UM1483
User manual

Low power motor control board STEVAL-IHM036V1 featuring SLLIMM™ STGIPN3H60 and MCU STM32F100C6T6B

1 Introduction

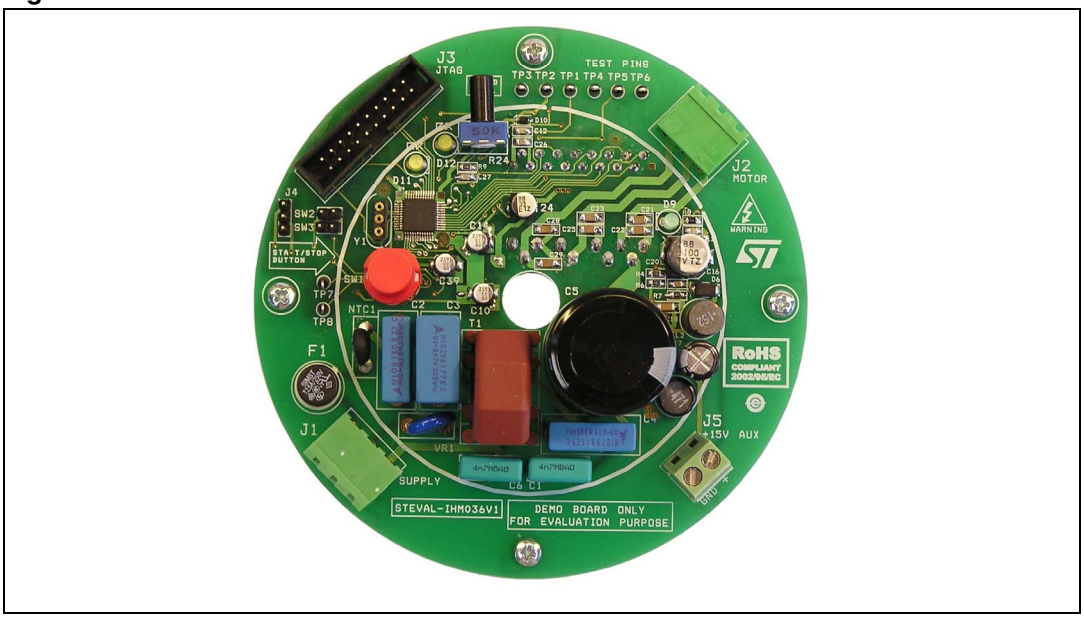
This document describes the low power motor control board STEVAL-IHM036V1 featuring the SLLIMM™ (small low-loss intelligent molded module) STGIPN3H60 and MCU STM32F100C6T6B. The demonstration board is an AC/DC inverter that generates a 3-phase waveform for driving 3-phase permanent magnet synchronous motors (PMSM) with field-oriented control (FOC) up to maximal 100 W without sensors. The used controller belongs to the STMicroelectronics™ ARM® Cortex™-M3 core-based medium density STM32™ MCU family.

The main device presented in this user manual is a universal, fully evaluated and populated design consisting of a 3-phase inverter bridge based on the 600 V IGBT power module in NDIP-26L package. The IGBT power module integrated all power IGBT switches with freewheeling diodes together with the high voltage gate drivers. Thanks to this integrated module, the system has been specifically designed to achieve power inverter in a reliable and compact design. Such integration saves PCB space occupation and assembly costs together with high reliability due to the design simplicity.

The board is designed to be compatible with single-phase mains for the European range of supply voltage 230 VAC (+/- 15%), or corresponding DC supply voltage. The board includes a power supply stage with VIPer™16 in buck configuration to generate +15 V supply voltage required by the application.

This document is associated with the release of the STEVAL-IHM036V1 demonstration board (see *Figure 1*).

Figure 1. STEVAL-IHM036V1



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2 System introduction

2.1 Main characteristics

The information listed below shows the converter specification data and the main parameters set for the STEVAL-IHM036V1 demonstration board.

- Minimum input voltage 275 VDC or 195 VAC
- Maximum input voltage 375 VDC or 265 VAC
- Maximum output power for applied motor up to 100 W
- Input inrush limitation based on NTC resistor
- +15 V auxiliary power supply based on a buck converter with VIPer16
- Using IGBT SLLIMM™ STGIPN3H60 in NDIP-26L molded package
- Fully populated board conception with test points
- Overcurrent hardware protection
- Overtemperature protection based on NTC resistor
- Based on STMicroelectronic's ARM® Cortex™-M3 core-based STM32F100C6T6B microcontroller
- Possibility to modify the board with RS-485 bus
- Field-oriented control (FOC) firmware customized with “STM32 PMSM FOC SDK v3.0 Motor Control Firmware Library” (see www.st.com/internet/com/SOFTWARE_RESOURCES/SW_COMPONENT/FIRMWARE/stm32_pmsm_foc_motorcontrol_fwlib.zip)
- Compliance with EN55014 (CISPR 14), IEC 61000-4-5 and IEC61000-4-4
- PCB type and size:
  - Material of PCB - FR-4
  - Double-sided layout
  - Copper thickness: ~60 µm
  - Total dimensions of demonstration board: circular shape, diameter 115 mm

2.2 Target application

- Household water heating pumps
- Dishwasher pumps
- Refrigerator compressors
- High-end fans

2.3 Safety and operating instructions

2.3.1 General terms

Warning: **During assembly, testing, and normal operation, the demonstration board poses several inherent hazards, including bare wires, moving or rotating parts and hot surfaces. There is danger of serious personal injury and damage to property if the kit or components are improperly used or installed incorrectly. The kit is not electrically isolated from the AC/DC input. The demonstration 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. Do not touch the demonstration board after disconnection from the voltage supply; several parts and power terminals, which contain energized capacitors, must be allowed to discharge.**

All operations involving transportation, installation and use, as well as maintenance, are to be carried out by skilled technical personnel (national accident prevention rules must be observed). For the purpose of these basic safety instructions, “skilled technical personnel” are considered as suitably qualified people who are familiar with the installation, use, and maintenance of power electronic systems.

2.3.2 Demonstration board intended use

The STEVAL-IHM036V1 demonstration board is designed for demonstration purposes only and must not be used in final applications. The technical data, as well as information concerning the power supply conditions, must only be taken from the relevant documentation and must be strictly observed.

2.3.3 Demonstration board installation

The installation and cooling of the demonstration board must be in accordance with the specifications and the targeted application.

- The motor drive converters are protected against excessive strain. In particular, no components are to be bent or isolating distances altered during the course of transportation or handling.
- No contact must be made with other electronic components and contacts.
- The boards contain electrostatically sensitive components that are prone to damage through improper use. Electrical components must not be mechanically damaged or destroyed.

2.3.4 Electrical connections

Applicable national accident prevention rules must be followed when working on the main power supply. The electrical installation must be carried out in accordance with the appropriate requirements.

A system architecture which supplies power to the demonstration board must be equipped with additional control and protective devices in accordance with the applicable safety requirements (e. g. compliance with technical equipment and accident prevention rules).

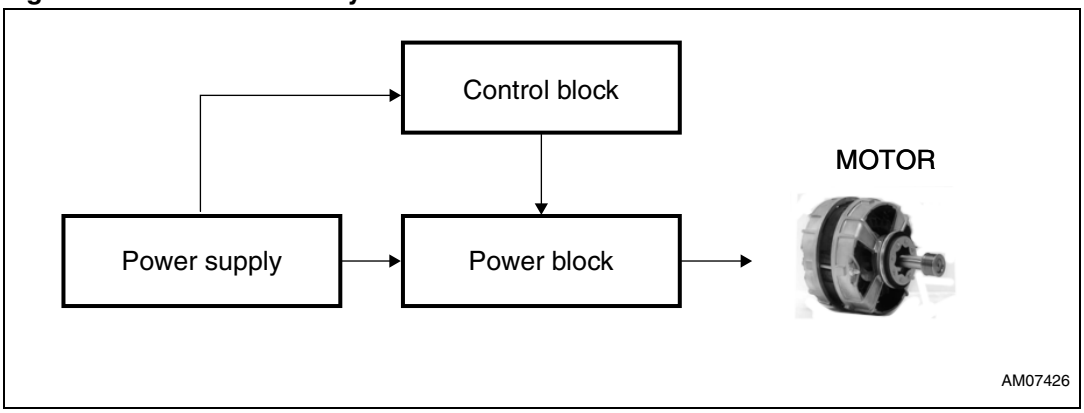
3 Board description

3.1 System architecture

A generic motor control system can be basically schematized as the arrangement of four main blocks (see *Figure 2*).

- **Control block** - its main task is to accept user commands and motor drive configuration parameters. It provides all digital signals to implement the proper motor driving strategy. The STM32F100C6T6B MCU belongs to the value line medium and low density STM32 MCU family and was selected as the key component of the control block.
- **Power block** - it is based on 3-phase inverter topology. The heart of the power block is the STGIPN3H60 small low-loss intelligent molded module which contains all the necessary active components. Please refer to the STGIP3H60 datasheet for more information.
- **Motor** - The STEVAL-IHM036V1 demonstration board is able to properly drive any PMSM up to 100 W of nominal power, but the FOC itself is mostly conceived for sinusoidal shaped back-EMF.
- **Power supply block** - able to work from 195 VAC to 265 VAC or corresponding DC voltage from 275 VDC to 375 VDC. The power block is based on a buck converter with a VIPer16 controller. It is also possible to supply the application through a J5 connector with +15 VDC. Please refer to *Figure 6* for more information on how to connect the board to the required application.

Figure 2. Motor control system architecture



Of the above motor control system architecture, the STEVAL-IHM036V1 does not include any motor itself.

3.2 The board schematic

Figure 3. STEVAL-IHM036V1 schematic - part 1

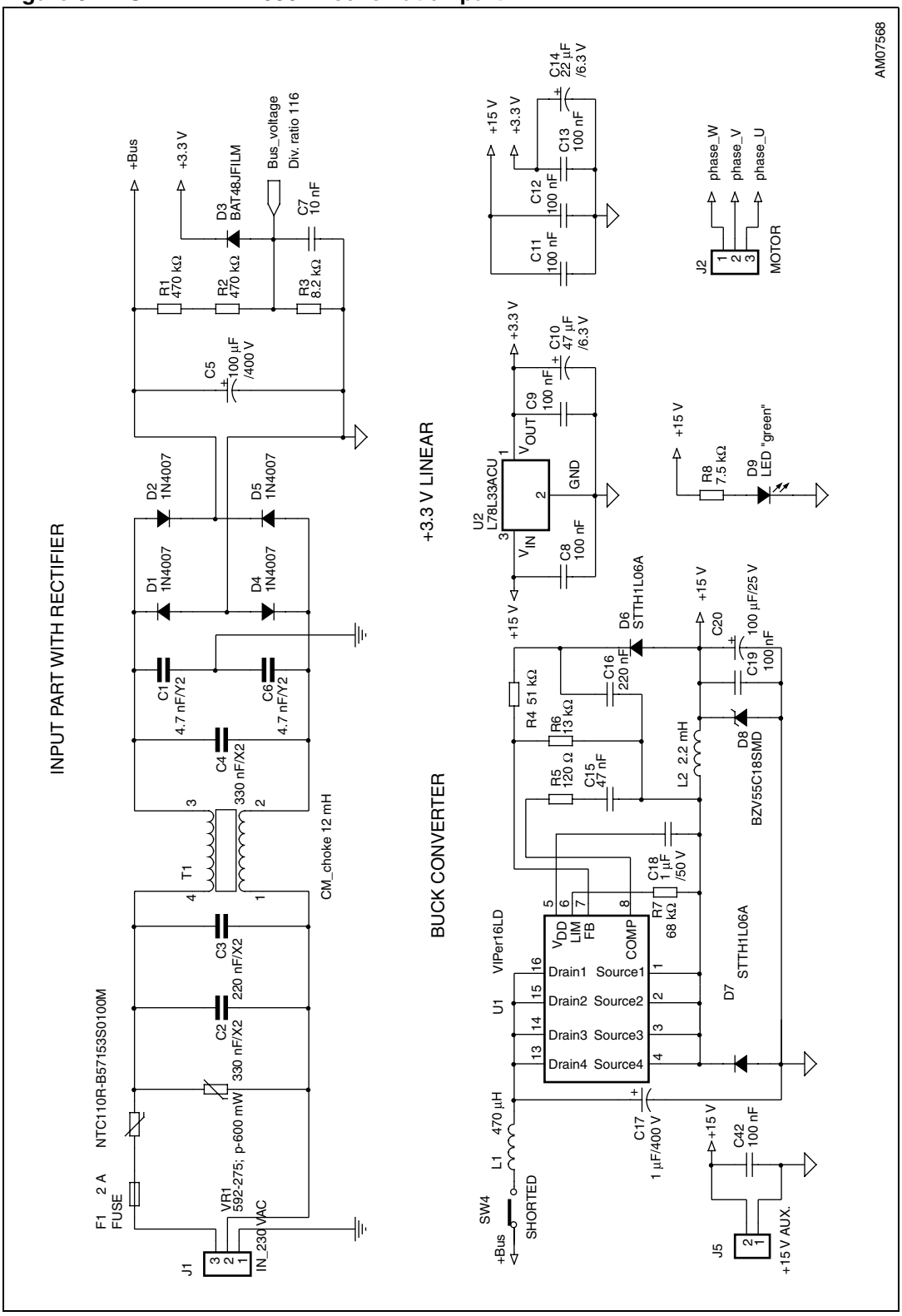


Figure 4. STEVAL-IHM036V1 schematic - part 2

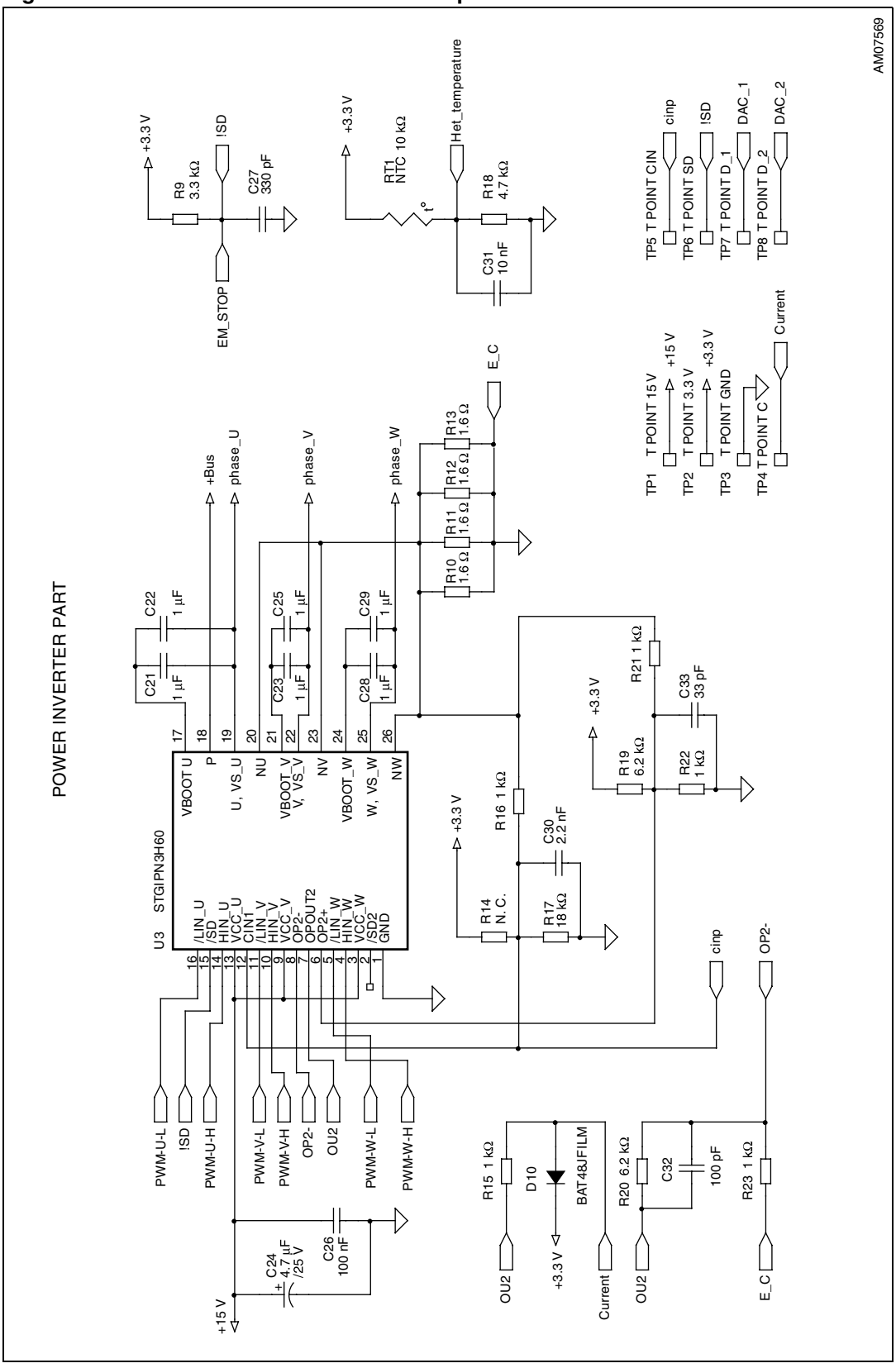
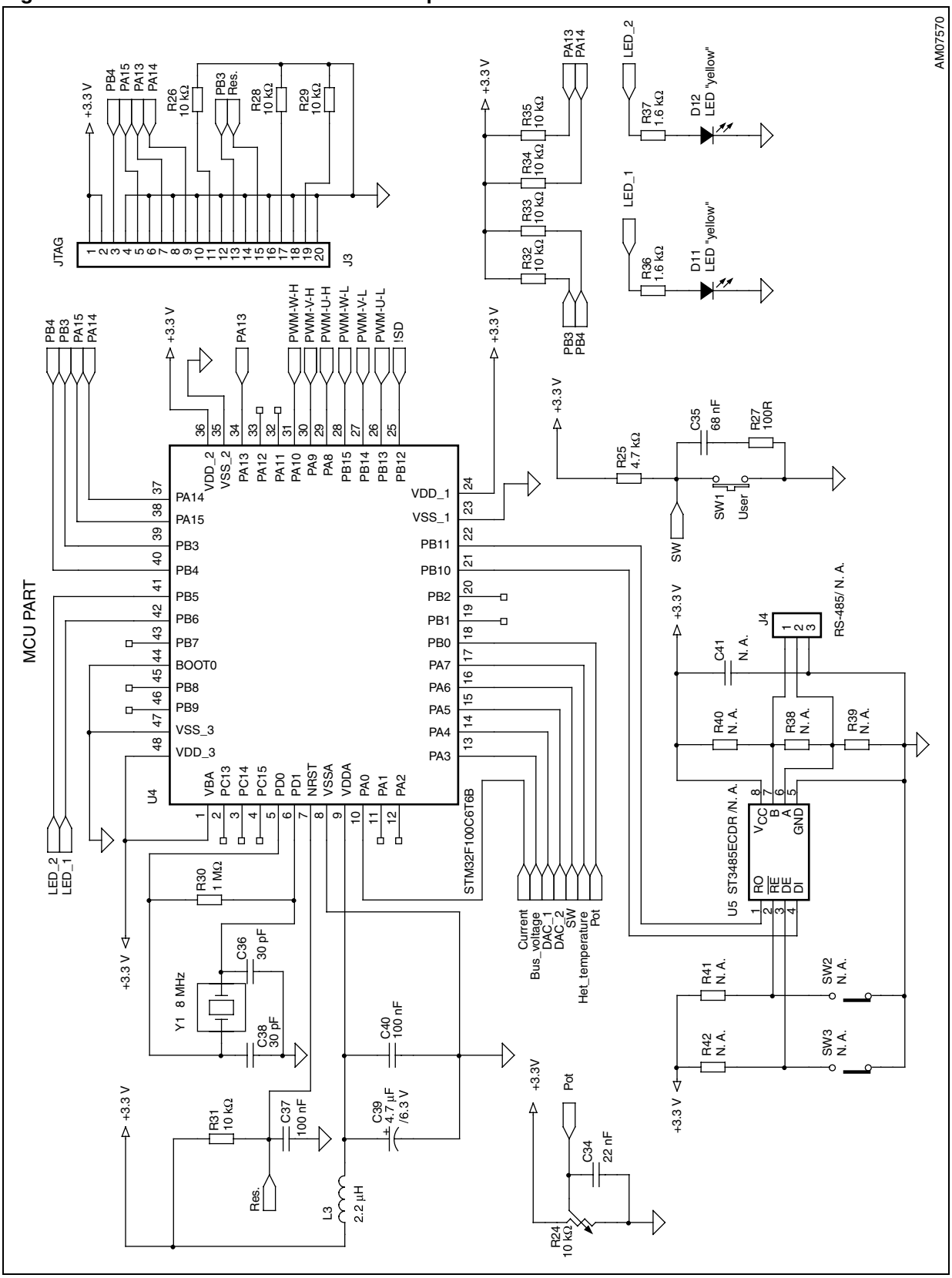


Figure 5. STEVAL-IHM036V1 schematic - part 3



3.3 Board architecture description

3.3.1 Power supply

The power supply in the STEVAL-IHM036V1 demonstration board is designed for European supply voltage range 230 VAC. The real range of the input voltage is from 195 VAC or 275 VDC to 265 VAC or 375 VDC.

The auxiliary power supply for all active components on the demonstration board is implemented as a buck converter based on U1 VIPer16LD which works with a fixed frequency of 60 kHz. The output voltage of the converter is +15 VDC. Voltage is fed into the intelligent power module (IPM) as supply voltage, as well as into linear regulator L78L33ACU. The linear regulator provides +3.3 VDC for supplying MCU, operational amplifiers, and further related parts placed on the demonstration board. Please refer to STMicroelectronics VIPer16LD datasheet for more information.

For testing purposes the board may also operate in wide supply voltage range from 18 VDC to 400 VDC. A dual supplying mode could be used in this situation. The jumper SW4 must be disconnected. In this mode, voltage on the input connector J1 is normally linked through power switches to the motor. An external auxiliary voltage is fed through the J5 connector from an external power source. The voltage of the used external power supply must be in the range +14.8 V to +15.5 V with availability to sink current 0.5 A. This is a mode which allows to use the demonstration board for various supply voltages. It is especially convenient for low voltage motors.

Information regarding the value of the supply bus voltage on the main filtering capacitors is sensed with the voltage divider built around R1, R2 and R3 and is fed into the MCU to ADC. The proper voltage multiplication for applied resistors divider is 116.

The presence of +15 VDC on the board is indicated with D9 green LED “Power ON”. *Figure 6* describes the power supply section through a simplified block diagram.

Figure 6. Power supply block diagram

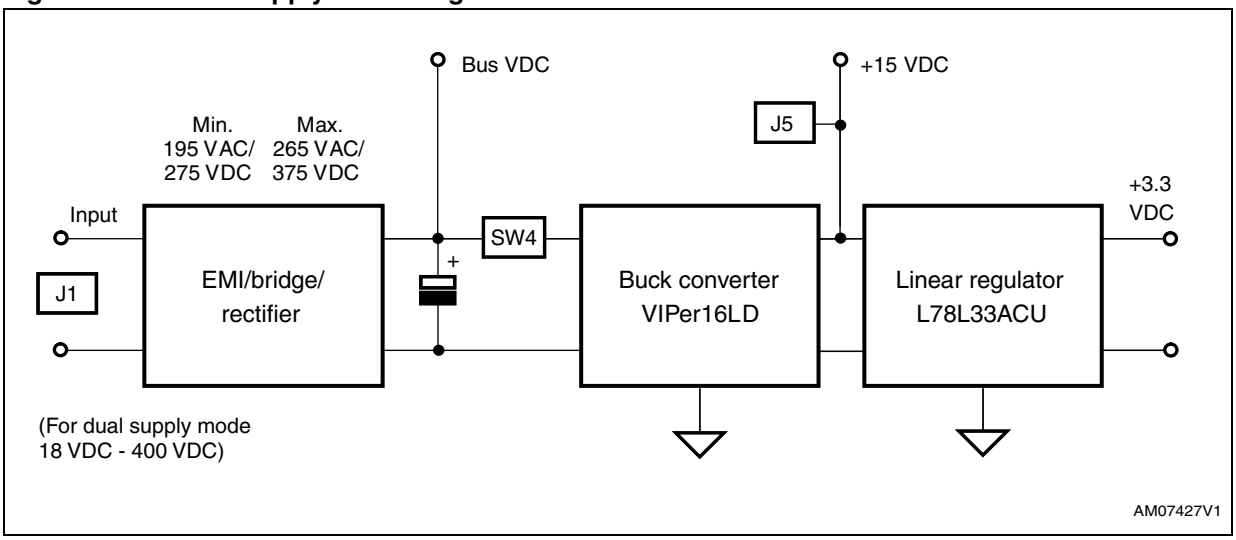


Table 1. Jumper settings single/dual supply mode

Single supply mode	Dual supply mode
SW4 present	SW4 not present
	(J1 - input voltage; J5 - aux. voltage)

3.3.2 Input part of the converter

The input stage of the demonstration board is provided with an NTC resistor to eliminate input inrush current peak during the charging of the bulk capacitors. A fuse for nominal current 2 A is implemented in series with the resistor.

The complete EMI filter is based on common mode choke, X2 and Y2 capacitors were implemented on the STEVAL-IHM036V1 demonstration board. The EMI filter was performing to fulfill the radio disturbance requirements coming from EN55014 (CISPR 14).

The supply input of the inverter is protected with the varistor VR1 against disturbances. The board is in compliance with surge tests according to IEC 61000-4-5 up to 2 kV and also with burst immunity according to IEC61000-4-4 up to 2 kV with positive and negative pulses.

3.3.3 Control block with value line STM32 MCU

The control stage of the STEVAL-IHM036V1 board is designed around an STM32F100C6T6B microcontroller in a 48-pin LQFP package. The STM32F100C6T6B MCU belongs to the value line medium and low density STM32 MCU family.

The interface between the user and the board, for commands, is based on user button SW1 and the potentiometer R24. Indicated status is based on two LED diodes D11 and D12.

The STM32F100C6T6B microcontroller, present on the board, is intended to be used in conjunction with the external 8 MHz crystal Y1.

The board could be featured with a non-insulated RS-485 bus. On the PCB an SO-8 foot pin is prepared, which allows to assemble STMicroelectronics transceiver ST3485ECD. Use of this feature allows to evaluate the board in applications where serial communication is required. Due to application intention, the kit is not electrically isolated from the DC input. This topology is very common in motor drives. The microprocessor and the transceiver are grounded by the integrated ground of the DC bus. The microprocessor and associated circuitry are hot and MUST be isolated from user controls and communication interfaces. The board is not galvanic isolated from the supply mains. As a result of this, make sure to connect any RS-485 devices to the board which has no galvanic isolated ports. Before updating the board with such a peripheral, please refer to STMicroelectronics ST3485ECD datasheet for more information on how to connect I/O.

For development and debugging purposes, the board features a standard 20-pin JTAG interface connector for connection of debugging/programming tools for ARM core-based devices.

Table 2 lists the I/O assignments for the STM32F100C6T6B MCU.

Table 2. I/O assignment

LQFP48	Pin name	Type	I/O assignment	MC using
1	V_{BAT}			
2	PC13		Not connected	
3	PC14		Not connected	
4	PC15		Not connected	
5	OSC_IN		Crystal oscillator 8 MHz	
6	OSC_OUT		Crystal oscillator 8 MHz	
7	NRST		RESET	
8	V_{SSA}	S		
9	V_{DDA}	S		
10	PA0	I	ADC1_IN0	Current
11	PA1		Not connected	
12	PA2		Not connected	
13	PA3	I	ADC1_IN3	Bus voltage feedback
14	PA4	O	DAC1_OUT	DAC 1
15	PA5	O	DAC2_OUT	DAC 2
16	PA6	I	PA6	User switch SW1
17	PA7	I	ADC1_IN7	Temperature feedback
18	PB0	I	ADC1_IN8	Potentiometer input
19	PB1		Not connected	
20	PB2		Not connected	
21	PB10	O	USART3_TX	Optional/ RS-485 TX
22	PB11	I	USART3_RX	Optional/ RS-485 RX
23	V_{SS_1}	S		
24	V_{DD_1}	S		
25	PB12	I	PB12	MC emergency STOP
26	PB13	O	TIM1_CH1N	Phase_U-L
27	PB14	O	TIM1_CH2N	Phase_V-L
28	PB15	O	TIM1_CH3N	Phase_W-L
29	PA8	O	TIM1_CH1	Phase_U-H
30	PA9	O	TIM1_CH2	Phase_L-H
31	PA10	O	TIM1_CH3	Phase_W-H
32	PA11		Not connected	
33	PA12		Not connected	
34	PA13	I/O	PA13	JTAG
35	V_{SS_2}	S		

Table 2. I/O assignment (continued)

LQFP48	Pin name	Type	I/O assignment	MC using
36	V_{DD_2}	S		
37	PA14	I/O	PA14	JTAG
38	PA15	I/O	PA15	JTAG
39	PB3	I/O	PB3	JTAG
40	PB4	I/O	PB4	JTAG
41	PB5	O	PB5	LED 2
42	PB6	O	PB6	LED 1
43	PB7		Not connected	
44	BOOT 0			GND
45	PB8		Not connected	
46	PB9		Not connected	
47	VSS_3	S		
48	VDD_3	S		

3.3.4 Power block based on IGBT module

The IGBT SLLIMM™ module STGIPN3H60 consists of high rugged IGBT power switches and three smart drivers. STGIPN3H60 is provided with advanced gate smart drivers and many features, such as integrated comparators for overcurrent or short-circuit protection, free operational amplifier and the “SMART SHUTDOWN” function are available. Please refer to the STMicroelectronics STGIPN3H60 device datasheets for more information.

3.3.5 Overcurrent protection

Hardware overcurrent protection (OCP) is implemented on the board. This feature takes advantage of STGIPN3H60 SLLIMM™ module where an internal comparator is implemented. Thanks to the internal connection between the comparator output and shutdown block of the IPM, the intervention time of overcurrent protection is extremely low, ranging slightly above 200 ns. Please see *Figure 7* for a detailed view of OCP.

Overcurrent protection acts as soon as the voltage on the CIN pin rises above the internal voltage reference (typical value V_{REF_INT} is 0.53 V). Considering the default value of the OCP shunt resistor, it follows that the maximum allowed current is equal to:

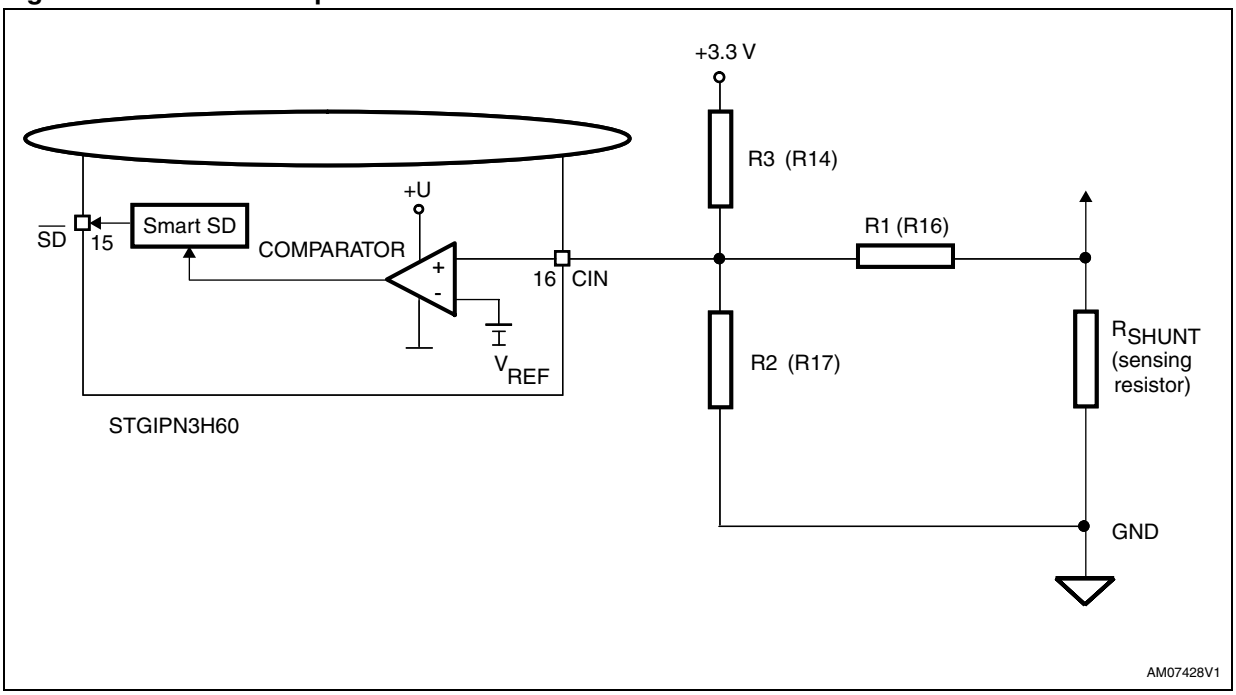
Equation 1

$$I_{SHUNT\_MAX} = \frac{0.53 \times (R1 \times R2 + R2 \times R3 + R1 \times R3) - 3.3 \times R1 \times R2}{R_{SHUNT} \times R2 \times R3}$$

with the default values this gives:

I_{SHUNT_MAX} ~ 1.4 A

Figure 7. Overcurrent protection based on STGIPN3H60



3.3.6 Single-shunt current sensing amplifying network

The STEVAL-IHM036V1 motor control demonstration board is configured to run in single-shunt current reading configuration modes which is suitable for using field-oriented control (FOC).

Current sensing networks were the chosen configurations with the shunt resistor together with an amplifying measured voltage with an operational amplifier integrated into the SLLIMM™ module STGIPN3H60.

Details of the FOC current sensing reading configuration are shown in *Figure 8*. In this configuration, the alternating signal on the shunt resistor, with positive and negative values, must be converted to be compatible with the single positive input of the microcontroller A-D converter used to read the current value.

The op amp is used in follower mode with gain of the op amp set by resistors r and R:

Equation 2

$$G = \frac{R + r}{r}$$

It is possible to calculate the voltage on the op amp output OP OUT - V_{OUT} as the sum of a bias V_{BIAS} and a signal V_{SIGN} component equal to:

Equation 3

$$V_{OUT} = V_{SIGN} + V_{BIAS}$$

$$V_{BIAS} = \frac{3.3}{\left(\frac{1}{R1} + \frac{1}{R2} + \frac{1}{R3}\right) \times R3} \times G$$

$$V_{SIGN} = \frac{I \times R_{SHUNT}}{\left(\frac{1}{R1} + \frac{1}{R2} + \frac{1}{R3}\right) \times R1} \times G$$

Total gain of the circuit with the resistor divider is equal to:

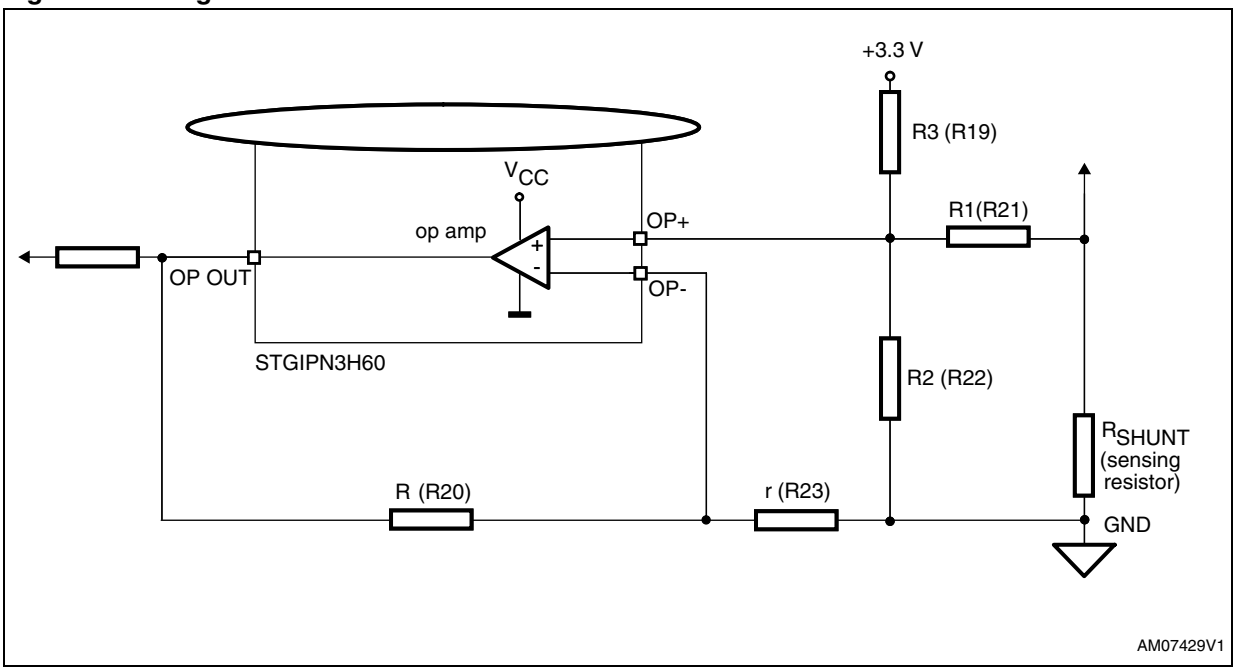
Equation 4

$$G_{TOT} = \frac{V_{SIGN}}{V_{IN}} = \frac{V_{SIGN}}{R_{SHUNT} \times I}$$

with the default values this gives:

- V_{BIAS} = 1.77 V
- Maximal voltage of V_{SIGN} = *1.5 V*
- G = 7.2
- G_{TOT} = 3.33
- Maximum current amplifiable without distortion is 1.1 A.

Figure 8. Single-shunt FOC network



3.3.7 Temperature feedback

Temperature feedback is implemented on the STEVAL-IHM036V1 demonstration board. This feature fully protects the IPM module against damage when the temperature on the junction on the IPM overruns a defined value. The temperature is sensed through an NTC resistor RT1. The measured signal is fed to the MCU control unit to be read with an A-D converter.

4 Testing of the demonstration board

The overall test of the demonstration board was performed on a motor bench with applied testing PMSM motor. Parameter lists of the used testing motor are below.

Motor parameters:

- Maximal motor power: 300 W
- 4-pole pairs
- Ls = 16.5 mH; Rs = 8 Ω
- Ke = 36 V
- Nominal speed: 2400 rpm (160 Hz)

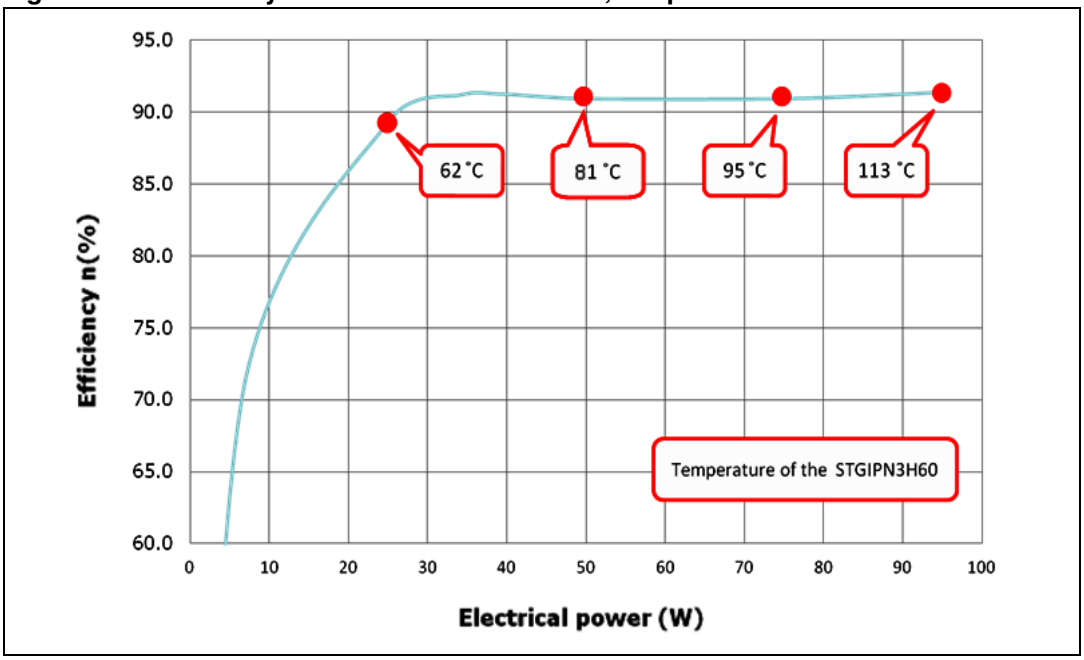
The STMicroelectronics released “STM32 FOC firmware library v3.0” was customized to be compatible with demonstration board STEVAL-IHM036V1. All related parameters of the motor were included in the source code via “ST Motor Control Workbench” application (see www.st.com/internet/com/SOFTWARE_RESOURCES/TOOL/CONFIGURATION_UTILITY/motorcontrol_workbench.zip).

Test conditions:

- Sensorless sinusoidal field-oriented control
- Supply voltage 230 VAC; frequency 50 Hz
- Ambient temperature: 25 °C
- PWM switching frequency: 16 kHz
- Testing for output electrical power: 25 W, 50 W, 75 W and 95 W.

The duration of the tests was around 1 hour for each mentioned electrical output power. Measured parameters were taken at the end of the each test condition when all parameters had a stable value.

Figure 9. Efficiency of the STEVAL-IHM036V1, temperature of the STGIPN3H60



As seen in *Figure 9*, the overall efficiency of the whole demonstration board STEVAL-IHM036V1 is above to 90% for almost the whole range of the output power.
The temperature of the IGBT SLLIMM™ module STGIPN3H60 itself, for each load test with electrical output power 25 W, 50 W, 75 W and 95 W, is also marked in the graph.

4.1 Hardware test results of EMC compliance with EN rules EMC IEC 61000-4-4 burst immunity

The demonstration board STEVAL-IHM036V1 was tested to be pre-compliant with IEC 61000-4-4. Test conditions with results are listed below.

Test condition:

- Ambient temperature: 25 °C
- Air humidity: 50%
- Supply voltage: 230 VAC
- Testing motor as load; electric output power equal to 50 W

Test signal: according to IEC 61000-4-4:

- Polarity: positive/negative
- Burst duration: 15 ms ± 20% at 5 kHz
- Burst period: 300 ms ± 20%
- Duration time: minimum 1 minute
- Applied to: power supply lines (AC line - L and N; L and PE)

Conclusion:

Application functionality was not influenced by applied burst disturbance. The application passed 2 kV burst testing (level 4 according to IEC 61000-4-4) with criteria A (without functionality influence and without damage).

4.2 Hardware test results of EMC compliance with EN rules EMC IEC 61000-4-5 surge tests

The demonstration board STEVAL-IHM036V1 was tested to be pre-compliant with IEC 61000-4-5. Test conditions with results are listed below.

Test condition:

- Ambient temperature: 25 °C
- Air humidity: 47%
- Supply voltage: 230 VAC
- Testing motor as load; electric output power equal to 50 W

Test signal: according to IEC 61000-4-5; level 3 (2 kV line to line, 2 kV line to earth):

- Polarity: positive/negative
- Duration time 5 events; repetition 1 minute
- Phase angle: 0, 90, 180 and 270 degrees

Applied to: differential mode (L line to N line)

common mode (AC line to PE earth)

Conclusion:

Application functionality was not influenced by applied surges disturbance. The application is pre-compliant to IEC 61000 -4-5 level 3 (2 kV line to line and 2 kV line to earth).

4.3 Radio disturbance characteristic according to EN55014 (CISPR14-1)

The demonstration board STEVAL-IHM036V1 was tested to be pre-compliant with CISPR 14-1 specification for conducted measurements for a frequency range from 150 kHz to 30 MHz. Test conditions with results are listed below.

Test condition:

- Ambient temperature: 24 °C
- Air humidity: 50%
- Supply voltage: 230 VAC
- Testing motor as load; electric output power equal to 50 W

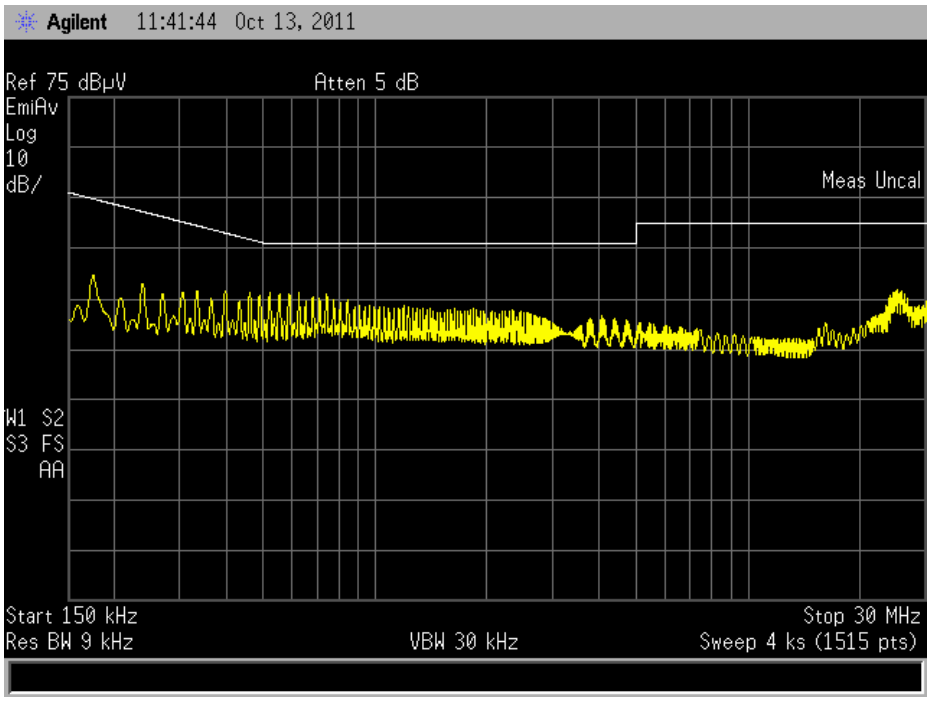
Test signal: according to CISPR 14-1:

- Frequency range 150 kHz - 30 MHz, detectors average and quasi-peak
- Measured on power supply lines (AC line - L and N)

Conclusion:

The demonstration board STEVAL-IHM036V1 is pre-compliant with radio disturbance according to CISPR14 for a frequency range from 150 kHz to 30 MHz with both, quasi-peak and average detector. *Figure 10* shows results of measured disturbance with average detector.

Figure 10. EMC conducted emissions, detector average



5 Using STEVAL-IHM036V1 with the STM32 PMSM FOC SDK v3.0 Motor Control Firmware Library

The “STM32 PMSM FOC SDK v3.0 Motor Control Firmware Library” is a firmware library performing the field-oriented control of a permanent magnet synchronous motor (PMSM) in both sensor and sensorless configurations.

It is possible to configure the firmware to use the STEVAL-IHM036V1 as a complete motor control platform.

This section describes the modifications to be applied to the “STM32 PMSM FOC SDK v3.0 Motor Control Firmware Library” in order to make the firmware compatible with the STEVAL-IHM036V1.

5.1 Environmental considerations

Warning: The STEVAL-IHM036V1 demonstration board must only be used in a power laboratory. The voltage used in the drive system presents a shock hazard.

The kit is not electrically isolated from the DC input. This topology is very common in motor drives. The microprocessor is grounded by the integrated ground of the DC bus. The microprocessor and associated circuitry are hot and MUST be isolated from user controls and communication interfaces.

Warning: All measuring equipment must be isolated from the main power supply before powering up the motor drive. To use an oscilloscope with the kit, it is safer to isolate the DC supply AND the oscilloscope. This prevents a shock 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.

An isolated AC power supply can be constructed using an isolation transformer and a variable transformer.

Note: Isolating the application rather than the oscilloscope is highly recommended in any case.

5.2 Hardware requirements

To run the STEVAL-IHM036V1 together with the STM32 FOC firmware library, the following is required:

- The board: STEVAL-IHM036V1
- High voltage insulated AC power supply up to 230 VAC
- J-Link programmer - ST-Link (not included in the package)
- J-Link insulating board (not included in the package)
- 3-phase brushless motor with permanent magnet rotor (not included in the package)
- Insulated oscilloscope (as required)
- Insulated multimeter (as required)

5.3 Software requirements

To customize, compile, and download the STM32 FOC firmware library v3.0, a toolchain must be installed. Please check the availability on STMicroelectronics' website or contact your nearest STMicroelectronics' office to get documentation about the "STM32 PMSM FOC SDK v3.0 Motor Control Firmware Library" (see www.st.com/internet/com/SOFTWARE_RESOURCES/SW_COMPONENT/FIRMWARE/stm32_pmsm_foc_motorcontrol_fwlib.zip). The used firmware for STEVAL-IHM036V1 was customized with a free 32 kB limited version of the IAR™ tool "EWARM v6.0".

5.4 STM32 motor control firmware library v3.0 customization

(See: www.st.com/internet/com/SOFTWARE_RESOURCES/TOOL/CONFIGURATION_UTILITY/motorcontrol_workbench.zip.)

To customize the STM32 FOC firmware library v3.0, the "ST Motor Control Workbench" can be used. The required parameters for the power stage and control stage are reported in *Table 3* and *Table 4*.

Table 3. STEVAL-IHM036V1 motor control workbench parameters for power part

Parameter	STEVAL-IHM036V1 default value	Unit
ICL shutout	Disabled	
Dissipative brake	Disabled	
Bus voltage sensing	Disabled	
Bus voltage divider 1/…	116	
Min. rated voltage	18	V
Max. rated voltage	350	V
Nominal voltage	325	V
Temperature sensing	Enabled	
V0	1055	mV
T0	25	°C
ΔV/ΔT	29	mV/°C
Max. working temperature on sensor	90	°C
Overcurrent protection	Enabled	
Comparator threshold	0.55	V
Overcurrent network gain	0.39	V/A
Expected overcurrent threshold	1.41	A
Overcurrent feedback signal polarity	Active-low	
Overcurrent protection disabling network	Disabled	
Current sensing	Enabled	
Current reading topology	One shunt resistor	
Shunt resistor(s) value	0.4	Ω
Amplifying network gain	3.33	
T-rise	1000	ns
Power switches - minimal deadtime	500	ns
Power switches - max. switching frequency	50	kHz
U, V, W driver - high side driving signal	Active-high	
U, V, W driver - low side driving signal complemented from high side	Disabled	
U, V, W driver - low side driving signal polarity	Active-low	

Table 4. STEVAL-IHM036V1 motor control workbench parameters for control and drive part

Parameter	STEVAL-IHM036V1 default value	Unit
Digital I/O timer	TIM1	
TIM1 remapping	No remap	
Analog input - ADC channel for current reading	ADC1_IN0	
Analog input - bus voltage feedback	ADC1_IN3	
Analog input - temperature feedback	ADC1_IN7	
MCU selection - STM32 subfamily	Value line medium density	
MCU selection - CPU frequency	24	MHz
MCU selection - Nominal MCU voltage	3.3	V
Drive management - user interface - joystick, LCD, button	Disabled	
Drive management - user interface - DAC functionality	Enabled	
Drive management - user interface - serial communication	Disabled	
Drive management - drive settings - execution rate	2	PWM

The released firmware, which is loaded on the STEVAL-IHM036V1 demonstration board, is prepared in order to be compatible with the PMSM SHIMANO motor which is included in the “STM32 Motor Control Starter Kit” (see www.st.com/internet/evalboard/product/252075.jsp) package. It is run only in dual supply mode. The preloaded modification of the firmware is for demonstration purposes only. For testing purposes please connect a low voltage SHIMANO motor to connector J2. Remove jumper SW4 and apply auxiliary supply voltage +15 V to connector J5 with polarity, as marked on the demonstration board. Connect the supply source with nominal voltage 25 V capable of delivering 3 A into connector J1. The green LED D9 indicates +15 V auxiliary voltage. The yellow LED D12 indicates idle status of the MCU. The motor should start to turn immediately after pressing user button SW1, which is also indicated with the yellow LED D11. Pressing switch SW1 again causes motor halt.

6 Description of STEVAL-IHM036V1 connections

Table 5 gives a detailed description of the test pins used.

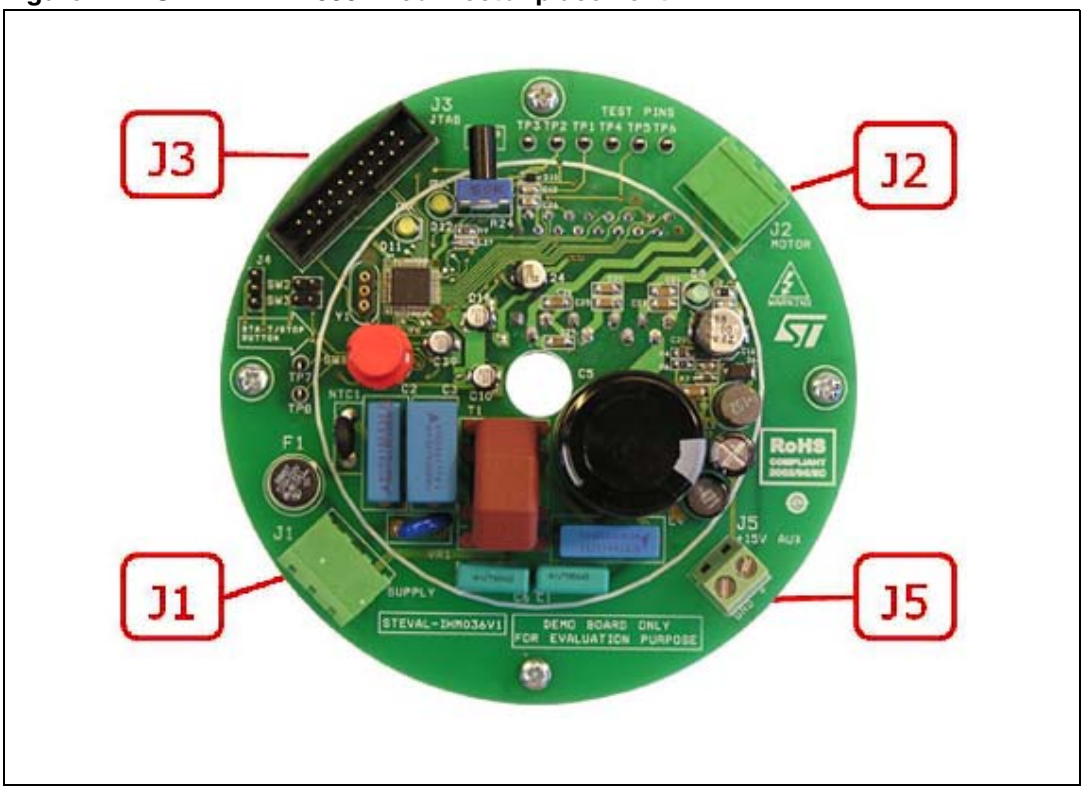
Table 5. Test pins description

Number	Description
TP1	15 VDC - auxiliary supply voltage
TP2	3.3 VDC - auxiliary supply voltage for MCU
TP3	GND
TP4	Current signal on the ADC1_IN0
TP5	Signal on input of overcurrent comparator
TP6	MC emergency STOP
TP7	DAC1_OUT
TP8	DAC2_OUT

Connector placement

A basic description of the placement of all connectors on the board is visible in *Figure 11*.

Figure 11. STEVAL-IHM036V1 connector placement



7 Bill of material

A list of components used to build the demonstration board is shown in *Table 6*. The majority of the active components used are available from STMicroelectronics.

Table 6. Bill of material

Reference	Value / part number	Manufacturer	Manufacturer code
C1, C6	4.7 nF/Y2	EPCOS	B32021A3472M
C2, C4	330 nF/X2	EPCOS	B32922C3334M
C3	220 nF/X2	EPCOS	B32922C3224M
C5	100 µF/400 V	EPCOS	B43505A9107M000
C7, C31	10 nF	Any	
C8, C9, C11, C12, C13, C19, C26, C37, C40, C42	100 nF	Any	
C10, C14	22 µF/6.3 V	Any	
C15	47 nF	Any	
C16	150 nF	Any	
C17	1 µF/400 V	Any	
C18	1 µF/50 V	Any	
C20	100 µF/25 V	Panasonic	EEEFC1E101AP
C21, C22, C23, C25, C28, C29	1 µF/50 V	Any	
C24	4.7 µF/25 V	Panasonic	EEE1EA4R7SR
C27	330 pF	Any	
C30	2.2 nF	Any	
C32	100 pF	Any	
C33	33 pF	Any	
C34	22 nF	Any	
C35	68 nF	Any	
C36, C38	30 pF	Any	
C39	6.8 µF/10 V	Any	
SW2, SW3, R38, R39, R40, R41, C41, R42	Not assembled		
D1, D2, D4, D5	1N4007SMD	Any	
D6, D7	STTH1L06A	STMicroelectronics	STTH1L06A
D3, D10	BAT48JFILM	STMicroelectronics	BAT48JFILM
D8	BZV55C18SMD	Any	
D9	LED green	Any	

Table 6. Bill of material (continued)

Reference	Value / part number	Manufacturer	Manufacturer code
D11, D12	LED yellow	Any	
F1 (A)	2 A	Any	
F1 (B)	Fuse socket	Any	
J1 (A), J2 (A)	Connector header	Würth Elektronik	691 313 710 003
J1 (B), J2 (B)	Connector vertical	Würth Elektronik	691 352 710 003
J3	Connector MLW10	Any	
J4	Not assembled		
J5	+15 V AUX.	Würth Elektronik	691 212 710 002
L1	470 µH	Würth Elektronik	744 741 471
L2	2.2 mH	Würth Elektronik	768 772 152
L3	100 µH	Panasonic	ELJFC101JF
NTC1	10 Ω	EPCOS	B57153S100M
RT1	10 kΩ	EPCOS	B57471V2103J062
R1, R2	470 kΩ	Any	
R3	8k2	Any	
R4	51 k	Any	
R5	120 R	Any	
R6	13 kΩ	Any	
R7	68 kΩ	Any	
R8	7.5 kΩ	Any	
R9	3.3 kΩ	Any	
R24	10 kΩ	Any	
R26, R28, R29, R31, R32, R33, R34, R35	10 kΩ	Any	
R10, R11, R12, R13	1.6 Ω	Any	
R14	Not assembled	Any	
R15, R16, R23	1 kΩ	Any	
R17	18 kΩ	Any	
R18, R25	4.7 kΩ	Any	
R19, R20	6.2 kΩ	Any	
R21, R22	1 kΩ	Any	
R27	100 Ω	Any	
R30	1 MΩ	Any	
R36, R37	1.6 kΩ	Any	
SW1	USER button	Any	

Table 6. Bill of material (continued)

Reference	Value / part number	Manufacturer	Manufacturer code
SW4	SHORTED		
TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP8	Test points	Any	
T1	CM_choke 12 mH	Würth Elektronik	744 622 1012
U1	VIPer16LD	STMicroelectronics	VIPer16LD
U2	L78L33ACU	STMicroelectronics	L78L33ACU
U3	STGIPN3H60	STMicroelectronics	STGIPN3H60
U4	STM32F100C6T6B	STMicroelectronics	STM32F100C6T6B
U5	Not assembled	STMicroelectronics	ST3485ECD
VR1	592-275; p-600 mW	Any	
Y1	8 MHz	Any	

8 PCB layout

For this application, a standard, double-layer, coppered PCB with a ~60 µm copper thickness was selected. The PCB material is FR-4.

The dimensions of the board are:

- Circular shape: diameter 115 mm (diameter of the proposed functional area without connectors is 80 mm)
- PCB thickness: 1.55 mm

Figure 12. Component placement - top side

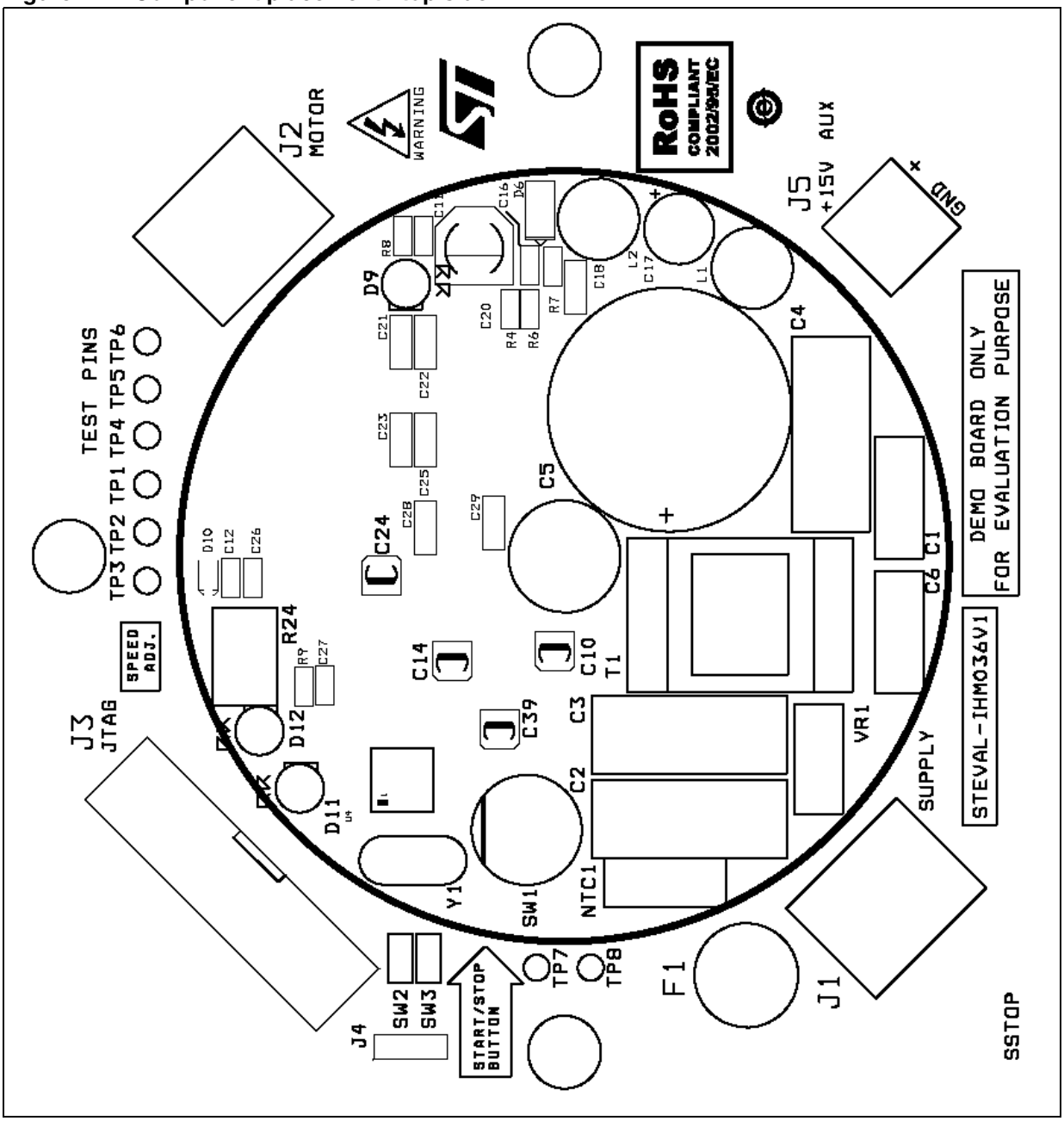
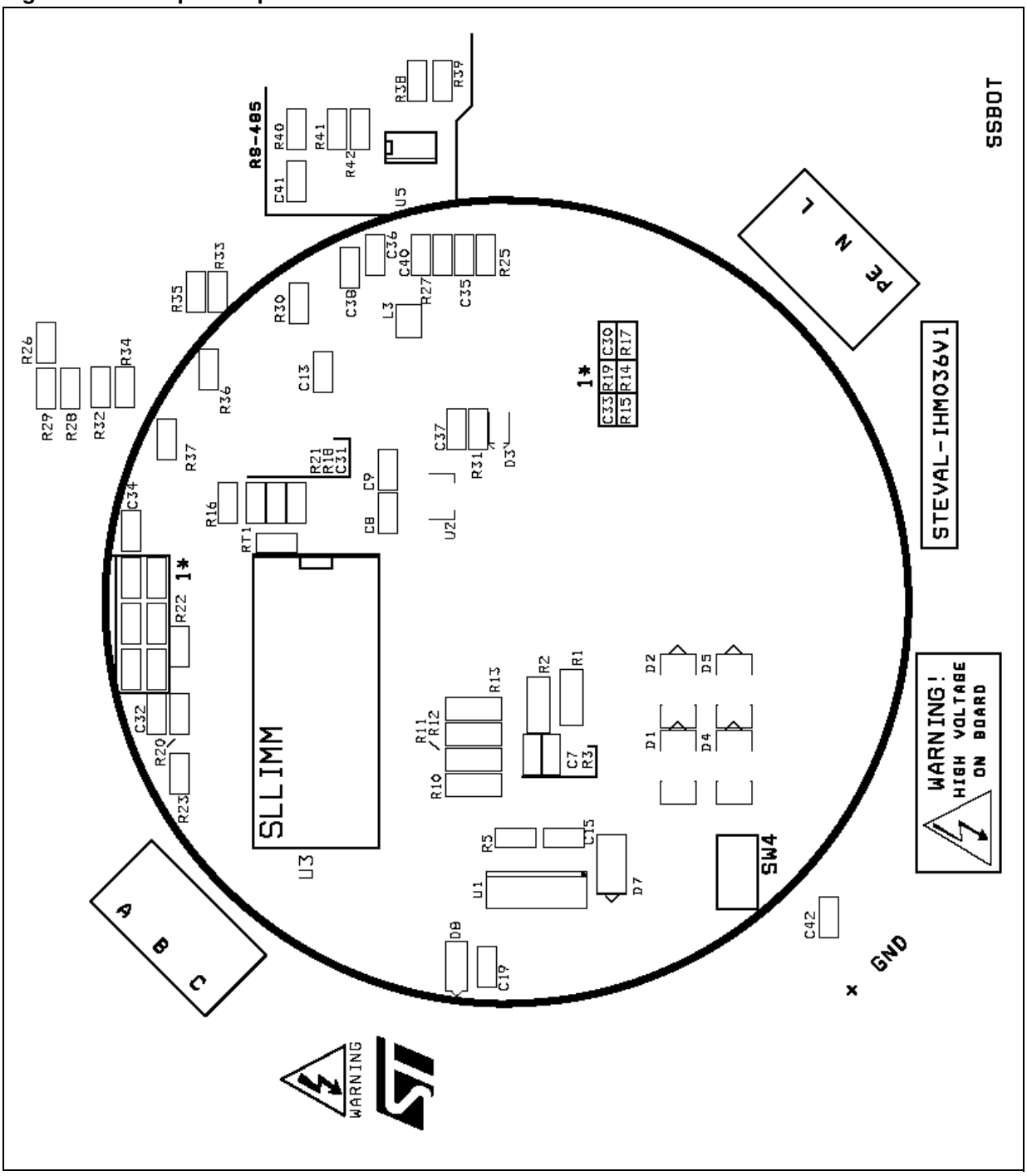


Figure 13. Component placement - bottom side



9 Ordering information

The demonstration board is available through the standard ordering system, the ordering code is: STEVAL-IHM036V1. The items delivered include the assembled demonstration board, board documentation, and PCB fabrication data, such as Gerber files, assembly files (pick and place), component documentation, and firmware with commented source code.

10 Conclusion

This document describes a low power 3-phase motor control STEVAL-IHM036V1 demonstration board based on the SLLIMM™ module STGIPN3H60 and STM32F100C6T6B MCU as a universal and adaptable motor control platform for low power, single-phase supply applications.

11 References

1. STGIPN3H60 datasheet
2. VIPer16 datasheet
3. STM32F100x4 STM32F100x6 STM32F100x8 STM32F100xB datasheet
4. UM0379 user manual
5. www.st.com/internet/mcu/family/141.jsp

12 Revision history

Table 7. Document revision history

Date	Revision	Changes
30-Nov-2011	1	Initial release.

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