CC3200R1 电源管理功耗测试笔记

Overview:

1、CC3200 在网状态功耗柱状图

2、CC3200 间接在网功耗柱状图

3、CC3200 电池供电使用时间图

4、CC3200 功耗测试总结表

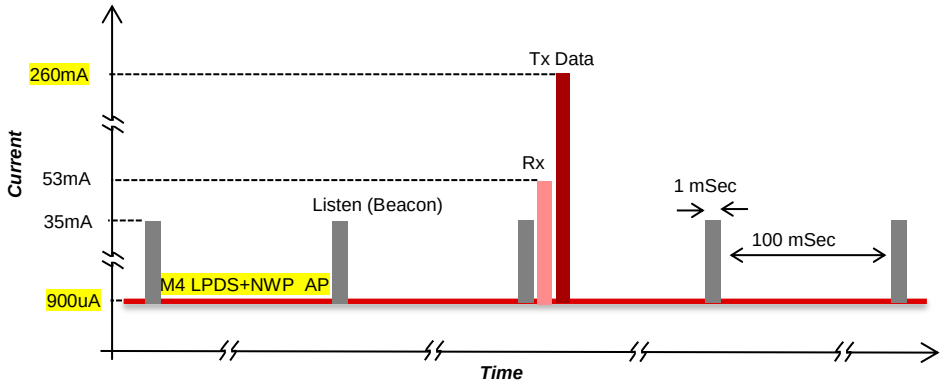
5、CC3200 实验测试图片

一、CC3200 连接 AP 在网状态的功耗消耗柱状图(Always Connected)：

1.1 Immediately responds to the application – can send data at any time

1.2 Reachable from the network while saving power

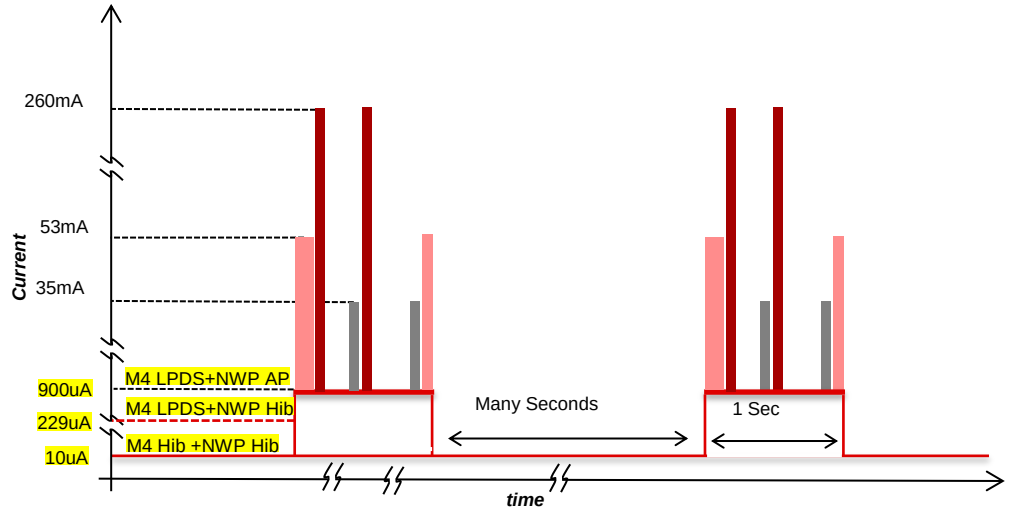
1.3 Best for communication duty cycles <15 sec or when fast response time is needed



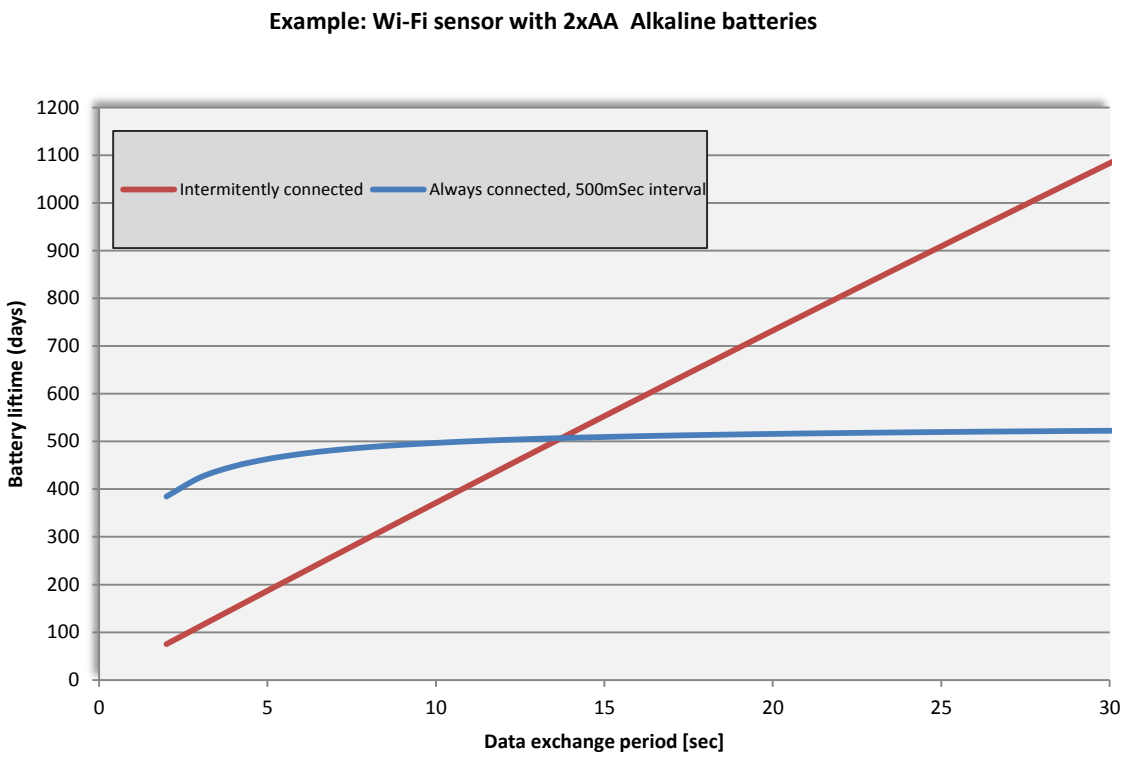
二、CC3200 间断连接 AP 在网状态的功耗消耗柱状图(Intermittently Connected)：

2.1 Lowest power consumption for communication duty cycle >15 sec

2.2 Application wakes up the device periodically on an external trigger or timer to check for pending information on the network



三、电池使用寿命时间图：



Example Energy

• P2 = 60 sec

• W1 = 233 uA x 3.0 V = 0.0007 W (assuming a long sleep interval of 1 sec)

• E2 = 25 mA x 200 msec x 3.0 V = 15 mJ (assuming part of the 200 ms is at RX current, very short time at TX current, and part in LPDS current resulting in 25 mA average over the 200 ms)

Battery – 2AA alkaline battery rated at 1.5 V, each connected in series with a capacity of 2000 mAh:

• B = 2000 mAh

• V = 3.0 V T (device lifespan) = 2000 x 3.0 / (0.0007 +0.015/60) / (1000 x 24) =~ 263 days

四、实验室实际测试功耗记录(测试代码 idle_profile_nonos)：

模式	条件	电流消耗	测试图	**Datasheet**
M4 Active(80MHz)+NWP connect AP	1	15.9mA	图 1	**15.3mA**
M4 LPDS+NWP start but do nothing	2	282uA	图 2	**266uA**
M4 LPDS+NWP connect AP<1>	3	600uA~2mA(Avr=900uA)	图 3 图 4	**825uA**
M4 LPDS+NWP Hib<2>	4	229uA	图 5	**120uA**
M4 Hib+NWP Hib	5	10.65uA	图 6	**4uA**

备注：M4 LPDS(RAM-Retained)/Hib(RAM-Not Retained) 唤醒：RTC+GPIO(UART 复用 GPIO)

M4 Active+NWP connect AP =15.9mA

M4 LPDS+NWP connect AP =600uA~2mA 波动 大约平均功耗为 1mA 左右

M4 LPDS+NWP start but do nothing 即 sl_start 但不连接 AP =282uA

M4 LPDS+NWP 进入 Hib 模式 229uA 注意此时网络已经断开，但是 RAM 还是保存的！

M4 Hib+NWP 进入 Hib 模式 10.65uA(注意 Hib 模式下测试的电流消耗为 CC3200+SPI_Flash 的功耗，而 Datasheet 上 4uA 是不包括 SPI_Flash 的功耗)

注意 CC3200-Launchpad 上测试功耗板子 SPI_Flash=M25PX80,从 Datasheet 上获取低功耗模式下的功耗最大为 10uA,可能在几个 uA 左右。

Micron M25PX80 Serial Flash Embedded Memory
Electrical Characteristics

Electrical Characteristics

Table 15: Power Up Timing Specifications

Symbol	Parameter	Min	Max	Units
^{t}VSL	V_{CC}[MIN] to S# LOW	30	–	µs
^{t}PUW	Time delay to WRITE command	1	10	ms
V_{WI}	Write Inhibit voltage	1.5	2.1	V

Note: 1. These parameters are characterized only.

Table 16: DC Current Specifications

Symbol	Parameter	Test Condition	Device Grade 6		Device Grade 3		Units
			Min	Max	Min	Max	
I_{LI}	Input leakage current	–	–	±2	–	±2	µA
I_{LO}	Output leakage current	–	–	±2	–	±2	µA
I_{CC1}	Standby current	S# = V_{CC}, V_{IN} = V_{SS} or V_{CC}	–	50	–	100	µA
I_{CC2}	Deep power-down current	S# = V_{CC}, V_{IN} = V_{SS} or V_{CC}	–	10	–	100	µA

1、CC3200-Datasheet 中描述：

MCU ACTIVE			54 OFDM	TX power level = 0		229	mA
				TX power level = 4		166	
		RX	1 DSSS			59	
			54 OFDM			59	
	NWP idle connected(3)					15.3	

MCU LPDS			54 OFDM	TX power level = 0		223		mA
				TX power level = 4		160		
		RX	1 DSSS			53		
			54 OFDM			53		
	NWP LPDS(4)					0.25	250uA-64kRAM 266uA-128kRAM	
	NWP idle connected(3)					0.825		

2、在 CC3200-TRM 中描述：

peripheral and pin configurations. 连接AP不发数据空闲模式下，测试电流为1mA左右，多数在600uA波动

- Total system current (incl WiFi and network periodic wake-up) as low as 700uA.
- When networking and WiFi subsystems are disabled, chip draws around 120uA.
  - 40MHz XTAL and PLL are turned off. 32.768 KHz XTAL is kept alive.
  - Most of digital logic is turned off. Digital supply voltage is reduced to 0.9V.
  - SRAM can be retained in multiples of 64KB.

NWP-sl_stop进入hib模式，也就是M4=LPDS+NWP=Hib模式整体功耗。此时网络断开了但是M4的RAM还是保存的，并不需要重启！可通过RTC+GPIO唤醒。
实际测试功耗229uA(256k RAM保持)

MCU hibernate(5)	NWP hibernate(6)				4		µA
Peak calibration current (7)		V_{BAT} = 3.3 V			450		mA
		V_{BAT} = 2.1 V			670		
		V_{BAT} = 1.85 V			700		

(4) LPDS current does not include the external serial flash. The LPDS number reported is with retention of 64KB MCU SRAM. The CC3200 device can be configured to retain 0KB, 64KB, 128KB, 192KB or 256KB SRAM in LPDS. Each 64KB retained increases LPDS current by 4 µA.

(5) For the 1.85-V mode, the Hibernate current is higher by 50 µA across all operating modes because of leakage into the PA and analog power inputs.

(6) Serial flash current consumption in power-down mode during hibernate is not included.

(7) The complete calibration can take up to 17 mJ of energy from the battery over a time of 24 ms. Calibration is performed sparingly

五、测试记录照片

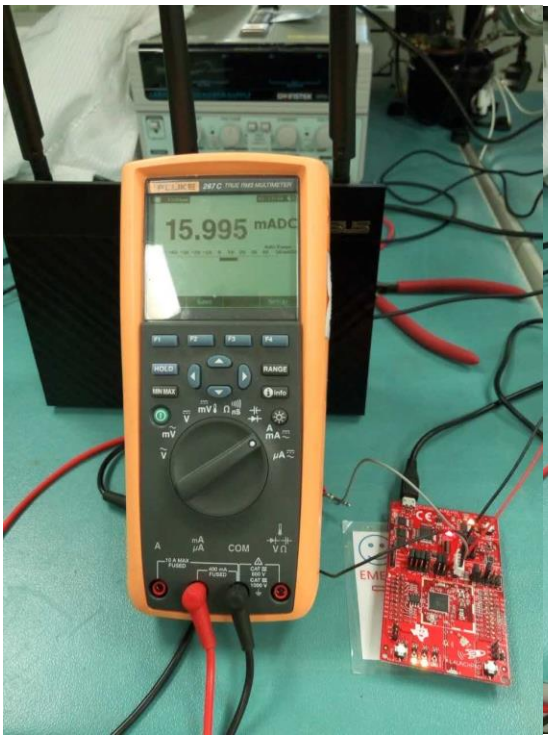


图 1

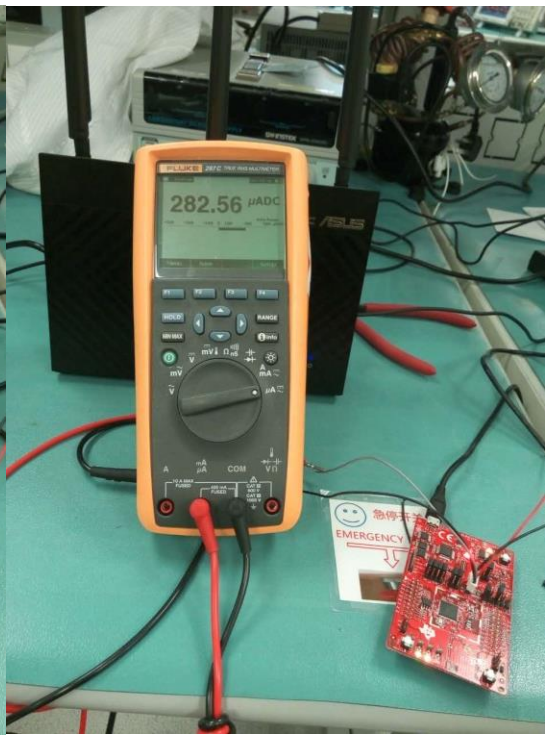


图 2

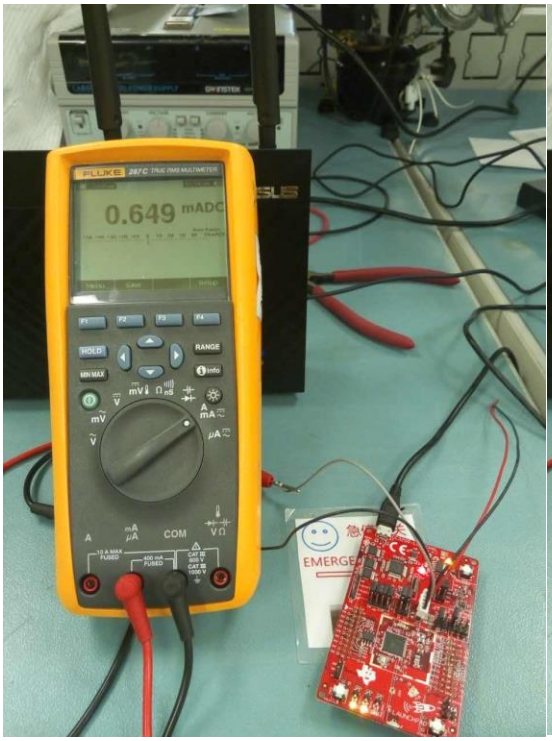


图 3

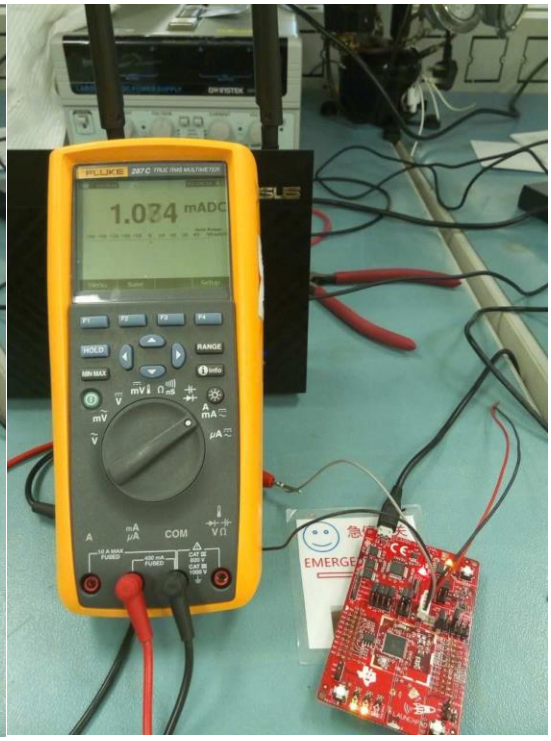


图 4

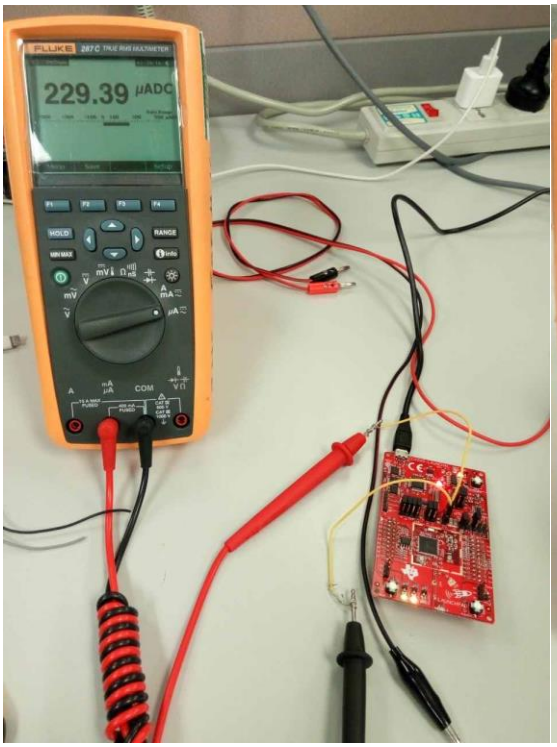


图 5

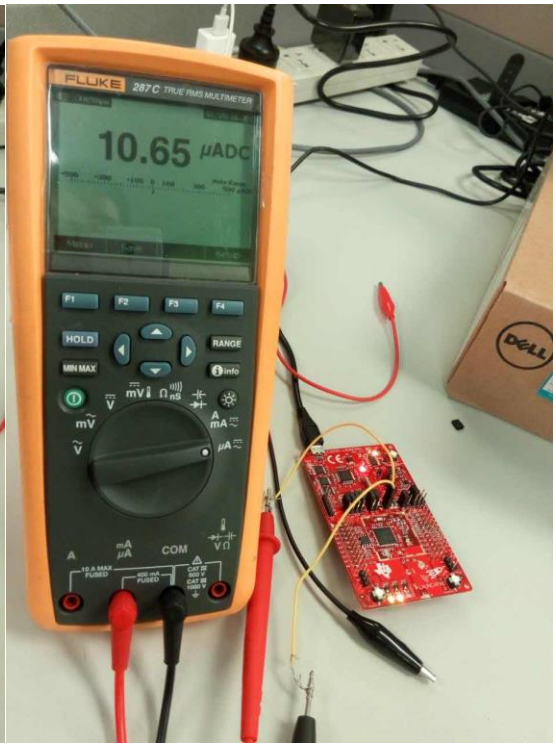


图 6

特别注意从 CC3200 的 Datasheet 中可以发现 NWP 在没有网络活动时会自动休眠！
从测试条件 2 测试就会得出，在启动 NWP 没有连接网络时，NWP 整体功耗很低！

MCU hibernate mode	The lowest power mode in which all digital logic is power-gated. Only a small section of the logic directly powered by the input supply is retained. The real-time clock (RTC) clock keeps running and the MCU supports wakeup from an external event or from an RTC timer expiry. Wake-up time is longer than LPDS mode at about 15 ms plus the time to load the application from serial flash, which varies according to code size. In this mode, the MCU can be configured to wake up using the RTC timer or external event on a GPIO (GPIO0–GPIO6). GPIO-2/4/11/13/17/24 唤醒

The NWP can be active or in LPDS mode and takes care of its own mode transitions. When there is no network activity, the NWP sleeps most of the time and wakes up only for beacon reception.

//----------需要弄明白这几个 nwp 电源管理区别及影响

在 nwp programming 中 ***4.6.1 Power Policy***

//#define SL_NORMAL_POLICY (0)

//#define SL_LOW_LATENCY_POLICY (1)

//#define SL_LOW_POWER_POLICY (2)

//#define SL_ALWAYS_ON_POLICY (3) nwp 一直处于接收模式下，接收无线数据

//#define SL_LONG_SLEEP_INTERVAL_POLICY (4) This policy works in client mode only