What is Displacement Current?

Displacement current is a quantity appearing in Maxwell's equations. Displacement current definition is defined in terms of the rate of change of the electric displacement field (D). It can be explained by the phenomenon observed in a capacitor.

Current in a capacitor.

When a capacitor starts charging, there is no conduction of charge between the plates. However, because of the change in charge accumulation with time above the plates, the electric field changes causing the displacement current as below-

$$ID=JDS=S\partial D\partial t$$

Where,

- S is the area of the capacitor plate.
- I_D is the displacement current.
- J_D is the displacement current density.
- D is related to electric field E as D = εE
- ε is the permittivity of the medium in between the plates.

Displacement Current Equation

Displacement current has the same unit and effect on the magnetic field as is for conduction current depicted by Maxwell's equation-

$$\nabla\times H=J+JD$$

Where,

- H is related to magnetic field B as B = μH
- μ is the permeability of the medium in between the plates.
- J is the conducting current density.
- J_D is the displacement current density.

We know that

$$\nabla.(\nabla\times H)=0 and \nabla.J=-\partial\rho/\partial t=-\nabla.\partial D/\partial t$$

Using Gauss's law the above relation becomes,

$$\nabla.D=\rho$$

Here, ρ is the electric charge density.

Thus,

$JD=\partial D/\partial t$
displacement current density is necessary to balance RHS with LHS of the equation.