



STM32 Digital Power Solutions

STMicroelectronics
Kevin Liang

STM32: a developer-first strategy since 2007



STM32 is a key enabler: empowering embedded developers around the world to release their creativity.

We provide embedded developers with cutting-edge hardware and software technology, comprehensive support, and high-quality, reliable supply. This helps them build designs that are smarter, more connected, and more secure.

**The first choice for
32-bit MCU developers**

Source: Aspecore embedded survey, 2022

#1 GP MCU
Worldwide

Source: OMDIA CLT, 2022, 2023

100,000+ customers

Our technology starts with You



STM32 portfolio

 MPU

STM32MP1
1 GHz Cortex-A7
209 MHz Cortex-M4

STM32MP2
Dual 1.5 GHz Cortex-A35
400 MHz Cortex-M33

 High-performance MCUs

STM32F2
398 CoreMark
120 MHz Cortex-M3

STM32F4
608 CoreMark
180 MHz Cortex-M4

STM32F7
1,082 CoreMark
216 MHz Cortex-M7

STM32H5
1,023 CoreMark
250 MHz Cortex-M33

STM32H7
3347 CoreMark
Up to 600 MHz Cortex -M7
240 MHz Cortex -M4

STM32N6
3,360 CoreMark
800 MHz Cortex -M55
Neural processing unit

 Mainstream MCUs

STM32F3
245 CoreMark
72 MHz Cortex-M4

STM32G4
569 CoreMark
170 MHz Cortex-M4

Mixed-signal MCUs

STM32C0
114 CoreMark
48 MHz Cortex M0+

STM32F0
106 CoreMark
48 MHz Cortex-M0

STM32G0
142 CoreMark
64 MHz Cortex-M0+

STM32F1
177 CoreMark
72 MHz Cortex-M3

 Ultra-low-power MCUs

STM32L0
75 CoreMark
32 MHz Cortex-M0+

STM32U0
140 CoreMark
56 MHz Cortex-M0+

STM32L4
273 CoreMark
80 MHz Cortex-M4

STM32U3
393 CoreMark
96 MHz Cortex-M33

STM32L4+
409 CoreMark
120 MHz Cortex-M4

STM32L5
443 CoreMark
110 MHz Cortex-M33

STM32U5
651 CoreMark
160 MHz Cortex-M33

 Wireless MCUs

STM32WL
162 CoreMark
48 MHz Cortex-M4
48 MHz Cortex-M0+

STM32WB0
156 CoreMark
64 MHz Cortex-M0+

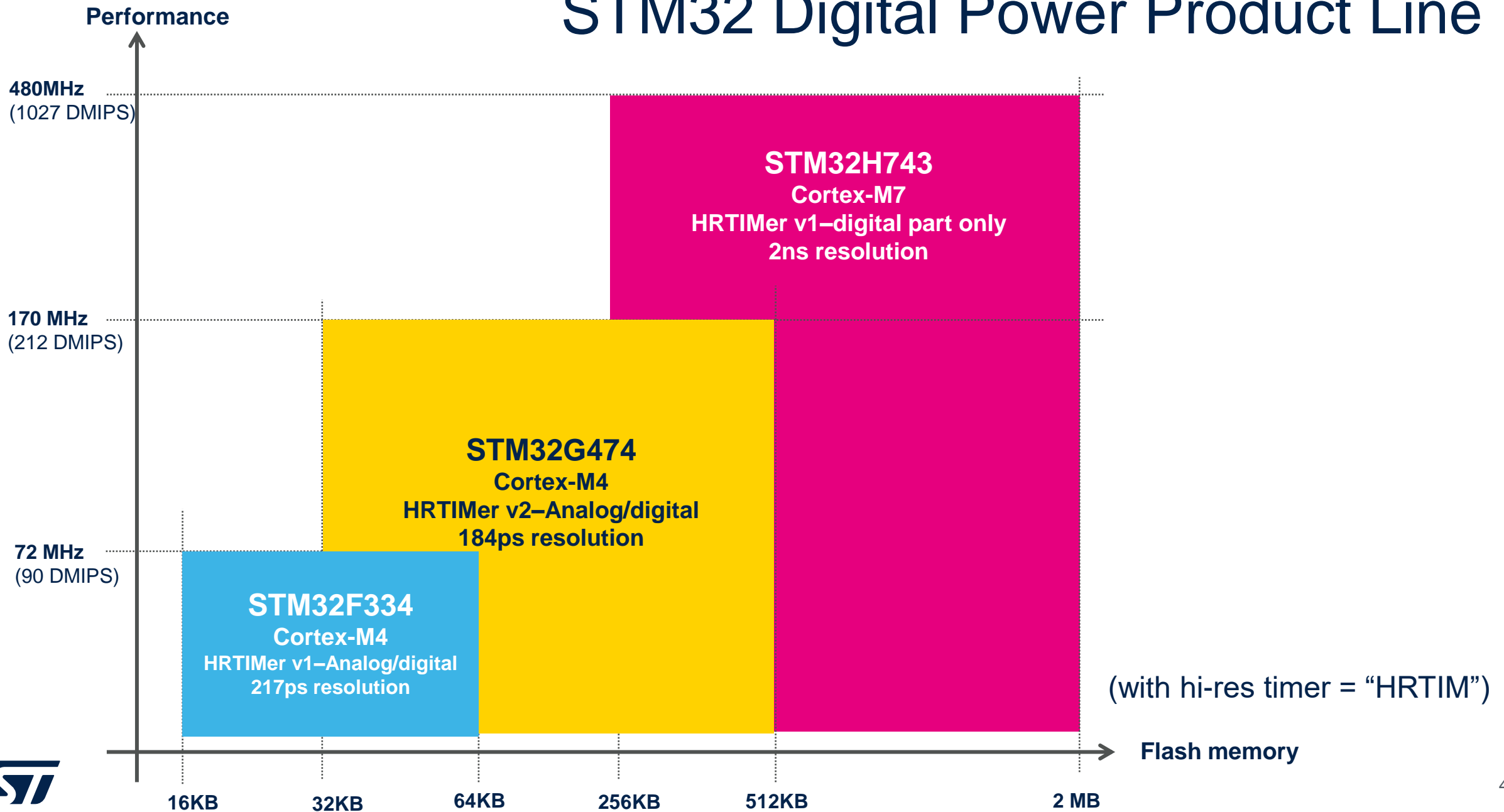
STM32WB
216 CoreMark
64 MHz Cortex-M4
32 MHz Cortex-M0+

STM32WBA
407 CoreMark
100 MHz Cortex-M33

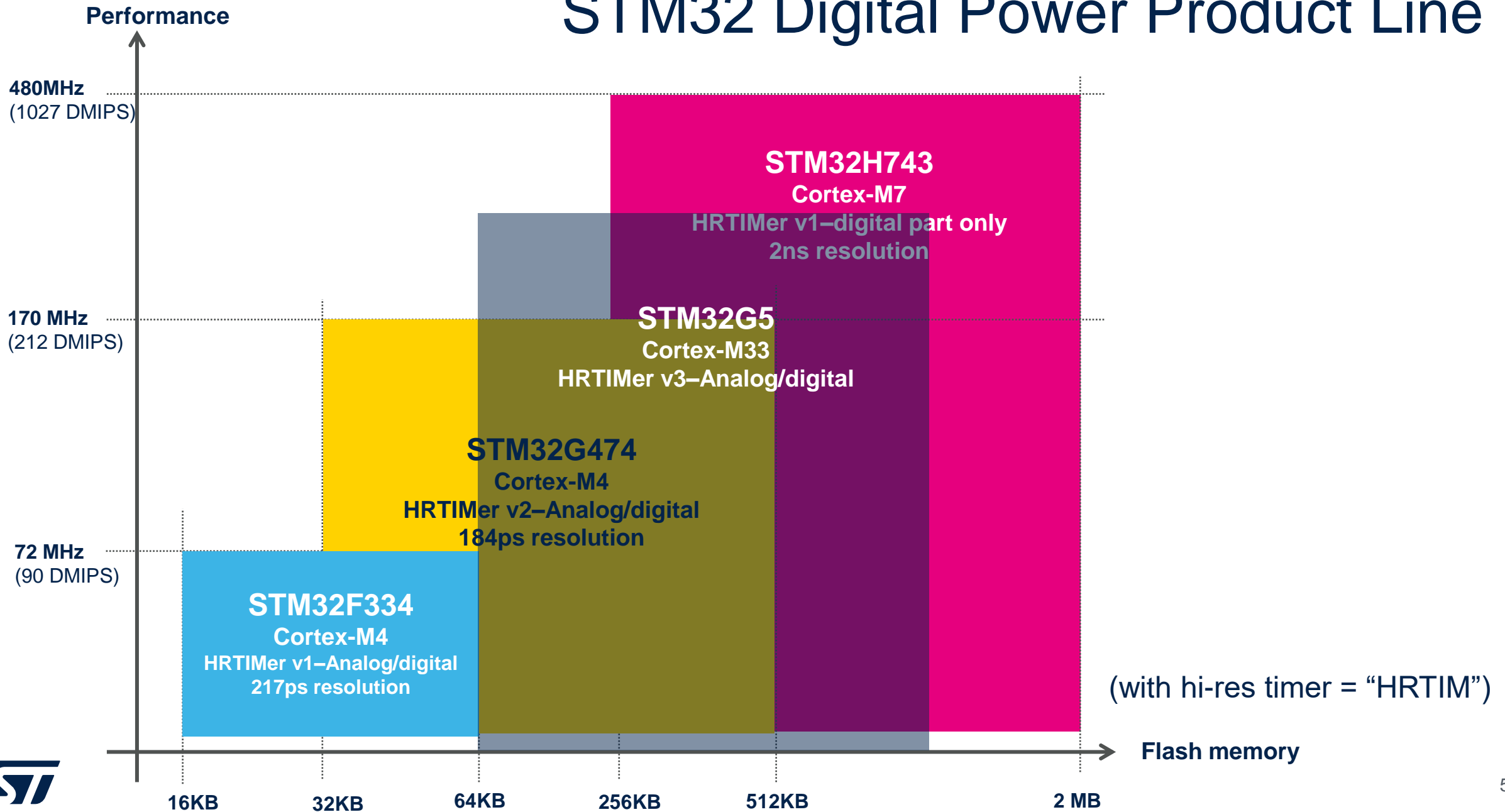


Latest product generation
 Radio coprocessor only
 New series or lines introduced in 2025

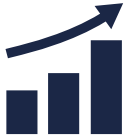
STM32 Digital Power Product Line



STM32 Digital Power Product Line



STM32G4 Series for Digital Power



High performance

Arm® Cortex®-M4 + FPU running @ 170MHz
+ 3x accelerators: ART, routine booster (CCM),
Math. accelerator (Cordic and FMAC)



7x comparators

Down to 19 ns propagation delay



5 x ADC

5x12-bit, 16-bit oversampling
4 MSPS (0.25µs)

7 x DAC

12-bit DAC 15 MspS



Motor control timer & high-resolution Timer (D-Power)

12 channels up to 184 ps resolution



High temperature
from -40°C up to + 125°C

Security

Arm PSA Level 1 logical security certification



USB Type-C® Power Delivery



High robustness

Highly immune to fast transients
Robust IOs against negative injections



Functional Safety

SIL and CLASSB Safety Packages, including
Self-Test Library

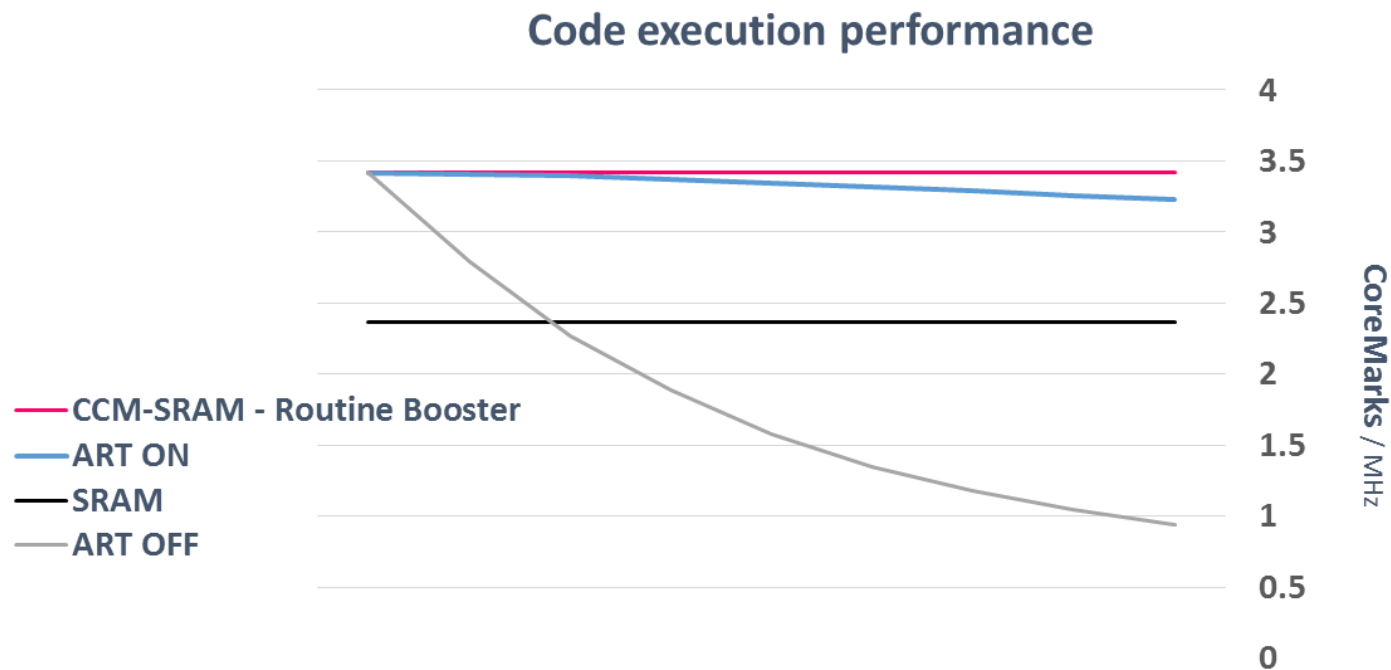
FD CAN

Up to 3 instances
Payload bit rate 8 times bigger than standard CAN



Greater performance

170 MHz CPU performance (Arm® Cortex®-M4) with three accelerators



Number of Wait States	0	1	2	3	4
CPU Clock (MHz)	34	68	102	136	170



Arm® Cortex®-M4 with **FPU**

Up to 170 MHz CPU frequency

Up to 213 DMIPS and 569 CoreMark® results

3 different hardware accelerators:

- **ART Accelerator** (~dynamic cache)
→ full code acceleration (average)
- **Routine booster CCM-SRAM**
(~static cache) → determinism preserved
- **Mathematical** (Cordic + FMAC)

Function acceleration and CPU offload

1. CORDIC (Trigo)

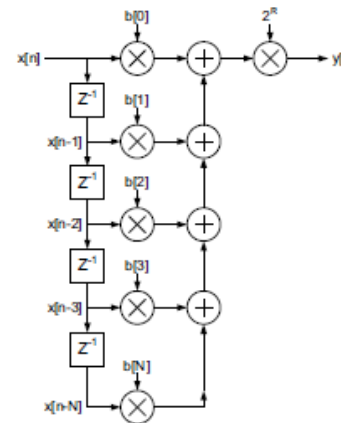
- Very helpful for field oriented motor control method (FOC)

- Vector rotation (polar to rectangular): Sin, Cos
- Vector translation (rectangular to polar): Atan2, modulus
- Sinh, Cosh, Exp
- Atan, Atanh
- Square root
- Ln

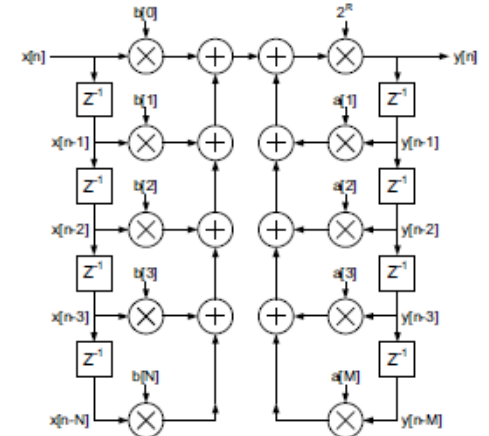
2. Filter math accelerator (FMAC)

- Can be used to create
 - 3p3z compensator (\rightarrow digital power)
 - Sigma Delta modulator
 - Noise shaper

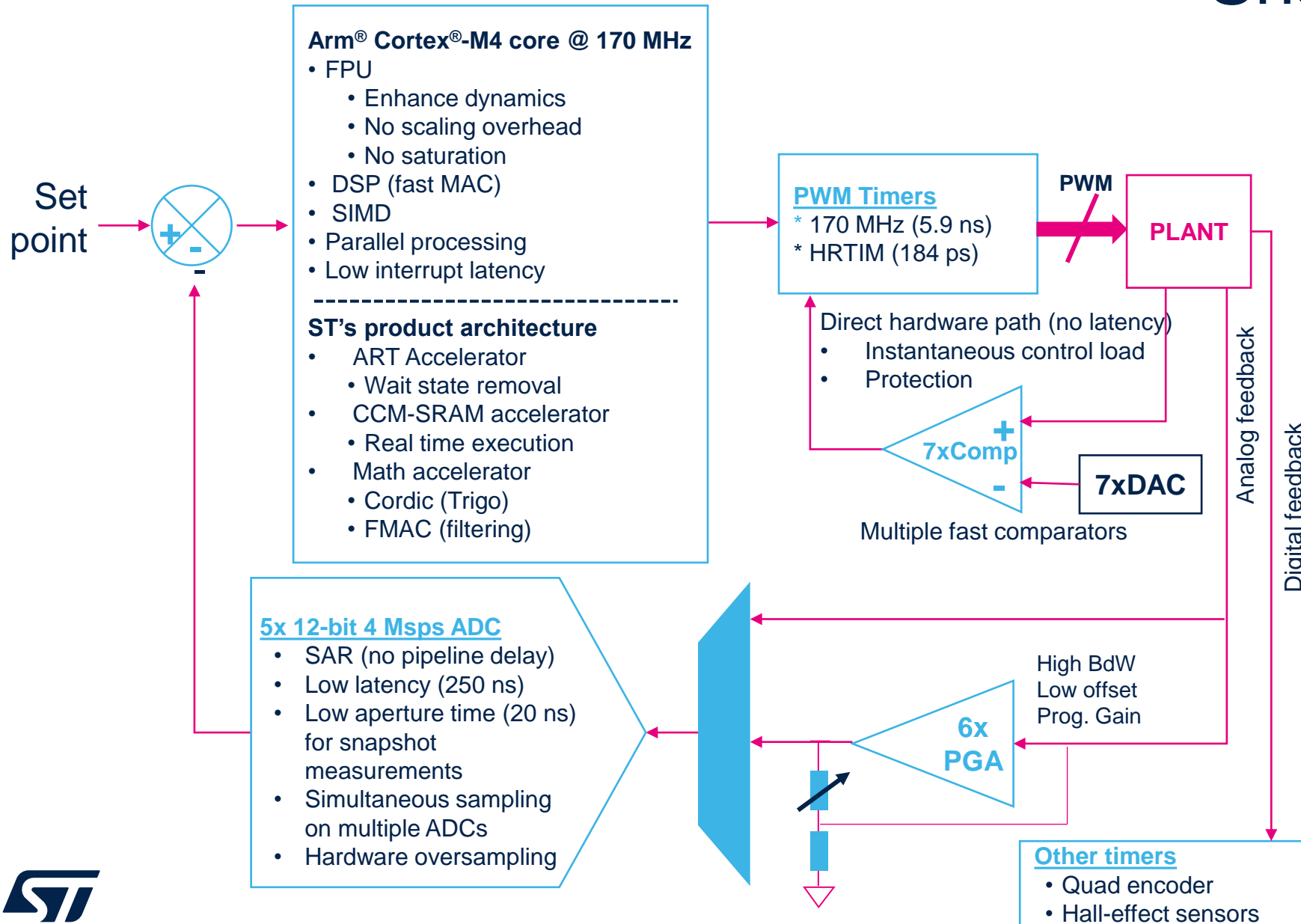
FIR filter



IIR filter



Shaped for control



Easy use of the analog and digital resources thanks to high peripheral interconnect and flexible bus matrix

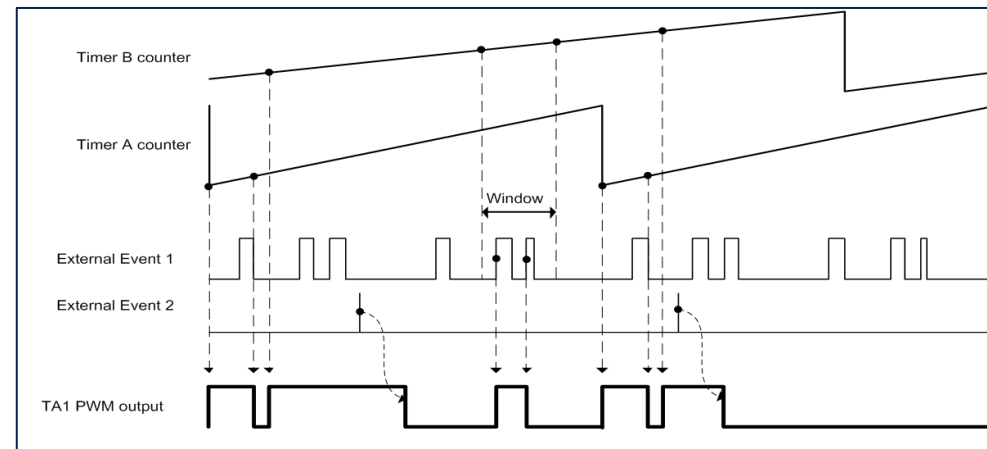
HRTimer – High resolution and much more

High resolution PWM

- 12 channels with 184 ps resolution on frequency and duty cycle
- 184 ps is equivalent to a 5.4GHz timer clock

Flexible PWM generation

- 7 x independent time base to create various shape of PWM
- 6 x complementary pair PWM outputs
- Up to 32 set/reset transitions per PWM period thanks to the built-in crossbar
- Controller/target configuration for multi phase converter



Multiple Event handlers

- 6 x digital and analog fault input
- 10 x events cycle to cycle current control or PWM restart (constant Ton/Toff)
- Blanking, windowing, and digital filter

12 independent channels

- Any topology supported from 1x 12 PWM (triple interleaved LLC (server application)) up to 12 x 1 PWM (multiple independent buck converters (lighting))

Cybersecurity in Digital Power

M-CRPS and SPDM for server power supply



M-CRPS V1.05 RC5 (Sept'24), 12.9 Security Chapter

- 12.9.2 Security Boot
- 12.9.3 Security Firmware Update
- 12.9.5 Security Algorithm support
 - OCP HW Security Boot White Paper*

Strength

Crypto algorithms:

- Symmetric crypto : AES-256
- Asymmetric crypto : ECDSA P384, ECDH P384, RSA
- Hash : SHA2 384
- PQC : Not mandatory with SPDM1.2, but SPDM1.4

PQC in CNSA 2.0 Commercial National Security Algorithm

National Security Agency | Cybersecurity Advisory

Announcing the Commercial National Security Algorithm Suite 2.0

Executive summary
The need for protection against a future deployment of a cryptanalytically relevant quantum computer (CRQC) is well documented. That story begins in the mid-1990s when Peter Shor discovered a CRQC would break public-key systems still used today. Continued progress in quantum computing research by academia, industry, and some governments suggests that the vision of quantum computing will ultimately be realized. Hence, now is the time to plan, prepare, and budget for an effective transition to quantum-resistant (QR) algorithms, to assure continued protection of National Security Systems (NSS) and related assets.

This advisory notifies NSS owners, operators, and vendors of future requirements for QR algorithms for NSS. These algorithms (also referred to as post-quantum algorithms) are analyzed as being secure against both classical and quantum computers. They are an update to those in the Commercial National Security Algorithm Suite (referred to as CNSA 1.0, the algorithms currently listed in CNSSP 15, Annex B). NSA will reference this update as CNSA Suite 2.0, and any future updates will modify the version number.

NSA is providing this advisory in accordance with authorities detailed in [NSD-42](#), [NSM-8](#), [NSM-10](#), [CNSSP 11](#), and [CNSSP 15](#). Its direction applies to all NSS use of public cryptographic algorithms (as opposed to algorithms NSA developed), including those on all unclassified and classified NSS. Using any cryptographic algorithms the National Manager did not approve is generally not allowed, and requires a waiver specific to the algorithm, implementation, and use case. In accordance with CNSSP 11, software and hardware providing cryptographic services require [National Information Assurance Partnership \(NIAP\)](#) or NSA validation in addition to meeting the requirements of the appropriate version of CNSA.

Public-key
CRYSTALS-Dilithium
CRYSTALS-Kyber

Symmetric-key
Advanced Encryption Standard (AES)
Secure Hash Algorithm (SHA)

Software and Firmware Updates
Xtended Merkle Signature Scheme (XMSS)
Leighton-Hicall Signature (LMS)

PQC Algorithms standardized by NIST

NIST standards released in August 2024

Algorithm	Purpose	FIPS standards
CRYSTALS-Kyber (Lattice-based)	Key encryption	FIPS-203 (ML-KEM)
CRYSTALS-Dilithium (Lattice-based)	Digital signature	FIPS-204 (ML-DSA)
SPHINCS+ (Stateless hash-based)**	Digital signature	FIPS-205 (SLH-DSA)
FALCON (Lattice-based)*	Digital signature	FIPS-206 (FN-DSA) not yet released

* NIST: "...since there may be use cases for which CRYSTALS-Dilithium signatures are too large."

** NIST: "to avoid relying only on the security of lattices for signatures"

Algorithms previously standardized by NIST

- XMSS and LMS are 2 PQC Statefull hash-based signature schemes standardized in Oct/2020
- Typical use case: Firmware upgrade signature

Statefull signature	Standard
XMSS	SP800-208
LMS	



STM32 PQC offer

- PQC library already available for download on st.com : [X-CUBE-PQC](#)
 - Cryptographic algorithms:
 - LMS + XMSS with HW SHA-2 acceleration
 - LMS signature verification perf.: 4 ms for 2.5 Kbytes signature (20 ms w/o acceleration) on STM32H5
 - ML-DSA+ML-KEM without HW acceleration
 - CAVP certified to guarantee bug free implementation: certificate available [here](#)
 - Currently supports STM32H563
 - Support of STM32G4 as alpha version.
- PQC integrated in [X-CUBE-CRYPTOLIBV5](#) in 2026Q1
 - Classic cryptography + PQC
 - All STM32 products supported
 - CAVP certification



STM32 X-CUBE-PQC offer summarized

Part Nb.	PQC Support date	LMS	XMSS	ML-KEM	ML-DSA
STM32H5	Now	√ HW accelerated ⁽¹⁾	√ HW accelerated ⁽¹⁾	√ CAVP certified	√ CAVP certified
STM32G4	October 2025	√	√	√	√
All other parts	2026Q1	√ Acceleration subject to SHA2 IP availability CAVP certified	√ Acceleration subject to SHA2 IP availability CAVP certified	√ Acceleration subject to SHA3 IP availability CAVP certified	√ Acceleration subject to SHA3 IP availability CAVP certified

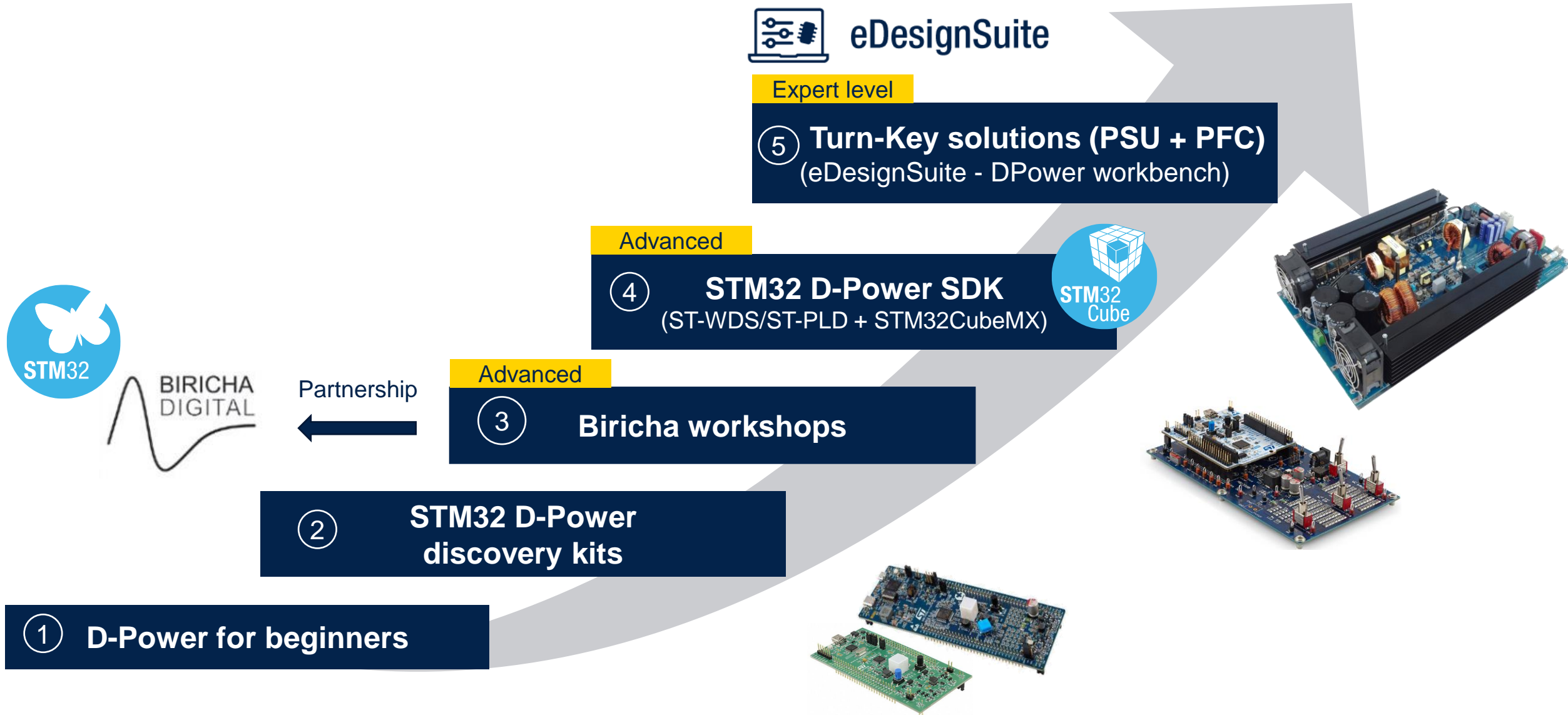
(1) Hardware acceleration increases performance by approximately five times



STM32 Digital Power Ecosystem



STM32 Digital Power: an ecosystem tailored to your needs



Digital Power for Beginners

Videos and webinars

- Understanding the basics of digital with online videos and webinars



The basics of Digital Power in Power Supply and Factor Correction applications (19:22)



Designing Digital Power Supply Units (10:49)



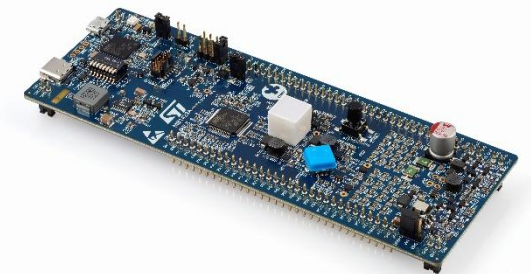
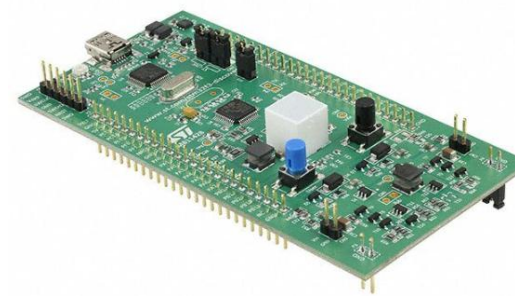
How to design a digital power supply using an STM32 microcontroller (55:32)



How to design a digital PFC step by step using an STM32 microcontroller (01:14:02)

STM32 Discovery kit and application notes

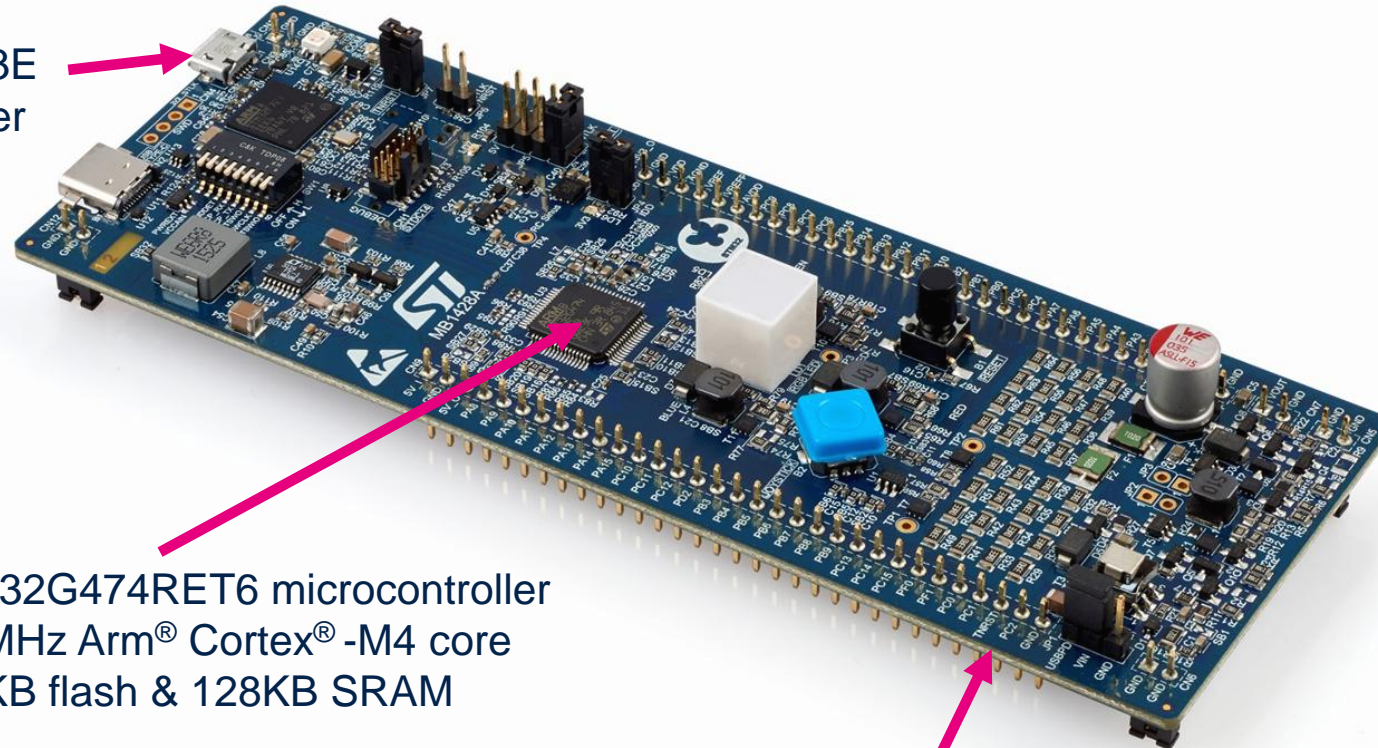
- **STM32F334 and STM32G474 discovery kits**
 - Complete demonstration and development platform with free example code.
- Application notes
 - [AN4539: HRTimer V2 cookbook](#)
 - [AN5496: buck converter in voltage mode](#)
 - [AN5497: buck converter in current mode](#)



Synchronous Buck Converter

B-G474E-DPOW1

On-board STLINK-V3E
debugger/programmer



ST
STM32G4

STM32G474RET6 microcontroller
170MHz Arm® Cortex® -M4 core
512KB flash & 128KB SRAM

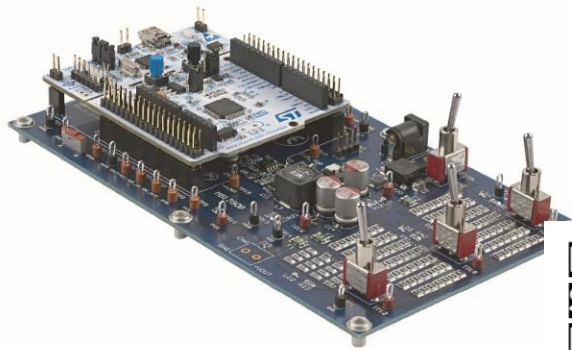
Buck converter circuit with
onboard resistor loads

Digital Power Workshops with Biricha

Implement digital power supplies and power factor correction

STM32 PSU/PFC design

Step-in Digital Power technology



Biricha digital power:
World leading expertise and training in digital power

Workshop based on STM32F334 and STM32G474 Nucleo
and its dedicated digital power expansion board

STMicroelectronics brings industry leading ST MCUs
together with Biricha's tools and training



STM32 System Solutions

STDES-3KWTLCP



STM32G4



3 kW digital power supply
(Totem pole PFC +
FB LLC + SR)

STDES-VRECTFD



STM32G4

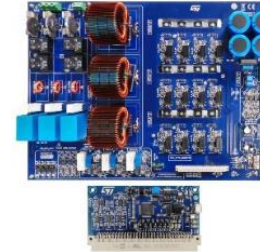


**15 kW 3-ph
Vienna PFC Converter**

STDES-PFCBIDIR



STM32G4



**15 kW 3-ph
Bidirectional AC/DC DC/AC
Convertor**

STDES-30KVVRECT



STM32G4



30 kW Vienna PFC rectifier

STDES-2KW5CH48V



STM32G4



**2.5 kW - 48 V battery charger for
industrial LEVs**
(CCM PFC and FB LLC converter)

STDES-6KWHVDCDC



STM32G4



**6 kW high voltage DC-DC
converter for EV charging**
(FB LLC)

STDES-30KVVRECT



STM32G4



**25 kW Dual Active Bridge
Converter**
(Bidirectional DC/DC converter)





STM32 system evaluation tools

STEVAL-ISA172V2



2 kW fully digital power supply
(PFC 2ph interleaved + DC-DC FB phase shift)



STM32F3

STEVAL-DPSLLCK1



3 kW DC-DC digital power supply
(Full bridge LLC resonant with synch rectification)



STM32F3

STEVAL-DPSTPFC1



3.6 kW PFC Totem Pole with inrush current limiter
(PFC Bridgeless Totem Pole)



STM32F3

STEVAL-TTPPFC01



2 kW, 3-channel interleaved totem-pole PFC



STM32G4



Reference Board Resource



Products

Tools & software

Applications

Solutions

ST Developer Zone

About us



Search a RPN, a product category...



Evaluation tools > Solution evaluation tools > Power supplies and converters > STDES-VRECTFD >

STDES-VRECTFD

ACTIVE



Save to myST

15 kW, three-level, three-phase Vienna rectifier with digital control for power factor correction



Download databrief

Overview



Sample & Buy

Documentation

CAD Resources

Tools & Software

Quality & Reliability

Quick links

[Product Specifications](#)

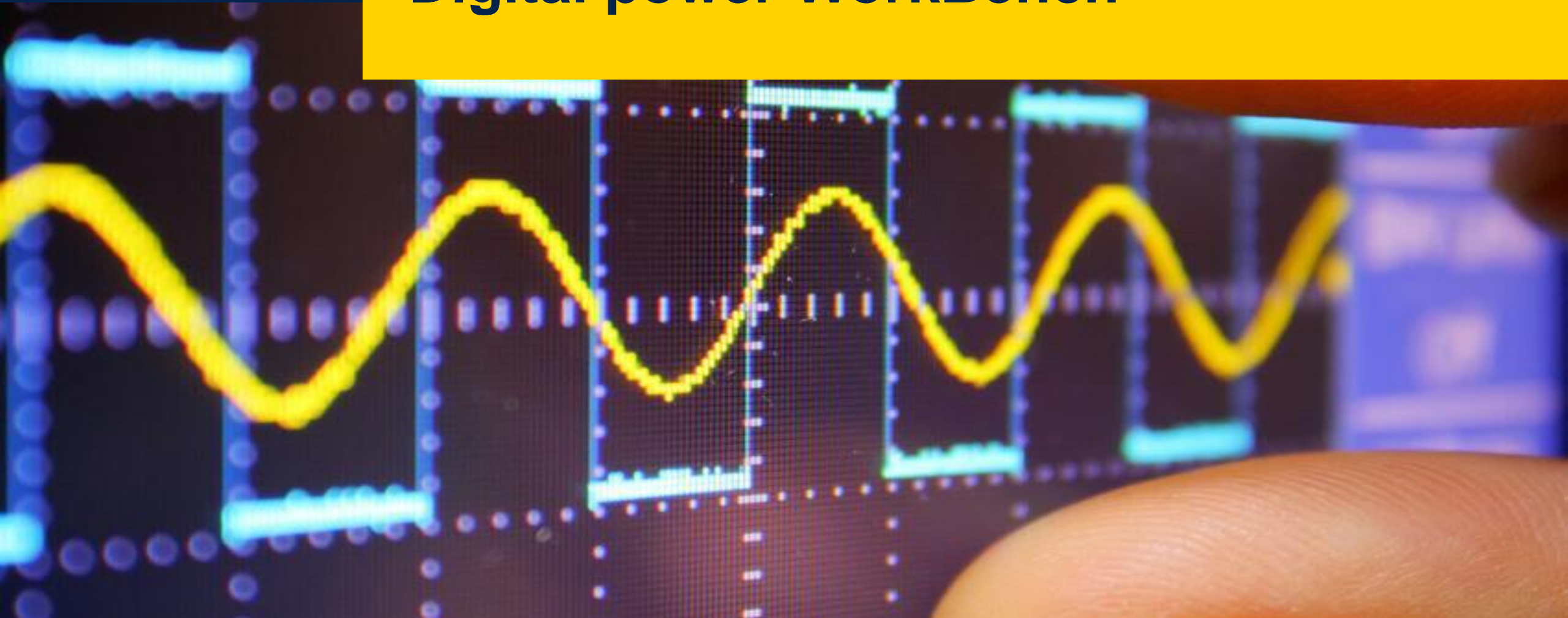
[User Manuals](#)

[Evaluation Board Terms of Use](#)

- Documentation : User Manual, Product Specification
- CAD Resources : Schematic, Gerber file, BOM
- Tools & Software : Firmware binary image (No source code)



Digital power WorkBench





Digital power WorkBench in eDesignSuite

System design tool addressing BOM-rich applications



Power stage optimizer



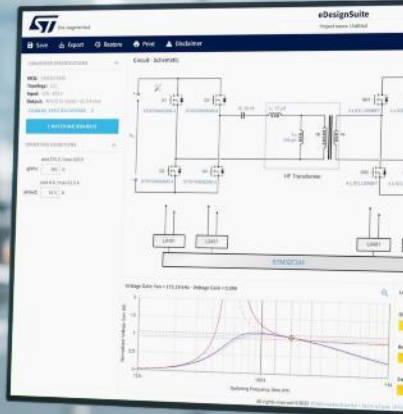
Electrical simulation in signal conditioning



STM32 FW generator



Evaluation board selector



Supported topologies (AC/DC, DC/DC)

- ZVS&CCM Interleaved Totem-Pole, Vienna Rectifier, 3-Level T-Type Converter
- FB LLC, DAB

2024 roadmap

- Bidirectional CLLC (3 – 11 kW)
- MPPT Buck / Boost (7 – 15 kW)
- 3-phase bridge PFC – B6 (11 – 22 kW)
- 3-phase CLLC (11 – 22 kW)



GUI

- Schematic view, BOM, Bode Diagrams, Power losses (for Power Transistors and Diodes)
- Wizard based design customization

Hardware sizing

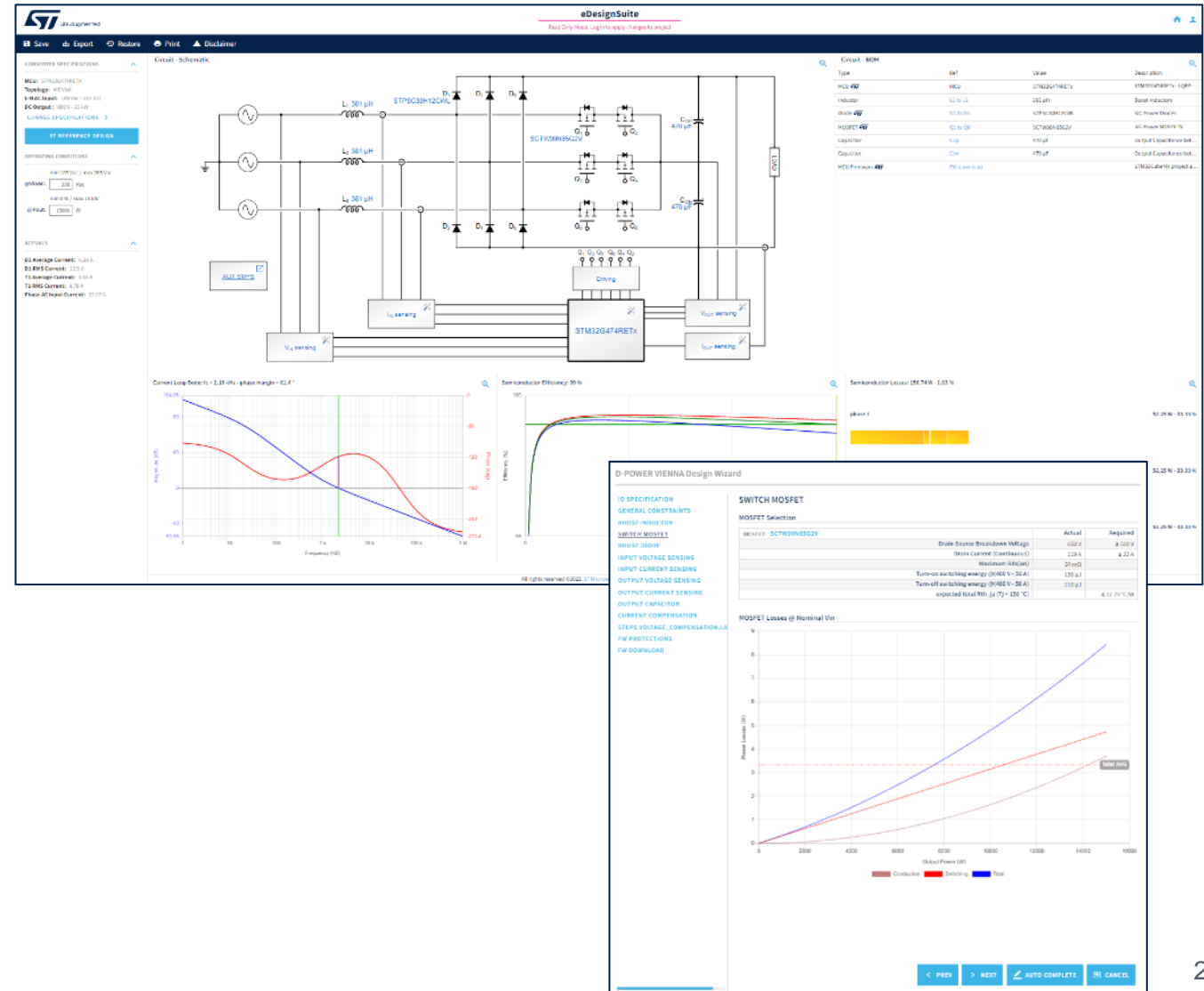
- Magnetics, power switch selection, diodes selection, current Loop and voltage loop compensation

Firmware customization

- Sensing, protections, voltage control and Current Control

Firmware delivery

- Compatibility with STM32Cube tools: delivery of custom STM32Cube expansion pack for Vienna Rectifier solution + STM32CubeMX project (.ioc file) reflecting all current solution customization



The screenshot displays the eDesignSuite software interface. The main window shows a schematic diagram of a power converter circuit, including an input filter with inductors (L1, L2, L3) and capacitors (C1, C2), a three-phase bridge rectifier, a DC-link capacitor (C3), and a three-phase inverter with IGBTs and diodes. The inverter is driven by an STM32G474RETx microcontroller. Below the schematic, there are two plots: a Bode plot showing the current loop transfer function with a phase margin of 62.4° and a crossover frequency of 2.33 kHz, and a plot showing the semiconductor efficiency (95%) and the inductor loss (156.74W, 1.03%).

On the right side, there is a BOM (Bill of Materials) table:

Type	Ref	Value	Description
IGBT	IGBT	STW60N18ET5	600V 18A IGBT
DIODE	DIODE	2SD1500	2SD1500
DIODE	DIODE	15PFC60010000	15PFC60010000
IGBT	IGBT	STW60N18ET5	600V 18A IGBT
CAPACITOR	CAP	470uF	470uF 50V Electrolytic
CAPACITOR	CAP	470uF	470uF 50V Electrolytic
IGBT	IGBT	STW60N18ET5	600V 18A IGBT

At the bottom, the 'D-POWER VIENNA Design Wizard' is open, showing the 'SWITCH MOSFET' selection screen. The selected MOSFET is SCTW60N18ET5. The wizard also shows a 'MOSFET Losses @ Nominal Vin' plot, which is a line graph showing the power loss in Watts versus Output Power in Watts. The plot includes three lines: Conduction (red), Switching (blue), and Total (green). The total loss increases from approximately 0.5W at 0W output to about 8W at 1400W output.



ST Digital Power Workbench

eDesignSuite > Power Management Design Center > Digital Power Workbench

Sort by: Suggested 10 products

SHOW ONLY

Eval Board Available [10] **Eval Board**

New Products [4] **New**

TOPOLOGY

3-Phase 2-Level (B6) Converter [1]

3-Level T-type Converter [1]

Vienna Rectifier [1]

Dual Active Bridge Converter [1]

Bi-dir CCM Totem-Pole PFC [1]

CLLC [1]

Multilevel Buck with MPPT [1]

Multilevel Boost with MPPT [1]

ZVS Totem-Pole PFC [1]

FB LLC [1]

Show less

APPLICATION

3-Phase 2-Level (B6) Converter
STDES-BCBIDIR

Bidirectional power
3-phase Vac: 85 - 265 L+N Vac
Vdc: up to 1000 V
Power factor: > 0.99
efficiency: > 97 %
fsw: 50 - 100 kHz
Pdc: 3 - 20 kW

[View product details](#)
[Customize solution](#)

3-Level T-type Converter
STDES-PFCBIDIR

Bidirectional power
3-phase Vac: 85 - 265 L+N Vac
Vdc: up to 1000 V
efficiency: > 98 %
fsw: 50 - 100 kHz
Pdc: 6 - 15 kW

[View product details](#)
[Customize solution](#)

Vienna Rectifier
STDES-VRECTFD

3-phase Vin: 85 - 265 L+N Vac
Vout: up to 1000 V
Power factor: > 0.99
efficiency: > 98 %
fsw: 50 - 100 kHz
Pout: 6 - 20 kW

[View product details](#)
[Customize solution](#)

Dual Active Bridge Converter
STDES-DAB

Bidirectional power
Vin High Volt
Vout Low Volt
efficiency: > 98 %
Pout Low Volt

[View product details](#)
[Customize solution](#)

Bi-dir CCM Totem-Pole PFC
STEVAL-7BIDIRCB

Bidirectional power
Vin: 90 - 265 Vac
Vout: up to 530 V
Power factor: > 0.99
efficiency: > 99 %
Pout: 700 - 7000 W

[View product details](#)
[Customize solution](#)

CLLC
STEVAL-7BIDIRCB

Bidirectional power
Vbus: 375 - 550 V
Vbat: 550 - 850 V
efficiency: > 98 %
Pout: 3000 - 8000 W

[View product details](#)
[Customize solution](#)

Multilevel Buck with MPPT
STEVAL-10MLPVCB

Vpan: 425 - 850 V
Vout: 350 - 650 V
efficiency: > 99 %
Pout: 6 - 10 kW

[View product details](#)
[Customize solution](#)

Multilevel Boost with MPPT
STEVAL-10MLPVCB

Vin: 275 - 760 V
Vout: 600 - 800 V
efficiency: > 99 %
Pout: 6 - 12 kW

[View product details](#)
[Customize solution](#)

Clicking on the button the to start your design, hardware sizing, and firmware customization based on ST reference Design.

STDES-DAB

Dual Active Bridge Converter

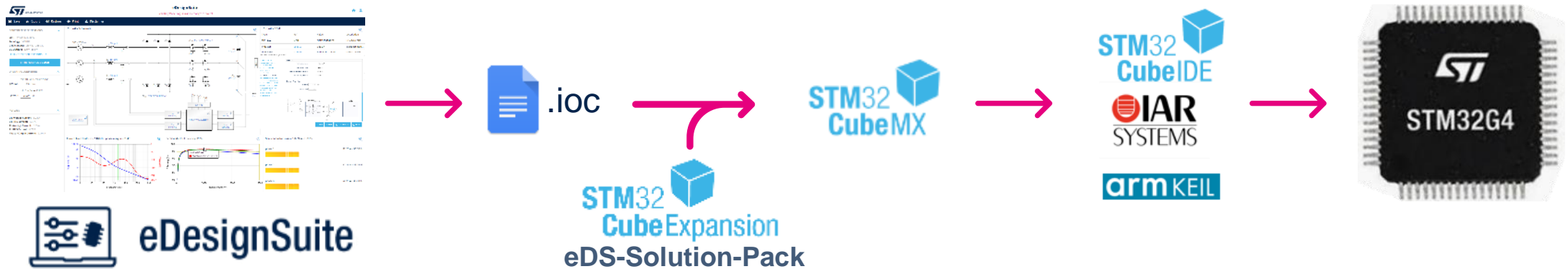
Bidirectional power
Vin High Volt
Vout Low Volt
efficiency: > 98 %
Pout Low Volt

Efficiency vs. Output Power

Power Factor vs. Output Power

26

FW generation and delivery workflow



Firmware delivery

Compatibility with STM32Cube tools: delivery of custom STM32Cube expansion pack for Vienna Rectifier solution + STM32CubeMX project (.ioc file) reflecting all current solution customization

Our technology starts with You



Find out more at www.st.com/STM32G4

© STMicroelectronics - All rights reserved.

ST logo is a trademark or a registered trademark of STMicroelectronics International NV or its affiliates in the EU and/or other countries.

For additional information about ST trademarks, please refer to www.st.com/trademarks.

All other product or service names are the property of their respective owners.

