# The dc nanogrid architecture

Design, Architecture

The schematic of the DC nanogrid architecture scheme is shown Fig 1. All the subsystems such as DC nanogrid power converter, AC-DC converter, MPPT based solar PV converter battery bank, nanogrid controller, protection and distribution unit are incorporated in a rack (DC nanogrid power rack) in a compact fashion, the Nanogrid controller acts as the master controller of the system, the 48 V DC power lines from DC nanogrid rack is distributed to various rooms in the home (here the rooms are three). The local control in each room section is achieved by corresponding room controllers which is configured as slave controllers. All the internal communications are by means of CAN-Controller area network (wired) and external communications are enabled through Zigbee channel. An android tablet with Zigbee interface is configured to facilitate smart home features in DC nanogrid home. The detailed DC nano grid control architecture is depicted in Fig 1 and Fig 2.

In addition to the power architecture two communication layers also integrated in the system for enabling effective communication viz. CAN (Controller area network) and Zigbee. The subsystems in the DC nanogrid power rack are interconnected through CAN bus and instantaneously taken up by Nanogrid controller (Master controller) which is responsible for overall control of the system. In rooms, the room controller and subsystems (under the particular room controller such as power socket, switch etc.) are also interconnected by means of CAN bus. These wired communications constitutes the internal communication in DC nanogrid system. The external communication between Nanogrid controller and room controllers is enabled through Zigbee channel, the Zigbee nodes in master (DC nanogrid system

controller) and slaves (room controllers) will perform wireless communication over the DC nanogrid architecture.

Nanogrid controller is the Master Controller in the DC nanogrid system. It control and manages the DC nanogrid system. It communicates with the other nodes in DC nanogrid communication network, like DC nanogrid power converter, AC-DC controller through CAN bus. Dc nanogrid Controller is also having Zigbee channels to communicate to outside network under room controller such as power socket, power switch. CAN (Controller area Network) is increasingly used in home automation and other areas, so CAN network is consider for DC nanogrid network. The power management and control strategy of the complete system is programmed in the digital controller. The digital controller used is dsPIC from microchip family. PIC microcontrollers enable easy network connectivity and cost effective embedded designs. The main controller board with dsPIC33FJ256GP710 Room controller is programmed to manage and control the respective zone, being a slave controller it takes up the command from Nanogrid controller through Zigbee node, the subsystems comes under the room controller viz. power socket and power sockets are connected with the controller through CAN bus (internal communication) DC nanogrid power converter module is the main converter in DC nanogrid system which also includes MPPT based solar converter and bidirectional DC-DC converter (BDC), DC nanogrid battery system composed of the power circuit and the control circuit. The bidirectional DC-DC converter plays a key role for the system controlling the charging and discharging Modes of the battery, correspondingly the buck and boost modes of the converter. The microcontroller controls the

operations of the converter based on the voltage and current parameters of both the 48Vdc DC bus side and the 48Vdc battery side. From the DC nanogrid system point of view this controller acts as the local controller connected to the Nanogrid controller through a communication network based on CAN open standard. The control circuit consists of a DSP control board, voltage & current sensor and interface board and the IGBT isolated driver circuit board. DSP TMS320F28234 is the core of the control system, by using its built-in A/D converter, converts the analog value, obtained from the voltage & current sensor board which reads the voltage and current of both the 48V battery side and the 48V DC Bus side, to digital form as feedback. This value is compared to set references to compute the corresponding duty cycle for the Buck and Boost Modes to produce the PWM waveforms at the set switching frequency.

DC nanogrid at home may allow for easier integration of renewable energy source like solar. A boost Converter topology along with the buck converter topology is used for the power conversions. MPPT algorithm is used to track maximum amount of power. Battery bank stores the excess power generated during the peak sunlight hours, and supplies it to the load at night or in cloudy weather conditions. Boost Converter topology along with the buck converter topology is a better choice for the solar converter, as it can generate a stable 48V DC bus distribution voltage with different solar panels. This converter is interfaced with the DC nanogrid Controller through a DC nanogrid communication network.

48 V, 42 Ah Lead acid battery unit is used for energy storage option for the DC nanogrid system. It is connected to the 48V DC bus through a bidirectional DC-DC Converter which controls the power flow to and from the battery, deciding the modes of operation – charging (boost mode) and discharging (buck mode).

DC nanogrid power socket/switch is an intelligent outlet that has the ability to measure and control electrical devices plugged /connected in this socket. Each socket is having power line and DC nanogrid data line. A device when it is plugged into this socket, power and data lines will get interfaced. A key benefit of this socket is more efficient usage of energy, resulting in decreased costs. This socket provides a 48V, 5 V (Power USB) stable DC output. Using the energy manager in the DC nanogrid controller, all equipment plugged in to the power socket can be turned on or off remotely. This power socket will be made for different power ratings such as 100W, 200W, 500W etc.