Charge-control in the diode: Discussion

- The familiar i–v curve of the diode is an equilibrium relationship that can be violated during transient conditions
- During the turn-on and turn-off switching transients, the current deviates substantially from the equilibrium i–v curve, because of change in the stored charge and change in the charge within the reverse-bias depletion region
- Under forward-biased conditions, the stored minority charge causes "conductivity modulation" of the resistance of the lightly-doped n^- region, reducing the device on-resistance

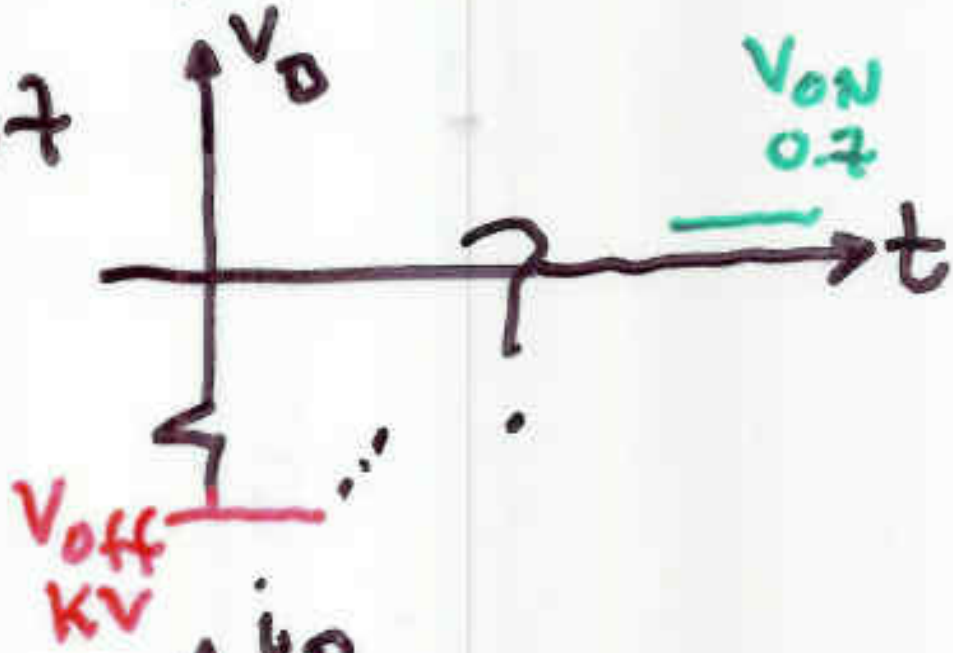
PIN Diode Dynamics

$V_{ON} \cong 0.7\ V$

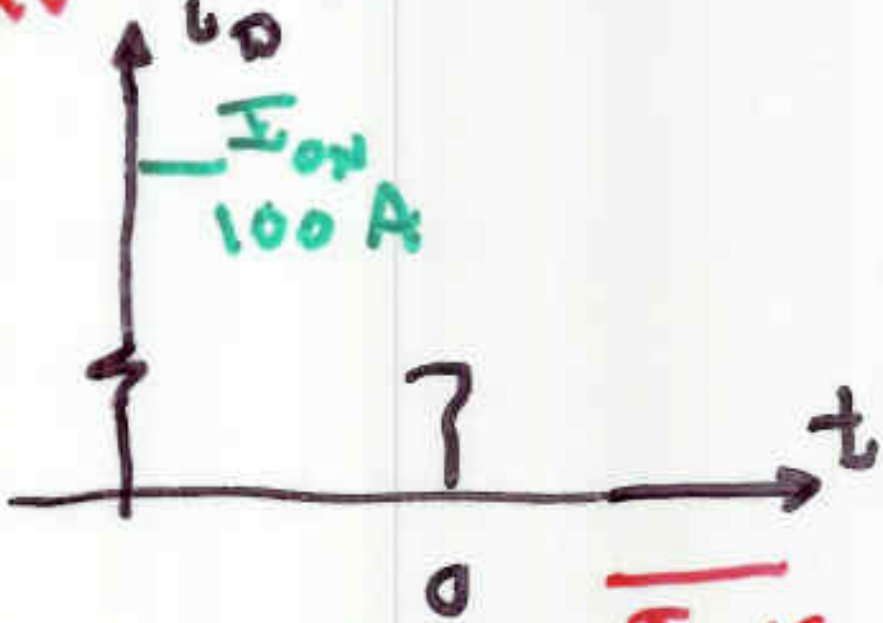
DC $I_{off} \sim \mu A$

Transient

Off to ON Voltage

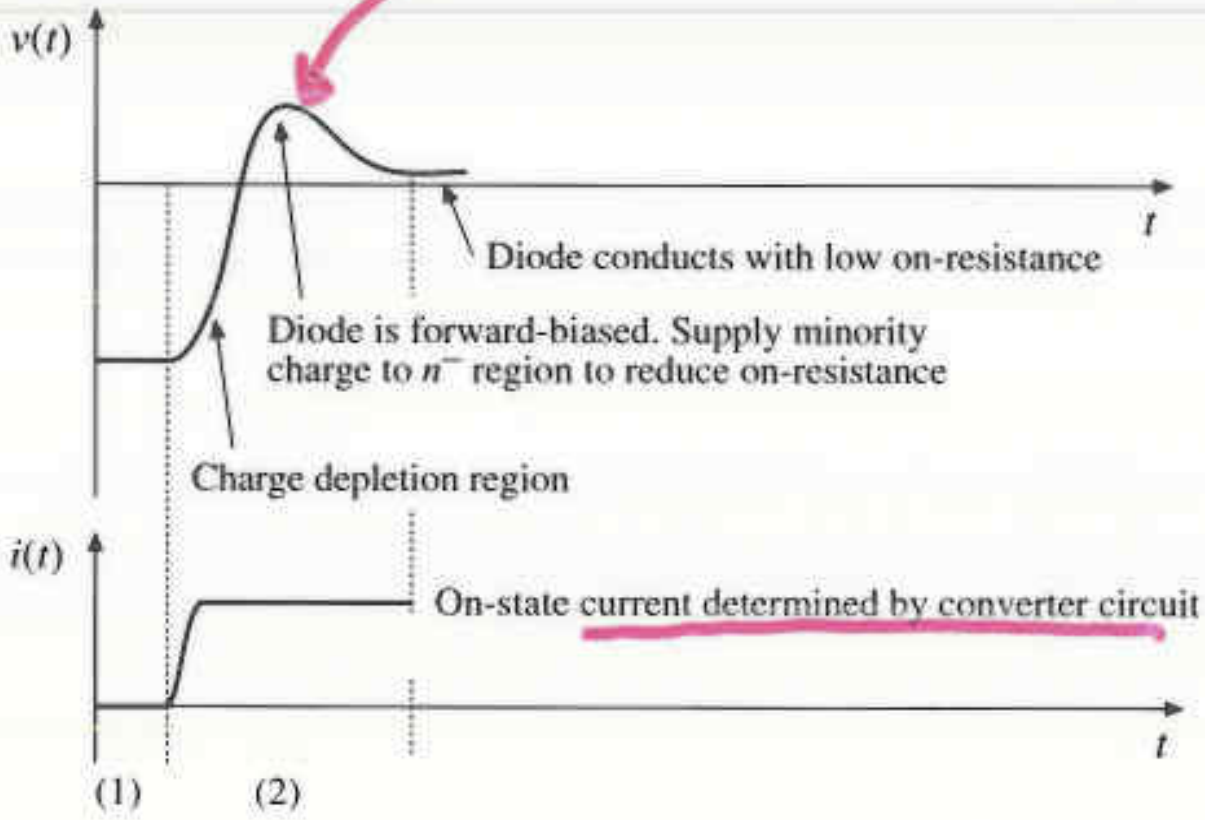


ON to off Current



What about
ON-off } $v_D(t)$
off-ON } $i_D(t)$

Turn-on transient

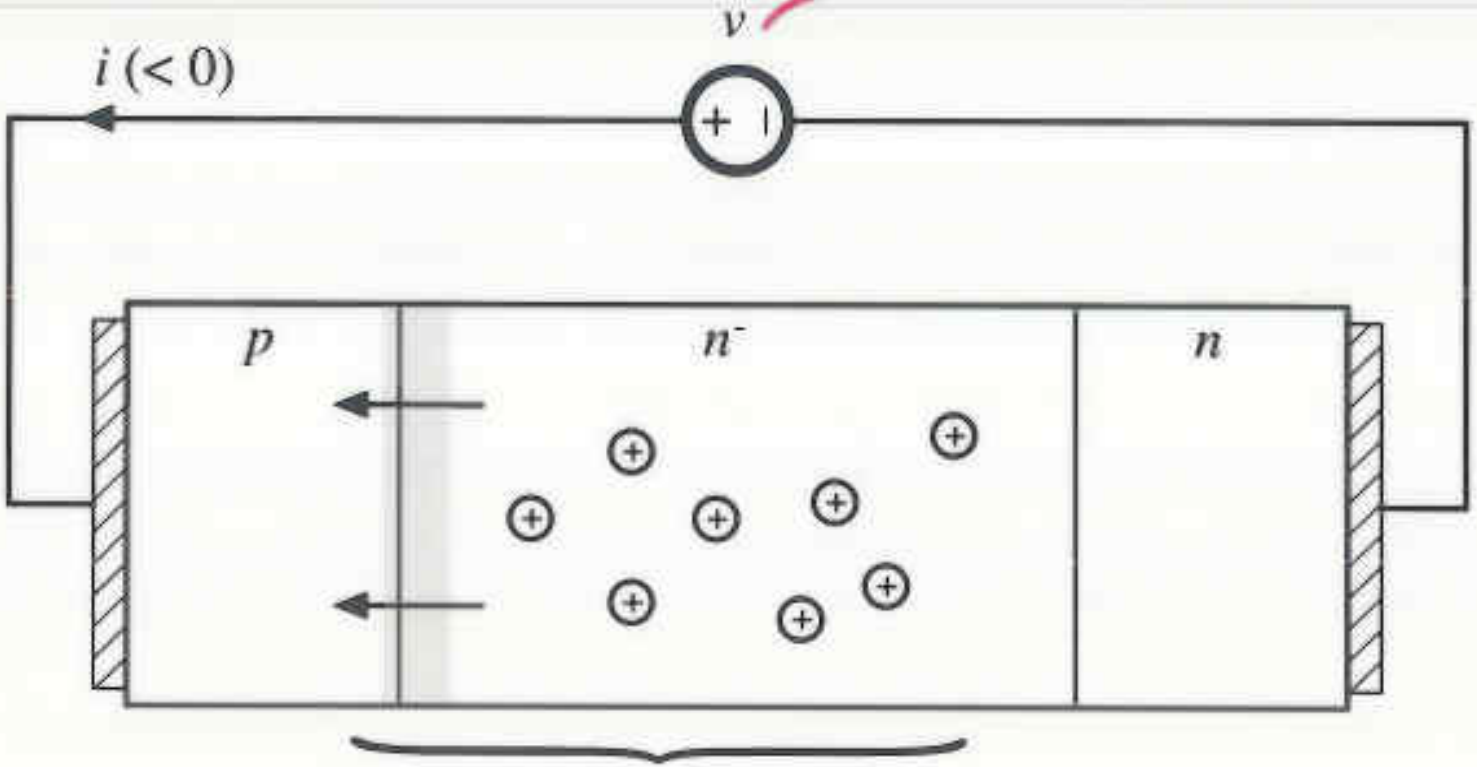


The current $i(t)$ is determined by the converter circuit. This current supplies:

- charge to increase voltage across depletion region
- charge needed to support the on-state current
- charge to reduce on-resistance of n^- region

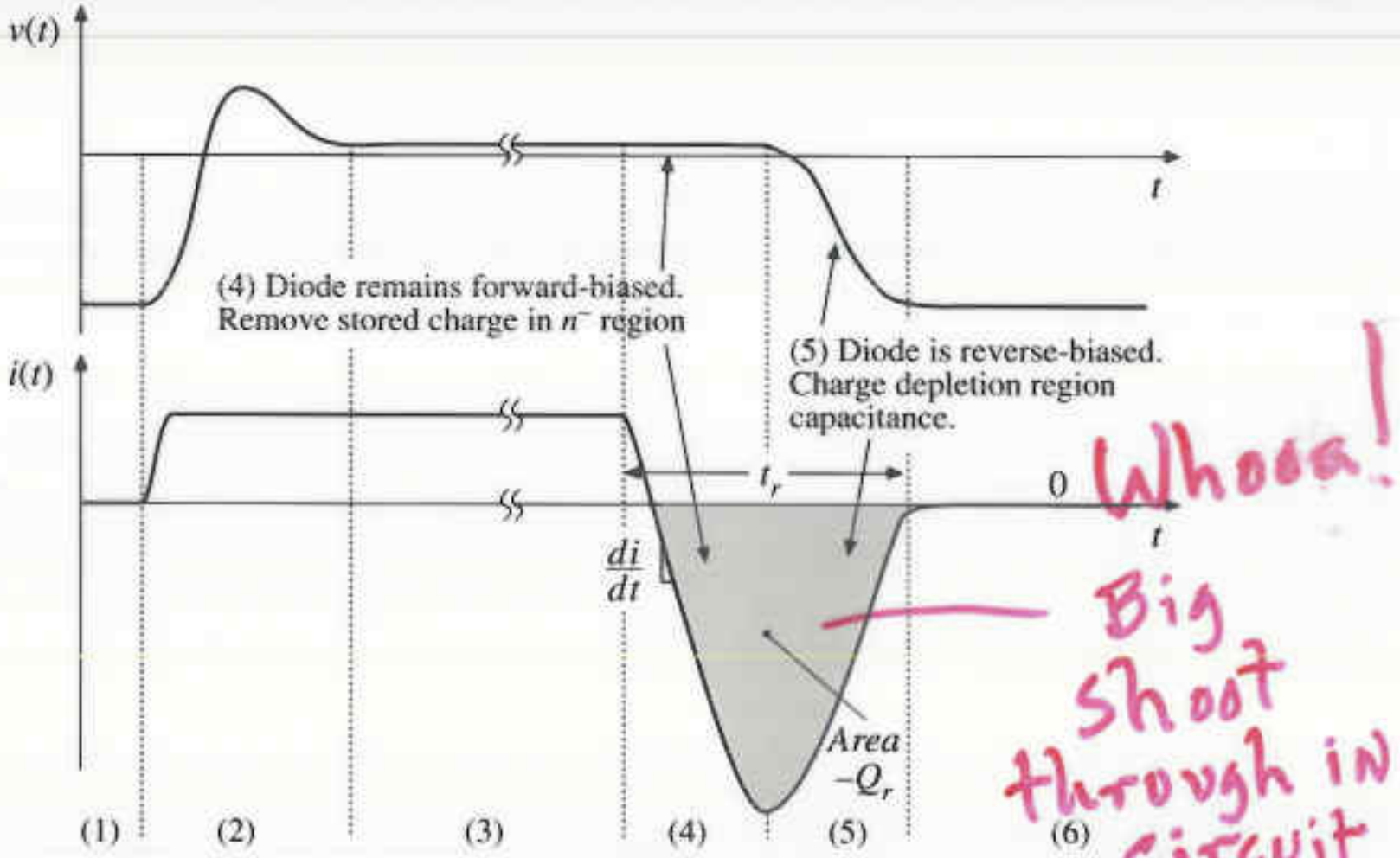
Turn-off transient

flip polarity



Q_r

Diode turn-off transient
continued



Whoa!

Big shoot through in circuit

All together

Typical diode switching waveforms