

## **PLGLEMRV-10 User Manual**

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This guide applies to the following versions:

Hardware: **PLGLEMRV-10**

Software: **V1.0**

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## 1. OVERVIEW

### 1.1. Premier Lighting PLGLEMRV-10 electronic board - main components and functions

The PLGLEMRV-10 (PL - GLEM REV 1.0 schematics, Chapter 3/page 5) is an electronic device designed by Premier Lighting implementing the following circuits and functions:

- CPU Microchip PIC18FK20, FLASH/SRAM/ EEPROM memory
- RS232 serial communication interface for internal settings during code development
- JTAG interface for downloading the code
- Analog to digital signal conversion
- Digital I/Os
- Motion sensing circuit
- Day light harvesting circuit
- Step dimming circuit for LED-based lights
- Programmable timer
- Real-time power measurement
- RF communication - Micrel MICRF505 Transceiver, 902-928MHz, max output power 10dBm , max 38.4kbps data rate, -103dBm sensitivity,
- Onboard low power supply

The PLGLEMRV-10 is designed for controlling a wireless network of LED-based lights, photo below, produced by Premier Lighting, under an application code developed by Premier Lighting based on the Micrel's MicrelNet V4 reference design.

Typical LED-based light with PLGLEMRV-10 control is shown below.



### **1.2. RF chipset - Micrel MICRF505**

The MICRF505 is a true single-chip, frequency shift keying (FSK) transceiver intended for use in halfduplex, bidirectional RF links. The multi-channelled FSK transceiver is intended for UHF radio equipment in compliance with the North American Federal Communications Commission (FCC) part 15.247 and the European Telecommunication Standard Institute (ETSI) specification, EN300 220.

The transmitter consists of a PLL frequency synthesizer and power amplifier. The frequency synthesizer consists of a voltage-controlled oscillator (VCO), a crystal oscillator, dual modulus prescaler, programmable frequency dividers, and a phase detector.

The loop-filter is external for flexibility and can be a simple passive circuit. The output power of the power amplifier can be programmed to seven levels. A lock-detect circuit detects when the PLL is in lock. In receive mode, the PLL synthesizer generates the local oscillator (LO) signal. The N, M, and A values that give the LO frequency are stored in the N0, M0, and A0 registers.

The receiver is a zero intermediate frequency (IF) type which makes channel filtering possible with low power, integrated low-pass filters. The receiver consists of a low noise amplifier (LNA) that drives a quadrature mix pair. The mixer outputs feed two identical signal channels in phase quadrature. Each channel includes a pre-amplifier, a third order Sallen-Key RC low-pass filter that protects the following switched-capacitor filter from strong adjacent channel signals, and a limiter. The main channel filter is a switched-capacitor implementation of a six-pole elliptic low pass filter.

The I and Q channel outputs are demodulated and produce a digital data output. The demodulator detects the relative phase of the I and the Q channel signal. If the I channel signal lags behind the Q channel, the FSK tone frequency is above the LO frequency (data '1'). If the I channel leads the Q channel, the FSK tone is below the LO frequency (data '0'). The output of the receiver is available on the DataIXO pin. A receive signal strength indicator (RSSI) circuit indicates the received signal level.

### **1.3. PLGLEMRV-10 - RF network - RadioWire® MicrelNet™**

PLGLEMRV-10 implements the RadioWire MicrelNet™, a networking solution based upon a flexible multi-level star networking topology. It is fully scalable in all directions and can be configured to operate as a basic star network to a complex multilevel, multi cluster networking solution with repeater functionality. The MicrelNet™ is fully FCC part 15.247 compliant as a frequency 25 hopping channels.

An IP addressing scheme in MicrelNet allows for easily recognizable source address and destination address formatting the data packets. Software CRCs ensure data delivery. The MicrelNet code stack can run in 8 KBytes of memory on an 8-bit microcontroller.

MicrelNet stack operates in a cluster tree network, with one central Master capable of communicating with other masters and Slaves in a MicrelNet network. The Master is responsible for maintaining the link by transmitting timestamps every 4 seconds approximately. If Slave is reset or gets out of sync, it request a timestamp from Master. Stop-and-wait ARQ (packets being acknowledged or retransmitted) is implemented.

MicrelNet implements an automatic hopping between 25 frequencies to meet the FCC part15.247 regulations. The units will jump approximately 10 times per second.

There is an internal 3-byte (24bit) timer in both Master and Slaves units. The 3 bytes are called Timer\_Upper, Timer\_High and Timer\_Low. A Timer\_Low overflow generates an interrupt every 0.37ms with a 11.0592MHz crystal connected to the microcontroller. In the interrupt service routine, ISR, the Timer\_Upper and Timer\_High registers are updated.

Timer\_High overflows every  $256 \times 0.37\text{ms} = 94.8\text{msec}$ . This overflow is used to indicate “time-to-change-frequency”. A flag is set in ISR, the flag being tested in the main program. Whenever Timer\_High overflows, the Timer\_Upper is incremented.

When the main program detects time-to-change-frequency, it uses Timer\_Upper as an index in frequency/channel mapping table. The dwell time of hopping is 94.8 ms and each channel is used equally on average. The 25 channel frequencies are selected in a pseudo random order. An example of the order is:

{0,1,10,20,22,21,2,11,23,14,19,3,4,9,12,18,17,5,13,6,16,24,7,15,8} where Channel 0 is 904.25MHz and Channel 24 is 926.06MHz.

The receivers are matched to the transmitters to use the same hopping channel sequence. The receivers hop channels in synchronization with the transmitter’s signals. The near term distribution of hops appears random, the long term distribution appears evenly distributed over the hop set and sequential hop sets.

## **2. PLGLEMVR-10 RF TUNING**

There is no possibility to tune the RF circuit in the field. All the components, according to the PL- GLEM REV 1.0 – RF.pdf schematic are placed on board during the automated pick and place manufacturing process.

## **3. PLGLEMVR-10 ASSEMBLY – FCC / IC IDENTIFICATION LABELS**

The PLGLEMVR-10 and the lights are assembled, programmed and tested by Premier Lighting Ltd. Any field problem related to the lights is solved by replacing the problematic light with a new light. The troubleshooting and repair of the lights are done by qualified Premier’s personnel, only.

### **3.1. FCC and IC identification label – Modular transceiver**

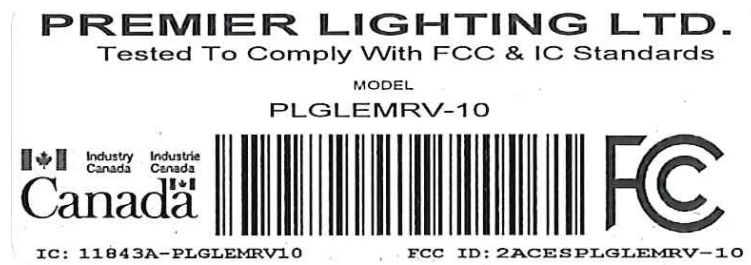
The modular transceiver must be labeled with its own FCC and IC identification number as shown below.

FCC ID: 2ACESPLGLEMVR-10

IC: 11843A-PLGLEMVR10

Model: PLGLEMVR-10 RF Module Label

The RF module box label will be printed on the outside of the module box that is mounted to the heat sink plate inside the full fixture. The label will be visible when the heat sink plate assembly is removed from the inside of the fixture housing.



Label specifications are:

Dimensions	Each side 2.625" wide x 1" high
Font	Arial, 4 to 7-point & Courier NEW, 4-point
Application	Avery white label, permanent-adhesive
Bar Code	Code 128 Auto, 0.355" Height, 0.008 density
Includes embedded FCC and IC logos	

### 3.2. External FCC and IC entification label

An exterior label specifying “Contains FCC ID and IC ID” has to be affixed to the light enclosure and be visible as shown below.

FCC ID: 2ACESPLGLEMRV-10

IC: 11843A-PLGLEMRV10

Model: VP81210 4X50LEDLL 120~277V label on outside of fixture, clearly stating “CONTAINS IC: 11843A-PLGLEMRV10” and “CONTAINS FCC ID: 2ACESPLGLEMRV-10”.

The model label will be printed on the outside of one end of the full fixture housing. The label will be visible from the ground when the fixture is installed on site.



Label specifications are:

Dimensions	Each side 2.625" wide x 1" high
Font	Arial, 4 to 7-point & Courier NEW, 3-point
Application	Avery white label, permanent-adhesive
Bar Code	Code 128 Auto, 0.315" Height, 0.003 density
Includes embedded FCC and IC logos	

#### **4. EMC COMPLIANCE**

##### **4.1. Regulatory Compliance - Transmitter**

###### **FCC Compliance Class B Digital Device**

This equipment **PLGLEMRV-10 (FCC ID: 2ACESPLGLEMRV-10)** has been tested and found to comply with the limits for a Class B digital device pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- 1) Reorient or relocate the receiving antenna.
- 2) Increase the separation between the equipment and receiver.
- 3) Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- 4) Consult the dealer or an experienced radio/TV technician for help.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

###### **FCC Declaration of Conformity**

This device **PLGLEMRV-10 (FCC ID: 2ACESPLGLEMRV-10)** complies with part 15 of the FCC rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

###### **Industry Canada Compliance**

The Premier Lighting Wireless Transmitter model PLGLEMRV-10 is certified with IC certification number **IC: 11843A-PLGLEMRV10**.

This device complies with Industry Canada license-exempt RSS standard(s)(RSS-210 Issue 8).

Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference received, including interference that may cause undesired operation of the device.

Cet appareil est conforme avec les normes de l'Industrie Canada-sans les standards RSS(s). L'utilisation est soumise aux deux conditions suivantes: (1) cet appareil ne peut pas provoquer d'interférences et (2) cet appareil doit accepter toute interférence, y compris les interférences qui peuvent causer un mauvais fonctionnement de l'appareil.



#### **4.2. Regulatory Compliance - Receiver**

##### **FCC Compliance Class B - Digital Device**

PLGLEMRV-10 (FCC ID: 2ACESPLGLEMRV-10) has been tested and found to comply with the limits for Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- 1) Reorient or relocate the receiving antenna.
  - 2) Increase the separation between the equipment and receiver.
  - 3) Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
  - 4) Consult the dealer or an experienced radio/TV technician for help.
- Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

##### **FCC Declaration of Conformity**

This device PLGLEMRV-10 (FCC ID: 2ACESPLGLEMRV-10) complies with part 15 of the FCC rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

##### **Industry Canada Compliance**

This device PLGLEMRV-10 complies with Industry Canada license-exempt RSS standard(s)(RSS-210 Issue 8).

Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference received, including interference that may cause undesired operation of the device.

Cet appareil PLGLEMRV-10 est conforme avec aux CNR d'Industrie Canada applicable aux appareils radio exempts de licence. L'utilisation est soumise aux deux conditions suivantes: (1) cet appareil ne peut pas provoquer d'interférences et (2) cet appareil doit accepter toute interférence, y compris les interférences qui peuvent causer un mauvais fonctionnement de l'appareil.