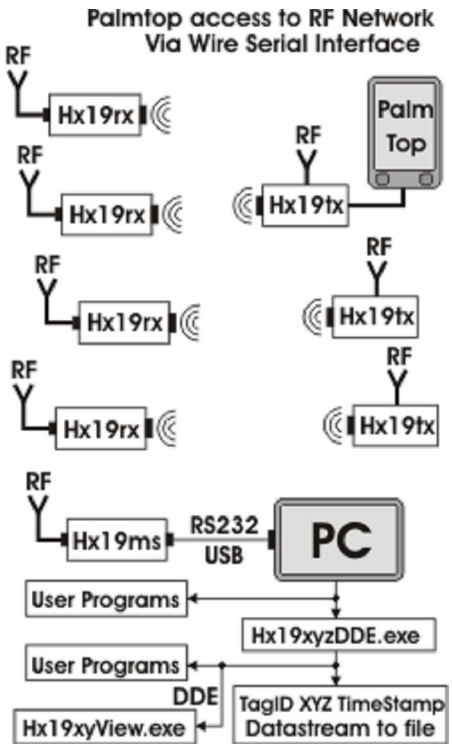
FEATURES

- Device to device range up to 14 meters (monotone only)
- High precision 1mm typically
- Low RF power device to device relay networking
- USID (Ultrasonic Id) up to 1023 unique identities
- RFID (Radio Frequency Id) no limit on unique identities
- Combination mode USID and RFID
- Battery capable operation for the entire system
- USB and standard RS232C Serial Interface for PC
- Only three components and every possible positioning contingency
- Applications cover both tracking and guidance

Wireless HX19 Introduction

The HX19; is designed to satisfy most local positioning needs, with very high precision using ultrasound. Both ultrasonic receivers, and transmitters are linked to the controlling computer through a 2.4Ghz 250Kbaud RF network. This system combines USID (ultrasonic ID), RFID (radio frequency ID) and RF wireless network communication. Radio is used as a start signal, for synchronization. Precisely 4mS after receiving the synchronization over an RF channel, the transmitter emits RFID and coded USID; or a monotone sonic signal while flashing a blue LED. The receivers report via serial port the time elapsed from RF synchronization start, until the arrival of the airborne ultrasonic signal. Absolute distance can be computed from the transmitter to every receiver in range. The transmitter is equipped with a serial I/O, this serial pin can be used be relayed processed information to the tag. E.g. the transmitter can receive information about its own position from a central server. This enables guidance just as easily as tracking. The HX19 is useful for both absolute, and TDOA (time difference of arrival) multilateration positioning.



Users can access the RF device-to-device communication network using either a transmitter/tag port pin, or a hx19m USB / serial interface.

The Hx19 is not only a synchronized system; it can operate asynchronously as well. RFID and USID; can be utilized in combination by the programmer; for a very reliable fail-safe positioning, of people and objects. The RFID can be used for omni-directional non-line of sight localization through walls; while the boundary sensitive USID, is used for specific localization within the confine.

HX19TXHWE
Wires provide RF data access and control

HX19TX
Ultrasonic RF battery Transmitter Tag

HX19RX
Ultrasonic RF Receiver

HX19MS USB Monitor Synchronizer

Basic HX19 communications

HX19 components utilize a powerful command structure, using both direct commands and nested message features. All the commands; are read from the first character to the last; each command is executed on first come first serve basis. Operations requiring synchronized action take place after the command line has been fully serviced. Characters that are not valid commands are ignored, and therefore free to use. Dots, commas, space and etc between commands bear no consequence. Carriage return is a delimiter and shouldn't be used. Numeric values where required; must follow the command immediately, and the value must remain unbroken. Spaces or other characters will break up the numeric value.

Addressing sequences; tolerate no numeric breakup, T1234& is transmitter 1234. The sequence T& addresses all transmitters. A trend for the HX19 protocol is to have the first alphanumeric character represent a device class.

The character / is used by the hx19 communication protocol; to separate data from checksum (not visible to the average user). CR or carriage return, is used by the protocol as a delimiter. Within brackets < > or [ ] the character | can be used to generate carriage return and line feed.

HX19 Communications Syntax

Example: Command string syntax: T21& m14 i49 n90 e

T21& is the address portion of the command string. The first character of the string must represent the class of the recipient, “T” for tags, “R” for receivers and “M” for monitor. Exclamation “!” gets the attention of all device regardless of class. For private device addressing; the class character, must be followed by unbroken numeric characters; terminated with “&”. In the command line, unassigned characters are ignored, and can be used to make the sequence more readable. Characters m, i, n, e are all commands recognized by the HX19TX. m: sets the operating mode, i: sets the monotone period, n: sets the number of ultrasonic periods emitted and e: stores the operating parameters permanently on flash memory.

T&m14i49n90e sets all transmitters to the (see above) T21 configuration

! p0 e: this command sequence will force all devices, tags, receivers, monitor and etc; to set RF transmitter at lowest power, and store current operating parameters permanently on flash memory.

Using the “!” exclamation to configure all devices in one go can be dangerous.

For example, ! t111 r33 this command line will force all devices to transmit on channel 111 and receive on channel 33. The hx19m USB monitor is always inverted in this community; it receives transmissions, and transmits commands. In this case it should be set to receive on channel 111 and transmit on channel 33. This can be corrected with the following line command.

M&r111t33 This corrects all hx19m monitors.

Continuous sample rates

For hx19 version 1.1, three sample rates can be selected. These are 4 s/s, 8 s/s and 16 s/s. Hx19 v1.1 is sensitive to the time required for ultrasound to travel to destination. It needs to receive, process and transmit the result within that timeframe. At 16s/s the situation gets tight, and there is only room to deliver the results from 6 receivers. At this rate the receivers can be lined up to transmit one after another. For the ultrasonic receiver the user needs to select the queue order (q command), i.e. give each receiver its place in the queue. If two receivers share the same place in the result queue, there will be transmission disorder. It is possible to get around this, by setting different RF transmission channels, for receivers sharing the same queue number. At the highest rate there is only time for 6 receivers per RF transmit channel; 127 RF channels are available. For sample rates 4s/s there is time for 90 results, while at 8s/s there is time for roughly 30.

The ‘f#’ command Selection of sample rates

Version 1.1 base sample rate, is 4 s/s. Command ‘f’ will allow this rate to be altered. Command line “!&f1” will set all devices receiving commands to 4s/s. Similarly “!&f2” will set devices to 8s/s, and “!&f4” will select nominal 16s/s (15.75). Rates can be set privately like this. “M&f4 and T&f1”, in this case the hx19ms will synchronize 4 times before the transmitter emits RFID/USID once.

Battery duration can be decreased, if devices are not all set at the same sample rates

The Hx19tx USID RFID tag

HX19TX is battery powered; batteries sizes 2325, 2320, 2330, 2032 can all slide into the bottom battery sleeve. Once a battery is inserted into the battery holder the tag will enter its idle mode. In idle mode the Hx19tx by default flashes a blue LED at intervals between 4 and 8 seconds. During the flashes by default it emits USID (ultrasonic ID) and RFID (radio frequency ID). The randomized LED flashing; is visible through the translucent blue box. This is referred to as the activity cycle. The LED can be shut down using RF link. During the activity cycle; the tag also scans for incoming RF synchronization signal. If no such signal is detected, the device goes to sleep to reserve battery power. Otherwise; the activity cycle is synchronized, and driven by the synchronization signal. Latency of the synchronous activity; is less than a microsecond. Initially! The activation cycle is initiated 16 times per second (f4 by default), and the LED if enabled will be flashing rapidly. An Hx19ms (see below) connected to a computer serial I/O or a USB port; can be used to synchronize, and monitor the hx19 network. It is also used to send control and configuration parameters to the hx19 devices

HX19TX SIZE: 35 x 35 x 15 mm

Unlike the hx19m and hx19r series the hx19t series can only accept commands and configuration while synchronized with if enabled the LED flashing rabidly.

The hx19ms connected to serial or a USB port; at a rate of 250k baud, can broadcast commands to a range of 30 meters, at full power. Hx19 devices scan for pertinent control characters in the broadcasted serial stream. Large alphabetic letters signify addresses. Small letters are considered commands, and are sometimes followed by a numeric control value. The letters T and ! are interpreted as hx19t series addressing codes, i.e. “T” means attention all tags and “!” attention all devices (including tags).

Syntax examples:

The first character in a control string (line command), must be the device type. Tags understand two types "!" or "T" only. T is the first character of a private address, it must be followed with a number terminated with &. Only numeric characters can exist between T and &, e.g. "T1234&". If numeric characters are omitted, "T&" the tag assumes the message is pertinent. Strings following addresses, are interpreted as configuration commands. Following is a simple string; broadcasted from a hx19ms (monitor synchronizer), within 30 meters of a hx19tx.

T& m2 d1 e

The mode command above shuts down the LED. In this case **all** tags within range of the hx19ms, will stop flashing the blue LED during emission. They will stop emitting RFID, and they will stay asleep for a short time as commanded by d1, only 0.25 seconds. Finally the current configuration is permanently stored on FLASH memory.

Another example: ! = e or simply !e

Characters not listed for control are ignored, the dummy = is ignored. All devices receiving this command including receivers and repeaters will store the **current** control parameters on EEPROM.

Given that the tag (enclosure) is labeled 13 this, constitutes the private address of the transmitter. Then consider the following string broadcasted from a hx19ms:

T13& m7, d6, e (This is just as valid: T13&m7d6e or T13&)

Only device labeled 13 will respond to the broadcasted string above. Tag 13 will commence RFID and USID and will flash the LED every time the signals are emitted. It will set downtime to 6 seconds average, and store current operating parameters on FLASH.

To get an acknowledgement that the string was received, then use the [ ] to force the T series to broadcast before they go to sleep.

T13& m7 d6 e [T13 got the message]

After the hx19tx labeled 13, has serviced the control parameters m7d6e; it will broadcast T13 got the message. This message "T13 got the message" should be visible in if running hx19Access.

Tag Commands Summery

These following short commands, dictate the behavior of the hx19tx ultrasonic RF tags. Below the # indicates, decimal numeric characters need to follow the command. Be aware # is sometimes used as acknowledge during data interchange.

Tag Commands Summery

!	Attention all devices. Global call to all devices, including tags respond
T&	Public transmitter call, all tags respond to this call
T#&	Addresses a specific tag privately where # is the tags specific numeric ID.
e	The device stores current parameters on EEPROM
p#	RF transmission power, used to control the range bubble (default 2, range 0 through 3)
r#:	Select RF input channel range (1 to 127). (default 2)
t#:	Select RF output channel range (1 to 127) (default 2)
[	Everything between the first opening "[" and the last "]" closing bracket is RF broadcasted
m#	Mode # is a decimal value setting and clearing the mode bits
< >	Received data between the first and the last bracket is placed on the serial wire I/O
d#	Downtime # is a decimal value controlling the sleep duration
h	Deep sleep, the device essentially shuts off (sync strobing will wake the device in 24-64s)
i#	Period of the monotone ultrasonic burst (default 49 corresponds to 40khz)
n#	Number of periods or length of the burst (default 30 periods)
f#:	Sample rates f1=4 s/s, f2=8s/s and f4=16s/s

The mode control byte is bit manipulated. The user must set the bits of the control byte high or low to control the features or operational mode of the hx19tx. Following is a description of what the bits do.

Mode bits:

Bit.0 Set:	The LED is on during the activity cycle
Bit.1 Set:	USID or ultrasonic ID is emitted during the activity cycle
Bit.2 Set:	RFID or radio frequency ID is emitted during the activity cycle
Bit.3 Set:	Ultrasonic monotone enabled
Bit.4 xxx:	Reserved do not set.
Bit.5 Set:	Enable Direct Network Access
Bit.6 Set:	Disable serial com pin

Mode bits: Binary fundamentals

To set both bit 0 and 1 compute (1+2) enter m3.
To set bit 0, 1 and 6 compute (1+2+64) and enter m67.
To set bit 0 and 2 compute (1+4) and enter m5.
To set the polling bit 7, bit 0 and 2 compute (128+1+4) and enter m133.

If USID, RFID and Monotone are disabled, then the activity cycle becomes short and the LED flashing is weak. But this reduces power consumption considerably

Downtime [d#] (# default 6)

If the hx19tx tag, finds the command d in the configuration string from the hx19ms. Then it will use the first numeric value it finds, to select the downtime. This parameter, controls how long the device stays at sleep. The following table, shows the time durations available. If the [h] command is used to shut down the hx19tx, downtime is multiplied by eight; until re-synchronization

Value # following d	1	2	3	4	5	6
Sleep duration (Seconds)	0.25	0.5	1	2	4	8

T17& d4 this string sets the down time for tag 17 to 2 seconds nominally, the unit randomly selects either 1 or 2 seconds for flashing the IDs. E.g. if sleep duration is set at 8 seconds then the device randomly executes 4 or 8 second sleep time.

Shutdown [h]

When the command h is found in the setup string, the hx19tx tag immediately shuts down, and the current sleep time is eight folded. The tag will wake up periodically and go through the activity cycle; if no airborne RF is detected it goes to sleep. There are two ways of waking the tag from deep sleep: Broadcasting sync signal using the hx19ms; or pressing the emergency button, if the unit is equipped with one. If the emergency button is held down while in deep sleep, the unit will wakeup immediately and transmit the emergency call at high rates.

T& m0 h this sequence addresses all tags. It will shut off the LED, USID, RFID and eightfold their sleep time. In this case there is no feedback, to indicate any action, one cannot know if all the units got the message. In deep sleep the hx19tx comes up at least once every 64 seconds to look for sync. if not found it goes back to sleep. The hx19ms series must strobe sync continuously for more than 64 seconds to establish state of alertness. Sync duration for 70 seconds wakes the tags with certainty.

EEPROM (FLASH) save [e]

If the hx19tx finds the e in the command string, the current parameters under which the device is operating are stored on FLASH; and will be restored in case the tag looses power.

Battery Status [b]

Counters are cleared when the unit looses power, i.e. the battery is removed for replacement. The counters are incremented for every chirp the unit emits. This provides a rough way of monitoring the battery status. Note that the device must be addressed privately for battery feedback. E.g. T4& b When tag 4 receives command b, it will broadcast the battery status counters.

Period [i#] (# default 49 (40khz)): implemented on next sync

The value that follows the command i, sets the period of the monotone ultrasonic burst **(bit.3 of the mode byte must be set high). P**ings can be preceded by RFID, to identify its source. RFID and US ping occur with 4 ms separation.

Number of Periods [n#] (# default 30): implemented on next sync

This command controls the duration of the ultrasonic burst, and the value that follows n is the total number of periods in the ping that are emitted. Monotone is not an identifiable ultrasonic signature, clearing the monotone bit resets to identifiable ultrasonic identity.

T13&=m14 i49 n100

The string above will shut of the LED, select monotone and emit RFID + sonic ping. Since the i-value is 49 the hx19tx will transmit 100 periods at 40khz (25µS each) to the ultrasonic sensor. The duration of the burst is therefore 2.5mS.

Monotone Frequency = 4Mhz / [2 x (# +1)] # is the alphanumeric following I

The 'f#' command Selection of sample rates

Version 1.1 base sample rate, is 4 s/s. Command 'f' will allow this rate to be altered. Command line "!&f1" will set all devices receiving commands to 4s/s. Similarly "!&f2" will set devices to 8s/s, and "!&f4" will select nominal 16s/s (15.75). Rates can be set privately like this. "M&f4 and T&f1", in this case the hx19ms will synchronize 4 times before the transmitter emits RFID/USID once.

Battery duration can be decreased, if devices are not all set at the same sample rates

Radio Power Level [p#] (# default 2)

The numeric value following the command p, dictates the power used to transmit the RFID, and therefore the range of the RF bubble. Power levels are shown in the following table.

Value following p	0	1	2	3
Radio transmission power	-20dBm	-10dBm	-5dBm	0dBm

Radio Channel out [t#] (default 2)

This command allows the user to change the RF channel through which the hx19t series broadcast its result.

Example: T245&=p0 t121 r122

The string above will set transmitter 245, to broadcast on channel 121 using minimum power, and receive through channel r122.

Radio Channel in [r#] (default 2)

This command allows the user to change the RF channel through which hx19t device receives broadcasts.

Example: T& r111 e

The string above will set all transmitters, to receive through channel 111. This setup will be stored on EEPROM (FLASH), and reloaded in case the receiver looses power.

Sample rate selection [f#] (see above)

Serial I/O Com Pin Bidirectional

A port pin (com pin), can be used to receive or transmit broadcast (simplex); hx19t series are able to relay information from the RF network, to the object it is attached to. When the com-pin is transmitting, it is configured as output. Otherwise the com-pin is at high impedance state (hi-z). Communication baud rate is 250kbaud. Both RX and TX utilize a single wire, and the signal needs to be inverted for RS232 port.

If bit five of the mode byte (see above) is set "direct access to RF network" is enabled. All data received via the hx19tx com-pin, is broadcasted as it becomes available; and all that is received from the network, is dumped serially through the com-pin. Units used for direct network access, are sensitive to pertinent commands, arriving through both RF and own com-pin.

Commands directed privately to a hx19 unit through own com-pins are not broadcasted.

Example: T6& m7 <what goes around comes around> t123

If this string is signaled through a com-pin on a tag other than tag 6, it is immediately broadcasted. Consequently if the string is received by T6: then T6 will turn on its LED, and enable both RFID and USID. String between the brackets, "what goes around comes around" will be signaled on T6 com-pin if enabled. And then T6 will set its RF channel at 123.

If T6 "Direct RF network access bit" is enabled, then the entire received string, plus the string in the brackets is dumped through an enabled T6 com-pin.

Own address signaled through the com-pin

If ***T6& p0 [broadcast this] d1/888*** is signaled through the T6 com-pin then the string

"T6& p0 [broadcast this] d1/888|T6#" is broadcasted and echoed back.

T6# is appended by T6 to acknowledge receipt of the string. If correct checksum is received with the CR delimiter, Hx19T6 will process the command, and when finished, issue acknowledge. This will be "T6#".

The symbol | is here only to represent a carriage return, following the hexadecimal checksum 888. This is the sum, of all the ASCII values from the first character, to the / forwards slash.

If your addressing is **not private**, e.g. like this T&[testing]/430, then the following is echoed back.

T&[testing]/430|#

Notice the private acknowledge is missing, but the # indicates the command was processed i.e. it was broadcasted.

Installing the Battery

After a new battery is placed in the holder the transmitter LED blinks 3 times, this indicates all is well. If this doesn't happen; then it may be necessary to shunt the battery with a metal object, or simply remove the battery and insert it again. If the com-pin is enabled; the character D will be signaled through the com-pin, when the battery is installed. In this case the transmitter has been started with its default parameters. If parameters are at some point, stored on EEPROM (flash), the pin will signal E when a new battery is installed. This means: parameters stored are reentered into the system. If these parameters contain an error, the user may be in trouble.

Fixing Erroneous parameters in EEPROM

Remove the batteries completely for minimum. 10 sec. If the transmitter has an emergency button, then hold it down while the tag boots up. When the transmitter LED has blinked 3 times release the button. It is also possible, to shunt the battery, while pressing the emergency button. If you continue holding the button, the unit will issue emergency broadcast, at high rate (no harm done). The com-pin will signal D instead of E, this indicates success; the default parameters have been loaded. After default parameters are loaded, either current (default), or correct parameters must be loaded in to the EEPROM (flash) using the e command. It is not necessary to monitor the com-pin while resetting to original parameters.

If there is trouble and there is no emergency button contact Hexamite.

Com Pin Startup Signals

After either D or E is signaled, indicating what parameters, were loaded. Then the enabled com-pin will signal < as main action cycle is executed. Just before the unit goes to sleep; the com-pin signals > closing bracket. Between the brackets, the device is active and listening for a sync signal. In idle mode; the unit will wake up, at the average interval of 6 seconds, if no sync is detected, it goes back to sleep.

Control Parameters:

All parameters including the mode byte; can be modified while the hx19tx is in synchronous mode, and on the fly. This can be done using either RF or I/O com-pin on the tag. The parameters remain unchanged, until either re-modified, or the battery is removed from the holder for more than approx. ten seconds, (it varies depending on operating state). To ensure; parameters remain unchanged when the battery is removed, these must have been stored on the hx19tx EEPROM flash, prior to battery removal.

The Hx19r v1.1 the receiver

The hx19rx receiver can operate in two basic modes, alert mode, and low power battery mode.

Continuous mode (bit.2 clear)

In continuous active mode the hx19rx is always alert, any tag within radio frequency range is processed without delay. Current consumption in this mode is approx. 25mA.

Battery mode (bit.2 set)

In this mode, if no synchronizing RF activity is detected, the hx19rx goes to sleep to preserve energy. It wakes up periodically, to look for RF activity. When a synchronizing RF signal is found, it enters active mode, and remains there until the RF sync is no longer detected. Current consumption in this mode, is under 5mA at full synchronous sampling rate of 16 samples per second.

The Hx19rx output string.

In active mode the Hx19rx, waits for the reception of either RFID, or a special RF synchronization signal. Upon arrival of the RF signal, it clears its timer and initiates a stopwatch. It logs, the first ultrasonic wave front's time of arrival, and prefixes time of flight with the character A. Then, it proceeds to take a closer look at the incoming signal. If it detects an ultrasonic identity start sequence, it puts the prefix B to the time of flight, and continues to stage C. In stage C, the identity of the Ultrasonic Signal is extracted and stored, and the prefix C is attached to the time of flight value.

The full output format broadcasted by the Hx19rx

[Receiver ID] [RFID] [(prefix)-Time of sonic flight] [USID] / [checksum]

RF Output String Syntax: R6 X5 C6850 U5
Wire Output String Syntax: R6 X5 C6850 U5

Conditions: Mode bit.1 is set

Output String Analysis

Please refer to the string shown above (output string syntax). X5 is the RFID of tag marked 5. The string indicates that tag 5 is 6850 mm away from receiver 6. Code U5 indicates the signal is authentic. It cannot have come from any other source than tag 5. Even if the ultrasonic identity code is missing, probability that the signal came from a different source is insignificant.

The prefix C in front of 6850, means full timing process was accomplished. If A leads the time of flight value, only the first edge of the ultrasonic wave authenticates the measurement. A can be trusted, unless the units are operating in noisy environment. Prefix B is a reliable indicator that a true ultrasonic timing signal was received, but the timing is not precise. The USID will not be available unless the prefix is C. Prefixes give the programmer some flexibility in case the USID isn't available.

In case there is no ultrasound present in any form, the string will contain the RFID and the receiver ID followed by the checksum.

No ultrasound, example: X**5 R7.** Tag 5 RFID, was received by receiver 7

The function, of the hx19r series can be modified, using the 2.4Ghz radio connection at 250baud. USB port of most computers can be used to that end; other options exist like direct serial communication using RS232 or RS485/422, and the Ethernet. Hexamite can provide a bridge to the hx19 for most interface preferences.

Parameters:

If the hx19r series is set for battery savings mode, then parameters can be modified only, while the unit is in synchronization with the strobing hx19ms.

Parameters remain unchanged, until either re-modified, or the unit looses power. To remain unchanged, in the event of a power loss at start up, parameters must be stored on the hx19r series EEPROM (flash).

Lower case alphabetic characters, are recognized as commands by the hx19 system, the command may or may not have a control numeric value referred to as #. A control value is interpreted as the first unbroken numeric characters following the command identifier. The syntax of the control string is shown below.

Receiver Commands Summery

!	Attention all devices. Global call to all devices, receivers included
R&	Public transmitter call, all tags respond to this call
R#&	Addresses a specific receiver privately, # is the specific numeric ID.
e	The device stores current operating parameters on EEPROM
p#	Select RF transmission power, used to control the range bubble (default 2, range 0 through 3)
r#:	Select RF input channel range (1 to 127). (default 2)
t#:	Select RF output channel range (1 to 127) (default 2)
[	Everything between the first opening "[" and the last "]" closing bracket is RF broadcasted
m#	Mode # is a decimal value setting and clearing the mode bits
< >	ASCII data between the first and the last bracket is relayed to the serial I/O (RS485/RS232)
b	Receiver looks for ^# between broadcast brackets and replaces with # characters from memory
h	Deep sleep, the device essentially shuts off (sync strobing will wake the device in 24-64s)
f#:	Sample rates f1=4 s/s, f2=8s/s and f4=16s/s
q#:	Sets up a receiver result queue, receiver limit is 6 at 16s/s, 31 at 8s/s and 99 at 4s/s

Mode Byte
Bit.0 (1). Set: High precision, no noise immunity. Clear: Medium precision, high noise immunity *
Bit.1 (2). Set: RFID must precede the sonic signal
Bit.2 (4). Set: Power Savings (battery mode)
Bit.3 (8). Set: Disable sonic timing and USID scanning (removed)
Bit.4 (16). Reserved: Don't set this bit)
Bit.5 (32). Set: Eliminates reverberation errors in modes where bit 1 is cleared.
Bit.6 (64). Set: LED Off
Bit.7 (128). Set: Disable streaming data. And put results into a storage ring buffer for polling

Binary fundamentals
To set both bit 0 and 1 compute (1+2) enter m3
To set bit 0, 1 and 6 compute (1+2+64) and enter m67
To set bit 0 and 2 compute (1+4) and enter m5
To set the polling bit 7, bit 0 and 2 compute (128+1+4) and enter m133

* Both Bit.1 and Bit.0 must be set high for the high precision mode
** If this bit is set, be sure the tag is sending its RFID on the channel where the receiver is set to receive RF.

EEPROM save [e]

If the hx19rx finds the command e in the setup string, the current parameters under which the device is operating get transferred to EEPROM (flash). These parameters will install during startup.

Radio Power Level [p#] (default 2)

The numeric value, following the command p, dictates the RF power used to transmit the receiver output string. Power levels are shown in the following table. The power levels affect the range of the receiver RF range bubble from 5 to 40 meters

Value following p	0	1	2	3
Radio transmission power	-20dBm	-10dBm	-5dBm	0dBm

Radio Channel out [t#] (default 2)

This command, allows the user to change the RF channel, through which the hx19rx broadcasts its result.

Example: R12345&=p0 t121 r122

Command line shown above will configure receiver 12345, to broadcast on channel 121, using minimum power, and receive through channel 122.

Radio Channel in [r#] (default 2)

This command allows the user to change the RF channel, through which it receives broadcasts.

Example: R& r111 e

The string shown above will set all receivers, to receive RF through channel 111. This configuration will be stored on EEPROM (flash), and reloaded in case the receiver looses power.

Mode control:

The mode control is bit manipulated, the user must set the bits of the control byte high or low to control the features or operational mode of the hx19rx receiver. Following is a description of what the bits do.

Bit.0 (1). Set: High precision, no noise immunity. Clear: Medium precision, high noise immunity
Bit.1 (2). Set: RFID must precede a sonic signal
Bit.2 (4). Set: Power Savings (battery mode)
Bit.3 (8). Set: Disable sonic timing and USID scanning (removed)
Bit.4 (16). Reserved: Don't set this bit)
Bit.5 (32). Set: Eliminates reverberation errors in modes where bit 1 is cleared.
Bit.6 (64). Set: LED Off
Bit.7 (128). Set: Disable streaming data. And put results into a storage ring buffer for polling

Bit.0.set	Just the first wave front returning will be timed. Highest timing classification displayed is A. This bit should be set, if a long distance positioning is required, in a sonically quiet surrounding. Positioning range and angle is significantly increased.
Bit.1.set	The hx19rx will not scan for USID in the absence of accompanying RFID. On time-out the Hx19r output string will contain at least the receiver ID and RFID. Otherwise all three are included receiver ID, RFID and USID. If this bit is clear the hx19r series will not hang until RFID times out.
Bit.2.set	If set the hx19rx enters sleep mode, or battery saving mode. It can take roughly a minute to wake it up from deep sleep. Once it wakes up to synchronized activity, it enters full action, consuming roughly 4mA at 16 samples/second (full action).
Bit.3.set	If set the unit does not scan for ultrasonic activity.
Bit.4.	RESERVED. keep this bit clear.
Bit.5.set	Reduces signal sensitivity of the receiver. It may help where ambient noise is high and the system is operating in first wave mode.
Bit.6.set	Dims the LED
Bit.7.set	This will disable streaming data through RF, and accumulate processed data in a ring buffer 128 characters long. Oldest data is overwritten by new data.

Selection of sample rates [f#] (Receivers v1.1 Only)

Version 1.1 base sample rate, is 4 s/s. Command 'f' will allow this rate to be altered. Command line "!&f1" will set all devices receiving commands to 4s/s. Similarly "!&f2" will set devices to 8s/s, and "!&f4" will select nominal 16s/s (15.75). Rates can be set privately like this. "M&f4 and T&f1", in this case the hx19ms will synchronize 4 times before the transmitter emits RFID/USID once.

Battery duration can be decreased, if devices are not all set at the same sample rates.

Queue order [q#] (Receivers v1.1 Only)

At 8 samples per second, there is more time to transmit results than at 16 s/s. At 16 s/s there is time for only 6 receivers to broadcast their result. If a high-speed precision sampling is required using more than 6 receivers, then the extra receivers, must be set to broadcast on another frequency channel. More hx19ms devices are needed to monitor the other channels. In this case data may be split between two USB/RS232 ports.

At 8 samples per second there is time for 30 receivers to transmit results. And at 4 s/s there is time for 90 receivers.

Syntax: "R1&q3" sets receiver 1 to transmit its distance result, third in the queue, and "R1&q3e" stores this queue assignment permanently on EEPROM.

For "f4" 16s/s options are q1 through q6, and slow rate "f1" 4s/s options are q1 through q90

The HX19MS monitor / synchronizer

This device is the bridge between the computer (programmer) and the hx19 positioning system. Manipulating this device is somewhat similar to the hx19r and hx19t series. It will take command lines directly from the PC, through USB or serial I/O, analyze and apply to itself, and/or broadcast onto the hx19 network. The hx19ms, is the master synchronizer for the whole network. It monitors broadcasts from all other hx19 devices, receivers, tags and other HX19MS units.

Above on the left is a hx19ms-RS232 version. The RF communication; is controlled using a RS232 or a TTL input. HX19MS-USB on the right; enables access to the HX19 RF network via USB port. Hexamite provides visual basic programs, with source code to help the programmer understand the communication procedure. The hx19ms accepts a few direct commands; its general address type is M.

Many hx19ms devices can be connected to different computers to monitor hx19 activities, but only one should control synchronization

Monitor Synchronizer Command Summery

These following commands dictate the behavior of the hx19ms ultrasonic RF monitor-synchronizer, the # signifies a decimal numeric character that should follow the command.

Monitor Synchronizer Command Summery

!	Attention all devices. Global call to all devices, monitors included
M&	Public monitor synchronizer call, every HX19MS responds to this call
M#&	Addresses a specific a HX19MS privately, # is the specific numeric device ID.
e	The device stores current operating parameters on EEPROM
p#	Select RF transmission power, used to control the range bubble (default 2, range 0 through 3)
r#:	Select RF input channel range (1 to 127). (default 2)
t#:	Select RF output channel range (1 to 127) (default 2)
[	The device broadcasts its Receive Buffers excluding first opening and closing brackets
m#	Mode # is a decimal value setting and clearing the mode bits (default 0)
< >	Received data between the first and the last bracket is placed on the serial wire I/O
$	Enables the synchronization strobe
%	Stops the synchronization strobe
g	Get contents of round buffer (polling)
f#:	Sample rates f1=4 s/s, f2=8s/s and f4=16s/s
s#	Tag firing sequence. Select s1 and tag 1 transmits after tag 0. Sequence s9 > 0,1,2,3,4,5,6,7,8,9 *

Mode Byte

Bit.0 Set:	Silent running. No RF data dumping via wire (USB/RS232/RS485)
Bit.1 Set:	Repeater enabled. All received RF data is broadcasted as it comes.
Bit.2 Set:	Disable broadcast of incoming Wire data
Bit.3 Set:	Enable dedicated RF command mode

* The s cannot be stored permanently like p,r,t and m values. Scan mode is stopped if any character comes through the USB port. And scan mode is halted on boot or restart. If the user wishes to multiplex through multiple tags at high rate, the scan (number of tags) must be entered

EEPROM save [e]

If the hx19ms finds the command e in the setup string, the current parameters, under which the device is operating, is stored on EEPROM, and will be restored after the device loses power.

Radio Channel out [t#] (default 2)

This command, allows the user to change the RF channel, through which the hx19ms broadcasts its result.

Example: M5&=p0 t121 r122

Command line shown above will configure hx19ms-5, to broadcast on channel 121, and receive on channel 122.

Radio Channel in [r#] (default 2)

Following command "r" allows the user to change the RF channel, where hx19ms receives broadcasts.

Example: M& r111 e

The string shown above; will set all hx19ms devices in range, to receive RF on channel 111. This configuration is stored on EEPROM (flash), and reloaded in case of power loss.

Synchronize command [$]

When the hx19ms receives this command character, it broadcasts synchronization signals over the network. Every device in range eventually enters synchronized activity cycle, timing latency is within a microsecond.

Example: M33&$ Sets M33 as the master synchronizer

During a synchronized cycle, command codes can be broadcasted to any hx19 device synchronized with the master hx19ms, but only through the master hx19ms. This holds true, regardless of the battery settings of hx19 devices.

Asynchronous command [%]

Synchronization strobe is turned off. In this mode, network broadcast is repeated on the serial lines (through the serial port). Here the hx19ms acts as a passive RF monitor receiver only.

Radio Power Level [p] (default 2)

The numeric value following the command "p", controls the power, used by the hx19ms to transmit to other devices on the RF network. Power levels indicative of range, are shown in the following table.

Value following p	0	1	2	3
Radio transmission power	-20dBm	-10dBm	-5dBm	0dBm

Get round buffer [g]

The hx19ms stores all incoming RF data, in a round buffer, size 384 bytes. When the device receives the "g" command, it dumps the available stored RF data through its serial wire. If a silent running mode is selected (mode.bit.0 set), then networks of hx19ms can be polled for their content.

M1& g When this command is received over wire network, monitor M1 will dump data

Mode Byte [m#] (default 0)

The mode byte is bit manipulated, the user must set the bits of the control byte high or low to select the features or operating mode of the hx19tx. Following is a description of what the bits do.

Bit.0 Set:	Silent running. No RF data dumping via wire (USB/RS232/RS485/Ethernet)
Bit.1 Set:	Repeater enabled. All incoming RF data is broadcasted as it comes.
Bit.2 Set:	Disable broadcast of incoming Wire data
Bit.3 Set:	Enable dedicated RF command mode

Bit.0 Set: Silent running, no data comes through the serial port, unless it is found between command brackets < >. I.e. the device does not transmit anything through wires, unless specifically told to do so.

Bit.1 Set: The hx19ms can be used as a relaying repeater to extend the broadcasting range.

Bit.2.Set The device does not repeat, or broadcast incoming RF data on the wire port (USB/RS232/RS485/Ethernet)

Bit.3 Set: If the communication is intense. Spending time on repeating all RF data on the wire port, or storing in buffer may be an unacceptable overhead. Setting this bit high will make the HX19MS more alert to RF interchange.

Selection of sample rates [f#]

Version 1.1 base sample rate, is 4 s/s. Command ‘f’ will allow this rate to be altered. Command line “!&f1” will set all devices receiving commands to 4s/s. Similarly “!&f2” will set devices to 8s/s, and “!&f4” will select nominal 16s/s (15.75). Rates can be set privately like this. “M&f4 and T&f1”, in this case the hx19ms will synchronize 4 times before the transmitter emits RFID/USID once.

Battery duration can be decreased, if devices are not all set at the same sample rates.

The scan command [s#]

Scan is essentially a time multiplexer, it calls tags based on their least significant address digit. Command “s”, will force the hx19ms to include an address code following synrhonization. Only tags with last digit equal to the code, will respond (emit). Command line M&s3 will result in the following:

Given that tags 30, 12, 23,101 and 14 are in range they will emit one after another as follows.

30, 101, 12, 23. Note that 14 is missing. This firing sequence is repeated, and may be necessary if many transmitters are pointing to the same receiver.

ADDENDUM : Tag power consumption

*The Hx19tx is a low power USID/RFID tag. Maximum input voltage is 3.6Vdc and minimum input voltage is 2.5Vdc. At full operating speed of 16 emissions per second, the unit consumes about 5mA. During deep sleep it consumes approximately 20 micro amps. The power consumption depends on the duration of the sleep stage. As a rule of thumb, the emission lasts 13mS, during this time the unit consumes approximately 20mA. Given that there are about 62.5mS between samples at 16 samples/second, ideally the overall current consumption is I = 13mS * 20mA / 63mS. The current consumption will be close to the calculated value.*

Using a 300mAh cell the unit should run for approx. 60 hours at full speed 16s/s. If the user remembers to shut the device off with the command character [h] while not using it, the battery life will be extended significantly. When the battery is installed, a blue LED inside the box will flash ***twice****. Then it will immediately activate, and emit by default USID, RFID and flash the LED for the* ***third*** *time. After startup, the tag will emit and flash the LED at random 8 or 4 second intervals. Faint bat like clicks should be heard while the LED flashes if the sensor is brought close to an ear. This indicates the sensor is emitting a sonic signal.*

HX19TX-bat

Hx19tx-bat is a battery version, it can accept variety of 3 v coin cell lithium batteries. These are BR2320, BR2325, BR2330, BR2032, CR2320, CR2325 and CR2330. CR2032 will fit into the holder, but it may need to be secured. A Philips screwdriver can be used to remove the bottom plate from the main box. The assembly may need to be taken out of the box to slide the battery in.

Size 35 x 35 x 15mm

The HX19 Access

If the access program doesn't find a file called port.txt, containing reference to the serial port, that connects the computer to the hx19ms; and error window pops up. Go to “Windows Control Panel” or “My Computer” and find “Device Manager”. Under Ports (COM & LPT) the port number to which the Hx19 is linked, can be found. Note that “Visual Basic” may not find ports over 16. In case all ports are occupied, it still may be possible to share one of the already allocated ports under 16. After typing the serial port number into the blue window then click Ok. If a tag is within RFID should scroll down the main white window.

Open device manager and
Open Ports (COM & LPT)
Plug your Hx19ms into a USB port

You should see a change when your USB port is added. If a port number higher than 15 is assigned to the hx19ms, you need to change it as follows.

Right click on your new USB port, and select properties
Select “Port Settings” and click on Advanced
Scroll down Com Port Number, and select a port lower than 15 even if it is marked “In Use”