UM1553
User manual

STEVAL-IHM034V2 dual motor control and PFC demonstration board featuring the STM32F103RC and STGIPS20C60

Introduction

The STEVAL-IHM034V2 is a complete motor control kit solution, for the evaluation of STMicroelectronics wide product portfolio targeted at applications where it is necessary to simultaneously drive two motors in sensorless field oriented control (FOC) and perform active power factor correction (PFC) through digital control of a single-stage boost DC-DC converter. Typical application is in room air conditioners (RACs), where this solution can drive the compressor, the outdoor fan, and the PFC.

The microcontroller unit is the STMicroelectronics ARM™ Cortex-M3 core-based STM32F103RC, which is able to simultaneously carry out all the above mentioned tasks. The board is compatible for use with the STM32F2 series, and with the ARM™ Cortex-M4 core-based STM32F4 series.

Motor 1 is powered by the onboard SLLIMM™ (small low-loss intelligent molded module) STGIPS20C60; motor 2 can be powered by an external STMicroelectronics power stage, such as those that can be evaluated by means of the STEVAL-IHM021V2, STEVAL-IHM024V1, STEVAL-IHM032V1, or STEVAL-IHM035V2.

Simultaneously, the same microcontroller unit drives the onboard boost PFC stage, designed with the STGW35HF60W ultrafast IGBT and the STTH15R06 Turbo2 ultrafast diode.

The STEVAL-IHM034V2 can be used together with the STM32 permanent magnet synchronous motors (PMSM) single/dual FOC software development kit (SDK) v3.2, and successive versions, and its compatible PFC firmware v1.0 plug-in, and successive versions. This user manual provides information on using the STEVAL-IHM034V2 board and its hardware features.

Figure 1. Image

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- Nominal power: 1300 W, max. power 1700 W
- Digital PFC section:
  - Single-stage boost converter
  - STGW35HF60WD ultrafast IGBT in TO-247 package; it may be replaced with an STGW35HF60W if a free-wheeling diode (like the STTH2L06) is soldered on between its collector and emitter
  - Turbo2 ultrafast diode STTH15R06D in TO-220AC package
  - AC mains current sensing (shunt resistor and amplification, using rail-to-rail input/output 8 MHz TSV914)
  - DC bus voltage sensing
  - Hardware overcurrent protection
  - Hardware overvoltage protection
  - AC mains voltage zero crossing detection
  - Rectified AC mains voltage sensing
  - External boost inductor
- Inverter section (motor 1 drive):
  - IGBT intelligent power module STGIPS20C60 in SDIP 25L molded package
  - 3-shunt or DC link motor current sensing (shunt resistor and amplification, using rail-to-rail input/output 8 MHz TSV914)
  - Hardware overcurrent protection
  - Heatsink temperature measurement
  - Overcurrent protection disabling network
- Control section:
  - Centralized dual motor control and PFC drive, using STM32F103RCT6
  - MC connector to drive the second motor power stage (a compatible power board, such as STEVAL-IHM021V2, STEVAL-IHM024V1, or STEVAL-IHM032V1, can be plugged here)
  - SWD programming and debugging
  - JTAG programming (DC +5 V supply only, see *Section 2.4*)
  - USART communication using ST3232C, insulated with optocouplers;
  - Other functions: user key, reset, potentiometer, user LED, NTC relay, test points
- Power supply:
  - +15 V, +3.3 V power supply based on VIPER16, L78L33AC, LD1117S33TR.

1.1 Target application

Air conditioning motor drive (compressor, outdoor fan) and PFC.

2 Safety and operating instructions

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 a 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.

2.1 Demonstration board intended use

The STEVAL-IHM034V2 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.

2.2 Demonstration board installation

The installation and cooling of the demonstration board must be done 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 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).

2.4 Microcontroller programming

Only when an opto-isolated SWD dongle (such as the ST-LINK/V2-ISOL) or an isolated laptop is available, can the application be programmed and debugged in SWD mode being powered by the AC mains.

On the contrary, it can be programmed in SWD or JTAG mode while J14 is being supplied from an external +5 V DC source. The external +5 V DC source must always be removed before plugging AC mains terminals.

It is recommended that the firmware takes over heatsink temperature measurement and related actions when the heatsink is overheating, and to close, after a certain time, the in-rush current limiter.

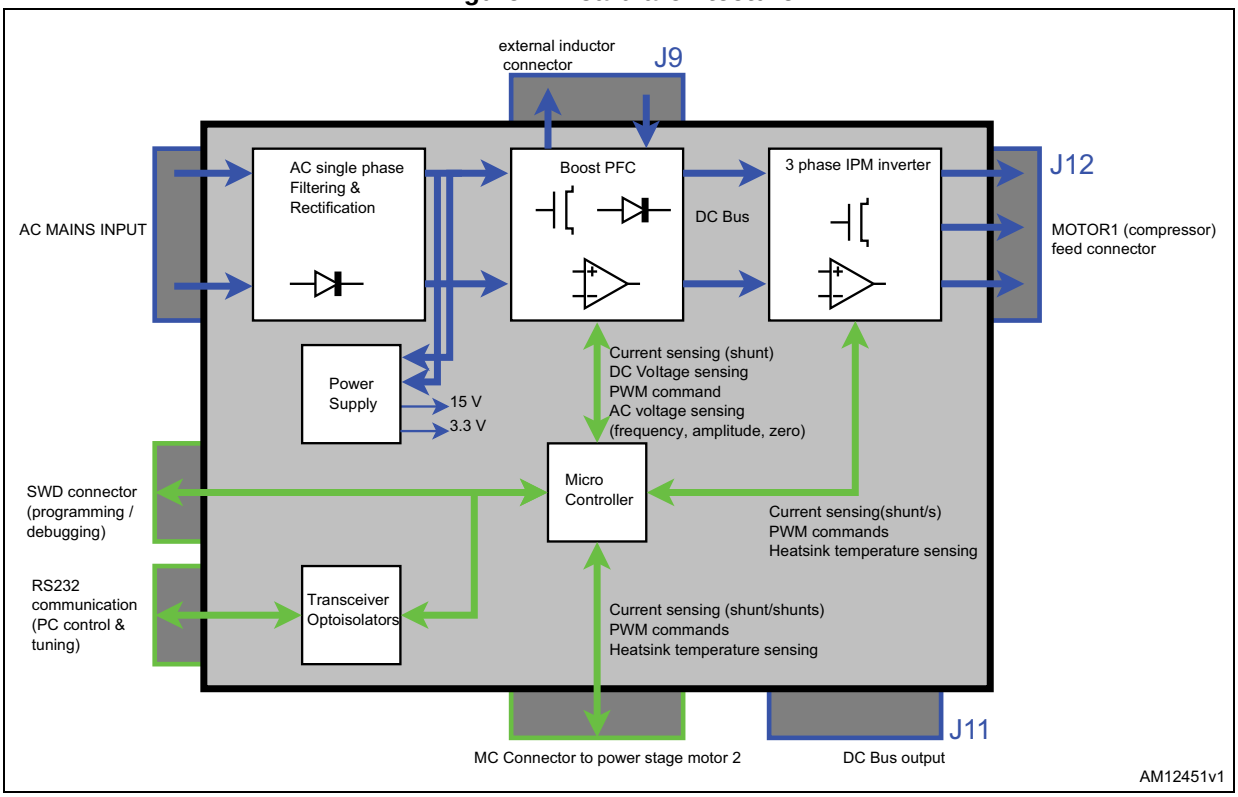
3 Board description

3.1 System architecture

Figure 2 shows the board architecture. It is made up of:

- Converter stage: single phase AC-DC rectifier, microcontroller-driven DC-DC boost for power factor correction functionality and related protection, signals and conditioning
- Inverter stage: microcontroller-driven DC-AC three-phase inverter and related protection, signals and conditioning
- Power supply: provides +15 V, +3.3 V
- Control: the onboard programmable microcontroller is able to receive commands and send measurements using an opto-isolated RS232 channel. It controls power devices (inverter, PFC, optional second motor power stage) and senses signals related to motor currents, mains current, bus voltage, heatsink temperature, and mains frequency.

Figure 2. Board architecture



3.2 Board schematic

Figure 3. Schematic (1 of 9)

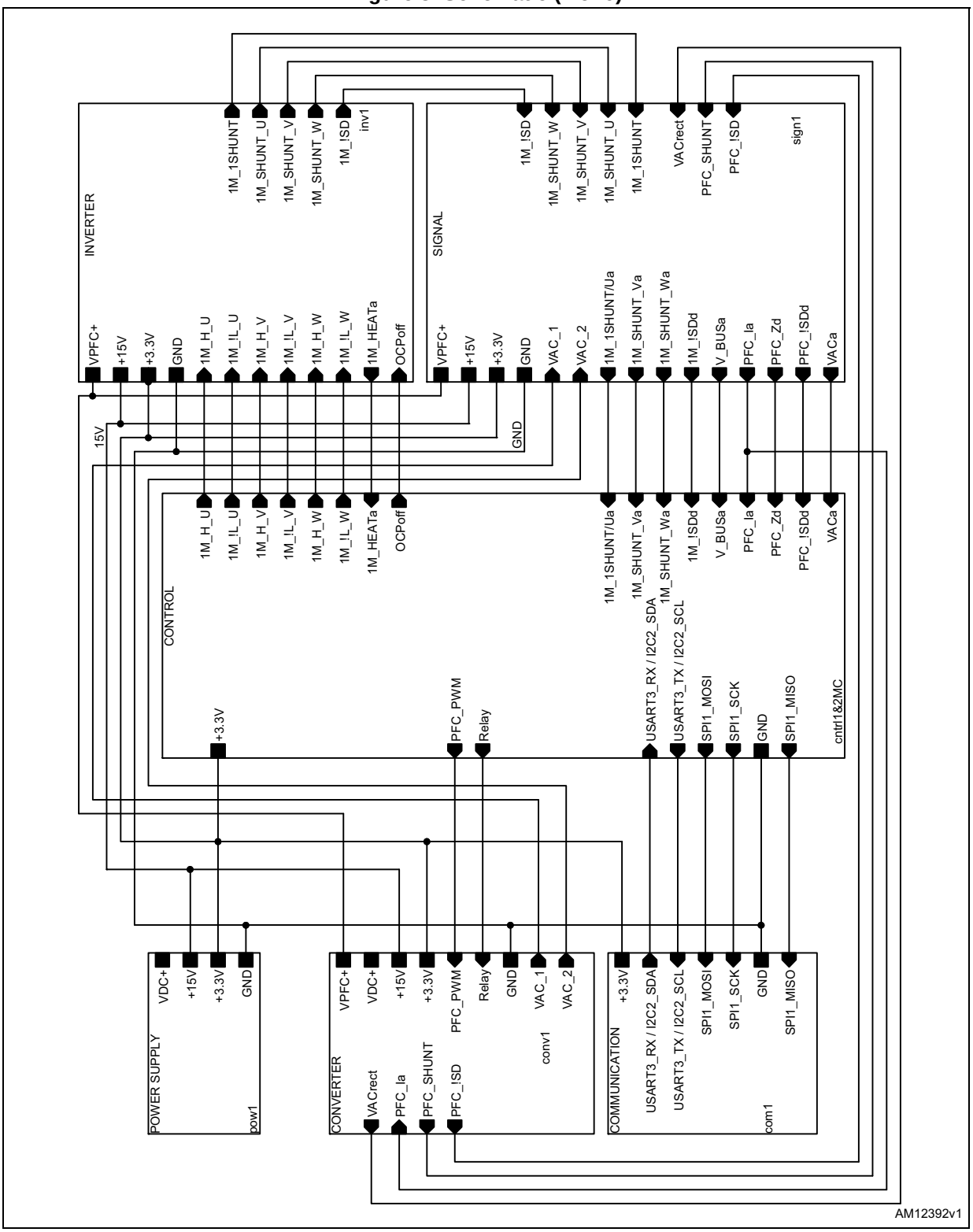


Figure 4. Schematic (2 of 9)

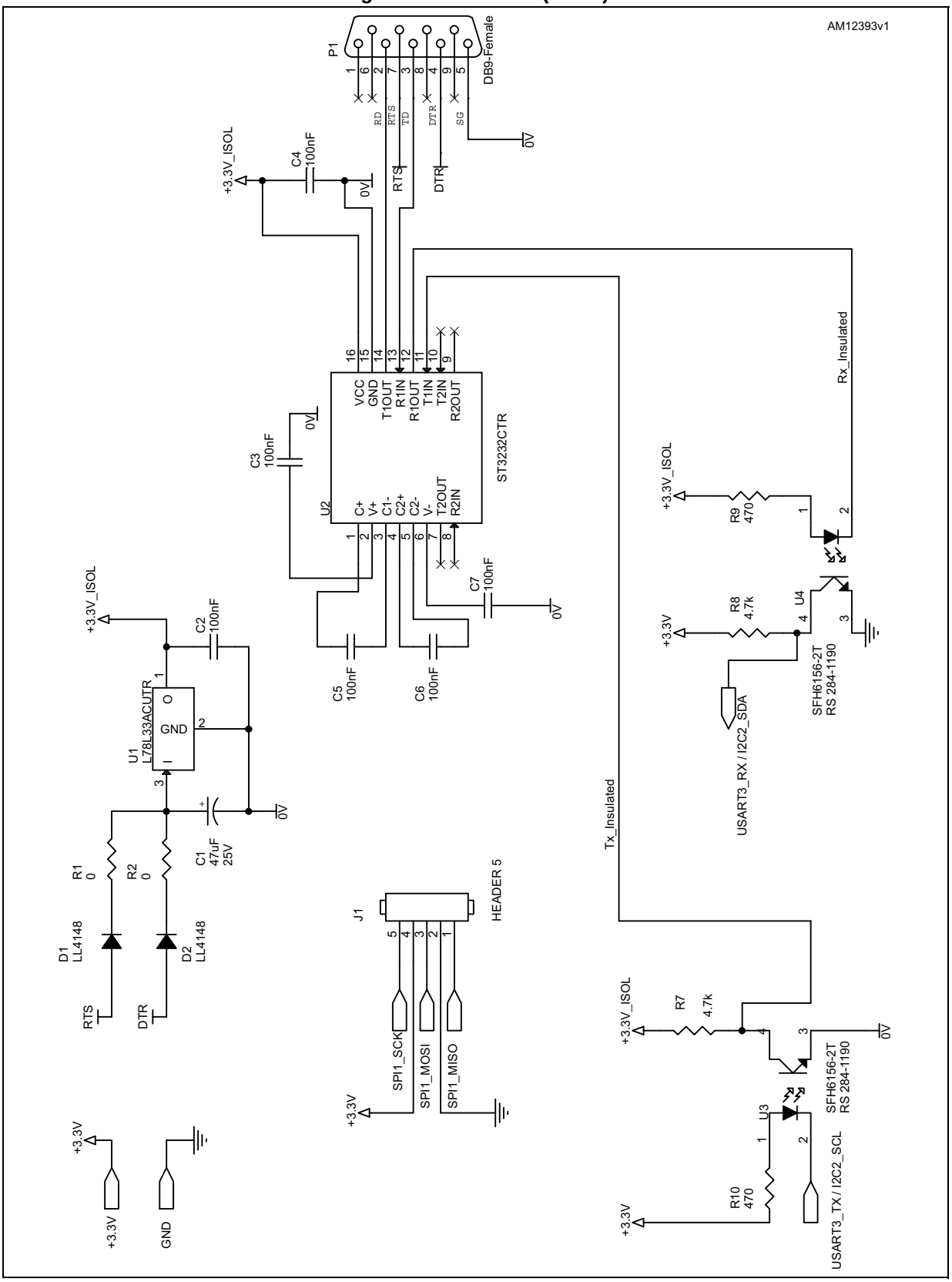


Figure 5. Schematic (3 of 9)

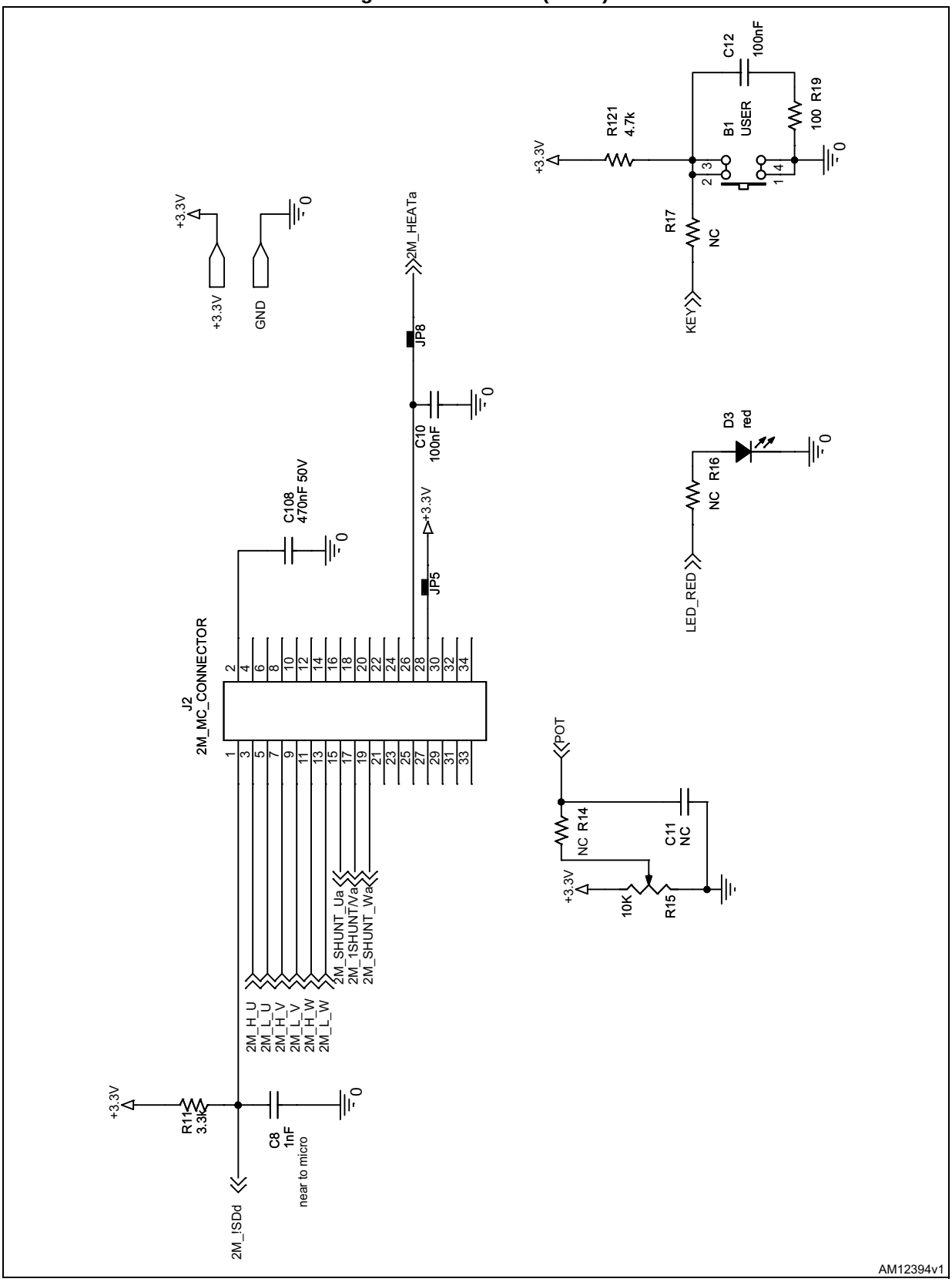


Figure 6. Schematic (4 of 9)

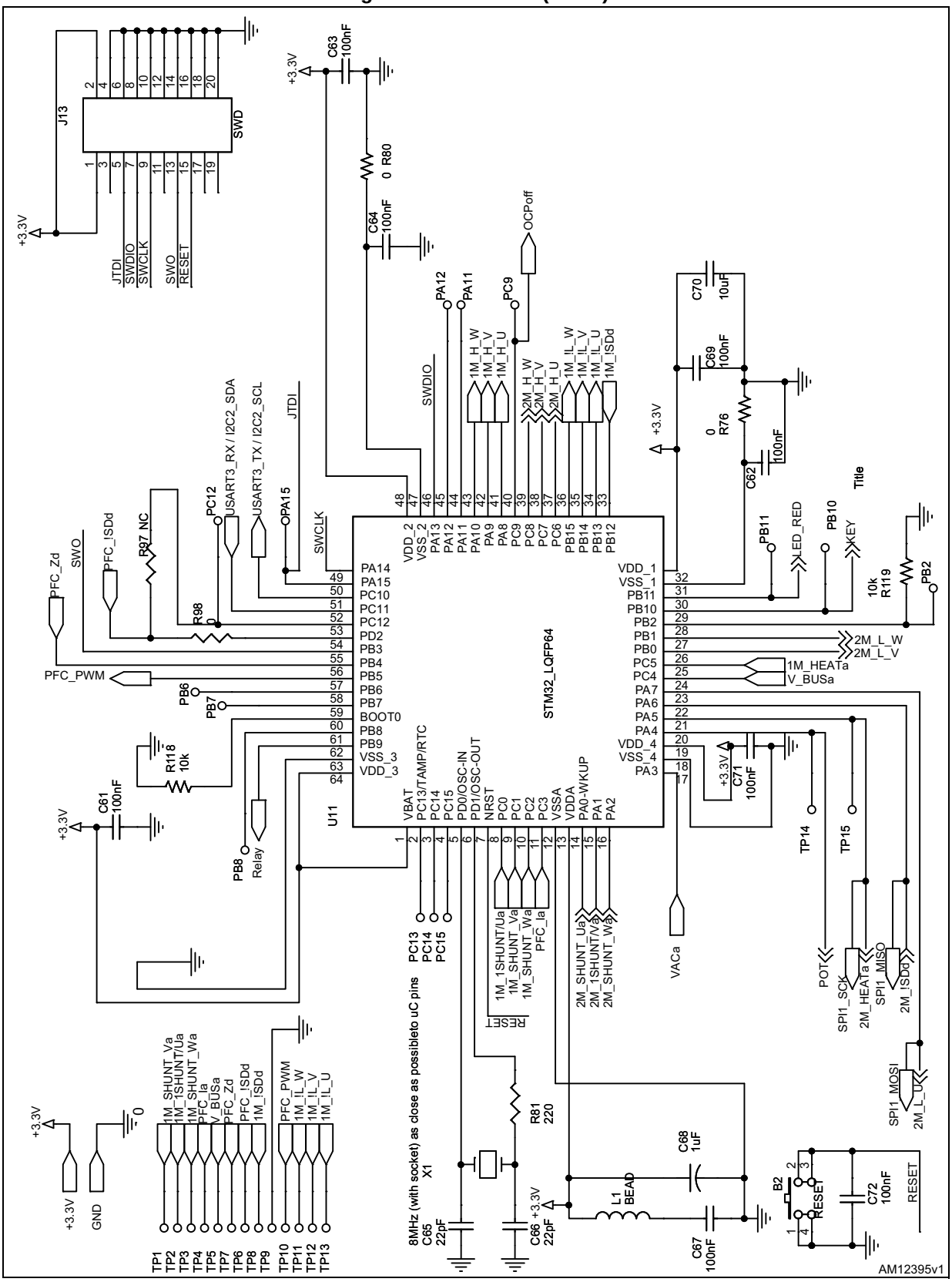


Figure 7. Schematic (5 of 9)

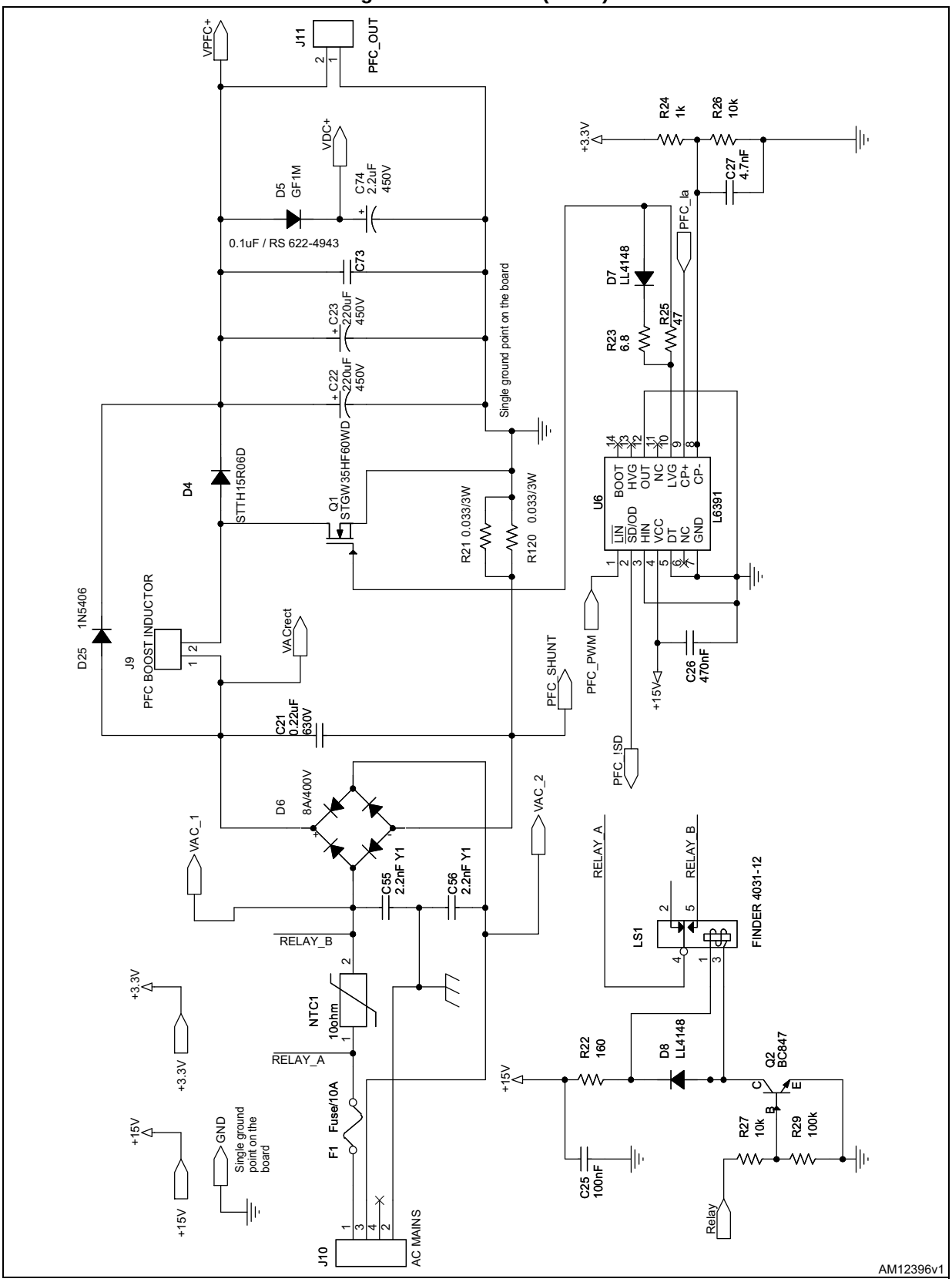


Figure 8. Schematic (6 of 9)

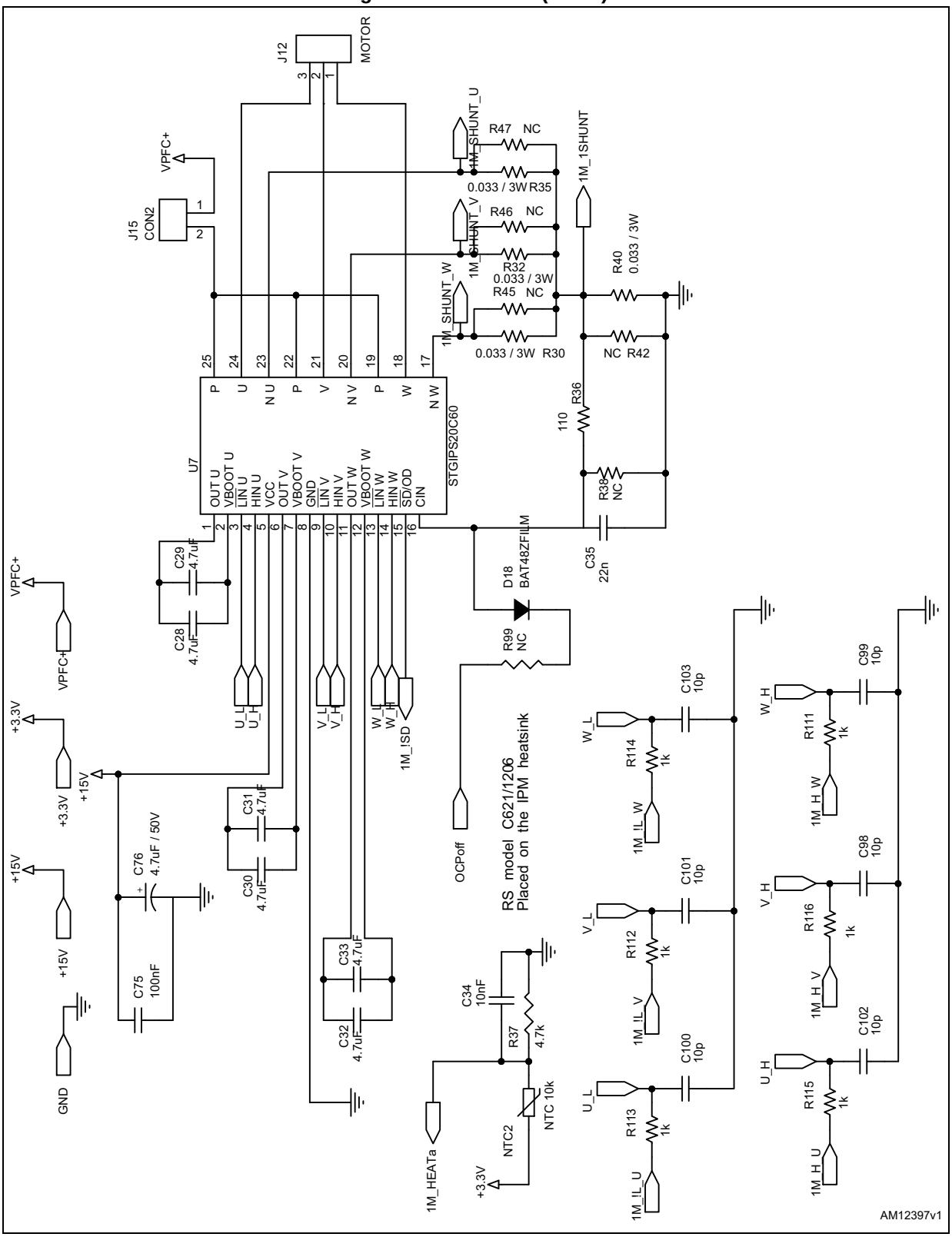


Figure 9. Schematic (7 of 9)

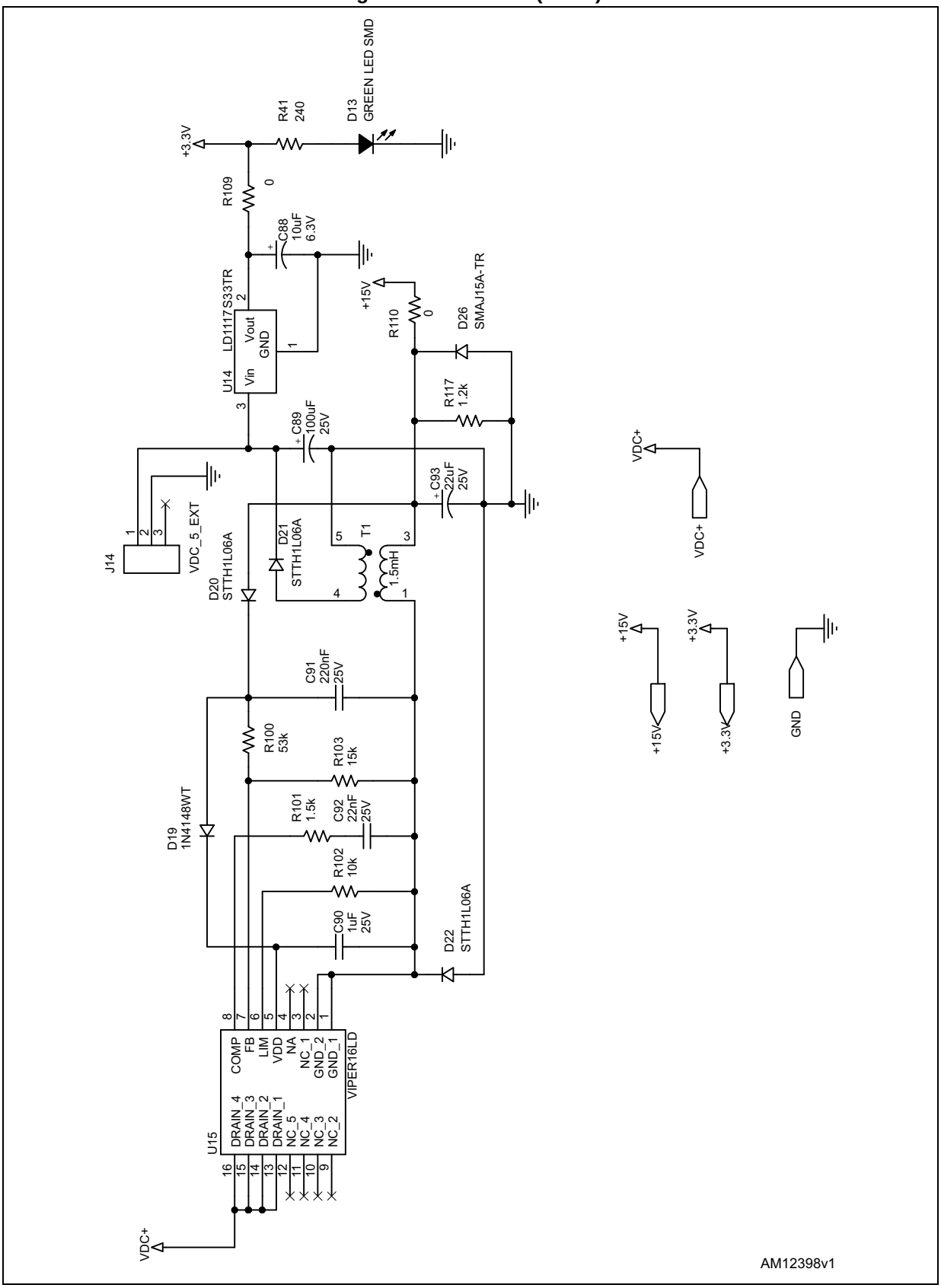


Figure 10. Schematic (8 of 9)

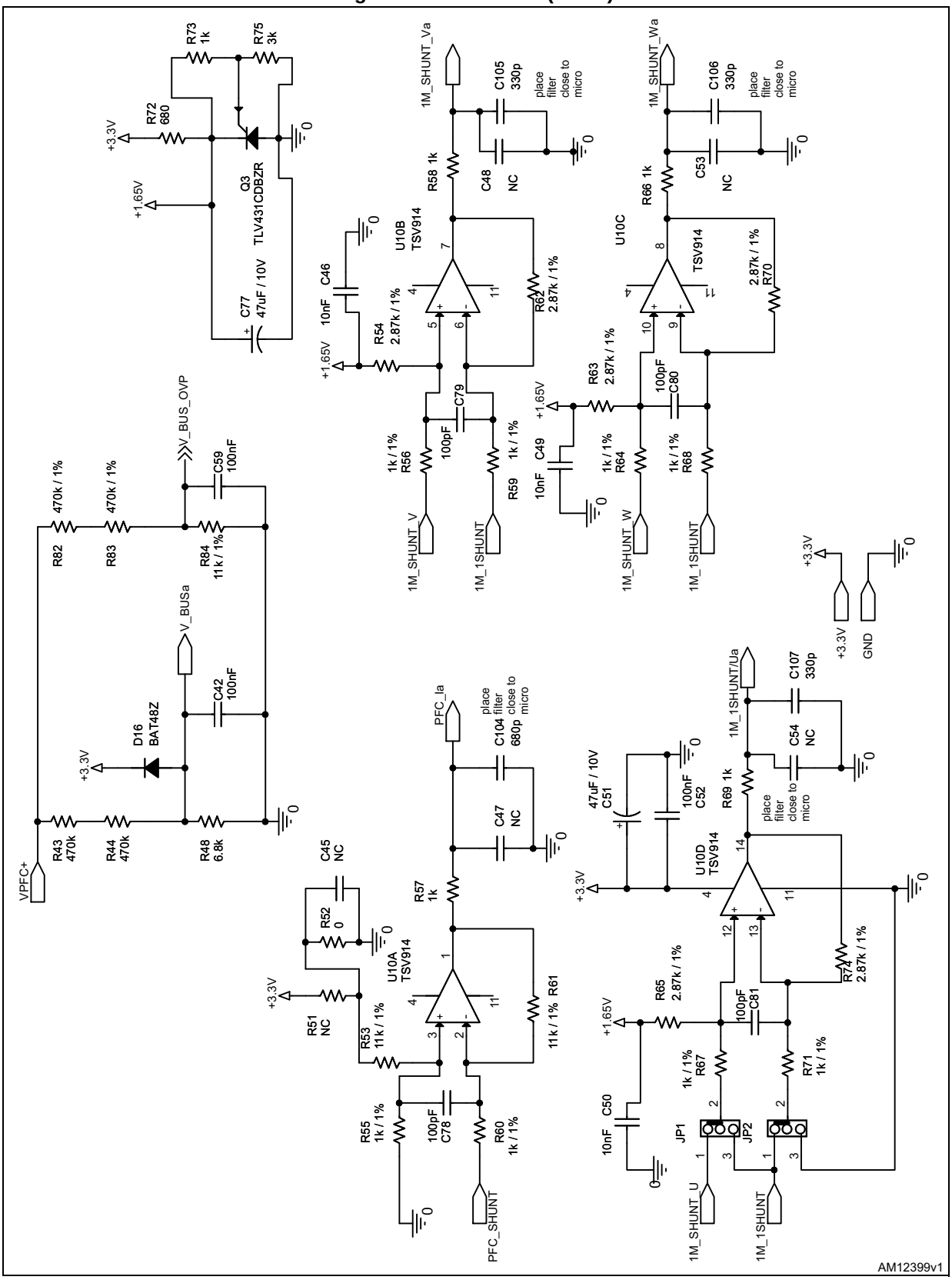
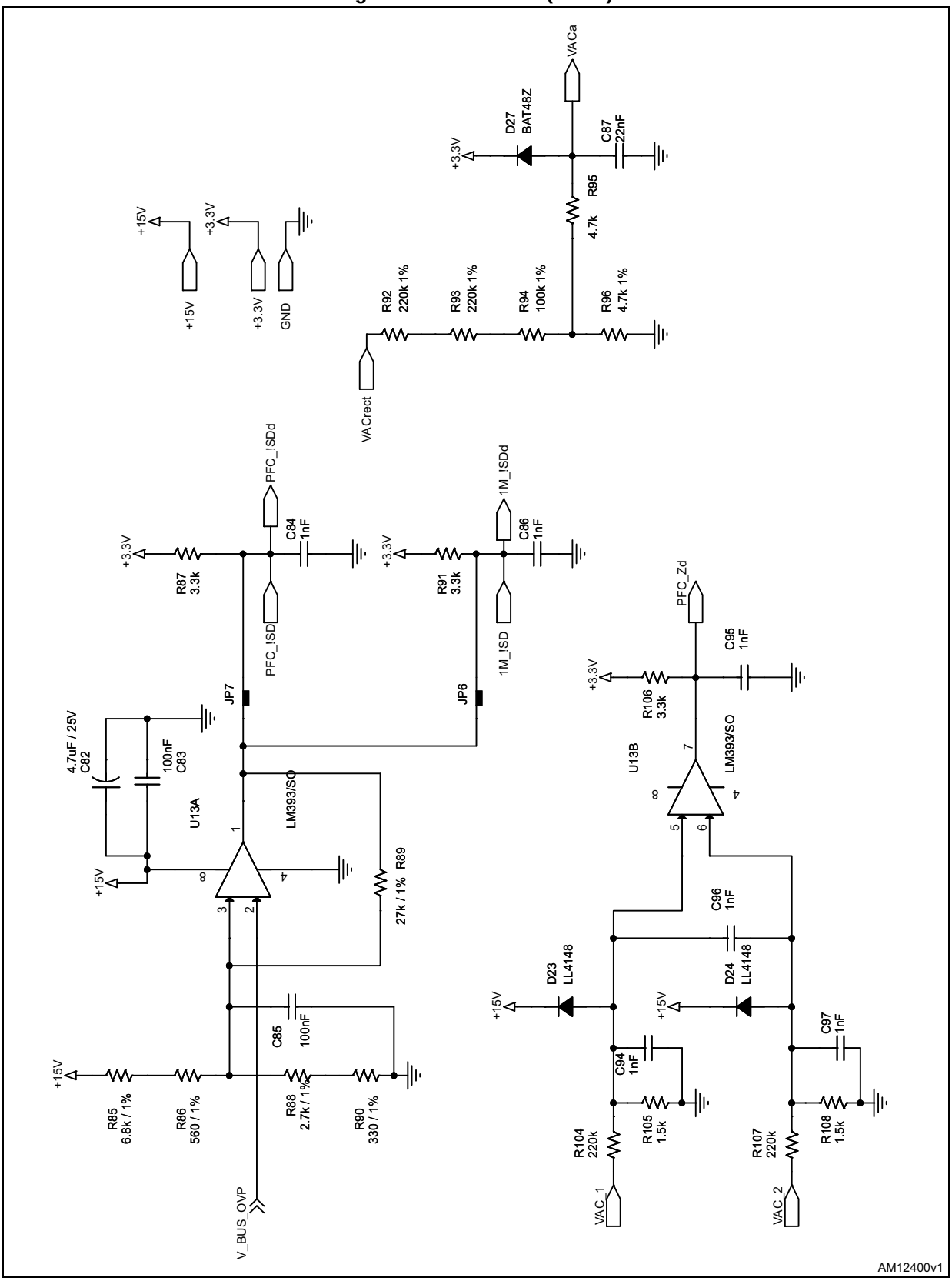


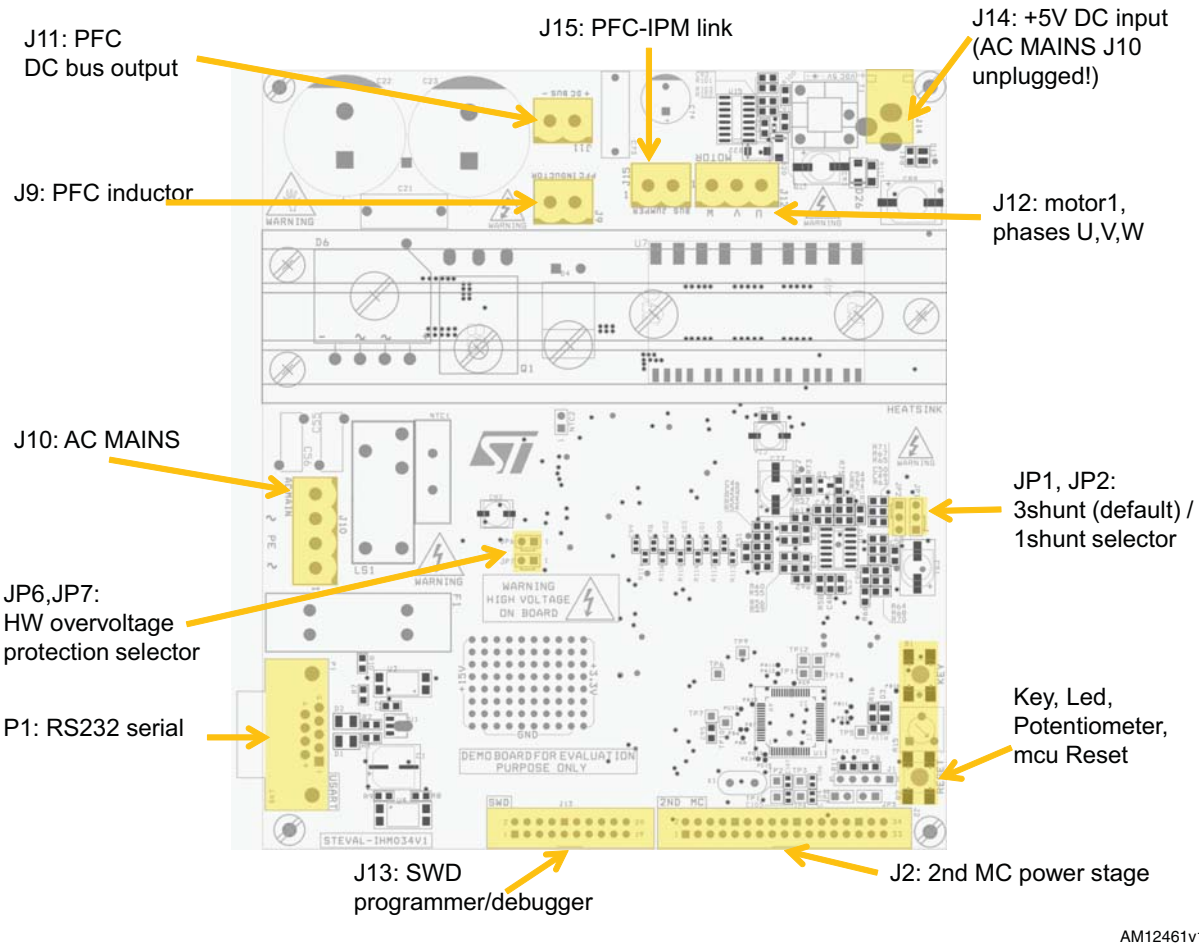
Figure 11. Schematic (9 of 9)



4 Connector placement

A basic description of the placement of the most important connectors and jumpers on the board is represented in *Figure 12*.

Figure 12. Connector placement



5 Description of jumpers, test pins and connectors

Table 1, *2* and *3* give a detailed description of the jumpers, test pins, and pinout of the connectors used.

Table 1. Jumper description

Jumper	Selection	Description
JP1, JP2	JP1 and JP2 both default position (as silk screen)	3-shunt current sensing
	JP1 and JP2 both contrary position (as silk screen)	1-shunt (DC bus link) current sensing
JP5	JP5 present (default)	+3.3 V linked with 2nd motor power stage (if present)
	JP5 **NOT** present	+3.3 V NOT linked with 2nd motor power stage (if present)
JP6	JP6 present (default)	Hardware overvoltage protection (and PFC overcurrent protection, according to JP7) OR-ed with motor overcurrent protection, therefore acting at the same time on the STM32 BKIN pin and STGIPS20C60 !SD/OD pin
	JP6 **NOT** present	Hardware overvoltage protection (and PFC overcurrent protection, according to JP7) NOT OR-ed with motor overcurrent protection
JP7	JP7 present (default)	Hardware overvoltage protection OR-ed with PFC overcurrent protection, therefore acting at the same time on the STM32 TIM3_ETR pin and L6391 !SD/OD pin
	JP7 **NOT** present	Hardware overvoltage protection NOT OR-ed with PFC overcurrent protection (not recommended)
JP6 & JP7	JP6 and JP7 present	Hardware overvoltage protection, motor overcurrent protection and PFC overcurrent protection OR-ed and acting at the same time on the STM32 TIM3_ETR, BKIN pins, L6391 !SD/OD pin, STGIPS20C60 !SD/OD pin
	JP6 and JP7 **NOT** present	Overvoltage protection disabled (not recommended)
JP8	JP8 present (default)	Heatsink temperature from motor 2 power stage can be measured by STM32 through pin PA5; DAC peripheral should be disabled
	JP8 **NOT** present	Heatsink temperature from motor 2 power stage cannot be measured by STM32 through pin PA5, DAC peripheral may be enabled if, at the same time, R14 is NC (see below)
R14	0 Ohm	The onboard potentiometer R15 can be measured by STM32 through pin PA4, DAC peripheral should be disabled
	NC (default)	The onboard potentiometer R15 cannot be measured by STM32 through pin PA4; DAC peripheral may be enabled if, at the same time, JP8 is removed (see above).
R99	NC (default)	Motor 1 overcurrent protection disabling can't be performed
	0 Ohm	Motor 1 overcurrent protection disabling may be done by STM32 through pin PC9

Table 1. Jumper description (continued)

Jumper	Selection	Description
J15	J15 present (default)	PFC stage linked with IPM DC power inputs. This jumper can be conveniently used to measure (with an isolated probe) PFC current output, so as to assess PFC efficiency
	J16 not present	PFC stage not linked with IPM DC power inputs. In this condition, the PFC load is only that supplied from connector J11

Table 2. Connector description

Name	Description
J9	PFC inductor connector; if PFC stage is not used, a short jumper (able to bear DC bus capacitor charge currents) should be connected here, otherwise the rectified AC mains is not used (power supply, inverter, microcontroller not fed)
J10	AC mains connector.
J11	DC bus output connector, polarity to respect board silkscreen; if the system is to be configured for dual motor control, motor 2 power stage is to be fed with DC voltage from here. On the contrary, the connector can remain unused.
J12	Motor 1 connector: U: phase U V: phase V W: phase W
J13	STM32 SWD programming and debugging
	STM32 JTAG programming, **only if AC mains is disconnected** and board supplied through J14.
J14	+5 V DC power supply for offline (power stage OFF) STM32 programming or debugging. **The board should never be supplied from both J10 and J14.** When STM32 is supplied from J14, it can be programmed / debugged through the JTAG channel
2ND_MC (J2 in schematics)	Motor control connector for second motor power stage, if the system is to be configured for dual motor control.
P1	RS232 serial communication port

Table 3. Test point description

Number	Description
TP1	3-shunt configuration (refer to JP1/JP2): motor current phase V - amplified measurement of voltage drop on shunt R32
	1-shunt configuration (refer to JP1/JP2): motor currents (DC link method) - amplified measurement of voltage drop on shunt R40
TP2	3-shunt configuration (refer to JP1/JP2): motor current phase U - amplified measurement of voltage drop on shunt R35

Table 3. Test point description (continued)

Number	Description
TP3	3-shunt configuration (refer to JP1/JP2): motor current phase W - amplified measurement of voltage drop on shunt R30
TP5	DC bus partition as sent to the microcontroller, partitioning ratio is 139
TP6	PFC overcurrent protection signal (active low)
TP7	AC mains, voltage zero crossing detection signal
TP8	Motor 1, overcurrent protection signal (active low)
TP9	GND
TP10	PWM signal sent from microcontroller to PFC driver
TP11	PWM signal, phase U, low-side, sent from microcontroller to IPM inverter
TP12	PWM signal, phase V, low-side, sent from microcontroller to IPM inverter
TP13	PWM signal, phase V, low-side, sent from microcontroller to IPM inverter
TP14	DAC peripheral, output 1
TP15	DAC peripheral, output 2

6 STM32 pinout

Table 4 summarizes the STM32 pinout assignment on this STEVAL-IHM034V2.

Table 4. STM32 pin assignment

Functionality	STM32 peripheral	Port / pin		Connected to	
Motor 1	TIM1,ch1N	PB13	No remap	STGIPS20C60	!LIN U
	TIM1, ch2N	PB14			!LIN V
	TIM1, ch3N	PB15			!LIN W
	TIM1, ch1	PA8			HIN U
	TIM1, ch2	PA9			HIN V
	TIM1, ch3	PA10			HIN W
	TIM1, BKIN	PB12			!SD/OD
	ADC123, ch 10	PC0		TSV914	1-shunt: DC link current measurement 3-shunt: phase U current measurement
	ADC123, ch 11	PC1			3-shunt: phase V current measurement
	ADC123, ch 12	PC2			3-shunt: phase W current measurement
Motor 2	TIM8,ch1N	PA7		2ND_MC connector, pin 5	
	TIM8, ch2N	PB0		2ND_MC connector, pin 9	
	TIM8, ch3N	PB1		2ND_MC connector, pin 13	
	TIM8, ch1	PC6		2ND_MC connector, pin 3	
	TIM8, ch2	PC7		2ND_MC connector, pin 7	
	TIM8, ch3	PC8		2ND_MC connector, pin 11	
	TIM8, BKIN	PA6		2ND_MC connector, pin 1	
	ADC12, ch 5	PA5 (through jumper JP8)		2ND_MC connector, pin 26; heatsink temperature	
	ADC123, ch 1	PA1		2ND_MC connector, pin 17; 1-shunt: DC link current measurement network; 3-shunt: phase V current measurement	
	ADC123, ch 0	PA0		2ND_MC connector, pin 15; 3-shunt: phase U current measurement	
	ADC123, ch 2	PA2		2ND_MC connector, pin 19; 3-shunt: phase W current measurement	
PFC	TIM3, ch1	PB4	Partial remap	L6391	PWM !LIN
	TIM3, ch2	PB5		LM193	AC mains zero crossing voltage detector

Table 4. STM32 pin assignment (continued)

Functionality	STM32 peripheral	Port / pin		Connected to	
PFC	TIM3, ETR	PD2		L6391	Overcurrent protection !SD/OD
	ADC123, ch 13	PC3		TSV914	PFC current measurement
	ADC123, ch3	PA3		AC mains rectified, partitioned voltage, sampled before PFC stage	
RS232 communication	USART3, RX	PC11	Partial remap	ST3232CTR	R1OUT
	USART3, TX	PC10			T1IN
DC bus voltage	ADC12, ch14	PC4		DC bus partitioned voltage	
Heatsink temperature	ADC12, ch15	PC5		Voltage from NTC2 network	
User key LED Potentiometer	GPIO GPIO ADC12, ch4	PB10 PB11 PA4		B1, through R17 D3, through R16 R15, through R14 not mounted	
In-rush current limiter relay	GPIO	PB9		Relay LS1 driving network	
Overcurrent disabling network	GPIO	PC9		D18, through R99 not mounted	

6.1 Configuration for STM32F2 and STM32F4 series

This board is able to host a microcontroller from the STMicroelectronics STM32F2 and STM32F4 series, please contact your nearest ST sales office or support team to request samples.

These parts have a close compatibility with the STM32F103 family, all functional pins are pin-to-pin compatible, therefore *Table 4* continues to be valid.

On the other hand, some power pins are different (see relevant datasheets) but this board - through few resistors - allows the modifications needed to be implemented, summarized in *Table 5*.

Table 5. STM32F2 and STM32F4 configuration

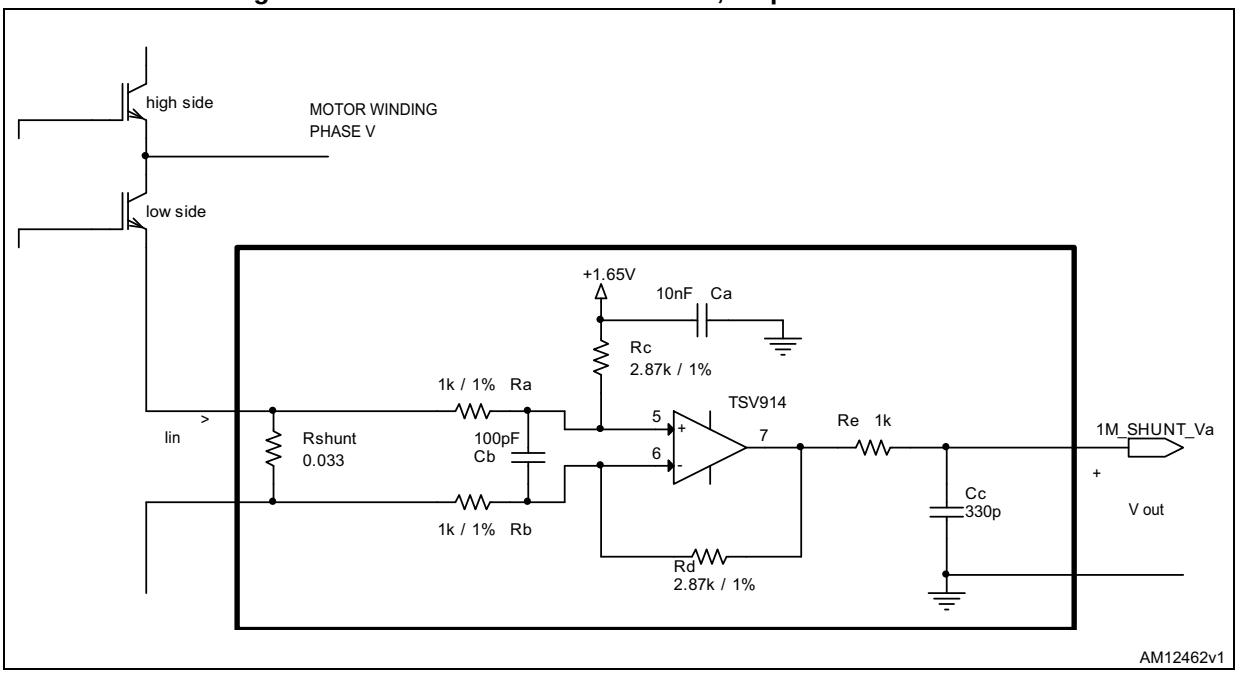
STM32 part onboard	Board configuration
STM32F103	R80 = 0 Ω; R76 = 0 Ω
STM32F2 or STM32F4	R80 = not present; R76 = not present

7 Hardware settings / configuration

7.1 Motor 1, phase current amplification network

Motor 1 phase current measurements are performed using shunt resistors (single or 3-shunt topology, according to jumpers JP1 and JP2) and the differential amplification network shown in *Figure 13* for phase V; phase U, W and DC link have the same topology, *Table 5* summarizes - for each of them - the components used.

Figure 13. Motor current measurement, amplification network



Maximum current that can be read - compatibly with IPM capability - is set to be 17.6 A 0-to-pk, 12.45 A RMS.

A 0.033 Ω shunt resistor is chosen, whose power rate should be greater than:

Equation 1

$$P_{shunt} = \frac{R_{shunt} \cdot {I_{rms}}^2}{2} = \frac{0.033\Omega \cdot 12{,}45\ A^2}{2} = 2.55W$$

The amplification network must allow bidirectional current sensing, so that an output offset Vo = +1.65 V represents a zero current.

Therefore, the maximum measurable phase current, considering that the output swings from +1,65 V to +3.3 V for positive currents and from +1.65 V to 0 for negative going currents, is:

Equation 2

$$MaxMeasCurrent = \frac{\Delta V}{r_m} = \frac{1.65V}{r_m} = 17.6A$$

$$r_m = \frac{\Delta \mathrm{V}}{\mathrm{MaxMeasCurrent}} = \frac{1.65V}{17.6A} = 0.09375\Omega$$

The overall trans-resistance of the two-port network - represented by the orange block - is:

Equation 3

$$r_m = R_{shunt} \cdot A = 0.033\Omega \cdot A = 0.09375\Omega$$

$$A = \frac{r_m}{R_{shunt}} = \frac{0.09375\Omega}{0.033\Omega} = 2.84$$

Finally, choosing R_a = Rb and R_c = Rd, the differential gain of the circuit is:

Equation 4

$$A = \frac{R_c}{R_a} = 2.84$$

The RC filter is designed so as to have a time constant that matches noise parameters in the range of 1.5 µs:

Equation 5

$$4 \cdot \tau = 4 \cdot RC = 1.5\mu s$$

$$C = \frac{1.5\mu s}{4 \cdot 1000\Omega} = 375\,pF\ (330\mathrm{pF\,selected})$$

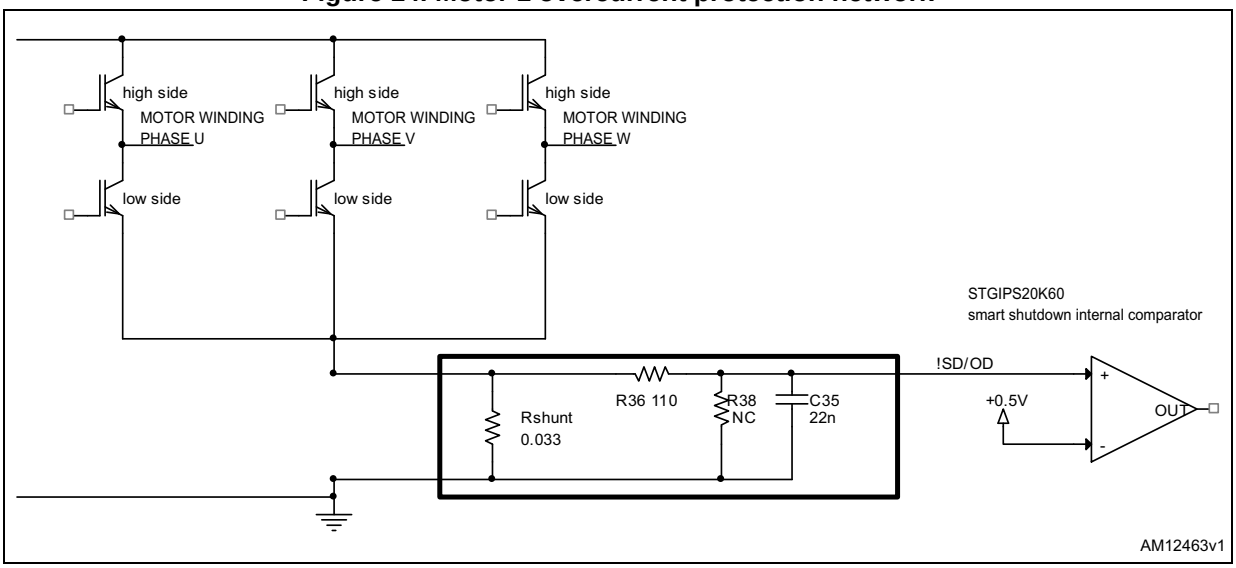
Table 6. Amplifying networks

	Amplifying network				RC filter	
	Ra	**Rb**	**Rc**	**Rd**	**Re**	**Cc**
Phase U or DC link	R67	R71	R65	R74	R69	C107
Phase V	R56	R59	R54	R62	R58	C105
Phase W	R64	R68	R63	R70	R66	C106

7.2 Motor 1, overcurrent protection network

The motor 1 overcurrent protection schematic is shown in *Figure 14*.

Figure 14. Motor 1 overcurrent protection network



Considering the trans-resistance of the two-port network represented by the orange block:

Equation 6

$$r_m = R_{shunt} = 0.033\,\Omega$$

and the STGIPS20C60 + 0.58 V internal comparator max. reference voltage (typical 0.54 V, minimum 0.5 V), the overcurrent protection, carried out by the STGIPS20C60 smart shutdown function, is set to occur at:

Equation 7

$$IPMOvercurrentThreshold = \frac{0.58V}{0.033\Omega} = 17.58\,\mathrm{A}$$

The RC filter is designed so as to have a time constant that matches the 5 µs STGIPS20C60 short-circuit withstand time:

Equation 8

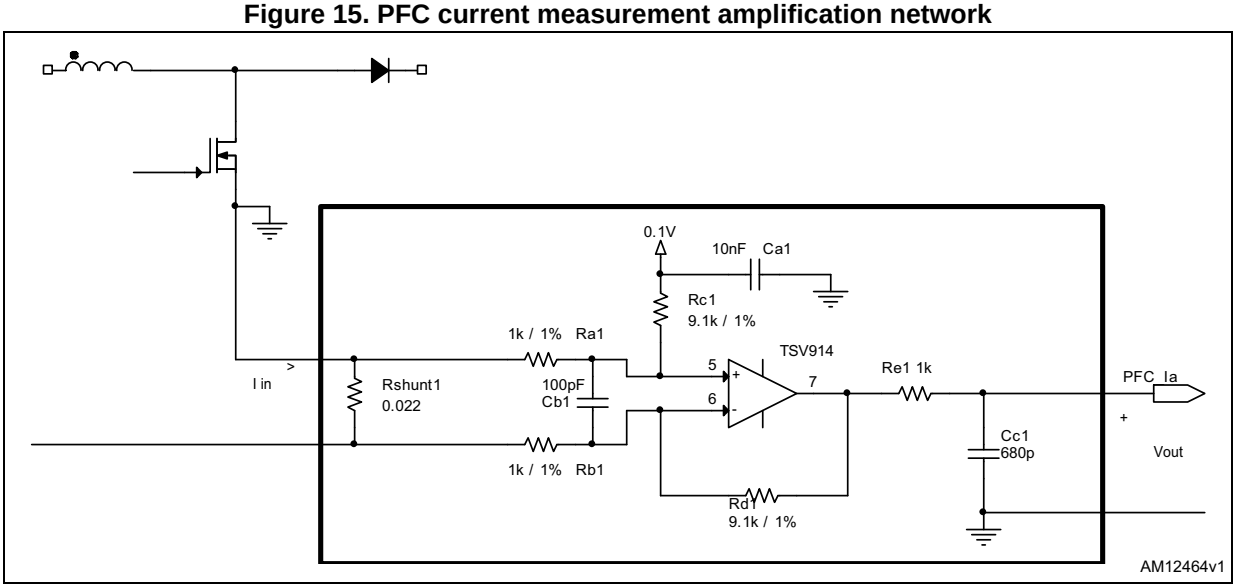
$$4 \cdot \tau = 4 \cdot RC = 5\mu s$$

$$C = \frac{5\mu s}{4 \cdot 110\Omega} = 11nF\ (22\mathrm{nF\ selected})$$

7.3 PFC stage, mains current amplification network

Mains current measurement for PFC stage control is performed using a shunt resistor and the differential amplification network shown in *Figure 14*.

Figure 15. PFC current measurement amplification network



Board maximum input current is 8.69 A RMS, drawn by a 1.7 kW load at minimum AC voltage 195 V RMS. Maximum peak current is set to be 15 A 0-to-pk, to accommodate for up to 44% current ripple.

A 0.0165 Ω shunt resistor is chosen, whose power rate should be greater than:

Equation 9

$$P_{shunt} = R_{shunt} \cdot {I_{rms}}^2 = 0.0165\Omega \cdot 8.69\,A^2 = 1.25W$$

An offset Vo = +0.1 V is added so as to minimize the linearity error / saturation recovery for low current values.

Equation 10

$$MaxMeasCurrent = \frac{\Delta V}{r_m} = \frac{3.15V}{r_m} = 15A$$

$$r_m = \frac{\Delta V}{\text{MaxMeasCurrent}} = \frac{3.15V}{15A} = 0.21\Omega$$

The overall trans-resistance of the two-port network - represented by the orange block - is:

Equation 11

$$r_m = R_{shunt} \cdot A = 0.0165\Omega \cdot A = 0.21\Omega$$

$$A = \frac{r_m}{R_{shunt}} = \frac{0.21\Omega}{0.0165\Omega} = 12.73\,(11\text{ is chosen})$$

Therefore:

Equation 12

$$r_m = 0.1815\Omega$$

$$MaxMeasCurrent = \frac{3.15V}{0.1815\Omega} = 17.36A$$

Finally, choosing Ra = Rb and Rc = Rd, the differential gain of the circuit is:

Equation 13

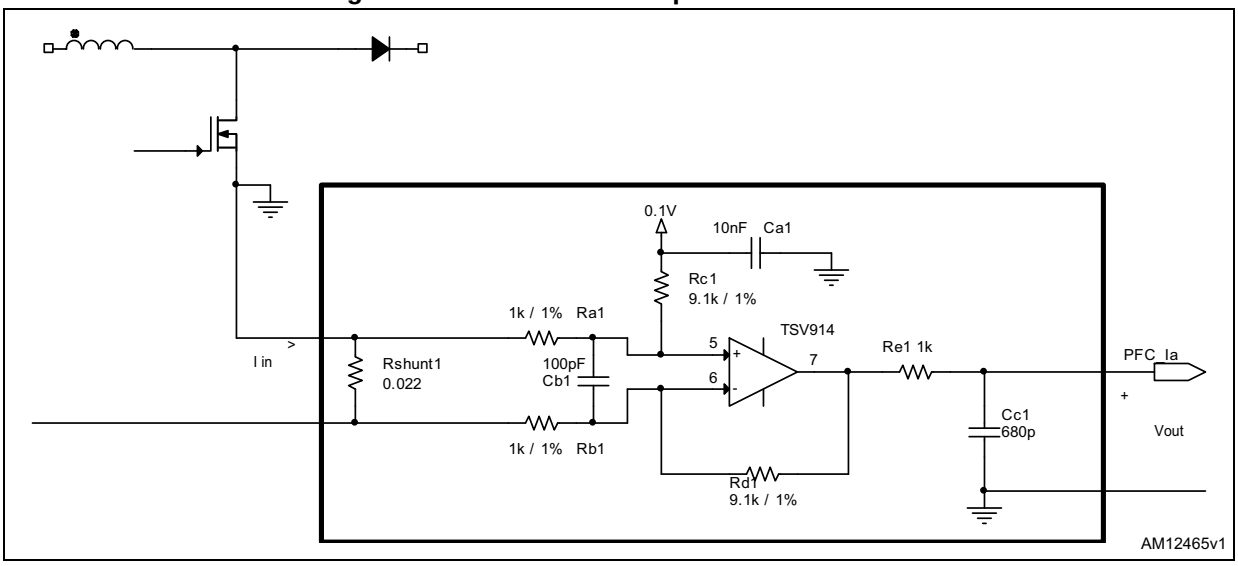
$$A = \frac{R_c}{R_a} = 11$$

The RC filter is designed so as to have a time constant that matches a typical 20 kHz PWM frequency.

7.4 PFC stage, overcurrent protection

The overcurrent protection network of the PFC stage is shown in *Figure 15*.

Figure 16. PFC overcurrent protection network



Considering the trans-resistance of the mains current sensing network, the 0.1 V offset and the +3 V threshold fixed at L6391 CP- comparator input by the voltage divider R24 and R26, the overcurrent protection, carried out by the L6391 smart shutdown function, is set to occur at:

Equation 14

$$PFCOvercurrentThreshold = \frac{2.9V}{0.1815\Omega} = 15.98A$$

7.5 Single motor configuration

This section describes the basic steps to configure the hardware to drive a single motor application (without PFC). Nonetheless, a thorough reading of all the sections of this user manual is recommended, *Section 2* in particular.

- A jumper should be placed in the connector J9 (the wire should be able to bear the repetitive DC bus capacitor charge currents)
- A jumper should be placed in the connector J15 (the wire should be able to bear IPM input current)
- Single shunt or 3-shunt current measurement topology to be selected through jumper JP1 and JP2
- Motor windings to abut connector J10
- Overvoltage protection to be optionally enabled (JP6)
- +5 V DC power supply to be provided through connector J14
- JTAG or SWD programmer connected through J13 can now flash the customized firmware
- +5 V DC power supply to be removed from connector J14
- JTAG or SWD programmer to be removed from connector J13
- It is now possible to plug AC mains terminals to connector J10.

The application can now be controlled by means of the opto-isolated RS232 serial communication channel, if the firmware provides for its handling. The STM32 PMSM FOC SDK v3.2 and successive versions, used in conjunction with STMCWB v2.0, and successive versions, allows a PC to send commands / receive status information about the running motor.

Only in a case where an opto-isolated SWD dongle (such as the ST-LINK/V2-ISOL) or an isolated laptop is available, can the application be programmed and debugged in SWD mode being powered by the AC mains.

On the contrary, it can be programmed in SWD or JTAG mode while J14 is being supplied from an external +5 V DC source. The external source must be removed before plugging AC mains terminals.

7.6 Dual motor configuration

This section describes the basic steps to configure the hardware to drive two motors, the first one powered by the onboard IPM inverter, the second by an external ST power stage. Nonetheless, a thorough reading of all the sections of this user manual is recommended, *Section 2* in particular.

- A jumper should be placed in the connector J9 (the wire should be able to bear the repetitive DC bus capacitor charge currents)
- A jumper should be placed in the connector J15 (the wire should be able to bear IPM input current)
- Single shunt or 3-shunt current measurement topology to be selected through jumper JP1 and JP2
- Motor windings to abut connector J10

- Overvoltage protection to be optionally enabled (JP6)
- Second motor power stage MC connector linked to 2ND_MC (J2) connector with the provided short ribbon cable
- Second power stage is to be fed with DC voltage from DC bus output connector J11, polarity to respect board silkscreen; if the power stage hasn't got a dedicated DC power input connector, it's recommended not to feed from its rectifier input but directly across the DC bus
- Second power stage bulk capacitor(s) must be removed, filtering capacitors to be added if not present
- Motor 2 windings to abut dedicated connector on second power stage
- JTAG or SWD programmer connected through J13 can now flash the customized firmware
- +5 V DC power supply to be removed from connector J14
- JTAG or SWD programmer to be removed from connector J13
- It's now possible to plug AC mains terminals to connector J10.

The application can now be controlled by means of the opto-isolated RS232 serial communication channel, if the firmware provides for its handling. The STM32 PMSM FOC SDK v3.2, and successive versions, used in conjunction with STMCWB v2.0, and successive versions, allows a PC to send commands / receive status information about the running dual motor control.

Only in a case where an opto-isolated SWD dongle (such as the ST-LINK/V2-ISOL) or an isolated laptop is available, can the application be programmed and debugged in SWD mode being powered by the AC mains.

On the contrary, it can be programmed in SWD or JTAG mode while J14 is being supplied from an external +5 V DC source. The external source must be removed before plugging AC mains terminals.

7.7 Dual motor and PFC configuration

This section describes the basic steps to configure the hardware to drive two motors and PFC, the first one powered by the onboard IPM inverter, the second by an external ST

power stage. Nonetheless, a thorough reading of all the sections of this user manual is recommended, *Section 2* in particular.

- A proper inductor for PFC operation, or the one included in the kit (whose datasheet is reported in *Figure 17* and *18*), should be placed in the connector J9
- A jumper should be placed in the connector J15 (the wire should be able to bear IPM input current)
- Single shunt or 3-shunt current measurement topology to be selected through jumper JP1 and JP2
- Motor 1 windings to abut connector J10
- PFC overvoltage protection to be enabled (JP7)
- Overvoltage protection OR-ing with IPM overcurrent protection (JP6) enabled (recommended)
- Second motor power stage MC connector linked to 2ND_MC (J2) connector with the provided short ribbon cable
- Second power stage is to be fed with DC voltage from DC bus output connector J11, polarity to respect board silkscreen; if the power stage hasn't got a dedicated DC power input connector, it's recommended not to feed from its rectifier input but directly across the DC bus
- Second power stage bulk capacitor(s) must be removed, filtering capacitors to be added if not present
- Motor 2 windings to abut dedicated connector on second power stage
- JTAG or SWD programmer connected through J13 can now flash the customized firmware
- +5 V DC power supply to be removed from connector J14
- JTAG or SWD programmer to be removed from connector J13
- It's now possible to plug AC mains terminals to connector J10.

The application can now be controlled by means of the opto-isolated RS232 serial communication channel, if the firmware provides for its handling. The STM32 PMSM FOC SDK v3.2, and successive versions, used in conjunction with the PFC library plug-in v1.0 and STMCWB v2.0, and successive versions, allows a PC to send commands / receive status information about the running dual motor control and PFC.

Only in a case where an opto-isolated SWD dongle (such as the ST-LINK/V2-ISOL) or an isolated laptop is available, can the application be programmed and debugged in SWD mode being powered by the AC mains.

On the contrary, it can be programmed in SWD or JTAG mode while J14 is being supplied from an external +5 V DC source. The external source must be removed before plugging AC mains terminals.

7.8 PFC configuration

This section describes the basic steps to configure the hardware to drive the PFC for an external load. Nonetheless, a thorough reading of all the sections of this user manual is recommended, *Section 2* in particular.

- A proper inductor for PFC operations, or the one included in the kit (whose datasheet is reported in *Figure 17* and *18*), should be placed in the connector J9
- External load to be fed with DC voltage from DC bus output connector J11, polarity to respect board silkscreen
- PFC overvoltage protection to be enabled (JP7)
- Overvoltage protection OR-ing with IPM overcurrent protection to be disabled (JP6)
- Jumper in connector J15 removed
- JTAG or SWD programmer connected through J13 can now flash the customized firmware
- +5 V DC power supply to be removed from connector J14
- JTAG or SWD programmer to be removed from connector J13
- It's now possible to plug AC mains terminals to connector J10.

The application can now be controlled by means of the opto-isolated RS232 serial communication channel, if the firmware provides for its handling. The STM32 PMSM FOC SDK v3.2, and successive versions, used in conjunction with PFC library plug-in v1.0 and STMCWB v2.0, and successive versions, allows a PC to send commands / receive status information about PFC.

Only in a case where an opto-isolated SWD dongle (such as the ST-LINK/V2-ISOL) or an isolated laptop is available, can the application be programmed and debugged in SWD mode being powered by the AC mains. On the contrary, it can be programmed in SWD or JTAG mode while J14 is being supplied from an external +5 V DC source. The external source must be removed before plugging AC mains terminals.

8 Firmware configuration for STM32 PMSM FOC SDK

Table 7 summarizes the parameters to be set - through the “ST motor control workbench” GUI - in order to customize the STM32 PMSM FOC SDK v3.2 for this STEVAL-IHM034V2.

On the other hand, inside the IDE used to batch-build and download the SDK firmware, the user project must be configured by selecting from the menu STM3210E-EVAL (in case of single motor and PFC) or STEVAL-IHM022_DUALDRIVE (in case of dual motor and PFC); for more information, see the UM1052 user manual, section 6.2.

Table 7. Parameters for “ST motor control workbench” GUI

Section	Field	Parameter	STEVAL-IHM034V2 value	Unit or note
POWER STAGE 1	ICL shut-out	Polarity	High	
	Rated bus voltage	Min. voltage	40	V
	Rated bus voltage	Max. voltage	450	V
	Rated bus voltage	Nominal voltage	320	V
	Bus voltage sensing	Bus voltage divider	139	
	Temperature sensing	V0	2600	mV
	Temperature sensing	T0	74	°C
	Temperature sensing	ΔV/ΔT	30	28 mV/°C
	Temperature sensing	Max. working temp	90	°C
	Overcurrent protection	Comparator threshold	0.54	V
	Overcurrent protection	Overcurrent network gain	0.03	V/A
	Overcurrent protection	Overcurrent feed polar	Active low	
	Overcurrent protection	Disabling network	Active low	
	Current sensing (JP1&JP2 default)	1-shunt resistor		
	Current sensing (JP1&JP2 default)	Shunt resistor value	0.033	W
	Current sensing (JP1&JP2 default)	Amplifying network gain	2.87	
	Current sensing (JP1&JP2 default)	T-Rise	1500	ns
	Current sensing (JP1&JP2 opposite)	3-shunt resistor		
	Current sensing (JP1&JP2 opposite)	Shunt resistor value	0.033	W
	Current sensing (JP1&JP2 opposite)	Amplifying network gain	2.87	
	Current sensing (JP1&JP2 opposite)	T-Noise	2500	ns
	Current sensing (JP1&JP2 opposite)	T-Rise	1500	ns

Table 7. Parameters for “ST motor control workbench” GUI (continued)

Section	Field	Parameter	STEVAL-IHM034V2 value	Unit or note
POWER STAGE 1	Phase U driver	High-side polarity	Active high	
	Phase U driver	Low-side polarity	Active low	
	Phase V driver	High-side polarity	Active high	
	Phase V driver	Low-side polarity	Active low	
	Phase W driver	High-side polarity	Active high	
	Phase W driver	Low-side polarity	Active low	
	Power switches	Min. deadtime	1000	Ns
	Power switches	Max. switching freq.	20	kHz
	PFC enable	Check box		Enable or disable
POWER STAGE 2	According to parameters of connected motor 2 power stage			
CONTROL STAGE	MCU and clock frequency	MCU selection	Performance line high density	
	MCU and clock frequency	CPU frequency	72	MHz
	MCU and clock frequency	Nominal MCU supply voltage	3.3	V
	Analog input	Motor 1 ADC ch phase U (3-shunt selected)	ADC12_IN10	
	Analog input	Motor 1 ADC ch phase V (3-shunt selected)	ADC12_IN11	
	Analog input	Motor 1 ADC ch phase W (3-shunt selected)	ADC12_IN12	
	Analog input	Motor 1 ADC ch (1-shunt selected)	ADC3_IN10	
	Analog input	Motor 1 Bus voltage feedback ADC ch	ADC12_IN14	
	Analog input	Motor 1 Heatsink temperature feedback ADC ch	ADC12_IN15	
	Analog input	Motor 2 ADC ch phase U (3-shunt selected)	ADC12_IN0	
	Analog input	Motor 2 ADC ch phase V (3-shunt selected)	ADC12_IN1	

Table 7. Parameters for “ST motor control workbench” GUI (continued)

Section	Field	Parameter	STEVAL-IHM034V2 value	Unit or note
CONTROL STAGE	Analog input	Motor 2 ADC ch phase W (3-shunt selected)	ADC12_IN2	
	Analog input	Motor 2 ADC ch (1-shunt selected)	ADC12_IN1	
	Analog input	Motor 2 bus voltage feedback ADC ch		To be disabled in power stage 2 parameters
	Analog input	Motor 2 temperature feedback ADC ch	ADC12_IN5	Through jumper JP8, excluding DAC functionality
	DAC functionality	DAC peripheral	PA4, PA5	Excluding motor 2 temperature feedback and potentiometer R15
	Digital I/O	Motor 1 timer	TIM1	
	Digital I/O	Motor 1 TIM1 remapping	No remap	
	Digital I/O	Serial COM channel	USART3	
	Digital I/O	USART3 remap	Partial remap	
	Digital I/O	In-rush current limiter	B - 9	
	Digital I/O	Overcurrent protection disabling (if function is activated)	C - 9	
	Digital I/O	Motor 2 timer	TIM8	
Section	Field	Parameter	STEVAL-IHM034V2 value	Unit or note

Table 8. BOM

Reference	Part / value	Tolerance %	Voltage current	WATT	Technology information	Package	Manuf.	Manuf. code	More Info
B1	User				Surface mount tactile switch	SMD	Any		RS code: 183-701
B2	Reset				Surface mount tactile switch	SMD	Any		RS code: 183-701
C77,C51	47 µF	+/-20%	10 V		Aluminium electrolytic capacitor	SMT	Panasonic	EEE1AA470SP	RS code:536-9843
C1	47 µF	+/-20%	25 V		Aluminium electrolytic capacitor	SMD	Any		RS code: 537-0225
C2,C3,C4,C5, C6,C7,C10,C12 ,C25,C42,C61, C62,C67,C72, C71,C69,C64, C63,C59,C83, C85,C75	100 nF	+/-10%	50 V		Ceramic capacitor X7R	SMD 0805			
C8,C84,C95,	1 nF	+/-10%	50 V		Ceramic capacitor X7R	SMD 0805			
C11,R14,R16, R17,R38,R99, R97,C47,C48, C53,C54	NC	Do not fit	Do not fit	Do not fit	Do not fit	Do not fit	Do not fit	Do not fit	Do not fit
C65,C66	22 pF	+/-10%	50 V		Ceramic capacitor X7R	SMD 0805	Any		
C68	1 µF	+/-10%	16 V		Tantalium capacitor	SMD			RS:code:496-4043
C28,C29,C30, C31,C32,C33	4.7 µF	+/-10%	50 V		Ceramic capacitor X7R	SMD 1206	Any		

Table 8. BOM (continued)

Reference	Part / value	Tolerance %	Voltage current	WATT	Technology information	Package	Manuf.	Manuf. code	More Info
C21	0.22 µF	+/-20%	300 V		X2 capacitor	Through hole			Distrelec code: 820765
C70	10 µF	+/-10%	16 V		Ceramic capacitor X7R	SMD			RS code:106-846
C22,C23	220 µF	+/-20%	450 V		Electrolytic capacitor	Through hole			RS code: 575-147
C74	2.2 µF	+/-20%	450 V		Electrolytic capacitor	Through hole		450YK2.2M 10X12.5	RS code: 193-7256
C45,C50,C52	2.2 µF	+/-10%	50 V		Ceramic capacitor X7R	SMD 0805	Any		
C26,C108,C86	470 nF	+/-10%	50 V		Ceramic capacitor X7R	SMD 0805	Any		
C94,C96,C97	5.6 nF	+/-10%	50 V		Ceramic capacitor X7R	SMD 0805	Any		
C27	4.7 nF	+/-10%	50 V		Ceramic capacitor X7R	SMD 0805	Any		
C34,C46,C49	10 nF	+/-10%	50 V		Ceramic capacitor X7R	SMD 0805	Any		
C93,C76,C82	22 µF	+/-20%	25 V		Aluminium electrolytic capacitor	SMT	Panasonic	EEE1EA220SP	RS: 536-9893
C87,C92,C35	22 nF	+/-10%	50 V		Ceramic capacitor X7R	SMD 0805	Any		
C90	1 µF	+/-5%	25 V		Aluminium electrolytic capacitor	SMD 0805	Any		
C88	10 µF	+/-20%	6.3 V		Ceramic SMT capacitor	1206	Murata	GRM31CR60J106KA01L	RS: 653-0541

Table 8. BOM (continued)

Reference	Part / value	Tolerance %	Voltage current	WATT	Technology information	Package	Manuf.	Manuf. code	More Info
C78,C79,C80, C81,	100 pF	+/-10%	50 V		Ceramic capacitor X7R	SMD 0805	Any		
C105,C106, C107	330 pF	+/-10%	50 V		Ceramic capacitor X7R	SMD 0603	Any		
C104	680 pF	+/-10%	50 V		Ceramic capacitor X7R	SMD 0603	Any		
C73	100 nF	+/-5%	630 VCC		Polyester film capacitor	Through hole	Panasonic	ECQE6104 JF	RS:622-4943
C91	220 nF	+/-5%	25 V		Ceramic capacitor X7R	0805	Any		
C89	100 µF	+/-20%	25 V		Aluminium electrolytic capacitor	SMT	Panasonic	ECEV1EA1 01P	RS code: 628-4024
C55, C56	2.2 nF	+/-20%	400 V		Y1 ceramic capacitor	Through hole			RS code: 214-5903
C98,C99,C100, C101,C102, C103	10 pF	+/-20%	25 V		Ceramic capacitor X7R	SMD 0603	Any		
D1,D2,D7,D8, D23,D24	LL4148				Switching diode_	SOD-80			Distrelec code: 601496
D3	Red LED SMD				Chip LED	SMD 0805			Distrele code: 250154
D4	STTH15R06D				Turbo 2 ultrafast high voltage rectifier	TO-220	ST	STTH15L06 D	
D5	GF1M		1000 V/ 1 A		Rectifier diode	DO214BA	Vishay	GF1M	RS code: 629-1123
D6	8 A/ 400 V AC diode bridge		400 V/ 8 A		Single-phase bridge rectifier	Through hole	Vishay	KBU8G-E4	RS code: 634-9288

Table 8. BOM (continued)

Reference	Part / value	Tolerance %	Voltage current	WATT	Technology information	Package	Manuf.	Manuf. code	More Info
D19	1N4148WT				High conductance fast switching diode	SOD 523	FAIRCHILD	1N4148WT	rs code: 708-2163
D20,D21,D22	STTH1L06A				Turbo 2 ultrafast high voltage rectifier	SMA	ST	STTH1L06A	
D16,D18,D27	BAT48Z				Small signal Schottky diodes	SOD-123	ST	BAT48ZFILM	
D13	GREEN LED SMD				Chip LED	SMD 0805	Any		Distrele code: 250158
D25	1N5406		600 V/3 A		Rectifier diode	DO201AD	Any		RS code: 628-9574
D26	SMAJ15A				Transil	SMA	ST	SMAJ15A-TR	
L1	FCM1608KF-601T03		600 Ω/100 MHz		Ferrite bead	SMD 0603	WURTH		Distrelec code: 330821
F1	Fuse		250 V/ 10 A		Time lag fuse	-	RS		RS code: 563-334
SOCKET for F1	Socket for F1				SOCKET for F1	Through hole	Schurter	31.8231	RS code: 336-7851
JP1,JP2	Jumper				3-way single row strip line connector (male connector) 2,54 mm pitch	Vertical through hole	Any		RS code: 495-8470
J1	SPI				5-way single row strip line connector (male connector) 2,54 mm pitch	Vertical through hole	Any		RS code: 495-8470

Table 8. BOM (continued)

Reference	Part / value	Tolerance %	Voltage current	WATT	Technology information	Package	Manuf.	Manuf. code	More Info
J2	2M_MC_CONNECTOR				34-way IDC low profile boxed header 2,54 mm pitch	Vertical through hole	Any		RS code: 473-8311
JP5,JP6,JP7	Jumper				2-way single row strip line connector (male connector) 2,54 mm pitch	Vertical through hole	Any		RS code: 495-8470
	Jumper				Female jumper 2.54mm black		Any		
J13	JTAG\SWD				20-way IDC low profile boxed header 2,54 mm pitch	Vertical through hole	Any		RS code: 461-770
J9	PFC boost inductor				2-way vertical closed header, 5.08 mm pitch vertical	Through hole	Phoenix Contact		RS code: 189-6199
					2-way parallel rising clamp, 5.08 mm		Phoenix Contact		RS code: 189-6010
J10	AC mains				4-way vertical closed header, 5.08 mm pitch vertical	Through hole	Phoenix Contact		RS code: 189-6228
					4-way parallel rising clamp, 5.08 mm		Phoenix Contact		RS code: 189-6032

Table 8. BOM (continued)

Reference	Part / value	Tolerance %	Voltage current	WATT	Technology information	Package	Manuf.	Manuf. code	More Info
J11	PFC_OUT				2-way vertical closed header, 5.08 mm pitch vertical	Through hole	Phoenix Contact		RS code: 189-6199
J12	Motor				3-way vertical closed header, 5.08 mm pitch vertical	Through hole	Phoenix Contact		RS code: 189-6212
					3-way parallel rising clamp, 5.08 mm		Phoenix Contact		RS code: 189-6026
J15	PFC boost inductor				2-way vertical closed header, 5.08 mm pitch vertical	Through hole	Phoenix Contact		RS code: 189-6199
LS1	FINDER 4031-12		12 V/10 A		Relè 12 V 12 A	Through hole	Finder	40.31.7.012 .0000	RS code: 351-601
NTC1	10				Coated-Disk NTC thermistor	Through hole	Epcos	B57364-S100-M	Distrelec code: 730723
NTC2	NTC 10 k				Temperature measurement probe assemblies	Through hole	Epcos	B57703M103G	RS code: 191-2128
P1	DB9-female				9-way r/a PCB D female, US footprint 8.1 mm	Through hole	Any		RS code: 542-8043
Q1	STGW35HF60WD				35 A, 600 V ultrafast IGBT	TO-247	ST	STW23NM60N	
Q2	BC847				NPN transistor		NXP	BC847	RS code: 436-7953
Q3	TLV431CDBZR				V-Ref adjustable 1.24 V to 6 V	SOT-23	Texas Instruments	TLV431CDBZRG4	RS code: 661-9635

Table 8. BOM (continued)

Reference	Part / value	Tolerance %	Voltage current	WATT	Technology information	Package	Manuf.	Manuf. code	More Info
R90,R41	240	+/-1%		1/8 W	Resistor	SMD 0805			
R7	4.7 kΩ	+/-1%		1/8 W	Resistor	SMD 0805			
R8	4.7 kΩ	+/-1%		1/8 W	Resistor	SMD 0805			
R11,R87,R91, R106	3.3 kΩ	+/-1%		1/8 W	Resistor	SMD 0805			
R15,R118, R119	10 kΩ				Trimmer	Through hole	Bourns	3386F-1-103LF	
R72	680 Ω	+/-1%		1/8 W	Resistor	SMD 0805	Any		
R27,R26	10 kΩ	+/-1%		1/8 W	Resistor	SMD 0805	Any		
R1,R2,R98,R76 ,R80,R110, R109	0	+/-1%		1/8 W	Resistor	SMD 0805	Any		
R19,R52	100 Ω	+/-1%		1/8 W	Resistor	SMD 0805	Any		
R81	220 Ω	+/-1%		1/8 W	Resistor	SMD 0805	Any		
R22	160 Ω	+/-1%		1/4 W	Resistor	SMD 1206	Any		
R23	6.8 Ω	+/-1%		1/8 W	Resistor	SMD 0805	Any		
R25	47 Ω	+/-1%		1/8 W	Resistor	SMD 0805	Any		
R29,R94	100 kΩ	+/-1%		1/8 W	Resistor	SMD 0805	Any		
R30,R32,R35, R40,R21,R120	0.033 Ω	+/-1%		3 W	Resistor	SMD 2512	DISTRELEC	DISTRELEC-71.52.11	Distrelec code: 715211
R37,R96,R95, R121	4.7 kΩ	+/-1%		1/8 W	Resistor	SMD 0805	Any		
R103	15 kΩ	+/-1%		1/8 W	Resistor	SMD 0805	Any		
R43,R44,R82, R83	470 kΩ	+/-1%		1/8 W	Resistor	SMD 0805	Any		
R105,R108, R101	1.5 kΩ	+/-1%		1/8 W	Resistor	SMD 0805	Any		

Table 8. BOM (continued)

Reference	Part / value	Tolerance %	Voltage current	WATT	Technology information	Package	Manuf.	Manuf. code	More Info
R102	10 kΩ	+/-1%		1/8 W	Resistor	SMD 0805	Any		
R88	3.9 kΩ	+/-1%		1/8 W	Resistor	SMD 0805	Any		
R89	15 kΩ	+/-1%		1/8 W	Resistor	SMD 0805	Any		
R86	560 Ω	+/-1%		1/8 W	Resistor	SMD 0805	Any		
R48,R85	6.8 kΩ	+/-1%		1/8 W	Resistor	SMD 0805	Any		
R92,R93,R104, R107	220 kΩ	+/-1%		1/8 W	Resistor	SMD 0805	Any		
R75,R51	3 kΩ	+/-1%		1/8 W	Resistor	SMD 0805	Any		
R54,R62,R63, R70,R65,R74	2.87 kΩ	+/-1%		1/8 W	Resistor	SMD 0805	Any		
R55,R56,R59, R60,R64,R67, R68,R71,R24, R57,R58,R66, R69,R73	1 kΩ	+/-1%		1/8 W	Resistor	SMD 0805	Any		
R36	110 Ω	+/-1%		1/8 W	Resistor	SMD 0805	Any		
R84,R53,R61	11 kΩ	+/-1%		1/8 W	Resistor	SMD 0805	Any		
R100	53 kΩ	+/-1%		1/8 W	Resistor	SMD 0805	Any		
R10,R9	470 Ω	+/-1%		1/8 W	Resistor	SMD 0805	Any		
R111,R112, R113,R114, R115,R116	1 kΩ	+/-1%		1/8 W	Resistor	SMD 0603	Any		
R117	1.2 kΩ	+/-1%		1/4 W	Resistor	SMD 1206	Any		

Table 8. BOM (continued)

Reference	Part / value	Tolerance %	Voltage current	WATT	Technology information	Package	Manuf.	Manuf. code	More Info
TP1,TP2,TP3, TP4,TP5,TP6, TP7,TP8,TP9, TP10,TP11, TP12,TP13, TP14,TP15	TEST POINT_3				1-way single row strip line connector (male connector) 2,54 mm pitch	Through hole	Any		RS code: 101-2391
T1	1.41 mH/15-3.3 V		15-3.3 V	2.55 W	Transformer-	Through hole	MAGNETICA	2092.0001	
U1	L78L33ACUTR				Positive voltage regulators	SOT-89	ST	L78L33ACUTR	
U2	ST3232CTR				± 15 kV ESD protection 3 to 5.5 V low power, up to 250 kbps, RS-232 drivers and receivers	TSSOP16	ST	ST3232CTR	
U3,U4	SFH6156-2T				Optocoupler phototrans	SMD	Vishay/Semiconductors	SFH6156-2T	RS code: 2841190
U13	LM193				Low power single voltage comparator	SO8	ST	LM193D	
U11	STM32F103RCT6				HIGH-density performance line ARM-based 32-bit MCU	LQFP64	ST	STM32F103RCT6	
U6	L6391				High-voltage high and low-side driver	SO-14	ST	L6391	
U7	STGIPS20C60				IGBT intelligent power module (IPM) 20 A - 600 V	SDIP-25L molded	ST	STGIPS20C60	

Table 8. BOM (continued)

Reference	Part / value	Tolerance %	Voltage current	WATT	Technology information	Package	Manuf.	Manuf. code	More Info
U14	LD1117S33TR				Low drop fixed and adjustable positive voltage regulators	SOT-223	ST	LD1117S33 TR	
U15	VIPER16LD				Low power offline SMPS primary switcher	SO-16	ST	VIPER16LD	
U10	TSV914				Rail-to-rail input/output 8 MHz operational amplifiers	SO-14	ST	TSV914ID	
J14	PCB DC power socket		12 V / 1A		Mini DC power socket 2,5 mm	Through hole	RS	448-376	RS code: 448-376
Heatsink	L=220 mm				Heatsink		PADA(www.pada.it)	G8425140	
	Distance				Distance M3, 10 mm long, plastic, with screw, for corners		Any		
X1	8 MHz (with socket)				8 MHz crystal	Through hole	Any		RS code: 547-6200
Socket for X1	Socket for X1				2-way single row strip line connector (female connector) 2,54mm pitch	Through hole	Any		Distrelec code: 120324
Kit for TO-220 insulation					Mica, sleeve for screw				

Table 8. BOM (continued)

Reference	Part / value	Tolerance %	Voltage current	WATT	Technology information	Package	Manuf.	Manuf. code	More Info
Kit for TO-247 insulation					mica				
SPACER	SPACER L=10 x 3 mm				NYLON			R.S.-325-687	R.S.-325-687
ISO metric ivory nylon 6.6 full NUT,M3	NYLON-NUT				NYLON-NUT			R.S.525-701	R.S.525-701
External PFC inductor	1 mH		12 A RMS				MAGNETICA	2006.0008	See *Figure 17* and *18*

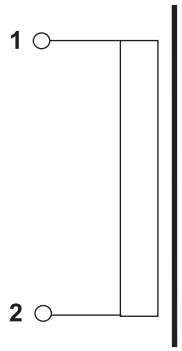
Figure 17. Technical sheet of PFC inductor (page 1 of 2)

STP 04	Product Technical Specification	*Code* : **5395**
Product: **hiperCoil 1mH 12A$_{RMS}$ 18A$_{PK}$**		*Class Code* :**2006.0008**
Date : 20/12/10	*Revision*: 03	Page 1 of 2

TYPICAL APPLICATION

INDUCTOR FOR BUCK, BOOST AND BUCK-BOOST DC/DC CONVERTER, SUITABLE ALSO IN HALF-BRIDGE, PUSH-PULL AND FULL-BRIDGE APPLICATIONS

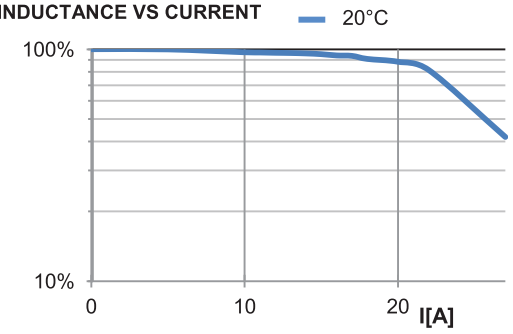
CIRCUIT DIAGRAM



TECHNICAL DATA

INDUCTANCE *(MEASURE 1KHZ, 0A, TA 20°C)*	1mH ±15%
INDUCTANCE *(MEASURE 1KHZ, 12A, TA 20°C)*	965uH ±15%
RESISTANCE *(MEASURE DC, TA 20°C)*	47 mΩ max
OPERATING CURRENT *(MEASURE DC , TA 20°C)*	18 A MAX
SATURATION CURRENT *(MEASURE DC, L ≥ 50%NOM, TA 20°C)*	26 A MAX
RESONANCE FREQUENCY *(TA 20°C)*	350 KHZ NOM
PARASITIC CAPACITANCE *(MEASURE PIN 1-2, F 1MHZ, TA 20°C)*	200 pF NOM
OPERATING TEMPERATURE RANGE *(IR 12A)*	-10°C÷+60°C
MAXIMUM DIMENSIONS	97X68 H80 mm
WEIGHT	1425 g APPROX

INDUCTANCE VS CURRENT



INDUCTANCE VS FREQUENCY

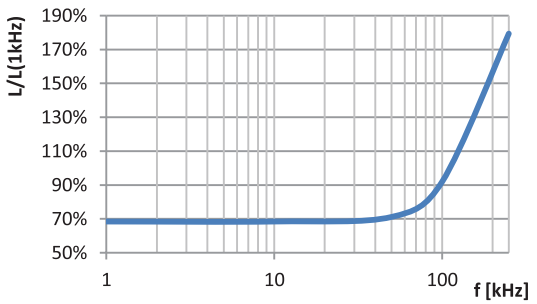


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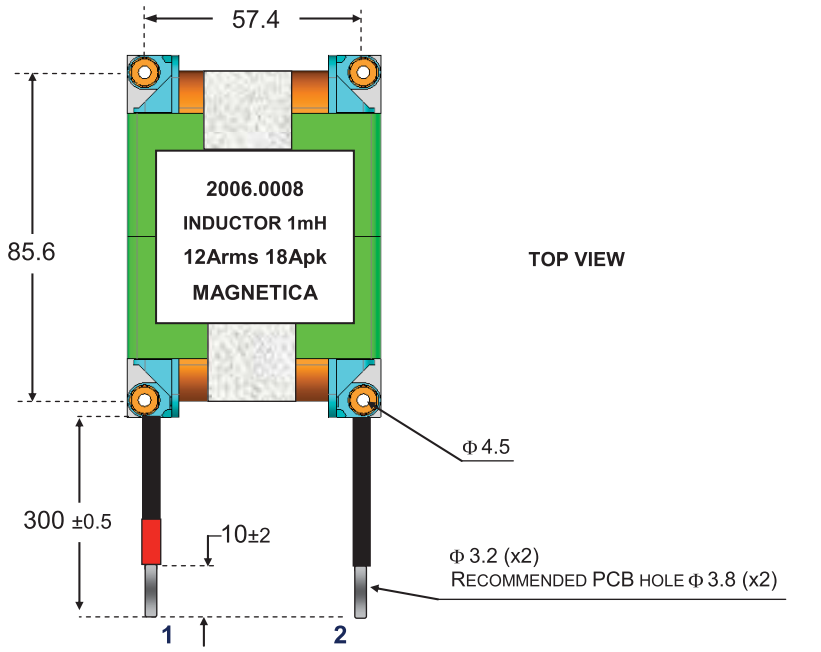
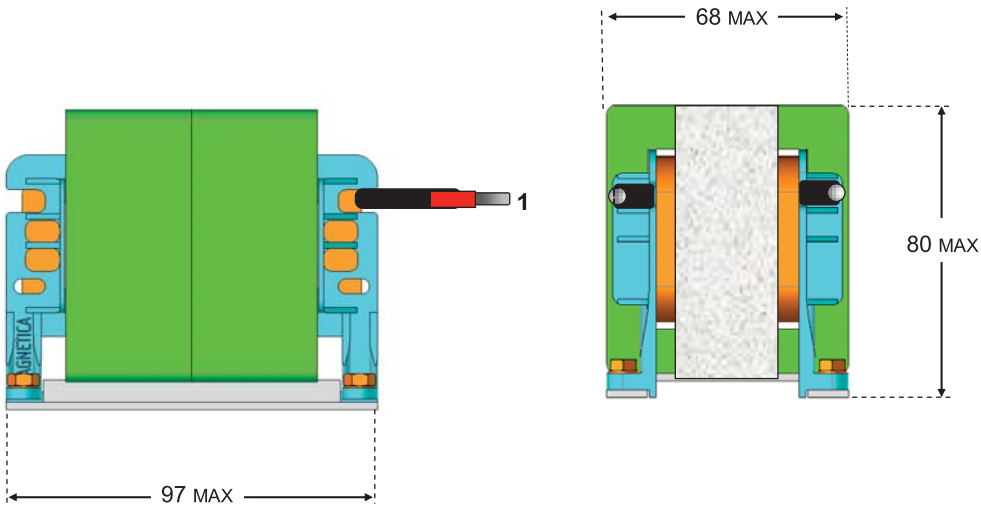
Figure 18. Technical sheet of PFC inductor (page 2 of 2)

STP 04	Product Technical Specification	*Code* : **5395**
Product: **hiperCoil 1mH 12A$_{RMS}$ 18A$_{PK}$**		*Class Code* :**2006.0008**
Date : 20/12/10	*Revision*: 03	Page 2 of 2

DIMENSIONAL DRAWING

DIMENSIONS IN MILLIMETERS, DRAWING NOT IN SCALE





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9 References

1. STGIPS20C60 datasheet
2. VIPER16 datasheet
3. STM32F103RC datasheet
4. TSV91x datasheet
5. STPSC1206 datasheet
6. STB38N65M5, STF38N65M5, STP38N65M5, STW38N65M5 datasheets
7. STTH15R06 datasheet
8. STGF35HF60W, STGW35HF60W, STGFW35HF60W datasheets
9. STM32F2 datasheet
10. STM32F4 datasheet
11. UM1052 user manual.

10 Revision history

Table 9. Document revision history

Date	Revision	Changes
05-Oct-2012	1	Initial release.
16-Dec-2013	2	Modified: STEVAL-IHM034V1 in STEVAL-IHM034V2 and STGIPS20K60 in STGIPS20C60. Updated: *Figure 4 on page 10*, *Figure 8 on page 14* and *Figure 9 on page 15*.

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