

Solution for Grid export Issue for Grid connected Photovoltaic Power Systems

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Abstract - This concept is suitable at unavailability of net-metering systems for captive consumption grid connected solar power plants. It presents an overview of the state of the art of grid export issue for PV inverters at low and medium level solar power plants, mainly intended for rooftop applications. The paper focuses on-site problem and challenges to stop the grid-export issue at under-loaded conditions of self consumers of grid-tied solar power plants. The topology without bidirectional inverters has big advantages like low cost, volume and maintenance. In addition, it often reaches higher priority than topologies with bidirectional inverters. Therefore the new concepts are important for future developments.

Keywords: Grid-export, Grid-connected, Irradiation, String inverters, Power relays.

1. INTRODUCTION

The solar energy becomes a more important contribution to the total energy consumed in the world. Today the contribution from photovoltaic (PV) energy compared to the other energy sources is very low, but due to decreasing system prices the market for PV systems is one of the most stable and fastest growing in the world. If this trend continues, PV will be one of the most important energy sources in the future. To maintain the

further spread of PV systems it is important to decrease the cost and valuable improvements can be made on the side of Grid connected PV-systems; at the same time improve the efficiency and reliability of these systems.

In the part of improvements in the grid connected system, the grid export issue overcome by using this simplest topology with very economical level at the place of bidirectional inverters and battery banks. It does not require any battery bank and it works at entire day (i.e. day time).

2. OVERVIEW AND STATE OF THE TOPOLOGY

The solar inverters together with PV-modules are treated as a system, if this system connected to grid supply, and then it is called as Grid connected system. PV-modules are connected in combinations of series and parallel configurations to get a higher power level for the PV system. Very common is a series connection of modules (the cells inside the modules are connected in series, too). The series connection of modules is called as string.

DC-voltages which are higher than the peak voltage of the grid (about 325 VDC min. for 230V-AC-grids) have the advantage that the inverter does not need to step up the voltage by a DC/DC-stage.

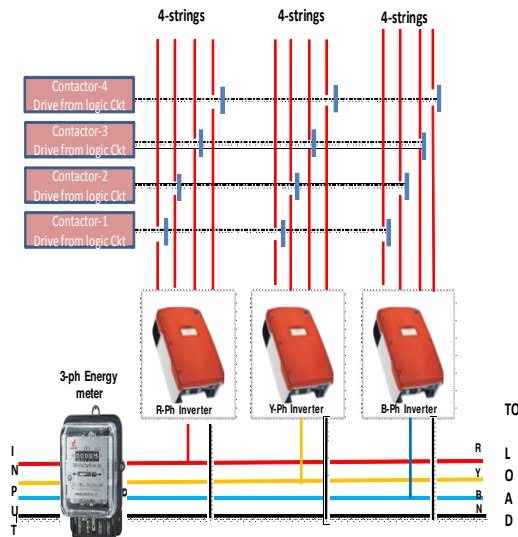


Fig.1. Configuration of topology arrangement.

The multistring inverters have often a very wide input voltage range which gives the user big freedom in design of his PV-system. This is why multistring-inverters have a good acceptance. An example is the inverter SB5000TL from SMA has input with a voltage range from 325 V to 550 V and a peak power of 5kW.

String inverter's connection arrangement shown in the figure 1. Basically it is a string-inverter with three (or four) inputs, in this concept the input strings are monitored / controlled by sun intensity-level in the entire day time, by using electronic circuitry.

3. FUNCTIONAL BLOCKS OF THE CIRCUIT

The automatic logic circuit (electronic circuitry) divided to three-sections:-

- Power Supply section.
- Irradiation amplifier & night-sleep section.
- Power-contactor/Relay driver section.

A) Power supply section: It is a power supply for entire circuit, to activate the components of electronic circuit, it consists,

- 1 Amp control transformer,
- Bridge / Centre taped full-wave rectifier,
- Filter capacitors with voltage regulators.

B) Irradiation amplifier & night-sleep section: This section will play vital-role in the circuit. The circuit diagram shown Fig.2, it consists,

- Irradiation amplifier section
- Night-sleep section.
- Irradiation amplifier section: The voltage drop across shunt resistance of SPV-cell is amplified in to millivolts to volts, to compare with V_r (3.3V ref. voltage) to switch-ON/OFF the relays/contactors, as per sun-intensity.
- Night-sleep section: This section will help to switch-OFF the relays / contactors in the night-time. It helps to increase the life of the power-contactors.

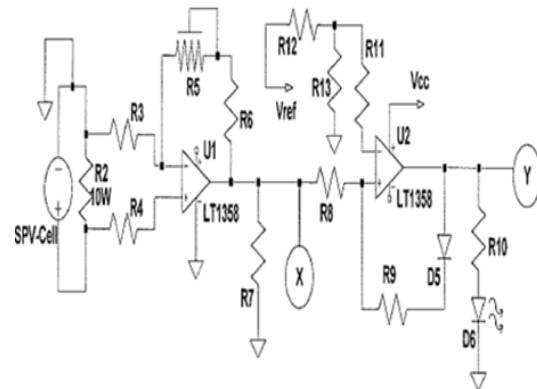


Fig. 2 Circuit diagram for Irradiation amplifier & night-sleep section.

C) Power-contactor driving section:
This section will switch-ON/switch-OFF the power contactors, to add or subtract the strings to the inverters. The Fig.3 shows the detailed circuit.

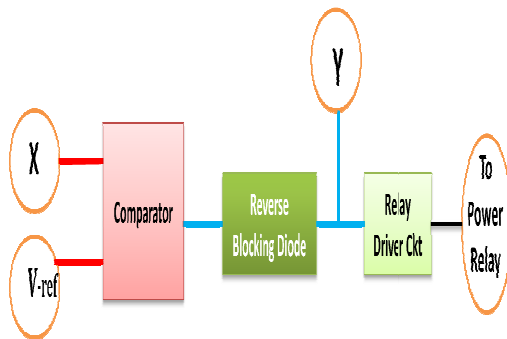


Fig. 3. Automatic logic relay driver circuit block diagram.

The main-components are:-

- LM 324 IC (for comparators)
- SL 100-NPN Transistors (to drive the 12V relays)
- 12V dc, 1C/O. 6Amps relays (to drive the power-contactors).

3.1. Case Study & Conditions:

If $P_{gen} > P_{Load}$, Case1 (To Grid export),

If $P_{gen} < P_{Load}$, Case2 (From Grid Consumption),

If $P_{gen} = P_{Load}$ Case3 (No export & No consumption).

Case1: (Grid export),

$$\text{If } P_{gen} > P_{Load} , \quad \text{----- (1)}$$

Where,

P_{gen} =PV energy generation in kWh,

P_{Load} =Energy consumption by load in kWh.

The above case defines that the PV generation of the grid tied system is generating more units then the load consumption units, it exports that extra units to grid lines via EB-energy (Non-netmetering / Unidirectional) meter.

Case2: (Grid Consumption),

$$\text{If } P_{gen} < P_{Load} , \quad \text{----- (2)}$$

In this case it defines that the PV generation of the grid tied system is generating less units then the load consumption units, it consumes the balance extra units from grid.

Case3: (No export & No consumption),

$$\text{If } P_{gen} = P_{Load} \quad \text{----- (3)}$$

It defines that the PV generation of the grid tied system is equal to the load consumption units.

3.2 . Comparison:

Case	Generation Units	Charge Units for	Acceptability
Caes1	If $P_{gen} > P_{load}$	Pay charge for export Units	Not acceptable
Case2	If $P_{gen} < P_{load}$	Pay charge for consumption Units	Acceptable
Case3	If $P_{gen} = P_{load}$	No charges	Acceptable

The case1 is not acceptable condition at generation is more than consumption. By using this topology, it will be balanced like case3 even at case1 conditions also.

3.2.1. The below table gives the difference with others proposed solutions.

Sl. No.	Existing Grid connected systems	New concept grid connected systems
1	The existing systems are compatible with grid connectivity.	Yes, this new concept also compatible with grid connectivity.
2	Not suitable for small and medium scale applications.	Perfect suitable for small and medium scale applications
3	Grid connection compulsory.	Grid connection Not required.
4	At under load conditions grid export issue will rise.	No export at any load conditions.
5	Bi directional meter required.	Not required bi directional meter.
6	The existing systems will not work with grid absents.	It will work even at grid failure /absent conditions also.
7	The existing systems are not a grid independent system.	It is grid independent system.

3.3. Power wiring:

It requires some modification in the stringing section. The strings are connected through power-relays. The connection diagram shown in the figure 1. As per sun-intensity the strings will added / subtracted to the inverters, to maintain approximately constant power from the strings.

Most of the issues will be resolves with this new-proposed solution. We can charge the batteries in the day-time; utilize it as a backup in the night time for some loads.

No power will be export to the grid with this solution (it is the major issue). As per this concept, it does not require any

Bidirectional inverters, AS-Box and other stuff etc.

It has a SPV-string management solution. As per sun-irradiation, the inverter's strings will come into picture. It monitors the sun-Irradiation, as per sun intensity, the strings will added or subtracted to the string Inverters.

4. CONCLUSION

PV-systems offer a wide range of possibilities and configurations for the use of power electronic converters. This given topology and the technology are presented as promising for the future. Future work will be, to improve the topologies with special respect to the real utilization.

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