6.1 SUMMARY OF RESEARCH WORK

In this chapter, a summary of the work reported in the thesis and major contributions are presented. This chapter concludes with the suggestions for the future work that can be carried out in this area.

The research work started with the design of a novel SSIFB converter for remote power solutions. The performance under the boost and buck mode was studied on the implemented prototype. Its input voltage was varied from 60V to 90V and output voltage was 112.5V for boost mode and 61.5V for buck mode. Load variation was between 80W to 120W. The main switches $S_a$ and $S_b$ used ZVS turn on and voltage stress on all switches were equal to the sum of input and output voltages. This configuration had smaller current stress on switches. ZVS was achieved by a single component (i.e.) one auxiliary inductor $L_r$. Hence, the losses in resonant circuit were reduced. An efficiency of 89.11% was achieved in the buck mode and 89.5% in the boost mode and the proposed SSIFB converter topology was found to have good regulation characteristics for input voltage variations and the changes in the load.

Later, the most frequently used Maximum Power Point Tracking algorithms viz., OCV, P&O and INC techniques were studied on a PV system with Soft Switched Interleaved Flyback converter (PV- SSIFB) used for
remote power solutions. The steady state performance of each of the MPPT algorithms has been investigated for different irradiations ranging from 0.15 KW/m² to 0.9KW/m² and compared in terms of tracking speed, accuracy, and MPPT efficiency. The suitability and limitations of all three proposed algorithms were analyzed using simulation and validated by hardware results obtained on 100W PV- SSIFB converter prototype. It was observed that the MPP tracking speed of direct methods viz., P&O and INC techniques were almost same ranging from 0.038 sec to 0.085 sec. OCV method was slower than direct methods with tracking speed ranging from 0.082 sec to 0.12 sec. Also it has been noted that both P&O and INC techniques provided higher efficiency at medium and high irradiations when compared to OCV method. Though implementation of P&O method was simpler than INC method, it incurred additional power loss due to the oscillations at MPP. Maximum efficiency reached by INC and P&O methods at higher irradiations of 0.9KW/m² was 98.26% and 93.47% respectively. OCV MPPT method was more suitable for lower irradiations and provided an efficiency of 96.1% at irradiation of 0.3 KW/m². Thus it is concluded that OCV MPPT method provides an effective MPP tracking at low irradiations up to 0.35KW/m² and INC MPPT method offers the better steady state performance at medium and higher irradiations above 0.35KW/m².

Next, a novel LOCV-VSS-INC method based HMPPT controller has been proposed for a PV-SSIFB system. The performance of the system has been verified by simulation results and validated by experimental results. The steady state performance has been analyzed for low and high irradiations ranging from 0.15 KW/m² to 0.9KW/m². The dynamic performance has been evaluated by rapidly varying the irradiation from 0.3 KW/m² to 0.9KW/m² and load from 150Ω to 100 Ω. It is observed that, on comparison with the conventional FSS-INC and OCV MPPT methods, the proposed HMPPT algorithm exhibits the performance enhancement in terms of tracking time,
steady state oscillations, accuracy and efficiency. Tracking speed varies from 0.045 sec to 0.07 sec for constant irradiations and settles within 0.02 sec when a rapid change in irradiation and load occurred. The HMPPT controller provides an efficiency of 98.02 % even at the lowest irradiation of 0.15KW/m². The SSIFB converter, designed to have low current stress on active switches, shows an efficiency of 92 to 97% for different irradiation levels.

Finally, a Multi Objective Control Strategy (MOCS) was presented for the energy management of PV –SSIFB system. The proposed control strategy was implemented on 100W hardware model and its performance was investigated during charging and discharging modes of the batteries by varying the irradiations from 0.9KW/m² to 0.3 KW/m². Constant voltage and constant current mode of charging the batteries have also been studied by changing the load demand from 80% to 125% of full load demand at irradiation 0.9KW/m². It is observed that, during the constant voltage charging mode, the PV module had discarded the MPPT and the voltage reference was changed to higher value to balance the load and charging requirement. Thus the proposed control strategy optimizes the power flow between the PV modules, batteries and loads such that PV power is utilized effectively and battery was charged in all 3 charging modes viz., constant voltage, constant current and floating charge mode.

6.2 CONCLUSION

In this research work, a Solar Power Conditioner Unit for charging remote area portable electronic appliances and gadgets was designed using Soft Switched Interleaved Flyback (SSIFB) converter. To increase the performance of designed PV- SSIFB system, a novel LOCV-VSS-INC strategy based Hybrid MPPT controller was developed and investigated. Finally, for an efficient utilization of PV power and battery power in the
designed PV-SSIFB system, a multi objective energy management scheme was developed and implemented.

6.3 SCOPE FOR FUTURE WORK

The future focus areas and extensions of the present research work are listed below:

i. Deployment of PV technology to disaster and emergency management is a new trending area in research. An efficient Solar Power Conditioner Unit can be designed and implemented for trailer mounted mobile PV power systems that provide electricity to health clinics and communication systems at the disaster sites.

ii. Artificial intelligence based non-conventional MPPT approaches such as evolutionary or genetic algorithm method, Artificial Neural Network method and fuzzy logic method can be developed to track the MPP under normal, rapid changing and partial shading conditions.

iii. The feasibility and compatibility of other multi output, isolated DC-DC converter topologies such as push-pull, forward and bridge converters can be investigated for designing a Power Conditioner Unit for solar DC micro grids.