Operating Manual

COMMPAK-900 *TM*

900 MHz Spread Spectrum Transceiver

Revision 1.00 March 6, 2001

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COMMPAK-900™

900 MHz
Spread-Spectrum
Radio Modem

WARNING

In order to comply with the FCC/IC adopted RF exposure requirements, this transmitter system will be installed by the manufacturer's reseller professional. Installation of all antennas must be performed in a manner that will provide at least 23 cm clearance from the front radiating aperture, to any user or member of the public.

EQUIPMENT LABELING

The manufacturer, product name, and FCC and Industry Canada identifiers of this product must appear on the outside label of the end-user equipment.

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Encom ' products are appropriate for home, office, or industrial use, but are not authorized for utilization in applications where failure could result in damage to property or human injury or loss of life.

The electronic equipment described in this manual generates, uses, and radiates radio frequency energy. Operation of this equipment in a residential area may cause radio interference, in which case the user, at his own expense, will be required to take whatever measures necessary to correct the interference.

FCC Declaration of Conformity

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 caused undesired operation.

Encom Wireless Data Solutions Inc., products are warranted against all failures which occur as a result of defective material or workmanship within 24 months of purchase by the user. This warranty does not extend to products that, in the opinion of Encom Wireless Data Solutions Inc.., have been subject to misuse, accidents, lightning strikes, improper installation or application, nor shall it extend to units which have, in Encom Wireless Data Solutions Inc.'s opinion, been opened, tampered with or repaired by an unauthorized facility.

Manual Revision 1.00, March 6, 2001.

1. Introduction

1.0 Product Overview

The COMMPAK-900™ is a high-performance embedded wireless data transceiver. Operating in the 902 - 928 MHz ISM band, this frequency-hopping spread-spectrum module is capable of providing reliable wireless data transfer between almost any type of equipment which uses an asynchronous serial interface. The small-size and superior RF performance of this module make it ideal for many applications. Typical uses for this module include:

- SCADA
- Traffic Control
- Remote Monitoring
- Telemetry;
- Remote Camera/Robot Control;
- Security Systems; and,
- Display Signs.

While a pair of COMMPAK-900™ modules can link two terminal devices ("point-to-point" operation), multiple modules can be used together to create a network of various topologies, including "point-to-multipoint" and "repeater" operation. Multiple independent networks can operate concurrently, so it is possible for unrelated communications to take place in the same or a nearby area without sacrificing privacy or reliability.

1.1 Features

Key features of the COMMPAK-900™ include:

- transmission within a public, license-exempt band of the radio spectrum[1] – this means that it can be used without access fees (such as those incurred by cellular airtime);
- a serial I/O data port with handshaking and hardware flow control, allowing the COMMPAK-900™ to interface directly to any equipment with an asynchronous serial interface.
- 64 sets of user-selectable pseudo-random hopping patterns, intelligently designed to offer the possibility of separately operating multiple networks while providing security, reliability and high tolerance to interference;
- encryption key with 65536 user-selectable values to maximize security and privacy of communications;
- built-in CRC-16 error detection and auto re-transmit to provide 100% accuracy and reliability of data;
- ease of installation and use – the COMMPAK-900™ module uses a Windows based configuration utility named ControlPAK™. This software provide simple access to all parameters within the radio module.

While the typical application for the COMMPAK-900™ is to provide a short- to mid-range wireless communications link between DTEs, it can be adapted to almost any situation where an asynchronous serial interface is used and data intercommunication is required.

[1] 902-928 MHz, which is license-free within North America; may need to be factory-configured differently for some countries.

1.2 About this Manual

This manual has been provided as a guide and reference for installing and using COMMPAK-900™ wireless modem modules. The manual contains instructions, suggestions, and information which will help you set up and achieve optimal performance from your equipment using the COMMPAK-900™ module.

It is assumed that users of the COMMPAK-900™ module have either system integration or system design experience. Throughout the manual, you will encounter not only illustrations that further elaborate on the accompanying text, but also several symbols which you should be attentive to:

Caution or Warning: Usually advises against some action which could result in undesired or detrimental consequences.

Point to Remember: Highlights a key feature, point, or step which is worth noting, Keeping these in mind will make using the COMMPAK-900 more useful or easier to use.

Tip: An idea or suggestion is provided to improve efficiency or to make something more useful.

With that in mind, enjoy extending the boundaries of your communications with the COMMPAK-900™ module.

1.0.1 DC Characteristics

Sym	Characteristic	Min	Typ	Max	Units
AV_{CC}	Radio Supply Voltage	4.9	5.0	5.5	V
DV_{CC}	Logic Supply Voltage	4.75	5.0	5.5	V
V_{POT}	Power On Reset Threshold Voltage	1.8	2	2.2	V
V_{RST}	Reset Pin Threshold Voltage		$DV_{CC}/2$		V
AI_{CCR}	Radio Supply Current in Receive Mode	96	107	117	mA
AI_{CCT0}	Radio Supply Current at 1mW Transmit	68	108	119	mA
AI_{CCT1}	Radio Supply Current at 10mW Transmit	111	123	135	mA
AI_{CCT2}	Radio Supply Current at 100mW Transmit	157	174	191	mA
AI_{CCT3}	Radio Supply Current at 1W Transmit	398	442	486	mA
DI_{CC}	Logic Supply Current	95	105	115	mA
V_{IL}	Input Low Voltage (Pins 23,24,27)	-0.5		$.3DV_{CC}$	V
V_{IH}	Input High Voltage (Pins 23,24,27)	$0.6V_{CC}$		$V_{CC}+.5$	V
V_{OL}	Output Low Voltage (Pins 21,22,26,28-33)			0.6	V
V_{OH}	Output High Voltage (Pins 21,22,26,28-33)	4.2			V
I_{SRCE}	Sourcing Current (Pins 21,22,26,28-33)			10	mA

IMPORTANT:

For best performance, it is strongly recommended to use a separate, linearly regulated supply for Vcc Radio. Do not directly feed a switching power supply into Vcc Radio.

Caution: **Using any other power supply which does not provide the proper voltage or current could damage the COMMPAK-900™ module.**

2. Power Connection

The **COMMPAK-900™** power port provides a polarized locking power connection for the power cable. The **COMMPAK-900™** is supplied with a 72-inch power cable. The **COMMPAK-900™** requires a 10 to 30 VDC fused power source and is designed for use in negative ground systems only. The antenna must be connected to the radio prior to applying power to it.

Power connection to the **COMMPAK-900™** is as follows:

Cable Leads	Power Supply Connections
Power Cable Red lead	To power supply fused +Vdc
Power Cable Black lead	To power supply ground

3. Modes of Operation

The COMMPAK-900™ modem can be easily configured to meet a wide range of needs and applications. The module is designed such that all communication is through one serial port (Pins 21 to 28 on the module). This port has two functions:

1. It provides the asynchronous interface with the host equipment for data that is sent/received on the RF channel. When operating in this fashion, the module is said to be in **data mode**.
2. It is also used for configuring and programming the module. When operating in this fashion, the module is said to be in **command mode**.

In addition to **data mode** and **command mode**, there is a third mode of operation called **diagnostics mode**. The module will always be in one of these three modes:

3.1 Data Mode

Data mode is the normal operating mode of the COMMPAK-900™. When in data mode, the COMMPAK-900™ is communicating with other COMMPAK-900™ modules, and facilitating wireless asynchronous serial communication amongst two or more terminal devices. There are three basic elements to any COMMPAK-900™ communications network:

- One module configured as the **Master**
- Zero or more modules configured as **Repeaters**
- One or more modules configured as **Slaves**

The function of the Master is to provide synchronization for the entire network, and to control the flow of data. There is always one Master per network. The Master is the ultimate destination for all data collected at the various Repeater's and Slave's serial ports. With the network set up for Point-to-Multipoint communication, all data received at the Master's serial port is transmitted to every Repeater and Slave in the network. The COMMPAK-900™ is a frequency hopping transceiver, meaning that it "hops" to a new frequency after a predetermined time interval. This time interval is a fixed time set by the user, and can range from 8ms to 120ms. The COMMPAK-900™ hops according to a pseudorandom pattern of 50 different channels.

When configured as a Slave, the COMMPAK-900™ searches for synchronization with a Master. Network topologies consisting of a single *Master* and virtually any combination of *Slaves* and *Repeaters* may be deployed. The functionality of any particular COMMPAK-900™ can be configured as follows:

- **Master Point-to-Point**: The modem is configured to communicate with a single *Slave*, either directly, or through one or more *Repeaters*.
  - **Master Point-to-Multipoint**: The modem is configured to communicate with one or more *Slaves* and/or *Repeaters*.
  - **Slave**: The modem is configured to communicate with one *Master* either directly or through one or more *Repeaters*..
  - **Repeater**: The modem is configured to pass information from either a *Master* or another *Repeater* onto subsequent *Repeaters* and/or *Slaves* and vice versa. The *Repeater* also acts as a *Slave* in the sense that, like a *Slave*, it passes information to/from its serial port.

Examples of different network topologies are shown in Figure 4. Network 1 shows Point-to-Point communication between a Master and Slave. Network 2 makes use of a Repeater to communicate with the Slave. Network 3 illustrates a simple Point-to-Multipoint network with no Repeaters. Networks 4 and 5 gives examples of Point-to-Multipoint networks consisting of both Repeaters and Slaves. There is effectively no restriction to the number of Repeaters and Slaves that can be added to a network. As seen in Network 4, a Master can communicate directly with both Slaves and Repeaters.

3.2 Command Mode

The COMMPAK-900™ firmware has been designed to allow the user to customize the operation of the modem through Windows based proprietary software program called ControlPak™. This is discussed in further detail under ControlPak™ Configuration Software as to how to use the software. ControlPAK™ allows the user to control the entire operation of the COMMPAK-900™ radio module. One of the most important features that ControlPAK™ provides control over is the output power of the COMMPAK-900™ transceiver.

The allowable settings are:

1 mW
10 mW
100 mW
1000 mW

By having control over the output power of the COMMPAK-900™ transceiver, users are able to minimize **"RF Polution"**. The following warning must be considered when selecting the output power on the COMMPAK-900™ radio module.

IMPORTANT:

FCC Regulations allow up to 36 dBi effective radiated power (ERP). Therefore, the sum of the transmitted power (in dBm), the cabling loss and the antenna gain cannot exceed 36 dBi.

1 mW = 0 dBm

10 mW = 10 dBm

100 mW = 20 dBm

1000 mW = 30 dBm

For example, when transmitting 1 Watt (30 dBm), the antenna gain cannot exceed 36 - 30 = 6 dBi. If an antenna with a gain higher than 6 dBi were to be used, the power setting must be adjusted appropriately.

Encom Wireless Data Solutions Inc. limits the COMMPAK-900™'s transmitted power to 100mW for all units purchased with antennas with gain above 6dBi.

3.3 Diagnostics Mode

The COMMPAK-900™ transceiver is equipped with the software functionality to provide complete system-wide diagnostics and configuration. Using ControlPAK™ software, users can test and configure their entire wireless network from the master radio. For more information on the functionality of **Diagnostics Mode**, consult future revisions of this manual.

4. Data Port

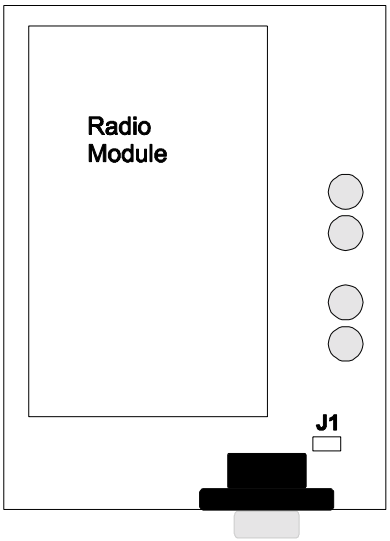
The **COMMPAK-900™** is available with a standard RS232 data configuration or optionally configured for 2 Wire RS485 or 4 Wire RS485 or HART® operation. Radios configured for RS485 or HART® operation are supplied with a programming cable, which permits direct connection to a computer for programming.

4.1 RS232 Configuration

The standard **COMMPAK-900™** RS232 serial port is used to connect the radio to peripheral equipment that supports the RS-232 type format. This serial interface port meets the EIA RS-232C interface standard and is provided on a DE-9 female connector. A standard RS232 modem cable is used for programming the RS232 configured **COMMPAK-900™**.

Pin Number	Input or Output	Pin Description
1	OUTPUT	**DCD –Data Carrier Detect.**
2	OUTPUT	**RXD – Received Data.** Outputs RX data to the connected device.
3	INPUT	**TXD – Transmitted Data.** Accepts TX data from the connected device.
4	INPUT	**Sleep Mode Enable. *** see below** Low = Enables Sleep Mode. High = Disables Sleep Mode and reactivates the radio
5		**Signal Ground.** Common DC ground.
6		Not Used
7	INPUT	**RTS – Request to send.**
8	OUTPUT	**CTS – Clear to send.**
9		Not Used

4.1.1 Sleep Mode



The COMMPAK-900™ is normally configured with the Sleep Mode function disabled. The Sleep Mode function is enabled by removing J1, the diagram on the left indicates the location of J1.
With J1 removed the radio Sleep Mode can be activated by tying Pin 4 of the RS232 data port low. The radio is reactivated and Sleep Mode deactivated by tying this pin high.

When J1 is removed to activate the Sleep Mode function, Pin 4 must be tied either high or low. The radio will not function correctly if J1 is removed and Pin 4 of the data port is left unconnected.

4.2 4 Wire RS485 Configuration

The **COMMPAK-900™** radio configured for 4 Wire RS485 operation may be programmed to operate in either Full or Half Duplex mode. The 4 Wire RS485 Data Port connections are provided on the DE-9 female connector and are outlined below.

The **COMMPAK-900™** radio is provided with a programming cable that allows you to connect the RS485 configured radio directly to your computer for programming.

Pin Number	Input or Output	Pin Description
1	OUTPUT	**RX+ Received Data.** Outputs RX data to the connected device.
2		**Not Used**
3		Not Used
4		Not Used
5		**Signal Ground.**
6	OUTPUT	**RX- Received Data.** Outputs RX data to the connected device.
7		Not Used
8	INPUT	**TX+ Transmitted Data.** Accepts TX data from the connected device.
9	INPUT	**TX- Transmitted Data.** Accepts TX data from the connected device.

4.3 2 Wire RS485 Configuration

The 2 Wire RS485 Data Port connections are provided on the DE-9 female connector and are outlined below.

Pin Number	Input or Output	Pin Description
1	INPUT / OUTPUT	**T/R +** Transmit / Receive data positive lead.
2		**Not Used**
3		Not Used
4		Not Used
5		**Signal Ground.**
6	INPUT / OUTPUT	**T/R -** Transmit / Receive data negative lead.
7		Not Used
8	INPUT / OUTPUT	**T/R +** Transmit / Receive data positive lead.
9	INPUT / OUTPUT	**T/R -** Transmit / Receive data negative lead.

Note: 4 leads are used for the 2 Wire RS485 data connections, as well as a ground connection. Pins 1 and 8 must be tied together for T/R +. Pins 6 and 9 must be tied together for T/R-.

5. LED Indicators

The **COMMPAK-900™** radio front panel LEDs indicate its operational status. The LEDs and their functions are as follows:

5.3.1 PWR (Red)

On both the Master and Local radios, the PWR LED indicates the radio is powered on.

The PWR LED will be ON solid when power is applied to the radio.

5.3.2 TXD **(Red)**

On both the Master and Local radios, the TXD LED indicates the radio is TRANSMITTING data.

5.3.3 RXD **(Red)**

On both the Master and Local radios, the RXD LED indicates the radio is RECEIVING data.

5.4 RSSI

5.4.1 MASTER

The RSSI LEDs indicate the level of the received signals from the Local Intersections. The LEDs initially remain OFF until a signal is received from any Local. Following the initial received signal the RSSI LEDs indicate the level of the received signal from each Local Intersection as they transmit, as detailed below. If communications to all Remote and/or Repeater sites is lost the RSSI LEDs will remain ON for 3 minutes, then all the RSSI LEDs will turn OFF.

5.4.2 LOCAL

The RSSI LEDs indicate the level of the received signal from the MASTER. The LEDs will FLASH in sequence if the Local radio is not locked to the Master. When the Local is locked to the Master the number of LEDs on or flashing will indicate the level of the signal received from the Master Intersection, as detailed below.

5.4.3 MASTER and LOCAL

A single flashing LED indicates a very poor and unusable signal. Three LEDs ON SOLID indicate a very strong and reliable received signal.

5.4.4 REPEATER

The RSSI LEDs will indicate the received RF signal level from the Master.

In multiple Repeater systems, the RSSI LEDs will indicate the received RF signal level from the upstream Repeater.

6. Installation

When deploying your system, care must be taken to ensure the **path loss** (reduction of signal strength from transmitter to receiver in dB) between equipment does not exceed the system gain (140 dB in the above example). It is recommended to design for a **gain margin** of at least 10 dB to ensure reliable communication. Gain margin is the difference between system gain and path loss. Referring to the same example, suppose the path loss is 100 dB, the gain margin would be 40 dB, which is more than adequate for reliable communication.

Path loss is a very complicated calculation which mainly depends on the terrain profile, and the height of the antennas off the ground.

The following table provides path loss numbers for varying antenna heights and antenna separation: These numbers are real averages taken from rural environments. They do not apply to urban, non-line-of-sight environments.

Distance (km)	Base Height (m)	Mobile Height (m)	Path Loss (dB)
5	15	2.5	116.5
5	30	2.5	110.9
8	15	2.5	124.1
8	15	5	117.7
8	15	10	105
16	15	2.5	135.3
16	15	5	128.9
16	15	10	116.2
16	30	10	109.6
16	30	5	122.4
16	30	2.5	128.8

Once the equipment is deployed, you can verify the signal strength by entering into Command Mode using ControlPAK™ and reading the RSSI value. The RSSI value provides the average signal strength in dBm. The minimum strength for communication is roughly -105 dBm. For consistent reliable communication, you should try to deploy the equipment such that signal strength exceeds -95 dBm.

6.5 Antennas and Cabling

This section describes the recommended procedure for installing cabling and antennas for use with the COMMPAK-900™ module.

6.5.1 Internal Cabling

The most common method for installing the module is to run a cable from the module's MCX connector to a reverse TNC bulkhead connector on the chassis of the equipment as shown in Figure 11. This cable is supplied by Encom Wireless Data Solutions Inc.

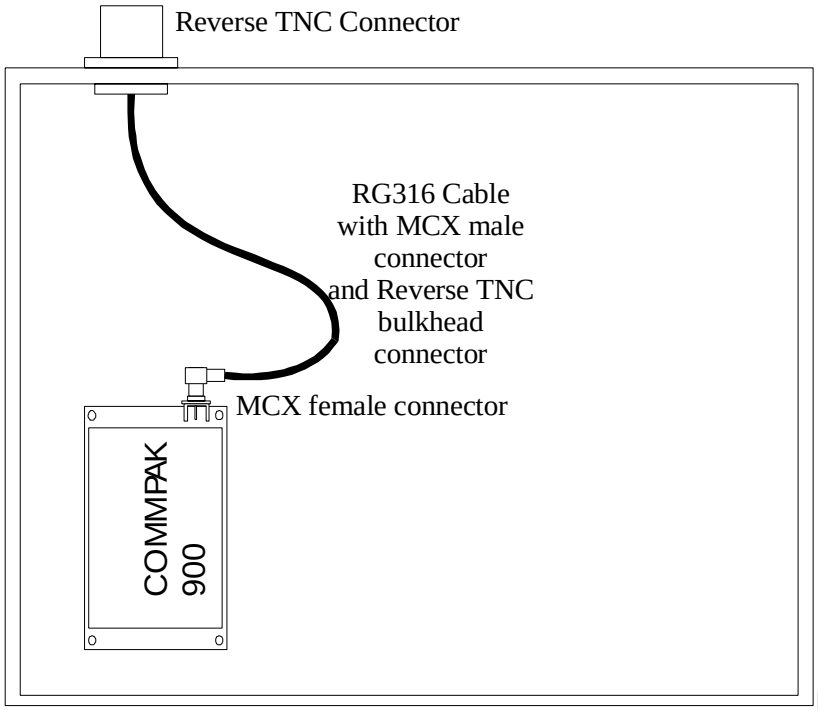


Figure 11.

Cable losses are negligible for the short piece used within the chassis. Additional losses up to 0.5 dB may be present in the MCX and Reverse TNC connections.

The installation, removal or maintenance of all antenna components must be carried out by qualified and experienced personnel.

Never work on an antenna system when there is lightning in the area.

Direct human contact with the antenna is potentially unhealthy when the COMMPAK-900 is generating RF energy. Always ensure that the COMMPAK-900 equipment is powered down during installation.

6.5.2 Installing External Cables, Antennas and Lightning Arrestors

The installation, removal or maintenance of all antenna components must be carried out by qualified and experienced personnel.

Never work on an antenna system when there is lightning in the area.

Direct human contact with the antenna is potentially unhealthy when the COMMPAK-900™ is generating RF energy. Always ensure that the COMMPAK-900™ equipment is powered down during installation.

Surge Arrestors

The most effective protection against lightning is to install two lightning (surge) arrestors. One at the antenna, and the other at the interface with the equipment. The surge arrestor grounding system should be fully interconnected with the transmission tower and power grounding systems to form a single, fully integrated ground circuit. Typically, both ports on surge arrestors are N-female.

Cabling

The following coax cables are recommended:

Cable	Loss (dB/100ft)
LMR 195	10.7
LMR 400	3.9
LMR 600	2.5

Factors to take into consideration when choosing a cable are:

- price;
- bend radius limitations (the lower performance cables generally can bend more sharply)
- performance requirements; and,
- distance between the equipment and the antenna.

When installing the cable, always begin fastening at the top near the antenna connector/surge arrestor. The cable must be supported at the top with a hose clamp or wrap lock, and at 5 ft intervals down the length of the tower. Over-tightening the fasteners will dent the cable and reduce performance. If properly grounded surge arrestors are not installed at both the top and the bottom of the cable, then the cable should be grounded to the tower at these locations using a cable grounding kit. If the tower is non-conductive, then a separate conductor, physically separate from the cable, should be run down the tower.

To comply with FCC regulations, .you must limit ERP to 36 dBm or less.

Antenna

Before choosing an antenna, you should have some knowledge of the path loss and the topology of the equipment. If the equipment is in a fixed location and is to communicate with only one other unit also in a fixed location, then a Yagi antenna is suitable. Choose a Yagi with enough gain to ensure adequate gain margin. When deploying the Yagi, point the antenna towards the intended target, ensuring the antenna elements are perpendicular to the ground.

If the equipment must communicate with multiple or mobile transceivers, then select an Omni-directional antenna with appropriate gain.

The Effective Radiated Power (ERP) emitted from the antenna cannot exceed +36 dBm ERP.

With the COMMPAK-900 set to full power, ERP is calculated as follows:

ERP = 30 - (Cabling and Connector Losses) + (Antenna Gain) < 36

Use the guidelines in the previous section for calculating cable and connector losses. If cabling and connector losses are 2 dB, then the maximum allowable gain of the antenna will be 8 dB.

External Filter

Although the COMMPAK-900™ is capable of filtering out RF noise in most environments, there are circumstances that require external filtering. Paging towers, and cellular base stations in close proximity to the COMMPAK-900™ antenna can desensitize the receiver. Encom's external cavity filter eliminates this problem. The filter has two N-female ports and should be connected in line at the interface to the RF equipment.

Weatherproofing

Type N and RTNC connectors are not weatherproof. All connectors should be taped with rubber splicing tape (weatherproofing tape), and then coated with a sealant.

7. ControlPAK™ Configuration Software

ENCOM Wireless Data Solutions has developed the ControlPAK™ software for configuration of the **COMMPAK-900™** radio.

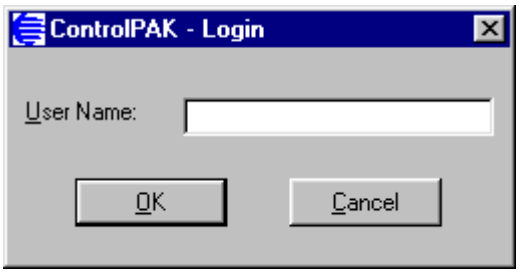
7.1 ControlPAK™ Software Installation

1. Insert Disk #1 into your P.C.
2. Click the Start button. Click Run.
3. Click the Browse button. Locate and select the ControlPAK™ Set Up file.
4. With the ControlPAK™ Set Up file path in the RUN menu screen, click OK.
5. The ControlPAK™ software will now be installed on your computer.
6. Your installation may require only 2 of the 3 disks.

7.2 Serial Connection

1. The COMMPAK-900™ radio provides RS232 Programming capability for radios configured for RS485 , which eliminates the requirement for a data convertor.
2. Connect the COMMPAK-900™ radio Data port to your PC as follows;
    A. RS232 Configuration - Use a standard straight through serial cable, which includes all serial connections.
    B. RS485 Configuration – Use the supplied RS485 programming cable.

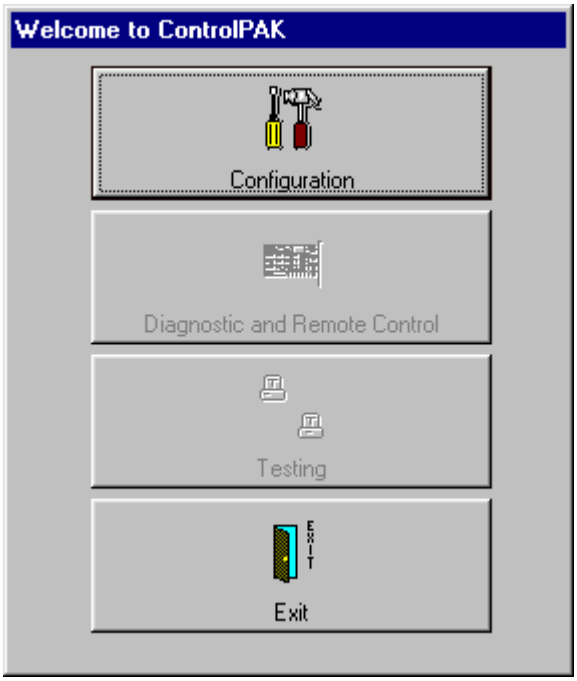
7.3 ControlPAK™ Operation



7.3.1 Log In

1. Click on the ControlPAK Icon to launch ControlPAK.
2. User Name = SCADA

7.3.2 Initial Menu



Configuration

Select this menu to continue with the configuration of your radio.

Diagnostic and Remote Control

This feature is currently undergoing final testing and completion.

Testing

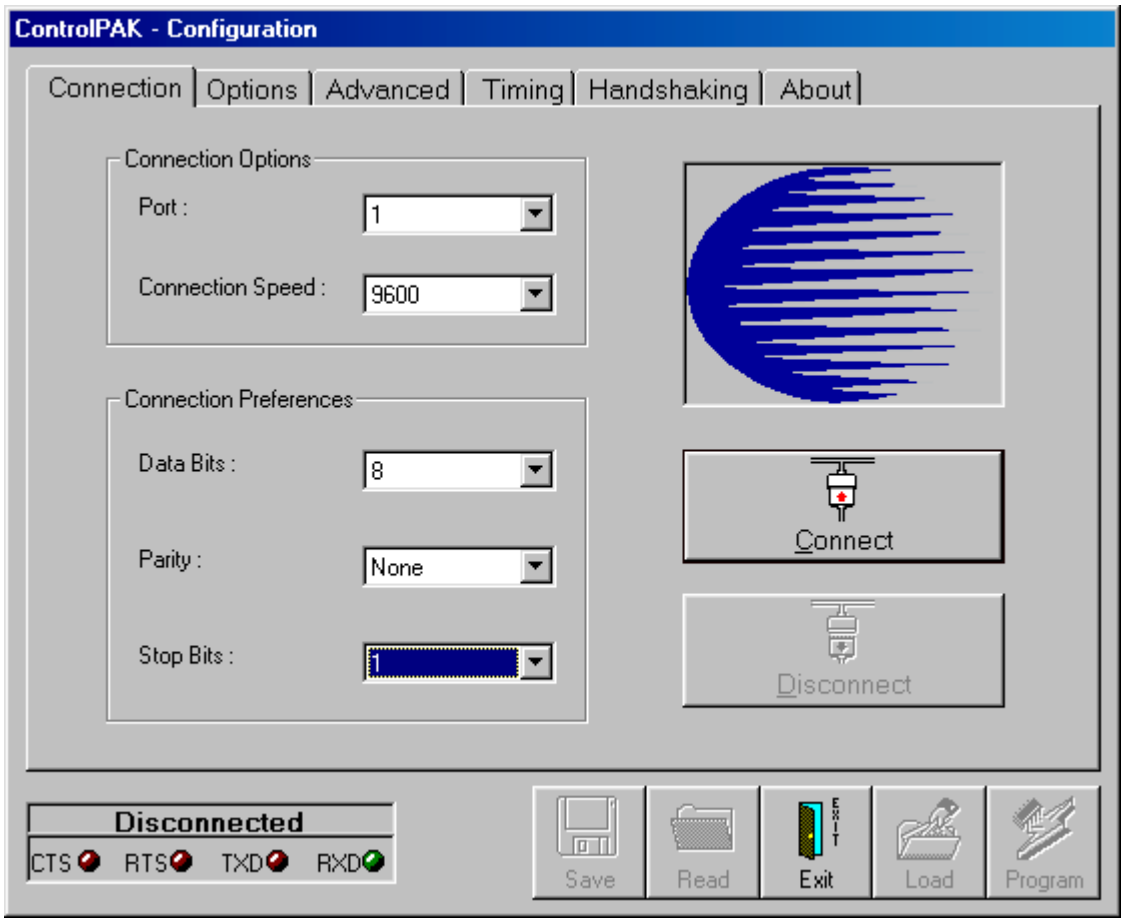
This feature is currently undergoing final testing and completion.

EXIT

Select EXIT to quit ControlPAK.

7.3.3 Configuration Menu

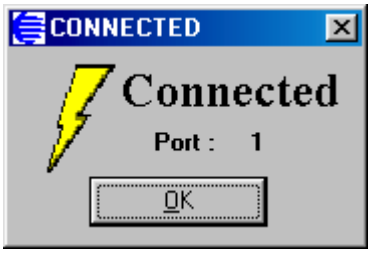
When the Configuration menu is selected in the previous step the main Configuration screen, shown below, will appear.



7.3.4 Software - Connection

1. The ControlPAK™ software must first be connected to the COMMPAK-900™ radio.
2. Only the Connection and About menus can be accessed before a connection is established. If the connection has not been established an Error Message will appear, when you attempt to access the other Configuration menus.
3. Select the computer Port number that the radio is connected to.
4. Enter the radio's current baud rate and data format, if available, which will speed up the Connection procedure, however the software will Connect without these entries.
5. Click on Connect. The message: Attempting to Connect, shown on the below, will appear.

6. ControlPAK™ will automatically determine the radio baud rate and data format and establish a connection from the radio to the computer.
7. When the connection has been established the message Connected shown on below, will appear. The radio's current baud rate and data format will be shown in the Connection menu. Click OK.



8. The next menu requires you to select if the COMMPAK-900™ radio has either the HART or RS485 option installed. Select none if the radio is configured for RS232 operation.

9. If the ControlPAK™ software is unable to establish a connection to the radio an Error message will appear.

Note: **When the COMMPAK-900™ radio has connected to the ControlPAK™ software the PWR LED will turn OFF indicating that the transceiver is in COMMAND mode**.

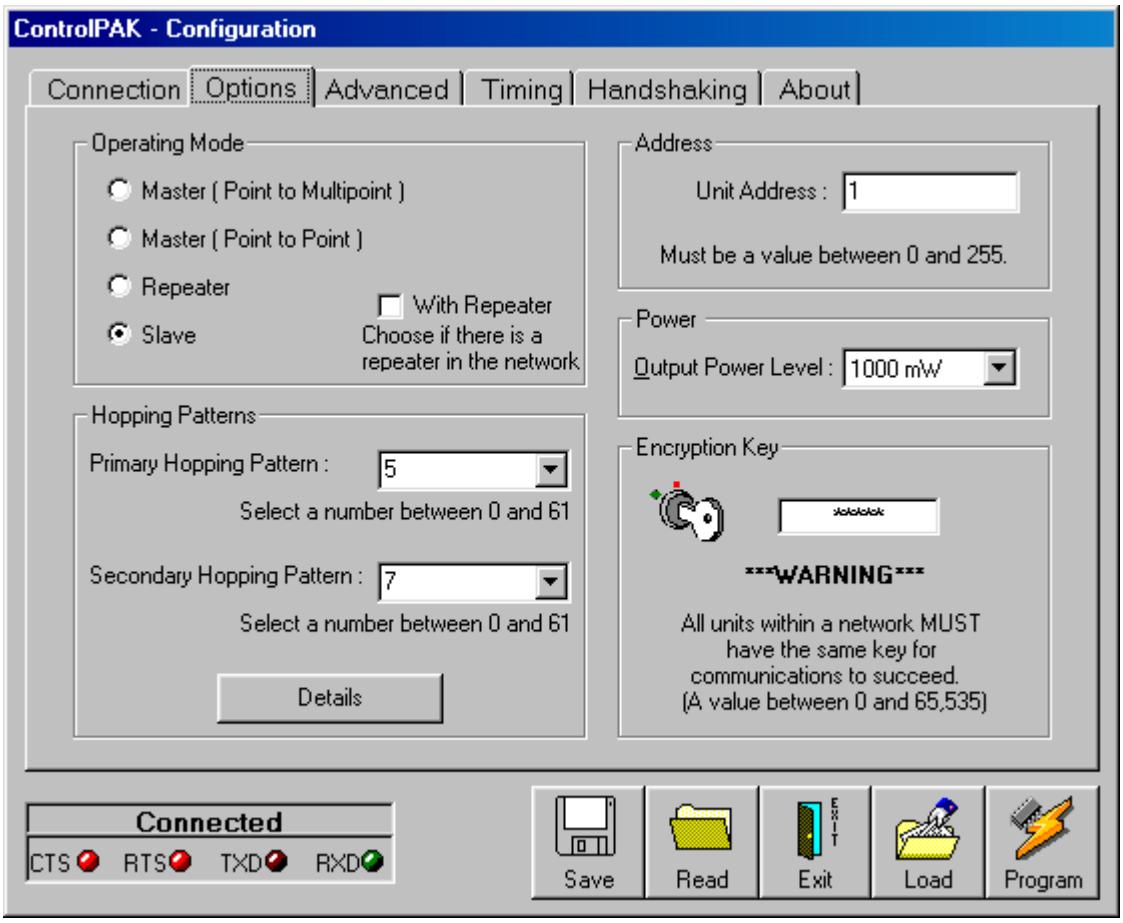
7.3.5 Software - Disconnect

1. The Disconnect button is activated when the ControlPAK™ software has connected to a radio.
2. When you have completed programming a radio click the Disconnect button to disconnect the radio from the ControlPAK™ software.
3. When you click the Disconnect button, a message will appear; “Program Changes to Radio?”. Click on NO if you are certain you have programmed the changes. Click on Yes if you would like to Program the Changes to the radio.
4. When the software has been Disconnected the Connect button will be activated and the software is now ready for Connection to the next radio.
5. When you are programming multiple radios, you must first Disconnect the software from the radio that was just programmed, prior to programming the next radio.

Note: If you forget to click the Disconnect button and set up another radio for programming, the ControlPAK software will still have the Disconnect button activated. Click the Disconnect button, wait until the Connect button is activated. Click the Connect button to Connect to the radio currently set up for programming.

6. An error message will appear if you attempt to Program a radio that has not been correctly Connected to the ControlPAK™ software.

7.3.6 Configuration - Radio Options



7.3.7 Output Power Selection

The Output Power Level determines at what power the COMMPAK-900™ transmits. The COMMPAK-900™'s sensitive receiver can operate with very low power levels, so it is recommended that the lowest power necessary is used; using excessive power contributes to unnecessary **"RF pollution**".

The allowable settings are:

1 mW
10 mW
100 mW
1000 mW

Ideally, you should test the communications performance between units starting from a low power level and working upward until the RSSI is sufficiently high and a reliable link is established. Although the conditions will vary widely between applications, typical uses for some of the settings are described below:

Power	Use
1 mW	For in-building use, typically provides a link up to 300 feet on the same floor or up/down a level. Outdoors, distances of 10 km can be achieved if high-gain (directional) antennas are placed high above ground level and are in direct line-of-sight.
10 mW	200-500 ft indoors, 8-15 km* outdoors.
100 mW	400-800 ft indoors, 15-25 km* outdoors.
1000 mW (1 W)	Typically provides communications up to a distance of 1000 feet or more in-building on the same floor or up/down a few levels, depending on building construction (wood, concrete, steel, etc.). In ideal line-of-sight conditions, up to 30 km* or more can be achieved. Note that only an antenna with a gain of no more than 6 dBi may be used. **Any higher is a violation of FCC rules**. See IMPORTANT warning below.

* These outdoor distances assume antennas are mounted at least 100 ft above ground level

IMPORTANT:

FCC Regulations allow up to 36 dBi effective radiated power (ERP). Therefore, the sum of the transmitted power (in dBm), the cabling loss and the antenna gain cannot exceed 36 dBi.

1 mW = 0 dBm

10 mW = 10 dBm

100 mW = 20 dBm

1000 mW = 30 dBm

For example, when transmitting 1 Watt (30 dBm), the antenna gain cannot exceed 36 - 30 = 6 dBi. If an antenna with a gain higher than 6 dBi were to be used, the power setting must be adjusted appropriately.

Encom Wireless Data Solutions Inc. limits the COMMPAK-900™'s transmitted power to 100mW for all units purchased with antennas with gain above 6dBi.

7.3.8 Hopping Patterns

- Several SCADA Systems can operate in one area by selecting a specific Hopping Pattern for each system.
- Also some of the Hopping Patterns notch out part of the Spread Spectrum frequency band, which may eliminate interference in some cases.
- The Secondary Hopping Pattern only applies to radios that are configured as Repeaters.
- Click on the Details button for further information.

7.3.9 Unit Address

Point to Multipoint System

- This address is used only for radio diagnostics software, which is currently being developed.
- All Remotes will have a specific Unit Address that will be used by the Master radio for Diagnostics Polling.

Point to Point System

- This address is used by the Master to indicate the address of the radio it will communicate with.
- When you select the Operating Mode – Master (Point to Point), the message below will appear.

- The Slave radio must have the same address as the one entered in the Master radio.
- This mode of operation is typically used for file transfer and offers more secure and robust operation.

7.3.10 Encryption Key

This parameter allows you to enter a key value used by ControlPAK™ for encryption of the data.

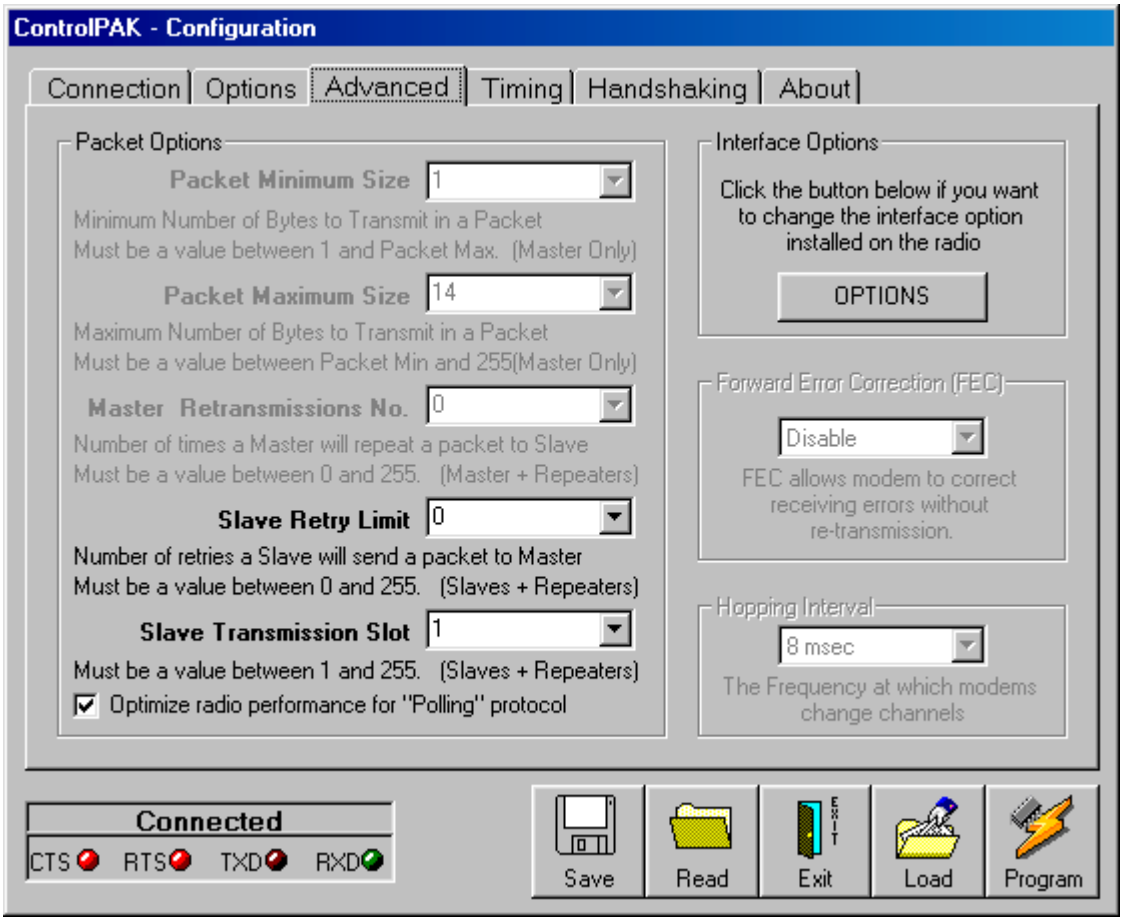
The Encryption Key can only be read from a ControlPAK™ Configuration file it cannot be read from the radio. This allows a greater level of security but the following items and procedures must be followed when entering a User defined Encryption Key and reconfiguring radios programmed with a User defined Encryption Key:

Create the Configuration files by configuring and programming the radios and saving the configurations to specific files. ie; Master, Repeater, Slave The initial entry of the Encryption Key requires the User to enter the Encryption Key as indicated in the ControlPAK™ software. For this initial entry of the user defined Encryption Key the radio can be programmed directly from ControlPAK™.

ALL subsequent configuration parameter changes to any of the radios with this user defined Encryption Key must be made by **Connecting** the radio to the ControlPAK™ software and then **Reading** the applicable configuration file for the radio. Now all required configuration changes for the radio can be made. **Save** the new configuration and **Program** the radio

- If the procedure outlined above is not followed the user defined Encryption Key can be lost. When the radio configuration is read, the Encryption Key is read as non-characters and the ControlPAK™ default Encryption Key is then entered on screen. If you make a configuration change and do not re-enter your Encryption Key the ControlPAK™ default Encryption Key will be programmed to the radio. However, if you follow the procedure above the correct Encryption Key will be read from the Configuration file.

7.3.11 Configuration – Advanced Radio Options



Packet Minimum and Maximum Size – This defines the size of the packets transmitted and is set in the Master only. The connected device must transmit at least the number of bits indicated by the packet minimum size before the radio will transmit.

Master Retransmissions – This defines the number of times the Master and the Repeater radios will transmit each message to the Slave radios. The Repeater radio does not use this parameter when transmitting to the Master radio.

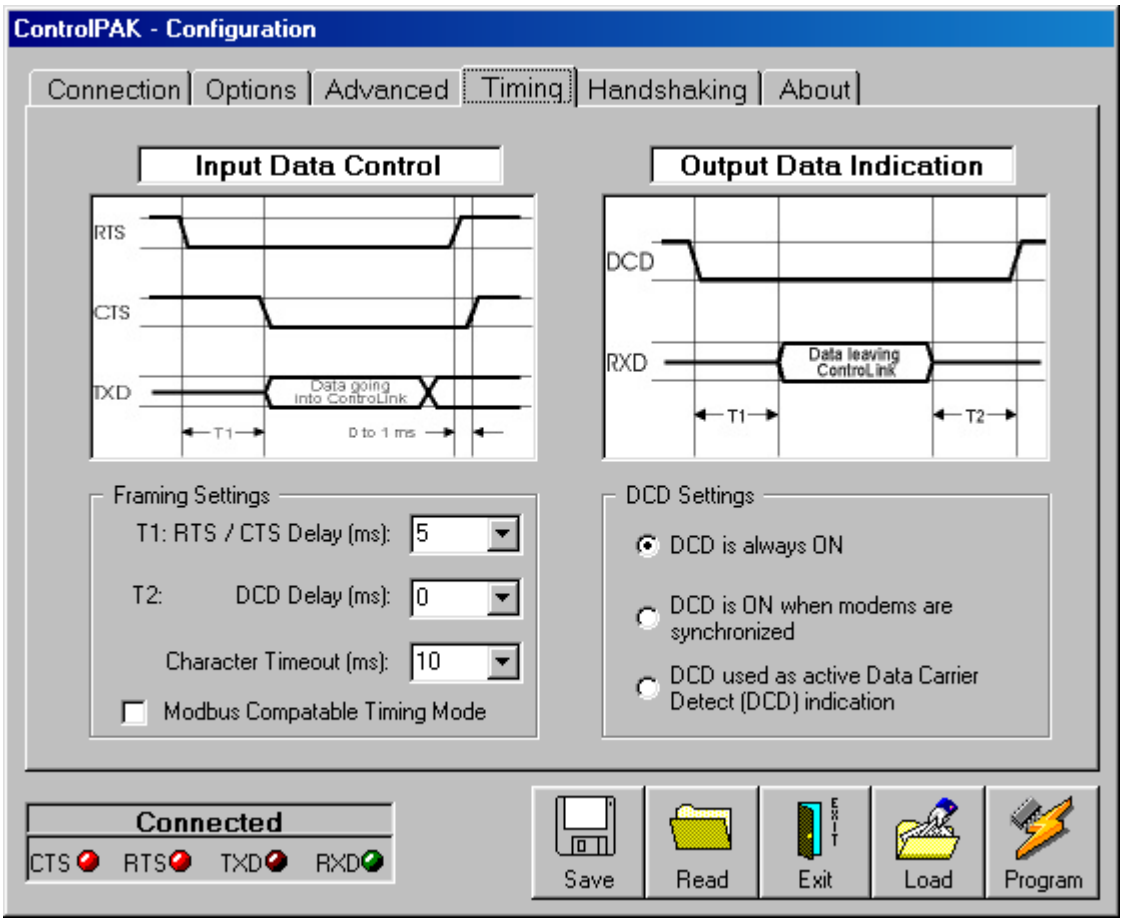
Slave Retry Limit – The Slave and Repeater radios must receive an acknowledgement from the Master and this parameter defines the number of times the Slave and Repeater radios will retransmit their data. If the limit is reached and the Slave or Repeater radio has not received an acknowledgement the data is discarded.

Slave Transmission Slot – When the Master radio has transmitted its data, it then provides a time period made up of 255 timeslots for the Slave to respond. For SCADA polling applications the Slaves should all respond in timeslot 1. When you check 'Optimize radio performance for "Polling protocol"' ControlPAK™ sets this parameter to 1.

Forward Error Correction (FEC) – This parameter is set in the Master only and determines if this additional method of error correction is used in your system.

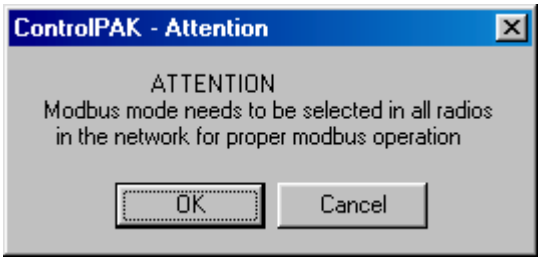
Hopping Interval – This parameter is set in the Master radio only. If the Hopping Interval is set lower than the default of 8 the overall throughput will decrease. ControlPAK™ will restrict the maximum packet size based on the Hopping Interval and whether FEC is selected.

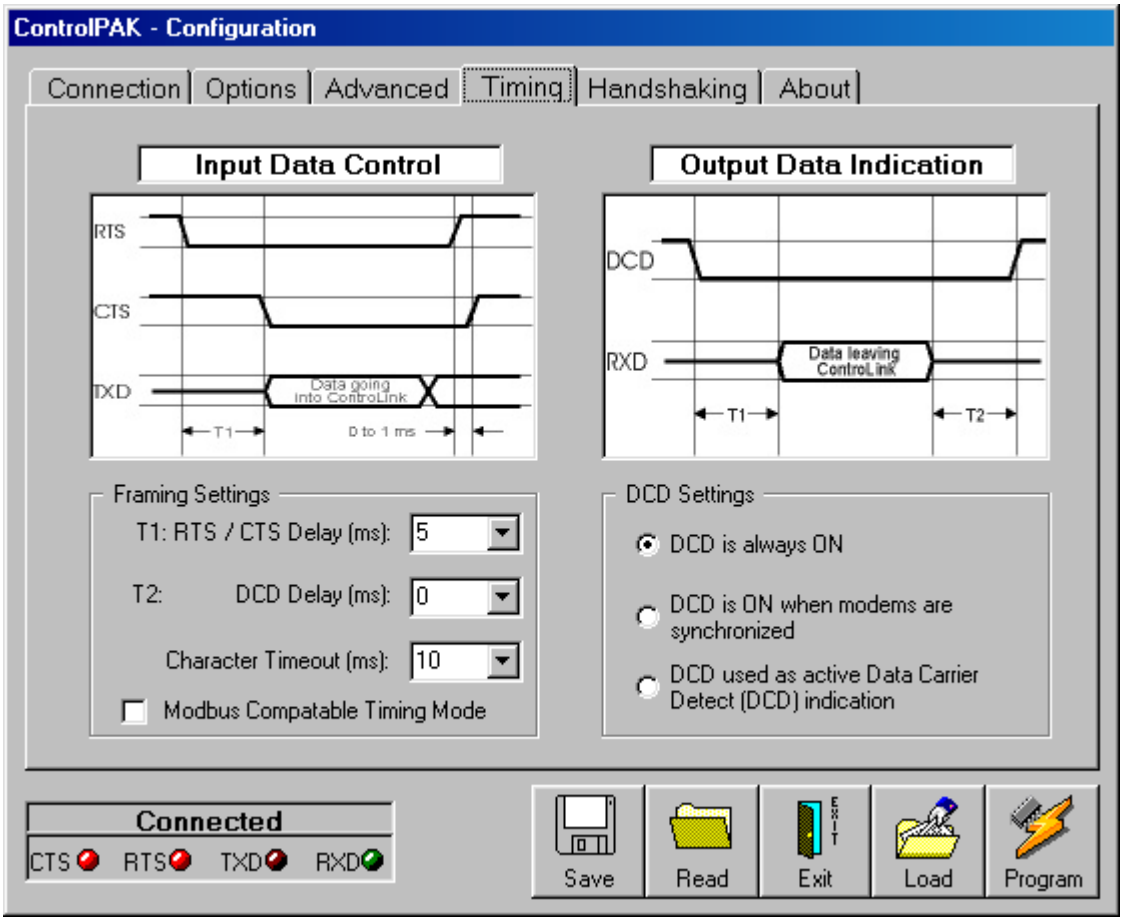
7.3.12 Configuration –Radio Timing Parameters



Framing Settings

- **T1.** Sets the delay between the reception of RTS from the device connected to the COMMPAK-900™ radio and the activation of CTS by the radio. This only applies if Hardware Handshaking is selected. This parameter is also used to set the time period from when the COMMPAK-900™ radio receives data from another radio and outputs this data to the connected device.
- **T2.** Sets the time that DCD remains activated after reception of the data packet.
- **Character Timeout.** Sets the amount of time the COMMPAK-900™ radio waits for a data packet before retrying
- **Modbus Compatible Timing Mode.** When this mode is selected ControlPAK automatically configures the timing parameters

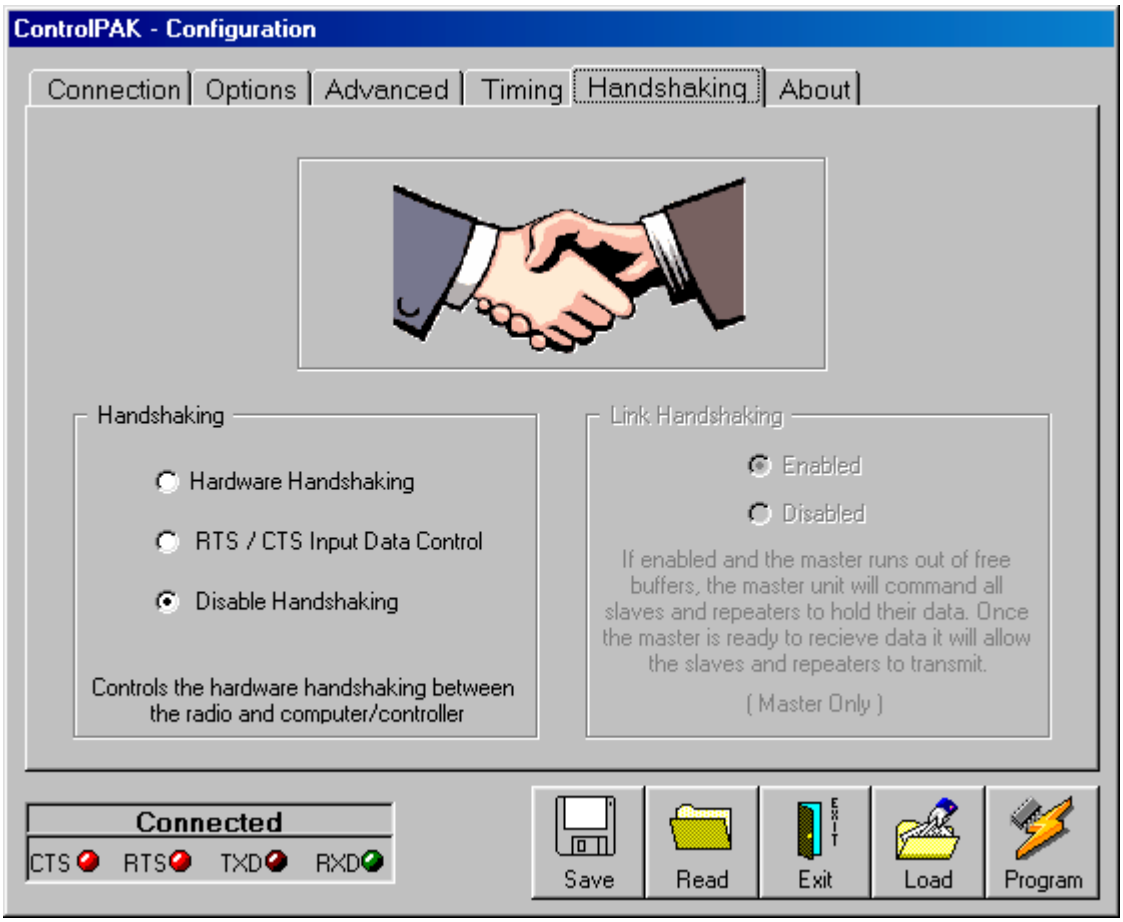




DCD Settings

- **DCD is always ON.** This setting is used when connecting to the COMMPAK-900™ radio to devices that require a constant DCD signal to indicate the radio is connected.
- **DCD is ON when modems are synchronized.** This setting can be used to provide an indication to your equipment that the radio link has dropped out.
- **DCD used as active DCD indication.** Configures DCD for standard data detection operation.

7.3.13 Configuration –Radio Handshaking Parameters



Handshaking

- **Hardware Handshaking.** This setting is typically used for Point-to-Point communication between two DTE devices, such as computers. An example application would be file transfers. This mode of handshaking indicates the status of the Receive Buffer level in each radio. Only the CTS signal is used for ea
- **RTS/CTS Input Data Control**. Enables RTS/CTS input data framing. If this feature is enabled, the appropriate timing parameters must be set on the **TIMING** page. If MODBUS mode is selected, these values will be automatically selected by ControlPAK™ and are not user configurable.

7.3.14 ControlPAK Version

The about page allows the user to view the version details of ControlPAK™ and the COMMPAK-900™ wireless transceiver. This information can be extremely useful when troubleshooting and service are required.

7.3.15 Radio Programming

- When you have completed the selection of the parameters required for reconfiguring your radio, click on the PROGRAM button.
- If you do not Program the radio with the new configuration, a message will appear when you Disconnect or Exit the program.

7.3.16 Saving Configurations To Files

- Configurations may be saved to a file designated by the User.
- Click on the **Save** button.
- The ControlPAK software will guide you through the Save procedure.
- **Appending Files.** ControlPAK allows you to append an existing file, in order for you to save related configurations in a single file. For example, the MAIN SCADA configurations, Master, Local and Repeater may all be saved in a single file designated MAIN SCADA. The initial file is created when the first configuration is saved. This file can then be appended by selecting it, when saving the additional configurations. When you select an existing file, a message will appear asking if you would like to append the existing file.

7.3.17 Loading Configurations From Files

- The ControlPAK software must be connected to a radio as outlined in Section 5.3.4, to load a Configuration from a file.
- Click on the **Read** button to load configurations from an existing file.
- Select the required file the Configuration is saved in.
- Follow the previously outlined procedures for Programming the radio.

8. COMMPAK-900™ Technical Specifications

8.3.1 Electrical/Environment Specifications:

Power Requirement	**8 to 30 VDC**
Power Consumption	450mA at 1W Transmit, 250mA Receive and 10uA Sleep Mode
Operating Environment	Temperature: -34 to +72°C, Humidity: 5 to 95% non-condensing
Memory	Non-volatile configuration memory
Operational Modes	Point-to-Point, Point-to-Multipoint and Peer-to-Peer

8.3.2 Mechanical Specifications:

Dimensions (W x D x H)	90mm(3.56 inch) x 101mm (4.38 inch) x 42mm(1.69 inch) Excluding connectors and mounting bracket.
Enclosure Material	Milled aluminum, black, baked powder coat finish
Serial Data Connector	9-pin female D-sub
Antenna Connector	Reverse polarity TNC male
Power Connector	Molex 4.2mm (0.165 inch) pitch Mini-Fit, Jr.™ Plug (72 inch power cable included)

8.3.3 Serial Data Interface Specifications:

Data Interface	Asynchronous RS-232, Optional 2/4-wire RS485*
Signals	Sig. GND, TXD, RXD, RTS, CTS, DTR#, Data Active DCD
Data Format	1200 to115,200 bps. 7 or 8 Data bits with Odd, Even or No Parity.
Bandwidth	115,200 bps, uncompressed half-duplex. Approximately 100 kbps sustained in intelligent asymmetrical full-duplex transmission mode.
Data Transmission	Key-by data or RTS data input framing with programmable RTS/CTS time delay.

- **TXD and RXD are still supported in RS232 format (only in programming mode) with this option installed.**

 # In Sleep Mode, the radio is reactivated by the DTR signal with at least a 30msec warm up time.

8.3.4 Radio Specifications:

Technology	Frequency Hopping Spread Spectrum
Operating Frequency	902 – 928 MHz
Hopping Pattern	**62 pseudo-random**
System Gain	135 dB
Receive Sensitivity	-106 dBm @ 10^{-6} BER
Output Power	1mW, 10mW, 100mW, 1W (user-selectable)
Error Detection	CRC-16 with auto-retransmit
Encryption	**Up to 65535 combinations**
Diagnostics	3 LED bar graph to indicate RSSI and RF Link quality, Dedicated LEDs for TXD and RXD display.