HT32F65740G_MCU Board
Hardware Description

Revision: V1.10 Date: October 29, 2025

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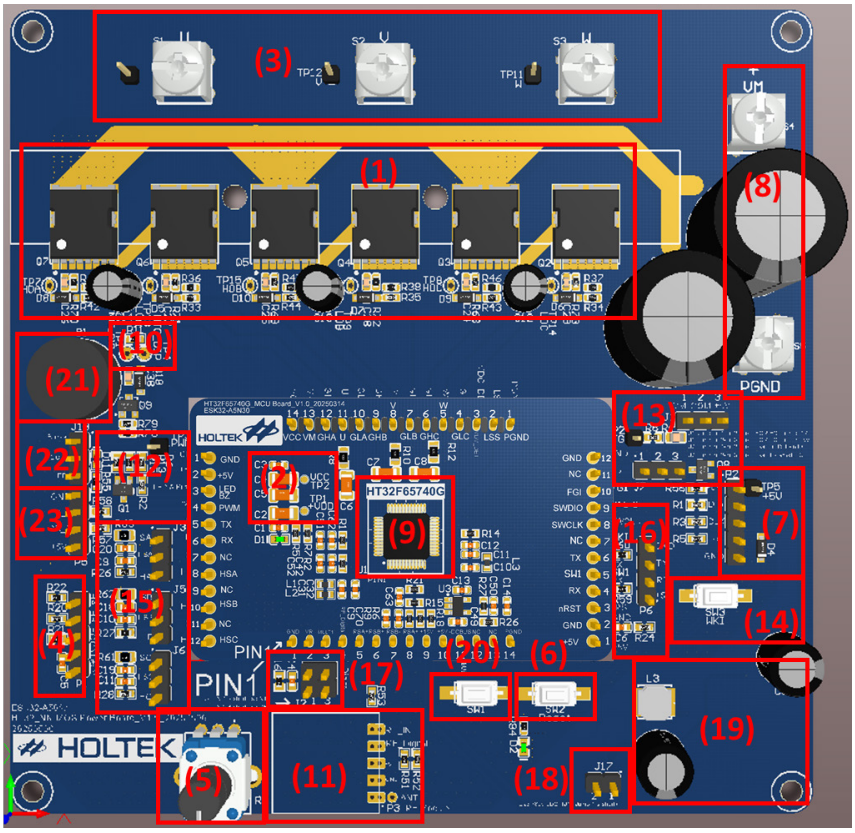
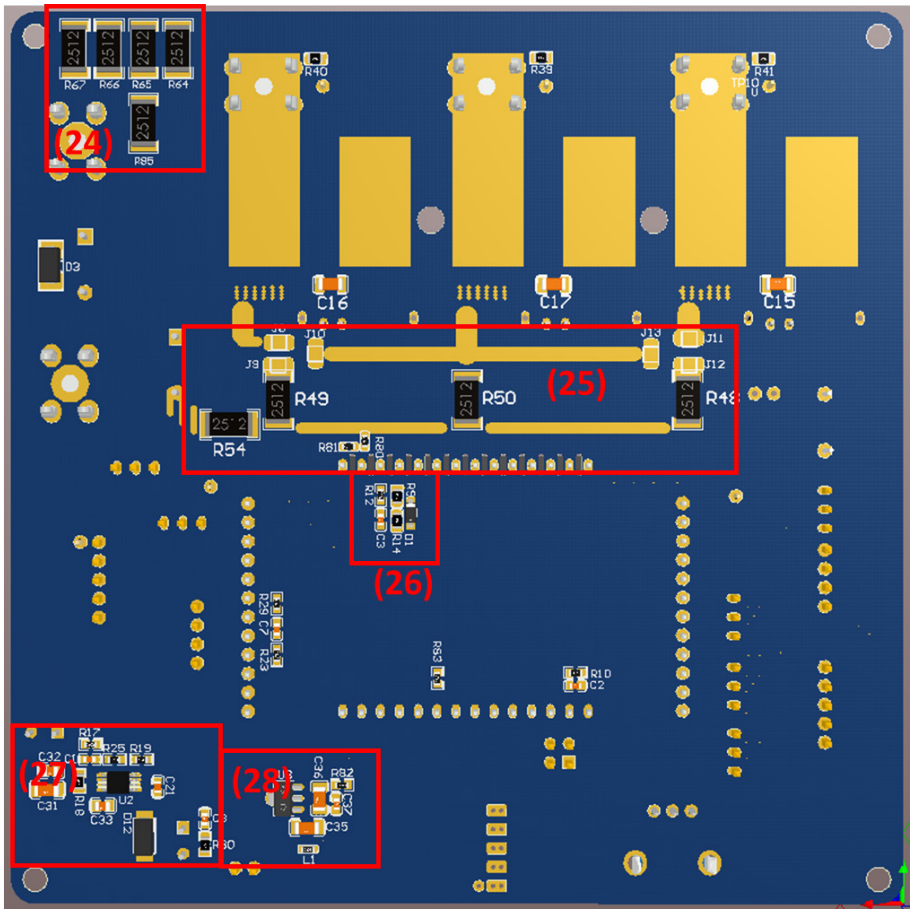
1. Introduction

The HT32F65740G_MCU Board and HT32 N/N MOS Power Board hardware description are shown in the following figure: (1) MOSFET inverters; (2) VCC capacitor and 5V LDO output; (3) U, V and W screw terminals; (4) Hall sensor interface; (5) VR variable resistor; (6) Reset button; (7) SWD programming interface; (8) DC input voltage screw terminals; (9) HT32F65740G MCU; (10) NTC temperature sensor; (11) RF receiving module; (12) external PWM command signal receiving circuit; (13) FG speed signal circuit; (14) MCU sleep wake-up circuit; (15) jumper cap for function selection between Hall sensor motor and sensorless motor; (16) Motor Workshop communication interface; (17) jumper cap for function selection between NTC and RF; (18) jumper cap for 7805 LDO; (19) DC-DC buck converter circuit; (20) button; (21) 5V buzzer; (22) jumper cap for function selection between buzzer and LED; (23) communication interface.



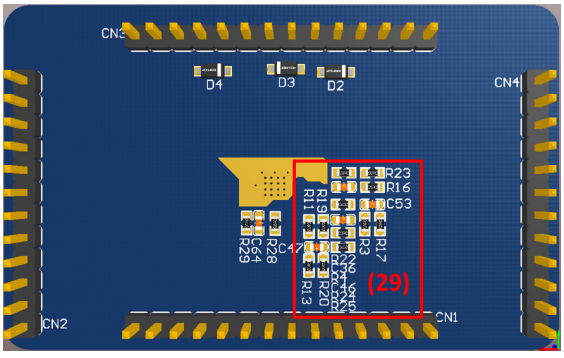
BLDC Motor Workshop HT32F65740G_MCU Board (Top Board) and HT32 N/N MOS Power Board (Bottom Board) Front View

The HT32 N/N MOS Power Board Back View hardware description is shown in the following figure: (24) Backup R_Shunt resistors; (25) J8, J9, J10, J11, J12 and J13 jumper pads; (26) DC input voltage detection circuit; (27) DC-DC buck converter circuit; (28) 7805 LDO circuit.



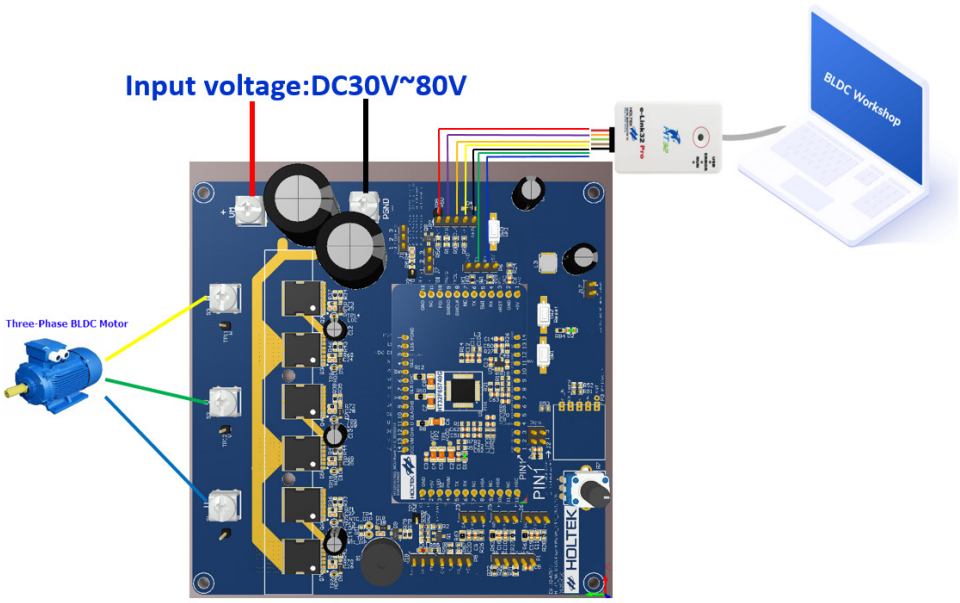
BLDC Motor Workshop HT32 N/N MOS Power Board Back View

The HT32F65740G_MCU Board Back View hardware description is shown in the following figure: (29) two-shunt resistor current sampling circuit.



BLDC Motor Workshop HT32F65740G_MCU Board Back View

The HT32F65740G_MCU Board development environment is shown in the following figure. The PC should be connected to the e-Link32 Pro via the USB port using a Mini USB cable. Then connect the e-Link32 Pro to the HT32F65740G_MCU Board to allow the HT32F65740G_MCU Board to communicate with the BLDC motor workshop. The input voltage range is DC 30V~80V.



HT32F65740G_MCU Board Development Environment

Features

- Input voltage: DC 30V~80V
- Maximum DC bus current: 20A
- Maximum motor phase current: 66.7A
- R_Shunt (Phase): 0.005Ω/2512/1%/2W
- DC bus voltage divider ratio: 1/22.25
- Gate-driver polarity:
  - Low side active low
  - High side active high

The HT32F65740G_MCU Board maximum motor phase current is 66.7A. For the phase current sampling OPA amplification setting as shown in the following figure, the default hardware parameters are shown as follows:

(1) The HT32 N/N MOS Power Board R48, R50 and R54 specifications are 0.005Ω/2512/±1%/2W.

(2) The HT32 N/N MOS Power Board R49 specification is 0Ω/2512/±1%/2W.

(3) Shorting J8 and J9, shorting J11 and J12.

(4) HT32F65740G_MCU Board R3, R17, R13 and R20 specifications are 180Ω.

(5) HT32F65740G_MCU Board R4, R16, R11 and R19 specifications are 820Ω.

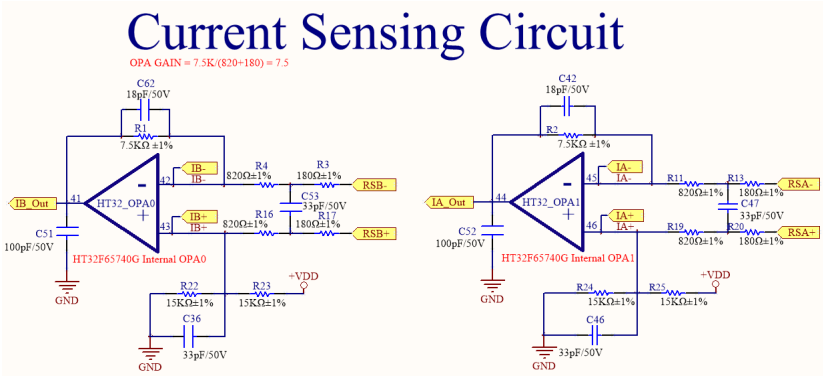
(6) HT32F65740G_MCU Board R1 and R2 specifications are 7.5kΩ.

(7) HT32F65740G_MCU Board R22, R23, R24 and R25 specifications are 15kΩ.

Under these hardware parameters, the maximum phase current under which the motor can operate is:

$$I_{max} = \frac{2.5V}{R\_Shunt \times Gain} = \frac{2.5V}{0.005\Omega \times 7.5} = 66.7A$$

When designing the amplifier gain and R_Shunt resistance, it should be noted that the motor operating phase current range must not be larger than the maximum sampling value of the motor phase current. If the motor operating phase current range is set too large, the resolution of the sampling current will be affected.



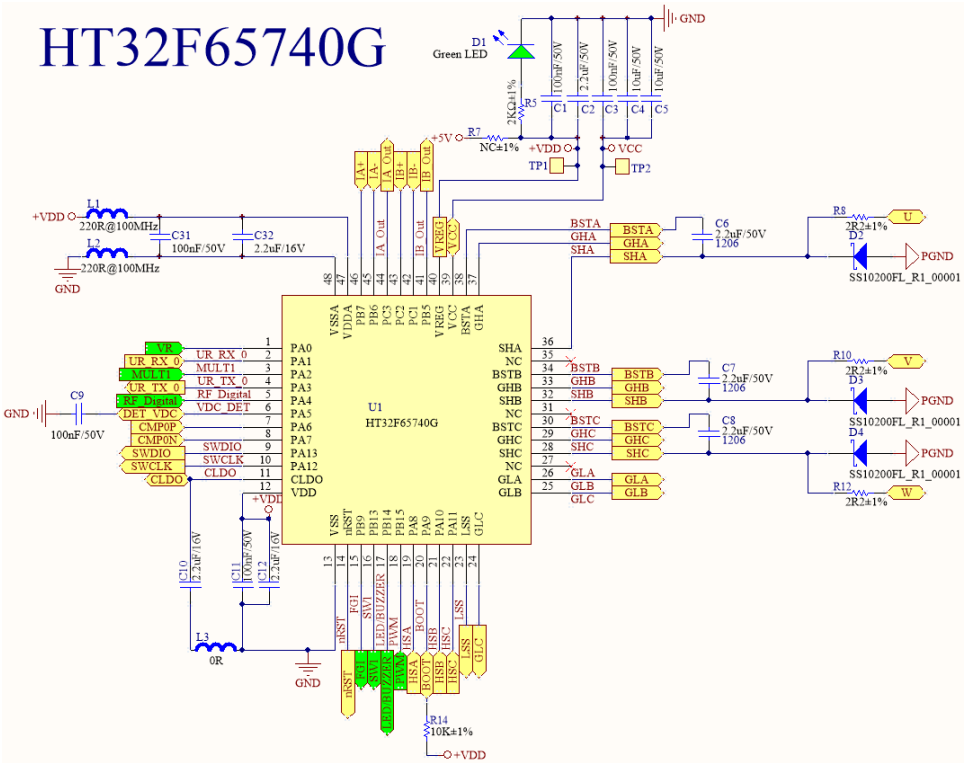
Phase Current Sampling OPA Amplification Setting

2. Schematics

This chapter will present the schematics and explain the HT32F65740G_MCU Board and HT32 N/N MOS Power Board hardware circuits as shown in sections from 2-1 to 2-15.

2-1 HT32F65740G Peripheral Component Reference Circuit

The following figure shows the HT32F65740G peripheral component reference circuit, which uses a 110V N/N half-bridge gate-driver. It has an integrated bootstrap diode with a current-limiting resistor and an internal 5V LDO for the MCU circuit power supply. The current drive capacity is 1.5A for the source and 2.5A for the drain. The gate-driver circuit provides various protection functions, such as over temperature protection, VCC under voltage protection, VBST under voltage protection and 5V LDO under voltage protection.



HT32F65740G Peripheral Component Reference Circuit

2-2 Inverter Circuit

The following figure shows the inverter circuit, in which the switching component part number is the AGM15T05LL, the component specifications of which are shown in the first table below. The MOSFET drive capability can be adjusted by the rising and falling time, which is implemented using the gate resistor and the diode. The R_Shunt resistors are used to feedback the phase current signals which are amplified by the internal OPA and then used by the MCU for FOC closed-loop control. The hardware default values of these resistors are 0.05Ω/2512/1%. Users should pay attention to the component rated power to ensure that they are above 2W if they wish to change the resistance value.

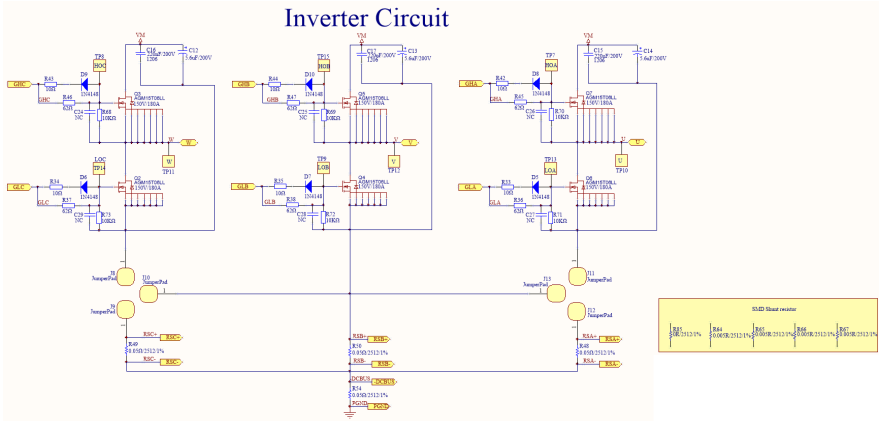
Since the HT32F65740G is a two-shunt resistor control MCU, the R_shunt resistor must be configured as follows: shorting J8 and J9; shorting J11 and J12; R49 is 0Ω, R48, R50 and R54 are all 50mΩ, which constitutes the HT32F65740G connection configuration. Since the current sampling resistor jumper settings on the bottom board is related to the MCU on the top board, the factory defaults to remove J8, J9, J10, J11, J12 and J13 jumper connections. Users should determine the current sampling resistor jumper settings on the bottom board based on the MCU selected for the top board, referencing the second table below.

Item	Value
V_{ds}	+150V
$R_{ds(on).max}$ @ V_{GS}=10V	6mΩ
I_d	180A
C_{iss}	5025pF

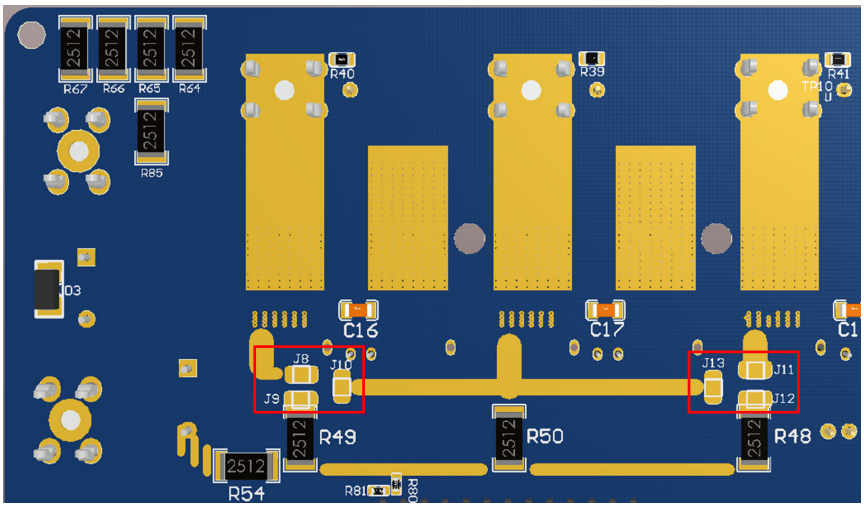
AGM15T05LL Specifications

MCU on the Top Board	Current Sampling Resistor Jumper Settings on the Bottom Board	Bus Over Current Detection Resistor
HT32F65x32G (Single-shunt resistor control)	Shorting J8 and J10, shorting J11 and J13; R49=50mΩ (default), R50=0Ω (swaps with R85), R48=50mΩ (default)	R54=50mΩ (default)
HT32F65x40G (Two-shunt resistor control)	Shorting J8 and J9, shorting J11 and J12; R49=0Ω (swaps with R85), R50=50mΩ (default), R48=50mΩ (default)	R54=50mΩ (default)
HT32F66x46G (Three-shunt resistor control + bus over current detection)	Shorting J8 and J9, shorting J11 and J12; R49=50mΩ (default), R50=50mΩ (default), R48=50mΩ (default)	R54=50mΩ (default)
HT32F65x33G (Two-shunt resistor control + bus over current detection)	Shorting J8 and J9, shorting J11 and J12; R49=0Ω (swaps with R85), R50=50mΩ (default), R48=50mΩ (default)	R54=50mΩ (default)

Current Sampling Resistor Jumper Setting Table on the Bottom Board



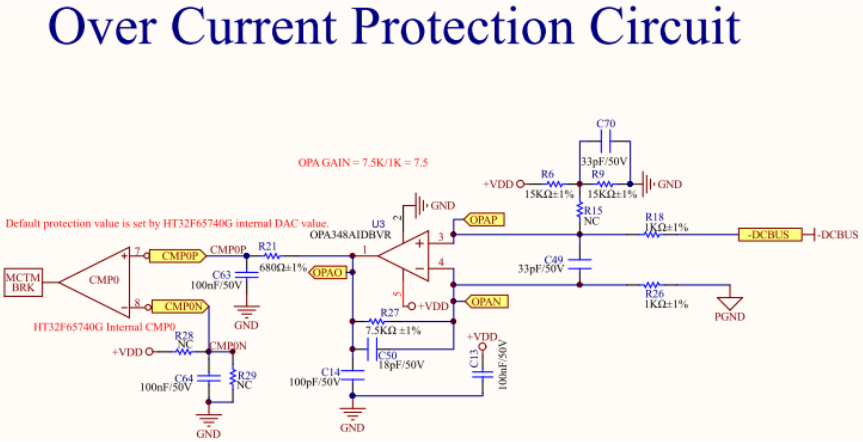
Inverter Circuit



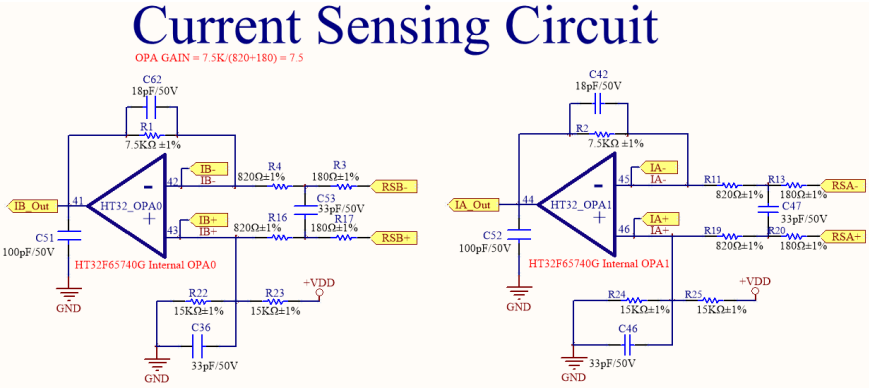
Actual Component Layout

2-3 Over Current Protection Circuit and Current Sensing Circuit

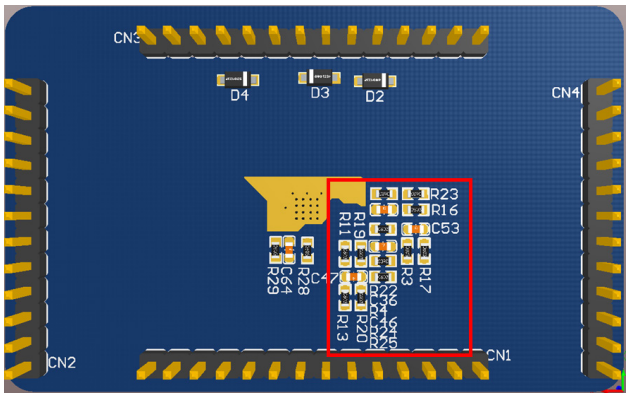
The following two figures show the over current protection circuit and the current sensing circuit. The voltage of the DC bus R_Shunt passes through a low-pass filter and enters the comparator, where it is compared with the over current threshold of the internal DAC to achieve the over current protection function.



Over Current Protection Circuit



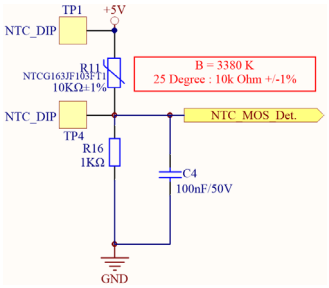
Current Sensing Circuit



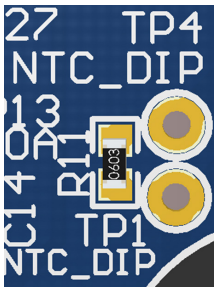
Actual Component Layout

2-4 MOSFET Temperature Feedback Circuit

The following figure shows the MOSFET temperature feedback circuit. Its NTC part number is the NTCG163JF103FT1, which has a negative temperature coefficient and a B value of 3380K±1%. The signals can be read by the MCU ADC to calculate the current NTC resistance. Then the B value can be used to calculate the current MOSFET temperature. The R11 is supplied in an SMD 0603 package. If the temperature function is required, the NTC should be placed close to the MOSFET, the R11 SMD can be removed and replaced with a plug-in NTC resistor. The NTC can be located closer to the heat source via the NTC pins, and the NTC pins can be soldered to the NTC_DIP through-hole.



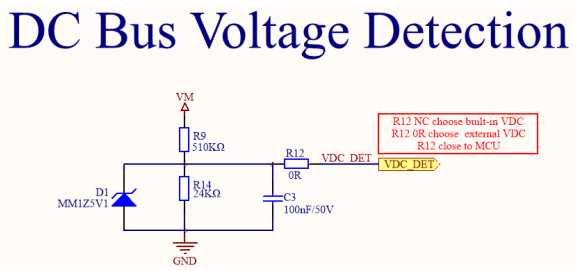
MOSFET Temperature Feedback Circuit

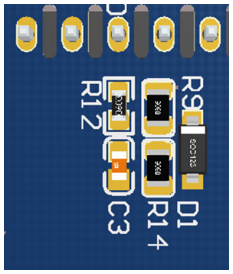


Actual Component Layout and NTC_DIP Position

2-5 DC Bus Voltage Feedback Circuit

The following figure shows the DC bus voltage feedback circuit. In the hardware design, the ratio of the V_{DC_DET} feedback signal to the actual DC bus voltage is 1/22.25 by default. The MCU reads the V_{DC_DET} voltage and then calculates the DC bus voltage with the hardware voltage ratio mentioned above.

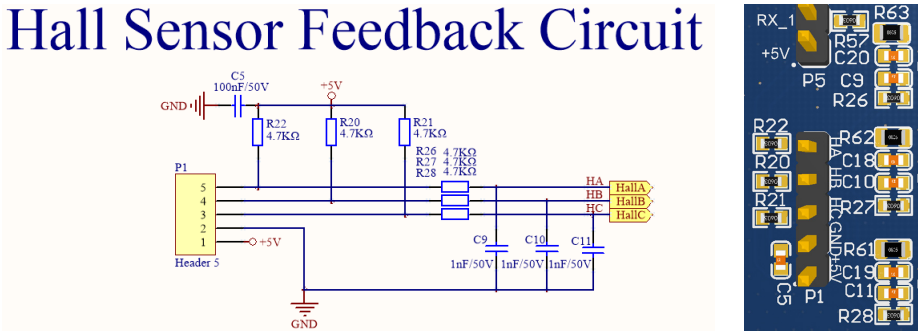




DC Bus Voltage Feedback Circuit and Actual Component Layout

2-6 Hall Sensor Feedback Circuit

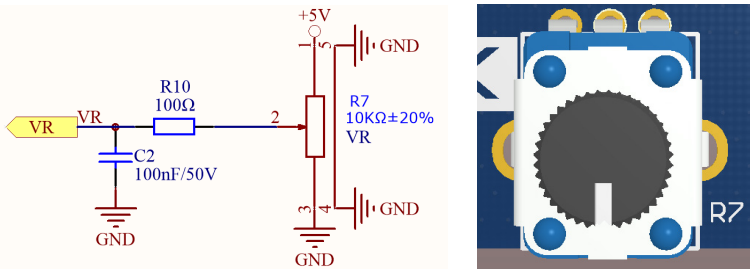
The following figure shows the Hall sensor feedback circuit. If the motor has a Hall sensor, three Hall signals can be connected to Pin3~Pin5 in the P1 header. The signals will be pulled high to +5V using the pull-up resistor and then be input to the MCU for commutation signal processing through a low-pass filter.



Hall Sensor Feedback Circuit and Actual Component Layout

2-7 VR Variable Resistor Circuit

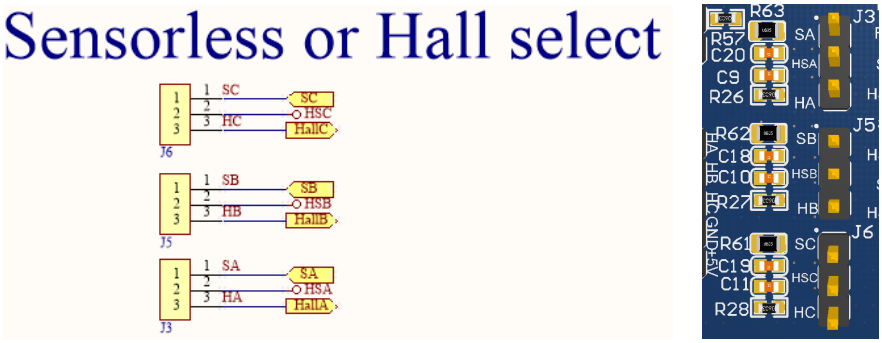
The following figure shows the VR variable resistor circuit, in which the VR divider voltage is transmitted to the MCU ADC through a low-pass filter. In practical applications, the circuit can be used for the motor speed control to implement the human-machine interface function.



VR Variable Resistor Circuit and Actual Component Layout

2-8 Sensorless and Hall Sensor Jumper Settings

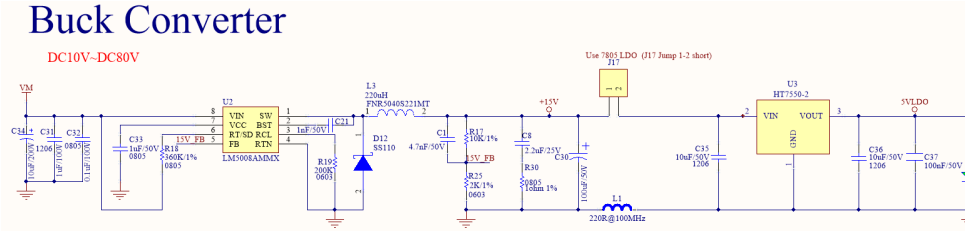
The following figure shows the Sensorless and Hall sensor jumper settings. The Hall signals, HallA, HallB and HallC, are selected by shorting Pin2 and Pin3 of the three external jumpers J3, J5 and J6. The sensorless signals, SA, SB, or SC, are selected by shorting Pin1 and Pin2 of the three external jumpers J3, J5 and J6. The hardware defaults to being Sensorless.



Sensorless and Hall Sensor Jumper Settings and Actual Component Layout

2-9 VCC Power Supply Circuit

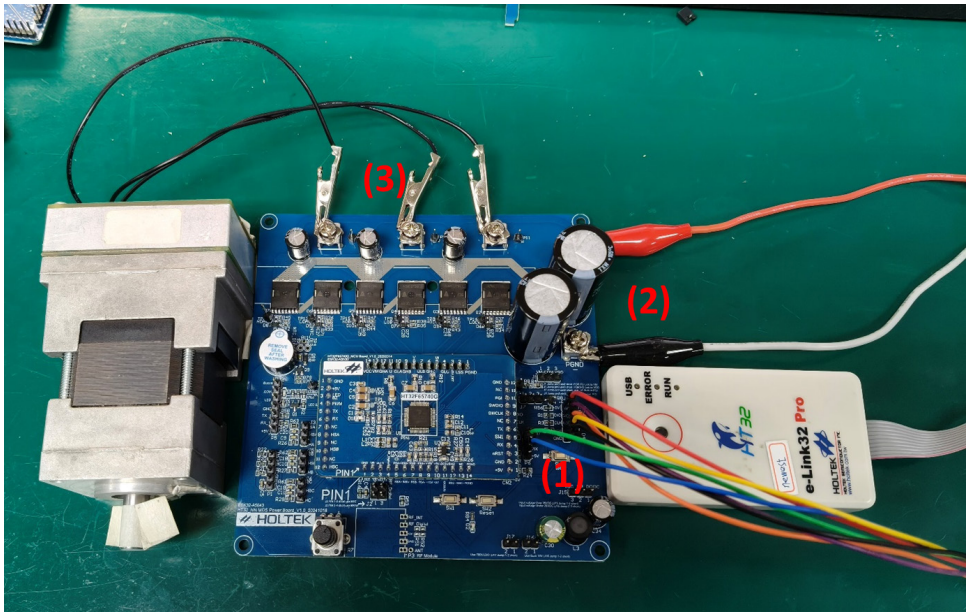
The following figure shows the VCC power supply circuit. The input power V_M is stepped down to 15V through a DC-DC converter, the LM5008AMMX, then converted to 5V through an LDO. The 15V and 5V power supplies are then supplied to the top board MCU. By default, the J17 header is shorted through a jump cap to use the external LDO power supply.



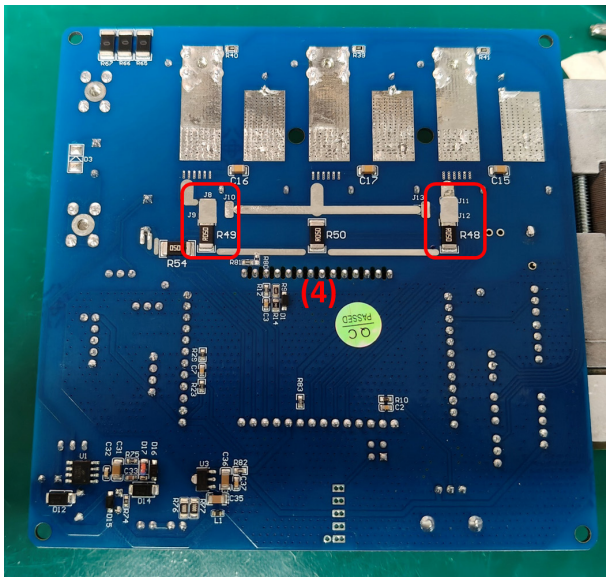
VCC Power Supply Circuit

2-10 Programming Interface and Motor Workshop Communication Connection

First, check whether the HT32F65740G_MCU Board and HT32 N/N MOS Power Board hardware connection is setup properly. As shown in the first figure below, there are four points to check: (1) e-Link32 Pro connection; (2) input power connection; (3) motor connection; (4) as shown in the second figure below, the sampling resistor configuration of the bottom board: J8 and J9 are shorted, J11 and J12 are shorted, R49 is 0Ω, and R48, R50 and R54 are 50mΩ.

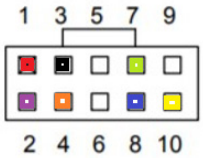


Check HT32F65740G_MCU Board and HT 32 N/N MOS Power Board Hardware Connection



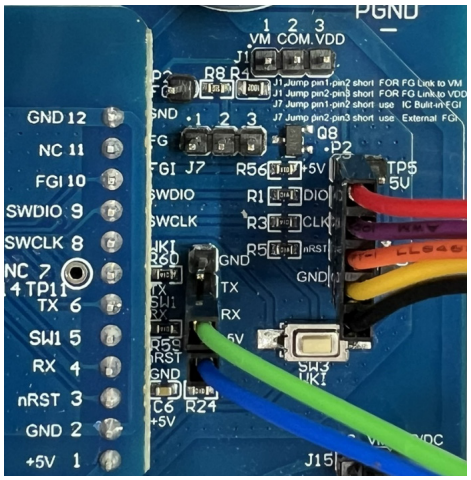
Check HT32 N/N MOS Power Board Current Sampling Resistor Configuration

As shown in the first figure above, connect the three phase lines of the motor to the U, V and W terminals of the HT32 N/N MOS Power Board, and then connect the Mini USB cable to the PC USB port. Connect the e-Link32 Pro output port to the HT32 N/N MOS Power Board P2 header through Dupont lines, as shown in the following three figures. The connections for the P2 header are 5V (red line), SWDIO (purple line), SWCLK (orange line), nRST (yellow line) and GND (black line) from top to bottom. Connect the e-Link32 Pro Pin8 VCOM_TXD to the P6_USR_RX on the HT32F65740G_MCU Board (blue line) and connect the e-Link32 Pro Pin7 VCOM_RXD to the P6_USR_TX on the HT32F65740G_MCU Board (green line). The 24V power supply is connected to the VM and PGND screw terminals. After this has been implemented, the hardware connection setup is complete.

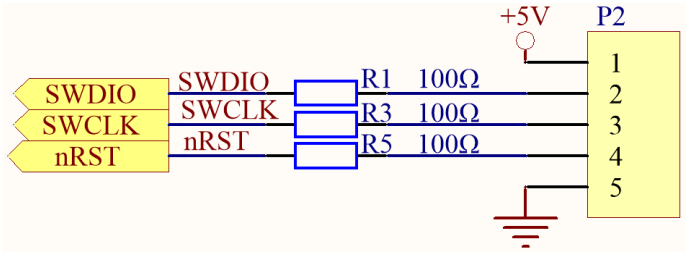


Pin#	Description	Pin#	Description
1	5V	2	SWDIO
3	GND	4	SWCLK
5	GND	6	Reserved
7	NC (VCOM_RXD(Note))	8	NC (VCOM_TXD(Note))
9	GND	10	Reset

e-Link32 Pro Pin Definition



HT32 N/N MOS Power Board P2 and P6 Connection Lines

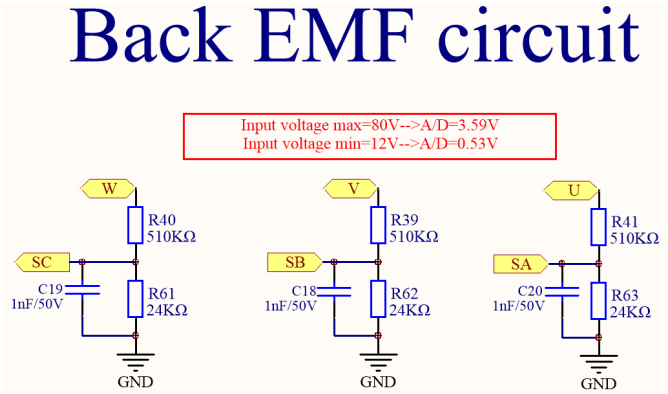


P2 Pin Definition

2-11 Back EMF Detection Circuit

The following figure shows the Back EMF detection circuit which is used to detect the motor phase voltage value. It is recommended that the voltage after division should not exceed 4V. The resistance values of the voltage divider resistors connected to ground, R61, R62 and R63, are fixed at 24kΩ. Assuming that the maximum input voltage is 80V, the resistance of the voltage divider resistors connected to the phase voltage are 510kΩ. The divided voltage is calculated as follows:

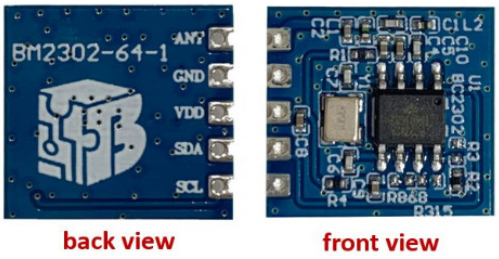
$$80V \times (\frac{24k\Omega}{24k\Omega+510k\Omega}) = 3.59V$$



Back EMF Detection Circuit

2-12 RF Receiving Module

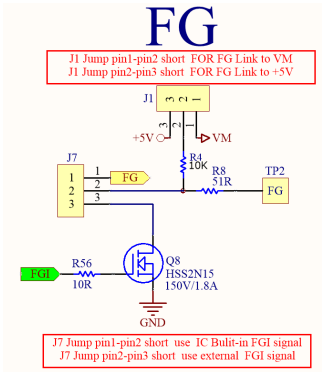
The following figure shows the 433MHz Low-IF OOK receiving module, the BM2302-64-1. If you have a requirement for long-distance remote control, you can purchase this module on the Best Modules online. By default, the hardware board does not include this module.



RF Receiving Module

2-13 FG Speed Function

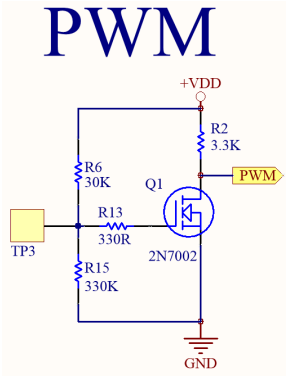
The following figure shows the FG speed function. By shorting the Pin2 and Pin3 of the J7 header on the bottom board with a jump cap, the external FGI signal provided by the HT32F65740G can be selected. In addition, the J1 header can be shorted with a jump cap to pull-up the FG output voltage level to VM or 5V to meet the external circuit input voltage requirements.

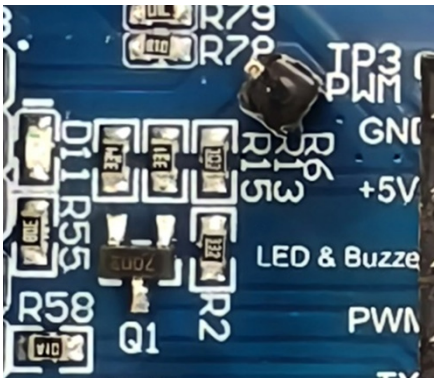


FG Speed Function

2-14 PWM Command Function

The following figure shows the PWM command function. By connecting the external PWM command signal to the TP3 header and using the Q1 MOSFET to invert the PWM signal output, an inverted PWM command signal will be generated.

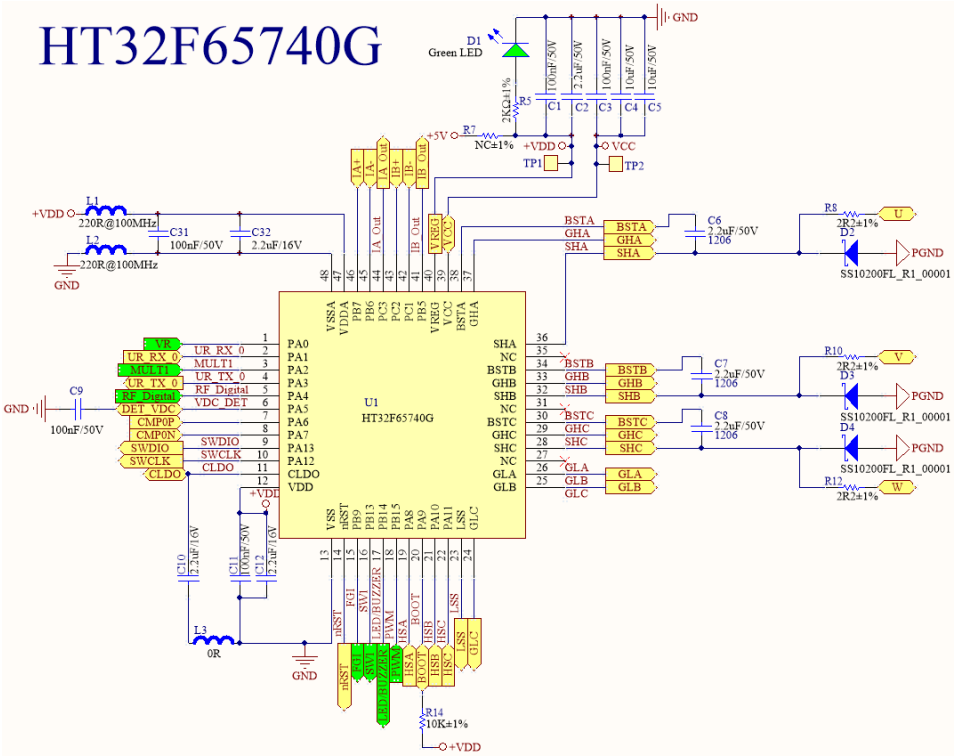




PWM Command Function

2-15 MCU Pin Function Definition

The following figure shows the HT32F65740G pinout diagram. The following table shows the MCU pin function definition.



HT32F65740G Pinout Diagram

PA0(VR)	PA1(USR_RX_0)	PA2(RF_INT & NTC)
PA3(USR_TX_0)	PA4(RF_Digital)	PA5(VDC_DET)
PA12(SWCLK)	PA13(SWDIO)	PB13(SW1)
PB14(LED & BUZZER)	PB15(PWM)	PA8(HSA)
PA10(HSB)	PA11(HSC)	

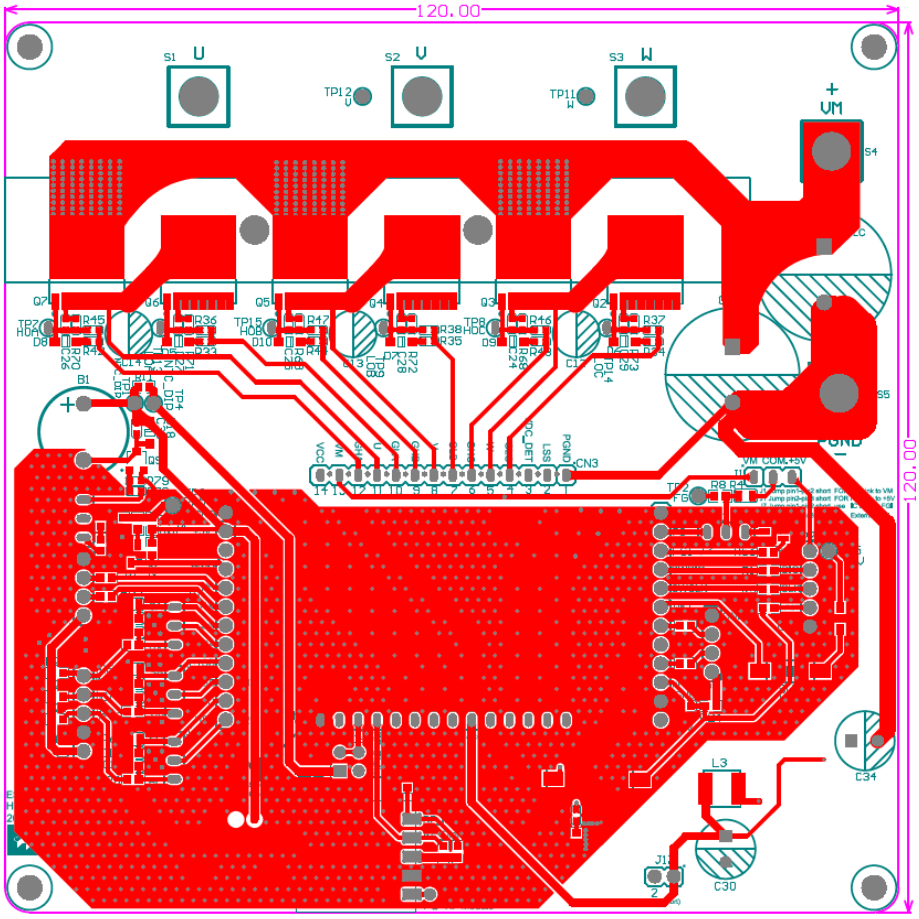
MCU Pin Function Definition

3. PCB Layout

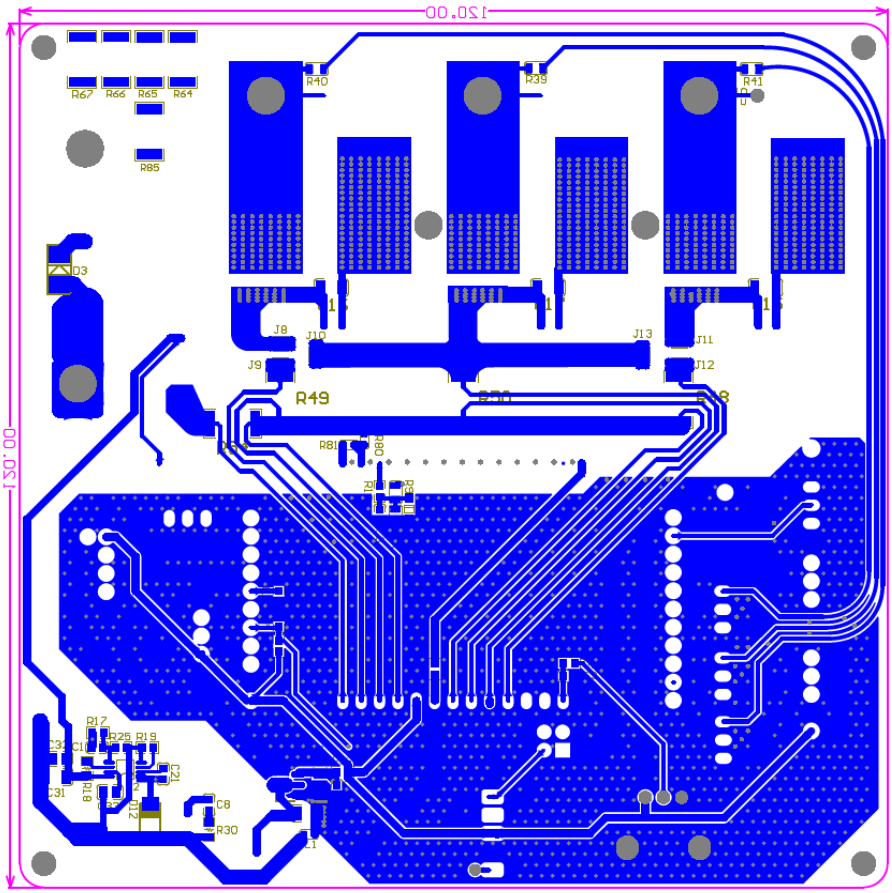
The two figures below show the HT32 N/N MOS Power Board PCB layout, the detailed specifications of which are shown in the following table.

Length×Width	120×120 (mm)
Thickness	1.6 (mm)
Number of Layers	2 (layers)
Copper Foil Thickness	1 (Oz)
Material	FR-4
Solder Mask Layer Colour	Blue

HT32 N/N MOS Power Board PCB Specifications



HT32 N/N MOS Power Board_Top Layer

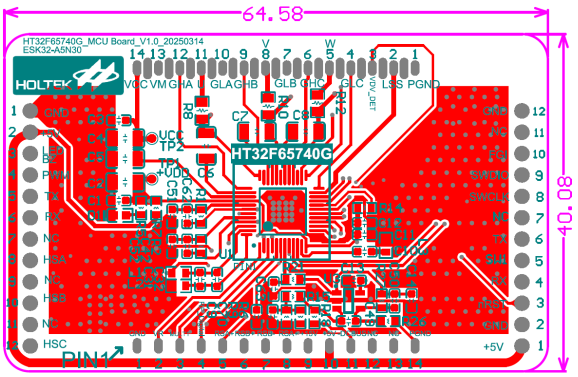


HT32 N/N MOS Power Board_Bottom Layer

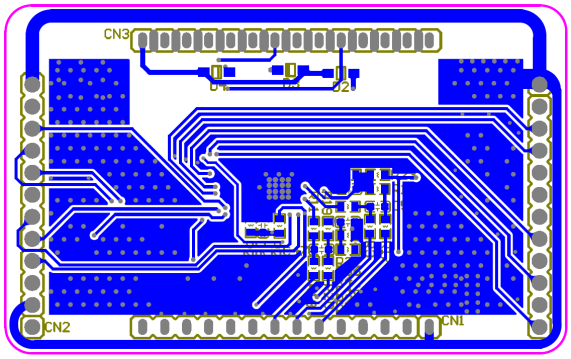
The two figures below show the HT32F65740G_MCU Board PCB layout, the detailed specifications of which are shown in the following table.

Length×Width	64.58×40.08 (mm)
Thickness	1.6 (mm)
Number of Layers	2 (layers)
Copper Foil Thickness	1 (Oz)
Material	FR-4
Solder Mask Layer Colour	Blue

HT32F65740G_MCU Board PCB Specifications



HT32F65740G_MCU Board_Top Layer



HT32F65740G_MCU Board_Bottom Layer

4. BOM List

The following table shows the HT32 N/N MOS Power Board BOM list, which shows all the circuit board required components.

No.	Description/Specification	Footprint/ Dimension	Designator	Quantity
1	SMD Capacitor, 220nF/200V ±10% X7R	1206	C15, C16, C17	3
2	SMD Capacitor, 10μF/50V ±10% X7R	1206	C35, C36	2
3	SMD Resistor, 100Ω±1%	1206	R76, R77	2
4	SMD Resistor, 0.05Ω/2512/±1%/3W	2512	R48, R49, R50, R54	4
5	SMD Resistor, 0.005Ω/2512/±1%/3W	2512	R64, R65, R66, R67	4
6	SMD Resistor, 0R/2512/±1%/3W	2512	R85	1
7	SMD Capacitor, 100nF/50V ±10% X7R	0603	C2, C3, C4, C5, C6, C7, C37, C38	8
8	SMD Capacitor, 1nF/50V ±10% X7R	0603	C9, C10, C11, C18, C19, C20	6
9	SMD Inductor, 220R @ 100MHz	0603	L1	1
10	SMD Resistor, 100Ω±1%	0603	R1, R3, R5, R10, R57, R58, R59, R60	8
11	SMD Resistor, 3.3K±1%	0603	R2	1
12	SMD Resistor, 30K±1%	0603	R6	1
13	SMD Resistor, 51R±1%	0603	R8	1
14	NTC Negative Resistor, NTC 10kΩ±1%	0603	R11	1
15	SMD Resistor, 0R	0603	R12, R82, R81, R83	4
16	SMD Resistor, 330R±1%	0603	R13	1
17	SMD Resistor, 24kΩ±1%	0603	R14, R61, R62, R63	4
18	SMD Resistor, 330K±1%	0603	R15	1
19	SMD Resistor, 1kΩ±1%	0603	R16, R53, R78	3
20	SMD Resistor, 4.7kΩ±1%	0603	R20, R21, R22, R26, R27, R28	6
21	SMD Resistor, 100kΩ±1%	0603	R23, R24, R29	3
22	SMD Resistor, 10Ω±1%	0603	R33, R34, R35, R42, R43, R44	6
23	SMD Resistor, 62Ω±1%	0603	R36, R37, R38, R45, R46, R47	6
24	SMD Resistor, 2kΩ±1%	0603	R55, R25	2
25	SMD Resistor, 10R±1%	0603	R56	1
26	SMD Resistor, 10kΩ±1%	0603	R68, R69, R70, R71, R72, R73, R79, R17	8
27	SMD Resistor, 2kΩ±1%	0603	R84	1
28	SMD Capacitor, 4.7nF/50V ±10% X7R	0603	C1	1

No.	Description/Specification	Footprint/ Dimension	Designator	Quantity
29	SMD Capacitor, 2.2μF/25V ±10% X7R	0603	C8	1
30	SMD Capacitor, 1nF/50V ±10% X7R	0603	C21	1
31	SMD Resistor, 200kΩ±1%	0603	R19	1
32	SMD Green LED, standard brightness	0603_LED	D2	1
33	SMD Red LED, standard brightness	0603_LED	D11	1
34	SMD Resistor, 10K±1%	0805	R4	1
35	SMD Resistor, 510kΩ±1%	0805	R9, R39, R40, R41	4
36	SMD Capacitor, 0.1μF/100V ±10% X7R	0805	C32	1
37	SMD Capacitor, 1μF/50V ±10% X7R	0805	C33	1
38	SMD Resistor, 360kΩ±1%	0805	R18	1
39	SMD Resistor, 1Ω±1%	0805	R30	1
40	SMD Capacitor, 1μF/100V ±10% X7R	1206	C31	1
41	Electrolytic Capacitor, 560μF/200V/ D18×45mm	CEC18_V_P7.5	C22, C23	2
42	Electrolytic Capacitor, 5.6μF/200V/D6.3×9mm	CEC6.3_V_P2.5	C12, C13, C14	3
43	Electrolytic Capacitor, 10μF/200V/D8×11.5mm	CEC8_V_P3.5	C34	1
44	Electrolytic Capacitor, 100μF/50V/D8×12mm	CEC8_V_P3.5	C30	1
45	Buzzer, SUN-12095-5VPA7.6	D=12mm	B1	1
46	Single-row Header (P=2.54mm, 12Pin, 180 degree)	Header_1×12P	CN2, CN4	2
47	Single-row Header (P=2.54mm, 14Pin, 180 degree)	Header_1×14P	CN1, CN3	2
48	Single-row Header (P=2.54mm, 1Pin, 180 degree)	Header_1×1P	TP2, TP3, TP5, TP10, TP11, TP12	6
49	Single-row Header (P=2.54mm, 2Pin, 180 degree)	Header_1×2P	J17	1
50	Single-row Header (P=2.54mm, 3Pin, 180 degree)	Header_1×3P	J1, J3, J5, J6, J7, J15, J18	7
51	Single-row Header (P=2.54mm, 4Pin, 180 degree)	Header_1×4P	P5, P6	2
52	Single-row Header (P=2.54mm, 5Pin, 180 degree)	Header_1×5P	P1, P2	2
53	Double-row Header (P=2.54mm, 2×2Pin, 180 degree)	Header_2×2P	J2	1
54	SMD Diode, SS110	SMA	D12	1
55	SMD Inductor, L=220μH FNR5040S221MT	SMD, 5×5mm	L3	1
56	SMD Zener Diode, MM1Z5V1	SOD-123	D1	1
57	SMD Diode, 1N4148	SOD-123	D4, D5, D6, D7, D8, D9, D10, D18	8
58	N-ch MOSFET, 2N7002	SOT-23	Q1	1
59	N-ch MOSFET, 150V/1.8A, HSS2N15	SOT-23	Q8	1
60	NPN 25V/1.5A, SS8050	SOT-23	Q9	1
61	HT7550-2	SOT-89	U3	1
62	N-ch MOSFET, 150V/180A, AGM15T05LL	TOLL-8	Q2, Q3, Q4, Q5, Q6, Q7	6
63	Buck IC, LM5008AMMX	VSSOP8	U2	1
64	Screw Terminal	Plug-in type	S1, S2, S3, S4, S5	5
65	Variable Resistor, 10kΩ±20%, RK09K1130A5R	Plug-in type	R7	1
66	SMD Button, TS-1101-C-W	SMD	SW1, SW2, SW3	3
67	Black Jumper Cap	Pitch=2.54		4

HT32 N/N MOS Power Board_BOM List

The following table shows the HT32F65740G_MCU Board BOM list, which shows all the circuit board required components.

No.	Description/Specification	Footprint/ Dimension	Designator	Quantity
1	HT32F65740G_32-bit MCU	LQFP48_EP PAD	U1	1
2	SMD Capacitor, 33pF/50V COG	0603	C36, C46, C47, C49, C53, C70	6
3	SMD Capacitor, 100nF/50V X7R	0603	C1, C3, C9, C11, C13, C31, C63, C64	8
4	SMD Capacitor, 100pF/50V NPO	0603	C14, C51, C52	3
5	SMD Capacitor, 18pF/50V NPO	0603	C42, C50, C62	3
6	SMD Capacitor, 2.2μF/16V X7R	0603	C10, C12, C32	3
7	SMD Capacitor, 2.2μF/50V X7R	1206	C2, C6, C7, C8	4
8	SMD Capacitor, 10μF/50V X7R	1206	C4, C5	2
9	SMD Inductor, 220R @ 100MHz	0603	L1, L2	2
10	SMD Green LED, standard brightness	0603	D1	1
11	SMD Resistor, 0Ω±5%	0603	L3	1
12	SMD Resistor, 1kΩ±1%	0603	R18, R26	2
13	SMD Resistor, 10K±1%	0603	R14	1
14	SMD Resistor, 2kΩ±1%	0603	R5	1
15	SMD Resistor, 680Ω±1%	0603	R21	1
16	SMD Resistor, 820Ω±1%	0603	R4, R11, R16, R19	4
17	SMD Resistor, 15kΩ±1%	0603	R6, R9, R22, R23, R24, R25	6
18	SMD Resistor, 180Ω±1%	0603	R3, R13, R17, R20	4
19	SMD Resistor, 7.5kΩ ±1%	0603	R1, R2, R27	3
20	SMD Resistor, 2R2±1%	0805	R8, R10, R12	3
21	SMD Diode, SS10200FL	SOD-123F	D2, D3, D4	3
22	Operational Amplifier, OPA348AIDBVR	SOT-23-5	U3	1
23	Single-row Header (P=2.54mm, 12Pin, 180 degree)	Header_1×12P	CN2, CN4	2
24	Single-row Header (P=2.54mm, 14Pin, 180 degree)	Header_1×14P	CN1, CN3	2

HT32F65740G_MCU Board_BOM List