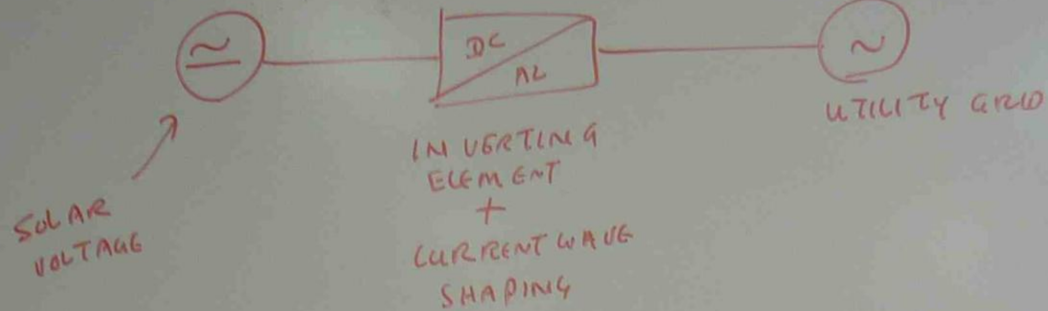
GRID CONNECTED INVERTER TOPOLOGIES

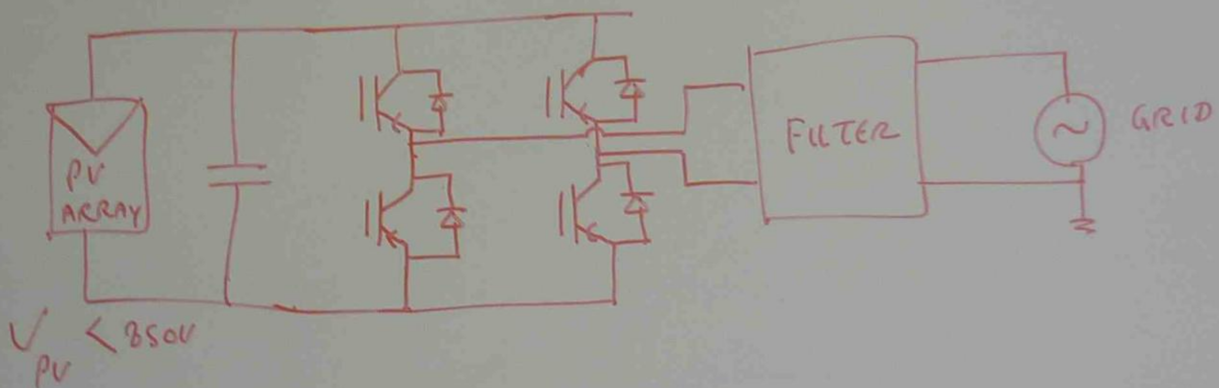
AN INVERTER HAS TO FULFILL THREE FUNCTIONS IN ORDER TO FEED ENERGY FROM A P.V ARRAY INTO THE UTILITY GRID.

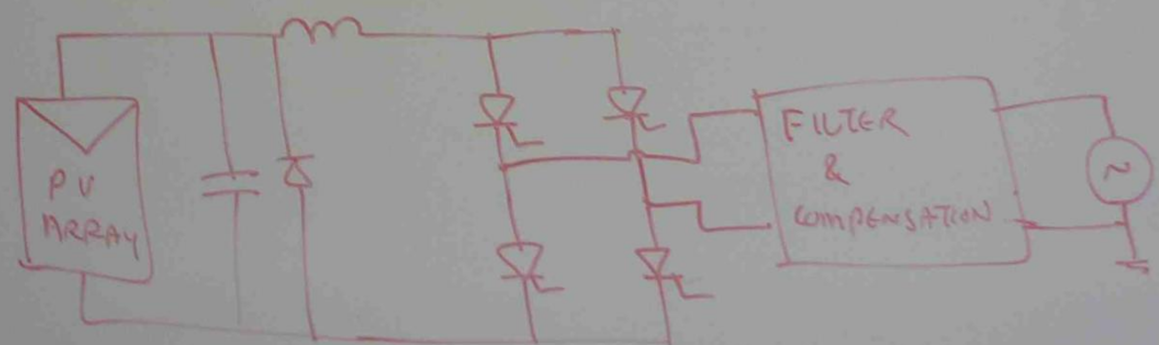
1. TO SHAPE THE CURRENT INTO A SINUSOIDAL WAVEFORM
2. TO INVERT THE CURRENT INTO AN AC CURRENT
3. IF THE P.V ARRAY VOLTAGE IS LOWER THAN THE GRID VOLTAGE, THE P.V ARRAY VOLTAGE HAS TO BE BOOSTED WITH A FURTHER ELEMENT.

※ SYNCHRONISATION.

TRANSFORMERLESS PV INVERTER

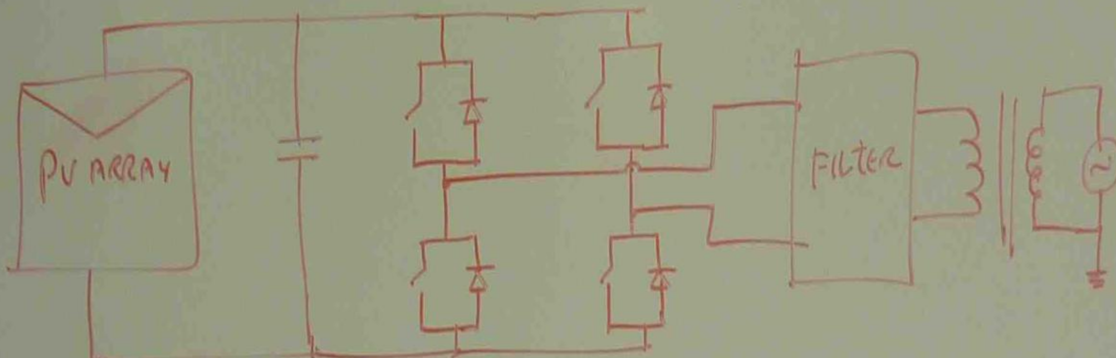




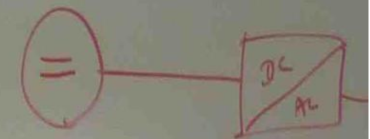


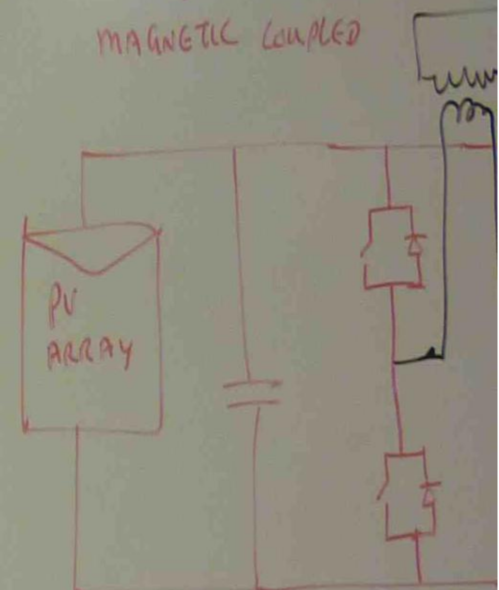
P.V INVERTER WITH FREQUENCY TRANSFORMER

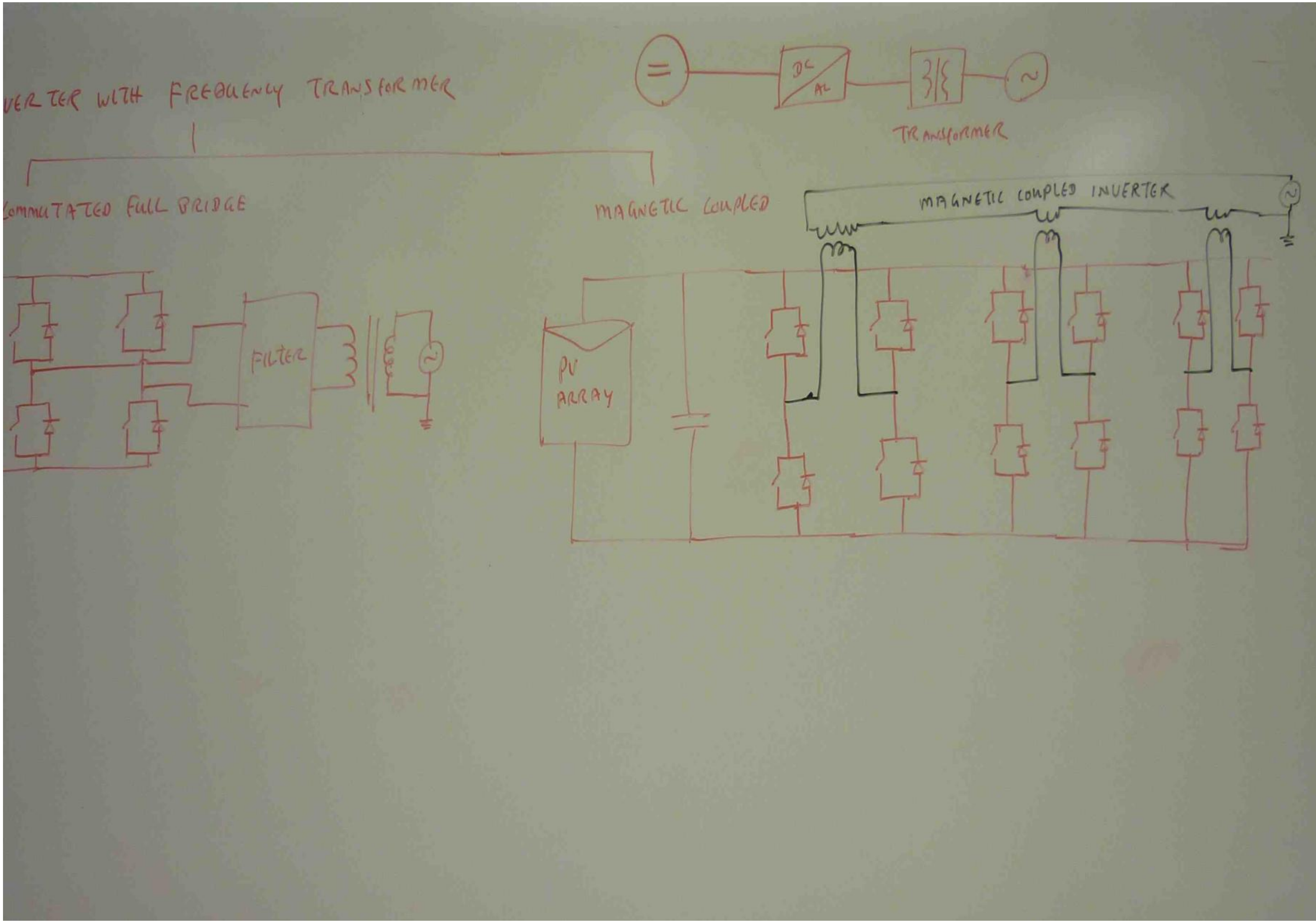
SELF COMMUTATED FULL BRIDGE



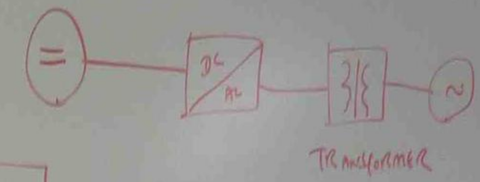
MAGNETIC COUPLED





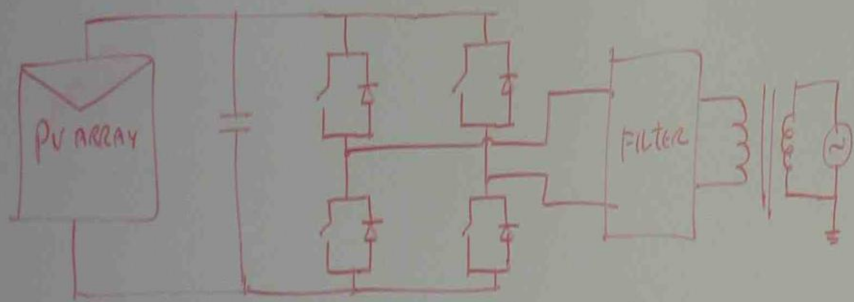

VERTER WITH FREQUENCY TRANSFORMER
OMMUTATED FULL BRIDGE
MAGNETIC COUPLED
DC
AC
TRANSFORMER
MAGNETIC COUPLED INVERTER
FILTER
PV
ARRAY

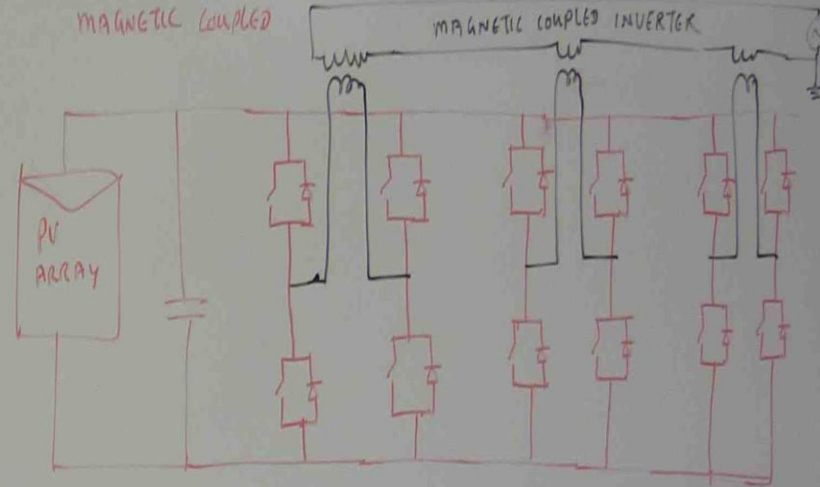
P.V INVERTER WITH FREQUENCY TRANSFORMER



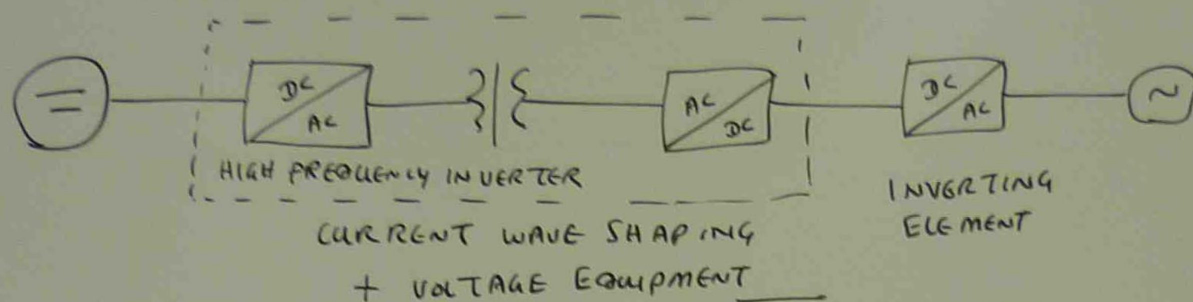
SELF COMMUTATED FULL BRIDGE

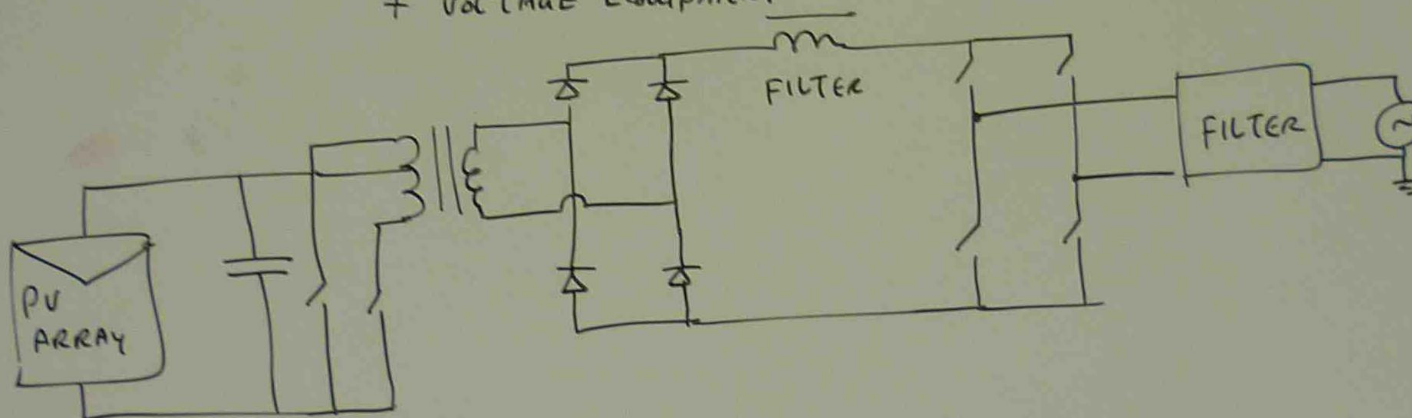
MAGNETIC COUPLED



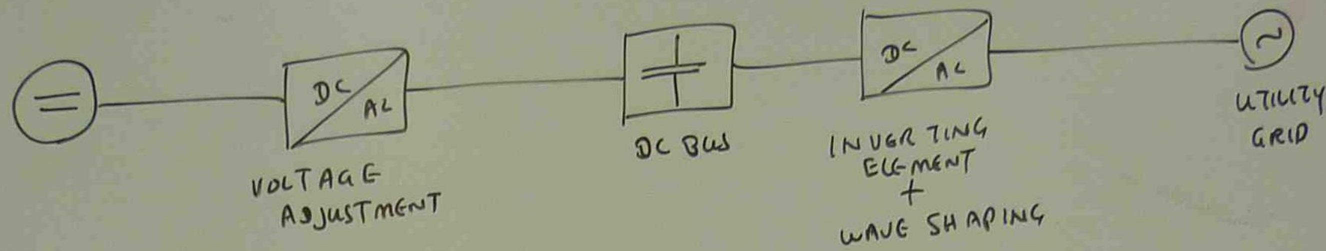


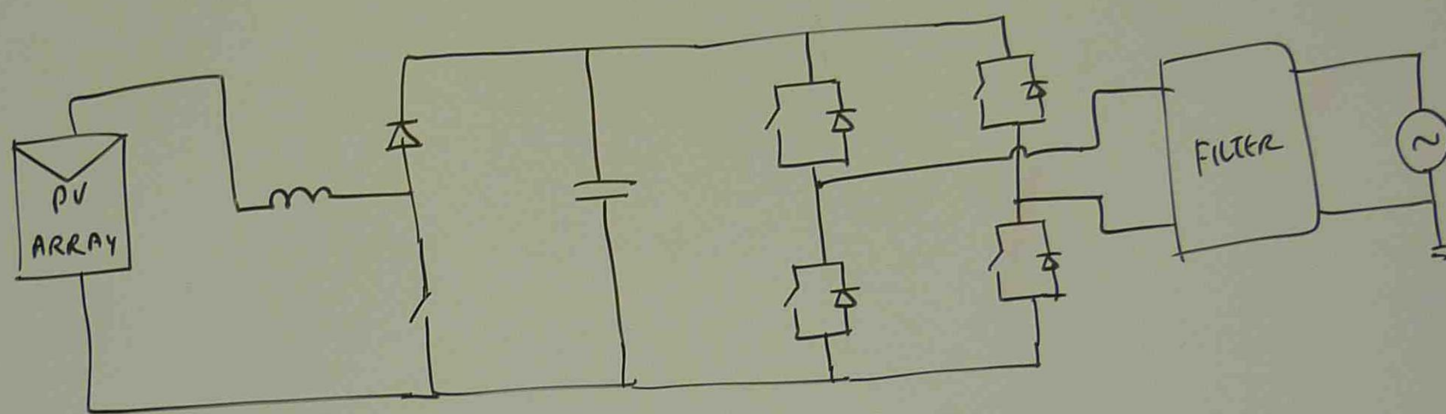
PV INVERTER WITH SEVERAL CONVERSION STAGE AND HIGH FREQUENCY TRANSFORMER





TRANSFORMERLESS PV INVERTER WITH SEVERAL CONVERSION STAGES INCLUDING BOOST STAGE

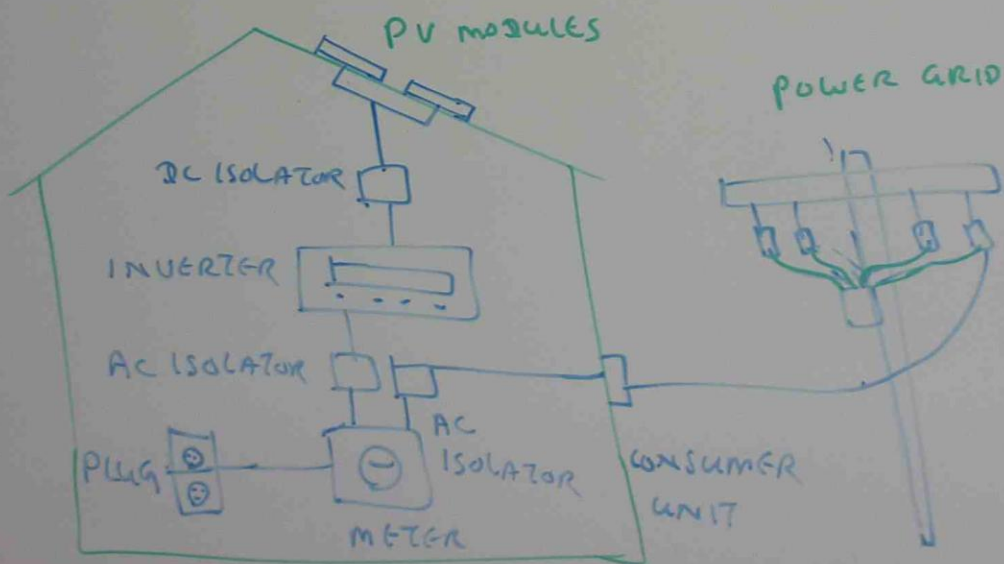




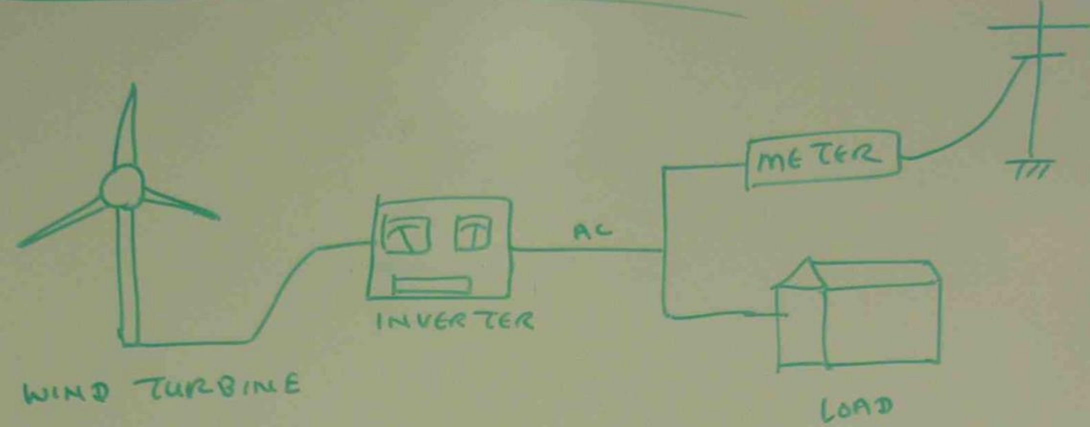
CONFIGURATION AND STANDARDS FOR GRID CONNECTED P.V SYSTEM

GRID CONNECTED PHOTOVOLTAIC SYSTEMS ARE THE MOST COMMON TYPE OF GRID CONNECTED SYSTEM. AS ELECTRICITY PRODUCED DURING THE DAY TIME IS EITHER USED (OR) DIRECTED BACK INTO THE ELECTRICITY GRID, AND AT NIGHT, ELECTRICITY IS PURCHASED FROM THE GRID. THERE IS NO NEED FOR AN EXPENSIVE BATTERY BANK.

GRID CONNECTED PV SYSTEM



WIND TURBINE GRID CONNECTED SYSTEM



RENEWABLE ENERGY DEVICES SUCH AS P.V MODULES AND WIND TURBINES ARE ALSO BEING USED ON A SMALL SCALE IN AREAS WHERE THE ELECTRICITY GRID IS AVAILABLE.

THE OUTPUT FROM THE RENEWABLE ENERGY CONVERSION DEVICE IS EXPORTED TO THE GRID AFTER BEING CONVERTED TO AC AT CORRECT VOLTAGE AND SYNCHRONIZED WITH GRID FREQUENCY DURING TIMES OF EXCESS SUPPLY.

GRID CONNECTED INVERTERS STANDARDS TESTING

STANDARDS AUSTRALIA HAS RELEASED THREE STANDARDS WHICH ARE PERTINENT TO GRID-CONNECTED INVERTER SYSTEMS. THESE ARE

AS 4777.1 - 2002 GRID CONNECTION OF ENERGY SYSTEM VIA INVERTERS PART (1): INSTALLATION REQUIREMENTS.

AS 4777.2 - 2002 - GRID CONNECTION OF ENERGY SYSTEM VIA INVERTERS PART(2): INVERTER REQUIREMENTS

AS 4777.3 - 2002 - GRID CONNECTION OF ENERGY SYSTEM VIA INVERTERS PART(3): GRID PROTECTION REQUIREMENTS.

INVERTERS MUST BE TESTED AGAINST AS 4777.2 - 2002 BY AN APPROPRIATE LABORATORY ACCREDITED TO TEST TO AS 4777 (CLEAN ENERGY COUNCIL: 2008).

MPPT (MAXIMUM POWER POINT TRACKING)

WITH RESPECT TO GRID CONNECTED INVERTERS, MPPT IS A METHOD OF FORCING THE SOLAR PANELS TO PROVIDE THE INVERTER WITH THE HIGHEST POWER IT CAN.

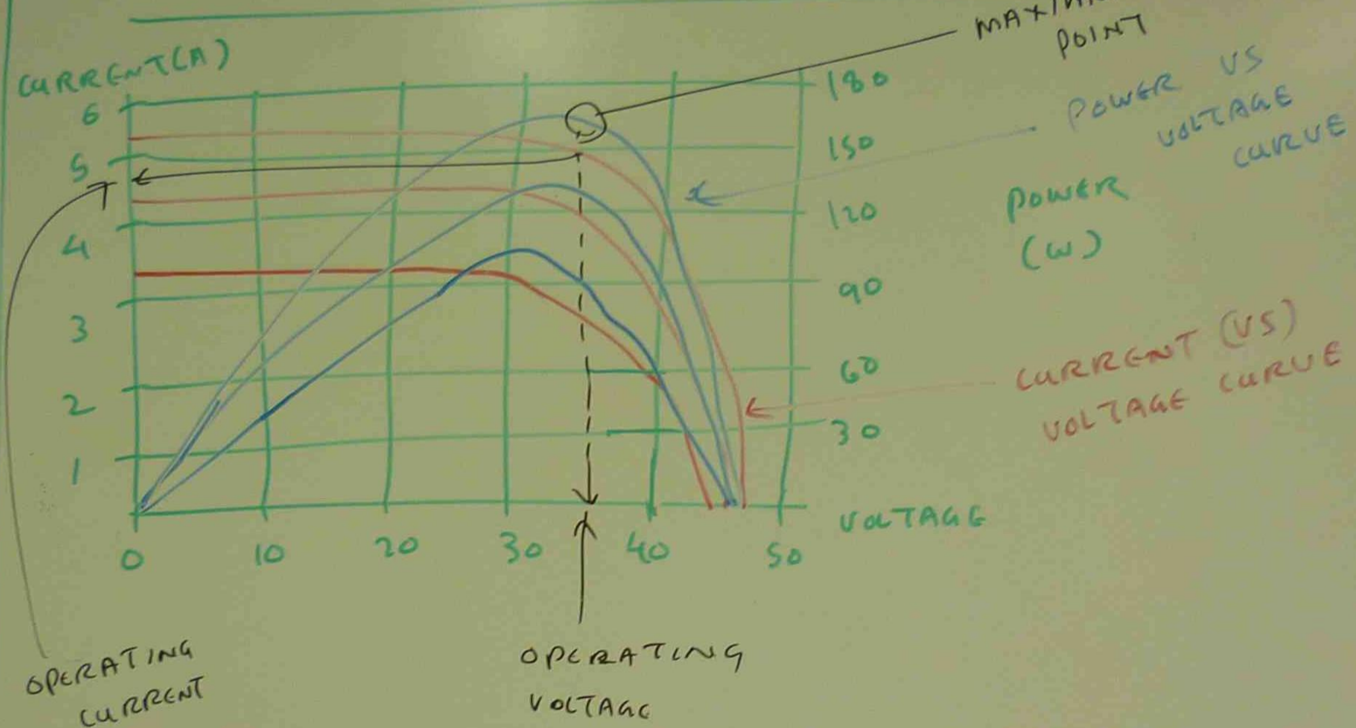
VOLTAGE RATING OF SOLAR PANELS FOR REMOTE AREA POWER SUPPLY SYSTEM

SOLAR PANELS ARE DESIGNED TO PROVIDE 48V (OR) 96V WITH BATTERY PANELS.

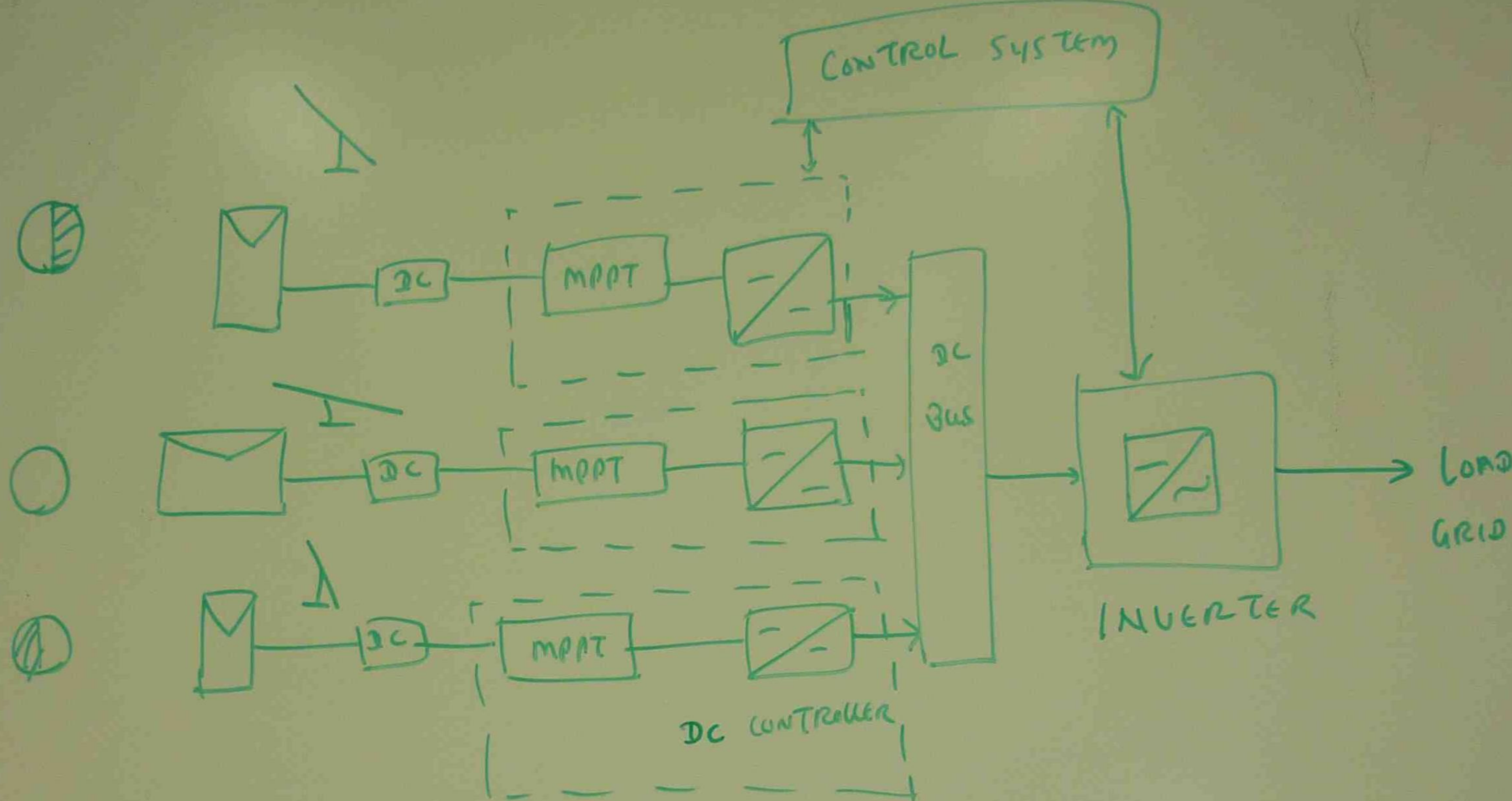
PROTECTION

ISLANDING PROTECTION – THE SUPPLY FROM SOLAR PANEL TO GRID MUST BE OFF WHEN THE GRID POWER IS SWITCHED OFF.

TYPICAL SOLAR PANEL IV CURVE

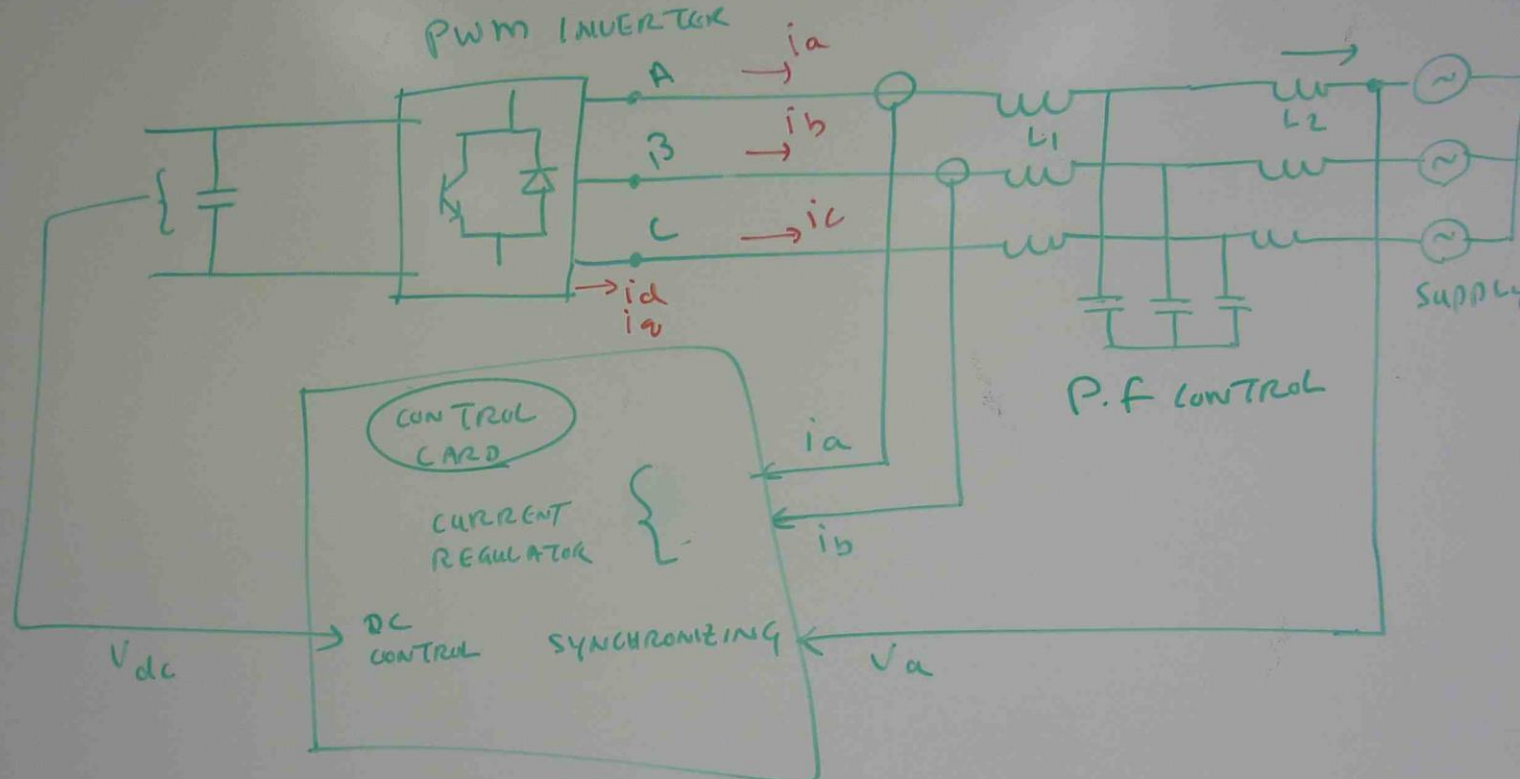


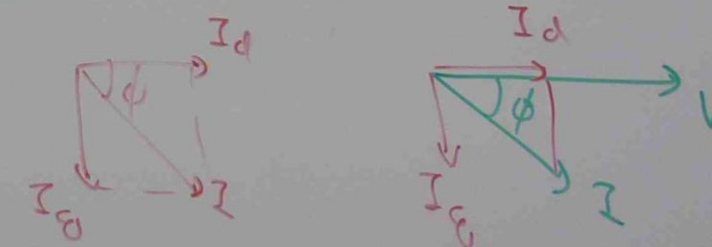
VOLTAGE JUMP, VOLTAGE DROP ARE ALSO REQUIRED TO MONITOR.



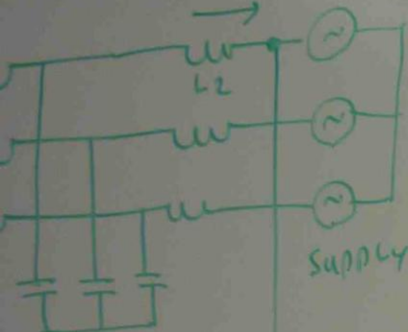
MULTI STRINGS P.V INVERTER SYSTEM

GRID CONNECTED P.V SYSTEM CONTROL SYSTEM

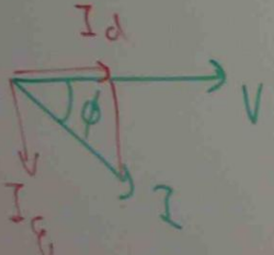




SYSTEM



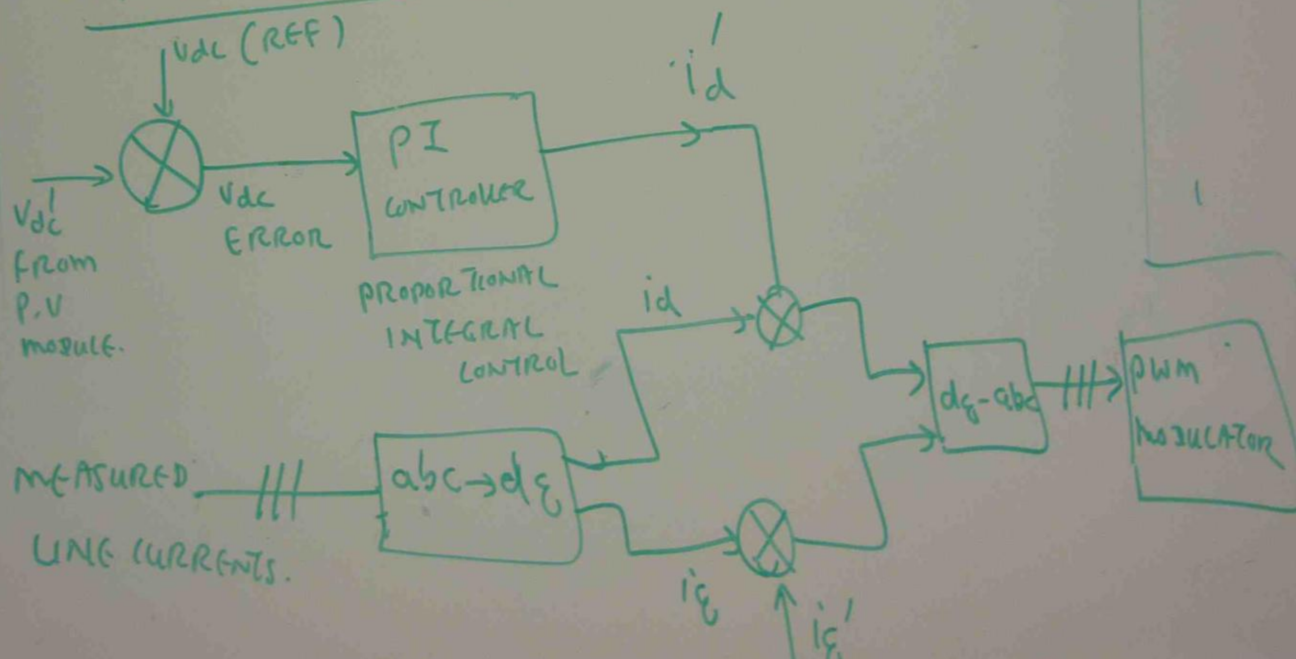
P.F CONTROL



MATHEMATICAL MODELLING FOR SYNCHRONOUS TRANSFORMATION

$$\begin{bmatrix} i_d \\ i_q \end{bmatrix} = \sqrt{\frac{2}{3}} \begin{bmatrix} \cos\theta & \cos\left(\theta - \frac{2\pi}{3}\right) & \cos\left(\theta + \frac{2\pi}{3}\right) \\ \cos\theta & \sin\left(\theta - \frac{2\pi}{3}\right) & \sin\left(\theta + \frac{2\pi}{3}\right) \end{bmatrix} \begin{bmatrix} i_a \\ i_b \\ i_c \end{bmatrix}$$

SYSTEM MODELLING – SWITCHED MODE



PWM

RA

SWITC

ACSUPP

AC FI

INVER

SUPP

SH

D

25

PARAMETERS OF GRID CONNECTED POWER INVERTER

$$\begin{matrix} \frac{2\pi}{3}) \\ \\ \frac{2\pi}{3}) \end{matrix} \Bigg] \begin{bmatrix} i_a \\ i_b \\ i_c \end{bmatrix}$$

PWM CONVERTER

RATING - ———— 10KVA

SWITCHING FREQUENCY ———— 5 KHZ

AC SUPPLY VOLTAGE

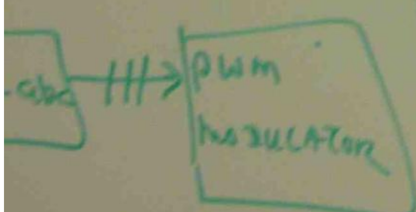
— 415V (LINE TO LINE)

AC FILTER

INVERTER INDUCTANCE (L_1) - 6.5 mH

SUPPLY INDUCTANCE (L_2) - 1mH

SHUNT CAPACITANCE (C_f) - 15μF



DC LINK

DC VOLTAGE (V_{dc}) = 700V

DC CAPACITANCE (C_{dc}) = 2200μF.

REVIEW QUESTIONS FOR K035 TEST

1. SKETCH SIMPLE INVERTER CIRCUIT AND EXPLAIN THE OPERATION

2. SKETCH P.V MODULES & GRID CONNECTED SYSTEM

3. SKETCH FUNDAMENTAL SINE WAVE, SQUARE WAVE, 3rd HARMONIC AND 5th HARMONIC

4. EXPLAIN THE FOLLOWINGS
   (a) SINGLE INVERTER GRID CONNECTED SYSTEM
   (b) MULTIPLE INVERTER SYSTEM
   (c) POWER SURGE

5. WHY SINE WAVE INVERTER IS REQUIRED FOR SOME OF ELECTRICAL APPLIANCES AND NAME THE EQUIPMENTS REQUIRING SINE WAVE.

6. SKETCH 3ϕ INVERTER WITH STAR CONNECTED LOAD

7. EXPLAIN THE FOLLOWINGS
   (a) GRID CONNECTED INVERTERS
   (b) MODIFIED SINE WAVE INVERTER
   (c) PULSE WIDTH MODULATION
   (d) BUDDA OSCILLATOR
   (e) SINE WAVE GENERATOR

8. SKETCH GRID CONNECTED MICRO INVERTER AND INSTALLATION FOR RESIDENTIAL SYSTEM

9. SKETCH CARRIER SINE WAVE GENERATOR AND EXPLAIN IT.

6. SKETCH 3ϕ INVERTER WITH STAR CONNECTED LOAD

7. EXPLAIN THE FOLLOWINGS
   (a) GRID CONNECTED INVERTERS
   (b) MODIFIED SINE WAVE INVERTER
   (c) PULSE WIDTH MODULATION
   (d) 8038A OSCILLATOR
   (e) SINE WAVE GENERATOR

8. SKETCH GRID CONNECTED MICRO INVERTER AND INSTALLATION FOR RESIDENTIAL SYSTEM

9. SKETCH CARRIER SINE WAVE GENERATOR AND EXPLAIN IT.

10. SKETCH THE PRACTICAL CONNECTION OF PWM CONVERTER WITH COMPLETED COMPONENTS

11. SKETCH THE GRID CONNECTED INVERTER CONTROL DIAGRAM AND EXPRESS THE MATHEMATICAL MODELLING AND SYSTEM MODELLING - SWITCHED MODE