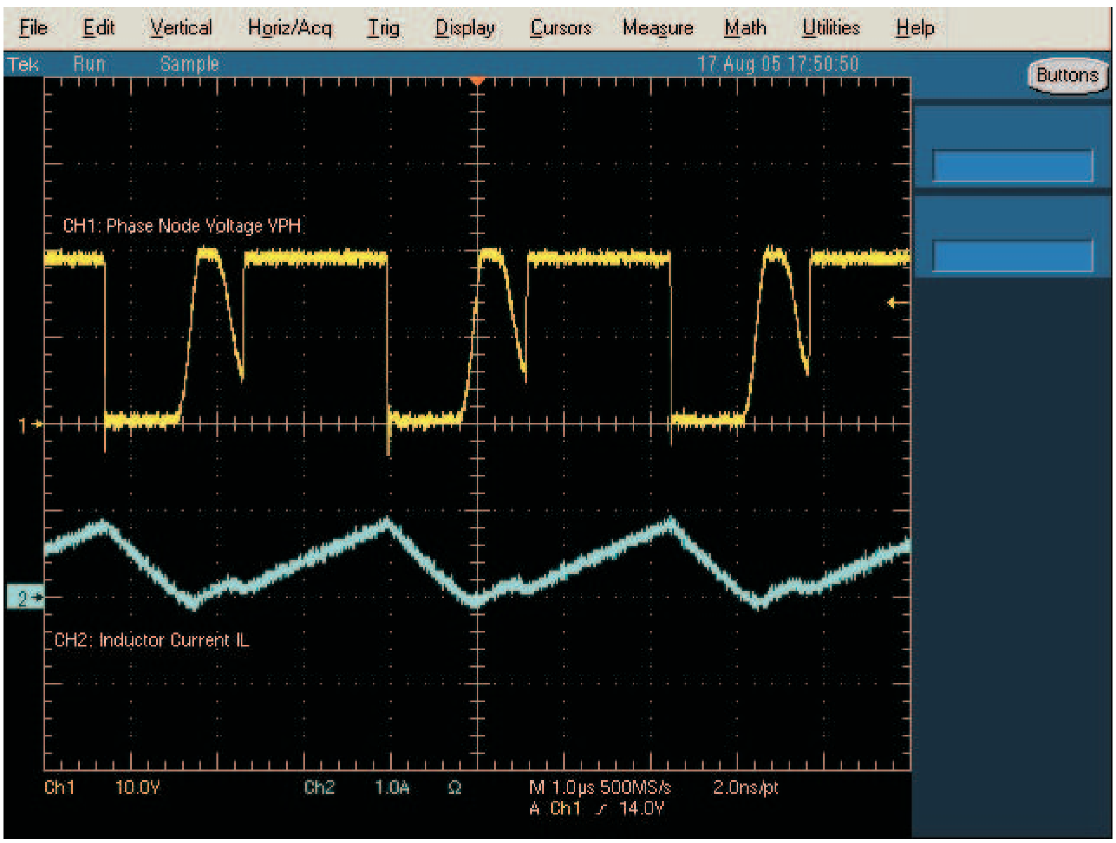


Figure 7. The Waveforms at Ibat = 300 mA

2. Install J14 (4-cell battery pack selected)
   a. Observe → D14 (4 CELLS) on
   b. Measure → Ibat = 4000 mA ± 200 mA.
   c. Observe → The inductor current waveform looks like that shown in Figure 8.

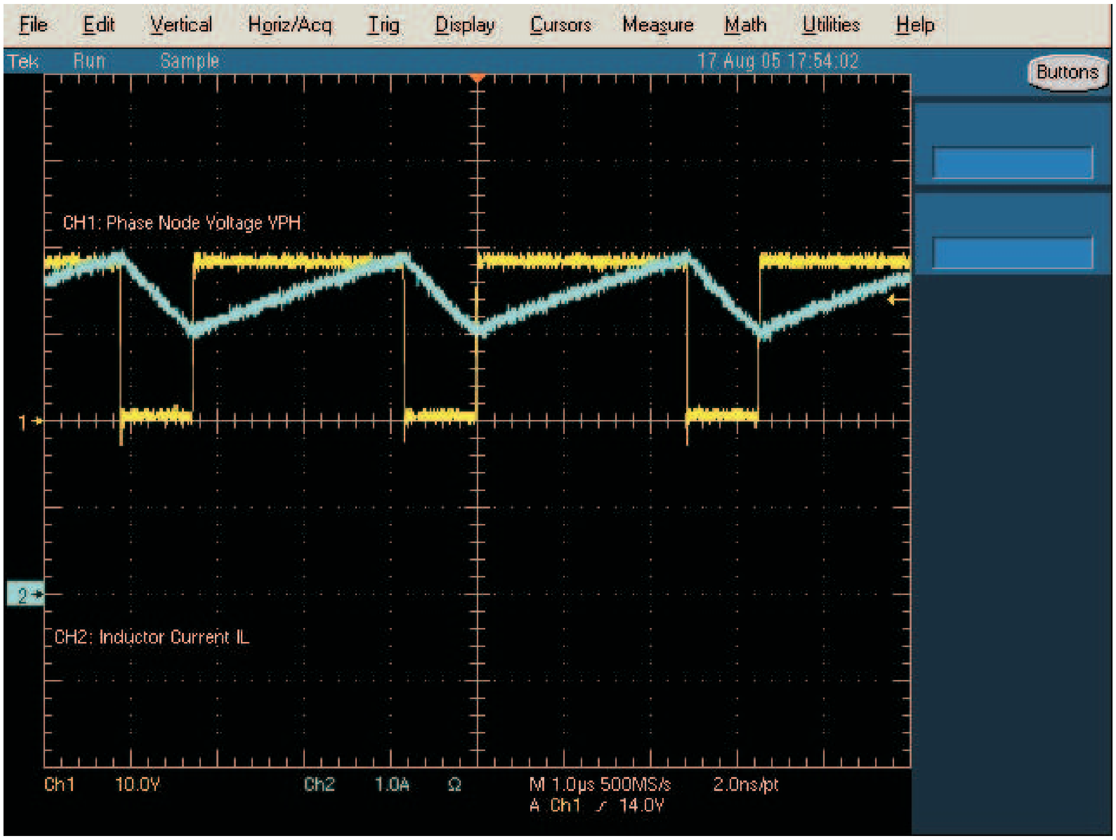


Figure 8. The Waveforms at Ibat = 4000 mA

3. Slowly increase the output voltage of the Kepco load until Ibat = 300 mA ± 20 mA
   a. Measure → V(J1(VBAT, GND)) = 16.8 V ± 200 mV

2.4.7 Power Path Selection

1. Uninstall J11 (disable the charging).
2. Slowly decrease the voltage of the Kepco load to 12.5 V ± 0.1 V.
   a. Measure → V(J1(VSYS)) = 19 V ± 1 V (adapter connected to system)
   b. Observe → D9 (BYPASS) on, D13 (ACSW ON) on, D17 (BATDRV ON) off.
3. Turn off PS#1.
   a. Measure → V(J1(VSYS)) = 12.5 V ± 200 mV (battery connected to system)
   b. Observe → D9 (BYPASS) off, D13 (ACSW ON) off, D17 (BATDRV ON) on

2.4.8 Battery Discharge Current Sense (*bq24730 Only*)

1. Measure → V(J7(IADAPT)):= 0 mV ± 20 mV
2. Set the electronic load current to 1 A ± 50 mA. Enable the output of the electronic load.
   a. Measure → Ibat = –1000 mA ± 200 mA.
   b. Measure → V(J7(IADAPT)):= 0 mV ± 20 mV
3. Disable the output of the electronic load. The jumpers are installed as:
   a. J3 (-DCG-) on, J4 (-DCG-) on, J13 off, J6 (-SNS-) on.
   b. The setup is now like that shown in Figure 9.

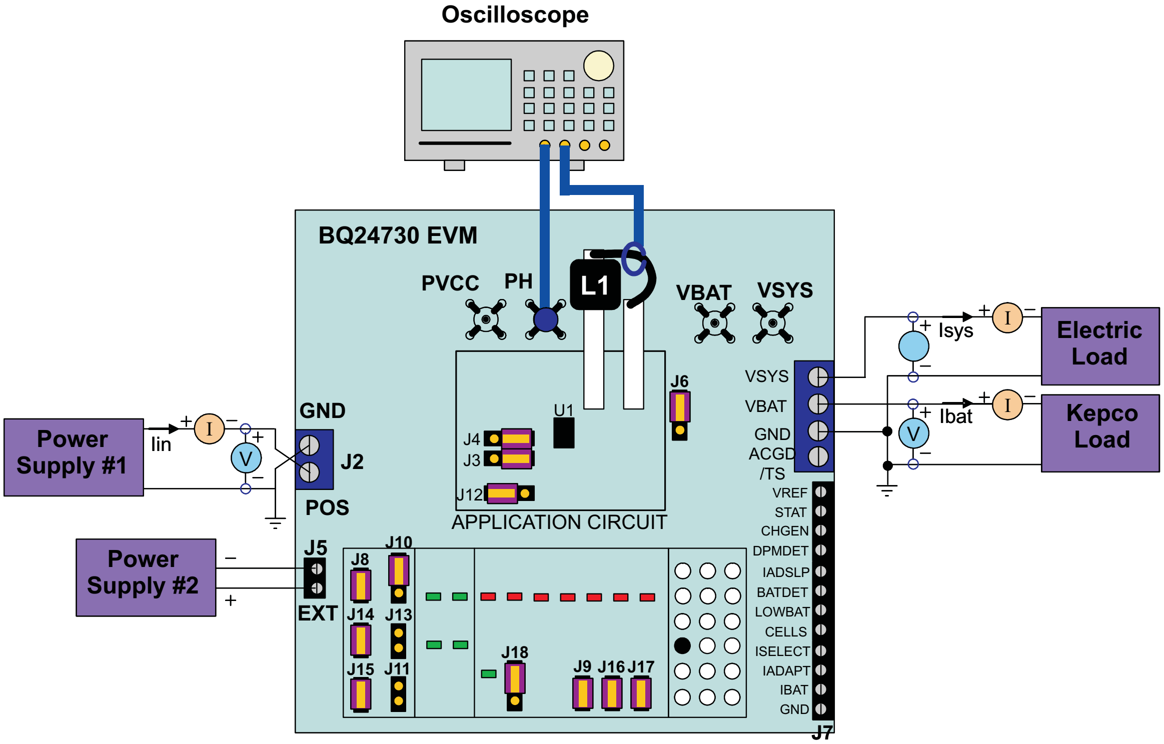


Figure 9. Test Setup for bq24730EVM

4. Enable the output of the electronic load.
   a. Observe → D15 (IAD EN) on (the input current amplifier is activated).
   b. Measure → Ibat = –1000 mA ± 200 mA.
   c. Measure → V(J7(IADAPT)) = 200 mV ± 50 mV

3 Circuit Design and Layout Guideline

3.1 Optional Components

The bq24730/31EVM has all components required for robust operation on a wide range of different operating conditions and AC adapter/load transients. However, some of its components might not be required or can be of distinct value, depending on the application condition. See bq24730/31 application documents for details.

Component	When it must be added to application circuit
D2/R6	Turnon time for bypass switch Q2 needs to be increased
D4/R8	Turnon time for AC switch Q3 needs to be increased
D6/R14	Turnon time for battery switch Q7 or Q28 needs to be increased
C13/C15	Switching time for AC switch Q3 needs to be increased
R9/R10 (See note 1)	Switching time for switch Q1 needs to be increased
R11	Switching time for switch Q5 needs to be increased
C1/C2/C3/C4 value	These capacitors (or some of them) are always required for PWM ripple current filtering. Value might be decreased as long as the low-current ripple, low-transient voltage spike, and loop-response stability can be specified.

3.2 Layout Tips

1. The control stage and the power stage should be laid out separately. At each layer, the signal ground and the power ground are connected only at the power pad with a single point underneath the IC.
2. AC current-sense resistor must be connected to ACP (pin 4) and ACN (pin 3) by 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.
3. Charge current-sense resistor must be connected to SRP (pin 27), SRN (pin 26), SYNP (pin 29), and SYNN (pin 28) by 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 VCC (pin 16), VREF5 (pin 15), and REGN (pin 36) should be placed underneath the IC (on the bottom layer) and make the interconnections to the IC as short as possible.
5. Decoupling capacitors for BAT (pin 25), IBAT (pin 23), and IADAPT (pin 22) must be placed close to the corresponding IC pins and make the interconnections to the IC as short as possible.
6. C13 and C15, if used, must be placed as close to Q3 (AC switch) as possible.
7. Decoupling capacitor C12 for the charger input must be placed close to the Q1 drain and Q5 source.

4 Bill of Materials, Board Layout, and Schematics

4.1 Bill of Materials

bq24730 -001	bq24731 -002	RefDes	Value	Description	Size	Part Number	MFR
4	4	C1–C4	10µF	Capacitor, Ceramic, 10-µF, 25-V, X5R, 20%	1206	ECJ-3YB1E106M	Panasonic - ECG
0	0	C13	Open	Capacitor, Ceramic, Open, 50-V, X7R, 10%	0603		
1	1	C15	10nF	Capacitor, Ceramic, 0.01-µF, 50-V, X7R, 10%	0603	C0603C103K5RACTU	Kemet
2	2	C16, C28	4.7µF	Capacitor, Ceramic, 4.7-µF, 50-V, X7R, 10%	1210	GRM32ER71H475KA88L	Murata
2	2	C17, C24	1µF	Capacitor, Ceramic, 1-µF, 25-V, X7R, 10%	0805	C2012X7R1E105K	TDK
4	4	C19, C33–C35	0.1µF	Capacitor, Ceramic, 50V, X7R, 10%	0603	GRM188R71H104KA93D	Murata
1	1	C20	43pF	Capacitor, Ceramic, 43-pF, 50-V, C0G, 5%	0603	GRM1885C1H430JA01D	Murata
1	1	C21	2000pF	Capacitor, Ceramic, 2000pF, 50-V, C0G, 5%	0805	GRM2165C1H202JA01D	Murata
1	1	C22	160pF	Capacitor, Ceramic, 160-pF, 50-V, C0G, 5%	0603	GRM1885C1H161JA01D	Murata
13	13	C5, C8, C12, C14, C18, C23, C25–C27, C29–C32	0.1µF	Capacitor, Ceramic, 0.1-µF, 50-V, X7R, 10%	0805	C0805C104K5RACTU	Kemet
7	7	C6, C7, C9–C11, C36, C37	10µF	Capacitor, Ceramic, 50V, F, 20%/80%	1210	ECJ-4YF1H106Z	Panasonic - ECG
1	1	D1	MBRS130TR	Diode, Schottky, 1A, 30V	SMB	MBRS130TR	IR
3	3	D2, D4, D6	BAS16	Diode, Switching, 10-mA, 85-V, 350-mW	SOT23	BAS16	Vishay-Liteon
1	1	D3	BAT54	Diode, Schottky, 200-mA, 30-V	SOT23	BAT54	Vishay-Liteon
1	1	D5	BAT54C	Diode, Dual Schottky, 200-mA, 30-V	SOT23	BAT54C	Vishay-Liteon
5	5	D7, D11, D14, D15, D18	Green	Diode, LED, Green, 2.1-V, 20-mA, 6-mcd	0603	160-1183-1-ND	Liteon

bq24730 -001	bq24731 -002	RefDes	Value	Description	Size	Part Number	MFR
7	7	D8–D10, D12, D13, D16, D17	Red	Diode, LED, Red, 1.8-V, 20-mA, 20-mcd	0603	160-1181-1-ND	Liteon
1	1	J1	ED1516	Terminal Block, 4-pin, 15-A, 5,1mm	0.80 × 0.35	ED2227	OST
3	3	J10, J12, J18	PTC36SAAN	Header, 3-pin, 100mil spacing, (36-pin strip)	0.100 × 3	PTC36SAAN	Sullins
1	1	J2	ED1609-ND	Terminal Block, 2-pin, 15-A, 5,1mm	0.40 × 0.35	ED1609	OST
3	3	J3, J4, J6		Header, 3-pin, 100mil spacing, (36-pin strip)	0.100 × 3	PTC36SAAN	Sullins
1	1	J5		Terminal Block, 2-pin, 6-A, 3,5mm	0.27 × 0.25	ED1514	OST
1	1	J7	ED1524-ND	Terminal Block, 12-pin, 6-A, 3,5mm	1.65 × 0.250	ED1524-ND	OST
8	8	J8, J9, J11, J13–J17	PTC36SAAN	Header, 2-pin, 100mil spacing, (36-pin strip)	0.100 × 2	PTC36SAAN	Sullins
1	1	L1	15µH	Inductor, SMT, 5-A, 25-mΩ	0.492 sq in	DR127-150	Coiltronics
2	2	Q1, Q5	FDS6680A	Transistor, MOSFET, NChan, 30V, 12.5A, Rds 9.5 mΩ	SO8	FDS6680A	Fairchild
3	3	Q13, Q20, Q30	TP0610K	MOSFET, P-Ch, 60V, Rds 6Ω, Id 185 mA	SOT-23	TP0610K	Vishay-Siliconix
4	4	Q2, Q3, Q7, Q28	Si4435DY	MOSFET, P-ch, 30-V, 8.0-A, 20-mΩ	SO8	Si4435DY	Siliconix
20	20	Q8–Q12, Q14– Q19, Q21–Q27, Q29, Q32	2N7002	MOSFET, N-ch, 60-V, 115-mA, 1.2-Ω	SOT23	2N7002DICT	Vishay-Liteon
2	2	R1, R2	0.01	Resistor, Chip, 0.010-Ω, 1/2-W, 1%	2010	WSL2010.010±1%	Vishay- Dale
1	1	R15	28k	Resistor, Chip, 28k-Ω, 1/16-W, 1%	0603	Std	Std
1	1	R16	6k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	1	R17	100k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	1	R18	30k	Resistor, Chip, 30k-Ohms, 1/16-W, 1%	0603	Std	Std
1	1	R19	24.9k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	1	R20	200k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
14	14	R22, R30–R35, R37, R38, R41, R45, R52, R57, R62	20k	Resistor, Chip, 20k-Ω, 1/16-W, 5%	0603	Std	Std
1	1	R23	300k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	1	R24	49.9k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
2	2	R25, R27	1k	Resistor, Chip, 1kΩ, 1/16-W, 5%	0603	Std	Std
1	1	R26	21k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	1	R28	33.2k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	1	R29	5.62k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	1	R3	365k	Resistor, Chip, 365k-Ohms, 1/16-W, 1%	0603	Std	Std
0	1	R36	118k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	1	R37	48.7k	Resistor, Chip, 48.7kΩ, 1/16-W, 1%	0603	Std	Std
9	9	R39, R40, R47, R49, R51, R53, R54, R58, R65	1.5k	Resistor, Chip, 1.5kΩ, 1/16-W, 5%	0603	Std	Std
0	0	R4	Open	Resistor, Chip, Open, 1/16-W, 5%	0603	Std	Std
3	3	R42, R50, R59	2.2k	Resistor, Chip, 2.2kΩ, 1/16-W, 5%	0603	Std	Std
1	1	R44	10k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	1	R46	20k	Resistor, Chip, 20kΩ, 1/16-W, 1%	0603	Std	Std

bq24730 -001	bq24731 -002	RefDes	Value	Description	Size	Part Number	MFR
10	10	R5, R12, R13, R21, R43, R48, R55, R56, R60, R61	100k	Resistor, Chip, 100kΩ, 1/16-W, 5%	0603	Std	Std
5	5	R6, R8, R10, R11, R14	0	Resistor, Chip, 0Ω, 1/16-W, 5%	0603	Std	Std
1	1	R63	0	Resistor, Chip, 1/16W, 5%	0402	Std	Std
1	1	R64	5.1k	Resistor, Chip, 5.1kΩ, 1/16-W, 5%	0603	Std	Std
1	1	R9	15	Resistor, Chip, 15Ω, 1/16-W, 5%	0603	Std	Std
14	14	SJ1–SJ14	929950-00	Shorting jumper, 2-pin, 100mil spacing		929950-00	3M/ESD
4	4			6-32 NYL nuts			
4	4	ST1–ST4	4816	STANDOFF M/F HEX 6-32 NYL 0.500"	sf_thvt_325_rnd	4816	Keystone
22	22	TP1, TP2, TP5–TP10, TP12–TP22, TP43, TP46, TP55	5002	Test Point, White, Thru Hole Color Keyed	0.100 × 0.100	5002	Keystone
4	4	TP11, TP40, TP44, TP48	5001	Test Point, Black, Thru Hole Color Keyed	0.100 × 0.100	5001	Keystone
0	0	TP4, TP23–TP36, TP38, TP39, TP41, TP42, TP45, TP50, TP51, TP52		Test Point, 0.020 Hole			
4	4	TP47, TP49, TP53, TP54		Adaptor, 3.5-mm probe clip (or 131-5031-00)	0.2	131-4244-00	
1	0	U1	bq24730RGF	IC, Advance Multi Cell Synchronous Notebook Charger and SPS	0.242 × 0.242	bq24730RGF	TI
0	1	U1	bq24731RGF	IC, Advance Multi Cell Synchronous Notebook Charger and SPS	0.242 × 0.242	bq24731RGF	TI

4.2 Board Layout

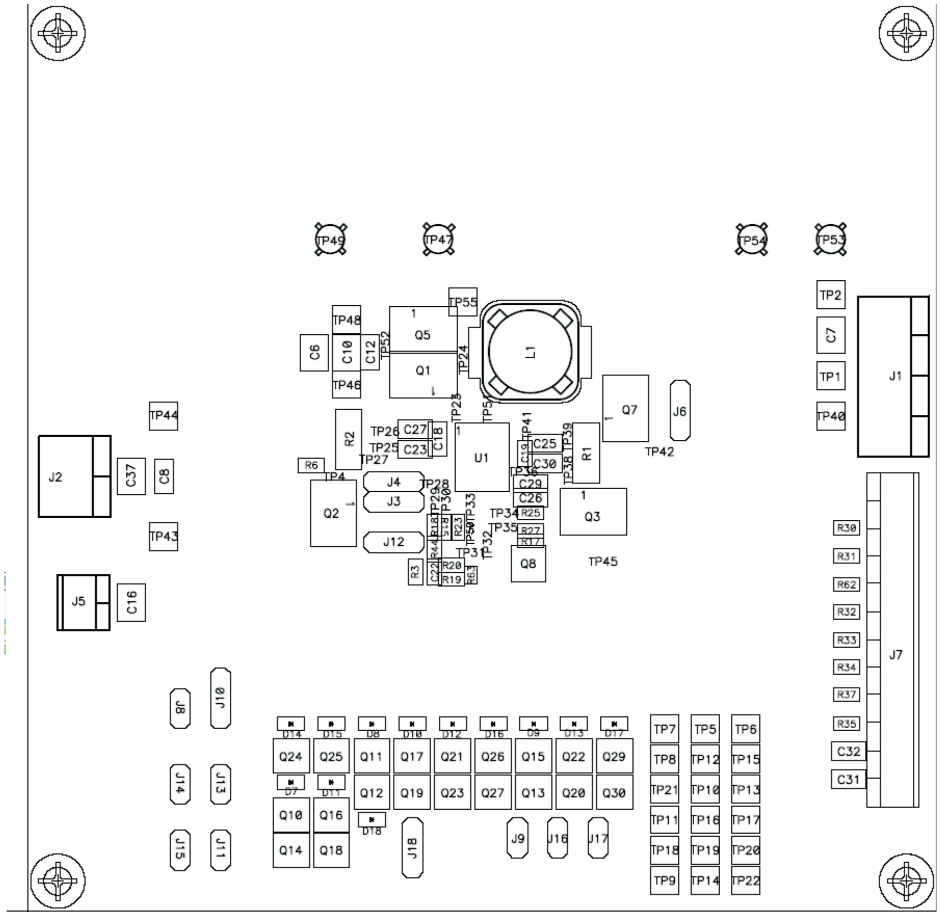


Figure 10. Top Assembly

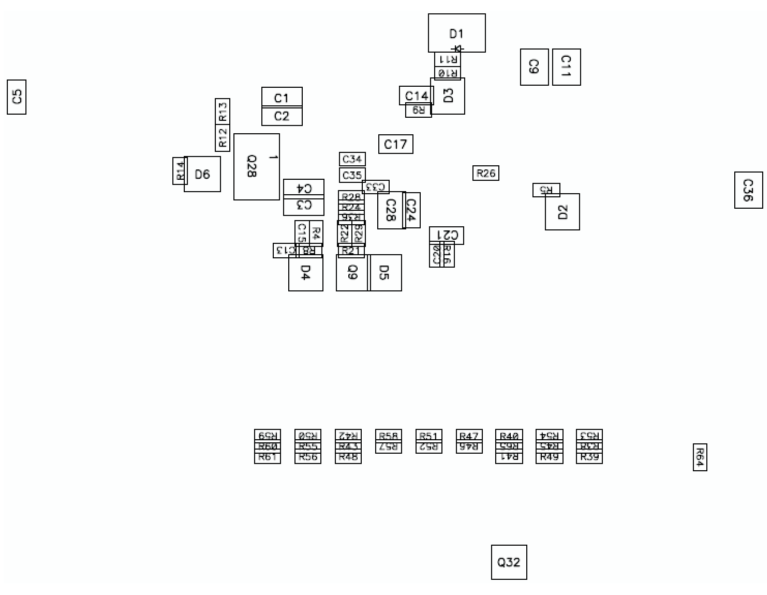


Figure 11. Bottom Assembly

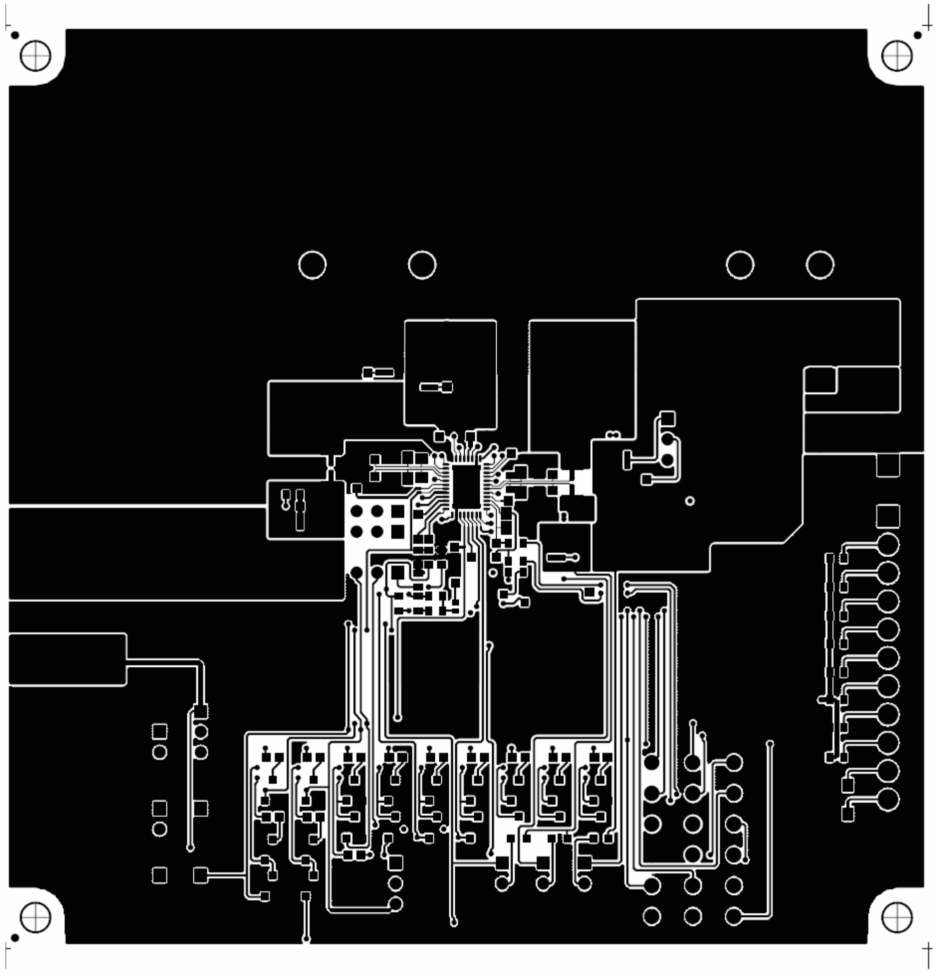


Figure 12. Layer 1

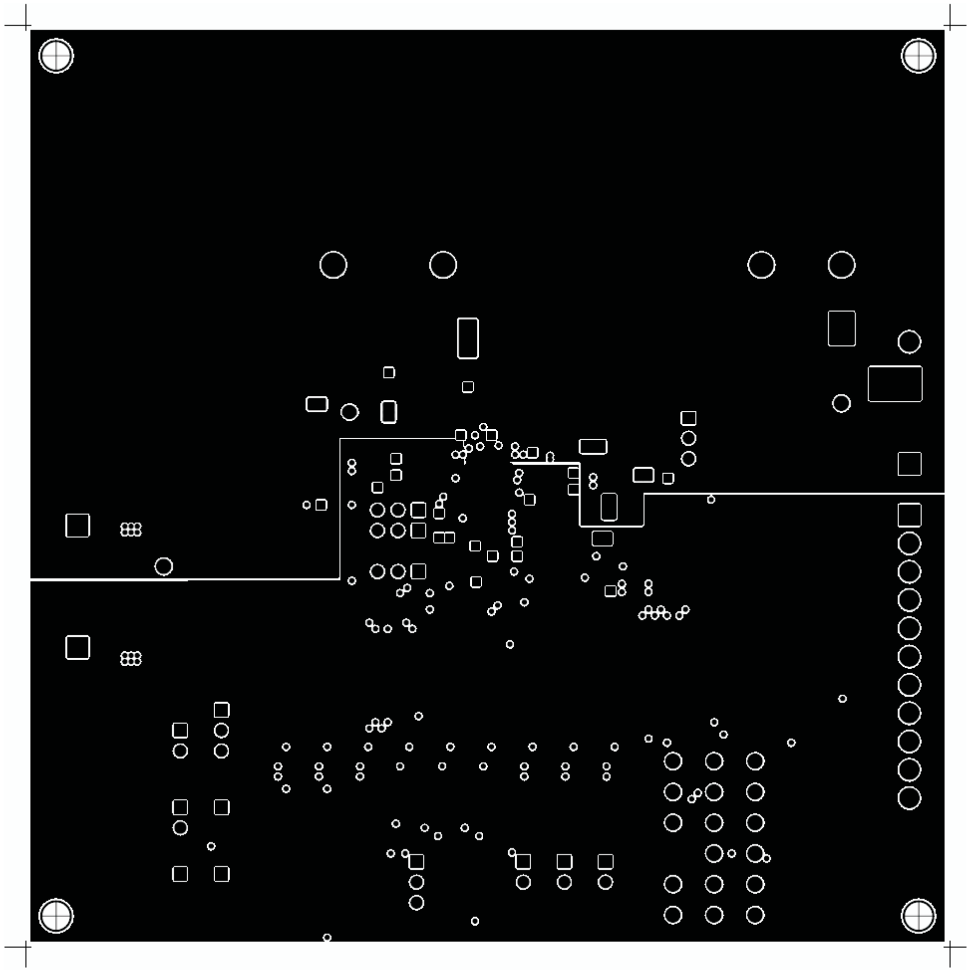


Figure 13. Layer 2

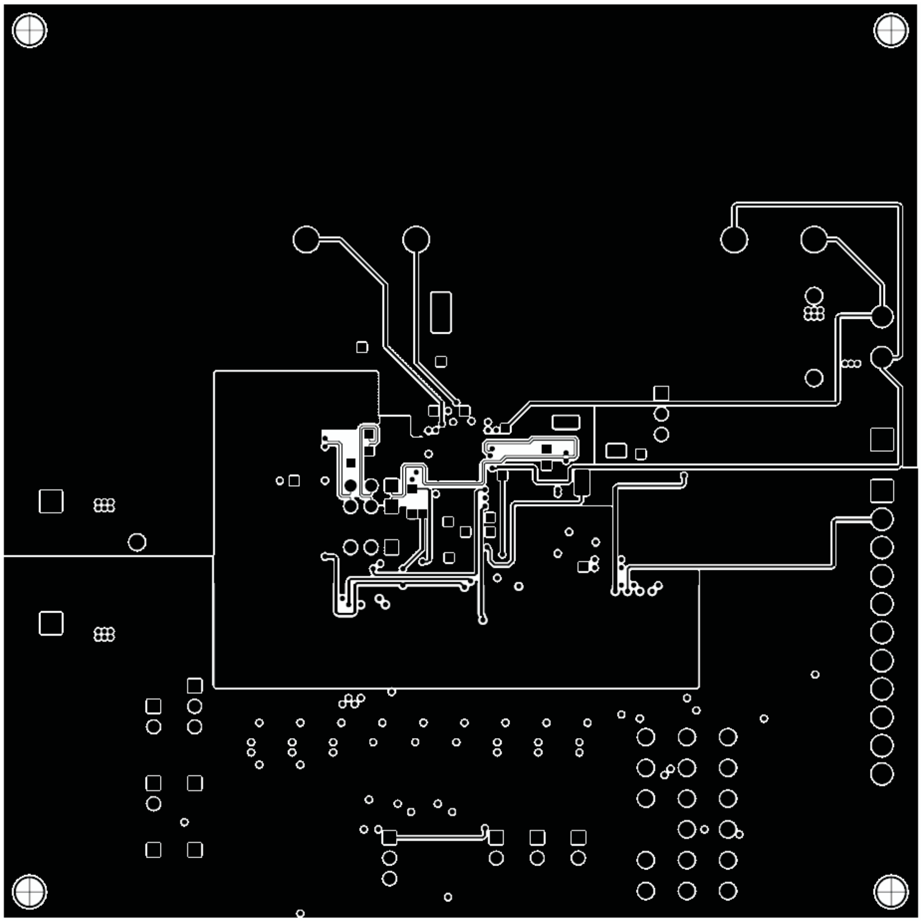


Figure 14. Layer 3

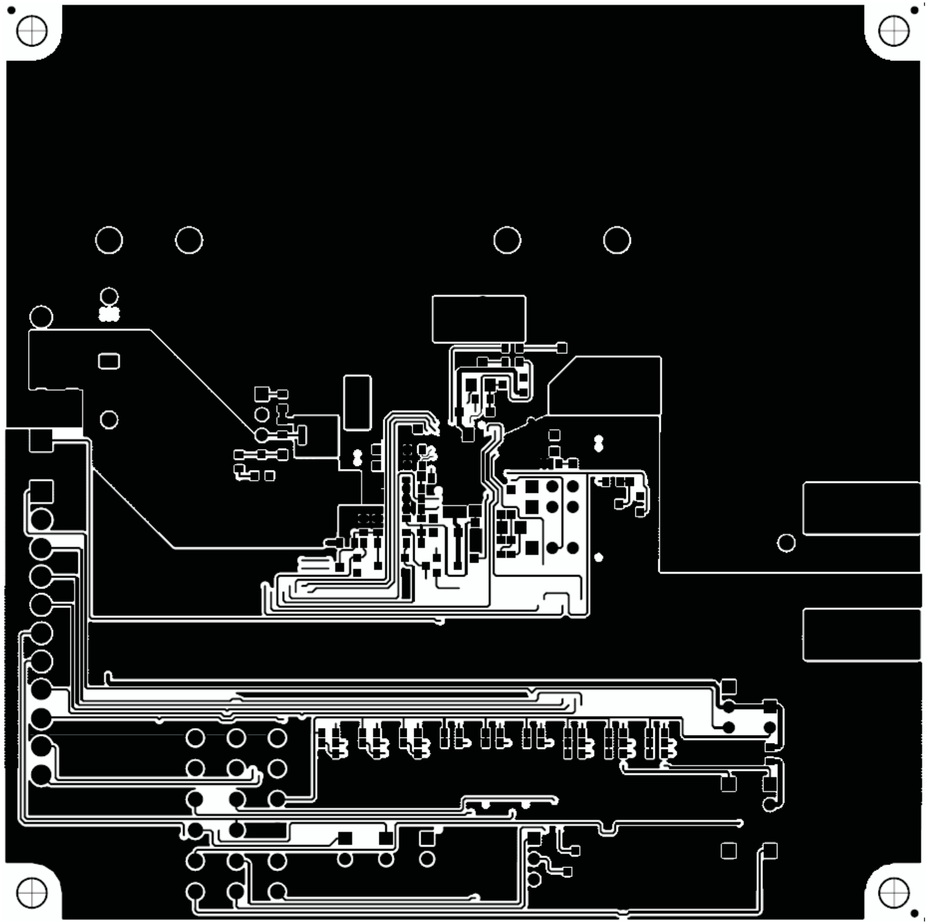


Figure 15. Layer 4

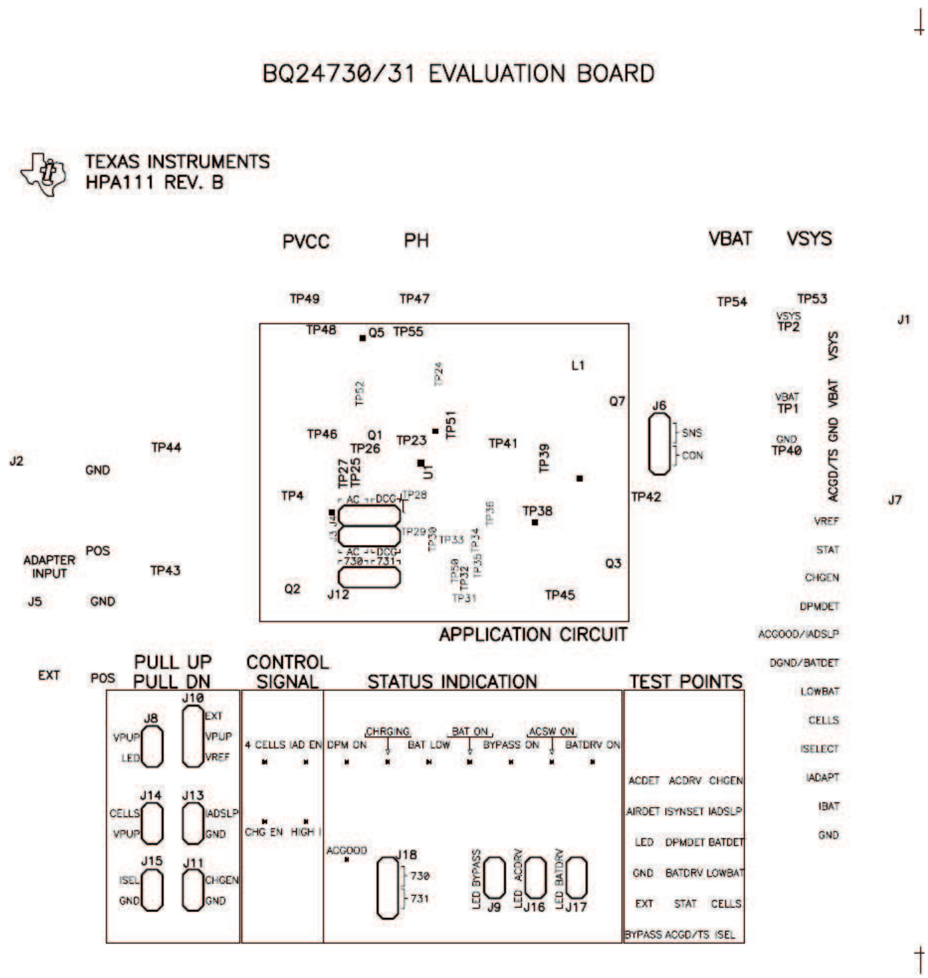
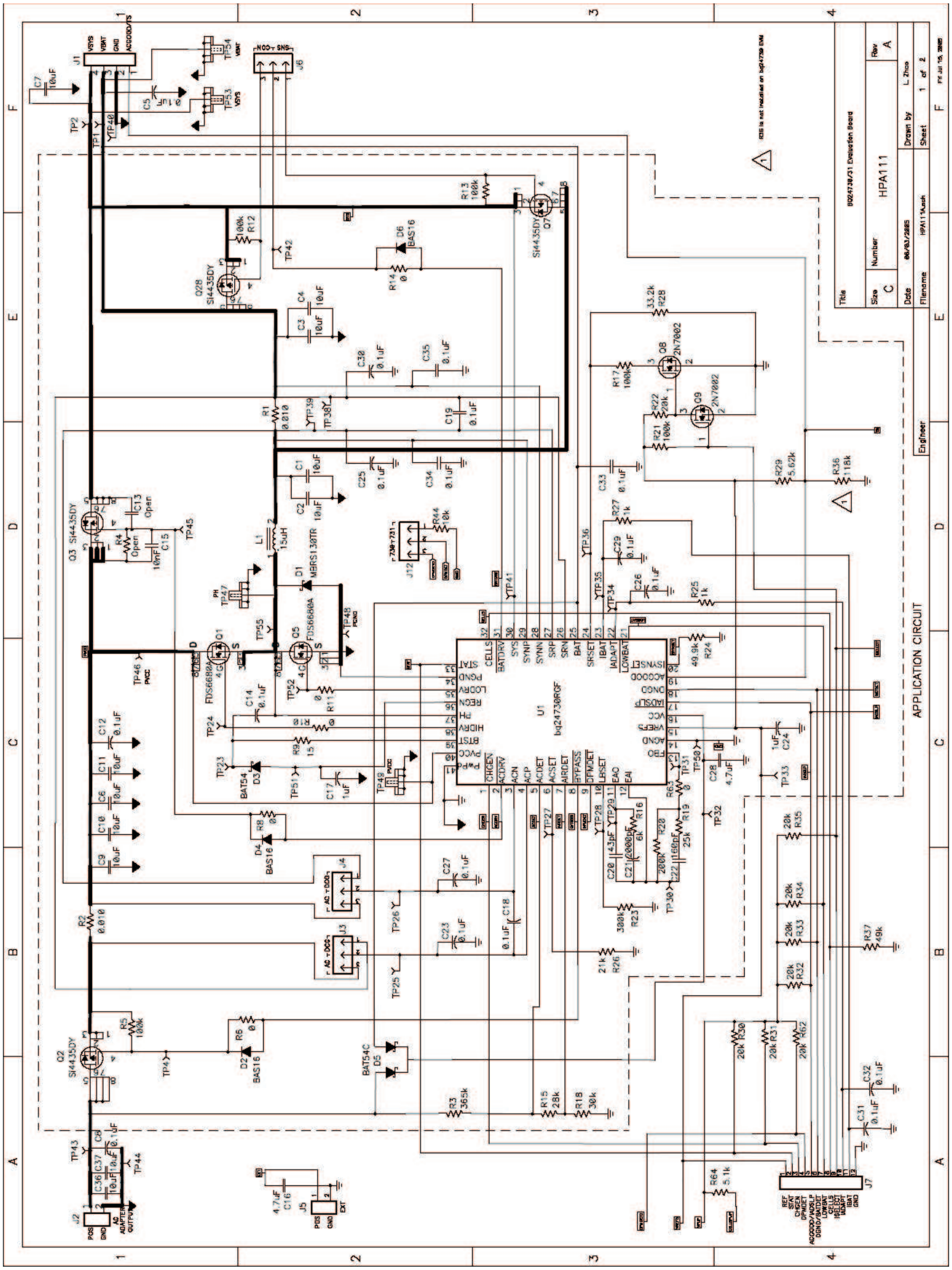
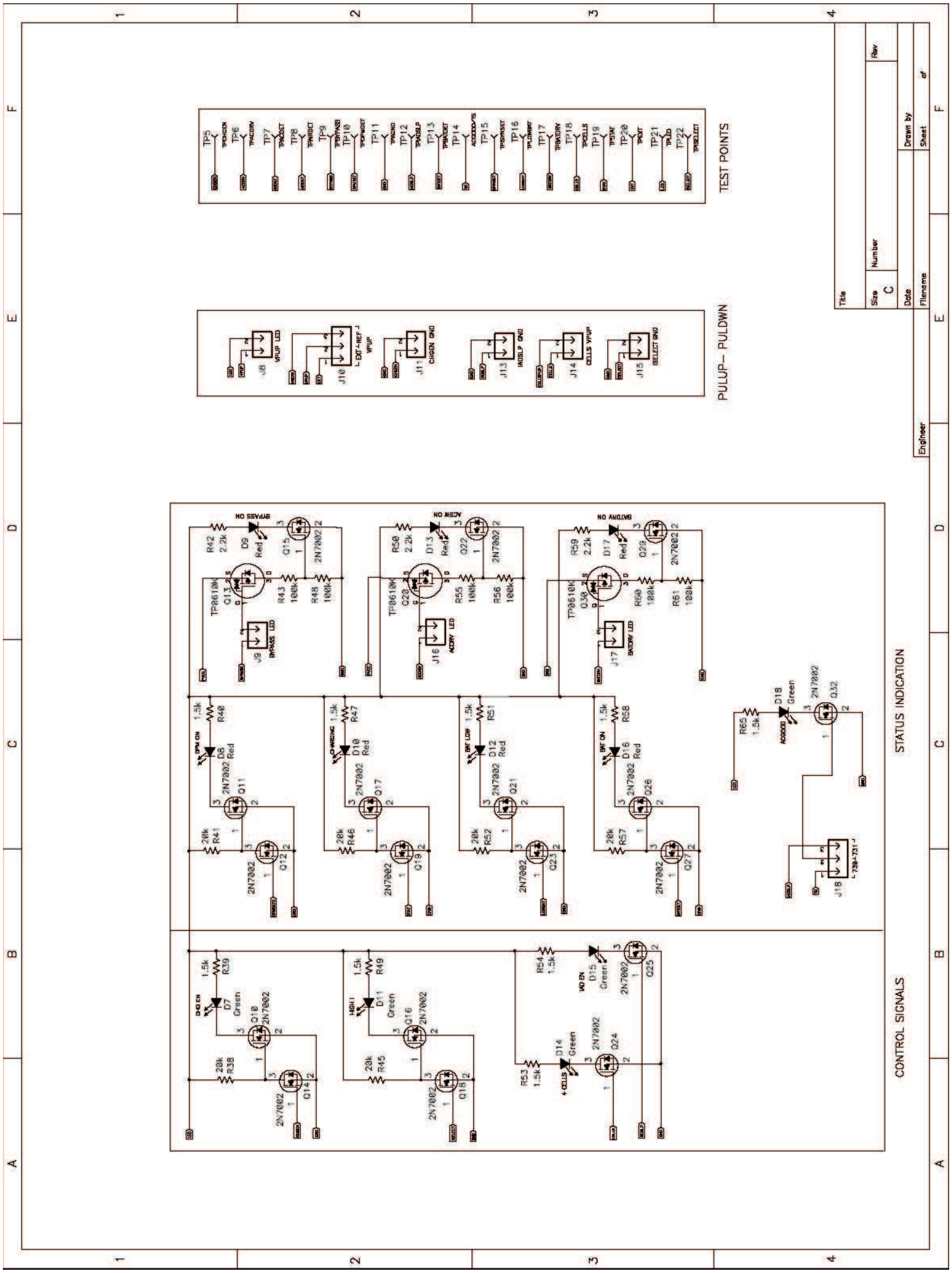


Figure 16. Silk Screen

4.3 Schematics

The schematics are shown on the following pages.




TEST POINTS
PULUP– PULDWN
STATUS INDICATION
CONTROL SIGNALS

EVALUATION BOARD/KIT IMPORTANT NOTICE

Texas Instruments (TI) provides the enclosed product(s) under the following conditions:

This evaluation board/kit is intended for use for **ENGINEERING DEVELOPMENT, DEMONSTRATION, OR EVALUATION PURPOSES ONLY** and is not considered by TI to be a finished end-product fit for general consumer use. Persons handling the product(s) must have electronics training and observe good engineering practice standards. As such, the goods being provided are not intended to be complete in terms of required design-, marketing-, and/or manufacturing-related protective considerations, including product safety and environmental measures typically found in end products that incorporate such semiconductor components or circuit boards. This evaluation board/kit does not fall within the scope of the European Union directives regarding electromagnetic compatibility, restricted substances (RoHS), recycling (WEEE), FCC, CE or UL, and therefore may not meet the technical requirements of these directives or other related directives.

Should this evaluation board/kit not meet the specifications indicated in the User's Guide, the board/kit may be returned within 30 days from the date of delivery for a full refund. THE FOREGOING WARRANTY IS THE EXCLUSIVE WARRANTY MADE BY SELLER TO BUYER AND IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED, IMPLIED, OR STATUTORY, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE.

The user assumes all responsibility and liability for proper and safe handling of the goods. Further, the user indemnifies TI from all claims arising from the handling or use of the goods. Due to the open construction of the product, it is the user's responsibility to take any and all appropriate precautions with regard to electrostatic discharge.

EXCEPT TO THE EXTENT OF THE INDEMNITY SET FORTH ABOVE, NEITHER PARTY SHALL BE LIABLE TO THE OTHER FOR ANY INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES.

TI currently deals with a variety of customers for products, and therefore our arrangement with the user **is not exclusive.**

TI assumes **no liability for applications assistance, customer product design, software performance, or infringement of patents or services described herein.**

Please read the User's Guide and, specifically, the Warnings and Restrictions notice in the User's Guide prior to handling the product. This notice contains important safety information about temperatures and voltages. For additional information on TI's environmental and/or safety programs, please contact the TI application engineer or visit www.ti.com/esh.

No license is granted under any patent right or other intellectual property right of TI covering or relating to any machine, process, or combination in which such TI products or services might be or are used.

FCC Warning

This evaluation board/kit is intended for use for **ENGINEERING DEVELOPMENT, DEMONSTRATION, OR EVALUATION PURPOSES ONLY** and is not considered by TI to be a finished end-product fit for general consumer use. It generates, uses, and can radiate radio frequency energy and has not been tested for compliance with the limits of computing devices pursuant to part 15 of FCC rules, which are designed to provide reasonable protection against radio frequency interference. Operation of this equipment in other environments may cause interference with radio communications, in which case the user at his own expense will be required to take whatever measures may be required to correct this interference.

EVM WARNINGS AND RESTRICTIONS

It is important to operate this EVM within the input voltage range of 0 V to 24 V and the output voltage range of 0 V to 20 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 50°C. The EVM is designed to operate properly with certain components above 50°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.

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