APPLICATION NOTE

AN414

Wireless Control Application Kit

Introduction

The Wireless Control Application Kit highlights the interface of MaxStream's 900 MHz XCite™ or 2.4 GHz XStream™ wireless data modules with one of Rabbit Semiconductor's single-board computers, the LP3500. The Wireless Control Application Kit comes with sample programs that illustrate the simple configuration and control of a new or existing Rabbit-based embedded system via a wireless interface using either the Modbus protocol or a direct point-to-point protocol (PPP) serial connection with a Web browser.

The MaxStream wireless data modules are each mounted on an RS-232/RS-485 Interface Board that provides the power supply and a DB9 serial interface with flow control. Two wireless data modules and two RS-232/RS-485 Interface Boards are included in the Application Kit to allow you to attach one assembly to the LP3500 control system, and to use the other assembly with your PC to interface wirelessly with the LP3500 control system.

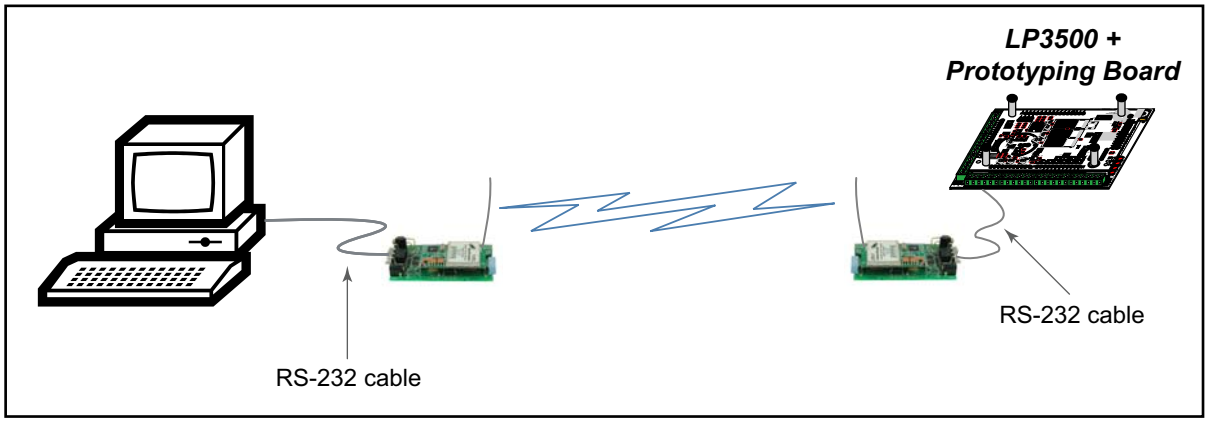


Figure 1. Wireless Interface Setup

The sample programs included with the Wireless Control Application Kit serve as a template for a robust wireless implementation with a serial connection. A Modbus sample program shows how to control the single-board computer, which is set up as a slave device, from a PC that serves as the Modbus master. PPP sample programs show how to use the point-to-point protocol directly and via a Web browser. Possible applications include remote monitoring, proximity sensor readings, wireless I/O control, and data transmission.

Table 1 compares the features of the MaxStream 900 MHz XCite™ and 2.4 GHz XStream™ RF modules used in the Wireless Control Application Kits.

Table 1. Maxstream RF Modules in Wireless Control Application Kit

Feature		RF Module	
		MaxStream XCite™	**MaxStream XStream™**
Frequency		902–928 MHz	2.4000–2.4835 GHz
Performance*	Indoor Range	up to 300 ft (90 m)	up to 600 ft (180 m)
	Outdoor Line-of Sight Range	up to 1000 ft (300 m)	up to 3 miles (5 km)
	Power Output	4 mW (6 dBm)	50 mW (17 dBm)
	RF Data Rate	9.6 Kbps	9.6 Kbps
	Interface Data Rate	up to 57.6 Kbps	up to 57.6 Kbps
	Receiver Sensitivity	-108 dBm (@ 9600 bps)	-110 dBm (@ 9600 bps)
Networking	Spread-Spectrum Type	FHSS (frequency hopping)	FHSS (frequency hopping)
	Network Topologies Supported	• Peer-to-peer • Point-to-point • Point-to-multipoint	• Peer-to-peer • Point-to-point • Point-to-multipoint • Repeater
	Filtration Options	• VID (vendor ID number) • Channels • Addressing	• VID (vendor ID number) • Channels • Addressing
	Channel Capacity	7 frequency hopping *or* 25 single-frequency	7 hop sequences share 25 frequencies
	Addressing	65,000 network addresses per channel	65,000 network addresses per channel
Power (typical)	Supply Voltage	2.8–5.5 V DC (regulated)	5 V ± 0.25 V DC (regulated)
	Transmit Current	55 mA @ 2.85 V	150 mA
	Receive Current	45 mA @ 2.85 V	50 mA
	Sleep Current	20 µA	26 µA

* The maximum range can only be realized with a high-gain antenna. The actual range also depends on the environment, any structures in the way, network connections, and on whether the Modbus or the point-to-point protocol is used (the range will be less when using PPP). See **Additional Reference Information** for more information on maximizing the range.

MaxStream also offers a 900 MHz XStream™ RF module.

Even though the wireless data modules will operate at baud rates faster than 9600 bps, the 9600 bps baud rate is used in the sample programs to maximize reliable data transfer over the largest possible distance using the wire antennas on the wireless data modules included with the Wireless Control Application Kit.

Application Kit Features

- LP3500 single-board computer with LP3500 Prototyping Board
- Two 900 MHz XCite™ or two 2.4 GHz XStream™ RF modules with two MaxStream RS-232/RS-485 Interface Boards
- Dynamic C CDs for RabbitWeb module, Point-to Point Protocol (PPP) module, and Modbus module
- Complete Dynamic C software CD and supplemental CD with sample programs and reference information related to the Application Kit

Example Applications

- Low-cost wireless embedded control applications
- Remote monitoring of equipment, devices, locations
- Simple data-logging applications
- Peer-to-peer and point-to-point/multipoint networking control

What Else You Will Need

Dynamic C must be installed on your PC. Insert the Dynamic C CD from the Application Kit in your PC's CD-ROM drive. If the installation does not auto-start, run the **`setup.exe`** program in the root directory of the Dynamic C CD. Install the software from the supplemental CD and any Dynamic C software modules after you install Dynamic C.

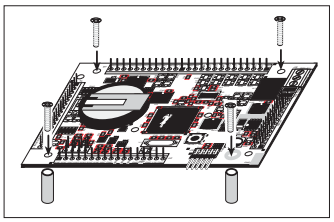
Besides what is supplied with the Application Kit, you will need a PC with an available COM or USB port to program the LP3500 in the Application Kit. If your PC only has a USB port, you will also need an RS-232/USB converter. Note that not all RS-232/USB converters work with Dynamic C.

Hardware Setup

The ***Wireless Control Application Kit Getting Started*** instructions included with the Application Kit shows how to set up and program the LP3500 with its Prototyping Board, then interface it wirelessly with your PC via MaxStream's 900 MHz XCite™ or 2.4 GHz XStream™ wireless data modules.

The following steps from the ***Wireless Control Application Kit Getting Started*** instructions summarize the setup process once Dynamic C, the Dynamic C modules, and the software from the supplemental CD have been installed on your PC.

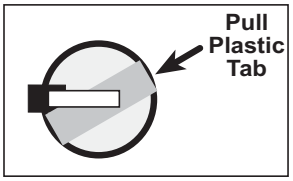
LP3500 Setup



LP3500 Connections

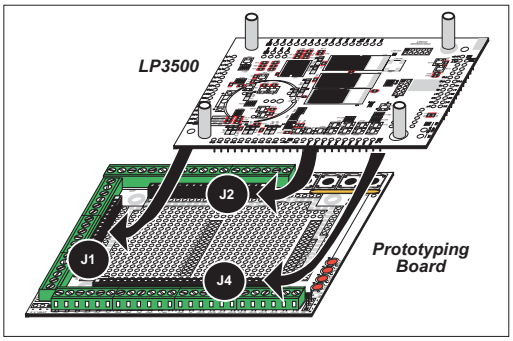
Use the 4-40 screws to attach the metal standoffs to the LP3500 board as shown.

Remove Battery Tab



The backup battery on the LP3500 has a plastic tab to protect the battery against discharging before the LP3500 is placed into service. The backup battery protects the contents of the SRAM and keeps the real-time clock running when regular power to the LP3500 is interrupted.

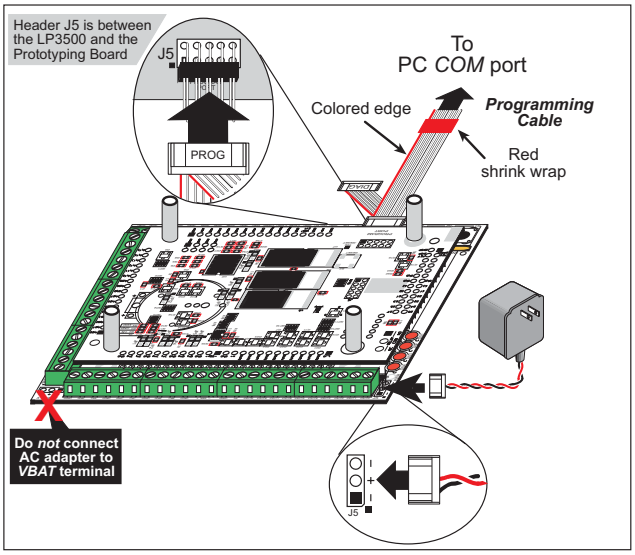
Attach LP3500 to Prototyping Board



Press the pins from the headers on the bottom side of the LP3500 firmly into the corresponding header sockets located at J1, J2, and J4 on the Prototyping Board.

NOTE: It is important that you line up the header pins on the LP3500 exactly with the corresponding header sockets J1, J2, and J4 on the Prototyping Board. The header pins may become bent or damaged if the pin alignment is offset, and the LP3500 will not work. Permanent electrical damage may also result if a misaligned LP3500 is powered up.

Connect Programming Cable



The programming cable connects the LP3500 to the PC running Dynamic C to download programs and to monitor the LP3500 during debugging.

Connect the 10-pin connector of the programming cable labeled **PROG** to header J5 on the LP3500. Ensure that the colored edge lines up with pin 1 as shown. (Do not use the **DIAG** connector, which is used for a normal serial connection.) Connect the other end of the programming cable to a COM port on your PC.

NOTE: Be sure to use the programming cable (Part No. 101-0513) supplied with this Application Kit—the programming cable has red shrink wrap around the RS-232 converter section located in the middle of the cable. Programming cables from other Rabbit Semiconductor kits are not designed to work with the LP3500.

NOTE: Some PCs now come equipped only with a USB port. It may be possible to use an RS-232/USB converter (Part No. 540-0070) with the programming cable supplied with the Application Kit. Note that not all RS-232/USB converters work with Dynamic C.

Connect Power Supply

Hook up the connector from the 12 V AC adapter to header J5 on the Prototyping Board as shown above. The orientation of this connector is not important since the VIN (positive) voltage is the middle pin, and GND is available on both ends of the three-pin header J5.

NOTE: Do ***not*** connect the AC adapter to the **VBAT** terminal on the Prototyping Board. The **VBAT** terminal supplies the backup battery voltage of 3 V, and the LP3500 may be damaged if subjected to the raw DC voltage from the AC adapter through the **VBAT** terminal.

Plug in the AC adapter. If you are using your own power supply, it must provide 3 V to 30 V DC—voltages outside this range could damage the LP3500.

NOTE: A hardware reset may be done by pressing the RESET switch on the LP3500. The LP3500 may also be reset by unplugging the AC adapter, then plugging it back in. However, when the LP3500 is operating in the power-save mode, the backup battery will provide sufficient voltage to prevent a reset from happening, in which case you will have to press the RESET switch on the LP3500. Reset switches are located on both sides of the LP3500 board.

Run a Sample Program

Once the LP3500 is connected as described, start Dynamic C by double-clicking on the Dynamic C icon or by double-clicking on **dcrab_XXXX.exe** in the Dynamic C root directory, where **XXXX** are version-specific characters.

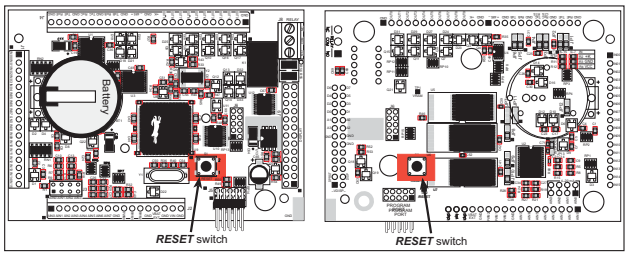
If you are using a USB port to connect your computer to the LP3500, choose **Options > Project Options** and check "Use USB to Serial Converter" in "Serial Options" on the **Communications** tab. Click **OK** to save the settings.

There are three sample programs available to set up the LP3500 to illustrate a wireless interface via the MaxStream 900 MHz XCite™ or 2.4 GHz XStream™ wireless data modules.

Type of Interface	Sample Program	Dynamic C Folder
Modbus	MODBUS_SERIAL_SLAVE.C	SAMPLES\Modbus
Point-to-Point Protocol	DIRECT_PPP.C	SAMPLES\WirelessControl
Point-to-Point Protocol with Web Interface	DIRECT_PPP_HTTP.C	SAMPLES\WirelessControl

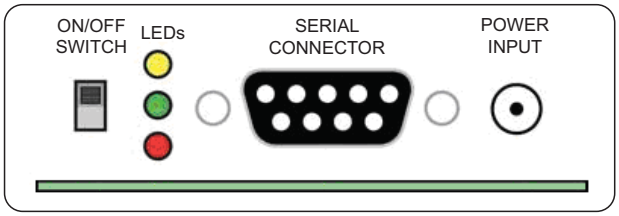
The sample programs are listed in order of their increasing complexity.

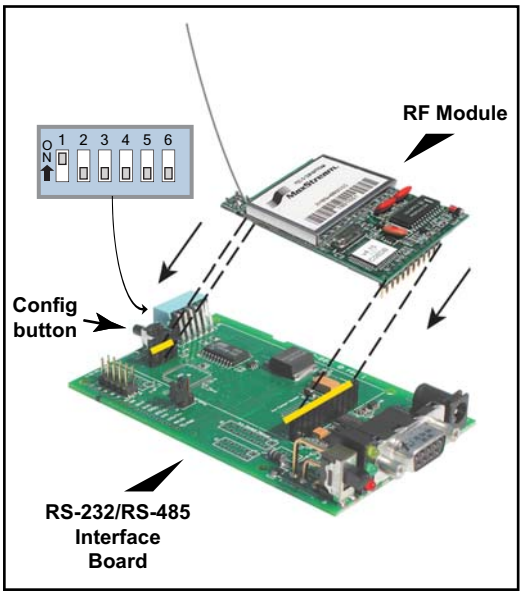
Use the **File** menu to open the desired sample program, then press function key **F9** to compile and run the program. Remove the programming cable and reset the LP3500 once the program has compiled and is running. A reset switch is located on both sides of the LP3500 near the programming header.



Wireless Data Module Setup

1. Set the DIP switches on both RS-232/RS-485 Interface Boards to the **RS-232 Mode** [Switch 1 is ON (up) and the remaining 5 switches are OFF (down)].
2. Mount each wireless data module to an RS-232/RS-485 Interface Board as shown at right.
3. Use the DB9F to DB9M serial cable to connect one Interface Board to your PC COM port. You may use the RS-232/USB converter (Part No. 540-0070) if your PC does not have a COM port.





4. Locate and double-click **`setup_x-ctu.exe`** in the Dynamic C **`DCRabbit…\X-CTU software`** directory to install the X-CTU application that you will use to set up the wireless data modules.
5. Connect a 9 V AC adapter to the power input on the RS-232/RS-485 Interface Board. Use the ON/OFF switch on the RS-232/RS-485 Interface Board to turn the Interface Board on— the red LED should light up.
6. Start X-CTU from the desktop icon and set the "PC Settings" tab to **38400** baud (XCite™ module) or **19200** baud (XStream™ module), **NONE** flow control, **8** data bits, parity **NONE**, **1** stop bit. Click **Test/Query**, then click **OK** when you get the report "Communication with modem…OK" that displays the modem type and firmware. Note the modem type (XC09-038 or X24-019). The settings in this step apply only when you have a module "fresh out of the box" — otherwise use the settings in Step 8.
7. Click **Read** on the "Modem Configuration" tab. The modem type identified in the previous step should display, and you will now set the serial options. Click **Write** when you have set the serial options.

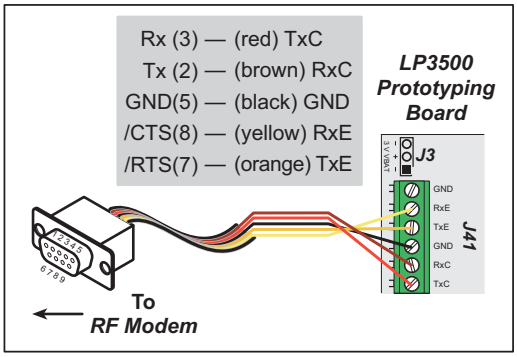
XC09-038 (XCite™)	X24-019 (XStream™)
• *AT Command/Serial Interface Options* CD – D03 Configuration = 2 - low	• *Networking* RR – Retries = FF
• *Non-AT Settable Parameters/Serial Interfacing Options* Baud Rate = 3 - 9600 DI2 Configuration = 0 - Disable (Modbus only) = 1 - RTS flow control (PPP only)	• *Serial Interfacing Options* BD – Interface Data Rate = 3 - 9600 RT – DI2 Configuration = 0 - Disable (Modbus only) = 2 - RTS flow control (PPP only) CD – D03 Configuration = 2 - low

NOTE: The D12 configuration varies depending on whether you will be working with the **`MODBUS_SERIAL_SLAVE.C`** or the PPP sample programs. Remember to reconfigure the wireless data module following Steps 7–8 when changing between these sample programs.

8. Now set the "PC Settings" tab to **9600** baud, **NONE** flow control (Modbus sample program) or **HARDWARE** flow control (other sample programs), **8** data bits, parity **NONE**, **1** stop bit. Click **Test/Query**, then click **OK** when you get the report "Communication with modem…OK" that displays the modem type and firmware.

9. Turn the Interface Board OFF, then use the DB9M to bare wire leads serial cable to connect this Interface Board to header J41 on the LP3500 Prototyping Board. Turn the Interface Board back ON.

10. Connect the other Interface Board to your PC COM port (see Step 3) and repeat Steps 5–8. Leave this Interface Board connected to your PC.



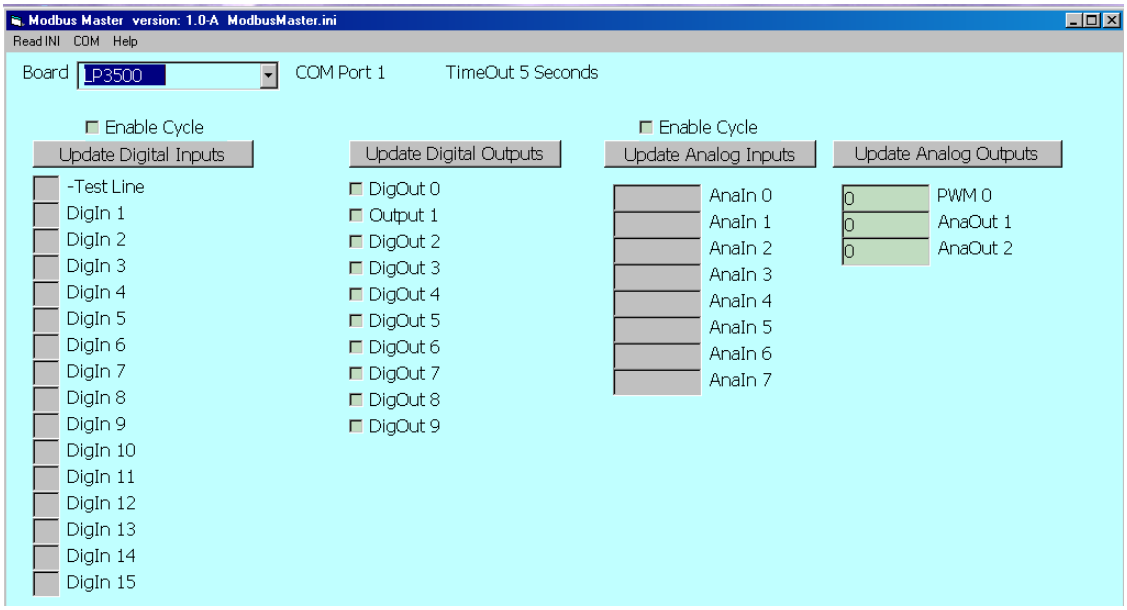
After you place the Interface Board connected to the LP3500 some distance away from the PC workstation, you will be able to try to control the LP3500 wirelessly from the PC workstation. See **Additional Reference Information** for more information on signal loss and maximizing the range.

Wireless Control Demonstrations

You are now ready to access the LP3500 from your PC through a wireless interface. The specific access instructions depend on the sample program you loaded on the LP3500. Appendix A documents the use of the Dynamic C function calls and macros in the sample programs.

MODBUS_SERIAL_SLAVE.C

Start the ModbusMaster application that you installed from the supplemental CD — double-click the **ModbusMaster.exe** file in the Dynamic C **Modbus** folder. Select the LP3500 from the **Board** pull-down menu, then select your choice of any of DigOut 0 to DigOut 3. The corresponding LEDs on the LP3500 Prototyping Board will light up once you click "Update Digital Outputs." If you experience any problems, check that the **COM Port** to the right of the board matches the COM port on your PC. If it does not, you may change it using the **COM** menu on the menu bar.



You may access the remaining LP3500 I/O by checking the corresponding boxes and clicking the corresponding "Update" button.

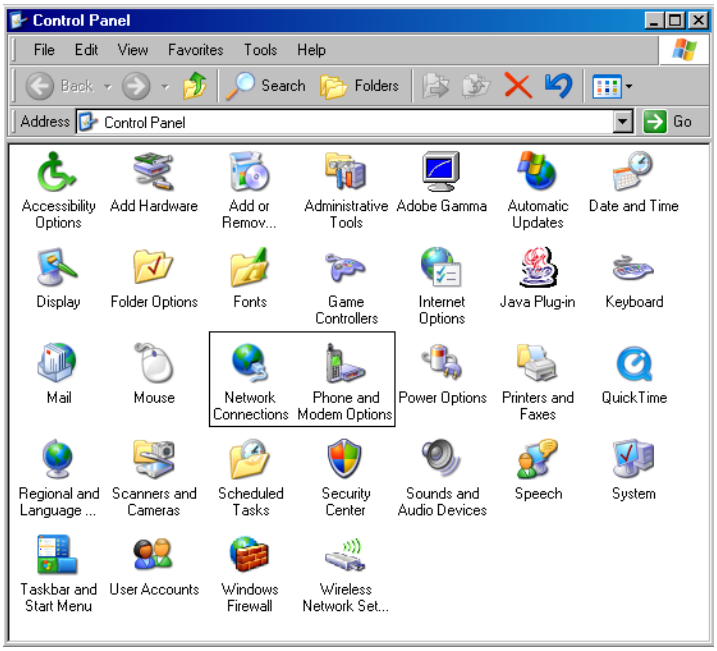
The ModbusMaster application performs the functions of a Modbus master in a system that may include up to five Rabbit-based Modbus slave devices, but is not a complete implementation of a Modbus master. When the program first starts up, it looks for a definition file (**ModbusMaster.ini**) within the same folder. If one is not found, you will be prompted to find one. You may also tell the program to use another definition file by selecting **Read INI** from the menu bar. Additional information about the ModbusMaster application is available in the Dynamic C **Modbus/Docs** folder.

DIRECT_PPP.C and DIRECT_PPP_HTTP.C

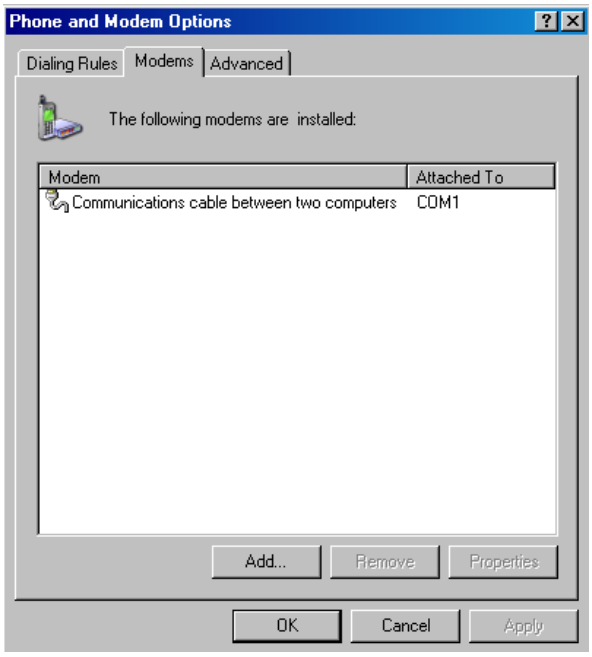
Before accessing the LP3500 wirelessly, you will have to configure your PC or notebook. If the PC or notebook is connected to a network, it is recommended that you disconnect it from the network. The screen shots shown here are from Windows XP Professional — the interface is similar for other versions of Windows.

Set Up PC Modem

1. Go to the control panel (**Start > Settings > Control Panel**) and double-click the **Phone and Modems Options** icon.



2. Click the “Modems” tab and press the **Add** button. The **Add Hardware Wizard** will open.
3. Check the “Don't detect my modem; I will select it from a list” box and press **Next**.
4. Click on “Communications cable between two computers” under **Models** and press **Next**.
5. Click the COM port that the PC will be using for this connection and press **Next**.
6. Press **Finish** and then press **OK**.



Set Up Network Connection

1. Go to the control panel (**Start > Settings > Control Panel**) and double-click the **Network Connections** icon.
2. Click the "New Connection Wizard," then press **Next** to bring up the **New Connection Wizard**.
3. Select "Set up an advanced connection" and press **Next**.
4. Select "Connect directly to another computer" and press **Next**.
5. Select "Guest" and press **Next**.
6. Enter a specific name for the Rabbit-based device (for example, LP3500) and press **Next**.
7. Select "Communications cable between two computers…" and press **Next**.
8. Select "Anyone's use" and press **Next**, then press **Finish**.
9. When the dialup window pops up, press the **Properties** button
10. Verify that the COM port selected previously is displayed under the "General" tab and press the **Configure** button.
11. Set the "Maximum speed (bps)" to 9600 and check only the "Enable hardware flow control" box, leave the other settings unchecked, and press **OK**.
12. Check "Display progress while connecting" under the "Options" tab in the dialup window, and leave other dialing settings unchecked.
13. Select "Typical (recommended settings)" and "Allow unsecured password" under the "Security" tab in the dialup window.
14. Press the **Settings** button under the "Networking" tab, uncheck all the checkboxes, then press **OK**.
15. Double click ":Internet Protocol (TCP/IP)," then press the **Advanced** button, uncheck "Use IP header compression" and uncheck "Use default gateway on remote network" under the "General" tab. Now go to the "WINS" tab and select "Disable NetBIOS over TCP/IP,".and press **OK**.
16. Press **OK** two more times to close the TCP/IP properties page.
17. Click **OK** to close the dialup window and save the settings.

The dialup connection should begin and the LP3500 running either sample program will be accessible wirelessly. The dialup will be repeated a few times before timing out if there is a connection problem. If you do encounter a connection problem, turn both Interface Boards off, verify that the DB9 connector is connected securely, then turn the Interface Boards back on.

Double-click the connection you named in Step 6 from the **Network Connections** window that may be reached from the control panel (**Start > Settings > Control Panel**). You may access the LP3500 in the future from here without having to set up the modem or configure the network parameters again.

What to Expect

If you are running **`DIRECT_PPP.C`** on the LP3500, you may ping the LP3500 to demonstrate the PPP wireless connection. Run the Windows command dialog (**Start > Run**, then enter **`cmd`**) and type the following ping command:

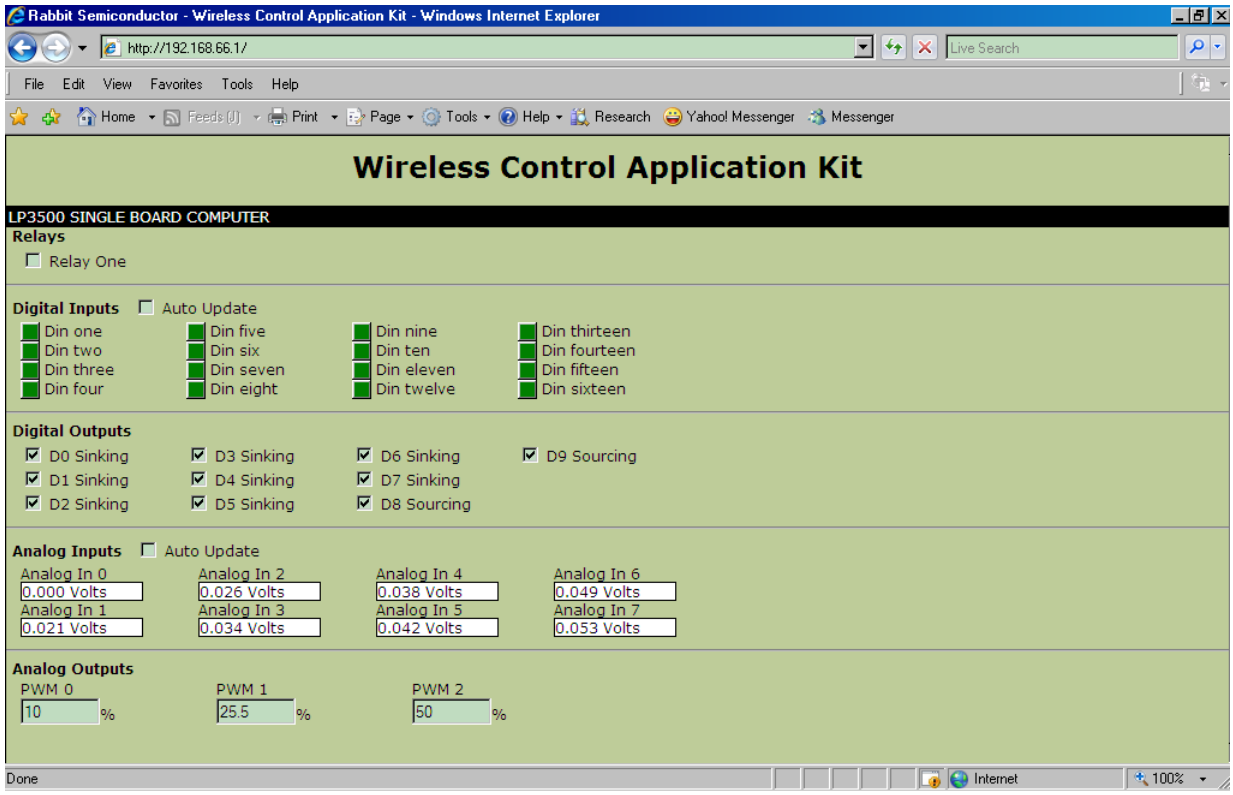
```
ping 192.168.66.1
```

then click **Enter**. The window will display the results of the ping. Close the window (**`exit [return]`**) when you are done.

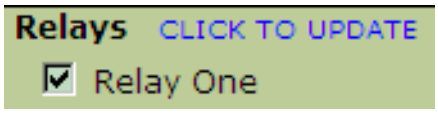
If you are running **DIRECT_PPP_HTTP.C** on the LP3500, you may also ping the LP3500 to demonstrate the PPP wireless connection following the above instructions. You may also open your Web browser and enter the following URL to interface wirelessly with the LP3500 via the Web browser.

```
http://192.168.66.1/
```

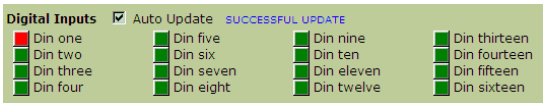
You will get the following display (keep in mind that it may take a minute or two to fully load the various image components, whose loading status you will be able to watch in the Web browser).



- You may turn the relay ON or OFF by CHECKING or UNCHECKING **Relay One**, then clicking on the **CLICK TO UPDATE**.



- Try pressing and holding down one of the switches on the LP3500 Prototyping Board, say the corner switch S1, then CHECK the **Auto Update** for the **Digital Inputs**. You will see **GETTING DATA** and **SUCCESSFUL UPDATE** status messages, and then see a visual indication in the Web browser that **Din one** is high.



- UNCHECK any of the **D0–D3 Sinking Digital Outputs**, then click on **CLICK TO UPDATE**. You will then see the corresponding DS1–DS4 lights light up on the LP3500 Prototyping Board.

Analog inputs and analog outputs may be handled accordingly.

Additional Reference Information

The following manuals are available from the documentation installed on your PC when you installed the Dynamic C CD and the supplemental CD for this application kit.

LP3500 User's Manual

XCite™ RF Module Product Manual

XStream™ RF Module Product Manual

Check the Rabbit Semiconductor and the MaxStream Web sites for additional information and the latest versions of supporting documentation.

MaxStream has several documents dealing with RF signal losses, RF installation tips, and selecting a radio frequency.

Indoor Path Loss

Maximizing Range

900 MHz vs 2.4 GHz

Appendix A — Software Reference

Sample Programs

MODBUS_SERIAL_SLAVE.C

Let's examine some of the code in the **MODBUS_SERIAL_SLAVE.C** sample program. In this sample program, the LP3500 is the *slave* device, and the PC is the *master.*

Macro Definitions

```
#define MODBUS_DEBUG_PRINT 0
#define MODBUS_SLAVE_DEBUG nodebug
#define USE_MODBUS_CRC
#define BYTE_TIME 32
```

Defining the **MODBUS_DEBUG_PRINT** macro to its default value of 0 means that no messages will be printed. The **MODBUS_SLAVE_DEBUG** macro is set to **nodebug** to compile the **MODBUS_SLAVE.LIB** library without any debugging. The **USE_MODBUS_CRC** macro enables a cyclic redundancy check for the data. The **BYTE_TIME** macro sets the maximum number of byte times to wait between received bytes because the XCite™ wireless data module does not transmit all the bytes in a packet at once.

LP3500 Configuration Macros

```
#define  MY_MODBUS_ADDRESS 3
#define  SERIAL_MODE 0
#define MODBUS_PORT C
#define  CINBUFSIZE 127
#define  COUTBUFSIZE 127
#define  MODBUS_BAUD 9600
#define INPUT_ONE LOW
#define OUTPUT_ONE LOW
```

The **MY_MODBUS_ADDRESS** macro sets the Modbus address of the LP3500 to 3; Modbus addresses of 1-247 may be used. The **SERIAL_MODE** macro is set to 0, which causes the **serMode()** function call to set up Serial Ports B, C, and E on the LP3500 as regular RS-232 serial ports with no flow control. The **MODBUS_PORT** macro assigns Serial Port C as the Modbus serial port. The **CINBUFSIZE** and **COUTBUFSIZE** macros set the buffer sizes of the circular input and output buffers. The **MODBUS_BAUD** macro sets the baud rate to 9600 bps. The **INPUT_ONE** and **OUTPUT_ONE** macros set whether a logic one is a high or a low.

LP3500 Operation

The remaining code sets up the analog and digital I/O on the LP3500 so that the Modbus host can then execute the individual I/O. The **MODBUS_Serial_tick()** function call checks for command from the PC that is acting as the Modbus master.

DIRECT_PPP_HTTP.C

Let's examine some of the code in the **DIRECT_PPP_HTTP.C** sample program. In this sample program, the LP3500 will be the *host* device, which means that it will wait for the *guest* device to begin the PPP session. Once the PPP options are negotiated, the host device will use the following network parameters.

```
HOST_IP "192.168.66.1"
GUEST_IP "192.168.66.2"
```

The host device will provide the guest device with the following network parameters.

```
HOST_GATEWAY "192.168.66.1"
HOST_NETMASK "255.255.255.0"
```

Once the connection is established, the LP3500 will act as an HTTP Web server. The Web server can be accessed by typing the host's IP address in the guest PC's Web browser.

First, the program settings used at startup are defined. These macros are used by the parameters in the function calls, and you may change the macro definitions to suit your needs.

PPP Compile Time Settings

```
#define TCPCONFIG 0
```

The **TCPCONFIG** macro tells Dynamic C to select the TCP/IP configuration from a list of default configurations. When **TCPCONFIG 0** is specified, the network parameters are set in the program. Use **TCPCONFIG 1** or **TCPCONFIG 3** if you are going to access the wireless data module via an Ethernet connection instead of via a direct serial connection.

```
#define PPP_BAUD 9600L
```

This macro sets the PPP baud rate to 9600 bps.

```
#if((_BOARD_TYPE_ & 0xFF00) == (LP3500 & 0xFF00))
   #define LP3500_SBC
#endif

#ifdef LP3500_SBC
   #define USE_PPP_SERIAL 0x04
     // 0x02 for B, 0x04 for C, 0x08 for D,.....
   #define IFS_PPPp IF_PPP2
      // IF_PPP0 for A, IF_PPP1 for B, IF_PPP2 for C, .....
   #define IFS_PPPn "IF_PPP2"  // used for STDIO debugging info
#else // assume RCM3720 and not using Ethernet
   #define USE_PPP_SERIAL  0x08
      // 0x02 for B, 0x04 for C, 0x08 for D,.....
   #define IFS_PPPp IF_PPP3
      // IF_PPP0 for A, IF_PPP1 for B, IF_PPP2 for C, .....
   #define IFS_PPPn "IF_PPP3"  // used for STDIO debugging info
#endif
```

This block of code specifies the LP3500, and assigns the serial ports — Serial Port C is used for the PPP connection. An alternate serial port configuration is provide for the RCM3720 RabbitCore module, which may also be used without modifying this sample program — the RCM3720 uses Serial Port D for the PPP connection.

The next macro settings improve the performance of the sample program when using the XCite™ wireless data module by compensating for its smaller buffer and lack of over-the-air flow control. The macros are not needed when the XStream™ wireless data module is used.,

```
#define ETH_MTU 400          // XCite has a 438 byte buffer
#define HTTP_MAXBUFFER ETH_MTU-40
#define TCP_BUF_SIZE (ETH_MTU-40)*2
#define TCP_MINRTO 250       // min RTO, default 10 ms
#define RETRAN_STRAT_TIME 25  // check RTO, default 10 ms
#define TCP_LAZYUPD 250      // packet delays, default 5 ms
```

Finally, the LP3500 or RCM3720 is identified as the host that will be listening for a guest.

```
#define DIALUP_SENDEXPECT  "'' &CLIENT @CLIENTSERVER '' @PPP '@'"
```

Network Settings

```
#define HOST_IP "192.168.66.1"
#define GUEST_IP "192.168.66.2"
#define HOST_GATEWAY "192.168.66.1"
#define HOST_NETMASK "255.255.255.0"
```

These macros set the IP addresses of the LP3500/RCM3720 host and the PC guest, and define the gateway and netmask for the host.

```
#define CHK_SIGNAL 20
```

The **CHK_SIGNAL** macro specifies a time limit in seconds for the HTTP socket to be idle when PPP is up. Wireless data modules may lose their signal, but the LP3500 will not recognize that this happened, so the PC will be pinged when the time limit expires — if there is no response, the PPP connection is terminated and re-initialized.

```
#define PING_TIMEOUT 1
```

The **PING_TIMEOUT** macro specifies the number of seconds to wait for the ping response.

Network Settings

The **LOCAL_VERBOSE** macro enables the printing out of error messages in the Dynamic C **STDIO** window. The colors are also defined here.

RabbitWeb Macros

```
#define USE_RABBITWEB 1
#define SSPEC_MAXNAME 32
#define HTTP_MAXSERVERS 1
```

The **USE_RABBITWEB** macro is defined to **1** to use the HTTP server enhancements. The **SSPEC_MAXNAME** macro defines the maximum length of mime type (default = 20), and the **HTTP_MAXSERVERS** macro is set to **1** (one server at a time) to reduce RF traffic.

```
#memmap xmem
#use "dcrtcp.lib"
#use "http.lib"
```

The **#define** of **USE_RABBITWEB** is followed by a request to map functions not flagged as root into **xmem**. The two **#use** statements allow the application the use of the main TCP/IP libraries (all brought in by **DCRTCP.LIB**) and the HTTP server library (which also brings in the resource manager library, **ZSERVER.LIB**).

Web Browser Display

The **ximport** imports the support HTML and javascript pages that are served up by the LP3500 host.

```
#ximport "pages/index.htm"  index_htm
#ximport "pages/lp3500.htm" lp3500_htm
#ximport "pages/digital.js" digital_js
#ximport "pages/analog.js"  analog_js
#ximport "pages/ajax.js"    ajax_js
```

Let's look at how this is done.

When a Web page is requested by a Web browser, the page is loaded, and any images, scripts, CSS, or iframes in the page will begin to load automatically as the main page is loaded. Some Web browsers such as Internet Explorer can only have two simultaneous connections, while other browsers can handle many more. This can create too much bidirectional traffic for the wireless data modules to handle. Hardware flow control only works for the wired serial interface to the wireless data modules so they can stop the data when their buffer is full. There is no such capability for the wireless data flow — the receiving wireless data module cannot stop the wireless data if its buffer gets full. Most issues here are kept to a minimum by setting up the wireless data modules for a baud rate of 9600 bps, and the amount of data flowing between them is further limited by setting the **HTTP_MAXSERVERS** macro to **1** (one server at a time). We also set the **ETH_MTU** macro to 400 bytes because the XCite™ module only has a 438-byte buffer; this ensures that full packets are sent. The **TCP_BUF_SIZE** macro is also limited to 2 times the **ETH_MTU** value minus 40 (because of extra Ethernet overhead) to prevent windowing. This basically means only one packet will be sent out and it must be ACKed before the next one is released.

The downloading process is long, and javascript code keeps track of the loading and displays some kind of status. To do this, the index.htm page uses the **onload** function to trigger an event when the page is fully loaded. The event handler or **getPage** function is then called, and sets an iframe's source file to lp3500.htm; the iframe is located in the index.htm page. This causes the browser to fetch the lp3500.htm

page, then the **getPage()** function calls the **loadStatus** function, passing it a "0" for operation and "lp3500.htm" for file name. The **loadStatus** function displays that we are getting the lp3500.htm page. While all this is happing, a script is called every 1000 ms to flash the message "Loading @ <baud> bps".

When the iframe, which contains the lp3500.htm file, loads, it also triggers its own onload event when it is fully loaded. The event handler function **loadStatus** in the index.htm page is called, and passes a "1" and "lp3500.htm" to indicate that the page has loaded. Another function, **getScripts**, which is located in the lp3500.htm page, is called when the onload event occurs. The **getScripts** function fetches the digital.js, analog.js, and ajax.jx files one file at a time. Each script file has a call to **scriptCb**, which is a function in lp3500.htm. This function lets the lp3500.htm page know that the script has loaded. The **scriptCb** function calls the **loadStatus** function, just like the other pages, to indicate this script has loaded. The **scriptCb** function then calls **getScript** to load the next script, and the process for loading scripts continues until all the scripts are loaded. The number of scripts to load is determined by the scripts array in the lp3500.htm page. When all files are loaded, the **loadStatus** function is called with a "2" parameter to indicate that all files were loaded and to display the elapsed time to load. The **pageInit** function in the lp3500.htm page is called, and all RabbitWeb variables are set up. Finally, the **doneLoading** function, which is located in the index.htm page stops the flashing "Loading" indicator and hides the loading status information. The Web browser now displays the loaded iframe (lp3500.htm), which displays all the I/O controls.

The ajax.js script is used to post and/or get information from the Rabbit-based LP3500 http server. This is used to create more of a real-time experience when dealing with I/O control and monitoring. AJAX (asynchronous javascripts and XML) provides a more application-type feel for Web pages since it allows the Web browser to communicate with the http server in the background. This reduces the usual constant reloading of pages and images when interacting with the web server.

Relays

The LP3500 has a relay, whose control through the RabbitWeb interface is governed by the **relaySetup**, **relayLabels**, **relayStatus**, and **relayOutUpdate** function calls. You would simply change the name or add additional labels to **relayLabels** to match the relays on your specific board.

```
int relayLabels;
#web relayLabels select("Relay One")
```

Digital Inputs

The control of the 16 digital inputs through the RabbitWeb interface is governed by the **digInSetup**, **digInLabels**, **digInStatus**, and **digInUpdate** function calls. You would simply change the name or add additional labels to **digInLabels** to match the relays on your specific board.

```
int digInLabels;
#web digInLabels select("Din one", "Din two", "Din three", "Din four",\
   "Din five", "Din six", "Din seven", "Din eight", "Din nine",\
   "Din ten", "Din eleven", "Din twelve", "Din thirteen",\
   "Din fourteen", "Din fifteen", "Din sixteen")
```

Digital Outputs

The control of the 10 digital outputs through the RabbitWeb interface is governed by the **digOutSetup**, **digOutLabels**, **digOutStatus**, and **digOutUpdate** function calls. You would simply change the name or add additional labels to **digOutLabels** to match the relays on your specific board.

```
int digOutLabels;
#web digOutLabels select("D0 Sinking", "D1 Sinking", "D2 Sinking",\
   "D3 Sinking", "D4 Sinking", "D5 Sinking", "D6 Sinking",\
   "D7 Sinking", "D8 Sourcing", "D9 Sourcing")
```

Analog Inputs

The control of the eight analog inputs through the RabbitWeb interface is governed by the **anaInSetup**, **anaIns**, **anaInStatus**, and **anaInUpdate** function calls. The **anaInSetup** function call is used to assign the **Analog Inputs** name to the group header and to specify the number of inputs, rows, and column width. Each **anaIns** label is unique because of the different configurations of each analog channel, and that is also why the **anaInStatus** array has a value of **8**. You would simply change the name or add additional labels to **anaIns** to match the inputs on your specific board.

```
int anaInSetup; // group header, #of inputs, #of rows, column width
#web anaInSetup select("Analog Inputs","8","2","135px")
int anaIns[8];  // label, unit, min, max
#web anaIns[0] select("Analog In 0", "Volts", "0", "20")
#web anaIns[1] select("Analog In 1", "Volts", "0", "10")
#web anaIns[2] select("Analog In 2", "Volts", "0", "5")
#web anaIns[3] select("Analog In 3", "Volts", "0", "4")
#web anaIns[4] select("Analog In 4", "Volts", "0", "2.5")
#web anaIns[5] select("Analog In 5", "Volts", "0", "2")
#web anaIns[6] select("Analog In 6", "Volts", "0", "1.25")
#web anaIns[7] select("Analog In 7", "Volts", "0", "1")

.

.

void anaInUpdate()
```

As the analog inputs are read, the **anaInUpdate()** function call updates their values in the Web browser.

```
for(i=0;i<8;i++)
   anaInStatus[i] = anaInVolts(i,i);
```

The **anaInVolts()** function call reads each of the eight analog inputs, and in turn converts each raw reading to a voltage; the first parameter in **anaInVolts()** is the channel number (0–7), and the second parameter is the gain code (0–7) as explained in the function help or the ***LP3500 User's Manual***. The different gain codes for each channel represent different voltage ranges as shown below.

Analog Channel	Voltage Range
0	0–20 V
1	0–10 V
2	0–5 V
3	0–4 V
4	0–2.5 V
5	0–2 V
6	0–1.25 V
7	0–1 V

You may specify a standard gain code for all the channels, you may set up an analog input channel with a thermistor to measure temperature, or you may configure some of the analog inputs to measure current — refer to the ***LP3500 User's Manual*** for information on how to do this and the Dynamic C function calls. The corresponding labels in the sample program might then be as shown below.

```
int anaIns[8]; // label, unit, min, max
#web anaIns[0] select("Analog In 0", "mA", "4", "20")
#web anaIns[1] select("Analog In 1", "mA", "4", "20")
#web anaIns[2] select("Analog In 2", "Volts", "0", "5")
#web anaIns[3] select("Analog In 3", "Volts", "0", "5")
#web anaIns[4] select("Analog In 4", "&#176;C", "0", "20")
#web anaIns[5] select("Analog In 5", "&#176;F", "32", "100")
#web anaIns[6] select("Analog In 6", "Volts", "0", "1")
#web anaIns[7] select("Analog In 7", "Volts", "0", "1")
```

This reflects the following use of the analog inputs.

- 0—current measurement via **anaInmAmps()**.
- 1—current measurement via **anaInmAmps()**.
- 2—voltage measurement via **anaInVolts(2, 2)**.
- 3—voltage measurement via **anaInVolts(3, 2)**.
- 4—temperature measurement in °C via **anaIn(4, SINGLE, 0)**.
- 5—temperature measurement in °F via **anaIn(4, SINGLE, 0)**.
- 6—voltage measurement via **anaInVolts(6, 7)**.
- 7—voltage measurement via **anaInVolts(7, 7)**.

Analog Outputs

The control of the three analog outputs through the RabbitWeb interface is governed by the **anaOutSetup**, **anaOuts**, **anaOutStatus**, and **anaOutUpdate** function calls. The **anaOutSetup** function call is used to assign the **Analog Outputs** name to the group header and to specify the number of inputs, rows, and column width. Each **anaOuts** label is unique to allow for different configurations of each analog channel, and that is also why the **anaOutStatus** array has a value of **3**. You would simply change the name or add additional labels to **anaOuts** to match the outputs on your specific board.

```
int anaOutSetup; // group header, #of outputs, #of rows, column width
#web anaOutSetup select("Analog Outputs","3","1","150px")
int anaOuts[3];  // label, unit, min, max
#web anaOuts[0] select("PWM 0", "%", "0", "100")
#web anaOuts[1] select("PWM 1", "%", "0", "100")
#web anaOuts[2] select("PWM 2", "%", "0", "100")
```

As the analog outputs are read, the **anaOutUpdate()** function call updates their values in the Web browser. Each of the three PWM analog outputs is set up for a 100% duty cycle in this sample program via the **pwmOut()** function call.

Appendix B — Specifications

Complete specifications for the LP3500 and the LP3500 Prototyping Board are available in the ***LP3500 User's Manual***.

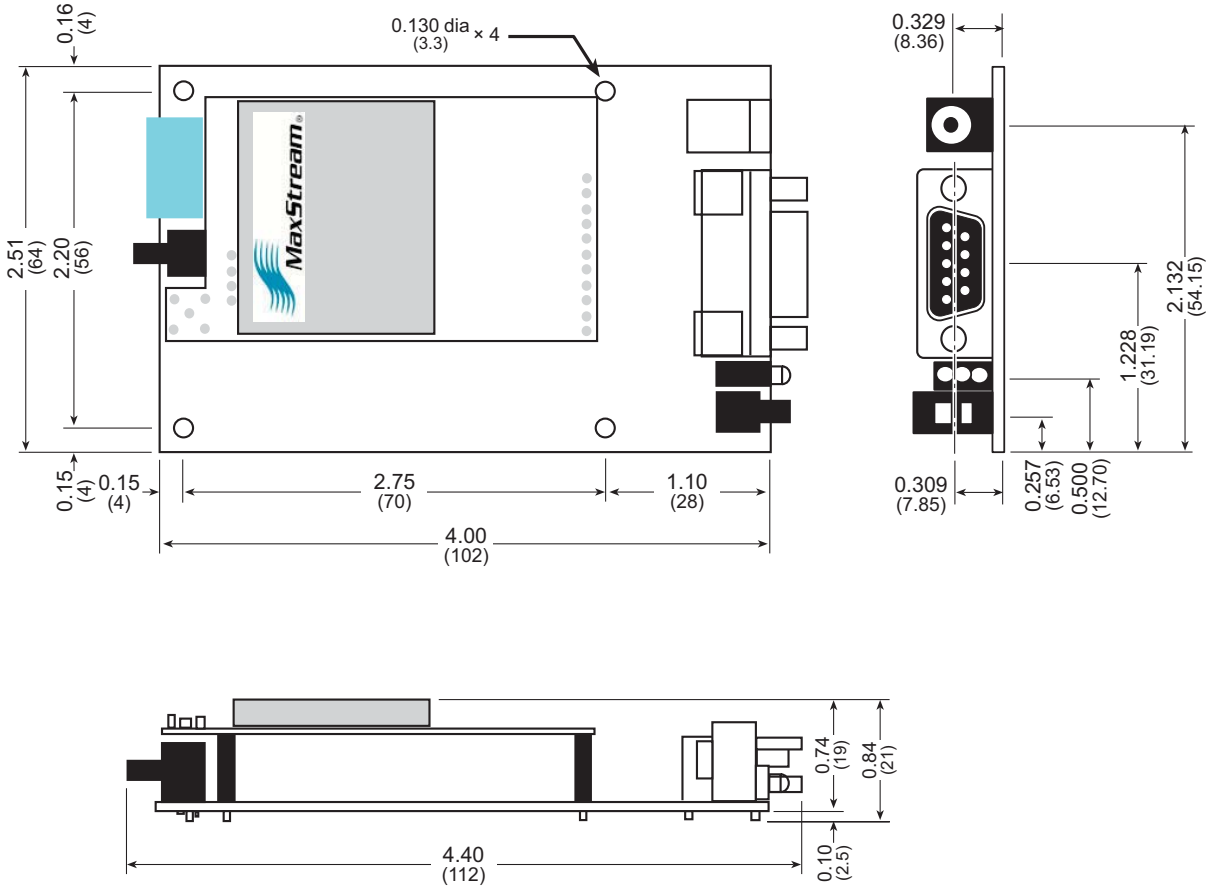


Figure A-1. RS-232/RS-485 Interface Board Dimensions (with Wireless Data Module Installed)

NOTE: All measurements are in inches followed by millimeters enclosed in parentheses. All dimensions have a manufacturing tolerance of ±0.01" (0.25 mm).