



# UPB Lamp Module (LM1) Firmware Specification

V 1.0

01/13/05

# Revision History

Rev	Date	Description
1.0	1-13-05	CEC– Initial release (based on WS1D v1.4)

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## **1. The Lamp Module (LM1)**

The Lamp Module shall be a receptacle mountable light switch capable of controlling the light level of a single 600W channel 120VAC lighting load. The LM1 shall be controlled by Universal Powerline Bus™ (UPB) Commands. In addition to controlling the lighting load, the LM1 can be configured to transmit a set of UPB Reports onto the powerline when certain events occur. The LM1 also contains a single bi-color LED to indicate status, modes, and events.



Figure 1: The UPB Lamp Module (LM1)

### **1.1. Light Dimmer**

The LM1 has Light Dimmer logic capable of producing 200 different levels of light output as well as off. The Light Dimmer can be configured (or commanded) to change light levels immediately (“Snap”) as well as gradually (“Fade”).

### **1.2. UPB Receiver**

The LM1 has UPB Receiver Logic capable of receiving UPB Communication Packets from the powerline.

### **1.3. UPB Transmitter**

The LM1 has UPB Transmitter Logic capable of transmitting UPB Communication Packets onto the powerline.

#### **1.4. UPB Core Logic**

The LM1 conforms to the UPB System Model as defined in the UPB System Description document. The LM1 has UPB Core Logic capable of responding to the UPB Core Command Message Set as described in the UPB System Description document.

#### **1.5. Pushbutton**

The LM1 shall have a pushbutton to initiate; setup mode, factory default mode, and test mode.

#### **1.6. LED Indicator**

The LM1 has a bi-color LED indicator used to indicate its current status and mode of operation.

## 2. Modes Of Operation

The LM1 **shall** be capable of being put into any of four different modes of operation: Normal Mode, SETUP Mode, TEST Mode, and Factory Default Mode.

### 2.1. Normal Mode

The LM1 **shall** be able to operate in the Normal Mode. The Normal Mode is the LM1's default mode of operation. While in the Normal Mode the LM1 **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 5.5 "Special Mode LED Indications".

### 2.2. SETUP Mode

The LM1 **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 LM1 **shall** be able to enter into the SETUP Mode by two 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 pushbutton depressed in a special sequence as described in section 4.3.3 - "Entering SETUP Mode". While in the SETUP Mode, the LED indicator **shall** indicate this mode of operation as defined in section 5.5 "Special Mode LED Indications".

### 2.3. TEST Mode

The LM1 shall have a TEST Mode allowing the user to manually change the output on and off. To initiate TEST Mode the user must hold down the pushbutton for a minimum of two seconds. The LED shall blink fast red indicating entry of TEST Mode. Subsequent single clicks to the pushbutton shall cause the output to toggle from 100% to 0%. TEST Mode can be exited by depressing the pushbutton for a minimum of two seconds or waiting five minutes for it to timeout and return to normal mode.

### 2.4. Factory Default Mode

The LM1 **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 LM1 **shall** be able to enter into the Factory Default Mode as described in section

4.3.5 - “ Entering Factory Default Mode”. While in the Factory Default Mode, the LED indicator **shall** indicate this mode of operation as defined in section 5.5 “Special Mode LED Indications”.



### 3. UPB Setup Registers

Like all UPB devices that conform to the UPB System Model, the LM1 **shall** have a set of non-volatile 8-bit registers known as UPB Setup Registers. The LM1 **shall** have a total of 256 UPB Setup Registers. These registers are used to define and configure how the LM1 will operate as well as to store other important information as described herein. The LM1 **shall** allow read/write access to its UPB Setup Registers via special UPB Messages communicated on the powerline. The LM1's Setup Registers are partitioned into three main groups (the UPBID, the Configuration Registers, and the Scratch-Pad Registers) as described below.

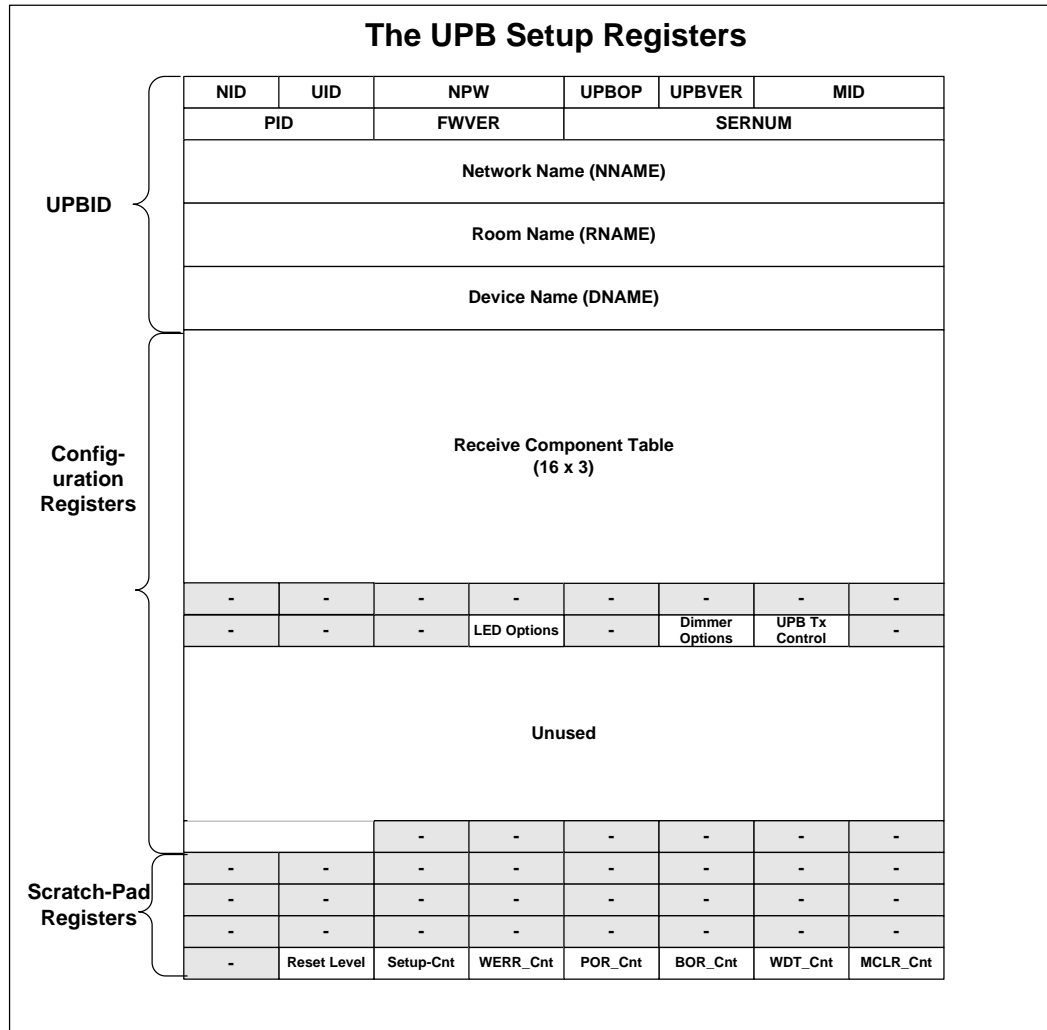


Figure 2: The LM1 UPB Setup Registers

### 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 LM1 **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	01 (0x01)	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	01 (0x0001) LM1	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 LM1 ”	A human readable (ASCII) name for this UPB device.

Table 1: The LM1'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 LM1 **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 LM1 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 6 for factory defaults	Configuration table containing 16 Receive Component Records used for receiving UPB Link Packets.
Unused	0x70 – 0x8A	255 (0xFF)	Unused
LED Options	0x8B	138 (0x8A)	Configurable options for the Status LED.
Unused	0x8C	255 (0xFF)	Unused
Dimmer Options	0x8D	131 (0x83)	Configurable options for the light dimmer circuit.
UPB Tx Control	0x8E	132 (0x84)	Configurable options for UPB Transmissions.
Unused	0x8F-BF	255 (0xFF)	Unused

Table 2: The Wall Switch Dimmer's 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. The LM1 **shall** implement the Scratch-Pad Registers in the last 64 Setup Registers. Table 3 describes the Scratch-Pad Registers for the Wall Switch Dimmer. 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	0xC0 – 0xF8	Unused
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: The Wall Switch Dimmer’s Scratch-Pad Registers

## 4. Light Dimmer Operations

### 4.1. Light Levels

The LM1 dimmer output **shall** be capable of creating any of 200 distinct Light Levels (1 – 200) as well as OFF (0). Light Level #0 corresponds to 0% (OFF) and Light Level #200 corresponds to 100% (MAX). When the LM1 sets its Light Level to a new value, it can either do it immediately, called a “Snap”, or it can do it gradually over time, called a “Fade”. The LM1 can be configured (or commanded) to use one of sixteen possible Fade Rates in setting its new Light Level (see Section 4.2).

#### 4.1.1.Pseudo-Logarithmic Dimming Curve

The LM1 **shall** implement a pseudo-logarithmic dimming curve for creating smooth lighting transitions between its 200 Light Levels.

#### 4.1.2.The Reset Light Level

Approximately once every 2 seconds the LM1 **shall** save its current Light Level (in %) into non-volatile memory as the Reset Light Level. When the LM1 first powers up, it **shall** restore its current Light Level (%) to the saved Reset Light Level value.

## 4.2. Fade Rates

Whenever the LM1 sets its Light Level to a new value, it can either do it immediately, called a Snap, or it can do it a little bit at a time, called a Fade. The LM1 **shall** be able to be configured or commanded to use one of sixteen possible Fade Rates (including Snap) in setting its new Light Level as described in Table 4 below.

Fade Rate	Fade Time (0% – 100%)	Time Per Step
0	Snap!	0
1	0.8 seconds	4.167mS
2	1.6 seconds	8.333 mS
3	3.3 seconds	16.67mS
4	5 seconds	25mS
5	6.6 seconds	33.3 mS
6	10 seconds	50 mS
7	20 seconds	100 mS
8	30 seconds	150 mS
9	1 minute	300 mS
10	2 minutes	600 mS
11	5 minutes	1.5 seconds
12	10 minutes	3 seconds
13	15 minutes	4.5 seconds
14	0.5 hours	9 seconds
15	1.0 hour	18 seconds

Table 4: LM1 Dimmer Fade Rates

### 4.3. Dimmer Options Register

The LM1 **shall** have an 8-bit Dimmer Options Register implemented at address 0x8D of its non-volatile Setup Registers. The Dimmer Options Register (Figure 3) has bits and fields that are used to customize the dimmer operation using a UPB Setup Tool.

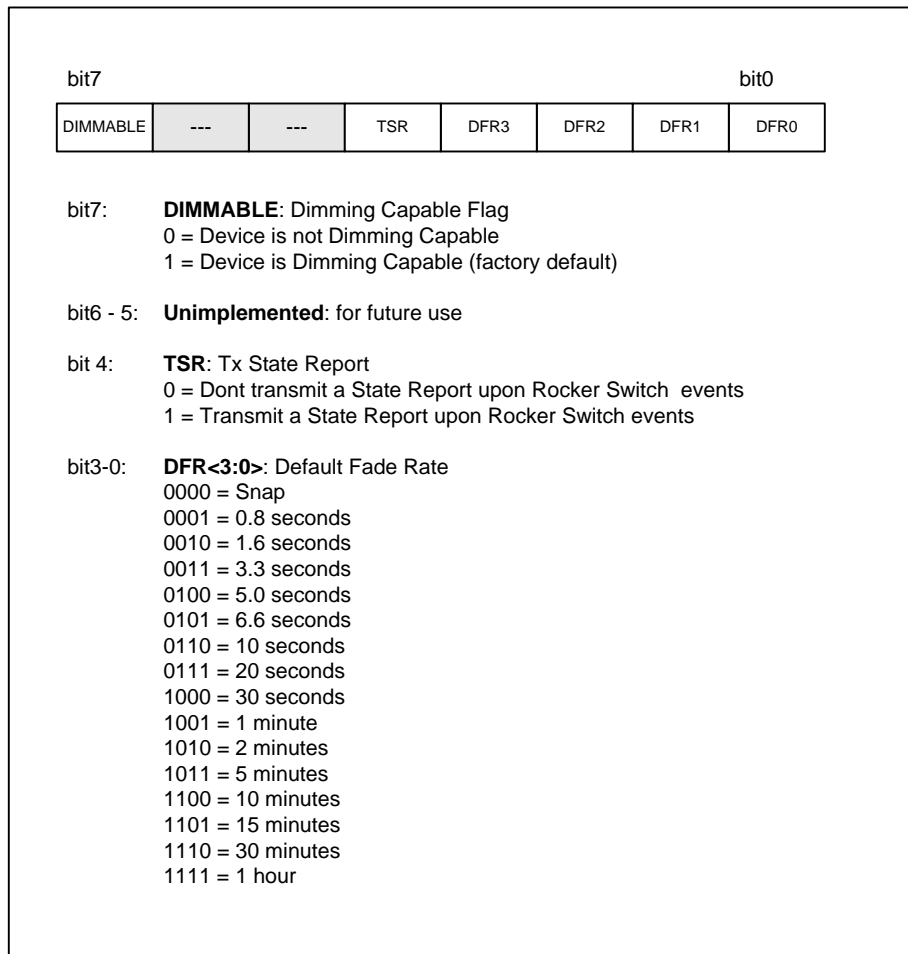


Figure 3: The Dimmer Options Register

#### 4.3.1. The Dimming Capable Flag

The LM1 **shall** have a 1-bit Dimming Capable Flag implemented as part of its Dimmer Options Setup Register (Figure 3). When this flag is set to 1 (factory default state), the LM1 **shall** allow full 200 level light dimming capabilities. When this flag is cleared to 0, the LM1 **shall** only allow On (100%) and Off (0%) capabilities.

### **4.3.2. The Default Fade Rate**

The LM1 **shall** have a 4-bit Default Fade Rate implemented as part of its Dimmer Options Register (Figure 3). Whenever the LM1 is commanded to use the “default fade rate” it **shall** use the value in the Default Fade Rate field of the Dimmer Options Register. Also, whenever the LM1 is commanded or configured to use a Fade Rate value above 15 it **shall** use the value in the Default Fade Rate field instead.

### **4.3.3. Entering SETUP Mode**

The LM1 **shall** enter SETUP Mode when the pushbutton is multi-tapped for exactly 5 times. When the LM1 enters the SETUP Mode it **shall** indicate so by flashing its dimmer’s lighting load on and off and by blinking its LED as defined in section 5.5.

### **4.3.4. Exiting SETUP Mode**

Once in the SETUP Mode, the LM1 **shall** exit SETUP Mode and enter the Normal Mode when either Rocker Switch is multi-tapped once. When the LM1 exits the SETUP Mode it will indicate so by flashing its dimmer’s lighting load on and off and by stopping the blinking of its LED as defined in section 5.5.

### **4.3.5. Entering Factory Default Mode**

Once in the SETUP Mode, the LM1 **shall** exit SETUP Mode and enter the Factory Default Mode when either pushbutton is multi-tapped for exactly 10 times. When the LM1 enters the Factory Default Mode it will indicate so by flashing its dimmer’s lighting load on and off and by blinking its LED as defined in section 5.5.

### **4.3.6. Exiting Factory Default Mode**

Once in the Factory Default Mode, the LM1 **shall** exit Factory Defaults Mode and enter the Normal Mode when the pushbutton is multi-tapped exactly once. When the LM1 exits the SETUP Mode it will indicate so by flashing its dimmer’s lighting load on and off and by stopping the blinking of its LED as defined in section 5.5.

## **5. Status LED Operation**

The LM1 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 below).

## 5.1. The LED Options Register

The LM1 shall have an 8-bit LED Options Register implemented at address 0x8B of its non-volatile Setup Registers. The LED Options Register (Table 5) 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
6 - 4	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 5: The LED Options Register

## 5.2. 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 LM1 **shall** operate the Status LED in the Load Indicator LED Mode as described in Section 5.3. If bit #7 is set (1) then the LM1 **shall** operate the Status LED in the Diagnostic LED Mode as described in Section 5.4.

## 5.3. The Load Indicator LED Mode

If the Load Indicator LED Mode is enabled, the LM1 shall turn the Status LED to a color based on the on/off state of the dimmer output. If the dimmer output is set to 0% (off) the LM1 **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 5. If the dimmer output is set above 0% the LM1 **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 5.



## 5.4. The Diagnostic LED Mode

If the Diagnostic LED Mode is enabled, the LM1 **shall** turn the Status LED solid orange. Whenever the LM1 transmits a UPB message, it **shall** indicate so by blinking the status LED red. Whenever the LM1 receives a valid UPB message, it **shall** indicate so by blinking the status LED green. Whenever the LM1 receives an invalid UPB message, it **shall** indicate so by blinking the status LED black (off).

## 5.5. Special Mode LED Indications

The LM1 has two special modes that it can be put into: SETUP Mode and Factory Default Mode. When the LM1 is in SETUP Mode it **shall** indicate so by blinking its status LED alternately between green and black (off). When the LM1 is in Factory Default Mode it **shall** indicate so by blinking its status LED alternately between red and black (off). When the LM1 is in Normal Mode it **shall** indicate so by stopping the blinking and turning its status LED to solid orange.

## 5.6. Firmware Version LED Indication

When power is first applied, the LM1 **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 LM1 will therefore blink its LED four times upon power-up: red-green-red-green.

## 6. UPB Message Receiving

The LM1 **shall** be capable of receiving UPB messages from the powerline.

### 6.1. Receive Components

The LM1 uses the concept of Receive Components (as described in the UPB System Description document) to configure its UPB Link Packet receiving behavior. The LM1 **shall** have sixteen 3-byte Receive Components implemented in its non-volatile Configuration Registers as shown in Table 6. All sixteen Receive Components (referred to as Presets) are associated with the dimmer's single light dimmer output. Each Receive Component **shall** have an associated Link ID byte that is used when receiving UPB Link Packets. Each Receive Component **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 6 for details).

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	003	80	255
Preset #4	0x49 – 0x4B	004	60	255
Preset #5	0x4C – 0x4E	005	40	255
Preset #6	0x4F – 0x51	006	20	255
Preset #7	0x52 – 0x54	007	100	255
Preset #8	0x55 – 0x57	008	100	255
Preset #9	0x58 – 0x5A	009	100	255
Preset #10	0x5B – 0x5D	010	100	255
Preset #11	0x5E – 0x60	011	100	255
Preset #12	0x61 – 0x63	012	100	255
Preset #13	0x64 – 0x66	013	100	255
Preset #14	0x67 – 0x69	014	100	255
Preset #15	0x6A – 0x6C	015	100	255
Preset #16	0x6D – 0x6F	016	100	255

Table 6: Receive Component Table

### 6.1.1.Receiving UPB Link Packets

Whenever the LM1 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 LM1 and it **shall** be ignored. If a match is found then the LM1 **shall** accept the Link Packet for further processing. The particular Receive Component that had the Link ID match is “linked” to this Link Packet.

### 6.1.2.Activating/Deactivating Receive Components

The LM1 **shall** handle the special UPB Link Packet commands of “Activate” and “Deactivate”. When the LM1 accepts the “Activate” command it **shall** set its dimmer’s output using the Light Level and Fade Rate parameters of the “linked” Receive Component. When the LM1 accepts the “Deactivate” command it **shall** set its dimmer’s output to 0% using the Fade Rate parameter of the “linked” Receive Component.

### 6.1.3.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 LM1 **shall** handle the special UPB Link Packet command of “Store Preset”. When the LM1 accepts the “Store Preset” command it **shall** store its current Light Level (%) into the “linked” Receive Component (Preset).

## 6.2. Receiving The Core Command Message Set

The LM1 **shall** be capable of handling received UPB Messages from the UPB Core Command Message Set as described in the UPB System Description document.

## 6.3. Receiving The Device Control Command Set

Besides handling the UPB Core Commands, the LM1 **shall** also handle the following set of UPB Commands from the UPB Device Control Command Set (see Table 7).

MDID (Hex)	Command Name	Command Description
0x20	Activate	Commands the LM1 to “activate” its linked Receive Component’s (Preset) Light Level and Fade Rate.
0x21	Deactivate	Commands the LM1 to “deactivate” its linked Receive Component’s (Preset) Light Level and Fade Rate.

MDID (Hex)	Command Name	Command Description
0x22	Goto	Commands the LM1 to set its dimmer output to the specified Light Level at the specified Fade Rate.
0x23	Fade Start	Commands the LM1 to set its dimmer output to the specified Light Level at the specified Fade Rate as long as the Dimming Option bit is set to 1 (i.e. Dimming-Capable).
0x24	Fade Stop	Commands the LM1 to stop fading and stay at the current Light Level.
0x25	Blink	Commands the LM1 to blink its dimmer output from 0% to 100% at the specified Blink Rate.
0x30	Report State	Commands the LM1 to send back a Device State Report containing the current dimmer Light Level (%).
0x31	Store Preset	Commands the LM1 to store its current dimmer Light Level (%) value as its linked Receive Component's (Preset) new Light Level.

Table 7: LM1 UPB Device Control Commands

#### 6.4. The “Activate” Command

When the LM1 receives and accepts an “Activate” Command message (MDID = 0x20) in a UPB Link Packet it **shall** set its Dimmer’s light level to the Light Level value of the linked Receive Component (Preset) using the Fade Rate of the linked Receive Component (Preset).

#### 6.5. The “Deactivate” Command

When the LM1 receives and accepts a “Deactivate Link” Command message (MDID = 0x21) in a UPB Link Packet it **shall** set its Dimmer’s light level to 0% (OFF) using the Fade Rate of the linked Receive Component (Preset).

#### 6.6. The “Goto” Command

When the LM1 receives and accepts a “Goto” Command message (MDID = 0x22) in a UPB Link Packet or a UPB Direct Packet it **shall** start its Light Dimmer fading its light level towards the specified Light Level using the specified Fade Rate. If no Fade Rate is specified in the command then the LM1 **shall** use its Default Fade Rate instead.

### 6.7. The “Fade Start” Command

When the LM1 receives and accepts a “Fade Start” Command message (MDID = 0x23) in a UPB Link Packet or a UPB Direct Packet it **shall** start its Light Dimmer fading its light level towards the specified Light Level using the specified Fade Rate. If no Fade Rate is specified in the command then the LM1 **shall** use its Default Fade Rate instead. This command **shall** be ignored if the Dimming Capable Flag in the Dimmer Options Register is set to 0 (not dimming capable).

### 6.8. The “Fade Stop” Command

When the LM1 receives and accepts a “Fade Stop” Command message (MDID = 0x24) in a UPB Link Packet or a UPB Direct Packet it **shall** stop its Light Dimmer from fading its light level any farther.

### 6.9. The “Blink” Command

When the LM1 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 LM1 **shall** calculate the time between blinking as:

$$\text{Time between blinking} = 16.667\text{mS} * \text{Blink Rate value}$$

If no Blink Rate value is specified in the command then the LM1 **shall** use a default Blink Rate value of 30 (0.5 seconds) instead.

### 6.10. The “Store Preset” Command

When the LM1 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.

### 6.11. The “Report Status” Command

When the LM1 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

Table 8 - LL is the current Light Level % (0x00 – 0x64) of the LM1 dimmer.

## 7. UPB Transmission

### 7.1. The UPB Transmit Control Register

The LM1 **shall** have an 8-bit UPB Transmit Control Register implemented in its non-volatile Setup Registers that allows for the customization of its Rocker Switch Triggered Transmissions. Figure 4 shows the UPB Transmit Control Register and explains the meanings of its various bits and fields. The UPB Transmit Control Register can be changed with the use of a UPB Setup Tool so that the Rocker Switch Triggered Transmissions behavior of the LM1 can be customized.

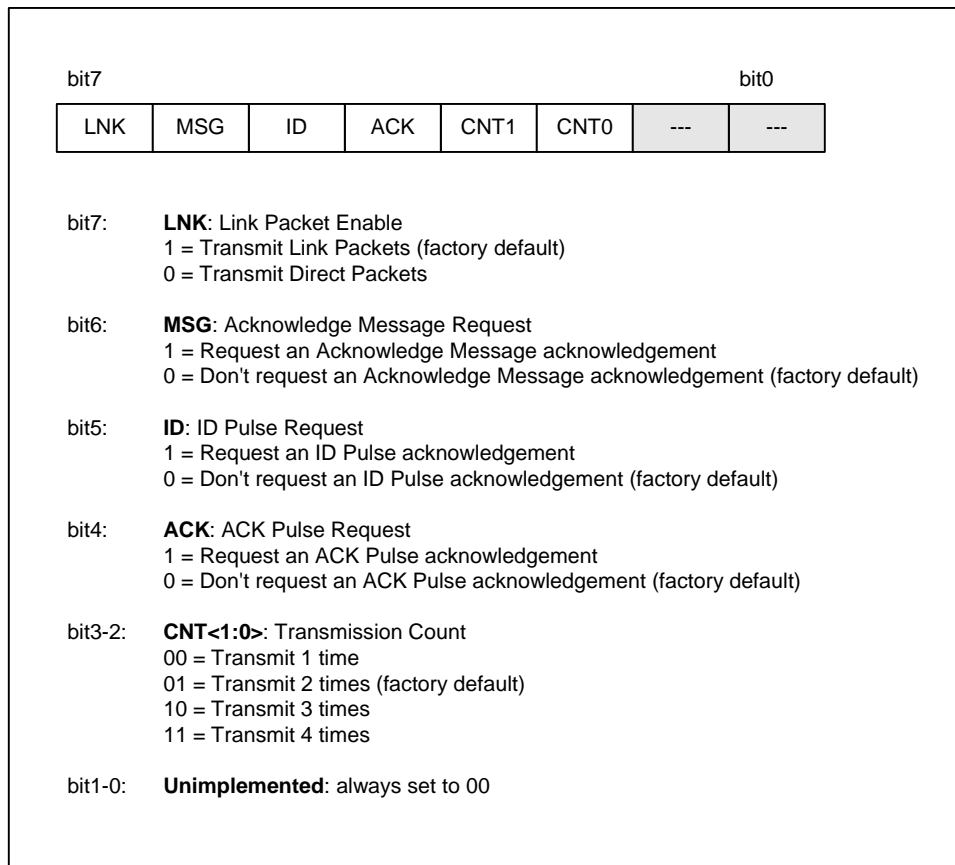


Figure 4: The UPB Transmit Control Register

### **7.1.1.Link Packet Enable**

Bit #7 of the UPB Transmit Control Register is used to configure whether LM1 Triggered Transmissions are sent in Link Packets or Direct Packets. If this bit is set to '0' the LM1 **shall** build and transmit all triggered transmissions with the LNK-bit cleared in its Control Word (Direct Packet). If this bit is set to '1' the LM1 **shall** build and transmit all triggered transmissions with the LNK-bit set in its Control Word (Link Packet).

### **7.1.2.Acknowledge Message Request**

Bit #6 of the UPB Transmit Control Register is used to configure whether an Acknowledge Message is requested from the receiver of any triggered transmissions. If this bit is set to '1' the LM1 **shall** build and transmit triggered transmissions with the MSG-bit set in its Control Word.

### **7.1.3.ID Pulse Request**

Bit #5 of the UPB Transmit Control Register is used to configure whether an ID Pulse is requested from the receiver of any triggered transmissions. If this bit is set to '1' the LM1 **shall** build and transmit all triggered transmissions with the ID-bit set in its Control Word.

### **7.1.4.ACK Pulse Request**

Bit #4 of the UPB Transmit Control Register is used to configure whether an ACK Pulse is requested from the receiver of any triggered transmissions. If this bit is set to '1' the LM1 **shall** build and transmit all triggered transmissions with the ACK-bit set in its Control Word.

### **7.1.5.Transmission Count**

Bit #3 and #2 of the UPB Transmit Control Register are used to configure how many times to transmit a message in a row for each triggered transmission event. If this field is set to 00 the LM1 **shall** transmit any triggered transmission one time only. If this field is set to 01 or 10 or 11 the LM1 **shall** transmit any triggered transmission two times or three times or four times respectively.

## **7.2. Automatic State Report Transmissions**

The LM1 can be configured to trigger transmissions of State Reports when Light Level changes are sensed due to UPB activity. These Automatic State Reports can be used to inform home automation controllers of the LM1's current Light Level.

### 7.2.1. Enabling Automatic State Reports

Automatic State Report Transmissions are enabled by setting bit#4 of the Dimmer Options Register (Figure 3). If Automatic State Report Transmissions are enabled the LM1 **shall** build and transmit a State Report message whenever a Light Level change has occurred.

### 7.2.2. 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 the LM1 is assigned. 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

Table 9 - LL is the current Light Level % (0x00 – 0x64) of the LM1 dimmer.



## **8. Factory Default Operation**

This section describes the operation of the LM1 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 4.3.5.

### **8.1. Power-Up Operation**

Upon power-up the LM1 will enter Normal Mode and will display its current firmware version by blinking its LED four times as described in section 5.6. It will then read the saved Reset Light Level from non-volatile memory and set its dimmer’s light level to the Reset Light Level at the Default Fade Rate (3.3 seconds). The LM1 will set its LED color to orange and await further events such as UPB Communication Packet Receptions.

### **8.2. Dimmer Operation**

The LM1 factory default is for dimming-capable whereby its dimmer can produce 200 different light levels as well as off that it fades between using a pseudo-logarithmic dimming curve. The LM1 factory default value for its Default Fade Rate is 3. With this value, the LM1 will span the lighting range from 0% to 100% in approximately 3.3 seconds. The Default Fade Rate is used whenever the specified Fade Rate is an illegal value (above 15).

### **8.3. UPB Communication Packet Receptions**

The LM1 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 LM1 also handles the set of UPB Commands described in Table 7.

## 8.4. UPB Receive Components

The LM1 has 16 Receive Components (called Presets) that are configured for receiving Link Packets addressed to its NID. The factory default Link IDs that the LM1 will accept are Link IDs #1 through #16 as shown in Table 10.

Receive Component	Link ID	Light Level	Fade Rate
Preset #1	001	100%	Default Fade Rate
Preset #2	002	0%	Default Fade Rate
Preset #3	003	80%	Default Fade Rate
Preset #4	004	60%	Default Fade Rate
Preset #5	005	40%	Default Fade Rate
Preset #6	006	20%	Default Fade Rate
Preset #7	007	100%	Default Fade Rate
Preset #8	008	100%	Default Fade Rate
Preset #9	009	100%	Default Fade Rate
Preset #10	010	100%	Default Fade Rate
Preset #11	011	100%	Default Fade Rate
Preset #12	012	100%	Default Fade Rate
Preset #13	013	100%	Default Fade Rate
Preset #14	014	100%	Default Fade Rate
Preset #15	015	100%	Default Fade Rate
Preset #16	016	100%	Default Fade Rate

Table 10: Factory Default Presets

## **8.5. Activate Link Command Operation**

The LM1 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 LM1 receives a Link Activate command addressed to its NID and one of these Link IDs it will set its dimmer output to the associated Light Level at the associated Fade Rate (see Table 10).

## **8.6. Deactivate Link Command Operation**

The LM1 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 LM1 receives a Link Deactivate command addressed to its NID and one of these Link IDs it will set its dimmer output to 0% (off) at the associated Fade Rate (see Table 10).

## **8.7. Changing Preset Light Levels**

The LM1 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 LM1 receives a Store State command addressed to its NID and one of these Link IDs it will store its current dimmer Light Level into the associated Light Level parameter of the Preset.

## **8.8. UPB Communication Packet Transmissions**

The LM1 will transmit UPB Communication Packets onto the powerline in response to various commands from the UPB Core Command Message Set (as described in the [UPB System Description](#) document). The LM1 factory default setting is for no Rocker Switch Transmissions.