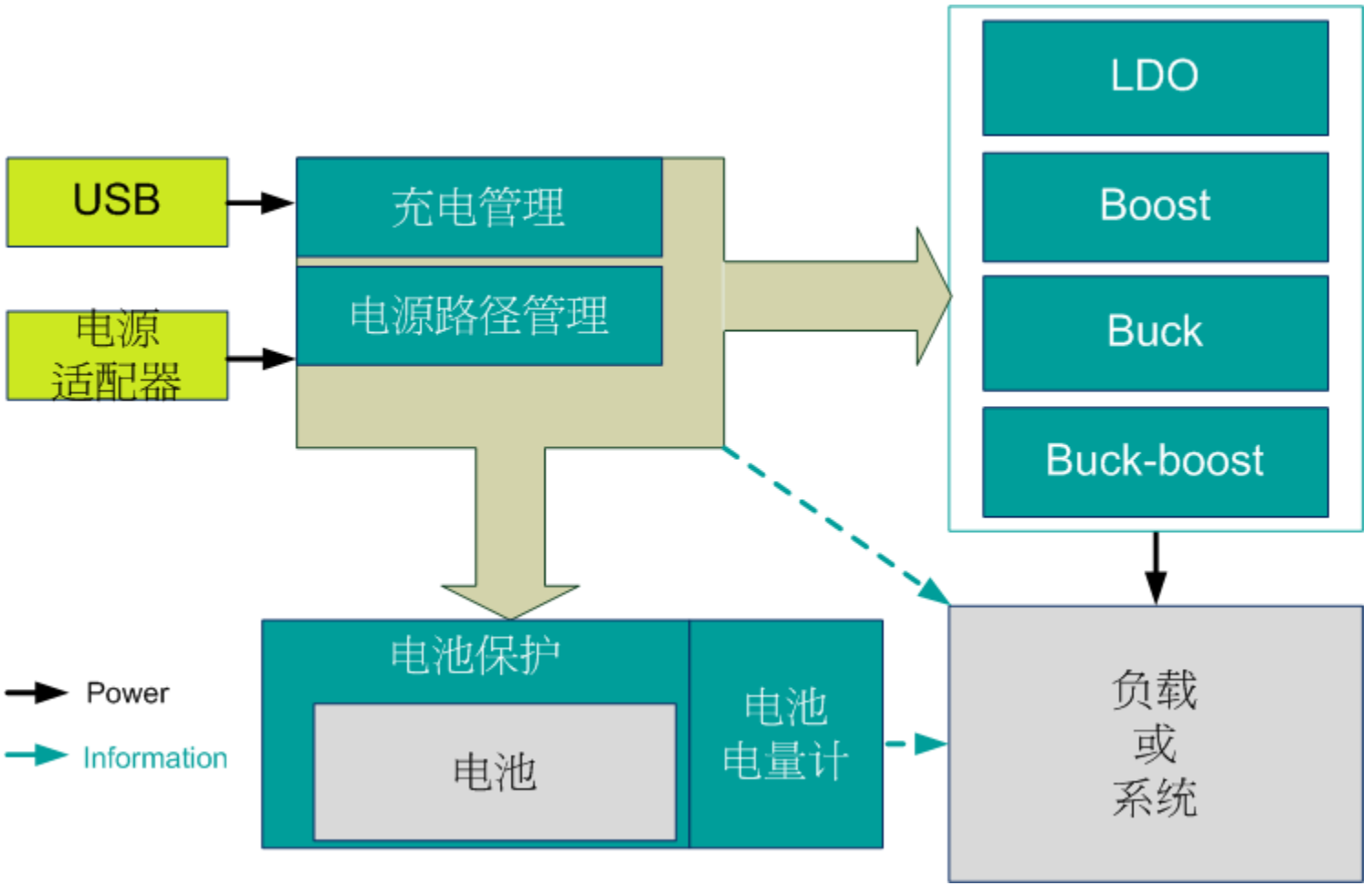
如何让充满电的锂离子电池使用时间更长久？

郑刚

2015年10月

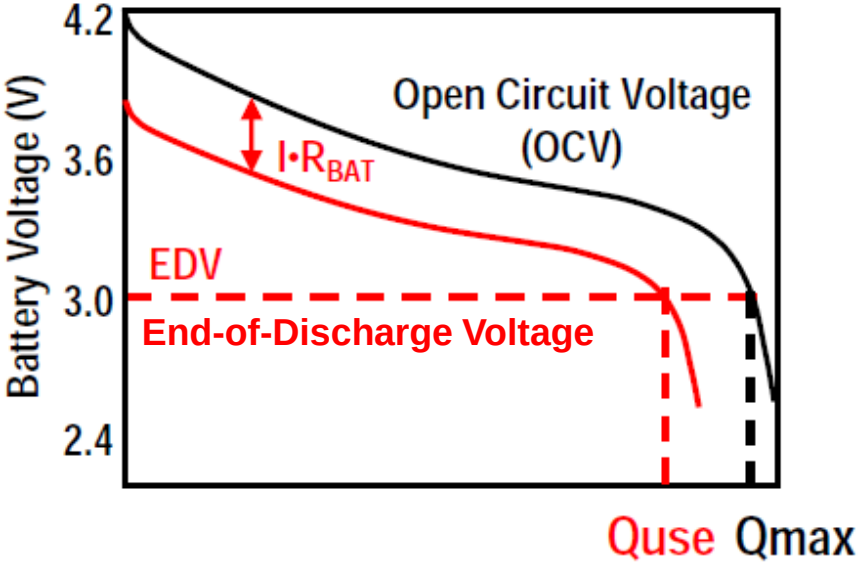
RICHTEK
your power partner.

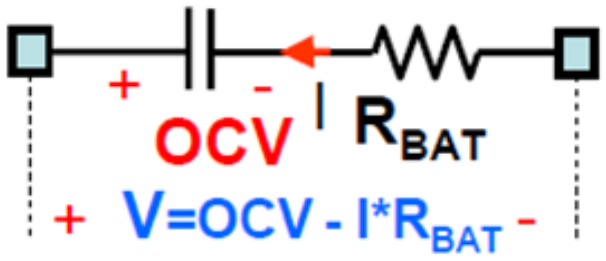
简化的锂离子电池应用系统

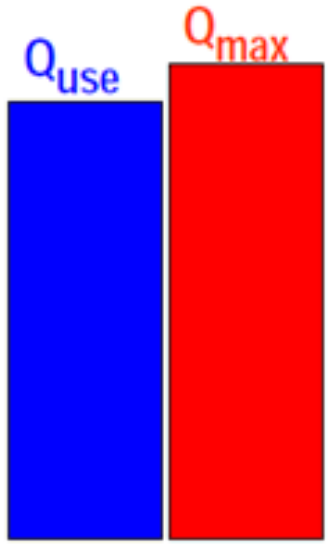


锂离子电池的特性

锂离子电池的等效电路

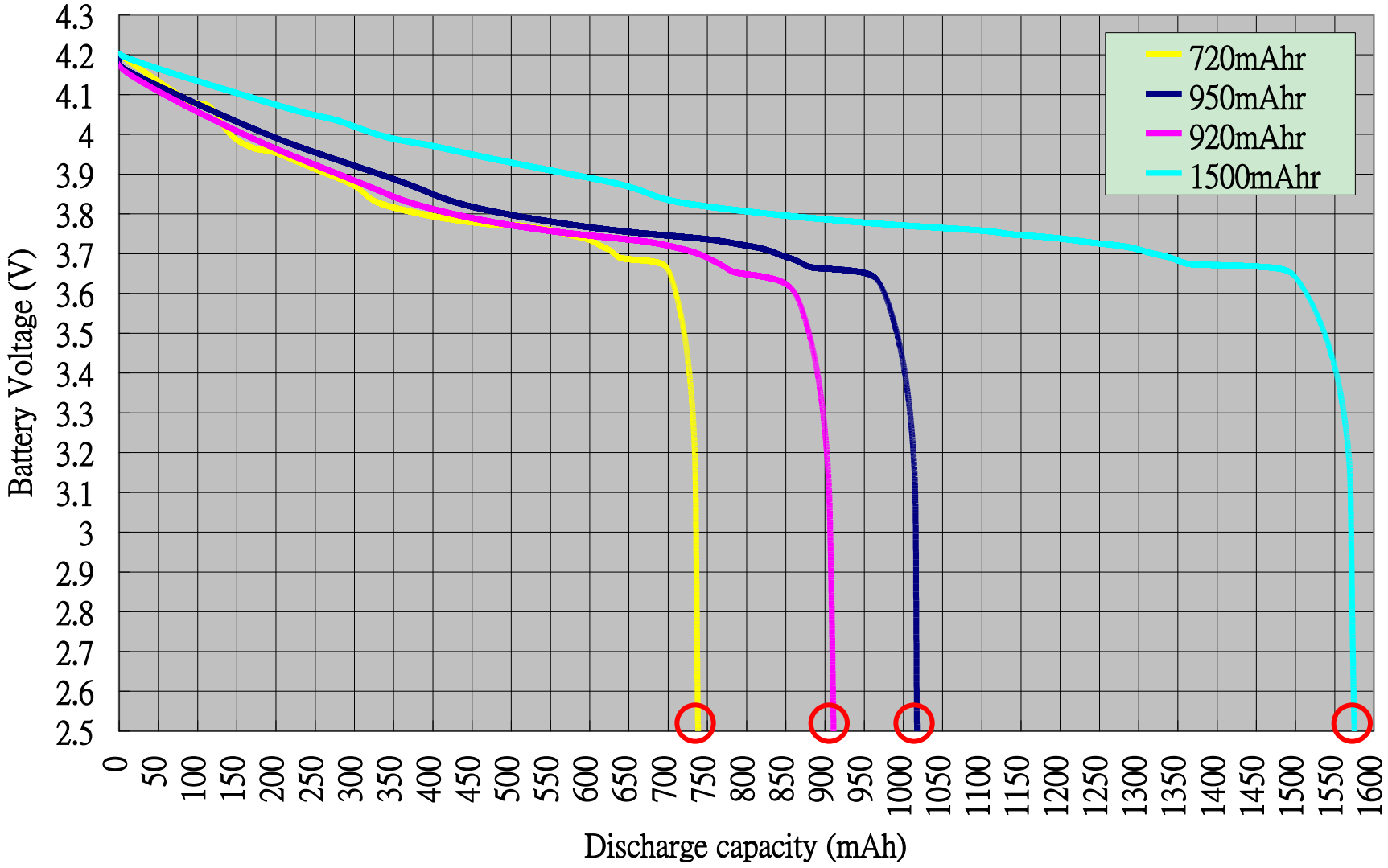




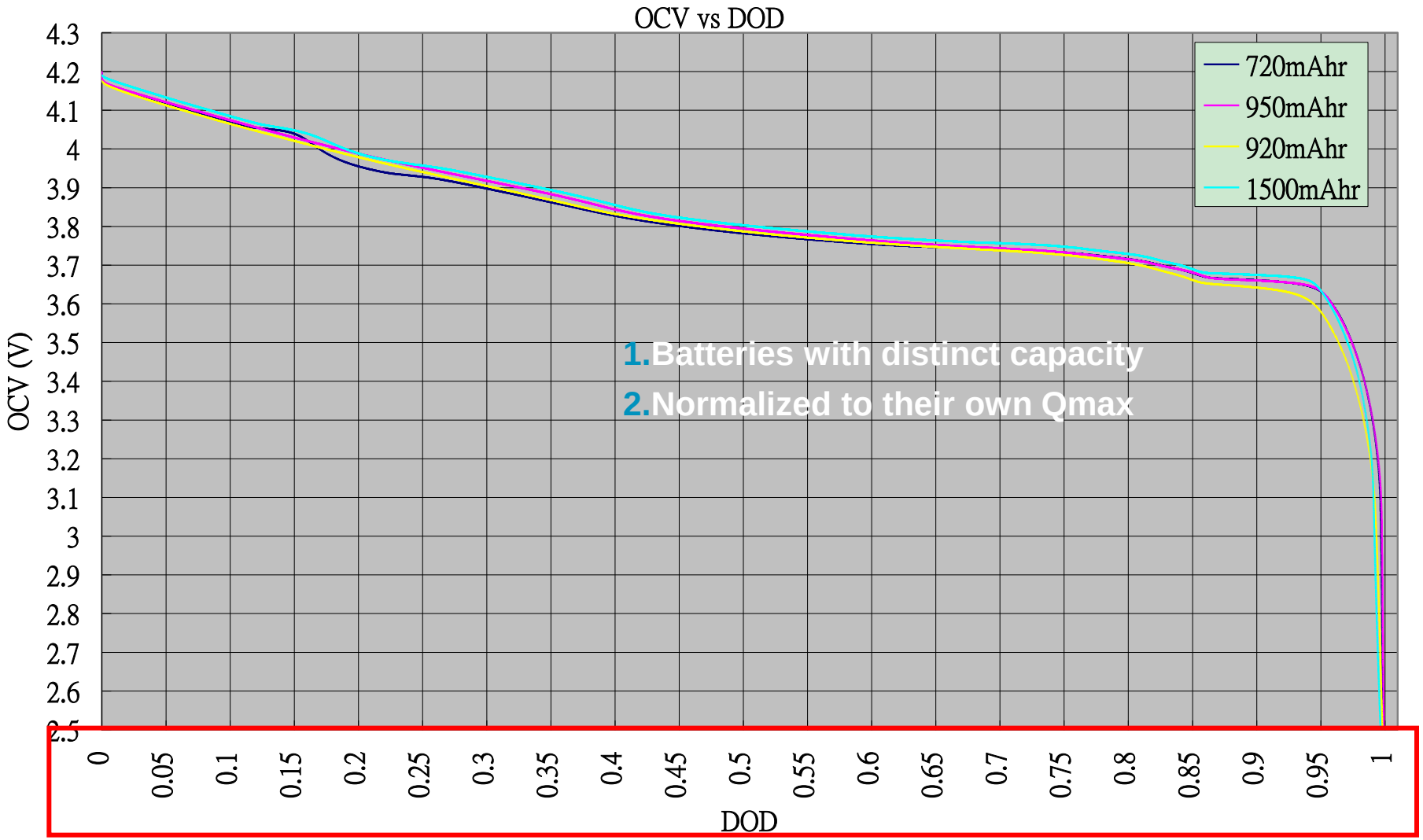


- Q_{max}：最大化学容量
- EDV：放电终止电压
- $Q_{use}<Q_{max}$
- Q_{use} 决定于 IR 电压降 和 EDV
- R_{BAT} 随寿命增长

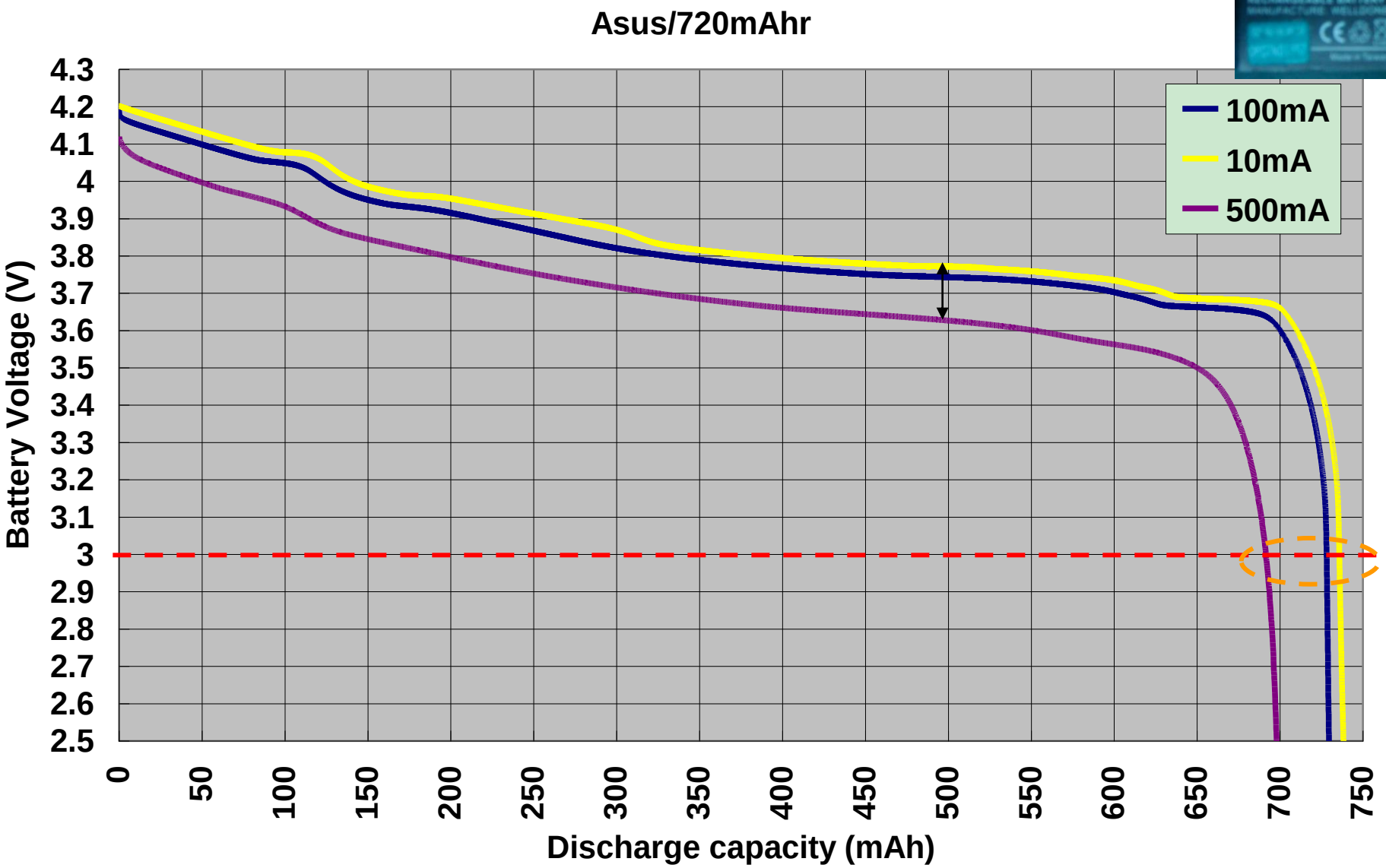
开路电压(OCV) vs 放电容量



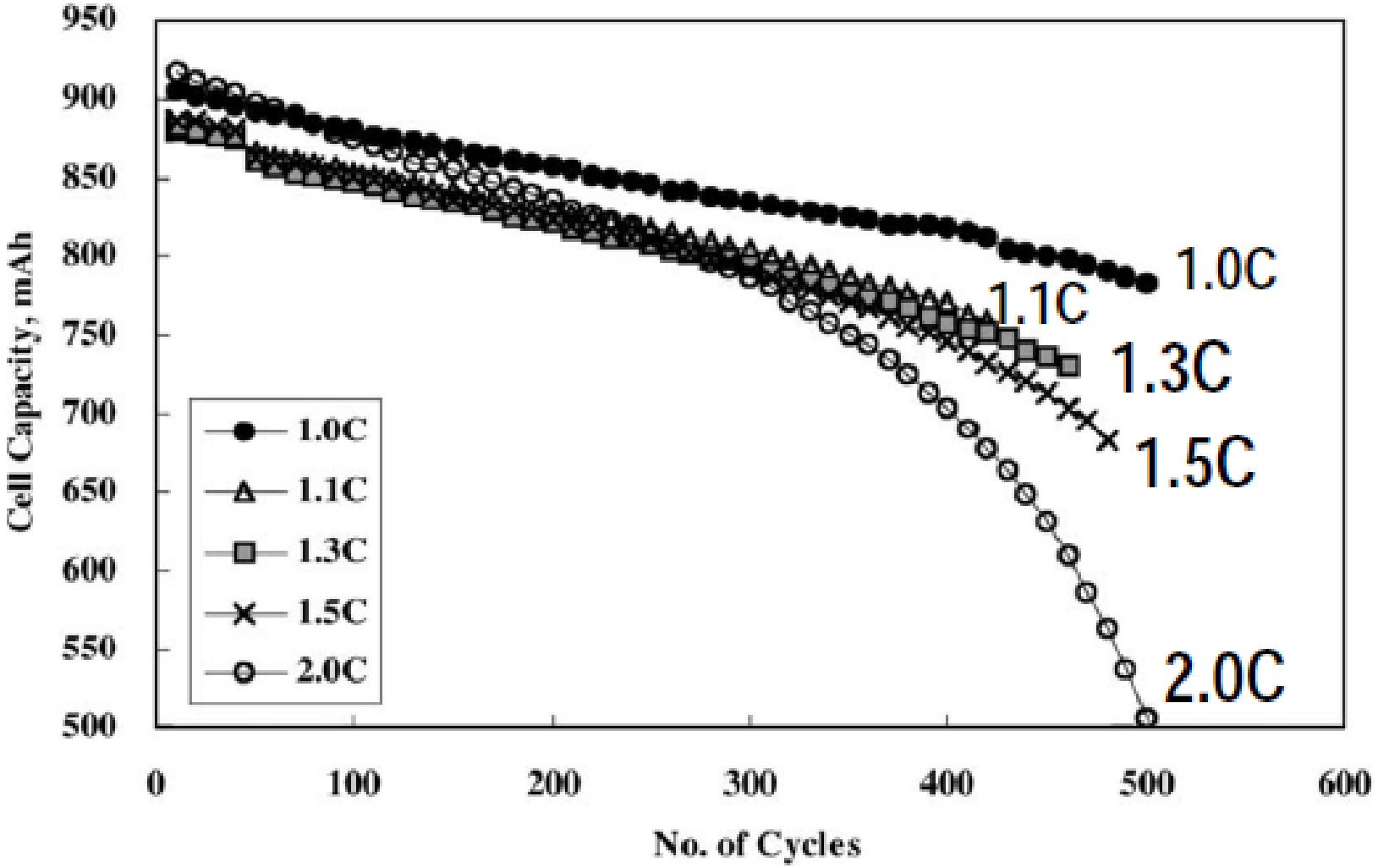
OCV vs DOD(放电深度，以其 Q_{max}归一化)



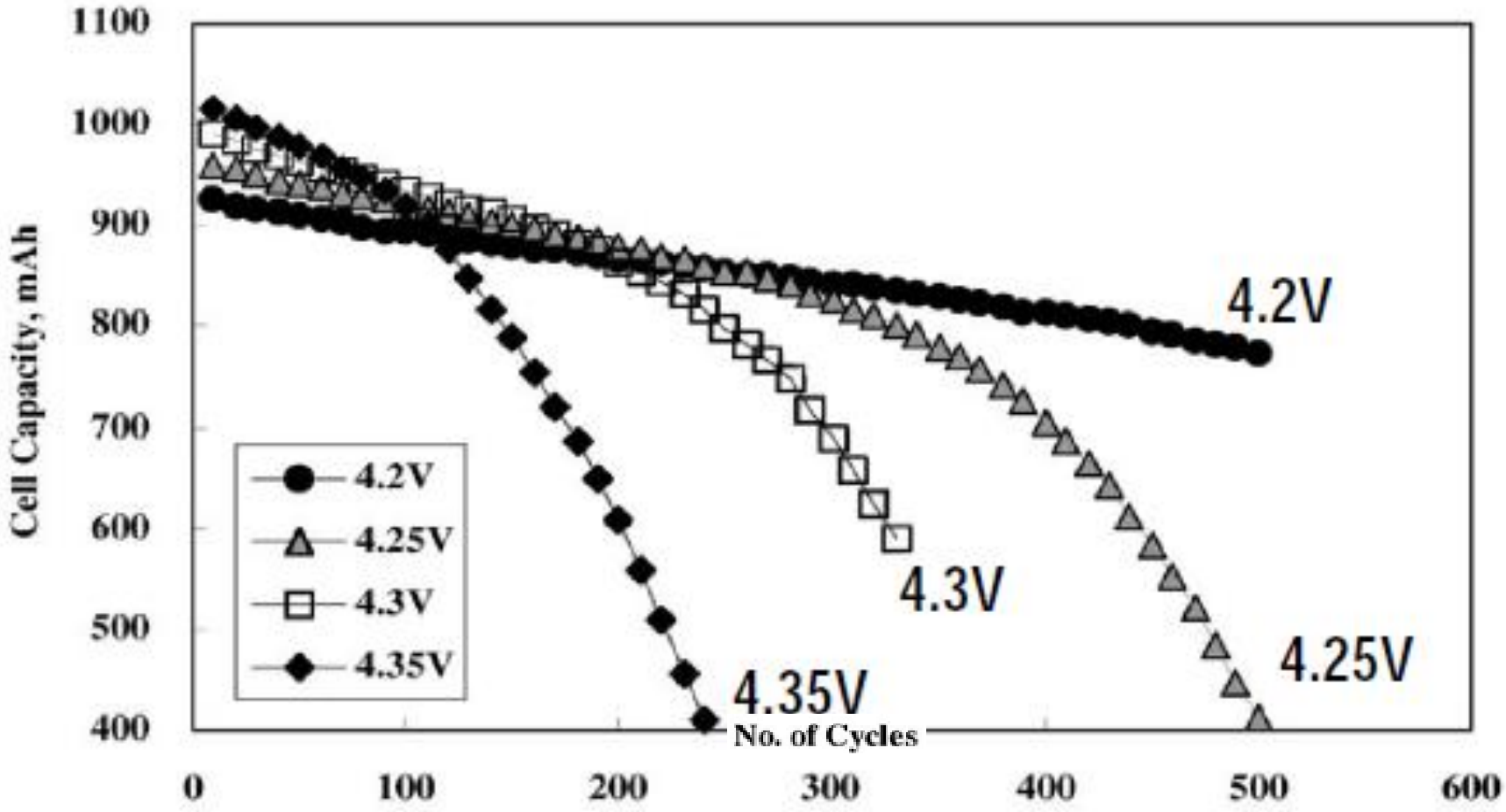
放电电流对容量和外显电压的影响



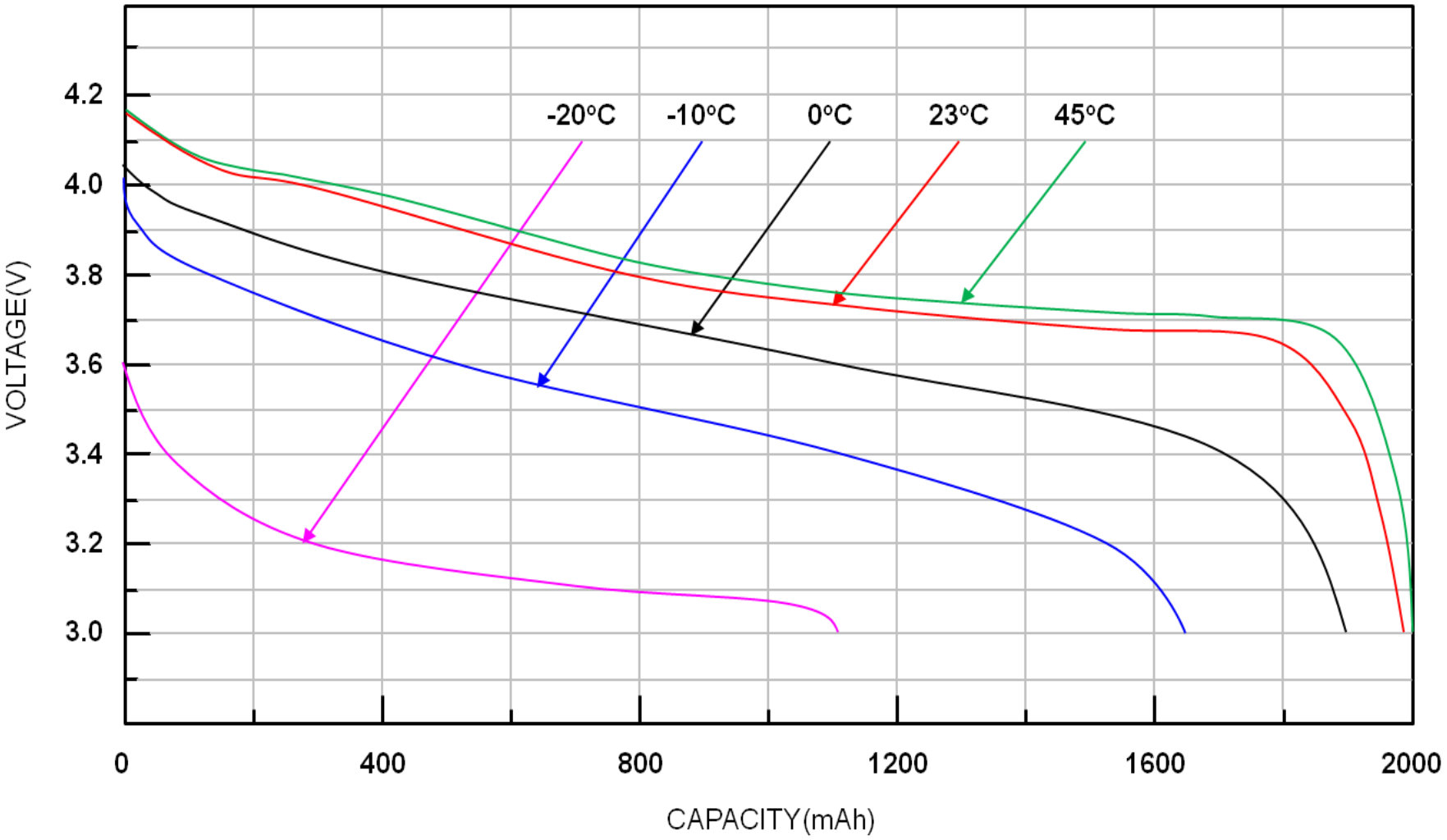
电池充电电流与电池寿命之间的关系



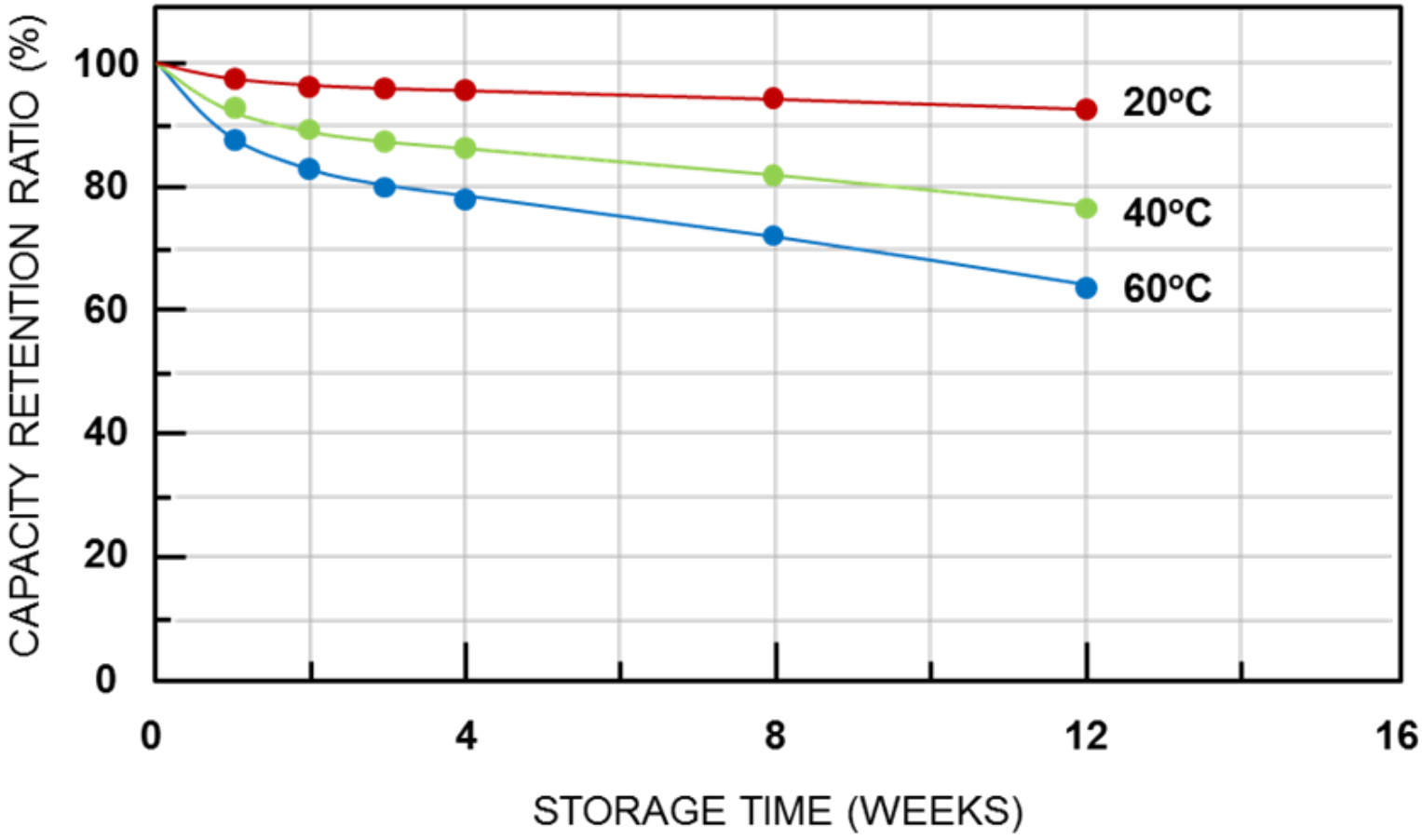
电池充电电压与容量和寿命的关系



温度对电池容量、电压的影响



温度对电池自放电的影响



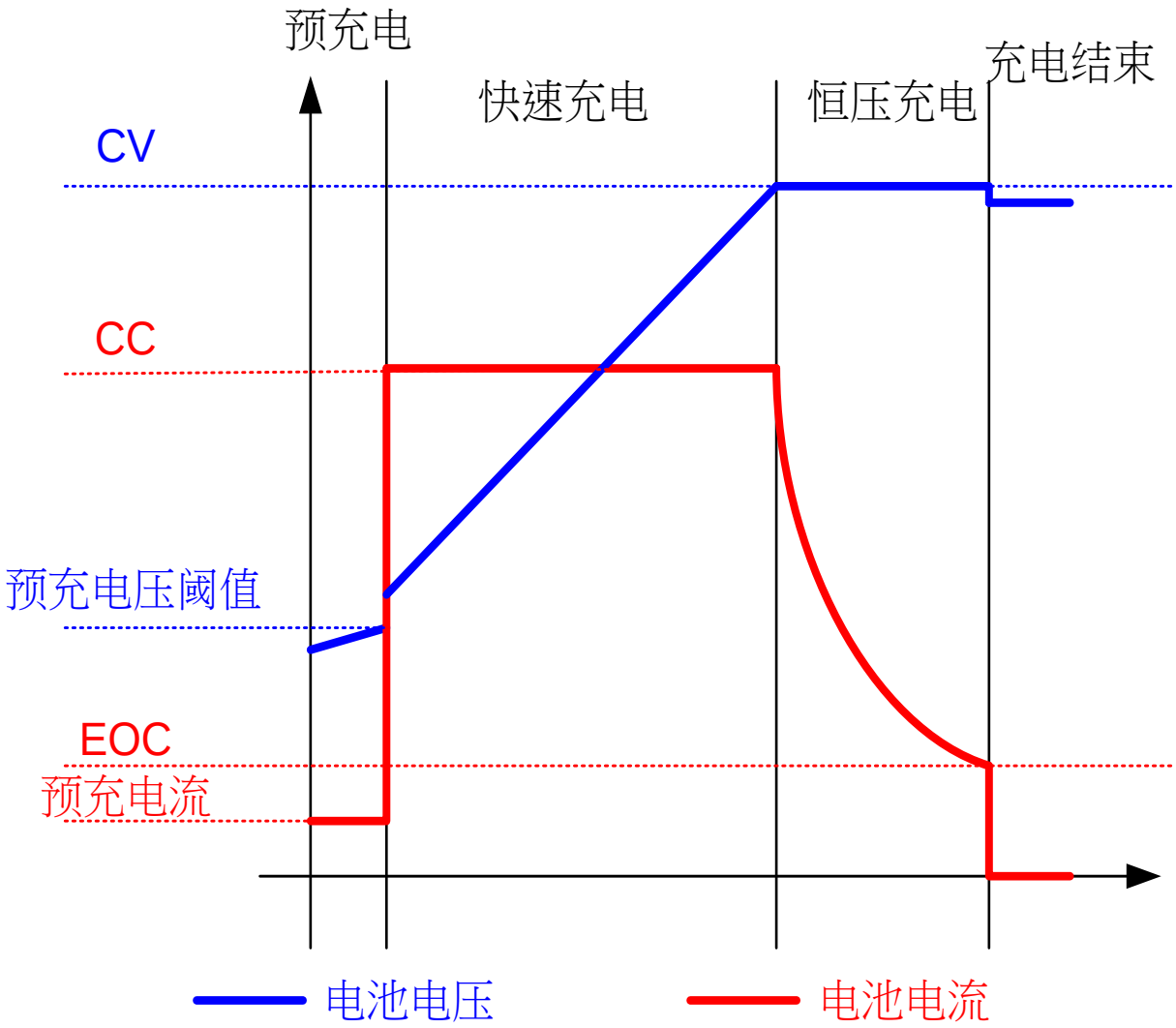
对目标的分解

怎样才能用得久？

- 充得足够满
- 用得够充分
- 消耗速度低
  - 高效率地用
  - 能省则省
  - 能关则关
- 辅助措施
  - 控制好温度
  - 了解电池容量状况
  - 依据状况确定用电策略

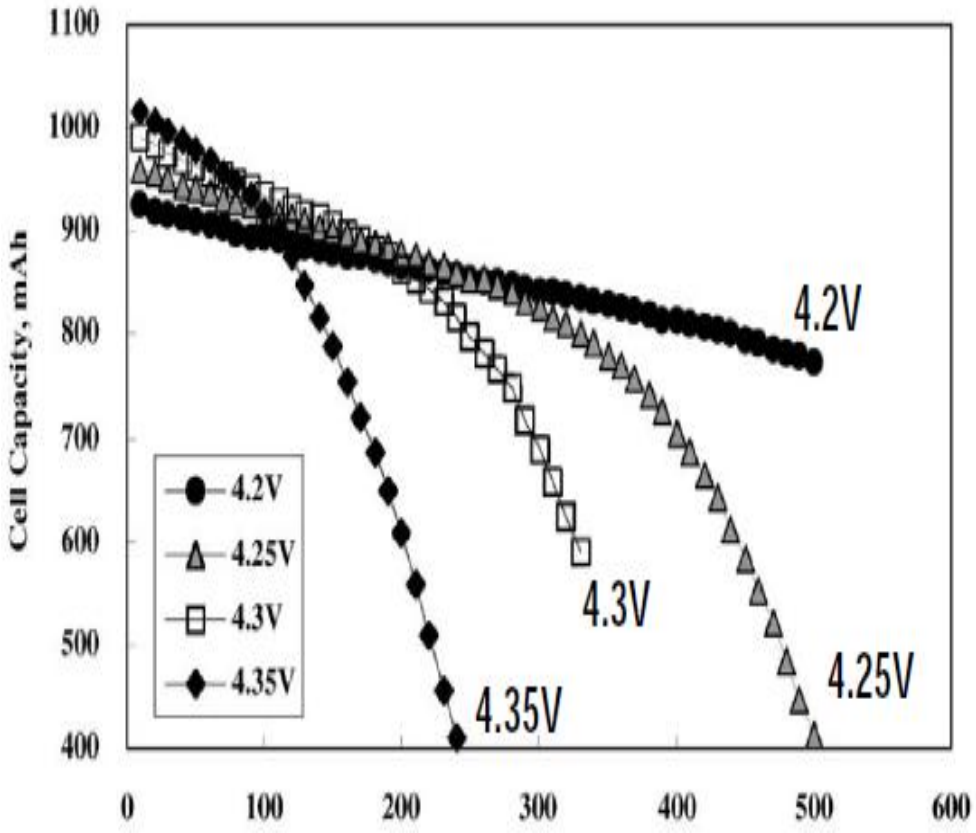
怎样充得满？

充电的三阶段策略



影响充满程度的参数

- **CV恒压充电电压**
  - 电压越高，容量越大
  - 电压影响循环寿命
- **EOC充电终止电流**
  - 影响最终的电池开路电压
  - 对充电时间有影响



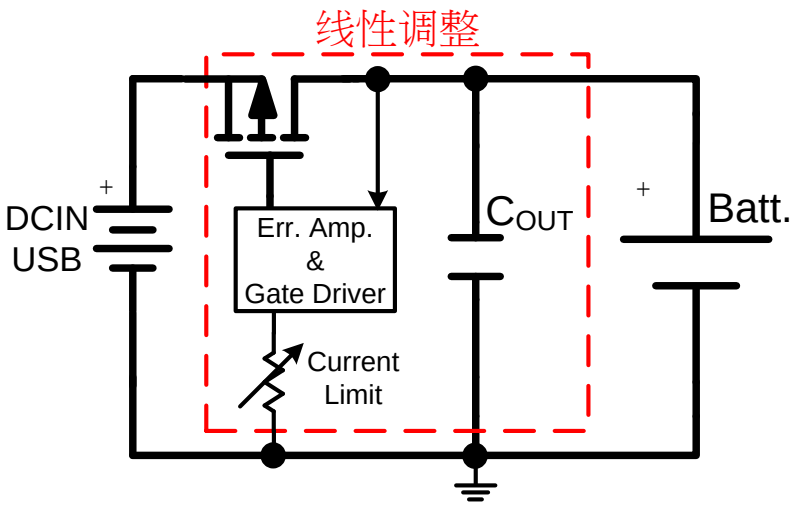
忠告：

过高的充电电压将导致电池损毁，甚至可能带来安全事故。

充电IC分类

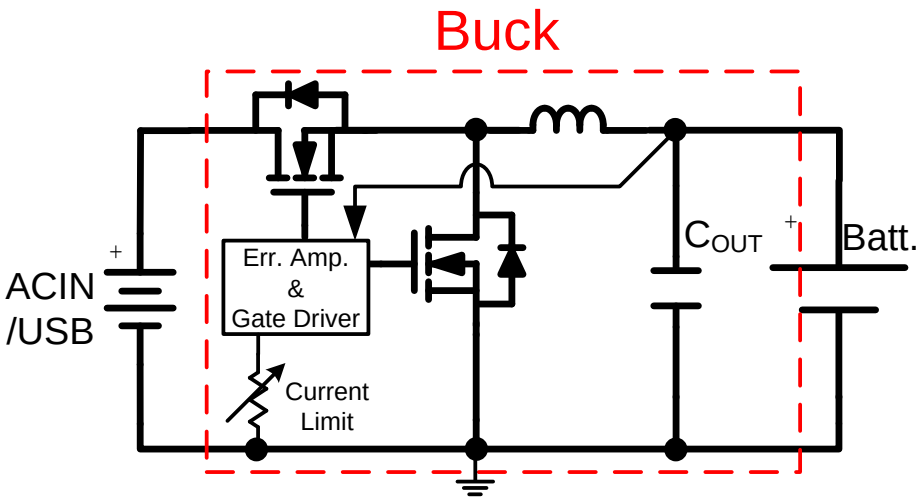
线性充电IC

- RT9502
- RT9503A
- RT9521
- RT9526A
- RT9532
- RT9532H
- RT9536

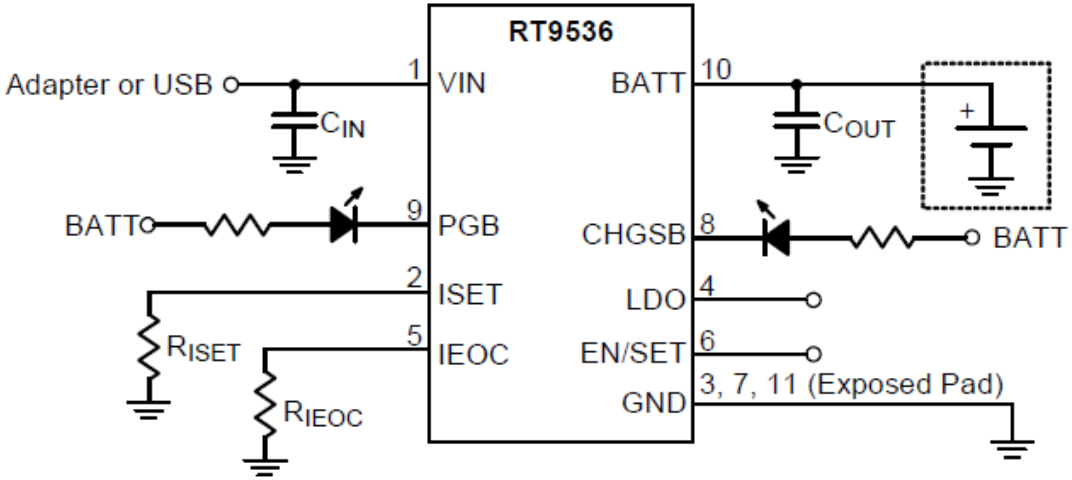


开关式充电IC

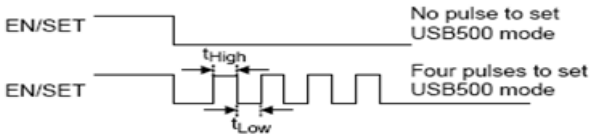
- RT9450A
- RT9451(12V，4A)
- RT9531/4/5/8(30V)



RT9536选择充电电压的方法

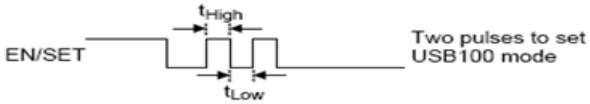


A. USB500 Mode with **CV =4.2V**

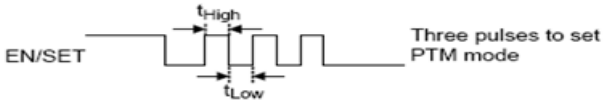


B. ISET Mode with **CV =4.2V**

C. USB100 Mode with **CV =4.2V**

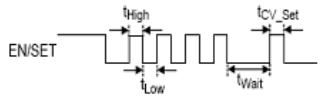


D. PTM Mode with **CV =4.2V**



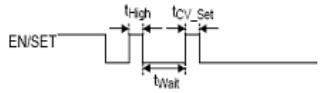
$100\mu s < t_{High}, t_{Low} < 700\mu s$

E. USB500 Mode with **CV =4.35V**



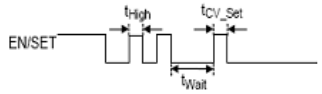
Four pulses to set USB500 mode
Besides, wait the time, t_{Wait} and send a pulse of t_{CV_SET} width for CV = 4.35V

F. ISET Mode with **CV =4.35V**



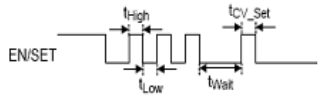
One pulse to set ISET mode
Besides, wait the time, t_{Wait} and send a pulse of t_{CV_SET} width for CV = 4.35V

G. USB100 Mode with **CV =4.35V**



Two pulses to set USB100 mode
Besides, wait the time, t_{Wait} and send a pulse of t_{CV_SET} width for CV = 4.35V

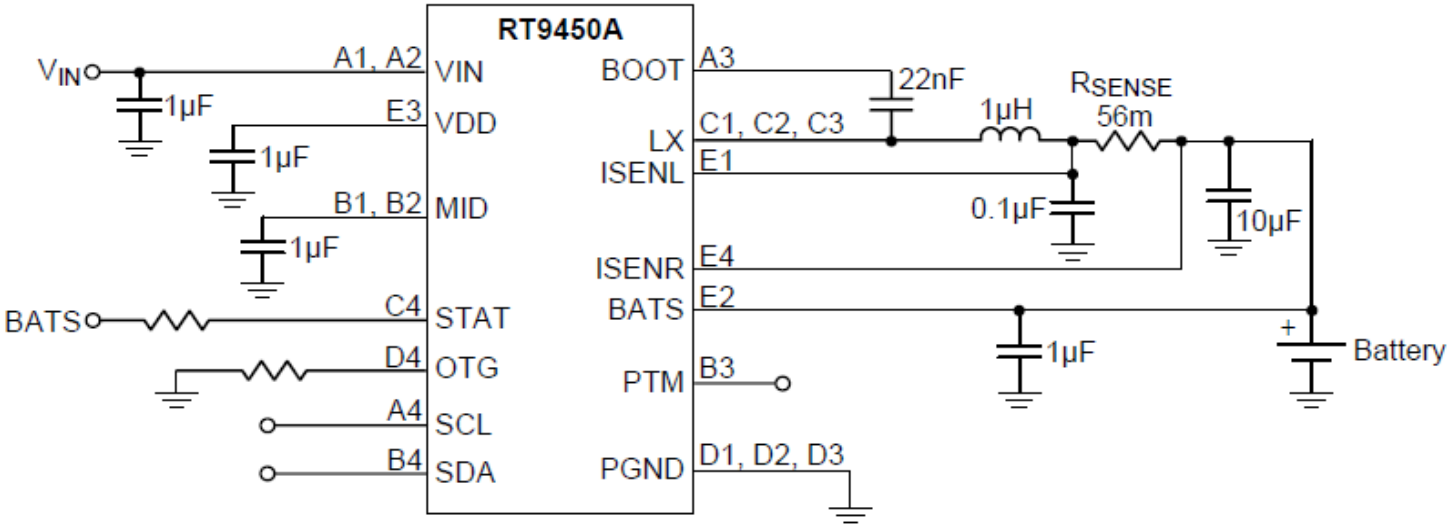
H. PTM Mode with **CV =4.35V**

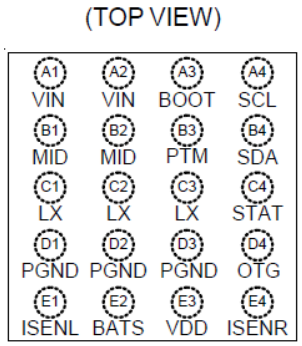


Three pulses to set PTM mode
Besides, wait the time, t_{Wait} and send a pulse of t_{CV_SET} width for CV = 4.35V

$100\mu s < t_{High}, t_{Low} < 700\mu s$, $1.5ms < t_{Wait} 750\mu s < t_{CV\_Set} < 1ms$

开关式充电IC RT9450A可支持几乎任意的充电终止参数





WL-CSP-20B 2x2 (BSC)

Output Charge Voltage	V_{OREG}	Voltage Regulation I^2C Programmable	3.5	--	4.45	V
Voltage Regulation Accuracy		0 to 85°C	–1	--	1	%
Current Regulation (Fast Charge)						
Output Charge Current	I_{CHRG}	$V_{BATS} < V_{OREG}$, VIN > V_{SLP}, R_{SENSE} = 56mΩ, I^2C Programmable Per 120mA	0.66	--	1.5	A
Regulation Accuracy			–5	--	5	%
Charge Termination Detection						
Termination Charge Current	I_{EOC}	$V_{BATS} < V_{OREG}$, VIN > V_{SLP}, R_{SENSE} = 56mΩ, I^2C Programmable Per 60mA	60	--	480	mA
Boost Mode Operation						
Output Voltage Level		To VIN	--	5.05	--	V
Output Accuracy		Including Line / Load Regulation	–3	--	3	%
MAX Output Current			500	--	--	mA

级差：20mV

级差：120mA

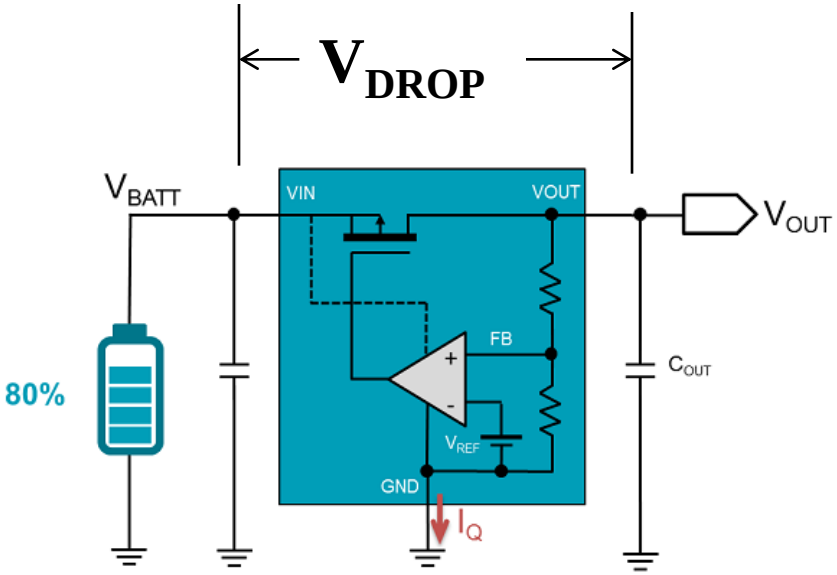
级差：60mA

怎样高效、充分利用电池能量？

效率计算方法

$$Eff = \frac{P_{OUT}}{P_{IN}} = \frac{V_{OUT} \times I_{OUT}}{V_{IN} \times I_{IN}}$$

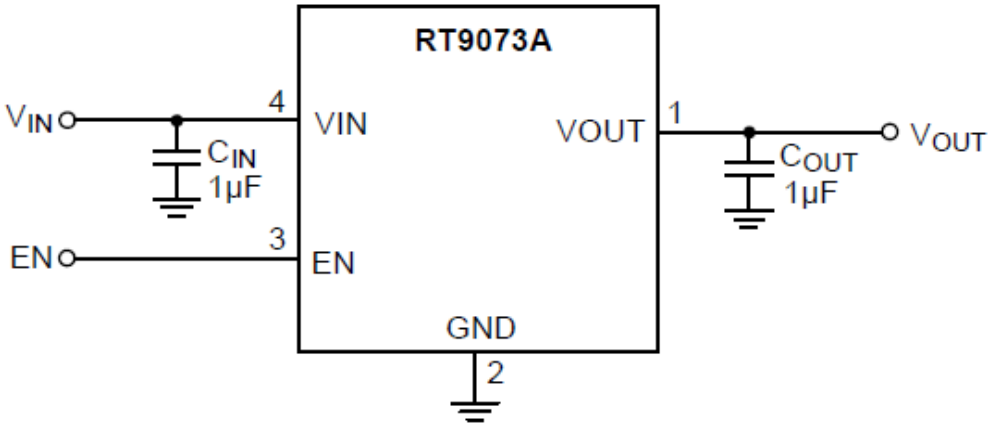
线性稳压器的效率

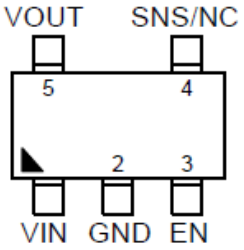


- I_Q越小，效率越高
  - 轻载时很重要
- V_{DROP}越小，效率越高
  - 重载时很重要
- 重载、压差大时发热严重
- 只能解决降压问题

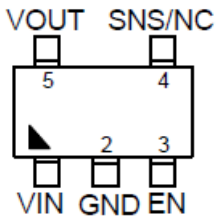
RT9073/A——1μA LDO

- I_Q = 1μA
- V_{IN} = 1.2V~5.5V
- V_{OUT} = 0.9V~3.3V
- I_{OUT} = 250mA
- V_{DROP} = 0.5V@250mA
- PSRR = 75dB@1kHz

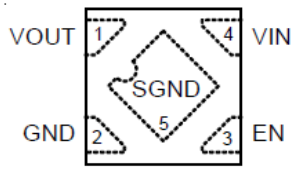




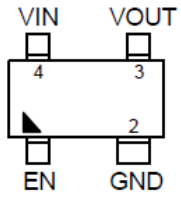
SOT-23-5



SC-70-5



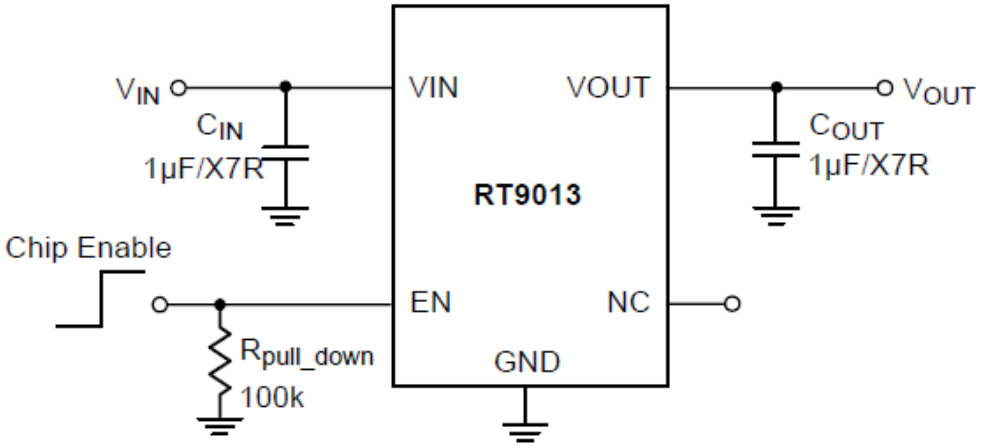
ZQFN-4L 1x1 (ZDFN-4L 1x1)

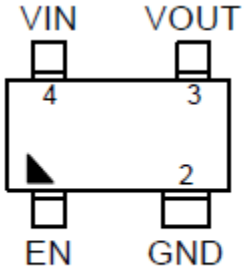


SC-82 (SSOT-24)

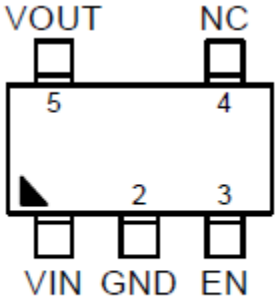
RT9013——500mA LDO

- I_Q = 25μA
- V_{IN} = 2.2V~5.5V
- V_{OUT} = 1.2V~3.3V
- I_{OUT} = 500mA
- V_{DROP}=250mV@500mA

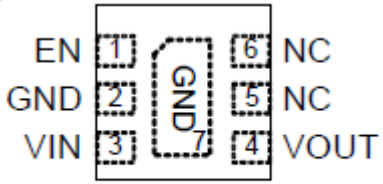




SC-82

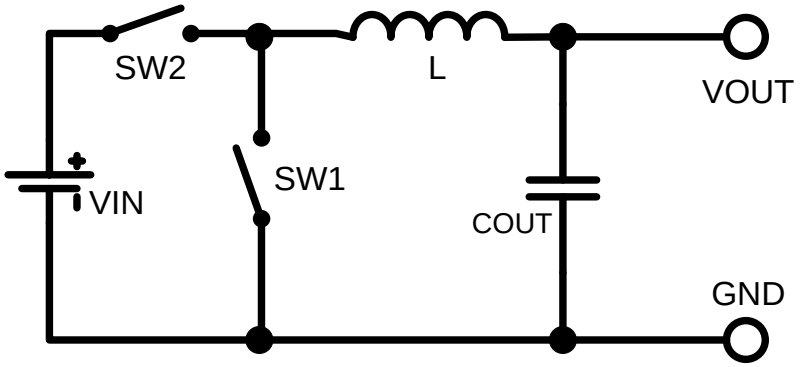


SOT-23-5 / SC-70-5

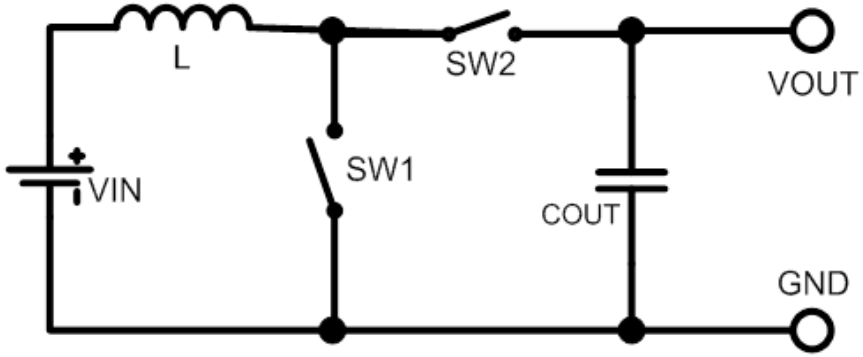


WDFN-6L 2x2

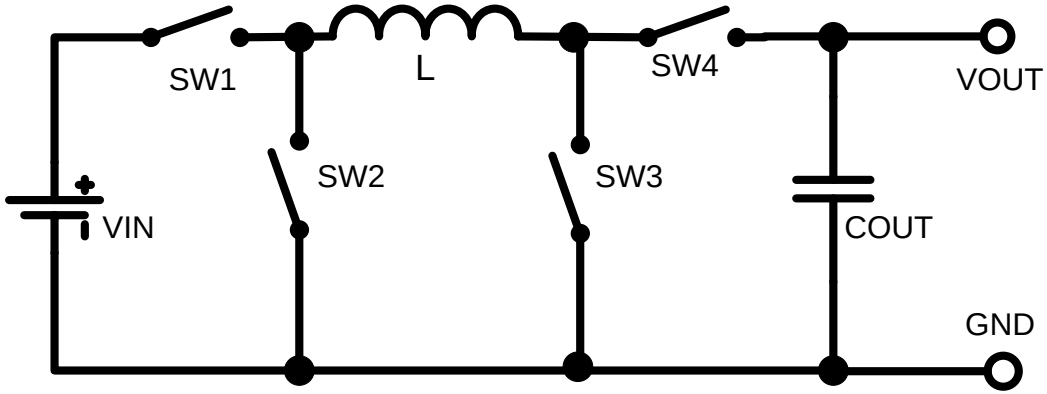
常用的开关转换器拓扑



Buck



Boost



Buck-Boost

各种拓扑的作用和特性

Buck

- 降压
- $V_{IN} < V_{OUT}$时，V_{OUT}随V_{IN}改变

Boost

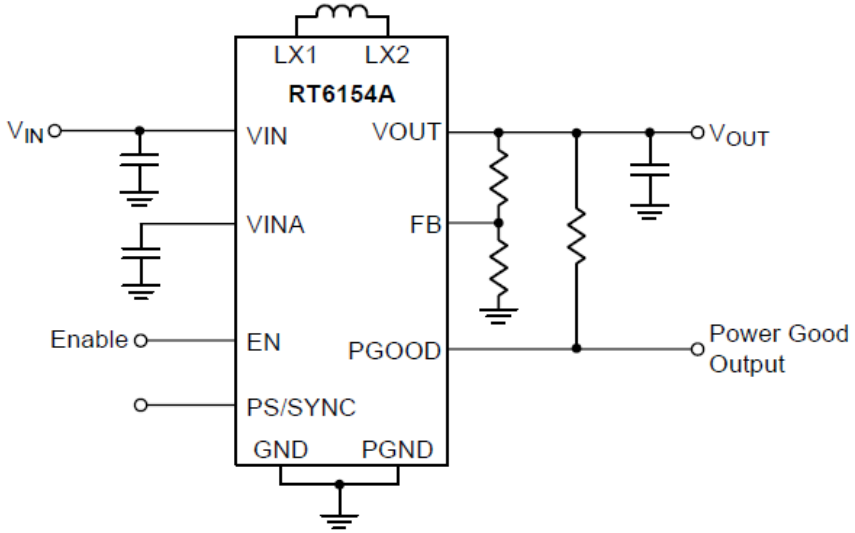
- 升压
- $V_{IN} > V_{OUT}$时，V_{OUT}随V_{IN}改变

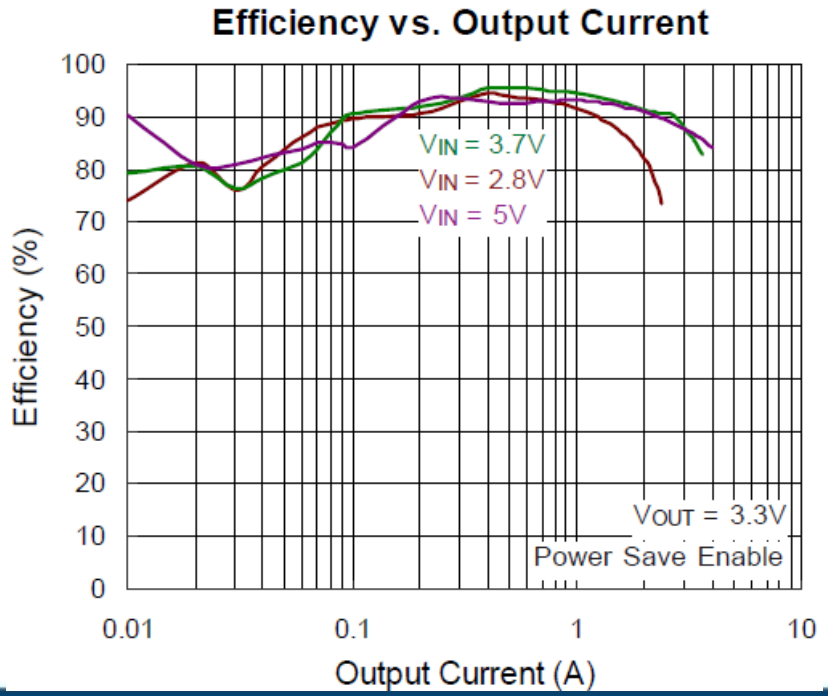
Buck-Boost

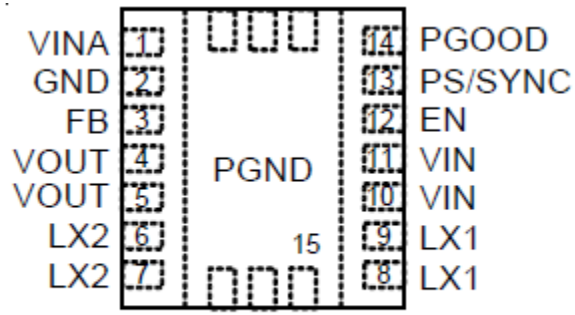
- 自动升压/降压
- 无论V_{IN}、 V_{OUT}关系如何，V_{OUT}总是保持恒定

RT6154A/B——Buck-Boost实例

- V_{IN} = 1.8V~5.5V
- V_{OUT} = 1.8V~5.5V
- I_{OUT} = 4A

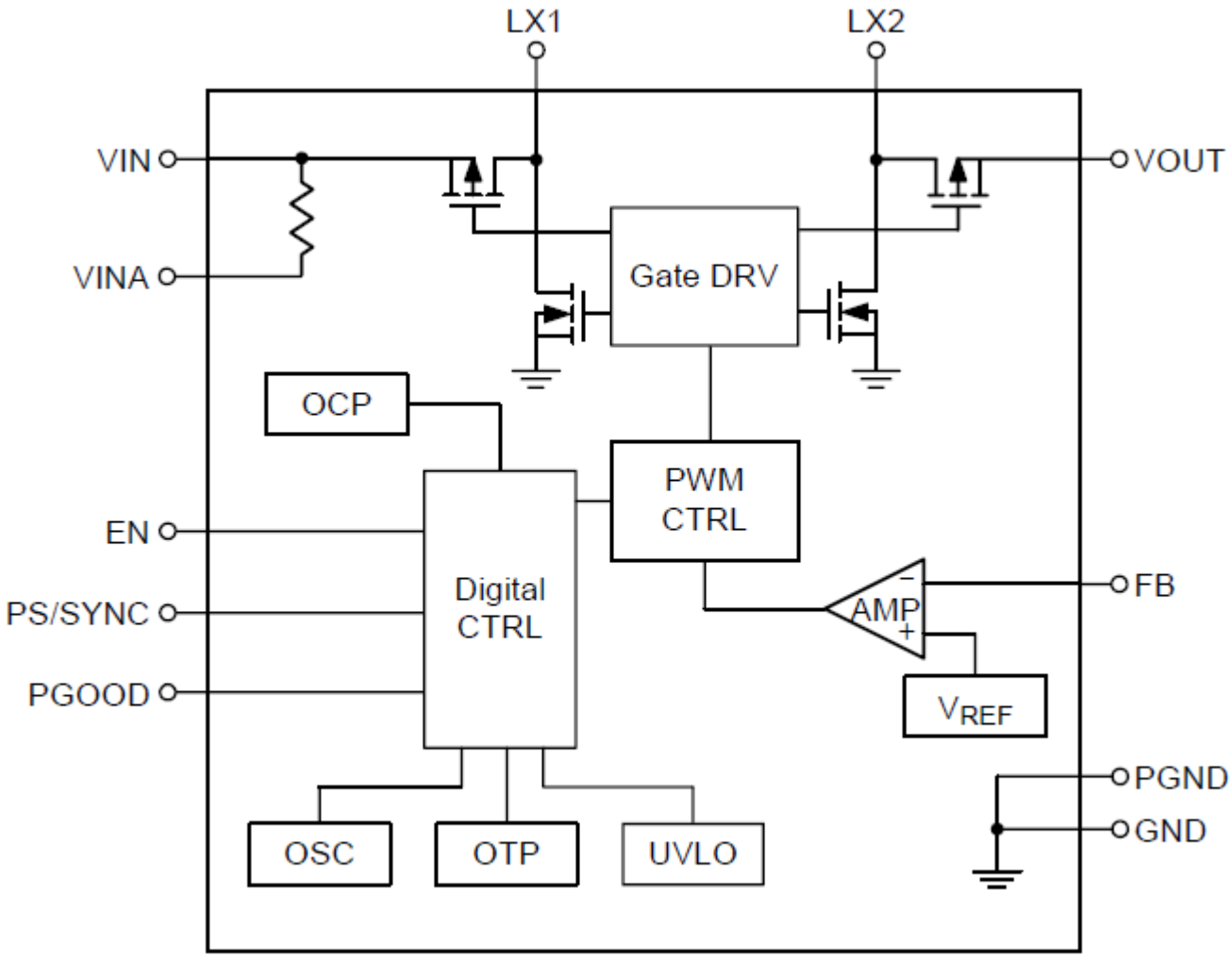




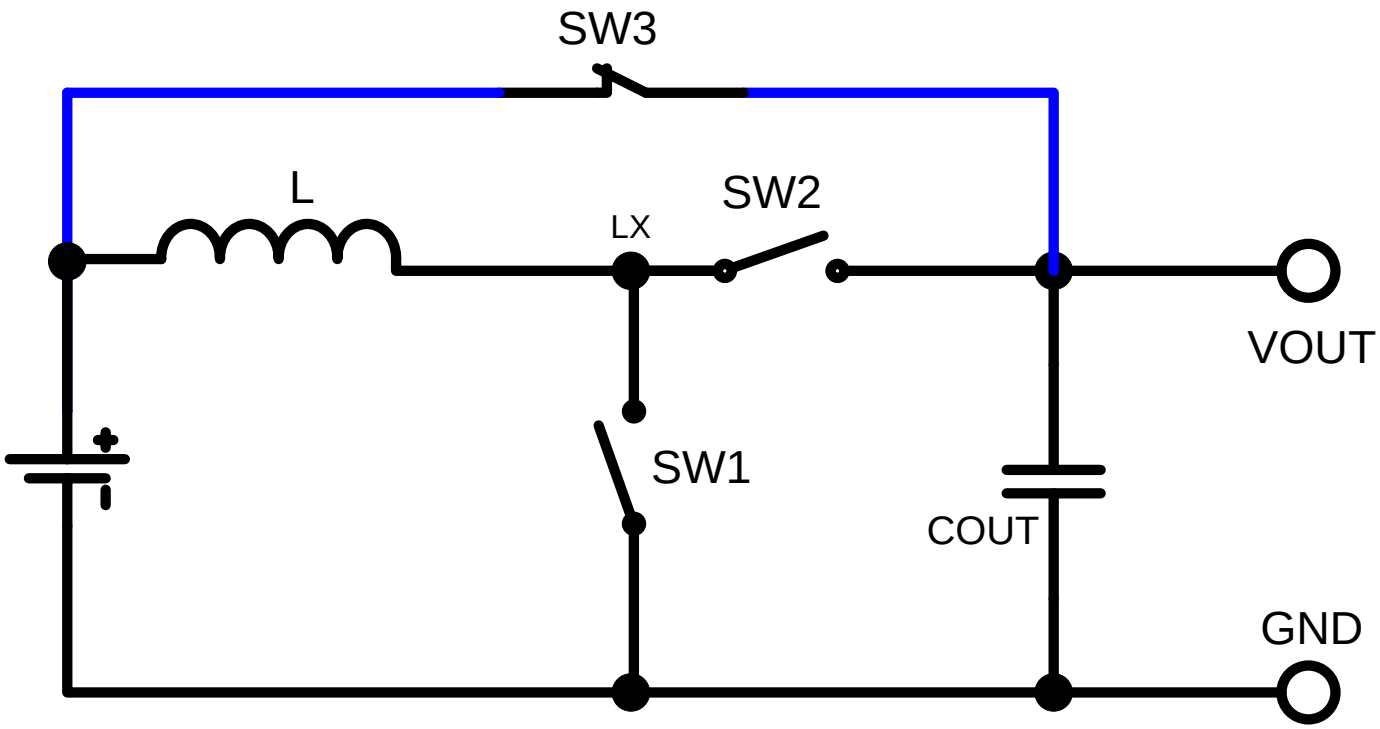


WDFN-14AL 4x3

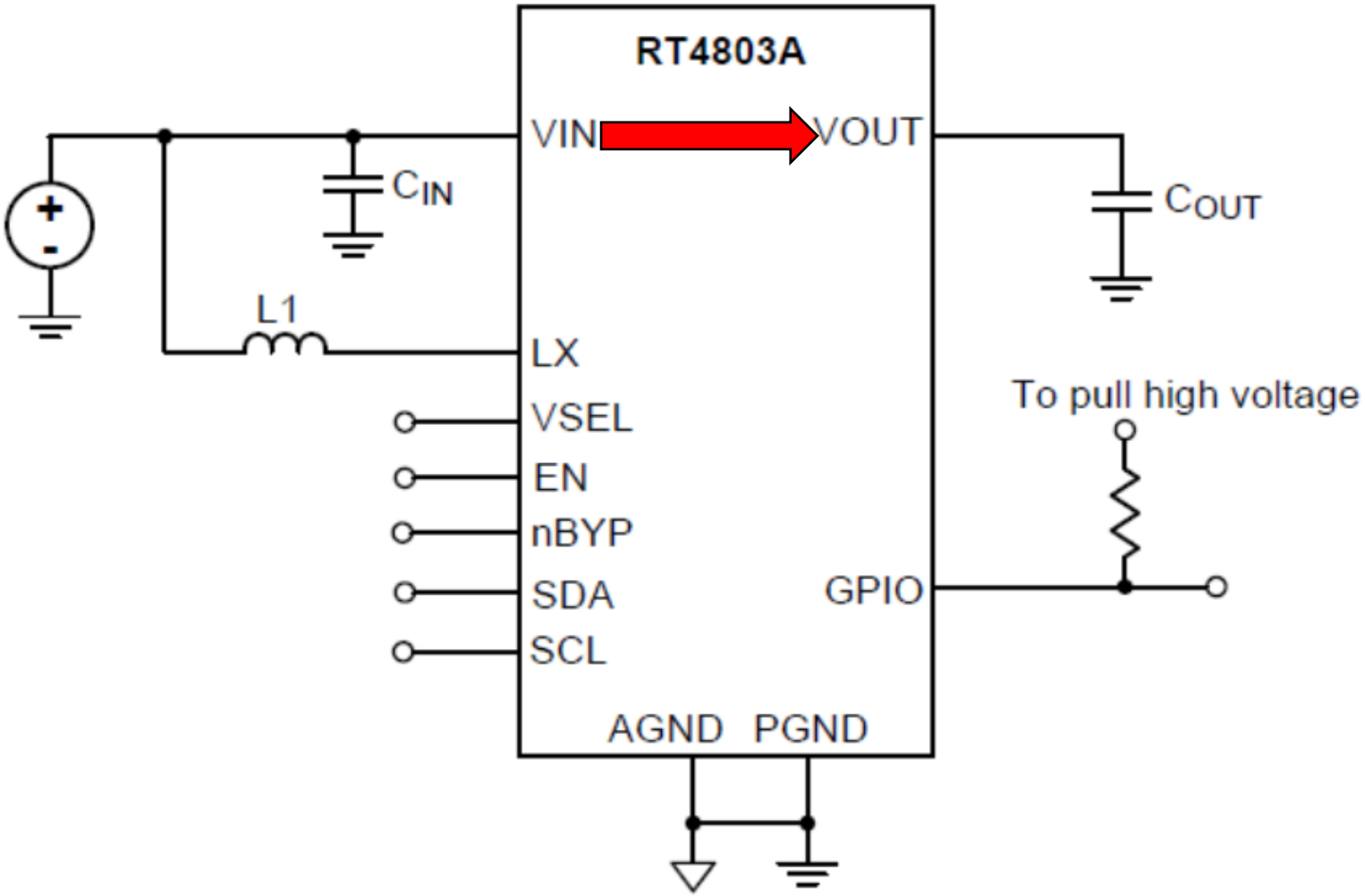
Buck-Boost相对复杂的内部框图



带旁路的Boost

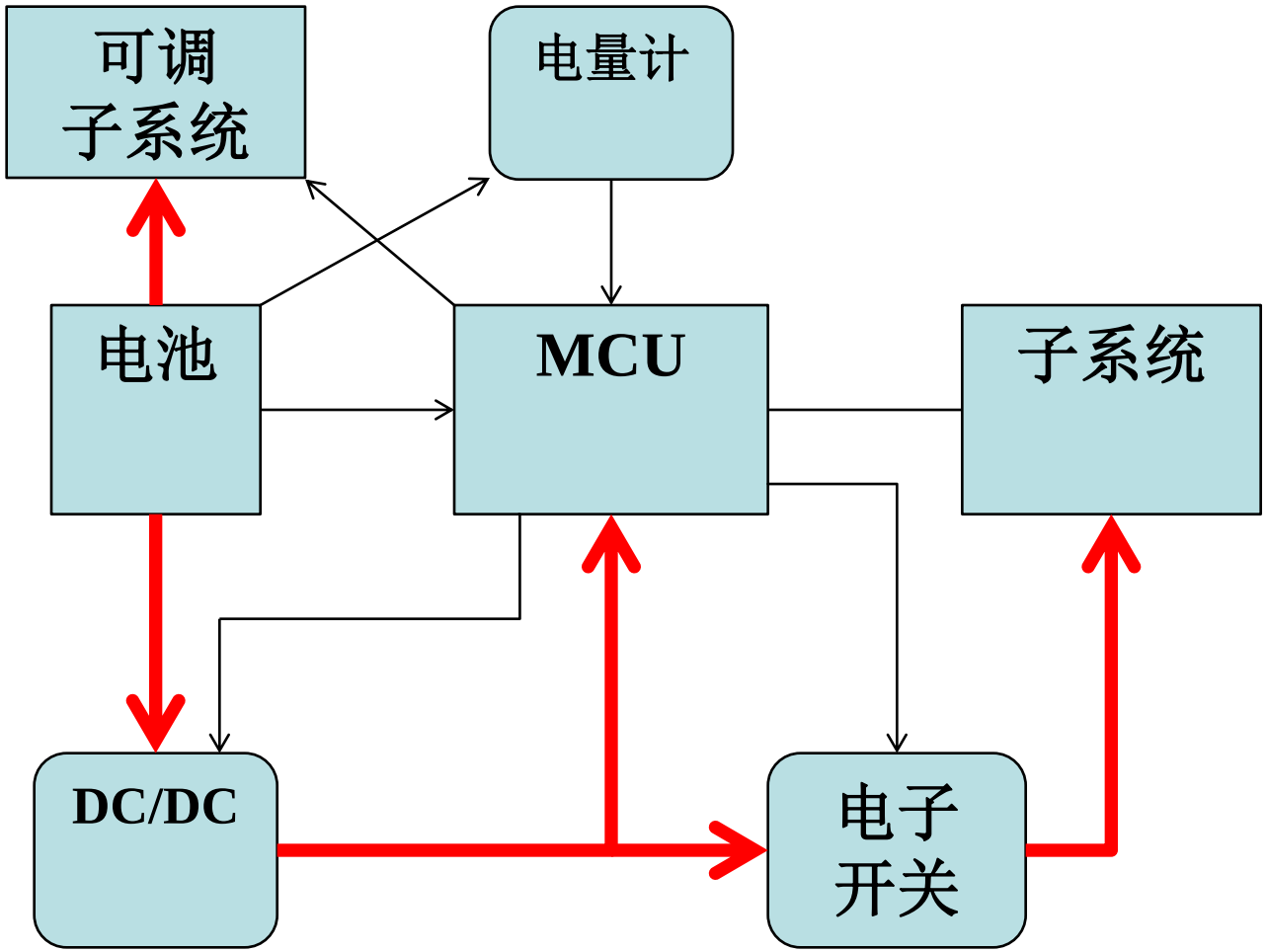


怎样利用Boost的缺陷为应用服务？



文章阅读地址

从系统的角度出发降低消耗



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thank you.