WN-100 User Guide

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FCC §15.19(a)(3) / RSS Gen 7.1.5- FCC two-part warning statement:

“The WN-100 device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.”

FCC §15.21 warning statement:

"Changes or modifications not expressly approved by Newtrax Technologies Inc. could void the user's authority to operate the equipment."

The antenna(s) used for this transmitter must be installed to provide a separation distance of at least 20 cm from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter. End users and installers must be provided with antenna installation instructions and transmitter operating conditions for satisfying RF exposure compliance.

The modular transmitter must be labelled with its own FCC ID number, and, if the FCC ID is not visible when the module is installed inside another device, then the outside of the device into which the module is installed must also display a label referring to the enclosed module. This exterior label can use wording such as the following:

> *“Contains Transmitter Module FCC ID: TXKWN-100 or “Contains FCC ID: TXKWN-100”*
>
> *“Contains Transmitter Module IC: 6314A-WN100 or Contains IC: 6314A-WN100”*

1 Introduction

This document will guide you through your first successful installation of a Newtrax wireless mesh network development kit.

This document contains important troubleshooting information. You may ask specific questions by e-mail at support@newtraxtech.com or by phone at 1-877-NEWTRAX.

2 Development Kit Quick Start

In order to quickly use the development kit, perform the following steps:

1. Power up the IGS-100 by plugging in the power cord. It takes approximately 60 seconds to be ready. Its default IP address is 192.168.0.10. It can be changed to be compatible with your LAN with the following steps:
   - Modify the IP address of any computer such that the subnet matches.
   - Connect that computer to the IGS-100 with a cross-over Ethernet cable.
   - Connect through telnet (see 2 below) and type the setigsip command. Enter the new IP address.
   - Modify the IP address of the computer to its original value.
   - Connect both the computer and the IGS-100 to the LAN.
2. Connect via the IGS-100 through any computer that supports telnet. Type the following command:
   - **telnet [IGS-100 IP address]**

   Figure 1 shows a sample connection boot-up text.

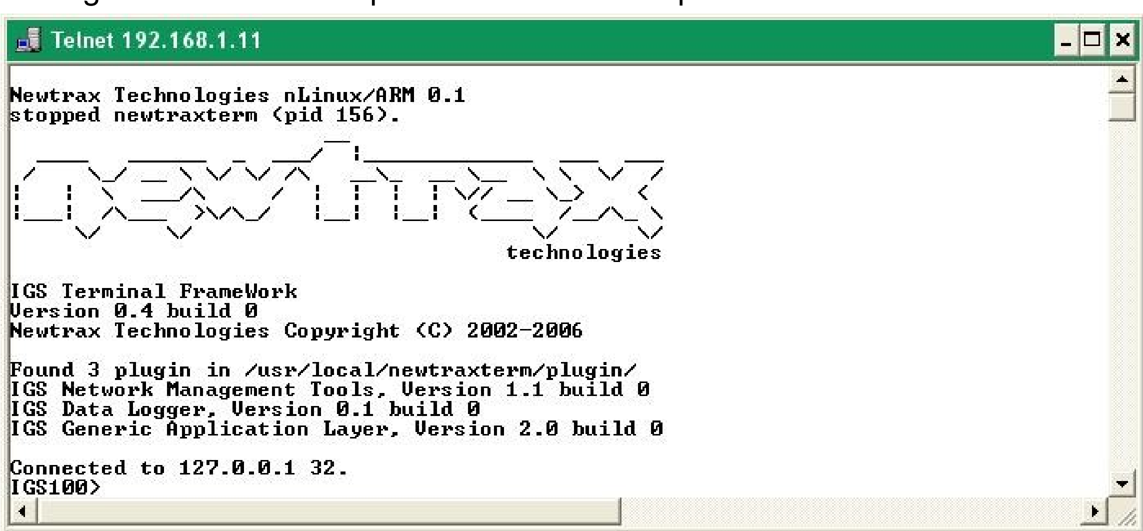

Figure 1: IGS-100 connection boot-up text

3. Turn on the WN-100 wireless nodes, using the JP1 jumpers, with an interval of 10 seconds between each turn on. Each node should be at a minimum distance of 1.5 m to each other. Start with the ones closest to the gateway and continue onward.

   In the network forming process, you should observe the following:

   - At power up, a wireless node scans the network for a nearby node to connect to. The LEDs remained turned off until completion which lasts a maximum of 55 seconds.
   - If the WN-100 finds a nearby node, its green LED will blink. Otherwise, its red LED will blink, indicating it is waiting for other nodes to connect to it.
   - Every node will then look for the gateway, as they are programmed in the default application layer. A node's LEDs can occasionally stop blinking in that process until the node finds a route. Some of the nodes will have both green and red LEDs blinking after the gateway is found.

   At the end, every node should have any of its red or green LED blink at a pace of 686ms. This process should last a maximum of 10 minutes. There should be, at minimum, an equal number of WN-100 nodes with their green LED blinking than WN-100 nodes with their red LED blinking. In low-power mode, the LEDs turn off completely after 15 minutes of operation. If all nodes that should be in RF range only have their red LED blinking, there is something wrong. See the Section 9 - Network Management Tools and Section 10 – Troubleshooting of the User Guide for details on how to troubleshoot the network.

4. Type **help** on the IGS-100 console in order to view all commands that may be sent to a node or the gateway. A WEB server and a FTP server (login: igs, password: anonymous) are also available at the IGS-100 IP address.

5. If you want to view a log of what appeared on the terminal window, type the IGS-100 IP address on any web navigator and open the file name set with the *logpath* command.

3 Default Application Layer

The default application layer is provided as example and the source code is freely available on the development CD. It is strongly suggested to understand your RF environment, as explained in Section 5 - Considerations for an Optimal RF Link before implementing your own application. The default application layer does the following:

3.1 Automatic routing to gateway

Every wireless node attempts to make a connection with the gateway. When a device has a successful connection, its net ID, a unique 32-bit number, and the application version and build numbers appear in the terminal window:

IGS100> netID: 14, Msg: Application Version 2.0 build 0

3.2 Periodic transmission of thermistor input

Every wireless node in the network automatically transmits the thermistor input every 100 seconds. In the terminal window, the origin node netID, the type of sensor and the temperature reading will appear:

IGS100> netID: 14, Msg: Acquisition Data, SensorID: Thermistor 1, Data: 25.00

If the thermistor is not connected, the value will be erroneous.

3.3 Remote configuration, monitoring and control via the IGS-100

A user may send commands to any wireless node in the network for remote configuration, monitoring and control. The documentation of the available commands is displayed when typing *help* in the terminal window: See Section 9 - Network Management Tools for more information.

4 Newtrax Flat Mesh Network Protocol Stack Features

In the flat mesh network topology, each node acts as a router to any other node in the network. Figure 2 illustrates an example of a wireless network topology.

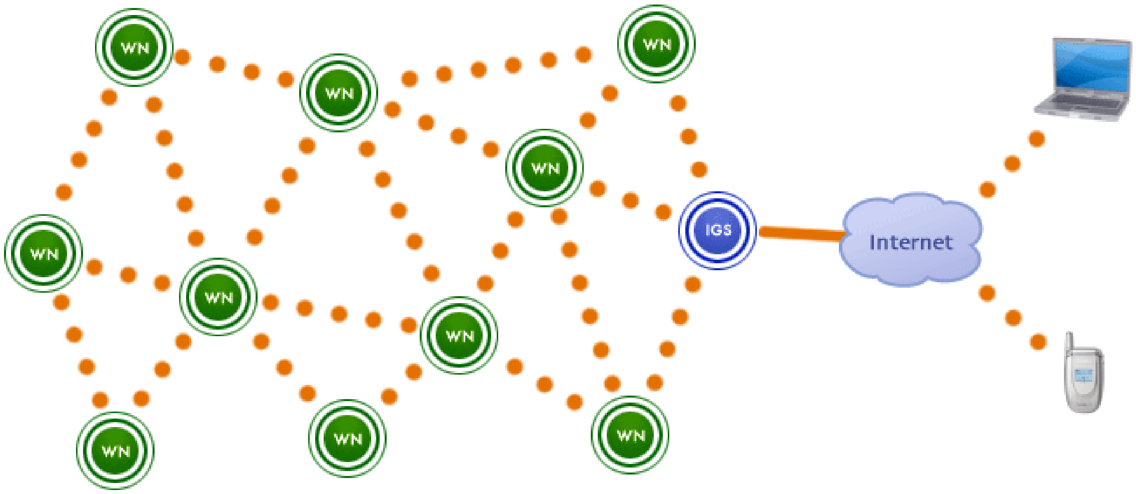

Figure 2: Typical wireless sensor network architecture

The network is self-forming, self-healing and self-optimizing. Here is a short description of each feature:

4.1 Self-forming

As outlined in Section 2 - Development Kit Quick Start, network self-forming after startup follows these network discovery steps:

1. A wireless node looks for nearby nodes to connect to. If it does not find any, it makes itself available for others to connect to it.
2. If a wireless node does not have a route to the gateway, or to any other node it wishes to connect to, it will scan the network for connection.
3. The steps 1 and 2 are repeated until the node receives an answer of successful connection. This process may take up to 10 minutes, depending on the node density.

4.2 Self-healing

If one of the node is powered down or is malfunctioning, a route to the gateway may be broken. In that case, every node in that route is notified and a new network discovery process, as outlined in the previous section, is automatically initiated.

4.3 Self-optimizing

If a node finds out it has a weak RF link with another node or becomes notified of a shorter route, it may drop a connection. It will then attempt to discover or switch to a better route.

5 Considerations for an Optimal RF Link

There are simple ways to optimize the quality of a RF link, only by considering the antenna, enclosure and locations of WN-100 nodes in the network.

5.1 Antenna knowledge base

The antenna performance is affected by its orientation and its polarization and by the ground plane.

Antenna orientation

The antenna orientation is important in order to maximize the line-of-sight range: antennas of communicating WN-100 nodes should have the same orientation.

However, when the environment is harsh, RF signals coming from reflections dominate such that antenna orientation does not play a significant role.

Antenna polarization

Polarization refers to the orientation of the lines of flux in an electromagnetic field. It is dependent on the type of antenna and the orientation of the ground plane relative to the antenna.

If the transmitter and receiver's antennas do not have the same polarization, a certain amount of power will be lost.

In order to minimize the effect of polarization on performance, you should use the same type of antenna, oriented in the same direction relative to the ground plane, for all nodes.

Antenna ground plane

In the case of a quarter-wave antenna, the ground plane acts as a counterpoise to form, a centered half-wave dipole. Since this plane is essentially the other half of the antenna, its size and proximity are essential. Often an antenna can appear smaller than its specified wavelength. This is due to internal mechanical tricks, such as helical windings, that can reduce the antenna's physical size. This does not mean that the same size is appropriate for the ground plane. A compromised ground plane can affect antenna pattern and can detune the antenna.

Optimum performance will be obtained from a quarter or half-wave straight whip mounted at a right angle to the ground plane. In many cases, this is not desirable for practical or ergonomic reasons, thus, an alternative antenna style such as a helical, loop, or patch may be used and the corresponding sacrifice in performance accepted.

Figure 3 illustrates various ground plane polarization relative to the antenna and possible trade-offs.

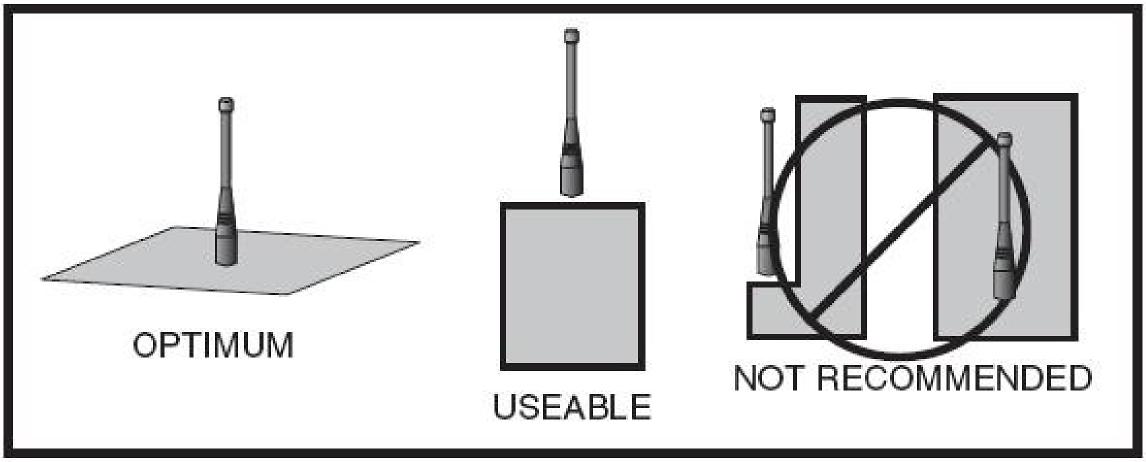

Figure 3: Ground plane polarization

5.2 Suggested antenna types

RSS Gen 7.1.4 warning statements:

"This device has been designed to operate with the antennas listed below, and having a maximum gain of 3 dB. Antennas not included in this list or having a gain greater than 3 dB are strictly prohibited for use with this device. The required antenna impedance is 50 ohms."

- *3.0 dBi Whip with coaxial cable and magnetic base*

  (Antenna Factor, ANT-ELE-S01-005)
- *2.4 dBi Whip (Antenna Factor, ANT-916-CW-RCL)*

"To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that permitted for successful communication."

The Linx Technologies website support section, in particular the application note AN-00500, contains useful information.

5.3 Enclosure

As outlined in the previous section, the enclosure may hinder the performance of the RF system. For optimal performance, the antenna should be **completely** at the exterior of the enclosure, clear of any nearby conductive objects except the ground plane.

If you require the antenna to be inside the enclosure, the enclosure must be in plastic. The location of components around the antenna and enclosure, especially metallic ones, must be carefully chosen. Newtrax performed the following tests with two communicating WN-100 nodes with a RCL antenna enclosed in a small plastic enclosure. Both enclosures had a D battery inside.

- Without the board, antenna and battery immersed in epoxy: The range is approximately 80% of the range of two communicating WN-100 with their antenna completely outside.
- With the board, antenna and battery immersed in epoxy: The range is approximately 50% of the range of two communicating WN-100 with their antenna completely outside.

A panel-mount crimped antenna must be attached to a metallic enclosure.

5.4 Finding the optimal location of WN-100 nodes

For optimal performance, a network should be installed in an area where collaborating wireless nodes have as much line-of-sight as possible between each other. If you can avoid installing wireless node within high-attenuation materials, such as thick concrete or metal, you should investigate methods of doing so.

It is recommended to test the WN-100 nodes in your environment before making an installation. With the default application layer, follow these simple steps:

1. Position two wireless nodes at a minimum distance of 1.5 m to each other.
2. Power on one node and wait until its red LED blinks.
3. Power on the other node and wait until its green LED blinks. If it does not, go back to step 1.
4. Two people should walk around and position themselves with the wireless nodes within the areas where you plan to install the wireless nodes.
5. When the RF signal is optimal, the green LED blinks at an interval of 686 ms. The less frequent the green LED blinks, the weaker the RF signal is. If the green LED blinks correctly a minimum of 90% of the time, the RF link is acceptable.

Section 10 - Troubleshooting describes how the LEDs should be blinking in more details.

In turn, you will find out where to optimally install the WN-100 nodes and if you have to add WN-100 repeater nodes in extremely harsh locations. You may also find out that your enclosure and antenna are not optimal for RF communication.

6 WN-100 Hardware

6.1 Power

Requirements

- 3.0 to 5.5 VDC @ 250 mA minimum unregulated power input into the VBATT input of the terminal block.

Two M3 screw holes on the WN-100 motherboard can be used to fix a custom power conversion PCB.

Power consumption

Power consumption by mode:

- Sleep: 60 µA
- Application processing: 2.3 mA / input
- Rx: 18.3 mA
- Tx @ -4 dBm: 31.7 mA
- Tx @ 11 dBm: 70.0 mA

Recommended batteries

Any Lithium Thionyl Chloride (Li/SOCl2) 3.6V battery or rechargeable 3.6 Lithium-ion battery.

Life time

With a 16000 mAh 3.6 V Lithium-Thionyl-Chloride battery, a device will have a following life time if the payloads are sent periodically at an interval of:

- 10 seconds: 9 months - 1.5 year
- 1 minute: 1 year - 1.8 year
- 10 minutes: 1.1 year - 2 years

The network can be slowed down in order to achieve a higher life time.

6.2 *Inputs and outputs*

The inputs and outputs are accessible via the 3.5 mm #28-16 AWG J2 terminal block on the WN-100. All but one of the inputs and outputs are connected to the WN-100 MCU - the 4-20 mA input requires a Dual-MCU architecture.

RS-232

The RS-232 connection is a standard 3-pin RS-232 - RS232RX, RS232TX and GND of terminal block J2 in the standard development kit.

Open-collector output

Figure 4 illustrates the functional diagram of the output-collector outputs, pins OC_OUT1 and OC_OUT2 of terminal block J2 in the standard development kit. It is essentially a digital output that can be pulled-up with any voltage source VCC_CLIENT and resistor R_CLIENT.

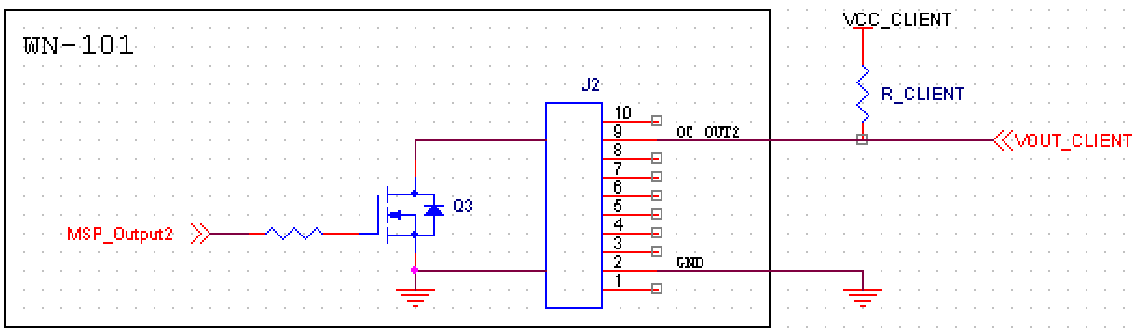

Figure 4: Open-collector output user interface diagram

Dry contact input

Figure 5 illustrates the dry-contact input user interface, pin DC_IN of terminal block J2 in the standard development kit. An open-circuit is logical 1 while ground is logical 0. The maximum resistance to guarantee closed contact of DC_IN to ground is 150 kOhm while the maximum leakage current to guarantee open contact is 1 uA. Current consumption is 10 uA when closed.

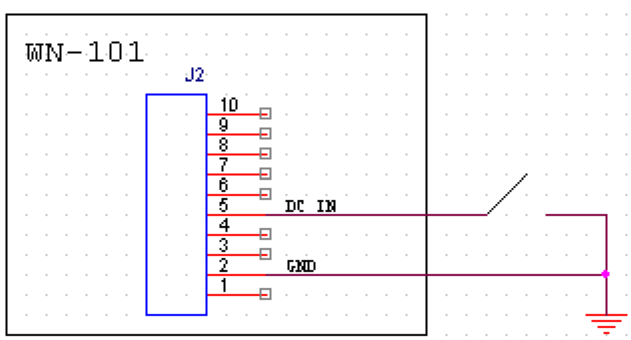

Figure 5: Dry-contact input user interface diagram

The dry-contact input - in the default configuration - may be turned into a digital input by changing two resistance values on the motherboard. For a dry input, resistance R42 with package 0603 must be equal to 5.1 MOhm while resistance R45 with package 0603 must be equal to 1 Mohm.

Digital input

Figure 6 illustrates the digital input user interface, pin DC_IN of terminal block J2 in the standard development kit, which is a dry contact by default. DC_IN is driven by VIN_CLIENT, which must be between 0-2V for logical 0 and between 4-60V for logical 1. The maximum sink current is 100 uA and output resistance is 500 Ohm.

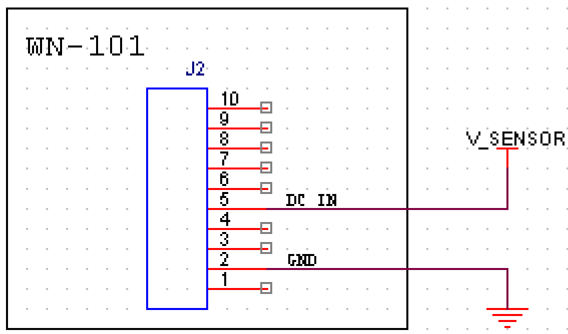

Figure 6: Digital Input user interface diagram

The dry-contact input may be turned into a digital input by changing resistance R42 to 3 MOhm and by removing resistance R45.

Thermistor input

Figure 7 illustrates the thermistor input functional diagram, pin THERM of terminal block J2 in the standard development kit. The input is simply a voltage divider. The current design with resistance R39 equal to 80.6 kOhm (+-0.1%) and capacitance C27 equal to 0.01 uF (+-10%) is optimized for a temperature range of -40 °C to 60 °C with the 10 kOhm (+/- 0.1 %) Alpha 14C1002-C3. Resistance R39 and capacitance C27 may be changed to suit any other thermistor.

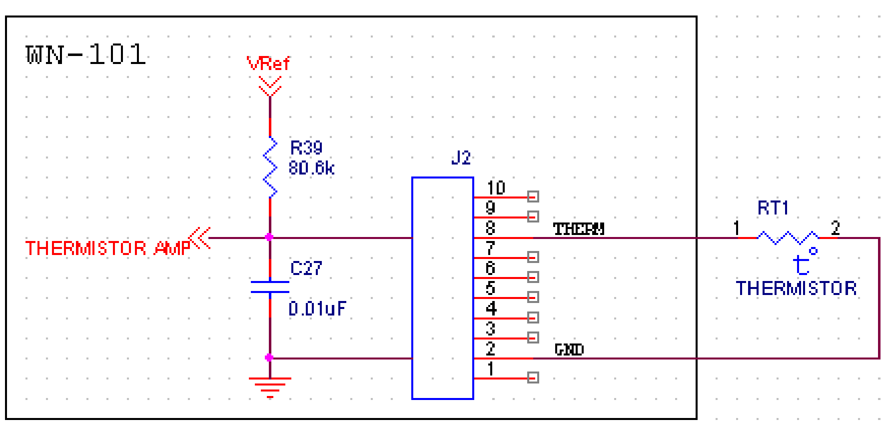

Figure 7: Thermistor input user interface

Resistance R39 and capacitance C27 may be changed to suit any other thermistor. Here are a few important points:

- The maximum output voltage to THERMISTOR_AMP must be 1.9V.
- The output is non-linear. Linearization must be done in software with the thermistor tables. Error below 1 °C can be easily achieved.
- The LPF -3dB equation is f-3dB = 1/((RT1 || R39)*C27*2*pi). For the case of the alpha thermistor, the LPF -3dB range is [263.8, 5965] +/- 10% Hz for the temperature values of -40 °C to 60 °C.

A value of 30.0 kOhm would be optimized for the 50 kOhm Honeywell 135-503LFW-J01 within the temperature range of 0 to 150 °C.

4-20 mA input

Figure 8 illustrates the 4-20 mA input user interface diagram, pin 4_20MA of terminal block J2 in the standard development kit. 4-20 mA input is only supported in the **Dual-MCU** architecture.

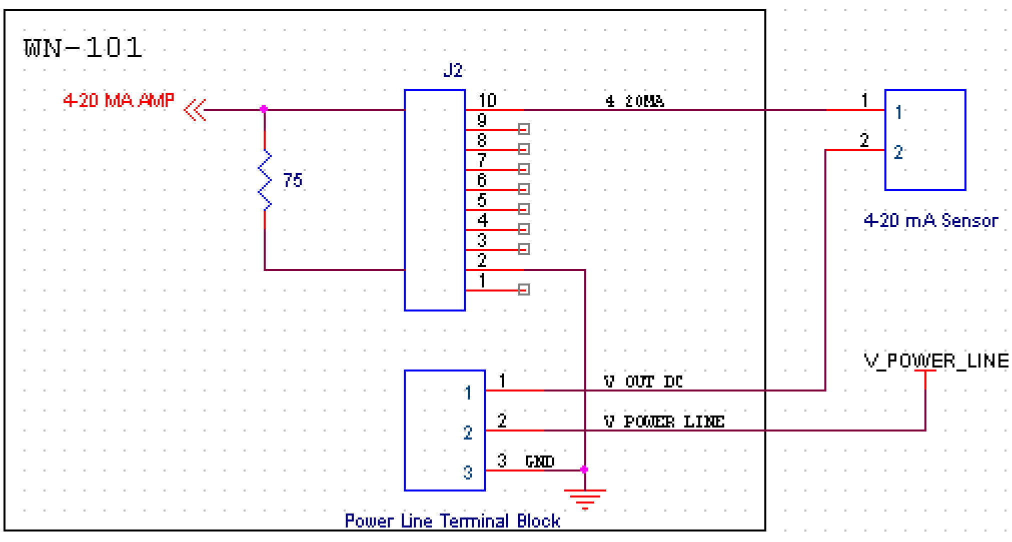

Figure 8: 4-20mA input user interface

A custom power line board may be screwed into the dedicated holes on the WN-100 motherboard. This power board must convert, if necessary, the power line voltage V_POWER_LINE - such as 24V AC, or 110V AC - into a V_OUT_DC voltage compatible with the sensor supply voltage range, which usually approximately varies between 10V and 48V.

[4, 20 mA] current range nominally maps to [33, 983] counts into the 10-bit ADC. A 10% headroom was given in the ADC range when accounting for circuit tolerances.

R19 and C9 may be changed in order to modify the LPF -3dB cutoff frequency. Currently, R19 is set to 10 kOhm and C9 to 2 nF. The resulting cutoff frequency is:

1/(R19*C9*2*pi) = 7957 Hz.

However, the 4-20 mA instrumentation amplifier resistive load must be at least 10 kOhm. Also, a careful choice of R19 and C9 will affect the timing of the ADC since it is directly connected to it. Figure 9 illustrates the ADC interface circuit.

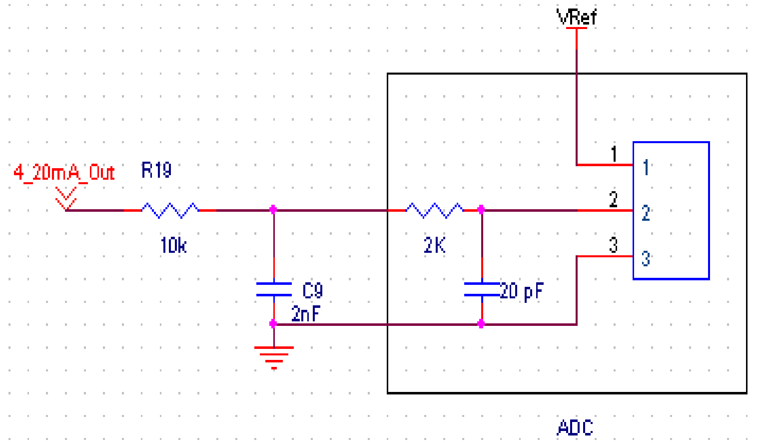

Figure 9: 4-20mA input ADC interface

The 4-20 mA components consume 10 mW in idle mode. The WN-100 should not be used with batteries if the components are soldered. The 4-20 mA circuit is not included in the development kit package.

Analog voltage input

Figure 10 illustrates the 0-XV analog input user interface diagram, pin A_IN of terminal block J2 in the standard development kit.

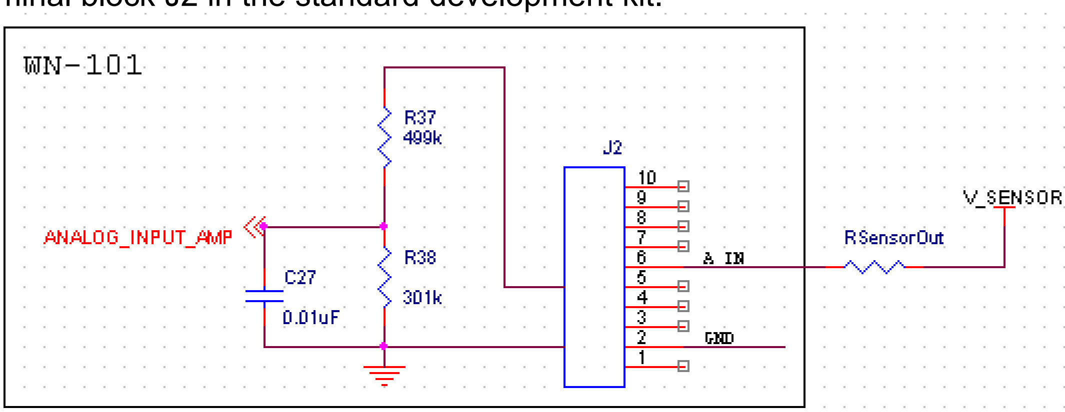

Figure 10: Analog voltage input user interface

The default circuitry is designed for a 0-5V sensor. The default LPF -3dB frequency is:

1/(((R37+RSensorOut) || R38) * C27*2*pi) = 1/(((499k + 0)|| 301k)*0.01uF*2*pi) = 84.77 Hz

It is assumed that RsensorOut, the sensor output resistance, is equal to 0 Ohm. R37 and R38 have 0.1% tolerance.

Any sensor range greater than 1.9 V can be accommodated with this circuit. The following must be followed:

- ANALOG_INPUT_AMP = (R38*V_SENSOR)/(R38 + R37 + RSensorOut).

  It cannot be greater than 1.9 V.
- f-3dB = 1/(((R37+RSensorOut) || R38) * C27*2*pi). C27 may be changed to fit any frequency requirement.
- The amplifier gain is set by R36 and R35. The voltage fed to the ADC is equal to:

  ANALOG_INPUT_AMP * (1 + R36/R35). The default values of R36 and R35 are 25.5 kOhm (+- 1%) and 100 kOhm (+- 1 %) respectively in order to map 0 - 1.9V to the 0 - 2.5V ADC range, taking into account circuit tolerances.

6.3 On-board accelerometer

The on-board accelerometer is a 2D ADXL320 MEMS accelerometer, from Analog Devices, www.analog.com. The accelerometer is only supported in the **Dual-MCU** architecture and is not present in the standard development kit.

The accelerometer is powered by a 2.5V voltage reference. Therefore, the values given in the specification sheet must be scaled down.

Nominally:

ADC = (1.25 * 2.333 – 1.333 * VAcc) * (1024 / 2.5V) (counts), where

VAcc = (Acceleration(g)*Sensitivity(V/g))+Offset(V)).

This equation maps to the 10-bit ADC range.

For example, if the nominal offset is 1.25V and the nominal sensitivity is 145 mV/g, the 5g, 0g, and -5g values will be:

5g -> 116 counts

0g -> 512 counts

-5g -> 908 counts

One must take into account the circuit tolerances and the accelerometer tolerances when calculating the accelerometer error. If it doesn't meet your application requirements, you should calibrate the accelerometer with the method of your choice. The simplest method would be to measure the acceleration at 1g and -1g by slowly placing both axes of accelerometer parallel to the gravitational force in both directions. The values of offset and sensitivity can then be calculated.

The accelerometer sinks 0.48 mA of current when in operation. If your application requires low-power operation, you may want to reduce the sampling duty cycle. If so, revisit the accelerometer timing requirements.

6.4 Packaging options

Enclosure

The WN-100 was designed to mount into any of the IP67 **1554EGY, 1554E2GY**, **1555EGY** or the **1555E2GY** polycarbonate or ABS enclosures from Hammond Manufacturing, www.hammondmfg.com.

It could also fit in a myriad of metal enclosures, such as the IP65 **1590Z100GY** from Hammond Manufacturing.

LED and power switch

The WN-100 can accommodate 2 panel-mount (D1 and D3) LEDs or one surface mount bi-color LED (D2), such as in the standard development kit.

A panel-mount switch may be soldered into JP2 - contact us for details.

7 WN-100 Programming

7.1 Open-source firmware programming

A user is able to customize or program his own application using the provided open-source firmware. See the "WN-100 and WN-100 Development Manual" for more information.

7.2 WN-100 software upload via RS-232

The content of **wn100.a43,** the WN-100 binary code file, or of **wn101mb.a43**, the WN-100 motherboard MCU binary code file, can be downloaded into a WN-100 device by performing the two following steps:

1. Connect the WN-100 to a PC through the RS232 COM1 port.
2. Execute the makefile target **download-codeRs232** in the software project or use the **FlashTransfer** application directly from the command line.

7.3 Data download from external flash via RS-232

The content of the data flash may be downloaded at any time with a PC through RS-232. Perform the following steps:

1. Connect the WN-100 to a PC through the RS232 COM1
2. Execute the makefile target **download-data** in the software project or use the **FlashTransfer** application directly from the command line.

8 IGS-100 Internet Gateway and Server

The IGS-100 Internet Gateway and Server interfaces the Newtrax wireless network with the outside world. It connects to a PC through an Ethernet network interface.

The Newtrax IGS-100 has a low-power ARM9 CPU motherboard running an embedded Linux operating system and a Newtrax RF module within its enclosure. The RF module acts as a modem, such that the IGS-100 communicates with the Newtrax wireless network the same way a WN-100 does.

The IGS-100 can be customized with your custom code, see the “WN-100 and WN-100 Development Manual” for details.

8.1 Software

- Embedded Linux OS
- Newtrax IGS Gateway: Acts as a bridge between the Newtrax wireless network and the TCP/IP network
- Newtrax IGS Terminal Framework: A basic Command Line Interface (CLI) that supports custom plug-ins to add functionality. Available on the standard Telnet port (23) of the IGS-100
- Newtrax IGS Network Management Tools: Library of various network tools (e.g. ping, traceroute, device status) for the Newtrax wireless network. Available in the IGS Terminal Framework as a plug-in.

8.2 Hardware

- 200MHz ARM9 CPU with MMU
- 32MB SDRAM
- 32MB FLASH
- 2 USB ports (USB Flash drive supported)
- 10/100 Ethernet interface

8.3 Memory extension

The non-volatile memory of the IGS-100 can be extended by connecting a USB flash drive onto one of the USB connectors. The USB drive will be automatically available in the /usb/ directory.

8.4 IGS-100 software update

Updates for the IGS-100 will be periodically released by Newtrax Technologies. You can update the IGS-100 software by following these steps:

1. Power up the IGS-100 by plugging in the power cord. It takes approximately 60 seconds to be ready.
2. Use a FTP software to connect to the IGS-100 FTP Server. The default IP address is 192.168.0.10 and the FTP port is 21.
3. Upload the IGS update file (e.g. igs_1.1_build0.frm) in the directory "/firmware_update".
4. Restart the IGS-100 by unplugging the power cord and plugging it back.

   N.B. Rebooting the IGS-100 resets its wireless connectivity.
5. The front panel LEDs will flash rapidly to indicate that the IGS-100 is updating its software. It is important not to remove power at this time.
6. When the software update is completed, the IGS-100 will restart automatically and the LEDs will stop blinking.

8.5 IGS-100 terminal

The IGS-100 Terminal is available on the Telnet port (23) of the IGS-100. Any standard Telnet client software is supported. Once you establish a Telnet connection with the IGS-100, use the command *help* to get a list and description of important commands supported by the current IGS-100 firmware.

9 Network Management Tools

Several network management tool commands are available through the terminal command line in order to troubleshoot a Newtrax wireless network. Here is an explanation of the commands:

- *ping [netID]:* Pings the node with *netID*. It is useful in determining if a certain node is alive or has a connection with the gateway. If a node can not create a route, a ping command will help creating it.
- *traceroute [netID]:* Finds the route information between a node with *netID* and the gateway. Every node in the route will answer until the target node does.
- *statistics [netID]:* Gets RF performance statistics over a time period on node with *netID*. It is useful in determining if the current locations of nodes are acceptable.
- *reinitialize [netID]:* Reinitializes the node with *netID* to the default network state. Equivalent to a network reboot for that node.
- *errorstat [netID]:* Gets the number of errors of a node with *netID*. It will be useful in understanding the causes of malfunctioning nodes.
- *igs_statistics:* Gets the status of the IGS-100 gateway. It is useful in determining if the IGS-100 is active.
- *igs_reinit :* Reinitializes the IGS-100.

10 Troubleshooting

- The LEDs stopped blinking or I can't communicate with a certain WN-100. What should I do?

  The node could be in low-power mode, which is set with the API function *SetPowerInfo()*. If your device is running on batteries, check if the battery is still functional. Otherwise, the device could be either in self-forming, self-healing or self-optimizing mode. Wait for a maximum of 5 minutes to see if a reliable connection is made.

- There are too many WN-100 nodes that only have their red LED blinking. What's going on?

  If you are completely sure that there is no other WN-100 with a green LED blinking, the WN-100 did not detect each other. If they are in RF range, then wait for 5 minutes until it tries again to connect to each other. If it does not happen, you might have a range problem. See below for more information.

- I believe the nodes are connected together but I can't communicate with a certain WN-100 node(s). What could be happening?

  The node may be in self-forming, self-healing or self-optimizing mode. Wait for 5 minutes to see what happens. If the problem is not resolved, perform the following steps with the network management tools:

  1. Use the *traceroute* command in order to validate if it has a route to the gateway.
  2. If it does have a route, use the *statistics* command in order to determine the quality of the link. The statistics should show a message reception of minimum 80%. If you believe the quality of the RF link is poor refer to Section 5 - Considerations for an Optimal RF Link. Continue with the following steps. If it does not respond, go to step 4.
  3. Use the *errorstat* command in order to determine if the node has had significant protocol errors.
  4. Use the *reinitialize* command in order to reset the concerned node(s). Wait for at least 3 minutes.
  5. If step 4 does not work, repeat step 1 to 4 for nearby nodes that are not connected with the gateway.
  6. Manually reset the concerned nodes.

  If any of these don't work, you may have a weak RF link. See below.

- I believe the RF link could be stronger. How can I test it?

  As explained in Section 5 - Considerations for an Optimal RF Link, many factors may influence a RF link. You must validate that it is not explained by the antenna, or the enclosure. You should follow these simple steps:

1. Turn off 1 one WN-100 node that does not have and remove them from their enclosures, unless you are using a crimped antenna mounted on a metallic enclosure.
2. Power on one node and wait until its red LED blinks.
3. Power on the other node and wait until its green LED blinks. If it does not, go back to step 1.
4. Two people should walk around and position themselves with the wireless nodes within the areas where you plan to install them.
5. When the RF signal is optimal, the green LED blinks at an interval of 0.686 seconds. The less frequent the green LED blinks, the weaker the RF signal is. If the green LED blinks correctly a minimum of 90% of the time, the RF link is acceptable.

The nodes might be in a very RF harsh zone. You may change the locations of the WN-100 nodes in order to have as much line of sight as possible among another. In the last resort, you may have to add a simple WN-100 repeater between two existing nodes. The multi-hop algorithm will take charge of adding RF robustness.