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Industrial Summit 2020
Shenzhen, China | 2 December
POWERING YOUR INNOVATION

Wireless power

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Industrial Power & Energy Competence Center
AP Region, STMicroelectronics

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Our mission: safe and reliable products

Qi certification, Robust design, No overheat

WPC 2019 market survey:

More than 80% of the TX cannot pass EPP Qi conformance tests

More than 60% of the TX cannot pass BPP Qi conformance tests

TX most frequent cause of fail:

loose power control may cause RX overvoltage

poor heating prevention

Our STWBC and STWBC2 products outmatch Qi spec:

Better heating prevention

Finer patented power control – no RX overvoltage

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WIRELESS POWER CONSORTIUM

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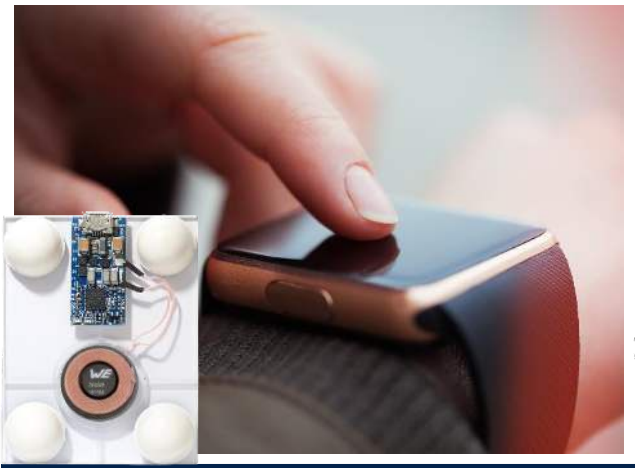
Wireless power TX family and roadmap

1 - 2.5 W
Wearable Devices

Optimized for ultra-compact battery-operated

IC: STWBC-WA
EVB: STEVAL-ISB045V1



5 -15 W Single coil
Smartphones

Qi 1.2.4 BPP/EPP certified

IC: STWBC-EP
EVALSTWBC-EP
STEVAL-ISB044V1

5 -15 W Multi-coil
Smartphones

Qi 1.2.4 EPP certified

STWBC-MC
STEVAL-ISB047V1
STEVAL-QiNFCAU1*

15 - 50 W
super fast charge Smartphones

Qi 1.2.4 certified

STWBC2*
STEVAL-STSC*

A complete development ecosystem is available including certified reference design boards, API libraries, documentation and graphical user interfaces to access to real-time data and configurable parameters.
Optimized Time-To-Market

***available Q1 2021**

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STWBC2x family

Digital controller for wireless power TX integrated 32-bit MCU with Flash Memory

Qi and Ki

WIRELESS POWER CONSORTIUM

Limitless Wireless Power Architecture

Multi Market Flexibility
OEMs and MM

Future Proof -Ready for Standard and Proprietary Protocol Evolution

Key Added Value Features : Fast Loop patent, High Voltage and Flash Memory, USB PD, robust triple demodulation

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STWBC2

Qi Wireless power TX with embedded 32bit MCU, DCDC controller and gate drivers for consumer and industrial applications

ES available
MP Jan 2021

50W eval board

Key features

- WPC Qi 1.2.4 and fast charge proprietary extensions
- ARM 32-bit Cortex™-M0+ CPU up to 64MHz
- Buck/Boost digital DCDC + full bridge inverter
- 3x Half bridge drivers
- 1ns resolution PWM generator (40MHz PLL, 17-step DLL)
- USB-QC and USB-PD interfaces

Key benefits

- Limitless fast charge operations (50W and more)
- Leading edge integration – short BOM
- Best in class efficiency
- UART FW update with 128kB flash, 32kB SRAM

KEY APPLICATIONS

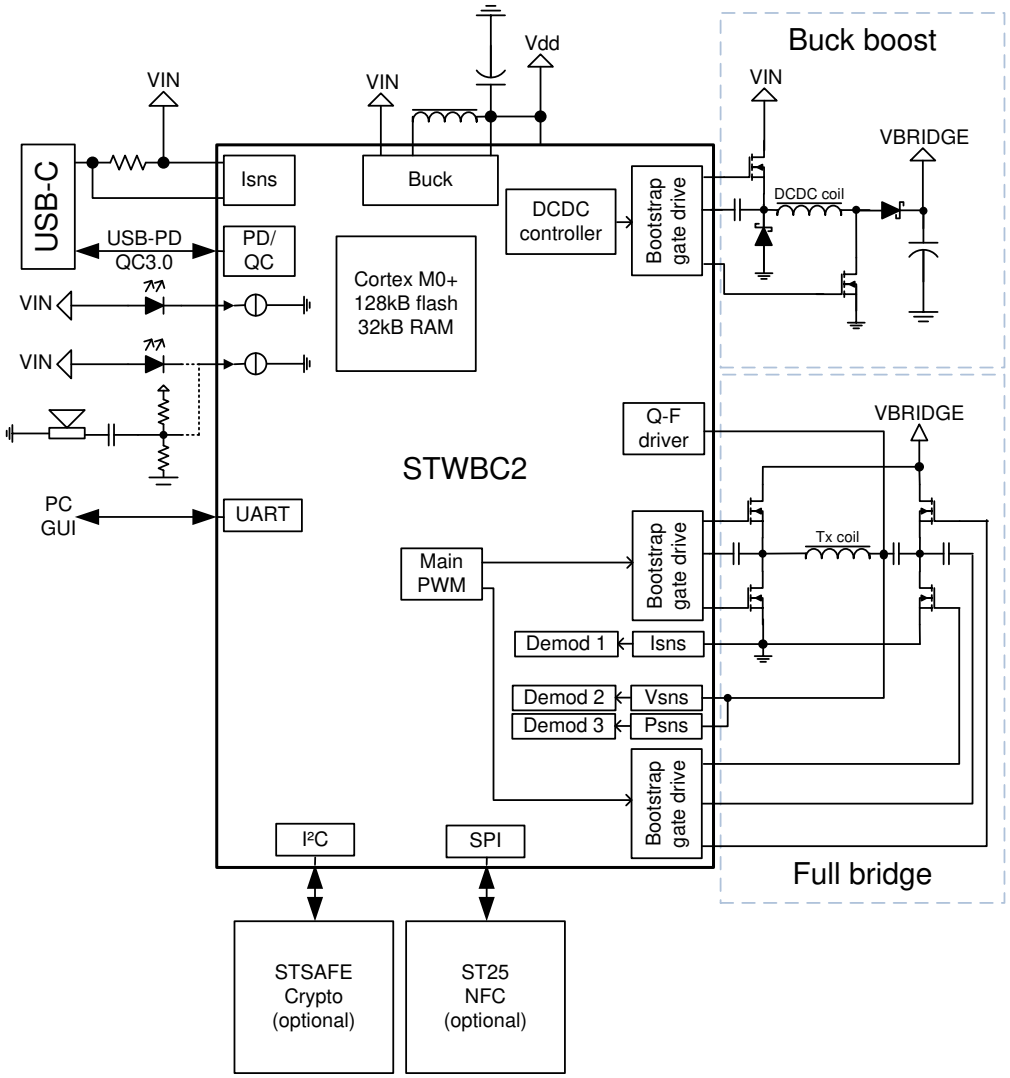
- Ultra fast charging pads for Smartphones, Laptops and tablets
- Wireless chargers for Drones, Lawn mowers, Robots, Tools, eBikes

STWBC2 product description

Package: QFN 8x8 68L 0.4mm pitch

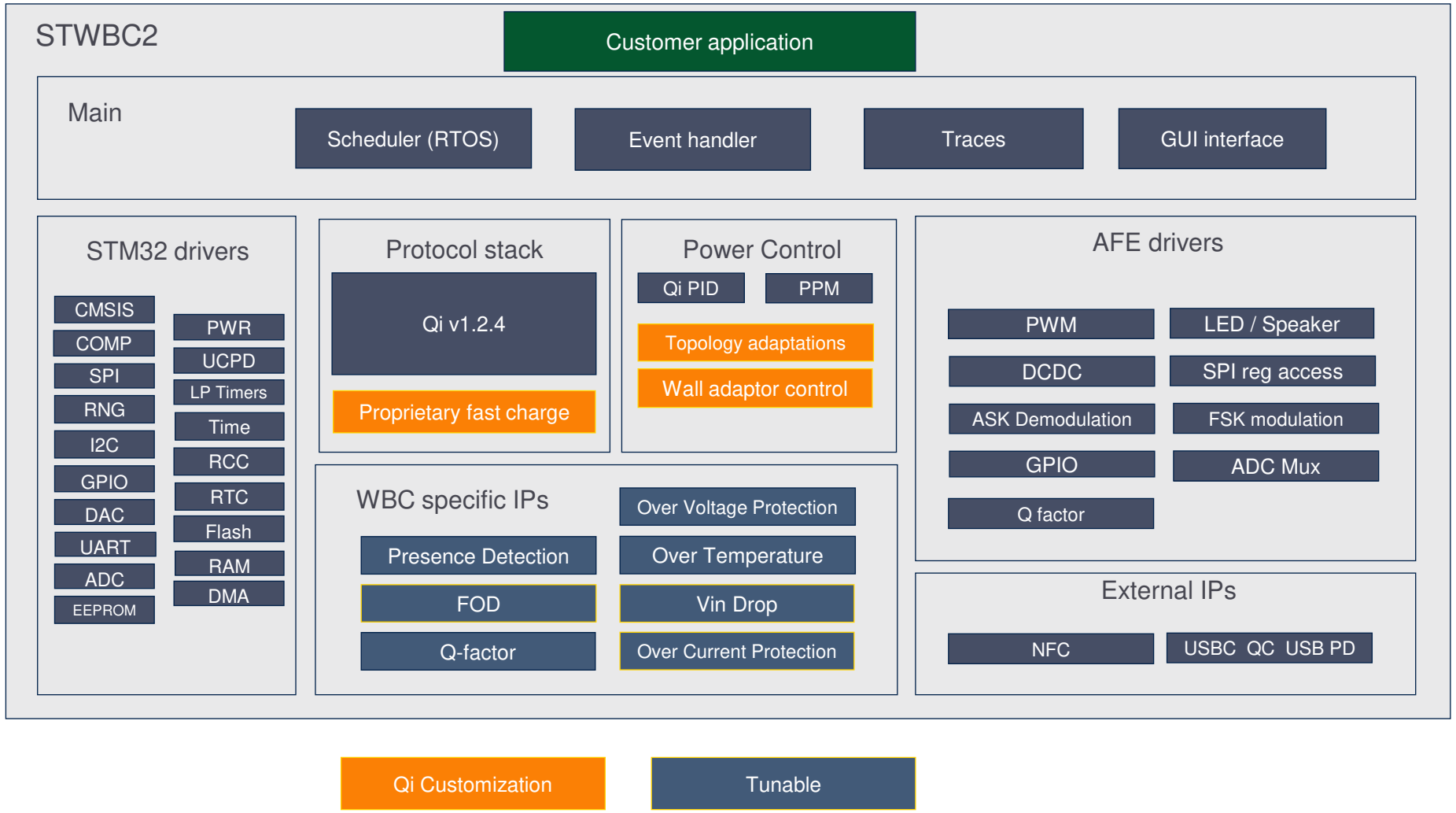
Main Features and key IPs

- 15W WPC **Qi EPP 1.2.4 and Qi 1.3***
- **50W ST Super charge** proprietary extension
- ARM 32-bit Cortex™-M0+ CPU up to 64MHz
- **3x Half bridge drivers** for Full Bridge topologies + DC/DC
- Flexible topology: half / full bridge, fixed / variable frequency
- **Buck, Boost, Buck/Boost digital controller**
- **1ns resolution PWM** generator (40MHz PLL, 17-step DLL)
- Qi FSK programmable modulator
- Integrated I, V, Φ sensors and demodulators.
- Qfactor driver for improved Foreign Object Detection
- VIN operating range: 4.1V to 24V
- **USB Power Delivery**, QC 3.0
- UART, SPI, I2C interfaces for NFC and Authentication
- 12-bit ADC
- **128 Kbytes of Flash memory**
- 32 Kbytes of SRAM with HW parity check



*Note: STWBC2 Qi 1.3 compliance after WPC standard ratification

FW architecture of baseline



Target one flexible topology

- MP-A2 based but customizable to other single coil topology
- **Qi EPP 1.2.4**
- STSC (ST proprietary protocol for high power)
- 2 Power Extended modes implemented (F or V control)
- Multi Power mode with **Generic PID implemented**
- Generic FOD management
- Generic OVP management
- USB-PD, USB-QC, jack inputs

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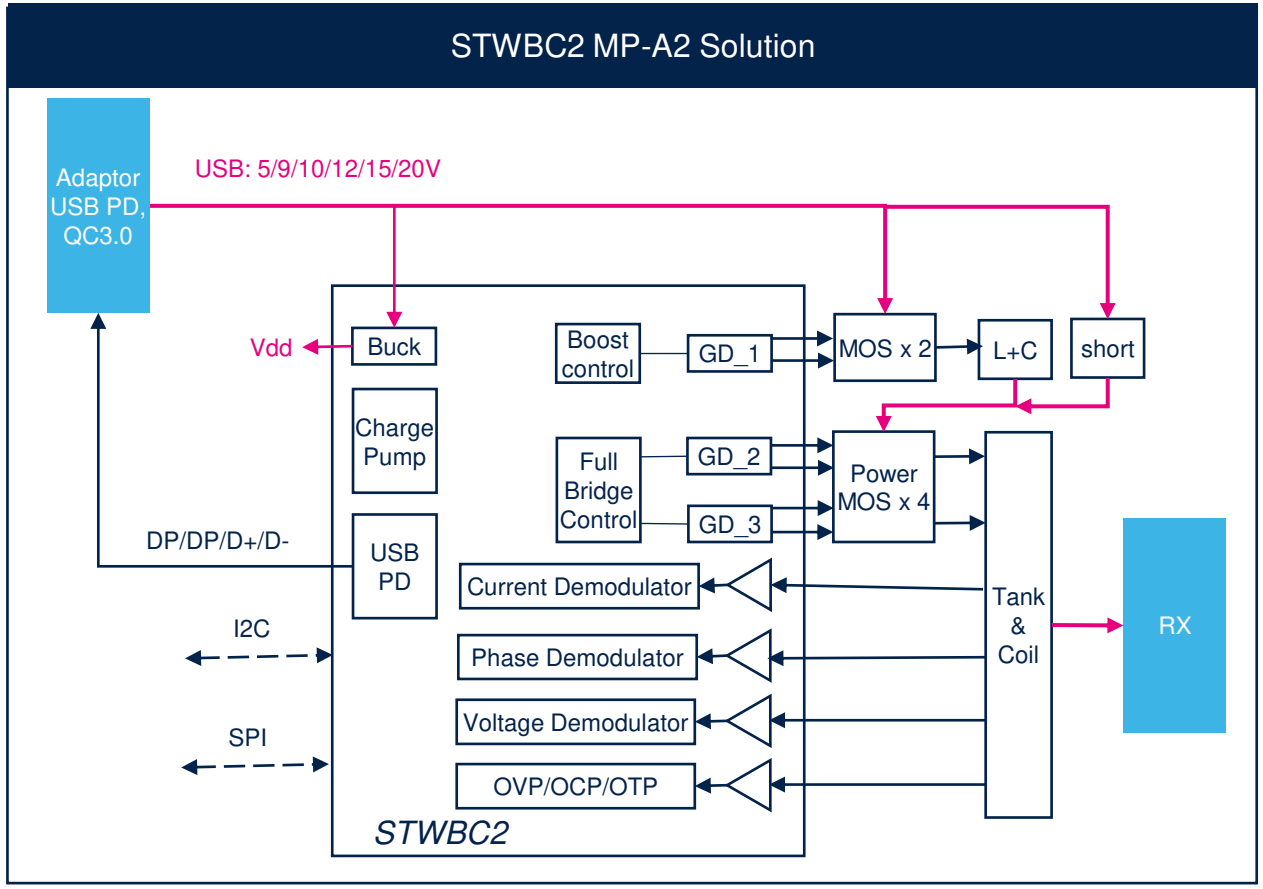
High Power TX architecture proposal full bridge, variable frequency

- Universal charger
  - 50W or more capable with 20V 3A input
  - 27W capable with 10V 4A input
  - 15W EPP / 5W BPP Qi 1.2.4 compliant
  - 10W Samsung proprietary fast charge
- High level of integration / Short BOM
  - Full bridge architecture
  - Digital boost DCDC with short for 50W mode
  - Q-factor driver, Sense and Demodulation
  - USB-PD and custom USB interfaces
- Enhanced safety
  - Q-Factor based FOD, possible proprietary calibration
  - OV, OC, OT protections
- Stable charge, large charging area
  - Triple path demodulation (V, I ,Phase)



Qi Topologies efficiency comparison

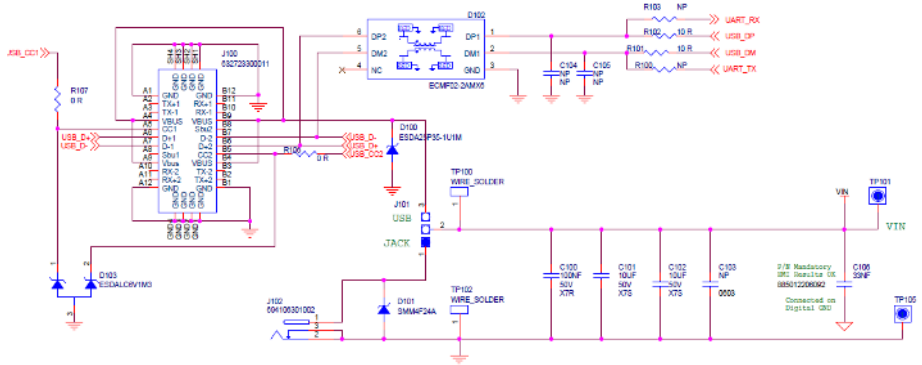
Type of Tx	Power components	Losses on Tx	Losses on Tx at 40W
Variable frequency (MP-A2, MP-A22)	Bridge: 4xMOS	~10% (bridge + tank)	~5W
Fixed frequency Variable voltage (MP-A9, MP-A11, ..)	Bridge: 4xNMOS DCDC: 2xNMOS + 2xSchottky + 4.7µH	~10% (bridge + tank) 5~10% (DCDC)	8W~12W
Variable voltage Filtered tank (MPA13, …)	Bridge: 4xNMOS DCDC: 2xNMOS + 2xSchottky + 4.7µH Filter: 2x1µH + 4x100nF COG	~20% (bridge + tank + filter) 5~10% (DCDC)	**15W~20W**

- Topologies with good EMI and RF coexistence have drawbacks:
  - On cost: buck-boost DCDC required, filter required
  - On efficiency: up to 20% degradation with DCDC + filtered tank
- At high power transfer, **only variable frequency topologies appear realistic** considering the Tx power to dissipate

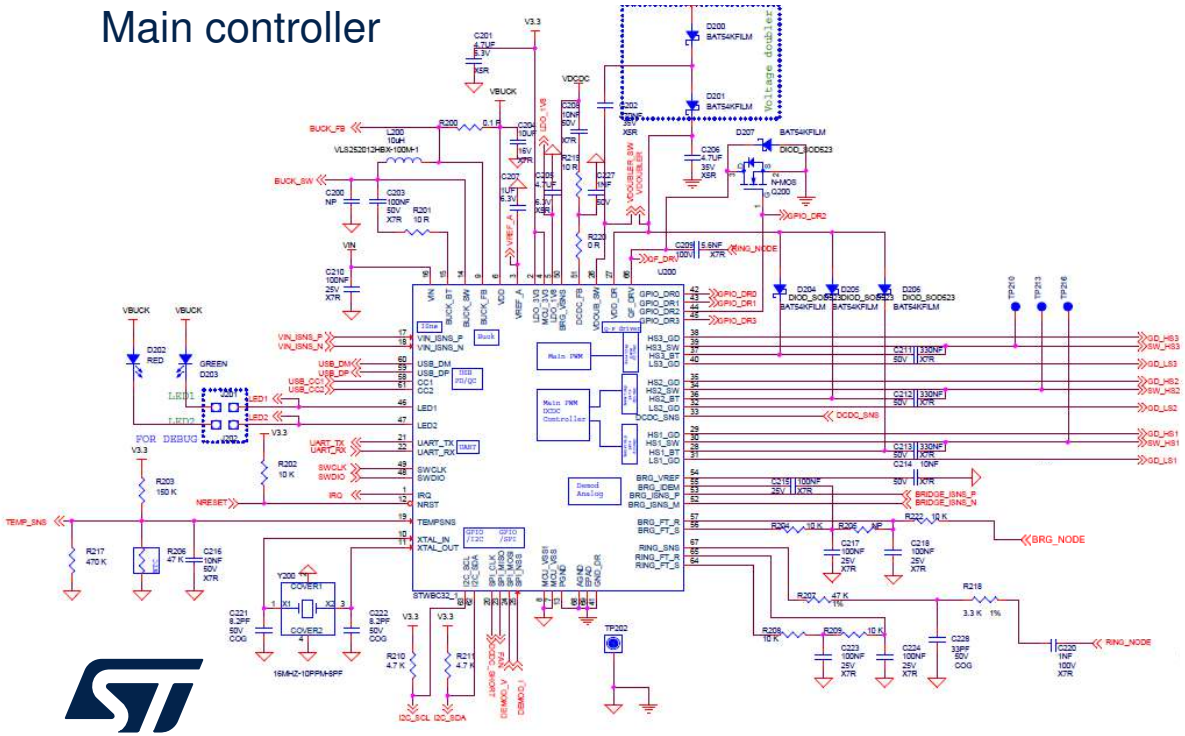
➔ **ST chose MP-A2 (MP-A22 in roadmap)**

MP-A2 reference schematics

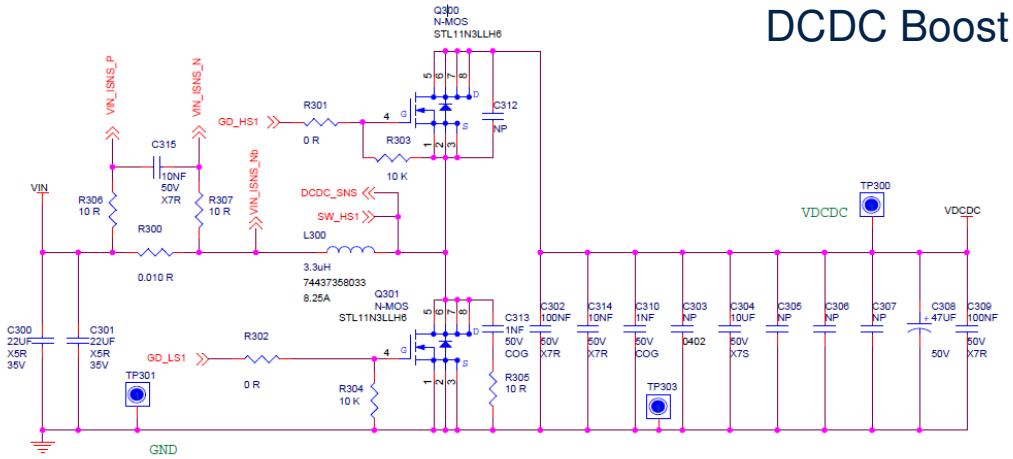
USB Type-C input

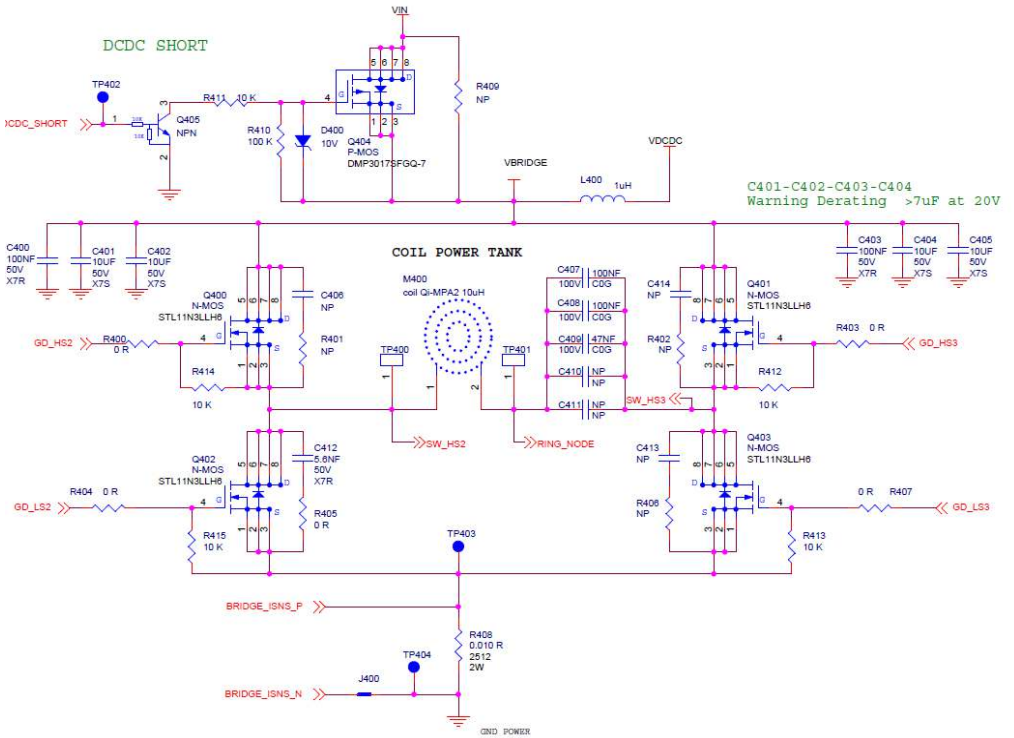


Main controller



DCDC Boost





STWBC2 competition analysis

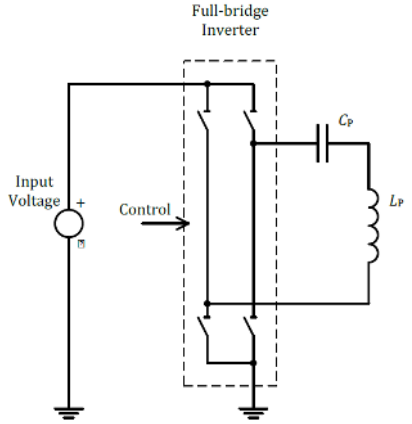
	STWBC2	R* P9247
Max power	50W	30W
Qi protocol	1.2.4 EPP (1.3 ready)	1.2.4 EPP
Input voltage range	4.5V – 24V	5V – 19V
Full bridge inverter max voltage	40V (65V AMR)	19V
Flash memory	128kB	No (OTP)
USB-PD interface (sink)	Yes	no
Communication interfaces	SPI, I2C, UART	I2C
Integrated DCDC controller	Yes	no
Integrated gate drivers	3 x Half Bridge	2 x Half Bridge
Vin current sensor	Yes	Yes
Phase demodulator	Yes	no
RX overvoltage protection	Yes	no
Improved FOD management	Yes	no

STWBC2 deliverables

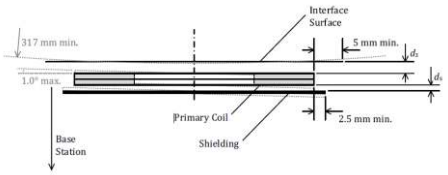
- Software
  - FW libraries / source (IAR 8.3x)
  - GUI Windows application
- Documentation
  - EVB User Manual
  - Datasheet
  - Schematic, PCB layout + Design guidelines
  - Generic PID and converters guideline (for topology change)
  - Guideline for proprietary protocol porting
- Hardware
  - Evaluation boards: MP-A2 topology , MP-A22 topology (Available June 2021)

Backup

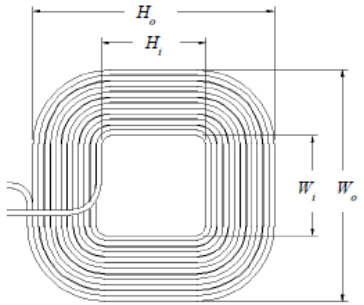
MP-A2



Lp = 10 ±10% µH
Cp = 247 ±5% nF
fop = 110 kHz to 145 kHz
duty cycle of $ton/tperiod$ = 5% to 50%.
VBridge = 12V

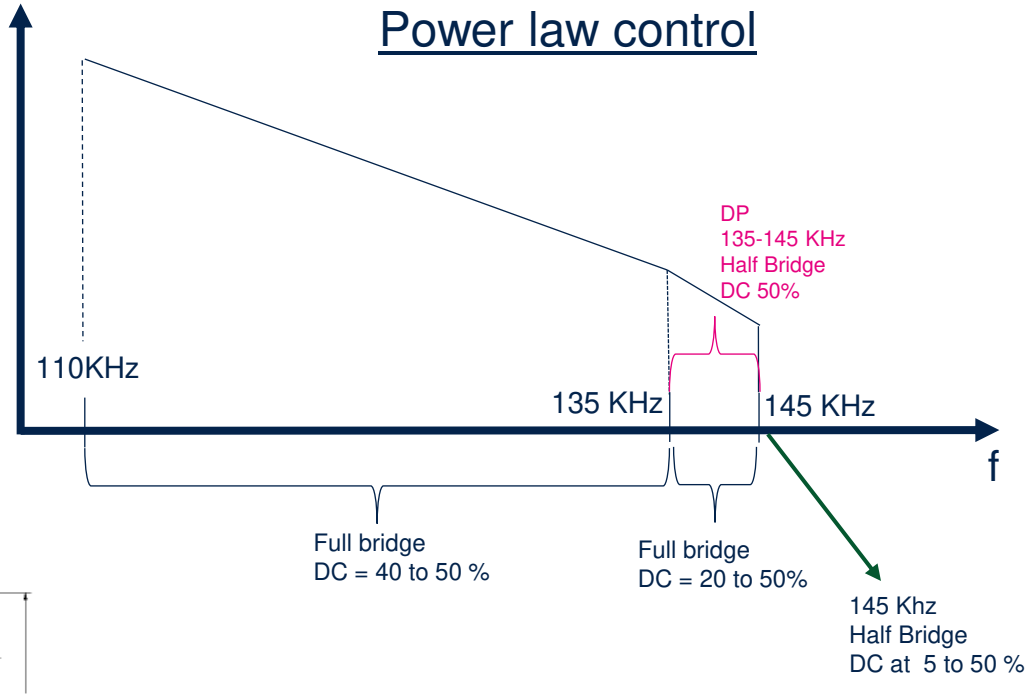


dz = 3mm



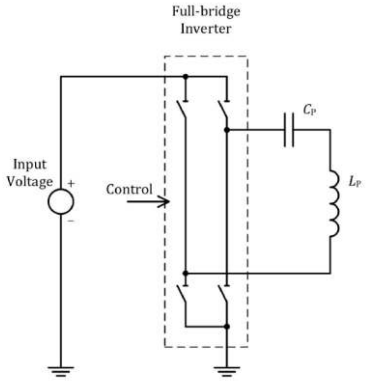
Parameter	Symbol	Value
Outer height	H_o	$48^{\pm0.5}$ mm
Inner height	H_i	$19^{\pm0.5}$ mm
Outer width	W_o	$48^{\pm0.5}$ mm
Inner width	W_i	$19^{\pm0.5}$ mm
Thickness	d_c	$1.1^{\pm0.3}$ mm
Number of turns per layer	N	12
Number of layers	–	1

Power law control

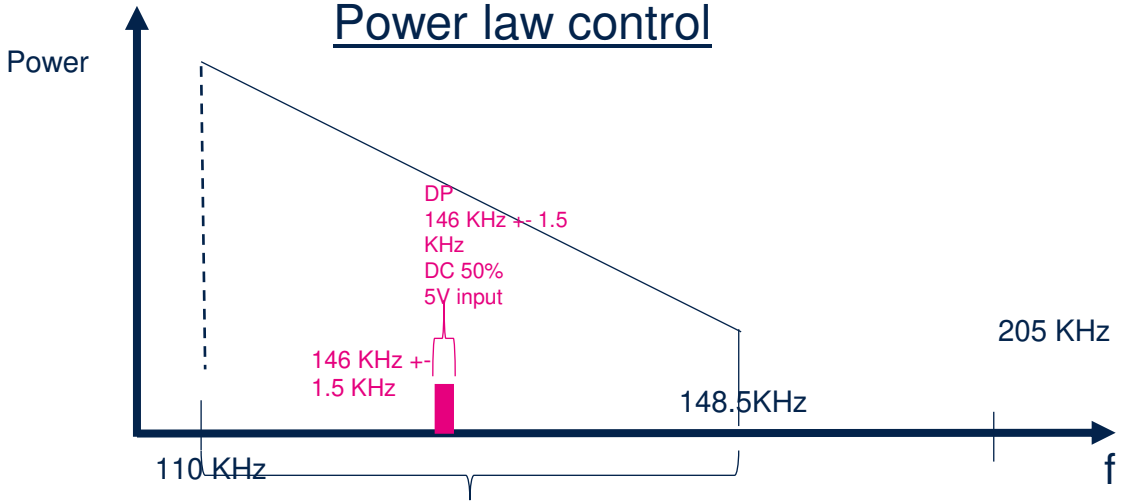


Digital ping (DP) :
135 kHz to 140 kHz Half Bridge
duty cycle of 50%

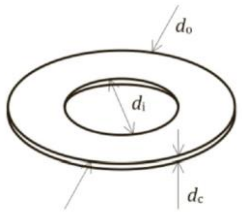
MP-A22



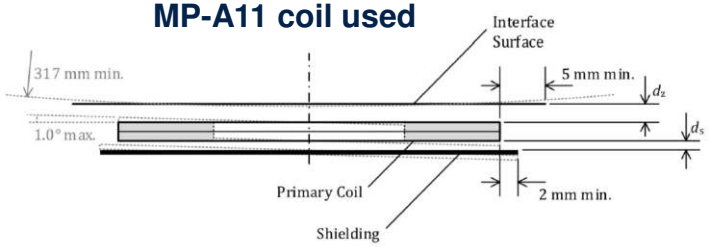
Power law control



Lp = 6,3 µH ±10%
Cp = 440 ±5% nF
fop = 110 kHz to 148.5 kHz
Duty = 50%
VBridge = 5V for Ping and up to 5W ,
9V from 5 to 10W and 12V from 10 to 15W for EPP
5V for BPP



MP-A11 coil used



dz = 3 mm +-0.5mm

Number of layers: 1 or 2
Wire type: No.40 AWG x 105 strands
Shielding thickness: Ths = 1.5 mm min.
Shielding material: Ni-Zn ferrite

Parameter	Symbol	Value
Outer length	d_o	$44.0^{\pm 1.5}$ mm
Inner length	d_i	$20.5^{\pm 0.5}$ mm
Thickness	d_c	$2.1^{+0.5}$ mm
Number of turns per layer	N	10 (5 bifilar turns)
Number of layers	–	1 or 2

PID parameters for Operating Frequency control			
Parameter	**Symbol**	**Value**	**Unit**
Proportional gain	K_p	10	mA^{-1}
Integral gain	K_i	0.05	$mA^{-1} * ms^{-1}$
Derivative gain	K_d	0	$mA^{-1} * ms$
Integral term limit	M_I	3,000	N.A.
PID output limit	M_PID	20,000	N.A

PID parameters for Duty Cycle control			
Parameter	**Symbol**	**Value**	**Unit**
Proportional gain	K_p	10	mA^{-1}
Integral gain	K_i	0.05	$mA^{-1} * ms^{-1}$
Derivative gain	K_d	0	$mA^{-1} * ms$
Integral term limit	M_I	3,000	N.A.
PID output limit	M_PID	20,000	N.A
Scaling factor	Sv	-0.01	%

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Thank you

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