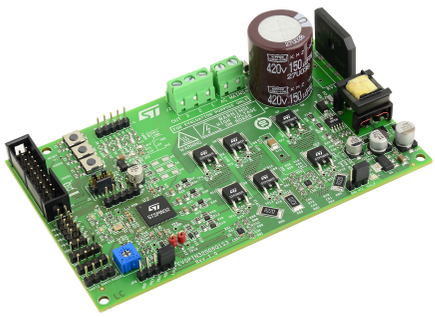
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EVSPIN32G06Q1S3

Data brief

3-phase inverter based on STSPIN32G0601Q with 3-shunt topology



STSPIN

Product status link
EVSPIN32G06Q1S3

Features

- Input voltage from 35 V_{AC} (50 V_{DC}) to 280 V_{AC} (400 V_{DC})
- Suitable for ~250 W applications, 1 A_{RMS} phase current
- STGD6M65DF2 IGBTs power stage featuring:
  - $V_{(BR)CES}$ = 650 V
  - $V_{CE(sat)}$ = 1.55 V @ I_C = 6 A
- Overcurrent threshold set to 3.5 A_{peak}
- Dual footprint for IGBT/MOSFET package:
  - DPAK or PowerFlat 8x8 HV
- Three-shunt current sensing, suitable for:
  - Sensored or sensorless three-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 or STLINK/V2 debugger/ programmer
- 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 EVSPIN32G06Q1S3 board is a 3-phase complete inverter based on the STSPIN32G0601 controller, which embeds a 3-phase 600 V gate driver and a Cortex®-M0+ STM32 MCU. The power stage features STGD6M65DF2 IGBTs, but can be populated with any IGBT or Power MOSFET in DPAK or powerFLAT 8x8 HV package. The board has a three-shunt sensing topology, and is intended for Field-Oriented Control (FOC) algorithm, in either sensored or sensorless mode. This makes it especially suited to drive permanent magnet synchronous motors (PMSMs). 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.

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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).

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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.

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2 Schematic diagrams

Figure 1. **EVSPIN32G06Q1S3 schematic - driver output stages**

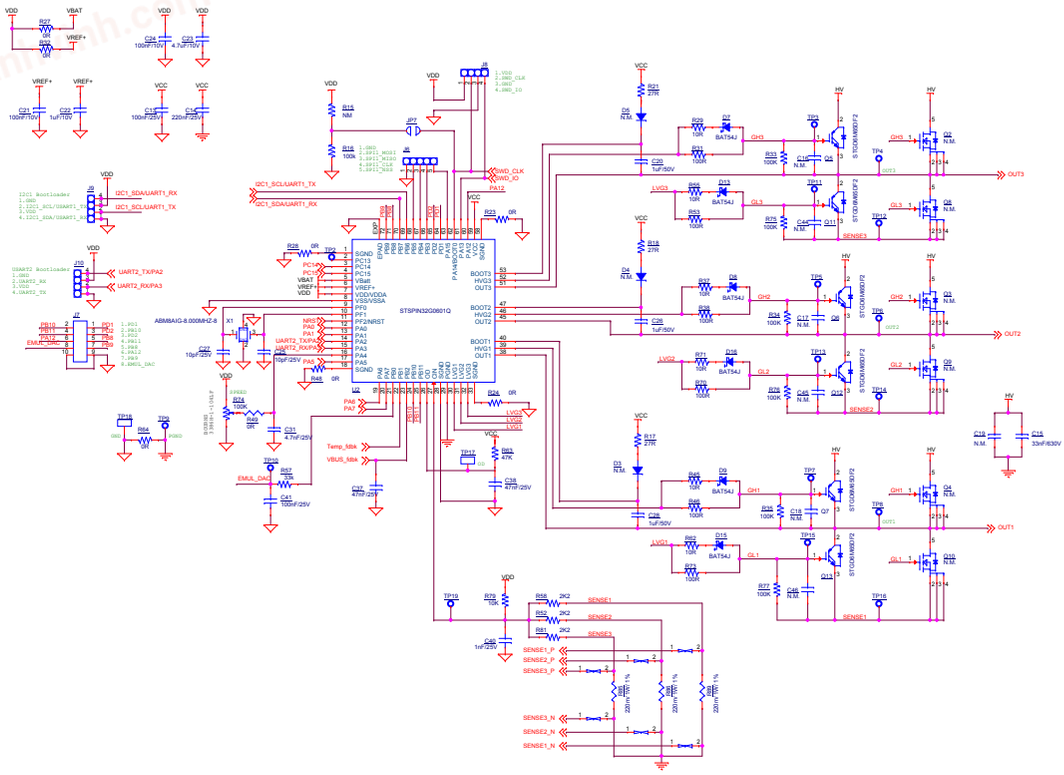
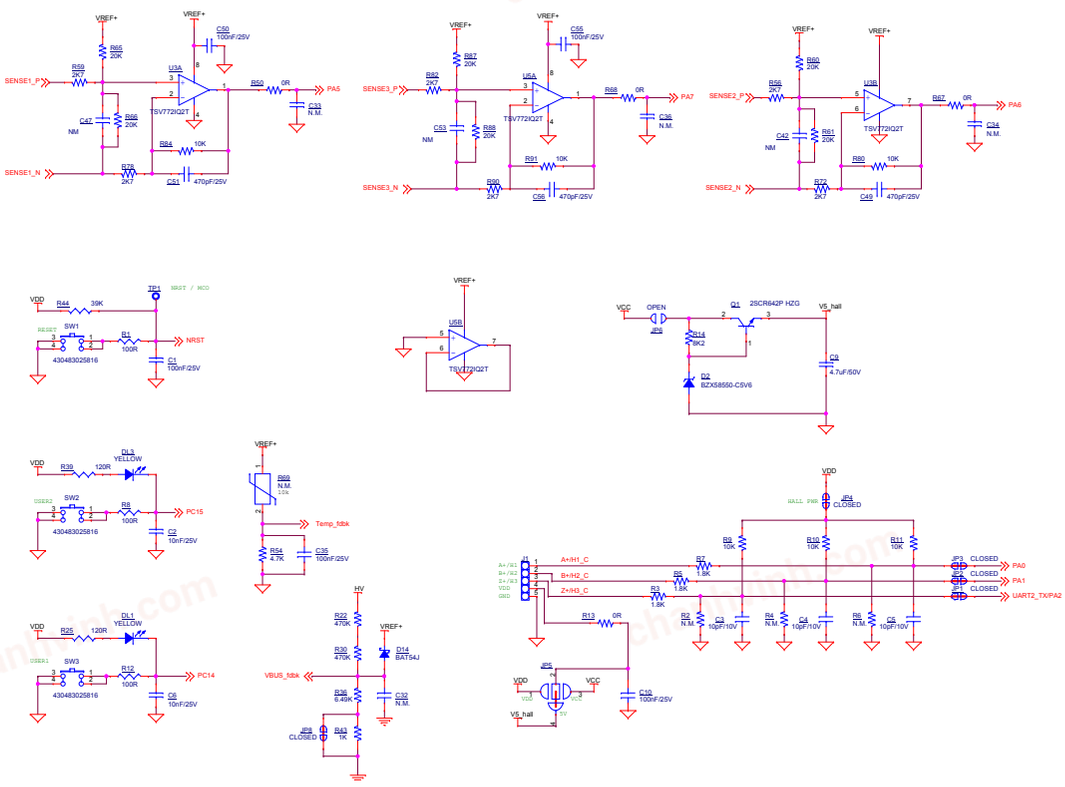


Figure 2. **EVSPIN32G06Q1S3 schematic - feedback network**



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Figure 3. **EVSPIN32G06Q1S3 schematic - power supply**

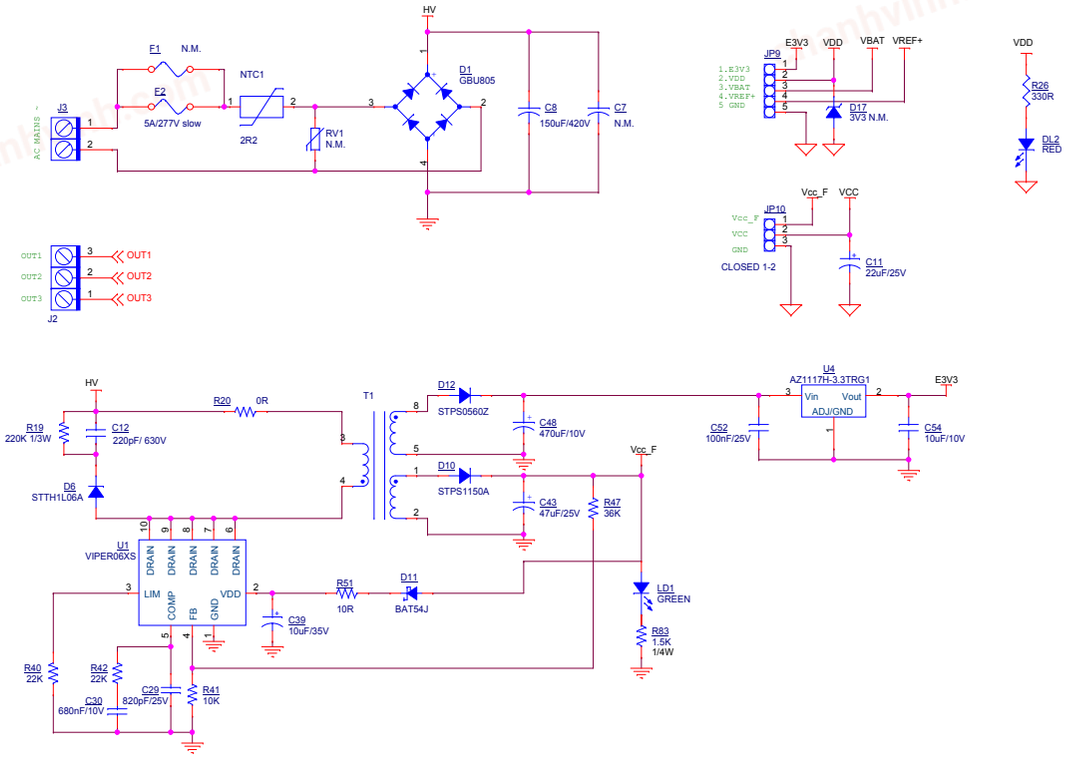
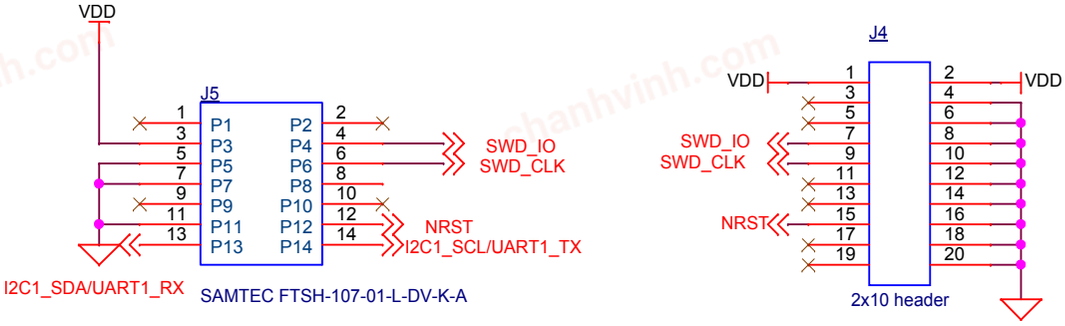


Figure 4. **EVSPIN32G06Q1S3 schematic - connectors**



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3 Bill of materials

Table 1. **EVSPIN32G06Q1S3 bill of materials**

Part reference	Part description	Part Value	Package / Manufacturer' code
C1, C10, C13, C35, C41, C50, C52, C55	SMT ceramic capacitor	100 nF / 25 V	Size 0603
C2, C6	SMT ceramic capacitor	10 nF / 25 V	Size 0603
C3, C4, C5	SMT ceramic capacitor	10 pF / 10 V	Size 0603
C7	THT electrolytic capacitor	N.M.	Radial p7.5 d18 h25 mm Rubycon 450BXW68MEFC18X25 or equivalent
C8	THT electrolytic capacitor	150 µF / 420 V	Radial p10 d22 h27.5 mm United Chemi-Con EKMZ421VSN151MP25S or equivalent
C9	SMT ceramic capacitor	4.7 µF / 50 V	Size 1206
C11	SMT Aluminum electrolytic capacitor	22 µF / 25 V	5x5.4 mm Panasonic EEE1EA220WR or equivalent
C12	SMT ceramic capacitor	220 pF / 630 V	Size 1206 Multicomp MC1206N221J631CT or equivalent
C14	SMT ceramic capacitor	220 nF / 25 V	Size 0603
C15	SMT multilayer capacitor	33 nF / 630 V	Size 1210
C16, C17, C18, C32, C33, C34, C36, C44, C45, C46	SMT ceramic capacitor	N.M.	Size 0603
C19	Film, metallized polypropylene	N.M.	4x13 mm, pitch 10 mm KEMET R71MF31004030K or equivalent
C20, C26, C28	SMT ceramic capacitor	1 µF / 50 V	Size 0805
C21, C24	SMT ceramic capacitor	100 nF / 10 V	Size 0603
C22	SMT ceramic capacitor	1 µF / 10 V	Size 0603
C23	SMT ceramic capacitor	4.7 µF / 10 V	Size 0603
C25, C27	SMT ceramic capacitor	10 pF / 25 V	Size 0603
C29	SMT ceramic capacitor	820 pF / 25 V	Size 0603
C30	SMT ceramic capacitor	680 nF / 10 V	Size 0603
C31	SMT ceramic capacitor	4.7 nF / 25 V	Size 0603
C37, C38	SMT ceramic capacitor	47 nF / 25 V	Size 0603
C39	SMT Aluminum electrolytic. capacitor	10 µF / 35 V	5x5.4 mm Panasonic EEE1VA100SR or equivalent
C40	SMT ceramic capacitor	1 nF / 25 V	Size 0603
C42, C47, C53	SMT ceramic capacitor	N.M.	Size 0603

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Part reference	Part description	Part Value	Package / Manufacturer' code
C43	SMT Aluminum electrolytic capacitor	47 µF / 25 V	6.3x5.8 mm Nichicon UCD1E470MCL1GS or equivalent
C48	SMT Aluminum electrolytic capacitor	470 µF / 10 V	6.3x7.7 mm Chemi-con EMZR100ARA471MF80G or equivalent
C49, C51, C56	SMT ceramic capacitor	470 pF / 25 V	Size 0603
C54	SMT ceramic capacitor	10 µF / 10 V	Size 1206
DL1, DL3	Yellow LED	YELLOW	Size 0603 Würth Elektronik
DL2	Red LED	RED	Size 0603 Würth Elektronik 150060RS75000 or equivalent
D1	8 A glass passivated single-phase bridge rectifier	GBU805	Taiwan Semiconductor
D2	Low-current voltage regulator diodes	BZX58550-C5V6	SOD523 (SC-79) Nexperia
D3, D4, D5	Turbo 2 ultrafast high-voltage rectifier	N.M.	SMA STMicroelectronics STTH1L06A
D6	Turbo 2 ultrafast high voltage rectifier	STTH1L06A	SMA STMicroelectronics
D7, D8, D9, D11, D13, D14, D15, D16	40 V, 300 mA small signal Schottky SMT diode	BAT54J	SOD-323 STMicroelectronics
D10	150 V, 1 A power Schottky rectifier	STPS1150A	SMA STMicroelectronics
D12	60 V, 0.5 A Schottky rectifier	STPS0560Z	SOD-123 STMicroelectronics
D17	3.3 V Zener diode	N.M.	SOD-123
F1	Time-lag radial lead micro fuse	N.M.	Belfuse 0697-xx or equivalent
F2	Surface mount fuse, time-lag T	5 A / 277 V slow	UMT 250 Schurter 3403.0173.24
JP1, JP2, JP3, JP4, JP8	SMT jumper	Closed	Soldering pad
JP5	SMT jumper	Closed 2-4	Soldering pad
JP6	SMT jumper	Open	Soldering pad
JP7	SMT jumper	Open	Soldering pad
JP9	Strip connector	1x5 pins, 2.54 mm Closed 1-2	Würth Elektronik 61300511121 or equivalent
JP10	Strip connector	1x3 pins, 2.54 mm Closed 1-2	Amphenol FCI 68000-403HLF or equivalent
J1	Strip connector	1x5 pins, 2.54 mm	Amphenol FCI 68000-405HLF or equivalent

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Part reference	Part description	Part Value	Package / Manufacturer' code
J2	Connector terminal block T.H.	MORSV-508-3P_screw	3 poles, pitch 5.08 mm Phoenix Contact 1715857 or equivalent
J3	Connector terminal block T.H.	MORSV-508-2P_screw	2 poles, pitch 5.08 mm Phoenix Contact 1715721 or equivalent
J4	Male box header	2 x 10 pins	Würth Elektronik 61202021621
J5	SMT micro header	FTSH-107-01-L-DV-K-A	Pitch 1.27 mm Samtec
J6	Strip connector	1x5 pins, 2.54 mm	Würth Elektronik 61300511121 or equivalent
J7	Strip connector	2x5 pins, 2.54 mm	Würth Elektronik 61301021121 or equivalent
J8, J9, J10	Strip connector	1x4 pins, 2.54 mm	Amphenol FCI 68000-404HLF or equivalent
LD1	Green LED	GREEN	Size 0805
NTC1	NTC Thermistor for inrush current limiting	2.2 Ω	TDK B57236S0229M000 or equivalent
Q1	Transistor BJT 30 V / 10 A	2SCR642P HZG or equivalent	SOT-89 ROHM
Q2, Q3, Q4, Q8, Q9, Q10	N-channel 600 V, 0.195 Ω typ., 15 A MDmesh DM2 power MOSFET	N.M.	PowerFLAT 8x8 STMicroelectronics STL24N60DM2
Q5, Q6, Q7, Q11, Q12, Q13	Trench gate field-stop IGBT, M series 650 V, 6 A low loss	STGD6M65DF2	DPAK STMicroelectronics
RV1	Varistor	N.M.	Pitch 2.3x7.5 mm
R1, R8, R12	SMT Resistor	100 Ω	Size 0603
R2, R4, R6	SMT Resistor	N.M.	Size 0603
R3, R5, R7	SMT Resistor	1.8 kΩ	Size 0603
R9, R10, R11, R41, R79, R80, R84, R91	SMT Resistor	10 kΩ	Size 0603
R13, R27, R32, R49, R50, R64, R67, R68	SMT resistor	0 Ω	Size 0603
R14	SMT Resistor	8.2 kΩ	Size 0603
R15	SMT Resistor	N.M.	Size 0603
R16, R33, R34, R35, R75, R76, R77	SMT Resistor	100 kΩ	Size 0603
R17, R18, R21	SMT resistor	27 Ω	Size 0805
R19	SMT Resistor	220 kΩ / 1/3 W	Size 0805 TE Connectivity CRGH0805J220K or equivalent
R20	SMT Resistor	0 Ω	Size 1206
R22, R30	SMT Resistor	470 kΩ	Size 1206

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Part reference	Part description	Part Value	Package / Manufacturer' code
R23, R24, R28, R48	SMT Resistor	0 Ω	Size 0603
R25, R39	SMT Resistor	120 Ω	Size 0603
R26	SMT Resistor	330 Ω	Size 0603
R29, R37, R45, R55, R62, R71	SMT Resistor	10 Ω	Size 0805
R31, R38, R46, R53, R70, R73	SMT Resistor	100 Ω	Size 0805
R36	SMT Resistor	6.49 kΩ	Size 0805
R40, R42	SMT Resistor	22 kΩ	Size 0603
R43	SMT Resistor	1 kΩ	Size 0805
R44	SMT Resistor	39 kΩ	Size 0603
R47	SMT Resistor	36 kΩ	Size 0603
R51	SMT Resistor	10 Ω	Size 0603
R52, R58, R81	SMT Resistor	2.2 kΩ	Size 0603
R54	SMT Resistor	4.7 kΩ	Size 0603
R56, R59, R72, R78, R82, R90	SMT Resistor	2.7 kΩ	Size 0603
R57	SMT Resistor	33 kΩ	Size 0603
R60, R61, R65, R66, R87, R88	SMT Resistor	20 kΩ	Size 0603
R63	SMT Resistor	47 kΩ	Size 0603
R69	NTC Resistor	N.M.	Hole 0.8 mm
R74	Trimming potentiometer	100 kΩ	Bourns 3362P-1-104-LF or equivalent
R83	SMT Resistor	1.5 kΩ	Size 1206
R85, R86, R89	SMT Resistor	220 mΩ / 1 W / 1%	Size 2512 / 1210
SW1, SW2, SW3	CMS tactile switches - 6x6 J-bend	430483025816 or equivalent	Würth Elektronik
TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP8, TP9, TP10, TP11, TP12, TP13, TP14, TP15, TP16, TP19	Test point for probe	Metallized hole	0.8 mm diameter
TP17, TP18	Ring test point	Red test point 1mm	Keystone 5000 or equivalent
T1	Switch mode transformer 2.3 W 60 kHz 3.15 mH 7-15 V	750318434	Würth Elektronik or Magnetica 1921.0059
U1	Fixed-frequency VIPer plus family	VIPER06XS	SSO10 STMicroelectronics
U2	600 V three-phase controller with MCU	STSPIN32G0601Q	QFN 10x10 72L pitch 0.5 STMicroelectronics
U3, U5	High bandwidth (20 MHz) low offset (200 µV) rail-to-rail 5 V op amp	TSV772IQ2T	DFN8 2x2 STMicroelectronics or TSV912IQ2T
U4	Low dropout linear regulator	AZ1117H-3.3TRG1	SOT-223

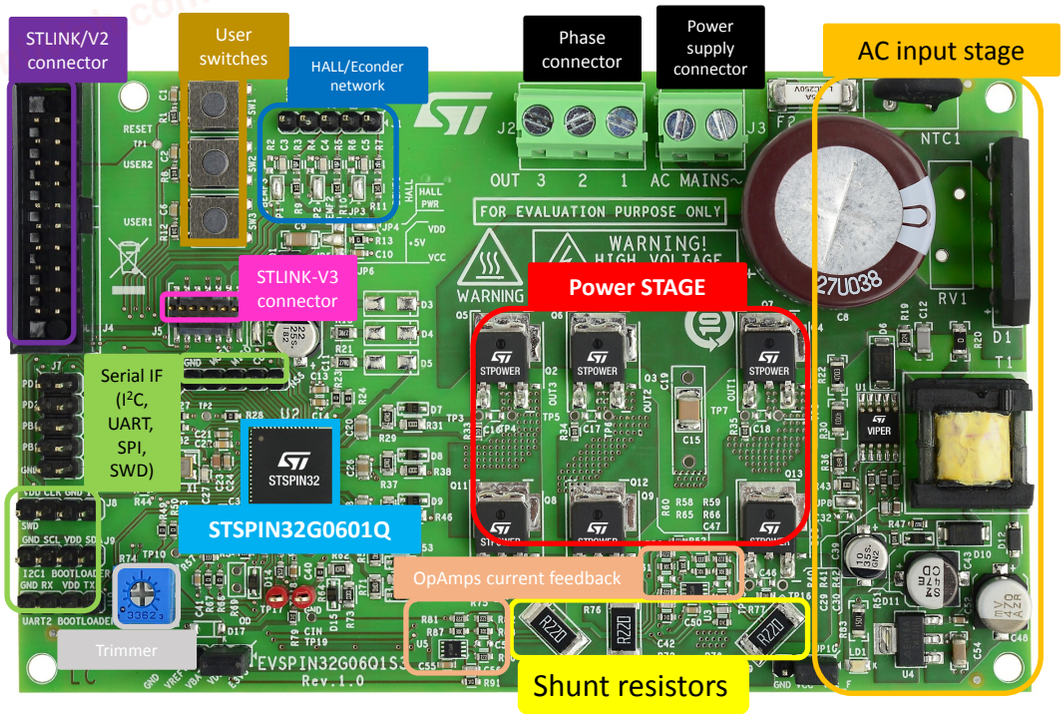
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Part reference	Part description	Part Value	Package / Manufacturer' code
			Diodes Incorporated or AZ1117H-3.3TRE1
X1	Automotive & industrial grade ceramic base SMD crystal	ABM8AIG-8.000MHZ-8 or equivalent	Abracon

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4 Layout and component placements

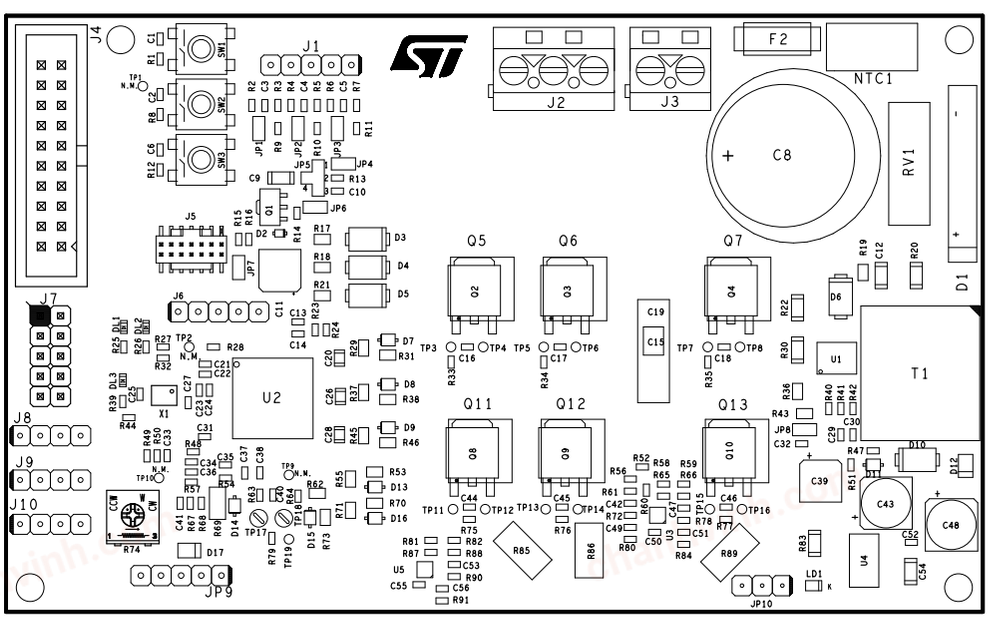
Figure 5. **EVSPIN32G06Q1S1 - functional blocks**



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. **EVSPIN32G06Q1S3 layout - component placement top view**



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Figure 7. **EVSPIN32G06Q1S3 layout - top layer**

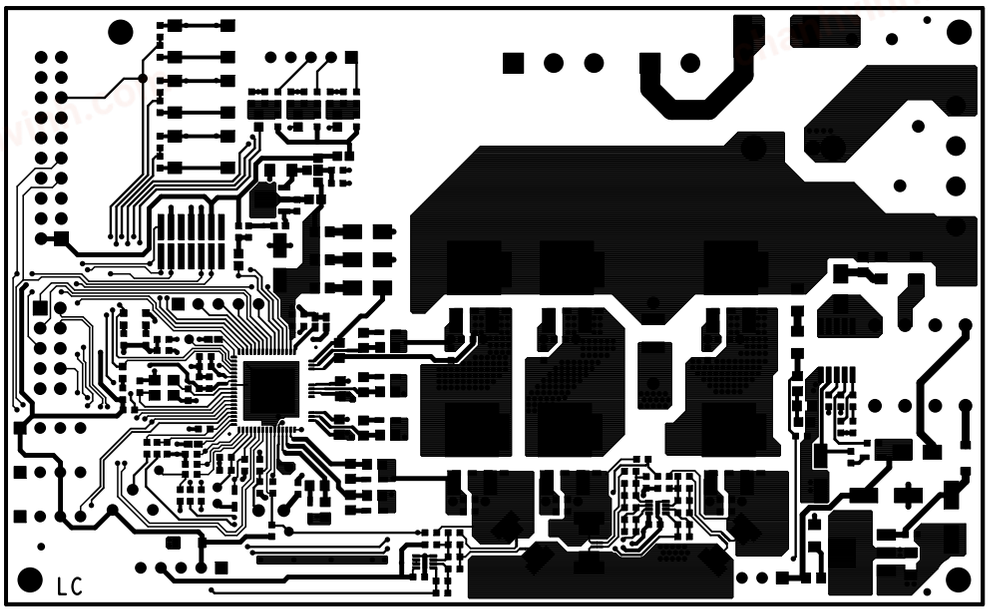
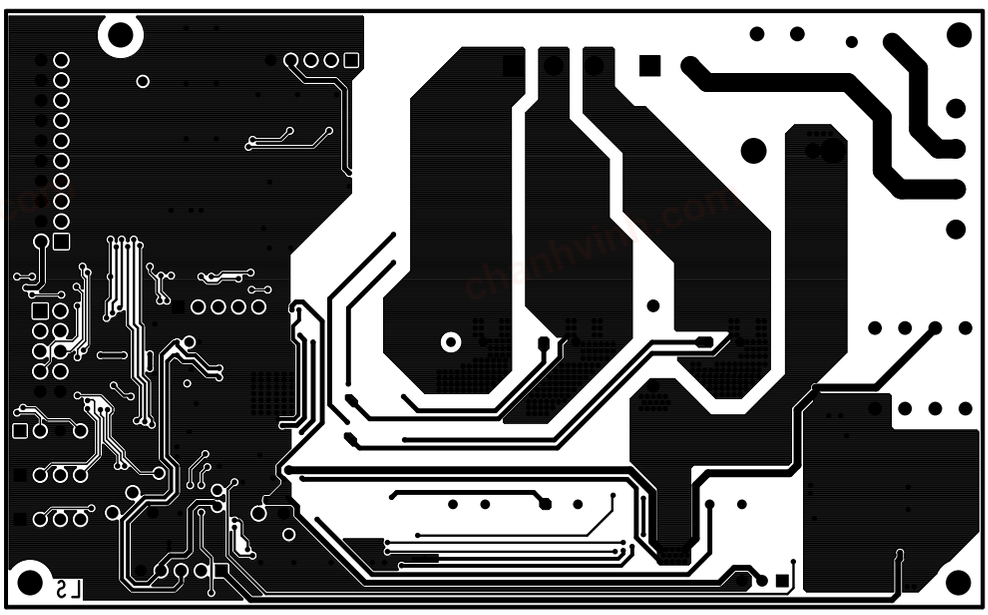


Figure 8. **EVSPIN32G06Q1S3 layout - bottom layer**



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Revision history

Table 2. **Document revision history**

Date	Version	Changes
22-Feb-2024	1	Initial release.

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