Digital Power Guide

Contents

Introduction

Digital power applications use digitally controlled solutions to increase power density, accelerate control loops, allow complex topology management, and improve design flexibility

KEY FEATURES & BENEFITS

- Facilitates compliance with the most stringent energy efficiency requirements
- Greater power density with higher switching frequency and faster control loops
- System level reliability, and safety with failure prediction in power distribution

Digital power solutions from hardware and software concepts

It provides the possibility to build smart power systems that automatically adapt to their environmental changes and continuously optimize the overall system efficiency.

Mostly applied to switched-mode power supplies (SMPS), digital power focuses mainly on solutions for server and datacenters PSUs, telecom power, EV charging stations, UPS, energy generation systems, and recently adopted in sophisticated chargers and adapters for smartphones and laptops in high-end TV and lighting applications.

Our products and solutions

The extensive ST digital power portfolio includes microcontrollers and digital controllers for digital power conversion applications.

ST power discretes are optimized for soft-switching resonant and hard-switching converters and maximize system efficiency for low-power and high-power applications. The latest GaN-based products deliver better energy efficiency and enable more compact designs of power supplies for a broad range applications. Power modules enable more compact and lighter system solutions with Si and SiC MOSFET and diodes, and IGBT.

Our digital power solutions can be implemented using dedicated evaluation boards, reference designs, technical documentations, and eDesignSuite software configurator and design tools.

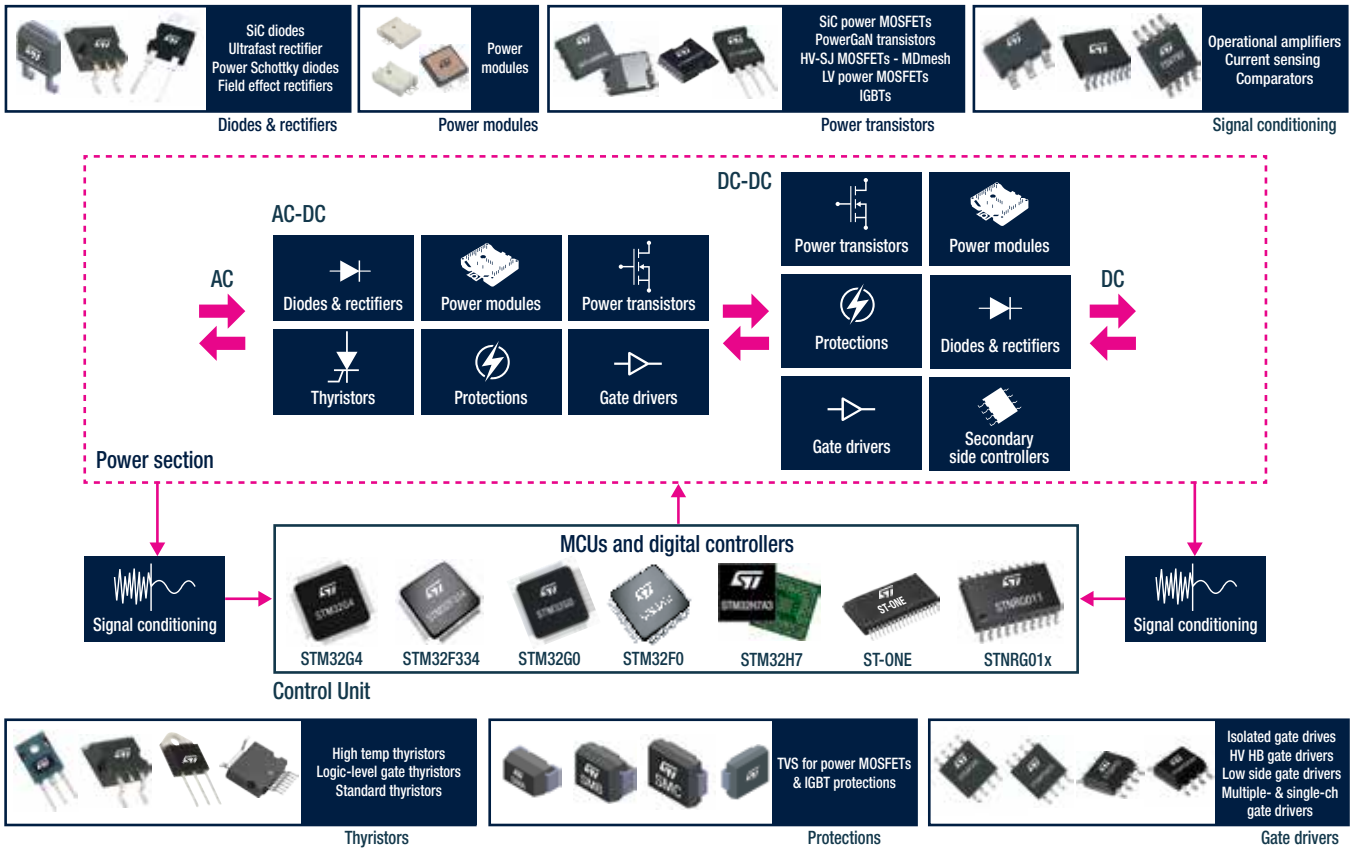


Fig1: Digital power general architecture

DIGITAL POWER MANAGEMENT ARCHITECTURE AND ST KEY PRODUCTS

Building blocks & key products

A typical digital power system mainly consists of a control section and a power stage. The control unit is addressed by our flagship family of STM32G4 and STM32F334 MCUs and our STNRG digital combo controllers or by the fully integrated ST-ONE.

The power stage implements different topologies depending on the power level or customer specifications.

Featured ST products include:

1) the unique MDmesh family of super-junction Power MOSFETs, which includes MDmesh M6/DM6, MDmesh M9/DM9, MDmesh K5, MDmesh K6 series, addressing both soft- and hard-switching topologies.
2) wide range of industry-leading silicon carbide (SiC) MOSFETs and diodes in heavy expansion and development.
3) discrete gallium nitride (GaN) devices and integrated GaN Power systems-in-packages.
Furthermore, gate drivers ensure accurate and efficient activation of the power stage. We offer gate driver solutions both for superjunction MOSFETs, IGBTs, and optimized solutions for SiC and GaN transistors. The auxiliary power supply block is managed by our VIPer family of advanced high-voltage converters.

Product class	Product subclass	Series	Part number	ST competitive edge
Power MOSFETs & GaN transistors	SiC power MOSFETs	GEN1: 1200 V, 1700 V GEN2: 650 V, 1200 V GEN3: 650 V, 750 V, 900 V, 1200 V	SCT*120/170G1(AG)	• Flat $R_{DS(on)}$ over temperature • Lower switching losses • Very cost competitive • Gen3 - ultra-fast series with the best Ron vs. Qg trade off: highly suitable for very high frequency applications & AG qualified
			SCT*N65/120G2(AG)	
			SCT*65/75/90/120G3(AG)	
	PowerGaN transistors	G-HEMT	SGT*R65A*	• Enhancement mode normally off transistor • Very high switching speed • High power management capability • Extremely low capacitances • Kelvin source pad for optimum gate driving • Zero reverse recovery charge

Product class	Product subclass	Series	Part number	ST competitive edge
Power MOSFETs & GaN transistors	MDmesh HV & VHV superjunction MOSFETs	Standard series		
		MDmesh M9	ST*60N*M9 ST*65N*M9	• Lowest Qg • Higher reverse diode dv/dt and MOSFET dv/dt ruggedness • Suited for hard and soft switching topologies
		MDmesh M6	ST*60M6 ST*65M6	• Developed to enhance the resonant converter performance • Extremely low gate charge: high frequency operation • Optimized threshold voltage: reduced switching losses • Optimized Coss: increased power efficiency at light load
		MDmesh M2	ST*60M2 ST*65M2	• Low Qg • Optimized for light load conditions • Suited for hard switching & ZVS/LLC topologies
		MDmesh M5	ST*65M5	• Extremely low $R_{DS(on)}$ • High switching speed • Suited for hard switching topologies
		MDmesh K6	ST*80N*K6	• Industry's best $R_{DS(on)}$ for 800V voltage range • High switching speed • Lowest Qg
		MDmesh K5	ST*80K5 ST*90K5 ST*105K5 ST*120K5	• Industry only, super-junction technology > 1000V • 100% avalanche tested • Very wide product portfolio, up to 1700V
		Fast-recovery body diode series		
		MDmesh DM9	ST*60N*DM9 ST*65N*DM9	• Improved intrinsic diode reverse recovery time (trr) • Higher dv/dt (120 V/ns) and di/dt capability (1300 A/µs) • Optimized body diode recovery phase and softness
		MDmesh DM6	ST*60DM6 ST*65DM6	• Developed to enhance the resonant converter performance • Low gate charge high frequency operation • Optimized threshold voltage: reduced switching losses • Optimized Coss: increased power efficiency at light load • Embedded fast diode: increased safe area for diode
		MDmesh DM2	ST*60DM2 ST*65DM2	• Improved trr of intrinsic diode • High dV/dt capability • Suited for ZVS/LLC topologies
		MDmesh DK5	ST*95DK5	• Lowest trr @ very high voltage • BVDSS • High dV/dt capability • Targeting high power 3-phase • Industrial equipment
	LV Power MOSFETs	40 V - 100 V STripFET™ F7 40 V - 100 V STripFET™ F8	ST*N4F7/F8 ST*N6F7 ST*N8F7 ST*N10F7/F8	**F8 Series** • Extremely low RDS(on), • Optimized FOM • Increased power density • Reduced conduction losses **F7 Series** • Optimized body diode (low Qrr) and Crss/Ciss to reduce EMI and achieve excellent switching performance

STPOWER

Product class	Product subclass	Series	Part number	ST competitive edge
IGBT & power modules	Trench gate field-stop IGBTs	600V V series Very high speed (50 to 100 kHz)	STG*V60DF	• Product range from 20 to 80 A • Industry's lowest Eoff for increased efficiency • Positive temperature coefficient for safe paralleling of multiple IGBTs • Several package options for different application needs
		650V HB series High speed (16 to 60 kHz)	STG*H65DFB	• Product range from 20 to 80 A • Optimized trade-off V_{CEsat}/E_{OFF} • Maximum junction temperature of 175 °C
		650V HB2 series High speed (16 to 60 kHz)	STG*H65DFB2	• Wide product range from 15 to 100 A • Optimized trade-off V_{CEsat}/E_{OFF} • Maximum junction temperature of 175°C • Lower gate charge for faster switching • Soft turn-off even with smaller gate resistance • Several package options
		1200V H series High speed (20 to 100 kHz)	STG*H120DF2	• Product range from 15 to 75 A • Very low turn-off energy • Maximum junction temperature: T_J = 175 °C • Short-circuit rugged • Available in TO247, TO247 LL, and MAX247
		1200V M series Low loss (2 to 20 kHz)	STG*M65DF2	• Product range from 8 to 75 A • Low loss and short-circuit rugged series • Maximum junction temperature: T_J = 175 °C • Available in TO220, TO247, TO247 LL, and MAX247 • Optimized tradeoff between static and dynamic loss for hard switching application
	Power modules	ACEPACK 1 ACEPACK 2	A2F20M65W3-FC A2U12M12W2-F1C A2U12M12W2-F2 A2U8M12W3-FC	• Multi-sourced with Infineon easy 1B /2B • STPOWER Studio for simulating thermal performance • Integrated NTC
		ACEPACK DMT-32	M1F45M12W2-1LA M1F80M12W2-1LA M1P45M12W2-1LA	• Automotive-grade AQG-324 qualified • Cost-effective and compact solution with a reduced time to market • Designed to implement different topologies and different pinout options • Optimal thermal performance thanks to AlN isolated substrate • Integrated NTC sensor

Product class	Product subclass	Series	Part number	ST competitive edge
Diodes & rectifiers	SiC diodes	650-1200 V series	STPSC*065 STPSC*H12	• No or negligible reverse recovery • Very low forward voltage • High forward surge capability • Wide portfolio with current rating from 2 to 40 A, various package offer (SMD,QFN,TH),2 series (low Vf, high Ifsm)
	Ultrafast rectifiers	200-400 V ultrafast rectifiers	STTH*02 STTH*03 STTH*04	• Various package offer • Ultrafast diode • Low VF trade off to improve efficiency and reliability of the converter
		600 V ultrafast rectifiers	STTH*06 STTH*L06 STTH*R06	
		800-1200 V ultrafast rectifiers	STTH*08 STTH*10 STTH*12 STTH*S12	
	Field effect rectifiers	FERD	FERD*45 FERD*50 FERD*60 FERD*100	• Low VF/Low IR trade off • Improved runaway safety
	Power Schottky diodes	Power Schottky high temperature	STPS*100	• Low VF/Low IR trade off • Avalanche specification • Robust technology
		Power Schottky low VF	STPS*30	
		Power Schottky medium VF and IR	STPS*45 STPS*200	
		Trench Schottky diodes	STPST*100	• Very Low Vf • Small package form and high power density

Product class	Product subclass	Series	Part number	ST competitive edge
Protections and EMI filters	Protections	TVS	SMAJ	• Various package offer
			SMBJ	
			SM15T	
			SMC30J	
			SMC50J	
		USB port protection	TCPP01-M12	• Integrated gate driver and CC line management with IEC61000-4-2 ESD protections • Companion chip to STM32 integrating USB-C PD controller making this combo a cost effective solution for sink devices
			TCPP02-M18	• OCP and analog current sense integrated with IEC61000-4-2 ESD protections • Companion chip to STM32G0 integrating two USB-C PD controllers making this combo a cost effective solution for dual port source applications
			TCPP03-M20	• OVP, OCP, and analog current sense integrated with IEC61000-4-2 ESD protection • Two integrated gate driver manage the sink and source path for USB-C Dual role Power applications
			USBLC6-2SC6	• ESD Protection for USB 2.0 High Speed
			ECMF2-40A100N6	• 2 lines Common mode filter with ESD protection for High Speed Serial interface
			ESDA25P35-1U1M	• Unidirectional single line TVS diode designed to protect the power line against EOS and ESD transients. Low leakage current at VRM
			ESDA24P140-1U3M	
		Gate protection	ESDAxxP-1U1M	• Unidirectional single line TVS diode designed to protect the power line against EOS and ESD transients. Low leakage current at VRM
			ESDA-1K	• EOS and ESD protection for charger and battery port
Thyristors & triacs	Thyristors (SCR)	Standard thyristors (SCR)	TN815-800B	• Greater robustness to surge • Higher immunity to electrical transient • High temperature SCR T_J = 150°C option preferred to fit higher power density SMPS • Large package offer, including SMD compact solutions: DPAK, D2PAK, D2PAK HV, D3PAK
			TN4050-12PI	
			TN6050-12PI	
		High temp thyristors (SCR)	TN5050H-12PI	
			TN8050H-12PI	
			TM8050H-8	
			TN4015H-6	
			TN1605H-8	
		Automotive grade thyristors	TN3050H-12W	
			TN4035HA-8GY	
			TN4050HA-12GY	
			TN4050HP-12G2Y	
			TN4050HP-12W	
			TN6050HP-12W	
		Thyristors for power breakers	TS110-8	
			X0115	
	Triacs	High temperature triacs	T835H-8	• ST's portfolio covers medium-power AC loads with 1 to 50 A triacs • 600 V, 800 V or 1200 V Triacs for large application field and AC voltage 1- or 3-phase • Full rated 150°C & 800 V, up to 50 A triac new series: 8H-Triac Txx35H-8
			T1635H-8	
			T5035H-8PI	
			T3035H-8	
		Standard and Snubberless Triacs	T1635T-8	
			T2535T-8	
			T2550-12	
	SCR power modules	ACEPACK SMIT	STTD6050H-12M2Y	• STTD is full bridge 1200 V 60 A; 2x SCRs and 2x diodes • STTN is half bridge leg 1200 V 60 A; 2x SCR • Automotive grade products
			STTH6050H-12M1Y	

Product class	Product subclass	Series	Part number	ST competitive edge
Secondary-side controllers	Synchronous rectification controllers	Rectification controller for flyback converter	SRK1000	• Guaranteed by maximum conduction of SR MOSFET in all load conditions thanks to fast turn-on with minimum delay and the innovative adaptive turn-off logic • Meets stringent no-load consumption SMPS requirements with low-consumption mode Iq=160 µA (typ) • Mixed DCM/CCM operation easily managed • Automatic sleep mode at light loads • Different options for blanking time after turn-off to support applications needs • No need to add circuit for stray inductance compensation • No Schottky diode (in parallel to SR MOSFET) required for managing CC regulation
			SRK1000A	
			SRK1000B	
			SRK1001	
		Rectification controller for LLC resonant converter	SRK2000A	• Maximum conduction of SR MOSFETs in all load conditions thanks to fast turn-on with minimum delay and adaptive blanking time, and to the innovative adaptive turn-off logic • Meets stringent no-load consumption SMPS requirements with low-consumption mode Iq=50 µA (typ) • Programmable low-consumption operations during burst mode • Robust design preventing current inversion • Safe management of load transient, light loads and startup condition • Automatic sleep mode at light load, (SRK2001) • Parasitic inductance self-compensation • No need to add circuit for stray inductance compensation • Kelvin sensing to sense the drain-source voltage of each MOSFET
			SRK2001	
			SRK2001A	

Product class	Product subclass	Series	Part number	ST competitive edge
Digital power MCUs & controllers	STM32 32 bit Arm Cortex MCUs	STM32G4	STM32G474	• HRTIM features • Analog IPs & GP peripherals features and larger number • Higher computational performance (Speed, FPU, FMAC, Cordic) • Better portfolio / pin-out (100 and 128-pin packages) • All products compatible up to 512K
		STM32F3	STM32F334	• HRTIMER flexibility • Higher computational performance • ARM vs proprietary core • More peripherals and PWMs
		STM32H7	STM32H725	• High performance up to 480 MHz • High resolution timer V1 (2.1ns resolution) for real time control • High-speed ADCs for precise and accurate control (3.6 Msps)
			STM32H735	
		STM32G0	STM32G071	• Very low power consumption • Timer frequency up to 128 Mhz resolution (8ns) • High-speed ADCs for precise and accurate control • UCPD interface • More RAM for Flash: up to 36 KB SRAM for 128 KB and 64 KB Flash memory
		STM32F0	STM32F071	• Suited for cost-sensitive applications. • Combine real-time performance, low-power operation, and the advanced architecture and peripherals of the STM32 platform
	Digital Power controllers	STNRG	STNRG011	• Robustness: 800 V start-up circuit • Flexibility: parameter's customization in FTP memory, core programmed in ROM, high level of programmability and monitoring • Higher efficiency (especially at light load): advanced burst mode and low quiescent current • Compactness: SO20 package for low pin count
			STNRG011A	
			STNRG012	
		ST-ONE	ST-ONE (single USB port)	• All-in-one digital controller for USB-PD chargers up to 100W • ZVS active clamp flyback + synchronous rectification • USB-PD 3.1 PPS interface and integrated 24V USB-PD PHY • >94% peak efficiency soft switching topology • >1Mhz operation with MasterGaN® and planar transformers • Small weight and size solution with >30W/inch^3 power density • 32bit Cortex M0+ core with 64kB embedded flash memory • >6.4kV reinforced galvanically isolated dual communication channel • Up to 140 W single port USB-PD 3.1 EPR, 100 W dual / multi port USB-PD 3.1
			ST-ONEMP (multiple USB port)	
			ST-ONEHP (single USB port)	

STM32

High Performance MCU

STM32H7
324CoreMark
480 MHz Cortex-M7
240 MHz Cortex-M4

Mainstream

STM32G0
142 CoreMark
64 MHz Cortex-M0+

STM32F0
106 CoreMark
48 MHz Cortex-M0

STM32G4 ●
550 CoreMark
170 MHz Cortex-M4

STM32F3 ●
245 CoreMark
72 MHz Cortex-M4

Arm® Cortex® core -M0 / -M0+ -M3 -M33 -M7 -M4

Legend: ● Optimized for mixed-signal applications

Integrated SMPS digital combo

STNRG

Common features:
- 800V start-up Circuit
- Complete set of PFC & LLC protection
- Parameter's customization in FTP memory
- Core programmed in ROM

	STNRG011	STNRG011A	STNRG012
	Digital combo multi-mode PFC and time shift LLC resonant controller	Digital combo multi-mode PFC and time shift LLC resonant controller	NEW Digital combo for LED Lighting & Industrial applications requiring DC source management
Features	• Integrated x-cap discharge circuit	• Integrated x-cap discharge circuit • Advanced OLP management	• AC and DC source management • Removed x-cap discharge circuit • New THD optimized for LED lighting to improve efficiency

GaN

Higher efficiency		94% efficiency	= -3 nuclear plants
Higher power density		4x smaller	= 200M kg less wasted material
Digital control		5x faster charge	= 45 min 100% charge

Product class	Product subclass	Series	Part number	ST competitive edge
MOSFETs & IGBTs gate drivers	Galvanically-isolated single and dual gate drivers	STGAP	STGAP4S	
			STGAP3S6I	For **STGAP3** • High robustness with embedded reinforced capacitive galvanic isolation capable to sustain 200 V/ns Common Mode Transient Immunity (CMTI) • Different current capability options with 10 A and 6 A in SO16W package • Dedicated UVLO and DESAT variants for SiC MOSFETs and IGBTs • Fast desaturation protection and optimized Miller Clamp driver function • Maximum safety thanks to the diagnostic functions for desaturation protection (DIAG) and for UVLO and over temperature (RDY)
			STGAP3S6S	
			STGAP3SXI	
			STGAP3SXS	
			STGAP2S	For **STGAP2SICS** • High robustness: embedded isolation and protection, specific UVLO for SiC, over temperature protection, spike effects reduction thanks to Miller clamp • 4 A current capability, 75 ns propagation delay and ±100 V/ns CMTI • 2 driving options: Miller clamp and separated outputs • High power density and easy design: lower system size and BOM cost
			STGAP2D	
			STGAP2HS	
			STGAP2GS	
			STGAP2GSN	
			STGAP2SICSN	
			STGAP2HD	
			STGAP2SICD	
			STGAP2SICS	
			STGAP2SICSA	
			STGAP2SICSAN	
			STGAP1BS	
	High voltage half Bridge gate drivers	HV HB gate drivers	L6491	• High driving current source and sink: up to 4A • Integrated bootstrap diode • Advanced features: interlocking and adjustable dead time • Integrated bootstrap diode, comparator for OCP with Smart Shut Down (SSD) • Shutdown and open-drain output pins
			L6494	
			L6498	
		HV HB gate drivers for GaNs	STDRIVEG600	
			STDRIVEG600W	
	Low side gate drivers	Single Channel drivers	PM8841	• 2 level turn-off • Dual independent low side driver (PM8834) • 4 A source/sink driver high current capability (PM8834) • Driver output parallel ability to support higher driving capability (PM8834) • Embedded drivers with anti cross conduction protection (PM8834)
			PM8851	
		Multiple Channel drivers	PM8834	
Gallium nitride (GaN) Power ICs	Integrated Smart GaN	MASTERGAN1:150 + 150 mΩ MASTERGAN1L: 150 + 150 mΩ MASTERGAN2: 150 + 225 mΩ MASTERGAN3: 225 + 450 mΩ MASTERGAN4: 225 + 225 mΩ MASTERGAN4L: 225 + 225 mΩ MASTERGAN5: 450 + 450 mΩ	MASTERGAN1	• Embedded half-bridge gate driver easily supplied by the integrated bootstrap diode • Overtemperature protection • Extended 3.3 to 15 V input range with hysteresis and pull-down • Accurate internal timing match • Interlocking function • -40 to 125°C operating temperature range • High switching frequency >1 MHz • No investment to learn GaN required • Fast time-to-market
			MASTERGAN2	
			MASTERGAN3	
			MASTERGAN4	
			MASTERGAN5	

Product class	Product subclass	Series	Part number	ST competitive edge
Signal conditioning (amplifiers and comparators)	Comparators	Automotive comparators	TS3021	• Propagation delay: 38 ns • Rail-to-rail inputs and Push-pull outputs • Supply operation from 1.8 to 5 V with low current consumption: 73 µA
			TS3022	
		High-speed comparators	TS3011	• Propagation delay: 8 ns • Rail-to-rail inputs and Push-pull outputs • Supply operation from 2.2 to 5 V with low current consumption 470 µA
	Current sense amplifiers	Current sensing	TSC2020	• Bidirectional, high-side and low-side current measurement • Wide common-mode voltage: -4 to 100 V • Enhanced PWM rejection • Integrated amplification gain of 20 V/V with guaranteed accuracy
			TSC2010	• Bidirectional, high side and low side current measurement • Wide common-mode voltage from -20 to 70 V, shutdown function integrated • Integrated amplification gain of 20 V/V, 60 V/V or 100 V/V with guaranteed accuracy
			TSC2011	
			TSC2012	
			TSC200	• High voltage, current sense amplifier with open drain comparator and ref • Wide common-mode voltage from -16 to 80 V, over current protection with integrated comparator + Ref • Integrated amplification gain of 20, 50 and 100 V/V with guaranteed accuracy
			TSC201	
			TSC202	
			TSC21*	• Bi-directional • Operating voltage -0.3 to 26 V • Amplification gain x50, x75, x100, x200, x500, x1000 • Offset voltage ±35 µV max • Gain error 1% max
	Digital power monitors	Digital current, voltage, power and temperature monitors	TSC1641	• High-side or low-side digital current sensing with voltage load measurement up to 60V • Dedicated for slow signals, with high precision • Compatible to all ST microcontrollers with I²C or MIPI I3C
	Operational Amplifiers	Precision Op Amps	TSZ121	• Outstanding accuracy (Vio 5 to 25 µV maximum @25 °C) enabling accurate signal conditioning • Excellent performance stability versus temperature changes (Vio 8 to 35 µV for -40° C<T<125 °C) for hassle-free design • Rail-to-rail input and output, minimum supply voltage 1.8 to 2.2 V, maximum supply voltage 5.5 V
			TSZ151	
			TSZ181	
			TSV772	• Excellent accuracy (Vio 200 µV maximum @25 °C) for accurate measurement • High bandwidth from 20 to 50 MHz for fast signal conditioning • Outstanding slew-rate from 13 to 30 V/µs enabling measurement of PWM pulses
			TSV782	
			TSV792	
			TSU101	• Super-low current consumption from 580 to 900 nA per channel • Rail-to-rail input and output, supply range from 1.5 to 5.5 V • Two flavors of accuracy with Vio lower than 150 µV or 3 mV
			TSU111	
			TSB812	• Wide supply voltage: 4 to 36 V • Very low offset voltage: 20 µV max. @ 25°C • Rail-to-rail output

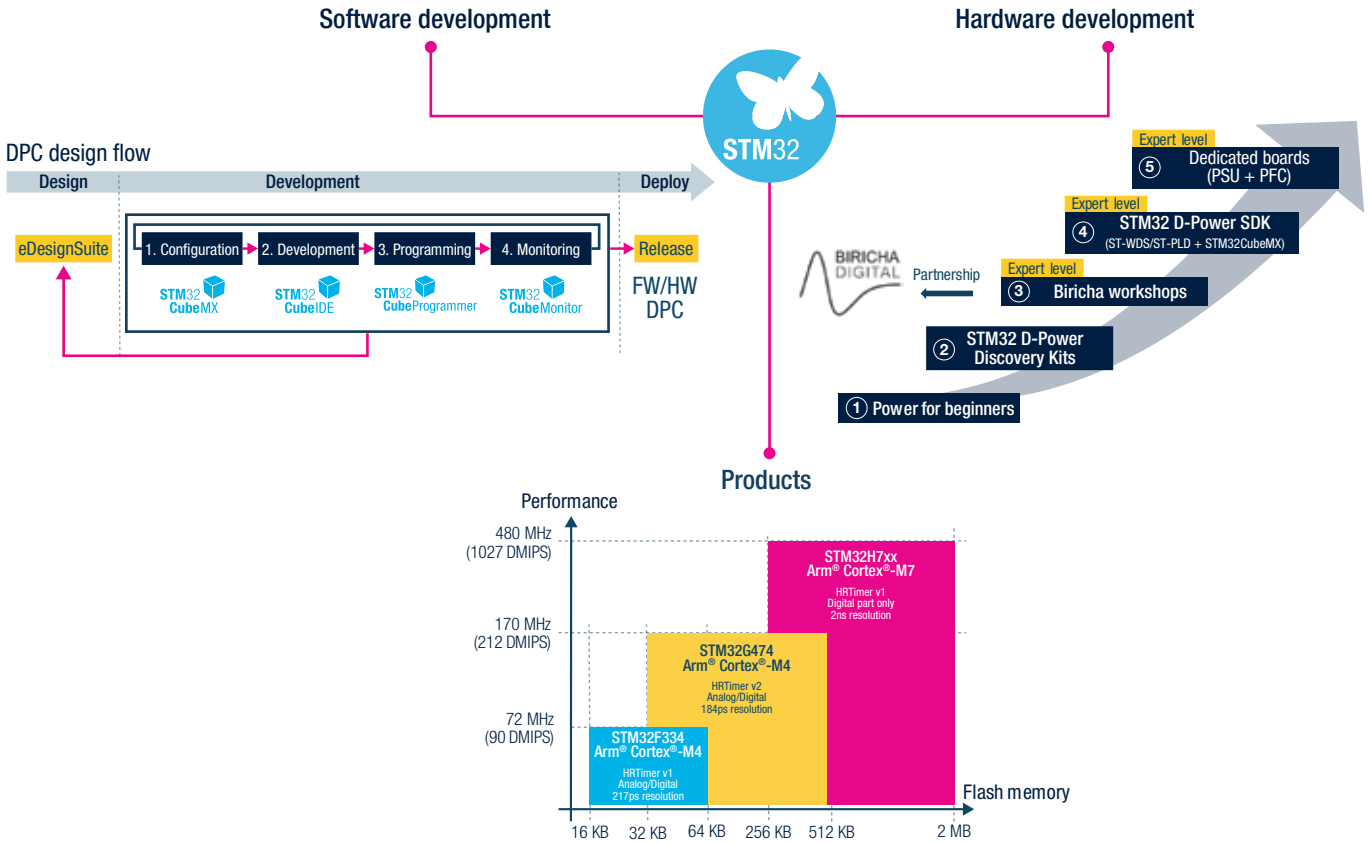
COMPREHENSIVE STM32 MCUs DIGITAL POWER DEVELOPMENT ECOSYSTEM

Overview

The STM32 Digital Power ecosystem (also referred to as D-Power) offers a complete set of materials, from hardware, software tools and embedded software to training resources and documentation. It is designed to support and accelerate the development of digital power applications, such as D-SMPS, lighting, EV charging, inverters for solar systems and wireless chargers.

STM32 D-Power product lines

STM32 D-Power product portfolio includes several lines from STM32 product series, offering maximum scalability and flexibility in terms of performance, from entry-level to high performance. STM32F3, STM32G4, and STM32H7 MCUs feature an embedded high-resolution timer (HRTimer), which is a powerful and flexible pulse width modulation (PWM) generator providing a resolution of up to 184ps.



DIGITAL POWER AND eDesignSuite SW TOOL

eDesignSuite is a free, comprehensive, online software tool that helps design and simulate a circuit based on specific components.

In six simple steps eDesignSuite will help you to:

- **Specify** your application use case
- **Select** the right IC or Discrete
- **Analyze** how it performs in the selected circuit configuration
- **Refine** the design with intuitive simulation iterations
- **Simulate** the circuit with the fast and powerful eDSim tool
- And finally, you will be ready to build a **prototype**.

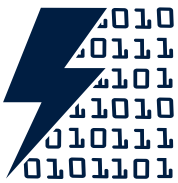
KEY FEATURES & BENEFITS

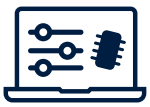
- Design of AC-DC and DC-DC power stage, digitally controlled with “standard PID model” and soon with models supported by Biricha’s software tools
- Optimize the power MOSFETs selection
- FW delivery based on user I/O specifications
- Full source code with common DPC architecture
- STM32CubeMX FW project compatible with multiple toolchain

DIGITAL POWER WORKBENCH

Design and simulation of digital power supply is now available on eDesignSuite thanks to our new Digital Power workbench.

This software tool drastically reduces the effort and time for the development of digital power converters by providing a step-by-step optimized design flow for both the power stage - helping to quickly achieve desired efficiency targets – and the digital feedback control loop - to achieve the expected closed-loop performance, and finally generating the firmware for the target STM32 microcontrollers.





eDesignSuite

Interleaved ZVS totem-pole PFC

LLC FB resonant converter

DAB-Dual Active Bridge converter

3-level T-type converter

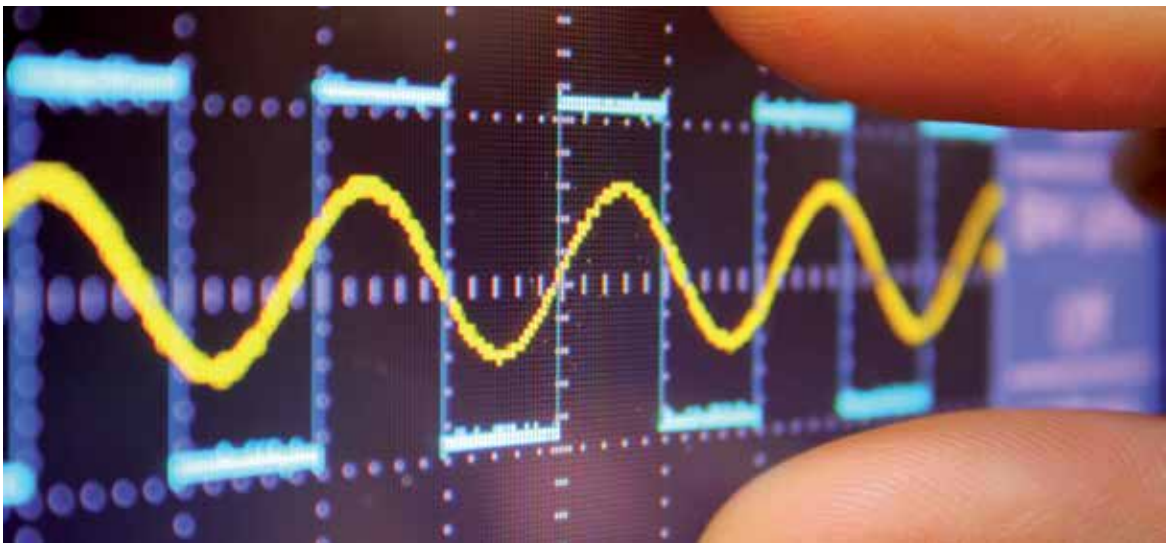
Vienna rectifier

CLLC converter

Bi-dir CCM totem-pole PFC

Multilevel Buck with MPPT

Multilevel Boost with MPPT



ST PLD

Digital PFC design software for STM32 from Biricha

Biricha has teamed up with STMicroelectronics to provide a special release of the “PLD - PFC Loop Design Tool” for use with the STM32 range of MCUs. This ST PLD design tool is free and allows the user to quickly stabilize their digital PFC stage controlled by an STM32 MCU.

The user enters their specification in ST PLD and the software automatically selects the compensator poles and zeros and calculates the controller coefficients, while keeping you in control at every stage of the process.

KEY FEATURES & BENEFITS

- ST PLD has been created for engineers who need to design digital PFC stage
- Automatically calculates poles and zeros as well as power stage components for boost PFC stages
- Sophisticated control algorithms stabilize digital power supplies with automatic coefficient calculations for the STM32 range of MCUs

ST WDS

Power supply design tool for STM32 from Biricha

Biricha has teamed up with STMicroelectronics to provide a special release of the “WDS - power supply design tool” for use with the STM32 range of MCUs. This ST WDS design tool is free and allows the user to quickly stabilize their digital power supply controlled by an STM32 MCU.

The user simply selects their topology and types enters their input/output specification into ST WDS. The software then automatically selects the compensator poles, zeros, and controller coefficients, while keeping you in control at every stage of the process.

KEY FEATURES & BENEFITS

- ST WDS is a comprehensive toolbox for digital power supply design engineers
- Designs and stabilizes digital PSU control loops in minutes
- Automatically calculates poles and zeros as well as power stage components for the most popular topologies
- Sophisticated control algorithms stabilize digital power supplies with automatic coefficient calculations for STM32 range of MCUs
- Simulations in time and frequency domains and ability to superimpose real measurements on simulated data

ST-WDS software for PSU
https://www.biricha.com/st-wds.html

ST-PLD software for PFC hyperlinked to:
https://www.biricha.com/st-pld.html

Evaluation boards and Reference designs

The comprehensive range of evaluation boards and reference designs lets you evaluate the performance and efficiency of ST products in real conditions.

STDES – reference designs	STEVAL – evaluation boards	EVAL, EVL, EV – evaluation boards	Discovery kit
			
Reference designs covering various application domains to demonstrate products capabilities and to ease development.	**Full feature system evaluation:** High power density reference boards featuring maximum system performance.	**Full feature product evaluation:** Reference board exposing all product features.	**Key feature prototyping:** STM32 product demonstration boards with specific application focuses.

STDES-BCBIDIR

11 kW Bidirectional converter based on three phase two level PFC and isolated DC-DC converter, featuring SiC and Digital Control

This 11-kW bidirectional battery charger is designed for high-voltage applications in industrial and automotive fields. It features two power stages: a PFC stage with a three-phase full-bridge topology and a DC-DC stage configurable in Dual Active Bridge (DAB) or CLLC resonant topologies. Both stages are digitally controlled by STM32G474RE microcontrollers. Thanks to our 1200 V SiC power modules (M1P45M12W2-1LA, M1F45M12W2-1LA), the system achieves peak efficiency greater than 99%.

STEVAL-7BIDIRCB

7 kW bidirectional AC-DC converter for ESS and industrial charger, full SiC-based

This 7-kW bidirectional evaluation board for Energy Storage Systems and industrial chargers is entirely based on our Gen3 automotive-grade Silicon Carbide power MOSFETs. The system consists of two stages: a bidirectional three-channel Interleaved Totem Pole PFC and a bidirectional full-bridge CLLC with synchronous rectification.
The solution boasts a peak efficiency of over 97% and a power density of 4.03 kW/dm³.

STDES-VRECTFD

15 kW Vienna PFC rectifier reference design with digital power control

This reference design is a complete solution for high-power three-phase AC-DC rectifier applications based on the Vienna topology. It features full digital control through the STM32G474RET3 MCU and provides both digital output voltage regulation and continuous conduction mode (CCM) current regulation for maximum power quality in terms of total harmonic distortion and power factor.

STDES-30KWVRECT

30 kW Vienna PFC rectifier reference design with digital power control

This digital power solution for high power three-phase active front-end rectifier applications is based on a three-level Vienna topology. This platform achieves more than 98.5% peak efficiency using SCTWA90N65G2V-4 and STPSC40H12C SiC MOSFET and discrete. It features full digital control using the STM32G474RET3 mixed-signal high performance microcontroller.

STDES-PFCBIDIR

15 kW, three-phase, three-level active front end bidirectional converter for industrial and electric vehicle DC fast charging applications

This reference design for three-phase AC-DC and DC-AC (800 VDC to 400 VAC) applications is well suited for the active front-end stage in high power charging stations, industrial battery chargers, and UPS.

STDES-DABBIDIR

25 kW, dual active bridge bidirectional power converter for EV charging and battery energy storage systems

This reference design is a bidirectional DC-DC power converter in a a dual active bridge (DAB) topology based on ACEPACK 2 SiC power module.

The STM32G474RE MCU, enabling digital-intensive power control and optimized for mixed-signal applications, manages soft switching DAB behavior by adaptive modulation techniques, according to the load/voltage variation.

STEVAL-TTPPFC01

99.3% efficiency, 2 kW, 3-channel interleaved totem-pole PFC with resonant ZVS digital control

This PFC solution features a remarkable 99.3% peak efficiency combined with very high-power factor and low THD using a three-channel interleaved totem-pole topology with ZVS digital control. The design is based on ST MDmesh DM6 superjunction power MOSFETs and an STM32G474 MCU implementing hysteresis current control.

STDES-3KWTLCP

3 kW telecom rectifier reference design with digital power control

The STDES-3KWTLCP is a 3 kW AC-DC converter for telecom rectifier applications. This reference design demonstrates very high power density (up to 40 W/inch^3) in a compact solution, with high peak efficiency (96.3%), low THD distortion (less than 5% THD at full load), and a reduced bill of materials.

STDES-SICGP4, STDES-SICGPHU3

Testing platform reference design for SiC MOSFETs in HiP247-4 , and HU3PAK packages

This reference design is a testing platform developed to test the high-speed switching performance of ST silicon carbide (SiC) MOSFETs. The platform implements a half-bridge configuration that supports HiP247-4 and HU3PAK packages. This platform allows testing the switching performance of the MOSFETs using the double-pulse test method.

STEVAL-DPSTPFC1

3.6 kW totem pole PFC with inrush current limiter reference design using TN3050H-12WY and SCTW35N65G2V

The STEVAL-D PSTPFC1 3.6 kW bridgeless totem pole boost circuit features digital power factor correction with inrush current limitation. It helps you implement an innovative topology in your design using the latest ST power kit devices: a silicon carbide MOSFET (SCTW35N65G2V), a thyristor SCR (TN3050H-12WY), an isolated FET driver (STGAP2S), and a 32-bit MCU (STM32F334).

STEVAL-DPSLLCK1

3 kW full bridge LLC resonant digital power supply evaluation kit

The STEVAL-DPSLLCK1 is a digitally controlled 3 kW full bridge LLC resonant DC-DC converter with output synchronous rectification. The kit consists of a power board, digital control board, adapter board, and firmware modules.

STEVAL-LLL009V1

300 W very high AC input voltage LED driver with digital power control

The STEVAL-LLL009V1 digitally controlled 300 W power supply combines PFC and half-bridge LCC resonant converter power stages. An STM32F334R8 microcontroller implements DC-DC and output synchronous rectification digital control, while the PFC is driven in transition mode by the L6562AT controller. The solution supports constant voltage and constant current operation.

STEVAL-DPSG474

Digital power supply control board based on STM32G474RE

The STEVAL-DPSG474 digital power supply control board provides all the PWM control signals, sensing networks, and protection features needed to control a wide range of digital power supply applications. An adapter board provides various communication interfaces and allows programing the microcontroller through a standard 20-pin JTAG connector.

STEVAL-DPS334C1

Digital power supply control board based on STM32F334

The STEVAL-DPS334C1 is a digital power supply control kit consisting of a main board based on the STM32F334R8 microcontroller family and an adapter board to program the microcontroller.

STDES-6KWHVDCDC

6 kW high voltage DC-DC converter for EV charging

This reference design consists of a full bridge digitally controlled LLC resonant converter. The LLC transformer output configuration is interchangeable between center tapped and full-wave, to ensure 200-1000 V output voltage range with the frequency foldback scheme.

EVLONE65W

Very high power density charger–65 W USB Type-C® power delivery

The EVLONE65W is a high power density USB Power Delivery board based on ST-ONE and MASTERGAN4 with RM8 transformer. It supports USB Power Delivery 3.1 PPS 3.3 to 16 V @3.75 A and 3.3 to 21 V @3.25 A, with a wide input voltage range. The peak efficiency 94 %; power density is 30 W/in^3; and weight is 66 g (2.3 oz).

STDES-65ACFADP

65 W USB Power Delivery charger with planar transformer

The STDES-65ACFADP is a high power density USB Power Delivery reference design based on ST-ONE and MASTERGAN2 with planar transformer. It supports USB Power Delivery 3.1 power profiles with universal 90 to 264 VAC input. Dimensions are 54x31x25 mm and power density is 30 W/in^3.

EVLONEMP

Very high power density board - 65 W multi-port (USB Type-C and USB Type-A) power delivery based on ST-ONEMP and MASTERGAN4

The EVLONEMP is one of the best power density USB Power Delivery multiport boards with a USB Type-A port and a USB Type-C® port supporting Programmable Power Supply (PPS). The design supports a wide range of input voltages and can deliver 10 W (5 V@2 A) on a Type-A port, and five fixed PDOs and two APDOs on a Type-C port.

EVLONE140W

140 W USB-PD 3.1 EPR certified reference design based on ST-ONEHP and MASTERGAN1

The EVLONE140W is one of the first reference design to be certified according to the USB-PD 3.1 EPR standard. It supports a wide range of input voltages and can deliver four SPR outputs, an EPR output and an AVS output up to 28 V at 5 A.

EVLSTNRG011-150

12 V – 150 W power supply based on STNRG011 digital combo and SRK2001adaptive synchronous rectifier controller

The EVLSTNRG011-150 is based on the STNRG011 IC, a digital combo that controls a two stages AC/DC SMPS. The front-end is a transition mode PFC pre-regulator and the second stage is an LLC HB resonant converter. The SRK2001 implements the synchronous rectification in order to obtain higher efficiency. No auxiliary supply is needed due to the very low consumption at the no-load.

EVL012LED

200 W LED driver using the STNRG012

The EVL012LED LED driver board features the STNRG012 controller, which manages both the front-end PFC preregulator and downstream resonant half-bridge converter. It has 90-277 Vac input, 36-56 Vdc output with 3.6A maximum output current, 200 W max power, very high efficiency (>93%), and very good power factor.

EVL011A150ADP

12 V-150 W power supply based on STNRG011A

The EVL011A150ADP is an evaluation board for 90 Vac to 264 Vac mains, addressing AC-DC converters for an all-in-one (AIO) computer or a general-purpose high-power adapter. The design is based on the STNRG011A digital combo IC that controls a two-stage AC-DC SMPS.

STEVAL-NRG011TV

200 W power supply based on STNRG011 digital combo for LED TV

The STEVAL-NRG011TV is a 200 W LED TV SMPS providing 12 V regulated output voltage (for MCU supply and audio system applications) and 65 V output voltage for LED back lighting. The design is based on the STNRG011 digital combo controller that controls a two-stage AC-DC SMPS.

STEVAL-SCR002V1

Inrush current limiter for active AC-DC bridge rectifier

The plug-and-play STEVAL-SCR002V1 introduces an innovative AC-DC front-end circuit to perform an inrush current limitation with TN1605H-6T High Temperature SCR, improving power converter efficiency, compactness and BOM reduction.

STDES-DIS001V1

Active discharge of high-voltage 400 V bus reference design

The STDES-DIS001V1 reference design allows you to evaluate silicon controlled rectifier TN4035HA as a discharge switch. It is suitable to discharge capacitance up to 3mF connected on 400 Vbus (800 V max.).

EVALMASTERGANx

Demonstration board for MASTERGANx high power density half-bridge high voltage driver with two 650 V enhanced mode GaN HEMT

The EVALMASTERGANx board is an easy-to-use and adaptable tool to evaluate the characteristics of MASTERGANx and to quickly create new topologies without requiring complete PCB designs.

EVSTDRIVEG600DG

Demonstration board for STDRIVEG600 600V high-speed half-bridge gate driver with enhanced mode GaN HEMTs

The EVSTDRIVEG600DG is an easy-to-use board for evaluating the characteristics of STDRIVEG600 driving 650 V e-Mode GaN switches.

EVSTDRIVEG600DM

Demonstration board for STDRIVEG600 600V high-speed half-bridge gate driver with MDmesh DM2 Power MOSFET

The EVSTDRIVEG600DM is an easy-to-use board for evaluating the characteristics of STDRIVEG600 driving 600V MDmesh DM2 Power MOSFET with fast recovery diode.

EVALSTGAP4S

Demonstration board for STGAP4S advanced galvanically isolated gate driver

The EVALSTGAP4S is a galvanically isolated single gate driver for IGBTs and SiC MOSFETs, featuring advanced protection, configuration, and diagnostics. It ensures true galvanic isolation between the channel gate driving and control/low voltage interface circuitry. The board supports evaluation of all STGAP4S features while driving a power switch up to 650 V and includes two SiC MOSFETs in a half-bridge configuration.

EVLSTGAP3SXS-H, EVLSTGAP3S6S

Half-bridge evaluation boards for STGAP3SXS/STGAP3S6S SiC MOSFETs isolated gate driver with protections

The EVLSTGAP3SXS-H and EVLSTGAP3S6S are half-bridge evaluation boards designed to evaluate the STGAP3SXS and STGAP3S6S isolated single gate drivers. They feature up to 10 A current capability, rail-to-rail outputs, and optimized UVLO and DESAT protection thresholds for SiC MOSFETs, making them ideal for high-power motor drivers in industrial applications.

EVALSTGAP1BS/…2HSCM/…2HSM/…2SCM/…2SICS/…2SICSC/…2SM/ EVSTGAP2SICSN/…2SICSNC

Demonstration board for STGAP2SICS & STGAP2SICSC isolated 4 A single gate drive

This board series allows evaluation of all the STGAP single channel device features while driving a half-bridge power stage with voltage rating from 1200 V up 1700 V. The board components are easy to access and modify for performance evaluation easier under different application conditions and fine adjustment of final application bill of materials.

EVALSTGAP2DM/…2HDM/…2SICD

Demonstration board for STGAP2DM/STGAP2HDM/STGAP2SICD isolated 4 A half-bridge gate driver

This board series allows evaluation of STGAP2DM, STGAP2HDM, and STGAP2SICD isolated dual gate drivers. The gate driver is characterized by 4 A current capability and rail-to-rail outputs, making the device also suitable for high power applications such as motor drivers in industrial applications equipped with SiC power switches.

EVSTGAP2GS/EVSTGAP2GSN

Demonstration board for STGAP2GS/STGAP2GSN isolated single gate driver with e-mode GaN transistor

This board series allows evaluation of STGAP2GS and STGAP2GSN isolated single gate drivers. The gate driver is characterized by 2 A source and 3 A sink capability and rail-to-rail outputs, making the device also suitable for mid and high power inverter applications such as power conversion and motor driver inverters in industrial applications equipped with GaN power switches.

B-G474E-DPOW1

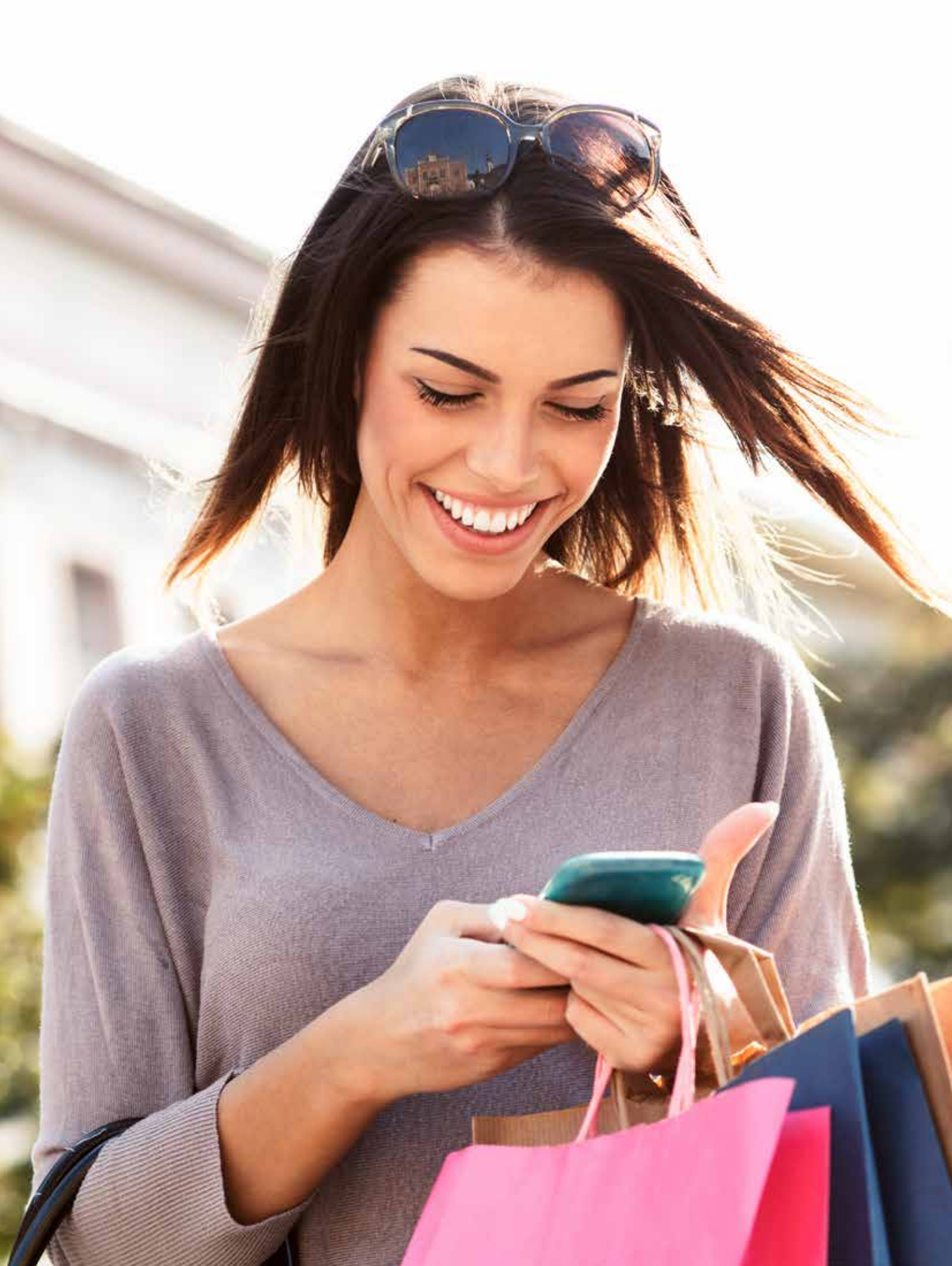
Discovery kit with STM32G474RE MCU

The B-G474E-DPOW1 Discovery kit is a digital power solution and a complete demonstration and development platform for the STM32G474RET6 microcontroller. Leveraging the new HRTimer-oriented features, 96 Kbytes of embedded RAM, math accelerator functions and USB Power Delivery 3.0 on the MCU, the B-G474E-DPOW1 Discovery kit based on the USB 2.0 FS Type-C® connector interface helps the user prototype digital power applications such as a buck-boost converter, RGB power LED lighting, or a class-D audio amplifier.

32F3348DISCOVERY

Discovery kit with STM32F334C8 MCU

The Discovery kit helps you discover the digital power features of the STM32F334 line of microcontrollers and develop your applications easily. It helps beginners and experienced users get started quickly. It includes an ST-LINK/V2-1 embedded debug tool interface, high brightness LED dimming with buck converter, buck/boost converter, LEDs, and push buttons.



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