Vector Controller (FOC) for BLDC Motors

Field-Oriented Control (FOC) is an important technology for motor systems, particularly those using permanent magnets (PM). In general, FOC provides an efficient way to control BLDC motor in adjustable speed drive applications that have quickly changing loads, and can improve the power efficiency of an AC induction motor, especially at lower speeds. For this reason, some designers mistakenly associate FOC for use only with AC motors. While it is true that today's brushless DC (BLDC) motors tend to very efficient, up to 96 percent even without FOC, the value FOC brings to these systems is reduced torque ripple, resulting in smoother motor performance and quieter operation.

In simple terms, FOC is a motor control technique where the system is trying to orient the stationary or "stator" flux vector to a specific degree relative to the rotor flux vector (see Figure 1). The optimal degree of orientation depends upon what characteristic of the motor needs to be maximized. The most common use of FOC is to maximize the motor's torque per amp. This is achieved when the stator flux vector is 90 degrees to the rotor flux vector unless the motor has a variable reluctance, such as a motor with a magnet buried inside it. In this case, the degree of orientation is typically 115 to 120 degrees.

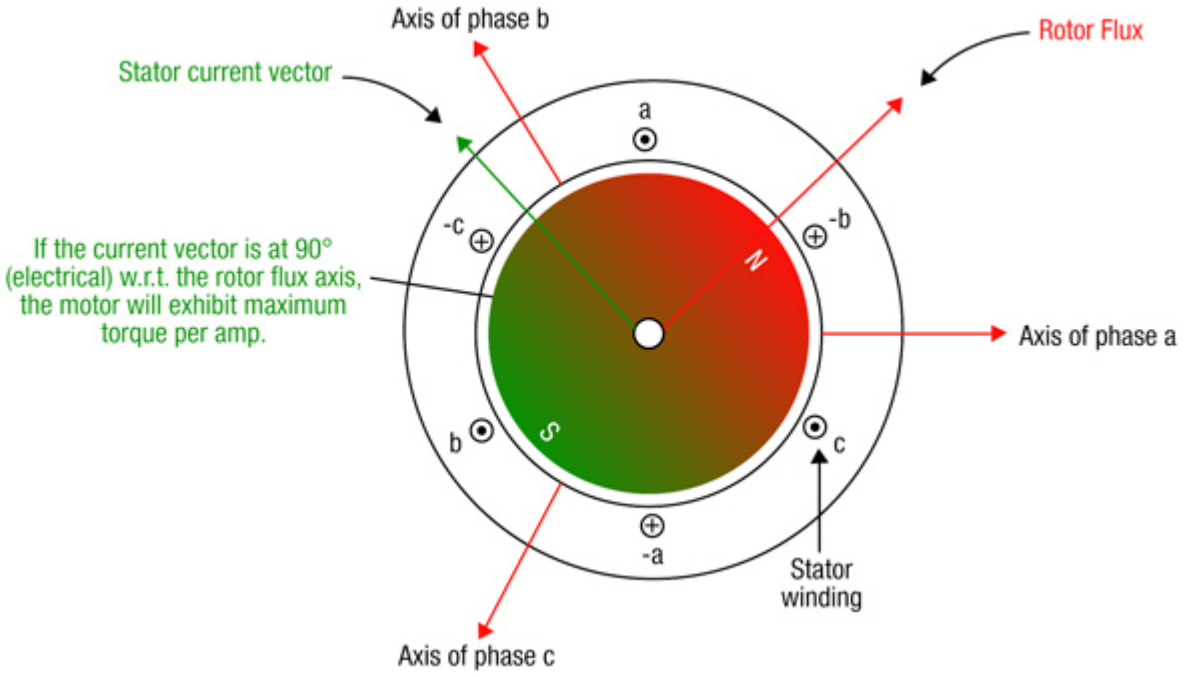


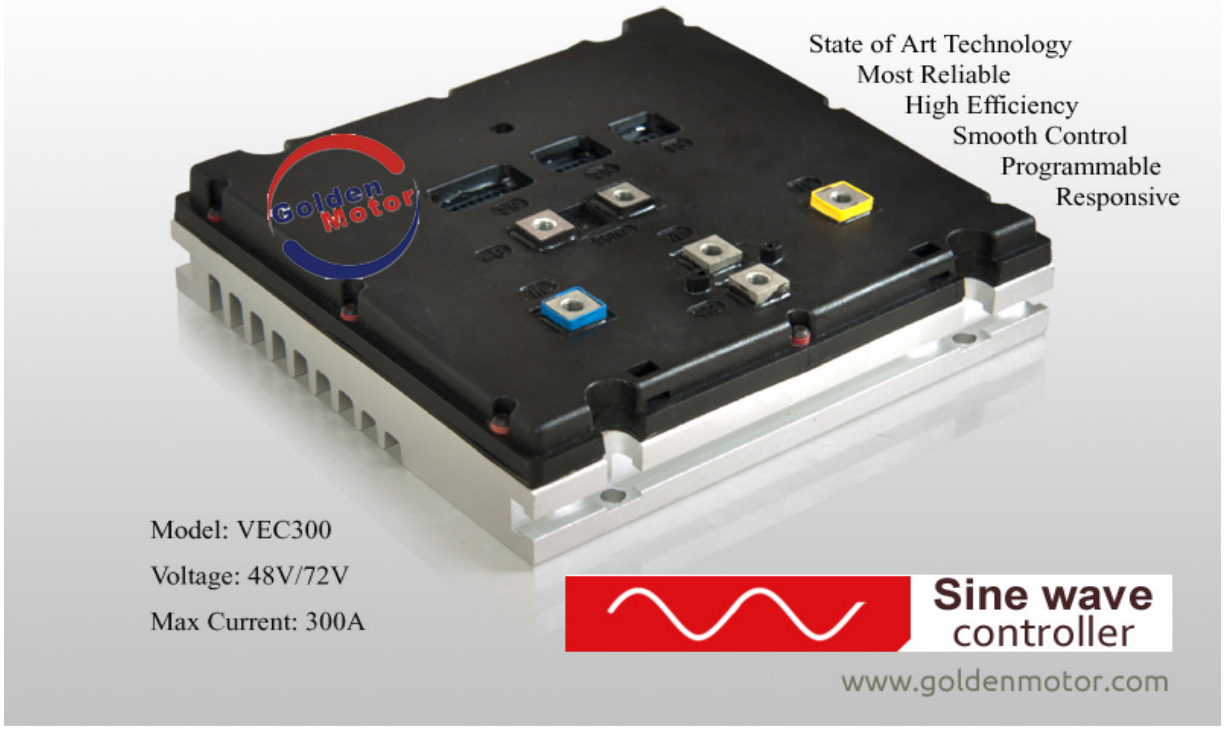
Figure 1: Field-oriented control techniques orient the stator flux vector to a specific degree relative to the rotor flux vector. (Source: Texas Instruments. Used with permission.)

Field Oriented Controller (vector control)

Best Tuned for BLDC Motor HPM10KW (48/72/96V 10KW)

Field Oriented Controller (vector control)

Best Tuned for BLDC Motor HPM5000 (48/72V 5KW)



Golden Motor's FOC controller products are specially designed for high power rating brushless dc (BLDC) motors from 1KW up to 20KW with voltages between 48V and 96V. The product series use the FOC(Field Oriented Control/Sine Wave）algorithm in which SVPWM is used to drive the power device so that it injects sinusoidal current to the three-phase of motor. Meanwhile, by using a 32-bit microprocessor which incorporates the latest ARM core，it exhibits excellent operational capability. The system handles several close loops which include torque, flux and speed loop and at the same time other high demand of real-time task operation is possible. By advanced control solution the system can achieve the following performance: maximum torque control, constant power control, speed closed loop control and regenerative braking. Compared with traditional square wave motor controller, the PMSM controller has the following obvious advantages:

Smooth driving

• Direct torque control，smooth start-up，excellent acceleration performance，especially in slow speed.

Low noise

• Vector control sinusoidal current injection and smooth motor output torque, which fully suppress the low frequency noise caused by the fluctuations of motor torque.

Programmable via PC

·Provide PC software(GUI) to program motor and control parameters to fine tune the drive system.
·Operating status can be monitored in real-time
·Support UART(standard)or CAN bus (optional)

Perfect protection functions

·Signal integrity detection (motor interface signal, control signal, etc.)
·Over-current protection, over or under voltage protection and over-temperature protection.
·Provide motor temperature-control interface

Main features

·On-site parameters tuning (Provide PC software)
·System power-on self-checking function
·Regenerative braking
·Brake, cruise, and three-mode speed selection interface
·Display interface
·LED for operation and fault status indication
·Cmpact design, which is convenient for vehicle installation

Applications

- Electric Cars
- Electric Motorcycles
- Electric Golf Buggies
- Electric Boats

FOC Controller Series

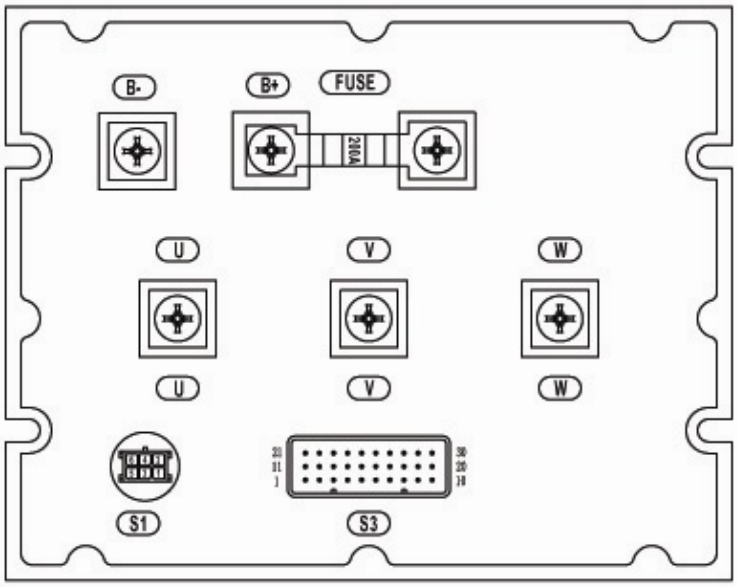
Model	Rated Voltage	Rated Current	Max Phase Current	Dimensions L*W*H Weight
VEC300-48	48V	120A	300A	190*180*50mm (2.5kg)
VEC300-72	72V	100A	300A	190*180*50mm (2.5kg)
VEC300-96	96V	80A	250A	190*180*50mm (2.5kg)
VEC500-48	48V	200A	500A	200*190*58mm (3.2kg)
VEC500-72	72V	150A	500A	200*190*58mm (3.2kg)
VEC500-96	96V	120A	450A	200*190*58mm (3.2kg)

Main Technical Parameters And Operation Characteristics

Main Performance	
Rated operation voltage	48V～96V
Rated DC BUS current	30A～200A
Rated output power	1000～10000W
Motor control mode	FOC
Quiescent operation current	20～40mA
Speed limit	Controlled by motor and configuration
Driving method	Direct torque control

System Protection Characteristics		**LED Blinking Times**
Over-voltage protection	Battery voltage is higher than default value	1
Under-voltage protection	Battery voltage is lower than default value	2
Motor over-current protection	Motor phase is short-circuit or phase to ground is short-circuit	3
Motor over-heat protection	Motor temperature is higher than default value	13
Stalling protection	Motor stalling time is over default value	4
HALL protection	HALL input is abnormal	5
MOSFET protection	MOSFET self-checking is abnormal	6
Phase winding disconnect protection	One of the motor phase is disconnection	7
Self-checking error protection	System internal power-on self-checking is abnormal	10
Controller over-heat protection	When controller operation temperature is higher than default value	11
Throttle protection	Throttle input is abnormal	12
Communication Characteristics		
UART communication	UART interface: parameter configuration and working state monitoring	
CAN communication	CAN interface: parameter configuration and working state monitoring	
Bluetooth communication	Bluetooth wireless interface: parameter configuration and working state monitoring	
LED indicator light	Indicate current working state or fault state	

VEC Controller functional pins definitions



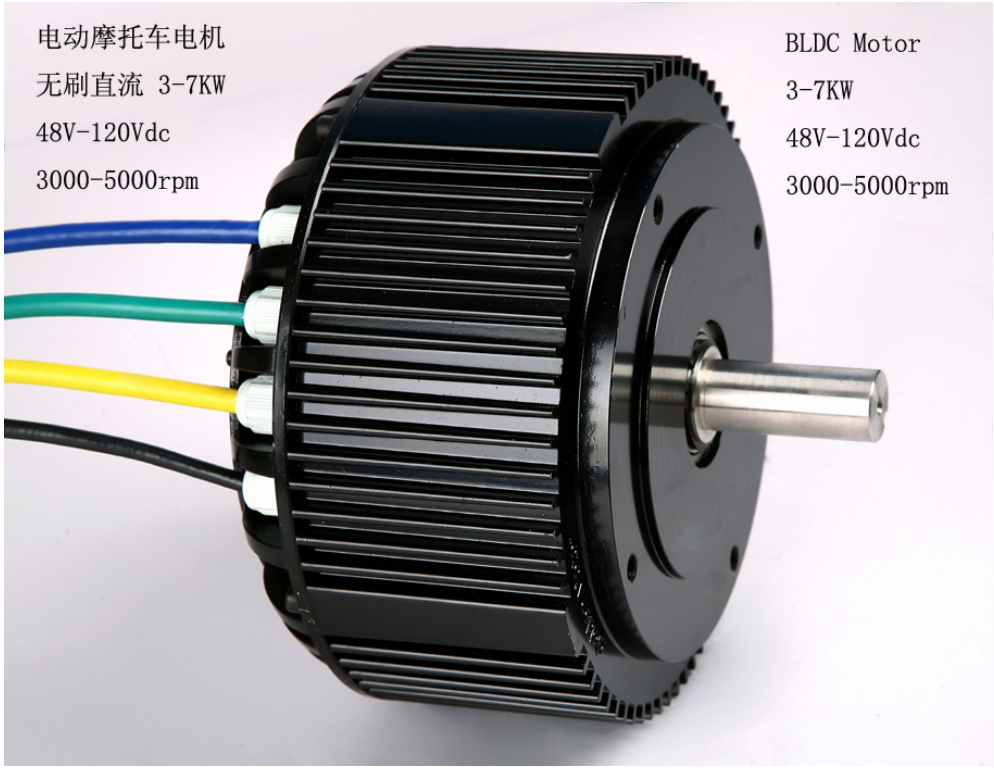
S1—Programming

①—GND（Black）
③—RX（Green&Yellow）
⑤—TX（Green）
⑥—+5V（Red）

S3—Function control wiring harness

(3)—Motor Temperture（White）
(4)(5)(6)—GND
(7)—Cruise（Gray）
(8)—Electric Lock（Orange）
(10)—Hall C（Blue）
(12)—Hall B（Green）
(13)—Hall A（Yellow）
(14)—+5V （Red）
(15)—+12V Brake(Yellow&White)
(16)—Brake (Blue&White)
(20)—High Speed (Blue)
(21)—GND (Black)
(24)—Low Speed (Blue)
(26)—GND（Black&White）
(27)—Throttle（Green&White）
(28)—+5V（Red&White）

Best tuned for BLDC Motors:


电动摩托车电机
无刷直流 3-7KW
48V-120Vdc
3000-5000rpm
BLDC Motor
3-7KW
48V-120Vdc
3000-5000rpm