ROHM SEMICONDUCTOR

Electronics for the Future

REF68020 : 2.5kW LLC Converter Reference Design

Contents

May. 2026, Rev.001E

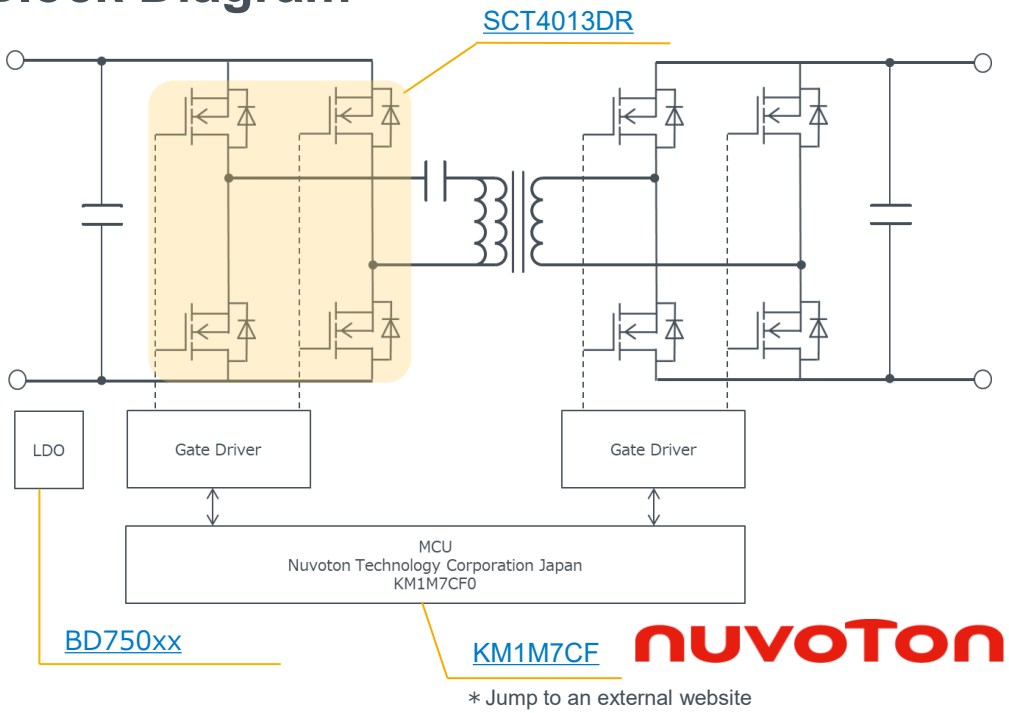
2.5kW LLC Converter, DC390Vin, DC48Vout

REF68020 –Reference Design

Feature

- Full-bridge LLC converters used in a variety of applications
- DC390Vin, Output DC48V, 53A (2.5kW)
- High efficiency (97.3% peak) achieved by using SiC MOSFETs for primary side.
- This board was developed by Nuvoton Technology. (LLC EVB – Nuvoton Jump to an external website)

<Block Diagram>



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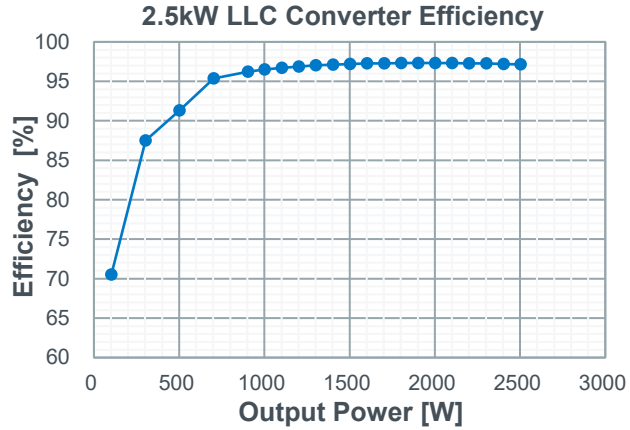
<Specification>

Input : DC390V

Output : DC48V, 53A

fsw = 125kHz (Normal state)

Efficiency : 97.3%



<Circuit configuration>

Full bridge LLC Converter

High-resolution PWM with 32-bit MCU(Nuvoton KM1M7CF0)

Controlling the primary and secondary sides with a single MCU

Using SiC MOSFETs for Primary side switching

＊ For more details about the board, please contact Nuvoton Technology Cooperation Japan.

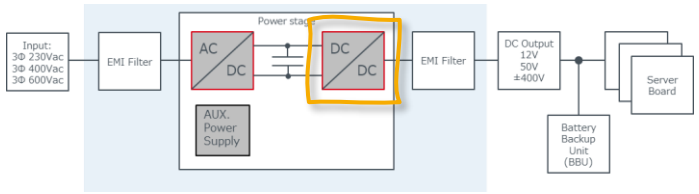
What is LLC Converter?

LLC converters are power conversion circuits that utilize resonance phenomena, consisting of a primary-side excitation inductance, resonant inductor, resonant capacitor, switching element, and secondary-side rectifier circuit. By employing soft-switching technologies such as ZVS (Zero Voltage Switching) (primary-side switch) and ZCS (Zero Voltage Switching) (secondary-side switch), switching losses are significantly reduced, achieving high efficiency and low EMI by suppressing switching noise. They are applicable to a variety of power conversion circuits.

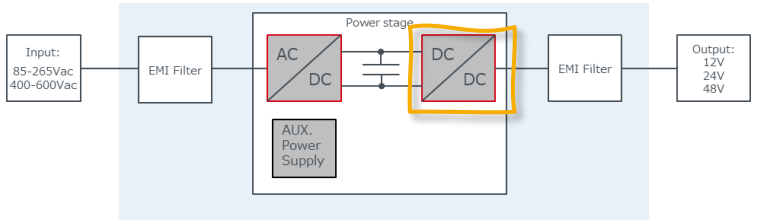
LLC converters that accept DC 400V input are used in applications where the DC voltage is converted from a commercial AC power input via a PFC (Power Factor Correction) and then converted to the voltage required by the system for distribution (server power supplies, industrial power supplies, PV hybrid inverters, ESS, UPS, xEV OBC (onboard charger), etc.), as well as for voltage conversion from the 400V battery of xEVs (xEV DC-DC converters, etc.). The secondary-side full-bridge rectifier circuit is a topology commonly used for relatively high power (up to several tens of kW) and relatively high output voltage (>48V).

This reference design is a DC 390V input, 48V output, 2.5kW LLC converter that incorporates Nuvoton Technology's high-resolution 32-bit MCU (KM1M7CF0) for power control and uses SiC MOSFETs as the primary switching element.

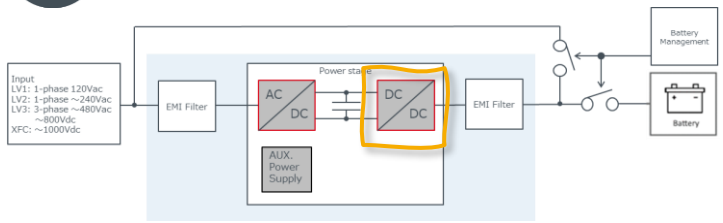
Data Center / AI Server PSU



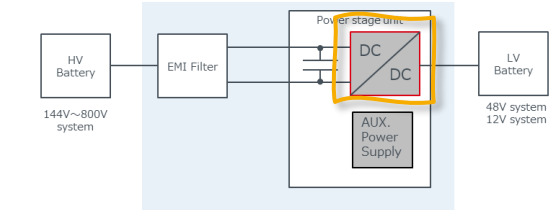
Industrial PSU



xEV OBC



xEV DC-DC

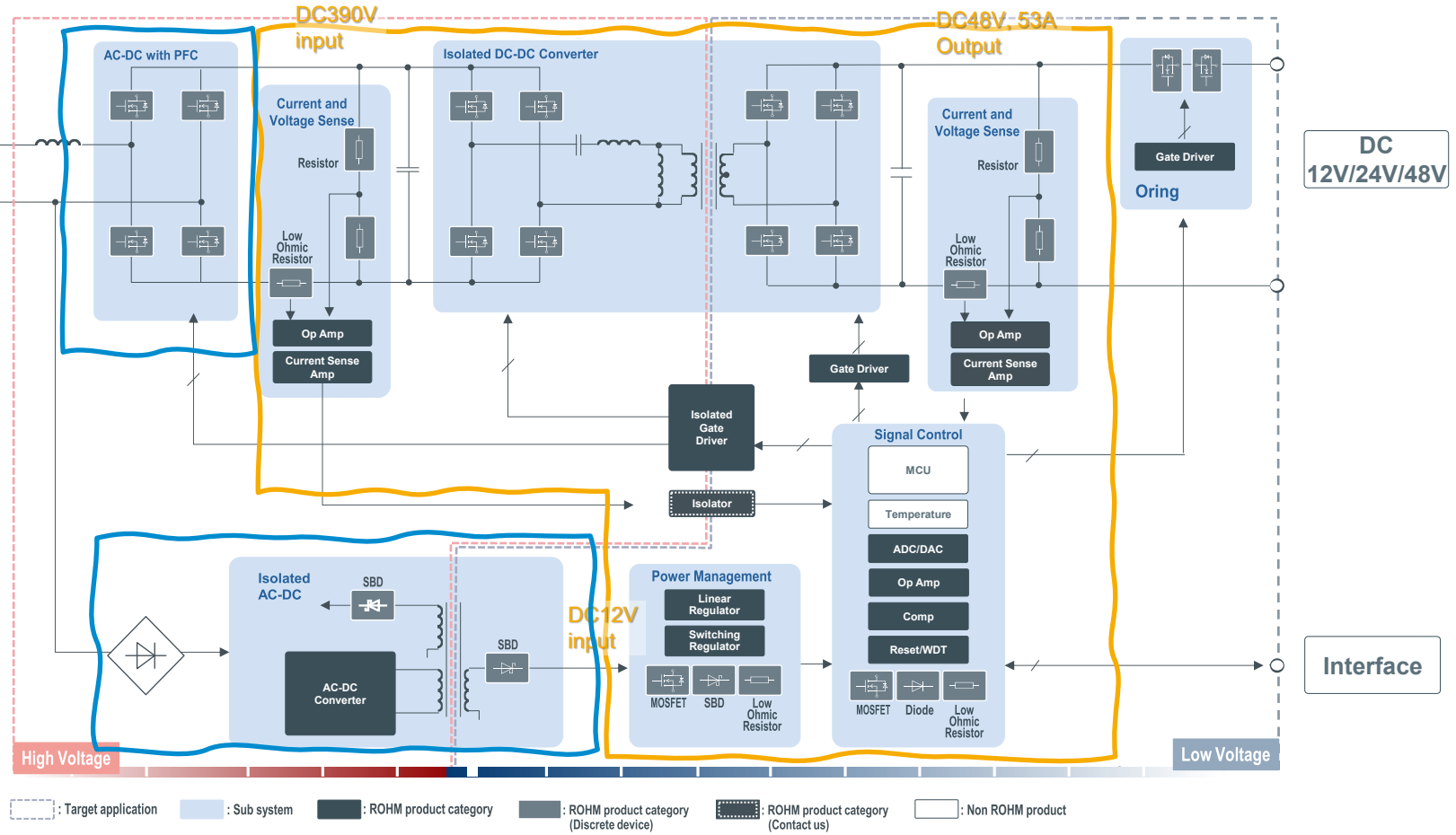


Reference Designs for Power Supply Unit (PSU)

REF67010 : 3.6kW Interleaved PFC
APEVK66001 : 3.6kW Totem Pole PFC

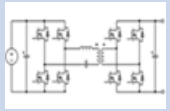
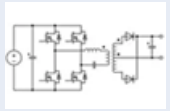
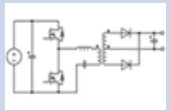
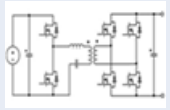
REF68020
2.5kW LLC Converter

REFACDC025
24W 12Vout
AC-DC Converter



Simulate LLC Converter Circuits (Simulation tools and Demo Circuits)

Reduce design time by utilizing simulation during power electronics circuit design. ROHM provides online tools and demo circuits for offline tools, allowing you to immediately perform simulations or obtain simulation circuits via the web.

Contents		ROHM Solution Simulator	ROHM PLECS Simulator	LTSpice® Demo Circuits	PLECS® Demo Circuits
Online / For Offline		Online simulation available		Downloadable circuits for offline tools	
Simulation tool		PARTQUEST™ Explore	PLECS®	LTSpice®	PLECS®
Features		High analog waveform reproducibility, AC analysis possible.	Loss and heat can be verified in seconds.	High analog waveform reproducibility, AC analysis possible.	Loss and heat can be verified in seconds.
Used for		Verify surges, ringing, AC characteristics, and so on, to design for stability and safety.	Select devices based on the losses and heat generation at the topology circuit.	Verify surges, ringing, AC characteristics, and so on, to design for stability and safety.	Select devices based on the losses and heat generation at the topology circuit.
LLC Converter Simulation Circuit			ROHM PLECS Simulator C-014-D : Discrete Package C-014-DOT : DOT-247 Package	C-014-D4 : Full Bridge LLC, Full Bridge Recti. TO-247-4L package C-014-DOT : Full Bridge LLC, Full Bridge Recti. DOT-247 package	C-014-D : Full Bridge LLC, Full Bridge Recti. Discrete Package C-014-DOT : Full Bridge LLC, Full Bridge Recti. DOT-247 package
		C-013. Full Bridge LLC, Diode Recti.			
		C-012. Half Bridge LLC, Diode Recti.		C-012 : Half Bridge LLC, Diode Recti. TO-247N package	
			ROHM PLECS Simulator C-023-D : Discrete Package C-023-DOT : DOT-247 Package		C-023-D : Half Bridge LLC, Full Bridge Recti. Discrete Package C-023-DOT : Half Bridge LLC, Full Bridge Recti. DOT-247 Package

Recommended Products for 3kW～5.5kW Power Supply Unit (PSU)

Totem Pole PFC

Fast Leg : SCT40xxDR(TO-247-4L)
SCT40xxDLL(TOLL)

Slow Leg : R60xxWNZ4(TO-247N)*
R60xxWNJ3(DFN8080)*

Isolated Gate Driver

For SiC : BM61S41RFV-C

For SJ-MOS : BM61M41RFV-C

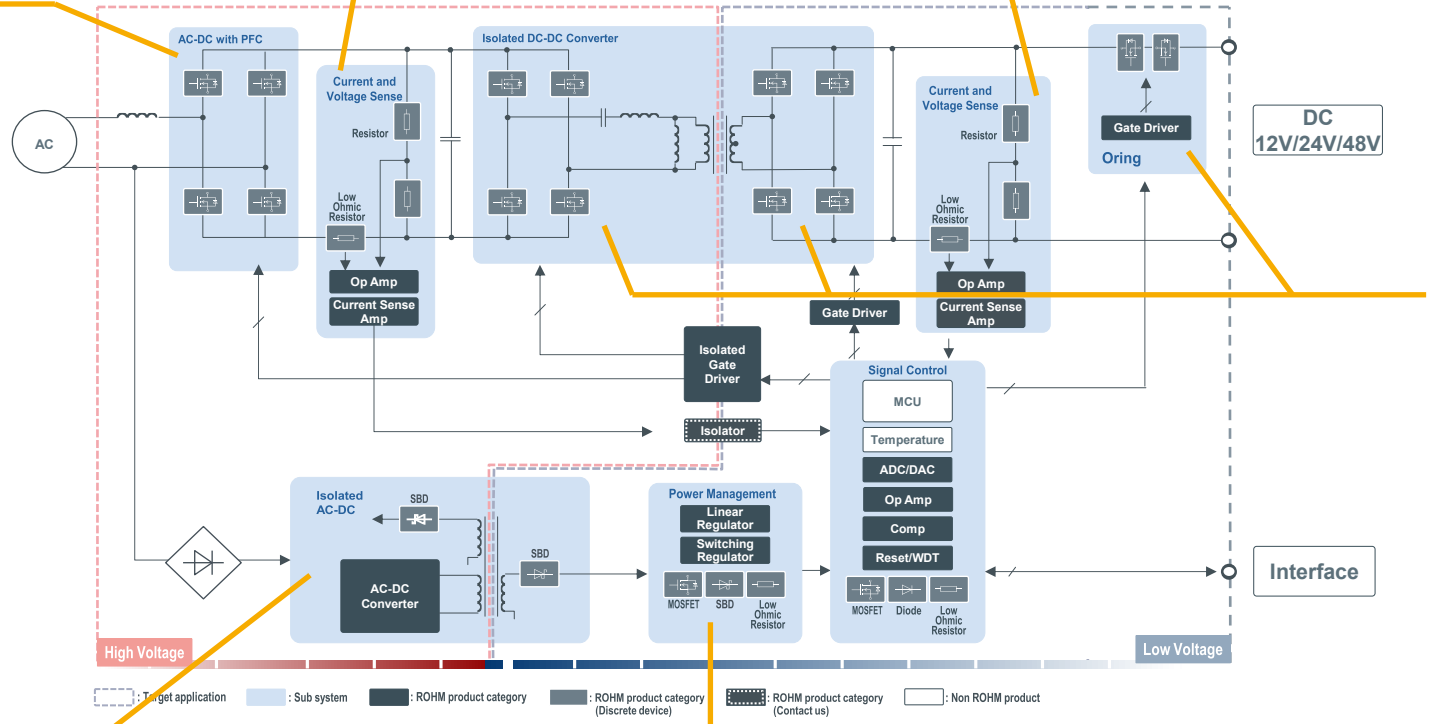
Current & Voltage Sense

Current Sense Amp : BD14xxx Series

Low offset OpAmps

Isolated Amp *

Shunt Resistor : PSR, GMR, PMR, LTR Series



AUX power supply

AC-DC Converter

Built in 1700V SiC : BM2SC Series

AC-DC Controller : BD768x Series

Power Management

LDOs

DC/DC Converter

Flyback DC-DC Converter : BD7Fxx Series

LLC Converter(Primary)

SJ-MOS
R60xxWNZ4(TO-247N)*
R60xxWNJ3(DFN8080)*

SiC-MOS
SCT40xxDWA(TO-263-7L)
SCT40xxDLL(TOLL)

GaN HEMT
GNP30xxTD-Z(TOLL)*

Gate Driver for SJ-MOS
BM62T40RFU *

Gate Driver for SiC-MOS
BM61S41RFV

Gate Driver for GaN-HEMT
BM6GD11BFJ

LLC Converter(Secondary) Oring [option]

Si-MOSFET

30V	RS6Exx, RS7Exx
40V	RS6Gxx, RS7Gxx, RH6Gxx
60V	RH6, RH8, RS6L, RG6L, RS7L
80V	RS7N200BH(DFN5060)*
100V	RS7P200CH *

Gate Driver for Si-MOSFET
BD2310G
BD2320EFJ
BM60214FU *

* : Under Development
As Of Apr.2026

Electronics for the Future

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1) The contents of this document are subject to change without notice for the purpose of improvement.
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