



# Inductors

What are they & how do they work

Nigel Moorby



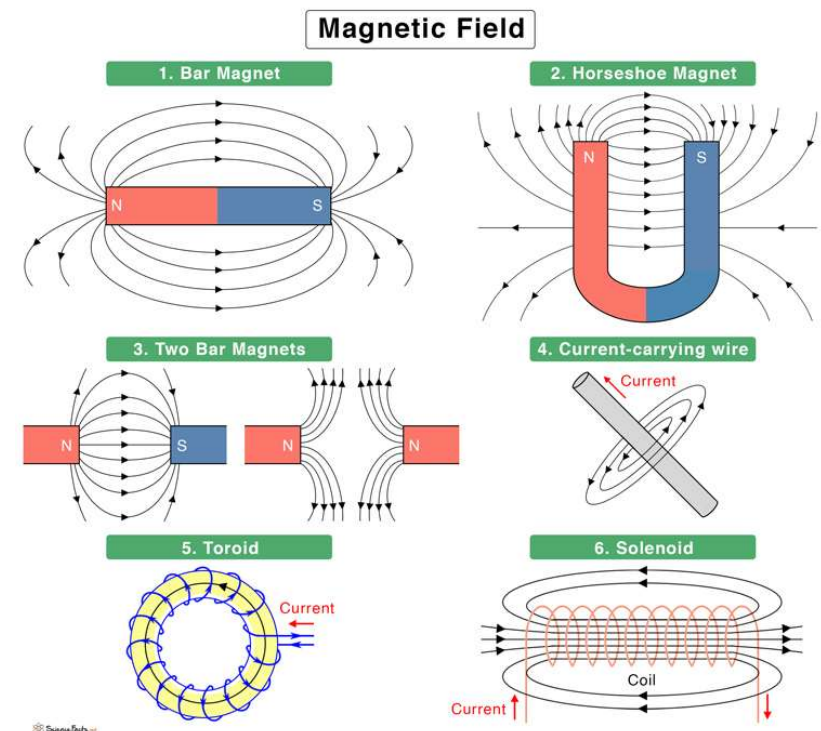
# What is an Inductor ?

- Inductors—they are passive, two-terminal electronic component that stores energy in a magnetic field when electric current flows through them.
- Inductors oppose sudden changes in current, making them essential for,
  - filtering, smoothing signals, and storing energy in power supplies.
- Also known as
  - coil,
  - choke,
  - or reactor

# Magnetic field



- A magnetic field is an invisible region of influence surrounding a,
  - magnet,
  - magnetic material,
  - or moving electric charge,within which magnetic force acts on other magnetic materials or charged particles.
- It acts as a non-contact force, with strength decreasing with distance from the source, often visualized using field lines.



# Inductance



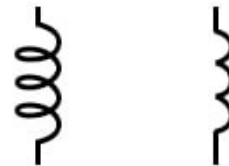
- Unit of inductance—self-inductance and mutual inductance—is the Henry (H).
- Joseph Henry is credited with the independent discovery of self-inductance, and the SI unit is named after him.
- The change in the electric current or flux induces an EMF in a coil, this property is called inductance.
- Most, if not all, electrical coils have inductance properties.
- Standard Definition:
  - One henry is the inductance of a closed circuit in which an electromotive force (EMF) of one volt is produced when the electric current in the circuit varies uniformly at a rate of one ampere per second.

# Inductor symbols



- There are two main classifications of inductors, **air core** and **iron core**.
  - The **air core** inductor does not necessarily mean that it does not have a core, it just not a magnetic core. It uses ceramic, plastic, or other non-magnetic material.
  - **Iron core** inductor on the other hand is an inductor that have iron as a core.
- Variable inductor are used to vary the inductance either by
  - moving the core or
  - changing the number of coils in circuit.
- A tapped inductor is a coil to which electrical access is available at more than one point.

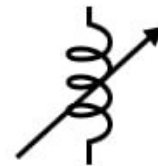
Fixed-value



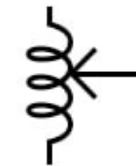
Iron-core



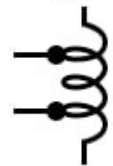
Variable



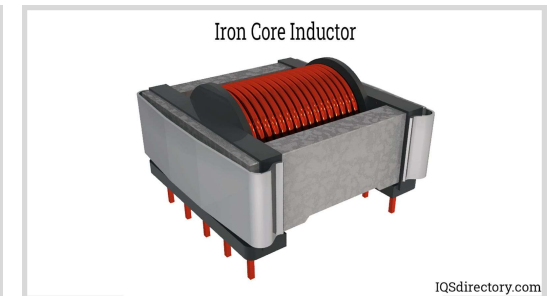
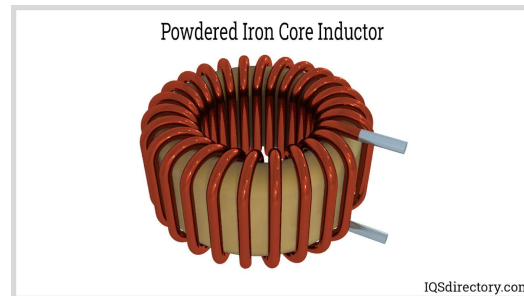
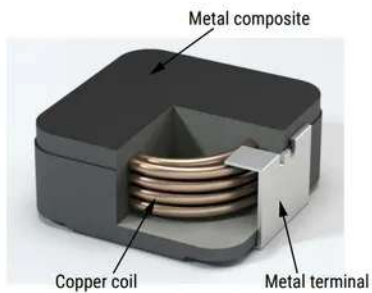
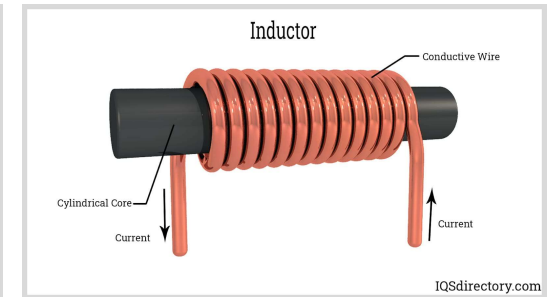
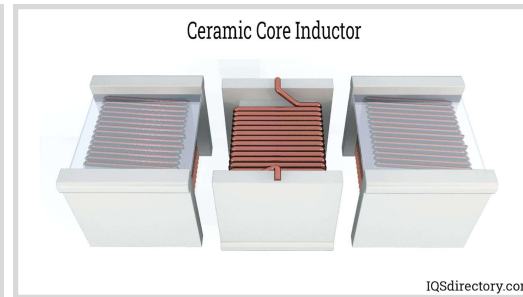
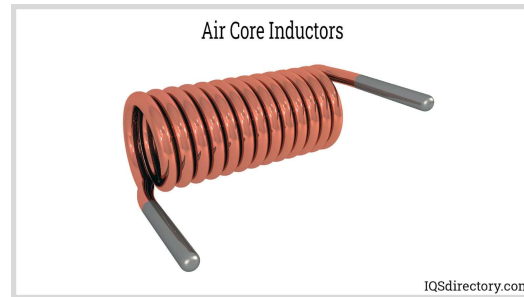
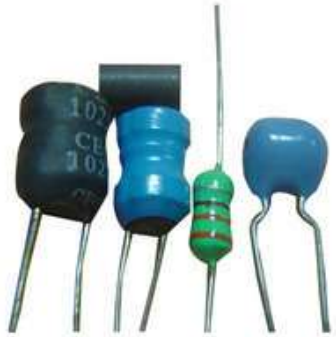
Variac



Tapped



# Inductor construction, fixed value



# Variable inductors

- Variable inductors either have an
  - adjustable core.
- Or
  - adjustable number of turns .

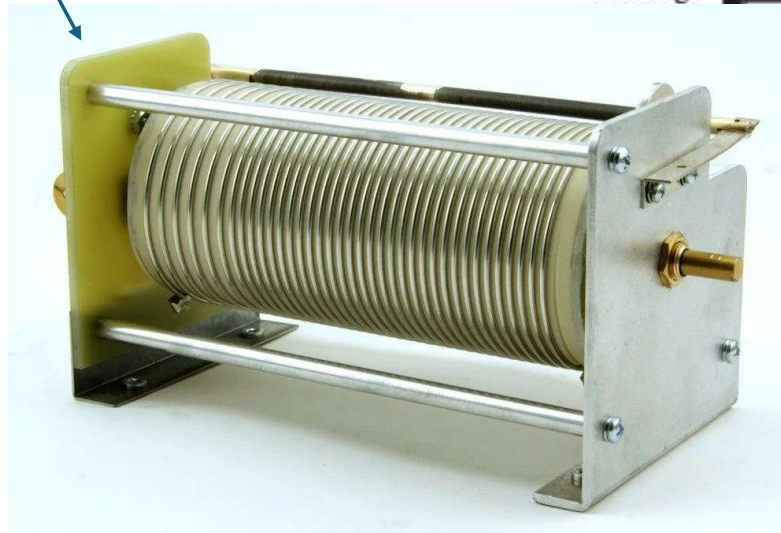
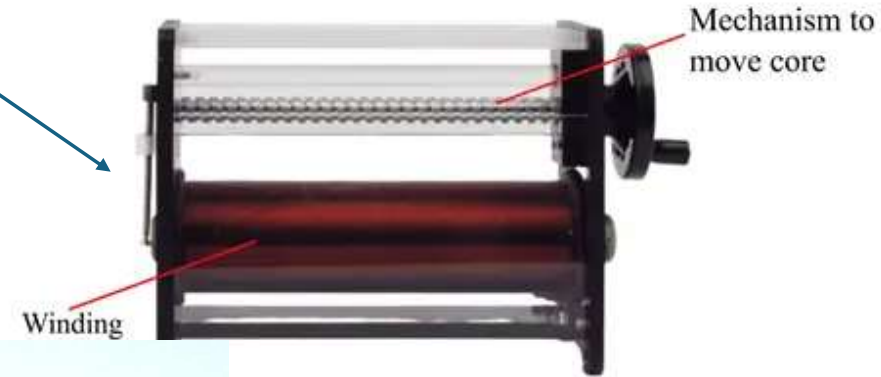
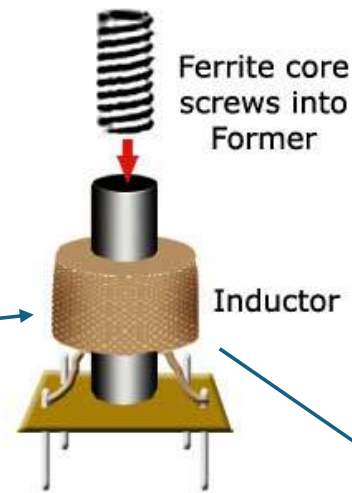


Figure 2 - Variable Inductor

# Inductor marking



- Inductors have their value marked in a number of ways
  - Colour code
  - Code marking on device
  - Value marking on the device

## Inductor Standard Marking Codes

WWW.ELECTRICALTECHNOLOGY.ORG



330  $\mu$ H (a)



4.7  $\mu$ H (b)



22 mH,  $\pm$ 0.2 nH (c)



6.8  $\mu$ H (d)



# Inductors, standard values

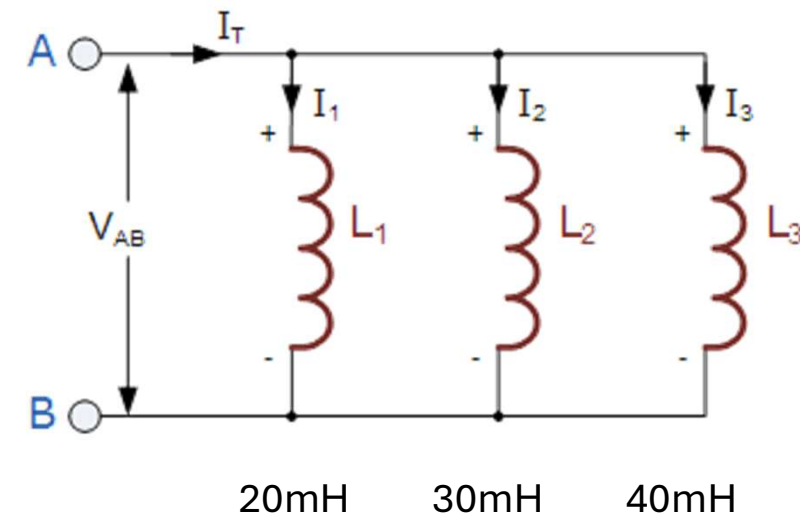
- The International Electrotechnical Commission (IEC) defined the preferred number series in 1952.
- Tables shows part of the values for
  - E6
  - E12
  - **E24** (common range)
  - E48
  - E96
  - E192
- **E24**: 10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82, 91

| E 6 | E12 | E24 | E48 | E96 | E192 | E 6 | E12 | E24 | E48 | E96 | E192 | E 6 | E12 | E24 | E48 | E96 | E192 |
|-----|-----|-----|-----|-----|------|-----|-----|-----|-----|-----|------|-----|-----|-----|-----|-----|------|
|     |     |     |     | 100 | 100  | 220 |     |     |     | 215 | 215  |     |     |     | 464 | 464 | 464  |
|     |     |     | 100 |     | 101  |     |     |     | 215 |     | 218  |     |     |     | 464 | 475 | 470  |
|     |     |     |     | 102 | 102  |     |     |     |     | 221 | 221  |     |     |     | 475 | 475 | 475  |
|     |     | 100 |     | 104 | 104  |     |     | 220 |     |     | 223  |     |     |     | 487 | 487 | 481  |
|     |     |     |     | 105 | 105  |     |     |     |     | 226 | 226  |     |     |     | 487 | 487 | 487  |
|     |     |     | 105 |     | 106  |     |     |     | 226 |     | 229  |     |     |     | 487 | 493 | 493  |
|     |     |     |     | 107 | 107  |     |     |     | 226 |     | 232  |     |     |     | 499 | 499 | 499  |
|     |     | 100 |     | 109 | 109  |     |     |     |     | 232 | 234  |     |     |     | 505 | 505 | 505  |
|     |     |     |     | 110 | 110  |     |     | 220 |     |     | 237  |     |     | 470 |     | 511 | 511  |
|     |     |     | 110 |     | 111  |     |     |     |     | 237 | 240  |     |     |     | 511 | 511 | 511  |
|     |     |     |     | 113 | 113  |     |     |     | 237 |     | 243  |     |     |     | 511 | 511 | 511  |
|     |     |     | 110 |     | 114  |     |     |     | 240 |     | 246  |     |     |     | 511 | 523 | 523  |
|     |     |     |     | 115 | 115  |     |     |     |     | 249 | 249  |     |     |     | 510 | 536 | 536  |
|     |     |     | 115 |     | 117  |     |     |     | 249 |     | 252  |     |     |     | 536 | 536 | 542  |
|     |     |     |     | 118 | 118  |     |     |     |     | 255 | 255  |     |     |     | 536 | 549 | 549  |
|     |     | 100 |     | 120 | 120  |     |     |     |     | 255 | 258  |     |     |     | 536 | 549 | 556  |
|     |     |     |     | 121 | 121  |     |     |     |     | 261 | 261  |     |     | 470 |     | 562 | 562  |
|     |     |     | 121 |     | 123  |     |     |     |     | 261 | 264  |     |     |     | 562 | 562 | 562  |
|     |     |     |     | 124 | 124  |     |     |     | 261 |     | 267  |     |     |     | 562 | 576 | 576  |
|     |     |     | 120 |     | 126  |     |     |     |     | 267 | 271  |     |     |     | 560 | 576 | 583  |
|     |     |     |     | 127 | 127  |     |     |     |     | 274 | 274  |     |     |     | 560 | 590 | 590  |
|     |     |     |     | 129 | 129  |     |     |     | 274 |     | 277  |     |     |     | 590 | 590 | 597  |
|     |     |     | 127 |     | 130  |     |     |     |     | 280 | 280  |     |     |     | 590 | 590 | 597  |
|     |     |     |     | 132 | 132  |     |     |     |     | 280 | 284  |     |     |     | 604 | 604 | 612  |
|     |     | 120 |     | 133 | 133  |     |     | 270 |     |     | 287  |     |     |     | 604 | 604 | 612  |
|     |     |     |     | 135 | 135  |     |     |     |     | 287 | 287  |     |     |     | 619 | 619 | 619  |
|     |     |     | 133 |     | 137  |     |     |     | 287 |     | 291  |     |     |     | 619 | 619 | 626  |
|     |     |     |     | 137 | 137  |     |     |     |     | 294 | 294  |     |     |     | 619 | 619 | 626  |
|     |     |     |     | 138 | 138  |     |     |     |     | 294 | 298  |     |     |     | 634 | 634 | 642  |
|     |     | 130 |     |     |      |     |     | 300 |     |     |      |     |     |     | 634 | 634 | 642  |
|     |     |     |     |     |      |     |     |     |     |     |      |     |     | 620 |     |     |      |



# Inductors in parallel

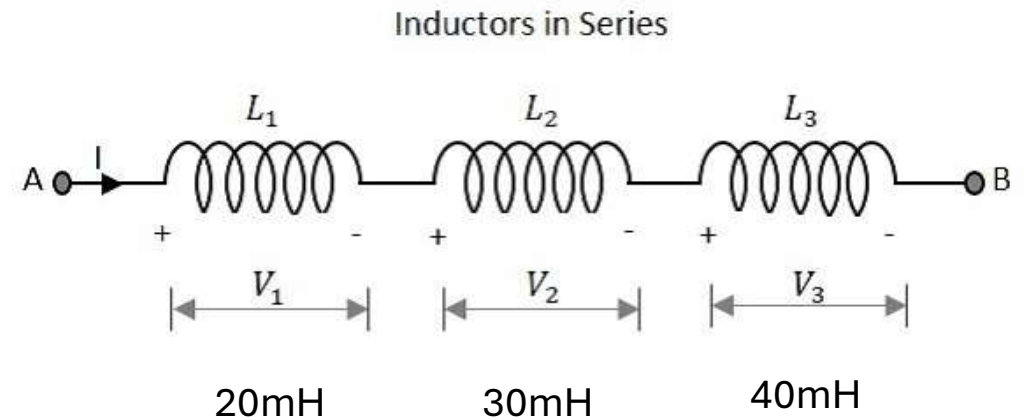
- $1/L_{\text{total}} = 1/L_1 + 1/L_2 + 1/L_3$
- $1/L_{\text{total}} = 1/20_{\text{mH}} + 1/30_{\text{mH}} + 1/40_{\text{mH}}$
- $1/L_{\text{total}} = 9.20_{\text{mH}}$





# Inductors in series

- $L_{\text{total}} = L_1 + L_2 + L_3$
- $L_{\text{total}} = 20_{\text{mH}} + 30_{\text{mH}} + 40_{\text{mH}}$
- $L_{\text{total}} = 90_{\text{mH}}$





# Summary

- Inductors store energy in a magnetic field.
- They come in many and varied forms of construction and capacity
- They are used in most electronic circuits for a variety of tasks.
  - Filters
  - Oscillators
  - Smoothing circuits
  - etc.
- **The next talk will cover how resistors, capacitors and inductors can be used in radio circuits**