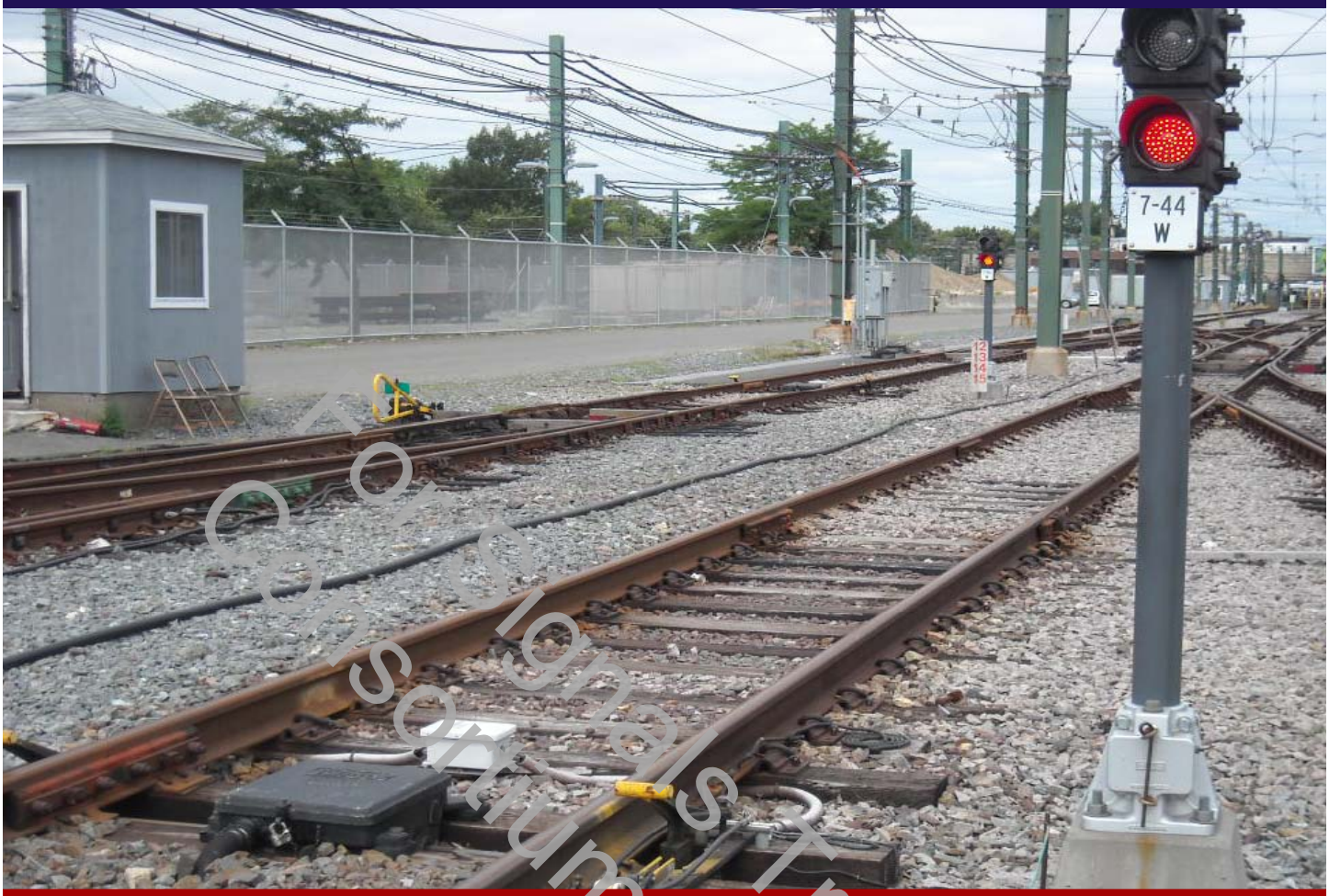

Introduction and Overview to Rail Signals

Course 101

PARTICIPANT GUIDE

SIGNALS TRAINING CONSORTIUM

Introduction and Overview to Track Circuits

Participant Guide

Signals Maintenance Training Consortium

COURSE 101

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Purpose of the Course

The purpose of the *Introduction and Overview to Track Circuits* course is to assist the participant in demonstrating proper safety procedures and gaining an overview the functions of switches, derails, and their associated components.

Approach of the Book

This course begins with an outline, a statement of purpose and objectives, and a list of key terms. The *outline* will discuss the main topics to be addressed in the course. A list of *key terms* identifies important terminology that will be introduced in this course. *Learning objectives* define the basic skills, knowledge, and abilities course participants should be able to demonstrate to show that they have learned the material presented in the course. A list of *key terms* identifies important terminology that is introduced in this course. *Review exercises* conclude this course to assist the participants in reviewing key information.

INTRODUCTION AND OVERVIEW TO TRACK CIRCUITS

Outline

Purpose and Objectives:

The purpose of this course is to provide the participant with an introduction to the basics of train detection and rail structure within different types of track circuits.

Following the completion of this course, the participant should be able to complete the exercises with an accuracy of 70% or greater:

- Recognize the principles and operations of track circuits
- Name the common of types track circuits
- Record types of track circuits at your location
- List the major components found in track circuits and examine their functions
- List basic components of rail structure
- Describe the difference between shunted and open track circuits

Key Terms

- Alternating Current (AC)
- Audio Frequency (AF)
- Broken Rail
- Bootleg
- Direct Current (DC)
- Double Rail
- Feed End
- Fuse
- Ground Rail aka Return Rail
- Impedance Bonds
- Insulated Joints
- Propulsion Return Current
- Rails
- Rail Bonds
- Rail Resistance
- Receiver
- Relay chatter
- Relay End
- Resistor
- Return Rail aka Ground Rail
- Signal Rail
- Single Rail
- Track Circuits
- Transceiver
- Transformer
- Transmitter
- Tuned Impedance Bonds
- Vane Relay
- Wee-Z™ Bonds

1-1 OVERVIEW

Train detection and rail structure form the fundamental foundation of signaling. The most common method to detect the presence of a train or a broken rail is to use **track circuits.** A track circuit is an arrangement of electrical and/or electronic equipment, including a length of the running rails, which permits detection of trains or broken rails within limits of the running rails.

It is important to note in this overview that using the terms “track circuit” and “track block” are not interchangeable. A block is a length of track with defined limits that may include several circuits. Within a block, the movement of trains is governed by block signals, cab signals, or both. Block and track circuit boundaries are defined by using impedance bonds, terminating receivers, or loops, or by insulated joints.

Fail-safe is a familiar term to every signal maintainer and the participant in this series of training was introduced to fail-safe principles in the Orientation course, *Signals 100*. Any failure of the system equipment, break in the rail or any break in the track circuit is designed to fail in the most restrictive state possible. As this course introduces the essential components of track circuits, the participant will learn that these are all fail-safe equipment.

Finally this course helps the new signal maintainer recognize the essential devices in a track circuit and prepare for later courses on maintaining, testing, and troubleshooting track circuits.

Warning: Safety Precautions!

As with all work on train tracks, the signal maintainer must strictly adhere to the worker safety policies of the transportation agency.

1-2 TYPES OF TRACK CIRCUITS

A track circuit is a simple electrical series circuit of which **rails** form a part. The rails act as conductors or a path for current to flow from an energy-producing device, such as a transformer, to an energy-receiving device, such as a track relay. With the exception of series overlays, all track circuits operate by sensing loss of transmitted energy whether shunted by train wheels or a broken rail.

Track circuits are differentiated by their source of electrical energy. Two main types in transit use on many railroads are DC and AC and these are described in the table below. Within AC and DC types of track circuits, there are some further distinctions made particularly with AF and Coded Track Circuits. Some common types of distinguishing track circuit power supply sources found in railway are:

Type	Description
DC	**Direct current** is the unidirectional flow of electric charge. Direct current is produced by sources such as batteries, thermocouples, solar cells, and commutator-type electric machines of the dynamo type. The DC power source could have a **transformer** and **rectifier** to keep the battery charged.
AC	**Alternating current** or **Power Frequency** is the flow of electric charge that periodically reverses direction. AC track circuits operate on a number of frequencies and a **transformer** provides the power at the feed end. At the other end of the track circuit is a relay. Voltages and frequencies vary by site and they also vary based on length of track circuit.
AF	**Audio Frequency** (**AF**). The AF track circuit **transmitter** introduces an audio signal of a specific assigned carrier frequency and modulation rate into the track either through wires connected directly to the rails or via tuned impedance bonds with each bond acting as a transmitter for one circuit and a receiver for the adjacent circuit. There is a relay connected to the output of the receiver portion of the module.
Coded track circuit	AC or DC circuit where the flow of current is coded in a pulse rate. The energy source is transmitted as pulses through the circuit and the receiver is designed to respond to the pulses. Different pulse rates are used to transmit conditions such as speed, signal aspect, and cab signal.
Electronic circuit	AC or DC circuit that is based on microprocessor modules which are programmed for train detection and signaling. Genrakode™, a product of Alstom Signaling, is one of the microprocessor-based track circuit systems in use among some of the properties in the Signals Consortium.

Even within each of these types, there are future distinctions to be made for categorizing. For example, there are several variations in frequency range for AF circuits. As the participant goes through on-the-job and classroom training, they will soon learn the various types of track circuits and how to maintain their components and related devices.

Many track circuits on railroad properties are of the AC and the AF arrangements. Within each of these there are certain common components and certain specialized equipment. These will be covered in detail in the next section of this course module.

The work of a signal maintainer involves many devices in the track circuit. In later courses the participant will be guided through maintaining and troubleshooting these devices and, for this course level, the participant will be guided through identifying the major components of AC and AF track circuits.

1-3 AC TRACK CIRCUITS

Arrangement

AC track circuits are considered conventional track circuits. Each section of track in an AC track circuit is separated from its neighboring sections by an insulated joint installed in one or both of the running rails. The two rails are referred to as the **Signal Rail** and the **Ground or Return Rail**.

The two most common arrangements are single rail and double rail.

A **single rail** track circuit arrangement is one where only one rail, the signal rail, has insulated joints. The other rail, the ground rail, is electrically continuous and is used for traction (propulsion) return.

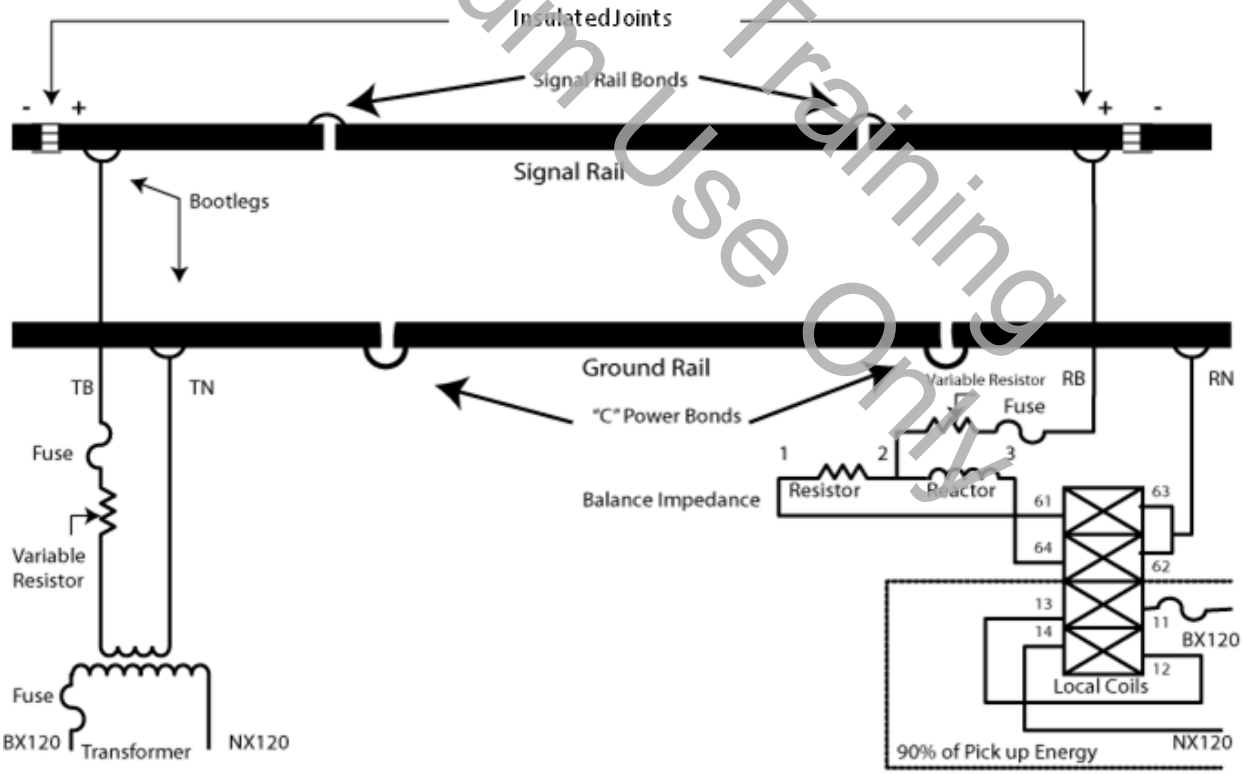

Figure 101.1 Single Rail AC Track Circuit –Courtesy MBTA

Rail Bonds

Very simply, a rail bond is a device used to transfer an electric circuit at a rail joint. Rail bonds, composed of copper wire, are welded to the head of the rail to maintain electrical continuity on the **running rails - rail used to support the wheels of trails running over them. (**see Figure 19). When these bonds are missing, broken or damaged, the integrity of the track circuit system is affected. Other terminology for rails bonds would be "signal bonds", "power bonds" and "C-bonds."

Figure 101.19 Rail Bonds welded rail joints –Courtesy MBTA

Impedance Bonds

Impedance bonds are often mounted between the rails and across two adjacent ties.

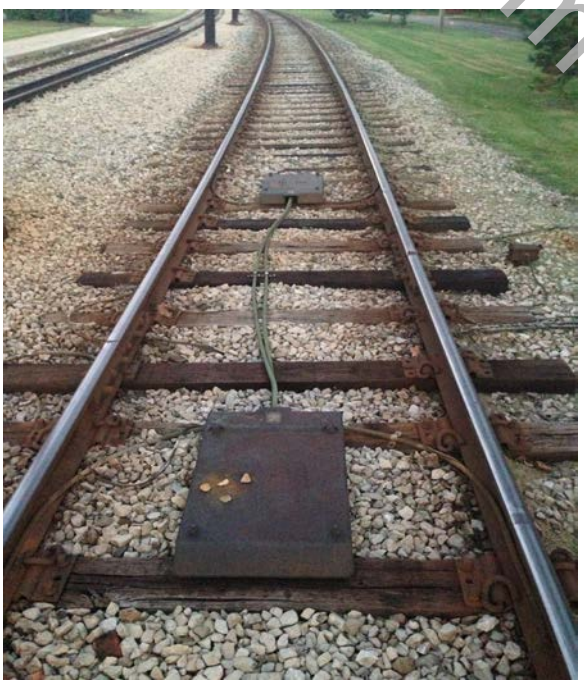

Figure 101.20 Impedance Bonds – Courtesy GCRTA

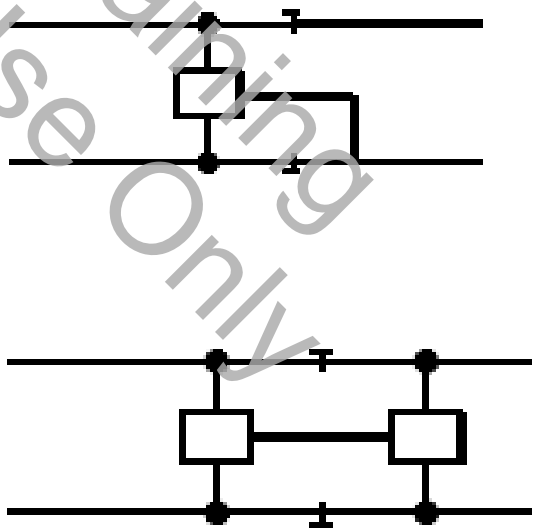

Figure 101.21 Symbols for impedance bonds

Classroom Activity Sheet 1

In the following chart, list the types of track circuits (DC, AC, AF, etc); arrangement (single rail, double rail); whey they are located in your rail system; and some of the major components in that track circuit.

Type and arrangement	Location	Major components

as **shunting** current away from the relay. An "occupied" condition is relayed to the wayside signal and the signal shows a stop indication for that block.

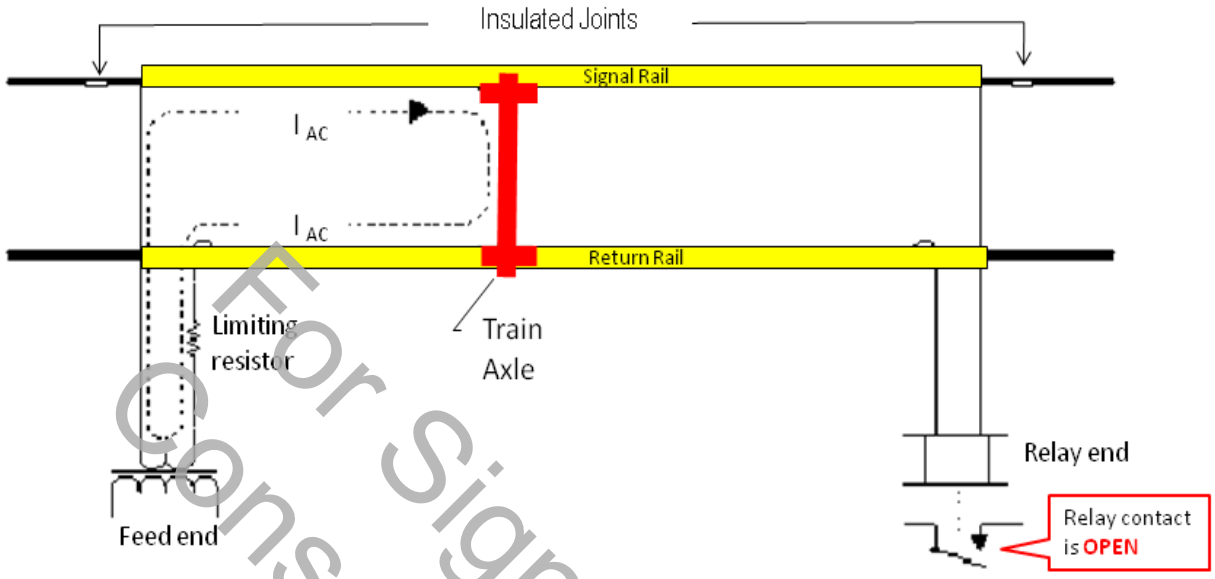

Figure 101.35 Train Occupying Track Circuit

Similarly, in the event of a broken rail or missing track component, with the circuit open, the lack of operating current de-energizes the circuit and the contact is open. In Figure 36, a broken rail is present on the 'signal rail.' In a real railroad environment, then are 'sneak' paths around a break in the return rail.

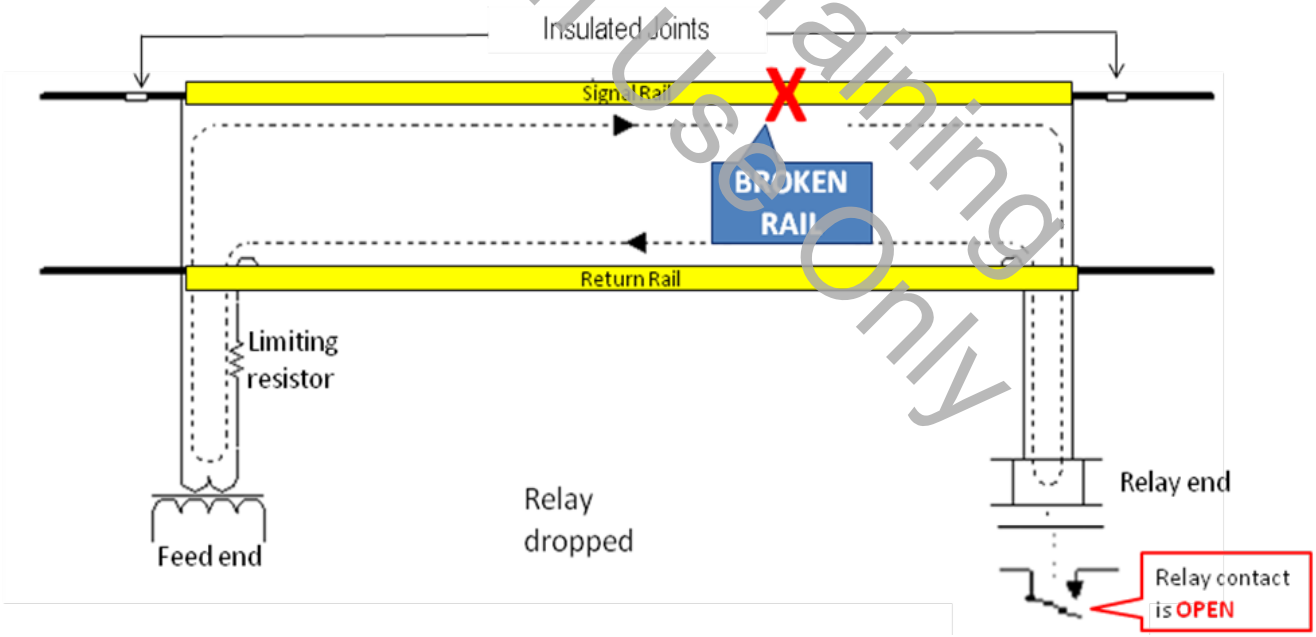

Figure 101.36 Broken Rail in Track Circuit with Dropped Relay