

Hx7 Identities

Each hx7 device has a unique identity that can be modified. Hx7 devices only acknowledge if addressed fully and completely. Ampersand is used to separate addresses and data, address is on the left side of the ampersand and commands+data on the right side. Hx7 devices have three distinct identity attributes, they can be ultrasonic position receivers (PILOTS), ultrasonic transmitters (BEACONS) and command receptors. As a (receiver or pilot) the first character in its identity is always capital R, when it is a beacon (transmitter) this character is always T. As a receptor of commands the first character is always X. The user cannot change this behavior, it is a key in the basic functionality of the system. The first character is not identity it defines the operational modes for the device.

Example:

!& is

The exclamation is a global address symbol, devices programmed to recognize the command will respond to the (is) command. Receiving this command hx7 devices will enable the IMU.

X&is All hx7 devices enable their internal IMU (inertial measurement units)

X2&is All devices with the first two identifiers equal to X2 will enable the IMU, a device that has the complete identity X2 will enable the IMU and acknowledge.

X23& is Here the addressing is getting more specific, only devices with 2 and 3 as first and second identifier will enable their IMU.
Note the device X2 will neither set its IMU nor acknowledge. If there is a device with X23 as a complete identity then that device will both enable the IMU and acknowledge.

To change the identity of a device

X23&me:(1000,2000,0)|

From here on device X23 will apply its addressing scheme to X(1000,2000,0)& is, device X23 will respond to the alias X(1000,2000,0).

Once the device is powered of and restarted the address X23 is back, the new name can be burned into (flash) permanent memory

X23&me:(1000,2000,0)| wrf

To get this device to acknowledge receipt the full address

X(1000,2000,0)& is

is required.

Deployment Templates (Deployment.Sect.1)

To fully exploit ultrasonic positioning in terms of speed and range some parametric control should be used to fully utilize what the laws of physics allow. In order to simplify the process the hx7 uses "Deployment Templates". These templates are scripts that the hx7 units are able to interpret. Since all devices are linked together on a 2.5Ghz network, one device may forward commands to another devices.

Please refer to [hx7shortForm.html](#)

Example1 A lone autonomous Pilot (hx7 transceiver).

In this case there is no avatar or central computer, so the stand alone system "PILOT" must acquire the ratsnest and do the processing internally. Being a pinstem system the user can add a parallel processor to resolve the ratsnest into xyz. Note: line is ignored if it is empty or contains ` or \\. Anything between angle brackets <> is treated as addressed command.

Command.txt

cmd	<X&rst>	reset PILOT
cmd	<void>	Add an extra delay and allow 2 seconds for bootup
cmd	<X& ac ^X&rst>	Set Pilot passive then reset all X class devices in RF range
cmd	<void>	Add an extra delay and allow 2 seconds for bootup
cmd	< ^X&ac ec ic osb>	Set other devices passive, no echo, no IMU, enable broadcast
cmd	<X& at:120 osp ^X22& at:130>	THE MASTER SHOULD ALWAYS EMIT FIRST
cmd	< ^X23&at:140>	
cmd	< ^X24&at:150>	
cmd	<X&ec mu:21.22.23.24 ms as>	

Commands for non specific devices don't generate an acknowledge, so each line is sent with a 1 second delay. Here the pilot is device X21 and these commands are coming through a direct TTL wire that connects to the lone transceiver device called PILOT (T21,R21 and X21). Other devices can receive commands from the PILOT through the RF2.5G network.

This data is going through a single RF channel, so the other devices must send in tandem, or be sending simultaneously on different RF frequency channels. It takes each device about 3-4(mS) to send its data via RF, so if the action starts at t0 then time of flight takes t1 (20mS for 6.88meters), then some time must be allocated to the processing of results t2 (3ms) and finally transmission of result must be in sequential order if all data is directed through a single pin or a single channel.

With reference to the command.txt file the PILOT sends its results through its pin (osp see shortform), the rest must broadcast results over RF (osb see shortform) internal wire transmissions are about 0.5-1(mS), while RF transmission are 4(mS). With reference to command.txt, PILOT sends its results at the t0+120(mS) mark, device 22 sends at t0+120(mS), device 23 sends at t0+140(mS) and device 24 sends at t0+150(mS). Plenty of time given, and note that the positioning frame repetition cannot exceed 1/(t0+154)(mS) or a:154. In case speed becomes important, time allocation becomes more stringent.

This command script will cause the system to generate a ratsnest of distances as shown below.

Ratsnest (deployment.sect2)

Note: the number following the letter A in the ratsnest data on the right indicates distance in millimeters. E.g. There are 2752 mm from device 22 to device 21.

The 3d Ratsnest

The data sequence on the right shows a typical ratsnest result, this is what the **command.txt** in deployment template (sect1) configured the system to do. The file contains 3 position frames containing 4 blocks holding 3 distance elements each. Frames may hold undefined amount of blocks, with undefinate number of distance elements.

cmd <X&ec mu:21.22.23.24| ms as>

The PILOT was set to repeatedly call device 21 which is itself and 22,23 and 24 in tandem any sequence can be used. Note that the echo command was disabled, otherwise the PILOT would have included the distance to the nearest object as deducted from the echo, i.e. the T21 block would have included 5 elements instead of 4.

This ratsnest frame is not moving and is internally static, all objects are stationary. Note that each distance has a cross reference, e.g. the distance between R22 and T24, gets crossed inside the frame and becomes R24 T22. The signal flies both ways in the frame, hence the average will cancel wind effect. Knowing one fixed distance within the structure, temperature variations may also be compensated leaving pure and accurate distance. Should it be desired to map wind in the area, the difference between cross distances can be used.

Leaving nothing to the imagination this data presented on the right would constitute dynamic position mapping, where devices in motion may interact spatially with each other on the fly litterally.

```
T21
R22 T21 A2752
R23 T21 A2483
R24 T21 A2945
T22
R21 T22 A2748
R23 T22 A1438
R24 T22 A1304
T23
R21 T23 A2479
R22 T23 A1438
R24 T23 A2204
T24
R21 T24 A2933
R22 T24 A1305
R23 T24 A2200
T21
R22 T21 A2752
R23 T21 A2484
R24 T21 A2945
T22
R21 T22 A2747
R23 T22 A1438
R24 T22 A1306
T23
R21 T23 A2479
R22 T23 A1428
R24 T23 A2204
T24
R21 T24 A2933
R22 T24 A1304
R23 T24 A2199
T21
R22 T21 A2752
R23 T21 A2484
R24 T21 A2945
T22
R21 T22 A2748
R23 T22 A1438
R24 T22 A1305
T23
R21 T23 A2487
R22 T23 A1429
R24 T23 A2195
T24
R21 T24 A2933
R22 T24 A1304
R23 T24 A2208
```

More Deployment Templates file:command.txt

```

`this setup works, note if there is ` or // in a line, the line is excluded
`the commands inside the <> are sent to the hx7 through any available gateway
cmd <M&%>
cmd <X&rst>
cmd <X&rst>                two rst commands in case airways are crowded*
cmd <void>                  give the devices 2 seconds to reboot after reset
cmd <X&ac f:40 ic ec ocp osb ocu>
//above: all hx7 are listeners, echo,IMU,pinout,usart disabled. broadcast enabled
cmd <X21& me:33 | at:60>    alias=33 outputs results on 60th millisecond
cmd <X22& me:34 | at:70>    alias=34 outputs results on 70th millisecond
cmd <X23& me:35 | at:80>    alias=35 outputs results on 80th millisecond
cmd <X24& me:36 | is i:2 at:50> same as above but imu is enabled
cmd <M&a:200 f:33 s:4$>

```

*** if using a single RF2.5Ghz channel to both transmit and receive, there can be a broadcast conflict in the air.**

```

T33
R36 T33 A2030
R36_18:FFD7FF703EE7FF50FF6E009AFFD1FF713EE6FF4BFF6D009F%16
R34 T33 A2351
R35 T33 A1125
T34
R36 T34 A2810
R36_18:FFC9FF703EE8FF56FF6E0091FFC8FF7C3EE8FF47FF6B0088%16
R35 T34 A1502
R33 T34 A2351
T35
R36 T35 A2707
R36_18:FFCDFF7D3EDFFF59FF6E0094FFDBFF793EE4FF52FF70009C%16
R34 T35 A1504
R33 T35 A1117
T36
R36_18:FFCBFF6A3EEBFF53FF6F0096FFC6FF713EEBFF55FF7000A1%16
R34 T36 A2811
R35 T36 A2707
R33 T36 A2017
T33
R36 T33 A2030
R36_18:FFC5FF803EE4FF54FF6C009FFFC1FF7B3EECF59FF6C009D%16
R34 T33 A2351
R35 T33 A1126
T34
R36 T34 A2811
R36_18:FFD3FF783EE9FF5AFF7300AAFFCAFF733EE9FF58FF760097%16
R35 T34 A1501
R33 T34 A2351
T35
R36 T35 A2707
R36_18:FFD3FF803EE8FF57FF760092FFD1FF6E3EE5FF55FF83009F%16
R34 T35 A1505
R33 T35 A1117
T36
R36_18:FFCEFF773EF5FF53FF81009FFFD2FF743EE3FF51FF7F0097%16
R34 T36 A2809
R35 T36 A2707
R33 T36 A2026

```

On the left is the result from the Deployment Template shown above. This example differs from deployment.sect.1 in that there is no specified PILOT, there is a RF monitor hx7ms connected to a computer via USB. Hx7ms allows a central computer to monitor and control a network of devices as avatars. In this case there are 3 hx7 devices. The signal flight time has been set for all the devices at f:40, 40mS of flight limiting range to 13 meters. This Deployment template is not tailored for speed it suggests mostly. The hx7ms disables ranging echo, IMU and all output gateways except the RF gateway (osb). Every device gets a new name and the IMU on device alias 36 is enabled. Device 36 delivers the content of its IMU with its distance result for each block in the frame. During high speed sampling, time is of the essence; so the IMU is presented in hexadecimal format to reduce the size of data transferred for every block. Each IMU record contains 6 x 16 bit two's compliment values, representing Accelerometer X,Y,Z and Gyro X,Y,Z. The hexadecimal value between the underscore_ and double dot : indicates data records available in the FiFo buffers of the IMU chip. Value following the % indicates what is left in the buffers after we pull our data. The command i:2 (see above) demands two IMU records for each block. With an interval of 200mS and the IMU sampling at 119s/s there are about 24 IMU records for each block cycle in this example.

High Speed Deployment Template

` this setup works, note if there is ` or // in a line, the line is excluded

` the commands inside the <> are sent to the hx7 through any available gateway

```
cmd <M&%>
```

```
cmd <X&rst>
```

reset all devices in the air

```
cmd <X&rst>
```

if lots of active devices are in the air, then repeat

```
cmd <void>
```

give the devices 2 seconds to reboot after reset

```
cmd <X&ac f:14 ic ec ocp osb ocu>
```

sets sonic flight at 14ms (5meters)

```
//above: all hx7 are listeners, echo,IMU,pinout,usart disabled. broadcast enabled
```

```
cmd <X24& at:18>
```

command gives X24 4mS (18 - 14) to compute distance to device 23

```
//on 18th mS X24 broadcasts distance data at 250Kb
```

```
//if receiver is hardwired USART can be used at 4Mbaud
```

This example is about high speed sampling using ultrasound up to 5meters. Extra care is required in this case when selecting parameters. At 43s/s and device to device operation our fast computers were lagging behind, data had to be buffered. For high speed 3D positioning, it would be wise to add an additional data manager to the PinStem structure that hosts the Hx7. Data should be transmitted pin to pin at 4Mbaud or higher, particularly so if the IMU is included in the data stream. The data can be buffered while the ultrasonic signal is in flight merged with data from other hx7 transceiver and streamed through a central computer. At high speed it is desirable to use more than a single channel to deliver the data stream.

On the right is the data stream resulting from the high speed Deployment Template above. The devices are stationary.

R24 T23 A4018

T23

R24 T23 A4019

T23

R24 T23 A4019

T23

R24 T23 A4019

T23

R24 T23 A4019

T23

R24 T23 A4015

T23

R24 T23 A4019

T23

R24 T23 A4018

T23

R24 T23 A4015

T23

R24 T23 A4019

T23

R24 T23 A4019

T23

R24 T23 A4015

T23

R24 T23 A4019

T23

R24 T23 A4019

T23

R24 T23 A4019

T23

R24 T23 A4018

T23

R24 T23 A4019