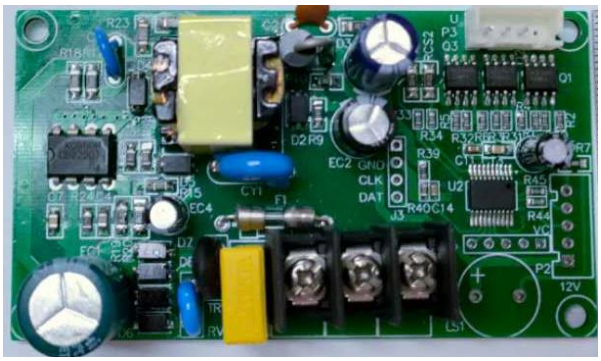
Subject **OB6625 Demo Board Manual**	Board Model: OB6625_20P_DC24V_FAN 2053 Doc. No.: OB_DOC_DBM_B_662500
	**Key Feature:** • AC 220V Input, DC 24V0.8A and 12V0.4A output • Single chip PMSM controller solution • High integration of MCU, pre-driver, high precision LDO. • Single shunt sensorless FOC control. • Primary-side sensing and regulation without TL431 and opto-coupler • Multi-mode PWM/PFM operation for efficiency improving • Good dynamic response, Built-in primary winding inductance compensation, Audio noise free operation • Programmable cable drop compensation • Comprehensive protection coverage with auto-recovery ▪ VDD over voltage protection ▪ Cycle-by-Cycle current limiting ▪ Feedback loop open protection ▪ Output short circuit protection ▪ On-chip OTP

Revision history:

Revise Date	Version	Reason/Issue
2021-06-03	00	First Issue

Contents Index

1. System Electrical Specification

1.1 Input Characteristic

AC input voltage rating	176Vac ~ 265Vac
AC input frequency range	47Hz ~ 63Hz

1.2 Motor Control Parameters

PWM frequency	16KHz
MCU supply voltage	5V±2%
5V supply current	50mA
Current sampling resistance	50mΩ
Current sampling amplification	4
Current sampling amplifier offset	Self-calibration
Max of MOSFET drain source voltage value	30V
Phase current limitation	3.5A

1.3 Switch Power Output characteristic

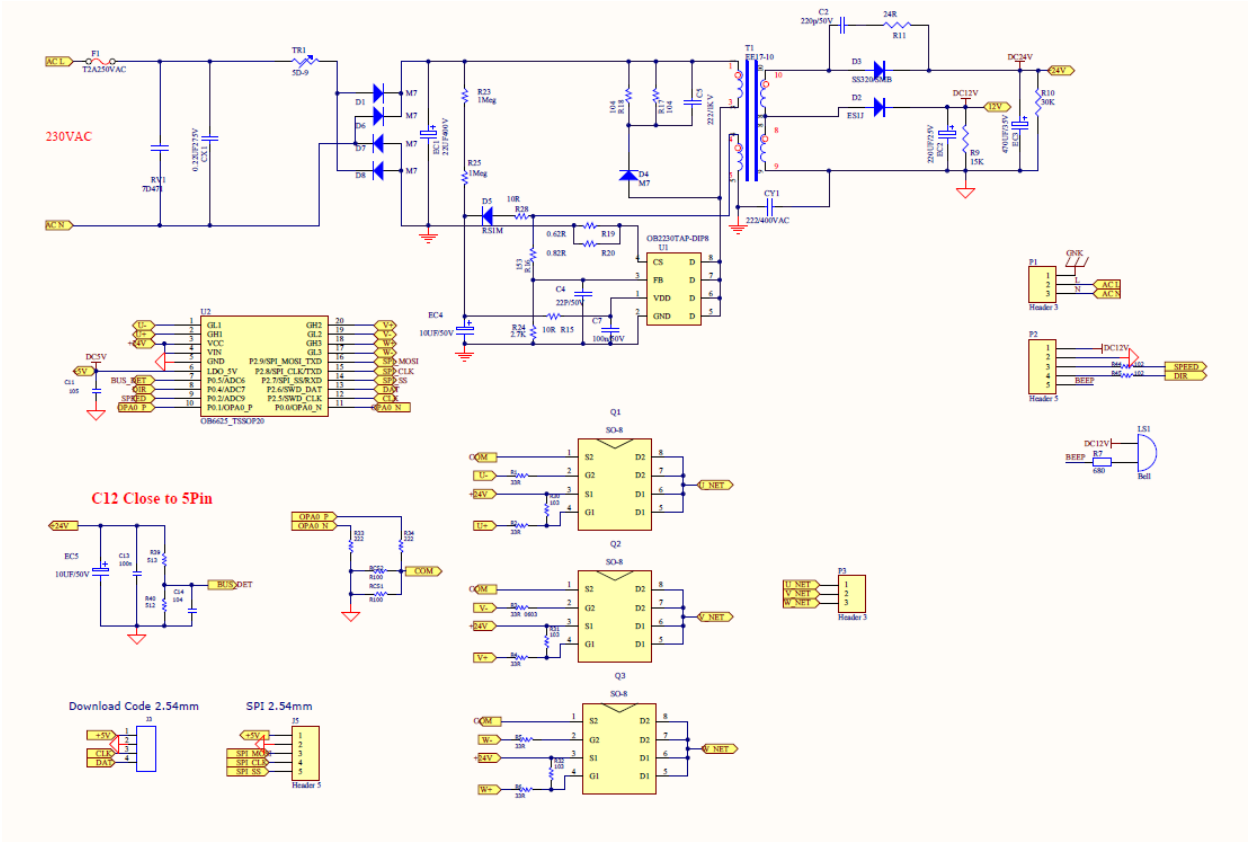
Max. Output Power	24W
Standby Power	<350mW @ 230V/50Hz, no load
Efficiency	>85%（230V 25%-100% AVE）
Short Circuit Protection	Output shut down with auto-recovery
Over Voltage Protection	Output shut down with latched
Over Current Protection	Output shut down with auto-recovery

1.4 Environmental

Operating Ambient Temperature	-20℃ to 40℃
Storage Temperature	-40 ℃ to 60 ℃
Storage Humidity	0% to 95% R.H.

2. Board Information

2.1 Schematic

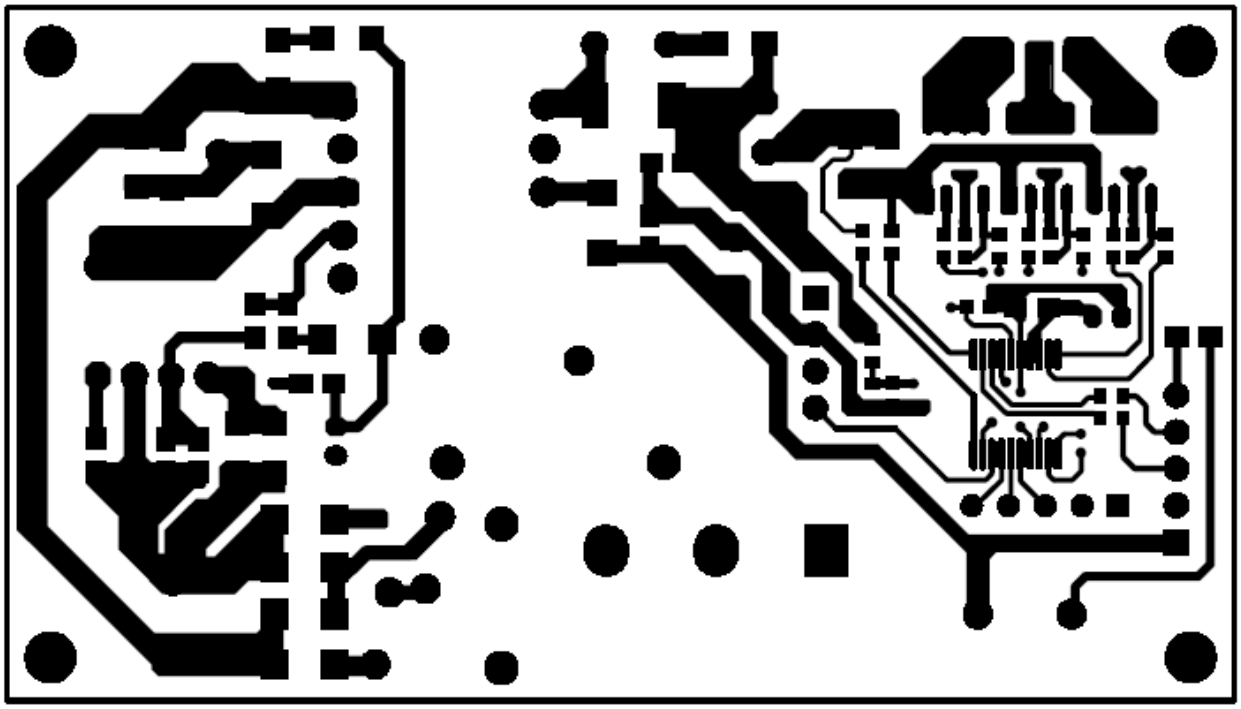


2.2 Bill of material

Position	Description	QTY
EC1	Capacitor, AISHI 22uF/400V, 12mm*20mm ,105℃,±20%	1
EC2	Capacitor, AISHI 220uF/25V, 6mm*13mm ,105℃,±20%	1
EC3	Capacitor, AISHI 470uF/35V, 10mm*25mm ,105℃,±20%	1
EC4,EC5	Capacitor, AISHI 10uF/50V,5mm*13mm ,105℃,±20%	2
C2	Capacitor, ceramic,470pF/500V, X7R, ±10%,DIP5mm	1
C4	Capacitor, ceramic,22pF/50V, X7R, ±10%,SMD0805	1
C5	Capacitor, ceramic,2.2nF/1KV, X7R, ±10% DIP5mm	1
C7,C13	Capacitor, ceramic,100nF/50V, X7R, ±10%,SMD0805	2
C11	Capacitor, ceramic,1uF/16V, X7R, ±10%,SMD0603	1
C14	Capacitor, ceramic,100nF/16V, X7R, ±10%,SMD0603	1
CX1	Capacitor, X2, 0.22uF/275VAC, 105℃,±20%	1
CY1	NC	1
D2	Diode ,fast recovery,ES1J ,1A/600V SMD	1
D3	Diode , SB3200,3A/400V SMD	1
D4,D6,D7,D8,D9	Diode, M7,SMA	5
D5	Diode, RS1M,SMA	1
F1	Fuse, 2A250V	1
TR1	MOV,5D-9	1
R1,R2,R3,R4,R5,R6	Resistor, chip, 51R ,1/16W,±5%,SMD0603	6
R7	Resistor, chip, 680R ,1/4W,±5%,SMD1206	1
R9	Resistor, chip, 15K ,1/8W,±5%,SMD0805	1
R10	Resistor, chip, 30K ,1/8W,±5%,SMD0805	1
R11	Resistor, chip, 22R ,1/4W,±5%,SMD1206	1
R15	Resistor, chip, 10R,1/8W,±5%,SMD0805	1
R16	Resistor, chip,15K ,1/8W,±1%,SMD0805	1
R17,R18	Resistor, chip, 100K ,1/4W,±5%,SMD1206	2
R19,R20	Resistor, chip, 1.2R,1/4W,±1%,SMD1206	2
R21	Resistor, chip, 1R,1/4W,±1%,SMD1206	1
R22	Resistor, chip, 0R ,1/4W,±5%,SMD1206	1
R23,R25,R26,R27	Resistor, chip, 1M ,1/4W,±5%,SMD1206	4
R24	Resistor, chip,2.7K ,1/8W,±1%,SMD0805	1
R28	Resistor, chip, 10R ,1/4W,±5%,SMD1206	1
R30,R31,R32	Resistor, chip, 10K ,1/16W,±5%,SMD0603	3
R33,R34	Resistor, chip, 2.2K ,1/16W,±5%,SMD0603	2
R39	Resistor, chip, 51K ,1/16W,±1%,SMD0603	1
R40	Resistor, chip, 5.1K ,1/16W,±1%,SMD0603	1
R44,R45	Resistor, chip, 1K ,1/16W,±5%,SMD0603	2
RCS1,RCS2	Resistor, chip, 0.1R ,1/4W,±1%,SMD1206	2
Q1,Q2,Q3	P+N MOS, NCE4606 / OBS3006, 30V6A,SOP8	3
T1	Transformer, Lp=700uH ,1KHz/0.3V,Bobbin EE17-10(5+5), core (EE17/10)	1

U1	IC,PWM controller, OB2230T, DIP8	1
U2	IC, PMSM FOC Controller SOC, OB6625VIP,TSSOP20	1
P1	栅栏式接线端子：DG/KF25C 7.62mm 3pin	1
P3	XH2.54mm, 3pin	1

2.3 PCB Garber File



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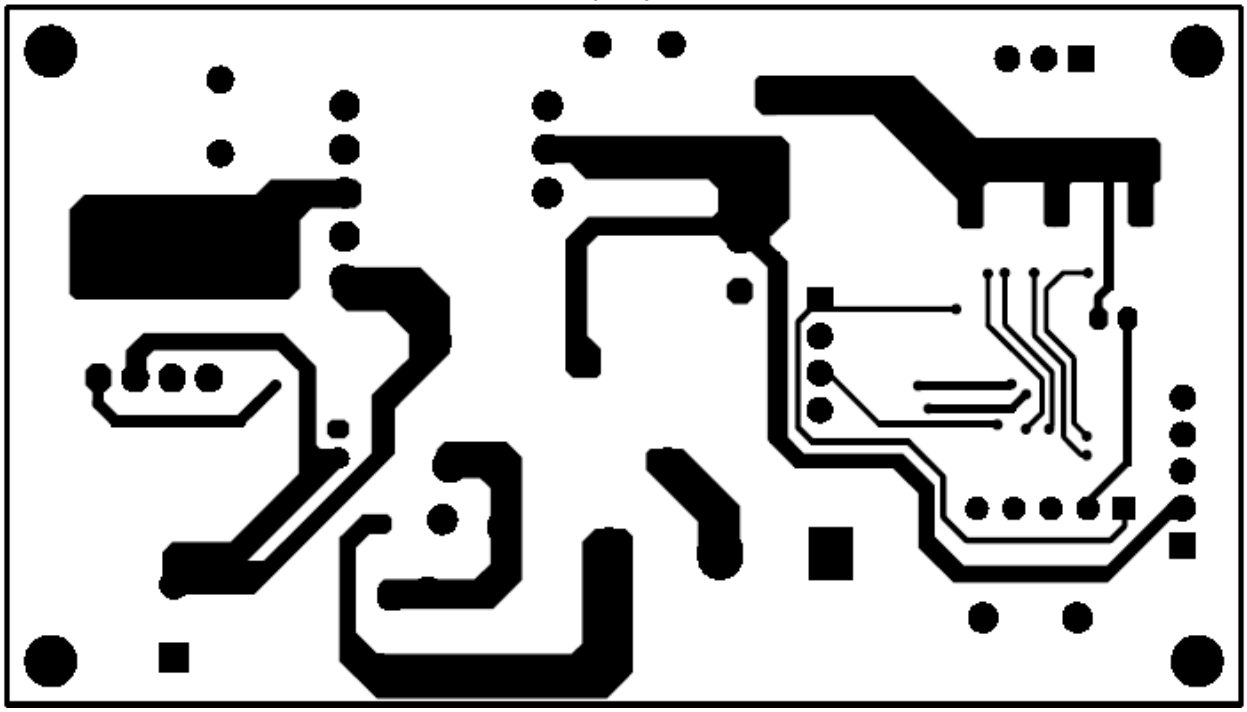

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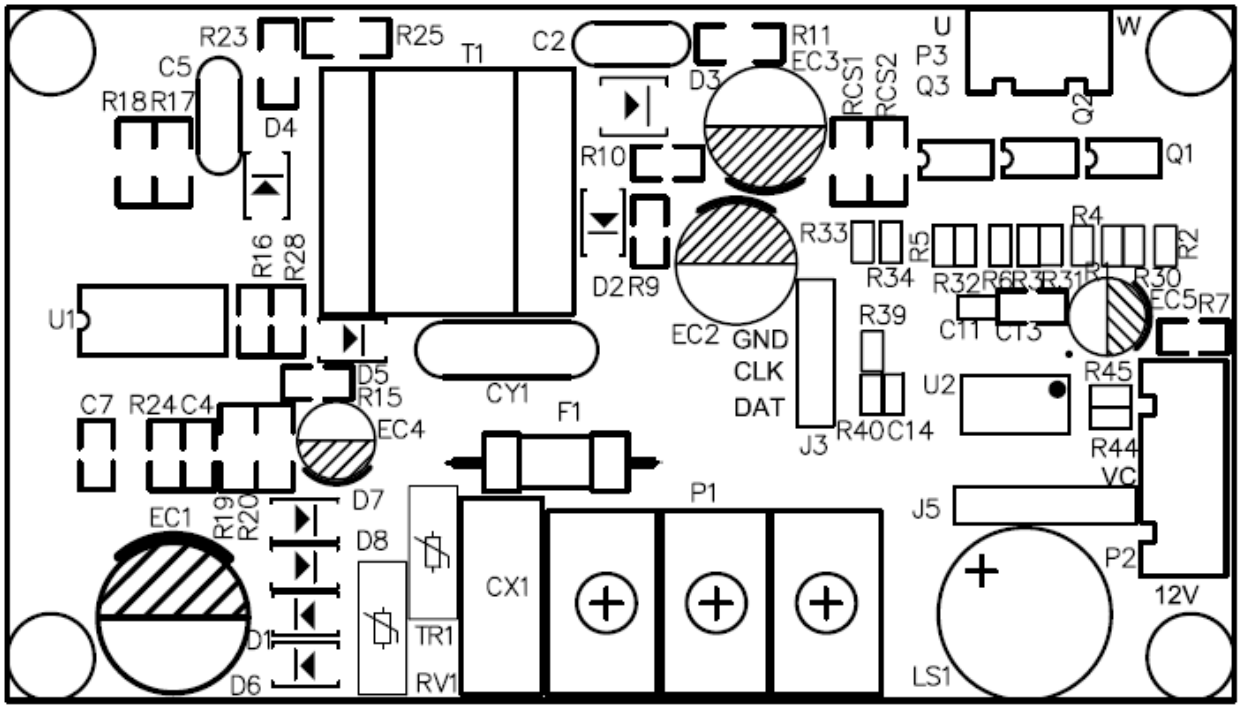
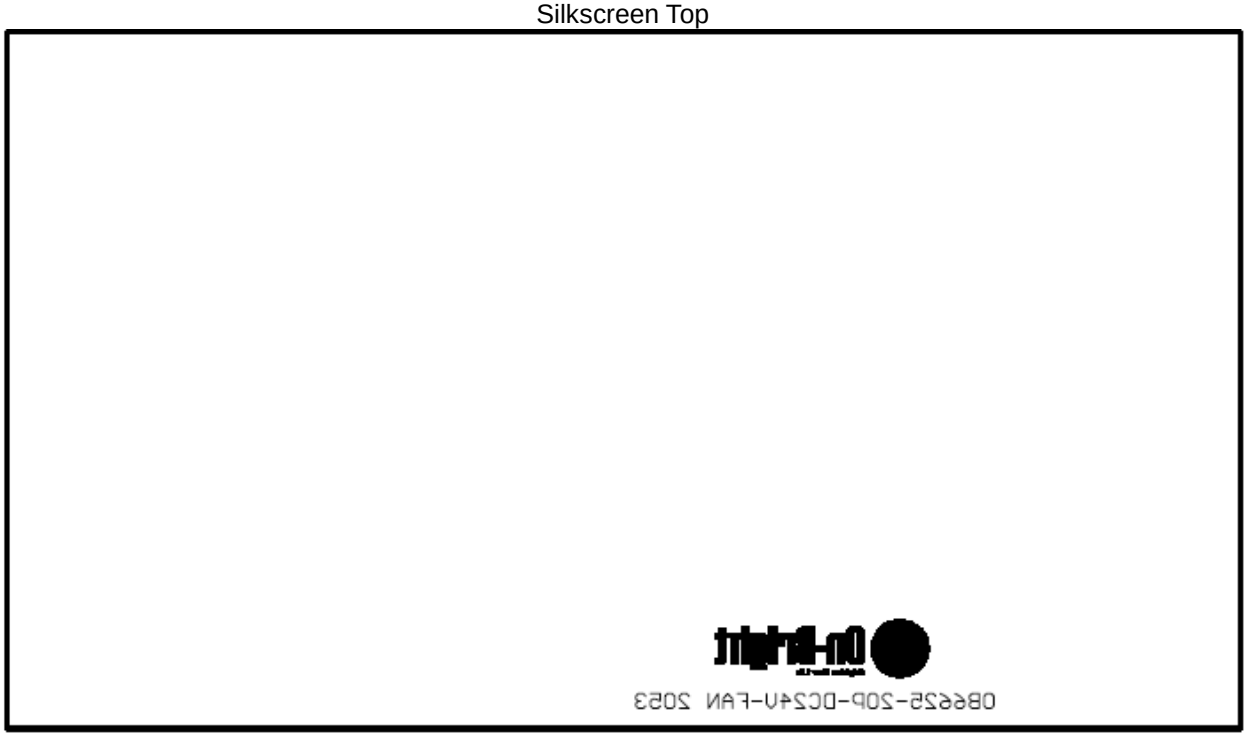
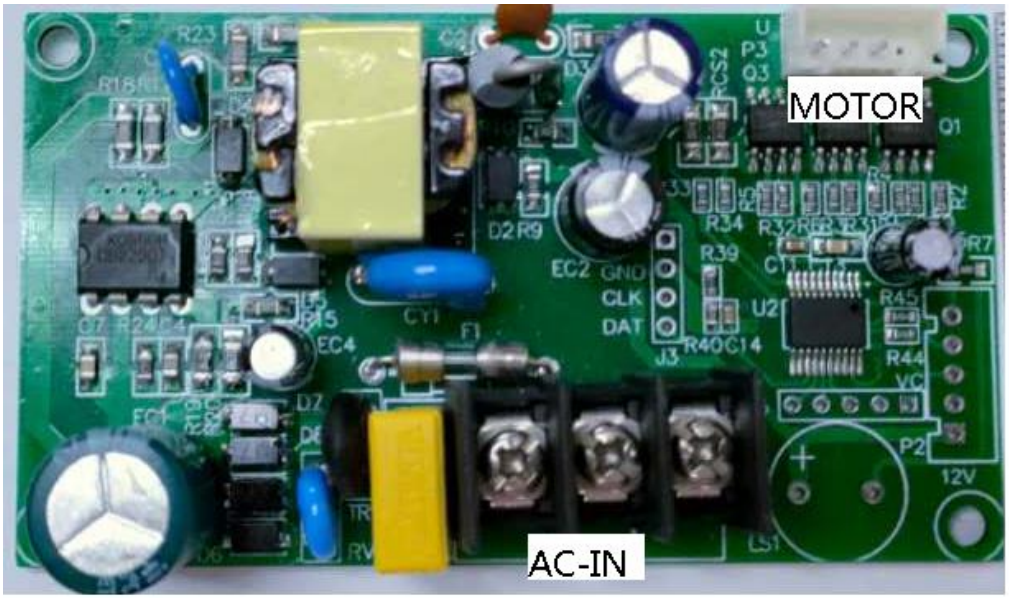


Silkscreen Top


Silkscreen Bot

2.4 Connector Function Description

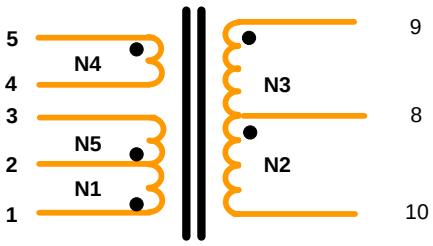


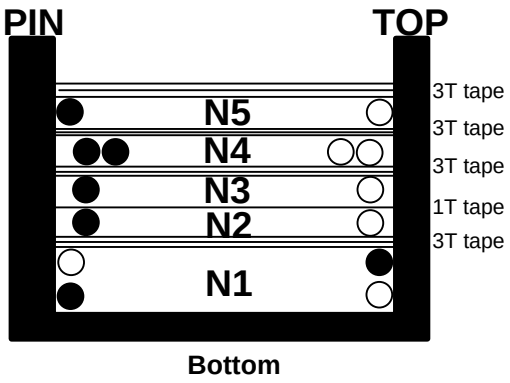
P2- 5pin connector

Pin Num	Description	Voltage Range
1	DC12 Output	12V
2	GND	0
3	Motor speed command (PWM)	0~5V
4	Motor Direction	0~5V
5	Beep In	0~12V

2.5 Transformer Design

Transformer Specification





Note：

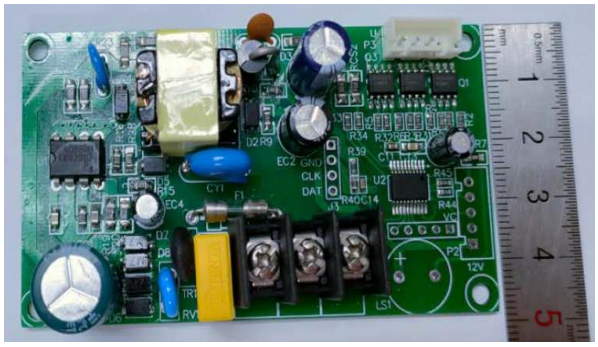
1. Bobbin: EE17-10(立式5+5)
2. Core material: EE17/10磁芯
3. L1-3=700uH +/- 7%. (at: 1KHz, 0.3V)

Transformer Winding data

No.	Winging	Material	Start	Turns	Finish	Remark
1	N1	Φ0.27*1 2UEW	1	56	2	顶部朝机
2	TAPE	TAPE W=9mm (Y)		3		
3	N2	Φ0.5*1 2UEW	8	12	10	顶部朝机
4	TAPE	TAPE W=9mm (Y)		1		居中密绕
5	N3	Φ0.5*1 2UEW	9	13	8	顶部朝机
6	TAPE	TAPE W=9mm (Y)		3		居中密绕
7	N4	Φ0.18*2 2UEW	5	16	4	顶部朝机
8	TAPE	TAPE W=9mm (Y)		3		居中密绕
9	N5	Φ0.27*1 2UEW	2	28	3	顶部朝机
10	TAPE	TAPE W=9mm (Y)		3		

备注：变压器次级绕组无绝缘。

2.6 BLDC Controller Board Snapshot



Top

Bottom

3. Performance Evaluation

This session presents the test results of OB2230T+OB6625VIP demo. TA=25℃

No	Parameter	Symbol	Min	Type	Max	Unit
1	Power Supply		176		265	Vac
2	MCU supply	LDO_5V	4.9	5	5.1	V
3	NMOS gate driver supply			12		V
4	PMOS gate driver supply			-11		V
5	Highside MOSFET Rise time	Tr_h		170		ns
6	Highside MOSFET Fall time	Tf_h		140		ns
7	Lowside MOSFET Rise time	Tr_l		350		ns
8	Lowside MOSFET Fall time	Tf_l		250		ns
9	PWM frequency	f_{PWM}		16		kHz
10	MOSFET Vds				30	V

Test Equipments

Item	Vender	Module
AC Source:	WEST	WEW1010
Digital Power Meter	YOKOGAWA	WT210
Electrical Load	Prodigit	3315C
Oscilloscope	LeCroy	WS424
Multimeter	VICTORY	VC9807A
Thermal	FLUKE	HS2

3.1 Input Characteristics

3.1.1 Input current and Standby power

The module was tested at different input voltages (from 176Vac to 264Vac)

Table 1 Input current at full load

Input Voltage	176V/50Hz	230V/50Hz	264V/50Hz
Input Current(A)	0.291	0.244	0.228

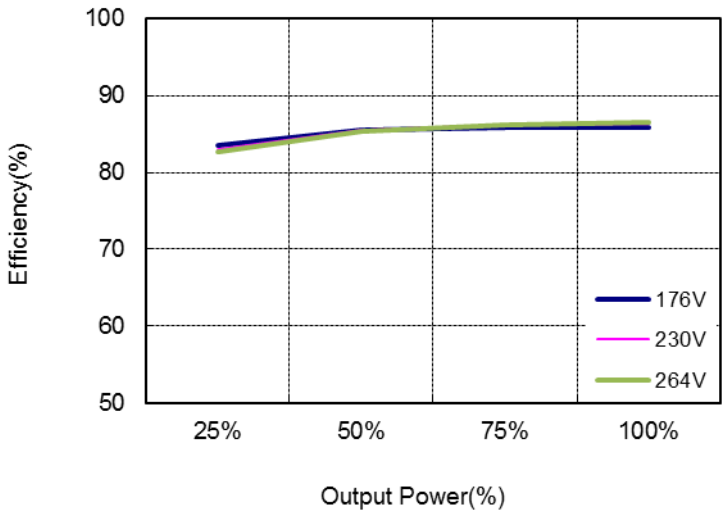
Table 2 Standby power at no load

Input Voltage	176V/50Hz	230V/50Hz	264V/50Hz
Pin (mW)	316	342	365

3.1.2 Efficiency

Table 3 Efficiency （PCB end）

Input voltage	10%	25%	50%	75%	100%	Aver. Eff.
176Vac/50HZ	77.82	83.54	85.54	85.82	85.79	85.17
230Vac/50HZ	76.95	83.07	85.50	86.15	86.42	85.28
264Vac/50HZ	76.12	82.62	85.37	86.17	86.47	85.15



Efficiency vs. Percent of Rated Output Power

3.2 Output Characteristics

3.2.1 Line Regulation & Load Regulation

Table 4 Line Regulation & Load Regulation

Input Voltage	Output Voltage (V)			
	24V No Load	24V Full Load	12V No Load	12V Full Load
176V/50Hz	23.81	23.98	11.91	11.51
230V/50Hz	23.68	23.98	11.88	11.51
264V/50Hz	23.70	24.03	11.88	11.52

3.2.2 Overshoot & Undershoot

Ac input switches ON for overshoot and OFF for undershoot

Table 5 Overshoot/undershoot measurement results

Input Voltage	Load	Item	Measure Data (%)	Waveform
176V/60Hz	Full load	overshoot	0	Fig.2
		undershoot	0	Fig.4
	No load	overshoot	0	Fig.5
264V/50Hz	Full load	overshoot	0	Fig.1
		undershoot	0	Fig.6
	No load	overshoot	0	Fig.4

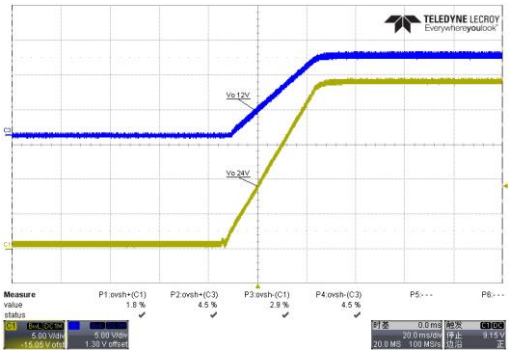


Fig. 1 Overshoot waveform@176Vac; full load

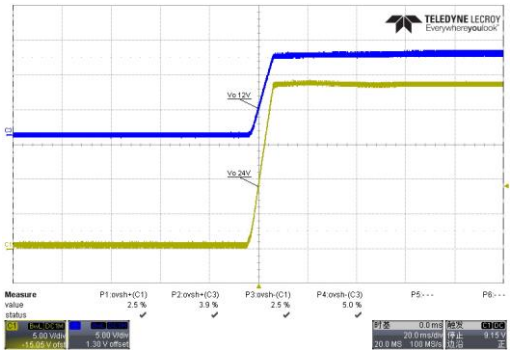


Fig. 21 Overshoot waveform @176Vac; no load

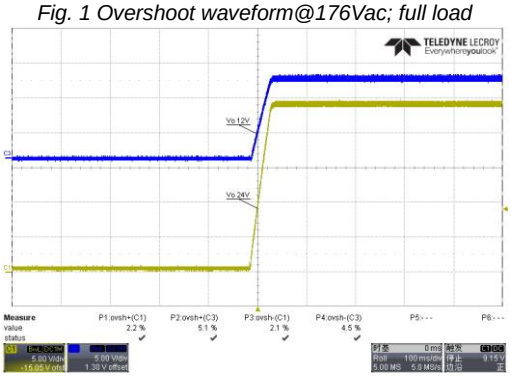


Fig. 3 Overshoot waveform @264Vac; full load

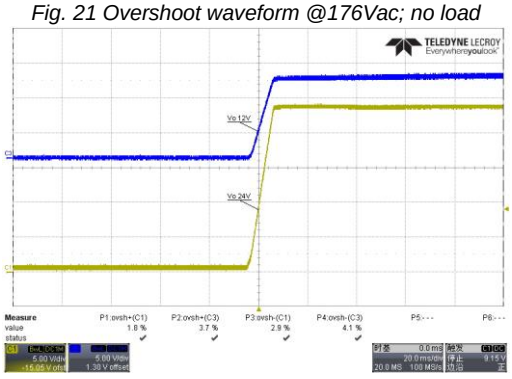


Fig. 4 Overshoot waveform @264Vac; no load

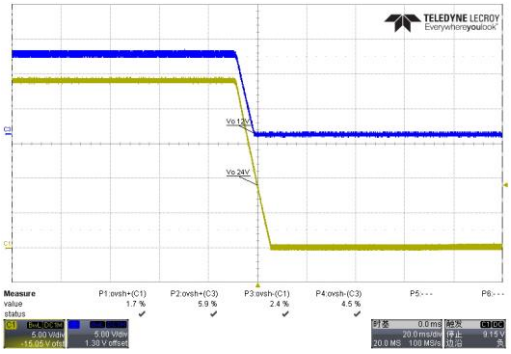


Fig. 5 Undershoot waveform@176Vac; full load

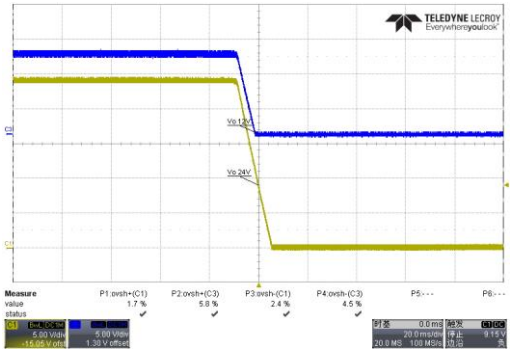


Fig. 6 Undershoot waveform @264Vac; full load

3.3 Switch Power Thermal Test

The thermal test is under 40℃ ambiance after 4hour full load ruining with 176Vac\230Vac\ 264Vac input in the box 10CM*10CM*5CM.

Table 11 Thermal test result

Position	Description	176Vac input	230Vac input	264Vac Input
T1	T1(wire)	113.3	111.8	111.7
T1	T1(core)	102.9	102.1	100.9
U1	IC	105.5	102.5	99.2
D2	ES1J	114.8	112.6	109.5
D3	SB3200	106.6	103.8	103.5

3.4 Switch Power important waveform

3.4.1CS, FB,Vdd & Vds waveform at no load/full load.

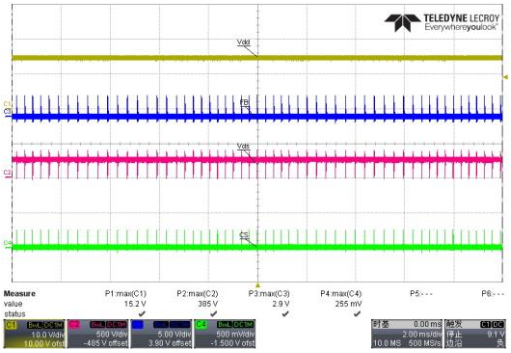


Fig. 7 CS,FB,Vdd&Vds wave form@176Vac; no load

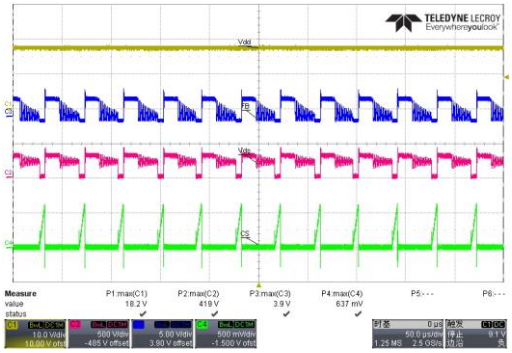


Fig. 8 CS,FB,Vdd&Vds wave form@176Vac; full load

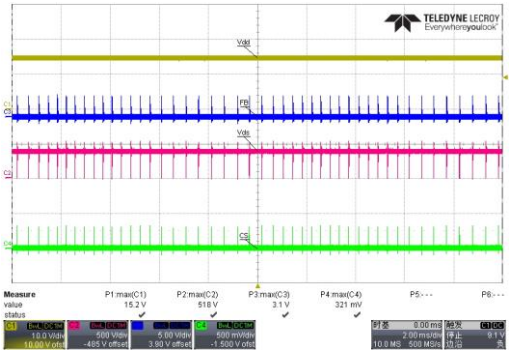


Fig. 9 CS,FB,Vdd&Vds wave form@264Vac; no load

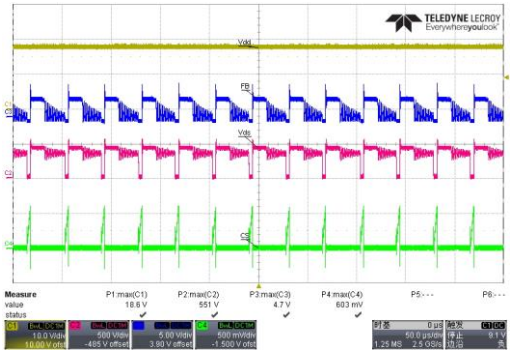


Fig. 10 CS,FB,Vdd&Vds wave form@264Vac; full load

3.5 Vds waveform at full load, start/normal/output short

3.5.1 Vds at full load, start/normal/output short

MOSFET measurement results

Item	Input voltage	Meas. Data （Vds_max）	Remark
Start Full load	264V/50HZ	566V	Fig. 11
Normal full load	264V/50HZ	559V	Fig. 13
Short work	264V/50HZ	488V	Fig. 15

Diode measurement results

Item	Input voltage	Meas. Data (Vak_min)	Remark
Start Full load	264V/50HZ	158V	Fig. 12
Normal full load	264V/50HZ	155V	Fig. 14
Short work	264V/50HZ	186V	Fig. 16

3.5.2 Vds,Vak at full load, start waveform

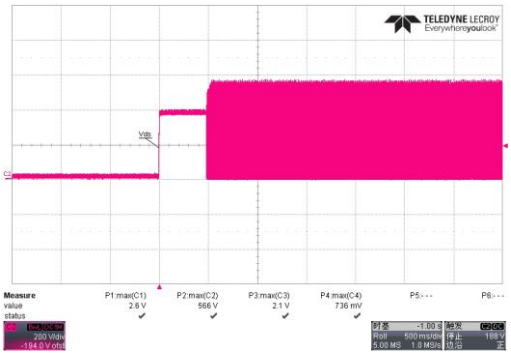


Fig. 11 Vds start up wave form@264Vac; full load

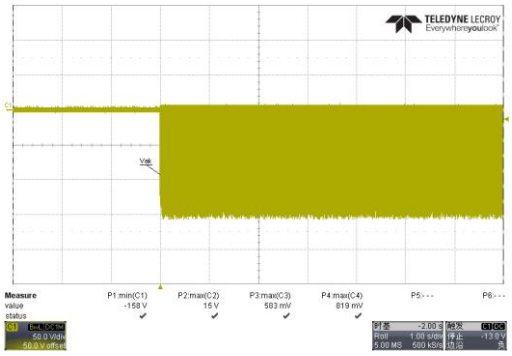


Fig. 12 Vdiode start up wave form@264Vac; full load

3.5.3 Vds,Vak at full load, normal waveform

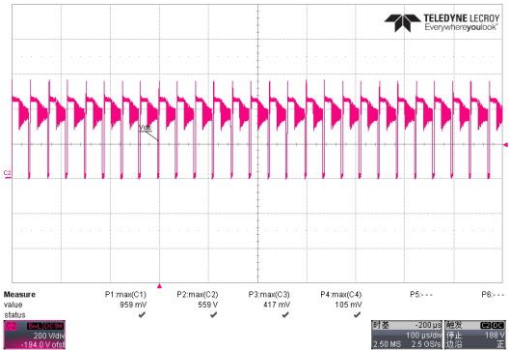


Fig. 2 Vds normal wave form@264Vac; full load

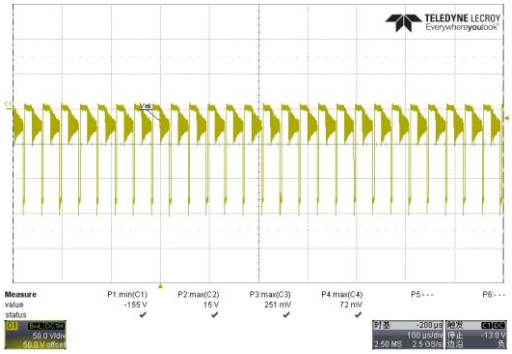


Fig. 3 Vdiode normal wave form@264Vac; full load

3.5.4 Vds,Vak at full load, output short waveform

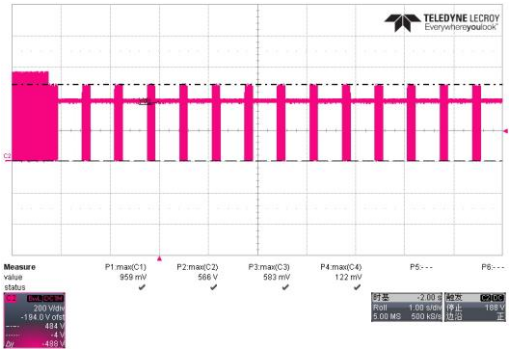


Fig. 13 Vds output short wave form@264Vac; full load

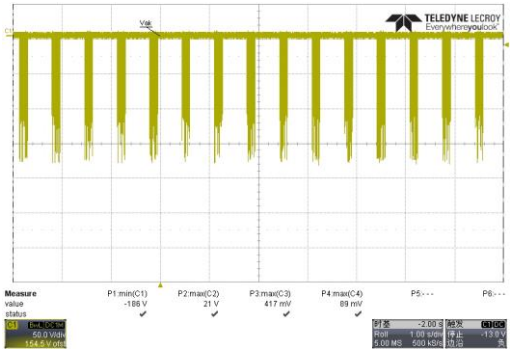


Fig. 14 Vdiode output short wave form@264Vac; full load

3.6 Motor Control

3.6.1 Power On

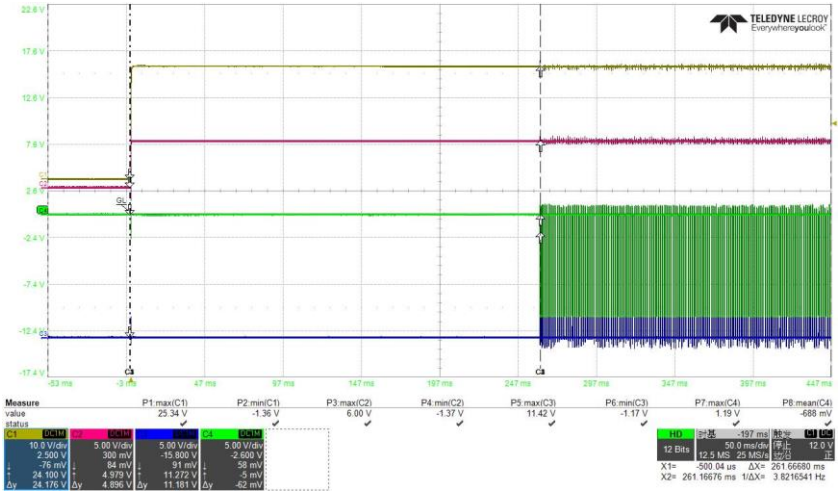


Fig. 15 Measured Bus voltage(Yellow), MCU supply voltage(Red), Lowside MOS GS(Blue), Highside MOS GS(Green) @ Bus = 24V

3.6.2 Power OFF

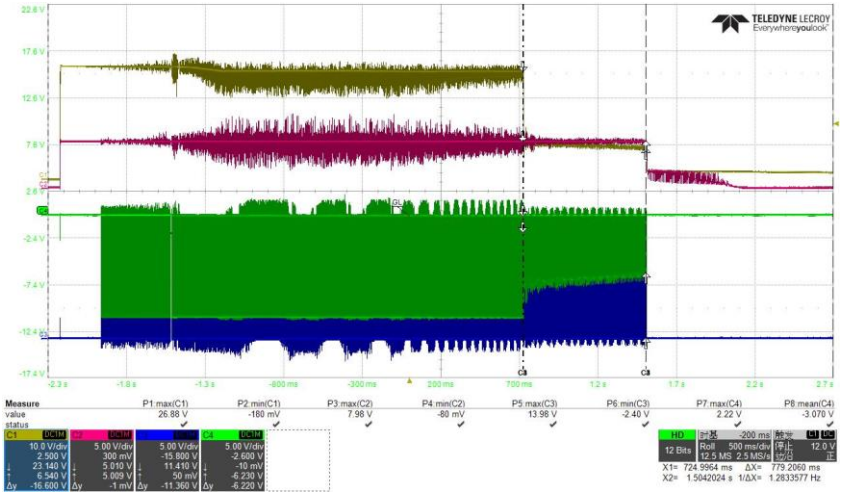


Fig.16 Measured Bus voltage(Yellow), MCU supply voltage(Red), Lowside MOS GS(Blue), Highside MOS GS(Green) @ Bus = 24V

3.6.3 MOSFET Vgs, Vds, Deadtime Waveform

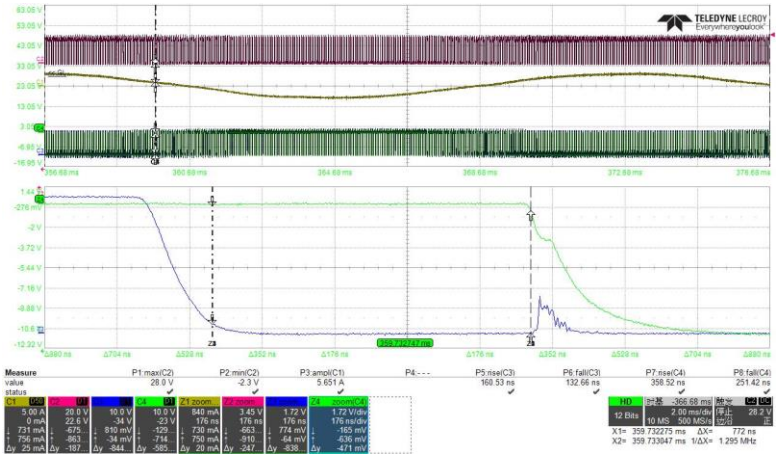


Fig. 17 Measured Phase Current(Yellow), Vds(Blue) , Lowside MOS GS(Blue), Highside MOS GS(Green) @ Bus = 24V

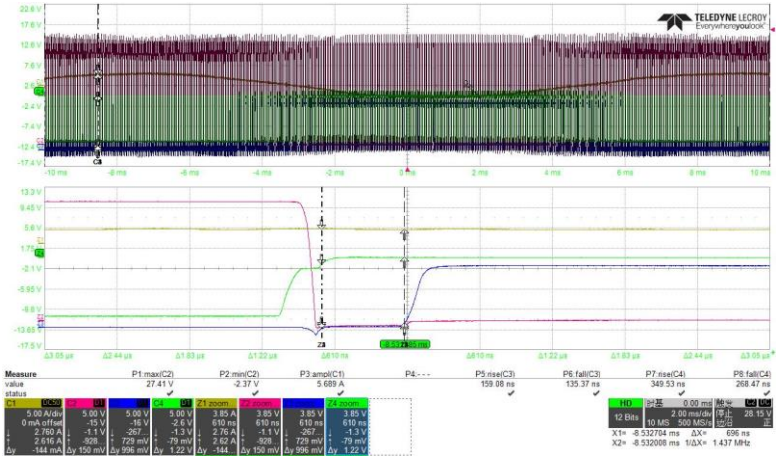


Fig. 18 Measured Phase Current(Yellow), Vds(Blue) , Lowside MOS GS(Blue), Highside MOS GS(Green) @ Bus = 24V

3.7 Motor

3.7.1 Motor in stationary

Setup: Vbus = 24V, Phase Current = 2.8A

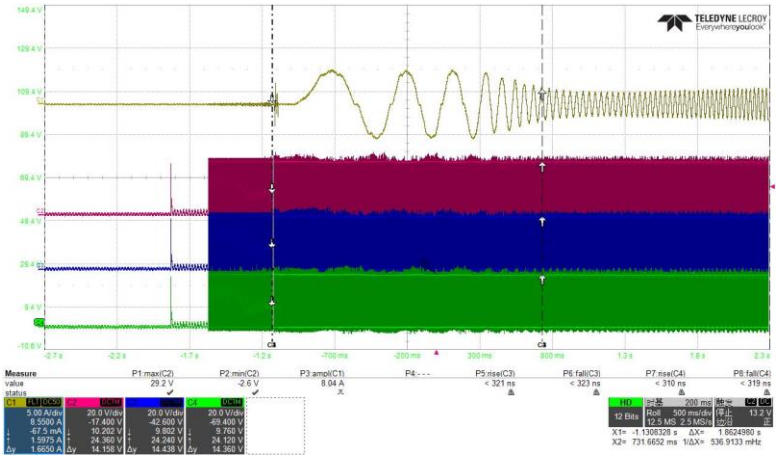


Fig. 19 Measured Phase Current(Yellow), U(Red),V(Blue),W(Green) @ Bus = 24V

3.7.2 Motor in spinning in the forward direction

Setup: Vbus = 24V, Phase Current = 2.8A
Motor Speed = 40RPM

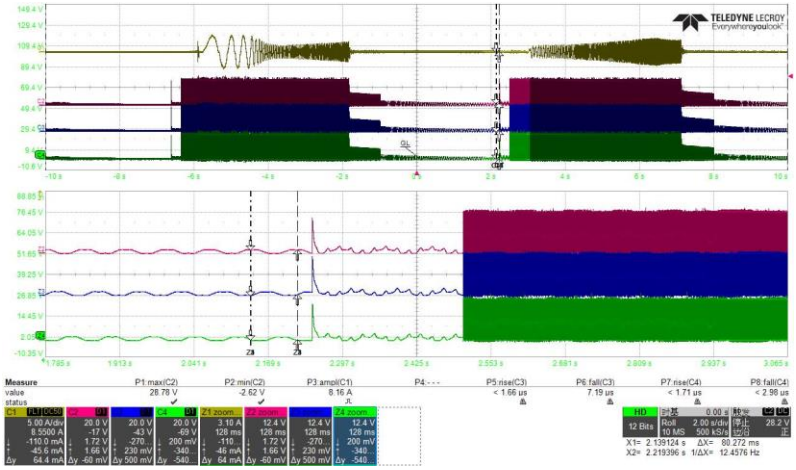


Fig. 20 Measured Phase Current(Yellow), U(Red),V(Blue),W(Green) @ Bus = 24V

3.7.3 Motor in spinning in the reverse direction

Setup: Vbus = 24V, Phase Current = 2.8A

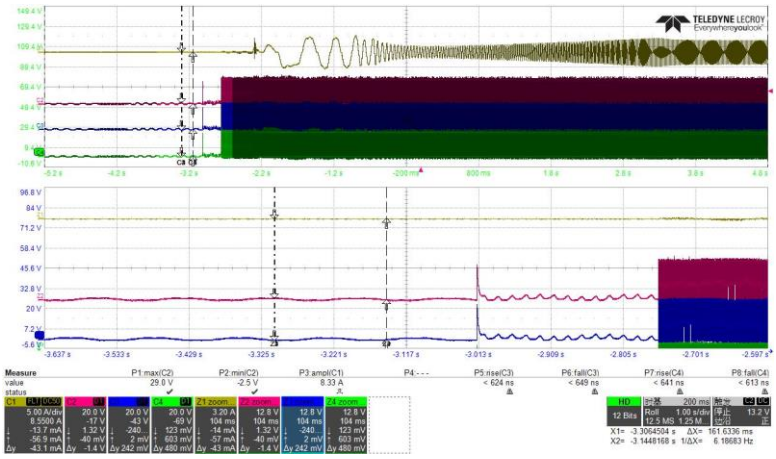


Fig. 21 Measured Phase Current(Yellow), U(Red),V(Blue),W(Green) @ Bus = 24V

3.7.4 Phase Shift

Phase Shift Time = 2.7us

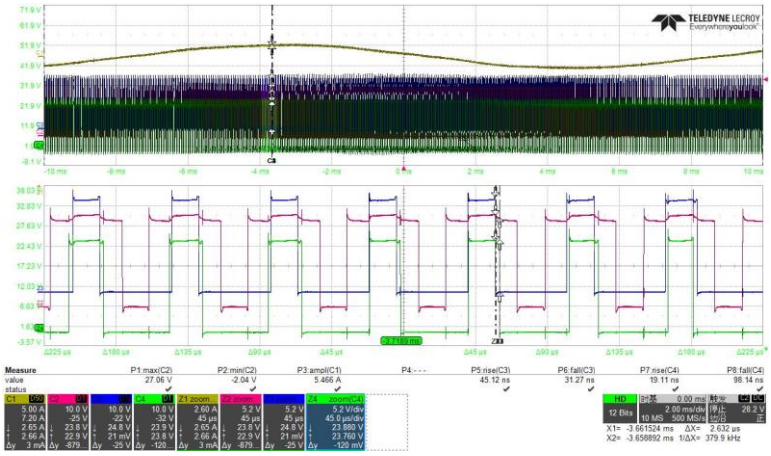


Fig. 22 Measured Phase Current(Yellow), Vds(Blue) , Lowside MOS GS(Blue), Highside MOS GS(Green) @ Bus = 24V

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