ADCON
RF TECHNOLOGY

B900SS-500
Radio Modem Card
Spread Spectrum
(FCC Part15.247)

Technical Manual

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Chapter 1. Objective

The objective of this document is to present the features and the application of the B900SS-500 radio module.

The operation of this module is divided into two chapters:

- The 'Basic Operation' chapter describes the Module operating modes and allows the user to learn the WinB900 Software in walking through it.

- The 'Advanced Operation' is especially   for users that want to program the module directly. It presents all the available commands.

Chapter 2. Module introduction

2.1. Description

The B900SS-500 is an FM radio transceiver with frequency hopping using an F.S.K modulation. The receiver is of a super beat oscillator type with heterodyning. It operates on the 902-928 MHz band and, therefore, is within U.S. FCC part 15.247 standard.

Using the frequency synthesis, it has a maximum of 50 channels spaced by 200 kHz and can communicate with equipment via a serial interface with RS-232 standard and TTL levels.
The serial link is completely programmable from 2400 up to 38400 Baud. The radio rate is established at 40 KBits/s.

The B900SS-500 uses the most recent technology of flash memory microcontroller, which allows the user to update or to load new features through the serial link.

Many parameters are programmable through the serial link and the default configuration is memorized in a Flash Bank with the 'ATO' order.

At each activation, the radio modem component is programmed with its configuration parameters (Channel, Speed, Protocol, etc.).

The default data are: RS-232 connection at 19.200 Baud, 8 bits, 1 stop bit, no parity, Frequency Table 1, Client modem.

All these parameters are accessible and modifiable with HAYES (or AT) commands.

2.2. Specifications

2.2.1. General

The B900SS-500 is a radio card component that receives and transmits data according to a frequency table selected by the user.

2.2.2. Specifications of the B900SS-500

Radio Part :

- Electronic :

Frequency:	902 to 928 MHz (FCC part 15-247).
Number of channels:	50, channel 0 to 49.
Channel selection:	Frequency hopping, according to a random table of 50 channels. 8 tables are stored in Flash memory.
Radio rate:	40 KBits/s.
Modulation/Demodulation:	FSK (Frequency Shift Keying).
Bit encoding:	Quad Frequencies encoding.
RF sensitivity:	-97 dBm (± 2 dB) at 50 Ohms.
RF power:	+27 dBm (500 mW) (± 2 dB) over 50 Ohms.
Error rate:	$<10^{-4}$ bytes to -95 dBm.
Saturation:	Two modules communicate at 0 dBm.
Operation Temp.:	Standard operation : 14°F to +131°F.
Storage Temp.:	-40°F to +176°F.
Relative humidity:	From 20% to 90% RH (without condensation).

- Performance range :

Length of communication :	500 to 1,000 Feet in difficult environment (Ex. : buildings, reinforced concrete), 3,400 to 4,500 Feet in open environment (Ex : Ground level), 11,000 Feet in view and in height (Ex: between buildings).
Obstacles Impact :	Walls, trees, obstacles can strongly reduce the range.

<u>Digital Part</u> :

- Electronic :

    Processor: FLASH Microcontroller
    Programming: Upload and download with a PC through the RS232
                            serial link and a specific cable.

    Program Memory :   16 Kbytes of FLASH
    Data Memory: 512 bytes of RAM for stack and data
    Flash Data Memory :   256 bytes for all parameters (Registers).

    Serial Link: 2400 to 38400 Baud, NRZ format, 5 volts TTL ou
                            RS232 level with TxD, RxD, CTS and RTS.

- Power Supply :

    Supply voltage: 3,6V monitored (± 5%).
                            MAX RATING : 4V.
    Consumption: Receive   Transmit   Sleep
                            <50mA   <900mA   <15µA

- Hayes Commands :

    The user can program all the parameters. A Windows programming
    software is supplied "on-line" with documentation support. (See AT
    commands).

    Examples of Hayes commands:
       Serial: Serial link rate, parity, bit count, stop bit count, Serial Time-
                    out, …
       Radio: Channels table selection, retry count, …
       Mode: Point to Point, Network (future), Stand-by, etc.

<u>Dimensions :</u>

    Weight: <50 g (without antenna).
    Dimensions: 107 x 52 x14 mm (without antenna).
    Connectors: 1x Delta-Ribbon 26 pins receptacle from 3M.

2.2.3. Schematic

See Appendix 1 for the principle schematics and the physical description of the card.

2.3. Available Configuration

2.3.1. Software Configuration

The B900SS-500 has 3 operating modes managed by the WinB900 Software (See Chapter 3) :

- "Hayes",
- Point-to-Point,
- Network.

2.3.2. Hardware Configuration

All the B900SS product radio modules are delivered with the necessary software for operation. For more information, refer to Appendix 4.

With each radio module, the following is available :

- Series of programming ASCII messages to integrate the radio modems with a serial link (Terminal & .

- A Windows configuration and test software programming the radio modules and testing the links (quality, distance, shadow area, etc.).

- A set of reference material available in CD-ROM.

2.3.3. Antennas

2.3.3.1.   General

The radio module beams signals and communicates with its antenna, which is absolutely essential.

If it has a defective antenna, if this antenna fails to balance or is installed in a noisy environment, it can lead to a bad result.

For more information, refer to Appendix 3.

Purpose :

- ½ length wave model Omni +3dBi antenna with a short coaxial cable.
- Directive +6dBi antenna with a short coaxial cable.

Chapter 3. Basic Operation

3.1. General

The B900SS-500 can operate with three data communication modes:

- <u>"Hayes"</u>: inspired from the standard Hayes for voice modems, it is used to program the modem's parameters.

- <u>"Point-to-Point"</u>: Two B900SS-500 replace a cable (the Half-duplex operation copies the function of an RS-485 cable). This mode automatically handles the data security (encapsulation, iterations, etc.)

- <u>"Network"</u>: Several B900SS-500 can work together, in accordance with a Client/Server structure. A Server will then be able to handle up to 16 clients simultaneously.

3.2. "Hayes" Mode

The Hayes commands used by the radio module are in conformity with the Hayes protocol standard used for the voice modems. This protocol is based on the following principle: A data frame always starts with the two ASCII characters "AT" for "ATtention". The commands follow and are coded on one or several characters eventually with additional data.

Since the B900SS-500 does not operate exactly like a voice modem, it includes additional "AT" codes.

These commands are principally used to read and write the data in the configuration registers stored in Flash.

3.3. "Point-to-Point" Mode

In this mode, two B900SS-500 Modems can communicate together without getting any interference with other Modems.

For this purpose, their work is synchronized and constantly jumping frequency, avoiding interference with another transmitter: if one or more channels are busy, the data will be transmitted through another channel.

On the other hand, a "Personal Network" owns each set of modem. The data used for a "Personal Network" cannot be intercepted by another "Personal Network". Each "Personal Network" owns a Master, which handles the communication (synchronization, priority, etc.) and a Slave that obeys its Master.

The first synchronization is named "Acquisition", and lets a Slave get acquainted with its Master (No. of Personal Network, Frequency Table used, etc.). Eventually, at each powered reset, the Slave will synchronize, then later be able to communicate with its Master. A "Lock" signal shows if a Slave has been synchronized with its Master or not.

Eventually, this synchronization is maintained all along the Master/Slave Dialogue.

A hardware flow control (RTS/CTS) is present on the Modems serial link in order to let the user know that the buffer (130 characters) starts to saturate. The alarm level is by default 130 characters and can be programmed through the S215 Register.

Finally, an Ack_Tx signal, synchronized on the RTS signal, allows the transmitter user to know if the receiver user has received a data frame or not.

For more specific information and to get the Time Series Charts, see the following chapter ("Advanced Part") and the Appendix 5.

3.4. "Network" Mode

In this mode, several B900SS-500 Modems are able to communicate with each other. Therefore, they constitute a Network handled by a Server Modem that can hold up to 16 Client Modems.

The acquisition procedures, the modems synchronization and the RTS/CTS and Ack_Tx signals handling are the same as for the "Point-to-Point" Mode.

On the other hand, when a frame is sent, it is necessary that a character indicating the receiver modem number precedes the data frame. Also, in receiving the frame, a character preceding this frame indicates the transmitter modem.

3.5. B900SS-500 Operation

3.5.1. Installation and Connection

A B900SS-500 radio module is provided with an antenna and a serial cable which can be connected directly to a PC RS232 interface. This cable has also a power supply connector to connect a stabilized 3,6V power supply (see picture).

¼ wave antenna

RS232 Cable for PC and Power supply with a 25 pins Sub-D connector and a 2 pins power supply connector.
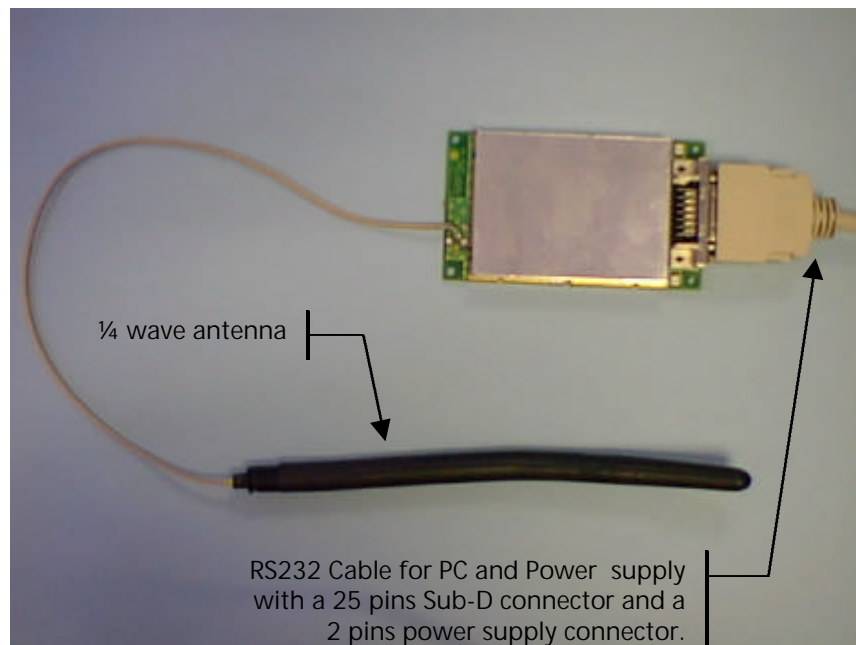
A Windows Software, 'WinB900' configures and tests the B900SS-500 radio module. In order to install it on your PC, launch 'Setup.exe' located on the CD-ROM supplied with the modem, in the WinB900 directory.

3.5.2. WinB900 Software Utilization in Point-to-Point Mode

The WinB900 Software can have two radio modules communicate between the COM1 and COM2 Port of a PC, or between COMx and COMy of two PC. The software detect automatically if a B900SS is connected on port COM1 and/or COM2.

In a first phase, the two modems have to recognize each other ("Acquisition"). Go in the "Quick Configuration" Menu, to the "Acquisition" Option. When this option is selected, the software displays the following screen:
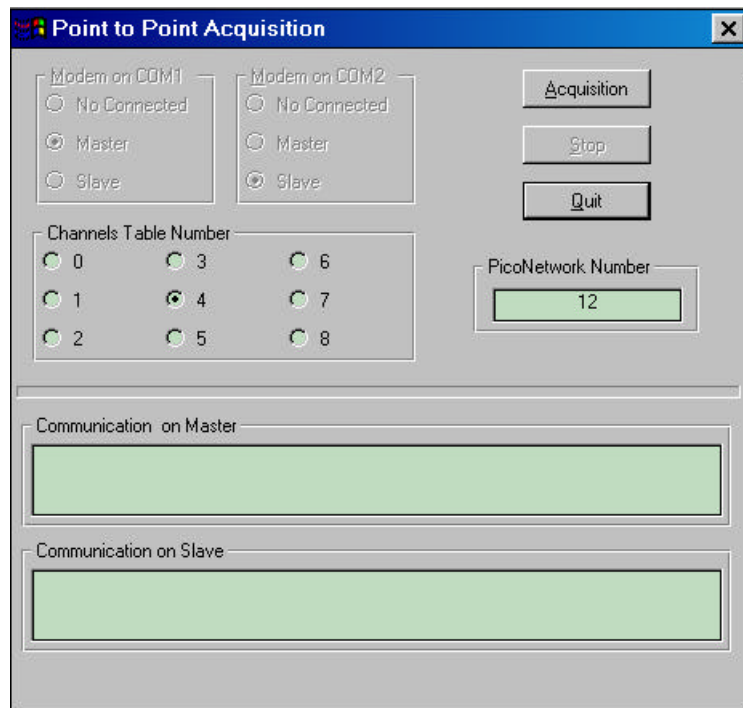
When the two B900SS are present, modem on COM1 is Master always and modem on COM2 is a Slave always. When only one modem is present, the user can select the type of modem (Master or Slave).

Select the table of the chosen channels as well as the No. of Network (between 1 and 65535), and then launch the Acquisition clicking on the "Point-to-Point Acquisition" button.

After clicking the button, the following message appears:

You can then quit the window. The Modems are synchronized.

Consequently, you can communicate between the Modems with the 'Point-to-Point Dialogue' Option from the "Quick Configuration" menu. When this option is selected, the software displays the following screen:
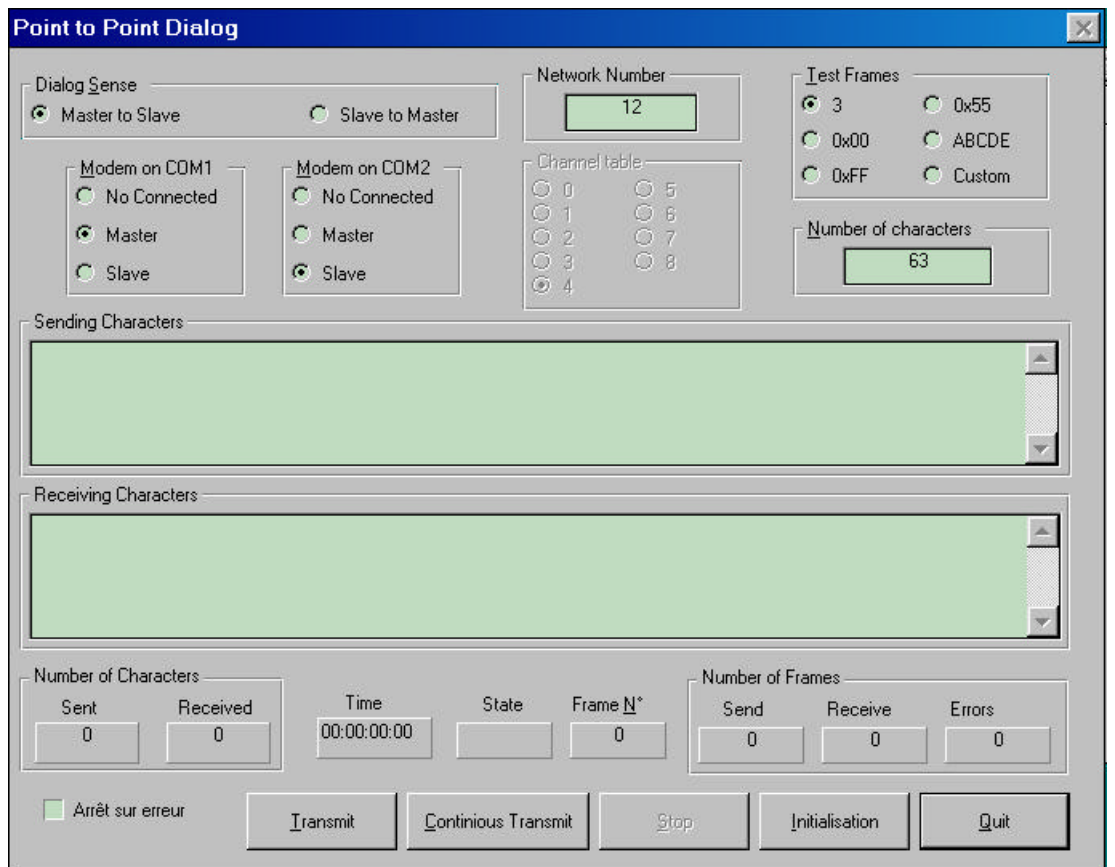
The different fields and buttons are described below:

- "Sending Characters" Field
  This side of the window sends the data entry.

- "Receiving Characters" Field
  This side of the window shows the received data.

- "Test Frames" Selection
  This selection allows to select the type of character sent. For example, 0x00 sends a character frame only made of a 0x00 binary character.
  If the "Free" frame type is selected, the user can type the frame in the "Sent Character" field. This frame will then be sent.

- "Dialog Sense" Selection
  This selection allows to select the sense of transmission : since Master to Slave or since Slave to Master.

- "Modem on COMx" Field
  This field allows to select if modem is present on port COMx and if, the type of this Modem : Master or Slave.

- "Characters Count" Field
  This field allows to select the character count to be sent if the selected test frame type is any other than "free".

- Button: "Transmit"
  This button sends the frame entered previously to the Characters section to be sent.

- Button: "Continuous Transmit"
  This button sends continuously the frame entered previously to the Data section to be sent.

- Button: "Initialization"
  This button reinitializes all the counter fields (Elapse Time, Character Count, Frame Count, etc.)

- Button: "Stop"
  This button stops a continuous upload.

- Button: "Quit"
  This button leaves this window and returns to the main menu.

- "Character Count Sent/Received" Fields
  These fields show the sizes of the sent and received frames.

- "Elapsed time" Field
  This field shows how long it takes the modem to upload the same frame during a continuous upload.

- "Sent/Received/Corrupted Count" Fields
  These fields show the amount of frames correctly uploaded, downloaded or corrupted (or not received) since the start of a continuous upload.

- "Stop on Error" Selection
  This selection stops automatically the continuous upload if a frame is corrupted.

3.5.3. Use of the WinB900 Software in Network Mode

The operating principle is similar to the Point-to-Point Mode.

In a first phase, the two modems have to recognize each other ("Acquisition"). Go in the "Quick Configuration" Menu, to the "Network Acquisition" option . When this option is selected, the software displays the following screen:
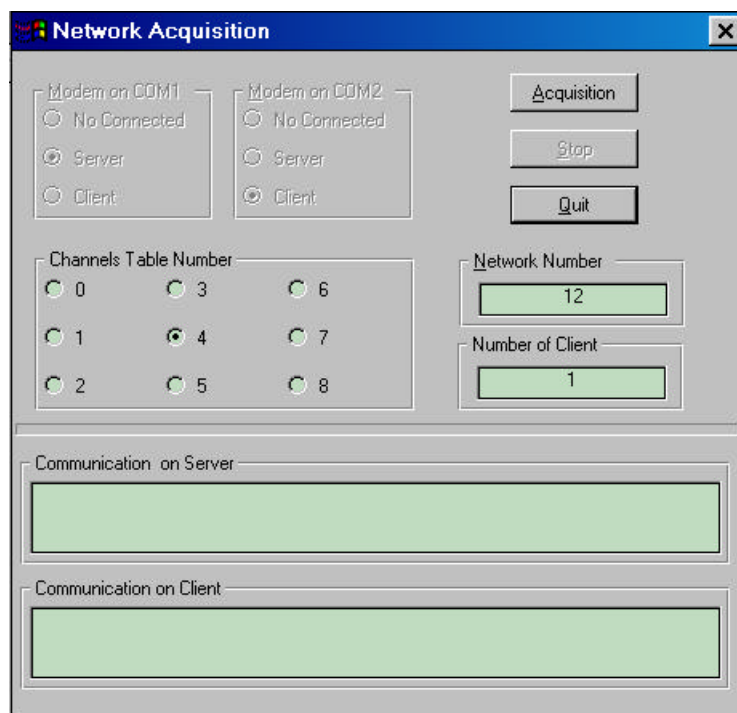
When the two B900SS are present, modem on COM1 is Server always and modem on COM2 is a Client always. When only one modem is present, the user can select the type of modem (Server or Client).

It should be noticed that if the Modem already holds a Network Number and Clients, these two pieces of information will display in the "Network No." and "Clients Count". If the Network No. is modified, the Server will then lose all the Clients already acquired.

Acquisition can be launched by clicking on the "Acquisition" button. After this, the following message is displayed :

You can then quit the window. The Modems are synchronized.

You can then communicate between the Modems with the 'Network Dialogue' Option from the "Quick Configuration" Menu. When you pick this option, the software displays the following :
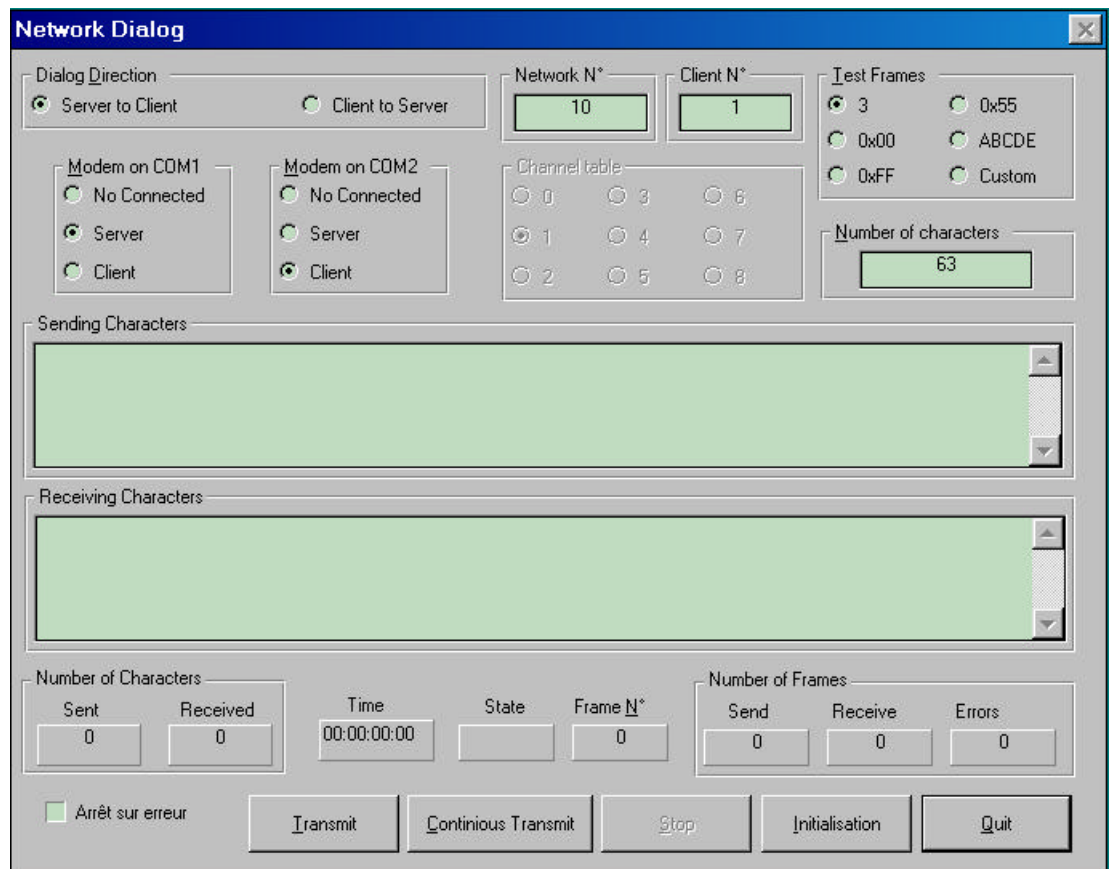
The different fields and buttons are similar to the ones described in the previous paragraph at the "Point-to-Point Dialogue" window. Only two new fields appear:

- "Network Number"
  This field indicates the Network No. in the Server and Client.

- "Client Number"
  This field indicates the Modem No. in the Client (if present).

3.5.4. Use of the "Terminal" or "HyperTerminal" Software

The B900SS-500 radio modules can also be handled from a Windows "HyperTerminal" or "Terminal" type communication software.

The software has to be configured, in order to communicate at 19200 Baud, 8 bits, no parity, 1 stop bit through a Serial link. To start with a correct configuration for HyperTerminal and Terminal, the following directories are provided :

- "B900-CM1.ht" for "HyperTerminal" on COM1.
- "B900-CM2.ht" for "HyperTerminal" on COM2.
- "B900-CM1.trm" for "Terminal" on COM1.
- "B900-CM2.trm" for "Terminal" on COM2.

In this case, if your modems have already been configured and already been "Acquired", you can send data frames with these software immediately. Otherwise, refer to Chapter 4 (Advanced Operation) to know how to use the Registers.

Chapter 4. *Advanced Operation*

4.1. *General*

The section "Basic Operation" shown us how to operate the B900SS-500 Radio Module.

This section's objective is to know the module more completely; particularly the Hayes commands necessary to handle the modem.

4.2. **"Hayes" Protocol Commands**

4.2.1. General

These commands configure the Modem assigning different values in the registers (S200 and next). They also enable the user to know the state of the registers and the version of the modem software. These frames can only be sent if the CTS signal is active except when in Acquisition Mode.

These commands support the 'Hayes' protocol used by the voice Modems. When a command is sent, it always has to be preceded by the 'AT' characters (ATtention). When a command has been sent, it always has to be followed by the <CR> character (carriage return, Hexadecimal 0x13 code).

NOTE: The time slot between two characters of the command has to be inferior to Time-Out (S214). As a result, the commands have to be sent by block:

A	T	Command	Additive command	...	<CR>

The sole exception is the passing command from the Operation Mode in progress to the Hayes Mode: In this case, the escape code ('+++') has to be followed and preceded by a silence period that lasts at least the same as time out. In this case only, the command will neither be preceded by AT, nor followed by <CR>

These commands are described in detail in the next chapter.

4.2.2. Description of the standard commands

Here is a description of possible commands :

'+++':   **Running in Hayes Mode.**
This command allows the user to return to Hayes Mode when the Modem is in "Point-to-Point" ou "Network" Mode. It cannot be preceded by AT, only by an idle time (blank) that can be set through the S214 register for the duration.

NOTE : When the Modem runs in "AT" Mode, it is no longer in radio receiver.

'ATO':   **Running in "Point-to-Point" or "Network" Mode.**
This command allows the user to run the Modem in the Mode according the S220 Register. To retrieve the "Hayes" Mode, send out the sequence '+++'.

ATTENTION : all registers which are modified by an AT command are stored on Flash ONLY AFTER this command.

NOTE : this command also automatically leaves the Acquisition Mode.

'ATSn?':   **Display of the S Number n Register content.**
The content of the B900SS-500 operating parameters are found in named 'S' registers, and are numbered as described in Chapter VII- 3. Some parameters are standard for all the Hayes Modems; others are specific to B900SS-500.
(See Table in Appendix 6).

If the requested register is correct, the modem responds: ''Sxxx=yyy'' with xxx: register number and yyy: register content.
If the requested register is incorrect, the modem responds with the error character 'E' (0x45).

These parameters are saved in EEPROM Memory and automatically reloaded during a reset or when powered up.

'ATSn=m': **Assignment to the m Value at the S Register n Number.**
Loading of a parameter in a register. This parameter is automatically saved in Flash Memory **AFTER** the ATO command.
The n and m values are given in ASCII coded decimals. If the assigned register is correct, the modem responds with the OK character 'O' (0x4F).
If the assigned register is incorrect or if the value goes over the limits of this register, the modem responds with the error character 'E' (0x45).

'AT/S': **Content Uncoded Display of all Significant Records.**
All the Modem significant registers (radio configuration, serial configuration, operating mode...) are sent on the serial link uncoded, ready to be displayed using a software such as "Terminal" for Windows.
The response is a list of all the used registers with their value, each register being separated from the other with the "Carriage Return" character (CR): "S200=xx<CR>S201=yy<CR>...."

'AT/V': **Uncoded Display of the Modem Software Version.**
The information on the version number, conception date and the program CRC are sent to the uncoded serial link, ready to be displayed using a software such as "Terminal" for Windows.
The response is as follows: "Version B900SS-500 : x.xx<CR>"

'ATMx': **Running/Stop the Acquisition Mode.**
This command allows to toggle from Normal Mode to Acquisition Mode and vice-versa, according to the x value. The Modem is in Normal Mode by default.
Then there is: x = '0' → Normal Mode ('ATO' also operate),
                x = '1' → Acquisition Mode.
If the command is given correctly, the modem responds with the OK character 'O' (0x4F), otherwise with the error character 'E' (0x45).

'ATP': **Running in Standby Mode.**
This command allows the user to running to Standby Mode. The Modem is in Normal Mode by default.
If the command is correctly given, the modem responds with the OK character 'O' (0x4F), otherwise with the Error character 'E' (0x45).
The Modem exit to Standby-Mode for go to Normal Mode with another character.
N.B : during the Stand-By mode, the Client/Slave modem is de-synchronized and the wake-up can during between 1 and 5 second (time for re-acquire the synchronization).

'ATR':   **Parameters Reset.**
This command allows the user to reprogram ALL the stored EEPROM registers and give them their value by default.
If the command is correctly given, the modem responds with the OK character, 'O' (0x4F), otherwise with the Error character 'E' (0x45).

4.2.3. Registers Description

This section is available in Appendix 6.

4.3. **Operation Example**

4.3.1. Automatic Acquisition of two Point-to-Point Modems

To send the following commands to the Modem, it is necessary to use a software such as HyperTerminal for Windows.

In this case, only Master Modems are totally parameters and after the Acquisition command, the Master recognize the Slave, indicate this new table, channels, network and client number.

- <u>Parameterization of the "Master" Modem"</u> :

User:	+++	/* Run in Hayes Mode. */
Modem response:	O<CR>	
User:	ATS200=3<CR>	/* Choice of Frequency table 3. */
Modem response:	O<CR>	
User:	ATS201=0<CR>	/* Choice of No. 1 Synchronization Frequency. */
Modem response:	O<CR>	
User:	ATS202=10<CR>	/* Choice of No. 2 Synchronization Frequency. */
Modem response:	O<CR>	
User:	ATS203=20<CR>	/* Choice of No. 3 Synchronization Frequency. */
Modem response:	O<CR>	
User:	ATS204=30<CR>	/* Choice of No. 4 Synchronization Frequency. */
Modem response:	O<CR>	
User:	ATS205=1<CR>	/* Automatic Acquisition ON. */
Modem response:	O<CR>	
User:	ATS220=2<CR>	/* Choice of Master Mode. */
Modem response:	O<CR>	
User:	ATS250=10<CR>	/* Choice of Personal Network No 10. */
Modem response:	O<CR>	
User:	ATM1<CR>	/* Run in Acquisition Mode */
Modem response:	O<CR>	

The user now must configure the Slave Modem. Once this configuration has been done and the "ATM1" command activated, they acquire themselves and the Master Modem returns:

S252=1<CR>   /* Indicates Acquisition done, and N° of Slave */

User: AT0<CR>   /* Quit Acquisition and run in Point-to-Point Mode */
Modem response: O<CR>

- Parameterization of the "Slave" Modem:

Before parametering the Slave Modem, the Server must have been configured and must be in Acquisition Mode.

User: +++   /* Run in Hayes Mode. */
Modem response: O<CR>

User: ATS200=3<CR>   /* Choice of the Frequency Table 3. */
Modem response: O<CR>

User: ATS201=0<CR>   /* Choice of No. 1 Synchronization Frequency. */
Modem response: O<CR>

User: ATS202=10<CR>   /* Choice of No. 2 Synchronization Frequency. */
Modem response: O<CR>

User: ATS203=20<CR>   /* Choice of No. 3 Synchronization Frequency. */
Modem response: O<CR>

User: ATS204=30<CR>   /* Choice of No. 4 Synchronization Frequency. */
Modem response: O<CR>

User: ATS205=1<CR>   /* Automatic Acquisition ON. */
Modem response: O<CR>

User: ATS220=3<CR>   /* Choice of Slave Mode. */
Modem response: O<CR>

User: ATS250=0<CR>   /* Indicates Virgin Slave (No Client Network N°0). */
Modem response: O<CR>

User: ATM1<CR>   /* Run in Acquisition Mode */
Modem response: O<CR>

At this time, the two Modems have to acquire themselves, and the Slave Modem respond

S250=10<CR>S252=1<CR>   /* Indicates Acquisition done with Network N°10 and Slave N°

User: AT0<CR>   /* Quit Acquisition and run in Point to Point Mode */
Modem response: O<CR>

4.3.2. Manual Acquisition of two Point-to-Point Modems

To send the following commands to the Modem, it is necessary to use a software such as HyperTerminal for Windows.

In this case, both Master AND Slave Modems are totally parameters : user MUST indicate the same frequency table, radio channels, network number and the correct client number.

- <u>Parameterization of the "Master" Modem"</u> :

| User: | +++ | /* Run in Hayes Mode. */ |
| Modem response: | O<CR> | |

| User: | ATS200=3<CR> | /* Choice of Frequency table 3. */ |
| Modem response: | O<CR> | |

| User: | ATS201=0<CR> | /* Choice of No. 1 Synchronization Frequency. */ |
| Modem response: | O<CR> | |

| User: | ATS202=10<CR> | /* Choice of No. 2 Synchronization Frequency. */ |
| Modem response: | O<CR> | |

| User: | ATS203=20<CR> | /* Choice of No. 3 Synchronization Frequency. */ |
| Modem response: | O<CR> | |

| User: | ATS204=30<CR> | /* Choice of No. 4 Synchronization Frequency. */ |
| Modem response: | O<CR> | |

| User: | ATS205=0<CR> | /* Automatic Acquisition OFF. */ |
| Modem response: | O<CR> | |

| User: | ATS220=2<CR> | /* Choice of Master Mode. */ |
| Modem response: | O<CR> | |

| User: | ATS250=10<CR> | /* Choice of Personal Network No 10. */ |
| Modem response: | O<CR> | |

| User: | ATS253=1<CR> | /* Indicate the numbers of Slave */ |
| Modem response: | O<CR> | |

| User: | AT0<CR> | /* Run in Point-to-Point Mode */ |
| Modem response: | O<CR> | |

- <u>Parameterization of the "Slave" Modem</u>:

Before parametering the Slave Modem, the Server must have been configured.

```
User:             +++                /* Run in Hayes Mode. */
Modem response:  O<CR>

User:             ATS200=3<CR>       /* Choice of the Frequency Table 3. */
Modem response:  O<CR>

User:             ATS201=0<CR>       /* Choice of No. 1 Synchronization Frequency. */
Modem response:  O<CR>

User:             ATS202=10<CR>      /* Choice of No. 2 Synchronization Frequency. */
Modem response:  O<CR>

User:             ATS203=20<CR>      /* Choice of No. 3 Synchronization Frequency. */
Modem response:  O<CR>

User:             ATS204=30<CR>      /* Choice of No. 4 Synchronization Frequency. */
Modem response:  O<CR>

User:             ATS205=0<CR>       /* Automatic Acquisition OFF. */
Modem response:  O<CR>

User:             ATS220=3<CR>       /* Choice of Slave Mode. */
Modem response:  O<CR>

User:             ATS250=10<CR>      /* Choice of Personal Network No 10. */
Modem response:  O<CR>

User:             ATS250=10<CR>      /* Choice of Slave No : 1. */
Modem response:  O<CR>
```

At this time, the two Modem are Acquired, because ALL Network parameters are set.

```
User:             AT0<CR>            /* Run in Point to Point Mode */
Modem response:  O<CR>
```

4.4. ***Radio Test Commands***

These Special AT commands are integrated in the B900SS-500 in order to measure in continuous emission, and are primarily used during radio tests (radiated power, linewidth, etc.) to respect the Part15-247 FCC standard.
It stops when any character is sent:

- ATT0: Transfer of a pure carrier with the frequency chosen by the channel command.
- ATT1: Transfer of a modulated carrier '00'.
- ATT2: Transfer of a modulated carrier '01'.
- ATT3: Transfer of a modulated carrier '10'.
- ATT4: Transfer of a modulated carrier '11'.

NOTE: the character <CR> follows each command.

4.5. *Advanced Operation of WinB900 software*

4.5.1. Hayes commands

The parameterization with the Hayes commands can be simply done with the WinB900 software.

The option "Hayes Commands" of the "Advanced Configuration" allows to perform all of the Hayes Commands on the modems connected to the PC. When this option is selected, the software displays the following window :
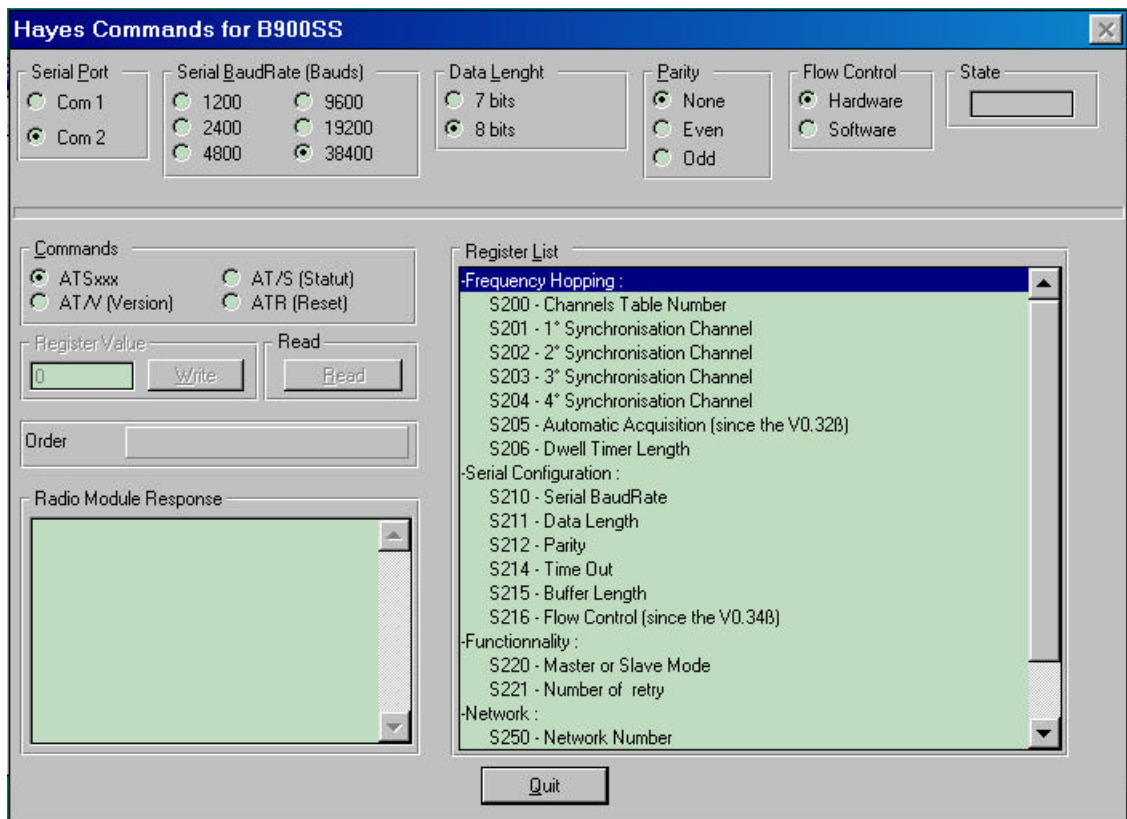
The top section allows the user to select the port to work on and describes the state of the serial link (speed, parity, etc.).

The serial link state is not directly modifiable : It will follow the evolution of the values in S210 to S212 registers.

The bottom end sends Hayes commands. All the Registers are present with the content explanation for each of them.

There are four types of possible manipulation:

- ✎ Read/Write on the Registers: Select the "ATSxxx" option in the "Available Commands", then select the required register clicking on it in the "Registers List".
  - If you want to read a register, click now on the "Read" button. The "Syntax" window will display the sent command while the "Radio Module Response" window will display the B900SS response.
  - If you want to write in a register, indicate the value that you want to give to this register in the "Register Value" window, then click on the "Write" Button. The "Syntax" window will display the sent command while the "Radio Module Response" window will display the B900SS response.

- ✎ Read the Firmware Version: Select the "AT/V" option in the "Available Commands", then click on the "Read" button. The "Syntax" window will display the sent command while the "Radio Module Response" will display the B900SS response.

- ✎ Read the Status Information: Select the "AT/S" option in the "Available Commands", then click on the "Read" button. The "Syntax" window will display the sent command while the "Radio Module Response" window will display the B900SS response.

- ✎ Registers Reset to the default value: Select the "ATR" option in the "Available Commands", then click on the "Read" button. The "Syntax" window will display the sent command while the "Radio Module Response" will display the B900SS response.

4.5.2. Test Commands

Carrier Transmission Tests can also be simply realized with the WinB900 Software.

The "Carrier Test" option of the "Advanced Configuration" Menu allows to test Carrier Transmission from a radio module.

When this option is selected, the software display the following window:
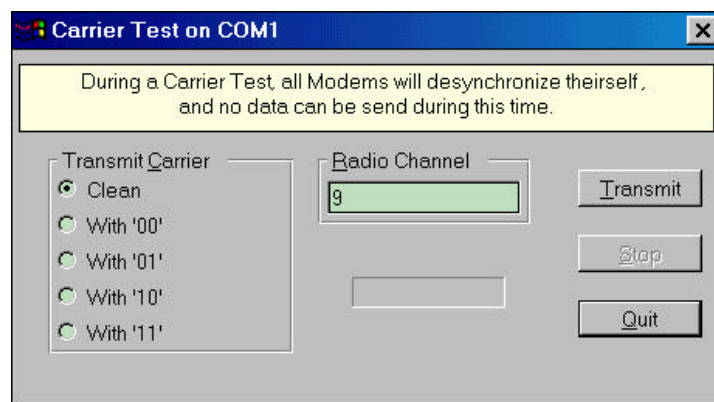
- • "Carrier Transmission" Selection
  Through this window, it is possible to transmit several types of carrier to check the power and the signal modulation. Here are the following Carrier's choice:
  - • Pure
  - • Modulated at '00'
  - • Modulated at '01'
  - • Modulated at '10'
  - • Modulated at '11'

  Remark:
  If a transmission is in progress and you want to change the carrier type, it is imperative to stop the transmission before selecting another carrier, otherwise your change will not take effect

- • "Radio Channel" Field
  This Field available for input specifies the radio channel where the selected carrier will be transmitted from.

- "Transmission" Button
  This button allows to initiate the selected carrier transmission based on the chosen channel. When this button is selected, a red rectangle appears indicating that the modem is transmitting.

- "Stop" Button
  This button stops transmitting the selected carrier.

- "Quit" Button
  This button returns to the Main Window.

Appendix 1: Schematic Diagram

RF Switch

902 MHz
Transmitter/ Receiver

PLL

MicroController

+

Flash Memory

RxD
TxD
CTS
RTS
Ack_Tx
Lock
Stand-By
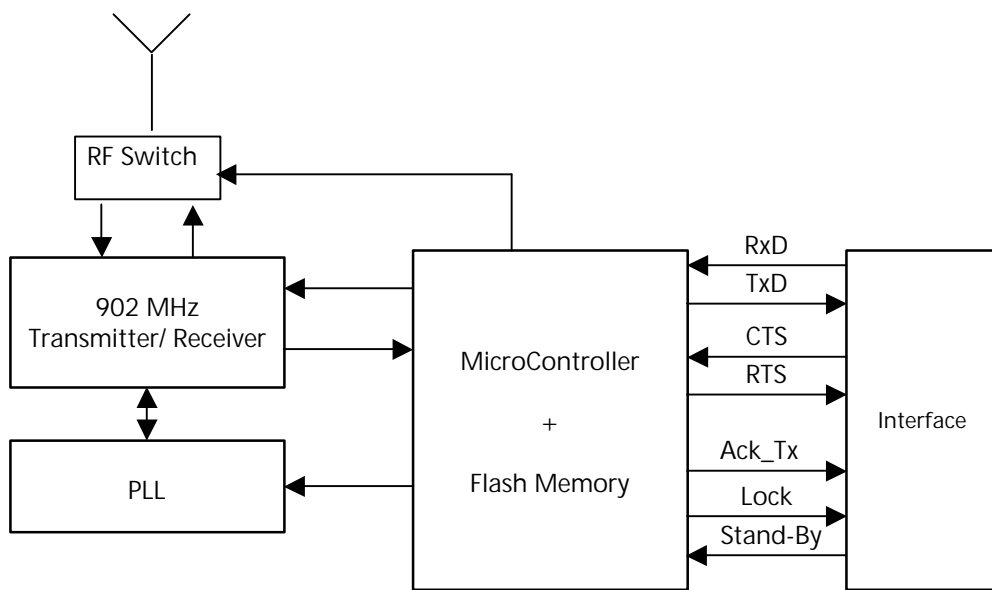
Interface

Appendix 2: Mechanical Drawings

Drawing of the B900SS-500 Card

N.B. : dimensions are in millimeters

90.0

84.0

3.0

52.0

46.0

3.0

Antenna connector

Red and Green Led for function indicator

Serial and supply power connector
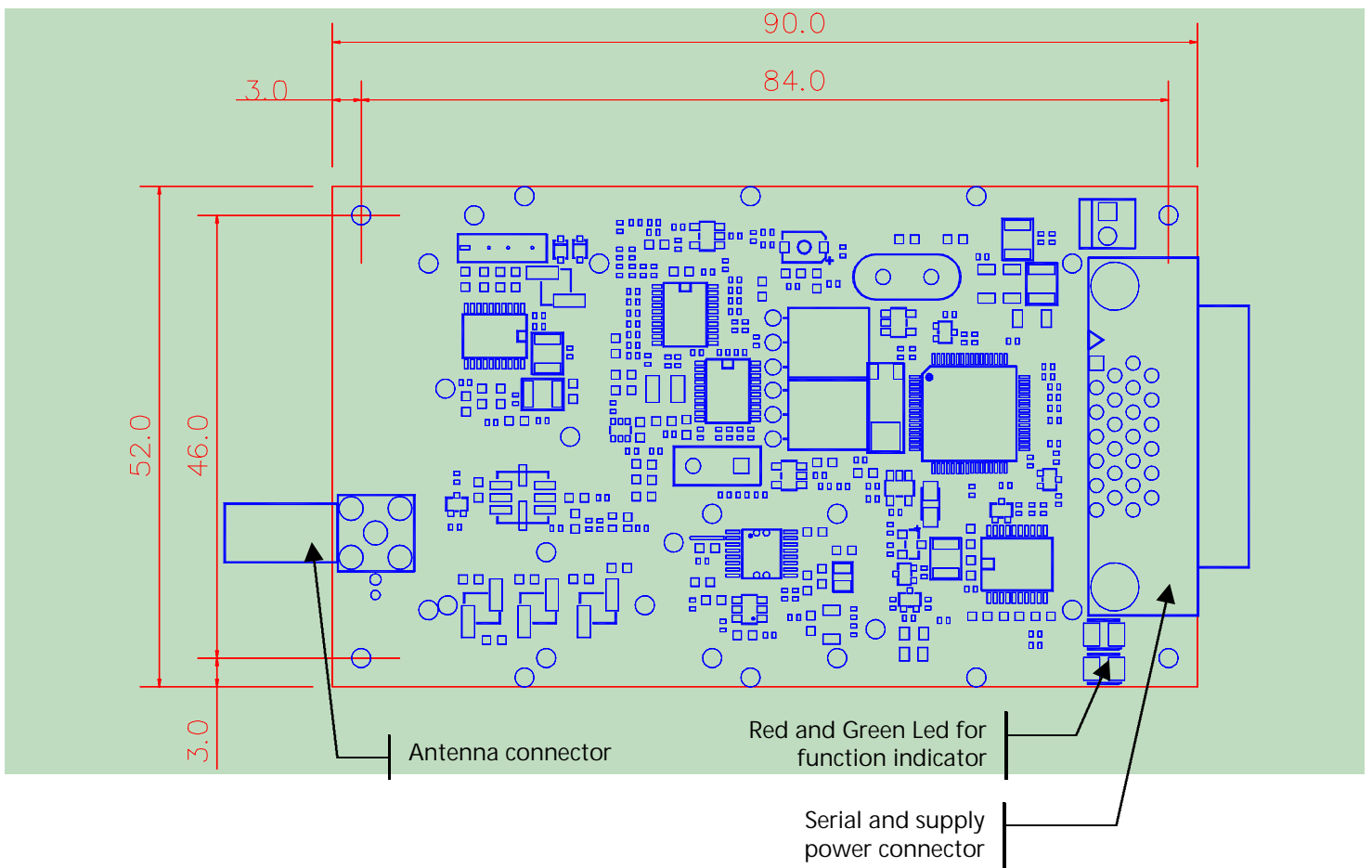
Interface Signals

The Modem will communicate with the host through an interface with the following signals:

Bus Pin	Interface Function	Signal direction µC	Level of Signal ([1])	µC Function
1 & 2	VDD	-	3,6V	3,6 volts power for digital & radio ("low noisy").
3	RxD	I	TTL	RxD UART : Serial Data Reception
4	TxD	O	TTL	TxD UART : Serial Data Emission
5	RTS	I	TTL	RT S: Request To Send.
6	CTS	O	TTL	CTS : Clear To Send **(INACTIVE)**.
7	Ack_Tx	O	TTL	Radio Transmission Ok.
8	Tx/Rx	O	TTL	Serial Reception or Transmission.
9	Stand-By	I	TTL	Stand-By with Synchronization On/Off.
10	Lock	O	TTL	Network Synchronization Ok.
11	Tck_Flash	I	TTL	Clock using when flashing firmware.
12	RESET	I	TTL	External Reset. Also used during the programming of the Flash Program.
13	RxD_Flash	I	TTL	Data Reception using when flashing firmware.
14	TxD_Flash	I	TTL	Data Emission using when flashing firmware.
15	I/O1	I/O	TTL/Analog	Analog Input or Logic Input/Output.
16	RSSI	S	Analog	Analog level of the received radio signal
17	I/O3	I/O	TTL/Analog	Analog Input or Logic Input/Output.
18	I/O2	I/O	TTL/Analog	Analog Input or Logic Input/Output.
19	I/O5	I/O	TTL/Analog	Analog Input or Logic Input/Output.
20	I/O4	I/O	TTL/Analog	Analog Input or Logic Input/Output.
21	RxD – RS232	I	RS-232	RxD UART : Serial Data Reception
22	TxD – RS232	O	RS-232	TxD UART : Serial Data Emission
23	RTS – RS232	I	RS-232	RTS : Request To Send.
24	CTS – RS232	O	RS-232	CTS : Clear To Send **(INACTIVE)**.
25 & 26	GND	-	0V	Ground

([1]):   TTL level is a signal between 0 and 3,6V.

NOTE: The connector used is the Delta-Ribbon 26-pin receptable manufactured and distributed by 3M.

Signals Description

LOCK: Only used on the Client/Slave : Indicates that the synchronization with
                 the Server/Master is valid. Latter indicates if the Server/Master is at radio
                 range. Active on high.

RESET: Reset hardware of the modem card. Maximum Duration: 200 ms. Active
                 on low.

ACK_TX: Indicates that the buffer transmission has been executed correctly. This
                 signal is valid at the end of the transmission of a radio message (Active
                 RTS Signal) and is kept until RTS returns to inactive. Active (buffer
                 transmitted) on low.

xx_Flash :   Signals for the Flash programming of the Modem from the host. There
                 are three signals: RxD, TxD and Clock.
                 When the host wants to read and/or modify the Flash, the modem must
                 absolutely be in reset by activating the RESET Signal.

CTS :   Clear To Send: signal into the Modem. Indicates if the Modem can send
                 serial data to the User (Active on low) or not (Inactive on high).
                 N.B. : NOT USED IN EXISTING VERSION.

RTS :   Request To Send: signal going out of the Modem. Indicates that the user
                 can transmit serial data (Active on low) or not (Inactive on high). This
                 signal switches when the serial reception buffer's filling rate reaches a
                 programmable threshold (S215) or when the user finished to transmit
                 serial data (out on Time-Out).

TxD, RxD: Serial link signals in NRZ format. TxD is for the data going out of the
                 Modem while RxD is for the data coming into the Modem. Le logic '1' is
                 represented by high.

Tx/Rx :   Indicates that the serial link is on reception or emission mode. This signal
                 can be used with an half-duplex interface (typical a RS-485). Signal
                 Active (serial on reception mode) on low.

Stand-By :   Stand-By with Synchronization : signal into the Modem. Indicates if the
                 Modem is in Low-Power Mode (1) or in Normal Mode (0).
                 With this signal, the synchronization always active and the Modem can
                 wake-up in Dwell-Timer (S206) milliseconds maximum.

I/Ox :   Analog Input (12 bits) or Logic Input/Output. Not used in Standard
                 firmware, these E/S can be used in a specific firmware or in the future
                 Standard Firmware. Actually used as Logic Input.

Connector Drawing

The selected connector is the Delta-Ribbon from the 3M. It is a DIP 26-pin angled connector.

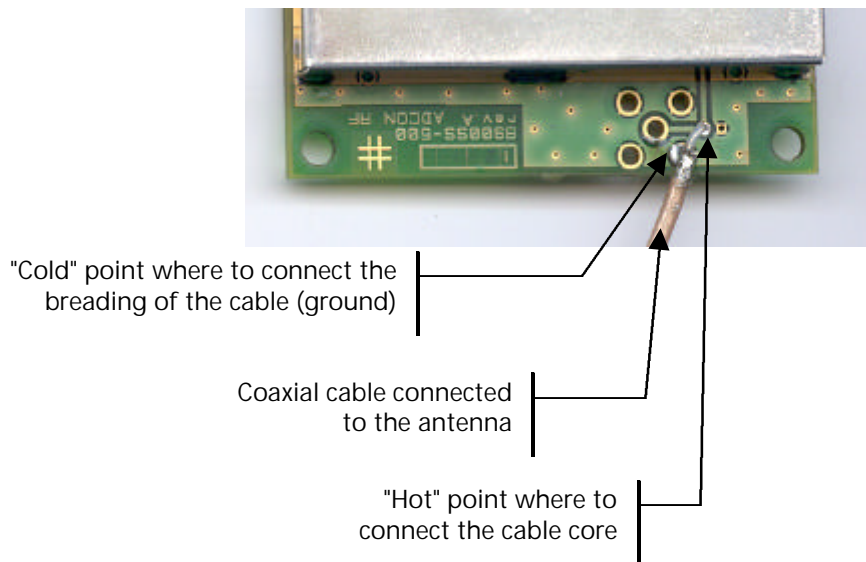| Contact Quantity	Dimensions				
	A	B	C	D	E
14	.300 [7.62]	.93 [23.6]	1.16 [29.6]	.50 [12.6]	.77 [19.6]
20	.450 [11.43]	1.08 [27.5]	1.31 [33.4]	.65 [16.4]	.92 [23.4]
26	.600 [15.24]	1.23 [31.3]	1.46 [37.2]	.80 [20.2]	1.07 [27.2]
36	.850 [21.59]	1.48 [37.6]	1.71 [43.5]	1.05 [26.6]	1.32 [33.6]
40	.950 [24.13]	1.58 [40.2]	1.81 [46.1]	1.15 [29.1]	1.42 [36.1]
50	1.200 [30.48]	1.831 [46.50]	2.06 [52.5]	1.40 [35.5]	1.67 [42.5]
68	1.650 [41.91]	2.281 [57.93]	2.51 [63.9]	1.85 [46.9]	2.12 [53.9]
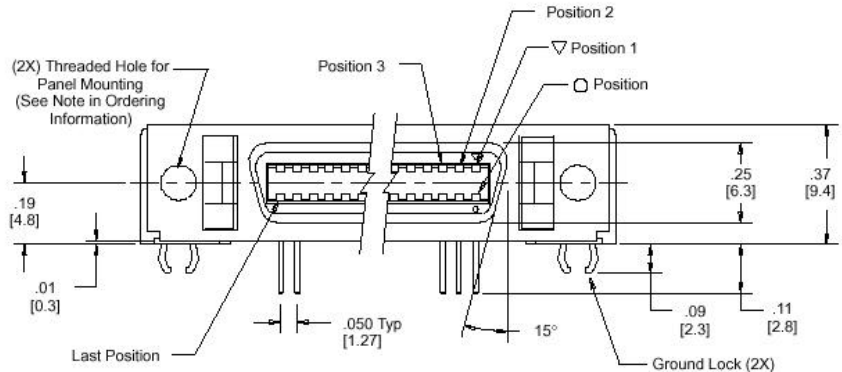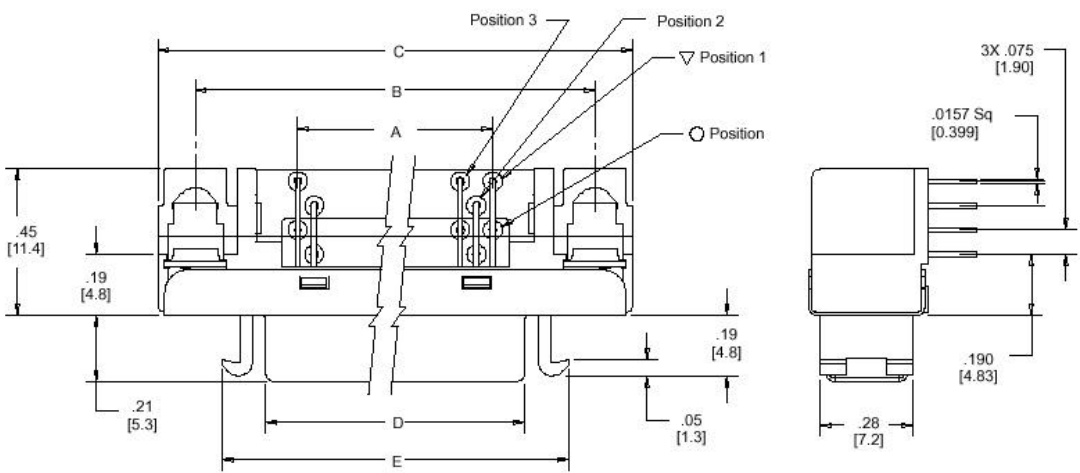
Connecting Cable Description

The associated cable should have a mini Delta-Ribbon receptacle with 26 points on one point and a standard Sub-D 25 points male with a 2 point supply power connector on the second point. The connection following :

Mini Delta-Ribbon (26 pts)				Sub-D 25 points				Power Connect. (2 pts)	
Designation	I/O	N°		N°	I/O	Designation		N°	Designation
Power supply 3.6V	I	1 & 2	→				→	1 (Red)	Power 3.6V
Rxd	I	3	→	9	O	TxD – Hôte			
TxD	O	4	→	10	I	RxD – Hôte			
RTS	O	5	→	11	I	CTS			
CTS	I	6	→	12	O	RTS			
Ack_Tx	O	7	→	13	I	Ack_Tx			
Tx/Rx	O	8	→	14	I	Tx/Rx			
Stand-By	I	9	→	15	O	Stand-By			
Lock	O	10	→	16	I	Lock			
Tck_Flash	I	11							
Reset	I	12	→	17	O	Reset			
RxD_Flash	I	13							
TxD_Flash	O	14							
I/O 1	I/O	15	→	21	I/O	I/O 1			
RSSI (Analogique)	S	16	→	18	I	RSSI (Analog.)			
I/O3	I/O	17	→	23	I/O	I/O3			
I/O2	I/O	18	→	22	I/O	I/O2			
I/O 5	I/O	19	→	25	I/O	I/O 5			
I/O 4	I/O	20	→	24	I/O	I/O 4			
RxD (RS232)	I	21	→	2	O	TxD – PC			
TxD (RS232)	O	22	→	3	I	RxD – PC			
RTS (RS232)	O	23	→	5	I	CTS – PC			
CTS (RS232)	I	24	→	4	O	RTS – PC			
GND	I	25 & 26	→	7	I	GND	→	2 (Black)	GND

Appendix 3: Antenna Connection

Here is an example of the coaxial cable connection of the 900MHz antenna provided with the B900SS-500. The hot and cold point can be easily be seen before and after soldering cable.

"Cold" point where to connect the breading of the cable (ground)

Coaxial cable connected to the antenna

"Hot" point where to connect the cable core

Appendix 4: Connexion for WinB900

Here is how to make the connections to the B900SS-500 in order to operate them with the WinB900 Software:
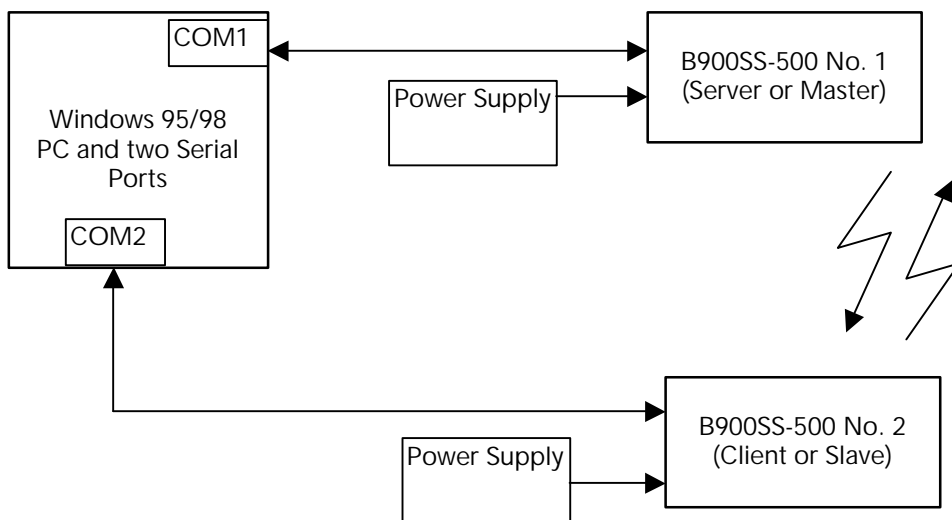
Appendix 5: Timing Diagrams

The user sends data

Stop on CTS,
Length ≥ S215

Stop on TimeOut
Length<S215

TxD Serial Data   Serial Data   Serial Data

TimeOut

RTS Active   inactive

Active

Radio Radio Transmission
Result : Error   Radio Transmission
Result : OK   Radio

Ack_Tx active   inactive

Lock

If Slave, Master/Slave synchronization just
ended correctly.

The user Receives data

Radio — Data Reception ... Data Reception ... Data Reception

CTS — active / inactive

RxD — Serial Data / Serial Data cut in two. / Serial Data

The CTS signal indicates that the user reception buffer is full. Therefore, the modem does not send data on the serial link during that time. However, the basic radio operation (synchronization, signal lock, etc.) and the data transmission on the radio (with data reception on the serial link) continues to operate normally. On the other hand, if another modem sends a data frame on the radio, this radio frame is not handled (and then not acknowledged). The Transmitter Modem considers this radio frame as lost and indicates it to the user. (Ack_Tx signal).

It would be better to avoid making the CTS inactive as much as possible.

N.B. : CTS SIGNAL NOT USED IN ACTUAL VERSION.

Appendix 6: Description of the registers

This section shows a list of all the registers that configure the modems with a software such as HyperTerminal for Windows.

The B900SS-500 modem will offer several facilities of possible settings.

Each parameter will be in a register and will have a default value that can be changed in sending the command 'ATSxxx=yy' (Hayes command). Also, the parameter value will be read when sending the command 'ATSxxx?'.

These parameters are stored in the Eeprom memory and will be available as soon as powered up.

NOTE: Access Type: 'R' Read and/or 'W' Write.

Access Type	Register	Name	Description
		Frequency Jump	
R/W	S200	N°. of Used Frequency Table	Between 0 and 8. When Table 0 is selected, the channels remain the same and stay on the selected channel in S201 (used only for the tests). **Default: 1.**
R/W	S201	First Frequency reserved for the synchronization.	Between 0 and 49. Has to be different from S202,S203 and S204. **Default: 0.**
R/W	S202	Second Frequency reserved for the synchronization.	Between 0 and 49. Has to be different from S201, S203 and S204. **Default: 15.**
R/W	S203	Third Frequency reserved for the synchronization.	Between 0 and 49. Has to be different from S201, S202 et S204. **Default: 30.**
R/W	S204	Fourth Frequency reserved for the synchronization.	Between 0 and 49. Has to be different from S201, S202 et S203. **Default: 45.**
R/W	S205	Auto-Acquisition On	Indicate if Acquisition Mode is necessary for build a Point-to-Point or a Network communication. If not, users MUST write and verify ALL network parameters (S250 to S254). '0' : Auto-Acquisition Off. '1' : Auto-Acquisition On. **Default: 1.**
R	S206	Dwell Timer Length	Calculated based on the Buffer Size (S215) **AND** Client Count (S253). Given in milliseconds. **Default: 115 ms (130 Bytes/1 client).**

Access Type	Register	Name	Description
		Serial Link	
R/W	S210	Speed.	Indicates the speed on the Serial Connection '2': 2400 Baud. '3': 4800 Baud. '4': 9600 Baud. **'5': 19200 Baud (Default)**. '6': 38400 Baud
R/W	S211	Data Bits	Serial Link Data Bits. '7': 7 bits. **'8': 8 bits (Default).**
R/W	S212	Parity	Indicates Serial Link Parity Type: **'1': None (Default).** '2': Even. '3': Odd.
R/W	S213	Stop Bits	Indicates Serial Link numbers of Stop Bits : **'1': One Stop Bit (Default).** '2': Two Stop Bit.
R/W	S214	Serial Link Time Out	Time_Out in milliseconds. Between 2 and 100 milliseconds. **Default: 5 ms.**
R/W	S215	Buffer Size	Indicates the maximum size of the frames that will be given to the Modem. When this size is reached, the modem resets the RTS signal, and if another byte is received, it is **loss**. It has to be between 30 Bytes and 130 Bytes (physical size). **Default: 130 Bytes.**

Access Type	Register	Name	Description
		Operation	
R/W	S220	Server or Client Mode	Indicates the operation of the Modem. When the Modem is configured as Master (or Server), the S252 Register switches automatically to 0xFF, while it switches to 0 when configured as Slave (or Client). '0' : Server (Network), '1' : Client (Network), '2' : Master, **'3': Slave (Default).**
R/W	S221	Recovery Count	Maximum recovery count in case of problems (Non-Ack response to a message). If this Register is at 0, the frames are not checked and considered as still good (used for the tests). **Default: 2.**
		Personal Network Control	
R/W	S250	Number of Personal Network (or Network)	This register gives the Personal Network (Network) number on 2 Bytes. Only the two members of a same Personal Network can communicate with each other. Between 0 and 65535, it is at 0 when the modem is reset. <u>NOTE</u>: When this register is reset to 0, Registers S252, S253 and S254 are also automatically reset to 0. **Default: 0.**
R or R/W (^{2})	S252	Modem Number	Gives the Modem a unique number for a given Personal Network. Number on one Byte is 0 when the Modem is reset, 1 if it is a Slave, between 1 and 16 if it is a Client and 255 if it is the Master. **Default: 0.**
R or R/W (^{2})	S253	Clients Count	Gives the Client count of a Master Modem or a Server. Between 0 and 1 if Master, 0 and 16 if Server. **Default: 0.**
R/W	S254	Client Addition	Gives the number of a Client to be added in the already set up network. This number should be between 1 and S253. Only used on a Network Server. **Default: 0.**

(^{2}) : This registers are in R/W mode if Auto-Acquisition is deselected (S205=0), and only in Read mode if Auto-Acquisition is selected (S205=1).

Appendix 7: Document Revisions History

No. of Revision	Date	Author	Subject
0.1	05/04/01	GS	Creation.
0.2	19/06/01	GS	Modification about WinB900SS

Appendix 8: B900SS-500 Firmware Version History

Version 0.01ß :   First version of the B900SS-500 firmware. Full compatible with the firmware V0.31a of the B900SS-20.

Version 0.02ß :   Evolution of the V0.01ß. Full compatible with the firmware V0.33ß of the B900SS-20, with the same evolutions.

Version 0. 30ß :   Evolution of the V0.02ß. Full compatible with the firmware V0.36ß of the B900SS-20, with the same evolutions.

Version 0. 40ß :   Evolution of the V0.30ß. Modification of all Channels Tables, based on the B900SS FCC restriction. Normally compatible with the firmware V0.40ß of the B900SS-20.
Version now in Test by FCC.

RF EXPOSURE STATEMENT

Notice in Installation Manual:

FCC Radiation Exposure Statement

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment, when installed as directed. This equipment should be installed and operated with fix-mounted antennas that are installed with a minimum of 21 centimeters of separation distance between the antenna and all persons' body during normal operations.

RF Exposure Calculations:

The following information provides the **minimum** separation distance for the highest gain antenna provided with **the Adcon Telemetry MQXB900SS-500**, as calculated from **FCC OET 65 Appendix B, Table 1B** Guidelines for General Population/Uncontrolled Exposure. This calculation is based on the highest EIRP possible from the system, considering maximum power and antenna gain, and considering a 0.61 mW/cm^2 uncontrolled exposure limit.

R $\quad = \sqrt{(Po*G) / (4*Pi*S)}$

Formula derived from
OET BULLETIN 65 (edition 97-01)
Section 2, equation 3

R $\quad =$ Minimum safe distance from antenna

S	$=$	Exposure Limit (from FCC OET 65, appendix B, Table 1 part B)
	$=$	f / 1500
	$=$	915 / 1500
	$=$	0.61 mW/cm^2 at 915MHz

Po	$=$	Peak RF energy
	$=$	500 mW

G	$=$	antenna gain (numeric)
		G(isotropic) $\quad = \quad$ 6dBd + 2.15 $\, = \quad$ 8.15 dBi
		G(numeric) $\quad = \quad$ 10^(G(dBi)/10)
	$=$	6.531

R $\quad = \sqrt{(500 * 6.531) / (4 * Pi * 0.61)}$

R $\quad =$ **20.64 centimeters**