DM2200-916-DK Development Kit User's Guide



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DM2200-916-DK Development Kit Warranty

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Notice on the Restricted use of the DM2200-916-DK

The DM2200-916-DK Development Kit, and any products employing DM2200-916-DK components, operate on a shared radio band. Radio interference can occur in any place at any time, and thus communications may not be absolutely reliable. Products using DM2200-916-DK components must be designed so that a loss of communications due to radio interference or otherwise will not endanger either people or property, and will not cause the loss of valuable data. CIRRONET assumes no liability for the performance of products which are designed or created using the DM2200-916-DK or its components. **CIRRONET products are not suitable for use in life-support applications, biological hazard applications, nuclear control applications, or radioactive areas.**

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1 DM2200-916-DK Development Kit Introduction

1.1 Development Kit Purpose

The DM2200-916-DK Development Kit is a tool for evaluating and prototyping low-power wireless sensor applications that require a network of nodes to cover the application's physical space. Examples of these types of applications include utility meter reading networks and industrial process instrumentation networks.

1.2 Intended Kit User

The DM2200-916-DK Development Kit is intended for use by professional engineers with a working knowledge of data communications and electronic sensor applications. The Kit is not intended for use by individuals that do not have this professional background. Please refer to the Special Notices section in the front of this manual.

1.3 General Kit Description

The DM2200-916-DK Development Kit contains four nodes. Each node consists of a DM2200-916VM radio module and an IM2200-1 interface module. The DM2200-916VM radio module is based on RFM's 10 mW TR8100 3rd generation ASH transceiver. The DM2200-916VM also includes Cirronet's VersaMESH network protocol and application firmware.

1.4 Development Kit Features

The DM2200-916-DK Development Kit includes the following features:

- "Out of the box" 916.5 MHz wireless mesh network demonstration
- Four preconfigured nodes - a master and three field nodes
- Each field node supports up to 10 application I/O ports plus a serial interface
- Very low operating power requirements plus integrated power management - compatible with battery operation
- Robust master-slave *and/or* symmetrical MESH network connectivity
- Straightforward command/response application programming interface
- Flexible application I/O capability including pulse-count metering support
- FCC 15.247 module certification for the DM2200-916VM allows a commercial system to be built using Kit components

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2 Kit Assembly, Testing and Software Installation

2.1 Development Kit Contents

- Four DM2200-916VM Transceiver Modules
- Four IM2200-1 Interface Boards
- One Software and Documentation CD
- One Standard DB-9 External Modem Cable
- Four Regulated 5 Vdc Wall Plug Power Supplies
- Four Battery Holders (3 AAA batteries required for each holder)

2.2 Additional Items Needed

- One PC with Microsoft Windows® XP Operating System

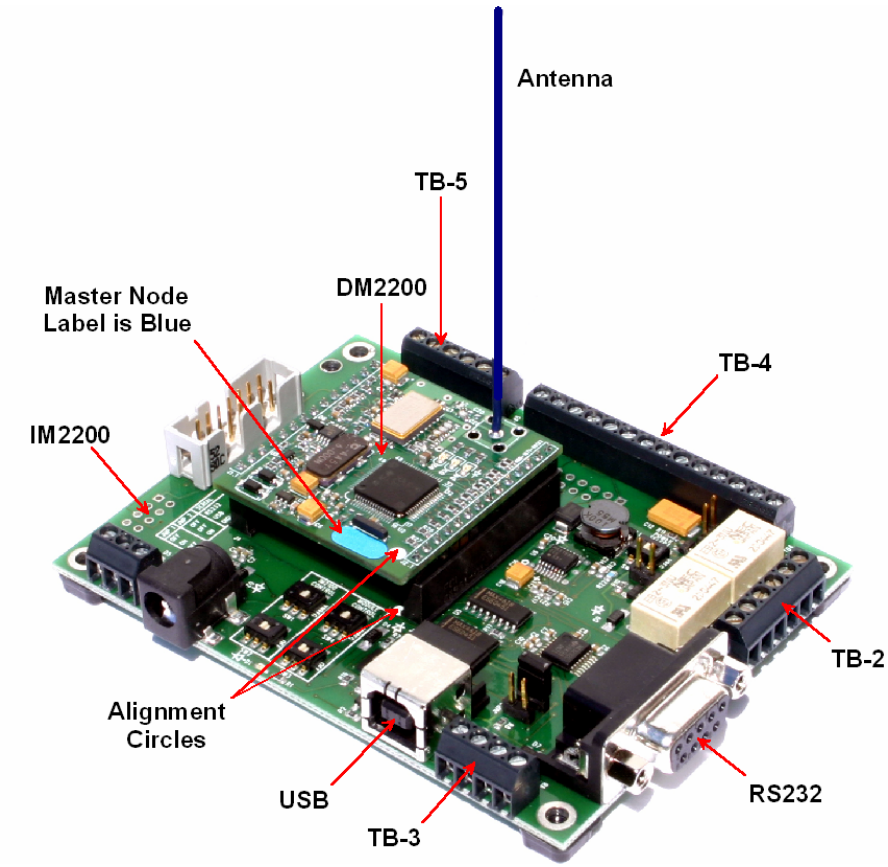


Figure 2.3.1

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2.3 Development Kit Hardware Assembly

Observe ESD precautions when handling the development kit circuit boards. Unplug the DM2200-916VM from the IM2200-1 and gently straighten out the antenna as shown in Figure 2.3.1. Plug the DM2200-916VM back into the IM2200-1, taking care to match the alignment circles. Check that no DM2200-916VM connector pins are exposed due to misalignment with the IM2200-1 socket. Do this for all four sets of boards.

For RS232 operation, set each power configuration switch in the direction of its arrow as shown in Figure 2.3.2, and remove the jumper as show in Figure 2.3.3. In this case the node will be powered from either a wall plug DC power supply or a battery pack.

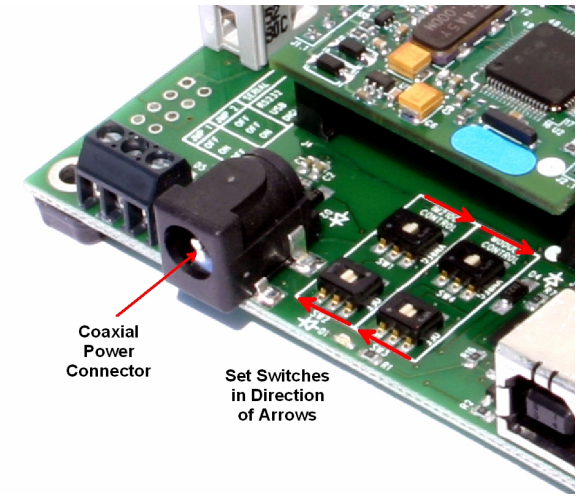


Figure 2.3.2

For USB operation, set each power configuration switch in the direction of its arrow as shown in Figure 2.3.2, and leave the jumper show in Figure 2.3.3 in place. Note that only the master node should be configured for USB operation.

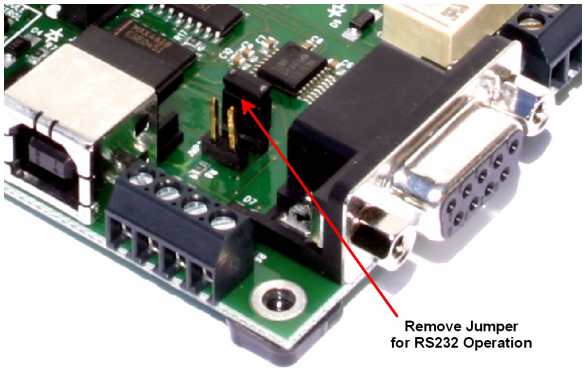


Figure 2.3.3

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2.4 Utility Software Installation

Load the utility software and documentation from the kit CD. Note that the software runs under Microsoft Windows XP using Microsoft .NET libraries.

When operating the master node from the USB interface, a USB software driver pair must be loaded on the PC to support the CP2101 serial port to USB bridge IC on the IM2200-1. Once loaded, the driver will present the USB connection as a virtual COM port to the utility software. Check Cirronet's web site www.cirronet.com periodically for additional software and software updates for the DM2200-916-DK.

2.5 Development Kit Testing

Connect the master board set (node) to the PC with the DB-9 external modem cable. As shown in Figure 2.3.1, the master node has a blue label for identification. Do not connect the other board sets (field nodes) to a PC. Connect each board set to a wall plug DC power supply. The location of the IM2200 coaxial power connector is show in Figure 2.3.2. Referring to Figure 3.7.1 below, the red LED on the master node should be solid on, and the red LED on each field node should be blinking slowly.

Run the Master Beacon Enable utility program that came on the CD. In about 10 to 20 seconds, the red LED on each field node should change from slow blinking to steady on, indicating each field node has joined the master node network. The development kit is now ready for use.

2.6 Documentation and Related Support

The documentation on the Kit CD includes the first four items listed below. The last two items and Section 5 of this manual provide information on Cirronet customer support resources for developing DM2200 applications. Check Cirronet's web site www.cirronet.com periodically for DM2200-916VM documentation updates.

- *DM2200-916-DK User's Guide* - this manual, which covers the details of operating the development kit and building small systems with it.

- *DM2200-916VM System User's Guide* - this manual covers incorporating DM2200-916VM modules into products and systems, including how to install, configure, operate and maintain a DM2200 MESH network.

- *DM2200-916VM Software User's Guide* - this document covers the use and format of all application programming interface (API) commands, responses, event and data messages supported by VersMESH, and how to use them to configure and operate a DM2200 network with your application program.

- *DM2200-916VM, DM2200-916VM-1, IM2200 and IM2200-1 Data Sheets* - these documents cover the specifications of the DM2200-916VM Transceiver Module and its optional IM2200 and IM2200-1 Application Interface Modules.

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- *Factory and Field Application Support* - Cirronet's application engineers provide customer support by e-mail, phone, FAX, field seminars and on-site visits.

- *DM2200 Customization* - Cirronet offers hardware and software customization services for specific applications. See Section 5 below for further details.

3 Kit Operation

3.1 DM2200/VersaMESH Exerciser Utility

The main utility program on the CD is called the *DM2200/VersaMESH Exerciser Utility*. This program provides the following support:

- Resetting a node to its factory default configuration

- Changing the ID (address) of a node and/or the ID of the network

- Assigning master functionality to a node

- Binding field nodes to the master node

- Configuring a node's I/O ports for a specific application

- Setting network and node power management parameters

- Demonstrating VersaMESH commands

Also, Section 2 of the DM2200-916VM Software User's Guide uses the DM2200-916-DK for demonstrating how to write host software to do basic DM2200 network and application tasks. Refer to this material in conjunction with running the utility program.

Note that as shipped, one node in the DM2200-916-DK has already been configured as a master node, and the other three nodes have been bound to it. The master node has a blue label as shown in Figure 2.3.1. The 10 configurable I/O ports on each node have been predefined:

- I/O port configuration:
  GP1 - digital input with optional pulse counting and event messaging
  GP2 - digital input with optional event messaging
  GP3 - digital input
  GP4 - digital output (can optionally drive relay on IM2200-1)
  GP5 - digital output (can optionally drive relay on IM2200-1)
  GP6 - 12-bit ADC input
  GP7 - 12-bit ADC input
  CFG0 - digital input
  CFG1 - digital input

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CFG2 - digital input

GP0 is a 12-bit ADC input dedicated to RSSI measurements, and CFG3 is a digital input dedicated to hardware reset. These two ports are not reconfigurable.

Figure 3.1.1 shows the main frame of the *Exerciser Utility*, and Figures 3.1.2, 3.1.3 and 3.1.4 show the main frame menus.



Figure 3.1.1

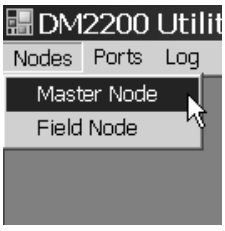


Figure 3.1.2

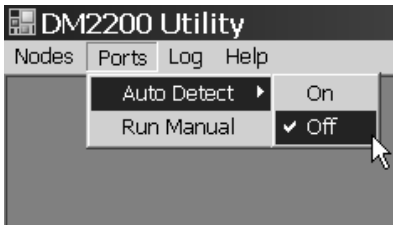


Figure 3.1.3

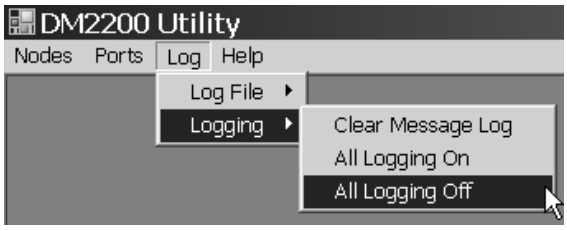


Figure 3.1.4

The *Nodes* menu allows the selection of either the *Master Node* or the *Field Node* frame. While both frames can be displayed at the same time, only one can be active at

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a time. The *Ports* menu supports the serial interface, and will detect and display the USB bridge virtual COM port number by selecting *Auto Detect On* or *Run Manual*. The virtual COM port number should be noted for subsequent use in the *Master Node* and *Field Node* frames. The *Log* menu allows the log file to be opened with *Logging On*, closed with *Logging Off*, and cleared with *Clear Message Log*. The *Log Messages* buttons in each frame control data flow to the log file.

Figure 3.1.5 shows the details of the *Master Node* frame, and Figure 3.1.6 shows the details of the *Field Node* frame.

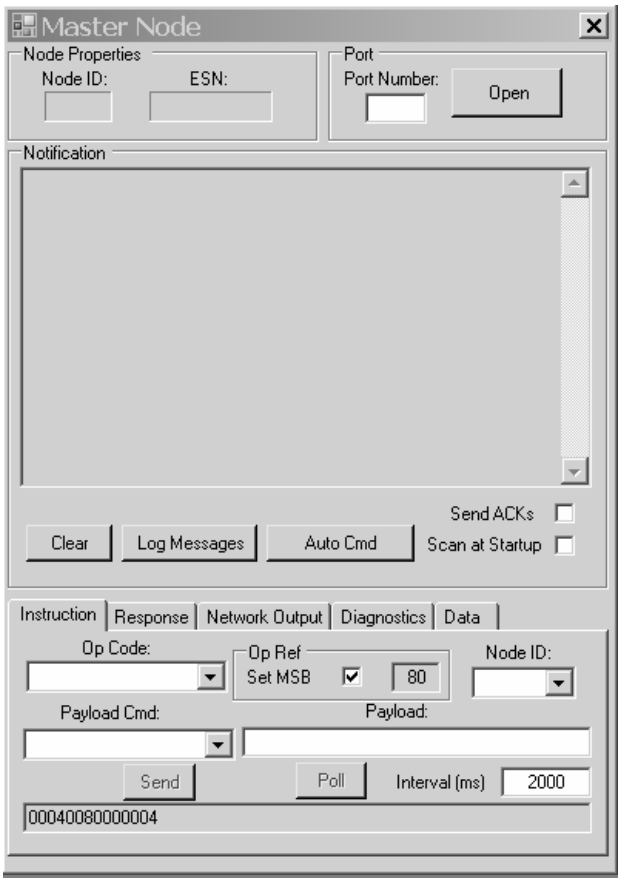


Figure 3.1.5

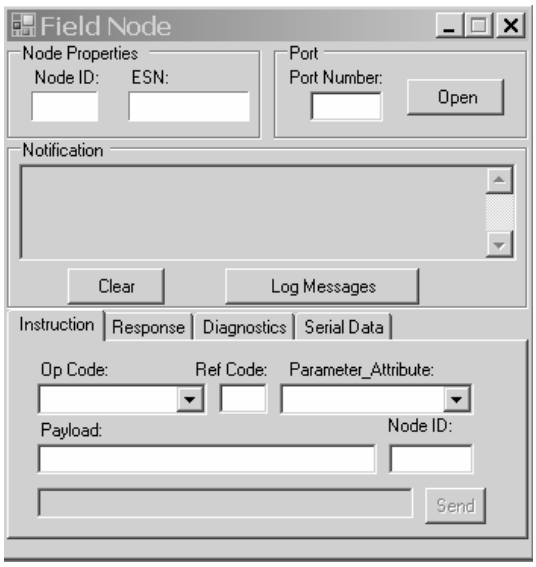


Figure 3.1.6

Both *Master Node* and *Field Node* frames include *Notification* text boxes which track message traffic to and from the master node, and both frames include *Instruction*, *Response* and other tabs to facilitate the creation of command messages and the interpretation of a responses, etc. All data that appears in these frames is in little endian format (low to high bytes of a multi-byte value are ordered left to right). There are two exceptions; the *ESN and ADC* values, are shown in big endian format.

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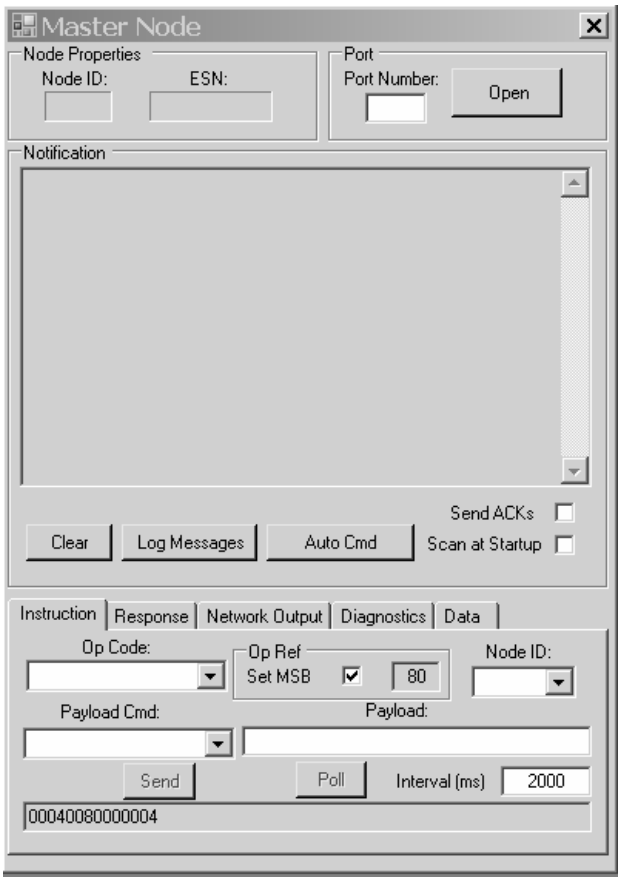


Figure 3.1.7

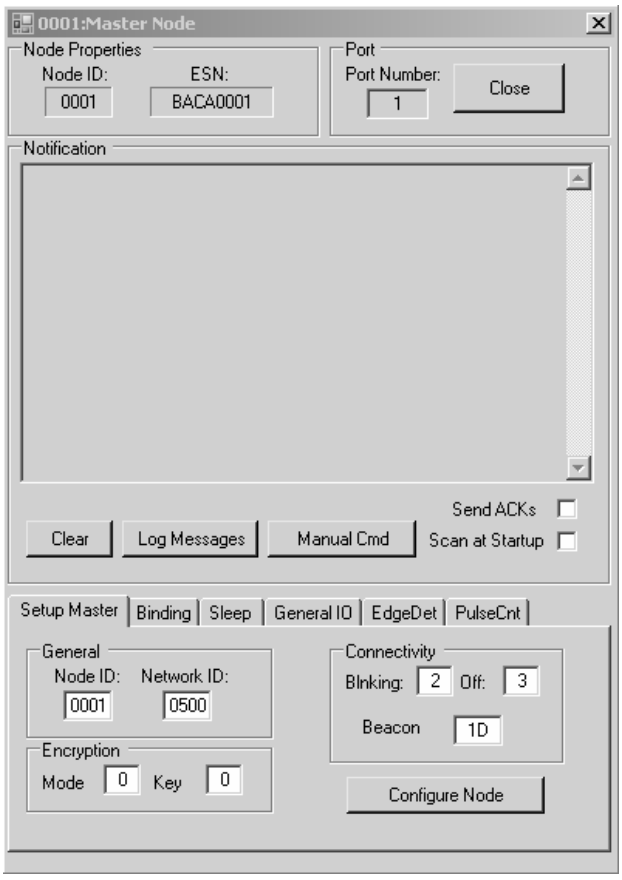


Figure 3.1.8

Figure 3.1.7 shows the *Manual Cmd* tab strip The *Instruction* tab allow the user to construct and send VersaMESH commands. The *Op Code* and *Payload Cmd* drop down list boxes facilitate command construction. The node address for the command is entered in the *Node ID* box or selected from the *Node ID* drop down list. Some commands require a manually entered payload, such as a *CMD_DAT* serial message output command. The *Response* tab displays and interprets response messages. Figures 3.4.1 and 3.4.2 show a manual command and response set. The *Network Output* tab displays event and other messages that are automatically generated in the network. See Figure 3.6.3 for a network event message example. The *Diagnostics* tab displays diagnostic messages, and the *Data* tab displays serial messages input to a field node that is in data mode. Note that the *Master Node* frame can be switched from the *Manual Cmd* tab strip to the *Auto Cmd* tab strip by clicking the *Auto Cmd* button.

Figure 3.1.8 shows the *Auto Cmd* tab strip. Each tab in this strip can launch one or more macros (sequences of VersaMESH commands) to implement functions such defining the master node, binding a field node, or configuring the pulse counter.

The *Setup Master* tab configures the master node for the network, as discussed in section 3.2. The *Binding* tab is used to send binding configuration data from the master node to a field node being bound to the system, as discussed in section 3.3. The *Sleep*

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tab is used to configure master node and field node sleep parameters, as shown in Figure 3.5.1. The *General I/O* tab is used to configure the function of an I/O pin (port), read the ADC value from an I/O pin, or read an I/O pin's digital input state, or set its digital output state. The *EdgeDet* tab is used to enable event messages on I/O port 2, and to select a rising edge or a falling edge as the even trigger. The *PulseCnt* tab is used to configure the pulse counting parameters associated with I/O port 1. See Figure 3.6.2 for a pulse counting configuration example. The *Master Node* frame can be switched from the Auto *Cmd* tab strip to the *Manual Cmd* tab strip by clicking the *Manual Cmd* button.

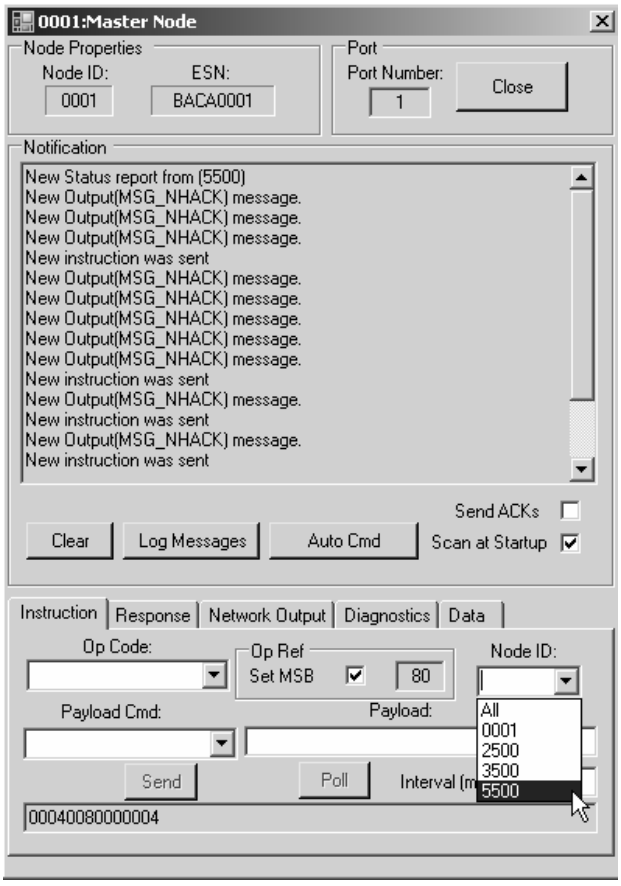


Figure 3.1.9

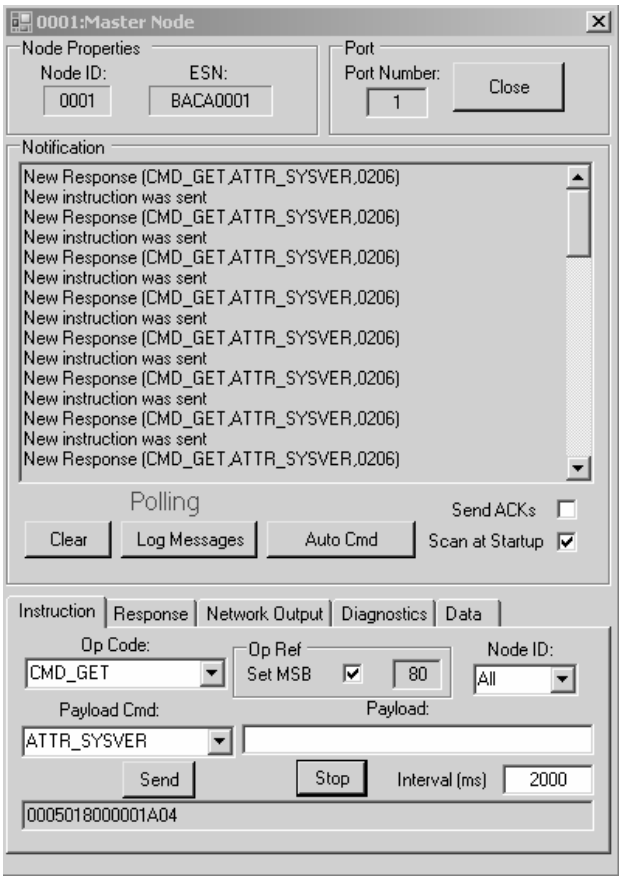


Figure 3.1.10

Checking the *Scan at Startup* box and then opening the serial port will cause the utility program to collect the addresses of all bound and powered field nodes in a system. These addresses are displayed in the *Node ID* drop down box as shown in Figure 3.1.9. Once a command is constructed, it can be sent once using the *Send* button, or sent at regular intervals using the *Poll* button. The poll interval is entered in milliseconds, with 2000 ms the default interval. The target address for the command can be entered directly into the Node ID box, or selected from the drop down list. A single address must be used with the *Send* button. Either a single address or *All* can be used with the *Poll* button. When *All* is selected, the command is sent to each address in the *Node ID* drop down box in a repeating cycle, as shown in Figure 3.1.10.

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3.2 Assigning a Master Node

The first configuration step in creating a DM2200 network is to designate a *master node,* also referred to as a coordinator or base station. The master node is unique in four ways. First, only the master node that can initiate RF commands to *bind* (add) other nodes into the network. Second, the master node is always the destination for *status* and *event messages* generated by other nodes in the network. Third, the master node periodically sends *beacons* that are used by the other nodes in the network to optimize their routing to the master node. Fourth, master beacon orchestrates the network's power management sleep cycles.

A node is designated as a master by sending it a sequence of configuration commands. Here is an overview of the command sequence:

- A command is sent to the node to retrieve its current node ID, electronic serial number (ESN), and master ID.
- A command is then sent updating the node ID. This ID must be unique within the network.
- Next, a command is sent, using the new node ID, to set the value of several connectivity beacon parameters. These will be passed on to any node being bound to the master node's network.
- A command is then sent to set the network ID. Only messages carrying this node ID will be handled by the network. This allows overlapping networks to operate independently.
- Next, a command is sent to set the master node beacon interval, typically in the range of 10 to 60 seconds.
- Finally, a command is sent to set the operating mode of the node as a *master node*.

A newly configured master node immediately sends out its first beacon to announce its designation as the network master. The master node configuration is preserved when a node is powered off.

Figure 3.2.1 shows the *Setup Master* macro tab in the *Master Node* frame. This macro executes the series of steps discussed above. The ESN, current node ID and master ID are retrieved from the node automatically when the *Port Number* is entered and the serial port is opened. Defaults are presented for all values in the white boxes of the *Setup Master* tab. These values are updated as needed and the *Configure Node* button is clicked. The macro then runs and configures the master node. The macro message traffic is shown in the *Notification* text box.

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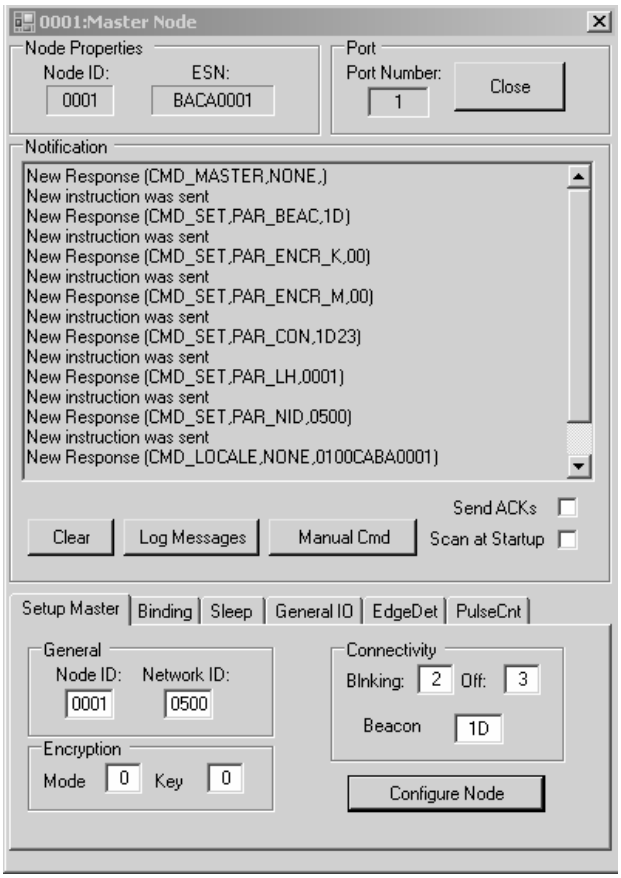


Figure 3.2.1

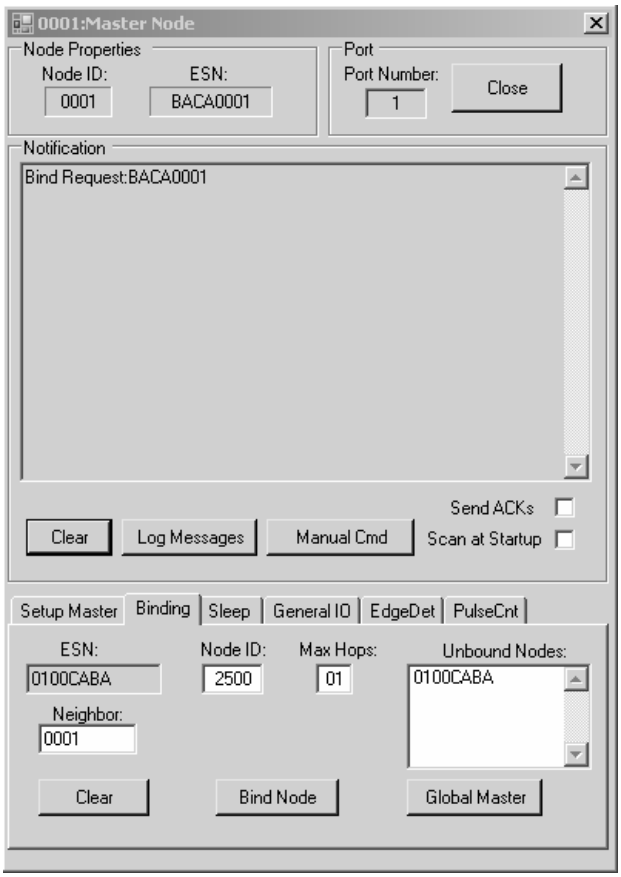


Figure 3.3.1

3.3 Binding Nodes into a Network

Once a master node has been designated, the rest of the nodes can be bound to the network. When an unbound node is turned on, it periodically transmits a bind request. If the unbound node can communicate directly with the master node, the master acts on the request directly. Otherwise, the bind request is routed to the master node starting with a bound node(s) that can directly hear the bind request and is configured to forward it. Once a bind request is received by the master node, it is passed to the master node's host computer.

The role of the host computer in the binding process is to determine if the node generating the bind request is authorized to become part of the network. If so, the host computer issues a bind command through the master node. If the unbound node can communicate directly with the master node, the command is sent directly to the unbound node. Otherwise, the command is sent to a bound node that is in direct communication with the unbound node.

It is good practice to power up and bind nodes one at a time before field installation. This avoid the possibility of overloading a new network with bind requests and bind command packets.

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When a node is bound, it receives its unique node ID, the network ID, the master node ID, connectivity parameters and encryption data. As soon as the newly bound node receives a master beacon, its connectivity LED will switch from rapid blinking to solid on. Shortly after being bound, the newly bound node will send a status message to the master node. The node is then ready to accept I/O configuration commands, and to participate in network activities.

Figure 3.3.1 shows the *Binding* macro tab in the *Master Node* dialog frame. The ESN value is captured automatically from the bind request transmission. The neighbor ID is set to the master ID, and a node ID of 0x0025 (25 00 in little endian byte order) is specified for the node being bound. To complete the binding process, the *Bind Node* button is clicked, and then the *Global Master* (master beacon) button is clicked.

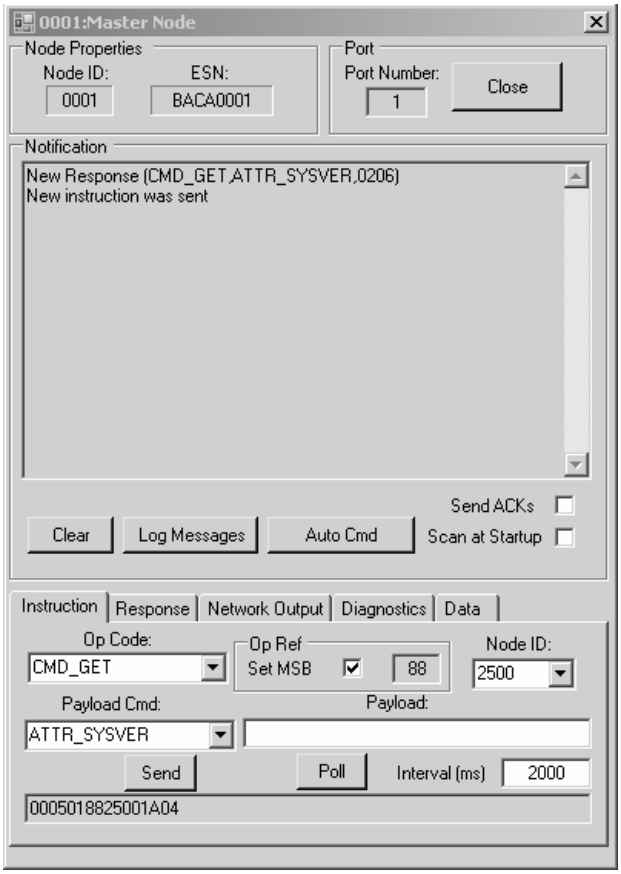


Figure 3.4.1

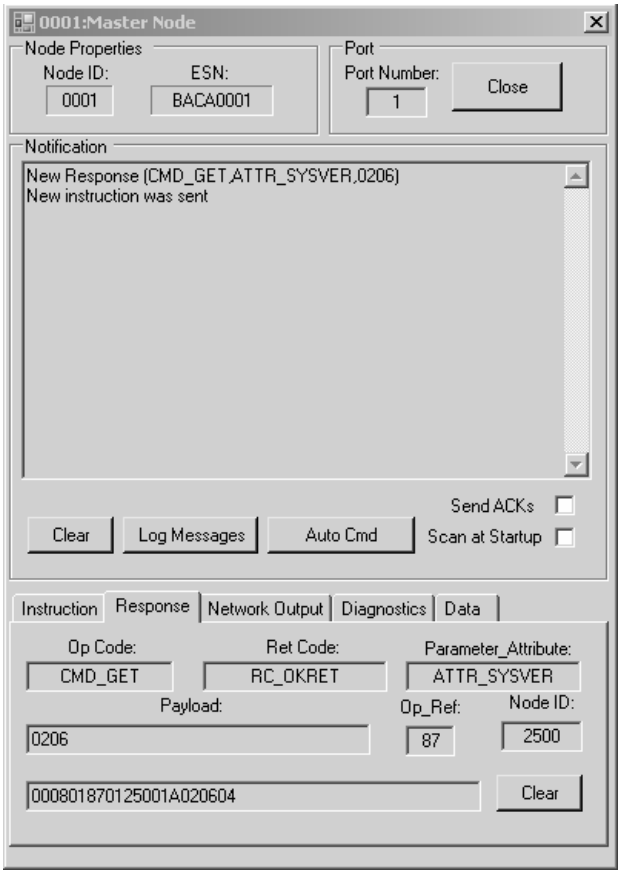


Figure 3.4.2

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3.4 Manual Commands and Responses

Figure 3.4.1 shows the manual construction of a command to get the firmware version. CMD_GET is selected from the *Op Code* drop down box and ATTR_SYSVER (system version attribute) is selected from the *Payload Cmd* drop down box. The command is addressed to node 0x0025 (25 00 little endian) and sent. Note the constructed command is shown in the text box at the bottom of the *Master Node* frame. Figure 3.4.2 shows the response to this command, including the response string and the interpreted *Op Code*, *Attribute*, etc.

3.5 Sleep Mode Parameters

Figure 3.5.1 shows the *Sleep* tab details. All parameters are in seconds and in little endian format. There are two sleep mode parameters to set for the master node, *Sync* and *Rest*. When power management is enabled, the master node alternates between these two states. During the *Sync* period, the master node adds “seconds until sleep” data to its master beacons. At the start of the sleep period, the master node switches to its *Rest* state. During the rest period, the master node continues to send out beacons, but without *Sync* data. At the end of its *Rest* period, the master node switches back to its *Sync* state, beginning a new power management cycle.

The field node counterpart to *Sync* is *preparation*. A field node only has to hear one master beacon with *Sync* data to prepare for its sleep period. During a field node’s preparation period, it continues normal operation but runs its own “*seconds to sleep*” timer that has been synchronized with the master beacon data.

The sleep *mode* and the sleep *Duration* are both programmable for each field node. There are four possible sleep modes:

- *Deep Sleep*, with the radio turned off and the microprocessor running at minimum power consumption for a specified time period.
- *Light Sleep*, with the radio turned off and the microprocessor configured to service interrupts for pulse counting, etc., for a specified time period.
- *Awake*, for those nodes in the network running from mains power. Awake nodes operate continuously.
- *Transmit Only*, for “leaf” nodes at the edge of a network that transmit only event messages. Transmit only nodes must be supported by routing paths consisting of awake nodes.

To select the sleep *mode*, place the mouse cursor in the *Sleep Level* text box and click to switch between modes.

The sleep *Duration* for a field node is usually set shorter than the master node *Rest* period, allowing an interval for active operation during each master node power

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management cycle. However, it is also possible to set the sleep *Duration* on a field node to span a number of master node cycles, where operation of the field node can be infrequent and very low power usage is important.

Note: use the *Stop Sleep* button to disable the sleep cycle at the master node. If a DM2200 network (Kit) is turned off with sleep mode enabled, sleep mode will resume when the network is powered up the next time.

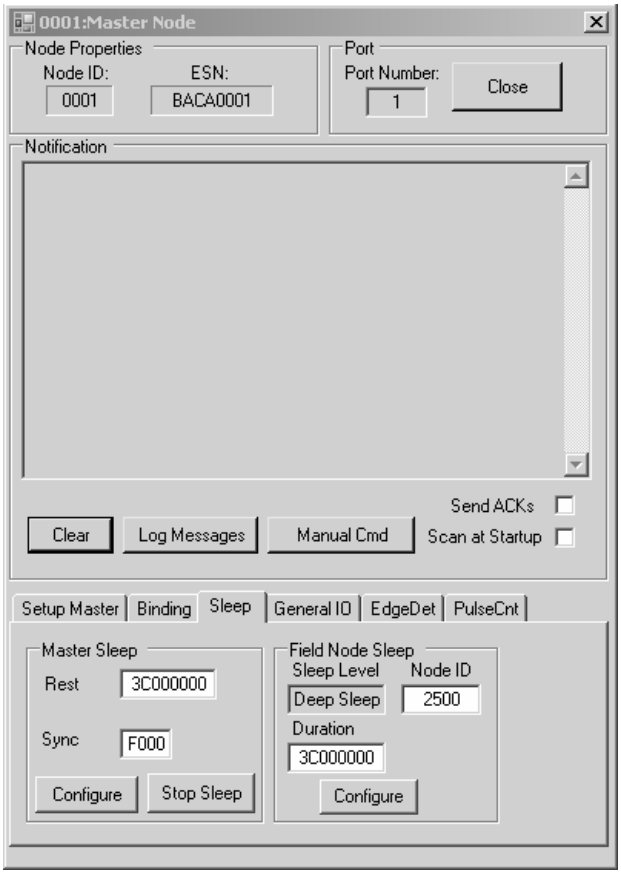


Figure 3.5.1

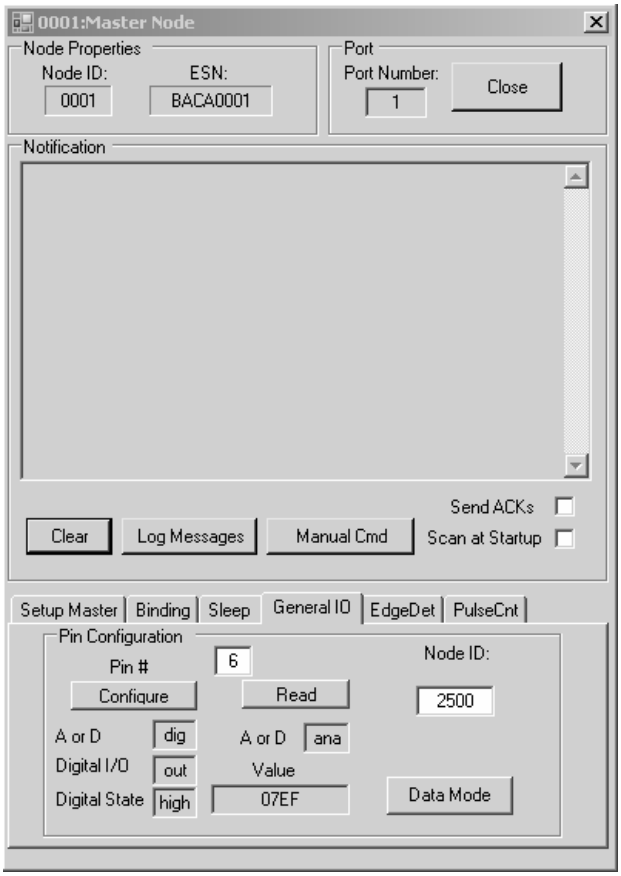


Figure 3.6.1

3.6 Application I/O Configuration

The default I/O configuration for the Kit nodes is detailed in Section 3.1 above. GP1 through GP7 are general purpose I/O ports and each one can be configured as a 12-bit ADC input, a digital input, or a digital output. Auxiliary I/O ports CFG0 through CFG2 can each be configured as a digital input or a digital output. Note that when GP1 is configured as a digital input, it can optionally count pulses and send event messages when the count reaches specific values. When GP2 is configured as a digital input, it can send a event message on a change of state. When GP4 and GP5 are defined as digital outputs, they can optionally control the form-C relays on the IM2200-1 interface board. These special capabilities should be kept in mind when planning the I/O configuration of a Kit node.

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The serial ports on the three field nodes can also be used to interface data loggers, lab printers and other devices with fixed programming.

Figure 3.6.1 illustrates using the *General I/O* tab to *Read* the ADC input on GP6 at Node 0x0025 (25 00 little endian). The value of the ADC reading is 0x07EF (high byte is on the left in the *Value* text box). The *Configure* group of controls on the left side of Figure 3.6.1 are primarily used to configure a pin as a digital input or output, and to set the output state. Place the mouse cursor in the *Digital I/O* text box and click to switch between input and output. Place the mouse cursor in the *Digital State* text box and click to switch between high and low.

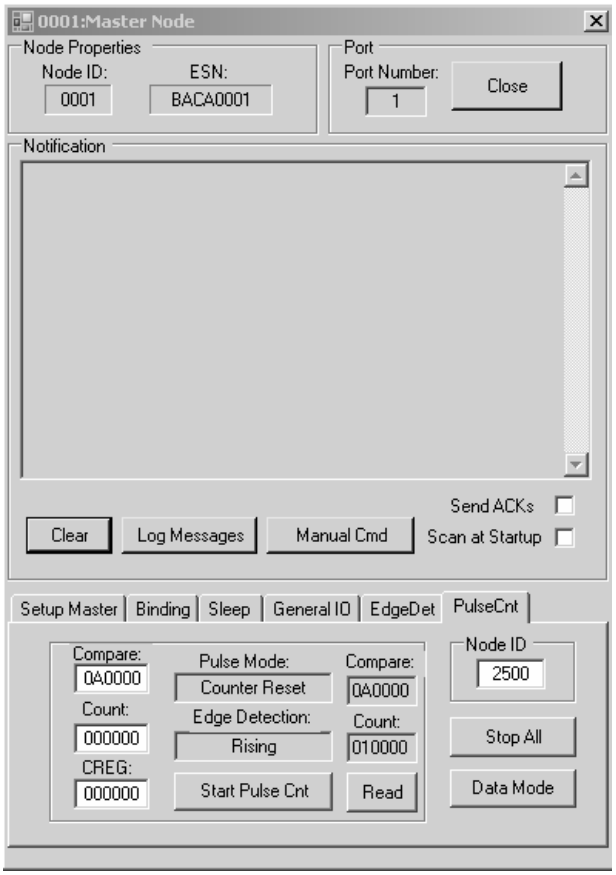


Figure 3.6.2

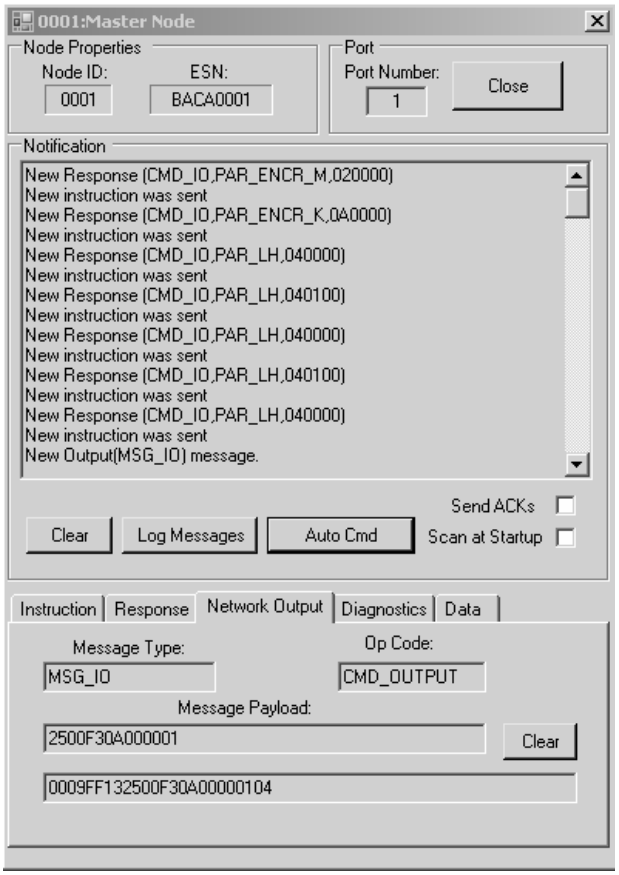


Figure 3.6.3

The details of the *PulseCnt* tab are shown in Figure 3.6.2. All parameters are in counts and in little endian format. GP1 is able to count up to 10 pulses/second, with the option to count on falling edges or on rising edges. To select the counting edge, place the mouse cursor in the *Edge Detection* text box and click to switch between *Rising* and *Falling*. Pulse counts are stored in a 24-bit register that can be preset, read and reset. Note that GP1 can count pulses during a power management sleep cycle when in the *Light Sleep* mode.

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The pulse counter is supported by two 24-bit companion registers. The first companion register provides a *Compare* function. When the comparator register is loaded with a value and enabled, an event message is triggered when the pulse count matches the value in the comparator. At this point the value of the comparator can be optionally subtracted from the pulse counter to reset it.

The second companion register is the *CREG* offset register. It can be used with either the pulse counter or the comparator register. The *CREG* offset register supports two modes of operation. In the *comparator offset* mode, when the pulse-count register value reaches the comparator value, an event message is triggered, and the value in the comparator is *increased* by the value in the *CREG* offset register. For example, if the value in the comparator register is initially 1000 and the value in the offset register is 100, an event message will be sent when the value in the pulse-count register reaches 1000, 1100, 1200, etc.

In the *counter offset* mode, when the pulse count reaches the comparator value, an event message is triggered, and the value in the pulse counter is *decreased* by the value in the *CREG* offset register. For example, if the value in the comparator register is initially 1000 and the value in the offset register is 100, an event message will be sent when the value in the pulse counter reaches 1000. At this point, the value in the pulse counter is "backed down" 100 counts to a value of 900. When the value in the pulse counter again reaches 1000, the next event message with be sent and the value in the pulse counter will again be reset to 900.

To select the counter operating mode, place the mouse cursor in the *Pulse Mode* text box and click to switch between *Counter Reset*, *Counter Incr* (increase comparator by CREG) or *Counter Decr* (decrease counter by CREG).

Pulse counting is enabled with the *Start Pulse Cnt* button and disabled with the *Stop All* button. The *Read* button retrieves the current values in the counter, comparator register and CREG register.

The pulse-count register and comparator register exhibit 24-bit modulo behavior and will gracefully "wrap around" on an overflow or underflow.

Figure 3.6.3 shows the network event message that was sent when the pulse counter value at field node address 0x0025 (25 00 little endian) reached the value in the comparator register. The pulse counter was also reset at that point.

In addition to the *DM2200/VersaMESH Exerciser Utility,* check the CD and Cirronet's web site www.cirronet.com for additional DM2200-916VM demo programs. Also, see the *DM2200-916VM Software User's Guide* for more examples and API documentation.

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3.7 LED Interpretation

There is a green, yellow and red LED located on top of the DM2200, as shown in Figure 3.7.1. The green LED blinks when the node receives a packet. The yellow LED blinks when the node transmits a packet. The red LED provides connectivity status as follows:

- Fast blinking indicates the node is not bound to a network
- Solid ON indicates the node is bound and hearing most of the beacon traffic from the master node
- Slow blinking indicates the node is bound, but has not heard a packet from the master node since waking from sleep, powering up, or for a length of time longer than a specified number of beacon periods.
- Solid OFF indicates the node is powered down, in a sleep cycle, or is on and bound, but has not heard a packet from the master node in a length of time longer than a specified number of beacon packets.

The red LED connectivity indication is useful in maintaining a DM2200 network.

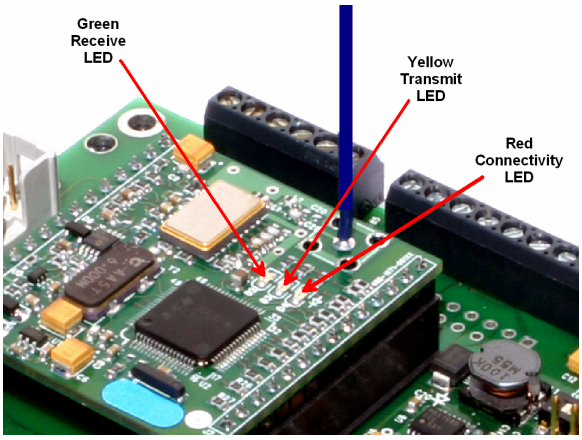


Figure 3.7.1

4 Application Prototyping

4.1 Power Supply Considerations

The master node is usually powered by either the 5 Vdc wall plug power supply or the USB connection. A field node can be powered by either a 5 Vdc wall plug power supply or a battery pack. Other unregulated power supplies in the 3.7 to 14 Vdc range can also be used to power a node, or a regulated power supply (battery) in the range of 2.9 to 3.7 volts can be used. The details of configuring the switches and jumpers for each of these power supply options is explained on Page 2 of the IM2200-1 Data Sheet.

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Care must be taken to set the switches and jumpers on the IM2200-1 correctly for the power source used. If the switches and/or jumpers are not set correctly, both the DM2200-916VM and IM2200-1 can be damaged, and a fire or safety hazard can be created. Also, care must be taken so that analog or logic inputs stay within the voltage range of 0 to VDDM (voltage at TB5-1 on the IM2200-1). Applying a voltage outside of the 0 to VDDM voltage range to an analog or logic input can damage the node.

4.2 ESD and Transient Protection

DM2200-916VM and IM2200-1 circuit boards are electrostatic discharge (ESD) sensitive. ESD precautions must be observed when handling and installing these components. DM2200-916VM and IM2200-1 installations must be protected from electrical transients on the power supply and I/O lines. This is especially important in outdoor installations, and/or where connections are made to sensors with long leads. *Inadequate transient protection can result in damage and/or create a fire and safety hazard.*

4.3 Enclosures and Antennas

Enclosures must be made of plastics or other materials with low RF attenuation to avoid compromising antenna performance. Metal enclosures are not suitable as they will block antenna radiation and reception. Outdoor enclosures must be water tight, such as a NEMA 12 fiberglass enclosure.

The operating range of the DM2200-916VM depends on the antenna being located properly. The standard DM2200-916VM antenna (part number 400-1687-001) should be straight and perpendicular to the DM2200 PCB, and the DM2200 should be mounted so that the antenna is vertical. Care should be taken to keep the antenna at least 0.5 inch away from the sides of its enclosure. *Note: many other antennas can be used with the DM2200-916VM, but each new antenna must be added to the DM2200-916VM FCC module certification before deployment.* Contact Cirronet for details.

4.4 Locating and Installing Nodes

Field nodes are normally located close to the sensors being connected to them. The exceptions to this rule is where the sensors are located in a very harsh environment (high temperature, caustic atmosphere, etc.), or the sensors are in a location where RF propagation would likely be very poor, such as point near ground level with a heavy concentration of metal walls, pipes, etc. In these cases the field nodes should be located as near as practical to the sensors, but in a relatively benign environment with reasonably good RF propagation potential. Field node enclosures should be mounted so the antenna is at least 3 feet above the ground or floor, and where practical 6 to 12 feet above the ground or floor. Ideally, enclosures should be mounted in open areas with the antennas spaced away from metal objects, wires or cables.

The “open field” operating range between two DM2200-916-DK nodes placed 4 feet above the ground is about 600 meters. The operating range will be less if the nodes are

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near the ground and/or in a difficult RF propagation environment. Except in very poor RF environments, the operating range between two DM2200-916-DK nodes should be at least 200 meters. A simple installation sketch is useful in estimating the distances between the nodes in a network, and assessing if redundant routing paths appear to exist. In some installations, supplemental router nodes may be required.

4.5 Application Interface Connections

Referring to Figures 2.3.1 and 4.5.1, the application I/O port connections are located on IM2200-1 on terminal blocks TB4 and TB5. Notice that the DM2200-916VM regulated supply voltage, VDDM, has been brought out several places on TB4 and also one place on TB5. Also, GND is available at several places on TB4 and one place on TB5.

VDDM and GND can be used to set up ratiometric ADC measurements for thermistor-resistor temperature sensors, etc. The total current drawn from VDDM by all external connections should not exceed 5 mA. Digital I/O pins CFG0 - CFG3 include 100K pull up resistors to VDDM to facilitate detecting isolated switch contact closures.

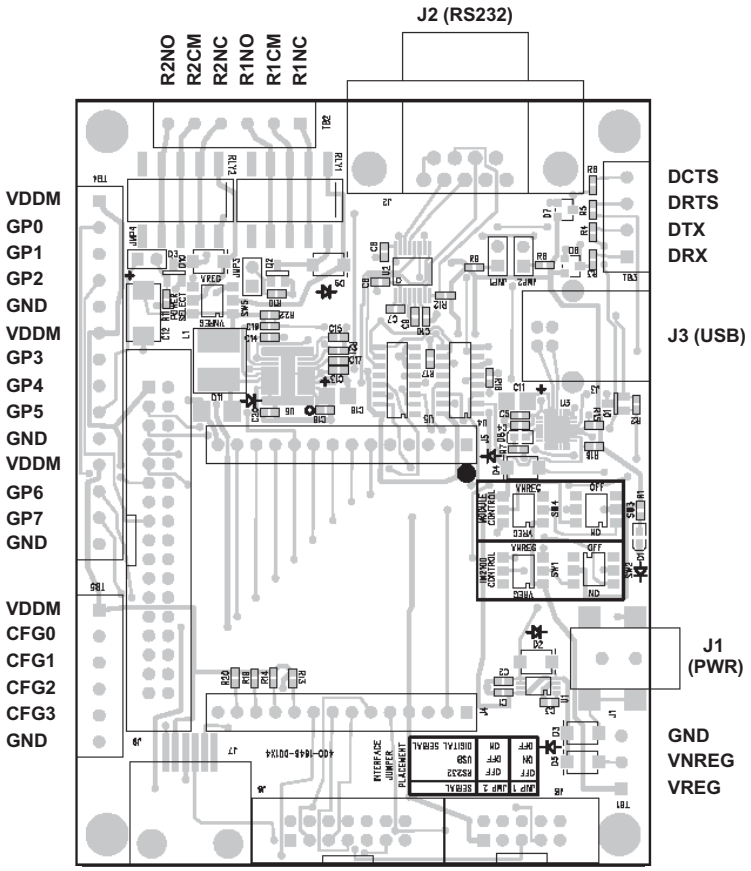


Figure 4.5.1

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Contacts from the Form-C relays are brought to terminal block TB-2. These relays can be operated by GP4 and GP5 when they are defined as outputs. Note there is a separate power supply on the IM2200-1 to operate the relays, as explained on Page 2 of the IM2200-1 Data Sheet.

A direct connection to the DM2200-916VM serial port can be made at terminal block TB-3. Jumper blocks JMP1 and JMP2 must be configured specifically to support this connection, as explained on Page 2 of the IM2200-1 Data Sheet. This is a 3 V logic connection. *Attempting to connect 5 V logic signals, RS232 signals or other improper signals to TB-3 can damage both the DM2200-916VM and IM2200-1.*

4.6 FCC Compliance, Labeling and Notices

The DM2200-916VM is certified as a module for operation under FCC Part 15 Rules, Section 15.247. In order to take advantage of this module certification, the user must provide proper enclosure labeling, include specific disclaimer language in the user's manual, and use the antenna supplied or approved by Cirronet with the module.

A clearly visible label is required on the outside of the user's (OEM) enclosure stating that: *This product contains a DM2200-916VM radio module, FCC ID: TE6-DM2200A.*

Further, the manual for the user's product or system must include the follow advisory: *This 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.*

WARNING: This device operates under Part 15 of the FCC rules. Any modification to this device, not expressly authorized by Cirronet, Inc., may void the user's authority to operate this device.

5. About Cirronet, Inc.

5.1 Company Overview

Cirronet, Inc. was founded in 1987 and became a wholly owned subsidiary of RF Monolithics, Inc. in 2006. Since its founding, Cirronet has delivered a wide range of high performance RF products for industrial, commercial and medical applications. Cirronet's RF product line includes high performance FHSS radios, industrial WiFi and Bluetooth radios, 802.15.4 and Zigbee modules, and the DM series wireless mesh network sensor modules.

RF Monolithics, Inc. (RFM) was founded in 1979, and became a publicly traded company in 1994 (NASDAQ, RFMI). Since its founding, RFM has shipped more than 750,000,000 products for low power radio applications. Applications for these products include automotive keyless entry and tire pressure monitoring systems, wireless utility meter reading systems, garage door and gate controls, residential and commercial

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alarm systems, medical telemetry, and active RFID tags. Applications for other RFM products include satellite broadcast radios, cellular phone systems, commercial and military avionics, and fiber optic communications.

5.2 Web Site Support

Cirronet's web site address is www.cirronet.com. The latest information on the DM2200-916VM and other radio modules and products is maintained here. Check the web site periodically for the latest information on the DM2200 and other Cirronet products.

5.3 E-mail, Phone and FAX Support

Cirronet's general E-mail information and support address is info@cirronet.com. It is often useful to follow-up an E-mail inquiry with a support phone call, so please include your phone number and time zone in your inquiry. Cirronet's main phone number is US 678.684.2000. Operator assistance is available from 08:00 to 17:00 (US Eastern Time Zone) Monday through Friday. Cirronet's main FAX number is 678.684.2001.

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