Gen II Radio Protocol

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Definitions:

Primary Monitor: The monitor from which all sensors receive acknowledgments. It must be present for the sensors to send transmissions.

Secondary Monitor: Any additional monitors in the area; Will take the position as Primary Monitor in the event of a Primary Monitor failure. These monitors do not send acknowledgments.

VID: Vendor Identification; a security feature in the Laird radio that allows networks to be isolated from other vendors.

Network ID: refers to the given hop-sequence for a radio. Changing this can create zones and help minimize interference.

Back-off Time: This is the random time period given to a Secondary Monitor to wait before attempting to take the place of the Primary Monitor.

Introduction:

Gen II products will use Laird Technologies' embedded radio module. There are two different variations that are used: the 2.4GHz (PN: LT2510) or 900MHz (PN: PRM240) module. Either frequency has the same footprint.

This radio has a small outline package, measuring only 1.0"x1.75". It is powered by 3.3V, and uses only 190mA (230mA for 900MHz) to transmit a signal. The current consumption for hibernation is 50µA (30µA for 900MHz) The output power for the radio is adjustable, and can be set to anywhere from 2.5mW to 125mW (6.3mW – 200mW for 900Mhz), giving the radio a range from .25mi to 2.5mi (.5 to 3.2mi for 900MHz).

New Features:

- Configurable VID: security ID that can be set for each customer to secure network.
  Note: VID can only be set once, so if the wrong VID is set, then the radio cannot be used.
- Network ID: can use this to minimize interference from other networks, and also to create specific zones.
- Adjustable Output Power
- Adjustable Baud Rate
- Acknowledgments: from Primary Monitor only.

Protocol:

Due to the new features and capabilities of this radio, there are some changes to the radio protocol. Here are some of the major changes:

- Primary/Secondary Monitors: The major difference between Primary and Secondary Monitors is that Primary Monitors get acknowledgments from the sensors. This is useful in that it allows the sensor to have an RSSI (receive signal strength indicator) value. Secondary Monitors receive all transmissions, but do not send acknowledgments. Also unique to this configuration is that the presence of the Primary Monitor is required in order for the Secondary Monitor(s) to function. While this can create a potential dependence on a single node for the radios to function, there are several backup methods that prevent this from occurring (Explained in detail in the *Network Reliability* section).
- Network ID: This attribute must be the same on all radios that need to communicate with each other. If there are separate zones that do not need to be seen on the respective monitors, then the number can be changed to make that possible. Changing the Network ID essentially changes the hop sequence of the radio. If not all radios have the same hop sequence, they cannot communicate with each other. *Note: Each network needs its own Primary Monitor.*
- VID: This feature is set once at Otis Instruments. It cannot be changed or read once it has been set, so the correct value needs to be set initially. This allows networks to be secured. (If a nearby plant has the same radios as another plant, as long as the VIDs are different, then neither plant can see the other plant's radios.)

Network Reliability

Due to the nature of this radio protocol, it is mandatory for a Primary Monitor to be present to receive transmissions from the sensors. In order to prevent the network from going down, the following scenarios have been created:

- *The Primary Monitor goes down, and there is a Secondary Monitor in the area:* The Secondary Monitor checks for the presence of other Secondary Monitors, then it becomes the Primary Monitor. It also displays "NP#" on the left side of the screen, indicating a "new primary," where "#" indicates the Network ID. The Sensors in the area will display a fault until it sees the replacement Primary.
- *The Primary Monitor goes down, and there are multiple Secondary Monitors:* Each Secondary Monitor has a random "back-off" time in which it waits before attempting to become the primary monitor. When the first Secondary Monitor finishes its "back-off", it checks to see if there is a Primary Monitor, and then becomes the Primary Monitor if none are yet present. The remaining secondary monitors finish their "back-off" time and then, sensing the presence of the new Primary Monitor, resume their positions as Secondary Monitors. After a Secondary Monitor becomes the Primary, only that monitor will indicate that it has become the New Primary by displaying "NP#" on the left side of the screen (where "#" indicates Network ID). That indicator will stay until the original Primary Monitor is back online.
- *The Primary Monitor goes down, a Secondary Monitor takes its place, and the Primary*

Monitor is restored: In this instance, when the Primary Monitor is restored, it will send out a beacon letting the Secondary Monitor know it is functioning again. This will prompt the Secondary Monitor to "step down" and resume its position as Secondary Monitor. Also, any indicators present on the Secondary Monitor will now be cleared since the Primary Monitor is functioning again.

- *The Primary Monitor goes down, and two Secondary Monitors set up as Primary Monitors because they are out of range of each other:* This situation is unavoidable as the Secondary Monitors cannot see each other because they are out of range. This normally takes place if the Primary Monitor is situated in the middle of both Secondary Monitors. In this case, all sensors in range of one Primary will report to that monitor. If there are any sensors in range of both monitors, then whichever monitor's beacon is last received by the sensor before it transmits, the sensor will transmit to that monitor. Also, if that particular Primary monitor is not set up to see that radio address, then the sensor will report to that monitor and its transmission will be ignored. However, the two new Primary monitors will display the indicators showing that they are replacement Primary Monitors, prompting the user to correct the situation. Once the Primary is functioning again, the Secondary Monitors will resume their original positions.

- *The Secondary Monitor loses communication with the Primary Monitor but the Primary is still on and functioning:* Sometimes interference occurs between the Primary and the Secondary causing them to not see one another. This can result in the Secondary becoming a Primary Monitor. However, this will cause them to continue not seeing each other. In order to correct this, the Secondary Monitor will periodically "step down" to look for the original Primary Monitor. If the Secondary Monitor is able to once again see the Primary, then the Secondary will return to being a Secondary Monitor. If it still does not see the Primary, then the Secondary Monitor resumes the place of the Primary. The wait period will last 1 to 2.5 minutes before it "steps down" again to check for the presence of the Primary. The Secondary will remain offline to check for 5 seconds. This is more than enough time for the Primary to resume it's position if it is online again. If the primary is still offline after this, the Secondary will continue to check every five minutes and continue to display the "NP#" indicator until it can see the original Primary again.

- *The Primary Monitor goes down, and two Secondary Monitors set up as Primary Monitors but are in range of each other:* In the event that this situation occurs, both New Primaries will continue to check for the presence of the original Primary. Because they will not utilize the same wait period, one New Primary will check before the other. When that New Primary sees the presence of the other, it will step down to act as secondary again. Then the remaining New Primary will check, see that it is the only Primary, and remain so until the original one is restored. The maximum wait time for this situation to correct itself (only one New Primary) itself is approximately 3.25 minutes.

  - *NOTE: In the event that this situation occurs with more than two monitors (Aka, more than two monitors step up to be New Primary Monitors, the 3.25 minute wait still applies. It will still take 3.25 minutes for the situation to correct itself.*