21C, for World geared motor!

BLDC MOTOR

SPG Co., Ltd.

BLDC MOTOR

Coding System

DC BRUSHLESS MOTOR

DL – 88 4 30 LG I A

- DL : DC Input DC Brushless (ADL : AC Input DC Brushless)
- 88 : Stator core Diameter
- 4 : Magnet pole
- 30 : Stack
- LG : Company
- I : SET Ex) I : Air Conditioner for Interior, O : Air Conditioner for Exterior, W : Washing, E : Refrigerator evaporator, P : Printer
- A : SERIAL NO

Exception	7806	7	⇨	Stator Diameter (ø76)
	89812	89	⇨	Stator Diameter (ø88)
	82412	82	⇨	Stator Diameter (ø83)
	5905	59	⇨	Stator Diameter (ø58)

DC BRUSHLESS GEARED MOTOR

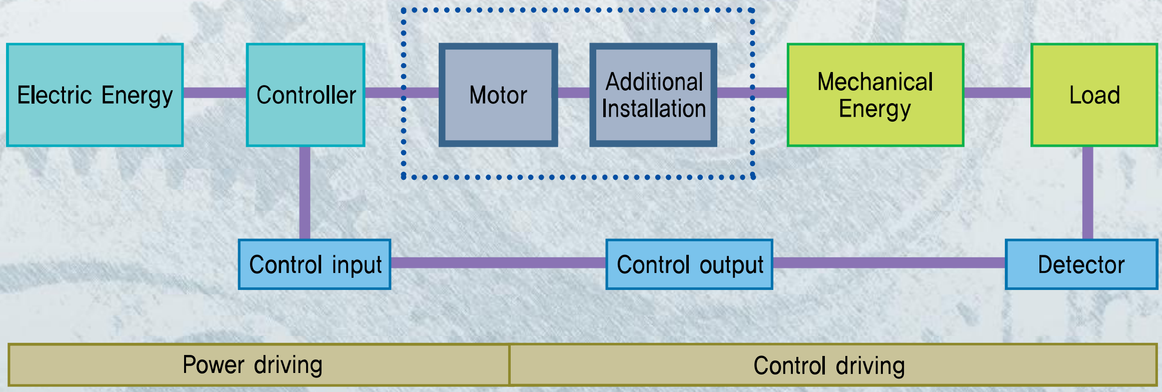
DLG – 45 8 13 KX P A

- DLG : DC Input DC Brushless (ADL : AC Input DC Brushless)
- 45 : Stator core Diameter
- 8 : Magnet pole
- 13 : Stack
- KX : Company
- P : SET Ex) W : Washing, E : Refrigerator evaporator, P : Printer
- A : SERIAL NO

Motor definition

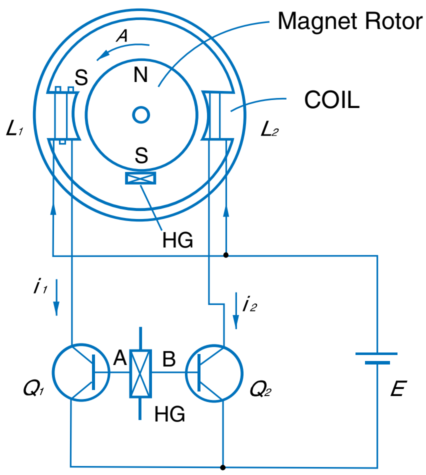
(1) Motor definition : Electric Energy conversion to Mechanical Energy By magnetic field effect, electric energy converted to rotation or linear movement . Energy conversion device.

(2) Motor Function : Function to convert Electric Energy to Mechanical Energy
Output Control With the controller, torque converted.



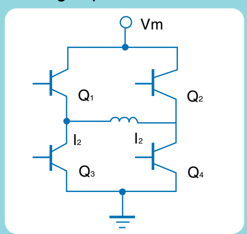
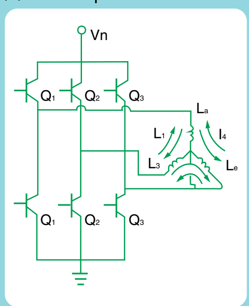
BLDC Motor driving method

For the reference of using Hall Sensor, maximummagnet flux move to S-pole of Rotor magnet and output generated to A side then TR Q_1 electrified, Coil L_1 being Magnetization, it send the electricity to i_1 direction. By Flaming's Rule , S-pole form in right side of L_1, Rotor magnet 's S-pole push and N-pole pull 180 degree rotation, so S-pole of Magnet become more distance as well as magnetic flux sensing being gone.(No out-put of A and B). However in case of N-pole getting closed to Hall Sensor by magnet inertia, N-pole having maximum magnetization, it make B side power, TR Q_2 electrified and Coil L_2 magnetization.
And Current flow to i_2 side, S-pole form in left side of L_2, finally S-pole of Rotor magnet push and N-pole pull 360 degree rotation.

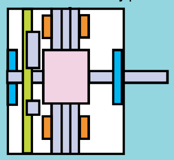
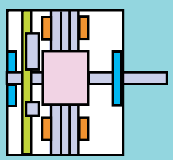
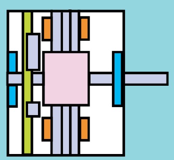


BLDC Motor Category

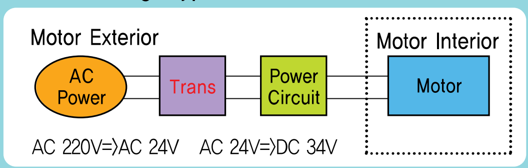
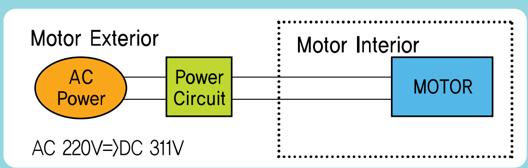
1) Classification by Driving Method

Classification	Circuit composition	Strong Point	Weak Point
(1) Single phase 	Switching 2 TR operation 1 Sensor or 2 Sensors Twice Slot Simple Circuit composition	Simple Circuit composition- Low Cost	Caulking torque high. Efficiency low. Starting torque low. Disadvantage for Noise and Vibration. Fluctuation range of rotation high. Disadvantage on low driving.
(2) Three phase 	Switchin 6 TR operation 2 Sensors or 3 sensors Three times of Slot Complicated circuit	Caulking torque low. Efficiency high. Starting torque high. Advantage for Noise and Vibration. Fluctuation range of rotation low. Advantage on low driving. Miniaturization. Variety range of counter-measure of control specification.	Complicated circuit- High Cost

2) Classification by driving circuit position

Classification	Hall sensor	Drive circuit	Lead wire
(1) Circuit built-in type 	Interior disposition	Interior disposition	* Single phase : Basic double line + α (VM, Gnd) * Three phase : Basic triple line + α (VM, Vc, Gnd) * Connection of interior pcb pattern
(2) Circuit exterior type 	Interior disposition	Exterior disposition	* Exterior : Basic 8 lines (Vc,Gnd,W1,W2,W3, H1,H2,H3)
(3) Circuit exterior type 	None	Exterior disposition	* Exterior : Basic triple line + α (W1,W2,W3)

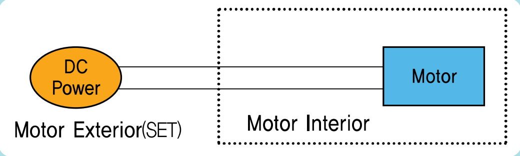
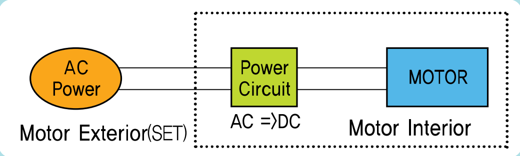
3) Classification by DC input voltage

Classification	Characteristic
(1) DC low-voltage type 	* Motor driving power(DC power) to be supplied to Motor input part directly, VM power under 60V. * Voltage range : Generally 10~60V
(2) DC high-voltage type 	* Motor driving power(DC power) to be supplied to Motor input part directly, VM power over 60V * Voltage range : Generally 60~350V * High drive composition cost, high wiring labor cost

■ DC power specification

Classification	VM	Vc	Gnd	Vsp	Etc
Classification	24V Variable	12V fix	-	-	FG, CW/CCW
Application(High-voltage)	140/310V Variable	15V fix	-	0 ~ 6V	FG, CW/CCW
Application(High-Voltage / Control)	140/310V Variable	15V fix	-	0 ~ 6V	FG, CW/CCW
Power supply sequence	3	2	1	4	

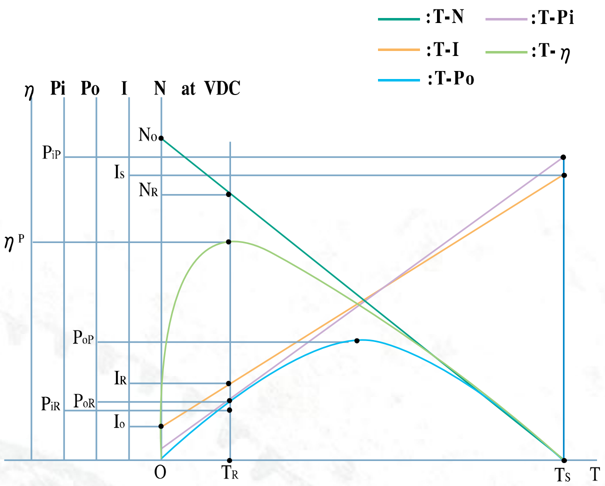
4) Classification by Input Power

Classification	Characteristic
(1) DC/DC 	* Motor driving power(DC power) to be supplied to Motor input part directly : Single phase, three phase * In this case, AC powerRectification(Stabilization), power factor)DC power
(2) AC/DC 	* AC power supplying to Motor input part and power rectified by DC, DC power move the motor : Single phase, three phase * In this case, Set supplied by AC power Inside of Motor, Rectification(Stabilization), power factor) DC power

Strong and weak point of BLDC Motor

Classification	AC MOTOR	BLDC MOTOR
Rpm	No available rpm performance on condition by over synchronous speed * 2 Pole, 60Hz : 3600 rpm Instability motor driving level condition by low driving	Available Rpm performance over synchronous speed * No limitation of Pole and frequency Stable driving performance under low-speed.
Control performance	The Performance is not in proportion * Phase control, Tap Control, etc Needed additional rpm control function (FG)	Relative performance-Good condition of control capability * Voltage control and Current control, etc No Needed additional rpm control function (FG)
Efficiency	Average 10~50%	Average 40~60%
Drive circuit	Not necessary	Necessary(Driving circuit)
Starting specification	T-N-I curve, Driving performance is relatively low.	Linear characteristic of T-N-I, Good condition of driving performance
Configuration	Relatively large dimension on same performance	Compact possible
Cost	Low	High

BLDC Motor Characteristic curve



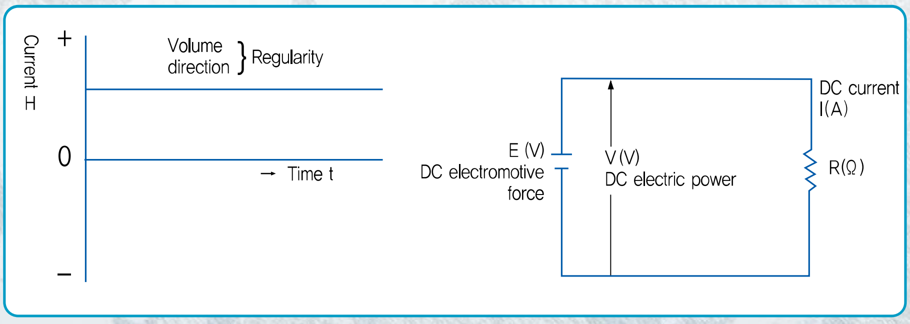
N : Revolution(rpm) T : Torque(kg.cm) I : Current(A) Po : Output(W) Pi : Input(W) η : Efficiency(%)	N_O : No load revolution(rpm) N_R : Rated load(peak efficiency)revolution(rpm) T_R : Rated load(peak efficiency)Torque(kg · cm) T_S : Locking Torque(kg · cm) I_O : No load current(A) I_R : Rated load(peak efficiency)current(A) I_S : Locking Torque(A) P_{OP} : Peak output(W) P_{OR} : Rated load(peak efficiency)output(W) P_{iP} : Peak input(W) P_{iR} : Rated load(peak efficiency)input(W) η_P : Peak efficiency(rated load)
$Po = N \times T \times 1.027 \times 10^{-2}$ $Pi = I \times V$ $\eta = Po / Pi \times 100$	$P_{OP} = (T_S/2) \times (N_O/2) \times 1.027 \times 10^{-2}$ $P_{OR} = T_R \times N_R \times 1.027 \times 10^{-2}$ $P_{iP} = I_S \times V$ $P_{iR} = I_R \times V$ $\eta_P = P_{OR}/P_{iR} \times 100$

BLDC Motor-Related Terms

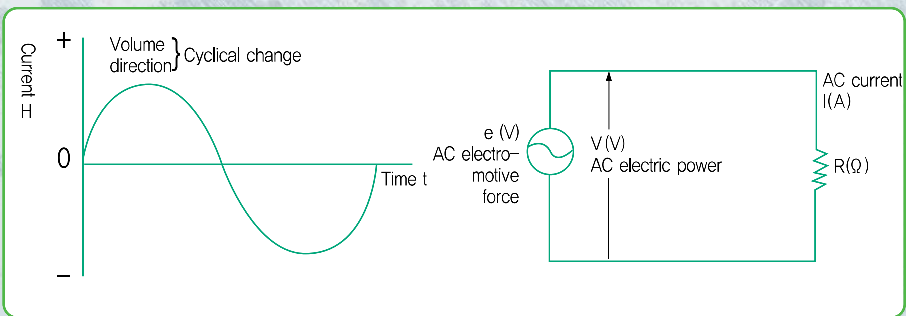
(1) Rated Voltage : Real voltage to motor driving, specified performance range
Voltage increase and decrease affect on the temperature increase and torque decrease

(2) DC(Direct Current) & AC(Alternate Current)

a. DC (Direct Current) : Stable DC volume and direction on time



b. AC(Alternate Current) : Cyclical change of AC volume and direction on time



(3) Rating : The specified requirements and the limit under rating design condition.
a. Continuous Rating : Continuous operation under the specified conditions.
b. Intermittent Rating : Specified period of time under the specified conditions.
c. Interactive Rating : Cyclic operations of stopping and running with certain load.

(4) Torque : Turning Effect
a. Starting Torque : Torque of motor starting
b. Stalling Torque : Maximum Torque under by rated motor condition
c. Rated Torque : Continuous torque having the rated out-put under by motor rated condition.

(5) Torque constant : No magnetic flux change during motor rotation in case of using permanent magnet.
Torque is in proportion to only Input current. $T = Kt \times I$
Kt(Numerical formula) is torque constant.

(6) Reversible electromotive force constant : Reversible Electromotive force(E) is in proportion to Motor rotation speed (W),
But inverse proportion to Terminal voltage(V)
The formula $E = Ke \times \omega$ (Ke : Reversible electromotive constant)

(7) Speed
a. Synchronous speed : Motor speed(An alternating current) designed by pole number and Electricity frequency.
$Ns = (120 \times f) / P$ Ns : Synchronous speed (rpm) f : Electricity frequency (Hz) P : Pole
b. No-Load rotation speed : Under condition of No-Load is imposed on the output axis.
c. Rated rotation speed : Motor rotation with rated output.

(8) Output : Motor capability to rotation by unit period.(The power originated by shaft)
a. 1 [W] = 1 [J/s] = 1 [N · m/s] = 1/9.8 [kgf · m/s], 1HP : 746W
b. Torque T [N · m] = (Po×9.8) / (N×1.027)
b. Rated Output : The rated Voltage of Motor, rated frequency, rated rpm, rated torque on the condition of the optimized specification

(9) Input : Input (Voltage × Current) is total amount of electric energy and loss needed to motor running. (W : Watt)
a. In case of direct current : $Pi = V \times I$ [W]
b. In case of single-phase current : $Pi = V \times I \times \cos \Phi$ [W]
c. In case of three-phase current : $Pi = \sqrt{3} \times V \times I \times \cos \Phi$ [W]

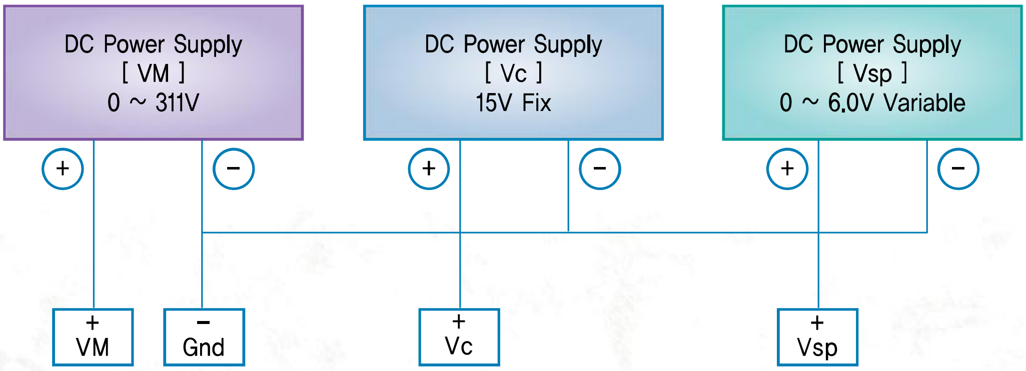
(10) Efficiency : The ratio of Input and Output Efficiency(%) = (Output / Input)×100, Efficiency(%) = {(Input − Loss) / Input}×100,
Efficiency(%) = {Output / (Output + Loss)}×100

(11) Loss : Inefficiency factor being changed by heat, vibration and noise
a. Mechanical reason
- Coil damage : Coil Heat loss by Coil resistance
- Core damage : Hysteresis loss and over current loss.
- Mechanical loss : Friction loss (Bearing and Shaft, etc) and windage (Friction loss of rotation object in air)

a. Loss by Load and No-Load
★No – Load loss : Current loss under by no-load (Core and mechanical)
- Core loss : Loss by fixed iron core
- Eddy Current Loss
- Coil damage : Loss of wiring resistance between fixture and rotor- Heat loss (I^2×R)
- Mechanical loss : Friction and windage
★Load loss : Heat loss by coil demage

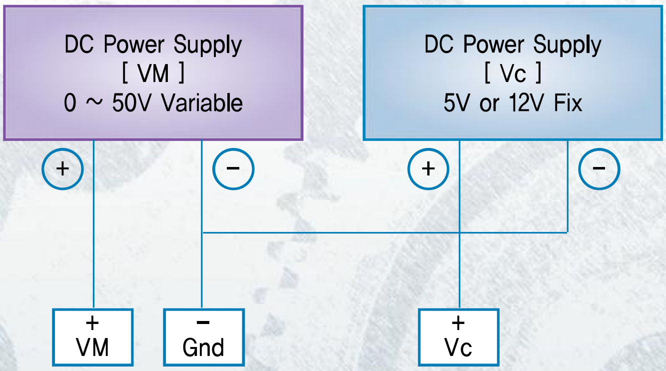
Test Method(General Specification) of BLDC Motor

1. High-Voltage application (Air-conditioner/Air-purifier/Pump)



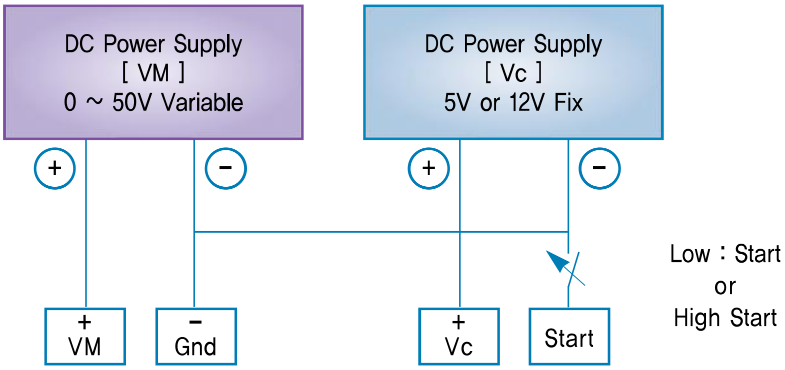
① Ground of VM,Vc and Vsp DC power supply make in common with
② The Control lever of DC Power supply for VM,Vc,Vsp adjust 0(V)
③ DC Power supply for VM and Vc powered on.
④ The control lever of DC supply for Vcc adjust 15V.
⑤ The control lever of DC Power supply for VM adjust 311V .
⑥ The voltage is adjusted by the control lever for Vsp.

2. Low-Voltage application (Air-conditioner/Gas Boiler etc.)



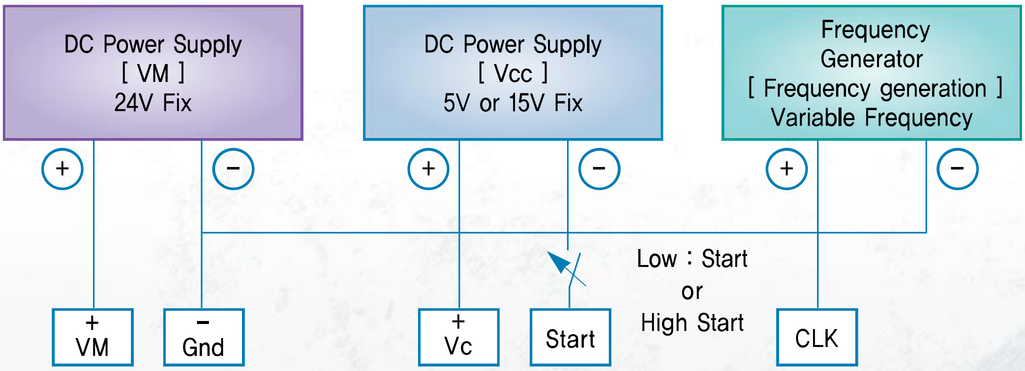
① Ground of VM,Vc DC power supply make in common with.
② The Control lever of DC Power supply for VM,Vc adjust 0(V).
③ DC Power supply for VM and Vc powered on.
④ The control lever of DC Power supply for Vcc adjust 12/5V.
⑤ The control lever of DC POWER SUPPLY for VM adjust Rated Voltage.

3. Fax machine application (Interior oscillation)



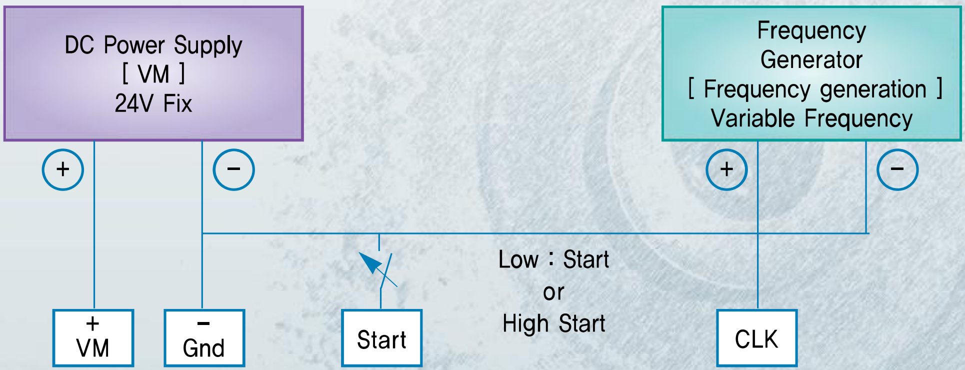
① Ground of VM, Vc DC Power Supply make in common with..
② The Control lever of DC Power Supply for VM, Vc adjust 0(V).
③ DC Power supply for VM and Vc powered on.
④ The control lever of DC Supply for Vcc adjust 5V.
⑤ The control lever of DC Power Supply for VM adjust rated voltage.

4. Fax machine application (Exterior oscillation)



① Ground of VM, Vc DC Power Supplyand Frequency generator make in common with.
② The Control lever of DC Power Supply for VM, Vc adjust 0(V).
③ DC Power Supply for VM, Vc and Frequency generator powered on.
④ The control lever of DC Supply for Vcc adjust 5V.
⑤ The control lever of DC Power Supply for VM adjust 24V.
⑥ Adjust the frequency and voltage by the control lever of Frequency generator.

5. Fax machine application (Exterior oscillation 2)



① Ground of VM DC Power Supply and Frequency generator make in common with.
② The Control lever of DC Power Supply for VM adjust 0(V).
③ DC Power Supply for VM and Frequency generator powered on.
④ The control lever of DC Supply for VM adjust 24V.
⑤ Adjust the frequency and voltage by the control lever of Frequency generator.