User's Guide

TFG1900A Series Function/Arbitrary Waveform Generators

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Introduction of TFG1900A Series Function/Arbitrary Waveform Generators

The present guide is valid for three models of TFG1900A Series Function/Arbitrary Waveform Generators:

TFG1903A, TFG1905A, TFG1910A and TFG1920A, the highest sine wave frequency of which are respectively 3MHz, 5MHz, 10MHz and 20MHz.

With Direct Digital Synthesis (DDS) technology, the TFG1900A Series Function/Arbitrary Waveform Generators are of the high performance indexes and rich function characteristics which are necessary for the fast completion of measuring. The clear and bright VFD fluorescent display interface is convenient for the users to operate and observe.

The generators are of the following advanced specifications and powerful function characteristics:

- **Two-channel output:** two independent output channels, CHA and CHB, the characteristics of the two are the same
- **Sync output:** output sync signal
- **Frequency characteristics:** frequency accuracy 20ppm, 6 digits, resolution 1μHz
- **Amplitude offset characteristics:** amplitude and offset accuracy 1%, 5 digits, resolution 0.1mV
- **Unlimited measurement range:** without limitation for the whole range, digital setting directly
- **Non-intergraded process:** up to the stable value immediately when switching, continuous signal phase and amplitude without deflection
- **High waveform accuracy:** the output waveform is synthesized by the computation value of functions with higher waveform accuracy and less distortion
- **Square and Ramp:** set accurate square duty cycle and Ramp symmetry
- **Pulse:** set accurate pulse width
- **Arbitrary:** 11 internal fixed waveforms and 5 user-defined waveforms
- **Phase characteristics:** set phase difference of CHA and CHB
- **Modulation characteristics:** output FM, AM, PM, PWM, FSK signal
- **Frequency sweeping:** be of the function of output linearity or logarithm frequency sweeping signal, start point and stop point can be set arbitrarily

- **Burst characteristics:** output burst signal of which the number has been set.
- **External trigger:** external trigger is available under frequency sweeping, FSK modulation and burst function.
- **Frequency measurement:** be of the function of frequency measurement function.
- **Computation function:** frequency or period, amplitude virtual value or peak-peak value can be selected.
- **Operation mode:** keyboard operation, fluorescent display screen, direct digital setting or continuous adjusting by knobs.
- **High reliability:** large scale integrated circuit, surface-mount technology, high reliability and long service life
- **Programmable interface:** equipped with USB device interface, with which the generator could be program-control and download waveforms
- **Programmable interface:** equipped with USB host interface, with which the parameter setting and user-defined waveforms could be stored to a U disk

TFG1900A Series Function/Arbitrary Waveform Generators and accessories

- TFG19xxA Series Function/Arbitrary Waveform Generator 1
- 3-core power cord 1
- CD 1

And the following contents are included in CD:

USB Driver programmer

Remote control demonstration software

Waveform edition software

User's Guide

Programmers' Guide

Waveform edition instruction

Interface usage instruction

Summary of this Guide

Chapter 1 Getting started

To learn the basic operation of the generator now.

Chapter 2 Principle introduction

To describe the basic working principle of the generator.

Chapter 3 Reference

To introduce the functions, operations and applications of the generator in detail.

Chapter 4 Service and support

To promise warranty and technological support of the generator.

Chapter 5 Specification

To list the function characteristics and specifications of the generator.

Note: This document is just a guide of operation of this instrument, it is unavoidable for not-so-adequate description of technology and wrong printing, please excuse any modification of the contents without special notification.

Content

Chapter 1 Getting started

The front and rear panels, operations and functions of the TFG1900 series function generator are described in this chapter so as to help users to master the basic operation as quickly as possible. The main contents of this chapter are as follows:

1.1 Prepare the generator for use

1.1.1 Check the generator and the accessories

Check the completeness of the generator and its accessories based on the package list. If the packing box is damaged badly, please keep it till the generator passes the performance test.

1.1.2 Connect to power supply

Boot the generator only under the following conditions.

Voltage: AC 100～240V Frequency: 45～65Hz

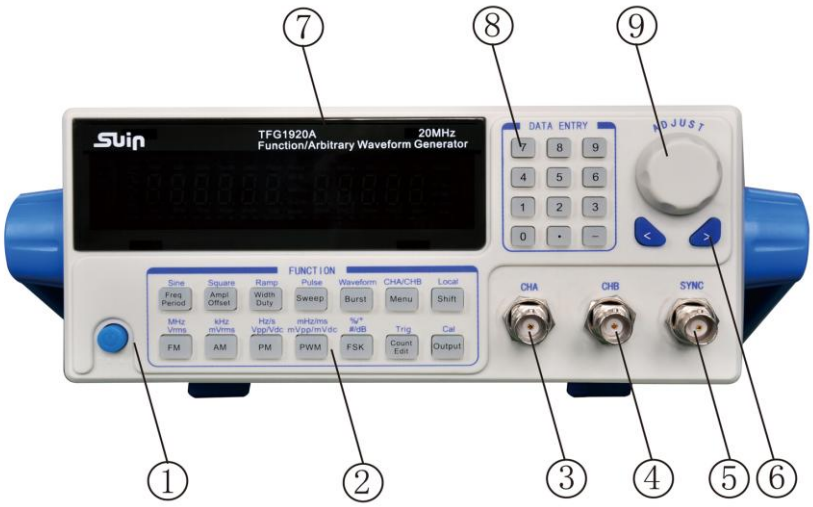
Power consumption: ＜30VA

Temperature: 0～40℃ Humidity: ＜80％

Plug the attaching plug into an AC100~240V outlet with grounding conductor, press the mains switch on the panel in to turn on the generator. The generator now is initializing itself and obtaining the default parameters, outputting sine waveform under continuous working state, with frequency and amplitude of the signal displayed.

Warning: In order to ensure the security of the operator, use triple-core socket outlet with grounding conductor.

1.2 Front panel



1. Power switch 2. Function keys 3. CHA output 4. CHB output
5. SYNC output 6. Arrow keys 7. Display screen 8. Number keys
9. Adjusting knob

1.3 Rear panel

1. Modulation in 2. Trig in 3. Count in 4. Fan
5. Power socket 6. USB Device 7. USB Host

1.4 Display introduction

The display screen display two groups of digits, the group on the left with 6 digits shows frequency, period and attenuation and so on of the signals. And the 5 digits on the right show amplitude, offset, duty cycle and so on of the signals. There are also letter and letter indicator lights on the display screen, to indicate present waveform signal, parameter options and also units of parameters.

1.5 Keyboard introduction

There are totally 28 keys on the front panel (see front panel picture), the functions of which respectively are:

【0】【1】【2】【3】【4】【5】【6】【7】【8】【9】keys: Digits inputting key.

【.】key: Point inputting key.

【-】key: Minus inputting key, press this key to input minus under offset and waveform edition option. Press this key to enable or disable the key-tone circularly under other options.

【＜】key: Move the cursor left; delete the input when inputting digits.

【＞】key: Move the cursor right.

【Freq/Period】select frequency and period circularly; disable calibration process when calibrating.

【Ampl/Offset】keys: select amplitude and offset circularly.

【Width/Duty】key: select pulse width, duty cycle of square or symmetry of Ramp circularly.

【FM】【AM】【PM】【PWM】【FSK】【Sweep】【Burst】keys: press them to select respectively frequency modulation, amplitude modulation, phase modulation, pulse width modulation, frequency shift keying, frequency sweeping and burst functions, press again to return back to continuous function.

【Count/Edit】key: press this key to select waveform edition function when CHA output user-defined waveforms, and select frequency measurement function under other functions, press again to return back to continuous function.

【Menu】key: key for menu, select different options circularly under different functions(see below function option list).

【Shift/Local】key: select shift, or press this key to resume keyboard function under program control state.

【Output】key: open and close output signal circularly.

【Sine】【Square】【Ramp】【Pulse】keys: shift keys, select respectively sinewave, square, Ramp and pulse four common waveforms fast.

【Waveform】key: shift key, select respectively 16 kinds of waveforms with the waveform sequence numbers.

【CHA/CHB】key: shift key, select CHA and CHB as output channel circularly.

【Trig】key: shift key, manual trigger under frequency sweeping and burst functions

【Cal】key: shift key, select parameter calibration function.

Unit key: The five keys with unit characters above them on the left bottom of the instrument are not shift keys, but double-function keys, press these keys directly to execute the functions marked on themselves; when inputting digits with numeric keys, press these five keys to select the unit of the inputting and end the digits inputting at the same time.

Options list of menu

Menu	Option
CHA continuous	Amplitude attenuation, output mode, state and waveform storage, state recall
CHB continuous	Amplitude attenuation, output mode, AB phase difference, version number
FM	Frequency deviation, modulation frequency, modulation waveform, modulation source
AM	Modulation amplitude depth, modulation frequency, modulation waveform, modulation source
PM	Phase deviation, modulation frequency, modulation waveform, modulation source
PWM	Pulse width deviation, modulation frequency, modulation waveform, modulation source
FSK	Hop frequency, hop rate, trigger source
Frequency sweeping	Start frequency, end frequency, sweep time, sweep mode, trigger source
Burst	Repeated period, pulse count, start phase, trigger source
Waveform edition	Edition point number, horizontal phase, vertical voltage
Frequency measurement	Gate time
Calibration	Calibration value: zero, offset, amplitude, frequency, flatness

1.6 Basic operation

Below are some samples to describe the basic operation of the generator, for more complex usage and problems, please refer to the details in chapter 3.

1.6.1 CHA continuous function: CHA outputs stable and continuous signal with continuous.

Press【Shift】【CHA/CHB】key, select "CHA" option, and set CHA parameters.

Frequency setting: set frequency value as 3.5kHz

Press【Freq】key and select "Hz" unit, press【3】【.】【5】【kHz】.

Frequency adjusting: Press【＜】or【＞】key to move the cursor, switch the adjusting knob left or right to decrease or increase the digit on the cursor position, borrowing from or carrying to the former digit continuously. Move the cursor left to do rough adjusting, and right to do fine adjusting. The adjusting knob is applicable for adjusting digits of other options too, which will not be described any more.

Period setting: set the period as 2.5ms

Press【Period】key and select "s" unit, press【2】【.】【5】【ms】.

Amplitude setting: set amplitude value as 1.5Vpp

Press【Ampl】key and select "Vpp" unit, press【1】【.】【5】【Vpp】.

Attenuation setting: set attenuation as 0dB

Press【Menu】key and select "Atten" option, press【0】【dB】.

Offset setting: set DC offset as -1Vdc

Press【Offset】key and select "Vdc" unit, press【-】【1】【Vdc】.

Common waveform selection: select square

Press【Shift】【Square】.

Duty cycle setting: set square duty cycle as 20％

Press【Duty】key, press【2】【0】【％】.

Other waveform selection: select exponent waveform(waveform sequence number 5, see waveform sequence number table)

Press【Shift】【Waveform】key, press【5】【#】.

Output mode selection: the phase of output signal is the opposite of the one of sync signal

Press【Menu】key, select "Mode" option and press 【1】【#】.

1.6.2 CHB continuous: CHB outputs stable and continuous signal with continuous.

Press【Shift】【CHA/CHB】key, select "CHB" option and set CHB parameters.

AB phase difference setting: set the phase difference of CHA and CHB as 90°

Press【Menu】key, select "Phase" option and press【9】【0】【°】.

Other parameter setting of CHB is the same as the one of CHA.

1.6.3 Frequency modulation function: set the CHA continuous as 20kHz first.

Press【FM】key to output frequency modulation signal.

Modulation frequency setting: set modulation frequency as 10Hz

Press【Menu】key, select "Mod_f" option and press【1】【0】【Hz】.

Frequency deviation setting: set frequency deviation as 2kHz

Press【Menu】key, select "Devia" option and press 【2】【kHz】.

Modulation waveform setting: set the modulation waveform as Ramp

Press【Menu】key, select "Shape" option and press【2】【#】.

Modulation source setting: set external modulation source

Press【Menu】key, select "Source" option and press【1】【#】.

Return back to continuous function:

Under frequency modulation, press 【FM】key to return back to continuous function.

1.6.4 Amplitude modulation function:

Press【AM】key to output amplitude modulation signal.

Modulation frequency setting: set modulation frequency as 1kHz

Press【Menu】key, select "Mod_f" option and press【1】【kHz】.

Modulation amplitude depth setting: set modulation amplitude depth as 50%

Press【Menu】key, select "Depth" option and press【5】【0】【%】.

Modulation waveform setting: set modulation waveform as sinewave

Press【Menu】key, select "Shape" option and press【0】【#】.

Modulation source setting: set internal modulation source

Press【Menu】key, select "Source" option and press【0】【#】.

Return back to continuous function:

Under amplitude modulation, press【AM】key to return back to continuous function.

1.6.5 Phase modulation function:

Press【PM】key to output phase modulation signal.

Modulation frequency setting: set modulation frequency as 10kHz

Press【Menu】key, select "Mod_f" option and press【1】【0】【kHz】.

Phase deviation setting: set phase deviation as 180°

Press【Menu】key, select "Devia" option and press【1】【8】【0】【°】.

Modulation waveform setting: set modulation waveform as square

Press【Menu】key, select "Shape" option and press【1】【#】.

Modulation source setting: set external modulation source

Press【Menu】key, select "Source" option and press【1】【#】.

Return back to continuous function:

Under phase modulation, press【PM】key to return back to continuous function.

1.6.6 Pulse width modulation function:

Press【PWM】key to output pulse width modulation signal.

Modulation frequency setting: set modulation frequency as 1Hz

Press【Menu】key, select "Mod_f" option and press【1】【Hz】.

Pulse width deviation setting: set pulse width deviation as 80%

Press【Menu】key, select "Devia" option and press【8】【0】【%】.

Modulation waveform setting: set modulation waveform as sinewave

Press【Menu】key, select "Shape" option and press【0】【#】.

Modulation source setting: set internal modulation source

Press【Menu】key, select "Source" option and press【0】【#】.

Return back to continuous function:

Under pulse width modulation, press【PWM】key to return back to continuous function.

1.6.7 Frequency shift keying function: set waveform as sinewave

Press【FSK】key to output frequency shift keying signal.

Hop rate setting: set hop rate as 1kHz

Press【Menu】key, select "Rate" option and press【1】【kHz】.

Hop frequency setting: set hop frequency as 2kHz

Press【Menu】key, select "Hop_f" option and press【2】【kHz】.

Trigger source setting: set internal trigger source

Press【Menu】key, select "Source" option and press【0】【#】.

Return back to continuous function:

Under frequency shift keying function, press【FSK】key to return back to continuous function.

1.6.8 Frequency sweeping function:

Press【Sweep】key to output frequency sweeping signal.

Start frequency setting: set the start frequency as 5kHz

Press【Menu】key, select "Start" frequency and press【5】【kHz】.

End frequency setting: set end frequency as 20Hz

Press【Menu】key, select "Stop" and press【2】【0】【Hz】.

Sweeping time setting: set sweeping time as 5s

Press【Menu】key, select "Time" option and press【5】【s】.

Sweeping mode setting: set logarithm sweeping mode

Press【Menu】key, select "Mode" option and press【1】【#】.

Trigger source setting: set external trigger source

Press【Menu】key, select "Source" option and press【1】【#】.

Single trigger setting: trigger sweeping once

Press【Shift】【Trig】keys to trigger sweeping once.

Return back to continuous function:

Under frequency sweeping, press【Sweep】key to return back to continuous function.

1.6.9 Burst function: set continuous as 1kHz

Press【Burst】key to output burst signal.

Repeated period setting: set repeated period as 5ms

Press【Menu】key, select "Period" option and press【5】【ms】.

Pulse count setting: set pulse count as 1

Press【Menu】key, select "Ncyc" option and press【1】【#】.

Start phase setting: set start phase as 180°

Press【Menu】key, select "Phase" option and press【1】【8】【0】【°】.

Trigger source setting: set internal trigger source

Press【Menu】key, select "Source" option and press【0】【#】.

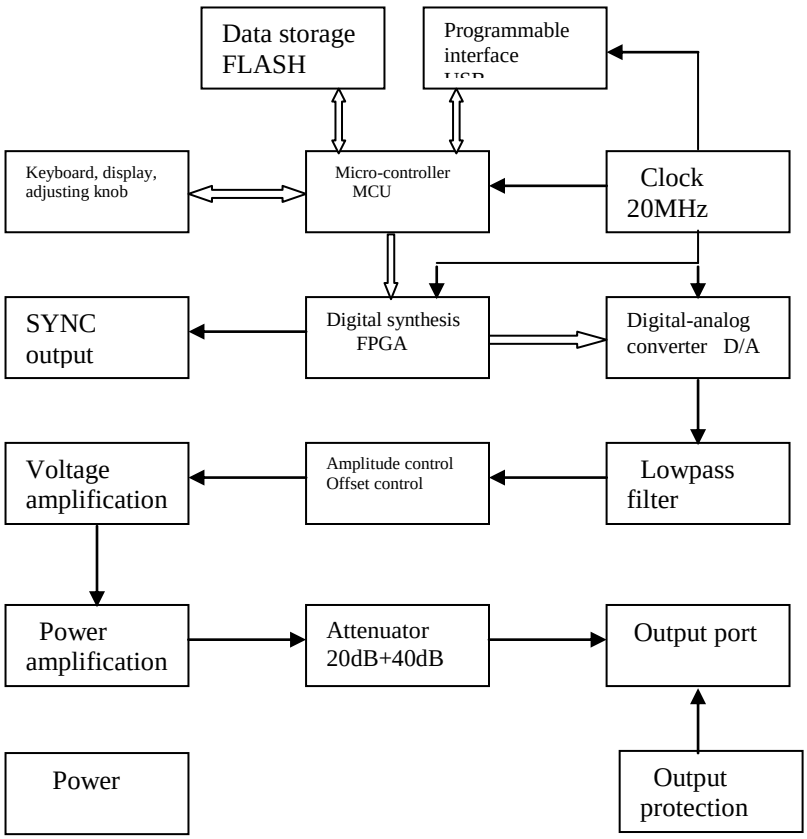
Return back to continuous function:

Under burst function, press【Burst】to return back to continuous function.

Chapter 2 Principle introduction

This chapter describes the basic concept of signal shaping and internal operation of the generator, to help users to learn more about the performance and specifications, then operate the generator more smoothly.

2.1 Principle diagram of generator



2.2 DDS working principle

To generate a voltage signal, traditional analog function generator adopt electronic components to consist oscillator by many different means, the signals generated are of poor frequency accuracy and stability, low resolution, inconvenient to set frequency and programmed with computer, but request complex techniques. Direct Digital Synthesis (DDS) technology is an up-to-date technique to generates signals, it need no oscillator but digital synthesis technique to generate series of data-current which convert to analog signals through digital-analog converter.

To generate a sine signal, for example, the function of Y＝SinX should be digitally

quantized first, and then taking x as the address and y as the quantized data to store them into waveform memorizer. DDS uses phase adding technique to control the address of waveform memorizer. Add a phase increment on the present result of phase accumulator in each sampling clock period so as to change the output frequency value by change phase increment. According to the address from the phase accumulator, take the quantized data out from the wave memorizer and then convert it into analog voltage via digit-analog converter and operation amplifier. Since the waveform data are discontinuous sampling, stair sine waveform is output from DDS generator. The included high-level harmonic wave should be filtered by lowpass filter so to output a continuous sine wave. With high accurate reference voltage source in digit-analog converter, the output waveform is of high amplitude accuracy and stability.

Amplitude controller is a multiplication digital-analog converter, analog signal that has been filtered is the voltage standard of the digital-analog converter, this standard multiplies amplitude value inputting with the numeric key to make output signal frequency be equal to this inputting value. Offset controller is also a multiplication digital-analog converter, a high-accuracy DC voltage standard of which multiplies offset value inputting with the numeric key to make the output signal offset be equal to this inputting value. The synthesized signal from amplitude and offset controllers is amplified by the power amplifier and voltage amplifier then output from output port.

2.3 Control working principle

Micro-controller controls the keyboard and display parts with interface circuit, when a key is pressed, the micro-controller recognizes the code of pressed key and executes corresponding command program of this key. The display circuit will work to display the instrument's working state and each parameter.

Switch the adjusting knob on the panel to change the digit on the cursor position, generating a trigger pulse every 15°rotation. The microprocessor could judge the rotation is left or right, if it is left, the number in the position of cursor will be subtracted by 1; if it is right, the number in the position of cursor will be added by 1 with continuous carry or borrow.

Chapter 3 Reference

3.1 Data input

3.1.1 Input with the numeric keys Select an option and input with the numeric keys the parameters of this option. The ten digit keys are of the function of inputting data from left to right one by one. Point is allowed in this data, but only the first one is valid when more than one points inputted. Under "offset" function, minus may be input. The digit keys input digit to the display area which do not work yet and could be deleted by pressing 【＜】, or select this option again , to input right one if it is a wrong input, but these must happen before pressing an unit key. End the digits input and make them valid by pressing an unit key.

For any input by pressing the point key and the units, the generator will display this input in its own certain form. Such as, the generator displays 1.50000 kHz for both of input of 1.5 kHz and 1500 Hz.

3.1.2 Adjust with the adjusting knob In actual operations, users may use the adjusting knob to continuously adjust the signal. Press 【＜】or【＞】to move the cursor left or right. Rotate the adjusting knob on the front panel right to add the digit on the cursor position by 1, it can do a carry to the former; rotate the adjusting knob left to subtract the digit on the cursor position by 1, it can borrow digit from the former. The digit adjusted by the adjusting knob works immediately and no need to press unit key. Move the cursor to the left to do rough adjusting by the knob, and to the right to do fine adjusting.

3.1.3 Selection of the inputting means For known data, it is the most convenient to use numeric keys to input as it can be gotten easily without the generating of transient data no matter how big the change of the data is, which is so important in some operations. For the modifying of the entered data or for entering sequence data to observe, it will be more convenient to use the adjusting knob. So user should select flexibly according to the different applications.

3.2 CHA continuous

"CHA continuous" means CHA outputs stable and continuous signal, of which the waveform, frequency, amplitude and phase will not change along with time.

Press【Shift】【CHA/CHB】key, select "CHA" option and then set the parameters of CHA.

3.2.1 Frequency setting Press【Freq】key, the light of which will be on, press "Hz" unit to display present frequency value. Input frequency value with numeric keys or adjusting knob and the signals of this frequency will be output from the output port.

3.2.2 Period setting Press【Period】key, the light of which will be on, press "s" unit to display present period value, input period value with numeric keys or adjusting knob. Frequency is synthesized in the internal of the generator, and converted to period when inputting and displaying. Limited by the frequency low resolution, for a comparatively long period, the generator could only output some frequency points with long period interval, so the period of actual output signal may be comparatively different from them, which should be under consideration during operations.

3.2.3 Amplitude setting Press【Ampl】key, the light of which will be on, press "Vpp" or "Vrms" to display present amplitude value, input amplitude value with numeric keys or adjusting knob and the signals of this amplitude will be output from the output port.

The relation between maximum amplitude and DC offset value should be below formula, if the setting of amplitude exceeds specification, the generator will modify it until it is within the range of allowed maximum amplitude value.

$$Vpp \leq 2 \times (10 - |offset|)$$

3.2.4 Amplitude value form There are two forms for amplitude input and display: peak-peak form and RMS form. Press 【Vpp】or【mVpp】to input amplitude peak-peak value after inputting the digits, press【Vrms】or【mVrms】to input amplitude RMS value. RMS value is applicable only to sinewave, square wave, Ramp wave and pulse wave four common waveforms, and other waveforms could only be shown by amplitude peak-peak value.

3.2.5 Amplitude attenuation setting Press【Ampl】key and select "Atten" option to show the present attenuation value. Amplitude attenuation is auto as default of booting and there display "Auto", the generator will select automatically proper attenuation proportion according to the amplitude setting value, higher amplitude resolution, higher signal-noise ratio and less waveform distortion could be realized at the same time regardless of the amplitude magnitude of the signal. The output signal makes a momentary hop when the attenuation changes, which is not welcome in some

operations, but the generator has fixed attenuation function to avoid this circumstance. Input attenuation values of 0dB, 20dB, 40dB and 60dB with the numeric keys, input 80dB to select auto attenuation. Users may use the adjusting knob as well, the attenuation changes to next one for every step of the rotation. When select fixed attenuation mode, the attenuation is fixed while the signal amplitude changes, and the output signal could changes continuously within the whole amplitude range. But higher distortion of the waveform and poor signal-noise ratio maybe appear when the attenuation is 0dB and the amplitude of the signal is small.

3.2.6 Output load The setting value of amplitude is calibrated when the output end is open. The real voltage of output load is the setting value of amplitude multiplied by the assignment ratio of load impedance and output impedance. The output impedance of the generator is fixed at 50Ω. When the load impedance is high enough, the assignment ratio approaches to 1. The voltage loss of output impedance can be neglected. The real voltage approaches to the setting value of amplitude. But when the load impedance is lower, the voltage loss of output impedance cannot be neglected. It should be paid more attention that the real voltage does not accord with the setting value of amplitude. Especially when the frequency is comparatively high, the output and the change of inductance and condensance on the load will cause a comparatively large error.

With 50Ω output resistance, a momentary short-circuit of the output port makes no damage to the generator, but the users should try to avoid long time short-circuit under high voltage output as a danger of making damage to the generator. The generator has function of opposite voltage protection, with which the generator close output automatically, make an alarm with the output indicating light off when carelessly connect a high voltage(less than 30V) to the output port. Open the output by pressing 【Output】key only after the fault cleared.

3.2.7 Offset setting Press【Offset】key, the light of which will be on, press "Vdc" unit to display present offset value. Input offset value with the numeric keys or adjusting knob for the output signal to generate this DC offset.

The relationship between the maximum DC offset and amplitude value should be below formula, if the setting of offset exceeds, the generator will modify it until it is within the limit of the maximum offset value.

$$|\text{offset}| \leq 10 - \text{Vpp} \div 2$$

When it comes to adjust the DC offset of the output signals, it is more convenient to use the adjusting knob than the numeric keys. As usual, taking no account of the sign of the present DC offset, right rotation makes the DC level up, while left rotation makes it down, the sign of the DC offset value changes automatically when passing the zero point.

3.2.8 DC voltage output Set amplitude at 0V, the offset value could be set arbitrarily within ±10V range, the generator is now a DC voltage power supply and outputs specified DC voltage signal.

3.2.9 Output waveform selection The generator could output 16 kinds of waveforms, and sine, square, Ramp and pulse are four common waveforms, press 【Shift】【Sine】,【Shift】【Square】【Shift】【Ramp】and 【Shift】【Pulse】keys to select them directly, the corresponding waveform character light will be on. All 16 kinds of waveforms could be selected with the waveform sequence numbers, press【Shift】【Waveform】key, and the instrument shows the present waveform sequence number, users may select output waveforms by inputting waveform sequence number with the numeric keys or adjusting knob. Except the four common waveforms, the waveform character of other waveforms is "Arb". The waveform sequence numbers of 16 kinds of waveforms are as listed as below:

Waveform sequence numbers list

Sequence number	Waveform	Sequence number	Waveform	Sequence number	Waveform
00	Sine	06	Logarithm	12	User-defined 2
01	Square	07	Sinc	13	User-defined 3
02	Ramp	08	Half-round	14	User-defined 4
03	Pulse	09	Cardiogram	15	User-defined 5
04	White noise	10	Vibration		
05	Exponent	11	User-defined 1		

3.2.10 Duty cycle setting When the present selection of waveform is square, press 【Duty】key, the "Duty" keyboard light will be on and the generator display current duty cycle value, input duty cycle value with numeric keys or adjusting knob, then the output will be a square with a fixed duty cycle value. While the frequency of square changes, its duty cycle keeps the same. The definition of square duty cycle is the ratio of high level time of one square to the period of this square. When the frequency of square is comparatively high, the setting of duty cycle is limited by the edge time,

in a relationship as below formula:

Duty cycle× Period≥2× Edge time or Duty cycle ×Period≤ Period－(2× Edge time)

3.2.11 Symmetry setting When the present selection of waveform is Ramp, press【Duty】key, the "Duty" keyboard light will be on and the generator display current symmetry value, input symmetry value with numeric keys or adjusting knob, then the output will be a Ramp with a fixed symmetry value. While the frequency of a Ramp changes, its symmetry keeps the same. The definition of Ramp symmetry is the ratio of rising time of one Ramp to the period of this Ramp. Ramp with 100% symmetry is named as rising Ramp wave, and Ramp with 0% symmetry is named as falling Ramp wave, Ramp with 50% symmetry is named as triangle wave.

3.2.12 Pulse width setting: select pulse wave and press【Width】key, the "Width" keyboard indicator will be lighted and the generator display current pulse width value, the users may use the numeric keys or knob to input pulse width value, and the generator will output pulse wave with this pulse width set. The pulse width keeps unchanging while the pulse frequency changes. Pulse width is defined as, the time value of the high level of the pulse wave. When the frequency of the pulse wave is comparatively high, the set of pulse width will be limited by edge time, and should accord with below formula:

Pulse width≥2×edge time or period-pulse width≥2×edge time

3.2.13 Output mode setting press【Menu】key and select "Mode" option to display the output mode value, use the numeric keys or knob to input mode value. There are only two values to choose: 0 or 1, when set the value as 0, the signal from the output port is in-phase with the sync port, and when set it as 1, the two are inverted.

3.3 CHB continuous

"CHB continuous" means CHB outputs stable and continuous signal, of which the waveform, frequency, amplitude and phase will not change along with time.

Press【Shift】【CHA/CHB】key, select "CHB" option and then set parameters of CHB.

3.3.1 Phase difference between CHA and CHB setting: when the frequencies of CHA and CHB are the same, press【Menu】key and select "Phase" option, the generator will indicate the phase difference between CHA and CHB, use the numeric keys or knob to input phase difference value, the phase difference between signals

from CHA and CHB could be set in advance. It is meaningless to set phase difference when the frequencies of CHA and CHB are different.

The settings of other parameters of CHB is the same as the one of CHA.

Below contents give detail explanations of FM, AM, PM, PWM, FSK, frequency sweeping, burst and arbitrary waveform functions, which are only applicable to CHA.

3.4 Frequency modulation (FM)

In Frequency modulation, the frequency of the carrier is varied by the instantaneous voltage of modulating waveform, all the 16 kinds of waveforms listed in the waveforms table could be used as carrier waveform. Before entering into frequency modulation, the users should set the waveform, frequency and amplitude value of the carrier wave first under CHA continuous function.

Press【FM】key, the keyboard indicator of "FM" will be on, and CHA output frequency modulation signal.

3.4.1 Frequency deviation: press【Menu】key and select "Devia" option, and then set frequency deviation value. Frequency deviation represents the frequency variation of carrier wave when the modulating waveform is with full amplitude during FM process. When the amplitude of the modulating waveform is at positive peak value, the output frequency is equal to the frequency of the carrier plus the frequency deviation, and when it is at the negative peak value, the output frequency is equal to the carrier frequency minus the frequency deviation. Therefore, the frequency deviation setting must conform to the following two conditions:

(Carrier frequency－frequency deviation)＞0

(Carrier frequency＋frequency deviation)＜The upper limit of the generator

3.4.2 Modulation frequency: press【Menu】key and select "Mod_f" option, and then set modulation frequency value. In FM, modulation frequency is usually far lower than carrier frequency.

3.4.3 Modulation waveform: press【Menu】key and select "Shape" option, set modulation waveform by setting waveform No., the modulation waveform may be any one of the 16 kinds of waveforms listed in the waveforms table.

3.4.4 Modulation source: press【Menu】key, select "Source" option and then set modulation source, there are only two values to choose: 0 and 1. Set the value as 0 to choose internal modulation source, and set it as 1 to choose external modulation source. If external modulation source is chosen, connect a modulation signal to the

《Modulation In》port on the rear panel of the generator. When external modulation signal reaching to full amplitude as ±5V, the display of frequency deviation accords with its real value. Or the display of frequency deviation is incorrect.

3.4.5 Sync output: in FM, the generator outputs a sync signal from the front panel "Sync" connector, which is a square wave with TTL level and 50% duty cycle, its frequency is equal to modulating wave frequency and its phase is referenced to the phase of the modulating wave.

In FM, press【FM】key, the keyboard indicator of "FM" will be off, the generator will exit frequency modulation function and return back to continuous function.

3.5 Amplitude modulation(AM)

In AM, the amplitude of the carrier is varied by the instantaneous voltage of the modulating waveform, all the 16 kinds of waveforms listed in the waveforms table could be used as carrier waveform. Before entering into amplitude modulation, the users should set the waveform, frequency and amplitude value of the carrier wave first under CHA continuous function.

Press【AM】key, the keyboard indicator of "AM" will be on and CHA output amplitude modulation signal.

3.5.1 Modulation depth: press【Menu】key and select "Depth" option, and then set modulation depth value. Modulation depth represents the percentage of variation of the carrier amplitude to the amplitude setting value while the modulating wave is with full amplitude during AM process. If the maximum amplitude of the modulated carrier waveform is called as Amax, the minimum amplitude as Amin, the amplitude setting value as A, the modulation depth as M, then the relationship between the four values is:

$Amax=(1+M)\times A\div 2.2$ $Amin=(1-M)\times A\div 2.2$

Then the modulation depth is $M=(Amax-Amin)\times 1.1\div A$

If modulation depth is 120%, Amax=A, Amin=-0.09A. If modulation depth is 100%, Amax=0.909A, Amin=0. If modulation depth is 50%, Amax=0.682A, Amin=0.227A. If modulation depth is 0%, Amax=0.455A, Amin=0.455A. That is to say, when modulation depth is 0, carrier amplitude is about half of the amplitude setting.

3.5.2 Modulation frequency: press【Menu】key and select "Mod_f" option, and then set modulation frequency value. In AM, modulation frequency is usually far lower than carrier frequency.

3.5.3 Modulation waveform: press【Menu】key and select "Shape" option, set

modulation waveform by setting waveform No.,the modulation waveform may be any one of the 16 kinds of waveforms listed in the waveforms table.

3.5.4 Modulation source: press【Menu】key, select "Source" option and then set modulation source, there are only two values to choose: 0 and 1. Set the value as 0 to choose internal modulation source, and set it as 1 to choose external modulation source. If external modulation source is chosen, connect a modulation signal to the 《Modulation In》port on the rear panel of the generator. When external modulation signal reaching to full amplitude as ±5V, the display of modulation depth accords with its real value. Or the display of modulation depth is incorrect.

3.5.5 Sync output: in AM, the generator outputs a sync signal from the front panel "Sync" connector, which is a square wave with TTL level and 50% duty cycle, its frequency is equal to modulating frequency and its phase is referenced to the phase of the modulating signal.

In AM, press【AM】key again, the "AM" indicator will be off, and the generator exits AM function and returns back to continuous function.

3.6 Phase modulation (PM)

In PM, the phase of the carrier is varied by the instantaneous voltage of the modulating waveform, all the 16 kinds of waveforms listed in the waveforms table could be used as carrier waveform. Before entering into phase modulation, the users should set the waveform, frequency and amplitude value of the carrier wave first under CHA continuous function.

Press【PM】key to light "PM", and the CHA output phase modulation signal.

3.6.1 Phase deviation: press【Menu】key and select "Devia" option, and then set phase deviation value. Phase deviation represents the variation of carrier phase while the modulating waveform is with full amplitude in phase modulation. When the amplitude of the modulating waveform is at positive peak value, the phase of the outputted signal increase one phase shift, and when it is at the negative peak value, the phase of the outputted signal decrease one phase shift.

3.6.2 Modulation frequency: press【Menu】key and select "Mod_f" option and then set modulation frequency value. In PM, modulation frequency is usually far lower than carrier frequency.

3.6.3 Modulation waveform: press【Menu】key and select "Shape" option, set modulation waveform by setting waveform No., the modulation waveform may be any one of the 16 kinds of waveforms listed in the waveforms table.

3.6.4 Modulation source: press【Menu】key, select "Source" option and then set modulation source, there are only two values to choose: 0 and 1. Set the value as 0 to choose internal modulation source, and set it as 1 to choose external modulation source. If external modulation source is chosen, connect a modulation signal to the 《Modulation In》port on the rear panel of the generator. When external modulation signal reaching to full amplitude as ±5V, the display of phase deviation accords with its real value. Or the display of phase deviation is incorrect.

3.6.5 Sync output: in PM, the generator outputs a sync signal from the front panel "Sync" connector, which is a square wave with TTL level and 50% duty cycle, its frequency is equal to modulating frequency and its phase is referenced to the phase of the modulating signal.

In PM, press【PM】key, the "PM" indicator will be off, the generator exits PM function and returns back to continuous function.

3.7 Pulse width modulation (PWM)

In PWM, the pulse width of the carrier varies with the instantaneous voltage of the modulating signal, and the waveform shape of the carrier must be pulse. Before entering into PWM, users should firstly set the frequency and amplitude of carrier wave under CHA continuous function.

Press【PWM】key, the keyboard indicator of "PWM" will be on and the CHA output phase width modulation signal, the carrier wave is automatically set as pulse wave.

3.7.1 Pulse width deviation: Press【Menu】key and select "Devia" option, then set pulse width deviation value. It represents the variation of carrier pulse width to the period of the pulse when the modulating waveform is with full amplitude during PWM process, also the variation of the duty cycle. Name the maximum duty cycle of modulated carrier as Dmax, and the minimum as Dmin, the pulse width deviation's formula should be:

Pulse width deviation＝Dmax－Dmin

If Dmax=80%, Dmin=20%, the pulse width deviation is 60％. If Dmax=50%, Dmin=50%, the pulse width deviation should be 0%. That is to say, when pulse width deviation is 0, the duty cycle of pulse wave is 50%.

3.7.2 Modulation frequency: Press【Menu】key, select "Mod_f" option and set modulation frequency value.

3.7.3 Modulation waveform: press【Menu】key and select "Shape" option, set modulation waveform by setting waveform No., the modulation waveform may be any one of the 16 kinds of waveforms listed in the waveforms table.

3.7.4 Modulation source: press【Menu】key, select "Source" option and then set modulation source, there are only two values to choose: 0 and 1. Set the value as 0 to choose internal modulation source, and set it as 1 to choose external modulation source. If external modulation source is chosen, connect a modulation signal to the 《Modulation In》port on the rear panel of the generator. When external modulation signal reaching to full amplitude as ±5V, the display of pulse width deviation accords with its real value. Or the display of pulse width deviation is incorrect.

3.7.5 Sync output: in PWM, the generator outputs a sync signal from the front panel "Sync" connector, which is a square wave with TTL level and 50% duty cycle, its frequency is equal to modulating frequency and its phase is referenced to the phase of the modulating signal.

In PWM, press【PWM】key, the "PWM" keyboard indicator will be off, and the generator exits PWM function and returns back to continuous function.

3.8 Frequency shift keying(FSK)

In FSK, the frequency of the carrier shifts between "carrier frequency" and "hop frequency" alternately, the rate at which the output shifts is determined by hop rate, all the 16 waveforms listed in the waveforms table could be used as carrier wave. Before entering into FSK, users should firstly set the waveform, frequency and amplitude value of the carrier wave under CHA continuous function.

Press【FSK】key to light "FSK" keyboard indicator, and CHA will output FSK signal.

3.8.1 Hop frequency: press【Menu】key to light "Hop_f" character, and then set hop frequency value. Frequency shift keying is similar with FM whose modulating waveform is square. "hop frequency" is similar with "frequency deviation", with the difference of, frequency deviation is an offset value that the frequency of carrier wave plus or minus, whose setting range is relational with the frequency of carrier wave, hop frequency could be set arbitrarily within whole frequency range, it has no relationship with carrier frequency.

3.8.2 Hop rate: press【Menu】key to light "Rate" character, then set hop rate value. In FSK, the modulation waveform is fixed as a square wave with 50% duty cycle, the frequency of the square wave is the hop rate.

3.8.3 Trigger source: press【Menu】key, select "Source" option and then set trigger source, there are only two values to choose: 0 and 1. Set the value as 0 to choose internal trigger source, and set it as 1 to choose external trigger source. If external

trigger source is chosen, connect a TTL trigger signal to the 《Trig In》port on the rear panel of the generator. When the trigger signal is with logic low level, the frequency of output signal is the carrier frequency. When the trigger signal is with logic high level, the frequency of output signal is the hop frequency. When external trigger source is chosen, the hop rate setting is ignored.

3.8.4 Sync output: in FSK, the generator outputs a sync signal from the front panel "Sync" connector, which is a square wave with TTL level and 50% duty cycle, its frequency is equal to the hop rate. When the output signal is the carrier, a low level sync signal is outputted. When the output is hop frequency, a high level sync signal is outputted.

In FSK, press【FSK】key again, the "FSK" keyboard indicator will be off, the generator exits FSK function and returns back to continuous function.

3.9 Frequency sweeping function

In frequency sweep, the output frequency changes from the start frequency point to the end frequency point according to the setting sweep time. Users may sweep within the whole frequency range. During this process, the phase of output signals is continuous. All the 16 kinds of waveform except of pulse and white noise listed in the waveform table could be swept.

Linearity frequency sweeping is similar with Ramp frequency modulation, with the difference of, frequency sweeping does not use modulation waveform, but continuously output a series of discrete frequency points according to certain time interval.

Press【Sweep】key, the light of it will be lighted and the CHA output frequency sweeping signal.

3.9.1 Start and end frequency Press【Menu】key to light "Start" letter and then set start frequency point. Press【Menu】key to light "Stop" letter and then set end frequency point. If the end frequency value is more than the start frequency value, the sweep is positive from lower frequency to higher frequency, increasing step by step from the start frequency to the end frequency and then return to the start frequency. If end frequency value is less than the start frequency value, the sweep is opposite from higher frequency to lower frequency, decreasing step by step from the start frequency to the end frequency and then return to the start frequency.

3.9.2 Sweeping time Press【Menu】key and select "Time" option and then set sweep time value. Sweep time means the time of sweeping from the start frequency

point to the end frequency point. The sweep time of every frequency point is the same, so the longer the sweep time is, the more frequency points are swept, the less the step of the frequency point is, and the finer the sweep is. The shorter of the sweep time is, the less frequency points are swept, the more the step of the frequency point is, and the rougher the sweep is.

3.9.3 Sweeping mode Press【Menu】key and select "Mode" option to set sweeping mode. There are only two value of sweeping mode: 0 and 1, Set the value as 0 to select "linear" option, and the sweeping mode now is linearity. Set the value as 1 to select "log" option, to select logarithm mode.

Under linearity sweeping mode, the frequency step is fixed, but a fixed frequency step always does a bad effect when sweeping comparatively wide-range frequency. In that case, the resolution is high when sweeping high end of frequency, the frequency changes slowly, and the sweeping is fine. But the resolution is low when sweeping the low end of frequency, the frequency changes very quickly, the sweeping is rough. So linearity sweeping is applicable only for sweeping with narrow frequency range.

Under logarithm sweeping mode, the frequency step value is not fixed but changes according to logarithm relation. When sweeping the high end of frequency, the frequency step value is comparatively large; when sweeping the low end of frequency, the frequency step value is comparatively small. The frequency change is comparatively average for sweeping with wide frequency range. So logarithm sweeping is applicable for sweeping with wide frequency range.

3.9.4 Trigger source: press【Menu】key, select "Source" option and then set trigger source, there are only two values to choose: 0 and 1. Set the value as 0 to choose internal trigger source, and set it as 1 to choose external trigger source. If external trigger source is chosen, the sweeping will stop when reaching to the end point, then each time you press 【Shift】【trig】keys, the sweeping will run once, then stop on the start frequency and wait for next trigger. External trigger signal could also be chosen, connect a TTL trigger signal to the 《Trig In》port on the rear panel of the generator. The sweeping will run once at the rising edge of each trigger signal. Of course, the period of trigger signal should be longer than sweeping time.

3.9.5 Sync output During frequency sweeping, the 《Sync》port on the front panel output a sync signal. A sync signal is a pulse wave signal with TTL level, of which the rising edge of the pulse is match along with the start point of the sweeping, and

the falling edge is match along with the middle point of the sweeping area, the period of the pulse wave is the same with sweeping time.

Under sweeping function, press【Sweep】key(the "Sweep" key-light will be off) to exit frequency sweeping function and return back to continuous function.

3.10 Burst

It is explained that in burst mode, the word "burst" means the cycle of any waveform, not only the pulse. In burst output, instrument outputs continuously a series of burst or trigger and output a single burst according to repeated period, pulse count and start phase set. All the 16 waveforms listed in the waveforms table could be used as burst waveform. Before entering into burst function, users should firstly set the waveform, frequency and amplitude value of the burst under CHA continuous function.

Press 【Burst】key to light "Burst" keyboard indicator, the CHA will output burst signal.

3.10.1 Repeated Period: press【Menu】key and select "Period" option, and then set repeated period. Period represents time from the start of one burst to the start of the next one which must be long enough to contain the pulse numbers of setting, as the following formula shows:

Repeated period＞(Pulse count / Pulse frequency)

If the repeated period setting is too short, the instrument will modify it to the allowable minimum value.

3.10.2 Burst count: press【Menu】key and select "Ncyc" option, and then set the burst count. Burst count represents the number of cycles of burst in a repeated period, which must be small enough to be contained in one repeated period, as following formula shows:

Pulse count＜(repeated period ×pulse frequency)

If the burst count setting is too big, the instrument will modify it to the allowable maximum value.

3.10.3 Start phase: press【Menu】key and select "Phase" option, and then set start and end phase value. The start and end of the burst are always on the same phase of the waveform, this phase is named as the start phase. The start phase setting range is 0° to 360°, it is not available to square wave.

3.10.4 Trigger source: press【Menu】key, select "Source" option and set trigger source, there are only two values to choose. Set the value as 0 to choose internal

trigger source, and set it as 1 to choose external trigger source. When choosing external trigger source, burst output will stop, then each time you press 【Shift】【trig】keys, the generator will output a burst, then keep on the start phase and wait for next trigger. External trigger signal could be chosen as well, connect a TTL trigger signal to the 《Trig In》port on the rear panel of the generator. The generator will output a burst at the rising edge of each trigger signal, then keep on the start phase and wait for next trigger. Of course, the period of the trigger signal should accords with the limitation condition of repeated period setting. When external trigger source is chosen, the setting of repeated period is ignored.

3.10.5 Sync output: during burst output, a sync signal can be outputted from the front panel "Sync" connector. It is a TTL level's pulse wave, its rising edge is corresponding to the burst starting point, while the falling edge is corresponding to the end of the burst. That is to say, during the continuation of burst, sync output keeps high level; during the stop period of burst, sync output keeps at low level.

In burst function, press 【Burst】key again, the "Burst" keyboard indicator will be off, the generator exits burst function and returns back to continuous function.

3.11 Arbitrary waveform

The generator could output 16 kinds of waveforms(see waveform sequence number table), where 0#～10# are internal fixed waveforms, which the users could only use but not edit or make any change to, 11#～15# are user-defined waveforms, the users may edit arbitrary waveforms by themselves, or edit and change current waveforms.

3.11.1 Keyboard edition: the users may use the keyboard to edit and change the user-defined waveforms, follow below steps:

A. select CHA tone, set frequency 1kHz, amplitude 20Vpp.

B. press【Shift】【Waveform】and select "#" unit, set a waveform sequence number within 11#～15# to recall a user-defined waveform.

C. press【Edit】key, the "Edit" keyboard will be on, and the users may start to edit and change current waveform.

D. press【Menu】key and select "#" unit to set editing point sequence number.

E. press【Menu】key and select "°" unit to set horizontal phase value. The setting range of horizontal phase value is 0°～360°, the horizontal phase value of 0# editing point must be 0°, and the one of the last editing point must be 360°, with the one of

middle editing points increased one by one.

F. press【Menu】key and select "Vdc" unit to set vertical voltage value, of which the setting range is -10V～+10V, if you need cycle of waveform continuous, you must make the vertical voltage values of points 0° and 360° equal.

G. Start from 0# editing point, set a series of editing points with above method. The generator can connect each point together in lines to form a user-defined waveform. Connect an oscilloscope to the CHA output port to real-time observe the effect of the edition. The least points for a user-defined waveform is 2(such as Ramp), 800 points at most.

H. Press【Edit】key, the "Edit" keyboard indicator will be off and the generator exit waveform edition state.

I. Press 【Menu】key and select 'Store', enter any one waveform number from 11 to 15 using keypad, finally press 【#】key. Then the current waveform is stored in specified volatile-memory and won't be lost even power off. Please well note that only keypad operation is available for waveform store under 'Store' option, and knob operation will be disabled.

3.11.2 Edit with PC: It is able to edit simple user-defined waveforms with few editing points with the keyboard of the generator, and its advantage is real-time editing and outputting, and the waveforms edited could be modified arbitrarily. But as for complicated waveforms with many editing points, editing with keyboard wastes time much, you'd better edit on computer screen using a mouse with the waveform-editor software, then download the waveform data to the generator. Follow below steps:

A. Install the waveform edition software written in the CD of the generator to the PC, connect the generator to the PC with an USB cable. Switch on the generator and select CHA tone.

B. Run the waveform edition software, to show arbitrary waveform edition interface, edit any waveform with the mouse. After finishing waveform edit, then download the waveform data to the generator. If needed, user can store the download waveform and which won't be lost even at power off.

C. The operation for waveform-editor software is introduced in detail in CD.

3.11.3 Waveform storage: regardless of downloaded from PC using software or edited using the keyboard, the user-defined waveforms data are stored in volatile memory, they will vanish on turning off the generator. If you want to preserve the waveform for a long time, please store the data.

Press【Menu】key, select "Store" option and input with the keyboard one waveform sequence number from 11#～15#, press【#】key, then the current waveform will be persevered in specified non-volatile memory and will not vanish even turning off the generator. Of course when you store a new waveform, the selected memory will be overwritten by the new data, in order to prevent that several waveform sequence No. are continuously stored by carelessly rotating the knob, the knob is locked under "Store" option and the users could only use keyboard to store data.

3.11.4 Waveform recall: after the user-defined waveform is stored, press 【Shift】【Waveform】key to set waveform sequence number, to recall user-defined waveform of this sequence number.

3.12 Setting parameter storage

A lot kinds of working parameters of the generator could be set during operation, such as waveform, frequency, amplitude and so on, total more than 40 kinds, which are totally called as the setting parameter of the generator.

3.12.1 Setting parameter storage: the generator has 6 non-volatile memories, to store 6 groups of setting parameters respectively, which will not lose even if cutting off the power. The generator uses location 0# to hold the default settings, to prevent the default setting parameter from being changed, the 0# memory area is designed to not allow storage operation. Use 1#～5# memory area to store user-defined setting parameter. The 1# memory area stores the power-on setting parameters, the users may store setting parameters usually used to the 1# memory area, which will be automatically recalled when generator power on or system reset.

Under CHA tone function, press 【Menu】key and select "Store" option, then input memory area within 1#～5# with the keyboard and press【#】key, the current setting parameters of the generator will be stored to the non-volatile memory with this specified memory area number, these setting parameters will not lose even if power off the generator. A new group of setting parameter stored will cover the former data in this memory area, to prevent storing data to more than one memory area continuously by rotating the knob carelessly, and under "Store" option, the knob function is locked and the users could

only store with the keyboard.

3.12.2 Setting parameter recall: after finishing the setting parameter storage and under CHA tone, press【Menu】key and select "Recall" option to set one memory area number within 0#～5#, then press【#】key to recall the setting parameter stored in this memory area. After the recall of the setting parameter, the generator will work with this new setting parameter.

3.13 External memory

You can use U disk as external memory. Connect U disk with "USB host" port on the rear panel and "U" mark will be shown on the low-left corner of screen. If pull out the U disk from the port, the "USB" mark disappear. No matter storing or recalling the user-defined waveforms or setting parameters, U disk is the first choice of the generator. If a U disk is connected to the generator, storage and recall process in the U disk, and if no U disk is connected, storage and recall process in the internal non-volatile memory of the generator.

If use a U disk to store user-defined waveforms, the generator creates automatically in the U disk corresponding file name WAVE11.ARB～WAVE15.ARB according to waveform sequence numbers, and then store the user-defined waveforms data to corresponding file. If use a U disk to store setting parameters, the generator creates automatically in the U disk corresponding file name SETUP1.SET～SETUP5.SET according to memory area numbers, and then store the setting parameters to corresponding file. If U disk storage failed, the generator will make an alarm. When recall form a U disk, the generator will find in the U disk matched file name according to the input of user-defined waveform sequence number or setting parameter memory area number, and if find the match file, the data in this file will be recalled, and there is no matched file name in the U disk, the recall operation failed and the generator will make an alarm.

Using a U disk memory makes it possible to store and recall user-defined waveforms and setting parameters, so several users could use one generator.

3.14 Frequency measurement

The generator is designed to be added a pulse counter, with which the users could measure frequency of signals, this pulse counter has completely no relationship with the function/arbitrary waveform generator but is only one more function of the generator.

Connect the signal to be tested to the 《Count In》port on the rear panel of the generator, press【Count】key and the "Count" keyboard indicator will be on, and a twinkling "Gate" mark will appear on the down-right corner of the screen, now the generator starts to measure the frequency of the input signal and show the measurement value at the same time.

3.14.1 Gate time setting: press【Menu】key and select "Gate" option, the frequency measurement will stop and the users now could set gate time value. The frequency measurement will resume after finishing the gate time setting, and the twinkle rate of the "Gate" mark will change too. The gate time indicates the sampling interval time of tested signal, the longer the gate time is, the more the sampling data, so the users may get more stable measurement result and higher measurement resolution. And the shorter the gate time is, the better the tested signal is tracked, but short gate time will result in low measurement resolution. Generally, gate time should be longer than the period of tested signal.

3.14.2 Coupling mode: the tested signal adapts AC coupling method, and the input attenuation is comparatively larger when frequency is comparatively lower, so when frequency is lower than 10Hz, the users should better increase the amplitude of the tested signal properly.

3.14.3 Low-pass filter: when the frequency of tested signal is comparatively low and with a high-frequency noise added with it, the high-frequency noise may trigger the counter which will result in getting larger measurement result compared with the correct value. In this case, a low-pass filter should be used externally to filter the high-frequency noise in the tested signal, and to get correct measurement result.

3.15 Output port

There are three output ports on the front panel of the instrument, users must not input signal to the output port as a possibility of damaging the instrument.

3.15.1 Signal output port《CHA》: the signals of CHA are all output from this output port, press 【Output】key to open or close the signal from the output port circularly. The output port is open when the "Output" light is on, and close when the "Output" is off.If wrongly connect external high voltage to signal output port, instrument will suffer "inverse filling" danger, and then instrument will turn on the protection function, close immediately signal output port and make an alarm with the "Output"light off. In this case, you must check external load, only after eliminating the failure can press【output】key to

open signal output port.

3.15.2 Signal output port《CHB》: the signals of CHB are all output from this output port, the characteristics of which is the same as the one of 《CHA》.

3.15.3 Sync output port《Sync》: output pulse wave compatible with TTL, high level＞4V, low level ＜0.3V. Sync signal is different under different function.

A. When CHA is under continuous function, sync signal is a square signal with TTL level, the frequency of sync signal is the same as the frequency of the signal from 《CHA》port, when the output mode is set to be 0, the phase of sync signal is the same as the phase of the signal from the 《CHA》port. When the output mode is set to be 1, the phase of sync signal is the opposite of the phase of the signal from the 《CHA》port.

B. When CHB is under continuous function, sync signal is a square signal with TTL level, the frequency of sync signal is the same as the frequency of the signal from 《CHB》port, when the output mode is set to be 0, the phase of sync signal is the same as the phase of the signal from the 《CHB》port. When the output mode is set to be 1, the phase of sync signal is the opposite of the phase of the signal from the 《CHB》port.

C. Under FM, AM, PM, PWM, sync signal is a square with 50% duty cycle, the frequency of which is equal to the modulation wave, and the phase is referenced to the modulation wave.

D. Under FSK, sync signal is a square with 50% duty cycle, the frequency of which is equal to the hop rate, when outputting carrier frequency, sync signal is with low level. When outputting hop frequency, sync signal is with high level.

E. Under frequency sweep function, the sync signal is a pulse signal with TTL level, the rising edge of the pulse wave match along with the start point of the sweep, and the falling edge of the pulse wave match along with the middle point of sweep range, the period of pulse wave is the same as sweep time.

F. Under burst output, sync is a pulse wave, the rising edge of which corresponds to the start point of the burst, and the falling edge corresponds to the end point, and the period is equal to the repeated period of the burst.

G. Under frequency sweeping, burst and FSK functions, if external trigger or

manual trigger is selected, the frequency of the sync signal was determined by the trigger signal.

3.16 Input port

There are three input ports on the rear panel of the generator, which could only be used as external signal input port, and not signal output port.

3.16.1 Modulation input port《Modulation In》: input external modulation signal under FM, AM, PM and PWM functions.

3.16.2 Trigger input port《Trig In》: input external trigger signal under FSK, frequency sweeping and burst functions.

3.16.3 Count input port《Count In》: input external signal to be tested under frequency measurement function.

3.17 Communication port

3.17.1 USB device interface 《USB Device》: the instrument could be program-controlled by connecting to computer through this interface with an USB cable, or down user-defined waveform data with waveform edition software, or update the firmware program of the generator with firmware updating software, the use method of this interface is described in detail in the CD that attached with the instrument.

3.17.2 USB host port《USB Host》: plug in an U disk, to store and recall the user-defined waveforms and setting parameters of the generator.

3.18 Parameter calibration

The instrument is calibrated before shipment, but some specifications may change a bit lot during long time of use. To ensure the accuracy, the instrument should be calibrated termly. Users may regain the accuracy of the instrument by operating the keyboard to calibrate the main specifications without removing the cover of the instrument.

3.18.1 Enable calibration After booting, the calibration is in off state, and the generator could not be calibrated without inputting calibration password, this is a way to protect calibrated parameters which may be changed carelessly. To enable calibration, select sine wave and then press【Shift】【Cal】key, the calibration password displayed as 0, input calibration password 1900, press【#】key to enable calibration. If currently the generator is under CHA tone function, you may calibrate CHA, and if under CHB tone function now, you may calibrate CHB.

3.18.2 Parameters calibration Press【Menu】key to display calibration value on the left, and calibration sequence number on the right when setting calibration conditions automatically. Adjust calibration value to calibrate present selected calibration option and make the output expected. Continue to press 【Menu】key and the calibration sequence number will increase step by step, users could calibrate all those options respectively, which is shown in the following list. During calibration process, press 【Shift】【Cal】key at any time then press【Menu】key to return the calibration sequence number to 00.

Parameter calibration table

Sequence No.	Default calibration value	Output nominal value	Adjust the calibration value till the output is within the error range
00	1000	0Vdc	Zero calibration：output DC voltage －20～20mVdc
01	1000	10Vdc	Offset calibration：output DC voltage 9.87～10.13Vdc
02	900	7Vrms	Amplitude calibration：output AC voltage 6.928～7.072Vrms
03	300	0.71Vrms	Amplitude calibration：output AC voltage 0.701～0.719Vrms
04	500	1MHz	Frequency calibration：output frequency 1MHz±20Hz
05～**	100～150	5Vpp	Flatness calibration：output amplitude 4.5Vpp～5.1Vpp

** The sequence No. of TFG1903A is 05～07, The sequence No. of TFG1905A is 05～09, the sequence No. of TFG1910A is 05～14, the sequence No. of TFG1920A is 05～24.

3.18.3 Disable calibration After finishing the calibration, press 【Shift】【Cal】key and there display 1900, press any numeric keys then【#】key to store the calibration parameters, disable calibration and exit the process.

During the calibration process, if wrong calibration occurred, press 【Freq】key at any time to disable calibration and exit without storing calibration parameters.

After rebooting, the generator automatically recalls and uses the calibration

parameters stored during last calibration.

3.19 Default setting

3.19.1 Continuous function of CHA and CHB: continuous function is default after booting.

Waveform: sinewave Frequency: 1kHz Amplitude: 1Vpp

Attenuation: Auto Offset: 0Vdc Duty cycle: 50%

Symmetry: 50% Pulse width: 0.2ms Output mode: in-phase

Output port: open

3.19.2 Modulation function: (FM, AM, PM, PWM)

Frequency deviation: 1kHz Modulation amplitude depth: 100%

Phase deviation: 180°

Pulse width deviation: 50% Modulation frequency: 1kHz

Modulation waveform: sine Trigger source: internal

3.19.3 Frequency shift keying function:

Hop frequency: 4kHz Hop rate: 1kHz

Modulation waveform: square Trigger source: internal

3.19.4 Frequency sweeping function

Start frequency: 100H End frequency: 1kHz Sweep time: 3s

Sweep mode: linearity Trigger source: Internal

3.19.5 Burst:

Repeated period: 10ms Pulse count: 3 Start phase: 0°

Trigger source: Internal

3.20 Firmware version

Under CHB tone, press【Menu】key, the firmware version of the generator will be displayed: xxxx.xx, which is helpful when repair and could not be set or change.

Chapter 4 Service and support

4.1 Warranty

Shijiazhuang Suin Instruments Co.,Ltd. will give one year's warranty to maintaining or replacing since consignment for the verified quality problem of the product.

Except for this explanation and the description in the warranty card, the company has no other warranty, in proclamation or in implication. Under no circumstances, the company will responsible for the direct, indirect or other secondary loss.

4.2 Contact us

If you have any questions or inconvenient during the use of our products please do not hesitate to contact us.

Monday thru Friday 8: 00-17: 00

Telephone: +86-311-86086971

Fax: +86-311-86018511

E-mail address: export@suintest.com

You are welcome to visit the website of Shijiazhuang Suin Instruments Co.,Ltd.:

http://www.suintest.com

Chapter 5 Specifications (see note 1)

5.1 Output characteristics of CHA and CHB

5.1.1 Waveform characteristics

Standard waveforms: Sine, Square, Ramp, Pulse, Noise, Exponent, Logarithm , SINC, half-round, Cardiogram, Quake.

Arbitrary: 5 waveforms

5.1.2 Sinewave spectral purity

Harmonic distortion: （1Vpp）≤－40dBc（≤5MHz）

≤－35dBc（＞5MHz）

Total distortion: （20Hz～20kHz，20Vpp）≤0.5％

5.1.3 Square, pulse and Ramp characteristics

Edge time of square and pulse：≤35ns Overshoot：≤ 10 ％

Duty cycle of square：0.1％～99.9％（Limited by edge time）

Pulse width：100ns～2000s

Ramp symmetry：0.0％～100.0％

5.1.4 Arbitrary characteristics

Waveform length：4096 points

Sampling rate：100 MSa/s

Amplitude resolution：10 bits

Bandwidth of filter：50MHz

Non-volatile memory：5 waveforms

5.1.5 Frequency characteristics

Frequency range:

Sine: 1μHz～20MHz(see note 2) Square, pulse: 1μHz～5MHz Others: 1μHz～1MHz

Frequency resolution: 1μHz, 6 digits

Frequency accuracy: ±20ppm

5.1.6 Amplitude characteristics(Auto-attenuation, offset 0Vdc)

Amplitude range: Frequency≤8MHz: 0～10Vpp(50Ω load) 0～20Vpp(open-circuit load)

Frequency>8MHz: 0～9Vpp(50Ω load) 0～18Vpp(open-circuit load)

Amplitude resolution: 2mVpp (Amplitude＞2Vpp) 0.2mVpp(Amplitude≤2Vpp)

Amplitude accuracy (1kHz, ＞5mVrms, auto attenuation): ±(setting×1％＋2mVrms)

Amplitude flatness (Sinewave, compared to 1MHz, 5Vpp): ±10%

5.1.7 Offset characteristics (amplitude 0Vpp)

Offset range: ±5Vdc(50Ω load) ±10Vdc(open-circuit load)

Resolution: 2mVdc

Offset accuracy: ±(setting value×1%＋20mVdc)

5.1.8 Phase characteristics

Output mode: positive/opposite

Phase difference CHA and CHB: 0°～360° Resolution: 1°

5.1.9 Parameter storage characterstics

Non-volatile parameters: 5 groups

5.1.10 Output port

Output impedance: 50Ω nominal

Output protection: Close output automatically if over-load

5.2 Modulation characteristics of CHA

5.2.1 FM, AM, PM, PWM

Carrier waveform: 16 kinds of waveforms including sine, square, Ramp and so on(only pulse is applicable to PWM)

Modulation waveform: 16 kinds of waveforms including sine, square, Ramp and so on

Modulation frequency: 2mHz～20kHz

Frequency deviation: 1μHz～20MHz(see note2)

Modulation amplitude depth: 0%～120%

Phase deviation: 0°～360°

Pulse width deviation: 0%～99%

Modulation source: internal/external

5.2.2 FSK

Carrier waveform: 16 kinds of waveforms including sine, square, Ramp and so on

Modulation waveform: square

FSK rate: 1mHz～100kHz

Hop frequency: 1μHz～20MHz(see note2)

Trigger source: internal/external

5.3 Frequency sweeping characteristics of CHA

Sweeping waveform: 16 kinds of waveforms of sine, square, Ramp and so on.

Sweeping range: Start and stop frequency can be set arbitrarily

Sweeping time: 50ms to 500s

Sweeping mode: linearity, logarithm

Trigger source: internal/external/ single

5.4 Burst characteristics of CHA

Waveform: 16 kinds of waveforms including sine, square, Ramp and so on

Repeated period: 1μs～500s

Pulse count: 1～1000000

Start phase: 0°～360°

Trigger source: internal/external/single

5.5 Sync output characteristics

5.5.1 Waveform characteristics: Square, edge time≤20nS

5.5.2 Level characteristics: TTL compatible

5.5.3 Impedance characteristics: 50Ω nominal

5.6 Modulation input

5.6.1 Input voltage: 5Vpp full scale

5.6.2 Input impedance: ＞10kΩ

5.7 Trigger input

5.7.1 Input level: TTL compatible

5.7.2 Input impedance: ＞10kΩ

5.8 Frequency measurement

5.8.1 Input frequency: 1Hz～100MHz

5.8.2 Input amplitude: 100mVrms～7Vrms

5.8.3 Strobe time: 50ms～5s

5.9 Programmable interface

USB device interface, USB host interface

5.10 General characteristics

5.10.1 Power condition: Voltage: AC 100～240V Frequency: 45～65Hz

Power consumption: ＜30VA

5.10.2 Environment conditions: Temperature: 0～40℃ Humidity: ＜80％

5.10.3 Operation characteristics: Fully key operation, continuously adjust with adjusting knob.

5.10.4 Display: VFD fluorescence display screen

5.10.5 Dimension: 322 mm×256 mm×102 mm Weight: 1.5kg

5.10.6 Technique: Surface-mount technology, large scale integrated circuit, high reliability, long service life.

Note 1: The test of the specifications should be done around temperature of 18℃ to 28℃, after 30 minutes of booting.

Note 2: Sinewave frequency range of TFG1903A: 1μHz～3MHz

Sinewave frequency range of TFG1905A: 1μHz～5MHz

Sinewave frequency range of TFG1910A: 1μHz～10MHz

Sinewave frequency range of TFG1920A: 1μHz～20MHz