

Model
H-424MS

Spread Spectrum
SDI-12 Radio Bridge



Owner's Manual
Version 1.1
(for system revision "C" or higher)

User Agreement/ WATERLOG® Warranty

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This agreement accompanies an interface module comprising firmware, circuitry and other electronic equipment in an enclosed housing, and packaged together with written instructional materials. The packaged electronic circuitry and instructional materials herein are collectively referred to as the "PRODUCT." The PRODUCT is made available from DESIGN ANALYSIS ASSOCIATES, INC., of 75 West 100 South, Logan, Utah 84321 (hereinafter referred to as "DESIGN ANALYSIS"), and contains information and embodies technology that is confidential and proprietary to DESIGN ANALYSIS, and the availability and use of the PRODUCT is extended to you, the USER, solely on the basis of the terms of agreement which follow.

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6. GOVERNING LAW

This Agreement and its validity and interpretation shall be governed by the laws of the State of Utah, notwithstanding any choice of law rules of Utah or any other state or jurisdiction.

Chapter 1 Operation

1.1 Introduction

The **WATERLOG**[®] H-424MS is a spread spectrum SDI-12 radio bridge. The radio link is easy to use and works with any SDI-12 data recorder. The radio link provides transparent, SDI-12 compliant communication between your data recorder and one or more remote sites. All SDI-12 commands are supported, including manufacturer specific extended commands.

Two or more H-424MS modules are required; one connected to the data recorder (master) and one located at each remote site (slaves). Each remote site can have multiple SDI-12 sensors. The master and slave H-424MS modules are identical, a user accessible circuit board jumper determines whether the H-424MS operates as a master or slave.

The radio link uses modern frequency hopping spread spectrum telemetry radios. Spread spectrum technology is highly secure and has good interference immunity. The radio operates in the license-free, 900 Mhz ISM Band eliminating the need for any FCC licensing.

The radio system has an optional power-save feature which allows operation with less than 2mA of average standby battery current.

1.2 Operation

Each H-424MS contains a small microprocessor and a spread spectrum telemetry radio. The microprocessor buffers commands and data between the SDI-12 port and the radio. All SDI-12 compliant commands will work, including manufacturer specific extended commands. Note however, your data logger must support SDI-12 compliant “retries” to work with the H-424MS. Most data loggers support retries while logging but certain models do not provide retries for transparent commands. Transparent SDI-12 commands will not work with these data loggers.

A circuit board jumper selects either full power or power-save operation. When jumpered for full power operation, each H-424MS draws approximately 100mA continuous. The full power mode has the advantage of providing completely transparent SDI-12 communication with no waiting for the remote sites to power-up.

Unfortunately, for power save operation the SDI-12 protocol has no handshake mechanism for delaying the timing of the sensor response. This makes it difficult to implement a radio link which has remote stations operating in a low power sleep mode. When operated in the power save mode, the H-424MS radio link uses the wakeup scheme described in the next section.

Normally the H-424MS operates as a transparent SDI-12 to SDI-12 bridge. However, in order to wake the remote end of the link from sleep the master H-424MS can be addressed itself as a “sensor”. The H-424MS comes from the factory with its address set to “0”. When the master H-424MS detects address 0 it responds as a SDI-12 sensor and does not pass the command to the remote site(s). Issuing the “0M!” command causes the H-424MS to perform a wakeup sequence to the remote sites. The timing is controlled by two timers; a Wakeup and an Inactivity timer. The settings of these programmable timers is stored in EEPROM within the H-424MS;

Power Save Operating Sequence

1. The data recorder first issues a “0M!” command to the master H-424MS module.
2. The master H-424MS responds to the command as a pseudo “sensor”, and reports the measurement will take a fixed period of time to complete. The reported time is determined by the Wakeup Interval time setting + 1 seconds.
3. The master H-424MS transmits wakeup nulls every 40usec during the “measurement”.
4. Remote H-424MS modules periodically wake up and check for inbound messages. The wake up is initiated by a low power circuit controlled by the Wakeup Interval setting.
5. If an inbound message is detected while awake, the remote module remains awake for a period set by the Inactivity Timer.
6. At the completion of the “0M!” command, both the master and slave H-424MS modules are awake and can service a SDI-12 command. At this point the data logger issues measurement or other commands to the actual remote sensors.
7. If no additional commands are sent by the data logger, both master and remote modules resume their low power sleep mode after their respective Inactivity Timers run down.

1.3 Setting the Jumpers

The H-424MS circuit board has three push-on jumpers which must be properly set. Each jumper is a 3-pin stake-pin header with two possible positions. The jumpers can be accessed by opening the front cover of the enclosure.

Jumper	Function	Options	Description
J2	Mode	Master/Slave	Selects either Master or Slave operation
J3	Power Save	On/Off	Enables or disables the power save feature
J6	Loopback Test	On/Off	Enables or disables the loopback test mode

All H-424MS's in the installation **MUST** have the same power-save jumper selection. Leave the **Loopback Test** jumper in the OFF position for normal operation.

1.4 Programming Your Data Recorder

You must prepare your data recorder to receive and record SDI-12 data from the sensors attached to the data recorder. Since data recorders differ widely, refer to your recorder manufacturer's directions.

If you are not using the H-424MS power save feature (power save jumpers are set to OFF), no additional programming of the data recorder is needed. The SDI-12 radio link will operate transparent to the data recorder's operation. Do not set the address of any remote sensor to "0".

If you are using the H-424MS power save feature (power save jumpers set to ON), you will need to program your data recorder to collect one data value from the local H-424MS with a "0M!" command. The H-424MS's address can be changed if necessary (see Chapter 2). The dummy data value collected can be discarded. The data recorder must make this "measurement" BEFORE attempting to access any sensor located on the remote end of the radio bridge. The purpose of this pseudo measurement is to allow built-in time to wake the remote sites from sleep. The H-424MS will send a normal service request at the completion of the "measurement".

Your data logger allows you to select which SDI-12 addresses which will be logged, but certain models do not allow the address sequence to be specified. Often the logger will start at the lowest selected address and automatically sequence to increasing addresses. You must change the address of your sensors or of the H-424MS such that the H-424MS's "pseudo" sensor is always accessed first. The H-424MS comes from the factory with its address set to "0" which will work for most installations.

1.5 Programming the H-424MS Power Save Settings

When the power save option is not selected, the radios are continually powered, normally in a receive mode drawing 135mA. In order to reduce the power draw use the power save mode. If the power save option is selected, the radios are normally turned off, reducing the standby power draw to 0.5mA. Periodically the slave H-424MS wakes up from the low power mode, turns the radio on and listens for messages from the master. The Wake Interval value determines how often this occurs. The default Wake Interval is 15 seconds. The slave listens for 170ms, if no messages are found it returns to the sleep condition. The Wake Interval setting determines the average current draw, for this example the slave draws 0.5mA for 15 seconds and 135mA for 170ms. A shorter Wake Interval setting allows faster completion of the "0M!" command at the cost of higher average current drain.

The master H-424MS remains in the 0.5mA low power mode until the data logger issues a break. After receiving the "0M!" command the radio is turned on, requiring 135mA. If no SDI-12 activity is detected over a period of time controlled by the Inactivity Timer setting, the radio is turned off and the master resumes its 0.5mA low power mode. The default Inactivity Timer is 30 seconds.

The H-424MS modules comes from the factory with the following settings:

SDI Address:	0
Wakeup Interval:	15 Seconds
Inactivity Timer:	30 Seconds

These settings should work for most applications, these values provide a good compromise between low power operation and system responsiveness. Both Master and Slave H-424MS modules must be programmed with the SAME timer settings. The programmed timer settings of the Master module can be observed or changed with extended commands addressed to sensor “0” (see Chapter 2 for details). The settings of the remote (slave) module cannot be accessed remotely. To observe or change the timer settings of a remote module the module must be temporarily removed from service, jumpered as a master, and connected directly to the data recorder as a local “sensor”. After programming, the module must be jumpered as a slave again and returned to service at the remote site.

1.6 Connecting The Antenna

The H-424MS may be used with a 50-ohm, 900 Mhz antenna providing the effective radiated power is 6dB or less. The antenna connector is a reverse type-TNC connector which is required to meet FCC part 15.203 regulations. A simple vertical whip antenna will work up to 2 or 3 miles. Longer distances require a directional antenna with gain. A 6dB or 9dB YAGI will work fine, do not use a 12dB model. At 900 MHz, RG58 type coaxial antenna feed lines have excessive loss (1.8dB/10 feet). Consider using newer low loss RF cable such as Times Microwave LMR-400 or similar (0.8dB/10 feet). The LMR-400 requires special RG8 connectors.

The H-424MS is packaged in a weather tight enclosure and is best mounted as close to the antenna as possible. The H-424MS has a ground lug which should be connected to a good earth ground with a heavy copper wire. The ground helps provides lightning protection for the radio, your sensors and the data logger.

The H-424MS radios all operate at the same frequency. If multiple data logger sites are deployed, make certain the radios of each separate logging site cannot “hear” each other. The radios can be ordered with alternate frequencies, please contact the factory for further information.

1.7 Making SDI-12 Connections

The H-424MS enclosure has a 4-pin SDI-12 connector. The power for the H-424MS and the radio is supplied by the SDI-12 +12V input. Table 1 shows the proper connections. Refer to the wiring diagram printed on the H-424MS's product label for the connector pinout.

SDI-12 Connector		
Pin	Name	Wire Color
1	+12Volt DC	Red
2	SDI-12 Data	White
3	Ground	Black
4	Ground	Shield

Words of caution:

- Even though the H-424MS operates in a low power mode, the transmitter requires 800mA for short bursts. Make certain your wiring and battery is capable of supplying sufficient current .
- Keep the lead wires as short as possible.
- Use shielded cables in noisy environments.
- Connect the ground post to a good earth ground.

1.8 Troubleshooting

The H-424MS circuit board has a red LED indicator which is lighted when the radio is powered. After installing the H-424MS's, antennas and wiring; make the following tests:

1.8.1 Testing With Power Save Jumpers = OFF:

The LED indicators in both master and slave should be continually illuminated. Using the transparent mode of your data logger issue a "0I!" command. The master H-424MS should respond with a SDI-12 identification string. Issue a command to your remote SDI-12 sensor. Check for the correct response.

1.8.2 Testing With Power Save Jumpers = ON:

The LED indicator in the slave should blink every 15 seconds. If you have changed the Wake Interval setting, the LED should blink at your chosen interval. The LED indicator in the master should be OFF. Using the transparent mode of your data logger, issue a "0I!" command. The master H-424MS should respond with a SDI-12 identification string. Issue a "0M!" command, the H-424MS should respond with "00161<cr><lf>" and the LED in the master should light. The next time the slave powers up its radio, the slave should detect inbound messages and

remain on for 30 seconds. Before the 30 second inactivity time elapses, issue a “aM!” or other command to your sensor and check for proper response. After 30 seconds of inactivity, the LED indicators on both master and slave modules should go out indicating the inactivity timers have powered down the radios.

1.8.3 Troubleshooting The Radios:

If the above tests fail, the problem may be in the radio or antenna system. The radios are difficult to field test when operating with the SDI-12 protocol due to the short bursts of data. The radio system can be more easily tested with the aid of a lap-top computer or RS-232 terminal. With the following setup you can transmit ASCII messages or other test data while testing or aligning the antennas. The radio link is tested by connecting a computer terminal to one radio and jumpering the other radio for Loopback Test operation. With this test, one person can test both up-link and down-link communication paths.

The radios have a standard RS-232C interface which operates at 9600 baud. For hand typed ASCII text or bursts less than 40 bytes, no special handshaking is needed. To prevent the system from turning the radio power off, jumper both H424's for Power Save = OFF. On one of the radios, unplug the ribbon cable between the radio and the control board. You will need to remove the four screws holding the radio to the backplate to access the 9-pin RS-232 connector on the radio. The radios have a female DB9 connector, pin-2 is received data output and pin-3 is transmit data input. With a standard 9-pin RS-232 cable, connect the radio to a laptop computer or terminal. Leave the cable to the control board disconnected. If you are using a computer, use a terminal program such as XTALK or PROCOMM to communicate with the radio. Make sure your computer or terminal is set for full-duplex, 9600 Baud. The other radio in the link to be tested must be programmed for “loopback test” operation. Do this by setting the Loopback Test jumper of the remote radio to the ON position.

Test the radio link by typing characters and checking for the proper echoed response. As you type, the characters are transmitted to the remote station then re-transmitted back to the local station and displayed on your screen. Both up-link and down-link paths are tested at the same time.

1.9 FCC Restrictions

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help

1.10 Agency Certifications

The 9XStream RF module complies with Part 15 of the FCC rules and regulations. Compliance with the labeling requirements, FCC notices and antenna usage guidelines is required by the system integrator. The 9XStream module may only be used with antennas that have been tested and approved for use with this module.

SDI-12 Command and Response Protocol

2.1 SDI-12 Command and Response Protocol

Normally the H-424MS operates as a transparent SDI-12 to SDI-12 bridge. However, in order to wake the remote end of the link from sleep the master H-424MS can be addressed itself as a “sensor”. The H-424MS comes from the factory with its address set to “0”. When the master H-424MS detects address 0 it responds as a SDI-12 sensor and does not pass the command to the remote site(s). Issuing the “0M!” command causes the H-424MS to perform a wakeup sequence to the remote sites. In addition, address 0 allows the Wakeup and Inactivity Timer settings of the H-424MS link to be observed or modified.

The following is a brief description of the Serial Digital Interface (SDI-12) Command and Response protocol used by the **WATERLOG**® Series Model H-424MS “sensor”. Included is a description of the commands and data format supported by the H-424MS.

Refer to the document "A SERIAL DIGITAL INTERFACE STANDARD FOR HYDROLOGIC AND ENVIRONMENTAL SENSORS". Version 1.2 April 12, 1996 Coordinated by the SDI-12 Support Group, 135 East Center, Logan, Utah.

During normal communication, the data recorder sends an address together with a command to the H-424MS. The H-424MS then replies with a "response". In the following descriptions, SDI-12 commands and responses are enclosed in quotes. The SDI-12 address and the command/response terminators are defined as follows:

"a"	Is the sensor address. The following ASCII Characters are valid addresses: "0-9", "A-Z", "a-z", "*", "?". The H-424MS will be initially programmed at the factory with the address of "9". Addresses "0 to 8" and "A to Z" or "a to z" can be used for additional sensors connected to the same SDI-12 bus. Address "*" and "?" are "wild card" addresses which select any remote sensor, regardless of its actual address.
"!"	Is the last character of a command block.
"<cr><lf>"	Are carriage return (0D) hex and line feed (0A) hex characters. They are the last two characters of a response block.

Notes:

- All commands/responses are upper-case printable ASCII characters.
- Commands must be terminated with a "!" character.
- Responses are terminated with <cr><lf> characters.
- The command string must be transmitted in a contiguous block with no gaps of more than 1.66 milliseconds between characters.

2.2 Measure Command

The H-424MS Measure Command causes the H-424MS to wake the remote site(s) from low power sleep. The time required to complete this process is the Wake Interval setting plus 1-second. During this period the H-424MS transmits wakeup nulls which are detected by the remote site(s) when they periodically wake and check for activity. To be SDI-12 compliant a dummy data value is stored in the sensor's buffer for subsequent collection using "D" commands. The data will be retained in the sensor until another "M", "C" or "V" command is executed.

Command	Response	Description
"aM! "	"atttn<cr><lf>"	Initiate measurement

Where:

- a is the sensor address ("0-9", "A-Z", "a-z", "*", "?").
- M is an upper-case ASCII character
- ttt is a three digit integer (000-999) specifying the maximum time, in seconds, the sensor will take to complete the command and have measurement data available in its buffer.
- n is a single digit integer (0-9) specifying the number of values that will be placed in the data buffer. If "n" is zero (0), no data will be available using subsequent "D" commands.

Upon completion of the measurement, a service request "a<cr><lf>" is sent to the data recorder indicating the sensor data is ready. The data recorder may wake the sensor with a break and collect the data anytime after the service request is received or the specified processing time has elapsed.

Example of a H-424MS "aM!" command:

Command	Response	Time	Values	Description
"aM! "	"a0161<cr><lf>"	16 sec	1	Wakeup the remote stations

Subsequent Command	Response
"aD0"	a+1<cr><lf>

Where:

1 = Fixed dummy "data".

2.3 Send Data Command

The Send Data command returns sensor data generated as the result of previous "aM!", "aC!" or "aV!" commands. Values returned will be sent in 33 characters or less. The sensor's data buffer will not be altered by this command.

Command	Response
----- "aD0!" through "aD9!"	----- "apd.d . . . pd.d<cr><lf>"

Where:

- a is the sensor address ("0-9", "A-Z", "a-z", "*", "?").
- D0..D9 are upper-case ASCII characters.
- p Is a polarity sign (+ or -)
- d.d represents numeric digits before and/or after the decimal. A decimal may be used in any position in the value after the polarity sign. If a decimal is not used, it will be assumed to be after the last digit.

For example: +3.29 +23.5 -25.45 +300

If one or more values were specified and a "aD0!" returns no data (a<CR><LF> only), it means that the measurement was aborted and a new "M" command must be sent.

2.4 Initiate Verify Command

The Verify Command causes a verify sequence to be performed. The result of this command is similar to the "aM!" command except that the values generated are fixed test data and the results of diagnostic checksum tests. The data generated in response to this command is placed in the sensor's buffer for subsequent collection using "D" commands. The data will be retained in the sensor until another "M", "C" or "V" command is executed.

Command	Response	Description
"aV!"	"atttn<cr><lf>"	Initiate verify sequence

Where:

- a is the sensor address ("0-9", "A-Z", "a-z", "*", "?").
- V is an upper-case ASCII character.
- ttt is a three digit integer (000-999) specifying the maximum time, in seconds, the sensor will take to complete the command and have data available in its buffer.
- n is a single digit integer (0-9) specifying the number of values that will be placed in the data buffer. If "n" is zero (0), no data will be available using subsequent "D" commands

Example of a H-424MS "aV!" command:

Command	Response	Time	Values	Description
"aV!"	"a0013<cr><lf>"	1 sec	3	Return fixed data and diagnostic data for testing purposes.

Subsequent Command	Response
"aD0"	a+123.456+78.9+y<cr><lf>

Key	Description	Units
+123.456	Fixed test data	
+78.9	Fixed test data	
y	ROM checksum test	0 = Failed, 1 = Passed

2.5 Send Acknowledge Command

The Send Acknowledge Command returns a simple status response which includes the address of the sensor. Any measurement data in the sensor's buffer is not disturbed.

Command	Response
----- "a!"	----- "a<cr><lf>"

Where:

a Is the sensor address ("0-9", "A-Z", "a-z", "*", "?").

2.6 Send Identification Command

The Send Identification command responds with sensor vendor, model, and version data. Any measurement data in the sensor's buffer is not disturbed.

Command	Response
----- "aI!"	----- "a1ccccccmmmmmvvxx...xx<cr><lf>"

Where:

a is the sensor address ("0-9", "A-Z", "a-z", "*", "?").

I is an upper-case ASCII character.

ll is the SDI-12 version compatibility level, e.g. version 1.2 is represented as "12".

cccccc is an 8 character vendor identification to be specified by the vendor and usually in the form of a company name or its abbreviation.

mmmmm is a 6 character field specifying the sensor model number.

vvv is a 3 character field specifying the sensor version number.

xx...xx is an optional field of up to a maximum of 13 characters to be used for serial number or other specific sensor information not relevant to operation of the data recorder.

Example of a H-424MS "aI!" command:

"a12 DAA H-424vvvS#nnnnnnVkkk<cr><lf>"

H-424MS implementation of the optional 13 character field:
S#nnnnnnVkkk (12 bytes total)

Where:

"nnnnnn" is a six character sensor serial number
"kkk" is a three digit sensor firmware revision level

2.7 Change Sensor Address

The Change Sensor Address Command allows the sensor address to be changed. The address is stored in non-volatile EEPROM within the sensor. The H-424MS will not respond if the command was invalid, the address was out of range, or the EEPROM programming operation failed.

Command	Response	Description
----- "aAn!"	----- "n<cr><lf>"	----- Change sensor address

Where:

- a is the current (old) sensor address ("0-9", "A-Z", "a-z", "*", "?"). An ASCII "*" may be used as a "wild card" address if the current address is unknown and only one sensor is connected to the bus.
- A is an upper-case ASCII character.
- n is the new sensor address to be programmed ("0-9", "A-Z", "a-z", "*", "?").

NOTE: To verify the new address use the "Identify Command."

Example of a "Change Sensor Address" command:

Command	Response	Description
----- "aA2!"	----- "2<cr><lf>"	----- Change sensor address to "2"

2.8 Read Wake Interval and Read Inactivity Timer Commands

The Wake Interval and Inactivity Timer values control the H-424MS's power save operation. These values can be read by the SDI-12 host with the following commands. Note only the settings of the H-424MS which is jumpered for “Master” operation can be read.

The default values are:

Wake Interval: 15 Seconds
 Inactivity Timer: 30 Seconds

Command	Response	Description
"aXRW!"	"a0011<cr><lf>"	Read Wake Interval (seconds)
"aXRI!"	"a0011<cr><lf>"	Read Inactivity Timer (seconds)

Where:

a is the sensor address ("0-9", "A-Z", "a-z", "*", "?").

XRW are upper case characters.

XRI are upper case characters.

This command takes 001 seconds to complete and places 1 value in the data buffer. Use the “aD0” command to collect and view the value.

Example of a H-424MS Extended "Read Wake Interval" command:				
Command	Response	Time	Values	Description
"aXRW!"	"a0011<cr><lf>"	1 sec	1	Read Value
Command	Response	Description		
"aD0!"	"a+15.<cr><lf>"	Wake Interval is 15 seconds		

2.9 Write Wake Interval and Write Inactivity Timer Commands

The Wake Interval and Inactivity Timer values control the H-424MS's power save operation. These values can be written by the SDI-12 host with the following commands. Note only the settings of the H-424MS which is jumpered for "Master" operation can be accessed.

These commands allows the user to write (change) the timer values. The new value is stored in non-volatile EEPROM within the H-424MS. Once the new timer value is written to the EEPROM, a copy is sent to the sensor data buffer for verification. This data can be viewed by using a subsequent "D" command. To observe the timer settings any other time, use the "Read Wake Interval" or "Read Inactivity Timer" commands.

Command	Response	Description
"aXWWddd!"	"a0011<cr><lf>"	Write Wake Interval
"aXWIddd!"	"a0011<cr><lf>"	Write Inactivity Timer

Where:

- a is the sensor address ("0-9", "A-Z", "a-z", "*", "?").
- XWW are upper case characters.
- XWI are upper case characters.
- ddd is the new timer value. Valid settings are from 1 to 255 seconds. The input format is very flexible. Some examples are shown below.
 - 20.0
 - 10
 - 255.0

Example of a H-424MS Extended "Write Wakeup Interval" command:

Command	Response	Time	Values	Description
"aXWI20!"	"a0011<cr><lf>"	1 sec	1	Write Timer Setting
Command	Response	Description		
"aD0!"	"a+20.<cr><lf>"	Timer verified at 20.0 seconds		

Appendix A Specifications

Protocol

Local: SDI-12
Remote: SDI-12
Type: Transparent SDI-12.
Works with all SDI-12 commands including extended and V1.2 commands.
Requirements: Data logger must support multiple (3/3) SDI-12 breaks with retries.

Radio

Frequency Range: 902 to 928 Mhz
Line of Sight: 7 plus miles - depending on antenna and site conditions.
Modulation Type: Frequency Hopping Spread Spectrum
RF Connector: Reverse Type-TNC
Transmit Power: 100 mW (20 dBm)
Receive Sensitivity: -110 dBm

SDI-12 Output

Baud Rate: 1200
Protocol: SDI-12, 7-bit even parity, 1 stop bit
Output Voltage Levels:
 minimum high level: 3.5 volts
 maximum low level: 0.8 volts

Power Requirements

Voltage Input: 9.6 to 18.0 Volts DC
Power Control: Remote station uses programable sleep/wakeup to detect carrier.
Current:
 Standby: 510ua (sleep)
 Receive: 135 mA
 Transmit: 800 mA
 Average w/
 power control: Less than 2.0mA

Environmental

Operating Temperature: -40 to 60°C
Storage Temperature: -50 to 70°C
Humidity: 0 to 100%

Mechanical

Enclosure: Fiberglass, NEMA 4
Size: 8.00 x 6.00 x 4.00 in.
W/ hinged screw cover

Connector

H-424-MS: Switchcraft EN3P4M (4-pin male)
Mate: Switchcraft EN3C4F (4-pin female)

Warranty

The **WATERLOG**® H-424MS is warranted against defects in materials and workmanship for one year from date of shipment.

