

CLW-3/3A INTELLIGENT ULTRASONIC LEVEL METER TECHNICAL MANUAL



ISO9001: 2000 Quality Management System Certificate No.:

02006Q10334R0S

WUXI BIBO ELECTRONIC EQUIPMENT PLANT

Preface

Wuxi Bibo Electronic Equipment Plant situated at the foot of Huishan Hill near the bank of Taihu Lake is an enterprise specialized in research, design and manufacture of hi-tech products.

For many years the plant has engaged in development and production of electronic instruments for ultrasonic measurements etc. It has a team of middle-level and senior technical personnel with strong theoretical knowledge, rich design experiences and excellent management capabilities in this field and a force of well-trained staff members. With this vigorous manpower the plant has successfully applied the military-use sonar technique to ultrasonic measuring scope.

CLW series intelligent ultrasonic level meter is a computerized measuring instrument integrating optical, acoustic, electronic and microelectronic techniques. The products are mainly used for measuring level of material in bin in the fields of metallurgy, coal mines, power generation, cements, fertile, etc. CLW series is capable of measuring level of solids like raw coal, sintered materials, green stock, finished materials, etc; powdery materials like coal powder, lime, fertile, cement, etc; water level of water treatment system in water supply plant and levels of corrosive liquids. For their strong adaptability to various deteriorate environments and great significance in energy saving, reduction of consumption, enhancing product quality and lessening operator's labor intensity the products become the essential equipment in industrial automation.

Ultrasonic sensor (transducer) as the core element in level meter firstly adopts in design the high-strength and high-reliable longitudinal vibrator as its drive source in the country and uses broad-band round radiating plate with high-order bending vibration mode as its radiating surface. The features of lower quality factor, sharp directivity, even low lobes, higher electroacoustic transformation, higher adaptability to deteriorate environment and the like make the ultrasonic level meters hold the leading position in China. In order to follow expansion of applications and meet different customer requirements the plant pushes different-sized air horning transducers of high-temperature, anticorrosion and short blind area versions.

Its technical personnel have developed and designed the system by digesting and absorbing advanced technique of foreign products of the same kind and according to China's actual conditions. Digital filter, optoelectronic isolation, statistical analysis, analysis of curves, range gate tracking techniques, etc are employed to effectively suppress

influences of electrical and external noises and improve anti-interference capacity. Thereby, the products are capable of satisfy the requirements of level measurement under severe conditions of high temperature, high humidity, high-density dust, strong vibration, etc in the trades of metallurgy, mines, power generation, cements, fertile and so on.

Particularly, intensity of echo waves and their locations on the time axis can be observed directly on LCD display. This feature is peculiar among the foreign and home-made products of the same kind.

CLW series intelligent ultrasonic level meters conform to the enterprise standard **Q/320212DD01-94** put on file by **Jiangsu Provincial Standard Bureau with the registered number of Jiangsu Wuxi Standard Record & Registration 1835#-94-5.**

The series products were granted the license No. **Jiangsu Manufacturing 02000182** of production of measuring apparatus in 1995

The products were awarded “**Silver Medal of China Hi-tech New Product Fair**”.

In 1996 the products passed appraisal of Scientific and Technological Achievements sponsored by Jiangsu Provincial Science and Technology Commission and formerly the Ministry of Metallurgy to accept the certificate of **Jiangsu Science Approved No. [96]-149.** They were appraised as “**The main performances of the instrument lead in the domestic products of the same kind and reach 1990s international advanced level among the same kind of products**”.

The enterprise has been awarded as “**Lay Stress on Contract and Be Trustworthy**” Enterprise and got the certificate of Copper prize since 1994.

Many design institutes have selected our product in their design projects.

A great amount of large-size and middle-size enterprises have been using our products for many years.

According to quality tracking MTBF value of our products exceeded 10000 hours.

In the time of introduction of a great number of foreign products into our country the reason why we can obtain a share in domestic market is that we overcame the disadvantages of expensive imported product, strict operating conditions, poor time efficiency of after-sale service, unsmooth supply of spare parts and components and so on.

One of our consistent targets is to gradually substitute for imported product.

In order to thank for trust of new and old clients to our products we'll make our efforts to pursue better.

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1. General

Firstly thank you for selection of BIBO brand CLW-3/3A intelligent ultrasonic level meter developed and produced by our plant. It is a measuring instrument integrating optics, electronics and acoustics. CLW-3 is inquired and set by using buttons; CLW-3A is inquired and set with a manual controller and has a LCD display. Please carefully read the manual before operation and keep it well. That will offer you an aid.

1.1 Purpose

CLW-3/3A intelligent ultrasonic level meter combines features and requirements of ultrasonic technique applied in the fields of metallurgy, mining, cement, fertile, etc. For its great significance in energy saving, reduction of power consumption and enhance of product quality it is an essential apparatus for industrial automation. It can not only measure level of solid materials such as raw coal, green stock, finished material, lime, et al, but also measure liquid level. Fitted with underwater transducer the apparatus can also detect water depth or measure thickness of sediment in water channel. It is easy to operate and high in reliability. When multiple apparatuses are combined to be used in a region of network, they can be individually numbered so as to respectively display each corresponding level signal.

1.2 Composition

CLW-3 consists of two main units—ultrasonic sensor (transducer) and display control box.

Ultrasonic sensor (transducer)	1 pc
Display control box	1 pc

CLW-3A consists of three units—ultrasonic sensor (transducer), display control box and manual controller.

Ultrasonic sensor (transducer)	1 pc
Display control box	1 pc
Manual controller	1 pc

1.3 Operating and storing conditions

Humidity:	30% - 80%	Atmospheric pressure:	86 – 106kPa
Power supply:	220V ± 10% 50Hz		

1.4 Main parameters

Range (varied with different ultrasonic sensor (transducer) being selected): 0.8 – 30m

Blind area (varied with different ultrasonic sensor (transducer) being selected): < 0.8m

Measurement accuracy: Full scale ± 1%

Display form: LCD display

Output interface: Analog DC signal 4 – 20mA (0 - 510 Ω) 0 – 10V

RS485 interface top/bottom alarm switch signal

Contact capacity ~220V 2A

2. Principle of operation

2.1 System block diagram

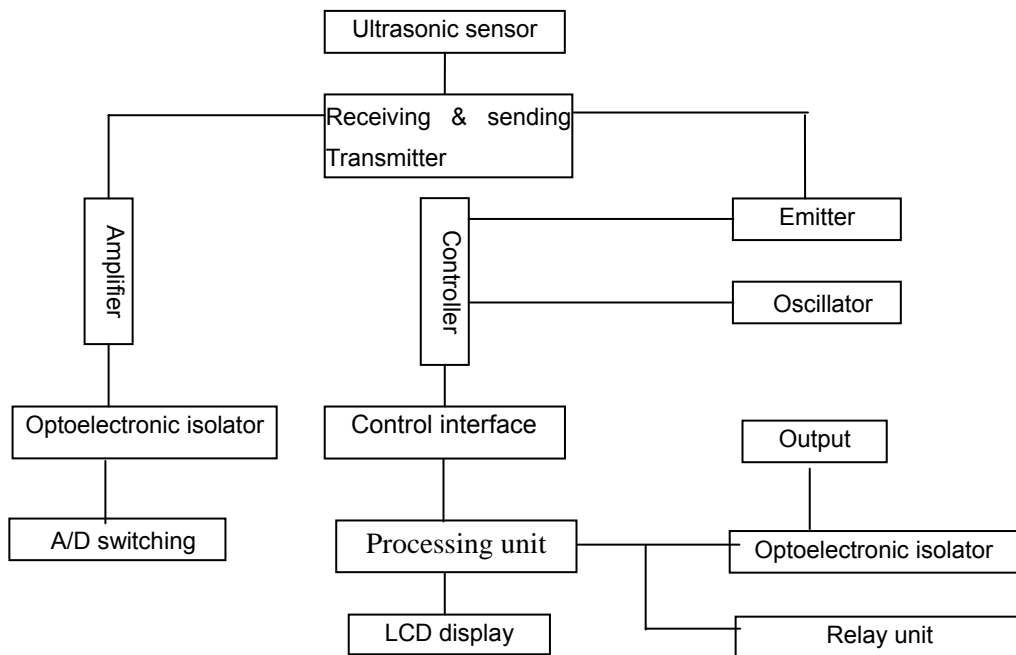


Fig.1 System block diagram

2.2 Basic configuration

CLW-3 consists of two main units.

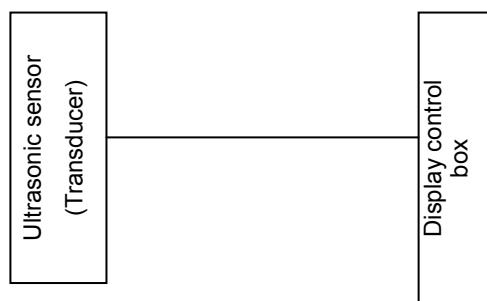


Fig 2.1

CLW-3A consists of three main units.

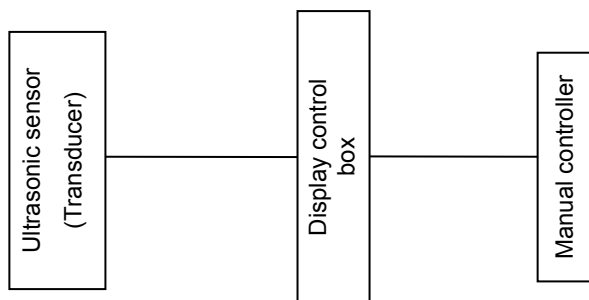


Fig 2.2

3. Installation and debugging

3.1 Installation

3.1.1 Preparation for installation

Overall dimensions of ultrasonic sensor (transducer) and display control box are shown in Appendix A.

Mounting frame is shown in Appendix B.

Before installation start the apparatus for inspection. Aim the sensor at a wall or plate positioned several meters away (within the set range) and start the apparatus to observe two minutes. At that time the indicated value should be close to the actual measured value, which means the apparatus is kept well during transportation and storage.

Prepare mounting frame of ultrasonic sensor (transducer) according to Appendix B. Position the retaining screws on the wall according to mounting dimensions of display control box in Appendix A. Use iron pipe of I.D. 25 – 30mm as cable duct.

3.1.2 Fixing the sensor

According to Appendix B make a flange with a centering hole for fixing the sensor and a slot for laying cable. When the sensor is fixed on the flange, mount the flange on other frame.

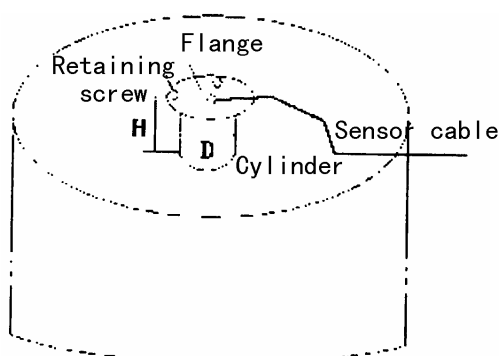


Fig.3 Installation diagram in an enclosed bin

In order to avoid ultrasonic wave generated by the sensor to radiate the edge of bin wall, assuming that D is diameter of the centering hole, H is height of frame, relationship between D and H must follow Table 1 and width W of frame be in correspondence to D . For enclosed bin the frame can be a cylinder fitted with a flange without slot as illustrated in Appendix B and diameter D of the cylinder and height H should conform to Table 1.

Table 1 (unit: mm)

D	270	300	380	450	500	550	600
H	100	300	500	700	1000	1500	2000

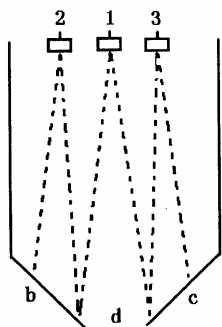


Fig.4

Ultrasonic sensor (transducer) emits sonic pulse in a 7° conical beam. In the acoustic passage echo wave will be produced when the pulse meets any object. For avoiding echo waves reflected by real level to be shielded by those from bin walls, crud, frame and material flow the sensor should be arranged as shown in Fig.4.

Location 1 as the best one; locations 2,3 as the second to select.

The lowest measuring point:

- Location 1 at point d;
- Location 2 at point b;
- Location 3 at point c.

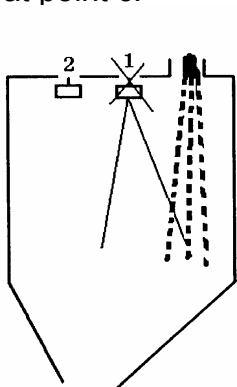


Fig. 6

Ultrasonic sensor (transducer) can't be too close to the feeding hole, otherwise dropping materials will interfere ultrasonic measurement as shown in Fig.6.

Location 1 wrong, While feeding materials, measurement

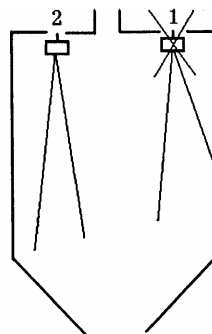


Fig.5

- 1) Ultrasonic sensor (transducer) should avoid lateral welded seam on slotted wall, structural member and crude slotted wall;
- 2) Aim the ultrasonic sensor (transducer) at discharge port as shown in Fig.5.

- Location 1 wrong
- Location 2 correct

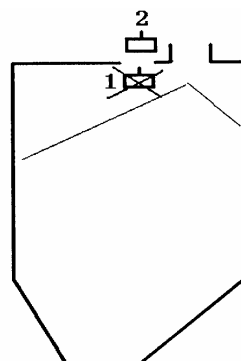
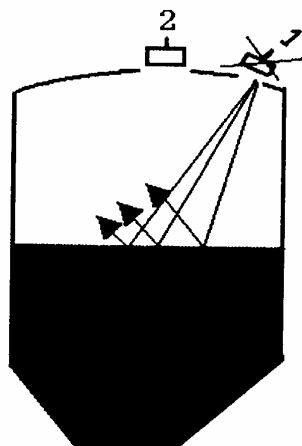


Fig. 7

In order to effectively measuring higher level, the sensor should be placed at the nearest distance of $>0.8m$ from level. Height of frame should be determined based on this principle as shown in Fig.7.

will be influenced;
Location 2 correct.

Location 1 wrong;
Location 2 correct.



In liquid bin since liquid level is evener, the sensor must be positioned in parallel to the level as shown in Fig.8.

Location 1 wrong; No wave received
Location 2 correct.

Fig.8

3.1.3 Fixing display control box

Display control box can be hung on wall. When hanging it, pay attention to the 25m long cable connecting with the sensor and try to select a drier, cleaner place without rain penetration and corrosion to electrical components for access to maintenance.

3.1.4 Wiring

During wiring do the best to reduce length of cable. According to the shortest distance (lateral and vertical) lay the iron duct, remove aviation plug and make connection. Notice: When removing aviation plug, record it for recovering later. Clear off the remaining sections and refit the aviation plug.

3.1.5 Cabling diagram

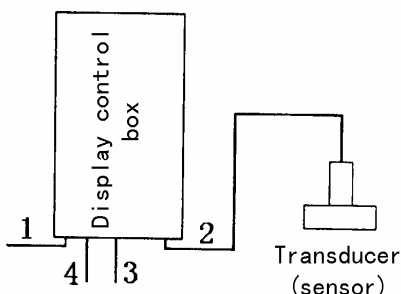


Fig.9.1 CLW-3 cabling diagram

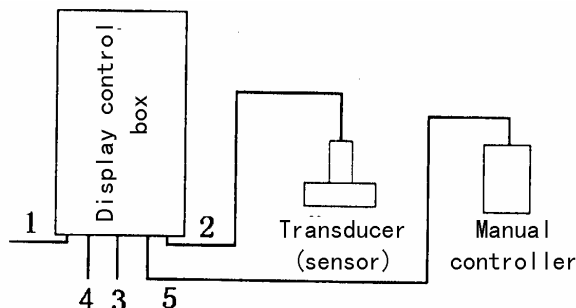


Fig.9.2 CLW-3A cabling diagram

Table 2 Cable allocation

Cable No.	Type/specification	Description
1	YZ3×0.5	220VAC power lead 5m
2	SBPH2×0.5	Ultrasonic sensor (transducer) special cable, 25m
3	AVV-7-3P7×0.15	Output signal cable 5m
4	4×0.2	Upper/lower alarm cable, user-prepared
5		Manual controller interface (for CLW-3A only)

3.1.5.1 Cable 1

Used as power cable. Its connecting terminal is $\Phi 14$ 4-pin aviation plug (P14K11-4).

Table 3 Cable 1

1	L (220VAC)
2	N
3	Grounded
4	No use

3.1.5.2 Cable 2

Used to connect ultrasonic sensor (transducer) and display control box. Connection between the sensor and cable is available and disassembled; cable is connected with display control box via the $\Phi 14$ 3-pin aviation plug (P14K11-3).

Table 4 Cable 2

1	White
2	Black
3	Shielded

3.1.5.3 Cable 3

Used as output signal cable. Its terminal is $\Phi 14$ 7-pin aviation plug (P14K11-7). Pins 1, 2 are 485 outputs; Pins 3, 4, 5 are outputs of analog DC & voltage control signals (4-20mA and 0-10V); Pins 6, 7 are buzzer outputs.

Table 5 Cable 3

Pin	Color	Function
1	Yellow	485 +
2	White	485 -
3	Red	20mA
4	Blue	10V
5	Black	GND-1
6	Purple	Buzzer +
7	Grey	Buzzer -

3.1.5.4 Cable 4

It is used as control cable for upper/lower alarm. User-prepared.

Table 6 Cable 4

1	Upper alarm
2	Lower alarm
3	Upper alarm
4	Lower alarm

3.1.5.5 Interface 5

It is used for connecting manual controller, only for CLW-3A. Manual controller is supplied on demand.

4. Start up

4.1 Display control box

Open the display control box as shown in Fig.10. Turn on Power switch and the power LED on power card is lit. That means the box is energized.

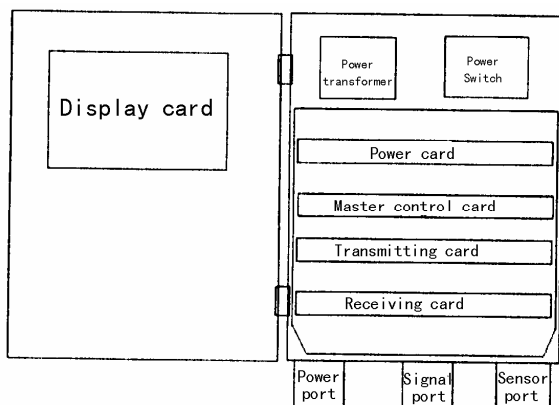


Fig. 10.1 CLW-3 display control box

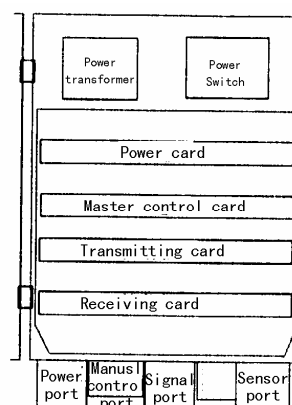


Fig. 10.2 CLW-3A display control box

4.2 Outside view of display control box

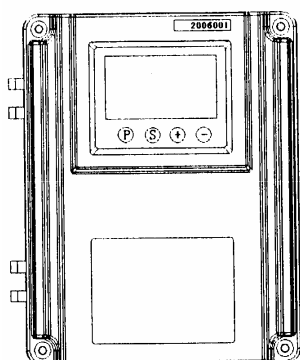


Fig. 11.1 Outside view of CLW-3

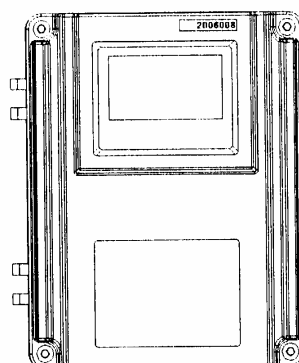


Fig.11.2 Outside view of CLW-3A

When the display control box is powered on, interface of Fig.12 will appear on the LCD display. Several seconds later Interface of Fig.13 will be presented. Range value or percentage is displayed with variation of parameter setting. In case communication is improper, the interface as Fig.14 will come out.

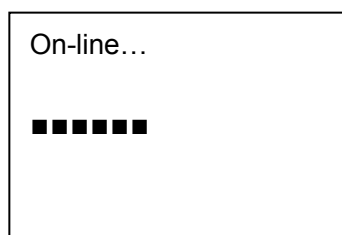


Fig.12

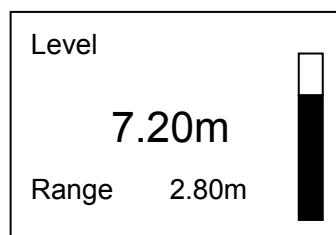


Fig.13

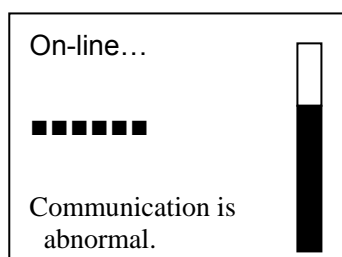


Fig.14

★ Each time the apparatus is stopped, it must be restarted 10 sec later. Starting it immediately will cause abnormal operation.

★ The apparatus has power-off protection function and all the set parameters can be permanently preserved.

5. Functions of keys

For CLW-3 model keys are located on the panel of display control box; for CLW-3A keys are positioned on the manual controller, but their definitions and functions are identical.

5.1 P Setting key

By pressing the key the system enters into setting state.

5.2 S Shifting key for leftward cycling

The key is used for cyclically moving the cursor from right to left.

5.3 + Increment key/ backward scroll

The key is used for increasing digit by 1 or reversely scrolling menu or selecting function.

5.4 – Decrement key/ Forward scroll

The key is used for decreasing digit by 1 or forward scrolling menu or selecting function.

6 Parameter enquiry and setting

6.1 Sketch of bin parameters

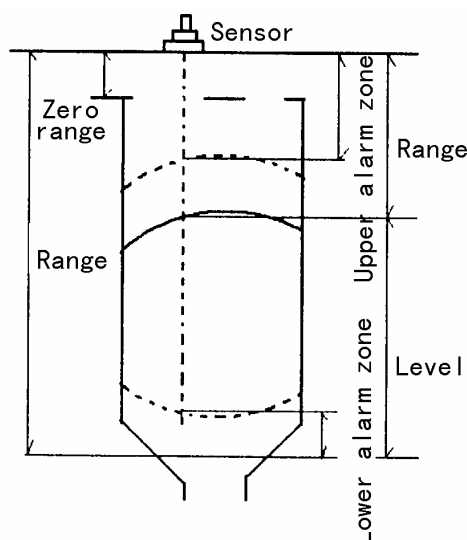


Fig.15 Sketch of bin parameters

6.2 Parameter enquiry

In the interface as Fig.13, by pressing P key the Fig.16 will appear. When it is required to enquire the state of the set parameter, use the +, - keys to move the cursor to the "Parameter Enquiry" item. Then press P key and the system enters Parameter enquiry interface. At that time setting states of all system parameters can be enquired, but not modified. In any interface of enquiring system parameters, only when pressing the P, S keys simultaneously, the system can automatically exit from the state and the interface as Fig.13 will be recovered. The second group of parameters has already been set at ex factory delivery and won't be changed unless stated otherwise.

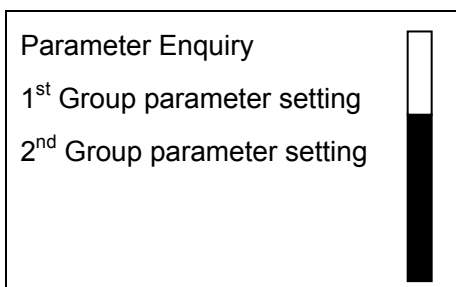


Fig.16

6.3 Parameter setting

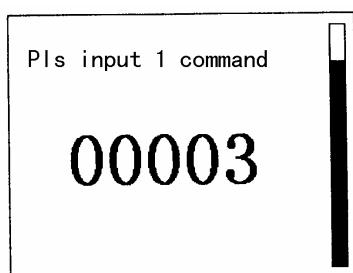


Fig. 17

In the interface as Fig.13, by pressing P key the interface as Fig.16 will appear. Use the +, - keys to move the cursor to the “Parameter Enquiry” item. Then press P key and the interface as Fig.17, i. e. system command inputting interface is presented. The interface is specially set for avoiding system commands to be arbitrarily altered. Only with the correct input command the system can enter the parameter modifying state. The command is 3 here. When correct command is inputted, press the P key and the system enters the modifying state of the 1st group system parameter. See the interface in Fig.18.

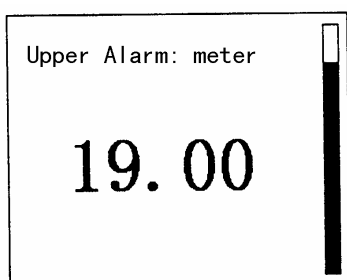


Fig. 18

6.3.1 Setting Upper Alarm

When entering the interface as Fig.18, use the S key to select the required position and then the +, - key to change digit till the right one. Finally press the P key to confirm the parameter is modified and next parameter setting is begun simultaneously.

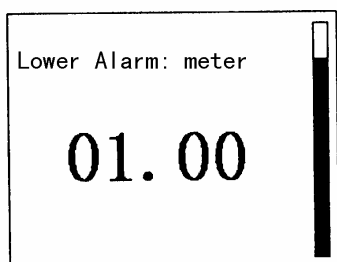


Fig. 19

6.3.2 Setting Lower Alarm

When entering the interface as Fig.19, use the S key to select the required position and then the +, - key to change digit till the right one. Finally press the P key to confirm the parameter is modified and next parameter setting is begun simultaneously.

6.3.3 How to set buzzer

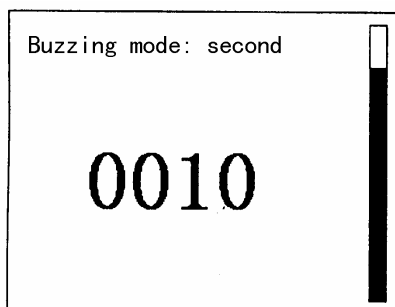


Fig. 20

Enter into the interface as Fig.20. Then select the digit by using the S key and set the number by key + or —. Press key P to confirm and start next setting. The buzzer, when selecting 0000, will howl all the time if you set the howl mode. If time is set for howl mode, the buzzer will stop howling when time is up. At this time the indicator light will glitter to hint that level is within the warning zone.

6.3.4 How to set time for screen protection

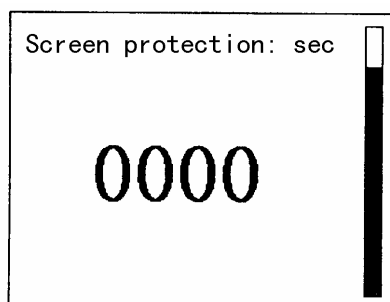


Fig. 21

Enter into the interface as Fig. 21. Then select the digit by using the S key and set the number by using key + or —. Press key P to confirm and start next setting. If you set 0000 for screen protection, the background light of screen will shine all the time. If time is set, the background light will shut off when time is up.

6.3.5 How to set temperature sensor

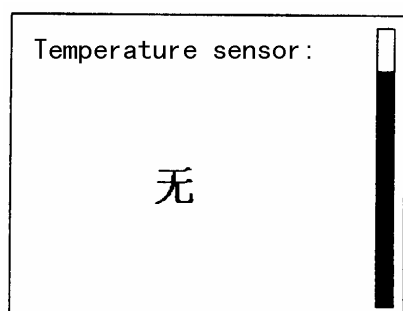


Fig. 22

Enter into the interface as Fig. 22. Then select the digit by using key S and set the number by using key + or —. Press key P to confirm and start next setting. You can choose yes or no to set this parameter. If the temperature meter is not connected, the parameter shall be set as NO.

6.3.6 How to set temperature

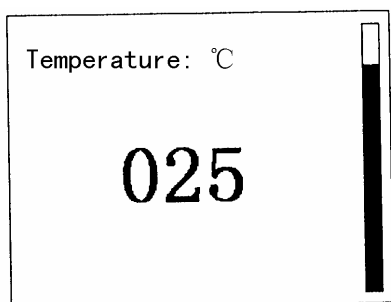


Fig. 23

Enter into the interface as Fig. 23. Then select the digit by using key S and set the number by using key + or —. Press key P to confirm and start next setting. This parameter shall be set as per the temperature surrounding the ultrasonic sensor (transducer).

6.3.7 How to set gain control mode

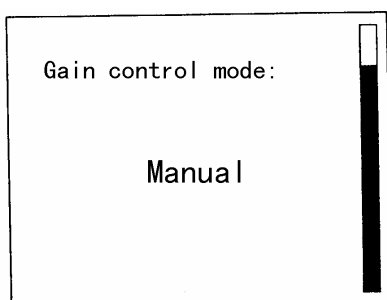


Fig. 24

Enter into the interface as Fig. 24. Then select the digit by using key S and set the number by using key + or —. Press key P to confirm and start next setting. You can choose "manual" or "automatic" for this parameter.

6.3.8 How to set manual gain

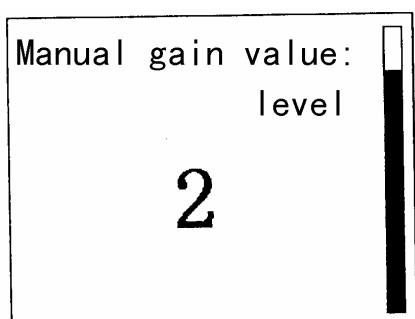


Fig. 25

Enter into the interface as Fig. 25. Then select the digit by using key S and set the number by using key + or —. Press key P to confirm and start next setting. You can choose 0-7 for this parameter to ensure detection according to the amplitude of echo. The min value is 0 and the max value is 7.

6.3.9 How to set zero distance

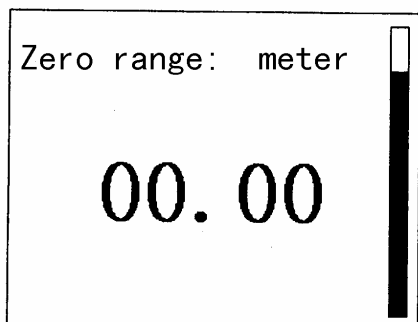


Fig. 27

Enter into the interface as Fig. 26. Then select the digit by key S and set the number by using key + or —. Press key P to confirm and start next setting. This parameter has been set before ex-factory. It shows the position of full range (20mA) on the radiation plate of the ultrasonic sensor (transducer). If 00.50 is set for this parameter, it means 20mA is 50cm away in front of the ultrasonic sensor (transducer).

6.3.10 How to set blind sector

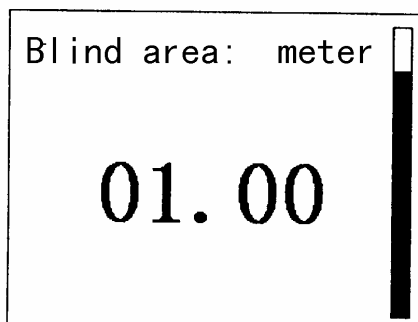


Fig. 28

Enter into the interface as Fig. 27. Then select the digit by using key S and set the number by using key + or —. Press key P to confirm and start next setting. This parameter has been set before ex-factory according to the equipped ultrasonic sensor (transducer).

6.3.11 How to set range

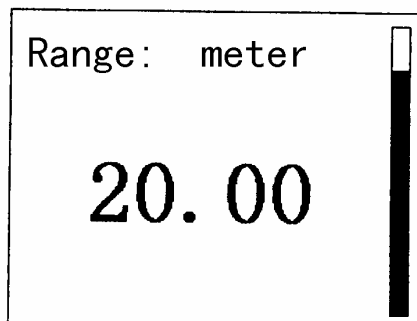


Fig. 29

Enter into the interface as Fig. 28. Then select the digit by key S and set the number by using key + or —. Press key P to confirm and start next setting. If 20.00 is set for the range, the meter will show 4mA for empty bin when the lowest level is 20m away from the ultrasonic sensor (transducer).

6.3.12 How to set detection mode

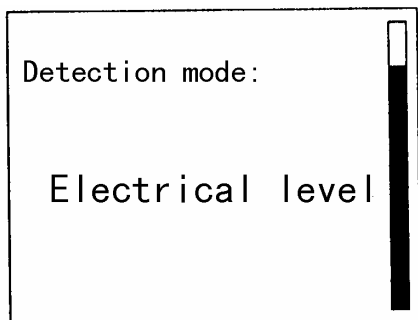


Fig. 29

Enter into the interface as Fig. 29. Then select the digit by using key S and set the number by using key + or —. Press key P to confirm and start next setting. You can choose Max or Electrical level for this parameter.

6.3.13 How to set electrical level

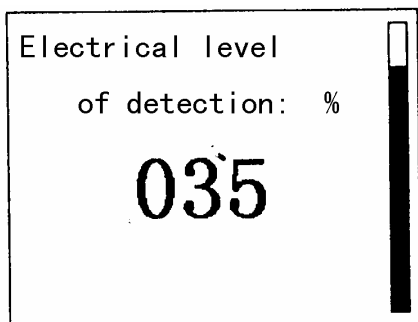


Fig. 30

Enter into the interface as Fig. 30. Then select the digit by using key S and set the number by using key + or —. Press key P to confirm and start next setting.

6.3.14 How to set tracking gate of distance

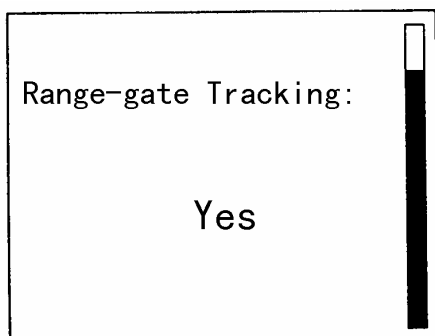


Fig. 31

Enter into the interface as Fig. 31. Then select the digit by using key S and set the number by using key + or —. Press key P to confirm and start next setting. You can choose Yes or No for this parameter. The interface is shown as “∩”

6.3.15 How to set times of average

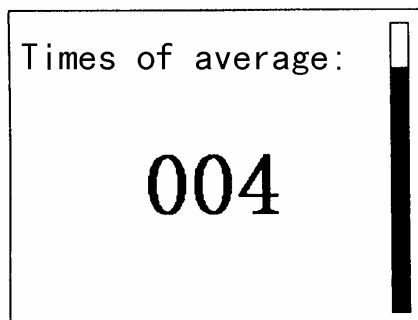


Fig. 32

Enter into the interface as Fig. 32. Then select the digit by using key S and set the number by using key + or —. Press key P to confirm and start next setting.

6.3.16 How to set display mode of level

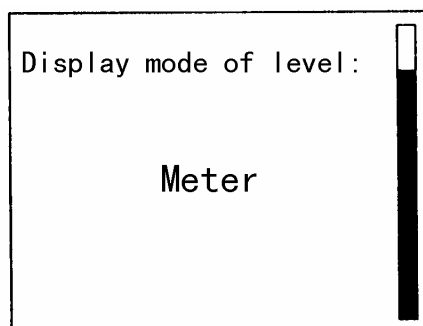


Fig. 33

Enter into the interface as Fig. 33. Then select the digit by using key S and set the number by using key + or —. Press key P to confirm and start next setting. You can choose meter, % or range for this parameter. "Meter" shows the actual height of material. "%" shows the percentage of material to bin capacity. "Range" shows the actual distance from the radiation plate of ultrasonic sensor (transducer) to the level. The longer distance, the more material can be accommodated. A histogram will be shown on the interface.

7. Maintenance

7.1

Follow problems are not apparatus's failure

7.1.1

In the apparatus, ultrasonic sensor has different transmitting cycles, so as to avoid some periodical interference.

7.1.2

When the detection range $< 1.90\text{m}$ in lab, if you move the ultrasonic sensor away to change the detection distance suddenly (move more than 0.8m per second), the display value will not change because of function of " blind area processing". To resolve this problem, please move the ultrasonic sensor near to the former place and remove it slowly.

7.1.3

If the detection distance change suddenly in lab, the display value will not change because the apparatus needs several seconds to confirm the sudden change. Then the apparatus shows the value or sets the parameter of echo to 7. Thus the apparatus can process the moved distance of ultrasonic sensor (transducer) in time.

7.1.4

The relay does not work when alarm sounds. It is because the interval of two alarms is too short. If you wait a few seconds, the relay will continue to work. It is specially set to avoid any damage to the units under control caused by quick action of the relay.

7.1.5

The relay remains in alarm station when alarm does not sound, which can avoid the relay to jump ceaselessly on the alarm point, The alarm modes of relay and LED are different. LED's alarm line is one point and relay's alarm line is a range of 0.30m . Please refer to Fig. 34.

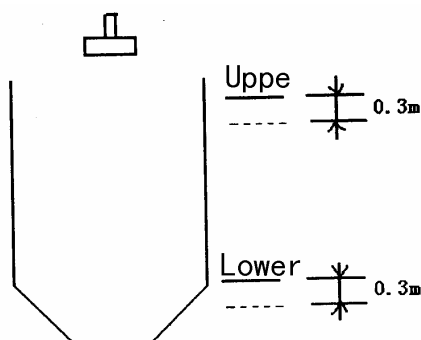


Fig. 34

Working process of alarm relay: When level >upper value, the upper alarm relay will be picking-up until the level lowers down to the upper value (-0.30). When level <lower value, the lower alarm relay will be picking-up until the level lifts up to the lower value (+0.30).

7.2

Check and clean the ultrasonic sensor (transducer) periodically.

8. Failure analysis

8.1

The apparatus does not emit ultrasonic waves and the sensor does not work.

Open the display control box and check the indicating lamp. If the apparatus is energized, check the 220VAC circuit and electrical fuse (1~1.5A). If there is no problem of power supply, please check the plugs and connectors. If all the things above are OK, maybe there is something wrong with high-voltage protection, receiving card and external connection.

8.2

If you can hear sound from ultrasonic sensor but nothing is detected, touch the sensor surface by hand. If there is not any vibration, it tells us there's something wrong with the ultrasonic sensor.

8.3

If the level remains high, adjust the value of blind area larger, e.g. from 1.2m to 1.5m.

8.4

The echo's amplitude A is the same as the amplitude of noise.

If the echo's amplitude $A > 9V$, it does not need any adjustment. If it does not work normally, please perform as follows:

- 1) Measure the distance from the level to the ultrasonic sensor (transducer). Ultrasonic wave can travel and return 1m about per 5.8ms in air. Thus we can estimate the position of echo on the horizontal axe of oscilloscope. If the measured distance is 3m, the time-difference between emitted wave and echo shall be 17.4ms. Please refer to Table 7.

Table 7

Distance (m)	Time-difference (ms)	Distance (m)	Time-difference (ms)
0.5	2.9	5.5	31.9
1.0	5.8	6.0	34.8
1.5	8.7	6.5	37.7
2.0	11.6	7.0	40.6
2.5	14.5	7.5	43.5
3.0	17.4	8.0	46.4
3.5	20.3	8.5	59.3
4.0	23.2	9.0	52.2
4.5	26.1	9.5	55.1
5.0	29.0	10.0	58.0

2) Only after the measured distance is larger than 3m you can continue working. Otherwise please wait until the level lowers down.

3) Observe the echo on the control box by oscilloscope with synchronous out-trigger. Find the real echo according to above estimated time and record its position on the oscilloscope. The wave shape of echo is shown as Fig. 35. (5V/div, t=5ms/div)

4) Observe TVC curve by oscilloscope. Adjust the potentiometer RP301, RP302 on the receiving card to make initial voltage 5v and time-control 15ms, as shown in Fig. 36 (5V/div, t=10ms). The wave shape of echo is shown as Fig. 37. Keep eyes on the echo and decrease manual gain step by step until the echo is shown as Fig. 38. If the gain is lowered to 0, but the trail is still very large, please adjust the gain potentiometer RP300 on the receiving card anticlockwise to decrease the gain until the shape of echo is shown as Fig. 38. Echo's amplitude changes a lot in practice. If more than 50% are larger than 6V, that's OK. Then cut off the power supply of display control box and recover after 10 seconds.

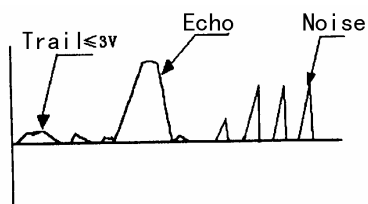


Fig. 35

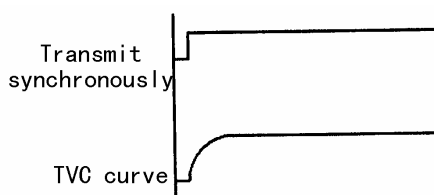


Fig. 36

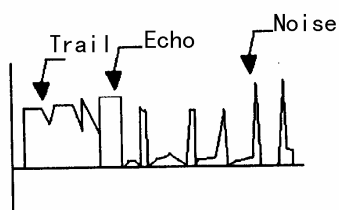


Fig. 37

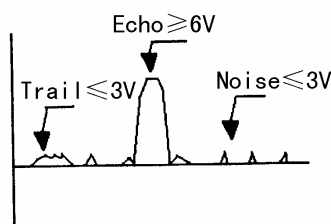
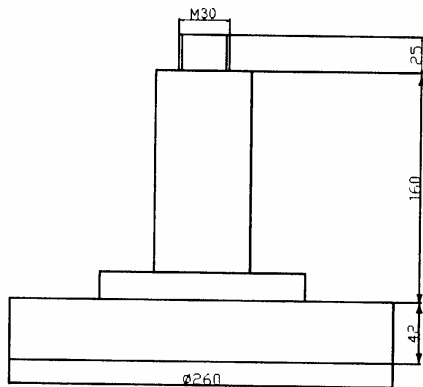


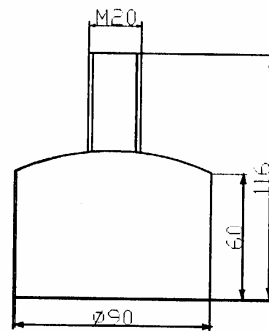
Fig. 38

Annex A

I . Dimension of ultrasonic sensor (transducer)



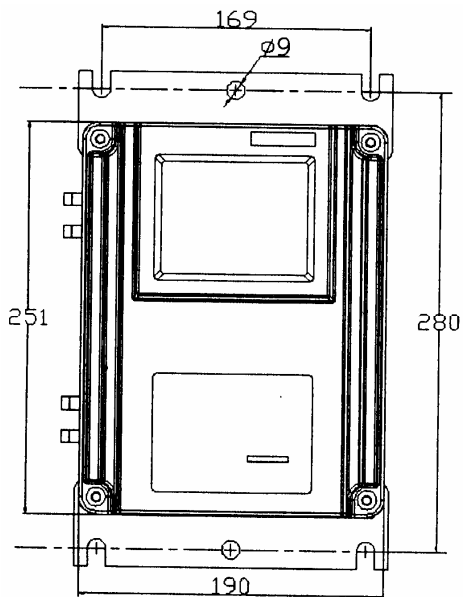
Normal-temperature transducer



Short-range transducer

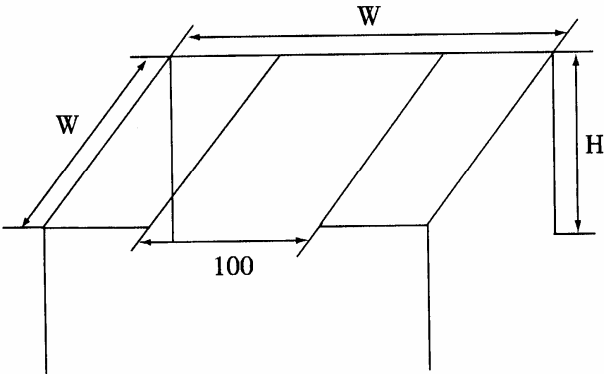
II . Dimensions and outside view of display control box

251mm (L) *190mm(W) *88 (H) mm



Appendix B

I . Sketch of mounting frame



II . Sketch of flange

