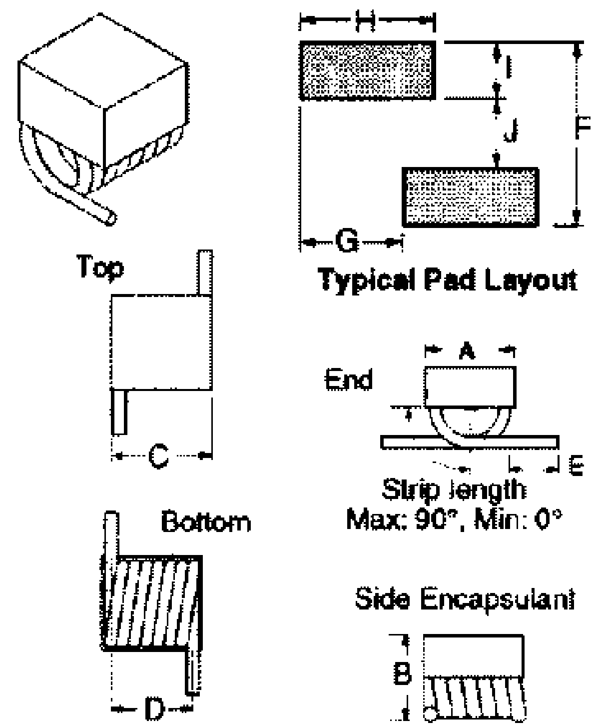
Series 4426 Surface Mount Air Core Inductors

High Q, wire wound air cores over a wide frequency range.
Flat cap top is suitable for automatic placement.

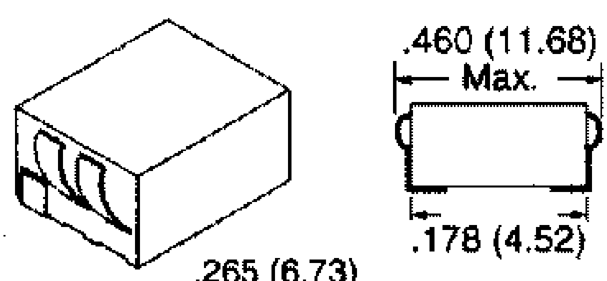
	Size A		Size B	
	(inch)	(mm)	(inch)	(mm)
A Max	.120	3.05	.120	3.05
B Max	.125	3.18	.125	3.18
C Max	.145	3.68	.270	6.86
D	.115±.010	2.92±.25	.230±.010	5.84±.25
E	.05±.015	1.27±.38	.05±.015	1.27±.38
F	.165	4.19	.285	7.23
G	.110	2.79	.110	2.79
H	.130	3.30	.130	3.30
I	.050	1.27	.050	1.27
J	.065	1.65	.185	4.69



Size Code	Induct. (nH)	Turns	Q Min.	Digi-Key Part No.	Price Each 1	10	50	100	API Delevan Part No.
Series 4426 Air Core Inductors									
A	2.5±10%	1	145	DN4001-ND	1.16	1.05	1.01	.97	4426-1
	5.0±10%	2	140	DN4002-ND	1.16	1.05	1.01	.97	4426-2
	8.0±5%	3	140	DN4003-ND	1.16	1.05	1.01	.97	4426-3
	12.5±5%	4	137	DN4004-ND	1.16	1.05	1.01	.97	4426-4
	18.5±5%	5	132	DN4005-ND	1.16	1.05	1.01	.97	4426-5
B	17.5±5%	6	100	DN4006-ND	1.16	1.05	1.01	.97	4426-6
	22.0±5%	7	102	DN4007-ND	1.16	1.05	1.01	.97	4426-7
	28.0±5%	8	105	DN4008-ND	1.16	1.05	1.01	.97	4426-8
	35.5±5%	9	112	DN4009-ND	1.16	1.05	1.01	.97	4426-9
	43.0±5%	10	106	DN4010-ND	1.16	1.05	1.01	.97	4426-10

4426KIT-ND (API Delevan Part No. 4426KIT)
Series 4426 Inductor Kit. 5 each of 10 values (2.5nH to 43nH), 50 total pieces........................**$25.50**

NEW! Series SMB 2.5 Surface Mount Shield Beads



Operating Temperature Range: –40°C to +125°C

We've talked about getting magnetic Fields from moving charges (current)

$$B = \frac{\mu_0 I}{2\pi r} \quad \text{wire}$$

$$B = \mu_0 n I \quad \text{solenoid} \qquad n = \frac{N}{\ell}$$

$$B = \frac{\mu_0 N I}{2\pi r} \quad \text{toroid}$$

We've talked about induced EmF from a changing magnetic flux

$$\mathcal{E} = -\frac{d\phi_B}{dt} \qquad \phi_B = \int \vec{B}\cdot d\vec{A} \qquad \mathcal{E} = \oint \vec{E}\cdot d\vec{s}$$

Now lets combine the two of these using a solenoid. In a solenoid, each coil has an area to contribute to the flux

$$\Phi_B = B_{solenoid}(N A_{coil}) = (\mu_0 n I) N A$$

so, we could conveniently change B by changing the current

$$\frac{d\Phi_B}{dt} = \underbrace{\left(\mu_0 \frac{N}{\ell}\right)(NA)}\frac{dI}{dt}$$

these are just constants that depend on how the solenoid is made & what's inside

When we deal with these things in a circuit, we'll combine the constant part so that

$$\frac{d\Phi_B}{dt} = L\frac{dI}{dt}$$

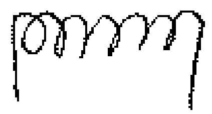
L is called the self inductance

The units of Inductance are Henrys

$$1\,H = \frac{Vs}{A} = \frac{Tm^2}{A}$$

A fairly typical inductance in a small circuit component is $\sim 10\mu H$ {usually a high permeability material though $\mu_0 \Rightarrow \mu$}

For an air core inductor



$N = (10\ \text{turns})$ $\ell = 5.8mm$

$A \sim \pi(1mm)^2$

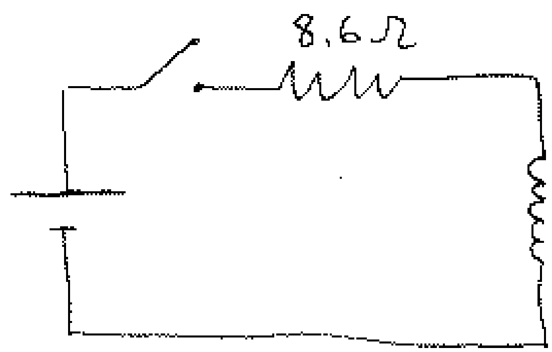
(These guys are called "chokes" They "choke" high frequency)

$$L \sim 4\pi \times 10^{-7} \frac{(10\,\text{turns})^2}{5.8mm\left(\frac{1m}{1000mm}\right)} \pi\left(1mm \frac{1m}{1000mm}\right)^2$$

$= 68nH$ not too far of the the catalog $43 \pm 5\%\,nH$

so we have $\mathcal{E} = -L\frac{dI}{dt}$ The changing B field of the solenoid itself cause the EmF

Lets put one of these do-dads in a circuit



What's going to happen when I throw the switch

The mag field inside the 9H inductor is 0, and will want to stay that way

So initially, $I=0$ & $\frac{dI}{dt}$ will be large (the inductor will be fighting the change)

after a long time $\frac{dI}{dt} = 0$ & steady current will flow.

After the switch is thrown

$$V - IR - L\frac{dI}{dt} = 0$$

like $V - \frac{q}{C} - \frac{dq}{dt}R = 0$ has sol

$$Q(t) = CV\left(1 - e^{-t/RC}\right)$$

{same eqns have same solutions}

replace

$$C \leftrightarrow \frac{1}{R} \qquad R \leftrightarrow L \qquad Q \leftrightarrow I$$

$$I(t) = \frac{V}{R}\left(1 - e^{-\frac{R}{L}t}\right)$$

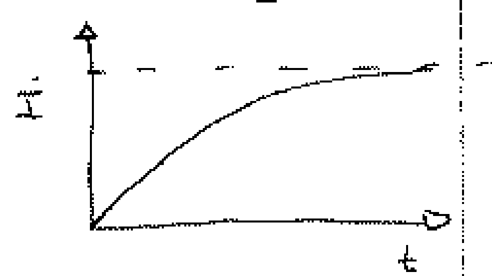
$$\text{so } \frac{dI}{dt} = \frac{V}{L}e^{-\frac{R}{L}(t)}$$

recall units of L $\frac{Vs}{A}$

$$\frac{R}{L} = \frac{R}{(Vs/A)} = \frac{V}{Vs} = \frac{1}{s}$$

H unit of Ωs

C units of s/Ω



the time constant of this circuit $= \frac{9\,H}{8.6\,\Omega} \sim 1\,s$

so, If I put a light bulb in at one point, should take a few seconds for us to see it.

Now, even more interesting, what happens when we open the switch.

The inductor is going to fight to maintain current I through it self since there's a b field through there.

But, an open switch is like a huge resistance, so, apparently

$I_{big}\, R_{big}$ should give us V_{big} right?

lets look at this another way

There is energy stored by the inductor as the current Increases

$$V = L\frac{dI}{dt} \qquad IV = LI\frac{dI}{dt}$$

$$\int \text{Power}(\text{time}) = \int_0^{\infty} LI\frac{dI}{dt}$$

$$= L\int_0^{\infty} \frac{V}{R}\left(1-e^{-\frac{R}{L}t}\right)\frac{V}{L}e^{-\frac{R}{L}t}\,dt$$

$$= \frac{V^2}{R}\int_0^{\infty}\left(e^{-\frac{R}{L}t} - e^{-\frac{2R}{L}t}\right)dt$$

$$= \frac{V^2}{R}\left(-\frac{L}{R}e^{-\frac{R}{L}t}\Big|_0^{\infty} - \left(-\frac{L}{2R}\right)e^{-\frac{2R}{L}t}\Big|_0^{\infty}\right)$$

$$= \frac{V^2}{R}\frac{L}{R}\left(1-\frac{1}{2}\right) = \frac{I^2 L}{2}$$

& all this power, when we open the switch gets dumped into the resistance of the open s with with a time constant of

$$\text{(say)} \quad \frac{9\,\Omega s}{10^6\,\Omega} = 10^{-5}\,s$$

That's a lot of energy to dump in so short a time

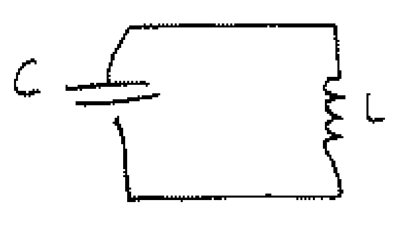
$$U_{stored} = \frac{\left(\frac{6V}{8.6\Omega}\right)^2 9H}{2} = 2.2\,J$$

$$\text{Power} \sim \frac{\Delta E}{\Delta t} \approx \frac{2.2\,J}{10^{-5}\,s}$$ close to a MW

wow

Lets take a look and see what happens (demo) (really works)

We could also combine Capacitance and inductance together.



you'll get an expression that looks like

$$\frac{q_{cap}}{C} = -L\frac{dI_{cap}}{dt}$$

$$= -L\frac{d^2q_{cap}}{dt^2}$$

$$-\frac{q_{cap}}{C} = L\frac{d^2q_{cap}}{dt^2}$$

You've seen this before

$$-kx = F_{spring} = m\frac{d^2x}{dt^2}$$

and the charge sloshes back and forth like a mass on a spring (analog computer)

Last thought

The presence of an electric field inside a capacitor is a stored energy

The presence of a magnetic field inside a solenoid is a stored energy

$$U = \frac{1}{2}CV^2 = \frac{1}{2}\frac{\varepsilon_0 A}{d}(Ed)^2 = \frac{1}{2}\varepsilon(d \cdot A)E^2$$

$$= \frac{1}{2}\varepsilon_0 \text{ Volume } E^2$$

$$U = \frac{1}{2}LI^2 = \frac{1}{2}\mu_0 \frac{N^2}{L}A\left(\frac{B}{\mu_0 \frac{N}{l}}\right)^2 = \frac{1}{2}\frac{1}{\mu_0} lA(B^2)$$

$$= \frac{1}{2}\frac{1}{\mu_0} \text{ Volume } B^2$$

There is an energy density associated with the mere presence of a B field or an E field

$$u_E = \frac{U_E}{V} = \frac{1}{2}\varepsilon_0 E^2$$

$$u_B = \frac{U_B}{V} = \frac{1}{2}\frac{B^2}{\mu_0}$$

next time we'll see how light works & these concepts will prove useful