For Air-Conditioner Fan Motor

3-Phase Brushless Fan Motor Driver BM620XFS Evaluation Board

BM620xFS-EVK-001

Introduction

This evaluation board has been developed for ROHM's motor driver customers evaluating BM620XFS series. This motor driver IC integrates a MOSFET as the output transistor, and put in a small full molding package with the controller chip and the high voltage gate driver chip. The protection circuits for overcurrent, overheating, under voltage lock out and the high voltage bootstrap diode with current regulation are built-in.

Lineup Matrix

Commutation	600V/1.5A (Max)	600V/2.5A (Max)
120° square waveform commutation driver	BM6204FS	BM6205FS
150° wide-angle waveform commutation driver	BM6206FS	BM6207FS
180° sinusoidal waveform commutation driver	BM6208FS	BM6209FS

Evaluation Board

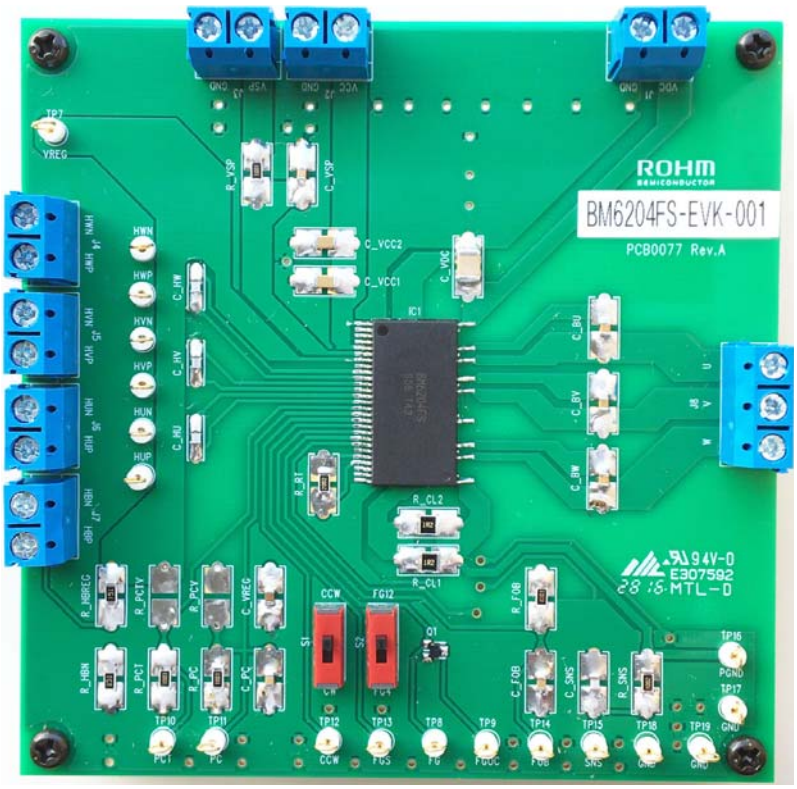

Figure 1. BM6204FS-EVK-001 Evaluation Board

Absolute Maximum Ratings(Ta = 25°C)

VCC=20V, VSP=20V, VDC=600V (BM6204~09FS common ratings)

Driver Outputs (DC)	±1.5A	Driver Outputs (Pulse)	±2.5A	(BM6204FS, BM6206FS, BM6208FS)
Driver Outputs (DC)	±2.5A	Driver Outputs (Pulse)	±4.0A	(BM6205FS, BM6207FS, BM6209FS)

Evaluation Board Recommended Operating Conditions(Ta = 25°C)

VCC = 13.5V to 16.5V, VDC = 310V to 400V

Operation Procedures

Necessary equipments

- DC power-supply of 18V for VCC/VSP input
- DC power-supply of 400V/4A for VDC input
- 3-Phase Brushless Fan Motor

Connecting the equipments(for Hall elements Motor application)

1. DC power-supply preset to 15V(for VCC), 0V(for VSP) , 0V(for VDC) and then the powers output turn off.
2. FG monitor sets the S1 switch, and Motor direction sets the S2 switch.
   Don't change S2 switch setting while the Motor is operating.
3. Connect positive-terminal of Hall elements DC power to HBP terminal, and negative-terminal to HBN terminal.
4. Connect positive-terminal of Hall elements U to HUP terminal, and negative-terminal to HUN terminal.
5. Connect positive-terminal of Hall elements V to HVP terminal, and negative-terminal to HVN terminal.
6. Connect positive-terminal of Hall elements W to HWP terminal, and negative-terminal to HWN terminal.
7. Connect U-terminal of Motor to U terminal, and V-terminal to V terminal, W-terminal to W terminal.
8. Turn on DC power-supply outputs. (1.VCC, 2.VSP, 3.VDC)
9. Set voltage for DC power-supply output for VDC.
10. Check Motor operation at VSP>2.1V(typ) starting.
    If Motor doesn't operate, Motor terminal connection may be wrong, please set VSP and VDC voltage at 0V.
11. VSP voltage control the rotation speed.

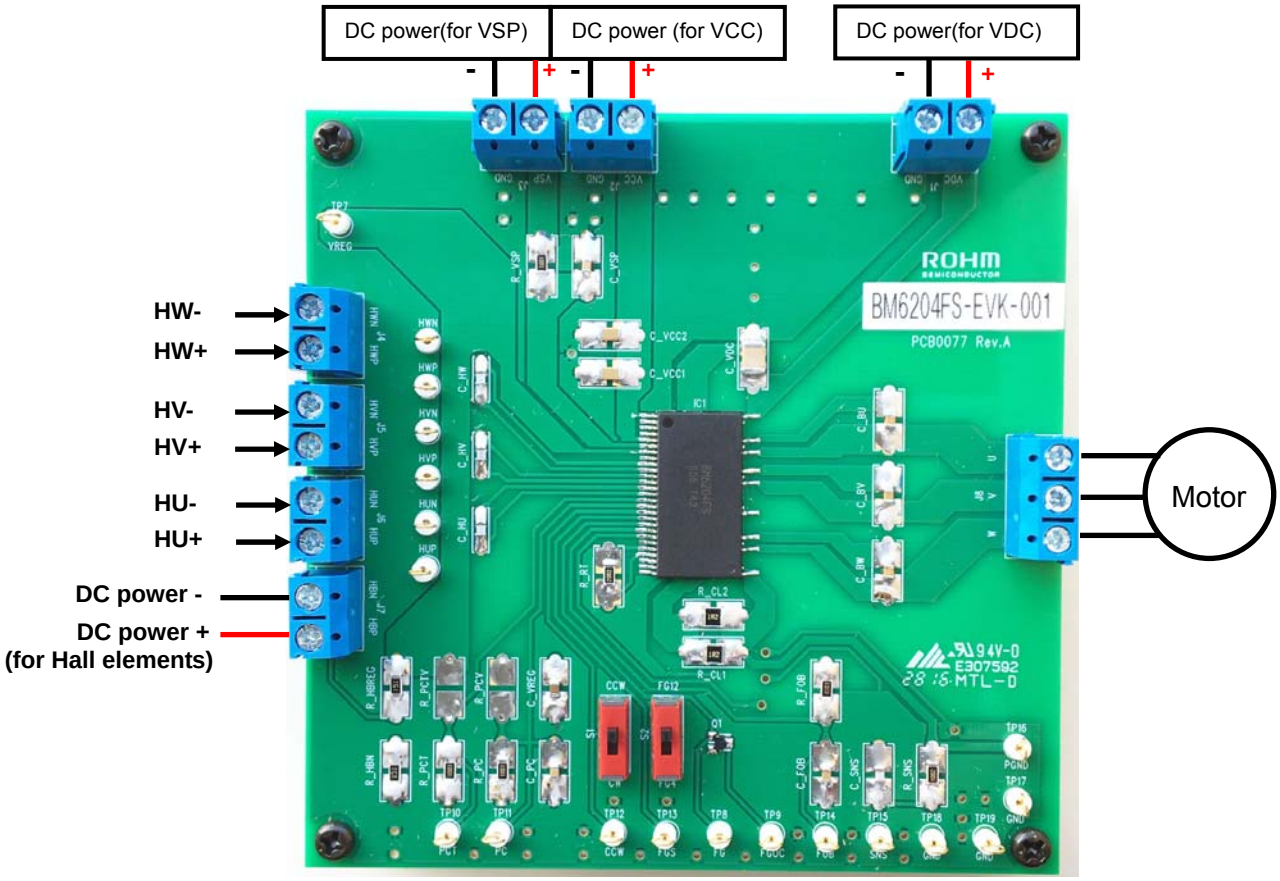

Figure 2. Connection Diagram (for Hall elements Motor appliation)

Operation Procedures

Connecting the equipments(for Hall IC Motor application)

This Evaluation Board is for Hall elements Motor application.
When you use a Hall IC Motor, please change setting.

- C_HU, C_HV, C_HW capacitor take off.
- R_HBREG, R_HBN resistance take off, and R_HBREG short to VREG, R_HBN short to GND.

1. DC power-supply preset to 15V(for VCC), 0V(for VSP), 0V(for VDC) and then the powers output turn off.
2. FG monitor set S1 switch, Motor direction set S2 switch.
   Don't change the S2 switch setting while the Motor is operating.
3. Connect positive-terminal of Hall IC DC power to HBP terminal, and negative-terminal to HBN terminal.
4. Connect terminal of Hall IC U to HUP terminal.
5. Connect terminal of Hall IC V to HVP terminal.
6. Connect terminal of Hall IC W to HWP terminal.
7. Input bias voltage to HUN, HVN, HWN terminal.(1.0V to 2.5V)
7. Connect U-terminal of Motor to U terminal, and V-terminal to V terminal, W-terminal to W terminal.
8. Turn on DC power-supply outputs. (1.VCC, 2.VSP, 3.VDC)
9. Set voltage for DC power-supply output for VDC.
10. Check Motor operation at VSP>2.1V(typ) starting
    If Motor doesn't operate, Motor terminal connection may be wrong, please set VSP and VDC voltage at 0V.
11. VSP voltage control the rotation speed.

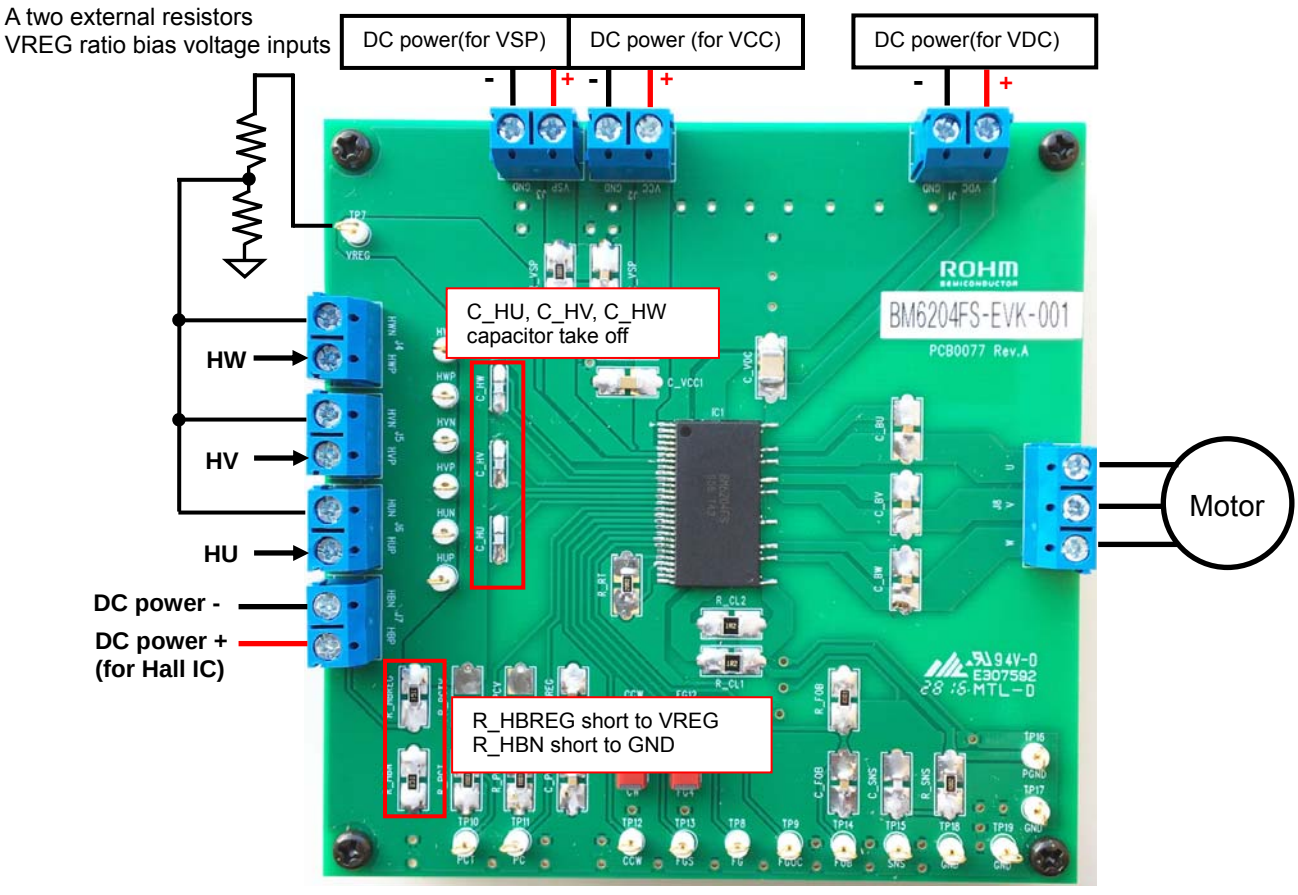

Figure 3. Connection Diagram (for Hall IC Motor application)

Application Circuit Example

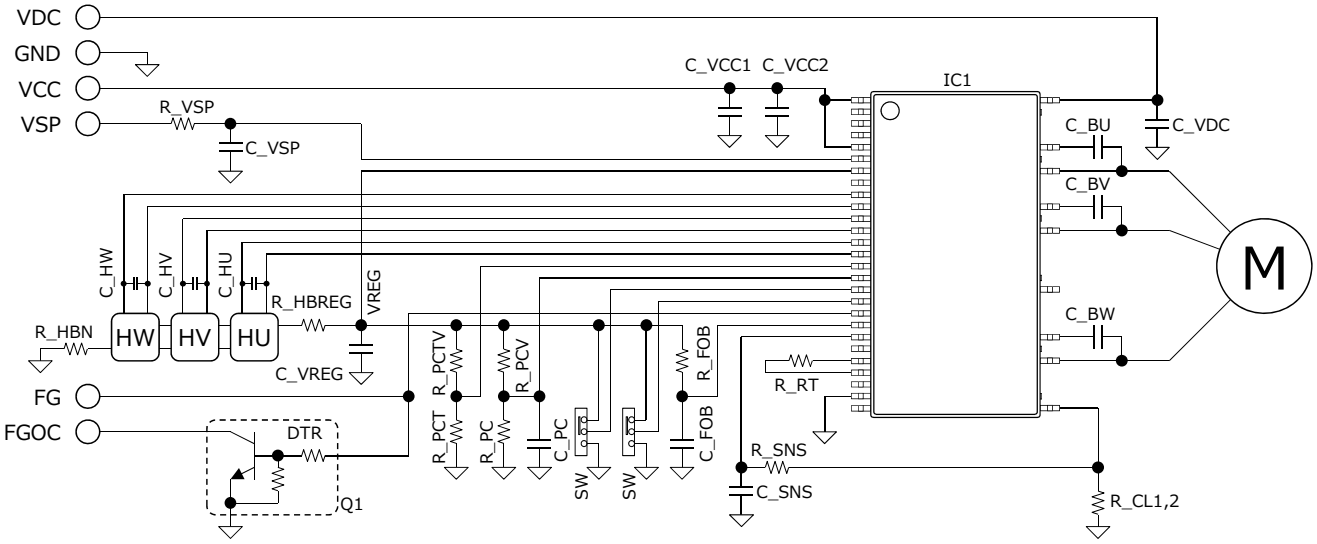

Figure 4. Application Example (180° Sinusoidal Commutation Driver)

Table 1. Parts List

Parts	Value	Manufacturer	Type	Parts	Value	Manufacturer	Type
IC1	-	ROHM	BM6208FS	C_VSP	0.1μF	MURATA	GRM219R71E104KA01
R_VSP	1kΩ	ROHM	MCR18EZPF1001	C_HU	2200pF	MURATA	GRM2162C1H222JA01
R_HBREG	150Ω	ROHM	MCR18EZPJ151	C_HV	2200pF	MURATA	GRM2162C1H222JA01
R_HBN	150Ω	ROHM	MCR18EZPJ151	C_HW	2200pF	MURATA	GRM2162C1H222JA01
R_RT	20kΩ	ROHM	MCR18EZPF2002	C_VCC1	10 μF	MURATA	GRM319R61E106KA12
R_PCT	100kΩ	ROHM	MCR18EZPF1003	C_VCC2	10 μF	MURATA	GRM319R61E106KA12
R_PC	100kΩ	ROHM	MCR18EZPF1003	C_BU	2.2μF	MURATA	GRM21BR61E225KA12
R_CL1,2	0.6Ω	ROHM	MCR25JZHJ1R2 x 2	C_BV	2.2μF	MURATA	GRM21BR61E225KA12
R_SNS	10kΩ	ROHM	MCR18EZPF1002	C_BW	2.2μF	MURATA	GRM21BR61E225KA12
SW	-	NKK	SS-12SDP2	C_PC	0.1μF	MURATA	GRM219R71E104KA01
SW	-	NKK	SS-12SDP2	C_VREG	2.2μF	MURATA	GRM219R71E105KA88
R_PCTV	-	-	-	C_SNS	100pF	MURATA	GRM2162C2A101JA01
R_PCV	-	-	-	C_VDC	0.1μF	MURATA	GRM43DR72J104KW01
R_FOB	100kΩ	ROHM	MCR18EZPF1003	C_FOB	0.1μF	MURATA	GRM219R71E104KA01
Q1	-	ROHM	DTC014EUB	HX	-	-	Hall elements

Functional Block Diagram (120° square waveform commutation driver)

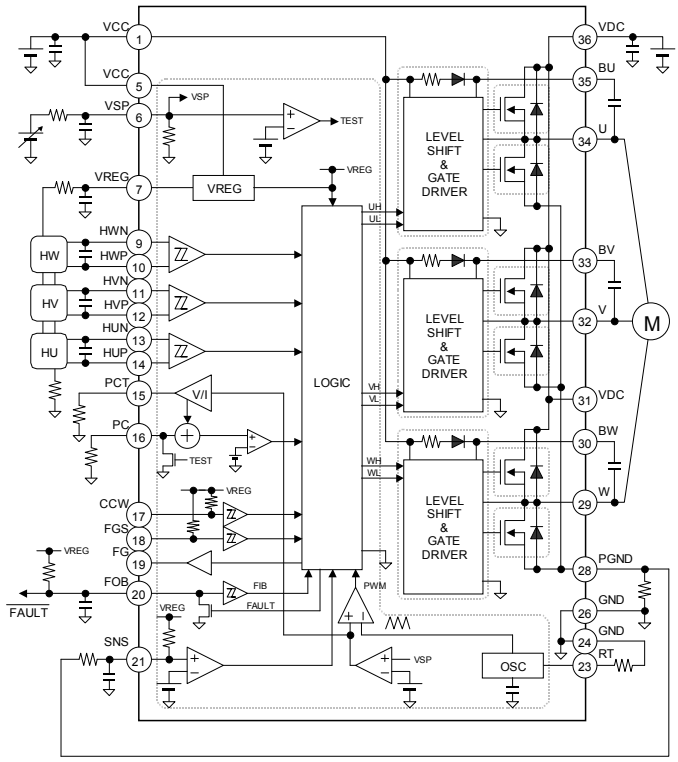

Figure 5. Block Diagram

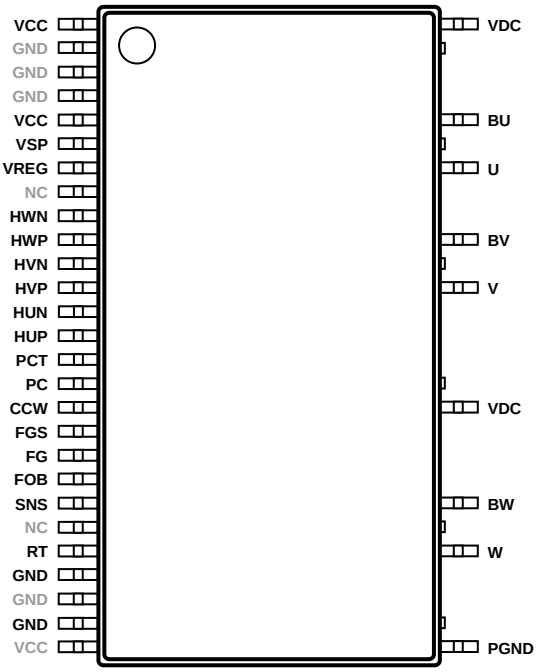

Figure 6. Pin Configuration (Top View)

Table 2. Pin Description (NC: No Connection)

Pin	Name	Function	Pin	Name	Function
1	VCC	Low voltage power supply	36	VDC	High voltage power supply
2	GND	Ground	-	VDC	
3	GND	Ground			
4	GND	Ground			
5	VCC	Low voltage power supply	35	BU	Phase U floating power supply
6	VSP	Duty control voltage input pin	-	U	
7	VREG	Regulator output	34	U	Phase U output
8	NC				
9	HWN	Hall input pin phase W-			
10	HWP	Hall input pin phase W+	33	BV	Phase V floating power supply
11	HVN	Hall input pin phase V-	-	V	
12	HVP	Hall input pin phase V+	32	V	Phase V output
13	HUN	Hall input pin phase U-			
14	HUP	Hall input pin phase U+			
15	PCT	VSP offset voltage output pin			
16	PC	PWM switching arm setting pin	-	VDC	
17	CCW	Direction switch (H:CCW)	31	VDC	High voltage power supply
18	FGS	FG pulse # switch (H:12, L:4)			
19	FG	FG signal output			
20	FOB	Fault signal output (open drain)			
21	SNS	Over current sense pin	30	BW	Phase W floating power supply
22	NC		-	W	
23	RT	Carrier frequency setting pin	29	W	Phase W output
24	GND	Ground			
25	GND	Ground			
26	GND	Ground	-	PGND	
27	VCC	Low voltage power supply	28	PGND	Ground (current sense pin)

Note) All pin cut surfaces visible from the side of package are expressed as a "-" in the column of pin number.

Functional Block Diagram (150° wide-angle waveform commutation driver)

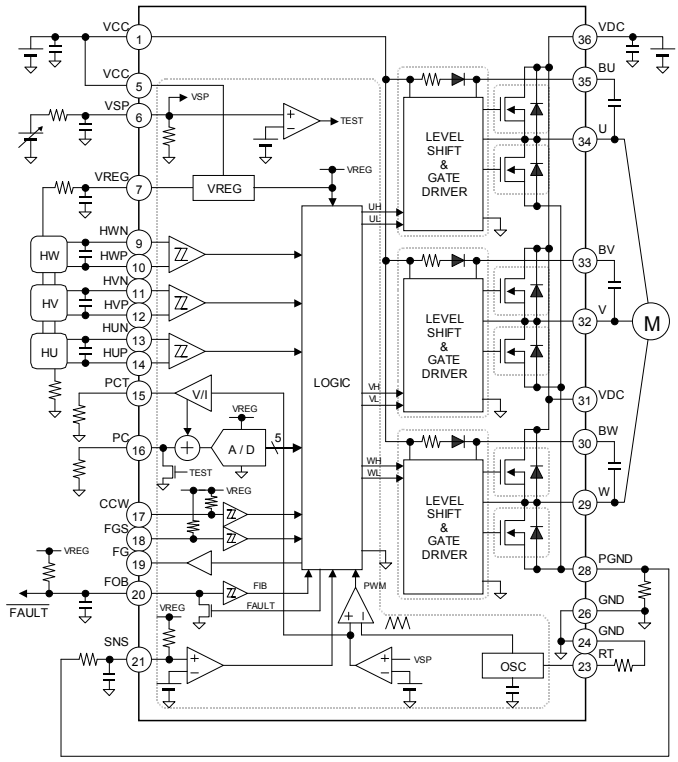

Figure 7. Block Diagram

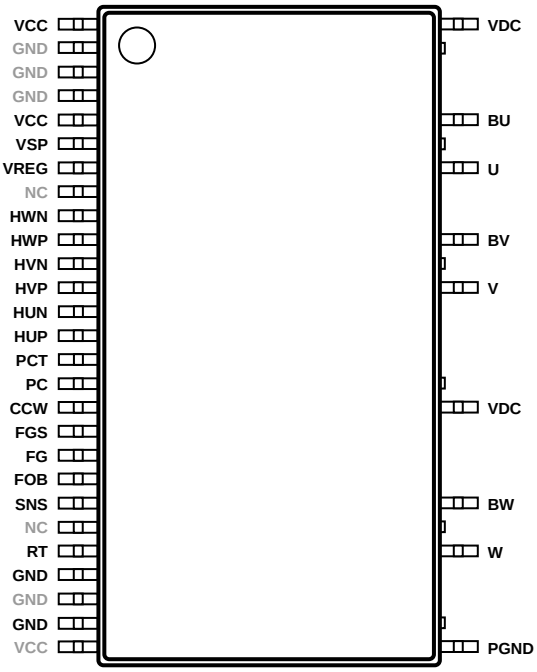

Figure 8. Pin Configuration (Top View)

Table 3. Pin Description (NC: No Connection)

Pin	Name	Function	Pin	Name	Function
1	VCC	Low voltage power supply	36	VDC	High voltage power supply
2	GND	Ground	-	VDC	
3	GND	Ground			
4	GND	Ground			
5	VCC	Low voltage power supply	35	BU	Phase U floating power supply
6	VSP	Duty control voltage input pin	-	U	
7	VREG	Regulator output	34	U	Phase U output
8	NC				
9	HWN	Hall input pin phase W-			
10	HWP	Hall input pin phase W+	33	BV	Phase V floating power supply
11	HVN	Hall input pin phase V-	-	V	
12	HVP	Hall input pin phase V+	32	V	Phase V output
13	HUN	Hall input pin phase U-			
14	HUP	Hall input pin phase U+			
15	PCT	VSP offset voltage output pin			
16	PC	Phase control input pin	-	VDC	
17	CCW	Direction switch (H:CCW)	31	VDC	High voltage power supply
18	FGS	FG pulse # switch (H:12, L:4)			
19	FG	FG signal output			
20	FOB	Fault signal output (open drain)			
21	SNS	Over current sense pin	30	BW	Phase W floating power supply
22	NC		-	W	
23	RT	Carrier frequency setting pin	29	W	Phase W output
24	GND	Ground			
25	GND	Ground			
26	GND	Ground	-	PGND	
27	VCC	Low voltage power supply	28	PGND	Ground (current sense pin)

Note) All pin cut surfaces visible from the side of package are expressed as a "-" in the column of pin number.

Functional Block Diagram (180° sinusoidal waveform commutation driver)

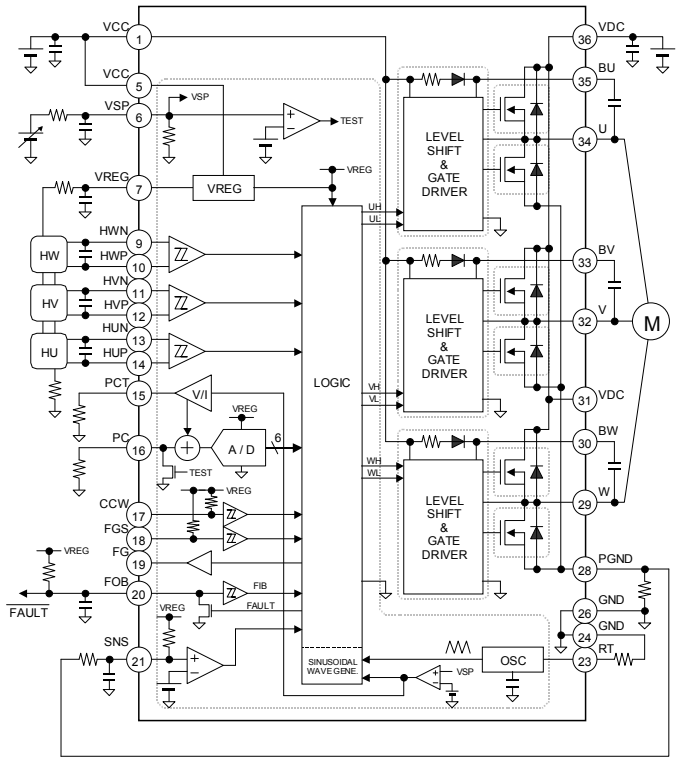

Figure 9. Block Diagram

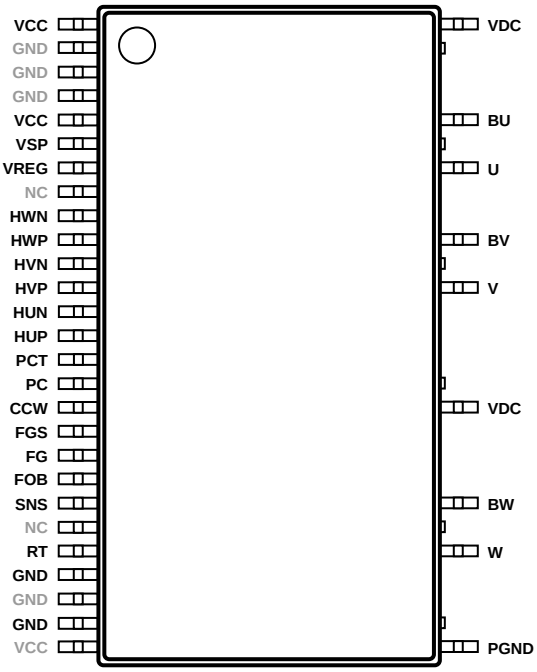

Figure 10. Pin Configuration (Top View)

Table 4. Pin Description (NC: No Connection)

Pin	Name	Function	Pin	Name	Function
1	VCC	Low voltage power supply	36	VDC	High voltage power supply
2	GND	Ground	-	VDC	
3	GND	Ground			
4	GND	Ground			
5	VCC	Low voltage power supply	35	BU	Phase U floating power supply
6	VSP	Duty control voltage input pin	-	U	
7	VREG	Regulator output	34	U	Phase U output
8	NC				
9	HWN	Hall input pin phase W-			
10	HWP	Hall input pin phase W+	33	BV	Phase V floating power supply
11	HVN	Hall input pin phase V-	-	V	
12	HVP	Hall input pin phase V+	32	V	Phase V output
13	HUN	Hall input pin phase U-			
14	HUP	Hall input pin phase U+			
15	PCT	VSP offset voltage output pin			
16	PC	Phase control input pin	-	VDC	
17	CCW	Direction switch (H:CCW)	31	VDC	High voltage power supply
18	FGS	FG pulse # switch (H:12, L:4)			
19	FG	FG signal output			
20	FOB	Fault signal output (open drain)			
21	SNS	Over current sense pin	30	BW	Phase W floating power supply
22	NC		-	W	
23	RT	Carrier frequency setting pin	29	W	Phase W output
24	GND	Ground			
25	GND	Ground			
26	GND	Ground	-	PGND	
27	VCC	Low voltage power supply	28	PGND	Ground (current sense pin)

Note) All pin cut surfaces visible from the side of package are expressed as a "-" in the column of pin number.

Operation Mode table

Table 5. Operation Mode; 120° square waveform commutation driver

Conditions	Detected direction	Forward (CW:U~V~W, CCW:U~W~V)				Reverse (CW:U~W~V, CCW:U~V~W)			
	Hall sensor frequency	< 1.4Hz		1.4Hz <		< 1.4Hz		1.4Hz <	
	PC pin	L	H	L	H	L	H	L	H
Normal operation	$V_{SP} < V_{SPMIN}$ (Duty off)	Upper and lower arm off							
	$V_{SPMIN} < V_{SP} < V_{SPMAX}$ (Control range)	Upper and lower switching			Upper switching	Upper and lower switching		Upper switching	
	$V_{SPTST} < V_{SP}$ (Testing mode)			Upper and lower switching					
Protect operation	Current limiter (Note 1)	Upper arm off						Upper and lower arm off	
	Overcurrent (Note 2)	Upper and lower arm off							
	TSD (Note 2)								
	External input (Note 2)								
	UVLO (Note 3)								
	Motor lock								
	Hall sensor abnormally	Upper and lower arm off and latch							

(Note) The controller monitors both edges of three hall sensors for detecting period.
(Note 1) It returns to normal operation by the carrier frequency synchronization.
(Note 2) It works together with the fault operation, and returns after the release time synchronizing with the carrier frequency.
(Note 3) It returns to normal operation after 32 cycles of the carrier oscillation period.

Table 6. Operation Mode; 150° wide-angle waveform commutation driver

Conditions	Detected direction	Forward (CW:U~V~W, CCW:U~W~V)		Reverse (CW:U~W~V, CCW:U~V~W)	
	Hall sensor frequency	< 1.4Hz	1.4Hz <	< 1.4Hz	1.4Hz <
Normal operation	$V_{SP} < V_{SPMIN}$ (Duty off)	Upper and lower arm off			
	$V_{SPMIN} < V_{SP} < V_{SPMAX}$ (Control range)	120° Upper and lower switching	150°Upper switching	120° Upper and lower switching	120° Upper switching
	$V_{SPTST} < V_{SP}$ (Testing mode)		150° Upper switching (No lead angle)		
Protect operation	Current limiter (Note 1)	Upper arm off			Upper and lower arm off
	Overcurrent (Note 2)	Upper and lower arm off			
	TSD (Note 2)				
	External input (Note 2)				
	UVLO (Note 3)				
	Motor lock				
	Hall sensor abnormally	Upper and lower arm off and latch			

(Note) The controller monitors both edges of three hall sensors for detecting period.
(Note) Phase control function only operates at 150° commutation mode. However, the controller forces no lead angle during the testing mode.
(Note 1) It returns to normal operation by the carrier frequency synchronization.
(Note 2) It works together with the fault operation, and returns after the release time synchronizing with the carrier frequency.
(Note 3) It returns to normal operation after 32 cycles of the carrier oscillation period.

Table 7. Operation Mode; 180° sinusoidal waveform commutation driver

Conditions	Detected direction	Forward (CW:U~V~W, CCW:U~W~V)		Reverse (CW:U~W~V, CCW:U~V~W)	
	Hall sensor frequency	< 1.4Hz	1.4Hz <	< 1.4Hz	1.4Hz <
Normal operation	$V_{SP} < V_{SPMIN}$ (Duty off)	Upper and lower arm off			
	$V_{SPMIN} < V_{SP} < V_{SPMAX}$ (Control range)	120° Upper and lower switching	180° sinusoidal Upper and lower switching	120° Upper and lower switching	120° Upper switching
	$V_{SPTST} < V_{SP}$ (Testing mode)		180° sinusoidal (No lead angle)		
Protect operation	Current limiter (Note 1)	Upper arm off			Upper and lower arm off
	Overcurrent (Note 2)	Upper and lower arm off			
	TSD (Note 2)				
	External input (Note 2)				
	UVLO (Note 3)				
	Motor lock				
	Hall sensor abnormally	Upper and lower arm off and latch			

(Note) The controller monitors both edges of three hall sensors for detecting period.
(Note) Phase control function only operates at sinusoidal commutation mode. However, the controller forces no lead angle during the testing mode.
(Note 1) It returns to normal operation by the carrier frequency synchronization.
(Note 2) It works together with the fault operation, and returns after the release time synchronizing with the carrier frequency.
(Note 3) It returns to normal operation after 32 cycles of the carrier oscillation period.

Evaluation Board Layout

Board Size : 100mm x 100mm x 1.6mm (2 Layers), Material : FR-4, Copper Foil Thickness: 35μm

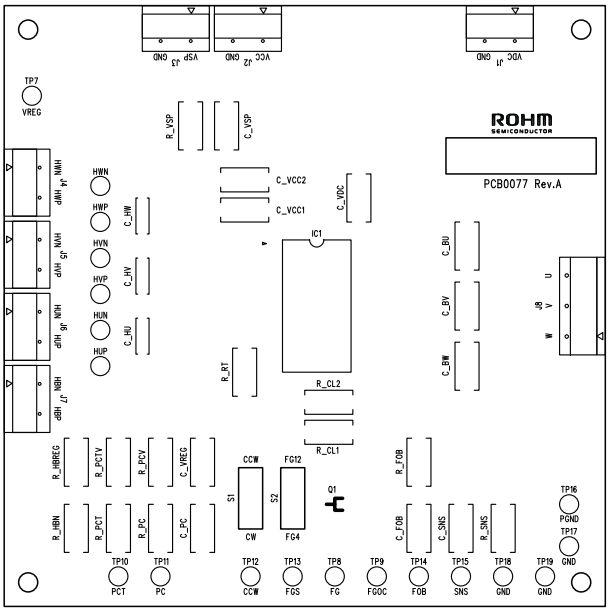

Figure 11. Top Layer, Silk Pattern (Top View)

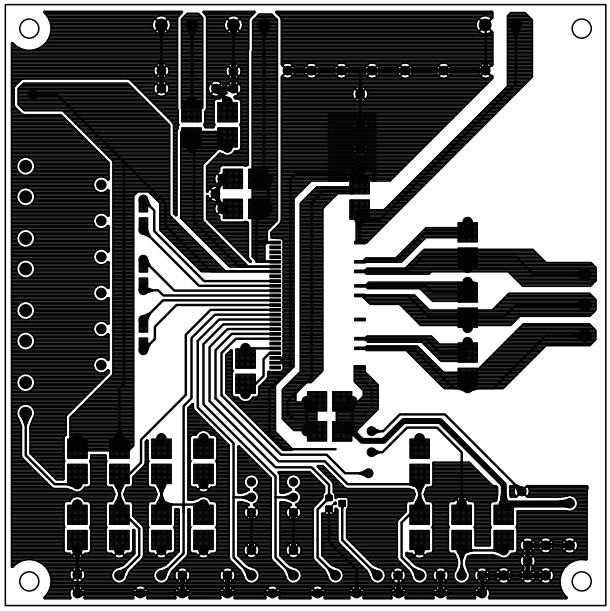

Figure 12. Top Layer, Copper Foil Pattern (Top View)

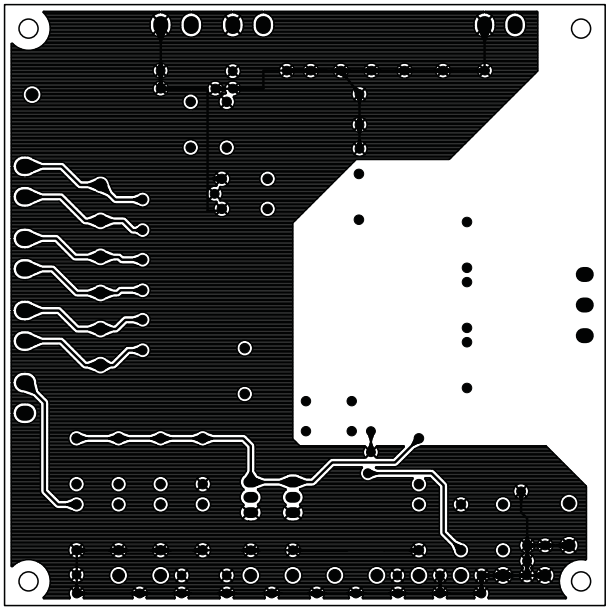

Figure 13. Bottom Layer, Copper Foil Pattern (Top View)

Evaluation Board waveform

conditions:VCC=15V, VDC=310V, VSP=2.8~3.2V (600rpm adjust), FGS=CCW=L (FG4pulse and CW rotate)

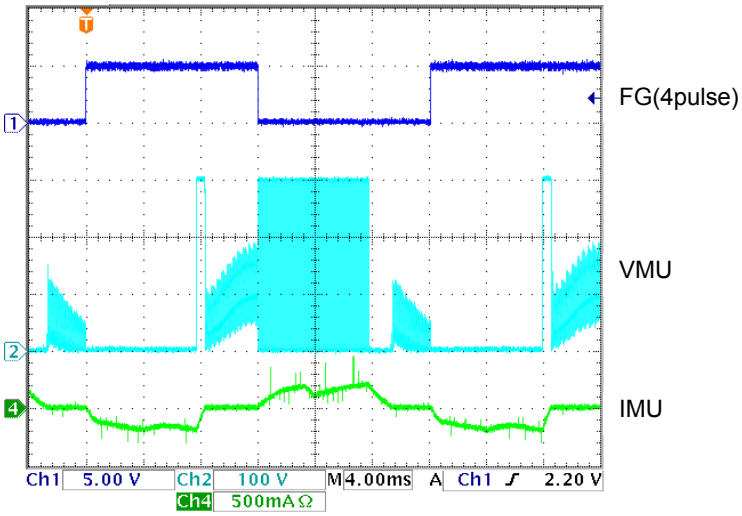

Figure 14. 120° square waveform (BM6204FS, BM6205FS)

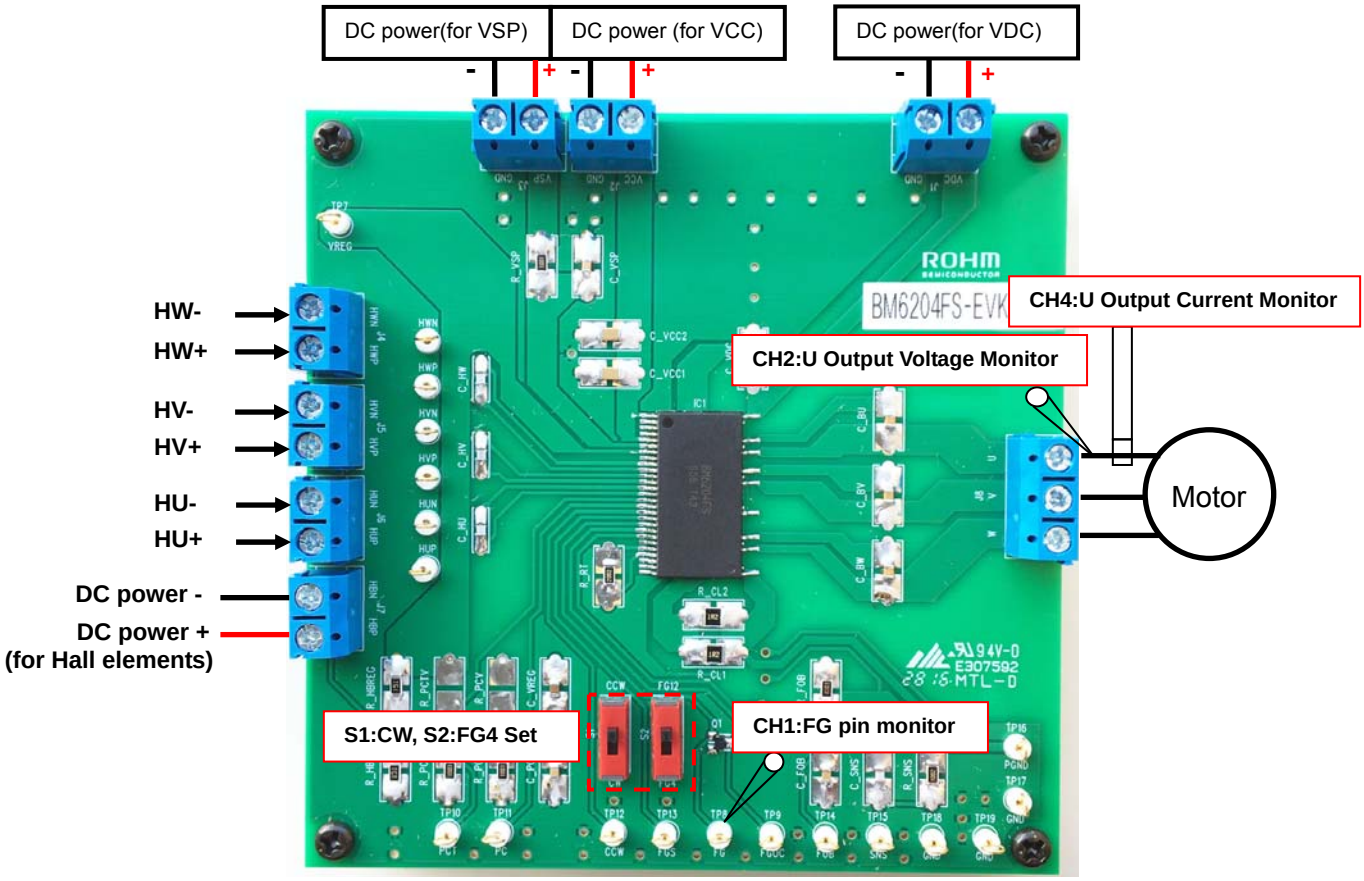

Figure 15. 120° square waveform Evaluation Board setting

Evaluation Board waveform

condition:VCC=15V, VDC=310V, VSP=2.8~3.2V (600rpm adjust), FGS=CCW=L (FG4pulse and CW rotate)

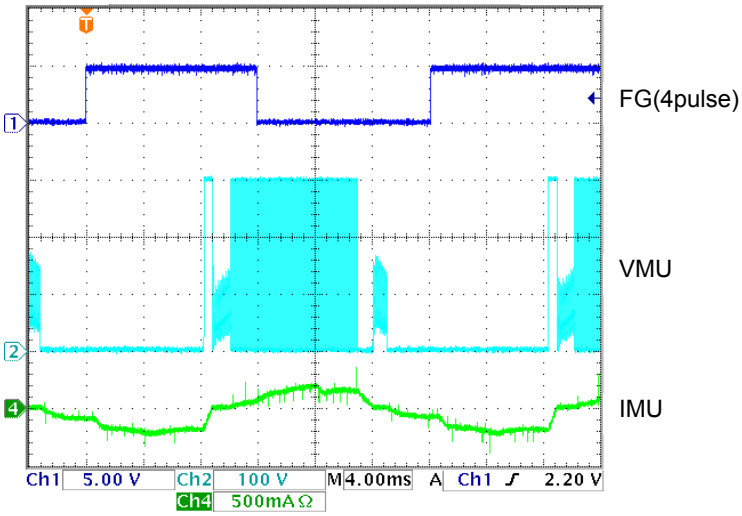

Figure 16. 150° wide-angle waveform (BM6206FS, BM6207FS)

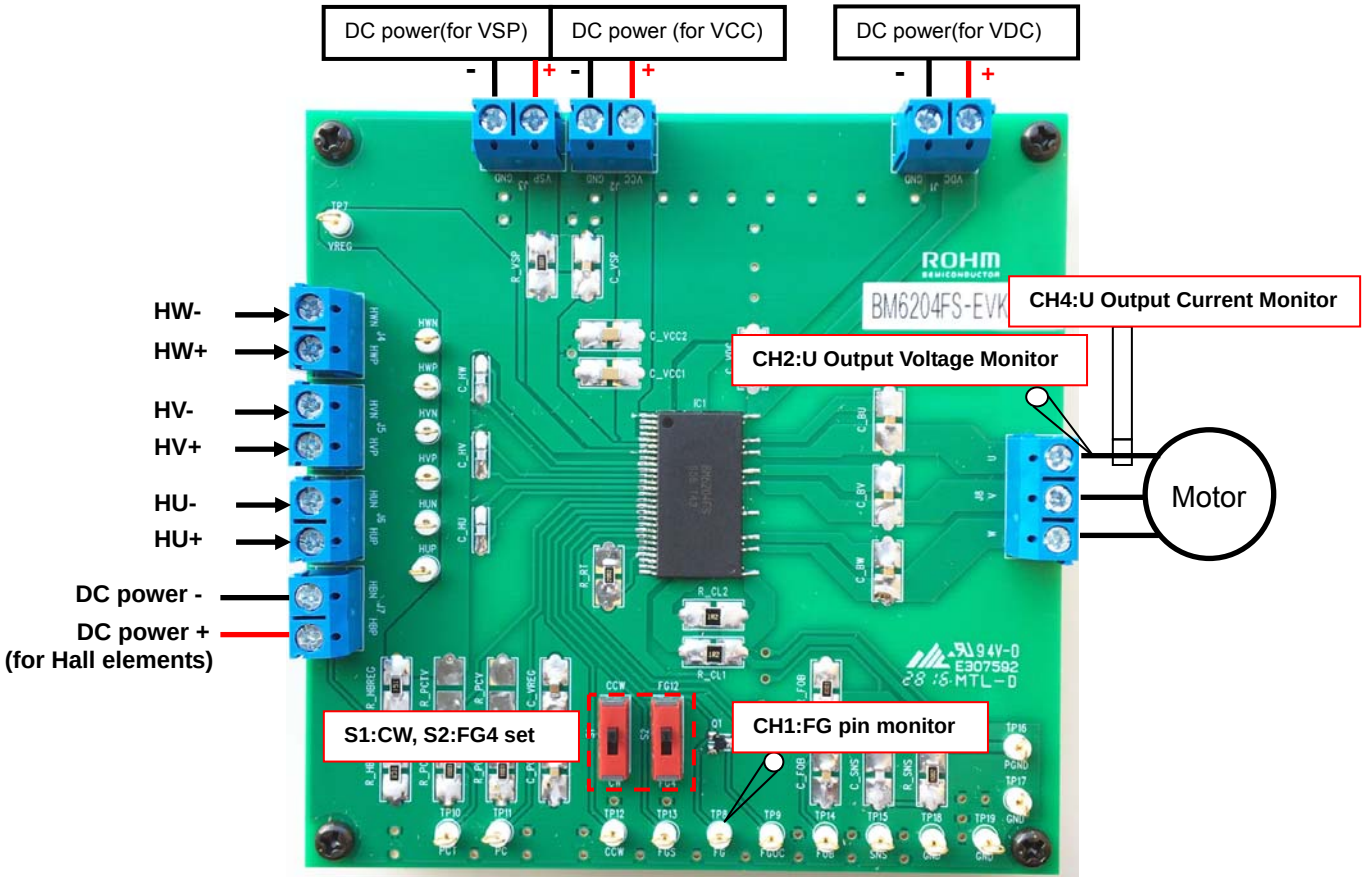

Figure 17. 150°wide-angle waveform Evaluation Board setting

Evaluation Board waveform

condition:VCC=15V, VDC=310V, VSP=2.8~3.2V (600rpm adjust), FGS=CCW=L (FG4pulse and CW rotate)

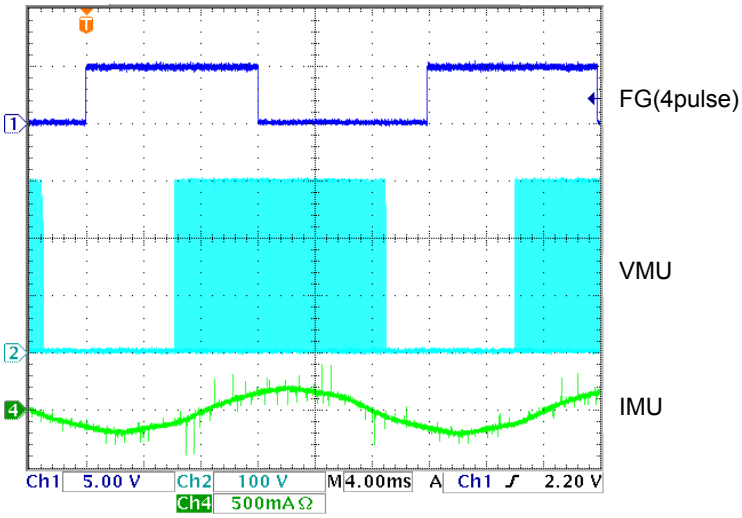

Figure 18. 180° sinusoidal waveform(BM6208FS, BM6209FS)

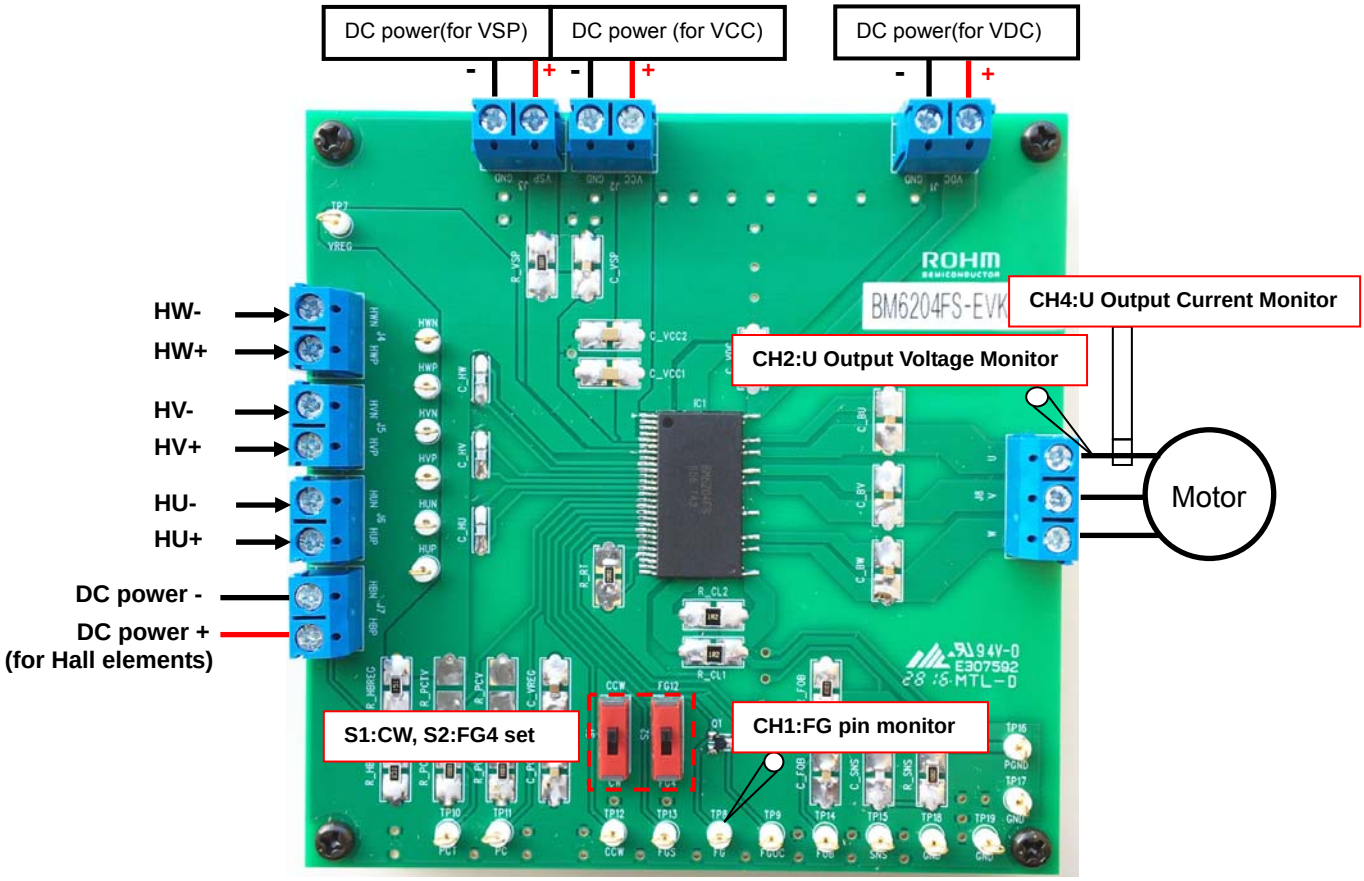

Figure 19. 180°sinusoidal waveform Evaluation Board setting

Revision History

Date	Revision	Changes
29.Aug.2016	001	New release

Notes

1) The information contained herein is subject to change without notice.

2) Before you use our Products, please contact our sales representative and verify the latest specifications :

3) Although ROHM is continuously working to improve product reliability and quality, semiconductors can break down and malfunction due to various factors.
Therefore, in order to prevent personal injury or fire arising from failure, please take safety measures such as complying with the derating characteristics, implementing redundant and fire prevention designs, and utilizing backups and fail-safe procedures. ROHM shall have no responsibility for any damages arising out of the use of our Poducts beyond the rating specified by ROHM.

4) Examples of application circuits, circuit constants and any other information contained herein are provided only to illustrate the standard usage and operations of the Products. The peripheral conditions must be taken into account when designing circuits for mass production.

5) The technical information specified herein is intended only to show the typical functions of and examples of application circuits for the Products. ROHM does not grant you, explicitly or implicitly, any license to use or exercise intellectual property or other rights held by ROHM or any other parties. ROHM shall have no responsibility whatsoever for any dispute arising out of the use of such technical information.

6) The Products are intended for use in general electronic equipment (i.e. AV/OA devices, communication, consumer systems, gaming/entertainment sets) as well as the applications indicated in this document.

7) The Products specified in this document are not designed to be radiation tolerant.

8) For use of our Products in applications requiring a high degree of reliability (as exemplified below), please contact and consult with a ROHM representative : transportation equipment (i.e. cars, ships, trains), primary communication equipment, traffic lights, fire/crime prevention, safety equipment, medical systems, servers, solar cells, and power transmission systems.

9) Do not use our Products in applications requiring extremely high reliability, such as aerospace equipment, nuclear power control systems, and submarine repeaters.

10) ROHM shall have no responsibility for any damages or injury arising from non-compliance with the recommended usage conditions and specifications contained herein.

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