Fully assembled board developed for performance evaluation only, not available for sale

STDES-7KWOBC

7 kW on-board charger (OBC) reference design

Features

- Front-end PFC stage using 2-channel interleaved totem pole topology operating at 70 kHz
- Digital inrush current control
- DC-DC stage using FB LLC resonant topology with 140 kHz resonant frequency
- Constant current and constant voltage mode
- Control stage based on SPC58NN84E7RMHBR MCU
- 12 V input supply voltage galvanically isolated from output voltage GND (high voltage battery)
- Bus bar interconnection possibility
- PFC stage:
  - Key products: TN3050H-12GY-TR SCRs, STBR3012G2Y bypass diodes, SCTH35N65G2V-7AG SiC power MOSFET
  - Input: 85 to 265 V<sub>AC</sub>, 45 to 65 Hz
  - Digital inrush current limiter
  - Max. input current: 32 A<sub>rms</sub>
  - Switching frequency: 70 kHz
  - Average current mode control in continuous conduction mode (CCM)
  - PID or 2p2z 2x independent current loop regulators
  - PID or 2p2pz voltage regulator
  - SPC58NN84E7RMHBR MCU controller
- DC-DC stage:
  - Key products: STB47N60DM6AG power MOSFET, STPSC20065GY-TR output diodes, A6387 gate driver
  - Output voltage: 250 to 450 V<sub>DC</sub>
  - Switching frequency: 92 to 250 kHz with start-up at 350 kHz
  - Two independent current loops (CC)
  - One voltage loop plus current balancing (CV)
  - PID regulators
  - SPC58NN84E7RMHBR MCU controller
- RoHs compliant

Description

The STDES-7KWOBC is an on-board charger (OBC) reference design that allows charging the battery of electric vehicles (EV) through your home AC mains plug or a private/public outlet (AC charging station).

The reference design embeds two sections: an interleaved totem pole PFC with SiC and a dual galvanic isolated full bridge LLC DC-DC ZVS resonant converter, based on MDmesh DM6 super-junction power MOSFETs.

The power platform is a 7 kW module able to deliver a constant current (CC) or constant voltage (CV) on the output to be used as standalone (1 PH+ N), in parallel or in 3-phase mode (3Ph + N) to reach 21 kW.

The underlying insulated metal substrate (IMS) on aluminum base plate enables very effective heat dissipation, forced air or liquid cooling.
Each module composing the reference design allows an easy interconnection among modules of the same type through wires or bus bar connection, reaching a higher output power.

This reference design key factor is the efficiency and high-power density gained thanks to SiC and SJ power MOSFETs, silicon and SiC diodes, gate drivers, the SPC58NN84E7RMHBR power architecture automotive-grade microcontroller, and SCR thyristors for inrush current limitation.

The STDES-7KWOBC is a fully assembled kit developed for performance evaluation only, not available for sale.
Figure 1. Mother board circuit schematic - AUX PS
Figure 4. Mother board circuit schematic - input section
Figure 5. Mother board circuit schematic - LLC control

Note: Keep all filtering parts traces as short as possible to the DSMPS Connector

STDES-7KWOBC
Schematic diagrams
Figure 6. Mother board circuit schematic - PFC control

Figure 7. Mother board circuit schematic - vertical adapter
Figure 8. Mother board circuit schematic - DSMPS connector

Figure 9. Mother board circuit schematic - A6387 LLC (1 of 4)
Figure 14. Mother board circuit schematic - STGAP1AS PFC (2 of 4)
Figure 15. Mother board circuit schematic - STGAP1AS PFC (3 of 4)
Figure 16. Mother board circuit schematic - STGAP1AS PFC (4 of 4)

VDD = VREG only for VDD = 3.3V

VDD
GND
VH
VL
GND_ISO

Gate
SPI_SDO
SPI_SDI
SPI_CS
SPI_CK

Emitter
IN-/DIAG2
IN_PWM
Vsense
DIAG1
SPI_SD

GND_D
GND_D
GND_D
GND_D
GND_D
GND_D

R291 0.0
C273 1 4.7uF
C277 1uF
C270 0.1uF
C271 4.7uF

C274 1 0.1uF
C276 1 0.1uF
C281 1 0.1uF
C278 1 0.1uF

D81 A
C
STPS360AFY

C272 1 0.1uF

C275 1 0.1uF
C280 100pF

R293 2.7
C282 1uF

R289 0.0
IC9 1 GND

STGAP1AS 2 SDO 3 SDI 4 CS 5 CK 6 Vreg 7 VDD 8 IN-/DIAG2 9 IN+

DIAG1 10 SD 11 SD 12 GND1 13 14 VREG_ISO 15 VREG 16

SENSE

VH
DESAT
VCECLAMP
CLAMP
VL1
ASC

R294 10
R295 100

DB4543

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Figure 17. Mother board circuit schematic - A6387 drivers plus IMS connector
Figure 18. Mother board circuit schematic - full bridge LLC plus diodes on IMS
Figure 19. IMS board and mother board mechanical parts
Figure 20. Mother board circuit schematic - PFC GAP drivers plus IMS connector
Figure 21. IMS board circuit schematic - SCR drivers plus IMS connectors
Figure 22. IMS board circuit schematic - totem pole PFC and current sensors
Figure 23. Control board circuit schematic - communication
Figure 24. Control board circuit schematic - comparators
Figure 25. Control board circuit schematic - DSMPS connector

![Diagram of control board circuit schematic - DSMPS connector]
Figure 26. Control board circuit schematic - SPC58NN84E7 MCU IO
Figure 27. Control board circuit schematic - SPC58NN84E7 MCU PSU
Figure 28. Control board circuit schematic - power supply
Revision history

<table>
<thead>
<tr>
<th>Date</th>
<th>Revision</th>
<th>Changes</th>
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<tbody>
<tr>
<td>06-Aug-2021</td>
<td>1</td>
<td>Initial release.</td>
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<tr>
<td>24-Jan-2022</td>
<td>2</td>
<td>Added reference to SPC58NN84E7RMHBR. Updated Section 1 Schematic diagrams.</td>
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