BLDC Motor Workshop
– LVPB-A Hardware Description

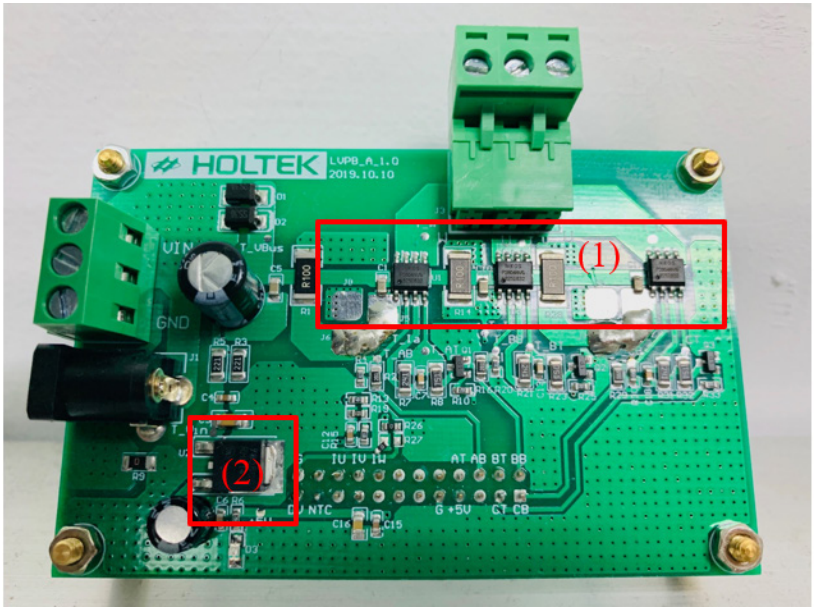
Revision: V1.00 Date: May 06, 2020

www.holtek.com

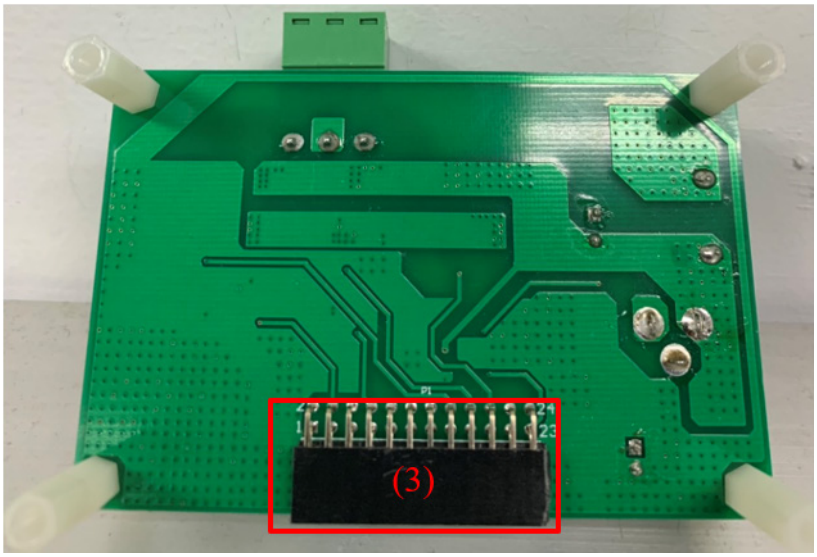
Table of Contents

1. Introduction

The BLDC Motor Workshop LVPB-A is shown in Figure 1-1. The framed part (1) in Figure 1-1(a) is the driver circuit. The framed part (2) in Figure 1-1(a) is the 5V LDO circuit. The framed part (3) in Figure 1-1(b) is the connector with FOC-EVB. In addition, the LVPB-A contains the VDC voltage feedback circuit, users can utilise the MCU peripheral ADC pin, ADC1-IN3, to read the signal.



(a)



(b)

Figure 1-1 BLDC Motor Workshop LVPB-A

The LVPB-A development environment is shown in Figure 1-2. Users should connect the LVPB-A with FOC-EVB, and connect the EV board to PC through a USB cable simultaneously, allowing the target MCU to communicate with the BLDC Motor Workshop. The input voltage range is DC 9V~26V.

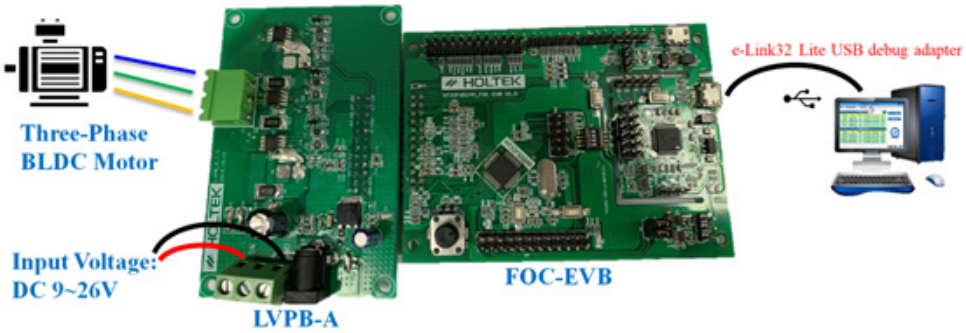


Figure 1-2 LVPB-A Development Environment

Feature

- Input voltage: DC9V~26V
- Max. DC Bus current: 2.5A
- Max. motor phase current: 3.0A
- R_Shunt(Phase): 0.1Ω/2512/1%
- DC Bus Voltage Divider Ratio: 1/11.00
- Gate-Driver Polarity:
  - ♦ Low side active high
  - ♦ High side active high

As the above feature shows, the LVPB-A maximum motor phase current is 3A, the hardware parameters are shown as follows:

(1) The LVPB-A R40, R41 and R42 R_shunt specifications are all 0.1Ω/2512/1%.

(2) The FOC-EVB R11 and R12 specifications are both 7.5kΩ/0603/1%.

(3) The FOC-EVB R26, R27, R29 and R30 specifications are all 15kΩ/0603/1%.

Therefore, the maximum motor operating current is:

I(motor max. current) = 2.3/(R_shunt×OPA Gain) = 2.3/(0.1×7.5) = 3.0A.

2. Schematics

This section will present the schematics and explain the LVPB-A hardware circuit as shown in chapters from 2-1 to 2-5.

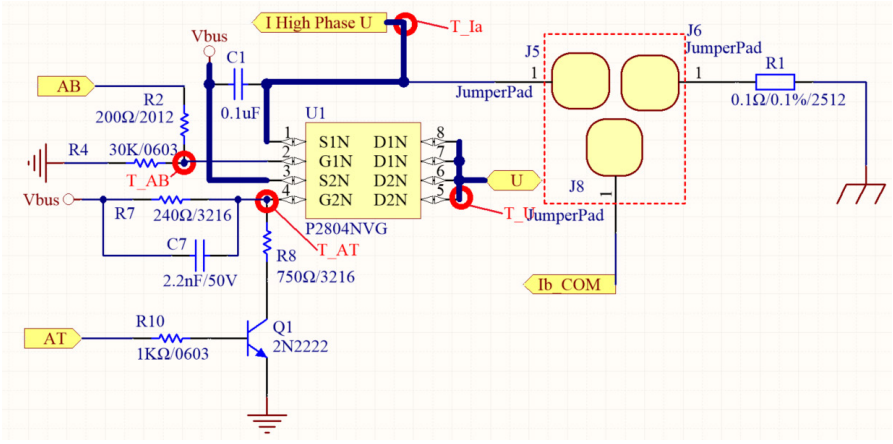
2-1 Driver Circuit

Figure 2-1 shows the driver circuit. The circuit adopts a component named P2804NVG, which includes an N-channel MOSFET(1) and a P-channel MOSFET(2). The N-channel MOSFET is used as the low side switching component while the P-channel MOSFET is used as the high side switching component. Taking the Phase-A as an example:

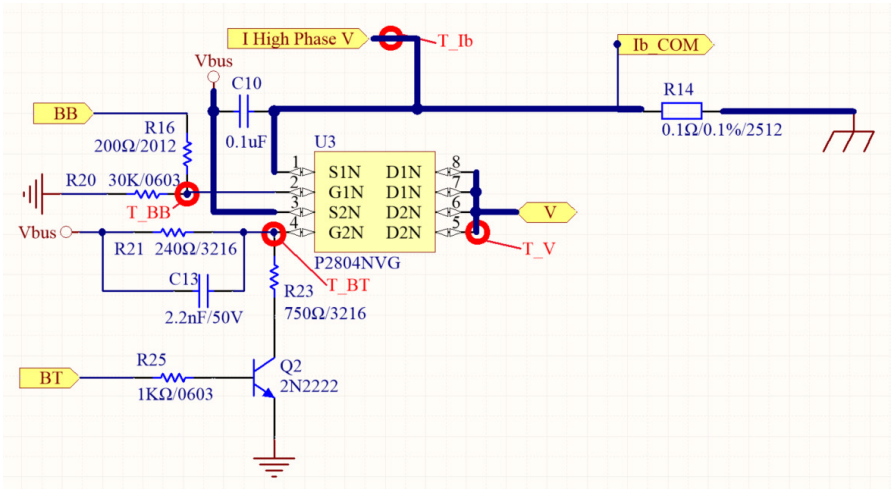
If the MCU output PWM AT is low and AB is high, the BJT Q1 will be off, Vgs2=0 and the P-channel MOSFET will be in cut-off state. As the Vgs1>0, the N-channel MOSFET is in on state.

If the MCU output PWM AT is high and AB is low, the BJT Q1 will be on, Vgs2<0 and the P-channel MOSFET will be in on state. As the Vgs1=0, the N-channel MOSFET is in cut-off state.

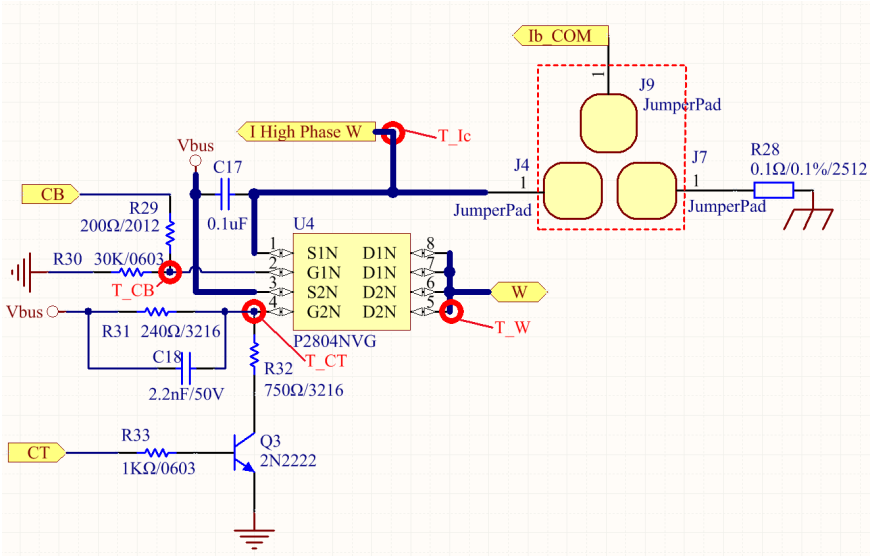
For jumper pads, in order to select three R_Shunts feedback motor current, the source electrode of the low side MOSFETs should be connected to the shunt resistors, that is, J5 should be shorted to J6 and J4 should be shorted to J7.



(a)



(b)



(c)

Figure 2-1 Driver Circuit

2-2 LDO Circuit

Figure 2-2 shows the 5V LDO circuit, which adopts the 7805 LDO. The circuit output is mainly used for MCU component power supply by being connected to the FOC-EVB through the connector P1. Users can check the LED D3 to determine if the LVPB-A circuit supplies power to the EV board successfully.

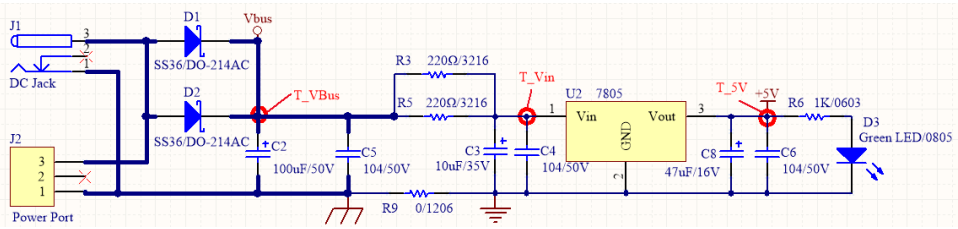


Figure 2-2 LDO Circuit

2-3 VDC Voltage Feedback Circuit

Figure 2-3 shows the VDC voltage feedback circuit. In hardware design, the ratio of the Det_VDC feedback signal and the actual VDC voltage is 1/11 by default. The current VDC voltage can be calculated by the voltage read from MCU ADC1-IN3 and the hardware default reduction ratio.

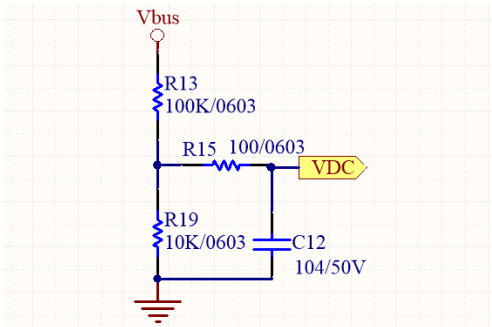


Figure 2-3 VDC Voltage Feedback Circuit

2-4 Signals and Power Test Points

The LVPB-A signals and power test points include the driver input/output signals of AT, AB, U, BT, BB, V, CT, CB and W, the phase current feedback signals of Ia, Ib and Ic as well as the 5V LDO input/output voltage.

2-5 Connector Between LVPB-A and FOC-EVB

Figure 2-4 shows the connector between LVPB-A and FOC-EVB, which contains the driver circuit input signals of AT, AB, BT, BB, CT and CB, the VDC voltage feedback signal Det_VDC, the three phase current feedback signals of I High Phase U, I High Phase V and I High Phase W as well as the 5V LDO output voltage. The pin definitions are shown in Table 2-1.

Pin No.	Definition	Pin No.	Definition
1	CB	2	BB
3	CT	4	BT
5	NC	6	AB
7	5V	8	AT
9	GND	10	NC
11	NC	12	NC
13	NC	14	NC
15	NC	16	I High Phase W
17	NC	18	I High Phase V
19	NC	20	I High Phase U
21	NC	22	NC
23	Det_VDC	24	GND

Table 2-1 Pin Definitions for the Connector Between LVPB-A and FOC-EVB

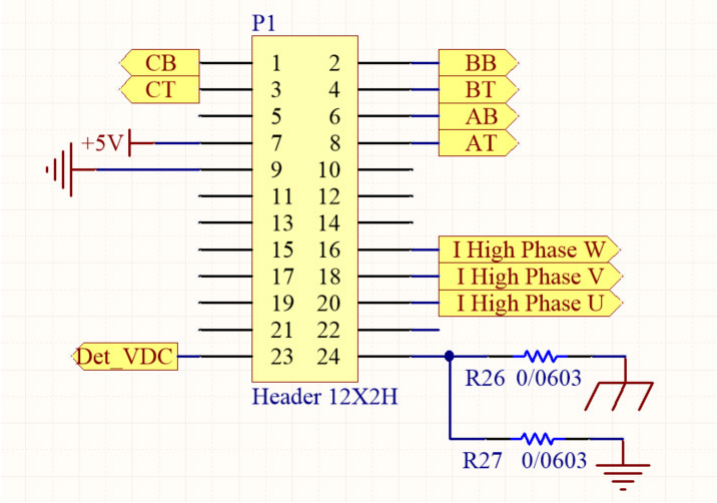


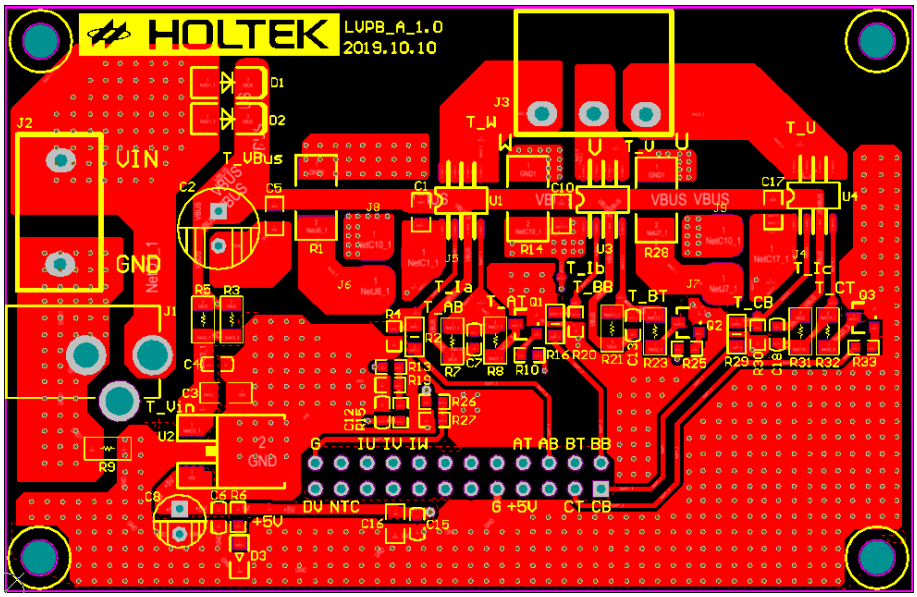
Figure 2-4 Connector Between LVPB-A and FOC-EVB

3. PCB Layout

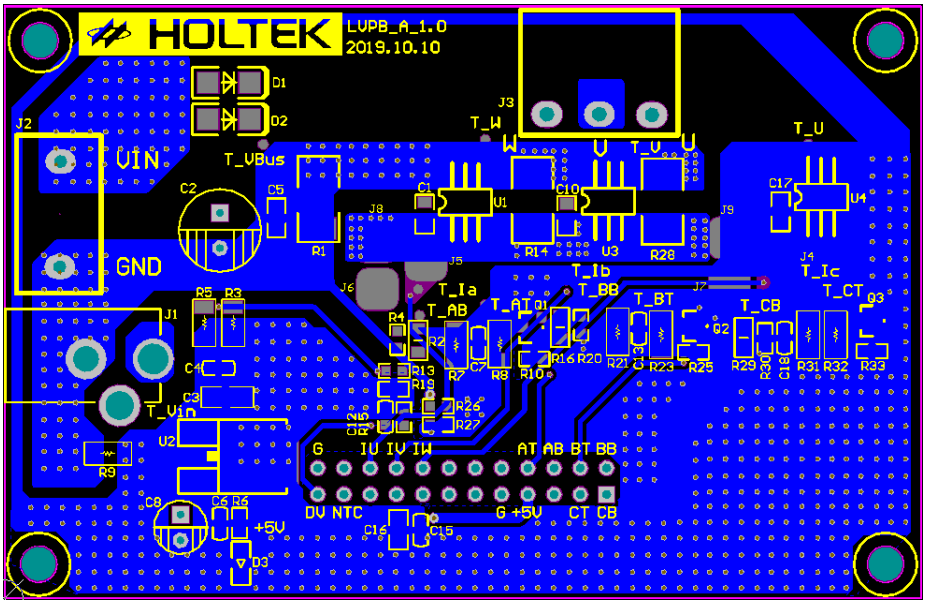
Fig. 3-1 shows the LVPB-A PCB layout, the detailed specifications of which are shown in Table 3-1.

Length × Width	58 × 89 (mm)
Thickness	1.6 (mm)
Number of Layers	2 (Layer)
Copper Foil Thickness	2 (Oz)
Material	FR-4
Solder Mask Layer Colour	Green

Table 3-1 LVPB-A Circuit Board Specifications



(a)



(b)

Figure 3-1 BLDC Motor Workshop LVPB-A PCB Layout: (a) Upper Layer; (b) Lower Layer

4. BOM List

Table 4-1 shows the LVPB-A BOM list, which lists all the required components for a set of circuit board.

No.	Comment	Description	Designator	Quantity
1	0.1μF, 50V, ±5%, 0805	Capacitor MLCC	C1, C5, C10, C17	4
2	10μF, 50V, ±10%, 1206	Capacitor MLCC	C3	1
3	0.1μF, 50V, ±5%, 0603	Capacitor MLCC	C4, C6, C12, C15	4
4	2.2nF, 50V, ±5%, 0603	Capacitor MLCC	C7, C13, C18	3
5	10μF, 35V, ±5%, 0805	Capacitor MLCC	C16	1
6	47μF, 16V, (5×12mm)	Polarized Capacitor (Radial)	C8	1
7	100μF, 50V, (8×13mm)	Polarized Capacitor (Radial)	C2	1
8	LED, Green, 0805	Typical INFRARED GaAs LED	D3	1
9	DC Jack	Low Voltage Power Supply Connector	J1	1
10	3-Pin Connector, Pitch5.08mm	Header, 3-Pin	J2	1
11	3-Pin Connector, Pitch5.08mm, 90degree	Header, 3-Pin	J3	1
12	12×2-Pin Connector, Pitch2.54mm, 90degree	Header, 12-Pin, Dual row, Right Angle	P1	1
13	MMBT2222A, SOT-23	NPN Bipolar Transistor	Q1, Q2, Q3	3
14	0.1Ω, 2512, ±1%	1% SMD Resistor	R1, R14, R28	3
15	200Ω, 0805, ±5%	SMD Resistor	R2, R16, R29	3
16	220Ω, 1206, ±5%	SMD Resistor	R3, R5	2
17	240Ω, 1206, ±5%	SMD Resistor	R7, R21, R31	3
18	750Ω, 1206, ±5%	SMD Resistor	R8, R23, R32	3
19	0Ω, 1206, ±5%	SMD Resistor	R9	1
20	0Ω, 0603, ±5%	SMD Resistor	R26	1
21	30kΩ, 0603, ±5%	SMD Resistor	R4, R20, R30	3
22	1kΩ, 0603, ±5%	SMD Resistor	R6, R10, R25, R33	4
23	100kΩ, 0603, ±5%	SMD Resistor	R13	1
24	100Ω, 0603, ±5%	SMD Resistor	R15	1
25	10kΩ, 0603, ±5%	SMD Resistor	R19	1
26	P2804NVG, 8SOP	N-& P-Channel MOSFET	U1, U3, U4	3
27	7805, TO252	Voltage Regulator IC	U2	1
28	NC	Pad (NC)	R27, J4, J5, J6, J7, J8, J9	7

Table 4-1 BLDC Motor Workshop LVPB-A BOM List