

AT-NPC Module Switching Pattern (Three Phase)

Fuji Electric Co., Ltd.

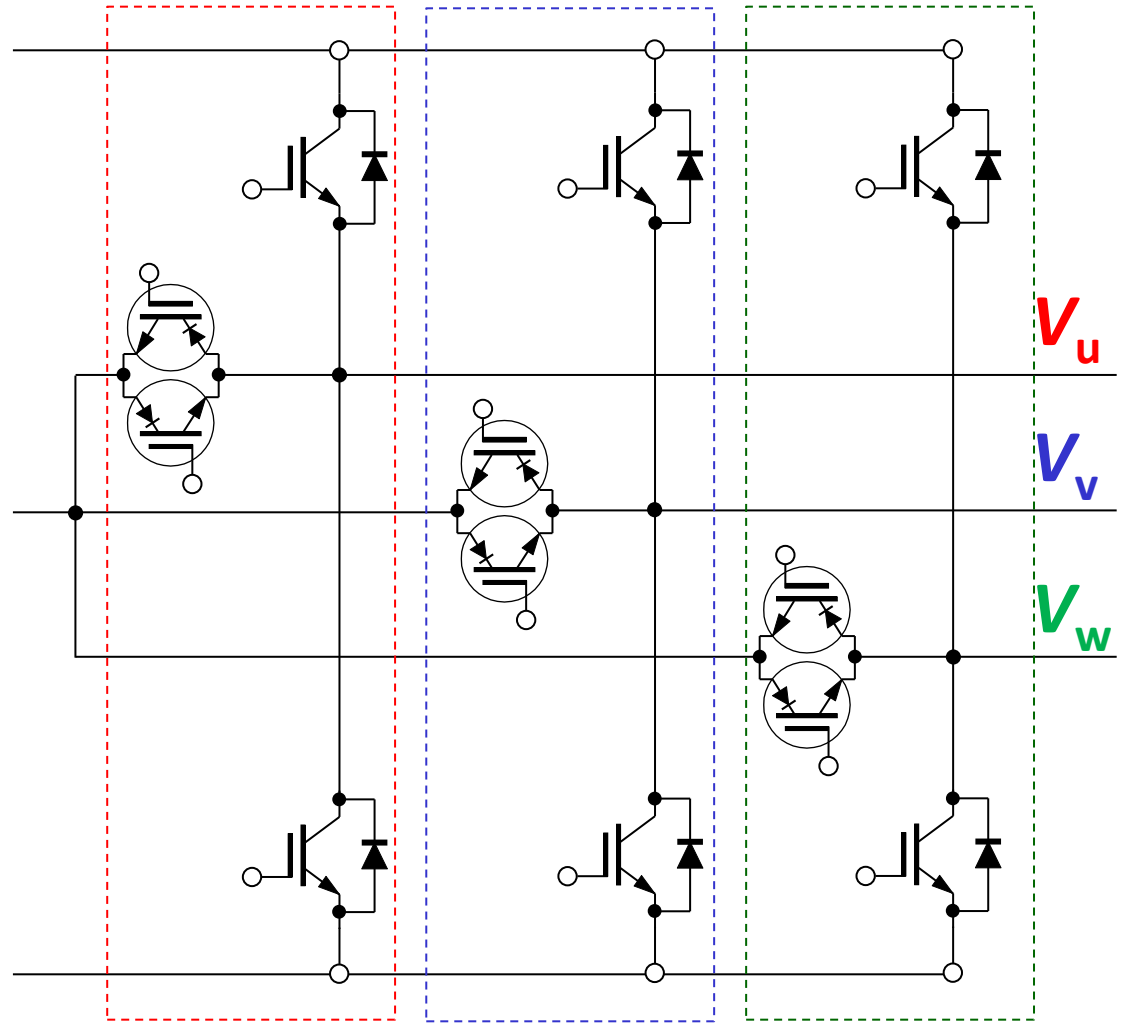
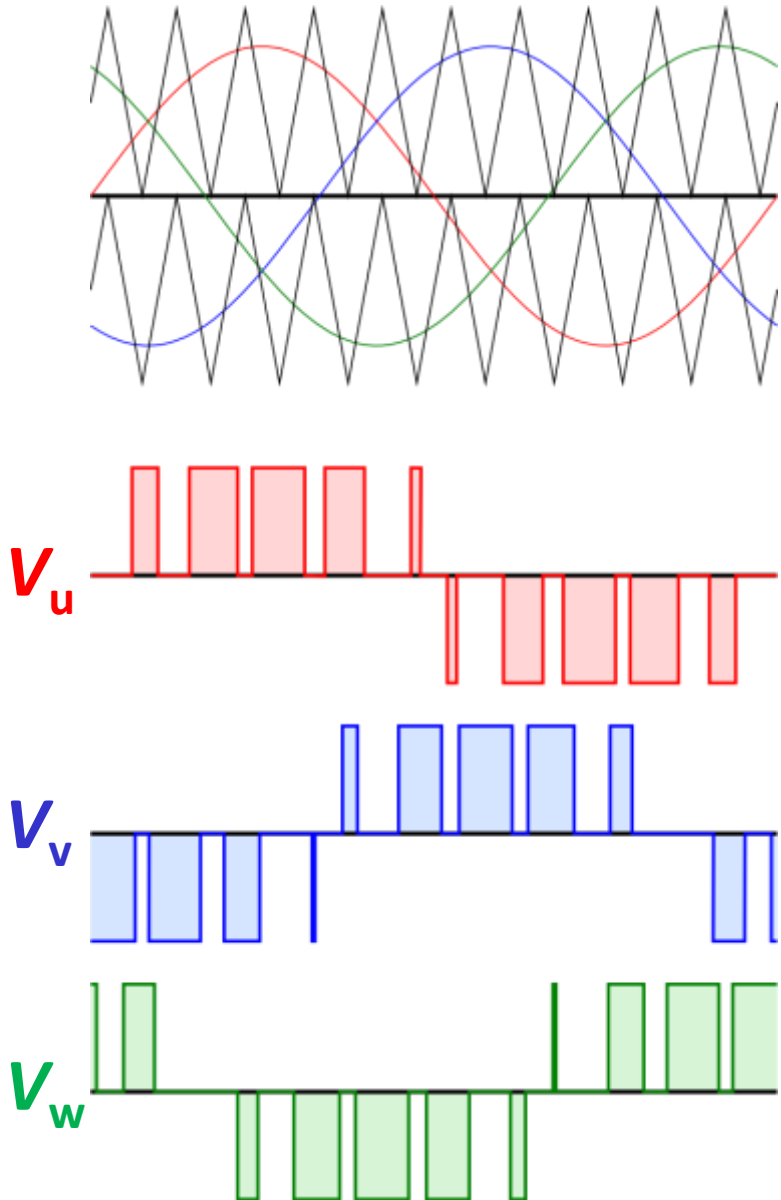
Device Application Technology Dept.

Semiconductor Div.

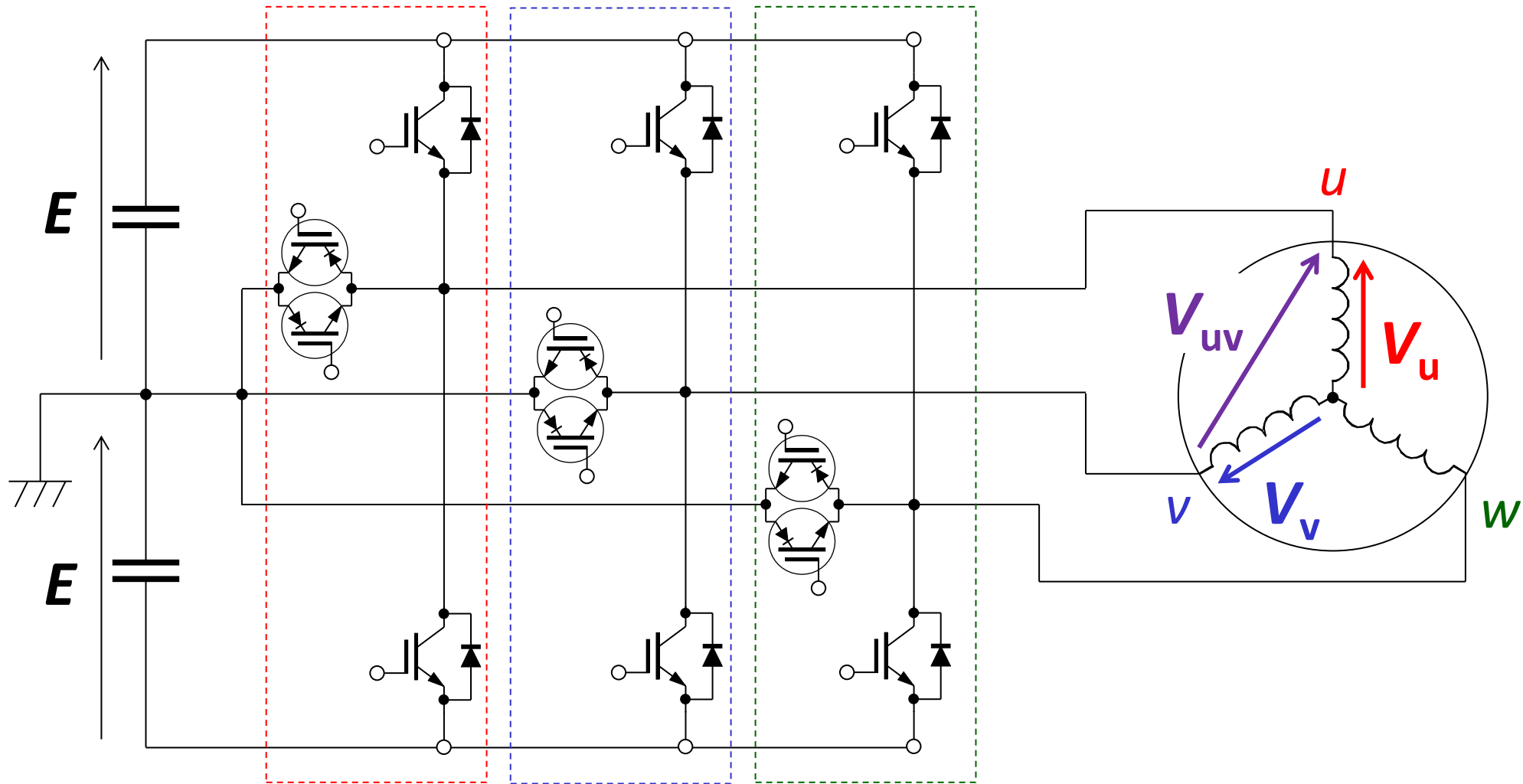
Sales Group

Mar, 2015

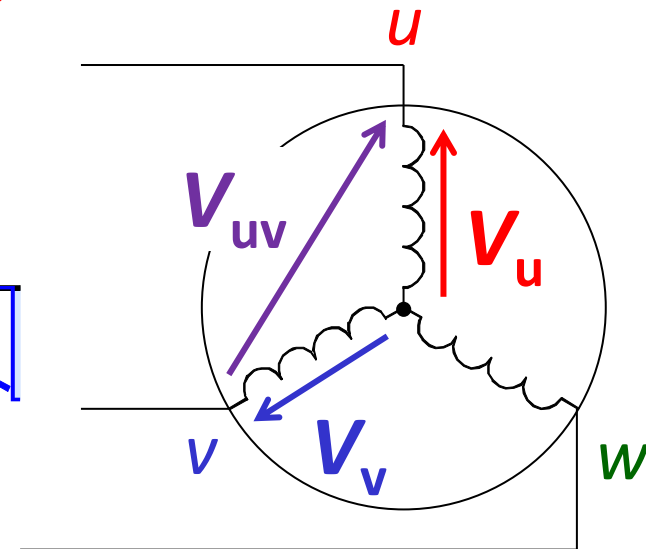
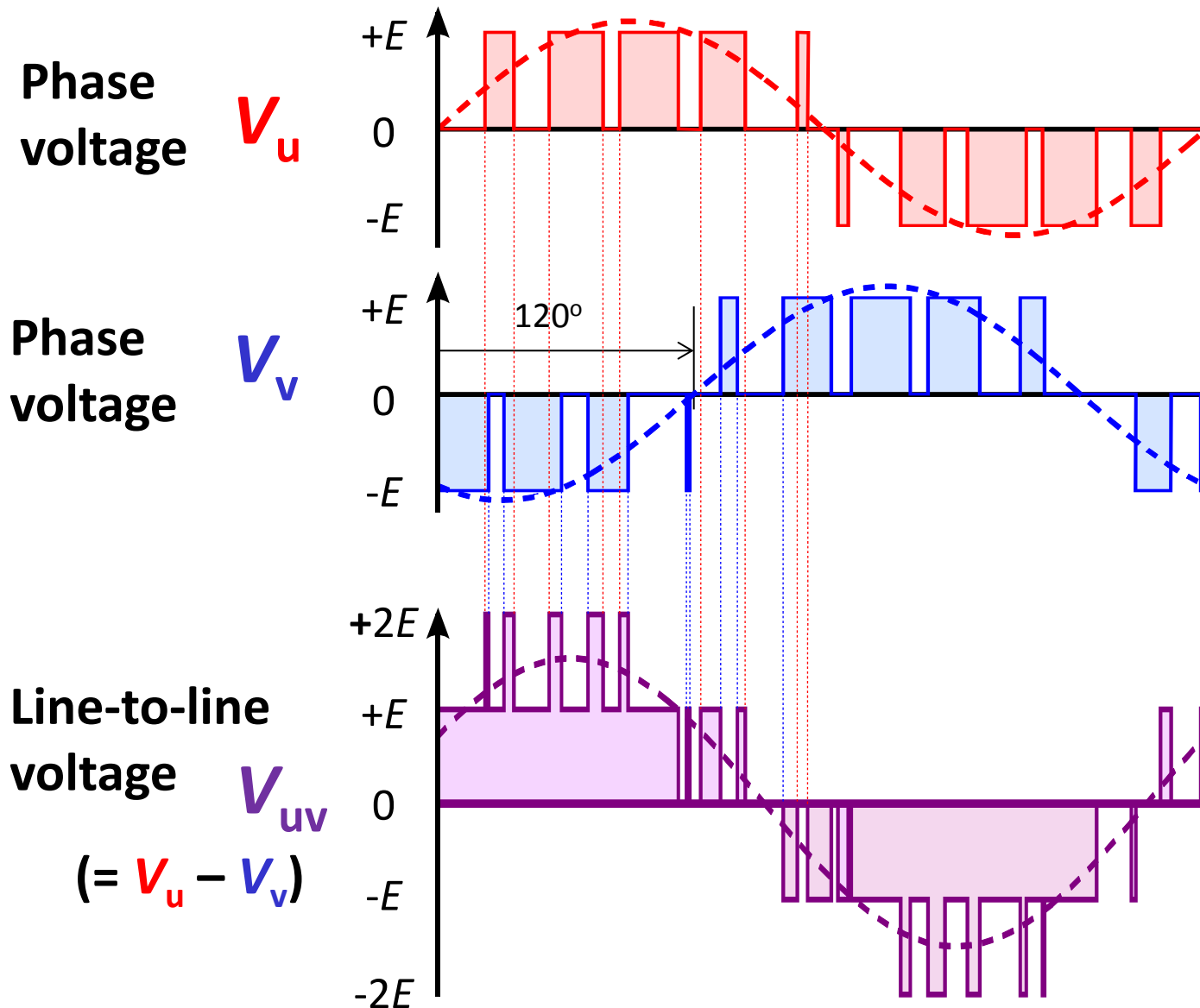
3-phase 3-level Circuit (AT-NPC)



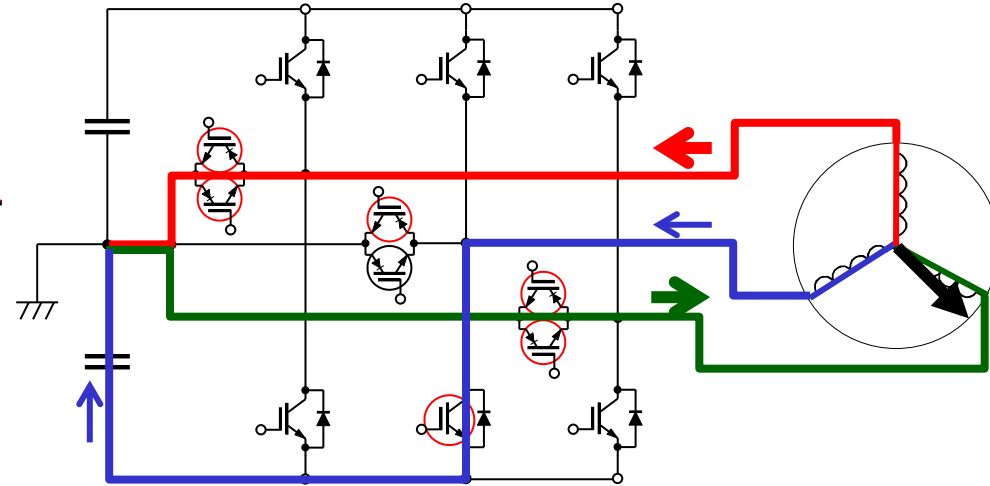
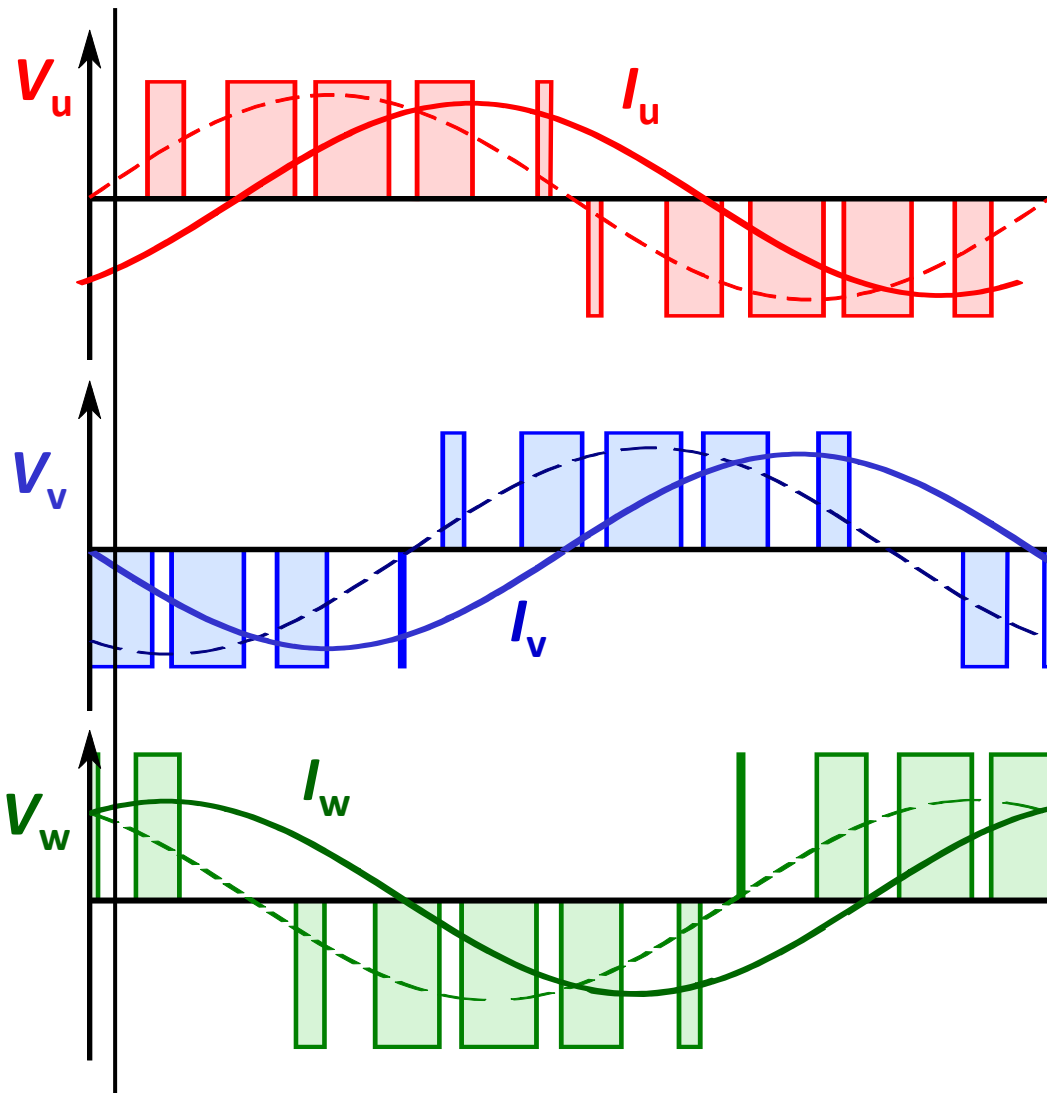
3-phase 3-level Circuit



Output Line-to-Line Voltage

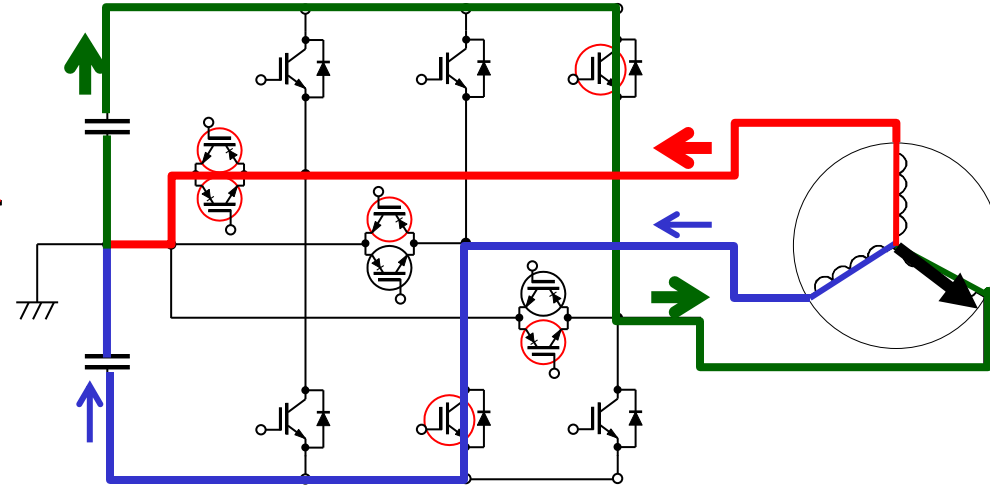
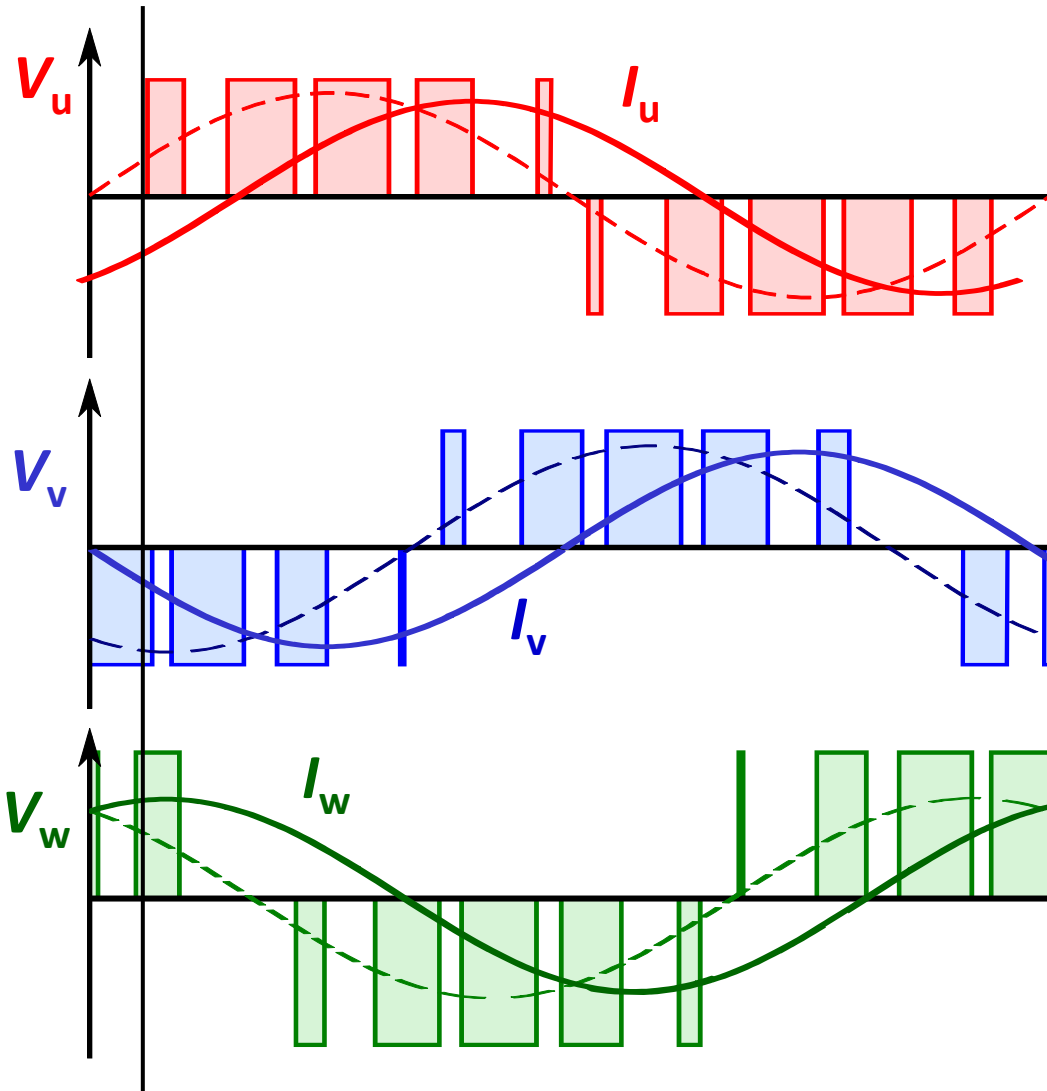


3-Phase Circuit with Inductive Load



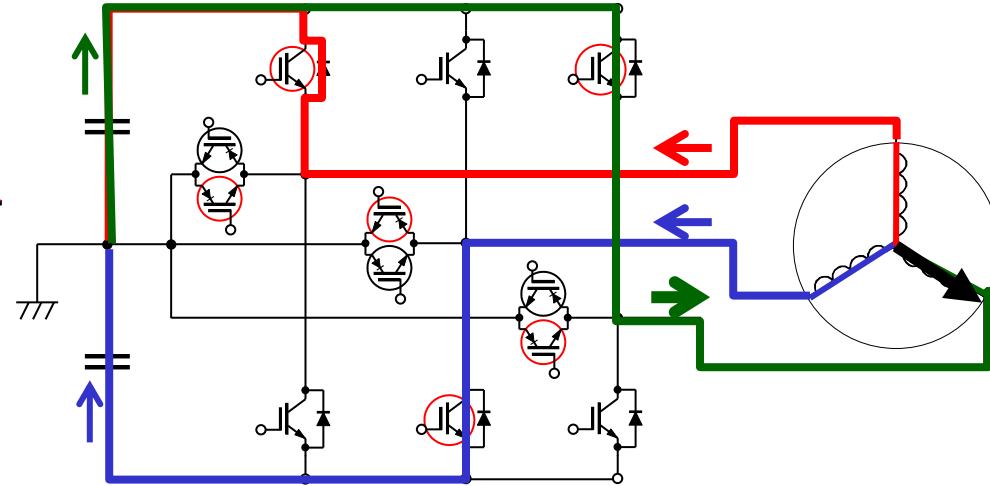
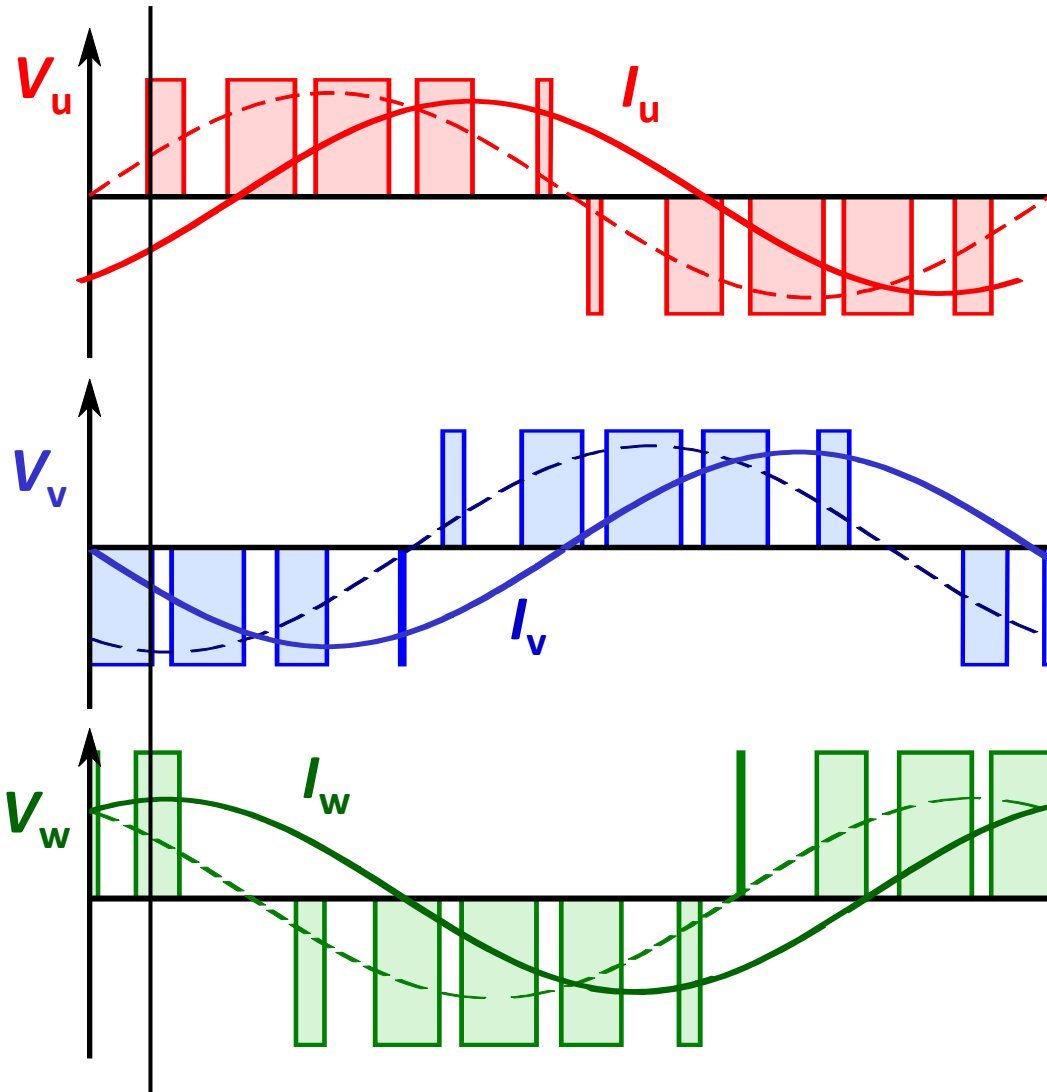
V_u	V_v	V_w
0	$-E$	0
I_u	I_v	I_w
RB-FW	-IGBT	RB-FW

3-Phase Circuit with Inductive Load



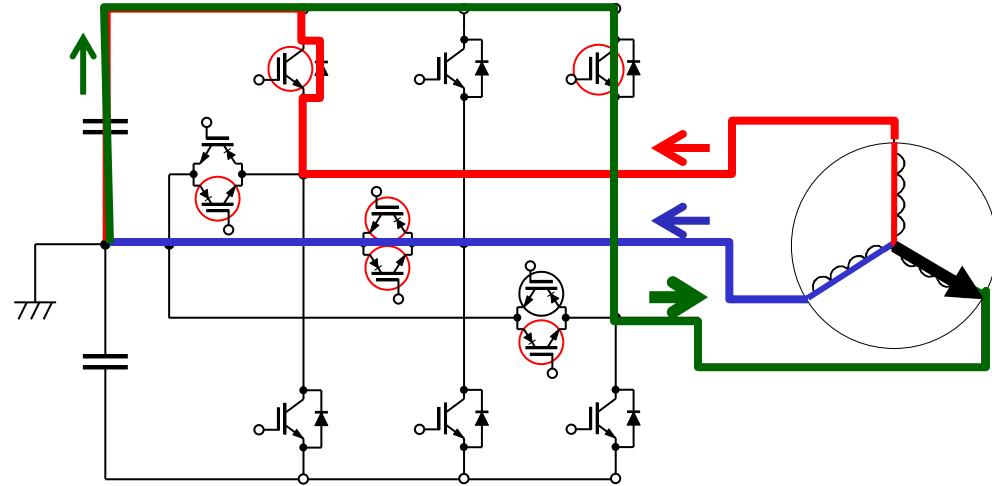
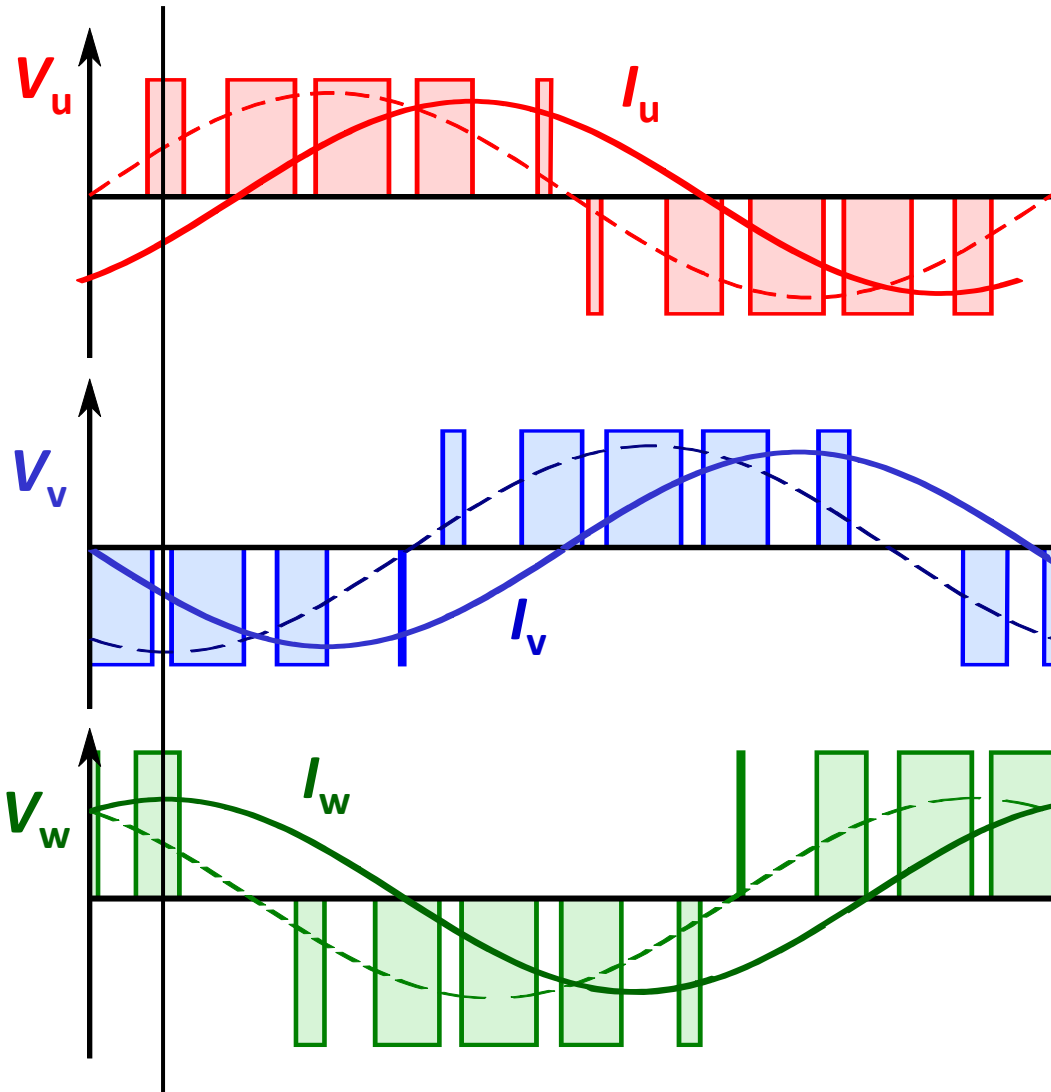
V_u	V_v	V_w
0	-E	+E
I_u	I_v	I_w
RB-FW	-IGBT	+IGBT

3-Phase Circuit with Inductive Load



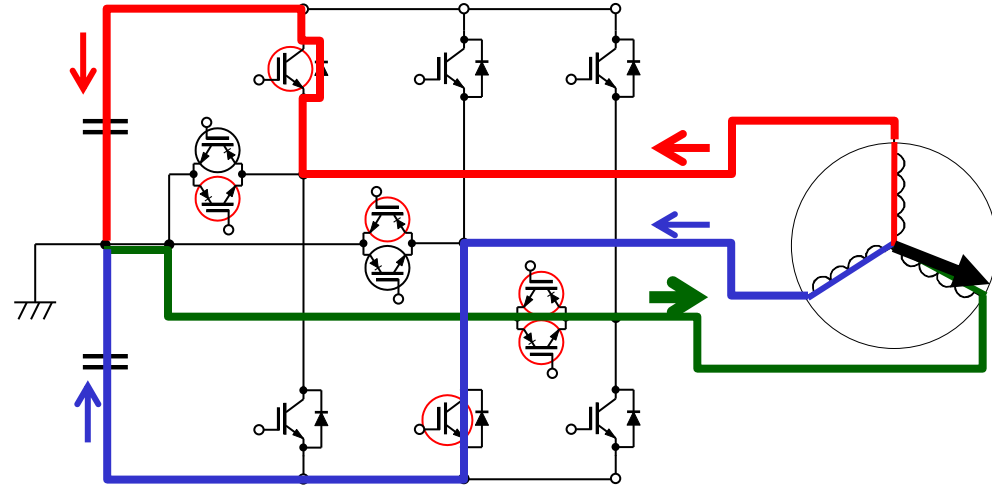
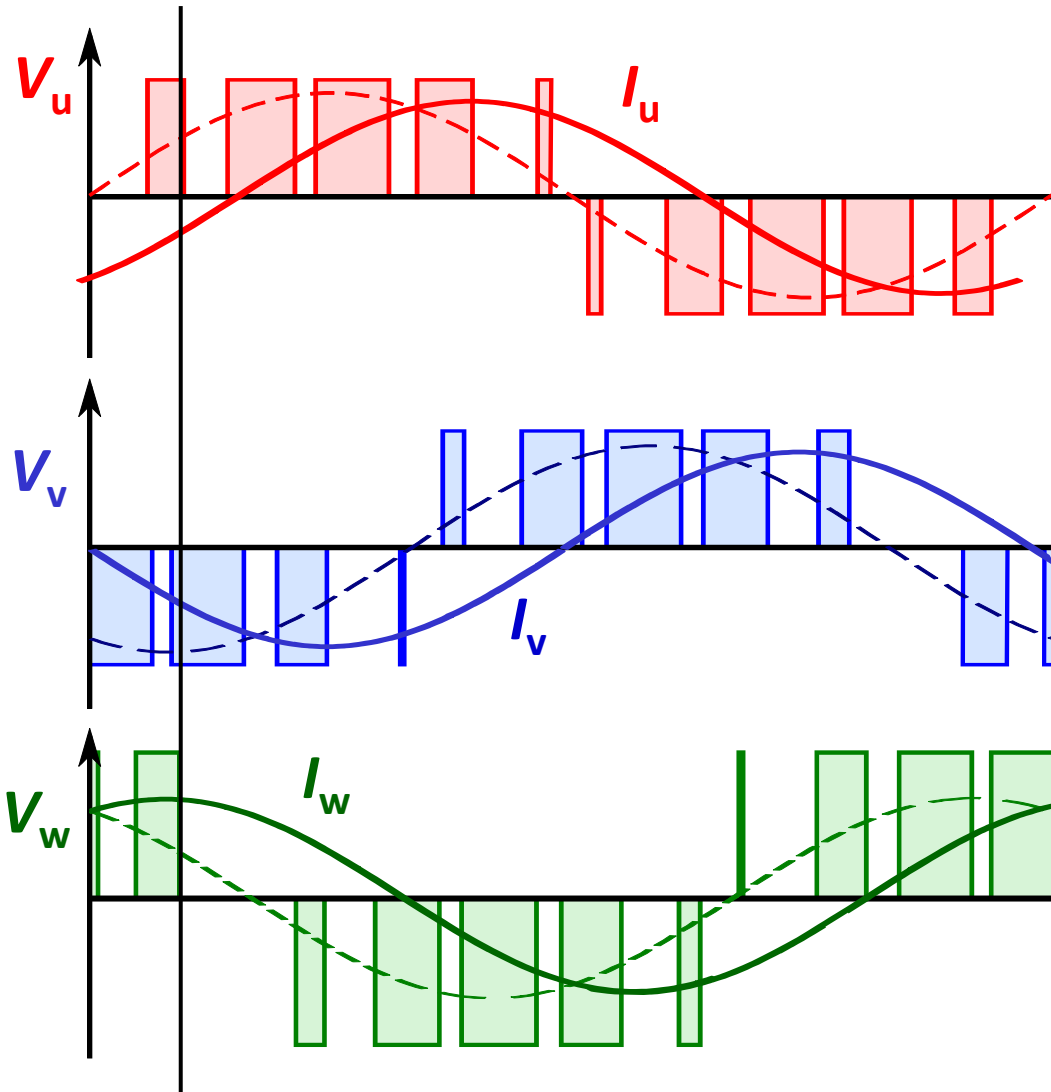
V_u	V_v	V_w
$+E$	$-E$	$+E$
I_u	I_v	I_w
+FWD	-IGBT	+IGBT

3-Phase Circuit with Inductive Load



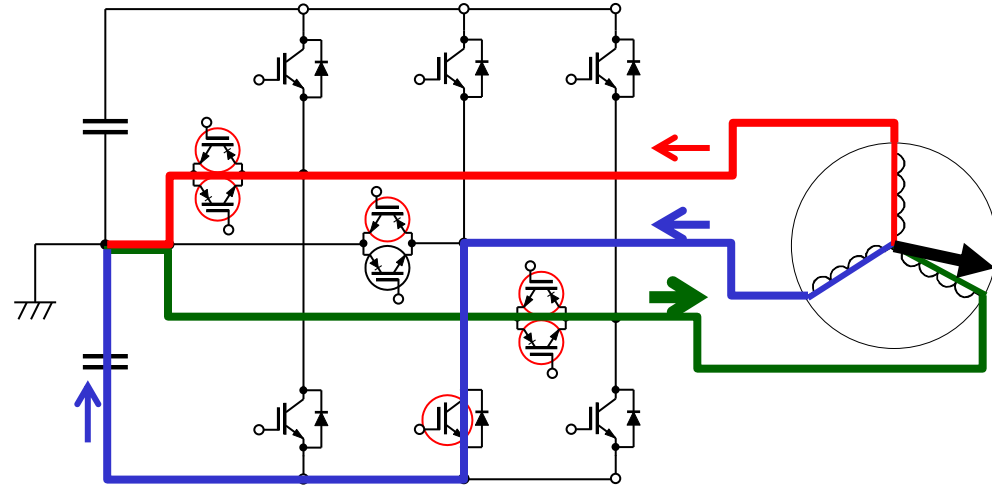
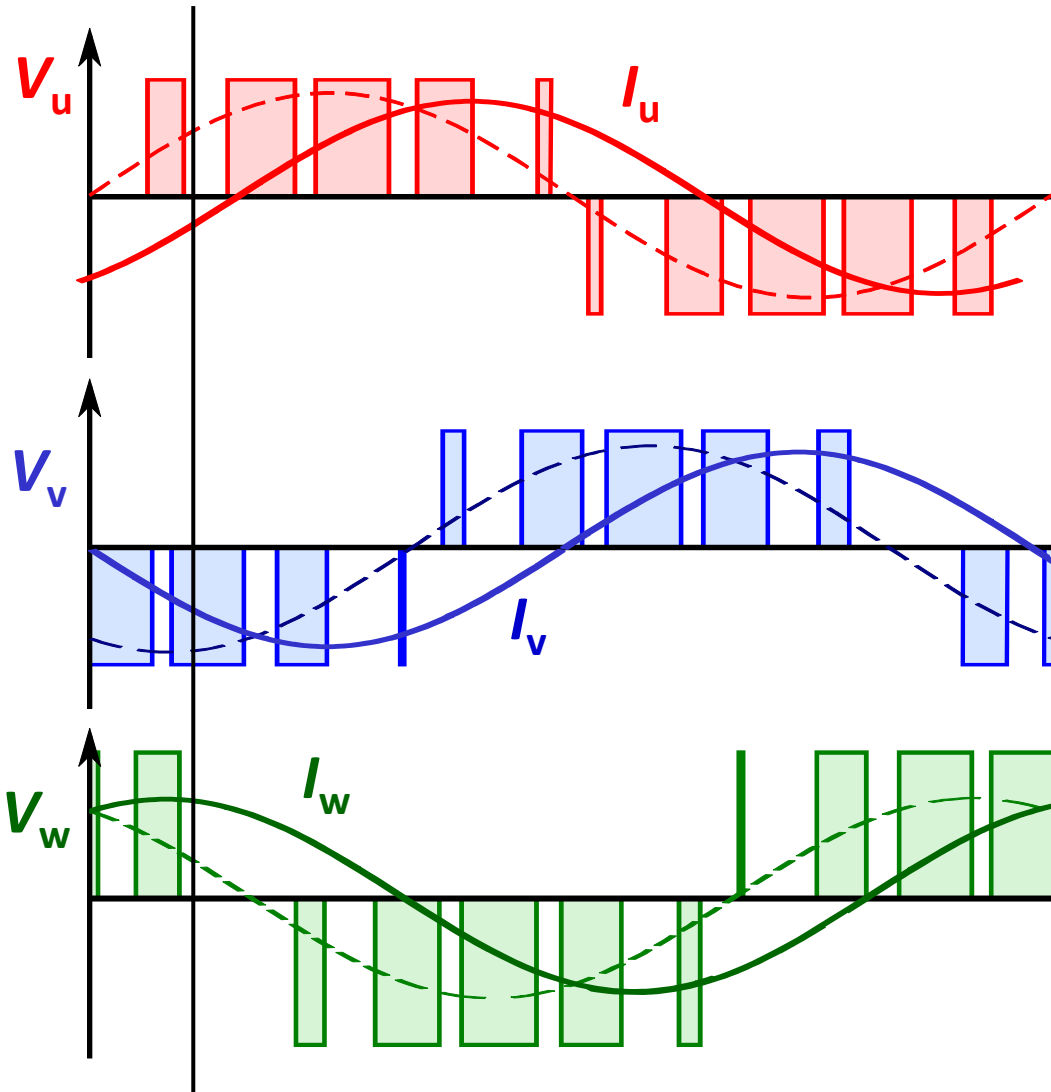
V_u	V_v	V_w
$+E$	0	$+E$
I_u	I_v	I_w
+FWD	RB-FW	+IGBT

3-Phase Circuit with Inductive Load



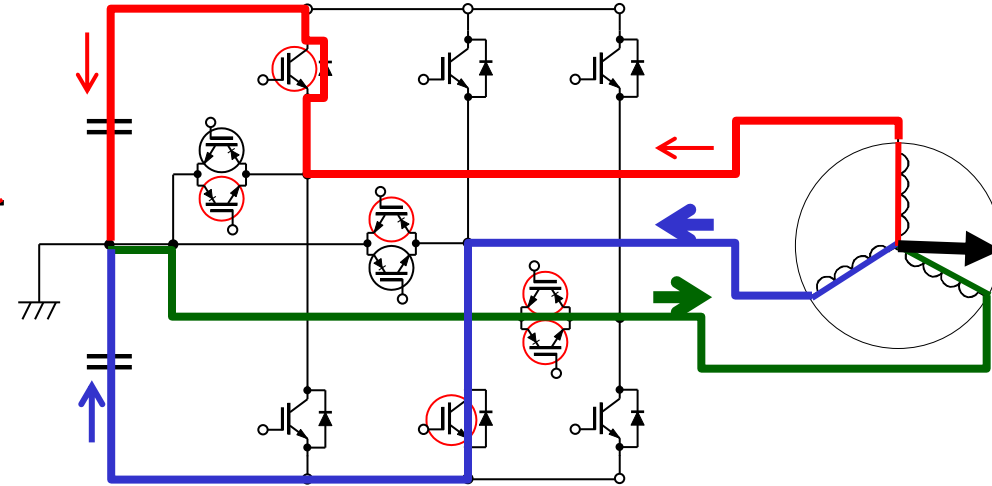
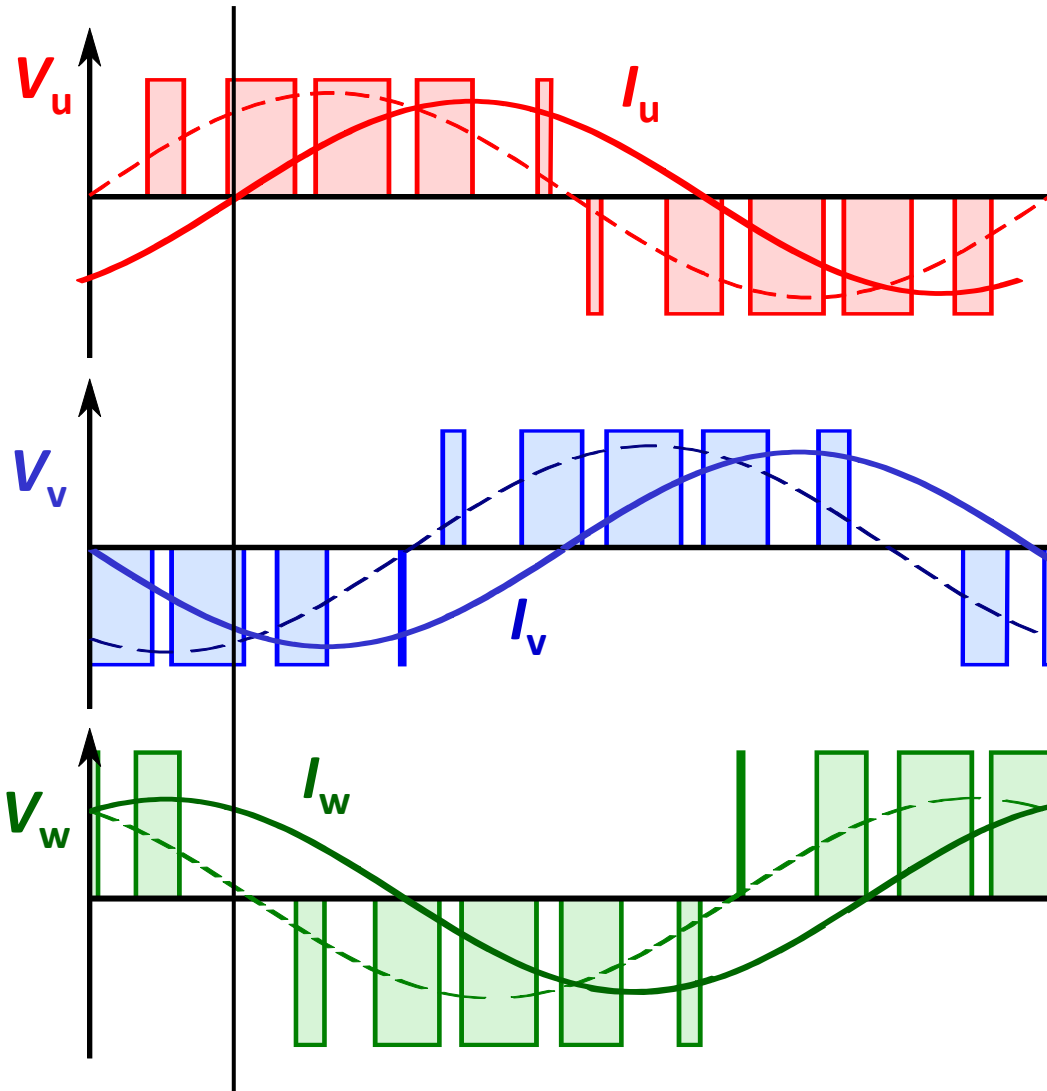
V_u	V_v	V_w
$+E$	$-E$	0
I_u	I_v	I_w
+FWD	-IGBT	RB-FW

3-Phase Circuit with Inductive Load



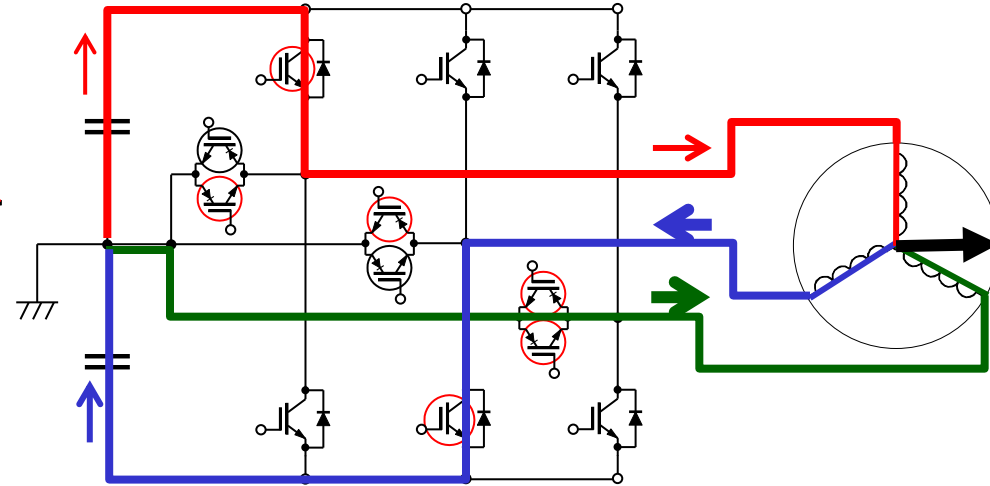
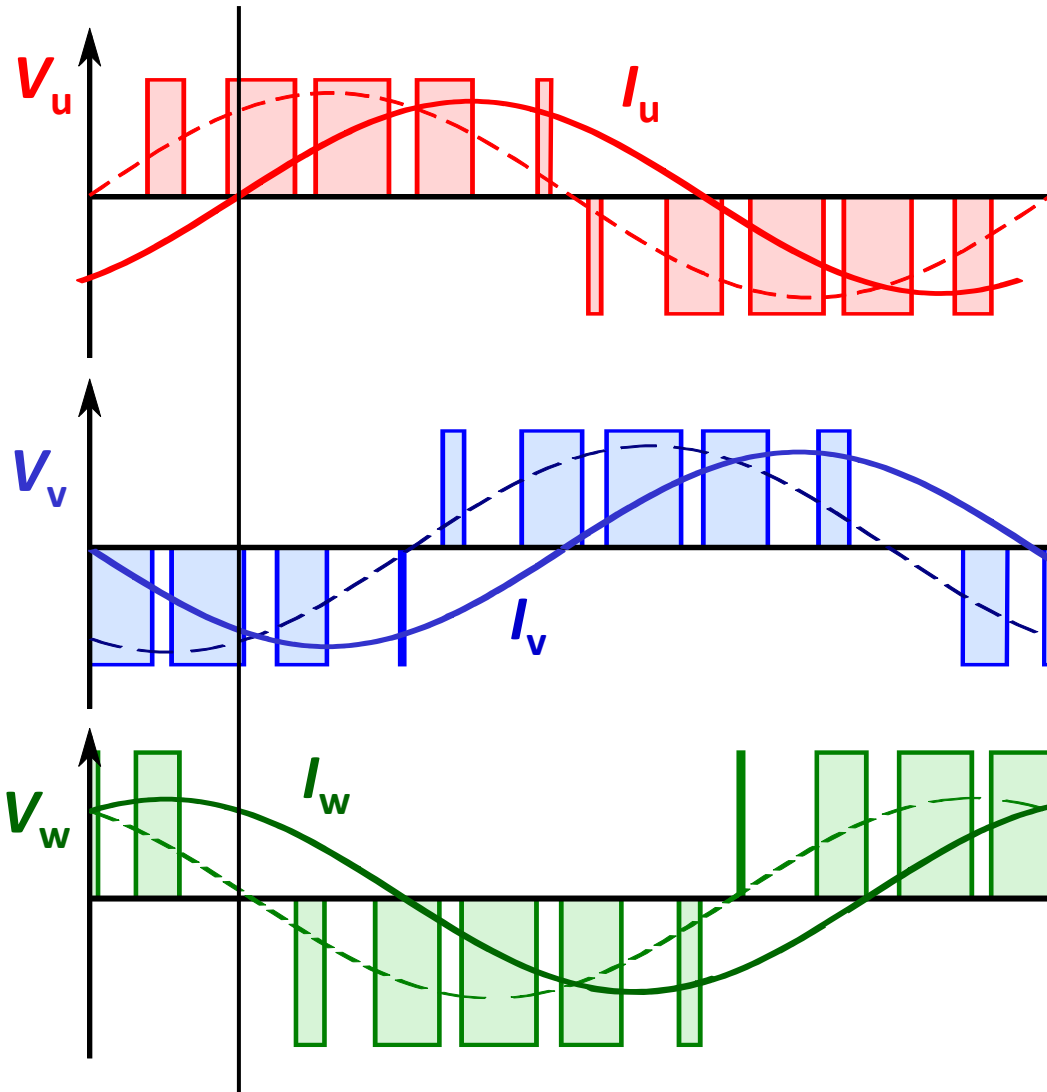
V_u	V_v	V_w
0	$-E$	0
I_u	I_v	I_w
RB-FW	-IGBT	RB-FW

3-Phase Circuit with Inductive Load



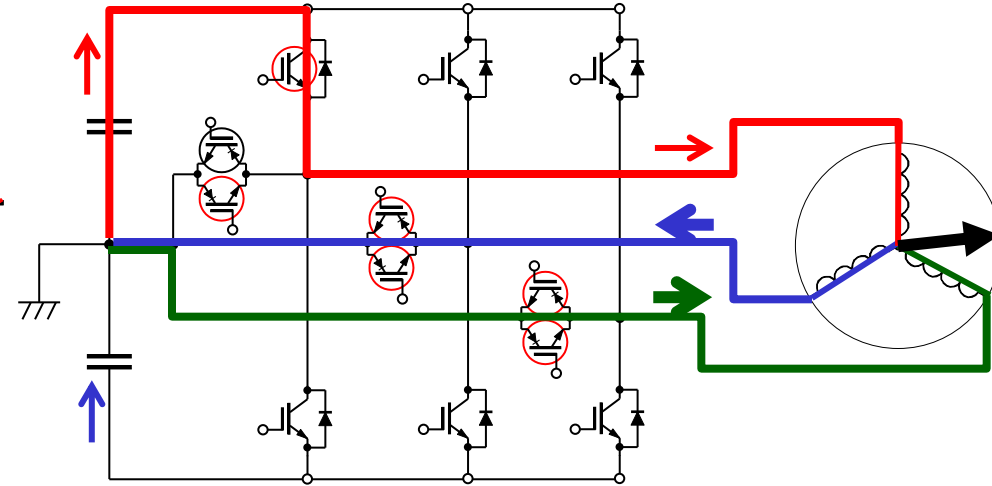
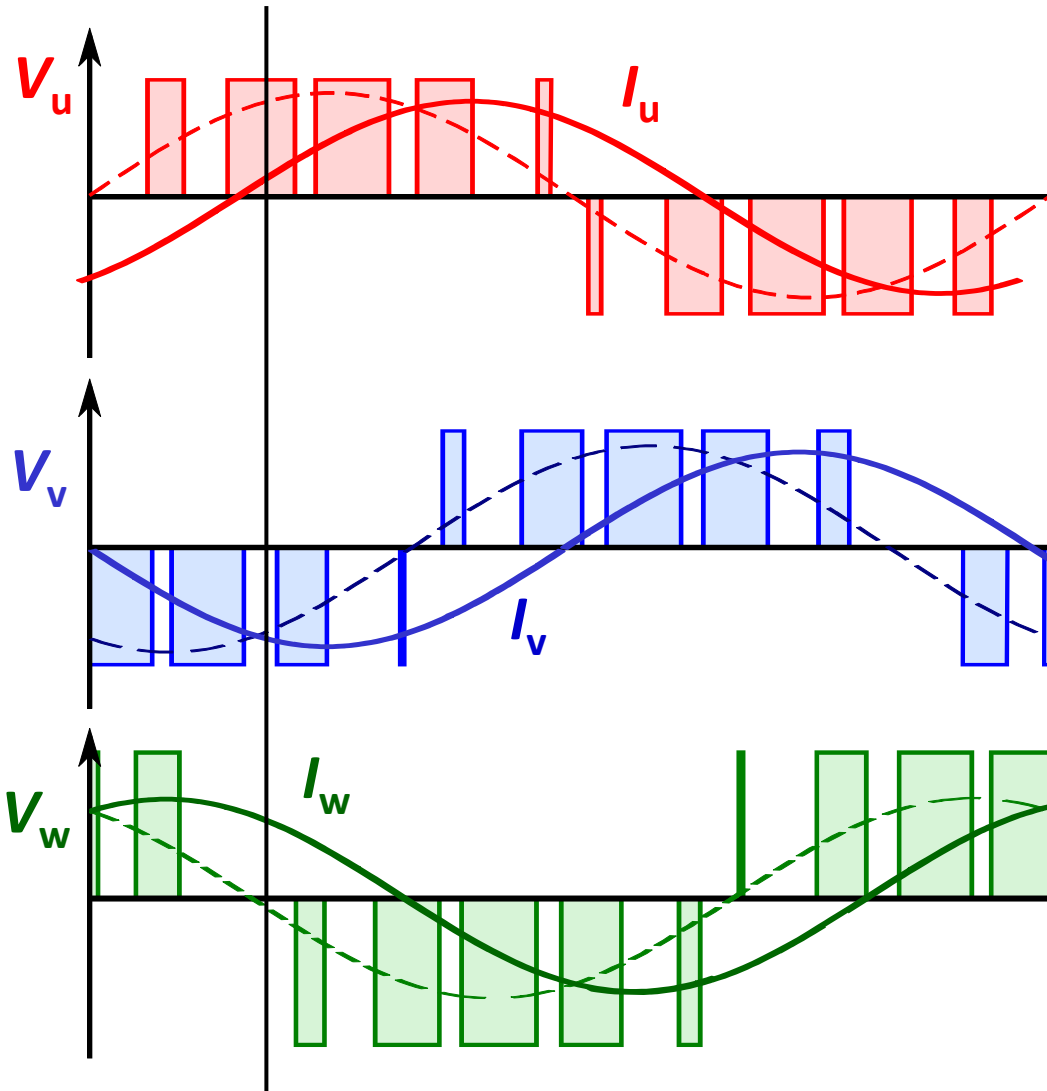
V_u	V_v	V_w
$+E$	$-E$	0
I_u	I_v	I_w
+FWD	-IGBT	RB-FW

3-Phase Circuit with Inductive Load



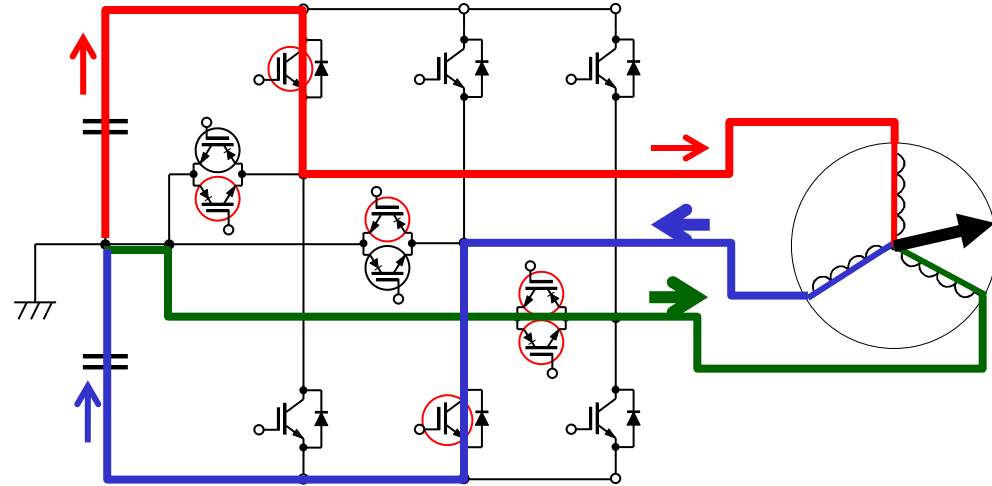
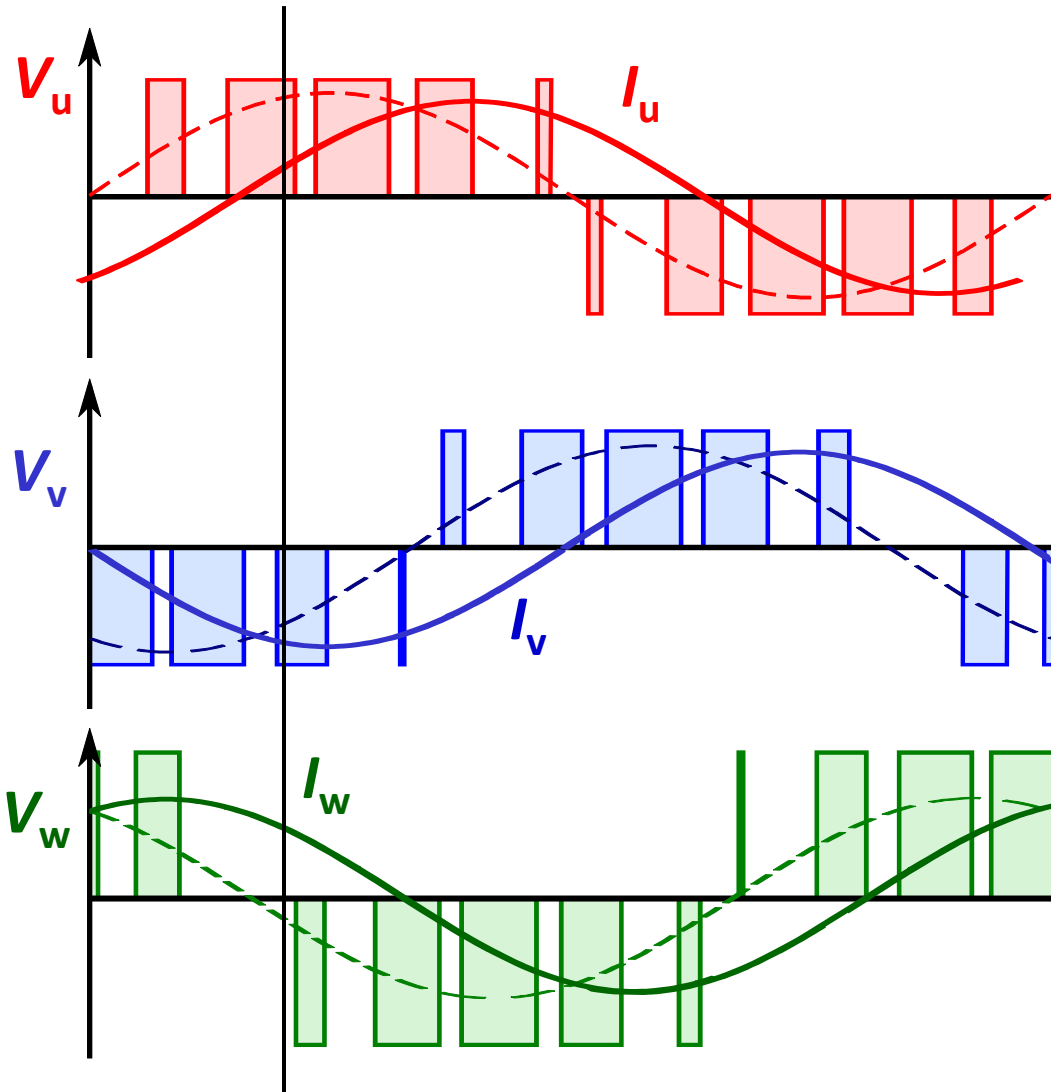
V_u	V_v	V_w
$+E$	$-E$	0
I_u	I_v	I_w
+IGBT	-IGBT	RB-FW

3-Phase Circuit with Inductive Load



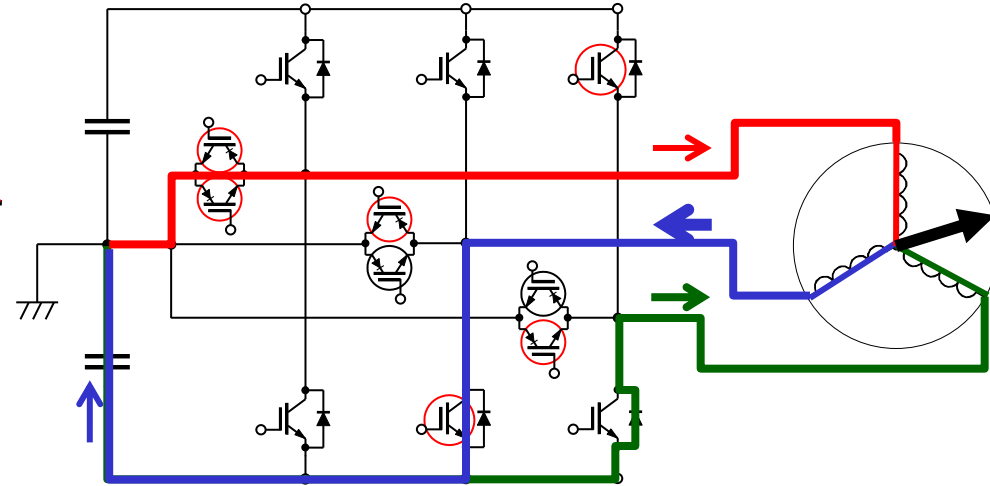
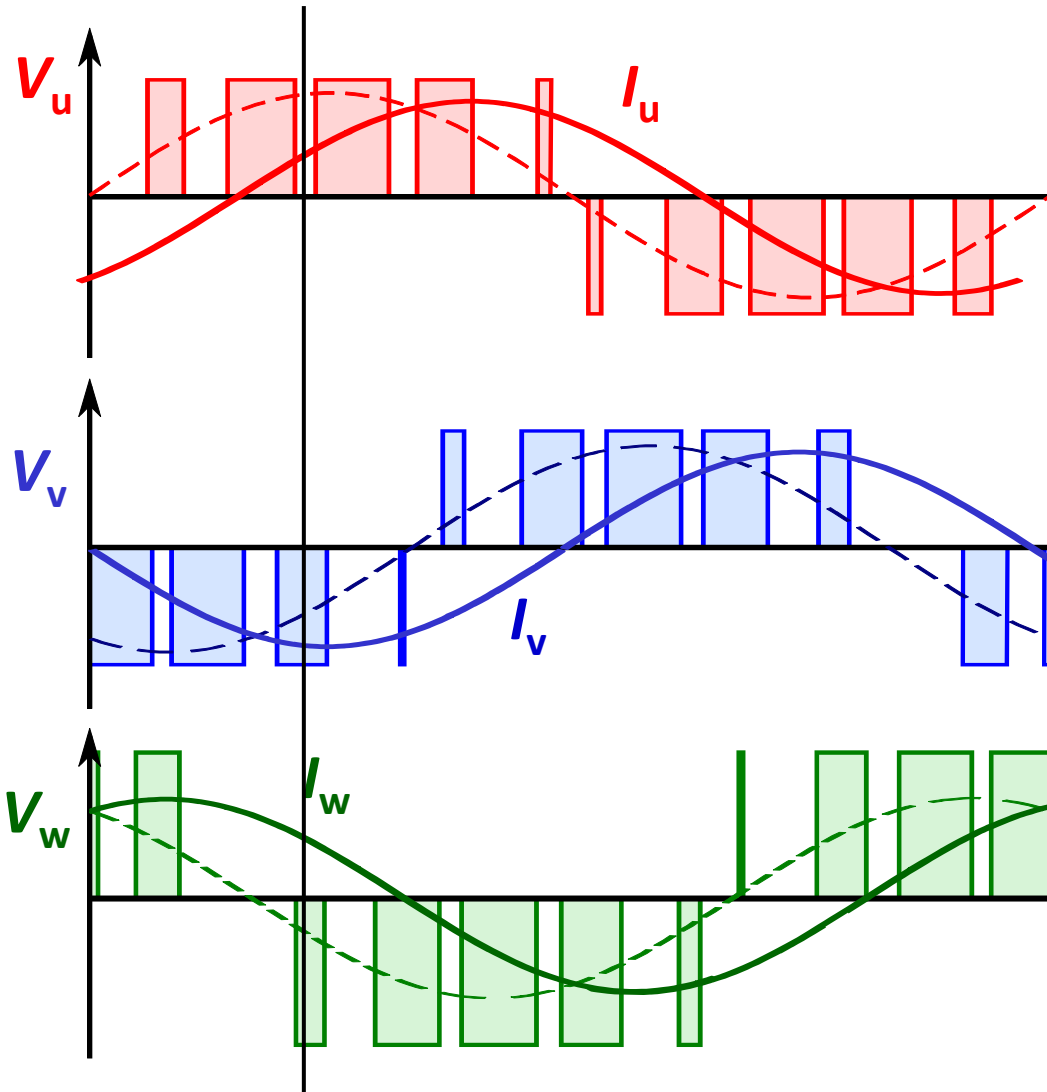
V_u	V_v	V_w
$+E$	0	0
I_u	I_v	I_w
+IGBT	RB-FW	RB-FW

3-Phase Circuit with Inductive Load



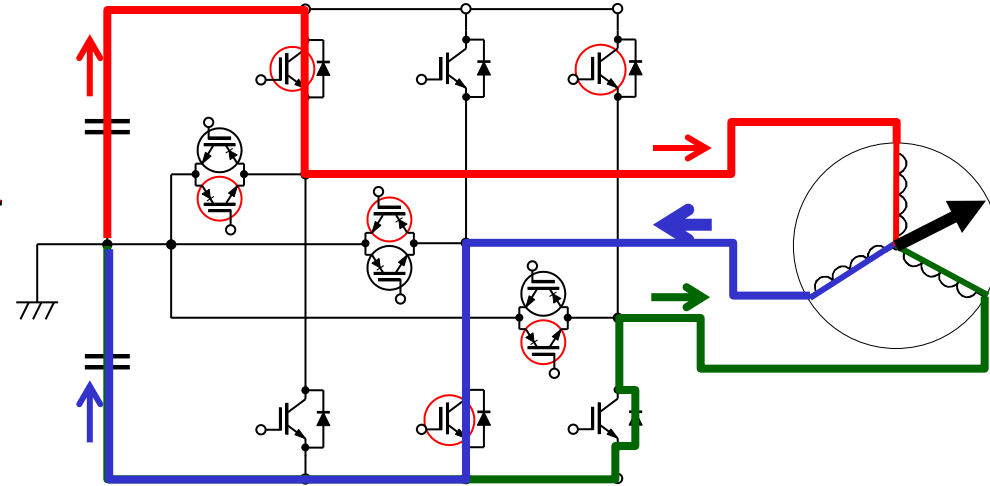
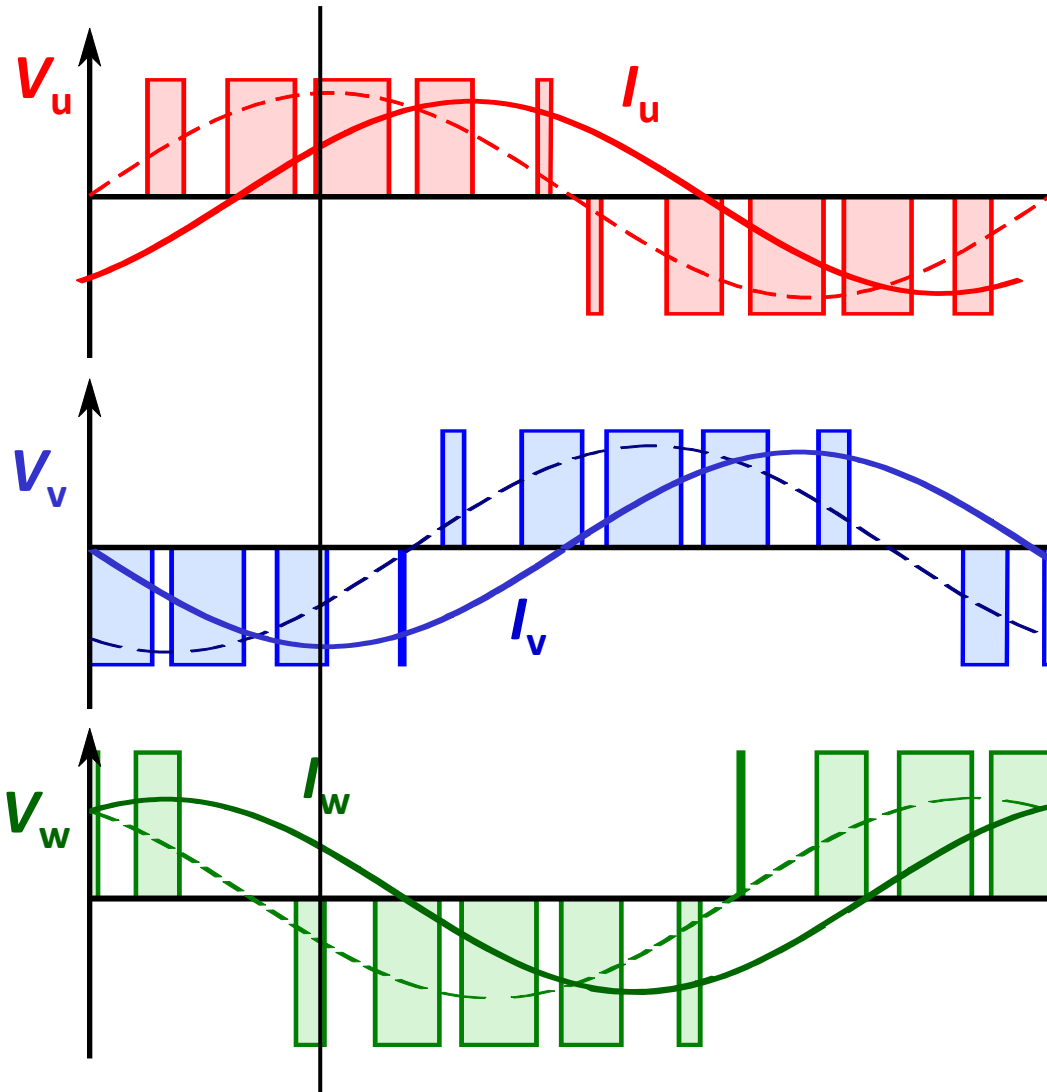
V_u	V_v	V_w
$+E$	$-E$	0
I_u	I_v	I_w
+IGBT	-IGBT	RB-FW

3-Phase Circuit with Inductive Load



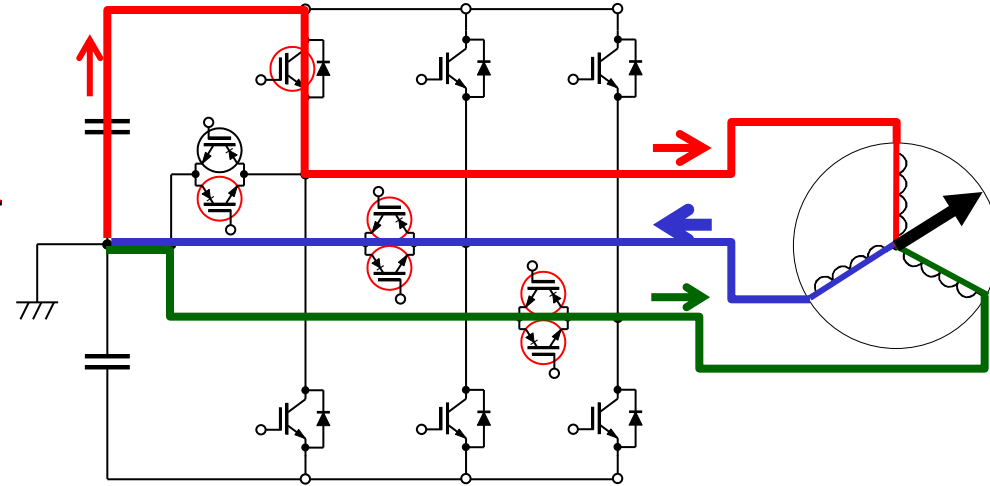
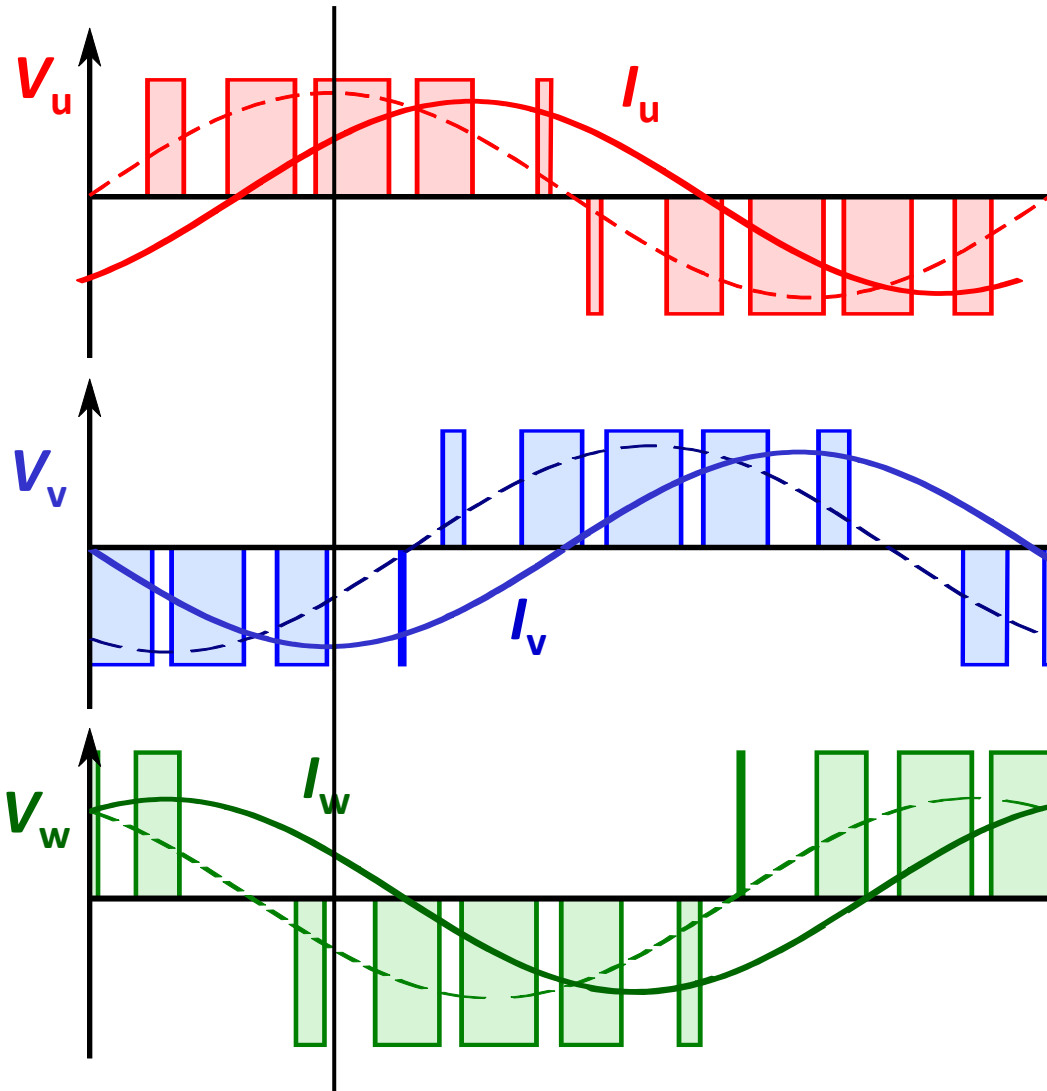
V_u	V_v	V_w
0	$-E$	$-E$
I_u	I_v	I_w
RB-FW	-IGBT	-FWD

3-Phase Circuit with Inductive Load



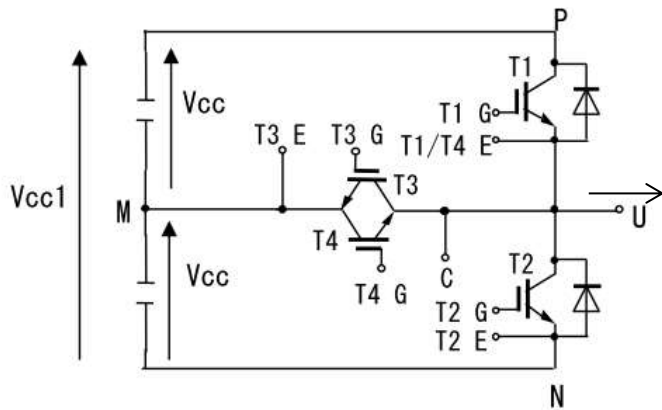
V_u	V_v	V_w
$+E$	$-E$	$-E$
I_u	I_v	I_w
+IGBT	-IGBT	-FWD

3-Phase Circuit with Inductive Load



V_u	V_v	V_w
$+E$	0	0
I_u	I_v	I_w
+IGBT	RB-FW	RB-FW

Switching Mode



d

SW mode	Load L	T1	T2	T3	T4
A	M-U	SW	OFF	OFF	ON
	M-U	OFF	SW	ON	OFF
B	P-U	OFF	OFF	SW	ON
	U-N	OFF	OFF	ON	SW

		Current	
		+	-
Phase Voltage	+	T: Psat ↑(A) T1: Eon, T4:Err ↓(A) T1: Eoff	D1: Pf ↑(B) T3: Eoff ↓(B) T3: Eon, D2:Err
	0	T4: Psat, Pf ↑(B) T4: Eon, D2:Err ↓(B) T4: Eoff	T3: Psat, Pf ↑(A) T2: Eoff ↓(A) T2: Eon, T3:Err
	-	D2: Pf	T2: Psat