Icom America, Inc.
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Mobile Radio Installation Considerations for Digital Radios:

DC Line Interference

Introduction

Successful radio installation in vehicles can be greatly affected by the quality and purity of the DC line input voltage. Because mobile radios are designed to see only DC voltage (generally 13.6 Volts) at the power input, the introduction of alternator noise, relay/solenoid voltage pulses, or other electronic interference can affect how the radio will perform.

This document describes interference issues in digital radios. Since digital radios are sending and receiving data, any degradation of that data, which is called BER or "Bit Error Rate", can impair the radio's ability to decode the signal at all. With analog radios, such interference could be noticed as static noise in the transmit audio or in the speaker audio. Although this reduced the quality of the audio, the radio was generally still functional.

Prerequisites

This document assumes that the radio is installed using correct industry standards and the DC power line originates at the vehicle battery. If the connection is anywhere other than the battery, the introduction of interference rises dramatically.

Error Symptoms

With high BER symptoms, anything above 3% or more results in the following:

- Audio cuts out
- No audio at all
- Garbled audio or "drunk talk"
- Radio won't handshake on trunking systems
- Radio wont register on another site after a de-registration
- Radio de-registers from a site that is in close proximity

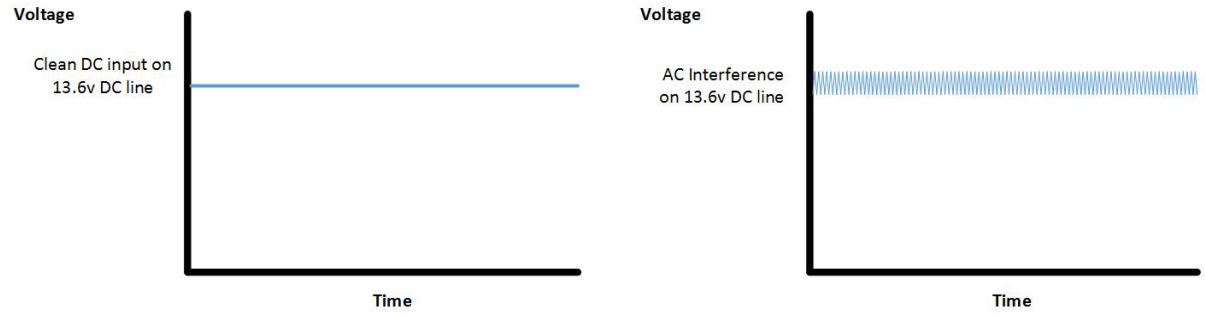

Figure 1: Clean and Noisy DC Lines

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DC Input w/ No Interference: A clean DC input in a vehicle installation would have 13.6 volts DC on the input line. Connecting a Multi-Meter to the line, the technician would see near zero *AC voltage* on the DC line while the vehicle motor is running and revving.

A typical installation in an average vehicle can show anywhere between 10 and 50mV of *AC voltage* measured with a Multi-meter while the motor is running and revving.

DC Input w/ High Interference: AC Voltage measured in the 100 mV plus range. In older vehicles or those with poor grounding, diesel trucks and school buses, or vehicles with many atypical electronic devices, there can be a greater amount of interference on the DC power line going to the radio. This can be in excess of 100, 200 or 300 plus mV of **AC voltage** as measured with a Multi-meter on the DC line.

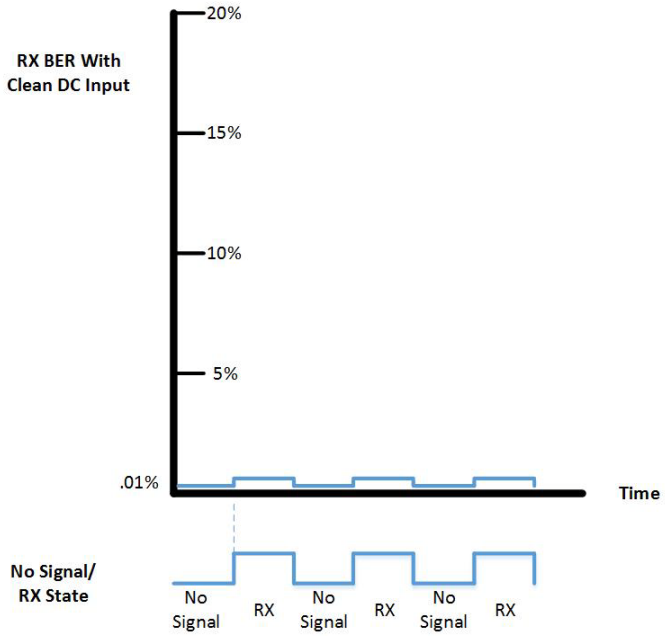

Figure 2: Idle and Receiving Signal with No Interference

No interference on the DC Line: AC < 50 mV while radio is receiving. As the radio transitions between Standby and Receive conditions, the BER rate, as read on the display of the radio *while the radio is receiving a signal* (user Set Mode), stays very low, generally .1% and less.

Symptoms while vehicle is operating: None, radios operate optimally with this DC input.

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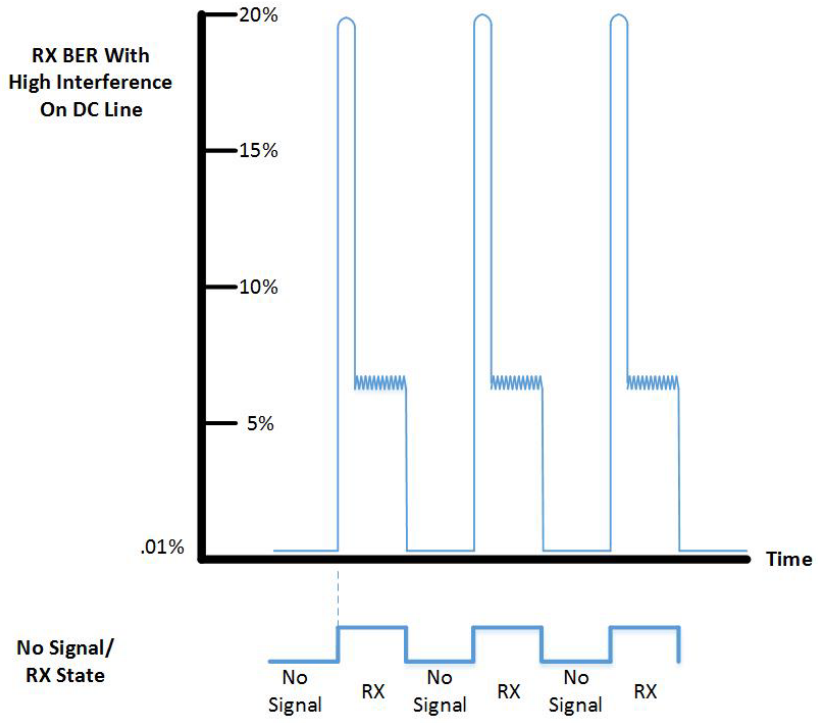

Figure 3: High Interference with No Filtering

High interference on the DC Line and no DC line Filters being used: *AC > 100 mV* on the line while the vehicle is running and revving.

As the radio transitions between Standby and Receive conditions, the BER shows 0% at Standby and can go as high as 20% while the radio is seeing a signal. Such Bit Error Rates are so excessive that the radio does not understand the data enough to accurately decode it for audio purposes or other data uses such as trunking or special features.

Symptoms while vehicle is operating:

- Audio cuts out
- No audio at all
- Garbled audio or “drunk talk”
- Radio won’t handshake (on trunking systems)
- Radio wont register on another site after a de-registration
- Radio de-registers from a site that is in close proximity

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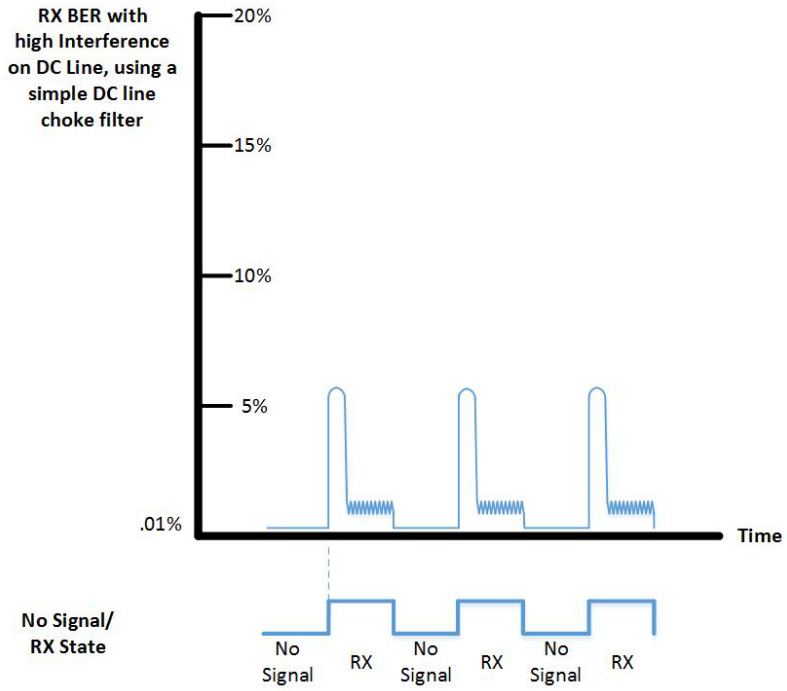

Figure 4: High Interference with Simple Choke Filter Installed

***High interference* on the DC Line and *simple DC line Filters (Choke)* being used: AC > 100 mV but less than 50 mV after installing the choke. Initial BER spike is prominent**

The addition of the choke removes the majority of the AC voltage from the DC input, but is unable to remove the initial burst at the point of initial signal reception due the simple choke design. As the radio transitions between Standby and Receive conditions, the BER shows 0% at Standby and can go as high as 5-10% for an i*nstant* at the initial point of signal reception. Such Bit Error Rates are so excessive that the radio does not understand the data enough to accurately decode it for audio purposes or other data uses such as trunking or special.

Note: Ferrite Beads are not effective as radio line chokes.

Symptoms while vehicle is operating:

- Radio won't always handshake (on trunking systems)
- Radio wont register on another site after a de-registration.
- A quality "simple choke" filter should reduce the AC interference on the DC line to approximately 50 mV or less.

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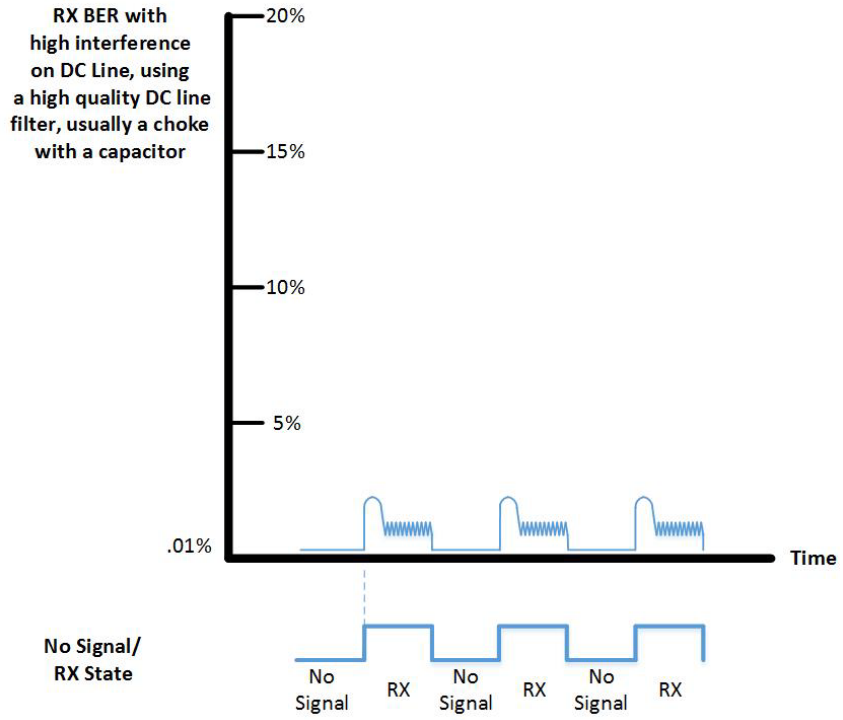

Figure 5

***High interference* on the DC Line with high level *DC line Filters composed of a Choke* and large capacitor and being used: AC > 100 mV but less than 50 mV after installing the choke while vehicle is running and revving. Initial RX "spike" is greatly reduced.**

The addition of the more effective line filter removes the majority of the AC voltage from the DC input and takes out the initial AC "spike" that the simple choke was unable to filter. As the radio transitions between Standby and Receive conditions, the BER shows 0% at Standby and can show some spiking for an i*nstant* at the initial point of signal reception. The spike is smaller and, if using a quality filter, will not inhibit registration issues.

Symptoms while vehicle is operating: The radio will operate effectively as long as the DC line filter is of good quality, the receive BER is generally 50 mV or less while receiving, and the spike is minimal at the initial signal reception.