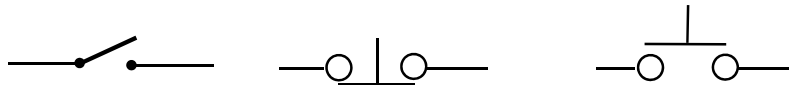


# Electrical Parts

## Switch



- Power window      ACC, Fuel pump, Blower fan, Lamp (front, rear, fog)
- Door lock          ABS, Blower Fan, Cooling Fan, Fuel Fan
- Seat control        Head lamp washer, Starter
- Sun roof            Multifunction switch
- Door mirror        Warning lamp switch
- Flasher unit        Trunk opener
- Intermittent wiper
- Door opening/shutting detection, signal transmission

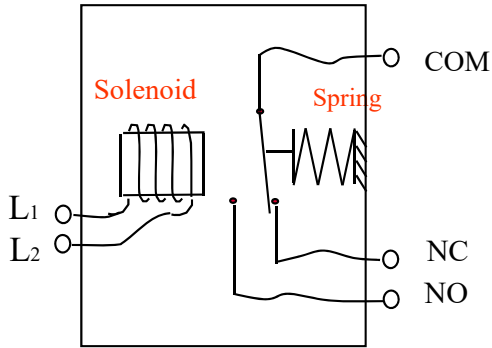
Oil pressure detection  
 Standard operating pressure: 15 kPa  
 Normal closed type



# Electrical Parts

## Relay

자동차의 환경은 전기적으로나 열적으로 가혹  
트랜지스터 회로를 설계하는 것은 상당한 추가 작업이 필요



- 통전 저항이 매우 낮습니다.
- 고전력 저전압 시스템에 효율이 높고 히트 싱크가 필요하지 않음
- 꺼 졌을 때 누출이 매우 적음. 따라서 배터리 방전에 대한 걱정없이 출력을 스위칭 되지 않은 배터리 전원에 연결할 수 있음.
- 스파이크, 서지, 온도 변화 등에 강하다.
- 전기적으로 절연 (solenoid 와 스위치 회로 부분 사이)  
온도 측면에서 훨씬 안정적.  
밀폐 계전기는  $-30^{\circ}\text{C}$ 와  $+70^{\circ}\text{C}$ 에서 본질적으로 동일한 특성

트랜지스터는  $-30^{\circ}\text{C}$ 와  $+70^{\circ}\text{C}$ 에서 상당히 다르게 작동, 회로가 복잡해짐.

하이 사이드 또는 로우 사이드 스위칭에 쉽게 사용할 수 있음.

하이 사이드 스위칭을 위해 N 채널 FET를 사용하려면 주 전원 공급 전압보다 높은 게이트 구동 전압이 필요.

- 가격이 저렴

### 릴레이의 단점 (트랜지스터에 비교하여)

1. 코일에는 약간의 전력이 필요합니다.
2. 사이클 수명이 제한됩니다
3. 그들은 물리적으로 크다

Electrical Parts

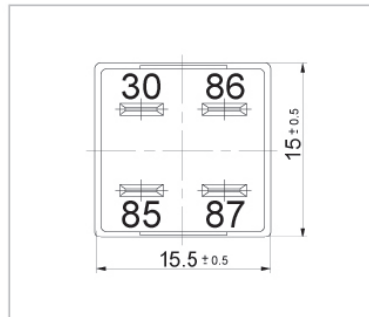
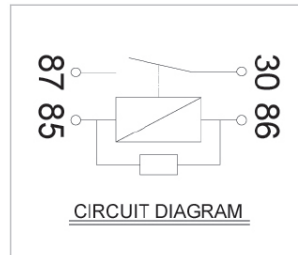
Relay



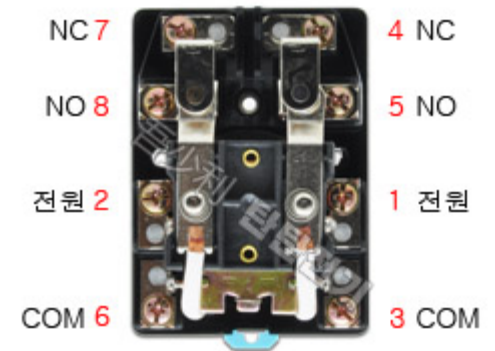
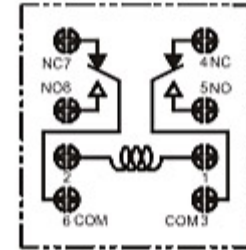
4P-12V /자동차 릴레이 DC 40A 용량



5P-12V /자동차 릴레이 DC 40A 용량



2 Form C

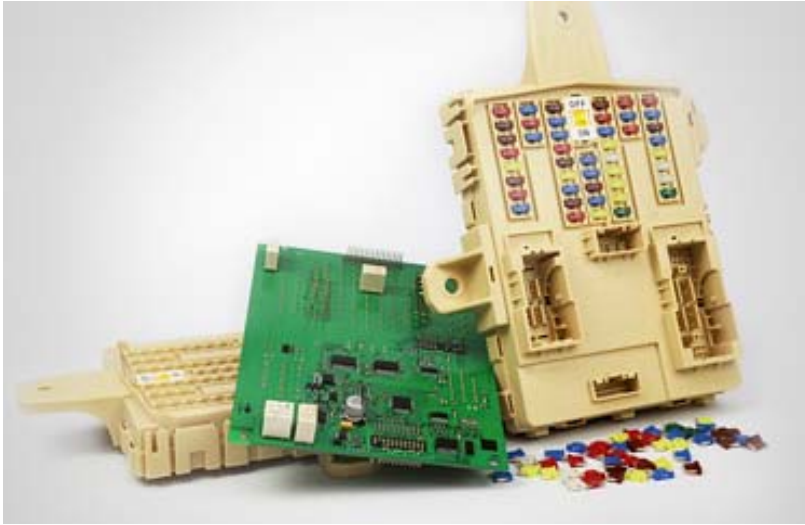


<http://www.jem-techno.co.kr>  
<http://www.kyungshin.co.kr/main.asp>  
<http://www.inzi.co.kr/product/product>



## Electrical Parts

### SMART JUNCTION BLOCK



[http://www.kyungshin.co.kr/sub02/sub04\\_01.asp](http://www.kyungshin.co.kr/sub02/sub04_01.asp)

#### - 기능 및 역할

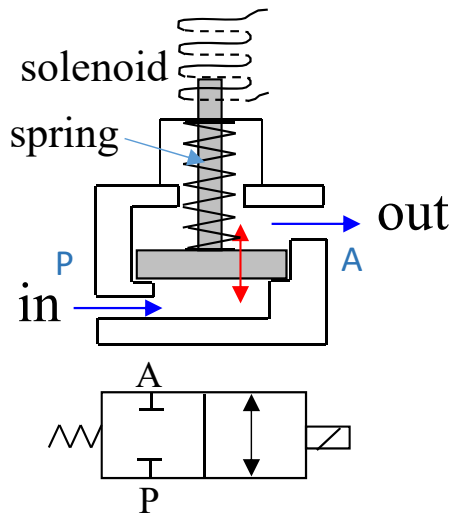
- 램프 제어용 반도체 릴레이(IPS) 및 CAN 통신 입출력 제어가 가능하게 한 정션 블록, 논리회로를 통한 신호처리, 모니터링, 회로보호, 고장진단 등이 가능하다.

IPS (Intelligent Power Switch)  
CAN (Controller Area Network)

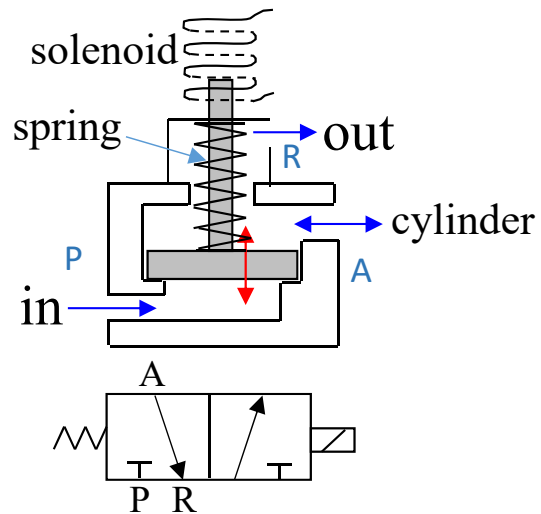
Electrical Parts

방향제어밸브

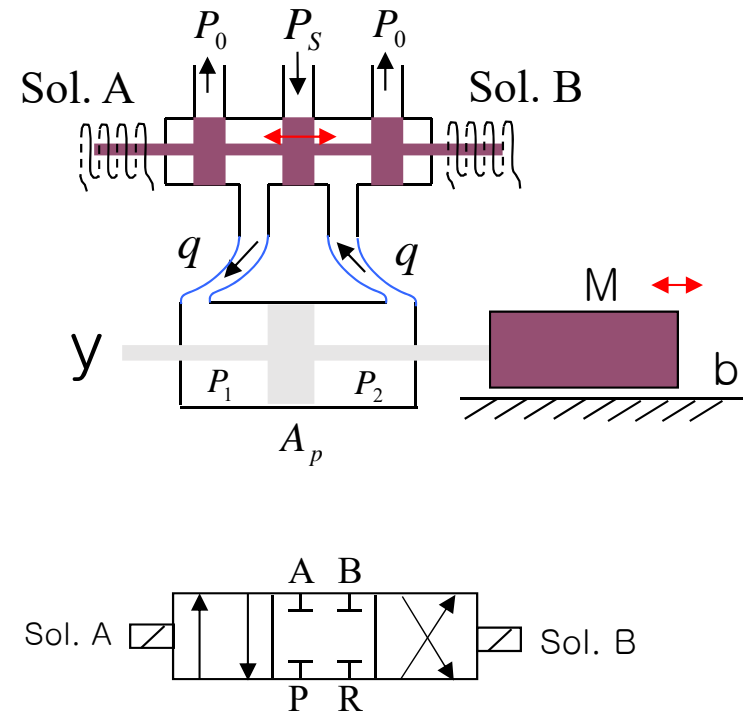
2 port 2 way



3 port 2 way

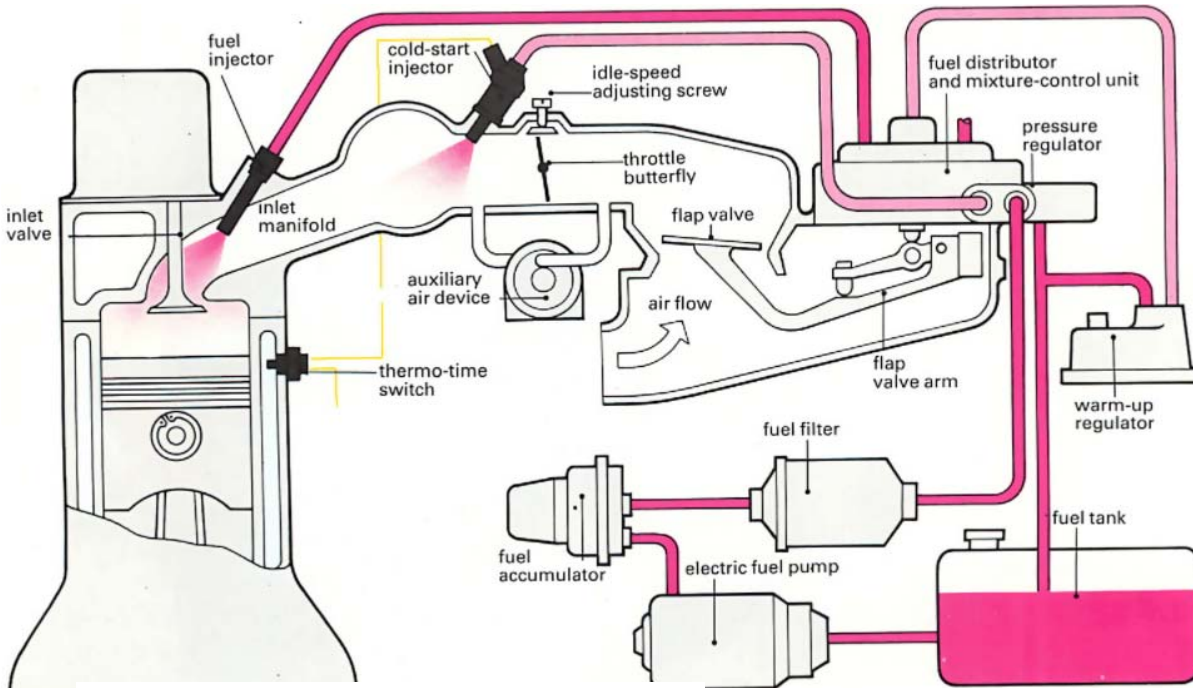


5 port 2 way



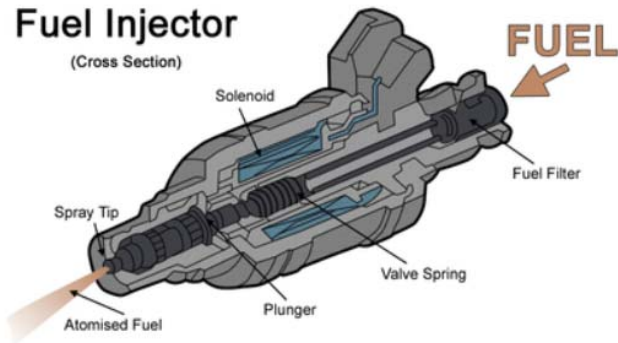
Electrical Parts

Lucas mechanical fuel injection system

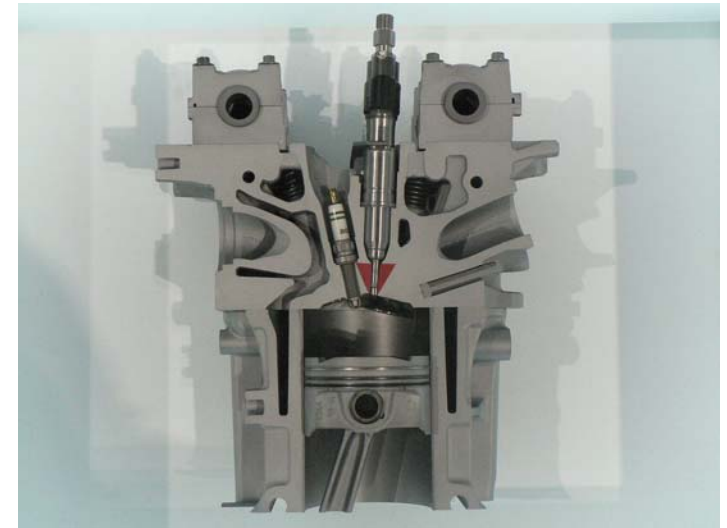


Fuel Injector

(Cross Section)



■ Solenoid Components ■ Fuel Injector Assembly



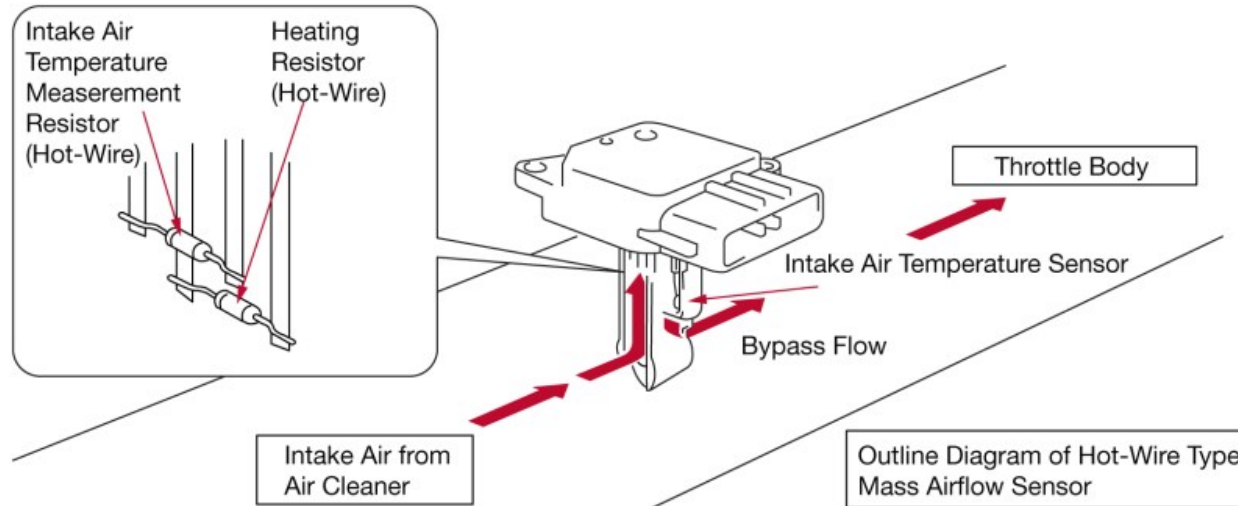
[https://en.wikipedia.org/wiki/Fuel\\_injection](https://en.wikipedia.org/wiki/Fuel_injection)

In the case of gasoline direct injection the high-pressure circuit is fed via the high-pressure pump, which supplies the fuel pressure in the fuel rail at the required high level of up to 350 bar

<https://www.st.com/en/applications/powertrain-for-ice/gasoline-direct-injection-gdi.html>

## Electrical Parts

### Sensors



The Mass Air Flow Sensor measures the amount of air volume flowing into a car's engine, and sends the Electronic Control Unit (ECU) a voltage that represents the airflow.

- the plug-in hot wire
- The hot-wire type MAF Sensor responds to temperature changes in the heating element. Changes in the resistance value and current of the heating element are converted into proportional voltage in the control circuit, and then sent to the ECU to calculate the amount of engine intake air volume.
- also detects the intake air temperature
- the ECU judges the air density and corrects the fuel injection quantity.

[https://www.hitachi-automotive.us/Products/Aftermarket/EMS/Air\\_Flow\\_Sensors/index.htm](https://www.hitachi-automotive.us/Products/Aftermarket/EMS/Air_Flow_Sensors/index.htm)

<https://www.denso-am.eu/products/automotive-aftermarket/engine-management-systems/mass-air-flow-sensors/how-they-work/>

## Electrical Parts

Mass Airflow Sensors



Manifold Absolute Pressure Sensors



Liquid Temperature Sensors



Air Temperature Sensors



Premium Oxygen (O2) Sensors

O2 sensor or lambda sensor.



[https://en.wikipedia.org/wiki/Oxygen\\_sensor](https://en.wikipedia.org/wiki/Oxygen_sensor)  
<https://www.boschautoparts.com/en/auto/oxygen-sensors>

•Extreme Accuracy under extreme conditions: -40°F (-40 °C ) ↔ +260°F (127 °C)



## Electrical Parts

An **oxygen sensor** (*lambda sensor*)

where lambda refers to air–fuel equivalence ratio,

### Function of a lambda probe

Lambda probes provide feedback to an ECU. Where applicable, gasoline, propane and natural gas engines are fitted with three-way catalysts to comply with on road vehicle emissions legislation. Using the lambda sensor signal, the ECU can operate the engine slightly rich of lambda = 1, this is the ideal operating mixture for a three way catalyst to be effective. Robert Bosch GmbH introduced the first automotive lambda probe in 1976, and it was first used by Volvo and Saab in that year. The sensors were introduced in the US from about 1979 and were required on all models of cars in many countries in Europe in 1993.

By measuring the proportion of oxygen in the remaining exhaust gas, and by knowing the volume and temperature of the air entering the cylinders amongst other things, an ECU can use look-up tables to determine the amount of fuel required to burn at the stoichiometric ratio (14.7:1 air: fuel by mass for gasoline) to ensure complete combustion.

### The probe

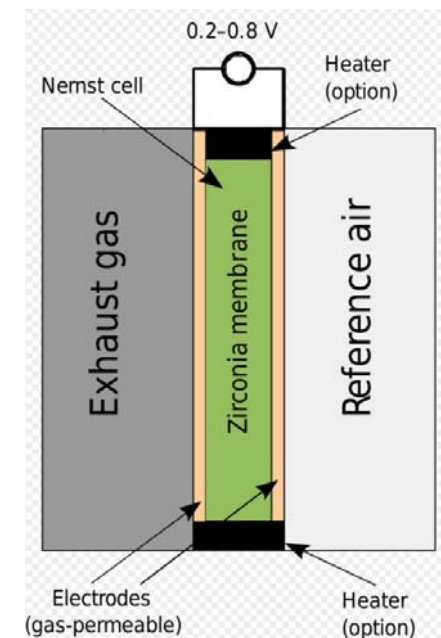
The sensor element is a ceramic cylinder plated inside and outside with porous platinum electrodes; the whole assembly is protected by a metal gauze. It operates by measuring the difference in oxygen between the exhaust gas and the external air and generates a voltage or changes its resistance depending on the difference between the two.

The sensors only work effectively when heated to approximately 316 °C (600 °F), so most newer lambda probes have heating elements encased in the ceramic that bring the ceramic tip up to temperature quickly. Older probes, without heating elements, would eventually be heated by the exhaust, but there is a time lag between when the engine is started and when the components in the exhaust system come to a thermal equilibrium. The length of time required for the exhaust gases to bring the probe to temperature depends on the temperature of the ambient air and the geometry of the exhaust system. Without a heater, the process may take several minutes. There are pollution problems that are attributed to this slow start-up process, including a similar problem with the working temperature of a catalytic converter.

The probe typically has four wires attached to it: two for the lambda output, and two for the heater power, although some automakers use the metal case as ground for the sensor element signal, resulting in three wires. Earlier non-electrically-heated sensors had one or two wires.

$$\lambda = \frac{AFR}{AFR_{stoich}}$$

*AFR: air – fuel ratio*



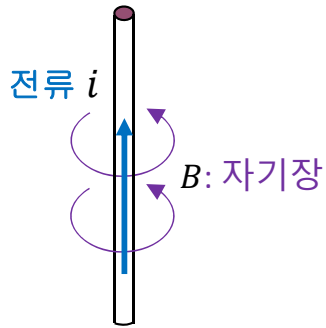
[https://en.wikipedia.org/wiki/Stoichiometry#Stoichiometric\\_air-to-fuel\\_ratios\\_of\\_common\\_fuels](https://en.wikipedia.org/wiki/Stoichiometry#Stoichiometric_air-to-fuel_ratios_of_common_fuels)

<https://www.fixdapp.com/blog/oxygen-sensor>

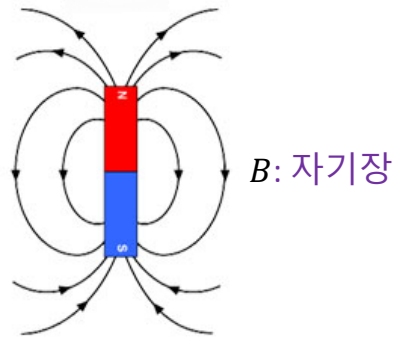
[https://en.wikipedia.org/wiki/Air%E2%80%93fuel\\_ratio#Air%E2%80%93fuel\\_equivalence\\_ratio\\_\(%CE%BB\)](https://en.wikipedia.org/wiki/Air%E2%80%93fuel_ratio#Air%E2%80%93fuel_equivalence_ratio_(%CE%BB))

Electrical Parts

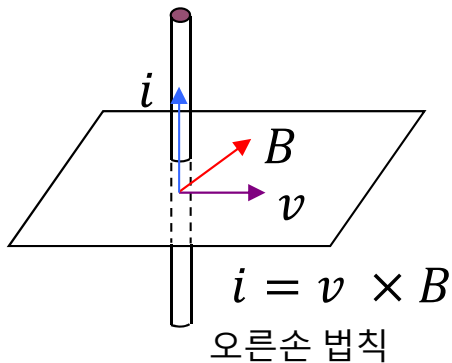
Motor



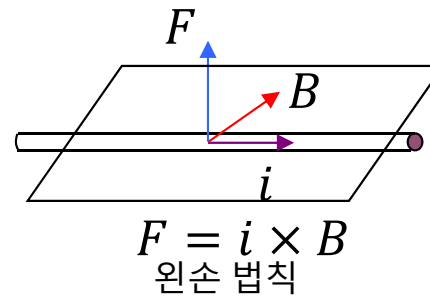
전류가 만드는 자기장



영구 자석이 만드는 자기장



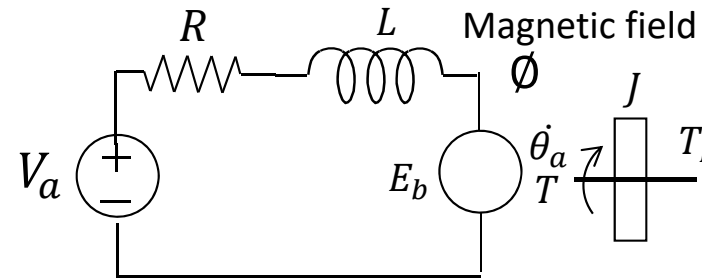
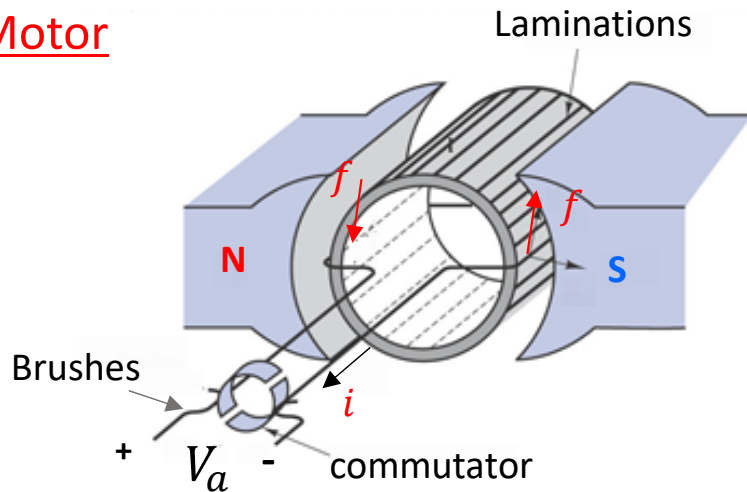
자기장  $B$ 가 있는 공간에서  
도체가  $v$ 의 속도로 이동할 경우  
도체에 흐르는 전류  $i$



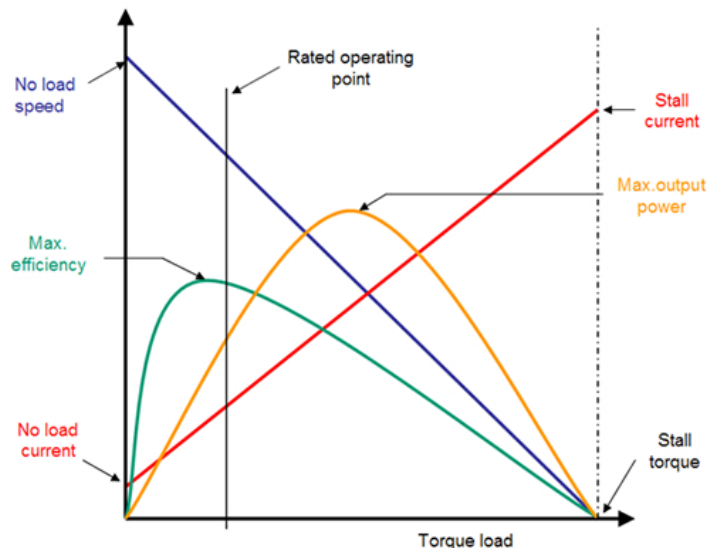
자기장  $B$ 가 있는 공간에서  
도체에 전류  $i$ 가 흐르는 경우  
도체가 받는 힘  $F$

Electrical Parts

DC Motor



DC motor characteristics (open loop)



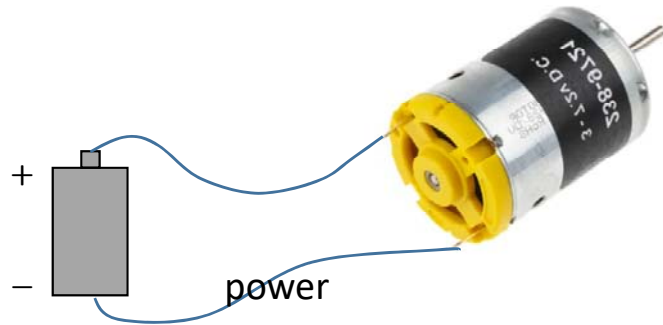
역기전력:  $E_b = K_b \dot{\theta}_a$   
 $V_a = R_a i_a + L \frac{di}{dt} + E_b$   
 토크:  $T = K_t i_a$   
 $T = J \ddot{\theta}_a + b \dot{\theta}_a + T_L$

Static Controls and Braking of Motors  
 K.C. Agrawal, in [Industrial Power Engineering Handbook](#), 2001

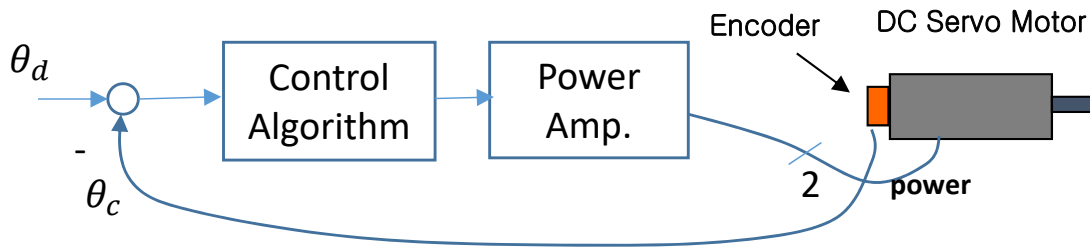
Electrical Parts

DC Motor

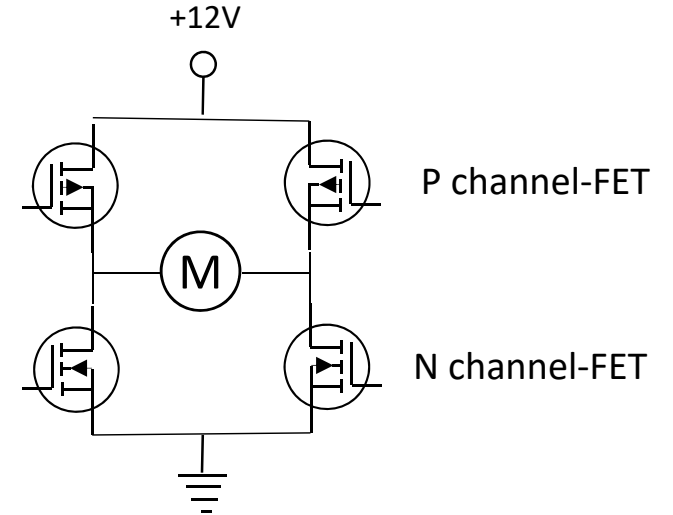
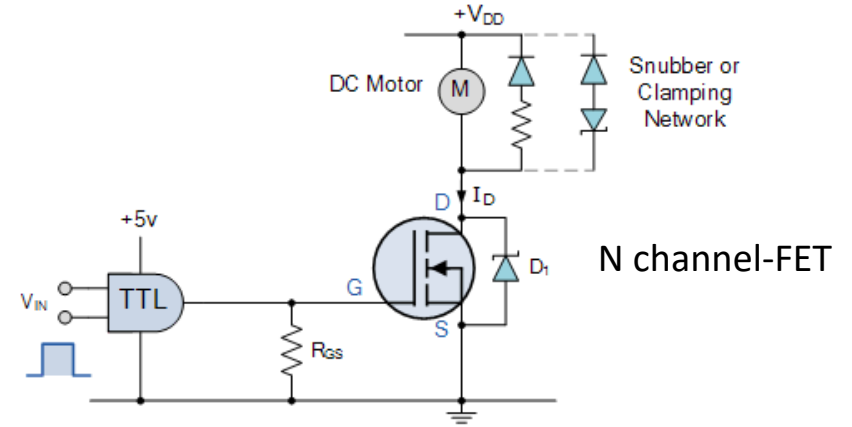
DC motor open loop control



DC servo motor Closed loop control



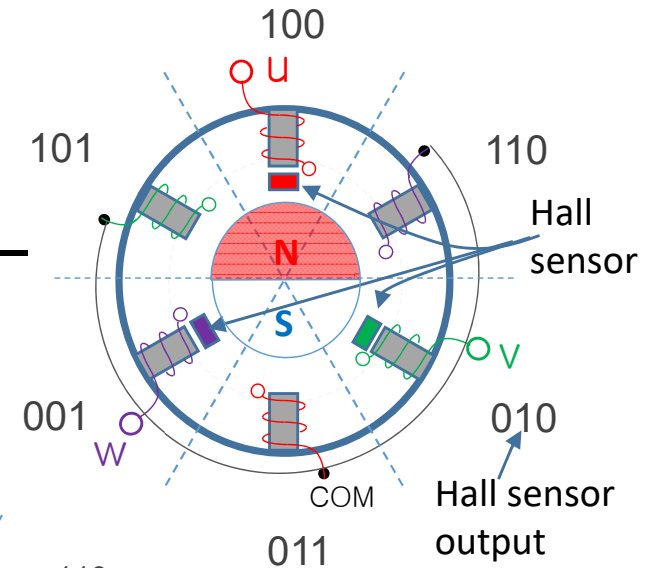
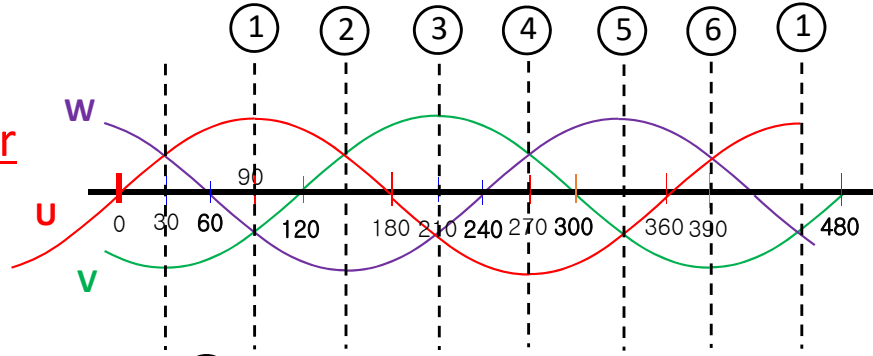
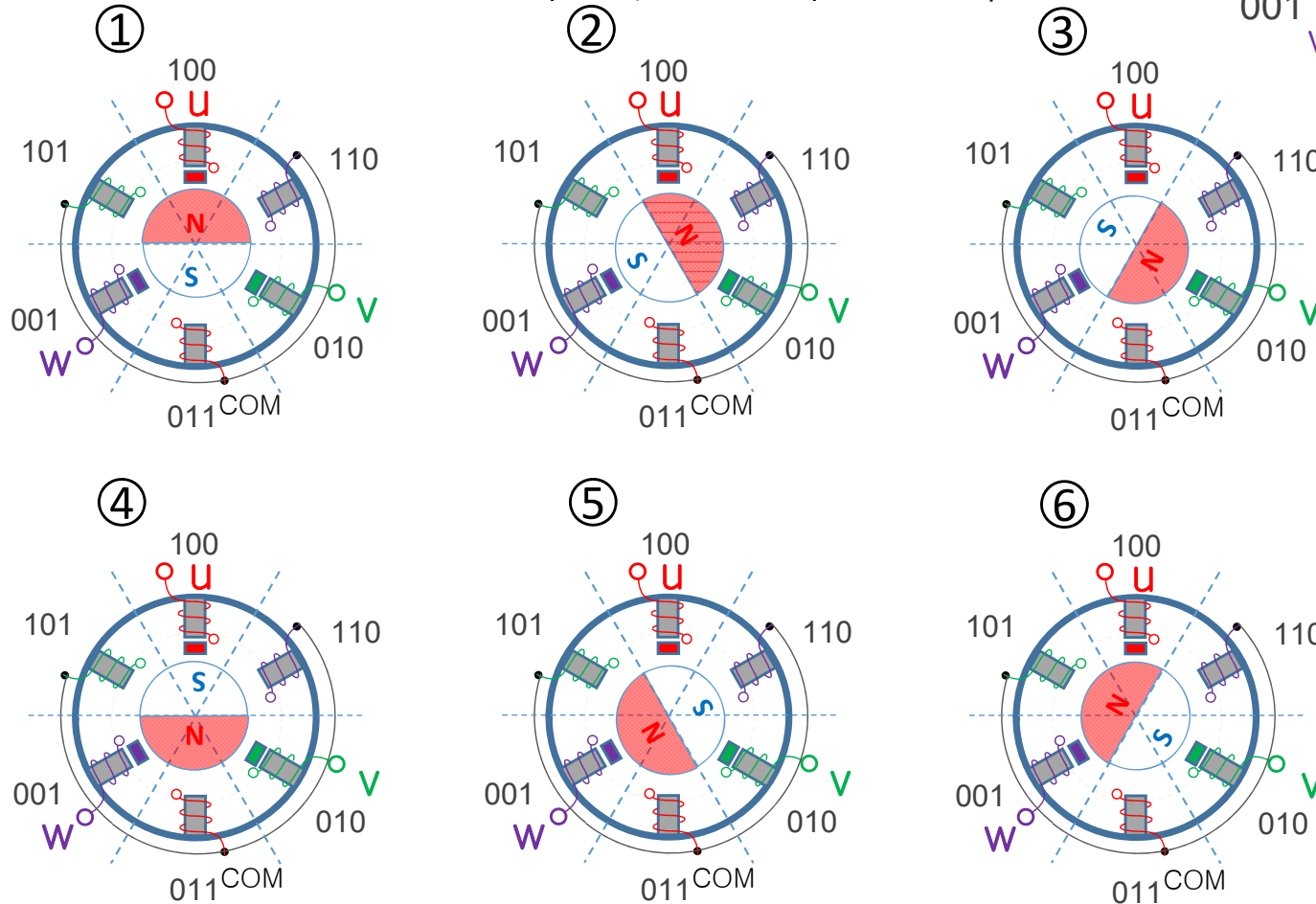
영구자석형 모타, driver로 구성  
 고속 응답성, 고정도, 고효율, 양호한 제어성  
 brush와 commutator(정류자)가 필요; 보수, 점검이 필요



Electrical Parts

AC Servo (Brushless DC) Motor

3 phase PMSM  
Y connection



Hall sensor output

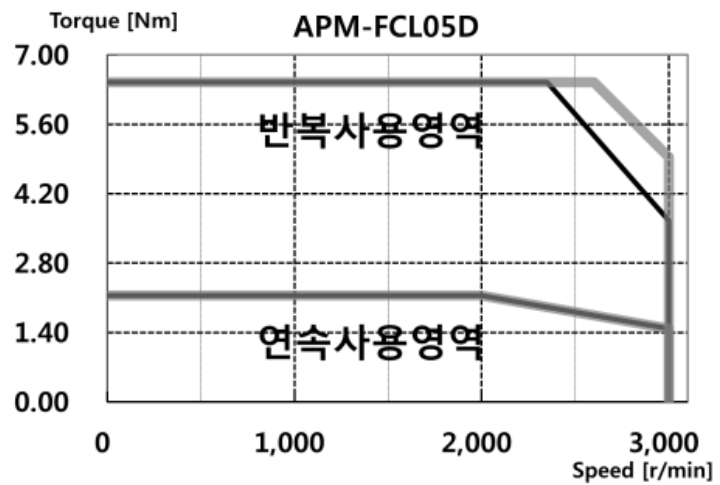
N → 1

S → 0

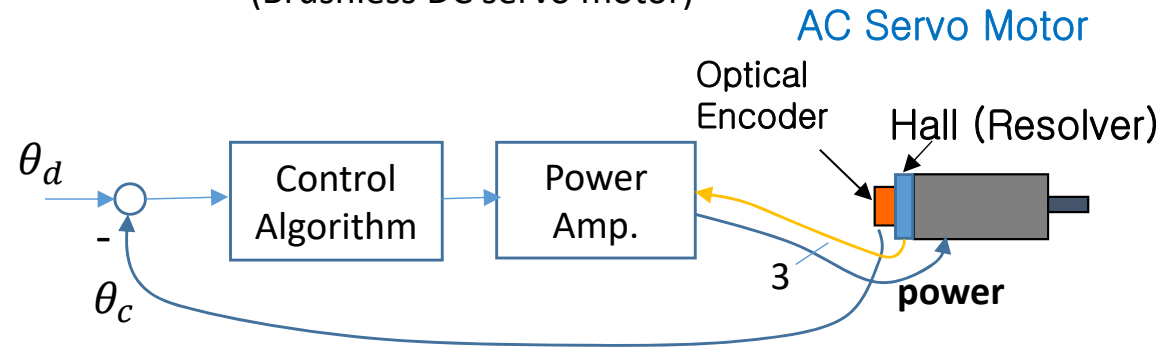
# Electrical Parts

## AC Servo (Brushless DC) Motor

Permanent Magnet Synchronous Motor (PMSM)



AC servo motor Closed loop control (Brushless DC servo motor)



IONIQ (Hyundai Hybrid)

- DC 서보 모타에 비하여 구조가 간단; brush와 commutator 가 없음.
- driver의 구조가 복잡
- brush에 의한 정류 한계가 없음
- 고속에서 순간 최대 토크를 출력  
→ 응답 특성이 좋다.
- 고정자에 코일 → 방열이 양호
- brush의 잡음이 없음
- 제어가 복잡- closed loop 제어
- 고속 회전, 대 토크, 소형 경량화

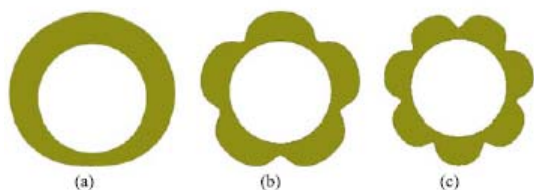
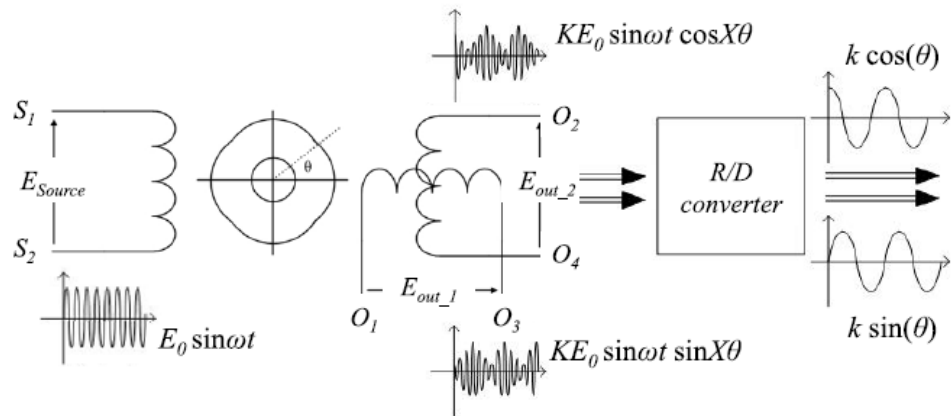
# Electrical Parts

## Resolver

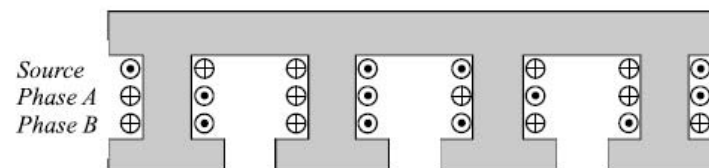
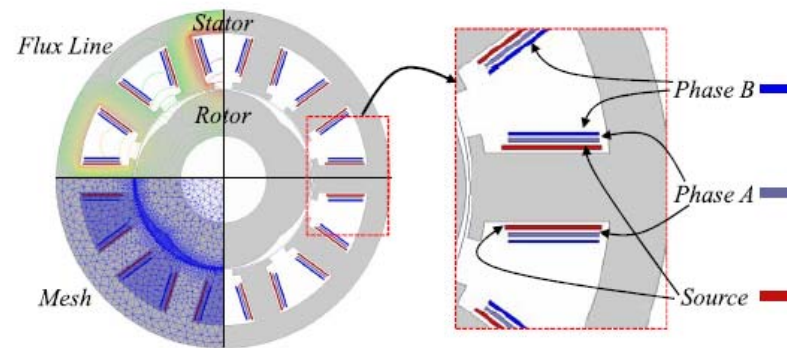
Rotor의 회전 각도 측정

The features are described in the following.

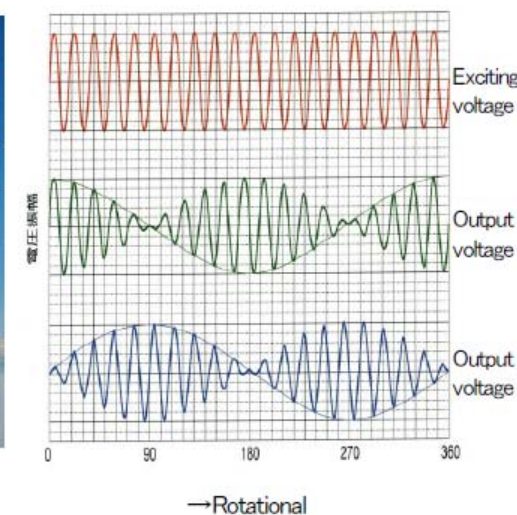
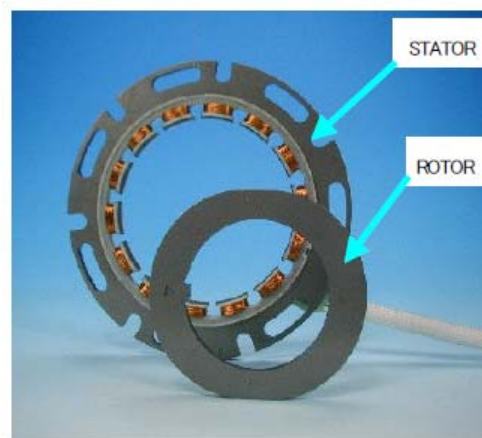
- 1) Thin flat shape with large bore-hole
- 2) Wide operating temperature range of -40 to 150 degree C
- 3) High reliability under harsh environmental conditions, such as vibration, Shock, oil-resistant
- 4) High resolution and absolute angle detection
- 5) Low cost and mass production capability



Variant poles of resolver rotor: (a) 1-X; (b) 5-X; and (c) 7-X.



Proposal of Improved Winding Method for VR Resolver  
 IEEE TRANSACTIONS ON MAGNETICS, VOL. 51, NO. 3, MARCH 2015, 8102404



Development of VR Resolver system for hybrid electric vehicles  
 awardn08-04.pdf