



IEEE Recommended Practice for Microprocessor-Based Protection Equipment Firmware Control

IEEE Power Engineering Society

Sponsored by the
Power System Relaying Committee

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Abstract: This recommended practice deals with the implications surrounding the use and administration of firmware revisions for protection-related equipment. In general, the number of firmware revisions have become prolific since the introduction of microprocessor-based protection related equipment and no standard means of dealing with the issues surrounding this situation has been addressed. This recommended practice attempts to provide guidelines for the effective communication of firmware-related issues with the intent of helping to maximize the security and reliability of the power system.

Keywords: firmware, IED, Intelligent Electronic Device, microprocessor, revisions, software

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Introduction

This introduction is not part of IEEE Std C37.231-2006, IEEE Recommended Practice for Microprocessor-Based Protection Equipment Firmware Control.

In the past few years, the technology used for the protection of the power system has evolved from electromechanical devices, to solid state, to microprocessor-based devices. Electromechanical devices had the inherent characteristic that their behavior was dependant upon physical or mechanical properties determined by the laws of physics. With the introduction of solid-state technology into protection and control, the earlier generation of microprocessor-based protective devices were developed and applied. Feature enhancements or product deficiencies were addressed by installing new integrated circuits or printed circuit board upgrades. Today's microprocessor-based devices, however, are mostly controlled by the firmware or code that instructs the device how to operate and perform. Firmware refers to programming code that is based on the internal operating paradigms of the microprocessor, or microcontroller, being used in the particular application. This code is based on the specific performance desired from the device and is typically stored in read-only memory. A certain DSP may be used for an automotive application in one instance, a business-related application in a second instance, and a protective relaying function in a third instance. What distinguishes the application is the firmware code written to control the processor (or processing chip) being used.

The implementation of the desired functionality is not based on the hardware construction of a physical device (as with the electromechanical device) but on the algorithms coded by the programmers. This leads to a wealth of different ways of implementing specific functions such as filtering, anti-aliasing, protection, metering, and combinations thereof. Over time the manufacturer may want to augment existing functionality by adding new features, such as changing the range/performance of certain functions, or correcting certain deficiencies found in the performance of the device. All of this leads to the possibility of a firmware change.

The reality of a firmware change for existing devices can have vast and far reaching implications. Questions arise such as: How important is the change? Is the firmware change compatible with existing devices? How important or critical is the new firmware for existing customers? What is the impact on documentation? How does one test the new revision? How does one ascertain that existing functionality has not changed? The user is also concerned about the reliability of the equipment purchased as well as the cost associated with changing firmware in existing devices.

Underpinning any firmware revision notification mechanism is the need for accurate and up-to-date records. This is the responsibility of both the manufacturer and user. As is the case for automobiles and other consumer products, recall notices and information bulletins are realities of doing business. In some cases, due diligence may have to be exercised in order to avoid legal implication, for example, in cases where a product may lead to loss of revenue or may impact system or scheme performance.

Due to the fact that the person who applies a firmware change to the actual device may not be the same individual as the one corresponding with the manufacturer or the field personnel who actually commissions the device, the term *firmware controller* is used in this document to refer to the individual who has the responsibility to maintain the firmware for protection devices. The firmware controller could be the end-user (field personnel), the engineering design department, purchasing, or any number of alternatives (as practices vary among users). The firmware controller will most likely be different from case-to-case and is a generic term in this document.

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