



# XDPP1140/1148

## Digital power controller

Dec. 2024



# Applications & Topologies



## Applications

Remote radio head power

Base band unit (BBU)

Digital units power (DU)

Power supply and delivery units (PSU, PDU)

Active & Passive antenna systems

Small cell power

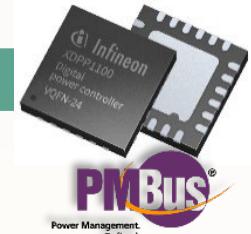
Telecom UPS systems

Digital and analog brick modules

Datacenter application & server motherboard

## Topologies

### Isolated DCDC



### Non-Isolated DCDC

Full-bridge  
Half-bridge  
ACF

### Regulated LLC

### Non-Isolated Buck

Inverting  
Buck-boost  
-48 V – 28 V

Interleaved  
HB/ACF/Buck

PSFB HVDC  
400 V – 12/24/48 V

Switch tank  
capacitor

Zero voltage  
switching

# Infineon protection ICs, digital controller, gate driver and MOSFETs

## Complete IBC datacenter solution



### Digital protection IC Hot-swap controllers & eFuses

- Hot-swap (XDP™7xx) for AI servers/datacenter and Telecom
- Industry's 1<sup>st</sup> wide voltage range hot-swap controller with a programmable digital SOA control
- Superior current reporting **accuracy** ( $\pm 1\%$ )
- Boost mode control technology for safer turn-ON of high capacitance always ON systems
- eFuse (TDA7xx) for AI server; supports all the XDP7xx HSC features plus integrated MOSFET..
- eFuse ES Q2 CY25 In Dev.



VQFN-29

### PoL DC-DC switching regulator IC

- PoL (TDA48001) for AI servers/datacentres and telecom, etc
- 100 V, 1 A constant frequency synchronous buck
- Reduced solution size by efficient high-frequency operation & Tiny QFN-13
- Eliminates RC with internal loop compensation by fixed-frequency I-Mode control
- Reduces power loss for telecom/server power by on-the-fly Vout adjust



In Dev.

### Digital power controller XDP™ P1100

- Industry's most **mature & advanced** controller technology with best-in-class **transient response**
- **Flexibility** with ARM Cortex™ M0 microcontroller (software defined digital controller) for faster design cycle & tailored performance
- Industry's **smallest digital power controllers** enable higher power density
- XDP1140/48 ES available now In Dev.



VQFN-24

### Gate driver EiceDRIVER™

- Best-in-class gate driver ICs includes isolated gate driver ICs and non-isolated gate driver ICs **optimized** for high voltage and low voltage MOSFETs
- Gate driver ICs are available in different configurations, packages and feature sets
- Dual high-side driver In Dev.



### MOSFETs OptiMOS™ & GaN

- Best in-class 15-150 V power MOSFETs
- Industry's best figure of merit (FOM)
- increase efficiency, power density, and cost-effectiveness
- Industrial qualified
- 175°C rated
- Available in both industry standard and proprietary packages



# XDP™ Digital controller XDPP11xx for isolated and non-isolated DC-DC



## Features

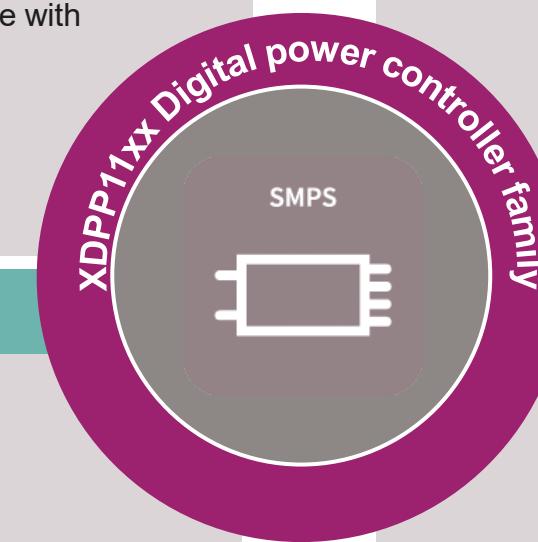
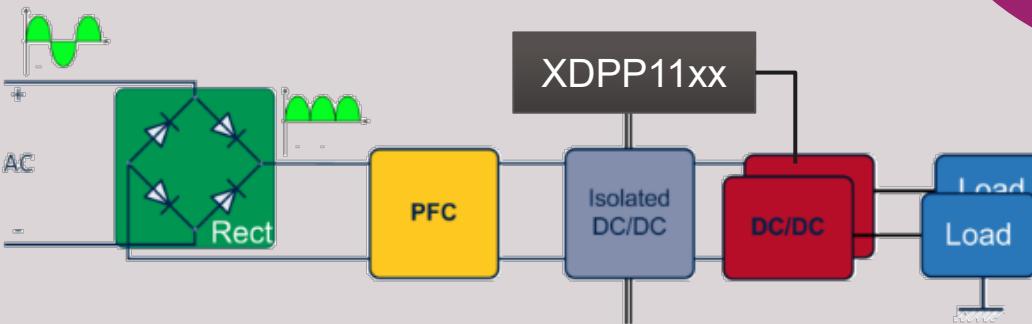
- Best-in-class analog front-end performance
- Pre-programmed hardware peripherals with digital control loop
- System configuration with GUI support
- Integrated ARM Cortex™ M0 provides ability to differentiate with customized firmware for increased competitiveness
- Highly flexible, suitable for isolated and non-isolated topologies
- Industry's smallest digital power controller 4 mm x 4 mm

## Topologies

- Full-bridge
- Half-bridge
- Active clamp forward
- Non-isolated buck, boost
- Inverting buck-boost
- Interleaved
- Close loop LLC
- HVDC, telemetry 400 V input

## Typical application

- Telecom, datacom DC/DC converter
- 48 V IBC



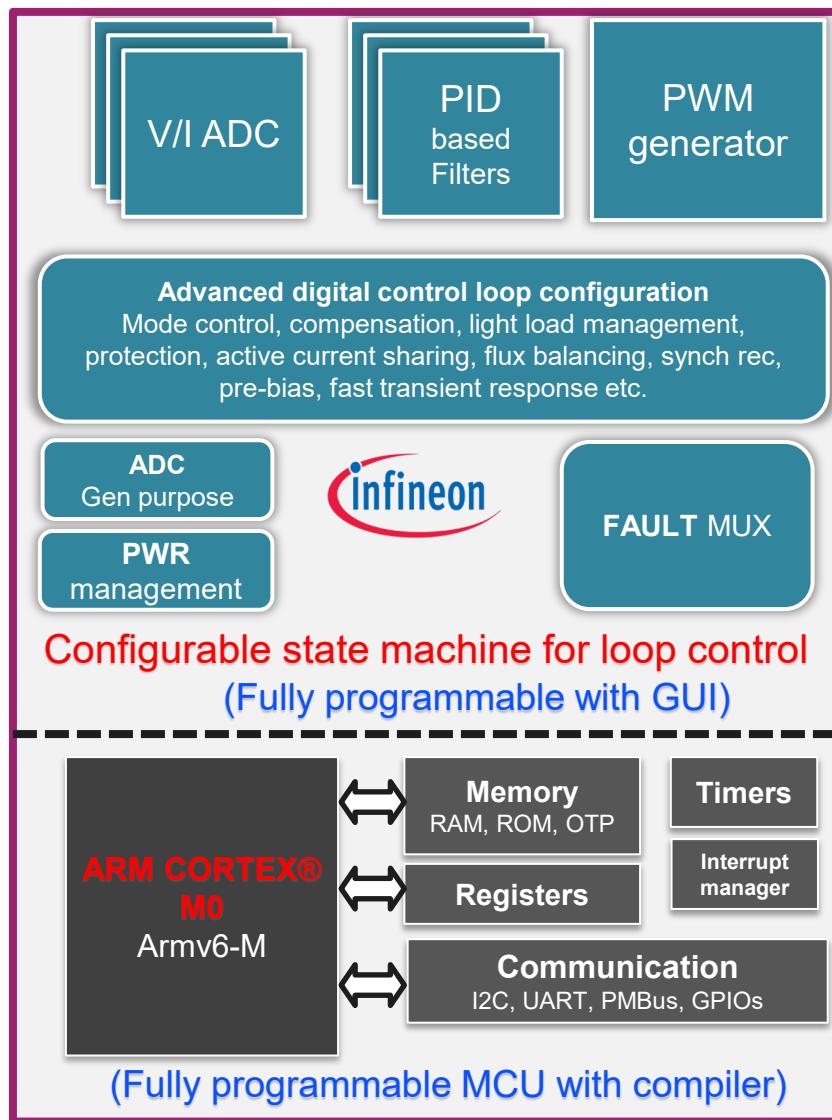
## Communication

- PMBus
- I2C
- UART
- SPI



24-pin 4x4 mm VQFN

# XDPP11xx FW/ HW partition



## Hardware functions

- State machine:
  - Mode control
  - Loop control
  - Fault comparators
  - Feed-forward
  - Current sharing
  - Current balancing
  - Flux balancing
  - Burst mode
  - Low pass filtering
- MCU:
  - Memory management
  - DMA controller
  - GPIO
  - Watchdog timer
  - DTimer
  - PMBus module
  - I<sup>2</sup>C module
  - CRC module
  - UART module
  - Debugger

## Firmware functions:

- System FW module (boot procedure, power management)
- Patch FW module
- PMBus FW module
- Regulation FW module
- Telemetry FW module
- Fault FW module
- Logger FW module
- Configurator FW module

# XDPP11xx - Architecture benefits

## Application optimized digital control

- Pre-programmed advanced digital control (e.g. startup into pre-bias, mode control, loop control, protection features, feed-forward, flux balancing, active transient support, etc.)
- → Less firmware development efforts

## Dedicated hardware peripherals

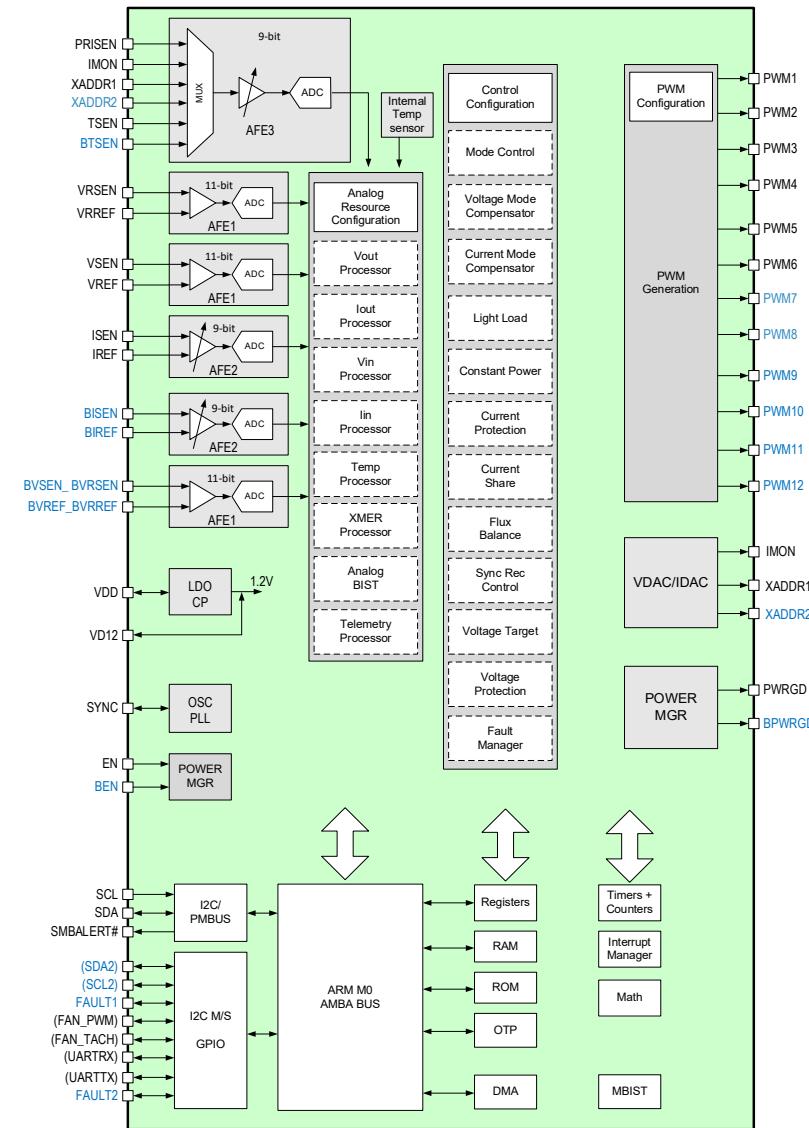
- Optimized for DCDC converter topologies and brick applications and brings superior performance (e.g. support different topologies FB, HB, interleaving, LLC, ZSC, HSC, RHSC, SHSC, DRHSC etc., high efficiency and high density)

## Highest sampling rate ADCs

- The fastest response 50 ns. No external comparator is required. → system level BOM and board space savings
- Allows direct current sensing without external amplifier → system level BOM and board space savings
- Cycle-by-cycle peak current limiting within 100 ns
- → highest system robustness

## Small footprint

- Smallest package 4 mm x 4 mm, 56% footprint reduction
- → PCB board savings



Blue pins: pins that are available in XDPP1100-Q040

## Adding support to closed loop LLC & PFM standby mode

### Key features

- ARM Cortex™ M0 core
- Supports PWM and **PFM** control loop
- Hardware based PID compensator with 3 poles and 2 zeros
- Up to 6 DPWM outputs with 78.125 ps resolution and 2 MHz max frequency
- Up to 11 GPIO pins
- 1 MHz I<sup>2</sup>C/PMBus and **SPI** interface
- 100 MHz 11-bit VADC with 3-bit modulation
- 1.25 mV LSB, 156  $\mu$ V Vout sense resolution
- 0 to 2.1 V differential voltage range
- 200 MHz edge detection comparator
- Low-latency protection comparators
- **100 MHz** 9-bit IADC with current estimator
- **1.2V common mode voltage** with 1mV LSB
- 3 levels over current protection
- Supports temperature compensation
- **10-bit** 4-ch telemetry ADC

### Key firmware benefits

- Configurable with GUI Support
- Allows FW based customization
- Accurate V/I/Temp monitoring
- Pre-programmed control providing the fastest time-to-market

### Key hardware benefits

- **Precise SR timing control improves LLC efficiency**
- Excellent feed-forward performance
- **Hardware feed-forward for buck-boost topology**
- Enables volt-second flux balance
- Pre-bias startup with SR or DE mode
- **Fast transient response by non-linear PID**
- Active current sharing and current balance
- Sophisticated system level fault handling
- **Fast GPI input for external fault or SR control**
- **Low power consumption in sleep mode**
- Light load management
  - Burst, diode emulation, **phase shedding**
- **Phase shift for full-bridge LLC**

**XDPP1140**

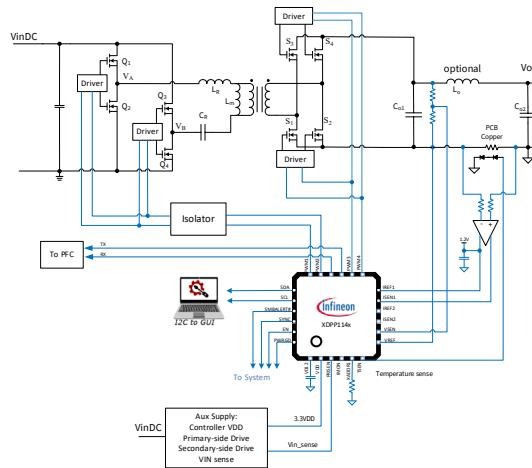
6x PWM  
2x VADC  
1x IADC  
4-ch TS ADC  
2 fast input  
11x GPIO  
VQFN-24  
4x4 mm<sup>2</sup>  
0.5 mm pitch

**XDPP1148**

6x PWM  
1x VADC  
2x IADC  
4-ch TS ADC  
2 fast input  
11x GPIO  
VQFN-24  
4x4 mm<sup>2</sup>  
0.5 mm pitch



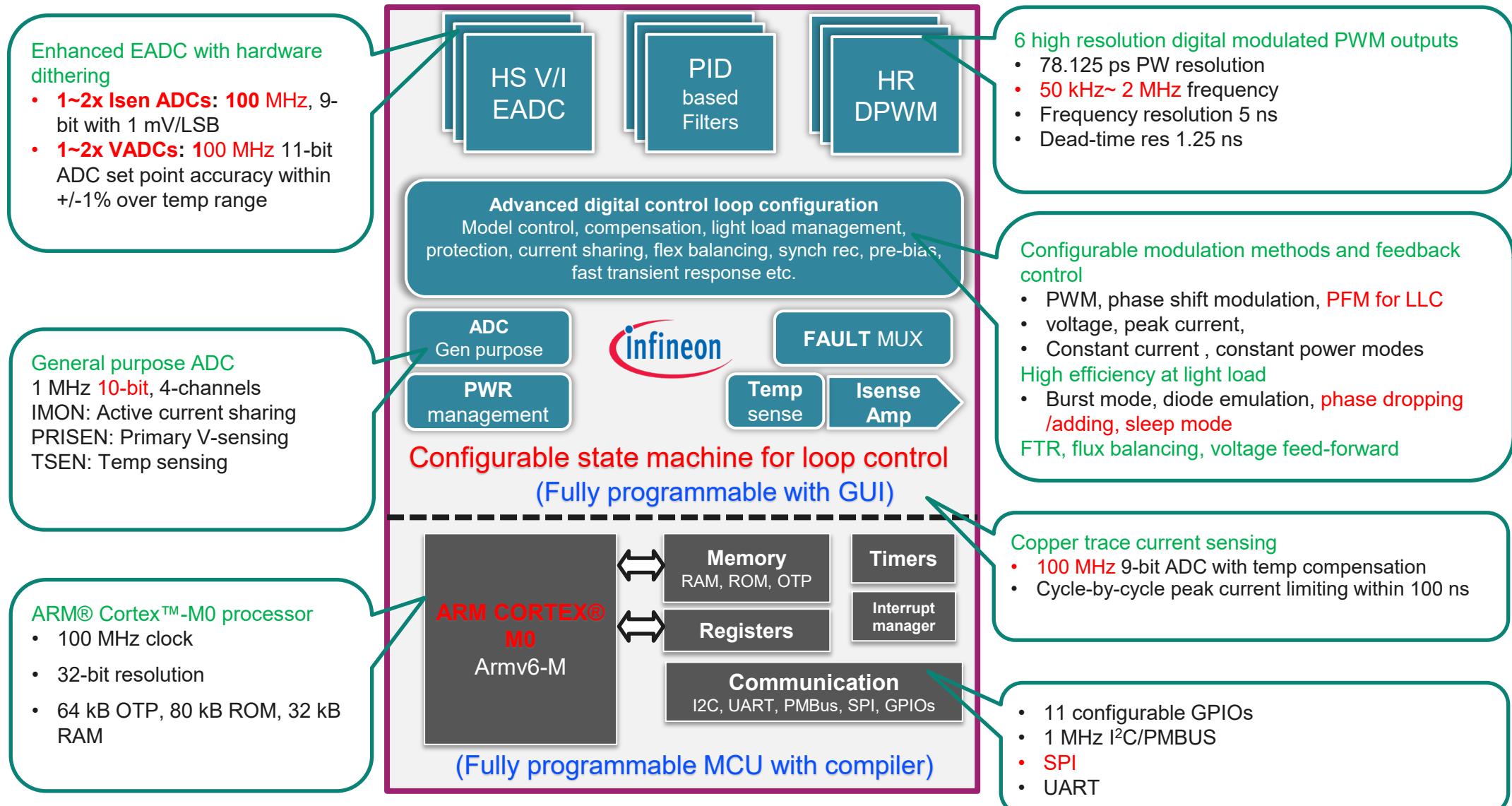
**VQFN 4x4 24-pin**



### Topologies:

- Full-bridge
- Half-bridge
- Active clamp forward
- Non-isolated buck, boost
- Inverting buck-boost
- Interleaved
- Close loop LLC (XDPP114x)
- HVDC, 400 V input (XDPP114x)

# XDPP1140/1148 Features

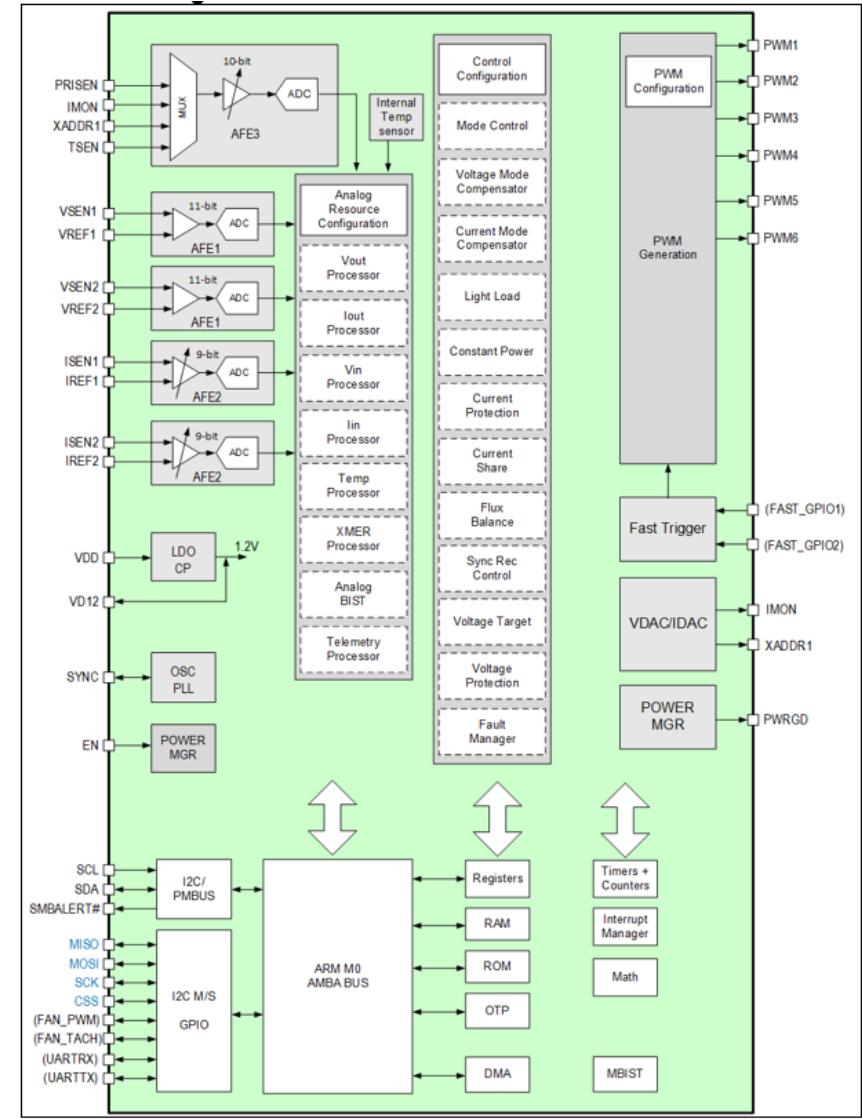


# XDPP1140/1148: Next Gen of XDPP1100 with added features



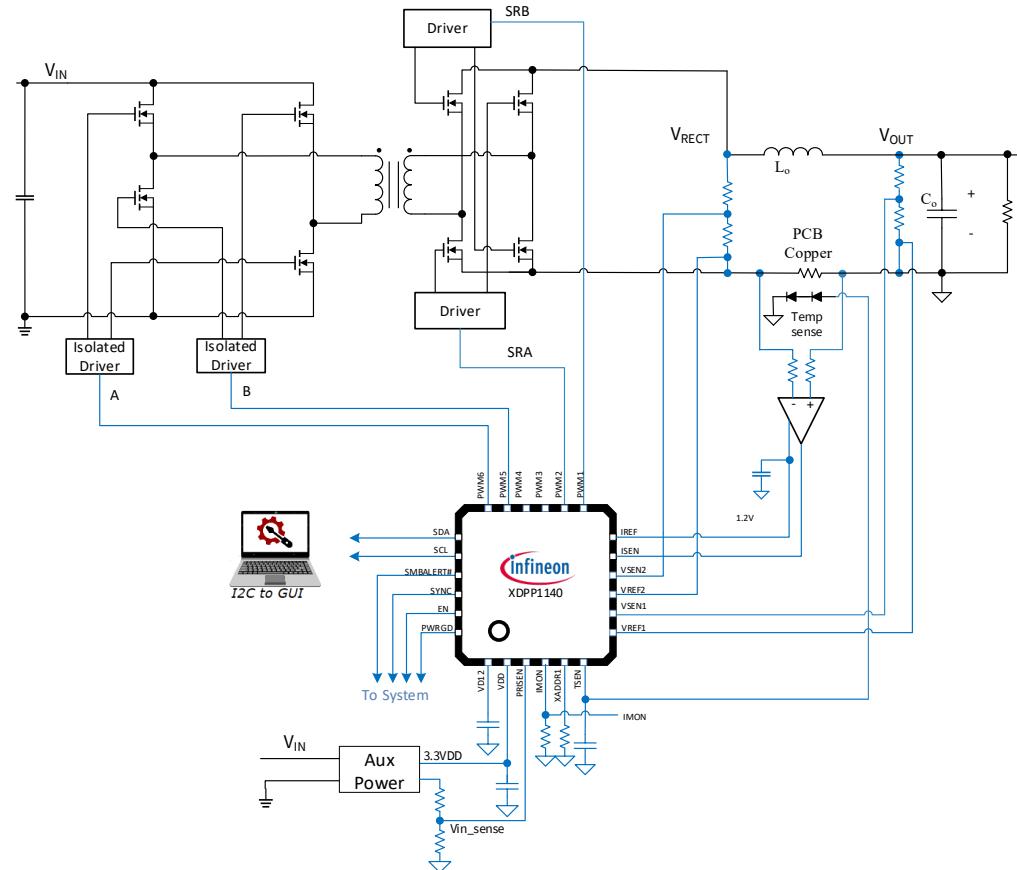
## Features

- Frequency modulation for **close loop LLC**; Hybrid soft-start for LLC
- Frequency range **50-2000 kHz**, increase resolution to **5 ns, adj 2.5 ns**
- Improve **IS ADC**, 100 Msps for high frequency LLC. Increase digital range to **256 A/phase**, increase current sense resolution through cycle averaging. Current sense with high tracking slew rate; support symmetric input for primary current sense, and configurable offset for secondary current sense
- **LLC SR control** – configurable Tres for below resonant SR control, adaptive SR max on time based on SR VDS sensing. Gradually changing SR duty-cycle when exist DE mode (SR soft on)
- Fast GPIO input, allows using external signal to define SR rising or falling edge
- **Light load feature including HW based DE, phase shedding, light load features** for LLC: burst at Fmax, phase shift for full-bridge LLC.
- **Sleep mode** for low power consumption
- **Reduce digitization noise** (VS ADC and VSP design improvement)
- **SPI**, slave/master mode, support high speed ext. EEPROM
- **3<sup>rd</sup> ramp** with forced duty-cycle config, enable regulation of 48 V to 12 V ZSC+3LFC, or any existing topology + ZSC
- **Duty-cycle lock for interleaved topologies**
- Increase **transformer\_scale range**, support scale higher than 1 for -48 V to 50 V application. Increase transformer\_scale resolution to 14-bit
- Increase **vrect\_scale** resolution to 16-bit
- **HW based feed-forward for buck-boost, boost topologies**
- Increase **TS ADC** to **10-bit**, support 2.4 V input. Make XADDR compatible with customers old design, support more TSEN options (i.e. 2 diodes in series).
- **Current sharing - AC droop, added droop at TON\_RISE**
- Fault management improvement, avoid FW reset (i.e. disable oscillating faults if FW can't keep up)
- Move errata and Jira fix to ROM



# XDPP1140/1148 enhancements & application (1)

- FB-FB -48 V to 50 V, transformer turns ratio 3:5

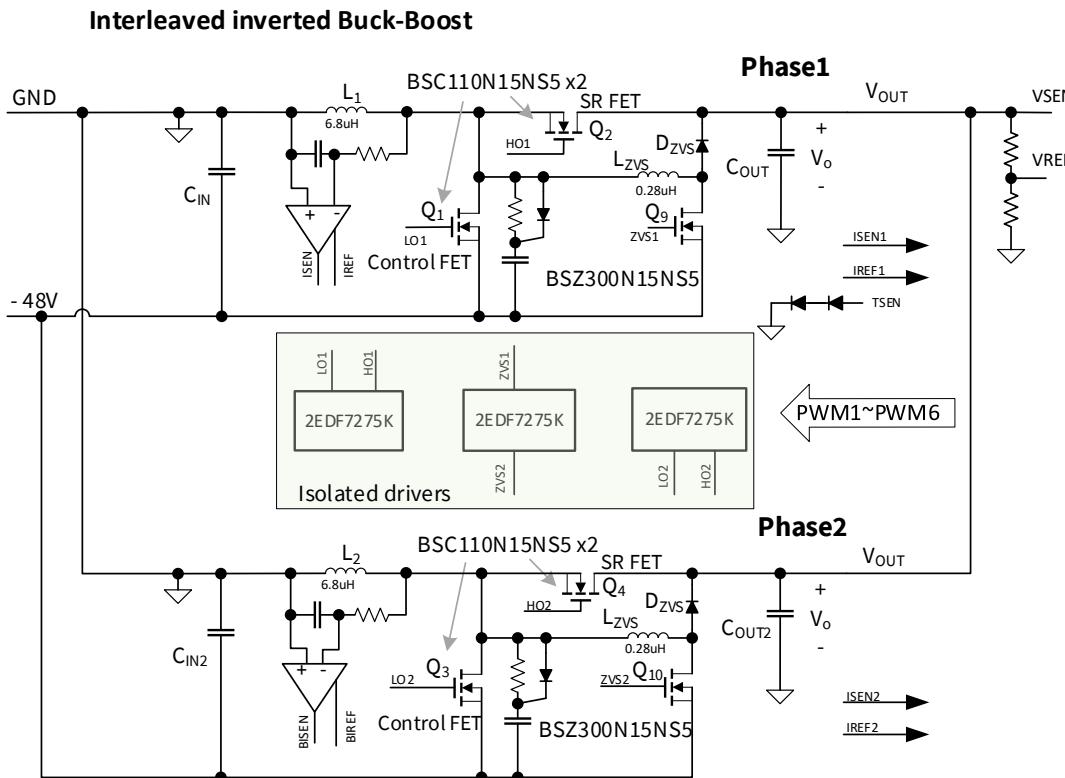


XDPP1140 fixed the following XDPP1100 limitations

- MFR\_TRANSFORMER\_SCALE** (Ns:Np) can't be set higher than 1. Requires FW patch to correct the turns ratio for Vin telemetry and feed-forward
- Feed-forward** duty-cycle resolution is coarse in high voltage (i.e. 50 Vout) applications, causes Vout ripple

# XDPP1140/1148 enhancements & application (2)

- Interleaved inverting buck-boost -48 V to 28 V

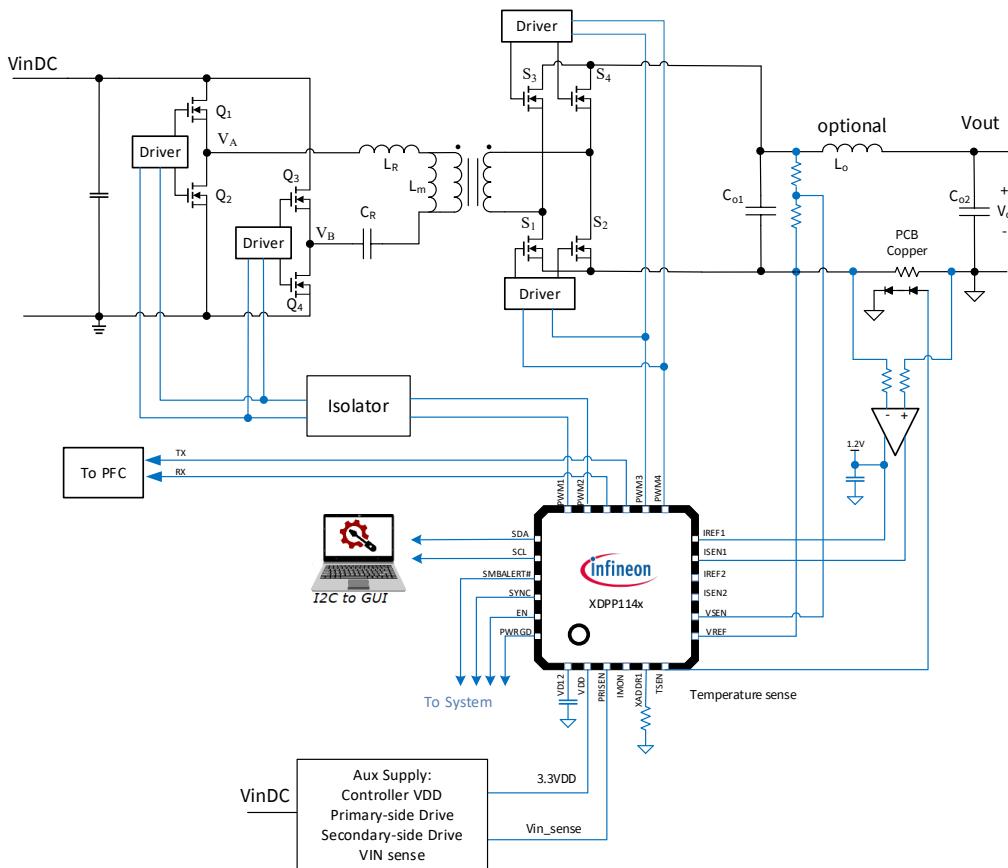


XDPP1148 improves the following

- 1. Feed-forward:** support hard-ware based feed-forward for the best-in-class line transient
- 2. Phase dropping:** hard-ware based phase dropping/ adding to improve efficiency at light load
- 3. Burst mode:** hard-ware based burst operation to improve efficiency at light load
- 4. Iout telemetry correction:** is included in ROM code, doesn't require FW patch

# XDPP1140/1148 enhancements & application (3)

- Regulated FB-LLC 48 V to 12 V

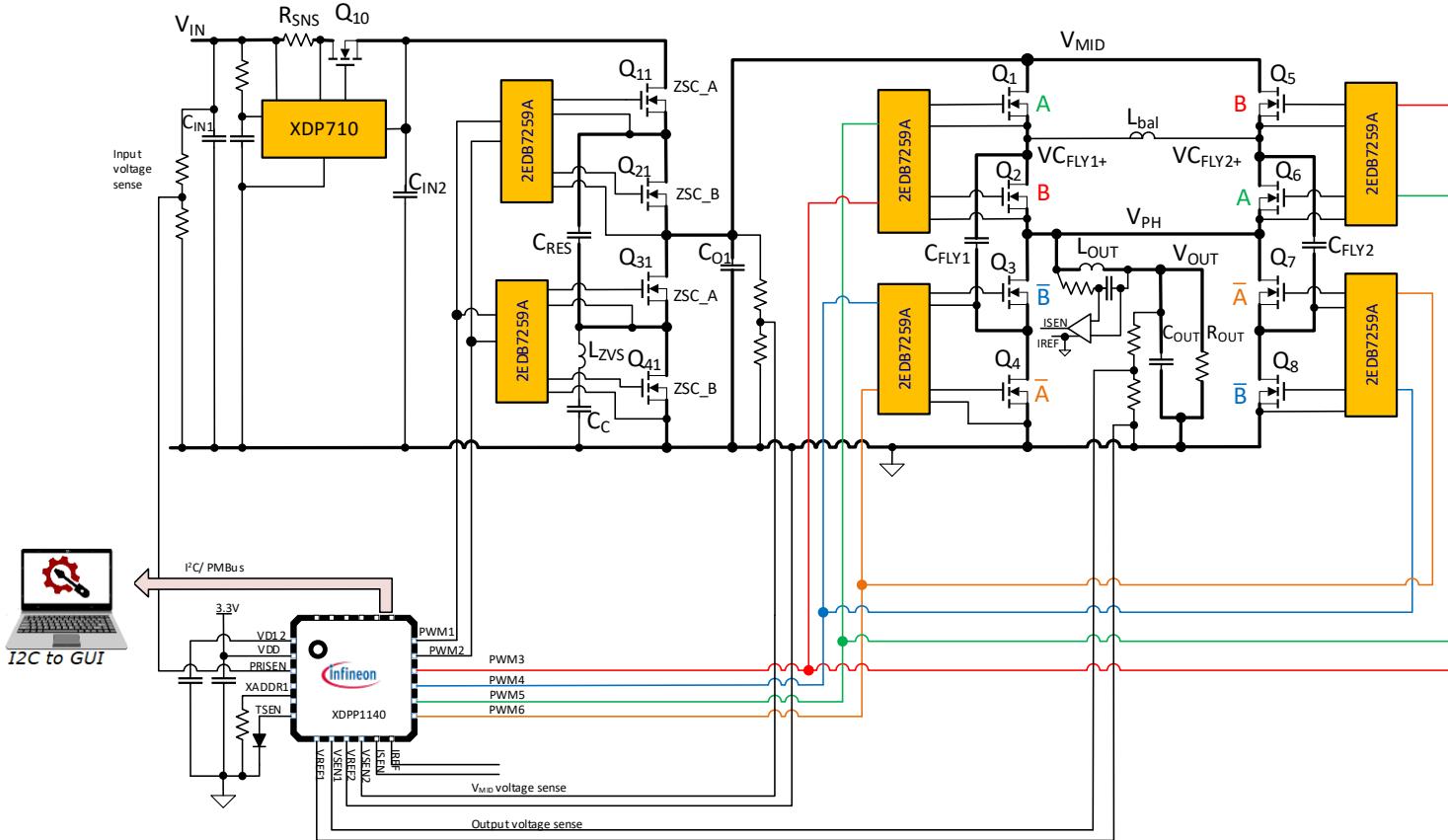


XDPP1140/1148 LLC has the following features

1. **Close loop LLC**
2. **Adaptive SR timing control based on VDS sensing**
3. **Burst mode** in light load
4. **Phase-shift** in light load for FB-LLC

# XDPP1140/1148 enhancements & application (4)

## – DR-HSC 48 V to 12 V

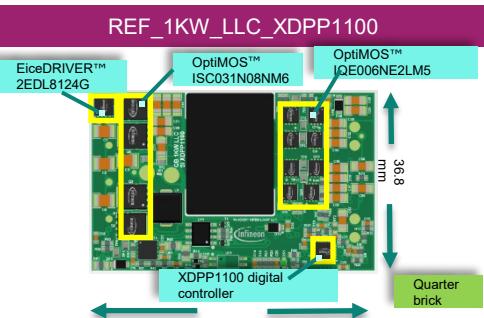


### XDPP1140 improvements for DR-HSC:

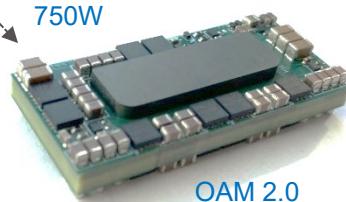
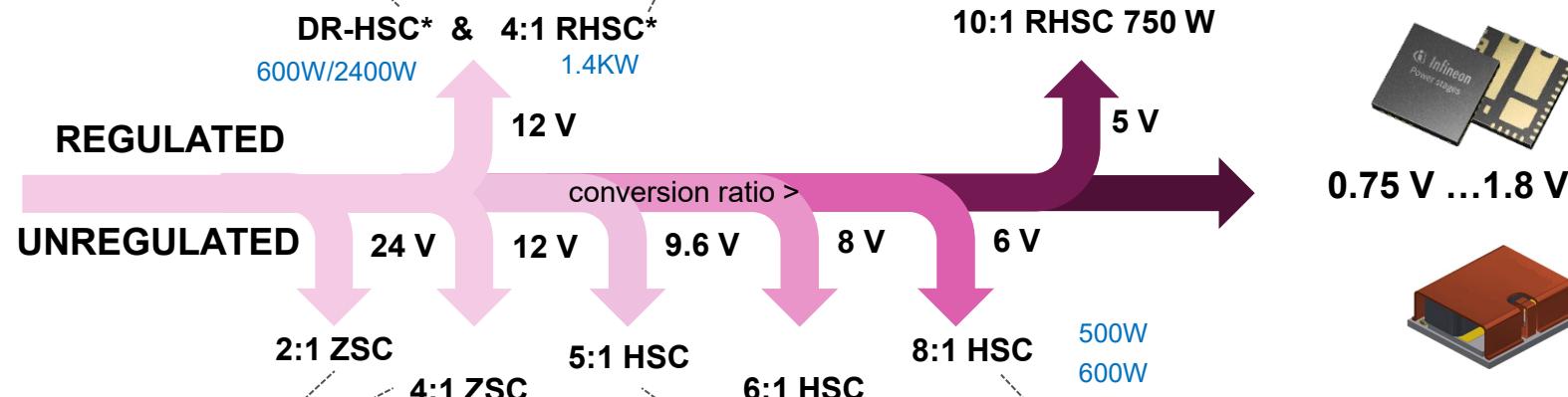
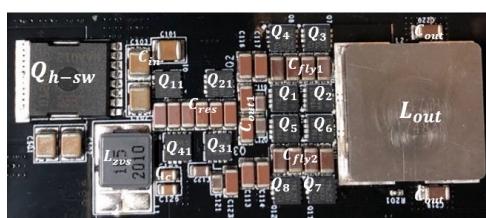
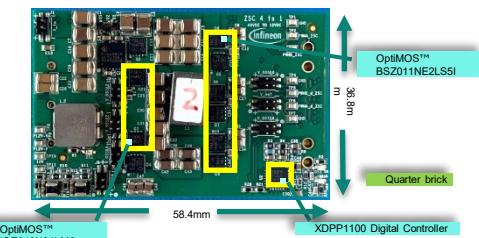
- Use the **3<sup>rd</sup> ramp** to drive 2:1 ZSC
- Config the 3LFC to interleaved-buck.
- No 50% duty-cycle limitation in the 3LFC
- Achieve full range regulation
- The **3<sup>rd</sup> ramp** has independent frequency
- Can sync with the ramp0 or runs freely

# 48 V architectures

## Infineon IBC portfolio – XDPP11xx reference designs



### REF\_1100W\_4TO1\_ZSC\_QB



## Multiphase buck System

- ❖ ZSC ... Zero voltage switching switched capacitor converter
- ❖ HSC... Hybrid switched capacitor converter
- ❖ DR-HSC... Dual stage regulated hybrid switched capacitor converter
- ❖ RHSC... Regulated hybrid switched capacitor converter

# Digital power support

## SUPPORT

- Power supply experts
- Digital and analog brick designs
- Firmware patch development in Asia & US
- Telecom, server, datacenter and HVDC application expertise
- [Product webpage](#)

## TRAINING & COLLETRAL

- XDPP11xx Design manual
- Regional firmware support
- Reference design library with step-by-step design process
- Training material
- [XDPP1100 MyICP link](#)
- [XDPP114x MyICP link](#)

## SOFTWARE

- Step-by-step FW development guide
- Example code for various isolated and non-isolated power topologies
- Patch development for customization
- Housekeeping code, fan control sequencing etc.



## REFERENCE & DEMO BOARDS

- Up to 9 digital brick designs
- 5 on-board telecom and server specific isolated and non-isolated power designs for IBC
- High voltage POLs
- Documentation, test reports, schematic and layout files to download



## EVM DAUGHTER CARDS

- Control card for XDPP11xx 4x4 and 6x6 packages available
- Can be plugged into any power stage using standard connector



## TOOLS

- Complimentary graphic user interface (GUI)
- Download from [Infineon Developer Center](#)
- Compatibility with commonly used IDEs (Keil, Eclipse)
- ARM licensed compilers OR GCC based license free platforms



# Support



## Collaterals and brochures

- Product briefs
- Selection guides
- Application brochures
- Presentations
- Press releases, ads

- [Digital Power Controllers](#)
- [Gate Drive ICs](#)
- [OptiMOS™ power MOSFETs](#)

## Technical material

- Application notes
- Technical articles
- Simulation models
- Datasheets, MCDS files
- PCB design data

- [48 V Power Distribution](#)
- [Hybrid switched-capacitor \(HSC\) – web landing page](#)
- [Hybrid switched-capacitor \(HSC\) – application note](#)

## Evaluation boards

- Evaluation boards
- Demoboards
- Reference designs

- [www.infineon.com/evaluationboards](#)

## Videos

- Technical videos
- Product information videos

- [www.infineon.com/mediacenter](#)

