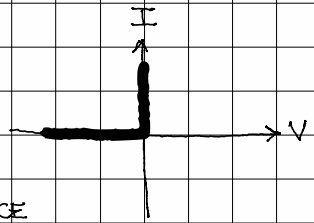
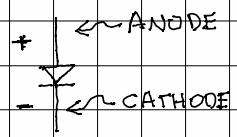
W2AEW

PRACTICAL GUIDE TO DIODES

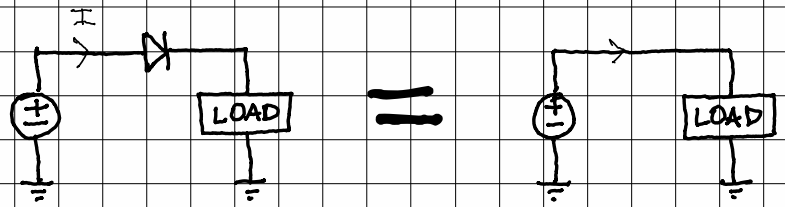
— FROM IDEAL TO REAL —



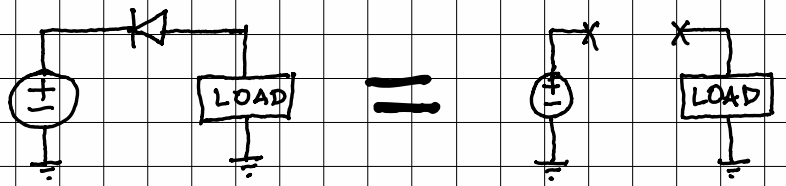
- THE IDEAL DIODE - THE ONE-WAY CHECK VALVE



- FORWARD DIRECTION = SHORT CIRCUIT, NO RESISTANCE



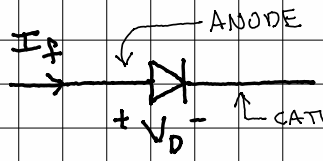
- REVERSE DIRECTION = OPEN CIRCUIT, INFINITE RESISTANCE

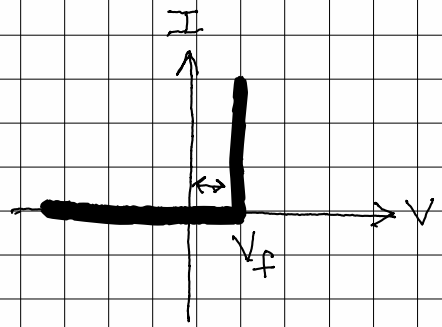


- IDEAL DIODE DOESN'T EXIST

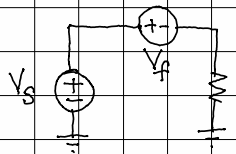
LETS START TO GET REAL ...

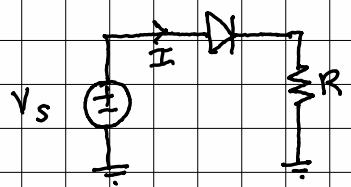
- FORWARD DIRECTION (FORWARD BIAS)





- IF $V_D < V_f$: OPEN CIRCUIT, NO CURRENT
- $V_D = V_f$: SHORT CIRCUIT, CURRENT FLOWS
  - V_D CAN'T BE GREATER THAN V_f
  - DIODE LOOKS LIKE A CONSTANT VOLTAGE DROP
  - CURRENT LIMITED BY LOAD



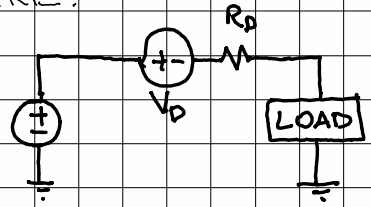


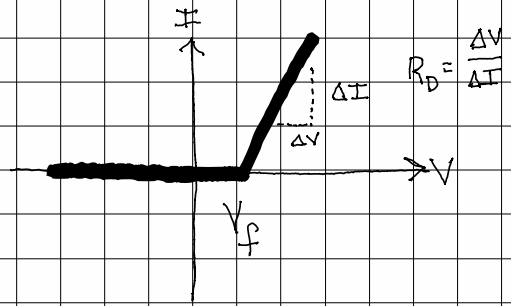
$$I = \frac{V_S - V_f}{R}$$

MANY CIRCUITS CAN BE ANALYZED LIKE THIS

A LITTLE MORE REAL...

- FORWARD BIAS
  - V_D INCREASES "SLIGHTLY" AS CURRENT INCREASES
  - APPEARS LIKE:

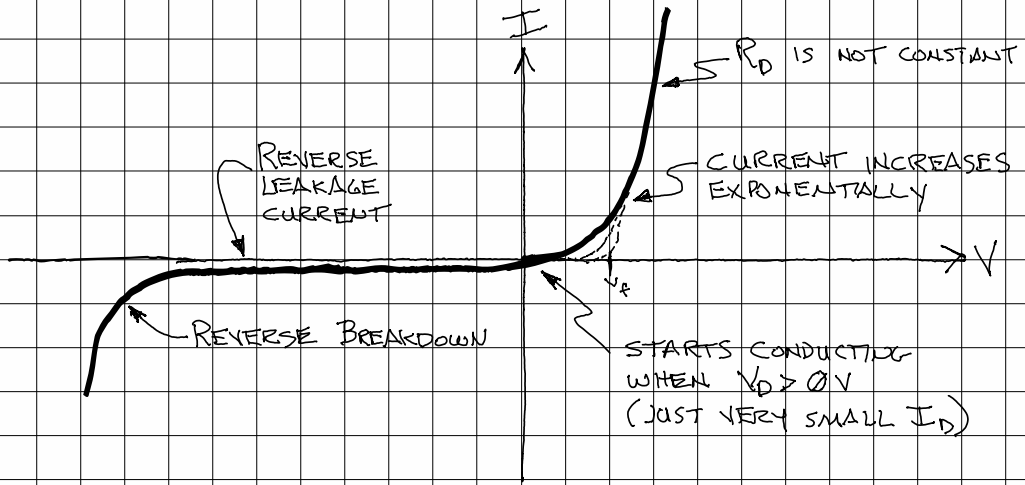




  - R_D IS THE "DYNAMIC RESISTANCE"
    - AKA: SMALL-SIGNAL OR INCREMENTAL RESISTANCE
  - TYPICALLY JUST A FEW / SEVERAL OHMS

A FEW MORE DETAILS ...

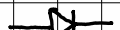
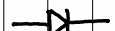
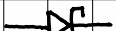
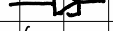
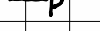
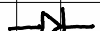
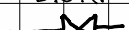
MUCH MORE ACCURATE V-I CURVE FOR DIODES



- ALL CHARACTERISTICS ARE TEMPERATURE DEPENDENT

More Diode Realities...

- Junction Capacitance
  - Bias dependent
- Charge Storage ← not on all diode types
  - Reverse current when switching off (briefly)
  - See video link (video #201)

- Many different types of diodes
  - Rectifier / General Purpose 
  - Switching Diodes  (video #82)
  - Schottky Diodes 
  - Zener / Avalanche Diodes  (video #289)
  - PIN Diodes  (videos #118 & #200 & #130)
  - Varactor / Vari-Cap Diodes  (video #147)
  - Light Emitting Diodes 
  - Laser Diodes / VCSELs
  - Photo Diodes 
  - * Tunnel Diodes   (video #204)
  - Step-Recovery / Snap Diodes 
  - * Gunn Diodes 
  - & more

More diode videos
#302 #77
#183 #161
#104 #167

* strange IV curves

Common Diode Specifications

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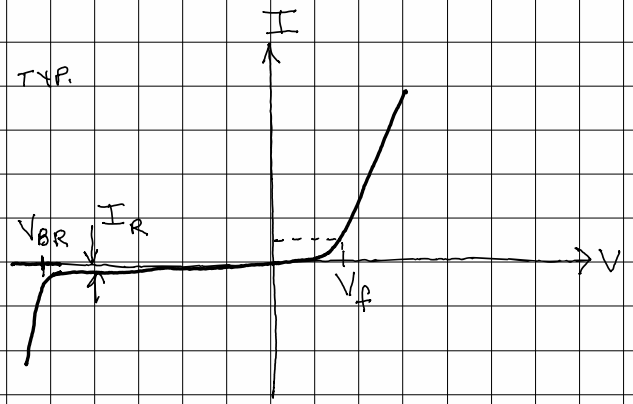
- V_f - Forward Voltage
  - Silicon PN diodes: 0.6 - 0.7V typ.
  - Germanium diodes: ≈ 0.3V
  - Schottky diodes: ≈ 0.2V



- I_f - Forward Current (operating)
- I_R - Reverse Current
  - Typically few nA
  - Ge & Schottky worse
- V_{BR} - Reverse Breakdown Voltage
  - Voltage where reverse current increases rapidly - usually don't go there!
  - V_Z = Zener Voltage - designed for operation in this region (video #289)
  - PIV = Peak Inverse Voltage - spec for power diodes, max reverse operating voltage
- t_{rr} - Reverse Recovery Time (video #201)
  - Time duration of reverse current flow when switching off
  - Ranges from <1ns to many µS or more
  - Schottky & switching diodes are fast
  - Power rectifiers, PIN diodes are slow