O2Micro®

Breathing Life into Mobility

虎尾科技大學

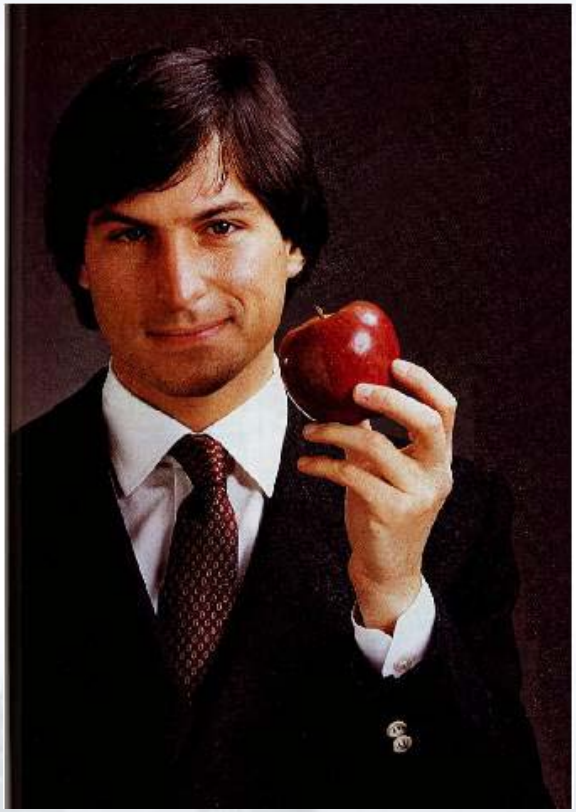
Date : 2011/11/29

O2Micro- Intelligent Lighting

Subject---Innovation /Creation

- Think Different
- Make Different

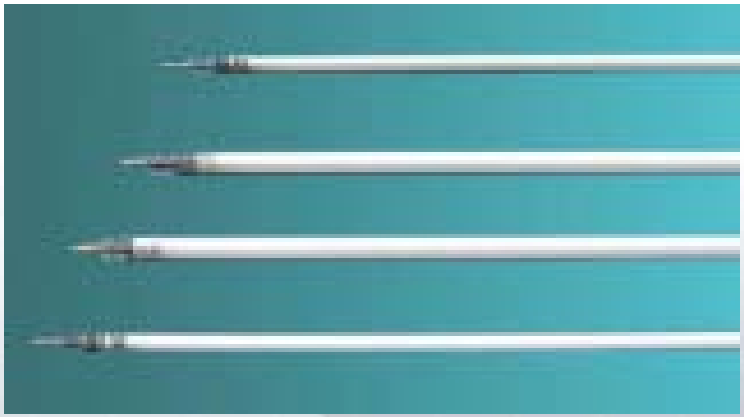
Steve Jobs



In Apple – MacBook Air

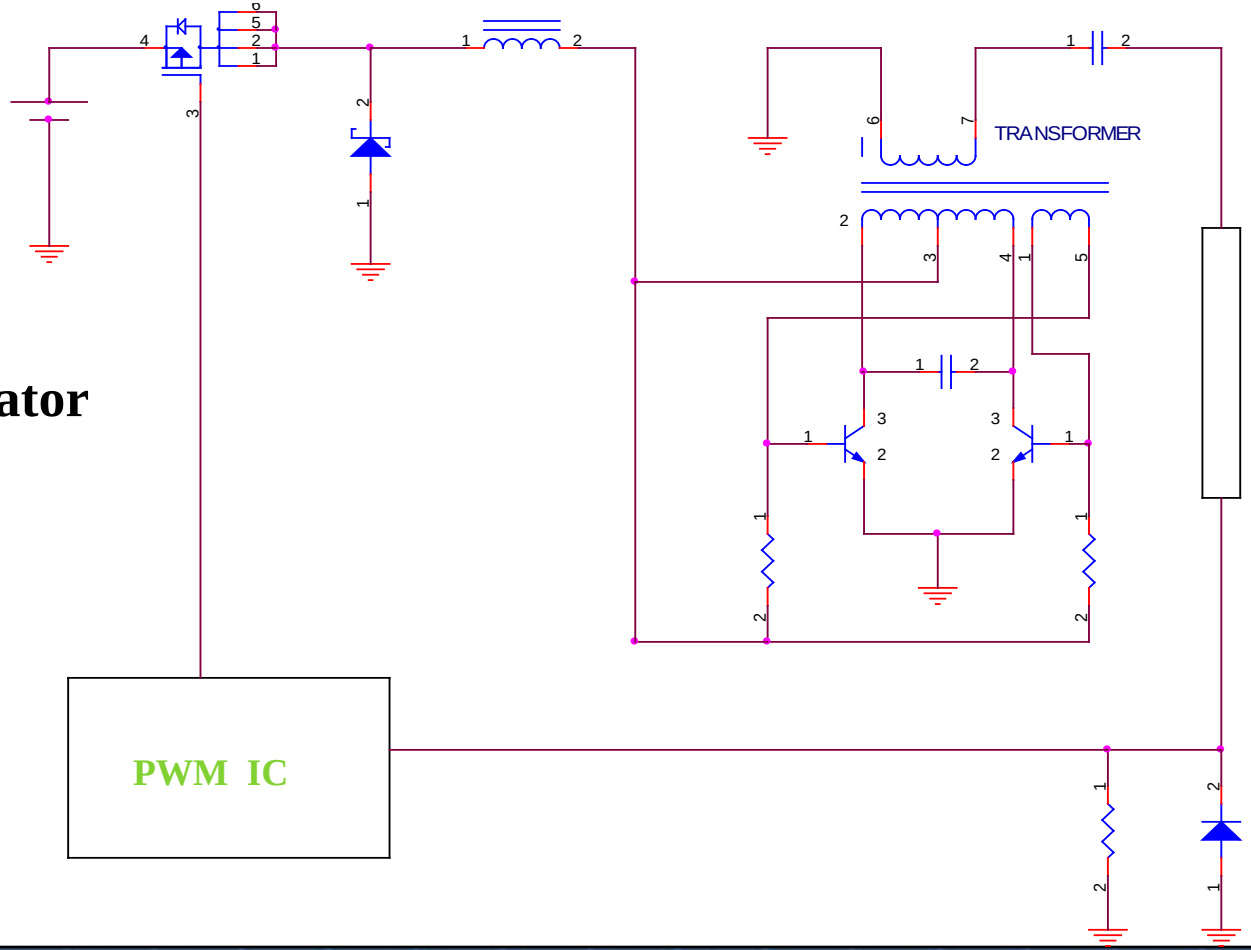
In Apple---I Pad, I Mac

Three Cases of My Experience---Case I



Inverter structure and principle

Two stages Buck/Royer Oscillator Inverter(1954)



Self Oscillator

Royer *Weakness:*

1. Low efficiency

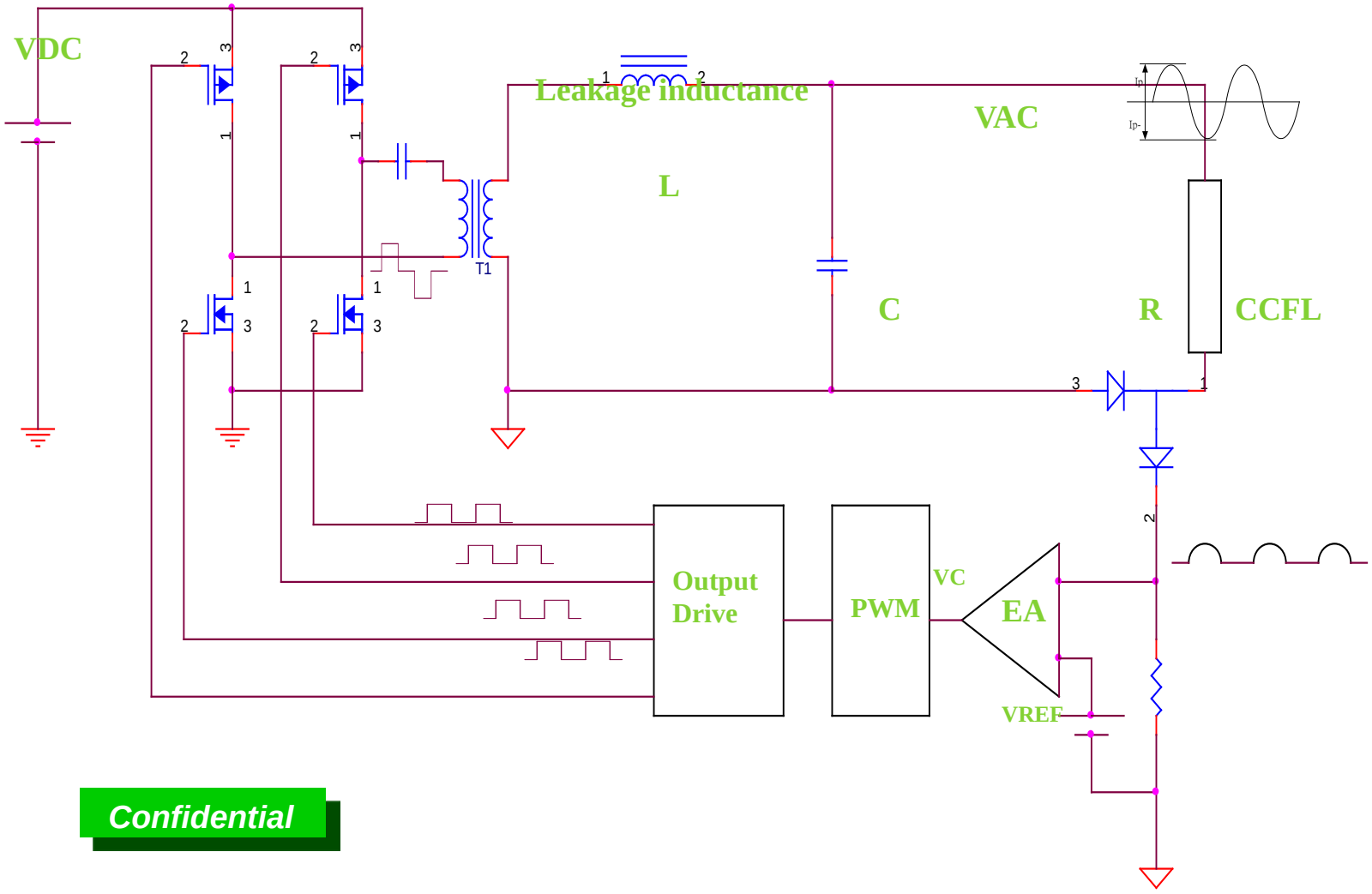
2.High temperature

3.Complex transformer

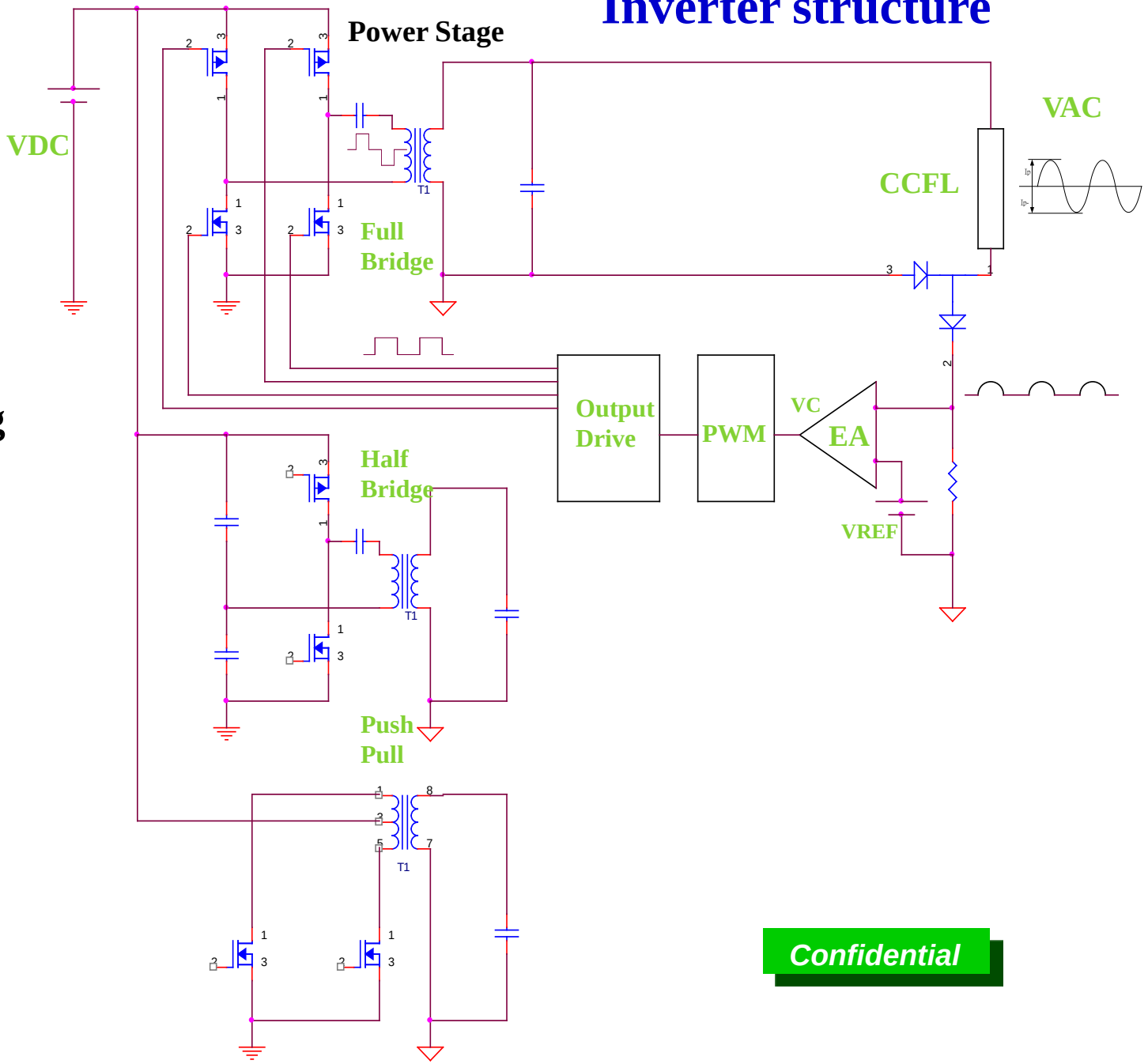
4.High voltage operation

5.Vary operating frequency

Single Stage Full Bridge Inverter



Inverter structure

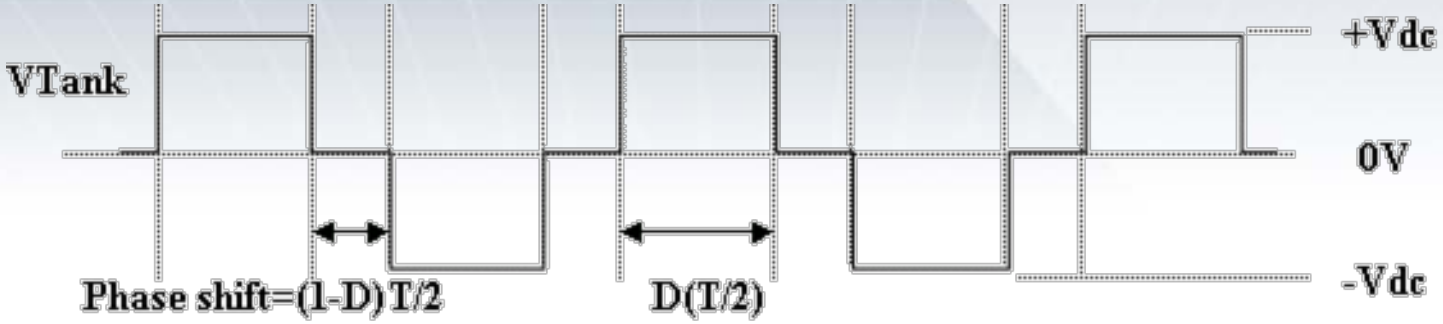


Extra Driving

Features:

1. High efficiency.
2. Simple transformer.
3. Low temperature.
4. High reliability.
5. Small board side
6. Low operating voltage.

Phase-Shift Full-Bridge Inverter



- The fundamental component of the voltage applied to the tank:

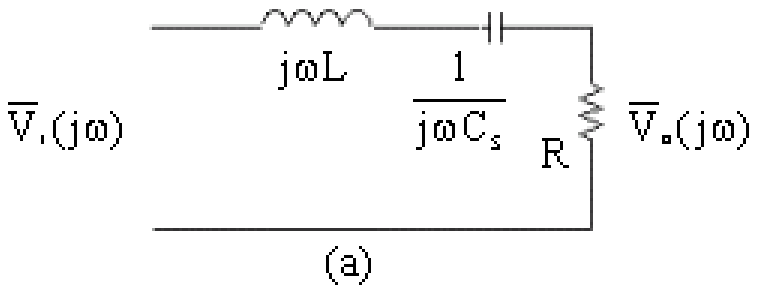
$$V_1 = \frac{4}{\pi} \cdot V_{in} \cdot \sin\left(\frac{\pi}{2} \cdot D\right) \cdot \sin(\omega_{sw} \cdot t)$$

- The output voltage of the inverter :

$$V_{out(rms)} = N \cdot M(\omega_n, Q) \cdot \frac{2\sqrt{2}}{\pi} \cdot V_{in} \cdot \sin(\frac{\pi}{2} \cdot D)$$

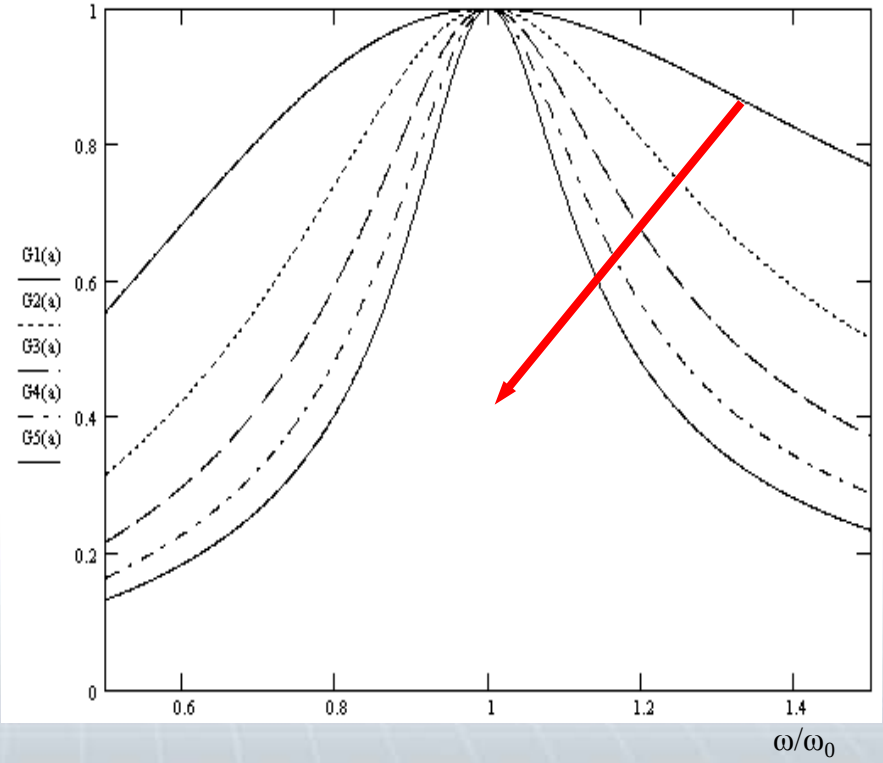
M (ω_n , Q) is the inverter voltage gain; N is the turn ratio of the transformer.

Background-
Resonant Inverter for CCFLs



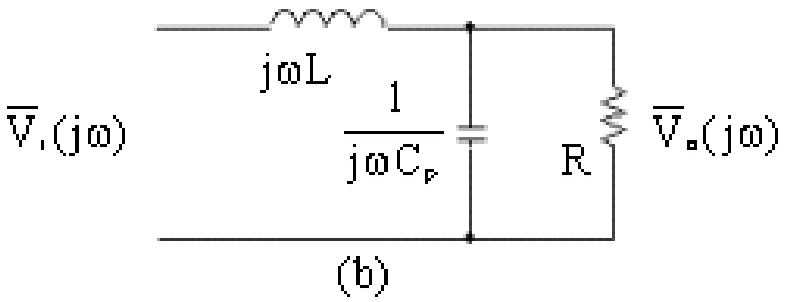
$$\left|\frac{\overline{V}_o(j\omega)}{\overline{V}_i(j\omega)}\right| = \frac{1}{\sqrt{1+Q_s^2\left(\frac{\omega}{\omega_s}-\frac{\omega_s}{\omega}\right)^2}}$$

$$\omega_s = 1/\sqrt{LC_s} \qquad Q_s = \omega_s L/R = 1/\omega_s C_s R$$



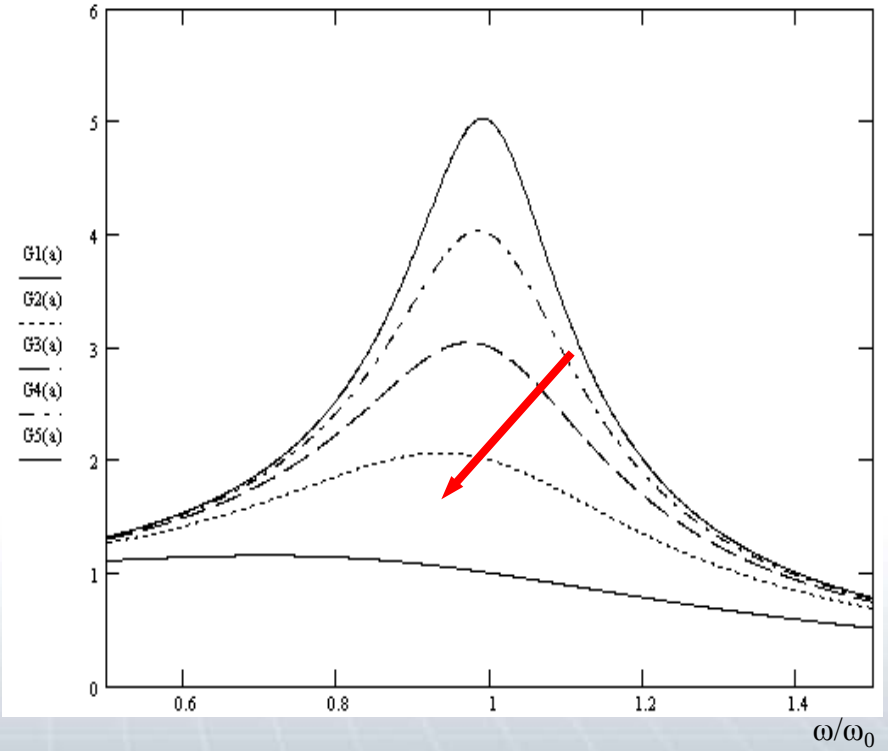
SLR Circuit Topology

Background-
Resonant Inverter for CCFLs



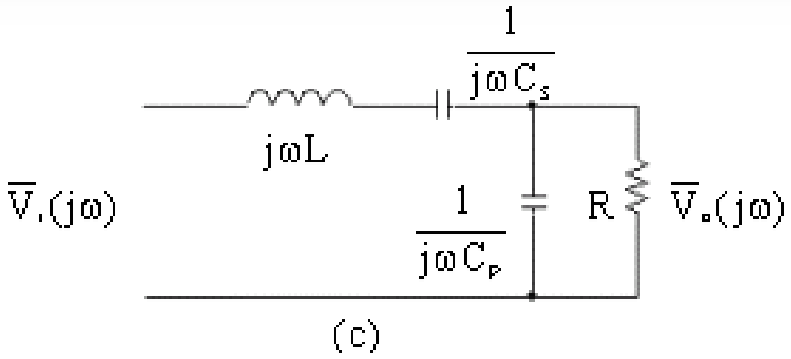
$$\left|\frac{\overline{V}_o(j\omega)}{\overline{V}_i(j\omega)}\right| = \frac{1}{\sqrt{\left(1-\left(\frac{\omega}{\omega_p}\right)^2\right)^2 + \left(\frac{\omega}{\omega_p Q_p}\right)^2}}$$

$$\omega_p = 1/\sqrt{LC_p} \qquad Q_p = R/\omega_p L = \omega_p C_p R$$

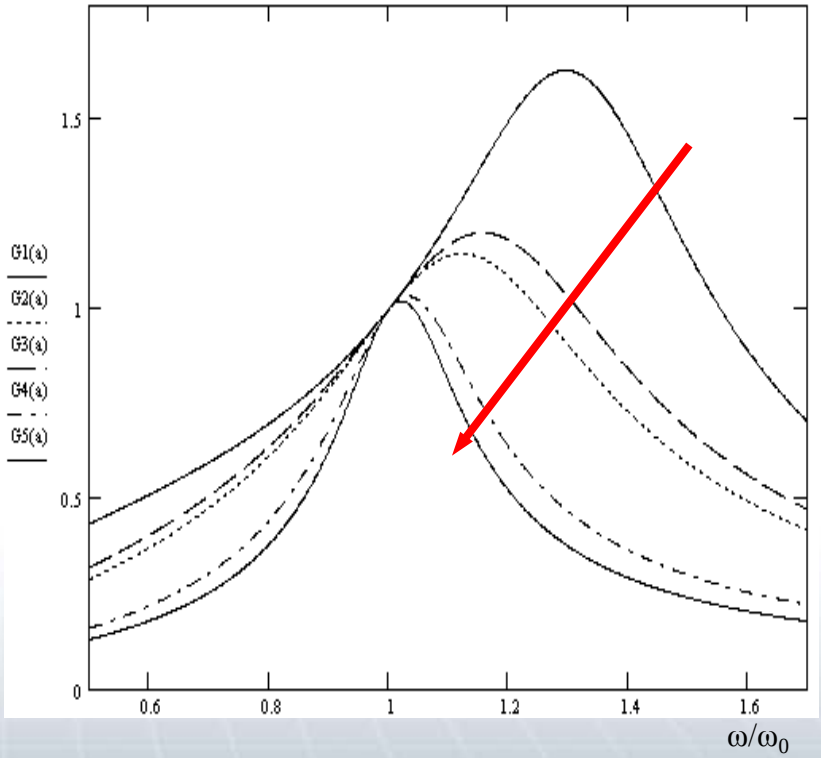


PLR Circuit Topology

Background-
Resonant Inverter for CCFLs

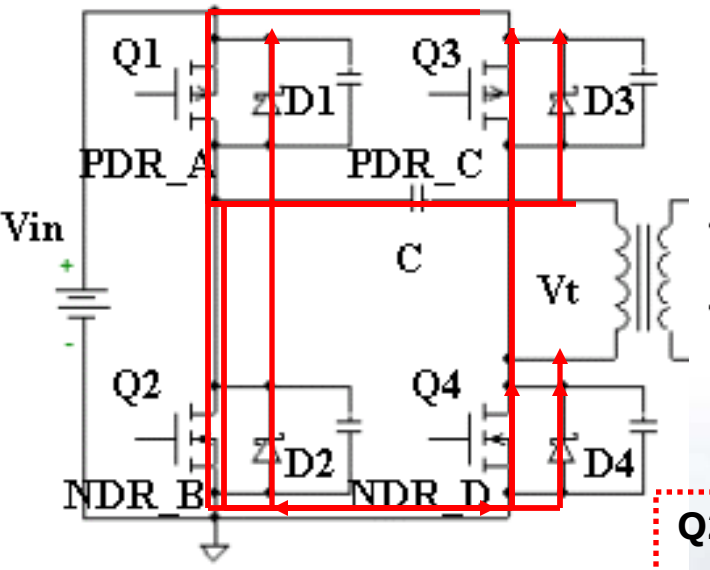


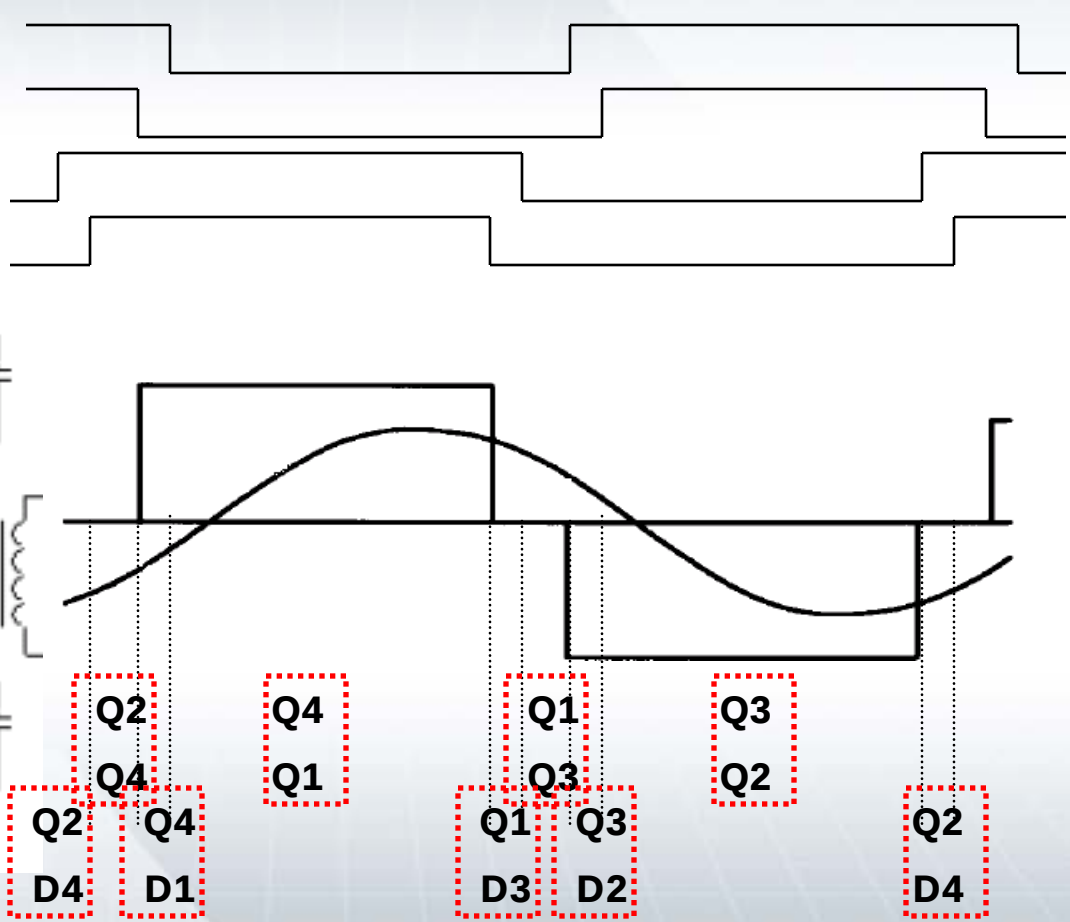
$$\left|\frac{\overline{V}_o(j\omega)}{\overline{V}_i(j\omega)}\right| = \frac{1}{\sqrt{\left(1+\frac{C_p}{C_s}-\left(\frac{\omega}{\omega_p}\right)^2\right)^2 + Q_s^2\left(\frac{\omega}{\omega_s}-\frac{\omega_s}{\omega}\right)^2}}$$



SPLR Circuit Topology

Phase-Shift Full-Bridge Inverter- Add Dead Time

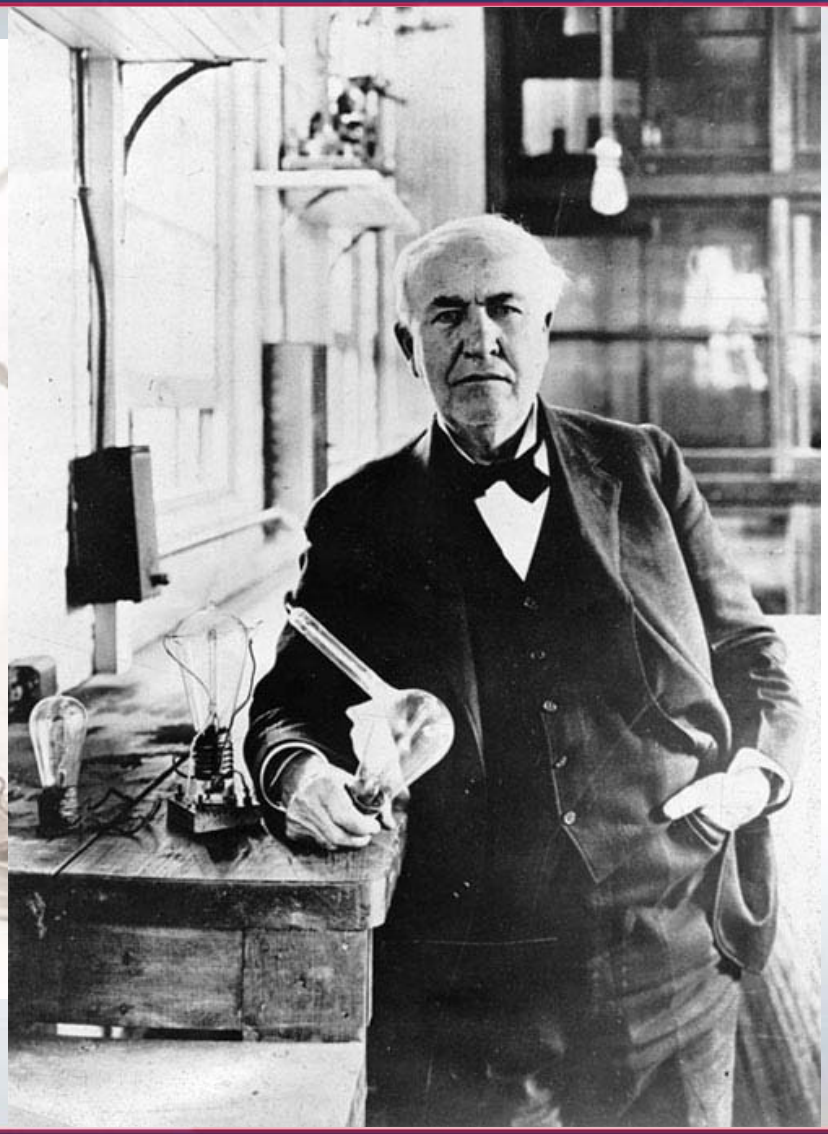




4 ZVS on

Case II

美國專利第223898號，電燈

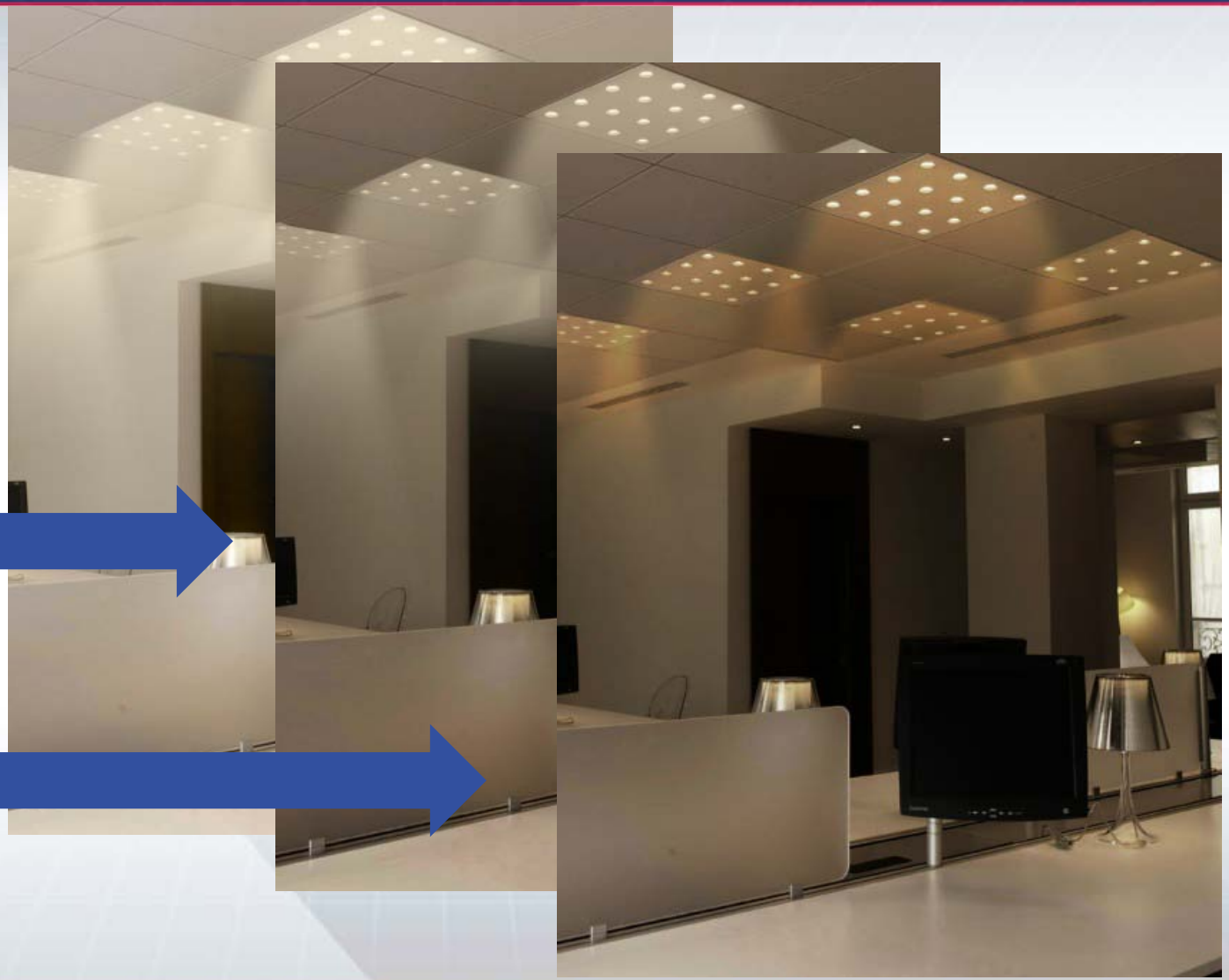


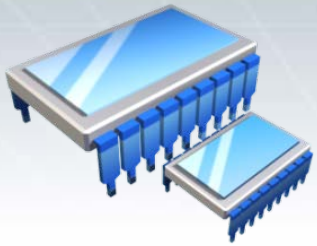
LED三段调光技术

第一阶:100%亮度

第二阶:50%亮度

第三阶:25%亮度



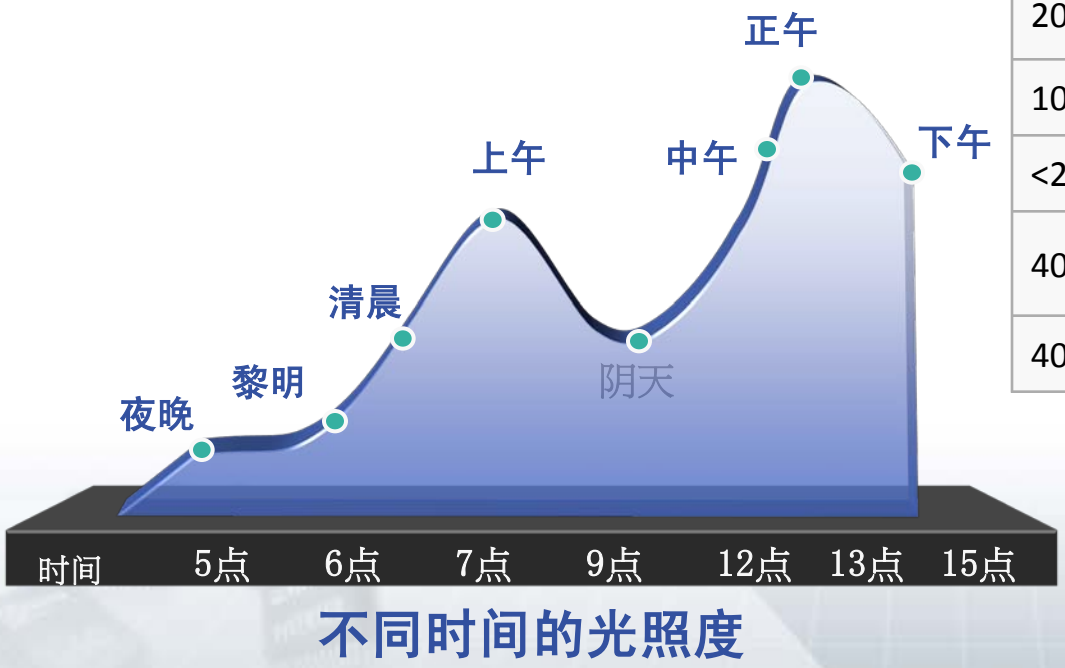


需要额外的元器件吗？

不需要!

常见的光照情况

不是所有时间，我们都需要全亮度的照明



不同时间的光照度

室外照度	例子
120,000勒克斯	最亮的阳光
110,000勒克斯	明亮的阳光
20000勒克司	湛蓝的天空，正午
10,000 - 15,000勒克斯	阴天，中午
<200勒克司	黑暗的风暴雨，中午
400勒克司	晴天,日出或日落
40勒克司	全阴，日出或日落

一个普通人的照明需求分析

一个人全天（每天约16小时）照明需求分析：

1

上午时段 07:00-12:00
下午时段 14:00-17:00
此时段所需照明强度

50%

使用O2第二段照明模式
与传统LED相比,节省

1/2

2

中午时段 12:00-14:00

此时段所需照明强度

25%

使用O2第三段照明模式
与传统LED相比,节省

3/4

3

晚餐后时段17:00-23:00

此时段所需照明强度

100%

使用O2第一段照明模式
与传统LED相比，节省

0

O2Micro® Breathing Life into Mobility

为每人每天节能

使用三阶调光技术的LED灯

相当于只需3W的LED照明

就能满足单人全天的照明需求

为家庭减轻负担

假设一个家庭，三房两厅两卫，共使用80W LED灯具
平均照明使用16小时，家庭电费0.65元/度

使用传统LED
一天耗电1.25度
每天电费0.82
全年照明费用约
300元

Vs

使用O2三段LED
一天耗电0.625度
每天电费0.41
全年照明费用约
150元

每年能为每户家庭节省

150元

为国家节约能源

使用三阶调光技术的LED灯

*中国全年约省电：**470亿千瓦时***

相当于三峡水电站半年发电量

*全年节煤：**1700万吨***

已投入市场的产品

OZ9995 Inside

OZ9992 Inside

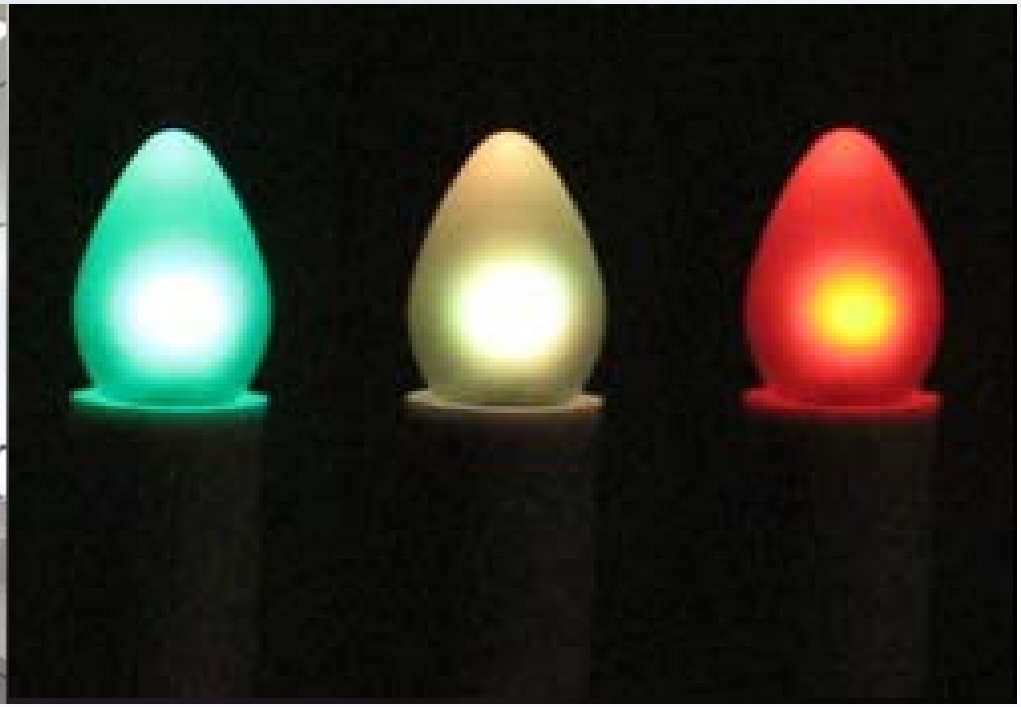
O2Micro Breathing Life into Mobility

O2Micro's 3-Step Dimming Controller Customers

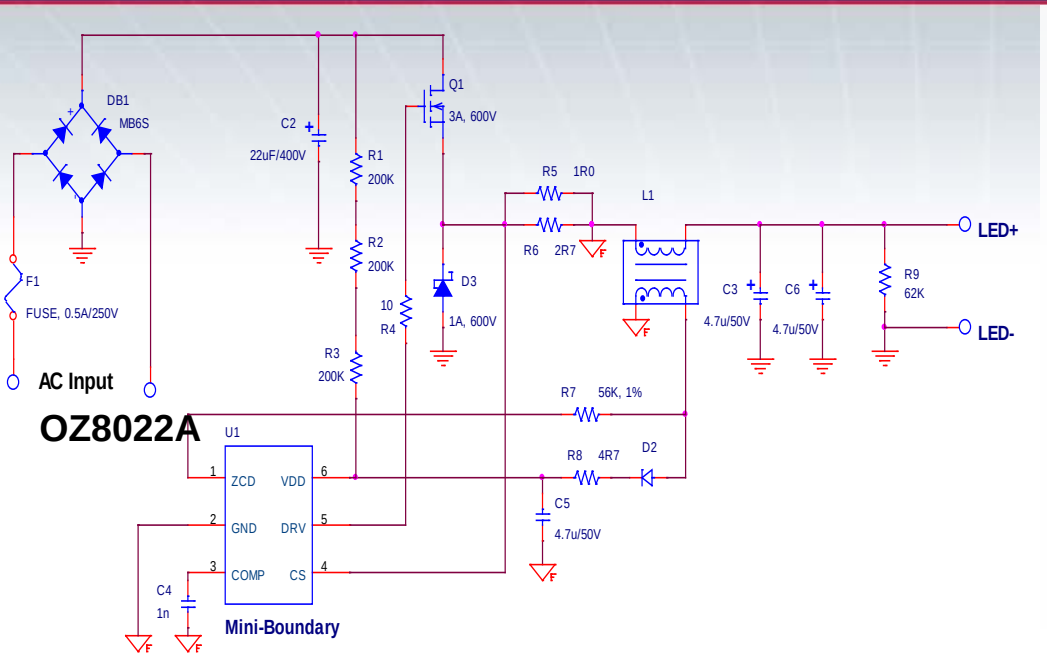
Mitsubishi

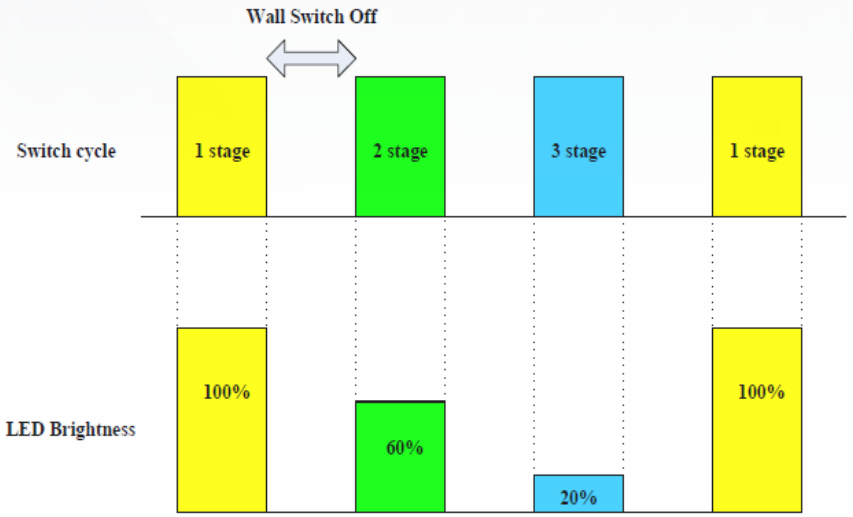
Orion

小夜灯功能的LED灯泡



LED Lighting---Free Dimming





Advantages:

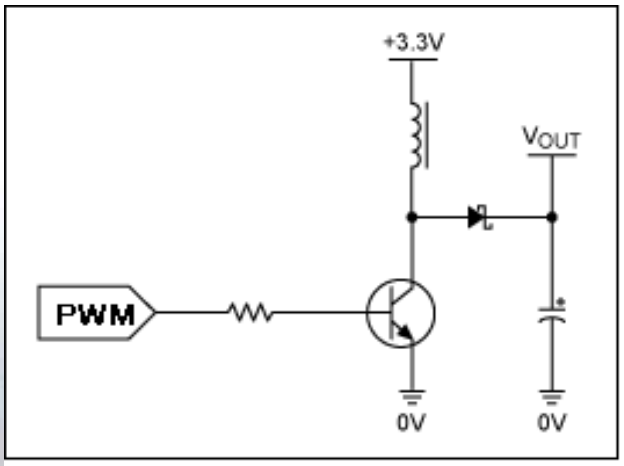
- Simple, only AC wall switch
- Inexpensive, less than 20 components
- Small, can be put in E17 bulb
- Efficient, energy saving
- Compatible, free-dimming control
- NO flickering

Case III

Bike Lamp Solutions

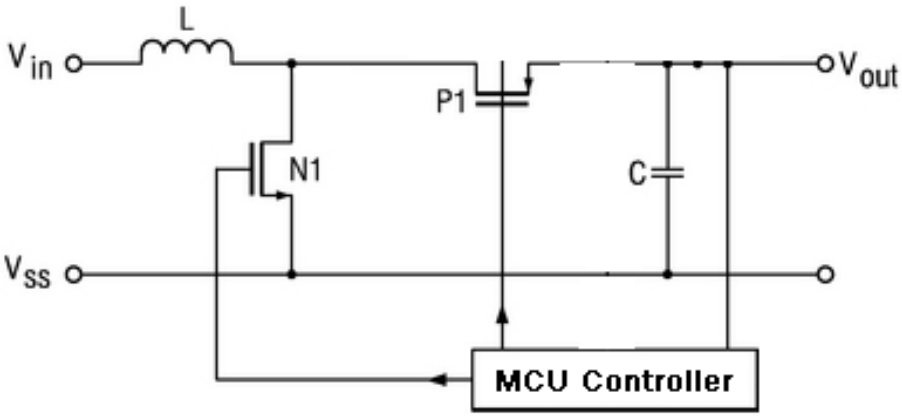
Prior Art

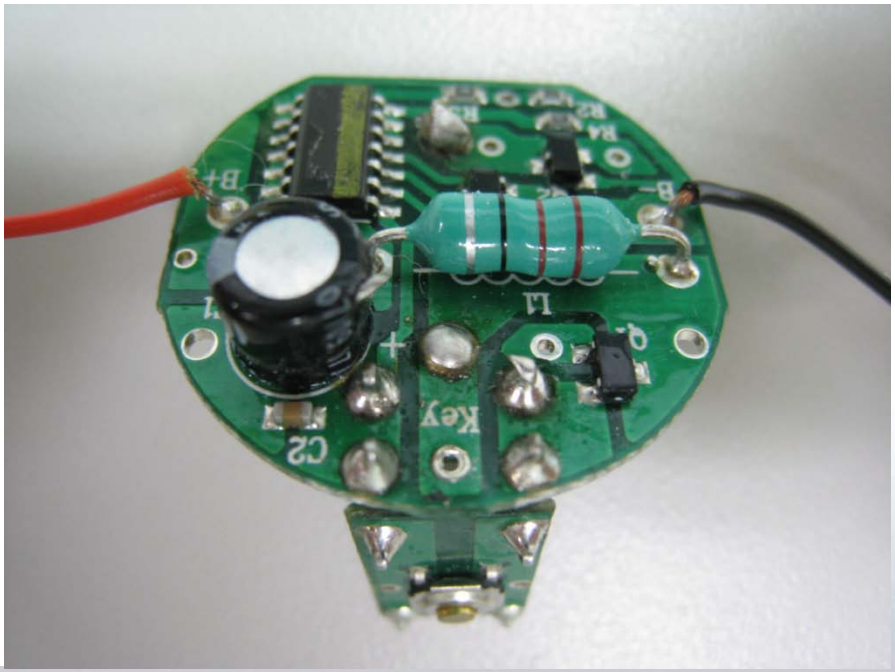
- More popular within Even Alkaline pack (2 or 4)
  - Battery pack in Europe
    - Usually 2 or 4 pack on sell
  - 2 Alkaline needs boost topology
    - Popular solution
      - MCU send constant PWM control
  - More application in 1 Alkaline (VBAT= 0.8~1.5V)
    - Boost voltage from 0.8V
    - Schottky diode forward voltage is above 0.6V
      - Startup voltage must above 1V



Boost topology

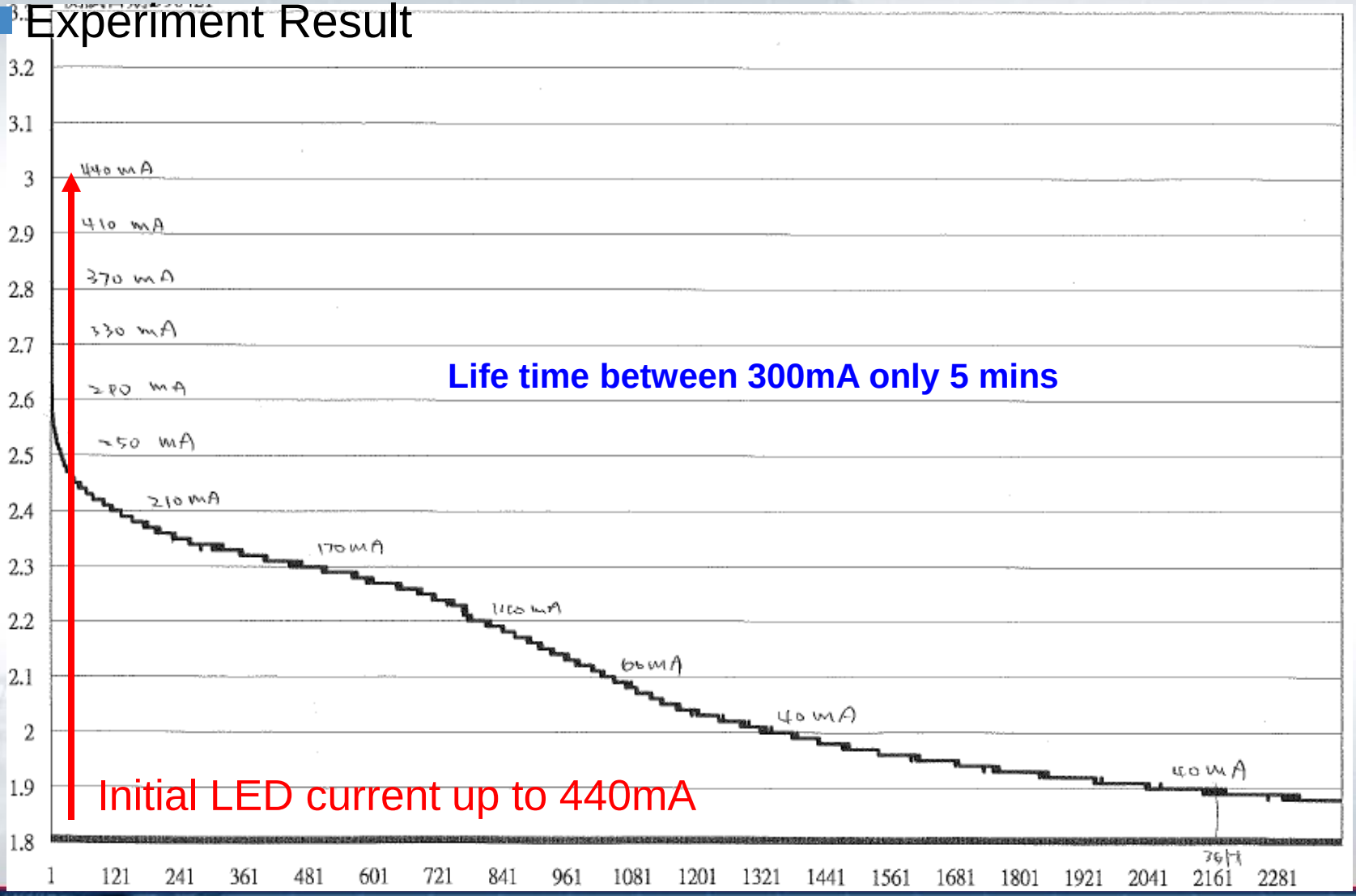
- Replace Schottky diode with PMOS
  - Startup from 0.8V
- BOM list (total 11 items)
  - MCU
  - 2 MOSFET
  - Inductor





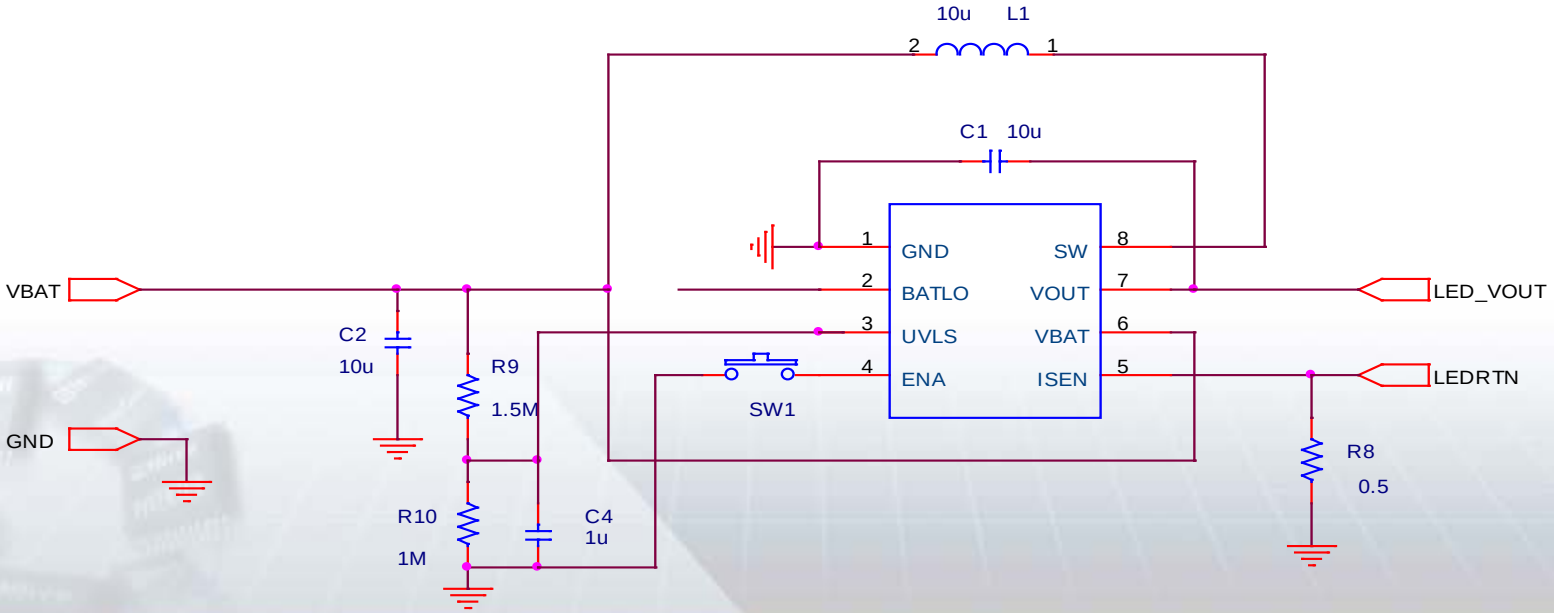
Traditional Circuit

- Experiment Result



Our Solution_711-26

- Features
  - Ultra low VIN start up and operation voltage from 0.8V
    - Support one or two cell NiMH or Alkaline battery
  - Minimum external component count
    - 7 items without 2 MOSFET
  - Constant LED current When VBAT=0.8~3V



Our Solution_711-26

- High Efficiency:

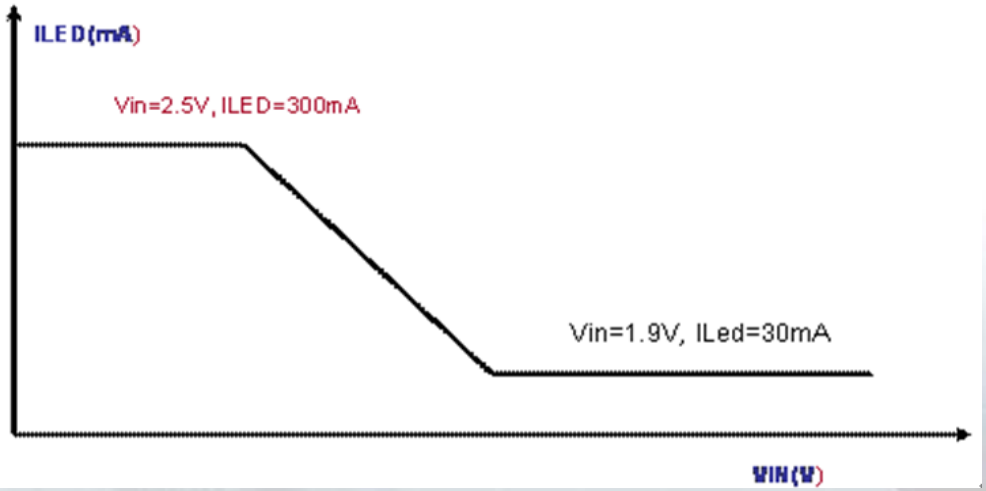
Vbat(V)	Iin(mA)	LED Voltage(V)	LED Current(mA)	Eff(%)
3	359	3.026	306	85.98
2.8	385	3.023	306.5	86.11
2.6	326	2.983	246.7	88.82
2.4	227	2.92	167	89.51
2.2	120	2.832	84	90.11

- Current Mode:

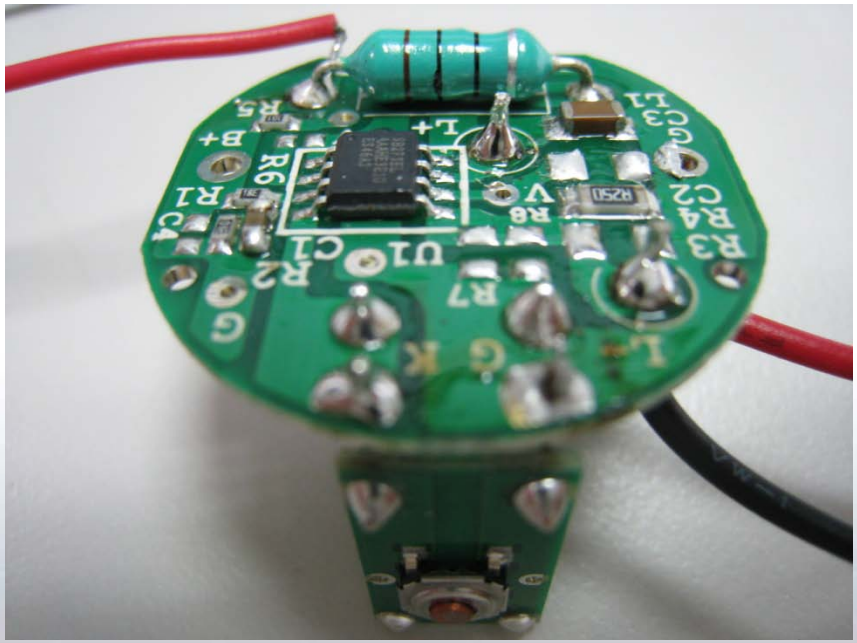
Vin(V)	Iin(mA)	VLED(V)	ILED(mA)	Eff(%)
3	586	2.663	518	78.46
2.8	363	2.591	323	82.34
2.6	180	2.497	164	87.50

Our Solution_711-26

- User-defined where LED current starts to decrease
  - Extend life time
- Build in Toggle Switch Modes



Our Solution right now!

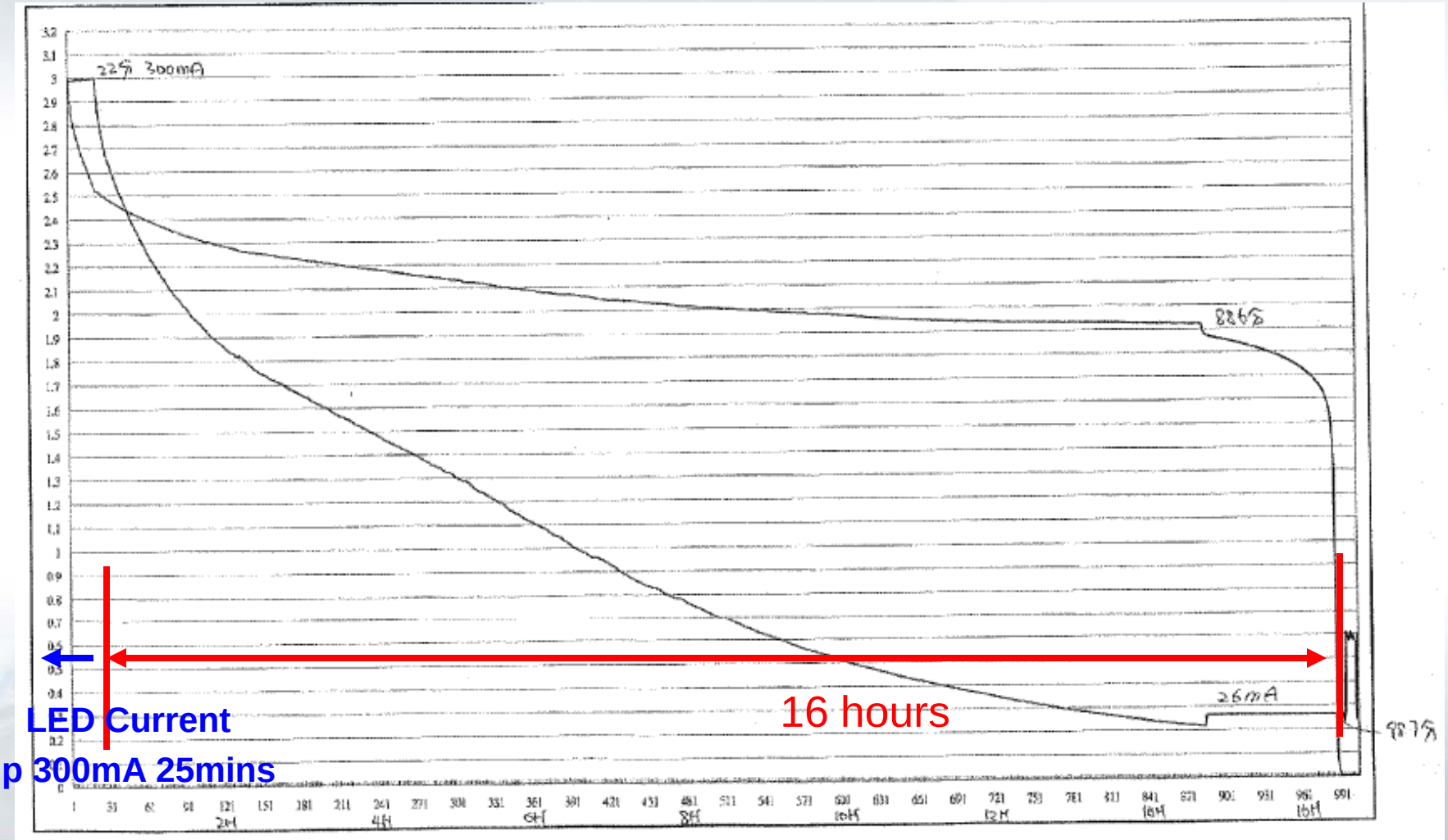


Our Solution_711-26

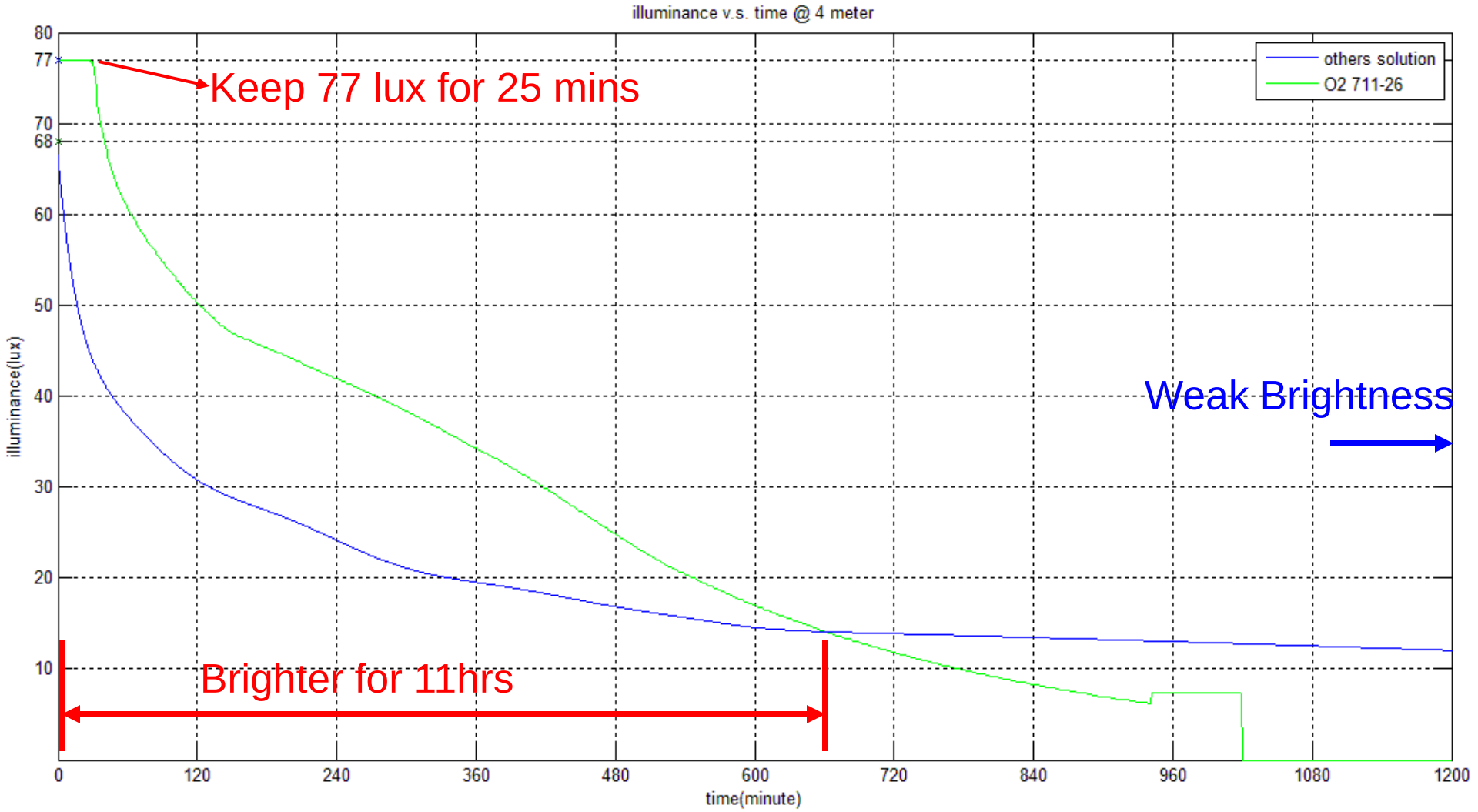
- Protections
  - Output Over-Voltage Protection (OVP)
  - Output Short-circuit Protection (SCP)
  - Over-Current Protection (OCP)
  - Over-Temperature Protection (OTP)

Our Solution_711-26

- Experiment Result



Luminance Comparison

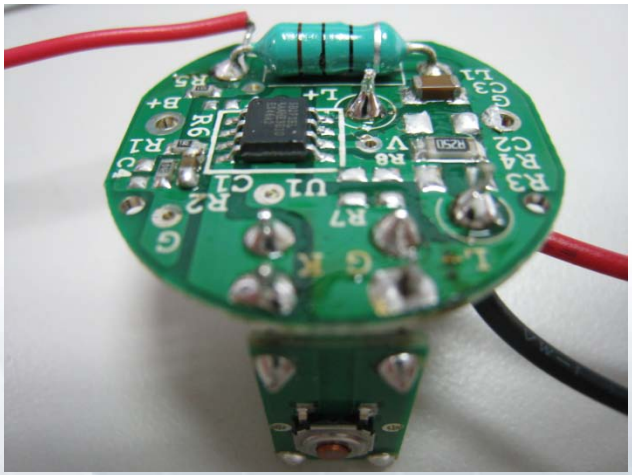


Comparison Advantage

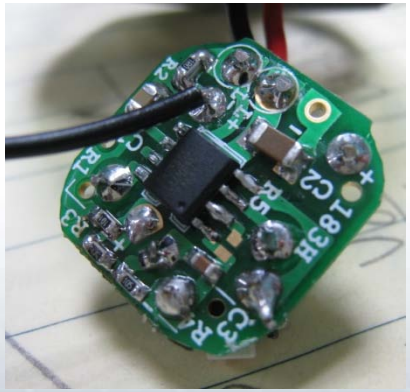
- **Smaller PCB, fewer component**
  - Support 1 Alkaline PCB size
- **Startup Voltage from 0.8V**
  - Build in MOSFET

Popular solution

Our solution



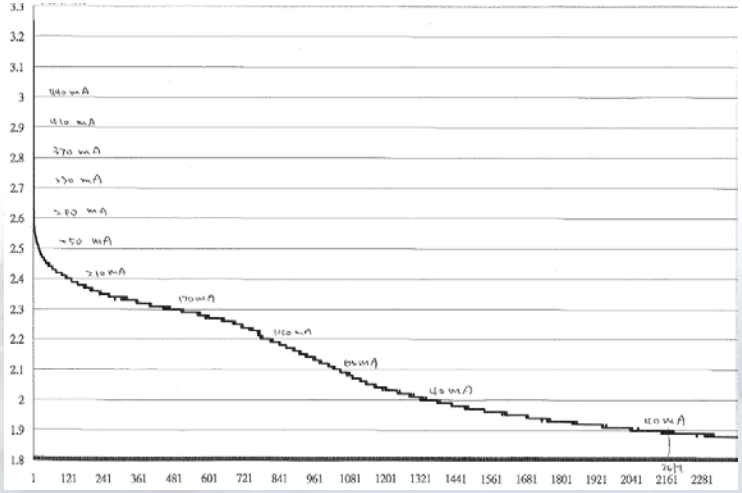
1 Alkaline



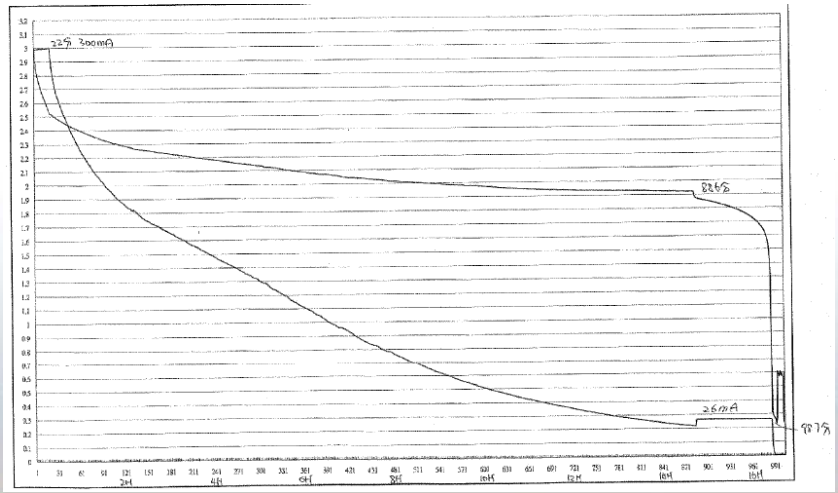
Comparison Advantage

- **Protect LED over current at beginning**
  - MCU solution cause 440mA initial
- **Insure constant LED current in MP stage**
  - MOSFET & inductor tolerance cause LED current variation
- **Provide life time for user define**

Popular solution



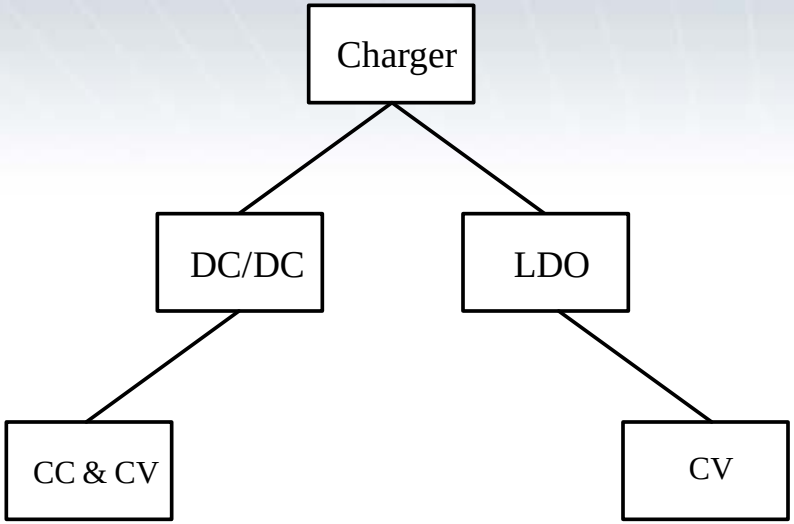
Our solution

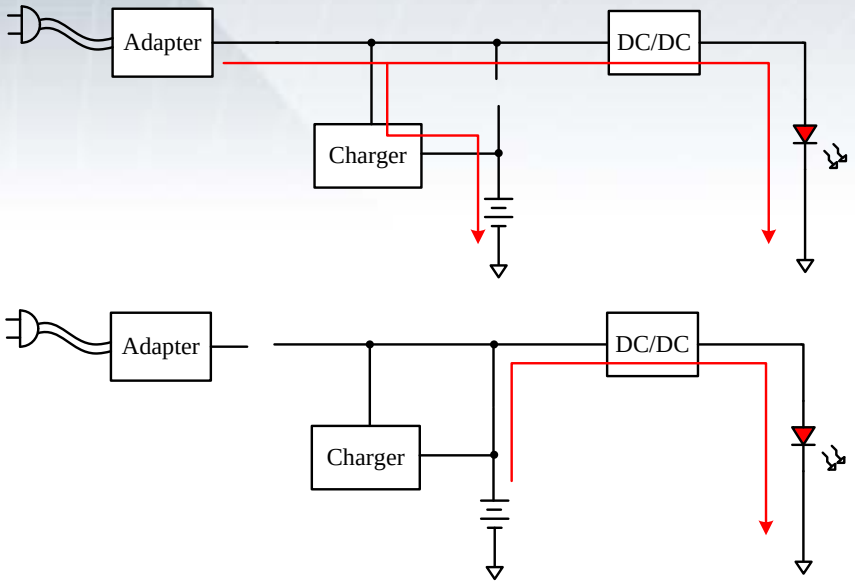


Bikehawk_BC

- More Charger Battery need in the future (Li or NimH)
- Develop IC for both charger and constant LED current
- Supports 1 Li-ion or 2-4 cell NimH batteries
- Automatic switching between constant current and constant voltage mode
- Over charge protection
- Automatic recharge
- Low-Battery, Battery full and charging STATUS output
- Drives up to 1-3 high brightness LEDs with forward current 350mA
- Supports both boost and/or buck mode operation

Current Solution

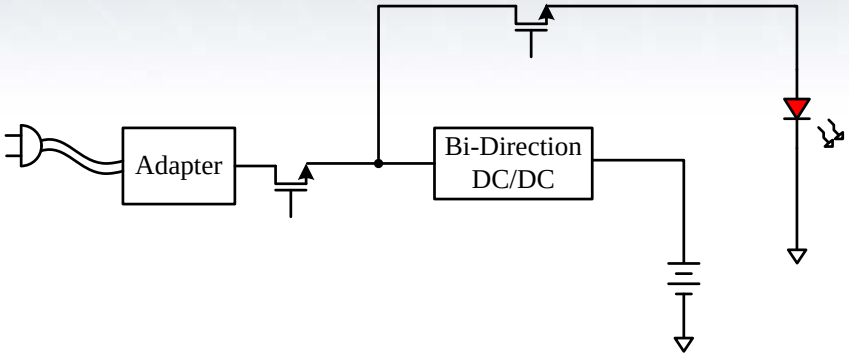


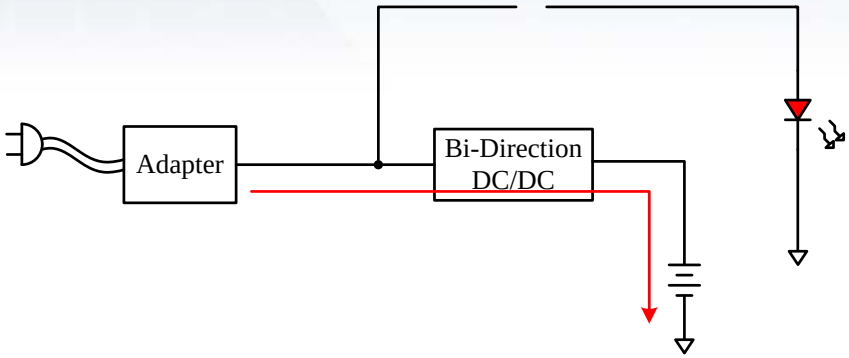


- LDO Disadvantage
  - Less Efficiency
  - Non Fast Charger

- Traditional switching topology
  - Larger PCB size - 2 power chains

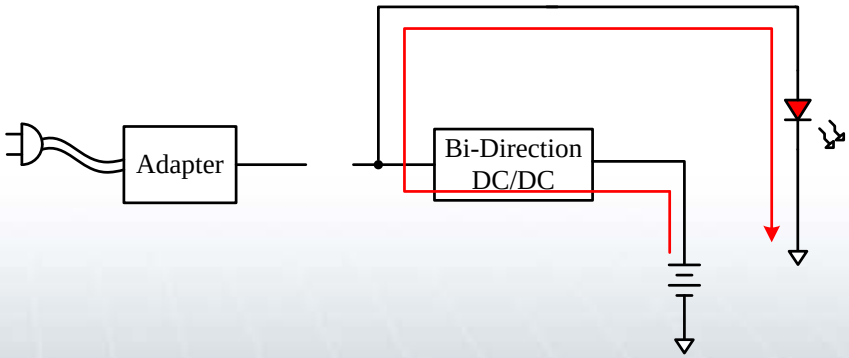
Bikehawk_BC Future





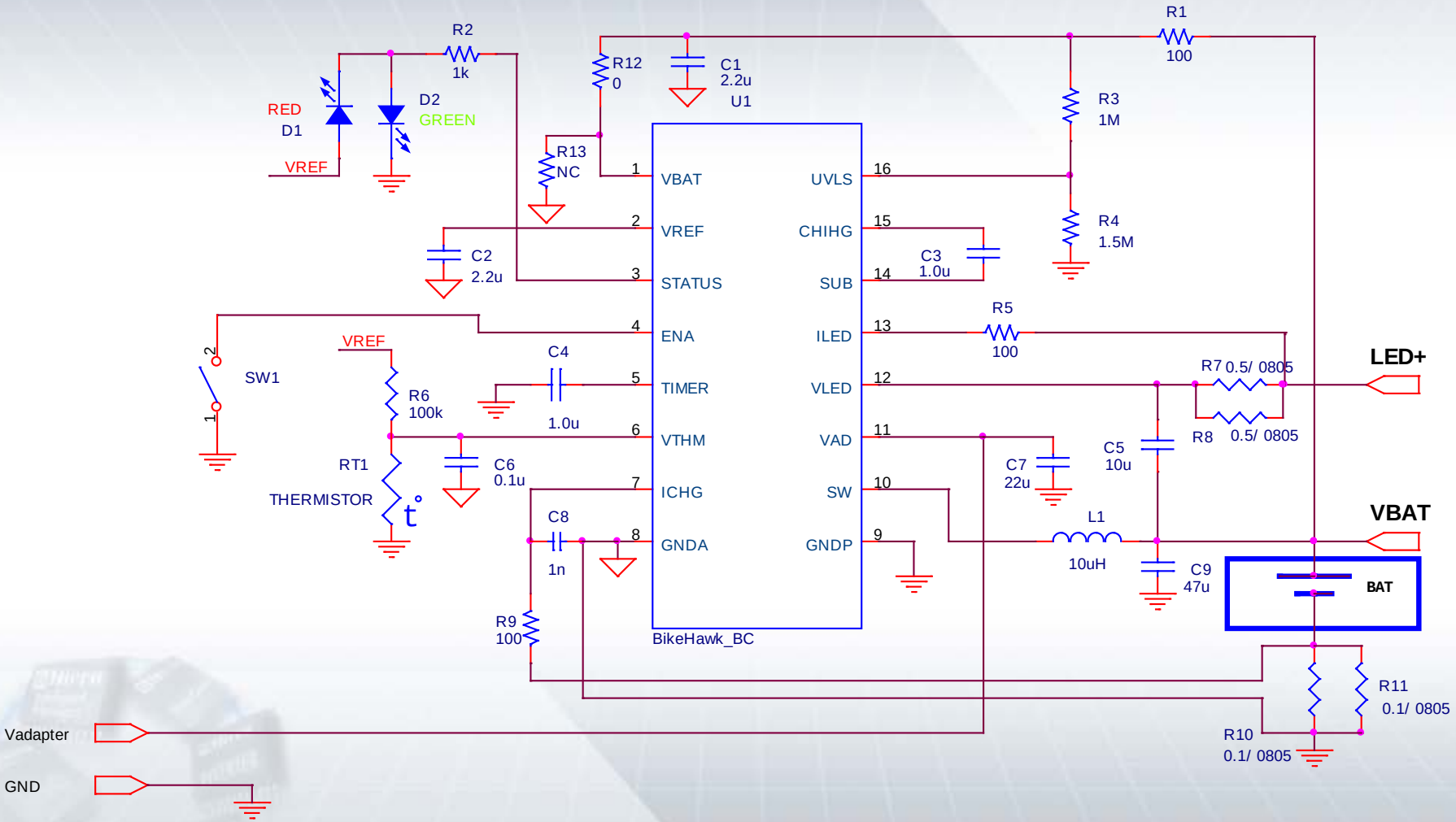
- New Patent Idea!

  Fast Charger and constant LED current Controller integrated



- Reduce to one single power chain??
  - Less Cost
  - Saving Area

BikeHawk_BC Schematic



Recommends

- Solution Provider
- Full Experience of Your Life
- Good Hobby
- Patent Skill

Survival Skill in Job---

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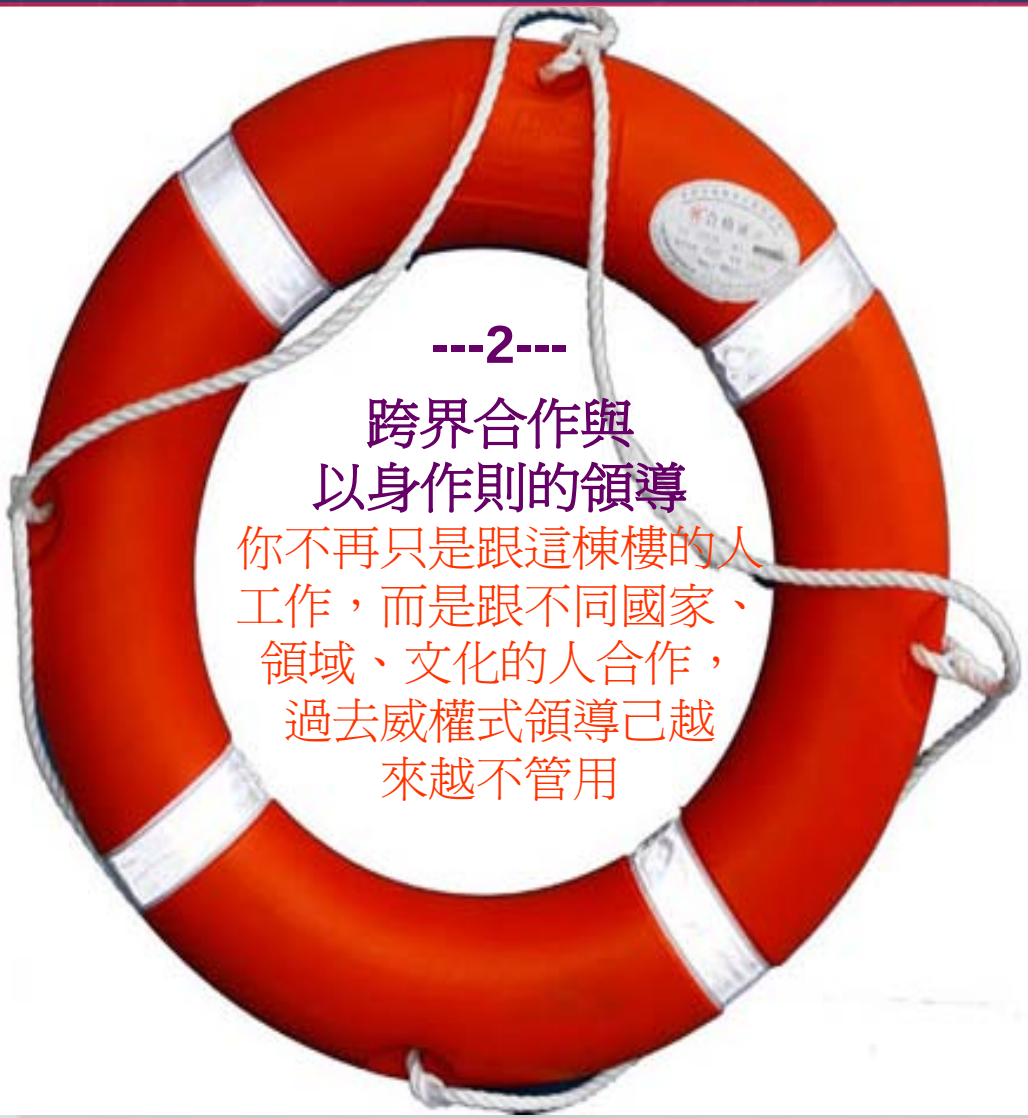
批判思考與解決問題

能夠問對問題，是
批判思考、解決問題
的第一步

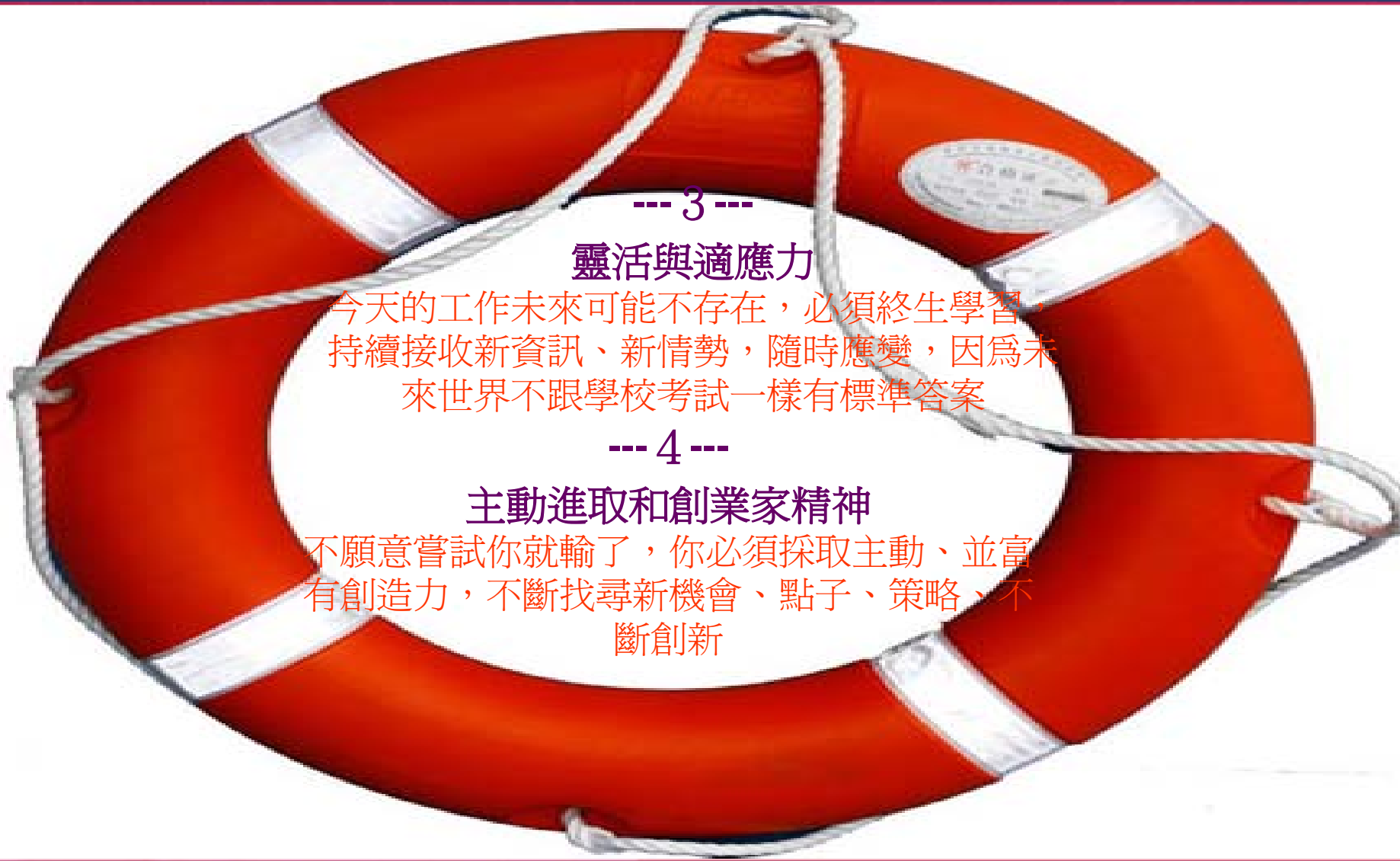


---2---

跨界合作與
以身作則的領導

你不再只是跟這棟樓的人
工作，而是跟不同國家、
領域、文化的人合作，
過去威權式領導已越
來越不管用

Survival Skill in Job---



--- 3 ---

靈活與適應力

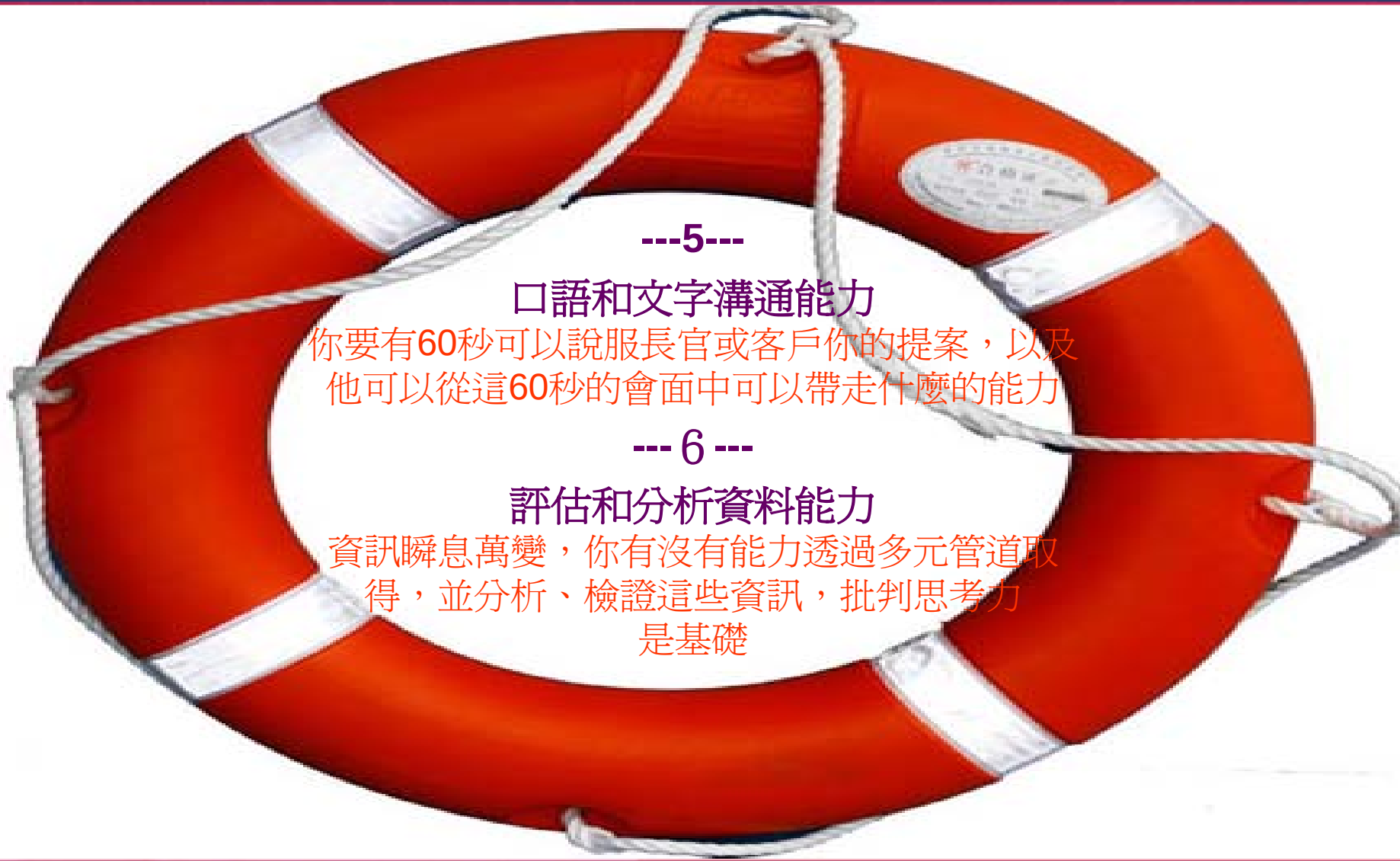
今天的工作未來可能不存在，必須終生學習，持續接收新資訊、新情勢，隨時應變，因爲未來世界不跟學校考試一樣有標準答案

--- 4 ---

主動進取和創業家精神

不願意嘗試你就輸了，你必須採取主動、並富有創造力，不斷找尋新機會、點子、策略、不斷創新

Survival Skill in Job---



---5---

口語和文字溝通能力

你要有60秒可以說服長官或客戶你的提案，以及他可以從這60秒的會面中可以帶走什麼的能力

--- 6 ---

評估和分析資料能力

資訊瞬息萬變，你有沒有能力透過多元管道取得，並分析、檢證這些資訊，批判思考力是基礎

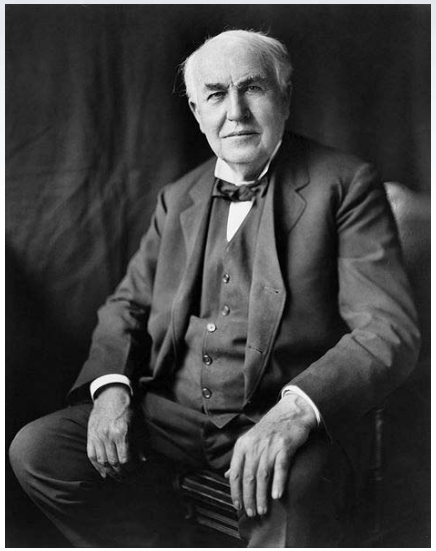
Survival Skill in Job---

--- 7 ---

好奇心與想像力

企業要的不只是聰明人，而是懂得問出好問題、追根究柢、對世界好奇的人，因爲好奇和追根究柢解答了最重要的問題

發明是百分之一的靈感加上百分之九十九的血汗。



Thomas Edison

我的人生哲學是工作，我要揭示大自然的奧秘。並以此爲人類造福。
我們活著的短暫一生中，我不知道還有什麼比這種服務更好的了。