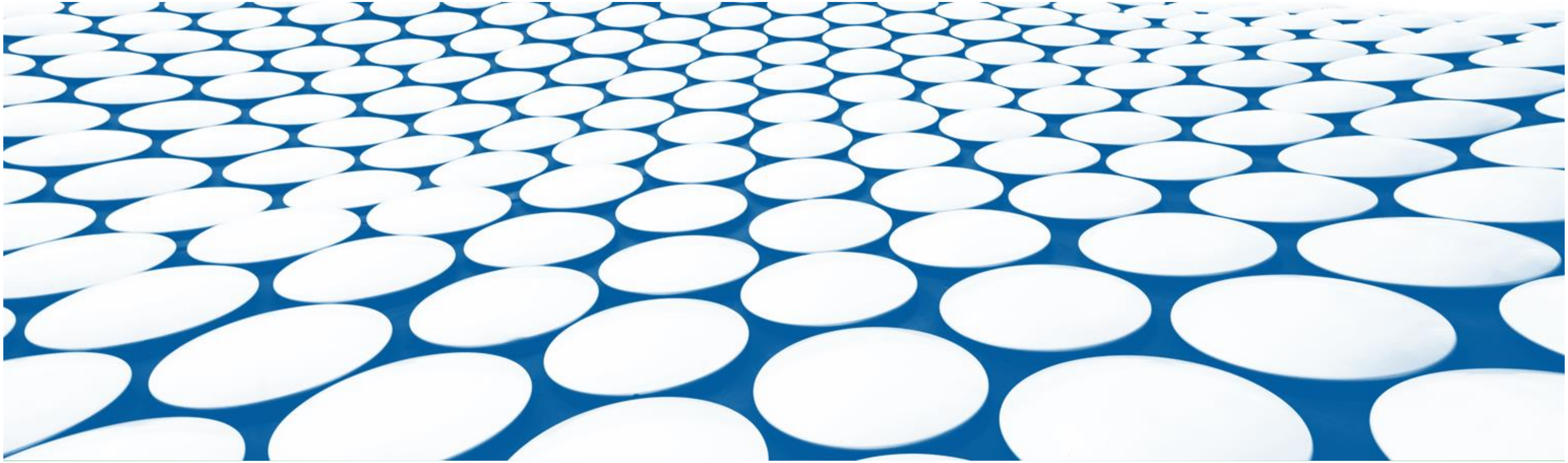
GROUNDING



GROUNDING

- Grounding is defined as electrical equipment connected directly to mother earth, or to some conducting body that serves in place of the earth, such as the steel frame of a plant.
- Proper grounding is an essential component for safely and reliably operating electrical systems.
- Improper grounding methodology has the potential to bring disastrous results from both an operational as well as a safety standpoint.
- There are many different categories and types of grounding principles.

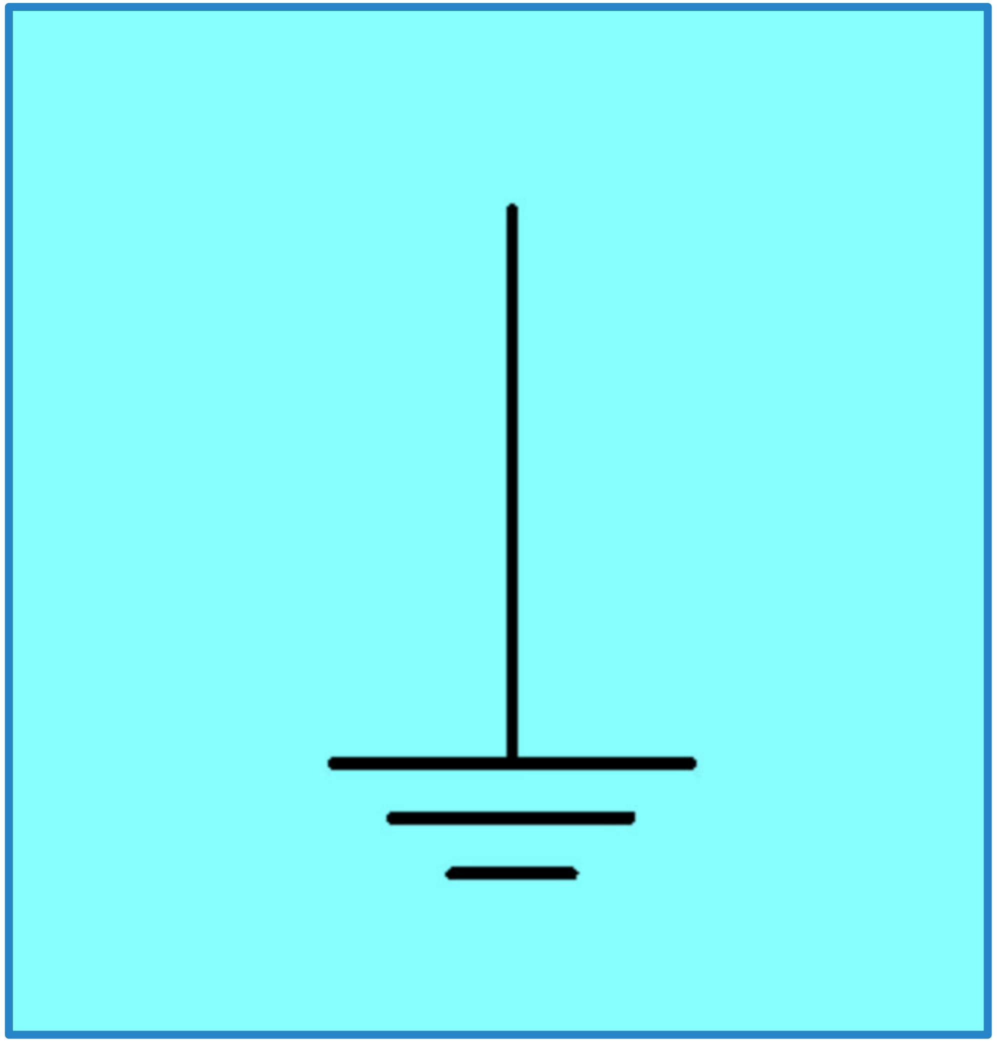
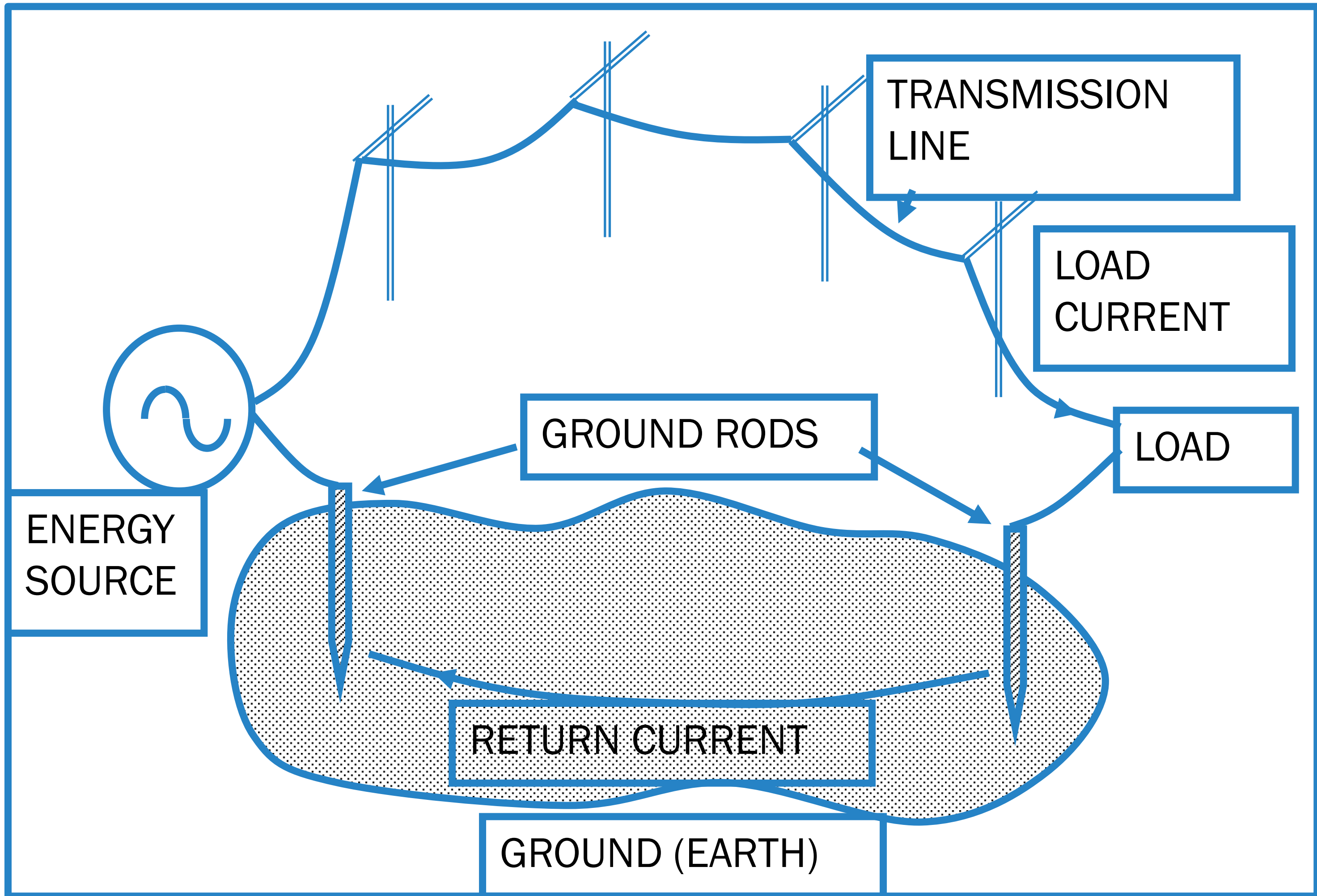
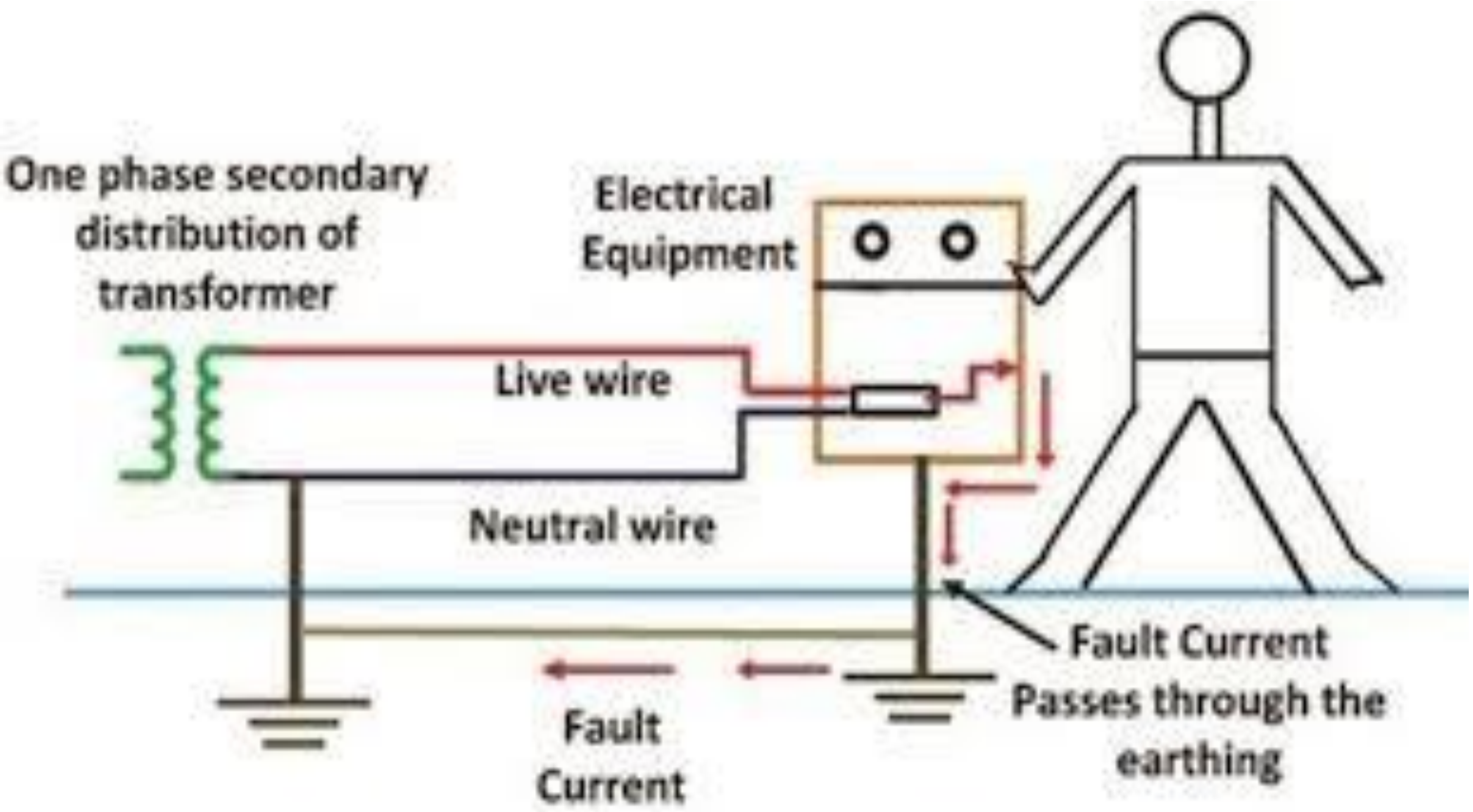


Figure: Earth Ground Symbol

CONCEPT OF EARTH AS GROUND

- It's a ground physically and electrically connected to earth via a conductive material such as copper, aluminum, or an aluminum alloy.
- A true earth ground, as defined by the National Electrical Code (NEC), consists of a conductive pipe, or rod, physically driven into the earth to a minimum depth of 8 feet.
- The earth provides an electrically neutral body, and due to the earth's virtually infinite state of neutrality, it is immune to electrical wavering.

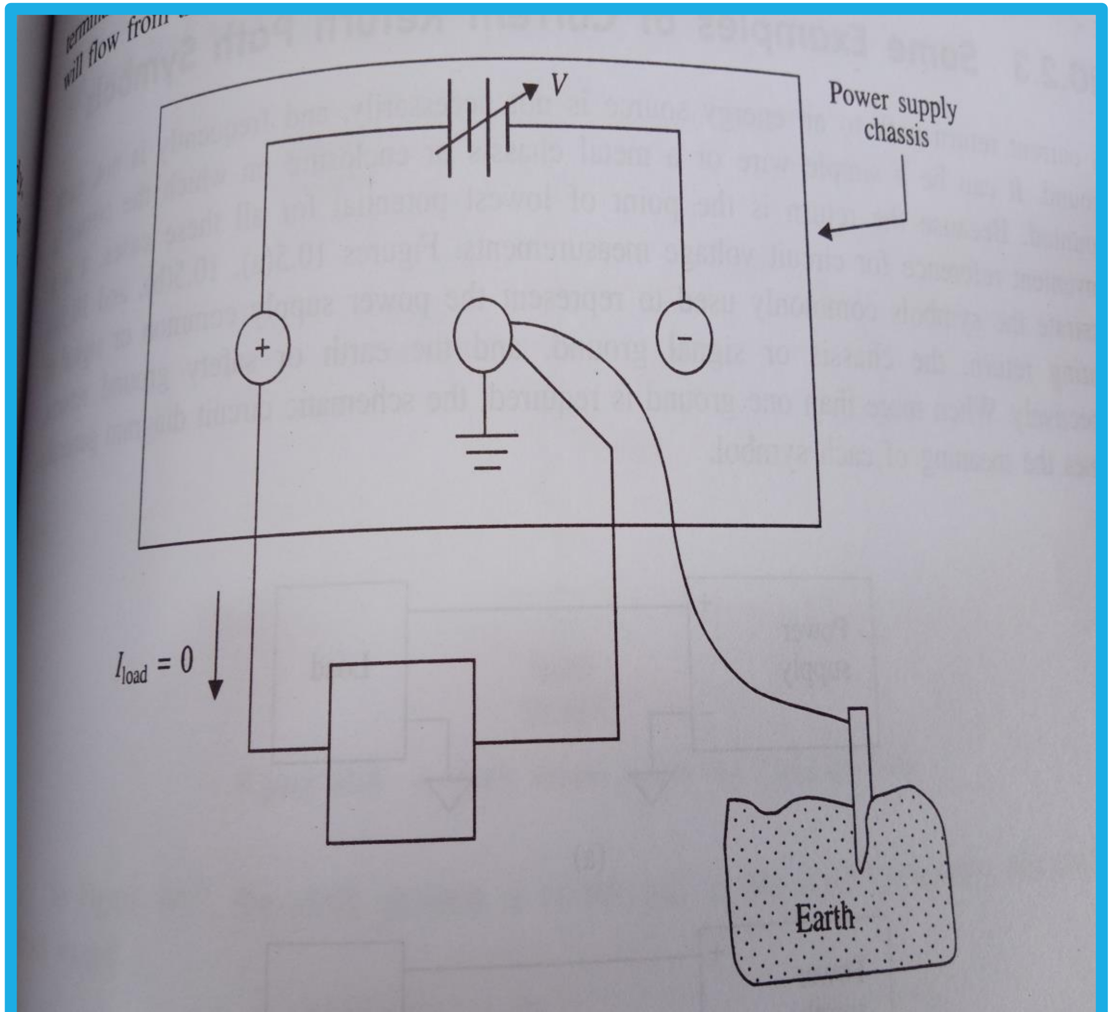




One phase secondary distribution of transformer
Electrical Equipment
Live wire
Neutral wire
Fault Current
Fault Current Passes through the earthing

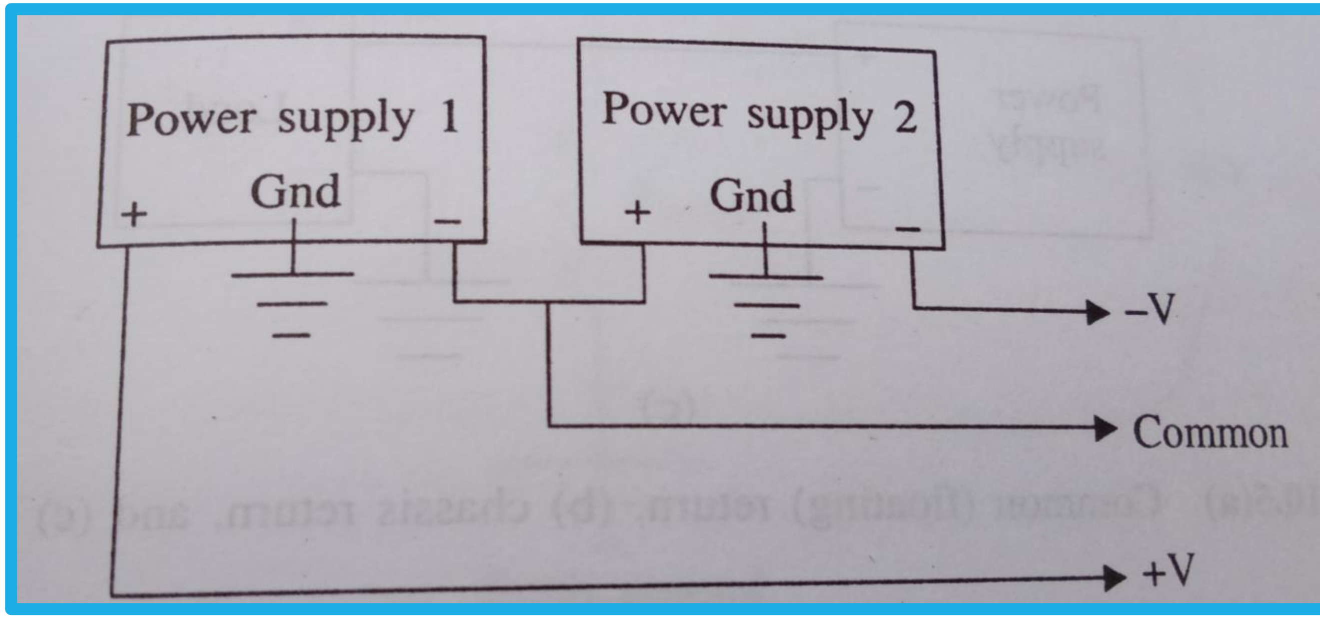
GROUNDING ERROR

- An equipment or device has a positive (+), a negative (-), and a GND (ground) terminal.
- The ground terminal (earth ground) is physically tied to the chassis, which in turn is connected to the ground wire within the power cord, which is finally connected to the earth via the three prong outlet.
- A fairly common mistake made is to connect a load between the positive (+) and the GND terminals.
- This incorrect connection won't allow the current to return to its energy source and, therefore, no current will flow.
- The proper connection is to connect the load between the positive (+) and negative (-) terminals.



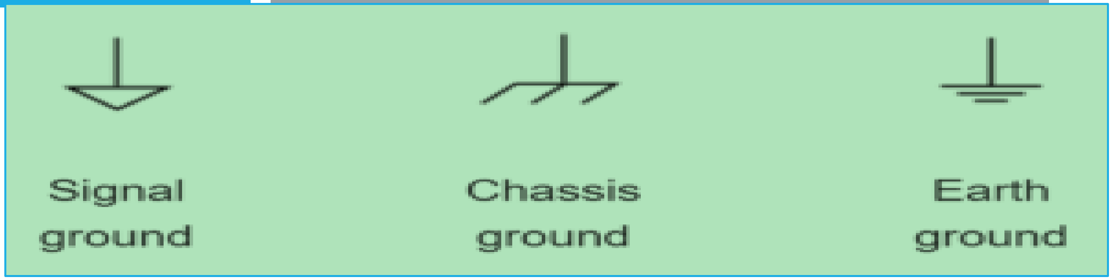
POWER SUPPLY CONFIGURATION

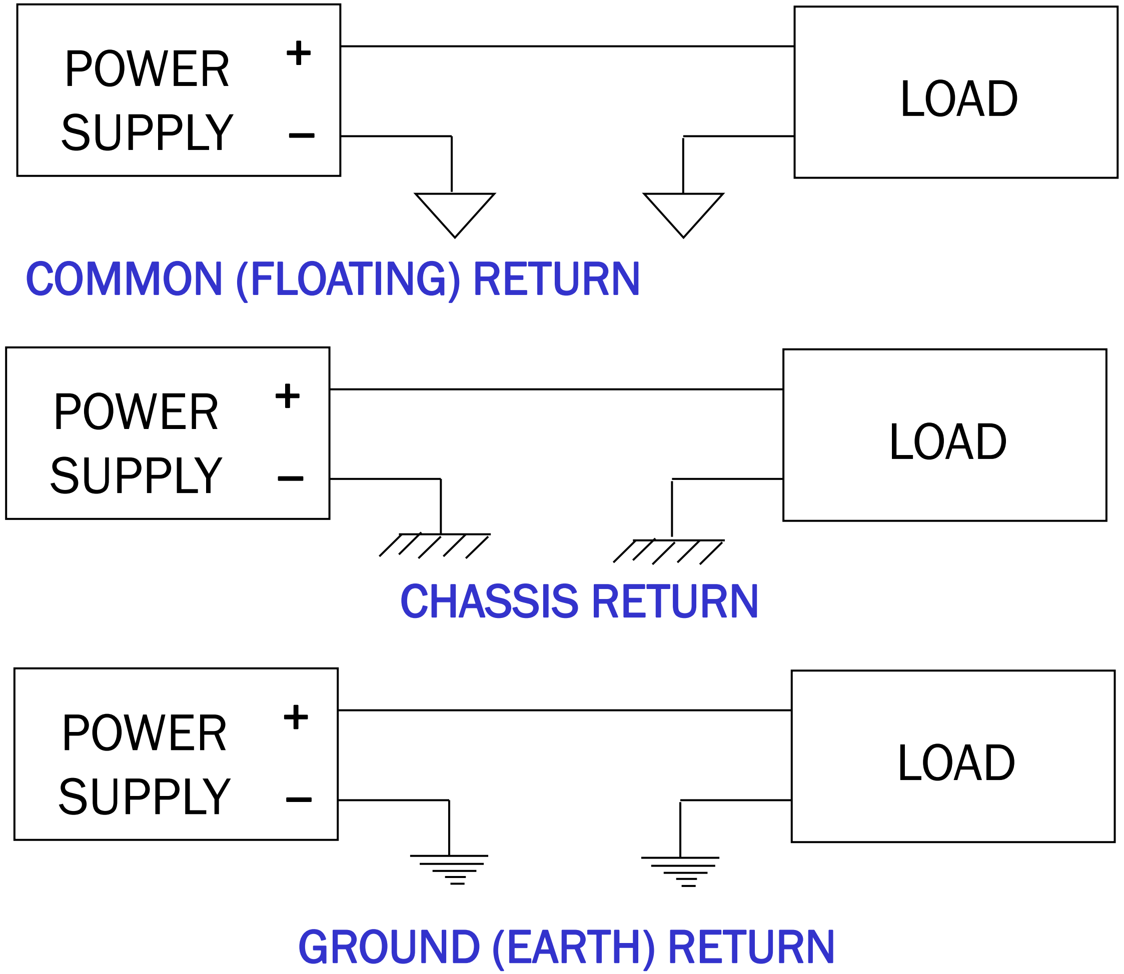
- The positive and negative terminals must be connected to complete a return path.
- Many circuits require a positive as well as –ve voltages



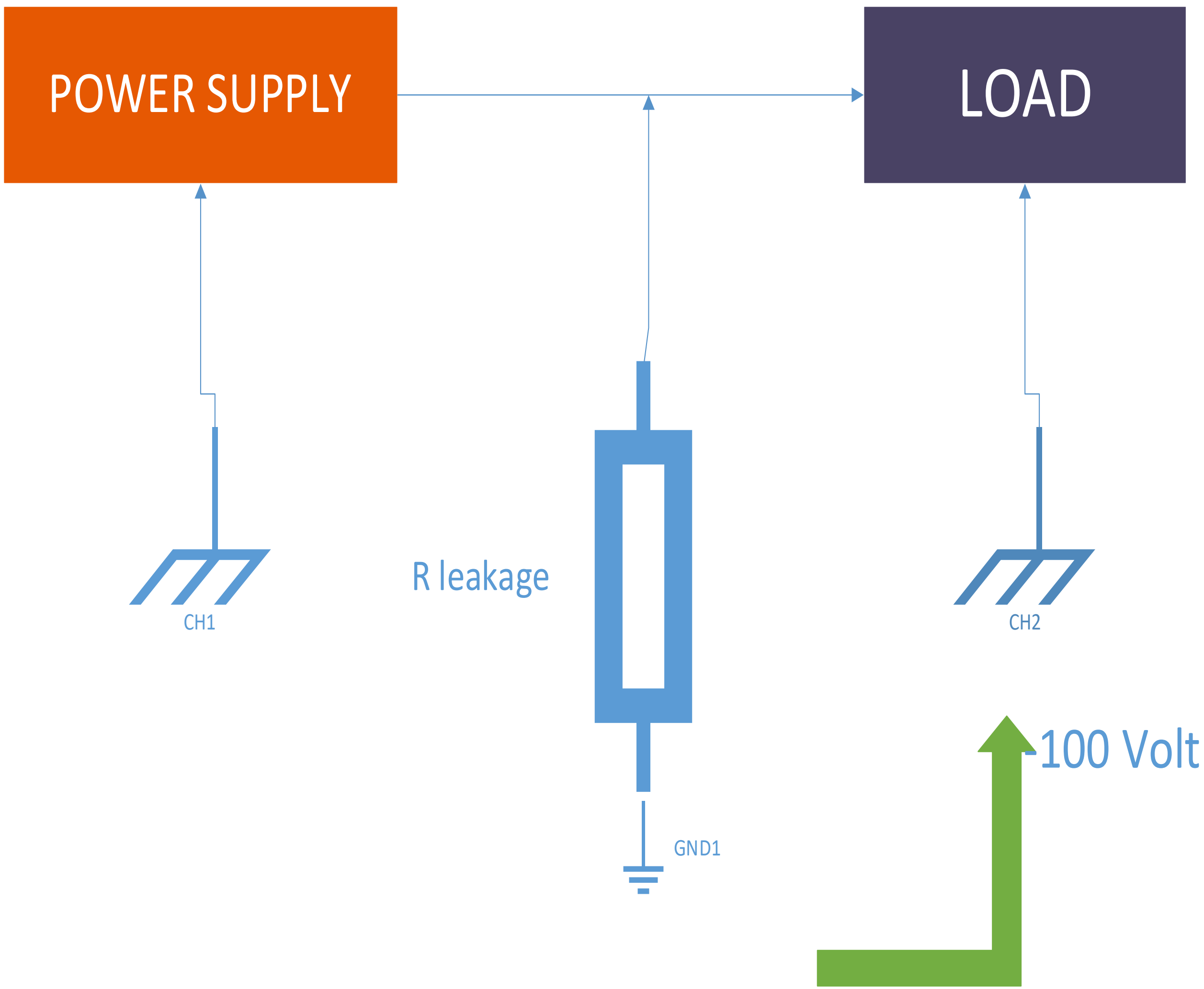
CURRENT RETURN PATH SYMBOLS

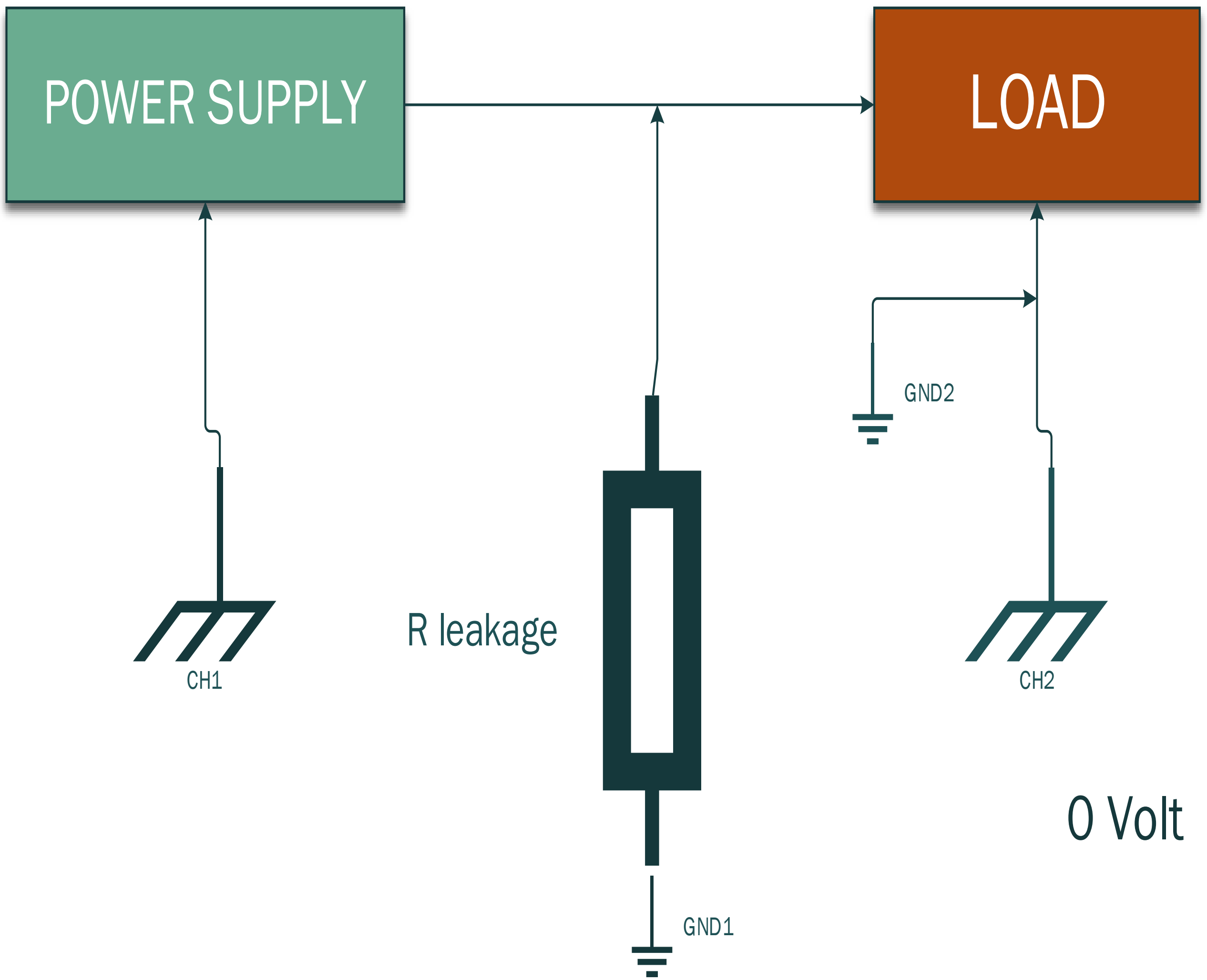
- A chassis ground is a ground-collection point that connects to the metal enclosure of an electrical device.
- A chassis ground may be used for shielding and grounding to prevent electrical shock.
- Mains earth ground and the (theoretically) 0V power rails are all tied together and connected to the chassis at that one point.





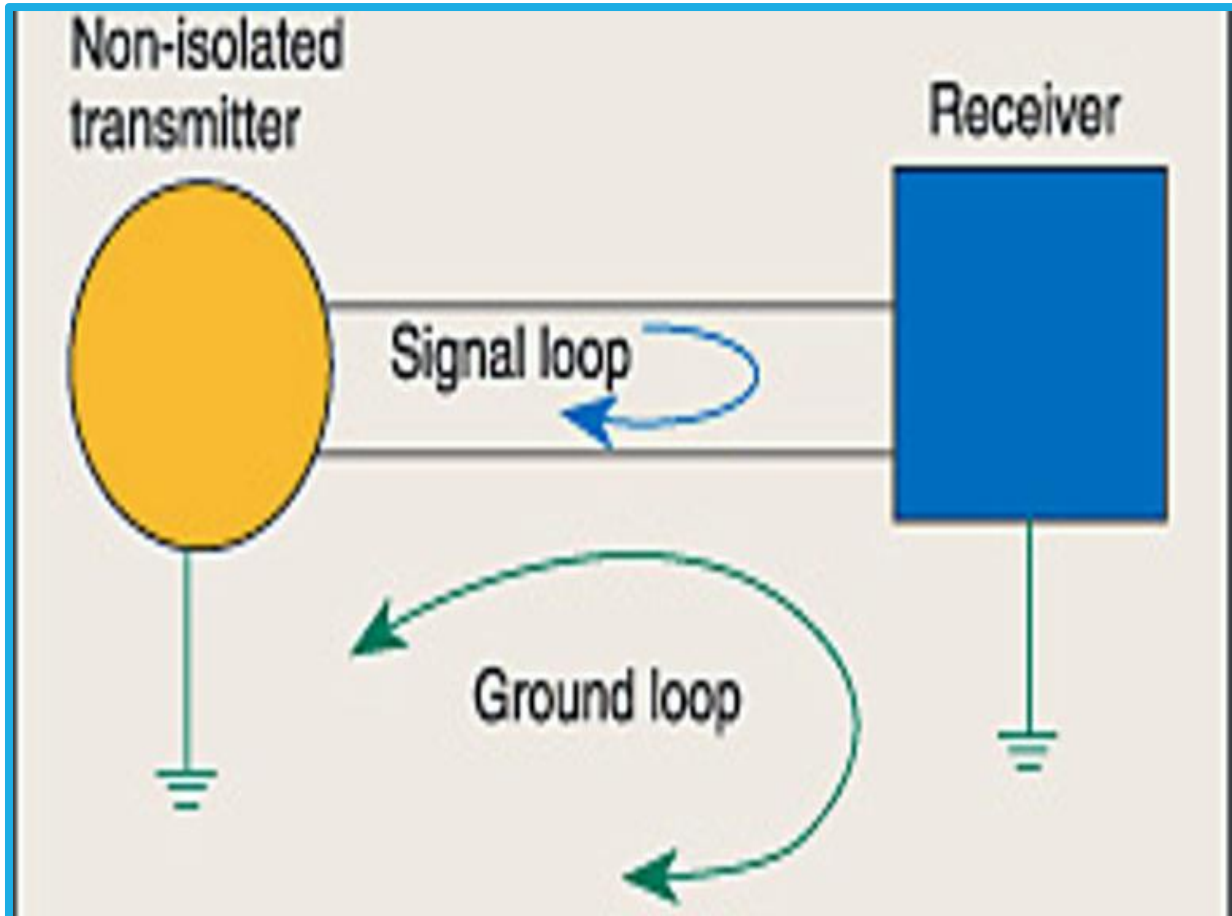
SHOCK EARTH PROTECTION USING EARTH GROUND





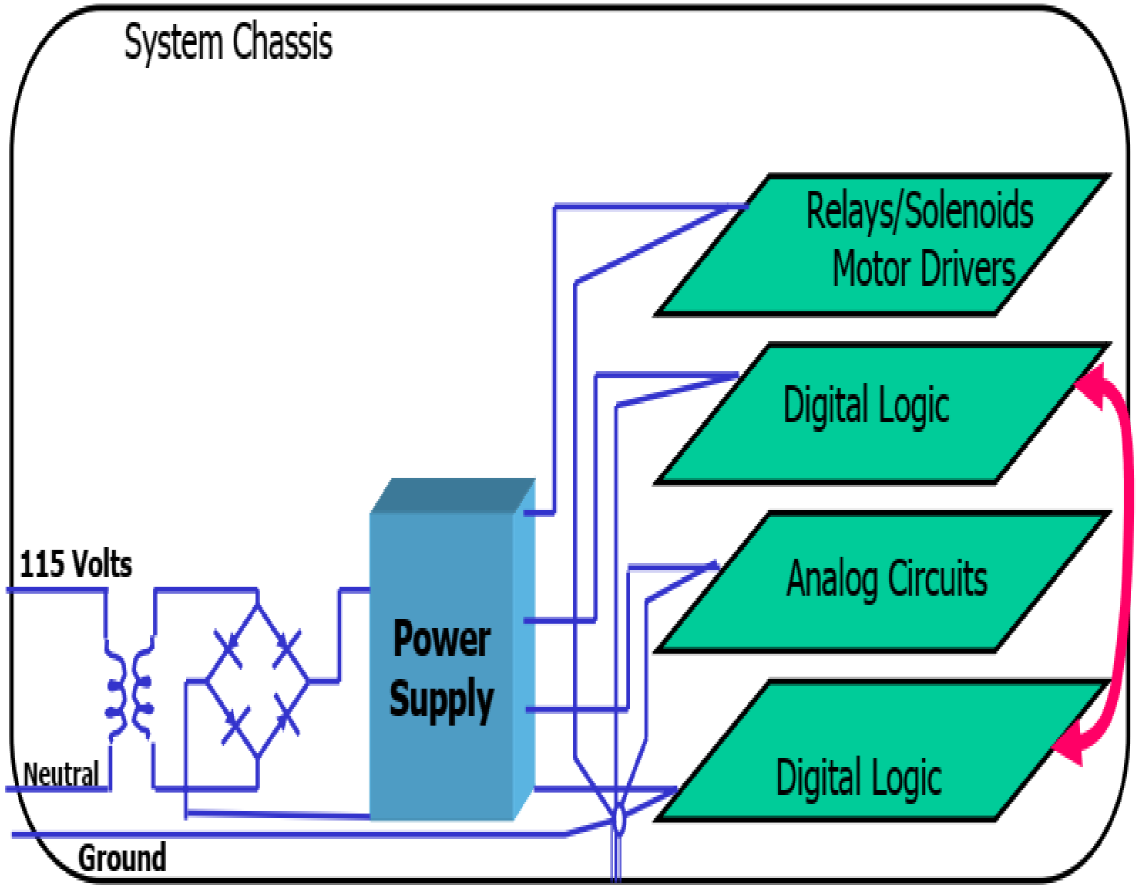
GROUNDING CONSIDERATIONS

- Ground loops also referred to as noise in an electrical system results from unwanted current that flows in a conductor connecting two points that are supposed to be at the same electrical potential, but aren't.
- When this condition occurs in instrumentation loops, adding electrical current or voltage to, or subtracting it from, the instrument signal is often detrimental to control system performance.

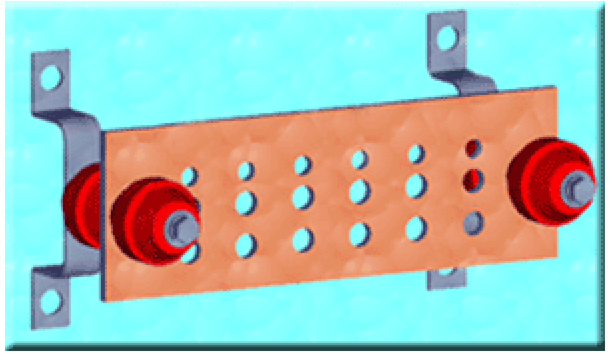


BASIC GROUND PRACTICES

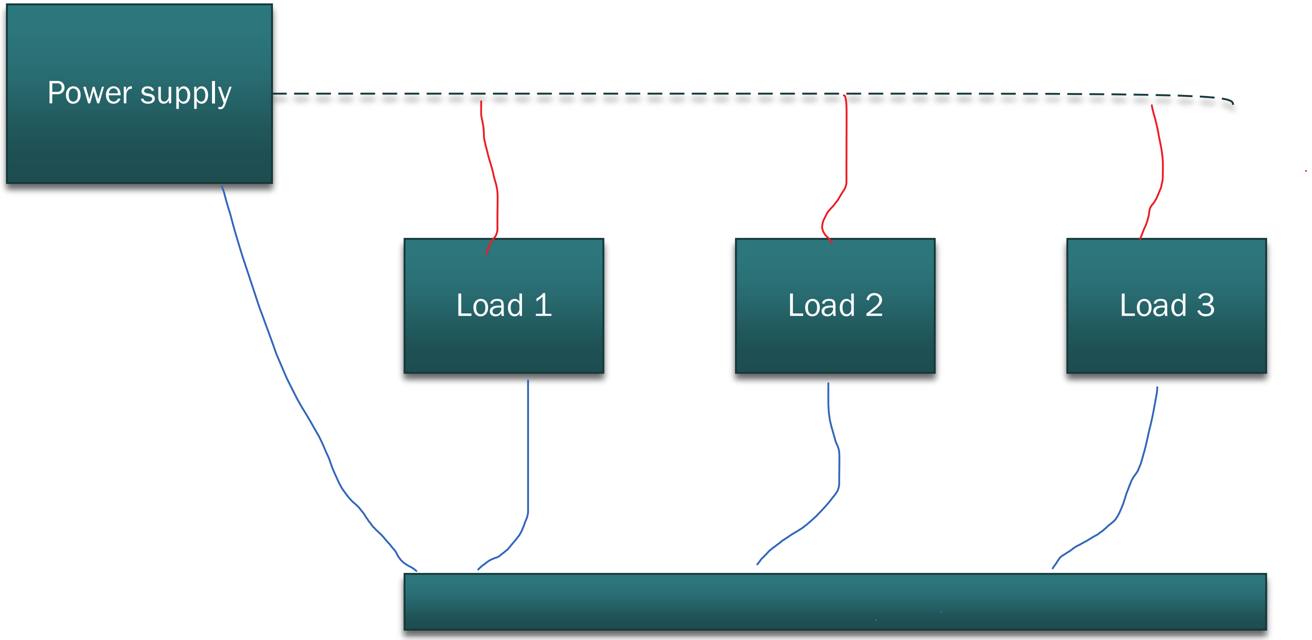
- Circuit Grounding
- Single point ground ensures that no ground loops are created.
- If a circuit has many ground points, connecting them to common point.



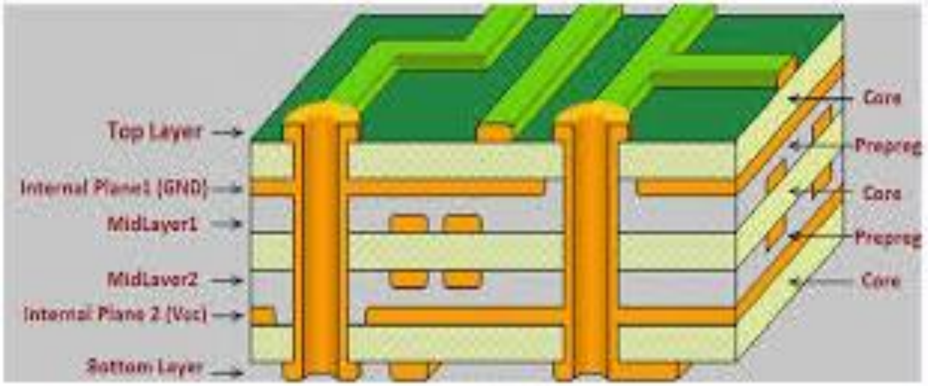
GROUND BUS



- Bus bars are constructed to serve an adequate substitute for single point ground.
- The bus bar is simply a heavy wire or copper bar of low resistance that can carry maximum sum total of load current back to power supply.
- The bus can be extended along the length of circuitry.



GROUND RETURN PLANE



- A ground plane is the return path for all signals including power distribution.
- It is homogeneous for dc power supply but inhomogeneous for other considerations.
- Multilayer PCB uses separate layers for supply and ground planes.
- A changing current in plane creates variable magnetic flux which generates voltage as

$\emptyset = BA = \mu_0 niA$

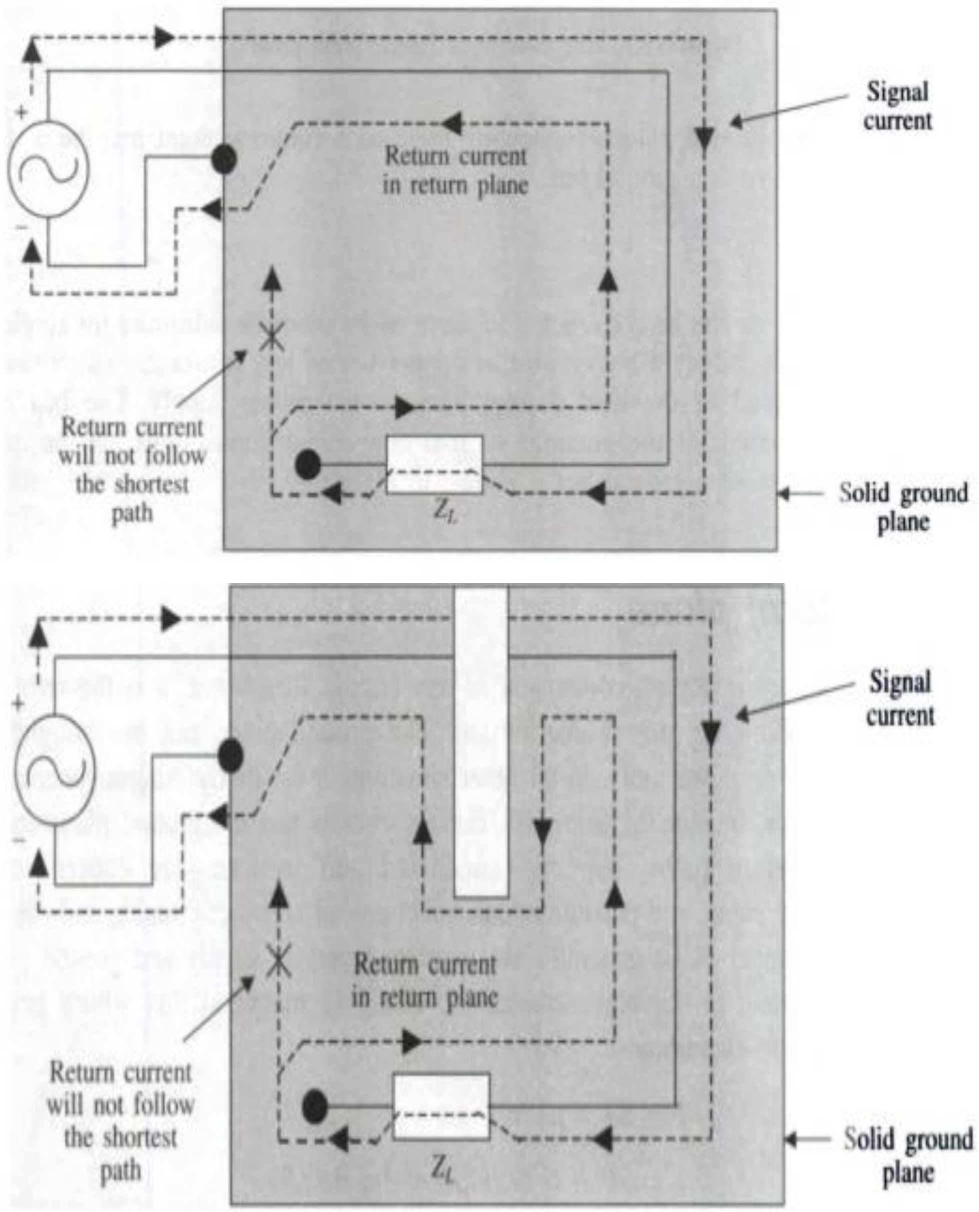
$v = d\emptyset/dt = A(dB/dt) = A\,\mu_0 n(di/dt)$

- Where Ø is magnetic flux and B magnetic field, A loop area, μ_0 permeability of free space,

  n is number of turns in loop, I current, v is voltage.

CONTD..

- At even modest frequencies, the return path of the current will attempt to flow directly underneath the conductor.
- If a return path is not provided, it will find a less desirable route through and around other parts of the circuit—perhaps creating an antenna along the way.
- Return currents seek the path of least impedance.
- At low frequencies, most of the return current in the ground plane flows directly from load to source.
- This straight line between load and source represents the path of least resistance and, at low frequencies, the path of least impedance as well.



REFERENCES

- Deltoro, ELECTRICAL ENGINEERING FUNDAMENTAL, Pearson, 2015.
- G Vijayaraghavan, Mark Brown, Malcolm Barnes, Practical Grounding, Bonding, Shielding and Surge Protection, Newness Publisher, 2004.
- *Anand, M.M.S., Electronic Instruments and Instrumentation Technology, Prentice Hall of India Private Limited, 2004.*

NUMERICAL ON CHEBYSHEV ANALOG FILTER

- Design a Chebyshev analog filter with maximum passband attenuation of 2.5 dB at $\Omega p = 20$ rad/sec and stop band attenuation of 30 dB at $\Omega s = 50$ rad/sec.

SOLUTION

Given Ap=2.5 db, Ωp = 20 rad/sec , As= 30 dB , Ωs = 50 rad/sec

Step-I: Calculation of parameter ε :

Ripple parameter

$$\epsilon = \left[10^{0.1 A_P(dB)} - 1\right]^{1/2} = \left[10^{0.1(2.5)} - 1\right]^{1/2} = 0.882$$

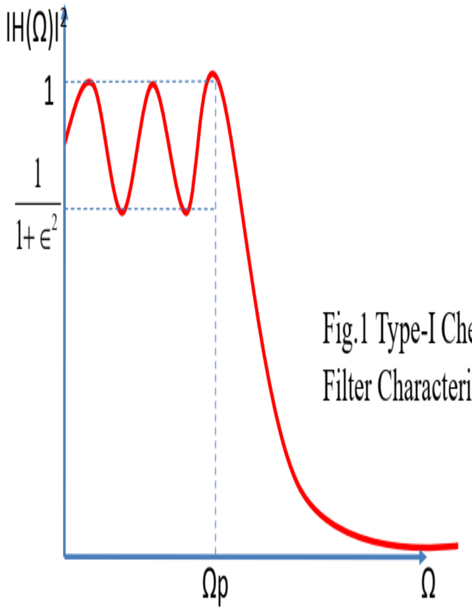


Fig.1 Type-I Chebyshev Filter Characteristics

Step II: Calculation of order N of the filter:

$$-A_S(dB) = -20\log_{10}\epsilon - 6(N-1) - 20N\log_{10}(\Omega_S)$$

$$-30 = -20\log_{10}(0.882) - 6(N-1) - 20N\log_{10}(50)$$

After solving, N=0.95

CONTD..

Step III: Calculation of poles:

- The pole positions are denoted by s_p ,

$$s_p = r\cos\theta_k + jR\sin\theta_k$$

- First we will calculate parameter 'β'

$$\beta = \left[\frac{\sqrt{1+\in^2}+1}{\in}\right]^{\frac{1}{N}} = \left[\frac{\sqrt{1+(0.882)^2}+1}{0.882}\right]^{\frac{1}{1}} = 2.64$$

- Now we will calculate the values of 'r' and 'R'

$$r = \Omega_p \frac{\beta^2-1}{2\beta} = 20\frac{(2.64)^2-1}{2(2.64)} = 22.6$$

$$R = \Omega_p \frac{\beta^2+1}{2\beta} = 20\frac{(2.64)^2+1}{2(2.64)} = 30.19$$

- Now we will calculate values of θ_k

$$\theta_k = \frac{\pi}{2} + \frac{(2k+1)\pi}{2N}, \qquad k=0 \text{ to } N-1$$

CONTD..

$$\theta_0 = \frac{\pi}{2} + \frac{(2\times 0+1)\pi}{2\times 1} = \pi$$

- Now we can write pole positions as

  $s_0 = r\cos\theta_0 + jR\sin\theta_0 = 22.6\cos\pi + j\,(30.19)\sin\pi = -22.6$

Step IV: Calculation of system function H(s):

The system transfer function H(s) of analog filter is given by,

$$H(s) = \frac{k}{(s-s_0)} = \frac{k}{(s+22.6)}$$

Here for N=1, we have

$k = b_0 = 22.6$

$$\therefore\ H(s) = \frac{22.6}{(s-s_0)}$$