

The Network Controller HX11C

To use the xyz or the datalog program the HX11TR transmitters/receivers must be connected to a network controller HX11C. The HX11C controls the network and the communications with the PC. It should be located within 2 meters of the PC. The program xyz.exe reads the data from the HX11C, and computes the position of the transmitters detected by the receivers. The power points on the HX11C, are connected to the network power lines, and can serve to supply power to the whole network. Be aware that telephone lines carry limited amperes, and there is a voltage drop in direct proportions to the wire length. In case of long lines, and high number of receivers, it may be necessary to use local power for a far away cluster of receivers.

If other deviation triangulation programs are used, although a direct multidrop communication is possible with the HX11TR, readily available RS485 devices are better for multidrop network applications.

Note that it may be necessary, to ground the power supply used to supply the network with power. Because some switching power supplies used for laptops can cause excessive line noise.

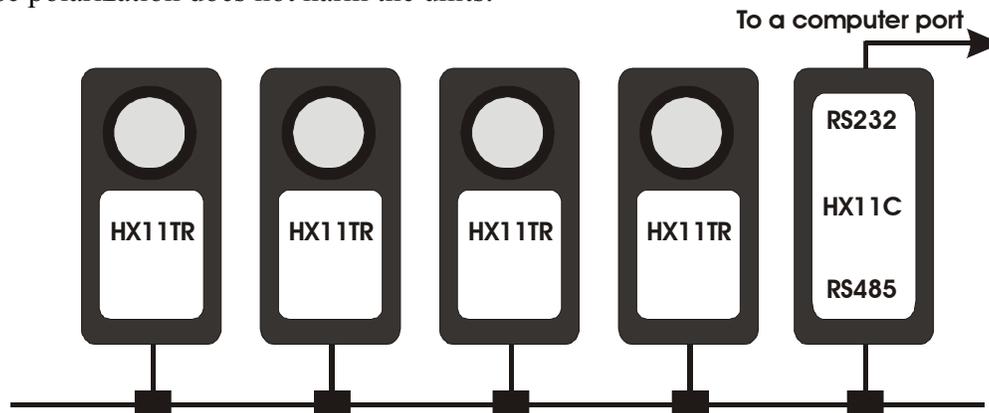


Specification	
Supply Voltage	7-16Vdc
Current Consumption	40mA
Network Drive Capacity	128 devices

Hx11 network

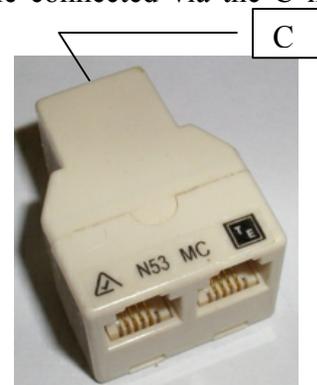
The HX11 components can be connected to a network of devices utilizing FCC RJ11 style port. The RJ12 or RJ11 socket can be found on most domestic telephones, it is the socket that connects the telephone to the wall fixture. Most HX11 components have one or two RJ11 sockets. The communications and power to the HX11 is supplied on the network through the RJ12 or RJ11 port. It is eventually up to the user, to choose local, mobile or network line power. Hx11 components have RS485 transceivers used for large networks, of several thousand hx11 devices communicating over long distance covering tens of kilometers.

The illustration below shows a Hx11 network, using T connectors (available from your nearest hardware store). The overall or total cable length should not exceed 10 miles or 16 kilometers for the RS485 network. All receivers have a direction diode on the input, reverse polarization does not harm the units.



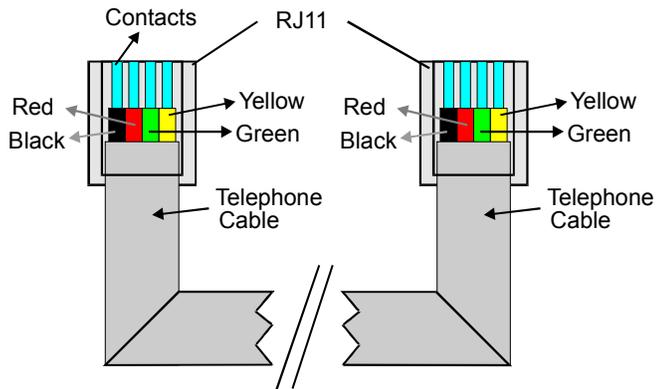
Using T connectors

T-Connectors are generally available at hardware stores selling telephone cables and accessories. The T connector joins 3 separate telephone cables, and it has 3 RJ11 or RJ12 sockets A, B and C. **The Hexamite network should have no wires crossed.** Some T connectors have the C input inverted. In this case the cable connected via the C input must be inverted too.



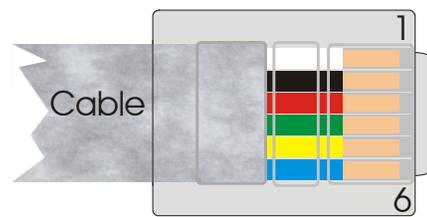
RJ11 and telephone cables

The figure on the right shows how the RJ11 needs to be attached to the cable. It is important that the colors match, when looking down on both topsides of the cable end RJ11 plugs. The cable connections should not be crossed. Inexpensive tools are available, to help join the RJ11 to the telephone cable. It does not damage the monitors if they are inadvertently inverted. But it could block out the whole multidrop network until removed and corrected.



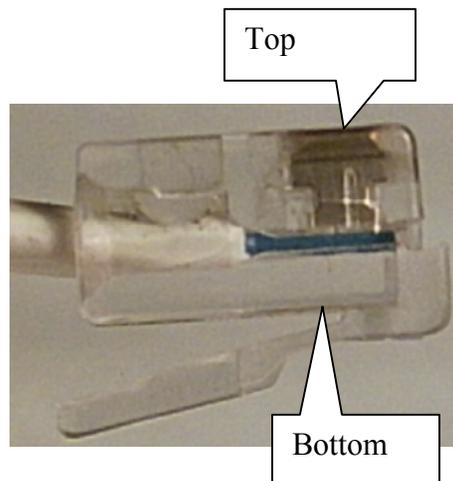
The RJ12 (RJ11)

The images to the right show a RJ12 jack and what we mean by top and bottom. It also shows how the colors are situated. The colors in the illustration to the right are listed 1 thru 6 looking from the top into the plug. This equals looking into the RJ12 socket, where the leftmost pin is pin 1 and the rightmost pin is pin 6.



Baud rates and settings

The HX11C communicates at 19200 baud, it uses one stop bit, no parity, and eight bits transfer.



Wire Configuration HX11 devices using RJ12			
Contact	Wire color	Wire function	Electrical Specs
1	White	Not Used	0 - 7 Vdc *
2	Black	Ground / Return (Negative)	0V
3	Red	RS485 Positive	+/- 7V
4	Green	RS485 Negative	+/- 7V
5	Yellow	Power Input (Positive)	8-16Vdc
6	Blue	Device Hard Reset	0 - 7 Vdc *
<i>* Current forced through the Mode and Reset pins should never exceed 20mA</i>			

RS232 to USB

If your interfacing device does not have RS232 port converters from USB to RS232 are readily available. Go to your nearest electronic store. These can be used to bridge the gap between the USB port and the Serial port.



Program datalog.exe

This program reads the data stream directly from the network controller. And stores the data on file. This file can then later be converted to timeline tag positioning data, using the program xyz in mode 1. If the program data is running; then xyz.exe running in mode 3 can tap into the data stream real time, while data from the network controller is being stored on file monData.hxm.

Please refer to the Data display window below. The first 4 digits in the data string are the hexadecimal representation of the monitor's ID. Each tag is represented with a total of 10 hexadecimal digits. The first 4 contain the tag's ID number and the remaining 6 represent the position timing data. If the same tag exists in both upper and lower acquisition cycles (see the data program window), then the tag transmission rate is too high. If the xyz.exe program is used to extract 3D position out of the monData.hxm where this rule is violated, it will probably crash. Sometimes a monitor can pick up the same tag twice in the same acquisition cycle, the xyz program treats the latter pickup as echo of the first and it is ignored.

CRITICAL OPERATION RULE

A monitor or monitors should not pick up the same tag in two consecutive acquisition cycles. Run the tags at the slowest transmission rate at first, and then gradually increase the rate, to find the limit.

Data display window		
Accepted	Banned	Accepted
4E50 000218355B #	4E50 0002618BCC #	4E50 00031399AC 00021507DB #
4E52 0002186B6F #	4E52 000261C1E8 #	4E52 000313D987 0002153DE9 #
4E54 0002185317 #	4E54 000261A980 #	4E54 000313BD38 0002152578 #
4E56 0002184403 #	4E56 0002619A75 #	4E56 0003139A33 000215167B #
4E50 000348DBFA #	4E50 0002103663 #	4E50 #
4E52 0003491BC6 #	4E52 0002106C6C #	4E52 #
4E54 000348FF83 #	4E54 000210540E #	4E54 #
4E56 000348DCC6 #	4E56 0002104500 #	4E56 #

If the xyz program cannot evaluate a position it returns 0 for the scanned coordinate. Setting the reference coordinates at a nonzero value, and making (0,0,0) an impossible position, evaluation failures can be ignored from a plot.

If ? follows the monitor rather than #, then that specific monitor is not replying to the polling of the Network Controller. In this case make sure the connection is good and the monitor is turned on. **NOTE: the network controller polls only the receivers specified in the layout.hxm file.**

Note that the rule of operations specified above, also applies to the xyz program in all modes of operation.

The XYZ program (See software utilities section)

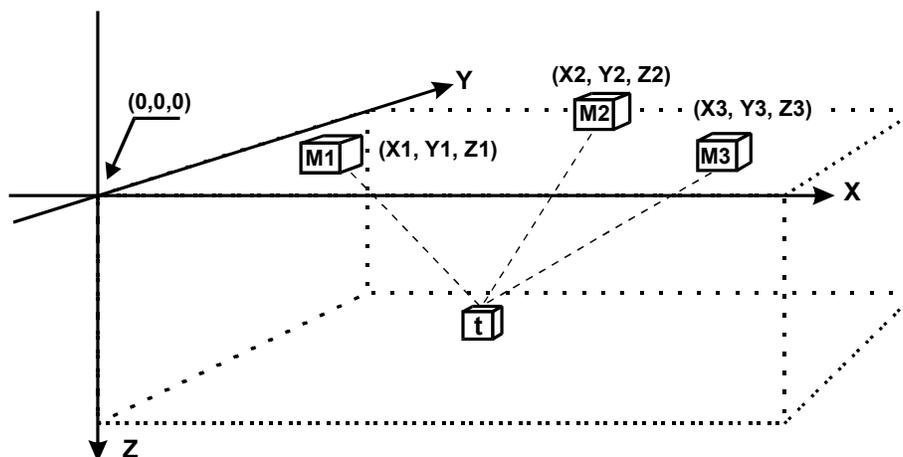
The XYZ program converts the position of multiple transmitters into actual 3D coordinates (X,Y,Z). It reads the time-tag of the transmitters, either directly from the HX11C (network controller) or from a file with the time-tag information such as monData.hxm. This file is created by a program called datalog. The XYZ program can also gather time-tag information through DDE and convert to 3D coordinates. It does this by comparing time-tags from several monitors (receivers), and computing the X, Y, Z coordinates from the time difference.

This data tag id, (X,Y,Z), time of arrival, is stored on a file named by the time and date the file was created. The user can tap into all data as it is being created by the xyz.exe program; for real time monitoring. This is done using DDE (Dynamic Data Exchange) see (DDE example) in the software section.

Using the XYZ program

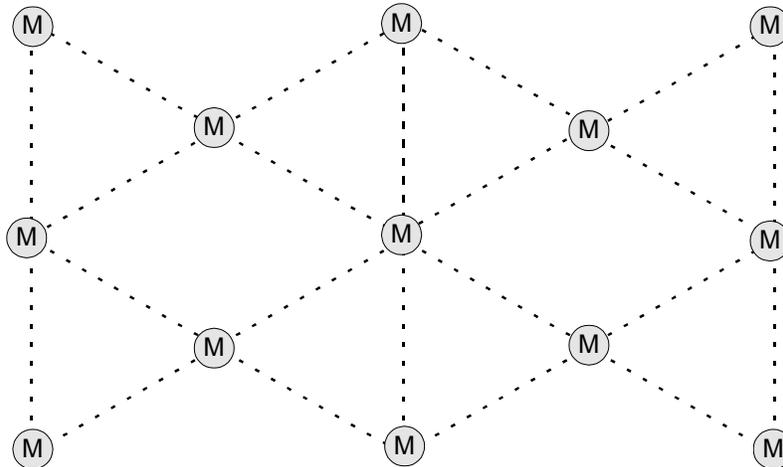
The XYZ program requires the (x,y,z) coordinates to be specified for each receiver, on the network. These coordinates can be entered into a text file (layout.hxm). The xyz program reads this file, and relative to origin (0,0,0) placed at the users convenience, it calculates the position of the transmitters in range based on these coordinates. All positions should be in the positive x and y quadrant. The tag coordinates and time of encounter are stored in directory [xyz Data]; on a file with a name given by time and data. Other program applications have access to the xyz data stream via DDE (dynamic data exchange).

The image below, suggests how overhead monitors can be set up for example in a room where the 0 (xy) plane is the ceiling.



Wide Area Coverage

The illustration below, suggests how a large area can be covered, using monitors. Any formation can be chosen. But the following formation will provide one of the best coverage per unit cost. In the following the D distances between monitors are everywhere the same. The monitors form 60-degree triangles. Depending on the density of the network, many monitors may contribute to the positioning of a given tag. The higher then number of monitors that detect the tag, the more accurate and stable will be the positioning.



Setting up for Z evaluation

The HX11 operates on equidistance principle. It assumes there exist equidistance lines between the monitors (receivers) which all cross where the tag or transmitter is located. Imagine the receivers set up in a triangle, and the transmitter located at equal distance from them all. In this case equidistance exists along a line right through the triangle. Therefore the fourth receiver is needed to fix Z to a point rather than a line. If Z needs to be tracked, don't set the receivers all on the same plane.

Data Evaluation and Errors

If the xyz program is unable to calculate coordinates, some of the X, Y or Z coordinates will read zero. Setting the receiver layout so that zero is an impossible coordinate (i.e.) at zero the transmitter is out of range, will help programs disregard unsuccessful scans. The last number in the data string i.e the result from the xyz program's position scan indicates how many lines were available to construct the coordinate. If this number is less than 3, what ever coordinates resulted should not be considered valid. Note that tags can collide, data from two or more tags may intercept and cause an erroneous reading. If a tag isn't picked up by more than two monitors (lines available number < 3); and it is picked up in one acquisition cycle (only) over a period of some time, it should be disregarded.

XYZ Version 2. program description

The XYZ needs four files to run, **these files must be located in the directory where the xyz.exe is located.** These files are:

MonData.hxm	(mode 1 only)
Layout.hxm	(must access in all modes)
Parameters.hxm	(must access in all modes)
Sspeed.hxm	(must access in all modes)

MonData.hxm is created by a program called data.exe. All files with hxm extension are text files which can be read and modified using Notepad.exe.

Layout.hxm, can be created by the user, or it can be created using the layout.exe program. First column is the monitor's X coordinate, the second column is the Y coordinate and the third column is the Z coordinate. The fourth column is the tag's ID.

File: Sspeed.hxm

XYZ looks for a speed of sound parameter in a file called sspeed.hxm on startup. In the sample file the speed of sound is set at 340 (m/s). Changing this value, will effect the outcome of the (xyz) coordinate calculation

File: Layout.hxm

2040	1440	0	20048
2950	1000	0	20050
2180	450	0	20052
1000	1000	0	20054

Coordinates are always entered in millimeters; the above translates to:

Monitor 20048 location: (x,y,z) (2040,1440,0)
Monitor 20050 location: (x,y,z) (2950,1000,0)
Monitor 20052 location: (x,y,z) (2180, 450,0)
Monitor 20054 location: (x,y,z) (1000,1000,0)

Suggestion

For testing using the parameter file below, set the monitors on a XY cross with about 2 meters between monitors on the XY axis. This is just a suggestion; any formation can be evaluated.

File: Parameters.hxm

The numbers in the following are arbitrary setting, these numbers should be set to suit the setup.

5	"Line1: Total Number of Monitors on this network "
1	"Line2: delay between updates"
1	"Line3: Communications Port 1,2,3,4,5,6 and etc"
1	"Line4: 1 = high and 0 = low communication speed"
1	"Line5: Mode 0 through 2"
256	"Line6: Scan Step"
1000.5	"Line7: Scan Tolerance"
10000	"Line8: Maximum Distance Between Monitors"
-200	"Line9: X scan range start in mm"
+200	"Line10: X scan range end in mm"
-200	"Line11: Y scan range start in mm"
+200	"Line12: Y scan range end in mm"
2000	"Line13: Z scan range start in mm"
4000	"Line14: Z scan range end in mm"
3	"Line15: viewing 1=on 0=off"
4000	"Line16: Viewing window full scale X"
4000	"Line17: viewing window full scale Y"
6000	"Line18: viewing window full scale Z"
0	"Line19: viewing window offset X"
0	"Line20: viewing window offset Y"
0	"Line21: viewing window offset Z"

Parameters Description

Line1: Total number of monitors on the network

This value is crucial, and must be updated if a monitor is added or removed from the network. The xyz program and data both rely on this number.

Line2: Sampling Rate Control (whole network)

For the standard systems the Interval between updates is calculated as follows:

Interval Between Updates= 0.131072s * (Sampling Rate Control Value)

The (Sampling Rate Control Value) must be an integer number from 1 to 255. If faster or slower update rates are desired, contact Hexamite; the HX11NC network controller needs to be modified or replaced. When the interval times out, data is recovered from all monitors on the network.

Line3: Communication Port

The value of this line selects the serial communications port used, Com1, Com2 ..., ComN. This parameter is an integer value representing the value of a free comport on the monitoring computer.

Line4: 1 = high and 0 = low communication speed

Not applicable, doesn't matter what you put here.

Line5: xyz Operation Mode

The value of this line can be 0, 1 or 2; these values select one of the following modes.

Mode 0: (Real Time Mode)

In this mode the program taps directly into the data stream from the Network controller HX11NC, this data is converted to xyz time coordinates and made available via DDE. See visual basic sample program DDEexample below section DDE interface. Note that in real time mode the data is not time tagged. Since this is real time the computer clock can be used to log time. In case of many tags and monitors working at high sampling rates, the computer may not be able to keep up in this mode. Therefore the communication buffer will fill up and eventually overflow, this will crash the program. Operations should be restarted at lower sampling rate with fewer monitors and tags. In case high-speed real-time operations are needed, monitor networks should be divided among more high-speed computers. The computers can then be networked together for high speed and large system operations.

Mode 1: (Filing Mode)

Data from file called MonData.hxm is converted to tag positions (x,y,z) on a timeline and stored in a subdirectory [xyz Data]. If this subdirectory doesn't exist on your computer the xyz program creates it. The name of the processed positioning data becomes the time and date the data was acquired. For example:

Jun 09 040609143505.xyz is actually the date June 9th 2004 and the time is 14:35:05.

If the format of this name is changed, the layout program will not be able to display the tag and it's position on the background image.

Mode 2: (Real Time Mode.)

In this mode the xyz program gets it's data from another program called data. This program must be up and running before xyz is executed in this mode. And like in mode 0 the xyz coordinates are available through DDE using the DDEexample program. In this real time mode falling behind is no problem. Program data taps into the data stream from the network controller hx11nc and stores the data in raw form on a file called monData.hxm. While this data is being stored on the file; the xyz program can monitor the data, convert it to xyz coordinates and make these coordinates available via DDE to the user for real time applications.

Line6: Scan Step

The computer has to scan for the rough x,y,z positions. This number represents the size of the scan step in mm. If for example the largest distance between two monitors detecting a specific tag is 2000mm. Then selecting this value as 100mm means 20 scans will determine the position. But in this case if for example there are 3000mm on the X axes, 2000mm on the Y axis and 500mm on the Z axis then the total number of steps are $30 \times 20 \times 5$ or 3000 steps total.

Once the rough position is found the computer iterates for the fine position 8 times cutting the scan step finer by the factor of two every time. For example if your scan step is 128 you have.

Iteration 1.	128/2 or	64mm
Iteration 2.	64/2 or	32mm
Iteration 3.	32/2 or	16mm
Iteration 4.	16/2 or	8mm
Iteration 5.	8/2 or	4mm
Iteration 6.	4/2 or	2mm
Iteration 7.	2/2 or	1mm
Iteration 8.	1/2 or	1/2mm

Experiment with this value to see what suits you best.

Line7: Scan Tolerance

The computer conducts minimum square error evaluation for the convergence of the coordinates. The resulting minima is $\text{ErrorX}^2 + \text{ErrorY}^2 + \text{ErrorZ}^2$. If the minima is greater than Scan Tolerance value that coordinate calculation is ignored.

Experiment with this value to see what suits you best.

Line8: Maximum Distance Between Monitors

This value tells the program the maximum allowable distance between the monitors which detect a given tag. For example. If there is a large setup and Tag 500 is detected by the monitors surrounding it. And it is detected by an error by a monitor elsewhere in the setup, perhaps 20 or more meters away. The XYZ program will attempt to include the error detection in the calculation for the position of Tag 500. This could delay the calculation for the point significantly, and give erroneous results. It is not likely that Tag 500 is picked up by an error, but it can happen.

Line9: X scan range start in mm

If for example two monitors pick up tag 100. Where one monitor is on the X axis at 20400 (mm) and the other at 22400 (mm). Given that this value equals (- 300) then the scan for the X position of tag 100 starts at 20100.

Line10: X scan range end in mm

Please refer to the example for line 9. This value determines where the scan for tag 100 ends. Given that this value equals (+200), the scan for tag 100 ends at X equals 22600 (mm)

Line11: Y scan range start in mm

If for example two monitors pick up tag 100. Where one monitor is on the Y axis at 20400 (mm) and the other at 22400 (mm). Given that this value equals (- 300) then the scan for the Y position of tag 100 starts at 20100.

Line12: Y scan range end in mm

Please refer to the example for line 9. This value determines where the scan for tag 100 ends. Given that this value equals (+200), the scan for tag 100 ends at Y equals 22600 (mm).

Line13: Z scan range start in mm

If for example two monitors pick up tag 100. Where one monitor is on the Z axis at 20400 (mm) and the other at 22400 (mm). Given that this value equals (- 300) then the scan for the Z position of tag 100 starts at 20100.

Line14: Z scan range end in mm

Please refer to the example for line 14. This value determines where the scan for tag 100 ends. Given that this value equals (+200), the scan for tag 100 ends at Z equals 22600 (mm).

All axis are treated equally. The setup in the parameters file is geared towards an office environment where the Z position of the monitors is 0. And the Z position for the tags can only be between 2 and 4 meters from the ceiling, this cuts down on processing time.

Line15: Viewing

This value enables graphic viewing of the xyz positioning in any mode. Please note that this feature slows the processing down considerably. The computer cannot process as many tag positions per second with this feature enabled, therefore real time operations risk falling behind.

Line 16 and 18: View Window Scaling

The value of line 4 and 5 is the full scale of the viewing window in terms of millimeters.

Lines 19 and 21: View Window Offset

The value of these lines will pan the viewing window left/right or up/down.