

## Frequency comparator CH7-1015. Application note #2.

### «Working with the device in remote control mode»

Frequency comparator CH7-1015 provides operation in remote control mode via the Ethernet interface of the local network using the TCP socket. In this mode, it provides parameter setting, remote start and stop of measurements, obtaining results and an array of measurements. This mode is primarily intended for the operation of the frequency comparator as part of a measuring system, where, using a commands set, any desired algorithm for using the device can be implemented. Also, this mode can be used directly if, for some reason, the remote desktop mode is not available. Unlike the remote desktop mode, which allows multiple access to one device from several workplaces, including the frequency comparator itself, the remote control mode allows you to control the device from only one workplace. In this case, control of the device from the front panel is blocked. To perform the remote control mode, it is necessary to connect the frequency comparator to the control PC via the local network. To operate within a peer-to-peer network, there is no need to change any router parameters. If you need to access the device from another network or need remote access over the Internet, you should provide port forwarding on your router that has access to the external network. The easiest way to demonstrate a connection to the device is to use a telnet client. This document describes how you can establish a connection and send commands using a Linux and Microsoft Windows PC. The basic principles of setting up access to the device in a peer-to-peer network are also considered. For more complex network configurations, the setup is the similar. The appendix contains the Protocol of information-logical interaction of the frequency comparator CH7-1015 with an external control device.

#### 1. Configuring the router.

To configure the router, you need a PC connected to it via a local network with an established connection. Also, you will need administrator rights to access the router. Let us consider setting up the router, for example, on the NetGear Genie router. For other routers, the configuring will be made in the same way. In this case, the device's web interface will be used for configuration. To access the router, launch any Internet browser on your PC and enter the router's IP address into its address bar. If the address is correct, a window will appear to enter the administrator's login and password. After entering them, the web interface will open in the browser window. Find there a tab with the name "Setup" and from the "Internet setup" field, copy or write down the IP address of the router in the external network. Find there a tab with the name «Setup» and from the «LAN Setup» field, copy or write down the IP address and IP Subnet Mask. These data will be needed in the

future to set up a connection. Find in the menu a tab with the name «Port Forwarding/Port Triggering». Select the «Port Forwarding» option. Click the button with the name "Add Custom Service" and in the new window enter the name of the new service, for example "CH7-1015\_Remote\_Control". Select the protocol - "TCP / UDP" and in the "Internal IP address" field enter the IP address under which the frequency comparator is registered in the network. You can find out it on the tab with the name "Attached devices" using the MAC address of the frequency comparator for identification. You can also find these parameters on the tab with the name "System" of the "Mode" window of the frequency comparator. Enter 49999 in the «External port range» field. This port will be used to exchange information between the control PC and the frequency comparator. Enter the same value in the «Internal port range» field or select an option «Use the same port range for Internal port». Save the changes by clicking the "Apply" button. From now on, all IP packets arriving at the router through this port will be forwarded to the frequency comparator, and responses will be sent to the addressee. In case you have several frequency comparators, and all of them require remote control, and also if there are any other devices using port 49999, you should create an appropriate number of new services with the corresponding IP addresses. You should also assign, if the router provides such an opportunity, to each of these devices a unique external port address through which information will be exchanged with this specific device. Select it from the range of 49152 - 65535. Most likely they will be unused. Save changes and close the router's web interface. Its configuring is complete.

## **2. Configuring the frequency comparator.**

Connect the frequency comparator to the router using the Ethernet cable supplied with the device. Turn on the device and wait for the user interface to load. Open the window with the name "Mode" by clicking the button located in the upper right corner, and go to the "System" tab (Fig. 1). In the "IP Address" field, input the IP address of the frequency comparator obtained from your system administrator. In the "Gateway" field, input the IP address of the router in the local network. This data could also be obtained at the previous stage "Configuring the router". Click the «Apply» button and check the new parameter values in the window status bar. Close the "Mode" window by clicking the "OK" button. Configuring the device's connection to the local network is completed. These values will be saved and used the next time the frequency comparator is turned on.



Fig. 1

### 3. The frequency comparator CH7-1015 remote control from a Linux PC.

For remote control of the frequency comparator from a Linux PC, there is no need to install any additional software, except for the optional installation of a telnet client, if it is not included in the basic software set. In this case, installation is carried out by the command "apt-get install telnet" from the terminal window.

Open the terminal window from the programs menu or by the «Ctr+Alt+T» combination, and in window that opens, start a telnet session by the «telnet <IP адрес прибора> <порт>» command. In our case, the command will be «telnet 192.168.1.24 49999». If the connection is successful, the system will respond «Connected to 192.168.1.24» message. From now on, you have one minute to switch the frequency comparator into remote control mode. If the device is not switched into remote control mode within this interval, the established connection will be terminated and the TCP socket will go into the waiting mode for a new connection. The telnet client will report this by the message "Connection closed by external host.".

Switch the device into remote control mode by the command «<0b,0,R>. Here: 0b - system address of the frequency comparator in hexadecimal format (11 in decimal), set by default; 0 - the command is addressed to the "device as a whole" subsystem; R - command to switch to remote control mode. After receiving the command, the device responds by the message «>0b,0,R,!» and displays an remote control information window (Fig. 2).

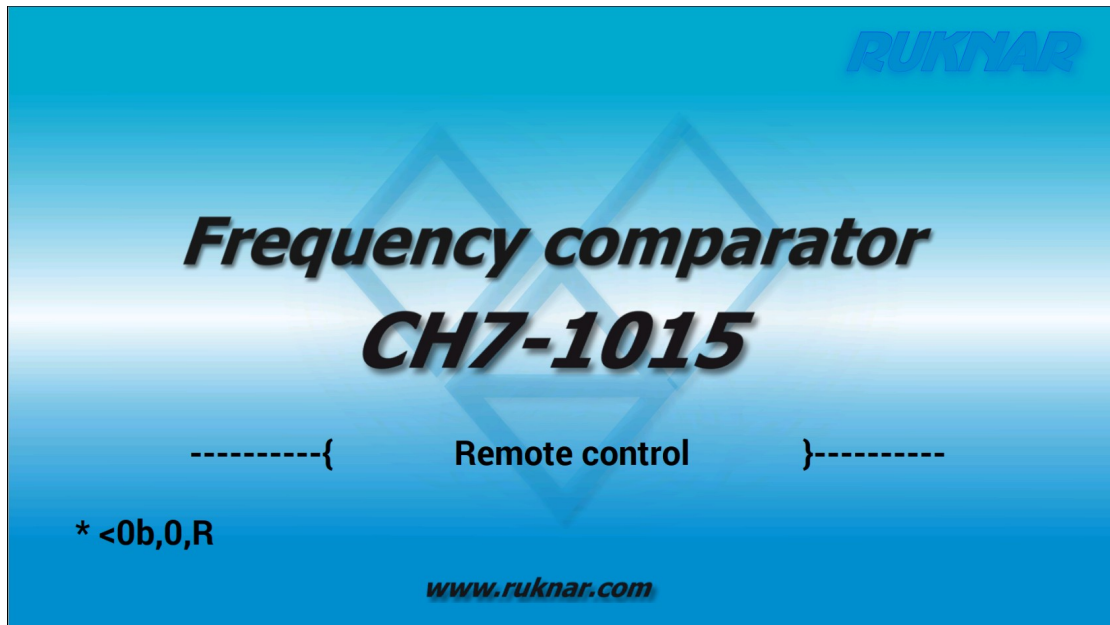
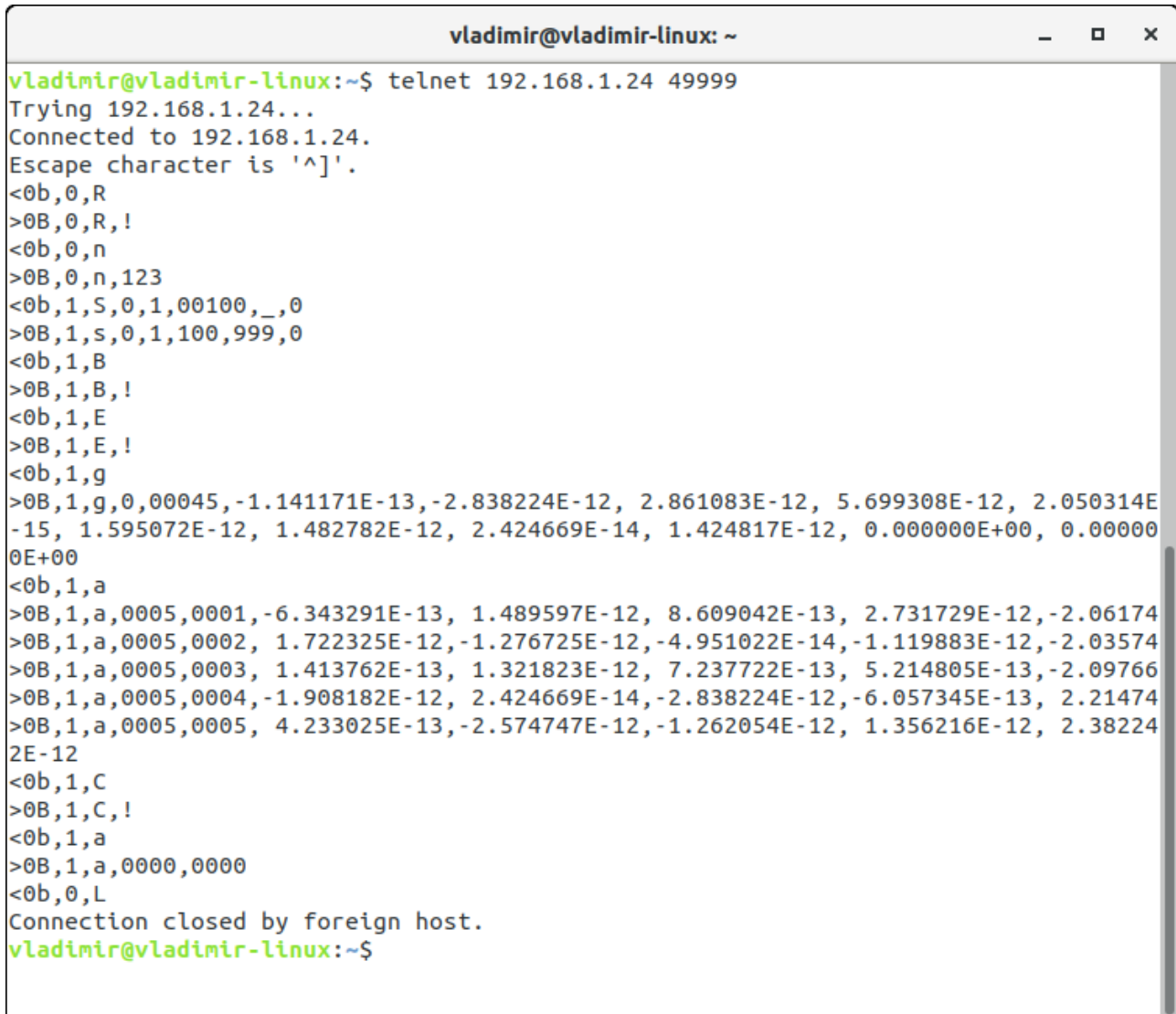


Fig. 2

Among other things, the last remote control command received by the frequency comparator will be displayed in the information window. The local control of the comparator frequency will be locked until you exit the remote control mode. From this moment, by sending the appropriate commands, you can set any desired measurement mode, start measurements and receive their results, stop them at any time. An example of such a session is shown in Fig. 3. There:

- the connection is established;
- the device is switched to remote control mode;
- the serial number of the device is requested;
- the following measurement parameters are set:
  - 10 MHz - the nominal frequency of measured signal;
  - 10 s - the averaging time;
  - 100 measurements - the length of cycle;
  - outliers - no change;
  - using the square root of two - not used.
- the measurements are started;
- the measurements are stopped before the normal end of the cycle;
- the results of measurements are requested;
- the array of measurements is requested;
- the results of measurements are cleared;
- the array of measurements is repeatedly requested;
- the device is switched to local control mode;

To separate the commands from the answer messages, in the example are additionally entered the <LF> symbols.



```
vladimir@vladimir-linux: ~
vladimir@vladimir-linux:~$ telnet 192.168.1.24 49999
Trying 192.168.1.24...
Connected to 192.168.1.24.
Escape character is '^]'.
<0b,0,R
>0B,0,R,!
<0b,0,n
>0B,0,n,123
<0b,1,S,0,1,00100,_,0
>0B,1,s,0,1,100,999,0
<0b,1,B
>0B,1,B,!
<0b,1,E
>0B,1,E,!
<0b,1,g
>0B,1,g,0,00045,-1.141171E-13,-2.838224E-12, 2.861083E-12, 5.699308E-12, 2.050314E
-15, 1.595072E-12, 1.482782E-12, 2.424669E-14, 1.424817E-12, 0.000000E+00, 0.00000
0E+00
<0b,1,a
>0B,1,a,0005,0001,-6.343291E-13, 1.489597E-12, 8.609042E-13, 2.731729E-12,-2.06174
>0B,1,a,0005,0002, 1.722325E-12,-1.276725E-12,-4.951022E-14,-1.119883E-12,-2.03574
>0B,1,a,0005,0003, 1.413762E-13, 1.321823E-12, 7.237722E-13, 5.214805E-13,-2.09766
>0B,1,a,0005,0004,-1.908182E-12, 2.424669E-14,-2.838224E-12,-6.057345E-13, 2.21474
>0B,1,a,0005,0005, 4.233025E-13,-2.574747E-12,-1.262054E-12, 1.356216E-12, 2.38224
2E-12
<0b,1,C
>0B,1,C,!
<0b,1,a
>0B,1,a,0000,0000
<0b,0,L
Connection closed by foreign host.
vladimir@vladimir-linux:~$
```

Fig. 3

After exiting the remote control mode, the device returns to the local (from the front panel) control mode with the last established measurement parameters.

#### 4. The frequency comparator CH7-1015 remote control from a Windows PC.

As with other operating systems, the telnet client software is required to demonstrate remote control of the frequency comparator from a Windows PC. This software may not be installed by default, but it can be installed optionally. We will consider this case using the example of the Windows 10 operating system. To install or confirm the installation of the telnet client software, open the «Settings» window and select there an «Apps» option (Fig. 4). Find there the item

«Programs and Features» and select an «Turn Windows features on or off» option.

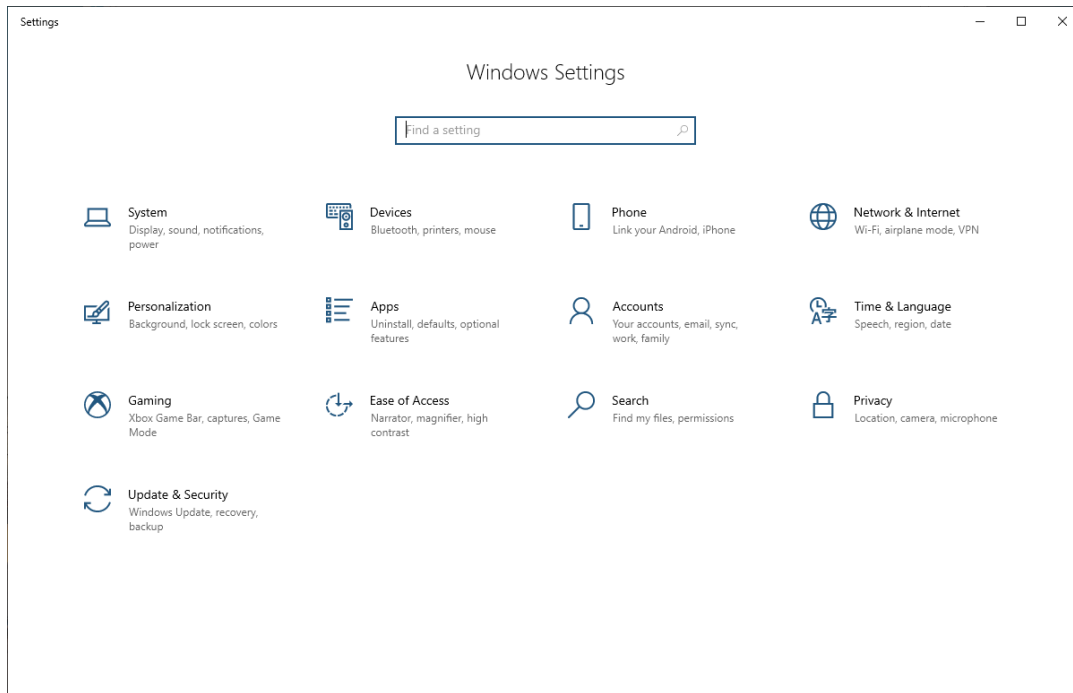


Fig. 4

Find the "Telnet Client" feature there and check it (Fig. 5). Click the "OK" button and wait for the service start.

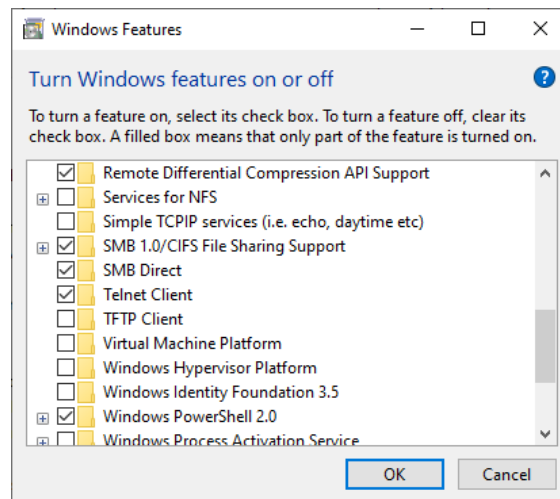


Fig. 5

After that, find the "Windows System" item in the «Start» menu and from there open the "Command Prompt" window. Type the command "telnet 192.168.1.24 49999" and switch the frequency comparator to the remote control mode (Fig. 6). All further work is carried out in the same way as in Linux OS, described in the previous section.



```
CA: Telnet 192.168.1.24
>0B,0,R,!
<0b,0,n
>0B,0,n,123
<0b,1,s
>0B,1,s,0,1,10000,999,0
```

Рис. 6

## Appendix.

**Protocol of information-logical interaction**

of the frequency comparator CH7-1015 with an external control device (version 1.1).

**1. Common statements.**

1.1 The device is controlled by sending commands and receiving response messages. The frequency comparator does not send any messages without a request.

1.2 The commands set is designed for remote control of all modes of frequency comparator CH7-1015 during its operation as part of an automated measuring system. This allows to receive information about the state of the device, program parameters, start measurements and receive their results.

1.3 The device is controlled through the Ethernet interface by means of TCP/IP protocol socket. To establish a connection, you must use the port number 49999 and the device's IP address specified on the «System» tab of the «Mode» window.

1.4 The field separator in commands and response messages is the "," (comma) character. Here and below, unless otherwise indicated, all characters are represented in ASCII code.

1.5 The final character of commands and response messages is the character <CR> (0x0D).

1.6 The format of the numeric fields is as follows:

- Unsigned integer - **xxxxxxxxxx** (a number of decimal digits– from 1 to 10);
- Signed integer - **zxxxxxxxxxx** (a number of decimal digits– from 1 to 10);
- Real - **zx.xxxxxxEzxx** (a number of fraction – up to 8);
- Real with a fixed point - **zxxxxxxxx.xxxxxx**;

where: **x** is a decimal digit from 0 to 9; **z** is a "+", "-", or " " space symbol.

1.7 Command header format: <**AD** (dress), **S** (ubsystem),

where: **AD** is two hexadecimal digits representing the device address in the measuring system (system address) (00 to FF);

**S** – a decimal digit representing the subsystem of the device to which the command is addressed from the set:

- 0 - frequency comparator as a whole;
- 1 - subsystem of the frequency comparator;
- 2 - subsystem of the rubidium oscillator.

For example: <**0F,0,R**<CR> - command the device with system address 0F to switch to remote control mode.



1.8 Response message header format: >**AD**(ress),**S**(ubsystem),

where: **AD** is two hexadecimal digits representing the device address in the measuring system (system address) (00 to FF);

**S** – a decimal digit representing the subsystem of the device from p.1.6 that answers to the command.

For example: >**0F,0,R,!<CR>** - a response message from the device with system address 0F about switching to the remote control mode.

1.9 Incomplete and out-of-format commands are not executed and no response message is issued. The number of fields in commands and response messages is fixed. Fields with a zero length are not allowed. A zero-length field is counted missing and is considered as a format violation. If you want to keep the current value of the parameter, the corresponding field must contain the "\_" character.

1.10 Any subsystem of the device, except for the subsystem "frequency comparator as a whole", may be absent in this particular device. In this case, the following response message is issued as a response to the correct command to the missing subsystem:

<**AD**(dress),**S**(ubsystem),?**<CR>**

For example: >**0F,2,?<CR>** - a response message from the device with system address 0F that does not have a rubidium oscillator subsystem, as a response to a correct command to the rubidium oscillator subsystem.

1.11 When using the local network interface for remote control, the command must specify the correct system address. If the connection is established, but the command to switch to remote control mode is not received within one minute, the established connection is canceled and the TCP socket enters the waiting state for a new connection.

1.12 The frequency comparator CH7-1015 supports multiple access to remote desktop using VNC (Virtual Network Computing) technology. To do this, use the port number 5900 and the IP address of the device specified in the «System» tab of the «Mode» window. To establish a connection through the client software, the password "ruknar" must be used. In remote desktop mode, only mouse control is supported.

## 2. Commands set.

2.1. The format of commands and response messages is shown in Table 1 and 2. It should be noted that commands requesting parameters or measurement results are specified in lowercase letters, and commands that set parameters are in uppercase.

Table 1. The format of commands and response messages for subsystem «0» - «frequency comparator as a whole».

#	Command	Response message	Description
1	<b>n</b>	<b>n,xxx</b> The numeric field is the serial number of the device.	( <b>N</b> )umber. Request the factory serial number of the device.
2	<b>R</b>	<b>R,!</b>	( <b>R</b> )emote. Switch the device to remote control mode.
3	<b>L</b>	<b>L,!</b>	( <b>L</b> )ocal. Switch the device to local (from the front panel) control mode.

Table 2. The format of commands and response messages for subsystem «1» - «frequency comparator».

#	Command	Response message	Description
1	<b>S,x,x,xxxxx,xxx,x</b>	<p><b>S,x,x,xxxxx,xxx,x</b> The first field is the frequency of the measured signal:</p> <p>0 - 10 MHz; 1- 5 MHz; 2 - 10,24MHz; 3 - 2,048MHz; 4 - 1 MHz.</p>	(S)et. Установка режима работы компаратора частотного.
2	<b>s</b>	<p>The second field is the averaging time: 0 - 1 s; 1 - 10 s; 2 - 100 s; 3 - 1000 s; 4 - 3600 s.</p> <p>The third field is the cycle length from 3 to 10000 measurements; The fourth field is the outliers removal settings. The numbers from 1 to 999 correspond to the values from <math>1 \cdot 10^{-11}</math> to <math>999 \cdot 10^{-11}</math>. Measurements that differ from the average by more than the specified value will be excluded from the array; The fifth field is the use of division by the square root of two when calculating statistics: 1 - used, 0 - not used.</p>	(s)et. Request the working parameters of the frequency comparator.
3	<b>B</b>	<p><b>B,! </b> when measurements started successfully; <b>B,? </b> when measurements are already in progress.</p>	(B)egin. To begin the measurements cycle.
4	<b>E</b>	<p><b>E,! </b> when measurements were successfully stopped; <b>E,? </b> when measurements are already stopped.</p>	(E)nd. To stop the measurements cycle.
5	<b>C</b>	<p><b>C,! </b> when the arrays have been cleared successfully; <b>C,? </b> when the measurement cycle has not yet been stopped.</p>	(C)lear. Clear array of measurements and array of results.
6	<b>g</b>	<p><b>g,x,xxxxx,zx.xxxxxxEzxx,zx.xxxxxxEzxx, zx.xxxxxxEzxx,zx.xxxxxxEzxx,zx.xxxxxxEzxx, zx.xxxxxxEzxx,zx.xxxxxxEzxx,zx.xxxxxxEzxx, zx.xxxxxxEzxx</b> The first field is a flag of the repeated results output: 0 — the results have been updated since the last request, 1 — these results have already been sent, and since the last request has not changed; The second field is the number of measurements at the time of the request; The third field is the average value at the time of</p>	(g)et. To get an array of measurement results. The command can be sent at any time regardless of the measurement status.  The current

#	Command	Response message	Description
		<p>the request;</p> <p>The fourth field is the minimum value;</p> <p>The fifth field is the maximum value;</p> <p>The sixth field is the scatter;</p> <p>The seventh field is the drift;</p> <p>The eighth field is the standard deviation;</p> <p>The ninth field is Allan variance;</p> <p>The tenth field is the median value;</p> <p>The eleventh field is the Hadamard variance;</p> <p>The twelfth field is the voltage of the reference signal;</p> <p>The thirteenth field is the voltage of the measured signal;</p>	<p>values of the results will be returned.</p>
7	<b>a</b>	<p><b>a,xxxx,xxxx,zx.xxxxxxEzxx, ..... ,zx.xxxxxxEzxx</b></p> <p>The array is sent as a series of messages of ten measurements each. In this case, the second field contains the number of all messages, and the third field shows the number of the current message. The last message can contain less than ten measurements. If there are no measurements in the array, the message will be generated with zero values in the second and third fields.</p>	<p><b>(a)</b>rray. To get an array of measurements.</p>