

ZC4116 distortion
measuring instrument

User's Manual

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I: General

ZC4116 low-distortion measuring instrument is a new type automatic digital instrument. The min. distortion is just 0.01%. It's a intelligent instrument of high cost efficiency as well as a newest member of the ZC4116 full-digital distortion instruments by ZCTEK.

The voltage, distortion, and frequency of the signal tested are displayed on a LCD. It adopts true RMS wave detection. Voltage measuring can be carried out fully automatically in the input voltage range of 1mV~300V and frequency range 10Hz~300kHz. Distortion measuring can be carried out fully automatically in the input voltage range of 100mV~300V and frequency range of 10Hz~110kHz. The distortion measuring range is 100%~0.01%. This instrument is capable of measuring balanced and imbalanced input voltage and distortion. The amplitude display unit can be V, mV, dB. Distortion can be displayed in % or dB. Inside the instrument designed are 400Hz hi-pass filter and 30kHz and 80kHz low pass filters to facilitate the use by the user.

This instrument is a new generation of multi-functional intelligent one fully automatic for measuring signal voltage, frequency, and signal distortion etc. It's also a high-level instrument that is fully digital, automatic, multifunctional, and intelligent for signal distortion measuring section in the country.

II: Main Features

1. Fully automatic for distortion test; automatic calibrating; and automatically tracking the filtering;
2. Measurable min distortion $\geq 0.01\%$
3. Set with 30kHz and 80kHz low-pass filters that reduce the influence of broadband anharmonic wave (such as noise), making the measuring of the harmonic distortion at low frequency bands more accurate.
4. The voltage range of the input signal for measuring signal distortion is improved to 100 mV~300V.
5. Having the function to measure balanced or imbalanced signals
6. Added with frequency counting function; the frequency of the measured signal can be displayed with the LCD directly.
7. Reserving the jack for monitoring the output of the oscilloscope, thus facilitating the user to observe the waveform of the measured signal and the overall harmonics filtering status in the measurement of low-distortion signals as well;
8. The filtering capacity for trapped wave network can reach 90dB~100dB;
9. Adopting high-precision true RMS wave detector that effectively reduces the wave detection error

III: Basic Operating Characteristic Indicators

1. Measuring of distortions

1) Frequency scope: imbalanced: 10Hz~110kHz;

Balanced: 10Hz~100kHz

2) Voltage range of input signal: 100mV~300V

3) Distortion measuring range:

Input voltage 300mV~300V:

100Hz~100kHz: 100%~0.01%; 20Hz~100Hz: 100%~0.03%

100kHz~150kHz: 100%~0.03%

Input voltage 100mV~300mV:

20Hz~110kHz: 100%~0.05%

4) Accuracy: a: 300Hz~5kHz ± 0.7 dB

b: 10Hz~110kHz ± 1.1 dB

When distortion is no more than 0.03% and the input signal is at 50-300mV:
 ± 2 dB

5) Residual distortion and noise (>1Vrms input):

a: 300Hz~5kHz $\leq 0.01\%$ *

b: 20Hz~20kHz $\leq 0.02\%$ **

c: 10Hz~110kHz $\leq 0.03\%$ *

* When the fundamental frequency is more than 400 Hz, the distortion is less than 0.1%, the access to 400Hz hi-pass filter and 30 kHz low-pass filter; Less than or equal to 400 Hz, 30 KHz low-pass filter access.

** When the fundamental frequency is more than 10 kHz, the distortion is less than 0.1%, the 80 kHz low-pass filter access;The distortion is less than 0.01%, the access 400 Hz hi-pass filter and 80 kHz low-pass;When the fundamental frequency is less than or equal to 10 kHz, 30 kHz low-pass filter access.

6) % display resolution:

10%~100%: 0.1%

1%~9.99%: 0.01%

0.1%~0.999%: 0.001%

< 0.1%: 0.001%

7) dB display resolution: 0.01dB

2. AC voltage measuring:

1) Voltage measuring range: 1mV~300V

2) Frequency range: imbalanced: 10Hz~300kHz

Balanced: 20Hz~40kHz

3) Frequency response based on 1kHz:

Imbalanced:

20Hz~20kHz $\leq \pm 0.5\text{dB}$

10Hz~100kHz $\leq \pm 1\text{dB}$

100kHz~300kHz $\leq \pm 1.5\text{dB}$

Balanced:

20Hz~30kHz $\leq \pm 1\text{dB}$

30kHz~40kHz $\leq \pm 1.5\text{dB}$

4) Voltage meter accuracy: (based on 1kHz) $\pm 3\%$; background noise $\leq 50\mu\text{V}$

5) Error of the effective value waveform of the voltage meter: $\leq 3\%$ (when the crest factor of the input signal is ≤ 3)

6) Display resolution:

Over 100V: 100mV

Over 10V: 10mV

Over 1V: 1mV

Over 100mV: 0.1mV

Over 10mV: 0.01mV

Over 1mV: 0.001mV

Below 1mV: 0.0001mV

3. Frequency measuring:

1) Frequency range for voltage measuring: 10Hz~300kHz; input signal: $\geq 10\text{mV}$

2) Frequency range for distortion measuring: 10Hz~110kHz; input signal $\geq 100\text{mV}$;

3) Accuracy: $0.1\% \pm 2$ characters

4. This instrument defines $0\text{dB} = 1\text{V}_{\text{rms}}$ ($0\text{dBm} = 0.7745\text{V}$ @ power measuring, which also means the power of 1mW at 600Ω ; therefore, the dBm value can be acquired just by adding 2.22 to the current dB reading) and dB display resolution: 0.01dB

5. Input impedance: $100\text{k}\Omega // 100\text{pF}$ (balanced, imbalanced)

6. Power voltage: $220\text{V} \pm 10\%$, $50\text{Hz} \pm 2\text{Hz}$

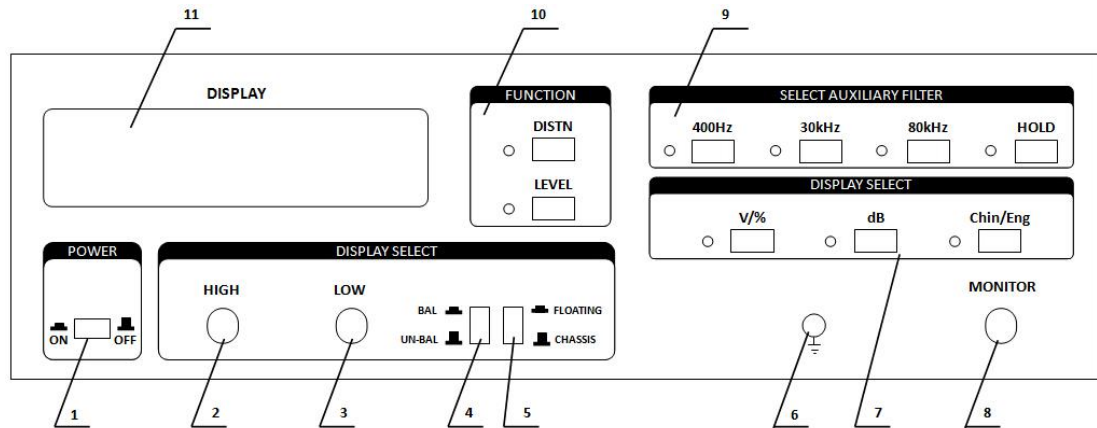
7. Power consumption: approx 20VA

8. The work environment condition of the instrument is Group II.

9. Volume: $350(\text{W})\text{mm} \times 120(\text{H})\text{mm} \times 340(\text{D})\text{mm}$

10. Weight: approx. 5kg

IV: Operation Panel



1. Layout and function descriptions of the front panel of the instrument:

(1) power switch: insert the power cord of the instrument into the socket board at the back of the instrument, with the other end connected to 220V AC power supply; press this key again to power on the instrument.

(2) and (3): **“HIGH”** and **“LOW”** socket at signal input end (2) and (3): **“HIGH”** and **“LOW”** are provided for measuring balanced input signal; for measuring imbalanced signals, connect the signal to **“HIGH”** end and with MODE selected at UNBAL (select with key **“BAL/UNBAL”**). For measuring balanced signal, set MODE at BAL (select with key **“BAL/UNBAL ”**) first, then connect the high end of the signal to **“HIGH”** and the low end of the signal to **“LOW”**.

(4) BAL switch: switch balanced or unbalanced input.

(5) FLOATING switch: FLOATING buttons, when measuring the 220 v power grid (without transformer isolation), according to balance of input methods, and press the button in a FLOATING state, other measurement according to the need to decide.

(6) earth terminal: the earth terminal on the front panel is for earthing the instrument casing. Before using this instrument, connect this earth terminal with that of the measured equipment, then connect to the ground reliably in a combined way.

(7) Display select key area:

V / % display unit transformation key, select the unit of measurement value of voltage (V) or (%);

dB key Choose the display units for the dB. When voltage measurement, can choose V or dB display, When distortion measurement, can choose % or dB display.

Chinese/ENG key select the display character is either Chinese or English.

(8) waveform monitoring terminals: connecting the oscillograph input to this jack can enable directly observation of the waveform of the measured signal or the filtered harmonics waveform. The output impedance at the oscillograph input end is 600Ω.

(9) Control area for selecting auxiliary filter

- **400**: it's 400Hz high-pass filter. When the measured signal is over 400Hz, pressing this key can mostly eliminate 50Hz power interference; pressing this key can improve the accuracy of low-distortion measuring especially for measurement of low-signal distortion.
- **30k, 80k**: low-pass filters that can be selected as needed; when measuring signal harmonics distortion, press 30kHz low-pass filter for signals below 10kHz; while 80kHz low-pass filter must be activated for signals up to 20kHz for eliminating high-frequency noise.
- **HOLD**: just for locking the harmonics filtering network.

(10) Measurement function key area:

- **LEVEL** key: press this button, the instrument enters voltage measuring state (the default setting of the instrument is that it enters voltage measuring state upon power-on).
- **DISTN** key: press this button, the instrument enters distortion measuring state; the time for testing the first-time distortion measuring state is often over 10 seconds; later, the time will be faster. Generally speaking, low-frequency signal measured needs longer harmonic filtering time; while hi-frequency harmonic filter needs shorter time. Indication of "LIMIT" means the input signal is lower than that as required for the measuring amplitude; in this case, increase the amplitude of the input signal.

(11) LCD display for measurement

2. Layout and function descriptions of the back panel of the instrument:



(1) AC power input socket

(2) Fuse holder

V: Operation Instructions

(1) Press the power switch on the panel, the instrument enters into voltage measuring state automatically.

(2) Voltage measuring:

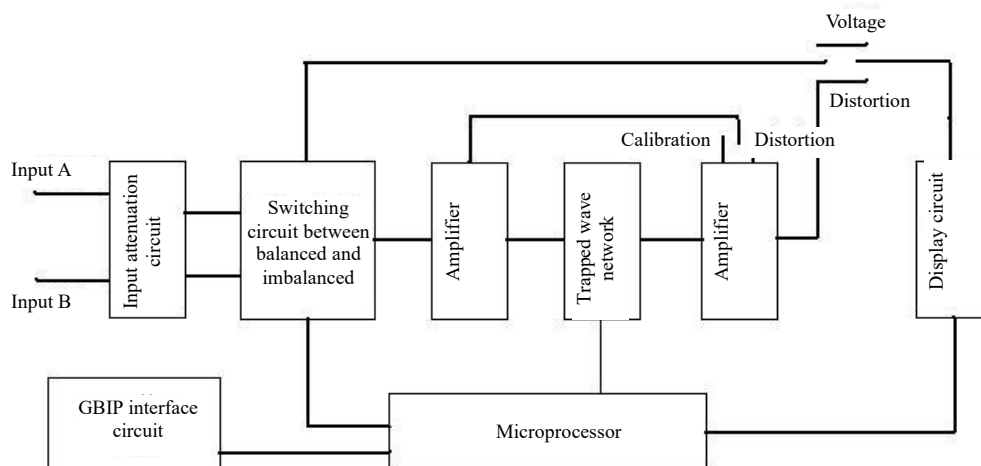
When the measured is imbalanced voltage signal, the signal cable just needs to be connected with the “HIGH” end; then can the measured signal voltage and frequency be displayed automatically. When the measured is balanced voltage signal, press BAL key first, then connect the high end to “HIGH” and the low end to “LOW”, thus realizing automatic measuring of balanced voltage. The unit of the voltage displayed can be set with key V% or key dB.

(3) Distortion measurement:

The method for connecting in imbalanced or balanced signal is the same as for voltage measurement. The voltage of the measured signal voltage shall be no less than 100mV (otherwise, it will show “LIMIT”). Press key DISTN to select distortion measuring method; the system will track the electric level and frequency of the measured signal automatically without any operation. The data can be recorded after the display has been stable. The unit for the displayed distortion can be dB or %; the instrument adopts % to display when distortion key is pressed. (Select filter as instructed in Section IV (6) of the manual. Generally speaking, the upper-limit frequency of the filter selected is 3-5 times bigger than the measured signal; in this case, the measurement accuracy will not be affected.)

VI: Work Principle

The work principle of this instrument adopts fundamental wave filtering method as shown below:



The critical circuit and components are applied with special design and manufacturing processes as well as combined with the computer technology. The frequency, amplitude of the input frequency is automatically tracked by

programming; harmonics filtering is carried out also automatically; the overall data is displayed on a LCD display. Besides, the operation panel of the instrument is also provided with a jack for monitoring the output of the oscillograph, so that the user can directly observe which harmonics form the distortion of the measured signal and the harmonics filtering state. In low-distortion signal measurement, the user can directly observe the overall harmonics filtering state.

For measuring of balanced signal, this instrument gives up the balanced transformer conversion solution of traditional instruments for that such solution needs complex manufacturing process, high cost, and narrow usable frequency band. This instrument employs special balanced-imbalance switching circuit to expand the usable frequency band.

The filtering capability of the trapped wave network of this instrument can reach 90~100dB; besides, it is also designed with three types of low-pass filters as 30kHz, 80kHz, and 750kHz; the proper filter can be added properly as needed in use to inhibit hi-frequency interference and notice influence, thus improving the measuring accuracy. On the other hand, 400Hz high-pass filter is also provided; pressing it can substantially eliminate the 50Hz power interference when measuring signal distortion over 400Hz.

This instrument adopts hi-precision true RMS wave detector so that no wave detection error as with mean value or quasi-effective value wave detectors will be brought about when the crest factor of the signal is no more than 3.

Measuring of distortion with this instrument:

$$D = \frac{\text{noise(噪声) + distortion(谐波)}}{\text{signal(信号) + noise + distortion}}$$

Display unit definition: % = D * 100%, dB = 20logD

When the distortion is over 10%, rectify by calculation with the following formula (according to metrological code JJG251-97):

$$D = \frac{D_0}{\sqrt{1 - D_0^2}}$$

Where: D0 is the displayed value of this instrument; D stands for the actual distortion value measured after rectification.

VII: List of Serial Interface Commands:

(1) Measuring method

Command	Description
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LEVEL	Electric level measuring
DISTN	Distortion measuring
SINAD	Signal-noise plus distortion measuring
S/N	Signal-noise measuring
FREQ	Frequency measuring

(2) Trapper setting

Command	Description
FAUTO	Automatic harmonics filtering
FHOLD	Harmonics filtering network holding
FX	The harmonics filtering network is closed at the preset frequency, where X stand for the frequency value such as 10.000kHz; 800.00Hz.

(3) Filter setting

Command	Description
L30K	Selecting 30kHz low pass
N30K	30kHz low pass off
L80K	Selecting 80kHz low pass
N80K	80kHz low pass off
L400	Selecting 400kHz high pass
N400	400kHz high pass off

(4) Output unit setting

Command	Description
OUTDB	Logarithmic representation of the output unit
OUTLN	Linear representation such as V,MV,%

(5) Output contents

Command	Description
RFREG	Read the frequency value
RMEAS	Read the measured value
RETURN	Exit from serial port

VIII: Maintenance & Service of the Instrument

- 1、 The factory-set power supply is 220V/50Hz
- 2、 The instrument can work continuously for 8 hours.
- 3、 Environment conditions for using and storing the instrument:
 - 1) Rated work ambient temperature: 0-40°C
 - 2) RH below 80%
 - 3) The room shall be well ventilated, free of acid, alkali and other corrosive gases; there shall be no violent mechanical vibration and intensive electromagnetic field actions.
- 4、 Repair of the instrument

This instrument is intelligent; some specially-designed circuit and components inside the instrument can ensure the overall performance of the instrument only when the specific parameter conditions are met. Only specially trained personnel are allowed to repair the instrument. The instrument is provided with 18-month warranty period and life-long maintenance service (any authorized dismantling of the instrument will invalidate the warranty provisions).

IX: Accessories

1. Power cord: 1 No.
2. Input cable: 2 Nos.
3. Oscillograph output cable: 1 No.
4. User's Manual: 1 copy