

PRL-2 A Series Wireless Pulse Link System Technical Manual

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Solid State Instruments

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PRL-2 Wireless Pulse Link System

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Introduction

The PRL-2 Pulse Radio Link is a Transmitter and Receiver system that wirelessly sends one channel of K-Y pulses from the transmitter to a paired receiver. The short-hop PRL-2 has a range of up to 1,000 feet depending on site topography and solves the problem of getting pulses across parking lots, vacant lots, roads, railroad tracks or other obstacles. With the PRL-2, you're now able to connect real-time KY pulses from a Form A pulse channel. The PRL-2 operates in a real-time mode, sending pulse transmissions approximately 10 times per second, thereby exactly mirroring the pulses from the meter. The PRL-2 eliminates trenching or other costly methods of getting wires strung between a meter and the destination receiving device as well as providing superior isolation against transients that could be induced in a long cable run. Additionally, ground rise problems are eliminated since there is no electrical connection between the two devices.

The PRL-2 Radio Pulse Link system consists of one PRT-2 Transmitter and one PRR-2 Receiver. The system uses Frequency Hopping Spread Spectrum (FHSS) technology to communicate on 64 frequencies between 902 to 927MHz, using one of 6 hop sequence "channels", and allows unlicensed operation by the user, allowing multiple systems to operate in the same radio airspace. Nominally, the PRL-2 will transmit pulses between 500 and 1,000 feet in an unobstructed line-of-sight configuration but may go farther depending on optimal site conditions.

PRT-2 TRANSMITTER

The **PRT-2** Transmitter is a small self-contained unit housed in a 4" x 4" x 2" NEMA 4X weatherproof enclosure. The PRT-2 Transmitter receives 2-Wire pulses from a meter's KYZ pulse initiator and sends them to the PRR-2 Receiver unit wirelessly. Pulse transmissions are sent to the receiver approximately 10 times per second. The PRT-2 Transmitter contains the transceiver radio, a microcontroller, power supply and all the circuitry and software to communicate with the Receiver. The power supply generates a +9VDC sense (wetting) voltage for the meter's dry-contact KYZ pulse initiator. The PRT-2 Transmitter is capable of operating on supply voltages of +12-60VDC, or 10-48VAC. The PRT-2 can be operated with batteries or a solar power supply such as Solid State Instruments' SPS-2 Solar Power Supply.

PRR-2 RECEIVER

The **PRR-2** Receiver is a small self-contained unit housed in a 4" x 4" x 2" NEMA 4X weatherproof enclosure. The PRR-2 contains the transceiver radio, a microcontroller, power supply and all the circuitry and software to receive pulses from the PRT-2 Transmitter and output them on the dry-contact, solid-state output. The PRR-2 is configured as 1 Form A output, operating in the real-time mode. The PRR-2 is intended to be mounted outdoors, in direct line-of-sight with the PRT-2. Operation may not be reliable if obstructed by trees, metal poles, buildings or other objects. The PRR-2 is capable of operating on supply voltages of 12-60VDC or 10-48VAC. The PRR-2 can be operated with batteries or a solar power supply such as Solid State Instruments' SPS-2 Solar Power Supply.

PRL-2 SYSTEM DESIGN AND PLANNING

SYSTEM CONFIGURATION - The PRL-2 is a Form A (2-Wire) Device.

Form A Configuration: The Form A configuration will transmit one 2-Wire (KY) pulse channel.

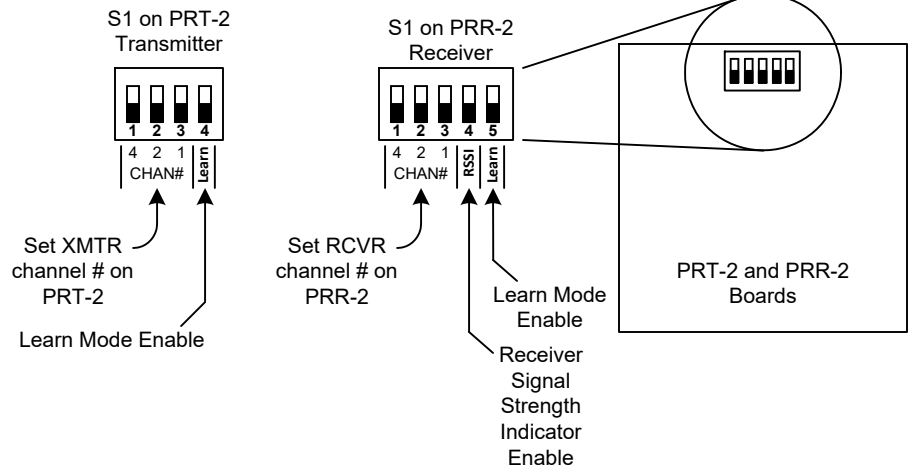
Dip Switch S1's switches #1 through #3 set the channel # or "hop" sequence. Both the PRT-2 Transmitter and the PRR-2 Receiver units must be set to the same channel or hop sequence. See Table 1 below.

The PRT-2 has a four position Dip Switch.

The PRR-2 has a five position to accommodate the RSSI indicator enable/disable function.

Table 1

Channel #	S1.1	S1.2	S1.3
1	DN	DN	DN
2	DN	DN	UP
3	DN	UP	DN
4	DN	UP	UP
5	UP	DN	DN
6	UP	DN	UP
5	UP	UP	DN
5	UP	UP	UP



SYSTEM CHANNEL - The PRL-2 System operates on one of 6 hop sequence channels. Each channel consists of 50 unique frequencies out of 64 frequencies available in the 902MHz to 927MHz range. This allows enhanced reliability since RF transmissions are transmitted on one of the channel frequencies until they are received by the receiver. Set the Transmitter and the Receiver to the same hop sequence channel number. Multiple PRL-2 systems can operate in the same radio airspace by each system having a different channel number. Once you have determined the channel # that you will use, configure Dip Switch S1's switches #1 through #3 on the PRT-2 Transmitter and the PRR-2 Receiver. Table 1 shows the dip switch combinations for each channel.

SYSTEM OPERATING MODE - The PRL-2 System operates in a near real-time operational mode, where the PRT-2 Transmitter transmits one transmission approximately 10 times per second. Packet Transmissions and Receptions are visually indicated with LEDs on both the radio module board and main board.



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CONSIDERATIONS FOR A SUCCESSFUL INSTALLATION

GENERAL - The PRL-2 System is designed to provide mirror-image pulses from the transmitter to the receiver. This is important for Peak Demand Control since the KW demand is determined by timing the pulses. The greater the time between pulses, the lower the demand. Conversely, the shorter time between pulses, the higher the demand. Every effort is made in the PRL-2 to be a "virtual copper wire" and make the pulses coming out of the receiver the same pulse width as the pulses going into the transmitter.

The PRL-2 System is designed for concentrated RF environments where there is a significant amount of RF traffic on these or adjacent frequencies. Pulses are continuously collected by the transmitter and immediately transmitted to the receiver.

APPROPRIATE PULSE VALUE - It is important to properly program the Pulse Value of the meter such that there are preferably no more than 2 pulses per second at the peak KW demand of the building or facility. If a high pulse rate is unavoidable from the meter and cannot be slowed down, consider one of the DPR Dividing Pulse Relays (DPR-1, DPR-2 or DPR-4) from Solid State Instruments.

MINIMUM PULSE WIDTH - Make sure that the pulse width coming from the meter is at least 100mS in duration, if not being outputted in the standard "toggle" format.

LINE OF SIGHT - Make sure that you have the Receiver in a location where the Transmitter can "see" it with a wide field of view. The PRL-2 is a Line-Of-Sight system, and the transmitter must have uninterrupted and unrestricted sight with the receiver radio at all times. Make sure that there are no trees, metal buildings, light poles, rail cars, trucks, buses or any other obstruction that gets in the line-of-sight between the transmitter and receiver at any time. Interruptions in the line-of-sight may cause pulses to be lost. Generally speaking, the PRL-2 will not transmit through concrete, concrete block or masonry walls. We can't stress this enough: The RF path must be line-of-sight!

HEIGHT - Mount the Transmitter and Receiver Radio/Antenna units up off the ground as high as reasonably possible, 14' minimum, to eliminate RF reflections, improve reception and transmission distance. The higher the transmitter is off the ground, the longer the transmission distance and the more reliable the reception by the receiver.

MOUNTING: If mounting on a metal surface, make sure that the antenna on the Transmitter or Receiver is mounted at least 6.1" away from metal siding. If the antenna is closer than 6.1", the signal may be corrupted and transmissions may be affected.

INTERFERENCE - The PRL-2 is a Frequency-Hopping Spread Spectrum system that communicates on 50 of 64 designated frequencies. It may or may not work in substations or in other areas where high-power energy fields exist or where RF energy may jam the signal. The electromagnetic field around high voltage conductors may cause enough interference so as to keep the system from transmitting correctly or may significantly reduce the range of the system. It has been reported that other high-power RF transmitters mounted within close proximity can jam or corrupt the signal even though they are not using the same frequencies.



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INSTRUCTION SHEET

PRT-2 TRANSMITTER SETTINGS

Setting the System CHANNEL - Each system -- the Transmitter and Receiver -- must operate on one of six different channels. A "channel" is a collection of 50 specific frequencies that are arranged in a specific "hop sequence". A unique channel allows multiple systems to operate in the same radio airspace without any interference with each other. Therefore, the transmitter and receiver must be set to the same channel setting. The channel address is set using a 3-bit binary code. See **Table 1** at right for the list of channels. Note that Channel #6 is the highest channel number and even though there are eight unique switch combinations, Channel 6 is the highest channel that can be selected. The last two switch combinations result in Channel #5 being selected.

Switch #4 - Pairing the Transmitter and Receiver - The PRT-2 System requires that each Transmitter and Receiver are paired together. Each Transmitter must learn the address of the Receiver it is designated to talk to. This makes it possible for the Transmitter to only talk to the designated Receiver and ignore other devices sending and receiving information on a particular frequency. After installation is complete, perform the pairing procedure described on page 10 **ONLY IF** the system has not been previously paired at the factory. *****Do not switch #4 UP if the system is already paired.*****

PRT-2
Transmitter
Base Unit

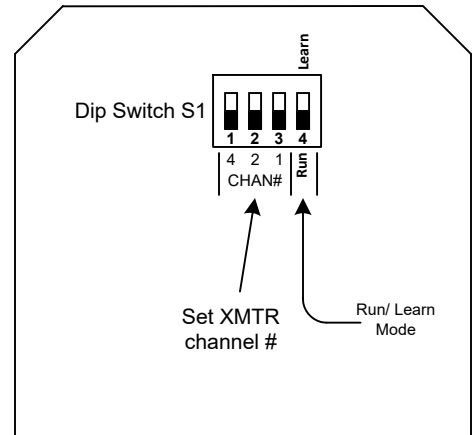


TABLE 1

CHANNEL#	SW#1	SW#2	SW#3
1	DN	DN	DN
2	DN	DN	UP
3	DN	UP	DN
4	DN	UP	UP
5	UP	DN	DN
6	UP	DN	UP
5	UP	UP	DN
5	UP	UP	UP

TABLE 2

Run/Learn	SW#8
RUN	DN
LEARN	UP



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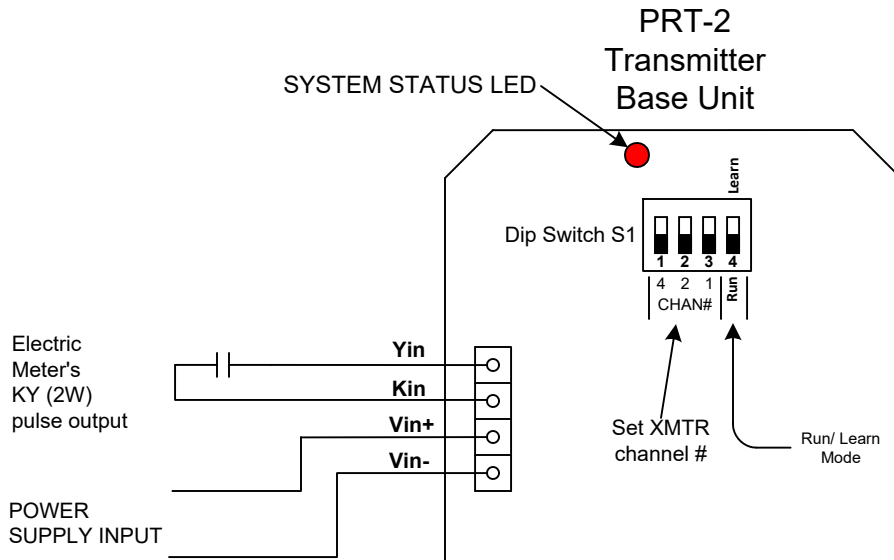
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INSTRUCTION SHEET

PRT-2 PULSE TRANSMITTER UNIT



MOUNTING POSITION - The PRT-2 Transmitter unit may be mounted in any position.

ENCLOSURE - The PRT-2 base unit is housed in a Noryl polycarbonate 4" x 4" x 2" NEMA 4X enclosure designed to be mounted outdoors.

POWER INPUT - For a DC power source between +12 and +60VDC, connect the positive "+" supply to the **RED** wire. Connect the negative ("-") supply to the **BLACK** wire. For an AC power source between 10 and 48VAC connect the AC source to the Red and Black Wires. Either wire may be connected to either wire of the AC source. Do not exceed the maximum voltage ratings.

INPUT CONFIGURATION - The PRT-2 accepts Form "A" (2-Wire) input using either the K & Y or K & Z terminals from an electric meter. The PRT-2's K terminal is the **BROWN** wire and the Y terminal is the **YELLOW** wire.

METER CONNECTIONS - Form A (2W) mode: Connect the PRT-2's "K" and "Y" input terminals to meter's "K" and "Y" terminals. The "Y" input terminals is "pulled-up" to +9VDC power supply, making it compatible with open-collector transistor meter outputs, as well as all non-polarized mechanical or solid state pulse outputs.

STATUS LEDs - The status LED's indicate current system status. A fast blink ~ 4 times per second indicates that the transmitter and receiver are paired and the transmitter is sending data to the receiver.



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PRR-2 RECEIVER SETTINGS

Setting the System CHANNEL - Each system -- the Transmitter and Receiver -- must operate on one of six different channels. A "channel" is a collection of 50 specific frequencies that are arranged in a specific "hop sequence". A unique channel allows multiple systems to operate in the same radio airspace without any interference with each other. Therefore, the transmitter and receiver must have the same channel setting. The channel address is set as a 3-bit binary code. See **Table 1** at right for complete list of the channels. Note that Channel #6 is the highest channel number and even though there are eight unique switch combinations, Channel 6 is the highest channel that can be selected. The last two switch combinations result in Channel #5 being selected.

RSSI Indicator* - The receiver has an Signal Strength Indicator to show the signal strength of the Transmitter. **This is a test mode and can only be used during installation.** See Diagnostics on page 13. Set **Switch #4 UP** to enable the RSSI LED bargraph. Once the system is operational, set **Switch #4** to **DOWN** to turn off the RSSI. See the description of this feature on Page 9.

Pairing the Transmitter and Receiver - The PRL-2 System requires that each Transmitter and Receiver are paired together. Each Transmitter must learn the address of the Receiver it is designated to talk to. This makes it possible for the Transmitter to only talk to the designated Receiver and ignore other devices sending and receiving information on a particular frequency. After installation is complete perform the **Pairing Procedure** described on page 10 ONLY if the pairing procedure has NOT been done at the factory. *****Do not put switch #5 into the UP position if the system has already been paired.*****

PRR-2 Receiver Base Unit

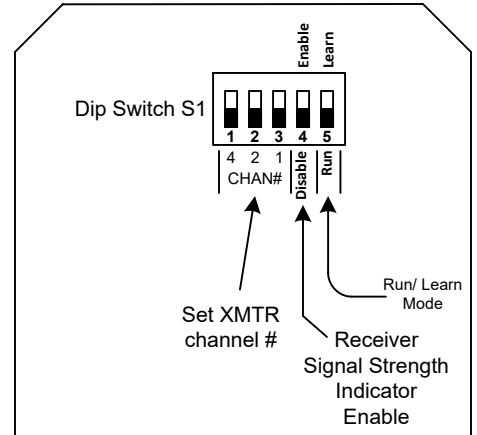


TABLE 1

CHANNEL#	SW#1	SW#2	SW#3
1	DN	DN	DN
2	DN	DN	UP
3	DN	UP	DN
4	DN	UP	UP
5	UP	DN	DN
6	UP	DN	UP
5	UP	UP	DN
5	UP	UP	UP

TABLE 2

RSSI Mode	SW#4
RSSI Disable	DN
RSSI Enable	UP

TABLE 3

Run/Learn	SW#5
RUN	DN
LEARN	UP

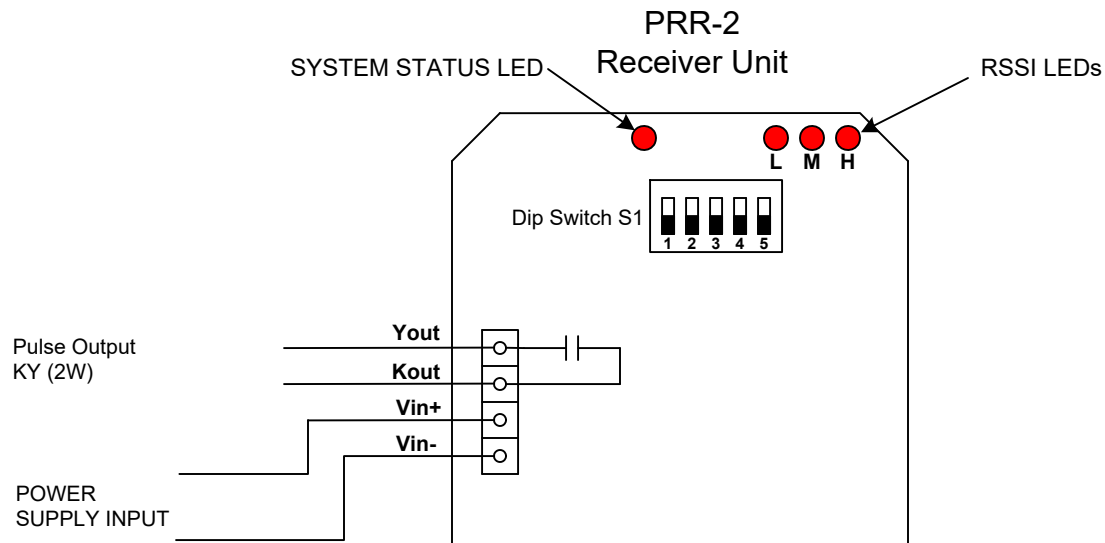


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INSTRUCTION SHEET

PRR-2 PULSE RECEIVER UNIT



GENERAL - The PRR-2 contains a power supply, output relays and all connection points.

MOUNTING POSITION - The PRR-2 Receiver unit may be mounted in any position.

ENCLOSURE - The PRR-2 Receiver is housed in a NEMA 4X weatherproof enclosure suitable for outdoor mounting.

POWER INPUT - For a DC power source between +12 and +60VDC, connect the positive "+" supply to the RED wire. Connect the negative ("-") supply to the BLACK wire. For an AC power source between 10 and 48VAC connect the AC source to the Red and Black Wires. Either wire may be connected to either wire of the AC source. Do not exceed the maximum voltage ratings.

STATUS LEDS - The status LED's indicate current system status. A fast blink ~ 4 times per second indicates that the transmitter and receiver are paired and the transmitter is sending data to the receiver.

RSSI SIGNAL STRENGTH INDICATOR - The PRR-2 contains a 3-LED bar graph that tells the relative signal strength coming from the Transmitter. It consists of three RED LEDs in the upper right-hand corner of the board.

OUTPUT CONFIGURATION - The PRR-2 contains a solid-state Form A dry-contact output. The solid state output is limited to 100mA@ 250VAC, 800mW maximum. Do not exceed this rating as the device will be destroyed. Transient voltage protection for the contacts of the solid state relays are provided by MOVs on board.



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Transmitter and Receiver Pairing Procedure (Learn Mode)

***** THE PRL-2 IS FACTORY PAIRED. DO NOT PAIR THE SYSTEM UPON INITIAL INSTALLATION. *****

Required only if re-pairing has not been done or if one end has been replaced.

This procedure pairs the PRT-2 Transmitter with a specific PRR-2 Receiver. The PRL-2 system WILL NOT work unless this procedure is completed. The PRL-2 system is factory paired and tested as a system, so the pairing procedure is not normally necessary to do at installation. In the event that Dip Switch #4 on the Transmitter or #5 on the Receiver is put in the UP position either accidentally or intentionally, the unit may be unpaired. Therefore, this procedure will need to be performed.

1. With the system powered down (OFF) at both ends, set the Transmitter and Receiver channel numbers (Dip Switches 1-3) to the same setting. (See instructions on pages 6 and 8 for the transmitter and receiver, respectively).
2. Set Dip Switch #4 on both the transmitter and Dip Switch #5 on the receiver to the "UP" position to put the system in the Learn mode.
3. Turn on power to the PRR-2 Receiver. The RED system status LED should flash slowly.
4. Turn on power to the PRT-2 Transmitter. The RED system status LED should flash in slow mode, about once per second) for a few seconds and then flash fast, about 4 times per second. The fast flash means that the system has paired itself together.
5. Return Dip Switch #5 (Receiver) to the "DOWN" position on PRR-2 Receiver Base FIRST. This puts the Receiver in the RUN (normal operation) mode. Status LED will flash fast in the RUN mode.
6. Return Dip Switch #4 (Transmitter) to the "DOWN" position on the PRT-2 Transmitter SECOND. This will put the Transmitter into the RUN (normal operation) mode. Status LED will flash fast in the RUN mode.
7. Once both units are in the RUN mode, you will see the KY output on the Receiver changing state to reflect the state of the transmitter's input. The Pulse Input and Output LED's on the Transmitter and Receiver will match.
8. If the Transmitter and Receiver boards ever need to be changed or if the transmitter and receiver units ever have to be deployed in a new system with a different transmitter or receiver board, the pairing procedure will have to be performed again.



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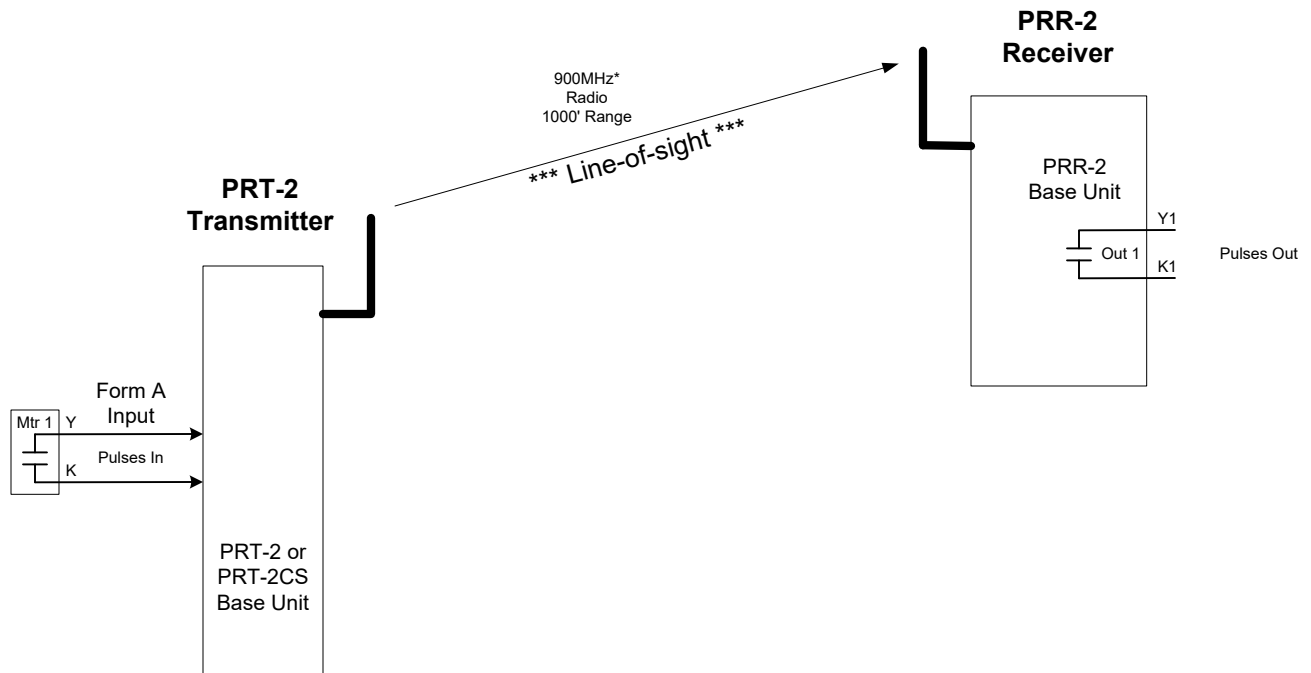
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PRL-2 Wireless Pulse Link Application



Notes:

- 1.) Transmitter and Receiver are Form A (2-Wire) only, K-Y or K-Z. Make sure that the utility configures all the meter's outputs for toggle mode, not momentary mode.
- 2.) Dip Switch #4(Transmitter) and #5(Receiver) must be DOWN on the both ends for normal operation (in RUN mode).
- 3.) Transmission is Line-Of-Sight and must not be blocked by trees, buildings, metal poles, trucks, railcars, etc.
- 4.) Transmission distance is variable up to 1000' depending on topography and conditions. Distance and reliability will increase as the height mounted above the ground increases. During extremely heavy rain, transmissions may not be reliable.

PRL-2 Wireless Pulse Link System Diagram		REVISIONS	
		NO.	DATE
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11/10/23	N/A		
LATEST REVISION	JOB NO.	CHECKED	DRAWN
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Troubleshooting and Tech Support

- 1.) Make sure that the transmission path between the Transmitter and the Receiver is free of ANY obstacles or anything that can interrupt the radio transmission line-of-sight path between the transmitter and receiver with a wide field of view. The Transmitter and Receiver units MUST be in continuous sight of each other – no interruptions from cars, trucks, railcars, trees, light poles, metal buildings, ANYTHING!
- 2.) Mount the Transmitter and Receiver units as high up off the ground as reasonably possible to prevent RF reflections from the ground. This will increase range and reliability, and also allow for certain obstacles to be avoided. Do not mount the Transmitter unit next to high voltage powerlines.
- 3.) Program the pulse constant (Ke value) of the electric meter high enough to allow for a pulse rate that will not exceed 2 pulses per second at maximum KW demand. This is well below the system's maximum pulse throughput rate but ensures excellent reliability. NOTE: the PRL-2 system does not change or modify the pulse values in any way. The pulse value is completely determined by the Ke value of the meter and the metering installation multiplier, which is based on Current Transformer (CT) and Potential Transformer (PT) ratios. Some meters are different and the programming of the pulse constant may vary from meter brand to meter brand.
- 4.) In extremely heavy rain or snow, the system may not be able to accurately receive all pulses transmitted. Like any other RF system, with enough interference, communications can be lost.
- 5.) RED System Status LED Light - The PRT-2 and PRR-2 units have Status LEDs to help the installer determine whether the system is operating correctly. Please see the tables on the Pages 7 and 9.
- 6.) If there is interference on the "hop sequence" channel you have selected, change to another channel. There are six channels to choose from. Both ends must have the same channel number. The system does not need to be powered down to change the channel #. However, it will not communicate while the channel numbers are not identical.
- 7.) The system's maximum reliable transmission distance will change with each installation since it is dependent on all of the environmental and electrical factors of each particular installation. While the distance is nominally specified as up to 1,000 feet, it may not work at the full range in some installations.
- 8.) The Transmitter and Receiver are designed for outdoor mounting and housed in a 4" x 4" x 2" NEMA 4X enclosure.

Troubleshooting Procedure:

- Check all wiring connections.
- Check that power is on and applied properly to all components.
- Check the RED LED on the Transmitter and Receiver boards and make sure they are flashing fast approximately 4 pulses per second.
- Check to make sure that the Transmitter and Receiver are both set to the same channel (Dip Switches #1-3)
- Make sure that there is not another system operating in the same RF airspace that has the same channel hop sequence selected.
- Check Red LED on the Transmitter's or Receiver's pulse input or output, and make sure they are flashing with pulses received from the meter.
- Check the Status LED on the Transmitter and Receiver main boards to ensure proper operation of the system. Both should be flashing fast for normal RUN operation.
- Use the Signal Strength LEDs (RSSI) on the Receiver to measure signal strength. Put Dip Switch #4 in the UP position on the Receiver to enable the RSSI indicator. Put in DOWN position when test complete to turn off RSSI. **Do not leave the RSSI indicator on during normal operation. Pulses may be lost if the RSSI is left on. The RSSI is a diagnostic tool only and not for normal operation.**
- Check that the antennas are securely screwed to the bulkhead connector.
- Use an ohmmeter or continuity checker across the KY terminals of the pulse output and determine whether each is opening and closing by watching the output's resistance change. When the output is open, there should be infinite resistance. When the output is closed, the on-state resistance should be approximately 18 to 25 ohms.
- Is the "downstream" equipment, that is receiving the pulses from the Receiver, providing a wetting voltage to the dry-contact output of the Receiver? Is the wetting voltage within the maximum specifications?

NOTICE TO USER - 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.

In order to maintain compliance with FCC regulations, shielded cables must be used with this equipment.

Operation with non-approved equipment or unshielded cables is likely to result in interference to radio and TV reception. The user is cautioned that changes and modifications made to the equipment without the approval of manufacturer could void the user's authority to operate this equipment.