ModHopper® - Wireless Modbus/Pulse Transceiver
Cat. No. R9120

Installation and Operation Manual

WEB VERSION

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1 PRODUCT APPLICATION LIMITATION

• Leviton products are not intended for use in critical applications such as nuclear facilities, human implantable devices or life support. Leviton is not liable, in whole or in part, for any claims or damages arising from such uses.

• Leviton strongly believes in continuous improvement, therefore we must reserve the right to change specifications and product offerings without notice. Where possible, we will substitute products with equivalent functionality when necessary.

NOTICE
This product is not intended for life safety applications.
Do not install this product in hazardous or classified locations.
The installer is responsible for conformance to all applicable codes.

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2 FEATURES AND SPECIFICATIONS

The ModHopper wireless Modbus/pulse transceiver is designed to allow systems integrators the ability to communicate with remote locations while avoiding the costs associated with running low voltage wiring to multiple locations in a single or between multiple buildings. To meet these requirements, the ModHopper™ provides the installer with all the tools necessary to install and configure the hardware and software with a minimum of time and investment.

Applications

The R9120 wireless Modbus/pulse transceiver has several applications. These include:
• Energy monitoring.
• Solar PV power generation monitoring.
• Malls, office buildings, and other tenant energy monitoring applications.

Processor	60MHz Arm7 embedded CPU
LED	3 x RF, 2 x RS485, 2 x pulse, Alive, Alarm
Protocols	Modbus RTU
Addressing	Modbus address may be set from 1 to 247 via DIP switch. Included Class 2
Power Supply[1,3]	Power supply requires 100-240VAC, 50/60Hz 0.5A
	(power supply not included in models with -T option)
Inputs[2]	2 pulse inputs, dry contact
	Monitor consumption/rate/min/max
	Pulse rate/width user selectable to 10Hz, 50Hz, 100Hz, or 250Hz.
	Pulse rate option: 10Hz, minimum pulse width 50ms
	Pulse rate option: 50Hz, minimum pulse width 10ms
	Pulse rate option: 100Hz, minimum pulse width 5ms
	Pulse rate option: 250Hz, minimum pulse width 2ms
	Contact closure threshold 100Ω to 2.5kΩ user selectable
	Pulse count values are stored in non-volatile memory
Communications[1]	RS485 (+,-, S), 9600/19200 baud, N, 8, 1, two wire.
	Supports up to 32 external devices per ModHopper. (expandable)
RF	Frequency hopping, ISM band, see table below.
	North America: Temperature 0°– 50° c[3], 0 – 95% humidity, non-condensing.
Environmental[2]	Pollution Degree 2, altitude up to 2000M.
	For indoor and outdoor use when used in an appropriate enclosure.
	The R9120 must be mounted inside a NEMA rated electrical enclosure for safety and isolation requirements when used outdoors.
EMC	FCC (USA): Part 15.247, Class A
	IC (Canada): RSS-210
Size	6.5" x 4.5" x 2.0" (260mm x 64mm x 45mm)
Mass	1.25 lbs (0.67 kg)

Product specific features:	R9120-5 (extended range)
FCC ID	OUR-9XTEND or MCQ-XBPSX
IC (Industry Canada)	4214A-9XTEND or 1846A-XBPSX
Encryption	256 bit AES
Max Range (indoor/urban)	3000ft
RF:	900MHz, 1000mW
Power Input[3]	9-30VDC, 900mA

[1] Inputs are intended for low voltage Class 2 or inputs or outputs.
[2] if the product is used in a manner not specified by the manufacture, the protection provided by the equipment may be impaired.
[3] Not intended for use with rechargeable batteries

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3.1 Installation Checklist

A ModHopper system installation has the following components:

Required hardware
- Two or more ModHopper R9120 transceivers.

External Hardware
- RS485 Modbus master system such as an A8812 EMH™ or a Modbus compatible PLC.
- Optional: RS485/Modbus slave devices such as power meters or IO modules.
- Optional: Pulse output transducers for measuring gas, electricity, water, etc. from existing meters and sensors. Make sure to obtain the pulse output scale, or multiplier for each device you will be using.
- Low voltage wire for attaching pulse or Modbus devices to the R9120, typically 18-24 gauge

3.2 Model Information

Before proceeding with the installation, verify the hardware is Rev C. It is important to use the correct manual that matches the hardware being installed.
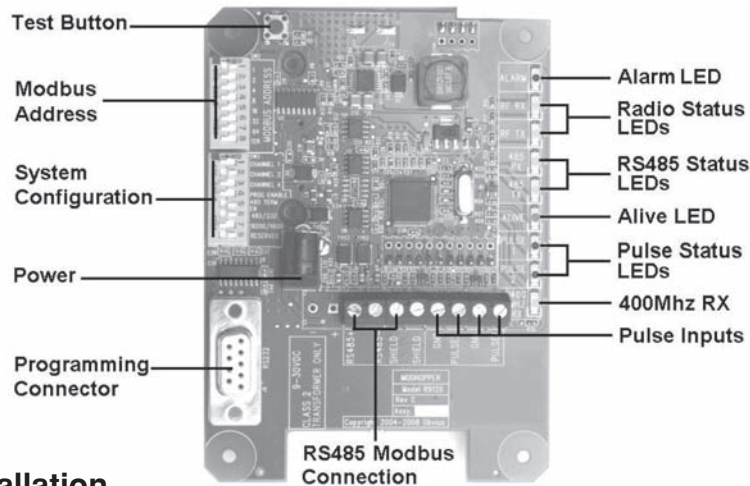


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MODHOPPER
Model R9120
Rev C
Assy.
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As per SIPCO LLC, this product may be used in a system and employ or practice certain features and/or methods of one or more of the following patents:

SIPCO, LLC
This product is covered by U.S. Patent No's: Patent No. 7,103,511, Patent No. 6,914,893, Patent No. 6,891,838, Patent No. 5,714,931, Patent No. 6,233,327, Patent No. 7,397,907, Patent No. 6,618,578, Patent No. 7,079,810, Patent No. 7,295,128, Patent No. 7,263,073, Patent No. 7,480,501, Patent No. 6,437,692, Patent No. 7,468,661, Patent No. 7,053,767, Patent No. 7,650,425, Patent No. 7,739,378

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Test Button — Alarm LED — Radio Status LEDs — RS485 Status LEDs — Alive LED — Pulse Status LEDs — 400Mhz RX — Pulse Inputs — Modbus Address — System Configuration — Power — Programming Connector — RS485 Modbus Connection

4.1 Hardware Installation

WARNING: TO AVOID DEATH OR INJURY, after wiring the ModHopper, remove all scraps of wire or foil shield from the electrical panel. This could be dangerous if wire scraps come into contact with high voltage wires.

4.1.1 Unpack materials; Remove all materials from shipping box and verify all required components are present.

4.1.2 Mount the ModHopper to a wall or inside the electrical enclosure if required. When mounting the ModHopper and the antenna inside an enclosure, a non-metallic enclosure will be required. Metal enclosures restrict RF communications. If a metal enclosure is required, use an external antenna and an RF antenna cable.

4.1.3 Connect the pulse output devices. For KYZ pulse output meters, attach the normally-open circuit to the ModHopper. These are usually the K and Z terminals.

4.1.4 Connect the RS485 Modbus network loop as shown in the wiring diagram. Follow the manufacturer's instructions for installing and powering other Modbus devices. Verify that the Modbus address settings are unique for each device (i.e., no two devices with the same address). Connect each device in the chain by "daisy-chaining" the devices together. Observe + and - polarity on the Modbus devices. For more information about Modbus loops, please read our Modbus FAQ available at www.Leviton.com.
Do not ground the RS485 shield inside an electrical panel. All RS485 and 24VDC power wires, including the shield should be insulated to prevent accidental contact to high voltage conductors.
The pulse, RS485 and power cable should be mechanically secured where it enters the electrical panel.
The wire used to provide pulse and RS485 communications should be insulated to meet the requirements of the voltages present whatever box in which the wire is mounted. For example, Belden™ 1120A has a 600V insulation rating and can be used in many applications. Check with your electrical installer for details as local code requirements may vary.

4.1.5 Attach the antenna to the ModHopper. When using an antenna cable, avoid sharp bends; kinks in the antenna cable will degrade performance.

4.1.6 Attach the power to the ModHopper and apply power. Observe the LEDs to confirm the device is operating.
- Alive (green): blinks once per second while the system is operating correctly.
- RS485 RX: The RX led should blink whenever a modbus query is sent on the RS485 loop. (regardless of the target address of the query). If the ModHopper is attached to an EMH, the RX led should blink about once per second.
- RS485 TX: The TX LED will blink when the R9120 responds to a modbus query.

Note: If cleaning is required, use a dry towel to remove dust from the ModHopper.
CAUTION: Do not use fluids to clean the ModHopper.

5.1 Modbus Address

Before the ModHopper can be used, you must set the Modbus address of the ModHopper. This address must be unique among all Modbus devices in the system including all devices that are connected on remote wireless links. Address 0 (all switches off) is not allowed.

Select an address, and set the DIP switches to match.

The sum of the value of the switches is the address. In the example to the right, address 52 is set by placing switch 4, 16 and 32 to the on position. Note: 4 + 16 + 32 = 52
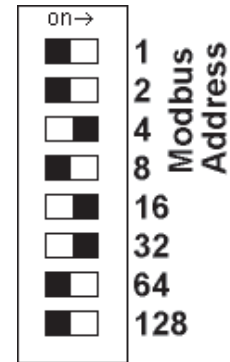
5.2 System Setting

For most systems, set all of the system switches to the "off" position.

Radio channel: This option selects the channel number that can be used to isolate a group of ModHoppers. This option may be set for channels 0 to 6. Channel 7 (all 3 switches on) is not allowed.

Programming: Set the "Prog Enable" to Off for normal operation.

485 Termination Enable: Set the "485 Term En" to ON to enable a 120 ohm termination resistor on the RS485 network. This should be used when the ModHopper is on the end of a 485 wiring run. Set this switch to OFF when the ModHopper is in the middle of an RS485 wiring run.

Port RS232 or RS485: Set the switch to the "off" position for RS485 operation. The ModHopper can communicate via the RS232 connection however most Modbus devices will need 485 terminals.

Baud Rate: This option sets the serial port speed for the Modbus devices connected to the ModHopper. Set this option to "off" for 19200. Set the switch to "on" for 9600 baud.

Reserved: Set this option to Off.
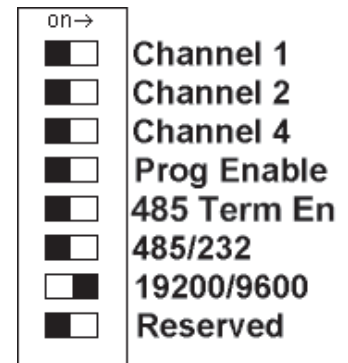
5.3 Status LEDs

The device should power up and be ready in a few seconds. The LEDs should blink in the following manner.

- The "Alive" LED should start to blink about once per second.
- The Alarm LED will blink when transmission errors occur.
- The RF TX/RX LEDs will blink when the radio is receiving or transmitting data.
- The RS485 LEDs will blink for local Modbus activity.
- The Pulse input LEDs will light when the corresponding pulse input terminals are closed.
- If the device has the -SN option, the 400MHz LED will blink when an RF packet from a 400MHz sensor transmitter is received.
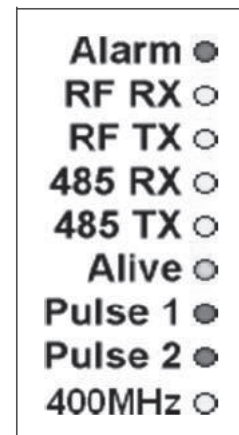
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5.4 Signal Strength Test

When the ModHopper is operating, the Test Button can be used to report the signal strength received by the ModHopper from another unit.

Press and hold down the test button. The status LEDs will light up as a bar graph display. Each LED is approximately 10% of scale. For example if PULSE 1 and 2 are on, the received strength is approximately 20% to 29%.

For useful signal reporting, it is important to turn off all but one other ModHopper. When reporting the signal strength, the most recent wireless transmission received is displayed. If two ModHoppers are transmitting, the display will only show the most recently received packet, and the user will not be able to determine which ModHopper the signal strength being reported.

Note: the normal operation of the ModHopper is suspended while the test button is pressed. Modbus communications and wireless transmissions are not processed.

5.5 Monitoring usage

The ModHopper has several data points that may be read using the Modbus protocol.

For each of the two pulse inputs, the ModHopper reports a value for consumption and rate. Rate fields are provided for the average rate during the log period (block demand), the instantaneous rate, and the min/max instantaneous rate observed during the log period. The pulse counts for each input are stored in non-volatile memory to preserve the count when power is removed. For more information on the specific Modbus registers used for the pulse inputs, refer to the Modbus register section of this manual.

When configuring a Modbus Master such as a PLC, TCP Gateway, or computer software, you must increase the timeout on the RS485 port of your system. The ModHopper adds about 500mS of delay per hop. In a complex system with multiple ModHoppers, a 1 to 2 second round trip time is not uncommon.

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5.6 EMH Data Display Page

When using the ModHopper with the EMH data acquisition server, the EMH will read the pulse input data from the ModHopper and provide configuration menus for all of the ModHopper options.

The EMH will display will report all the data values present on the ModHopper. In addition, the instantaneous min/max rate values will be cleared after each logging interval. Click the Configure button to set up pulse input names, unit of measure and multipliers as needed.

5.7 EMH Advanced Configuration Options

The EMH setup and configuration page includes an advanced configuration page to set all of the ModHopper features with a convenient web page interface.
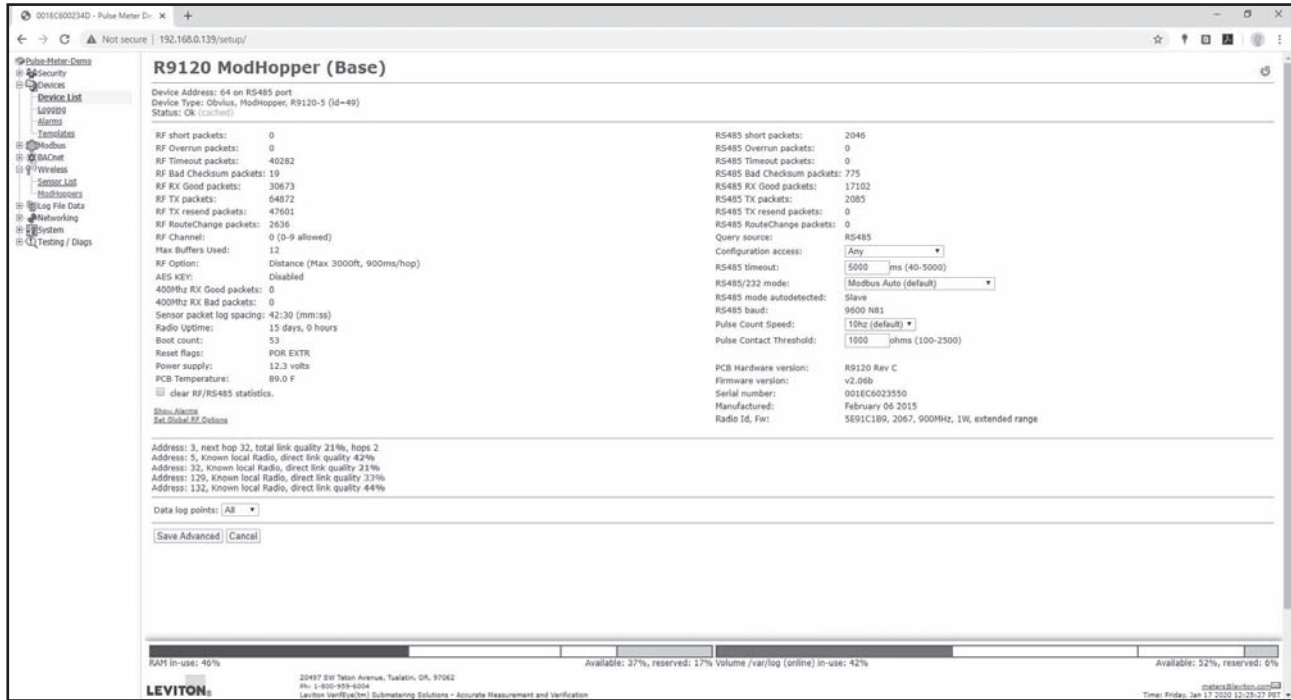
In this setup page, there are several options available.

- Serial port timeout, and protocol configuration. When a request comes in over the wireless mesh network and is sent out on the ModHopper RS485 serial port, the ModHopper must wait for the attached Modbus device to reply to the query. The timeout option controls how long the ModHopper will wait before giving up on the attached Modbus device and discarding the query. Most Modbus devices will respond in 150ms or less.

- Pulse input contact closure threshold: allows you to set a maximum resistance to be counted as a "closed" contact. This is helpful when using intrinsic barrier devices. Default of 500 ohms will work in most applications.

- Pulse input maximum count frequency. For most pulse meters, 10Hz is adequate. Faster counting of mechanical relays may result in "relay bounce" and give an incorrect count. Consult the pulse output device for information on maximum expected pulse output rate.

- Data log control: enable/disable EMH data logging for the ModHopper. Note: this is an internal EMH feature, and does not set any registers on the ModHopper.

In addition to the configuration options, some further details about the ModHopper are provided. These include the serial number, firmware version, uptime, RF/RS485 packet counters, and internal temperature and power supply monitor. For further information configuration and status registers, refer to the Modbus section in this manual.

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5.8 EMH route mapping display

The EMH data acquisition server has additional diagnostic features that assist with ModHopper deployments. The most useful is the ModHopper route map. Select the ModHoppers menu from the Wireless section in the EMH menu tree as shown below.
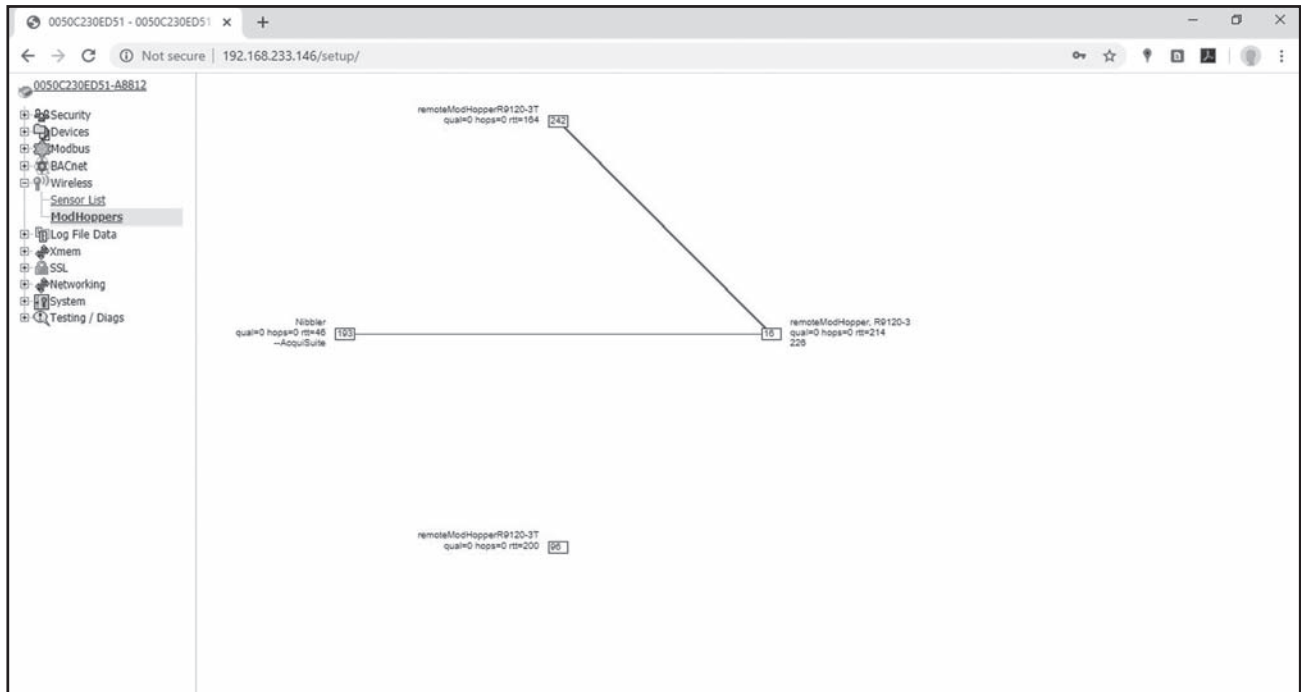
The graph will draw a blue box for each ModHopper that is attached to the system. The blue number inside the box icon is the Modbus address of the ModHopper. To the side of each icon, three lines of information will be shown.

•   The device list name will be shown to the side of each ModHopper icon

•   The link quality, hops and round trip time (rtt) will be printed under the ModHopper name.

•   A list of attached Modbus device addresses will be shown on the third line. This is a list of addresses that the ModHopper has automatically detected on the local RS485 port.

The graph will print strong links in thick green lines. Lines progress from green to yellow to red to indicate weak links.

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6 MODBUS REGISTERS

6.1 Supported Modbus Functions

The R9120 device responds to the following Modbus query functions:

0x11   Report slave ID.

0x03   read holding registers (multiple)

0x06   preset single register

These should be sufficient to perform all operations (read many values, make single change, and identify). In addition the device will respond to with Modbus exceptions for invalid function, value, and register if out of bound requests are made.

Modbus function 0x11 Slave ID function will respond with
ID=49 and one of the following ID text values: "Leviton, ModHopper, R9120-5"

6.2 Modbus Register List

All modbus registers are read-only unless otherwise noted.

```
Data points:

offset   point   type    desc
-------  ------- ------- ------------------

0        40001   UINT32  (N/V) pulse count 1 MSW
1        40002   UINT32  (N/V) pulse count 1 LSW
2        40003   UINT32  (N/V) pulse count 2 MSW
3        40004   UINT32  (N/V) pulse count 2 LSW  (same format as pulse count 1)
4        40005   UINT16  inst pulse 1 time (seconds)
5        40006   UINT16  inst pulse 2 time (seconds)
6        40007   UINT16  (R/W) min pulse 1 time (seconds) (write clears min/max)
7        40008   UINT16  (R/W) min pulse 2 time (seconds)
8        40009   UINT16  (R/W) max pulse 1 time (seconds)
9        40010   UINT16  (R/W) max pulse 2 time (seconds)
10       40011   UINT16  (R/W, N/V) inst pulse count size. (default 5)

100      40101   UINT16  Serial Number (bytes 1,2) (serial number)
101      40102   UINT16  Serial Number (bytes 3,4)
102      40103   UINT16  Serial Number (bytes 5,6)
103      40104   UINT16  firmware version (e.g. v1.03, high byte=major,
                           lowbyte=minor, 0x8000 flag set for Beta)
104      40105   UINT16  boot count
105      40106   UINT32  mfg date MSW
106      40107   UINT32  mfg date LSW
107      40108   UINT16  radio group id setting (0-6)
108      40109   UINT16  alarm flags  (0x01 = boot from watchdog)
109      40110   UINT16  max packet buffers used.
110      40111   UINT32  Radio up time (seconds) MSW
111      40112   UINT32  Radio up time (seconds) LSW
112      40113   UINT16  RF short packets. write 0 to clear stat counters.
                         (R/W firmware 1.17 or later)
113      40114   UINT16  RS485 short packets
114      40115   UINT16  RF Overrun packets
115      40116   UINT16  RS485 Overrun packets
116      40117   UINT16  RF Timeout packets
117      40118   UINT16  RS485 Timeout packets
offset   point   type    desc
-------  ------- ------- ------------------
118      40119   UINT16  RF BadChecksum packets
119      40120   UINT16  RS485 BadChecksum packets
120      40121   UINT16  RF RX Good packets
121      40122   UINT16  RS485 RX Good packets
122      40123   UINT16  RF TX packets
123      40124   UINT16  RS485 T Good packets
124      40125   UINT16  RF TX resend packets
125      40126   UINT16  RS485 TX resend packets
```

```
126     40127   UINT16   RF RouteChange packets
127     40128   UINT16   RS485 RouteChange packets
128     40129   UINT16   Number of known nodes. (including ourselves)
129     40130   UINT16   Our modbus address
130     40131   UINT16   R9120 Hardware Version (0=rev-A, 1=rev-B, etc)
131     40132   UINT16   Model number    bytes 1,2 (4 registers = 8 char string)
132     40133   UINT16   Model number    bytes 3,4 (4 registers = 8 char string)
133     40134   UINT16   Model number    bytes 5,6 (4 registers = 8 char string)
134     40135   UINT16   Model number    bytes 7,8 (4 registers = 8 char string)
135     40136   UINT16   Radio Serial MSW
136     40137   UINT16   Radio Serial LSW
137     40138   UINT16   Radio Firmware
138     40139   UINT16   Radio Type 1=R9120-1(lowpower), 2=R9120-3(highpower)
                           0=unknown)

139     40140   UINT16   (R/W) Modbus 485 timeout in ms. Default 240ms range 40max
                           to 2000ms. Affects modhopper in master mode only.
                           (max 5000ms in v1.17)

140     40141   UINT16   (R/W) Pulse KYZ flag bitmap.  0x01 = pulse1 kyz mode,
                           0x02 = p2, etc.

141     40142   UINT16   Reserved

142     40143   UINT16   (R/W) RS485 force master/slave modes. 0=auto/default,
                           1=force-master, 2=force-slave. (firmware 1.17 or later)

143     40144   UINT16   RS485 master/slave mode status.  0=master, 1=slave.
                           (firmware 1.17 or later)

144     40145   UINT16   RS485 baud rate.  2=9600, 3=19200.  (firmware 1.17 or
                           later)

145     40146   UINT16   (R/W) contact closure threshold. in ohms.  100-2550 ohms
                           allowed. (rev-c only, firmware 2.02 or later)

146     40147   UINT16   (R/W) contact closure speed, pulse speed: 0=10Hz/default,
                           1=50Hz, 2=100Hz, 3=250Hz  (firmware 2.02 or later)

147     40148   UINT16   power supply voltage monitor (rev-c only) scale: x100

148     40149   UINT16   pcb temperature monitor        (rev-c only) scale: x100

149     40150   UINT16   400MHz RX Good packet count  (rev-c only)

150     40151   UINT16   400MHz RX Bad packet count   (rev-c only)

151     40152   UINT16   (R/W) minimum packet time, how frequent to save sensor data
                           packets.  (10-2550 seconds)  (firmware 2.02 or later)

153     40154   UINT16   Radio RF speed mode (0=distance, 1=speed)
                           (rev-c, -5 modhopper only, fw 2.05 or later )

154     40155   UINT16   Reserved

155     40156   UINT16   (R/W) preference lock.  0=unlocked, 1=locked.  when locked,
                           preferences can be changed from 485 port only.
                           (firmware 2.05 or later)

156     40157   UINT16   AES Encryption key present.
                           0=not available, 1=not-active,  2=key-active/256bit.
                           (firmware 2.05 or later, -5 modhopper only)

157     40158   UINT16   Max allowed software RF channel setting.  0=not available.
                           (firmware 2.06 or later)

712     40713   UINT16   bitmap of known radios (16 registers) LSB, MSB order.
                                 bit0=n/a, bit1=addr1, etc.
```

6 MODBUS REGISTERS

6.3 Register Functions

Pulse Count: The pulse count is stored as an unsigned 32bit integer. This allows for 2^32 pulses (4.2 billion) to be counted before rollover. On Modbus systems that do not allow you to read 32 bit values, you can calculate the pulse count as follows:

count = (MSW * 65536) + LSW
or
count = (MSW << 16) | LSW   [bit shift high order word by 16 bits and x or against low order word]

Pulse count registers accumulate a total number of pulses received on each pulse input. The pulse count totals always increment and cannot be cleared or set to an arbitrary value to prevent tampering. All pulse count totals are stored in non-volatile memory to preserve counts during power failure. The unsigned 32 bit counter values can accumulate up to 4.29 billion (2^32) pulses before rollover.

All 32 bit data point values are encoded in 2 Modbus registers (16 bits each). Modbus master systems should always query the A8332 using a single query to read an entire block of registers. Never use two queries to read one register and then combine the two results into a single 32 bit value. Doing so will allow the pulse count to increment in the middle of the two Modbus queries, and will cause intermittent data readings that are incorrect.

For example, a pulse input has a count of 65534. This is represented as a 32 bit hex number 0x0000FFFE. The first 4 digits are the MSW register, the second 4 digits are the LSW register. The Modbus Master reads the first (MSW) register and gets 0x0000. In between the two readings, the pulse input counts 2 more pulses, making the total 65536 or 0x00010000 in hex. Next the Master reads the second (LSW) register and gets 0x0000. When the two registers are combined, the result is 0x00000000. The proper way to handle this situation is to simply read both registers in a single Modbus query.

Instantaneous Pulse Rate: The pulse rate values for instantaneous, min and max rates are calculated based on the time between arriving pulses. For example, if InstPulse1 = 30, and inst pulse count size is 5, then the average rate for the last 5 pulses is 6 seconds per pulse. To convert the register values (in seconds) to a rate value, use the following formula.

RatePerHour = (N * 60 * 60 / Inst_Register)

Where InstRegister is any of the 6 register values 4 through 9. N is the instantaneous pulse count size at offset 10.

Min/Max pulse rate: These 4 registers are calculated from the instantaneous pulse rate. These latching registers are updated whenever the minimum or maximum rate fields are exceeded by the instantaneous rate. These 4 registers may be cleared by writing a zero to the register. Writing to one min/max register clears all four min/max registers.

7 MECHANICAL DRAWINGS

7.1 The R9120 must be wall mounted, or mounted inside an appropriate enclosure rated for the weather, location, and electrical components located inside it. The R9120 mounting holes are detailed below.

R9120 ModHopper Footprint

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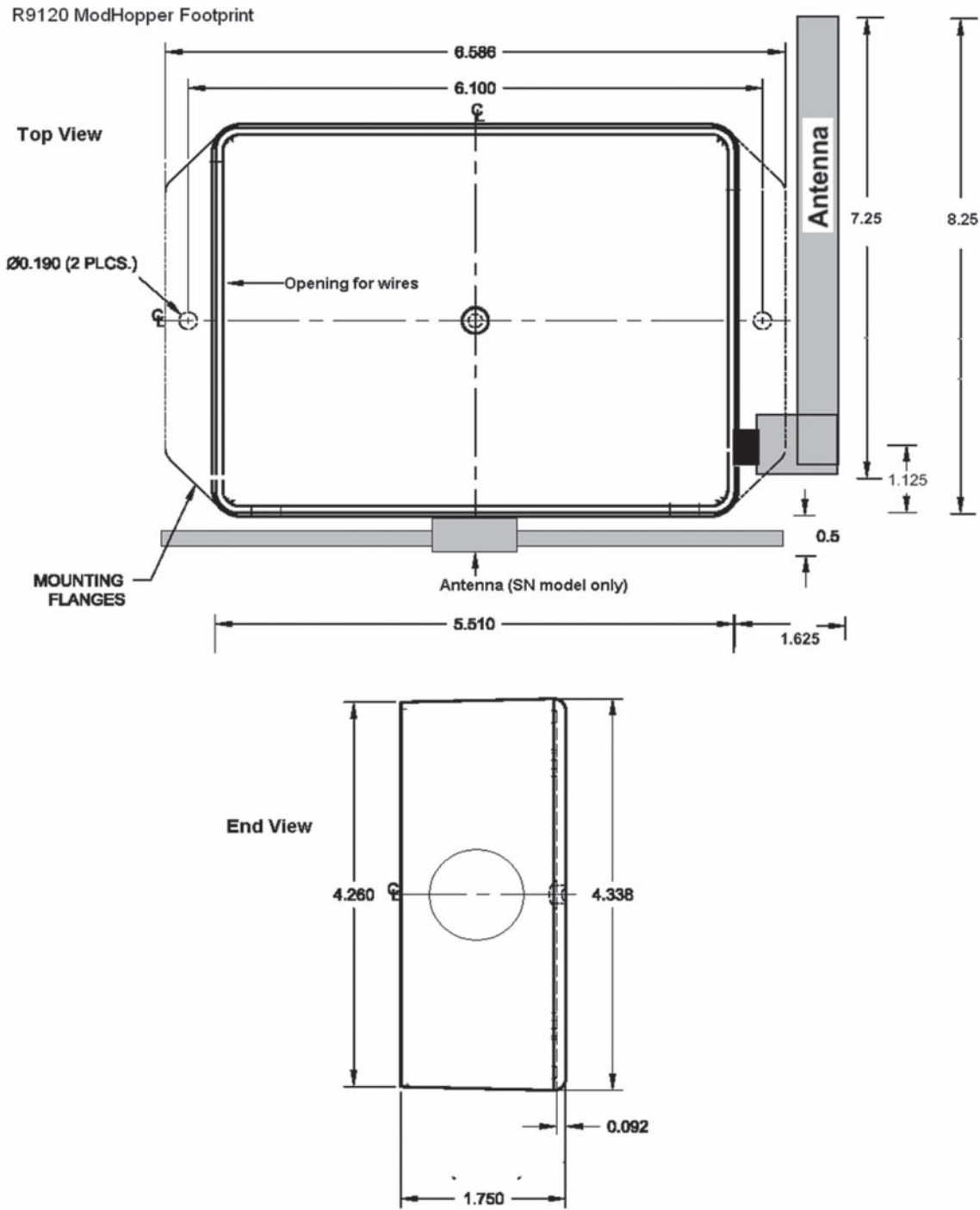
8 WARRANTY AND CONTACT INFORMATION

FCC STATEMENT:

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

Any changes or modifications not expressly approved by Leviton Manufacturing Co., could void the user's authority to operate the equipment

TRADEMARK DISCLAIMER:

Use herein of third party trademarks, service marks, trade names, brand names and/or product names are for informational purposes only, are/may be the trademarks of their respective owners; such use is not meant to imply affiliation, sponsorship, or endorsement. Modbus is a U.S. registered trademark of Schneider Electric USA, Inc. The Leviton logo is a registered trademark of Leviton Manufacturing Co., Inc. Modhopper is a registered trademark of Obvius, LLC.

FCC SUPPLIERS DECLARATION OF CONFORMITY:

Model R9120 manufactured by Obvius Holdings, LLC, 20497 SW Teton Avenue, Tualatin, OR 97062, www.obvius.com. This device 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.

IC STATEMENT:

This device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Leviton Manufacturing Co., Inc.

201 North Service Road, Melville, NY 11747

Visit Leviton's Web site at www.leviton.com

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Specifications and price subject to change at any time without notice.

FOR CANADA ONLY

For warranty information and/or product returns, residents of Canada should contact Leviton in writing at **Leviton Manufacturing of Canada ULC** to the attention of the **Quality Assurance Department, 165 Hymus Blvd, Pointe-Claire (Quebec), Canada H9R 1E9 or by telephone at 1 800 405-5320.**

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(Canada Only) www.leviton.com**

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