User's Guide

数英仪器 Digital Instruments

TFG1900B Series Function Generators

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Introduction of TFG1900B Series Function Generators

The present guide is valid for four models of TFG1900B series function generators: TFG1903B, the maximum frequency of sinewave is 3MHz; TFG1905B, the maximum frequency of sinewave is 5MHz; TFG1910B, the maximum frequency of sinewave is 10MHz; TFG1920B, the maximum frequency of sinewave is 20MHz.

With Direct Digital Synthesis (DDS) technology, TFG1900B series function generator are of the high performance indexes and function characteristics which are necessary for the fast completion of measuring. The simple and clear front panel design and VFD fluorescent display interface are convenient for the users to operate and observe.

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

- **High frequency accuracy:** up to the level of 10^{-5}.
- **High frequency resolution:** 10μHz.
- **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.
- **Multi-waveform:** 16 types of waveforms can be output.
- **Square characteristics**: Accurate square duty cycle can be set.
- **Ramp characteristics:** May set accurate ramp symmetry
- **Frequency sweeping:** Be of the function of frequency sweeping, start point and end point can be set arbitrarily.
- **Modulation characteristics:** output FM, AM, PM, PWM, FSK signal.
- **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.
- **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.

TFG1900B series function generators and accessories (package list)

TFG19xxB function generator	1
3-core power supply	1
CD	1

(USB driver, user's guide, programmer's guide, interface introduction, interface demonstration)

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: please excuse any modification of the contents without special notification. Besides, it is unavoidable for not-so-adequate description and wrong printing. The present document is just a guide for the user and will not warrant in any form including, but not limited to, those for special aims.

Content

Chapter 1 Getting started

The front and rear panels, operations and functions of the TFG1900B 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 Preparing 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

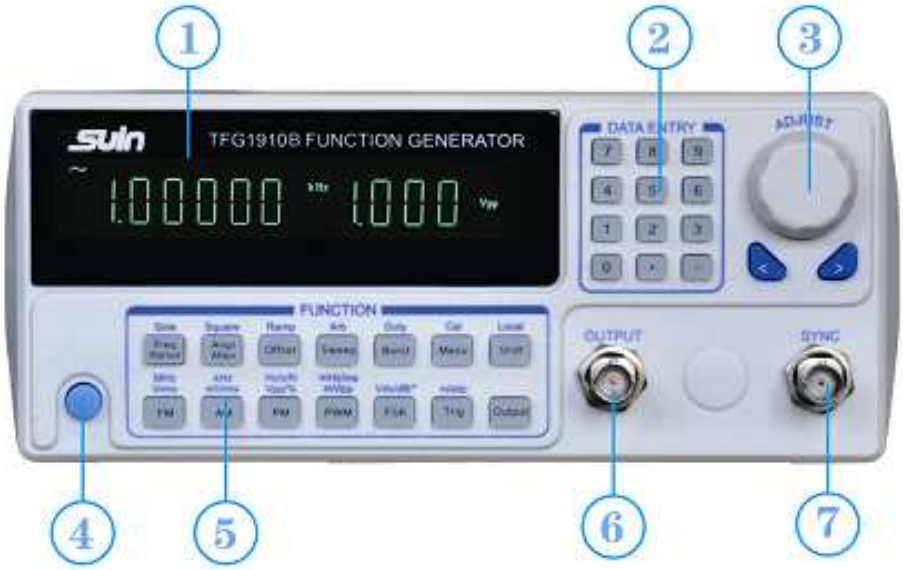
Power consumption: ＜20VA

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 continuity 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. Display screen 2. Numeric keys 3. Adjusting knob 4. Power Switch 5. Function keys 6. Waveform output 7. Sync output

1.3 Rear panel

1. USB device interface 2. Trig in 3.Power outlet

1.4 Display introduction

The display screen display two groups of digits, the group on the left with 6 digits

shows frequency, period, attenuation, duty cycle and so on of the signals. And the four digits on the right show amplitude, offset 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" 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】key: select frequency and period circularly, disable calibration process when calibrating.

【Ampl】【Atten】key: select amplitude and attenuation circularly.

【Offset】key: select offset.

【FM】【AM】【PM】【PWM】【FSK】【Sweep】【Burst】key: respectively select and exit FM, AM, PM, PWM, FSK, frequency sweeping and burst function.

【Trigg】key: select external trigger under frequency sweeping, FSK modulation and burst function.

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

【Shift】key: select shift key, return back to keyboard function under remote control state.

【Sine】【Square】【Ramp】key: shift key, select respectively sinewave, square and ramp three common waveforms.

【Arb】key: shift key, select 16 kinds of waveforms with the waveforms sequence number.

【Duty】key: shift key, select duty cycle of square and symmetry of ramp.

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

Unit key: The six keys with unit characters above them on the 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 six keys to select the unit of the inputting and end the digits inputting at the same time.

【Menu】key: key for menu, select different options circularly under different functions, see below list:

Options list of menu

Menu	Option
Tone	Phase and version of waveform
Frequency sweeping	Start frequency, end frequency, sweep time, sweep mode
Burst	Period, pulse count, start phase
FM	Modulation frequency, modulation frequency deviation, modulation waveform
AM	Modulation frequency, modulation amplitude depth, modulation waveform
PM	Modulation frequency, phase deviation, modulation waveform
PWM	Modulation frequency, modulation width depth, modulation waveform
FSK	Hop rate, hop frequency
Calibration	Calibration value: zero, offset, amplitude, frequency, amplitude 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 Continuity function: continuity function is default after booting, and the instrument outputs signal with continuous frequency.

Frequency setting: Set the frequency value at 3.5 kHz

【Freq】【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 carry 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

【Period】【2】【.】【5】【ms】.

Amplitude setting: set the amplitude as 1.5Vpp

【Ampl】【1】【.】【5】【Vpp】.

Attenuation setting: set the attenuation as 0dB（Auto attenuation is default after booting）

【Atten】【0】【dB】.

Offset setting: set DC offset as -1Vdc

【Offset】【-】【1】【Vdc】.

Common waveform selection: select square（sine wave is default after booting）

【Shift】【Square】.

Duty cycle setting: set the duty cycle of square as 20%

【Shift】【Duty】【2】【0】【%】.

Other waveforms selection: Select exponent waveform (sequence number 9, see sequence number list)

【Shift】【Arb】【1】【2】【N】.

Below content shows the function setting, in order to observe and measure, users may set the continuous signal as sinewave, with amplitude of 1Vpp,and offset of 0Vdc.

1.6.2 Frequency sweeping function:

Press【Sweep】key to output frequency sweeping signal.

Start frequency setting: Set the start frequency at 5kHz.

Press【Menu】key to light the "Start" letter, press【5】【kHz】.

End frequency setting: Set the end frequency at 2kHz

Press【Menu】key to light the "Stop" letter, press【2】【kHz】.

Sweeping time setting: Set the sweeping time at 5s.

Press【Menu】key to light the "Time" letter, press【5】【s】.

Sweeping mode setting: set logarithm sweeping mode

Press【Menu】key, press【1】【N】.

Trigger sweep setting: press【Trig】key, the sweeping will end when reaching to the end point, each time you press【Trig】key, the generator trigger sweep once. Press 【Sweep】key again to resume to continuous sweep.

1.6.3 Burst function: set continuous frequency as 1kHz.

【Burst】key, output burst signal.

Repeated period setting: set repeated period as 5ms

【Menu】key, light "Period" character, press【5】【ms】.

Pulse count setting: set pulse count as 1

【Menu】key, light "Ncyc" character, press【1】【N】.

Start phase setting: set start phase as 180°.

【Menu】key, light "Phase" character, press【1】【8】【0】【°】.

Trigger burst setting: press【Trig】key to stop the output of burst, then each time you press【Trig】key, the generator triggers a burst once. Press【Burst】key to resume continuous burst.

1.6.4 Frequency modulation function: set continuous frequency as 20kHz

【FM】key, output frequency modulation signal.

Modulation frequency setting: set modulation frequency as 10Hz

Press【Menu】key to light "Mod_f" character, press【1】【0】【Hz】.

Frequency deviation setting: set frequency deviation as 2kHz.

Press【Menu】key to light "Devia" character, press【2】【kHz】.

Modulation waveform setting: set modulation waveform as tri-angle

Press【Menu】key to light "Shape" character, press【2】【#】.

1.6.5 Amplitude modulation function:

【AM】key, output amplitude modulation signal.

Modulation frequency setting: set modulation frequency as 1kHz.

Press【Menu】key to light "Mod_f" character, press【1】【kHz】.

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

Press【Menu】key to light "Depth" character, then press【5】【0】【%】.

Modulation waveform setting: set modulation waveform as sine.

Press【Menu】key to light "Shape" character, then press【0】【#】.

1.6.6 Phase modulation function:

【PM】key, output phase modulation signal.

Modulation frequency setting: set modulation frequency as 10kHz.

Press【Menu】key to light "Mod_f" character, then press【1】【0】【kHz】.

Phase deviation setting: set phase deviation as 180°.

Press【Menu】key to light "Phase" character, then press【1】【8】【0】【°】.

Modulation waveform setting: set modulation waveform as square.

Press【Menu】key to light "Shape" character, then press【1】【#】.

1.6.7 Pulse width modulation function:

【PWM】key, output pulse width modulation signal.

Modulation frequency setting: set modulation frequency as 1Hz

Press【Menu】key to light "Mod_f" character, then press【1】【Hz】.

Pulse Width Deviation Setting：set pulse width deviation as 80%.

Press【Menu】key to light "Devia" character, then press【8】【0】【%】.

Modulation waveform setting: set modulation waveform as sine.

Press【Menu】key to light "Shape" character, and then press【0】【#】.

1.6.8 Frequency shift keying function: set the waveform as sine.

【FSK】key, output FSK signal.

Hop rate setting: set hop rate as 1kHz.

Press【Menu】key to light "Rate" character, then press【1】【kHz】.

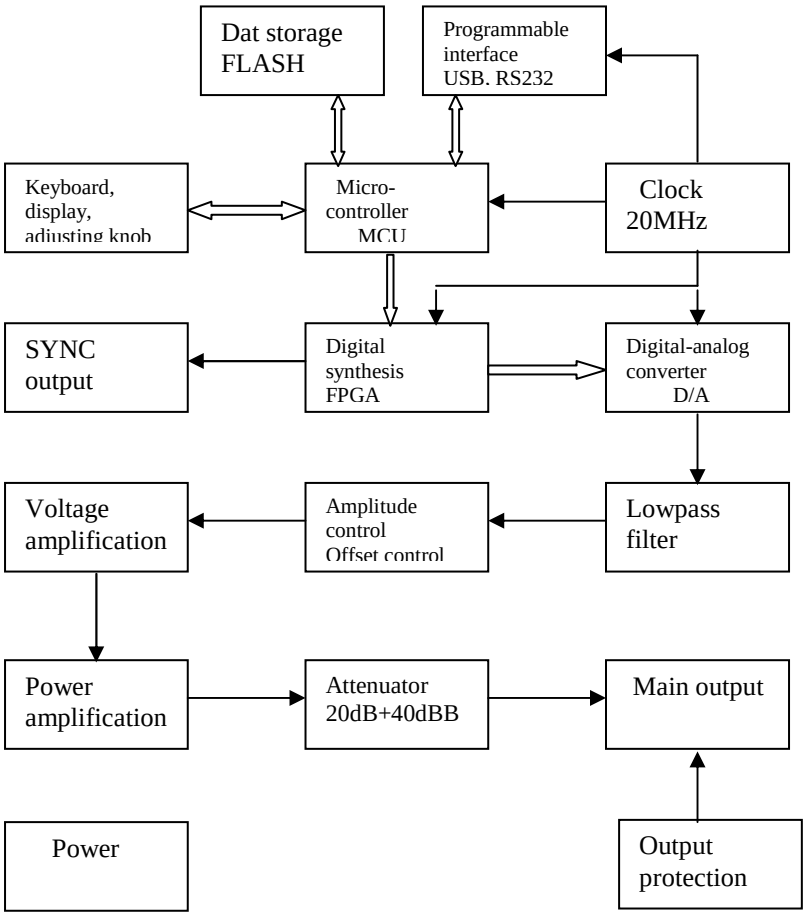
Hop frequency setting: set hop frequency as 2kHz.

Press【Menu】key to light "Hop" character, then press【2】【kHz】.

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 if 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 Operation Guide

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 Continuity function

After booting, the generator enters continuity function automatically, continuity

function means the output signal is stable and continuous, of which the waveform, frequency, amplitude and phase will not change along with the time change.

3.2.1 Frequency setting

Press【Freq】key, the light of which will be on, 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【Freq】key, the light of "Period" will be on, 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. Although the setting and displaying period value are accurate, 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, 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 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 and ramp wave, and other waveforms could only be shown by amplitude peak-peak value.

3.2.5 Amplitude attenuation setting

Press【Ampl】key to light "Atten" and 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 （including inductance and condensance） 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.

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, 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.

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

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, press 【Shift】【Sine】, 【Shift】【Square】, 【Shift】【Ramp】keys to directly select these three kinds of common waveforms, the corresponding waveform character will be displayed. Users may select all 16 kinds of waveforms with waveforms sequence numbers, press 【Shift】【Arb】key to show current waveforms sequence numbers, users may also input waveforms sequence numbers with numeric keys or adjusting knob to select the corresponding waveforms defined by the sequence numbers. Except three common waveforms, the waveform characters of other waveforms are "Arb". The waveform sequence numbers of 16 kinds of waveforms are as listed as below:

Output waveform sequence numbers list

Sequence Number	Waveform	Sequence Number	Waveform
00	Sine	08	Limit sine
01	Square	09	Exponent
02	Ramp	10	Logarithm
03	Pos-pulse	11	Tangent
04	Neg-pulse	12	Sin(x)/x
05	Stair	13	Half round
06	Noise	14	Cardiac
07	Half sine	15	Quake

3.2.10 Duty cycle setting

When the present selection of waveform is square or ramp(including pos-square and pos-ramp), users may press shift key【Duty】to display present duty cycle value, input duty cycle value with numeric keys or adjusting knob, then the output will be square or ramp with a fixed duty cycle value. The definition of square duty cycle is the ratio of high level time of one square to the period of this square. The usual thought of square duty cycle is 50%, waveforms with other duty cycle are usually named pulse. The definition of ramp duty cycle is the ratio of rising time of one ramp to the period of this ramp. The ramp duty cycle is usually named ramp symmetry, ramps with symmetry of 0% or 100% are usually named sawtooth wave, and ramp with symmetry of 50% is named triangle wave.

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 Output phase setting

Under continuity function, press 【Menu】to display output phase value, input phase value with numeric keys or adjusting knob, there are only two output phase values, 0 and 1. When setting the value as 0, the phase of signal from 《OUTPUT》 port is the same with the one from《SYNC》port, while when setting the phase as 1, the two are opposite.

3.2.12 Software version number

Under continuity function, press【Menu】to show the software version number: xxxx.xx of the generator, which is helpful for maintain and could not be set or changed.

3.3 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 could be swept, of course it makes no sense to sweep DC or noise. 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 generator enters frequency sweeping function.

3.3.1 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.

3.3.2 Sweeping time

Press【Menu】key to light "Time" letter 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.

3.3.3 Sweeping mode

Press【Menu】key to set sweeping mode. Set the value as 0, the character "linear"

will be lighted, and the sweeping mode now is linearity. Set the value as 1, the character "log" will be lighted, 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.

3.3.4 Trigger sweeping

When continuous sweep, the generator uses internal continuous trigger source, and the sweep runs continuously and repeatedly. Press【trig】key to light "trig" keyboard indicator, and the sweep will end when reaching to the end point, then each time you press【trig】key, the sweep runs once and then stops at the start frequency waiting for the next trigger. External trigger is also available, input TTL trigger signal into the 《Trig In》port on the rear panel. The sweep runs once at the rising edge of each trigger signal. Of course, the period of trigger signal should be larger than the sweep time set. In trigger sweep, press【Sweep】key, the "trig" keyboard indicator will be off and the generator resumes to continuous sweep mode.

3.3.5 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 continuity function.

3.4 Burst function

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 a waveform with a specified number of cycles and at a specified period at a starting phase, or it outputs a waveform with a specified number of cycles only single once. All the 16 waveforms could be used as burst waveform, Of course, using DC or noise signal as burst signal is invalid. Before entering burst function, users should set the waveform, frequency and amplitude of the burst under the continuity function.

Press 【Burst】key to light "Burst" keyboard indicator, the generator will enter into burst function.

3.4.1 Repeated Period: press【Menu】key to light "Period" character, and then set repeated period. Period represents time from the start of one pulse string 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.

3.4.2 Burst count: press【Menu】key to light "Ncyc" indicator, and then set the burst count. Burst count represents the number of cycles of pulse string 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 pulse count setting is too big, the instrument will modify it to the allowable maximum value.

3.4.3 Start phase: press【Menu】key to light "Phase" character, and then set start and end phase value. The start and end of the pulse string 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.

3.4.4 Trigger burst: In continuous burst mode, the generator uses internal continuous trigger source to output continuous burst based on the repeated period and burst count set in advance. Press【trig】key to light "trig" keyboard indicator, the burst output stop, and

the generator outputs a burst each time pressing〖trig〗key, then keep on the start phase point and wait for the next trigger. You can also use external trigger source, input TTL trigger signal from the instrument rear panel "Trig In" connector. The generator outputs a burst at each rising edge of the trigger signal, then keeps on the start phase point and waits for the next trigger. Of course, the trigger signal cycle should conform to the restricted conditions of burst period. When trigger burst, the setting of period is ignored. When trigger burst, press【Burst】key, the "trig" keyboard light will be off and the generator will resume to continuous burst mode.

3.4.5 Sync output: regardless of in the continuous burst, single burst mode or gated output mode, 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 continuous burst, press 【Burst】key again, the keyboard indicator will be off, the generator exit burst function and return back to continuity function.

3.5 Frequency modulation（FM）

In Frequency modulation, the frequency of the carrier is varied by the instantaneous voltage of modulating waveform, all 16 waveforms could be used as carrier waveform, Of course, using DC or noise as carrier wave is invalid. Before entering into frequency modulation, users should firstly set the waveform, frequency and amplitude of carrier wave under continuity function.

Press【FM】key, the keyboard indicator of "FM" will be on, and the generator will enter into frequency modulation function.

3.5.1 Modulation frequency: press【Menu】key to light "Mod_f" character, and then set modulation frequency value. In FM, modulation frequency is usually far lower than carrier frequency.

3.5.2 Frequency deviation: press【Menu】key to light "Devia" character, 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

3.5.3 Modulation waveform: press【Menu】key to light "Shape" character, the current modulation waveform sequence No. is shown, input modulation waveform No. with the numeric keys or adjusting knob to select modulation waveform, the modulation waveform may be any one of the 16 kinds of waveforms listed in the waveforms table in section 3.2.9.

3.5.4 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 light of "FM" will be off, the generator will exit frequency modulation function and return back to continuity function.

3.6 Amplitude modulation（AM）

In AM, the amplitude of the carrier is varied by the instantaneous voltage of the modulating waveform, all the 16 waveforms could be used as carrier waveform, of course, it is invalid to use DC or noise. Before entering into amplitude modulation, users should firstly set the waveform, frequency and amplitude of carrier wave under continuity function.

Press【AM】key, the keyboard light of "AM" will be on and the generator enter into amplitude modulation function.

3.6.1 Modulation frequency: press【Menu】key to light "Mod_f" character, and then set modulation frequency value. In AM, modulation frequency is usually far lower than carrier frequency.

3.6.2 Modulation depth: press【Menu】key to light "Depth" character, 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 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)×A÷2.2　　Amin＝(1-M)×A÷2.2

Then the modulation depth is M＝(Amax－Amin)×1.1÷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 half of the amplitude setting.

3.6.3 Modulation waveform: press【Menu】key to light "Shape" character, the current modulation waveform sequence No. is shown, input modulation waveform No. with the numeric keys or adjusting knob to select modulation waveform, the modulation waveform may be any one of the 16 kinds of waveforms listed in the waveforms table in section 3.2.9.

3.6.4 Sync output: in AM, the generator outputs a sync signal from the front panel "Sync" connector, which is 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" light will be off, and the generator exits AM function and returns back to continuity function.

3.7 Phase modulation（PM）

In PM, the phase of the carrier is varied by the instantaneous voltage of the modulating waveform, all the 16 waveforms could be used as carrier waveform, Of course, it is invalid to use DC or noise. Before entering into phase modulation, users should firstly set the waveform, frequency and amplitude of carrier wave under continuity function.

Press【PM】key to light "PM", the generator enters into PM function.

3.7.1 Modulation frequency: press【Menu】key to light "Mod_f" character and then set modulation frequency value. In PM, modulation frequency is usually far lower than carrier frequency.

3.7.2 Phase deviation: press【Menu】key to light "Devia" character, 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.

3.7.3 Modulation waveform: press【Menu】key to light "Shape" character, the current modulation waveform sequence No. is shown, input modulation waveform No. with the numeric keys or adjusting knob to select modulation waveform, the

modulation waveform may be any one of the 16 kinds of waveforms listed in the waveforms table in section 3.2.9.

3.7.4 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" keyboard light will be off, the generator exits PM function and returns back to continuity function.

3.8 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 continuity function.

Press【PWM】key, the keyboard indicator of "PWM" will be on and the generator enter into pulse width modulation function, the carrier wave is automatically set as pulse wave.

3.8.1 Modulation frequency: Press【Menu】key to light "Mod_f" character and set modulation frequency value. In pulse width modulation, modulation frequency is far lower than carrier frequency.

3.8.2 Pulse width deviation: Press【Menu】key to light "Depth" indicator and 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%.

3.8.3 Modulation waveform: press【Menu】key to light "Shape" character, the current modulation waveform sequence No. is shown, input modulation waveform No. with the numeric keys or adjusting knob to select modulation waveform, the modulation waveform may be any one of the 16 kinds of waveforms listed in the waveforms table in section 3.2.9.

3.8.4 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 light will be off, and the generator exits PWM function and returns back to continuity function.

3.9 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 16 waveforms could be used as carrier wave, Of course, using DC or noise signal as carrier wave is invalid. Before entering into FSK, users should firstly set the waveform, frequency and amplitude of carrier wave under continuity function.

Press【FSK】key to light "FSK" keyboard indicator, the generator enter into FSK function.

3.9.1 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.

3.9.2 Hop frequency: frequency shift keying is similar with FM whose modulating waveform is square. "hop frequency" is similar with "frequency offset", with the difference of, frequency offset 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.

3.9.3 External trigger: after entering into FSK function, the generator uses internal trigger source as default, outputs FSK signal based on hop rate set. Press【trig】key, the "trig" keyboard indicator will be on and the generator enter into FSK mode with external trigger. The trigger signal with TTL level is inputted from the rear panel "Trig In" connector. If the level of the trigger signal is low, the frequency of the output signal is that of the carrier, if the level of the trigger signal is high, the frequency of the output signal is the hop frequency. When using external trigger, the setting of hop rate is ignored. When using external trigger, press【FSK】key, the "trig" keyboard indicator will be off and the generator resume to internal trigger mode.

3.9.4 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 internal trigger FSK, press【FSK】key again, the "FSK" keyboard indicator will be off, the generator exits FSK function and returns back to continuity function.

3.10 Output port

There are two 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.

3.10.1 Signal output port《Output》: the signals that the instrument generates are all output from the signal 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 closed 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.

3.10.2 Sync output port《Sync》: output pulse wave compatible with TTL and CMOS, high level＞4V,low level ＜0.3V.

A. Under continuity 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《Output》port, when the phase is set to be 0, the phase of sync signal is the same as the phase of the signal from the 《Output》port. When the phase is set to be 1, the phase of sync signal is the opposite of the phase of the signal from the 《Output》port.

B. 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.

C. In FM,AM,PM,PWM modulation, sync signal is a square wave with 50% duty cycle, whose frequency equals to frequency of modulating waveform and phase refers to the phase of modulating waveform.

D. In FSK, sync signal is a square wave with 50% duty cycle, whose frequency equals to hop rate, when outputting carrier frequency, sync signal is low level; when outputting hop frequency, sync signal is high level.

E. When pulse string output, sync signal is a pulse wave whose rising edge corresponds to

start point, falling edge corresponds to stop point, and cycle equals to pulse string repeated cycle.

F. In frequency sweep, pulse string and FSK, if select manual trigger or external trigger, frequency of sync signal will be determined by trigger signal.

3.11 Input port

There is a trigger input port《Trig In》on the rear panel of the generator, which could be used only as the input channel of external signal, but not output channel. This port could be also used as the input channel of pulse signal which is compatible with TTL and CMOS, the high level of which is higher than 4V, and low level is lower than 0.3V.

3.12 Programmable interface

There is an USB device interface 《USB Device》on the rear panel of the instrument, through which the instrument could be program-controlled by connecting to computer with an USB cable,the use method of this interface is described in detail in the CD that attached with the instrument.

3.13 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.

3.13.1 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 key【Cal】, the calibration password displayed as 0, input calibration password 1900, press【N】key to enable calibration.

3.13.2 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 key【Cal】at any time then press【Menu】key to return the calibration sequence number to 00.

Parameter calibration table

Sequence No.	Default calibra-tion value	Output nominal value	Adjust the calibration value till the output is within the error range
00	2047	0Vdc	Zero calibration: output DC voltage －20～20mVdc
01	870	10Vdc	Offset calibration: output DC voltage 9.88～10.12Vdc
02	873	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	5Vpp	Flatness calibration: output amplitude 4.5Vpp～5.5Vpp

** TFG1903B sequence No. is 05～07, TFG1905B is 05～09, TFG1910B is 05～14, TFG1920B is 05～24

3.13.3 Disable calibration

After finishing the calibration, press【Cal】key and there display 1900, press any numeric keys then【N】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.

3.14 Default setting

3.14.1 Continuity function: continuity function is default after booting.

Waveform: sinewave Frequency: 1kHz Amplitude: 1Vpp

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

Output phase: 0° Output port: open

3.14.2 Frequency sweeping function

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

Sweep mode: linearity Trigger mode: internally continuous

3.14.3 Burst

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

Trigger mode: internally continuous

3.14.4 Modulation (FM, AM, PM, PWM)

Modulation frequency: 1kHz Modulation frequency deviation: 1kHz

Modulation amplitude depth: 100%

Phase offset: 180° Modulation width depth: 50% Modulation waveform: Sine

3.14.5 FSK

Hop rate: 1kHz Hop frequency: 4kHz Modulation waveform: square

Trigger mode: internal continuous

3.15 Power Amplifier (Option)

If user selects power amplifier, a power amplifier board will be supplied in the package. It is an independent component of the generator, 'Amplifer In' in rear panel is input connector of power amplifier and 'Amlifer Out' is output connector of power amplifier.

Connect the input signal to 'Amplifer In' connector, then amplified signal can be obtained at the connector of 'Amlifer Out'. The input signal can be the output signal of this instrument or other device's.

3.15.1 Input Waveform

Sine. For other waveforms, the distortion will be greater.

3.15.2 Input voltage

The multiple of the power amplifier is double and the maximum output amplitude is 9Vrms. So the maximum input amplitude should be limited within 4.5Vrms. The output signal will be distorted beyond the limitation.

3.15.3 Frequency range

The frequency range of the power amplifier is 100Hz to 10kHz.

3.15.4 Output power

The expression of power for the power amplifier is

$$P = V^2 / R$$

Where, P is the output power(the unit is W), V is the output virtual amplitude value (the unit is Vrms), R is the load resistance（the unit is Ω）.

The maximum output amplitude can reach 9Vrms and the minimum load resistance can be 2Ω. Besides, the higher the temperature of the working environment, the larger is the frequency of the output signal and the greater the distortion of the output signal. Usually, the maximum output power can reach 10W(8Ω).

3.15.5 Output protection

The power amplifier is of short circuit protection function and over heat protection. Usually it is unable to be destroyed but long time output short circuit should be avoided. The frequency, amplitude and loading should be best within the limitation, two of which, especially, cannot get the limitation at the same time in case that the power amplifier is damaged.

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(after service) Fax: +86-311-86018511

+86-311-86014314(technical support)

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

5.1.1 Waveform

Type: 16 waveforms including Sine, Square, Ramp, Exponent, Logarithm, Noise, etc.

Length: 1024 points

Sampling Rate: 100 MSa/s

Amplitude Resolution: 8 bits

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

≤－35dBc（＞5MHz）

Total Distortion of Sine: （20Hz～20kHz, 20Vpp） ≤0.5％

Rising/Falling Edge Time: ≤35ns Overshoot: ≤ 10 ％

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

Symmetry of Ramp: 0.0％～100.0％

5.1.2 Frequency

Range: Sine: 10μHz～20MHz(Note 2) Square: 10μHz～5MHz Others: 10μHz～1MHz

Resolution: 10μHz, 6 digits

Accuracy: ±50ppm

5.1.3 Amplitude（Auto Attenuation, offset 0Vdc)

Range：frequency≤8MHz：0～10Vpp(50Ω load) 0～20Vpp(open-circuit load)

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

Resolution：5mVpp(amplitude＞2Vpp) 0.5mVpp(amplitude≤2Vpp)

Accuracy (1kHz,＞5mVrms): ±（Setting×1％＋2mVrms）

Flatness (Sine, compared to 1MHz,5Vpp): ±10％

Output impedance: 50Ω typical value

5.1.4 Offset（Amplitude 0Vpp）

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

Resolution: 5mVdc

Accuracy: ±(Setting×1％＋20mVdc)

5.1.5 Sweep

Waveform: 16 kinds of waveforms including sine, square, ramp, etc.

Range: set start and end point arbitrarily

Time: 50ms～500s

Mode: linearity, logarithm

Trigger source: Internal continuous, external signal, manual trigger

5.1.6 FM, AM, PM, PWM

Carrier waveform: 16 kinds of waveforms including sine, square, ramp, etc.（PWM only for pulse）

Modulation waveform: 16 kinds of waveforms including sine, square, ramp, etc.

Modulation frequency: 40mHz～20kHz

Frequency offset: 10μHz～20MHz(Note 2)

Modulation amplitude depth: 0%～120%

Phase offset: 0°～360°

Pulse width deviation: 0%～99%

5.1.7 FSK

Carrier waveform: 16 kinds of waveforms including sine, square, ramp, etc.

Modulation waveform: Square

FSK rate: 40mHz～100kHz

Hop frequency: 10μHz～20MHz(Note 2)

Trigger source: Internal continuous, external signal

5.1.8 Burst

Waveform: 16 kinds of waveforms including sine, square, ramp

Repeated period: 1μs～20s

Pulse count: 1～1000000

Start phase: 0°～360°

Trigger source: Internal continuous, external signal, manual trigger

5.2 SYNC

5.2.1 Waveform: Square, edge time ≤20 ns

5.2.2 Amplitude: TTL compatible, low level＜0.3 V, high level＞4 V

5.3 Programmable Interface

USB device interface, of which the operation guide is written into the attached CD.

5.4 General Characteristics

5.4.1 Power condition:

Voltage: AC 100～240V Frequency: 45～65Hz Power consumption: ＜20VA

5.4.2 Environment condition**:** Temperature: 0～40℃ Humidity: ＜80％

5.4.3 Operation characteristics:

Fully key-operation, continuously adjust with the knob.

5.4.4 Display: VFD fluorescence display screen

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

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

5.5 Power Amplifier (Option)

5.5.1 Input signal:

Voltage: 0Vrms to 4.5Vrms

Frequency: 100Hz to 10kHz

5.5.2 Voltage Amplifier: double

5.5.3 Output Power: 10W (load 8Ω)

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 TFG1903B: 10μHz to 3MHz

Sinewave frequency range of TFG1905B: 10μHz to 5MHz

Sinewave frequency range of TFG1910B: 10μHz to 10MHz

Sinewave frequency range of TFG1920B: 10μHz to 20MHz