Capacitor in an AC circuit

Young Won Lim
06/26/2017

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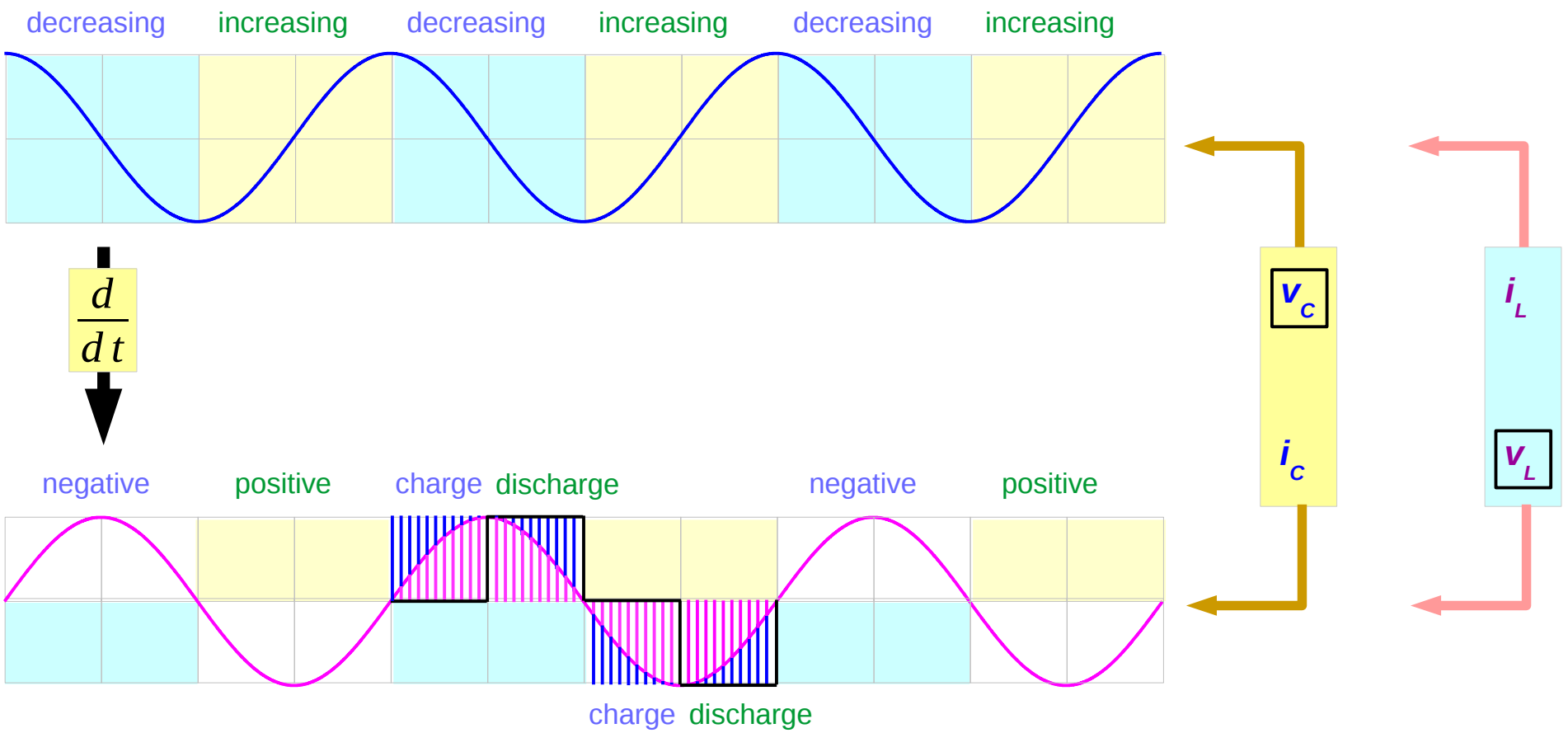
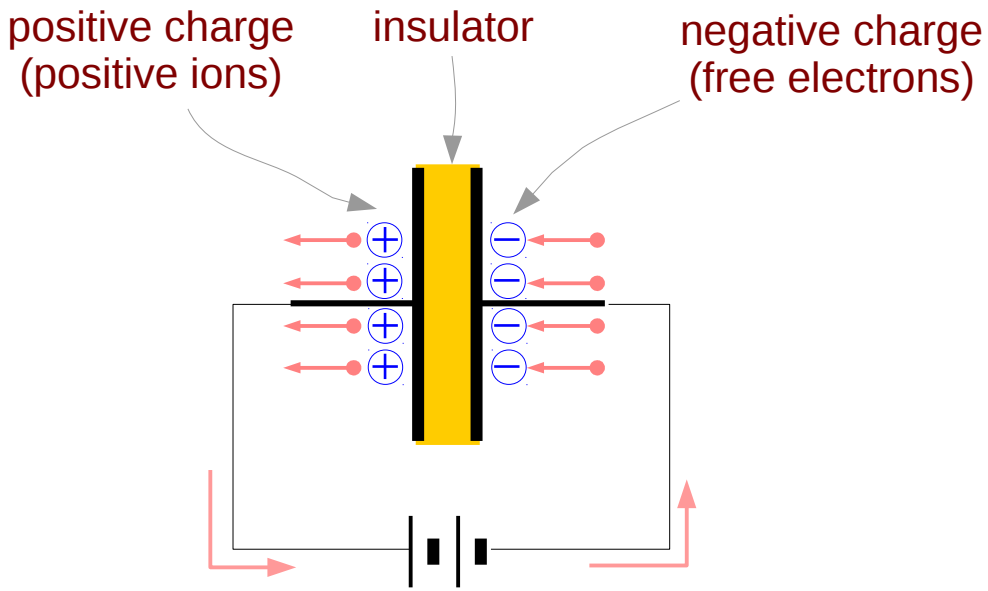
06/26/2017

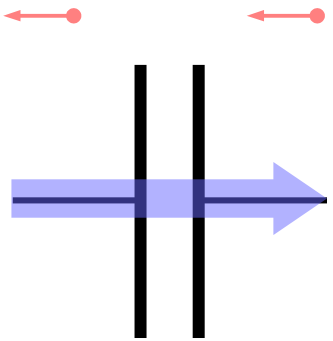
Everchanging signal pairs



Capacitor Current

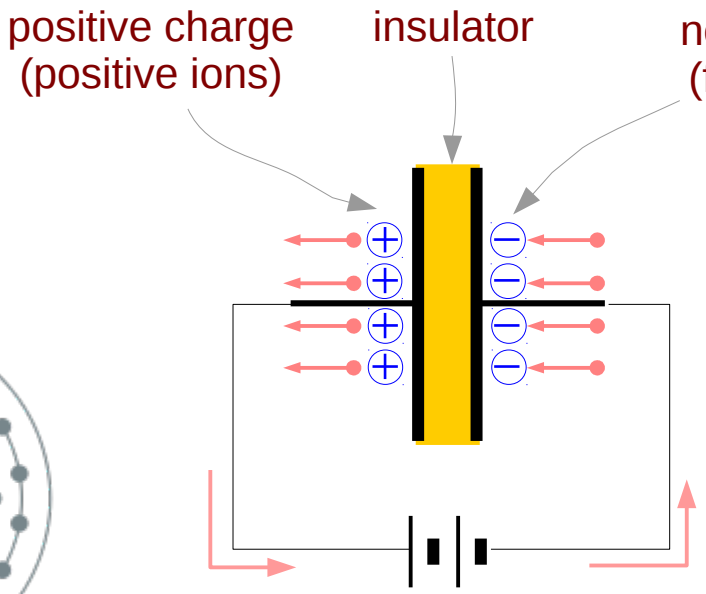


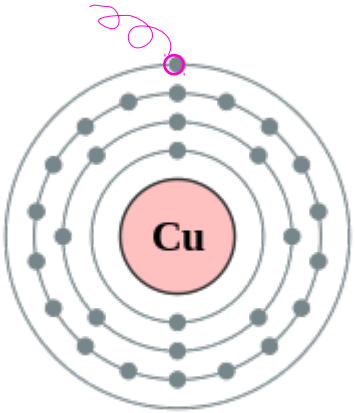
Think as electrons move to the left



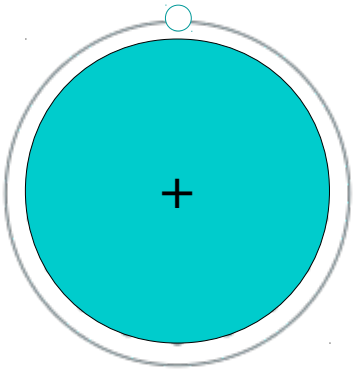
Displacement Current

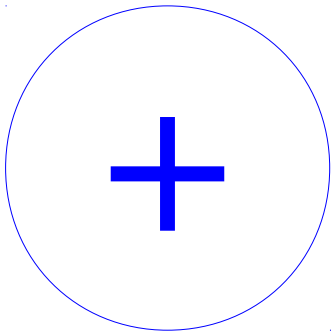
Positive ions and free electrons

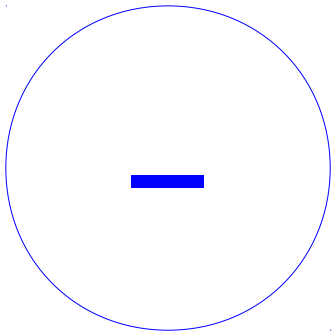




[[commons:User crap]] (original work by commons:User:Greg Robson) https://upload.wikimedia.org/wikipedia/commons/thumb/f/f7/Electron_shell_029_Copper_-_no_label.svg/200px-Electron_shell_029_Copper_-_no_label.svg.png



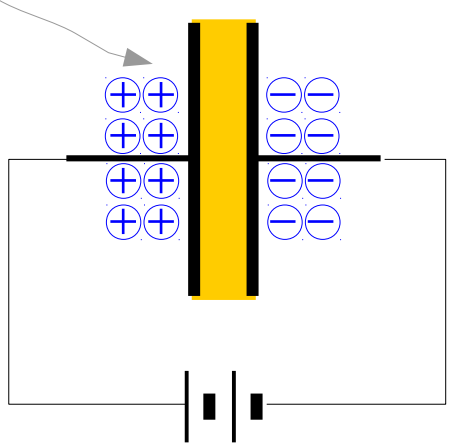




Three States

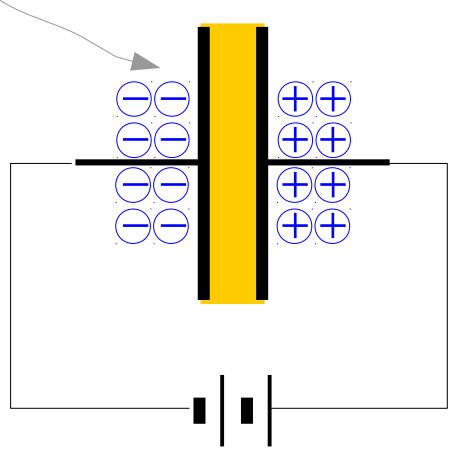
positive charge
(positive ions)

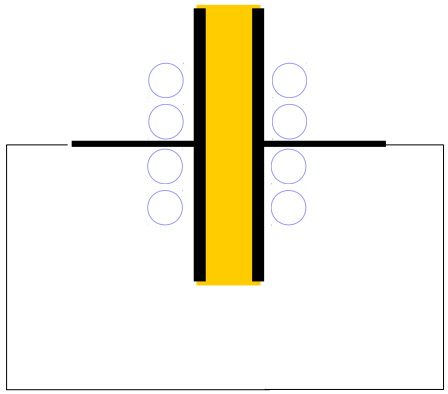
Positive Charged State



negative charge
(free electrons)

Negative Charged State



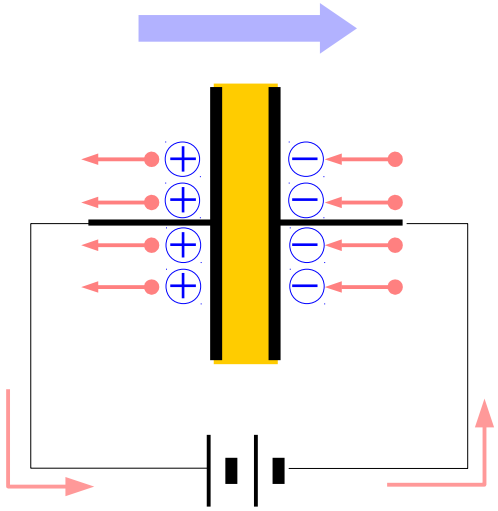


Fully Discharged State

Inter-State Current Flowing

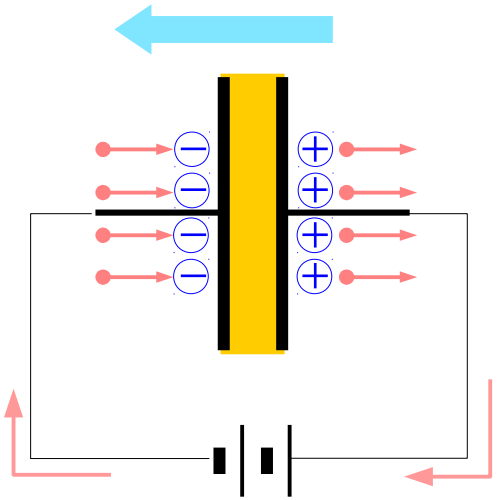
Positive Charging

(+) current flow direction

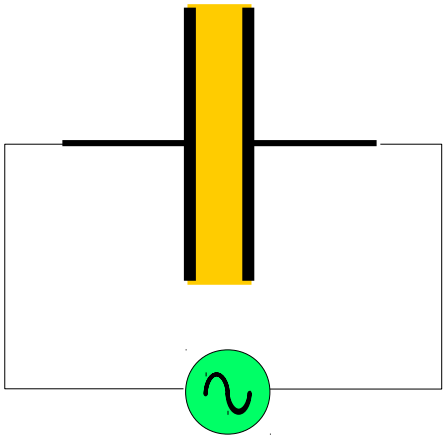


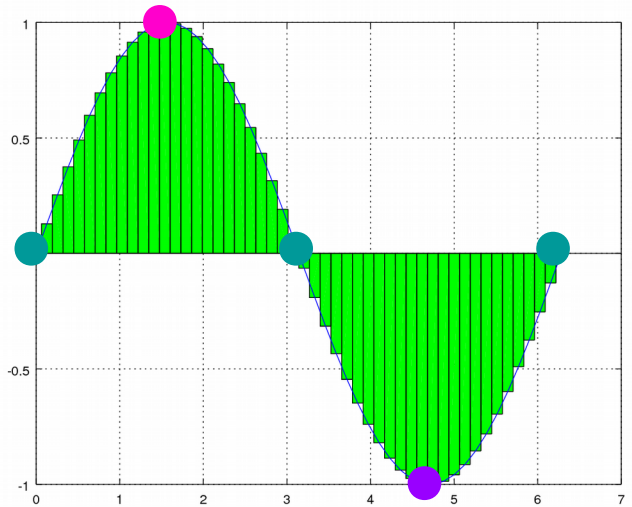
Negative Charging

(–) current flow direction

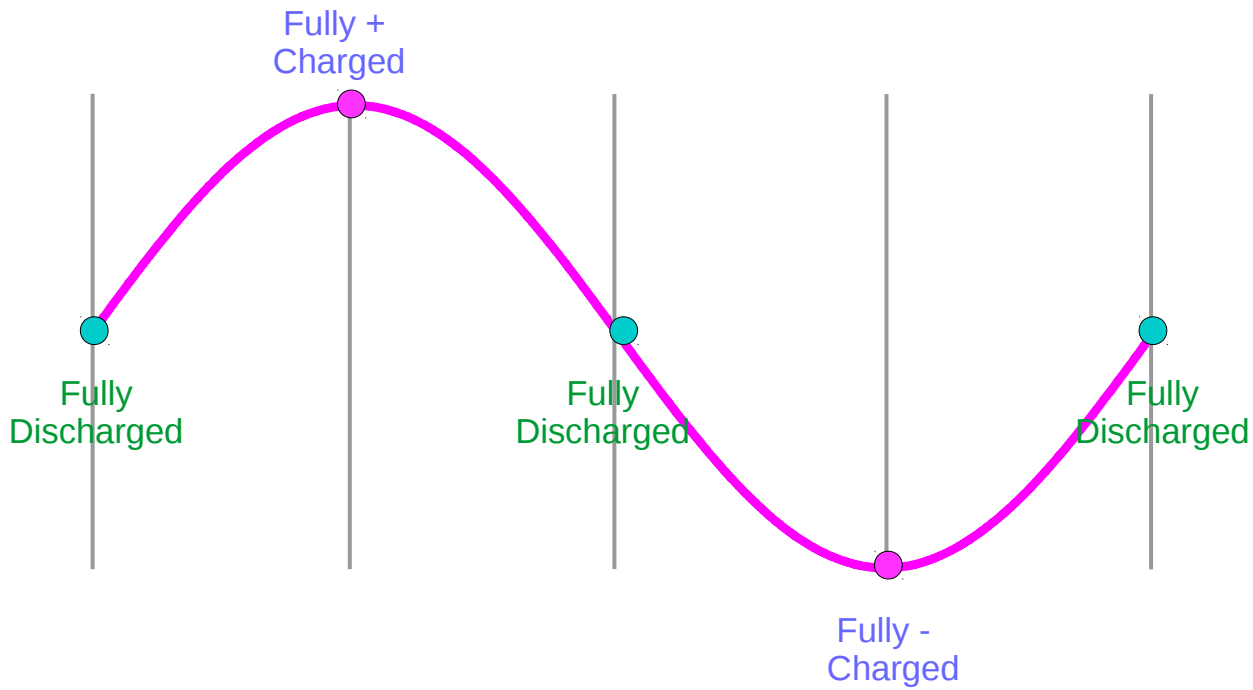


An AC Voltage Source

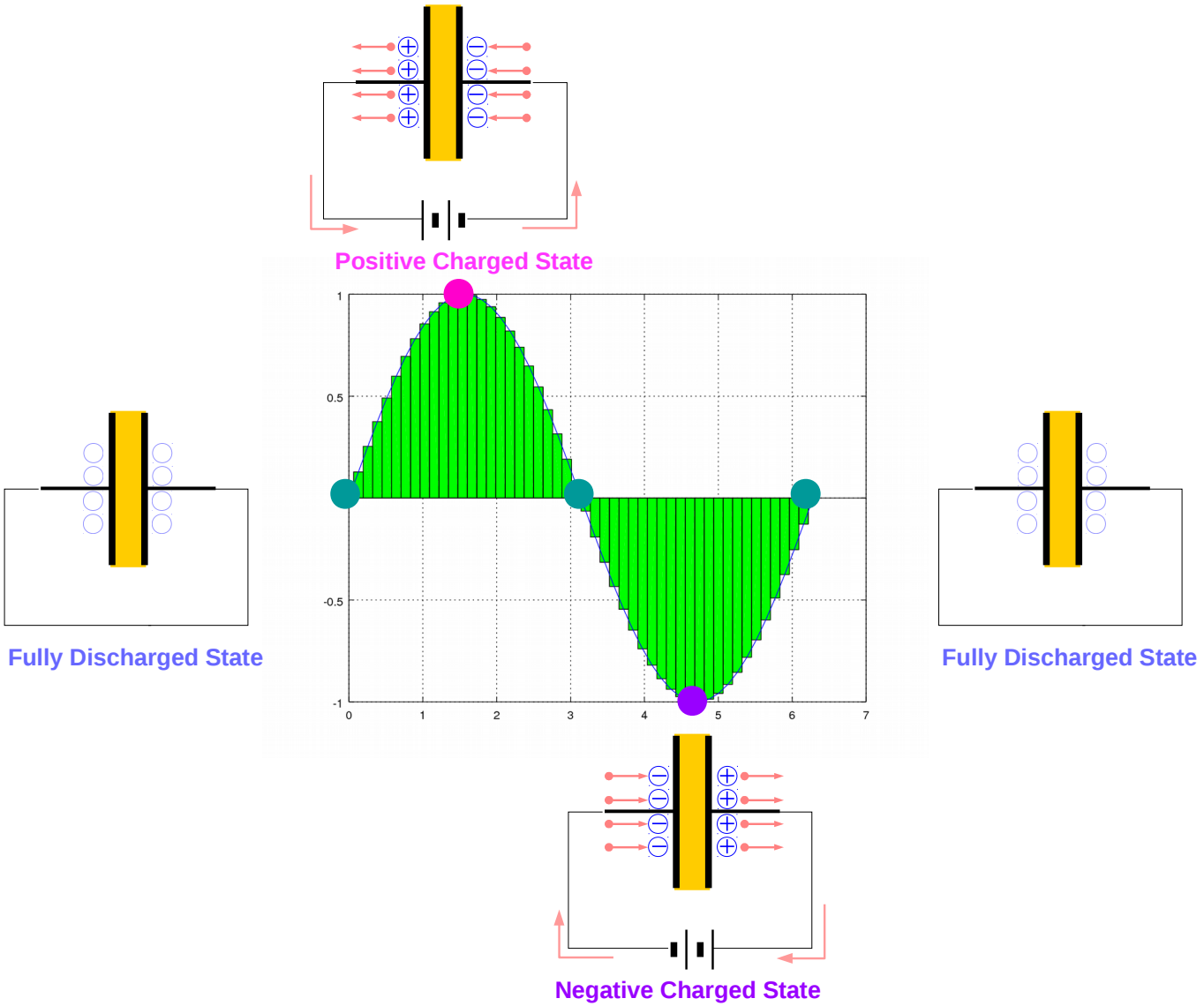




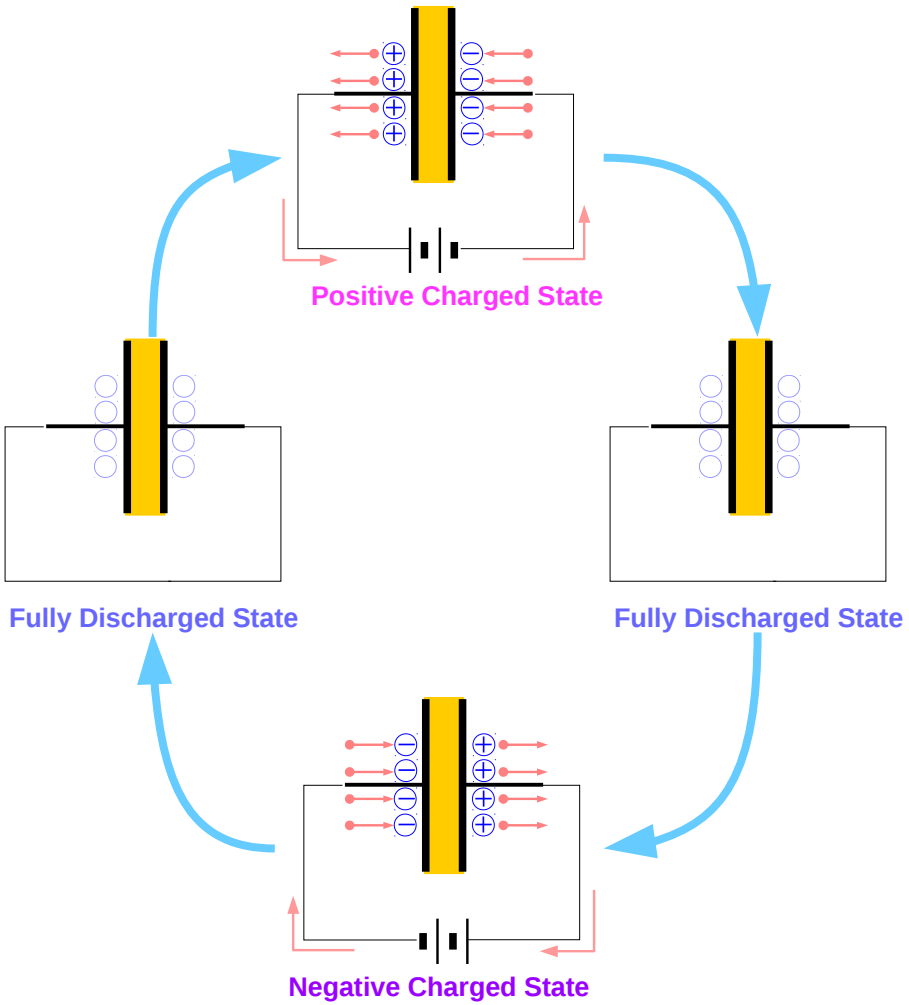
Fully Charged and Fully Discharged

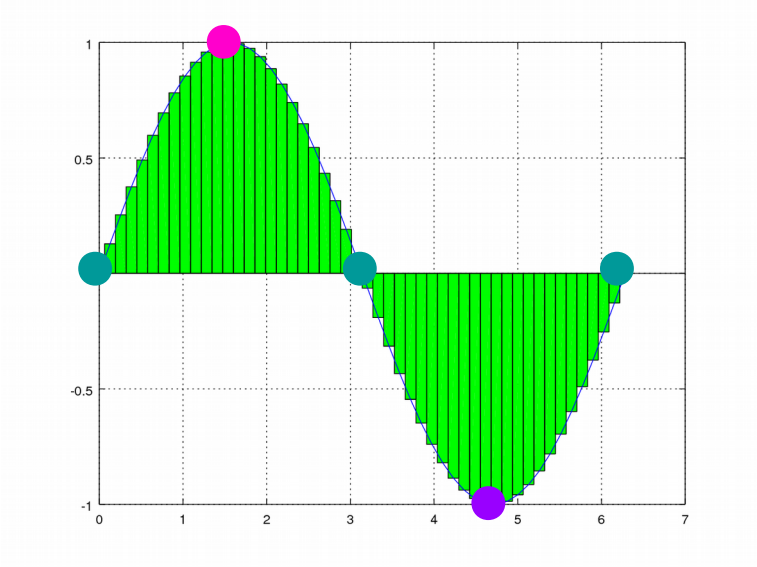


A Cycle

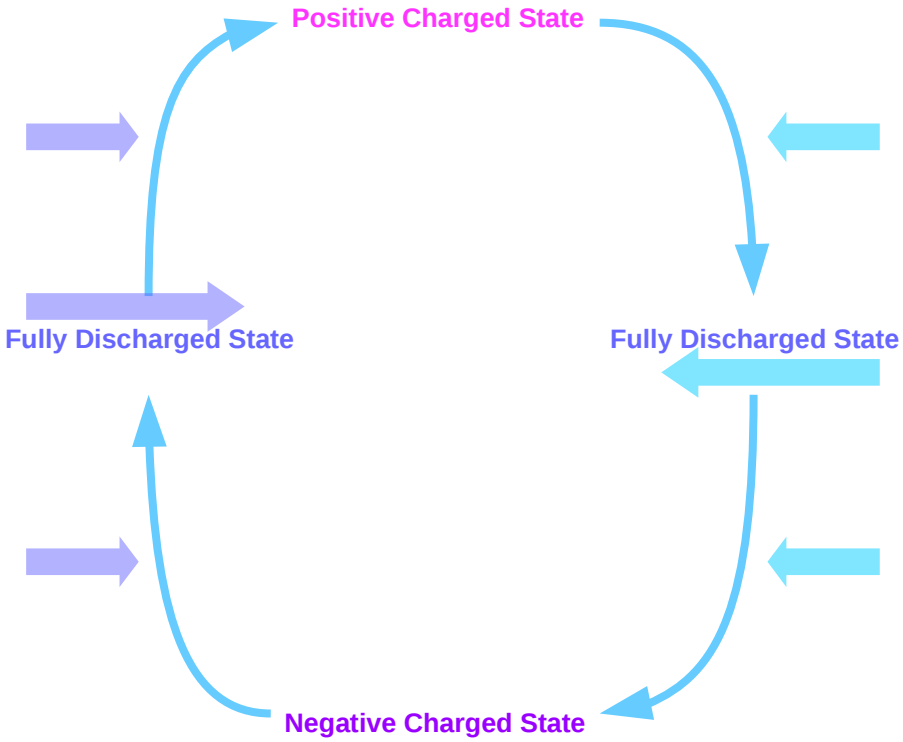

Positive Charged State
Fully Discharged State
Fully Discharged State
Negative Charged State

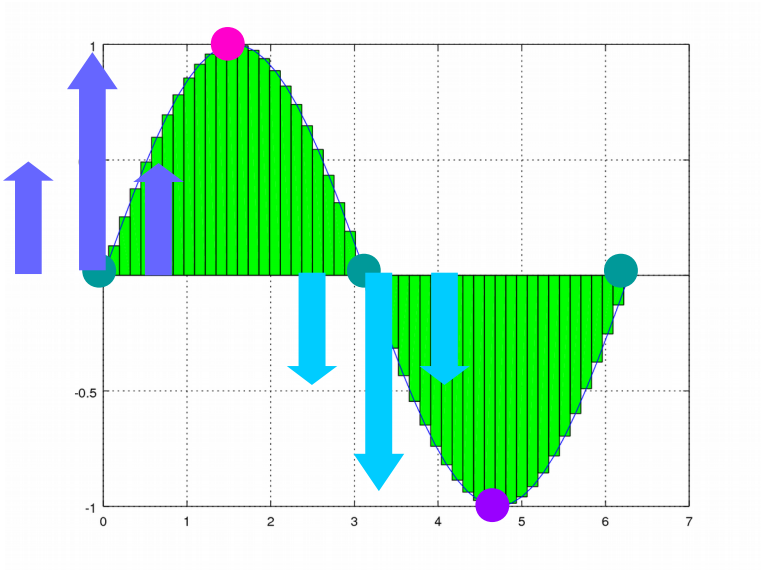
State Transition Diagram



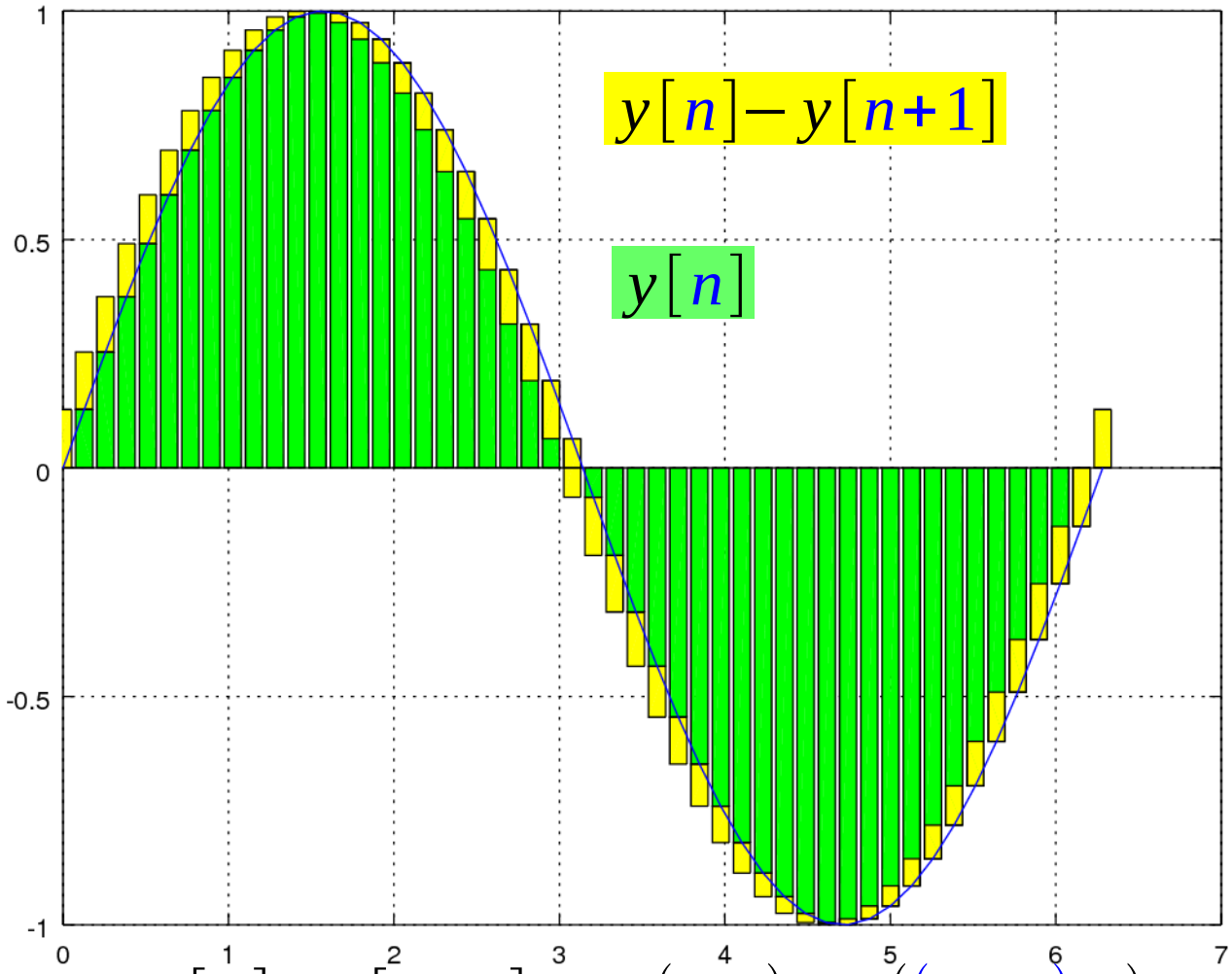


Current Flow





Fully Charged and Fully Discharged



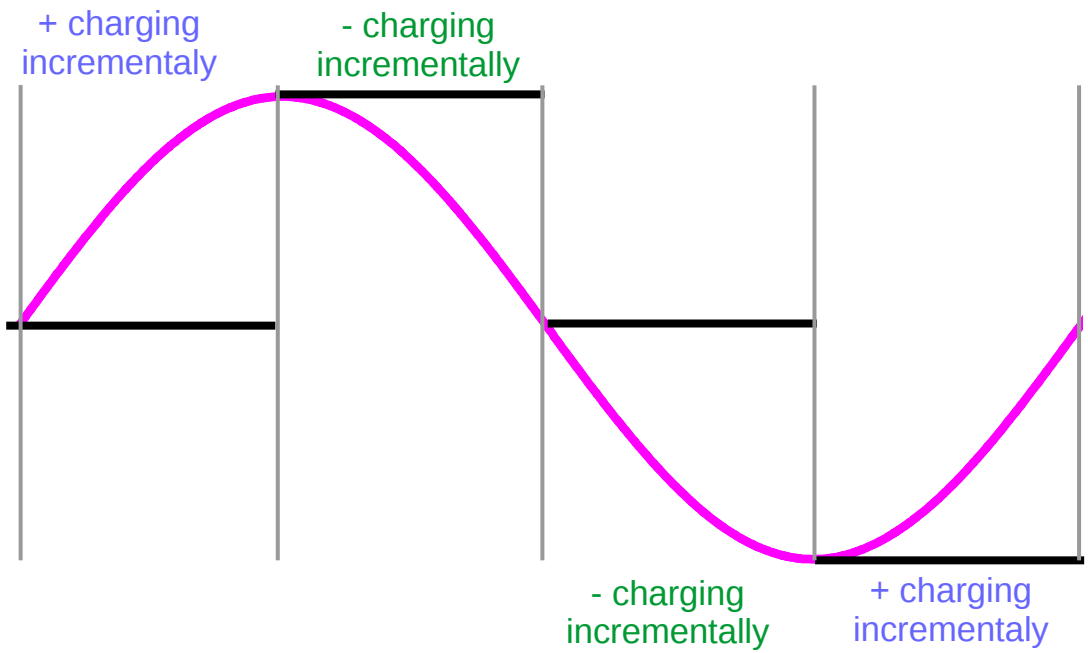

```
 h = bar(t1, [y1' y2'],
"stacked")
set(h(1), "facecolor", "g");
set(h(2), "facecolor", "y");
hold on
plot(t1, y1)
axis([0 7 -1 1]);
```

$$y[n]-y[n+1] = y(nT)-y((n+1)T)=\sin(nT)-\sin((n+1)T)$$

Continuous Charing and Discharging Operations

Incremental Voltage Increment ➡ + Charging incrementally

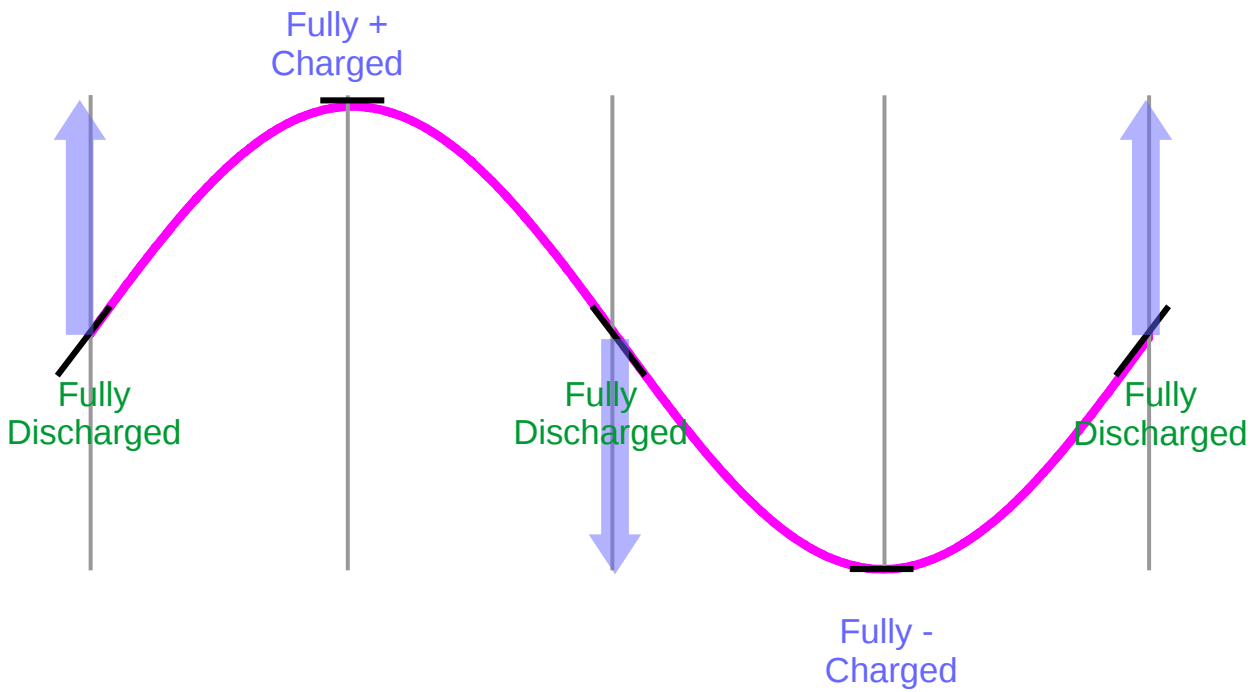
Incremental Voltage Decrement ➡ – Charging incrementally



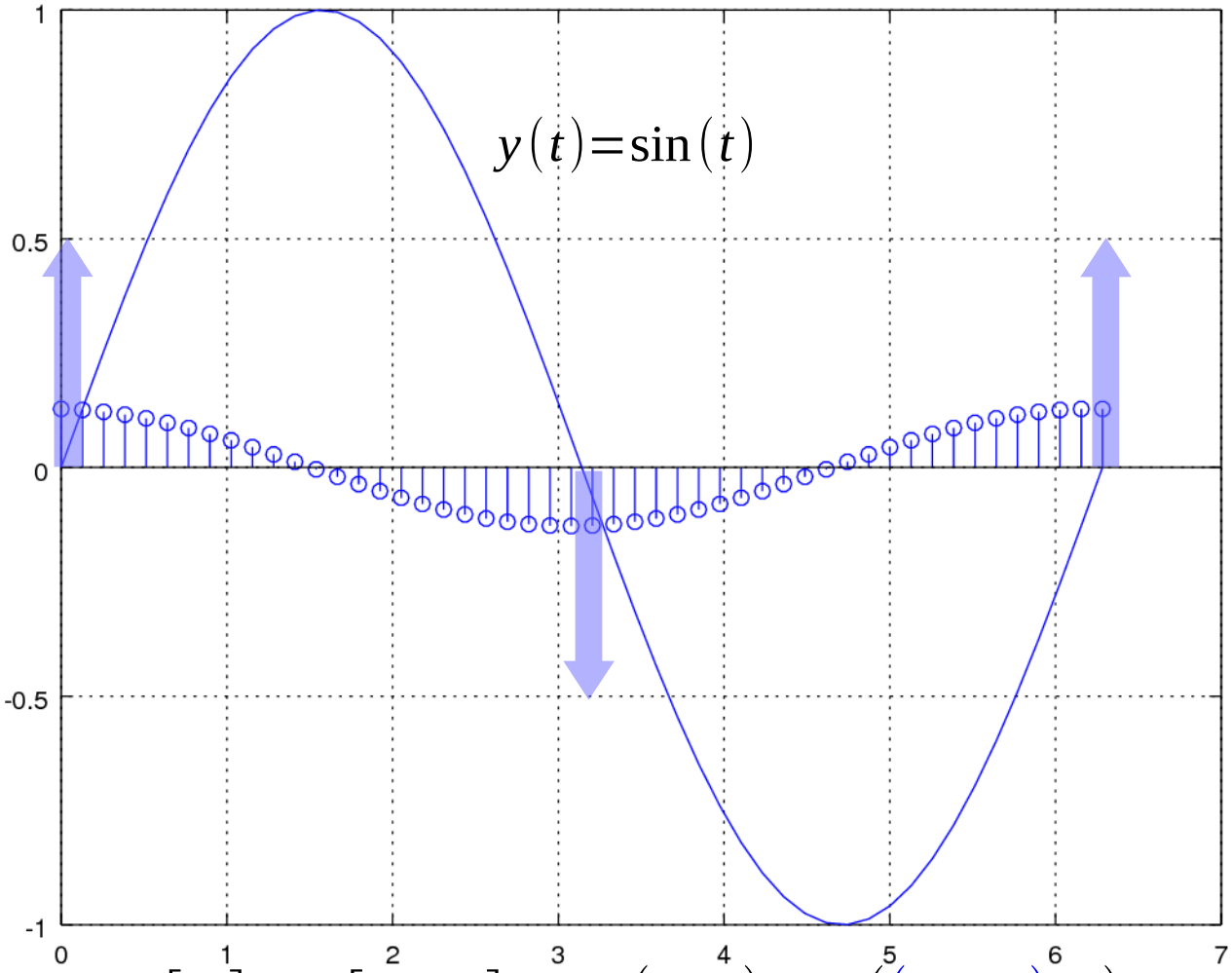
Fully Discharged : Large Current

Incremental Voltage Increment ➡ Continuous Charging

Incremental Voltage Decrement ➡ Continuous Discharging



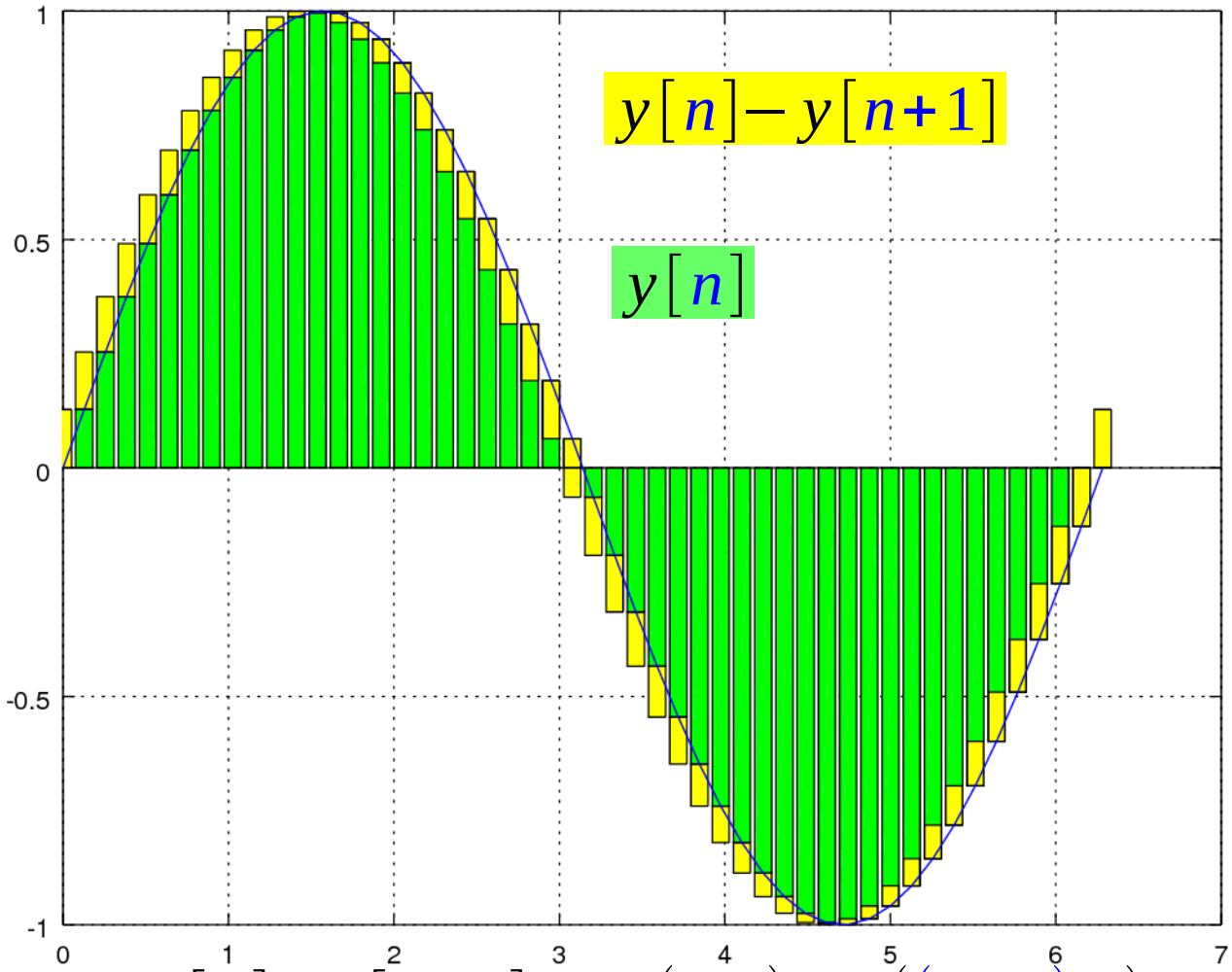
y[n+1] – y[n]




```
t = linspace(0, pi*2, 50);
t1 = t;
t2 = t + t(2);
y1 = sin(t1);
y2 = sin(t2) - sin(t1);
stem(t1, y2)
hold on
plot(t1, y1)
```

$$y[n]-y[n+1]=y(nT)-y((n+1)T)=\sin(nT)-\sin((n+1)T)$$

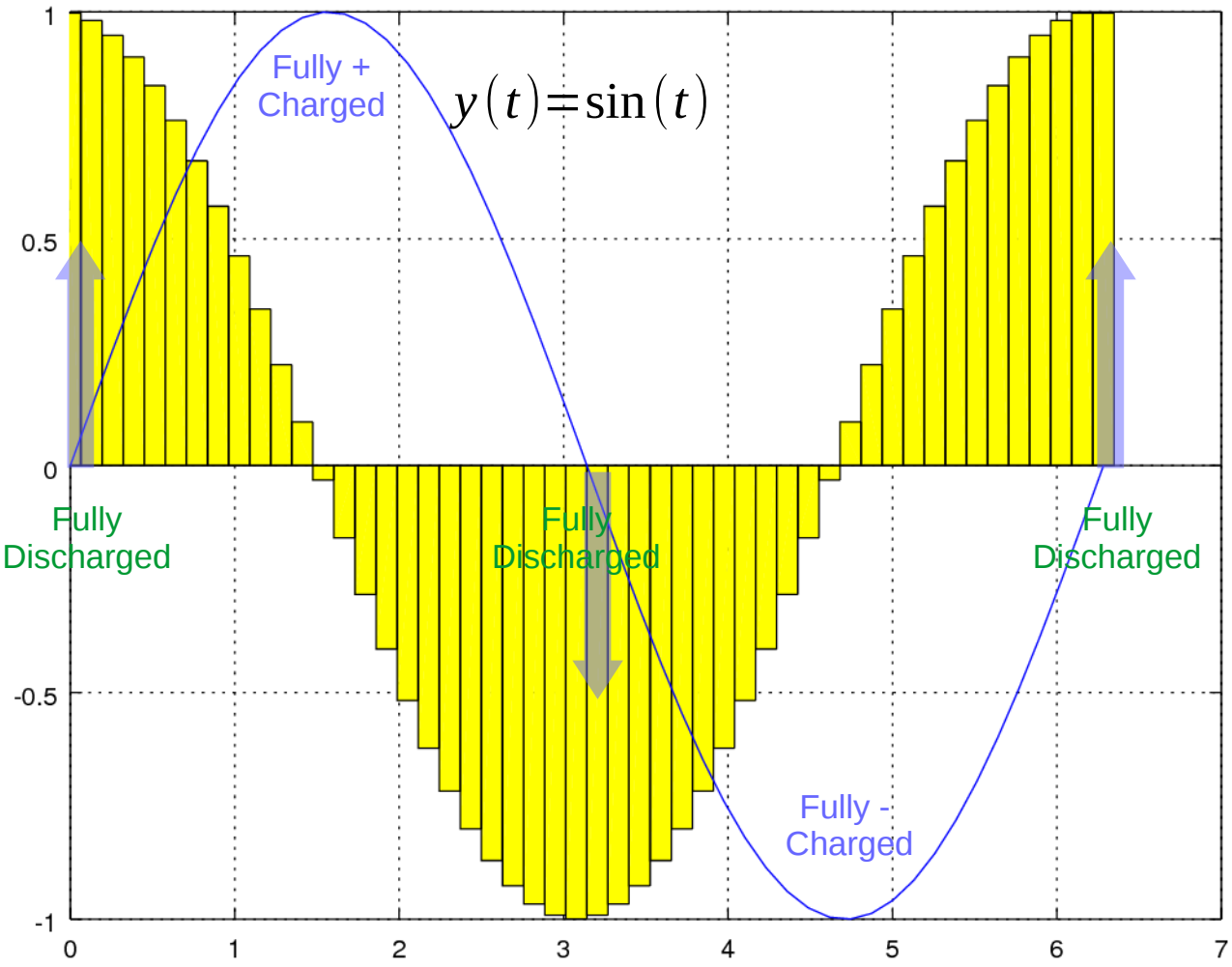
Fully Charged and Fully Discharged




```
 h = bar(t1, [y1' y2'], "stacked")
set(h(1), "facecolor", "g");
set(h(2), "facecolor", "y");
hold on
plot(t1, y1)
axis([0 7 -1 1]);
```

$$y[n]-y[n+1] = y(nT)-y((n+1)T)=\sin(nT)-\sin((n+1)T)$$

Fully Charged and Fully Discharged

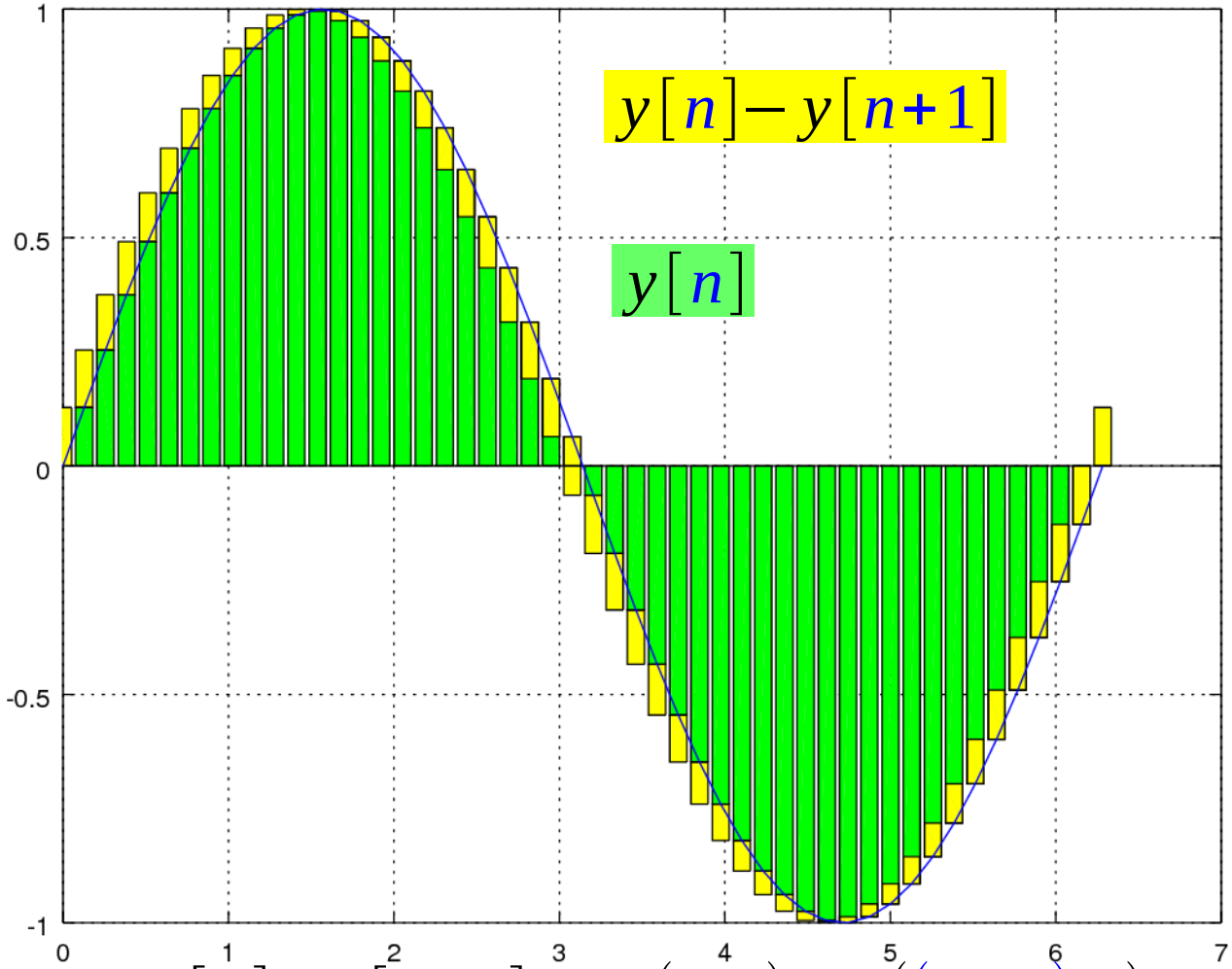



```
h = bar(t1, y2/t(2), "hist")
set(h(1), "facecolor", "y");
hold on
plot(t1, y1)
axis([0 7 -1 1]);
```

$$\frac{y[n]-y[n+1]}{T}$$

$$\propto \frac{dy}{dt}$$

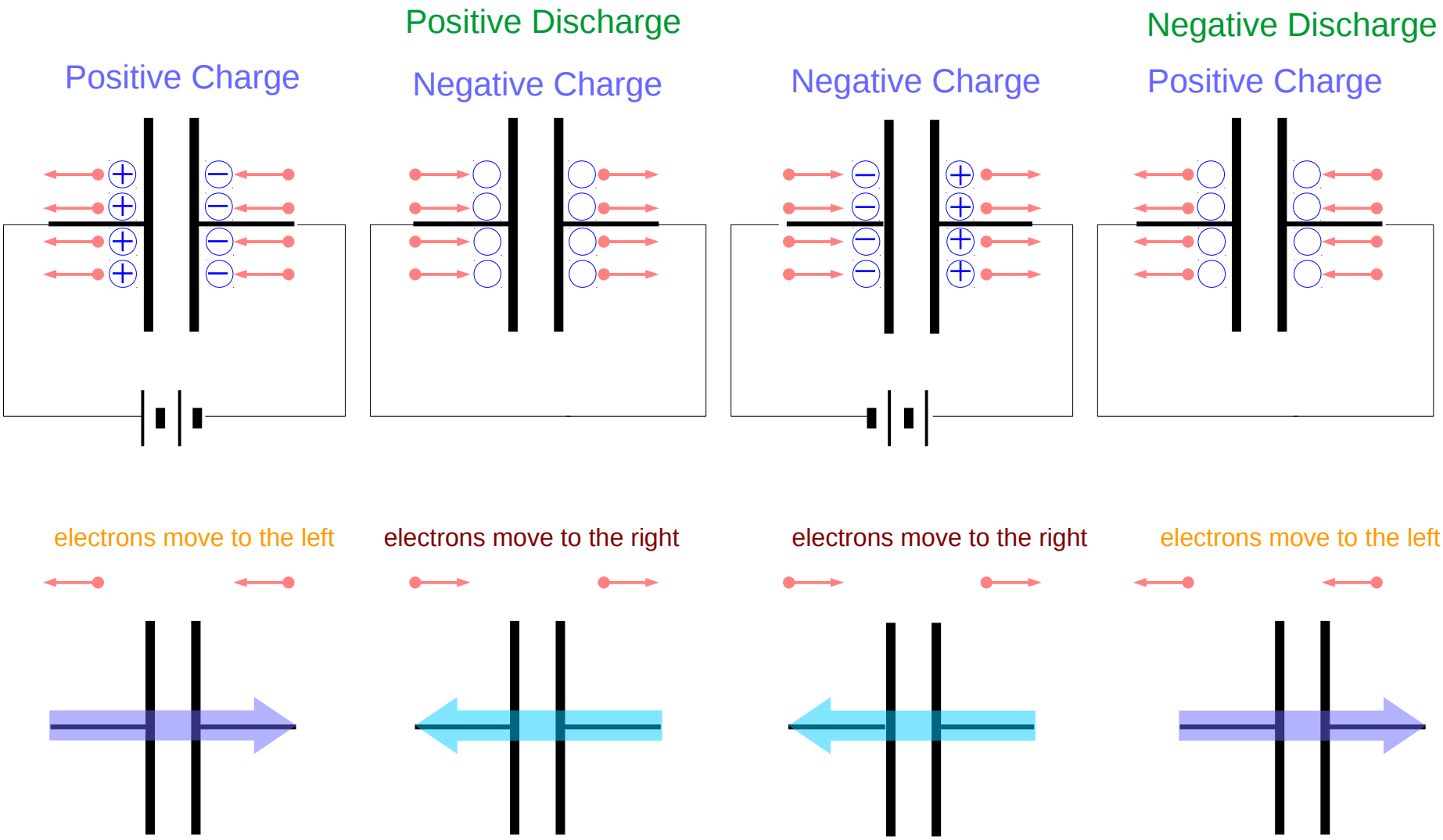
Fully Charged and Fully Discharged



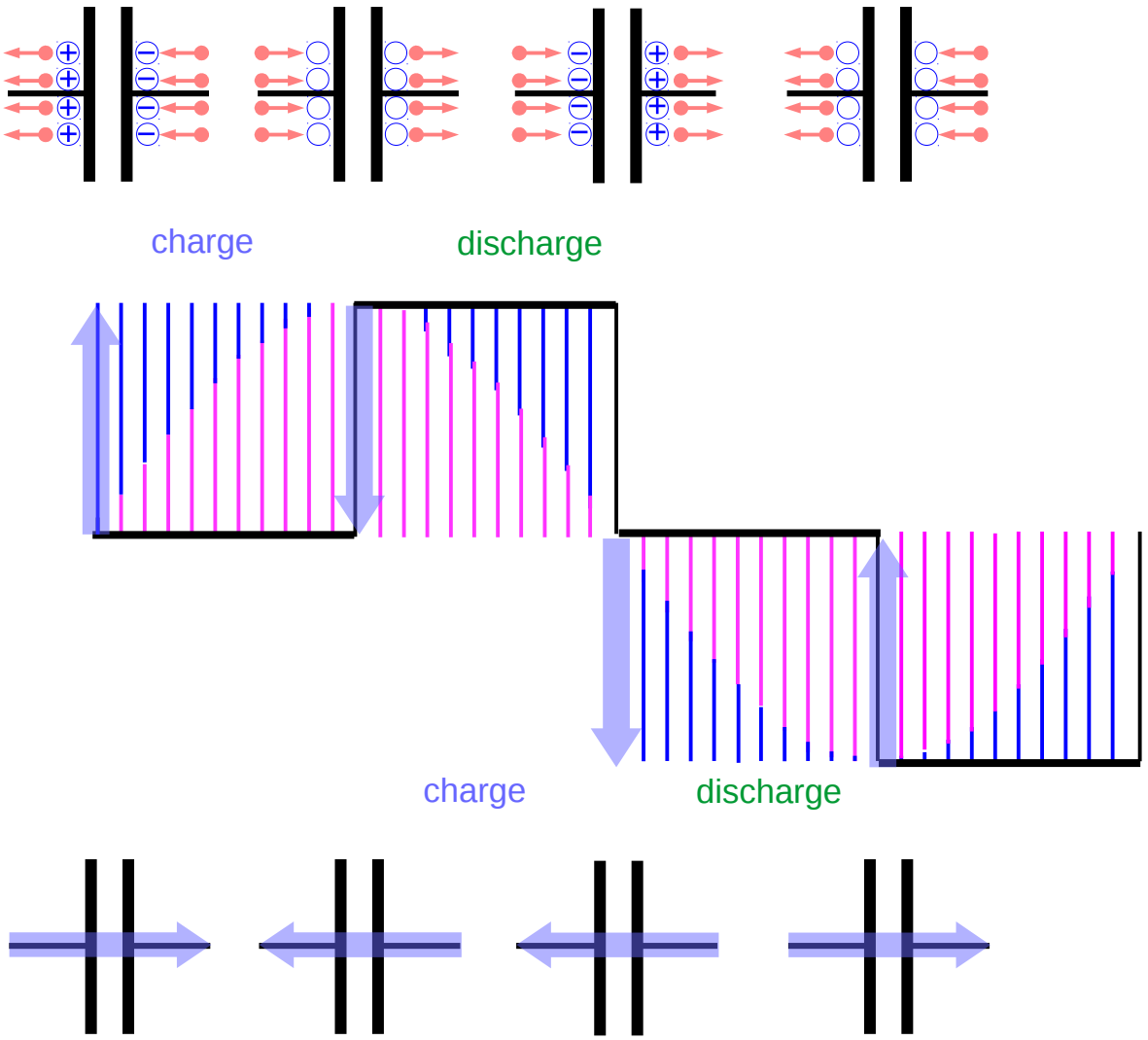

```
 h = bar(t1, [y1' y2'], "stacked")
set(h(1), "facecolor", "g");
set(h(2), "facecolor", "y");
hold on
plot(t1, y1)
axis([0 pi]);
```

$$y[n]-y[n+1] = y(nT)-y((n+1)T)=\sin(nT)-\sin((n+1)T)$$

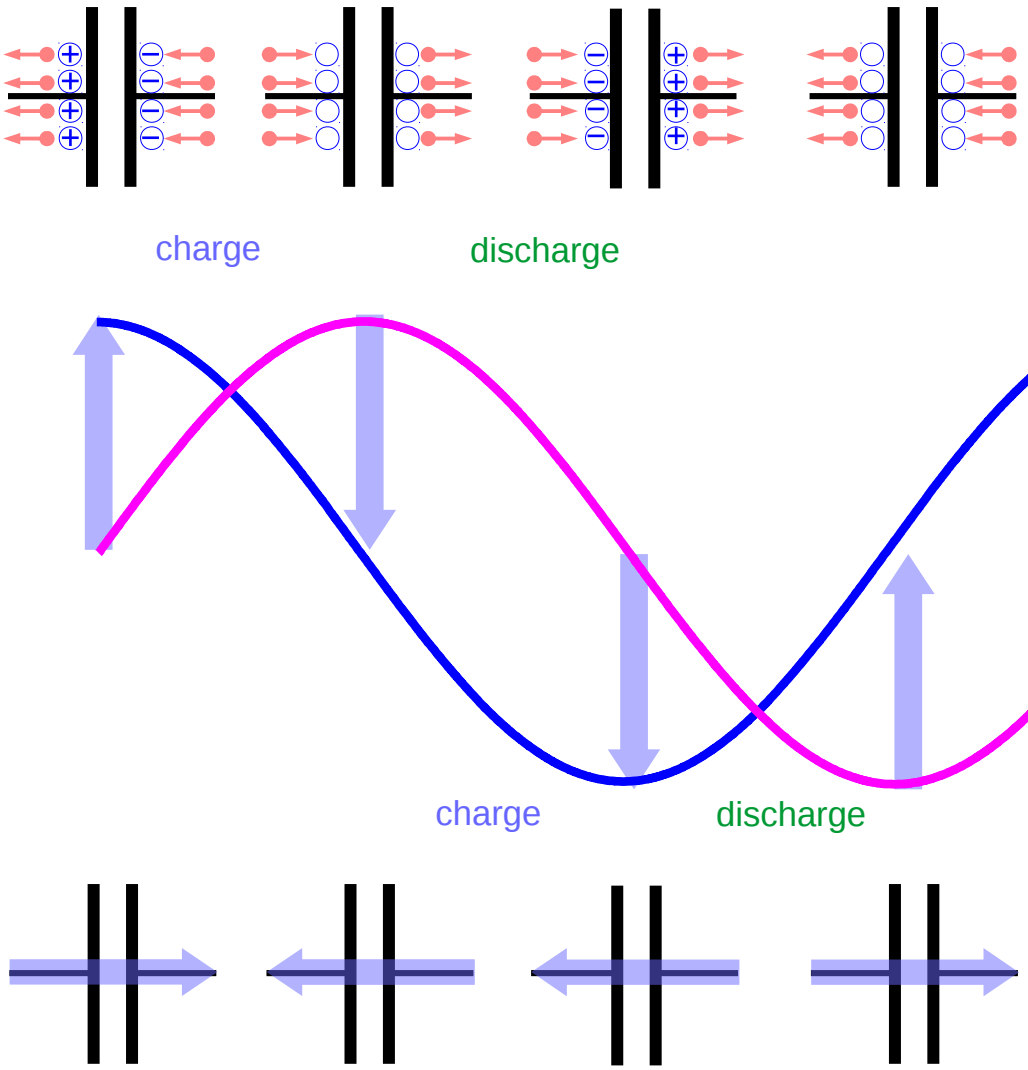
Everchanging signal pairs



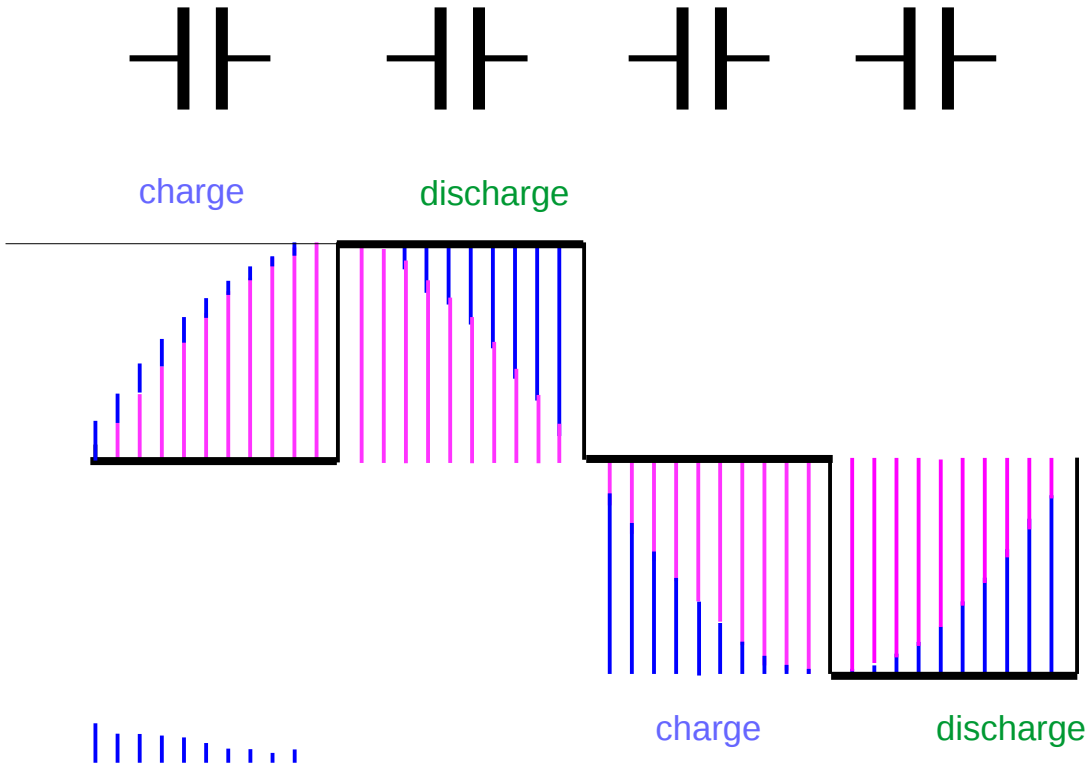
Everchanging signal pairs



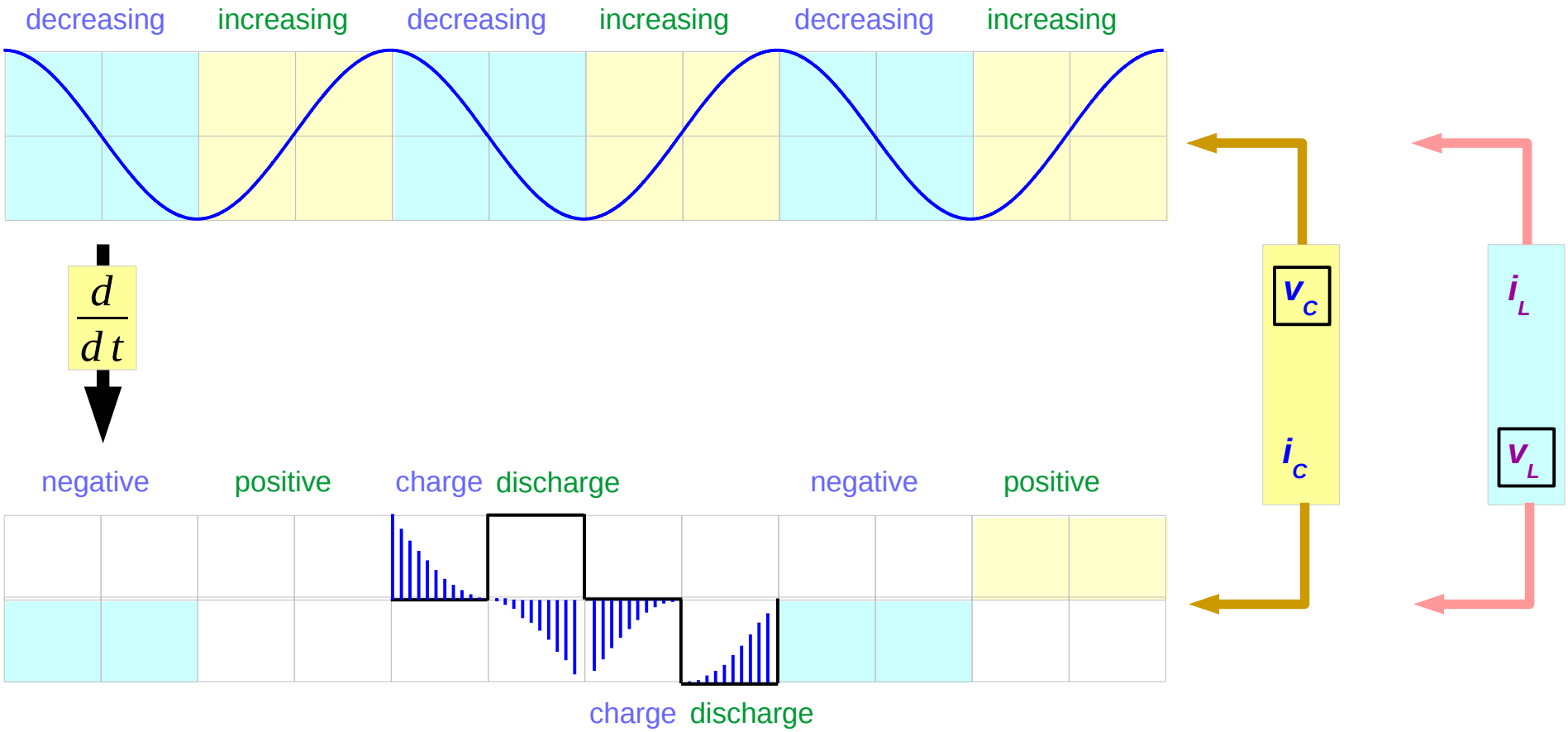
Everchanging signal pairs



Everchanging signal pairs

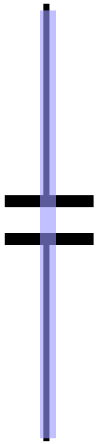


Everchanging signal pairs



I leads V by 90°

Initial charge

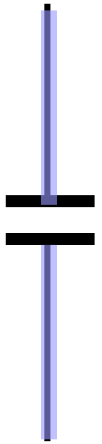


SHORT

V = 0

I : peak

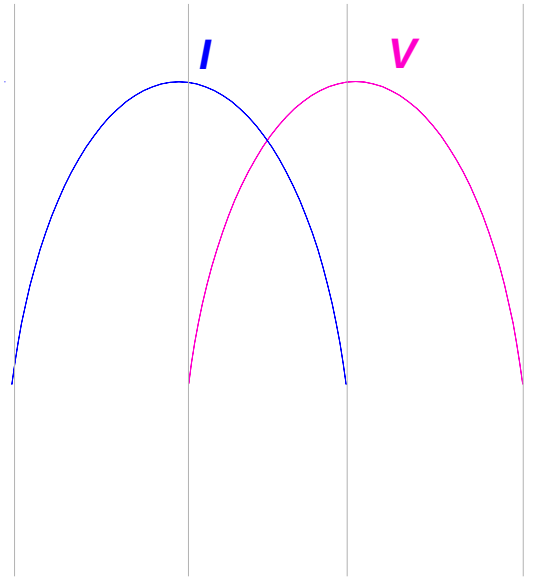
Full charge



OPEN

I = 0

V : peak



References

[1] http://en.wikipedia.org/
[2] J.H. McClellan, et al., Signal Processing First, Pearson Prentice Hall, 2003