

Subject OB6617 Demo Board Manual	Board Model: OB6617_2009_Protel Doc. No.: OB_DOC_DBM_E_661701
	<p>Key Feature:</p> <ul style="list-style-type: none"> • Single chip BLDC controller solution • High integration of MCU, pre-driver, high speed rail-to-rail operation amplifier, high precision LDO, current protection comparator. • Six-step BLDC control with hall sensor feedback • 20% duty start, and motor fast sop • Automatic power off with time delay • MOSFET temperature sensing and thermal protection. • Tow levels battery under voltage protection • Battery residual capacity display • PCB size small, and assemble conveniently

Revision history:

Revise Date	Version	Reason/Issue
2020-5-4	00	First Issue
2020-9-7	01	Updated BOM list

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1. System Electrical Specification

1.1 Input Characteristic

▪ DC input voltage rating	5 cells Li-Iron battery of 3.7V
▪ DC input voltage	14V to 25V
▪ Handle working voltage	0 to 5V

1.2 System parameters

▪ PWM frequency	20KHz
▪ MCU supply voltage	5V±2%
▪ 5V supply current	100mA
▪ Current sampling resistance	1mΩ
▪ Current sampling amplification	16
▪ Current sampling amplifier offset	Self-calibration
▪ Gate driver supply voltage	Battery voltage 18V @ 5 cells battery
▪ Max of MOSFET drain source voltage value	30V
▪ MOSFET thermal sensor precision	1%

1.3 Output characteristic

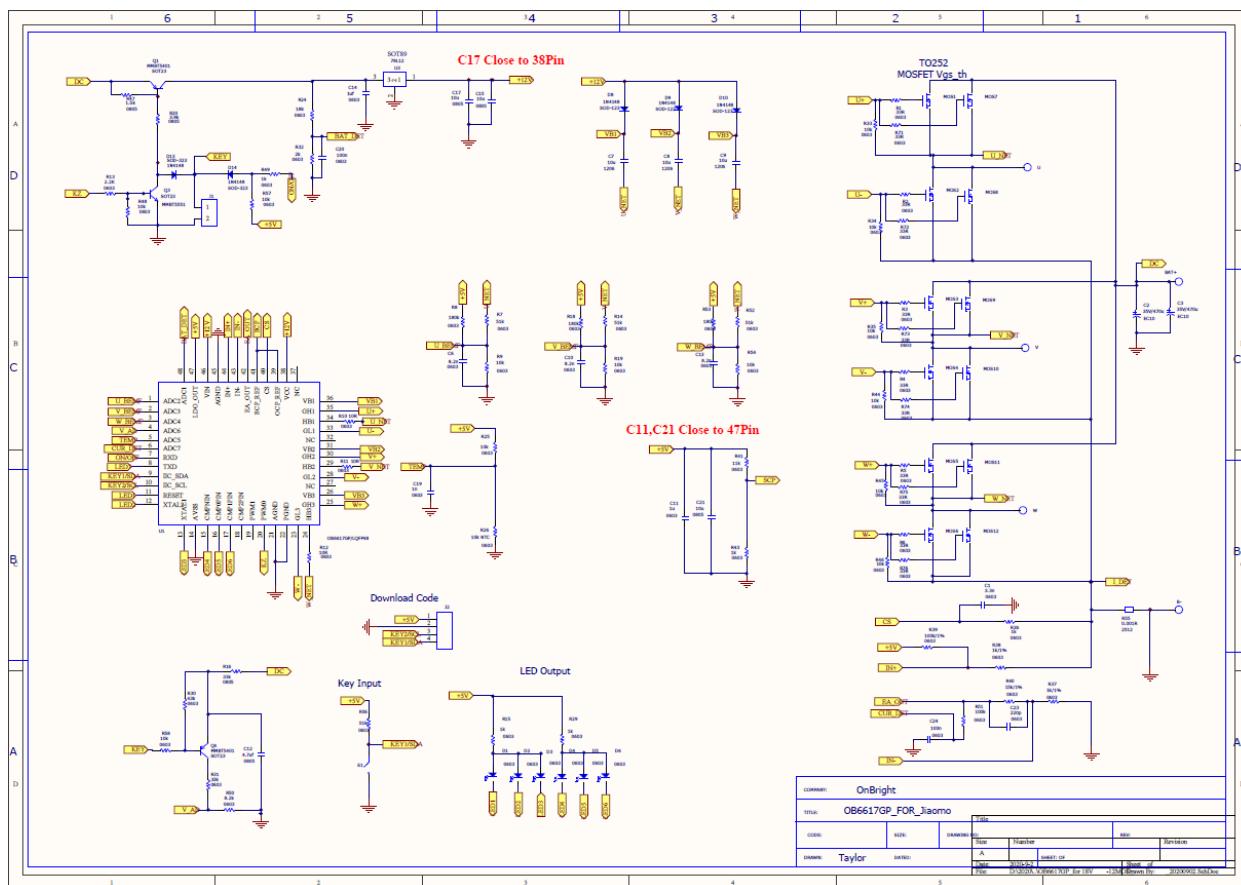
▪ Primary overcurrent protection of bus	65A
▪ Bus primary overcurrent protection delay	0.2s
▪ Secondary overcurrent protection of bus	45A
▪ Bus secondary overcurrent protection delay	1.5s
▪ Phase current limitation	80A
▪ Maximum of PWM duty	100%
▪ Minimum of PWM duty	20%

1.4 Environmental

▪ Operating Ambient Temperature	-20°C to 60°C
▪ Storage Temperature	-40 °C to 100 °C
▪ Storage Humidity	0% to 95% R.H.

2. Board Information

2.1 Schematic



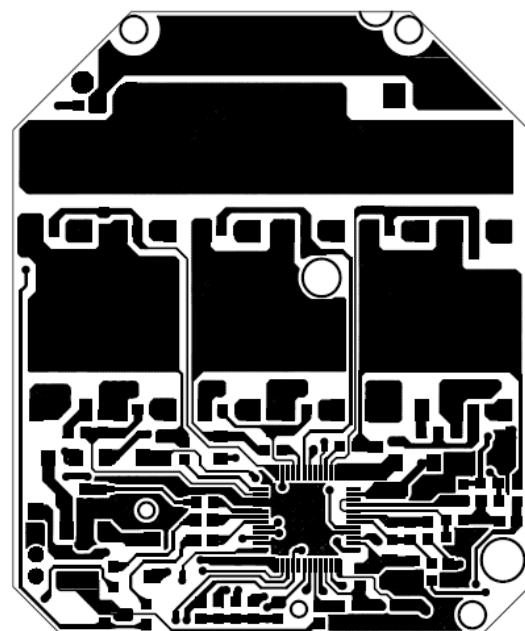
2.2 Bill of material

Position	Description	Package	QTY
C1	Capacitor,ceramic,3.3nf/25V,X7R,10%	0603	1
C2, C3	Capacitor, aluminum electrolytic, 470uf/35V, -40/105°C	EC10	2
C6, C10, C13	Capacitor,ceramic,8.2nf/25V,X7R,10%	0603	3
C7,C8, C9, C15, C17, C21	Capacitor,ceramic,10uf/25V,X7R,10%	0805	6
C12	Capacitor,ceramic,4.7uf/25V,X7R,10%	0805	1
C11,C14	Capacitor,ceramic,1uf/25V,X7R,10%	0603	2
C19	Capacitor,ceramic,1nf/25V,X7R,10%	0603	1
C23	Capacitor,ceramic,220pf/25V,X7R,10%	0603	1
C20, C24	Capacitor,ceramic,100nf/25V,X7R,10%	0603	2
D1, D2, D3, D4, D5, D6	LED, Green	0603	6
D8,D9,D10	1N4148	SOD-123	3
D13, D14	1N4148	SOD-323	2
MOS1,MOS2,MOS3,MOS4,MOS5, MOS6,MOS7,MOS8,MOS9,MOS10, MOS11,MOS12	Power MOS	TO252	12
Q1, Q4	PNP,MMBT5401	SOT23	2
Q3	NPN,MMBT5551	SOT23	1
R1,R2,R3,R4,R5,R6,R71,R72, R73, R74,R75,R76	Resistor,chip,33R,5%	0603	12
R7,R14,R52	Resistor,chip,51K,1%	0603	3
R9,R19,R54	Resistor,chip,10K,1%	0603	3
R56	Resistor,chip,51K,5%	0603	1
R8,R18,R53	Resistor,chip,180k,1%	0603	3
R25,R33,R34,R35,R44,R45,R46, R48,R57,R58	Resistor,chip,10k,5%	0603	10
R10,R11,R12	Resistor,chip,10R,5%	0603	3
R13	Resistor,chip,2.2k,5%	0603	1
R15,R29,R36,R43,R49	Resistor,chip,1k,5%	0603	5
R16	Resistor,chip,33k,5%	0805	1
R31	Resistor,chip,33k,5%	0603	1
R20	Resistor,chip,3.9k,5%	0805	1
R24	Resistor,chip,18k,1%	0805	1
R26	NTC,TSM1A103-34D,10K,B=3435,1%	0603	1
R30	Resistor,chip,43k,5%	0603	1
R32	Resistor,chip,2k,1%	0603	1
R37,R38	Resistor,chip,1k,1%	0603	2
R39,R51	Resistor,chip,100k,1%	0603	2
R40	Resistor,chip,15k,1%	0603	1
R41	Resistor,chip,11k,5%	0603	1
R47	Resistor,chip,1.5k,5%	0603	1

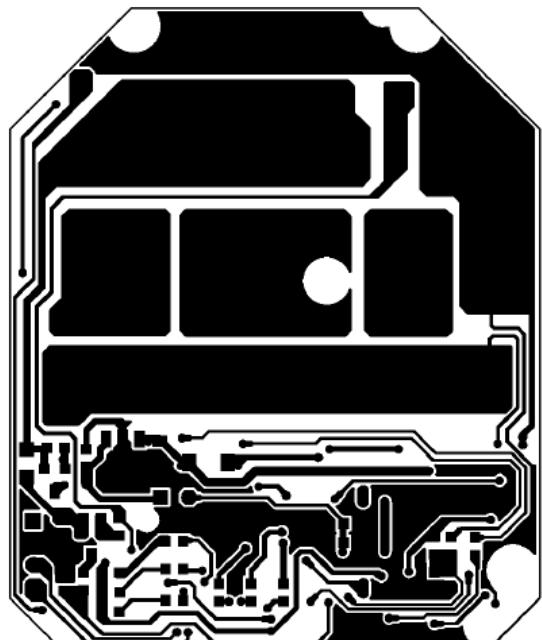
R50	Resistor,chip,8.2k,5%	0603	1
R55	Resistor,chip,1mR,1%,3W	2512	1
S1	Key,6mm*7mm,auto-release	SWPB	1
U1	OB6617GP	LQFP48	1
U3	78L12	SOT89	1

Note1: BOM is used in 5 cells battery

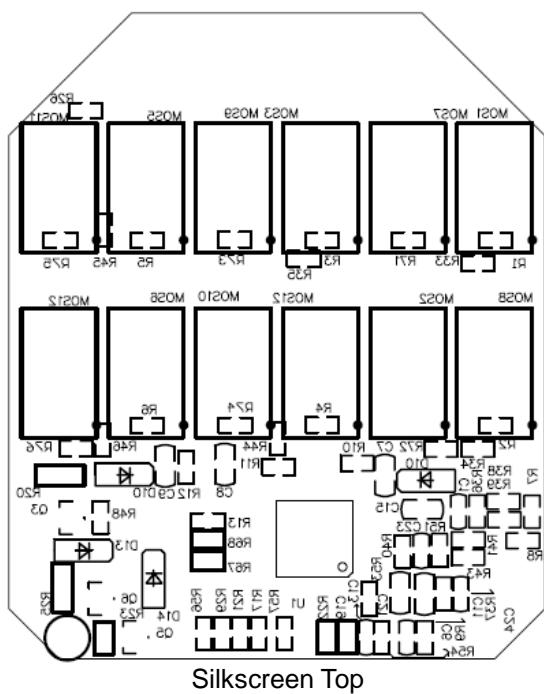
2.3 PCB Garber File



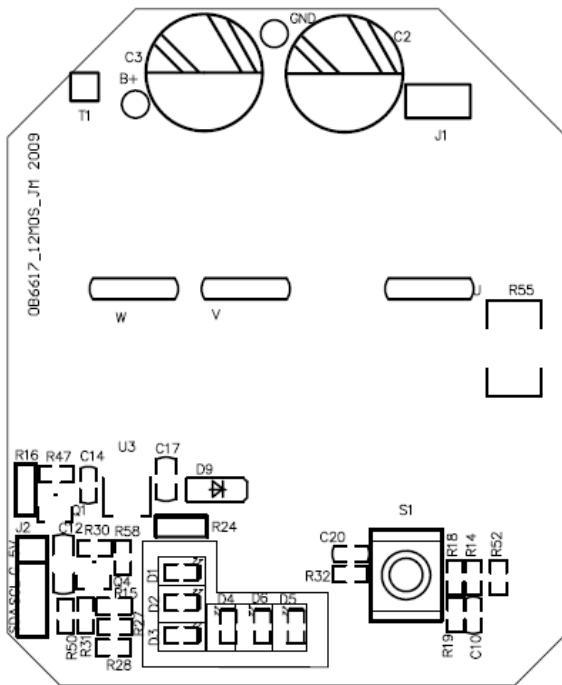
Top Layer



Bottom Layer

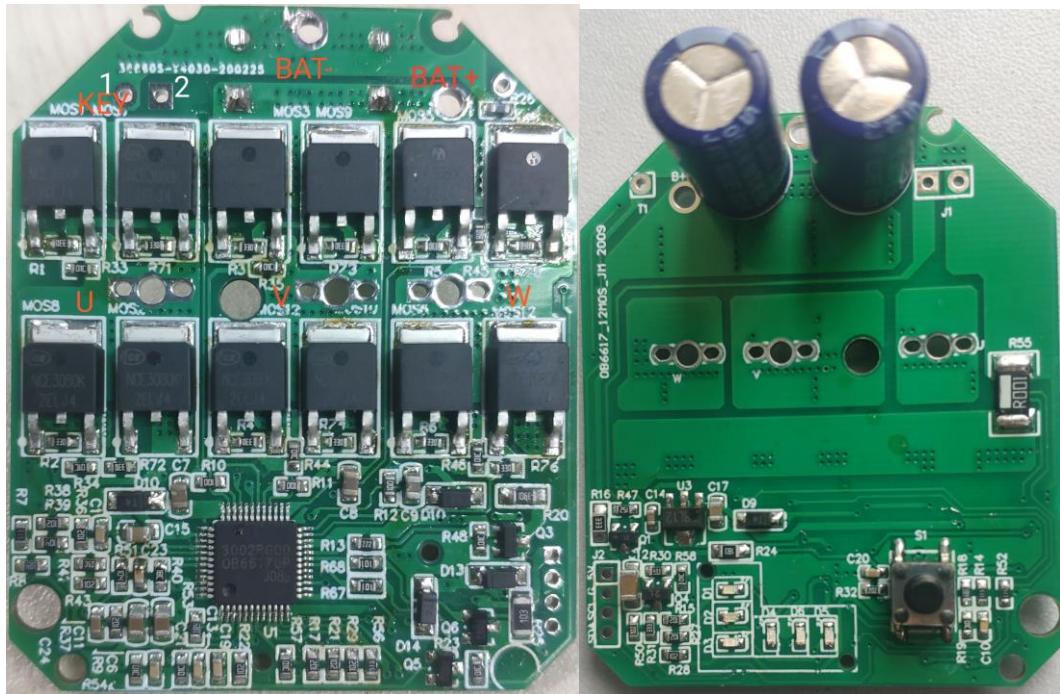


Silkscreen Top



Silkscreen Bottom

2.4 Connector Function Description

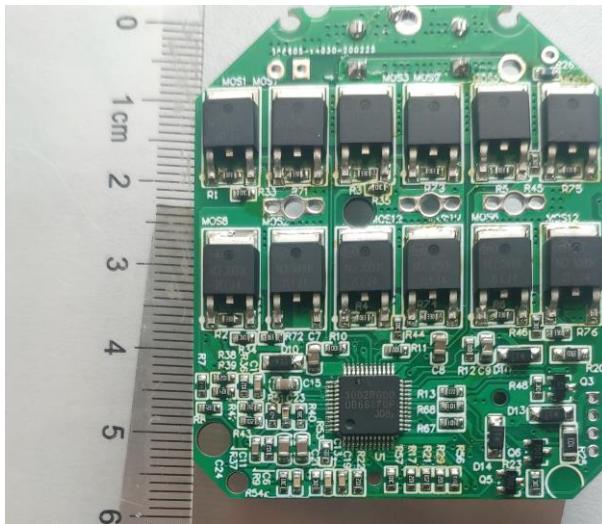


Name	Description
BAT+	Battery input, Bus+
BAT-	Battery input, GND
U	Motor U phase output
V	Motor V phase output
W	Motor W phase output

J1- 2pin connector

Pin Num	Description
1	GND
2	KEY

2.5 BLDC Controller Board Snapshot



Top



Bottom

3. Performance Evaluation

This session presents the test results of OB6617GP 18V/45A Angle Grinder Controller demo. TA=25°C

No	Parameter	Symbol	Min	Type	Max	Unit
1	Battery UVP	V_{bus_UVLO}		14		V
2	MCU supply	LDO_5V	4.9	5	5.1	V
3	Gate driver supply	LDO_12V		12		V
4	MOSFET gate voltage	V_{gs}		12		V
5	Highside MOSFET Rise time	T_{r_h}		0.448		us
6	Highside MOSFET Fall time	T_{f_h}		0.456		us
7	Lowside MOSFET Rise time	T_{r_l}		0.43		us
8	Lowside MOSFET Fall time	T_{f_l}		0.482		us
9	PWM frequency	f_{PWM}		20		kHz
10	PWM duty	Duty	20		100	%
11	Six step control logic					
12	Current amplify coefficient			16		
13	MOSFET current shutdown time in MOTOR short circuit				10	us
14	MOSFET Vds in MOTOR short circuit				30	V

Test Equipments

Item	Module
DC source	LW12050KD
Oscilloscope	LeCroy HDO420
Current meter	Tek TCPA300
Differential probe	CATIII
Multi-meter	VC9808

3.1 Voltage Test

3.1.1 Gate Driver & MCU Supply Power ON/OFF



Fig. 1 Measured bus voltage ,VCC=12V, LDO=5V @ bus=20V
 Power On Time = 75ms

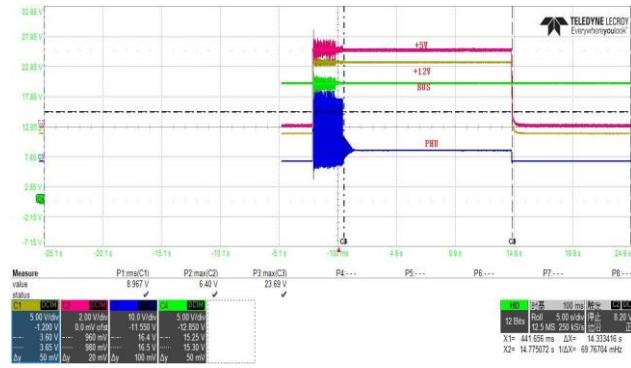


Fig. 2 Measured bus voltage ,VCC=12V, LDO=5V @ bus=20V
 Power Off Time = 14s

3.1.2 Battery Under Voltage Lockout

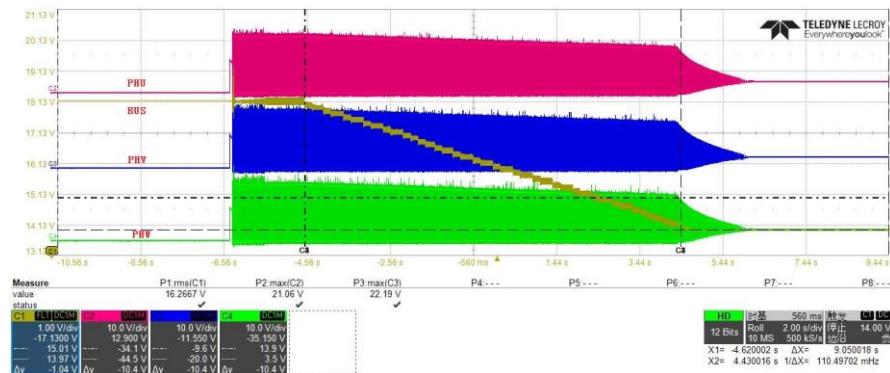


Fig. 3 Measured Bus voltage and UVW output voltage @ bus = 18V

3.2 MOSFET

3.2.1 Vgs Voltage = 12V @ BUS = 18V

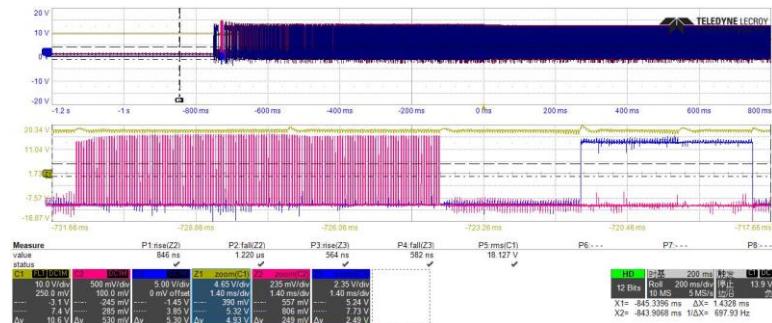


Fig. 4 Measured VBUS Voltage(Yellow), highside(RED) and lowside(BLUE) MOSFET Vgs @ bus = 18V

3.2.2 Vgs Rise/Fall Edge Time

	GH1	GH2	GH3	GL1	GL2	GL3
tr/us	0.448	0.485	0.426	0.43	0.43	0.438
tf/us	0.456	0.457	0.562	0.482	0.468	0.439

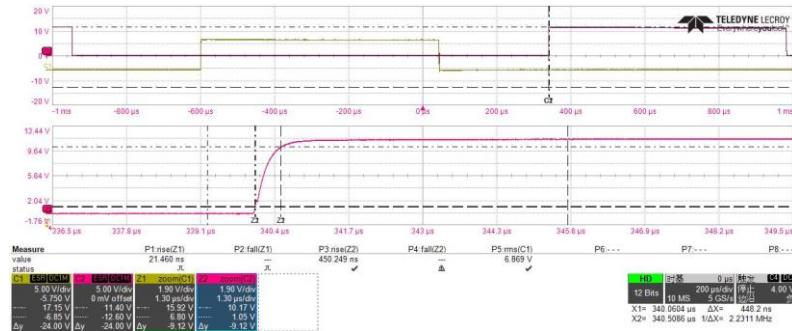


Fig. 5 Measured U-Phase highside Rise MOSFET Vgs @ bus = 18V

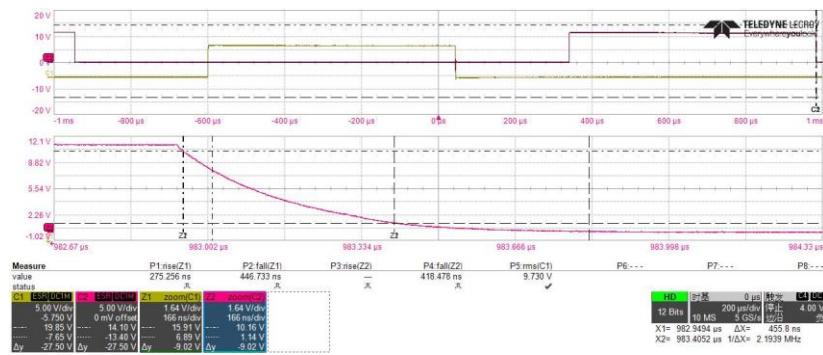


Fig. 6 Measured U-Phase highside Fall MOSFET Vgs @ bus = 18V

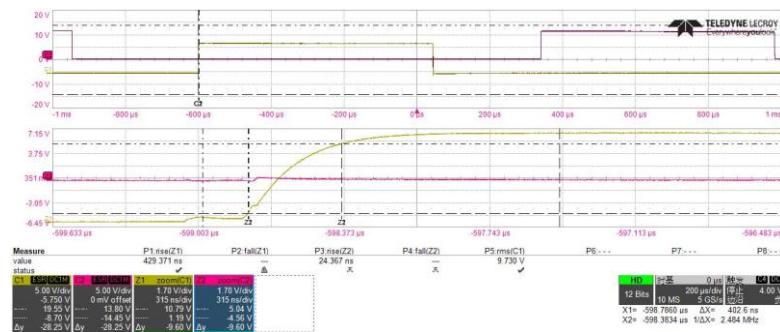
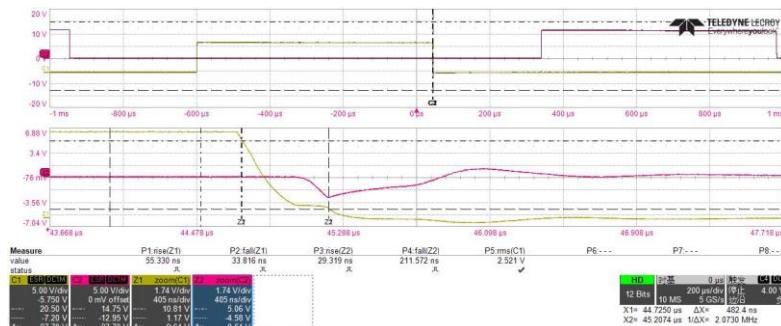
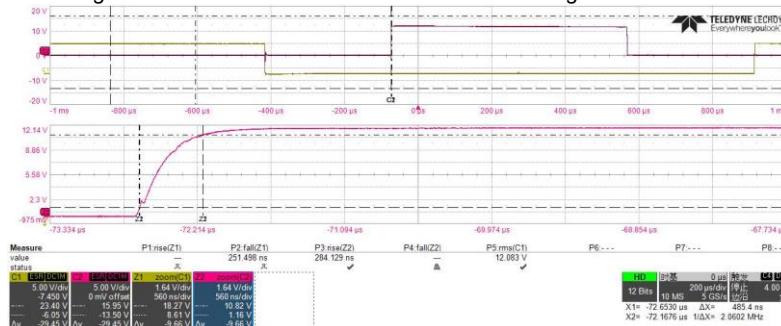
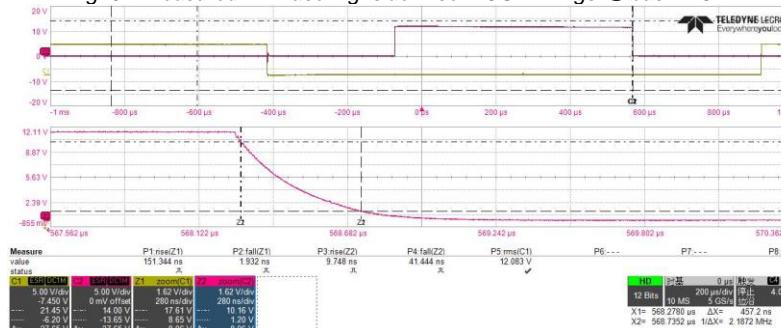
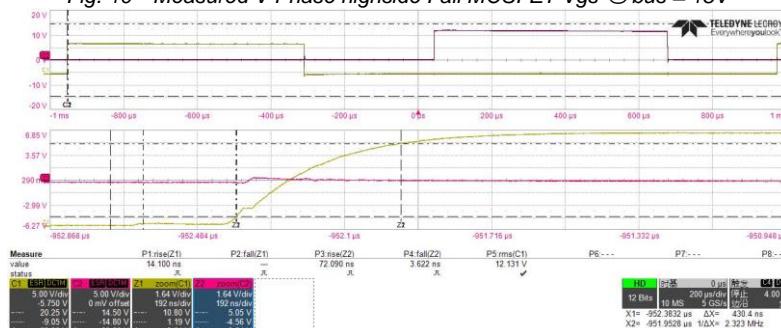
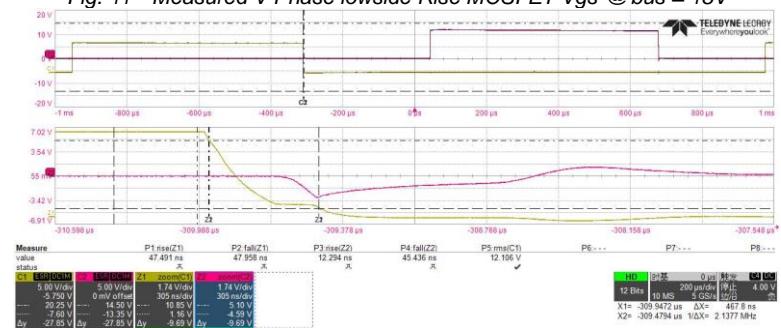


Fig. 7 Measured U-Phase lowside Rise MOSFET Vgs @ bus = 18V


 Fig. 8 Measured U-Phase lowside Fall MOSFET V_{gs} @ bus = 18V

 Fig. 9 Measured V-Phase highside Rise MOSFET V_{gs} @ bus = 18V

 Fig. 10 Measured V-Phase highside Fall MOSFET V_{gs} @ bus = 18V

 Fig. 11 Measured V-Phase lowside Rise MOSFET V_{gs} @ bus = 18V

 Fig. 12 Measured V-Phase lowside Fall MOSFET V_{gs} @ bus = 18V

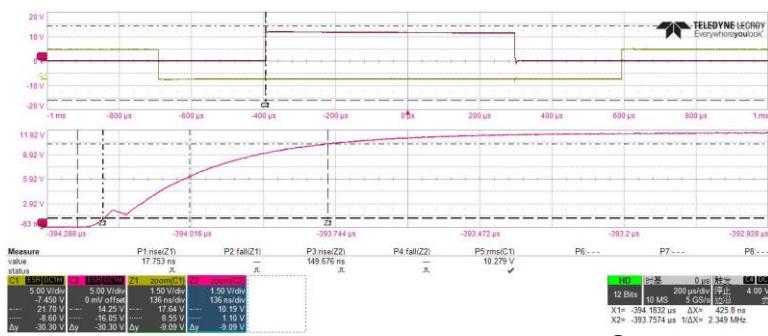


Fig. 13 Measured W-Phase highside Rise MOSFET Vgs @ bus = 18V

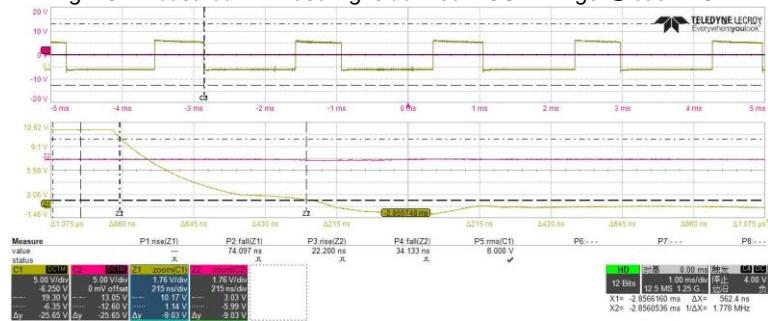


Fig. 14 Measured W-Phase highside Fall MOSFET Vgs @ bus = 18V

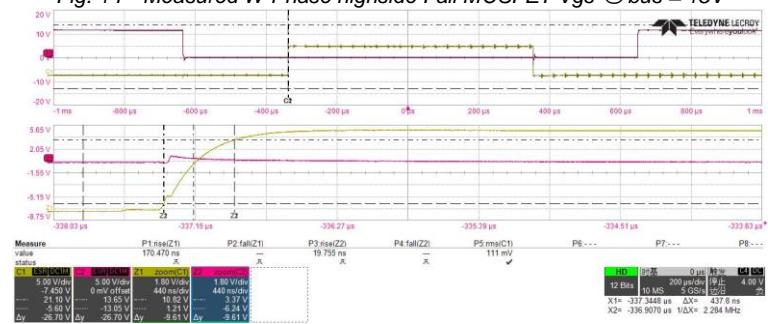


Fig. 15 Measured W-Phase lowside Rise MOSFET Vgs @ bus = 18V

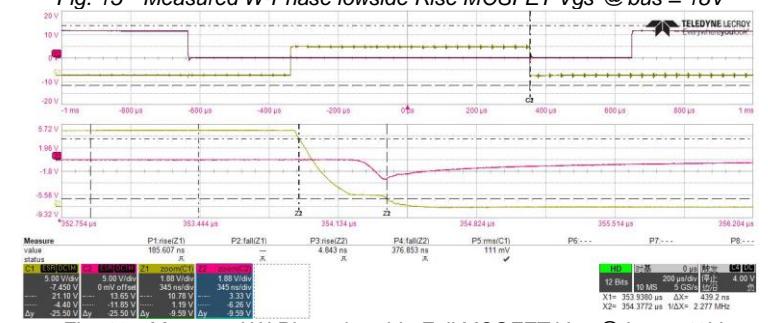


Fig. 16 Measured W-Phase lowside Fall MOSFET Vgs @ bus = 18V

3.2.3 Vds Strike Voltage @ Bus = 21V

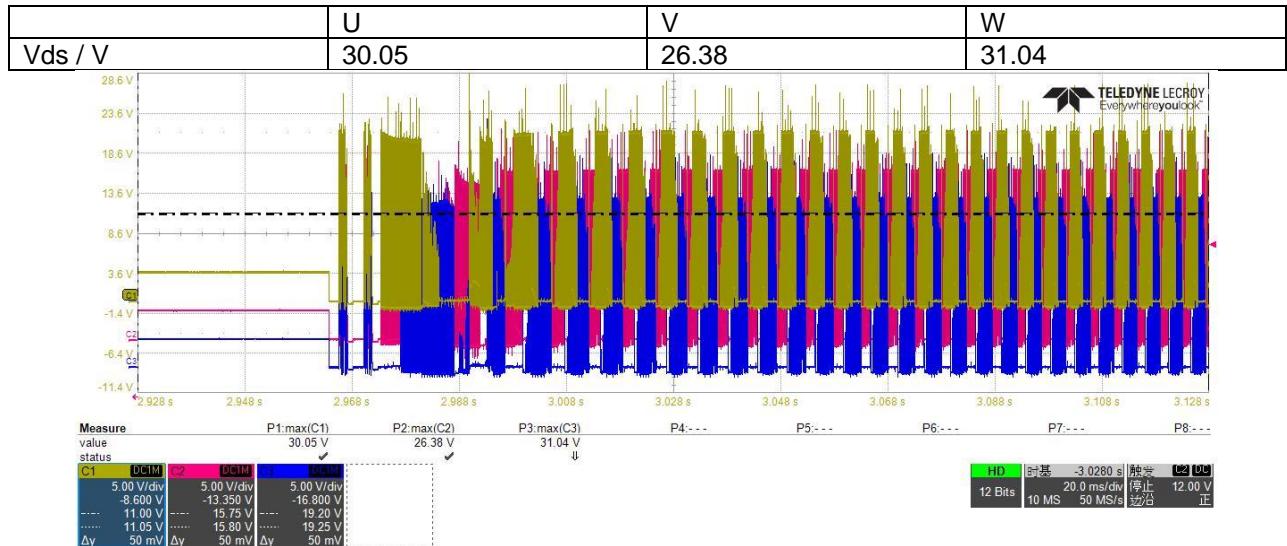


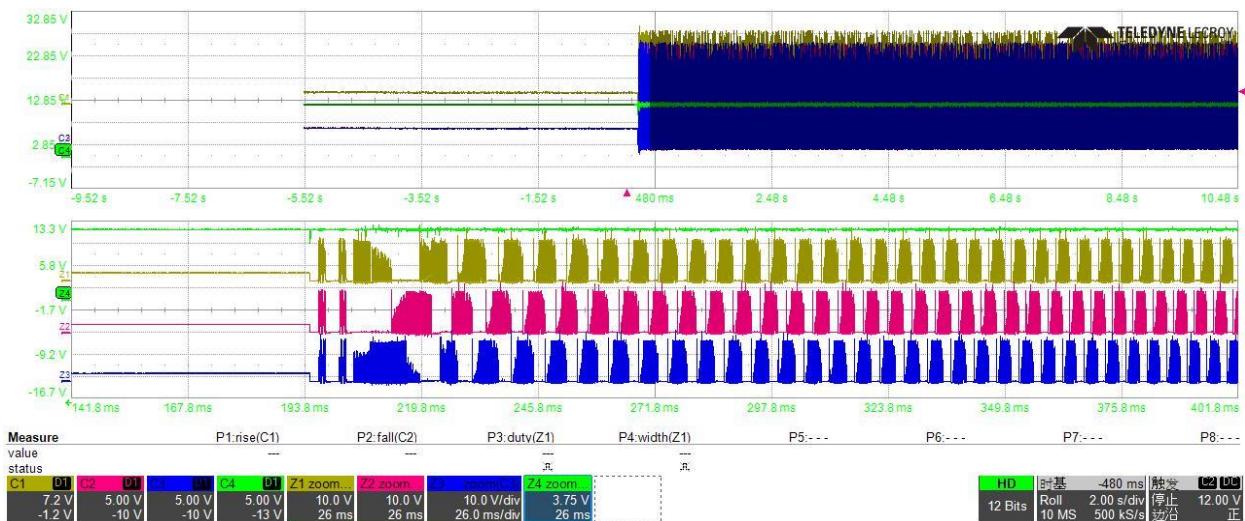
Fig. 8 Measured U(Yellow), V(Red), W(Green) MOSFET Vds strike voltage @ bus = 21V

3.3 Current Sensing



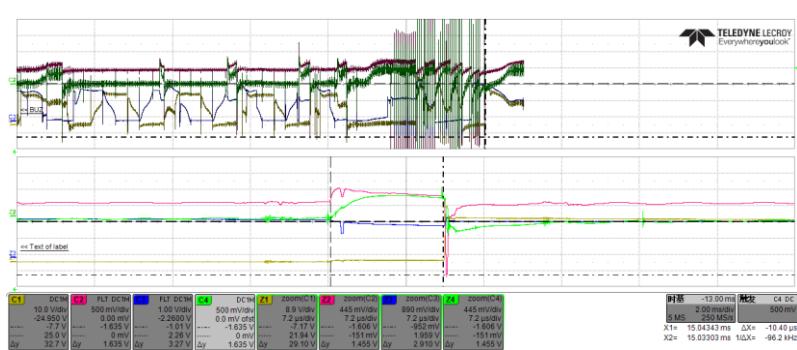
Fig.9 Measured Amplifier output(Red), pha-current(Green),pha-voltage(Yellow) @ bus = 18V

3.4 Motor Run

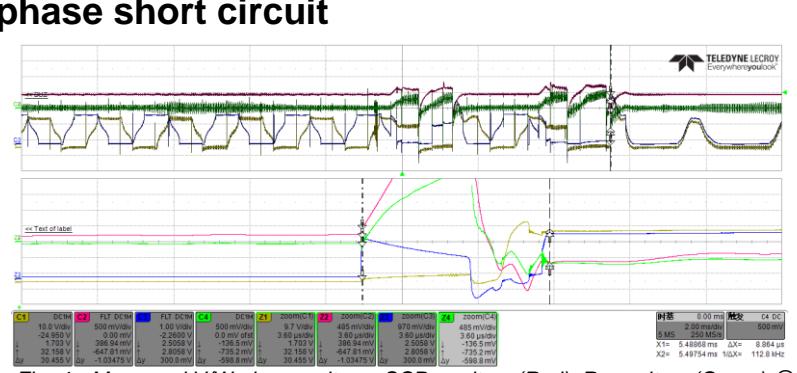


3.5 Motor Short Circuit Protection

3.5.1 U-V phase short circuit



3.5.2 V-W phase short circuit



3.6 Temperature Test

3.6.1 Temperature Measure

Setup : Bus voltage = 20.2V, Bus Current = 13.9A, TA = 80°C

	MOS1	MOS3	MOS5	MOS8	MOS10	MOS12	Heat Sink
3min	99.2	93.9	90.7	104.9	102.9	100.9	89.1
30min	99.7	97.2	91	105.3	103	101.2	105.2
60min	99.3	96.6	91.5	104.5	102.9	101.1	106.1
90min	99.4	96.6	91.3	104.8	102.9	101.2	105.5

3.7 Reliability

3.7.1 Low Temperature Reliability

Setup: TA = -40°C, Bus Voltage = 18V

Result: Pass

3.7.2 High Temperature Reliability

Setup: TA = 80°C, Bus Voltage = 20V

Result: Pass

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