

STEVAL-IHM039V1 dual motor control demonstration board featuring the STM32F415 microcontroller

Introduction

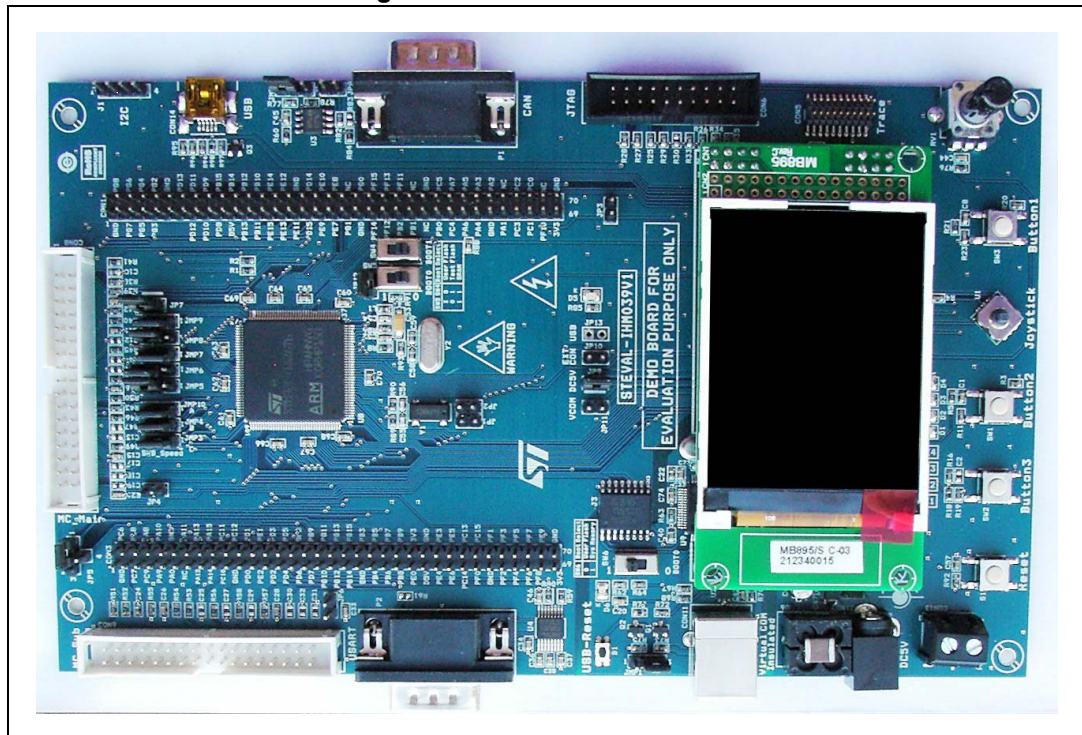
The STEVAL-IHM039V1 demonstration board is designed as a dual motor field-oriented control (FOC) development platform for STMicroelectronics' ARM Cortex™-M4 32-bit core-based STM32F415ZG microcontroller with up to 168 MHz of clock frequency and FPU support. The board features full-speed USB 2.0 and CAN 2.0 A/B compliant interfaces; 1 I²S/I²C channel, 1 USART channel and 1 insulate USART through USB to serial bridge, 2 DAC channels, internal 192+4KB SRAM and 1 MB Flash memory, and JTAG and SWD debugging support. The board is designed to implement multiple motor controls and offers an advanced user I/O interface (LCD QVGA display and joystick key). Extension headers make it easy to connect a daughterboard or wrapping board for specific applications.

With dedicated hardware features, the STEVAL-IHM39V1 board is designed to help developers to evaluate the device and develop their own applications.

The STEVAL-IHM39V1 can be used together with the STM32 PMSM single/dual FOC SDK v3.x and two of the possible STMicroelectronics demonstration power boards equipped with MC connector for a complete dual motor control evaluation and development platform.

The demonstration board can be ordered through order code STEVAL-IHM039V1.

Figure 1. Demonstration board



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1 Features

- STMicroelectronics' ARM™ Cortex-M4 core-based STM32F415ZG microcontroller
- Two full-featured MC connectors for interfacing with any of the possible STMicroelectronics demonstration power boards
- JTAG, SWD and trace debug support
- USB connector for isolated virtual com port
- USB 2.0 full speed connection
- 240 x 320 TFT color LCD
- Joystick with 4-direction control and selector
- 4 LEDs
- Reset plus three user buttons
- Five 5 V power supply sources: 2-way screw connector, power jack, two USB connectors or daughterboard
- Boot from user Flash or system memory
- CAN 2.0 A/B compliant connection
- I²C connection
- RS-232 channel with RTS/CTS handshake support
- Extension connectors for daughterboard or wrapping area board

2 Board description

Figure 2. Schematic diagram (1 of 9)

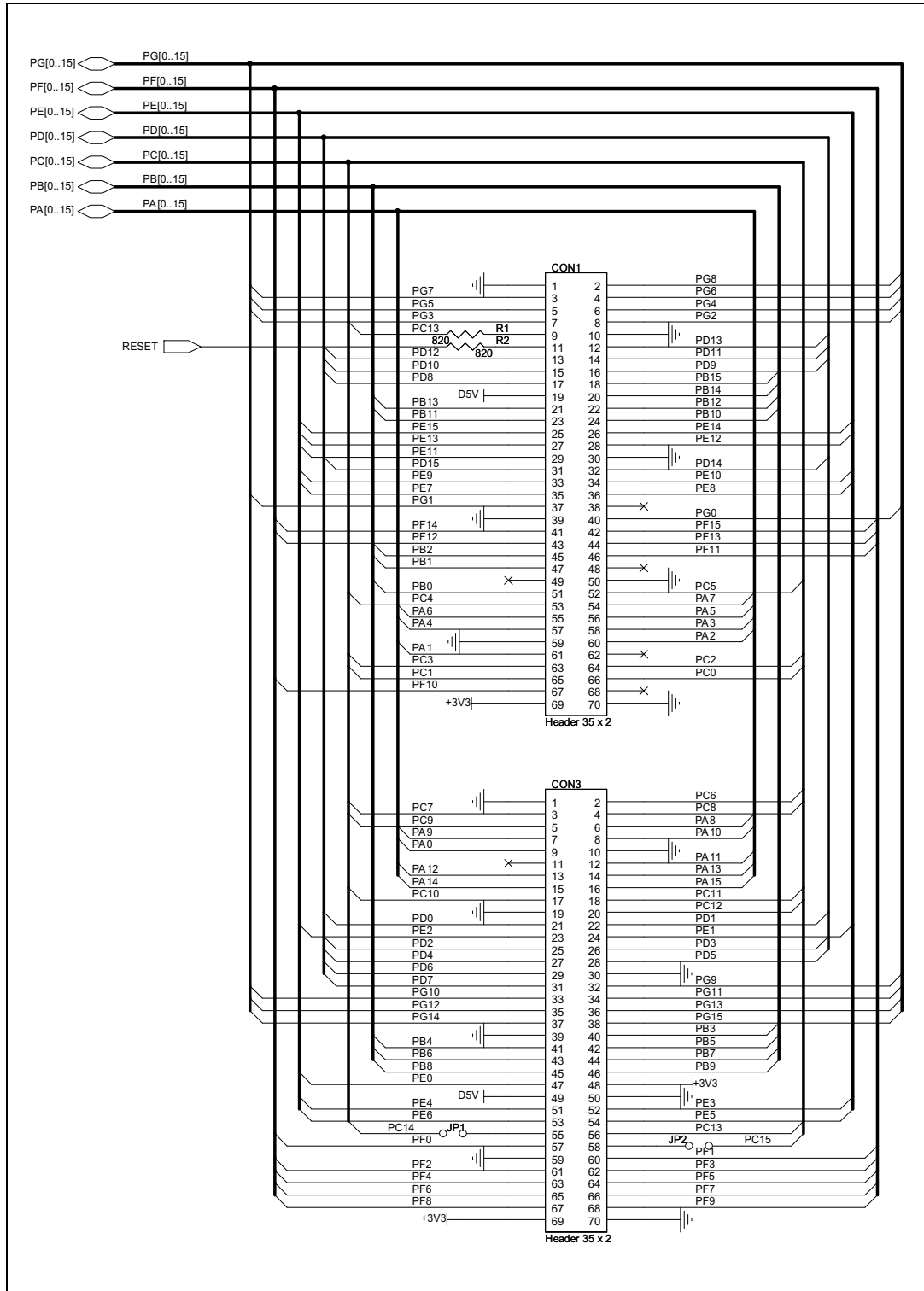


Figure 3. Schematic diagram (2 of 9)

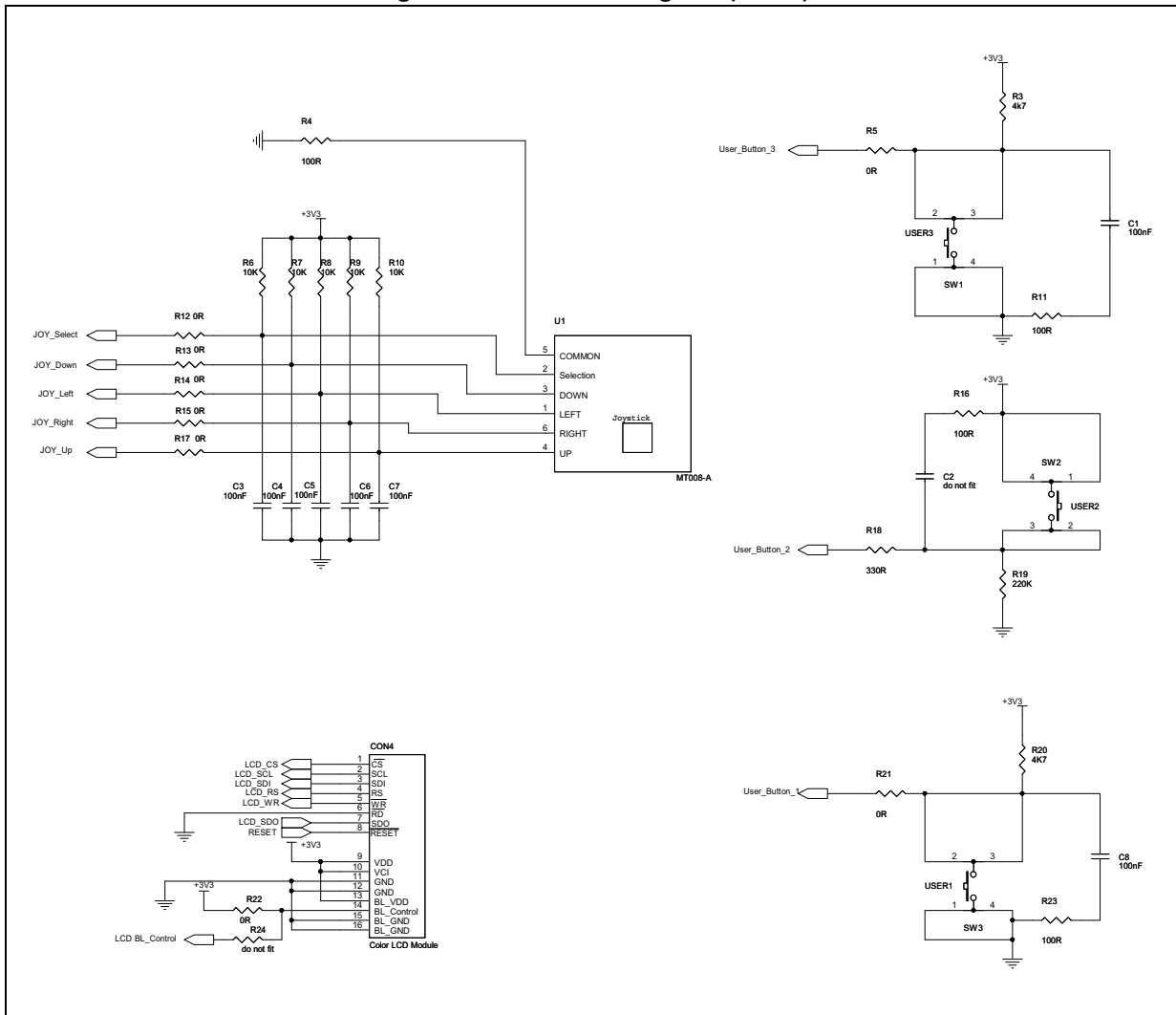


Figure 4. Schematic diagram (3 of 9)

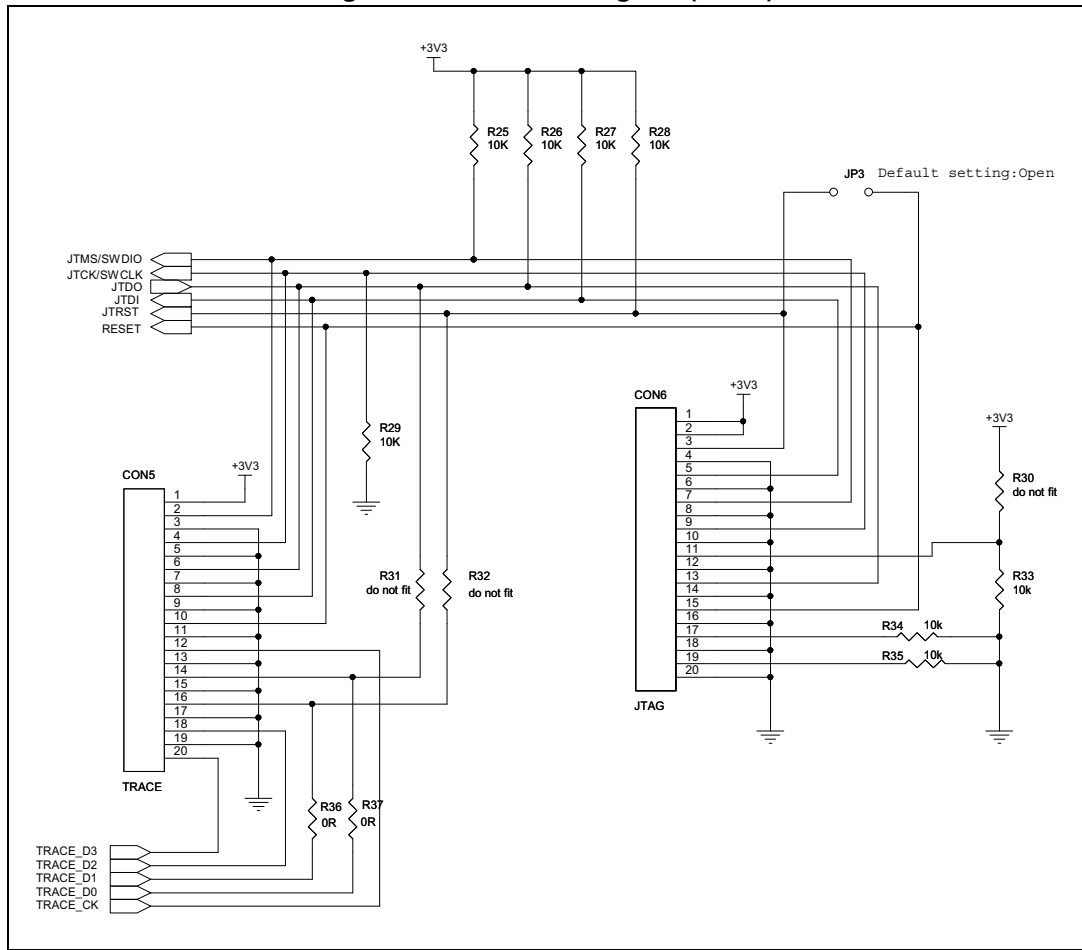


Figure 5. Schematic diagram (4 of 9)

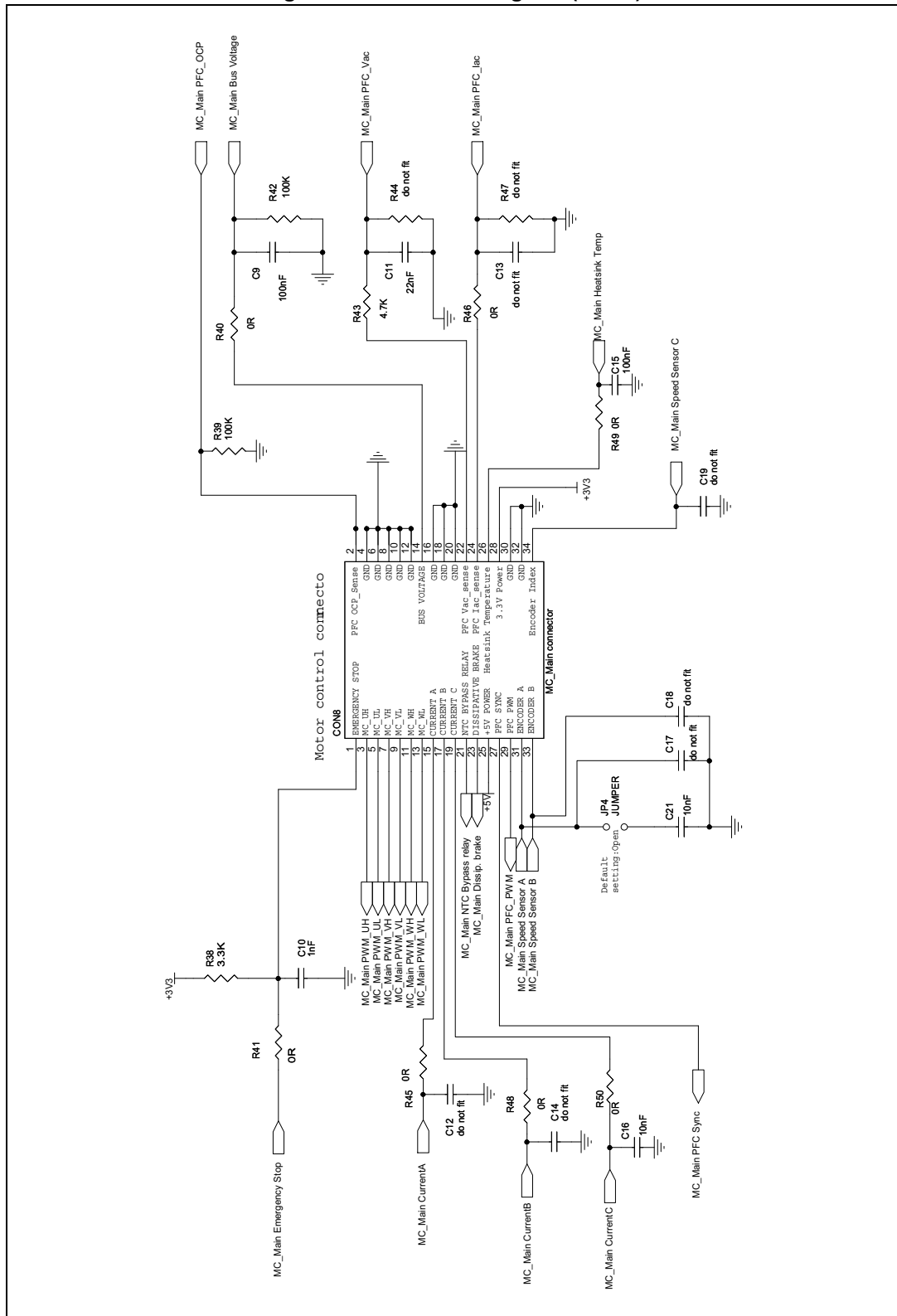


Figure 6. Schematic diagram (5 of 9)

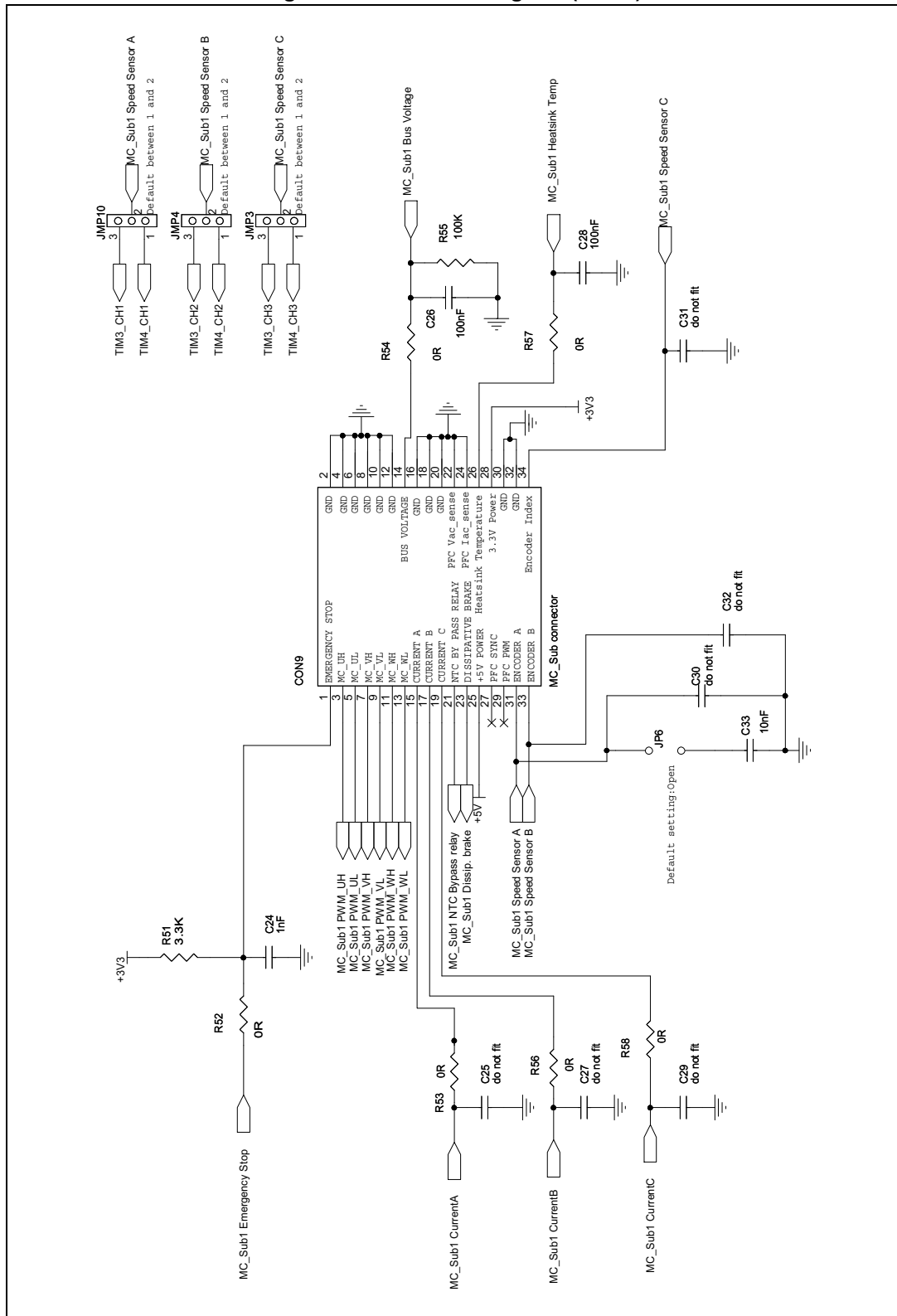


Figure 7. Schematic diagram (6 of 9)

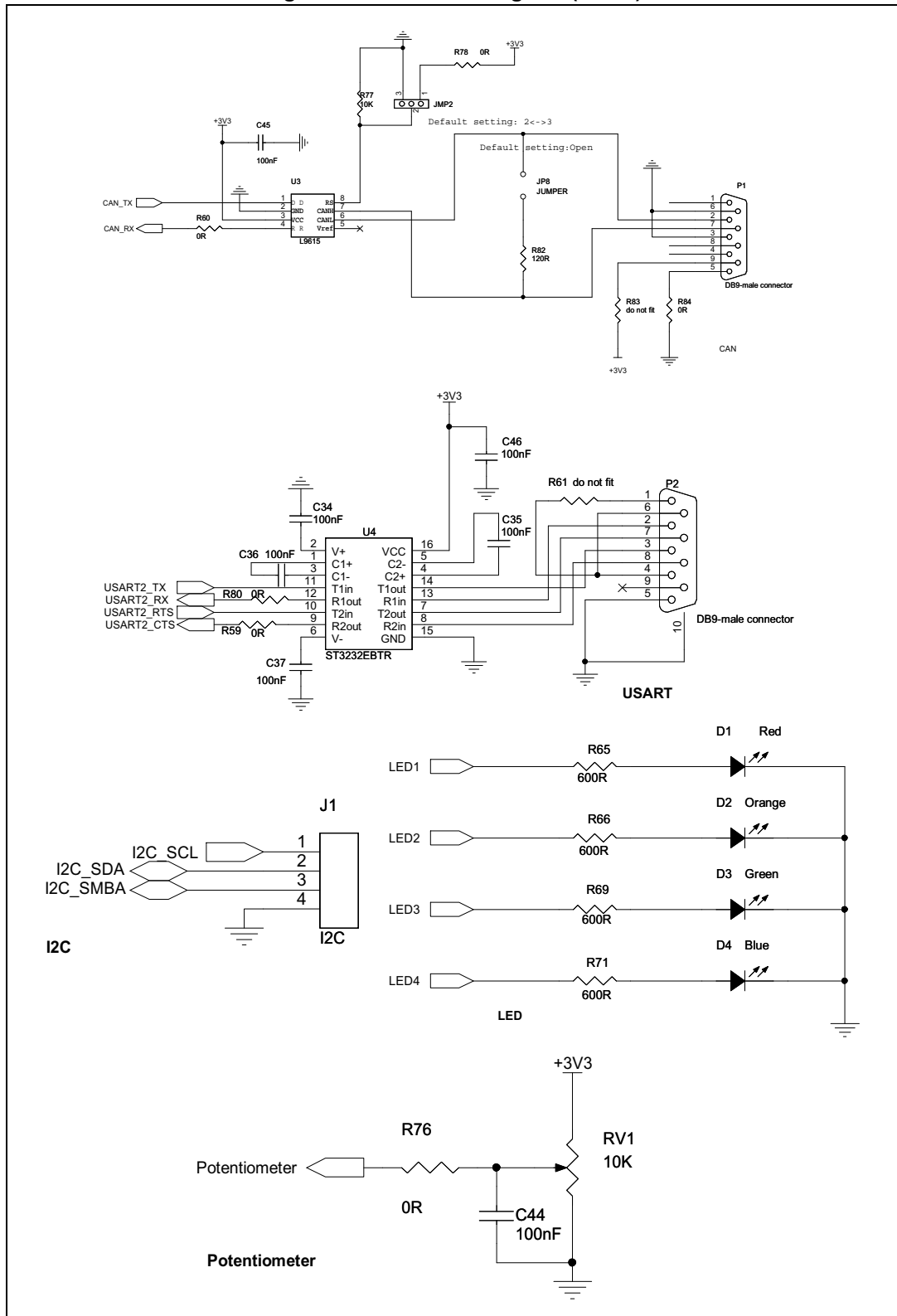


Figure 8. Schematic diagram (7 of 9)

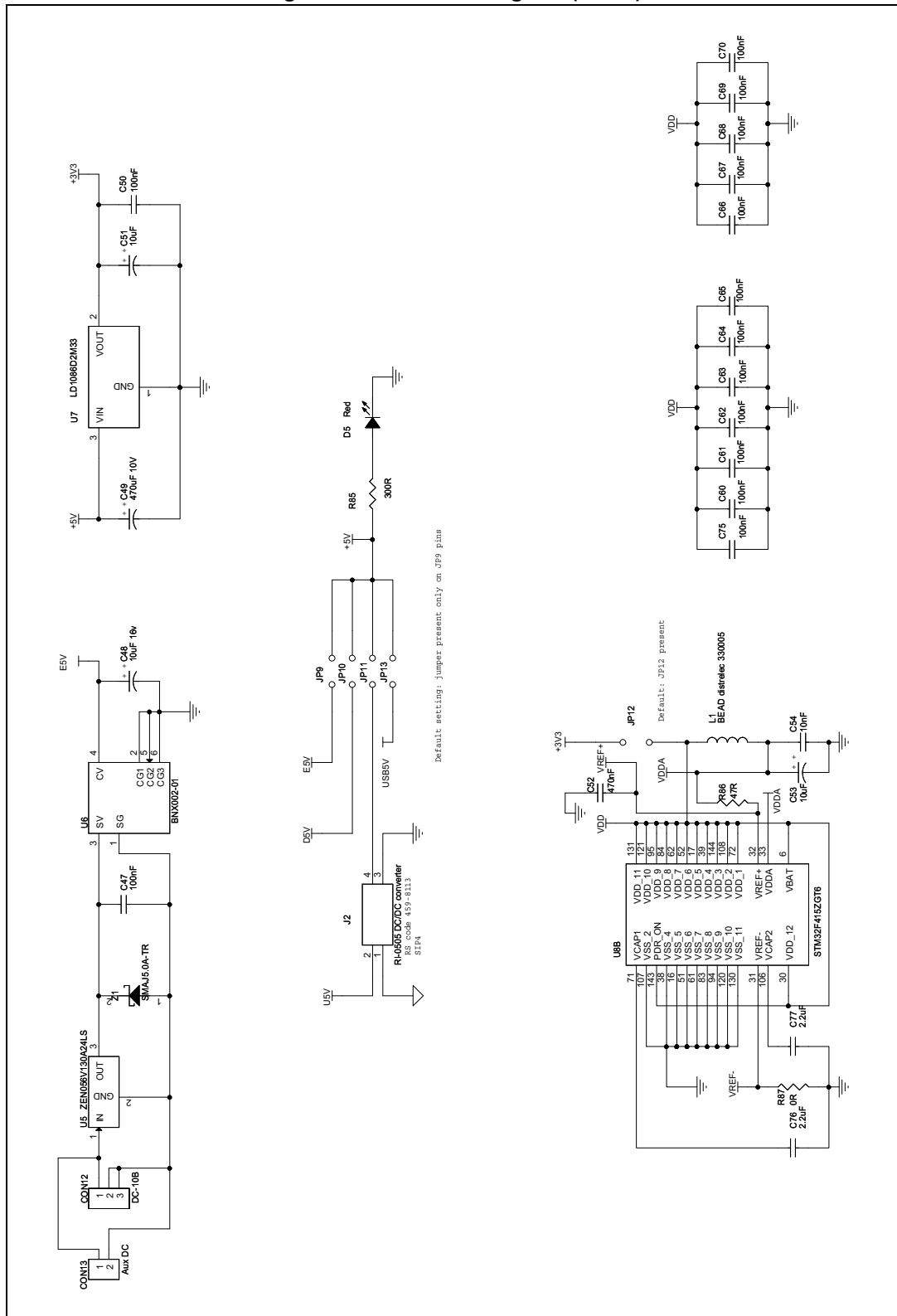
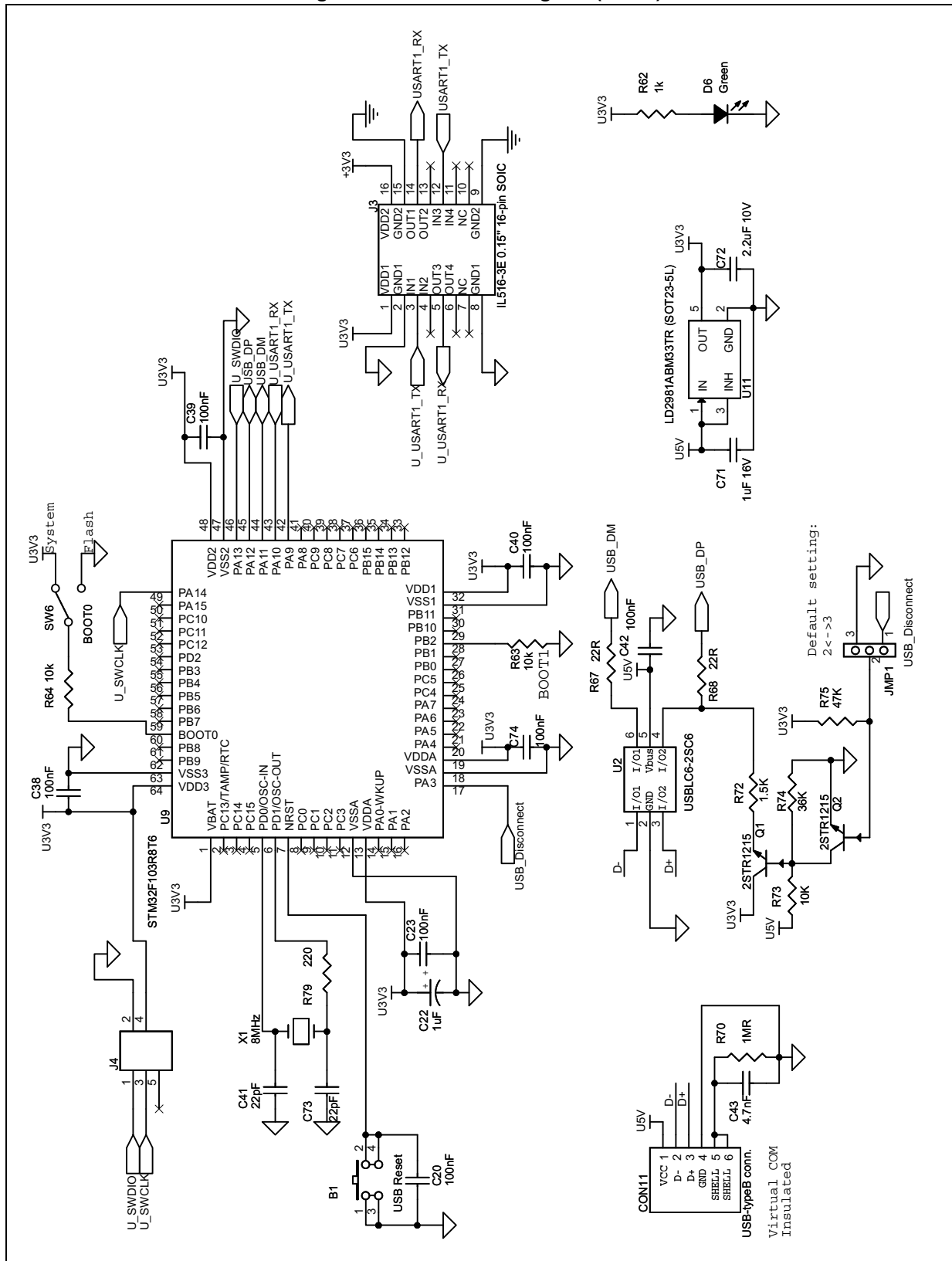


Figure 10. Schematic diagram (9 of 9)



3 Jumper settings

Table 1 gives a detailed description of the jumpers used.

Table 1. Jumper settings

Jumper	Selection	Description
JP1	Close	PC14 is connected to the extension connector CON3
	Open (default)	PC14 isn't connected to the extension connector CON3
JP2	Close	PC15 is connected to the extension connector CON3
	Open (default)	PC15 isn't connected to the extension connector CON3
JP4	Close	Add 10nF of capacitor to filter the motor 1 sensor input (Encoder A/H1)
	Open (default)	No filter added
JP6	Close	Add 10nF of capacitor to filter the motor 2 sensor input (Encoder A/H1)
	Open (default)	No filter added
JMP3	Between 1-2 (default)	TIM4_CH3 is used for motor 2 sensor input (Encoder Index/H3)
	Between 2-3	TIM3_CH3 is used for motor 2 sensor input (Encoder Index/H3). See JMP5.
JMP4	Between 1-2 (default)	TIM4_CH2 is used for motor 2 sensor input (Encoder B/H2)
	Between 2-3	TIM3_CH2 is used for motor 2 sensor input (Encoder B/H2). See JPM8.
JMP10	Between 1-2 (default)	TIM4_CH1 is used for motor 2 sensor input (Encoder A/H1)
	Between 2-3	TIM3_CH1 is used for motor 2 sensor input See JP5.
JP9	Open	+5 V is not supplied by the 2-way screw connector CON13 or by the power jack CON12
	Close (default)	+5 V is supplied by the 2-way screw connector CON13 or by the power jack CON12

Table 1. Jumper settings (continued)

Jumper	Selection	Description
JP10	Open (default)	+5 V is not connected to the extension connector
	Close	+5 V is connected to the extension connector
JP11	Open (default)	+5 V is not supplied by USB connector CON11
	Close	+5 V is supplied by USB connector CON11
JP13	Open (default)	+5 V is not supplied by USB connector CON14
	Close	+5V is supplied by USB connector CON14
JMP5	Between 1-2	The microcontroller pin PB0 (TIM3_CH3) is used for motor 2 sensor input (Encoder Index/H3). See JMP3.
	Between 2-3 (default)	The microcontroller pin PB0 (ADC12_IN8) is connected to the phase C motor 2 current feedback (MC_Sub1 CurrentC).
JMP6	Between 1-2	Use this setting if TIM3 is used for speed and positioning feedback for the motor 2.
	Between 2-3 (default)	The microcontroller pin PB1 (ADC12_IN9) is connected to the temperature sensor of power stage 1 (MC_Main Heatsink Temp).
JMP7	Between 1-2 (default)	The microcontroller pin PA2 (ADC123_IN2) is connected to the temperature sensor of power stage 2 (MC_Sub1 Heatsink Temp).
	Between 2-3	The microcontroller pin PA2 (ADC123_IN2) is connected to the AC current feedback of power stage 1 (MC_Main PFC_lac).
JMP8	Between 1-2	The microcontroller pin PB5 (TIM3_Ch2) is used for motor control 2 sensor input (Encoder B/H2). See JPM4.
	Between 2-3	The microcontroller pin PB5 (TIM3_Ch2) is connected to the PFC PWM output (MC_Main PFC_PWM).

Table 1. Jumper settings (continued)

Jumper	Selection	Description
JMP9	Between 1-2	The microcontroller pin PC3 (ADC123_IN13) is connected to the AC voltage input sensing of the power stage 1 (MC_Main PFC_Vac).
	Between 2-3 (default)	The microcontroller pin PC3 (ADC123_IN13) is used for bus voltage measurement of the power stage 2 (MC_Sub1 Bus Voltage).
JP5	Between 1-2 (default)	The microcontroller pin PB4 (JTRST) is connected to the JTAG connector CON6
	Between 2-3	The microcontroller pin PB4 is connected to the synchronization feedback signal coming from power stage (MC_Main PFC Sync)
	Between 2-4	The microcontroller pin PB4 (TIM3_CH1) is used for motor control 2 sensor input (Encoder A/H1). See JMP10.
JP7	Closed	This must be closed if TIM4 is used for speed and positioning feedback for the motor 2.

4 Using the STEVAL-IHM039V1 with the STM32 FOC firmware library

The “STM32 FOC firmware library” provided together with the STM3210B-MCKIT performs the field oriented control (FOC) of a permanent magnet synchronous motor (PMSM) in both sensor and sensorless configurations.

It is possible to configure the firmware to work with the STEVAL-IHM039V1 board and to establish a real-time communication for debugging/tuning purposes using the ST motor control workbench.

This section describes how the “STM32 FOC firmware library” v3.2 or higher can be used together with the STEVAL-IFN003V1 and with the ST motor control workbench release 2.0 or higher.

4.1 Hardware requirements

The following items are required to run the STEVAL-IHM039V1 together with the “STM32 FOC firmware library”.

- The STEVAL-IHM039V1 board
- A DC power supply (up to 48 V)
- A programmer/debugger dongle (not included in the package). To program/debug the STEVAL-IHM039V1, a dongle with JTAG or single wire debugging capabilities (SWD) is required. Use of an insulated dongle (like “ST-LINK/V2-ISOL”) is always recommended.
- A 3-phase brushless motor with permanent magnet rotor (not included in the package)
- A USB cable with USB connector (type B) to establish a real-time communication (not included in the package).
- An insulated oscilloscope (as needed).
- An insulated multimeter (as needed).

4.2 Software requirements

To customize, compile and download the “STM32 FOC firmware library” v3.2 or above, a tool chain must be installed. Please refer to the UM1052 user manual for details on how to set up the proper tool chain.

Before establishing the real-time communication it is also necessary to install the “STM32 Virtual COM Port Driver” available for download from the ST website.

Two specific configuration files for the ST motor control Workbench designed to work with the STEVAL-IHM039V1 exist (see [Table 2](#)). Both are present in the STM32 PMSM FOC Firmware Library, under “\Utilities\WB_Projects\SDK3xx” subfolder or in the ST MC Workbench, under “\WB_Projects\SDK3xx”.

Table 2. STEVAL-IHM039V1 configuration files for ST motor control Workbench

Configuration file name	Intended use
SDK3xx-STEVAL-IHM039V1-MB459-Shinano-SINGLE-DRIVE.stmc	STEVAL-IHM039 in single drive configuration
SDK32x-STEVAL-IHM039V1-MB459-Shinano-DUAL-DRIVE.stmc	STEVAL-IHM039 in dual drive configuration

To establish real-time communication between STEVAL-IHM039V1 and the ST motor control Workbench, after installing the “STM32 Virtual COM Port Driver”, connect a USB cable (type B) to the CON11 connector on the STEVAL-IHM039V1.

New hardware will be found on the system and the driver will be installed. A new COM port will be added to the system and the new COM port (Ex. COM58) can be set up in the ST motor control Workbench under the “monitor” window to establish the connection.

5 Bill of material

Table 3. Bill of material

Item	Quantity	Reference	Part	Tolerance	Description
1	1	B1	TD-0341 [RESET/Black]		Micro tactile switch
2	2	CON1,CON3	Header 35 x 2		2x35 way double row strip line connector (male connector) 2.54 mm pitch
3	1	CON4	Color LCD module		2 strip line connector (female connector) 2x8 way double row 2.54 mm pitch
4	1	CON5	TRACE		2x10 way double row strip line connector (male connector) 1.27 mm pitch
5	1	CON6	JTAG		20 way IDC low profile boxed header 2.54 mm pitch
6	1	CON8	MC_Main connector		34 way IDC low profile boxed header 2.54 mm pitch
7	1	CON9	MC_Sub1 connector		34 way IDC low profile boxed header 2.54 mm pitch
8	1	CON11	USB-typeB conn.		USB connector
9	1	CON12	DC-10B		Mini DC power socket 2.5 mm
10	1	CON13	Aux DC - 250 V		2 way PCB screw terminal, 5.08 mm pitch
11	1	CON14	MiniUSB-typeB conn.		MiniUSB connector
12	40	C1,C3,C4,C5,C6,C7,C8,C9,	100 nF 16 V	+/-10%	Ceramic capacitor X7R
13		C15,C20,C23,C26,C28,C34,C35,			
14		C36,C37,C38,C39,C40,C42,C44,			
15		C45,C46,C47,C50,C57,C60,C61,			
16		C62,C63,C64,C65,C66,C67,C68,			
17		C69,C70,C74,C75			

Table 3. Bill of material (continued)

Item	Quantity	Reference	Part	Tolerance	Description
18	21	C2,C12,C13,C14,C17, C18,	do not fit		
19		C19,R24,C25,C27,C29, R30,			
20		C30,R31,C31,R32,C32, R44,			
21		R47,R61,R83			
22	2	C10,C24	1 nF	+/-10%	Ceramic capacitor X7R
23	1	C11	22 nF	+/-10%	Ceramic capacitor X7R
24	4	C16,C21,C33,C54	10 nF	+/-10%	Ceramic capacitor X7R
25	1	C22	1 uF	+/-10%	Ceramic capacitor X7R
26	4	C41,C58,C59,C73	22 pF	+/-10%	Ceramic capacitor X7R
27	1	C43	4.7 nF	+/-10%	Ceramic capacitor X7R
28	1	C48	10 uF 16 V	+/-10%	Electrolytic aluminum capacitor
29	1	C49	470 uF 10 V	+/-10%	Electrolytic aluminum capacitor
30	2	C51,C53	10 uF	+/-10%	Ceramic capacitor X7R
31	1	C52	470 nF	+/-10%	Ceramic capacitor X7R
32	2	C55,C56	10 pF	+/-10%	Ceramic capacitor X7R
33	1	C71	1 uF	+/-10%	Ceramic capacitor X7R
34	1	C72	2.2 uF 10 V	+/-20%	Electrolytic aluminum capacitor
35	2	C76,C77	2.2 uF 16 V	+/-10%	Ceramic capacitor X7R
36	2	D1,D5	Red		Chip LED
37	1	D2	Orange		Chip LED
38	2	D3,D6	Green		Chip LED
39	1	D4	Blue		Chip LED
40	10	JMP1,JMP2,JMP3,JMP 4,JMP5,	Jump_linear 3		3 way single row strip line connector (male connector) 2.54mm pitch
41		JMP6,JMP7,JMP8,JMP 9,			
42		JMP10			
43	11	JP1,JP2,JP3,JP4,JP6,J P7,JP8,JP9,	JUMPER		2 way single row strip line connector (male connector) 2.54mm pitch

Table 3. Bill of material (continued)

Item	Quantity	Reference	Part	Tolerance	Description
44		JP10,JP11,JP12			
45	1	JP5	CON3+1_1		3+1 way single row strip line connector (male connector) 2.54mm pitch
46	1	J1	I2C		4 way single row strip line connector (male connector) 2.54mm pitch
47	1	J2	RI-0505 DC-DC converter		Isolated DC-DC converter
48	1	J3	IL516-3E 0.15" 16-pin SOIC		4 channel opto-isolator
49	1	J4			3 way dual row strip line connector
(male connector) 2,54 mm pitch					
50	1	L1	BEAD distrelec 330005		Data line filter
51	2	P1,P2	DB9-male connector		9 way r/a PCB D plug,US footprint
52	3	Q1,Q2,Q3	2STR1215		Low voltage fast-switching NPN power transistor
53	22	R6,R7,R8,R9,R10,R25,	10 K	+/- 1%	Resistor
54		R26,R27,R28,R29,R33,R34,			
55		R35,R63,R64,R73,R77,R88,			
56		R91,R92,R97			
57	2	R1,R2	820	+/- 1%	Resistor
58	2	R3,R20	4K7	+/- 1%	Resistor
59	4	R4,R11,R16,R23	100 R	+/- 1%	Resistor
60	32	R5,R12,R13,R14,R15,R17,	0R	+/- 1%	Resistor
61		R21,R22,R36,R37,R40,R41,			
62		R45,R46,R48,R49,R50,R52,			
63		R53,R54,R56,R57,R58,R59,			

Table 3. Bill of material (continued)

Item	Quantity	Reference	Part	Tolerance	Description
64		R60,R76,R78,R80,R84, R87,			
65		R89,R90			
66	1	R18	330 R	+/- 1%	Resistor
67	1	R19	220 K	+/- 1%	Resistor
68	2	R38,R51	3.3 K	+/- 1%	Resistor
69	3	R39,R42,R55	100 K	+/- 1%	Resistor
70	1	R43	4.7 K	+/- 1%	Resistor
71	1	R62	1 k	+/- 1%	Resistor
72	4	R65,R66,R69,R71	600 R	+/- 1%	Resistor
73	2	R67,R68	22 R	+/- 1%	Resistor
74	1	R70	1 MR	+/- 1%	Resistor
75	2	R72,R96	1.5 K	+/- 1%	Resistor
76	2	R74,R98	36 K	+/- 1%	Resistor
77	1	R75	47 K	+/- 1%	Resistor
78	1	R79	220	+/- 1%	Resistor
79	1	R82	120 R	+/- 1%	Resistor
80	1	R85	300 R	+/- 1%	Resistor
81	1	R86	47 R	+/- 1%	Resistor
82	1	R93	390 R	+/- 1%	Resistor
83	2	R94,R95	10 R	+/- 1%	Resistor
84	1	SW1	USER3		Surface mount tactile switch
85	1	SW2	USER2		Surface mount tactile switch
86	1	SW3	USER1		Surface mount tactile switch
87	1	SW4	BOOT1		1-pole miniature slide switches through hole
88	2	SW5,SW6	BOOT0		1-pole miniature slide switches through hole
89	1	S1	RESET		Surface Mount Tactile Switch
90	1	U1	MT008-A		Joystick
91	1	U2	USBLC6-2SC6		Very low capacitance ESD protection
92	1	U3	L9615		CAN transceiver
93	1	U4	ST3232EBTR		RS-232 transceiver

Table 3. Bill of material (continued)

Item	Quantity	Reference	Part	Tolerance	Description
94	1	U5	ZEN056V130A24LS	5.6 V	Polymer protected Zener diode 5.6V
95	1	U6	BNX002-01	50 V/10 A	PCB mount DC power filter
96	1	U7	LD1086D2M33TR		Low drop linear regulator
97	1	U8	STM32F415ZGT6		
98	1	U9	STM32F103R8T6		
99	1	U11	LD2981ABM33TR		Low drop linear regulator
100	2	X1,Y2	8 MHz		
101	1	Y1	32.768 KHz		
102	1	Z1	SMAJ5.0A-TR		Transil
103	1	RV1	10 K (Trimmer)		
104	14	jumper			Jumper on JMP3,JMP4,JMP10,JMP5, JMP6, JMP7,JMP8,JMP9,JMP2,JP5,JMP1,JP7,JP9,JP12

6 Revision history

Table 4. Document revision history

Date	Revision	Changes
19-Mar-2013	1	Initial release.

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