INVITATION FOR THE EXPRESSION OF INTEREST (EoI) FOR TRANSFER OF TECHNOLOGY (ToT) OF THE PROJECTS DEVELOPED UNDER ELECTRIC VEHICLE SUB-SYSTEM (EVSS-01) PROGRAMME

EoI No: CDAC(T)/PEG/EVSS-01/EOI-C2-205/2025

इलेक्ट्रॉनिकी और सूचना प्रौद्योगिकी मंत्रालय
भारत सरकार
Ministry of Electronics and Information Technology
Government of India

ELECTRIC VEHICLE SUBSYSTEM

No: CDAC(T)/PEG/EVSS-01/EOI-C2-205/2025

INVITATION FOR EXPRESSION OF INTEREST (EoI) FOR TRANSFER OF TECHNOLOGY (ToT)

The Ministry of Electronics and Information Technology (MeitY) launched the program "Development of Electric Vehicle Sub-Systems (EVSS)" to enhance India's Electric Vehicle (EV) ecosystem in March 2022. The program has focused on developing key EV components such as DC-DC Converters, EV charging systems, drive train system, and Battery Management Systems. Through strong collaboration among academic institutions, research organizations, and industry partners, the initiative has significantly accelerated the growth of indigenous technologies. The technologies developed under EVSS-01 include products that have reached Technology Readiness Levels (TRL) 7 to 8.

PEG of CDAC Thiruvananthapuram is the Nodal Centre for the Project Management Unit EVSS-01 program, funded by the Ministry of Electronics and Information Technology (MeitY). In this context, Project Management Unit (EVSS-01 PMU) invites Expression of Interest (EoI) from Indian companies for the Transfer of Technology (ToT) developed by various institutes and industries under the EVSS program. The objective is to enable companies to absorb technology for manufacturing, marketing, selling, and deploying the innovative technologies developed under the program.

1. Applications for Expression of Interest (EoI) are invited for Transfer of Technology (ToT)/commercialization of the products mentioned in Annexure I from the organizations with relevant experience.
2. Interested Industries/Institutes are requested to provide the necessary information in the format mentioned under Annexure-II and Annexure-III (Part-A and Part-B) below as part of their EoI application with all relevant supporting documents.
3. EoI applications need to be submitted in a sealed envelope with the marking on top **"EoI for EVSS-01 Technology,"** and it should reach the following address on or before **15.09.2025 by 5:00 P.M**.

   The Chief Investigator,
   Nodal Centre, EVSS-01
   Power Electronics Group
   Centre for Development of Advanced Computing (C-DAC),
   Vellayambalam, Thiruvananthapuram, Kerala 695033. India
   Ph: 0471-2723333-3267, E mail: evss-pmu@cdac.in

4. EVSS_01-PMU reserves the right to extend the application deadline. Any such extension will not affect the terms and conditions of the application process.
5. EVSS_01-PMU may periodically amend the published EoI application documents to integrate technological upgrades.
6. During the evaluation process of the submitted EoI applications, EVSS_01-PMU will communicate any clarifications required via email, with a specified deadline for responses.
7. Eligible applicants may be invited for discussions with the EoI Processing Committee.
8. Representatives of EVSS_01-PMU may visit the applicant's premises, if necessary and with prior notice, to inspect and assess the information provided in the application.
9. As per recommendations of the EoI/ToT committee, EVSS_01-PMU reserves the right to reject all or any application without assigning any reason thereof.
10. Canvassing in any form would summarily disqualify the applicant.
11. All costs and expenses associated with the submission of EoI applications shall be borne by the applicants while submitting the EoI; and EVSS_01-PMU 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.
12. Any Indian Institute/Industry can submit applications for more than one technology, which can be indicated in the Technology Requirement Details form (Annexure-II).
13. The ToT committee constituted by MeitY, will determine the terms, conditions, and pricing for technology transfer and communicate them to the selected applicants.
14. Terms and Conditions for the Transfer of Technology (ToT), if agreeable to the shortlisted applicants, will be formalized through an agreement.
15. The address for communication is provided below.

Dr Sigi C Joseph
Scientist 'F'
Power Electronics Group/Nodal Centre EVSS-01
C-DAC, Thiruvananthapuram
Kerala- 695033, India
E mail: sigicj@cdac.in
Ph: 0471-2723333-3487

Annexure I List of Technology

Annexure – II Technology Requirement Details.

Name of the Technology required for EoI with Sl.NO	
EoI Technology ID	
Purpose of acquiring the Technology	

Annexure – III (Part-A) Company Profile of the bidder

(Please use additional sheets as annexures to this document, if needed, to provide clearer information)

A.	Company Profile:
1.	Name of the Organization: Website:
2.	Name of the Contact Person: Address: Mobile: Landline: 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) Names of Directors of the Board/ Proprietors d) Name and address of NRI(s), if any e) Others (Please Specify.)
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 as a manufacturing unit
9.	Permanent Account Number
10	GST Reg. No.
11	ISO or any equivalent Certification
12	Any other additional relevant information

Annexure – III (Part B) Technical Collaborations of the bidder (Details to the maximum can be given)

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 years 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: B.E./ B. Tech/ M. Tech / PhD DIPLOMA SKILLED TECHNICIANS 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.

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

Signature with Name & Seal:

Place: Date:

EoI Technology ID: EVSS01_ToT_01

1. **Name of the Product /Technology** : Solar-Grid Interfaced High Gain AC Charging station for Electric Vehicles

2. **Name of Chief Investigator** : K. Ramachandra Sekhar

3. **Name of the Lead Institution** : IIT Ropar

4. **Target Application** : Solar AC charger

5. **Product /Technology Specifications in a Table**

Parameter	Specifications
Input Voltage Range	70-450V (Dual stage) (single phase) 650V-1000V (single stage) (Three phase)
Nominal Input voltage	350V (DC) (Single phase) 800 V(DC) (Three phase)
Rated output voltage	230 V (AC RMS)
Rated output Power	3.3 kW -5 kW (upto)
Power factor	Unity
Switching frequency	20kHz
Efficiency	>96%
Control Features:	Deficit power balance mechanism for adaptive MPPT
Isolation	Direct (without transformer)
Cooling Type	Heat sink (natural air cooled)
Enclosure type	IP65

6. **Applicable standards:**

Testing Standard	specification
IEC 60529	IP protection
IEC61683	Efficiency
IEEE 519	Current THD requirement
IEC62116	Islanding grid connected system
IEC62109	PV charger safety
IEC61000-6-4	Immunity requirement
IEC61000-6-2	Emission requirement

7. **Certifications if any:** Nil

8. Unique Features of the Technology:

- Unity power factor in grid drawing and grid injection mode
- Guarantees the 3% THD with Distorted grid.
- 99% solar extraction efficiency.
- 96% operating efficiency (Ero efficiency)
- IP65 Protection

9. Maturity of the Technology: Prototype

10. Brief Description of the Product

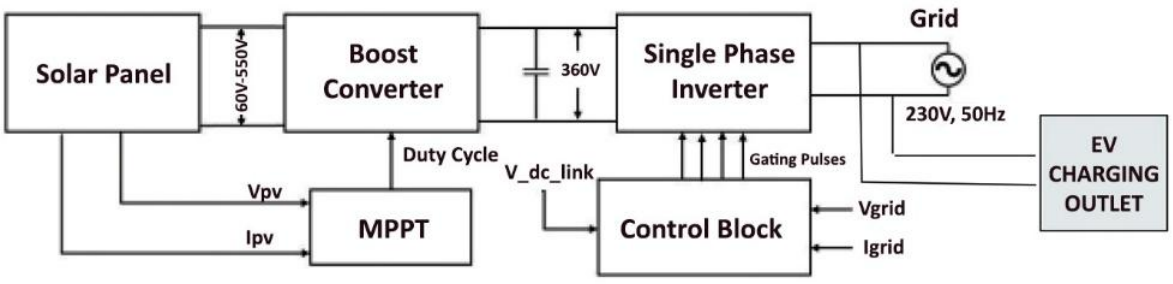
Input Voltage Range: - 70-450V

1st stage: - DC-DC Converter (Boost Converter) for Maximum Power Point Tracking.
2nd stage: - Single Phase Inverter with unipolar or Bipolar PWM technique with current control Loop.

A closed loop boost converter is implemented in the first stage with MPPT control to boost the solar panel dc voltage at the input of a single-phase inverter. The operating input range of the boost converter is 70V-450V. This can be achieved by sensing the voltage and current of the PV panel, and the switch's duty is adjusted to track the maximum power point.

In the inverter stage, the input DC bus voltage of 360V is modulated to an output AC voltage of 230V (RMS) through unipolar or bipolar PWM switching by varying the modulation index. Later the modulating signal is passed through the LC filter to feed the perfect sine current to the grid/charging point at a defined frequency of 50Hz and with THD less than 3%.

The proposed topology of a single-phase grid-tied inverter is thoroughly verified in simulations by pumping 3kW of power with a closed-loop control scheme. The converter's performance is checked by changing the irradiance for a wide range of power variations, and it was found that even at lower irradiance, the proposed converter is capable of achieving the Maximum power point efficiency of 99.5%.



11. Present Status of the Product/Other information:

It is in prototyping and testing stage

12. Product Brochure:

Ministry of Electronics & Information Technology, Government of India

Solar – Grid interfaced High Gain AC Charging Station for Electric Vehicles

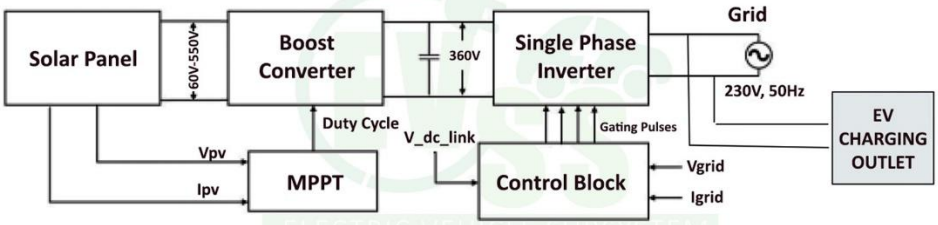
SOLAR EV CHARGER

A single-phase and three-phase AC charger powered by a solar photovoltaic system for Electric Vehicle(EV) charging.

Key Features

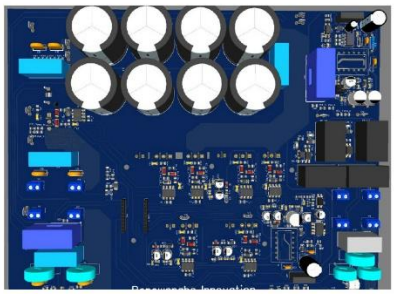
- Unity power factor in grid drawing and grid injection mode
- Guarantees the 3% THD with Distorted grid
- Solar extraction efficiency of 99%
- Operating efficiency (Ero efficiency) of 96%
- IP65 Protection

Product architecture- Single Line Diagram



Specifications

Parameter	Specifications
Input Voltage	Single phase: 70-450V (Dual stage)
	Three phase: 650V-1000V (Single stage)
Nominal Input voltage	Single phase: 350V (DC)
	Three phase: 800V(DC)
Rated output voltage	230V (AC RMS)
Output Frequency	50Hz
Rated output Power	3.3kW - 5kW
Power factor	Unity
Switching frequency	20kHz
Efficiency	>96%
Isolation	Direct (without transformer)
Cooling Type	Heat sink (natural air cooled)
Enclosure type	IP65
Control Features	Deficit power balance mechanism for adaptive MPPT



Indian Institute of Technology
Ropar

Centre for Development of Advanced Computing
Thiruvananthapuram

<u>EoI Technology ID</u>: EVSS01_ToT_02

1. **Name of the Product /Technology** : 3kW DC-DC Converter (HV)
2. **Name of Chief Investigator** : Mr. Ashish Deshpande
3. **Name of the Lead Product/ Technology Developer** : M/s Kalyani Powertrain Ltd.
4. **Target Applications:**

- Charges the auxiliary battery in an electric vehicle.
- Provides power to external loads such as lamps, cooling fans, and electrical components.

5. **Product /Technology Specifications:**

Parameter	**Specifications**
Input Voltage Range	450 to 800V
Nominal Input voltage	650V
Rated output voltage	28V (27.8V – 28.06V)
Rated output Power	3.0 kW
Output current	110A (@ 28Vdc)
Efficiency	>92%
Communication Interface	CAN 2.0
Control Features:	PWM and digital control
Isolation	Galvanic between input & output
Protection Features	Over voltage, over current
Ingress Protection Rating	IP67
Output voltage ripple	2%
Output voltage noise	2%
Coolant temp with no derating	-40°C to 65°C
Ambient temp @ full load, with no power derating	-40°C to 80°C
Cooling Type	Liquid Cooling
Dimensions (L x B x H) mm	389 x 261 x 99
Enclosure type	Aluminium

6. **Applicable standards:** IEC, AIS
7. **Certifications if any:** RoHS compliance

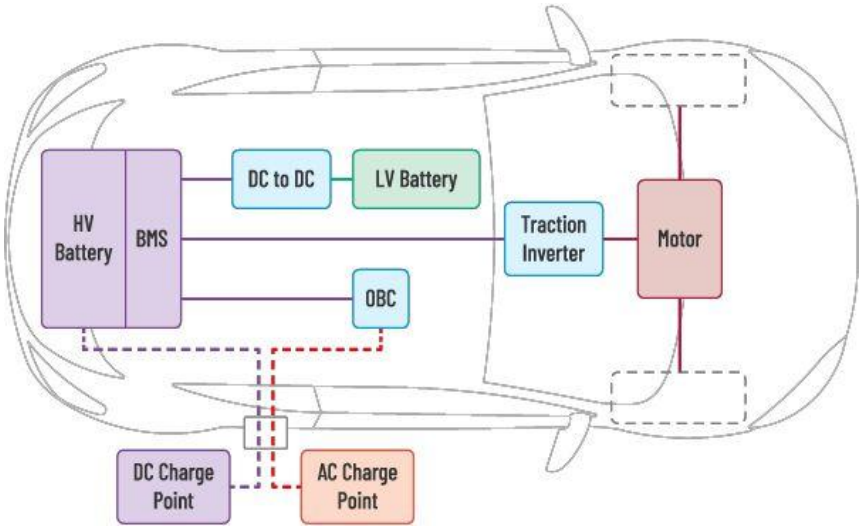
8. Unique Features of the Technology:

- Voltages allow wide input and very stable output.
- Precise voltage regulation.

9. Maturity of the Technology: TRL Level 7

10. Brief Description of the Product:

3kW DC-DC converter is designed to efficiently convert 650V DC battery power to a 28V DC output, adhering to stringent global automotive standards for safety, EMI, environmental impact, and mechanical robustness. The converter employs a state-of-the-art Phase-Shift Full Bridge ZVS topology, which is optimized for high-power SMPS applications. This topology, combined with a high-frequency inverter, high-frequency step-down transformer, high-frequency rectifier, and LC filter, ensures high efficiency and minimal output ripple and noise. To further enhance efficiency and power density, the converter operates at a high frequency of 100 kHz. Silicon carbide MOSFETs are utilized as power switches to minimize high frequency switching losses. Additionally, an inrush current limiter is integrated to protect the 650V battery, and various safety features, including overvoltage protection and reverse polarity protection, are implemented. The converter incorporates CAN 2.0b communication protocol for flexible control and monitoring. This advanced design enables the 3kW DC-DC converter to deliver reliable and efficient power conversion for automotive applications.



11. Present Status of the Product/Other information:
Prototype is available for demonstration

12. Product Brochure:

EVSS ELECTRIC VEHICLE SUBSYSTEM

Ministry of Electronics & Information Technology, Government of India

3kW DC-DC Converter (HV)

High voltage, high power 3kW DC-DC converter is developed to convert high voltage power supplied from the traction battery into low voltage suitable to power low voltage auxiliary systems in the vehicle. High Volumetric and Gravimetric Power Density allows easy installation and mounting while liquid cooled system confirms reliable operation in widely varied environmental conditions

Unique Features

- Voltages allow wide input and very stable output
- Precise voltage regulation

Key Features

- AEC grade components
- Adjustable Voltage Output
- CAN Bus Interface
- Galvanic Isolation between Input & Output
- Protection against overvoltage
- Protection against overcurrent

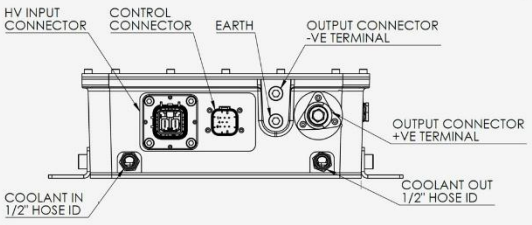
Target Application

- Charges the auxiliary battery in an electric vehicle
- Provides power to external loads such as lamps, cooling fans, and electrical components

Specifications

Maximum Output power	3 kW
Input Voltage Range	450V - 800V DC
Input Nominal Voltage	650V DC
Input Maximum Current	7.3A
Input Capacitance	20uF
Output Nominal Voltage	27.8V – 28.06V DC
Maximum output Current	110 A (@ 28Vdc)
Output Peak power	3.5kW for 10 Seconds
Efficiency	92 %
Enclosure Protection	IP67
Cooling Type	Liquid Cooling
Turn-On Delay	60 Sec (From start to Nominal Voltage)
Turn-Off Timing	100ms (PS wakeup delay;(monotonic Vo fall))
Protections	Over-Current, Over-Voltage, Over-Temperature, High Input Voltage and Input fuse
Dimensions (L x W x H)	389 x 261 x 99 (mm)
Operating Temp (Deg C)	-40°C to 65°C (Coolant temp with no derating)
	-40°C to 80°C (Ambient temp @ full load, with no power derating)
Weight	9.31 kg
Mounting holes	8 holes, M8 x 1.25 x 12 Deep

Connectors, Pin configuration with cable gauges:



Bharat Forge Limited
Pune

BHARAT FORGE | KALYANI

Centre for Development of Advanced Computing
Thiruvananthapuram

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EOI Technology ID: EVSS01_ToT_05

1. **Name of the Product /Technology** : Reduced rare-earth interior permanent magnet synchronous motor (IPMSM) & High efficiency EV Motor Controller

2. **Name of Chief Investigator** : Dr. Krishna Raj R

3. **Name of the Lead Institution** : CART - IIT Delhi

PART A: IPMS MOTOR

4.(a). Target Application:

- High-speed two-wheelers
- electric loaders (three-wheelers)

5.(a). Product /Technology Specifications in a Table

Parameter	Specifications
Input Voltage	282 V(RMS)
Rated Power	5 kW
Rated Torque	17 N-m
Rated Speed	2800 rpm
Maximum Speed	5600 rpm
Motor Type	Mid-motor drive
Ingress Protection Rating	IP67

6.(a). Applicable standards: As per AIS-041 Standard

7.(a). Certifications if any: Nil

8.(a). Unique Features of the Technology:

- It uses a combination of rare-earth and non-rare-earth magnets.
- Non-rare-earth magnets constitute the majority of the total magnet volume.

9.(a). Maturity of the Technology:

Testing of the motor under rated torque and speed is underway. Testing with specific drive-cycle is to be carried out.

10.(a). Brief Description of the Product:

A combination of NdFeB magnets (of N52 grade) and Ferrite magnets (of Y30 grade) have been used for the interior permanent synchronous machine. At the same time, fractional slot winding is used to achieve sinusoidal back-emf and reduce cogging torque. It has been found through experiments that the cogging

torque is within 2% of the rated torque. The simulation results demonstrate that the torque ripple is around 11%. The peak value of efficiency is found to be 93.1%.

11.(a). Present Status of the Product/Other information

The tests related to characterization of the motor and cogging torque has been conducted. On-field trial and certification are to be done.

Part B: MOTOR CONTROLLER

4.(b). Target Application: Mini e-loaders

5.(b). Product /Technology Specifications in a Table:

Parameter	Specifications
Input voltage range	200V-400V DC
Nominal Input voltage	400V DC
Rated output Power	5 kW
Output current	22 A
Efficiency	96% - 98%
Communication Interface	CAN
Control Features:	MTPA, Flux weakening, MTPV
Protection Features	Desaturation Protection, Under-voltage lock-out protection for the device.
Cooling Type	Naturally cooled
Dimensions (L x B x H) mm	350 x 280 x 170
Enclosure type	Aluminium

6.(b). Applicable standards:

Automotive EMI standards , AIS standards as applicable to motor controller

7.(b). Certifications is any: Nil

8.(b). Unique Features of the Technology:

- The controller is developed using state-of-the-art SiC technology.
- It ensures high efficiency in torque and speed-controlled operations.
- Supports regenerative braking options.
- Includes main electrical protection features.

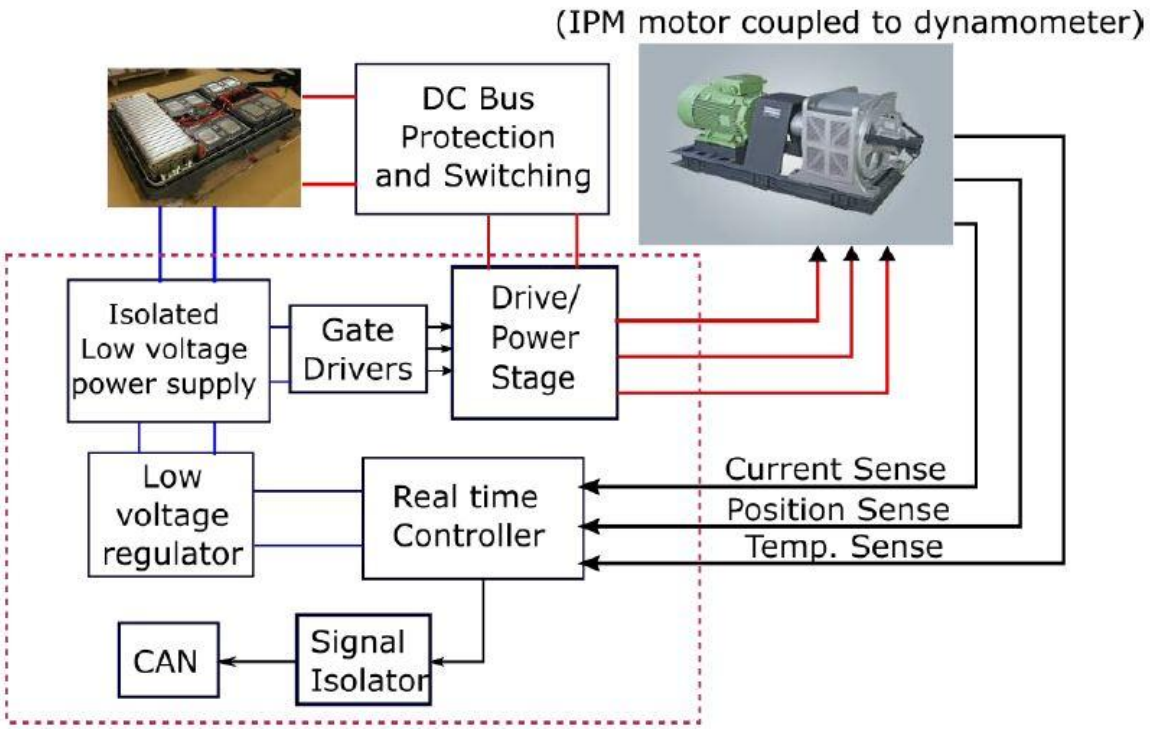
- Provides protection against thermal runaway.
- Incorporates real-time controllers with Vehicle Control Unit (VCU) features.
- Designed with ingress protection for durability and reliability.

9.(b). Maturity of the Technology:

The product is in testing phase, needs real field field deployment and trials, reliability testing and upgradations.

10.(b). Brief Description of the Product

The product is a 5 kW IPMSM motor controller which is developed along with 5 kW motor, targeted for EV applications. Both control algorithms and hardware are designed in order to cater for best efficiency and reliability for an electric vehicle. SiC device technology is used in this proof of concept design. Aluminium chasis is used as enclosure both for ingress protection and thermal management.



11.(b). Present Status of the Product/Other information

The product is currently to be tested for full power, standards and reliability and to be tested with developed motor for performance and drive cycle performance.

12. Product Brochure: (a) 5kW IPMS Motor

Ministry of Electronics & Information Technology, Government of India

ELECTRIC VEHICLE SUBSYSTEM

Reduced Rare-Earth Interior Permanent Magnet Synchronous Motor

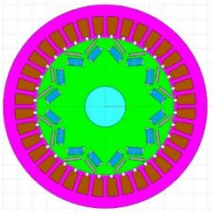
A high efficiency interior permanent magnet synchronous motor (IPMSM) has been developed to promote indigenization. Electric Vehicle (EV) Motors typically operate in low speed region of the drive cycle (especially for urban city driving). This design maximizes the efficiency of the motor corresponding to those operating points.

Stator Assembly

Rotor Topology

Unique Features

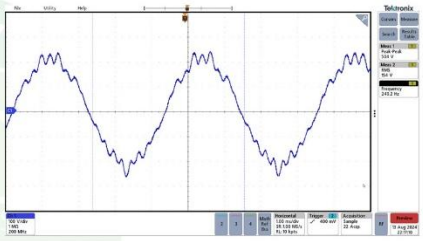
- It uses a combination of rare-earth and non-rare-earth magnets
- Non-rare-earth magnets constitute the majority of the total magnet volume
- Reduction in torque pulsation and cogging torque to improve the starting performance and passenger comfort



Cross-sectional View of developed IPMSM

Key Features

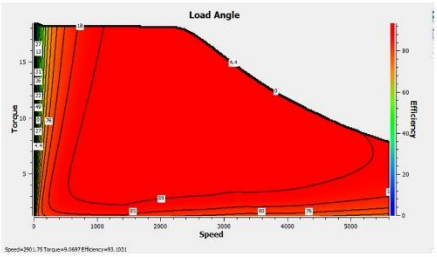
- Deployment of hybrid magnet structure (NdFeB and Ferrite) for reducing the content of rare-earth magnets
- Use of fractional slot winding for reduction of cogging torque
- Sinusoidal back-emf
- Efficiency is greater than 90% at higher speeds



Waveform of back-emf (line-to-line)

Target Application

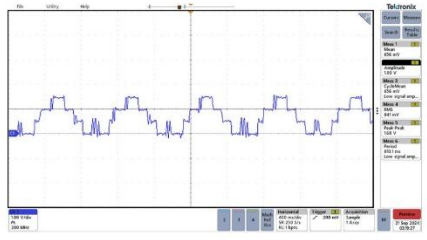
- High-speed two-wheelers
- Electric loaders (three-wheelers)



Efficiency Map

Technical Specifications

Parameter	Specifications
Input Voltage	282V(RMS)
Rated Power	5kW
Rated Torque	17 N-m
Rated Speed	2800 rpm
Maximum Speed	5600 rpm
Motor Type	Mid-motor drive
Efficiency	93.1%
Torque ripple	11%
No. of slots	36
Ingress Protection Rating	IP67



Cogging torque waveform

Centre for Automotive Research and Tribology (CART)
IIT Delhi

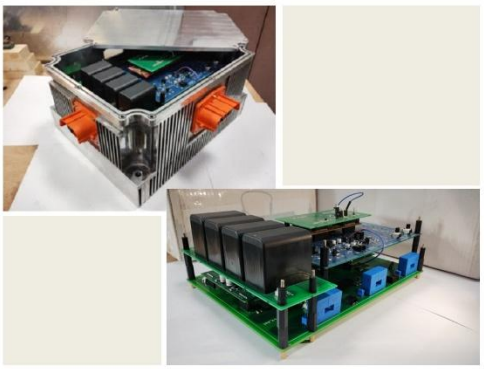
Centre for Development of Advanced Computing
Thiruvananthapuram

(b) 5kW Motor Controller

Ministry of Electronics & Information Technology, Government of India

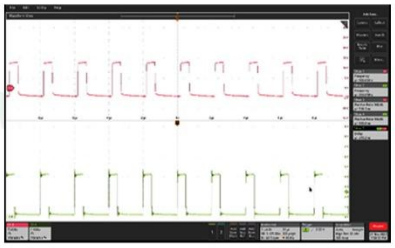
High efficiency 5kW inverter for automotive application

The product is a 5kW IPMSM motor drive controller which is developed along with 5kW motor, targeted for Electric Vehicles (EV) applications. Both control algorithms and hardware are designed in order to cater for best efficiency and reliability for an EV. SiC device technology is used in this proof of concept design. Aluminium chassis is used as enclosure both for ingress protection and thermal management.



Unique Features

- Torque and speed control of the EV motor.
- Reverse operation of the EV motor with a limit on maximum reverse speed
- Protection against various failures in the motor drive.
- Regenerative braking
- Protection against overload operation through thermal sensors
- Vehicle level control features
- CAN communication for integration with vehicle-level control units



Gate driver output

Key Features

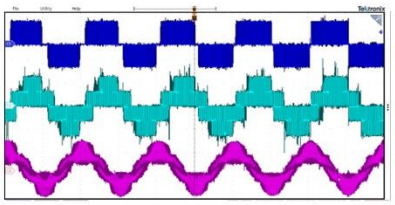
- High frequency converter design with discrete SiC devices
- Torque control and speed control modes with high efficiency operating points
- Design and development of firmware for synchronized drive operation with various operating modes of EV

Technical Specifications

Parameter	Specifications
Input Voltage Range	200V- 400V DC
Nominal Input Voltage	400V DC
Rated Output Voltage	282V (RMS)
Rated Output Power	5kW
Output Current	22A
Efficiency	96-98%
Control Features	Torque control and speed control modes
Cooling Type	Naturally cooled
Dimensions (L x B x H)	350 x 280 x170 (mm)
Protection Features	Desaturation protection and Under Voltage lock-out protection for the device

Target Application

- Low power Mini/ E-loader segments
- Golf carts
- Carriage vehicles in airports



Output Waveforms

Centre for Automotive Research and Tribology (CART)
IIT Delhi

Centre for Development of Advanced Computing
Thiruvananthapuram

EOI Technology ID: EVSS01_ToT_06

1. **Name of the Product /Technology** : Module integrated battery management system

2. **Name of Chief Investigator** : Dr. Sandip Ghosh

3. **Name of the Lead Institution** : IIT (BHU) Varanasi

4. **Target Application:**
   - Battery Management System with Active Balancing for Li-ion batteries.

5. **Product /Technology Specifications in a Table**

Parameter	Specifications
Technology	Electronic Circuit and Firmware for Active Balancing of Cells and Modules
Nominal voltage	Multiples of 48V module (reconfigurable)
Balancing current rating	0.5A for cell and 5A for module
Efficiency	More than 90% (computed experimentally over SoC balancing)
Module Communication Interface	CAN
Control Features	Specialized switching strategy
PCB Dimensions (L x B)mm	160 x 90 (for each of the BMS boards, and active cell balancing board)

6. **Applicable standards:** Nil

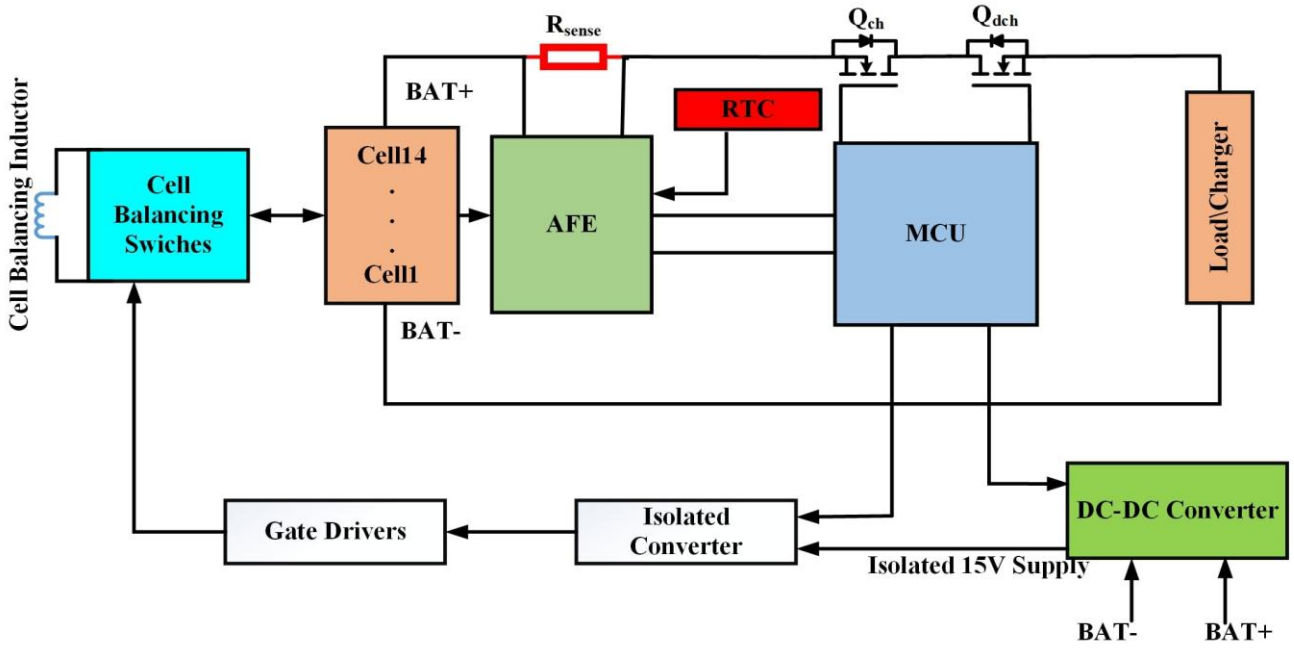
7. **Certifications if any:** Nil

8. **Unique Features of the Technology:**
   - Few components used
   - Smaller form factor of PCB for large number of cells.

9. **Maturity of the Technology:** TRL 7

10. **Brief Description of the Product:**

The product is an indigenous power electronics circuit to enable active balancing Li-ion battery cells and modules. While the cells within the modules are balanced, master-slave communication among modules enables module balancing. The product is packaged in a single PCB within a module while integrable to slave boards for module balancing. The system is highly efficient due to use of fewer parts and specialized switching of balancing switches.



11. **Present Status of the Product/Other information:** Project completed. Prototype demonstrated at TRL7.

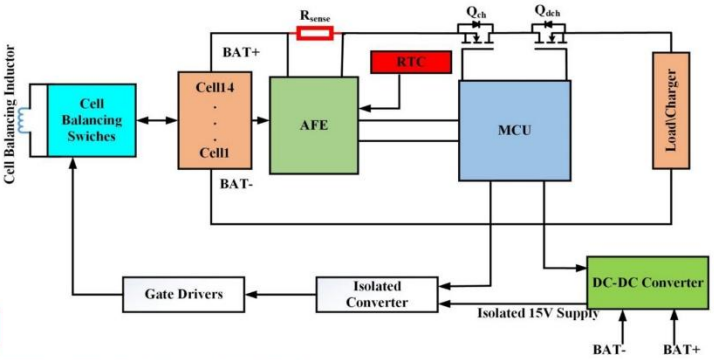
12. Product Brochure

Ministry of Electronics & Information Technology, Government of India

Module Integrated Battery Management System

An advanced battery management system (BMS) with capabilities of state of charge (SoC) estimation and active balancing system for Li-ion battery packs for EVs is realised. The BMS is scalable in the sense that modules can be integrated in master-slave fashion to attain higher voltage levels. The active balancing system is incorporated at the cell level, as well as the module level for uniform balancing across the pack. The balancing system is efficient and durable in the sense that the passive components used is fail-proof.

BMS Board



Key Features

- **Active balancing :** Smart energy management for capacity utilization, fail-proof and efficient passive component
- **Scalable for various applications:** Suitable for EVs, renewable energy storage, and backup power systems
- **Cell-to-cell & Module-to-module balancing :** Ensures uniform charge distribution for enhanced performance
- **CAN communication** Enables seamless data exchange between modules
- **Data monitoring:** Voltage, current and temperature
- **State estimation:** State of charge (SoC), state of health (SoH)

Unique Features

- Scalable, module-integrated
- Both the cell-level and module-level efficient active balancing
- Integrated SoC estimation algorithms
- Generic, hence reconfigurable
- On-board data-logging

Technical Specifications

- **Nominal voltage:** multiples of 48V module (reconfigurable)
- **Balancing current rating:** 0.5A for cell and 5A for module
- **Efficiency:** Better than 90% (computed experimentally over SoC balancing)
- **Module Communication Interface:** CAN
- **Control Features:** Specialized switching strategy
- **Product Type:** Designed PCB and switching software
- **PCB Dimensions (L x B) mm:** (160mm x 90mm) for each of the BMS boards, and active cell balancing board

Target Applications

- Two and three-wheel EVs
- Integrated modules for four-wheel EVs.

Indian Institute of Technology (B.H.U)
Varanasi

Centre for Development of Advanced Computing
Thiruvananthapuram

EOI Technology ID: EVSS01_ToT_07

1. **Name of the Product /Technology** : Portable 2kW Chargers for Electric 2W/3W & 3kW On-board charger (OBC) for LCV Segment
2. **Name of Chief Investigator** : Dr. Kaushal Kumar Jha
3. **Name of the Lead Institution** : Centre for Excellence in Energy and Telecommunications (CEET), IIT Madras
4. **Target Application** : Portable and OBC for 2W/3W and LCV Segment
5. **Product /Technology Specifications** : **(a) 2kW Portable Charger**

Input Specification	
Nominal Input Voltage	170V AC to 265V AC
AC Line frequency range	47Hz to 63Hz
Power factor	Greater than 0.9 from 10 percent rated load
Efficiency	92 to 95 % depending on the load at 230VAC
Total Harmonic Distortion	Less than 15% from 10% of the load at high line, for class A equipment
Output Specification	
Output voltage range	40 V DC to 87V DC
Nominal Voltage	48V / 60V / 72V
Maximum output power	2.0 kW
Peak output power	1.8 kW
Maximum output current	38A / 30A / 25A
Other Specification	
Protections	Complying with IEC 60950 Over-voltage/Under-voltage, Over-current / Under-current, Over- temperature/Under-temperature, Short-circuit, Time-out conditions, Reverse Polarity protection
Communication Interfaces	CAN, RS 485
LED Indications	LED Indications for battery status, Charging, Error and Fault condition
EMI & EMC	Complying to IEC 61000-3-1 / EN55011, Group 1, Class A
Surge	Complying with IEC/EN61000-4-5
Input Connector	230V 15A Cable
Output Connector	Customizable
Enclosure Protection	IP20
Cooling	Forced Cooling
Dimensions (L x B x H)mm	286 × 174 × 93
Working temperature	0-50 deg C (rated power up to 40 deg C)
Working humidity	20-90% non-condensing
Storage temperature humidity	-20 to 115 deg C

Product /Technology Specifications : (b) 3kW On-board Charger

Input Specification	
Voltage (nominal)	230VAC as per IS 12360
Operational Voltage range	170 – 300V AC 230V Nominal
Frequency	45 - 65Hz
Input current	15A
Power factor	Greater than 0.9 from 10 percent rated load
Efficiency	92 to 95 % depending on the load at 230VAC
Output Specification	
Output Voltage (Nominal)	380V
Output Current	8A
Max. Output Power	3.3kW
Indications	LED indications
Mechanical	
Enclosure Protection	IP67
Environmental	
Operating Temperature	0 to 50 deg.C
Cooling	Forced Cooling
Storage Temperature	-10 to 85 deg.C
Humidity	10 to 95%RH
Relative Humidity	20 – 90 % RH non-condensing
Protections	
Over-Load	105% rated output power, auto recovery when fault condition is removed
Over-Voltage	Recovers automatically when fault condition is removed
Reverse Polarity	Protection provided
EMC/EMI	Inbuilt EMI filter
Connection	
Input	Mains Cord 6A/240VAC 3 core 0.5Sq.mm 1500mm length with Indian Standard 3 pin plug
Output	Battery compatible connector
Safety	
Safety Standard	Designed to meet UL60950-1
Communication	
Battery Communication	CAN 2.0B (Optional)
Back-end Communication	GPRS/Wi-Fi (Optional)

6. Applicable standards: Safety standard: UL60950-1, EMI/EMC CISPR25

7. Certifications if any: NIL

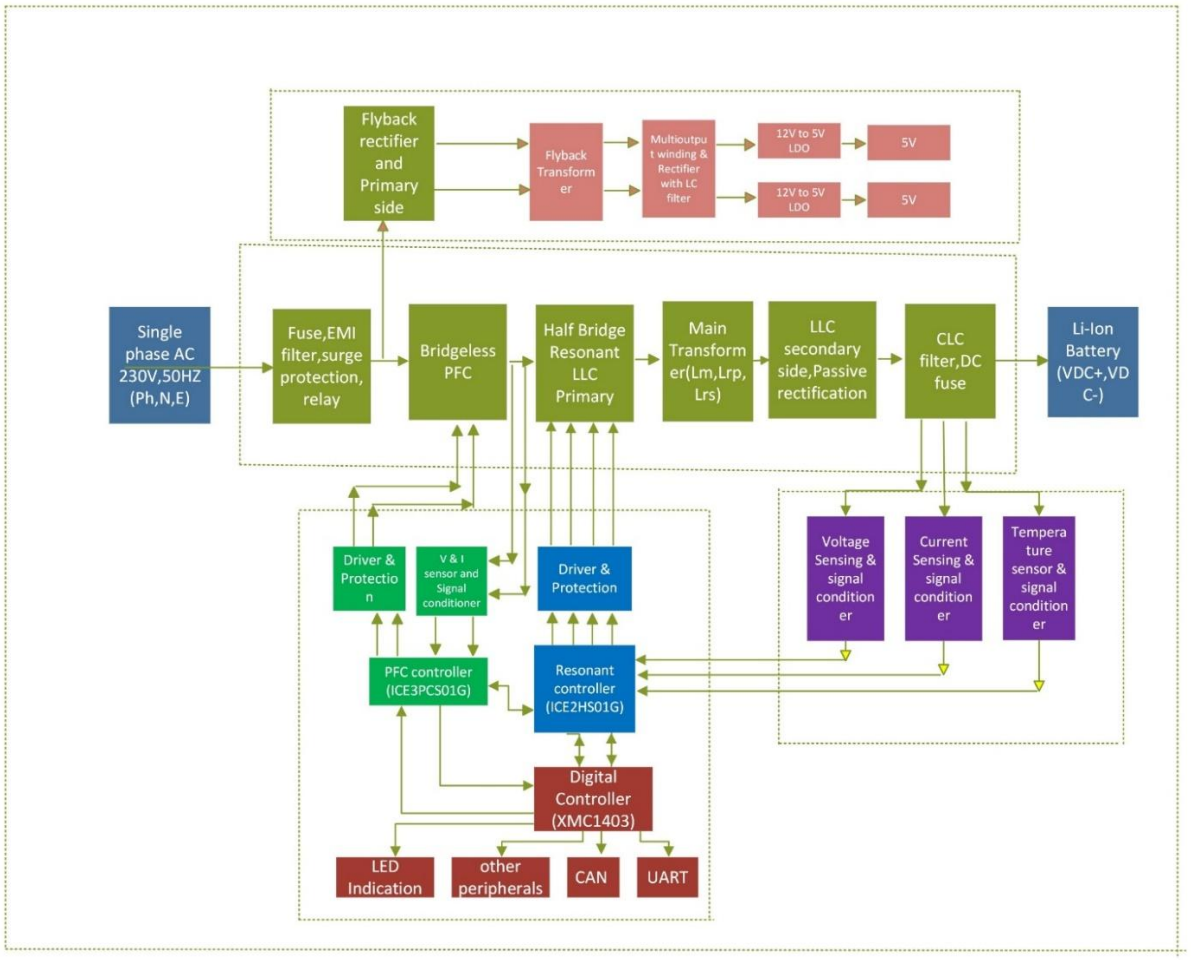
8. Unique Features of the Technology:

- High efficiency & good power factor
- Built-in protection & safety features
- Production level firmware configurable output voltage
- Customized CC-CV setting
- Intelligent charging control
- CAN enabled chargers

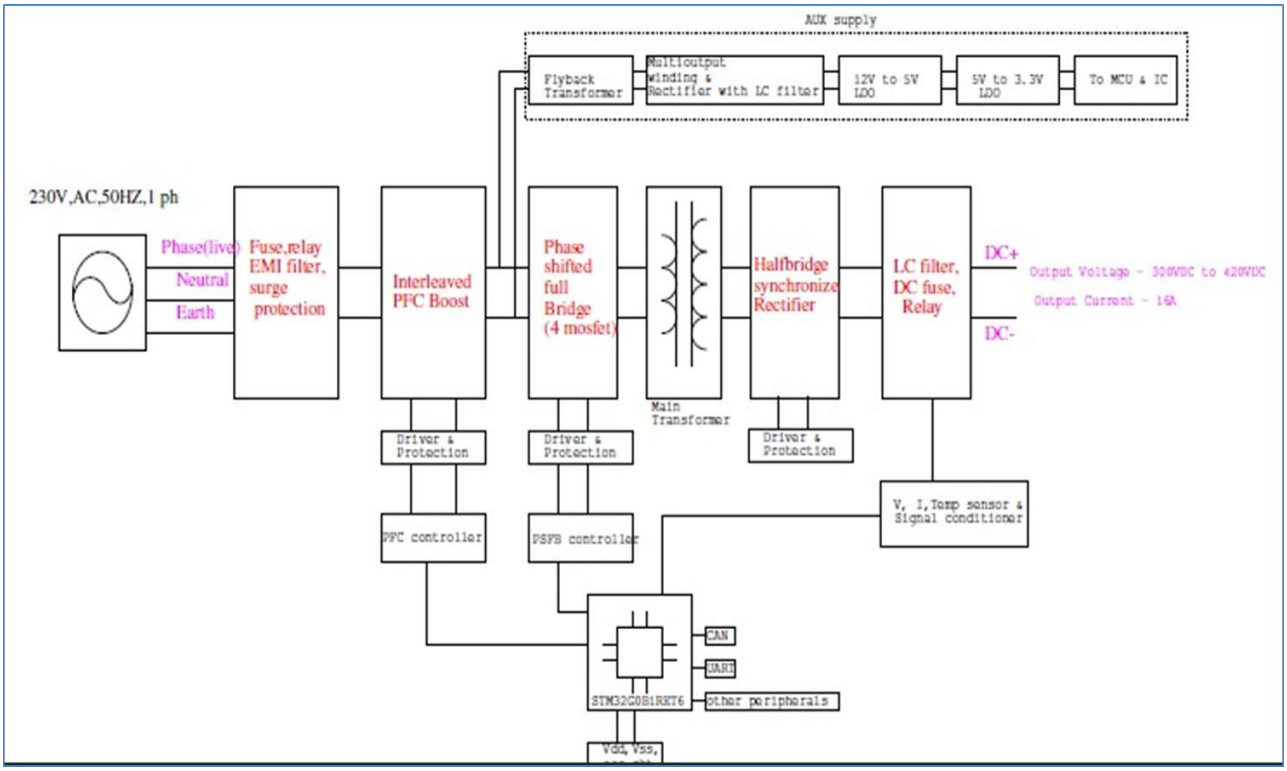
9. Maturity of the Technology: TRL 7

10. Brief Description of the Product:

The product includes portable and on-board charging solutions designed for electric vehicles in India. Portable chargers serve two-wheelers (2W), three-wheelers (3W), and quadricycles, offering flexible and convenient charging. The on-board charging solution is specifically designed for the light commercial vehicle (LCV) segment. These solutions address the unique needs of the Indian market, supporting the growth of EV adoption.



(2kW Charger Block diagram)



(3kW Charger Block diagram)

11. Present Status of the Product/Other information: 2kW & 3kW chargers are ready for commercialization.

12. Product Brochure: (a) 2kW Portable charger

Ministry of Electronics & Information Technology, Government of India

2kW Portable EV Charger

The product is a portable charging solution designed specifically for electric vehicles (EVs) in India. It caters to two-wheelers (2W) and three-wheelers (3W), offering flexible and convenient charging options. This innovative solution addresses the unique needs of the Indian market, supporting the widespread adoption and growth of electric vehicles

Unique Features

- High efficiency & good power factor
- Built-in protection & safety features
- Production level firmware configurable output voltage
- Customized CC-CV setting
- Intelligent charging control
- CAN enabled chargers

Charger Output Voltage

48V | 60V | 72V

Specifications

Input Nominal Voltage	170V AC to 265V AC
Input AC Line frequency range	47Hz to 63Hz
Output voltage range	40 V DC to 87V DC
Output Nominal Voltage	48V / 60V / 72V
Maximum output power	2.0 kW
Output Peak power	1.8 kW
Maximum output current	38A / 30A / 25A
Communication Interfaces	CAN, RS 485
Surge	Complying to IEC/EN61000-4-5
Input Connector	230V 15A Cable
Power factor	Greater than 0.9 from 10 percent rated load
Efficiency	92 to 95 % depending on the load at 230VAC
Output Connector	Customizable
Enclosure Protection	IP20
Cooling	Forced Cooling
Dimensions(mm)	286 × 174 × 93
Working temperature	0-50 deg C (rated power up to 40 deg C)
Working humidity	20-90% non-condensing
Storage temperature humidity	-20 to 115 deg C
LED Indications	LED Indications for battery status, Charging, Error and Fault condition
EMI & EMC	Complying to IEC 61000-3-1 / EN55011, Group 1, Class A
Protections	Complying with IEC 60950 Over-voltage/Under-voltage, Over-current / Under-current, Over- temperature/ Under-temperature, Short-circuit, Time-out conditions, Reverse Polarity protection

Target Application

- Portable chargers for 2 wheeler and 3 wheeler Electric vehicles

The Centre of Excellence in Energy and Telecommunications
(CEET)

Centre for Development of Advanced Computing
Thiruvananthapuram

(b) 3kW On-Board Charger

Ministry of Electronics & Information Technology, Government of India

3kW DC On-board EV Charger

The product is an on-board charging solution designed specifically for electric vehicles (EVs) in India. This charger is ideal for three-wheelers (3W) and quadricycles, offering flexible and convenient charging options. Additionally, the on-board charging solution is tailored for the light commercial vehicle (LCV) segment. These solutions address the unique needs of the Indian market, supporting the widespread adoption and growth of electric vehicles.

Unique Features

- High efficiency & good power factor
- Built-in protection & safety features
- Production level firmware configurable output voltage
- Customized CC-CV setting
- Intelligent charging control
- CAN enabled chargers

Charger Output Voltage

380V

Target Application

- On-board charger for 3 Wheelers and Quadricycles with better thermal management

Specifications

Input Voltage (nominal)	230VAC as per IS 12360
Operational input Voltage range	170 – 300V AC 230V Nominal
Frequency	45Hz – 65Hz
Input current	15A
Power factor	Greater than 0.9 from 10% rated load
Efficiency	92% - 95 % depending on the load at 230VAC
Output Voltage (Nominal)	380V
Output Current	8A
Output Max. Power	3.3kW
Indications	LED indications
Enclosure Protection	IP67
Operating Temperature	0 to 50 °C
Cooling	Forced Cooling
Storage Temperature	-10° C to 85° C
Humidity	10% – 95%RH
Relative Humidity	20% – 90 % RH non-condensing
Over-Load	105% of rated output power, auto recovery when fault condition is removed Over-Voltage Recovers automatically when fault condition is removed
Reverse Polarity	Protection provided
EMC/EMI	Inbuilt EMI filter
Safety	Designed to meet UL60950-1
Communication	Battery Communication CAN 2.0B (Optional), Back-end Communication GPRS/Wi-Fi (Optional)

The Centre of Excellence in Energy and Telecommunications
(CEET)

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Thiruvananthapuram

EoI Technology ID: EVSS01_ToT_08

1. **Name of the Product /Technology :** High Performance isolated DC-DC Converters suitable for Auxiliary Supply in EVs

2. **Name of Chief Investigator :** Dr. Rupesh Wandhare

3. **Name of the Lead Institution :** Indian Institute of Technology Hyderabad (IIT-H)

4. **Target Applications:**
   - DC-DC converters for Auxiliary Power supply of Electric Vehicles
   - Assisting in converting traditional solar water pumping to universal controller by solar PV to battery charging
   - Any DC generator to battery charging

5. **Product /Technology Specifications in a Table:**

Parameter	Specifications	
	300/14 V	**96/14 V**
Input Voltage Range	214 – 360 V	72-150 V
Nominal Input voltage	300 V	96 V
Rated output voltage	14 V	14 V
Rated output Power	2.2 kW	1.5 kW
Output current	157 A (max)	107 A (max)
Efficiency	93.7 %	94.1 %
Communication Interface	CAN enabled	CAN enabled
Control Features	a. Output current control b. Optional output voltage control (6-16 V)	a. Output current control b. Optional output voltage control (6-16 V)
Isolation	Galvanic Isolation	Galvanic Isolation
Protection Features	Input overvoltage, output-overcurrent/short circuit & over-temperature.	Input overvoltage, output-overcurrent/short circuit & over-temperature.
Ingress Protection Rating	NA	NA
Cooling Type	Forced Air cooling	Forced Air cooling
Dimensions (L x B x H) mm	165 x 278 x128	165 x 278 x128
Enclosure type	MS Sheet	MS Sheet

6. **Applicable standards:** None

7. **Certifications if any:** None

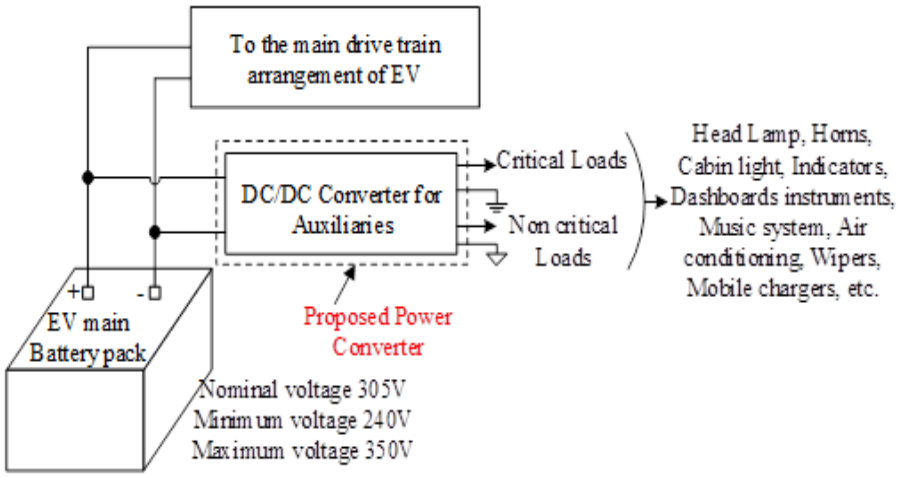
8. Unique Features of the Technology:

- Hybrid Bridge Isolated DC-DC converter with Coupled Inductor ZVS Half -Bridge regulation stage cascaded with a Push-pull isolation stage with synchronous rectification.
- SiC-Si MOSFET-based High-Frequency Conversion with Galvanic isolation.
- Wide input voltage range and wide output scalability.
- 80 Plus Efficiency from 10-100 % load range

9. Maturity of the Technology: TRL-7 testing completed.

10. Brief Description of the Product:

The proposed patented technology is a Hybrid Bridge Isolated DC-DC converter consisting of a front regulation stage of a Coupled Inductor ZVS Half-Bridge cascaded with a Push-pull isolation stage and synchronous rectification. It is an energy-efficient DC-DC converter suitable for interfacing high-voltage DC ports such as battery packs with low-voltage battery packs/auxiliary loads in industry applications and electric vehicles.



11. Present Status of the Product/Other information:

PI is also checking the possibility of startup in incubation center of Indian Institute of Technology Hyderabad for the commercialization of the project. The required modifications will be done in prototype to meet industry requirement. Also, PI is trying to convert traditional solar water pumping into USPC with battery backup with help of industry partner.

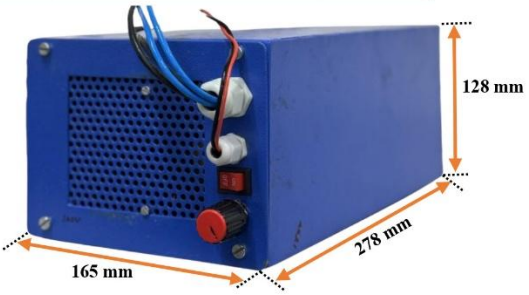
12. Product Brochure: (a) Power module for 300/14V

Ministry of Electronics & Information Technology, Government of India

High Performance Isolated DC-DC Converter with a Wide Range of Operations for Auxiliary Supply in EV

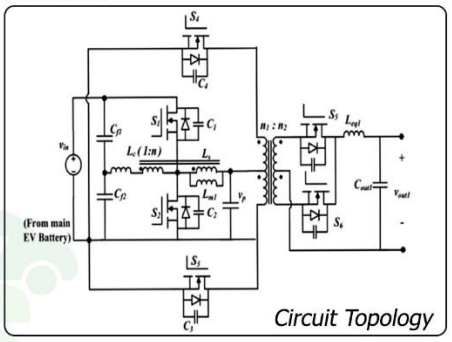
Isolated Auxiliary Power Module 300/14 V

This patented technology is a Hybrid Bridge Isolated DC-DC converter consisting of a front regulation stage of a Coupled Inductor ZVS Half-Bridge cascaded with a Push-pull isolation stage and synchronous rectification. It is an energy-efficient DC-DC converter suitable for interfacing high-voltage DC ports such as battery packs with low-voltage battery packs/auxiliary loads in industry applications and electric vehicles



Unique Features

- SiC-Si MOSFET-based High-Frequency Conversion with Galvanic isolation
- Wide input voltage range and wide output scalability.
- 80 Plus Efficiency from 10-100 % load range



Circuit Topology

Key Features

- Rated power around 2.2kW
- Input Voltage Range: 214-360V at 300 V (nominal)
- Output current control provision
- Output Voltage Range (Optional): 6-16 V
- Peak efficiency around 93.7%.
- Input soft start feature
- Output regulated at 14V (adjustable as per requirement) up to a load of 157A
- CAN communication enabled for On/Off/Control operation and monitoring

Specifications

Maximum output power	2.2kW
Input Voltage Range	214V - 360V DC
Input Nominal Voltage	300V DC
Input Nominal Current	7.5A
Input Maximum Current	12A
Input Capacitance	50uF
Output Nominal Voltage	14V DC
Maximum output Current	157A
Inrush/Start-up Current	<3.48A (Tested at Vin=300 V)
No-load Power	<33W [Tested at Vin=300 V (SMPS+MCU power)]
Peak Efficiency	93.7% (Tested at Vin=300 V,Vout=14V,Iout=96 A, 1.34 kW)
Enclosure Protection	IP33
Cooling	Forced Air cooling
Start-up time for nominal voltage	1.4 Sec-3.5 Sec (Tested at Vin=300 V, Vout=14V, Iout=125 A ,1.75 kW)
Peak Overshoot Voltage	3.85 V (Tested at Vin=300 V, Vout=14 V, Iout=150 A, 2.1 kW)
Protections	Input Over/Under-Voltage, Output Over-Current/short circuit, Over-Temperature
Dimensions (L x B x H)	165 x 278 x128 (mm)
Converter Temperature (Deg C)	63.8 °C (Tested at Vin=300 V, Vout=14 V, Iout=150 A, 2.1 kW)
Weight	7.5 kg

Target Application

- DC-DC converters for Auxiliary Power supply of Electric Vehicles
- Assisting in converting traditional solar water pumping to universal controller by solar PV to battery charging
- Any DC generator to battery charging

Indian Institute of Technology
Hyderabad

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Thiruvananthapuram

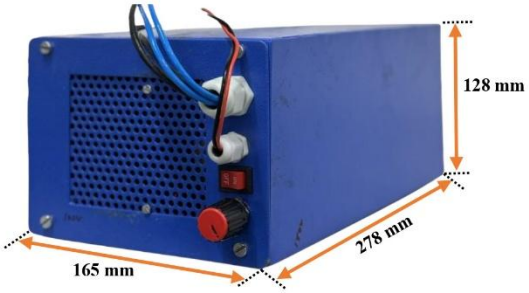
(b) Power module for 96/14V

Ministry of Electronics & Information Technology, Government of India

High Performance Isolated DC-DC Converter with a Wide Range of Operations for Auxiliary Supply in EV

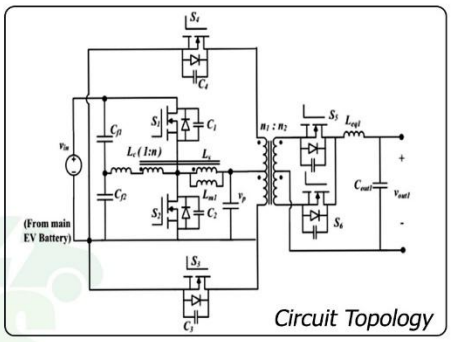
Isolated Auxiliary Power Module 96/14 V

This patented technology is a Hybrid Bridge Isolated DC-DC converter consisting of a front regulation stage of a Coupled Inductor ZVS Half-Bridge cascaded with a Push-pull isolation stage and synchronous rectification. It is an energy-efficient DC-DC converter suitable for interfacing high-voltage DC ports such as battery packs with low-voltage battery packs/auxiliary loads in industry applications and electric vehicles.



Unique Features

- SiC-Si MOSFET-based High-Frequency Conversion with Galvanic isolation
- Wide input voltage range and wide output scalability.
- 80 Plus Efficiency from 10-100 % load range



Circuit Topology

Key Features

- Rated power around 1.5kW.
- Input Voltage Range: 72-150 V at 96V (nominal)
- Output current control provision.
- Output Voltage Range (Optional): 6-16V
- Peak efficiency around 94.1 %.
- Input soft start feature
- Output regulated at 14V (adjustable as per requirement) up to a load of 107A
- CAN communication enabled for On/Off/Control operation and monitoring

Specifications

Maximum output power	1.5 kW
Input Voltage Range	72V - 150V DC
Input Nominal Voltage	96V DC
Input Nominal Current	16 A
Input Maximum Current	24 A
Input Capacitance	50uF
Output Nominal Voltage	14V DC
Maximum output Current	107 A
Inrush/Start-up Current	<1.2A (Tested at Vin=96 V)
No-load Power	<37 W [Tested at Vin=96 V (SMPS+MCU power)]
Peak Efficiency	94.1% (Tested at Vin=96 V,Vout=14V,Iout=71.5 A, 1.0 kW)
Enclosure Protection	IP33
Cooling	Forced Air cooling
Start-up time for nominal voltage	1.4 Sec-3.5 Sec (Tested at Vin=96 V, Vout=14V, Iout=95 A, 1.33 kW)
Peak Overshoot Voltage	3.85 V (Tested at Vin=96 V, Vout=14 V, Iout=105 A, 1.47 kW)
Protections	Input Over/Under-Voltage, Over-Current/short circuit, Over-Temperature
Dimensions (L x B x H)	165 x 278 x128(mm)
Converter Temperature (Deg C)	64.5 °C (Tested at Vin=96 V, Vout=14 V, Iout=105 A, 1.47 kW)
Weight	6.8 kg

Target Application

- DC-DC converters for Auxiliary Power supply of Electric Vehicles
- Assisting in converting traditional solar water pumping to universal controller by solar PV to battery charging
- Any DC generator to battery charging

Indian Institute of Technology
Hyderabad

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EOI Technology ID: EVSS01_ToT_09

1. **Name of the Product /Technology** : High-Power Density GaN (Gallium Nitride) based DC-DC Converter for 2/3-Wheeler EV application

2. **Name of Chief Investigator** : Dr. A. Hemachander

3. **Name of the Lead Institution** : NIT Puducherry, Karaikal

4. **Target Application** : Electric Vehicle auxiliary power supply

5. **Product /Technology Specifications in a Table:**

Parameter	Specifications
Input Voltage Range	36-72 V
Nominal Input voltage	48 V
Rated output voltage	14 V (5% tolerance)
Rated output Power	500 W
Output current	Upto 36 A
Switching frequency	100 - 360 kHz
Efficiency	Better than 90%
Operating Temperature	-20°C to 75°C
Communication Interface	-
Control Features:	Peak Voltage Mode Control
Isolation	-
Protection Features	Over Voltage, Over current
Ingress Protection Rating	IP 24 (Not formally tested)
Cooling Type	Aluminium Heat Sink with fin structures for enhanced dissipation
Dimensions (L x B x H) mm	125 x 72 x 85
Enclosure type	Aluminium case
Thermal Interface Materials	Thermal pads, adhesive to ensure efficient heat transfer

6. **Applicable standards:** Not formally tested

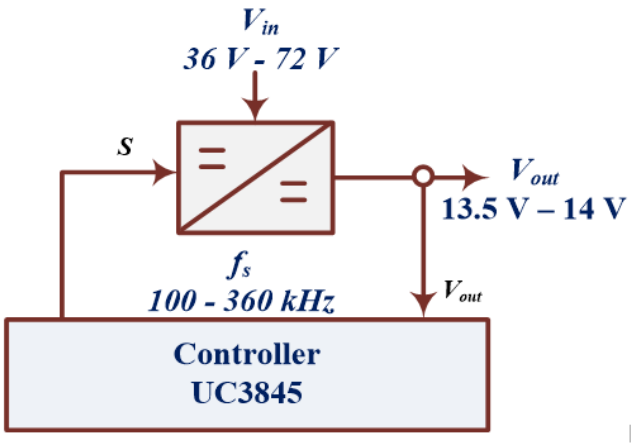
7. **Certifications if any:** Not formally tested

8. **Unique Features of the Technology:**
   - Used Gallium Nitride switch for the specified application in EV
   - High switching frequency for the specified application
   - High reliability

9. **Maturity of the Technology:** TRL 7

10. Brief Description of the Product:

It is a high-Power Density GaN - based DC-DC Converter for 2-Wheeler and 3-Wheeler EV application to supply 13.5/14 V for the auxiliary supplies in the EV. It is compact in size and highly reliable.



11. Present Status of the Product/Other information:

The product developed has been successfully tested in the vehicle environment and achieved TRL 7. The certification process is currently underway.

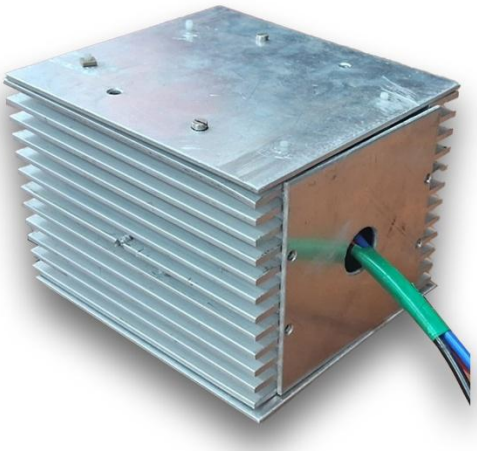
12. Product Brochure:

Ministry of Electronics & Information Technology, Government of India

High-power density GaN based DC-DC Converter for 2/3-wheeler EV application

Auxiliary DC-DC Converter for 2/3 - Wheeler EV

A high-power density 500W DC-DC converter with the given specifications with industrial standard is developed . The input varies from 35-72V and the output is regulated at 13.5/14V with 36A of output current



Unique Features

- High reliability design
- High switching frequency for the specified application
- Gallium Nitride switches were used in the converter

Technical Specifications

Parameter		Specification
Input voltage range	:	36 - 72V
Output voltage	:	14 V (5% tolerance)
Output current	:	36A
Power rating	:	500W
Switching frequency	:	100 – 360 kHz
Operating Temperature	:	- 20° C to +75° C
Heat Sink	:	Aluminium with fin structures for enhanced dissipation
Thermal interface materials	:	Thermal Pads, Adhesive to ensure efficient Heat Transfer
Control Scheme	:	Peak Voltage Mode Control
Conversion Efficiency	:	Better than 90%
Protection Features	:	Over Voltage, Over Current
Package Size	:	Compact, suitable for EV systems
Topology	:	Gallium Nitride switch-based Buck Converter

Converter Card

Controller Card

Target Applications

- Two and three-wheel EVs
- Other Electric Vehicle auxiliary power supply

National Institute of Technology
Puducherry

Centre for Development of Advanced Computing
Thiruvananthapuram

EoI Technology ID: EVSS01_ToT_12

1. **Name of the Product /Technology :** Smart BMS
2. **Name of Chief Investigator :** Dr. Mukesh Singh
3. **Name of the Lead Institution :** Thapar Institute, Patiala
4. **Other Institutes :** IIT Kanpur
5. **Target Applications:**

- **Electric Vehicles:** Optimizes battery usage and lifespan through precise SOC (State of Charge) and SOH (State of Health) predictions.
- **Renewable Energy Storage Systems:** It may be used for efficient energy management and extends storage solution lifespan.
- **Other Applications:**
  - Grid energy storage.
  - Portable electronics.
  - Industrial battery systems.

Accurate monitoring and predictive maintenance are essential for reliability and performance in these applications.

6. **Product /Technology Specifications in a Table:**

Parameter	Specifications
Input Voltage Range	0-96V
Nominal Input voltage	51.4V
Rated output voltage	51.4V
Rated output Power	5140W
Output current	100 A
Efficiency	96%
Communication Interface	CAN Bus, Wi-Fi, SIM
Control Features:	ESP32, Passive Balancing
Isolation	Isolated with Fault Detection
Protection Features	1. Over Voltage 2. Under Voltage 3. Over Current 4. Over Temperature 5. Under Temperature
Ingress Protection Rating	AIS 156, AIS 004, AIS 038 Rev2
Cooling Type	Natural Aspirated
Dimensions (L x B x H) mm	220x85x30 mm
Enclosure type	Mild Steel Battery Enclosure Box

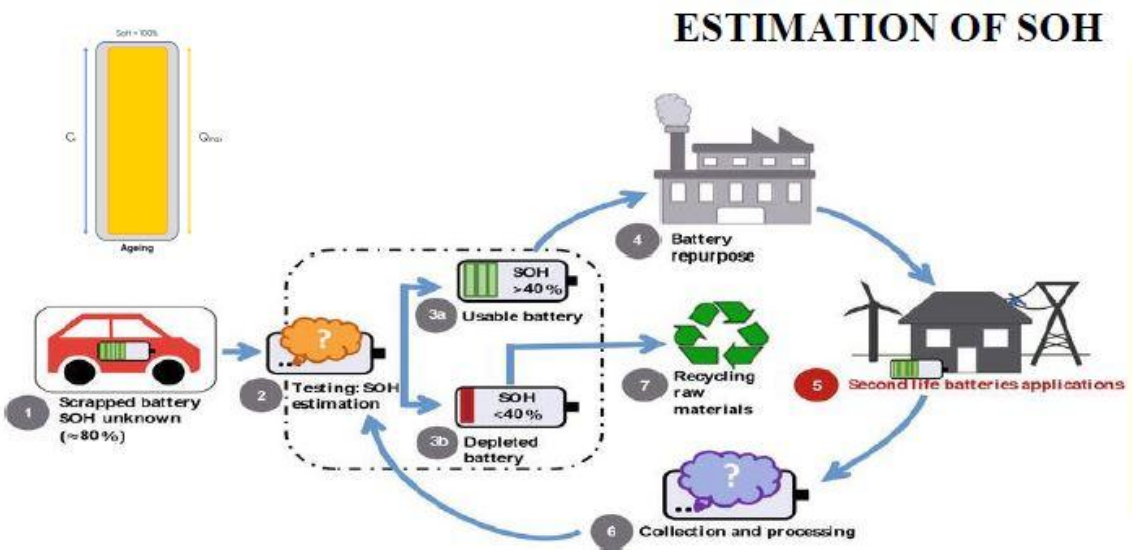
7. **Applicable standards:** AIS 156, AIS 004, AIS 038 Rev2.
8. **Certifications if any:** Under Process
9. **Unique Features of the Technology:**

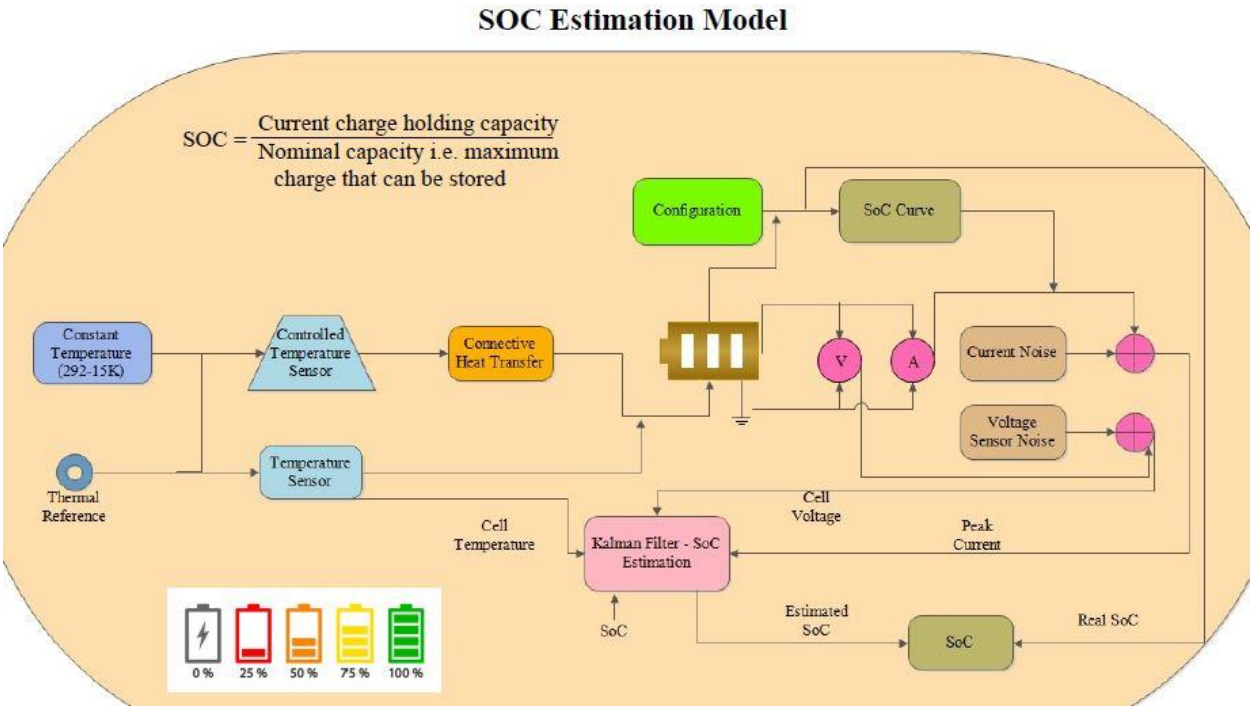
- Developed an intelligent battery management system to estimate the real-time state of charge of electric vehicle batteries (NMC, LFP, LCO, and LTO) using hybrid techniques.
- Designed hybrid methods using deep learning and model-based methods for estimating real-time SOC from SOH data.
- Real-time data is stored in the cloud to conduct a real-time SOC analysis from SOH data.
- The BMS is compatible with the specific chemistry of the battery (LFP, NMC, LTO), as each chemistry has different operating voltages, thermal characteristics, and charging requirements.

10. **Maturity of the Technology:** TRL-7 to TRL-9
11. **Brief Description of the Product:**

The Battery Management System (BMS) is designed to ensure optimal performance and safety by monitoring the voltage of individual cells and the overall battery pack, preventing overcharging or deep discharge. It measures current flow to maintain safe operating limits and uses temperature sensors to prevent overheating. To maintain balance, the BMS employs passive cell balancing by dissipating excess energy from higher-voltage cells as heat. It also features protection mechanisms, including overvoltage, under-voltage, and overcurrent safeguards, to prevent damage during charging and discharging. Data logging capabilities record key metrics such as voltage, current, and temperature for analysis and optimization, while its energy-efficient design minimizes power consumption. Engineered for durability, the BMS withstands harsh conditions like vibration, moisture, and extreme temperatures. Communication is facilitated through CAN Bus for interaction with external devices, and emerging wireless technologies enable remote monitoring and control, advancing BMS.

The Battery Management System (BMS) features bidirectional data transfer capabilities using MQTT, supporting command acceptance for seamless communication and control. It integrates with an AI/ML environment, linking various machine learning models to batteries for accurate State of Charge (SOC) and State of Health (SOH) predictions. Reinforcement learning techniques further fine-tune SOH predictions, enhancing accuracy and adaptability. A real-time dashboard, implemented with Java-based frameworks such as Spring Boot and Angular, provides efficient visualization and management of battery data. The backend database is powered by MongoDB, ensuring scalable and flexible data storage. Additionally, an API data interface feeds real-time data to machine learning models, maintaining accuracy and ensuring up-to-date SOC and SOH predictions.





12. Present Status of the Product/Other information: Product of hardware BMS and cloud assisted BMS is under use in the E-cart and it ready for TOT.

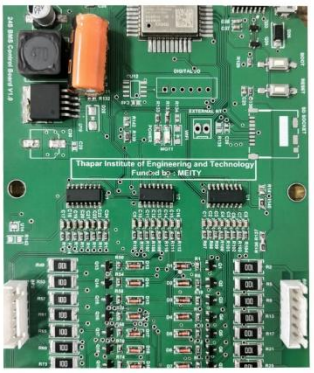
13. Product Brochure

EVSS ELECTRIC VEHICLE SUBSYSTEM

Ministry of Electronics & Information Technology, Government of India

Smart Battery Management System

The Battery Management System (BMS) optimizes performance and safety by monitoring voltage, current, and temperature while preventing overcharging, deep discharge, and overheating. It employs passive cell balancing and protection mechanisms to ensure battery longevity, with data logging for analysis and optimization. Featuring CAN Bus and wireless communication, it supports remote monitoring and control. The BMS integrates AI/ML for accurate SOC and SOH predictions, using reinforcement learning for enhanced adaptability. A real-time dashboard with Java-based frameworks and MongoDB ensures efficient data visualization, while an API interface keeps machine learning models updated



Unique Features

- Intelligent BMS for real-time SOC estimationof EV batteries (NMC, LFP, LCO, LTO) using hybrid techniques
- Hybrid methods combining deep learning and model- based approaches to estimate SOC from SOH data
- Real-time data storage in the cloud for SOC analysis
- Ensured BMS compatibility with different battery chemistries (LFP, NMC, LTO) considering their unique characteristics

Specifications

Parameter	Specifications
Input Voltage Range	0-96V DC
Nominal Input voltage	51.4V DC
Rated output voltage	51.4V DC
Rated output Power	5140W
Output current	100 A
Efficiency	96%
Temperature Range	-15°C to 65°C
Connection	2 Wire
Monitoring	Cloud based Real-Time
Cell chemistry	LFP, LCO, LTO, NMC
Comm. Interface	CAN Bus, Wi-Fi, SIM
Control Features	ESP32, Passive Balancing
Isolation	Isolated with Fault Detection
Protection Features	1.Over/Under Voltage 2.Over Current 3.Over/Under Temperature
Cooling Type	Natural Aspirated
Dimensions (L x B x H)	220x85x30 (mm)
Enclosure type	Mild Steel Battery Enclosure Box

Key Features

- Cost effective
- Accurate prediction of SOC from aging battery life
- Reliable BMS with safe operating envelop (SOE)
- Cloud integration for Real-Time predictions
- View battery and vehicle data with accurate location on cloud

Cloud based Features

- MQTT based bi-directional communication
- SQL database incorporated for capturing the data received from MQTT broker
- APIs designed to extract and filter data from SQL database
- Latest weekly data is fed to AI+ML algorithms for retaining and predictions ahead

Target Application

- Electric Vehicles
- Renewable Energy Storage Systems
- Grid energy storage.
- Portable electronics.
- Industrial battery systems

Thapar Institute of Engineering and Technology
Patiala

Centre for Development of Advanced Computing
Thiruvananthapuram

सी डैक CDAC

EoI Technology ID: EVSS01_ToT_13

1. **Name of the Product /Technology :** Adaptive BLDC motor controller
2. **Name of Chief Investigator :** Prof. Chandrashekhar N. Bhende
3. **Name of the Lead Institution :** IIT Bhubaneswar
4. **Target Application :** Light weight electric vehicles
5. **Product /Technology Specifications in a Table**

Parameter	Specifications
Input Voltage Range	44 - 60 V
Nominal Input voltage	48 V (dc link input, battery voltage)
Rated output voltage	36 V (inverter output line voltage)
Rated output Power	1.5 kW – 2.5 kW
Output current	30 A - 40 A
Efficiency	85 – 90 %
Communication Interface	Proximity sensor based pedal input
Control Features:	Motor control
Isolation	Optical Isolation between motor controller and power circuit (Motor drive)
Protection Features	Over current protection
Cooling Type	Aluminium heat sink - Air cooled (Fan cooled)
Dimensions (L x B x H) mm	(250 x 150 x 60) Motor controller card size
Enclosure type	Plastic enclosure for the motor controller

6. **Applicable standards:** Nil

7. **Certifications if any:** Nil

8. **Unique Features of the Technology:**

- Eliminating the need for an encoder for control.
- Fuzzy-based adaptive gain control which reduces transient current.
- Enhanced battery life.

9. **Maturity of the Technology:** Prototype

10. Brief Description of the Product

As EV runs continuously with frequent starting, accelerating, braking and gear change phenomena, its transient response should very good. Therefore, there is need to develop the advance and improved controller for EV so that its performance is improved in terms of efficiency under the conditions of uncertainty in traffic and road conditions. In the view of wide range of operating conditions, conventional controls may have more battery current during transient conditions.

The proposed fuzzy-based advance controller will help in reducing the overshoot in battery current and hence, battery life is improved. The developed fuzzy logic-based BLDC motor controller that uses speed reference input and feedback from Hall position sensors to calculate motor speed, eliminating the need for an encoder

This controller is integrated with commercial 3-wheeler EV and tested on the road conditions in the IIT campus.

Figure 1. Schematic diagram of EV system

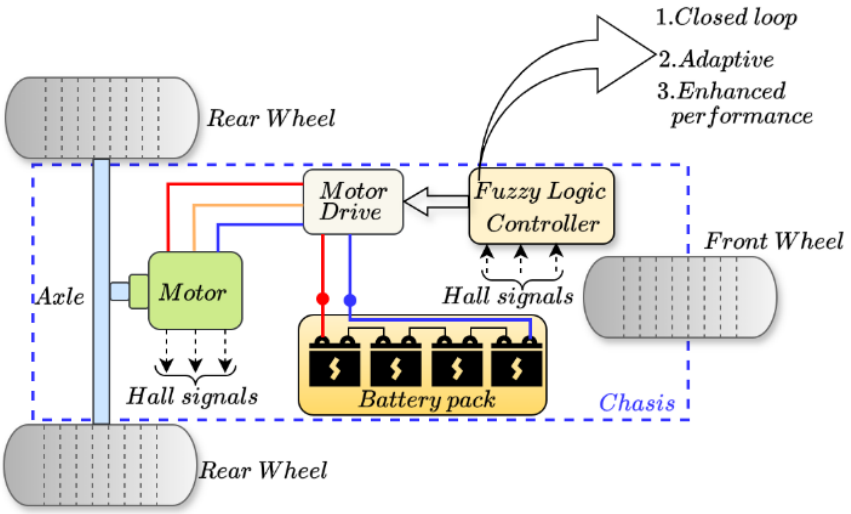
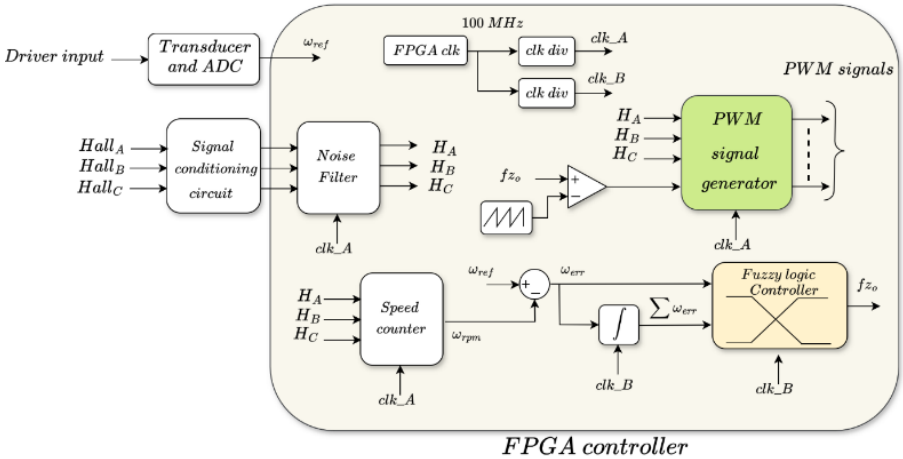


Figure 2. Block diagram-based representation of FPGA based implementation



11. Present Status of the Product/Other information:

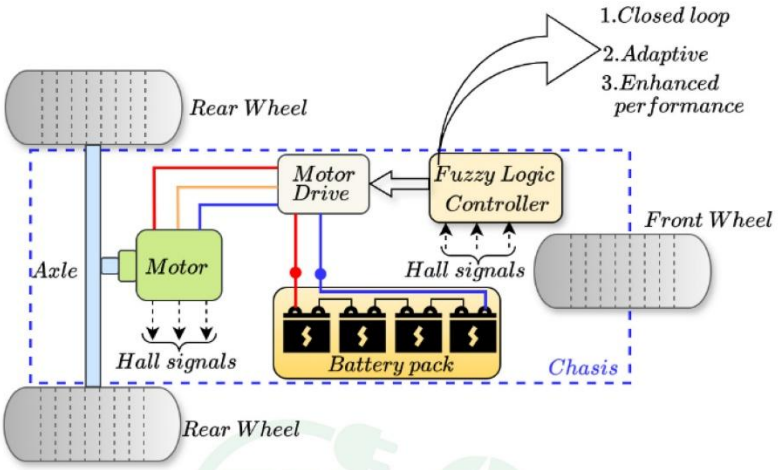
The developed fuzzy-based controller is integrated with commercial 3-wheeler EV having BLDC motor and tested on the road conditions in the IIT campus.

12. Product Brochure:

Ministry of Electronics & Information Technology, Government of India

Adaptive motor controller for BLDC Motor based three-wheeler Electric Vehicle

A Fuzzy Logic -Based Encoderless BLDC Motor Adaptive Controller for Enhanced Battery Performance for Electric Vehicle (EV)



Specifications

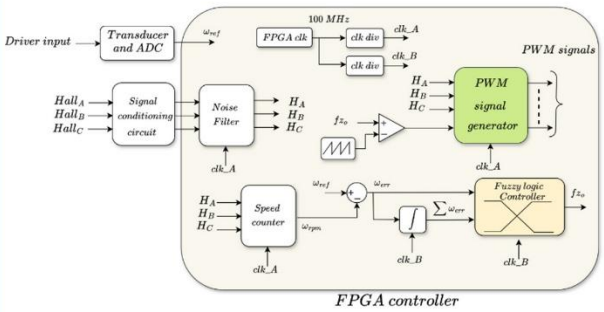
Input Voltage Range	44-60V
Nominal Input Voltage	48 V
Rated Output Power	1.5 kW to 2.5 kW
Output Current	30 A – 40 A
Efficiency	85 % – 90 %
Communication Interface	Proximity sensor based pedal input
Control Features	FPGA
Isolation	Opto-isolated gate drivers
Protection Features	Overcurrent protection.
Cooling Type	Aluminium heat sink (air cooled)
Dimensions (L x B x H)	250 x 150 x 60 mm
Working Temperature	25° C to 45° C (ambient temperature)

Target Application

- Light-weight electric vehicles (LEV)

Unique Features

- Eliminating the need for an encoder for control
- Fuzzy-based adaptive gain control which reduces transient current
- Enhanced battery life



FPGA controller

Future Scope

- Extension of the proposed concept to other permanent magnet motors
- Development of low-cost reconfigurable FPGA-based IC for motor drive applications
- Universal motor driver card

Indian Institute Of Technology (IIT)
Bhubaneswar

Centre for Development of Advanced Computing
Thiruvananthapuram

EOI Technology ID: EVSS01_ToT_14

1. **Name of the Product /Technology**: On-board Fast DC Chargers Using High-Speed GaN HEMT for Two-Wheeler (2W) EVs

2. **Name of Chief Investigator** : Prof. Mayank Shrivastava

3. **Name of the Lead Institution** : Indian Institute of Science, Bengaluru

4. **Name of other Institutes** : CDAC Thiruvananthapuram

5. **Target Application**:
   On-board Fast DC Chargers for Two-Wheeler (2W) EVs

6. **Product /Technology Specifications in a Table:**

Parameter	Specifications
Input Voltage Range	180Vrms - 265Vrms
Nominal Input voltage	230 Vrms P + N + PE(+6% and -10%)
Input frequency	50Hz
Rated output voltage	48 V DC
Rated output Power	3 kW
Output current	62.5A DC
Efficiency	97%
Communication Interface	CAN
Control Features:	Constant current (CC), Constant Voltage (CV)
Isolation	Galvanic Isolation
Protection Features	• Over current • Short circuit • Over voltage • Under voltage • Surge protection • Reverse Polarity
Ingress Protection Rating	IP 62
Ambient temperature	0°C – 55°C
Cooling Type	Forced air with Frameless Fan
Dimensions (L x B x H) mm	185 x 150 x 56 mm
Enclosure type	Aluminium

7. **Applicable standards:**
   - For components : AEC-Q100, AEC-Q200
   - For communication : ISO 11898

8. **Certifications if any:** Nil

9. **Unique Features of the Technology:**
   - GaN Based System
   - High power density and reduced weight.

- Forced air cooling only
- High frequency converters with low footprint and superior performance

10. Maturity of the Technology:

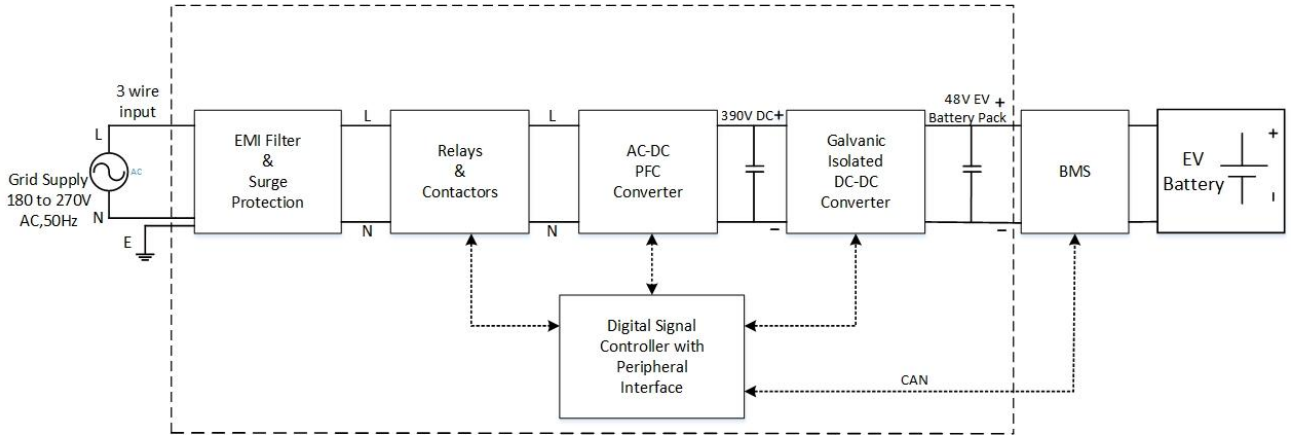
TRL 8 with Commercialization capability

11. Brief Description of the Product

The 3 kW On-board DC Chargers (OBC) is developed using high-speed GaN HEMT. This converter operates at high switching frequencies resulting in high performance, high efficiency, high power density and reduced weight.

Key Features

- Highly efficient PFC topology for in AC-DC conversion
- DC-DC converter with Galvanic Isolation
- High frequency converters with low footprint and superior performance
- Indigenous technology solution for reliable, fast On-board EV charger for Two-Wheeler (2W) EVs



12. Present Status of the Product/Other information

- Product under final lab level testing phase
- Field trails pending

13. Product Brochure:

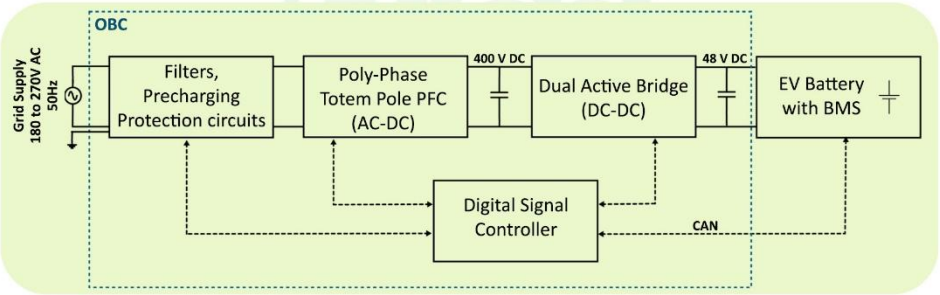
Ministry of Electronics & Information Technology, Government of India

3kW On-Board fast DC Charger (OBC)
with high-speed GaN HEMTs for Electric Two-Wheeler (E-2W)

A 3kW On-Board DC Chargers (OBC) is developed using high-speed Gallium Nitride High-Electron-Mobility Transist (GaN HEMT) with recent power electronics topologies. This converter operates at high switching frequencies resulting a compact low weight, high performance, higher efficiency, high power density.

Key Features

- GaN HEMT Based system
- High efficient Poly-Phase PFC topology for AC-DC conversion
- Dual Active Bridge (DAB) topology for DC-DC conversion
- High Frequency Planar technologies used
- High frequency converters with low footprint and superior performance
- Indigenous technology solution for reliable, fast On-board EV charger for Two-Wheeler (E-2W)
- Ingress protection: IP 62



Technical Specifications

Energy transfer mode			Conductive
Input	AC Supply	Nominal Voltage	230Vrms P + N + PE (+6% and -10%)
		Input frequency	50Hz, ± l.5Hz
Thermal	Ambient Temperature		0 to 55°C
	Cooling		Forced air with Frameless Fan
Mechanical	IP Rating		IP 62
	Mounting Type		Chassis mount
	Dimension (W x L x H)		185 x 150 x 56 mm
Output	Nominal voltage		48V DC
	Nominal Current		62 A DC
	Nominal & Peak Power		3 kW & 3.3 kW
Protection			• Over current • Short circuit • Over voltage • Under voltage • Surge protection
Communication between OBC and vehicle BMS			CAN
Physical Connection			Flying leads

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