Basic Circuits of Insulation Type DC-DC Converters

Insulation type DC-DC converters actively use transformers and support high output power. Understanding the basic principles and core circuits will deepen your understanding.

**<Principles of Transformers and Direction of Electromotive Force>**

- **Magnetic flux from the primary winding**
- **Reverse effect magnetic flux from the secondary winding**

When the switch is ON, magnetic flux is generated by the primary winding, but electromagnetic force (inverse electromagnetic force) is generated to prevent the magnetic flux from doubling. The magnetic flux from the primary winding passes through the core and reverse effect magnetic flux from the secondary winding is generated, creating electromagnetic force (inverse electromagnetic force) and current (inductive current). When the switch is OFF, the current flows in the opposite direction.

**Flyback Converter**

Low and Medium Output Power Types

- **Switch ON**
  - Transformer

- **Switch OFF**
  - The transformer core stores energy, so no choke coil is needed.

**Forward Converter (Single-switching type)**

Medium Output Power Type

- **Switch ON**
  - Choke coil

- **Switch OFF**
  - The choke coil generates electromagnetic force (reverse electromagnetic force) generated in the primary and secondary windings as a result of the transformer principle and current flows through the diode (D1) [7]. At this time, energy is stored in the choke coil.

**RCC Type (self-exciting flyback converter)**

Low Output Power Types

- **ON/ON Types and ON/OFF Types**
  - DC-DC converters are available in ON/ON types that output energy when the switching elements are on and ON/OFF types that output energy when the switching elements are off.

**Types by Output Voltage and Power**

<table>
<thead>
<tr>
<th>Output Voltage (V)</th>
<th>ON/ON Types (RCC, flyback, etc.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>10</td>
<td>100</td>
</tr>
<tr>
<td>100</td>
<td>1000</td>
</tr>
</tbody>
</table>

**B-H Curves of Magnetic Cores**

- **B: Magnetic flux density**
- **H: Magnetic field**
- **Saturation magnetization**

**Comparison of Performance of Core Types**

<table>
<thead>
<tr>
<th>Iron</th>
<th>Silicon</th>
<th>Ferite</th>
<th>Manganese</th>
<th>Permalloy</th>
<th>Germania</th>
</tr>
</thead>
<tbody>
<tr>
<td>Losses</td>
<td>Poor</td>
<td>Acceptable</td>
<td>Good</td>
<td>Excellent</td>
<td>Excellent</td>
</tr>
</tbody>
</table>

The transformer is the key component of insulation type DC-DC converters. Iron cores generate high losses (thermal losses) at high frequencies, so they are not used.