LN Series Wireless Solution Guide

Technical Bulletin

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Johnson Controls

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Introduction

The LN Series controller product line offers an innovative line of wireless battery-less sensors and switches intended for use with the LN Series wireless-option controllers. The sensors and switches provide you with the freedom and convenience to place and move them anywhere within the receiver limits without worrying about wiring, drilling, or disrupting the visual look of their space.

The wireless battery-less sensors and switches harvest the smallest amount of energy from a variety of sources. Most sensors use the light sources within the building, through solar cells. The solar cells require only 4 hours a day of charging to operate in total darkness for over 20 hours. This helps reduce operational energy and maintenance costs. If necessary, you can use batteries as a backup. Battery lifetime varies from 5 to 10 years depending on the component aging and self-discharge of the used battery. Switches are powered by the actual pushing of the button switch, known as a motion converter.

Energy Harvesting

Energy harvesting is the process of procuring small amounts of energy from various sources for conversion to a power or energy source. This process of energy conversion can take place in the form of motion conversion, solar conversion, thermal conversion, rotation conversion, and vibration conversion.

Most of the LN Series sensors use solar conversion through small solar cells. These solar cells use light absorbed from the sun and indoor lights. Light switches use motion conversion through an electrodynamic energy converter.

Mounting Considerations

Mounting considerations are different for *Radio Transmissions Range* and *Solar Energy Storage*. Both options are discussed in the following sections.

Radio Transmissions Range

When you install wireless equipment, ensure the distances and obstructions do not impede transmission.

In best conditions, where there are no obstructions creating screening, a radio signal is transmitted in a 20 meters (65 feet) range for the 868.3 MHz and a maximum 10 meters (32 feet) for the 316 MHz, between the Transmitter (Tx) and the Receiver (Rx).

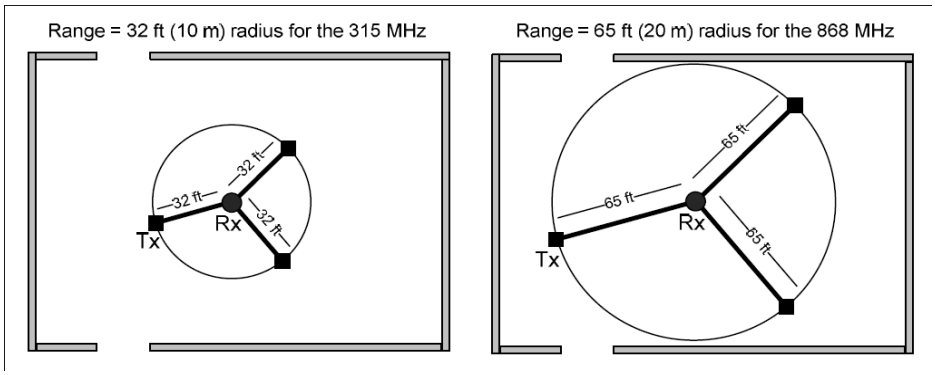

Figure 1: Transmitter and Receiver Distance

To obtain the best radio signal, avoid the following mounting and installation factors that restrict transmissions range:

- Receiver mounted on a massive wall or inside metal enclosures
- Receiver or sensor mounted next to walls with metal structures
- Receiver placed next to a room corner
- Receiver or sensor installed on a metal junction box or metal mounting plate. If this installation cannot be avoided, then make sure the receiver's antenna is straightened out and away from metal (at least 1 inch [2.5 centimeters] away).
- Switch or sensor mounted on a metal surface or structure (up to 30% loss of transmission range) or metal stud (at least 4 inches from stud)
- Range along a narrow floor

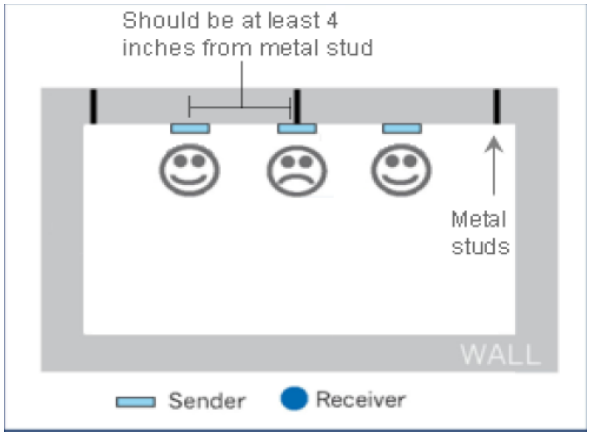

Figure 2: Avoid Placing Sensor Directly on Metal Studs

Radio signals are electromagnetic waves; hence the further they travel, the weaker the signal becomes and the range is limited. The coverage is further decreased by specific materials found in the direction of the transmission. For example, while radio waves can penetrate a wall, they are dampened more than if the waves were on a direct-line-of-sight (LoS) path (Table 1).

Table 1: Types of Wireless Range Reducers

Material	Range Reduction vs. LoS
Uncoated, without metal (wood, drywall, glass)	0 - 10%
Brick, particle board	5 - 35%
Metal, ferro concrete, mirrors	10 - 90%

Signal Transmission Quality Testing

To ensure that the actual signal transmission quality is acceptable, we strongly advise you to check the signal quality using a field strength meter such as the EPM 300 (868 MHz) or EPM 300C (315 MHz) field strength meter. This meter unit tests the actual transmission strength and quality of the received data.

Field strength tests are ideally conducted with two installers (one sending a signal from a transmitter, such as a light switch, and one receiving the signal with the EPM 300/C). However, the EPM 300/C can also be set to hold a received signal so that a single installer can send a signal and then go to the EPM 300/C and check if it was received. Ideally, installers use a pair of EPM 300/C to take advantage of their repeater and radio link test modes.

Radio Signal Screening

Massive objects made of metal reflect electromagnetic waves and create what is known as a radio shadow. Therefore, when installing the wireless equipment, it is important to ensure that distances and obstructions do not impede transmissions.

Metallic obstructions such as wall reinforcements, machinery, and metal office furniture (large filing cabinets) are major sources of field strength reduction, but small metal studs on a gypsum dry wall do not show a recognizable screening. Furthermore, fire-safety walls, elevator shafts, stairwells, and supply areas should be considered as complete transmission screens.

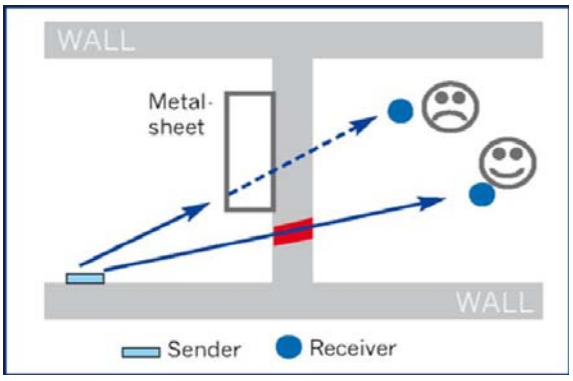

Figure 3: Screening of Radio Wave (Metallic Parts)

In addition, the angle at which the transmission travels through the obstructions has a major influence on the field strength. The steeper the angle through an obstruction, the more the field strength dampens. Therefore, we recommend that you arrange the transmission so that it travels straight and perpendicularly through the obstruction.

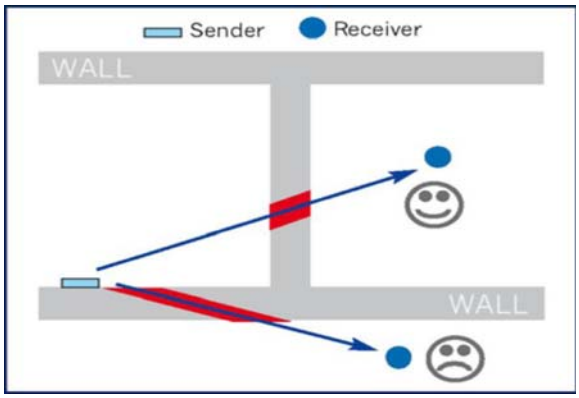

Figure 4: Penetration Angle of Radio Wave

Important objects and factors that decrease or constrain coverage, include:

- metal separation walls or hollow, lightweight walls filled with insulating wool on metal foil
- false ceilings with panels made of metal or carbon fiber
- steel furniture, lead glass or glass with metal coating (typically not used indoors)
- switches mounted on metal surfaces (typically 30% loss of range)
- metallic switch frames (typically 30% loss of range)

The wireless receiver should not be installed on the same side of the wall as the transmitter. Near a wall, the radio waves are likely to be subject to interfering dispersions or reflections. The position of the wireless receiver has to be on the opposite or connecting wall and in the central location of the room. Where possible, the receiver antenna should be at least 4 inches (10 centimeters) away from the wall corner or concrete ceiling.

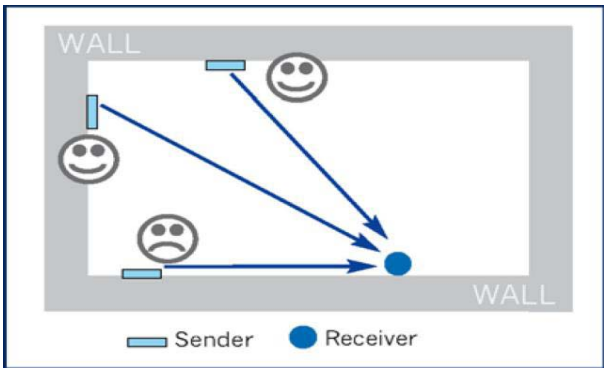

Figure 5: Radio Wave Along Wall

Unrelated transmitters that emit high-frequency signals, such as computers, audio, and video equipment, should be more than 0.5 meters (2 feet) from the receiver to avoid possible interference.

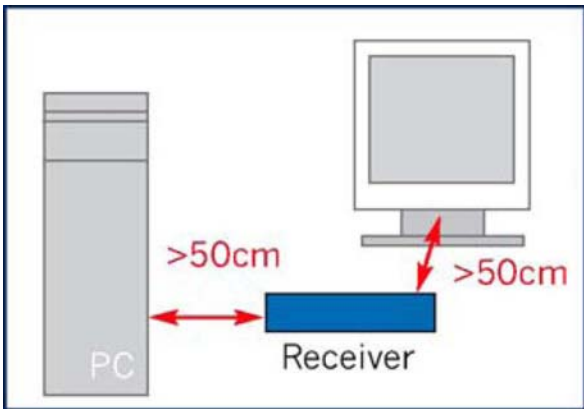

Figure 6: Distance to Interference Sources

We also recommend that you avoid placing a wireless receiver and sensor directly below or on top of each other. For example, if a wireless receiver is placed in the ceiling, then the sensor should not be placed on the wall just below the ceiling, on the same vertical axis as the receiver. The sensor or the receiver should be relocated to obtain a better transmission range.

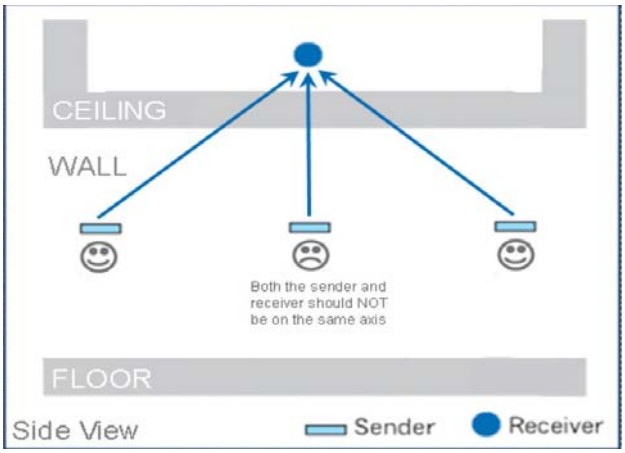

Figure 7: Wireless Receiver Ceiling Installation

Repeaters

Repeaters are wireless devices that help deal with screening and poor reception. A repeater receives transmissions and resends an amplified transmission to the receiver. This way, the transmission range can be increased and obstacles can be bypassed. Repeaters do not require any configuration and are operational by connecting them to the supply voltage.

Repeaters help transmit refreshed signals to enhance range and reliability. They are used to route around obstructions or interference, and act as range extensions that use the radio frequency (RF) network to send information at longer distances between a transmitter and receiver.

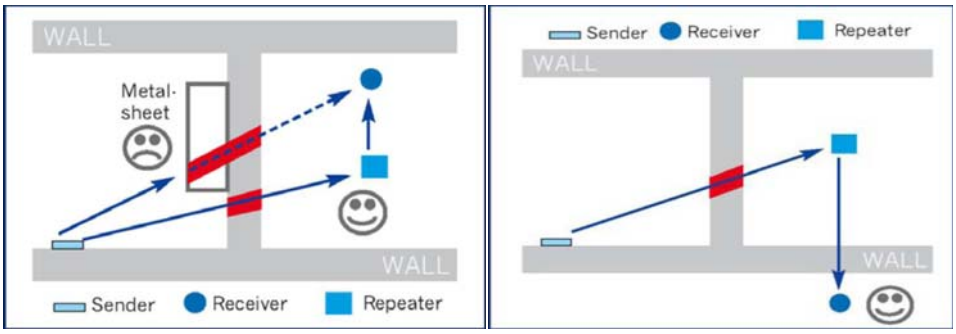

Figure 8: Use of Repeaters

In a setting where a metallic object needs to be bypassed, such as in an elevator shaft, or stairwell, mounting an additional repeater at a suited location can easily provide a better radio signal coverage.

IMPORTANT: Avoid metallic obstructions when setting up your wireless system; for example, elevator shafts, electric riser, and metal enclosures. Metallic obstructions are major obstacles for wireless communication

Solar Energy Storage

Wireless sensors enabled with solar cells use energy converted from natural and artificial light for their daily operation. All sensors store energy so they can continue to operate in the absence of sufficient light. Due to energy-optimized wireless technology, our wireless devices use a solar cell to supply the necessary energy to operate. To meet special requirements concerning correct and sufficient ambient brightness, it is necessary to observe basic conditions when selecting the mounting location:

- a minimum illumination of 200lx available to the sensor for at least 4 hours everyday with artificial fluorescent lighting or for at least 3 hours everyday with natural sunlight. Otherwise, a minimum illumination of 260lx available to the sensor for at least 3 hours everyday with artificial fluorescent lighting. See Table 6 for typical brightness levels within different establishments.
- total illumination does not exceed 1000lx for long periods
- the angle of incidence relative to the solar cell is not too steep when illuminating the sensor with direct artificial light such as spotlights
- avoid placing the sensor under direct sunlight so you do not receive inaccurate temperature measurements
- mount the sensor in an obstruction-free area while keeping the use of the room and within reception range of controller
- an increase in the sending rate of the wireless device requires more energy and illumination

Solar Energy Charging Guidelines

When solar energy devices are stored in darkness for a long period of time, the solar-powered energy storage drains. You must fully charge the device prior to use. Generally you may fully charge the device in a single day or you may begin immediate operation. If you begin immediate operation, ensure the environment has light at least 7 hours per day at 200 brightness level (lx) for 3 consecutive days. After the device is charged, it only requires light exposure for 4 hours at 200lx.

Note: The device may take between 30-60 minutes before it is able to transmit the first signal if you begin immediate operation.

After you initially charge the wireless sensor, it is ready for use. The sensor should be exposed to a minimum of 4 hours of light at 200lx daily. The minimum exposure allows the device to operate for the next 72 hours in the dark.

Note: If you do not expose the wireless sensor to the minimum light requirements, it may result in the wireless sensor to completely discharge. If the wireless sensor completely discharges it disables the wireless sensor's ability to continuously operate the controller.

For locations where the minimum daily exposure is not always ensured, use a 3.6 V Lithium battery (3.6 V SAFT® Type LS 14250, 1/2 AA) to maintain constant communication between the sensor and the controller. This battery only acts as a backup power source if the sensor discharges while operating in the absence of light. Table 2 describes the wireless sensor approximate initial full-charging time.

Table 2: Wireless Sensor Approximate Full-Charging Time

Number of Continuous Hours	Brightness Level (lx)
18	200lx
11	300lx
9	400lx
7	600lx
5	800lx

Installation Instructions

The wireless receiver can be mounted on a ceiling or wall using screws or double-sided tape, or on a metal enclosure using a 1/2-inch NPT hub. Whichever method is used, the wireless receiver should not be 16 inches (41 centimeters) or more away from the controller or any network communications cables.

Wall Mounting with Tape

Wall mounting is accomplished by fastening the sensor base plate to a flat wall surface with the included adhesive double-sided tape. Apply the tape to the back of the receiver first and then stick the receiver to the desired mounting area.

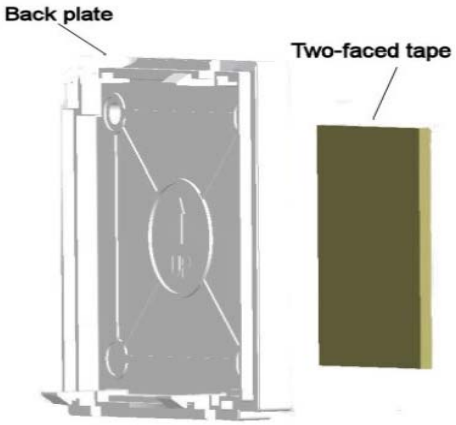

Figure 9: Mounting Using Double-Sided Tape

Wall Mounting with Screws

1. Open the receiver by separating the front and back plates.
2. Use the mounting holes on the back plate to mark the location of the holes to be drilled.
3. Remove the back plate and the drill holes.
4. Clean the newly drilled holes, insert wall anchors, and then fasten the back plate with screws.
5. Reattach the receiver to the back plate.

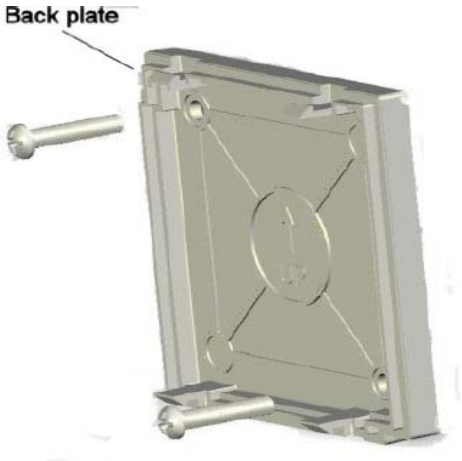

Figure 10: Mounting Using Wall Screws

Metal Enclosure Mounting

If the receiver is to be mounted on a metal enclosure, then a 1/2-inch NPT hub can be used. The 1/2-inch NPT hub is composed of three parts (Figure 11):

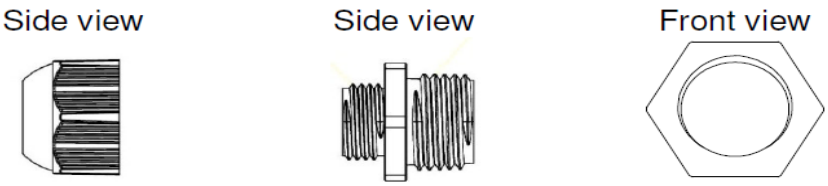

Figure 11: NPT Hub Pieces

To mount the receiver on a metal enclosure:

1. Affix the NPT hub to the bottom of the wireless receiver. Ensure the cap of the NPT is undone.
2. Place the wireless receiver on the enclosure, aligning the NPT hub with the enclosure's hole.
3. Using the cap, tighten the wireless receiver to the enclosure.

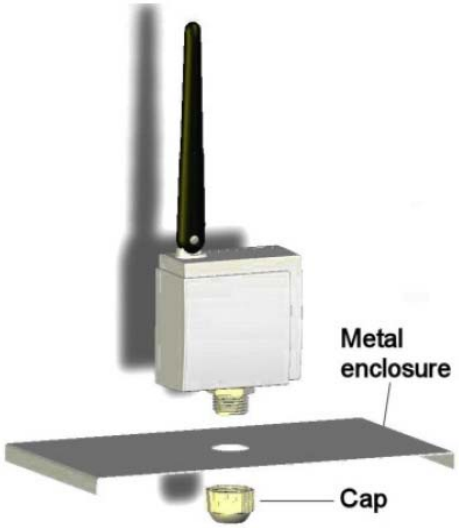

Figure 12: Mounting on a Metal Enclosure

Connecting the Wireless Receiver

After mounting, the wireless receiver should be connected to the controller's wireless port with the supplied 6.5-foot (2-meter) cable.

IMPORTANT: Do not substitute with a cable from other sources. This cable cannot be made any longer and must not be modified.

The wireless receiver's socket is located inside the device. To locate it, open the wireless receiver by separating its front and back plates.

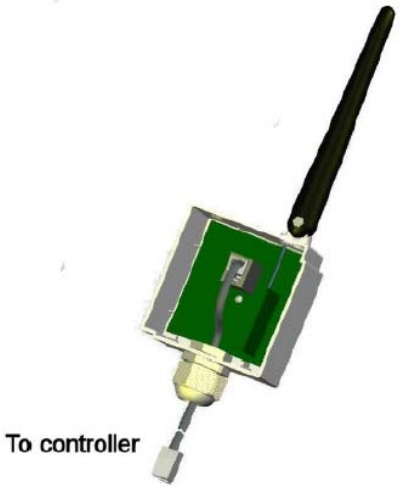

Figure 13: Socket Location

Wireless-Option Wireless Receivers

Table 3 lists the two LN Series wireless-option wireless receivers.

Table 3: Wireless Receivers

Receiver Model	Description
LN-WMOD868-0	Receiver for the 868.3 MHz wireless-option sensors and switches.
LN-WMOD315-0	Receiver for the 315 MHz wireless-option sensors and switches.

Test and Validation Tools

Table 4 lists the test and validation tool.

Table 4: Test and Validation Tool

Tool	Description
EPM 300	Field strength meter for finding optimal mounting place for transmitters and receivers.

Sensors and Switches

When you connect the Johnson Controls® LN Series Controllers to the Wireless Receiver, all the wireless-option controllers can receive wireless input signals in both 315 MHz and 868.3 MHz frequencies. The controllers must use the same data telegram format, for example, the LN GPI software. Table 5 lists the supported, sensors.

Table 5: LN Series Supported Sensors

Model	Description
SR04	Room temperature sensor, wireless, solar cell powered, complete with battery holder (ordered separately)
SR04P	Room temperature sensor, wireless, solar cell powered with setpoint adjustment, complete with battery holder (ordered separately)
SR04PT	Room temperature sensor, wireless, solar cell powered with setpoint adjustment and override, complete with battery holder (ordered separately)
SR04P MS	Room temperature sensor, wireless, solar cell powered with setpoint adjustment and slide switch on/off (O/I), complete with battery holder (ordered separately)
SR04PST	Room temperature sensor, wireless, solar cell powered with setpoint adjustment, fan speed adjustment, override, complete with battery holder (ordered separately)
SR04 RH	Room humidity and temperature sensor, wireless, solar cell powered. complete with battery holder (ordered separately)
SR04P RH	Room humidity and temperature sensor, wireless, solar cell powered. Complete with battery holder (ordered separately).
SR04PT RH	Room humidity and temperature sensor, wireless, solar cell powered. Complete with battery holder (ordered separately).
SR04P MS RH	Room humidity and temperature sensor, wireless, solar cell powered with setpoint adjustment and slide switch O/I (on/off). Complete with battery holder (ordered separately).
SR65 AKF Series	Duct temperature sensor, wireless, solar cell powered. Complete with battery holder (ordered separately).
SR65 TF Series	Cable temperature sensor, wireless, solar cell powered. Complete with battery holder (ordered separately).
SR65 VFG	Surface temperature contact sensor, wireless, solar cell powered. Complete with battery holder (ordered separately).
SR65	Outdoor temperature sensor, wireless, solar cell powered. Complete with battery holder (ordered separately).
SRW01	Door/window contact sensor, wireless, solar cell powered.
MC-17	Door/window contact sensor, wireless, solar cell powered.
SR65 LI	Outdoor light sensor, wireless, solar cell powered. complete with battery holder (ordered separately).
SR65 DI	Digital input (2-wire dry contact) for potential-free contacts, wireless, solar cell powered. Complete with battery pack (ordered separately).
ERTP Repeater Series	Low voltage and high voltage repeaters for out-of-range sensors, wireless, powered by 24 V or 120/277 V or 120/347 V. **Note:** Due to high voltage, check with local authorities before installation.

Typical Brightness Levels (lx)

Table 6 describes the typical brightness levels in various locations.

Table 6: Typical Brightness Levels

Illumination Area	Type Destination/Workspace	Typical Brightness (lx)
Home	Usually	100-500lx
Schools	Corridor	100-300lx
	Classroom (general)	300-750lx
	Reading room (laboratory)	500-1500lx
Offices	Computer room (general)	200-500lx
	Meeting room	300-700lx
	Canteen	150-300lx
	Corridors	50-100lx
	Reception	300-700lx
	Restroom	100-300lx
Factories	Production hall	500-1500lx
	Development, office	300-750lx
	Design CAD	500-1500lx
	Laboratory, inspection work	750-1500lx
	Packaging of products	150-500lx
	Storage	100-300lx
Hospitals	Visitor room	300-500lx
	First aid, storage	500-1500lx
	Bedroom	100-300lx
	Pharmacies	500-1000lx
	Wash rooms	150-300lx
Hotels	Reception	200-500lx
	Entrance area	100-300lx
	Restaurant	150-300lx
	Restroom	150-300lx
	Bars	50-150lx
	Corridors	50-100lx
	Staircases	50-150lx
Stores	Saleroom	300-1000lx
	Show room	500-1500lx
	Packaging area	200-300lx
	Lounge	300-500lx
	Conference room	300-700lx
Trade Show	Booth	300-500lx
Sports Arena	Indoor area	200-500lx

Technical Specifications

Transmission Norms

Table 7 lists the countries where wireless devices meet the transmission norms. Use this table as a guideline. Before you begin installation, contact your local authorities.

Table 7: Transmission Norms

Region		868.3 MHz	315 MHz	Notes
America	**United States, Canada[1]**		Yes (every 6.5 seconds)	868.3 MHz meets transmission norms but is not supported
	Brazil, Colombia	Yes (every 6.5 seconds)[2]	Yes (every 6.5 seconds)	
	Mexico	Yes (every 6.5 seconds)		
	Argentina			Convergence to FCC expected
Europe	**European Union (includes: Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovak Republic, Slovenia, Spain, Sweden, United Kingdom**	Yes (every 0.4 seconds)[3]		
	Rest of Europe: Albania, Bosnia-Herzegovian, Croatia, Georgia, Monaco, Serbia, Turkey, Ukraine	Yes		
	Russia	In process		Following R&TTE in process

Table 7: Transmission Norms

Region		868.3 MHz	315 MHz	Notes
Asia Pacific	**New Zealand**	Yes	Yes	
	Australia	Yes		Special license and fee necessary: www.acma.gov.au
	French Polynesia, Papua New Guinea, Tonga	Yes		
	China, Hong Kong, Taiwan		Yes	
	Bangladesh	Yes	Yes	
	India		Yes	FCC compliant equipment is accepted for type approval
	Japan		Yes	PTM200C does have MIC grant
	Malaysia	Yes		On special license, approval necessary: www.sirim.my
	Singapore	Yes	Yes	
	South Korea			Convergence to Japan expected
	Thailand		Yes	
	Vietnam	Yes	Yes	
Middle East	**Saudi Arabia, Lebanon**	Yes	Yes	
	United Arab Emirates (Dubai, Abu Dhabi)	Yes	Yes	PTM200 does have TRA grant (868.3MHz)
	Israel		Yes	
	Kuwait, Oman, Jordan, Tajikistan	Yes		
	Bahrain		Yes	
Africa	**Burkina Faso, Djibouti, Malawi, Mauritius, South Africa, Swaziland, Togo, Uganda, Zambia, Zimbabwe**	Yes		
	Egypt			Approval necessary: www.ntra.gov.eg

1. Johnson Controls, Inc. has attained FCC and IC approvals for the 315 MHz Wireless Receiver and recommends using this transmission frequency in North America. Avoid the 868.3 MHz transmission because of a potential source of interference from truck radio stations. Depending on the distance to the wireless installation, this interference may cause some disturbances to the wireless transmission.
2. This is an FCC duty cycle regulation; 1 radio packet of a transmitter should not be sent within 6.5 seconds of the previous one.
3. This is an R&TTE duty cycle regulation; 1 radio packet of a transmitter should not be send with 0.4 seconds of the previous one.

Wireless Sensor and Switch Specifications

Table 8: Wireless Sensor and Switch Specification

Operating Temperature	-25 to 65°C (-13 to 149°F)
Data Range	120 to 125 kbps
Channel Bandwidth	280 kHz
Modulation Type	Amplitude-shift keying (ASK)
Frequency	868.3 MHz/315 MHz
Transmission Power	Maximum 10 mW
Transmission Range	100 m line of sight; 20 m between walls

Troubleshooting

Table 9: Wireless Troubleshooting

Problem	Symptom	Solution
Wireless Receiver and wireless battery-less sensors and switches not communicating	Wireless Receiver not associated with controller	Using the controller's configuration plug-in or wizard, check the wireless sensor input configuration menu. Refer to the controller's user guide for more information.
	Power Discharge	1. Recharge the wireless device with light (if solar-powered) or replace the battery (if battery-powered), 2. Ensure sufficient light intensity (200lx for 4 hours/day).
	WIreless device too far from the wireless receiver	Reposition the wireless device to be within the range of the wireless receiver.

United States Emissions Compliance

This equipment 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:

- Reorient or relocate the receiving antenna.

- Increase the separation between the equipment and receiver.

- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

- Consult the dealer or an experienced radio/TV technician for help.

Canadian Emissions Compliance

This Class (B) digital apparatus meets all the requirements of the Canadian Interference-Causing Equipment Regulations.

Cet appareil numérique de la Classe (B) respecte toutes les exigences du Règlement sur le matériel brouilleur du Canada.

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