

# WiSI™



## Network Guide

RUGID COMPUTER, INC.  
9730-F1 Lathrop Industrial Dr. SW  
Olympia, WA 98512  
USA

[support@rugidcomputer.com](mailto:support@rugidcomputer.com)

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## 1 Overview

The WiSI™ Network Guide provides an overview of the Network Specifications and Recommendations for field deployment. Guidelines are also discussed for using the built in network analysis capabilities of the WiSI system to assist in field deployment and performance analysis.




WiSI comes standard with a 2.4GHz radio and antenna or RP-SMA connector. The WiSI network is based upon the IEEE 802.15.4 standard.

### 1.1 System Components

A WiSI system consists of a collection of the three WiSI components:

- Coordinator (only one per network)
- Router (Externally Powered)
- End Node (Solar Powered or External Powered models)

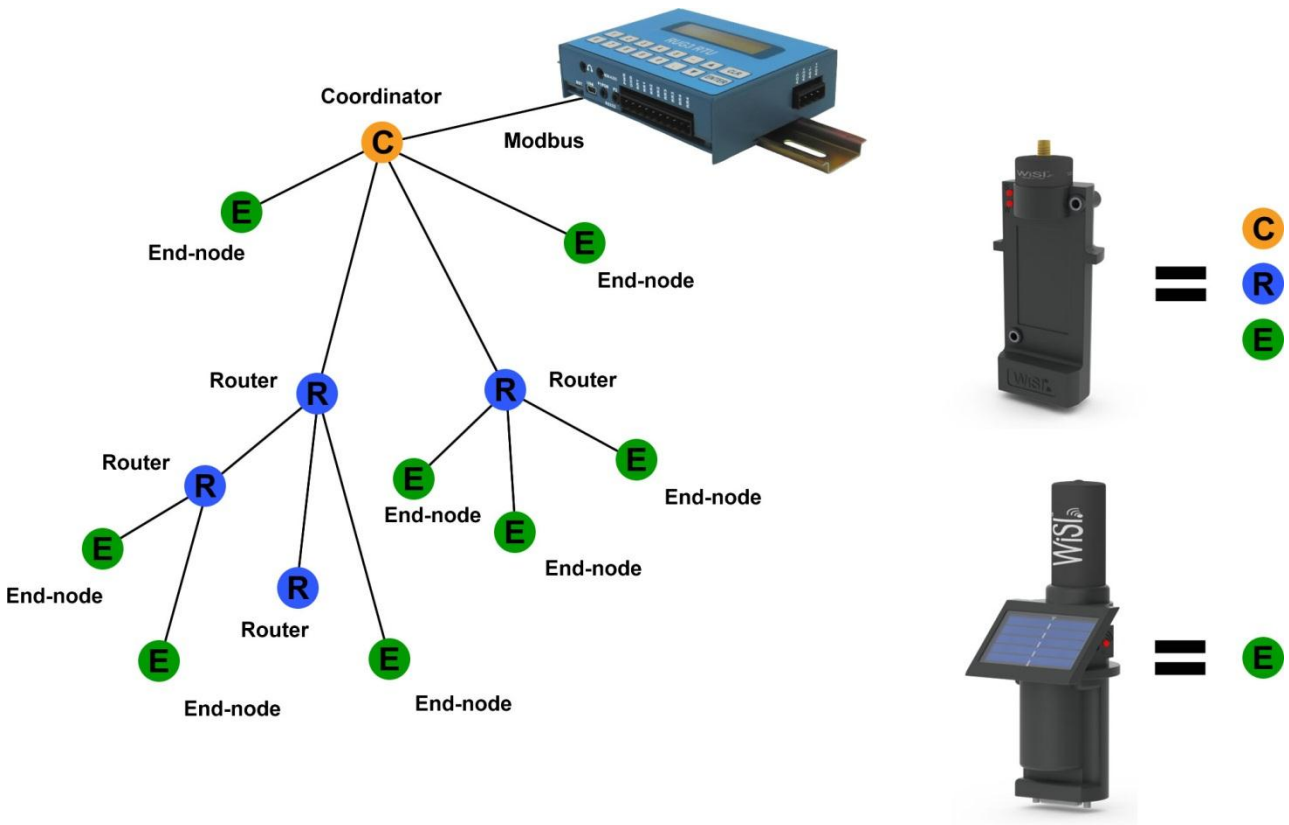
The node types and their roles are summarized in the table below. Note that a WiSI network must have one and only one Coordinator which provides the access point for the wireless network from upstream control and data acquisition systems.

WiSI Component	Role
Coordinator 	<p>The Coordinator is an essential node and plays a fundamental role at system initialization, during which its tasks are:</p> <ul style="list-style-type: none"> <li>• Selects the radio channel to be used by the WiSI network</li> <li>• Starts the network</li> <li>• Allows other nodes to connect to it (that is, to join the network)</li> </ul> <p>The Coordinator provides message routing, security management and acts as a Modbus slave to an upstream RTU passing data to and from the WiSI network. In addition, the Coordinator may also gather local data and respond to digital I/O requests just like all WiSI nodes. A Coordinator must remain active and therefore cannot sleep.</p>
Router 	<p>In addition to gathering local data and responding to digital I/O requests, the Router also:</p> <ul style="list-style-type: none"> <li>• Relays messages from one node to another (routing)</li> <li>• Allows other nodes to connect to it (that is, to join the network)</li> </ul> <p>A Router must remain active and therefore cannot sleep.</p>
End Node 	<p>An End Node gathers local data and responds to digital I/O requests as well as sending and receiving network messages.</p> <p>An End Node can only communicate with upstream Routers or the System Coordinator. The WiSI End Node can be externally powered, or self powered with its own integrated solar power source and long life super capacitor storage. The WiSI End Node will sleep when not gathering, transmitting or receiving data.</p> <p>End Nodes cannot relay messages and cannot allow other nodes to connect to the network through them.</p>

WiSI nodes come in two flavors; Externally Powered (EP), and Solar Powered (SP). WiSI Externally Powered nodes are available to perform any of the roles defined for network elements; Coordinator, Router or End Node. WiSI Solar Powered nodes are only available for End Node applications.

## 1.2 Dynamically Self Configuring Network

A WiSI wireless network self configures upon startup, and will automatically reconfigure as required to maintain network integrity. Every WiSI network consists of a single Coordinator which maintains network integrity and conveys network data to and from the Modbus connected RTU. Reliable network communications is maintained by automatic network reconfiguration using redundant communication paths.



The WiSI Configuration Console is used to configure and load each of the WiSI network components.

## 2 Network Specifics

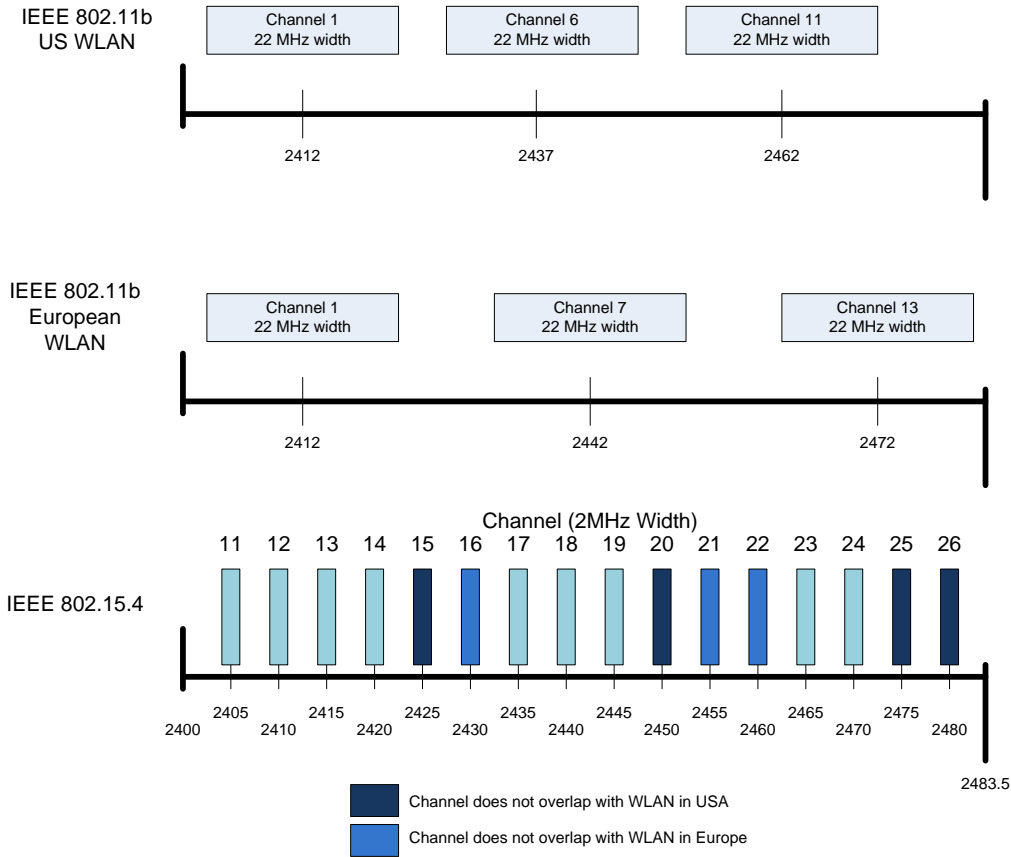
The WiSI radio uses the IEEE 802.15.4 standards to send and receive data in the unlicensed 2.4GHz band using a proprietary message protocol. This band, also known as an ISM (Industrial, Scientific and Medical) band allows many different systems to use it at the same time. An IEEE 802.15.4 network will likely share its frequency space with systems such as Wi-Fi (e.g. IEEE802.11b/g wireless LAN), video distribution, Bluetooth and cordless telephones. However, the IEEE 802.15.4 protocol is well suited to shared-band operation. It has 16 separate channels that allow the system to "choose" a channel that is not being used by other 2.4-GHz deployed systems.

The IEEE 802.15.4 protocol provides a reliable radio link. The protocol employs a robust modulation scheme that is not easily disturbed by other 2.4-GHz band users. Furthermore, the radio modem uses Direct Sequence Spread Spectrum (DSSS) coding that improves transmitter-to-receiver range and offers some protection against interference.

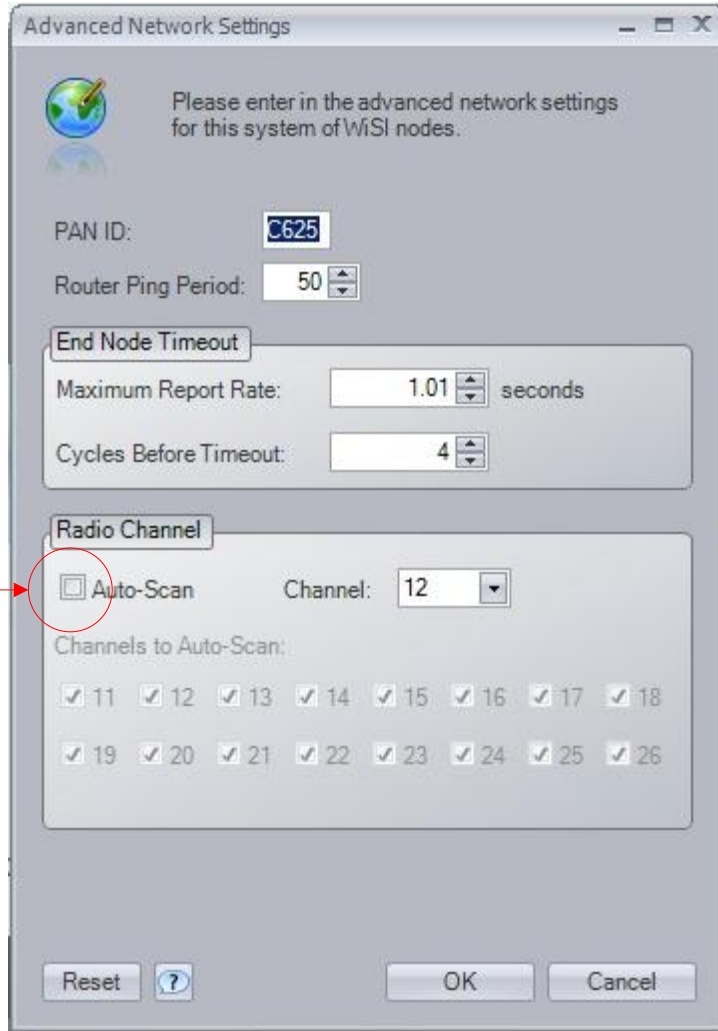
For an IEEE 802.15.4-based radio link, the radio transmit power is limited by the local regulatory radio regulations. WiSI modules are designed to comply with these regulations and are available with a transmit power of approximately 100 mW.

## 2.1 Channel Selection

The WiSI Configuration Console allows the selection of a specific channel (11-26), or the WiSI Coordinator can be configured to select the quietest channel automatically. The following diagram compares the channel/frequency distribution for IEEE 802.11b Wireless LAN versus IEEE 802.15.4. Note that several WiSI IEEE 802.15.4 channels avoid overlap with USA and European WLAN assigned spectrum. It may be useful to try these channels first if interference with local WLAN activity is anticipated.



An alternative is to allow the WiSI Coordinator to pick the quietest channel. This is accomplished by checking the “Auto-Scan” check box in the Radio Channel portion of the Advanced Network Settings screen. Notice that when Auto-Scan is selected, the developer has the opportunity to select which channels should be considered as candidates via the “Channels to Auto-Scan” check boxes.



*Note: Auto-Scan allows the WiSI to select the quietest radio channel at initialization. However, it will not automatically switch to a new channel if the present channel becomes noisy.*

## 2.2 Data Rate

The WiSI Network operates at a data rate of 250 kbps. A typical WiSI upstream data transmission consists of a data set ranging from 2 to 30 registers (4 to 60 bytes). At the network data rate, this equates to a data transmission time ranging between 0.0001 and 0.002 seconds (plus network overhead). With these very fast data transmission rates, WiSI maintains extremely low communication latency.

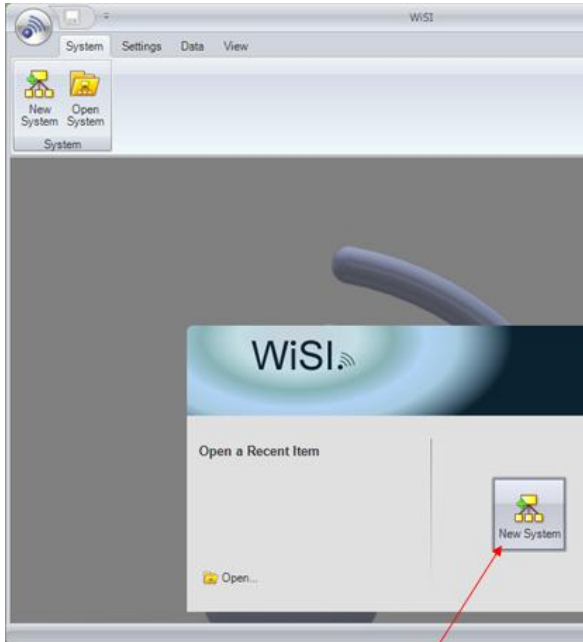
## 2.3 Transmitter Power

WiSI modules currently support a transmit power of 19dBm (79mW).

## 2.4 Network ID

Each WiSI network is primarily identified by its Network ID. This is a 32 bit value that is defined by the WiSI System Developer – usually when starting a WiSI design using the Configuration Console. The Network ID must be unique within the radio reception range of the specific WiSI system under development. Within the Configuration Console, the Network ID is expressed as any combination of 8 hexadecimal characters (0,1,2,3,4,5,6,7,8,9,A,B,C,D,E,F)

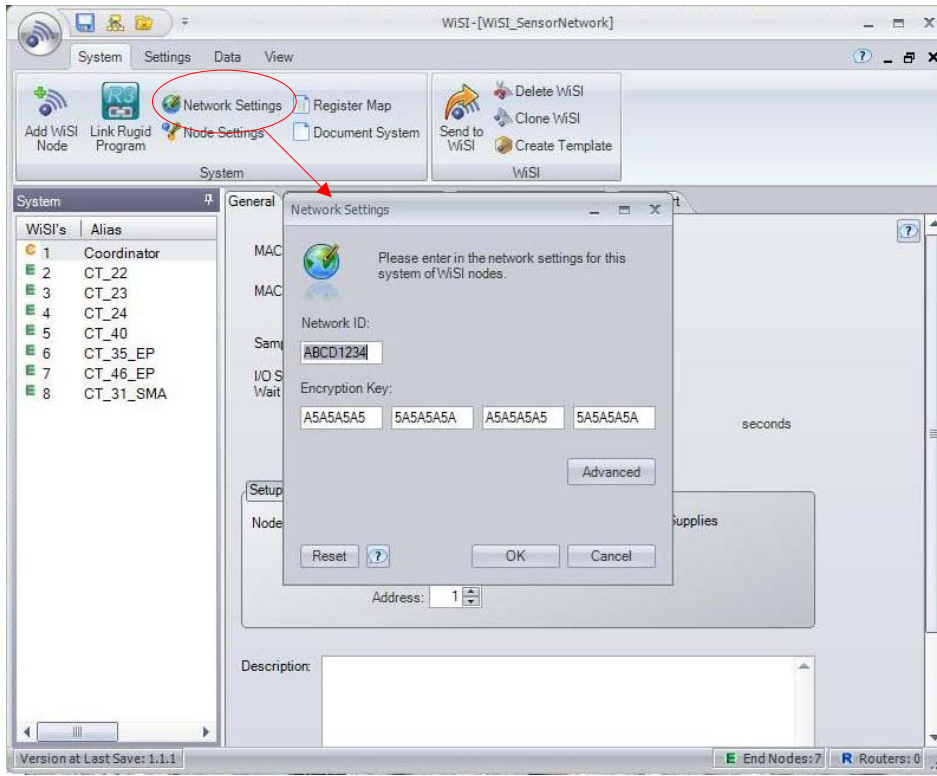
The Configuration Console provides several avenues for setting the Network ID. The first is presented as the first screen when a New System is selected from the WiSI Configuration Console entry as shown below.



*Note: The Network ID identifies a unique WiSI network domain. Make sure if you are working on multiple WiSI designs simultaneously that you have assigned a unique Network ID to each project to avoid network conflicts while the system is under development.*

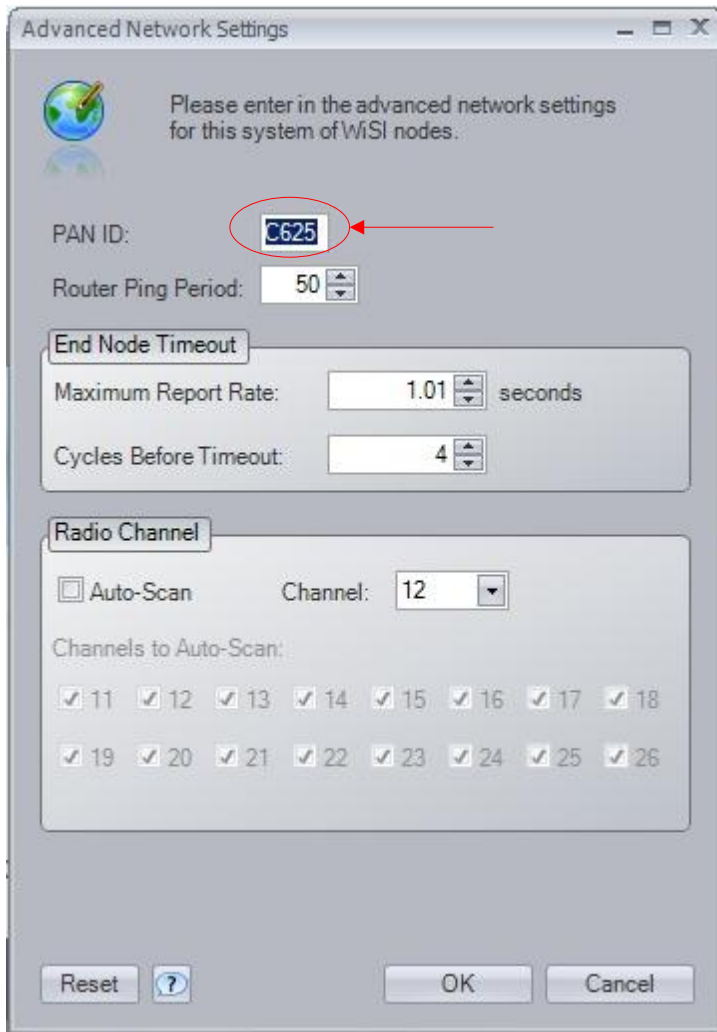


The Network ID can be changed for an existing WiSI system by selecting the “Network Settings” toolbar entry.



## 2.5 Pan ID

The WiSI network provides a secondary level of network identification called the Personal Area Network ID. This is a 16-bit value which should be unique to the network. This value is set by the developer using the Configuration Console Advanced Network Settings screen. Upon initialization, the Coordinator listens for the PAN IDs of any neighboring networks to check that the specified PAN ID is unique – if it is not, the Coordinator assigns a different PAN ID.



## 2.6 Message Encryption and Security

WiSI incorporates security measures to prevent intrusion from potentially hostile agents and from neighboring networks:

- **Encryption:** To prevent external agents from interpreting WiSI messages, the data is encrypted at the source and decrypted at the destination using the same key. Only devices with the correct key can decrypt the encrypted data. Encryption is based on the AES (Advanced Encryption Standard) CCM algorithm. This is a very high security encryption system implemented at the IEEE 802.15.4 level by hardware within the WiSI module.
- **Integrity:** The encryption service adds a 128-bit Message Integrity Code (MIC) to each message which allows the detection of any message tampering by devices without the correct encryption/decryption key.
- **Replay Attack Prevention:** A Nounce (Number Used Once for Session Authentication) is used to protect against replay attacks in which old messages are later re-sent to a device.

The Encryption Key is specified in the Network Settings screen.

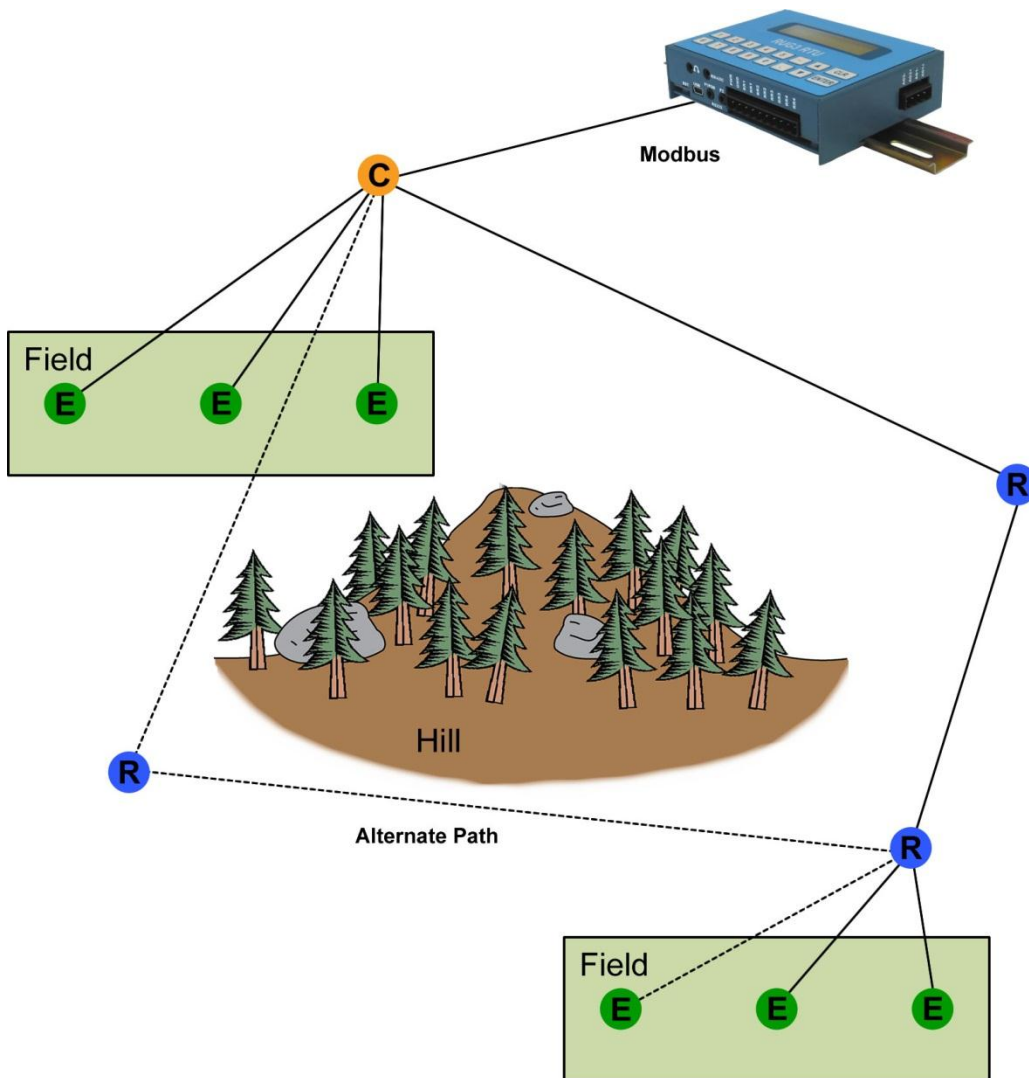


## 2.7 Network Topology

WiSI Network Topology is defined by the physical topology of the deployment site, and by topological network constraints specified through the Configuration Console.

### 2.7.1 Physical Topological Factors

Any real world WiSI deployment will face constraints based on fixed and dynamic factors affecting radio wave transmission and reception. Fixed constraints will include hills, trees, buildings, metal structures such as fences and power lines. All of these physical obstacles affect the ability of radio waves to communicate between nodes of the WiSI network. WiSI radios work best with line-of-sight clear paths between communicating radios. However, a WiSI tree network can effectively communicate around blocking obstacles by relaying node communications through Routers that can “wrap” around an otherwise impenetrable obstacle. In the following example, Routers are used to route the network around a physical obstacle. In this case, the WiSI modules were specifically located so that line-of-sight was maintained.



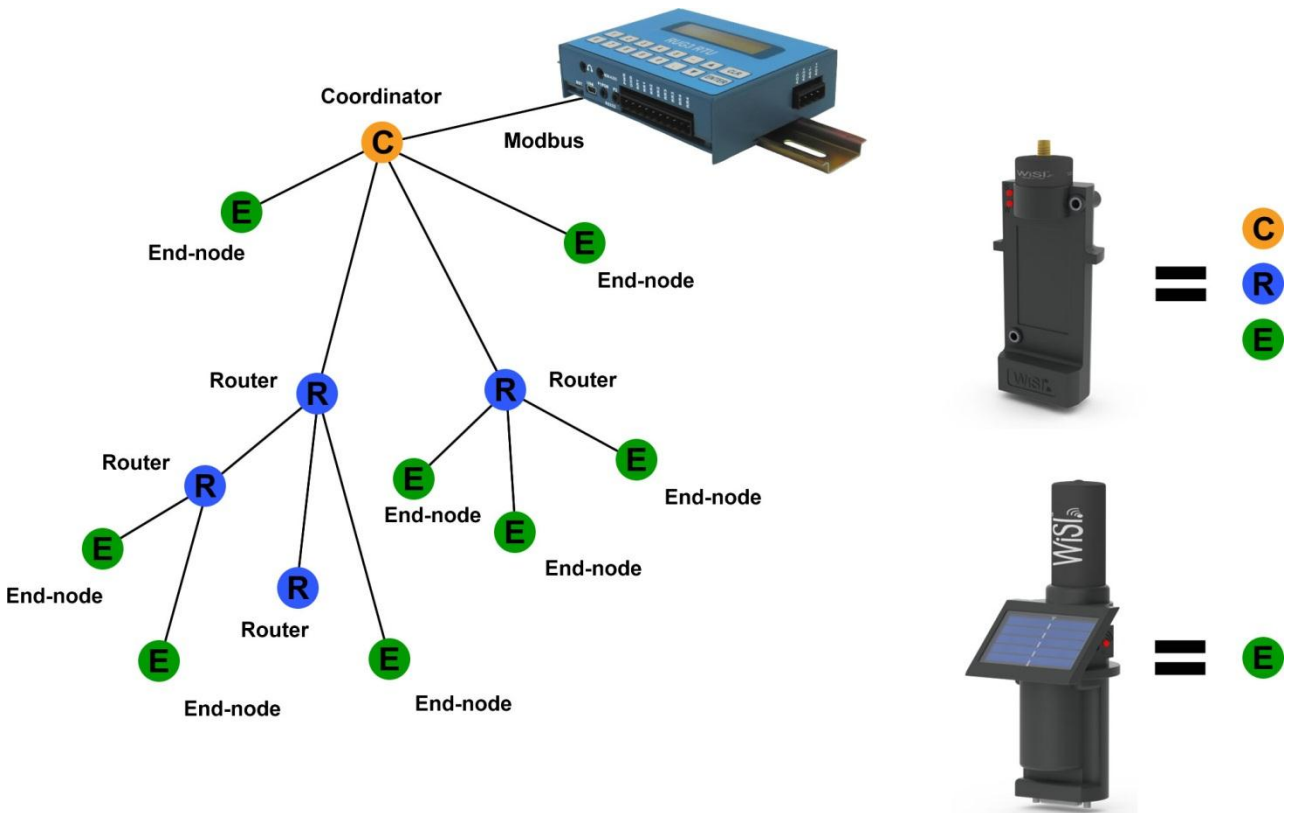
Additional Routers can be strategically placed to provide alternate paths for communication as seen in the example above. These alternative paths are automatically and dynamically adjusted by the WiSI network to optimize signal transmission. Network Path Redundancy considerations will be further addressed in Section 2.7.3.

## 2.7.2 Network Architecture Topological Factors

A WiSI system is a dynamically self configuring network. There are several characteristics that the WiSI system designer can define through the Configuration Console to affect how a WiSI network assembles itself into an operational system.

As seen in the diagram below, a WiSI network consists of a single Coordinator connected wirelessly to a distributed collection of Routers and End Nodes. A key concept of a WiSI network is that Coordinators and Routers can have children (from a network hierarchy perspective), while End Nodes cannot. End Nodes can only connect to the Coordinator or one of the Routers that belong to the network.

During WiSI network development, the Configuration Console creates a database of MAC addresses of every node in the WiSI network. The MAC addresses of deployed Routers/End Nodes must match the MAC address for the particular node entered during development. It is important to note that a WiSI node, programmed with the same Network Application ID, but not part of the target WiSI project, would be able to join the deployed WiSI network. However, the rogue node's data would be ignored by the Coordinator because the MAC of the rogue node would not exist in the MAC address database for this network.



A WiSI network will auto-assemble upon power up of the Coordinator. Upon power up, the Coordinator will:

- Select the specified IEEE 802.15.4 radio channel as described in Section 2.1
- Or, search for the quietest channel from the options specified by the WiSI system developer, and assign the channel
- Start the network using the specified Network Application ID and Personal Area Network ID.
- The Coordinator is then ready to respond to queries from other nodes that want to join the network

Routers and End Nodes will join the existing network with the predefined Network Application ID created by the Coordinator. This association was created by the Configuration Console during the WiSI development. An unconnected Router or End Node scans the available channels to find operating networks and identifies the one to join based on the matching Network Application ID. The Router or End Node selects the attachment point into the network based on the following criteria:

- First – the node selects the closest path to the coordinator (fewest hops)
- Second – selects the upstream node with the fewest connected children
- Third – if there are still multiple candidates, selects the connection with the strongest signal strength

Based on the above criteria, the node then sends a message to the chosen Router/Coordinator asking to join the network. The chosen Router/Coordinator then determines whether it is currently allowing devices to join, and ensures that it has not already reached its maximum number of children. If these criteria are satisfied, the Router/Coordinator then allows the device to join.

There are several key factors under the control of the WiSI developer that influence the resultant network topology. These are the maximum number of Router's and End-point's Children, Sleeping Children, and Hops.

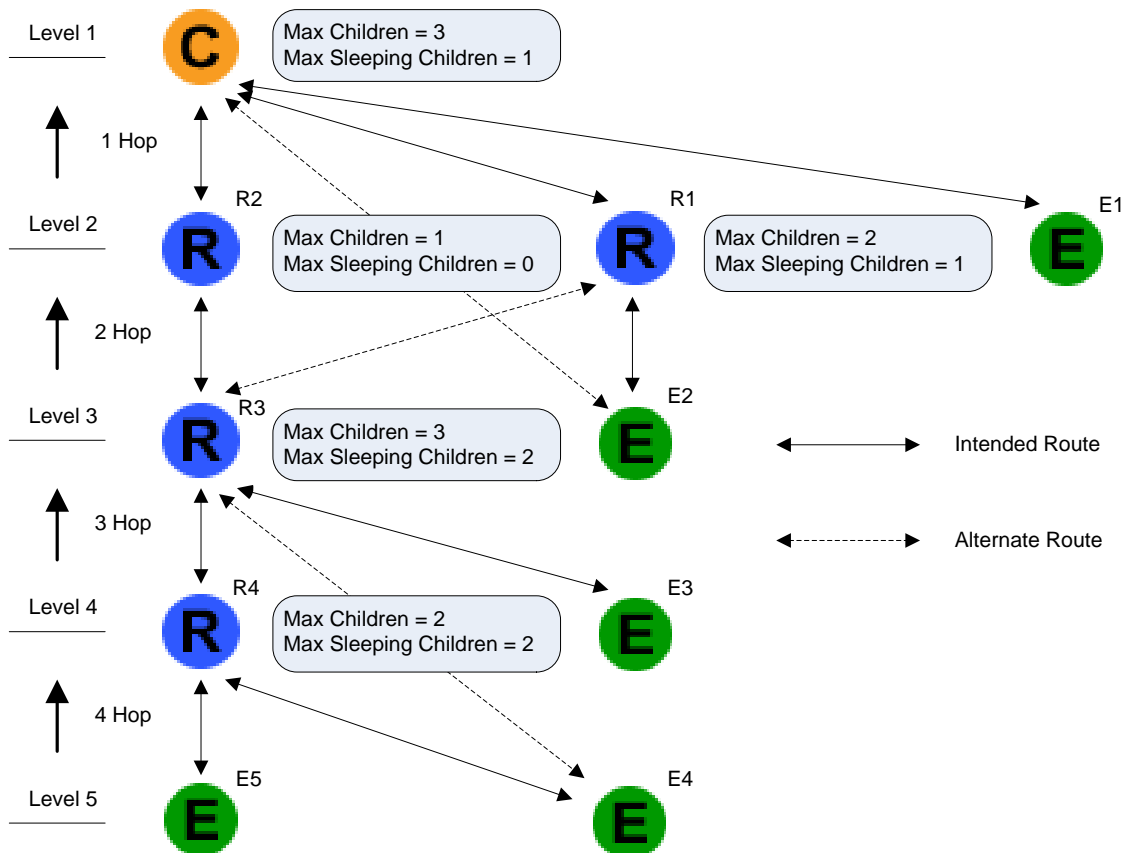
Children are defined as any node which connects downstream in the network hierarchy from the Coordinator. Sleeping Children are End Nodes, where the term sleeping infers that these nodes are normally in an extremely low power state. Sleeping End Nodes periodically wake (as configured by the Configuration Console) to gather sensor data.

### 2.7.3 Designing a Network

The WiSI network will auto-assemble based on the constraints imposed during the design using the Configuration Console. Although it is tempting to attempt to use the constraints of Max Children and Max Sleeping Children to constrain an auto-assembled network into a preconceived configuration – there are risks. The following example shows a hypothetical network consisting of a Coordinator, 4 Routers, and 5 End Nodes. An attempt has been made to constrain the network topology by selecting the Max Children and Max Sleeping Children to force the network to assume the connections defined by the “Intended Route”

Unfortunately, depending on network timing, it is possible that R1 and R2, and E2 may connect to the Coordinator first. This will leave E1 searching for a home with one of the other network Routers. If the line-of-sight is blocked between E1 and the other network routers, it may be stranded permanently, unable to join the network.

Network Hierarchy



As you can see from the above example, attempting to fix-design a WiSI network can have undesirable and potentially unpredictable consequences. Much better results can be achieved by letting the WiSI network auto configure. The following section provides an example of allowing auto configuration, and demonstrates the added advantages of network path redundancy.

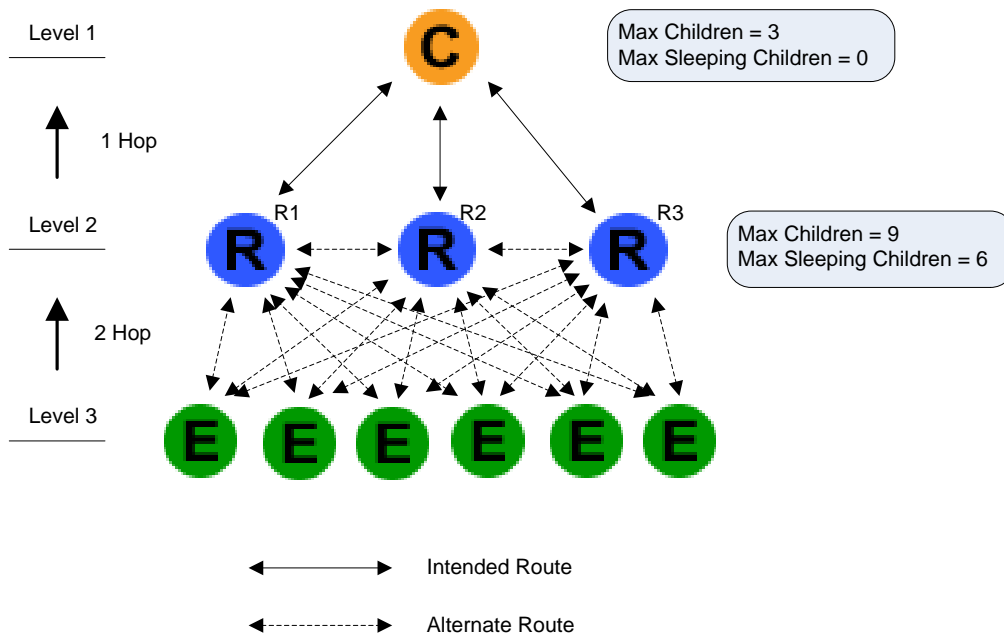


### 2.7.4 Allowing WiSI to Auto Configure a Network

WiSI is an auto configuring network that dynamically adjusts to changing environmental conditions. We can promote the dynamic creation of robust self healing networks by carefully choosing of the “Max Children” and “Max Sleeping Children” parameters

The following example consists of system of a 6 End Nodes supported by a collection of 3 Routers. The Coordinator is restricted to only connecting with Routers. Each Router is configured to allow connection to each of the End Nodes as well as allowing space for two of the three Routers. This configuration will allow any Router to support the entire population of End Nodes. With this configuration, each End Node has assortment of possible network connections, or redundant paths to maintain network connectivity.

#### Auto-Assembled Network Hierarchy



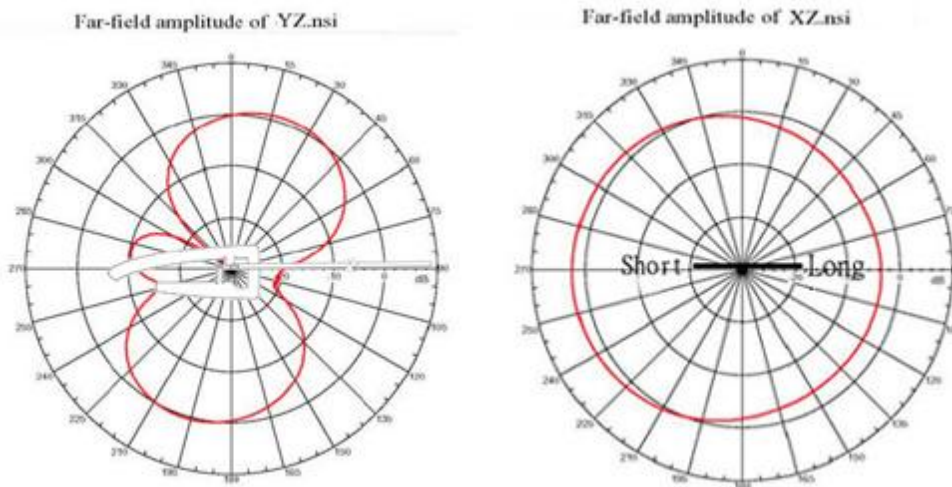
This configuration also shortens the number of “hops” for messages to reach the Coordinator, thus decreasing network latency

### 3 Antenna Selection

WiSI Nodes are available with embedded antennas, or a RP-SMA antenna connector.

#### 3.1 Embedded Antenna

The WiSI embedded antenna provides an Omni field pattern with a gain of 2.5 dBi and linear polarization.



#### 3.2 Router Antenna

Choosing the best Router antenna depends on network topology and reasons for router deployment. A Router is required for every 16 sleeping End Nodes. The WiSI\_OA\_RPSMA 2.5 gain antenna is appropriate for dense applications which require Routers due to high End Node density. In this case, high signal gain is not a driving factor. In contrast, the high gain E-1050-AT antenna is most appropriate in deployments where the system is more linear and requires covering as much distance as possible.

Each WiSI node reports signal strength (RSSI) as a value from 0-255, with 255 being the highest. The Configuration Console can be used to retrieve RSSI information for each node in a deployed WiSI network. Examination of the RSSI data will assist the field engineer in determining the appropriate antenna for each situation. If line-of-sight is obviously in question, then a simple pair of nodes could be used to identify the best or necessary antenna gain for a particular site.

#### 3.3 WiSI Antenna Placement

One of the most important factors when placing any node is its height above its immediate environment. Head height or above is preferred, and the higher the better for maximizing range. If nodes must be placed in positions very close to the ground, then the range may be reduced by between 50% and 90%. It is also important to consider the environment close to the antenna. If possible, avoid placing the node where there are obscuring objects (such as metal pillars, posts or signs) near to the antenna - a close object obscures a wider range of solid angle.

## 4 Network Design Considerations

### 4.1 Adjacent Network Data Isolation

The network ID will need to be unique for each system. Traffic will be increased in the 2.4GHz band so one should consider their choice for reporting frequencies.

### 4.2 Repeater Placement

Router nodes are always available for routing messages. Nodes will dynamically determine the best path back to the coordinator based on signal strength and availability to join a router (parent). Routers are always “on”.

With spread spectrum everything is specified line-of-sight. Repeaters should be placed where line-of-sight is inhibited or the distance is greater than a single hop. All WiSI units report a received signal strength indicator (RSSI), a value from 0-255, with 255 being the highest. A pair of WiSI units could be used for a quick test during an initial site evaluation.

Remember, Routers require an external power source. For remote applications where power is not available this usually involves a solar panel, battery, regulator and enclosure which will increase the installation cost. Routers are also appropriate for sites where instrument/sensor power requirements exceed the capacity of the solar powered node's 25mA power source.

### 4.3 Dynamic Network Adaptation

A WiSI network will auto configure, and re-configure as required to maintain network integrity.

## 5 Network Operation

The WiSI Network consists of a collection of End Nodes, Routers, and a Coordinator. The network is set in motion by configuring each node with the Configuration Console, and applying power. Each End Node and Router will report in to the Coordinator at their specified report interval. The Coordinator gathers the specified remote data, and waits for a Modbus Master query to retrieve the data. Gathered data can be viewed through the Modbus Master, or the Configuration Console.

The data pulled from the Coordinator is always data that is present on the Coordinator at the time of the request. Since nodes call in and update their data based on their configured call in frequencies, the age of the data returned from the Coordinator will be different for each node data.

### 5.1 Viewing Real-Time Data at the Coordinator via Modbus Master

The specific method of viewing remotely gathered WiSI data via the Modbus Master is dependent upon the system implementation, and beyond the scope of this document. However, from a Modbus protocol perspective, the most significant bit of the first register for each nodes block of data will identify if the data is new, or already read. A value of 1 for this bit indicates the data is new.

### 5.2 Viewing Real-Time Data at the Coordinator with the Configuration Console

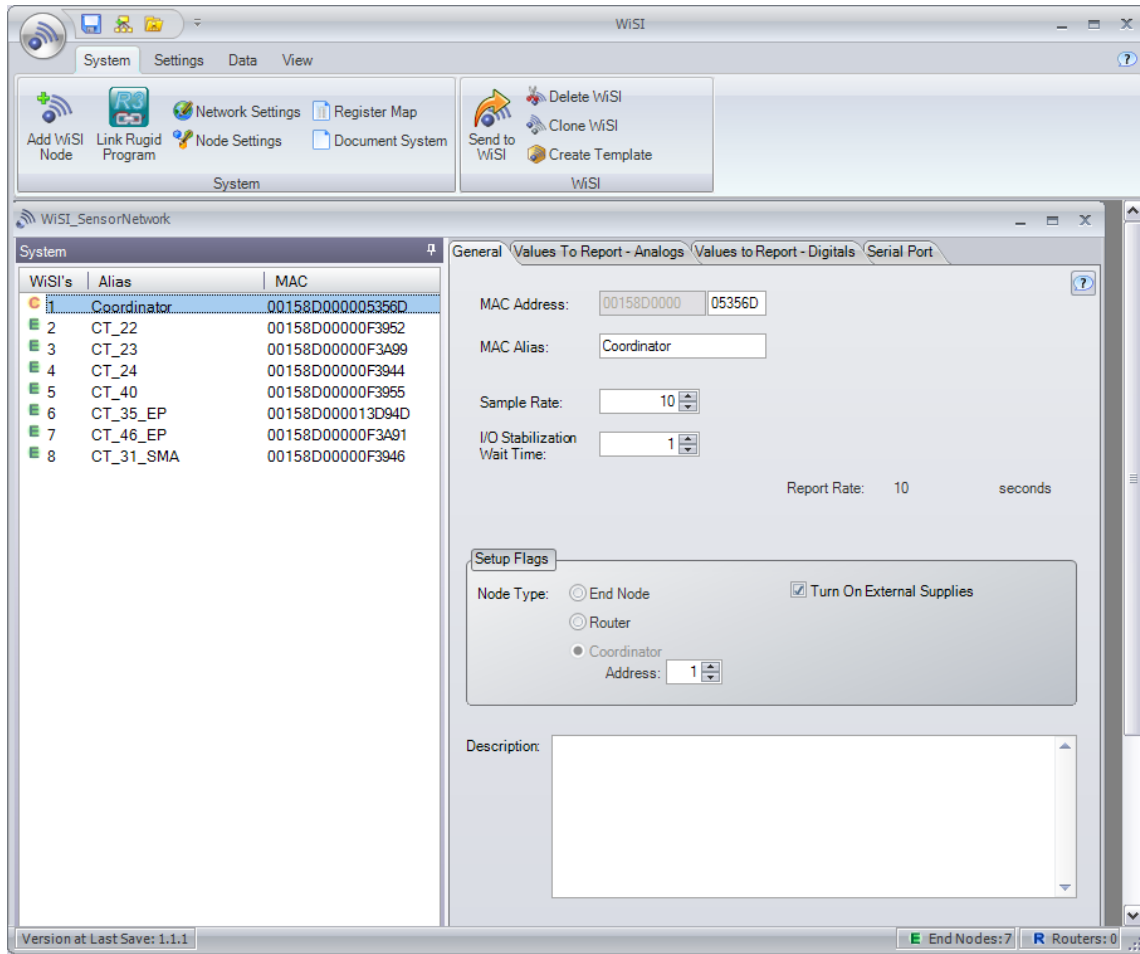
The Configuration Console can be used to view real time data at the Coordinator that has been gathered by downstream Router and End Nodes. It is important to remember that the Configuration Console can only display data for an active network, when the Configuration Console is running the specific Project which corresponds to that specific running network. Consequently, it is not possible to simply plug in a Configuration Console to an unknown running WiSI network, and extract useful dynamic data. This is because the Configuration Console must map the returning data with the specific nodes and variables defined by the WiSI network design. Returning data without the corresponding WiSI Configuration Console Project definition is useless. Therefore, it is important that you make sure you have backed up a WiSI Configuration Console Project for each operational system.

The Configuration Console performs Modbus queries on a specified interval. Simply select the specific node to view the latest reported data.

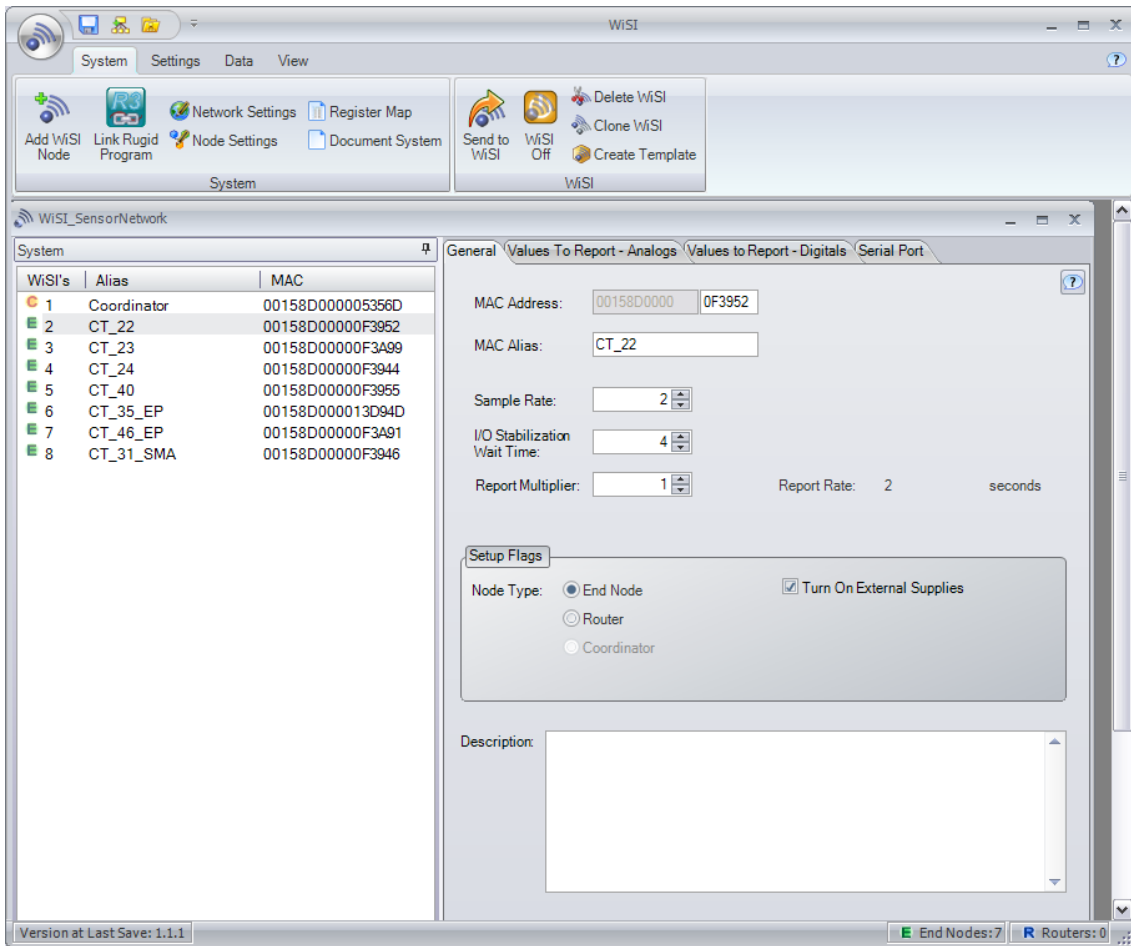
The following example, copied from the WiSI Quick Start Guide demonstrates using the Configuration Console to dynamically view real time sensor data on an operational WiSI network.

The WiSI Configuration Console provides a quick and easy way to view real-time data gathered over the wireless network. Simply connect the Coordinator to the WiSI Configuration Console. The following example shows a WiSI wireless network consisting of a Coordinator and 7 End Nodes.

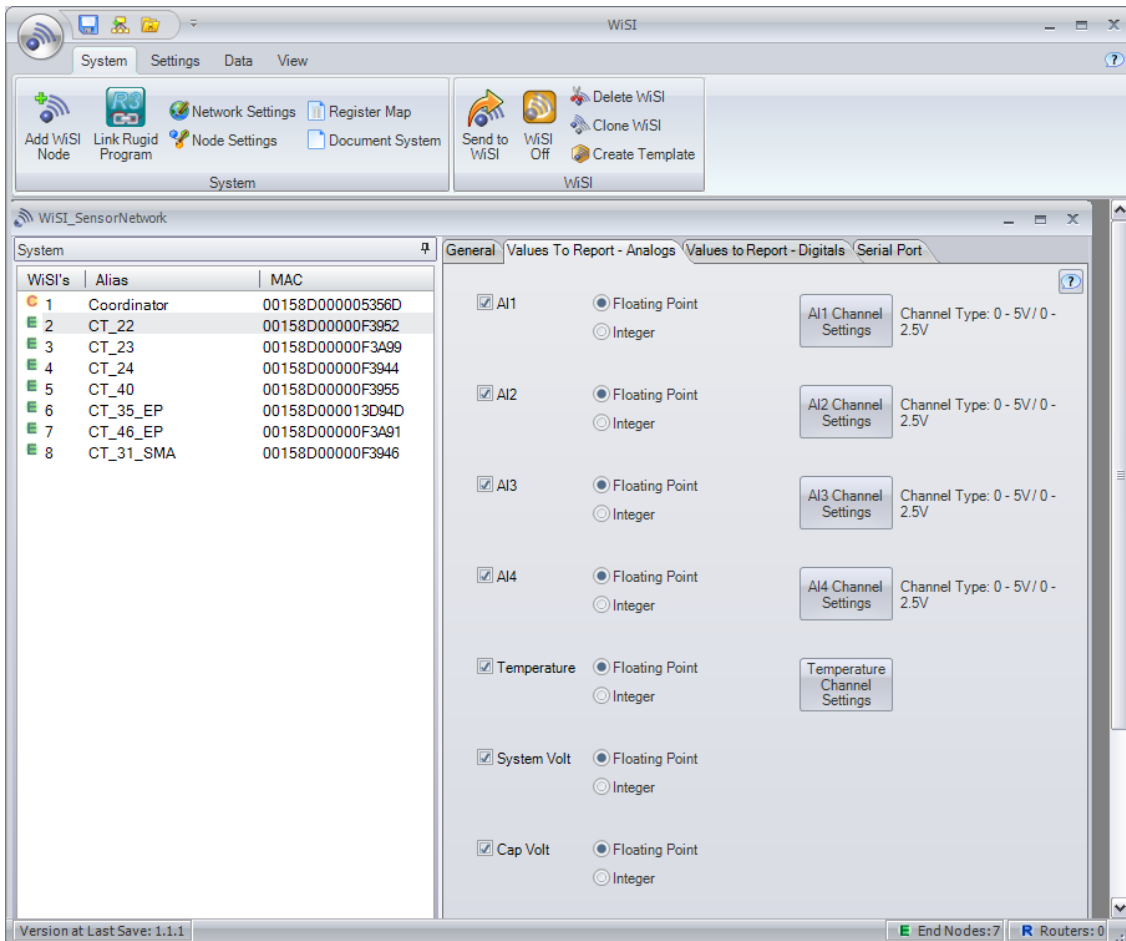
This screen shot shows the configuration of the Coordinator.



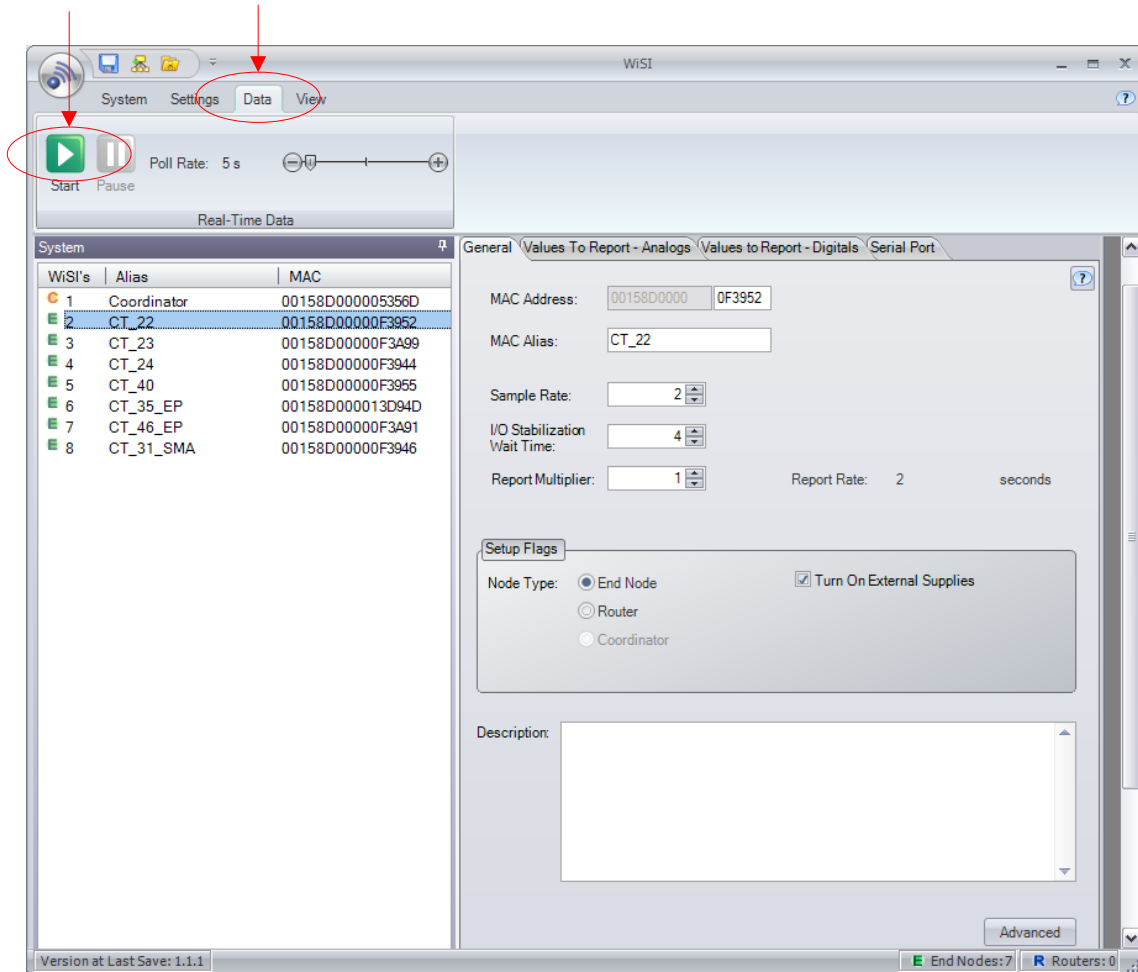
This screen shot shows the configuration of the CT-22 End Node. Note that the CT-22 End Node is configured for a 2 second sample rate, I/O Stabilization Rate of 0.4 seconds, and a Report Multiplier of 1.



The following screen shot shows the configuration of CT-22 End Node Analog Sensor inputs. Note that this End Node is configured to report the sensor values of all 4 Analog inputs, as well as Temperature, System Voltage, and Capacitor Voltage.

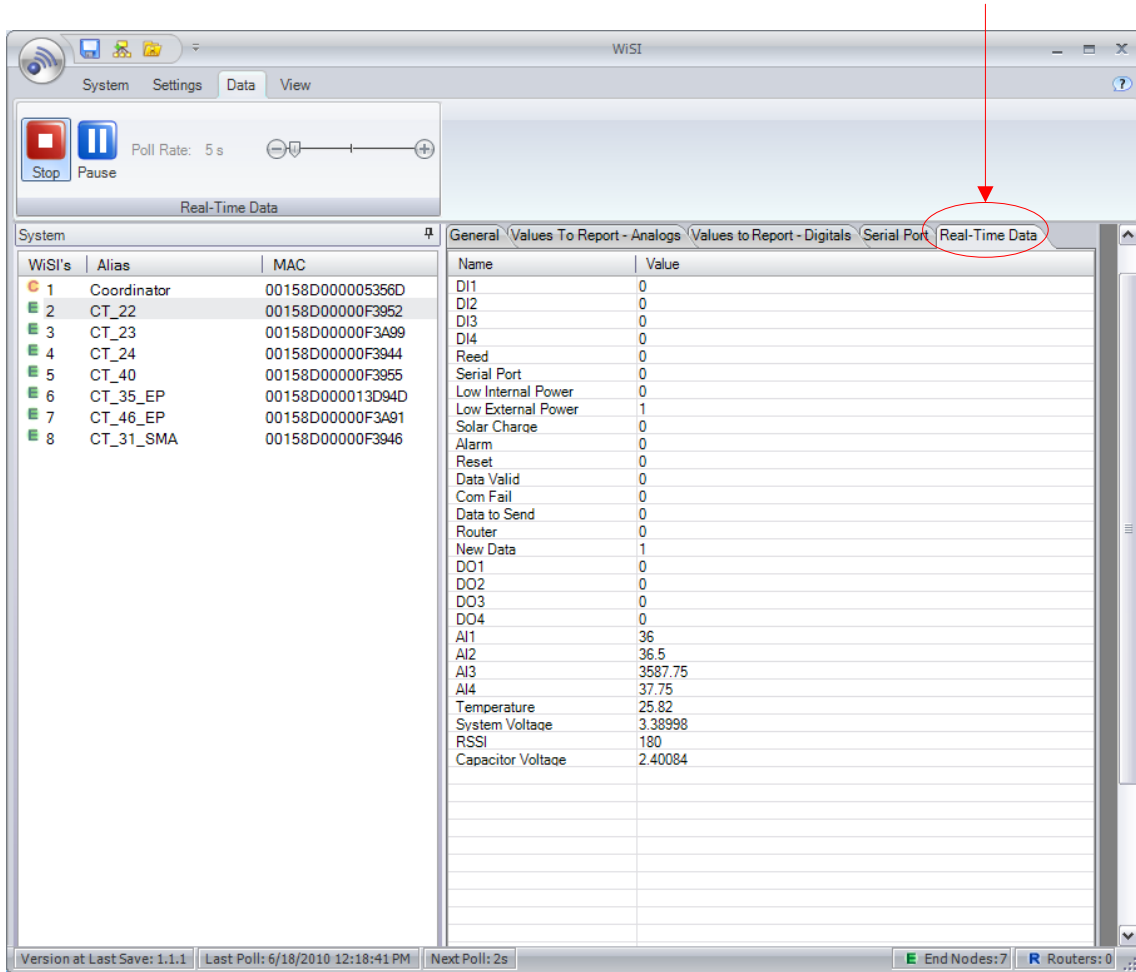


Load all WiSI nodes, and apply power to start the wireless network running. Plug the WiSI Coordinator into the WiSI Docking station (or remotely via RS232 serial connection). Open the project in the WiSI Configuration Console, select the specific WiSI node of interest, and select the 'Data' tab. This will bring up the current view of the sensor inputs for the specific WiSI node. Select the 'Start' button to view data.





Selecting the 'Start' button will add a new 'Real-Time Data' tab to the WiSI Configuration Console tabbed display area. The following screen shows the 'Real-Time Data' tab selected on the running CT-22 End Node. All Real-Time registers are cleared to zero at startup.

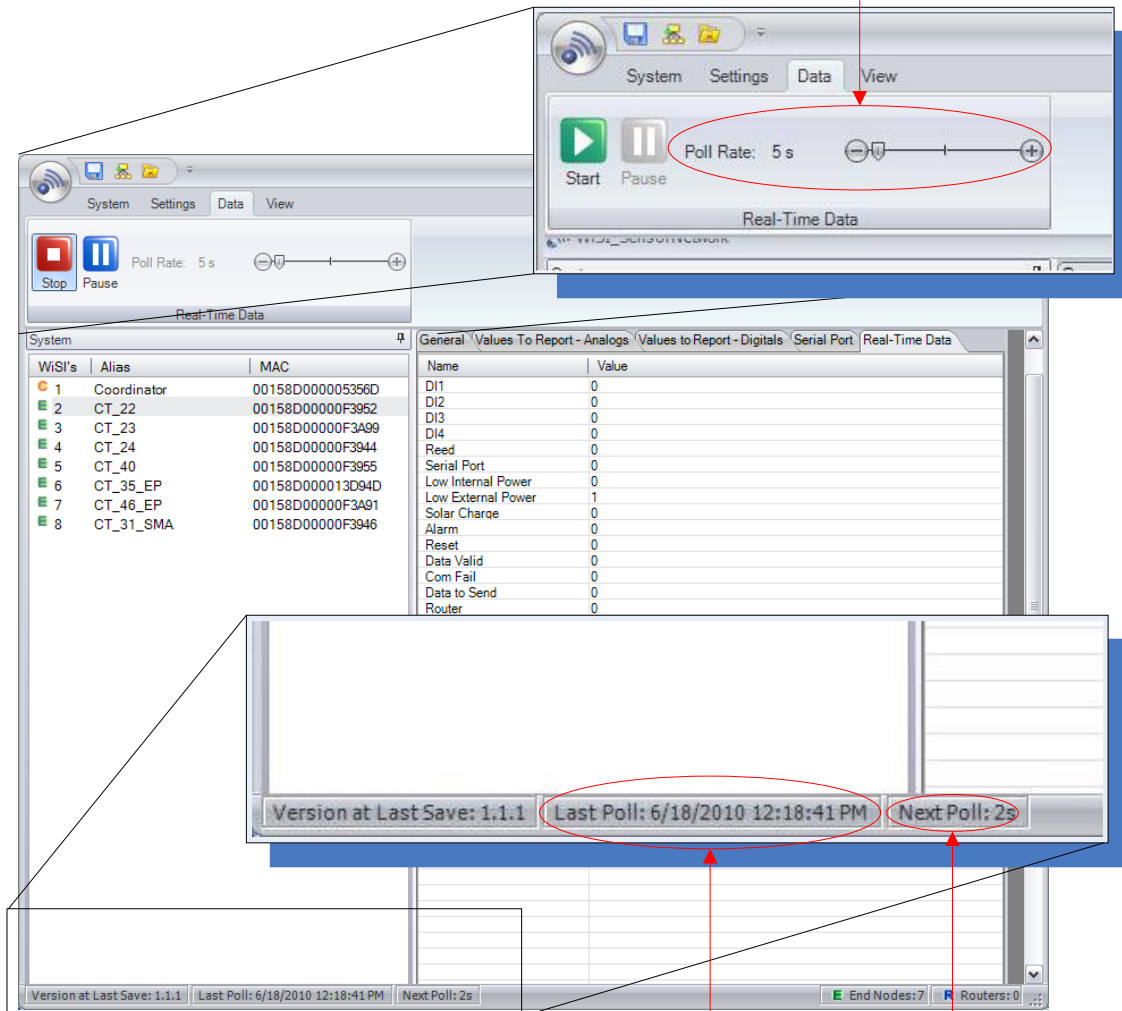


The following table is a list of the possible real time data which can be returned from a WiSI node.

Real-Time Data Name	Value
DI1	Current value of Digital Input 1
DI2	Current value of Digital Input 2
DI3	Current value of Digital Input 3
DI4	Current value of Digital Input 4
Low Internal Power	When capacitor voltage goes below 1.2 volts
Low External Power	When external supply voltage is less than 12.5 volts
Solar Charge	Solar charging occurring
Alarm	An alarm condition has been detected
Reset	If node has been reset – cleared after reporting
Com Fail	Set by Coordinator if node did not report within activity timeout
Router	Bit set if node is a router
New Data	Bit set when an End Node sends data to Coordinator – cleared after Modbus read.
DO1	Current value of Digital Output 1
DO2	Current value of Digital Output 2
DO3	Current value of Digital Output 3
DO4	Current value of Digital Output 4
Reed Wake	Indicates node woken by Reed input
Serial Port Wake	Indicates node woken by Serial Port input
Timer Wake	Indicates node woken by Timer input
Radio Wake	Indicates node woken by Radio Command input
DI1 Alarm	If any of AI or DI channels are configured for Alarming – status bit will be present
DI2 Alarm	If any of AI or DI channels are configured for Alarming – status bit will be present
DI3 Alarm	If any of AI or DI channels are configured for Alarming – status bit will be present
DI4 Alarm	If any of AI or DI channels are configured for Alarming – status bit will be present
AI1 Alarm High	If any of AI or DI channels are configured for Alarming – status bit will be present
AI1 Alarm Low	If any of AI or DI channels are configured for Alarming – status bit will be present
AI 2 Alarm High	If any of AI or DI channels are configured for Alarming – status bit will be present
AI 2 Alarm Low	If any of AI or DI channels are configured for Alarming – status bit will be present
AI 3 Alarm High	If any of AI or DI channels are configured for Alarming – status bit will be present
AI3 Alarm Low	If any of AI or DI channels are configured for Alarming – status bit will be present
AI4 Alarm High	If any of AI or DI channels are configured for Alarming – status bit will be present
AI4 Alarm Low	If any of AI or DI channels are configured for Alarming – status bit will be present
Temp Alarm High	If any of AI or DI channels are configured for Alarming – status bit will be present
Temp Alarm Low	If any of AI or DI channels are configured for Alarming – status bit will be present
AI1	Current value of Analog Input 1
AI2	Current value of Analog Input 2
AI3	Current value of Analog Input 3
AI4	Current value of Analog Input 3
Temperature	Current node temperature in degree C
System Voltage	Radio supply voltage
RSSI	If Router or End Node then Radio Received Signal Strength Indicator – value 0 to 255 If Coordinator then broken into two entries – “Number of Children” & “Number of Nodes”
Capacitor Voltage	Current value of storage capacitor
DI1 – EU Value or Pulse Cnt	Dependent upon how channel is configured to convert pulse counts to engineering units
DI2 – EU Value or Pulse Cnt	Dependent upon how channel is configured to convert pulse counts to engineering units
DI3 – EU Value or Pulse Cnt	Dependent upon how channel is configured to convert pulse counts to engineering units
DI4 – EU Value or Pulse Cnt	Dependent upon how channel is configured to convert pulse counts to engineering units
DI1 – Pulse/EU per minute	Dependent upon how channel is configured to convert pulse counts to engineering units
DI2 – Pulse/EU per minute	Dependent upon how channel is configured to convert pulse counts to engineering units
DI3 – Pulse/EU per minute	Dependent upon how channel is configured to convert pulse counts to engineering units
DI4 – Pulse/EU per minute	Dependent upon how channel is configured to convert pulse counts to engineering units

The Poll Time for retrieving Real-Time Data from the Coordinator can be adjusted with the slider. Select the 'Pause' button to stop polling and view Real-Time Data for any node in the system at the moment 'Pause' was pressed. This makes it simple to compare Real-Time data at any instant across the entire network of WiSI nodes.

Adjust Real-Time Data poll rate with slider.



Display Last Poll Time

Next Poll Time

### 5.3 Viewing Real-Time Data at the End/Router Node with the Configuration Console

Currently you cannot see live data while directly connecting to an end device. This will likely be implemented in the future. However, note that it will require an RS-232 connection to be brought out during installation so that you could connect to the system without removing the IO connections.

### 5.4 Using RSSI to Tune Network Topology

### 5.5 Trouble Shooting a Live WiSI Network

The Configuration Console can be used to provide insight into the real-time operation of a WiSI network. This can be facilitated by mounting a DB-9F connector inside the RTU/Coordinator enclosure to provide simple access to the WiSI Coordinator serial port. When connected to the Coordinator serial port, the Configuration Console can be used to monitor remote data, change configurations, test, and trouble shoot an active network using a laptop.

It is also possible to utilize a standard USB to RS-232 serial converter. The most significant issue when using a USB to serial converter is reproducing serial timing such as pauses between characters. USB packetizes data which can result in characters being grouped together in a packet when really they were meant to be spaced in time. The only timing requirement that could be a problem is the single character that is sent out to wake up a sleeping End Node. This byte wakes up the WiSI and tells the unit to turn on its serial port for an incoming message. With the integrated USB to serial on the WiSI docking station it was found that the 4ms delay is long enough that the single byte was sent to the WiSI before the complete message followed. Since the timing of different converters may be different, this time can be increased with the slider bar in the configuration SW under the "Settings" tab.

### 5.6 Modifying Node Configuration in Operational Network

Altering the configuration of data gathered at an End Node requires the new configuration to be downloaded by the Configuration Console to both End Node and Coordinator. This is because the registers in the Coordinator are dynamically configured and packed together based on the configuration of each End Node. When the amount of data an End Node reports is changed, the alignment of the register is altered. Increasing the amount of data will over write the next nodes data.

Presently, the Configuration Console must be physically connected to the specific End Node to download the new configuration. Any WiSI node can be re-configured in a running WiSI network. However, it is good practice to update the Coordinator first with any reconfiguration before applying the associated End/Router Node configuration change. This will avoid the potential node data overwrite as described above.

A future release of the Configuration Console will support remotely updating the End Node configuration through the Coordinator.