

WaveWare
VHF & UHF
Paging Data Receivers



WaveWare Technologies Inc.

User Manual

Version B4

November 2000

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Paging Data Receiver User Manual

This manual covers the following products:

Models:	0601-0013	150-160 MHz, 25 kHz channel spacing, 512 bps POCSAG data rate
	0601-0014	450-470 MHz, 25 kHz channel spacing, 512 bps POCSAG data rate

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2. Specifications

Physical and Environmental Specifications

Dimensions:	5" x 7" x 2" enclosure, not including connectors or antenna
Operating Temperature:	-30 to +60°C
Humidity:	95 % non-condensing
Vibration:	0.27 G (5 to 500 Hz)
Shock:	3G or 2 ft. drop
RF I/O:	external rubber duck antenna

General Electrical Specifications

Power supply:	+12VDC
Frequency step size:	6.25kHz
Frequency stability:	2.5ppm.
Power consumption:	<90mA at 12V
Frequency range:	150-160MHz (0601-0013) 450-470MHz (0601-0014)
RF circuits no-tune bandwidth:	10MHz VHF, 20MHz UHF (using external antenna)
Built-in antenna Bandwidth:	2% of center frequency.
Received Signaling Format and speed:	POCSAG at 512, 1200, or 2400bps, must be ordered from factory at one speed, non-reconfigurable.
Maximum message length:	512 characters recommended or as limited by transmit baud rate accuracy. If RS232 baud rate is less than POCSAG data rate, then limited by 128 character buffer.

Specifications of Receiver Section

Receiver sensitivity (512 bps):	99% decode at 0.20uV measured at OSX connector.
Adjacent channel rejection:	65dB
Image and spurious rejection:	55dB
Intermodulation rejection:	60dB
Channel Spacing:	W = 25 kHz, N = 12.5 kHz

User Features

Digital outputs:	12 CMOS type outputs
Serial output:	3-wire RS-232
Address codes:	4 different CAP Codes
Serial port baud rates:	1200, 2400, 4800, 9600, 19200.
Control outputs:	3 of the 12 CMOS outputs respond to commands similar to Motorola's <i>DataNet</i> Paging Data Receiver.

3. Introduction

The *Paging Data Receiver* family of POCSAG Data Receivers are high performance receiver modules which are ideal for remote control, one-way telemetry, and wide-area wireless messaging. They feature:

- *12 CMOS output ports, individually addressable*
- *Uses the reliable POCSAG digital paging format*
- *Receives 512, 1200, or 2400 baud POCSAG (factory configurable only)*
- *Serial port output for received messages*
- *Synthesized receiver - No crystals required*
- *Easy configuration via a built-in RS-232 port*
- *Compact size and an easy to use interface*
- *Activity LED*
- *Receives alpha or numeric messages*
- *External antenna*
- *Timed or static digital outputs*
- *Responds to industry standard "7xxx" output control commands*

WaveWare's *Paging Data Receiver* paging Data Receivers allow a user to remotely control electrical devices over very wide areas, even nation-wide! Because they use the standard POCSAG paging protocol, a *Paging Data Receiver* communication system may be as small or large as one wishes. A user may utilize their own on-site transmitter or they may utilize a paging carrier's wide-area network.

The *Paging Data Receiver* receivers decode POCSAG paging signals, and provide an RS-232 output of the received message. If the message is formatted in the common "7xxx" output control format, the digital output lines will respond appropriately. The digital outputs may be used to control LEDs, relays, external loads, or a host of other electromechanical devices. A built-in timer allows the outputs to be turned on for specific amounts of time, after which they are automatically turned off. This is particularly useful for lighting and pump control.

4. Addressing

The POCSAG communication protocol is used to send data to the *Paging Data Receiver*. POCSAG requires that all data transmitted be sent to a particular address. POCSAG addresses use a 21 bit address, meaning they are in the range of 0000001 through 2097151. Some companies refer to these addresses as CAP Codes.

Up to four addresses can be programmed into a *Paging Data Receiver* receiver. These addresses are the POCSAG addresses to which the *Paging Data Receiver* will respond. One is generally used for the unit's individual address, and another is generally used as a group address. Address number 1 is a combination of the first programmed CAP Code and the setting of the DIP switches on the *Paging Data Receiver*'s circuit board.

“7xxx” output control commands can also include an additional subaddress or password that can be used to share one Cap Code between a number of devices. The *Paging Data Receiver* will respond to up to two passwords or subaddresses allowing one to be used as an individual address and the other to be used as a group address. It is possible to selectively control serial data output using subaddresses, but only if the message content is prefixed with a “7xxx” output control command and the subaddress (password) value, and only if the “Command Message” mode is enabled. See the Annunciation Section of this manual for details.

The addresses are programmed into a unit it via the RS-232 serial port, when the *Paging Data Receiver* is in its programming mode. Refer to the Programming Section of this manual for information on how to program the *Paging Data Receiver*.

5. Serial Data Output

The *Paging Data Receiver* provides an RS-232 type serial output interface. All *non-control* messages that are received by the *Paging Data Receiver* are sent out the RS-232 serial data interface in the ASCII format. For a message to be properly received it must be sent to an address that matches one of the four addresses programmed into the *Paging Data Receiver*. Output control commands and serial data messages can be combined when the “Command Message” mode is enabled. See the Annunciation Section of this manual for details.

The data rate of the serial port, and its parameters, may be configured by the user. The configuration of the serial port parameters is done when the *Paging Data Receiver* is in the programming mode. See the Programming Section of this manual for details.

Some paging carriers insert dashes into messages sent to numeric pagers. If this is a problem, contact your carrier and request that dashed not be inserted, or tell them to send the messages in alphanumeric format.

The *Paging Data Receiver* RS-232 port is a 3-wire interface, and thus does not use hardware flow control.

An up to 16 character message header and trailer may be programmed into the *Paging Data Receiver*, using the programming mode **HR** and **TR** commands, entered as HEX values. If a pre-programmed header and/or trailer are configured, these will be concatenated with every data message the *Paging Data Receiver* sends to the serial port. If the pre-programmed header is configured, the character(s) configured will always be transmitted out the serial port immediately before the received message. If the pre-programmed trailer is configured, the character(s) will be sent out immediately after the received message. Headers and trailers will not be added to “7xxx” commands which are sent out the serial port by enabling the logging feature with the **LG ON** command.

The Carriage Return insertion or Line Feed insertion feature may be enabled or disabled from the program mode to allow the serial output to work properly with a variety of printers. The **CR ON** command will cause a Carriage Return to be inserted before any detected Line Feed character in the message. Similarly, the **LF ON** command will cause a Line Feed to be inserted after any Carriage Return in the message.

If the data rate of the RS-232 serial port is slower than the rate at which messages are sent to the *Paging Data Receiver* it will buffer the messages as it receives them. The buffer in the *Paging Data Receiver* is 128 characters deep. If the buffer fills, the next message received will overwrite the buffer. If the baud rate of the serial port is equal to or greater than the over-the-air POCSAG rate, the buffer will never overflow, and the message length is limited only by the accuracy of the transmit and receive baud rates. Message lengths of 512 characters or less are recommended.

It should be noted that the over-the-air POCSAG rate does not directly correlate to the serial port output rate because POCSAG messages are encoded differently than asynchronous serial data. Asynchronous serial data encoding is affected by the *Paging Data Receiver* configuration settings and is encoded as one start bit, seven or eight data bits, zero or one parity bit, followed by one or two stop bits. For example, when configured for 9600 baud, eight data bits, no parity and one stop bit each output character is encoded as 10 bits giving an effective output rate of 960 characters per second. POCSAG encoding differs for numeric and alpha-numeric pages but is can be generally described as three to five characters per 32 bit codeword. The following table shows the over-the-air data rate and the minimum required serial port rate to avoid buffer overrun when using eight data bits, no parity, and one stop bit (10 bits per output character).

POCSAG rate	Serial port rate (bps) for Alpha-numeric	Serial port rate (bps) for Numeric
512	458	800
1200	1072	1875
2400	2143	3750

Since the *Paging Data Receiver* only supports serial port output speeds of 1200, 2400, 4800, 9600, 19200, and 38400 baud, the appropriate output speed should be selected from these values to avoid buffer

overrun. For more detailed information see the chapter on POCSAG message formatting later in this manual.

6. Control Outputs

The *Paging Data Receiver* has 12 digital outputs, numbered 1 through 12. The outputs are digital CMOS type outputs, e.g. 0 VDC = low and +5VDC = high. Certain commands are used to set and clear each of the outputs. The commands must be a series of numeric digits sent to one of the *Paging Data Receiver*'s addresses. The *Paging Data Receiver* responds to commands in a manner very similar to Motorola's *DataNet* paging receivers.

Upon power up, *Paging Data Receiver* can set all outputs to whatever state was stored in the EEPROM prior to the last power down or to a state configured using the OP serial port command. The default setting is 0 (low) for all outputs.

Paging Data Receiver Output Control Commands are in the following format:

Function Code	Command Code	Sub-address (1-7 characters)	Data			Checksum
			X1	...	X12	

Control Output Message Structure

The Function Code determines what function is going to be performed, or which control output is going to be acted upon.

The Command Code tells the logical polarity of the output, or what to do with the output referenced in the Command Code.

The sub-address field can be used to specify an individual *Paging Data Receiver* receiver within a group of receivers configured to share a common CAP Code, or as a password used to validate output commands. Two passwords of up to 7 characters in length can be configured using the PW 1 and PW 2 serial port commands. When used as sub-addresses one can be used as an individual address and the other as a group address.

The Data field is used to simultaneously program the values of the outputs. The digital outputs are referred to as X1, X2, X3 ... X12. The number in the first data field is the polarity to set X1 to. The number in the second field is the polarity to set X2 to, and so on, up through X12. The number in the field must be either a "0", a "1", or a "U". A "0" will make the corresponding output low, and a "1" will cause the *Paging Data Receiver* to set the corresponding output high. A "U" character will leave the corresponding output unchanged.

The Checksum is a bit-for-bit EXCLUSIVE OR function across every ASCII byte in the command. The result of the XOR is converted to a two-byte HEX ASCII code. See the example for details. If you do not wish to use a checksum at the end of the message, you can disable it with the CS OFF command (see section 8).

Function Code	Command Code	Description
70	00	No output change
	14	Configure state of all control outputs simultaneously. Values in X1 through X12 are the logical outputs.
77		Control Output 1
78		Control Output 2
79		Control Output 3
	10	Logic 0
	11	Logic 1
	12	Cycle (logic 1, delay, logic 0)
	13	Cycle (logic 0, delay, logic 1)

Command Examples:

To send a command to set control output 3 high (to a 1) to a unit, the following command could be sent:

7911

To send a command to set all outputs high, the following command could be sent:

7014111111111111

To send a command to set output X5 high and leave all other outputs as they were, the following command could be sent:

7014UUUU1

To send a command to set control output 3 high (to a 1) for one minute, and then have it go back, send the following command. Note: The unit must have its timer already programmed to be one minute, using the DL command. See the Programming Section of this manual for details.

7912**Checksum Example:**

Message: 701412345000111000110

Function code = 70

Command code = 14

Password = 12345

Data = 000111000110 (turn outputs 1, 2, 3, 7, 8, 9, and 12 OFF and outputs 4, 5, 6, 10, and 11 ON)

Checksum: 37h XOR 30h XOR 31h XOR 34h XOR 31h XOR 32h XOR 33h XOR 34h XOR 35h XOR 30h XOR 30h XOR 30h XOR 31h XOR 31h XOR 31h XOR 30h XOR 30h XOR 30h XOR 31h XOR 31h XOR 30h = 32h

Converting the answer, 32h, to HEX ASCII yields two characters, one for the 3 and one for the 2.

Therefore, the actual message to send to the *Paging Data Receiver* is :

70141234500011100011032

Note: ASCII-HEX representation of Checksums can result in non-numeric characters so alphanumeric POCSAG formatting should be used when command checksums are present. Also, command passwords/sub-addresses can also contain non-numeric characters.

Note: Output command 7014 can be “abbreviated” by not sending the remaining output state digits when they are to be left unchanged. This may not work properly in all circumstances when command checksums are being used (specifically, when the first character of the checksum is a zero or a one and less than 12 data characters are present in the command). To avoid any problems, always specify all twelve data digits in the 7014 command when using checksums.

7. Annunciation

There are two methods of annunciating message arrival for applications that need to perform digital output manipulation while outputting message text to the serial port. The first method, called “Selective Annunciation”, is to send a 7xxx command prefix along with the message text. The second method, called “Global Annunciation”, is to configure 7xxx commands to be executed immediately when the unit’s CAP Code is recognized, for all received messages.

NOTE: It is not recommended that either method be used to “power up” external equipment that will be receiving the message text through the serial port. This is because the timing between Output Control Command execution and message text output is not deterministic and may result in messages being output before the receiving equipment it prepared to process it.

7.1. Command Messages (Selective Annunciation)

Under normal circumstances output commands and text messages are sent as separate POCSAG messages. When “Command Message” mode is enabled using the CM ON command (see section 8) text messages must be prefixed with a valid 7xxx output command...including passwords and/or checksums when configured. Messages not containing a valid 7xxx prefix are discarded and not output on the serial port. When a valid 7xxx command is included, the command is executed (and output on the serial port when command logging is enabled) then the text following the command is output along with the configured header and trailer strings. This feature provides security and/or subaddressing functionality for text messages as well as annunciation functionality on a message by message basis.

When no output change is desired the 7000 command should be used. This command allows password/subaddress and checksum processing without performing any output activities.

Examples:

Configuration: dl=60, lg=off, cs=off, pw1=ICU2, hd=28, tr=29

Received message: “Make \$1000 a day and be your own boss. Call now to learn how: 976-GET-RICH”

Output response: none

Serial output: none

Configuration: dl=60, lg=off, cs=off, pw1=ICU2, hd=28, tr=29

Received message: “7000Hello”

Output response: none

Serial output: none

Configuration: dl=60, lg=off, cs=off, pw1=ICU2, hd=28, tr=29

Received message: “7000ICU2Hello”

Output response: none

Serial output: “(Hello)”

Configuration: dl=60, lg=off, cs=off, pw1=OU812, hd=28, tr=29

Received message: “7000ICU2Hello”

Output response: none

Serial output: none

Configuration: dl=60, lg=off, cs=off, pw1=ICU2, hd=28, tr=29

Received message: “7712ICU2Hello”

Output response: output 1 set high, delay for 60 seconds, then low

Serial output: “(Hello)”

Configuration: dl=60, lg=off, cs=ON, pw1=ICU2, hd=28, tr=29

Received message: "7712ICU2DEHello"
Output response: none
Serial output: none

Configuration: dl=60, lg=off, cs=ON, pw1=ICU2, hd=28, tr=29
Received message: "7712ICU276Hello"
Output response: output 1 set high, delay for 60 seconds, then low
Serial output: "(Hello)"

Configuration: dl=60, lg=off, cs=ON, pw1=, hd=28, tr=29
Received message: "700007Hello"
Output response: none
Serial output: "(Hello)"

Configuration: dl=60, lg=ON, cs=off, pw1=, hd=28, tr=29
Received message: "70141111111111Hello"
Output response: all outputs set high
Serial output: "70141111111111^{<CR>}_{<LF>}(Hello)"

Configuration: dl=60, lg=ON, cs=off, pw1=, hd=28, tr=29
Received message: "7014000000000000"
Output response: all outputs set low
Serial output: "7014000000000000^{<CR>}_{<LF>}"

7.2. Function Code Commands (Global Annunciation)

The FC command is used to enter 7xxx output control commands to be executed upon recognition of the *Paging Data Receiver's* CAP code. When configured, the command corresponding to the function bits within the address codeword (refer to section 11) is executed as soon as the CAP Code match is recognized. Any text following any output control code in the received message will be output through the serial port. If the message contains an additional 7xxx output command, it will be executed after the function code command. There are four function code command entries corresponding to the four possible POCSAG function bit combinations. If an entry is left blank, no command will be executed upon reception of that function code. When only one response is desired, regardless of function code, all four entries should be set to contain the same command.

When command logging is enabled, using the LG ON command, the function code command will also be output to the serial port.

The commands entered using the FC configuration command should not contain password or checksum fields regardless of the CS and PW settings.

This feature provides the ability to automatically annunciate the output of all message text on the serial port using the digital outputs.

8. Programming

The *Paging Data Receiver* is configured by connecting a computer's RS-232 serial port to the RS-232 serial port on the *Paging Data Receiver*. The serial port should be configured on the PC for 9600 bps, 8 data bits, 1 stop bit, no parity. These are the parameters used when the unit is in the programming mode only, and the parameters set with the SP, SB, and SS commands are used when the unit is in the normal operating mode. Programs such as *ProComm* or *HyperTerminal* work well for communicating with the *Paging Data Receiver* in the programming mode. Messages received while in programming mode are output at 9600,n,8,1.

8.1. General Configuration

8.1.1. Placing the *Paging Data Receiver* into the Programming mode

Turn the power to the *Paging Data Receiver* on with the mode switch in the NORMAL position. Next, switch the mode switch over to the RESET position. This puts it into the programming mode.

Using a terminal program, press the <Enter> key. You should see the OK> prompt on the screen. The OK> is sent by the *Paging Data Receiver* indicating it is ready for a command.

When you enter a command into the *Paging Data Receiver*, it will respond with one of the following:

OK> indicates the command was accepted.
 ER> indicates bad format or bad data.
 ??> indicates unknown command.

8.1.2. *Paging Data Receiver* Programming Commands

SP x Set parity. x = O for odd, E for even, N for none, M for mark, S for space.

SB nn Set baud rate. nn = 1200, 2400, 4800, 9600, 19200, 38400. The default is 9600.

SS n Set stop bits. n = 1 or 2. Default is 1.

SD n Set data bits. n = 7 or 8. Default is 8.

PR nnn Set POCSAG speed, nnn = 512, 1200, or 2400.

CC 1 nn Set CAP Code 1 base address. nn = 1 - 2087152.

CC 2 nn Set CAP Code 2. nn = 1 - 2087152.

CC 3 nn Set CAP Code 3. nn = 1 - 2087152.

CC 4 nn Set CAP Code 4. nn = 1 - 2087152.

PM [ON/OFF] Enable Promiscuous mode. When enabled the *Paging Data Receiver* receives and processes all messages to all CAP Codes. Default is OFF.

LG [ON/OFF] Enable/disable logging of Control Output Commands to the serial port. Logged commands are sent without headers or trailers, and are followed by a carriage return and line feed. Default is OFF.

DF [AUTO/NUMERIC/ALPHA]

Specify the data format of POCSAG messages to be used. AUTO will determine the format from the function code sent on a message by message basis (00=Numeric, else Alphanumeric).

ALPHA or NUMERIC modes force the format regardless of the function code contained in the message address codeword. For more information on POCSAG message formatting refer to Section 11. Default is AUTO.

- DL nn** Set pulse time delay in seconds. Range 1 to 65000
- CM [ON/OFF]** Enable/disable Command Message mode. Default is OFF.
- CR [ON/OFF]** Enable/disable insertion of Carriage Return before detected Line Feed. Default is OFF.
- CS [ON/OFF]** Enable/disable output command checksum validation. Default is off.
- FC 0 cmd** Set 7xxx output command to be executed when a message is received with function code bits set to 00. Command should not contain password or checksum fields. Default is none.
- FC 1 cmd** Set 7xxx output command to be executed when a message is received with function code bits set to 01. Command should not contain password or checksum fields. Default is none.
- FC 2 cmd** Set 7xxx output command to be executed when a message is received with function code bits set to 10. Command should not contain password or checksum fields. Default is none.
- FC 3 cmd** Set 7xxx output command to be executed when a message is received with function code bits set to 11. Command should not contain password or checksum fields. Default is none.
- LF [ON/OFF]** Enable/disable insertion of Line Feed after detected Carriage Return. Default is off.
- HD hh hh** Program the header characters in hex. Up to 16 characters can be entered. Default is none.
- IN [ON/OFF]** Invert over-the-air data. Default is OFF.
- TR hh hh** Program the trailer characters in hex. Up to 16 characters can be entered. Default is none. Headers and trailers are not added to logged Control Output Commands.
- MO** Display the current configuration and operating modes.
- OP ssss** Set the power up state of the digital outputs. Use the **AUTO** parameter to restore the outputs to the last state before the power outage. The output state is specified as a string of zero or one digits representing output 1 through 12 from left to right. For example:
- OP 000000000001**
- Will program the unit to always power up with output 12 ON and all other outputs OFF.
- PW 1** Set the first output command password or sub-address. passwords can be up to seven characters in length and are not limited to numeric digits.
- PW 2** Set the second output command password or sub-address.
- RS** Reset the internal EEPROM. **CAUTION!** This will set internal decoder parameters to factory default state. (This will not effect receive frequency settings.)

8.2. Receive Frequency Programming

The EEPROM on the *Paging Data Receiver* board stores four user programmable frequencies, which are field selectable by placement of the jumper on JP3. A custom software program called PAGING DATA RECEIVER.EXE is used to program the frequencies in the unit. The *Paging Data Receiver* must have power applied to it to be programmed. The *Paging Data Receiver* can be programmed by following these steps:

1. With power turned off connect the serial port DB-9 connector on the *Paging Data Receiver* to the RS-232 port of a computer running the PAGING DATA RECEIVER.EXE program.
2. Apply power to the *Paging Data Receiver* and put the MODE switch on the *Paging Data Receiver* circuit board into the “TEST” position. This puts the board into the Frequency Programming mode.
3. Follow the PAGING DATA RECEIVER.EXE menu and prompts to enter frequencies for the four channels, 1,2,3 and 4. If you only want to use one channel you may program that frequency as channel 1, and leave the other 3 channels as they are.
4. When you have entered in the frequency information for the channels you wish to program, select the second item on the PAGING DATA RECEIVER.EXE menu. This tells the PC to send the data to the *Paging Data Receiver* via the serial port.
5. When the *Paging Data Receiver* is programmed, put the mode switch back to the center “NORM” position, shut power off, and remove the programming cable.

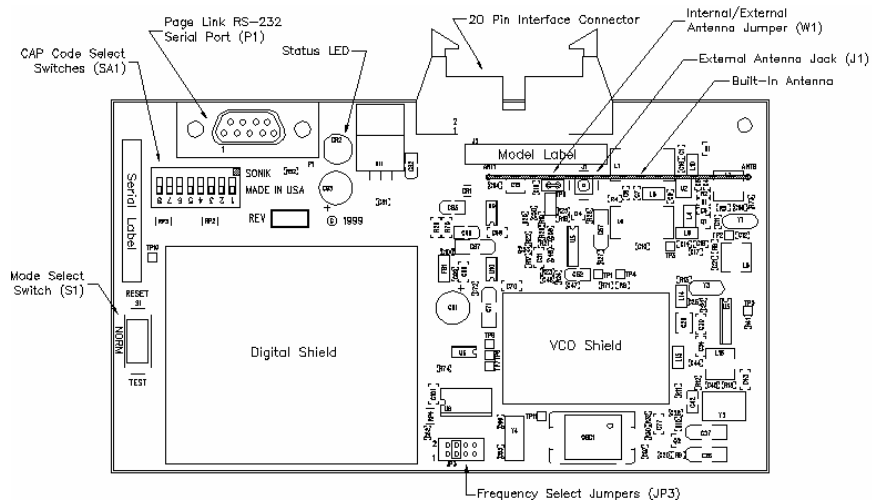
The Factory programmed frequencies are as follows:

Channel	VHF Default Frequency	UHF Default Frequency
1	150.1000MHz	450.1000MHz
2	155.1000MHz	467.8125MHz
3	158.1000MHz	467.8625MHz
4	160.1000MHz	470.1000MHz.

Since the EEPROM memory retains information with or without power, there is no need to reprogram the *Paging Data Receiver* when power is removed. The frequency information will be retained until the board is reprogrammed.

The receive frequency of the *Paging Data Receiver* can be changed at any time by simply moving the jumper on JP3 to another valid position. When this is done, the *Paging Data Receiver* will detect the new jumper position and retune to the new frequency within a few seconds. Refer to Section 9.3 for more details.

9. Paging Data Receiver Circuit Board



The *Paging Data Receiver* Circuit board has the following features:

9.1. External Antenna Jack, J1

An OSX female connector is located on the PCB. It allows one to connect an external antenna to the *Paging Data Receiver*. If the external antenna feature is to be used, Antenna Jumper W1 must be cut and the internal antenna must be cut and removed. If the internal antenna is used, W1 and the internal antenna must be in place as shown above. WaveWare uses an external antenna as standard equipment on the *Paging Data Receiver*.

9.2. CAP Code Select Switch

The CAP Code select switch is an offset to the CAP Code programmed in CAP Code memory location 1. (Programmed with the CC 1 nnn command). The *Paging Data Receiver* responds to the CAP Code address that is a combination of the CAP Code programmed in CC 1 register PLUS the binary value of the CAP Code select switch. The CAP Code select switch positions have the following values:

Switch	Weight	Switch	Weight
1	1	5	16
2	2	6	32
3	4	7	64
4	8	8	128

For example, if the CAP Code programmed in register 1 is 279000, and switches 1,3 and 8 are closed, then the *Paging Data Receiver* will respond to all messages sent to address 279133 ($279133 = 279000 + 1 + 4 + 128$). Refer to the programming section to see how to program the four CAP Code registers.

If the individual switch is in the ON position, then add its weight to the CC 1 register. If it is off, then do not add anything for that switch.

Note: *These switches are only read upon power up.* When you change them, you must cycle the power off and then back on.

The CAP Code display for CC 1 in the output of the “MO” command displays first the CAP Code that the *Paging Data Receiver* will respond to (based on switch settings) followed by the base address entered.

Notes: Setting all switches to the OFF position allows CC 1 to be configured in the same way as CC 2, CC 3, and CC 4. i.e. the CAP Code entered is the one that the *Paging Data Receiver* will respond to. When you modify a CAP Code, the new capcode may not be properly displayed when using the “MO” command, until you cycle power on the *Paging Data Receiver*.

9.3. Frequency Select Jumpers

The Frequency Select Jumpers on the *Paging Data Receiver* allow selection of one of the four pre-programmed frequencies. They are shown as JP3 on the circuit board.

The Frequency is selected by putting a jumper across two of the pins of JP3. Frequency 1 is the left-most pair of pins (pins 1&2), and frequency 4 is the right-most pair of pins.

9.4. Mode Switch

The mode switch is used to put the unit into the programming mode. **In normal operation, it must be in its center position.** If it is not in the center position, the *Paging Data Receiver* will not work!

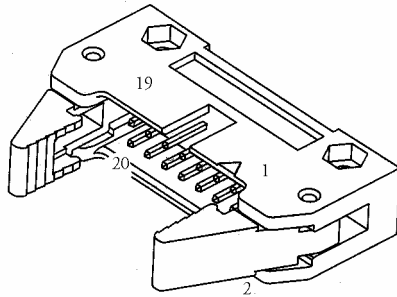
9.5. Activity LED

The LED on the *Paging Data Receiver* turns on at power up and blinks off when it detects the sync pattern of any page. If no synch pattern is detected for a period of at least one minute, then the LED will begin to blink one second on, one second off until a synch pattern is detected. Use this indicator to see if the *Paging Data Receiver* is within range of the paging system and to adjust internal antenna orientation.

10. Interface Connector

A 20-pin header connector is provided for the digital outputs and DC input to the *Paging Data Receiver*. The pins have the following functions:

Pin	Function	Pin	Function
1	X3 output	11	No connection
2	X7 output	12	X12 output
3	X6 output	13	X11 output
4	X2 output	14	Do not use and do not connect to anything!
5	X4 output	15	Ground
6	X1 output	16	No connect. Do not use.
7	X5 output	17	No connect. Do not use.
8	X8 output	18	No connect. Do not use.
9	X9 output	19	B+ input. 10-15VDC.
10	X10 output	20	No connect. Do not use.



The Interface Connector is Thomas & Betts type 609-2004.

The digital outputs, X1-X12, are CMOS type outputs. They will drive up to 5mA output. A digital low (0) will be less than 0.5V, and a digital high (1) will be greater than 4V.

WaveWare can provide audible and/or visible annunciation equipment as optional accessories with the *Paging Data Receiver*. The annunciation equipment typically requires a solid state relay or equivalent interface circuitry, to allow the low current capacity CMOS outputs to drive the high current requirements of the annunciation equipment. Contact the WaveWare sales department for information on the annunciation equipment options.

11. POCSAG Message Format

The following summary describes the coding used on POCSAG pager signals. The current text of the POCSAG standard is available as CCIR Radiopaging Format 1.

Note: Much alphanumeric paging - particularly that installed some time ago, uses a proprietary Motorola encoding format called GOLAY which is quite different from POCSAG.

POCSAG stands for Post Office Code Standardization Advisory Group. Post office in this context is the British Post Office which was the supplier of all telecommunications services in England before privatization.

A transmission consists of a preamble followed by batches of complete codewords, each batch commencing with a synchronization codeword (SC). The format of the signals is illustrated in Fig 1. Transmission may cease at the end of a batch when there are no further calls.

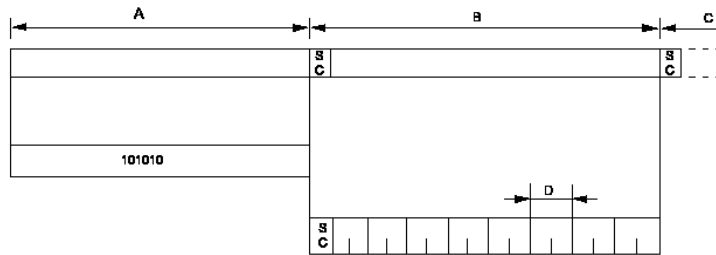


FIGURE 1 - Signal format

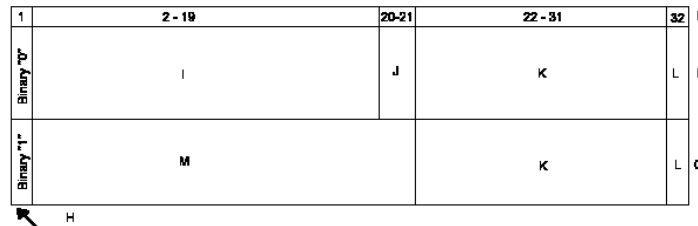
- A: preamble. Duration at least 576 bits = duration 1 batch + 1 codeword
- B: first batch
- C: second and subsequent batches
- D: one frame = 2 codewords
- SC: synchronization codeword
- Note. - 1 batch = synchronization codeword + 8 frames = 17 codewords.

POCSAG as defined in the standard, (original POCSAG) is 512 bits, although 1200 and 2400 baud formats are now common. It is a direct FSK (not AFSK) of the carrier wave with ± 4.5 kHz shift (less deviation than that is used in some US systems). Data is NRZ coded with the higher frequency representing 0 (space) and the lower one representing 1 (mark).

11.1. Codeword Structure

The basic unit of data in a POCSAG message is the codeword which is always a 32 bit long entity. The most significant bit of a codeword is transmitted first followed immediately by the next most significant bit and so forth. The data is NRZ, so that mark and space values (plus and minus voltages) as sampled on the output of the receiver discriminator at a 512 Hz rate correspond directly to bits in the codeword starting with the MSB.

The first (msb) bit of every POCSAG codeword (bit 1) indicates whether the codeword is an address codeword (pager address) (bit 1 = 0) or a message codeword (bit 1 = 1). The two codeword types have different internal structure.



Message Codeword Structure

Frame Sync

The frame synchronization sequence code is a reserved word used to identify the beginning of each batch. It is:

01111100110100100001010111011000

Address Codewords

Bit 1 (the flag bit) of an address codeword is always a zero. This distinguishes it from a message codeword.

Bits 2-19 are address bits corresponding to the 18 most significant bits of a 21 bit identity assigned to the pager.

For information regarding the least significant bit Bits 20 and 21 are the two function bits which are used to select the required address from the four assigned to the pager. Hence the total number of addresses is 2^{23} (over 8 million).

Bits 22 to 31 are the parity check bits and the final bit (bit 32) is chosen to give even parity.

Message Codewords

The structure of a message codeword is shown in the figure above. A message codeword always starts with a 1 (the flag bit) and the whole message always follows directly after the address codeword. The framing rules of the code format do not apply to a message and message codewords continue until terminated by the transmission of the next address codeword or idle codeword. Each message displaces at least one address codeword or idle codeword and the displaced address codewords are delayed and transmitted in the next available appropriate frame. Although message codewords may continue into the next batch, the normal batch structure is maintained, i.e., the batch will consist of 16 codewords, preceded by a synchronization codeword. At the conclusion of a message any waiting address codewords are transmitted, starting with the first appropriate to the first free frame or half frame.

Message codewords have 20 message bits, bit 2 to bit 21 inclusive and these are followed by the parity check bits obtained according to the procedure outlined below.

Idle Codeword

In the absence of an address codeword or message codeword, an idle codeword is transmitted. The idle codeword is a valid address codeword, which must not be allocated to pagers and has the following structure.

01111010100010011100000110010111

Codeword Generation (31:21 BCH + Parity)

Each codeword has 21 information bits, which correspond to the coefficients of a polynomial having terms from x^{30} down to x^{10} . This polynomial is divided, modulo-2, by the generating polynomial

$$x^{10} + x^9 + x^8 + x^6 + x^5 + x^3 + 1$$

The check bits correspond to the coefficients of the terms from x^9 to x^0 in the remainder polynomial found at the completion of this division.

The complete block, consisting of the information bits followed by the check bits, corresponds to the coefficients of a polynomial which is integrally divisible in modulo-2 fashion by the generating polynomial.

To the 31 bits of the block is added one additional bit to provide an even bit parity check of the whole codeword.

11.2. Message Formats

Although in principle, any message format can be inserted into message codewords, the following formats are regarded as standard. Adherence to these standards will enable a greater measure of interworking to be possible. The formats are not mixed within any one message.

"Numeric-only" format

The "numeric-only" format is provided for the transmission of messages which may be represented solely in decimal numerals together with spaces, hyphens, opening and closing brackets, an urgency symbol "U" and one other symbol. There are 4 bits per character in this format and its use will save air-time compared to the other format.

The address which introduces a message (or segment of a message) using this format has its function bits set to 00. The character-set used for the message is as shown in Table III which is based on Binary Coded Decimal (BCD). The bits of each character are transmitted in numerical order starting with bit No 1. Characters are transmitted in the same order as they are to be read and are packed 5 per message codeword. Any unwanted part of the codeword of the message is filled with space characters.

Table III: "Numeric-only" character set.

4-bit Combination	Displayed Character
Bit No.: 4321	
0000	"0"
0001	"1"
0010	"2"
0011	"3"
0100	"4"
0101	"5"
0110	"6"
0111	"7"
1000	"8"
1001	"9"
1010	"*" (spare)
1011	"U" (urgency indicator)
1100	" " (space)
1101	"," (hyphen)
1110	"]" (close bracket)
1111	"[" (open bracket)

"Alpha-numeric" format

This format can be used for the transmission of messages requiring a greater range of characters than that provided within the "numeric-only" format but it may also be used to replace the latter when circumstances make this essential or desirable. There are 7 bits per character in this format.

The page address which introduces a message (or segment of a message) using this format has its function bits set to 11.

The CCITT Alphabet No 5 (7 bits per character) is used in this format. As in the case of the "numeric-only" format, bit order starting with bit No 1 of each character, and character reading order are preserved in transmission. The complete message is partitioned into contiguous 20 bit blocks for the purpose of filling consecutive message codewords. Thus a character may be split between one message codeword and the next. Any unwanted part of the last codeword of the message is filled with appropriate non-printing characters such as "End of Message", "End of Text", Null, etc. All characters, except Null, are complete.

11.3. Transmission

Codewords are transmitted in groups of 16 (called batches), and each batch is preceded by a special 17th codeword which contains a fixed frame synchronization pattern. The sync word was 0x7CD215D8.

Batches of codewords in a transmission are preceded by a start of transmission preamble of reversals (10101010101 pattern) which must be at least 576 bits long.

Thus a transmission (paging burst) consists of carrier turnon during which it is modulated with 512 baud reversals (the preamble pattern) followed by at least 576/512 seconds worth of actual preamble, and then a sync codeword (0x7CD215D8), followed by 16 data/address codewords, another sync codeword, 16 more data/address codewords and so forth until the traffic is completely transmitted. All 16 of the last codewords of a transmission are always sent before the carrier is shut off, and if there is no message to be sent in them the idle codeword (0x7A89C197) is sent.

To save on battery power and not require that a pager receive all the bits of an entire transmission (allowing the receiver to be turned off most of the time, even when a message is being transmitted on the channel) a convention for addressing has been incorporated which splits the pager population into 8 groups. Members of each group only pay attention to the two address code words following the synch codeword of a block that correspond to their group. This means that as far as addressing is concerned, the 16 codewords in a batch are divided into 8 frames of two codewords apiece and any given pager pays attention only to the two in the frame to which it assigned.

A message to a pager consists of an address codeword in the proper two codeword frame within the batch to match the recipients frame assignment (based on the low three bits of the recipient's 21 bit effective address), and between 0 and n of the immediately following code words which contain the message text. A message is terminated by either another address code word or an idle codeword. Idle codewords have the special hex value of 0x7A89C197. A message with a long text may potentially spill over between two or more codeword batches.

12. Warranty

WaveWare Technologies Inc. Limited Warranty

Subject to the Limitations of Warranty and the Warranty Procedures, hereinafter set forth, WaveWare Technologies Inc. (WaveWare) hereby warrants this product to perform substantially in accordance with its specifications for a period of one year from the date of original purchase from WaveWare. WaveWare's sole obligation under this warranty and the purchaser's exclusive remedy under this or any other warranty expressed or implied, is the adjustment, repair, or replacement, at Sonik's discretion, of the defective WaveWare product.

Some states and jurisdictions do not allow limitations of an implied warranty, so the above limitation may not apply to you.

This warranty gives you specific legal rights, and you may have others, which vary from state/jurisdiction to state/jurisdiction.

WaveWare assumes no liability for consequential damages whatsoever.

12.1. Limitations of Warranty:

- a. This warranty is extended only to the original purchaser of the product and shall not be valid or enforceable unless such original purchaser shall have proof of purchase. This warranty does not apply to products sold under OEM agreements, and/or private label arrangements.
- b. This warranty is limited to repair or replacement of any materials found to be defective, any required servicing or adjustment of the product, or replacement of any materials found to be defective, or replacement of the product if WaveWare deems the repair of the product as ineffective or uneconomical.
- c. Tampering, misuse, attempted repair, or damage to this product shall invalidate this warranty.
- d. This warranty only applies to this product as it existed at the time of original purchase by the original purchaser from WaveWare. WaveWare may make design modifications and improvements to this product and shall be under no obligation to modify or alter this product to conform to such changes, additions, software bug fixes, or improvements.
- e. WaveWare assumes no responsibility for any consequential damages caused by or arising out of any such defect in materials or workmanship, or with respect to any breach of any implied warranty applicable to this product.
- f. WaveWare assumes no liability for consequential damages whatsoever. To the maximum extent permitted by law, in no event shall WaveWare or its suppliers be liable for any special, incidental, indirect, or consequential damages whatsoever (including, but not limited to, damages for loss of business profits, business interruption, loss of business information, or any other pecuniary loss) arising out of the use, or inability to use, the product, even if WaveWare has been advised of the possibility of such damages. WaveWare and its suppliers disclaim all other warranties, either expressed or implied, including but not limited to, implied warranties of merchantability or fitness for a particular purpose with regard to this product, its hardware, its software, or its firmware. Because some states do not allow exclusion of limitation of liability for consequential or incidental damages, the above limitations may not apply to you.

12.2. Warranty Procedure

To obtain warranty benefits provided by this warranty, it is the responsibility of the original purchaser to conform to the following procedures:

- a. Call WaveWare Customer Service Department and receive a Return Material Authorization Number (RMA).
- b. Without expense to WaveWare, return this product to WaveWare, attention of the Customer Service Department. WaveWare recommends that you insure the shipment for full value as WaveWare is not responsible for lost

shipments. Mark the outside of the shipping carton with the RMA number. Inside the shipping carton include the following items:

- The product, properly packaged.
- A full description of the defect for which warranty remedy is sought.
- Return address.
- Contact name and telephone number of person familiar with the problem/defect.

13. Appendix A: ASCII Codes

For your reference, here is a list of the commonly used ASCII characters.

Character	ASCII Hex Value	ASCII Decimal Value
<LF>	0A	10
<CR>	0D	13
<ESC>	16	27
space	20	32
0	30	48
1	31	49
2	32	50
3	33	51
4	34	52
5	35	53
6	36	54
7	37	55
8	38	56
9	39	57
A	41	65
U	55	85