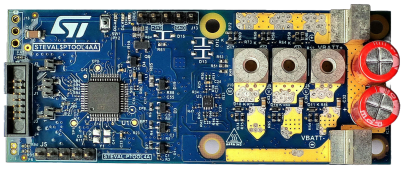
STEVAL-PTOOL4A

Data brief

Compact, customizable and configurable reference design for battery operated BLDC/PMSM power tools based on STM32G473 and STDRIVE 101



Product summary	
Compact, customizable and configurable reference design for battery operated BLDC/PMSM power tools based on STM32G473 and STDRIVE 101	STEVAL-PTOOL4A
Mainstream Arm Cortex-M4 MCU 170 MHz with 512 Kbytes of Flash memory, Math Accelerator, High Analog level integration	STM32G473CET6
Triple half-bridge gate driver	STDRIVE101
Applications	Industrial motor control

Features

- Input voltage from 12 to 28 V DC (Nominally 21 V)
- Output RMS current up to 20A
- The board comprises the following key devices:
  - STM32G473CET6: A high-performance Arm®-based Cortex®-M4 32-bit MCU+FPU in LQFP48 (7x7mm) package. The MCU embeds trigonometric and arithmetic math accelerators (CORDIC + FMAC), timers for motor control PWM and dead time generation
  - STDRIVE101: triple half-bridge gate driver in VFQFPN (4x4mm) with inbuilt regulator
  - STL220N6F7: six N-channel 60 V, 0.0012 Ω typ., 120 A, STripFET F7 power MOSFET in a PowerFLAT 5x6 package
  - L6981NDR: 38 V, 1.5 A synchronous step-down converter in a PowerSO-8 package
  - LDL112: 1.2 A low quiescent current LDO with reverse current protection in a SO8-batwing package
  - TSV912IQ2T: dual rail to rail input/output 8MHz op amp
  - BAT54KFILM: 40 V, 300 mA small signal Schottky diodes (single)
  - BAT54SWFILM: 40 V, 300 mA small signal Schottky diodes (series)
  - 2STR2160: low voltage fast switching PNP power transistor
  - 2STR1160: low voltage fast switching NPN power transistor
  - 2STR21STPS0560Z: 60 V, 0.25 A power Schottky rectifier
  - ESDALC6V1-1U2: single line low capacitance transil™ for ESD protection is a precision 500 mA regulator
- Hardware features enabling efficient motor control options
  - Independent ADCs for 3-phase current sensing through shunts
  - 3 ADC channels for back EMF sensing
  - Bus voltage sensing
  - Hardware over current protection through gate drive
  - Option for temperature sensing
  - Option for digital hall sensors or encoder inputs
  - Option for mounting heat sink

- Empowered with a feature-rich STM32 motor control ecosystem for permanent magnet synchronous motors (PMSM), brushless DC motors (BLDC)
  - Wide configurability via motor control library (MCSDK), associated GUI and profiler
  - Sensor less three-shunt or single-shunt vector field oriented control (FOC) algorithm (default)
  - Suitable for ST's high performance STM32 ZeST (zero speed full torque) algorithm, available on request
  - Option for sensor-less or sensored six step algorithm
  - Tuning of drive dynamics
  - Selection of operating parameters such as switching frequency
  - Other parameter values for nominal and fault conditions, for example, over the current threshold
  - Torque or speed mode operation
  - Fully protected with overcurrent protection, undervoltage lockout and thermal protection
  - Configuration examples with ST board designer, the JSON files are also provided
- Wide options for connectivity and user control
  - Serial wire debug (SWD) port for debugging/programming
  - Communication interfaces for SPI, UART, CAN /I2C pins
  - Connector for buttons and trimmer along with one onboard pushbutton switch
- Fault, status LEDs and interface for external LED for illumination
- Options for enhancement with daughter cards
  - Connector for mounting daughter board, for example, MEMS sensor board or memory
  - Connector for increasing input voltage range by replacement of DC-DC converter
- Test land areas on the board for monitoring important signals or DAC outputs for debugging

Description

The STEVAL-PTOOL4A is a compact system designed to control a brushless DC (BLDC) or a permanent-magnet synchronous motor (PMSM) in application such as a handheld battery-powered tool.

It works on the standard set of inputs such as throttle to control the motor torque/speed and to deliver power up to 250 W.

The board can be connected to a suitable 21 V / 250 W power tool motor. More peak power can be delivered with heatsink or with arrangement for circulating air to achieve better power dissipation.

This reference design is ideal for high-performance motor control to realize power tools such as drill machines, grinders, disc cutters, circular saws, leaf blowers, handheld mowers etc.

The small form factor and ample computing power make it suitable even for applications such as drones, wheelchairs, home appliances, e-bicycles, and robotic platforms.

The STEVAL-PTOOL4A includes a high performance STM32G473CE MCU featuring integrated peripherals especially optimized for motor control applications controlling a 3 phase full bridge converter consisting of six high current MOSFETS through triple half bridge gate driver STDRIVE101.

The MCU features multiple ADC peripherals thereby enabling simultaneous sampling of motor phase currents and back emf voltages.

The board has the capability to leverage on MCSDK library to provide options of both six-step or high performance FOC algorithm with configurability.

1 Schematic diagrams

Figure 1. **STEVAL-PTOOL4A circuit schematic (1 of 6)**

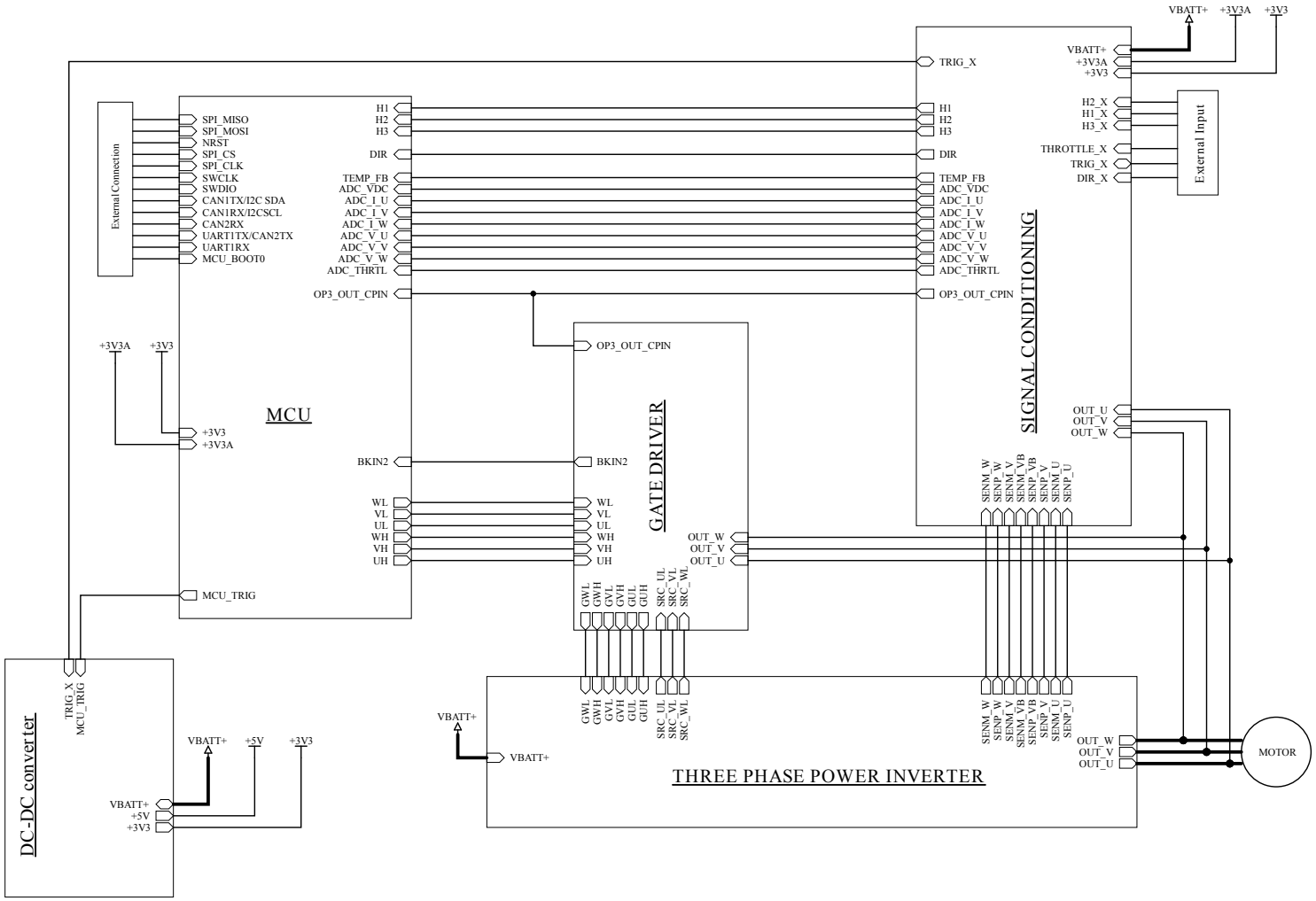


Figure 2. STEVAL-PTOOL4A circuit schematic (2 of 6)

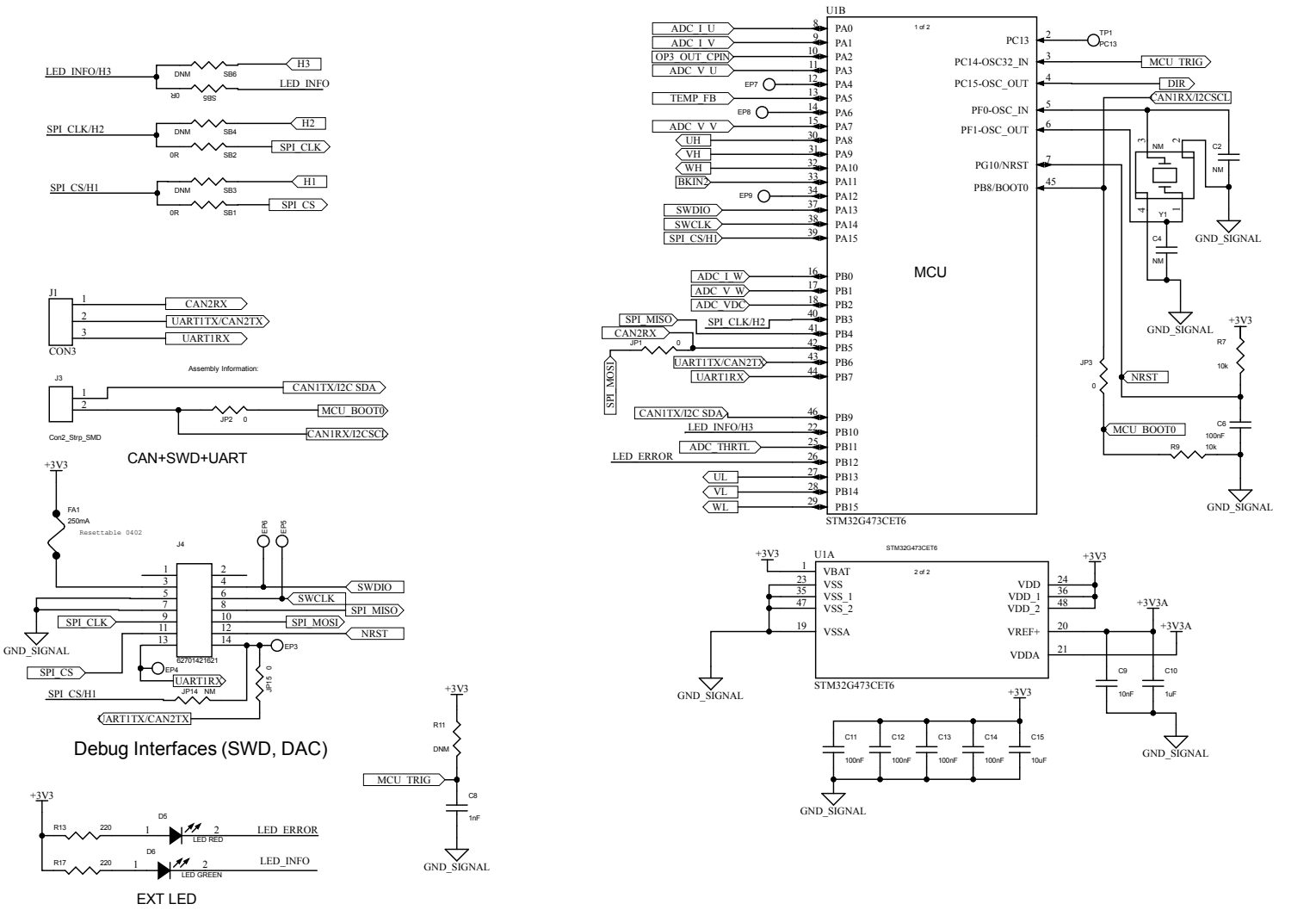


Figure 3. STEVAL-PTOOL4A circuit schematic (3 of 6)

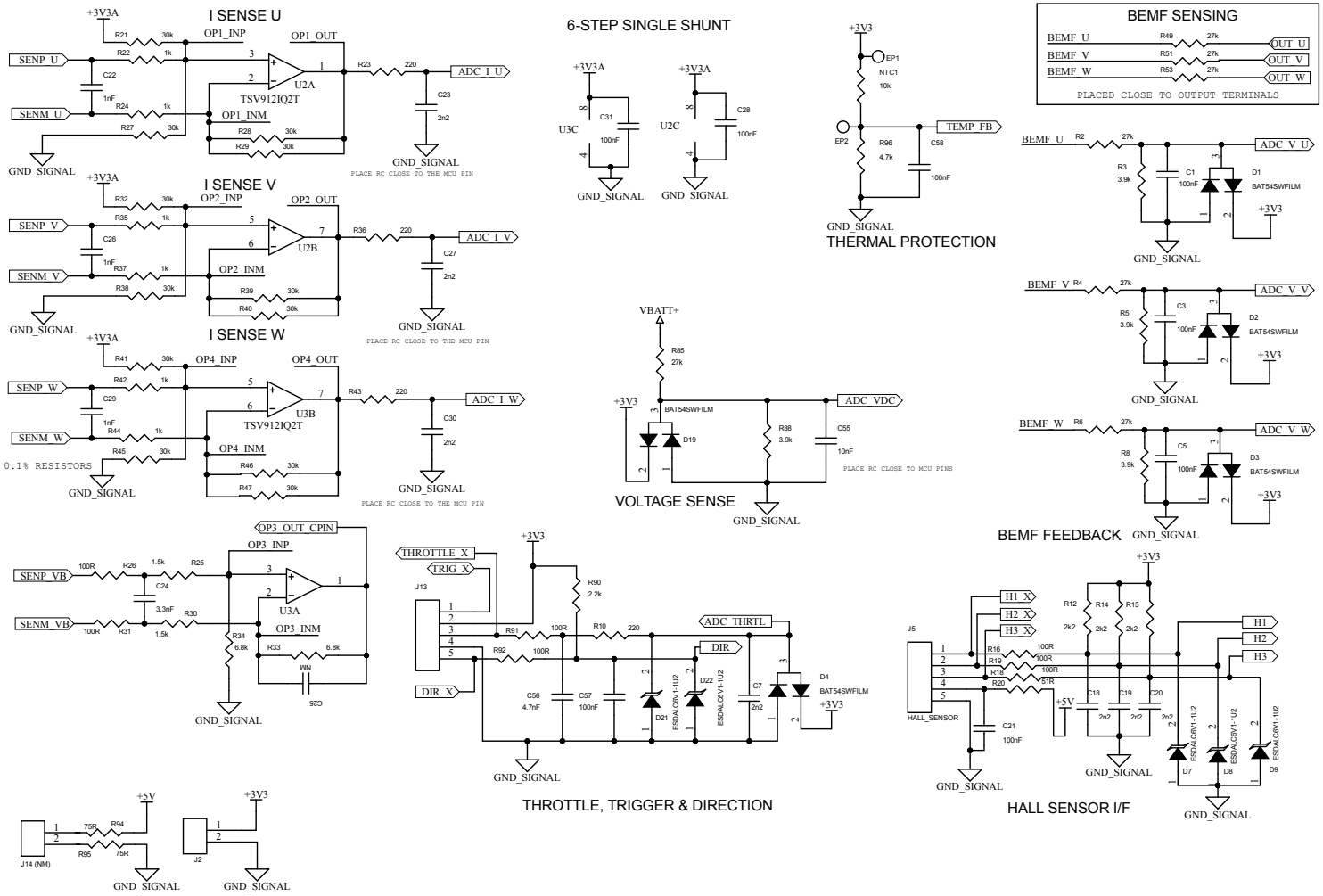


Figure 4. STEVAL-PTOOL4A circuit schematic (4 of 6)

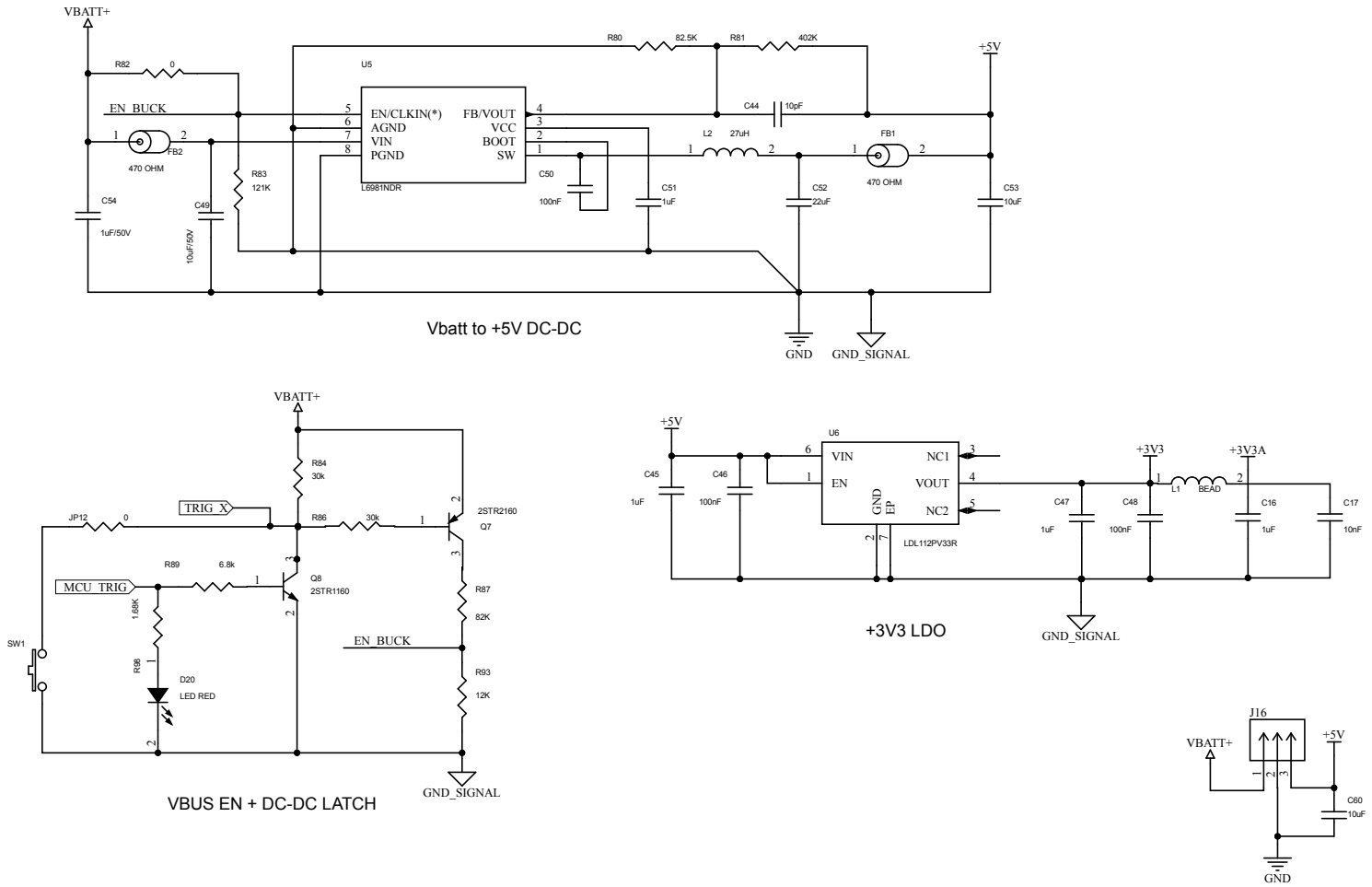


Figure 5. STEVAL-PTOOL4A circuit schematic (5 of 6)

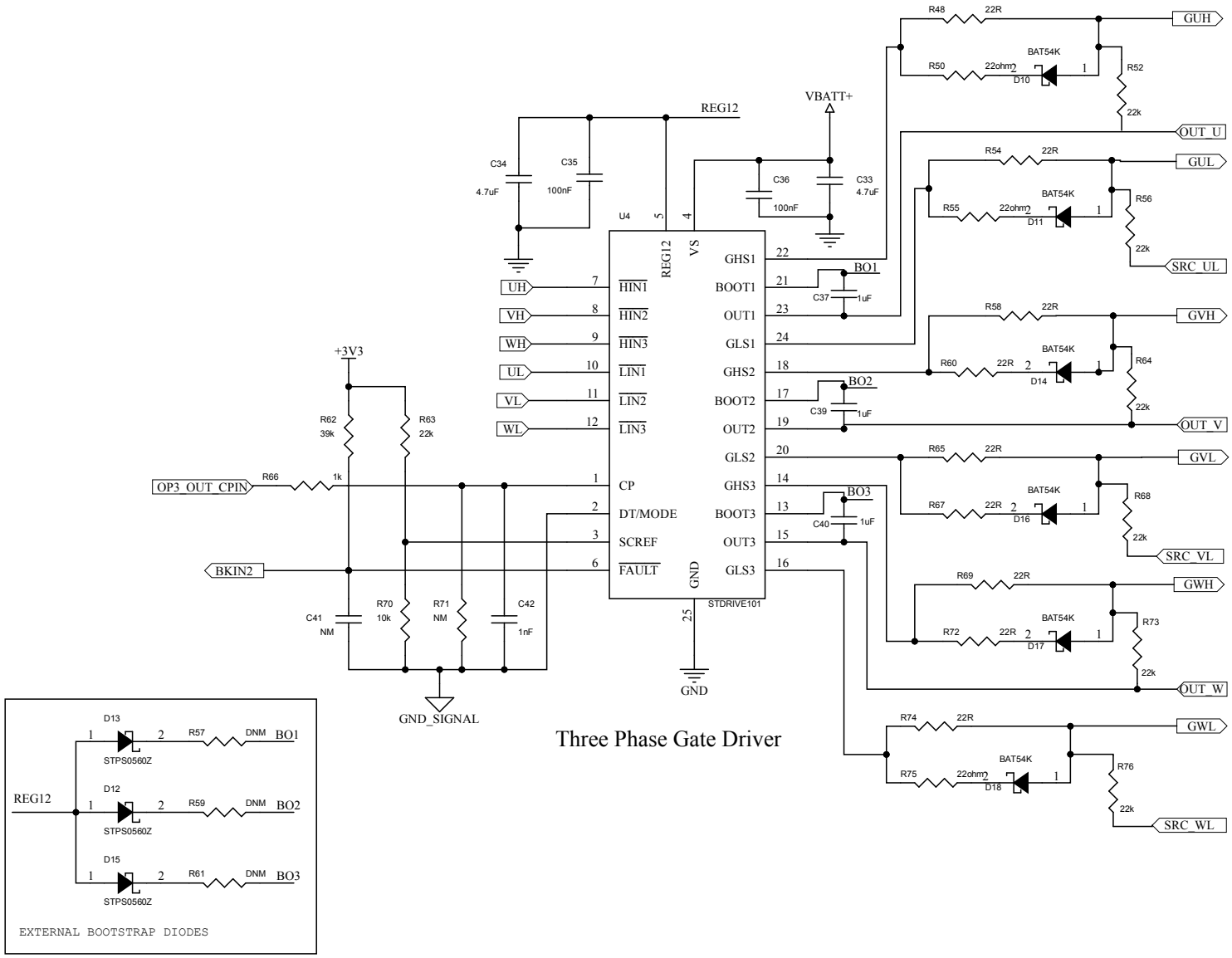
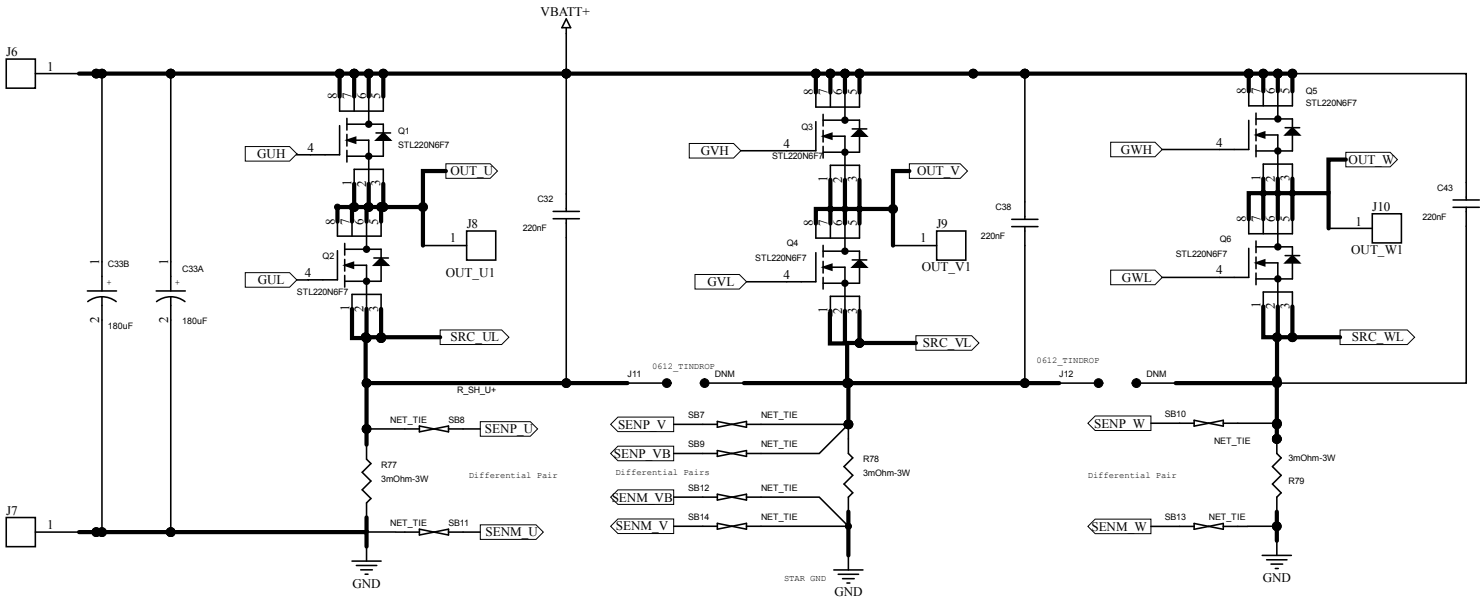


Figure 6. **STEVAL-PTOOL4A circuit schematic (6 of 6)**



2 Board versions

Table 1. **STEVAL-PTOOL4A versions**

PCB version	Schematic diagrams	Bill of materials
STEVAL$PTOOL4AA (1)	STEVAL$PTOOL4AA schematic diagrams	STEVAL$PTOOL4AA bill of materials

1. *This code identifies the STEVAL-PTOOL4A evaluation board first version. The STEVAL$PTOOL4AA code is printed on the board.*

Revision history

Table 2. **Document revision history**

Date	Revision	Changes
03-Apr-2024	1	Initial release.

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