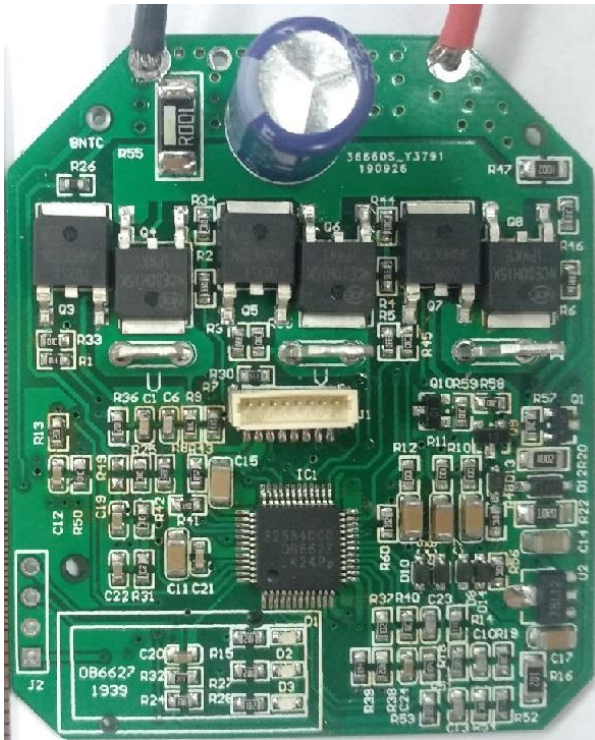


Subject
OB6627L Demo Board Manual

Board Model: OB6627L_1943_Protel
Doc. No.: OB_DOC_DBM_A_6627L00



Key Feature:

- 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
- Forward/Reverse selection
- 10% duty start, and motor fast stop
- Automatic power off with time delay
- MOSFET temperature sensing and thermal protection.
- Two levels battery under voltage protection
- Battery residual capacity display
- PCB size small, and assemble conveniently

Revision history:

Revise Date	Version	Reason/Issue
2019-10-25	00	First Issue

Contents Index

1.	System Electrical Specification.....	3
1.1	Input Characteristic.....	3
1.2	System parameters.....	3
1.3	Output characteristic.....	3
1.4	Environmental.....	3
2.	Board Information.....	4
2.1	Schematic.....	4
2.2	Bill of material.....	5
2.3	PCB Garber File.....	7
2.4	Heat-sink Drawing.....	8
2.5	Connector Function Description.....	9
2.6	BLDC Controller Board Snapshot.....	10
3.	Performance Evaluation.....	11
3.1	Voltage Test.....	12
3.1.1	Gate Driver & MCU Supply Power ON/OFF.....	12
3.1.2	OB6627L Under Voltage Lockout ON/OFF.....	12
3.1.3	Battery Under Voltage Lockout.....	13
3.2	MOSFET.....	13
3.2.1	Vgs Voltage = 12V @ BUS = 18V.....	13
3.2.2	Vgs Rise/Fall Edge Time.....	13
3.2.3	Vds Strike Voltage @ Bus = 21V.....	15
3.3	Current Sensing.....	15
3.4	Motor Control.....	16
3.4.1	Motor Run.....	16
3.4.2	Motor Brake.....	16
3.4.3	Motor Low Speed and Torque Maintain.....	17
3.5	Temperature Test.....	17
3.5.1	Temperature Measure.....	17
3.5.2	MOSFET Temperature Protection.....	17
3.6	Reliability.....	18
3.6.1	Low Temperature Reliability.....	18
3.6.2	High Temperature Reliability.....	18

1. System Electrical Specification

1.1 Input Characteristic

- DC input voltage rating 3~5 cells Li-Iron battery of 3.7V
- DC input voltage 7V to 25V
- Handle working voltage 0 to 5V
- Hall sensor working voltage 0 to 5V
- Motor steering signal type Differential signal

1.2 System parameters

- PWM frequency 20KHz
- MCU supply voltage $5V \pm 2\%$
- 5V supply current 100mA
- Current sampling resistance $1m\Omega$
- Current sampling amplification 16
- Current sampling amplifier offset Self-calibration
- Gate driver supply voltage Battery voltage @ 3 cells battery
12V @ 5 cells battery
- Max of MOSFET drain source voltage value 30V
- MOSFET thermal sensor precision 1%

1.3 Output characteristic

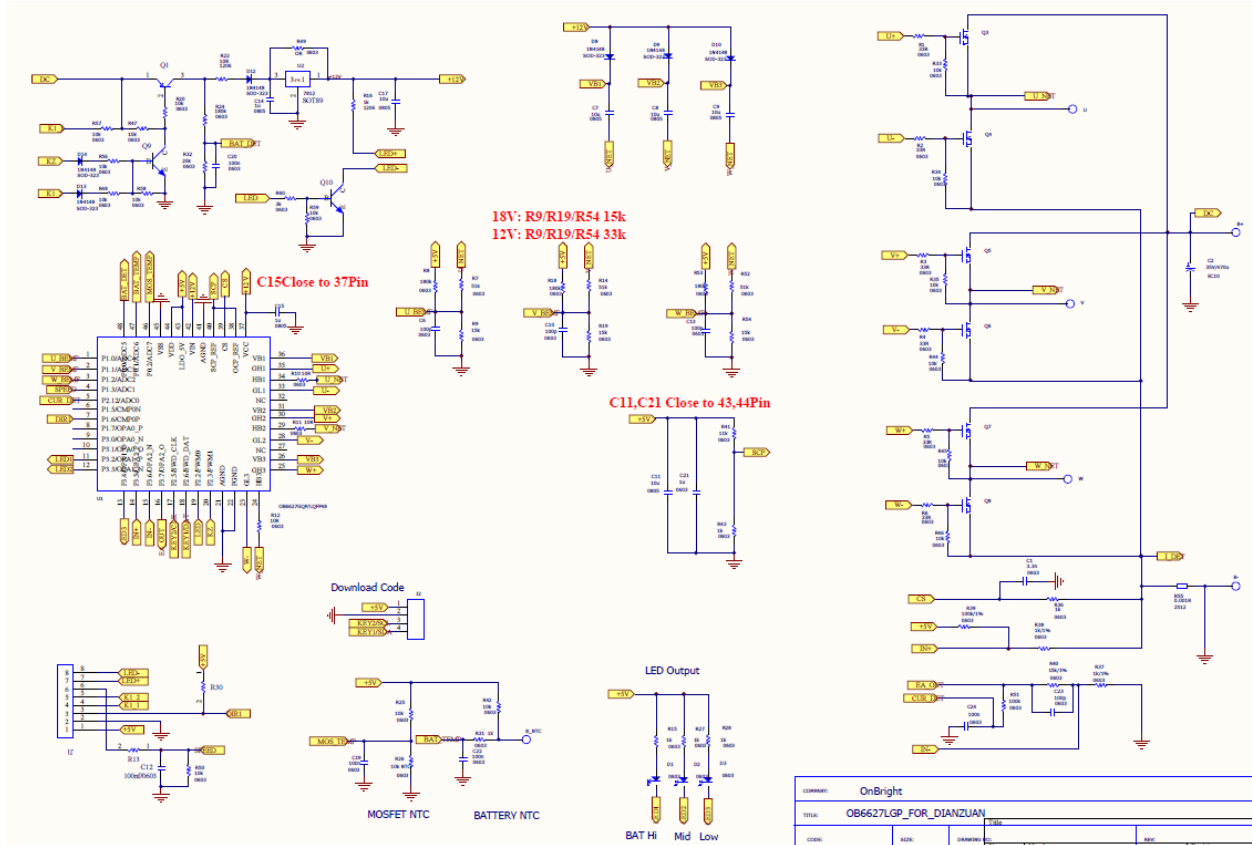
- Phase current limitation 100A
- Maximum of PWM duty 100%
- Minimum of PWM duty 10%

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

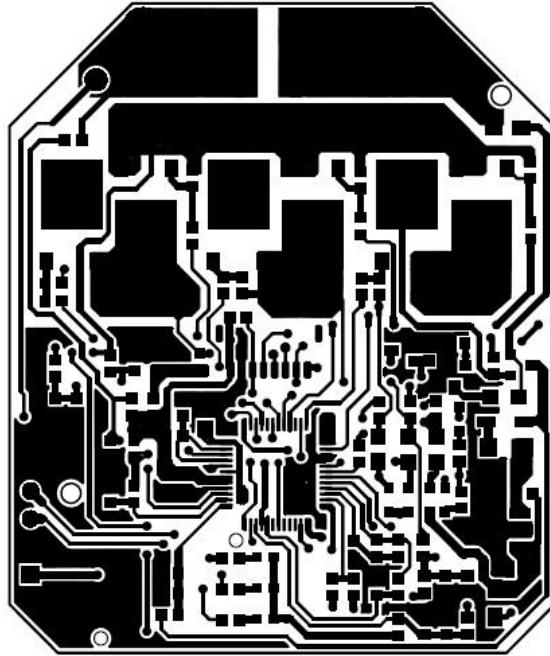
Position	Description	Package	QTY
C1	Capacitor,ceramic,3.3nf/25V,X7R,10%	0603	1
C2	Capacitor, aluminum electrolytic, 470uf/35V,-40/105°C	EC10	1
C6, C10, C13, C23	Capacitor,ceramic,100pf/25V,X7R,10%	0603	4
C7, C8, C9, C11, C17	Capacitor,ceramic,10uf/25V,X7R,10%	0805	5
C14, C15	Capacitor,ceramic,1uf/25V,X7R,10%	0805	2
C21	Capacitor,ceramic,1uf/25V,X7R,10%	0603	1
C12, C19, C20, C22, C24	Capacitor,ceramic,100nf/25V,X7R,10%	0603	5
D1, D2, D3	LED, Green	0603	3
D8, D9, D10, D12, D13, D14	T4,1N4148	SOD-323	5
J1	JST SH1.0mm,8pin Connector		1
Q1	PNP BJT, MMBT5401	SOT23	1
Q9, Q10	NPN BJT, MMBT5551	SOT23	2
Q3, Q4, Q5, Q6, Q7, Q8	Power MOS,NCE30H15K (30V150A)	TO252	6
R1, R2, R3, R4, R5, R6	Resistor,chip,20R,5%	0603	6
R7, R14, R30, R52	Resistor,chip,51k,5%	0603	4
R8, R18, R24, R53	Resistor,chip,180k,5%	0603	4
R9, R19, R54	Resistor,chip,15k,5%	0603	3
R10, R11, R12	Resistor,chip,10R,5%	0603	3
R13,R15,R27,R28,R31,R36, R43	Resistor,chip,1k,5%	0603	7
R25,R33,R34,R35,R42,R44,R45,R46,R48,R50,R56,R57,R58,R59	Resistor,chip,10k,5%	0603	14
R26	10k,NTC,TSM1A103^34D,B=3435	0603	1
R32	Resistor,chip,20k,5%	0603	1
R37, R38	Resistor,chip,1k,1%	0603	2
R39	Resistor,chip,100k,1%	0603	1
R40	Resistor,chip,15k,1%	0603	1
R41	Resistor,chip,11k,5%	0603	1
R51	Resistor,chip,100k,5%	0603	1
R60	Resistor,chip,3k,5%	0603	1
R22	Resistor,chip,10R,5%	1206	1
R16,	Resistor,chip,1k,5%	1206	1
R20,R47	Resistor,chip,10k,5%	1206	2
R55	Resistor,chip,1mR,1%	2512	1
U1	OB6627LGP	LQFP48	1
U2	78L12	SOT89	1
Connector	4.8mm 插片	4.8mm	3
Heatsink	1.6mm 铝基板	45mm*15mm	1

Note1: BOM is used in 4~5 cells battery

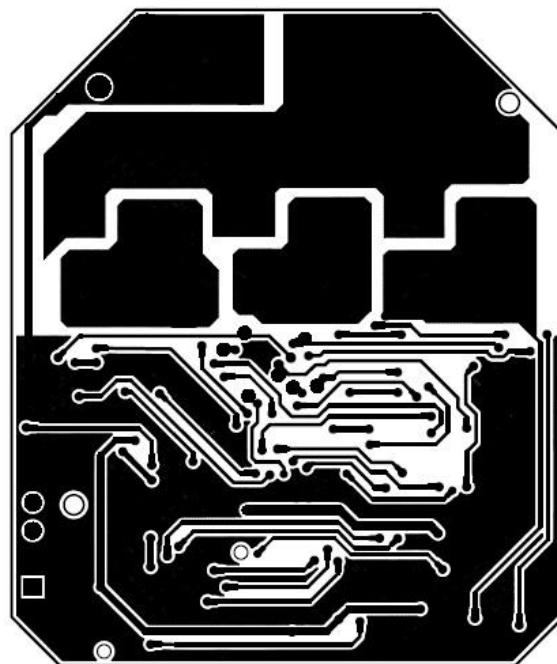
Note2: 3 cells battery BOM change:

Position	Description	Package	QTY
R9, R19, R54	Resistor,chip,15k,5%	0603	3
R49	Resistor,chip,0R	0603	1
U2	Not connect		

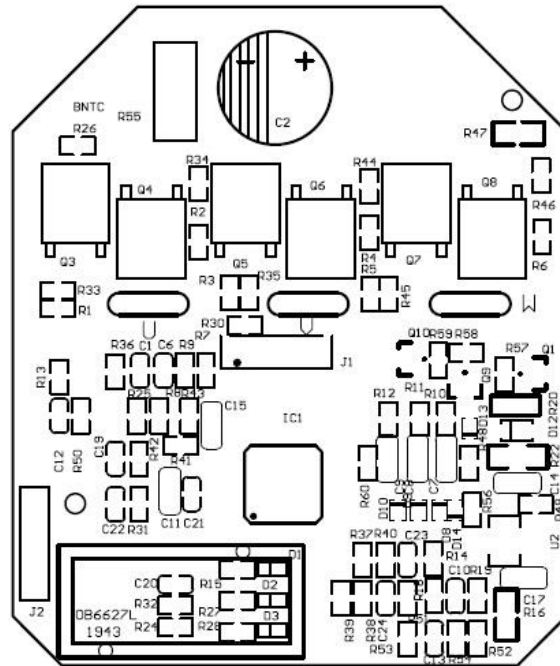
2.3 PCB Garber File



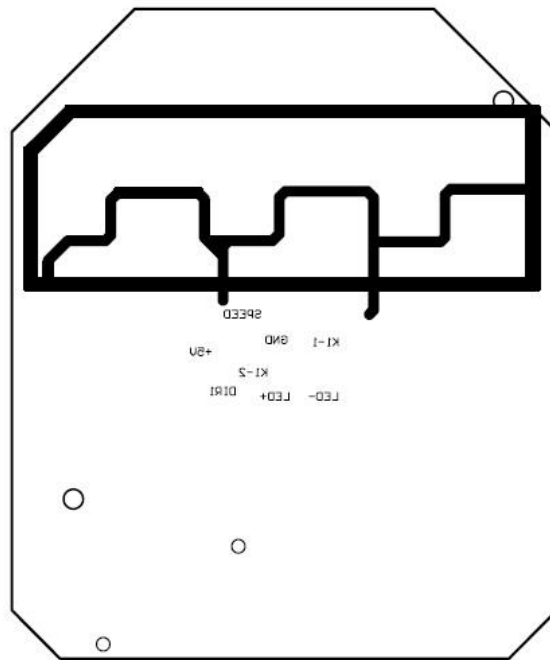
Top Layer



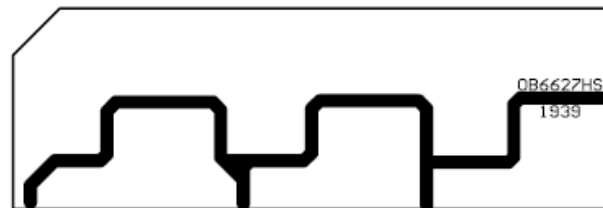
Bottom Layer



Silkscreen Top

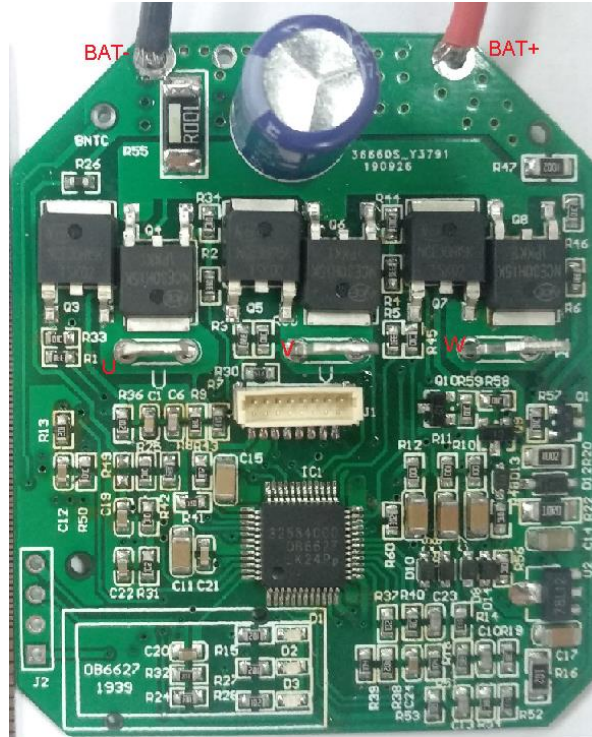


Silkscreen Bottom



Heat-sink Drawing

2.4 Connector Function Description

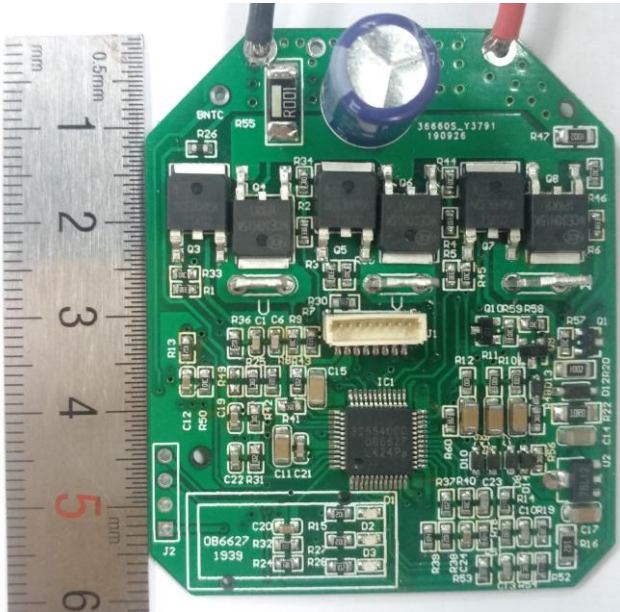


Name	Description
B+	Battery input, Bus+
B-	Battery input, GND
U	Motor U phase output
V	Motor V phase output
W	Motor W phase output

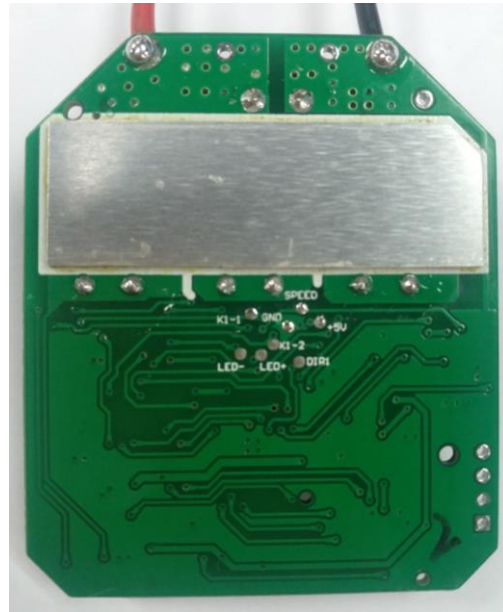
J1- 8pin connector

Pin Num	Description	Voltage Range
1	Speed signal supply	5V
2	GND	0
3	Motor Direction Control	0~5V
4	Motor steering signal 1	0~5V
5	Motor steering signal 2	0~5V
6	Speed signal input	0~5V
7	LED+	0~12V
8	LED-	0~12V

2.5 BLDC Controller Board Snapshot



Top



Bottom

3. Performance Evaluation

This session presents the test results of OB6627GP 18V/25A electric drill controller demo. TA=25°C

No	Parameter	Symbol	Min	Type	Max	Unit
1	Battery UVP	V_{bus_UVLO}		6		V
2	MCU supply	LDO_5V	4.9	5	5.1	V
3	Gate driver supply	LDO_12V		12		V
4	MOSFET gate voltage	Vgs		12		V
5	Highside MOSFET Rise time	Tr_h		0.7		us
6	Highside MOSFET Fall time	Tf_h		1.02		us
7	Lowside MOSFET Rise time	Tr_l		0.7		us
8	Lowside MOSFET Fall time	Tf_l		0.6		us
9	PWM frequency	f_{PWM}		20		kHz
10	PWM duty	Duty	10		100	%
11	Throttle voltage	$V_{throttle}$	0.55		4.6	V
12	Six step control logic					
13	Current amplify coefficient			16		
14	MOSFET current shutdown time in MOTOR short circuit				10	us
15	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

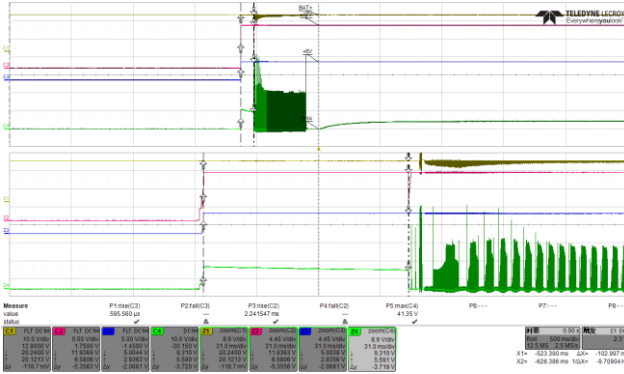


Fig. 1 Measured bus voltage ,VCC=12V, LDO=5V @ bus=20V

Power On Time = 100ms

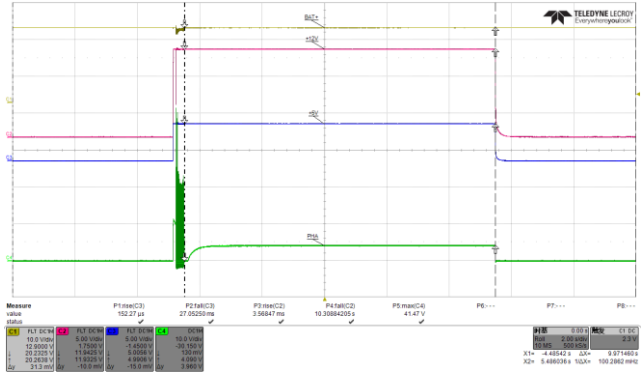


Fig. 2 Measured bus voltage ,VCC=12V, LDO=5V @ bus=20V

Power Off Time = 10s

3.1.2 OB6627L Under Voltage Lockout ON/OFF

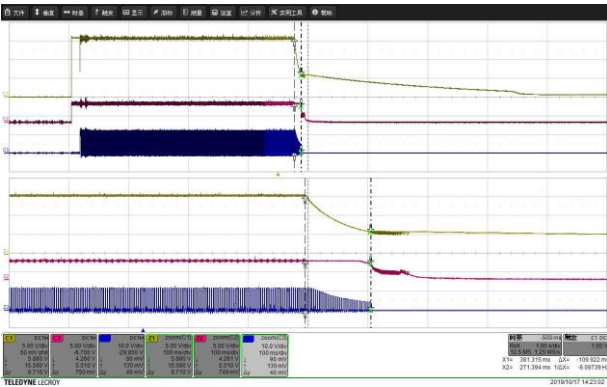


Fig. 3 Measured OB6627L supply voltage , LDO=5V, low-side Gate Driver @ bus = 18V

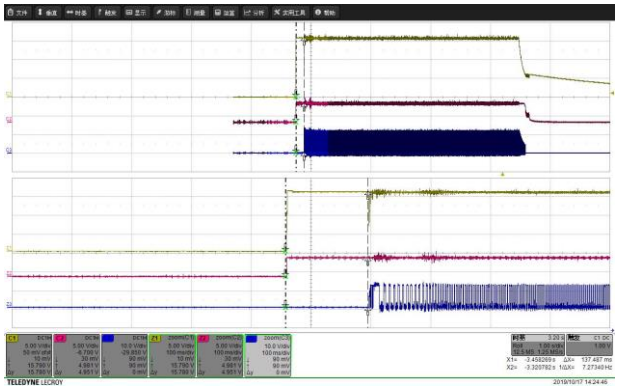


Fig. 4 Measured OB6627L supply voltage , LDO=5V, low-side Gate Driver @ bus = 18V

3.1.3 Battery Under Voltage Lockout

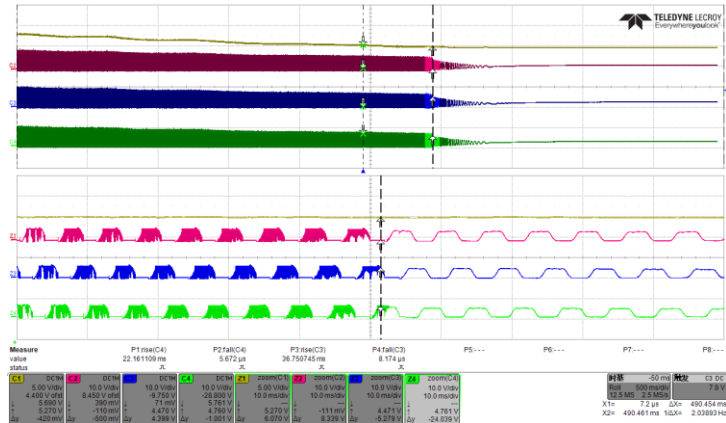


Fig. 5 Measured Bus voltage and UVW output voltage @ bus = 6V

3.2 MOSFET

3.2.1 Vgs Voltage = 12V @ BUS = 18V

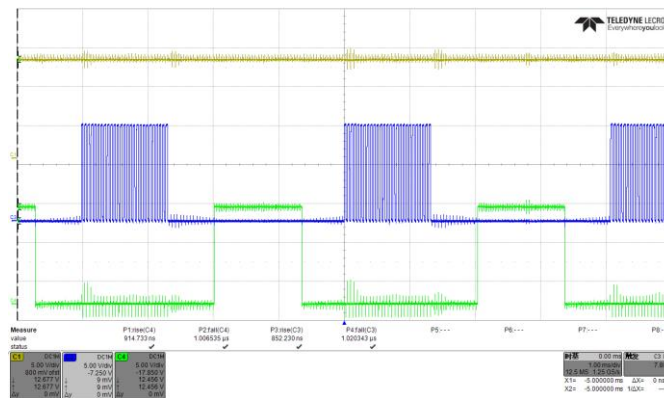


Fig. 6 Measured Vbs Voltage(Yellow), highside(Blue) and lowside(Green) MOSFET Vgs @ bus = 18V

3.2.2 Vgs Rise/Fall Edge Time

	GH1	GH2	GH3	GL1	GL2	GL3
tr/us	0.67	0.67	0.69	0.68	0.71	0.65
tf/us	1.03	1.04	1.03	0.74	0.71	0.71

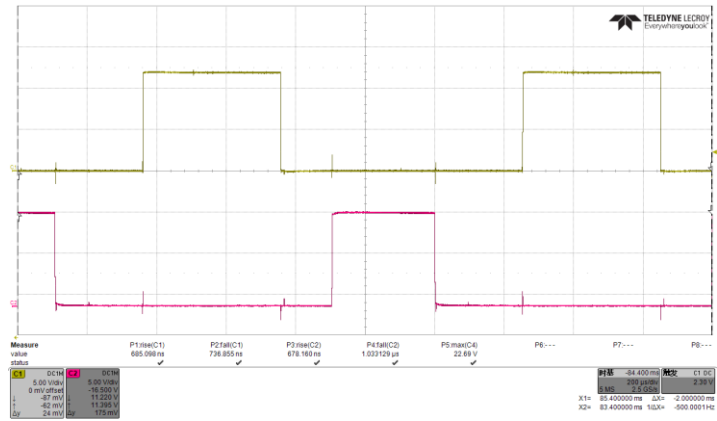


Fig. 7 Measured U-Phase highside(Red) and lowside(Yellow) MOSFET Vgs @ bus = 18V

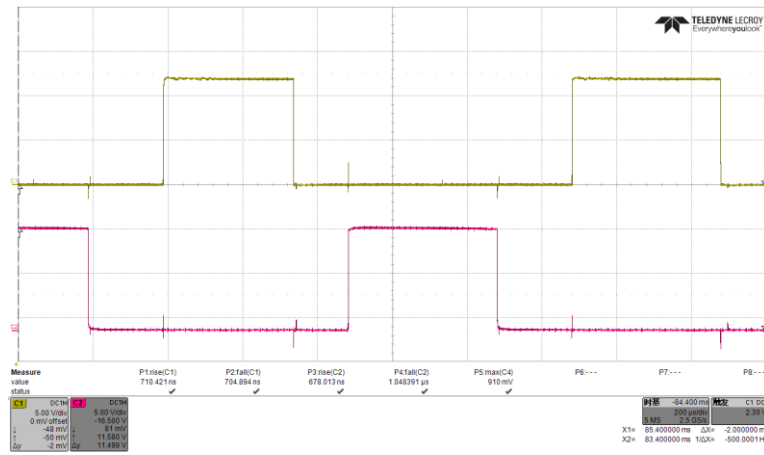


Fig. 8 Measured V-Phase highside(Red) and lowside(Yellow) MOSFET Vgs @ bus = 18V

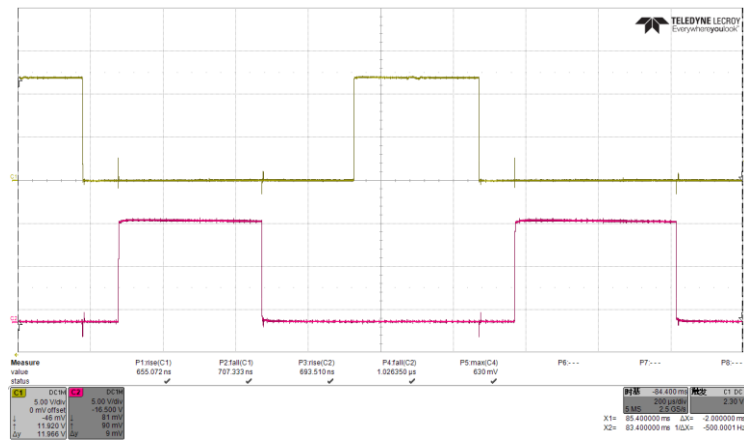


Fig. 9 Measured W-Phase highside(Red) and lowside(Yellow) MOSFET Vgs @ bus = 18V

3.2.3 Vds Strike Voltage @ Bus = 21V

	U	V	W
Vds / V	27.9	27	27.8

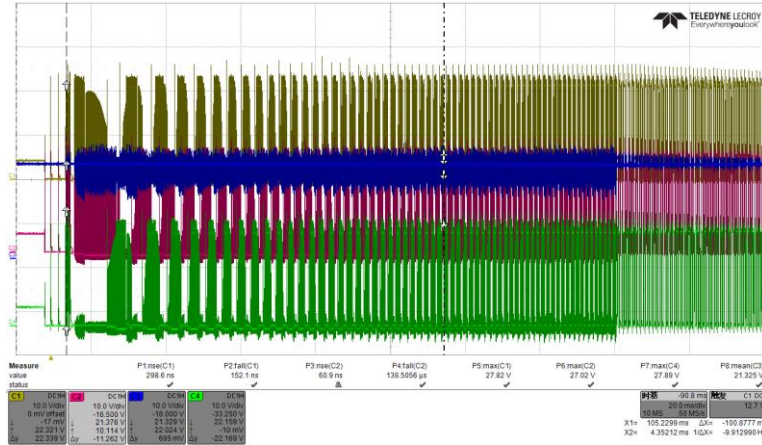


Fig. 10 Measured U(Yellow),V(Red),W(Green) MOSFET Vds strike voltage @ bus = 21V

3.3 Current Sensing

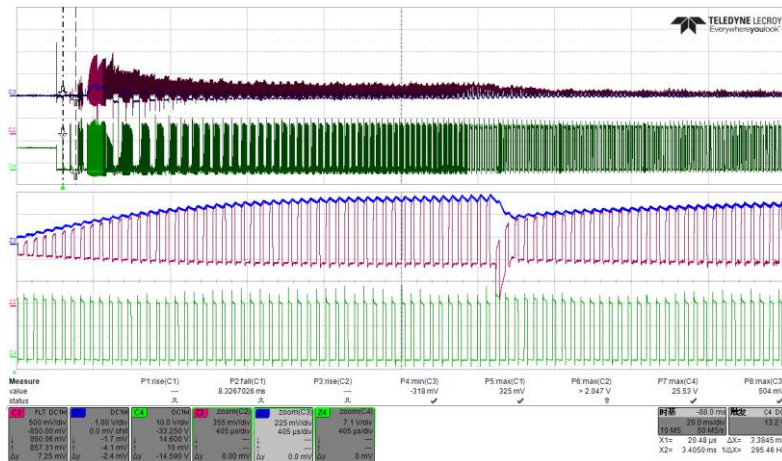


Fig. 11 Measured Amplifier output(Red), pha-current(Blue),pha-voltage(Green) @ bus = 18V

3.4 Motor Control

3.4.1 Motor Run

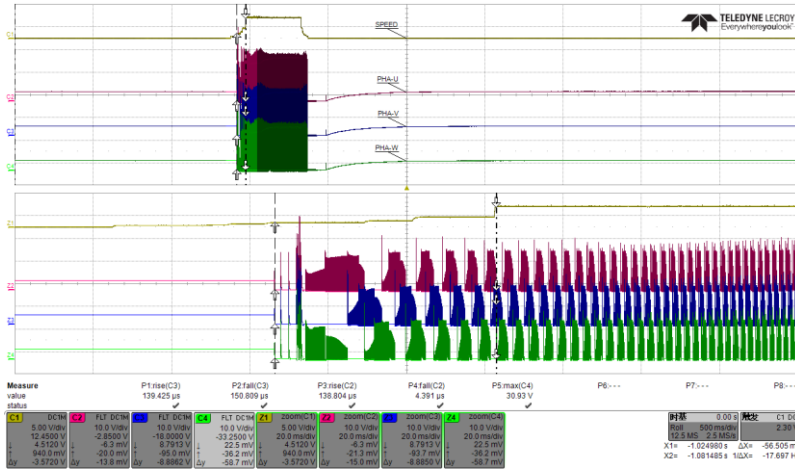


Fig. 12 Measured speed regulator(Yellow), U, V, W

3.4.2 Motor Brake

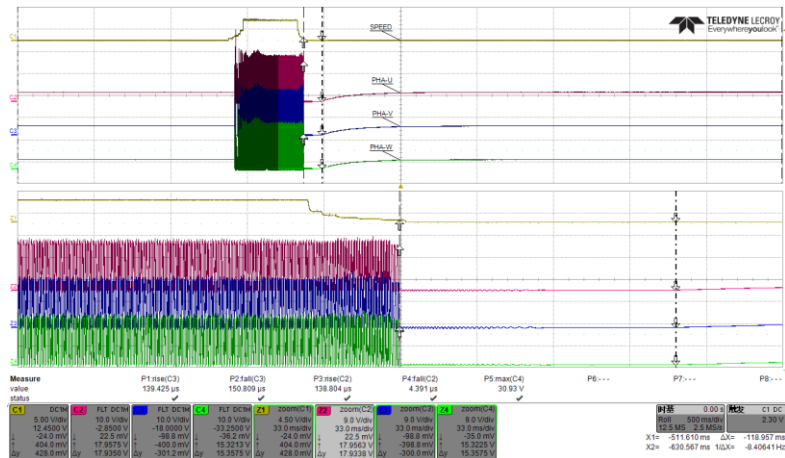


Fig. 13 Measured speed regulator(Yellow), U, V, W

Brake time = 120ms

3.4.3 Motor Low Speed and Torque Maintain

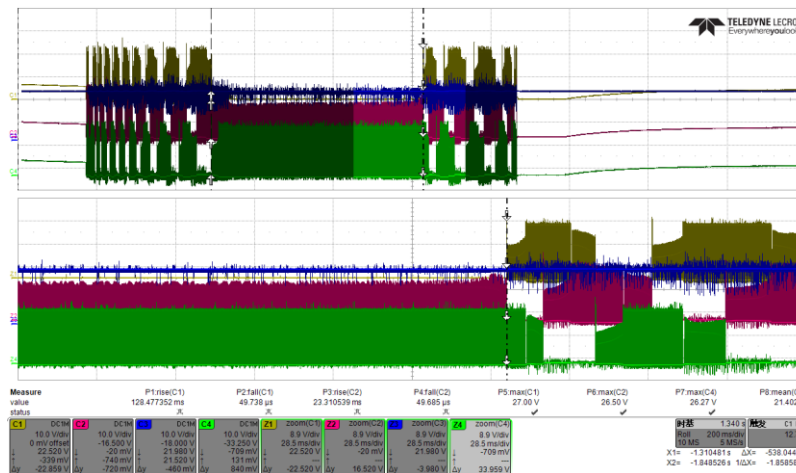


Fig. 14 Measured Bus(Blue),U,V,W at Motor stalling-station

3.5 Temperature Test

3.5.1 Temperature Measure

Setup : Bus voltage = 20.2V, Bus Current = 8.1A, TA = 80°C

	MOS1	MOS2	MOS3	MOS4	MOS5	MOS6	Heat Sink
3min	91.2	91.5	91.6	91.8	93.2	91.9	89.1
30min	110.4	108.2	111.3	109.3	108.3	110.9	105.2
60min	107.8	107.9	108.0	107.8	107.8	107.6	106.1
90min	107.7	107.8	107.7	107.8	107.8	108.1	105.5
120min	107.7	107.9	107.5	108.2	107.8	107.3	104.8

3.5.2 MOSFET Temperature Protection

Setup: Bus Voltage = 20V, Bus Current = 26A, Motor Stalling, TA = 25°C

	Protection Temp = 50°C	Protection Temp =80°C
NTC Resistance	45.8	71.3
MOS1	47.5	92.2
MOS2	48.1	98.3
MOS3	47.7	93.5
MOS4	48.3	97.2
MOS5	47.6	91.8
MOS6	47.5	96.2
Heat Sink	44.3	88.7

3.6 Reliability

3.6.1 Low Temperature Reliability

Setup: TA = -40°C, Bus Voltage = 18V
Result: Pass

3.6.2 High Temperature Reliability

Setup: TA = 80°C, Bus Voltage = 20V
Result: Pass

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