# 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-D-001/2024

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-D-001/2024

**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 **15.01.2025 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**

| EoI Technology ID | Product Name | Page No. |
|---|---|---|
| EVSS01_ToT_02 | 3 kW DC-DC Converter | 07 - 10 |
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| EVSS01_ToT_07 | Portable Chargers for Electric 2W/3W & On-board charger for LCV Segment | 15 - 17 |
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**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:<br>Website: |
| 2. | Name of the Contact Person:<br>Address:<br>Mobile:<br>Landline:<br>Fax:<br>E-Mail: |
| 3. | Year of Incorporation: |
| 4. | Type of Organization<br>a) Public Sector/ Limited/Private Limited/ Partnership/ Proprietary/Society/ Any other<br>b) Whether 'Foreign Equity Participation (Please give name of foreign equity participant and percentage thereof)<br>c) Names of Directors of the Board/ Proprietors<br>d) Name and address of NRI(s), if any<br>e) Others (Please Specify.) |
| 5. | Category of the firm: Large/Medium/Small scale unit / Others |
| 6. | Address of the Registered Office:<br>(Include Certificate of Registration) |
| 7. | Number of Offices with addresses (Excluding Registered Office):<br>India: …….<br>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<br>Technical:<br>B.E./ B. Tech/ M. Tech / PhD<br>DIPLOMA<br>SKILLED TECHNICIANS<br>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_02

1. **Name of the Product /Technology** : 3 kW DC-DC Converter
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 |
| Rated output Power | 3 kW |
| Output current | 115A |
| 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 |
| Dimensions (L x B x H) mm | 389 mm x 261 mm x 99 mm |
| Enclosure type | Aluminium |

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

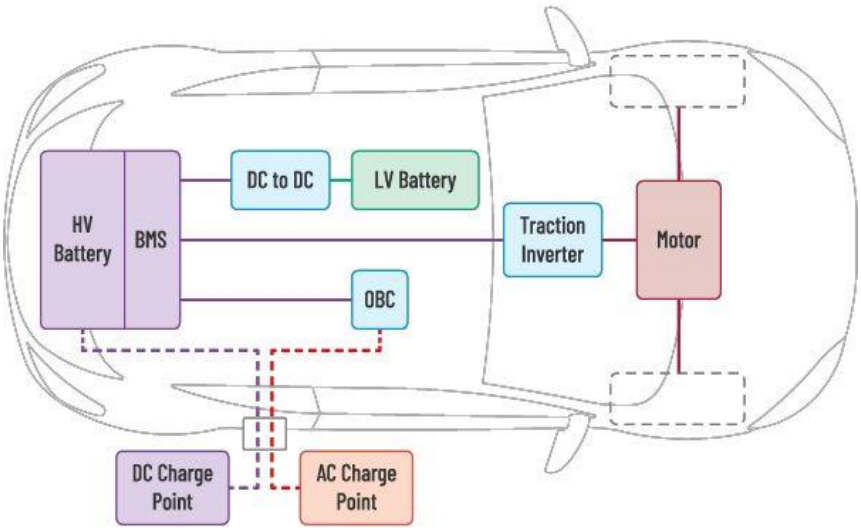
**8. Unique Features of the Technology:**

- 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 24V 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:**

BHARAT FORGE | KALYANI GROUP COMPANY

# DC-DC CONVERTER

## Product Description

High voltage, high power 3 kW DC-DC converter from Kalyani Powertrain is designed 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.

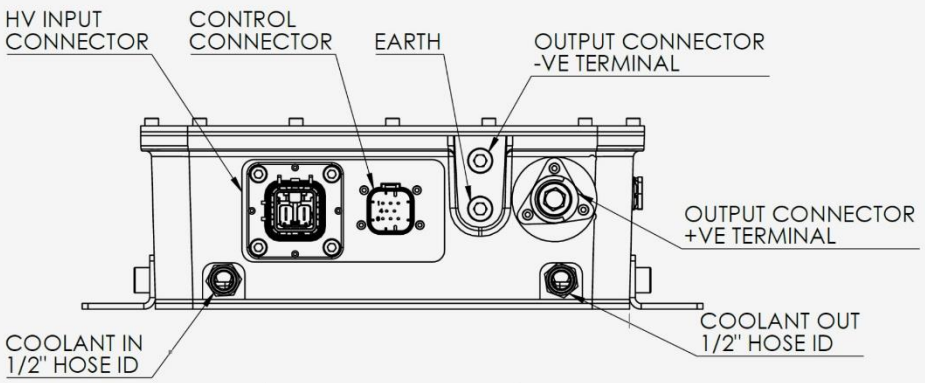
## Applications

Commercial vehicles (Battery - operated and Hybrid Trucks and Buses) and Off-highway vehicles.

## Product Features

- Power up to **3 kW**
- AEC grade components
- Input Voltage Range : **450V - 800V**
- Output Voltage : **28V DC**
- Adjustable Voltage Output
- Device efficiency 92%
- CAN Bus Interface
- Galvanic Isolation between Input & Output
- Protection against overvoltage
- Protection against overcurrent
- Protection class IP 67


## Connectors, Pin configuration with cable gauges:




सी डैक CDAC | इलेक्ट्रॉनिकी और सूचना प्रौद्योगिकी मंत्रालय Ministry of Electronics and Information Technology | EVSS ELECTRIC VEHICLE SUBSYSTEM

## Product Specifications

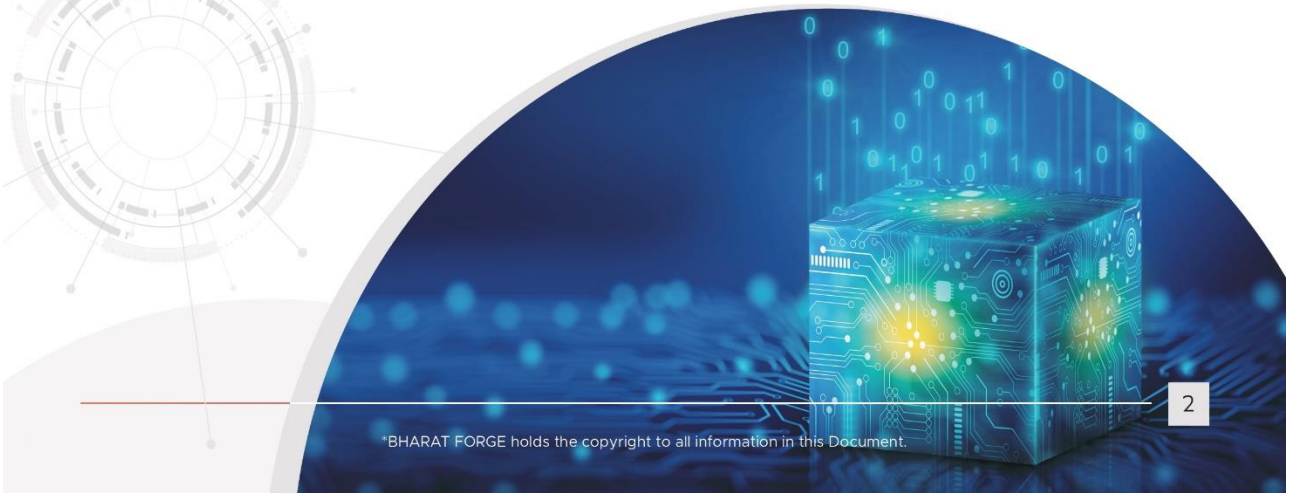
| Parameter | Description | Min | Nominal | Max |
|---|---|---|---|---|
| | Input Specifications | | | |
| Input Voltage | | 450 V | 650 V | 800 V |
| Input Current | | | | <7.3 A |
| Input Capacitance | | | 20 uF | |
| Efficiency | | 92% | | |
| Power Consumption @24Vdc | | | | 8 W |
| | Output Specifications | | | |
| Output Current | (@ 28Vdc) | | | 110 A |
| Output Power | Continuous 3kW; Peak 3.5kW (for 10 Seconds) | | | 3 kW |
| Output Voltage Set Point | | 27.8V | 28V | 28.06V |
| Turn-On Delay | From start to Nominal Voltage | | | 60 Sec |
| Turn-Off Timing | PS WAKEUP delay; (monotonic Vo fall) | | | 100 ms |
| Output Volt Ripple | | | | 2% of Vout |
| Output Volt Noise | | | | 2% of Vout |
| | Environmental Specifications | | | |
| | Operating: 62 kPa absolute pressure | | 3,600 | |
| Operating Temp (Deg C) | Coolant temp with no derating | -40°C | 65°C | |
| | Ambient temp @ full load, with no power derating | -40°C | 80°C | |

*Specifications are for the standard product and subjected to change as it is under development

**Protection against Over-Current, Over-Voltage, Over-Temperature, High Input Voltage and Input fuse**

## Mechanical Specifications

| Parameter | Description |
|---|---|
| Type of Cooling | Liquid |
| Dimensions (L x W x H), mm | 389 mm x 261 mm x 99 mm |
| Weight | 9.31 kg |
| Enclosure | IP 67 |
| Mounting holes | 8 holes, M8 x 1.25 x 12 Deep |





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**EoI Technology ID:** EVSS01_ToT_03

1. **Name of the Product /Technology :** Mobile Charging Station – Power Bank

2. **Name of Chief Investigator :** Mr. Shashank Narayan

3. **Name of the Lead Product/ Technology Developer :** M/s Log 9 Materials Scientific Pvt Ltd

4. **Target Applications:**

- Enables fast charging of electric vehicles (EVs) anywhere using DC001 charging.
- Provides on-demand charging services.
- Offers roadside assistance for EVs.

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

| Parameter | Specifications |
|---|---|
| Input Voltage Range | 3Ø, 415V (+6% and -10%) |
| Nominal Input voltage | 3Ø, 415V |
| Rated output voltage | 30-100 Vdc |
| Rated output Power | 15 kW |
| Output current | Max. 200 Amps |
| Efficiency | >90% |
| Communication Interface | CAN 2.0B |
| Control Features | HMI with touch screen |
| Protection Features | Over current, over voltage, over temperature protection |
| Ingress Protection Rating | IP 54 |
| Cooling Type | Forced air cooling |
| Dimensions (L x B x H) mm | 2145x1580x1830 (Overall product) |
| Enclosure type | Metal enclosed |

6. **Applicable standards:**
GBT - 27930, Bharat DC 001, AIS 138 Part B, AIS 048 for the Batteries.

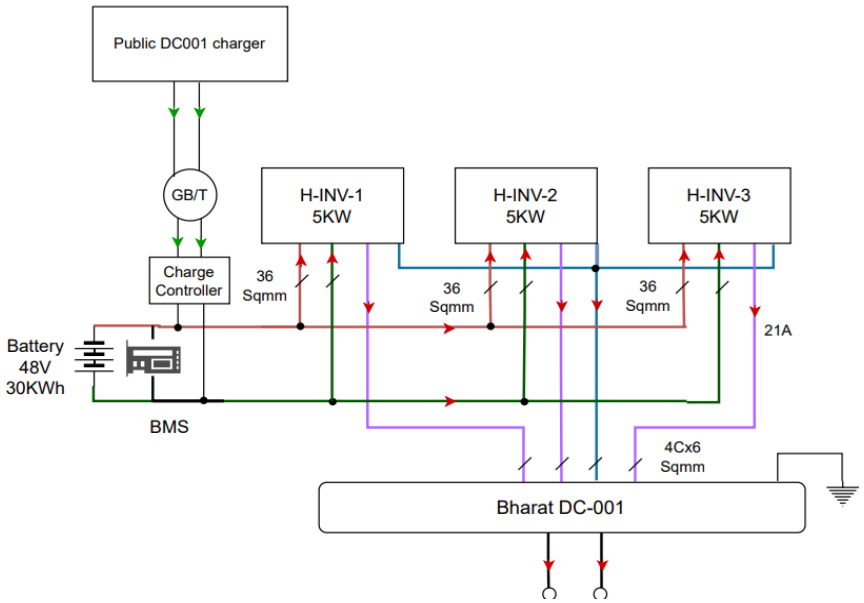
7. **Unique Features of the Technology:**

- Instacharge on Demand (IOD) is a charger mounted on a Mobility Platform and offers a completely off-grid solution.
- The charger can be moved as needed to rescue or charge vehicles anywhere.
- IOD is powered with 15kW and supports fast charging.
- Compatible with any vehicle that complies with the DC001 system.

8. **Maturity of the Technology:** TRL 8 & Above

## 9. Brief Description of the Product:

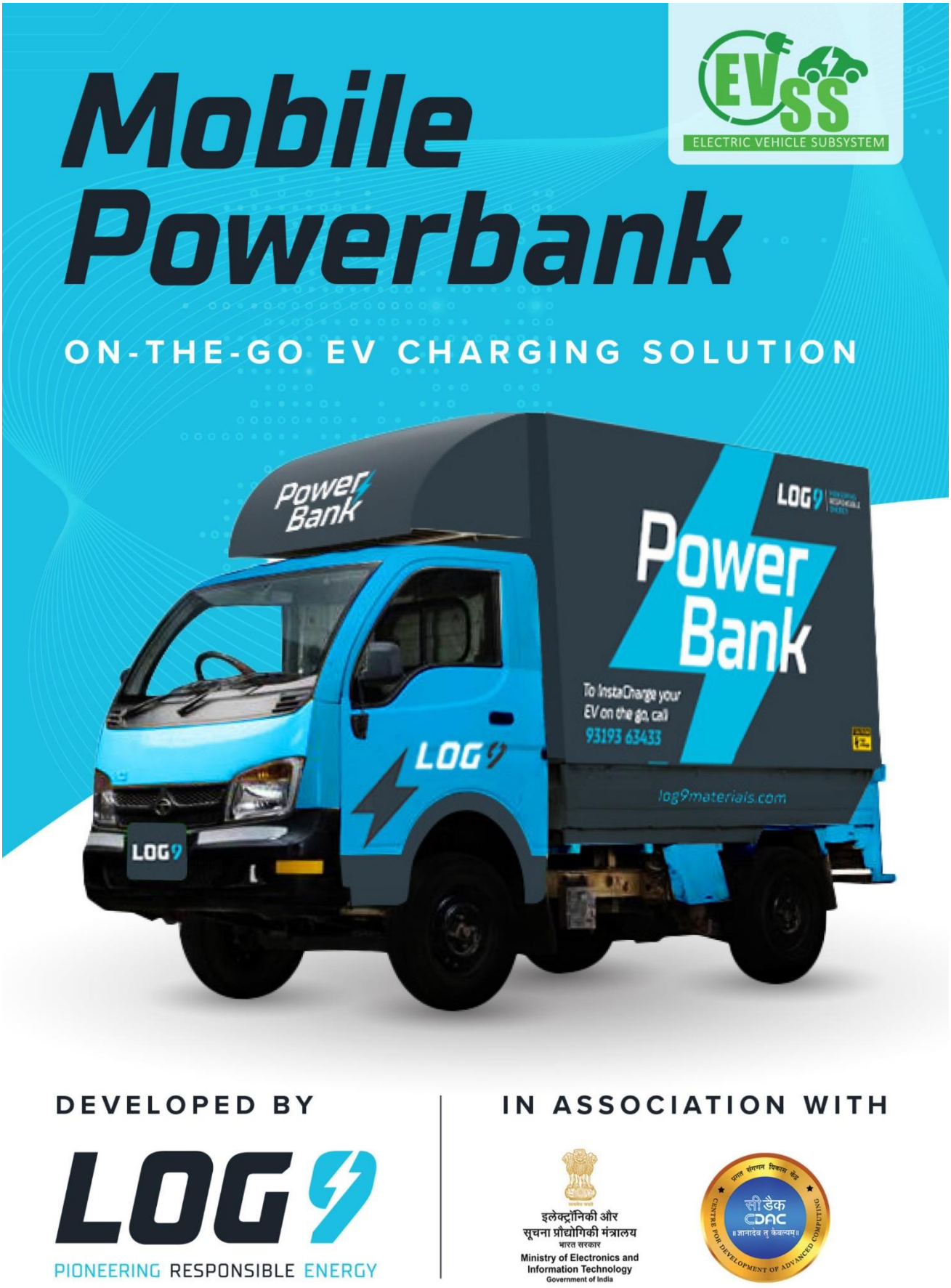
Instacharge on demand is a mobile EV DC fast charging solution**,** which can be mounted on a vehicle, to charge the EVs having DC 001 charging. It has a 16kWh fast charging battery pack which can charge multiple 2W or 3W on the go.




## 10. Present Status of the Product/Other information:

The overall field testing of the product is completed and many vehicles have been deployed in different locations. These vehicles are being used to charge the 3W fleets on the go.

**11. Product Brochure :**



Opportunity Charging in Remote Places

Mobile Charging Anywhere, Anytime

Encourages Faster Adoption of EV

Enables Remote Access to Power

## BATTERY SPECIFICATIONS

| | |
|---|---|
| Battery Capacity | 20 kWh |
| Cell Chemistry | LTO |
| No. of Cycles | 15000 Nos |
| Charging Method | GB/T or 3kw |

## SYSTEM SPECIFICATIONS

| | |
|---|---|
| No. of DC Outlets | 1 Nos |
| No. of Vehicles Charged Simultaneously | 1 Nos @ 15 kW |
| No. of Fast Charging Ports | 1 Nos |
| Maximum Output Power | 15 kW |
| Output Type | DC |
| Output Voltage | 30-100 V |
| Max Output Current | 200 A |
| System Weight | ~560 Kgs |
| Dimensions | 215 x 158 x 183 cm |

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**EOI Technology ID:** EVSS01_ToT_07

1. **Name of the Product /Technology** : Portable Chargers for Electric 2W/3W & On-board charger 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** :

| **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 to IEC/EN61000-4-5 |
| Input Connector | 230V 15A Cable |
| Output Connector | Customizable |
| Enclosure Protection | IP20 |
| Cooling | Forced Cooling |
| Dimensions | 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 |

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

**7. Certifications if any:** NIL

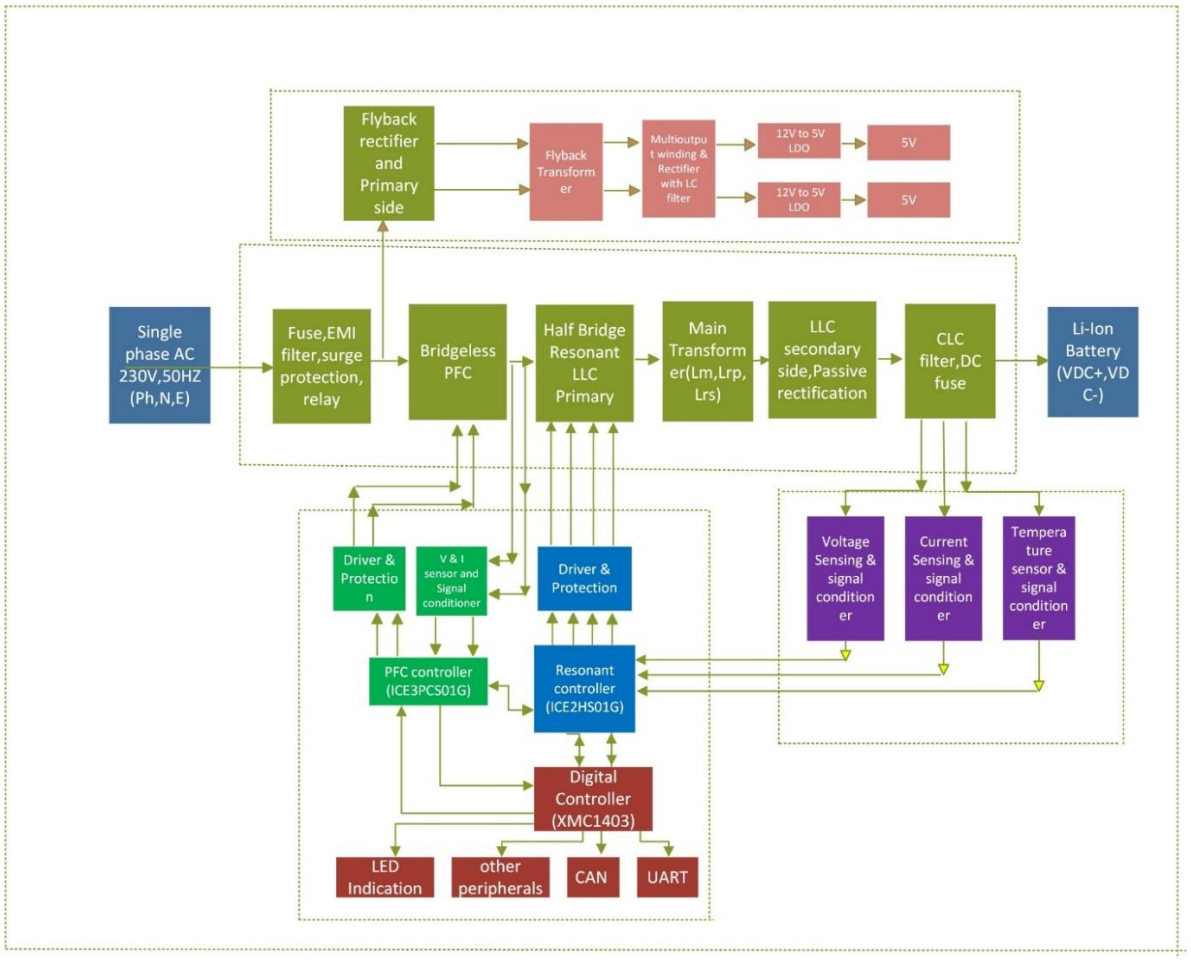
**8. Unique Features of the Technology:**

- 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.




**11. Present Status of the Product/Other information:** 2kW charger is ready for commercialization.

## 12. Product Brochure:

# 2 kW EV Charger

The objective of the project is to design and develop Portable / On-board chargers to address the requirement of 2 kW and quadricycle/ LCV electric vehicles used in India.


### Features

- CC/CV Profiling
- Wide input supply range
- Robust and reliable operation
- Higher efficiency
- Higher Powerfactor
- LED Indications

### Specifications

| | | |
|---|---|---|
| **Input** | Input Voltage Range | 190 VAC to 270 VAC |
| | Nominal Input Voltage | 230 VAC |
| | AC Line frequency range | 47 Hz to 63 Hz |
| | 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 that 15% from 10% of the load at high line, for class A equipment |
| **Output** | Nominal Voltage | 48V / 60V /72V |
| | Maximum output power | 2 kW |
| | Peak output power | 2 kW |
| | Maximum output current | 35A / 30A/ 25A |
| **Protections & Safety** | Protections | Complying with IEC 60950<br>Over-voltage/Under-voltage, Over-current/Under-current, Over-temperature conditions, Reverse Polarity protection /Under-temperature, Short-circuit, Time-out |
| **Communication** | Communication Interfaces | Isolated CAN |
| **Indications** | LED Indications | LED Indications for battery status,Charging,Error and Fault condition |
| **EMC, EMI & Surge Immunity** | EMI & EMC | Complying to IEC 61000-3-1 / EN55011, Group 1, Class A |
| | Surge | Complying to IEC/EN61000-4-5 |
| **Connection** | Input | 230V 15A Cable |
| | Output | Anderson 75X (Customizable) |
| **Other** | Enclosure Protection | IP20 |
| | Cooling | Forced Cooling |
| | Dimensions | 286 × 174 × 93 |
| **Environment** | Working temperature | 0-50 deg C |
| | Working humidity | 20-90% non-condensing |
| | Storage temperature humidity | -20 to 115 deg C |

**The Centre of Excellence in Energy and Telecommunications**
(CEET)

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**Centre for Development of Advanced Computing**
Thiruvananthapuram

**EoI Technology ID:** EVSS01_ToT_08

1. **Name of the Product /Technology :** High Performance DC-DC Converters suitable for Auxiliary Supply in EVs (Hybrid Bridge Isolated DC-DC Converter with Zero Voltage Switching for a Wide Range of Operations and Suitable for Auxiliary Supply in EV)

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 (under progress) | CAN (under progress) |
| Control Features | a. Output current control<br>b. Optional output voltage control (6-16 V) | a. Output current control<br>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 |

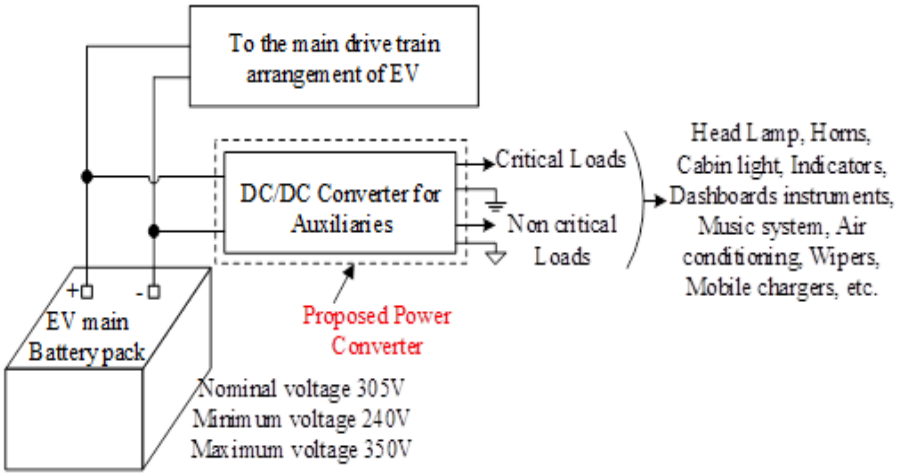
6. **Applicable standards:** None

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:**

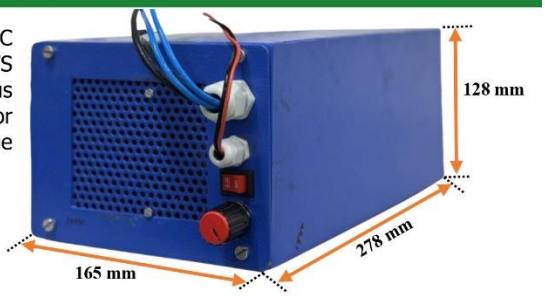
PI is also checking the possibility of startup in incubation center of Indian Institute of Technology Hyderabad for the commercialization of the project. The required modifications will be done in prototype to meet industry requirement. Also, PI is trying to convert traditional solar water pumping into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

## 12. Product Brochure:

# Hybrid Bridge Isolated DC-DC Converter with Zero Voltage Switching for a Wide Range of Operations and Suitable for Auxiliary Supply in EV

## Isolated Auxiliary Power Module 96/14 V

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 with 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.

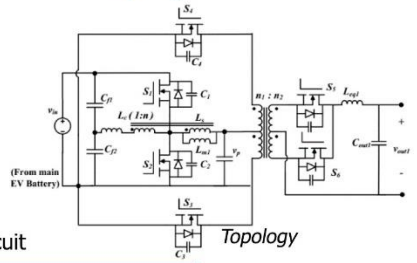



### Applications

- Electric vehicles for auxiliary loads
- Assisting in converting traditional solar water pumping to universal controller by solar PV to battery charging
- Any DC generator to battery charging

### Features

- Rated power around 1.5 kW.
- SiC-Si MOSFET-based High-Frequency Conversion with Galvanic isolation.
- Input Voltage Range: 72-150 V at 96 V (nominal)
- Output regulated at 14 V (adjustable as per requirement) up to a load of 107 A.
- Output current control provision.
- Output Voltage Range (Optional): 6-16 V
- Protections incorporated against input overvoltage, output overcurrent/short circuit & over-temperature.
- Peak efficiency around 94.1 %.
- 80 Plus Efficiency from 10-100 % load range
- Input soft start feature.



Topology

### Mechanical Specification

Cooling : Forced Air cooling
Dimensions : (LxBxH)165 mm x 278 mm x128 mm
Weight : 6.8 kg
Enclosure : IP33

### Protection Overview

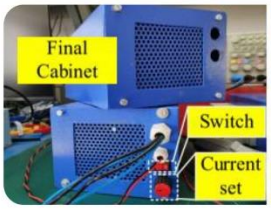
| Protection Type | Off Point | Reset Point | Remarks |
|---|---|---|---|
| Input Over-voltage | 165 V | 152 V | Regular operation occurs after input falls below 152 V |
| Input Under-voltage | 70 V | 75 V | Regular operation occurs after input reaches above 75 V |
| Output Short-circuit | 115 A | 108 A | Regular operation occurs after output falls below 108 A |
| Over-Temperature | 78 ºC | 68 ºC | Regular operation occurs after the temperature falls below 68 ºC |

### Product Specification- Input

| Parameter | Remarks/ Description | Min | Nominal | Max |
|---|---|---|---|---|
| Input Voltage | | 72 V | 96 V | 150 V |
| Input Current | | | 16 A | 24 A |
| Input Capacitance | | | 50 µF | |
| Peak Efficiency | Tested at $V_{in}$=96 V, $V_{out}$=14 V, $I_{out}$=71.5 A (1 kW) | | 94.1 % | |
| No-load Power | Tested at $V_{in}$=96 V (SMPS+MCU power) | | | < 37 W |
| Inrush/Start -up Current | Tested at $V_{in}$=96 V | | | < 1.2 A |

### Product Specification- Output

| Parameter | Remarks/Description | Nominal | Max |
|---|---|---|---|
| Output Voltage | | 14 V | |
| Output Current | | | 107 A |
| Output Power | | | 1.5 kW |
| Start-up time for nominal voltage | Tested at $V_{in}$=96 V, $V_{out}$=14 V, $I_{out}$=95 A (1.33 kW) | 1.4 sec | 3.5 sec |
| Output Voltage Ripple | | | 240 mV |
| Peak Overshoot Voltage | Tested at $V_{in}$=96 V, $V_{out}$=14 V, $I_{out}$=105 A (1.47 kW) | | 3.85 V |
| Converter Temperature | | | 64.5 ºC |





Indian Institute of Technology, Hyderabad

Centre for Development of Advanced Computing
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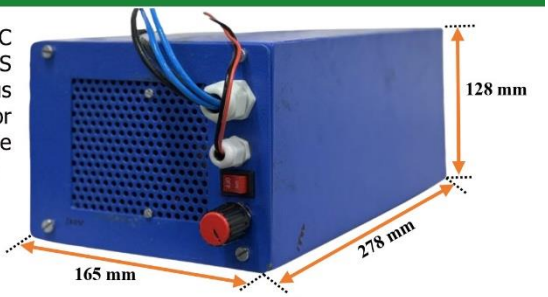
# Hybrid Bridge Isolated DC-DC Converter with Zero Voltage Switching for a Wide Range of Operations and Suitable for Auxiliary Supply in EV

## Isolated Auxiliary Power Module 300/14 V

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 with 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.

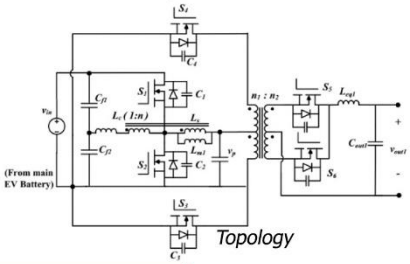



### Applications

- Electric vehicles for auxiliary loads
- Assisting in converting traditional solar water pumping to universal controller by solar PV to battery charging
- Any DC generator to battery charging

### Features

- Rated power around 2.2 kW.
- SiC-Si MOSFET-based High-Frequency Conversion with Galvanic isolation.
- Input Voltage Range: 214-360 V at 300 V (nominal)
- Output regulated at 14 V (adjustable as per requirement) up to a load of 157 A
- Output current control provision.
- Output Voltage Range (Optional): 6-16 V
- Protections incorporated against input overvoltage, output overcurrent/ short circuit & over-temperature.
- Peak efficiency around 93.7 %
- 80 Plus Efficiency from 10-100 % load range
- Input soft-start feature enabled.



Topology

### Mechanical Specification

Cooling : Forced Air cooling
Dimensions : (LxBxH)165 mm x 278 mm x128 mm
Weight : 7.5 kg
Enclosure : IP33

### Protection Overview

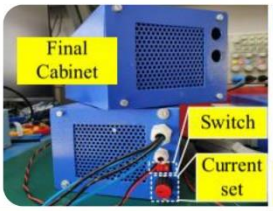
| Protection Type | Off Point | Reset Point | Remarks |
|---|---|---|---|
| Input Over-voltage | 360 V | 345 V | Regular operation occurs after input falls below 345 V |
| Input Under-voltage | 185 V | 210 V | Regular operation occurs after input reaches above 210 V |
| Output Short-circuit | 175 A | 160 A | Regular operation occurs after output falls below 160 A |
| Over-Temperature | 78 °C | 65 °C | Regular operation occurs after the temperature falls below 65 °C |

### Product Specification- Input

| Parameter | Remarks/ Description | Min | Nominal | Max |
|---|---|---|---|---|
| Input Voltage | | 214 V | 300 V | 360 V |
| Input Current | | | 7.5 A | 12 A |
| Input Capacitance | | | 50 µF | |
| Peak Efficiency | Tested at $V_{in}$=300 V, $V_{out}$=14 V, $I_{out}$=96 A (1.34 kW) | | 93.7 % | |
| No-load Power | Tested at $V_{in}$=300 V (SMPS+MCU power) | | | < 33 W |
| Inrush/Start-up Current | Tested at $V_{in}$=300 V | | | 3.48 A |

### Product Specification- Output

| Parameter | Remarks/ Description | Nominal | Max |
|---|---|---|---|
| Output Voltage | | 14 V | |
| Output Current | | | 157 A |
| Output Power | | | 2.2 kW |
| Start-up time for nominal voltage | Tested at $V_{in}$=300 V, $V_{out}$=14 V, $I_{out}$=125 A (1.75 kW) | 1.4 sec | 3.5 sec |
| Output Voltage Ripple | | | 380 mV |
| Peak Overshoot Voltage | Tested at $V_{in}$=300 V, $V_{out}$=14 V, $I_{out}$=150 A (2.1 kW) | | 4.5 V |
| Converter Temperature | | | 63.8 °C |





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**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: | Passive Balancing |
| Isolation | Isolated with Fault Detection |
| Protection Features | 1. Over Voltage<br>2. Under Voltage<br>3. Over Current<br>4. Over Temperature<br>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 |

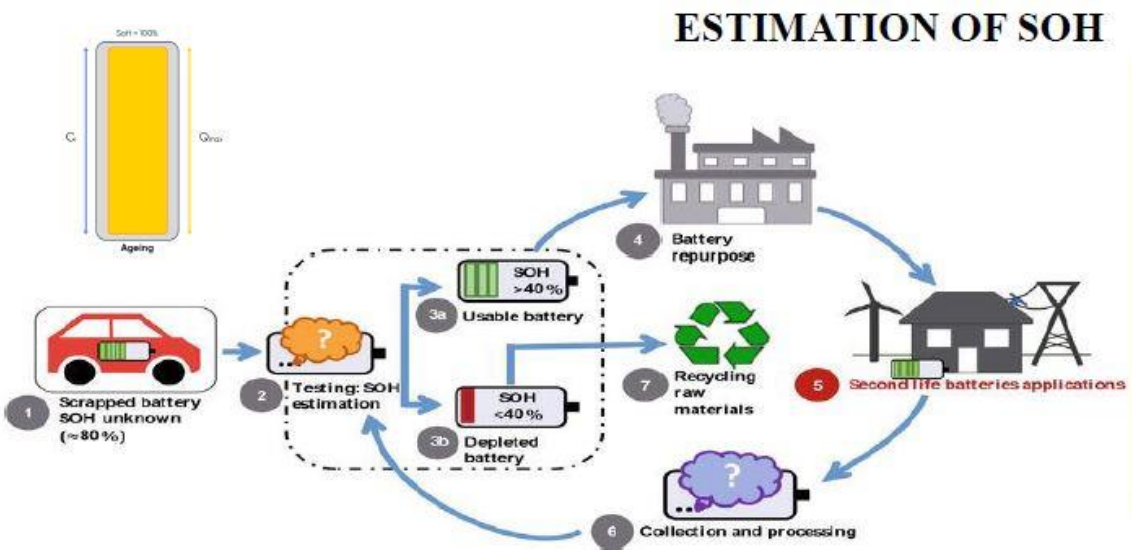
7. **Applicable standards:** AIS 156, AIS 004, AIS 038 Rev2.
8. **Certifications if any:** Under Process
9. **Unique Features of the Technology:**

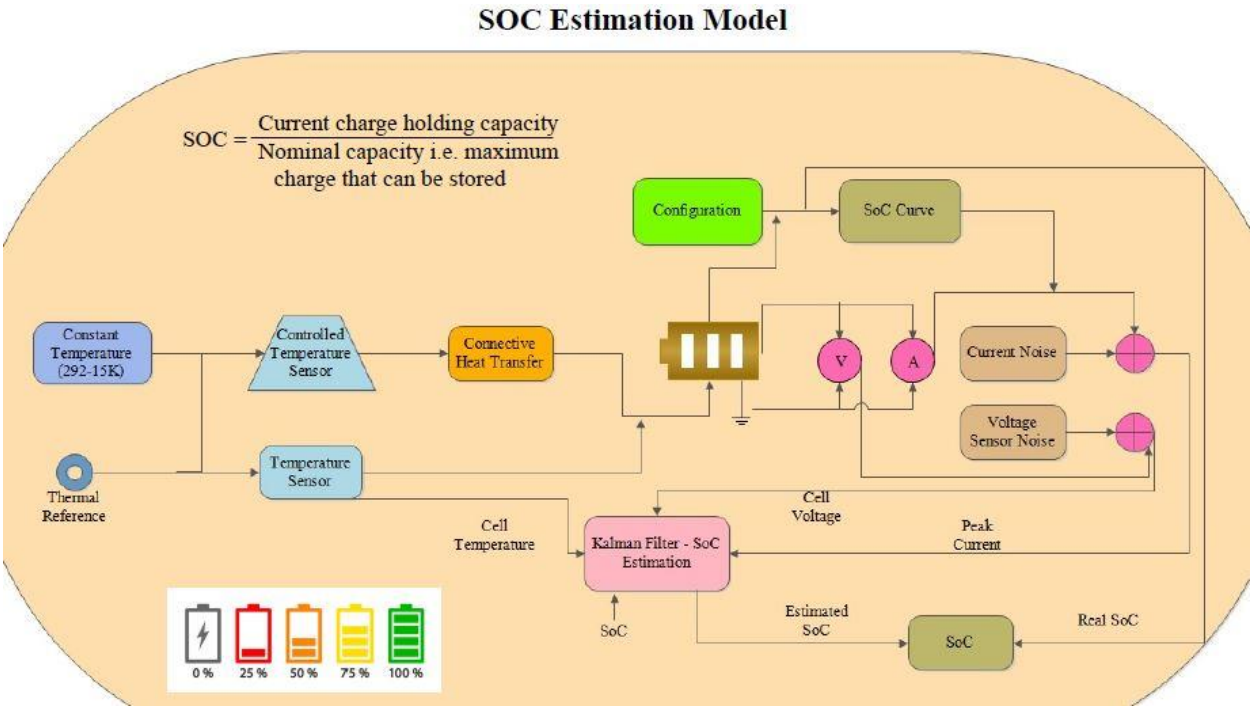
- Developed an intelligent battery management system to estimate the real-time state of charge of electric vehicle batteries (NMC, LFP, LCO, and LTO) using hybrid techniques.
- Designed hybrid methods using deep learning and model-based methods for estimating real-time SOC from SOH data.
- Real-time 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.

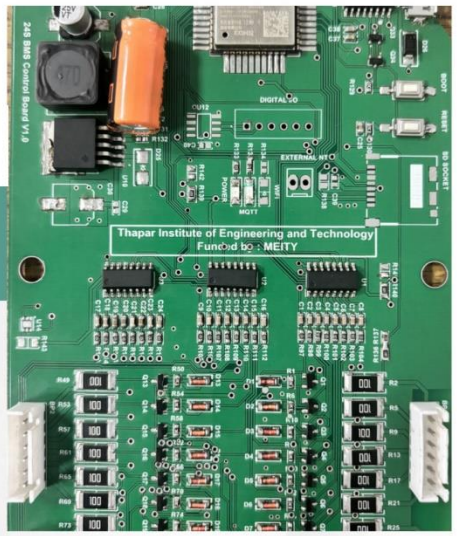



**12. Present Status of the Product/Other information:** Product of hardware BMS and cloud assisted BMS is under use in the E-cart and it ready for TOT.

## 13. Product Brochure

# SMART BATTERY MANAGEMENT SYSTEM




## OBJECTIVES

- To design and develop a Smart BMS for real-time estimation of SoC using a hybrid method
- To process the BMS data on a cloud server and estimate SoH
- To implement and validate the BMS in real-time for EV batteries

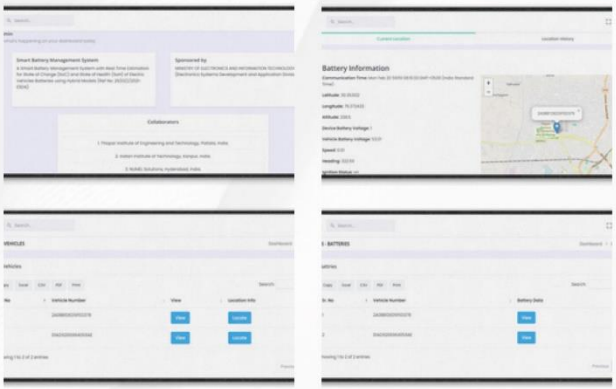
## PRODUCT SPECIFICATIONS

| | |
|---|---|
| **Operating Conditions** | |
| Voltage | 0-96V |
| Temperature Range | -15 to 65 C |
| BMS Type | Smart Cloud Storage |
| Monitoring | Cloud based Real-Time |
| **User Interface** | |
| Interface | Cloud, API, MQTT |
| Communication | CAN Bus, Wi-Fi |
| Security | GPRS, AWS Key, SQL |
| **Specifications** | |
| Cell Chemistry | LFP, LCO, LTO, NMC |
| Connection | 2 Wire |
| Charging Current | 25A |
| Current Balancing | Yes |
| Estimation | SoC and SoH |
| Controller | ESP32, Passive Balancing |
| Sensors | GPRS, Current Temperature, Voltage |
| Protections | Over/Under Voltage Over/Under Temperature |

## AT A GLANCE

### BENEFITS

- 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 DEPLOYMENT

### KEY POINTS

- 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

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