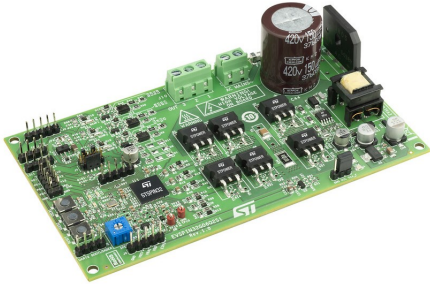


3-phase inverter based on STSPIN32G0602Q



Product status link

[EVSPIN32G06Q2S1](#)

Features

- Input voltage from 35 V_{AC} (50 V_{DC}) to 280 V_{AC} (400 V_{DC})
- Suitable for ~300 W applications, 1.2 A_{RMS} phase current
- STGB20M65DF2 IGBTs power stage featuring:
 - V_{(BR)CES} = 650 V
 - V_{CE(sat)} = 1.55 V @ I_C = 20 A
- Overcurrent threshold set to 8.3 A_{peak}
- Dual footprint for IGBT/MOSFET package: D²PAK or PowerFlat 8x8 HV
- Single-shunt current sensing, suitable for:
 - Sensored or sensorless 6-step algorithm
 - Sensored or sensorless single-shunt vector (FOC) algorithm
- Smart shutdown overcurrent protection
- Digital Hall sensors and encoder input
- Bus voltage sensing
- 15 V VCC and 3.3 V VDD supplies
- External connection through STLINK-V3SET
- Easy user interface with buttons and trimmer
- RoHS compliant

Applications

- Residential and industrial refrigerator compressors
- Industrial drives, pumps, and fans
- Air conditioning compressors and fans
- Corded power tools, garden tools
- Home appliances
- Industrial automation

Description

The **EVSPIN32G06Q2S1** board is a 3-phase complete inverter based on the STSPIN32G0602 controller, which embeds a 3-phase 600 V gate driver and a Cortex[®]-M0+ STM32 MCU. The power stage features STGB20M65DF2 IGBTs, but can be populated with any IGBT or Power MOSFET in D²PAK or powerFLAT 8x8 HV package. The board has a single-shunt sensing topology, and both FOC and 6-step control algorithms in either sensored or sensorless mode can be implemented. This allows driving permanent magnet synchronous motors (PMSMs) and brushless DC (BLDC) motors.

The evaluation board is compatible with a wide range input voltage from 35 V_{AC} (50 V_{DC}) to 280 V_{AC} (400 V_{DC}), and includes a power supply stage with the VIPER06XS in flyback configuration to generate +15 V and +3.3 V supply voltage required by the application.

Debug and configuration of firmware can be performed with standard STM32 tools through the STLINK debugger. SWD and UART TX-RX connectors are also available.

1 Safety and operating instructions



1.1 General terms

Warning: *During assembly, testing, and operation, the evaluation board poses several inherent hazards, including bare wires, moving or rotating parts, and hot surfaces.*

Danger: *There is a danger of serious personal injury, property damage, or death due to electrical shock and burn hazards if the kit or components are improperly used or installed incorrectly.*

Attention: *The kit is not electrically isolated from the high-voltage supply AC/DC input. The evaluation board is directly linked to the mains voltage. No insulation is ensured between the accessible parts and the high voltage. All measuring equipment must be isolated from the mains before powering the board. When using an oscilloscope with the demo, it must be isolated from the AC line. This prevents shock from occurring as a result of touching any single point in the circuit, but does NOT prevent shock when touching two or more points in the circuit.*

Important: *All operations involving transportation, installation and use, and maintenance must be performed by skilled technical personnel able to understand and implement national accident prevention regulations. For the purposes of these basic safety instructions, "skilled technical personnel" are suitably qualified people who are familiar with the installation, use, and maintenance of power electronic systems.*

1.2 Intended use of evaluation board

The evaluation board is designed for demonstration purposes only, and must not be used for electrical installations or machinery. Technical data and information concerning the power supply conditions are detailed in the documentation and should be strictly observed.

1.3 Installing the evaluation board

- The installation and cooling of the evaluation board must be in accordance with the specifications and target application.
- The motor drive converters must be protected against excessive strain. In particular, components should not be bent nor should isolating distances be altered during transportation or handling.
- No contact must be made with other electronic components and contacts.
- The board contains electrostatically sensitive components that are prone to damage if used incorrectly. Do not mechanically damage or destroy the electrical components (potential health risks).

1.4 Operating the evaluation board

To properly operate the board, follow these safety rules:

1. Work area safety:
 - The work area must be clean and tidy.
 - Do not work alone when boards are energized.
 - Protect against inadvertent access to the area where the board is energized using suitable barriers and signs.
 - A system architecture that supplies power to the evaluation board must be equipped with additional control and protective devices in accordance with the applicable safety requirements (i.e., compliance with technical equipment and accident prevention rules).
 - Use a non-conductive and stable work surface.
 - Use adequately insulated clamps and wires to attach measurement probes and instruments.
2. Electrical safety:
 - Remove the power supply from the board and electrical loads before taking any electrical measurements.
 - Proceed with the arrangement of measurement setup, wiring, or configuration paying attention to high voltage sections.
 - Once the setup is complete, energize the board.

Danger: *Do not touch the evaluation board when it is energized or immediately after it has been disconnected from the voltage supply as several parts and power terminals containing potentially energized capacitors need time to discharge.
Do not touch the boards after disconnection from the voltage supply as several parts, like heat sinks and transformers, may still be very hot.
The kit is not electrically isolated from the AC/DC input. The USB interface of the board does not insulate the host computer from high voltage. When the board is supplied at a voltage outside the ELV range, a proper insulation method such as a USB isolator must be used to operate the board.*

3. Personal safety:
 - Always wear suitable personal protective equipment such as, for example, insulating gloves and safety glasses.
 - Take adequate precautions and install the board in such a way to prevent accidental touch. Use protective shields such as, for example, an insulating box with interlocks, if necessary.

2 Schematic diagrams

Figure 1. EVSPIN32G06Q2S1 schematic - driver output stages

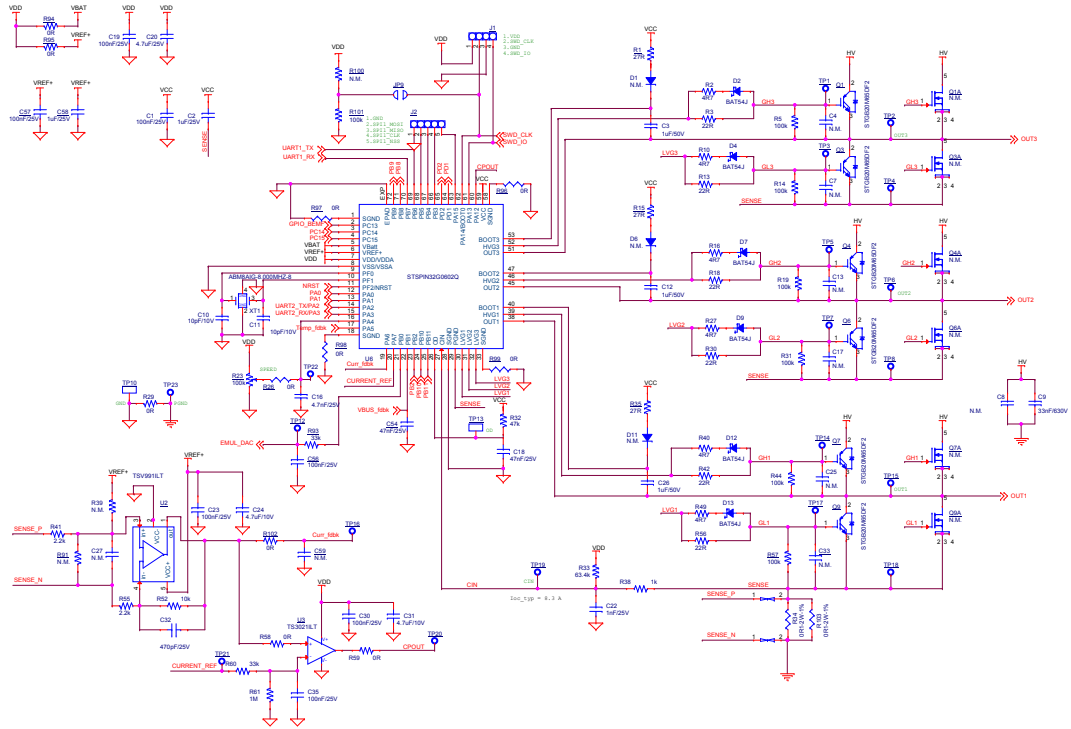


Figure 2. EVSPIN32G06Q2S1 schematic - feedback network

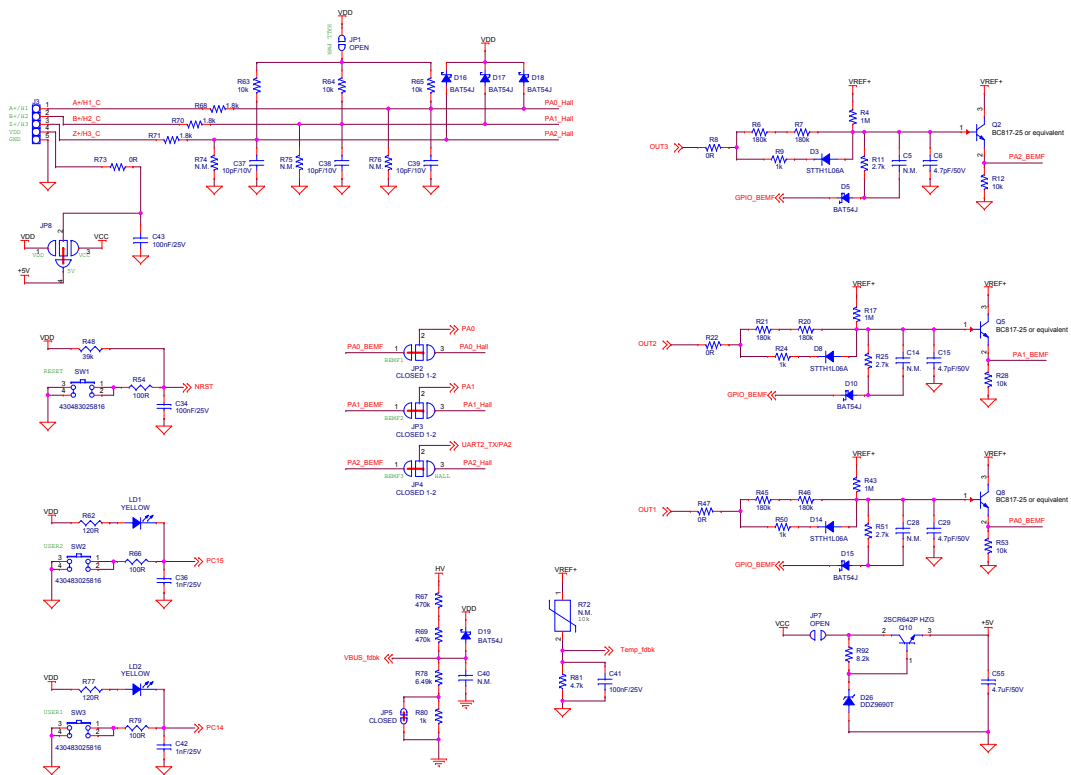


Figure 3. EVSPIN32G06Q2S1 schematic - power supply

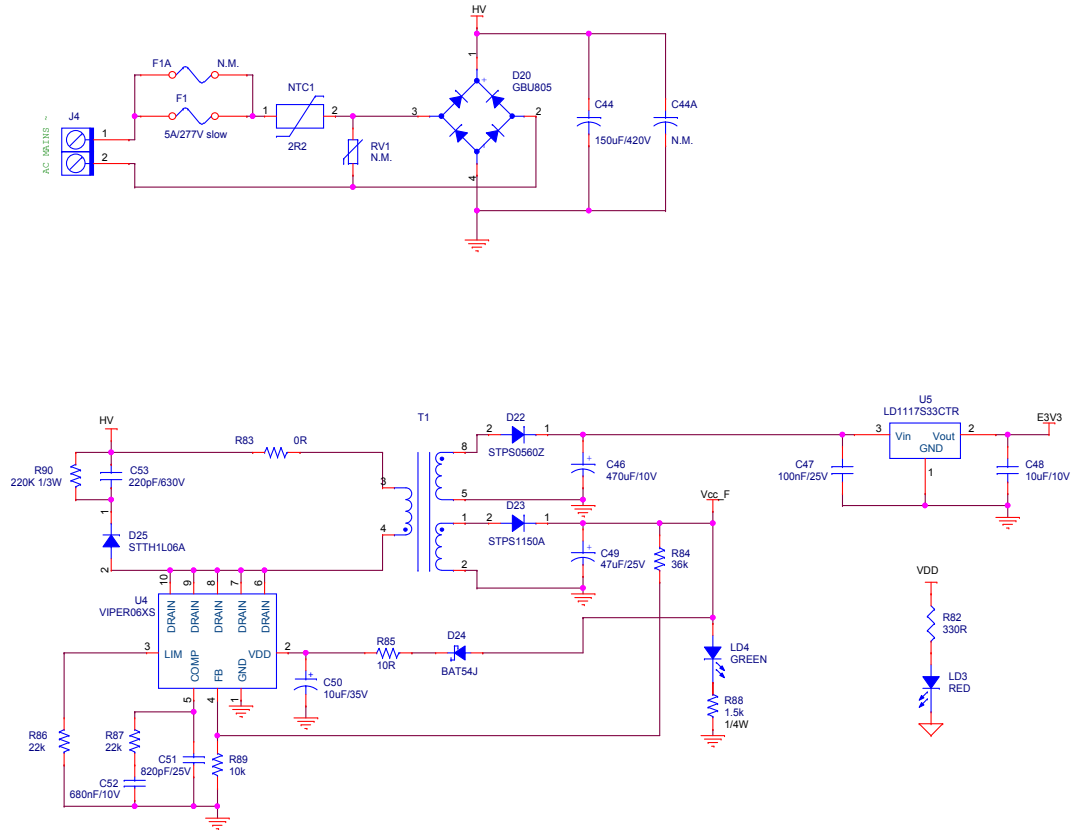
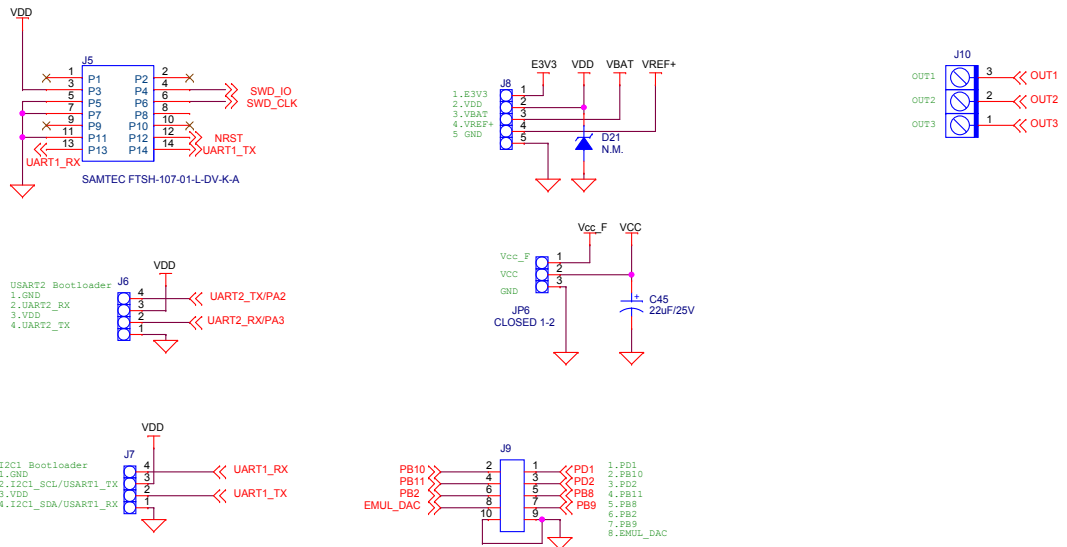


Figure 4. EVSPIN32G06Q2S1 schematic - connectors



3 Bill of materials

Table 1. EVSPIN32G06Q1S1 Bill of Materials

| Part reference | Part description | Part Value | Package / Manufacturer' code |
|---|-------------------------------------|--------------------------|--|
| C1, C19, C23, C30, C34, C35, C41, C43, C47, C56, C57 | SMT ceramic capacitor | 100 nF / 25 V | Size 0603 |
| C2, C58 | SMT ceramic capacitor | 1 μ F / 25 V | Size 0603 |
| C3, C12, C26 | SMT ceramic capacitor | 1 μ F / 50 V | Size 0805 |
| C4, C5, C7, C13, C14, C17, C25, C27, C28, C33, C40, C59 | SMT ceramic capacitor | N.M. | Size 0603 |
| C6, C15, C29 | SMT ceramic capacitor | 4.7 pF / 50 V | Size 0603 |
| C8 | Film metallized polypropylene | N.M. | 4x13 mm, pitch 10 mm Kemet R71MF31004030K or equivalent |
| C9 | SMT ceramic capacitor | 33 nF / 630 V | Size 1210 |
| C10, C11, C37, C38, C39 | SMT ceramic capacitor | 10 pF / 10 V | Size 0603 |
| C16 | SMT ceramic capacitor | 4.7 nF / 25 V | Size 0603 |
| C18, C54 | SMT ceramic capacitor | 47 nF / 25 V | Size 0603 |
| C20 | SMT ceramic capacitor | 4.7 μ F / 25 V / X5R | Size 0603 |
| C22, C36, C42 | SMT ceramic capacitor | 1 nF / 25 V | Size 0603 |
| C24, C31 | SMT ceramic capacitor | 4.7 μ F / 10 V | Size 0805 |
| C32 | SMT ceramic capacitor | 470 pF / 25 V | Size 0603 |
| C44 | THT electrolytic capacitor | 150 μ F / 420 V | Radial p10 d22h27.5 mm United Chemi-Con EKMZ421VSN151MP25S or equivalent |
| C44A | THT electrolytic capacitor | N.M. | Radial p7.5 d18h25 mm Rubycon 450BXW68MEFC18X25 or equivalent |
| C45 | SMD Aluminum electrolytic capacitor | 22 μ F / 25 V | 5x5.4 mm Panasonic EEE1EA220WR or equivalent |
| C46 | SMD Aluminum electrolytic capacitor | 470 μ F / 10 V | 6.3x7.7 mm Panasonic EEEFTA471XAP or equivalent |
| C48 | SMT ceramic capacitor | 10 μ F / 10 V | Size 1206 |
| C49 | SMD Aluminum electrolytic capacitor | 47 μ F / 25 V | 6.3x5.8 mm Nichicon UCD1E470MCL1GS or equivalent |
| C50 | SMD Aluminum electrolytic capacitor | 10 μ F / 35 V | 5x5.4 mm Panasonic EEE1VA100SR or equivalent |
| C51 | SMT ceramic capacitor | 820 pF / 25 V | Size 0603 |
| C52 | SMT ceramic capacitor | 680 nF / 10 V | Size 0603 |
| C53 | SMT ceramic capacitor | 220 pF / 630 V | Size 1206 |

| Part reference | Part description | Part Value | Package / Manufacturer' code |
|---|--|----------------------|--|
| | | | Multicom MC1206N221J631CT or equivalent |
| C55 | SMT ceramic capacitor | 4.7 μ F / 50 V | Size 1206 |
| D1, D6, D11 | Turbo 2 ultrafast high voltage rectifier | N.M. | SMA STMicroelectronics STTH1L06A or equivalent |
| D2, D4, D5, D7, D9, D10, D12, D13, D15, D16, D17, D18, D19, D24 | 40 V, 300 mA small signal Schottky SMT diode | BAT54J | SOD-323 STMicroelectronics BAT54JFILM or equivalent |
| D3, D8, D14, D25 | Turbo 2 Ultrafast high-voltage rectifier | STTH1L06A | SMA STMicroelectronics STTH1L06A or equivalent |
| D20 | 8 A glass passivated single-phase bridge rectifier | GBU805 | Taiwan Semiconductor GBU805 or equivalent |
| D21 | 3.3 V Zener diode | N.M. | SOD-123 |
| D22 | 60 V, 0.5 A Schottky rectifier | STPS0560Z | SOD-123 STMicroelectronics STPS0560Z or equivalent |
| D23 | 150 V, 1 A power Schottky rectifier | STPS1150A | SMA STMicroelectronics STPS1150A or equivalent |
| D26 | Surface mount Zener diode | DDZ9690T | SOD523 DIODES Incorporated DDZ9690T-7 or equivalent |
| F1 | Surface mount fuse, Time-Lag T | 5 A / 277 V slow | UMT250 Schurter 3403.0173.24 |
| F1A | Time Lag radial lead micro fuse | N.M. | Belfuse 0697-xx or equivalent |
| JP1, JP7 | SMT jumper | Open | Soldering pad |
| JP2, JP3, JP4 | SMT jumper | Closed 1-2 | Soldering pad |
| JP5 | SMT jumper | Closed | Soldering pad |
| JP6 | Strip connector | 1x3 pins, Closed 1-2 | Pitch 2.54 mm Amphenol FCI 68000-403HLF or equivalent |
| JP8 | SMT Jumper | Closed 2-4 | Soldering pad |
| JP9 | SMT jumper | Open | Soldering pad |
| J1, J6, J7 | Strip connector | 1x4 pins | Pitch 2.54 mm Amphenol FCI 68000-404HLF or equivalent |
| J2, J8 | Strip connector | 1x5 pins | Pitch 2.54 mm Würth Elektronik 61300511121 or equivalent |

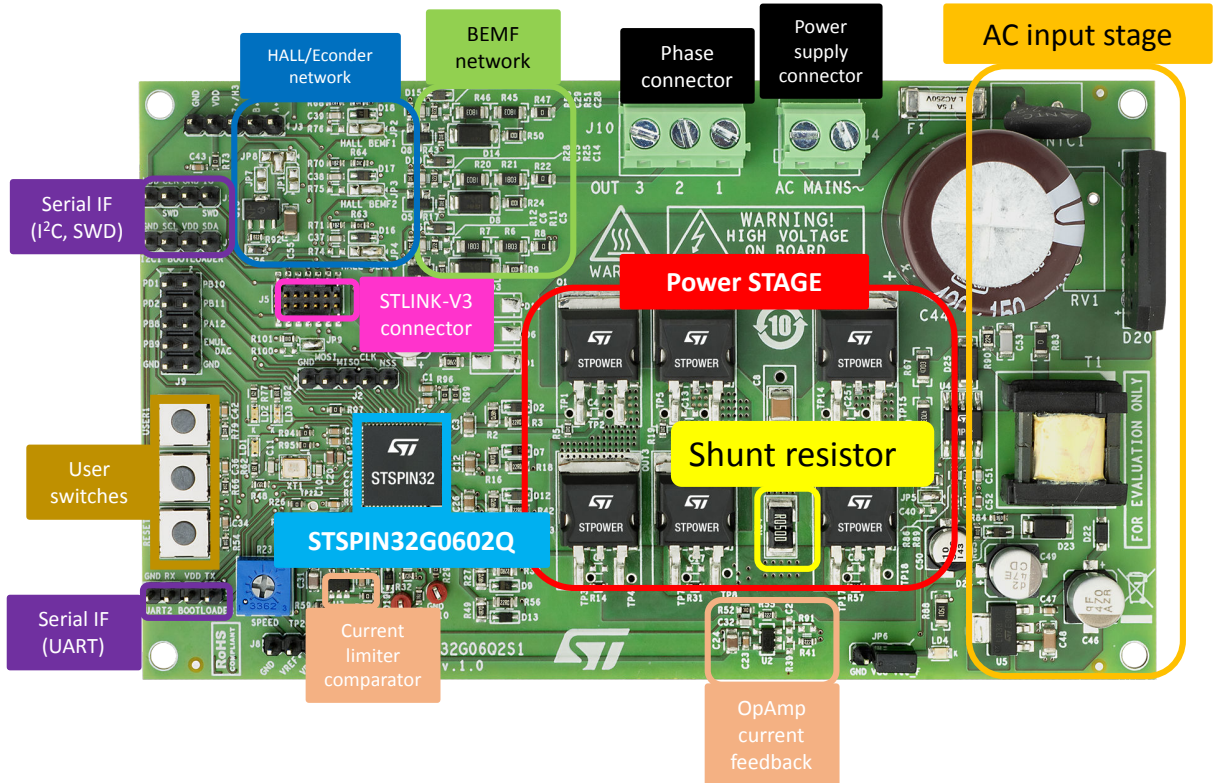
| Part reference | Part description | Part Value | Package / Manufacturer' code |
|-----------------------------------|---|--------------|--|
| J3 | Strip connector | 1x5 pins | Pitch 2.54 mm Amphenol FCI 68000-405HLF or equivalent |
| J4 | Connector terminal block T.H. | - | 2 poles, pitch 5.08 mm Phoenix Contact 1715721 or equivalent |
| J5 | SMT Micro Header | - | Pitch 1.27 mm Samtec FTSH-107-01-L-DV-K-A |
| J9 | Strip connector | 2x5 pins | Pitch 2.54 mm Würth Elektronik 61301021121 or equivalent |
| J10 | Connector terminal block T.H. | - | 3 poles, pitch 5.08 mm Phoenix Contact 1715857 or equivalent |
| LD1, LD2 | Yellow LED | YELLOW | Size 0603 Würth Elektronik 150060YS75000 or equivalent |
| LD3 | Red LED | RED | Size 0603 Würth Elektronik 150060RS75000 or equivalent |
| LD4 | Green LED | GREEN | Size 0805 |
| NTC1 | NTC thermistor for inrush current limiting | 2.2 Ω | TDK B57236S0229M000 or equivalent |
| Q1, Q3, Q4, Q6, Q7, Q9 | Trench gate field-stop, 650 V, 20 A, M series low-loss IGBT | STGB20M65DF2 | D ² PAK STMicroelectronics STGB20M65DF2 or equivalent |
| Q1A, Q3A, Q4A, Q6A, Q7A, Q9A | N-channel 600 V, 0.195 Ω typ., 15 A MDmesh DM2 power MOSFET | N.M. | PowerFLAT 8x8 STMicroelectronics STL24N60DM2 |
| Q2, Q5, Q8 | 45 V NPN small signal transistor | BC817-25 | SOT23 |
| Q10 | BJT 30 V 10 A | 2SCR642P HZG | SOT-89 ROHM 2SCR642PHZGT100 or equivalent |
| RV1 | Varistor | N.M. | Pitch 2.3x7.5 mm |
| R1, R15, R35 | SMT resistor | 27 Ω | Size 0805 |
| R2, R10, R16, R27, R40, R49 | SMT Resistor | 4.7 Ω | Size 0805 |
| R3, R13, R18, R30, R42, R56 | SMT Resistor | 22 Ω | Size 0805 |
| R4, R17, R43, R61 | SMT Resistor | 1 MΩ | Size 0603 |
| R5, R14, R19, R31, R44, R57, R101 | SMT Resistor | 100 kΩ | Size 0603 |
| R6, R7, R20, R21, R45, R46 | SMT Resistor | 180 kΩ | Size 1206 |
| R8, R22, R47 | SMT Resistor | 0 Ω | Size 0805 |

| Part reference | Part description | Part Value | Package / Manufacturer' code |
|--|--|---------------------|---|
| R9, R24, R50, R80 | SMT Resistor | 1 kΩ | Size 0805 |
| R11, R25, R51 | SMT Resistor | 2.7 kΩ | Size 0603 |
| R12, R28, R52, R53, R63, R64, R65, R89 | SMT Resistor | 10 kΩ | Size 0603 |
| R23 | Trimming Potentiometer | 100 kΩ | Bourns 3362P-1-104 LF or equivalent |
| R26, R29, R58, R59, R73, R94, R95, R102 | SMT Resistor | 0 Ω | Size 0603 |
| R32 | SMT Resistor | 47 kΩ | Size 0603 |
| R33 | SMT Resistor | 63.4 kΩ | Size 0603 |
| R34 | Power metal plate current sense resistor | 50 mΩ / 3W / 1% | Size 2512 Vishay WFMB2512R0500FEA or equivalent |
| R38 | SMT Resistor | 1 kΩ | Size 0603 |
| R39, R74, R75, R76, R91, R100 | SMT Resistor | N.M. | Size 0603 |
| R41, R55 | SMT Resistor | 2.2 kΩ | Size 0603 |
| R48 | SMT Resistor | 39 kΩ | Size 0603 |
| R54, R66, R79 | SMT Resistor | 100 Ω | Size 0603 |
| R60, R93 | SMT Resistor | 33 kΩ | Size 0603 |
| R62, R77 | SMT Resistor | 120 Ω | Size 0603 |
| R67, R69 | SMT Resistor | 470 kΩ | Size 1206 |
| R68, R70, R71 | SMT Resistor | 1.8 kΩ | Size 0603 |
| R72 | NTC Resistor | N.M. | Hole 0.8 mm |
| R78 | SMT Resistor | 6.49 kΩ | Size 0805 |
| R81 | SMT Resistor | 4.7 kΩ | Size 0603 |
| R82 | SMT Resistor | 330 Ω | Size 0603 |
| R83 | SMT Resistor | 0 Ω | Size 1206 |
| R84 | SMT Resistor | 36 kΩ | Size 0603 |
| R85 | SMT Resistor | 10 Ω | Size 0603 |
| R86, R87 | SMT Resistor | 22 kΩ | Size 0603 |
| R88 | SMT Resistor | 1.5 kΩ | Size 1206 |
| R90 | SMT Resistor | 220 kΩ / 1/3 W | Size 0805 TE Connectivity CRGH0805J220K or equivalent |
| R92 | SMT Resistor | 8.2 kΩ | Size 0603 |
| R96, R97, R98, R99 | SMT Resistor | 0 Ω | Size 0603 |
| SW1, SW2, SW3 | CMS tactile switches - 6x6 J-bend | | Würth Elektronik 430483025816 or equivalent |
| TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP8, TP12, TP14, TP15, TP16, TP17, TP18, TP19, TP20, TP21, TP22, TP23 | Test point for probe | - | Metallized hole, 0.8 mm |
| TP10, TP13 | Ring test point | Red test point 1 mm | Keystone 5003 or equivalent |

| Part reference | Part description | Part Value | Package / Manufacturer' code |
|----------------|---|----------------|--|
| T1 | Switch mode transformer 2.3 W 60 kHz 3.15 mH 7-15 V | - | Würth Elektronik 750318434 or Magnetics 1921.0059 |
| U1 | 600 V three-phase controller with MCU | STSPIN32G0602Q | QFN 10x10 72L pitch 0.5 STMicroelectronics STSPIN32G0602Q/TR |
| U2 | Rail-to-rail input/output 20 MHz GBP op amp | TSV991ILT | SOT23-5 STMicroelectronics |
| U3 | Rail-to-rail 1.8 V high-speed comparator | TS3021ILT | SOT23-5 STMicroelectronics |
| U4 | Fixed-frequency VIPer plus family | VIPER06XS | SSO10 STMicroelectronics |
| U5 | 800 mA, 3.3 V adjustable and fixed low drop positive voltage regulator | LD1117 | SOT-223 STMicroelectronics LD1117S33CTR or equivalent |
| XT1 | Automotive & industrial grade ceramic base SMD crystal | 8 MHz | Abracon ABM8AIG-8.000MHZ-8-V1R-T or equivalent |

4 Layout and component placements

Figure 5. EVSPIN32G06Q2S1 - functional blocks



Warning

The kit is not electrically isolated from the AC/DC input. The USB interface of the board does not insulate host computer from high voltage. When the board is supplied at a voltage outside the ELV range, a proper insulation method such as a USB isolator must be used to operate the board.

Figure 6. EVSPIN32G06Q2S1 layout - component placement top view

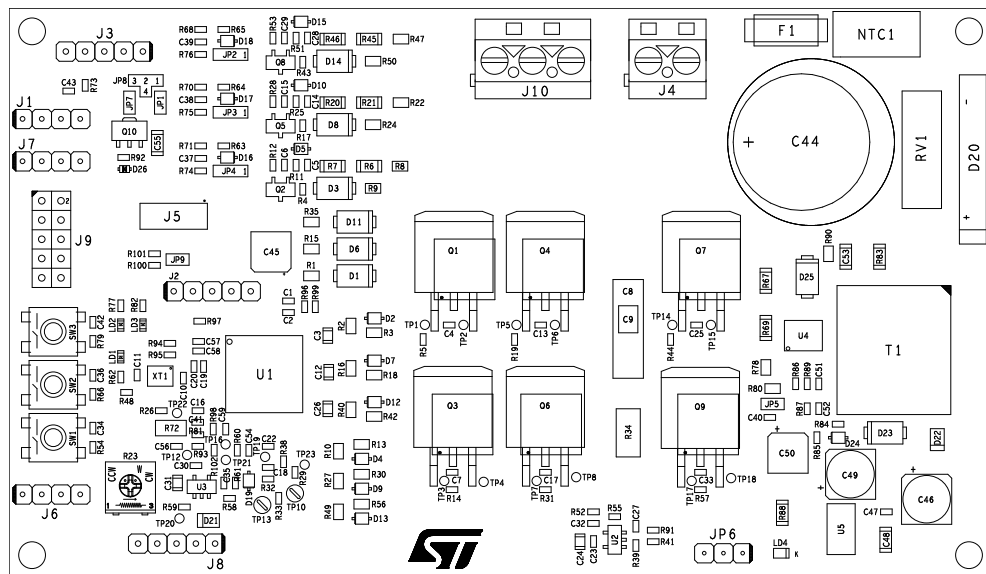


Figure 7. EVSPIN32G06Q2S1 layout - top layer

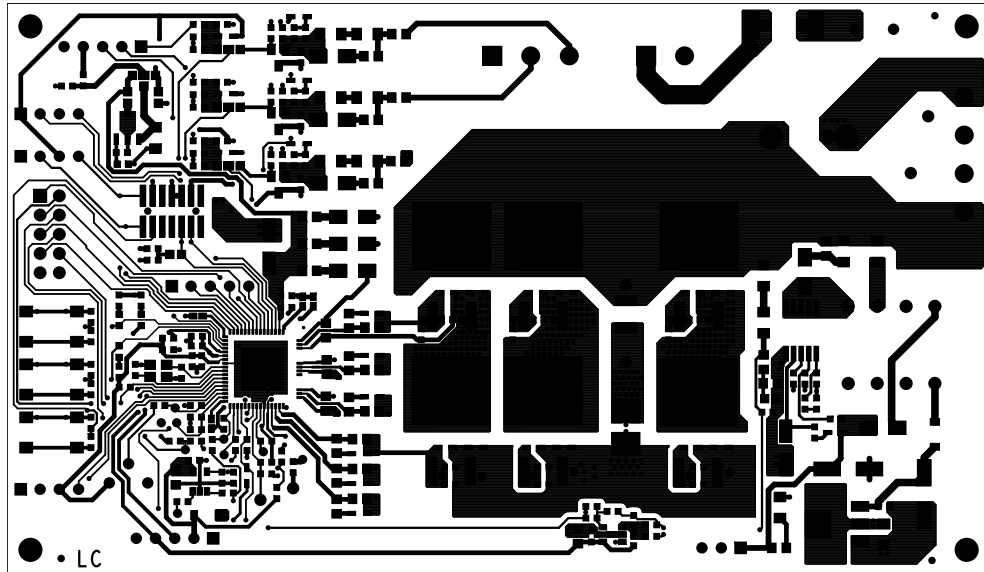
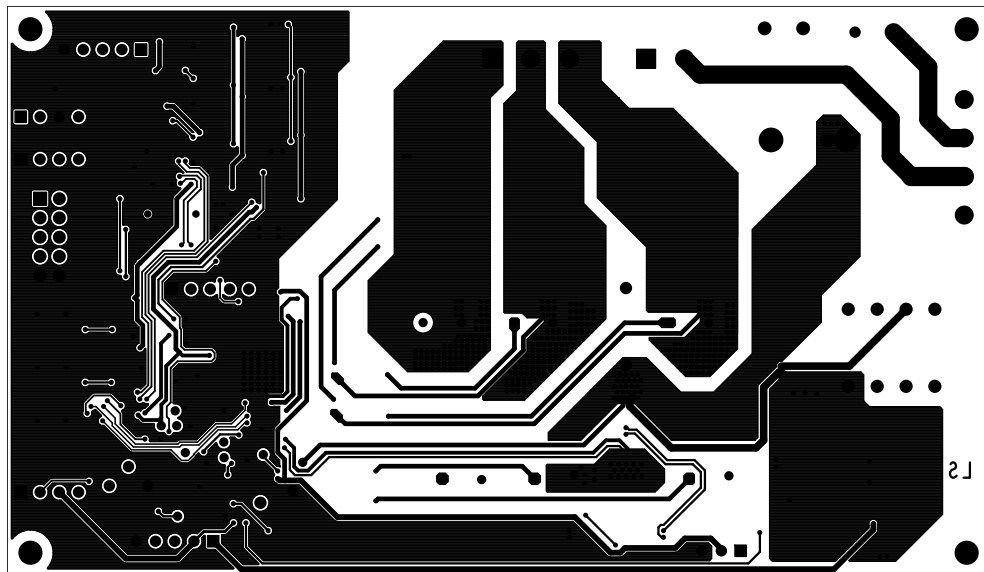


Figure 8. EVSPIN32G06Q2S1 layout - bottom layer



Revision history

Table 2. Document revision history

| Date | Version | Changes |
|-------------|---------|------------------|
| 05-Aug-2024 | 1 | Initial release. |

Contents

| | | |
|----------|--|-----------|
| 1 | Safety and operating instructions | 2 |
| 1.1 | General terms | 2 |
| 1.2 | Intended use of evaluation board | 2 |
| 1.3 | Installing the evaluation board | 2 |
| 1.4 | Operating the evaluation board | 3 |
| 2 | Schematic diagrams | 4 |
| 3 | Bill of materials | 6 |
| 4 | Layout and component placements | 11 |
| | Revision history | 13 |
| | List of tables | 15 |
| | List of figures | 16 |



List of tables

| | | |
|----------|---|----|
| Table 1. | EVSPIN32G06Q1S1 Bill of Materials | 6 |
| Table 2. | Document revision history | 13 |

List of figures

| | | |
|------------------|---|----|
| Figure 1. | EVSPIN32G06Q2S1 schematic - driver output stages | 4 |
| Figure 2. | EVSPIN32G06Q2S1 schematic - feedback network | 4 |
| Figure 3. | EVSPIN32G06Q2S1 schematic - power supply | 5 |
| Figure 4. | EVSPIN32G06Q2S1 schematic - connectors | 5 |
| Figure 5. | EVSPIN32G06Q2S1 - functional blocks | 11 |
| Figure 6. | EVSPIN32G06Q2S1 layout - component placement top view | 11 |
| Figure 7. | EVSPIN32G06Q2S1 layout - top layer | 12 |
| Figure 8. | EVSPIN32G06Q2S1 layout - bottom layer | 12 |

IMPORTANT NOTICE – READ CAREFULLY

STMicroelectronics NV and its subsidiaries (“ST”) reserve the right to make changes, corrections, enhancements, modifications, and improvements to ST products and/or to this document at any time without notice. Purchasers should obtain the latest relevant information on ST products before placing orders. ST products are sold pursuant to ST’s terms and conditions of sale in place at the time of order acknowledgment.

Purchasers are solely responsible for the choice, selection, and use of ST products and ST assumes no liability for application assistance or the design of purchasers’ products.

No license, express or implied, to any intellectual property right is granted by ST herein.

Resale of ST products with provisions different from the information set forth herein shall void any warranty granted by ST for such product.

ST and the ST logo are trademarks of ST. For additional information about ST trademarks, refer to www.st.com/trademarks. All other product or service names are the property of their respective owners.

Information in this document supersedes and replaces information previously supplied in any prior versions of this document.

© 2024 STMicroelectronics – All rights reserved