WAVEWARE™

WIRELESS COMMUNICATION SYSTEMS

Paging System Handbook

Version 4.0 Firmware

Introduction

Your **WaveWare**$_{tm}$ **Paging System** allows you to send paging messages to one or more persons via pagers, and devices that incorporate POCSAG paging data receivers. You can setup automatic transmission of messages or you can compose messages on the fly and transmit them immediately. When you attach your paging transmitter to a PC or other Host Device, plug in the provided power adapter, and install and activate your paging software, you will be ready to make full use of the paging system.

The WaveWare Paging System is composed of several components, including: the Transmitter Unit, the "Rubber Duck" Antenna, the Mounting Bracket Kit, the Interface Harness, and the Power Adapter. Your WaveWare Paging System has the following capabilities:

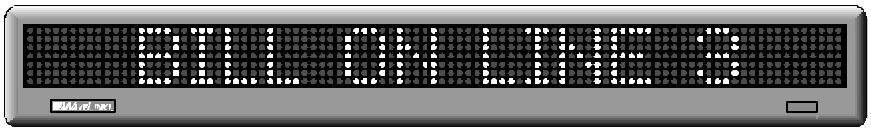
- ? Serial port controlled operation via RS-232 serial port, with configurable communication parameters. The communications interface will support baud rates of 300, 1200, 2400, and 9600, with None, Even, and Odd parities. The factory default setting is 9600 N81.
- ? 2 Watts effective radiated power with approximately 1 mile range, depending upon terrain and obstructions
- ? UHF band (450-470 MHz) crystal controlled transceiver. See the label on the Transmitter Unit to identify the operating frequency of the paging system.
- ? Industry standard POCSAG paging protocol covering the full range of paging functions, including:
  - ? 512, 1200 and 2400 bps RF data rates
  - ? tone/vibe only, numeric and alphanumeric paging message formats
  - ? multiple tone/vibration patterns
- ? Support for multiple paging control protocols, including:
  - ? TAP v1.8 (variations also known as IXO and PET)
  - ? Extended TAP (TAP compatible extended interface supporting embedded control characters and paging message encoding parameters appended to the pager PIN)
  - ? WaveWare Protocol, a direct serial command string that includes all paging control parameters in the command.
- ? Serial port controlled automatic switching between tone/vibe only, numeric, and alphanumeric paging message formats, including multiple tone/vibe cadences.
- ? Serial port controlled automatic switching between 512, 1200, and 2400 bps RF data rates
- ? Programmable Carrier Detect mode, which allows the automatic delay of transmission while a nearby transmitter of the same frequency is operating
- ? Programmable on-board pager database, supporting up to 4,995 pagers. Pager database not required for WaveWare and Extended TAP protocols.
- ? Programmable Supervisory Control mode, which causes the transmitter to automatically emit a radio signal every two minutes as a pinging event for supervisory control systems and for pagers and paging data receivers configured for Out of Range detection.
- ? Onboard watchdog timer to keep the transmitter on-line at all times
- ? Automatic transmitter duty cycle management

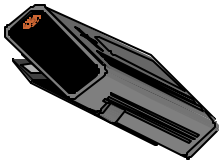
Obtaining Pagers for Your Paging System

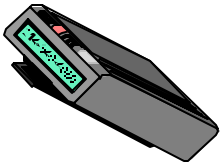
You can use a wide variety of paging receiver types with WaveWare Paging Systems, including tone/vibe, numeric, alphanumeric, and wireless message centers.

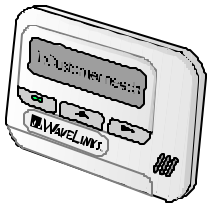
You can obtain WaveWare compatible paging receivers from many sources, including Motorola, NEC, Panasonic, and others. The paging receivers that you obtain for use with the WaveWare Paging Systems should meet the following basic specifications:

- **Frequency** - All paging receivers used with the WaveWare paging system must be of the same frequency and must match the frequency of the paging system transmitter. See the label on the WaveWare Transmitter Unit to identify the operating frequency of your paging system.
- **POCSAG** - All paging receivers used with the WaveWare paging system must be POCSAG compatible. POCSAG is the paging protocol most frequently used in the paging industry.
- **Pager Type** - You can mix different paging receiver types in a WaveWare installation. You can obtain the following paging receiver types for use with the WaveWare paging system:
  - Tone/vibe only, with or without multiple tone/vibrate cadence features. WaveWare paging systems support pagers with multiple tone/vibrate features. WaveWare Tone/Vibe Pagers have two capcodes and have multiple tone/vibrate features.
  - Numeric
  - Alphanumeric
  - WaveWare Wireless Message Centers (allow group message notification on scrolling multicolor LED displays, using WaveWare paging systems to communicate to the message centers)
- **Paging Data Rate** - You can mix different paging data rates (baud rates) in a WaveWare installation. The data rate of the paging receivers can be your choice of 512, 1200, or 2400 bps (bits per second).
- **Capcodes** - Each paging receiver used in a WaveWare paging system installation must have one or more capcodes (addresses) programmed into it. Each paging receiver used with a particular WaveWare installation, regardless of paging receiver type, must have a unique capcode programmed into it, in order to be able to transmit messages to that individual paging receiver. Contact your paging systems dealer for capcode assignment information.









Paging System Operation

Your **WaveWare Paging System** is a UHF transceiver, with onboard RS-232 communications, that transmits paging messages using the industry standard POCSAG paging protocol. The RS-232 communications allow you to interface the paging system to a PC or to other devices and systems that use RS-232 serial communications (Host Devices). The types of paging receivers that are compatible with your WaveWare paging system include:

- Any POCSAG compatible paging receiver operating on the same frequency as the paging transmitter (in the UHF band) and operating at 512, 1200, or 2400 bps data rate. Pagers of this type include tone/vibe, numeric, and alphanumeric models and can be obtained from WaveWare Technologies, Motorola, NEC, Panasonic, and others.
- WaveWare Wireless Message Centers, operating at the same frequency as your paging system.

The paging transmitter may be controlled by a PC that is running software designed to interface to the paging system. WaveWare wireless communication systems software is designed to take full advantage of the features of your WaveWare Paging System. The paging transmitter communications protocol is defined in this handbook to allow you or others to develop software or devices to directly control the transmitter.

The paging transmitter maintains an input buffer which can receive commands from the Host Device while a page is being transmitted. When a command is received from the Host Device, the transmitter responds with a message back to the Host Device. The paging transmitter encodes the paging messages into POCSAG paging format and transmits the encoded paging message to the paging receivers of your choice.

PC software developed to utilize the WaveWare Paging System can be designed to maintain a simple database of pager PIN numbers, or the software can be designed to allow definition of paging receiver attributes, including:

- Pager Type
  - Tone/Vibe Only, with or without multiple tone/vibrate cadences
  - Numeric
  - Alphanumeric
- Capcode - The unique address assigned to each paging receiver
- RF Data Rate
  - 512 bps
  - 1200 bps
  - 2400 bps

See Appendix A – WaveWare Paging Protocol for details on how to communicate to the WaveWare Paging System via the WaveWare Protocol. Refer to Appendix B – TAP Paging Protocol for details on how to communicate to the WaveWare Paging System via the TAP protocol.

The Transmitter Unit may require the setting of an onboard DIP switch to change communication interface parameters. Refer to Appendix C – DIP Switch Settings for details on how to configure the DIP switch, as required.

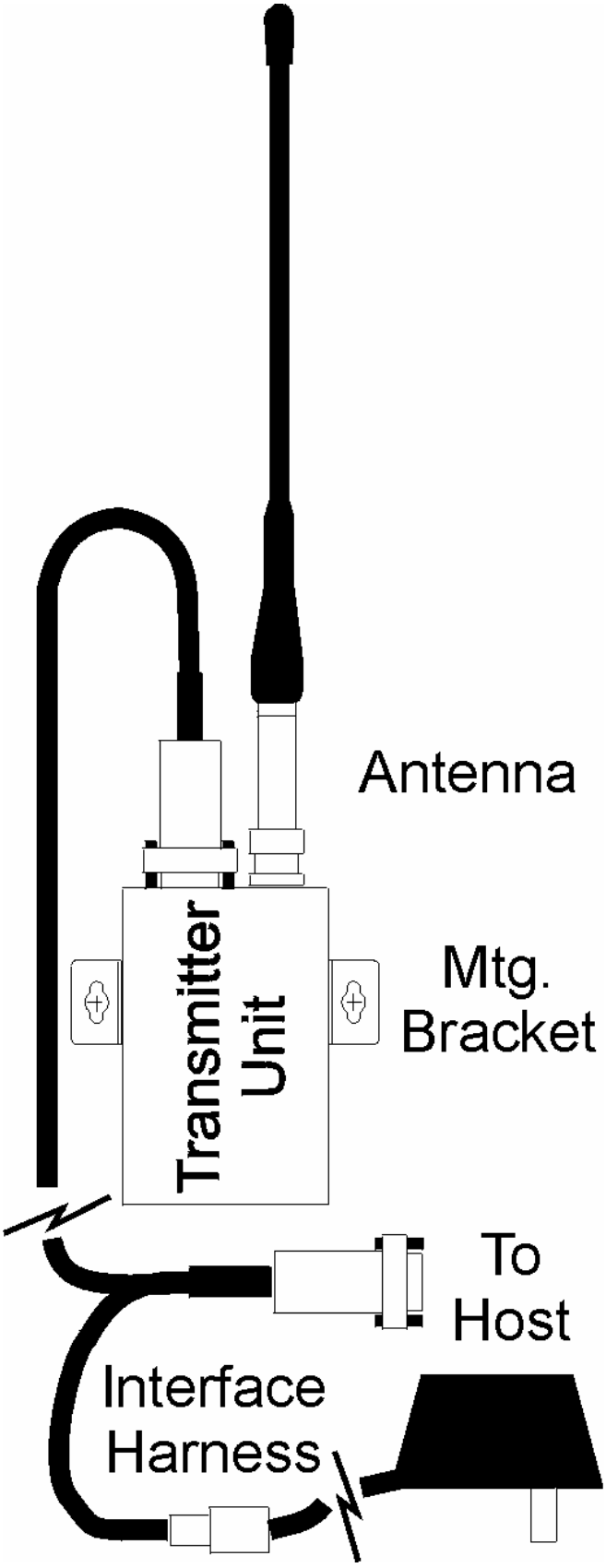
Paging Transmitter Installation

Your **WaveWare Paging System** includes a Transmitter Unit, a "Rubber Duck" Antenna, a Mounting Bracket Kit, an Interface Harness, and a Power Adapter. Refer to the diagram on the following page. To install the paging system, perform the following steps:

1. Attach the "Rubber Duck" Antenna to the Transmitter Unit. In normal paging operations, the paging transmitter antenna should be oriented in a vertical position to maximize the paging range.

Note: Do not attempt to operate the paging system without the antenna connected to the paging transmitter, as damage to the paging transmitter may occur.

2. Attach the Mounting Brackets to either side of the Transmitter Unit, reusing the two screws on each side of the paging system. Use the Mounting Brackets as a template to mark a location on a wall or other non-metal vertical surface to mount the Transmitter Unit. Attach the two #6 x ¾" sheet metal screws to the wall or vertical surface. Mount the Transmitter Unit onto the two screws, using the keyhole slots in the Mounting Brackets.
3. Plug the Interface Harness into an available DB9 serial port connector on the back of a Host Device, such as a PC or an alphanumeric paging terminal, such as the Canamex QUIKPAGER™. If the serial port has a DB25 connector, you must provide a DB25 to DB9 adapter, which is available from computer supply companies. Tighten connector screws.
4. Plug the Interface Harness into the DB9 female connector on the Transmitter Unit. Tighten connector screws.
5. Plug the Power Adapter into a 110 VAC power outlet. The red colored PWR/BAT LED indicator on the Transmitter Unit should be illuminated when power is properly applied.
6. If you are using a PC as a Host Device, load paging control software, such as WaveWare software, on the PC and configure it to operate with your WaveWare paging system. Make sure the proper serial port settings are defined. The green colored TX LED indicator on the Transmitter Unit should illuminate during a paging transmission. If the Carrier Detect function is enabled, you may see the green colored CD LED indicator temporarily illuminate prior to some paging transmissions, if a carrier signal is detected from a nearby transmitter at the same frequency as your WaveWare paging system.


Antenna
Transmitter Unit
Mtg. Bracket
To Host
Interface Harness

Trouble Shooting

POWER

When the WaveWare Paging Transmitter Unit is assembled and power is applied, you should be able to see a red PWR/BAT indicator illuminated on the Transmitter Unit. If not, verify that all connections are tight and verify that 110 VAC power is available at the power outlet. If connections are tight, power is available and the red PWR/BAT indicator doesn't illuminate, determine if the Power Adapter is at fault by trying another Power Adapter. If the Transmitter Unit still does not respond, the Transmitter Unit is most likely in need of repair or replacement.

At power-up, the Transmitter Unit is supposed to send a status message through the serial port to the host PC.

PAGERS

When you send a paging message command to the Transmitter unit from the PC, the green TX indicator on the Transmitter Unit should illuminate for a few seconds to indicate that transmission is occurring. If you don't receive a message on the selected paging receiver, follow the checklist below to troubleshoot paging reception:

1. Pager turned on
2. Pager has fresh battery
3. Pager properly defined in the paging control application software on the host PC.
4. Pager located at least arms length away from Transmitter Unit during transmission. (Some paging receivers do not properly decode paging messages when the paging receivers are located in close proximity to the transmitter antenna. Holding a paging receiver at arms length away from a transmitter antenna is usually sufficient to allow the paging receiver to properly decode a paging transmission).
5. Antenna attached to Transmitter Unit
6. Pager at the same frequency as the Paging System
7. Pager uses POCSAG paging protocol

CARRIER DETECT

If the Carrier Detect mode is activated, and you find that paging transmissions are delayed for significant periods of time due to interference on the channel, you should temporarily inactivate the Carrier Detect mode to allow transmissions to occur regardless of other transmissions on the channel. You may find that you get excellent paging reception even with Carrier Detect inactivated. You may want to contact your nearest FCC field office to find out what is causing the unwanted interference on your channel. Please note that the typical WaveWare paging system installation uses a 2 watt system that operates subservient to other operators on the same frequency. If you find that the unwanted transmissions are legal, and if you find that your paging reception is suffering due to the unwanted transmissions from another source, you may have to change your paging system to another operating frequency. A frequency change is a costly process and should be avoided.

If you have multiple WaveWare Paging Systems installed in the same facility, and at the same operating frequency, you should activate the Carrier Detect mode on all paging systems in order to ensure paging messages are being properly transmitted to paging receivers.

Appendix A – WaveWare Interface Specifications

This appendix is included for those who want to develop their own paging control software or add an interface for the **WaveWare Paging System** to their existing software applications. You can choose to use the WaveWare paging protocol defined in this appendix, or use the TAP paging protocol, defined in Appendix B – TAP Interface Specifications.

A simple definition of the difference between the WaveWare and TAP protocols is that the WaveWare protocol is a dedicated connection that doesn't require a login process and it assumes that the Host Device maintains a database of all paging parameters associated with a pager, including Capcode, Encoding Method, and RF Data Rate. The TAP protocol requires a connect and disconnect process and assumes that the Host Device only needs to maintain a database of pager reference numbers called PINs, and that the paging system maintains a database of all paging parameters associated with each PIN. The WaveWare interface supports paging messages up to 512 characters in length while the TAP interface supports paging messages up to 256 characters in length. Each protocol has its advantages and disadvantages, but both accomplish the process of causing POCSAG encoded paging messages to be delivered to local area pagers.

To configure your WaveWare paging system to use the WaveWare paging protocol, you may be required to configure the DIP switch bank in the paging transmitter. Please refer to Appendix C – DIP Switch Settings, for details on configuring communication protocols. As a quick reference, the DIP switch setting for the WaveWare interface is all 8 switches in the ON position, which tells the system to operate in WaveWare interface mode, with communication parameters of 9600N81.

Your WaveWare Paging System typically communicates with a Host Device via RS-232 at 9600 Baud, 8 data bits and 1 stop bit. The eighth data bit is ignored (no parity). You can configure the paging system for other serial communication parameters. Please refer to Appendix C – DIP Switch Settings, for details on serial communication parameters.

The paging system maintains an input buffer which can receive commands from the Host Device while a page is being transmitted. The input buffer should be able to contain approximately ten paging messages before getting full. When a command is received from the Host Device, the paging system responds with a message that includes error messages if the command was not understood or not properly transmitted. The normal response will echo the paging request command along with a status message.

The paging system can use hardware handshaking (CTS) to control the flow of paging message commands from the Host Device. Alternatively, the paging control software could use the response messages as a means of handshaking between the paging transmitter and the paging control software.

The paging transmitter encodes paging messages into POCSAG paging format and transmits the encoded paging message. If the Carrier Detect function is enabled, transmissions will be delayed while interfering signals are detected.

The commands available for serial port controlled paging using the WaveWare Paging Protocol include:

- System Identification
- Paging Message
- Setup
- Status

PAGING MESSAGE COMMAND

The Paging Message command is formatted as follows:

Example 1:

<SOH>TBCC...C<STX>XXXX...XXX<ETX><EOT>

Example 2:

<SOH>T,B,CC...C,<STX>XXXX...XXX<ETX><EOT><CR><LF>

Note: The commas, the <CR> character, and the <LF> character are optional in the Paging Message command. They are used for appearance purposes to separate subparts of the command string and for formatting the echoed output while troubleshooting the system.

<SOH> (Hex code 01) is used to mark the start of a message. This character resets the paging system and can be used to abort an incomplete paging command at any point prior to transmission.

T Alphanumeric character representing the type of paging message to be transmitted

- **A =** Alphanumeric
- **N =** Numeric
- **1 =** One Beep (tone/vibe only pagers)
- **2 =** Two Beeps (all pager types)
- **3 =** Three Beeps (all pager types)
- **4 =** Four Beeps (tone/vibe only pagers)

B Numeric character representing the data rate, in bits per second, at which the paging message is to be transmitted

- **5 =** 512 bps
- **1 =** 1200 bps
- **2 =** 2400 bps

Note: This numeric character may have one or no leading commas separating it from the paging message type.

C...C One to seven decimal numeric digits representing the capcode of the paging receiver to which the message will be transmitted. Capcodes are seven digit strings. Capcodes that begin with leading zeroes do not require the leading zeroes to be included in this numeric string, if you use comma delimiters. If comma delimiters are not used, you must include leading zeroes.

Note: This numeric string may have one or no leading commas separating it from the data rate.

<STX> (Hex code 02) is used to mark the beginning of a string of message characters to be transmitted. For paging message types of 1 to 4 Beeps (defined by the 'T' character above), this character and all following characters are ignored by the paging transmitter, until another <SOH> is encountered. This character may have one or no leading commas separating it from the capcode.

X...X A string of 0 to 256 alphanumeric message characters to be transmitted. For paging message types of 1 to 4 Beeps, this character and all following characters are ignored by the paging system, until another <SOH> is encountered.

<ETX> (Hex code 03) is used to mark the end of a string of message characters to be transmitted. For paging message types of 1 to 4 Beeps, this character and all following characters are ignored by the paging system, until another <SOH> is encountered.

<EOT> (Hex code 04) is used to mark the end of a Transmit Paging Message command string. All following characters are ignored by the paging system until a <SOH> character is encountered.

<CR><LF> (CR is Hex code 0D, LF is Hex code 0A) These characters are ignored by the paging system unless contained within a message string and are used only for formatting output on a PC. The <CR> and <LF> characters are optional.

Example 1:

<SOH>A,5,46180,<STX>This is a test<ETX><EOT><CR><LF>

will send the message "**This is a test**" at 512 bps to an alphanumeric pager with capcode 0046180.

Note: The POCSAG alphanumeric character set is the entire ASCII 7 bit character set.

Example 2:

<SOH>N,5,0765155,<STX>412-3433<ETX><EOT><CR><LF>

will send the message "**412-3433**" at 512 bps to a numeric pager with capcode 0765155.

Note: The POCSAG numeric character set allows Hyphen (-), space, left bracket ([), and right bracket (]) characters in addition to the normal numeric character set.

Example 3:

<SOH>N1765155<STX>412-3433<ETX><EOT>

will send the message "**412-3433**" at 1200 bps to a numeric pager with capcode 0765155. Note the lack of commas and the implied leading zeroes on the capcode.

Example 4:

<SOH>3,1,145678<EOT>
will send a three beep tone/vibe only message at 1200 bps to a tone/vibe only, a numeric, or an alphanumeric pager with capcode 0145678 and multiple tone/vibe cadence capability. Certain paging receiver models may not be designed to respond to multiple tone/vibe cadence messages.

Example 5:

<SOH>2,1,145678<STX>412-3433<ETX><EOT>

will send a two beep tone/vibe only message at 1200 bps to a paging receiver with capcode 0145678. Note that the portion of the string after the capcode is ignored by the paging system because the paging message type was a paging message type of one to four beeps.

Example 6:

<SOH>450006123<EOT><CR><LF>

will send a four beep tone only message at 512 bps to a paging receiver with capcode 0006123.

RESPONSE TO ALL COMMANDS

The paging system will respond immediately to all commands, including Paging Message commands, Setup Commands, and Status Commands, by echoing the Paging Message command back to the PC, and appending the echoed command with a status message in one of the following formats:

<SOH><ACK>V..V,QQ,D,C,II<EOT>

The ACK response is sent by the paging system to the PC immediately following a command if the command was understood by the paging system.

<SOH><NAK>EE<EOT>

The NAK response is sent by the paging system to the PC immediately following a command if the command was not understood by the paging system or if certain errors occur.

<SOH> (Hex code 01) is used to mark the start of a message.

<ACK> (Hex code 06) is used to indicate acknowledgement of valid reception of a command from the PC.

V..V Alphanumeric string that indicates the version number of the firmware in the paging system. The version number is followed by a comma character.

QQ A one to two numeric character string that indicates the quantity of paging messages that have been received by the paging system and not yet transmitted (Input Queue).

The QQ value is followed by a comma character. This parameter should be monitored if you intend to use software handshaking between your paging control software and the paging transmitter. The paging transmitter Input Queue overflows if the QQ value tries to exceed 14. As an example, with software handshaking, your software should stop sending data at a QQ value of 12 and resume sending data when the QQ value reaches 10 or less. You can query the size of the Input Queue by submitting a Status Command, described on the following pages.

D Numeric character that indicates whether the carrier detect circuit in the paging system is currently detecting a carrier signal or not. Valid values are:

0 = Carrier Signal Not Detected

1 = Carrier Signal Detected

Note: The carrier detect signal status is passed to the PC whether or not the paging system has been programmed to avoid transmitting when a carrier signal has been detected (see Programming Command below).

C A single numeric value used to indicate the On/Off state of the Carrier Detect mode. The numeric character is followed by a comma.

Valid values (C) are:

0 = Off

1 = On

II A two hexadecimal digit value that is reserved for future use.

<EOT> (Hex code 04) is used to mark the end of a message

<NAK> (Hex code 15) is used to indicate non-acknowledgment of a command from the PC.

<EE> Two numeric characters that indicate the particular error that caused non-acknowledgment of a command from the PC. The possible error values are:

01 = Invalid Message Type. Indicates a message type other than A, N, 1-4 was transmitted.

02 = Invalid Data Rate. Indicates a data rate other than 5, 1, or 2 was transmitted.

03 = Invalid Capcode. Indicates an invalid capcode was transmitted. Invalid capcodes are: 0-7, 2007664-2007671, 2045056-2045063, 2097144+.

04 = Input Buffer Overflow. Indicates the serial data input buffer in the paging system has overflowed. This condition would likely be caused by the host system not recognizing the CTS signal.

05 = Paging Buffer Overflow. Indicates the encoded paging message output buffer in the paging system has overflowed. This condition would likely be caused by excessive carrier signal detection while the Carrier Detect mode was enabled.

06 = Invalid Status/Setup Command. Indicates that the command was recognized as a Status or Setup command but the entire command string was not fully interpreted by the paging system.

07 = EEPROM Write Error. Indicates an internal system error in the paging system with regard to the proper storage of configuration information. This condition would likely indicate that paging system repair is required.

08 = Invalid Command Format. Indicates that the command was not fully recognized as a valid paging system command.

Example 1:

<SOH>A,5,46180,<STX>This is a test<ETX><EOT><SOH><ACK>V3.00,00,0,1,1A<EOT>

echoes the paging message command and acknowledges proper receipt of a command by appending the ACK, indicating paging system firmware version is 3.00, no paging messages in queue, no carrier signal is being detected, and Carrier Detect mode is set to ON. The last field does not currently provide useful information.

Example 2:

<SOH>4,5,0000006<EOT><SOH><NAK>03<EOT><CR><LF>

echoes the paging message command and indicates an error in receiving a command due to an invalid paging receiver capcode in a Paging Message command. Includes a <CR> and <LF> at the end of the response string if they were included in the paging message command.

SETUP COMMAND

You may program the WaveWare paging system to monitor for interference using the Carrier Detect mode. If the Carrier Detect mode is turned on, the paging system will hold paging messages in queue until an offending carrier signal is no longer detected at the transmission frequency of the paging system. The settings programmed by the Setup command will be remembered by the paging system even if power is removed from the paging system. The Setup command is formatted as follows:

<SOH>S,X,V<EOT>

Where the S indicates Setup Mode, X is the command type, and V is the value. The comma delimiters are optional.

X A single numeric value used to indicate the command type. The numeric character is followed by a comma.

Valid values (X) are:

1 = Carrier Detect Mode

V A single numeric value used to indicate the value of the command setting to be saved. The numeric character is followed by an EOT character.

Valid values (V) are:

0 = Off

1 = On

Example 1:

<SOH>S,1,0<EOT> will set the Carrier Detect function to the Off status.

Example 2:

<SOH>S11<EOT> will set the Carrier Detect function to the On status.

STATUS COMMAND

You may request the paging transmitter to respond with its current programmed settings using the Status command. The Status command is formatted as follows:

<SOH>S?<EOT>

Where the S? requests the paging system to respond with the status of its current programmed settings. The Status Command can be used in supervisory controlled applications to ensure the transmitter is still functioning, without causing unwanted paging transmissions.

Appendix B – TAP Interface Specifications

This appendix is included for those who want to develop their own paging control software or add an interface for the **WaveWare Paging System** to their existing software applications. You can choose to use the TAP protocol or the WaveWare protocol. Please refer to Appendix A – WaveWare Interface Specifications for details on how to interface your software application using the WaveWare protocol.

A simple definition of the difference between the WaveWare and TAP protocols is that the WaveWare protocol is a dedicated connection that doesn't require a login process and it assumes that the Host Device maintains a database of all paging parameters associated with a pager, including Capcode, Encoding Method, and RF Data Rate. The TAP protocol requires a connect and disconnect process and assumes that the Host Device only needs to maintain a database of pager reference numbers called PINs, and that the paging system maintains a database of all paging parameters associated with each PIN. The WaveWare interface supports paging messages up to 512 characters in length while the TAP interface supports paging messages up to 256 characters in length. Each protocol has its advantages and disadvantages, but both accomplish the process of causing POCSAG encoded paging messages to be delivered to local area pagers.

The TAP specifications are maintained by PCIA (Personal Communications Industries Association). The formal TAP specification can be obtained via the internet at www.pcia.com

To configure your WaveWare paging system to use the TAP paging protocol, you may be required to configure the DIP switch bank in the paging transmitter. Please refer to Appendix C – DIP Switch Settings, for details on configuring communication protocols. As a quick reference, the DIP switch setting for the TAP interface is all 8 switches in the ON position, except switch 6 is in the OFF position, which tells the system to operate in TAP interface mode, with communication parameters of 9600N81.

Your WaveWare Paging System typically communicates with a PC or other host device via RS-232 at 9600 Baud, 8 data bits and 1 stop bit. The eighth data bit is ignored (no parity). You can configure the paging system for other serial communication parameters. Please refer to Appendix C – DIP Switch Settings, for details on serial communication parameters.

The paging system maintains an input buffer which can receive commands from the PC while a page is being transmitted. The input buffer should be able to contain approximately ten paging messages before getting full. When a command is received from the PC, the paging system responds with a message that includes error messages if the command was not understood or not properly transmitted. The first three digits of each paging system response conforms to the response codes defined in the TAP v1.8 specification. See Appendix E – TAP Response Codes for a listing of the response codes.

The paging transmitter encodes paging messages into POCSAG paging format and transmits the encoded paging message. If the Carrier Detect function is enabled, transmissions will be delayed while interfering signals are detected.

Control characters recognized by the paging system include:

CARRIAGE RETURN	<CR>	$0D
START OF TEXT	<STX>	$02
END OF TEXT	<ETX>	$03
END OF TRANSMISSION	<EOT>	$04
SUBSTITUTE	<SUB>	$1A
ESCAPE	<ESC>	$1B

Control characters generated by the WaveWare paging system include.

LINE FEED	<LF>	$0A
CARRIAGE RETURN	<CR>	$0D
ACKNOWLEDGE	<ACK>	$06
NEGATIVE ACKNOWLEDGE	<NAK>	$15
ESCAPE	<ESC>	$1B

END OF TRANSMISSION <EOT>	$04

The operational modes available for paging using the TAP Paging Protocol include:

- System Identification Command
- Paging Session Login
- Paging Operation
- Paging Session Logout

SYSTEM IDENTIFICATION COMMAND

The System Identification command allows installation programs and other software applications to poll serial ports for the existence of a WaveWare paging transmitter using the standard ATI command.

When the WaveWare paging transmitter recognizes a command formatted as **ATI<CR>**, the transmitter responds with the following message:

WaveWare Paging Transmitter, v4.00

The firmware version number is subject to change.

PAGING SESSION LOGIN

The Paging Session Login mode allows a Host Device, sometimes called a Remote Entry Device, to initiate communications with the paging system. With the WaveWare Paging System, the Login process is optional. The WaveWare Paging System will automatically login a Host Device and process the paging message if it recognizes a properly formatted TAP message block at any point in it's operation.

The Host Device initiates the Login process by transmitting a carriage return **<CR>** character every two seconds until the paging system properly responds or until the Host Device times out and notifies the operator of a bad connection. The paging system will respond with **"ID=<CR>"** (Note: the quotation characters are used here only for reference and are not included in the transactions). The "ID=<CR>" will not be repeated or timed out by the paging system.

The Host Device should respond to the paging system with:

<ESC>PG1<CR> or **<ESC>pg1<CR>**

The WaveWare Paging System will then respond with:

110 1.8<CR>WaveWare Paging Transmitter v4.00<CR><ACK><CR>

The "110 1.8" message indicates that the system conforms to TAP specification version 1.8 and should be backward compatible with earlier TAP implementations. The paging system then notifies the Host Device that it is ready to accept messages as follows:

<ESC>[p<CR>

This completes the Login process.

PAGING OPERATION

Paging transactions are transmitted in blocks of characters, where one transaction is sent per block. Each block sent by the Host Device is acknowledged by the paging system. The Host Device must wait for this acknowledgement before sending the next block. The WaveWare Paging System provides acknowledgement in the form of an <ACK> character.

The WaveWare Paging System supports TAP message blocks up to 260 characters in length, with a 242 to 251 character message, from 1 to 10 characters for PIN (pager number), plus 5 control characters, and a 3 character checksum. (Message field length is restricted as follows: when a 1 character PIN is used, a 251 character message can be accommodated, and so on, for a total of 252 characters, such that when a 4 character PIN is used, a 248 character message can be accommodated. The maximum PIN field length of 10 causes a maximum message field length of 242 characters). A block always carries two fields with their associated carriage returns. The message field may be empty, but it's carriage return must be included in the data block. The TAP message block format is as follows:

<STX>PIN<CR>Message<CR><ETX>Checksum<CR>

The PIN field is a one to ten character pager number. Leading zeroes are not required. The Message field is a 1 to 251 character alphanumeric or numeric message. The Checksum field provides a checksum for the previous portion of the TAP message block. See Appendix D – TAP Checksum Calculation, for sample code to create the checksum field.

The Message field can be formatted as follows:

? For alphanumeric paging messages, all 7-bit ASCII "non-control" characters are valid except ^, ~, and _ (underscore)

? For numeric paging messages, valid characters are the numbers 0 through 9, - (hyphen), and space

? Control characters can be embedded into paging messages so that high end alpha pagers and paging data receivers can respond with formatted screen displays and with formatted serial output, as required. Control characters (typically <CR> and <LF>) can be embedded in messages by using the Transparency Option. The Transparency Option replaces a non-printable control character with the SUB (Hex 1A) character immediately followed by the control code offset by 40 Hex. See Appendix G - Embedded Control Characters for details on how to embed control characters in paging messages.

The WaveWare TAP interface supports PIN field lengths from 1 to 10 digits. The PIN field can be formatted as follows:

? PIN field lengths from 1 to 4 digits will cause a pager database lookup. PIN fields of this format must contain numeric digits only. The numeric PIN value will be compared to the PIN values stored in the WaveWare Paging System's onboard pager database.

? PIN field lengths from 5 to 10 digits will cause Extended PIN processing. Extended PIN processing assumes that the last 3 digits of the PIN field define paging message encoding attributes, while the preceding digits define the pager capcode. Extended PIN processing allows you to avoid the process of configuring a pager database in the WaveWare Paging System. See Appendix F – TAP Extended PIN Processing for details on how to format the PIN field.

When the Host Device delivers a TAP Message Block to the WaveWare Paging System, if the message block is properly formatted, and a 1 to 4 digit PIN field matches the pager database, the paging system will respond with:

213 Message Accepted – held for deferred delivery<CR>

Following the TAP message block response, when the input buffer of the paging system has capacity for another TAP message block, the paging system will send the following message.

<ACK><CR>

The <ACK><CR> response can be used as a flow control method to prevent overflow and lost messages. As an alternative flow control method, the RS-232 CTS signal is also asserted when the input buffer doesn't have capacity for another TAP message block, and deasserted when capacity exists in the input buffer.

When the Host Device delivers an improperly formatted TAP Message Block to the WaveWare Paging System, the paging system will respond with an error message and a <NAK><CR>. See Appendix E – TAP Response Codes for more information on paging system response messages. An example error message follows:

514 Checksum Error – Exp. 2:9 Got 2:X<CR>

<NAK><CR>

PAGING SESSION LOGOUT

The Paging Session Logout mode allows a Host Device, sometimes called a Remote Entry Device, to stop communications with the paging system. With the WaveWare Paging System, the Logout process is optional. The WaveWare Paging System will automatically login a Host Device and process the paging message if it recognizes a properly formatted TAP message block at any point in it's operation.

To initiate a logout (disconnect sequence) the Host Device should send the following to the paging system:

<ESC><EOT><CR>

Upon recognizing a logout command, the paging system will prepare for the login sequence by responding with:

ID=<CR>

Appendix C – DIP Switch Settings

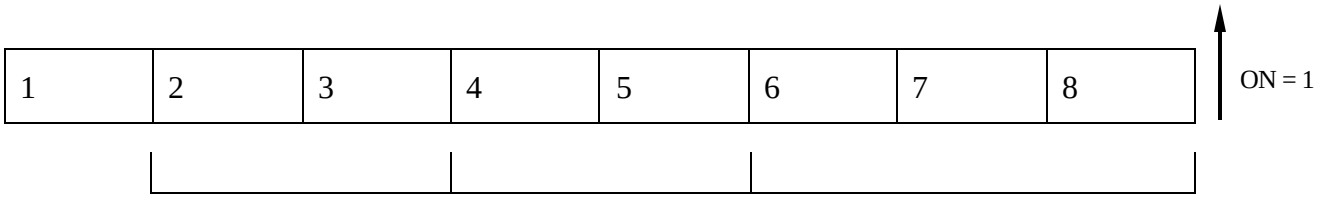
You may be required to configure the DIP switch bank in the paging transmitter to establish the appropriate operating mode and serial communication parameters.

Your WaveWare Paging System typically communicates with a PC or other host system via RS-232 at 9600 Baud, 8 data bits and 1 stop bit. The eighth data bit is ignored. You can configure the paging system for other serial communication parameters.

The available operating modes include:

- TAP Mode
- WaveWare PC Control Mode
- Pager Database Programming/WaveWare Keypad Control Mode
- Contact Monitoring Mode

DIP Switch Settings



Unused	Baud (Serial Interface)	Parity (Serial Interface)	Protocol
	11 = 9600	11 = None (N81)	111 = WaveWare PC Control
	10 = 2400	10 = None (N81)	110 = Keypad Control
	01 = 1200	01 = Even (E71)	101 = Unused
	00 = 300	00 = Odd	100 = Contact Closure
			011 = TAP
			010 = Unused
			001 = Unused
			000 = Unused

Your WaveWare paging system will normally be preconfigured to operate in TAP Mode, at 9600N81. Following are example DIP switch settings for WaveWare and TAP Modes, at 9600N81.

WaveWare PC Control Mode, 9600N81, All Switches ON

TAP Mode, 9600N81, Switch 6 OFF, All Other Switches ON

Appendix D – TAP Checksum Calculation

Following is sample Visual Basic™ code that creates a string to be sent to the paging system. A subset of the string has a checksum calculation performed on it, then the checksum and a control character are appended to form the string to be sent to the paging system. Refer to the TAP specification at www.pcia.com, for more details on the checksum calculation.

```
'String that checksum is calculated on, of the form:
'<STX>PIN<CR>Message<CR><ETX>
   TXString$ = Chr(2) & txtPIN.Text & Chr(13) & txtMessage.Text & Chr(13) & Chr(3)
'Calculate and append checksum
    j = 1
    Sum = 0
    Do Until j > Len(TXString$)
       B$ = Mid(TXString$, j, 1)
       D = Asc(B$)
       Sum = Sum + D
       j = j + 1
    Loop
'Create the three characters to be transmitted to represent this checksum.
    d3 = 48 + Sum - Int(Sum / 16) * 16
    Sum = Int(Sum / 16)
    d2 = 48 + Sum - Int(Sum / 16) * 16
    Sum = Int(Sum / 16)
    d1 = 48 + Sum - Int(Sum / 16) * 16
    Check1$ = Chr$(d1)
    Check2$ = Chr$(d2)
    Check3$ = Chr$(d3)
    CheckSum$ = Check1$ & Check2$ & Check3$
'Create complete string to be sent to paging system, of the form:
'<STX>PIN<CR>Message<CR><ETX>Checksum<CR>
    TXString$ = TXString$ & CheckSum$ & Chr(13)
```

Appendix E – TAP Response Codes

Following is a table of response codes supported by the WaveWare Paging System. Refer to the TAP specification at www.pcia.com, for more details on the Response Codes. **NOTE:** Response Code 213 occurs only with V4.0 firmware, while Response Code 211 occurs with newer firmware versions of the WaveWare Paging System.

Response Code	Definition
110 1.8	Paging system supports TAP Specification v1.8
211 Page(s) Sent Successfully	Paging message(s) successfully delivered
213 Message Accepted – held for deferred delivery	Paging message(s) successfully delivered
111 Paging terminal is processing the previous input -- please wait	Input buffer is temporarily full
510 – Invalid character in pager ID	Pager ID field contains illegal characters
511 Error - Pager ID not in database	Pager ID was legal and 1 to 4 characters in length, but didn't match database lookup
514 Checksum Error – Exp. XXX Got YYY	Checksum didn't match message block

Appendix F – TAP Extended PIN Processing

The WaveWare TAP interface supports PIN field lengths from 1 to 10 digits. The PIN field can be formatted as follows:

? PIN field lengths from 1 to 4 digits will cause a pager database lookup. PIN fields of this format must contain numeric digits only. The numeric PIN value will be compared to the PIN values stored in the WaveWare Paging System's onboard pager database.

? PIN field lengths from 5 to 10 digits will cause Extended PIN processing. Extended PIN processing assumes that the last 3 digits of the PIN field define paging message encoding attributes, while the preceding digits define the pager capcode. Extended PIN processing allows you to avoid the process of configuring a pager database in the WaveWare Paging System

Extended PIN fields should be of the form:

CCCCCCCERF, where **C** represents the capcode, **E** represents Message Encoding Type, **R** represents RF data rate, and **F** represents Function Code.

The Extended PIN field can be represented in either numeric or alphanumeric format. All Extended PIN fields must be between 5 and 10 digits in length to cause the paging system to perform Extended PIN processing.

Incorrect formatting of extended PIN fields causes a <NAK> response combined with an explanation message.

CCCCCCC is a 2 to 7 digit numeric value representing a pager capcode. Leading zeroes are optional except in the case of capcodes 8 and 9, which should be represented with at least one leading zero, e.g. 08 or 09.

E is the message encoding type, where "**0**" (zero), "**n**", or "**N**" represent "numeric encoding", and "**1**", "**a**", or "**A**" represent "alphanumeric encoding". The numeric values for **E** are provided to support numeric-only PIN fields in paging control software.

R is the RF data rate, where "**5**" represents 512 bps, "**1**" represents 1200 bps, and "**2**" represents 2400 bps.

F defines the function code to be delivered, where "**1**" is function code 1, "**2**" is function code 2, "**3**" is function code 3, and "**4**" is function code 4. A function code of "**0**" is also valid. A function code of "**0**" causes the default function code for a particular Message Encoding Type ("**E**") to be substituted. The default value for **F** is "**4**" when the **E** value is "alphanumeric encoding", and "**1**" when the **E** value is "numeric encoding".

Following are valid example Extended PIN fields causing Extended PIN processing:

08A20 – Causes delivery of a standard (function code 4) alphanumeric message to capcode 0000008 at 2400 bps

08A24 – Same result as above

08124 – Same result as above

0008124 – Same result as above

0000008124 – Same result as above

11A53 – Causes delivery of an alphanumeric message with function code 3 to capcode 0000011 at 512 bps

0000011A53 – Same result as above

11N53 – Same result as above, but with numeric encoding

11N50 – Same result as above, but with default function code of 1

038N52 – Causes delivery of a numeric message with function code 2 to capcode 0000038 at 512 bps

0000038N52 – Same result as above

0000038052 – Same result as above, but using zero (“0”) value for **E** parameter to indicate numeric encoding

0001001120 – Causes delivery of a standard (function code 4) alphanumeric message to capcode 0001001 at 2400 bps

0001001124 – Same result as above

Appendix G – Embedded Control Characters

To embed a control character in a paging message, include a <SUB> control character followed by an offset version of the control character you want to embed. You offset the control character by adding 40 HEX to the control character, to make the character printable. Adding 40 HEX to **Carriage Return** gives you **M**. Adding 40 HEX to **Line Feed** gives you **J**. The character combination of **<SUB>M** causes a Carriage Return control character to be embedded in the encoded paging message, while **<SUB>J** causes a Line Feed control character to be embedded. The **<SUB>** character needs to be passed to the WaveWare Paging System as a HEX character.

In the WaveWare Paging System Setup software, you can embed a Carriage Return by entering **<CR>** in the message body, and embed a Line Feed character by entering **<LF>** in the message body.

In the Microsoft Visual Basic programming language, you can use the following code example to define the embedded control character string to be delivered through the serial port to the paging system. In this example, we are embedding only the Carriage Return control character:

```
 DIM CarriageReturnString As String,
 DIM MessageLine1 As String
 DIM MessageLine2 As String
 DIM TXString As String
CarriageReturnString = Chr(26) & "M"
LineFeedString = Chr(26) & "J"
 MessageLine1 = "Line 1 of test message"
 MessageLine2 = "Line 2 of test message"
 TXString = MessageLine1 & CarriageReturnString & MessageLine2
form1.MSComm1.Output = TXString
```

Appendix H – Interface Harness Diagram