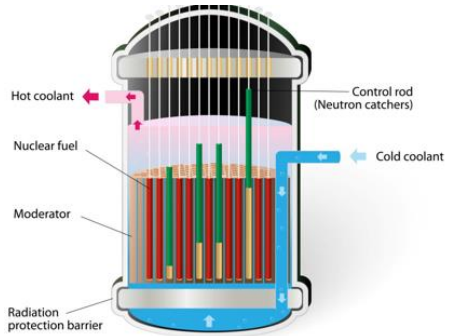
電源趨勢之高功率密度篇

A Leading Provider of Smart, Connected and Secure Embedded Solutions

Microchip ESE Philip Tseng


AI

Microchip Power Solutions



Nuclear Reactor

Wind

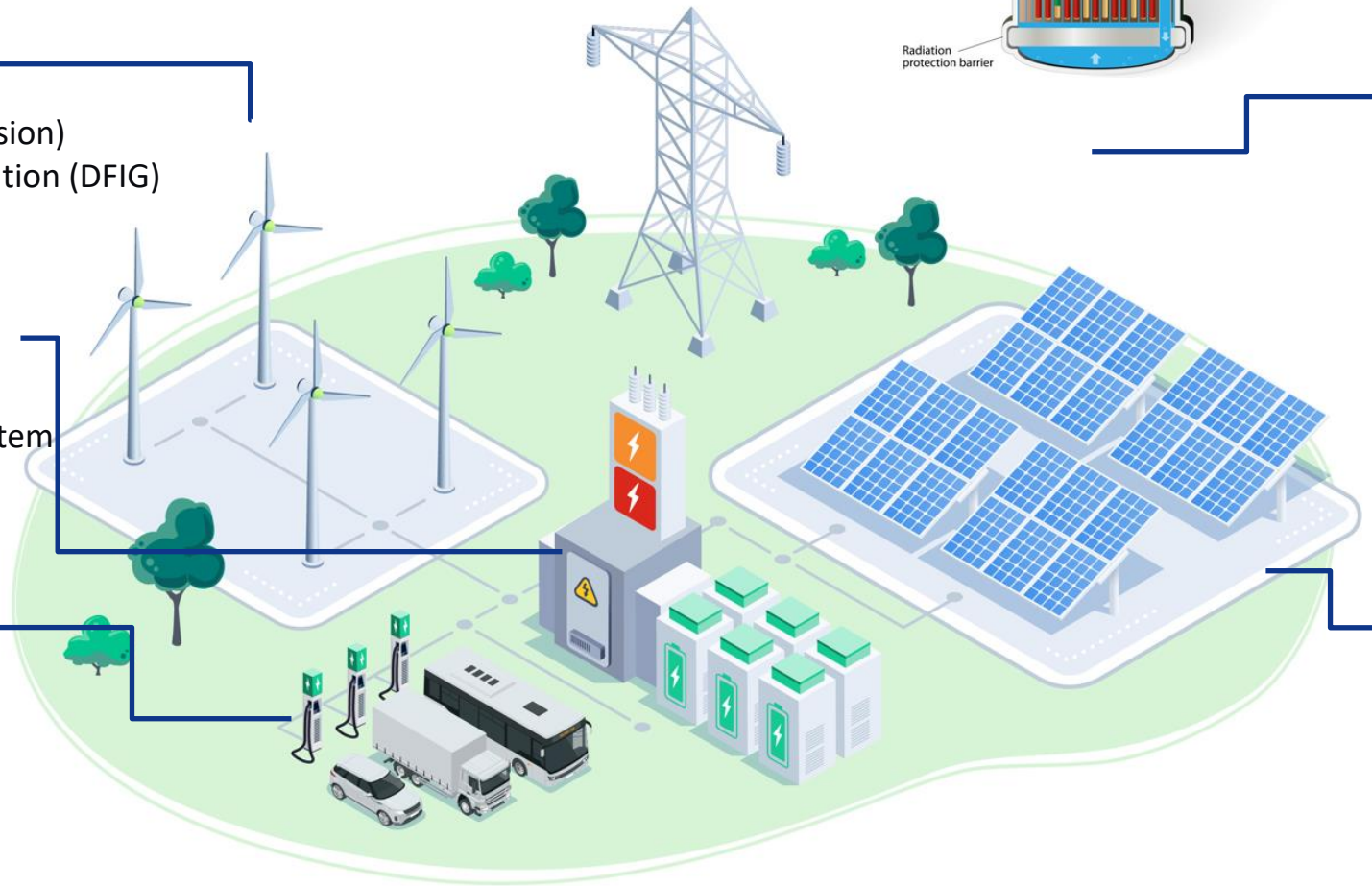
Drive Converter (Full Conversion)
Doubly-fed Inductive Generation (DFIG)

Energy Storage

BMS Battery Management System
Fuel Cell

Charging Pile

OCPP EV Charging Pile



Data Center

AC/DC, DC/DC, SiC, PoE

Solar

Microinverter
String Inverter
Central Inverter
Aux Power Supply
Solid State Circuit Breaker
Metering, PLC

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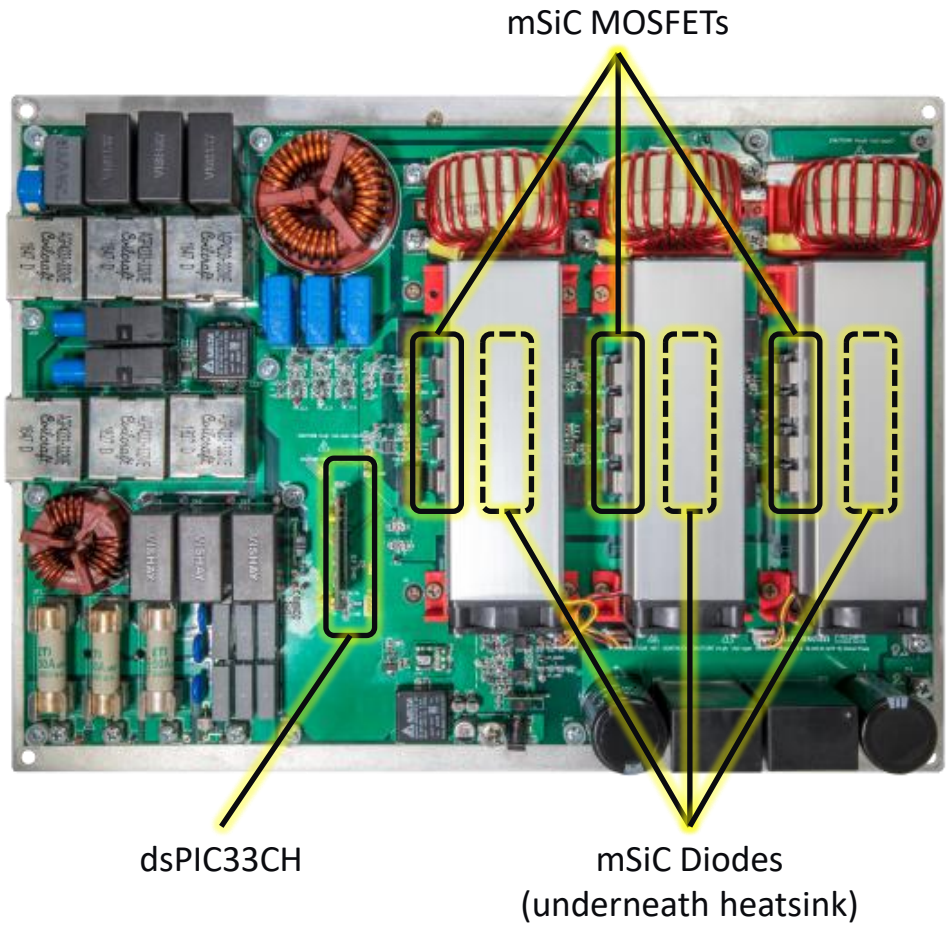
mSiC™ Solutions | 30 kW Vienna PFC

Modular and scalable PFC

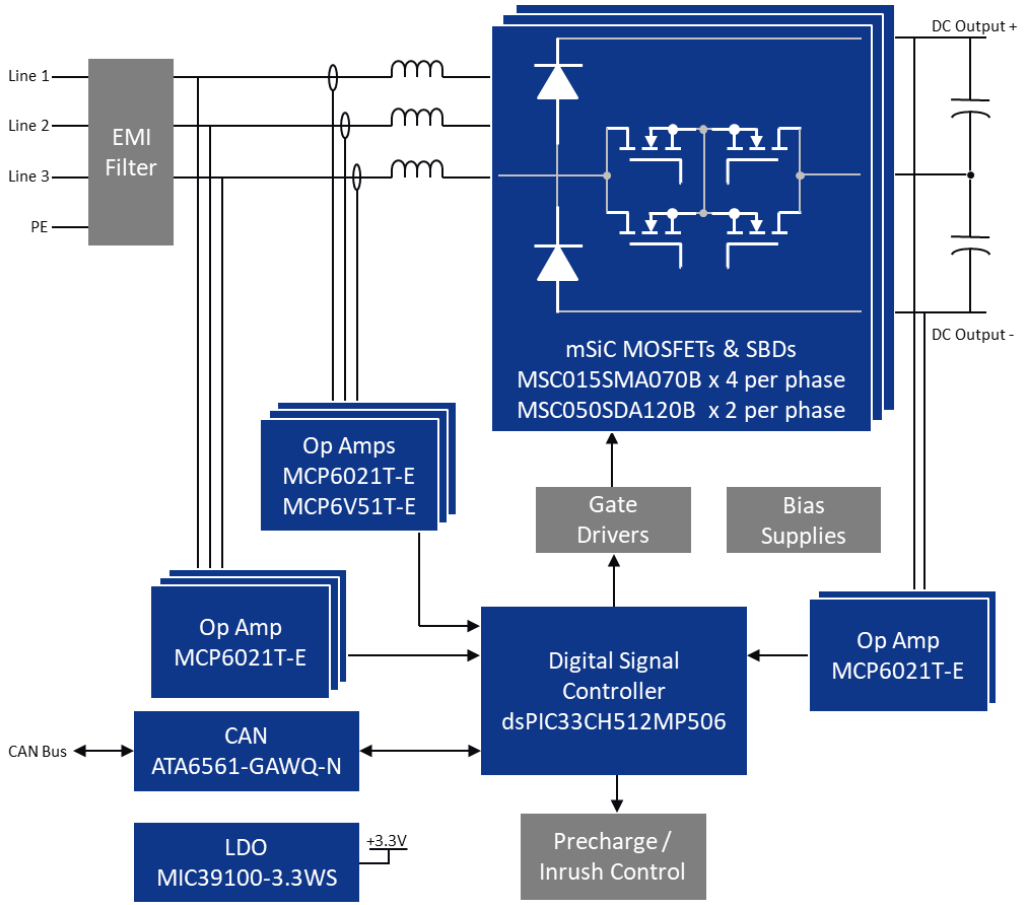
- 98.6 % peak efficiency
- 3-phase 380/400V_{AC}, 50/60 Hz input with 700V_{DC} output voltage
- Design for 20% over voltage on the line
- 700V mSiC MOSFETs and 1200V mSiC diodes
- Regulators, OP AMP, CAN
- 140 kHz PWM switching frequency
- < 5 % current THD at half and full loads
- dsPIC® DSC 3-level modulation digital control
- PCB design according to IEC standards, with consideration for safety, current stress, mechanical stress and noise immunity

mSiC™ Solutions | 30 kW Vienna PFC

Reference design



30 kW Vienna PFC Block Diagram



mSiC™ Solutions | 30 kW PSFB DC-DC Converter

Isolated 3-level DC-DC converter with enhanced soft switching

- 30 kW isolated uni-directional DC-DC converter
- 1200V mSiC MOSFETs and 1200V mSiC Diodes
- Regulators, OP AMP, Thermal sensor, CAN
- >98% peak efficiency
- 650V – 750V input
- 160V – 650V output at 60A maximum current
- 140 kHz PWM switching frequency
- 7.2 kW/L Power Density
- dsPIC® DSC 3-level modulation digital control
- PCB design according to IEC standards
  - Consideration for safety, current stress, mechanical stress, and noise immunity

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Digital Power Design Ecosystem

Fast Development / Reduce Risk

Starter kits

MPLAB® Code Configurator

Reference Designs

Development Boards / EVBs

MPLAB® PowerSmart™ Development Suite

App Notes
Code Examples
Libraries

```
_AltRegContext2Setup:

CTXTSWP #0x2   ; Swap to Alternate W-Reg #2

; w0 register used for compensator control reference

mov #ADCBUF3,  w1   ; Address of ADCBUF3 register
mov #CMP2DAC,  w2   ; Address of CMP2DAC register

; w3-w5 used for ACCAx and MAC/MPY instructions

mov #BOOST_COMP_2P2Z_POSTSCALER, w6
mov #BOOST_COMP_2P2Z_POSTSHIFT,  w7
mov #_boostOptions,              w8
mov #_boostABCoefficients,       w9
mov #_boostErrorControlHistory,  w10
mov #BOOST_COMP_2P2Z_MIN_CLAMP,  w11
mov #BOOST_COMP_2P2Z_MAX_CLAMP,  w12

CTXTSWP #0x0  ; Swap back to main register set

return
```

Royalty-free microcontroller and application-specific

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Software Simulation Tools

Power Smart

Development Suite for dsPIC® Digital Signal Controllers helps speed up power supply design by system modeling and code generation.

MPLAB® SiC Power Simulator

- Free PLECS-based online MPLAB SiC power simulator
- Quickly evaluate Microchip's mSiC power devices and modules across various topologies

MPLAB® Mindi™ Analog Simulator

- Microchip's free circuit simulation software available for download at www.microchip.com/Mindi
- Uses SIMetrix and SIMPLIS simulation environment for SPICE and piecewise-linear modeling

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Smart Energy Platform 2.0

Options	Metering Sensor	Metering Engine	Application Processor	Protocol Processor	Transceiver/ PHY	Edge Computing
DISCRETE	AFE (1ph/3ph) ATM90E26, ATM90E32, ATM90E36		Single Core PIC32CXMTG series		Radio PHY AT86RF 215M PLC PHY MPL360 MPL460	MPU SAMA7G54 SAMA5D2 SAM9X75 … …
PARTIAL INTEGRATION	ADC (1ph/3ph) ATSENSEx01, MCP391x	Dual Core ATSAM4C, PIC32CXMTC series				
SINGLE BOARD	System On Chip ATSAM4CMS/P, PIC32CXMTSH series				PLC+RF Hybrid Multi-chip	

+ Microchip portfolio: Crypto | Mem | Ana/Pwr | MCU/ MPU | BT, WiFi

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Microchip OCPP EV Charging Pile Solutions

AC Power

Level 1 & 2

Relay
eFuse

Level 3

AC to DC
30 kW 3-phase Vienna PFC

DC to DC
30 kW DC-DC

Relay
eFuse

DC Metering
MCP39F511A

OCPP Sever

AC Metering
ATM90E26/32/36

EEPROM
24AA025E48

PMIC
MCP16501

CAN
MCP2542

PLC
HomePlug Green PHY

UART

GPIO

SPI

MPU
SAM9X60
Or
SAMA5D27

UART

CAN

SPI

UART

UART

UART/USB

Security
TA100

Ethernet 10/100
KSZ8081RNAIA

I2C

EMAC 0

WIFI
ATWILC1000

SPI/SDIO

MiWi
SAMR30

BT
RNDB451

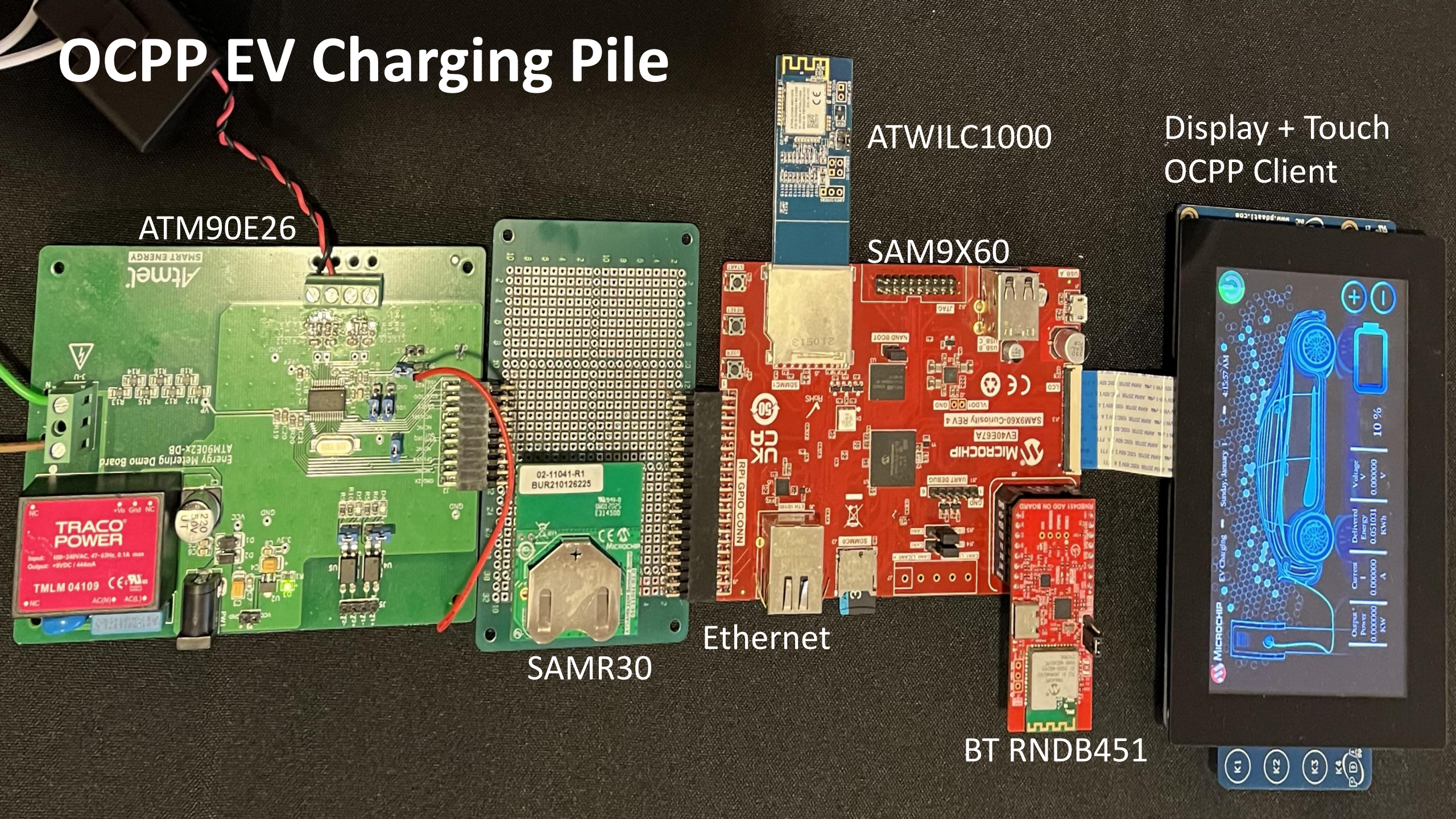
PLC
PL460

Thermal sensor

LCD Panel
maXTouch

OCPP Client

OCPP EV Charging Pile

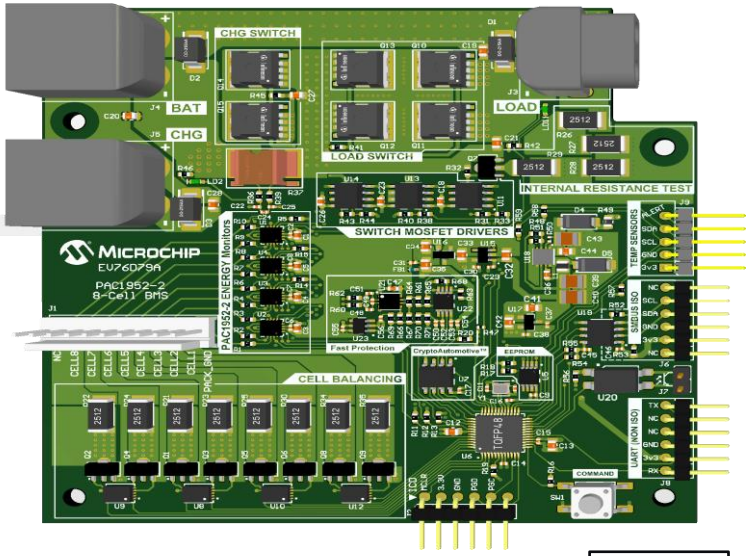


Battery Management Systems

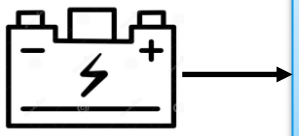
Microchip Top Values

- One stop shop for most BMS needs
- Strong support structure
- No End-of-Life policy
- Large variety of EV reference designs and eval boards
- 25+ years experience in Automotive

BMS Evaluation Board



Major Functions



Power management

- DC/DC Converters
  - Ideal for essential system power supply
  - Broad portfolio with discrete and integrated solution

Security

- Security TA100
  - Ideal to secure BMS applications
  - Authentication of messages from OEM server and/or charging station
  - Secure Boot, Secure Key Storage
  - Hardware crypto accelerators
  - Small footprint and low pin count

Battery Controller Unit

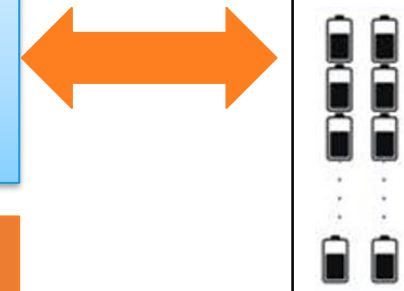
- 8/16/32-bit MCU's
  - Scalable portfolio from individual cell monitoring to full pack management
  - Flexible options for price, performance, form factor requirements and peripherals

Cell Monitoring and Balancing

- Analog Front-End
  - High performance: Fast sampling rate and high resolutions
  - Robust design for harsh environments
  - Low risk product, long time in the market
  - Small form factor

Battery Disconnect Unit

- SiC SBD/MOSFET's
  - Ideal for DC fast charging & power conversion
  - 700V-1700V, 17mΩ-90mΩ
  - Smallest Rdson range over temperature
  - Proven reliability and ruggedness
  - Dual fab strategy
  - Several independent substrate supplier



X-Cell Battery Pack

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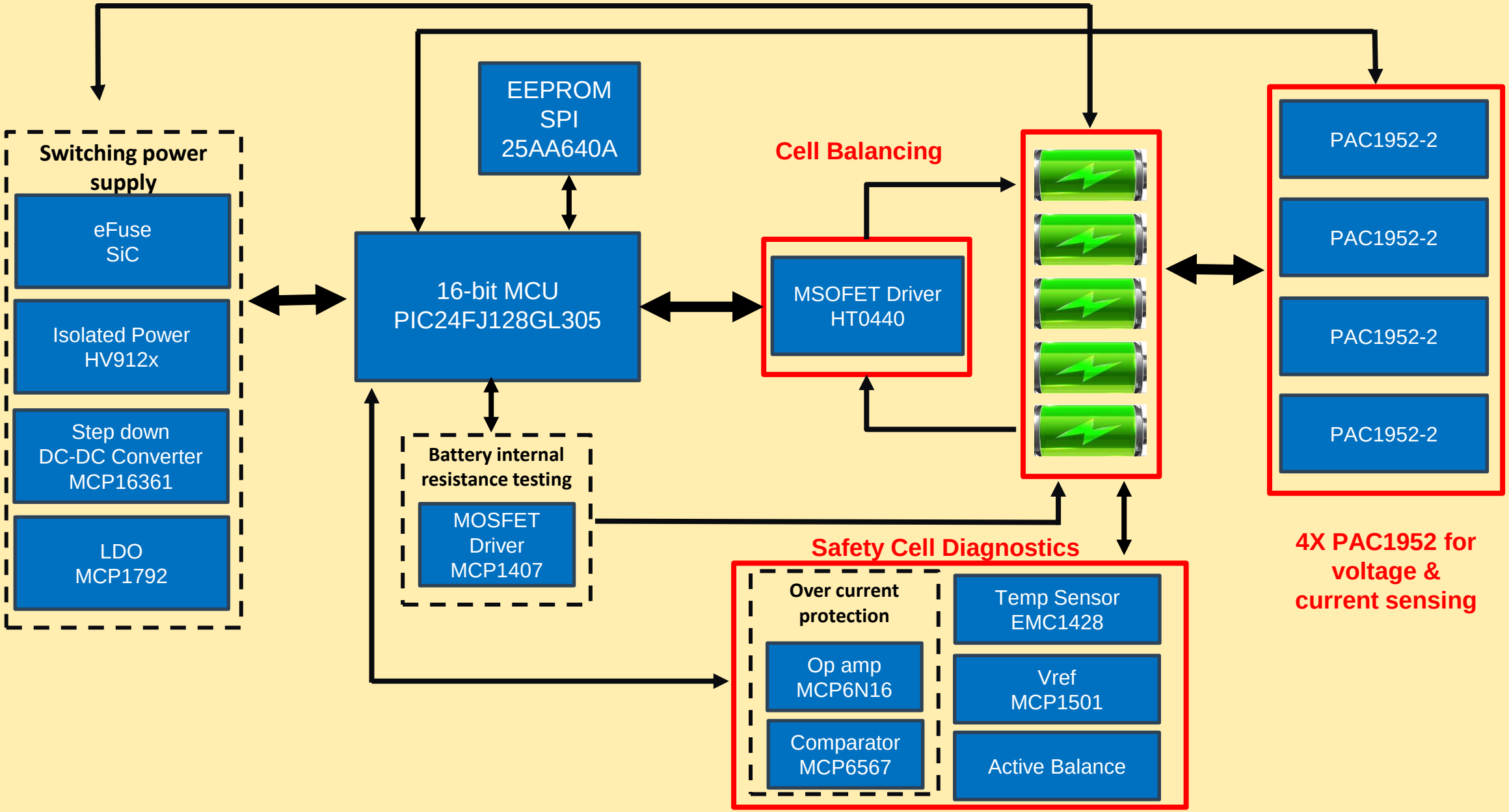
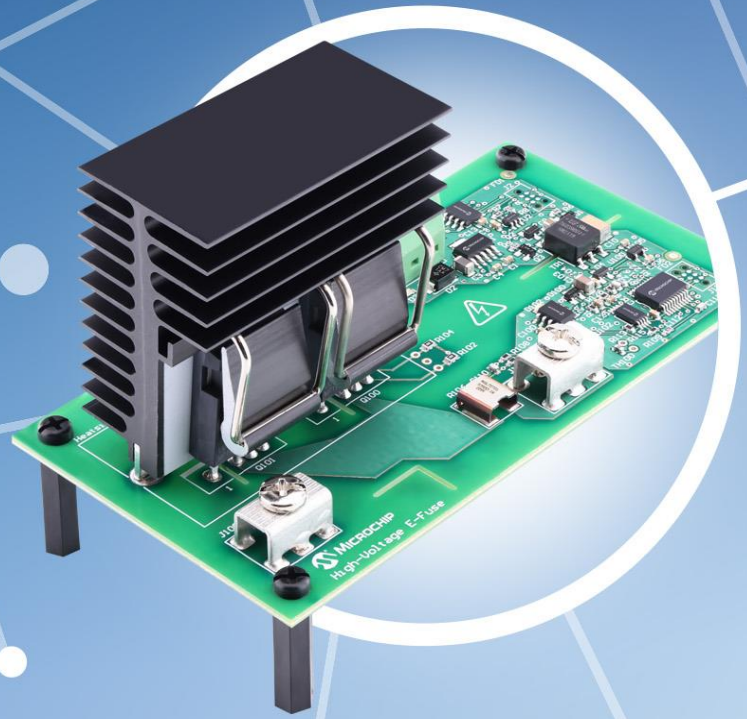
BMS Block Diagram

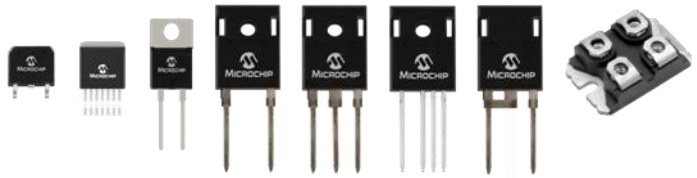


The Electrification of Everything



Higher Levels of
Power Fidelity are Required

mSiC™ Product Portfolio | 700V, 1200V, 1700V, 3.3 kV

Products	Packages	Portfolio
Bare Die		• 700V – 3.3 kV, 15 – 750 mΩ SiC MOSFETs • 700V – 3.3 kV, 10 – 90A SiC Schottky Barrier Diodes (SBDs)
Discretes		• 700V – 3.3 kV, 15 – 750 mΩ SiC MOSFETs • 700V – 3.3 kV, 10 – 100A SiC Schottky Barrier Diodes (SBDs)
Modules		• 700V – 1700V, 1.5 – 40 mΩ SiC MOSFETs • 700V – 1700V, 50 – 600A SiC Schottky Barrier Diodes (SBDs) • Baseplate-less and Custom Power Modules
Gate Drivers		• 1200V – 3.3 kV Plug-and-Play Gate Drivers • Augmented Switching™ Technology (Patented)

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Analog & Interface Products

Overview | Demo Boards | End Equipment | Chinese Tree

LINEAR
- Amplifiers
- Comparators

CONNECTIVITY
- CAN, CAN FD, LIN
- HV Interface
- USB and I/O Expanders
- Ethernet
- RF & Microwave, Wireless Interface
- High Speed Data/Video
- PCI Peripherals

SENSORS
- Temperature Sensors
- Infrared & Position Sensors
- Fan Control & Management

CO & FIRE DETECTION ICs
- Smoke Detector ICs
- Piezoelectric Horn Drivers

TIMING
- Clock & Timing Products
- Real Time Clock/Calendar

POWER MANAGEMENT
- DC/DC Converters
- PWM Controllers
- Battery Chargers
- Power Discretes
- Power Modules
- Digital Gate Drivers
- Power MOSFET Drivers
- Power over Ethernet
- Motor Drivers
- System Supervisors Voltage Detectors
- Power Switches
- Hot Swap / E-Fuses
- DDR & SCSI Terminators
- Display/LED Drivers
- Reverse Power Feed

MIXED SIGNAL
- A/D Converters
- Current/DC Power Measurement ICs
- Power Monitoring & Metering
- DACs & Digital Potentiometers
- Voltage References

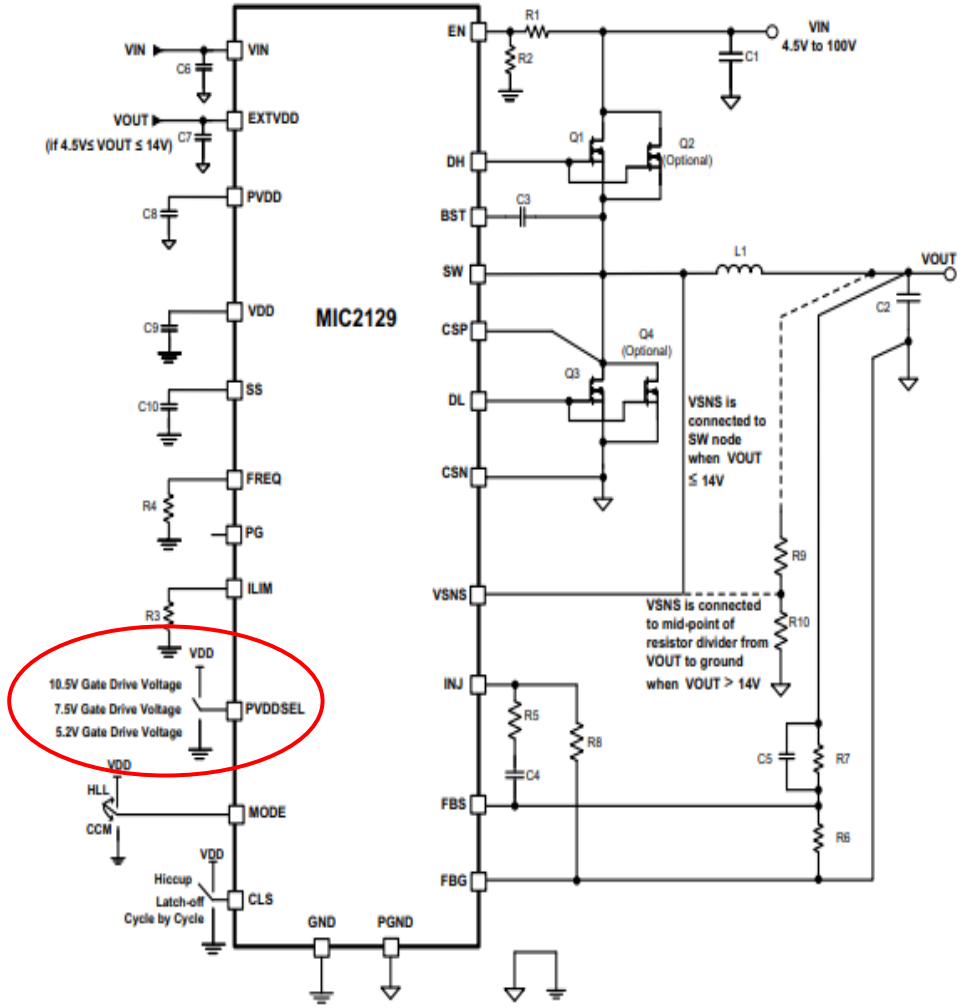
ULTRASOUND
- Ultrasound Products

Reference Designs

MIC2129
100V Synch. Buck Controllers with Adaptive On-Time Control

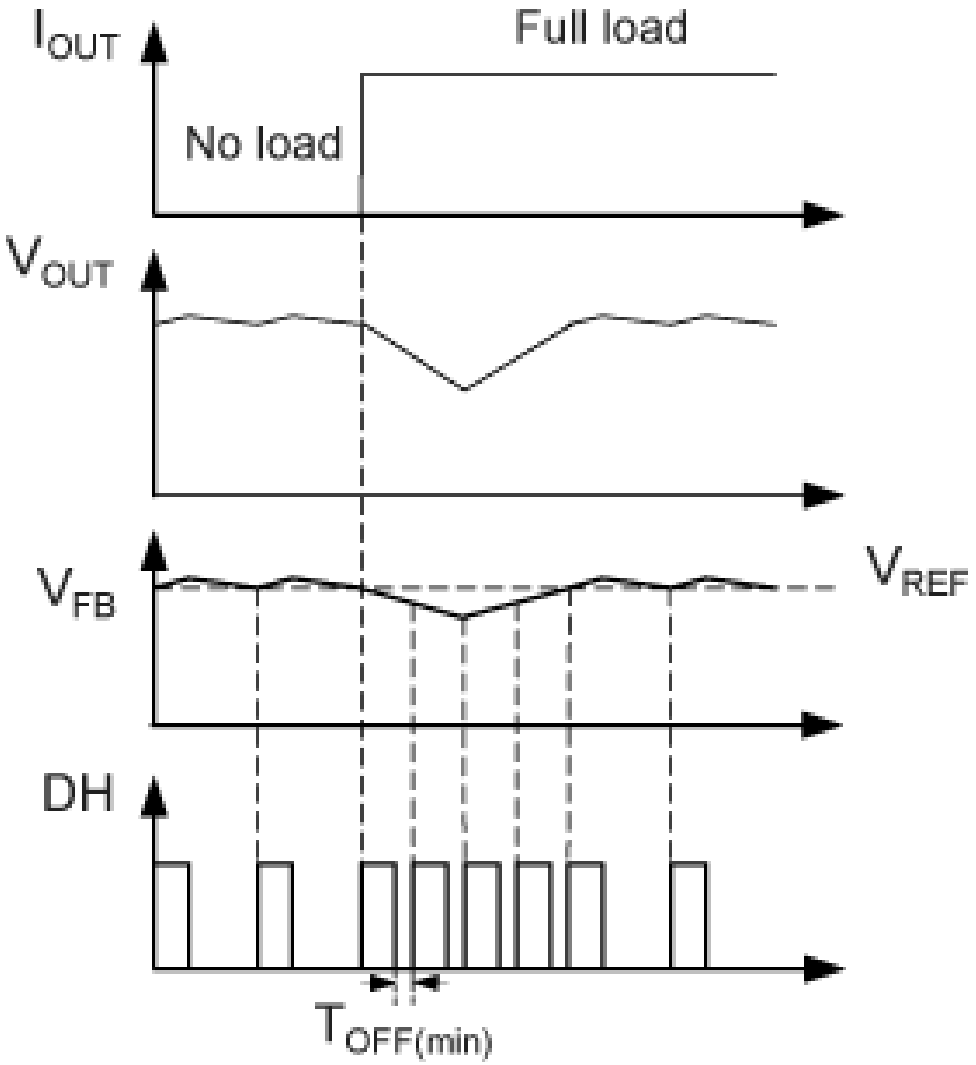
Features:

- 4.5V to 100V input voltage
- Selectable gate driver voltage (5.2V/7.5V/10.5V)
- AEC-Q100 Qualified
- Hyper Speed Control architecture
- High Delta V operation
- Any Capacitor™ stable
- Adjustable output voltage from 0.6 V to Vin*Dmax
- 100k to 800kHz, programmable switching frequency
- Built-in 5V regulator for single-supply operation
- Programmable current limit and “hiccup” mode short-circuit protection
- Programmable External soft start
- Internal compensation, and thermal shutdown
- Option for External and Internal VDD
- Supports safe start-up into a pre-biased output
- -40°C to +125°C junction temperature range
- Available in 24-pin 4mm x 4mm VQFN



Digitally Modified Adaptive On-Time Control HyperSpeed Control™

- **The switching frequency is increased during the load transient**
- **This solution provides fixed-frequency operation, but provides:**
  - Fast transient response
  - Smaller output capacitance



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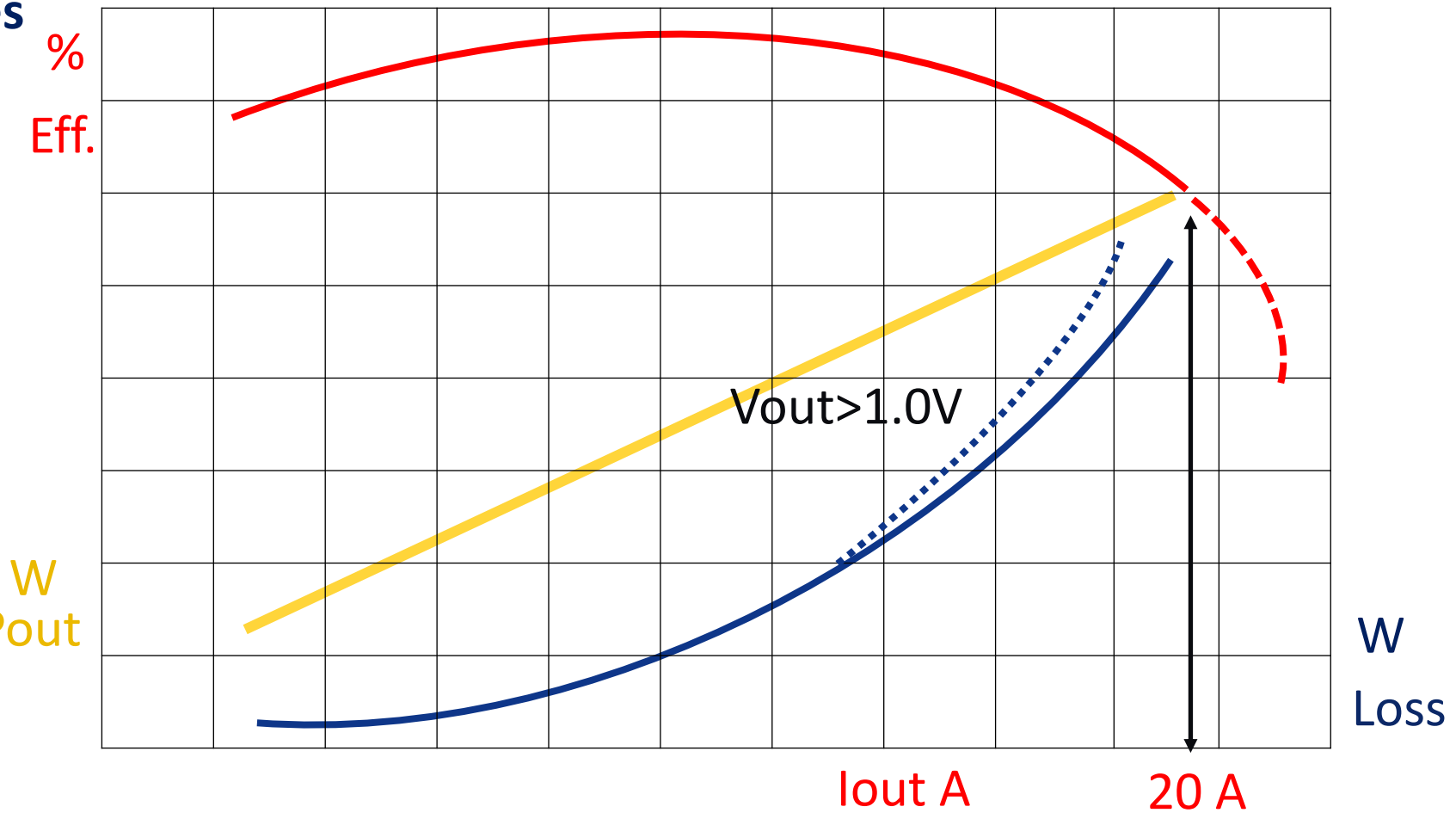
The Limitation of Single Phase Buck Converter Switching Power Efficiency and Losses

Conduction Losses

$Irms^2 * R$



Vin 12V
PWM 300KHz
Vout 1.0V
TA=25°
Rds-on_HS 5mΩ
Rds-on_LS 1mΩ
L 0.22u _DCR 0.2mΩ

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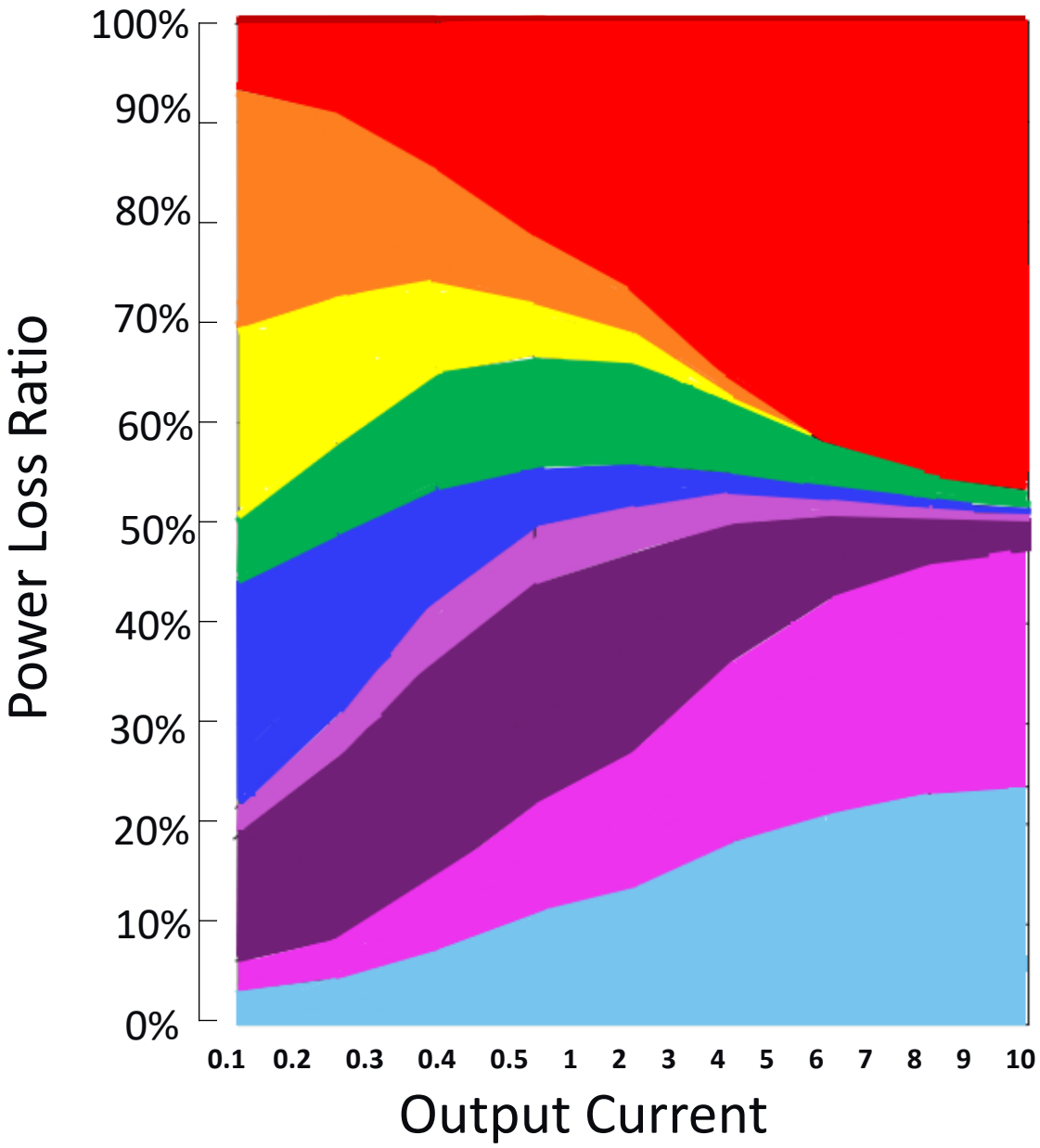
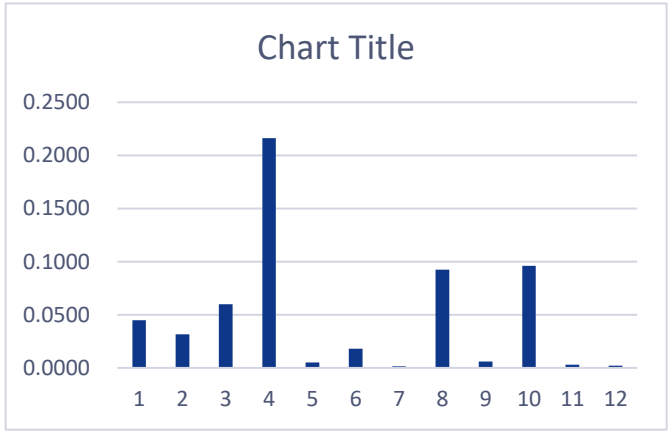
The limitation of Single Phase Buck Regulator



- Output Cap. Loss
- Input Cap. Loss
- Conduction Loss in the Inductor
- Operation Loss in the IC
- Gate Charge Loss
- Dead Time Loss
- MOSFET –Output Cap. Loss
- Reverse Recovery Loss in Body Diode
- Switching Loss in Low Side MOSFET
- Switching Loss in High Side MOSFET
- Conduction Loss in Low Side MOSFET
- Conduction Loss in High Side MOSFET



MPLAB® MINDI™ ANALOG SIMULATOR

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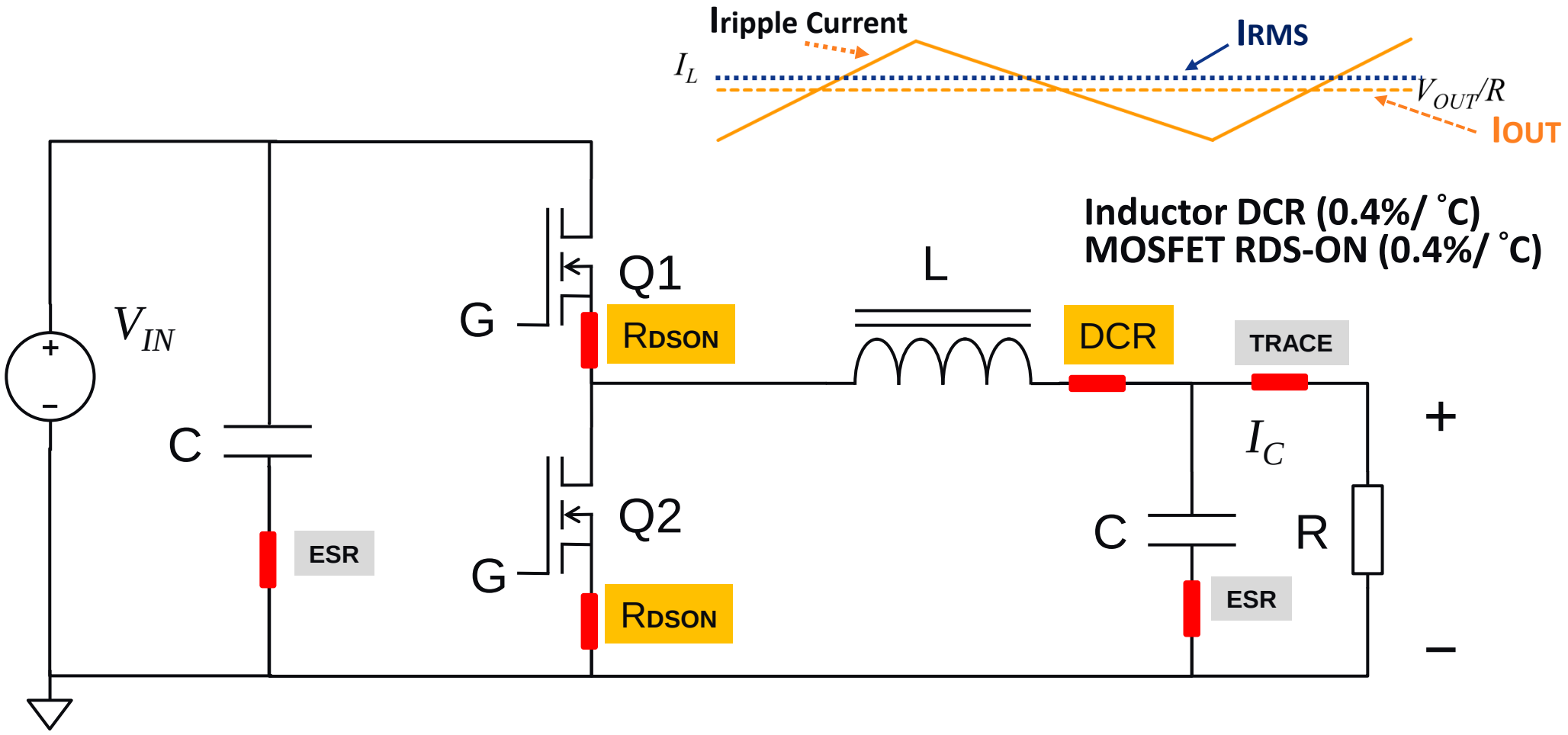
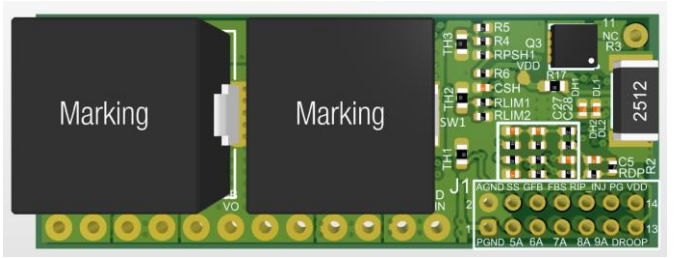
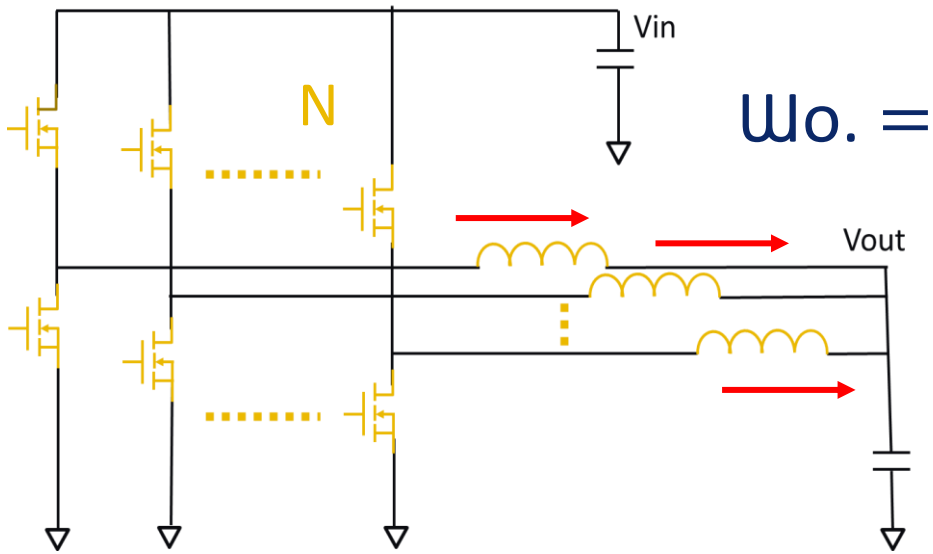
The limitation of Single Phase Buck Regulator



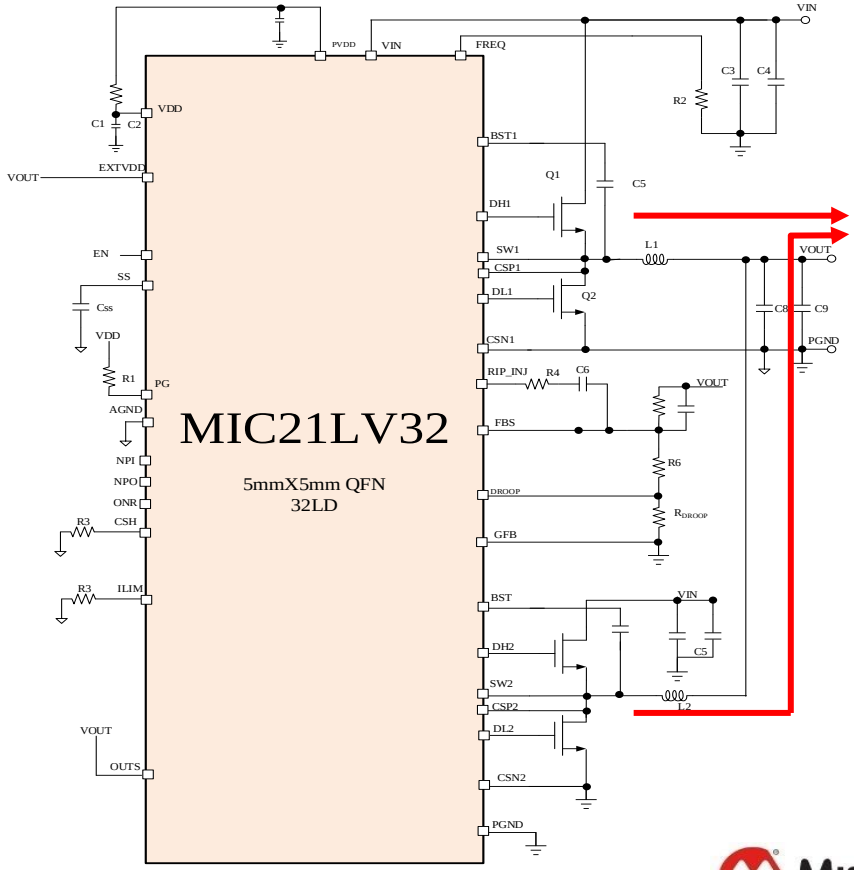
75V, Dual Phase ACOT Switching Buck Controller

- Input voltage range: 4.5V to 75V MIC2132/3
- Adjustable output from 0.6V to 32V
- MIC2132 Stackable for multiphase operation up to 8 phases
- Reference Design with MOSFET & GaN FET
- Accurate Current balancing between phases(Patent Issued)
- Accurate phasing between phases which are always 180° out of phase (Patent Issued)
- 200 KHZ to 800KHZ switching Frequency per phase
- Supports start up to pre-bias output
- Precision Enable function for low stand-by current
- External programmable soft start to reduce inrush current
- Compact size – 5 X 5 mm 32-pin QFN
- –40°C to +125°C junction temperature range





$$\omega_o = \frac{1}{\sqrt{LC}}$$



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Microchip Taiwan Tech Forum 2024

Microchip台灣科技論壇2024
人工智慧應用的核心元素

SMART | CONNECTED | SECURE

高雄　5月20日 | 福華飯店

Microchip Taiwan Tech Forum 2024

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台北　5月23日 | 集思台大會議中心 – 國際會議廳