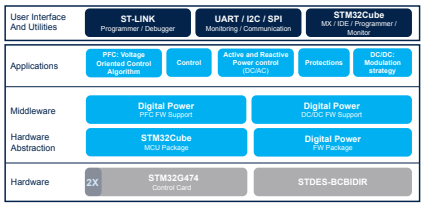
# STSW-BCBIDIR

Data brief

# Firmware for STDES-BCBIDIR, bidirectional power converter for battery charging applications




| Product summary | |
|---|---|
| Firmware for STDES-BCBIDIR, bidirectional power converter for battery charging applications | STSW-BCBIDIR |
| 11 kW bidirectional battery charger based on three phase two-level PFC and isolated DC-DC converter | STDES-BCBIDIR |
| Automotive-grade ACEPACK DMT-32 power module, fourpack topology, 1200 V, 47.5 mOhm typ. SiC Power MOSFET with NTC | M1F45M12W2-1LA |
| Mainstream Arm Cortex-M4 MCU 170 MHz with 512 Kbytes of Flash memory, Math Accelerator, HR Timer, High Analog level integration | STM32G474RET3 |
| Galvanically isolated 4 A dual gate driver | STGAP2SiCD |
| Applications | Battery Storage Systems for Home<br>On Board Charger (OBC) |

## Features

- Bidirectional control algorithm
- AC-DC (PFC control) and DC-AC
  - Voltage oriented control (VOC) algorithm
  - Power factor control (PFC)
  - DC bus regulation (PFC)
  - Soft startup (PFC)
  - Active and reactive power control (DC-AC)
- DC-DC control
  - Soft switching at wide load/voltage range
  - Embedded controls:
    - Voltage control
    - Current control
    - Soft startup
- Protections
  - Over current/voltage/power protections
  - Input/output operating voltage range protections
- Development environment
  - D-power firmware package for application parameters customization
  - Full integration on STM32Cube software ecosystem
- Based on the STM32G474RE MCU
  - Customizable full digital solution with high performance mixed-signal processing
  - High-resolution timer (HRTIM)
  - Integrated advanced analog peripherals

## Description

The STSW-BCBIDIR provides a solution to control the double-stage STDES-BCBIDIR power converter exploiting a mixed-signal digital MCU optimized for digital power applications.

The STM32Cube development environment is fully integrated to extend and simplify the user approach.

The PFC firmware handles complete three-phase, two-level AC-DC, and DC-AC power conversion control based on the STM32G474RE. The firmware includes a sophisticated voltage-oriented control (VOC) algorithm to handle either the power factor in AC-DC conversion or the AC output power (active and reactive) in DC-AC conversion.

The DC-DC firmware allows to operate the converter with extended soft switching thanks to the adaptive modulation techniques and enhanced voltage and load control at a wide range.

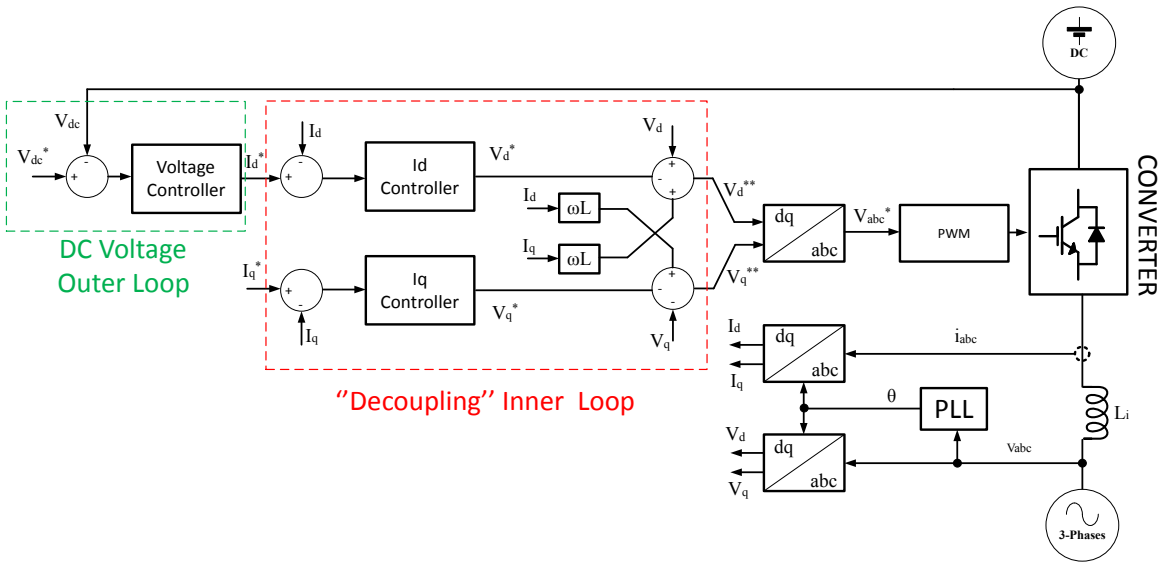
Additional features to improve reliability and safety are provided, for example, input and output overvoltage and overcurrent protections, soft startup.

# 1 Block diagram

## 1.1 PFC control scheme

The voltage-oriented control (VOC) algorithm implements vector control based on synchronous reference frames for current decoupling strategy. To deliver the highest possible power quality, the algorithm requires a high-performance microcontroller such as the STM32G474RE mixed-signal integrated control platform, featuring high-resolution timers and many PWM outputs, and advanced analog peripherals.

**Figure 1. Control scheme**




In rectifier mode (AC-DC), to obtain power factor values close to unity, the input current is controlled through the regulation of the direct (d-axis) component according to the output power demand, while setting the quadrature (q-axis) component to zero to achieve null reactive power and therefore the highest efficiency.

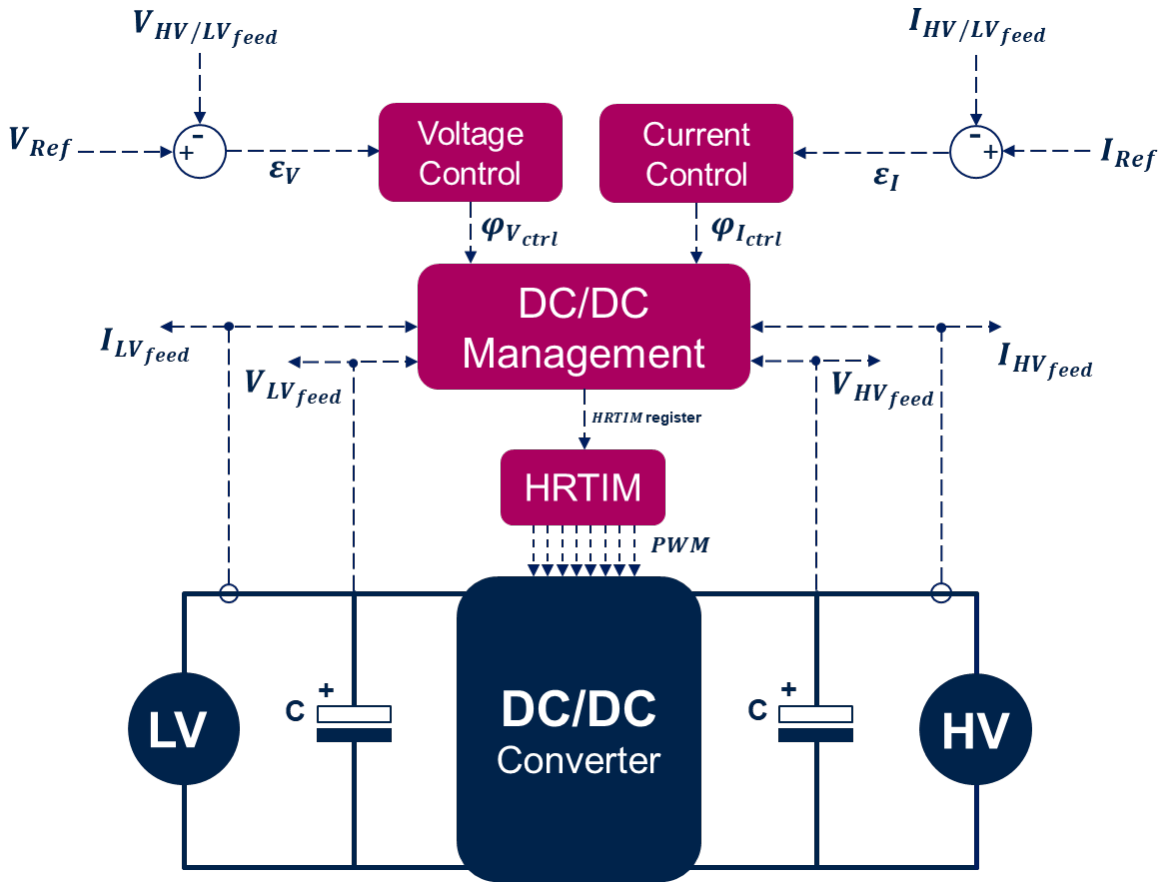
## 1.2 DC-DC control scheme

Voltage and current control are used to properly obtain the actual phase shift between primary and secondary bridge.

DAB management handles phase shift control to optimize soft switching DAB behavior at a wide voltage and load range.

Switch driving module exploits the high-resolution timers to obtain the best performance in switching frequency and the dead time management according to DAB requirements.

Figure 2. **DAB control block diagram**




The firmware can also be configured to handle the CLLC resonant DAB operation through a variable frequency control.

## Revision history

Table 1. **Document revision history**

| Date | Revision | Changes |
|---|---|---|
| 20-Dec-2023 | 1 | Initial release. |

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