Power Electronics

Old Mechanical Switch

- $\Delta t\begin{pmatrix}\text{on/off}\\ \text{off/on}\end{pmatrix} \simeq 100\text{ms}$ fastest

- No control within a Mains cycle ☹ 5-10 cycles pass before switch acts

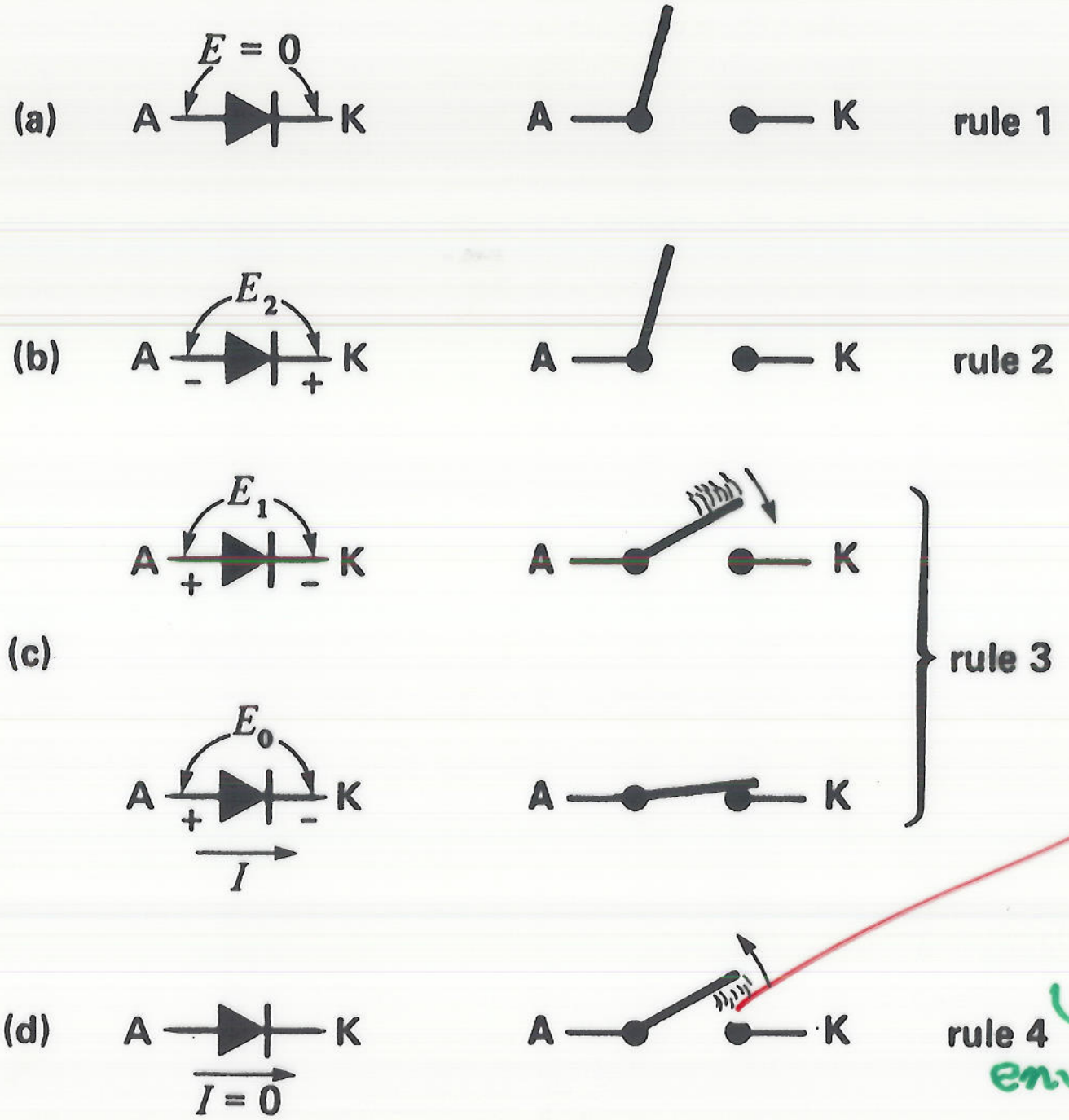
- $R_{off} = \infty$, $R_{on} = 0$ } ideal ☺

New Electronic Switch

- $\Delta t\begin{pmatrix}\text{on/off}\\ \text{off/on}\end{pmatrix} \simeq \mu s$ $\Delta t \simeq \frac{T_{mains}}{10^4}$

- Mains $\frac{1}{2}$ Cycle allows 100-1000 switches in $T/2$

- $R_{on} \simeq$ Ohms, $R_{off} \simeq M\Omega$ also V_{on} across switch


(a)
E = 0
A
K
rule 1
(b)
E2
A
K
rule 2
(c)
E1
A
K
rule 3
E0
I
(d)
I = 0
rule 4
ON
OPEN
Why
Arcs
Sparks
ON SW
OPEN
Unless SF6
environment

@MV 1/10 sec 10^5 Joules

Mechanical Sw:

1. Slow (> 1/10 second)
2. Arcs if we open without SF_6 chamber

Replace with Solid State

1. Sw time << 16.66 mS
2. Modern Solid state handles KA @ MV

$\Delta t < \mu S$

R_{off}

∞ mechanical vacuum

MΩ solid state

R_{ON}

$R_{ON} \simeq 0.1\,\Omega$ solid state

$R_{ON} = \mu\Omega$ metal switch

Switch time

FAST (μs) Switching within $\frac{T_{mains}}{2}$

Key new development

8.3-10mS

Allows for:

1 Improved P & Q control
★ change P flow direction ★
2 Variable power factor
Replace C, L with SW Angle
3 Improved protection for faults on line
Switch at $\frac{T_{mains}}{2}$
} Save Squirrels raptors
4 DC → DC Conversion at 95% efficiency up to 300 KW
5 f_{mains} → Variable f_{out} @ 95%
Wave Wave
AC → AC
6 Flexible AC Transmission (FACTS)