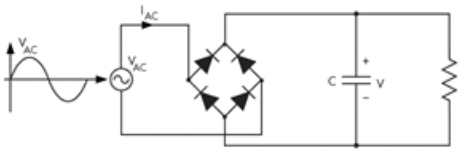
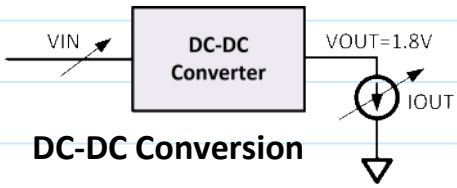
What is Power Management?

- Efficient and reliable means of Power delivery to a system.
- AC-DC / DC-AC
- DC-DC (Voltage Regulator)

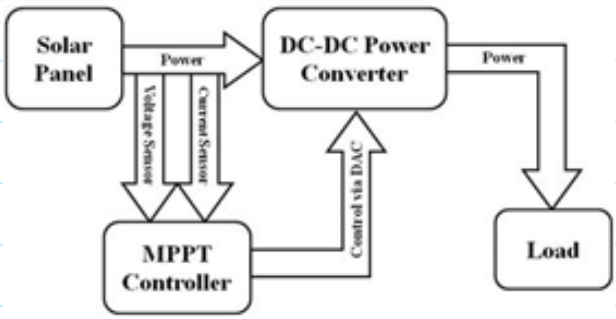


AC-DC/DC-AC Conversion



DC-DC Conversion

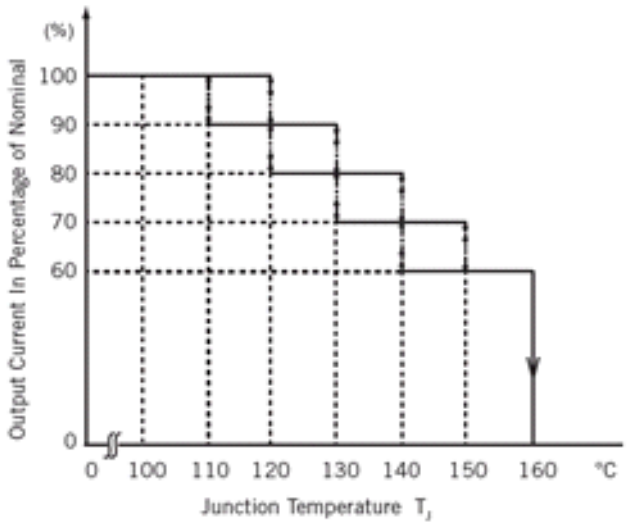
- Generating / tapping Power from freely available resources.



Energy Harvesting

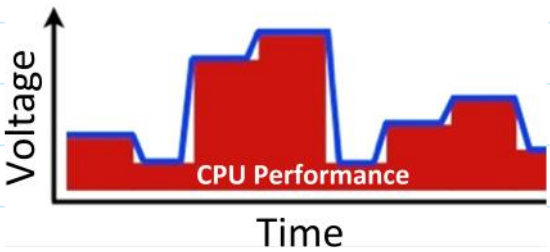
What is Power Management (Contd.)

Thermal Management
→ manage heat or losses



Current/Power derating

Voltage is controlled based on CPU performance



Dynamic Voltage Scaling (DVS)

PMIC Vs Power Electronics

Source: ST Microelectronics

High Power - Power Electronics (Discrete Solution)

Low/Mid Power - Power Management IC (Integrated Solution)

Power Electronics

→ Large solution mainly due to discrete components

→ Deals with high power → 100s W → kW

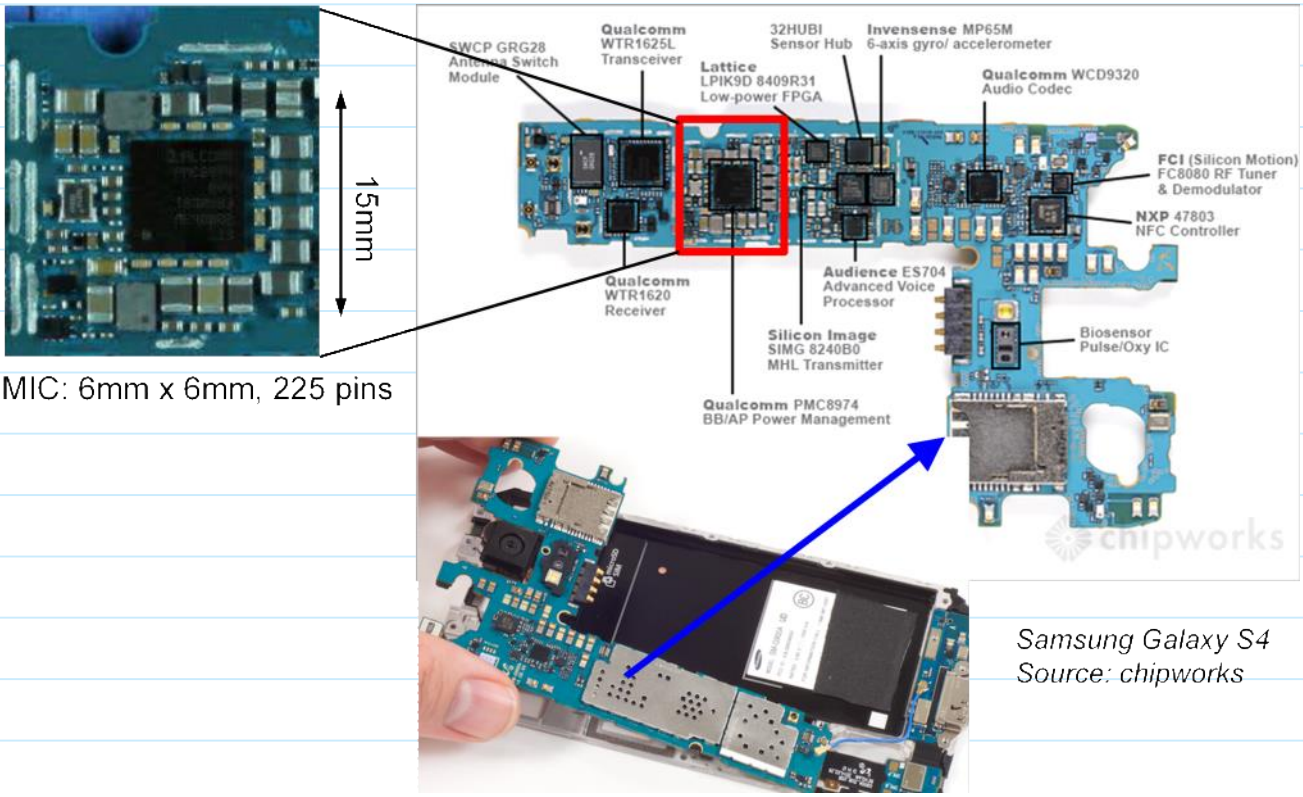
PMIC

→ Smaller solution

→ Single chip PMIC with off-chip passive components

→ Low/mid power mW → 10s W

Why do we need PMIC?

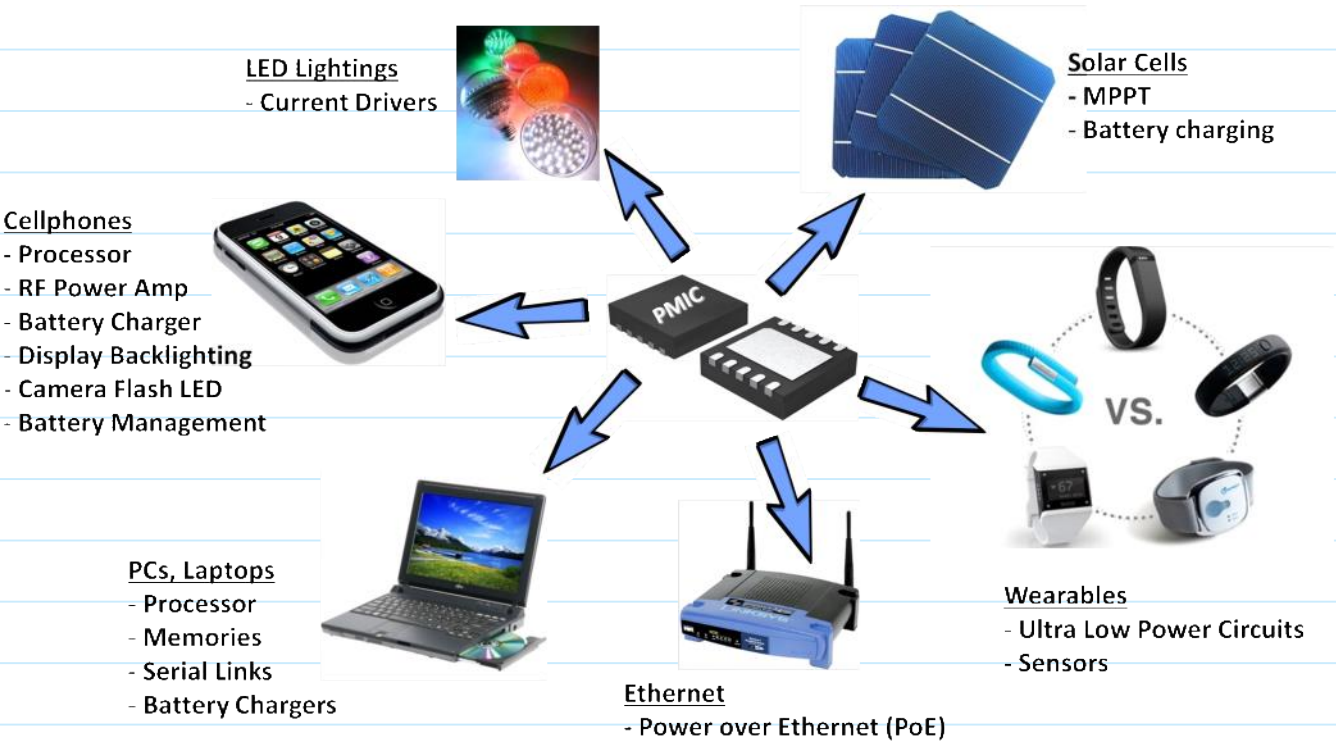


Need higher power in smaller area

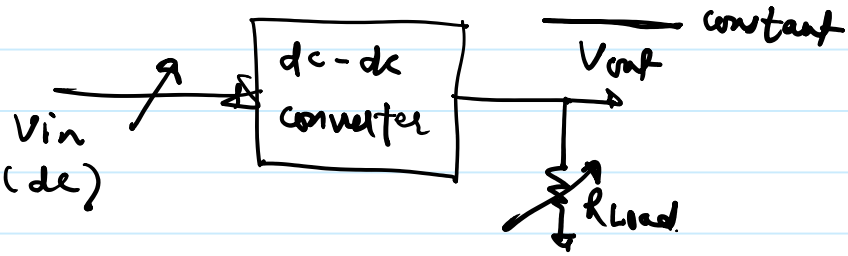
→ Higher power density

→ PMIC integrates most of the components on-chip hence reduces overall size.

Applications of PMIC



DC - DC converter (Voltage Regulator)



converts voltage from one power domain to other

- constant Vout
- Vout > Vin
- Vout < Vin
- Vout = Vin

Types of dc-dc converter

Switching
(inductive or capacitive)

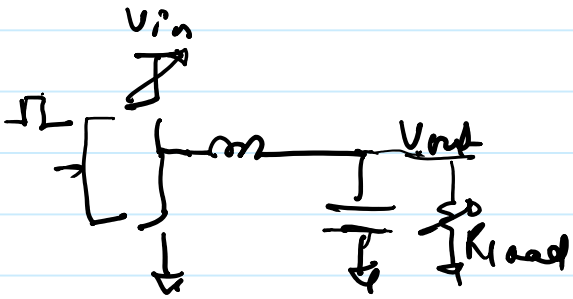
- Vout = Vin
- Vout < Vin
- Vout > Vin
- Vout = -Vi

Linear
(Pass FET)

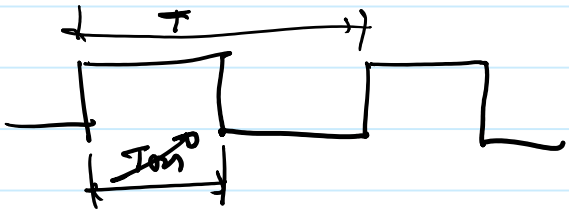
Vout < Vin

Switching Vs Linear Regulators

Switching



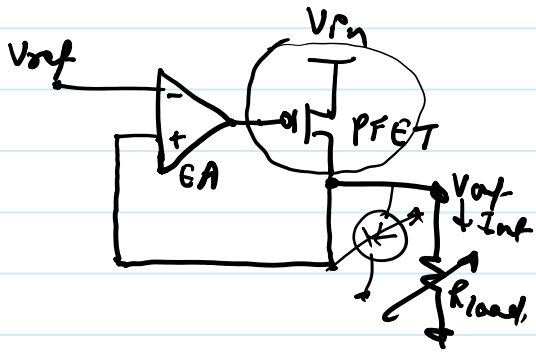
PWM based



$V_{out} = D \cdot V_{in}$

$D = \frac{T_{on}}{T}$

Linear



$V_{drop} = V_{in} - V_{out}$

$P_{loss} = V_{drop} \times I_{out}$

$V_{in} = 5V$

$V_{out} = 1V$

$I_{out} = 1A$

$V_{drop} = 5 - 1 = 4V$

Switching

$V_{out} = 1V$

$I_{out} = 1A$

$R_{dson} = 100m\Omega$

$P_{out} = V_{out} \times I_{out}$

$= 1W$

Switching losses

$= I_{out}^2 R_{ds-on} = (1)^2 \times 0.1$

$= 100mW$

$\eta \simeq 90\%$

Linear

$P_{loss} = V_{drop} \times I_{out}$

$= 4W$

$\eta = \frac{P_{out}}{P_{in}} = \frac{P_{out}}{P_{out} + P_{loss}}$

$= \frac{1W}{5W} = 20\%$

$V_{out} = 4V$

$I_{out} = 1A$

$V_{drop} = 5 - 4 = 1V$

$P_{loss} = 1W$

$\eta = \frac{4W}{5W} = 80\%$