LV8850GA

Recommended Operating Conditions at Ta = 25°C

Parameter	Symbol	Conditions	Ratings min	Ratings typ	Ratings max	Unit
Operating voltage	V_{CC}	V_{CC} pin		12		V
Operating supply voltage	V_{CCOP}	V_{CC} pin [2]	4		16	V
VG pin voltage range	V_G	VG pin (VCC+7V) [3]			21	V
Pin voltage range	V_L	SOSC, LIM, VCTL, PWMOSC, CSDOSC SOFTST, CTLSW, SYNSEL, F/R pin	0		VREG	V
Output current range	I_O	UL, VL, WL, UH, VH, WH pin	0		25	mA
Input PWM frequency range [4]	f(PWM)		20		60	kHz

[2]: When the voltage of VCC is reduced, the speed might not be controllable properly depending on settings.

[3]: For VG pin, be applied either VCC+7V or 21V, whichever is lower.

[4]: Make sure to adjust it according to External-FETs and types of Motor and maximum rotation speed.

Electrical Characteristics at Ta = 25°C, V_{CC} = 12V

Parameter	Symbol	Conditions	Ratings Min	Ratings typ	Ratings max	Unit
Supply current	I_{CC}	DC input mode, PWM=100%	7	10	13	mA
Internal oscillation circuit						
Oscillation frequency	f(MOSC)		8	10	12	MHz
Constant voltage output (VREG pin) [5]						
Output voltage1	V_{VREG}		3.6	4.0	4.2	V
Load fluctuation	ΔV_{REG}	Io = -5 to 0 mA			100	mV
Charge pump output (VG pin) [6]						
Output voltage	V_{VG}			Vcc+7		V
Output block						
On-resister of Upper-Tr in H-side	RONHH	Io=-10mA		25	40	Ω
On-resister of Lower-Tr in H-side	RONHL	Io=10mA		40	60	Ω
On-resister of Upper-Tr in L-side	RONLH	Io=-10mA		40	60	Ω
On-resister of Lower-Tr in L-side	RONLL	Io=10mA		25	40	Ω
VCTL amplifier (VCTL pin) at DC input mode (CTLSW pin=High)						
Input bias current	IB (CTL)		– 1		1	uA
Gain	G (CTL)			0.57		V/V
0% duty input voltage	VIN1 (CTL)		3.0	3.2	3.4	V
Max duty input voltage	VIN2 (CTL)		1.35	1.55	1.75	V
During direct PWM input (VCTL pin) at PWM input mode (CTLSW pin=Low)						
High level input voltage	VIH (PWM)	Out transistor ON	VREG – 1		VREG	V
Low level input voltage	VIL (PWM)	Output transistor OFF	0		1	V
Input mode select pin (CTLSW pin)						
High level input voltage	VIH(CTLSW)	DC input mode	VREG – 1		VREG	V
Low level input voltage	VIL(CTLSW)	PWM input mode	0		1	V
Internal PWM oscillator (PWMOSC pin)						
High level output voltage	VOH (PWM)		2.7	3.0	3.3	V
Low level output voltage	VOL (PWM)		1.75	2.0	2.25	V
Charge/ discharge current	I (PWM)	2.5V	±30	±45	±60	uA
Forward / Reverse switch (F/R pin) [7]						
High level input voltage	VIH (FR)	Energization: UOUT -> VOUT -> WOUT	VREG – 1		VREG	V
Low level input voltage	VIL (FR)	Energization: UOUT -> WOUT -> VOUT	0		1	V

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Parameter	Symbol	Conditions	Min	typ	max	Unit
Synchronous rectification switch (SYNSEL pin) [11]						
High level input voltage	VIH (SYN)	Synchronous rectification control is disabled	VREG – 1		VREG	V
Low level input voltage	VIL (SYN)	Synchronous rectification control is enabled	0		1	V
FG, RD output (FG pin, RD pin) [8]						
Low level output voltage	VFG	FG, RD pin. Io = 2mA			0.3	V
Maximum FG frequency [9]	f (FG)	[10]			600	Hz
Current limiter circuit (RF pin)						
Limiter voltage	VRF	RF = 0.2 ohm, limit current: 1.05A	0.18	0.21	0.23	V
Lock protection (CSDOSC pin)						
High level output input	VOH (CSD)		1.7	1.9	2.1	V
Low level output input	VOL (CSD)		0.25	0.40	0.55	V
Charge current	IC (CSD)		– 4.5	– 3.5	– 2.5	uA
Discharge current	ID (CSD)		0.25	0.35	0.45	uA
Ratio of charge and discharge	RI (CSD)		8	10	12	uA/uA
Internal Start-Up oscillator (SOSC pin)						
High level output input	VOH (SOSC)		0.9	1.1	1.3	V
Low level output input	VOL (SOSC)		0.45	0.60	0.75	V
Charge/ discharge current	I (SOSC)		±3.5	±5	±6.5	uA
SOFT start (SOFTS pin)						
SOFT start cancel voltage	VIH(STS)		0.9	1.2	1.45	V
SOFTS charge current	I(STS)		0.35	0.50	0.65	uA
Overheat protection circuit (thermal shutdown)						
Operating temperature	TSDON	Design guarantee [10]		160		deg.
Hysteresis temperature	∆TSD	Design guarantee [10]		20		deg.

*5: For VREG pin, it can be used for only internal and setting of this IC, not for power supply.

*6: For VG pin, be applied either VCC+7V or 21V, whichever is lower. And it can not be for power supply.

*7: Do not switch R/F pin during motor rotation. This may damage the IC and the motor.

*8: For FG, RD output pins, it is recommended to connect pull-up resistor between the pins and power supply of the controller.

*9: Be limited by External-FETs and types of Motor.

*10: Design guarantee: Signifies target value in design. These parameters are not tested in an independent IC.

*11: For heat reduction and higher efficiency, this IC uses synchronous rectification by setting the "SYSNSEL"-pin. However, it may increase supply voltage under usage conditions:

      * When output duty is reduced rapidly.
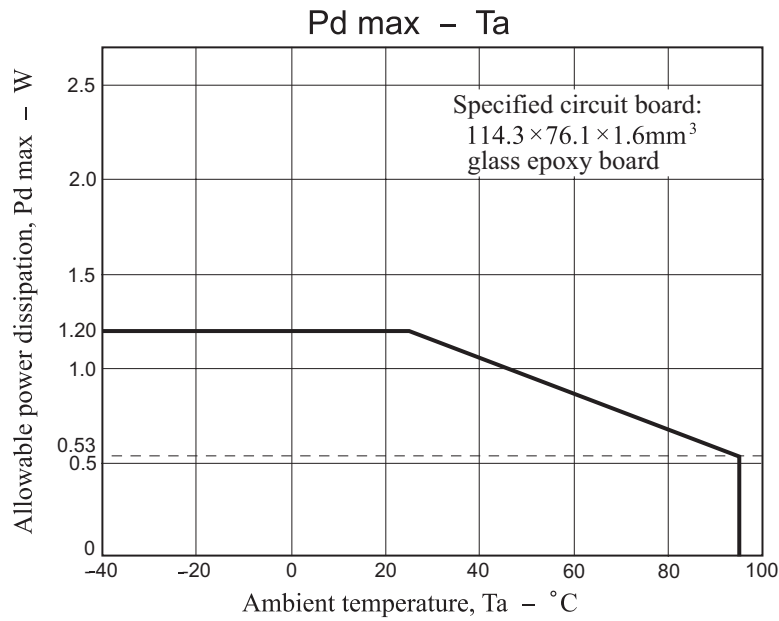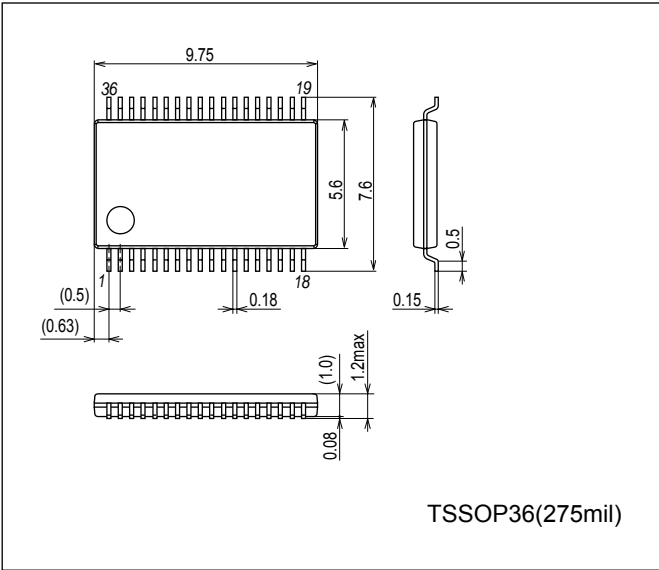
      * PWM input frequency is low. And other.

The above behavior depends on inserting a diode for protection against reverse connection, a bypass capacitor value between power supply and GND and FAN motor. Please confirm it enough. If the supply voltage shall increase, make sure that it does not exceed the maximum ratings with the following measures:

      *Select an optimal capacitor between power supply and GND.

      *Insert a zener diode between power supply and GND.

Package Dimensions

unit : mm (typ)
3253B

9.75

36 19

5.6
7.6

1 18

(0.5)
(0.63)
0.18

0.15

0.5

(1.0)
1.2max

0.08

TSSOP36(275mil)

Pd max – Ta

Allowable power dissipation, Pd max – W

2.5

2.0

1.5

1.20
1.0

0.53
0.5

0

Specified circuit board:
$114.3 \times 76.1 \times 1.6 mm^3$
glass epoxy board

−40   −20   0   20   40   60   80   100

Ambient temperature, Ta – °C

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Pin Assignment

Equivalent Circuit

Pin No.	Pin name	Equivalent Circuit
36 1 2	COM CIN FIL	
3	FG	
4	RD	
5 6	TGND TGND2	
7	SOSC	

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Pin No.	Pin name	Equivalent Circuit
8 9	LIM VCTL	
10	PWMOSC	
11	CSDOSC	
12	SOFTST	
13	SGND	
14	VREG	
15	VCC	

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Pin No.	Pin name	Equivalent Circuit
16 17 18 19 20	CP1 CPC1 CPC2 CP2 VG	
21 22 23	CTLSW SYNSEL F/R	
24 25	RFGND RF	
26	PGND	
27 29 31	WL VL UL	
28 30 32	WH VH UH	
33 34 35	WOUT VOUT UOUT	

No.A2205-7/14

Pin Functions

| Pin No.	Pin name	Function
1	CIN	Filter pin for motor position detection comparator. Make sure to connect a capacitor between FIL (PIN2) and CIN.
2	FIL	Filter pin for motor position detection comparator. Make sure to connect a capacitor between CIN (PIN1) and FIL.
3	FG	FG pulse output. Outputs pulse equivalent to 1 hole. Synchronizes with U-phase.
4	RD	Motor lock detection output. Outputs high level voltage when the motor is locked. Auto-recovery lock protection circuit.
5 6	TGND TGND2	Test pin. Connect to SGND.
7	SOSC	Setting pin for motor startup frequency. Make sure to connect a capacitor between SOSC and GND. Adjusts startup frequency according to charge/discharge current and the capacitor.
8	LIM	Voltage input for setting the lowest speed during DC control signal input mode. By dividing the regulator voltage with resistance and inputting the voltage (1 < LIM < 3V), you can set the lowest speed for the motor.
9	VCTL	Motor control voltage input. VCTL functions as DC control signal input pin and PWM control input signal input pin. CTLSW (PIN21) switches between DC input and PWM input.
10	PWMOSC	Reference frequency setting for PWM switching. Make sure to connect a capacitor between PWMOSC and GND. You can set a carrier frequency for PWM switching during DC control signal input mode by adjusting the capacitor.
11	CSDOSC	Setting pin for motor lock detection time. Make sure to connect a capacitor between CSDOSC and GND. You can set time to start lock protection operation by adjusting the capacitor.
12	SOFTST	Setting pin for soft start time. By connecting a capacitor between SOFTS and GND, you can start up the motor smoothly.
13	SGND	GND for the IC.
14	VREG	Regulator voltage output (4V). Make sure to connect a capacitor between VREG and GND. You cannot supply power outside the IC.
15	VCC	Supply for the IC. Make sure to connect a capacitor between VCC and GND.
16	CP1	Charge pump: pulse output for the 1st stage booster. Make sure to connect a capacitor between CP1 and CPC1 (17PIN).
17	CPC1	Charge pump: a pin for the 1st stage booster. Make sure to connect a capacitor between CPC1 and CP1 (PIN16).
18	CPC2	Charge pump: a pin for the 2nd stage booster. Make sure to connect a capacitor between CPC2 and CP2 (PIN19).
19	CP2	Charge pump: pulse output for the 2nd stage booster. Make sure to connect a capacitor between CP2 and CPC2 (PIN18).
20	VG	Charge pump: output for booster voltage. Make sure to connect a capacitor between VG and GND.
21	CTLSW	Switching pin for control input signal. CTLSW= "High": DC control signal input mode CTLSW="Low", PWM control signal input mode Configuration should be performed according to control method.
22	SYNSEL	Switching pin for synchronous rectification operation. SYNSEL="High": Stop SYNSEL="Low": Enable
23	F/R	Switching pin for motor rotation direction. The order of energization to the motor is as follows: "High" input: U→V→W "Low" input: U→W→V By changing the order, rotation direction is switched. Do not switch operation while the motor is driving.

Continue from the former page

| Pin No.	Pin name	Function
24	RFGND	GND for RF sensing for drive current detection. By connecting RFGND to RF (PIN25), drive current is detected with high precision.
25	RF	RF sensing for drive current detection. By connecting RF to RFGND, drive current is detected.
26	PGND	GND for the IC.
27 29 31	WL VL UL	Low-side pre-driver outputs. Make sure to connect Nch-Tr gate for motor drive to each pin. They outputs drive signal for the sink.
28 30 32	WH VH UH	High-side pre-driver outputs. Make sure to connect Nch-Tr gate for motor drive to each pin. They outputs drive signal for the source.
33 34 35	WOUT VOUT UOUT	Detection pin for motor back EMF voltage. Make sure to connect them to each phase of U,V,W of the motor.
36	COM	Connection pin for motor midpoint.

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Block Diagram

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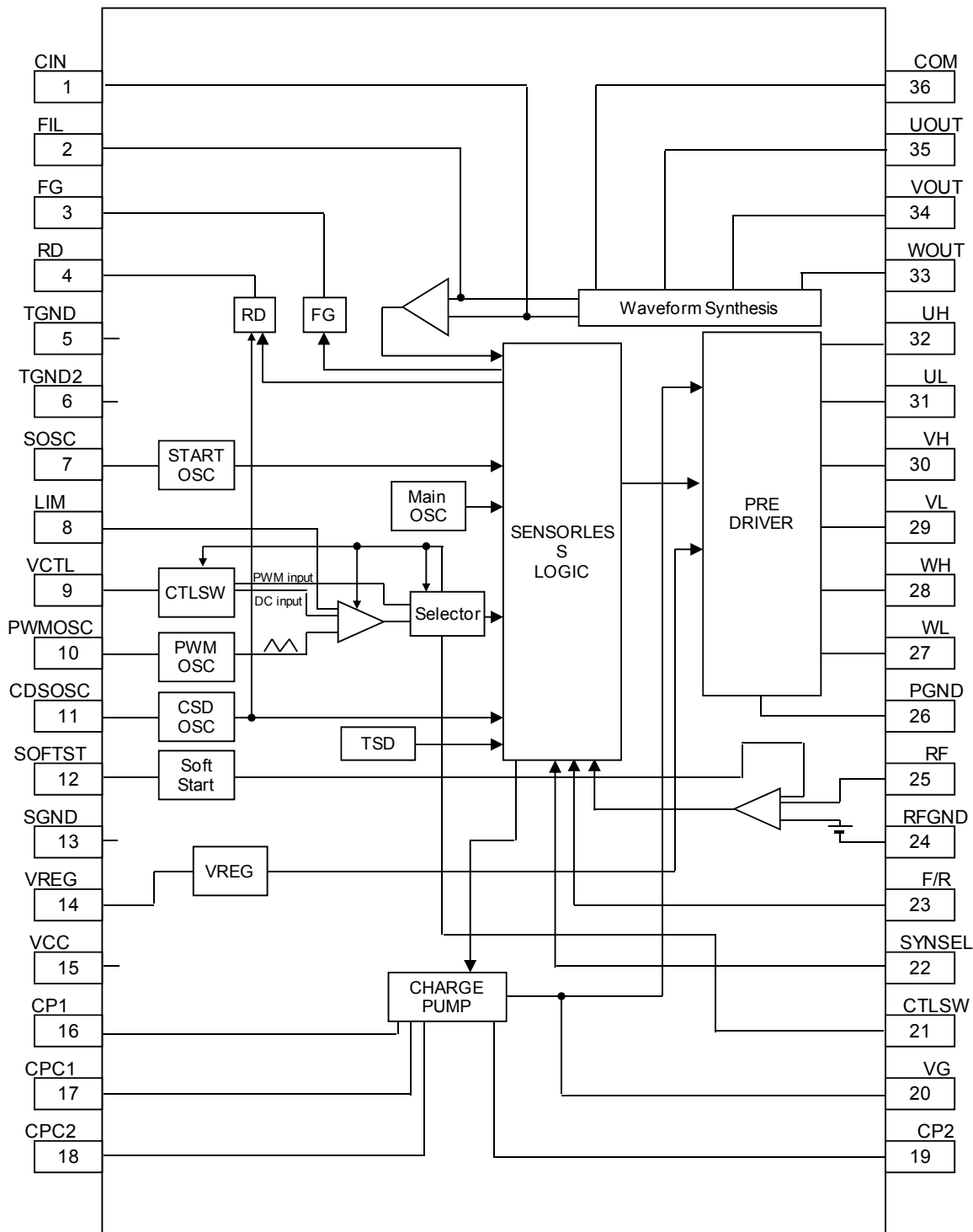
Application Circuit Example

* Each fixed number in the following FIG. is the referential value. Make sure to adjust it according to External-FETs and types of Motor.
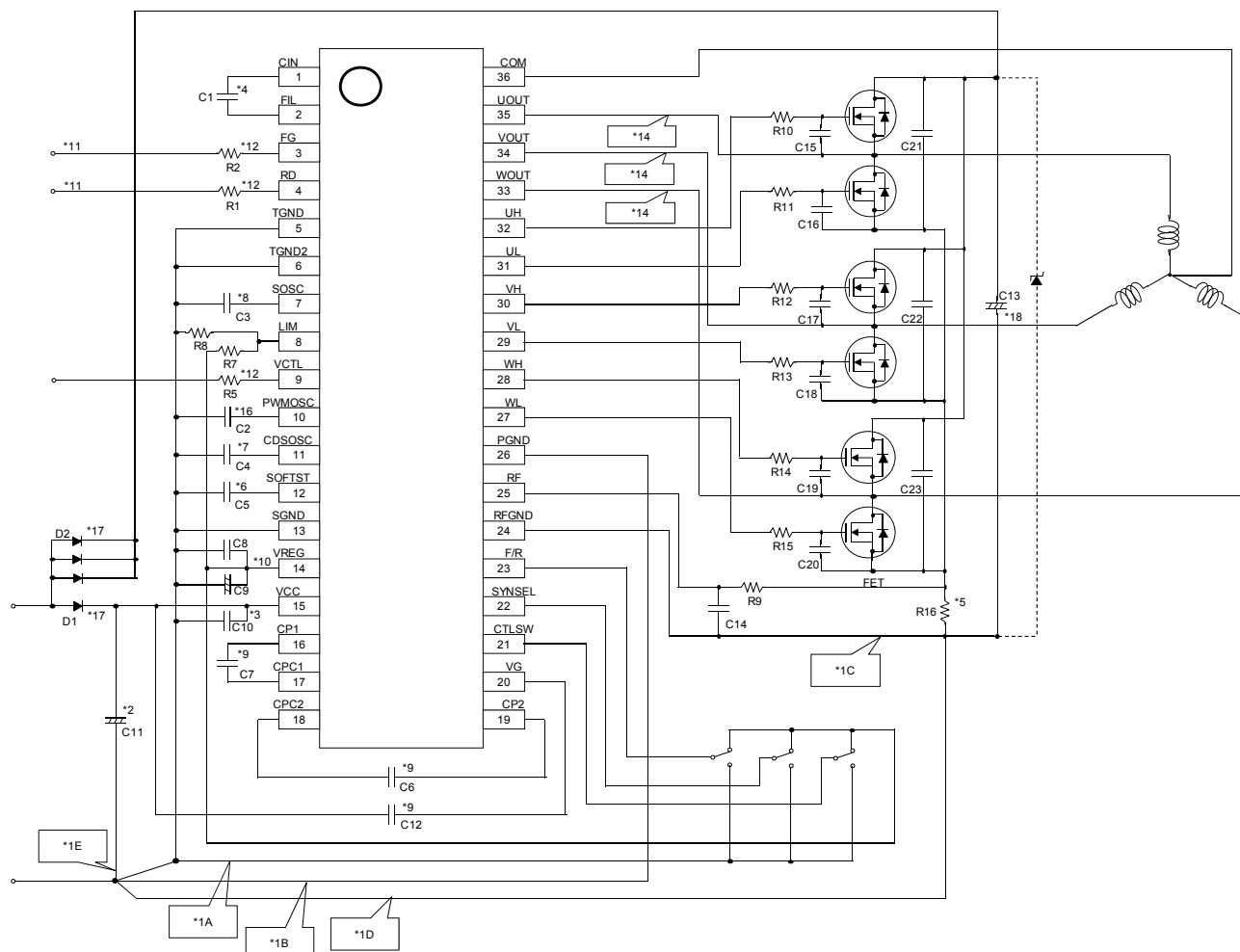
C1	1000pF	B-EMF detection filter	C14	470pF	RF filter
C2	470pF	PWM oscillator	C15	220pF	FET
C3	1000pF	Start-Up oscillator	C16	220pF	FET
C4	2.2uF	Lock-detection time	C17	220pF	FET
C5	2.2uF	Soft Start time	C18	220pF	FET
C6	0.15uF	Charge pump	C19	220pF	FET
C7	0.15uF	Charge pump	C20	220pF	FET
C12	0.47uF	Charge pump	C21	0.1uF	FET
C8	0.47uF	VREG	C22	0.1uF	FET
C9	10uF	VREG	C23	0.1uF	FET
C10	0.1uF	VCC	C13	33uF	VM
C11	47uF	VCC			
R1	100 Ω	RD	R9	510 Ω	RF filter
R2	100 Ω	FG	R10	330 Ω	FET, gate resistor
R3	100k Ω	RD	R11	510 Ω	FET, gate resistor
R4	100k Ω	FG	R12	330 Ω	FET, gate resistor
R5	100 Ω	Input signal	R13	510 Ω	FET, gate resistor
R7	100k Ω	LIM	R14	330 Ω	FET, gate resistor
R8	100k Ω	LIM	R15	510 Ω	FET, gate resistor
			R16	0.2 Ω	RF resistor
D1	DSE010		FET	NTMD5836	Nch / Nch
D2	DSP10				

A value of these circuit fixed number is one example. Make sure to adjust it according to External-FETs and types of Motor.

*1A, *1B, *1C, *1D, *1E .<GND line>
 GND is classified as follows: SGND, PGND RFGND and MGND.
   SGND (*1A) : Small-signal (VREG4, TGND, TGND2, PWMOSC, SYNSEL, CTLSW, SGND, VCTL,
                   LIM, SOFTS, F/R, CSDOSC, SOSC)
   MGND (*1B) : Middle-signal (PGND)
   PGND (*1D) : Power-signal (GND-side of RF-resistor, GND-side of bypass-capacitor for a Motor)
   RFGND (*1C) : Sensing-signal (RFGND)
 When design a PCB layout, SGND(*1A), MGND(*1B) and PGND(*1D) should be connected at a single GND with a capacitor (power supply stabilizer capacitor(*1E)) between VCC and GND.
 Power supply and GND should be connected as wide and short as possible. RFGND should be connected near the resistance which should be lined separately from the other GND line.

*2.<Power supply stabilizer capacitor for power stabilization>
 Power supply stabilization capacitor(C11) should be 10uF or higher.

*3.<Noise rejection capacitor>
 Noise rejection capacitor(C10) should be connected as short as possible.

*4.<CIN, FIL pin>
 Connection pin for filter capacitor. LV8850 detects rotor position using back-EMF (electromotive force) which is generated during rotation of the motor. Based on the information, energization timing for output pins are defined. Problems in startup due to noise can be improved by connecting a filter capacitor (C1) between CIN and FIL.
 If the capacitance is too high, energization timing of the output during high-speed rotation is delayed and efficiency is degraded. Make sure to connect capacitor between COMIN and FIL as short as possible to reject noise.

*5.<RF pin>
 Setting pin for current limiter. When pin voltage is higher than 0.21V, current is limited and recirculation mode is set. In the example of application circuit, current limiter is set at 1A. RF resistance (R16) is calculated as follows:
   RF resistance = 0.21V/ desired current limit value.
 If detection precision of current limit is low due to noise, make sure to insert a filter (R9, C14) between RF and RFGND.

*6.<SOFTST pin>
 Setting pin for soft start. Motor rotation count increases gradually by connecting a capacitor (C5) between SOFTST pin and SGND. The period of Soft-Start is calculated approximately as follows:
   Period of Soft-Start ≈ Capacitor value / 380 × 10-9
   ex) In the case of Capacitor value = 2.2uF,
         Then Period of Soft-Start ≈ 5.8s

*7.<CSDOSC pin>
 Capacitor connection pin for lock detection. It integrates constant current charger, constant current discharger circuit. Lock protection time can be modified by connecting capacitor (C4) between CSDOSC and SGND. When it isn't used, then make sure to connect to SGND. The Period of Start-Up and Lock is calculated approximately as follows:
   Period of Start-Up ≈ Capacitor value * 0.43 × 106
   Period of Lock ≈ Capacitor value * 4.29 × 106
   ex) In the case of Capacitor value = 2.2uF,
         Then Period of Start-Up ≈ 0.9s
              Period of Lock ≈ 9.4s

*8.<SOSC pin>
 Capacitor connection pin for setting startup frequency. Make sure to connect a capacitor (C3) between SOSC and SGND. The capacitor is required for SOSC pin to define frequency to start up motor.
 Also make sure to confirm constant when you change motors or circuit specification because optimum value changes according to startup condition. The Frequency of SOSC is calculated approximately as follows:
   Frequency of SOSC ≈ 5 × 10-6 / Capacitor value
   ex) In the case of Capacitor value = 1000pF,
         Then Frequency of SOSC ≈ 5kHz

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*9<VG,CP1,CPC1,CP2,CPC2 pin>
 Capacitor connection pin for pre-drive voltage generation and pre-drive power supply stabilizer. Make sure to connect capacitor to the pins because they generate voltage to drive upper output DMOS transistor. The layout should be as wide and short as possible.

*10.<VREG pin>
 Power supply pin for the internal control block. Regulator output pin to generate power supply for the control circuit. Make sure to connect capacitor (C8, C9) between VREG and SGND to stabilize operation of the control block. Make sure to connect the capacitor with greater capacitance than the one connected to the charge pump because it is used for power supply to the control block and to generate charge pump voltage.

*11.<FG/RD pin>
 Since FG, RD output are open-drain, it is recommended to connect pull-up resistance between FG and RD and the power supply for the controller.

*12.<Noise rejection resistor>
 Make sure to implement resistance (R1, R2, R5) for protection because the line is easily influenced by noise.

*14.<UOUT,VOUT,WOUT,COM pin>
 Back EMF detection pins. Make sure to line the pins as short as possible without crossing with the other lines.

*15.<VCTL pin>
 Make sure not to open.

*16.<PWMOSC pin>
 Capacitor connection pin for setting PWM frequency. When it is the "DC control signal input mode", make sure to connect a capacitor (C2) between PWMOSC and SGND as short as possible. When it is the "PWM control signal input mode", make sure to be open.
 Also make sure to confirm constant when you change motors or circuit specification because optimum value changes according to motor rotation speed. The Frequency of PWM is calculated approximately as follows:

   Frequency of PWM $\approx 23 \times 10\text{-}6$ / Capacitor value
   ex) In the case of Capacitor value = 470pF,
       Then Frequency of PWM $\approx$ 49kHz

*17.<Separation of power supply>
 Make sure to insert a diode to prevent the inverted-current from a motor.

*18.<Protection of VM (power supply for a motor)>
 When the motor power supply voltage (VM) abnormally rises by environment to use, please insert a Zener diode between a motor power supply and motor GND.

ORDERING INFORMATION

Device	Package	Shipping (Qty / Packing)
LV8850GA-AH	TSSOP36 (275mil) (Pb-Free / Halogen Free)	1000 / Tape & Reel