UPB
Wired In Relay Module (WIRM)
&
Receptacle Appliance Module (RAM)

Firmware Specification

V 1.1

1/14/05

Revision History

Spec. Rev.	Date	Firmware Rev.	Description
1.0	1/13/05	1.0	WIRM spec based on US1/2 (USQ) v1.7 spec.
1.1	1/14/05		Removed references to dimming

Table of Contents

1. Overview

The Wired in Relay Module (WIRM) and Receptacle Appliance Module (RAM) shall utilize the same firmware. Both units shall be non-dimmable single output devices with a single slave input. The WIRM shall take the form of a small enclosure with wire pigtails. The RAM shall take the form of a dual AC receptacle. The RAM shall control the lower receptacle while the upper receptacle shall be wired hot. The two module's differences are strictly mechanical and the firmware for both shall be referred to as the WIRM in the remainder of this document. Though the WIRM is a non-dimming device it shall react to UPB dimming commands such that non-zero dimming levels shall be ON, and zero dim levels shall be OFF. The WIRM shall have a slave input that may be configured as two pushbuttons with toggling functionality or as a single slave rocker. The WIRM shall have a pushbutton input for setup purposes. The WIRM device shall have two ways that can be employed to control its local relay: 1) remote slave switch, and 2) Universal Powerline Bus™ (UPB) Commands. The Slave Rocker or Slave Pushbutton#1 maybe configured to control the local relay, and/or configured to transmit UPB commands. The WIRM device shall contain a single bi-color LED to indicate status, modes, and events. The WIRM device shall contain a single pushbutton for setup purposes.

1.1. UPB Receiver

The WIRM device has UPB Receiver Logic capable of receiving UPB Communication Packets from the powerline.

1.2. UPB Transmitter

The WIRM device has UPB Transmitter Logic capable of transmitting UPB Communication Packets onto the powerline.

1.3. UPB Core Logic

The WIRM firmware conforms to the UPB System Model as defined in the UPB System Description document. The WIRM firmware has UPB Core Logic capable of responding to the UPB Core Command Message Set as described in the UPB System Description document.

1.4. LED Indicator

The WIRM device shall have a bi-color LED indicator used to indicate its current status and mode of operation.

1.5. Local Relay

The WIRM device shall control a relay capable of driving a 600 watt device.

1.6. Slave Switch

The WIRM shall have a slave input wire that maybe driven by a slave switch. The slave switch maybe a single rocker or a double pushbutton design. The Slave Switch may be configured to control the local relay and/or transmit UPB commands.

1.7. Push Button

The WIRM shall have a pushbutton utilized in setup of the device.

1.8. WIRM device Connections

The WIRM device **shall** have three wires that are used to connect it to power and an optional slave switch. Figure 1 shows how the WIRM device connects to the lighting system.
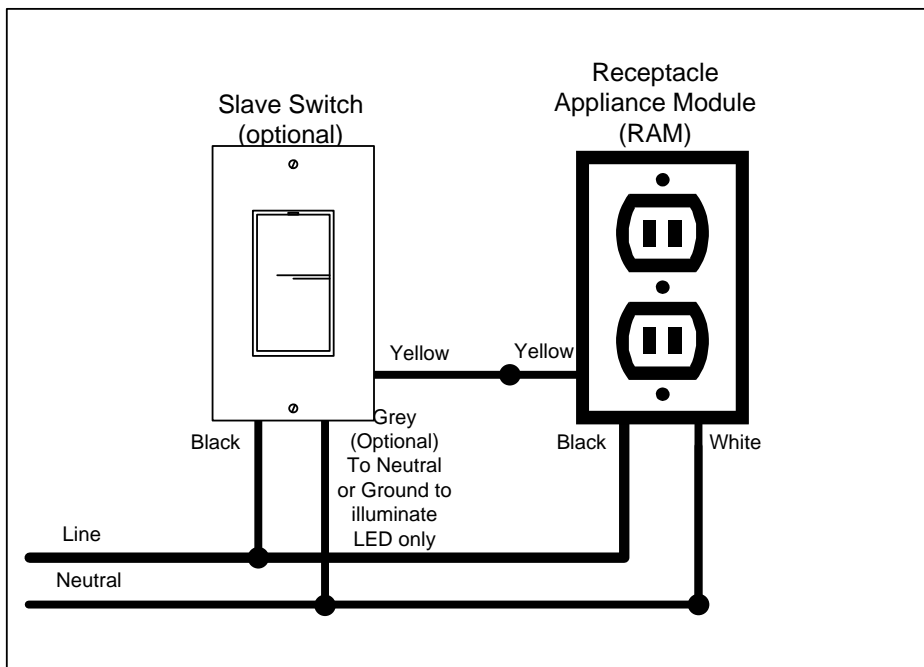
Figure 1 - RAM device connections to a lighting system

1.9. RAM device Conections
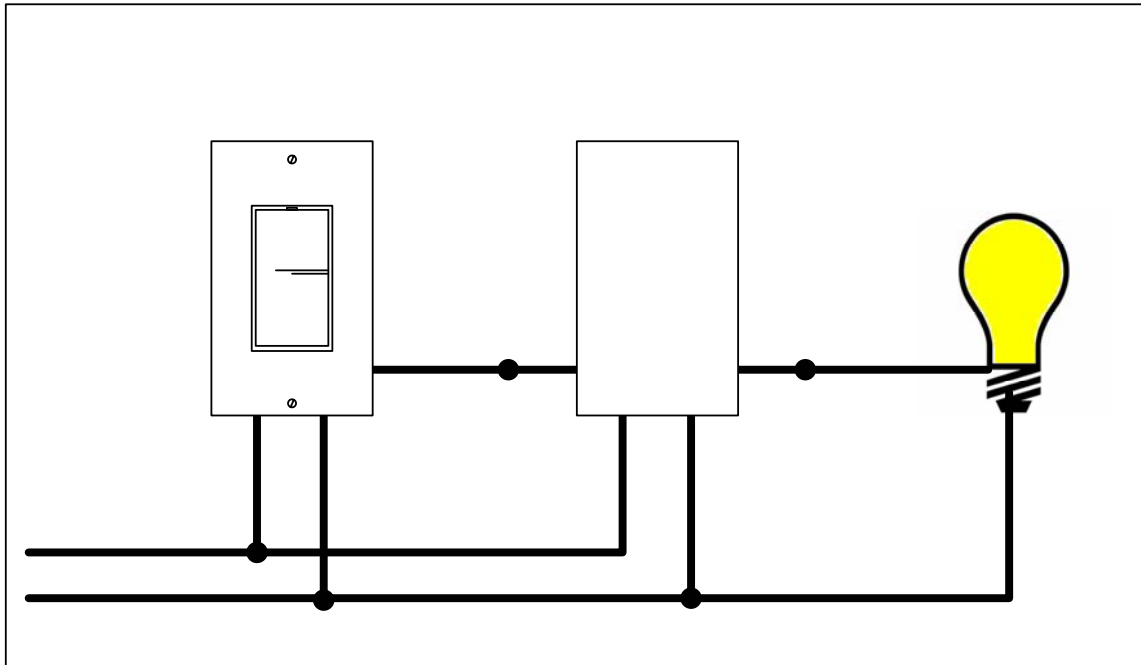
Figure 2 - WIRM device connections to a lighting system

2. Modes Of Operation

The WIRM device **shall** be capable of being put into any of three different modes of operation: Normal Mode, SETUP Mode, and Factory Default Mode.

2.1. Normal Mode

The WIRM device **shall** be able to operate in the Normal Mode. The Normal Mode is the WIRM device's default mode of operation. While in the Normal Mode the WIRM device **shall** be able to perform all of its normal operations except that Setup Register Write Protection is enabled. While in the Normal Mode, the LED indicator **shall** indicate this mode of operation as defined in section 6.1.4 " Special Mode LED Indications".

2.2. SETUP Mode

The WIRM device **shall** be able to operate in the SETUP Mode. The SETUP Mode is a special mode of operation that every UPB device that conforms to the UPB System Model must have. The UPB System Description document describes the SETUP Mode in more detail. The WIRM device **shall** be able to

Slave S
(option

enter into the SETUP Mode by three different methods. One is by receiving a valid "Start SETUP Mode" command message over the powerline as described in the UPB System Description document. The second method is by having its Slave Switch depressed in a special sequence as described in section 5.6.1. The method is by having its pushbutton depressed in a special sequence as described in section 5.6.1. While in the SETUP Mode, the LED indicator **shall** indicate this mode of operation as defined in section 6.1.4 " Special Mode LED Indications".

2.3. Factory Default Mode

The WIRM device **shall** be able to operate in the Factory Default Mode. The Factory Default Mode is a special mode of operation that, when entered, sets the Setup Registers to their Factory Default values as defined in Table 1 and Table 2. The WIRM device **shall** be able to enter into the Factory Default Mode as described in section 5.6.3 - " Entering Factory Default Mode". While in the Factory Default Mode, the LED indicator **shall** indicate this mode of operation as defined in section 6.1.4 " Special Mode LED Indications".

3. UPB Setup Registers

Like all UPB devices that conform to the UPB System Model, the WIRM device **shall** have a set of non-volatile 8-bit registers known as UPB Setup Registers. The WIRM device **shall** have a total of 256 UPB Setup Registers. These registers are used to define and configure how the WIRM device will operate as well as to store other important information as described herein. The WIRM device **shall** allow read/write access to its UPB Setup Registers via special UPB Messages communicated on the powerline. The WIRM device's Setup Registers are partitioned into three main groups (the UPBID, the Configuration Registers, and the Scratch-Pad Registers) as described below.
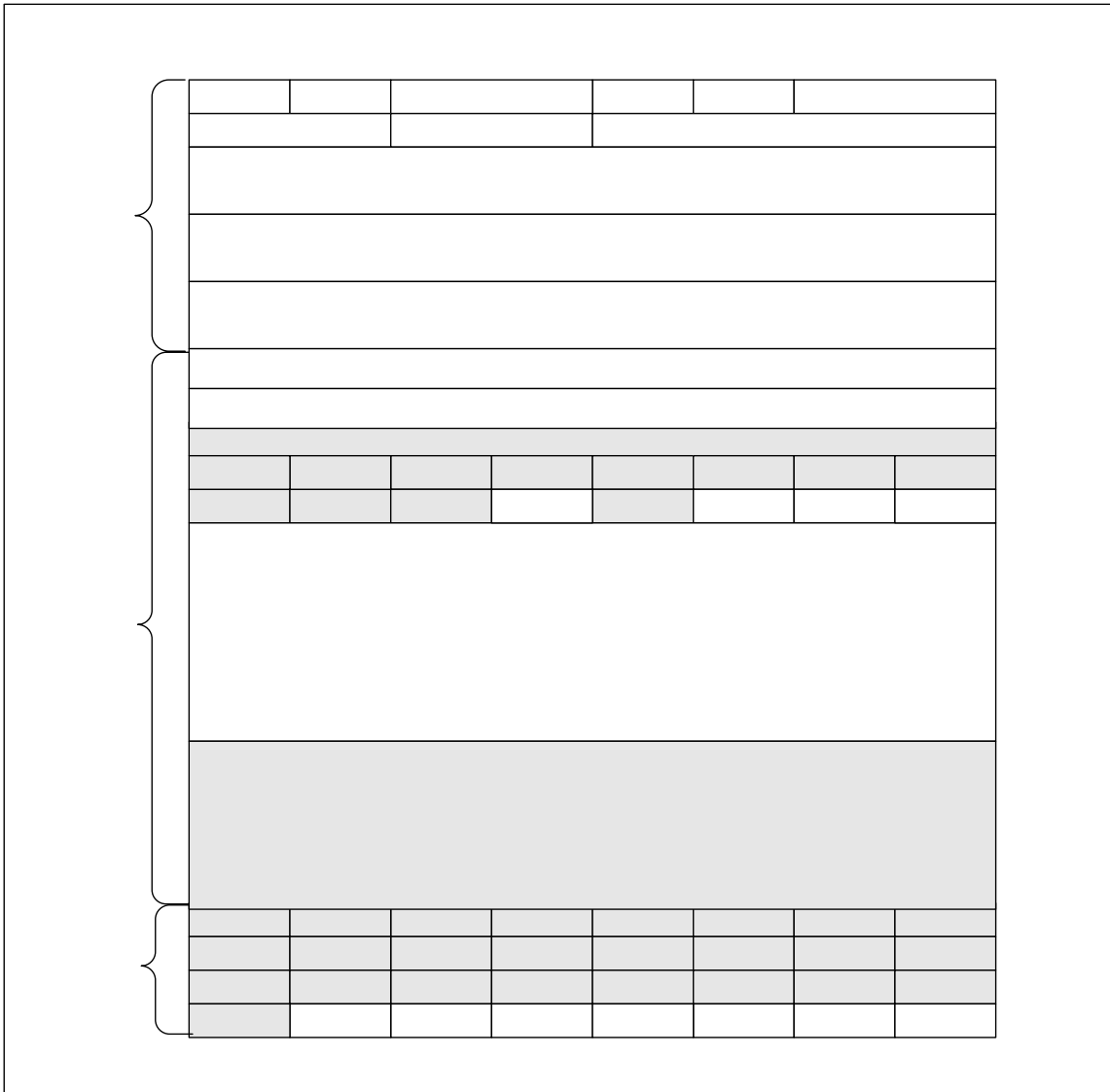
Figure 3 - UPB Setup Registers

3.1. The UPBID

The UPBID is a set of 64 non-volatile registers that contains information that uniquely identifies the individual UPB device. The WIRM device **shall** implement the UPBID in the first 64 Setup Registers. Table 1 below describes the Setup Registers that make up the UPBID. The table describes each register's use as well as its factory default value. The UPB System Description document contains more detailed information about the UPBID.

Setup Register Field Name	Reg. Num.	Factory Default	Description
Network ID (NID)	0x00	255 (0xFF)	Unique identifier (1 – 255) for the UPB Network that this device communicates on.
Unit ID (UID)	0x01	22 (0x16)	Unique identifier (1 – 255) for this UPB device.
Network Password (NPW)	0x02 – 0x03	4660 (0x1234)	Password designed to keep unauthorized users from modifying the Setup Registers of this device.
UPB Options (UPBOP)	0x04	00 (0x00)	Identifies UPB Options that are enabled for this device.
UPB Version (UPBVER)	0x05	01 (0x01)	Identifies the version of the UPB specification this device conforms to.
Manufacturer ID (MID)	0x06 – 0x07	04 (0x0004) SA	Unique identifier of the manufacturer of this UPB device.
Product ID (PID)	0x08 – 0x09	7 (0x07) WIRM device	The manufacturer's unique product identifier for this UPB device.
Firmware Version (FWVER)	0x0A – 0x0B	Depends on the current F/W	Identifies the version of firmware in this device.
Serial Number (SERNUM)	0x0C – 0x0F	Set by the manufacturer	The manufacturer's unique serial number for this UPB device.
Network Name (NNAME)	0x10 – 0x1F	"New Network Name"	A human readable (ASCII) name for the UPB Network that this device communicates on.
Room Name (RNAME)	0x20 – 0x2F	"New Room Name "	A human readable (ASCII) name for the Room that this UPB device is installed in.

Setup Register Field Name	Reg. Num.	Factory Default	Description
Device Name (DNAME)	0x30 – 0x3F	"New Relay Device"	A human readable (ASCII) name for this UPB device.

Table 1 - The WIRM device's UPBID

3.2. The Configuration Registers

The Configuration Registers are a set of non-volatile registers that configure how a device will operate. The WIRM device **shall** implement the Configuration Registers in the next 128 Setup Registers. The definition of the Configuration Registers is application dependent. Table 2 describes the Configuration Registers for the WIRM device application. The table describes each register's use as well as its factory default value.

Setup Register Field Name	Reg. Num.	Factory Default	Description
Receive Component Table	0x40 – 0x6F	See Table 10 for factory defaults	16 Receive Component Records used for receiving UPB Link Packets.
Transmit Component Table for Slave Rocker	0x70 – 0x79	See Table 12 factory defaults	Configuration table contains Transmit Component Records used for transmitting UPB Link Packets.
Unused	0x7A-0x8A	255 (0xFF)	Unused
LED Options	0x8B	9 (0x09)	Configurable options for the Status LED.
Unused	0x8C	255(0xFF)	Unused
Output Options	0x8D	131 (0x83)	Configures automatic state reports.
UPB Tx Control	0x8E	132 (0x84)	Configurable options for UPB Transmissions.
Rocker Options	0x8F	12(0xC0)	Determines Rocker Action and defines variant type
Transmit Command Table	0x90 – 0xBC	See Table 13 for factory defaults	Table for 16 Command IDs (CmdIds) with the 3-byte UPB Command Messages they represent.
Unused	0xBD – 0xE7	255 (0xFF)	Unused

Table 2 - Configuration Registers

3.3.   The Scratch-Pad Registers

The Scratch-Pad Registers are a set of non-volatile registers that the application can use for any purpose. Table 3 describes the Scratch-Pad Registers for the WIRM. The table describes each register's location and use. Note: there are no factory default values for these registers.

Setup Register Field Name	Reg. Num.	Description
Unused	0xE8 – 0xF8	255 (0xFF)
Reset Light Level	0xF9	Location to store the last Light Level before power-down.
Setup Mode Counter	0xFA	Count of number of times this device went into Setup Mode.
WERR Counter	0xFB	Count of number of times this device had a EEPROM Write Error.
POR Counter	0xFC	Count of number of times this device had a Power-On Reset.
BOR Counter	0xFD	Count of number of times this device had a Brown-Out Reset.
WDT Counter	0xFE	Count of number of times this device had a Watchdog Timer Reset.
MCLR Counter	0xFF	Count of number of times this device had a Master Clear Reset.

Table 3 - Scratch-Pad Registers

4. Relay Operations

4.1. Output Options Register

The WIRM device **shall** have an 8-bit Output Options Register implemented at address 0x8D of its non-volatile Setup Registers. The Output Options Register (Figure 4) has bits and fields that are used to customize the output operation using a UPB Setup Tool.

bit7   bit0

---	---	---	TSR	---	---	---	---

bit7:   **Unused**

bit6 - 5:   **Unused**

bit 4:   **TSR**: Tx State Report
            0 = Dont transmit a State Report upon Slave Rocker Switch events
            1 = Transmit a State Report upon Slave Rocker Switch events

bit3-0:   **Unused**
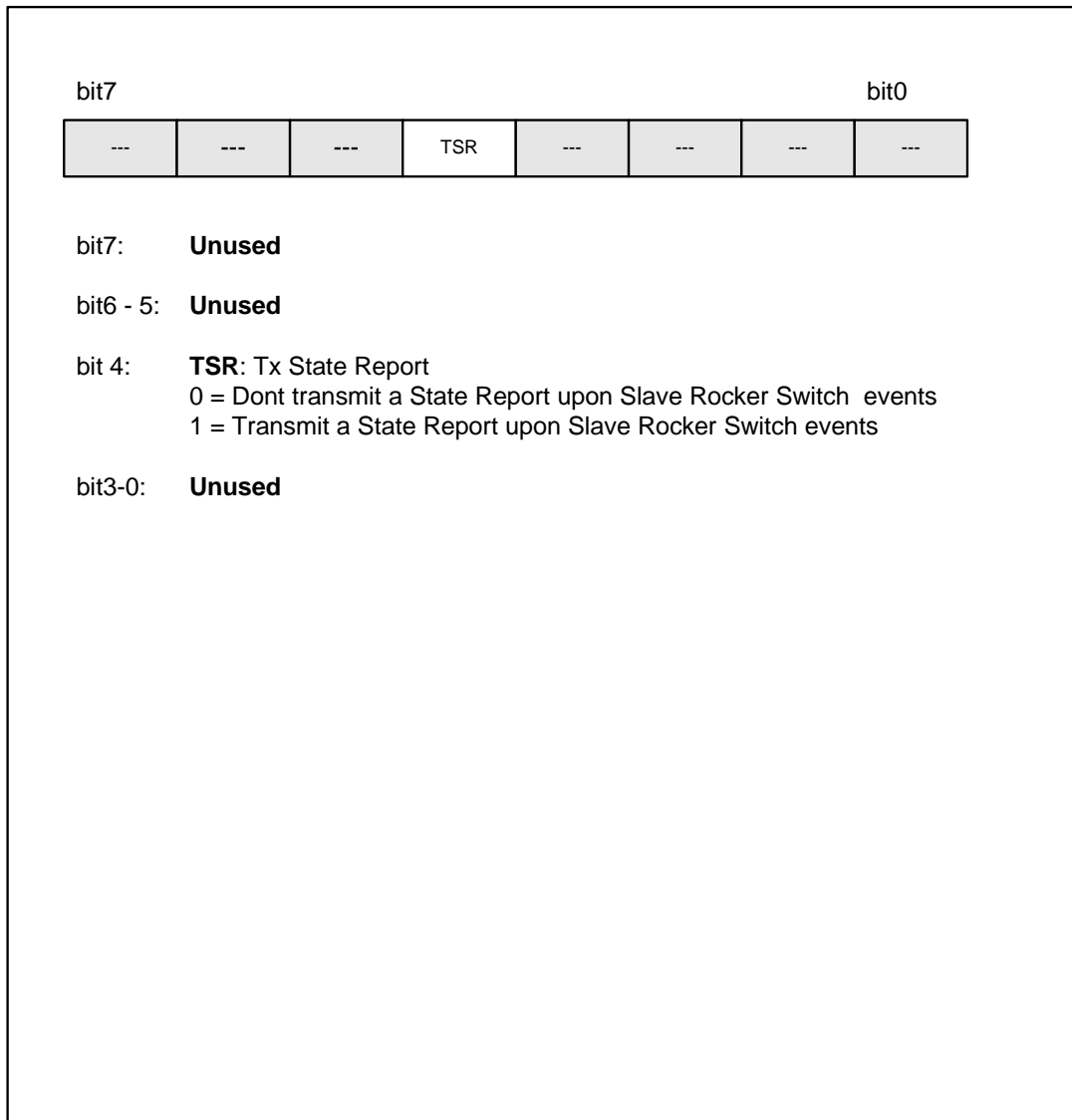
Figure 4 - Output Options Register

5. Slave Rocker Switch Operations

The WIRM device may have a Slave Rocker Switch that is used to control the load, transmit UPB Messages, and to put the WIRM device into special modes of operation.

5.1. Rocker Options Register

The Rocker Options Register is a non-volatile register (location 0x8F) that determines local control of the local output.

Bit	Name	Description
7	Rocker Connect	0 = Slave Rocker disconnect to local output 1 = Slave Rocker connected to local output
6	Not used	Not used
5	Not used	Not used
4	Rocker or Pushbutton	0 = local output controlled by Slave Rocker 1 = local output controlled by Slave Pushbutton#1
3 - 0	Variant Selection	Selects model variant

Table 4 – Rocker Options Register

5.1.1. Slave Rocker Connect

This option shall determine if the selected Slave Rocker shall control the local relay. When set to zero, the Slave Rocker shall be disconnected from the local relay. When set to one, the Slave Rocker shall control the local relay.

5.1.2. Rocker Or Pushbutton

This option is enabled by the Rocker Connect bit. Once activated, this option determines if the local relay is controlled by Slave Rocker or Slave Pushbutton#1. Slave Pushbutton#1 shall behave as a "super toggler" when selected.

5.1.3. Variant Selection

The lower nibble of the Rocker Options Register (location 0x8F) is defines the variant field. The variant field is solely for use of UPB setup tool to identify the configuration of the WIRM device. The WIRM firmware does not use the variant value to configure the device. When model variant is set to 15, the UPB setup tool declares the device unknown (or new). The Rocker Options register and Transmit Component Table values actually configure the device to determine how many rockers/pushbuttons are active and whether they function as pushbuttons (toggle function) or rockers.

Variant (Rocker Options LSB)	Model	Description
0	WIRM	Wired in Relay Module
1	RAM	Receptacle Appliance Module
2	WIRM/S	Wired in Relay Module /w slave rocker
3	RAM/S	Receptacle Appliance Module /w slave rocker
4	Not used	
5	Not used	
6	Not used	
7	Not used	
8	Not used	
9	Not used	
10	Not used	
11	Not used	
12	Not used	
13	Not used	
14	Not used	
15	Model undefined	Default

Table 5 – Rocker Options Variant field definitions

5.2. Slave Rocker Switch Events

The WIRM device **shall** be capable of detecting any of the four types of Slave Rocker Switch Events defined in Table 6.

Rocker Event	Definition
Single-Tap	The switch is pressed for at least 250 mS and then released before 750 mS and left released.
Multi-Tap (Double-Tap)	The switch is pressed for at least 250 mS and then released and pressed again before 750 mS and then released before 750 mS and left released.
Hold	The switch is pressed for at least 750 mS without being released.
Release	The switch was released after a Hold event.

Table 6 – Slave Rocker Switch Events

5.3. Slave Rocker Switch Load Control

A Slave Rocker Switch **may** be used by the WIRM device to control its output as defined in Table 7 below.

Slave Rocker Event	Action (Top Rocker)	Action (Bottom Rocker)
Single-Tap	Perform the Configured Rocker Switch Action as described in section 5.4.	Perform the configured Rocker Switch Output Action as described in section 5.4.
Double-Tap	Perform the Configured Rocker Switch Action as described in section 5.4.	Perform the configured Rocker Switch Output Action as described in section 5.4.
Hold	Turn on output.	Turn off output.
Release	None	none

Table 7 - Rocker Switch Load Control

5.4. Configured Slave Rocker Switch Output Actions

The WIRM device treats the Single-Tap and Double-Tap Rocker Switch Events specially, giving the user the freedom to configure the corresponding output action that they desire.   The WIRM device **shall** implement a Slave Rocker Switch Action Table in its non-volatile Setup Registers as shown in Table 8 to configure the "Output Action" to be performed on the load upon a Single-Tap and upon a Double-Tap event of the two Rocker Switches.

5.4.1. The Rocker Switch Action Table

The Rocker Switch Action Table **shall** be used to configure the "Output Action" to be performed on the load upon a Single-Tap and/or Double-Tap event.   Each "Output Action" **shall** be defined as a Light Level (%) to fade to and an associated Fade Rate to use to get it there.   The Slave Rocker Switch Action Table (Table 8) **shall** be 8 bytes long and **shall** be divided into four 2-byte records.   There **shall** be one record to correspond to each of the following events: Top Rocker Single-Tap, Top Rocker Double-Tap, Bottom Rocker Single-Tap, and Bottom Rocker Double-Tap. Each 2-byte record consists of one byte to represent the Light Level (%) and the other byte to represent the Fade Rate to use when the corresponding event occurs.

Setup Register Field Name	Reg. Num.	Level	Rate (N/A)
Top Rocker Single-Tap Output Action	0x7A – 0x7B	ON	000
Top Rocker Double-Tap Output Action	0x7C – 0x7D	ON	000
Bottom Rocker Single-Tap Output Action	0x7E – 0x7F	OFF	000
Bottom Rocker Double-Tap Output Action	0x80 – 0x81	OFF	000

Table 8 - Rocker Switch Action Table

5.5. Slave Rocker Switch Transmit Control

The WIRM device can optionally be configured to transmit UPB Messages when any of the Slave Rocker Switch Events listed in Table 6 occurs. Refer to section 5.1 for details on how to configure the WIRM device for Slave Rocker Switch Transmissions.

5.6. Slave Rocker Switch Mode Control

The Slave Rocker Switch **shall** be able to be used to put the WIRM device into different modes of operation. The WIRM device has three different modes of operation (Normal Mode, SETUP Mode, and Factory Default Mode) as defined in section 2.

5.6.1. Entering SETUP Mode

The WIRM device **shall** enter SETUP Mode when the Slave Rocker Switch or pushbutton is multi-tapped exactly 5 times. When the WIRM device enters the SETUP Mode it **shall** indicate so by flashing its output's lighting load on and off and by blinking its LED as defined in section 6.1.4.

5.6.2. Exiting SETUP Mode

Once in the SETUP Mode, the WIRM device **shall** exit SETUP Mode and enter the Normal Mode when the Slave Rocker Switch or pushbutton is multi-tapped exactly 2 times. When the WIRM device exits the SETUP Mode it will indicate so by flashing its outupt's lighting load on and off and by stopping the blinking of its LED as defined in section 6.1.4.

5.6.3. Entering Factory Default Mode

Once in the SETUP Mode, the WIRM device **shall** exit SETUP Mode and enter the Factory Default Mode when the Slave Rocker Switch or pushbutton is multi-tapped for exactly 10 times. When the WIRM device enters the Factory Default Mode it will indicate so by flashing its output's lighting load on and off and by blinking its LED as defined in section 6.1.4.

5.6.4. Exiting Factory Default Mode

Once in the Factory Default Mode, the WIRM device **shall** exit Factory Defaults Mode and enter the Normal Mode when the Slave Rocker Switch or pushbutton is multi-tapped for exactly 2 times. When the WIRM device exits the SETUP Mode it will indicate so by flashing its output's lighting load on and off and by stopping the blinking of its LED as defined in section 6.1.4.

6. Status LED Operation

The WIRM device has a single bi-color Light Emitting Diode (LED) that it uses to indicate its current status. The Status LED is configured by the settings in the LED Options Register as defined in Table 9.

6.1. The LED Options Register

The WIRM device shall have an 8-bit LED Options Register implemented at address 0x8B of its non-volatile Setup Registers. The LED Options Register (Table 9) has bits and fields that are used to customize the Status LED operation using a UPB Setup Tool.

Bit	Name	Description
7	LED Mode	0 = Load Indicator LED enabled 1 = Diagnostic LED enabled
4-6	Unused	Unused
3 - 2	Load On Color	00 = Black (off) 01 = Red 10 = Green 11 = Orange
1 - 0	Load Off Color	00 = Black (off) 01 = Red 10 = Green 11 = Orange

Table 9 - LED Options Register

6.1.1. LED Mode Selection

Bit #7 of the LED Options Register is used to select between two different LED Modes: The Load Indicator LED Mode or the Diagnostic LED Mode. If bit #7 is clear (0) then the WIRM device **shall** operate the Status LED in the Load Indicator LED Mode as described in Section 6.1.2. If bit #7 is set (1) then the WIRM device **shall** operate the Status LED in the Diagnostic LED Mode as described in Section 6.1.3.

6.1.2. The Load Indicator LED Mode

If the Load Indicator LED Mode is enabled, the WIRM device shall turn the Status LED to a color based on the on/off state of the output. If the output is set to 0% (off) the WIRM device **shall** set the Status LED to the color specified by the Load Off Color bits (1 and 0) of the LED Options Register as defined in Table 9. If the output is set above 0% the WIRM device **shall** set the Status LED to the color specified by the Load On Color bits (3 and 2) of the LED Options Register as defined in Table 9.

6.1.3. The Diagnostic LED Mode

If the Diagnostic LED Mode is enabled, the WIRM device **shall** turn the Status LED solid orange. Whenever the WIRM device transmits a UPB message, it **shall** indicate so by blinking the status LED red. Whenever the WIRM device receives a valid UPB message, it **shall** indicate so by blinking the status LED green. Whenever the WIRM device receives an invalid UPB message, it **shall** indicate so by blinking the status LED black (off).

6.1.4. Special Mode LED Indications

The WIRM device has two special modes that it can be put into: SETUP Mode and Factory Default Mode. When the WIRM device is in SETUP Mode it **shall** indicate so by blinking its status LED alternately between green and black (off). When the WIRM device is in Factory Default Mode it **shall** indicate so by blinking its status LED alternately between red and black (off). When the WIRM device is in Normal Mode it **shall** indicate so by stopping the blinking and turning its status LED to solid orange.

6.1.5. Firmware Version LED Indication

When power is first applied, the WIRM device **shall** use the status LED to indicate the version of the firmware it is running. It **shall** do this by blinking the LED four times. Each blink will either be red or green. The four blinks **shall** be such as to indicate the binary value that matches the least significant digit of the firmware version. A blink of red **shall** indicate a binary "zero" and a blink of green **shall** indicate a binary "one". As an example, if the firmware version is 4.15, then the LED will indicate the binary value for 5, which is 0-1-0-1. The WIRM device will therefore blink its LED four times upon power-up: red-green-red-green.

7. UPB Message Reception

The WIRM device **shall** be capable of receiving UPB messages from the powerline.

7.1. Receive Components

The WIRM device uses the concept of Receive Components (as described in the UPB System Description document) to configure its UPB Link Packet receiving behavior. Receive Components shall be referred to as Presets. The WIRM device **shall** have sixteen 3-byte Presets as shown in Table 10. Each Preset **shall** have an associated Link ID byte that is used when receiving UPB Link Packets. Each Preset **shall** also have an associated byte for holding a Light Level and Fade Rate for use in processing the "Activate" and "Deactivate" commands (see section 0 for details). Non-dimming devices, such as the WIRM, shall have no use for the fade rate. Non-dimming devices shall interpret the Light Level=1-99 as ON and Light Level=0 as OFF.

Setup Register Field Name	Register Numbers	Factory Default Values		
		Link ID	Light Level	Fade Rate
Preset #1	0x40 – 0x42	001	100	255
Preset #2	0x43 – 0x45	002	0	255
Preset #3	0x46 – 0x48	255	255	255
Preset #4	0x49 – 0x4B	255	255	255
Preset #5	0x4C – 0x4E	255	255	255
Preset #6	0x4F – 0x51	255	255	255
Preset #7	0x52 – 0x54	255	255	255
Preset #8	0x55 – 0x57	255	255	255
Preset #9	0x58 – 0x5A	255	255	255
Preset #10	0x5B – 0x5D	255	255	255
Preset #11	0x5E – 0x60	255	255	255
Preset #12	0x61 – 0x63	255	255	255
Preset #13	0x64 – 0x66	255	255	255
Preset #14	0x67 – 0x69	255	255	255
Preset #15	0x6A – 0x6C	255	255	255
Preset #16	0x6D – 0x6F	255	255	255

Table 10 - Receive Component Table

7.1.1. Receiving UPB Link Packets

Whenever the WIRM device receives a UPB Link Packet it will attempt to match its Destination ID to one of the valid Link IDs of its sixteen Receive Components. If a match is not found then that Link Packet is not for this WIRM device and it **shall** be ignored. If a match is found then the WIRM device **shall** accept the Link Packet for further processing. The particular Receive Component that had the Link ID match is "linked" to this Link Packet.

7.1.2. Activating/Deactivating Receive Components

The WIRM device **shall** handle the special UPB Link Packet commands of "Activate" and "Deactivate". When the WIRM device accepts the "Activate" command it **shall** set its output using the Light Level parameters of the "linked" Receive Component. When the WIRM device accepts the "Deactivate" command it **shall** set its output to OFF.

7.1.3. Changing Preset Light Levels and Fade Rates

The Receive Components Light Level and Fade Rate parameters can be changed (configured) with the use of a UPB Setup Tool. In addition, the WIRM device **shall** handle the special UPB Link Packet command of "Store Preset". When the WIRM device accepts the "Store Preset" command it **shall** store its current Light Level (%) into the "linked" Receive Component (Preset).

7.2. Receiving The Core Command Message Set

The WIRM device **shall** be capable of handling received UPB Messages from the UPB Core Command Message Set as described in the UPB System Description document.

7.3. Receiving the Device Control Command Set

Besides handling the UPB Core Commands, the WIRM device **shall** also handle the following set of UPB Commands from the UPB Device Control Command Set (see Table 11).

MDID (Hex)	Command Name	Command Description
0x20	Activate	Commands the WIRM device to "activate" its linked Receive Component's (Preset) Light Level.
0x21	Deactivate	Commands the WIRM device to "deactivate" its linked Receive Component's (Preset) Light Level.
0x22	Goto	Commands the WIRM device to set its output to the specified Light Level.
0x23	Fade Start	Commands the WIRM device to set its output to the specified Light Level.
0x24	Fade Stop	None.
0x25	Blink	Commands the WIRM device to blink its output from OFF to ON at the specified Blink Rate.
0x30	Report State	Commands the WIRM device to send back a Device State Report containing the current Output State.
0x31	Store Preset	Commands the WIRM device to store its current output state value as its linked Receive Component's (Preset) new Light Level.

Table 11 - WIRM device UPB Device Control Commands

7.4. The "Activate" Command

When the WIRM device receives and accepts an "Activate" Command message (MDID = 0x20) in a UPB Link Packet it **shall** set its Output to the Light Level value of the linked Receive Component (Preset).

7.5. The "Deactivate" Command

When the WIRM device receives and accepts a "Deactivate Link" Command message (MDID = 0x21) in a UPB Link Packet it **shall** set its output to OFF.

7.6. The "Goto" Command

When the WIRM device receives and accepts a "Goto" Command message (MDID = 0x22) in a UPB Link Packet or a UPB Direct Packet it **shall** set output state to the specified Light Level.

7.7. The "Fade Start" Command

When the WIRM device receives and accepts a "Fade Start" Command message (MDID = 0x23) in a UPB Link Packet or a UPB Direct Packet it **shall** output at the specified Light Level.

7.8. The "Fade Stop" Command

Non-dimming devices, such as the WIRM, shall take no action on this command.

7.9. The "Blink" Command

When the WIRM device receives and accepts a "Blink" Command message (MDID = 0x25) in a UPB Link Packet or a UPB Direct Packet it **shall** alternate its light level between 100% and 0% at the specified Blink Rate. The WIRM device **shall** calculate the time between blinking as:

*Time between blinking = 16.667mS * Blink Rate value*

If no Blink Rate value is specified in the command then the WIRM device **shall** use a default Blink Rate value of 30 (0.5 seconds) instead.

7.10. The "Store Preset" Command

When the WIRM device receives and accepts a "Store Preset" Command message (MDID = 0x31) in a UPB Link Packet it **shall** store its current Light Level value into the linked Preset Component.

7.11. The "Report Status" Command

When the WIRM device receives and accepts a "Report Status" Command message (MDID = 0x30) in a UPB Direct Packet it **shall** build and transmit a Device State Report message.

The "Device State" Report has a Message Data ID of **0x86** and has the following syntax:

MDID	Arg1
0x86	LL

Where LL is the current Light Level % (0x00 – 0x64) of the WIRM device output.

8. UPB Message Transmission

The WIRM device **shall** be capable of transmitting UPB messages from the powerline.

8.1. Transmit Components

The WIRM device uses the concept of Transmit Components (as described in the UPB System Description document) to configure its UPB Link Packet transmission behavior. The WIRM device **shall** have eight 5-byte Transmit Components implemented in its non-volatile Configuration Registers as shown in Table 104. The eight Transmit Components are associated with the eight rocker buttons. Each Transmit Component **shall** have an associated Link ID byte that is used when transmitting UPB Link Packets. Each Transmit Component **shall** have associated command bytes for rocker events; one-tap, two-tap, hold, and release.

8.2. Rocker Triggered UPB Transmissions

The rocker switches on the WIRM device may be programmed to trigger transmission of configured UPB Messages to other UPB devices. The WIRM device can be configured to transmit UPB Messages whenever any of the defined Rocker Events occur.

8.3. Transmit Components Table

The WIRM device uses the concept of Transmit Components (as described in the UPB System Description document) for programming its configurable 1-4 rockers for UPB Transmissions. The WIRM device has ten Transmit Components the slave rocker. See Figure 3.
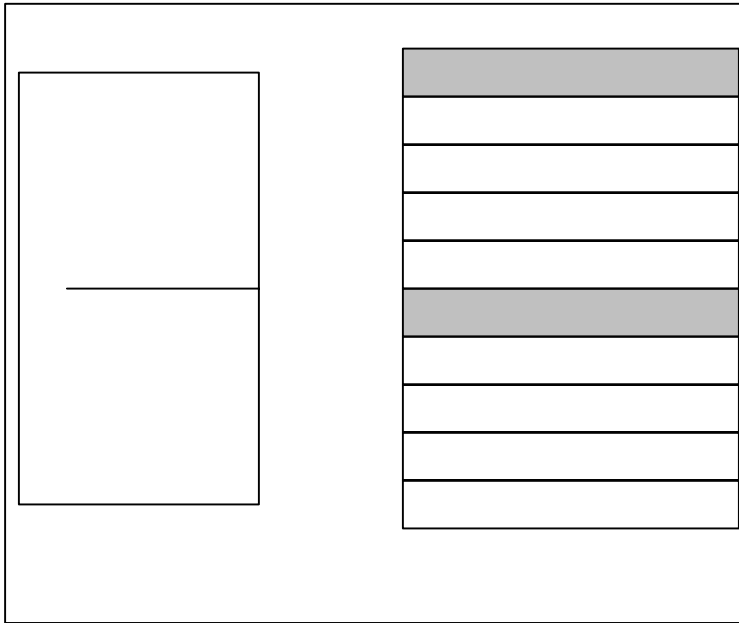
Figure 3 – Transmit Component Table

Setup Register Field Name	EE Address	Factory Default Values of Rocker Events				
		Link ID	1-Tap	2-Tap	Hold	Release
Slave Upper Rocker	0x70 – 0x74	0xFF	ACTIVATE (0x66)	SNAP_ON (0x88)	FADE_UP (0x33)	FADE_STOP (0x44)
Slave Lower Rocker	0x75 – 0x79	0xFF	DEACTIVATE (0x55)	SNAP_OFF (0x77)	FADE_DOWN (0x22)	FADE_STOP (0x44)

Table 12 - Transmit Component Table

The WIRM device **shall** implement Transmit Components in its non-volatile EE Configuration Registers as a 10-byte (2 x 5) Transmit Component Tables.

Sla

Upper

8.3.1. Transmit Component Table Toggle Feature

The WIRM device shall have the ability to support push button toggle feature. The toggle feature is supported by the values in the Transmit Component Table fields; 1-Tap, 2-Tap, Hold, and Release. On each of these actions the WIRM firmware shall toggle the upper and lower bit of the respective fields to generate a toggle action. When the upper and lower nibbles of these fields are identical, no toggle action shall be generated.

8.4. The Transmit Link ID

Each Transmit Component Record **shall** start with a 1-byte Link ID field. Each Transmit Component (Button) can either be assigned a Valid Link ID (from 1 to 254) or an Invalid Link ID (255). If it is assigned an Invalid Link ID then no UPB transmission **shall** take place. If it is assigned a Valid Link ID, however, then it **shall** use that Link ID in the Destination ID field of any Rocker Switch Transmissions.

8.4.1. The Transmit Command IDs

Each Transmit Component record **shall** have four additional bytes that can be assigned a 4-bit Command IDs. There **shall** be a Transmit Command ID byte corresponding to each of the four defined Rocker Events: Single-Tap, Double-Tap, Hold, and Release.

8.5. Using Command IDs

The 4-bit Command ID that gets selected **shall** be used by the WIRM device to determine what UPB Message to build and transmit. If the Command ID value is 15 then no UPB Message **shall** be built or transmitted. If the Command ID value is between 0 and 14 then the WIRM device **shall** use the Command ID as an index into the UPB Transmit Command Table to look-up a three-byte command message to be built and transmitted.

8.6. The UPB Transmit Command Table

The WIRM device **shall** implement a UPB Transmit Command Table in its non-volatile Setup Registers that allows for the customization of up to fifteen 3-byte UPB Messages. Table 13 shows the UPB Transmit Command Table for the WIRM device along with its factory default values. Each three-byte record corresponds to a Command ID value (0 – 14). The WIRM device **shall** use the UPB Transmit Command Table to look-up the three-byte UPB Message to build and transmit onto the UPB bus for the selected Command ID. The UPB Transmit Command Table can be changed with the use of a UPB Setup Tool so that other custom commands can be formed.

Setup Register Field Name	Reg. Num.	Cmd ID	Factory Default	Command Name
Tx Command #0	0x90 – 0x92	0	22 00 FF	Goto Off
Tx Command #1	0x93 – 0x95	1	22 64 FF	Goto On
Tx Command #2	0x96 – 0x98	2	23 00 FF	Fade Down
Tx Command #3	0x99 – 0x9B	3	23 64 FF	Fade Up
Tx Command #4	0x9C – 0x9E	4	24 FF FF	Fade Stop
Tx Command #5	0x9F – 0xA1	5	21 FF FF	Deactivate
Tx Command #6	0xA2 – 0xA4	6	20 FF FF	Activate
Tx Command #7	0xA5 – 0xA7	7	22 00 00	Snap Off
Tx Command #8	0xA8 – 0xAA	8	22 64 00	Snap On
Tx Command #9	0xAB – 0xAD	9	22 00 01	Quick Off
Tx Command #10	0xAE – 0xB0	10	22 64 01	Quick On
Tx Command #11	0xB1 – 0xB3	11	22 00 08	Slow Off
Tx Command #12	0xB4 – 0xB6	12	22 64 08	Slow On
Tx Command #13	0xB7 – 0xB9	13	25 1E FF	Blink
Tx Command #14	0xBA – 0xBC	14	00 FF FF	Null Command

Table 13 - Transmit Command Table

9. Automatic State Report Transmissions

Besides controlling the WIRM device's output and modes of operation, the two Rocker Switches can be configured to trigger transmissions of State Reports whenever they are single-tapped, double-tapped, or released. These Automatic State Reports can be used to inform home automation controllers when someone has altered a output state via the slave rocker switch action.

9.1. Enabling Automatic State Reports

Automatic State Report Transmissions are enabled by setting bit#4 of the Output Options Register (Figure 4). If Automatic State Report Transmissions are enabled the WIRM device **shall** build and transmit a State Report message whenever a Slave Rocker Switch causes a change of the output state.

9.2. Transmitting Automatic State Reports

The Automatic State Report Transmissions **shall** always be sent in a Direct Packet. The Automatic State Report Transmissions **shall** always be directed to the same Network ID assigned to the WIRM. The Automatic State Report Transmissions **shall** always be directed to the Broadcast Destination ID (0x00).

The Data field of the Automatic State Report Transmissions **shall** contain a "Device State" Report. The "Device State" Report has a Message Data ID of **0x86** and has the following syntax:

MDID	Arg1
0x86	LL

Where LL is the current Light Level % (0x00 – 0x64) of the WIRM device output.

10. Factory Default Operation

This section describes the operation of the WIRM device with its factory default settings enabled. These settings will be enabled "right out of the box" or whenever Factory Default Mode is enabled as described in section 5.6.3.

10.1. Power-Up Operation

Upon power-up the WIRM device will enter Normal Mode and will display its current firmware version by blinking its LED four times as described in section 6.1.5. It will then read the saved Reset Light Level from non-volatile memory and set its output's level to the Reset Output Level. The WIRM device will set its LED color to orange and await further events such as Local Rocker Switch Events, Slave Rocker Switch Events, or UPB Communication Packet Receptions.

10.2. Slave Rocker Switch Events

The optional Slave Rocker Switch can be used to change the WIRM device output level as described in Table 14.

Rocker Event	Action (Top Rocker)	Action (Bottom Rocker)
Single-Tap	ON	OFF
Double-Tap	ON	OFF
Hold	ON	OFF
Release	None	None

Table 14 - Slave Rocker Switch Output Actions

The Slave Rocker Switch can also be used to put the WIRM device into Setup Mode and Factory Default Mode as described in section 5.6

10.3. UPB Communication Packet Receptions

The WIRM device has a factory default Network ID of 255 and a factory default Unit ID of 001. It is capable of handling the UPB Core Command Message Set (as described in the UPB System Description document) for Direct Packets sent to this NID/UID. Besides handling the UPB Core Commands, the WIRM device also handles the set of UPB Commands described in Table 11.

10.4. UPB Receive Components

The WIRM device has 16 Receive Components (called Presets) that are configured for receiving Link Packets addressed to its NID. The factory default Link IDs that the WIRM device will accept are Link IDs #1 through #16 as shown in Table 15.

Receive Component	Link ID	Light Level	Fade Rate
Preset #1	001	100%	Default Fade Rate
Preset #2	002	0%	Default Fade Rate
Preset #3	Unused	Unused	Unused
Preset #4	Unused	Unused	Unused
Preset #5	Unused	Unused	Unused
Preset #6	Unused	Unused	Unused
Preset #7	Unused	Unused	Unused
Preset #8	Unused	Unused	Unused
Preset #9	Unused	Unused	Unused
Preset #10	Unused	Unused	Unused
Preset #11	Unused	Unused	Unused
Preset #12	Unused	Unused	Unused
Preset #13	Unused	Unused	Unused
Preset #14	Unused	Unused	Unused
Preset #15	Unused	Unused	Unused
Preset #16	Unused	Unused	Unused

Table 15 - Factory Default Presets

10.5. Activate Link Command Operation

The WIRM device has 16 Receive Components (called Presets) that are setup for receiving Link Packets with Link IDs #1 through #16. Each Preset has a Light Level and Fade Rate parameter associated with it that will be "activated" by the Link Activate command. Whenever the WIRM device receives a Link Activate command addressed to its NID and one of these Link IDs it will set its output to the associated Light Level.

10.6. Deactivate Link Command Operation

The WIRM device has 16 Receive Components (called Presets) that are setup for receiving Link Packets with Link IDs #1 through #16. Each Preset has a Light

Level and Fade Rate parameter associated with it that will be "deactivated" by the Link Deactivate command. Whenever the WIRM device receives a Link Deactivate command addressed to its NID and one of these Link IDs it will set its output to 0% (off).

10.7. Changing Preset Light Levels

The WIRM device has 16 Receive Components (called Presets) that are setup for receiving Link Packets with Link IDs #1 through #16. Each Preset has a Light Level and Fade Rate parameter associated with it. Whenever the WIRM device receives a Store State command addressed to its NID and one of these Link IDs it will store its current output level into the associated Light Level parameter of the Preset.

10.8. UPB Communication Packet Transmissions

The WIRM device will transmit UPB Communication Packets onto the powerline in response to various commands from the UPB Core Command Message Set (as described in the <u>UPB System Description</u> document). The WIRM device factory default setting is for no Rocker Switch Transmissions.