



Renewable Energy Technologies

A Quick Glance

P. Sensarma, Associate Professor,
Electrical Engineering,
IIT Kanpur.

No Escape

Energy (+ mass) can neither be created nor destroyed.

It can merely be transformed from one form to another

Energy Sources: Conventional

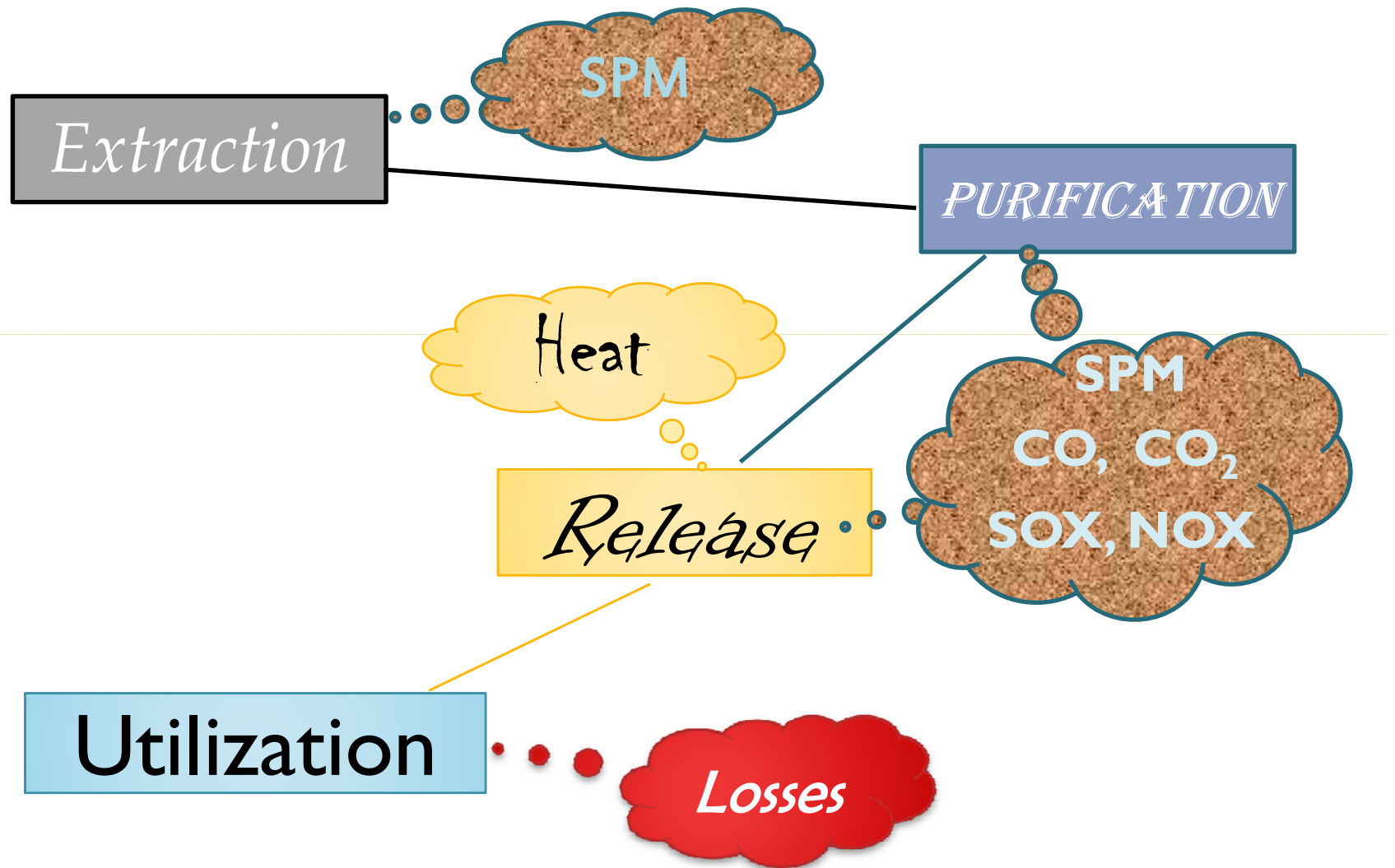


Mineral reserve

- *Limited*
- *Complex processing chain*



Energy chain (conventional)



“Non-conventional” sources



- Natural, everyday phenomena
- Available during the sun's life
 - Non-polluting processing chain
 - Zero emission
 - Intermittent nature


BUT.....

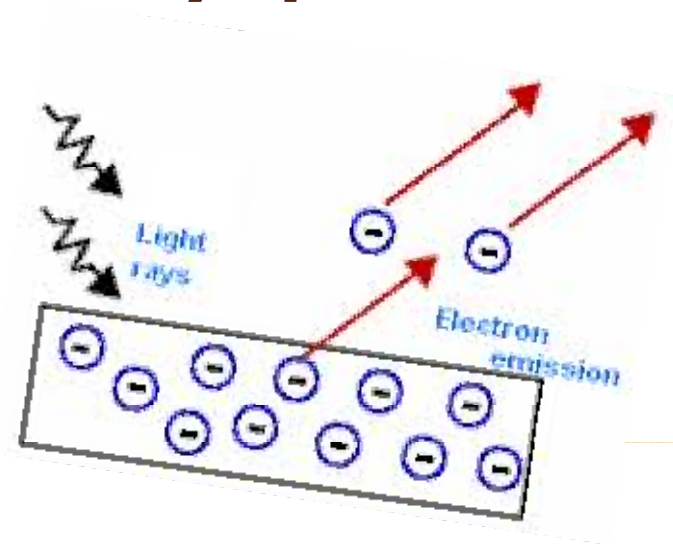
• WE WANT ELECTRICITY -

LOTS OF IT



Sunshine on my panel

Photoelectric Effect

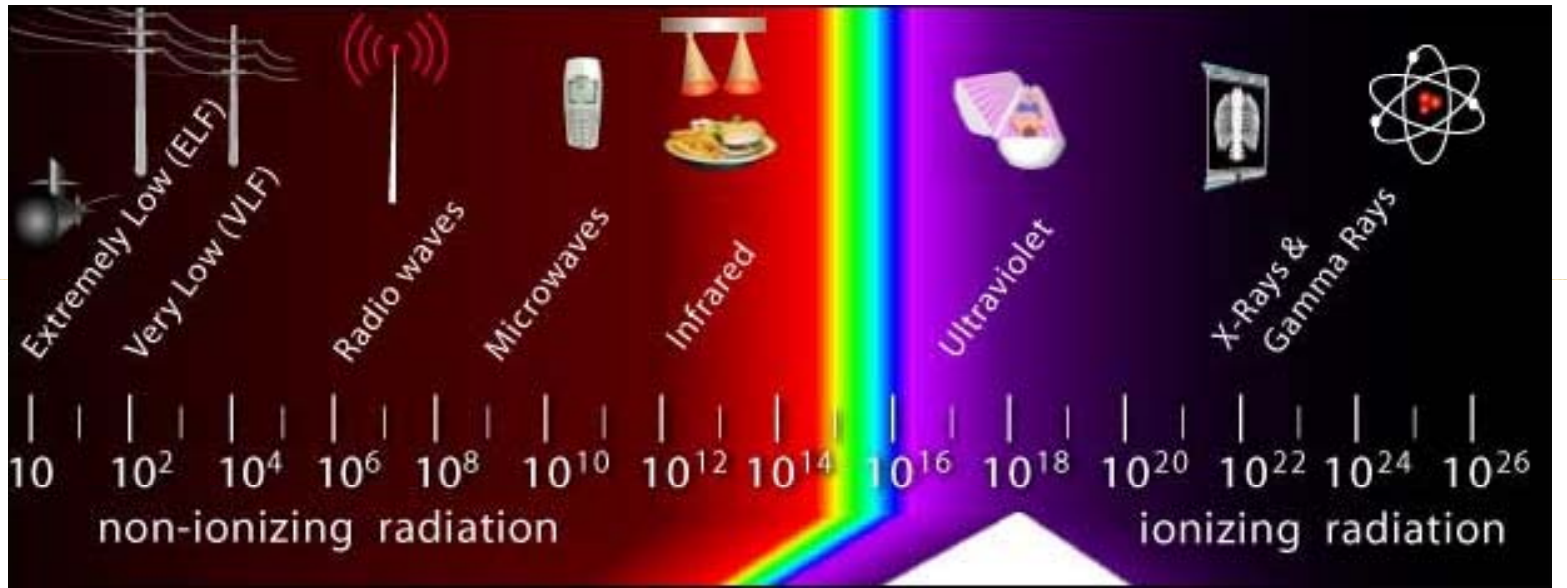
- Special materials
- Light  Electricity



But ... a few hitches

- Light is an electro-magnetic wave  frequency
- Any light frequency  excite photoelectrons
- Same frequency light may not excite in all materials

Sunshine on my panel



Frequency →

←→
Sunshine

Sunshine on my panel

Sunlight : FREE light

Search for materials which

- are excited with more of the solar spectrum

OR

Synthesize them

and THEN

Package photoelectric material and electrode

- less recombination, more electricity in the external circuit
- less reflection

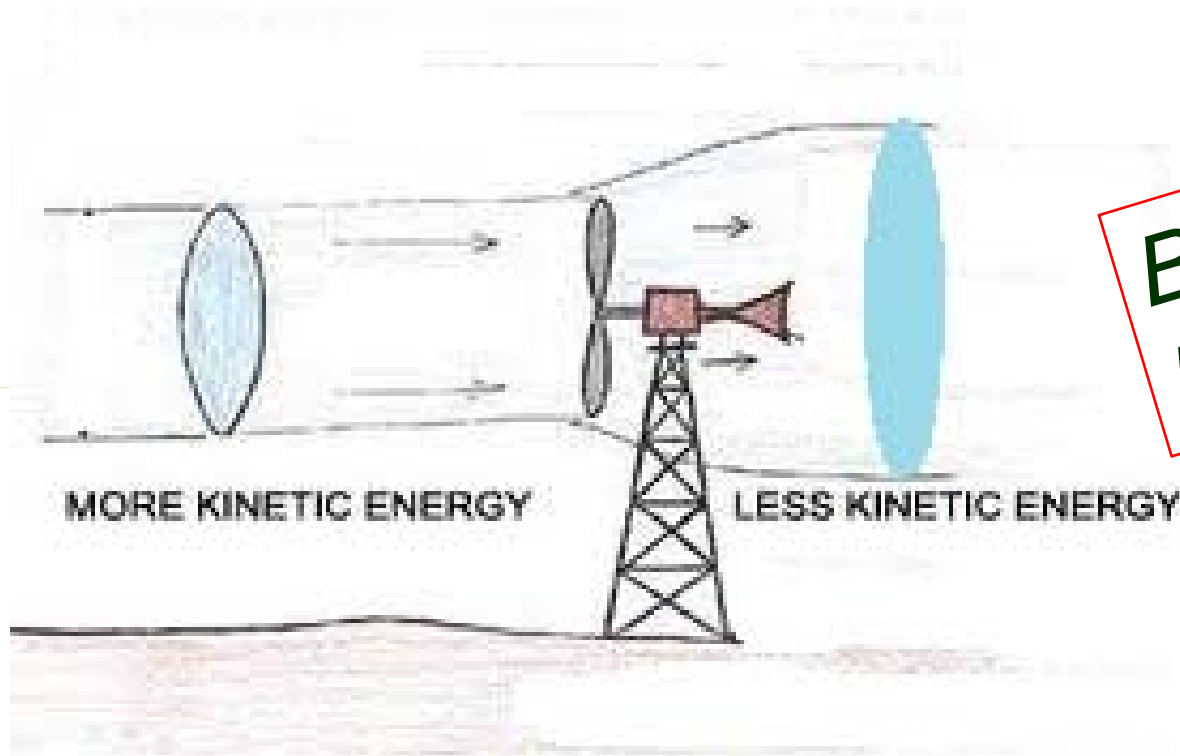
Sunshine on my panel

Conversion EFFICIENCY

$$\frac{\text{Electrical Energy Output}}{\text{Total LIGHT Energy Input}} \times 100\%$$

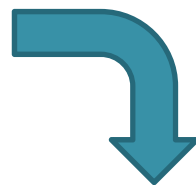
No energy LOST if efficiency less than 100%

Wind ... on the blades



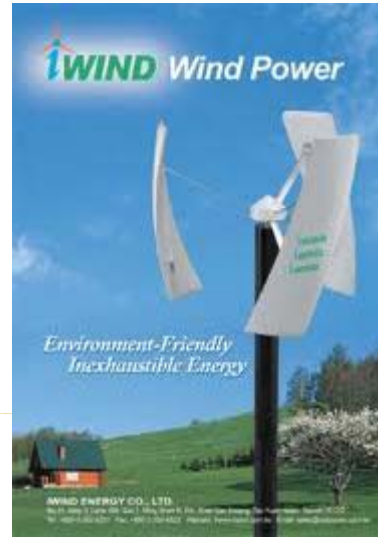
**Bernoulli's
Principle**

Linear wind flow



Rotation of turbine blades

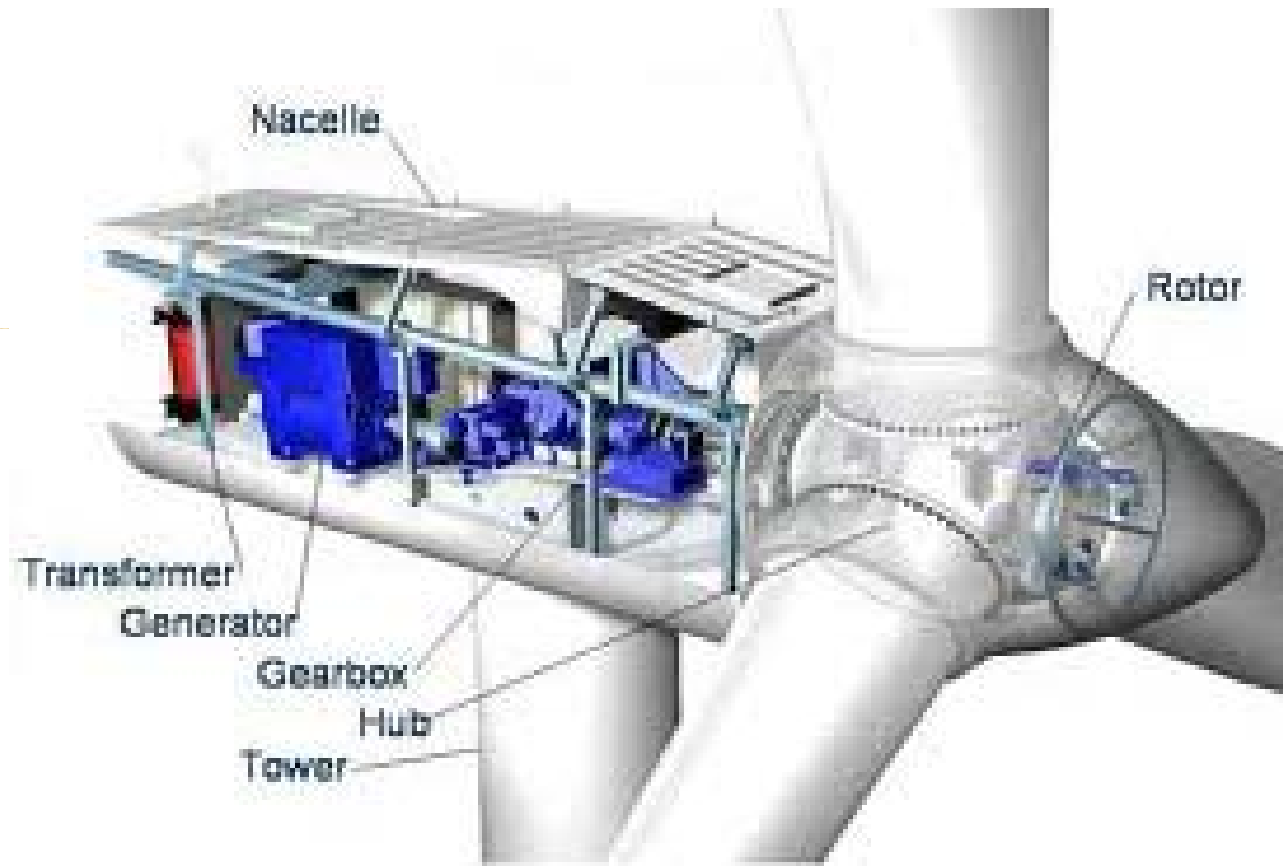
Wind ... on the blades



*Various Wind
Turbine Designs*



Wind ... on the blades



Wind ... on the blades



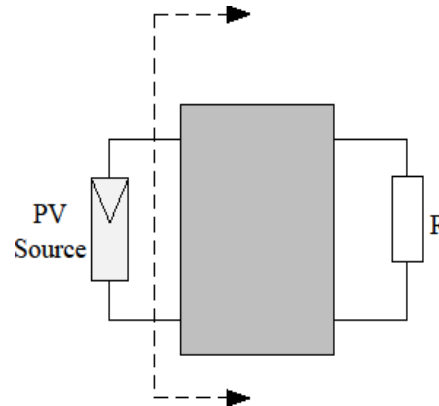
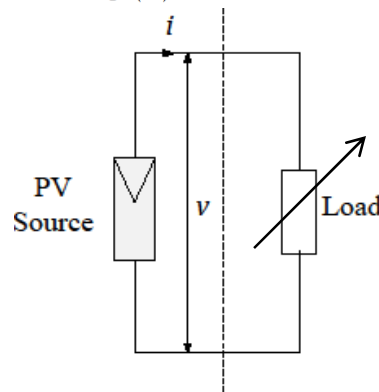
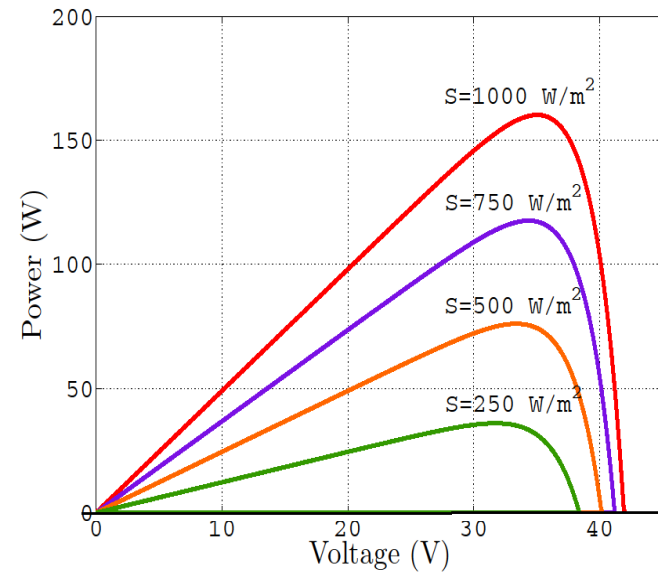
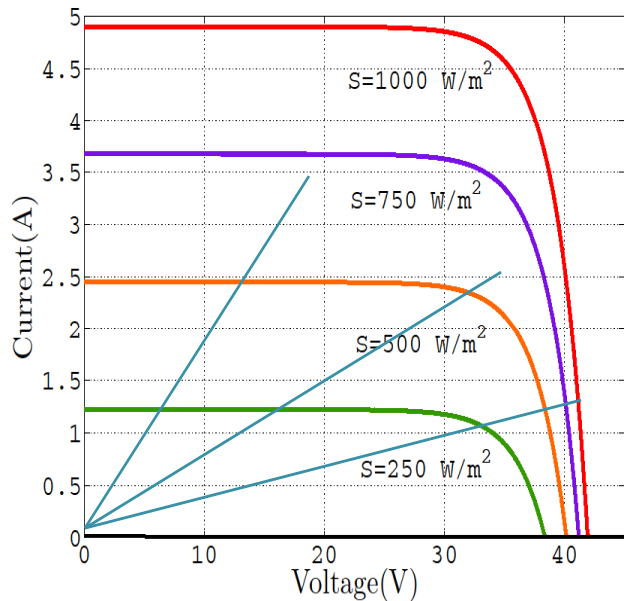


SOLAR PHOTOVOLTAICS

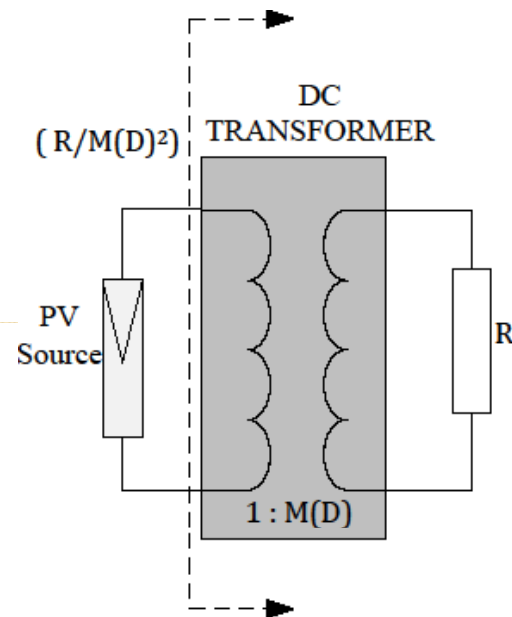


**WE THE ELECTRICAL
ENGINEERS**

PV – The MPPT Concept

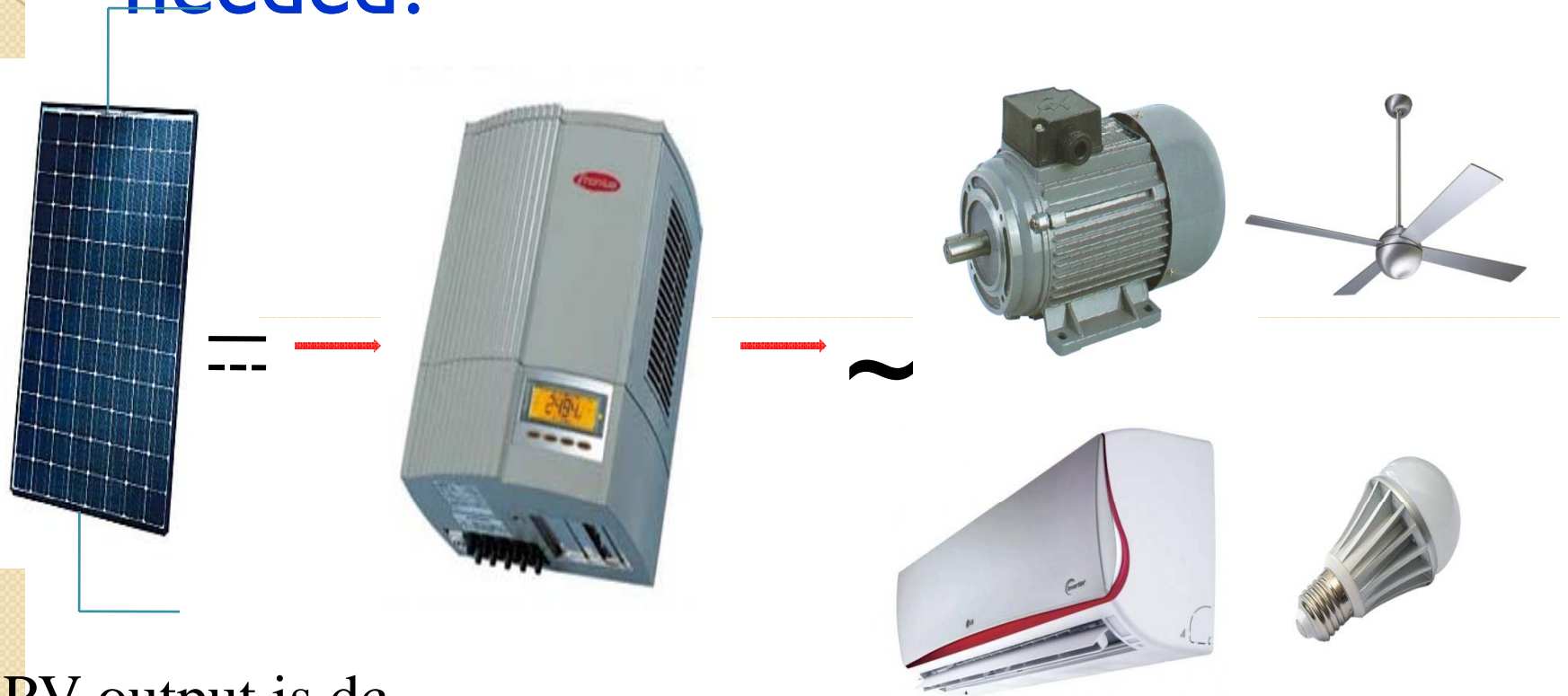


PV – The MPPT Concept



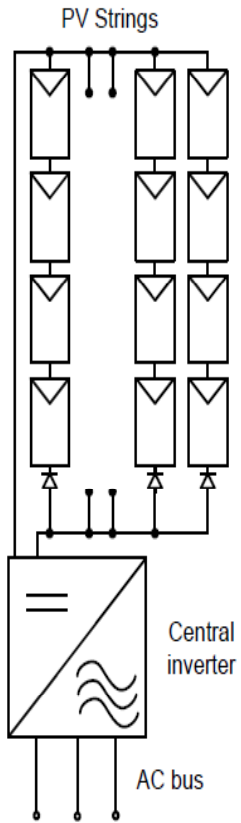
- MPP operation ensures maximum energy harvest
- Important as PV cells have low conversion efficiency($\sim 15\%$)

PV inverters – Why are they needed?

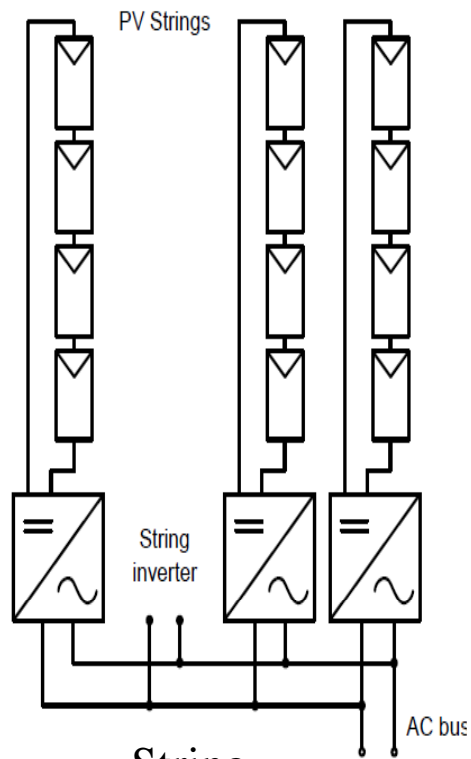


- PV output is dc
- Majority of consumer loads are ac
- Distribution systems are ac

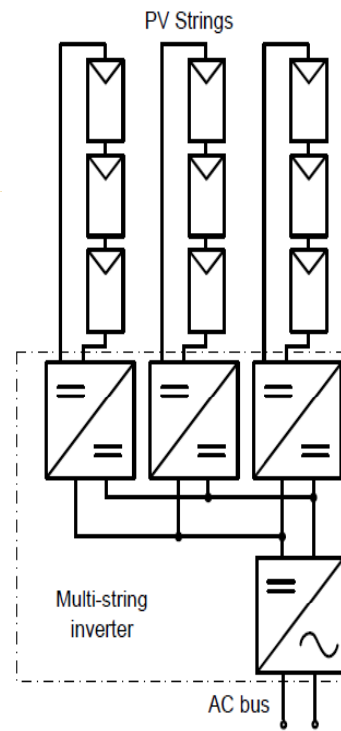
PV inverters -Types



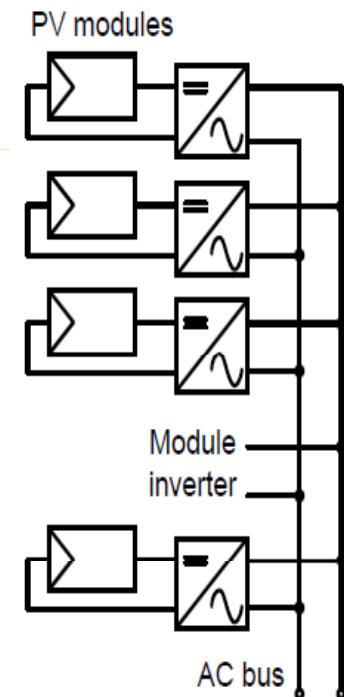
Central



String



Multi-string



Module-integrated

PV inverters -Types



Central/String inverter



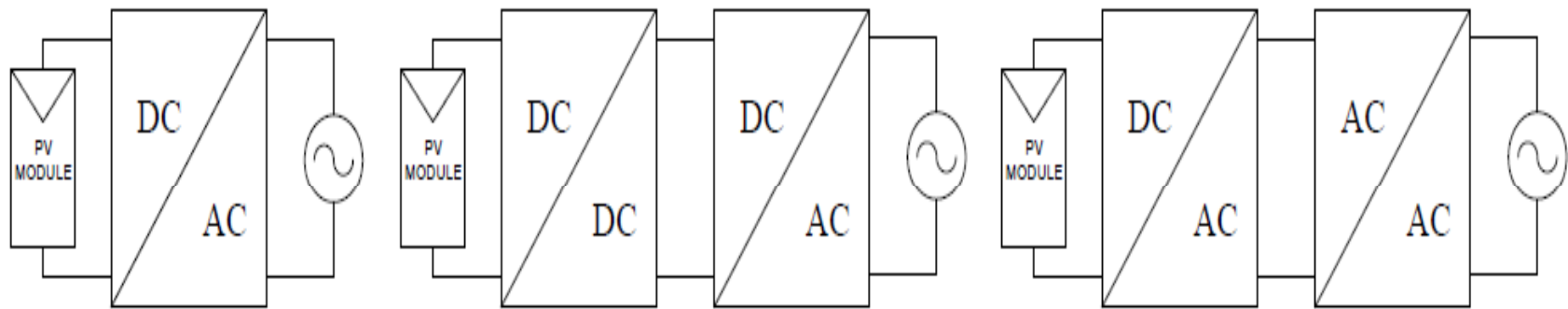
Microinverter

PV inverters –Microinverters

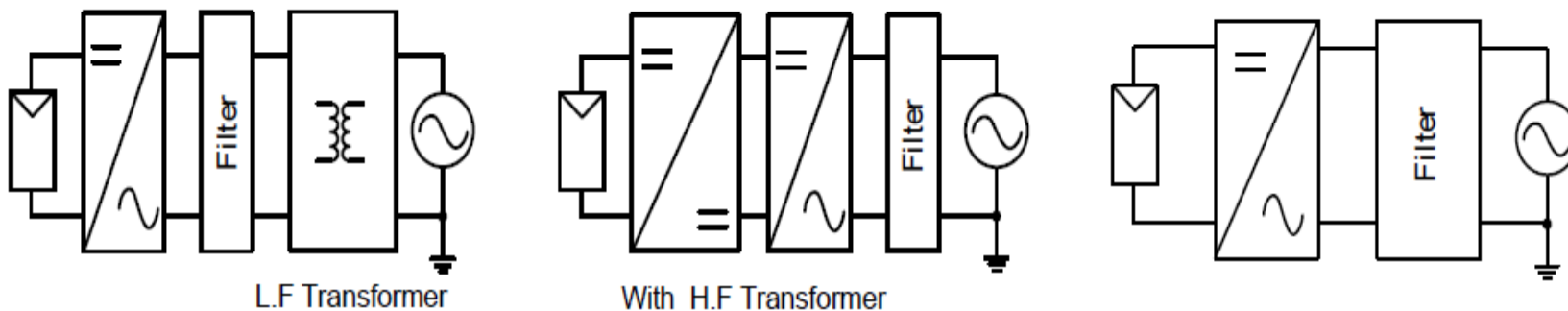
- Individual MPPT possible
- High voltage dc cabling absent
- Improved reliability
- Higher voltage boosting necessary

PV inverters –Types

- Single-stage / two-stage



- Isolated / non-isolated

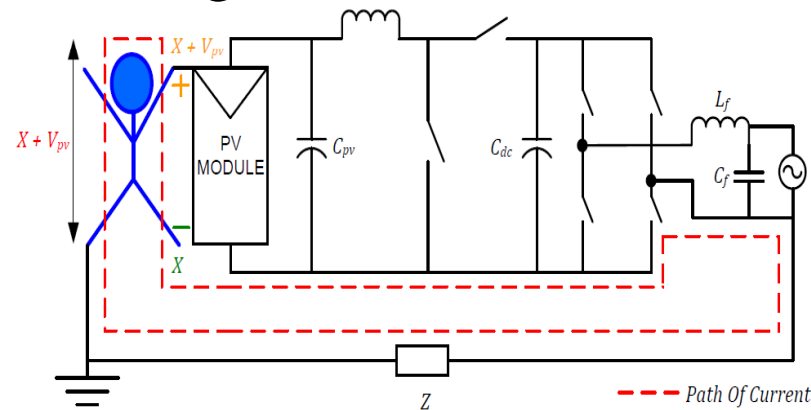


Grounding

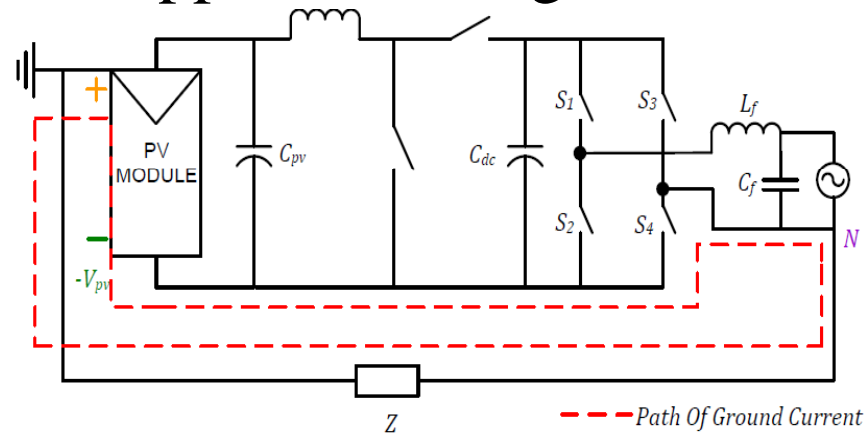
- To enhance personnel safety and minimize the effect of lightning surges on equipment
- **System grounding** – connecting electrical terminal to ground (e.g. negative or positive of a dc array, neutral of a split-phase system)
- **Equipment grounding** – connecting metal parts to ground (e.g. metal enclosure, module frame)

Grounding – System Grounding

- **Motivation** - mitigation of shock hazard

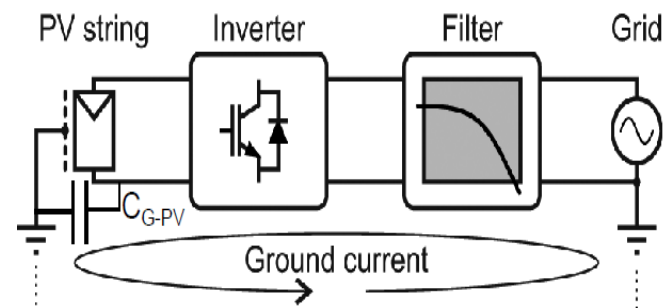
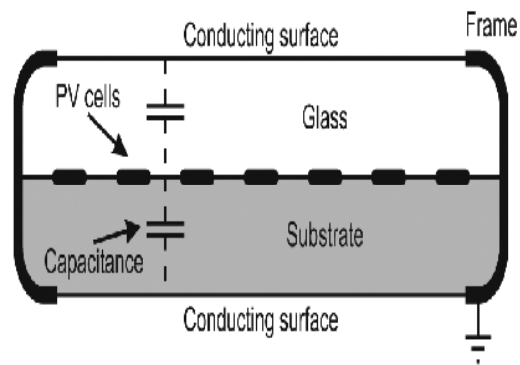


- **Repercussion** – appearance of ground current



Grounding – Equipment Grounding

- **Motivation** – relaxation of system grounding norm
- **Repercussion** – appearance of parasitic capacitance and ground current

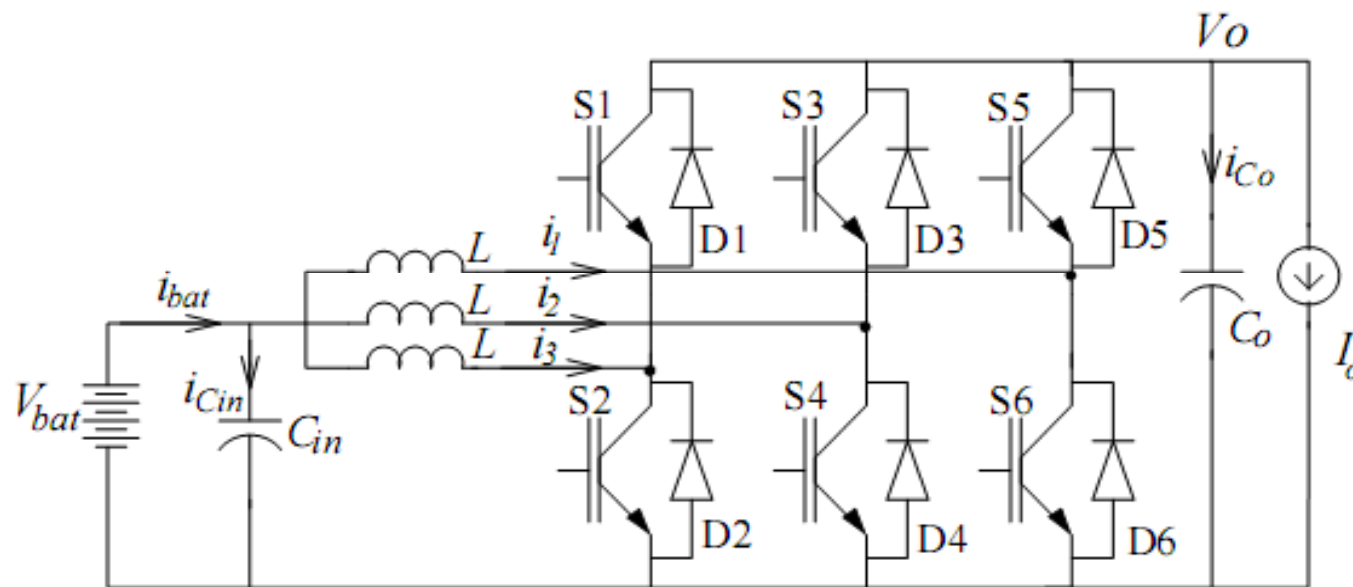


- Ground current increases losses, grid current distortion and EMI

The Battery Interface Module (BIM)

Salient features

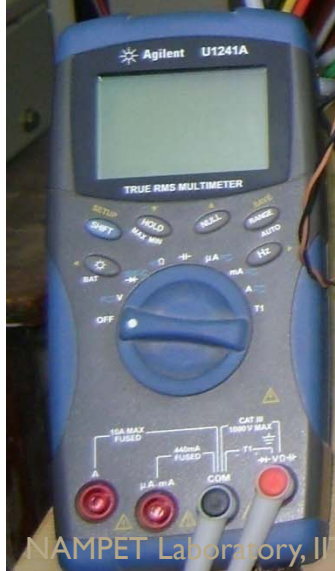
- Bi-directional
- Structurally the same as a VSI
- Compatible with the battery bank and DC bus ratings of a typical distributed generation system
- Modular- IPOP connected



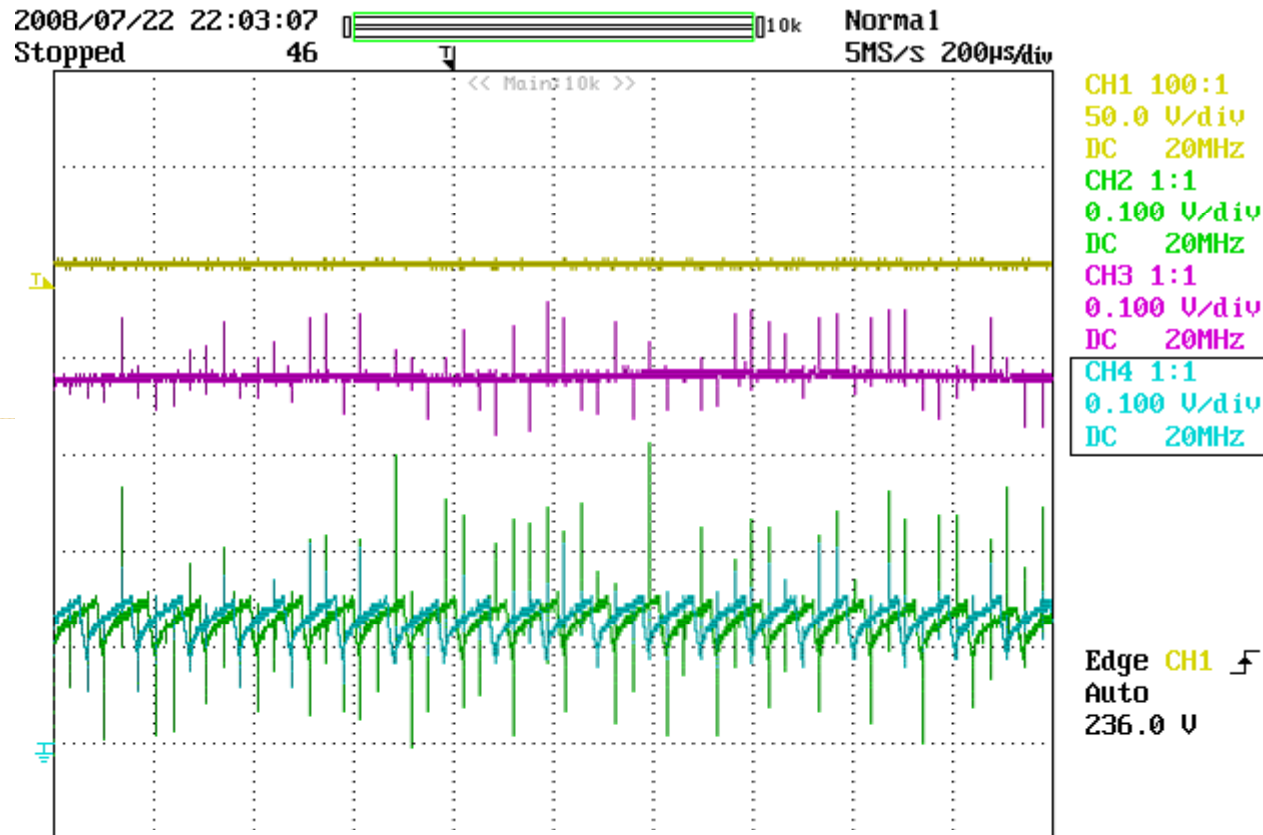
PROTECTION
CARD

BIM

LED Card

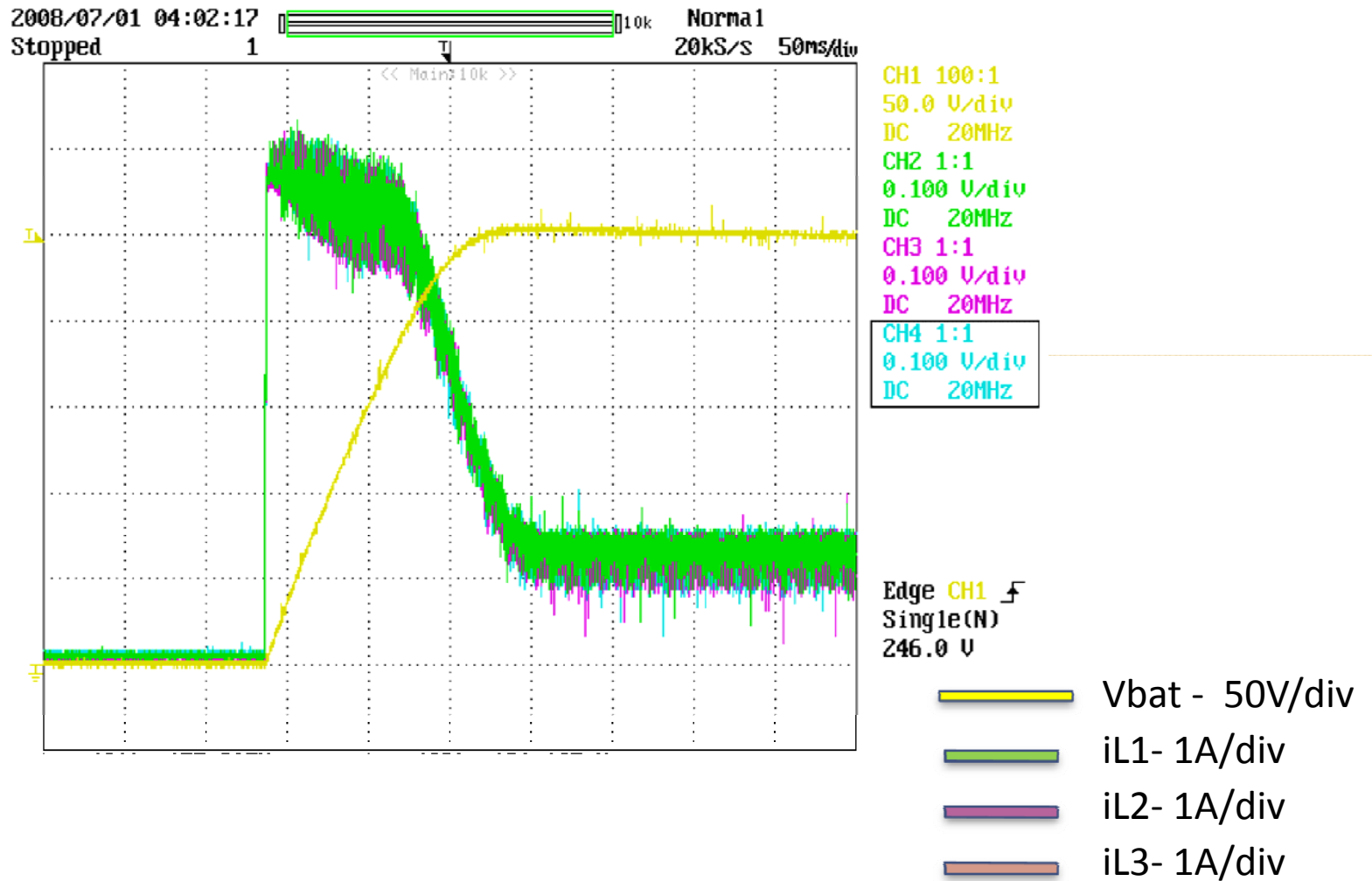


Constant Current Charging



- Vbat - 50V/div
- iL3- 1A/div
- Ibat- 1A/div
- iL1- 1A/div

Constant Voltage Charging





THANK YOU
