

## 제 8 장 인버터

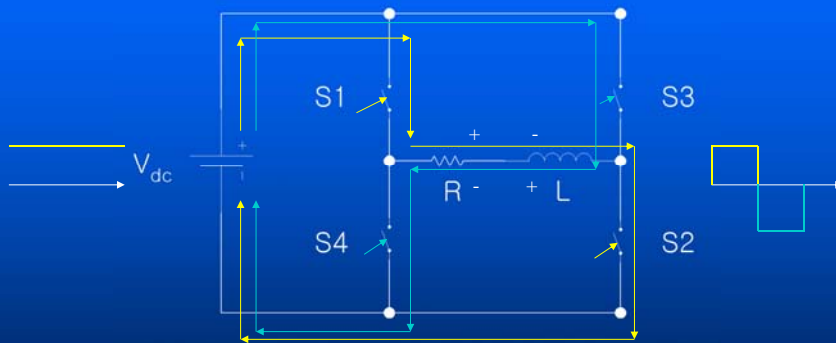
### *Inverter*

### *DC→AC*

## 8.1 개요

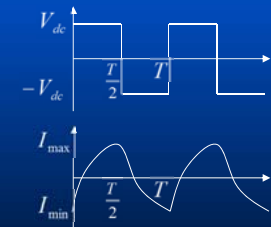
- DC를 이용하여 AC로 변환
- 용도
  - AC 모터속도제어
  - UPS(Uninterruptible Power Supply)
  - 태양광 발전
- 종류
  - 전브리지 변환기
  - 구형파 변환기
  - PWM 변환기

## 8.2 전브리지(Full Bridge)변환기



- S1+S2와 S3+S4를 주기적으로 동작하여 AC로 변환

## 8.3 구형파(Square Wave)변환기



- S1, S2 ON일 때

$$L \frac{di_0}{dt} + Ri_0 = V_{dc} \quad \text{Laplace Transform}$$

$$L\{SI(S) - i_0(+)\} + RI(S) = \frac{V_{dc}(S)}{S} \quad i_0(+)=I_{\min}$$

$$LSI(S) + RI(S) = \frac{V_{dc}(S) + SLI_{\min}}{S} \quad \div L$$

$$\left\{S + \frac{R}{L}\right\} I(S) = \frac{1}{L} \left\{ \frac{V_{dc}(S) + SLI_{\min}}{S} \right\}$$

$$\therefore I(S) = \frac{\frac{1}{L} \{V_{dc}(S) + SLI_{\min}\}}{S \left\{S + \frac{R}{L}\right\}}$$

### 8.3 구형파(Square Wave)변환기(2)

$$I(S) = \frac{\frac{1}{L}\{V_{dc}(S) + SLI_{min}\}}{S\left\{S + \frac{R}{L}\right\}} = \frac{A}{S} + \frac{B}{S + \frac{R}{L}} = \frac{A\left\{S + \frac{R}{L}\right\} + BS}{S\left\{S + \frac{R}{L}\right\}}$$

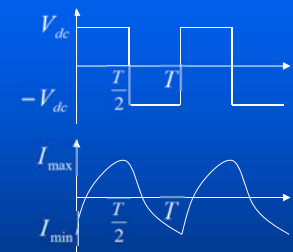
$$A \rightarrow S = 0 \quad \frac{R}{L}A = \frac{1}{L}V_{dc}(S), \quad \therefore A = \frac{V_{dc}(S)}{R}$$

$$B \rightarrow S = -\frac{R}{L} \quad -\frac{R}{L}B = \frac{1}{L}\left\{V_{dc}(S) - \frac{R}{L}LI_{min}\right\}, \quad \therefore B = -\frac{1}{R}V_{dc}(S) + I_{min}$$

$$I(S) = \frac{\frac{V_{dc}(S)}{R}}{S} + \frac{-\frac{1}{R}V_{dc}(S) + I_{min}}{\left\{S + \frac{R}{L}\right\}} \quad \text{Inverse Laplace Transform}$$

$$i_0(t) = \begin{cases} \frac{V_{dc}}{R} + \left\{I_{min} - \frac{V_{dc}}{R}\right\}e^{-\frac{R}{L}t} & \text{at } 0 \leq t \leq \frac{T}{2}, \because L^{-1}\left\{\frac{1}{(S-a)}\right\} = e^{-at} \\ -\frac{V_{dc}}{R} + \left\{I_{max} + \frac{V_{dc}}{R}\right\}e^{-\frac{R}{L}(t-\frac{T}{2})} & \text{at } \frac{T}{2} < t \leq T \end{cases}$$

### 8.3 구형파(Square Wave)변환기(3)



$$i_0(t) = \frac{V_{dc}}{R} + \left\{I_{min} - \frac{V_{dc}}{R}\right\}e^{-\frac{R}{L}t}$$

$$\text{at } t = \frac{T}{2}, \quad i_0(t) = I_{max}, \quad (I_{min} = -I_{max})$$

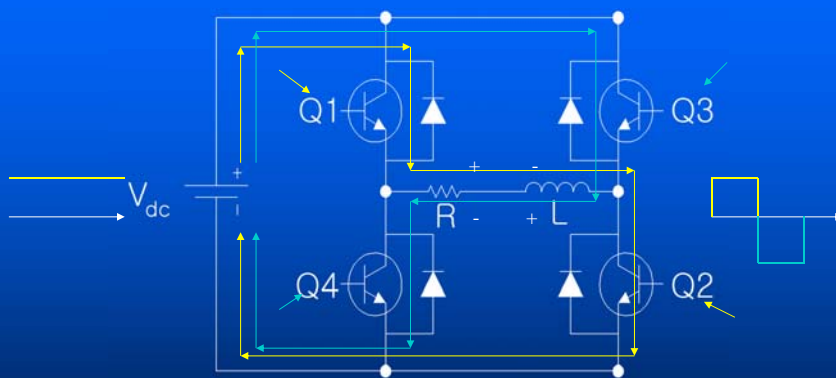
$$i_0\left(\frac{T}{2}\right) = I_{max} = \frac{V_{dc}}{R} + \left\{-I_{max} - \frac{V_{dc}}{R}\right\}e^{-\left(\frac{T}{2\tau}\right)},$$

$$I_{max} + I_{max}e^{-\left(\frac{T}{2\tau}\right)} = \frac{V_{dc}}{R} - \frac{V_{dc}}{R}e^{-\left(\frac{T}{2\tau}\right)}$$

$$I_{max}\left\{1 + e^{-\left(\frac{T}{2\tau}\right)}\right\} = \frac{V_{dc}}{R}\left\{1 - e^{-\left(\frac{T}{2\tau}\right)}\right\}$$

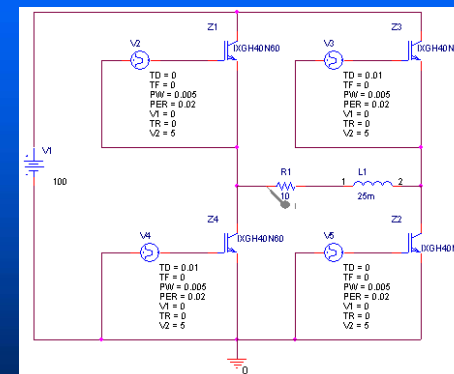
$$\therefore I_{max} = \frac{V_{dc}}{R} \frac{\left\{1 - e^{-\left(\frac{T}{2\tau}\right)}\right\}}{\left\{1 + e^{-\left(\frac{T}{2\tau}\right)}\right\}}$$

### 8.3 구형파 변환기: BJT 회로



- S1+S2와 S3+S4를 주기적으로 동작 AC로 변환

### 예제 8-1 인버터



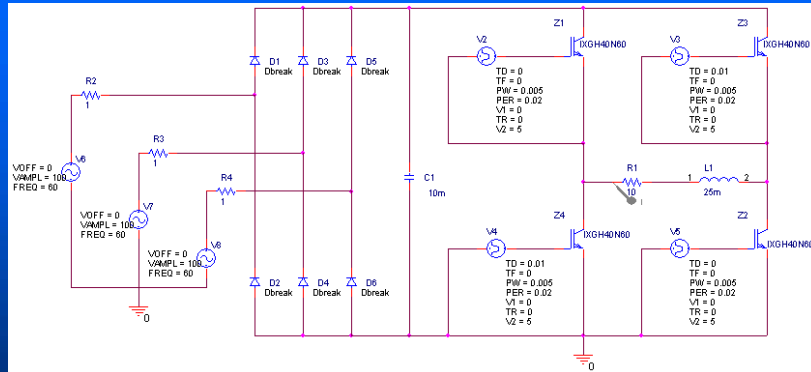
#### Parameter

- ✓  $V_S = 100 \text{ V}$
- ✓  $R = 10 \text{ ohm}$
- ✓  $L = 25 \text{ mH}$
- ✓  $f = 50 \text{ Hz } (T = 0.02 \text{ s})$
- ✓  $PW < 1/100 (0.01 \text{ s})$
- ✓ Step  
= 0 50 ms

#### Find

- ✓ 출력전압
- ✓ 전류 최대, 최소값

## 예제 8-1 정류기가 있는 인버터

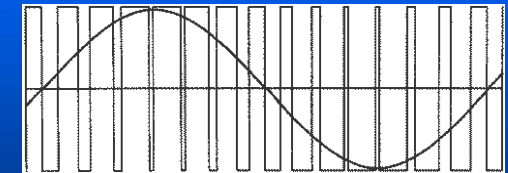
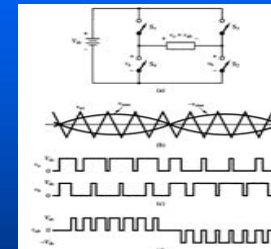


### Parameter

- ✓  $V_s = 170\text{ V}$   $C = 10\text{ mF}$   $R = 10\text{ ohm}$   $L = 25\text{ mH}$
- ✓  $f = 50\text{ Hz}$  ( $T = 0.02\text{ s}$ )  $PW < 1/100(0.01\text{ s})$  Step : 0.50 ms b

### Find : 출력전압 전류 최대, 최소값

## 8.10 PWM 변조 기술



- PWM(Pulse Width Modulation)
- 정교한 정현파(sin wave)를 얻을 수 있음

## 8.10 PWM 기술: 변조비

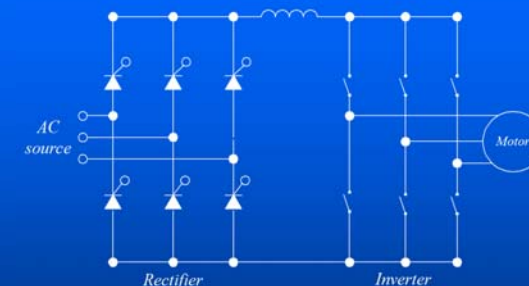
### ■ 주파수 변조비(Frequency Modulation Ratio)

$$m_f = \frac{f_{\text{carrier}}}{f_{\text{reference}}}$$

### ■ 크기 변조비(Amplitude Modulation Ratio)

$$m_a = \frac{V_{m \cdot \text{reference}}}{V_{m \cdot \text{carrier}}} \quad \text{if } m_a \leq 1 \quad V_1 = m_a V_{dc}$$

## 8.17 Induction Motor 속도제어



### ■ Speed Control

$$N = \frac{120f}{P}(1-s)$$

- 회전수는 주파수에 비례
- 주파수 제어로 정밀한 회전수(속도) 제어가 가능
- 전동열차, elevator, 전기차등에 사용

## UPS(무정전 전원공급장치)



- 정전시에 축전지에 저장된 DC를 INVERTER를 사용 AC로 변환하여 정전사고 방지
- UPS(Uninterruptible Power Supply)
- ESS(Energy Storage System): 에너지 저장장치

## 전력전자 종합

- AC → DC : 정류기(Rectifier)
- DC → AC : 인버터 (Inverter)
- AC → AC : AC-AC 컨버터 (AC-AC Converter)
- DC → DC : 초퍼 (DC chopper)
  - 승압 초퍼(Boost chopper)
  - 강압 초퍼(Buck chopper)
  - 강압 및 승압 초퍼(Buck-Boost chopper)

## 참고자료: Induction Motor 속도제어기



## 참고자료: UPS

