ACT2823 Evaluation Kit Application Report

REV 0, 01-Dec-2016

5V/3.4A Dual Cell Battery Power Manager

FEATURES

- Dedicated single-chip integrated dual cell battery management
- 4.5V-5.5V input voltage and 3.8A input current limit
- 5.07V+/-1% output with prioritized power path from input to output
- 3.3A output with CC regulation
- Pass MFi test
- Meet EN55022 class B radiated EMI standard
- Output short circuit protection and nearly zero power
- Output over voltage protection
- Dual cell battery overcharge, over discharge, over charge current and over discharge current protections
- >91% charge efficiency at 3.8A input
- >92% discharge efficiency at 3.3A output
- Configurable charge, discharge and HZ modes
- Output plug-in detection to wakeup
- Light load detection
- <10uA low battery drainage current
- Battery termination voltage 8.4V (ACT2823QJ-T1000) /8.7V (ACT2823QJ-T1435) for total dual cells
- 4 LED battery level indication
- Preconditioning for deeply depleted batter
- Capability to Charge Wearable Devices
- Built-in charge and discharge safety timer
- Optimized power path and battery charge control
- Thermal regulation for battery charge/discharge
- Accommodation for >10mA input source
- Battery over voltage protection
- TQFN5x5-40

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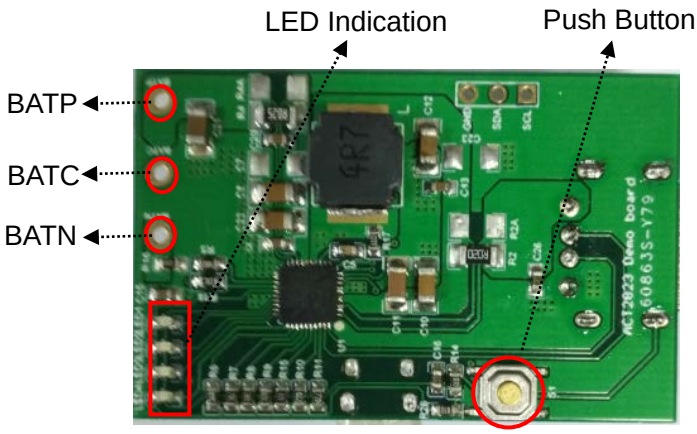
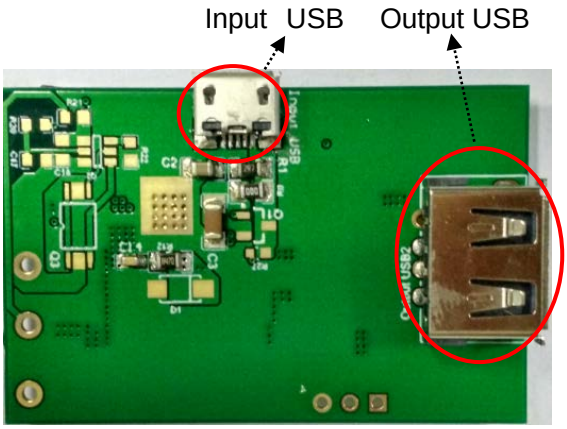
1 INTRODUCTION

This document supports both the ACT2823EVK1-1000 and the ACT2823EVK1-1435 Evaluation Kits. These kits are a proven application-circuit design for the ACT2823QJ-T1000 and ACT2823QJ-T1435 dual cell chargers with power path and single USB outputs. The EVKs contains a single micro-USB input and USB output. They provide both outputs with 3.3A. They are configured to charge a 2s Lithium-Ion battery at 1.0A. The EVKs operate very high charge efficiency of 96% and discharge efficiency of 95.6%. Both EVKs are identical except for the IC. The ACT2823QJ-T1000 EOC (end of charge voltage) is 8.4V while the ACT2823QJ-T1435 EOC is 8.7V for total battery.

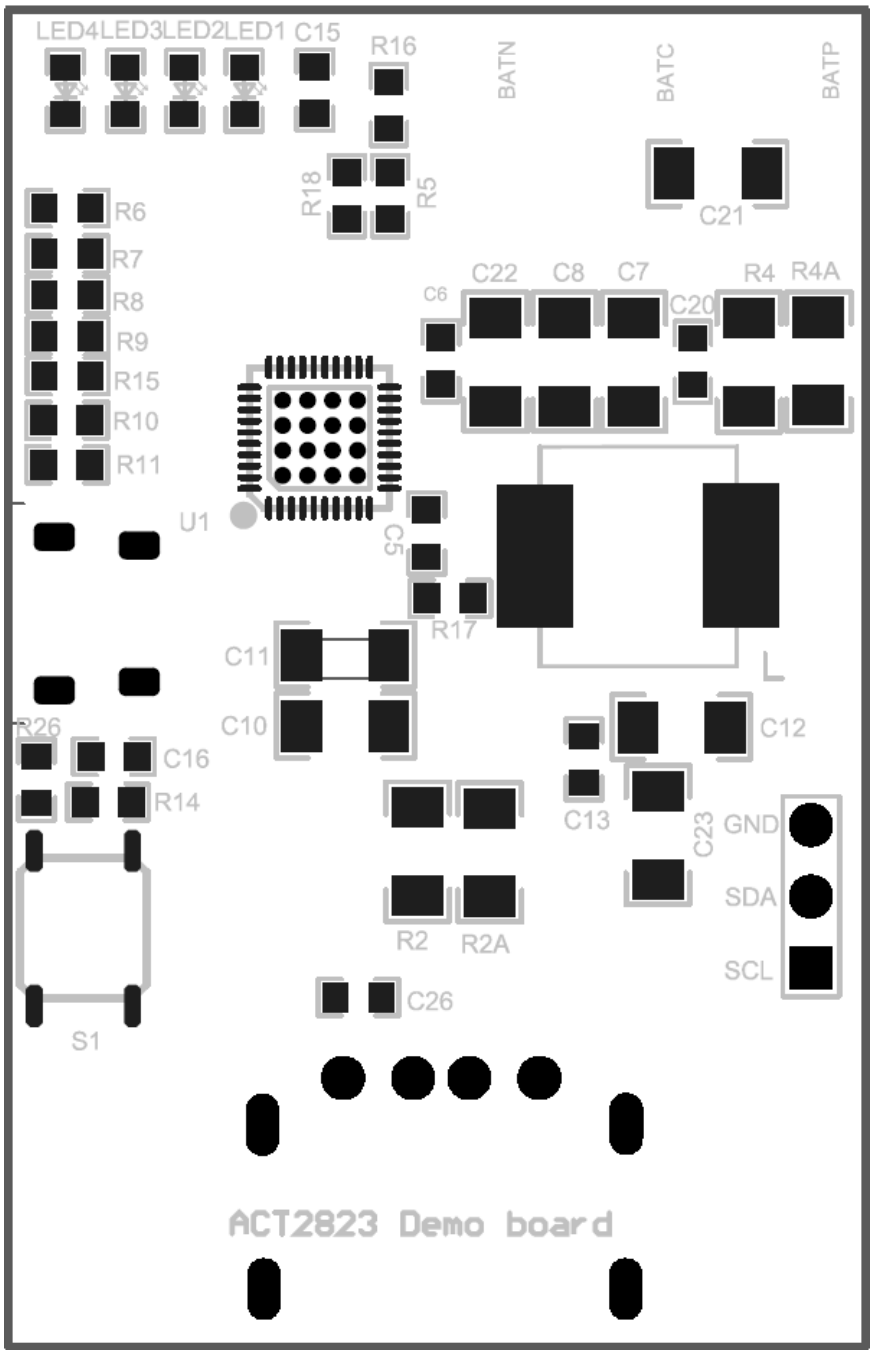
2 DEMO BOARD PHOTOS

(DEMO BOARD SIZE: 48mm*31mm)

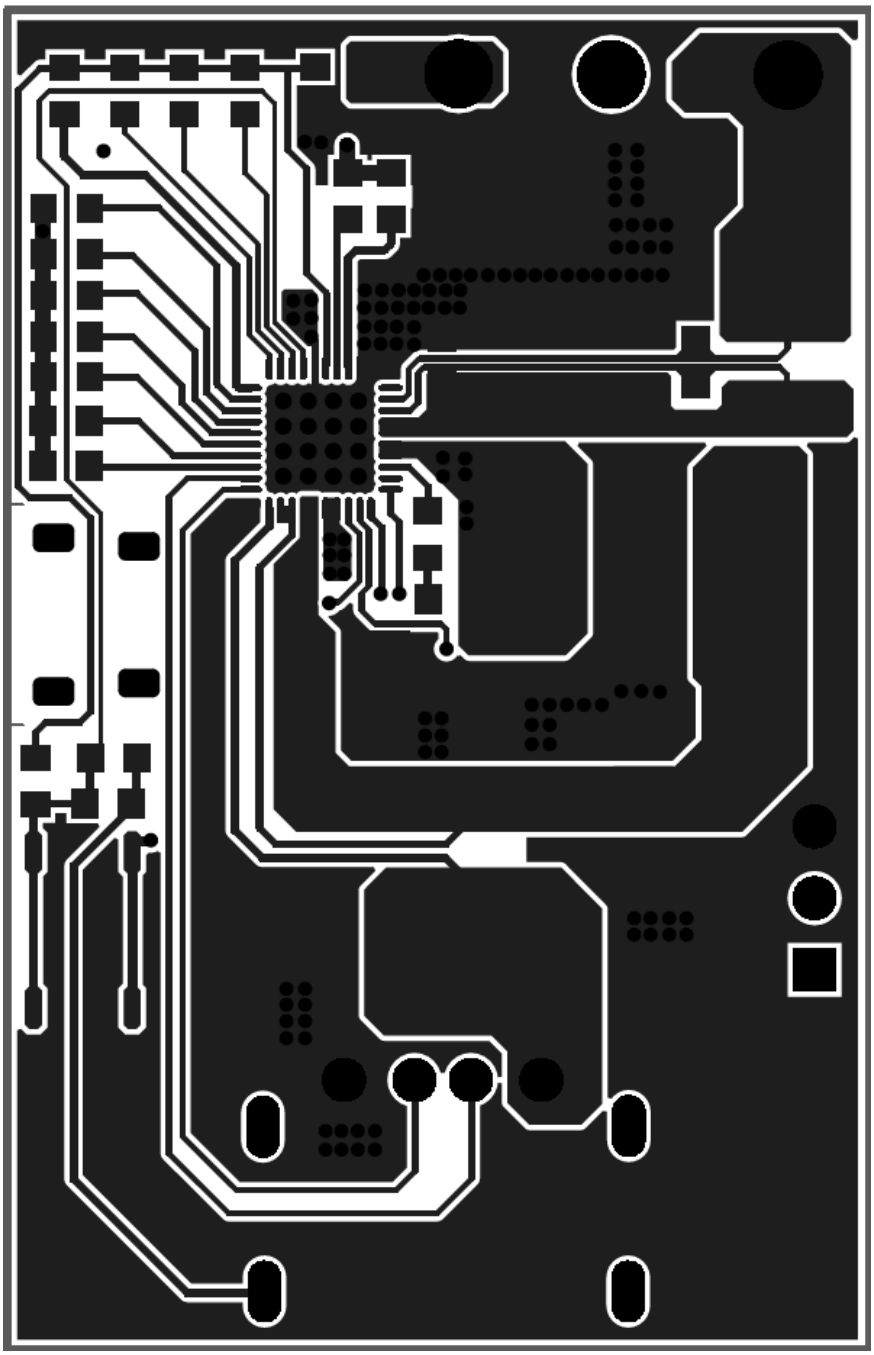




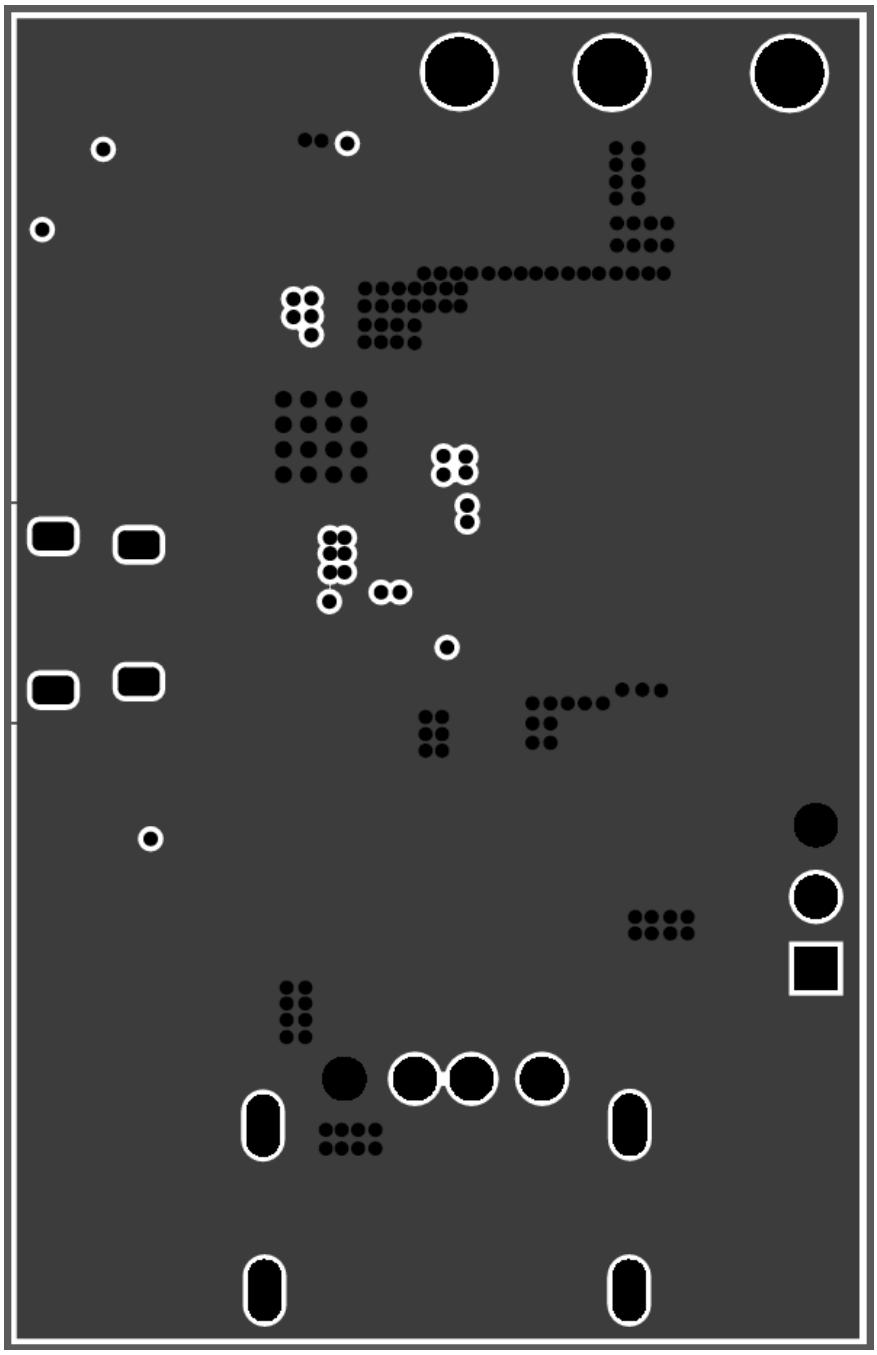
3 PCB LAYOUT



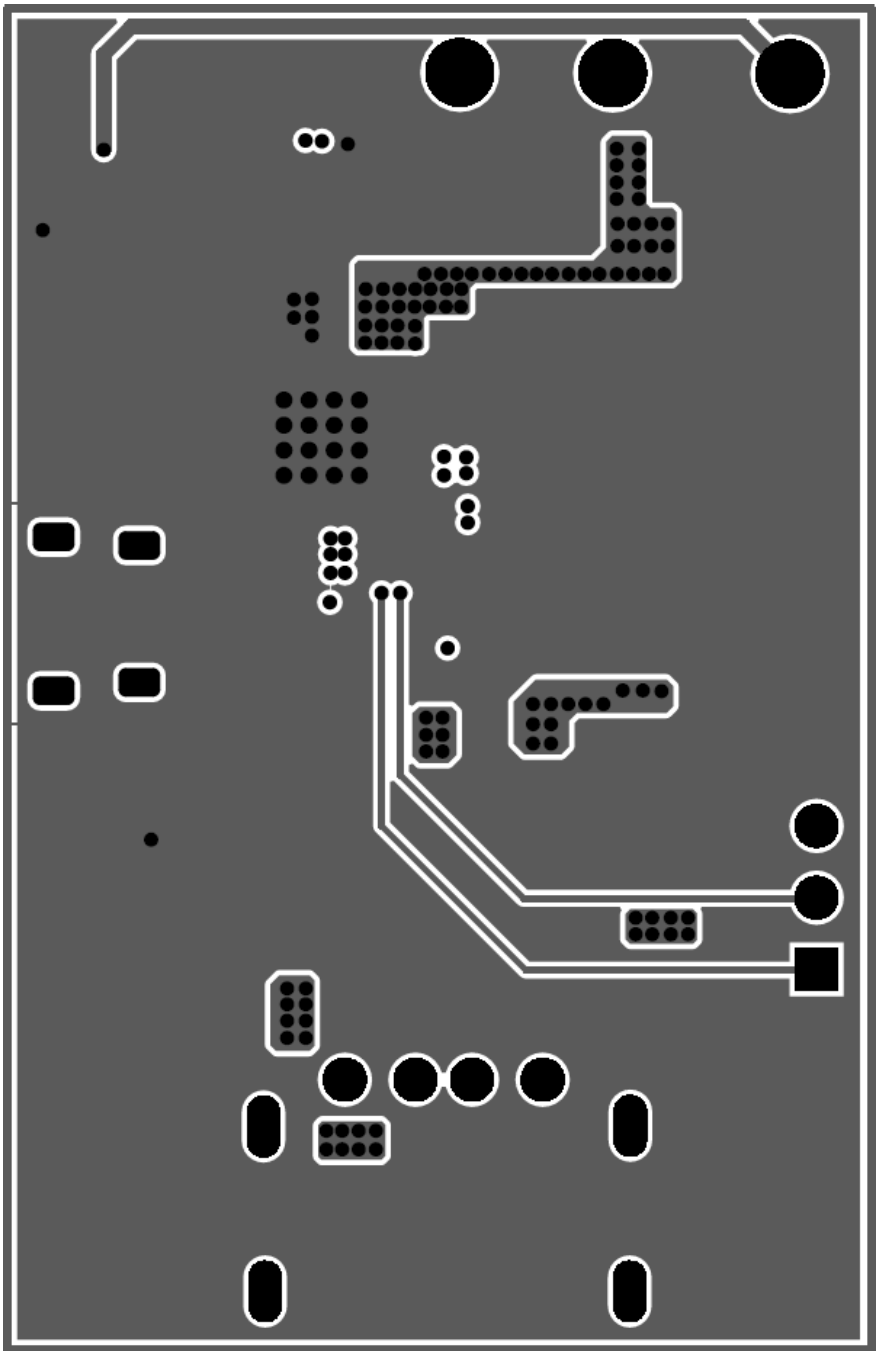
Top Assembly



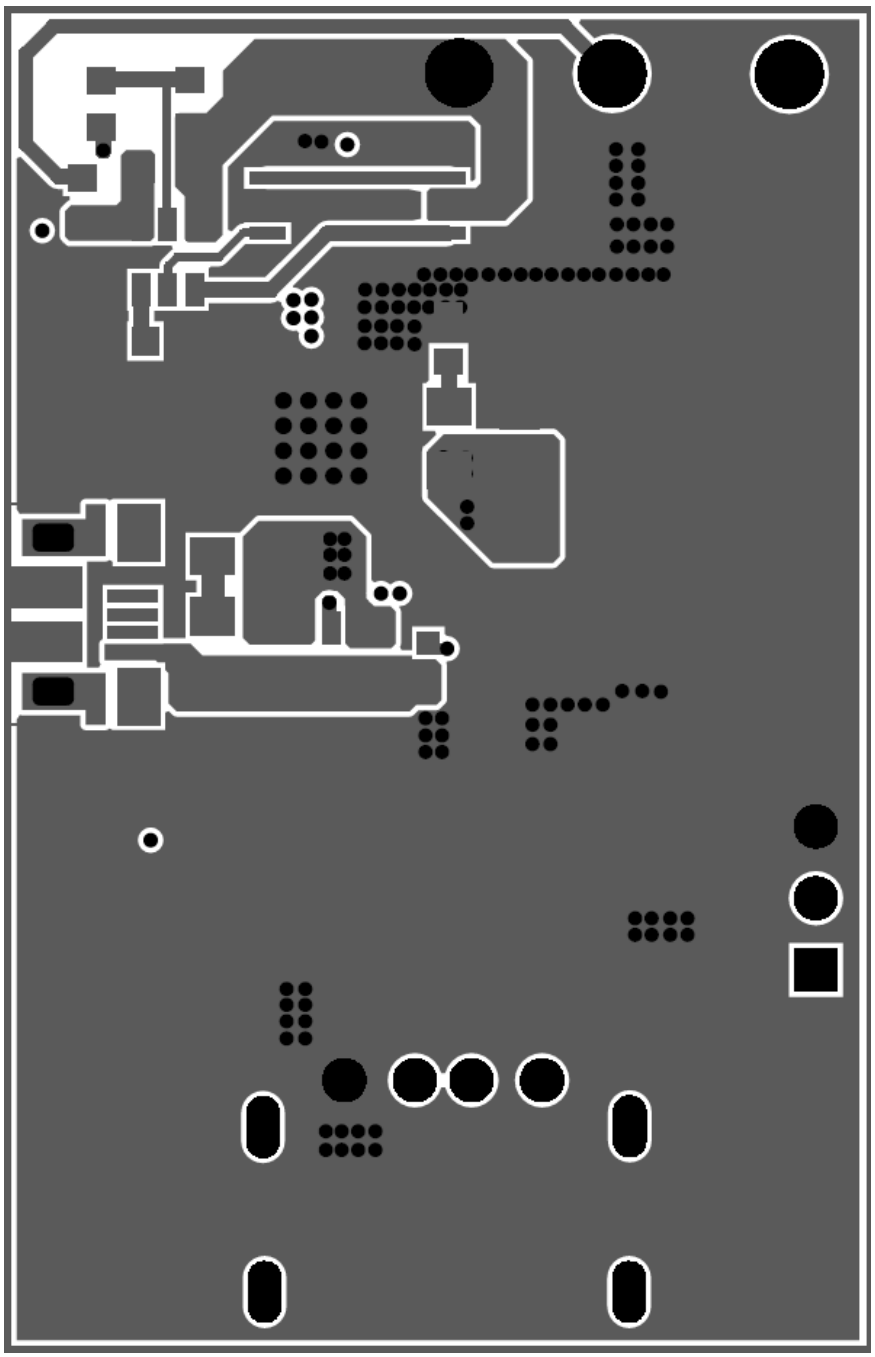
Top Layer



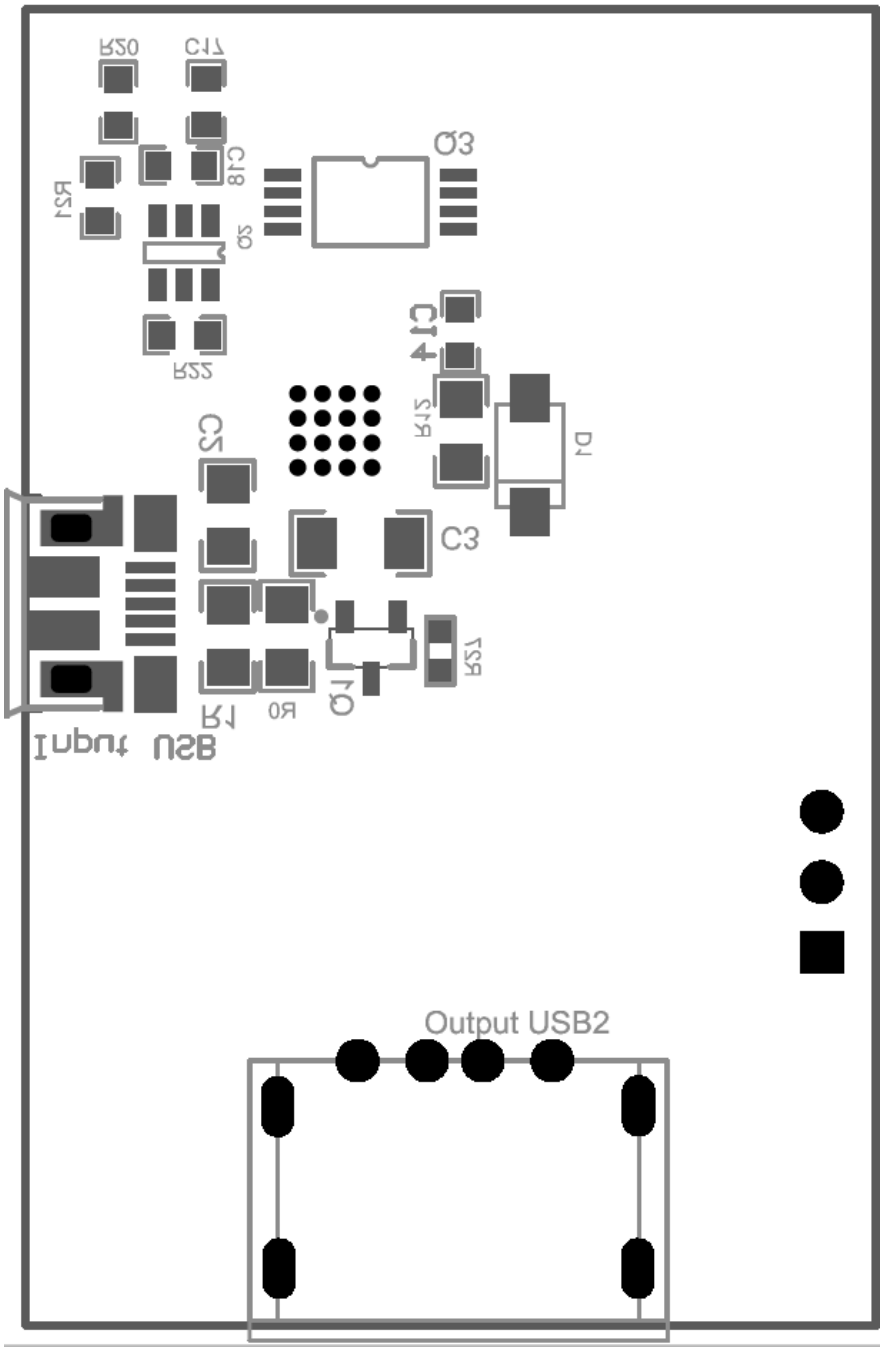
Layer 2



Layer 3

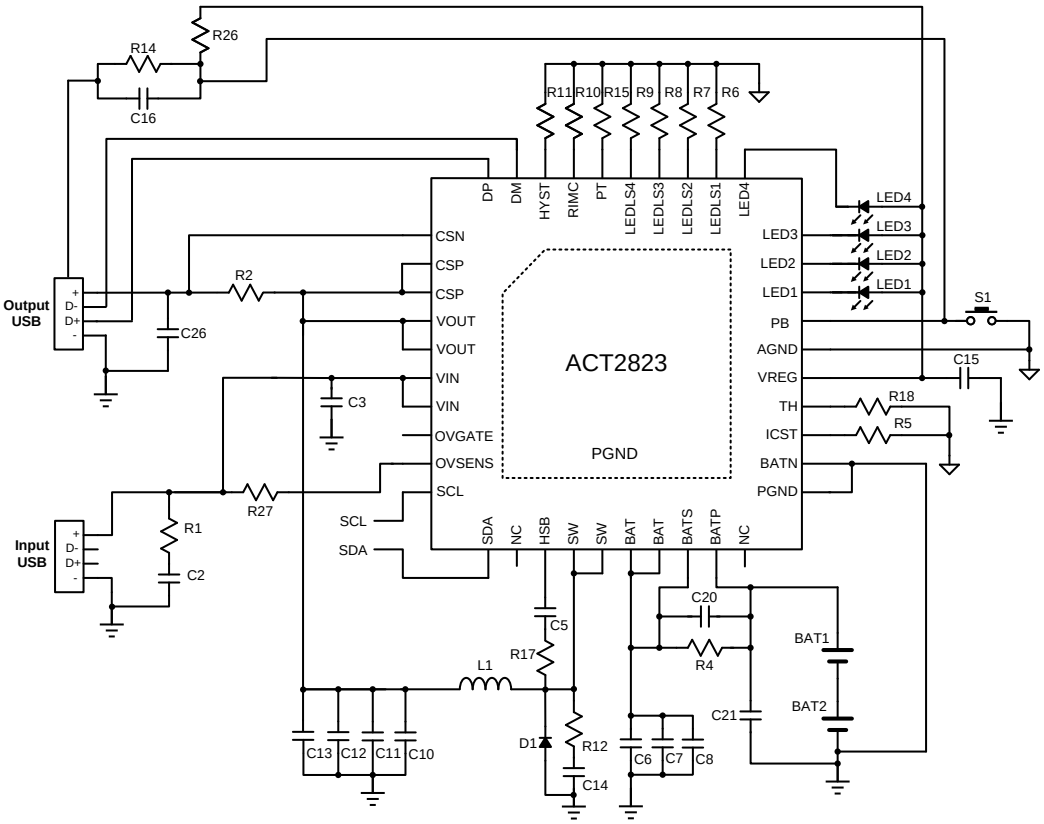


Bottom Layer



Bottom Assembly

4 SCHEMATICS



Application information

Charge Current Setting:

$$Ic(A) = \frac{200}{Rcs(m\Omega) \times Ricst(K\Omega)}$$

LED Indication:

MODE	TRIG	LED1	LED2	LED3	LED4
CHARGE	HIGH	$V_{LED1}+V_{IMC}+0.6*V_{HYST}$	$V_{LED2}+V_{IMC}+0.6*V_{HYST}$	$V_{LED3}+V_{IMC}+0.6*V_{HYST}$	$V_{LED4}+V_{IMC}+0.6*V_{HYST}$
	LOW	$V_{LED1}+V_{IMC}$-100mV	$V_{LED2}+V_{IMC}$-100mV	$V_{LED3}+V_{IMC}$-100mV	$V_{LED4}+V_{IMC}$-100mV
DISCHARGE	HIGH	$V_{LED1}-V_{IMC}$+100mV	$V_{LED2}-V_{IMC}$+100mV	$V_{LED3}-V_{IMC}$+100mV	$V_{LED4}-V_{IMC}$+100mV
	LOW	$V_{LED1}-V_{IMC}-0.6*V_{HYST}$	$V_{LED2}-V_{IMC}-0.6*V_{HYST}$	$V_{LED3}-V_{IMC}-0.6*V_{HYST}$	$V_{LED4}-V_{IMC}-0.6*V_{HYST}$

$$V_{LED\langle X\rangle}(A) = 5.5V + \frac{108K}{R_{LS\langle x\rangle}(K\Omega)}$$

$$V_{IMC}(V) = 2106K * IBAT(A) * \frac{R_{CS}(\Omega)}{R_{IMC}(K\Omega)}$$

$$V_{HYST\langle 4:3\rangle} = \frac{54K}{R_{HYST}(K\Omega)}$$

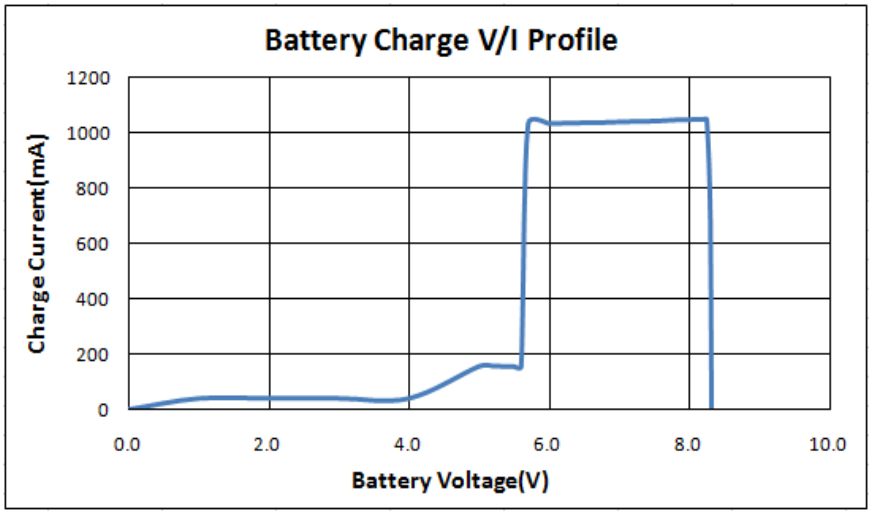
5 BILL OF MATERIALS

Item	Reference	Description	QTY		Manufacturer
			ACT2823EVK1-1000	ACT2823EVK1-1435	
1	L1	SWPA8040S4R7NT 4.7uH 5.9A(8*8*4mm)	1	1	Sunlord
2	D1	MBR1020VL, 20V/1A Schottky, SMA, Optional	1	1	Panjit
3	C7,C8,C21	Ceramic capacitor, 22uF/16V, X7R, 1206	3	3	Murata/TDK
4	C2	Ceramic capacitor, 4.7uF/10V, X7R, 0805	1	1	Murata/TDK
5	C3,C10,C11,C12	Ceramic capacitor, 22uF/10V, X7R, 1206	4	4	Murata/TDK
6	C5	Ceramic capacitor, 47nF/16V, X7R, 0603	1	1	Murata/TDK
7	C6,C13	Ceramic capacitor, 0.1uF/16V, X7R, 0603	2	2	Murata/TDK
8	C14	Ceramic capacitor, 2.2nF/10V, X7R, 0603	1	1	Murata/TDK
9	C15	Ceramic capacitor, 1uF/10V, X7R, 0603	1	1	Murata/TDK
10	C16	Ceramic capacitor, 2.2uF/10V, X7R, 0603	1	1	Murata/TDK
11	C20	Ceramic capacitor, 100nF/10V, X7R, 0603	1	1	Murata/TDK
12	C26	Ceramic capacitor, 3.3uF/10V, X7R, 0603	1	1	Murata/TDK
13	R1	Chip Resistor, 2.7Ω, 1/8W, 5%, 0805	1	1	Murata/TDK
14	R2	Chip Resistor, 20mΩ, 1/2W, 0.5%, 1206	1	1	SART
15	R4	Chip Resistor, 25mΩ, 1/2W, 0.5%, 1206	1	1	SART
16	R5	Chip Resistor, 8kΩ, 1/10W, 1%, 0603	1	1	Murata/TDK
17	R6	Chip Resistor, 83kΩ, 1/10W, 1%, 0603	1	1	Murata/TDK
18	R7	Chip Resistor, 63.5kΩ, 1/10W, 1%, 0603	1	1	Murata/TDK
19	R8	Chip Resistor, 51.4kΩ, 1/10W, 1%, 0603	1	1	Murata/TDK
20	R9	Chip Resistor, 41.5kΩ, 1/10W, 1%, 0603	1	1	Murata/TDK
21	R10,R11	Chip Resistor, 540kΩ, 1/10W, 1%, 0603	2	2	Murata/TDK
22	R12	Chip Resistor, 0.47Ω, 1/8W, 1%, 0805	1	1	Murata/TDK
23	R14,R26	Chip Resistor, 715K, 1/10W, 5%, 0603	2	2	Murata/TDK
24	R15	Chip Resistor, 12K, 1/10W, 1%, 0603	1	1	Murata/TDK
25	R17	Chip Resistor, 10Ω, 1/10W, 5%, 0603	1	1	Murata/TDK
26	R18	Chip Resistor, 10K, 1/10W, 5%, 0603	1	1	Murata/TDK
27	R27	Chip Resistor, 100Ω, 1/10W, 1%, 0603	1	1	Murata/TDK

28	LED1,LED2, LED3,LED4	LED, 0603, Blue	4	4	LED Manu
29	PB	Push Button Switch	1	1	
30	Output USB	10.2*14.6*7mm,4P	1	1	
31	Micro-USB	MICRO USB 5P/F SMT B	1	1	
32	U1	IC, ACT2823QJ-T1000 QFN 5X5-40	1	0	ACT
		IC, ACT2823QJ-T1435 QFN 5X5-40	0	1	ACT

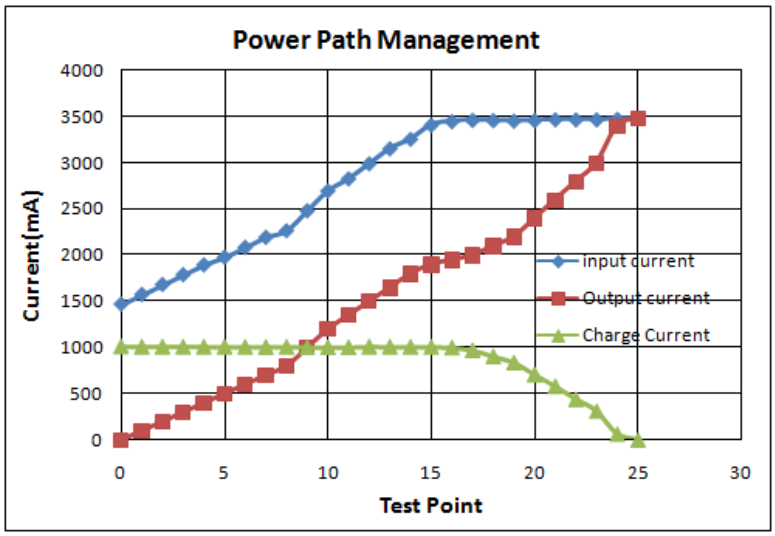
6 FUNCTIONAL TEST

6.1 Battery Charge V/I Profile



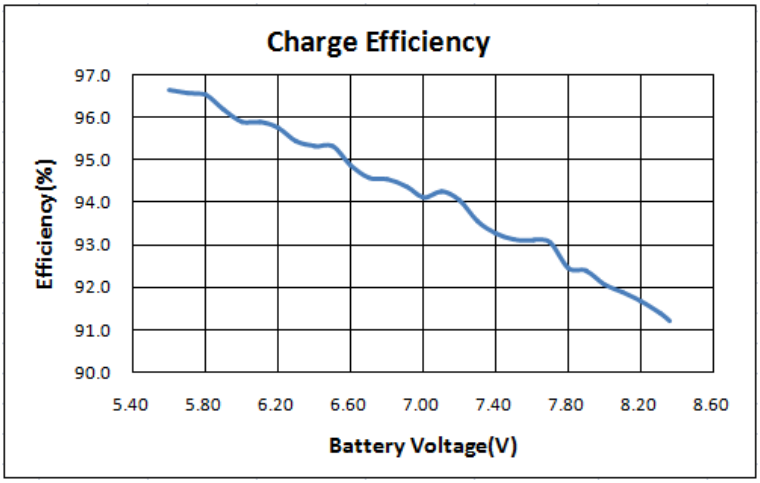
6.2 Power Path Function

(Test condition: Vin=5.05V, Vbat=7V, input current limit=3.8A, fast charge current=1.0A)

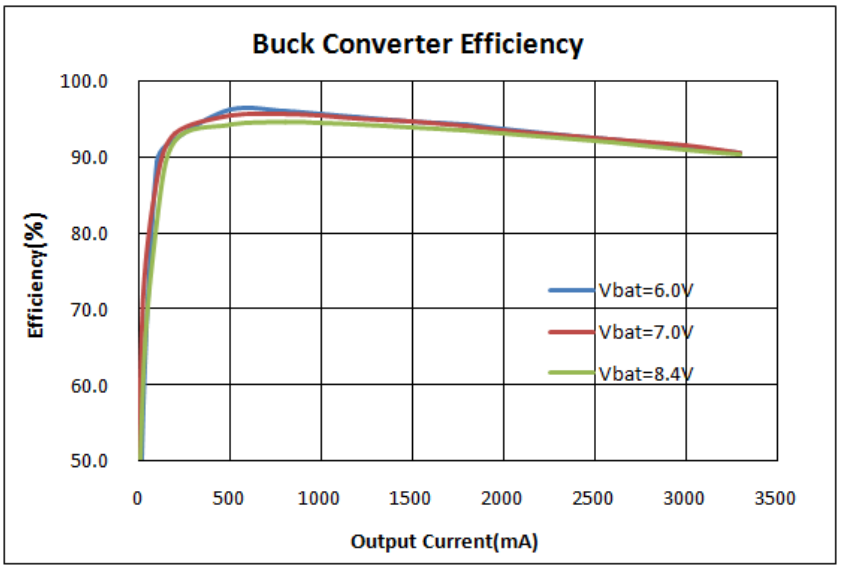


6.3 Charge Efficiency

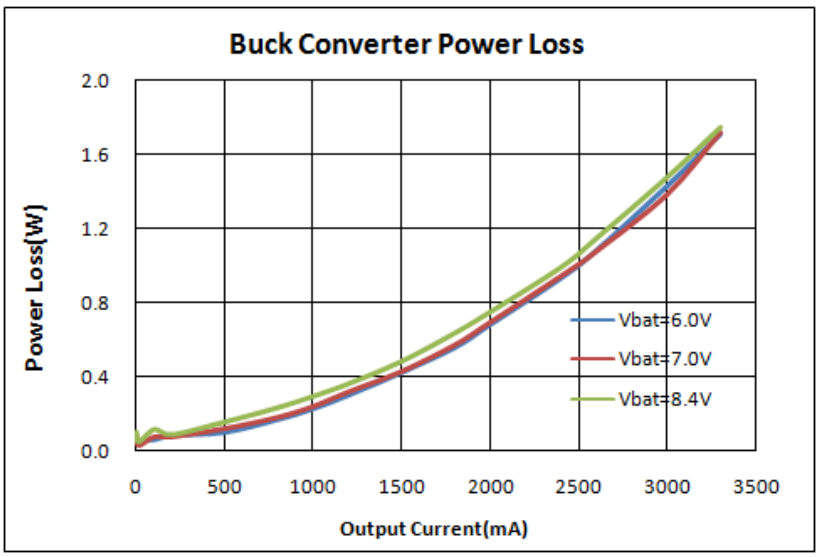
(Vin=5V and charge current set at 1000mA)



6.4 Buck Efficiency (Ta=25 ℃

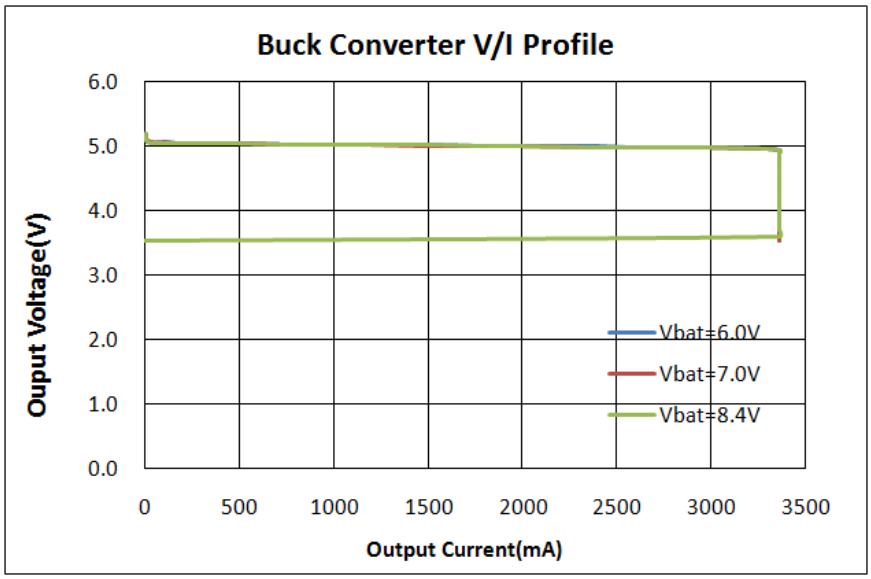


6.5 Buck Power Loss (Ta=25℃)



6.6 Buck Constant Current and Constant Voltage Regulation (Ta=25 ℃

Buck V/I Profile



6.7 Battery Leakage Current in HZ Mode

Test Conditions	Battery Input Current（μA）	Power Loss (μW)
Vbat=6V	2.5	15
Vbat=7V	2.6	18.2
Vbat=8V	2.8	22.4
Vbat=8.4V	3.1	26

6.8 Ripple and Noise

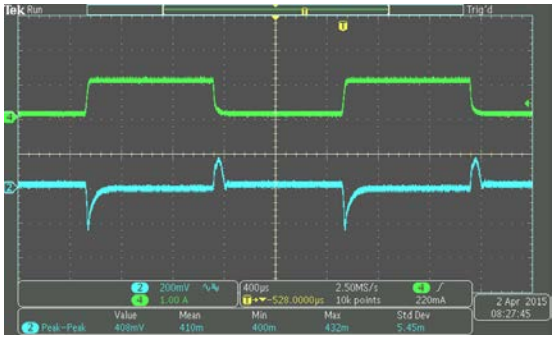
Ripple & noise are measured by using 20MHz bandwidth limited oscilloscope.

Test Conditions	Output Ripple at 2.4A Load (mV)	Output Ripple at 3.3A Load (mV)
Vbat=6.0V	45	50
Vbat=7.0V	40	50
Vbat=8.4V	40	45

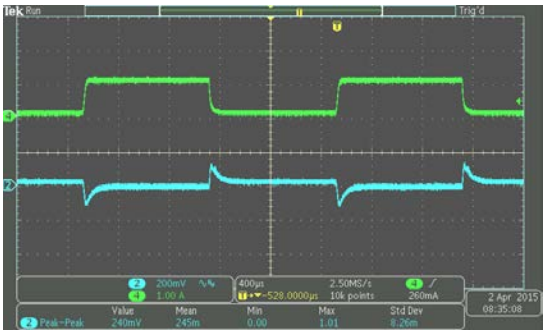
6.9 Load Dynamic Response Load Step

(Output=80mA-1A-80mA load step)

Vbat=8V

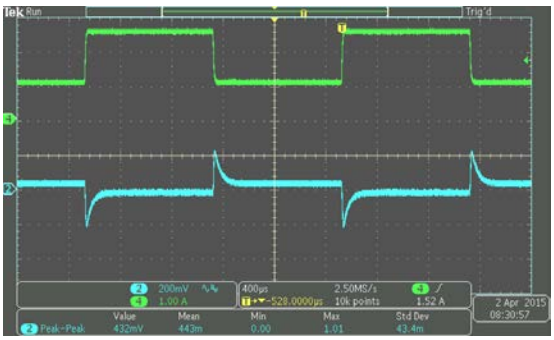


Vbat=6.6V

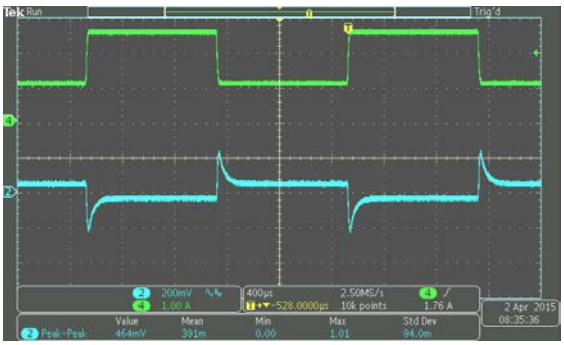


(Output=1A-2.4A-1A load step)

Vbat=8V



Vbat=6.6V



6.10 LED Indication

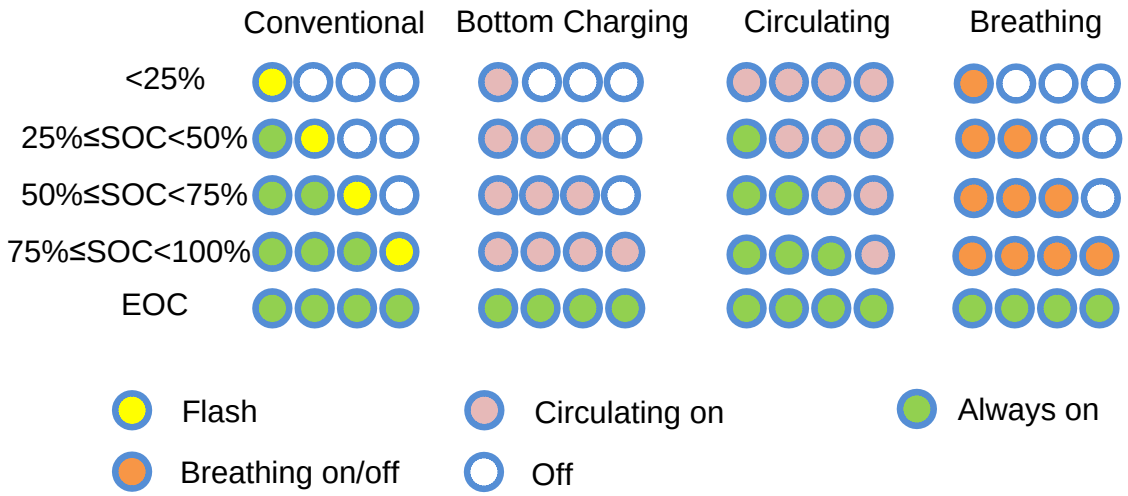
Conventional LED indication

PB time>40ms (HZ Mode)	LED1	LED2	LED3	LED4
VBAT<Vcut-off	Off	Off	Off	Off
Vcut-off ≤VBAT<VLED1	Flash	Off	Off	Off
VLED1≤VBAT<VLED2	On	Off	Off	Off
VLED2≤VBAT<VLED3	On	On	Off	Off
VLED3≤VBAT<VLED4	On	On	On	Off
VBAT≥VLED4	On	On	On	On

Charge Mode	LED1	LED2	LED3	LED4
VBAT<VLED2	Flash	Off	Off	Off
VLED2≤VBAT<VLED3	On	Flash	Off	Off
VLED3≤VBAT<VLED4	On	On	Flash	Off
VLED4≤VBAT Charge Mode	On	On	On	Flash
VLED4≤VBAT EOC Mode	On	On	On	On

ACT2823 is designed with a simple ADC to convert 5 levels of PT pin voltage into 5 application patterns.

INDICATION PATTERN	PT Resistor
Conventional Always On In Discharge	R15=3.3K
Conventional 5s Indication in Discharge	R15=12K
Breathing 5s Indication in Discharge	R15=24K
Bottom Charging 5s Indication in Discharge	R15=42K
Circulating 5s Indication in Discharge	R15=68K



6.11 System Management

- PB is pressed for >5s or Discharge load is <10mA for 12.5s, Discharge mode is go into HZ mode
- PB is pressed for 40ms, Discharge mode is turned on
- PB is pressed for 40ms, LED indication is on for 5.0 seconds
- 2 seconds transition time between Charge Mode and Boost Mode

6.12 Key Components Temperature Test (Ta=25C, burning for 2 hours)

Charge mode, 1.0A charge current

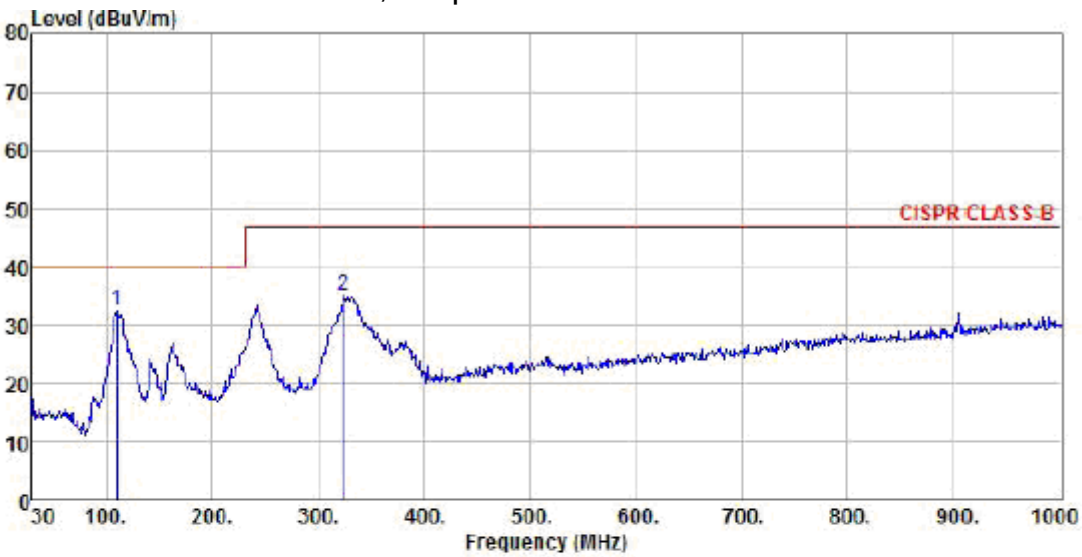
Vin(V)	IC(℃)	Inductor(℃	Vbat(V)
5.0	36.5	34.3	6
5.0	45.4	41.8	7.5
5.0	51.6	46.6	8.2

Discharge mode, 3.3A output current

Vbat(V)	IC(℃)	Inductor(℃	Vout(V)
6	67.3	60	5.0
7.5	75.6	63.8	5.0
8.2	77.5	66.1	5.0

7 EMI TEST

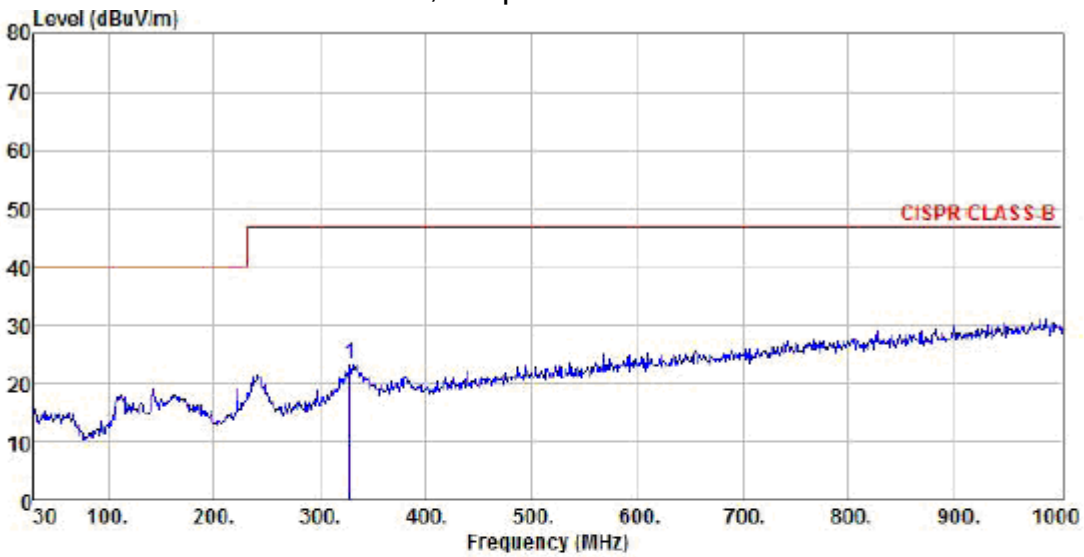
Vbat=7.8V, Output: 5V/3.3A Horizontal



Site : chamber
Condition : CISPR CLASS-B 3m VULB9160 HORIZONTAL
EUT :
Model Name : ACT2823
Temp/Humi : 21 ℃ / 50 %
Power Rating:
Mode : 5V/2.4A
Memo :

	Freq	ReadAntenna Level	Factor	Cable Loss	Preamp Factor	Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dB	
1 pp	109.54	20.11	11.07	1.41	0.00	32.59	40.00	-7.41	Peak
2	323.91	18.84	13.74	2.51	0.00	35.09	47.00	-11.91	Peak

Vbat=7.8V, Output: 5V/3.3A Vertical



Site : chamber
Condition : CISPR CLASS-B 3m VULB9160 VERTICAL
EUT :
Model Name : ACT2823
Temp/Humi : 21 ℃ / 50 %
Power Rating:
Mode : 5V/2.4A
Memo :

	Freq	Read Level	Antenna Factor	Cable Loss	Preamp Factor	Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dB	
1 pp	328.76	7.09	13.87	2.48	0.00	23.44	47.00	-23.56	Peak