ACT2804

Rev 2, Feb-04-2016

5V/3.4A Dual Cell Backup Battery Power Manager

FEATURES

- Dedicated Single-chip Integrated Battery Power Manager
- Dual Cell Battery Charger with Cell Balancing Management
- Auto Detection support USB BC1.2, Chinese YD/T 1591-2009, Apple 2.4A, and Samsung Devices
- Passed Apple MFi Test
- 4.5V-5.5V Input Voltage with 3.4A Input Current Limit
- 2.4A+1.0A Dual Outputs with CC Regulation
- 5.07V+/-1% Output with Prioritized Power Path from Input to Output
- 4.2V/4.35V +/- 0.5% Battery Charge Voltage Accuracy of Each Cell
- Output Plug-in Detection Wakeup and No Load Detection Sleep Mode
- Optimized Power Path and Battery Charge Control
- <10uA Low Battery Drainage Current
- I2C Port for Optimal System Performance and Status Reporting
- Configurable Charge, Discharge and HZ modes
- >92% Charge and Discharge Efficiency at 3.4A Output for Full Battery Range
- 4 Modes of LED Operation
- Preconditioning for Deeply Depleted Battery
- Weak Input Sources Accommodation
- Safety:
  - Input Over-voltage Protection
  - Nearly Zero Power Short Circuit Protection
  - Output Over-voltage Protection
  - Battery Over-charge and Over-discharge Protections
  - Charge/Discharge Thermal Regulation
- TQFN5x5-40 Package

APPLICATIONS

- Backup Battery Pack
- Power Bank
- Mobile Power
- Standalone Battery Charger with USB Output

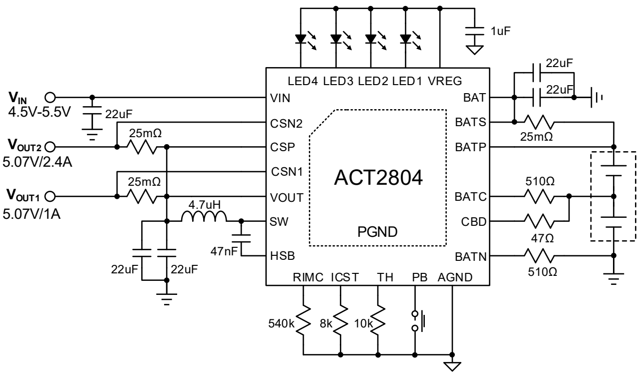
GENERAL DESCRIPTION

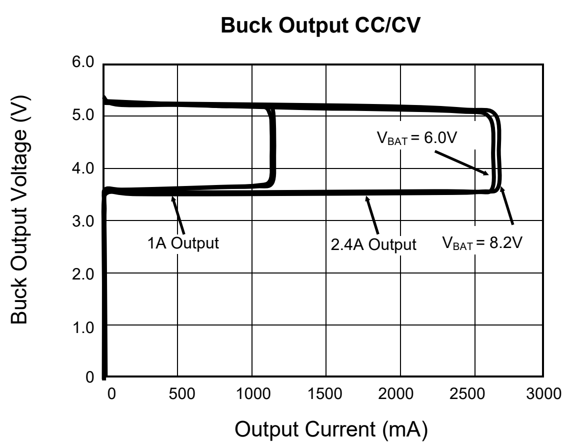
ACT2804 is a space-saving and dedicated single-chip solution for dual-cell battery charge and discharge. It takes 5V USB input source to charge a dual cell battery with boost configuration in three phases: preconditioning, constant current, and constant voltage. Charge is terminated when the current reaches 10% of the fast charge rate. The battery charger is thermally regulated at 110˚C with charge current foldback.

If input 5V is not present, ACT2804 discharge a dual cell battery with buck configuration to provide 5.07V+/-1% to output ports. There is a power path from input to output. The cycle-by-cycle peak current mode control, constant current regulation, short circuit protection and over voltage protection maximize safe operation.

ACT2804 provides 4 LED drive pins for battery capacity level and charge status indication to indicate 25%, 50%, 75%, and 75% above battery level with battery impedance compensation. The LED indication patterns are programmable .

ACT2804 is available in a thermally enhanced 5mmx5mm QFN55-40 package with exposed pad.

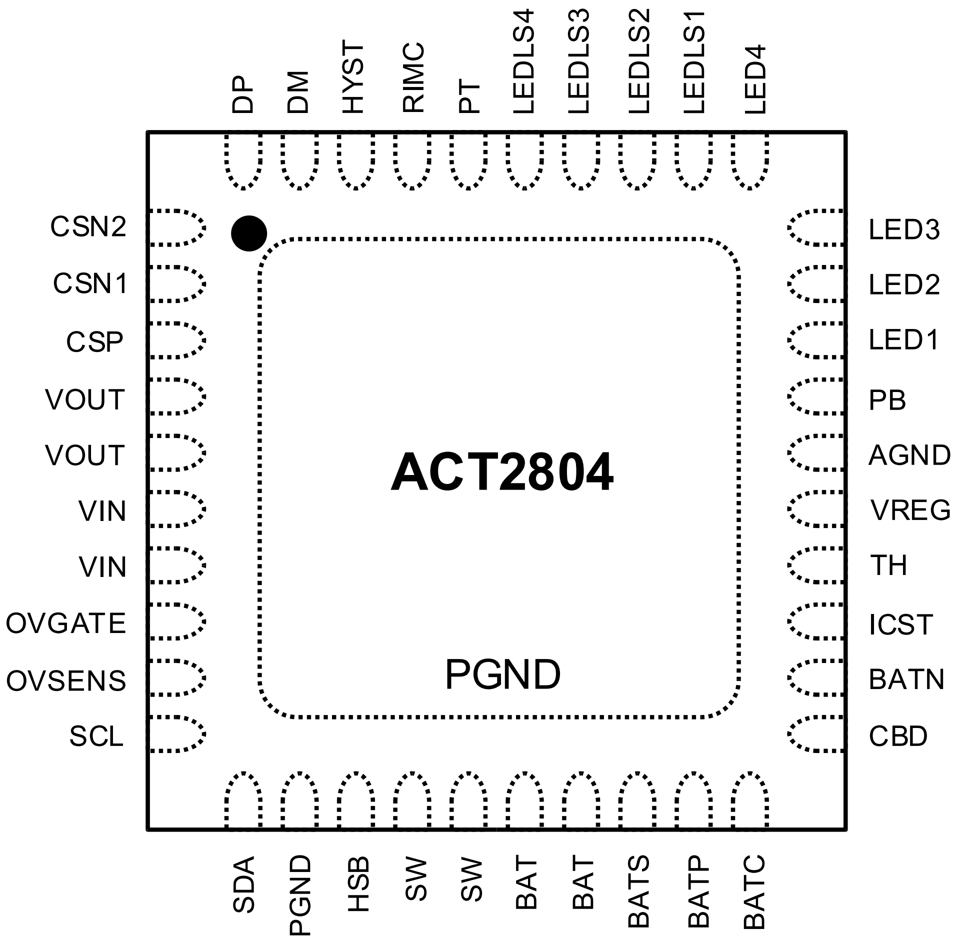




ORDERING INFORMATION

PART NUMBER	BATTERY CELL VOLTAGE	JUNCTION TEMPERATURE	PACKAGE	PINS
ACT2804QJ-T	4.20V	-40˚C to 150˚C	QFN55-40	40
ACT2804QJ-T0435	4.35V	-40˚C to 150˚C	QFN55-40	40

PIN CONFIGURATION



TOP VIEW

PIN DESCRIPTIONS

PIN	NAME	DESCRIPTION
1	CSN2	Output current sense negative input for channel 2.
2	CSN1	Output current sense negative input for channel 1.
3	CSP	Output current sense positive input.
4, 5	VOUT	Power Output Pin.
6, 7	VIN	USB or AC Adapter input.
8	OVGATE	Output to drive optional external NMOS protect IC from over voltage.
9	OVSENS	USB or AC Adapter input sense.
10	SCL	I2C clock input.
11	SDA	I2C data input.
12	PGND	Power ground. Directly connect this pin to IC thermal PAD and connect 10uF or 22uF high quality capacitors from BAT to PGND on the same layer with IC.
13	HSB	High side bias pin. Connect a 47nF ceramic capacitor from HSB to SW.
14,15	SW	Internal switch connected to a terminal of the output inductor.
16,17	BAT	BAT connection. Connect it to battery current sense positive terminal. Bypass BAT pin to PGND pin with high quality ceramic capacitors on the same layer with IC.
18	BATS	Battery charge current sense input. Connect to charge sense resistor positive terminal with Kevin sense.
19	BATP	Connect to charge sense resistor negative terminal and battery positive terminal.
20	BATC	Battery central point connection. Connect to dual battery cell common terminal.
21	CBD	Cell balancing discharge. Connect to a discharge resistor from this pin to battery common terminal.
22	BATN	Battery negative terminal.
23	ICST	Fast charge current setting pin. Connect a resistor from this pin to AGND to set the charging current. The current setting ranges from 0.5A-1.8A. The voltage at this pin reflects the charge current and discharge current in charge mode and discharge mode, respectively.
24	TH	Temperature sensing input. Connect to a battery thermistor terminal.
25	VREG	+5V Bias output. Connect a 1.0uF to this pin. This pin supplies up to 50mA output current. The bias turns on in charge mode and discharge mode. Internal register bit can shut down the bias. Bias turns off in HZ mode.

PIN DESCRIPTIONS

PIN	NAME	DESCRIPTION
26	AGND	Logic ground output. Connect this pin to the exposed PGND pad on same layer with IC.
27	PB	Push button input. When this pin is pushed for more than 40ms, LED1-4 indicators are enabled for 5 seconds.
28	LED1	Battery level indicator.
29	LED2	Battery level indicator.
30	LED3	Battery level indicator.
31	LED4	Battery level indicator.
32	LEDLS1	LED1 threshold level shift. Connect a resistor from the pin to AGND to shift LED1 threshold.
33	LEDLS2	LED2 threshold level shift. Connect a resistor from the pin to AGND to shift LED2 threshold.
34	LEDLS3	LED3 threshold level shift. Connect a resistor from the pin to AGND to shift LED3 threshold.
35	LEDLS4	LED4 threshold level shift. Connect a resistor from the pin to AGND to shift LED4 threshold.
36	PT	LED indication mode input. The 5 modes of LED indication patterns are set by a voltage at this pin. Connect a resistor at the pin to set the voltage and an LED indication pattern.
37	RIMC	RIMC Battery impedance compensation input.
38	HYST	The hysteresis window setting input. Connect a resistor at the pin to set the hysteresis windows for LED1, 2, 3, 4.
39	DM	Output port auto detection input. Connected to portable device D-.
40	DP	Output port auto detection input. Connected to portable device D+.
41	PGND	Exposed pad. Must be soldered to ground plane layer(s) on the PCB for best electrical and thermal conductivity.

ABSOLUTE MAXIMUM RATINGS①

PARAMETER	VALUE	UNIT
LEDLS1, LEDLS2, LEDLS3, LEDLS4, RIMC, HYST and PT to GND	-0.3 to +6	V
LED1, LED2, LED3 and LED4 to GND	-0.3 to +6	V
PB, DM, DP, TH, SCL, SDA and ICST to GND	-0.3 to +6	V
OVSENS to GND	-0.3 to +16	V
OVGATE to GND	-0.3 to +12	V
VIN, VOUT and VREG to GND	-0.3 to +6	V
CSP to CSN2, CSP to CSN1, CSP to VOUT	-0.3 to +0.3	V
BAT to BATS, BATS to BATP	-0.3 to +0.3	V
BATC to BATN	-0.3 to +6	V
BAT to BATC	-0.3 to +6	V
BATN to GND	-0.3 to +0.3	V
CBD to BAT	-6 to +0.3	V
BATN to CBD	-6 to +0.3	V
SW to PGND	-0.3 to +12	V
HSB to SW	-0.3 to +6	V
Junction to Ambient Thermal Resistance (θ_{JA})	40	℃/W
Operating Junction Temperature (T_J)	-40 to 150	℃
Operating Temperature Range (T_A)	-40 to 85	℃
Store Temperature	-55 to 150	℃
Lead Temperature (Soldering, 10 sec)	300	℃

Do not exceed these limits to prevent damage to the device. Exposure to absolute maximum rating conditions for long periods may affect device reliability.

ELECTRICAL CHARACTERISTICS

(V_{IN} = 5V, T_A = 25°C, unless otherwise specified.)

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Input Current Limit, Over Voltage Protection, Output Under Voltage Protection					
Input Voltage Range		4.5		5.5	V
Input Over Voltage Protection	VIN rising, V_{IN}_OVP	5.5	5.7	5.9	V
Input Over Voltage Hysteresis	VIN falling, VIN_OVP_HYST		290		mV
Input Under Voltage Lock-Out	VIN rising, V_{IN}_UVLO		4.2		V
Input Under Voltage Lock-Out Hysteresis	VIN falling, VIN_UVLO_HYST		200		mV
Input Current Limit Setting Range		-10%	3.4	+10%	A
Output Under voltage protection (UVP)	VOUT falling, VOUT_UVP		3.65		V
Output Under Voltage Protection Hysteresis	VOUT rising, VOUT_UVP_HYST		200		mV
Q1 wait time in hiccup mode			3		s
Boost Mode/Charge Mode					
Switching Frequency		-15%	400	+15%	KHz
Precondition Voltage Threshold of Each Cell	VBAT1,2 rising		2.8		V
Preconditioning current	Percentage of fast charge current		15		%
Boost Charger UVLO	VOUT rising, BST_UVLO		4.2		V
Battery End-Of-Charge Voltage	VBAT_EOC (ACT2804QJ-T)	-0.5%	4.2	+0.5%	V
	VBAT_EOC (ACT2804QJ-T0435)	-0.5%	4.35	+0.5%	V
End of Charge Detection Current	Percentage of fast charge current		10		%
Buck mode/Discharge					
Buck Under Voltage Lock-Out	VABT falling, VBAT1, 2		2.9		V
VOUT Output Regulation Voltage	REG3[1:0]=00		5.07		V
	REG3[1:0]=01		5.12		V
	REG3[1:0]=10		5.17		V
	REG3[1:0]=11		5.22		V
VOUT1 and VOUT2 Current Limit	RCS1=25mΩ, ICC1	1.05	1.25	1.40	A
	RCS2=25mΩ, ICC2	2.45	2.65	2.85	A

ELECTRICAL CHARACTERISTICS

(V_{IN} = 5V, T_A = 25°C, unless otherwise specified.)

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Buck Converter Under Voltage Protection Threshold	VOUT falling goes into hiccup		3.65		V
Buck Converter Over Voltage Protection Threshold	VOUT rising, BCK_OVP		5.7		V
Buck Convert Hiccup Time			3.4		s
Buck Converter Light-Load Cut-off Current		5	10	15	mA
Buck Converter Light-Load Cut-off Deglitch Time			12.5		s
High Side Switch Peak Current Limit	All condition	4.5			A
Over Temperature Protection	OTP		160		℃
Over Temperature Protection Hysteresis	OTP_HYST		20		℃
Battery Protection					
Battery Over Charge Current		2.6	3		A
Battery Over Voltage	Percentage of EOC Voltage	101.5	102.5	103.5	%
Battery Under Voltage and Short Circuit Protection			1.6		V
Preconditioning timer	If timer expires, goes to latch-off		1		hr
TH Pull-up Current	Charge mode		140		uA
	Discharge mode		100		uA
TH High Threshold	Charge mode		2.5		V
	Discharge mode		2.5		V
TH Low Threshold	Charge mode		1		V
	Discharge mode		0.57		V
System Management					
VREG Output Current			50		mA
PB Rising Threshold	PB rising, discharge mode		0.95		V
PB Falling Threshold	PB falling, discharge mode		0.75		V
PB internal pull up resistance	Pull up to internal supply		1.2		MΩ
Fault Condition Alarm Frequency	0.5s on and 0.5s off		1.0		Hz
Fault Condition Alarm Timer			10		s

ELECTRICAL CHARACTERISTICS

(V_{IN} = 5V, T_A = 25°C, unless otherwise specified.)

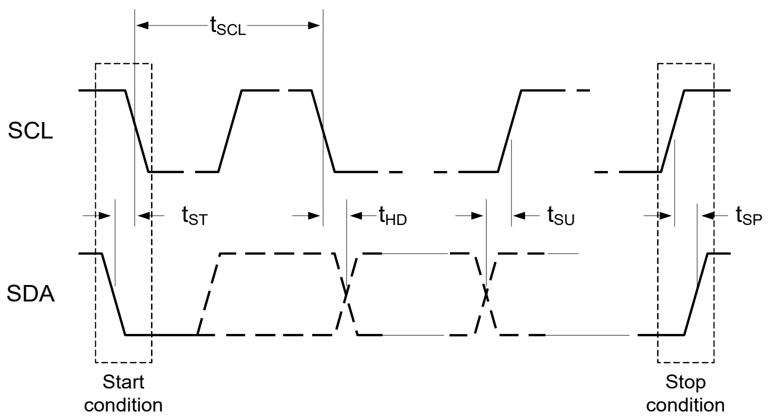
PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
LED Indication					
LED1-4 Indication Level Setting		5.5		8.8	V
LED Sink Current			3		mA
LED1-4 Scan Interval	For each LED pattern before lighting LEDs		0.5		s

ELECTRICAL CHARACTERISTICS

(V_{IN} = 5V, T_A = 25°C, unless otherwise specified.)

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
SCL, SDA Input Low	V_{CC}= 5V			0.4	V
SCL, SDA Input High	V_{CC}= 5V	1.25			V
SDA Leakage Current	SDA=5V			1	µA
SDA Output Low	I_{OL} = 5mA			0.35	V
SCL Clock Frequency, f_{SCL}		0		1000	kHz
SCL Low Period, t_{LOW}		0.5			µs
SCL High Period, t_{HIGH}		0.26			µs
SDA Data Setup Time, t_{SU}		50			ns
SDA Data Hold Time, t_{HD}	See Note: 1	0			ns
Start Setup Time, t_{ST}	For Start Condition	260			ns
Stop Setup Time, t_{SP}	For Stop Condition	260			ns
Capacitance on SCL or SDA Pin				10	pF
SDA Fall Time SDA, T_{of}	Device requirement			120	ns
Rise Time of both SDA and SCL, t_r	See Note: 3			120	ns
Fall Time of both SDA and SCL, t_f	See Note: 3			120	ns
Pulse Width of spikes must be suppressed on SCL and SDA		0		50	ns

Notes:
1. Comply to I2C timings for 1MHIZ operation - “Fast Mode Plus”
2. No internal timeout for I2C operations
3. This is a I2C system specification only. Rise and Fall time of SCL & SDA not controlled by the device.
4. Device Address is 7’h5A - Read Address is 8’hB4 and write is 8’hB5



FUNCTIONAL DESCRIPTION

ACT2804 is a complete battery charging and discharging power management solution for applications of dull-cell lithium-based backup battery pack or power bank.

With the advanced bidirectional architecture, a synchronous boost/buck converter is connected from VOUT to switching node (SW). The converter could be configured as either boost to charge battery or buck to discharge battery.

Modes of Operation

ACT2804 has 3 operation modes: charge mode, discharge mode, and high-impedance (HZ) mode.

High Impedance (HZ) Mode

HZ mode is the default mode. In HZ mode, all the switches are turned off , only PB circuit alive and the IC draws less than 10uA current from VBAT.

Discharge Mode

In discharge mode, Buck converter operates in CV/ CC regulation. VOUT1 current limit is set at 1.25A and VOUT2 current limit is set at 2.65A.

Charge Mode

ACT2804 is configured in charge mode (boost mode) when VIN is valid. In this mode, a battery is charged with trickle, preconditioning, fast charge, top-off and end of charge (EOC). The typical charge management is shown in Figure 1.

Precondition Charge

When operating in precondition state, the cell is charged at a reduced current at 15% of the programmed maximum fast charge constant current. Once V_{BAT} reaches the precondition threshold voltage the state machine jumps to the fast charge state.

Fast Charge

If battery voltage is above preconditioning threshold, boost converter charges battery with constant current. In fast charge state, the ACT2804 charges at the current set by the external resistor connected at the ICST pin. During a normal charge cycle fast charge continues in CC mode until V_{BAT} reaches the charge termination voltage, at which point the ACT2804 charges in top off state.

Top Off

Device transitions from Fast Charge (CC) to Top Off (CV), and moves to EOC (End of Charge) state when charging current is less than I_{EOC}.

End of Charge

In Top Off mode, when charges current decreases to 10% of set fast charge current, the boost converter goes into end of charge mode and keep monitoring the battery voltage.

Recharge

In EOC, device would re-charge batteries when both battery voltage levels drops 5% below V_{EOC}.

Battery Removal

If the battery is removed, boost converter regulates at the programmed regulation voltage.

Cell Balance

Cell Balance is activated in both Fast Charge and Top Off modes. Each battery is connected with a parallel bleeding switch.

Push Button

PB is always watched in HZ mode and discharge mode. If the push but on PB is pressed for >40mS in HZ mode, the LED (s) will turn on for 5 seconds. In the mean time, discharge mode is enabled.

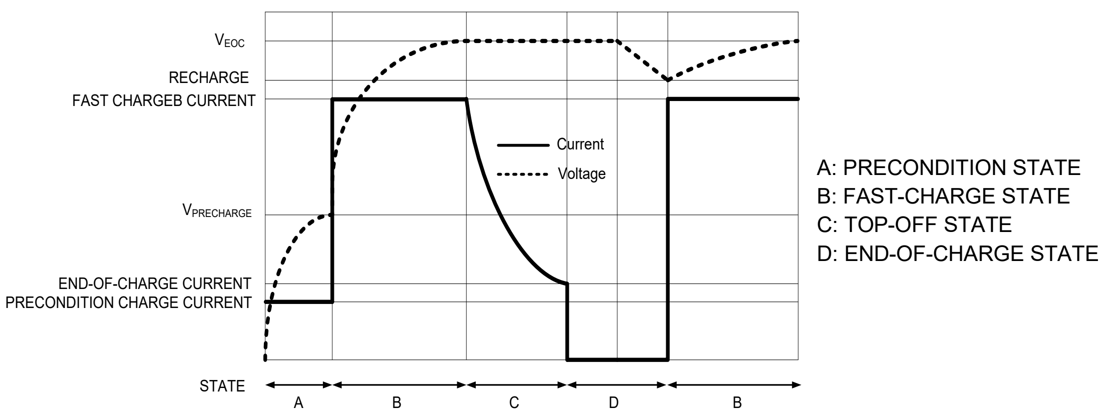


Figure 1. Typical Li+ Charge Profile and ACT2804 Charge States

APPLICATIONS INFORMATION

Fast Charge Current Control

The block diagram in Figure 2 shows how battery current is sensed for charge current control.

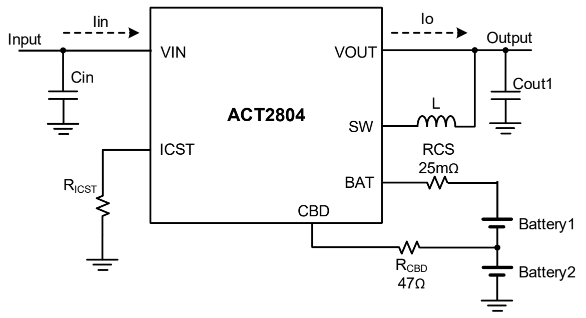


Figure 2: Battery current monitoring

A small percentage of charge current is sensed and sinked into a resistor connected at pin ICST. In charge mode, this would allow user to set fast charge current based on the following equation.

$$Ic(A) = \frac{1000}{5 * R_{CS}(m\Omega) * R_{ICST}(k\Omega)} \quad (1)$$

For example, I_C=1A with R_{CS}=25mΩ and R_{ICST}=8kΩ.

Recommended RICST is shown in following table:

I_C (A)	R_{ICST}		Units
	R_{CS}=25mΩ	R_{CS}=50mΩ	
0.8	10	5	kΩ
0.9	8.89	4.44	kΩ
1.0	8	4	kΩ
1.1	7.27	3.64	kΩ
1.2	6.67	3.33	kΩ
1.3	6.15	3.08	kΩ
1.4	5.71	2.86	kΩ
1.5	5.33	2.67	kΩ

During discharge mode, inputs of battery current sense amp are flipped to sense discharge current, and voltage level at pin ICST can be used (by the system) to monitor the magnitude of discharge current based on the following equation.

$$V_{ICST} = \frac{I_{DISCHARGE} \times R_{ICST}}{20k\Omega} \quad (2)$$

For example: V_{ICST}=0.4V with I_DISCHARGE=1A, and R_{ICST}=8kΩ.

LED Threshold Setting

LED1, LED2, LED3 and LED4 thresholds are adjustable with external resistors R_{LS1}, R_{LS2}, R_{LS3}, and R_{LS4} connected from LEDLS1, LEDLS2, LEDLS3, LEDLS4 to APNG respectively, as shows in Figure3.

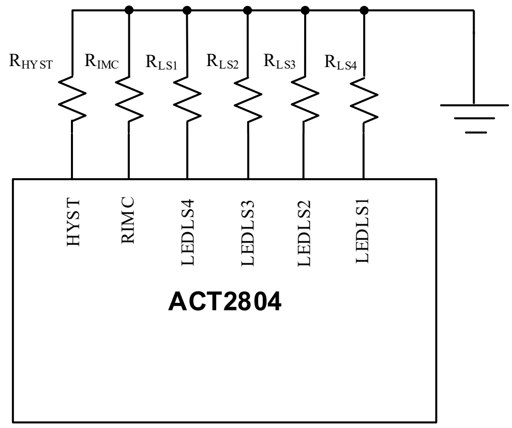


Figure 3: LED threshold setting

The following equation shows how the external resistor shifts the LED thresholds. The range of LED1-LED4 indicator threshold shift from 5.5V-8.8V.

$$V_{LEDX(V)} = 5.5V + \frac{108k\Omega}{R_{LSx}(k\Omega)} \quad (3)$$

R_{LSx} (kΩ)	V_{LEDx} (V)	R_{LSx} (kΩ)	V_{LEDx} (V)
40	8.2	72	7
43.2	8	90	6.7
47	7.798	108	6.5
49.1	7.7	120	6.4
57	7.395	135	6.3
60	7.3	180	6.1
67.5	7.1	270	5.9

VLED Example is given by the below table:

LED Hysteresis Window Setting

The adjustable LED voltage thresholds are set for HZ mode. In charge mode, the measured battery voltage is higher than in HZ mode, while in discharge mode, the measured battery voltage is lower. To have relatively better "fuel gauge" for battery, a programmable hysteresis window will help. When the battery voltage goes up (in charge mode), the thresholds become higher, when the battery voltage goes down, lower thresholds are applied.

ACT2804 provide HYST pin to set hysteresis window for each indication level as shows in Figure

APPLICATIONS INFORMATION

HYST pin is regulated at 1V. Its input current will determine hysteresis adjustment equally to all level. Connect HYST to APGN via a resistor to set hysteresis window.

Beside the hysteresis window, to avoid comparison oscillation, fixed 100mV of hysteresis is added to each LEVEL comparator.

Hysteresis window is given by below equation:

$$HYST(V) = \frac{54K}{RHYST(K\Omega)} \quad (4)$$

$$V_{HYST}\langle 4:3\rangle = 0.5 * HYST \qquad V_{HYST}\langle 2:1\rangle = 0.6 * HYST \quad (5)$$

Then RHYST Example is given by the below table:

R_{HYST} (kΩ)	LED1 VHYST	LED2 VHYST	LED3 VHYST	LED4 VHYST
Floating	0mV	0mV	0mV	0mV
270	120mV	120mV	100mV	100mV
135	240mV	240mV	200mV	200mV
90	360mV	360mV	300mV	300mV
67.5	480mV	480mV	400mV	400mV
54	600mV	600mV	500mV	500mV
45	720mV	720mV	600mV	600mV

Battery Impedance Compensation

To avoid the number of LEDs changes between charge and discharge modes. Internal impedance compensation circuit is built in. An external resistor is used to set the impedance from 100mΩ to 800mΩ. RIMC is corresponding to battery impedance. The LED1-4 thresholds shifted up and down based on the product of charge/discharge current and set impedance. RIMC value is given by below equation.

$$R_{IMC}(k\Omega) = 2160k\Omega \times \frac{R_{CS}(m\Omega)}{R_{BAT}(m\Omega)} \quad (6)$$

In case not using compensation, float RIMC then there is no compensation affects to trig-points.

RIMC example is given by the below table:

RBAT (mΩ)	100	200	300	400	500	600	700
RCS = 25 mΩ	540k	270k	180k	135k	108k	90k	77k
RCS = 50 mΩ	1280k	540k	360k	270k	216k	180k	154k

BATTERY TEMPERATURE MONITERING

The ACT2804 monitors the battery pack temperature by measuring TH voltage at the TH pin as shows in Figure 4. The TH pin is connected to the thermistor resistor net which includes a negative -temperature coefficient thermistor. An internal current source provides a bias current to generate TH voltage. The ACT2804 compares the voltage at the TH pin with the internal V_{THH} and V_{THL} thresholds to determine if charging or discharging is allowed. When V_{TH}<V_{THL} or V_{TH}>V_{THH}, it will be triggered latch off fault, there is 3 ways to wake up ACT2804 when V_{TH} returns to the normal range.

1. Push PB when latch off bit is not set
2. I^2C to clear faults in standby
3. Plug Vin to power up

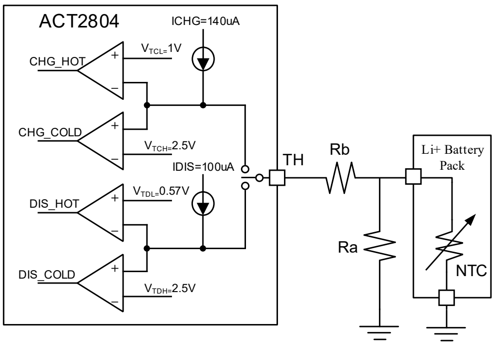


Figure 4: Thermistor setting

$$V_{TCL} = I_{CHG} \times Rchot \quad (7)$$

$$V_{TCH} = I_{CHG} \times Rcold \quad (8)$$

$$Rchot = Rb + \frac{Ra \times R_{NTCh}}{Ra + R_{NTCh}} \quad (9)$$

$$Rcold = Rb + \frac{Ra \times R_{NTCc}}{Ra + R_{NTCc}} \quad (10)$$

R_{NTCc} : NTC Resistor at cold temperature (Tcold)

R_{NTCh} : NTC Resistor at hot temperature (Thot)

From (7) (8) (9) and (10) calculate Ra and Rb in charge mode, as the same method, the resistors in discharge mode can be calculated.

For example, use NXRT15XH103 NTC resistor, the temperature in charge mode is 0℃ to 45℃,we know R_{NTCC}=27.219k and 4.917k at 0℃ to 45℃, respectively. We can calculate Ra=33kΩ and Rb=2.87kΩ based on the above formulas. As the same method we can calculate the value when the temperature is -20℃ to 60℃.

LED Indication

ACT2804 is designed 5 levels of PT pin voltage into 5 application patterns. A resistor is connected from PT pin to ground and the voltage at PT pin programs the LED indication patterns.

APPLICATIONS INFORMATION

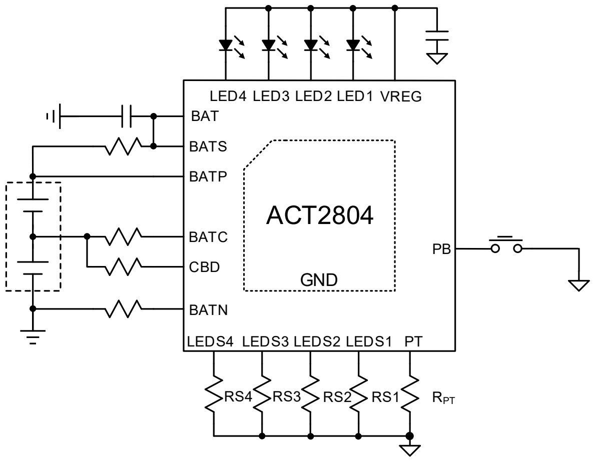


Figure 5: LED Indication

In discharge mode, when battery voltage goes below LED1 threshold, LED1 starts flashing until Buck (discharge mode) turns off due to either light load or Buck UVLO. The flash frequencies for all the LEDs are 0.5Hz with 1s on and 1s off.

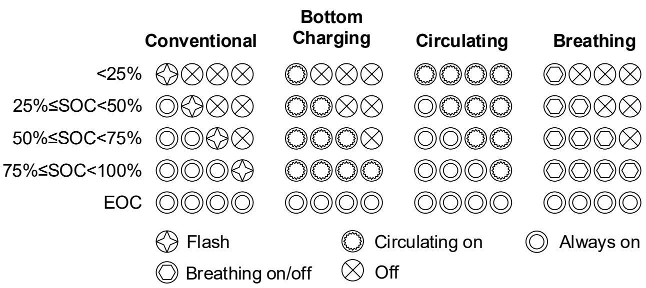
In HZ mode, when PB is pressed for 40ms, Buck turns on. If VBAT<LED1, LED1 starts flashing until Buck turns off.

Conventional indication patterns could behave to have two application. Setting R_{PT}=4kΩ to have “Always On”, setting R_{PT}=12kΩ to have “5s Indication”. The behaviors for both setting are same in charge mode.

See below table for more information.

#	INDICATION PATTERN	R_{PT}
1a	**Conventional** Always On In Discharge	4kΩ
1b	**Conventional** 5s Indication in Discharge	12kΩ
2	**Breathing** 5s Indication in Discharge	24kΩ
3	**Bottom Charging** 5s Indication in Discharge	40kΩ
4	**Circulating** 5s Indication in Discharge	56kΩ

Below shows 4 LED indication patterns.



LED1-4 Refreshing Cycle

Every time when VIN is plugged in or a PB is pushed, LED1, 2, 3, 4 turns on sequentially at 0.5s interval, like a LED scanning, and then goes into corresponding mode defined by PT pin.

LED1-4 Fault Alarm Signal

At fault conditions, actions are taken. In the meantime, all the 4 LEDs turn on/off with 0.5s on and 0.5s off for 10 seconds to send alarm signal out. The fault conditions include battery OVP, UVP, OTP.

PCB Board Layout Guidance

When laying out the printed circuit board, the following checklist should be used to ensure proper operation of the IC.

1. Arrange the power components to reduce the AC loop area.
2. Place the decoupling ceramic capacitor as close to BAT pin as possible. Use different capacitance combination to get better EMI performance.
3. Place the decoupling ceramic capacitors close to VIN pin, VOUT pin, and BAT pin.
4. Use copper plane for power GND for best heat dissipation and noise immunity.
5. Use Kevin sense from sense resistors to CSP and CSN1, CSN2 pins, and the sense resistor from BATS and BATP pins.
6. SW pad is a noisy node switching. It should be isolated away from the rest of circuit for good EMI and low noise operation.
7. Thermal pad is connected to GND layer through vias. PGND and AGND should be single-point connected.
8. RC snubber and external Schottky diode across SW to PGND can be added as needed for reducing SW spike and better EMI performance.

APPLICATIONS SCHEMATIC

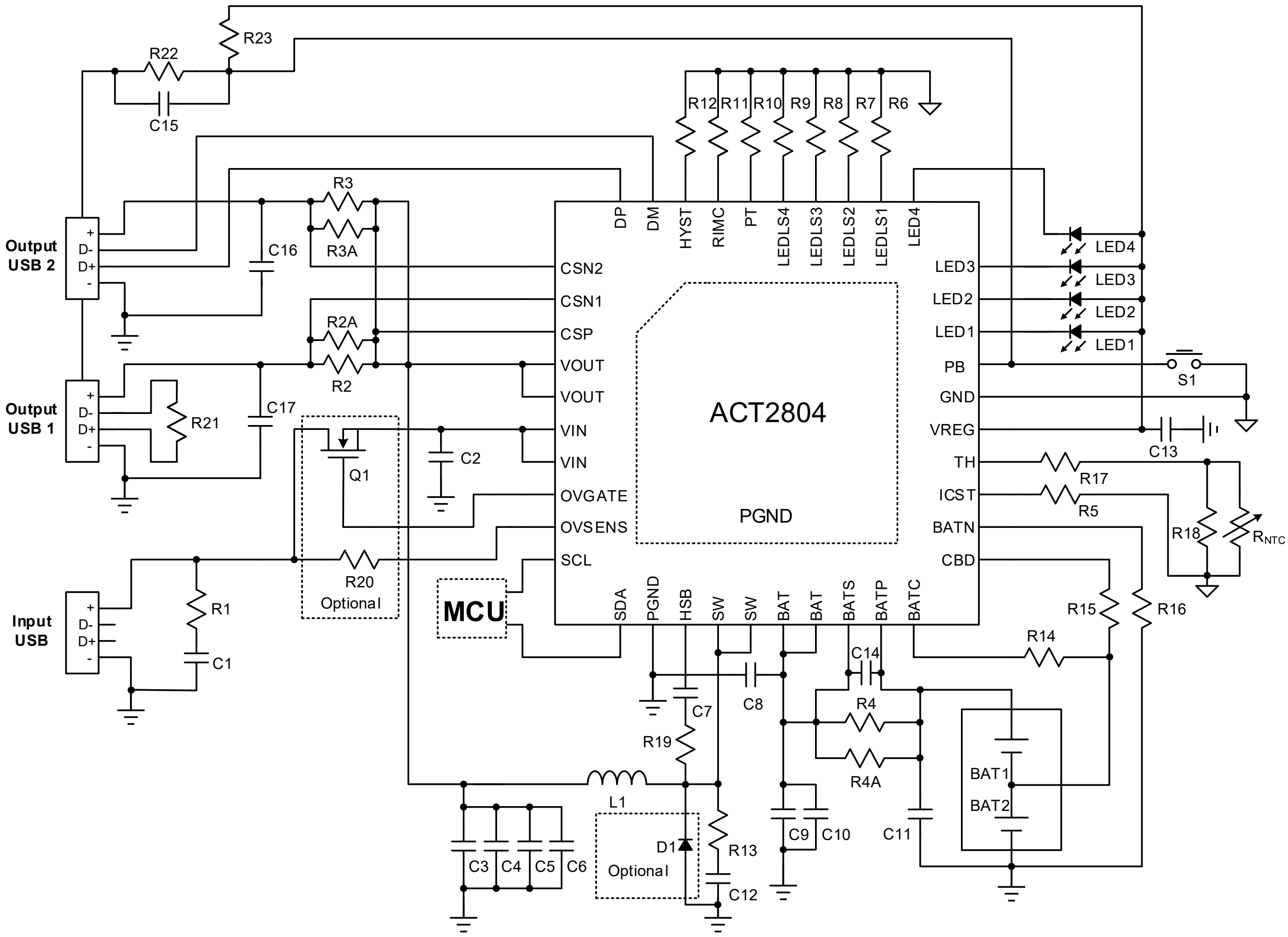


Figure 6. ACT2804 typical application circuit

(Input current limit 3.4A, fast charge current limit 1.0A, discharge output constant current 2.4A+1A)

Charge: Cold: 0°C, Hot: 45°C. Discharge: Cold: -20°C, Hot: 60°C.

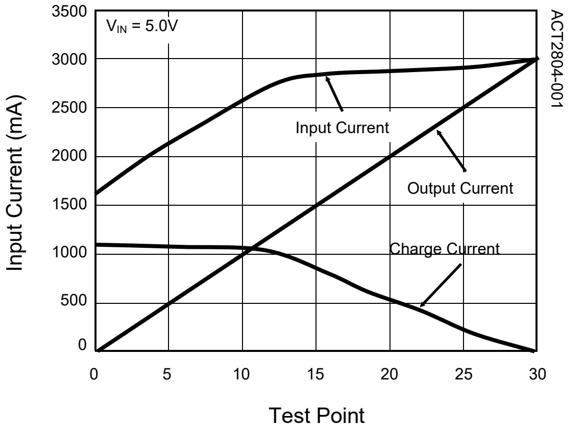
Table 5: BOM List

ITEM	REFERENCE	DESCRIPTION	QTY	MANUFACTURER
1	C1	Ceramic capacitor, 4.7uF/10V, X7R, 0805	1	Murata/TDK
2	C2,C3,C4,C5,C8, C9,C11	Ceramic capacitor, 22uF/16V, X7R, 1206	7	Murata/TDK
3	C6,C10	Ceramic capacitor, 0.1uF/16V, X7R, 0603	2	Murata/TDK
4	C7	Ceramic capacitor, 47nF/10V, X7R, 0603	1	Murata/TDK
5	C12	Ceramic capacitor, 2.2nF/16V, X7R, 0603	1	Murata/TDK
6	C13	Ceramic capacitor, 1uF/10V, X7R, 0603	1	Murata/TDK
7	C14	Ceramic capacitor, 100nF/16V, X7R, 0603	1	Murata/TDK
	C15	Ceramic capacitor, 2.2uF/10V, X7R, 0603	1	Murata/TDK
9	C16,C17	Ceramic capacitor, 3.3uF/10V, X7R, 0603	2	Murata/TDK
10	D1	MBR1020VL, 20V, 1A Schottky, optional	1	Panjit
11	L1	Core SWPA8040S4R7NT 4.7uH 5.9A	1	Sunlord
12	LED1,LED2, LED3,LED4	LED, 0603, Blue	4	LED Manu
13	R1	Chip Resistor, 2.7Ω, 1/8W, 1%, 0805	1	Murata/TDK
14	R2,R2A,R3,R3A,R4,R4A	Chip Resistor, 50mΩ, 1/2W, 1%, 1206	6	SART
15	R5	Chip Resistor, 8kΩ, 1/10W, 1%, 0603	1	Murata/TDK
16	R6	Chip Resistor, 83kΩ, 1/10W, 1%, 0603	1	Murata/TDK
17	R7	Chip Resistor, 63.5kΩ, 1/10W, 1%, 0603	1	Murata/TDK
18	R8	Chip Resistor, 51.4kΩ, 1/10W, 1%, 0603	1	Murata/TDK
19	R9	Chip Resistor, 41.5kΩ, 1/10W, 1%, 0603	1	Murata/TDK
20	R10	Chip Resistor, 12kΩ, 1/10W, 5%, 0603	1	Murata/TDK
21	R11,R12	Chip Resistor, 540kΩ, 1/10W, 1%, 0603	2	Murata/TDK
22	R13	Chip Resistor, 0.47Ω, 1/8W, 5%, 0805	1	Murata/TDK
23	R14,R16	Chip Resistor, 510Ω, 1/10W, 1%, 0603	2	Murata/TDK
24	R15	Chip Resistor, 47Ω, 1/4W, 5%, 1206	1	Murata/TDK
25	R17	Chip Resistor, 3k, 1/10W, 1%, 0603	1	Murata/TDK
26	R18	Chip Resistor, 32k, 1/10W, 1%, 0603	1	Murata/TDK
27	R19	Chip Resistor, 10Ω, 1/10W, 1%, 0603	1	Murata/TDK
28	R20	Chip Resistor, 200Ω, 1/10W, 5%, 0603, optional	1	Murata/TDK
29	R21	Chip Resistor, 100Ω, 1/10W, 5%, 0603	1	Murata/TDK
30	R22, R23	Chip Resistor, 715kΩ, 1/10W, 5%, 0603	2	Murata/TDK
31	R_{NTC}	103AT NTC Thermistor, NXRT15XH103V	1	Murata
32	Q1	8205A, Rdson < 25mΩ at VGS = 4.5 V, optional	1	TY
33	PB	Push Button Switch	1	Nikkai Omron
34	USB	10.2*14.6*7mm, 4P	2	
35	Micro-USB	MICRO USB 5P/F SMTB	1	
36	U1	IC, ACT2804, QFN 55-40	1	Active-Semi

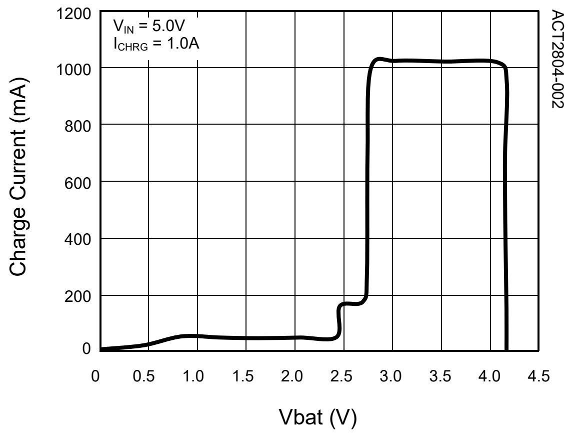
TYPICAL PERFORMANCE CHARACTERISTICS CONT'D

(Schematic as show in Figure 6, Ta = 25°C, unless otherwise specified)

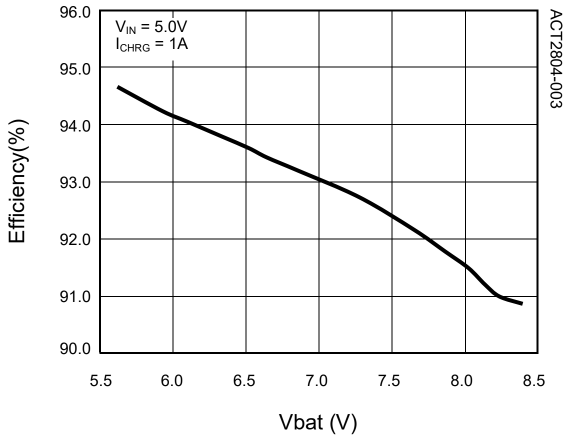
Charge Current vs. Output Current



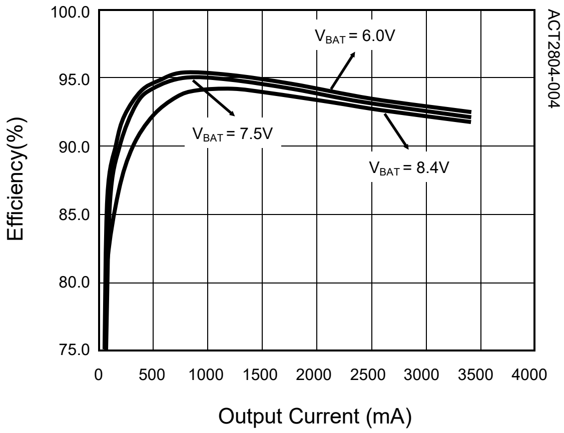
Battery Charge V/I Profile



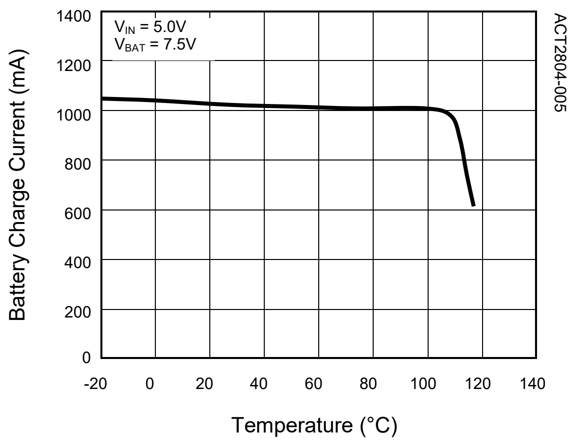
Charge Efficiency



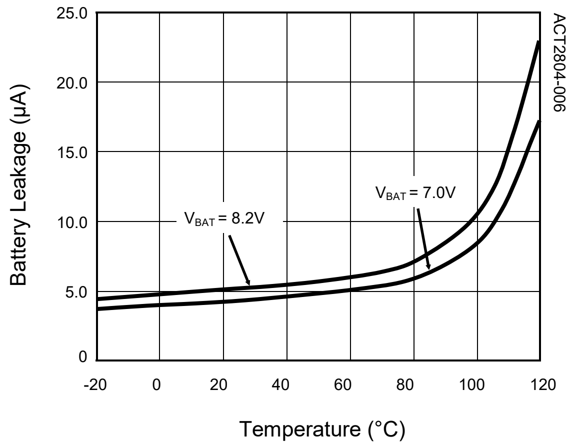
Discharge Efficiency



Battery Charge Current vs. Junction Temperature



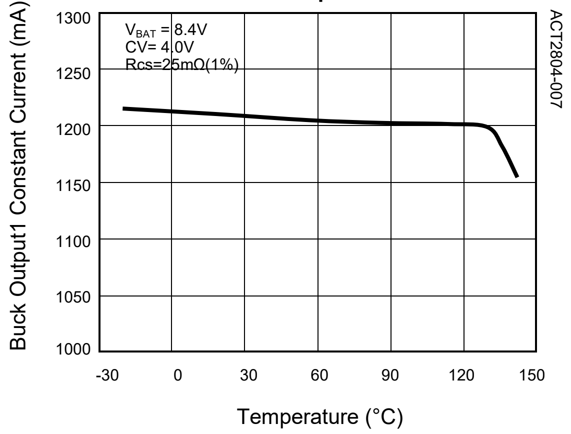
Battery Leakage vs. Junction Temperature (HZ Mode)



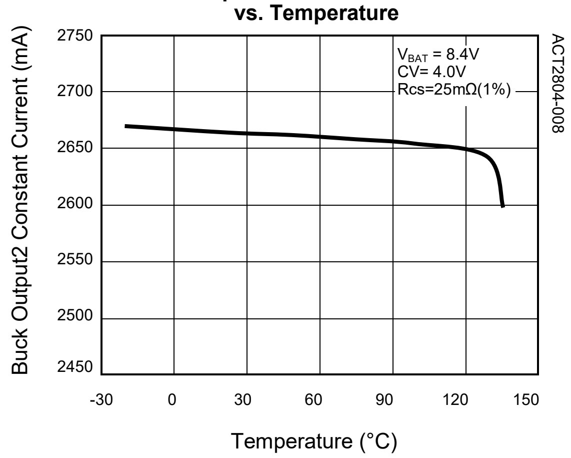
TYPICAL PERFORMANCE CHARACTERISTICS CONT'D

(Schematic as show in Figure 6, Ta = 25°C, unless otherwise specified)

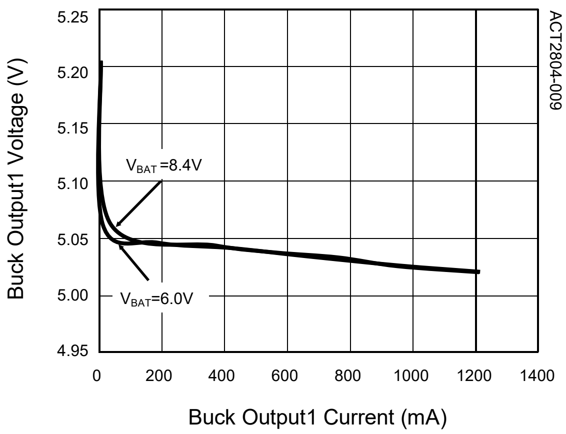
Buck Output1 Constant Current Limit vs. Temperature



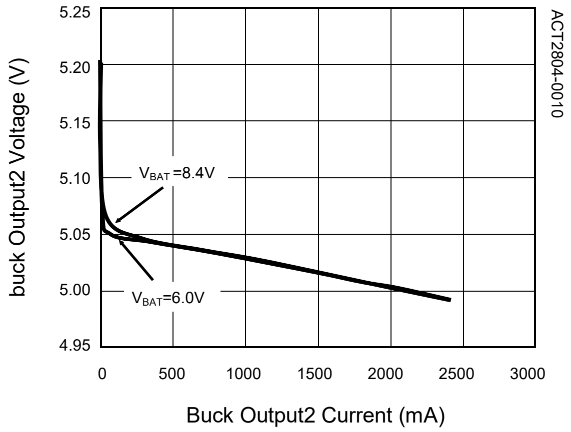
Buck Output2 Constant Current Limit vs. Temperature



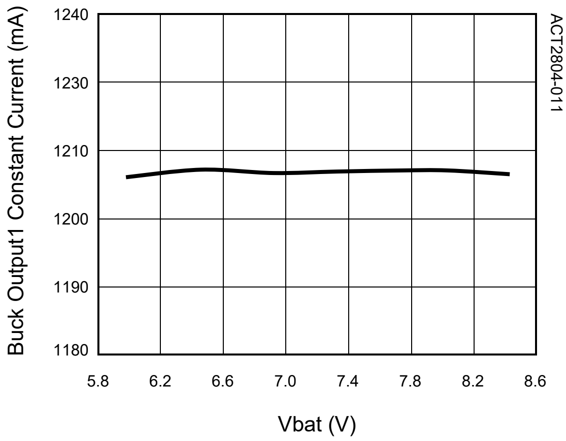
Buck Output1 Voltage vs. Output Current



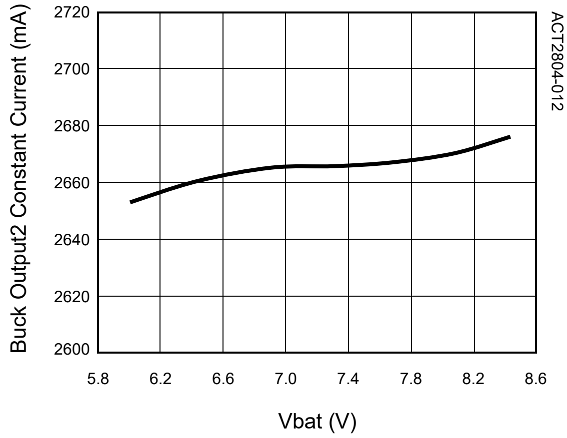
Buck Output2 Voltage vs. Output Current



Buck Output1 Constant Current Limit vs. V_{BAT}



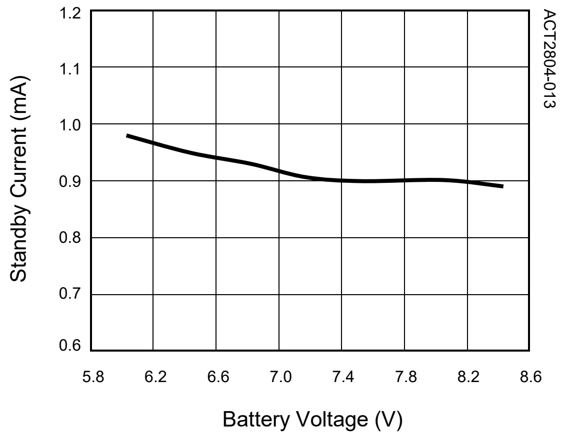
Buck Output2 Constant Current Limit vs. V_{BAT}



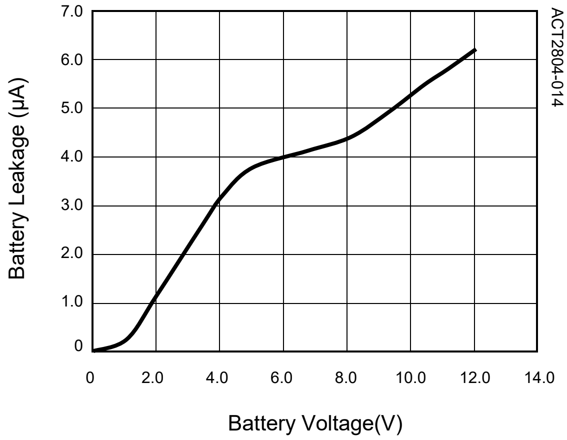
TYPICAL PERFORMANCE CHARACTERISTICS CONT'D

(Schematic as show in Figure 6, Ta = 25°C, unless otherwise specified)

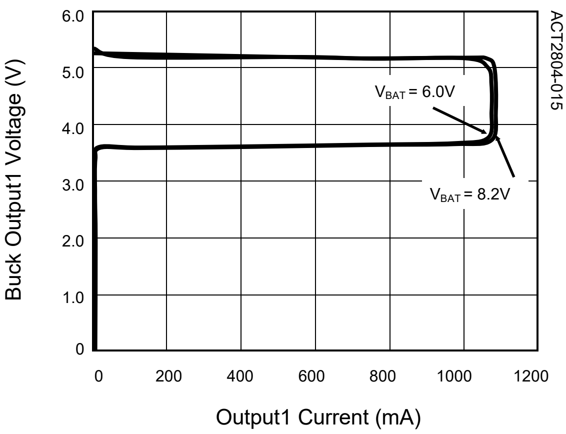
Buck Standby Current vs. Battery Voltage



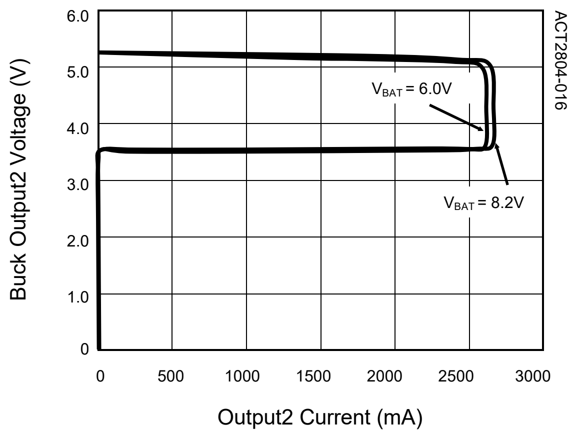
Battery Leakage vs. Battery Voltage (HZ Mode)



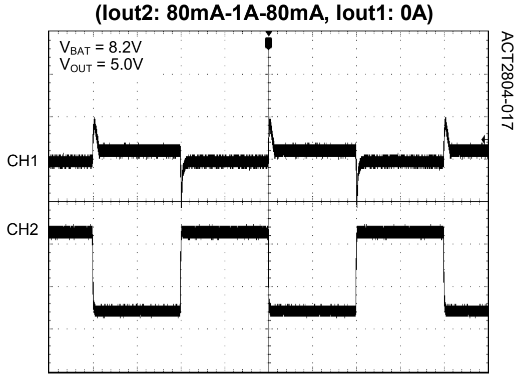
Buck Output1 CC/CV



Buck Output2 CC/CV

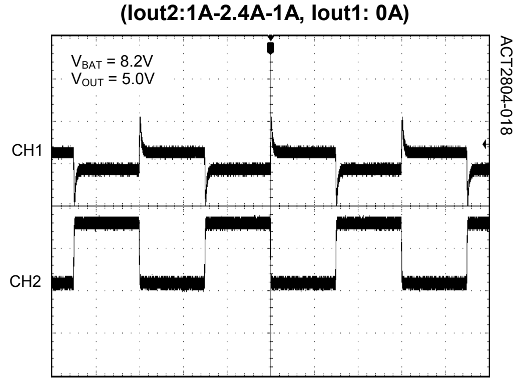


Buck Load Transient (Iout2: 80mA-1A-80mA, Iout1: 0A)



CH1: V_{OUT}, 200mV/div
CH2: I_{OUT}, 500mA/div
TIME: 1ms/div

Buck Load Transient (Iout2:1A-2.4A-1A, Iout1: 0A)

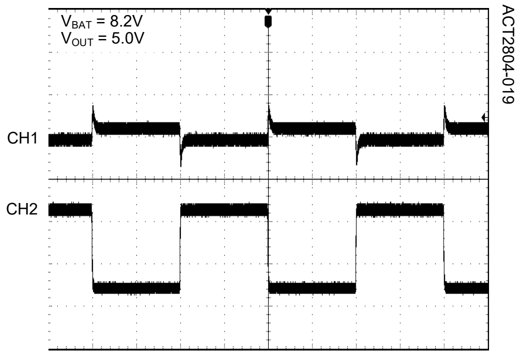


CH1: V_{OUT}, 200mV/div
CH2: I_{OUT}, 1A/div
TIME: 1ms/div

TYPICAL PERFORMANCE CHARACTERISTICS CONT'D

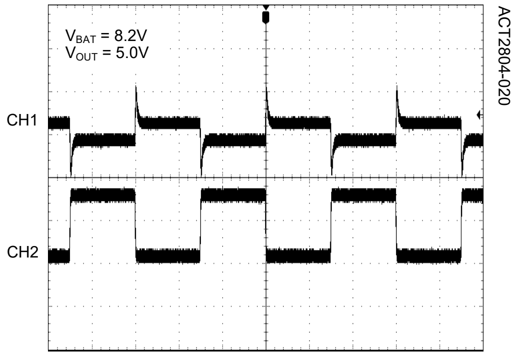
(Schematic as show in Figure 6, Ta = 25°C, unless otherwise specified)

Buck Load Transient
(Iout2: 80mA-1A-80mA, Iout1: 1A)



CH1: V_{OUT}, 200mV/div
CH2: I_{OUT}, 500mA/div
TIME: 1ms/div

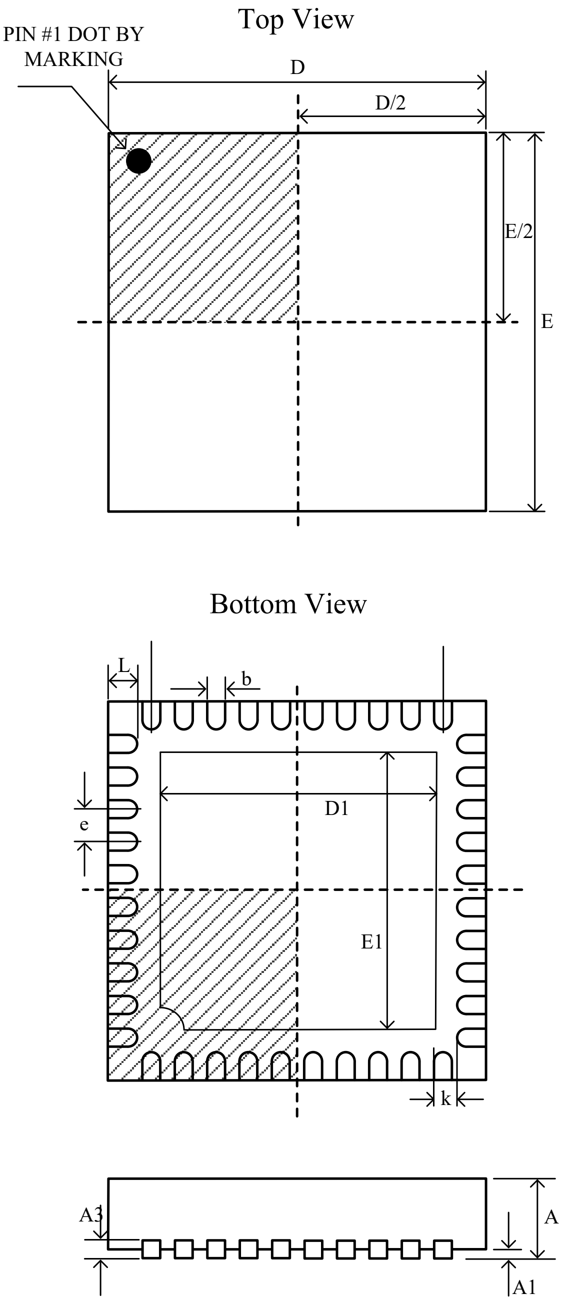
Buck Load Transient
(Iout2:1A-2.4A-1A, Iout1: 1A)



CH1: V_{OUT}, 200mV/div
CH2: I_{OUT}, 1A/div
TIME: 1ms/div

PACKAGE OUTLINE

QFN55-40 PACKAGE OUTLINE AND DIMENSIONS



SYMBOL	DIMENSION IN MILLIMETERS		DIMENSION IN INCHES	
	MIN	MAX	MIN	MAX
A	0.700	0.800	0.028	0.031
A1	0.000	0.050	0.000	0.002
A3	0.203 REF		0.008 REF	
b	0.150	0.250	0.006	0.010
D	4.924	5.076	0.194	0.200
E	4.924	5.076	0.194	0.200
D1	3.300	3.500	0.130	0.138
E1	3.300	3.500	0.130	0.138
e	0.400 TYP		0.016 TYP	
L	0.324	0.476	0.013	0.019
k	0.200 MIN		0.008 MIN	