AC Motor System Basics

1. Feature of AC motor

The AC motor model trucks covered by this manual use AC motors (three-phase induction motors) as the traction motor and pump motor. AC motors have the following advantages over DC motors:

(1) AC motors are simple in construction. Since they do not have friction parts like brushes and commutators, daily maintenance is significantly reduced.

(2) AC motors are compatible with high-speed operation.

(3) An AC motor of a certain size produces higher power than a DC motor of the same size.

2. Speed control of induction motors

Speed control of DC motors depends on regulation of the field and armature current amounts, while that of AC motors basically depends on adjustment of the frequency of the alternating current power supply. The speed of an AC motor is determined by the frequency of the power supply AC current and the load on the motor. In addition, the voltage and current to the motor must be controlled properly so that the motor operates in its optimum characteristic range. (Fig. 1)

The frequency and voltage can be controlled in a variety of methods including the "vector control method" employed in the AC motor model trucks. This method provides highly responsive control according to ever changing truck-operating conditions through high-speed calculation on huge amount of data. The vector control calculation is performed by the inverter. (Fig. 2)

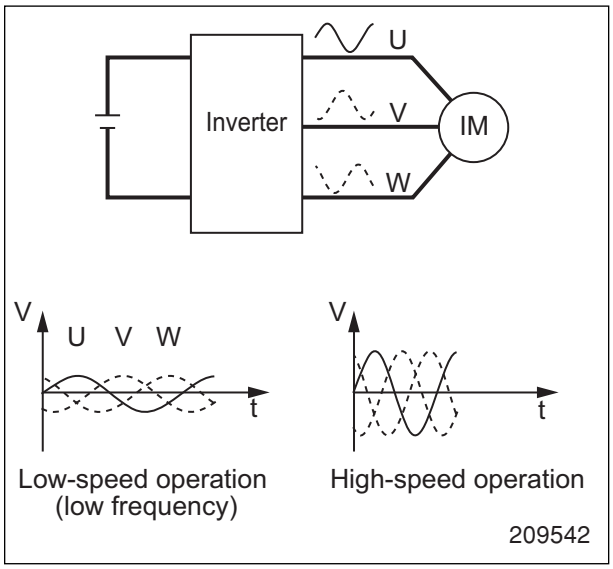

Fig. 1

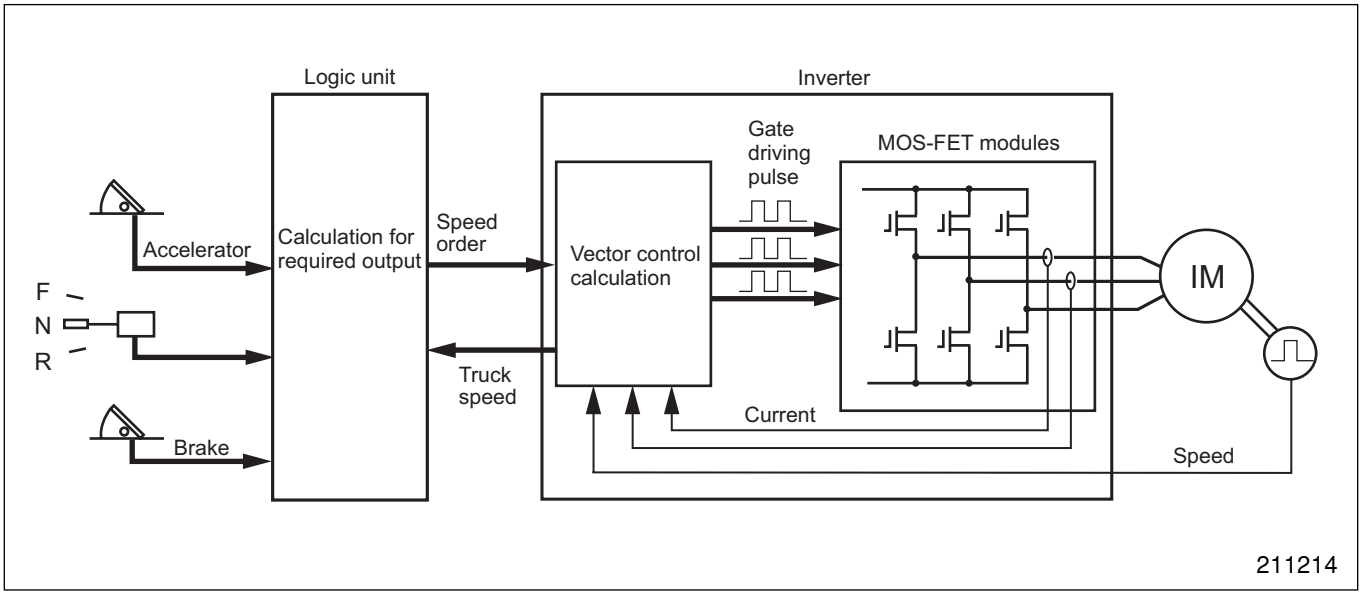

Fig. 2

3. Inverter

The truck battery delivers DC current, so the current must be converted into AC current to drive an AC motor. The device that converts direct current into alternating current is generally called an "inverter." The processes involved in creating AC current from DC current are described below.

(1) Changing DC voltage cyclically

If the switch in a circuit like a one shown in Fig. 3 is turned on for time T1 and then turned off for time T2 and this on-off operation is repeated many times, the average of the voltage applied to the load is determined by the ratio between T1 and T2. Varying the ratio, therefore, results in varying voltage. The ratio between T1 and T2 is called "duty ratio." By changing the duty ratio cyclically, it is possible to obtain cyclically changing DC voltage shown in Fig. 3.

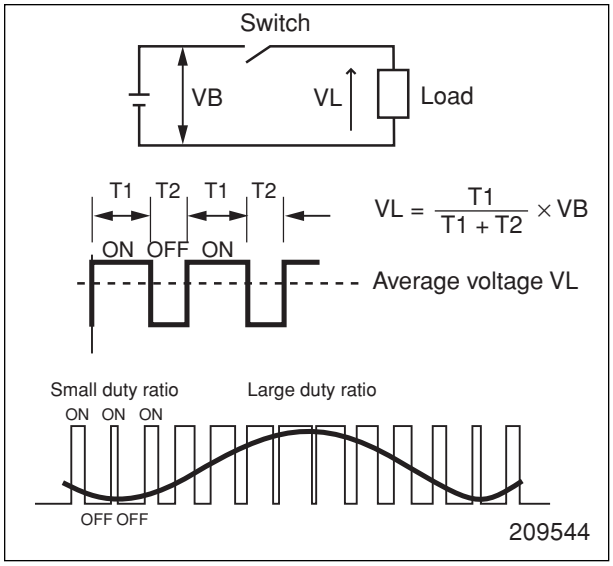

Fig. 3

(2) Converting DC power into AC power

Driving a three-phase AC motor using battery delivered power requires creating three phase outputs (U, V, W) of an identical waveform that differ in phase by 120° using a circuit with six switches S1 to S6 that are arranged as shown in Fig. 4. The outputs thus created forms a three-phase alternating current. Fig. 5 shows on-off condition of each switch (arm) and output voltage variation.

Functioning as switches in the inverter of the AC motor trucks are MOS-FET transistors. The MOS-FET transistors can switch at very high speeds, thus creating smooth waveforms of alternating current.

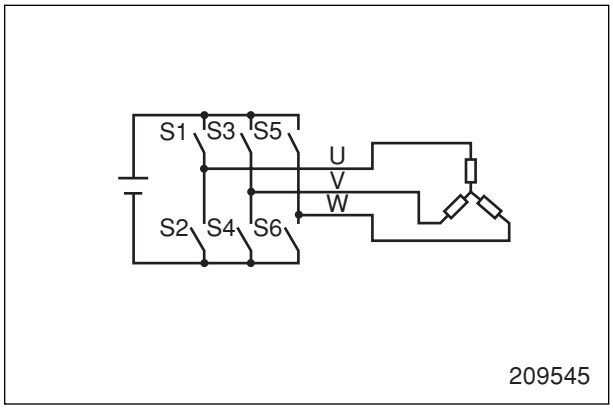

Fig. 4

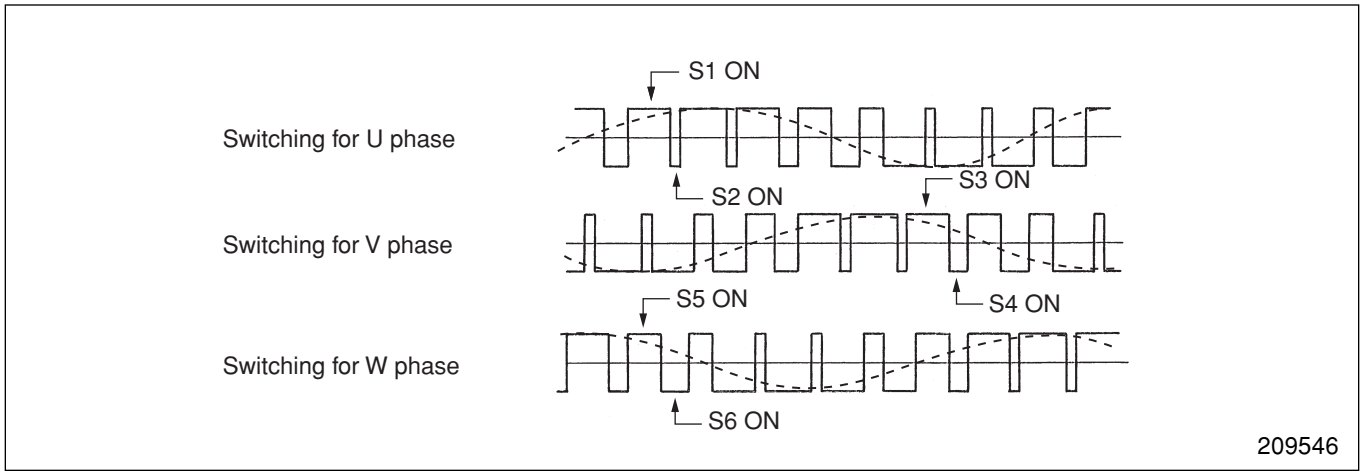

Fig. 5