EXPRESSION OF INTEREST FOR TRANSFER OF TECHNOLOGY

Power Electronics Group

Centre for Development of Advanced Computing

Thiruvananthapuram

08-01-2026

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1. Introduction

Centre for Development of Advanced Computing (C-DAC) invites "**Expression of Interest**" (EOI) from Indian companies/firms , startups for transfer of technology (ToT) from C-DAC and to, acquire licenses, market, sell and deploy product on non-exclusive basis.

Through this EOI, sealed financial H1 bid is invited on behalf of M/s Technology Promotion Centre, C-DAC, Thiruvananthapuram from reputed firms / companies registered in India, with relevant experience / involved in manufacturing / installation/marketing / implementation of products through Transfer of Technology (ToT) and Licensing. Bidders from countries sharing a land border with India can participate in this EOI only if they are registered with the Department of Promotion of Internal Trade (DPIIT) of the Indian Government. This document details about the product, terms and conditions for companies to propose their Expression of Interest and how to enter into Transfer of Technology (ToT) agreement based on the terms given herein.

2. Brief about C-DAC

The Centre for Development of Advanced Computing (C-DAC) is the premier R&D organization of the Ministry of Electronics and Information Technology (MeitY), Govt. of India for carrying out R&D in IT, Electronics and associated areas. It is a National Centre of Excellence, pioneering application-oriented research, design and development in Electronics and Information Technology. The Centre has contributed significantly to the growth of the industry in general and the electronics sector in particular through the indigenous development of commercially viable systems and products, foreign technology absorption, adaptation and upgrades, consultancy and training and turnkey implementation of contract projects. The Centre has several firsts to its credits and is the recipient of prestigious national level awards for excellence in application-oriented R & D The Mission mode programmes of C-DAC include High Performance Computing, Grid and Cloud Computing, Multilingual Computing & Heritage Computing, Strategic Electronics, VLSI and Embedded systems, Software technologies, Cyber Security & Cyber Forensics, Health Informatics, Intelligent Transportation Systems and others

3. List of the Technology to be transferred

Contents

4. Brief description about the technology to be transferred

Technology 1:

Substation Merging Unit for Digital Substation

1. Introduction

The Substation Merging Unit (SMU) is one of the most critical elements required in the development of modern digital substations. The SMU provides the suitable interface for the implementation of the process bus concept in modern Substation Automation Systems. These devices strategically positioned in the switchyards convert raw AC currents and voltages, as captured by current and voltage transformers, into a digital format known as Sampled Measured Values (SMVs). This digitized data is then efficiently transmitted to the substation via high-speed ethernet or optical networks.

To ensure seamless integration and interoperability, the merging units adhere to the IEC 61850-9-2LE standard for publishing data to the station bus. This standardized approach fosters efficient data exchange and lays the groundwork for creating fully digital substations. By eliminating the complexities of traditional analog systems, digital substations significantly enhance reliability and open up new avenues for automation. Substation Merging Units can be used in

- High-Voltage Substations - In high-voltage systems, SMUs are ideal due to the large distances between switchyard equipment and control rooms, reducing cabling needs
- Medium-Voltage Substations – Digitising the Switchyard, for real time monitoring
- Digital Substations
- Metering and Monitoring– Metering and Monitoring of Distribution network points

2. Key Features and Specifications of SMU include:

- Compliance: Compliant with IEC 61850-9-2 LE SMV standard.
- Measurement: Provides three-phase measurement of Currents and Voltages.
- Analog Interface: Supports Analog Interface of CT/PTs, with connections from CT/VT to MU typically hardwired.
- Communication Interfaces: Equipped with 2 Optical/Ethernet ports (100Base-FX, LC interface)
    - The protocol used is IEC 61850-9-2LE.

◦ SMV packets are typically transmitted in multicast mode at the process level, facilitating peer-to-peer communication where the destination does not need to be known by the sender.

- Synchronization: Supports synchronization via PTP (IEC 61850-9-3, IEEE1588) using a Fiber LC connector as the physical interface
- Accurate and error-free time synchronization is highly important for the syntonization of current and voltage measurements
- Analog Acquisition: Resolution of 16 bits and an acquisition rate of 256 samples/cycle (50 Hz).
- **Input Specifications:**

  Current Inputs: 4 Nos.

  Nominal Current: 5A

  Frequency: 50 Hz.

  Voltage Inputs: 4 Nos.

  Voltage: 110V AC.
- Power Supply: Operating Nominal Voltage options include 24V DC, 48V DC, and 230V AC, with a Max Current of 3A.
- Environmental: Operating Temperature range of -10 °C to 60 °C.
- Enclosure Protection: IP 54, IP 20 (backside).
- Form Factor: Dimensions of 238 mm x 200 mm x 228 mm
- Internal Components: Based on ARM Cortex-A8, 512MB DDR3, 8GB eMMC Flash, Ethernet, COM, USB, CAN bus, I2C, I2S, GPIO, and running Linux - Yocto

The existing Merging Unit market is constrained by a scarcity of domestically produced, cost-effective solutions, with prevailing options being predominantly expensive imports. The affordability of the system, particularly for large-scale, continuous operational requirements (24x7), could be significantly enhanced through licensed production utilizing C-DAC technology.

3. Substation Merging Unit (SMU) Datasheet

Substation Merging Unit (SMU) is a key element of the process bus in modern IEC 61850 based digital substations. SMU acquires current, voltage signals from conventional current and voltage transformers, merge them to digital signals and transmits them using IEC61850-9 2LE standard. This data can be subscribed by Intelligent Electronic Devices, Bay Controllers and/or Protection Relays that support this protocol. Substation Merging Unit enable real-time data collection and analysis, providing operators with comprehensive insights into grid performance and condition.

Technical Features

- Compliant with IEC 61850-9-2 LE SMV standard
- Suitable for Process Bus applications
- Three phase measurement of Currents and Voltages
- Analog Interface of CT/PTs
- Ethernet / Optical Interface
- Publisher of Sampled Measured Values
- Targeted for use in Electric Substations and Switchyards

Specifications

Specifications
Analog Acquisition
Resolution : 16 bits
Acquisition rate : 256 samples /Cycles (50 Hz)
Current Inputs
Analog Current Inputs : 4 Nos.
Nominal Current : 5A
Frequency : 50 Hz
Voltage Inputs
Analog Voltage Inputs : 4 Nos.
Voltage : 110V AC
Communication Interfaces
Optical/Ethernet ports : 2 Nos.
Interface : 100Base-FX, LC
Protocol : IEC61850-9-2LE
Synchronisation
Physical Interface : Fiber LC connector
PTP : IEC61850 9-3, IEEE1588
Power Supply
Operating Nominal Voltage : 24V DC/48V DC/230V AC
Max Current : 3A
Environmental
Operating Temperature : -10 °C to 60 °C
Enclosure Protection
Protection : IP 54, IP 20 (backside)
Form Factor : 238 mm x 200 mm x 228 mm

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Technology 2:

Static Compensator (STATCOM) for Power Quality Improvement

1. Brief description about the technology to be transferred

Power Quality (PQ) refers to the stability and consistency of the electricity supply. To increase energy efficiency, adoption of renewable energy production and accelerated development of Smart Grid technology are the top priorities for worldwide energy companies. Increased penetration of renewable systems causes power flow complexities in the network, harmonic issues, and dynamic voltage instability. Similarly, almost every electrical load is now being interfaced using electronic and power electronic circuits. This also leads to a number of power quality-related problems.

It is known that the efficiency of industrial activities depends on the power quality, as the disruptions of the distribution system will significantly affect the performance of electrical equipment. To ensure the proper functioning of electrical equipment it is important to mitigate the disturbances.

Some of the most common power quality issues are reactive power, unbalance, harmonics, neutral current, voltage sag/swell, flicker, etc. These power quality issues can be broadly classified as current-related and voltage-related power quality issues. Shunt compensation devices can mitigate current-related power quality solutions whereas series compensation devices can solve voltage-related PQ issues STATCOM is a shunt compensation device that can dynamically compensate current-related PQ issues such as reactive power, harmonics, unbalance, neutral current, etc.

This technology will be very much suitable for IT parks, arc furnaces, Process industries, Traction and hospitals, etc. to compensate for neutral current, unbalance current, harmonic current, and reactive current present in the load.

Fig.1 shows the shunt connected compensation device that is realized using voltage source inverter(VSI). The VSI is coupled to the Point of Common Coupling (PCC) using filters which can be simple inductive (L) filter or LCL filters. Without any compensation device, the grid current is the same as load current and has the following components, active(i_a), reactive(i_r) and harmonic(i_h) and unbalance($i_{unbalance}$). The shunt compensation device supplies all other components in load current other than active current so that the grid current is purely active. The advantages of using shunt compensation devices in electrical power distribution systems are manifold such as reduced transformer de-rating, reduction in cable losses, low equipment failure etc.

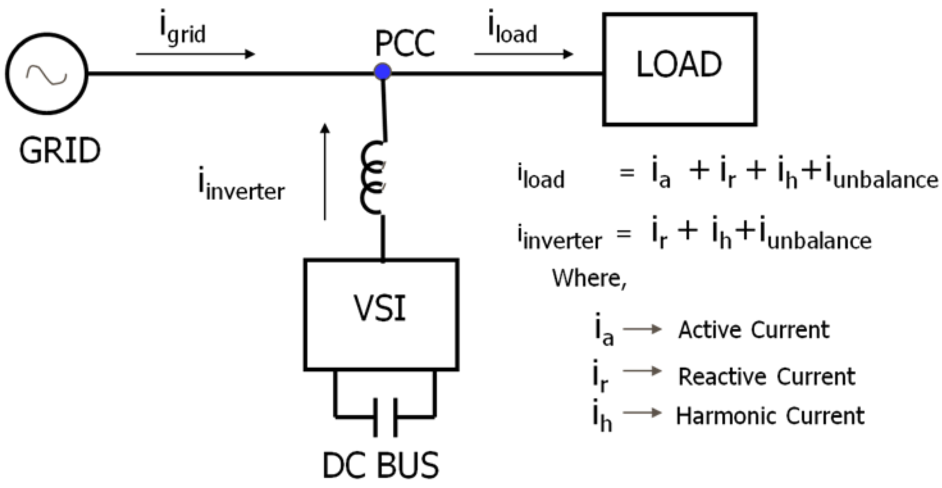


Fig.1: Shunt connected system for PQ improvement in grid

2. Major building blocks of STATCOM

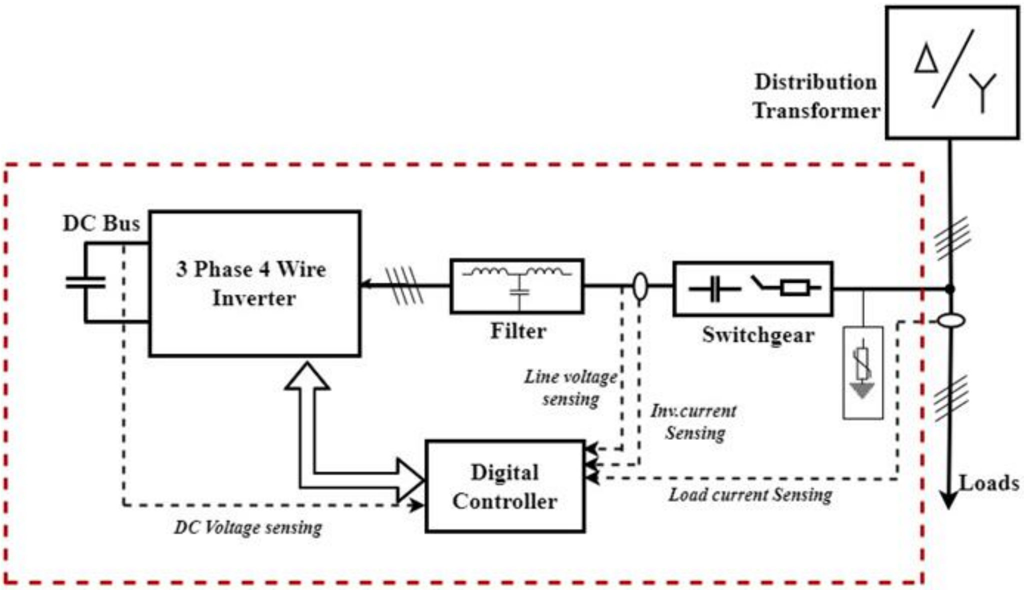


Fig 2. Building blocks of STATCOM

The major building blocks of the STATCOM is shown in Fig 2. The power conversion block is a three phase three wire/four wire inverter realized using Si/SiC-based IGBT switches. The switching devices are mounted on heatsinks for power dissipation and forced cooling is provided with fans. The DC bus capacitors, heatsink and gate drivers form a stack arrangement for the inverter. The line-side filter block is the major magnetics that provides filtering of switching harmonics. The control circuit of STATCOM includes sensing, scaling, protection circuits, digital controller and gate driver circuits. Other auxiliary circuits such as precharge circuits, contactors, switch gears, and surge arrestors also add to the necessary isolation and protection for the STATCOM system.

3. Major Specifications

CDAC offers a two-level/three level four-legged topology for STATCOM. The rating of the proto unit can be 50kVAR and its multiples as required by the customer.

The major specifications of STATCOM with typical rating of 50kVAR is tabulated in Table 1

Table 1 : STATCOM Specifications

Parameters	
Max.Ractive Power Output in kVAR @415V	To be fixed on the rating of the proto unit Typical 70A @ 50kVAR
Operating Conditions	
System Voltage (RMS)	$415V_{L-L}$ *(+10%, -15%)*
System Frequency(Hz)	49 Hz – 51 Hz
Operating Temperature Range	0 to 45°C
Product Specifications	
Reactive Power Compensation	Both Inductive and Capacitive
Rated RMS Current	70A @ 50kVAR
Electrical Connection	3Phase 4 wire
Converter Topology	Two-level IGBT Converter
Power Factor Correction	Yes
Load Current Balancing	Yes
Harmonic Compensation Capacity	% Capacity Programmable

Harmonic Compensation range	upto 13th order(Programmable)	
Functional Priority	1. Neutral current compensation 2. Unbalance current compensation 3. Reactive power compensation 4. Harmonic Compensation (Programmable, limited by the current rating of the system)	
Internal Thermal loss	Depends on the switching devices	
Dynamic Response Time	1 ms	
Correction time	Half cycle(10ms)	
Controller	TMS320F2812(Fixed point)/ TMS320F28379(Floating point)	
Control Method	Classic control	
Display	To be incorporated by the party Data will be provided as per the requirement, from the controller	
Approximate Dimensions (50kVA proto by CDAC)		Dimensions are based on a proto-unit engineering by the industry.
Width	850mm	
Depth	600mm	
Height	1300mm	
Weight in Kg	150 Kg (approximately)	
Protections	Voltage Surge, Current Surge, Over Voltage, Under Voltage, OverCurrent, DC bus overvoltage,Over Temperature, IGBT Short Circuit protection	
Alarms	Yes	
Ingress Protection	IP 21	
Cooling	Forced Air	
Cable Entry	Bottom	

4. Two-Level Inverter based STATCOM

Fig.3 shows a two-level four-legged VSI-based STATCOM connected to the utility line at the Point of Common Coupling (PCC).

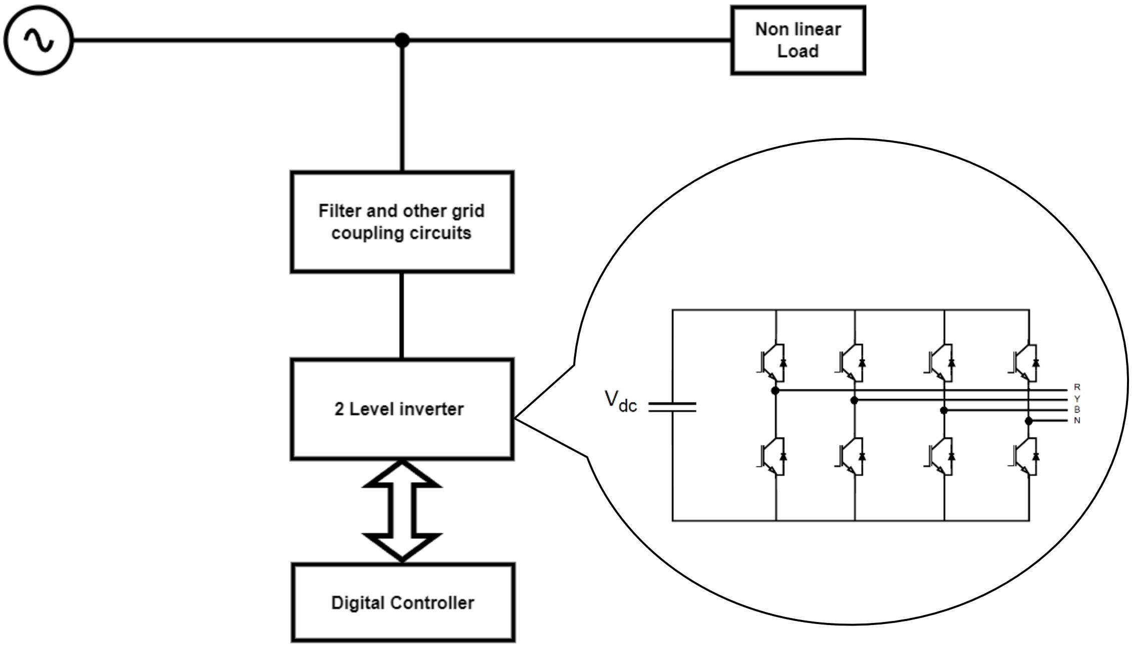


Fig. 3 : Two level Inverter based STATCOM

There are two switches per phase in a conventional, two-level inverter. A 2-Level inverter controls the voltage waveform of the converter output with 2 electric potentials, i.e. suppose we are providing Vdc as an input to a two level inverter then it will provide + Vdc/2 and – Vdc/2 on output. In order to build an AC voltage, these two newly generated voltages are usually switched.

For a three-phase four-wire system, a neutral point needs to be provided. If the load is balanced, the neutral point could be floating since there is no current going through it.

However, if the load is unbalanced, a floating neutral makes an inherently unbalanced three-phase output voltage because the control target of a balanced three-phase voltage contradicts the fact that the zero-sequence current cannot exist due to the topology constraint. A neutral current will also be present if the load contains triplen harmonics. In order to make the control target achievable, a neutral must be provided so that the zero-sequence can flow through.

Two-level four-legged configuration can handle the neutral current caused by an unbalanced load or balanced single-phase nonlinear loads. A balanced output voltage can be achieved due to the tightly regulated neutral point

5. Know how involved in the ToT:

CDAC will provide the know-how for two-level inverter-based STATCOM technology as per the customer requirement. The general package involves training and handing over of documents of the following components

1.1. *Design procedure for the power converter:* The design of power converter hardware based on the rating selected by the customer will be provided.
1.2. *Design of thermal management system:* The thermal management system includes the design of heatsink and cooling for the converter stack, cooling of magnetic components and panel cooling.
1.3. *Design of filter components:* The filter requirements of the converter vary based on the rating and switching frequency selected for the design.
1.4. *Design of sensor requirements:* The feedback signal requirements, selection of sensors, its scaling and protection circuits will be needed for the design.
1.5. *Design of the controller hardware and auxiliary circuit:* DSP/FPGA-based Digital controller design and other auxiliary circuits are the main components in the control hardware circuit design.
1.6. *Control philosophy and algorithm:* The control architecture and algorithm for the compensation of various power quality issues
1.7. *Controller software and calculation procedure for various scaling and control constants:* The control software architecture and its implementation, procedure for scaling of parameters, etc.
1.8. *Test procedure:* Testing involves the step-by-step of control hardware and power hardware and integrated testing will be provided
1.9. *Fabrication guidelines:* Mechanical assembly drawings and fabrication guidelines for the proto unit shall be shared by CDAC. The industry partner is responsible for the optimization and engineering as per the marketable product requirements.
1.10. *Field Trial support: Laboratory-tested proto unit may be tested in actual site conditions by the* industry partner, within the period of the ToT MoA. During this period, CDAC will provide technical support to the industry partner in case of emergency
1.11. Training will cover
    - ✓ Overall KNOWHOW
    - ✓ Design details of power circuit, PCBs and sub-circuits
    - ✓ Testing of PCBs and sub circuits
    - ✓ Control software
    - ✓ System Integration and testing

Technology 3:

Medium Voltage Drive

1. Introduction:

Variable speed drives have reached a wide range of applications, including high-voltage, high-performance drives. Many of these applications, such as rolling mill drives, pumps, blowers for the steel industry, traction drives, drives for cement industries, earthmovers, and mines, require Medium Voltage drives in the medium to high power range. Recently, various multilevel topologies have been proposed for these applications, each with several merits and demerits.

2. Proposed Converter topology

The basic configuration of the proposed Medium Voltage converter is shown in Fig-1. The main high voltage cell is a three-level or two-level converter with High voltage Insulated Gate Bipolar Transistor (HVIGBT) as switching devices. It switches at the fundamental frequency of the drive and operates in quasi-square wave mode. The series connected converter cells compensate the voltage harmonics of this main high voltage cell.

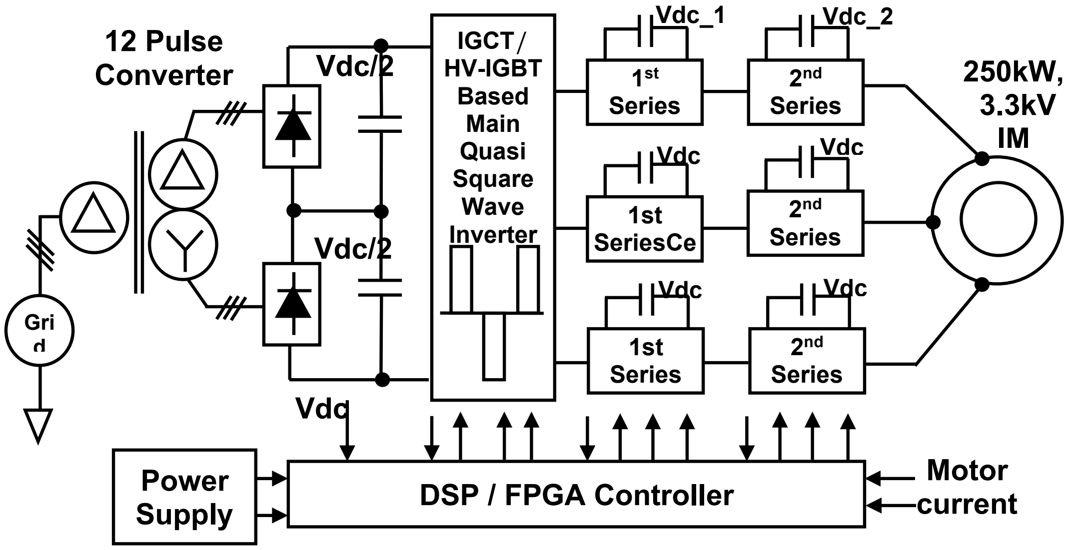


Fig-1 Basic Block diagram of the Medium Voltage drive

The dc bus voltage requirements for the series cells are naturally regulated at harmonic frequencies without using Voltage sensors and external dc source. The voltage magnitude of the series cells is considerably less than the main cell. To minimize the number of components in the hybrid converter, it is proposed only two compensators for each phase to compensate 5^{th} &7^{th} (combined) and 11^{th} & 13^{th} (combined) by the individual compensators. After the compensation, the motor terminal voltage will be nearly sinusoidal with very less dv/dt The gris side converter is a 12-pulse diode rectifier with two winding delta-star step up transformer with appropriate turns ratio to generate the dc voltage of 4 to 5kV.

3. Advantage of the Power Topology:

The proposed scheme offers the following features for medium voltage drives.

- ✓ Hybrid multi-level converter with only one energy source
- ✓ Applied $\left[\frac{dV}{dt}\right]$ across the motor terminal must be less to minimize the voltage surge and leakage current of the motor
- ✓ All the cell voltages must be naturally regulated without using dc bus voltage sensors for these cells.
- ✓ Number of cells must be less to achieve same output voltage distortion

4. Experimental Results:

The performance of the MV drive is validated in a 250kW, 3.3kV Squirrel cage Induction machine. Fig.2 shows the main square wave mode voltage nearly at 2kV DC bus voltage. Fig.3 shows the 5th and 7th cell harmonic compensated voltage waveform.

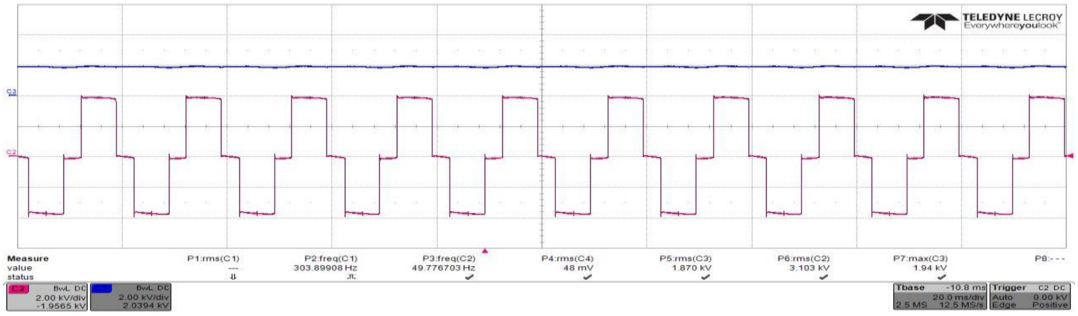


Fig.2. Three-level line to line voltage = 3.1kV at 50 Hz (Square wave mode of operation)
Main DC link voltage = 1.94kV

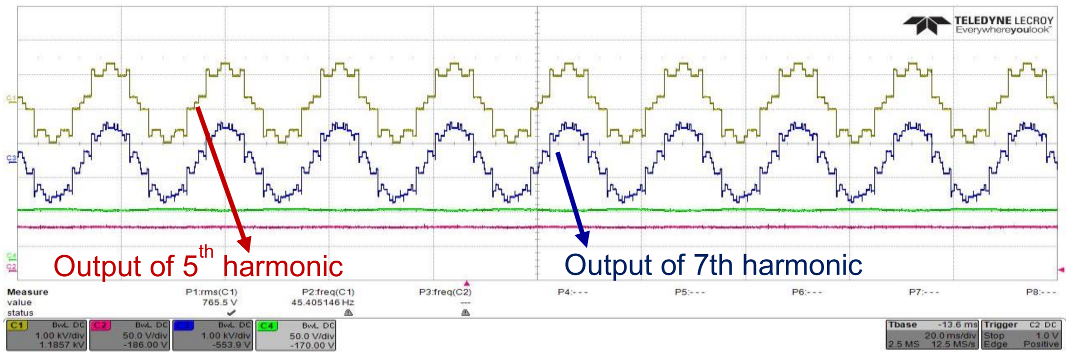
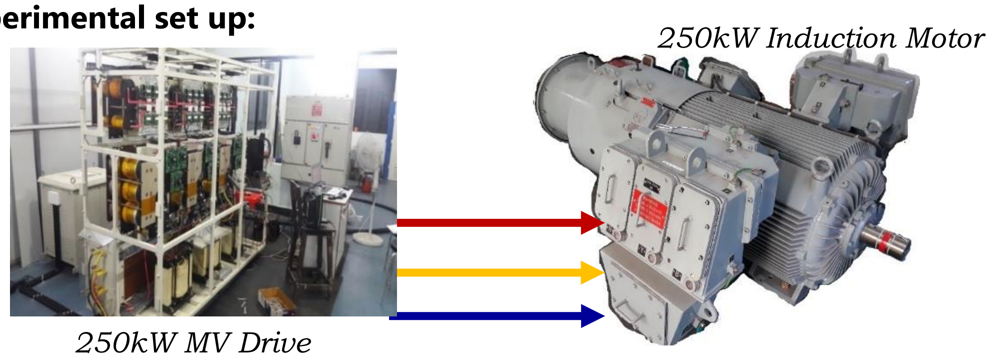


Fig.3. 5th and 7th Harmonic Compensated voltages

5. Experimental set up:



Technology 4:

2 kW GaN based Integrated Drive system for BLDC motor for Electric Vehicles

1. Introduction:

Energy efficiency has grown in significance in recent years to reduce costs and increase vehicle performance. Because of the losses and maintenance for brushes, conventional dc machines are not desirable for EV. Because of lower efficiency and energy density, induction machine-based systems are less desirable. BLDC motors are best option for low power drive applications especially under 3-5 kW because of their inherent advantages. Permanent magnet motors are an increasingly common component of motion control systems due to superior performance, smaller size, high torque to inertia ratio, high power density and efficiency.

Furthermore, WBG-device based converter design facilitate integration of motor & control, reducing wiring harness and increase reliability in drives. GaN based drives will provide the compactness required for applications having space constraints such as drones, space applications systems etc in the range of 200-2kW power.

2. Applications of GaN based Integrated Drive:

The integrated drive can support multiple applications:

a) ***Low power propulsion***

- Reduced wiring harness and compact nature of hardware makes it suitable for applications such as electric assisted wheelchairs
- Multiple drives can be made use in drone applications

b) ***Space***

- The reliability of GaN devices will help in developing solutions for space applications, with the support of an appropriate cooling system.

3. Advantages:

The significant features and advantages are:

- ***Indigenous & Cost-Effective***: The homegrown solution offers cost effectiveness in a system level due to less space requirement, reduced wiring harness and integration of power and control hardware
- ***Configurable***: Can supports different drive control algorithms

- ***Safe & Reliable***: Designed with external anti-parallel diodes to eliminate risks of thermal runaway. Top cooled devices support additional heat dissipation requirements.
- ***Compact & Portable***: Reduced size and weight due to high-frequency operation and near zero additional magnetics

4. Major building blocks:

The GaN based Integrated Drive system has the following core subsystems integrated into a single PCB:

a) 2 kW Power Hardware

- GaN MOSFET based inverter for BLDC drive
- External anti-parallel diodes for reverse conduction

b) Controller

- PIC based low-cost controller
- Thermal and electrical protection
- CAN based communication interface

5. Know how involved:

The product development involved a blend of advanced **power electronics and control systems** including:

- **Wide Bandgap Device Integration**: Design of **GaN-based converters** for high- frequency, high-efficiency operation
- **Controller design**: High-speed digital controller for motor drive applications
- **Design of compact hardware for low power application**: Designing integrated hardware including power module and control module for low power drive applications
- **Engineering**: Compact packaging, thermal management, and modular design enabling scalability and portability

6. Deliverables:

- Introductory technical document
- Design details
- Executable and binary files of software
- Testing support for one unit fabricated by the ToT partner

Technology-5

Micro Battery Energy Storage System (BESS)

1. Introduction:

A Micro Battery Energy Storage System (BESS) system, aimed at residential or small commercial applications, integrates battery storage with power electronics for localized energy management. The core challenge lies in achieving high-efficiency bidirectional power conversion within a compact, cost-effective form factor. Specifically, developing inverters capable of seamless grid-tied and off-grid operation, while maintaining low harmonic distortion and fast transient response, demands advanced control algorithms and wide-bandgap semiconductor technologies. Furthermore, ensuring thermal management within the power electronics, particularly in high ambient temperature environments, requires optimized heat dissipation designs and robust component selection. Productization introduces challenges in scaling manufacturing, ensuring component sourcing stability, and achieving reliable system performance over a long lifespan, all while meeting stringent safety and grid interconnection standards. The scheme for integration of a Micro BESS system is given in Fig 1.

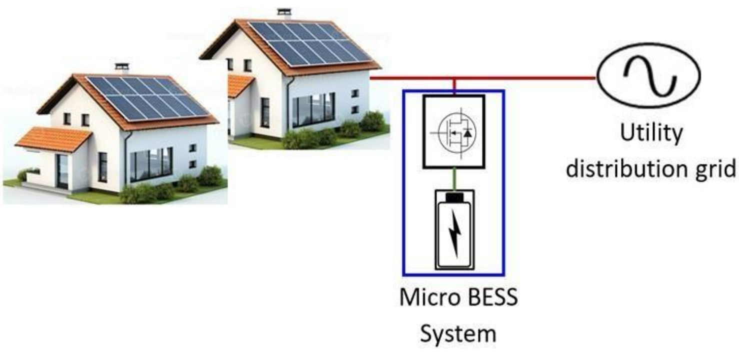


Fig 1. Scheme of integration of a micro-BESS

2. Applications of Micro BESS:

With growing power demand and goals for renewable energy, India is a promising market for energy storage solutions. The Micro BESS interface module, especially in the range of kW power level will find wide ranges of applications as follows.

- Renewable Energy Integration
- Pumped storage alternative
- Remote villages and islands
- EV charging stations
- Urban grid support (for residential and small commercial applications)

3. Salient Features of Micro BESS:

✓ Modular, redundant and scalable architecture

- ✓ Bi-directional power flow capability
- ✓ Wide voltage conversion ratio
- ✓ Digital controller hardware platform using dual-core microcontroller
- ✓ Flexible configuration with interchangeable power devices(Si/SiC devices) & gate drivers
- ✓ Galvanic isolation using high frequency transformer
- ✓ Higher system efficiency

4. Major building blocks of the Product:

The hardware prototype of Micro BESS interface module is shown in Fig. 2 and realized in rack mounted and foldable structure, enabling the product modularity and scalability.

- Stage I: Isolated bidirectional DC-DC Converter (DAB Converter) for interfacing with battery.
- Stage II: Three Phase four wire voltage source Inverter connected to LT side of distribution transformer

In stage I, the power hardware of dc-dc converter is realized with Dual active bridge (DAB) configuration, which consists of low voltage and high voltage bridge circuits and associated gate driver circuits. The gate drivers of dc-dc converter are IC based and can drive the semiconductor modules with nominal current rating upto 600A and inbuilt with protection functionalities; Vce(sat), Advanced active clamping, over current protection, under voltage lockout. Moreover, there is a flexibility to interchange the gate drivers according to type of semiconductors (IGBTs or MOSFETs)

In stage II, the input DC bus voltage is modulated to an output 3 phase AC voltage of 415V (RMS) through PWM modulation techniques. The output AC is passed through the LCL filter by ensuring the high quality of injected current with lower THD and grid synchronization.

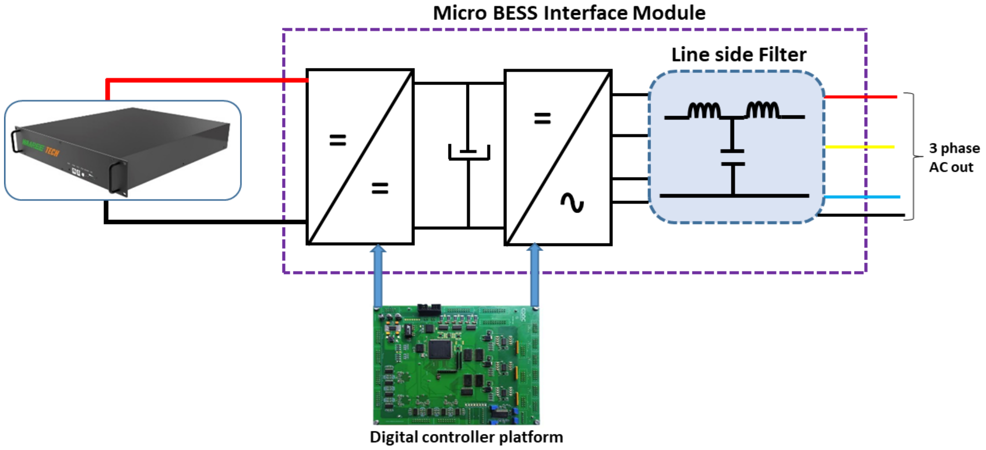


Fig 2. Scheme of Micro BESS Interface module

5. Technology Modules available for ToT

CDAC will provide the know-how for Micro BESS technology as per the customer requirement. The general package involves training and handing over of documents of the following components

1.1 Design procedure for the power converter: The design of power converter hardware based on the rating selected by the customer will be provided.

1.2 Design of thermal management system: The thermal management system includes the design of heatsink and cooling for the converter stack, cooling of magnetic components and panel cooling.

1.3 Design of filter components: The filter requirements of the converter vary based on the rating and switching frequency selected for the design.

1.4 Design of sensor requirements: The feedback signal requirements, selection of sensors, its scaling and protection circuits will be needed for the design.

1.5 Design of the controller hardware and auxiliary circuit: Digital controller design and other auxiliary circuits are the main components in the control hardware circuit design.

1.6 Control philosophy and algorithm: The control architecture and algorithm for the compensation of various power quality issues

1.7 Controller software for implementation: The control software architecture and its implementation, procedure for scaling of parameters, etc.

1.8 Test procedure: Testing involves the step-by-step of control hardware and power hardware and integrated testing will be provided

1.9 Fabrication guidelines: Mechanical assembly drawings and fabrication guidelines for the proto unit shall be shared by CDAC. The industry partner is responsible for the optimization and engineering as per the marketable product requirements.

1.10 Field Trial support: Laboratory-tested proto unit may be tested in actual site conditions by the industry partner, within the period of the ToT MoA. During this period, CDAC will provide technical support to the industry partner in case of emergency

1.11 Training will cover

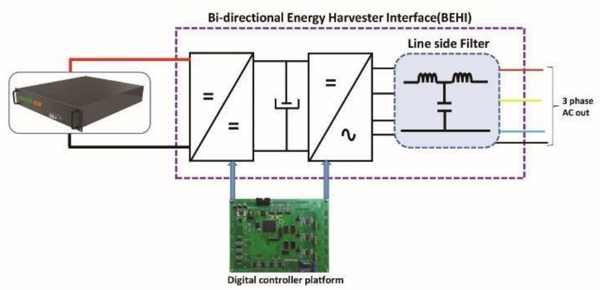
- ✓ Overall KNOWHOW
- ✓ Design details of power circuit, PCBs and sub-circuits
- ✓ Testing of PCBs and sub circuits
- ✓ Control software
- ✓ System Integration and testing

Micro Battery Energy Storage System (BESS)

Outcome of the project "Development and Implementation of Battery Energy Storage System for Power Quality Centre(BESS-PQC)" funded by MeitY, Govt of India through NaMPET-III. Micro BESS will be modular and can also be seamlessly paralleled for capacity enhancement. The developed proto unit is suitable for interfacing with Li-ion (or) Lead acid battery based BESS.

10 kVA BEHI for BESS

Dimension:
800 x 483 x 222 mm

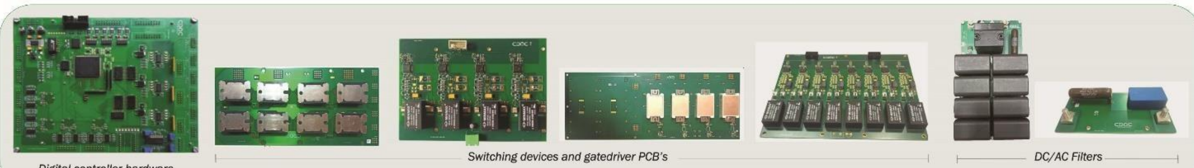


■ Salient Features

- Indigenously developed Power Conditioning System
- Bi-directional power flow capability
- Galvanic isolation using high frequency transformer
- Higher Modularity, Scalability and redundancy
- Higher system efficiency
- Advanced digital controller hardware platform using Delfino MCU(TI),200 MHz, 32 bit floating point, Dual core processor
- Power quality standards according to IEEE 519(no load to full load)
- Primary and back up protection implemented through software and hardware(Over voltage/current/gate driver faults)

■ System Specifications

Li-ion battery	
Power Capacity	8.256 kW
Energy Capacity	8.256 kWh
Nominal Voltage	96V
Battery chemistry	Lithium iron phosphate
DC-DC Converter	
Rated power	10 kW
Nominal Input voltage	96V
Output voltage	750V
Switching frequency	25 kHz
Switching Device	Si/SiC
Transformer construction	High frequency Litz wire based
DC-AC Converter	
Output voltage	3 phase 415V,50Hz
Switching frequency	25 kHz
Switching Device	SiC
Protections	OC,OV,OT



Digital controller hardware | *Switching devices and gatedriver PCB's* | *DC/AC Filters*

Major PCB's & Sub-system

Technology Transfer Centre (TTC), Power Electronics Group
Centre for Development of Advanced Computing
Vellayambalam, Thiruvananthapuram, Kerala - 695 033
Tel: +91-471-2723333, 2723226 Fax: +91-471-2722230, 2723456,
email: peg@cdac.in Website: www.nampet.in

An initiative of **Ministry of Electronics & information Technology,** Govt . of India
Electronics Niketan, 6, CGO Complex, Lodhi Road, New Delhi: 110003

Technology-6

Distribution Phasor Measurement Unit (DPMU) with Edge computing facilities

1. Introduction:

A Distribution PMU (D-PMU) is different from conventional PMUs in transmission system but perform the similar functionality. In a transmission system, by virtue of its long distance, the phase angle at two ends will have reasonable phase shift. When investigating a distribution system, phase angle difference in the line will be very low. Distribution level monitoring demands further complex systems for its multifaceted monitoring system because of its inherent variability in parameters, unbalances and requirement of higher resolution.

This Distribution PMUs is a general-purpose hardware suitable for reconfiguration as general monitoring equipment, flexible for adding additional sensed or derived quantities required for the distribution system measurement and control in addition to its DPMU functionality. D-PMUs are capable of providing adequate monitoring parameters such as voltage and current phasors, frequency information from positive sequence phase information, active and reactive power, voltage and current harmonics, power factor etc. will be installed at suitable locations and data will be communicated to substation level monitoring centre through merging units. Implementation of specific optimal communication medium such as optical fiber, Wi-Fi, 4G, PLCC etc. with appropriate data rates will be utilized.

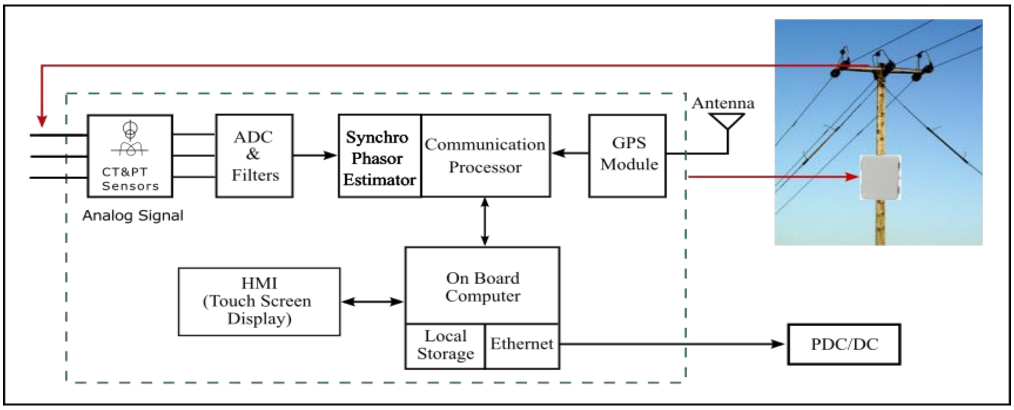


Fig 1. General Architecture of DPMU

2. Major building blocks of DPMU

i. Hardware module with digital controller

ii. Communication module with Single onboard computer

iii. Firmware for parameter estimation and communication

iv. GPS module for synchronization

3. Applications of D-PMU

The distribution system is evolving from a traditional radial structure to a bi- directional framework due to advancements in renewable generation technologies. This shift increases the system's variability and unpredictability, creating a need for more precise measurement and monitoring techniques within the distribution network. Distribution Phasor Measurement Units will play a pivotal role in this domain due to their high-precision measurement and rapid communication capabilities.

D-PMUs are designed to estimate time-tagged synchro phasors specifically for distribution systems. They can be installed at various voltage levels—such as 415V, 11kV, or higher, and may be deployed at substations or in the field. The high-resolution data monitored by D-PMUs can be leveraged to enhance manual grid operations by providing unprecedented situational awareness and early warnings. Additionally, this data supports automated control of power system assets and advanced power system management through big data analytics and machine learning techniques.

Some potential applications that can be developed using D-PMU include:

i. Real time monitoring and control
ii. Phase angle monitoring
iii. Predictive analytics and improved grid resilience
iv. Situational awareness of distribution system
v. Fault detection and post disturbance analysis

4. Advantages of D-PMU

a) D-PMU hardware architecture: The hardware architecture is multifunctional where intelligent sensors and equipment controllers etc. can be interfaced according to application. It is designed as a general-purpose hardware suitable for reconfiguration as general monitoring equipment.

b) Integration with smart power quality devices: DPMU can be seamlessly integrated with smart power quality devices to enable advanced monitoring and control functionalities. This integration allows for real-time measurement, analysis, and management of power quality parameters, helping to detect disturbances, improve system reliability, and optimize overall system performance.

5. Know how involved

a) Design of sensor requirements

b) Design of digital controller hardware and auxiliary circuits

c) Control architecture and algorithm

d) Implementation of controller software, calculation procedure for scaling of parameters etc.

e) Software architecture and implementation

f) Design documents and gerber files of digital controller hardware

g) Test procedures

h) Standard training which will cover

- Overall knowhow
- Design details of digital controller hardware and sub-circuits
- Testing of PCBs and sub circuits
- Control software testing
- System Integration and testing

Distribution Phasor Measurement Unit (D-PMU)

An intelligent sensor based edge computing device for power system Wide Area Monitoring

An intelligent sensor based edge computing device for power system Wide Area Monitoring. A device with unique ability to sample analog voltage and current waveforms in synchronism with a global reference signal and compute its phasor values and frequency information. The time stamped data will be exchanged with PDC/SCADA in real time. The device is also capable of sensing environmental parameters and status of other devices in the power system infrastructure

DPMU provides observability of the power systems events in a sub-cycle level

Specifications

No: of analog inputs	6 (3V and 3I)
Nominal frequency	50Hz
Synchronization	GPS
Communication	Ethernet/ Wireless
Data storage	Minimum 7 days internal storage
Standard	IEEE C37.118
Application	Distribution measurements
HMI	Graphical LCD with touchscreen
Additional/ optional measurements	⊙THD ⊙Active Power ⊙Reactive power ⊙Power factor

DPMU can coexist with various systems like power quality devices, renewable power plants, battery energy storage systems, transformers etc. and support for centralised monitoring, control and predictive interventions.

Applications

This high-performance D-PMU is an advanced solution that combines synchrophasor technology with edge computing to enhance real-time grid visibility, reliability, and efficiency. Other diverse applications of D-PMU are

- Realtime monitoring and control
- Phase angle monitoring
- Predictive analytics and Improved grid resilience
- Situational awareness of distribution system
- Fault detection and post-disturbance analysis

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Tel : +91471 2723333 / 2723226 , Email: peg@cdac.in

Ministry of Electronics & Information Technology, Government of India

Technology – 7

GB/T 27930-2015 Test Bed

1. Introduction:

The Power Electronics Group at C-DAC Thiruvananthapuram has developed an indigenous **GB/T 27930-2015 Test Bed** for evaluating EVSE communication controllers. This test system forms part of the *"Development of WBG-based EV Supply Equipment for Charging (WBG-EVSE)"* project, under the *National Mission on Power Electronics Technology (NaMPET Phase III)*.

The GB/T Test Bed enables **pre-compliance testing** of EV chargers conforming to GB/T 27930-2015 and GB/T 34658 standards. The integrated **testing software** performs CAN-bus communication analysis and protocol verification between the EV and EVSE. A prototype EV communication controller is included to emulate BMS behaviour and support testing in laboratory environments.

The test bed incorporates an intuitive **graphical user interface (GUI)** for real-time monitoring, data logging, and simulation of various charging and fault conditions.

2. Applications of GB/T Test Bed:

The test bed provides wide applicability in EV charging research, testing, and validation:

a) ***EVSE Manufacturer Testing***

- Enables pre-compliance testing of GB/T 27930-2015 communication protocol
- Facilitates debugging and validation of communication controllers

b) ***R&D and Academic Institutions***

- Serves as a training and research platform for EV communication protocol study
- Helps evaluate CAN-based EV–EVSE interaction sequences

c) ***System Integration and Interoperability Testing***

- Allows fault injection and message-level monitoring for interoperability studies
- Assists developers in verifying standard conformance prior to certification

3. Advantages of GB/T Test Bed:

The GB/T Test Bed offers several advantages compared with conventional or imported test setups:

- ***Protocol-Level Validation:*** Covers 33 charger test cases as per GB/T 34658
- ***Real-Time GUI Monitoring:*** Comprehensive and user-friendly visualization
- ***Message Logging & Debugging:*** In-built data logging for analysis and troubleshooting
- ***Fault* Simulation:** Enables fault injection and BMS-side response testing
- ***Optional Hardware Interface:*** Simulated charging plug for bench-level testing
- **Compact and Indigenous:** Designed and developed at C-DAC Thiruvananthapuram

4. Major building blocks of GB/T Test Bed:

The GB/T Test Bed comprises the following core subsystems:

a) ***Hardware Subsystem***

- Prototype EV communication controller card compliant with GB/T 27930-2015
- CAN analyzer hardware for communication capture and analysis
- Optional plug interface hardware for bench testing

b) ***Software Subsystem***

- GUI application for real-time data view, logging, and fault simulation
- CAN analyzer drivers and EV communication controller firmware
- Message logging and test case execution modules

c) ***System Documentation and Support***

- Electrical wiring diagram and mechanical assembly files
- User manual, installation guidelines, and fault diagnostic procedures

5. Know how involved:

The development integrates power electronics, embedded systems, and communication expertise, including:

- GB/T 27930 protocol stack implementation over CAN bus
- Real-time fault simulation and data logging framework
- GUI design for test sequence control and analysis
- Development of communication controller hardware and firmware
- System-level integration and test automation

6. Existing ToT of GB/T Test Bed

Nil

7. Proposed ToT of GB/T Test Bed

- GB/T test software with communication analyzer hardware
- PCB fabrication files and part list for EV communication controller
- CAN analyzer hardware fabrication files and part list
- System part list, electrical wiring diagram, and mechanical assembly files
- Technical manual with installation and repair guidelines
- GUI and firmware executables
- Two-day training at C-DAC (T):
    - Session 1: Design & Documentation: One-day orientation on design and software
    - Session 2: Module Verification: One-day training for verifying ToT partner modules

<u>Technology Fee:</u>

The parameters used to reach the proposed ToT fee is given below. Development cost = Rs. 60 Lakhs

Number of ToT expected = 2 Nos.

Average unit selling price = Rs. 40.00 Lakhs; Royalty expected per unit = 1.20 Lakhs

a. Complete ToT of GB/T Test Bed

ToT fee proposed : Rs. 30.00 Lakhs (Rupees Thirty Lakhs only)
(Taxes/levies extra)

ToT Duration : 6 months

No. of installments : 3 (50%, 30%, 20%)

Royalty : 3% of the bill value of the sold out systems

8. Deliverables:

- Introductory technical documents and training sessions
- Fabrication files of communication controller hardware
- Executable firmware and GUI software
- CAN analyzer hardware and drivers
- Documentation for installation and testing support for one proto unit

ToT committee may kindly deliberate and finalise the modes of ToT.

Technology-8

15 kW EV Charger

1. Introduction:

The **15 kW SiC-based DC EV Charger** is an indigenously developed, high-efficiency charging system designed in accordance with DC-001 specifications. The technology was developed by the Power Electronics Group at C-DAC Thiruvananthapuram under the *"Development of WBG-based EV Supply Equipment for Charging (WBG-EVSE)"* project, as part of the *National Mission on Power Electronics Technology (NaMPET Phase III)*.

The charger employs SiC-based power electronic converters and supports GB/T 27930 communication for EV–EVSE interface. It integrates multiple layers of protection and safety features in compliance with AIS-138, and offers comprehensive communication and user interfaces.

It provides a reliable, compact, and high-performance solution for low-voltage EV charging applications, particularly suitable for two-and three-wheelers, as well as small four-wheelers operating between 48V and 100V.

2. Applications of 15 kW EV Charger:

The developed charger serves application in the EV ecosystem:

- Suitable for public or private fast-charging installations
- Provides flexible output configurations (3.3 kW / 10 kW / 15 kW)
- Supports OCPP-based connectivity to Central Management Systems
- Provides dual guns with single vehicle charging option

3. Advantages of SiC-based EV Charger:

The developed charger offers significant advantages over conventional silicon-based and imported chargers:

- ***High Efficiency & Compact Design:*** SiC-based converters ensure higher switching frequency and reduced losses
- ***Configurable Output Levels:*** Supports 3.3 kW, 10 kW, and 15 kW output modes
- ***Smart Authentication:*** RFID and mobile app-based user access
- ***CMS Connectivity:*** OCPP support for backend integration
- ***Enhanced Reliability:*** Complies with AIS-138 protection standards

- ***Indigenous Technology:*** Fully designed and developed in India, reducing import dependency

4. Major building blocks of 15 kW EV Charger:

The 30 kW Battery Emulator comprises the following core subsystems:

a) ***Power Hardware Subsystem***
  - SiC-based power converters with galvanic isolation
  - Double conversion topology ensuring stable operation
  - Integrated electronic protections (overvoltage, overcurrent, short-circuit)

b) ***Control and Communication Subsystem***
  - GB/T 27930-based EV–EVSE communication
  - Connectivity to CMS via OCPP
  - Support for RFID/mobile app authentication

c) ***User Interface and Monitoring***
  - Touchscreen HMI with parameter visualization
  - Remote control and fault diagnostics

d) ***Auxiliary Systems***
  - Cooling, isolation, and power distribution circuits
  - Safety and protection circuits for field use

5. Know how involved:

The development integrates advanced power electronics and digital control technologies:

- SiC-based converter design for high-efficiency operation
- Double conversion topology with isolation
- GB/T 27930 EV–EVSE communication stack integration
- Embedded firmware and HMI software development
- OCPP protocol connectivity to CMS
- System-level protection and reliability engineering

6. Proposed ToT of 15 kW EV Charger

- Hardware design for fabrication (PCBs and mechanical)
- Bill of Materials and component selection guidelines
- Executable software for embedded control and HMI
- Wiring list and system documentation
- User manual and installation guidelines
- Two-day training at C-DAC (T):
- Session 1: Design and document orientation
- Session 2: Verification of ToT partner modules

7. Deliverables:

i. Introductory technical documents and training sessions
ii. Fabrication files and part list for the hardware modules
iii. Executable firmware and HMI software
iv. Bill of Materials and wiring list
v. Support for testing of one proto unit by ToT partner

Technology-9

Real-time battery emulation

1. Introduction:

The **Battery Emulator for 30 kW EV Systems** is an indigenous, high-performance testing platform designed to replicate the behavior of real battery packs without the limitations and risks associated with physical batteries. It enables precise and configurable emulation of key battery parameters such as voltage, current, State of Charge (SoC), Depth of Discharge (DoD), and temperature effects.

The system is equipped with CAN, and Ethernet communication interfaces, making it fully compatible with leading EV charging standards such IS17017 and ISO 15118. By incorporating SiC-based bidirectional converter technology, the emulator achieves high efficiency, rapid transient response, and a compact footprint suitable for laboratory, research, and industrial deployment.

Unlike conventional battery packs, this emulator eliminates charging/discharging delays, improves safety, and ensures repeatable, consistent test conditions—a critical requirement for EV developers, drive-train manufacturers, and EVSE validation teams.

2. Applications of Battery Emulator:

The battery emulator is versatile and supports multiple domains within the EV ecosystem:

a) ***Electric Vehicle Level Testing***

- Acts as a programmable energy source for four-wheeler LMV category EV systems
- Enables evaluation of propulsion systems, inverters, motor controllers, and auxiliary systems
- Provides controlled testing under variable operating conditions without risking real batteries

b) ***Drive System Development and Evaluation***

- Serves as a propulsion system test facility for OEMs, R&D organizations, and academic institutions
- Facilitates design validation and optimization of powertrain components
- Supports accelerated testing with dynamic load profiles

c) ***EVSE Validation***

- Functions as a programmable load to validate EVSE hardware and communication layers
- Supports back-to-back EVSE testing with minimum power loss (eliminating passive load banks)

3. Advantages of Battery Emulator based systems:

The developed emulator offers significant advantages over conventional approaches and imported alternatives:

- ***Cost-Effective & Indigenous***: Affordable solution compared to imported, proprietary emulators
- ***Configurable & Flexible***: Supports a wide range of chemistries and battery characteristics
- ***Safe & Reliable***: Eliminates risks of thermal runaway, over-charging, or over- discharging
- ***Time Saving***: Reduces test setup time by removing the need for charge/discharge preparation
- ***High Performance***: SiC-based converter design ensures high efficiency and rapid response to load dynamics
- ***Compact & Portable***: Reduced size and weight due to high-frequency operation and minimized magnetics
- ***Repeatable Results***: Ensures consistent testing, enabling better benchmarking and product development
- ***Environmentally Friendly***: Avoids unnecessary cycling of real batteries, thus extending resource life

4. Major building blocks of Battery Emulator:

The 30 kW Battery Emulator comprises the following core subsystems:

a. Power Hardware Subsystem

- SiC-based bidirectional DC-DC converter
- High-bandwidth design for dynamic response
- Integrated electronic protection (overvoltage, overcurrent, short-circuit)

b. Control and Modeling Subsystem

- Real-time battery models with configurable SoC & DoD
- RT controller for high-speed computation and control loops
- Safety interlocks and fault-handling mechanisms

c. Communication Subsystem

- Interfaces: CAN, Ethernet
- Support for global standards: IS 17017 & ISO 15118
- Configurable test sequences and automated test execution

d. User Interface and Monitoring

- Graphical User Interface (GUI) for configuration and visualization
- Real-time data logging and fault diagnostics
- Remote access for monitoring and control

e. Auxiliary Systems

- Cooling and thermal management
- Power distribution and isolation circuits
- Protection and safety circuits for laboratory use

5. Know how involved:

The product development involved a blend of advanced **power electronics, control systems, and communication technologies**, including:

- **Wide Bandgap Device Integration**: Design and optimization of **SiC-based converters** for high-frequency, high-efficiency operation
- **Battery Modeling Expertise**: Implementation of real-time, configurable models simulating lithium-ion and other chemistries with thermal and aging characteristics
- **Real-time Control Systems**: High-speed digital control architecture with deterministic response for safe operation
- **Communication Protocol Integration**
- **System Safety & Protection**: Advanced electronic protection circuits ensuring fault tolerance and safe operation
- **User Interface & Automation**: GUI-based configuration, automated test scripting, and remote monitoring capabilities
- **System Engineering**: Compact packaging, thermal management, and modular design enabling scalability and portability

6. Deliverables:

- Introductory technical document and preliminary training
- Design details of battery emulator hardware
- Executable and binary files of software
- Testing support for one unit fabricated by the ToT partner

Technology- 10

WBG Based Solar Powered Induction Cooktop with Battery backup Technology Transfer terms

1. Introduction:

As a part of NaMPET Phase III initiative from MeitY, the Power Electronics Group at CDAC Thiruvananthapuram developed WBG based Solar Powered Induction Cooktop (SPIC) with battery backup as part of the project titled "Development of WBG Solar Powered Induction Cooktop”. The product combines the advanced performance characteristics of wide bandgap semiconductors with renewable solar power to create a highly efficient, environment friendly cooking solution for household and portable defence applications.

The technology know-how for the WBG-based solar-powered induction cooktop with battery backup includes expertise in integrating high-efficiency solar panels with GaN based semiconductors for power conversion, monitoring/managing battery storage for reliable backup power. It also covers the development of MPPT algorithms, efficient control system design for optimal performance. Additionally, the ToT package includes design know how for PCB for high frequency operation, design and assembly of power electronics circuits for the deployment of the highly efficient product which ensure a sustainable and reliable cooking solution.

2. End users of WBG based SPIC:

- Residential induction cooktops users
- Rural communities without electricity access
- Off-shore Fisheries related activity areas
- Houseboat tourism activity areas
- Disaster Relief (DR) shelters
- Strategic operational areas
- Tourist and Trekking communities
- Alternate cooktop for individual household who make use of LPG Cylinders, Electrical induction and other fossil fuels as primary means.

3. Advantages of WBG based Solar Powered Induction Cooktop:

a) ***High Efficiency:*** The combination of WBG semiconductors and solar power ensures that the system operates with minimal power losses.

WBG devices offer faster switching speeds, lower conduction losses, and higher thermal tolerance, making the entire system more efficient compared to conventional silicon-based systems.

4. Sustainability and Eco-Friendliness:

The system is powered by renewable solar energy, which reduces dependence on the grid and lowers carbon emissions. This makes it an ideal solution for eco- conscious users.

5. Cost Savings in the Long Term:

Initial development cost may be higher due to the need for solar panels, WBG devices, and Battery pack included in the overall system development. However, the system will provide long-term savings through lower energy costs.

6. Compact and Efficient*:*

The use of WBG devices allows compact power electronic subsystem designs and high-frequency operation, which reduces the overall size and weight of the cooktop, while also improving efficiency.

7. Reduced Heat Generation in Electronics:

The high thermal management capabilities of WBG devices allow for better heat dissipation and reduce the need for complex cooling systems in the power electronics.

8. Major building blocks of Solar Powered Induction Cooktop:

WBG Based Solar Powered Induction Cooktop comprises the following core subsystems:

a) *Power Hardware Subsystem*

- WBG based Power Electronic converters High frequency operation
- Integration and Utilization of Solar Power
- Compatible with Lead Acid / Lithium-Ion battery
- Low profile system with light weight magnetics
- Compact Digital controller for double stage PE conversion

b) *Control system and Digital circuits*

a. Algorithm for Maximum Power Point Tracking
b. Control algorithm for Battery charge/discharge
c. Dedicated sensing and protection circuits for current, voltage & Temperature

9. Know how involved:

The product development involved a blend of advanced **power electronics design, control and digital implementation, mechanical and Thermal management**, including:

- **Wide Bandgap Device Integration**: Design and optimization of **WBG based converters** for high-frequency, high-efficiency double stage conversion
- **Integration of Battery as energy storage:** Monitoring/managing battery storage for reliable backup power
- Design of **MPPT algorithm** and control logic implementation as per the use case for optimal performance
- **Dedicated digital signal controller** design
- **High performance PCB design** for high frequency operation
- Integration of renewable energy for sustainable cooking solution.
- **System Safety & Protection**: Advanced electronic protection circuits ensuring safe operation of SPIC
- **System Engineering**: Compact packaging, thermal z management for the deployment of the highly efficient product

10. Existing ToT of SPIC

Nil

11. Proposed ToT of SPIC

1 kW WBG Based solar powered Induction cooktop with Lead acid battery backup

Submodules for ToT

a. Indigenously developed GaN Half bridge cards
b. HF MPPT Converter for Battery charging application
c. HF PSFB DC-DC converter for voltage isolation and amplification
d. Compact Digital controller for double stage PE converter applications

12. Deliverables:

i. Fabrication files and Bill of materials of the PCBs
ii. Mechanical design files
iii. Executable files of the embedded software
iv. Part list of the system
v. Wiring list of the system
vi. User manual, and guideline documents

Technology- 11

GaN based 3.3 kW SPV DC Charger Technology Transfer terms

1. Introduction:

As a part of NaMPET Phase III initiative from MeitY, the Power Electronics Group at CDAC Thiruvananthapuram developed “GaN based 3.3 kW SPV DC Charger” under the project titled "Development of WBG based EV Supply Equipment for Charging: WBG-EVSE”. Usage of Electric Vehicles reduces the air and noise pollution in urban localities and leads to a healthier lifestyle. However, an EV can be called 100% green vehicle only if it is charged through a renewable energy source like Solar, Wind or Green Hydrogen. Through this development we have developed a charging solution to charge the EV from Solar and thereby achieving 100% green energy vehicle.

The developed SPV DC charger is a single vehicle/gun conductive DC charger. The maximum power output delivery is 3.3kW at voltage level of 48V DC. This charger is developed targeting 2W/3W vehicles and slow charging of 4Ws. The scheme is achieved by a DC-DC MPPT based converter for solar PV, AC-DC PFC converter for controlling the bi-directional power flow between solar PV and Grid and a DC-DC converter for isolation between EV battery. The charger can accept both Solar DC input and as well as 230V, 50Hz AC grid depending on the availability/priority

2. Applications of GaN based 3.3 kW SPV DC Charger:

The GaN based 3.3 kW SPV DC Charger shall be used in following areas

a) Residential Solar DC chargers for utilizing Green Energy

b) EV Charging infrastructure in remote locations

c) Shall work as Grid-Tied inverters and utilize full installed capacity of SPV

3. Advantages of GaN based 3.3 kW SPV DC Charger based systems:

The developed 3.3 kW SPV DC Charger has the following unique features compared to the chargers available in the market:

a. Fully Indigenous development with customized options

b. Use of GaN technology for utilizing HF operation thereby reducing overall weight and size of the system.

c. Future adaption to V2H and V2L

d. Shall be customized for different Vehicle standard connectors

4. Major building blocks of GaN based 3.3 kW SPV DC Charger:

The 3.3 kW SPV DC Charger comprises the following core submodules:

a. Indigenously developed GaN Half bridge cards

b. Interleaved MPPT Converter for Battery charging application

c. GaN based Grid tied Inverters

d. GaN based bridgeless PFC converter

5. Know how involved:

The product development involved a blend of advanced **power electronics, control systems, and communication technologies**, including:

- **Wide Bandgap Device Integration**: Design and optimization of **GaN-based converters** for high-frequency, high-efficiency operation
- **Multiphase MPPT Converter**: Design and implementation of MPPT DC-DC converter for optimized solar energy tracking
- **Bridgeless PFC Converters**: Design and implementation of Totem pole Bridgeless PFC AC-DC Bidirectional converter for effective solar energy utilization and higher efficiency
- **GaN based PSFB converter with planar magnetics:** Design and implementation of PSFB converter (DC-DC) with planar transformer and highly efficient configurable battery charging characteristics.
- **Communication Protocol Integration:** Design and implementation of Protocol for Type 6 / Type 7 for E2W & E3W Fast Charging applications.
- **System Safety & Protection**: Advanced electronic protection circuits ensuring fault tolerance and safe operation
- **System Engineering**: Compact packaging, thermal management, and modular design enabling scalability and portability

6. Deliverables:

- Fabrication files and Bill of materials of the PCBs
- Mechanical design files
- Executable files of the embedded software
- Part list of the system
- Wiring list of the system
- User manual, and guideline documents

Technology- 12

Transformer-less Hybrid Power Conditioning Systems for Green Microgrid Applications

1. Introduction

A microgrid is a localized energy system that can generate, distribute, and regulate electricity within a defined area, such as a campus, community, or industrial site and can operate either connected to the main power grid or independently (islanded mode). Green energy microgrids will find a lot of applications as they enhance energy access in remote areas, reduce dependency on fossil fuels, and support the nation's transition toward sustainable and resilient power infrastructure. Power electronics play a vital role in microgrids by enabling efficient conversion, control, and integration of diverse energy sources, storage systems, and loads to ensure stable and reliable operation. C-DAC Thiruvananthapuram has successfully developed and deployed green energy microgrid technology with solar PV as the primary source of energy for remote communities.

2. Applications of Hybrid Microgrid

Being an efficient source of electrical energy, green microgrids will find various application as listed below

a. Power source for remote villages with limited access to electricity

b. Urban microgrid architecture for improving reliability and renewable integration

c. Power source for remote strategic establishments

d. Resilient power for disaster relief camps

e. Power source for electric vehicle charging, especially in remote settlements

3. Major building blocks of hybrid green microgrid

Figure 1 illustrates the general architecture of a green microgrid, from which the following key points can be derived

Primary sources of power – Primary sources of power can be any renewable source. It can be solar, wind or a mix of generation according to the availability at the specified location

Battery Energy Storage – A microgrid can operates independently from the main utility grid, supplying power directly to local loads using its own generation and storage resources. Hence a battery energy storage system become an integral part of the microgrid.

Backup generator - The backup generator is an essential component of a microgrid, particularly when operating in off-grid mode or in remote locations that experience prolonged power outages. It ensures uninterrupted power supply by providing ride- through support during periods of low renewable generation, such as the rainy season when solar power availability is limited.

Power Conditioning System (PCS): The power conditioning system is a multiport converter which has source side converter and load end inverter. Indicative block diagram of the PCS is given in Fig 2. The subsystems of the PCS are

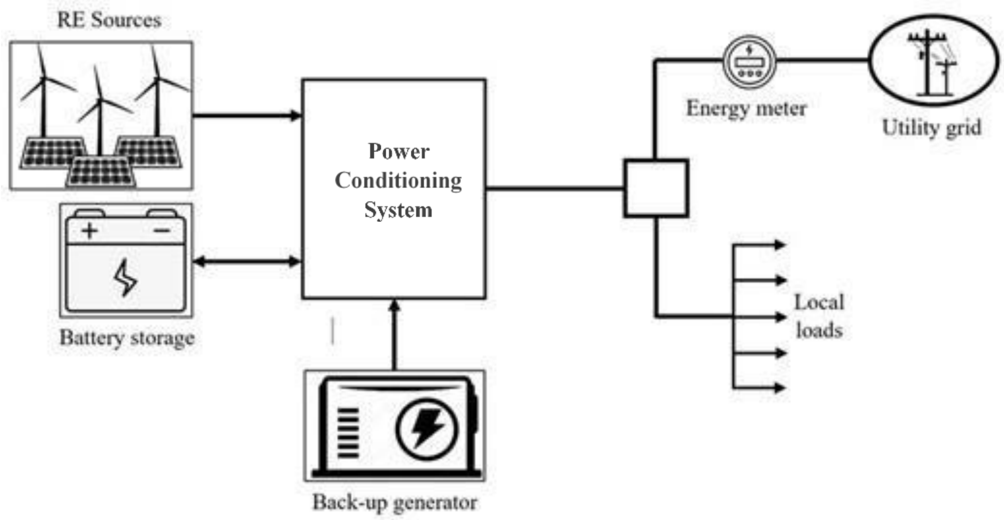


Fig 1. Basic structure of a green microgrid

a. Isolated DC-DC Converters for interfacing solar PV source to the microgrid
b. Isolated, bidirectional DC-DC converter for battery energy storage management
c. 3 Phase/1 Phase inverter for the load side (ON grid/OFF grid)
d. Central digital controller

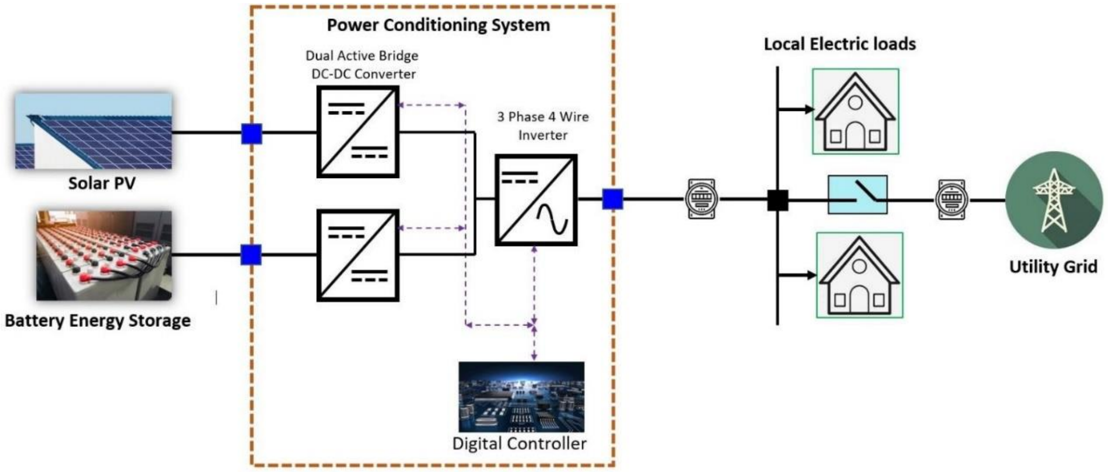


Fig 2. Block diagram of Microgrid PCS

4. Major features of the Hybrid PCS

- Hybrid PCS with Silicon Carbide(SiC) switching devices for Microgrid applications with typical power capacity of 25 kW
- Realisation with SiC switching devices for higher efficiency and improved power density
- Dual Active Bridge (DAB) based DC-DC converters for high frequency isolation
- Grid forming and grid support functions
- Three phase four leg inverters for handling unbalanced operation during standalone mode
- Smart energy storage management
- MPPT capability for solar PV integration
- Scalable design with capability for paralleling
- Graphical HMI interface application for configuration of Power Conditioning System and communication interface – 'iSEER'
- Ethernet based communication interface for interfacing with Microgrid Controllers
- Digital hardware having Dual core floating point DSP and FPGA co-processor

5. Know how involved

The know-how associated with the proposed technology transfer include

- Resource estimation and system sizing
- Power converter design – Inverters and DAB DC-DC converters for microgrids with SiC and IGBT devices

- Design of the magnetic components
- Design and implementation of sensor arrays for control
- Control philosophy for DAB converters, inverters and integrated operation
- Design and implementation of protections
- Real-time digital control using DSP/FPGA platform
- Supervisory controls and communication
- System engineering and test procedures
- Guidelines for field implementations
- Pre-compliance procedures for IEEE 2030.7 – Guide for microgrid controllers & IEEE 2030.8 – Interoperability for microgrid monitoring, control, and energy management

6. Deliverables/activities covered under the proposed ToT

- Detailed design document covering design calculations, components selection, circuit diagrams, BoM, gerber files for various PCBs, mechanical fabrication guidelines, test plan and procedure
- Dedicated training on the technology for the engineering team of the ToT partner
- Testing support for the first proto unit developed by the ToT partners

Technology – 13

High Voltage Power Supply of 150kVd.c., 65kW output

1. Brief description about the technology to be transferred

The system utilizes an LCC resonant topology to leverage transformer parasitic capacitances, ensuring efficient ZVS operation at high power levels. This drives a multiphase voltage multiplier which, through phase-interleaving, minimizes output impedance and voltage drop. This combination is specifically optimized to meet the stringent 800us rise time and 2% ripple requirements for high-power, 65kW, high-voltage, 150kV, output. The detailed specification is given in Table 1:

Table1

Sl. No.	Parameters	Specification
1	Peak output power	65kW max.
2	Load voltage range	40kV to 150kVp
3	Maximum output current	650mA
4	mAs range	0.4 to 800mAs
5	Rise time	Better than 0.8ms
6	Exposure (ON) time	Upto 3sec.
7	Load voltage regulation	±0.5%
8	High frequency ripple	< 2% pk-pk
9	Modulation method	Frequency modulation
10	Switching frequency	100kHz
11	Overall efficiency	> 90% at full load and > 85% at 20% load
12	Input voltage	415V +10%–15% line–line rms
13	Protections	1. Short circuit protection at load 2. Converter current protection

2. Major building blocks of High Voltage Power Supply:

1. H-bridge converter
2. LCC resonant tank
3. Voltage multiplier and high voltage transformer

Block diagram of the High voltage power supply is given in Fig. 1.

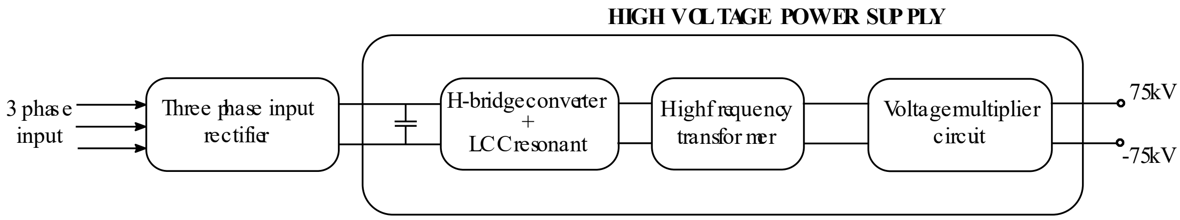
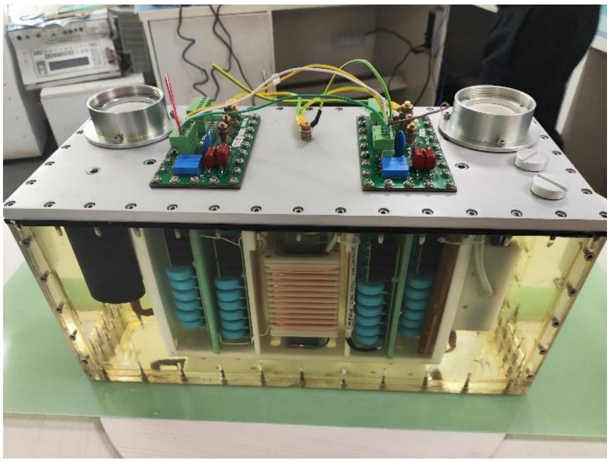


Fig.1 Block diagram of High Voltage Power Supply

3. Know how involved ToT:

1. Features and selection of resonant topology
2. Analysis and operation principle of LCC resonant converter
3. Derivation of design equation of LCC resonant converter
4. Selection of voltage multiplier circuit
5. Analysis and operation principle of voltage multiplier
6. Derivation of design equation of voltage multiplier
7. High voltage transformer design and effects of its various parameters on the converter performance
8. Design of various components of LCC converter and voltage multiplier
9. Selection methods of the designed components
10. Design and layout of digital controller PCB using FPGA
11. Layout of various PCBs related to LCC and voltage multiplier
12. Packaging of LCC converter and High voltage tank
13. Analysis of closed loop control algorithms and calculation of feedback constants
14. Introduction to the VHDL coding of control algorithms
15. Test plan and procedure for testing of LCC converter and High voltage tank
16. Introduction to the Graphics User Interface (GUI) for the design of LCC converter

LCC resonant converter topology based voltage multiplier circuit has many advantages in terms of providing stable values for the stary capacitance, soft switching from light load to heavy load conditions, minimizes the EMI/EMC issues, minimizes the reflected capacitance of the high voltage transformer and so on. The photographs of the fabricated LCC resonant converter and the HV tank are shown in Fig.2:



(a) LCC resonant converter	(b) HV tank

Fig.2 The photographs of the fabricated LCC resonant converter and the HV tank

4. Advantages of High Voltage Power Supply

1) Efficiency: Applying soft-switching technology the efficiency has been improved
2) Low rise time: Rise time of 800us has achieved with LCC converter and multiple secondary
3) Modularity: The proposed topology allows the use of power supply for radiology and fluroscopy
4) Indigenous: First indigenous high voltage power supply of 150kV, 65kW
5) One to one replace: The dimension has been fixed so that it can directly replace the imported power supply in the X-ray unit
6) Closed loop control algorithm for the LCC resonant converter to regulate the output d.c. voltage
7) GUI for the design of LCC converter

5. Applications of High Voltage Power Supply:

The high-voltage power supply is primarily designed for medical X-ray generation, specifically for applications such as radiography and fluoroscopy. However, the core technology is highly adaptable and can be customized for other specialized medical fields, including mammography, dental X-ray, and bone densitometry. Furthermore, the design architecture can be extended to support industrial X-ray applications.

6. C-DAC Deliverables

On payment of onetime license fee and signing of ToT agreement, the following items shall be provided by C-DAC to the ToT partner for production, product marketing support and PoC demonstration.

The deliverables will be

1. ToT Partnership certificate
2. Technical document on
    a. Operation of LCC resosnant converter and voltage multiplier
    b. Derivation of design equation of LCC resonant converter and voltage multiplier
    c. Design equation for the high voltage transformer and resonant inductor
    d. Design of LCC resonant converter, high voltage transformer and voltage multiplier against the chosen specification
    e. Selection methods of the designed components
    f. Closed loop control algorithms and calculation of feedback constants
    g. Test plan and procedure for testing of LCC converter, High voltage tank and its integrated testing
    h. User manual of GUI for the design of LCC converter
3. BoM and Sourcing details of all the components
4. Layouts and fabrication drawings for all PCBs including digital controller PCB using FPGA
5. Detailed fabrication drawings for the LCC converter, resonant inductor, high-voltage transformer, voltage multiplier, and high-voltage tank
6. VHDL source code for the high-voltage power supply
7. Graphics User Interface (GUI) for the design of LCC converter

7. Provision for instalment payment for ToT fee for High Voltage Power Supply

In addition to the ToT agreement terms specified in Section 5, provision has been made for the payment of the ToT fee in three installments, and this supersedes Section "Payment terms for One Time ToT Subscription License and Software Subscription License":

First instalment of 50%, plus applicable taxes, shall be paid upon the signing of the agreement. Following receipt of this instalment, comprehensive training shall be provided, covering: (a) the theoretical aspects of LCC converters and voltage multipliers; (b) the design of LCC converters, voltage multipliers, and high-voltage transformers; (c) selection methodologies for various components; and (d) the design of digital controller PCBs and other auxiliary PCBs.

30% plus applicable taxes shall be paid as second instalment. Upon receipt of this instalment, the following deliverables and activities shall be provided: the closed-loop control algorithm (including feedback constant selection), layouts and fabrication drawings for all PCBs, and detailed fabrication drawings for the LCC converter, resonant inductor, high-voltage transformer, voltage multiplier, and high-voltage tank.

The remaining 20%, plus applicable taxes, shall be paid as the third and final instalment. Upon receipt of this payment, the following deliverables and activities shall be provided: the VHDL source code for the high-voltage power supply, and a comprehensive Test Plan and Procedure for the (a) LCC resonant converter, (b) high-voltage tank, and (c) integrated inverter and tank testing. This phase also includes the validation of specifications, as well as the provision of a GUI for LCC converter design and the associated training.

However, only after making the entire ToT payment the ToT partner shall have the right to produce, market, distribute, and deploy " High Voltage Power Supply."

In addition, there shall be a royalty of 10% for all the ‘High Voltage Power Supply’ sold or deployed by the ToT partner for a period of 10 years from the date of commercialization of this technology.

8. Direct deployment of High Voltage Power Supply by C-DAC

When C-DAC directly receives orders for High Voltage Power Supplies from customers, C-DAC shall approach the Parties to whom the technology has been transferred to request a formal quotation. The Parties are expected to submit the quotations through GeM, either against a custom bid or by listing the product on the GeM portal. Evaluation will then be conducted in accordance with GeM purchase procedures. If the Party fails to respond to C-DAC’s request, C-DAC reserves the right to supply the High Voltage Power Supply directly to the customer.

5. Invitation for Expression of Interest

- C-DAC invites "Expression of Interest" (EOI) in the format given in Annexure-1 (Part A & Part B). Companies/firms can become ToT partner of C-DAC based on the information furnished in Annexure – I, subject to the assessment by C-DAC
- Expression of Interest (EOI) also seeks from interested industry vendors to offer the best price for one-time ToT license cost and Royalty cost for the above-mentioned product
- The minimum base price for the ToT has been finalised by the ToT Committee (constituted by the Competent Authority) as per the terms of reference finalised by C-DAC. The vendor offering the highest price as per the template mentioned in Annexure III shall be designated as H1 price. If the value of H1 price is more than the minimum base price finalised by C-DAC, then H1 bid shall be considered as the final price. If the value of H1 bid is less than the minimum base price finalised by C-DAC, then the base price finalised by C-DAC shall be considered as the final price.
- ToT is offered with all hardware know-how to manufacture the units along with the Binary executables will be provided.
- This invitation of EOI will be open till **Feb 17, 2026.** No companies/firms can offer the price for this product in this EOI invitation after the EOI closure date. The financial bids received till the last date of EOI shall only be evaluated to arrive at the final cost of ToT license.
- If there are no bidders to the EOI, the base cost already finalised by the ToT Committee shall be fixed as the license cost for the ToT.
- Interested companies may submit the expression of interest (see section 5.0, section 6.0 and Annexure III).
- The EOI bids received from the bidders shall be evaluated to discover the best H1 bid. Evaluation of the received bids and its shortlisting shall be based the assessment of the technical and of the bidders as applicable and also through site visit (manufacturing facility) if required by C-DAC.
- After the evaluation, the cost finalised by C-DAC for the ToT will be informed to all the bidders who have participated in the EOI.
- The draft ToT agreement will be shared with the eligible bidder. If the eligible bidder agrees to the terms and conditions of the agreement, the agreement can be signed after payment of the one-time ToT license fee as stipulated in the payment terms for that product. After the execution of the ToT Agreement and payment of one-time license fees, the successful bidder becomes eligible and qualified as a ToT partner of C-DAC.
- Participation in this EOI does not guarantee any association with C-DAC, unless the agreement is signed.

- The technology is offered on a non-exclusive basis.
- The submission of the EOI shall include all such documents that are specified herein to prove the authenticity of their offer and any claim made therein. All cost and expenses associated with submission of EOI shall be borne by the bidder while submitting the EOI and C-DAC shall have no liability, in any manner in this regard, or if it decides to terminate the process of short listing for any reason whatsoever
- C-DAC reserves the right of rejecting any offer without assigning reasons.
- There is neither a business guarantee nor any commitment for funding support from C-DAC to the selected ToT partner

Who can Apply

Any Indian Company registered under Indian Companies Act 2013 or Firms registered under LLP Act 2008, including MSMEs or Start Ups recognized by DPIIT who are willing to acquire licenses, market, sell and implement any of the listed technology can apply for ToT.

Bidders from countries sharing a land border with India can participate in this EOI only if they are registered with the Department of Promotion of Internal Trade (DPIIT) of the Indian Government. They have to submit the required self-declaration confirming their eligibility and restriction status as per the format attached herewith as Annexure –III

How to Apply

Interested bidders may send expression of interest by filling the template as per Annexure – 1 along with supporting documents to:

Head, Technology Promotion Centre,
Centre for Development of Advanced Computing (C-DAC),
Vellayambalam, Thiruvananthapuram,
Kerala, India, 695033
Phone: 0471 2727508 Fax: 0471 2723456 ext 3342
Email: tpc@cdac.in Website: www.cdac.in

ToT Agreement

- The ToT partner is selected based on the expression of interest submitted by interested bidders.
- If selected, the successful biddershall pay onetime ToT license subscription fee and sign the ToT agreement to become ToT partner of C-DAC. Onetime ToT license subscription fee finalised by C-DAC shall be informed to all the bidders who have participated in the EOI.

- C-DAC shall sign the technology transfer agreement with the successful bidder on receiving the onetime ToT license fee.
- The license will be granted on Non-Exclusive basis.
- The technology shall be transferred only after completing the full ToT payment.
- No ToT partner will be allowed to quote for the product unless they enter into an agreement with C-DAC and pays the one-time ToT fees. The ToT fees are non-refundable. In case any party offers /quotes the rates for any projects without ToT agreement with C-DAC, C-DAC will not be responsible for any such event

One time ToT license Subscription Validity & Renewal of ToT agreement

- Payment of one time ToT license fee grants the successful bidder for manufacturing, marketing and selling of the product , for a period of 3 years from the date of signing of the agreement.
- For continued support beyond 3 years the successful bidder shall be required to renew the ToT agreement by paying the fee defined by C-DAC before the expiry of valid subscription, which will be valid for a further extended period of two years.
- If the renewal is initiated after the stipulated period, a fresh ToT agreement needs to be signed by the successful bidder based on the EOI conditions prevailing at that time.
- After five years (from the date of signing the ToT agreement) a new ToT agreement is to be signed by the successful bidder based on the EOI conditions prevailing at that time.
- The successful bidder should have a valid ToT subscription license for providing any technical support on the ToT deliverables made by C-DAC.
- Any customisation requirements of the ToT partner shall be entertained by C-DAC only if a valid ToT subscription exists. Such customisations shall be undertaken by C-DAC at cost basis on mutually agreed terms and conditions

C-DAC Deliverables

- On payment of one-time license fee and signing of ToT agreement, the following list of items shall be provided by C-DAC to the ToT partner for production, product marketing support and PoC demonstration:
    1. Technical Manuals
    2. Bill of Materials
    3. Sourcing Details
    4. Assembly Details
    5. PCB Gerber files

6. Binary Files
7. Schematics
8. Test plan & Procedures
9. Production documents
10. Training
11. User Manuals

Training for ToT Partners

- C-DAC shall arrange training to the ToT partner at C-DAC, Thiruvananthapuram Centre (C-DAC(T)) after signing of ToT agreement.
- The training will be conducted at C-DAC(T) premises.
- The travel and boarding and lodging expenses of the trainee(s) during the period of training shall be borne by the ToT partner.
- For training requested outside C-DAC(T) premises air travel, boarding and lodging charges of C-DAC officials shall be borne by the ToT partner. C-DAC shall also charge manpower as per C-DAC rules prevailing at the time of training for outstation training. Nomination of the C-DAC trainers and period of stay for outstation training will be decided by C-DAC on mutual consultation, depending on the type of training requested.
- Additional training may also be given by C-DAC either at the premises of C-DAC(T) or at the location identified by the ToT partner on payment basis at mutually agreed terms and conditions

Field implementation support

- C-DAC shall provide remote support to the ToT partner for installation and configuration during the subscription period on case-to-case basis upon mutually agreed terms and conditions.
- If any onsite support is requested by the ToT partner, C-DAC shall support on mutually agreed terms and conditions.
- For onsite support outside C-DAC premises travel, boarding and lodging charges of C-DAC officials shall be borne by the ToT partner. C-DAC shall also charge manpower as per C-DAC rules prevailing at the time of support request for outstation support. Size of the C-DAC team and period of stay for outstation support shall be decided by C-DAC on mutual consultation, depending on the type of support requested

Direct implementation by C-DAC

- C-DAC reserves the right to implement technology solution directly at sites where C-DAC is awarded orders for implementation directly by the end user.

- If C-DAC is implementing directly, then the cost at which C-DAC will be offering the solution to the end user will be 140% of the cost finalised by C-DAC

Payment terms for One Time ToT Subscription License and Software Subscription License

- Indian Companies registered under Companies Act 2013/Firms registered under LLP Act 20228 including MSME: Shall pay the one-time ToT fee upon signing the agreement and the handover of ToT deliverables.
- Start-ups recognized by DPIIT: Shall pay the one-time ToT fee in three instalments:
    - First instalment of 30% plus applicable taxes shall be paid on signing the agreement.
    - Second instalment of 30% plus applicable taxes shall be paid at the time of handing over of all hardware manufacturing documents**.**
    - Balance 40% plus applicable taxes should be paid at the time of handing over of all remaining ToT deliverables including software for operationalizing the hardware resource. The payment of 3rd instalment shall be completed within 6 months' period of payment of first instalment**.**
- Royalty fee for each unit manufactured and sold to the client shall be paid to C-DAC, after which C-DAC will issue product activation licenses.

6. Annexure –I (Part-A)

Company Profile of the bidder

A.	**COMPANY PROFILE**
1.	Name of the Organization: Website:
2.	Name of the Contact Person: Address: Mobile: Land Line: Fax: E-mail:
3.	Year of incorporation
4.	Type of organization a. Public sector/Limited/Private Limited/partnership/proprietary society/ any other b. Whether Foreign Equity participation (please give name of foreign equity participant and percentage thereof) c. Name of directors of the board/proprietors d. Name and address of NRI(s), if any
5.	Category of the firm: Large/Medium/Small scale unit/others
6.	Address of the Registered Office: (Include Certificate of registration)
7.	Number of Offices with addresses (Excluding Registered Office): India, ...Abroad
8.	Certificate of registration a manufacturing Unit
9.	Permanent Account Number
10.	GST Reg. No.
11.	ISO or any equivalent certification

7. Annexure – I (Part B)

Technical Collaborations of the bidder

B.	ESSENTIAL REQUIREMENTS
1.	The organization must be a reputed firm/company/SME/Startup/R&D company incorporated in India
2.	The turnover is to be supported by financial statements of accounts/annual reports duly certified by a chartered accountant/Balance sheets of last 3 years/income tax returns for the last 3-year period
3.	Company profile, giving details of current activities and management/personnel structure including evidence of incorporation. The company should be registered and ISO or equivalent certified.
4.	Details of absorption of technology for a product/knowhow that has been taken up on production scale in the past may also be given
5.	The manpower strength (Technical: mechanical, electrical, electronics, software & non-technical etc.) at various levels to be furnished Technical: a. B.E./B.TECH/PhD b. DIPLOMA c. SKILLED TECHNICIANS d. UNSKILLED
6.	The list of machine tools/equipment/software/facilities available related with work to be furnished.
7.	The in-house technological expertise available to be furnished
8.	The list of equipment available for inspection and quality control to be furnished.
9.	The industry should have adequate space for undertaking this work. Available space-covered& open and location details to be furnished
10.	List of products/technologies worked with as regular activity in last three years. Give the list of products/technologies with general specifications and the customers

11.	List of PSUs /Govt. customers-with contact details (Address, Telephone no, contact person)
12.	The details of sales, marketing and maintenance network to be furnished
13.	The list of technical collaborators for various ongoing products may be furnished
14.	The bidder shall provide details of the sub-vendors in case they propose to employ for part work
C.	Expression of interest: spell out the extent of interest and envisaged market potential

I hereby declare that that the above information is true to the best of my knowledge.

Signature with Name & seal:

Place:

Date:

8. Annexure II

Substation Merging Unit (SMU) Datasheet

Annexure-III Financial Bid Format

(To be submitted by the bidder in sealed envelope)

Price bid for One time ToT License Subscription coat & Royalty Fee

Sl.No.	Hardware Product	One Time ToT Fee (Rs.)	Royalty Fee (Rs.)	Expected Sales volume per year
1.				

For any queries please contact:

Head, Technology Promotion Centre,

Centre for Development of Advanced Computing (C-DAC),

Vellayambalam, Thiruvananthapuram,

Kerala, India, 695033

Contact: 0471 2727508, 0471 2723333 (extn: 3220/3450/3249),

email: tpc@cdac.in