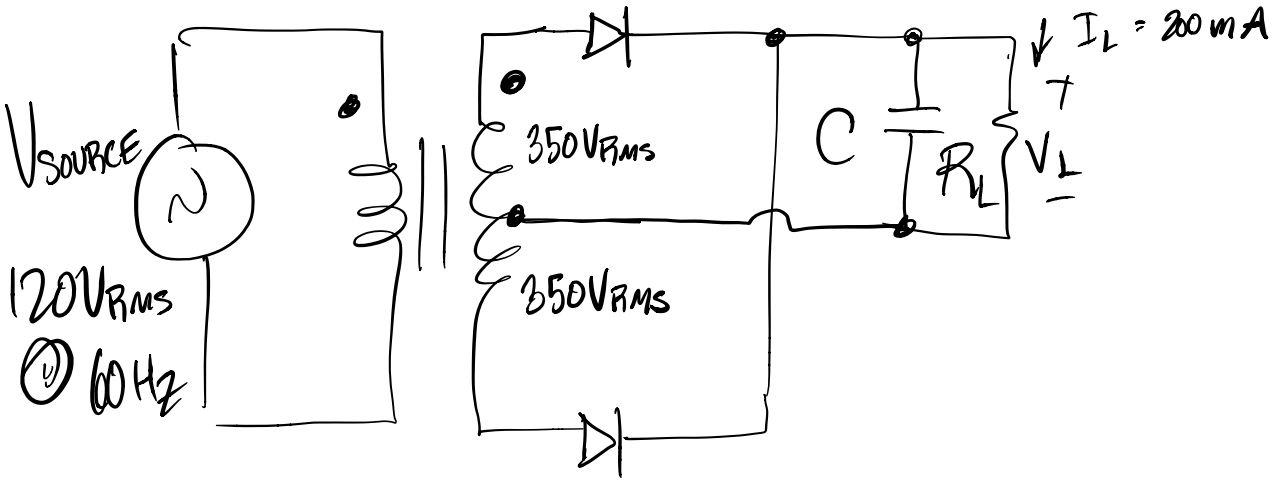


∴ center-tapped rectifier ⇒ full-wave

$$V_{peak} = \underbrace{V_{S(RMS)}\sqrt{2}}_{\text{one side!}} - V_D \quad \rightarrow 0.7\,V \text{ [Si]}$$

$$= 350\sqrt{2} - 0.7$$

$$V_{peak} = 494.3\,V$$

⑥ 5% ripple, V_L is close enough to V_{peak} that we can start there!

$V_{ripple} < 5\%$ of V_L

$V_{ripple} \lesssim 5\%$ of V_{peak}

$494.3 \cdot 0.05 = 24.72\ V_{p\text{-}p}$

$$V_{ripple(p\text{-}p)} \cong \frac{I_L}{2fC} \quad \text{[for full-wave]}$$

"Measure w/ micrometer
Mark w/ grease pencil
Chop w/ axe"

-- Dr. Ron Riechers

$$\longrightarrow C \geq \frac{I_L}{2f \cdot V_{ripple}} = \frac{0.200}{2 \cdot 60 \cdot 24.72}$$

$$= 6.74 \times 10^{-5}\ F$$

10
15
22
33
47
68

Use 68 uF → nearest E6 value

.. probably can't even get a 68 μF cap!

Use **100 μF**

-- guarantee ripple is small enough!

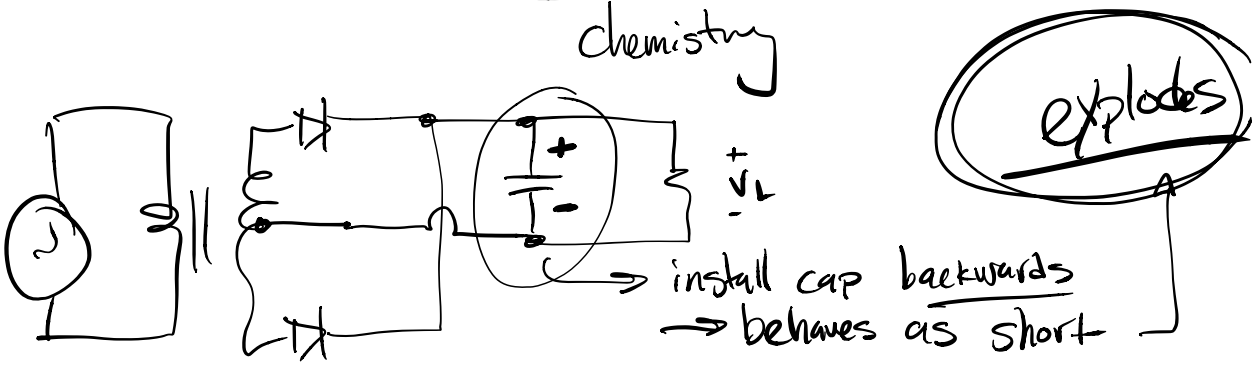
.. in reality: electrolytic capacitors are available in 10, 22, 47 [multiples thereof]

.. electrolytic capacitors use chemical electrolyte to greatly increase capacitance/unit volume

.. two penalties:

1.) have specific polarity that must be observed!

2.) finite lifespan due to chemistry



- capacitors have voltage ratings
- related to dielectric strength of capacitor
- too much voltage → electric field intensity too high
  → breakdown [short]
  → electrolytic: explosion
- for this design, $V_{peak} = 494.3\ V$

  use **500V capacitor**
- common voltage ratings:

  6.3V, 10V, 15V, 25V, 35V, 50V, 63V,
  100V, 150V, 250V, 300V, 450V,
  500V ↑

∴ Final V_L for this power supply:

∴ w/ actual capacitor value of 100 μF:

$$V_{ripple} \simeq \frac{I_L}{2fC} = \frac{0.200}{2 \cdot 60 \cdot 100 \times 10^{-6}}$$

$$= 16.67\, V_{p\text{-}p}$$

Check: $\frac{V_{ripple}}{V_{peak}} = \frac{16.67}{494.3} = 0.03372$

or 3.372%

< 5% ✓

$$V_L = V_{peak} - \frac{V_{ripple}}{2}$$

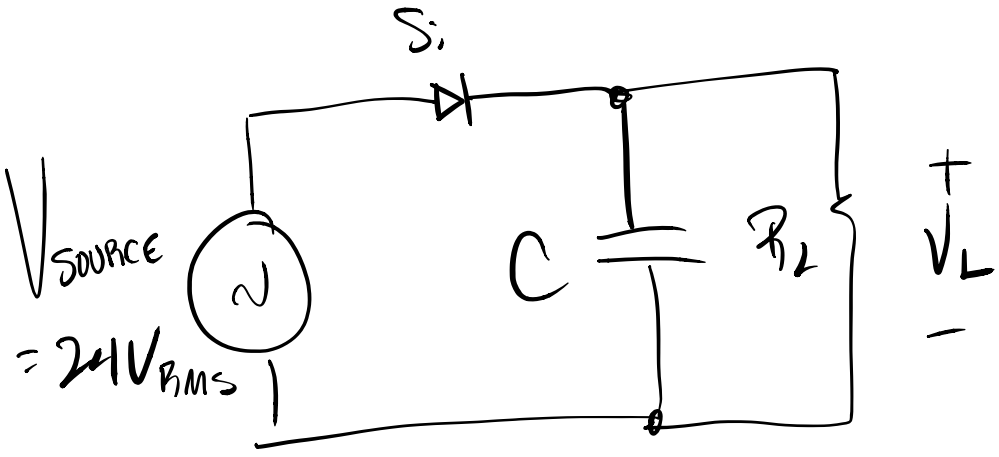
$$= 494.3 - \frac{1}{2} \cdot 16.67$$

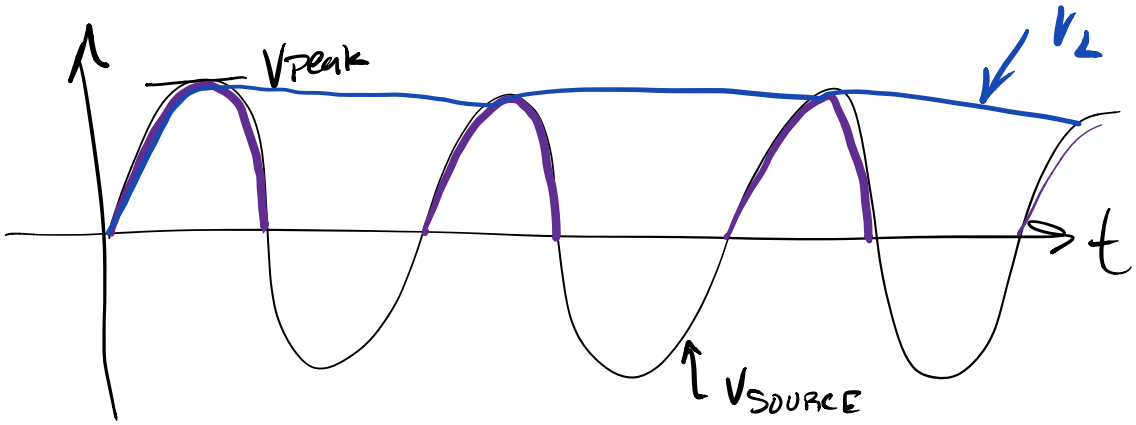
$$V_L = 486\ V$$

Diode Peak Inverse Voltage [PIV] Rating

- diodes have voltage ratings, too!
- why, if we use a constant-drop model of $V_D = 0.7V$ for Si?
- that is the <u>forward</u> voltage drop
- the issue is <u>reverse</u> voltages

ex: half-wave rectifier:





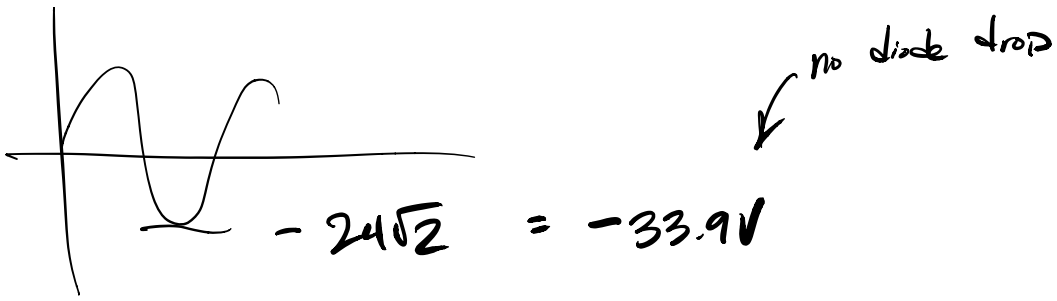
$$V_{peak} = V_{S(RMS)}\sqrt{2} - V_D$$

$$= 24\sqrt{2} - 0.7$$

$$= 33.2\ V_{DC}$$

- what happens during portions of the original sine wave when the diode is OFF?
  - V_L is held at approximately 33.2V (ripple is small)
    - → this is the diode's cathode
  - anode of diode is V_S

∴ the anode can swing as low as
negative V_{peak}



∴ at this instant, $V_D = V_{anode} - V_{cathode}$

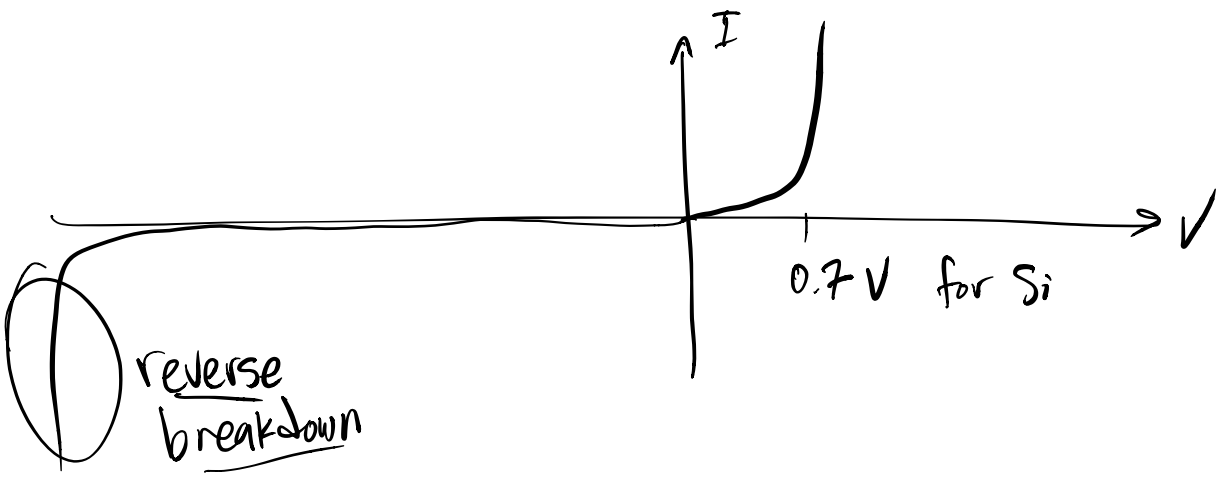
$= -33.9 - 33.2$

$\boxed{= -67.1\,V}$

∴ almost $-2\,V_{peak}$

∴ this is a reverse voltage

∴ No problem, unless it is sufficient to get into reverse-breakdown region of diode



- how do we know what voltage this happens?
  - function of size and chemistry

PIV [peak inverse voltage] rating

- specified by manufacturer of diode
- some common silicon diodes w/ 1A forward current rating, useful for many applications:

IN4001	50V	IN4006	800V
IN4002	100V	7	1000V
3	200V		
4	400V		
5	600V		

∴ different rectifier configurations have different max. reverse voltages

half-wave $\longrightarrow PIV > 2\sqrt{2}\, V_{s(RMS)}$

(half-wave example: use 1N4002 or better)
↓
100V

center-tap $\longrightarrow PIV > 2\sqrt{2}\, \underbrace{V_{s(RMS)}}_{\text{one side}}$

∴ for homework example:

$$2\sqrt{2}\, \underbrace{V_{s(RMS)}}_{\text{one-side}} = 2\sqrt{2} \cdot 350$$

$$= \underline{989.9\,V}$$

use 1N4007 (1000V)

full-wave bridge $\longrightarrow PIV > \sqrt{2}\, V_{s(RMS)}$