IMPEDANCE BONDS

An impedance bond is a centre-tapped inductance which is connected across the rails on both sides of the insulated joints. The centre taps of the pair of impedance bonds are connected together as shown. The purpose of the impedance bonds is to provide continuity between the track circuits for the DC propulsion power and to distribute the propulsion current between the two running rails. The impedance bonds do this while still maintaining a relatively high impedance at the signalling frequencies between the two rails and between adjacent track circuits.

Impedance bonds used for AC track circuits consist of two low-resistance windings wound in opposite directions on a laminated iron core. Each winding is connected across the rails on either side of the track, and centre taps from each winding are connected together. With DC traction, under normal circumstances equal currents flow in each half of each winding and if the traction currents are evenly distributed across the two rails, there is no resultant flux in the iron core. In this state, when the core is not magnetized, it presents a path of high impedance to the track circuit current. In the case of an imbalance, the core would be magnetized to saturation and the track circuit current would no longer be faced with a high-impedance path; therefore, an air gap is introduced in the magnetic circuit to prevent saturation, and the impedance bond presents high impedance to the track circuit current in all cases up to about 20% traction current imbalance. With AC traction, when the traction currents are unbalanced, the half coil that carries more current induces an e.m.f. in the opposite half coil that tends to equalize the current. So air gaps are not generally necessary for AC traction. The impedance of the bond to the signalling current can be further increased by adding a secondary coil and a capacitor across it, in what is known as a resonated impedance bond, Figure 1.

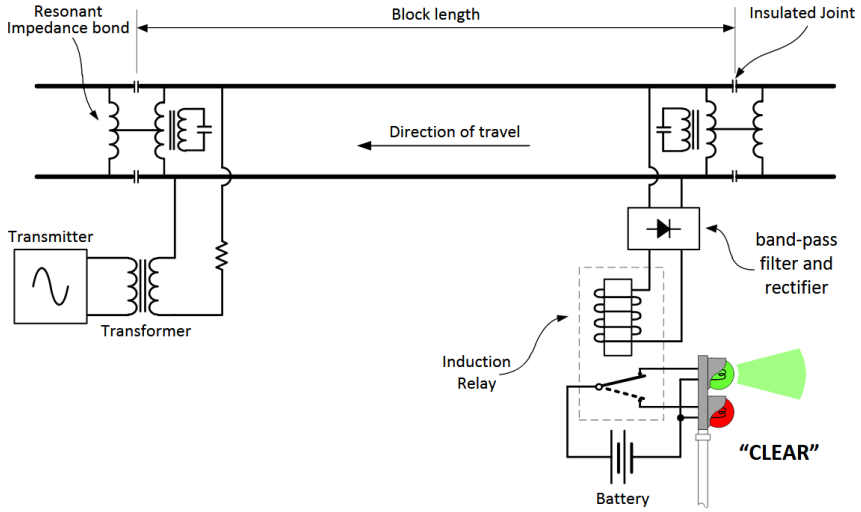

Figure 1: AC Track circuit with resonant impedance bond

The secondary coil steps up the voltage and allows the use of a smaller capacitor than would otherwise be required. Auto-coupled impedance bonds are a modification of the resonated impedance bond idea, Figure 2.
Here the winding across the rails in the track circuit zone forms one part of the winding of an auto-transformer, the other part having the capacitor in series. On one side of the track circuit, the other part of the auto-transformer is connected to the supply thereby being stepped down for the track circuit current, and the auto-transformer winding on the other side of the track circuit is connected to the track relay such that the track circuit current is stepped up to operate the relay. Thus, the current flowing in the bonds is usefully employed in operating the relay.

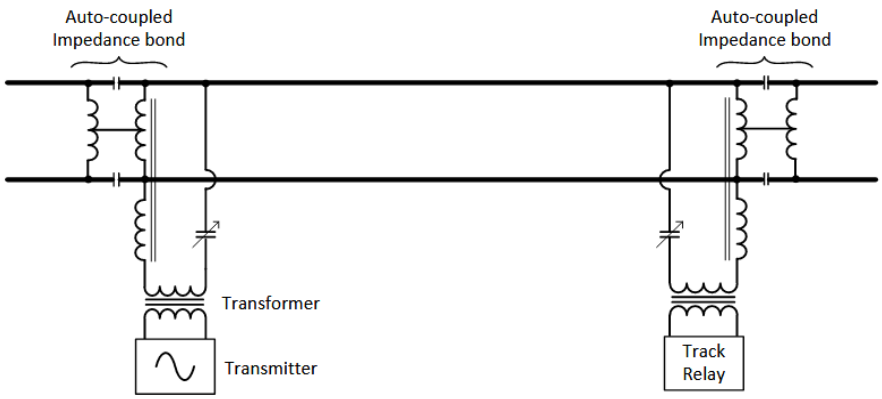

Figure 2: Track circuit with auto-coupled impedance bond

Source: http://www.railwaysignalling.eu/wp-content/uploads/2014/11/How-track-circuits-detect-and-protect-trains.pdf