bq24072/3/4/5/9(T) and bq24230/2 1.5-A Single-Chip Li-Ion and Li-Polymer Charge Management IC EVM

This user's guide describes the bq24072/3/4/5/9(T) and bq24230/2 (bqTINY-III™) evaluation module (EVM). The EVM provides a convenient method for evaluating the performance of a charge management and system power solution for portable applications using the bq24072/3/4/5/9(T) and bq24230/2 product families. A completely designed and tested module is presented. The charger is designed to deliver up to 1.5 A of continuous current to the system or charger for one-cell Li-ion or Li-polymer applications (see the data sheet for correct device) using a dc power supply. The charger is programmed from the factory to deliver 0.9 A of charging current. This EVM was designed as a stand-alone evaluation module, but it also can be interfaced with the system and host via the connectors and headers.

Contents

List of Figures

List of Tables

1 Introduction

The bq2407x and bq2432x powers the system while independently charging the battery. This feature reduces the charge and discharge cycles on the battery, allows for proper charge termination, and allows the system to run with an absent or defective battery pack. This feature also allows for the system to instantaneously turn on from an external power source even when using a deeply discharged battery pack.

This charger has one input and can be programmed to be used with an adapter or USB port as the power source for the system. In the USB configuration, the host can select from the two preset input maximum rates of 100 mA and 500 mA. The charger dynamically adjusts the charge rate based on the system load to stay within the 100-mA or 500-mA maximum limits. An external resistor, RSET1, sets the magnitude of the charge current. If the charge current exceeds the available input current, the voltage on the OUT pin drops to the DPPM threshold or the battery voltage, whichever is higher. The charging current is reduced to what current is available ($I_{BAT} = I_{IN} – I_{OUT}$).

The integrated circuit (IC) charges the battery in three phases: conditioning, constant current, and constant voltage. Charge is terminated based on minimum current. A resistor-programmable charge timer provides a backup safety for charge termination. The charge automatically re-starts if the battery voltage falls below an internal threshold. Sleep mode is entered when the supply is removed (Vin drops to the battery voltage).

2 Considerations When Testing and Using bq24072/3/4/5/9(T) and bq24230/2 ICs

Consider the following noteworthy items while testing and using the bq2403x ICs.

The bq24072/3/4/5/9(T) series targets current above a nominal 500 mA (>350 mA) and the difference are listed in Table 1.

Table 1. Ordering Information

Part Number	V_{OVP}	V_{BAT}	$V_{OUT(REG)}$	V_{DPM}	Optional Function	Marking
bq24072RGTR	6.6 V	4.2 V	V_{BAT} + 200 mV	$V_{O(REG)}$ – 100 mV	TD	CKP
bq24072RGTT	6.6 V	4.2 V	V_{BAT} + 200 mV	$V_{O(REG)}$ – 100 mV	TD	CKP
bq24072TRGTR	6.6 V	4.2 V	V_{BAT} + 225 mV	$V_{O(REG)}$ – 100 mV	TD	PAP
bq24072TRGTT	6.6 V	4.2 V	V_{BAT} + 225 mV	$V_{O(REG)}$ – 100 mV	TD	PAP
bq24073RGTR	6.6 V	4.2 V	4.4 V	$V_{O(REG)}$ – 100 mV	TD	CKQ
bq24073RGTT	6.6 V	4.2 V	4.4 V	$V_{O(REG)}$ – 100 mV	TD	CKQ
bq24074RGTR	10.5 V	4.2 V	4.4 V	$V_{O(REG)}$ – 100 mV	ITERM	BZF
bq24074RGTT	10.5 V	4.2 V	4.4 V	$V_{O(REG)}$ – 100 mV	ITERM	BZF
bq24075RGTR	6.6 V	4.2 V	5.5 V	4.3 V	SYSOFF	CDU
bq24075RGTT	6.6 V	4.2 V	5.5 V	4.3 V	SYSOFF	CDU
bq24075TRGTR	6.6 V	4.2 V	5.5 V	4.3 V	SYSOFF	OEC
bq24075TRGTT	6.6 V	4.1 V	5.5 V	4.3 V	SYSOFF	OEC
bq24079RGTR	6.6 V	4.1 V	5.5 V	4.3 V	SYSOFF	ODI
bq24079RGTT	6.6 V	4.1 V	5.5 V	4.3 V	SYSOFF	ODI
bq24079TRGTR	6.6 V	4.1 V	5.5 V	4.3 V	SYSOFF	OED
bq24079TRGTT	6.6 V	4.1 V	5.5 V	4.3 V	SYSOFF	OED

The bq24079(T) ICs are regulated to 4.1 V. The "T" version uses a voltage-based TS bias, which allows more flexibility in setting the temperature range, whereas the bq24072/3/4/5 ICs use current-biased TS.

The bq24230/2 family is identical to the bq24073/4 ICs except that they are trimmed and their target current values nominally are at 300 mA (<450 mA). This family is suited for headset designs. The pinout of each IC is the same across both families except pin 15 (JMP2 on the EVM); the pin 15 function is listed in Table 1 under the *Optional Function* column.

bqTINY-III is a trademark of Texas Instruments.

The two potential sources to power the system (V_{OUT}) are the input source and the battery (adapter or USB port). The IC is designed to power the system continuously. The battery, in most cases, is the last line of backup. If the adapter/USB input is not available (or disabled), the battery connects to the system.

In thermal regulation condition (T_J = 125°C not a first-choice design mode of operation), the charge current is reduced to the battery, and the system still gets its power from the input. The battery supplement is available in thermal regulation if the V_{OUT} falls to V_{BAT}. In thermal cutoff (~155°C), the input sources are disconnected, but the internal battery FET connects the battery to V_{OUT}.

3 Performance Specification Summary

Table 2 summarizes the performance specifications of the EVM.

Table 2. Performance Specification Summary for bq24072/3/4/5/9(T) and bq24230/2 EVMs

SPECIFICATION	TEST CONDITIONS	MIN	TYP	MAX	UNITS
Input dc Voltage, $V_{I(AC)}$		4.75	5	6.5	Volts
Battery Charge Current, $I_{O(CHG)}$			1	1.5	Amperes
Power Dissipation, bq24072/3/4/5/9(T) and bq24230/2 IC, 1 Cell	Pdiss = (Vin-Vout)Iout +(Vin-Vbat)Ibat			See(1)	Watts

(1) The HPA073 (bq24072/3/4/5/9(T) and bq24230/2) thermal design is optimized (8+ vias, 0.031-inch PCB, 2-oz. copper) to give θ_{JA} ~ 27°C/W.

3.1 Performance Recommendations

This IC is a linear battery charger and also powers the system from the input via the linear regulator output. The key here is that this is a linear device that is most efficient when the input voltage is not too far above the battery voltage (Vin = 4.75 V to 5.5 V). Too low of input voltage (less than the OUT voltage plus the dropout voltage) results in degraded performance. Excessive input voltage (>5.5 V) results in excess power dissipation and reduced performance via thermal regulation. The IC is rated to 28 V, and will not be damaged with Vin voltages less than this, but any Vin voltage over the overvoltage protection (OVP) threshold disables the IC. Thus, the recommended operating range for maximum performance is between 4.75 V and 5.5 V, with a preference toward the lower values.

4 Test Summary

This section covers the setup and tests performed in evaluating the EVM.

4.1 Equipment

- Power supply (+5.25 ±0.25 Vdc), current limit set to 2 A ±0.2 A
- Three Fluke 75 DMMs (equivalent or better)
- Oscilloscope, Model TDS220 (equivalent or better)

4.2 Equipment and EVM Setup

- Preset P/S#1 to 5.25 V ±0.25 V, 2 A ±0.25-A current limit, turn off and connect to J1-IN/GND (+ to IN and – to GND)
- Connect a 10-Ω, 10-W resistor to J2-OUT/VSS
- Connect a fully discharged (Vbat <2.8 V) Battery to J3-BAT+/VSS (+ to BAT+ and – to VSS).
- Apply the jumpers as per Table 3.
- For the bq2407xEVM, adjust the potentiometers as follows (measure resistance from TP# to VSS):
  - R8 (ILIM-TP12) = 750 Ω (743 to 757); R11 (ISET-TP16) = 1 kΩ (0.98 kΩ to 1.02 kΩ) and R16 (TS-TP1) = 7.5 kΩ (7.3 kΩ to 7.7 kΩ); and for ’74 (-003): R10 (ITERM-TP15) = 3 kΩ (2.98 kΩ to 3.02 kΩ).
- For the bq2423xEVM, adjust the potentiometers as follows (measure resistance from TP# to VSS):
  - R8 (ILIM-TP12) = 750 Ω (743 to 757); R11 (ISET-TP16) = 2.96 kΩ (2.93 kΩ to 2.99 kΩ) and R16 (TS-TP1) = 7.5 kΩ (7.3 kΩ to 7.7 kΩ); and for ’74 (-006): R10 (ITERM-TP15) = 3 kΩ (2.98 kΩ to 3.02 kΩ).

Table 3. bq240xx

Jumper	'72	'73 or '230	'74 or '232	'75
JMP1	RES–TMR	RES–TMR	RES–TMR	RES–TMR
JMP2	TD–Vss	TD–Vss	TD–Vss	TD–Vss
JMP3	CE–Vss	CE–Vss	CE–Vss	CE–Vss
JMP4	EN2–HI	EN2–HI	EN2–HI	EN2–HI
JMP5	EN1–Vss	EN1–Vss	EN1–Vss	EN1–Vss

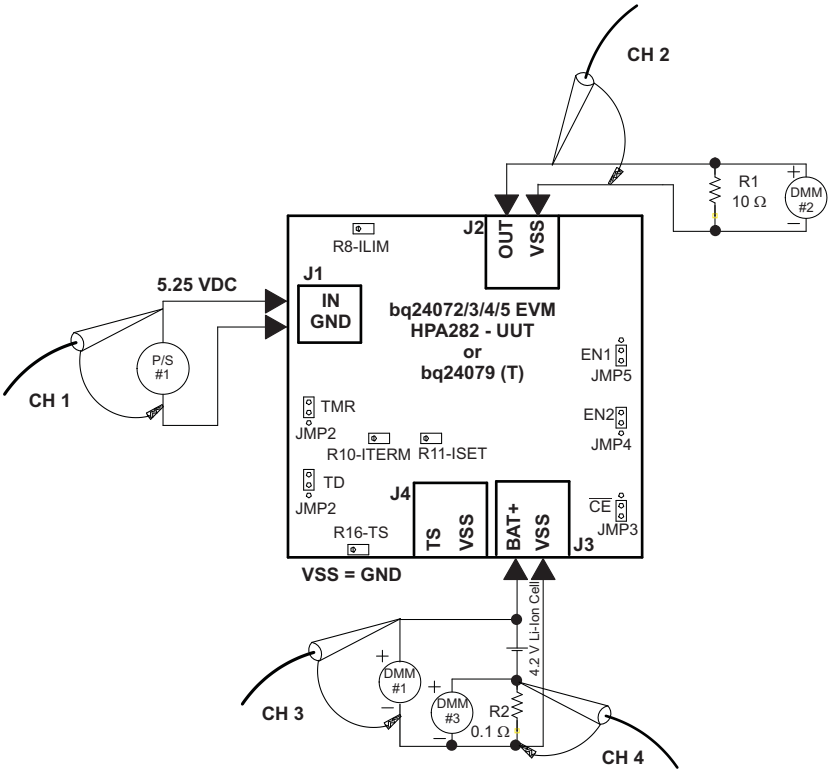


Figure 1. Test Diagram

4.3 Test Procedure

1. Verify that the equipment and EVM is set up according to the preceding section.
2. Verify that V_{OUT} is approximately equal to V_{BAT}
3. Turn on P/S#1, +5.25-Vdc supply to the UUT.
4. Verify V_{BAT} is between 2.4 Vdc and 3 Vdc, and the charger is in precharge state: LEDs CHG (D1) and PGOOD (D2) are on. If V_{BAT} is above the low-voltage threshold ($V_{(LOWV)}$ ~3 V), then the IC is in fast-charge mode. If the IC is in fast charge, skip step 7.
5. Verify DMM#3, I_{BAT} is ~9 mV or ~0.09 A
6. Verify that V_{OUT} for bq24072 is ~200 mV above the battery voltage or a minimum of 3.4 Vdc. For bq24073/4 verify that V_{OUT} is ~4.4 Vdc. Verify that bq24075/9(T) is ~5.5 Vdc for V_{IN} > 5.6 V and equal to V_{IN} for Vin < 5.6 V.
7. Allow the battery to charge until V_{BAT} is between 3.3 Vdc and 4 Vdc. The charger delivers the programmed constant current to the battery unless the input cannot source the required current.
8. Verify I_{BAT} is ~88 mV or ~0.9 A (for a 1-kΩ resistor on *ISET*).
9. Verify V_{OUT} : bq24072 – ~200 mV above the battery voltage.
10. Set JMP5 (EN1) to HI, and verify that the chip has been disabled, D1 (CHG) has turned off, and the P/S#1 current has dropped to zero. The internal battery FET must be on, connecting the BAT pin to the OUT pin. Verify that the voltage on the OUT pin is close to the battery voltage. See Figure 2 for

EN1/2 modes of operation.

11. SET JMP4 (EN2) to VSS. Verify that the input current is less than 500 mA (USB 500-mA mode). If the input current is restricted due to USB mode, or if the adapter is current limiting, the OUT pin drops in voltage and enters the DPM mode, if the system current is less than the restricted input current. This IC must be in DPM mode with the system voltage at the DPM
12. Set JMP5 (EN1) to VSS and verify USB 100-mA mode. The system load is more than the allowed 100 mA on the input, so the OUT voltage drops to the battery voltage, and the battery FET is switched on and supplements the input current. Verify that Vout has dropped just below the battery voltage and the battery is supplying Ibat, ~(Vout/10 Ω – 100 mA).
13. Set JMP4 (EN2) to HI to return to the ISET mode where the programmed current is ~0.9 A.
14. Set JMP3 to HI, and verify that the charging is disabled and that the CHG LED (D1) turns off. Verify that the system is still powered by the input. See Figure 3.
15. Set JMP3 to VSS, and verify that charging continues and that D1 turn on.
16. Record the OUT voltage and battery charge current. Adjust R8 CCW until the input current starts to be reduced (~2 turns). Note how the OUT voltage drops and the charge current is reduced as the input current limit loops kicks in and limits the input current. Adjust R8 to its original position
17. On the bq24075 IC, set JMP2 HI, and verify that the BAT FET turns off and allows no charging or discharging of the battery.
18. Adjust the R16 (TS-Pot) up or down until the TS threshold is reached. Verify that the charging current is disabled. Return the TS resistance within the normal range and verify the continued charging operation.
19. Allow the battery to continue to charge until the battery reaches voltage regulation, ~4.2 V ±40 mV for bq24072/3/4/5/9(T) and 4.1 V ±4 mV for bq24079(T). Verify that the voltage is regulated as the current tapers over the next one-to-two hours depending on the battery capacity. See Figure 4 for a charge profile (time in plot is not proportional to actual charge time).
20. Verify that the current tapers to around 90 mA (9 mV on DMM#3) when termination occurs. Note on the ’72 and ’73 ICs that termination can be disabled by setting the TD pin HI (JMP2). Also note that on ’74, the ITERM resistor (R10) can adjust the termination threshold.
21. Verify that the LED, D1, turns off and the current drops to zero.
22. Turn off P/S#1, and allow the system load to discharge the battery until a refresh charge is initiated. Verify that the battery voltage dropped to ~4.1 V for bq24072/3/4/5 and to 4.0 V for bq24079(T) prior to refresh.
23. Verify that the LED, D1, did not turn on for the refresh cycle.

This concludes the procedure for demonstrating the features of this power path charger. See the data sheet for more detailed explanations and instructive waveforms.

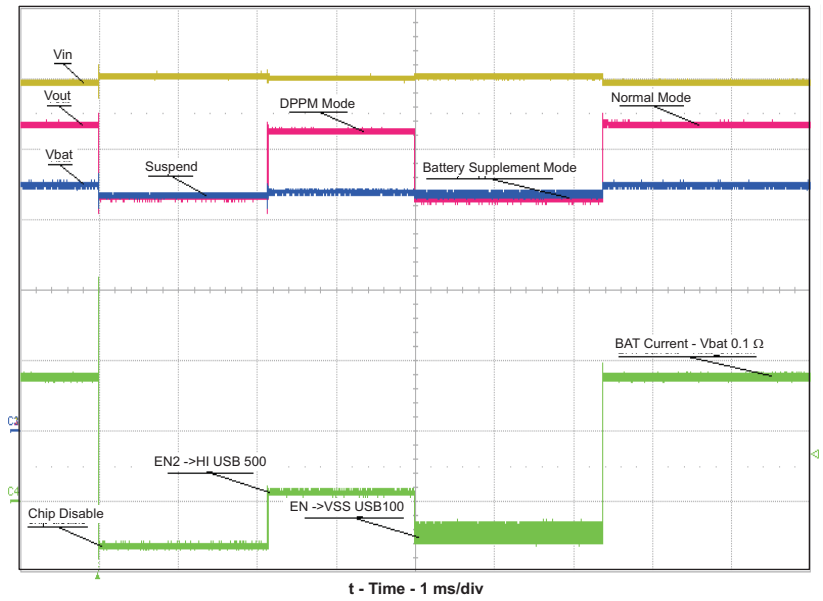


Figure 2. Modes of Operation Tested in Steps 11 Through 13

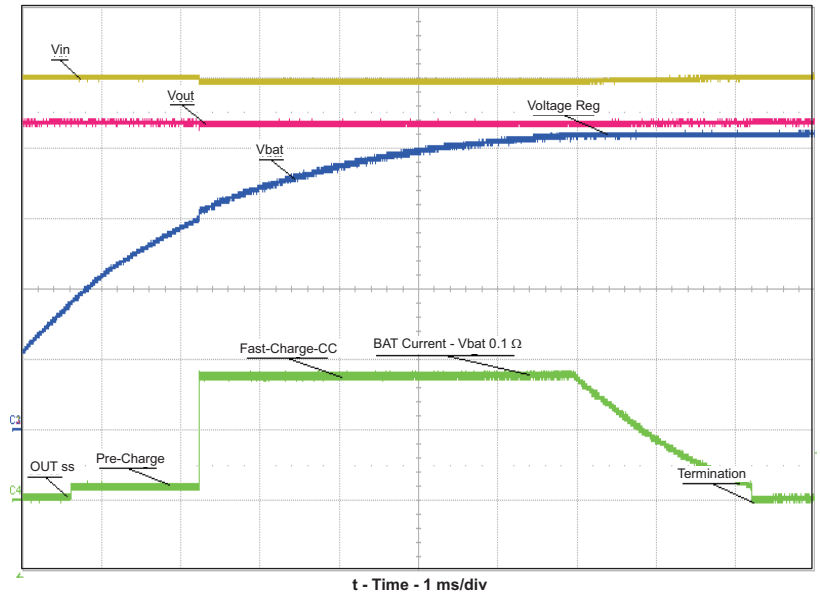


Figure 3. Charger Profile With EN1 = VSS and EN2 = HI, Programmed by ISET

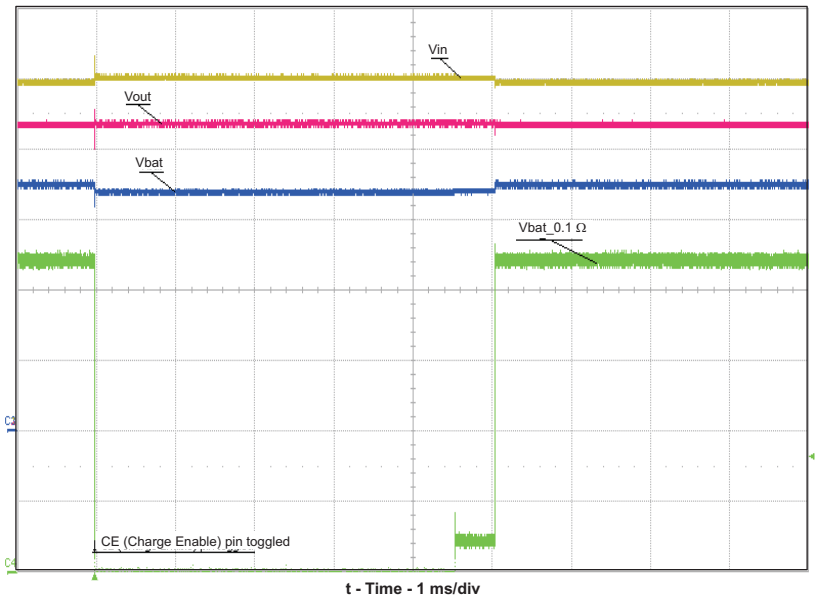


Figure 4. Charge Enabled, Pulled High, Then Low – Disables Charge

5 Schematic

The bq24072/3/4/5/9(T) and bq24230/2 EVM schematic appears on the last page of this document.

6 Physical Layouts

This section contains the board layout and assembly drawings for the EVM.

6.1 Board Layout

Figure 5 shows the top assembly view of the EVM. Figure 6 shows the top etch layer of the EVM and Figure 7 shows the bottom etch layer.

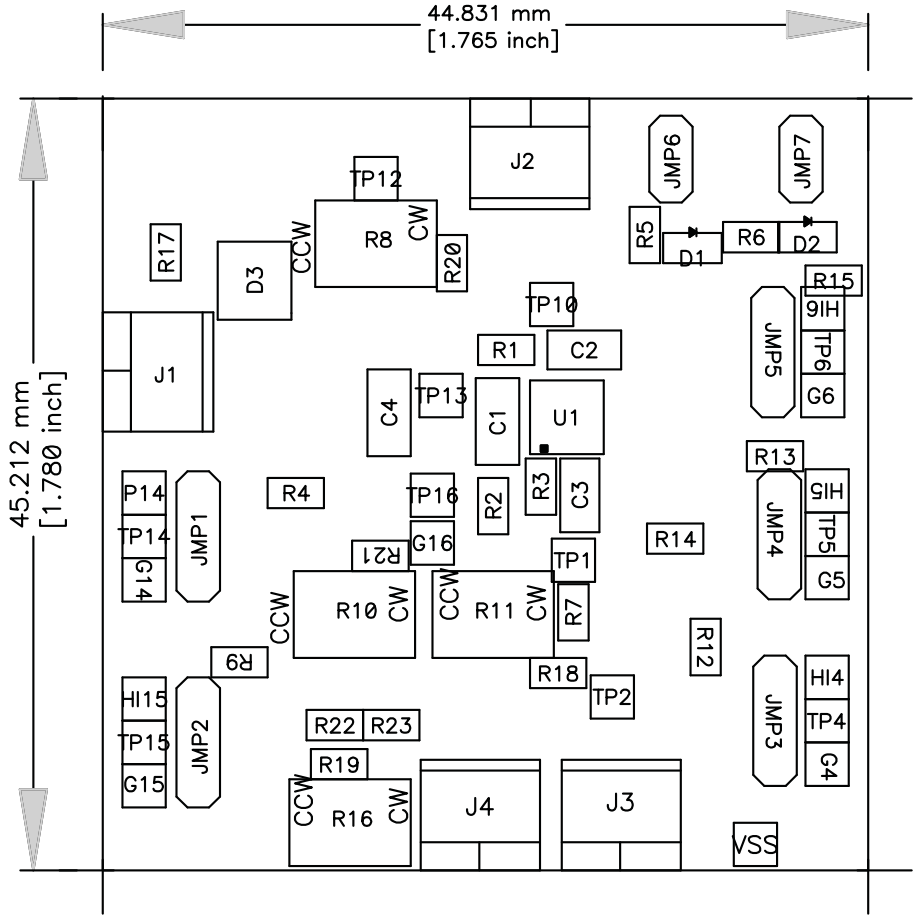


Figure 5. Top Assembly View

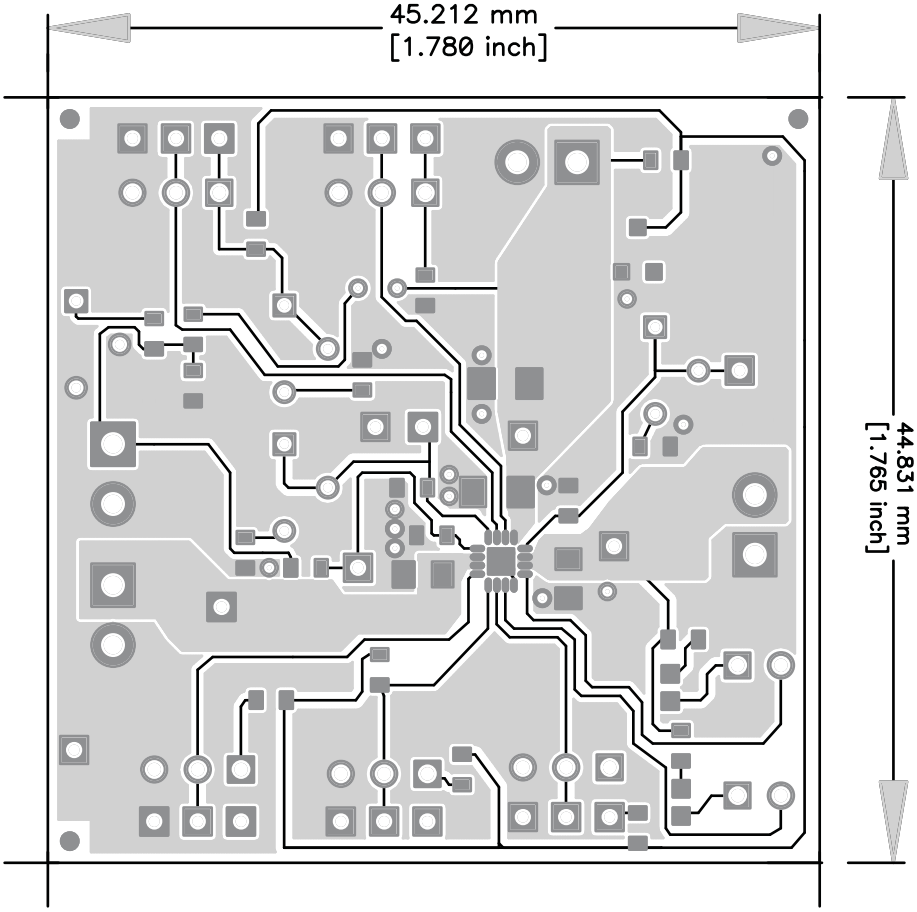


Figure 6. Board Layout – Top Etch Layer

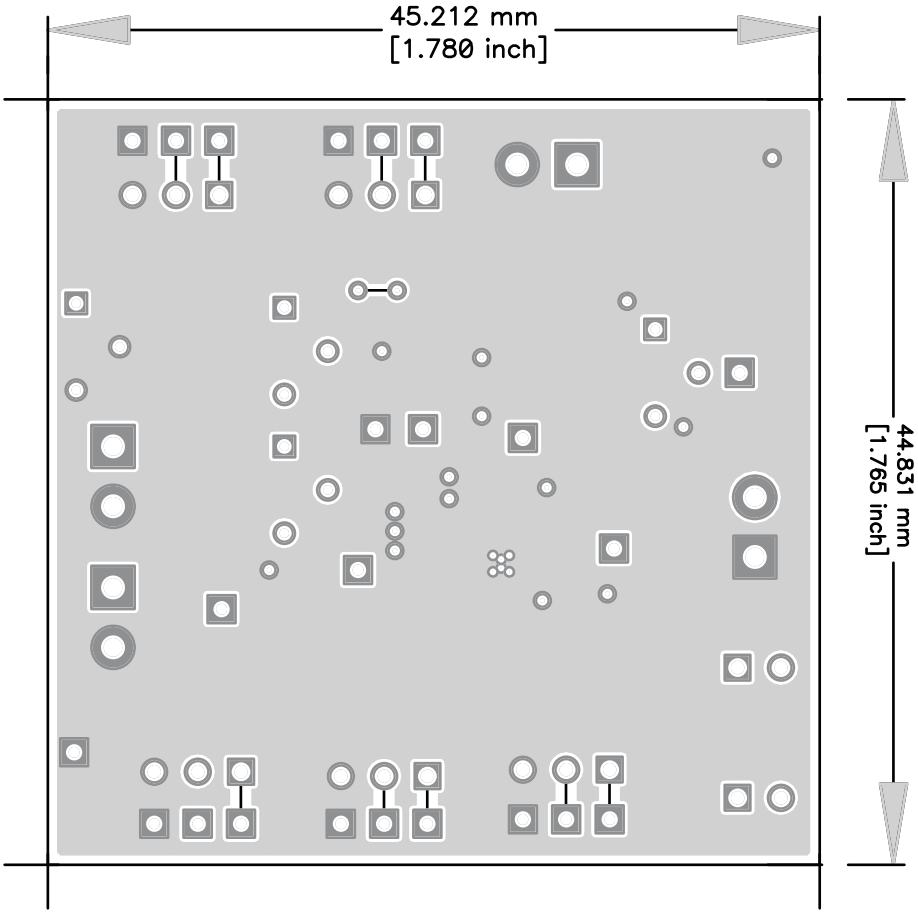


Figure 7. Board Layout – Bottom Etch Layer

7 Bill of Materials

Table 4. HPA282B Bill of Materials

-001	-002	-003	-004	RefDes	Value	Description	SIZE	Part Number	MFR
2	2	2	2	C1, C4	10uF	Capacitor, Ceramic, 10-uF, 25-V, X5R, 20%	1206	ECJ-3YB1E106M	Panasonic
2	2	2	2	C2, C3	10uF	Capacitor, Ceramic, 10-uF, 6.3-V, X5R, 20%	0805	ECJ-2FB0J106M	Panasonic
1	1	1	1	D1	Red	Diode, LED, Red, 1.8-V, 20-mA, 20-mcd	0603	LTST-C190CKT	Liteon
1	1	1	1	D2	Green	Diode, LED, Green, 2.1-V, 20-mA, 6-mcd	0603	LTST-C190GKT	Liteon
1	1	1	1	D3	BZX84C6v2T	Diode, Zener, 6.2-V, 350-mW	SOT-23	BZX84C6V2T	Diodes
2	2	2	2	J1, J2, J3, J4*	ED1514	Terminal Block, 2-pin, 6-A, 3.5mm	0.27 x 0.25	ED1514	OST
5	5	5	5	JMP1–JMP5	PEC02SAAN	Header, 3-pin, 100mil spacing	0.100 x 3	PEC02SAAN	Sullins
2	2	2	2	JMP6, JMP7	PEC03SAAN	Header, 2-pin, 100mil spacing	0.100 inch x 2	PEC03SAAN	Sullins
0	0	0	0	R1	732	Resistor, Chip, 1/16W, 1%	0603	Std	Std
0	0	1	0	R10	10k	Potentiometer, 1/4 in. Cermet, 12-Turn, Top-Adjust	0.25x0.17	3266W-103LF	Bourns
1	1	1	1	R11	10k	Potentiometer, 1/4 in. Cermet, 12-Turn, Top-Adjust	0.25x0.17	3266W-103LF	Bourns
1	1	1	1	R14	301k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	1	1	1	R16	50k	Potentiometer, 1/4 in. Cermet, 12-Turn, Top-Adjust	0.25x0.17	3266W-503LF	Bourns
1	1	1	1	R17	1k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
2	2	2	2	R18, R20	604	Resistor, Chip, 1/16W, 1%	0603	Std	Std
0	0	0	0	R2	1k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
0	0	0	0	R3	10k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	1	1	1	R4	49.9k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
2	2	2	2	R5, R6	1.5K	Resistor, Chip, 1/16W, 1%	0603	Std	Std
0	0	1	0	R21	1.5K	Resistor, Chip, 1/16W, 1%	0603	Std	Std
0	0	0	0	R22	23.7K	Resistor, Chip, 1/16W, 1%	0603	Std	Std
0	0	0	0	R23	11K	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	1	1	1	R7, R19	0	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	1	1	1	R8	5k	Potentiometer, 1/4 in. Cermet, 12-Turn, Top-Adjust	0.25x0.17	3266W-502LF	Bourns
1	1	0	1	R9	10k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
3	3	3	3	R12, R13, R15	10k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	0	0	0	U1	BQ24072RGT	IC, USB- Friendly Li-Ion Battery Charger and Power-Path Management	QFN-16	BQ24072RGT	TI
0	1	0	0	U1	BQ24073RGT		QFN-16	BQ24073RGT	TI
0	0	1	0	U1	BQ24074RGT		QFN-16	BQ24074RGT	TI
0	0	0	1	U1	BQ24075RGT		QFN-16	BQ24075RGT	TI
1	1	1	1	--		PCB, 1.8 In x 1.7 In x 0.031 In		HPA282	Any
7	7	7	7		929950-00	Shunts	100 mill	Black	3M

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.

5. * No substitutions of J1 through J4

6. Place Shunt as follows: JMP1=TRM:RES, JMP3=CE:VSS, JMP4=EN2:HI, JMP5, EN1:VSS, JMP6=pin1:pin2, JMP7=pin1:pin2
For JMP2=001/002/003=TD:HI, -004=TD:VSS:VSS,

Table 5. HPA282B Bill of Materials (Continued)

-005	-006	RefDes	Value	Description	SIZE	Part Number	MFR
2	2	C1, C4	10uF	Capacitor, Ceramic, 10-uF, 25-V, X5R, 20%	1206	ECJ-3YB1E106M	Panasonic
2	2	C2, C3	10uF	Capacitor, Ceramic, 10-uF, 6.3-V, X5R, 20%	0805	ECJ-2FB0J106M	Panasonic
1	1	D1	Red	Diode, LED, Red, 1.8-V, 20-mA, 20-mcd	0603	LTST-C190CKT	Liteon
1	1	D2	Green	Diode, LED, Green, 2.1-V, 20-mA, 6-mcd	0603	LTST-C190GKT	Liteon
1	1	D3	BZX84C6v2T	Diode, Zener, 6.2-V, 350-mW	SOT-23	BZX84C6V2T	Diodes
2	2	J1, J2, J3, J4*	ED1514	Terminal Block, 2-pin, 6-A, 3.5mm	0.27 x 0.25	ED1514	OST
5	5	JMP1– JMP5	PEC02SAAN	Header, 3-pin, 100mil spacing	0.100 x 3	PEC02SAAN	Sullins
2	2	JMP6, JMP7	PEC03SAAN	Header, 2-pin, 100mil spacing	0.100 inch x 2	PEC03SAAN	Sullins
0	0	R1	732	Resistor, Chip, 1/16W, 1%	0603	Std	Std
0	1	R10	10k	Potentiometer, 1/4 in. Cermet, 12-Turn, Top-Adjust	0.25x0.17	3266W-103LF	Bourns
1	1	R11	10k	Potentiometer, 1/4 in. Cermet, 12-Turn, Top-Adjust	0.25x0.17	3266W-103LF	Bourns
1	1	R14	301k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	1	R16	50k	Potentiometer, 1/4 in. Cermet, 12-Turn, Top-Adjust	0.25x0.17	3266W-503LF	Bourns
1	1	R17	1k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
2	2	R18, R20	604	Resistor, Chip, 1/16W, 1%	0603	Std	Std
0	0	R2	1k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
0	0	R3	10k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	1	R4	49.9k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
2	2	R5, R6	1.5K	Resistor, Chip, 1/16W, 1%	0603	Std	Std
0	1	R21	1.5K	Resistor, Chip, 1/16W, 1%	0603	Std	Std
0	0	R22	23.7K	Resistor, Chip, 1/16W, 1%	0603	Std	Std
0	0	R23	11K	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	1	R7, R19	0	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	1	R8	5k	Potentiometer, 1/4 in. Cermet, 12-Turn, Top-Adjust	0.25x0.17	3266W-502LF	Bourns
1	0	R9	10k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
3	3	R12, R13, R15	10k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	0	U1	BQ24230RGT	IC, USB- Friendly LiIon Battery Charger and Power-Path Management	QFN-16	BQ24230RGT	TI
0	1	U1	BQ24232RGT		QFN-16	BQ24232RGT	TI
1	1	--		PCB, 1.8 In x 1.7 In x 0.031 In		HPA282	Any
7	7		929950-00	Shunts	100 mill	Black	3M

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.

5. * No substitutions of J1 through J4

6. Place Shunt as follows: JMP1=TRM:RES, JMP3=CE:VSS, JMP4=EN2:HI, JMP5, EN1:VSS, JMP6=pin1:pin2, JMP7=pin1:pin2
For JMP2=001/002/003=TD:HI, -004=TD:VSS:VSS,

Table 6. HPS252B Bill of Materials

-007	RefDes	Value	Description	Size	Part Number	MFR
2	C1, C4	10uF	Capacitor, Ceramic, 10-uF, 25-V, X5R, 20%	1206	ECJ-3YB1E106M	Panasonic
2	C2, C3	10uF	Capacitor, Ceramic, 10-uF, 6.3-V, X5R, 20%	0805	ECJ-2FB0J106M	Panasonic
1	D1	Red	Diode, LED, Red, 1.8-V, 20-mA, 20-mcd	0603	LTST-C190CKT	Liteon
1	D2	Green	Diode, LED, Green, 2.1-V, 20-mA, 6-mcd	0603	LTST-C190GKT	Liteon
1	D3	BZX84C6v2T	Diode, Zener, 6.2-V, 350-mW	SOT-23	BZX84C6V2T	Diodes
2	J1, J2, J3, J4*	ED1514	Terminal Block, 2-pin, 6-A, 3.5mm	0.27 x 0.25	ED1514	OST
5	JMP1–JMP5	PEC02SAAN	Header, 3-pin, 100mil spacing	0.100 x 3	PEC02SAAN	Sullins
2	JMP6, JMP7	PEC03SAAN	Header, 2-pin, 100mil spacing	0.100 inch x 2	PEC03SAAN	Sullins
0	R1	732	Resistor, Chip, 1/16W, 1%	0603	Std	Std
0	R10	10k	Potentiometer, 1/4 in. Cermet, 12-Turn, Top-Adjust	0.25x0.17	3266W-103LF	Bourns
1	R11	10k	Potentiometer, 1/4 in. Cermet, 12-Turn, Top-Adjust	0.25x0.17	3266W-103LF	Bourns
1	R14	301k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	R16	50k	Potentiometer, 1/4 in. Cermet, 12-Turn, Top-Adjust	0.25x0.17	3266W-503LF	Bourns
1	R17	1k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
2	R18, R20	604	Resistor, Chip, 1/16W, 1%	0603	Std	Std
0	R2	1k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
0	R3	10k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	R4	49.9k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
2	R5, R6	1.5K	Resistor, Chip, 1/16W, 1%	0603	Std	Std
0	R21	1.5K	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	R22	23.7K	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	R23	11K	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	R7	100k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	R19	0	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	R8	5k	Potentiometer, 1/4 in. Cermet, 12-Turn, Top-Adjust	0.25x0.17	3266W-502LF	Bourns
1	R9	10k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
3	R12, R13, R15	10k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	U1	BQ24075TRGT	IC, USB- Friendly LiIon Battery Charger and Power-Path Management	QFN-16	BQ24075TRGT	TI
1	--		PCB, 1.8 In x 1.7 In x 0.031 In		HPA282	Any
7		929950-00	Shunts	100 mill	Black	3M

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.

5. * No substitutions of J1 through J4

6. Place Shunt as follows: JMP1=TRM:RES, JMP3=CE:VSS, JMP4=EN2:HI, JMP5, EN1:VSS, JMP6=pin1:pin2, JMP7=pin1:pin2

Table 7. HPA502A Bill of Materials

-001	-002	RefDes	Value	Description	Size	Part Number	MFR
2	2	C1, C4	10µF	Capacitor, Ceramic, 25-V, X5R, 20%	1206	ECJ-3YB1E106M	Panasonic
2	2	C2, C3	10µF	Capacitor, Ceramic, 6.3-V, X5R, 20%	0805	ECJ-2FB0J106M	Panasonic
1	1	D1	Red	Diode, LED, Red, 1.8-V, 20-mA, 20-mcd	0603	LTST-C190CKT	Liteon
1	1	D2	Green	Diode, LED, Green, 2.1-V, 20-mA, 6-mcd	0603	LTST-C190GKT	Liteon
1	1	D3	BZX84C6v2T	Diode, Zener, 6.2-V, 350-mW	SOT-23	BZX84C6V2T	Diodes
4	4	J1–J4*	ED1514	Terminal Block, 2-pin, 6-A, 3,5mm	0.27 x 0.25	ED1514	OST
5	5	JMP1–JMP5	PEC03SAAN	Header, 3-pin, 100mil spacing	0.100 x 3	PEC03SAAN	Sullins
2	2	JMP6, JMP7	PEC02SAAN	Header, 2-pin, 100mil spacing	0.100 inch x 2	PEC03SAAN	Sullins
0	0	R1	732	Resistor, Chip, 1/16W, 1%	0603	Std	Std
0	0	R10	10k	Potentiometer, 1/4 in. Cermet, 12-Turn, Top-Adjust	0.25 x 0.17	3266W-1-103LF	Bourns
1	1	R11	10k	Potentiometer, 1/4 in. Cermet, 12-Turn, Top-Adjust	0.25 x 0.17	3266W-1-103LF	Bourns
1	1	R14	301k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	1	R16	50k	Potentiometer, 1/4 in. Cermet, 12-Turn, Top-Adjust	0.25 x 0.17	3266W-503	Bourns
1	1	R17	1k	Resistor, Chip, 1/16-W, 1%	0603	Std	Std
2	2	R18, R20	604	Resistor, Chip, 1/16-W, 1%	0603	Std	Std
0	0	R2	1k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
0	0	R3	10k	Resistor, Chip, 1/16-W, 1%	0603	Std	Std
1	1	R4	49.9k	Resistor, Chip, 1/16-W, 1%	0603	Std	Std
2	2	R5, R6	1.5K	Resistor, Chip, 1/16-W, 1%	0603	Std	Std
0	0	R21	1.5K	Resistor, Chip, 1/16-W, 1%	0603	Std	Std
0	1	R22	2.7K	Resistor, Chip, 1/16-W, 1%	0603	Std	Std
0	1	R23	11K	Resistor, Chip, 1/16-W, 1%	0603	Std	Std
0	1	R7	100k	Resistor, Chip, 1/16-W, 1%	0603	Std	Std
1	0	R7	0	Resistor, Chip, 1/16-W, 1%	0603	Std	Std
1	1	R19	0	Resistor, Chip, 1/16-W, 1%	0603	Std	Std
1	1	R8	5k	Potentiometer, 1/4 in. Cermet, 12-Turn, Top-Adjust	0.25 x 0.17	3266W-1-502LF	Bourns
1	0	R9	10k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
3	3	R12, R13, R15	10k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	0	U1	BQ24079RGT	IC, USB- Friendly Li-Ion Battery Charger and Power-Path Management– Current based TS	QFN-16	BQ24079RGT	TI
0	1	U1	BQ24079TRGT	IC, USB- Friendly Li-Ion Battery Charger and Power-Path Management – Current based TS	QFN-16	BQ24079TRGT	TI
1	1	–		PCB, 1.8 In x 1.7 In x 0.031 In		HPA502	Any
7	7		929950-00	Shunts	100 mill	929950-00	3M

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.

5. * No substitutions of J1 through J4

6. Place Shunt as follows: JMP1=TRM:RES, JMP2=TD:VSS, JMP3=CE:VSS, JMP4=EN2:HI, JMP5, EN1:VSS, JMP6=pin1:pin2, JMP7=pin1:pin2

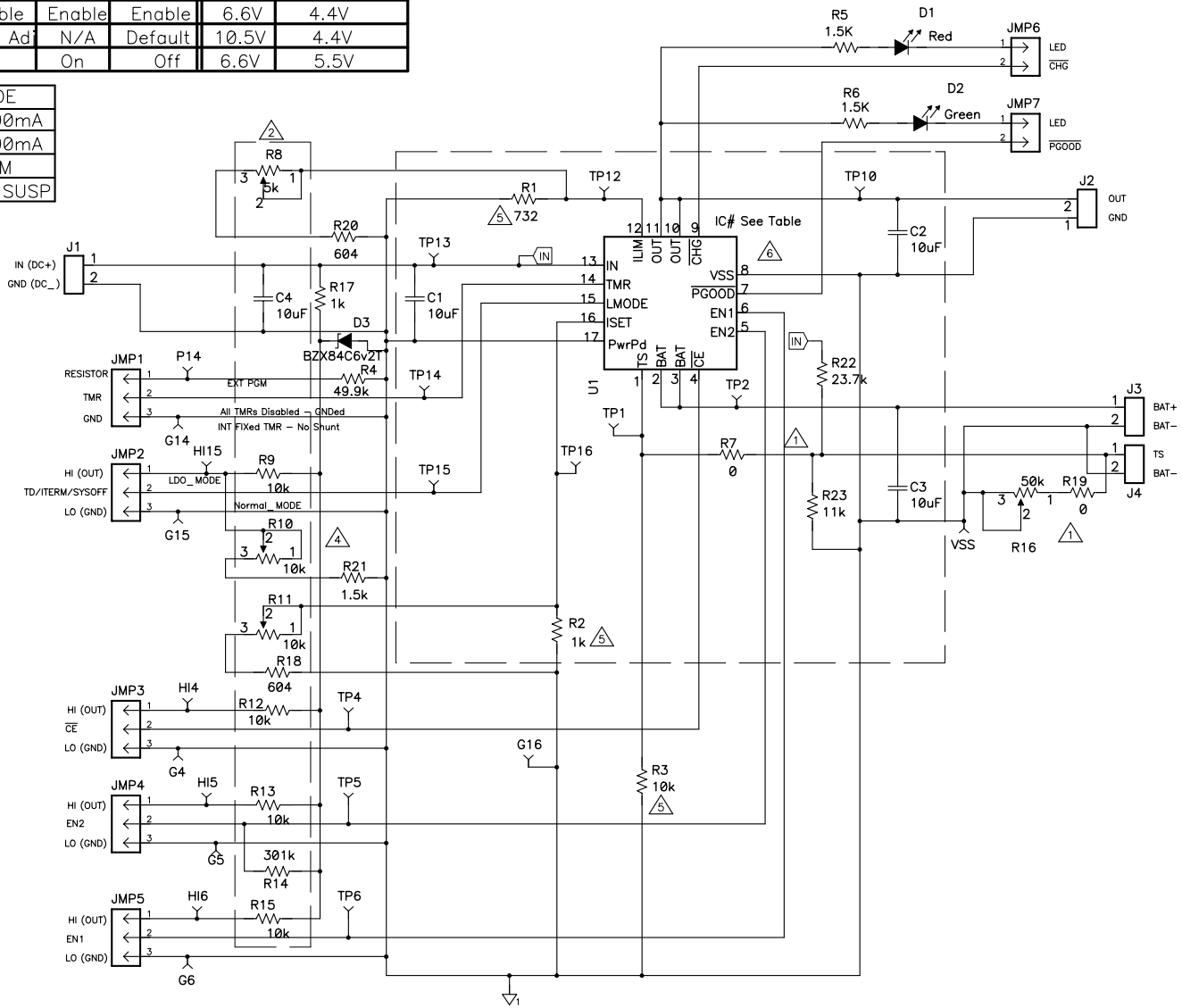
8 References

1. *bq24072/3/4/5/9(T), 1.2A USB-Friendly Li-Ion Battery Charger and Power-Path Management IC* data sheet SLUS810
2. *bq24075T, bq24079T, 1.5A USB-Friendly Li-Ion Battery Charger and Power-Path Management IC* data sheet (SLUS937)

For all ICs Pin 15 is the unique pin. The '7x are for higher current and '23x for lower current.
bq24072/3/4/5/9(T) = '72 or '73 or '74 or '75 or '79 or '79T
bq24230/2 = '230 or '232

Jumper	JMP – 2				
Signal U1–15_IC	HI	LOW	FLOAT	OVP	VOUT
TD '72	Disable	Enable	Enable	6.6V	VBAT+200mV
TD '73, '230	Disable	Enable	Enable	6.6V	4.4V
ITERM '74,'232	POT Adj	N/A	Default	10.5V	4.4V
SYSOFF'75,'79(T)	Off	On	Off	6.6V	5.5V

EN2	EN1	MODE
0	0	100mA
0	1	500mA
1	0	ILIM
1	1	CE SUSP



1. There are two types of TS control 1) Votlage based – R7, R22 and R23 installed (R3 not installed & (2) Current based – No resistors required (R3, R7, R22, R23, R19 and R16, but apply short to R7) or an optional adjustment using R3 and R7. A "thermsitor" is required either externally or on the PCB: R19 and R16 can be used in place of the thermistor for either TS type or R3 can replace all the resistors for the current based.
2. Resistors, in dotted box, typically not needed in a design but used here to assist in evaluation of the IC or to protect the EVM from incorrect input connections (R8 through R14). C4 may be used, if needed, for higher current applications.
3. Resistors, in the dashed box are the required components for a simplified design. Components outside the dashed box are optional components. See data sheet for more detail on desired features.
4. R10 is used for the ITERM feature found only on bq24078(T)
5. Not used See BOM for different Configurations.
6. Refer to Data sheet to if a "T" version of the the IC is available. The "T" (bq24072T) implies that the TS pin is voltage based instead of current based.

Texas Instruments

Title	bq24072/3/4/5/9(T)	
Size C	Number HPA282 / HPA502	Rev B
Date Tue Jul 14, 2009		Drawn by CHM
Filename HPA282B_UG.sch		Sheet 1 of 1

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 6.5 V and the output voltage range of 0 V to 6.5 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 85°C. The EVM is designed to operate properly with certain components above 60°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

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

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