

bq24750/50A/51/51A/51B/52/53 EVM (HPA207) For Multi Cell Synchronous Notebook Charger and System Power Selector

Contents

1	Introduction	1
2	Test Summary	4
3	PCB Layout Guideline	8
4	Bill of Materials, Board Layout and Schematics	9

List of Figures

1	Original Test Setup for HPA207-001, -004, or -005	5
2	Original Test Setup for HPA207-002, -003, -006, or -007	6
3	Test Setup for HPA207-001, -004, or -005	7
4	Test Setup for HPA207-002, -003, -006, or -007	7
5	Top Layer	12
6	2 nd Layer	13
7	3 rd Layer.....	14
8	Bottom Layer	15
9	Top Assembly.....	16
10	Bottom Assembly	17
11	Top Silk	18

List of Tables

1	Bill of Materials	9
---	-------------------------	---

1 Introduction

1.1 EVM Features

- Evaluation Module For the bq24750/50A/51/51A/51B/52/53
- High Efficiency NMOS-NMOS Synchronous Buck Charger With 300 kHz Frequency
- Battery/Adapter to System Power Selector Function
- User-Selectable 2-cell, 3-cell or 4-cell Li-ion Battery Voltage
- User-Programmable Battery Regulation Voltage with External Voltage Source (4.2/cell by Default)
- User-Programmable Charge Current with External Voltage Source (3 A by Default)
- User-Programmable Input Current Limit with External Voltage Source (4.5 A by Default)
- Pin Programmable Interface for Control and Status Communications with Host
- AC Adapter Operating Range 18 V to 22 V
- Adapter Overcurrent Protection
- ACFET Overpower 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 bq24750/50A/51/51A/51B/52/53 evaluation module is a complete charger module for evaluating a multi cell synchronous notebook charge and path selection solution using the bq24750/50A/51/51A/51B/52/53 devices. It is designed to deliver up to 6A of charge current to Li-Ion or Li-Pol applications. The charge current is programmable by external voltage input.

The bq24750/50A/51/51A/51B/52/53 has a highly integrated battery charge controller designed to work with external host commands. The battery voltage, charge current, input current limit 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 the ac adapter current, allowing monitoring of overall system power.

For details, see the bq24750 data sheet ([SLUS735](#)), the bq24750A data sheet ([SLUS834](#)), the bq24751 data sheet ([SLUS734](#)), the bq24751A data sheet ([SLUS756](#)), the bq24751B data sheet ([SLUS835](#)) and the bq24753 data sheet ([SLUS885](#)).

1.3 I/O Description

Jack		Description
J1-ACPWR		AC adapter, positive output
J1-PGND		AC adapter, negative output
J2-VADJ		VADJ pin (12)
J2-ACSET		ACSET pin (6)
J2-SRSET		SRSET pin (16)
J3-CHGEN		CHGEN pin (1)
J3-CELLS		CELLS pin (20)
J4-VEXT		External power supply, positive output
J4-GND		External power supply, negative output
J5-VREF		IC reference voltage VREF
J5-VDAC		VDAC pin (11)
J5-VDACEXT		External VDAC voltage
J5-GND		Ground
J6-TS		TS pin (8) output for bq24750/50A/52, OVPSET pin (8) output for bq24751/51A/51B/53
J6-PGND		Ground
J6-BAT		Connected to battery pack
J6-SYS		Connected to system
J7-ACGOOD		ACGOOD pin (13)
J7-IOUTF		R21 terminal connected to C23
J7-VREF		IC reference voltage VREF
J7-DPMDDET		pin number 21, DPMDDET for bq24750/50A/52, LEARN for bq24751/51A/51B/53
JP1-1	bq24751/51A/51B/53	OVPSET resistor divider for bq24751/51A/51B/53
JP1-2		Pin 8
JP1-3	bq24750/50A/52	TS resistor divider for bq24750/50A/52
JP2-1	LEARN DISA	Pin 21, LEARN for bq24751/51A/51B/53
JP2-2		Ground
JP3-1	ACDRV	ACDRV pin (4) output
JP3-2		LED drive

Jack		Description
JP4-1	LEDPWR	Pull-up voltage source
JP4-2		LED Pull-up power line
JP5-VEXT		External power supply
JP5-HI		Pull-up voltage source
JP5-VREF		IC reference voltage VREF
JP6-1	4.2V REG	REGN pin (24)
JP6-2		VADJ pin (12)
JP7-VREF		IC reference voltage VREF
JP7-VDAC		VDAC pin (11)
JP7-EXT		External VDAC voltage
JP8-1	BATDRV	BATDRV pin (14) output
JP8-2		LED drive
JP9-1	CHGDISA	Pull-up voltage source
JP9-2		$\overline{\text{CHGEN}}$ pin (1)
JP10-HI		Pull-up voltage source
JP10-CELLS		CELLS pin (20) output
JP10-LO		Ground

1.4 Control and Key Parameters Setting

Jack	Description	Factory Setting	
		-001, -004, or -005 (bq24750/50A/52)	-002, -003, -006, or -007 (bq24751/51A/51B/53)
JP1	Pin 8 connection 1-2 (751) : OVPSET 2-3 (750) : TS	Jumper on 2-3	Jumper on 1-2
JP2	Disable LEARN mode when on	Jumper Off	Jumper On
JP3	JP3 The conduction of the AC MOSFET is indicated by LED when on	Jumper On	Jumper On
JP4	The pull-up power source supplies the LEDs when on. LED has no power source when off.	Jumper On	Jumper On
JP5	Pull-up power source setting 1-2: Use VREF as the pull-up source 2-3: Use external power supply as the pull-up source	Jumper on 1-2 (HI and VREF)	Jumper on 1-2 (HI and VREF)
JP6	Connect REGN to VADJ when on	Jumper On	Jumper On
JP7	VDAC voltage source setting 1-2 : Connect VREF to VDAC 2-3 : Connect external voltage source to VDAC	Jumper on 1-2 (VREF and VDAC)	Jumper on 1-2 (VREF and VDAC)
JP8	The conduction of the battery MOSFET is indicated by LED when on	Jumper On	Jumper On
JP9	Disable charge process when on	Jumper On	Jumper On
JP10	Number of cells selection 1-2 (HI-CELLS) : 4 cells 2-3 (CELLS-LO) : 3 cells Open: 2 cells	Jumper on 2-3 (3 cells)	Jumper on 2-3 (3 cells)

1.5 Recommended Operating Conditions

SYMBOL	DESCRIPTION	MIN	TYP	MAX	UNIT
V _{IN} Supply voltage	Input voltage from ac adapter input	18	19	22	V
V _{BAT} Battery voltage	Voltage applied at VBAT terminal of J8	6	7–16.8	20	V
I _{AC} Supply current	Maximum input current from ac adapter	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 HPA207 evaluation board. On the test procedure the following naming conventions are followed. See the HPA207 schematic for details.

- VXXX : External voltage supply name (VADP, VBT, VSBT)
 LOADW: External load name (LOADR, LOADI)
 V(TPyyy): Voltage at HPA207 internal test point TPyyy. For example, V(TP12) means the voltage at TP12.
 V(Jxx): Voltage at HPA207 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 : HPA207 internal jumper Jxx terminals are shorted
 Jxx OFF: HPA207 internal jumper Jxx terminals are open
 Jxx (-YY-) ON: HPA207 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 (PS1): a power supply capable of supplying 20V at 5A is required.

Power Supply 2 (PS2): a power supply capable of supplying 5V at 1A is required. (for HPA207-001, -004, or -005 only)

2.2.2 LOAD 1

A 30V (or above), 5A (or above) electronic load that can operate at constant current mode

2.2.3 LOAD 2

A Kepco bipolar operational power supply/amplifier, 0 ± 20V (or above), 0 ± 6A (or above).

Or: A 20-V at 6-A (or above) dc power supply in parallel with a 3Ω, 100W+ power resistor which is thermally capable or well cooled for at least 100W power dissipation.

2.2.4 METERS

Seven Fluke 75 multimeters, (equivalent or better)
 Or: Four equivalent voltage meters and three equivalent current meters.
 The current meters must be capable of measuring 5A+ current.

2.2.5 OSCILLOSCOPES

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

2.3 Equipment Setup

- (A) Set the power supply 1 for $0V \pm 100mVDC$, $5.0 \pm 0.1A$ current limit and then turn off supply.
- (B) Connect the output of power supply 1 in series with a current meter (multimeter) to J1 (POS, GND).
- (C) Connect a voltage meter across J1 (POS, GND).
- (D) Set the power supply 2 for $1.6V \pm 100mVDC$, $1.0 \pm 0.1A$ current limit and then disable the output.
- (E) **(For HPA207-001, -004 or -005 only)** Connect the output of power supply 2 to J6 (TS, GND).
- (F) Turn off Load 1.
- (G) Set the voltage of Load 2 to $2V \pm 1V$. Turn off Load 2.
- (H) Connect a voltage meter across J6 (BAT, GND).
- (I) Connect a voltage meter across J6 (SYS, GND).
- (J) JP3: ON, JP8: ON, JP9: ON, JP6: ON, JP4: ON, JP10 (LO, CELLS): ON, JP5 (HI, VREF): ON, JP7 (VREF, VDAC): ON.
- (K) **(For HPA207-001, -004 or -005 only)** JP1(-750-): ON, JP2: OFF
- (L) **(For HPA207-002, -003, -006, or -007 only)** JP1 (-751-): ON, JP2: ON

After the steps above, the test setup for HPA207-001, -004, or -005 (bq24750/50A/52 EVM) is shown in [Figure 1](#). The test setup for HPA207-002, -003, -006, or -007 (bq24751/51A/51B/53 EVM) is shown in [Figure 2](#).

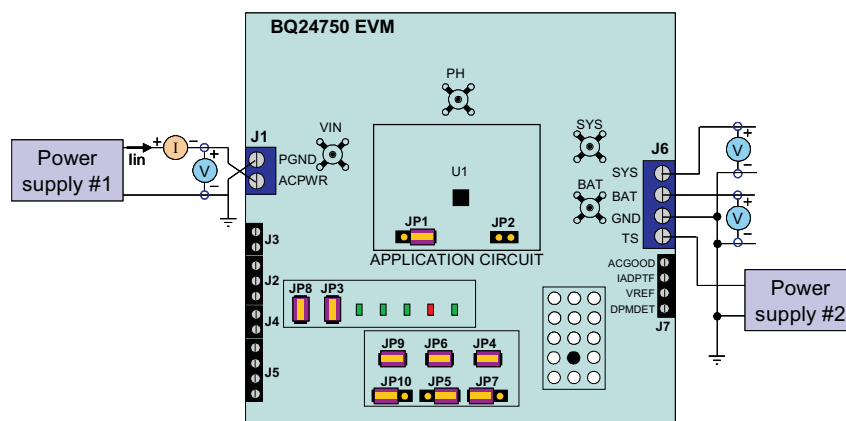


Figure 1. Original Test Setup for HPA207-001, -004, or -005

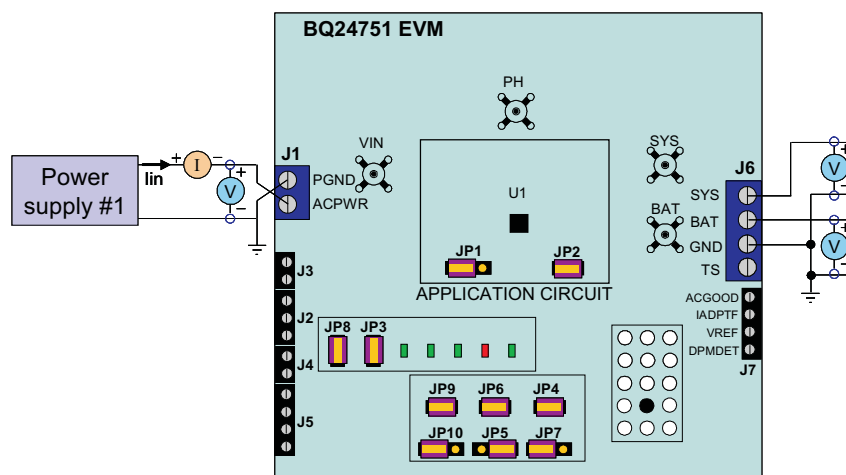


Figure 2. Original Test Setup for HPA207-002, -003, -006, or -007

2.4 Procedure

2.4.1 AC ADAPTER DETECTION THRESHOLD

1. Make sure EQUIPMENT SETUP steps are followed.
2. (For HPA207-001, -004, or -005 only) Turn on PS2.
3. Turn on PS1.
Measure → V(J6(VSYS)) = $0 \pm 500\text{mV}$
Measure → V(TP(VREF)) = $0\text{V} \pm 500\text{mV}$
Measure → V(TP(REGN)) = $0\text{V} \pm 500\text{mV}$
4. Increase the output voltage of PS1 until D7 (ACGOOD) on but do not exceed 19V.
Measure → V(TP(ACDET)) = $2.4\text{V} \pm 150\text{mV}$
Measure → V(J1(POS)) = $17.8\text{V} \pm 1\text{V}$
Measure → V(J6(SYS)) = $17.8\text{V} \pm 1\text{V}$
Measure → V(TP(VREF)) = $3.3\text{V} \pm 200\text{mV}$
Measure → V(TP(REGN)) = $6\text{V} \pm 500\text{V}$ (For HPA207-001, -002, or -004)
Measure → V(TP(REGN)) = $0.7\text{V} \pm 700\text{mV}$ (For HPA207-003, -005, -006, -007 only)
Measure → D4 (ACDRV) on. (Note: ignore D5 if testing HPA207-002, -003, -006, or -007)

2.4.2 SELECTION OF REGULATION VOLTAGE

1. Increase the voltage of PS1 until V(J5(POS)) = $19\text{V} \pm 0.1\text{V}$.
Measure → V(J6(BAT, GND)) = $0\text{V} \pm 1\text{V}$
 Uninstall JP9 (enable the charging)
Observe → D3 (CHG EN) on
Measure → V(J6(BAT)) = $12.6\text{V} \pm 200\text{mV}$
2. Install JP10 (CELLS, HI)
Measure → V(J6(BAT)) = $16.8\text{V} \pm 200\text{mV}$
3. Install JP10 (CELLS, LO)
Measure → V(J6(BAT)) = $12.6\text{V} \pm 200\text{mV}$

2.4.3 CHARGE CURRENT AND AC CURRENT REGULATION (DPM)

1. Install JP9 (Disable the charging).
2. Connect the Load 2 in series with a current meter (multimeter) to J6 (BAT, GND). Make sure a voltage meter is connected across J6 (BAT, GND). Turn on the Load 2. Set the output voltage to 10.5V.
3. Connect the output of the Load 1 in series with a current meter (multimeter) to J6 (SYS, GND). Make sure a voltage meter is connected across J6 (SYS, GND). Turn on the power of the Load 1. Set the load current to $4A \pm 50mA$ but disable the output. The setup is now like Figure 3 for HPA207-001, -004 or -005 and like Figure 4 for HPA207-002, -003, -006, or -007. Make sure $I_{bat} = 0A \pm 10mA$ and $I_{sys} = 0A \pm 10mA$.

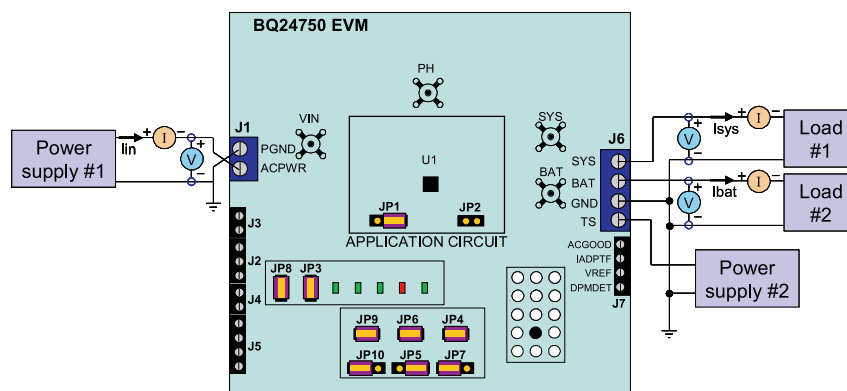


Figure 3. Test Setup for HPA207-001, -004, or -005

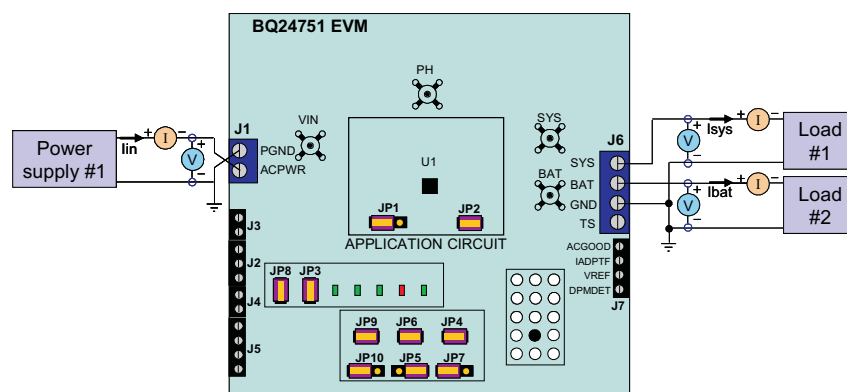


Figure 4. Test Setup for HPA207-002, -003, -006, or -007

4. Uninstall JP9 (Enable the charging).
Observe → D3 (CHG EN) on
5. Measure → $I_{bat} = 3000mA \pm 200mA$
Measure → $V(TP(IOUT)) = 300mV \pm 100mV$ (For HPA207-001, 002, -003, -005, -006, or -007)
Measure → $V(TP(IOUT)) = 600mV \pm 100mV$ (For HPA207-004 only)
6. Enable the output of the Load 1.
Observe → D5 (DPMDET) on (For HPA207-001, -004, or -005 only)
Measure → $I_{sys} = 4000mA \pm 200mA$, $I_{bat} = 1000mA \pm 500mA$, $I_{in} = 4500mA \pm 400mA$
7. Turn off the Load 1.
Measure → $I_{sys} = 0 \pm 100mA$, $I_{bat} = 3000mA \pm 200mA$

2.4.4 CHARGER CUT-OFF BY THERMISTOR (HPA207-001, -004, or -005 ONLY)

1. Slowly increase the output voltage of PS2 until $I_{bat} = 0 \pm 10\text{mA}$.
Measure → $V(J6(TS)) = 2.44\text{V} \pm 400\text{mV}$
2. Slowly decrease the output voltage of PS2.
Charge will resume. Continue to decrease the output voltage of PS2 slowly until $I_{bat} = 0 \pm 10\text{mA}$.
Measure → $V(J6(TS)) = 0.97\text{V} \pm 400\text{mV}$
3. Slowly increase the output voltage of PS2 to $1.6\text{V} \pm 100\text{mV}$.
Measure → $I_{bat} = 3000\text{mA} \pm 200\text{mA}$

2.4.5 LEARN MODE (HPA207-002, -003, -006, or -007 ONLY)

1. *Measure* → $V(J6(SYS)) = 19\text{V} \pm 1\text{V}$ (adapter connected to system)
2. Uninstall JP2 (Enable the learn mode).
Measure → $V(J6(SYS)) = 10.5\text{V} \pm 1\text{V}$ (battery connected to system)
3. Install JP2 (Disable the learn mode).
Measure → $V(J6(SYS)) = 19\text{V} \pm 1\text{V}$ (adapter connected to system)

2.4.6 POWER PATH SELECTION

1. Install JP9 (Disable the charging).
Measure → $V(J6(SYS)) = 19\text{V} \pm 1\text{V}$ (adapter connected to system)
Observe → D4 (ACDRV) on, D6 (BATDRV) off.
2. Turn off PS1.
Measure → $V(J6(SYS)) = 10.5\text{V} \pm 1\text{V}$ (battery connected to system)

3 PCB Layout Guideline

1. It is critical that the exposed power pad on the backside of the bq2475x 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 power pad.
3. AC current sense resistor must be connected to ACP (pin 3) and ACN (pin 2) 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. Charge current sense resistor must be connected to SRP (pin 19), SRN (pin 18) 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.
5. Decoupling capacitors for PVCC (pin 28), VREF (pin 10), REGN (pin 24) should be placed underneath the IC (on the bottom layer) and make the interconnections to the IC as short as possible.
6. Decoupling capacitors for BAT (pin 17), IADAPT or IBAT (pin 15) must be placed close to the corresponding IC pins and make the interconnections to the IC as short as possible.
7. Decoupling capacitor(s) for the charger input must be placed close to Q3 drain and Q4 source.

4 Bill of Materials, Board Layout and Schematics

Table 1. Bill of Materials

'50 -001	'51 -002	'51A -003	'52 -004	'50A -005	'51B -006	'53 -007	RefDes	Value	Description	Size	Part Number	MFR
0	0	0	0	0	0	0	C1	Open	Capacitor, Electrolytic, 22uF, 25 VDC	0.207 X 0.209 inch	UUD1E220 MCR1GS	Nichicon
0	0	0	0	0	0	0	C10, C21, C25,C29, C32	Open	Capacitor, Ceramic, 50V, X7R, 10%	603	C1608X7R1 H104K	TDK
1	1	1	1	1	1	1	C11	0.47uF	Capacitor, Ceramic, 50V, X7R, 10%	805	GRM21BR7 1H474KA88 L	muRata
4	4	4	4	4	4	4	C12, C13, C23, C26	10uF	Capacitor, Ceramic, 25V, X5R, 10%	1210	Std	Taiyo Yuden
0	0	0	0	0	0	0	C14	Open	Capacitor, Ceramic, vvV	805		
1	1	1	1	1	1	1	C15	4.7uF	Capacitor, Ceramic, 25V, X7R, 20%	1206	C3216X7R1 E475M	TDK
1	1	1	1	1	1	1	C16	100pF	Capacitor, Ceramic, 50V, C0G, 5%	603	C1608C0G1 H101J	TDK
0	0	0	0	0	0	0	C2	Open	Capacitor, Ceramic, 25V, X5R, 10%	1210	Std	Taiyo Yuden
0	0	0	0	0	0	0	C22, C33	Open	Capacitor, Ceramic, 25V, X5R, 10%	1206	GRM31CR6 1E106KA12 L	muRata
2	2	2	2	2	2	2	C24, C30	10uF	Capacitor, Ceramic, 25V, X5R, 10%	1206	GRM31CR6 1E106KA12 L	muRata
0	0	0	0	0	0	0	C3	Open	Capacitor, Ceramic, 35V, X7R, 10%	1206	C3216X7R1 H105K	Taiyo Yuden
2	2	2	2	2	2	2	C4, C31	0.01uF	Capacitor, Ceramic, 50V, X7R, 10%	603	C1608X7R1 H104K	TDK
1	1	1	1	1	1	1	C5	22 uF	Capacitor, Electrolytic, 22uF, 25 VDC	0.207 X 0.209 inch	UUD1E220 MCR1GS	Nichicon
0	0	0	0	0	0	0	C6	Open	Capacitor, Ceramic, vvV, [temp], [tol]	1210	Std	Vishay
7	7	7	7	7	7	7	C7, C9, C18, C20,C27, C28, C34	0.1uF	Capacitor, Ceramic, 50V, X7R, 10%	603	C1608X7R1 H104K	TDK
3	3	3	3	3	3	3	C8, C17, C19	1.0uF	Capacitor, Ceramic, 50V, X7R, 10%	1206	C3216X7R1 H105K	TDK
1	1	1	1	1	1	1	D1	BAT54	Diode, Schottky, 200mA, 30V	SOT23	BAT54	Vishay- Liteon
1	1	1	1	1	1	1	D2	MBRS1 30	Diode, Schottky, 1A, 30V	SMB	MBRS130T R	IR
4	4	4	4	4	4	4	D3, D4, D6, D7	Green	Diode, LED, Green, 2.1V, 20mA, 6mcd	603	LTST- C190GKT	Lite On
1	1	1	1	1	1	1	D5	Red	Diode, LED, Red, 1.8V, 20mA, 20mcd	603	LTST- C190CKT	Lite On
1	1	1	1	1	1	1	J1	ED160 9-ND	Terminal Block, 2 pin, 15A, 5.1mm	0.40 x 0.35 inch	ED1609	OST
1	1	1	1	1	1	1	J2	ED151 5	Terminal Block, 3 pin, 6A, 3.5mm	0.41 x 0.25 inch	ED1515	OST

Table 1. Bill of Materials (continued)

'50 -001	'51 -002	'51A -003	'52 -004	'50A -005	'51B -006	'53 -007	RefDes	Value	Description	Size	Part Number	MFR
2	2	2	2	2	2	2	J3, J4	ED151 4	Terminal Block, 2 pin, 6A, 3.5mm	0.27 x 0.25 inch	ED1514	OST
1	1	1	1	1	1	1	J6	ED222 7	Terminal Block, 4 pin, 15A, 5.1mm	0.80 x 0.35 inch	ED2227	OST
2	2	2	2	2	2	2	J5, J7	ED151 6	Terminal Block, 4 pin, 6A, 3.5mm	0.55 x 0.25 inch	ED1516	OST
4	4	4	4	4	4	4	JP1, JP5, JP7, JP10	PTC36 SAAN	Header, 3 pin, 100mil spacing, (36-pin strip)	0.100 inch x 3	PTC36SAA N	Sullins
6	6	6	6	6	6	6	JP2, JP3, JP4, JP6, JP8, JP9	PTC36 SAAN	Header, 2 pin, 100mil spacing, (36-pin strip)	0.100 inch x 2	PTC36SAA N	Sullins
1	1	1	1	1	1	1	L1	8.2uH	Inductor, SMT, 16A, 24.8milliohm	0.51 x 0.51 inch	IHLP5050C E8R2M01	Vishay
3	3	3	3	3	3	3	Q1, Q2, Q5	Si4435 DY	MOSFET, P-ch, 30V, 8.0A, 20milliohm	SO8	Si4435DY	Siliconix
2	2	2	2	2	2	2	Q3, Q4	FDS66 80A	Transistor, MOSFET, NChan, 30V, 12.5A, Rds 9.5 milliohm	SO8	FDS6680A	Fairchild
8	8	8	8	8	8	8	Q6, Q8, Q9, Q10, Q11, Q13, Q14, Q15	2N7002 DICT	MOSFET, N-ch, 60V, 115mA, 1.2Ohms	SOT23	2N7002DIC T	Vishay- Liteon
2	2	2	2	2	2	2	Q7, Q12	TP0610 K	MOSFET, P-Ch, 60V, Rds 6 ohms, Id 185 mA	SOT-23	TP0610K	Vishay- Siliconix
1	1	1	1	1	1	1	R1	422k	Resistor, Chip, 1/10W, 1%	603	Std	Std
2	2	2	2	2	2	2	R10, R11	0	Resistor, Chip, 1/16W, 5%	402	Std	Std
3	3	3	3	3	3	3	R12, R14, R18	100k	Resistor, Chip, 1/10W, 0.1%	805	ERA- 6YEB104V	Panasonic
1	1	1	1	1	1	1	R13	82k	Resistor, Chip, 1/10W, 0.1%	805	ERA- 6YEB823V	Panasonic
1	1	1	1	1	1	1	R15	43k	Resistor, Chip, 1/10W, 0.1%	805	ERA- 6YEB433V	Panasonic
1	1	1	1	1	1	1	R19	68k	Resistor, Chip, 1/10W, 0.1%	805	ERA- 6YEB683V	Panasonic
1	1	1	1	1	1	1	R2	71.5k	Resistor, Chip, 1/10W, 1%	603	Std	Std
3	3	3	3	3	3	3	R21, R26, R33	20.0k	Resistor, Chip, 1/16W, 1%	603	Std	Std
5	5	5	5	5	5	5	R24, R25, R27, R30, R34	2.21k	Resistor, Chip, 1/16W, 1%	603	Std	Std
1	1	1	1	1	1	1	R3	390k	Resistor, Chip, 1/16W, 1%	603	Std	Std
1	1	1	1	1	1	1	R31	10.0k	Resistor, Chip, 1/16W, 1%	603	Std	Std
1	1	1	1	1	1	1	R4	60.4k	Resistor, Chip, 1/16W, 1%	603	Std	Std
1	1	1	1	1	1	1	R5	5.62k	Resistor, Chip, 1/16W, 1%	402	Std	Std
1	1	1	1	1	1	1	R6	118k	Resistor, Chip, 1/16W, 1%	402	Std	Std
6	6	6	6	6	6	6	R7, R20, R22, R23, R28, R29	100k	Resistor, Chip, 1/16W, 1%	603	Std	Std
3	3	3	3	3	3	3	R8, R16, R32	10.0k	Resistor, Chip, 1/16W, 1%	402	Std	Std

Table 1. Bill of Materials (continued)

'50 -001	'51 -002	'51A -003	'52 -004	'50A -005	'51B -006	'53 -007	RefDes	Value	Description	Size	Part Number	MFR
2	2	2	2	2	2	2	R9, R17	0.01	Resistor, Chip, 1/2W, 1%	2010	WSL2010R0 100FEA	Dale
10	10	10	10	10	10	10	SJ1, SJ2, SJ3, SJ4, SJ5, SJ6, SJ7, SJ8, SJ9, SJ10	929950 -00	Shorting jumpers, 2-pin, 100mil spacing,		929950-00	3M/ESD
4	4	4	4	4	4	4			6-32 NYL nuts			
4	4	4	4	4	4	4	ST1, ST2, ST3, ST4	4816	STANDOFF M/F HEX 6-32 NYL .500"	sf_thvt_325_ rnd	Keystone	4816
2	2	2	2	2	2	2	TP1, TP20	5001	Test Point, Black, Thru Hole Color Keyed	0.100 x 0.100 inch	5001	Keystone
14	14	14	14	14	14	14	TP18,TP19, TP21,TP22, TP23,TP24, TP25,TP26, TP27,TP28, TP29,TP30, TP31,TP32	5002	Test Point, White, Thru Hole Color Keyed	0.100 x 0.100 inch	5002	Keystone
4	4	4	4	4	4	4	TP2,TP15,T P16,TP17	131- 4244- 00	Adaptor, 3.5-mm probe clip (or 131-5031-00)	0.200 inch	131-4244-00	Tektronix
0	0	0	0	0	0	0	TP3,TP4,TP 5,TP6,TP7,T P8,TP9,TP1 0,TP11,TP1 2,TP13,TP1 4	STD	Test Point, 0.020 Hole		STD	STD
1	0	0	0	0	0	0	U1	BQ247 50RHD	IC, Battery Charge Controller	QFN-28	BQ24750RH D	TI
0	1	0	0	0	0	0	U1	BQ247 51RHD	IC, Battery Charge Controller	QFN-28	BQ24751RH D	TI
0	0	1	0	0	0	0	U1	BQ247 51ARH D	IC, Battery Charge Controller	QFN-28	BQ24751AR HD	TI
0	0	0	1	0	0	0	U1	BQ247 52RHD	IC, Battery Charge Controller	QFN-28	BQ24752RH D	TI
0	0	0	0	1	0	0	U1	BQ247 50ARH D	IC, Battery Charge Controller	QFN-28	BQ24750AR HD	TI
0	0	0	0	0	1	0	U1	BQ247 51BRH D	IC, Battery Charge Controller	QFN-28	BQ24751BR HD	TI
0	0	0	0	0	0	1	U1	BQ247 53RHD	IC, Battery Charge Controller	QFN-28	BQ24753RH D	TI
1	1	1	1	1	1	1		HPA20 7	Printed Circuit board			Any

4.1 Board Layout

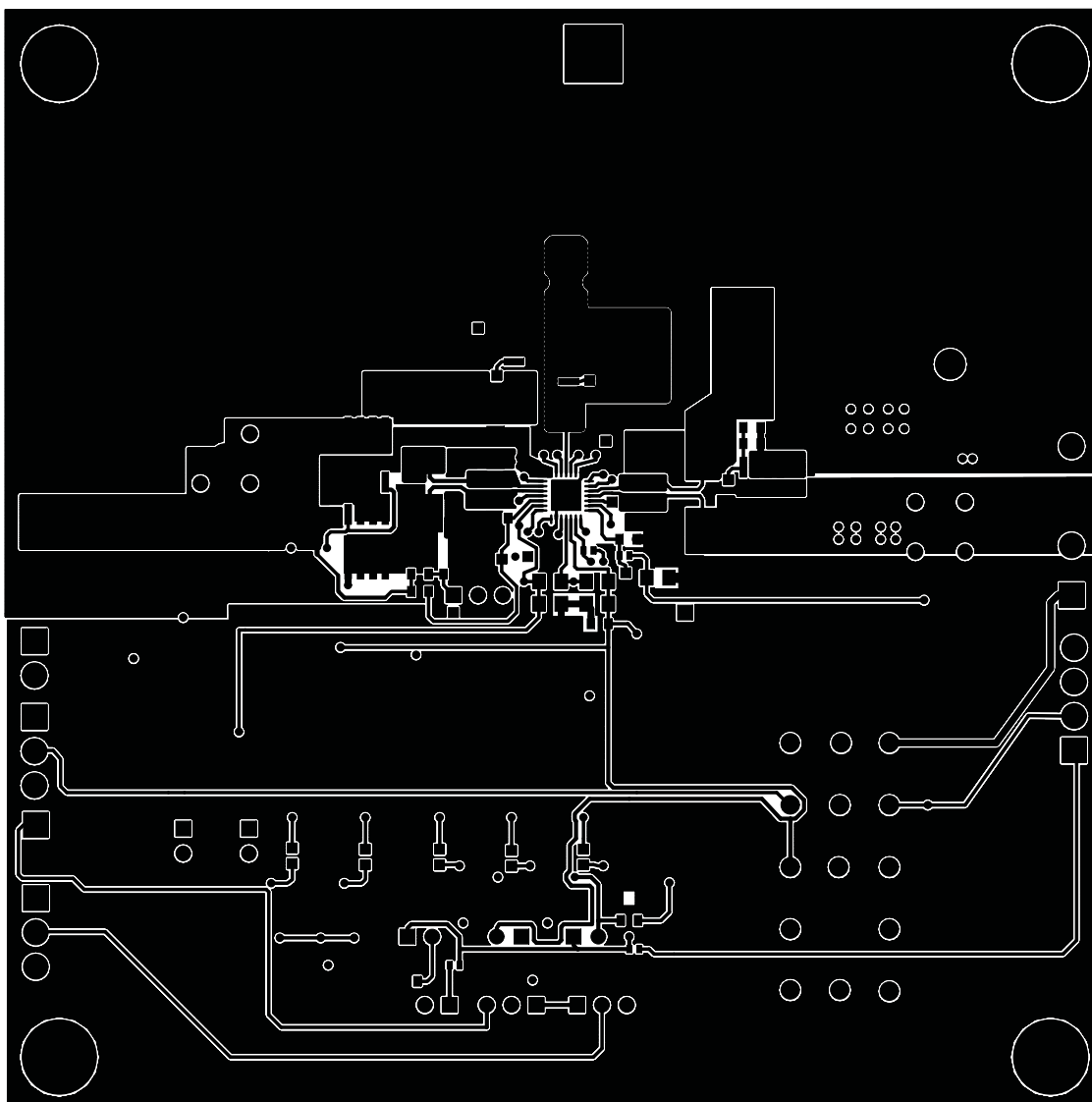


Figure 5. Top Layer

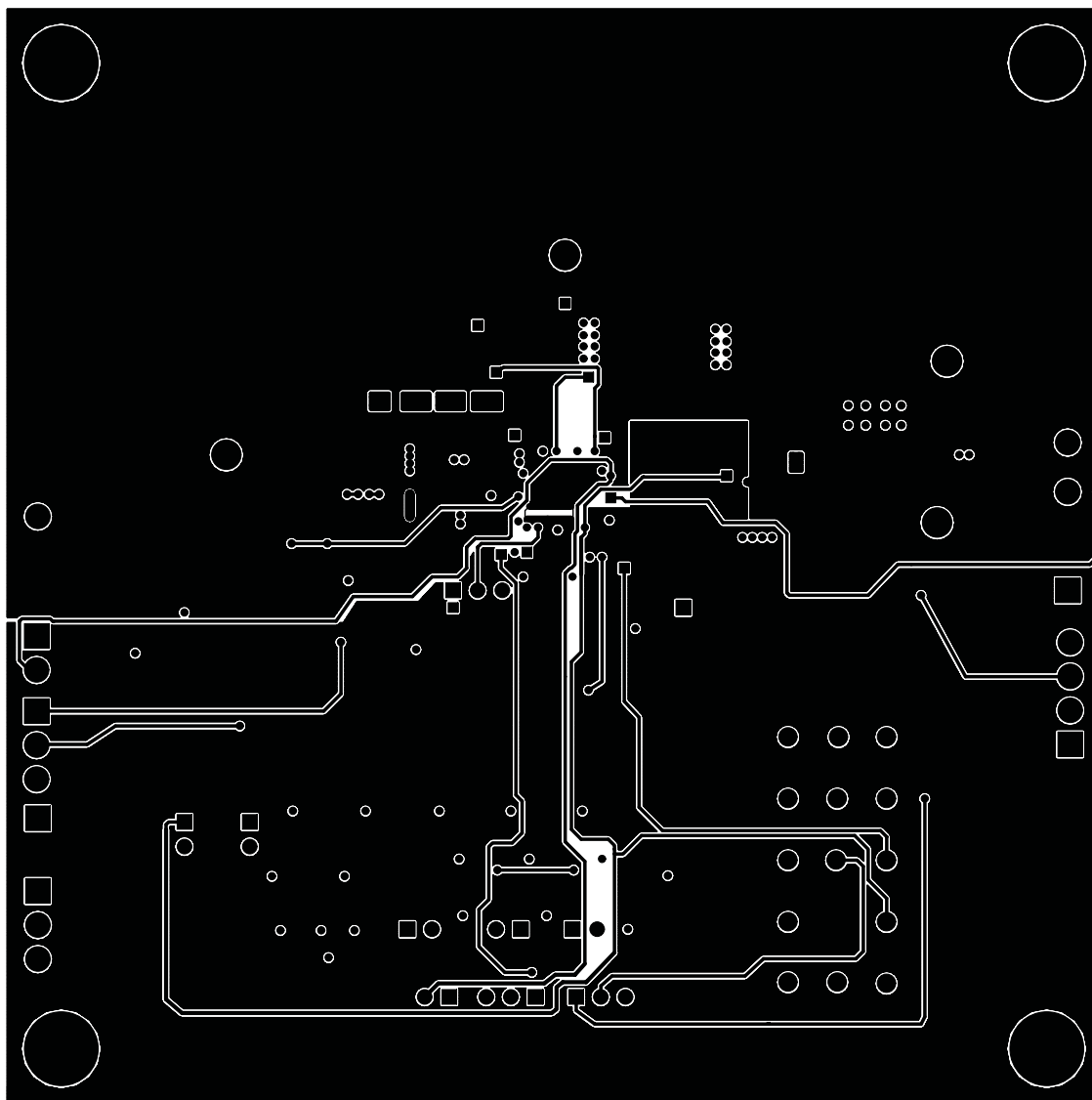


Figure 6. 2nd Layer

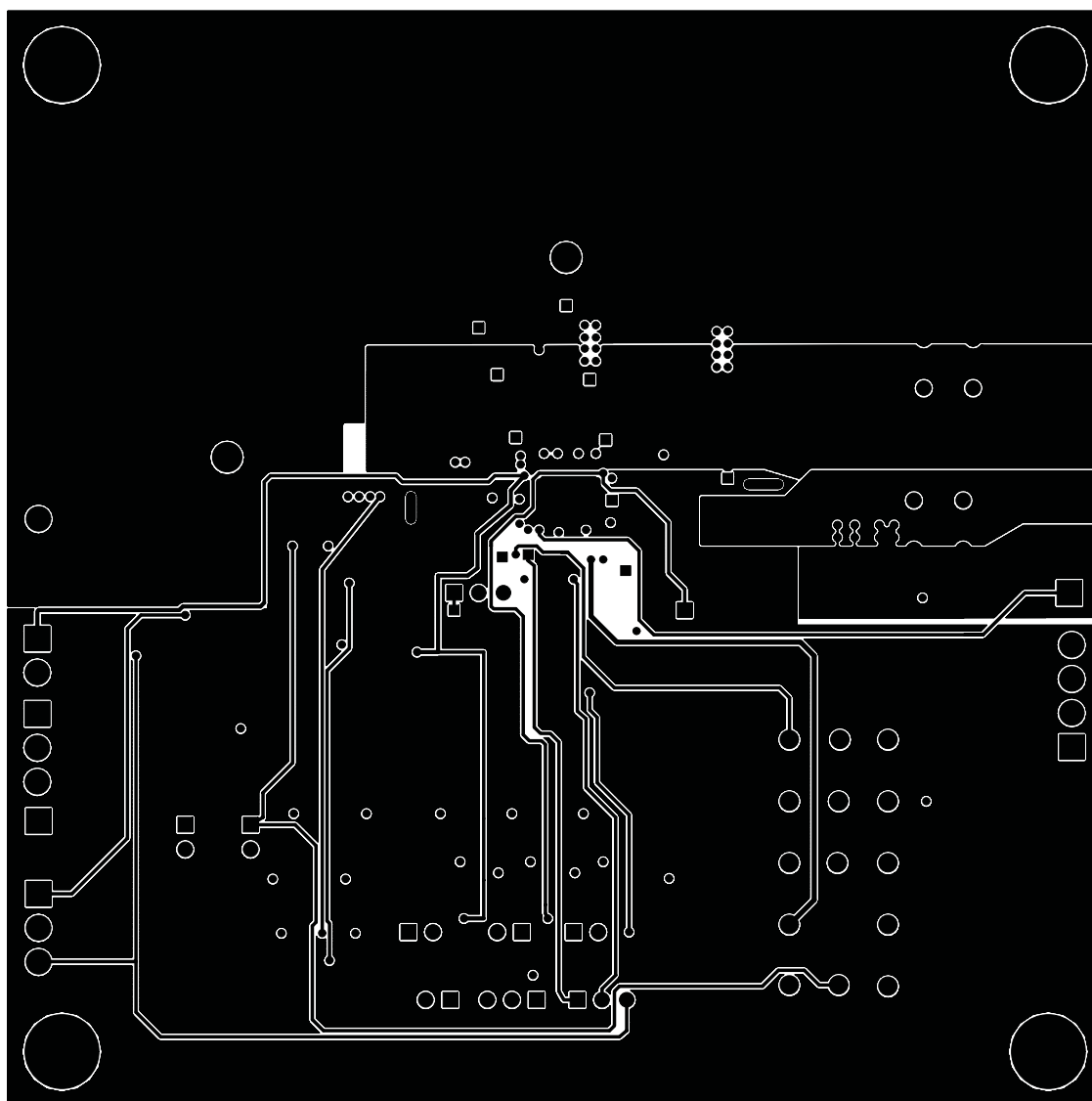


Figure 7. 3rd Layer

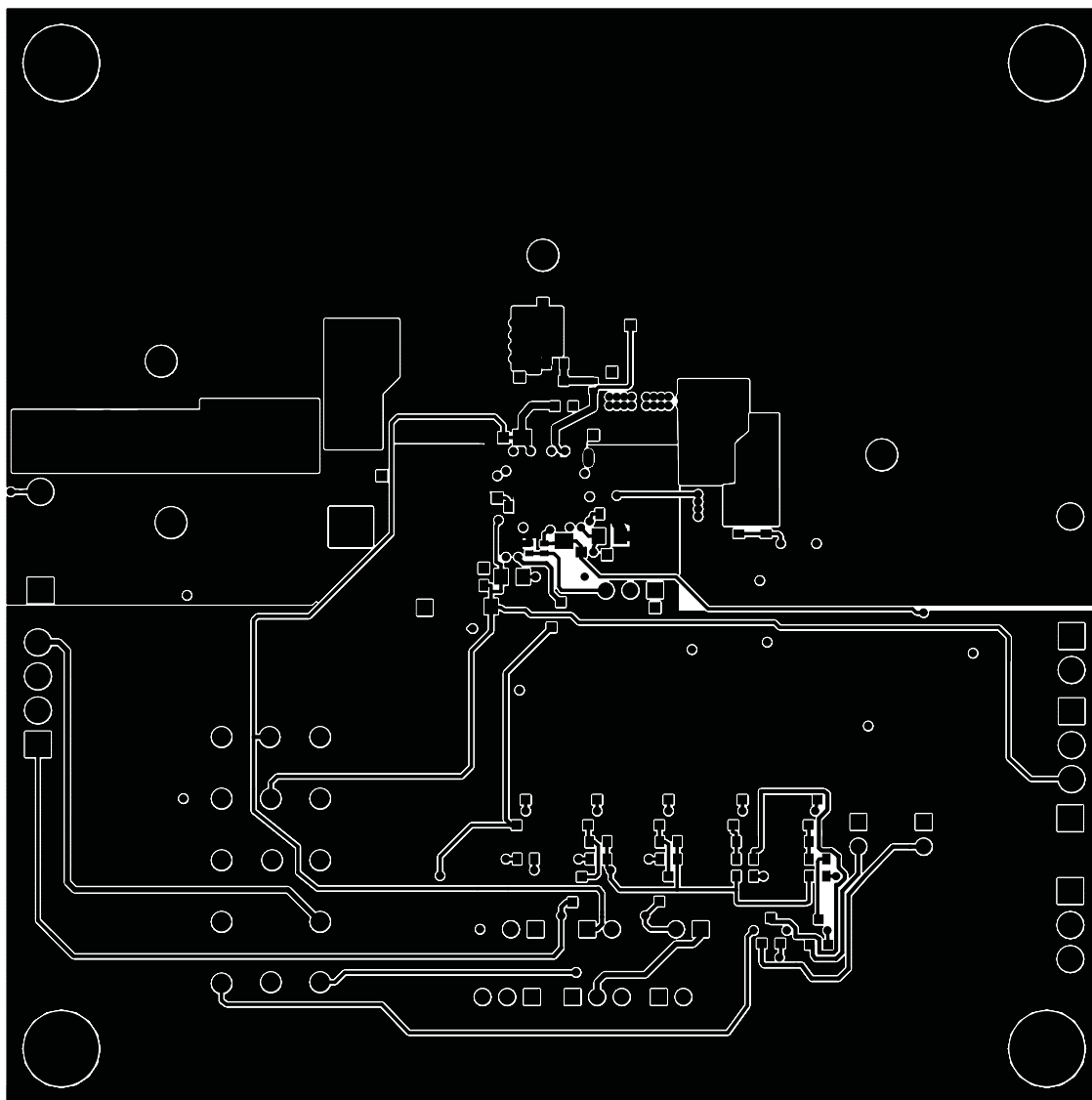


Figure 8. Bottom Layer



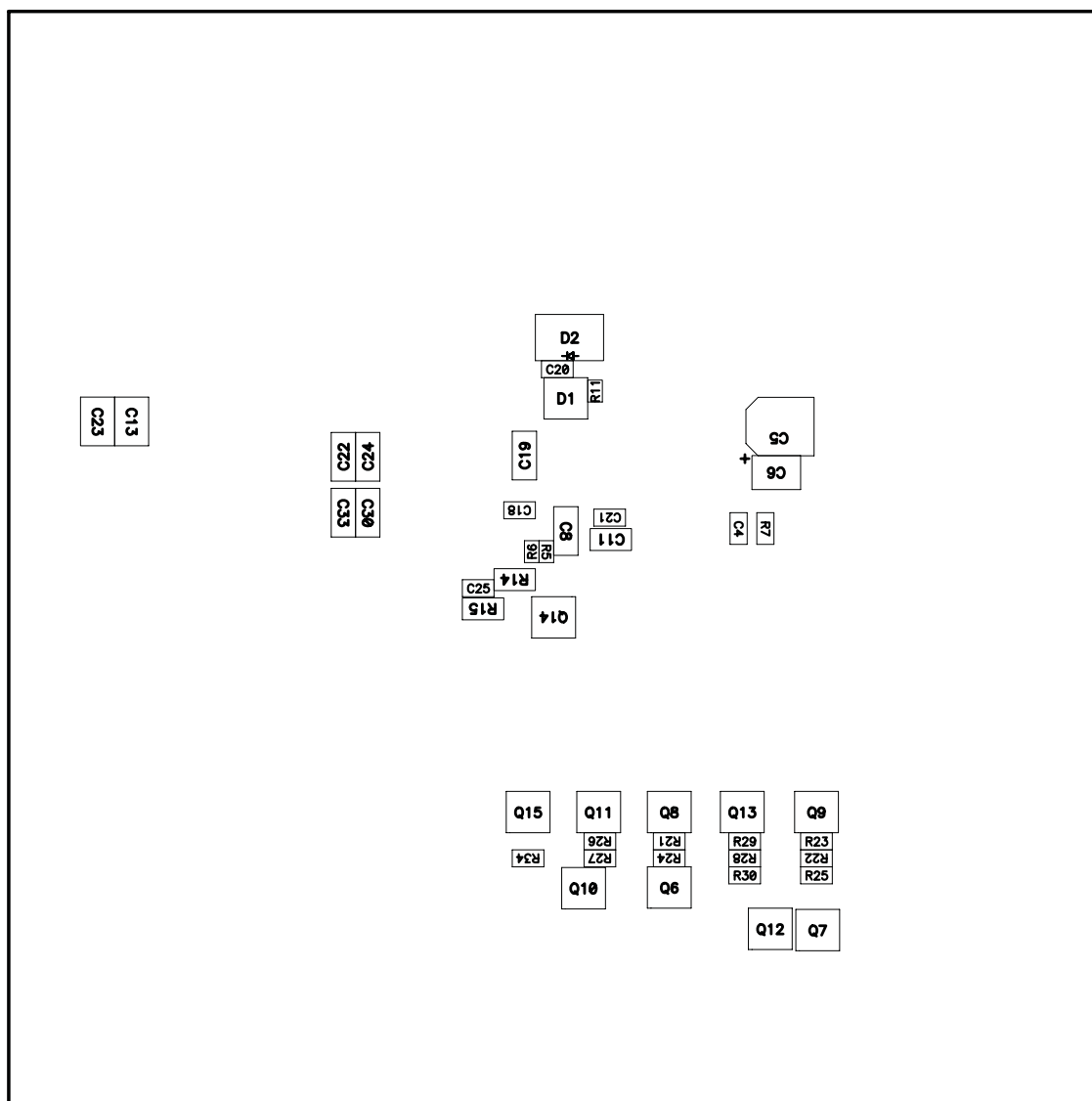
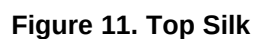
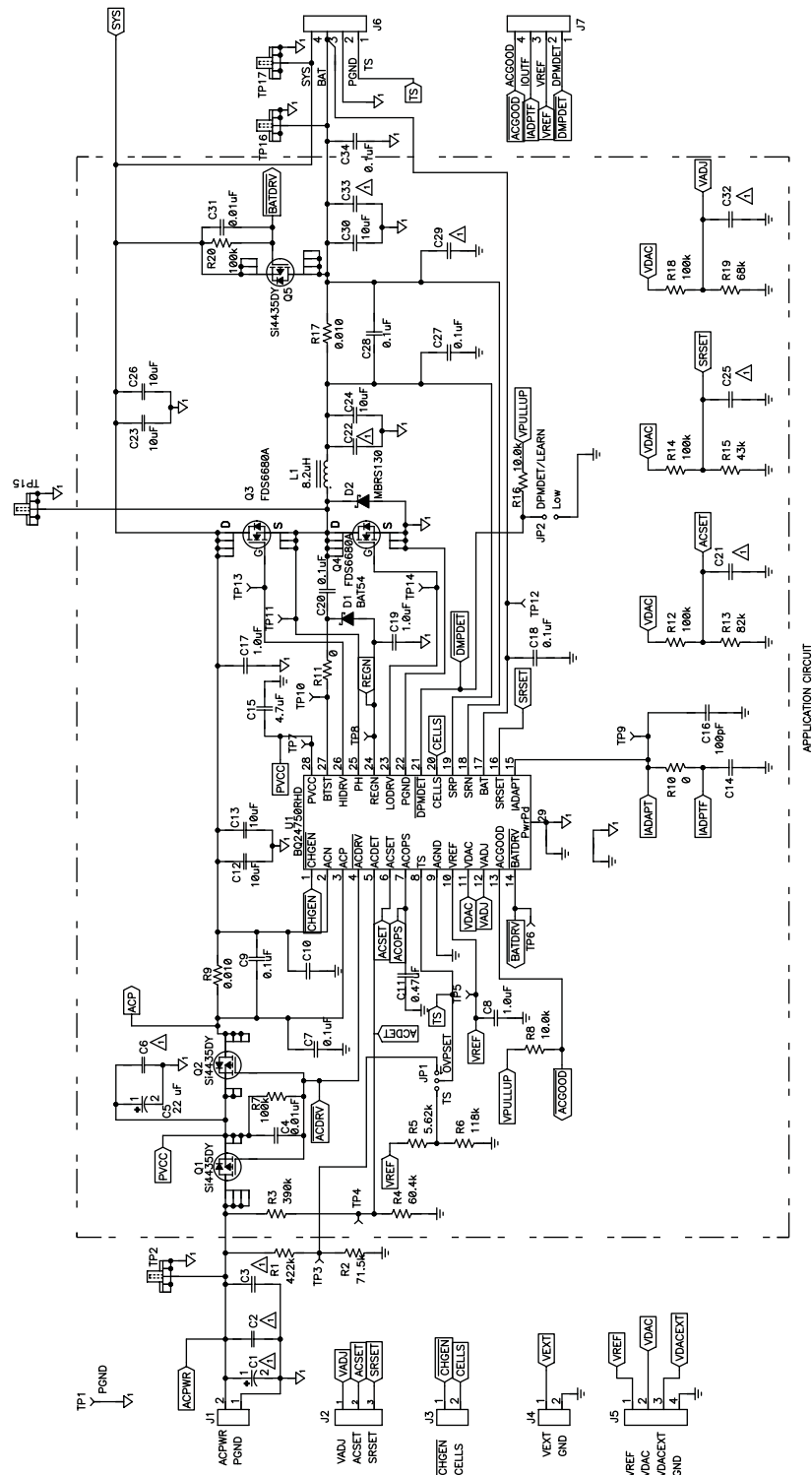
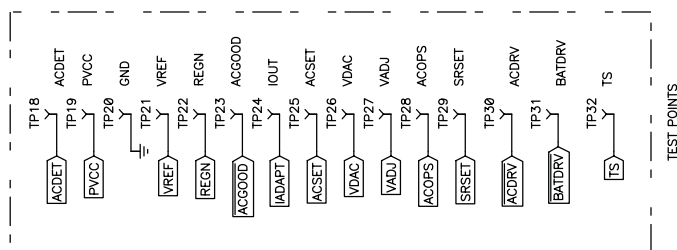
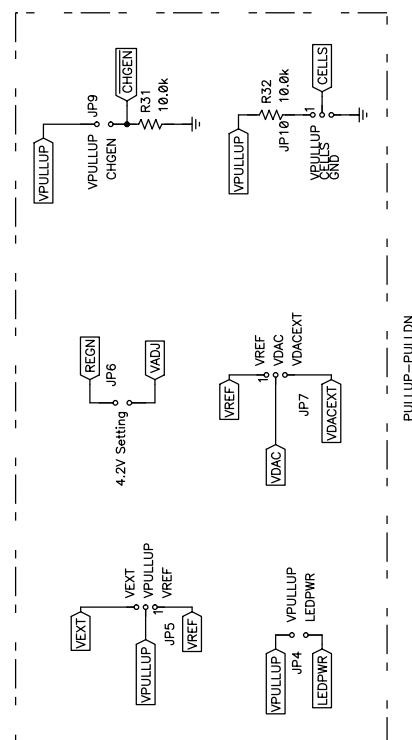
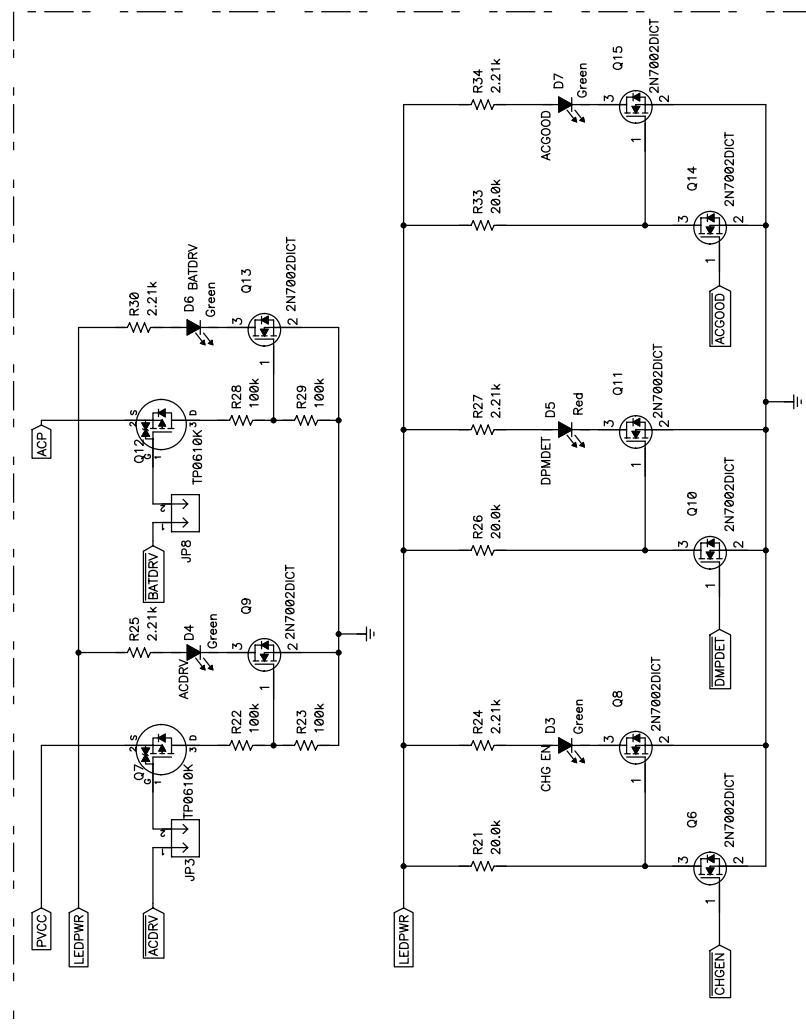


Figure 10. Bottom Assembly



The schematic is shown on the following page.





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 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.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2010, Texas Instruments Incorporated

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

TI products are not authorized for use in safety-critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, unless officers of the parties have executed an agreement specifically governing such use. Buyers represent that they have all necessary expertise in the safety and regulatory ramifications of their applications, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of TI products in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by TI. Further, Buyers must fully indemnify TI and its representatives against any damages arising out of the use of TI products in such safety-critical applications.

TI products are neither designed nor intended for use in military/aerospace applications or environments unless the TI products are specifically designated by TI as military-grade or "enhanced plastic." Only products designated by TI as military-grade meet military specifications. Buyers acknowledge and agree that any such use of TI products which TI has not designated as military-grade is solely at the Buyer's risk, and that they are solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI products are neither designed nor intended for use in automotive applications or environments unless the specific TI products are designated by TI as compliant with ISO/TS 16949 requirements. Buyers acknowledge and agree that, if they use any non-designated products in automotive applications, TI will not be responsible for any failure to meet such requirements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

Products		Applications	
Amplifiers	amplifier.ti.com	Audio	www.ti.com/audio
Data Converters	dataconverter.ti.com	Automotive	www.ti.com/automotive
DLP® Products	www.dlp.com	Communications and Telecom	www.ti.com/communications
DSP	dsp.ti.com	Computers and Peripherals	www.ti.com/computers
Clocks and Timers	www.ti.com/clocks	Consumer Electronics	www.ti.com/consumer-apps
Interface	interface.ti.com	Energy	www.ti.com/energy
Logic	logic.ti.com	Industrial	www.ti.com/industrial
Power Mgmt	power.ti.com	Medical	www.ti.com/medical
Microcontrollers	microcontroller.ti.com	Security	www.ti.com/security
RFID	www.ti-rfid.com	Space, Avionics & Defense	www.ti.com/space-avionics-defense
RF/IF and ZigBee® Solutions	www.ti.com/lprf	Video and Imaging	www.ti.com/video
		Wireless	www.ti.com/wireless-apps