THE DATASHEET OF

EA2802QLT1026

EA2802QL-T1028 User's Guide
5V/2.1A Power Bank Solution

Description

This document supports the **EA2802QL-T1028** Evaluation Kit. This kit is a proven application circuit design for the EA2802QL-T1028 charger with power path and single USB outputs. The EVK contains a single micro-USB input and USB output. It provides the output with 2.1A. It is configured to charge a battery with 2.1A. The EVK operates with very high charge efficiency of 89% and discharge efficiency of 95%（Vbat=4.1V). The EVK contains the ACT2802QL-T1028, but it can also be used to evaluate the ACT2802BQL-T1028 and ACT2802CQL-T1028 with minor modifications. Refer to the EVK BOM for the component change details. The ACT2802QL-T1028 has a battery temperature monitor function while the ACT2802BQL-T1028 and ACT 2802CQL-T1028 have flashlight functions.

PART NUMBER	OUTPUT	FLASHLIGHT	TH	PB TURN OFF BOOST	LEDS ALWAYS ON IN BOOST	PACKAGE
ACT2802QL-T1028	5V/2.5A	No	Yes	Yes	No	QFN44-24
ACT2802BQL-T1028	5V/2.5A	Yes	No	No	Yes	QFN44-24
ACT2802CQL-T1028	5V/2.5A	Yes	No	No	No	QFN44-24

Features

The EVK contains a high efficiency Buck and Boost DC/DC converter that operates either in CV (Constant Voltage) mode or CC(Constant Current) mode. The EVK provides up to 5V/2.1A output at 550 KHz switching frequency. It operates from Vin=4.5V to 5.5V to charge battery. Gerber files are available to minimize time-to-market for applications that want to use the EVK as an end product.

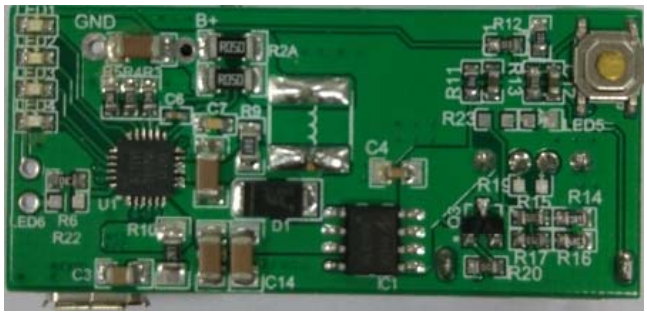


Figure 1 – EVK Picture - Top

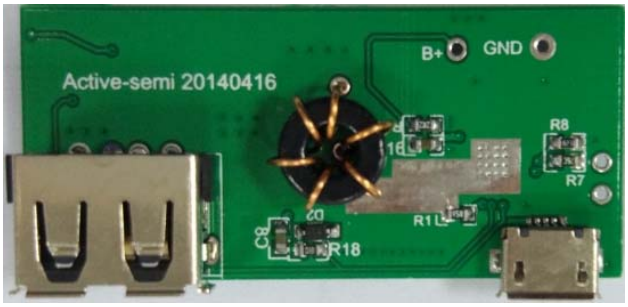


Figure 2 – EVK Picture - Bottom

Setup

Required Equipment

EA2802QL-T EVK

Power supply – 5V @ 3.5A for full power operation

Oscilloscope – >100MHz

Loads –Electronic/resistive load with 3A minimum current capability.

Digital Multimeters (DMM)

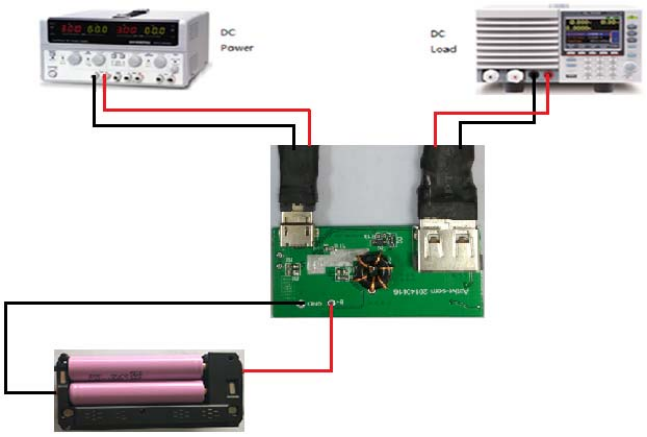


Figure 3 – EVK Setup

Hardware Setup

1. Connect a DC power supply across Vin and GND on the EVK.
2. Connect the EVK output to electronic load by USB connector.
3. Connect battery across B+ and GND.
4. Recommended Operating Conditions.

Table1. Recommended Operating Conditions

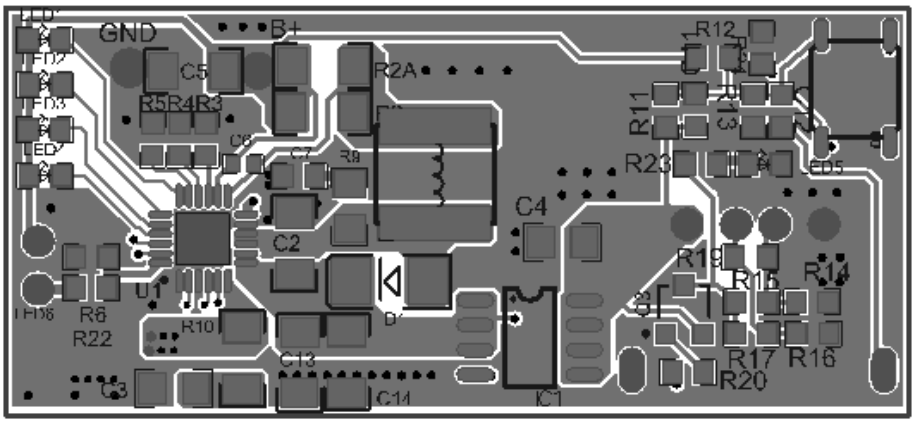
Parameter	Description	Min	Typ	Max	Unit
VIN	All buck input voltages	4.5	5	5.5	V
IOUT	Maximum load current		2.1		A

EVK Operation

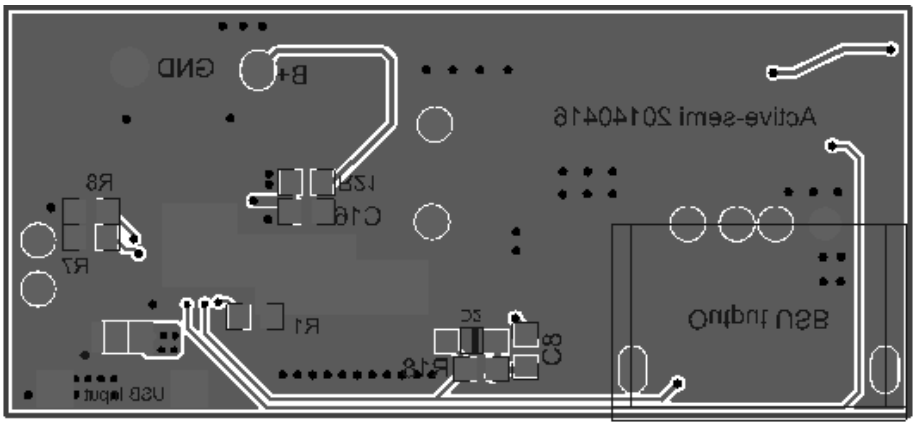
Turn on

Apply 5V to input.

PCB Layout



Top Layer



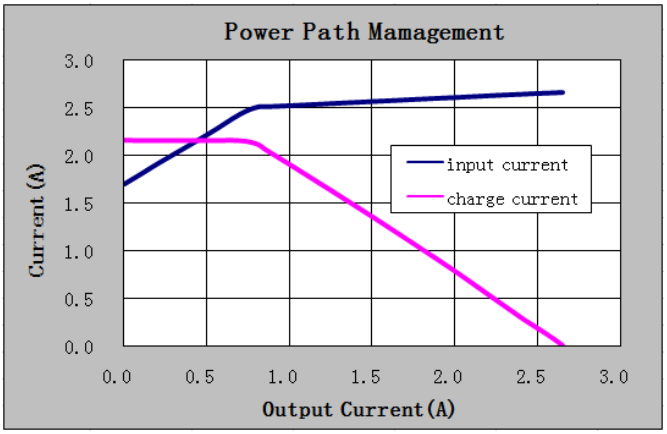
Bottom Layer

Test Results

Power Path Function

Input current(mA)	1698	1802	1909	2213	2429	2501	2506	2510	2535	2561	2603	2637	2652	2656
Output current(mA)	0	100	200	500	700	800	850	900	1200	1500	2000	2400	2600	2650
Charge current(mA)	2156	2154	2154	2154	2152	2118	2063	2009	1684	1352	780	292	65	0

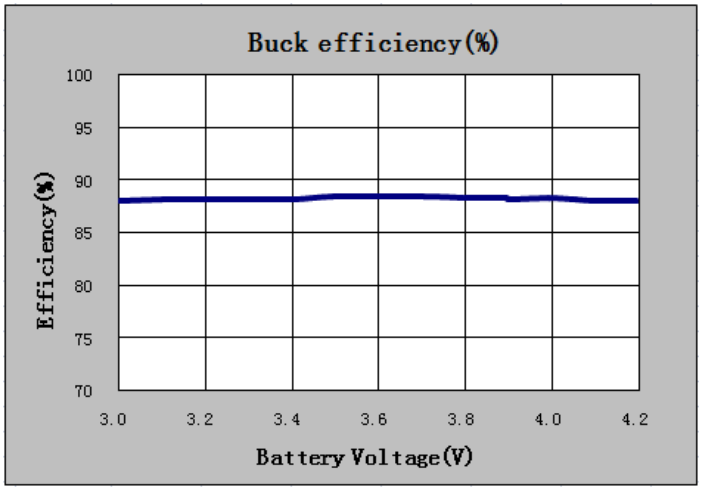
(Test condition: Vin=5 V, Vbat=3.7V, input current limit=3.2A, fast charge current=2.1A)



Charge Efficiency

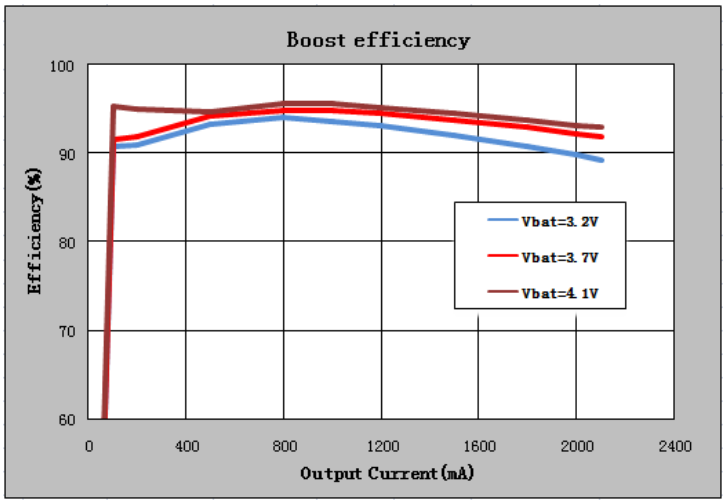
(Vin=5V and charge current set at 2100mA)

Battery Voltage (V)	3.0	3.2	3.5	3.7	4.1
Efficiency (%)	88.1	88.1	88.4	88.5	88.04

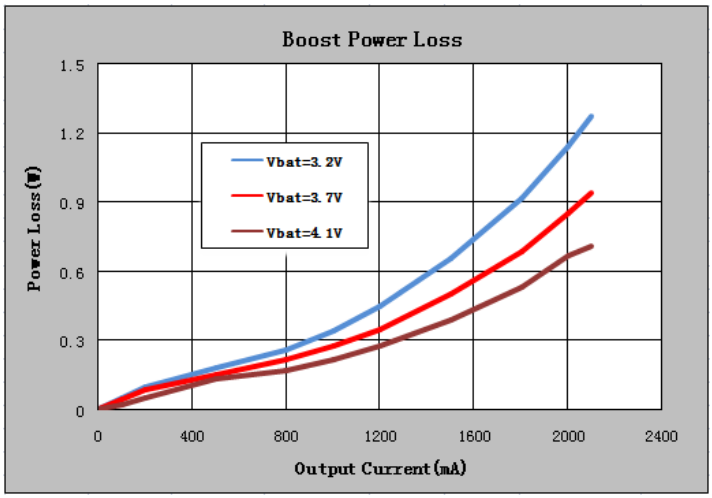

Buck efficiency(%)
100
95
90
85
80
75
70
Efficiency(%)
3.0
3.2
3.4
3.6
3.8
4.0
4.2
Battery Voltage(V)

Boost Efficiency and Power Loss (Ta=25□)

Vbat	Efficiency (%)				
	Io=100mA	Io=500mA	Io=1000mA	Io=1500mA	Io=2100mA
3.2V	90.7	93.2	93.6	92.0	89.2
3.7V	91.6	94.2	94.8	93.7	91.8
4.1V	95.3	94.9	95.9	95.1	93.7

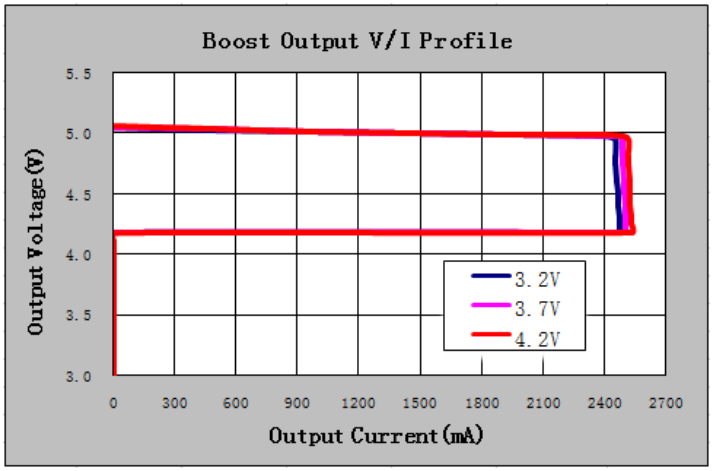


Vbat	Power Loss (W)				
	Io=500mA	Io=1000mA	Io=1500mA	Io=2000mA	Io=2100mA
3.2V	0.18	0.35	0.66	1.14	1.27
3.7V	0.15	0.28	0.50	0.85	0.94
4.1V	0.13	0.22	0.39	0.67	0.71



Boost Constant Current and Constant Voltage Regulation (Ta=25℃)

	Vbat=3.2V		Vbat=3.7V		Vbat=4.15V	
	Vout(V)	Iout(mA)	Vout (V)	Iout(mA)	Vout(V)	Iout(mA)
CC Load	5.049	0	5.055	0	5.057	0
	5.031	500	5.033	500	5.033	500
	5.019	1000	5.019	1000	5.018	1000
	4.98	2400	4.992	2000	4.987	2400
CV Load	4.95	2451	4.98	2483	4.96	2512
	4.81	2452	4.83	2486	4.81	2516
	4.75	2455	4.75	2488	4.74	2517
	4.60	2460	4.60	2492	4.61	2520
	4.51	2463	4.51	2495	4.52	2522
	4.40	2467	4.40	2499	4.41	2525
	4.30	2471	4.30	2501	4.31	2528
	4.26	2473	4.25	2504	4.25	2529
	4.20	2475	4.20	2505	4.19	2530
	4.18	2478	4.18	2509	4.18	2530
	4.17	0	4.17	0	4.17	0
	4.10	0	4.10	0	4.10	0
	3.5	0	3.5	0	3.5	0
	3.0	0	3.0	0	3.0	0



Battery Leakage Current in HZ Mode

Test Conditions	Battery Input Current (μA)	Power Loss (μW)
Vbat=2.8V	5.1	14.3
Vbat=3.2V	5.8	18.6
Vbat=3.7V	6.4	23.7
Vbat=4.2V	7.2	30.2

Ripple and Noise

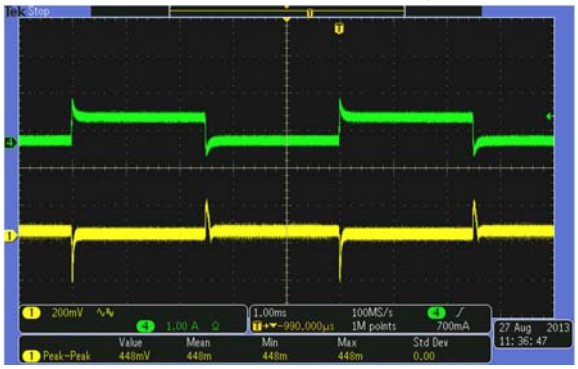
Ripple & noise are measured by using 20MHz bandwidth limited oscilloscope.

Test Conditions	Output Ripple at 1A Load (mV)	Output Ripple at 2.1A Load (mV)
Vbat=3.2V	20	64.8
Vbat=3.7V	16.8	49.6
Vbat=4.1V	15.2	39.2

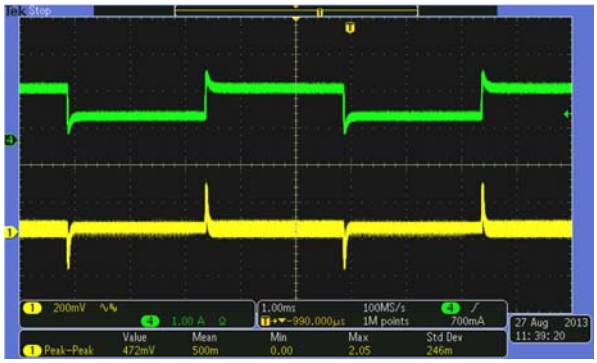
Load Dynamic Response Load Step(Vbat=3.7V)

CH1: output voltage CH4:output current

80mA-1000mA-80mA load step



1000mA-2100mA-1000mA load step



LED Indication

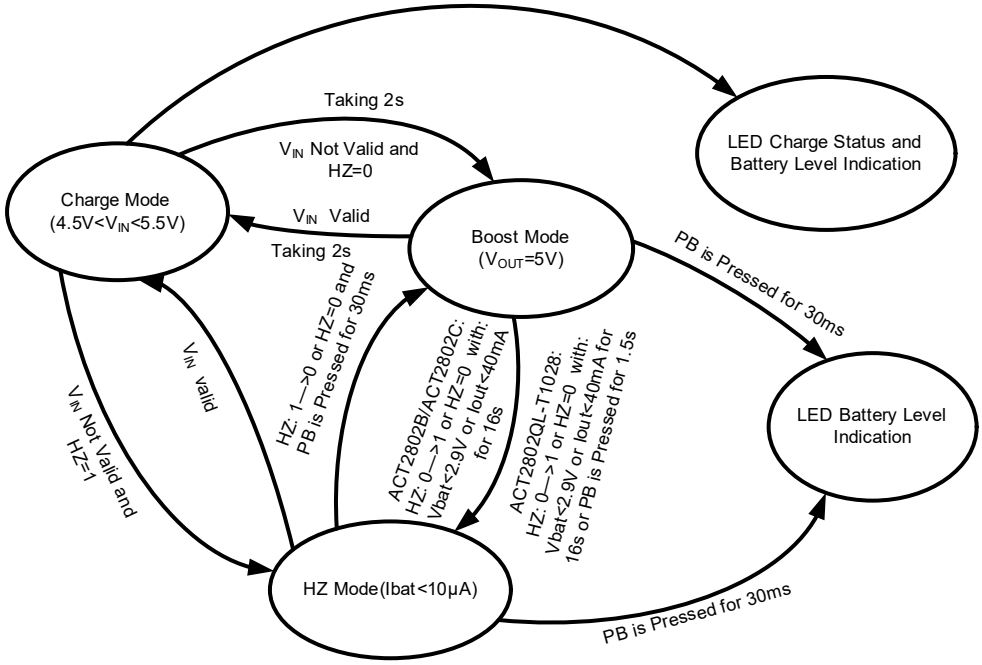
Conventional LED indication

PB time>30ms (HZ Mode)	LED1	LED2	LED3	LED4
VBAT<VLED1	Off	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<VLED1	Flash	Off	Off	Off
VLED1≤VBAT< VLED2	Flash	Off	Off	Off
VLED2≤VBAT< VLED3	On	Flash	Off	Off
VLED3≤VBAT ≤VLED4	On	On	Flash	Off
VLED4≤VBAT ≤ EOC Mode	On	On	On	Flash
LED4 ≤VBAT(EOC Mode)	On	On	On	On

System Management

ACT2802 System Operation Flow Chart



Key Components Temperature Test (Ta=40℃, burning for 2 hours)

Charge mode, 2.0A charge current

Vin(V)	IC(℃)	Inductor(℃)	PCB(℃)	Vbat(V)
5.0	68	60.2	52	3.2
5.0	69	62.1	54	3.7
5.0	68.2	61.6	53.7	4.1

Discharge mode, 2.1A output current

Vbat(V)	IC(℃)	Inductor(℃)	PCB(℃)	Vout(V)
3.2	87.5	86.5	78.2	5.0
3.7	74.2	76.8	68.6	5.0
4.1	65.3	68.6	62.4	5.0

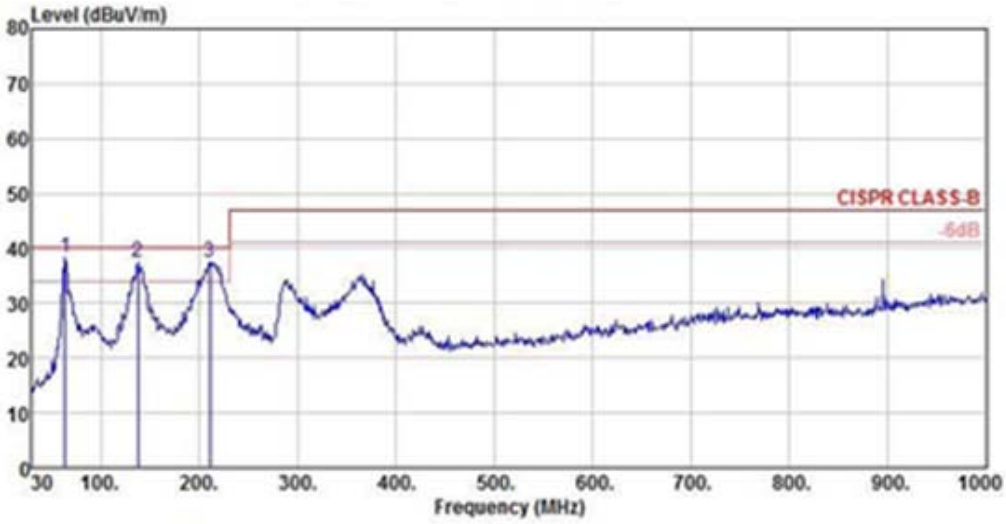
PCB Layout Guidance

The following guideline is base on the schematic.

1) Arrange the power components to reduce the AC loop size that consists of C2, VOUT, SW and PGND. C2(1206 size) must be placed close to the IC and across the VOUT and PGND traces and SW trace goes under the C2.
2) Use copper plane for PGND for best heat dissipation and noise immunity. AGND and PGND are connected under the IC thermal pad with 4x4 vias matrix.
3) SW copper area should be limited due to EMI consideration.
4) Use Kevin sense from sense resistor R2 and R2A to CSP and CSN pin.
5) A separate trace is from VBAT input to BAT pin for battery voltage sense accuracy.
6) RC snubber is recommended to add across SW to PGND to reduce EMI noise.
7) A 10V/3.0A schottky is added from inductor terminal to VOUT to reduce EMI noise.

EMI Test

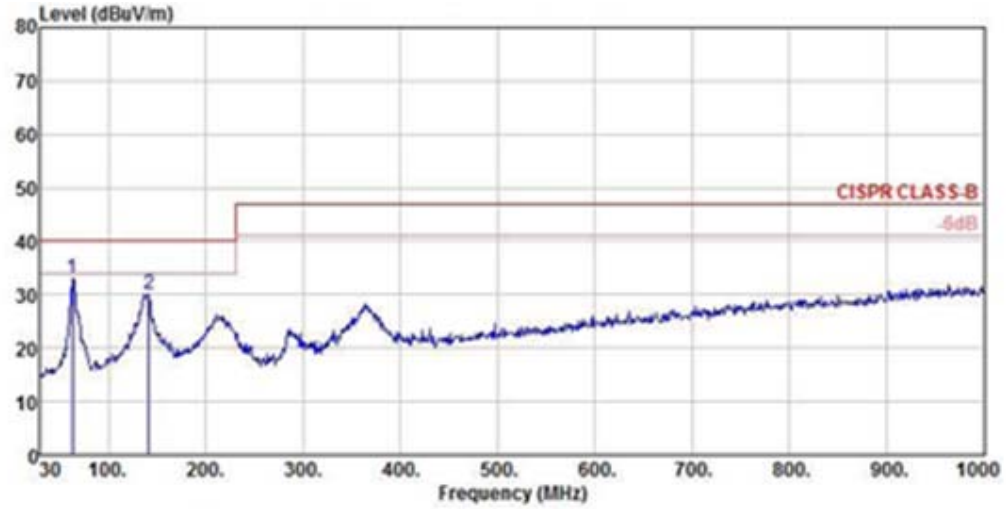
Vbat=4.1V, Output: 5V/2A Horizontal




```
Site          : chamber
Condition     : CISPR CLASS-B 3m VULB9160 HORIZONTAL
EUT           :
Model Name    : ACT2802 5V2A BOOST VBAT=4.1V
Temp/Humi     : 24 ℃ /58%
Power Rating: dc
Mode          :
Memo          :
              : #2
```

	Freq	ReadAntenna 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	63.95	24.96	12.34	1.07	0.00	38.37	40.00	-1.63	Peak
2 !	137.67	22.55	13.21	1.62	0.00	37.38	40.00	-2.62	Peak
3 !	210.42	24.86	10.57	1.94	0.00	37.37	40.00	-2.63	Peak

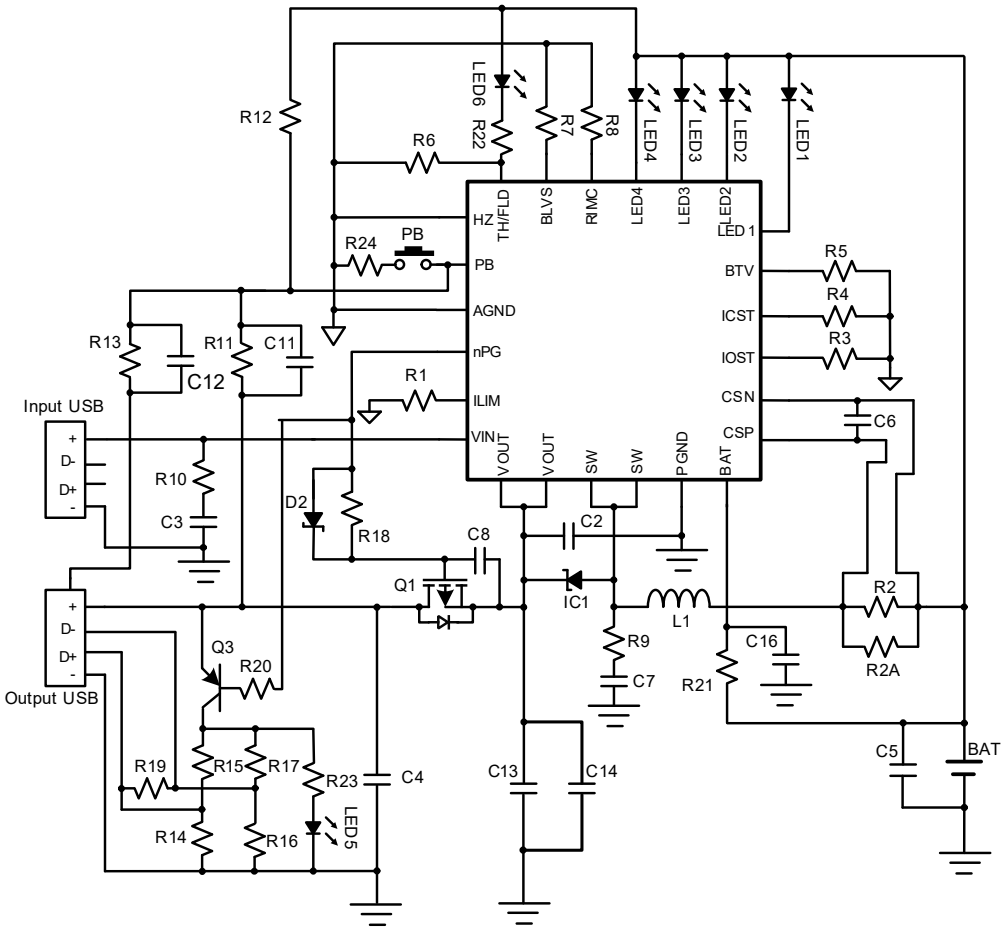
Vbat=4.1V, Output: 5V/2A Vertical



Site : chamber
Condition : CISPR CLASS-B 3m VULB9160 VERTICAL
EUT :
Model Name : ACT2802 5V2A BOOST VBAT=4.1V
Temp/Humi : 24 ℃ /58%
Power Rating: dc
Mode :
Memo :
: #2

	Freq	ReadAntenna 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	62.98	19.62	12.51	1.07	0.00	33.20	40.00	-6.80	Peak
2	141.55	14.97	13.47	1.62	0.00	30.06	40.00	-9.94	Peak

Schematic


R12
R6
LED6
R22
R7
R8
LED4
LED3
LED2
LED1
HZ
TH/FLD
BLVS
RMC
LED4
LED3
LED2
LED 1
R24
PB
PB
BTV
R5
AGND
ICST
R4
nPG
IOST
R3
R13
R11
C11
C12
R1
ILIM
CSN
Input USB
VIN
VOUT
VOUT
SW
SW
PGND
BAT
CSP
C6
+
D-
D+
-
R10
C3
D2
R18
C8
C2
Q1
IC1
L1
R2
R2A
R9
C7
C16
R21
Output USB
Q3
R20
R19
R15
R17
R23
C4
C13
C14
C5
BAT
R14
R16
LED5

Bill of Materials

Item	Reference	Description	QTY		Manufacturer
			EA2802QL-T1028	Components for ACT2802BQL-T1028 and ACT2802CQL-T1028	
1	L1	2.2uH 6*3*3 coil Φ0.55mm 6A	1	1	
2	IC1	AO4453,Rdson=19mΩ at GS=-4.5V	1	1	AOS
3	Q3	MMBT3906	1	1	Vishay
4	D1	SS12,Vf=0.5V, 20V Schottky	1	1	Diodes
5	D2	IN4148, Vf=0.7V, 75V Fast Swith Diode	1	1	Philips
6	C2,C5, C13,C14	Ceramic capacitor, 22uF/10V, X7R, 1206	3	3	Murata/TDK
7	C3	Ceramic capacitor, 4.7uF/10V, X7R, 0805	1	1	Murata/TDK
8	C4	Ceramic capacitor, 0.1uF/10V, X7R, 0603	1	1	Murata/TDK
9	C6	Ceramic capacitor, 10nF/10V, X7R, 0603	1	1	Murata/TDK
10	C7	Ceramic capacitor, 4.7nF/10V, X7R, 0603	1	1	Murata/TDK
11	C8,C11, C12, C16	Ceramic capacitor, 2.2uF/10V, X7R, 0603	4	4	Murata/TDK
12	R1	Chip Resistor, 750Ω, 1/10W, 1%, 0603	1	1	Murata/TDK
13	R2,R2A	Chip Resistor, 50mΩ, 1/4W, 1%, 1206	2	2	Sart
14	R3	Chip Resistor, 93.1kΩ, 1/10W, 1%, 0603	1	1	Murata/TDK
15	R4,R15	Chip Resistor, 43.2kΩ, 1/10W, 1%, 0603	2	2	Murata/TDK
16	R5	Chip Resistor, 25kΩ, 1/10W, 1%, 0603	1	1	Murata/TDK
17	R6	Chip Resistor, 10kΩ, 1/10W, 5%, 0603	1	0	Murata/TDK
18	R7	Chip Resistor, 60kΩ, 1/10W, 1%, 0603	1	1	Murata/TDK
19	R8	Chip Resistor, 100kΩ, 1/10W, 1%, 0603	1	1	Murata/TDK
20	R9	Chip Resistor, 1Ω, 1/8W, 5%, 0805	1	1	Murata/TDK
21	R10	Chip Resistor, 2.7Ω, 1/4W, 5%, 1206	1	1	Murata/TDK
22	R11	Chip Resistor, 200kΩ, 1/10W, 5%, 0603	1	1	Murata/TDK
23	R12,R13	Chip Resistor, 715kΩ, 1/10W, 5%, 0603	2	2	Murata/TDK
24	R14,R16	Chip Resistor, 49.9kΩ, 1/10W, 1%, 0603	2	2	Murata/TDK
25	R17	Chip Resistor, 75kΩ, 1/10W, 1%, 0603	1	1	Murata/TDK
26	R18,R20	Chip Resistor, 100kΩ, 1/10W, 5%, 0603	2	2	Murata/TDK
27	R19	Chip Resistor, 100Ω, 1/10W, 5%, 0603	0	0	Murata/TDK
28	R21	Chip Resistor, 2.2Ω, 1/10W, 5%, 0603	1	1	Murata/TDK

29	R22	Chip Resistor, 51Ω, 1/8W, 5%, 0805	0	1	Murata/TDK
30	R23	Chip Resistor, 1kΩ, 1/10W, 5%, 0603	0	0	Murata/TDK
31	R24	Chip Resistor, 100Ω, 1/10W, 5%, 0603	1	1	Murata/TDK
32	LED1,LED2 LED3,LED4	LED, 0603, Blue	4	4	
33	LED5	LED, 0603, Blue	0	0	
34	LED6	flashlight	0	1	
35	PB	Push Button	1	1	
36	USB	10.2*14.6*7mm, 4P, DIP, 90°	1	1	
37	Micro-USB	MICRO USB 5P/F SMT B	1	1	
38	U1	IC, ACT2802QL-T1028,QFN 44-24	1	0	Active Semi
		IC, ACT2802BQL-T1028 / ACT2802CQL-T1028,QFN 44-24	0	1	Active Semi

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