An MCE Technical Publication

AC Inverter Drives Electrical Noise & RFI

Motion Control Engineering, Incorporated

Revised March 1999

Purpose

This Technical Publication discusses electrical noise and Radio Frequency Interference (RFI) created by AC Inverter drives and possible effects on other equipment.

Motion Control Engineering, Inc. experience with AC inverter drives suggests that they can generate noise that may affect radio frequency sensitive equipment in the building. This phenomenon needs to be understood and considered prior to selection of an elevator drive system..

Overview

It is generally **believed that AC inverter drives are the ideal technology** providing maximum power savings, reduced motors cost and lower maintenance costs. AC inverter drives have **tradeoffs** that need to be recognized and understood. These tradeoffs (potential drawbacks) include greater harmonic distortion, radio frequency interference and other idiosyncrasies that can make typically used AC drives unfriendly.

In most instances, new construction design can address these issues; however, elevator modernization in existing buildings requires thoughtful consideration. It is important to have a **basic understanding of the tradeoffs** that are determining factors in the drive selection process.

Static Drives

MCE Technical Publications “Harmonic Analysis & Comparison” and “Motor Generator vs SCR” explored considerations for drive selection for a particular elevator control application. Issues addressed in these publications apply to all static drives, including the typical AC inverter drive.

Radio Frequency Interference “RFI”

AC inverter drives **can produce sufficient amounts of** Radio Frequency noise (**RFI**) that affect the operation of equipment susceptible to Radio Frequency noise. This is **particularly true in older buildings** when grounding is lacking or otherwise inadequate.

One example of a substantial RFI problem is a **brick apartment** complex, **built in the mid 20's,** where the elevator contractor was in the process of modernizing existing AC elevator equipment. After the first cars were modernized (new controllers included RFI filtering devices), the building superintendent complained that he **was unable to listen to his favorite**

radio station because of interference from the elevators. He stated that the **vintage AC elevator controls caused no problems**; however, the state-of-the-art **static drives generated disruptive RFI**.

The building manager, considering the complaint unfounded, suggested that the superintendent select a different radio station. The superintendent reported the incident **to the FCC**. Subsequently, the contractor received an FCC notice to **immediately respond and resolve** the problem.

At the building the complaint was verified using an **inexpensive AC plug in radio** and the superintendent's portable **battery operated radio** equipped with all the latest technology. In the elevator **machine room** the AC radio was tuned to the AM band and, as expected, there was a considerable amount of interference. At **roof level** the battery operated radio, tuned to the same frequencies, performed slightly better; however, a considerable amount of interference was evidenced.

In an apartment on the **fourth floor**, located in the middle of the building, both radios demonstrated a similar level of interference. Conditions were found to be the same in an apartment on the **first floor**. Outside, in the **courtyard** which is surrounded by many buildings, AM band station signals were very strong and free of interference.

Simply stepping back inside at the **first floor entrance** the interference returned. Using the battery operated radio, as the elevator ran one could hear interference during both acceleration and deceleration.

The conclusion, later confirmed by the drive manufacturer, was that the **building**, without a solid earth ground, was acting as an **antenna**. Grounding of the elevator drive system and motor was occurring through water pipes and whatever other steel may have been present in this brick building.

The **drive manufacturer** did additional research to identify some probable causes. The contractor needed to provide a **proper earth ground**, **ground the controller and the motor** to this proper earth ground, and use **insulated bushings** to isolate other devices from the controller and motor to prevent grounding to or through the water piping system. These recommendations are, generally, requirements of the National Electrical Code, but they are sometimes overlooked. An **additional suggestion** would have been to try an isolation transformer. The drive manufacturer subsequently confirmed the transformer may **not have helped in absence of a proper earth ground.**

This is one example of how **RF noise pollution can unintentionally be propagated** throughout a building. Improper grounding conditions make this possible. Nonetheless, grounding alone may not be the cause of some RFI problems. Certain incorrect installation and wiring practices can also create serious RFI problems.

IGBT's

All **modern AC Inverter drives use** power devices known as **Insulated Gate Bipolar Transistors (IGBTs).** These devices make it possible to minimize annoying audible noise by using switching frequencies beyond the audible range. Unfortunately, AC inverter drives using **IGBTs**, present a high potential for generating **RFI -- Radio Frequency Interference**.

Fast switching in these devices generates sharp-edged waveforms with high frequency components that generate more RFI. The most likely complaint is **interference with AM band radios 500-1600 Khz**. Nonetheless, **sensitive computers, medical equipment** and other noise-sensitive devices sharing the same power buss **could experience serious interference**.

In extreme cases, the **AC inverter drive itself can experience electrical noise interference**. If elevator machine room equipment is not correctly laid out and properly wired, the electrical noise propagated by the elevator drive system can interfere with the elevator controller.

An example is the building lacking a solid grounding system where the elevator system experienced multiple problems. A solid earth ground was provided to eliminate many electrical noise problems, yet the elevator controller itself was being affected by undetermined sources of noise.

The routing of the contractor's field wiring into the controller was examined and several deficiencies were found and corrected. It was subsequently determined that the step down power/isolation transformer required by this particular application was physically located too close to the front of the controller. With the controller door open, the transformer created interference that affected the control microcomputers. The remedy was placement of a shield between the transformer and the controller, although other medthods may have also worked.

Reducing/Preventing Electrical Noise

Electrical noise, whether it is conducted or radiated, can create unusual phenomenon that are difficult to evaluate. To avoid the effects of electrical noise pollution, consider:

- Proper grounding including correct ground conductor sizing
- Contractors routing of field wiring
- Controller and motor isolation to prevent indirect grounds
- Controller design and layout
- RFI filters
- Isolation transformers
- Higher standards of care by the installing contractor

Warnings from Manufacturers

MCE
Motion Control Engineering warns, in job specific manuals, "**For proper operation** of the AC inverter drive unit in your controller, **you must make sure** that a direct **solid groud is provided in the machine room to properly ground the controller and the motor**.

Indirect grounds such as building structure or water pipe may not provide proper grounding and **could act as an antenna to radiate RFI** noise, thus disturbing sensitive equipment in the building.

Improper grounding may also render any RFI filter and isolation transformer ineffective."

SAFTRONICS
When experiencing RFI problems with AC inverter drives, Saftronics has stated that the first step is to verify the existence of a **proper grounding system**. All too often, old commercial or residential construction relied on **"indirect" grounding methods** in which the building ground was accomplished via steel **water pipes or conduit** instead of **through solid, properly sized conductors**. This poor practice increases the likelihood that **common mode noise** will be **propagated** throughout the facility.

Conclusion

The phenomenon of AC static drive noise generation can adversely effect many devices including the controller itself. Nonetheless, AC static drives offer technology that, in numerous circumstances, can provide more benefits than alternative drives. Awareness of the circumstances that allow AC static drives to interfere with other devices and proper design considerations will greatly reduce the effects of these phenomenon.

While this publication addresses AC inverter drives, it is desirable to continually explore issues relating to emerging AC drive technology.

MCE's Technical Publication series is intended to be an informative catalyst for ongoing dialogue and sharing of information between consultants, elevator contractors, owners and other interested parties. MCE Technical Publications are available on our website at www.mceinc.com.

Don Alley, MCE Vice President, Research and Development
***MCE** R&D Staff*
January 1996
