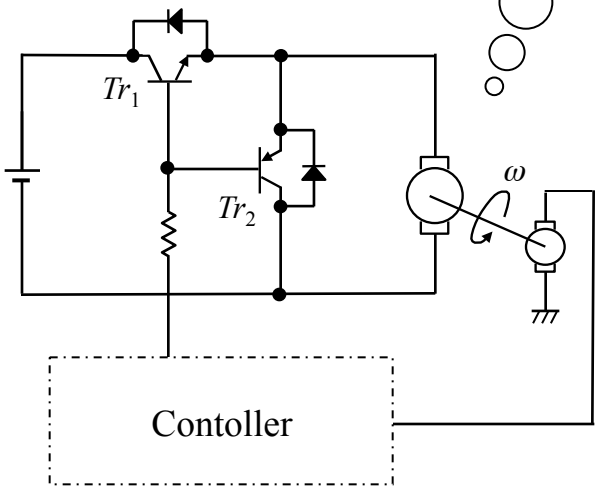
Power Electronics
No. 12: Half-bridge Inverter

Takeshi Furuhashi

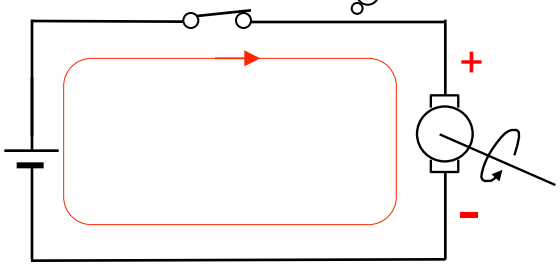
Furuhashi_at_cse.nagoya-u.ac.jp

Backward rotation is not available.

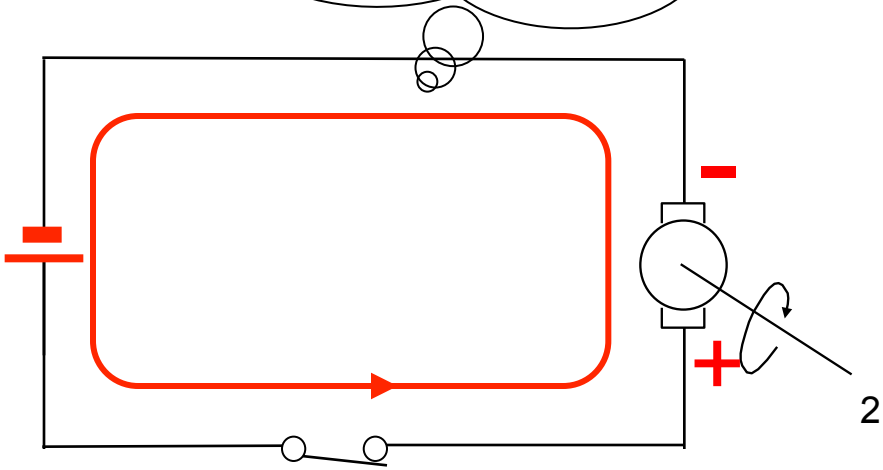


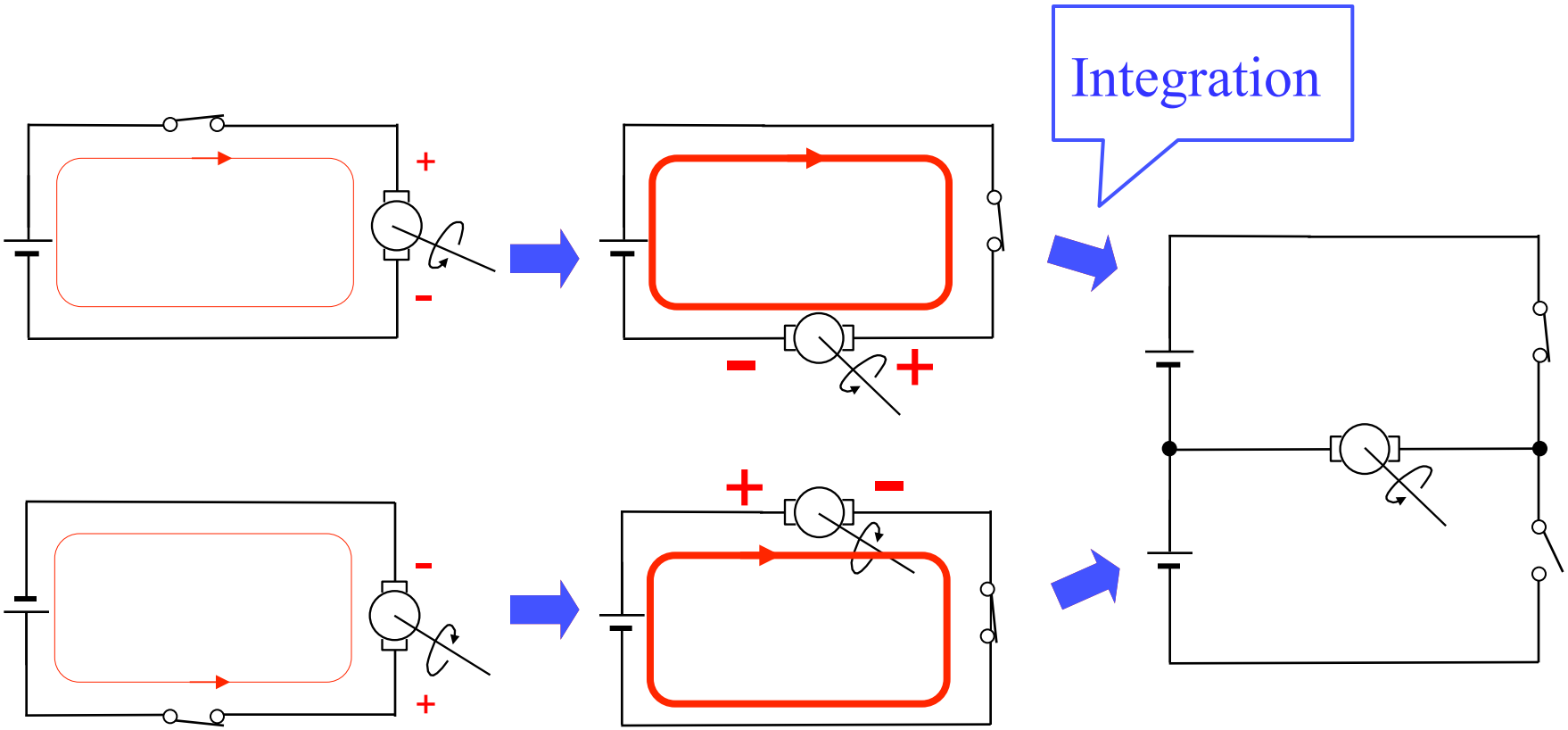
Step-up/down chopper for driving/ braking of the DC motor

Forward rotation



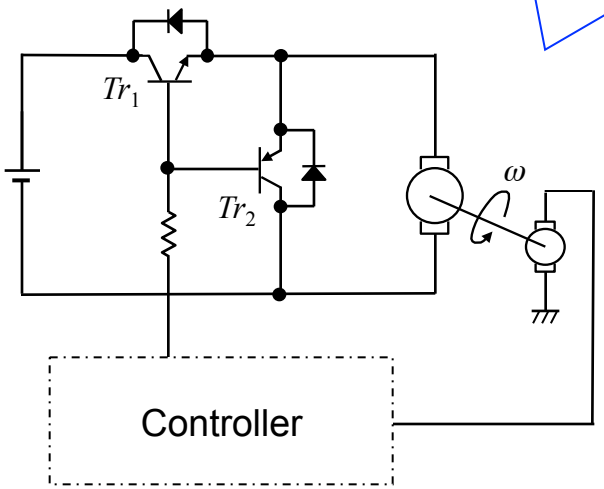
This circuit is necessary for backward rotation

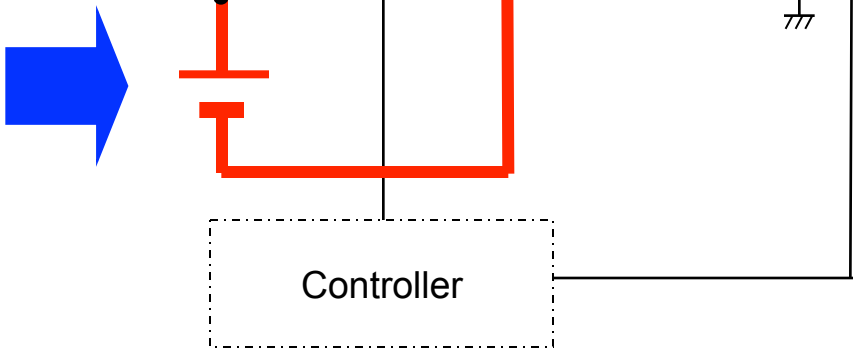




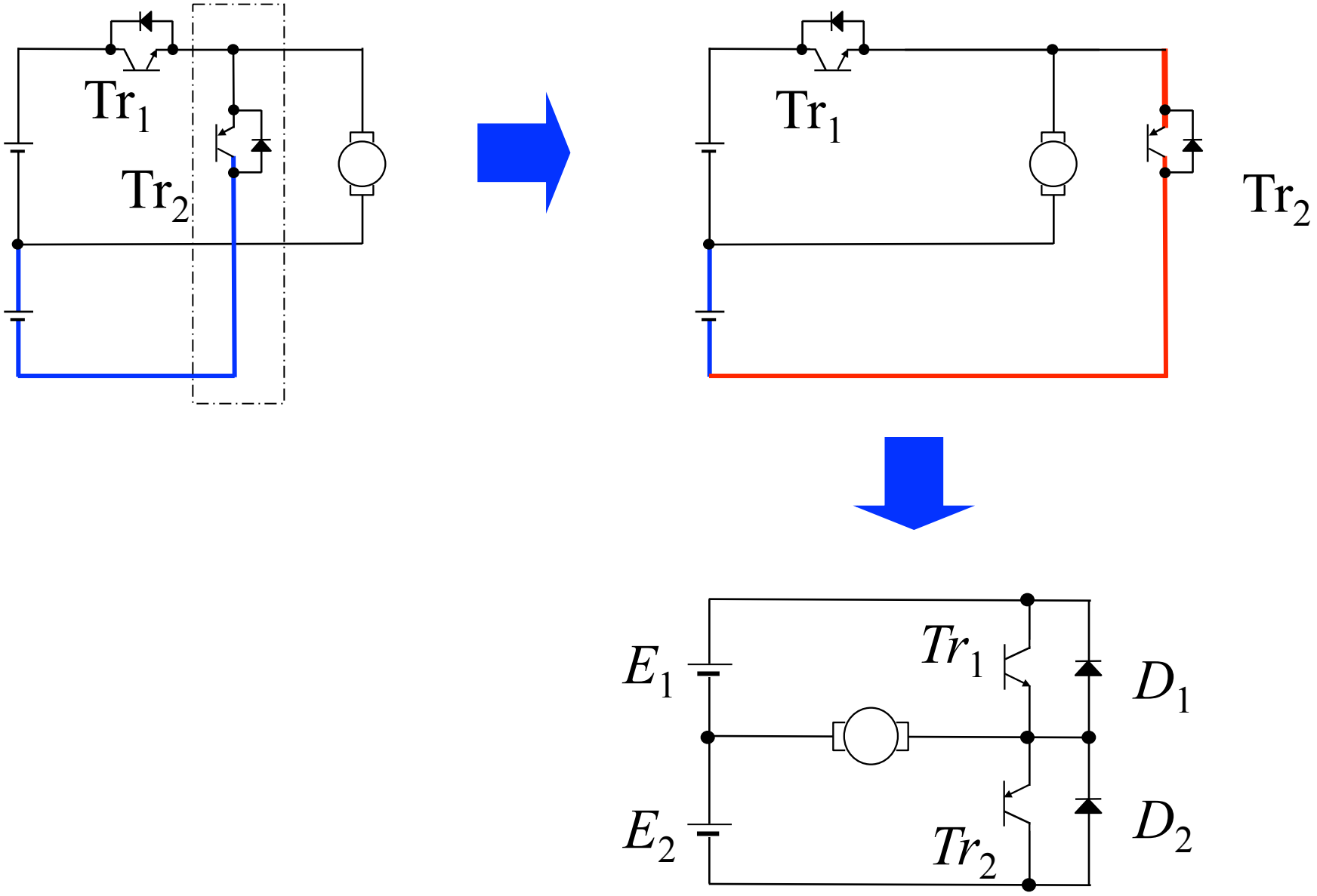
Integration of circuits for forward/reverse rotation

A small modification is needed.

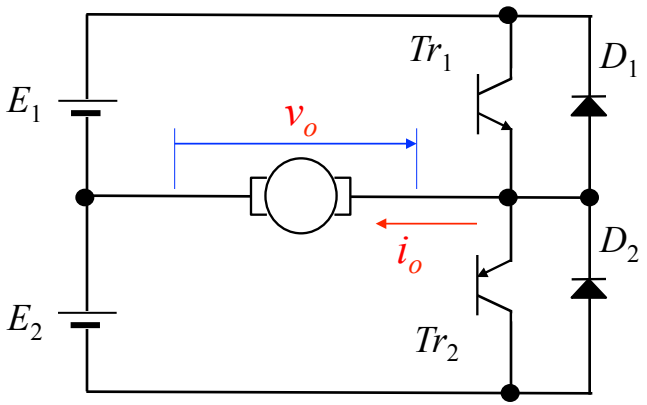




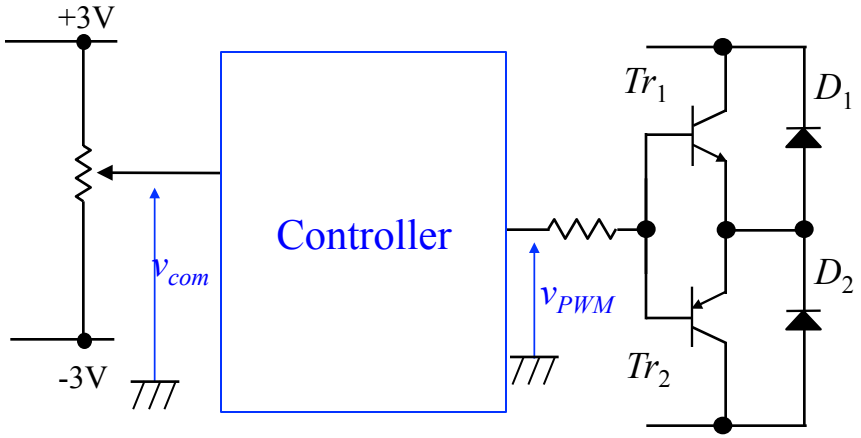
Step-up/down chopper for driving/ braking of the DC motor



Half-bridge inverter



Half-bridge inverter

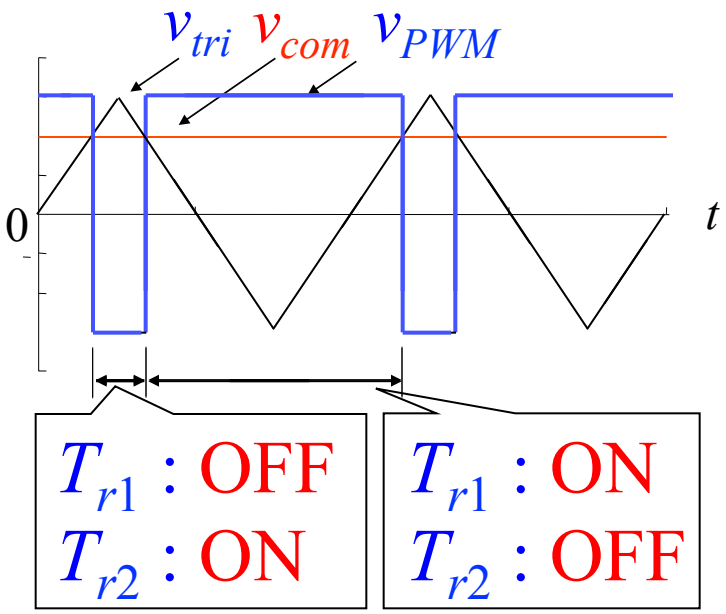


PWM waveform generator

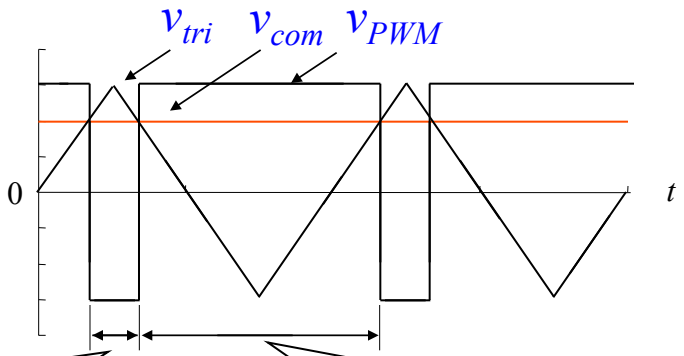
PWM control scheme for half-bridge inverter

If $v_{com} \geq v_{tri}$, T_{r1} : ON T_{r2} : OFF

If $v_{com} < v_{tri}$, T_{r1} : OFF T_{r2} : ON

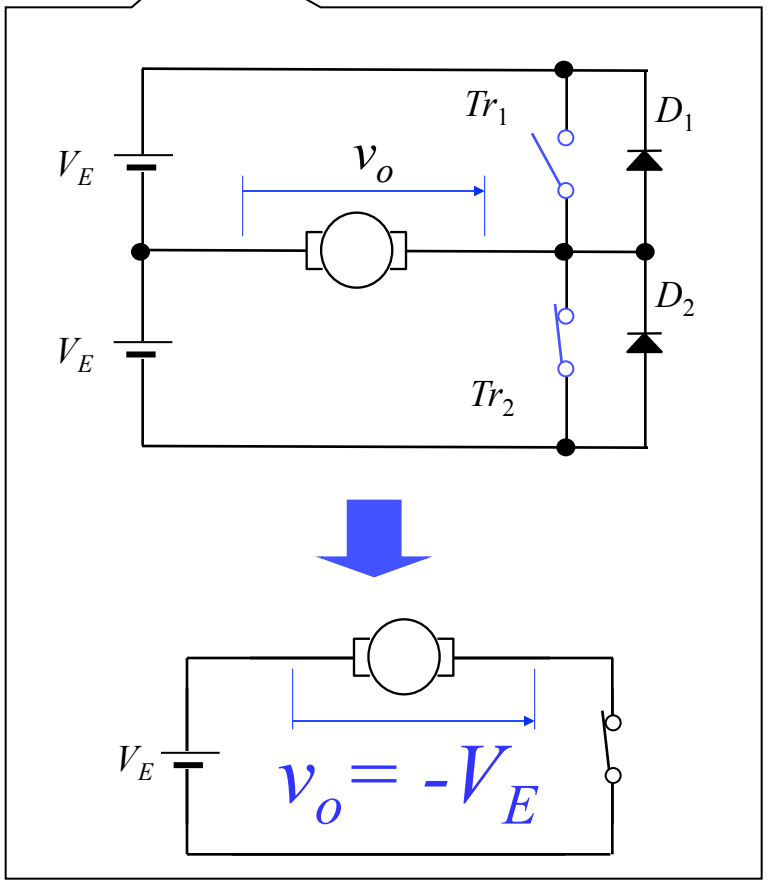


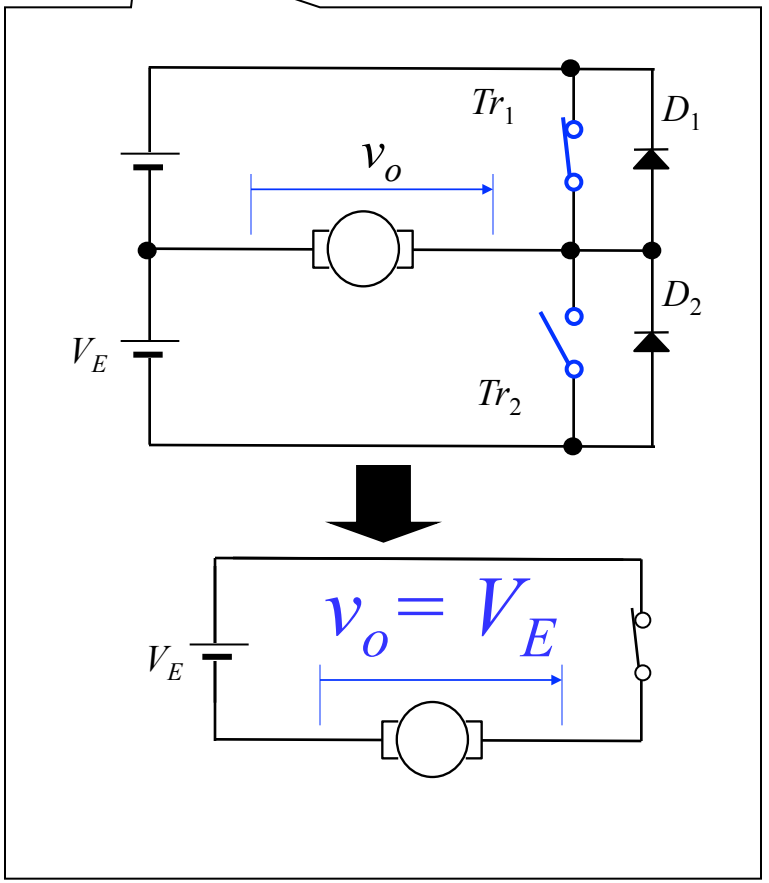
PWM waveform

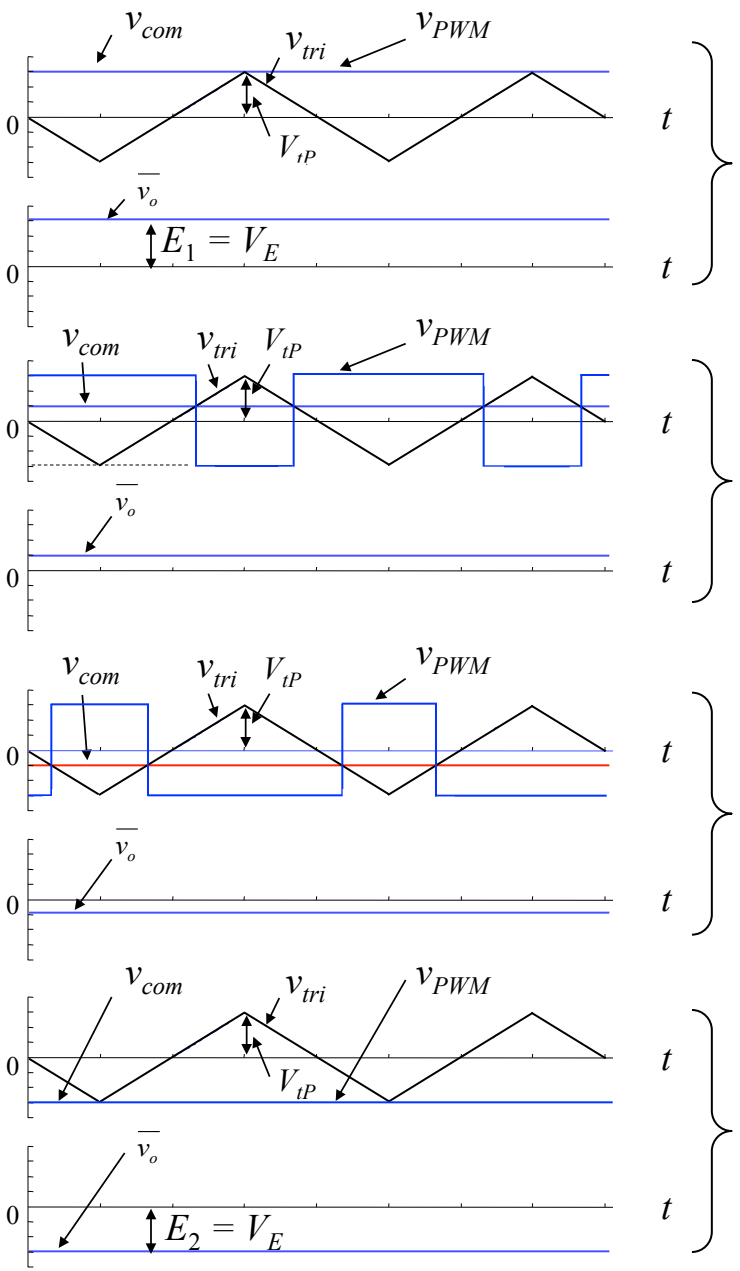


T_{r1} : OFF T_{r2} : ON

T_{r1}: ON T_{r2}: OFF







If $v_{com} = V_{tP},\ \delta_1 = 1$

$$\bar{v}_o = V_E$$

If $v_{com} = \frac{1}{3}V_{tP},\ \delta_1 = \frac{2}{3}$

$$\bar{v}_o = \frac{1}{3}V_E$$

If $v_{com} = -\frac{1}{3}V_{tP},\ \delta_1 = \frac{1}{3}$

$$\bar{v}_o = -\frac{1}{3}V_E$$

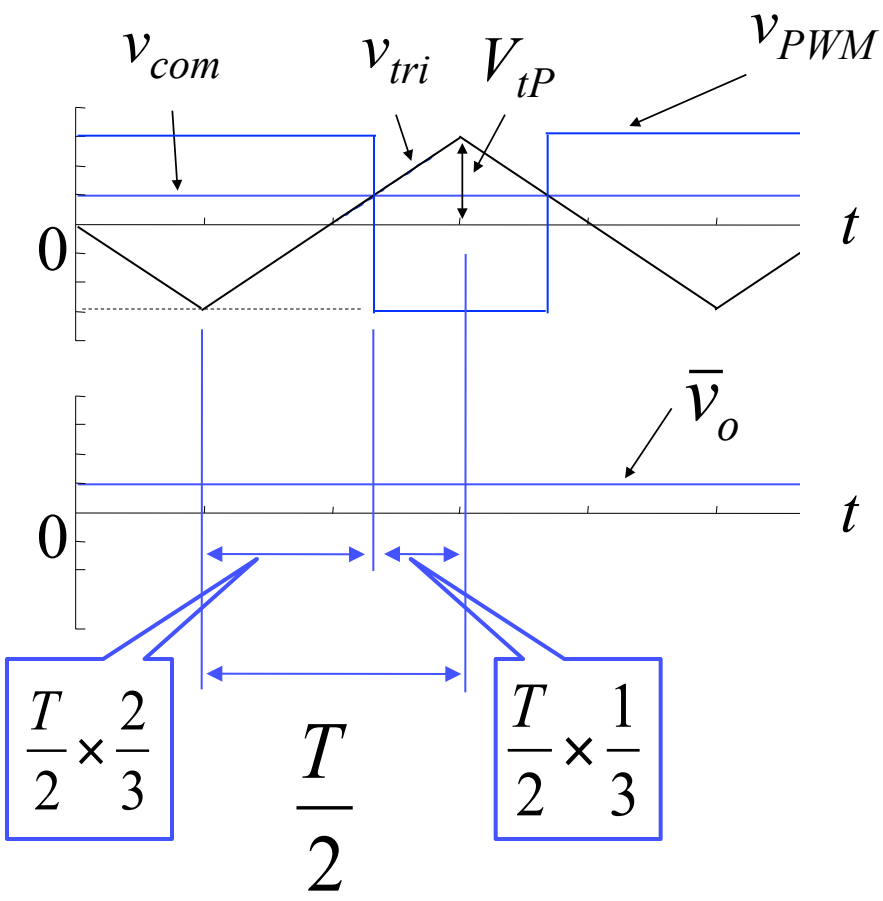
If $v_{com} = -V_{tP},\ \delta_1 = 0$

$$\bar{v}_o = -V_E$$

$$\delta_1 = \frac{1}{2}\left(\frac{v_{com}}{V_{tP}} + 1\right)$$

Half-bridge inverter and PWM waveforms

If $v_{com} = \frac{1}{3} V_{tP}$

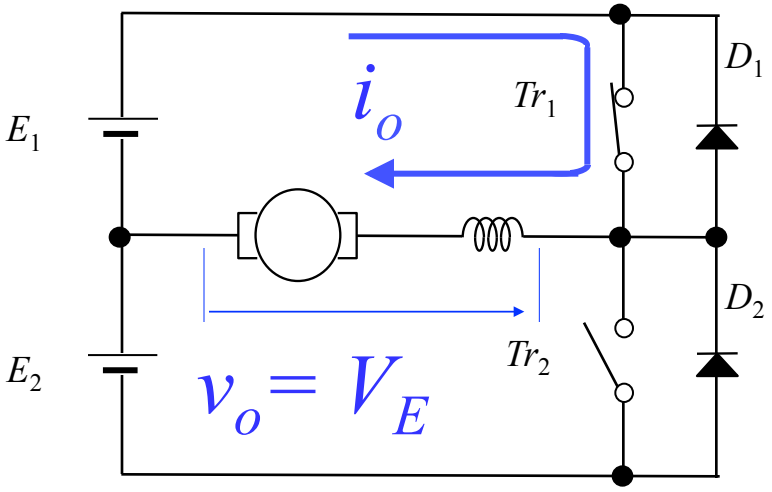


$$\bar{v}_o = \frac{2}{T}\int_0^{T/2} v_o dt$$

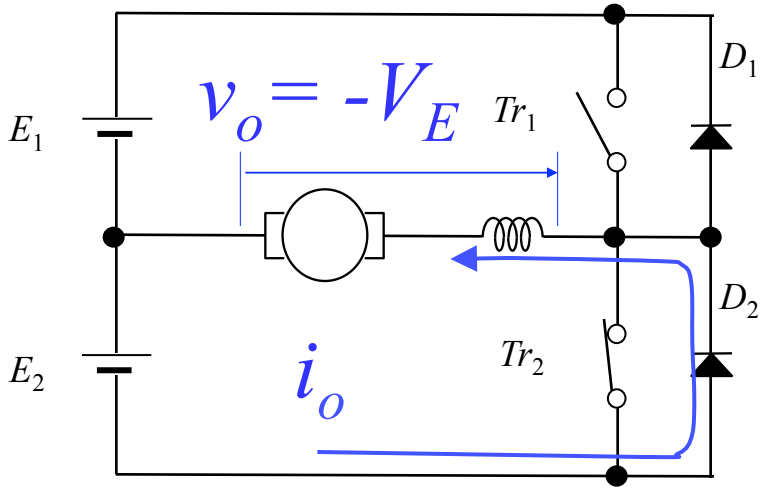
$$= \frac{2}{T}\left(\frac{T}{2} \times \frac{2}{3} V_E - \frac{T}{2} \times \frac{1}{3} V_E\right)$$

$$= \frac{1}{3} V_E$$

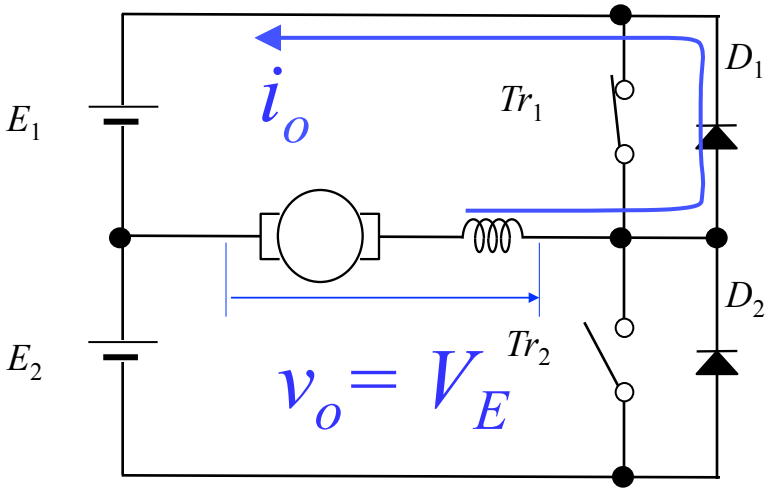
Four modes of the half-bridge inverter



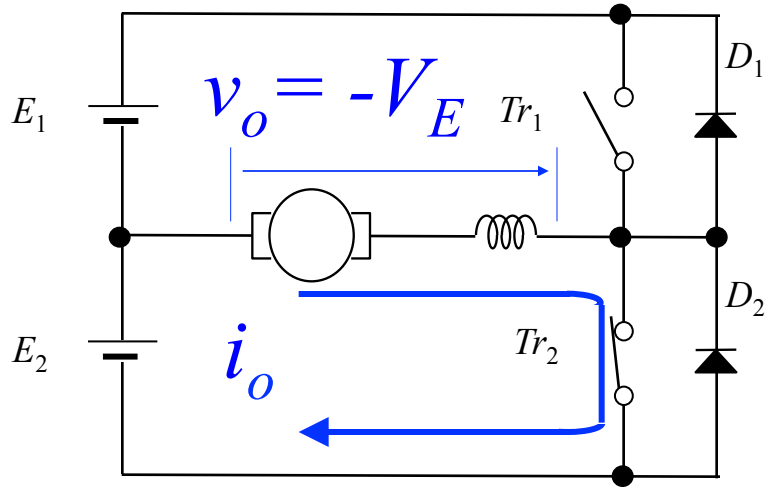
(a) $i_o > 0$, Tr_1: ON, Tr_2 : OFF



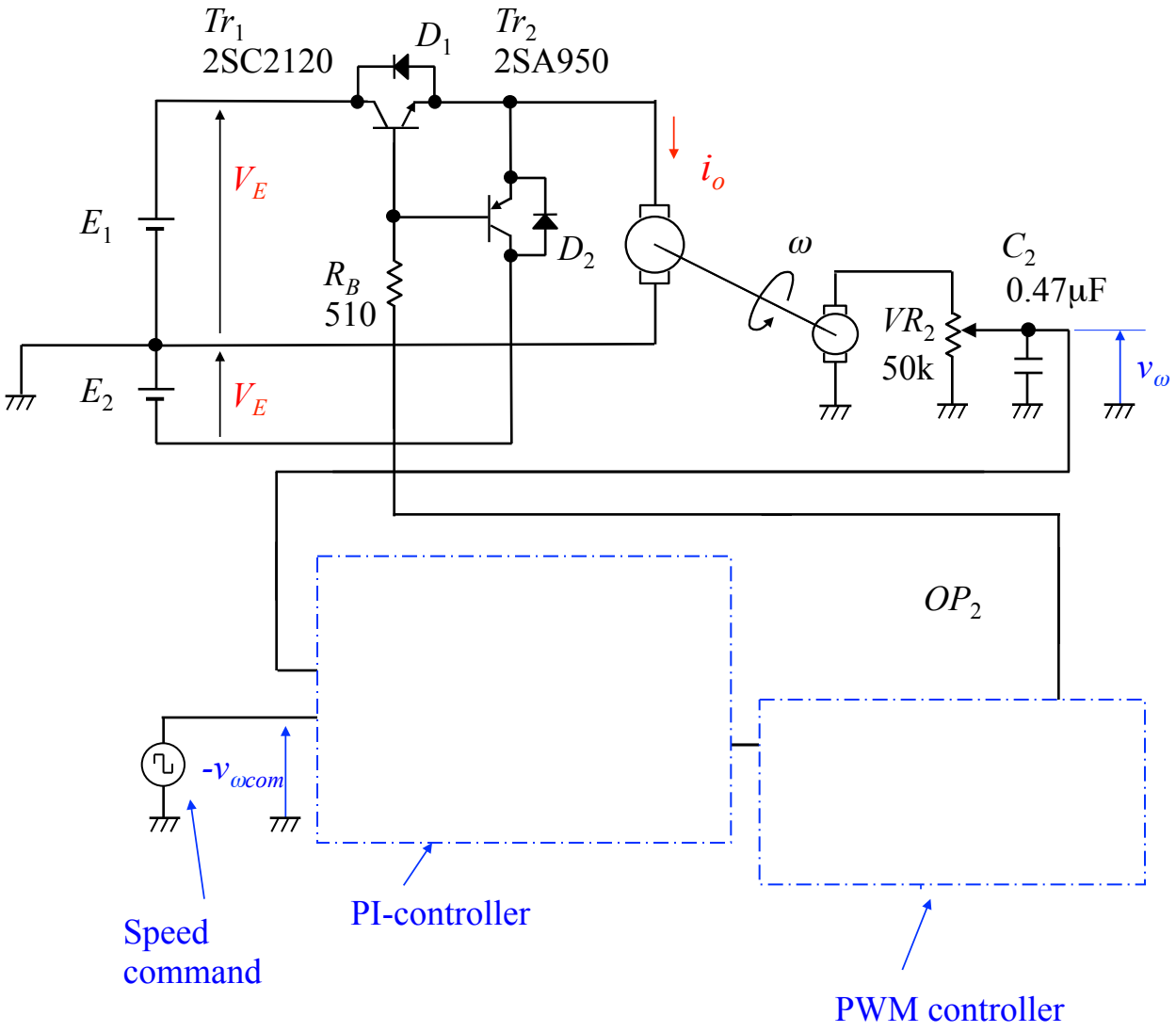
(b) $i_o > 0$, Tr_1: OFF, Tr_2: ON



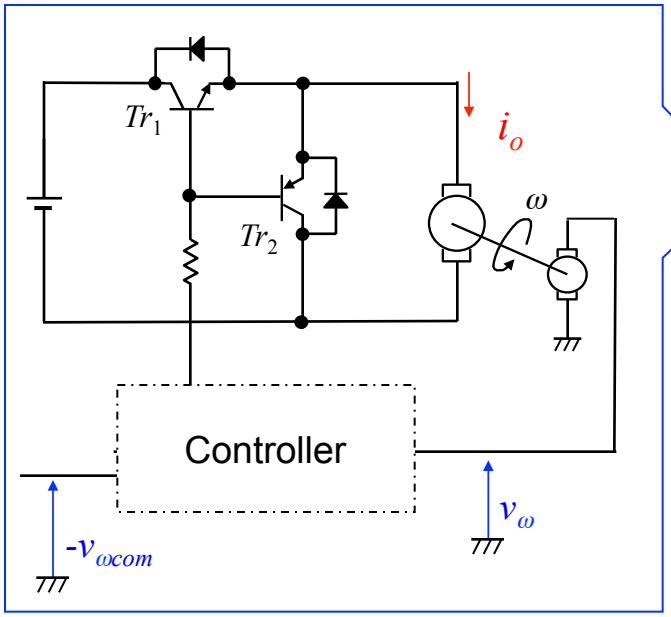
(c) $i_o < 0$, Tr_1: ON, Tr_2: OFF

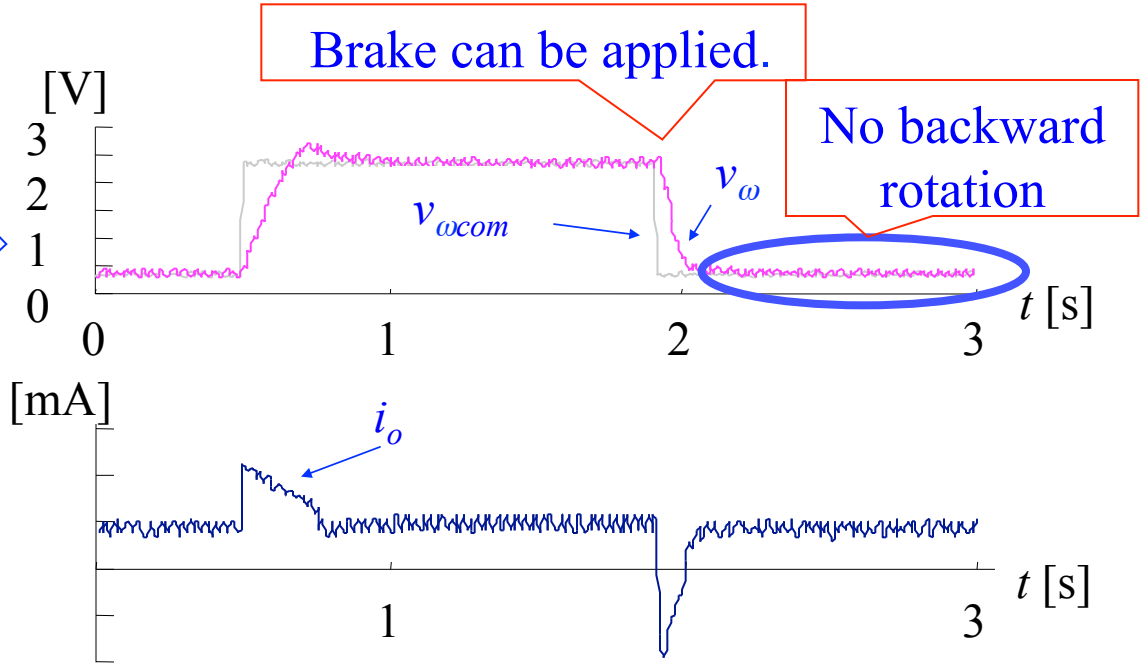


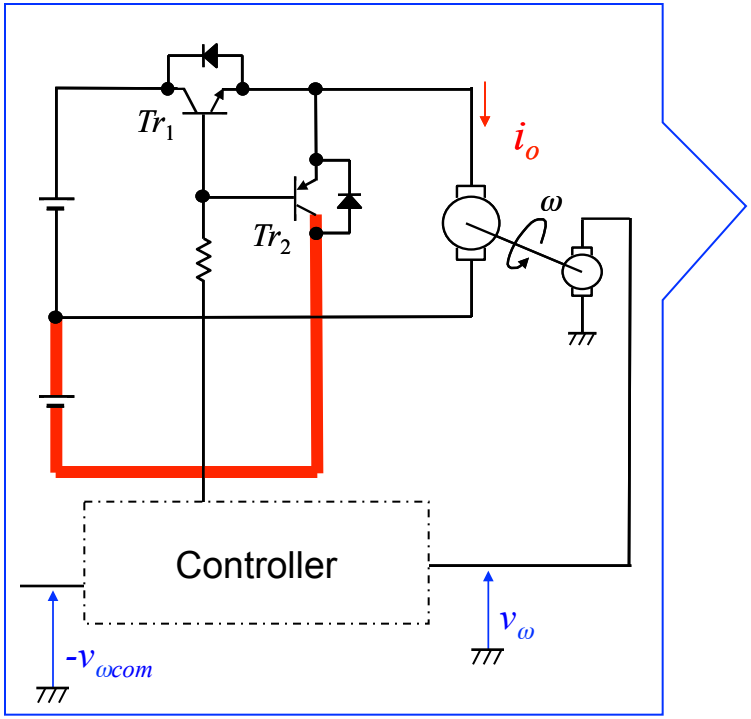
(d) $i_o < 0$, Tr_1: OFF, Tr_2: ON

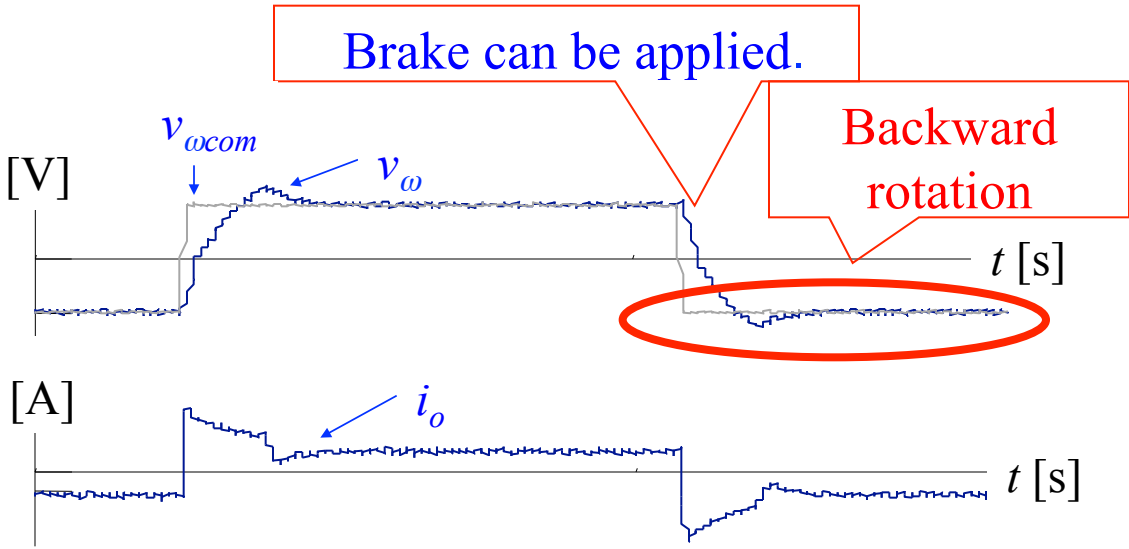


Half-bridge inverter and motor speed controller





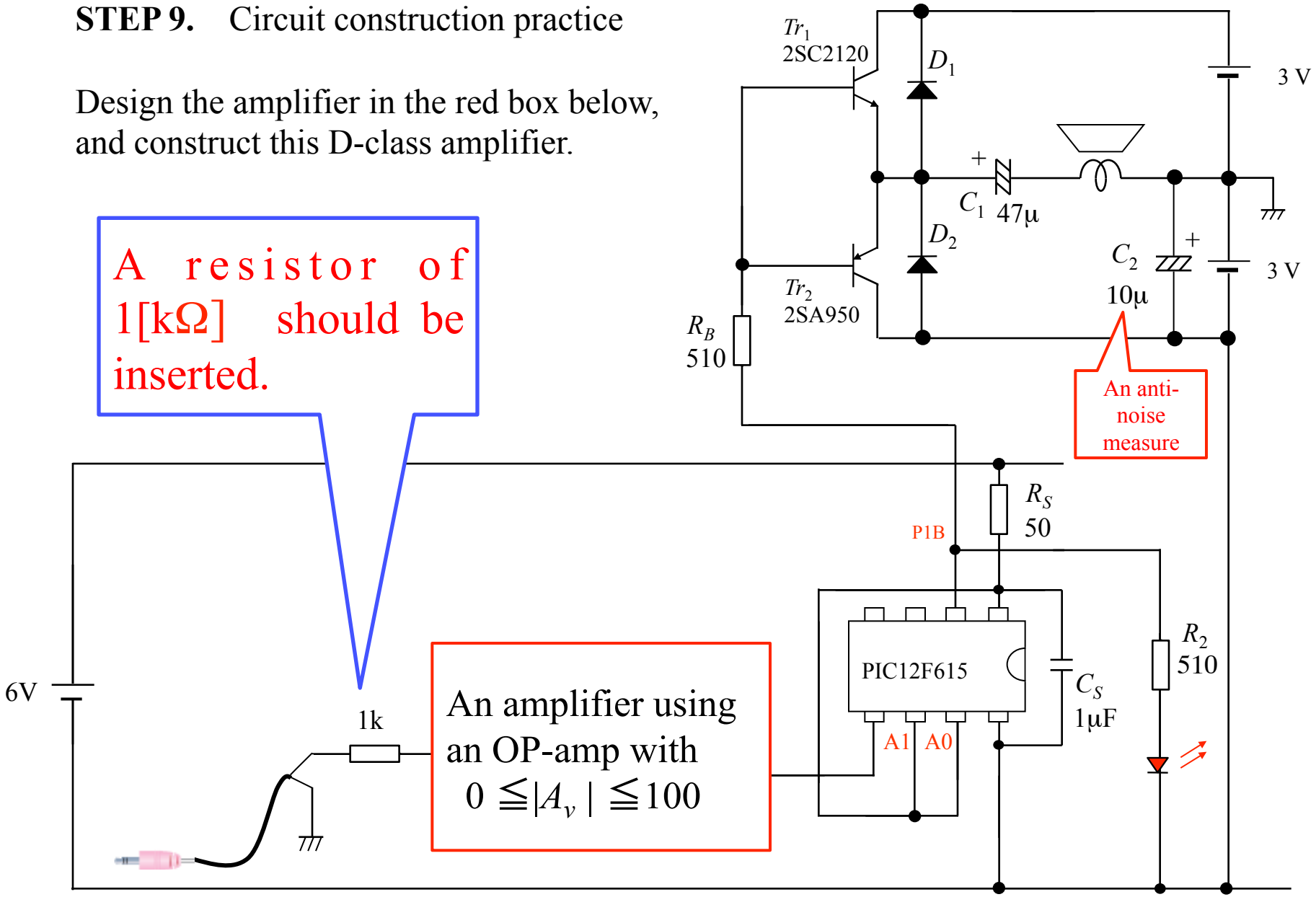




DC motor drive by a half-bridge inverter

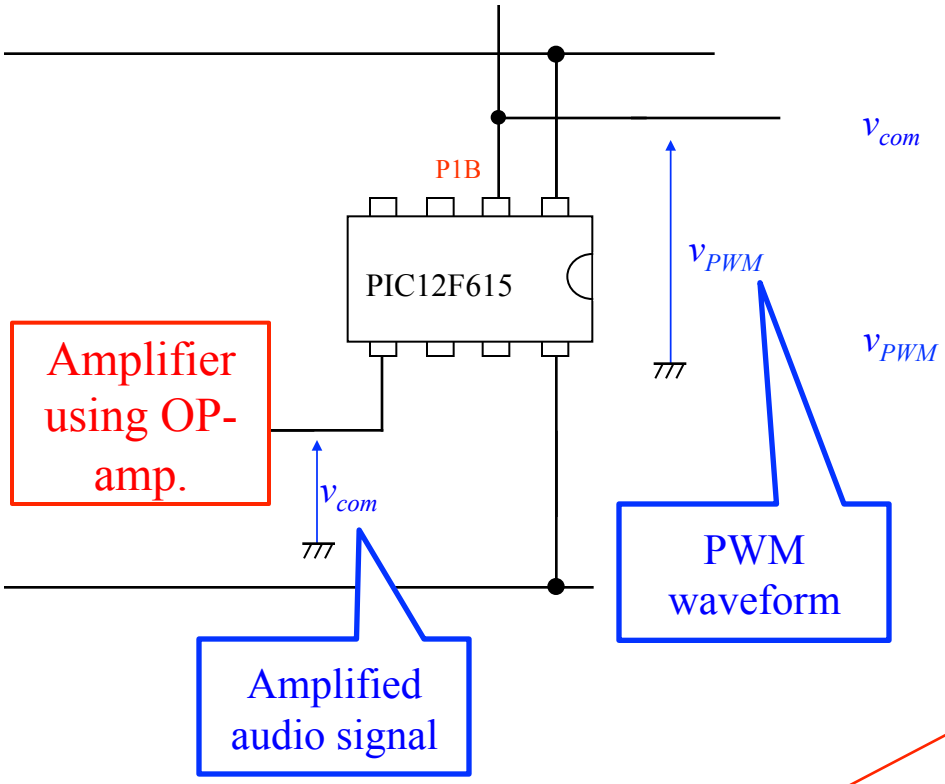
STEP 9. Circuit construction practice

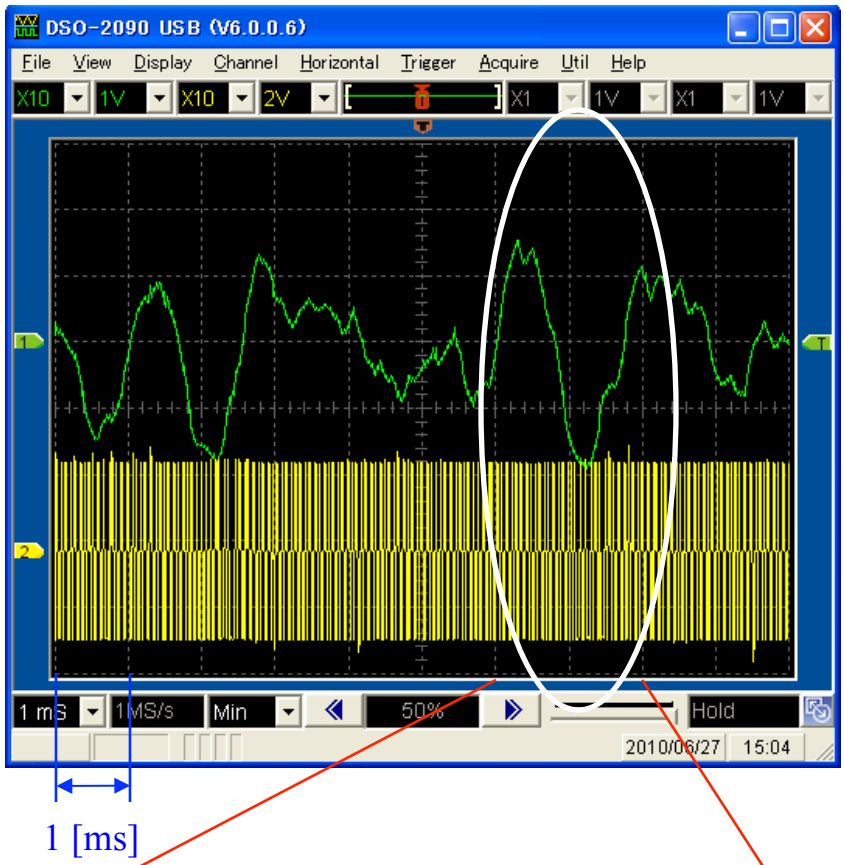
Design the amplifier in the red box below, and construct this D-class amplifier.



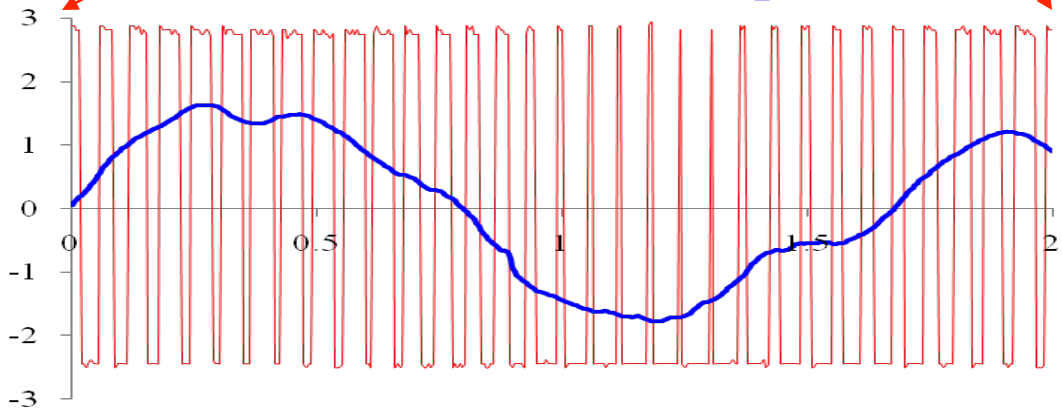
(A1 A0 = 11 : for D-class amp.)

STEP 9. Waveform of v_{PWM} for driving a half-bridge inverter

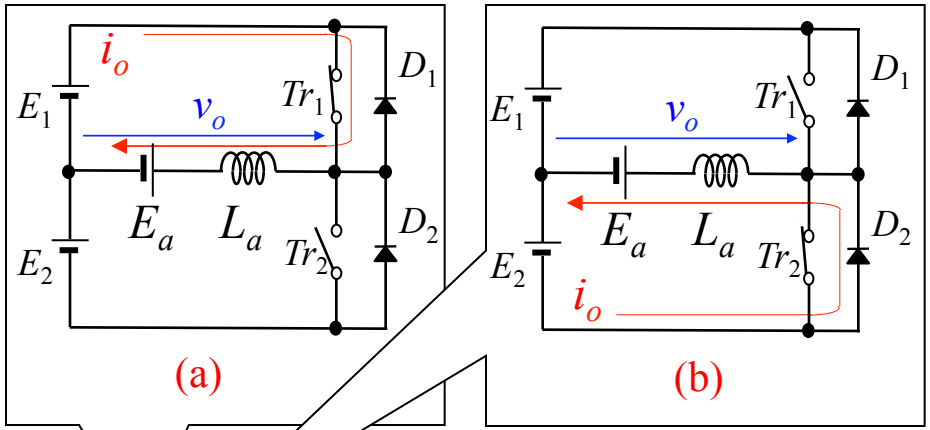




Time axis is expanded.



STEP 9. Problem In period (1) of Fig. 1, modes (a) and (b) are repeated. The output voltage v_o and output current i_o are given in Fig. 2. At the end of period (1), the speed command $v_{\omega com}$ is changed from positive to negative. Then, the voltage v_o is controlled as shown in Fig.2 and the current i_o drops quickly to be negative as shown in Fig. 2. Write the modes that occur in the inverter and the time durations when those modes appear after the command change in Fig. 2. At all times, in Fig. 2, the motor electro-motive force v_ω is assumed to be constant.



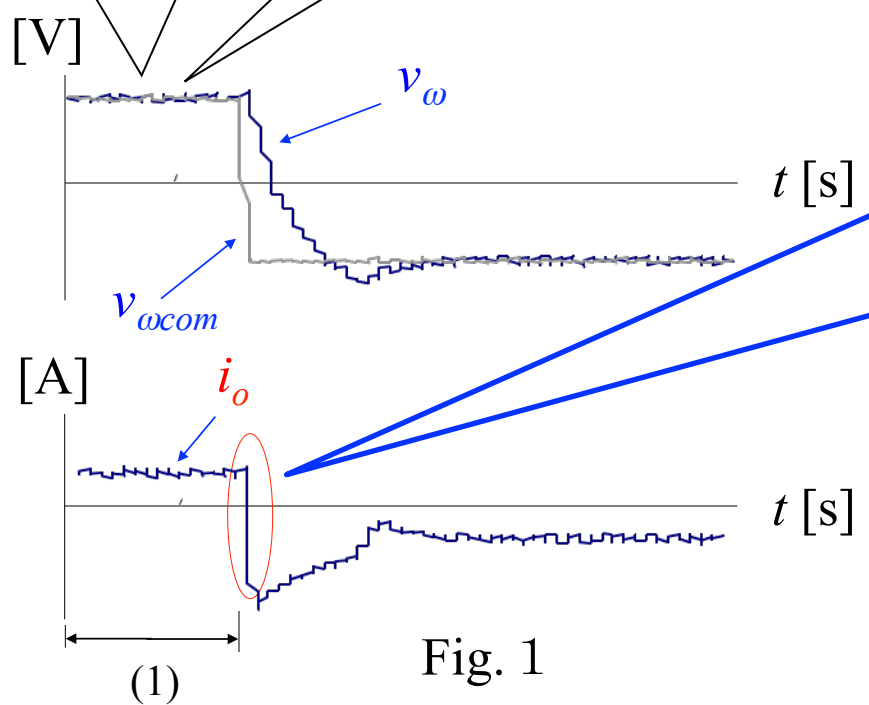


Fig. 1

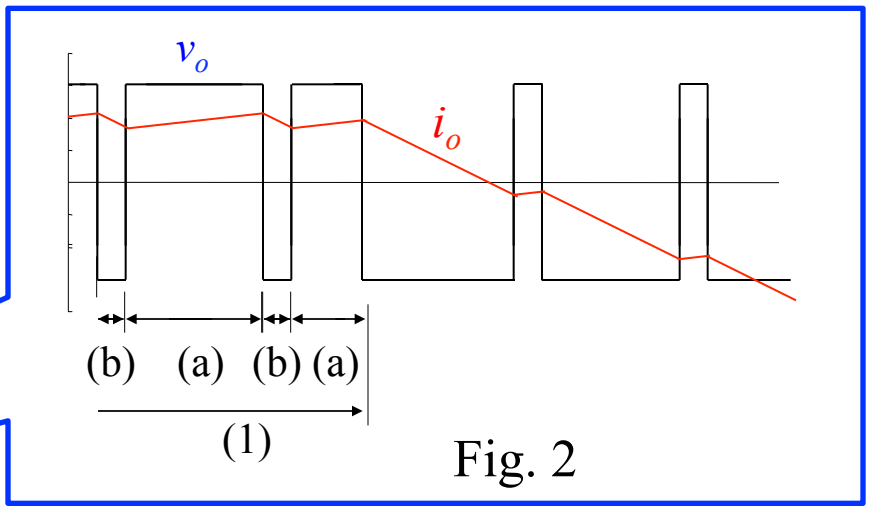


Fig. 2