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It is certified that the work contained in the thesis titled ***"Reconfigurable On-Board Power Processor with Wired and Wireless Charging for Electric Vehicles"*** by ***"Soumya Ranjan Meher"*** has been carried out under my supervision and this work has not been submitted elsewhere for a degree.

It is further certified that the student has fulfilled all the requirements of Comprehensive, Candidacy and SOTA for the award of Ph.D. Degree.

24/7/23

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I, ***Soumya Ranjan Meher***, certify that the work embodied in this thesis is my own bonafide work and carried out by me under the supervision of ***Dr. Rajeev Kumar Singh*** from ***July 2017 to May 2023*** at the ***Department of Electrical Engineering***, Indian Institute of Technology (Banaras Hindu University), Varanasi. The matter embodied in this thesis has not been submitted for the award of any other degree/diploma. I declare that I have faithfully acknowledged and given credits to the research workers wherever their works have been cited in my work in this thesis. I further declare that I have not wilfully copied any other's work, paragraphs, text, data, results, *etc*., reported in journals, books, magazines, reports dissertations, thesis, *etc*., or available at websites and have not included them in this thesis and have not cited as my own work.

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Date: 24/07/2023
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Dedicated to

Prabhu Jagannatha

Acknowledgement

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List of Acronyms

EV	Electric Vehicle
ICE	internal combustion engines
CNG	compressed natural gas
HEVs	Hybrid electric vehicles
PHEVs	Plug-in hybrid electric vehicles
BEVs	Battery powered electric vehicles
CC	constant current
CV	constant voltage
PFC	Power factor correction
CC-CV	Constant current–constant voltage
DAB	dual active bridge
FBC	full bridge converter
PI	proportional-integral
WPT	wireless power transfer
HFAC	high frequency AC
HF inverter	high frequency inverter
ZVS	zero-voltage switching
ZDS	zero-derivative switching
VCO	voltage-controlled oscillator
SCPT	Single Controlled PWM Technique
UPF	near unity power factor
FHA	first harmonic approximation
SoC	state of charge
THD	total harmonic distortion
PF	power factor
VSI	voltage source inverter
BLDC	brushless DC
R-OPC	reconfigurable on-board power converter
CM	common contact
NC	normally closed

NO	normally open
PM	permanent magnet
CUF	component utilization factor
MRC	magnetic resonance coupling
ZVDS	zero voltage derivative switching
PPU	power-processing unit
RPP	reconfigurable power processor

Symbols Used

M0	Mode 0 (Propulsion Mode)
M1	Mode 1 (Wired Charging)
M2	Mode 2 (Wireless Charging)
V_{AC}	AC input voltage at the grid side
I_{AC}	AC input current drawn from the grid
V_{dc}	Voltage across the DC link of the two-stage charger
V_{bat}	Battery terminal voltage
I_{bat}	Battery terminal current
$V_{SNL1\rightarrow3}$	Switch node voltages of respective nodes
$I_{MPH1\rightarrow3}$	Motor Phase currents of respective phases
$S_{1\rightarrow6}$	Power electronic switches (MOSFETs)
S_{inv}	Inverter switch (MOSFET used in EF_2 inverter)
$D_{1\rightarrow4}$	Power Diodes
$D_{S1\rightarrow S6}$	Antiparallel body diodes of the MOSFETs
$S_{1\rightarrow6}$	Power electronic switches (MOSFETs)
V_{dc}	Voltage across the DC link of the two-stage charger
C_{dc}	DC link Capacitor of the two-stage charger
C_0	Output capacitor
L_{boost}	Boost inductor at the input AC side
L_{in}	Boost inductor at the input grid side of the wireless charger
$L_{1\rightarrow3}$	Inductors used in the EF_2 inverter
$C_{1\rightarrow3}$	Capacitors used in the EF_2 inverter
C_{pmat}, C_{smat}	Primary and secondary side matching capacitor for WPT coils
L_r	Resonant inductance used in LLC series circuit to form the second stage of the two-stage charger
L_m	Mutual inductance of the isolation transformer in parallel with the load
C_r	Resonant capacitor used in LLC series circuit to form the second stage of the two-stage charger
R_{ac}	Reflected load resistance across the primary
Z_i	Equivalent input impedance at the input of LLC resonant circuit
f_{oc}	Open circuit frequency
f_{sc}	Short circuit frequency

f_s	Switching frequency
G_{LLC}	Gain of the LLC resonant circuit
G_{LLC_min}	Minimum value of G_{LLC}
G_{LLC_max}	Maximum values of G_{LLC}
Q	Quality factor of the circuit
G_s	Gain of the second stage of the two-stage charger
n	Turns ratio of the isolation transformer
L_A, L_B, L_C	Legg A, B and C of inverter
$K_{1\rightarrow5}$	Electromechanical Contactors
$PH_{1\rightarrow3}$	Respective phase windings of the BLDC Motor