

## Application Note

# Monitoring Network Health

### OVERVIEW

When using wireless technology, connectivity is always a concern, whether it's with your phone connecting to a cell tower, or several radios communicating with each other. In critical applications, it's important to know your network is healthy, and the data is reliable.

The SignalFire network provides multiple diagnostics to monitor your network, such as connectivity status, radio packet statistics, and signal strength.

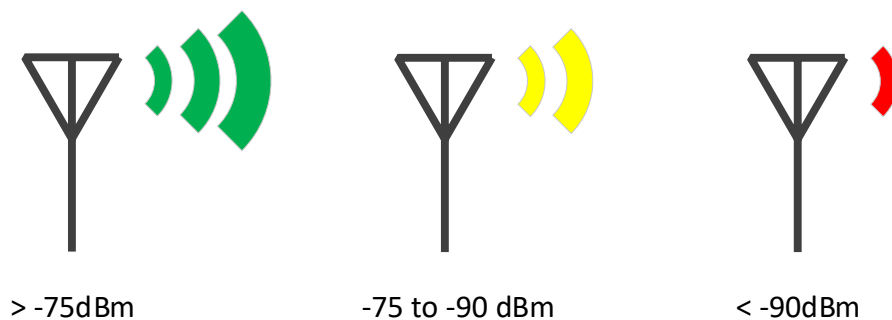
### RSSI

The strength of a signal is given by the Received Signal Strength Indicator (RSSI), the power of transmitted signal once it reaches the receiver. RSSI is on a logarithmic scale, in dBm. 1mW of received signal power is 0dBm, 0.1mW is -10dBm, 0.01mW is -20dBm, and so on, where a more negative number means weaker signal. SignalFire devices send signals orders of magnitude below 1mW, so the RSSI will be within an approximate range of -30dBm down to -110dBm.

Slave ID	Node Type	Node Name	RSSI (dBm)	Battery Voltage (V)	Checkin Interval	TTL (min): Current/Max	Mainboard Firmware	Radio Firmware	Configure
2	Sent MB 2DI	MB2DI	-57	3.285	2 min	10/12	0.58	2.51 (sleeping)	<input type="checkbox"/>

The RSSI of each node can be seen in the ToolKit when connected to the Gateway as one of the columns in the list of Modbus Slaves Reporting. Anything above -75dBm will be highlighted green to indicate good signal strength, -75dBm to -90dBm will be highlighted yellow to indicate medium signal strength, and anything below -90dBm will be highlighted red to indicate weak signal strength.

Communication is bidirectional, so every node has two RSSI's: one for the node transmitting to the Gateway, and another for the Gateway transmitting to the node. The RSSI for the Gateway transmitting to the node can be seen while connected to the node with the ToolKit. The RSSI in both directions should be close to each other; discrepancies may indicate problems in installation.



**To monitor the RSSI of any node, read register 65531 from that device's slave ID.** Seeing a node's RSSI jump around a wide range, or frequently hit below -100dBm may indicate installation issues, while seeing consistently good RSSIs but frequent missed check ins may indicate interference.

## TTL

Every node also has a Time-to-Live (TTL) counter. Due to a variety of factors, nodes may occasionally miss a check-in, though nodes will try multiple times to send each packet. If they do, they will try again at the next check-in, and the node will still appear checked in on the Gateway's list of Modbus Slaves Reporting. If the node repeatedly misses check-ins, the Gateway will consider the node gone after the TTL hits 0. The TTL timer starts off at 5 times the check-in interval, plus 2 minutes, so a node set to check in every minute will have a TTL of 7. If the device does not check in in 7 minutes, it is removed from the Gateway's list of connected devices.

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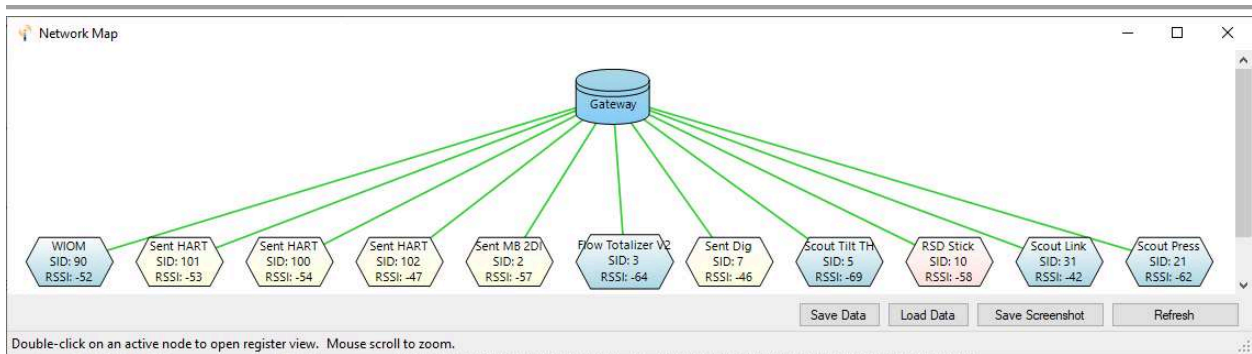
The TTL can be seen in the ToolKit when connected to the Gateway as two numbers. The number on the right is the countdown timer's initial value, and the number on the left is how much time is left on the countdown. In the example below, the TTL for node ID 2 starts at 12. If the node checks in every 2 minutes, the TTL timer will count down to 10 and then reset to 12 before it goes to 9. If it misses a check in, the timer will keep going down and reset to 12 once the next check in happens.

**To monitor the remaining TTL of any node, read register 65533 from that device's slave ID.** Using the same examples, if the TTL of the device keeps going below 10 without resetting, it can be surmised that the node is dropping communication.

## Mesh Network Repeaters

SignalFire radios operate in two modes: Sleeping and Repeater. In Sleeping mode, the radio only turns on at check-in, and is off otherwise. In Repeater mode, the radio is always on and listening for communication, allowing the network to act as a mesh. Nodes that cannot make a direct connection back to the Gateway can pass through nodes in Repeater mode. Nodes that are normally DC powered, such as the Wireless I/O Module and Modbus Stick, are set to Repeater mode by default. Nodes that may be battery powered, such as the Sentinel and Pressure Scout, operate in Sleeping mode by default to conserve power. **It is not recommended to set a node to Repeater Mode if it is battery powered.**

A visualization of how nodes are connected to the Gateway can be seen under Tools → Network Map while connected to the Gateway. Note that even if a node *can* pass through a Repeater and get better signal strength, it will always prioritize a direct connection to the Gateway. Nodes can change their route to the Gateway on the fly if necessary. A node choosing to avoid a Repeater, even if it would result in greater signal strength, does not indicate network issues.



If a node is having difficulty getting back to the Gateway and is missing several check ins, it is recommended to install either a Solar Powered Repeater or a DC-powered node such as a Modbus Stick in between the node and Gateway.

### Radio Packets per Minute

As the number of devices on the network increases, so does the amount of radio traffic. A high amount of radio traffic can overwhelm the system and lead to loss of communication. Each time a node checks in, it typically sends one packet to the Gateway (devices reading Modbus registers may send more). Thus, if a node has a check-in interval of 30 seconds, it is sending 2 packets per minute. If the PLC attempts to write a register over the air, or read a register not cached at the Gateway (called transparent writes and reads), each attempt adds an additional packet.

The total number of packets per minute can be seen in the Gateway window. It is recommended to keep this number to 60 packets per minute or less. If this number goes over 60, the ToolKit will issue a warning to the user. **If the number of nodes and their check-in intervals leads to more than 60 packets per minute, it is recommended that the user install an additional Gateway to handle the traffic.**

Product	GATEWAY(STICK)
Supply Voltage	11.535
Bootloader Version	2.01
Gateway Version	8.30
Gateway Version Date	28-Sep-2020
Radio Version	2.52
Radio Address	4482
Registers in Use	227 of 4700
Slave Entries in Use	11 of 240
Radio Packets/Minute	21 (Ideal Max of 60)

Packet-Per-Minute Calculator		
Enter the number of remote nodes at each check-in interval connected to the gateway.		
# Nodes	Check-In Interval	Packets Per Minute
1	5 seconds	12.0
2	15 seconds	8.0
6	1 minute	6.0
4	2 minutes	2.0
0	4.5 minutes	0.0
2	10 minutes	0.2
0	15 minutes	0.0
0	30 minutes	0.0
0	60 minutes	0.0
PACKETS PER MINUTE		28.2
(Packets per minute should be 60 or less for ideal communications.)		

Before installation, users may calculate the estimated packets per minute by going under Tools → Packet/Minute Calculator while connected to the Gateway and entering the number of nodes for each check-in interval.

## Modbus Registers

To monitor the health of the network, each node has registers for RSSI and TTL as previously mentioned, while the Gateway has a variety of registers as well, noted below:

**Slave ID** – Whether a specific Slave ID is present can be seen **starting at register 4001**. For example, to see if Slave ID 42 is present and connected, read register 4042 from the Gateway. If the node is present, it will be a '1', and if it's not present, it will be a '0'. A device goes from '1' to '0' if its TTL drops to 0, so this register can only be used to tell if the device is present, not if it's getting every check in.

The Gateway also stores this information in a more condensed form in registers **2000 – 2024**. Rather than a separate register for each slave ID, each register is a bitmask for the presence of 16 registers. For example, if slave ID 5 is present, the 6<sup>th</sup> bit from the right of register 2000 will be a '1'. Once its TTL drops to 0, that bit will be a '0'.

**Number of Slaves** – The number of slave ID's reporting in can be seen in register **2006**. This can be an alternative to checking each individual slave ID as a simple way to see if all the nodes are reporting in to the Gateway. For example, if it's known that there are 10 devices checking in to the Gateway, this register should always be 10. If it drops below this value, that means a node has dropped out and the network has issues.

**Radio Packets per Minute** – The current number of radio packets per minute can be seen in register **2032**. An alarm for the packets per minute can be seen in register **2033**, which flags '0' if the number is 60 or below, and flags '1' if the number is above 60.

## Gateway Log

The Gateway keeps a log of events, such as Node connects/disconnects, reboots, and RSD relay triggers. To view the log, go to Tools → View Gateway Log while connected to the Gateway in the ToolKit. This log also records every time a node is added or dropped from the list, as well as its RSSI and battery voltage. It can be quickly seen if a node is repeatedly dropping out and coming back, and if it's because of poor signal or a low battery. The screenshot below shows an event where a node comes online and then goes offline after missing check-ins.

2/25/2021 3:30:29 PM	558	NODEINFO	Slave 4 Timed Out, Radio Address 91690, Field Mon, Checkin Interval=6 sec, RSSI=-61, BattmV=3337, PPM=19
2/25/2021 3:28:28 PM	557	NODEINFO	Slave 4 Added, Radio Address 91690, Field Mon, Checkin Interval=6 sec, RSSI=-63, BattmV=3339, PPM=16

SignalFire nodes, specifically the Sentinels, Scouts, and Flow Totalizer, collect information on their connection and regularly send them to the Gateway. This info can be seen in the Node Statistics tab of the Gateway Log in version 2.2.21 of the ToolKit or later. This tab shows various metrics useful in diagnosing a network such as the number of packets sent and received, and number of retries. Note that for the Gateway to receive this information, the Gateway's firmware must be v8.30 or later. Nodes must have up to date firmware as well. Devices must have the following minimum firmware specified:

- Sentinel Analog v0.71
- Sentinel Digital v0.59
- Sentinel HART v0.64
- Sentinel Turbine v0.59

- Sentinel MB v0.65
- Sentinel MB2DI v0.58
- Pressure Scout v0.90
- Tilt Scout v0.84
- Link Scout v0.03
- Flow Totalizer V2 v1.12

Gateway Log							
Gateway Log				Log Statistics			
Node Statistics				Email Logs to Tech Support			
Slave ID	Node Type	Node Name	# Entries	Total Tx Count	Total Rx Count	Total Retry Count	Average Retry %
2	Sent MB 2DI	MB2DI	562	75564	52	5693	7
5	Scout Tilt TH	HATCH	566	17432	3	1826	10
7	Sent Dig	Discrete	566	145619	5	11709	8
21	Scout Press	PScout21	565	76702	15	6379	8
100	Sent HART	Vega81	564	550343	12923	20347	3
101	Sent HART	Rose5300	564	541529	34	23036	4
102	Sent HART	YokoEJA	562	537533	0	22061	4

**DETAIL VIEW**  
 Click on row in the table above to show details for a specific Slave ID.

Timestamp	Sequence #	Radio Address	Slave ID	Battery Voltage (mV)	Tx Count	Rx Count	Retry Count	Scan Tx Count	Scan Count	Retry %
3/9/2021 10:56:19 AM	5996	23856	2	3280	136	0	12	0	0	8
3/9/2021 6:55:55 AM	5989	23856	2	3275	132	0	8	0	0	6
3/9/2021 2:55:35 AM	5982	23856	2	3262	138	0	14	0	0	10
3/8/2021 10:55:10 PM	5975	23856	2	3272	131	0	7	0	0	5
3/8/2021 6:54:43 PM	5968	23856	2	3283	140	0	16	0	0	11
3/8/2021 2:54:19 PM	5961	23856	2	3283	137	0	13	0	0	9
3/8/2021 10:53:52 AM	5954	23856	2	3278	130	0	6	0	0	4

Refresh Clear Detail View Show All Load Stats from File Save Stats to File

When encountering issues, the Gateway log can be sent to SignalFire support for analysis and troubleshooting. To do so, click on the “Email Logs to Tech Support”. The ToolKit will automatically download all the necessary log files and attach them to an email to [support@signal-fire.com](mailto:support@signal-fire.com).