life.augmented

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

Wireless power

Alex Li

Industrial Power & Energy Competence Center

AP Region, STMicroelectronics

Power & Energy
Competence
Center

Our mission: safe and reliable products

Qi certification, Robust design, No overheat

ST Qi-certified reference designs
STEVAL-ISB047V1
STEVAL-ISB044V1

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

WIRELESS POWER CONSORTIUM

life.augmented

Power & Energy
Competence
Center

Wireless power TX family and roadmap

1 - 2.5 W	5 -15 W Single coil	5 -15 W Multi-coil	15 - 50 W
Wearable Devices	Smartphones	Smartphones	super fast charge Smartphones
Optimized for ultra-compact battery-operated	Qi 1.2.4 BPP/EPP certified	Qi 1.2.4 EPP certified	Qi 1.2.4 certified
IC: STWBC-WA EVB: STEVAL-ISB045V1	IC: STWBC-EP EVALSTWBC-EP STEVAL-ISB044V1	STWBC-MC STEVAL-ISB047V1 STEVAL-QiNFCAU1*	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

Power & Energy
Competence
Center

STWBC

STWBC2x family

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

Qi and Ki

Limitless Wireless Power Architecture

Multi Market Flexibility
OEMs and MM

Future Proof -Ready for Standard and Proprietary Protocol Evolution

WIRELESS POWER
CONSORTIUM

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

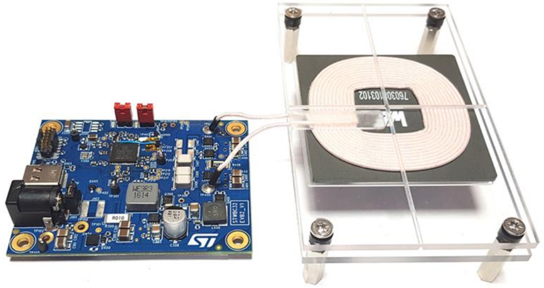
life.augmented

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

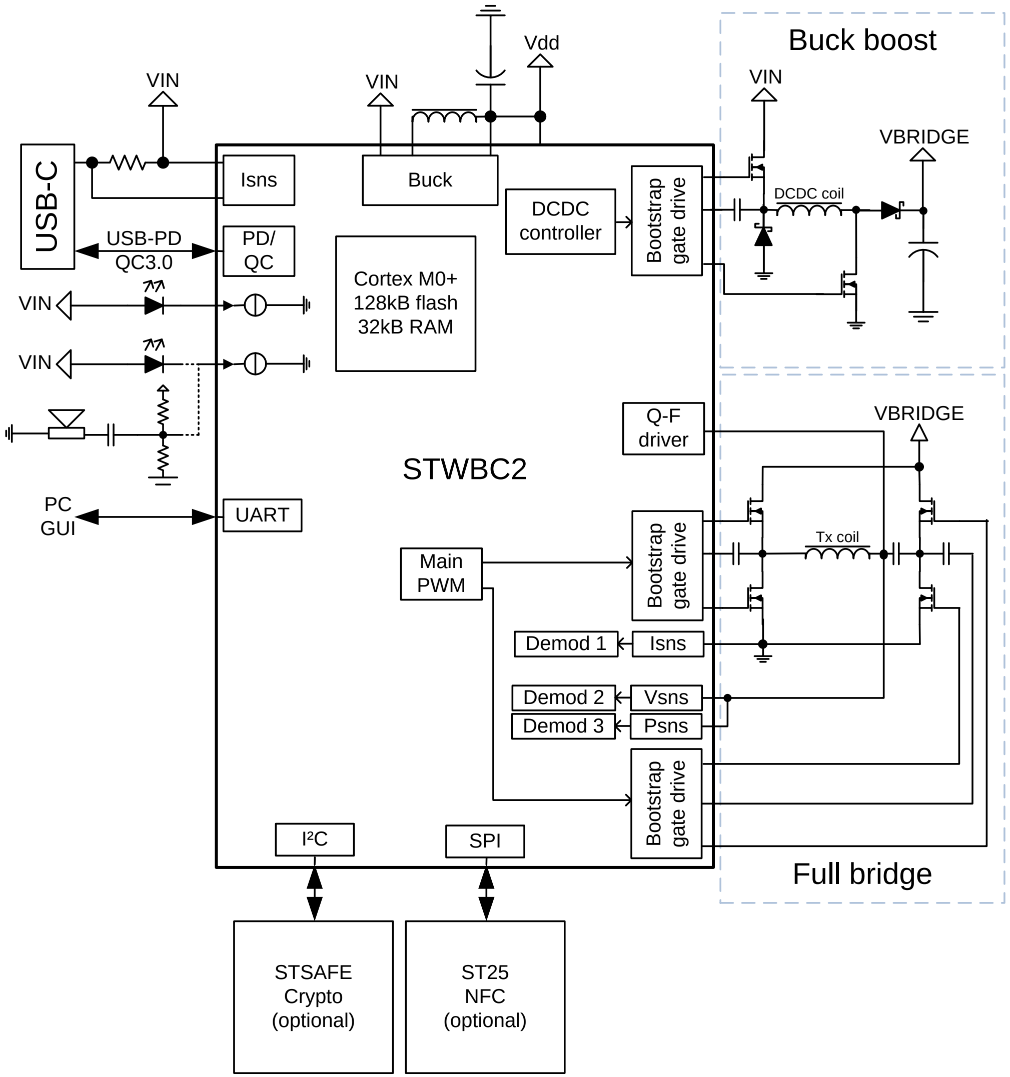
- Ultra fast charging pads for Smartphones, Laptops and tablets
- Wireless chargers for Drones, Lawn mowers, Robots, Tools, eBikes

STWBC2 product description

Package: QFN 8x8 68L 0.4mm pitch

Main Features and key IPs

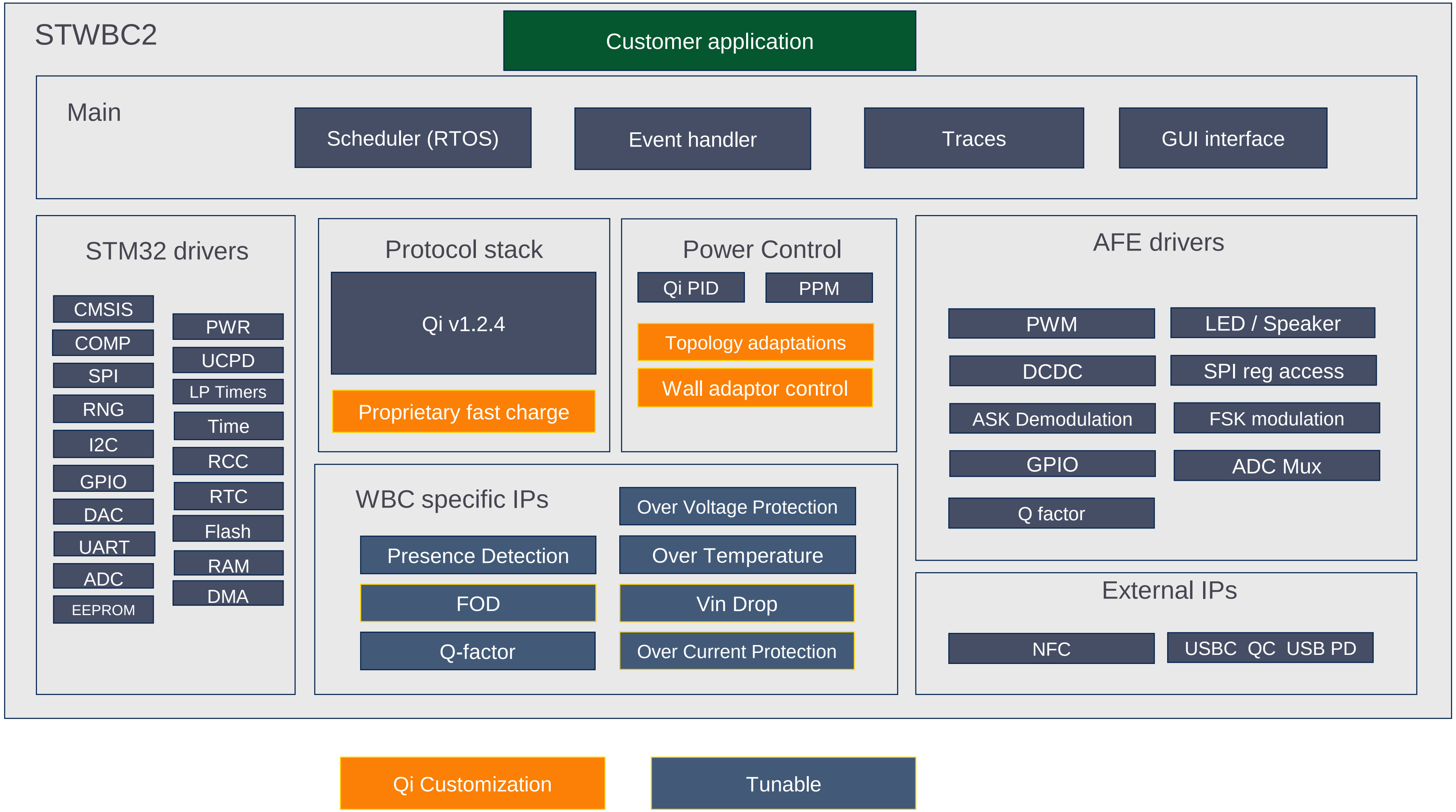
- 15W WPC **Qi EPP 1.2.4 and Qi 1.3***
- **50W ST Super charge** proprietary extension
- ARM 32-bit Cortex™-M0+ CPU up to 64MHz
- **3x Half bridge drivers** for Full Bridge topologies + DC/DC
- Flexible topology: half / full bridge, fixed / variable frequency
- **Buck, Boost, Buck/Boost digital controller**
- **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

Power & Energy
Competence
Center

FW architecture of baseline



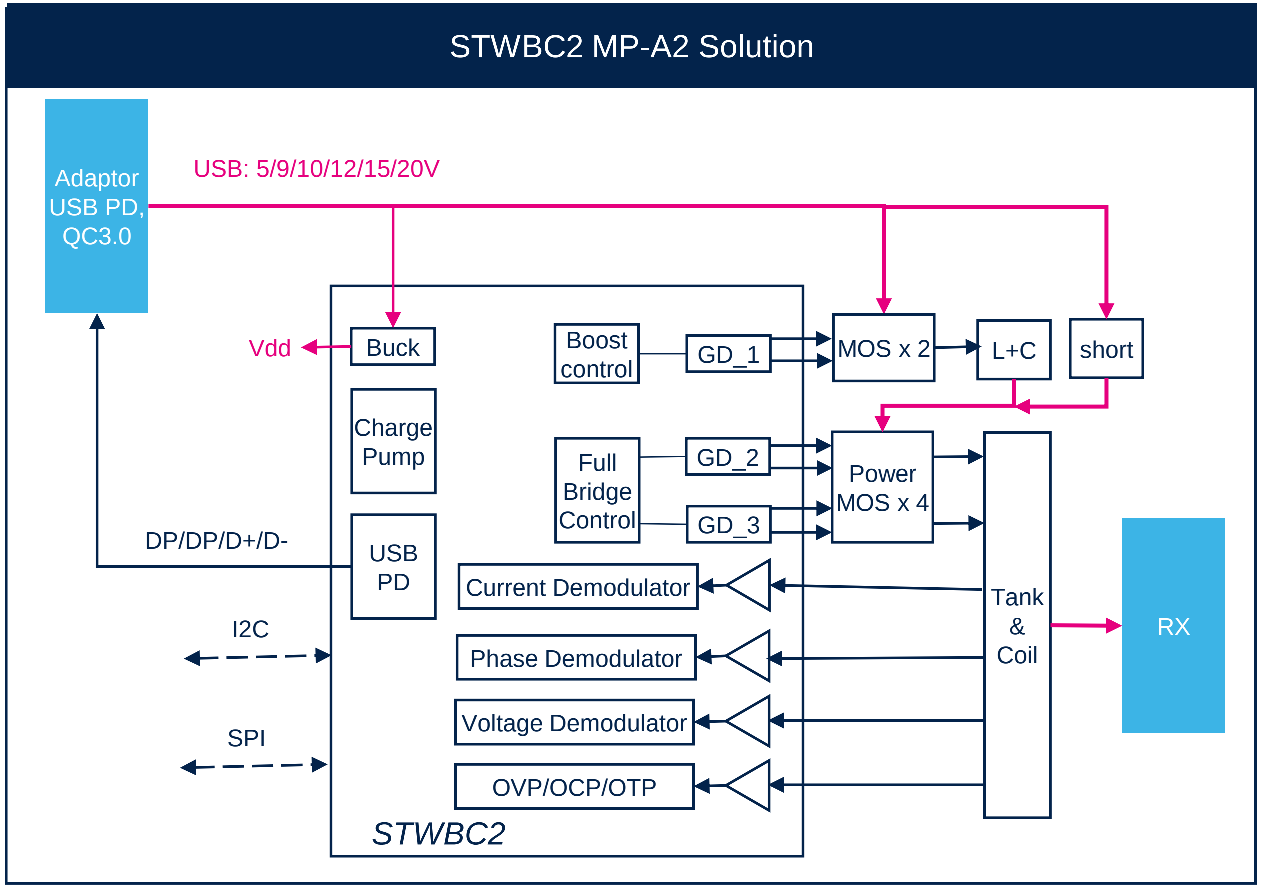
Target one flexible topology

- 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

life.augmented

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

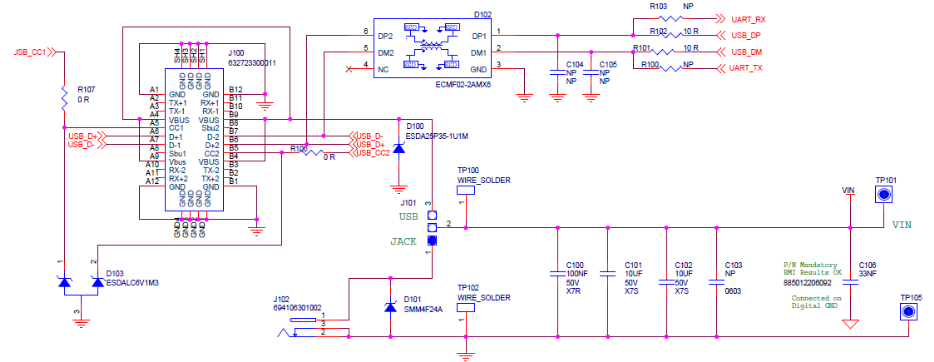
Type of Tx	Power components	Losses on Tx	Losses on Tx at 40W
Variable frequency (MP-A2, MP-A22)	Bridge: 4xMOS	~10% (bridge + tank)	~5W
Fixed frequency Variable voltage (MP-A9, MP-A11, ..)	Bridge: 4xNMOS DCDC: 2xNMOS + 2xSchottky + 4.7µH	~10% (bridge + tank) 5~10% (DCDC)	8W~12W
Variable voltage Filtered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

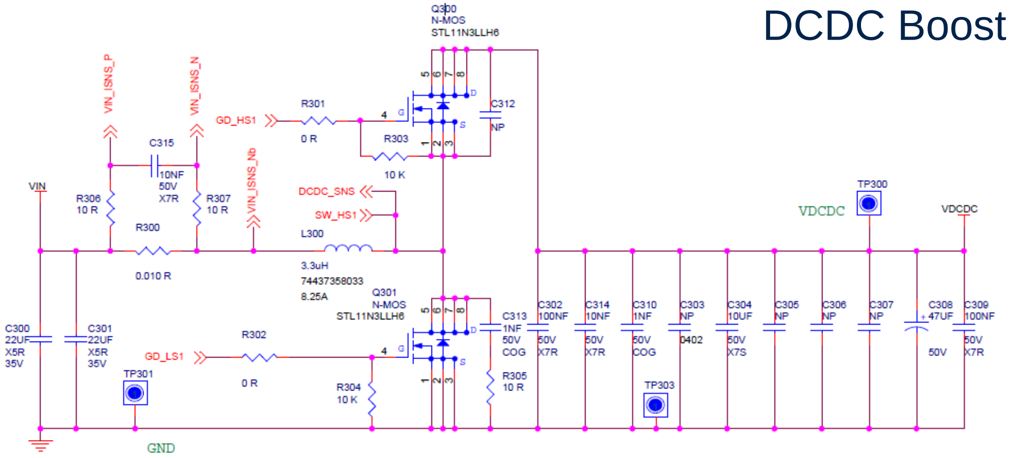
➔ ST chose MP-A2 (MP-A22 in roadmap)

MP-A2 reference schematics

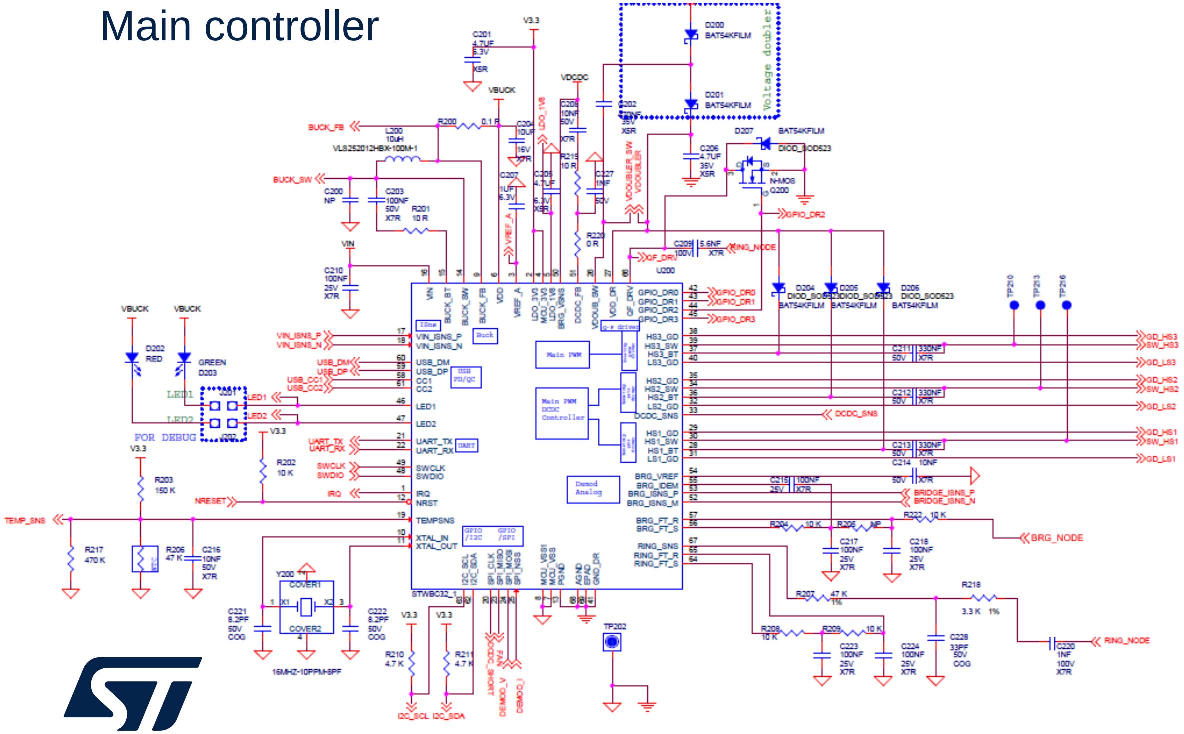
USB Type-C input

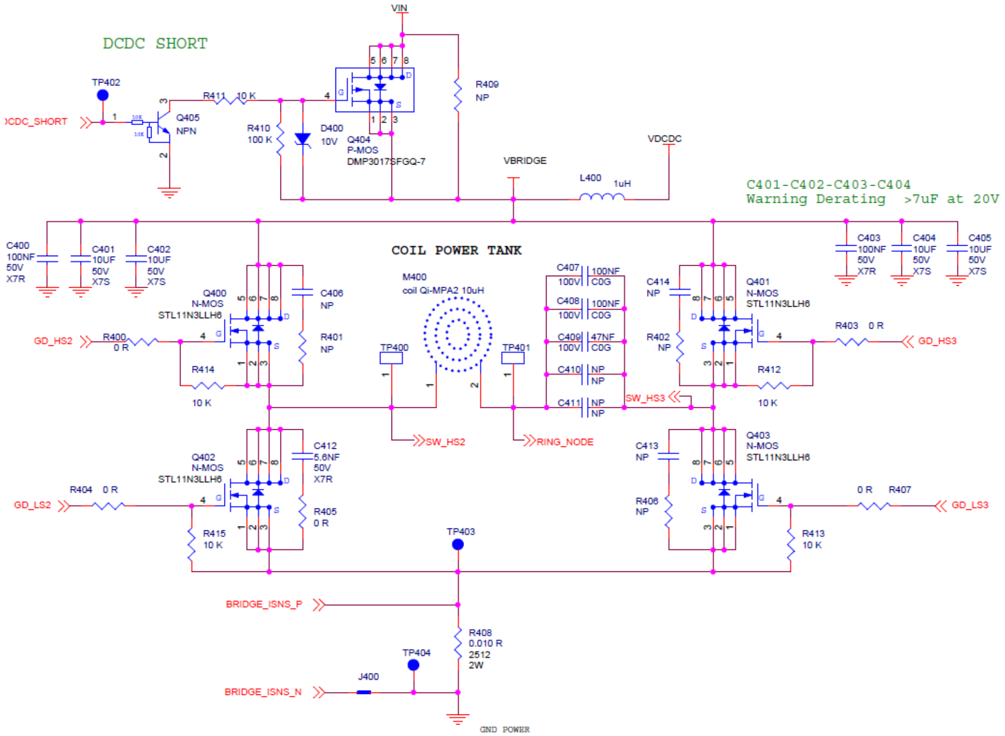


DCDC Boost



Main controller





life.augmented

STWBC2 competition analysis

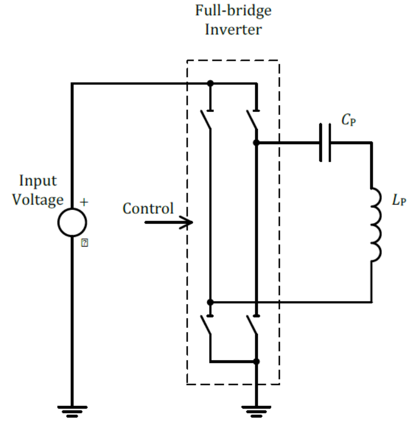
	STWBC2	R* P9247
Max power	50W	30W
Qi protocol	1.2.4 EPP (1.3 ready)	1.2.4 EPP
Input voltage range	4.5V – 24V	5V – 19V
Full bridge inverter max voltage	40V (65V AMR)	19V
Flash memory	128kB	No (OTP)
USB-PD interface (sink)	Yes	no
Communication interfaces	SPI, I2C, UART	I2C
Integrated DCDC controller	Yes	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)

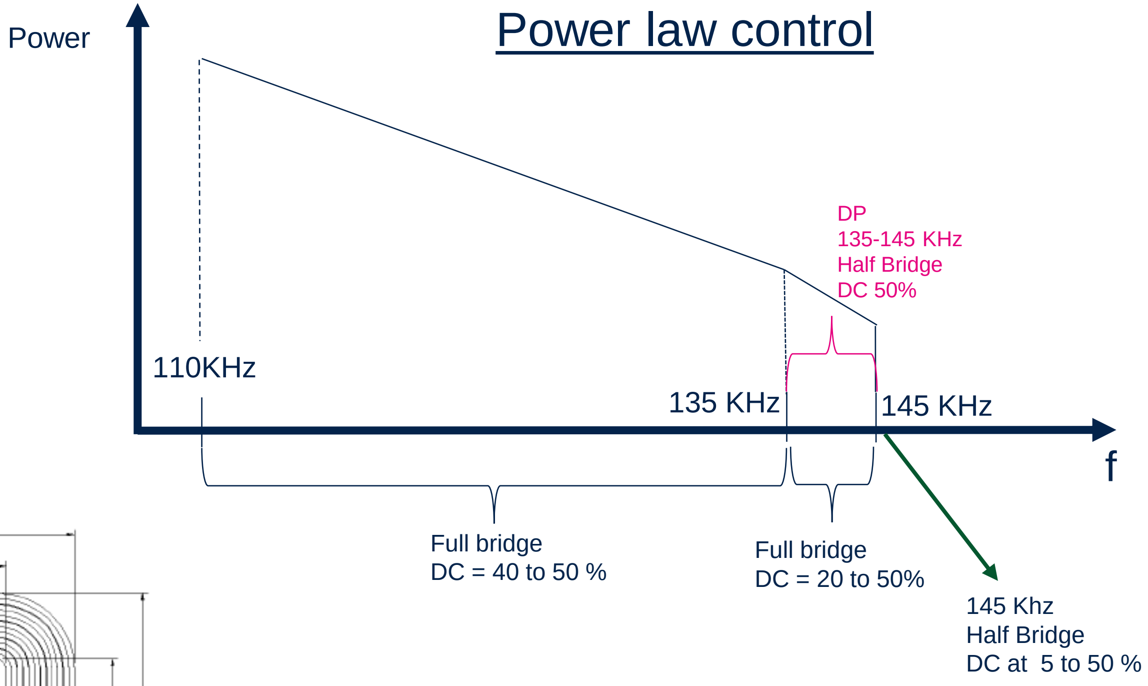
Backup

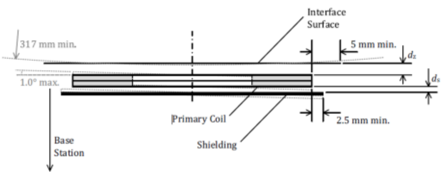
MP-A2



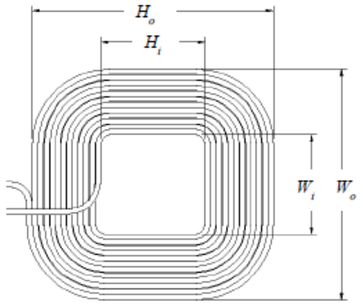
Lp = 10 ±10% µH
Cp = 247 ±5% nF
$f$op = 110 kHz to 145 kHz
duty cycle of $ton/tperiod$ = 5% to 50%.
VBridge = 12V

Power law control





dz = 3mm

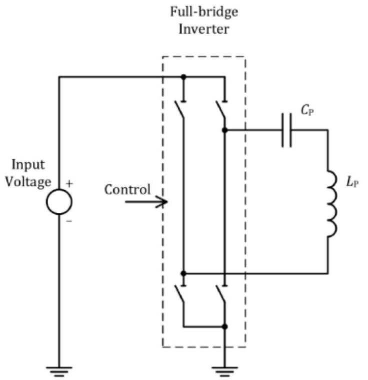


Parameter	Symbol	Value
Outer height	H_o	$48^{\pm 0.5}$ mm
Inner height	H_i	$19^{\pm 0.5}$ mm
Outer width	W_o	$48^{\pm 0.5}$ mm
Inner width	W_i	$19^{\pm 0.5}$ mm
Thickness	d_c	$1.1^{\pm 0.3}$ mm
Number of turns per layer	N	12
Number of layers	–	1

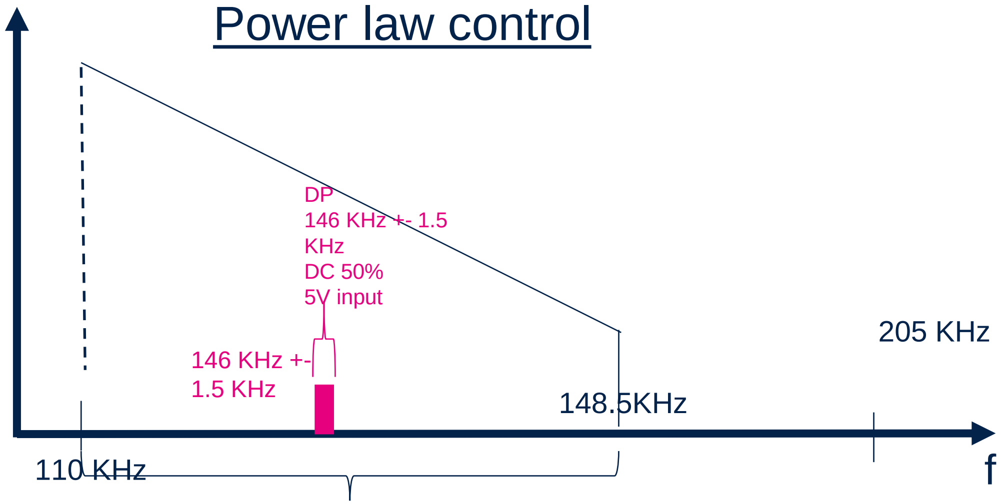
Digital ping (DP) :
135 kHz to 140 kHz Half Bridge
duty cycle of 50%

life.augmented

MP-A22

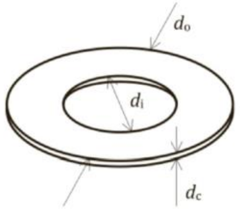


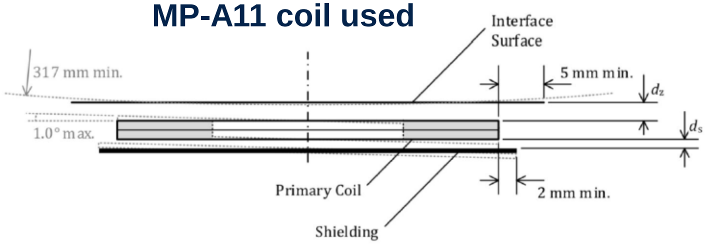
Power law control



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	$44.0^{\pm1.5}$ mm
Inner length	d_i	$20.5^{\pm0.5}$ 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	%

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

Thank you

life.augmented