Realization of switch using transistors and diodes
Realization of switch using transistors and diodes circuit driven.

Switching occurs naturally control, no external control.

Switch A: transistor

Switch B: diode

Buck converter example

Each device requires different driver.
Realization of buck converter using single-quadrant switches

Switches A and B are controlled by signals $s_A$ and $s_B$ respectively.
Fundamentals of Power Electronics

Chapter 4: Switch realization

Realization of buck converter using single-quadrant switches

Drive for VCC

Control

Vcc must float

I_{max} (from I_c(t))
Chapter 4: Switch Realization

Use of external diodes to prevent conduction

Body diode and its integral

Power MOSFET

Forces MOSFET into FET drain

Log V Before Vx =0

Diode body diode blocks

For i from parasitic diode

Slow vs. Fast

Fig. 4.18 & 48

Characteristics

Power MOSFET

Trend vs. Source

Diode conductors (on)

Transistor conductors (on)

Low vs. High

i

0
Chapter 4: Switch Realization

Diode realization

BJT / anti-parallel

Diode realization

4.1.2. Current-bi-directional MOSFETs

Figure 4.9 & 4B

Two-quadrant switches

Controlled by terminal

Usually an active switch

Normally operated as two-

Negative on-state current

Can conduct positive or

Voltage can block positive off-state

Advantages

Characteristics:

V-I

Instantaneous V-I

Points lie on the composite I-V
state and off-state operating
provided that the intended on-

Graph (diode conducts)

Graph (transistor conducts)

Output

Input

External bipolar

Bipolar
Chapter 4: Switch Realization

Use of external diodes to prevent conduction.

Power MOSFET

- Body diode
- Integral

Characteristics

MOSFET Body Diode

(on) (transistor conducts)

(on) (diode conducts)

Off
Two quadrant switches
Fundamentals of Power Electronics

Chapter 4: Switch realization

Fig. 4.22 PG 73

Two quadrant switches

NOS alone if internal diodes

if external diodes

current

voltage

on (diode conducts)

off

on (transistor conducts)
Chapter 4: Switch Realization

...be realized as shown characteristic, then switch can points lie on the composite I-V state and off-state operating provided that the intended on...

...voltage can block positive off-state negative on-state current can conduct positive or quadrantswitch: Normally operated as two-controlled by terminal C. Usually an active switch.

4.1.2. Current-Bidirectional

two-quadrant switches

BJT / anti-parallel
A simple inverter
A Simple Inverter

$$V_o = (2D - 1) V$$

DC level

Why it is required?

$$V_i(t) = 0$$

$$V_i(t) = V_{DC}$$

External diodes

$D$ and $D_2$ can handle reverse currents.

Currents before $Q$ on.

Symmetrical

$V_0(t) = V_{DC}$

$V_0(t) = V_{DC}$

Before $Q$ on.

$Q$ is ON.
Chapter 4: Switch Realization

Inverter

Two quadrant switches are required.

Hence, current-bidirectional sinusoidal:

\[ \frac{Y}{L} (1 - 2D) = \frac{Y}{(i)^0} = (i)^0 \]

Current variation is also the resulting inductor:

\[ (\omega L + a) \sin (\omega t) + 0.5 = (i)^0 \]

produce ac output:

Sinusoidal modulation to

Inverter: Sinusoidal modulation of D
Two quadrant switches are required. Hence, current is bidirectional.

\[ \frac{R}{\Lambda} (2D - 1) = (i)^0_{\Lambda} = (i)^0_{A} \]

Sinusoidal current variation is also present in the inductor.

**Diagonal Inductor:**

\[ d(t) = 0.5a \sin(\pi t) \]

Produce ac output

Sinusoidal modulation to

Recall: sinusoidal modulation of D

**Fig 4.12:** 2.9 69
The dc-3ac voltage source inverter (VSI) allows current to flow when switches are not yet closed.

Diodes allow current to flow even when switches are not yet closed.

Switches must block dc input voltage, and conduct ac load current.
Switches must block dc input voltage and conduct ac load current.

The dc-30ac voltage source inverter (VSI)