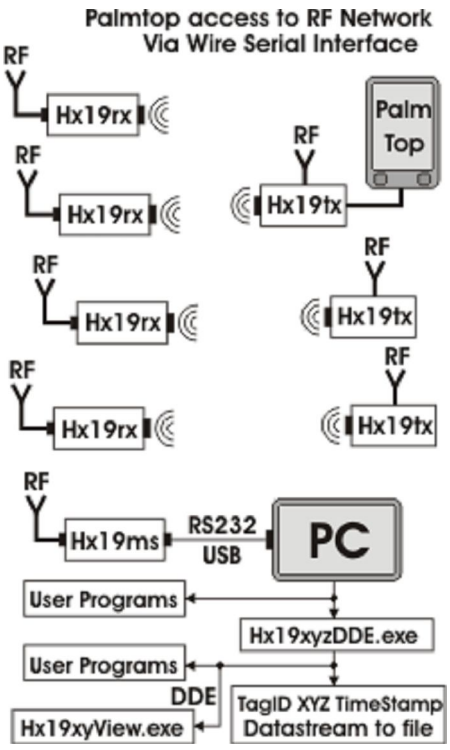
FEATURES

- 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 serve most positioning contingencies
- 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. For synchronization, radio is used as a start signal. Precisely 4mS, after receiving sync or a call, over an RF channel, the transmitter emits RFID and ultrasound, while flashing, a blue LED. Receivers report through a 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 to relay processed information to the tag. Transmitters can receive, own position coordinates, from a central server. This enables guidance as well as tracking. HX19 is useful for both absolute, and TDOA (time difference of arrival) multilateration positioning.

Users can access, the hx19 device-to-device RF COM. network, using either a transmitter/tag port-pin, or an 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. Weight 18 g

HX19TX
Ultrasonic RF battery Transmitter Tag. Weight 22 g

HX19RX
Ultrasonic RF Receiver.
Weight 40g

HX19MS USB Monitor Synchronizer
Weight 40g

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 ee

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, ee 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 ee: stores the operating parameters permanently on flash memory.

T&m14i49n90ee sets all transmitters to the (see above) T21 configuration

!& p0 ee: 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 a single broadcast 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; it receives transmissions from other devices, and transmits commands, which other devices receive. 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&r111t33This corrects all hx19m monitors within range.

Continuous sample rates

For hx19 version 2.1, three sample rates can be selected. These are 4 s/s, 8 s/s and 16 s/s. Hx19 v2.1 is sensitive to the time required for ultrasound to travel to destination. At 16s/s it needs to receive, process and transmit the result within a short timeframe, and there is only time to broadcast results from 5-6 receivers. The receivers should be lined up to transmit one after another, i.e. in tandem. 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 broadcasting 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 5 receivers per RF transmit channel; 125 RF channels are available. Under very intense positioning 625 receivers can monitor a single tag emitting 16 times per second. But this will require a high-speed computer, with 125 USB ports, or one port per hx19ms monitor.

For sample rates 4s/s there is time for 80 results, while at 8s/s there is time for broadcasting results from 28 receivers.

The ‘f#’ command Selection of sample rates

Version 2.1 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 semi-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; coin batteries size 2032 go into a holder on the back of the unit with minus facing the PCB. Once a battery is inserted into the battery holder the tag will enter idle mode. In idle mode the Hx19tx by default flashes a blue LED at intervals between 4 and 8 seconds. During the flashes it emits USID and RFID by default; i.e. ultrasonic and radio frequency identification. 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 from an hx19ms. Latency of the synchronous activity; is less than a microsecond. In synchronized mod (access program Sync selected); the acquisition cycle is strobed 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 beying strobed; with if enabled the LED flashing rabidly. Similarely if the hx19r is configured for battery savings, it must also be strobed for communication.

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 characters “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 corrispond to 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 "&"; are interpreted as configuration commands. Following is a simple string; broadcasted from an hx19ms (monitor synchronizer).

T& m2 d1 ee

If received by a tag, 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: !& = ee

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

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

T13& m7, d6, ee (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 emission, and will flash the LED every time 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, use the [ ] to force the T series to broadcast acknowledge 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. The following "T13 got the message" should be appear in an hx19Access textbox.

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.

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.
ee	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 125). (default ch. 123 = 2.523GHZ)
t#	Select RF output channel range (1 to 1257) (default ch. 123 = 2.523GHZ)
[	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)
ht	Shut off, device can be turned back on by grounding the USB ID pin (micro USB pin
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
b	get battery status
v	get device version
w	get status of work registers
x	Change the RFID of the tag
u	Change the USID of the tag

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 Set:	Disable USID/RFID on startup *
Bit.5 Set:	Enable Direct Network Access
Bit.6 Set:	Disable serial com pin
Bit.7 Set:	Enables Supply/Battery Monitoring**

Binary fundamentals Example:

To set bit 0, 1 and 6 compute $2^0 + 2^1 + 2^6 = (1+2+64) = 67$ (and enter M&m67)
To set bit 0, bit 2 and 7 compute $2^0 + 2^2 + 2^7 = (1+4+128) = 133$ (and enter M& m133)

* The hx19tx identifies itself on bootup, if other devices are in sync within range; it may disturb the sync cycle.

** The letter + is added to the RFID, the numeric character 0-9 following + represents the power supply level. It should not be higher than 7 and not lower than 3, to remove the S appendix the mode bit 7 must be cleared and the tag must be allowed to wake up from sleep, i.e. the sync function must be terminated.

Downtime [d#] (# default 6)

If the hx19t 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 sleep 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, commands following "h" are ignored. 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 shunting the micro USB pin3 to ground momentarily (see appendix 10 connecting the tag).

"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 [ee]

If the hx19tx finds the ee 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.

If micro USB pin 4 is shunted to ground while the device boots (starts up) then the flash parameters are not restored, default parameters are loaded into the work registers

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 contains no identifiable ultrasonic signature, clearing the monotone bit, will reestablish identifiable ultrasonic signal.

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 2.1 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 life can be decreased, if devices are not all set at the same sample rates

The 'b' command supply or battery level (Version 2.2 and above)

To check on the status of the battery or the level of the voltage supply the b command can be used. Dividing the result value with approximately 37 will yield a reasonable approach to the actual voltage level supplied to the tag. The voltage level should not be higher than 4.5V and not lower than 2.8V. If the value is not steady, your supply source is inadequate.

Radio Power Level [p#] (# default 3)

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 123)

This command; allows the user to change the RF channel, through which the hx19t series broadcast.

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 123)

This command; allows the user to change the RF channel, through which an hx19t receives data.

Example: T& r111 ee

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)

Change the RFID of a tag [x]

Syntax: T&xObama#

To change the RFID specify the new ID between the command x and # (max 16 char), any valid ASCII characters are accepted. The syntax example will name all active tags in RF range “Obama”. Given that the default tag ID is 23 then T23&Obama# will change address 23 to Obama.

Example: TObama&x87# ee [acknowledge]

This example assigns a new address 87 to a tag previously named Obama, and stores the result on flash (permanent memory).

Change the USID (Ultrasonic ID) of a tag [u]

Syntax: T&u843#

To change the USID specify the new ID between the command u and # (max 4 numeric char).

Example: T23&x71#u543# [OK]

Tag 23 will get the new address 71 and a new USID 543 and OK will be broadcasted as acknowledge.

Example: T23&ee

Will store current status of the hx19 tag in permanent memory.

Terminate Operation [ht]

Syntax: T&ht

This command terminates operation, in this state, the only way to resume operation is by shunting micro USB pin 3 to ground momentarily (see appendix 10 connecting the Tag). Activity on the serial I/O pin will also activate the Tag.

Serial I/O Com-Pin Bi-directional Simplex operation

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 an 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 echoed back.

T6# is appended by T6 to acknowledge receipt of the string. If correct checksum is received with the CR delimiter, Hx19 T6 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 the com-pin is enabled; 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.

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 v2 the receiver

The hx19r 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 at 3V, is under 6mA 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 P5 C6850 U5
Wire Output String Syntax: R6 P5 C6850 U5

Conditions: Mode bit.1 is set

Output String Analysis

Please refer to the string shown above (output string syntax). P5 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 high clarity and authentic. It cannot have come from any other source than tag 5. Even if the ultrasonic identity code is missing, the 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 receiver ID and the RFID.

No ultrasound, example: **R7 P5.** Tag 5 RFID, was received by receiver 7

The function, of the hx19r series can be modified, using the 2.4-2.5Ghz 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 the numeric string, 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.
ee	The device stores current operating parameters on EEPROM
p#	Select RF transmission power, used to control the range bubble (default 3, range 0 through 3)
r#	Select RF input channel range (1 to 125). (default ch. 123 = 2.523GHZ)
t#	Select RF output channel range (1 to 125) (default ch. 123 = 2.523GHZ)
[	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 5 at 16s/s, 29 at 8s/s and 80 at 4s/s
v	Gets the device version
w	gets the status of the work registers.

Mode Byte

Bit.0 (1). Set: High precision, no noise immunity. Clear: Medium precision, noise immunity *
Bit.1 (2). Set: RFID precedes USID, (If Bit.0 is set there is no USID). **
Bit.2 (4). Set: Power Savings (battery mode)
Bit.3 (8). NOT USED
Bit.4 (16). Set: Distance with C prefix has industrial grade noise immunity (monotone will not work)
Bit.5 (32). Set: Displays only identifiable signals with C prefix (monotone will not work)
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 Example:

To set bit 0, 1 and 6 compute $2^0 + 2^1 + 2^6 = (1+2+64) = 67$ (and enter M&m67)
To set bit 0, bit 2 and 7 compute $2^0 + 2^2 + 2^7 = (1+4+128) = 133$ (and enter M& 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 it's RFID on the channel where the receiver is set to receive RF.*

EEPROM save [ee]

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 123)

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 123)

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.

Mode Byte

Bit.0 (1). Set: High precision, no noise immunity. Clear: Medium precision, noise immunity *
Bit.1 (2). Set: RFID precedes USID, (If Bit.0 is set there is no USID). **
Bit.2 (4). Set: Power Savings (battery mode)
Bit.4 (16). Set: Distance with C prefix has industrial grade noise immunity (monotone will not work)
Bit.5 (32). Set: Displays only identifiable signals with C prefix (monotone will not work)
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 In the absence of accompanying RFID, the hx19rx will not scan for USID, the acquisition will simply time-out. On time-out, the Hx19r output string will contain at least the receiver ID and RFID. If RFID is detected, the output string is fully populated with receiver ID, RFID and USID.

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. If this bit is set the unit sets focus on the most reliable part of the ultrasonic signal, this part is not necessarily better in terms of precision, rather very distinquisable from noise.

Bit.5.set Forces the result string to contain only the noise reliable result, here precision loss is the price paid for environmental sonic disturbance.

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. If this bit is set the only way to get data from the receiver is by using the polling process.

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.

Queue order [q#]

For high-speed operation synchronization is required. The receivers operate like a stopwatch, and the tag is like the runner. On sync (start gun) the receiver starts timing and the tag starts running, when the tag hits the finish line the watch is stopped and the receiver calls out the time when the runner hits the mark. If many receivers call out the time result simultaneously over the same RF channel, the signal gets scrambled and the hx19ms connected to a PC USB will not understand any message. So the receivers must call out the result one following another. This is controlled with the q command, e.g. make receiver R41 q1 (the first to send), and R44 q2 (the second to send). R44 will call out its timing right behind R41. At high speed 16s/s the receivers must get ready quickly to start the whole process all over again. Therefore there is only time to call out about 4 results from receivers. At 8s/s we have more free time from the time the signal arrives to the time we must start another sampling cycle. Here far more receivers almost 30 can be called out, and at 4s/s we have plenty of time to call out almost 90 results.

Lets say there are two hx19ms, tune one hx19ms to receive on channel 119 and the other to receive on channel 118, set R41&q1t119 and R44&q1t118. Here R44 and R41 are both called out simultaneously R41 sends its results on RF channel 119 and R44 sends on RF channel 118, and instead of calling out only 4 results at 16s/s, 8 total results are called out before commencing with the next acquisition cycle. With demanding high speed operation more hx19ms units are required.

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.

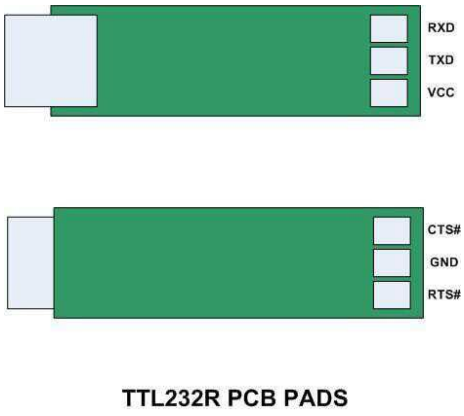
For “f4” 16s/s options are q1 through q6, and slow rate “f1” 4s/s options are q1 through q90

Using the Serial Output pin HX19R version 2.4 and above

Distance data is available on a serial output wire from the hx19receiver. This feature allows the user to read broadcasted data as it streams directly from the receiver through a wire. The serial output has a TTL format, i.e. inversed RS232 and the baud rate is 250Kbaud. Identification of the receiver and tag, plus the distance from the receiver to tag comes streaming through this port pin (wire). For hx19 devices this wire is typically the fourth from the ground wire on the ribbon cable.

Many devices are available that can utilize TTL serial data, FTDI serial to USB is very common and available device that turns a USB port into a COM port or a serial port. The hx19 devices interface directly to this device.

TTL-RS232R_PCB
Mouser part number: 895-TTL-232R-5V-PCB
Farnell part number: 1740366



TTL232R PCB PADS

The ground or negative reference on the hx19receiver usually closest to the edge of the micromatch plug connects directly to the GND pad (soldered one). VCC pad is soldered to the third wire counting the ground wire as number one. The fourth wire from the ground is the serial output, and it is soldered directly to the RXD pad.

FTDI devices are very common and available, and will interface many operating systems to COM I/O. Whatever devices used, make sure they are able to read 3.2V signals.

Hx19access is really just a simple terminal program; it can be used to read both data that comes from the hx19ms through RF wireless and data coming through hx19r wire simultaneously. The hx19ms uses FTDI drivers too. E.g. plug the hx19ms into a USB port and set the port to COM5, plug the hx19r wire interface into another USB port and set it to COM3. Then put a hx19access.exe into a directory holding port.txt file containing 5 (port number), and put another hx19access.exe into a separate directory holding port.txt file containing 3 (port number). Then run both hx19access.exe, and both privately wired and wireless network data should be visible.

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; process the line, and if applicable 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

!	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.
ee	The device stores current operating parameters on EEPROM
p#	Select RF transmission power, used to control the range bubble (default 3, range 0 through 3)
r#	Select RF input channel range (1 to 125). (default ch. 123 = 2.523GHZ)
t#	Select RF output channel range (1 to 125) (default ch. 123 = 2.523GHZ)
[	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
q#	set tag identities to be time multiplexed into (mux) memory syntax (q5:56,232,20)
s#	M& q0:33 s1 here tag 33 will be called repeatedly. M&q0:33,64 s2 here tags 33 and 64 will be called repeatedly

Mode Byte

Bit.0 Set:	Silent running. No RF data dumping via wire (USB/RS232/RS485)
Bit.1 Set:	Repeater mode enabled. All received RF data is re-broadcasted as it comes.
Bit.2 Set:	Disable broadcast of incoming Wire data
Bit.3 Set:	Enable dedicated RF command mode
Bit.4 Set:	Places an X as data set separator, useful for application programming if the hx19ms is not receiving RF on the tags RF transmission channel.
Bit.6 Set:	Auto start, the device will come up in strobe rate f4, maintain that rate for 16s to surely wake up all sleeping devices. Then it will use the rate in the work registered or last entered rate f1, f2 or f4
Bit.7 Set:	block RF broadcasted data from setting internal parameters

Binary fundamentals Example:

To set bit 0, 1 and 6 compute $2^0 + 2^1 + 2^6 = (1+2+64) = 67$ (and enter M&m67)
To set bit 0, bit 2 and 7 compute $2^0 + 2^2 + 2^7 = (1+4+128) = 133$ (and enter M& m133)

NOTE: Tags can only accept command strings while strobing, and the hx19ms should not be scanning. Prior to sending commands to tags the hx19ms must receive M&s0 this stops the scanning and places the tags in input mode.

EEPROM save [ee]

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 123)

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 123)

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 periodically 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)
Bit.1 Set:	Repeater mode enabled. All received RF data is re-broadcasted as it comes.
Bit.2 Set:	Disable broadcast of incoming Wire data
Bit.3 Set:	Enable dedicated RF command mode
Bit.4 Set:	Places an X as data set separator, useful for application programming if the hx19ms is not receiving RF on the tags RF transmission channel.
Bit.6 Set:	Auto start, the device will come up in strobe rate f4, maintain that rate for 16s to surely wake up all sleeping devices. Then it will use the rate in the work registered or last entered rate f1, f2 or f4
Bit.7 Set:	block RF broadcasted data from setting internal parameters

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.

Bit.4 set: If the hx19ms is tuned to a channel other than the channel where the tag is transmitting its RFID, it may be hard to see where one distance data array ends and the next starts. This is why we have added this feature, to assist the programmer to parse through each data set as it comes.

Bit.6 set: The device comes up directly into strobe mode, this can help in case of a power failure to ensure the fastest possible wake up for the battery units belonging to the system. The unit will start up flashing at 16s/s to trap the battery units when the check for RF activity. After 16 seconds the device uses the current data from the internal register to set back at the old strobe rate. When the device comes up from a power failure it loads the EEPROM data into the registers, so once the units are operating properly, make sure the whole data is stored on EEPROM using the ee switch, so it can recover from power failure.

Bit.7 set: This is a precautionary setting to block scrambled data from changing the settings of the hx19ms. All data is checked and double checked before the device acts on it, so this occurance is unlikely. However a device running for weeks and month exposed to microwaves from for example microwave ovens operating at 2.450 GHZ, can scramble the spectrum if the EM shield is out of order. Or the units are within a meter from a microwave emission.

Selection of sample rates [f#]

Version 2.1 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 queue command [q]

The q command sets the tag Ids to be called in mux memory, mux memory size is 128 total. To place a tag ID 55 and tag ID 67 into scanning queue at locations 30 and 31 respectively the command line M&q30: 55 67 will do the trick.

The scan command [s#]

Scan command s determines how many tags are called from memory location 0 to #.

M&q0:88 99 21 28 s3 $ will force the synchronizer to call tags 88 99 and 21 repeadedly

Default mux memory starts with tag ID 20 in location 0 with ID numbers increasing by one for every consecutive memory location.

ADDENDUM : Tag power consumption

*The Hx19tx is a low power USID/RFID tag. Maximum input voltage is 4.5Vdc and minimum input voltage is 2.5Vdc. At full operating speed of 16 emissions per second, the unit consumes about 6mA @ 3V. During deep sleep it consumes approximately 20 micro amps, and in standby approx. 0.1mA. 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] or [ht] 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

Hx19t can accept variety of 3 v coin cell lithium batteries. These LIR2032, BR2032 and CR2032 will fit into the holder, LIR2032 is a lithium Ion rechargeable batter. The hx19t will perform well using BR2032 and CR2032, but it will perform better using LIR2032.

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”