Technical Description of the ZDW120 Two-Wire Wall Dimmer
Written by Russell A. Phillips, RF Engineer for Advanced Control Technologies, Inc.
July 2004

The ZDW120 is a dimmer control that is designed for mounting in a standard wall switch box. It operates as a dimmer/switch to control up to 600W of permanently installed incandescent lighting. The device is wired in series with the load and operates from a 120VAC, 60Hz power source. The installation instructions provided with the unit specify that the device be installed in the hot side of the line in accordance with U.S Electrical Code. While the ZDW120 can work as a stand-alone switch, it is intended to work as a part of a group of similar, compatible home automation devices that are all can be controlled by a wireless remote control.

The dimmer module uses an application specific integrated circuit (ASIC) to control the switching circuitry, to execute instructions, and to control communications with other devices. It also features a flash memory IC to provide non-volatile retention of certain data. In addition, the ASIC contains a transceiver that is compatible with the transceivers found in each other control devices manufactured by ACT which may be a part of a User installation. It is also compatible of course with the transceiver used in the wireless remote control.

These transceivers operate in half-duplex fashion to provide two-way communications. The communications, while varied, most often consist of a command from the remote control followed by an acknowledgement by the addressed module(s) that a valid command was received.

The transceiver operates in the 900MHz ISM band at 908.42 MHz. The data, which is digital in nature, is Manchester encoded and sent using FSK modulation at a 9600 bit/sec rate. The deviation of the modulation is plus and minus 15 KHz

A 7.376974 MHz crystal oscillator is used both as a clock for the micro-controller and also as a reference oscillator for the fractional PLL frequency synthesizer portions of the ASIC. This PLL is used to generate both the local oscillator for the receiver and the fundamental frequency of the transmitter. The output power of the transmitter portion of the transceiver is controlled by the micro-controller which causes the transmit power to be very low for some setup functions.

Modulation of the transmitter is accomplished in the PLL by having the micro-controller cause it to use one divisor when the binary modulating data is zero (low) and a slightly different one, when it is one (high).

The receiver is a single conversion type. The local oscillator runs at 908.275 MHz (145 KHz below the receive frequency).

A wireless transmission occurs briefly in response to one of two events: 1) A manually issued command initiated by the User, or 2) An automated command that is initiated when the internal time of day clock matches a previously User-programmed time.

The communications are done using a protocol called the Z-Wave protocol, which is a wireless network protocol that has been especially designed for home automation products. It defines how various types of information are to be formatted into frames. These frames not only include commands and data, but also source and destination information, as well as checksums that are used for error detection. The ZDW120, the remote control, and other modules make up a wireless local network, where each of the modules can function as wireless repeaters (also half duplex). There is provision within the protocol for intelligent and adaptive routing and also for handling collisions.

Except for a handful of discrete passive components, the entire transceiver is contained in the ASIC, the ZW0102 made by Zensys. The transmitter and receiver share a common antenna. A SAW filter is used to help minimize receiver overload from strong signals on nearby frequencies and to attenuate any undesired harmonics from the transmitter. The antenna used in the ZDW120 is a wire antenna located inside the plastic rocker switch actuator. There are no external connections to the antenna. The aluminum enclosure of the dimmer is grounded for safety reasons. Any conducted emissions from the transceiver that may appear on the power lines are minimal and within applicable FCC limits.

The dimming function is accomplished by use of a triac that is switched on at zero-crossings of the AC line voltage. The duty cycle of the gate signal is varied via the micro-controller portion of the ASIC according to the desired lighting level. The ASIC adjusts the lighting level in response to the User pressing the rocker switch on the front of the unit, or in response to a command received from a remote control.

A brief tap of either the top or bottom of the rocker switch toggles the lighting on and off. Holding down the top of the rocker increases the brilliance of the lighting while holding down the bottom decreases it. An air-gap switch for safety purposes is provided that allows the User to completely remove power from the load when opened.