

PeakTech[®]

Prüf- und Messtechnik



Spitzentechnologie, die überzeugt



PeakTech[®] 1235

Operation manual

32-Channel Logic Analyzer

1. Brief Introduction

Today has been a digital information age. Compared with analog technique, the transmission and measurement of information is much different. Numerous data channels transmit simultaneously in the spatial distribution while data code flows are built according to certain format in the time distribution. The data code flows are the data words taking discrete time as independent variable but not the analog waveform taking continuous time as independent variable. Some important parameters in analog signal analysis are not so important in digital signal analysis. For instances, the digital signal analysis of voltage pay much attention to voltage higher or less than some threshold level; for the analysis of time, only the relative relations among the digital signals are noticed. So the traditional testing device (voltmeter, oscilloscope, etc.) can not measure and analyze digital system effectively, even not meet the requirements of circuit design and debugging in digital system. In such a case, Logic analyzer, a new-type data measuring instrument is manufactured to observe and measure the digital signals in digital information processing. Some special problems of designing and debugging in digital system are difficult to find and solve without the logic analyzer, such as transmission delay, competition risk and burr interference. At present, digital circuit and bus technique are used in many apparatuses. In order to analyze and validate the result of information processing, the logic analyzer must be used to find out the error in programming and running, measure and compare the state of digital logic circuit. With the rapid development of digital technique, using logic analyzer to analyze and solve the problems in digital circuit should be mastered. But the logic analyzer in present market is so complicated to understand and operate for teaching in universities and colleges. It is impossible to purchase a batch for high price. So a popular logic analyzer with basic necessary function, simple operation and appropriate price must be selected.

PeakTech[®] 1235 Logic Analyzer is such a practical measuring instrument meeting the above requirements in data field.

2. Prepare for use

2.1. Check up

Open the packing case and check whether the appearance of the instrument is intact, accessories are all there. If the package damaged severely, please don't open until consult with the departments concerned.

Packing list:

Name	Amount
<i>PeakTech</i> [®] 1235 logic analyzer	1
User's guide	1
3-core power cable	1
50 wires cables and connector	2
Input transferring boxes	2
Test hook	40
Test hook connecting cable	40
Interface demo CD	1
USB interface cable	1
RS-232 interface cable	1

2.2. Start operation

The instrument is used with the following conditions.

Power Supply:	Voltage:	100 ~ 240 V
	Frequency:	60 (1±5%) Hz
	Power:	<30 VA
Environmental Conditions:	Temperature:	0 ~ 40 °C
	Humidity:	80%
	No powerful electromagnetic interference	

Plug into the power receptacle with voltage from 100 to 240V and earthing wire, then press the power switch on the panel to make the generator connected to power source. Now the initialization of the generator begins. The name of instrument and manufacturer are displayed first, and then install the default parameters. Finally the timing waveform interface is displayed.

Warning!

For manipulator's safety, triple socket with safe earthing wire must be used.

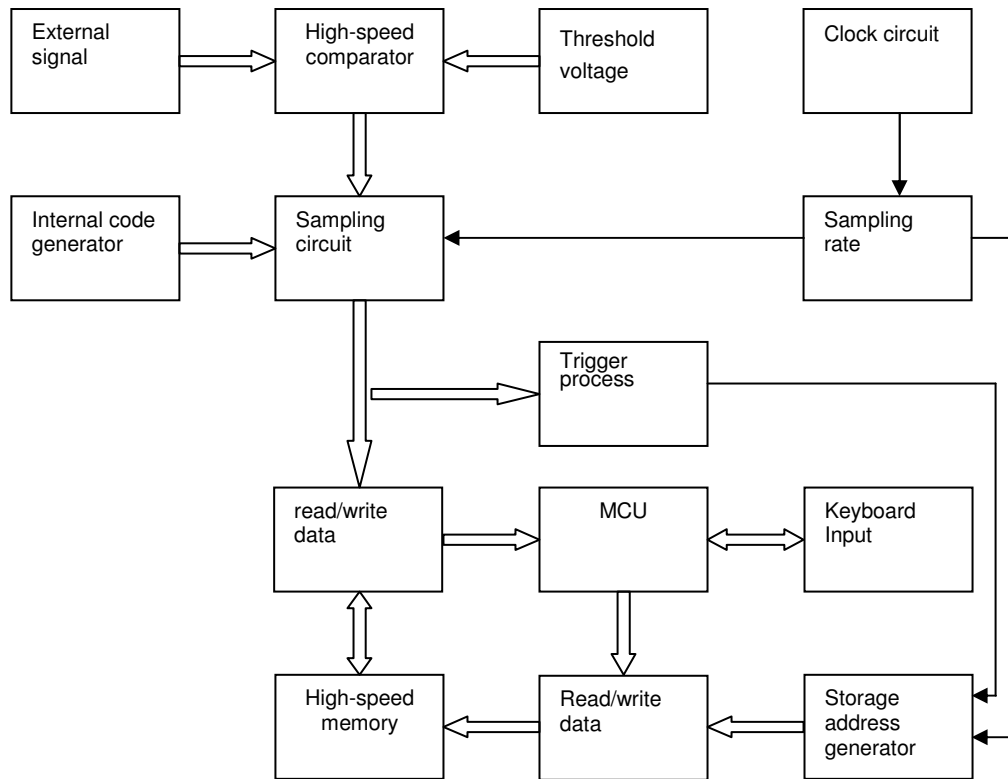
3. Principle summarize

When sample the external signal source, the external signal is sent into the positive input port of the high-speed comparator via the input circuit. The threshold circuit generates a threshold voltage according with the setting values, and sends the voltage to the negative input port of the high-speed comparator. A TTL level digital signal is generated by the comparison of the two signals and then the digital signal is stored synchronously in the data flip-latch by sampling clock. When sample the internal code, the code generator will produce 30 channels of internal digital signals which are stored synchronously in the data flip-latch by sampling clock. The sampling data in the data flip-latch are stored in high-speed memory according to appointed address.

Selecting the internal clock in timing sampling can set the cycle of sampling clock. State sampling with external clock can select the phase of sampling clock.

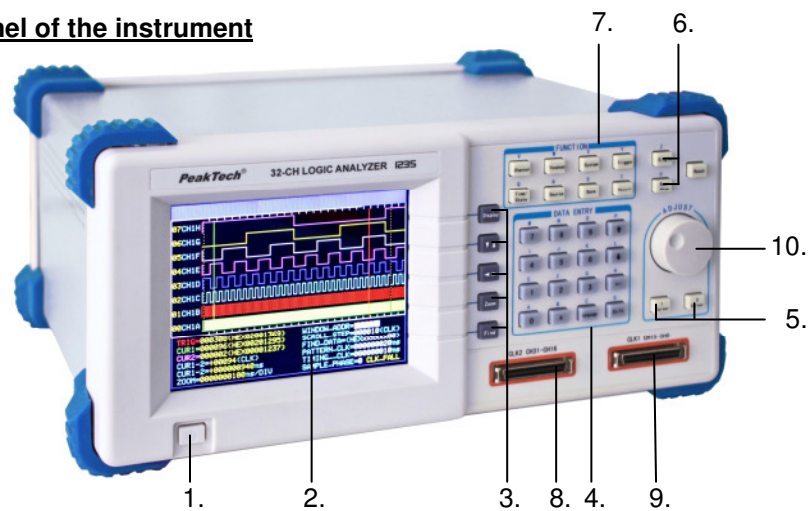
During the period of sampling storage, a "sequence add 1 counter" supplies storage address for the high-speed memory in memory control circuit, each sampling clock makes the memory change to a new writing address. At the same time the flip-latch sends a new sampling data, so a new data is stored in the memory. The start-up and end of the address counter is determined by the memory control circuit according to the parameters of triggering process. After sampling storage, Micro controller unit reads a series of data and send them to the LCD which will display the timing waveform and data list.

The work principle is shown as the following diagram.



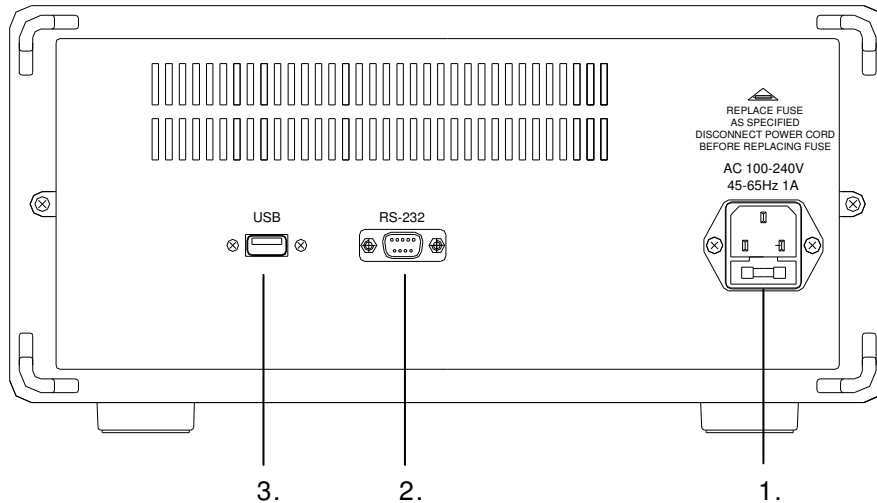
4. Display and keyboard

4.1. The panel of the instrument



Front panel

1. Power switch
2. Display screen
3. Display control keys
4. Data input keys
5. Cursor key
6. Sample key
7. Function keys
8. Signal input
9. Signal input
10. Adjusting knob



Rear panel

1. Power source outlet
2. RS232 interface
3. USB Device interface

4.2. Keyboard description

There are 34 keys on the front panel, functions are following:

4.2.1. Function optional key (8 keys)

- 【Channel】** : select and set the sequence order, name, color and switch of each channel in cycle.
- 【Threshold】** : select and set the threshold voltage.
- 【System】** : select and set the system parameters.
- 【Trigger】** : select and set the parameters and the switch in the trigger process.
- 【Time/State】** : select the mode of timing sample or state sample in cycle
- 【Source】** : select internal code generator or external signal source in cycle.
- 【Save】** : save the current setting parameters.
- 【Recall】** : recall the last saved setting parameters

4.2.2. Sample control (2 keys)

- 【Run/Stop】** : circular run/stop recycling sample
- 【Single】** : single sample

4.2.3. Number input (11 keys)

- 【0】 【1】 【2】**
- 【3】 【4】 【5】**
- 【6】 【7】 【8】**
- 【9】** : number input key
- 【x】** : special characters x, only used for data search input

4.2.4. Input control (4 keys)

- 【↑】 【↓】** : select the setting parameters up to down in cycle
- 【←】** : backspace, to delete the input data when the input hasn't finished
- 【Shift】** : used for input the English letters above the button

4.2.5. Display control (5 keys)

- 【Display】** : display timing waveforms or data lists in cycle.
- 【↑↓】** : use the knob to roll timing waveforms and data lists up and down
- 【←→】** : use the knob to roll timing waveforms and left and right
- 【Zoom】** : use the knob to zoom timing waveforms
- 【Find】** : find and display the data points suited the search conditions

4.2.6. Control knob (2 keys)

- 【Cursor 1】** : use the knob to move the cursor1 left and right
- 【Cursor 2】** : use the knob to move the cursor2 left and right

4.2.7. Working state (2 keys)

- 【Reset】** : initialize the instrument and resume the default parameters settings
- 【Language】** : Only English interface

4.3. Display description

On the top of the display screen, there are some words shown the function and the operation of the button you pressed (except the numeric keys). There are 3 types of display interface under the denotation words, details are following:

4.3.1. Waveforms display interface

The waveforms display frame is on the top of the display interface which displays eight channels of timing waveforms, the serial number and the name of the waveform, four different colors vertical cursor lines. There is one scale on the top of the waveform frame, and another one is on the bottom of the waveform frame. They are the zoom scales, the time value of every scale varies with the zoom coefficient. Below the waveform frame is the parameters display frame, the six parameters on the left is the state parameters, varies automatically with different operations, showing the current state of the equipment. The six parameters on the right is the parameters settings of the system, can be set with number keys.

4.3.2. Data display interface

The data display frame is on the top of the display interface which displays 19 rows of data, each row is one sampled data point in the memory, corresponding to 32 sample channels. The three columns of data from left to right is the address of data, the data value in Dec, the data value in Hex, the data value in Bin. The parameters display frame is below the data lists frame, the three parameters on the left is the state parameters, changes automatically with different operations, showing the current state of the instrument. The two parameters on the right is the parameters settings of the system, can be set with numeric keys.

4.3.3. Trigger settings interface

The trigger settings interface displays the whole trigger process. Adopting the graphical mode makes users can easy to understand the whole trigger process. The panes in the display interface is the nodes of the trigger process, the connect lines among the panes show the direction of the trigger process, six parameters can be set on the right, the left side have six switch can be set, the specifications of the setting shows in the chapters behind.

5. Instructions for use

5.1. Starting initialization

Press the power button to connect the electricity supply. Firstly the model number and the manufacturer of the instrument will be showed on the screen. Please operate the initialization program and load the default parameter settings. Then the timing waveforms of internal code will be displayed. All kinds of operational practice can be carried out without connecting with the external input signals.

Most of the researching objects of the logic analyzer are single or non-cyclical signals included in high speed data stream. So the analyzer can't display the signals in time on the screen as the oscilloscope does, but can sample the signals according to certain time (sample clock). It can catch and save the interesting signals by setting up the suitable trigger process. The saved data can be recalled showing on the screen and researched repeatedly.

5.2. Operation general principles

5.2.1. Keyboard description

When any key is pressed, there is a corresponding hint on the screen which explains the function and the operation of the key. If there is a circular symbol, consisting of two arrows laid end to end, on the left of the hint, then it is a cycle key. It runs different functions by pressing it repeatedly. If there is no circular symbol, the key has only one function.

5.2.2. Parameters input

If there are reverse numbers or characters on the screen, means the parameter is a selected one which can be set by pressing the keys. If the user needs to select other data, 【↑】 and 【↓】 can be used. The user also can turn the knob left and right to select other data cyclical. If input the wrong characters or numbers, user can delete them one by one by pressing 【←】. As soon as the reverse characters areas are filled with numbers, the parameter settings take effects. Meanwhile the 【←】 doesn't work anymore, unless restarting input process.

5.2.3. Letters input

The 26 letters, from A to Z, are marked on 26 keys. During the process of parameter input, press 【shift】 key and release the key, then input the letter you need. If there is no letter on the key, user can input space. The 【shift】 key is a one-kick. So if the user needs to input the next letter, please repeat the operations above.

5.3 Channels setting

5.3.1. Channel order setting

The double digits number 00-31, on the most left of the waveforms display frame, is the channel serial number. Press 【Channel】 key to select the channel serial number setting. Then set the channel sequence by numeric keys. The settings only change the position of channel waveforms on screen so that some channels of waveforms can be closely displayed and easily compared. However the real positions of sampling channels are not changed, the sampled data too. If the real positions of sampling channels need to be changed, user has to change the connection of the test nips for sampling on the circuit board.

5.3.2. Channels label setting

The four characters on the right of the channel serial numbers are the label of the channel. Press 【Channel】 key to select the channel label setting. Set the channel label by numeric keys or letter keys. Every channel label can be set by user.

5.3.3. Channels color setting

Press 【Channel】 key to select channel color setting. Set the color by numeric keys. Every channel can be set according to user's favorite color.

5.3.4. Channels switch setting

Press **【Channel】** key to select channel switch setting. Set the channel “on” by using the numeric key **【1】**. Set the channel “off” by using the key **【0】**. The settings will take effect in the process of next sampling display.

The settings of the channels are complicated but there is no need to change them frequently. Press **【Save】** to save the self-defined channel settings so that you can use it when you need without reset the settings.

5.4. Thresholds setting

Press **【Threshold】** key to select threshold voltage setting. The **【↑】** and **【↓】** pushbuttons are used to circularly select one of the six threshold voltages. Only knob can be used to set the value of threshold voltages in a continuous manner. The voltage will increase by turning the knob to right and decrease by turning the knob to left. When the voltage value passes the zero, the polarity sign will automatically change. The internal code-generator doesn't pass the voltage comparator, so the settings on threshold voltage aren't valid when sampling the internal code.

The analyzer has 32 external signals input channels and 2 external clock channels. The best performance is when the peak-to-peak value of input voltage is between 500mVpp and 20Vpp. The maximum input voltage handle is $\pm 40V$. After accessing the analyzer, the input signal first passes through the voltage comparison circuit and is compared with the threshold voltage set by the user. If the input signals are higher than the threshold voltage, the analyzer shows the number “1”, otherwise it shows the number “0”. Then the signals are sampled and saved and displayed on the screen.

Waveforms displayed by this means only reflect the timing logic when the input signals are higher or lower than the threshold voltage. It doesn't reflect the real amplitude of the input signals, and may be far different from the real waveforms of the input signals. This kind of waveforms displayed by logic analyzer is usually called a “pseudo waveform”.

In practical operation, the sampled signals appear by groups. For example, grouped by the data bus or the address bus. The characteristics of amplitude of a group of signals are the same, so use the same compare threshold voltage. In practical operation, there are many kinds of signals with different amplitude to be tested such as TTL, CMOS and ECL. In every experimental circuit, the amplitude characteristics of signals may be various. To satisfy these conditions, the instrument is deployed with six individual adjustable threshold voltages. Four of them are used in four channel groups which contain 8 signal input channels in each one. And the other 2 threshold voltages are used in 2 external clock input channels.

In practice, the instruments measure signals mostly in groups, for instance in the total line and address line. The amplitude characteristic of one group is identical and should use the same comparison threshold voltage. However the instrument has 32 signal input channels and again, it is not necessary to setup 32 independently adjustable threshold voltages. But in practice, there are signals measured with different amplitude for instance TTL, CMOS, and ECL.

In many experiment circuits, the amplitude required may vary. For this application, 6 independently adjustable threshold voltages are configured in instrument, 4 of which are used for 4 channel groups, each group has 8 signal input channels. The other two are used for 2 external clock input channels separately.

In practice, the electrical sources of +5V or +3.3V are usually used in digital system. So all default settings of the threshold voltage are +1.6V. Generally speaking, the setting range of the threshold voltages for TTL is between +5V and +3.3V. And the setting range of threshold voltages for CMOS is between +5V and +4.3V. If the tested signals contain large ringing effect or other noises, there are wrong data in the sampled results. When it happens, repeat sampling function to adjust the threshold voltage and observe the sampling waveforms, until clear and correct sampling waveforms are obtained.

5.5. Display setting

The *PeakTech*® 1235 logic analyzer can display a vast amount of data. There are two display modes of the sampling data: timing waveform display and data listing display.

5.5.1. Timing waveform display

Press **【Display】** to view timing waveforms for up to 8 channels displays. Each channel can be displayed with different color to easily indentify and separate them visually. The order of 32 channels waveforms is that the highest channel is on the top and the lowest channel is at the bottom. This is to enable the highest-order digit of the byte to be on the top and the lowest-order digit on the bottom.

5.5.2. Waveform rolling Up/Down

The waveform rolling can be used to observe all the waveforms in 32 channels. Press **【↑↓】** and turn the knob to browse the waveforms. If there is a need to compare the waveforms, the method of channel order setting (5.3.1) can be used to display the desired waveforms.

5.5.3. Waveform rolling Left/Right:

The *PeakTech*® 1235 allows for 260,000 memory addresses for each channel, however only 280 data points can be viewed due to the horizontal width of the screen. In order to display the needed blocks from the mass of stored data, the screen display window aim at any position in memory. This requires setting a changeable “window address” for display window, as long as changes the window address, the screen of analyzer will show the storing data block taking this address as initial point.

Parameter in the first row on the right bottom of the wave frame is the **window-addr**. The waveform displays the data on the most left, that is the data corresponding to the window address in sampling memory. Press **【System】** to select **window-addr** and can set the window address in Dec numbers with the range of 0~260000. After setting, the waveform of sampling storing data block, to which this window address corresponds, will display immediately. If one needs to continuously observe a waveform nearby the window, press **【←→】** and turn the knob, the window-address will change continuously, as if the waveform is rolling from left to right in the display window.

Parameter in second row on the right bottom of the wave frame is **scroll-step**, turn knob one step; the window-address will increase a scroll-step value. The higher the value of scroll-step is, the faster the speed of waveform rolling is, but this may miss needed part; the lower the value of scroll-step is, the slower the speed of rolling is, and the finer observe the waveforms. Press **【System】** to select **scroll-step**, the value of the scroll-step can be set by number keys with the range of 1~260 000, after the setting, press **【←→】** and turn the knob to roll the waveform left and right, so that the speed of waveform rolling will change.

Setting the window-address with number keys directly enables display window to locate in the data block needing to visit, and rolling waveforms with knob turning can observe the change situations of a section of waveform continuously.

5.5.4. Waveform zoom

In digital systems, the changing rate of the logic level may be very different in different data channels, in a timing waveform displaying graph; it may include 8 channels with big difference in changing rate of logic level. This brings a problem, that is, a large number of pulse waveforms crowds together in channel with fast changing rate of logic level and cannot be seen clearly, but in the channel with slow changing rate, it is a line on screen. To solve this problem, can stretch the waveforms in level direction and unfold the crowded pulse wave to visit waveform characteristics with fast changing, also can compress the waveforms and gather sparse pulse waveform together to visit waveform characteristics with slow changing.

Press **【Zoom】** key and turn the knob to make the display waveforms stretch or compress in horizontal direction. “**Zoom= ns/div**” in the sixth row on the left bottom of the wave frame will change, this ratio coefficient stands for time amount that each lattice of scale line represents, in the above and underside two rows of waveform frame. The essence of waveform amplification is that a number in sampling memory is displayed continuously with several points in waveform display. So, the amplifying waveform can make dense waveform be seen more clearly and let measurement become easy, it won't generate any distortion to waveform. But waveform amplification is unable to increase resolution; the original invisible contents are still not seen after amplification. If want to observe the detailed change, need to increase sampling velocity. The essence of compression is taking one number to display from several data points in sampling memory, therefore after compression, waveform's observing scope is broadened, but may lead to distortion and miss small changing part, more compression rate results in more serious distortion. So compression should be made gradually, one should not continue compressing when finds distortion. The amplifying or compression state will be displayed in present waveform, with the turn of knob; character indication displays on top of interface at any moment.

Because waveform zoom is taken sampling clock as the time unit, so the zoom ratio change is spaced by step, if measure waveform's interval with scale of waveform frame, may have error, just a rough measurement. If need to measure the interval of the waveform accurately, should use the method of cursor measurement.

The zoom function of the waveform is applied in the situation that the changing rate difference of the logic-level in every channel is very big in a group of waveforms, if the changing rate of the logic level in a group of waveforms is generally bigger or smaller, then should solve it by adjusting the sampling rate.

5.5.5. Data lookup

The instrument has convenient search function, after the sampling, can find the data conforming to the setting conditions in a large group of sampling data. Parameters in the third row on the right bottom of the wave frame is the **find-data** which is a 32bits data word in Hex format, press **【System】** to select **find-data**, can set search data word, input the numbers of 0~9 or the letters of A~F, also can input x(attention: the **【x】** on the right of the key **【0】**, is not the letter “x” in English), x means “ignore”, that is, no matching and contrast to this number in data find. After setting the find data word, press **【Find】** again, can find a data according with the searching conditions, denoting with a yellow dashed generally can be seen on the most left of the screen. At the same time, window address will also change to show the position of this data in sampling memory. Press **【Find】** repeatedly, until find the end point of sampling memory, thus can find all the data words conforming to setting conditions from sampling data.

The **find-data** function runs after finishing sampling and is used to look up data word set randomly in stored sampling data, this point is different from trigger conditions data word that will be described behind, the latter is preset in advance before sampling and used to capture data word conforming to trigger conditions.

5.5.6. Data listing display

Press **【Display】** key, 19 rows of data listings can be showed. In the data listing interface, the most left line is the Dec address value of sampling data in memory, and increase one continuously from the top to the bottom. The middle is the address value of the sampling data in Hex, the right one is the Bin address value, a parting line between each 8 bits Bin code so as to read conveniently. Use two different colors to distinguish the two adjacent lines, making display clear, beautiful and not easy to confuse. The storage depth of the instrument is 260,000 storing addresses, but the screen shows only 19 rows in the vertical height, therefore, data lists also must roll up and down in the display window. The parameter definitions and operation methods showed in data listing are the as timing waveforms display mentioned before. The window addresses, rolling step, find-data words are identical. The difference are that rolling up and down in the data lists equals rolling left and right in the timing waveforms display, and the found data is a row of orange data showed in upper part of data listing. The data listing cannot roll left and right, also cannot zoom.

5.6. Cursor setting

There are two cursors in this instrument for measurement: cursor1 and cursor2.

5.6.1. Timing waveforms cursor

In the timing waveforms display interface, press **【cursor 1】** key, the green cursor1 shows active state, turn the knob, enable the cursor1 to move left and right. Press **【cursor 2】** key, the purple cursor is chosen, turn the knob, enable the cursor2 to move left and right. The step of cursor movement can be set with number keys 0~9. For example, press **【1】**, then turn knob a lattice, the cursor moves one point distance on the screen, press **【9】**, then turn knob a lattice, the cursor moves nine points distance on the screen. Generally speaking, first move the cursor with the longer step to the aim point nearby, then move the cursor with the shorter step to the aim point.

5.6.2. Cursor measurement

It is available to measure the sampling data value of any points in the display waveforms and the time interval between any two points in the waveforms with it.

The second row on the left bottom of the waveform frame is the parameter value of cursor1, the third row is the parameter value of cursor2, the six numbers on the left of the parameter are the decimalization data address cursor indicates, and the 8 numbers on the right of the parameter are the Hex data value of position cursor indicates, which is the sampling data of 32 input channels, each number represents 4 channels, according to the general custom, the data from left to right represents the 32 input channels of waveforms from the top to the bottom in turn. So the screen only shows the waveforms of 8 channels, one can know the logic levels of the 32 channels as long as reads the data value of the cursor out without moving waveforms up and down to visit. When turn knob to make measurement cursor move, cursor parameter's address value and data value will change dynamically with it, when the two cursors move into the same point, their parameter values are identical.

The difference value between cursor1 and cursor2 displays in the 4th row on the left bottom of the waveform frame, denoted by sampling clock cycle, that is address value. The data in the 5th row on the left bottom is the difference value between cursor1 and cursor2, denoted by absolute time (ns). When the cursor1 is on the right of the cursor2, the two parameters are positive values; they are negative values on the left of cursor2. When the two cursors coincide with each other, their parameters are 0.

If want to measure the time difference between two points in present waveform interface, can move cursor1 and cursor2 to the two aim points respectively; it's easy to read the time difference or the address difference between the two points.

But if the address difference between the two points to be measured exceeds 280, the two points can't be displayed in the same interface at the same time, and cannot measure using the above method. To solve this problem, it sets the cursor1 and the cursor 2 into different characteristic. Cursor 1 is a drift cursor, appearing in the displaying window always, can be seen as an aim line, and able to move anywhere in window with knob. But cursor1 appears to suspend on waveform, and doesn't move with the waveforms together, its address value and data value will change with the waveform movement, denoting waveform's address value and data value cursor placed at any moment.

Cursor 2 is an adhering cursor, although it can be moved into anywhere in window with knob, it will adhere to waveform once stops moving, when waveform moves, cursor 2 moves as it. When moving the cursor 2 out, can imagine it still adheres to and moves with waveform, its address value and data value won't change not caring how long waveform moves. When we want to measure time or address difference between any two points in sampling waveforms, firstly move cursor 2 to the first aim point, then move waveform left or right until the second aim point displays no matter whether cursor2 moves display out and how long waveform moves, turn knob to move cursor1 to the second aim point, then able to read time or address value out between two aim points. After finishing once measurement, press **【cursor 2】** key to recall it into display window and begin the next measurement.

5.6.3. Data listing cursor

In data listing interface, cursor1, cursor2 and cursor measurement, are all the same as the cursors in timing waveform interface. The difference is that cursors in timing waveform display interface are vertical cursor lines, but in data listing display interface cursors are level white display row. There is only address display of two cursor rows about parameter display under data listing (data values in the listing already).

5.7. Sampling setting

The logic analyzer uses the sampling mode for data obtaining, which is sampling to input "digital", notice that it is not to collect sample to input signal directly, but to digital generated through comparison and distinguishing for input signal and threshold, and stores sampling data in memory. So, the basic requirement for logic analyzer use is setting sampling parameters correctly.

5.7.1. Sampling source

The purpose of using logic analyzer is to analyze the logic state of signal to be measured, so the aim signal to be sampled is external signal source surely. But take the following three points for consideration, set an educational pulse generator in instrument inner. First, many users may be not familiar with the logic analyzer, some may use it the first time, so first make operation practice to deepen apprehension for the correlation between various parameters' setting, and familiarize operational control for display interface, and not need to connect mass of input test nips, very conveniently no doubt. Moreover, external signals to be measured are usually unknown and complicated, may be mixed with random interference signal too, so it is necessary to set threshold voltage suitably and take sample to external signal directly, getting expectant result may be more difficult. Because the Inner Code Generator's logic relation is simple, waveform is pure and standard; one can quickly master logic analyzer's use with it. Second, in practical application, if the test result is different from expectant one, sometimes it is hard to make clear that the problem comes from the tested circuit or logic analyzer, here as long as use inner code generator to take samples and contrast, it is easy to find reasons. Third, when instrument fails to work and need repairing and debugging, the code generator is very convenient of course.

The inner code generator is composed of two types of signals, 00 ~ 15 channels are count waveforms, count value are 0~65535, and each clock cycle adds 1. 16~29 channels are shift pulse waveforms and high level pulse moves one bit to the right in turn from low to high channel. 30~31 channels are used to measure external clock1 and 2 (6.7.2). The code generator in the equipment, if only power is open, runs in its independent clock continuously till power closes. The inner code generator directly generates standard digital signals for sampling, not passing threshold voltage comparator. If choose inner code generator, then external digital signal cuts automatically, vice versa, they don't affect each other. Pressing **【source】** key can switch into inner code generator or external signal source in cycle, instrument default setting is inner code generator. The internal code-generator has its own adjustable clock, can emulate measured signals with different velocities, press **【system】** to select parameter pattern-clk and input the clock cycle value with decimalization numbers 0~9, its unit is ns, resolution is 10ns, the last number on the right has no use. The minimum cycle value is 20 ns; the maximum value is 999999990ns, approximate to 1s. After code generator's clock changes, waveform display's change is visible. The default setting of the clock cycle is 20 ns.

If take samples to external signal source, first connect one end of fifty-line cables to instrument input port, connect the other end to input-transferring case which has 16 signal input ends and one external clock input end, use single-core joint line to connect these input terminals and the test nips, then connect with sampling points on the circuit board with test nips. Each input terminal of transferring case has a grounding terminal correspondingly, although not all terminals are necessarily connected to circuit board's signal earth, but the more connect ground lines, the less noise of input signal makes, and the better for measurement. If connect only one ground line, sampling signal may get glitch interference, and bring difficulties for data analysis.

5.7.2. Sampling mode

There are two sampling modes for logic analyzer: One is timing sample which collects samples to the external signals using the internal equal time interval clock, the sampled data is equal time interval data, in other words it takes "time" as the independent variable. The timing waveforms after sampling can basically reflect the changes of the tested signal as time, this approach is known as the timing analysis, but the sampling clock and the tested system are independent each other and not synchronous, so it is also called "asynchronous sampling."

The other mode is state sample which collects samples using the clock of the tested system, the clock is equal time interval, and also can be random time interval. The sampling clock pulse can be seen as the discrete event, that is, take the "event" sequences as independent variable, the data listing after sampling reflects the logic state relation between the system clock and the other signals in the system, this mode is known as state analysis. Here, the sampling clock is synchronous with the tested system; it is also called "synchronous sampling." If take sample using inner clock to inner code generator, this also belongs to "synchronous sampling."

If use state sampling as sampling clock signal in measured system, must connect to special input channel **clk1** or **clk2**, otherwise the sampling couldn't start. If the noise in the external clock signals is too large, should adjust the threshold voltage settings of the external clock (5.4) so as to obtain a pure clock signal, if the sampling clock signal is poor, the sampled data can not be used. However, the external clock signals are not stored, also no special accesses to display waveforms, so it is impossible to know the quality of the clock signals after passing threshold voltage comparator. A substitute method mentioned once in (5.7.1): press **【source】** to select aim source and use inner clock as timing sampling, then connect external clock signal to the special clock channels **clk1** and **clk2**, here external clock can take samples to external clock signals, **clk1** and **clk2**'s timing waveforms display in 30~31 channels after sampling. When adjust the threshold voltage settings of the external clock, one can use the two channels to monitor the adjustment effect.

Sampling mode can be set with **【Time/State】** key, inner clock for timing sampling, and external clock for state sampling. The external clock contains external **clk1** and external **clk2**. The default setting is the timing sample, using internal clock.

5.7.3. Clock limitations

To visit the particular changes of the tested signals, we hope to use higher sampling velocity, but this would greatly increase the data amount in the memory. Besides, sometimes the tested signal is single or occasional and is included in the long data stream. To effectively capture them, we must lengthen the time of the sampling as we can; thus the data stored in the memory will be greater. But the space of the high-speed memory is limited, to solve this problem; the instrument sets two external clocks' logic "and" and logic "or" which is limiting an external clock using another one. For example, select the logic "and" of two external clocks as the sampling clock, use high level of the external **clk1** as the limit condition, only when external **clk1** is a high level, the sampling **clk2** can be opened, the sampling can run, in other times the **clk2** is shut down and cannot sample. If set limit conditions suitable, it can ensure that not only effectively capture the signals one interested in, but also save the space of the memory.

Using **【Time/State】** key can select limitation mode in cycle: the logic "and" and logic "or" of external clock **clk1** and **clk2**.

5.7.4. Sampling cycle

The logic analyzer captures data on the hop edge of the sampling clock; the data between two hop edges is ignored. If choose longer sampling cycle, the fast-changing sections of input signals will be missed, then the displayed waveforms will have serious distortion compared with the true waveforms of input signals both in amplitude and time, even invisible. One should use shorter sampling cycle in order to observe the particular changes of the tested signals, that is, to increase the sampling rate.

Generally speaking, the sampling cycle should be less 3-5 times than the narrowest pulse width of the tested signals. In other words, even the narrowest pulse of the tested signals should include three sampling points at least, which can truly reflect input signals' change as time.

The instrument uses internal clock in the time sampling, and clock cycle can be set. Press **【system】** to select parameter pattern-clk and input the clock cycle value with decimalization numbers 0~9, its unit is ns, resolution is 10ns, the last number on the right has no use. The minimum cycle value is 10 ns; the maximum value is 999999990ns, approximate to 1s. When code generator's clock is changed, waveform display's change is visible. The default setting of the clock cycle is 10 ns, that is to say, the highest sampling velocity is 100MHz.

The instrument uses the external clock cycle in state sampling; the sampling cycle can't be changed optionally, one needs to select the suitable signals as the sampling clock according to the state of the tested signals.

5.7.5. Sampling phase

The logic analyzer uses sampling clock's rising edge for data obtaining, but in state sampling using external clock, due to "synchronous sampling", sometimes should choose clock's function edge reasonably according to logic relation between signal and system clock of tested system. For instance, various logic levels change in system clock's rising edge, if samples using rising edge, various logic level is in changing then and the time is not consistent strictly, so sampling data may be wrong. If choose falling edge, all logic levels are just in stable state, sampling date won't be wrong.

Therefore, instrument sets sampling phase choices: rising edge sampling and falling edge sampling. In timing sampling to external signal with internal clock, sampling phase setting is out of meaning because of “asynchronous sampling”.

Press **【system】** to select **sample-phase** and set sampling phase in numbers, press **【0】** to select clock falling edge, press **【1】** to select rising edge.

The default setting is the falling edge sampling.

5.7.6. Sampling control

There are two keys used for controlling in the sampling process: press **【single】** key, sample process runs once only, after sampling, display the result in timing waveform or data listing, then can make various operations and analyses to it, this is universal using method of logic analyzer. Press **【Run/Stop】**, the sampling process runs automatically and repeatedly with result displaying each time, until press **【Run/Stop】**, sampling process stops, which is generally used to visit dynamic change of tested signal or dynamic response of the adjusting parameter setting, when grasp the characteristics of tested signal, or adjust parameter setting suitably, press **【single】** key to sample and analyze the results in detail.

5.8. Trigger setting

In modern digital system, the code stream rate is very high in us or ns level generally, which requires corresponding sampling velocity for logic analyzer. However, the space of memory in the instrument is limited, so in practical, the effective sampling time is very short, it can say sampling process completes instantaneously. If start up sampling process manually, this needs to press **【Single】** in an extreme accurate time, but it is too hard to do, moreover, the data needed sampling and storing is often contained in the long data stream, we don't know when we should start up to capture the data, so it is even more impossible to start up the sampling process manually. Due to limited memory space, large amount of data will enter memory soon after starting up, if sampling process can not stop immediately, following data will overwrite preceding ones, when press key manually, the data stored in the memory finally may not useful for us. So, manual control is also infeasible. The logic analyzer must run the sampling process automatically according to operator and stop after capturing useful signals automatically; this is the fundamental difference between logic analyzer and the data collector.

Using logic analyzer firstly, one may feel very difficult to start in trigger process setting and uneasy to understand the functions of setting parameters, press **【trigger】**, display a graphical trigger setting interface, which can make operator know the whole process of sampling visually and directly, and master setting method of trigger process.

5.8.1. Signal input

Signals input process is on the left of trigger setting interface: the external tested signal from “probe” passes through test nips, “commuting case”, transmitting cable, connector, to “comparator”, then compare with the “threshold voltage” to generate digital signals. Internal code generator pattern generates emulational digital signal, choose one of this two signals through switch “source select”, press **【source】** to select the switch state in cycle. The selected input signal passes through the channel switch “switches” to sampling circuit. The setting of the channel switch has been described in (5.3.4).

5.8.2. Start conditions

The sampling trigger process is on the right of the trigger setting interface, press **【Single】** key, the sampling process does not really start, but firstly to check start conditions, once the data in the input signals can match with it, the sampling process starts immediately.

The start “bit-select” can be set with numbers in Hex, representing 32 input channels, if set bit-select to 0, shows this channel can be ignored, without match checking, and has no influence on start whatever signal level of this channel is 0 or 1. If set bit-select to 1, shows the channel is effective, and must be made matching checking. The default setting of start bit-select is 0000FFFF, means that only detect 00~15 channels, ignore 16~32 channels.

The start “compare word” can be set with numbers in Hex, the default setting of start compare word is 00001234 and means once “1234” appears in 00~15 channels in the input data streams, in other words when the logic level of 00~15 channels is “0001001000110100”, the sampling process starts.

5.8.3. Start select

The “start select” can be set with numbers, the key **【0】** cut the switch, the key **【1】** connects the switch. If the start select switch is connected, “the start conditions” will be short-circuit, having no use. In other words, after pressing **【Single】**, the sampling process starts directly without detecting the start conditions, equal to random sample manually.

The default setting of the “start select switch” is “connect” in order to make random sampling drilling justly without specific sampling purpose, not need to set the start conditions. If the setting of the start select switch is “cut”, then only understand the tested signal clearly and have specific sampling purpose, can set the suited start conditions. Otherwise, if set start conditions unsuitably, then cannot satisfy start conditions forever, the sample can't start.

5.8.4. Trigger conditions

When sampling starts up, the instrument writes the sampling data into the high-speed memory continuously according to the sampling clock time. Once the memory is filled, it will be back to the top and overwrite the former data. Then when will the sampling process stop? The sampling purpose is making limited storage data blocks contain the signals we concern, so it needs to set the appropriate trigger conditions to capture the signals, after the signals are captured, the instrument takes a short time of “store delay”, the sampling process stops automatically. The suitable setting of trigger conditions can decrease storage of useless data, improve the effective utilization of the memory, and bring convenience for the data analysis.

The start “bit-select” can be set with numbers in Hex, representing 32 input channels, if set bit-select to 0, shows this channel can be ignored, without match checking, and has no influence on start whatever signal level of this channel is 0 or 1. If set bit-select to 1, shows the channel is effective, and must be made matching checking. The default setting of start bit-select is 0000FFFF, means that only check 00~07 channels, ignore 08~31 channels.

The start “compare word” can be set with numbers in Hex, the default setting of start compare word is 00000069 and means once Hex number 69 appears in 00~07 channels in the input data streams, in other words when the logic level of 00~07 channels is “01101001”, the trigger conditions is satisfied.

Different from start conditions, the trigger conditions sets three trigger limit switches, <, =, >, which are useful for testing the data fluctuant limit to the tested signals. The trigger limit switch can be set with number keys, press **【1】** to connect the switch, but only one is connected in the three trigger limit switch, once one switch is connected, the other two switches are disconnected. The default setting of the trigger limit switch is “=” connecting.

5.8.5. Event count

When the sampling process starts, the instrument starts to sample the input signals, and stores the sampling data in the memory, at the same time, compares the sampling data with the trigger conditions and the trigger limit switch, if the sampling data satisfy the trigger conditions and the trigger limit switch, means that it captures a trigger event. In some applications, the trigger event we care may appear many times, and the thing we interested in is the situations after the trigger event appears many times. If we can capture the trigger event for many times in one sampling process, that may be more convenient for analysis. So the instrument sets a trigger event counter, after the sampling process starts, the count value firstly resets, then the count value adds one when meets the trigger event once, till the count value reaches the setting value of the trigger event, the trigger process finishes.

The trigger events count can be set with numbers in Dec, the setting range is 1~999, the default setting of the trigger event count value is 001.

5.8.6. Trigger select

The trigger select switch can be set with numbers, the key **【0】** cuts the switch, the key **【1】** connects the switch. If the trigger select switch is connected, the trigger conditions, the trigger limit switch and the event counter are all short-circuit, having no use. In other words, after sampling process starts, the instrument does not detect the trigger conditions, also does not count the event, the trigger process finishes unconditionally.

The default setting of the “start select switch” is “connect” in order to make random sampling drilling justly, and has no specific sampling purpose on capturing what kind of signal, not need to set the trigger conditions and event count too. If the setting of the start select switch is “cut”, then only understand the tested signal clearly and have specific sampling purpose, can set the suitable trigger conditions, trigger limit switch and event count. Otherwise, if sets these parameters unsuitably, the trigger process may not finish.

5.8.7. Store delay

The sampling process can stop in usual after the trigger process finishes. But in some applications, we hope to delay a period of storage time of the sampling data in order to analyze some signals characteristics after trigger events. So a delay counter is set in this instrument, after the trigger process finishes, the sampling process still runs, meanwhile clears the delay counter and counts for sampling clock, the count value adds one each clock cycle, the sample process stops when the count value reaches the setting value of the delay counter.

The “store delay” can be set with numbers in Decimalization, the setting range is 1~260000, the unit is the number of sample cycles; the default setting of storage delay is 600 sample cycles.

Because both the default setting of the start select switch and the trigger select switch are “connected”, we don’t need to set the trigger process, just press 【Single】 key, the instrument doesn’t check, but directly starts sampling and makes storage delay, in other words, the sampling process stops automatically after sampling 600 clock cycles randomly.

5.8.8. Manually stop sample

As already mentioned above, if set the start select switch as disconnected, but set the start conditions unsuitably, the sampling process can’t start. If set trigger select switch as disconnected, but set trigger conditions unsuitably, the trigger process can’t stop. Under such two conditions, the instrument is on the detecting state all the times, until the suitable signals appear and displays “sample is processing, press any key to stop”. To release from this state, just press any key to stop the sampling process manually. Then one must study the tested signals carefully, reset the trigger process to make sure the sampling process can run normally.

5.8.9. Trigger cursor

Sometimes there may be one or several vertical red lines in the timing waveforms interface, they are trigger cursors. The positions of the cursors are the sampling data points that satisfy the setting of the trigger conditions in (5.8.4).

The parameter value of the trigger cursor is on the left bottom of the waveforms frame in first row, the six numbers on the left of the parameter are the addresses of the data in Dec that cursor indicates, the eight numbers on the right of the parameter are the values of the data in Hex that cursor indicates, i.e. the sampling data of the 32 input channels, every number represents four channels, according to the general custom, the data from left to right represents the 32 channels of waveforms from the top to the bottom in turn. Press 【single】 repeatedly for sampling and indication. Because it is random sampling, the position of the trigger cursor line changes every time, the address value in the parameters of the trigger cursor changes every time, the left six numbers of the data value change every time, but the right two bits of the parameter value is always 69. Because the default setting of the trigger condition is that 69 in Hex appears in 00~07 channels, other channels are ignored. That means the position that the trigger cursor line displays in the timing waveforms interface, is the data points which is fully in line with the trigger conditions.

The trigger cursor is the same as the above description in data listing interface, displaying in a row of red data. The left line is address value of cursor in Decimalization, middle line is data value of cursor in Hex, and the Bin data value of cursor is on the right line.

5.9 Save/Recall

The use of the logic Analyzer is complicated, there is a lot of parameters to set, through the descriptions in the foregoing sections, we can know that if some parameters set improper, the sample doesn't start, even it starts, maybe it can't sample the data we need. And even it samples the data we need, it may be not easy to analyze. Therefore, we need to read the descriptions of foregoing sections to understand the settings of these parameters. The logic analyzer isn't as popular as the oscilloscopes; the operations of the logic analyzer may have big differences from different manufacturers, for users' convenience, this instrument sets an internal code generator and a set of typical default parameters, which can demonstrate the various functions of the instrument better.

5.9.1. Parameters storage

The application area of the logic analyzer is broad; the parameters settings may be different in various application occasions, so just using the default settings is obviously not enough. To set parameters users need every time repeatedly is very troublesome in each use, so it sets parameter "save" function and save the present parameters settings of the instrument for the further use, press **【save】** key. The instrument will query firstly "Store? 0: parameter, 1: waveform, 2: cancel". Press **【0】** key to save the all currently setting parameters, even not lose when power-off.

5.9.2. Waveform storage

In practical application, catching an interesting sample data is not so easy for some little probability affairs. So user can set waveform storage function to save caught sample data for further analysis. The length of wave is 16348 sample data. Start address is current displayed window address. User can change the displayed window address by method of setting parameters or moving figure. Then press **【save】** key. The instrument will query firstly "Store? 0: parameter, 1: waveform, 2: cancel". Press **【1】** save data with length of 16k, current displayed window as start address.

5.9.3. Cancel the storage

If user press the **【save】** key by mistake and need not to save the current setting parameter or waveform, you can press **【2】** key cancel operation. Original parameters or waveform won't be destroyed.

5.9.4. Recall

Press **【Recall】** to recall the saved parameters and waveform data. After recalling, you can display them with window and data list, also can measure and analyze them in different ways. Recalled wave always exits except that user sample again. But after pressing **【Single】** or **【Run/Stop】**, new data will be shown. If needed, saved waveform data will be recalled by pressing **【Recall】** again.

5.10. Reset

Every time the power is turned on, the instrument firstly loads the default parameters settings, and then stores the default parameters settings. If modify the parameter setting in use process, and lead the instrument can't work normally, can press **【Reset】** to recall the default parameters settings for initialization to make instrument run normally.

5.11 Programmable interface

Instrument configures USB device interface and RS232 interface; user can send programmable command to instrument by computer. Instrument will work according with the command. Also it can upload the sample data into computer and display the sample waveform or data list on computer screen. User can refer to CDROM for detail instruction.

5.12. Remote update

With function of remote update, user can update the system software through the interface. Please refer to CDROM for detail instruction.

6. Specifications

6.1. Input characteristics

- * Input Channel: 32 data sample channels, two external clock channels.
- * Threshold voltage: 6 independently adjustable threshold voltages
- * Adjusting range: -6V to +6V, Resolution: 0.1V
- * Input impedance: Resistance >100k Ω Capacitance <8pf
- * Input range: 500mVpp to 20Vpp
- * Input protection: maximum input voltage $\pm 40V$, no damage

6.2. Sample / Storage characteristics

- * Timing Sample: internal clock, Sampling Rate 1Hz to 100MHz (10ns to 1s cycle), resolution: 10ns
- * State Sample: external clock clk1, external clock clk2
- * Sampling rate: 1Hz to 35MHz
- * Clock limit: external clock: clk1 AND clk2; clk1 OR clk2
- * Sample phase: rising edge, falling edge
- * Sampling objective: internal code-generator, external signal source
- * Sample control: single sampling, continuous repetitive sampling
- * Storage depth: 256 K sampling points for each channel

6.3. Trigger characteristics

- * Start conditions: 32bits start-select, 32bits start-compare word
- * Start select: select-switch: On/Off
- * Trigger conditions: 32bits trigger select, 32bits trigger comparing word
- * Trigger Limit: select switch : >, =, <
- * Event counter: 1 to 999 times
- * Trigger select: select switch:On/Off
- * Store delay: 1 to 256K sample cycles

6.4. Display characteristics

- * Screen display: 5.7-inch color LCD screen, resolution: 320 × 240 points
- * Display format: 8-channel timing waveforms, 18 rows data lists
- * Waves rolling: 32 Channels vertical rolling display, 256K data points plane rolling display
- * Lists rolling: 256K data rows vertical rolling display
- * Waveforms Zoom: horizontal zoom times: 1 to 100, scale: 1ns/div to 4s/div

6.5. Cursor characteristics

- * Measure Cursor 1: floating cursor, floats arbitrarily in display screen, and not moves together with the waveforms or the lists.
- * Measure Cursor 2: Sticking cursor as a reference point sticks on the waveforms or lists, moving together with it.
- * Cursor measure: move the position of the cursor can dynamically display the data values, the address distance and the interval of the two cursors.
- * Trigger cursor: the sample point accords with the trigger conditions.
- * Search cursor: the sample point accords with the search conditions.

6.6. Internal code-generator

- * Code Type: 00 to 15 channels are counters with adding one, 16 to 29 channels are shift pulses, 30 to 31 channels are used for monitoring external clock clk1 and clk2
- * Code Rate: frequency: 1Hz to 50MHz (cycle 20ns to 1s) resolution: 10ns

6.7. Operation characteristics

Keyboard operations, continuous adjustment knob

6.8. Power conditions:

- * Voltage: 100~240V
- * Frequency: 60Hz (1± 5%)
- * Power : <30VA

6.9. Environmental conditions:

- * Temperature: 0 to 40 °C humidity: <80%

6.10. Dimensions

- * Dimensions: 329 mm × 283 mm × 155 mm
- * weight: 3 kg

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This manual considers the latest technical knowing. Technical changings which are in the interest of progress reserved.

We herewith confirm, that the units are calibrated by the factory according to the specifications as per the technical specifications.

We recommend to calibrate the unit again, after one year.

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