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Signal Function Synthesizer

Mode : SFG-830

82FG-83000MA

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EC Declaration of Conformity

We

GOOD WILL INSTRUMENT CO., LTD.

(1) NO. 95 - 11, Pao Chung Rd., Hsin-Tien City, Taipei Hsien, Taiwan

(2) Plot 522, Lorong Perusahaan Baru 3, Prai Industrial Estate, 13600 Prai, Penang, Malaysia declare, that the below mentioned product

SFG-830

is herewith confirmed to comply with the requirements set out in the Council Directive on the Approximation of the Law of Member States relating to Electromagnetic Compatibility (89/336/EEC,92/31/EEC,93/68/EEC) and Low Voltage Equipment Directive(73/23/EEC).

For the evaluation regarding the Electromagnetic Compatibility and Low Voltage Equipment Directive, the following standards were applied:

EN50081-1: (1992) Electromagnetic compatibility - Generic emission standard Part 1: Residential, commercial and light industry		
Conducted Emission	EN 55022	class A
Radiated Emission		(1994)
Current Harmonics	EN 61000-3-2	+A12 (1996)
Voltage Fluctuations	EN 61000-3-3	(1995)
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EN50082-1: (1992) Electromagnetic compatibility - Generic immunity standard Part 1: Residential, commercial and light industry		
Electrostatic Discharge	IEC 1000-4-2	(1995)
Radiated Immunity	IEC 1000-4-3	(1995)
Electrical Fast Transients	IEC 1000-4-4	(1995)
Surge Immunity	IEC 1000-4-5	(1995)
Voltage Dip/Interruption	EN 61000-4-11	(1994)

EN50081-2: (1993) Electromagnetic compatibility - Generic emission standard Part 2: Industrial Environment		
Conducted Emission	EN 55011	class A
Radiated Emission		(1991)

Low Voltage Equipment Directive 73/23/EEC	
Low Voltage Directive	EN 61010-1:(1993)+A2:(1995)

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1. Precautions

SFG-830 is especially designed for safe operation. It has passed rigorous tests of inclement environment to ensure its reliability and good condition.

The following precautions are recommended to insure your safety and the best condition of this equipment.

(1) Safety Terms and Symbols

The following terms and symbols may appear in this manual:



WARNING This statement identifies conditions or practices that could result in injury or loss of life.



CAUTION This statement identifies conditions or practices that could result in damage to this product or other properties.

The following terms and symbols may appear on the product:

DANGER	This term indicates an immediately accessible injury hazard.
WARNING	This term indicates that an injury hazard may occur, but is not immediately accessible.
CAUTION	This term indicates potential damage to this product or other properties.



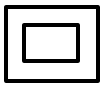
DANGER
High voltage



Protective ground terminal



ATTENTION
refer to manual



Double insulated



DANGER
Hot surface



Functional ground terminal

(2) Do not place any heavy objects on the instrument under any circumstances.

(3) Disassembling the instrument

Due to the precision of this instrument, all the disassembling, adjusting, and maintenance should be performed by a professional technician. If the instrument have to be opened or adjusted under some unavoidable conditions, it should be carried out by a technician who is familiar with SFG-830. Once there is any abnormality, please contact our company or the agency near you.

(4) Power Supply

AC input should be within the range of line voltage±10%, 50/60Hz. To prevent the instrument from burning up, be sure to check the line voltage before turning on power.

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(5) Grounding



WARNING To avoid electrical shock, the power cord protective grounding conductor must be connected to ground.

SFG-830 can be operated only with an earth grounded AC power cord that connects the case and ground well. This is to protect the user and the instrument from the risk of shock hazard.

(6) Fuse Replacement



WARNING For continued fire protection, replace fuse only with the specific type and rating. Disconnect the power cord before replacing fuse.

The fuse blows only if there is anything wrong with the instrument, and SFG-830 will stop working under this situation. Please check the cause of it, then replace an proper fuse as listed below. Be sure to use the correct fuse before changing the applying voltage.

90V ~ 132V : T 0.8A/250V
198V ~ 250V : T 0.5A/250V

Check the line voltage setting on the rear panel. If the line voltage setting does not match the one of your area, change the line voltage setting according to the following steps:

1. Open the cover of AC socket with flat-blade screwdriver.
2. Remove cam drum, rotate to correct selection and reinsert.

(7) Cleaning the Cabinet

Disconnect the AC power cord before cleaning the instrument.

Use a soft cloth dampened in a solution of mild detergent and water. Do not spray cleaner directly onto the instrument, since it may leak into the cabinet and cause damage.

Do not use chemicals containing benzing, benzne, toluene, xylene, acetone, or similar solvents.

(8) Operation environment

Indoor use
Altitude up to 2000m

Temperature to satisfy the specification :	18°C ~ 28°C (+64.4°F ~ +82.4°F)
Operating temperature :	0°C ~ 40°C (+32°F ~ +104°F)
Storage temperature :	-10°C ~ 70°C (+14°F ~ 158°F)
Relative humidity :	up to 90% when 0°C~35°C; up to 70% when 35°C~40°C
Installation category :	II
Pollution degree :	2

(9) Place SFG-830 in a location of satisfied environment as stated above free from dust, direct exposition of sunlight, and strong effect of magnetic fields.

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(10) For United Kingdom

NOTE

This lead/appliance must only be wired by competent persons.

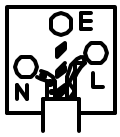
WARNING

THIS APPLIANCE MUST BE EARTHED

IMPORTANT

The wires in this lead are coloured in accordance with the following codes:

Green/Yellow :Earth
Blue :Neutral
Brown :Live (Phase)



As the colours of the wires in mains leads may not correspond with the coloured markings identified in your plug/appliance, proceed as follows:

The wire which is coloured Green and Yellow must be connected to the Earth terminal marked with the letter E or by the earth symbol ⏚ or coloured Green or Green and Yellow.

The wire which is coloured Blue must be connected to the terminal which is marked with the letter N or coloured Blue or Black.

The wire which is coloured Brown must be connected to the terminal marked with the letter L or P or coloured Brown or Red.

If in doubt, consult the instructions provided with the equipment or contact the supplier.

This cable/appliance should be protected by a suitably rated and approved HBC mains fuse; refer to the rating information on the equipment and/or user instructions for details. As a guide, cable of 0.75mm^2 should be protected by a 3A or 5A fuse. Larger conductors would normally require 13A types, depending on the connection method used.

Any moulded mains connector that requires removal/replacement must be destroyed by removal of any fuse and fuse carrier and disposed of immediately, as a plug with bared wires is hazardous if engaged in a live socket. Any re-wiring must be carried out in accordance with the information detailed in this section.

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2. Product Outline

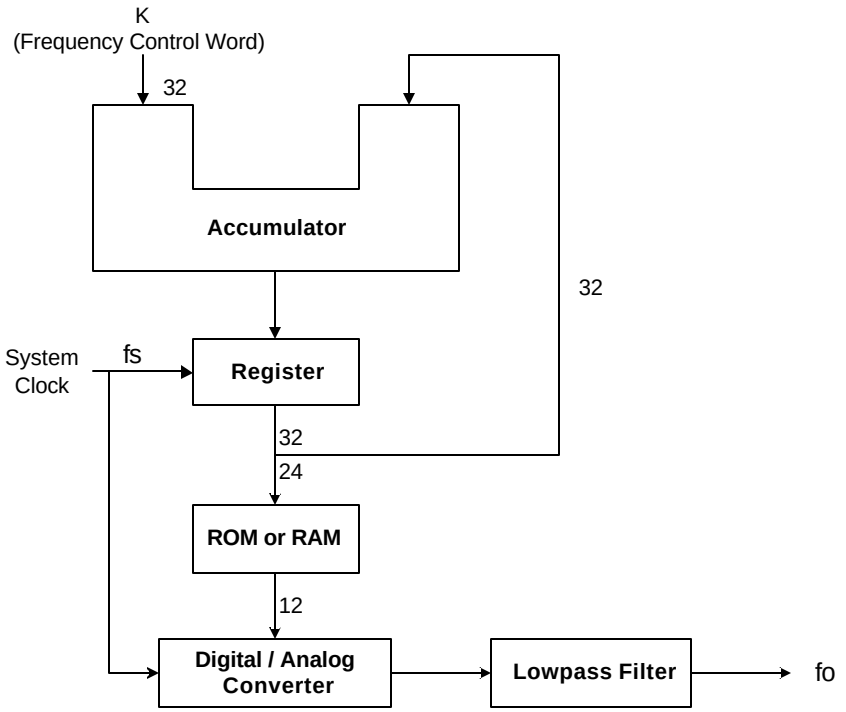
The frequency synthesis method applied by SFG-830 is Direct Digital Synthesis (DDS), a new technique that generates stable output frequency with extraordinary resolution.

Unlike SFG-830, traditional frequency synthesized function generators typically use Phase Locked Loop (PLL) techniques. In order to synthesize frequencies, PLL should be high-resolution (up to $1:10^6$ in general) and needs a stable frequency to be reference. Due to the utilization of dynamic loop filter, problems such as poor phase jitter and frequency switching response may occur when running the PLL system.

As in generating waveforms, PLL needs a wave-shaping circuit with an address counter that controlled by a variable frequency clock. The counter addresses memory locations in a waveform RAM, and the RAM output is converted by a high speed digital-to-analog converter (DAC) to produce an analog output signal. Problems like poor phase jitter and transient response may arise here as well.

Although DDS also generates analogue waveforms by way of the waveform RAM and high speed DAC, it does not have the problems as PLL does due to the use of fixed frequency clock (fs). Besides, the resolution of DDS is higher than that of PLL's. DDS's resolution is $fs/2^k$ where the digit of the control frequency word (K), which is more than 32bits in general, decides the quality of it.

Graph1 indicates the fundamental construction of a DDS frequency synthesizer.



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A DDS frequency synthesizer consists of a phase accumulator, a lookout table (ROM or RAM), a Digital-to-Analog Converter (DAC), and a Lowpass Filter (LPF). The amount in a phase accumulator is controlled by the frequency control word (K), which will be added by 1 after each system clock cycle(=1/fs). The output of the accumulator is used to position the data in the Table ROM (or RAM). The digital data will then be converted into a smooth analog waveform after passing through the DAC and LPF.

3. Features

SFG-830 is a functional signal generator that applies DDS (Direct Digital Synthesis) technique and can generate frequencies at a resolution of 20mHz, with a high frequency accuracy of 10ppm. Its main signal source can generate waveforms of sine wave, square wave, triangle wave, ramp wave, and arbitrary wave.

✧ The output frequency range and resolution of each waveform are:

Waveforms	Frequency Range	Resolution
Sine wave, square wave	20mHz ~ 30MHz	20mHz
Triangle wave, ramp wave	100mHz ~ 100kHz	10mHz
Arbitrary wave	42.949600MHz/N, where N=8,10,12,…,2^{15}	

✧ The depth of AM modulation : 0% ~ 100%

✧ Sweep range : 10mHz ~ 1kHz

✧ With FM and PSK modulation functions, and the users can choose the modulation signal source among sine wave, square wave, triangle wave, ramp wave, and arbitrary wave with modulation frequency up to 10kHz.

✧ The digital modulation and sweep functions provide you a stable and high-resolution (10mHz) modulation environment.

✧ SFG-830 has complete environment of computer interface, including standard RS232 and optional GPIB, to fulfill your requirement of automatic test and control.

✧ The arbitrary waveform function offers 12000×12bits data length for free compiling. The user can compile not only with keys on the front panel, but also through a compiling software “Arbitrary Waveform Composer Software for Windows” (optional).

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4. Specifications

Output Function	Sine, Triangle, Ramp, Square, Sync Output, Arbitrary	
Frequency Range	Sine	20mHz ~ 30MHz
	Square	20mHz ~ 30MHz
	Triangle	100mHz ~ 100kHz
	Ramp	10mHz ~ 100kHz
Frequency Resolution	Sine / Square	20mHz
	Triangle / Ramp	10mHz
Frequency Accuracy	± 10 ppm	
Frequency Aging	± 5 ppm / year	
Output Impedance	Source Impedance	50Ω ± 10%
Amplitude	Range	10mV~10Vp-p (into 50Ω) 8 amplitude ranges | Vac peak | + | Vdc | < 5V
	Resolution	3 digits
	Accuracy	± 0.5dB (Sine out) ± 12% (Square out) ± 5% (Triangle out) ± 5% (Arbitrary out)
DC Offset	Range	± 5V (into 50Ω) | Vac peak | + | Vdc | < 5V
	Resolution	3 digits
	Accuracy	± 1.5% of setting + 1mV
Sync Output	Sync Output	TTL levels
	Sync Fan-out	> 10 TTL load
Sine Output	Harmonics	DC ~ 100kHz : -50dBc 0.1MHz ~ 1MHz : -40dBc 1MHz ~ 10MHz : -30dBc 10MHz ~ 30MHz : -25dBc
Square Output	Rise / Fall Time	≤ 15ns
	Overshoot	≤ 5% (at full scale output)
	Asymmetry	± 1% of period + 4ns
Triangle and Ramp	Linearity	± 0.1% of full scale output

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Arbitrary Waveforms	Sample Rate	42.949600MHz/N, N=8, 10, 12,…2^{15}
	Waveform Length	12,000 points max.
	Vertical Resolution	12 bits
Sweep	Sweep Function	Line or Log
	Sweep Range	20mHz ~ 30MHz
	Sweep Time	0.01S ~ 1000S
Modulation	AM Modulation Function	External, Internal (sine, triangle, ramp, square)
	Modulation Rate	10mHz ~ 10kHz (Internal) 50kHz (max. external)
	Modulation Span	0 ~ 100%
	Ext. Input	±5V for 100% modulation
	Ext. Input Impedance	100 kΩ
	FM Function	Sine, Triangle, Ramp, Square
	Modulation Rate	10mHz ~ 10kHz
	Modulation Span	30mHz (100kHz for triangle, ramp)
	PSK Span	360 degrees
	Modulation Rate	20Hz ~ 10kHz
Interface	RS232 GPIB interface (optional) Arbitrary waveform composer software for Windows(optional)	
Accessories	GTL-101 × 1, Instruction Manual × 1	
Power Source	100/120/220/ 240V AC ±10%, 50/60Hz	
Dimensions	214 (W) × 89 (H) × 370 (D) mm	
Weight	Approx. 5kg	

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5. Front and Rear Panels

Front Panel

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(1) POWER button	:	Push in the button, then the power will be supplied and the display will light up. The power is off when push the button again to the flat position.
(2) UNIT keys	:	In 'Normal' mode, these keys are used to assign the unit and to set the entered value. For example, you can use dBm, Vrms, and Vpp to set the output amplitude. They can be used to set frequency (MHz, kHz, Hz), OFFSET, PHASE, etc. In STOR or RECL modes, they are used as 'Enter'.
(3) SHIFT key	:	Press this key to set the shift mode, and the SHIFT LED will light up. For example, press [SHIFT] + [DEFAU] can recall the default value of this instrument.
(4) ENTRY keys	:	[0] ~ [9], [.], and [±] keys are used to input value. A unit key should be pressed to set the entered value. [CLR] key is used to delete the entered value entirely and bring back the previous value. [STOR] key stores the settings into memory. [RECL] key recalls the system settings from memory.
(5) SWEEP/ MODULATE keys	:	These keys control the functions of sweep and modulation. [◀] and [▶] keys select the carrier waveform. [AM], [FM], and [PM] keys set the mode of modulation. [LIN] and [LOG] keys set the sweep method. [MOD ON/OFF] initiates sweep or modulation function. As to the functions of [STAR], [STOP], [SPAN], and [RATE] keys, please refer to the instruction in Chapter 6.
(6) MODIFY keys	:	These keys set the size and the increasing or decreasing mode of steps.
(7) FUNCTION keys	:	These keys controls the output functions. [◀] and [▶] keys select the output signal from arbitrary wave (ARB), sine wave, triangle wave, etc. [FREQ] key sets the frequency of output. [AMPL] key sets the amplitude of output. [OFFSET] key sets the DC level of output. [PHASE] key sets the phase in PSK modulation mode.
(8) MAIN OUTPUT BNC	:	This is the BNC connector that outputs all main signals. Output resistance is 50Ω.
(9) SYNC OUTPUT BNC	:	This is the synchronous output BNC connector that outputs a TTL-level signal.
(10) Interface LEDs	:	These LEDs indicate the current status when operating with the GPIB interface bus.
(11) Parameter display	:	This 11-digit display presents the parameter values and information about the current status.
(12) Unit/Function LEDs	:	These LEDs indicate the unit of the figures on display and the functions that are currently being used.

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Rear Panel

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① Power Entry model	:	This is the AC power input terminal. AC input should be within the range of line voltage±10%, 50/60Hz.
② Sweep/Modulation output	:	This terminal outputs the modulated waveform that is synchronous with the Sweep / Modulation function of this instrument.
③ EXT AM Input	:	This is the BNC connector for amplitude modulation input. The modulation index is 100% when±5 is input. The input resistance is 100kΩ.
④ GPIB connector	:	The optional GPIB (IEEE488.2 and SCPI) communication interface should be plugged here.
⑤ RS232 connector	:	This is the port of serial RS232 interface. The DCE and Buadrate is among 300 ~ 19.2k.

6. Operation

6.1 The Setup of Output Function

Use the two buttons [◀] or [▶] in the FUNCTION column on front panel to select an output waveform. Available waveforms are arranged in sequence SINE, SQU, TRIG, RAMP, and ARB (from left to right).

6.2 The Setup of Frequency

❶ Press [FREQ] button.
❷ Key in the desired value of frequency.
❸ Select a proper unit-button to specify the value.

Example: To set frequency at 250Hz, press [FREQ] first; then key in [2], [5], [0], and press [Hz].

The frequency range of waves:

Sine	0.02Hz	~	30MHz
Square	0.02Hz	~	30MHz
Triangle	0.1Hz	~	100kHz
RAMP	0.1Hz	~	100kHz
ARB	42.949600MHz/N, N=8, 10,12,…2^{15}		

6.3 The Setup of Amplitude

❶ Press [AMPL] button.
❷ Key in the desired value of amplitude.
❸ Select a proper unit-button to specify the value.

Example: To set amplitude at 5Vpp, press [AMPL] first, then key in [5] and press [Vpp].

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6.4 The Setup of Offset

❶ Press [OFFSET] button.
❷ Key in the desired value of offset.
❸ Select a proper unit-button to specify the value.

Example: To set offset at 1.2Vpp, press [OFFSET] first, then key in [1], [.], [2], and press [Vpp].

The limitations of input : (1) Amplitude should be among 0.01 ~ 10Vpp.
(2) Offset should be among ±5Vpp.
(3) AMPL + 2 × OFFSET ≤ 10Vpp.

6.5 The Setup of Arbitrary-Wave Compiler

This section explains the compiling procedure of arbitrary waveform by using buttons on the front panel. The detailed example of delivering data through optional GPIB will be stated in the chapter of communication interface.

❶ Set the output function to be "ARB" as stated in section 6.1.
❷ Press [FREQ] and the display will show the reading frequency of ARB function (range 42.9496MHz/N, where N=8, 10, 12,…2^{15}).
❸ Press [SHIFT] [ARB] to start arbitrary-wave compilation. There will be two set of figures on the display, the left one indicates the number of a certain point, and the right one represents the value of that point.
❹ Use [▲] or [▼] buttons in the MODIFY column to check out the value of the previous or the next point.
❺ To edit value of a point, press [SHIFT] + [▲]; key in numbers, and select a proper unit-button to specify new value of the point.

Note: [SHIFT] and [▲] buttons are used together for switching the blinking state between the number and the value of a point. Following the order of arranged points to compile arbitrary-wave is necessary.

Example of Compiling Arbitrary-Wave

The following example will guide you to proceed the compilation of arbitrary-wave. Here, 8 points (values are identified as 0, 400, 800, 1200, 0, 0, 0, 0 in an order) will be compiled. The changes of waveform will be observed via an oscilloscope.

Procedure :

❶ Use [◄] or [►] buttons in FUNCTION column to select [ARB] waveform.
❷ Press [SHIFT] and [ARB].
↳ The display will show "arb edit" for a while then shows "0001 2047", which indicates that you are in the compiling mode and the value of the first point is 2047. The number "0001" will be blinking.

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❸ Press [SHIFT] and [▲] to make the right-hand figures "2047" blinking; then key in [0] and press [Hz] to change the value of the first point from 2047 to 0.

❹ Press [SHIFT] and [▲] again to make the left-hand figures "0001" blinking.

❺ Press [▲] to compile the second point.

↳ The display will show "0002 -2047", which indicates the value of the second point is -2047. The number "0002" is blinking.

❻ Press [SHIFT] and [▲] to make "-2047" blinking; then key in [4], [0], [0], and press [Hz] to change the value of the second point from -2047 to 400.

❼ Repeat step ❹ to ❻ to complete the compilation of other points.

❽ Press [FREQ] and set the reading frequency according to the frequency setting procedure.

The limitations of input:

(1) Compiling points: up to 12000 points
(2) Compiling value : -2047 ~ +2047
(3) Reading frequency : 42.949600MHz/N, where N=8, 10, 12…2^{15}

6.6 Deleting the Data of Arbitrary Wave

❶ Press [SHIFT] and [ARB].

↳ The display will show "arb edit", then shifts to compiling mode.

❷ Press [SHIFT] and [ARB] again.

↳ The display will show "clr arb fnc", then shifts to the mode of deleting arbitrary wave.

❸ Press any unit-button.

↳ The display will show "a rb cleared" for a few seconds, then shows "clr arb fnc", which indicates that all the data of the arbitrary wave have been deleted.

❹ Press [SHIFT] and [ARB] to compile again.

6.7 The Setting of STOR Button

The STOR button is used to save the setup parameters of the instrument into its memory; numbers can be selected from 0 to 9, i.e., up to 10 groups.

❶ Push [STOR] button.
❷ Key in a number from 0 to 9 to indicate the number .
❸ Press any button from [DEG/ %], [mHz/dBm], [kHz/Vrms], or [Hz /Vpp] to complete.

Example: To save a parameter to the RAM of group #5, press [STOR] first. Then key in [5] and press [Hz].

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6.8 The Setting of RECL Button

The RECL button can retrieve the parameters saved in the RAM.

❶ Push [RECL] button.

❷ Key in the number of the group that you want to retrieve the parameters from.

❸ Select a button from [DEG/ %], [mHz/dBm], [kHz/Vrms], or [Hz/Vpp] to complete.

Example: To recall a parameter from the memory of group #5, press [RECL] first. Then key in [5] and press [Hz].

6.9 The SHIFT Key and Function Keys

SHIFT button is used to enable the secondary function of certain function keys that with blue symbols printed above. The SHIFT LED will be on after pressing the [SHIFT] button. At this time, only the buttons with blue symbols are workable. To release the SHIFT function, press [SHIFT] again.

❖ The Secondary Functions

1.	[SHIFT] + [SWP CF]	Displays sweep center frequency.
2.	[SHIFT] + [DEFAU]	Gets back to the default status of SFG-830.
3.	[SHIFT] + [ARB]	Sets up arbitrary-wave compiler.
4.	[SHIFT] + [DATA]	Displays the last 256 byte of ASCII data received by SFG-830.
5.	[SHIFT] + [GPIB]	Sets up GPIB on/off status by using the arrows buttons in MODIFY column.
6.	[SHIFT] + [ADDR]	Sets up GPIB address (range from 0 to 30).
7.	[SHIFT] + [LOCAL]	Switches RMT status to LOCAL status.
8.	[SHIFT] + [RS232]	Sets up RS232 on/off status and its BAUD RATE.
9.	[SHIFT] + [▲]	Switches the blinking state between the number and the value of a point for inputting data while compiling the arbitrary wave.
10.	[SHIFT] + [▼]	Switches the blinking state between the number and the value of a point for inputting data while compiling the arbitrary wave.

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6.10 Setup of LIN or LOG Sweep

SFG-830 can adopt frequency to sweep its function output for triangle and ramp waves. The type of sweep can be set as linear or log sweep.

❶ Select a main waveform by [◁] or [▷] button in FUNCTION column.
❷ Set triangle or ramp sweep mode by [◁] or [▷] button in SWEEP / MODULATION column.
❸ Press [LIN S] or [LOG S] button.
❹ Press [RATE] to set up sweep RATE/TIME (range 0.001Hz ~ 1kHz).
❺ Press [STAR] and [STOP] buttons to set up the starting and ending sweep frequency. This can also be done by pressing [SWP CF] and [SPAN].
❻Press [MOD ON/OFF] to initiate sweeping.

Note: Please refer to the example in next page for the setup of LIN Sweep.

❖ *Example of the Setup of LIN Sweep*

To set the following conditions:

- Output function : sine.
- Sweep waveform : ramp.
- Start frequency : 1kHz.
- Stop frequency : 10kHz.
- Speed 1 second.

Procedure:

❶ Use [◁] or [▷] button in FUNCTION column to select SINE waveform.
❷ Then use [◁] or [▷] button in SWEEP/MODULATION column to select RAMP waveform.
❸ Press [LIN S] button.
❹ Press [RATE], [1], [Hz].
❺ Press [STAR], [1], [kHz] first; then press [STOP], [1], [0], [kHz].
❻ Press [MOD ON/OFF] to start sweeping.

❖ *Example of the Setup of LOG Sweep*

To set the following conditions:

- Output function : sine.
- Sweep waveform : ramp.
- Start frequency : 1kHz.
- Stop frequency : 10kHz.
- Speed 0.1 second.

Procedure:

❶ Use [◁] or [▷] button in FUNCTION column to select SINE waveform.
❷ Then use [◁] or [▷] button in SWEEP/MODULATION column to select RAMP waveform.
❸ Press [LOG S] button.
❹ Press [RATE], [1], [0], [Hz].
❺ Press [STAR], [1], [kHz] first; then press [STOP], [1], [0], [kHz].
❻ Press [MOD ON/OFF] to start sweeping.

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Note:

① Different sequence of the steps taken will not make any change on the execution and the result.

② The bandwidth [SPAN] = stop frequency - start frequency

③ The center frequency [SWP CF] = [(stop frequency + start frequency)/2]

④ The start frequency [STAR] = center frequency of the sweep - bandwidth/2

⑤ The stop frequency [STOP] = center frequency of the sweep + bandwidth/2

⑥ The start and stop frequencies can be freely set according to the preference of different users.

⑦ SFG-830 can output waveform that is synchronized with its sweep function. In the example of setting up LIN sweep, the Sweep/modulation output terminal on the rear panel will output the waveform of ramp/1Hz.

6.11 Setup of AM Modulation

The AM modulation function offers sine, square, triangle, ramp, and arbitrary signals with a frequency range of 0% ~ 100%.

❶ Select a waveform by [◁] or [▷] button in FUNCTION column.

❷ Use [◁] or [▷] button in SWEEP / MODULATION column to select a modulation signal from sine, square, triangle, ramp, or ARB.

❸ Press [AM] button.

❹ Press [RATE] to set up sweep RATE/TIME (range 0.001Hz ~ 10kHz).

❺ Press [SPAN] to set the Modulation Depth (range 100%).

❻ Press [MOD ON/OFF] to start performing modulation.

❖ *Example of the Setup of AM Modulation*

To set the following conditions:

- Modulation waveform : sine.
- Frequency : 10kHz.
- Modulation rate : 100%.
- Signal : sine/100Hz AM modulation.

Procedure:

❶ Use [◁] or [▷] button in FUNCTION column to select SINE waveform.
❷ Press [FREQ], [1], [0], [kHz] buttons to set the frequency of the wave.
❸ Then use [◁] or [▷] button in SWEEP/MODULATION column to select SINE waveform.
❹ Press [AM].
❺ Press [RATE], [1], [0], [0], [Hz].
❻ Press [SPAN], [1], [0], [0],[%] to set the modulation depth.
❼ Press [MOD ON/OFF] to start performing modulation.

Note:

① Different sequence of the steps taken will not make any change on the execution and the result.

② SFG-830 has both internal and external modulation functions.

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③ The input voltage of external modulation is -5V ~ +5V.
   * If the input voltage is between 0V ~ +5V, the AM modulation will be the common modulation.
   * If the input voltage is between -5V ~ +5V, the AM modulation will be double sideband suppressed carrier (DSBSC).

④ SFG-830 can output waveform that is synchronized with its AM modulation signal. In the above example, the Sweep/modulation output terminal on the rear panel will output the waveform of SINE/100Hz.

⑤ The compiling of arbitrary wave should be carried out via the communication interface. Please refer to Example 2 in section 6.16.

6.12 Setup of FM Modulation

The AM modulation function offers sine, square, triangle, ramp, and arbitrary signals.

❶ Select a waveform by [◁] or [▷] button in FUNCTION column.
❷ Use [◁] or [▷] button in SWEEP / MODULATION column to select a modulation signal from sine, square, triangle, ramp, or ARB.
❸ Press [FM] button.
❹ Press [RATE] to set up sweep RATE/TIME (range 0.001Hz ~ 10kHz).
❺ Press [SPAN] to set the Frequency Span (0.001Hz~30MHz for sine and square; 100kHz for triangle, ramp and arb).
❻ Press [MOD ON/OFF] to start performing modulation.

❖ ***Example of the Setup of FM modulation***

To set the following conditions:

- Main waveform : sine.
- Main frequency : 100kHz.
- Span : 10kHz
- Modulation signal : sine/1kHz FM modulation.

Procedure:

❶ Use [◁] or [▷] button in FUNCTION column to select SINE waveform.
❷ Press [FREQ], [1], [0], [0], [kHz] buttons to set the frequency of the wave.
❸ Use [◁] or [▷] button in SWEEP/MODULATION column to select SINE waveform.
❹ Press [FM].
❺ Press [RATE], [1], [kHz].
❻ Press [SPAN], [1], [0], [kHz] to set span.
❼ Press [MOD ON/OFF] to start performing modulation.

Note:

① Different sequence of the steps taken will not make any change on the execution and the result.

② SFG-830 can output waveform that is synchronized with its FM modulation signal. In the above example, the Sweep/modulation output terminal on the rear panel will output the waveform of SINE/1kHz.

③ The compiling of arbitrary wave should be carried out via the communication interface. Please refer to Example 3 in section 6.16.

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6.13 Setup of PM Modulation

SFG-830 use 256PSK (Phase Shift Keyin) to generate PM modulation.

❶ Use [◁] or [▷] button in FUNCTION column to select SINE waveform.
❷ Press [PM] button.
❸ Press [RATE] to set up sweep RATE/TIME (range 20Hz ~ 10kHz).
❹ Press [PHASE] to set Phase Span (range 0^o ~ 360^o).
❺ Press [MOD ON/OFF] to start performing modulation.

❖ ***Example of the Setup of PM Modulation***

To set the following conditions:

- Main waveform : sine.
- Frequency : 10kHz.
- Rate : 100Hz.
- Angle : 100^o PSK modulation.

Procedure:

❶ Use [◁] or [▷] button in FUNCTION column to select SINE waveform.
❷ Press [FREQ], [1], [0], [kHz] buttons to set the frequency of the wave.
❸ Press [PM].
❹ Press [RATE], [1], [0], [0], [kHz].
❺ Press [PHASE], [1], [0], [0], [DEG / %] to set the phase to be 100^o.
❻ Press [MOD ON/OFF] to start performing modulation.

Note: Different sequence of the steps taken will not make any change on the execution and the result.

6.14 The Commands of GPIB Serial Interface

This section explains the GPIB commands that applied by SFG-380. All the 69 commands, including 54 instrument commands, and 15 IEEE488.2 common commands, correspond to the SCPI syntax. The syntax, function, and parameter of all the commands are listed below. It is helpful for you to control the remote instrument through either GPIB or RS232.

Example:

ibwrt “ IDN ?”
ibwrt “ SOUR : FREQ : SYNT 1000”
ibwrt “ SOUR : FREQ : STAR 1000 ; : SOUR : FREQ : STOP 10000”
= ibwrt “ SOUR : FREQ : STAR 1000 ; STOP 10000”

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(1) Common Commands of IEEE488.2

Command	Function	Parameter
*CLS	Clear status command	Nil
*ESE	Standard event status enable command	Numerical data
*ESE?	Standard event status enable query	Nil
*ESR?	Standard event status register query	Nil
*IDN?	Identification query	Nil
*OPC	Operation complete command	Numerical data
*OPC?	Operation complete query	Nil
*RCL	Recall command	Integer among 0 ~ 9
*RST	Reset command	Nil
*SAV	Save command	Integer among 0 ~ 9
*SRE	Service request enable command	Numerical data
*SRE?	Service request enable query	Nil
*STB?	Read status byte query	Nil
*TST?	Self-test query	Nil
*WAI	Wait-to-continue command	Nil

Note：① The range of numerical data is 0 ~ 255.
② For more details, please refer to appendix 1.

(2) Commands of the Instrument

Command	Function	Parameter
SYSTem:ERR?	Check the type of error messages	Nil
SOURce:FUNCtion:SINusoid	Select sine waves	Nil
SOURce:FUNCtion:SQUare	Select square waves	Nil
SOURce:FUNCtion:TRIangle	Select triangle waves	Nil
SOURce:FUNCtion:RAMP	Select ramp waves	Nil
SOURce:FUNCtion:ARBitrary	Select arbitrary waves	Nil
SOURce:FUNCtion:WAVEform?	Check the present waveform	Nil
SOURce:FREQuency:SYNThesis	Set the frequency of syntheti c waves	Numeric data
SOURce:FREQuency:SYNThesis?	Check the frequency of synthetic waves	Nil

Commands of the Instrument (cont.)

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Command	Function	Parameter
SOURce:FREQuency:CENTer	Set center frequency of synthetic waves	Numeric data
SOURce:FREQuency:CENTer?	Check the center frequency of synthetic waves	Nil
SOURce:FREQuency:SPAN	Set span frequency of synthetic waves	Numeric data
SOURce:FREQuency:SPAN?	Check the span frequency of synthetic waves	Nil
SOURce:FREQuency:STARt	Set the value of the initial frequency	Numeric data
SOURce:FREQuency:STARt?	Check the value of the initial frequency	Nil
SOURce:FREQuency:STOP	Set the value of the ending frequency	Numeric data
SOURce:FREQuency:STOP?	Check the value of the ending frequency	Nil
SOURce:SWEep:SPACing	Set the method of sweep	LINear or LOG
SOURce:SWEep:SPACing?	Check the method of sweep	Nil
SOURce:MODulation:STATe	Enable modulation function	ON/OFF or 0/1
SOURce:MODulation:STATe?	Check if in modulation mode	Nil
SOURce:PHASe:ADJust	Set the data of phase	Numeric data
SOURce:PHASe:ADJust?	Check the data of phase	Nil
SOURce:AMPLitude:LEVel	Set the value of output amplitude	Numeric data
SOURce:AMPLitude:LEVel?	Check the value of output amplitude	Nil
SOURce:AMPLitude:STATe	Get in amplitude mode	ON/OFF or 0/1
SOURce:AMPLitude:STATe?	Check if in amplitude mode	Nil
SOURce:AMPLitude:UNIT	Set the unit of output amplitude	VPP, VRMS or DBM
SOURce:OFFSet:LEVel	Set the voltage of offset	Numeric data
SOURce:OFFSet:LEVel?	Check the voltage of offset	Nil
SOURce:OFFSet:STATe	Get in bias mode	On/OFF or 0/1
SOURce:OFFSet:STATe?	Check if in bias mode	Nil
SOURce:SWEep:RATE	Set the rate of modulation	Numeric data
SOURce:SWEep:RATE?	Check the rate of modulation	Nil
SOURce:FUNCtion:SOURce	Set the waveform of modulatio n	1,2,3,4,5
SOURce:FUNCtion:SOURce?	Check the waveform of modulation	Nil
SOURce:FUNCtion:AM:STATe	Set AM modulation	ON/OFF or 0/1
SOURce:FUNCtion:AM:STATe?	Check if in AM modulation	Nil

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Commands of the Instrument (cont.)

Command	Function	Parameter
SOURce:FUNCtion:FM:STATe	Set FM modulation	ON/OFF or 0/1
SOURce:FUNCtion:FM:STATe?	Check if in FM modulation	Nil
SOURce:FUNCtion:PM:STATe	Set PM modulation	ON/OFF or 0/1
SOURce:FUNCtion:PM:STATe?	Check if in PM modulation	Nil
SOURce:FUNCtion:AM:SOURce	Set the waveform of AM modulation	1,2,3,4,5
SOURce:FUNCtion:AM:SOURce?	Check the waveform of AM modulation	Nil
SOURce:FUNCtion:FM:SOURce	Set the waveform of FM modulation	1,2,3,4,5
SOURce:FUNCtion:FM:SOURce?	Check the waveform of FM modulation	Nil
SOURce:FUNCtion:PM:SOURce	Set the waveform of PM modulation	1,2,3,4,5
SOURce:FUNCtion:PM:SOURce?	Check the waveform of PM modulation	Nil
SOURce:FUNCtion:AM:DEPTh	Set the depth of AM modulation	Numeric data
SOURce:FUNCtion:AM:DEPTh?	Check the depth of AM modulation	Nil
SOURce:FUNCtion:LDWF	Set the point of arbitrary wave in carrier wave mode	Numeric data
SOURce:FUNCtion:AMOD	Set the point of arbitrary wave in audio frequency	Numeric data
SOURce:FUNCtion:FM:DEViation	Set the span of FM modulation	Numeric data
SOURce:FUNCtion:FM:DEViation?	Check the span of FM modulation	Nil

NOTE : ① All of the above commands correspond with the SCPI Standard.
② You can key in the whole line or just the capital letters of each command.
③ The numeric data should be within the suitable range of each command.
For example: The range of a synthetic wave is 0.01Hz ~ 30MHz.
④ Parameters ON and 0 mean that the input mode is on; OFF and 1 mean that the input mode is off.
⑤ The meaning of parameters 1 ~ 5 are: 1 : Sine wave
2 : Square wave
3 : Triangle wave
4 : Ramp wave
5 : Arbitrary wave

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6.15 Syntax and Commands:

This section provides an overview of the commands for the SFG-830 Synthesized Function Generator.

SCPI (Standard Commands for Programmable Instruments) is a standard created by an international consortium of the major manufacturers of test and measurement equipment. SCPI uses IEEE488.2 syntax to provide common commands for the identical functions of various programmable instruments.

The goal of SCPI is to reduce Automatic Test Equipment (ATE) program development time. SCPI provides a consistent programming environment for instrument control and data usage. This consistent programming environment is achieved by the use of defined program messages, instrument responses, and data formats across all SCPI instruments, regardless of manufacturer.

Syntax : **SYSTem:ERRor?**

The above command is used to check if the instrument is working correctly after the GPIB command has been sent out. SFG-830 provides error messages including command error, execution error, device-specific error, and query error. A error message contains an integer, denoting an error number, and associated descriptive text, e.g., (0, No error), (-100, Command error), etc. The four categories of error messages are listed below.

- **Command Error**

  An error number in the range [-199, -100] indicates that an IEEE488.2 syntax error has been detected by the instrument's parser. The occurrence of any error in this class shall cause the command error bit (bit5) in the event status register to be set.

Error Number	Error Description
-100	Command error
-102	Syntax error
-103	Invalid separator
-104	Data type error
-108	parameters not allowed
-109	Missing parameter
-113	Undefined header
-121	Invalid character in number
-123	Exponent too large
-124	Too many digits
-160	Block data error
-161	Invalid block data
-168	Block data not allowed
-171	Invalid expression

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Execution Error

An error number in the range [-299, -200] indicates that an IEEE488.2 syntax error has been detected by the instrument's execution control block. The occurrence of any error in this class shall cause the execution error bit (bit 5) in the event status register to be set.

Error Number	Error Description
-200	Execution error
-201	Invalid while in local
-222	Data out of range
-225	Out of memory
-240	Hardware error

Device-Specific Error

An error number in the range [-399, -300] indicates that he instrument has detected an error which is not a command error, a query error, or an execution error. The occurrence of any error in this class shall cause the device-specific error bit (bit 3) in the event status register to be set.

Error Number	Error Description
-311	Memory error
-313	Calibration memory lost
-314	Save / recall memory lost
-315	Configuration memory lost
-330	Self-test failed
-350	Queue overflow

Query Error

An error number in the range [-499, -400] indicates that the output queue control of the instrument has detected a problem with the message exchange protocol described in IEEE488.2. The occurrence of any error in this class shall cause the query error bit (bit 2) in the event status register to be set.

Error Number	Error Description
-410	Query INTERRUPTED
-420	Query UNTERMINATED
-430	Query DEADLOCKED

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6.16 The Examples of the Communication Interface Software

EXAMPLE 1 ：Send Arbitrary Waveforms

```
#include   <stdlib.h>
#include   <userint.h>
#include   <utility.h>
#include  <gpib.h>
#include   <ansi_c.h>
#include   <string.h>

int      sfg830
int      data[10000] ;

void     main( )
{
          char    cmd[10] ;
          int       i,j,number ;
          double     amp,cycle,phase ;
          double     wave[10000] ;

          if   (   (sfg830=ibfind( ˋdev8ˊ )   <0   )
          {
          printf ( ˋcannot find SFG830\nˊ ) ;
          exit(1) ;
          }

          number=1000 ;
          amp=2 ;
          phase=0 ;
          cycle=1 ;
          SinePattern(number,amp/2,phase,cycle,wave) ;

          for(j=0 ; j<munber ; j++)
          {
             wave[j]=4094*wave[j]/amp ;
             data[j]=(short)(wave[j]+0.5) ;
          }
          for(j=0 ; j<number ; j++)
          {
             if(data[j]<0)
             data[j]=(0xffff-data[j]+1)+0x8000 ;
          }

          sprintf(cmd, ˋSOUR：FUNC：LDWF   %d\nˊ ,number) ;
          ibwrt(dev_, cmd,strlen(cmd)) ;

          ibwrt(dev_,cmd,40) ;
          if(cmd[1]= =0x31)
          {
             ibtmo   (dev_,T30s) ;

             ibwrt(dev_,(char*)data,(1ong)2*number) ;    /* send waveforms data */
             sprintf(cmd, ˋSOUR：FUNC：ARB\nˊ ) ;
             ibwrt(dev_,cmd,strlen(cmd)) ;
          }
}
```


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EXAMPLE 2 : Arbitrary Amplitude Modulation

```
#include   <stdlib.h>
#include   <userint.h>
#include   <utility.h>
#include   <gpib.h>
#include   <ansi_c.h>
#include   <string.h>

int      sfg830
int      data[10000] ;

void     main( )
{
          char    cmd[40] ;
          int       i,j,number ;
          double     amp,cycle,phase ;
          double     wave[10000] ;

          if   (   (sfg830=ibfind( `dev8' )   <0   )
          {
          printf ( `cannot find SFG830\n' ) ;
          exit(1) ;
          }

          number=1000 ;
          amp=2 ;
          phase=0 ;
          cycle=1 ;
          SinePattern(number,amp/2,phase,cycle,wave) ;

          for(j=0 ; j<number ; j++)
          {
             wave[j]=2048+(1368*wave[j])
             data[j]=(int)     (wave[j]+0.5) ;
          }

          sprintf(cmd, `SOUR : FUNC : SOUR   5\n' ) ;
          ibwrt(dev_,cmd,strlen(cmd)) ;

          sprintf(cmd, `SOUR : FUNC : AMOD   %d\n' ,number) ;
          ibwrt(dev_,cmd,strlen(cmd)) ;

          ibrd(dev_,cmd,40) ;

          ibtmo (dev_, T30s) ;

          ibwrt(dev_,(char   *)data,(1ong)2*number) ;  /* send waveforms data */

          sprintf(cmd, `SOUR : MOD : STAT 1\n' ) ;
          ibwrt(dev_,cmd,strlen(cmd)) ;

}
```


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EXAMPLE 3 ： Arbitrary Frequency Modulation

```
#include   <stdlib.h>
#include   <userint.h>
#include   <utility.h>
#include   <gpib.h>
#include   <ansi_c.h>
#include   <string.h>
int      sfg830
int      data[10000] ;
void     main( )
{
          char    cmd[40] ;
          int      i,j,number ;
          double     amp,cycle,phase ;
          double     wave[10000] ;
          double     t,center,span,s ;
          if   (   (sfg830=ibfind( `dev8´ )   <0   )
          {
          printf ( `cannot find SFG830\n´ ) ;
          exit(1) ;
          }
          number=1000 ;
          amp=2 ;
          phase=0 ;
          cycle=1 ;
          SinePattern(number,amp/2,phase,cycle,wave) ;
          number=1000 ;
          amp=2 ;
          phase=0 ;
          cycle=1 ;
          sinepattern(number,amp/2,phase,cycle,wave) ;
          s=pow(2.0,32.0) ;
          center=10.0E3 ;
          span=10.0E3 ;
          for(i=0 ; i<number ; i++)
          {
          t=span/2.0*wave[i] ;
          t+=center ;
          t/=42.9496E6 ;
          data[i]=(1ong)s*t ;
          }
          sprintf(cmd, `SOUR：FUNC：SOUR   5\n´ ) ;
          ibwrt(dev_,cmd,strlen(cmd)) ;
          sprintf(cmd, `SOUR：FUNC：AMOD %d\n´ ,number) ;
          ibwrt(dev_,cmd,strlen(cmd)) ;
          ibrd(dev_,cmd,40) ;
          ibtmo   (dev_,T30s) ;
          ibwrt(dev_,(char*)data,(long)4*number) ;  /*send waveforms data*/
          sprintf(cmd, `SOUR：MOD：STAT 1\n´ ) ;
          ibwrt(dev_,cmd,strlen(cmd)) ;
}
```


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7. Adjustment and Correction

7.1 Preparation

❶ Preheat the instrument for more than 30 minutes.
❷ The operation temperature should be 23±5°C, and the humidity should be lower than PH80%.
❸ The voltage should be (a) ±15V±0.90V or (b) ±5V±0.25V.
❹ If the voltage is correct, then plug in Q2334, Q2520 and AD834.
❺ Press [Shift] [9] [8] [3] [0], then all the calibration values will be cleared.

7.2 Adjusting Clock

❶ Set Conditions: Function : Sine Wave Amplitude : 5Vp-p
Modulation : OFF Frequency : 10MHz
❷ Use Counter to measure the output.
❸ Adjust X202 until the frequency reaches the range of 10MHz ±20Hz.

7.3 Adjusting the DC of Frequency Double

❶ Set Conditions: Function : Sine Wave Amplitude : 10Vp-p
Frequency : 10kHz
❷ Use an oscilloscope at AC 100mV/DIV, 20us/DIV to measure U303 - Pin 1.
❸ Adjust SVR301 until a flat DC signal shows up.

7.4 Adjusting D/A Ref

❶ Set Conditions: Function : Sine Wave Amplitude : 10Vp-p
Modulation : OFF Frequency : 1kHz
❷ Use an oscilloscope with 50 ohm load to measure the output.
❸ Adjust SVR201 until the output becomes symmetric sine waves.

7.5 Adjusting the Bandwidth

❶ Set conditions: Function : Square Wave Amplitude : 8Vp-p
Modulation : OFF Frequency : 10kHz
❷ Use DMM at DCV range to measure U601-Pin6, and adjust SVR601 until the readout to be 0.0V.
❸ Set conditions : Frequency : 100Hz
❹ Use an oscilloscope at 2V/DIV, 5ms/DIV, with 50 ohm load to measure the output. Then adjust SVR604 until the output becomes flat square waves.
❺ Set condition : Frequency : 500kHz
❻ Use an oscilloscope at 2V/DIV, 1us/DIV, with 50 ohm load to measure the output. Then adjust SVR602 until the output becomes flat square waves.
❼ Set condition : Frequency : 500kHz
❽ Use an oscilloscope at 2V/DIV, 200ns/DIV with 50 ohm load to measure the output. Then adjust SVO601 to get the shortest rise time and the overshoot be <5%.

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7.6 Adjusting the Filter

❶ Press [Shift] + [DEFAU] keys
❷ Set conditions: Function : ARB Amplitude : 8Vp-p
Frequency : 2MHz (sampling frequency)
❸ Use a oscilloscope at 2V/DIV, 200ns/DIV with 50 ohm load to measure the output.
❹ Adjust SVC301, 302, 303, and 304 in turn to get the shortest rise time and the smallest peak to peak ripple.
❺ Repeat steps ❶~❹ once.

7.7 Adjusting Harmonic Distortion

❶ Set conditions: Function : Sine Wave Amplitude : 8Vp-p
Frequency : 15kHz
❷ Use a spectrum analyzer with 50 ohm load, start frequency at 0Hz and stop frequency at 15kHz, to measure the output.
❸ Adjust SVR501 until get the smallest second harmonic (20kHz).
❹ Repeat step ❶ and ❷.
❺ Adjust SVR603 until third harmonic (45kHz) and fifth harmonic (75kHz) achieve the same level.

NOTE : When use software in calibrating , these steps should be gone through after Callier Null calibration. Meanwhile, adjust SVR501 and SVR603 to minimize distortion.

7.8 Calibrating by Software

(A) Calling Default Calibration Data

❶ Press [Shift], [9], [8],[3], [0] keys.

↳ The display will indicate "default" for a few seconds, then shows 1000.00Hz. The calling of default calibration data is then finished.

(B) Manual Calibration

Basic Steps :
❶ Press [Shift], [0], [8], [3], [0] keys to shift to the manual calibration mode.

↳ The display will indicate "CAL EDIT" for a few seconds, then shows 00001 (blinking) and 1000. The figures on the left side represent the Calibration Number, and the right-hand figures are the corresponding Calibration Value. The blinking area is where you can input figures, and can be switched by pressing the [◁] and [▷] keys in FUNCTION column.

❷ Use [△] and [▽] keys in MODIFY column or press numeric keys [0]~[9] to input the desired value.

Example:

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i.) If the display shows "00001 1000" and 00001 blinks, it means that the Calibration Number is ready for input. Press FUNCTION [▷] key once, then 1000 becomes blinking and you can input the Calibration Value. Press FUNCTION [◁] key once, then 00001 will blink again.

ii.) Press [4], [0], [6] and [Enter] keys will get to the Square Wave Symmetry Calibration mode, and the Calibration Value is 2000. Press FUNCTION [▷] key once, and 2000 will be blinking. Just input the desired figures, then the symmetry of square wave will be changed.

The table below lists the corresponding Calibration Numbers to Calibration items:

Calibration Item	Calibration Number	Calibration Mode
Positive Attenuator Calibration	1 ~ 8	Manual Calibration
Negative Attenuator Calibration	9 ~ 16	
Carrier Null Calibration	17 ~ 113	
Amplitude of Sine Wave	114 ~ 307	
Amplitude of Square Wave	308 ~ 404	
Amplitude of Triangle Wave	405	
Symmetry of Square Wave	406 ~ 502	
Sine DC Gain Calibration	503	Auto Calibration
Square DC Gain Calibration	504	
Triangle DC Gain Calibration	505	
Offset Adjustment	506 ~ 602	

The procedure of manual calibrating with software is as follows:

(1) Positive Attenuator Calibration

To calibrate the positive attenuator, you should go through Calibration Number 1 ~ 8 in turn, and perform the following 3 steps for each number.

❶ Set the Calibration Number.

❷ Use a DMM (FLUKE-8842) at DCV range to measure the output.

❸ Key in an appropriate Calibration Value to make the output to be the particular value listed below:

❶ Calibration Number	❷ Use a DMM (FLUKE-8842) at DCV range to measure the output	❸ Output should be :
1		39 ± 0.1mV
2		78 ± 0.5mV
3		156 ± 1mV
4		312 ± 1mV
5		625 ± 2mV
6		1.25V ± 10mV
7		2.5V ± 10mV
8		5V ± 10mV

(2) Negative Attenuator Calibration

To calibrate the negative attenuator, you should go through Calibration Number 9 ~ 16 in turn, and perform the following 3 steps for each number.

❶ Set the Calibration Number.

❷ Use a DMM (FLUKE-8842) at DCV range to measure the output.

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❸ Key in an appropriate Calibration Value to make the output to be the particular value listed below:

❶ Calibration Number		❸ Output should be :
9	❷ Use a DMM (FLUKE-8842) at DCV range to measure the output	-39 ± 0.1mV
10		-78 ± 0.5mV
11		-156 ± 1mV
12		-312 ± 1mV
13		-625 ± 2mV
14		-1.25V ± 10mV
15		-2.5V ± 10mV
16		-5V ± 10mV

(3) Carrier Null Calibration

❶ Set the Calibration Number to 17.
❷ Use a distortion meter (DM-155 A/B) to measure the output.
❸ Key in an appropriate calibration value to minimize the distortion.
Then go through step ❹~❼ repeatedly to calibrate the output of Number 18 ~ 113.
❹ Set the Calibration Number (18 ~ 113, one number each time).
❺ Use a spectrum analyzer to measure the output.
❻ Set the Center Frequency of the spectrum analyzer to be X, where $X = (Calibration\ Number - 17) \times 312500 + 1000$.
❼ Key in an appropriate Calibration Value to minimize the power of frequency Y, where $Y = \frac{X}{2}$.

(4) Calibrating the Amplitude of Sine Wave

❶ Set the Calibration Number 114 ~ 115 (one number each time).
❷ Use a DMM (FLUKE-8842) at ACV range with 50 ohm load to measure the output.
❸ Input an appropriate Calibration Value until the output to be the corresponding figures as listed in the table below.
Then go through step ❹~❻ repeatedly to calibrate the output of Number 116~307.
❹ Set the Calibration Number 116 ~ 307 (one number each time).
❺ Use a measuring receiver (HP-8902A) at ACV range to measure the output.
❻ Input an appropriate Calibration Value to make the output to be as follows:

Calibration Number 114~307	Output Voltage
odd	1.77 ± 0.005Vrms
even	3.54 ± 0.01Vrms

(5) Calibrating the Amplitude of Square Wave

Go through step ❶~❸ repeatedly to calibrate the output of Number 308 ~ 404.
❶ Set the Calibration Number.
❷ Use an oscilloscope with 50 ohm load to measure the output.
❸ Input an appropriate Calibration Value to make the output to be 10±1Vp-p.

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(6) Calibrating the Amplitude of Triangle Wave

❶ Set the Calibration Number to be 405.
❷ Use an oscilloscope at 50Ω to measure the output.
❸ Input an appropriate Calibration Value to make the output to be 10±1Vp-p.

(7) Calibrating the Symmetry of Square Wave

Go through step ❶~❸ *repeatedly to calibrate the output of Number 406 ~ 502.*

❶ Set the Calibration Number.
❷ Use a fixture with 50Ω to measure the output.
❻ Input an appropriate Calibration Value to make the output to be as follows:

Calibration Number	Duty
406 ~ 437	50% ± 1% + 4ns
438 ~ 460	48%
461 ~ 486	45%
487 ~ 502	40%

(8) Finishing Manual Calibration

❶ Press [STOR] key.

↳ "Default" will be shown on the display after 3 seconds.

(C) Automatic Calibration

❶ Press [Shift], [1], [8], [3], [0] keys to shift to automatic calibration mode.

↳ In a few minutes "Auto Cal" will be shown on the display, indicates the accomplishment of automatic calibration.

The table below lists the corresponding items to the Calibration Numbers:

Calibration Item	Calibration Number
Sine DC Gain	503
Square DC Gain	504
Triangle DC Gain	505
Adjusting DOB U	506 ~ 602

All of the calibrating procedure is accomplished after the automatic calibration.

7.9 Checking Frequency Accuracy

The deviation should be within ±5ppm.

❶ Set conditions: Function : Sine Wave Amplitude : 1Vp-p
Frequency : 10MHz

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❷ Use a counter with 50 ohm load to measure the output.
❸ Check and make sure the output is 10MHz± 40Hz.

7.10 Checking the Amplitude

(1) Check the Amplitude of Sine Wave

The deviation should be ±0.5dB (±5.9%).

❶ Set conditions: Function : Sine Wave **Amplitude : 3.54Vrms (10Vp-p)**
Frequency : 100Hz
❷ Use a DMM (FLUKE-8842) at ACV range with 50 ohm load to measure the output.
❸ Check and make sure that ***3.33Vrms < output < 3.74Vrms***.
❹ Keep the same Function and Amplitude, and set Frequency to be 1kHz, 10kHz, 100kHz, 1MHz, and 2 ~ 30MHz (step 2MHz) in turn.
❺ Perform step ❷~❹ (use measuring receiver HP-8902 instead) in each frequency setting until the Frequency = 30MHz.
❻ Set conditions: Function : Sine Wave **Amplitude : 1Vrms**
Frequency : 100Hz
❼ Use a DMM (FLUKE-8842) at ACV range with 50 ohm load to measure the output.
❽ Check and make sure that ***0.94Vrms < output < 1.04Vrms***.
❾ Keep the same Function and Amplitude, and set Frequency to be 1kHz, 10kHz, 100kHz, 1MHz, and 2 ~ 30MHz (step 2MHz) in turn.
❿ Perform step ❼~❾ (use measuring receiver HP-8902 instead) in each frequency setting until the Frequency = 30MHz.

(2) Checking the Amplitude of Square Wave

The deviation should be ±12%.

❶ Set conditions: Function : Square Wave Amplitude : 10Vp-p
Frequency : 100Hz
❷ Use an oscilloscope with 50 ohm load to measure the output.
❸ Check and make sure that ***8.8Vp-p < output < 11.2Vp-p***.
❹ Keep the same Function and Amplitude, and set Frequency to be 1kHz, 10kHz, 100kHz, 1MHz, and 2 ~ 30MHz (step 2MHz) in turn.
❺ Perform step ❸~❹ in each frequency setting until the Frequency = 30MHz.

(3) Checking the Amplitude of Triangle Wave

The deviation should be ±5%.

❶ Set conditions: Function : Triangle Wave Amplitude : 10Vp-p
Frequency : 100Hz
❷ Use an oscilloscope with 50 ohm load to measure the output.

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❸ Check and make sure that ***9.5Vp-p < output < 10.5Vp-p***.
❹ Keep the same Function and Amplitude, and set Frequency to be 1kHz, 10kHz, and 100kHz in turn.
❺ Perform step ❸~❹ in each frequency setting until the Frequency = 100kHz.

(4) Check the Accuracy of DC Offset

The deviation should be ±1.5% + 1mV.

❶ Set conditions: Function : Sine Wave Amplitude : 0.0Vp-p
Frequency : 1kHz DC Offset : 5V, -5V, 0V in turn
❷ Use a DMM at DCV range with 50 ohm load to measure the output.
❸ Check and make sure the corresponding output to each DC Offset is in the range listed below:

DC Offset	Output
5V	4.925V ≤ output ≤ 5.075V
-5V	-5.075V ≤ output ≤ -4.925V
0V	-1mV ≤ output ≤ +1mV.

(5) Checking the Sub Harmonic

The deviation should be <-50dBC.

❶ Set conditions: Function : Sine Wave Amplitude : 10Vp-p
DC Offset : 0V
❷ Use a spectrum analyzer to measure the output.
❸ Check and make sure that the corresponding output to each Frequency setting is in the range listed below:

Frequency	Center Frequency of Spectrum Analyzer	Harmonic
102kHz	51kHz	< -26.02dBm
1.001MHz	501kHz	
10.001MHz	5.001MHz	
20.001mHz	10.001MHz	
30.0mHz	15.0mHz	

(6) Checking the Harmonic Distortion

The deviation should be :

Deviation	Frequency
< -50dBC	< 100kHz
< -40dBC	0.1 ~ 1MHz
< -30dBC	1 ~ 10MHz
< -25dBC	10 ~ 30MHz

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❶ Set conditions: Function : Sine Wave Amplitude : 1Vp-p
Frequency : 100Hz
❷ Use a distortion meter (DM-155A/B) with 50 ohm load to measure the output.
❸ Check and make sure that the output should be ***< -50dBC (0.31%)***.
❹ Set the Frequency to be 1kHz, 10kHz, 50kHz, and 100kHz in turn.
❺ Perform step ❸ and ❹ until the Frequency = 100kHz.
❻ Use a spectrum analyzer to measure the output.
❼ Check and make sure that the corresponding output to each Frequency setting is in the range listed below:

Frequency	Output
500kHz	< -40dBC
5MHz	< -30dBC
15MHz	< -25dBC
30MHz	< -25dBC

(7) Checking the Phase Noise

The deviation should be <-50dBC.
❶ Set conditions: Function : Sine Wave Amplitude : 13dBm
Frequency : 10MHz
❷ Use a spectrum analyzer to measure the output.
❸ Check and make sure that the difference between the powers of 10MHz and 10MHz+15kHz is less than 50dBC.

(8) Checking the Rise Time of Squire Wave

The deviation should be : Rise Time < 15ns and Overshoot < 5% at full scale output.
❶ Set conditions: Function : Square Wave Amplitude : 10Vp-p
Frequency : 1MHz
❷ Use an oscilloscope with 50 ohm load to measure the output.
❸ Check and make sure that the Rise Time < 15ns and
the Overshoot / Undershoot < 500mVp-p.

(9) Checking the Symmetry of Square Wave

The deviation should be < ±1% of period +4ns.
❶ Set conditions: Function : Square Wave Amplitude : 15Vp-p
Frequency : 1MHz
❷ Use an oscilloscope with 50 ohm load to measure the output.
❸ Check and make sure that the output is 49:51 or 51:49.

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(10) Checking the AM Envelop Distortion

The deviation should be < -35dB at 1kHz.

❶ Use a spectrum analyzer, with Center Frequency at 1MHz and Span Frequency at 20kHz, to measure the output.

❷ Check and make sure that the differences between powers of Basic Wave and sidebands (2k, 3k, …, Offset) are less than 35dB.

8. The Block Diagram and Description of the System

Graph 2 is the block diagram of SFG-830 system, which consists of a micro processor unit (MPU), a direct digital synthesizer (DDS), a digital to analog converter (DAC), a RAM module, a low pass filter (LPF), a frequency double (F.D.), a square waveform comparator, a amplitude control, an output amplitude, an attenuator (ATT), etc. The principles of generating waveforms are stayed as follows:

(1) Sine Waveform

The data of waveform is stored in the lookout table of DDS (Q-2334). The output frequency can be altered by solely changing the control word K (please refer to Chapter 2). The digital output passes the DAC and be converted to a step-shape analog signal. This signal will then be filtered by a 9-level LPF2, and becomes a pure sine wave. Due to the frequency response of DDS and the points of the output waveform, the sine wave should pass the F.D. circuit (U301 and AD834), the amplitude control, the output amplitude, ATT, and output through the Main Out terminal.

(2) Square Waveform

The procedure of generating square waveforms is similar to that of generating sine waveforms. The only difference is that the signal will pass a square wave comparator circuit between the F.D. circuit and the amplitude control.

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(3) Triangle Waveform

When the user input a frequency, the MPU will calculate the correspondent data then save it in RAM(II) (U211-U213), and save the number of the data in the Up/Down Counter (U215-U218) 74F193. As the Up/Down counter is controlled by the B11 in DDS1 through 74F193 CLK Input, the desired frequency value can be obtained by changing the counter's reading frequency, i.e., the frequency of CLK. The output frequency of triangle waveform is lower that that of sine waveform and square waveform due to the different paths. The triangle wave passes a 7-level LPF1 and does not go through F.D.

(4) Ramp

The procedure of generating ramp is the same as that of generating triangle waveforms.

(5) AM Modulation

This includes internal modulation and external modulation with the same operation procedure. Take internal modulation for example, the input data will be calculated by MPU and be written in RAM(III) (8k×8); the Up/Down Counter will then read out the data in RAM and send it to the Amplitude Control (U501, AD834) via DAC. Different input voltages can change the output voltages of Amplitude Control, thus achieve the modulation effect.

(6) Sweep

(a) Sine wave and Square wave:

As to the sine wave sweep, the input data will be calculated by MPU and be written in RAM(I) (8k×8); DDS2 will then send a fixed frequency to read the sweep data from RAM(I), and send it to DDS1 through the Bus Selector. The digital sine wave signal generated from DDS1 will pass DAC, 9-level LPF, F.D., Amplitude Control, Output Amplitude, ATT, then output via DUT.

The procedure of square wave sweep is similar to the above one, except that the digital signal generated from DDS1 passes a Square Waveform Comparator between the F.D. and Amplitude Control.

(b) Triangle wave and Ramp:

The input data will be calculated by MPU and be written in RAM(II); DDS1 will then send a B11 control frequency to read the sweep data from RAM(II). Afterwards, the signal will pass the Bus Selector, DAC, 7-level LPF, Amplitude Control, Output Amplitude, ATT, then output via OUT BNC.

(7) FM Modulation

The principle of FM modulation is the same as that of Sweep, except that the data stored in RAM (I) is relevant to FM modulation.

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Appendix 1 Commands of IEEE488.2

＊IDN？	Identification Query

- After receipt of this query the instrument generates response message as below：
- The response consists of the following four fields：
  —Manufacture
  —Model
  —Serial Number (return 0 if not available)
  —firmware Revision (return 0 if not available)
- The fields are separated by commas.
- Example：GW.Inc,SFG-830,Serial number 1111-000-90,1.0.

＊RST	Reset Command

- The command performs a device reset which sets the instrument to a defined status as bellow：

modulation	OFF	frequency	1KHz
waveform	sine	amplitude	1V
DC-offset	OV		

- The reset command shall not affect the following：
  —The state of the IEEE 488.1 interface
  —The selected IEEE 488.1 address of the device
  —The Output Queue
  —The Service Request Enable Register.
  —The Standard Event Status Enable Register
  —Calibration data

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＊TST？	Selftest Query

- Cause an instrument to execute an internal self-test and returns a response showing the results of the self-test.
- A zero response indicates that self-test passed.
- A value other than zero indicates a self-test failure or error.
- The response syntax for the self-test query id defined as bellow：

0	Self-test has completed without errors detected.
1	CPU Error. The device has detected a problem in its CPU.
2	Sys RAM Error. The system RAM failed its test.
3	Code Error. The device ROM firmware has a checksum error.
4	8279 Error
5	A/D or D/A Error

＊WAI	Wait-to-Continue Command

- Prevents an instrument from executing another command until the operation caused by previous command is finished (sequential operation).

＊OPC	Operation Complete Command

- Sets bit 0 (Operation Complete Message) in the Standard Event Register when all pending instrument operations are finished.

＊OPC？	Operation Complete Query

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- Place an ASCII character 1 into the instrument‘s output queue when all pending instrument operations are finished.

＊CLS	Clear Status Command

- This command clears status data structures. On the other hand, it sets the bits of the ‘Standard Event Register’ and the ‘Status Byte Register’ to zero.
- The Output Queue and the MAV bit will not be cleared.

＊ESE	Standard Event Status Enable Command

- ＊ESE, followed by a decimal value, sets the bits of the ‘Standard Event Status Enable Register’ which correspond to that decimal value to 1. This enables the assigned bits of the ‘Standard Event Status Register’ .

＊ESE？	Standard Event Status Enable Query

- This query asks for the contents of the ‘Standard Event Status Event Register’ .The response is a decimal value, e.g., ‘255’ means all events of the ‘Standard Event Status Register’ are enabled, in other word, all bits are 1.

＊ESR？	Standard Event Status Register Query

- Ask for the contents of the ‘Standard Event Status Register’ . The response is a decimal value. The query clears the register contents.

＊SRE	Service Request Enable Command

- ＊ESE, followed by a decimal value, sets the bits of the ‘Service

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Request Enable Register' which correspond to that decimal value to 1, except bit 6. For all bits except bit 6, a bit value of one shall indicate an enabled condition. The bit value of one indicates a disabled condition. The bit value of bit 6 shall be ignored.

∗SRE ?	Service Request Enable Query

- Asks for the contents of the `Service Request Enable Register' . The response is a decimal value.

∗STB ?	Read Status Byte Query

- Asks for the contents of the `Status Byte Register' . The response is a decimal value.

∗SAV	Save Command

- This command followed by a decimal value stores the current instrument setting into the corresponding memory place. The contents of the memory is not affected by the command ∗RST or when POWER OFF the instrument.

∗RCL	Recall Command

- This command followed by a decimal value for the memory place call up and executes the instruments settings stored in that memory place.

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STATUS BYTE DEFINTIONS：

STB		Serial Poll Status Byte
0	Sweep Done	set when no sweeps are in progress
1	Mod Enable	set when modulation is enabled
2	not used	
3	not used	
4	MAV	The GPIB output queue is non-empty.
5	ESB	An unmasked bit in the ESE byte has been set.
6	RQS/MSS	SRQ (Service Request) bit.
7	ERRBIT	The GPIB command has error occurred.

ESR		Standard Event Status Byte
0	OPCOL	Operation complete.
1	RSQCTL	Request control.
2	QUEERR	Query error.
3	DDERR	Device dependent error.
4	EXUERR	Execution error.
5	CMDERR	Command error.
6	URSQ	User request.
7	PON	Set by power on.

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