USER MANUAL

31 MHz Synthesized Function Generator

Protek 9301 (1CH) / 9302 (2CH)

31MHz Synthesized Function Generator

Protek

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2. Line Voltage Check

The range of operating voltage used for this equipment refers to the following table. Before switching on you should always check the line voltage, and ensure to use within the range of operating voltage. In the case of general shipping, the voltage of this product is set to AC 220V. When using on other voltage, you can change it with Power and Voltage Selecting Switch.

NOMINAL	Operating Voltage Ranges	FUSE
AC 100 V	**AC 90 V ~ 110 V**	**250 V T2AL**
AC 120 V	**AC 108 V ~ 132 V**	
AC 220 V	**AC 198 V ~ 242 V**	**250 V T1AL**
AC 230 V	**AC 207 V ~ 253 V**	

Methods to convert power and voltage are as follows:

1) Remove power cable in AC Inlet.
2) Insert a minus (-) driver into the left slot of a cap of the fuse holder, and then push into the right to remove the cap.
3) Set Voltage Selecting Switch to the required voltage, and then insert Voltage Selection Switch with the voltage mark upside.
4) Insert a cap into the fuse holder and press it to complete assembly.
5) Insert power cable into AC Inlet.

When you want to set voltage to below AC 120V, please contact nearby agencies or sales offices since it is necessary to change the power cable and fuse. After using, disconnect power cable from AC Inlet to keep it.

⚠ **Be sure to use the prescribed part for the fuse.**

To avoid that over current damages a circuit, be sure to use proper rating fuses. The rating fuses are follows:

(Size) (Diameter x Length) mm	Type	Note
5.0 Ø x 20	**250 V T2AL**	**AC 98V - 132V**
	250 V T1AL	**AC 196V - 253V**

When parts other than the specified parts are used, it may dangerous as well as cause breakdowns. For that reason, never use them. If this fuse is short-circuited, check the cause, and when any damaged thing is detected, exchange it into the prescribed fuse after repairing it.

Safety Terms and Symbols

These terms are applicable only to this manual.

WARNING

Warning statements identify conditions or practices that could result in injury or loss of life.

CAUTION

Caution statements identify conditions or practices that could result in damage to this Product or other property.

NOTICE

Notice statements identify conditions that could result in incorrect test data from a device.

NO.	SYMBOL	DESCRIPTIONS	NO.	SYMBOL	DESCRIPTIONS
1		Alternating Current	5		ON (SUPPLY)
2		Caution (Refer to accompanying documents)	6		OFF (SUPPLY)
3		Protective Conductor Terminal	7		In-position of a bistable push control
4		Frame or Chassis Terminal	8		Out-position of a bistable push control

Product Description

1. Introduction

This equipment is Arbitrary & Function Generator of DDS(Direct Digital Synthesizer) with high resolution and high accuracy, available of generating signals as Modulation, SWEEP and Waveforms including SINE, SQUARE, TRIANGLE, RAMP, NOISE and ARBITRARY.

2. Features

1) 0.01uHz of resolution from 0.01uHz to 31MHz. and ±3ppm of accuracy.
2) Modulation functions including AM, FM, PM, BURST, Linear Sweep and Log Sweep.
3) Provides various outputs including SINE, SQUARE, TRAINGLE, RAMP, NOISE, and ARBITRARY waveforms.
4) Generates the arbitrary waveform of 40M samples sec. and available of saving 16k point of waveform.
5) Available of changing output voltage to the range from 0.05Vpp to 10.00Vpp and changing the unit to dBm or Vrms.
6) Each operation of CH1 and CH2 is perfectly independent.
7) RS232/GPIB interface.
8) Provides optionally Waveform Editing Software for Windows to facilitate producing and editing waveforms.

3. Applications

1) Test of sounds, images, communication equipments and electronic parts
2) Test of construction, civil engineering, machines and materials
3) Standard generator of communication facilities
4) Test of electronic equipments and measuring instruments
5) Automotive
6) Industrial
7) Biomedical
8) Sensor simulation
9) Manufacturing test

4. Specifications

1) Waveform Specifications

Standard Waveform Function	Sine, Square, Triangle, Ramp, Arbitrary, Noise
Software for Arbitrary Waveform	
Standard Waveform	Sine, Square, Triangle, Ramp, Damped Sine, Noise, Exponential Rise, Exponential Fall, DC, Freehand, Line
Waveform Length	16 to 16,383 points
Amplitude Resolution	12 bits
Sampling Rage	40 M samples/sec

2) Frequency Characteristics Specifications

	Frequency	Resolution
Sine, Square	31MHz	0.01uHz
Ramp, Triangle	2MHz	0.01uHz
Noise	10MHz	

3) Output Characteristics Specifications

FUNCTION OUTPUT	9301[1 Channel], 9302[2 Channels]
Inter Channel Crosstalk	< 0.05%
Source Impedance	50 ohm Floating
Amplitude Range	50mVp-p ~ 10Vp-p
Amplitude Resolution	5 digits
SYNC OUTPUT	Front - Panel TTL Output for each channel
Output Units	Vp-p, Vrms, dBm, %
DC Offset Range	± 5V (limited such that [Vp-p/2]+[DC Offset] <= 5V)
DC Offset Accuracy	± 1.5% of setting + 0.5mV (DC only) ± 80mV depending on AC and DC settings

3-1) Sine Wave Accuracy (0V DC Offset)

	0.01 uHz ~ 100kHz	100kHz ~ 20MHz	20MHz ~ 25MHz	25MHz ~ 31MHz
5 ~ 10Vp-p	± 0.2dB	± 0.3dB	± 0.6dB	± 0.9dB
0.05 ~ 5Vp-p	± 0.4dB	± 0.4dB	± 0.8dB	± 0.8dB

3-2) Square Wave Accuracy

	0.01uHz ~ 100kHz	100kHz ~ 20MHz	20MHz ~ 31MHz
5 ~ 10Vp-p	± 3%	± 6%	± 15%
0.05 ~ 5Vp-p	± 5%	± 8%	± 16%

3-3) Triangle, Ramp, Arbitrary Wave Accuracy

	0.01uHz ~ 100kHz	100kHz ~ 2MHz
5 ~ 10Vp-p	± 4%	± 8%
0.05 ~ 5Vp-p	± 5%	± 9%

4) Sine Wave Spectral Purity Specifications

ITEM	Frequency Range	Level
Harmonic Distortion	DC to 1 MHz	< -45dBc
	1MHz to 31MHz	< -32dBc
Spurious Components	Under 2MHz	< -65dBc (non-harmonic)
	2MHz ~ 31 MHz	< -65dBc + 6dBc/octave (non-harmonic)
Phase Noise	< -50dBc in a 30 kHz band centered on the carrier exclusive of discrete spurious signals	
Sub harmonic	< -50dBc	

5) Signal Characteristics Specifications

Square Waveform	
Rise / Fall Time	< 16ns (from 10 to 90%)
Asymmetry	< 1% of period + 4ns
Overshoot	< 5%

Arbitrary Waveform	
Rise / Fall Time	< 35ns
Linearity	0.5% of full scale output
Settling Time	< 1us to settle within 0.1% of final value at full output

6) Standard Time base

Accuracy	± 3ppm (20°C ~ 30°C)
Aging	± 3ppm/year
Input	10MHz/N ± 2 ppm. [N = 1 ~ 8] 1Vp-p minimum input level
Output	10MHz, > 1Vp-p sine into 50 ohms

7) Modulation Characteristics Specifications

Amplitude Modulation	
Source	Internal (Sine. Square, Triangle, Ramp, Arbitrary) or External
Depth	0 to 100% AM or ± 100% DSBSC
Rate	0.001 Hz to 10kHz internal. 20kHz max external
Distortion	< -35dB at 1 kHz, 80% depth
DSB Carrier	< -35dB typical at 1kHz modulation rate (DSBSC)
External Input	± 5V for 100% modulation, 100kΩ impedance

Frequency Modulation	
Source	Internal (Sine, Square, Triangle, Ramp, Arbitrary)
Rate	0.001Hz to 10kHz
Span	Sine, Square : 0.01uHz to 31MHz Triangle, Ramp : 0.01uHz to 2MHz Arbitrary : 0.01u to 40M samples/sec

Phase Modulation	
Source	Internal (Sine, Square, Triangle, Ramp, Arbitrary)
Rate	0.001 Hz to 10kHz
Phase	±9999.99<deg>

Burst Modulation	
Waveform	Sine, Square, Triangle, Ramp, Arbitrary
Frequency	Sine, Square, Triangle, Ramp: 2MHz Arbitrary: 40M samples/sec
Count	1 to 65000 cycles/burst
Phase Shift	<= 100kHz
Modulation Output	0V to 5V

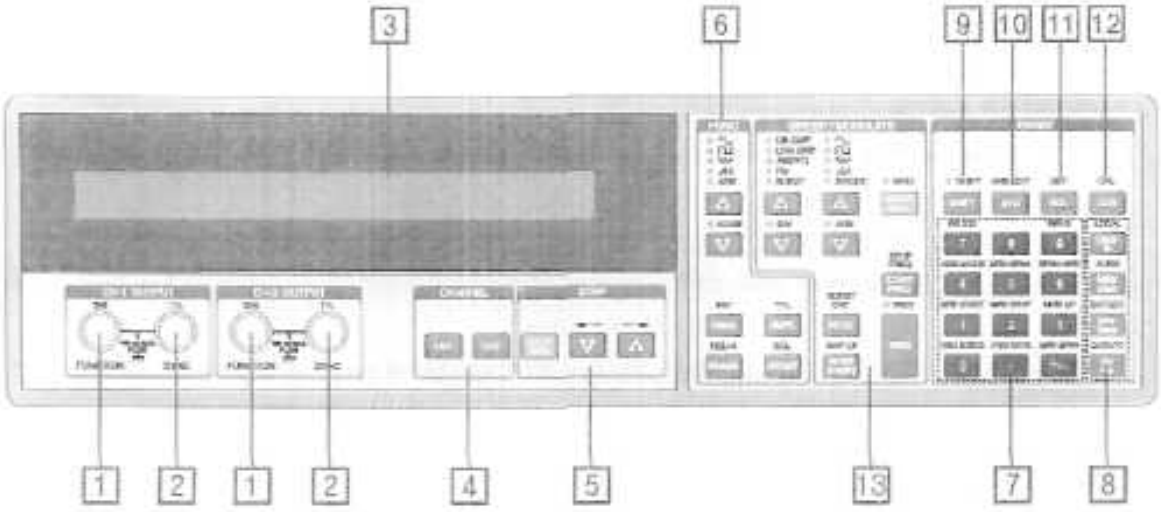
Frequency Sweep	
Type	Linear, Log
Sweep Waveform	Triangle, Ramp, Single
Sweep Time	0.001Hz to 10kHz
Span	Sine, Square : 0.01uHz to 31MHz Triangle, Ramp : 0.01uHz to 2MHz Arbitrary : 0.01u to 40M samples/sec
Marker Output	Two markers may be set at any sweep point (TTL output)
Sweep Output	0 ~ 10V linear ramp signal, synchronized to sweep

Trigger Generator	
Source	CH1: INT RATE, Single, POS EXT1, NEG EXT1, Line CH2: INT CH1, INT RATE, POS EXT2, NEG EXT2
Rate	0.0001s ~ 999.99s
External	Positive or Negative edge, TTL input
Output	TTL Output

8) General

Interfaces	RS-232 (2400 to 19200 BPS) and Optional GPIB
Dimensions	363mm x 109mm x 386mm (W X H X D)
Weight	9301: 8.2kg 9302: 8.7kg
Power	100/120/220/230 VAC 50/60Hz
Operating Temperature	5°C ~ 40°C
Operating Humidity	35% ~ 80%
Guaranteed Maintained Temperature	-20°C ~ 70°C
Guaranteed Maintained Humidity	< 85%
Power Consumption	9301: 46W 9302: 80W

1. Front Panel



1) CH1, CH2 Function Output (Only 9302 is available for CH2)

- Function output terminal with 50Ω of output impedance

CAUTION: This is Output Terminal. Don't connect External voltage.

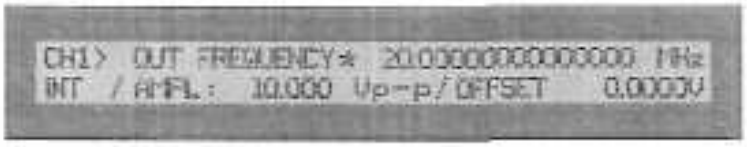
2) CH1, CH2 Sync Output (Only 9302 is available for CH2.)

- TTL square-wave output terminal synchronized with CH1 and CH2 Function output.
- When FUNCTION is set to NOISE, no output.

CAUTION: This is Output Terminal. Don't connect External voltage.

3) LCD Display

- Shows setting of ail modes as back-light attached display.



- **CH1**: Displays Channel. Select CH1 when power is on.
- **> OUT FREQUENCY**: Displays Setting mode. Select frequency setting mode when power is ON.
- *****: Displays in setting Step Size.
- **20.000000000000000MHz**: Sets a numeric value and unit.
- **INT**: Displays internal reference oscillation. (EXT: Displays External Reference Input)
- **/ AMPL: 10.0000Vp-p**: Displays output voltage and unit. (50Ω)
- **/ OFFSET 0.0000V**: Displays offset output voltage and unit.

4) CHANNEL (Only 9302 is available.)

- CHANNEL Key selects the required channel with [CH1] and [CH2] Key.

5) STEP KEYS

- The current parameter is available of increment and decrement with [▲/▼] Key of STEP.
- If you press [▲] Key, it increases in the current step size.
- If you press [▼] Key, it decreases in the current step size.
- If the setting value goes off a permitted limit of parameter, error message and beep sound occurs, and it is restored to the former value.
- [STEP SIZE] Key is used when user sets the step size of the displayed parameter.

6) FUNCTION KEYS

- Sets fundamental output waveform, frequency, output voltage, phase and offset.
- FUNC UP/DOWN [▲/▼] Key selects fundamental output waveform.
- [FREQ] Key sets frequency. If frequency goes off the maximum permitted limit oi output waveform, error message is displayed and the frequency is set to the maximum value of the waveform.
- [AMPL] Key sets output voltage: 0.05Vp-p ~ 10Vp-p.
- [PHASE] Key sets a starting phase in BURST Modulation.
- [OFFSET] Key sets DC Offset: (Vac Peak) + (Vdc) ≤ 5V.

7) ENTRY KEYS

- When you personally enter or modify parameters, use the keypad.
- If you press one of UNIT Keys, the entry is completed.
- Input Error is available of correction by using [CLR] Key.

8) UNIT KEYS: [DEG / %], [MHz / dBm], [kHz / Vrms], [Hz / Vpp]

- Finishes entering a value to input newly.
- When you input any parameter without the unit, this functions as Enter Key.
- If you press UNIT Key without inputting a new value during Amplitude display, amplitude is converted automatically to the proper unit and displayed (dBm, Vrms, Vp-p).

9) SHIFT KEY

- Used to select a function printed on the upper of each key.
- Press [SHIFT] (SHIFT LED ON) and select the desired key.
- Example
  ①. Selects and converts ARB mode

[SHIFT] → [ARB EDIT] → [SHIFT] → [ARM MODE]

② Initialization
[SHIFT]→[DEF]

③ Sets RS232
[SHIFT]→[RS232]→[STEP ▲/▼]

④ Saves WAVE
[SHIFT]→[WAVE]→[0...7]→[DATA(X)]→[STO]

⑤ Recalls WAVE
[SHIFT]→[WAVE]→[0...7]→[DATA(X)]→[RCL]

⑥ Sets START Frequency of Marker
[SHIFT]→[MRK START]→[1]→[0]→[kHz]

⑦ Sets STOP Frequency of Marker
[SHIFT]→[MRK STOP]→[2]→[0]→[kHz]

⑧ Sets SPAN of Marker
[SHIFT]→[MRK SPAN]→[2]→[0]→[kHz]

⑨ Sets CENTER Frequency of Marker
[SHIFT]→[MRK CF]→[1]→[5]→[kHz]

⑩ Marker function used in Sweep function
[SHIFT]→[MRK=SPAN]
[SHIFT]→[SPAN=MRK]

⑪ Selects Trigger Source
[SHIFT]→[TRIG SORCE]→[STEP<-]

⑫ Selects Trigger Rate
[SHIFT]→[TRIG RATE]→[0]→[.]→[0]→[0]→[5]→[Hz]

⑬ Selects Output Inversion
[SHIFT]→[INV]→[STEP<-]

⑭ Sets TTL
[SHIFT]→[TTL]

⑮ Sets ECL
[SHIFT]→[ECL]

10) STORE KEY

- Stores current output conditions of the equipment.
- Available of storing maximum 16s ("STORE MEMO NO": 0 ~ 15) of output conditions.
- Example:
  [STO]→[5]→[MHz]: Conditions adjusted in the current equipment are stored in STORE MEMO No. 5

11) RECALL KEY

- Recalls the output conditions of waveform stored as [STO].
- Example:
  [RCL]→[5]→[MHz]: Output conditions stored in STORE MEMO No. 5 are recalled

12)CLEAR KEY

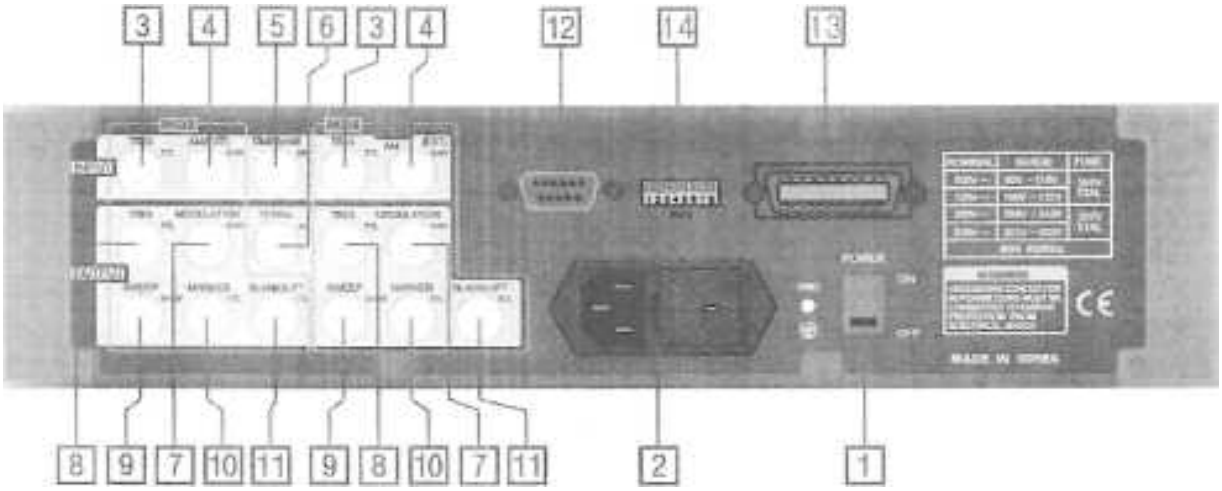
- Used for correcting input errors made in inputting Parameter with KEYPAD. If any error occurs in inputting Parameter and you press [CLR] Key, the input value is cleared and the former setting value is displayed.
- Example:
  [FREQ]→[20]→[MHz]→[25]→[CLR]: Output frequency displays 20MHz

13)SWEEP / MODULATE KEYS

- Modulation TYPE UP/DOWN [▲/▼] Key selects a modulation TYPE.
  - ✓ Modulation TYPE: LIN SWEEP, LOG SWEEP, AM, FM, BURST, PM
- Modulation Waveform UP / DOWN [▲/▼] Key selects a modulation waveform.
  - ✓ Modulation Waveforms: SINE, SQUARE, TRIANGLE, RAMP, SINGLE, ARBITRARY
  - ✓ Some MODULATION PARAMETERS have no relation with MODULATION TYPE.
  - ✓ For example. START frequency has no relation with AM, and if you select this, ERROR MESSAGE, "NO APPLICATION" will be displayed.
- [SWEEP MOD] Key switches SWEEP / MODULATE On/Off.
- [RATE] Key sets the frequency of modulation waveform.
  - ✓ 0.001Hz ~ 10kHz of the range in AM, FM and PM
  - ✓ 0.1ms ~ 1000s of the range in sweeping (Sweep Time is in inverse proportion to the Modulation Rate)
  - ✓ BURST Modulation has no relation with Modulation Rate
- [SPAN(depth)] Key
  - ✓ Sets Modulation Depth with 0.1% of resolution in AM mode (± 100%).
  - ✓ Sets the amount that output frequency changes from the center frequency in FM and SWEEP mode.
  - ✓ Output frequency of FM is within the range of (Center Frequency - SPAN/2) ~ (Center Frequency + SPAN/2) and the center frequency doesn't change for changing SPAN. If Center Frequency or SPAN goes off a limit permitted by SWEEP Frequency, error message shows, and then it is returned to the former value.
  - ✓ In PM Mode, SPAN is the PHASE value of phase modulation and sets 0.01<deg> of resolution with the range from 0° to 9999.99°. Phase modulation output is within the range of -SPAN/2 ~ +SPAN/2.

- [TRIG] Key
  - ✓ In setting Trigger Source to SINGLE in BURST Modulation, if you press [TRIG] Key. BURST occurs one time and TRIG LED ON.
  - ✓ In INT TRIGGER among Trigger Sources, if it triggers, TRIG LED ON.
  - ✓ When Trigger Source other than these is selected, TRIG LEF OFF regardless of Trigger.
- [START FREQ] Key sets the start frequency in LIN / LOG SWP.

2. Rear Panel



1) Power Switch

- Power ON / OFF of the equipment

2) Power Entry Module

- Includes line voltage selector and fuse of the equipment.
- In operating on 100/ 120V, use 2A Fuse.
- In operating on 220 / 230V, use 1A Fuse.

3) Trigger Input (CH1/CH2)

- External input Signal to trigger waveforms of BURST and SWEEP from various sources.
- Input impedance of 10kohm as input corresponding to TTL.
- Press [SHIFT]->[TRIG SOURCE] Key to select the trigger source as POS EXT/NEG EXT, and it is triggered by external signals.
- For SWEEP, only if you select SINGLE as the modulation waveform, it is available of using Trigger Source.
- POS EXT starts BURST/SWEEP on the rising edge of TRIGGER input.
- NEG EXT starts BURST/SWEEP on the falling edge of TRIGGER input.

4) AM (EXT) Input (CH1 / CH2)

- Controls amplitude of function output.
- 100kΩ of input impedance and ± 5V of range
  - ✓ When Modulation Depih is 100%, it outputs about 5V.
  - ✓ When Modulation Depth is 0%, it outputs 0V.
  - ✓ When Modulation Depth is -100%, it outputs about -5V.
- For general AM mode, 0 - 5V of range
- During D3BSC modulation, ± 5V of range
- Input is always available of operating.

5) Time Base Input

- Instead of Internal 10MHz TCXO signal, inputs Time Base of 10MHz. 1Vp-p from the external.
- Selects prior to internal 10MHz TCXO signal.
- 1kohm of input impedance
- CAUTION, Be careful with internal voltage of input.

6) 10MHz Output

- Outputs more than 1Vp-p sine wave of 10MHz in the internal oscillator of the equipment.
- 50Ω of output impedance

7) Modulation Output (CH1 / CH2)

- Outputs 0 ~ 5V waveform by modulation output terminal.

8) Trigger Output (CH1 / CH2)

- Used for conforming the external device to SWEEP BURST with TTL.
- When Trigger Sweep or Burst is started, it outputs in HIGH
- When Burst is completed, it outputs in LOW.

9) Sweep Output (CH1 / CH2)

- For sweeping, Sweep Modulation Waveform is output within 0 ~ 10V.

10) Marker Output (CH1 / CH2)

- Output coinciding with TTL
- When Frequency Sweep passes Start Marker Frequency, it outputs in HIGH.
- When Frequency Sweep passes Stop Marker Frequency, it outputs in LOW.

11) Blank/Lift Output (CH1 / CH2)

- Outputs coinciding with TTL
- When Frequency Sweep is under Up Sweep, it outputs in LOW.
- When Frequency Sweep is under Down Sweep, it outputs in HIGH.

12) RS232 Connector

- 9 pin D-SUB Connector
- See "PROGRAMMING" chapter of this manual.

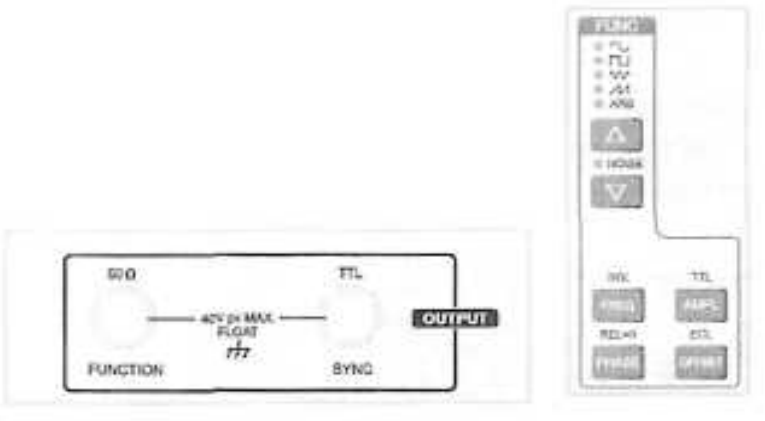
13) GPIB Connector (Option)

14) RS232 / GPIB Select Switch

- See "PROGRAMMING" chapter of this manual.

Operating and Use

1. Operation of Functions



1) Function Selecting

- As you press FUNC UP / DOWN [▲/▼] Key, output waveform is selected as follows:
  - ✓ SINE ↔ SQUARE ↔ TRIANGLE ↔ RAMP ↔ ARB ↔ NOISE
  - ✓ LED of selected function is ON.
- If the set frequency goes off the permitted limit of selected function, error message is displayed and the maximum frequency permitted in the function is set.
  - ✓ When 20MHz SQUARE, if you select TRIANGLE, "*FREQ ERROR" is displayed, and then it changes into 2MHz TRIANGLE.

2) Arbitrary Function

- Editing of Arbitrary Waveform
  - ✓ In editing mode of the front panel (ARB mode), it is available of operating.
  - ✓ It is available of editing and downloading in PC by using exclusive editing program (Arbitrary Waveform Composer) (Option)
- Arbitrary Waveform is repeated continuously.
- See Arbitrary Waveform Editing.

3) Frequency

- Press [FREQ] Key and set output frequency.
- It has 0.01uHz of frequency resolution for all functions.
- The maximum frequency differs by each function, as shown in the following table.

Function	Frequency Range
SINE	0.01uHz ~ 31.00000000000000MHz
SQUARE	0.01uHz ~ 31.00000000000000MHz
TRIANGLE	0.01uHz ~ 2.00000000000000MHz
RAMP	0.01uHz ~ 2.00000000000000MHz
NOISE	10MHz (Fixed)
ARBITRARY	0.01u ~ 20.00000000000000M, 40M Samples/sec

- Meaning of Frequency for ARB Function
  - ✓ Sampling Frequency of Arbitrary Waveform: 40M Samples/sec → 25ns/point
  - ✓ When editing a period of waveform with 100 Points, if you set ARB Function Frequency to 40M Samples/sec, the output frequency is 25ns x 100 points = 2500ns = 0.4MHz.
  - ✓ Dislike general frequency, it means the length of its stay spent in each point of arbitrary waveform.
- Example
- [FREQ]→[2]→[0]→[MHz]: Set to 20M Samples/sec (50ns/point)

4) Amplitude

- Press [AMPL] Key and set output level.
- Enter the required value with keypad and select units such as Vpp, Vrms and dBm.
- If DC Offset is on 0, each amplitude of function has ranges shown as the following table.

	Vp-p (50Ω)		Vrms (50Ω)		dBm (50Ω)	
	MAX	MIN	MAX	MIN	MAX	MIN
SINE	10V	50mV	3.535V	17.68mV	23.97	-22.05
SQUARE	10V	50mV	5V	25mV	26.98	-19.04
TRIANGLE	10V	50mV	2.886V	14.43mV	22.20	-23.82
RAMP	10V	50mV	2.886V	14.43mV	22.20	-23.82
NOISE	10V	50mV	2.09V	14.43mV	19.40	-26.62
ARBITRARY	10V	50mV	N/A	N/A	N/A	N/A

- For Amplitude, if you press UNIT Key, the aciual size doesn't change and it is available of exchanging between Vp-p, Vrms and dBm.
- Arbitrary Function Amplitude is set in Vp-p unit only.
- In changing to other functions, the value of Vp-p is fixed.
- Example
  [AMPL]→[5]→[Vpp]: Set to 5Vp-p.

5) Output Inversion

- In RAMP and ARB Function, it inverts the output.
- If you press [SHIFT]→[INV] Key, WAVE INVERT is displayed.
  - ✓ Select ON/OFF with [STEP ▲/▼] Key

- It is useful in converting Negative Ramp into Positive Ramp or inverting arbitrary waveform.
- Example
  [SHIFT]→[INV]→[STEP ▲/▼]

6) TTL Setting

- If you press [SHIFT]→[TTL]. Output Amplitude and Offset are set to TTL value.
  TTL value is 5Vpp for AMPL and 2.5V for Offset.
- Example
  [SHIFT] →[TTL]

7) ECL Setting

- If you press [SHIFT] → [ECL], Output Amplitude and Offset are set to ECL value.
  ECL value is 1Vp-p for AMPL and -1.3V for Offset.
- Example
  [SHIFT]→[ECL]

8) DC Offset

- It has a range within ± 5V, but it is limited to [AMPLITUDE [Vp-p]/2]+[DC Offset] ≤ 5V
- Select [OFFSET], and enter a new value by using Amplitude Unit Key.
  5 digit of resolution
- Size of DC Offset

AMPLITUDE	DC OFFSET	AMPLITUDE	DC OFFSET
10V	0V	4V	-3 ~ 3V
8V	-1 ~ 1V	2V	-4 ~ 4V
6V	-2 ~ 2V	0V	-5 ~ 5V

9) Phase (operating in BURST function only)

- In Burst Modulation, Phase sets a starting point of Burst.
- It is useful in starting Burst Modulation on the certain point of Waveform.
- Phase is available of changing with keypad, [DEG] and Step Key.
  It has a range within ± 9999.99° and 0.01° of resolution.
- Example ± 9999.99°
  [PHASE]→[4]→[5]→[DEG]: set to 45°

10) Zero Phase (operating in BURST function only)

- If you press [SHIFT]→[REL=0], Phase is set to"0".

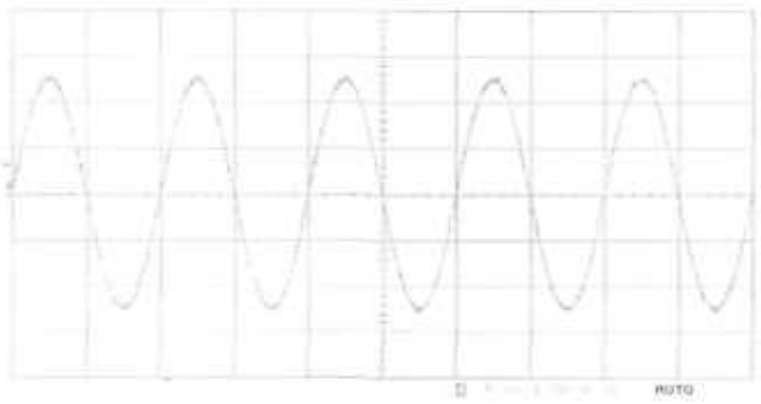
11) Noise Function

- It is available of modulating in external AM input only.

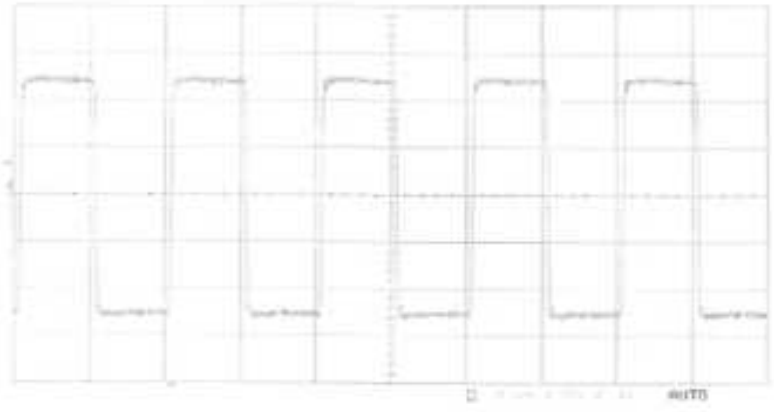
12) Basic Operation (SINE, SQUARE, TRIANGLE, ramp, noise)

- Waveform Selection
  - ✓ As you press FUNC UP / DOWN [▲/▼] Key. output waveform is selected as follows:
    : SINE ↔ SQUARE ↔ TRIANGLE ↔ RAMP ↔ ARB ↔ NOISE
- Frequency Change
  - ✓ [FREQ]→[2]→[.]→[0]→[5]→[MHz]
    : "OUT FREQUENCY" is displayed and the frequency is set to 2.05 MHz.
- Voltage Change
  - ✓ [AMPL]→[5]→[.]→[0]→[5]→[Vpp]
    : "AMPLITUDE LEVEL" is displayed and the amplitude is set to 5.05 Vp-p.
- Frequency /Voltage Output Unit Change
  - ✓ [MHz / dBm] / [kHz / Vrms] / [Hz / Vpp]
    : Since output frequency and voltage are changed according to UNITS KEY, a suitable value to the selected unit is displayed.
- STEP SIZE Use
  - ✓ If you press [STEP SIZE], the current Step Size of Parameter is displayed.
  - ✓ If you press [STEP SIZE] again, it is returned to the former Parameter display.
  - ✓ In STEP SIZE, it is available of entering a new value or changing the existing value when "*" is displayed on LCD.
  - ✓ [FREQ]→[2][.][5]→[MHz]→[STEP SIZE]→[2]→[kHz]→[STEP SIZE]
    →[STEP ▲]→[STEP ▲]
    : When you want to increase output frequency by 2.0kHz from 2.5MHz of frequency.
- Basic Waveform Use
  - ✓ Condition: For basic waveform output whose output frequency is 1MHz and output voltage 5 Vp-p.
    - ①. [SHIFT]→[DEF] : Initialization
    - ②. [FREQ]→[1]→[MHz]: Frequency is displayed and set to 1 MHz.
    - ③. [AMPL]→[5]→[Vpp] : Amplitude is displayed and set to 5Vp-p.

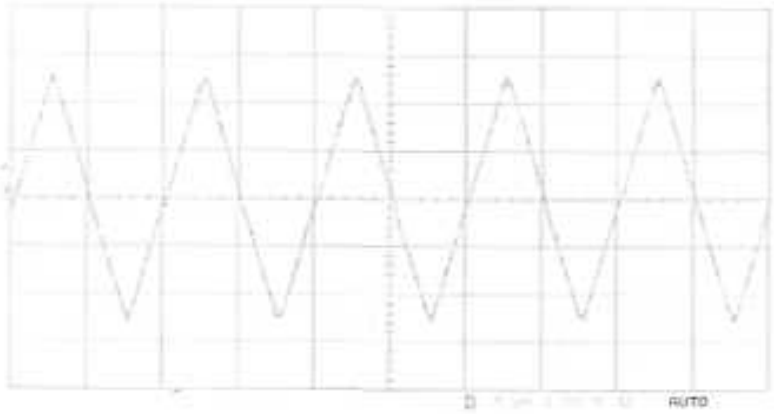
④. Initial value outputs SINE of 1 MHz and 5Vp-p.



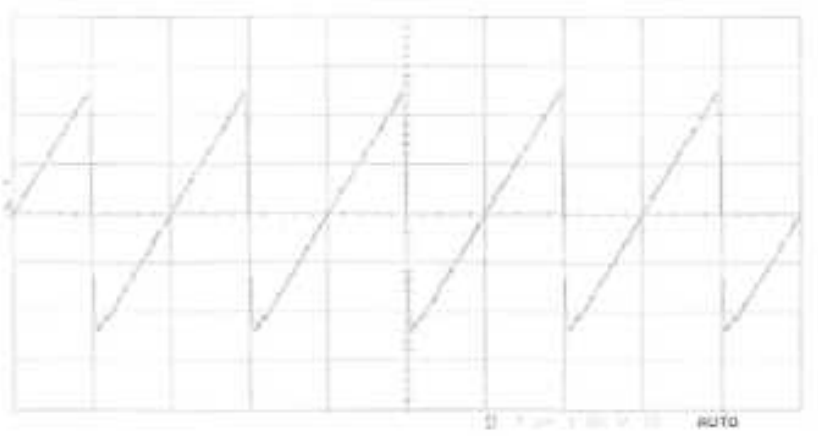
⑤. [FUNC ▼]: Output waveform is changed to SQUARE.



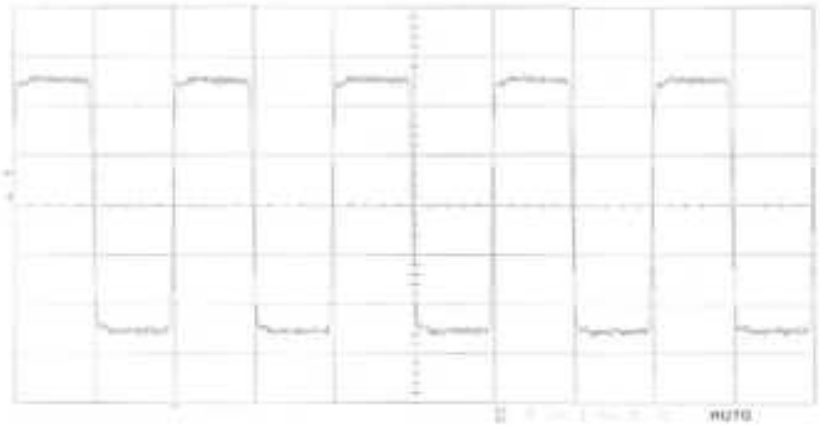
⑥. [FUNC ▼]: Output waveform is changed to TRIANGLE.



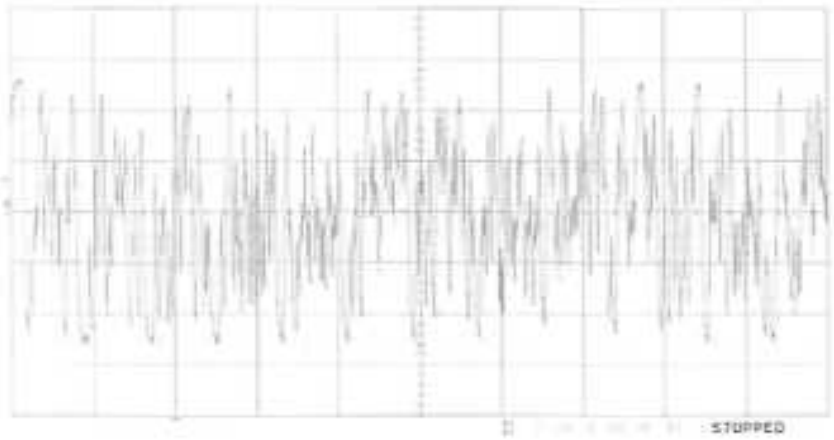
⑦. [FUNC ▼]: Output waveform is changed to RAMP.



⑧. [FUNC ▼]: The waveform stored as the initial value of ARB Mode is output.

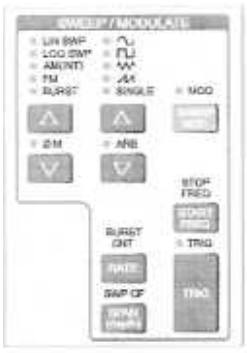


⑨. [FUNC ▼]: Output waveform is changed to NOISE.



2. SWEEP / MODULATE Operation

1) Introduction



- It is available of AM. FM, PM. Tone Burst and Frequency Sweep.
- Modulation Waveforms including SINE, SQUARE, RAMP, TRIANGLE and ARBITRARY.
- The frequency is available of sweeping in linear or logarithmic proportion.
    - ✓ After modulating low frequency unavailable of propagating effectively according to high frequency (carrier frequency) available of that, it performs effectively transmission and reception of information by activating it as radio wave.
    - ✓ Modulation: The process to load data of low frequency on carrier of high frequency
    - ✓ Demodulation: The process to restore the original data from modulated wave
    - ✓ Data to transmit is called modulation signal, and loading of modulation signal on carrier means transmission by changing amplitude, frequency and phase of the carrier with the modulation signal.
- Amplitude Modulation: a mode to change the amplitude (**E_c**) of carrier depending on signal wave
- Frequency Modulation: a mode to change the frequency (**ω_c**) of carrier depending on signal wave
- Phase Modulation: a mode to change the phase (**θ_c**) of carrier depending on signal wave

Carrier Signal:

2) Modulation On / Off

- Press [SWEEP MOD], and then Modulation is On/Off.
- When Modulation is On. MOD LED turns on.

3) Modulation Type

- Modulation TYPE UP/DOWN [▲/▼] Key selects a modulation form.
  - ✓ Modulation Forms: LIN SWEEP, LOG SWEEP, AM, FM, BURST, PM
- If you select it incorrectly, "NO APPLICATION" message is displayed.

4) Modulation Waveform

- Function Waveform to modulate is available of selecting with Modulation WAVEFORM UP / DOWN [▲/▼] Key.
  - ✓ Modulation waveforms: SINE, SQUARE, TRIANGLE, RAMP, SINGLE, ARBITRARY
  - ✓ If LED doesn't switch on, the waveform has no relation with the selected modulation type.
- Permissible combinations are as follows;
- If you want to use ARB waveform as modulation waveform, use it after storing in Wave Mode. (See Arbitrary Modulation part)

	SINE	SQUARE	TRIANGLE	RAMP	SINGLE	ARB
LIN SWP	No	No	Yes	Yes	Yes	No
LOG SWP	No	No	Yes	Yes	Yes	No
AM(INT)	Yes	Yes	Yes	Yes	No	Yes
FM	Yes	Yes	Yes	Yes	No	Yes
BURST	No	No	No	No	Yes	No
PM	Yes	Yes	Yes	Yes	No	Yes

* Basically, each CH may be used independently. However, select CH under modulation for simultaneous stable output of 2 channels when you select the following waveform conditions.

	CASE 1		CASE 2	
	CH 1	CH 2	CH 1	CH 2
FUNC	ARB	Don't Care	Don't Care	ARB
SWEEP	Don't Care	AM	AM	Don't Care
MOD	OFF	ON	ON	OFF
CH SELECT	**CH 2**		**CH 1**	
Note	Select the channel for AM to obtain the stable outputs			

5) Modulation Rate

- Sets frequency of modulation waveform
  - ✓ 0.001Hz ~ 10kHz of range in AM, FM and PM
  - ✓ 0.1ms ~ 1000s of range in sweeping (Sweep Time is inverse proportion to Modulation Rate.)
  - ✓ BURST MODULATION has no connection with MODULATION RATE.
- First, press [RATE] Key. and then set Modulation Rate with Unit keys of keypad, Hz and kHz.
- Rate setting: [RATE]→[1]→[kHz]: Frequency of modulation waveform is set to 1 kHz.
- Modulation waveform output 0~5V by Modulation Output Terminal (CH1, CH2)

6) Modulation Span / Depth

- In AM. [SPAN(depth)] Key sets Amplitude Modulation Depth with 0.1% resolution.
- In FM and SWEEP, [SPAN(depth)] Key sets Frequency Span with 0.01uHz resolution.
- In PM, [SPAN(depth)] Key sets Modulation PHASE of phase modulation.
  - ✓ 0° ~ 9999.99° of range
  - ✓ 0.01° of resolution
  - ✓ Phase modulation output of -SPAN/2 ~ +SPAN/2

2-1. Amplitude Modulation

1) Introduction

- Amplitude Modulation means a modulation technique to transmit by changing amplitude of carrier with modulation signal to transmit.
- In AM, the frequency spectrum has two sidebands and is displayed as three components of the upper sideband and the lower sideband loading carrier and the information on modulation frequency (modulation is completed).
- Usually. AM signal means DSB (Double SideBand) with carrier frequency.
- It is available of Amplitude Modulation using Internal and external signals.
- Modulation waveforms including SINE, SQUARE, TRIANGLE, RAMP and ARBITRARY.
- If you want to use ARB waveform as a modulation waveform, use it after storing in Wave Mode. (See Arbitrary Modulation part)
- It is available of DSBSC (Double Sideband Suppressed Carrier) modulation by external signal.

2) External AM Source

- AM input of the Rear panel is always available.
- Input voltage is within ±5V and has 20kHz of bandwidth.

3) Internal AM

- Internal Modulation Generator is available of modulation of all output functions except for NOISE.
- Modulation Waveforms of SINE, SQUARE, TRIANGLE, RAMP and ARBITRARY.

4) Modulation Depth

- If you press [DEPTH] Key, it is available of setting Amplitude Modulation Depth.
- Set it with keypad, DEG (%) or Step Key.
- It is within ±100% with 0.1% resolution.

- In a positive value, set to AM coincided with DEPTH.
- In a negative value, set to DSBSC modulation coincided with DEPTH.

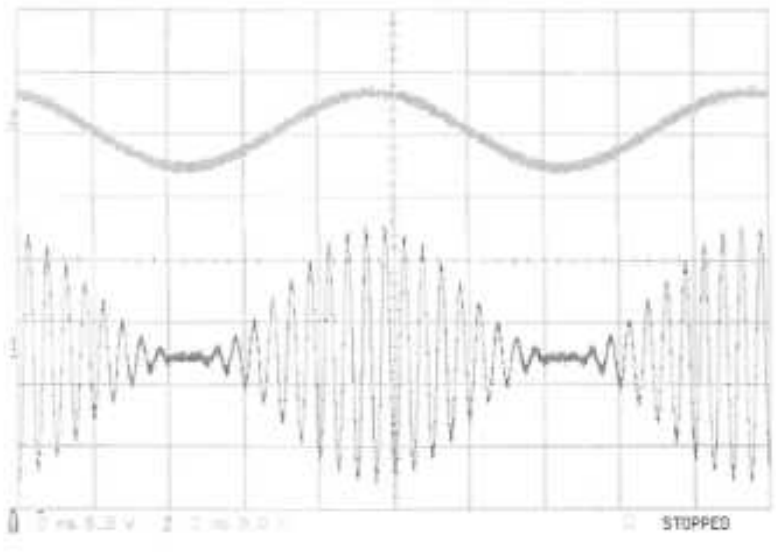
5) Modulation Rate

- Press [RATE] Key to set frequency of AM modulation waveform.
- Range of 0.001Hz ~ 10kHz

6) Example

- **Carrier**: 20kHz of SINE wave, **modulation wave**: 1 kHz of SINE wave, **modulation rate**: 100% of AM

① Select carrier, "SINE" with FUNC [▲/▼] Key
② Carrier Frequency Setting: [FREQ] → [2] → [0] → [kHz]
③ Carrier Amplitude Setting: [AMPL] → [5] → [Vpp]
④ Select a modulation form, "AM" with Modulation TYPE [▲/▼] Key
⑤ Rate Setting: [RATE] → [1] → [kHz]
⑥ Depth Setting: [DEPTH] → [1] → [0] → [0] → [%]
⑦ Select a modulation signal, "SINE" with Modulation WAVEFORM [▲/▼] Key.
⑧ If you press [SWEEP MOD] Key, waveform output is as follows:



[Carrier: 20kHz of SINE wave, Modulation wave: 1kHz of RAMP wave, Modulation rate: 100% of AM waveform]

2-2. Frequency Modulation

1) Introduction

- Frequency Modulation means a modulation technique to transmit by changing frequency of carrier according to signal wave, keeping the amplitude of carrier fixed.
- FM wave has numerous sidebands from center frequency and occupies wide bandwidth.
- When each frequency of signal wave is little, since numerous sidebands are generated but each frequency of signal wave is little, the bandwidth is unavailable of widening and it is available of suppressing occupied bandwidth within the fixed range.
- It is available of FM modulation except for NOISE by using the internal modulation generator.
- Modulation Waveforms such as SINE, SQUARE, TRIANGLE, RAMP and ARBITRARY.
- If you want to use ARB waveform as a modulation waveform, use it after storing in Wave Mode. (See Arbitrary Modulation part)
- MODULATION OUTPUT of the back panel outputs 0V ~ 5V in linear type, according to frequency output.

2) Frequency Span

- Sets the minimum and maximum frequency for Frequency Modulation.
- Press [SPAN] Key to set frequency amount changed from center frequency.
  - ✓ The minimum frequency setting: (Center Frequency) - (SPAN/2)
  - ✓ The maximum frequency setting: (Center Frequency) + (SPAN/2)
- Sets 0.01uHz of resolution within a permitted frequency range of each waveform.

3) Modulation Rate

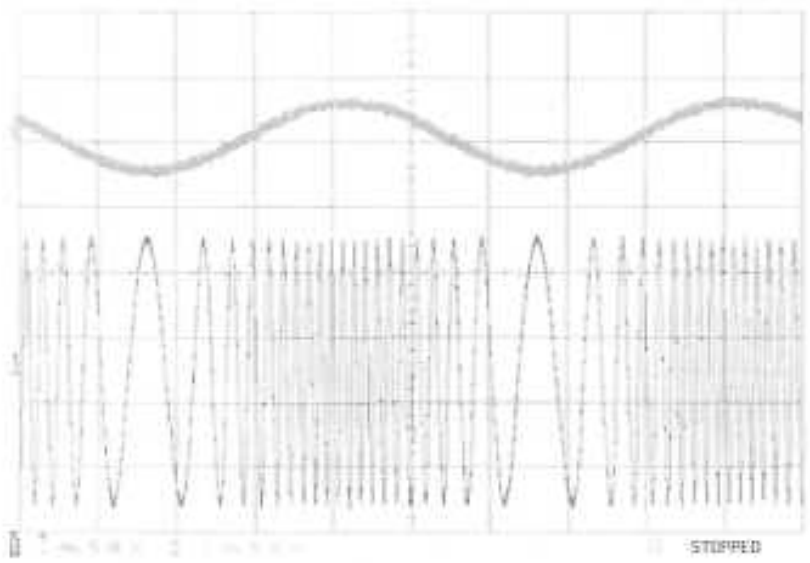
- Press [RATE] Key to set frequency of FM modulation waveform. (0.001 Hz ~ 10kHz of range)

4) Example

- **Carrier**: 20kHz of SINE wave, **Modulation wave**: FM indicating 1 kHz of SINE wave

① **.** Select carrier, "SINE" with FUNC UP / DOWN [▲/▼] Key
② **.** Carrier Center Frequency Setting: [FREQ]→[2]→[0]→[kHz]
③ **.** Carrier Amplitude Setting: [AMPL]→[1]→[0]→[Vpp]
④ **.** Select a modulation form, "FM" with Modulation TYPE UP / DOWN [▲/▼] Key
⑤ **.** Rate Setting: [RATE]→[1]→(kHz]
⑥ **.** Span Setting: [SPAN]→[3]→[0]→[kHz]

⑦. Select a modulation wave. "SINE" with Modulation WAVEFORM [▲/▼] Key
⑧. If you press [SWEEP MOD] Key, waveform output is as follows:



[**Carrier**: 30kHz of SINE wave, **Modulation wave**: waveform of frequency -modulated 1kHz of SINE wave]

2-3. Phase Modulation

1) Introduction

- Phase Modulation means a modulation technique to change phases of carrier according to amplitude of modulation signal wave, keeping the amplitude of carrier fixed.
- Although PM is basically similar to FM, in PM, the phase of carrier is in proportion to modulation signal and the frequency is in proportion to differential of modulation signal. (gradient of waveform)
- After integration and PM of modulation signal, it leads to FM wave. And after differentiation and FM, it leads to PM.
- The maximum frequency deviation is in proportion to frequency of modulation signal as well as amplitude of modulation signal.
- Necessary frequency band to transmit PM wave is not fixed.
- Modulation waveforms including SINE, SQUARE, TRIANGLE, RAMP and ARBITRARY.
- If you want to use ARB waveform as a modulation waveform, use it after storing in Wave Mode. (See Arbitrary Modulation part)
- MODULATION OUTPUT of the back panel outputs 0V ~ 5V in linear type, according to frequency output.

2) Modulation Phase

- Sets a phase for phase modulation.
- Press [SPAN] Key to set a phase changing on the basis of zero phase.
- It has 0° ~ 9999.99° of the range with 0.01° of resolution.

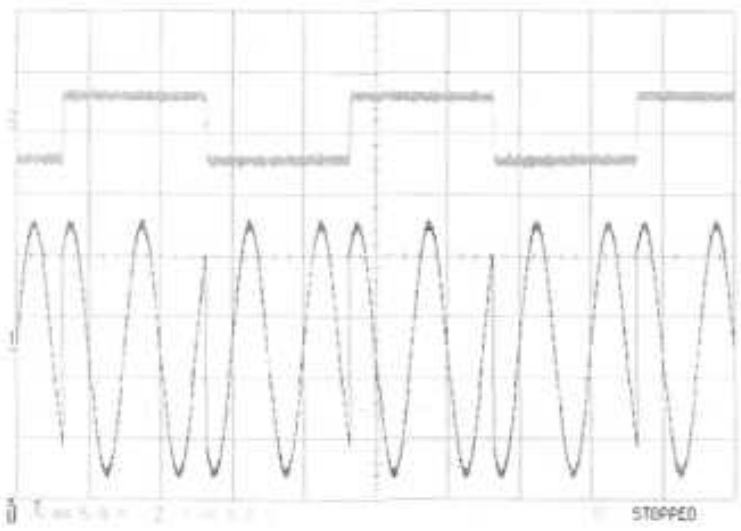
3) Modulation Rate

- Press [RATE] Key to set frequency of PM modulation waveform.
- 0.001Hz ~ 10kHz of range

4) Example

- **Carrier**: 10Vp-p , 2kHz of SINE wave, **Modulation waveform**: 1kHz rate, 180° phase, SQUARE of PM

  ①. Select carrier, SINE" with FUNC [▲/▼] Key
  ②. Carrier Frequency Setting: [FREQ]→[2]→[kHz]
  ③. Carrier Amplitude Setting: [AMPL]→[1]→[0]→[Vpp]
  ④. Select a modulation form, "PM" with Modulation TYPE [▲/▼] Key
  ⑤. Rate Setting: [RATE]→[1]→[kHz]
  ⑥. Phase Setting ; [SPAN]→[1]→[8]→[0]→[DEG]
  ⑦. Select a modulation wave, "SQUARE" with Modulation WAVEFORM [▲/▼] Key
  ⑧. If you press [SWEEP MOD] Key, waveform output is as follows;



[**Carrier**: 2kHz of SINE wave, **Modulation wave**: waveform of 1 kHz of SQUARE phase -modulated into 180° Phase]

2-4. Burst Modulation

1) Introduction

- It generates periodically Tone Burst of Output Function.
- Frequency of output function is limited to 2MHz on SINE, SQUARE. TRIANGLE, RAMP.
- In ARBITRARY, frequency is unlimited.
- When it receives Trigger signal, it begins to burst on the spot the phase of output waveform specifies and outputs as much as waveform cycles set in burst count, and then it stops.
- TRIGGER OUTPUT of the rear panel is used for synchronizing external equipments with Burst.
    - ✓ When burst is triggered: HIGH
    - ✓ When it stops: LOW
- If you want to use ARB waveform, use it after storing in Wave Mode.
  (See Arbitrary Modulation part)
- If you select ARB waveform, the initial setting value is displayed as INVERT RAMP waveform stored as default in 0 of "WAVE DATA NO".

2) Burst Count

- Press [SHIFT]→[BURST CNT] Key to set the number of burst cycles.
- 1 ~ 65,534 of range
- Burst Time = Burst Count / Frequency

3) Waveform Starting Point

- It changes the starting point of burst by converting phase.
    - ✓ Phase is available of starting waveform corresponding to ±9999.99°.
- The starting point of Burst is available in waveforms of SINE, SQUARE, TRIANGLE, RAMP and ARBITRARY.

4) Triggering Burst

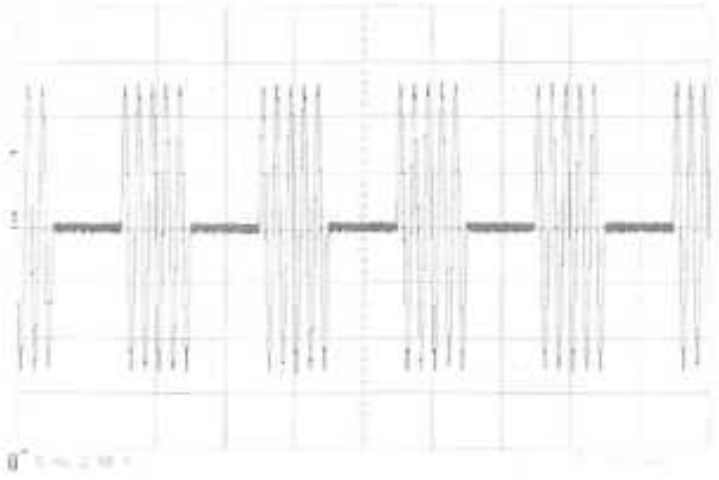
- Burst Modulation is the function triggered to the internal rate generator.
- Trigger is available of setting to internal trigger, external trigger, power frequency and SINGLE.
- If you set two channels on ARB at the same time in BURST mode,
    - ✓ The two channels aren't activated at the same time
    - ✓ Only selected channel is activated so the required BURST waveform is output.
    - ✓ For the other channel Wave mode, the waveform stored in 0 address is output.

- Delay may be given as much as the required cycles through the following process.
  - ✓ Channel 1 selects trigger to POS EXT 1.
  - ✓ Channel 2 selects trigger to NEG EXT 2.
    (See “TRIGGER GENERATOR" section for trigger setting)

5) Example

- Sine wave of 10kHz frequency. Burst waveform of 10Vp-p and five-times of burst counts.

  ①. Select SINE" with FUNC [▲/▼] Key
  ②. Frequency Setting: [FREQ]→[1]→[0]→[kHz]
  ③. Amplitude Setting: [AMPL]→[1]→[0]→[Vpp]
  ④. Select "BURST" with Modulation TYPE [▲/▼] Key
  ⑤. BURST Count Setting: [SHIFT]→[BURST CNT]→[5]→[Hz]
  ⑥. If you press [SWEEP MOD] Key. waveform output is as follows:



[Output waveform generates five BURST waveform per a cycle, with SINE wave of 10kHz as BURST waveform]

2-5. Frequency Sweeps

1) Introduction

- Frequency Sweep means to generate waveform changed at regular intervals by changing frequency of output signal smoothly and continuously over the whole frequency band.
- The frequency of the specified waveform is generated linearly or algebraically changes from the initial specified frequency to the final stop frequency, causing a frequency change, and the larger is interval between initial frequency and slop frequency, the more rapidly changes the frequency of the specified range.

- It is used in various fields including observing features of the frequency of each cordless-frequency circuit to calculate in wide and continuous range of frequency or adjusting frequency discriminators and wide-band amplification circuit.
- When sweeping continuously the whole frequency band, a possibility to lose important information between frequency spots may be removed.
- It is available of frequency sweep on SINE, SQUARE, TRIANGLE, RAMP and ARBITRARY.
- Sweep is set by entering Start/Stop Frequency or Center Frequency /Span.
- The kind is Linear or Log sweep according to output forms.
- For sweeping, frequency has continuous phases and outputs frequency modulation waveform.
- Sweep Time is within 0.0001 ~ 1000s.
- If you want to use ARB waveform, use it after storing in Wave Mode. (See "Arbitrary Modulation" section)
- When you select ARB waveform, for the initial setting value. INVERT RAMP waveform stored as default in 0 of WAVE MODE NO" is swept.

2) Sweep Type

- Select Linear or Log sweep with Modulation TYPE [▲/▼] Key.
- In Linear sweep, output frequency is changed linearly for sweep time.
- In Log sweep, output frequency is changed exponentially for sweep time.

3) Sweep Waveform

- It is available of setting TRIANGLE. RAMP and SINGLE with Modulation WAVEFORM [▲/▼] Key.
- When set to SINGLE
  - ✓ Output frequency sweeps Start Frequency until it accepts Trigger.
  - ✓ It repeats continuously to sweep with Stop Frequency.
- When set to RAMP
  - ✓ It repeats continuously the Sweep from Start Frequency to Stop Frequency.
- When set to TRIANGLE
  - ✓ For the half of a cycle, sweep up to Stop Frequency from Start Frequency.
  - ✓ For the other half of a cycle, it repeats continuously sweep down to Stop Frequency from Start Frequency.

4) Sweep Rate/Time

- The sweep period is set with [RATE] and keypad.
- The range of sweep rate is from 0.001Hz to 10kHz.

- Sweep rate corresponds to an inverse number of the sweep time.
- In TRIANGLE sweep, the sweep time is equal to (sweep up) + (sweep down).

5) Sweep Frequencies

- Sweep Range may be set by entering Start / Stop Frequency or Center Frequency / Span
  - ✓ Center Frequency = (Start Frequency + Stop Frequency) / 2
  - ✓ Span = Stop Frequency - Start Frequency
  - ✓ Start Frequency = Center Frequency - Span / 2
  - ✓ Stop Frequency = Center Frequency + Span / 2
- It is in proportion to Frequency Range of each function.

6) Start and Stop Frequencies

- Press [START FREQ] Key to enter Start Frequency.
  - ✓ Example
    [START FREQ]→[1]→[kHz]: Start Frequency is set on 1kHz.
- Press [SHIFT][STOP FREQ] Key to enter Stop Frequency.
  - ✓ Example
    [SHIFT]→[STOP FREQ]→[1]→[0]→[kHz]: Stop Frequency is set on 10kHz.
- If Stop Frequency is higher than Start Frequency: Sweep Up
- If Stop Frequency is lower than Start Frequency: Sweep Down

7) Center Frequency and Span

- Press [SHIFT]→[SWP CF] Key to set Center Frequency.
  - ✓ Example
    [SHIFT]→[SWP CF]→[7]→[kHz]: Center Frequency is set on 7kHz.
- Press [SPAN] Key to set span.
  - ✓ Example
    [SPAN]→[2]→[0]→[kHz]: Set span on 20kHz.
- Span value is limited to more than "0" and less than the maximum permitted frequency.
- Even if Center Frequency changes, Span is fixed.

8) Sweep Markers

- Under Sweep, Marker is designed as two including Start Frequency and Stop Frequency.
- Enter Marker Start Frequency: [SHIFT]→[MRK START]
- Enter Marker Stop Frequency: [SHIFT]→[MRK STOP]
- Enter Marker Center Frequency: [SHIFT]→[MRK CF]
- Enter Marker Span: [SHIFT]→[MRK SPAN]

- Marker Start / Stop Frequency is changed to be matched with the span.
- Even if span changes, Center Frequency is fixed.
- MARKER OUTPUT is TTL signal.
    - ✓ When Sweep Frequency passes Start Marker: HIGH
    - ✓ When Sweep Frequency passes Stop Marker: LOW
    - ✓ Example:
      [SHIFT]→[MRK START]→[3]→[kHz]: Start Marker is set to 3kHz.
      [SHIFT]→[MRK STOP]→[8]→[kHz]: Stop Marker is set to 8kHz.
      (For MARKER output, HIGH for 3kHz-8kHz in sweeping, and LOW for the rest band)

9) Marker to Span

- Press [SHIFT]→[MRK=SPAN] Key to place Marker to the end of Sweep Span.
- Set Marker Start Frequency to Sweep Start Frequency value.
- Set Marker Stop Frequency to Sweep Stop Frequency value.
- In setting Sweep, it is useful in searching Marker.

10) Span to Marker

- Press [SHIFT]→[SPAN=MRK] Key to place Sweep Span to the location of Marker.
- Set Sweep Start Frequency to Marker Start Frequency value.
- Set Sweep Stop Frequency to Marker Stop Frequency value.

11) Sweep Output

- SWEEP OUTPUT of the rear panel is 0~10V analog output of linear modulation waveform during sweeping.
    - ✓ For Sweep Start Frequency: 0V output
    - ✓ For Sweep Stop Frequency: 10V output
- It is available of using in driving Chart recorder or x-y oscilloscope.

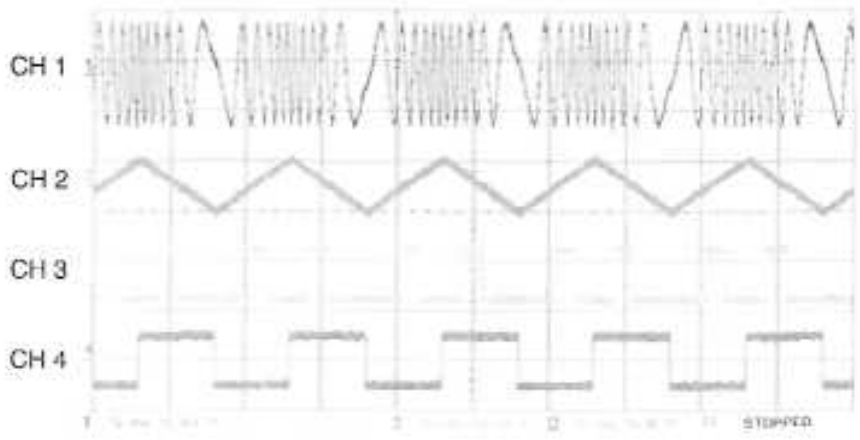
12) Blank/Lift Output

- BLANK/ LIFT OUTPUT is TTL signal.
    - ✓ For Sweep Up: LOW
    - ✓ For Sweep Down or Sweep Reset: HIGH
- OUTPUT is used in driving Chart Recorder for Sweep Retrace.

13) Example

- LIN SWEEP with Start Frequency as 1kHz, Stop Frequency as 20kHz, and TRIANGLE as 1kHz.

- Check output after setting Marker Start Frequency on 10kHz and Marker Stop Frequency on 15kHz.
- Oscilloscope is set to 200us / div.
  - ✓ CH 1: Connects FUNCTION OUTPUT of the rear panel.
  - ✓ CH 2: Connects SWEEP OUTPUT of the rear panel.
  - ✓ CH 3: Connects MARKER OUTPUT of the rear panel.
  - ✓ CH 4: Connects BLANK / LIFT OUTPUT of the rear panel.
  - ①. Select "SINE" with FUNC [▲/▼] Key
  - ②. Select "LIM SWEEP" with Modulation TYPE [▲/▼] Key
  - ③. Select "TRIANGLE" with Modulation WAVEFORM [▲/▼] Key
  - ④. START Frequency setting: [START FREQ]→[1]→[kHz]
  - ⑤. STOP Frequency setting: [SHIFT]→[STOP FREQ]→[2]→[0]→[kHz]
  - ⑥. RATE setting: [RATE]→[1]→[kHz]
  - ⑦. [SWEEP MOD] Key
  - ⑧. Marker Start Frequency setting: [SHIFT]→[MRK START]→[1]→[0]→[kHz]
  - ⑨. Marker Stop Frequency setting:[SHIFT]→[MRK STOP]→[1]→[5]→[kHz]
  - ⑩. Waveform output on oscilloscope is as follows:



- CH 1: FUNCTION OUTPUT of the front panel

  LIN-Sweeping waveform with START Frequency as 1kHz,
  Stop Frequency as 20kHz, and 1 kHz of TRIANGLE wave

- CH 2: SWEEP OUTPUT of the rear panel

  1kHz of TRIANGLE wave as SEEP waveform

- CH 3: MARKER OUTPUT of the rear panel

  When Sweep passes Start Marker: HIGH
  When it passes Stop Marker: LOW

- CH 4: BLANK / LIFT OUTPUT of the rear panel

  For Sweep Up: LOW
  For Sweep Down: HIGH

2-6. Trigger Generator

1) Introduction

- It is a function to trigger BURST and SWEEP waveform with various Trigger Sources.
- If BURST and SWEEP waveform are triggered, other Triggers are disregarded.

2) Trigger Source

- Press [SHIFT]→[TRIG SORCE] Key to check trigger source.
  - ✓ In CH2 mode, if INT CH1 is set, CH1 is the trigger source.
  - ✓ If LINE is set, it is synchronized with AC Power Frequency and available of trigger only in CH1 mode.
  - ✓ In SWEEP, only if you select SINGLE as modulation waveform, it is available of using Trigger Source.
- Press STEP KEY to change the source.

Source	FUNCTION
SINGLE	If you press (TRIG] key, BURST is started (CH1 only).
INT RATE	Starts BURST/SWEEP by the internal rate generator.
POS EXT	Starts BURST/SWEEP in the Rising Edge of TRIGGER input
NEG EXT	Starts BURST/SWEEP in the Failing Edge of TRIGGER Input.
LINE	Starts BURST/SWEEP by the power frequency (CH1 only).

3) Trigger Rate

- Press [SHIFT]→[TRIG RATE] Key to set the time of internal Trigger Generator.
- 0.0001s ~ 999.9s of range
- When two channels are used, trigger for each channel is same.
- In SINGLE of BURST, when you press [TRIG] Key, trigger is generated one time.

4) Trig LED

- Displays Trigger conditions in BURST / SWEEP.
  - ✓ In BURST Modulation, if you set SINGLE as Trigger Source and press [TRIG] Key, BURST is generated one time and TRIG LED ON.
  - ✓ In INT TRIGGER of Trigger Sources, if it is triggered, TRIG LED ON.
  - ✓ When the other Trigger Sources are selected, TRIG LED OFF regardless of Trigger.

5) Trig Input

- TRIGGER INPUT of the rear panel is TTL input.
- If POS EXT1 (2) or NEG EXT1 (2) is set as the trigger source, Trigger on the edge of this input.

6) Trig Output

- TRIGGER output of the rear panel is TTL output.
  - ✓ When triggering BURST: HIGH
  - ✓ When BURST is terminated: LOW
- It is available of operation for all Trigger Sources.

2-7. Wave Mode

1) Introduction

- In order to implement Arbitrary Modulation, it is necessary to store arbitrary waveform with "WAVE DATA NO".
- Available "WAVE DATA NO" is total eight (0~7).
- Size of the waveform is 4096 points.
- It is available both in CH1 and CH2.

2) Order

- Edit the required waveform in the Arbitrary Waveform Editing mode: See Arbitrary Waveform Editing.
- Enter WAVE Mode: [SHIFT]→[WAVE] Key
- Store in "WAVE DATA NO": [0...7]→[DATA(X)]→[STO]
- Load "WAVE DATA NO" stored in SWEEP / MODULATE function.
  : [SHIFT]→[WAVE]→[2]→[DATA(X)]

2-8. Arbitrary Modulation

1) Introduction

- It is used v/hen you want to use Arbitrary Waveform in SWEEP / MODULATE function.
- After storing Arbitrary Waveform with "WAVE DATA NO" in WAVE Mode, it is used by loading "WAVE DATA NO" stored in the SWEEP / MODULATE function.
- It has two methods 1)to load in SWEEP and BURST, and 2)to load in AM. FM and PM

2) Method 1

- Summary: In WAVE Mode, store Arbitrary waveform in WAVE DATA NO", load the stored waveform and use it as function waveforms of LIN SWEEP, LOG SWEEP and BURST.
- Use Mode: LIN SWEEP, LOG SWEEP, BURST

- Condition
  - ✓ FUNCTION is "ARB" (LED of ARB: ON)
  - ✓ ARB LED of SWEEP / MODULATE: OFF (Choice impossible)
- The initial setting is displayed as INVERT RAMP waveform, which is stored as default of 0 of WAVE DATA NO" in Wave Mode.
- Available WAVE DATA NO" is total eight (0 ~ 7).
- Size of the stored waveform is 4096 points.
- It is available both in CH1 and CH2.

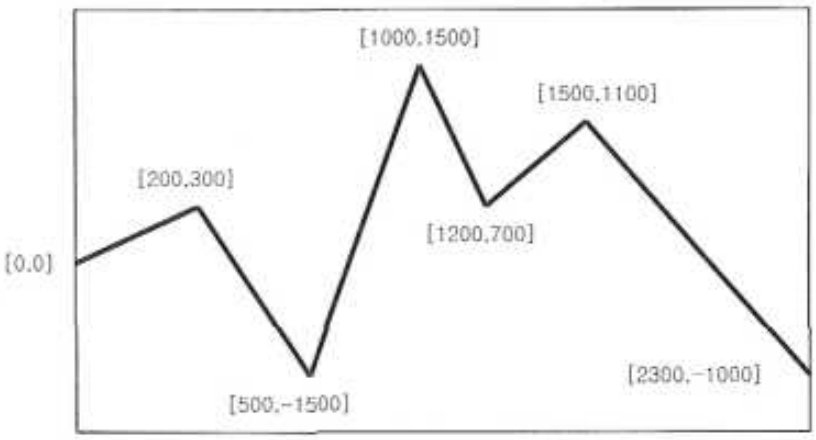
3) Method 2

- Summary: In WAVE Mode, it stores Arbitrary Waveform with 'WAVE DATA NO" and use it as Modulation Waveforms (Modulation wave) of AM, FM and PM by loading the stored waveform.
- Mode: AM, FM. PM
- Setting Condition
  - ✓ FUNCTION is "ARB" (LED of ARB: ON)
  - ✓ "ARB" of SWEEP/MODULATE (LED of ARB: ON)
- The initial setting is displayed as INVERT RAMP waveform, which is stored as default of 0 of "WAVE DATA NO" in WAVE mode.
- Available "WAVE DATA NO" is total eight (0 ~ 7).
- It is available both in CH1 and CH2.
- Size of the waveform stored in "WAVE DATA NO" is 4096 points.

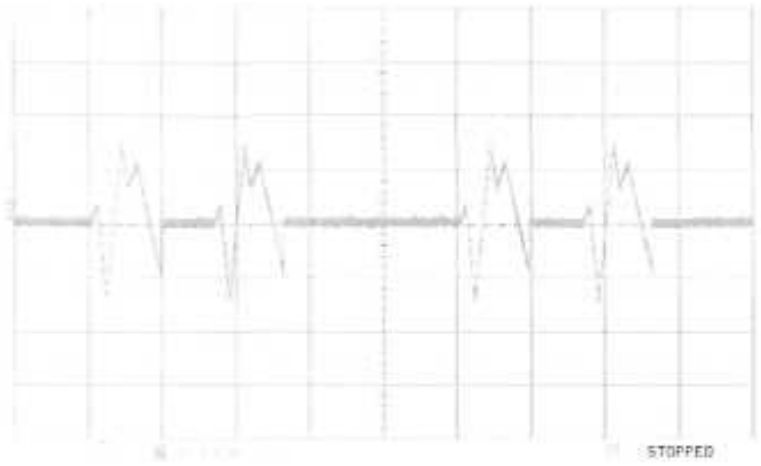
4) Example

- When using in BURST after storing Arbitrary Waveform in WAVE DATA NO 2.

1. Select "ARB" with FUNC [▲/▼] Key
2. Select ARB Editing Mode: [SHIFT]→[ARB E1DT]
3. Select ARB Editing Type: [SHIFT]→[ARB MODE] (Here, use Vector mode)
4. Address Setting: [ADRS]→[0]→[ADRS]
5. Data(X) Input: [DATA(X)]→[0]→[DATA(X)]
6. Data(Y) Input: (DATA(Y)]→[0]→[DATA(Y)]
7. Address Setting: [ADRS]→[1]→[ADRS]
8. Data(X) Input: [DATA(X)]→[200]→[DATA(X)]
9. Data(Y) Input: [DATA(Y)]→[300]→[DATA(Y)]
10. Repeat above procedures of (4) ~ (6) to input waveform as the following diagram.
11. Store in "WAVE DATA NO" 2: [SHIFT]→[WAVE]→[2]→[DATA(X)]→[STO]
12. Select "BURST" with Modulation TYPE [▲/▼] Key



13. Select frequency:
    [FREQ]→[3]→[0]→[kHz]
14. Select Trigger Rate:
    [SHIFT]→[TRIG RATE]→[0]→[.]→[0]→[0]→[0]→[1]→[DATA(X)]
15. Select BURST count:
    [SHIFT]→[BURST CNT]→[2]→[DATA(X)]
16. Regenerate waveform stored in WAVE DATA NO 2:
    [SHIFT]→[WAVE]→[2]→[DATA(X)]
17. Start Modulation:
    [SWEEP MOD]



[The output waveform outputs two BURST waveforms per a cycle, with 4K POINT of Arbitrary waveform stored in WAVE DATA NO as BURST]

3. Arbitrary Waveform Editing

1) Introduction

- Arbitrary Waveform Editing is of POINTER/ VECTOR mode.
- In Point mode, input the required Amplitude value in ADDRESS DATA(X).
- In Vector mode, input the DATA corresponding to time axis in DATA(X) and the required Amplitude value in DATA (Y).
- The amplitude value available of storing is within -2048 ~ +2047[12bit DAC].
- The maximum number of samples to compose waveform is 16383 points.

2) Sampling Rate

- When Function is set to ARB, the displayed frequency is Arbitrary Waveform Sampling Frequency.
- It displays stay time in each point of Arbitrary waveform.
  - ✓ It stays for 1/f time in each point.

3) Edit Menu and ARB Mode Selection

- [SHIFT]→[ARB EDIT]→[SHIFT]→[ARB MODE]→[SHIFT]→[ARB MODE]

4) Data Display

- **POINT Mode**

CH1> ARB. POINT A: A 3 D 2000
INT / AMPL: 10.00Vp-p / OFFSET 0.0000V

  - ✓ **A**: It is available of input within 0 ~ 16382 along the time axis in Point mode.
  - ✓ **D**: It is within -2048 - 2047 for Amplitude value in Point mode.
  - ✓ It is available of selecting with [STEP <up>/<dn>] or [SHIFT]→[ADRS] / [DATA] Key.

- **VECTOR Mode**

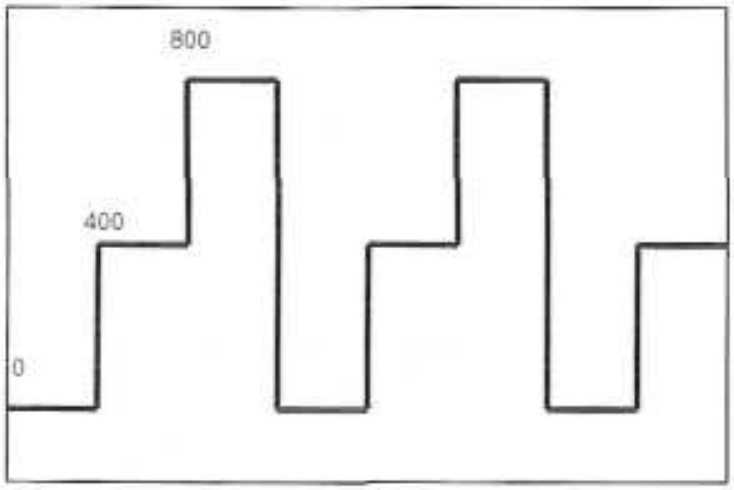
CH1> ARB. VECTOR A: 0 X----- Y-----
INT / AMPL: 10.00 Vp-p / OFFSET 0.0000V

  - ✓ **A**: Order
  - ✓ **X-----**: It is available of input within 0 ~ 16382 along the time axis in Vector mode.
  - ✓ **Y-----**: It is within -2048 ~ 2047 for Amplitude value in Vector mode.
  - ✓ It is available of selecting with [STEP ▲/▼] or [SHIFT]→[ADRS] / [DATA] Key.

5) Arbitrary Waveform Editing by Point Mode

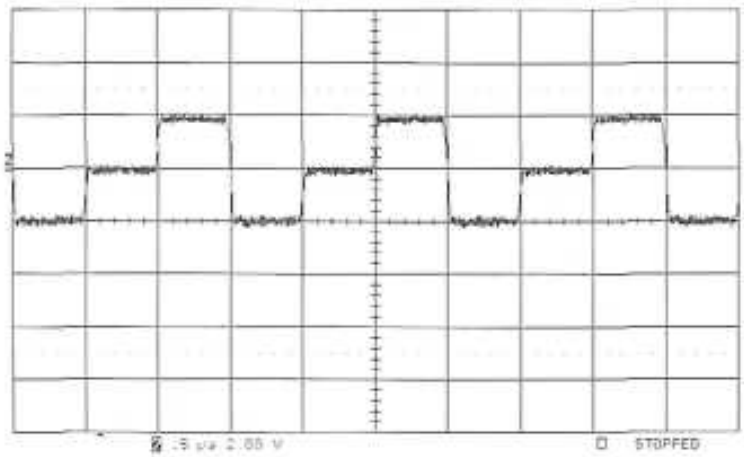
A	Point Number	INPUT DATA: 0 ~ 16382 INPUT IN ORDER
D	POINT Value (AMPLITUDE VALUE)	INPUT DATA[X]: -2048 ~ 2047 When Data value is not fixed, it is displayed in dash (----).

- It is convenient in editing sequential waveform along the time axis.
- Press [SHIFT]→[ARB EDIT]→[SHIFT]→[ARB MODE] to select POINT MODE.
- In Point mode, A is available of input within 0 ~ 16382 along the time axis.
- In Point mode, DATA[X] is within -2048 ~ 2047 for Amplitude value.
- It is available of using as WAVE DATA and store range is Address 0 ~ 4095.
- Example
  - ✓ Displays concretely waveform to edit.



  - ✓ The waveform as shown in the above diagram is edited with 3 points waveform having 0, 400 and 800 value.
  - ✓ To observe the waveform, connect Oscilloscope. (500ns/div)
  - ✓ DATA INPUT
    - ①. Select with FUNC [▲/▼] Key
    - ②. Frequency setting: [FREQ]→[2]→[MHz]
    - ③. Select ARB Editing Mode: [SHIFT]→[ARB EDIT]
    - ④. Select POINT mode: [SHIFT]→[ARB MODE] (Repeat this to select POINT mode!)
    - ⑤. Address setting: [ADRS]→[0]→[ADRS]
    - ⑥. Data input(X): [DATA(X)]
    - ⑦. Address setting: [ADRS]→[1]→[ADRS]
    - ⑧. Data input(X): [DATA(X)]→[4]→[0]→[0]→[DATA(X)]

⑨. Address setting: [ADRS]→[2]→[ADRS]
⑩. Data input(X): [DATA(X)]→[8]→[0]→[0]→[DATA(X)]

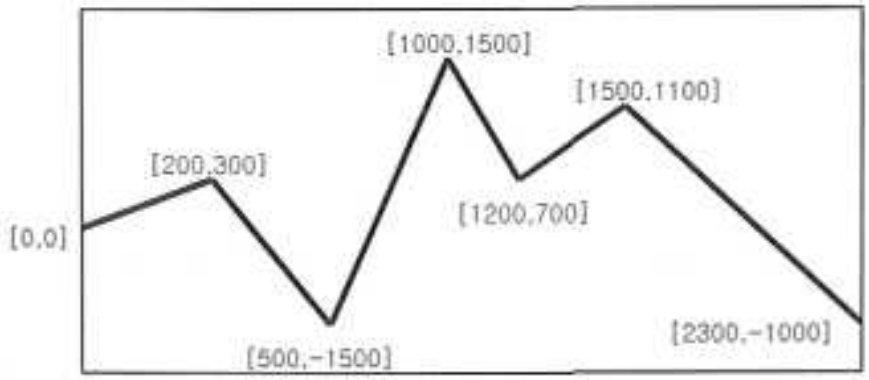


[Waveform output is Arbitrary waveform repealed every about 666kHz cycle.]

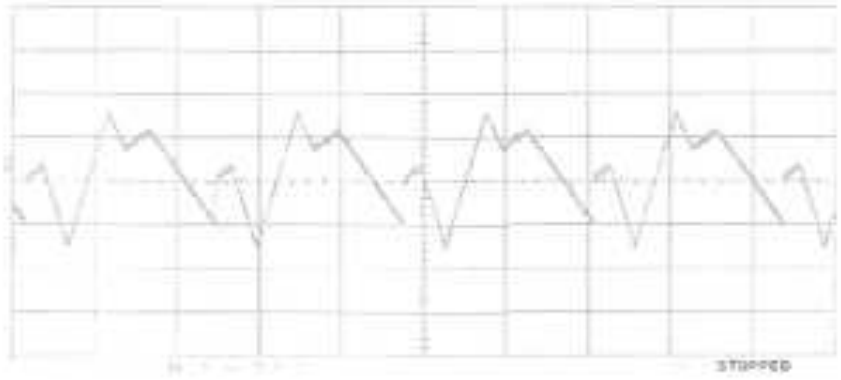
6) Arbitrary Waveform Editing by Vector Mode

A	Order	INPUT IN ORDER
X----	Time Axis Data	INPUT DATA [X]: 0 ~ 16382 When Data value is not fixed, it is displayed in dash(----).
Y----	AMPLITUDE VALUE	INPUT DATA[Y]: -2048 ~ 2047 When Data value is not fixed, it is displayed in dash(----).

- It is convenient in editing arbitrary waveform without the fixed interval.
- Press [SHIFT]→[ARB EDIT]→[SHIFT]→[ARB MODE] to select VECTOR MODE.
- If you want to remove, input the Address Number of an Intersection to remove and press [CLR] Key.
- DATA[X] INPUT is available of inputting 16382s along the time axis.
- DATA[Y] INPUT is within -2048 ~ +2047 for Amplitude value.
- It is available of using as WAVE DATA and store range is within Address 0 ~ 4095.
- Example
  - ✓ Displays concretely waveform to edit.



- ✓ The waveform as the above diagram is edited with seven VECTOR points including. (0,0), (200,300), (500,-1500), (1000,1500), (1200,700), (1500,1100) and (2300,-1000).
- ✓ To observe waveform, connect oscilloscope. (500ns/div)
- ✓ INPUT DATA
  - ①. Select "ARB" with FUNC [▲/▼] Key
  - ②. Frequency setting: [FREQ]→[2]→[MHz]
  - ③. Select ARB Editing Mode: [SHIFT]→[ARB EDIT]
  - ④. Select VECTOR Mode: [SHIFT]→[ARB MODE] (Repeat this to select VECTOR Mode)
  - ⑤. Address setting: [ADRS]→[0]→[ADRSI
  - ⑥. Data input(X): [DATA(X)]→[0]→[DATA(X)]
  - ⑦. Data input(Y): [DATA(Y)]→[0]→[DATA(Y)]
  - ⑧. Address setting: [ADRS]→[1]→[ADRS]
  - ⑨. Data input(X): [DATA(X)]→[2]→[0]→[0]→[DATA(X)]
  - ⑩. Data input(Y): [DATA(Y)]→[3]→[0]→[0]→[DATA(Y)]
  - ⑪. Repeat above procedures of (5) ~ (7) to input waveform as the following diagram.
  - ⑫. Address setting: [ADRS]→[6]→[ADRS]
  - ⑬. Data input(X): [DATA(X)]→[2]→[3]→[0]→[0]→[DATA(X)]
  - ⑭. Data input(Y): [DATA(Y)]→[-]→[1]→[0]→[0]→[0]→[DATA(Y)].



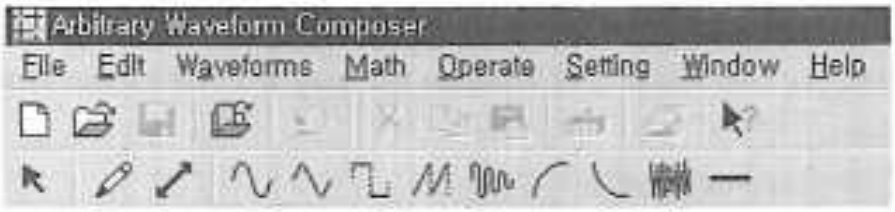
[The waveform output is Arbitrary waveform repeated every about 870Hz cycle]

4. GUI (Option)

1) Introduction

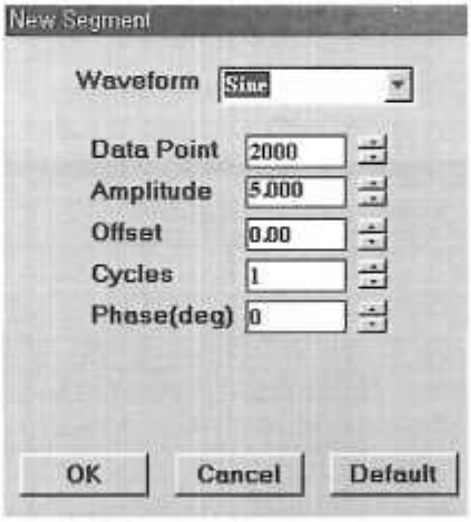
Arbitrary Waveform Composer is the software for IBM PC-Based Windows and the functions are follows;

①. Easy interface Environment



②. Basic waveform and Arbitrary waveform output

- It outputs basic waveform only by selecting icons in Edit Window provided by this program.
- Arbitrary waveform is available of output only by operating the mouse.
- When basic waveform is output, it is available of embodying various forms of waveform by changing conditions including Data Point, Amplitude, Offset, Cycles, Phase and Damp.



③. Edit Function

- By providing the following functions, it enables users to edit simply waveform on Edit Window.
- Edit Menu: Undo, Cut, Copy, Paste, Clear, Clear All, Select All
- Math Menu: Invert, Mirror, Add, Subtract. Multiply, Absolute, Expand to Fit

④. Save Function

- It saves data of waveform made on Edit Window in PC.
  Basic extension is .AFC.
- Files whose extensions are saved as .CSV or .PRN are available of using in other application programs by saving the data as ASCII type.

⑤. Import Function

- Imports data of waveform made in other programs.
- Provided that files available of import in this program shall be saved by the following conditions:

  ✓ Data Save mode: ASCII
  ✓ To save only Amplitude Data
  ✓ Each Amplitude Data is separated by "SPACE".
  ✓ Amplitude Data value is limited to the range within -5 ~ +5.

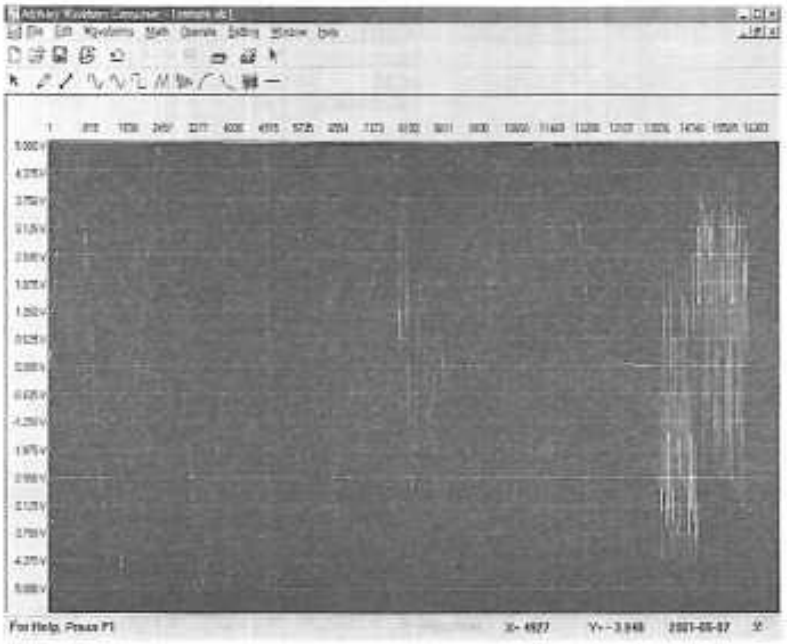
⑥. Download Function

- RS232 or GPIB
- It enables users to download data of waveform displayed on Edit Window by using this equipment.

⑦. Print Function

- It prints waveform displayed on Edit Window.

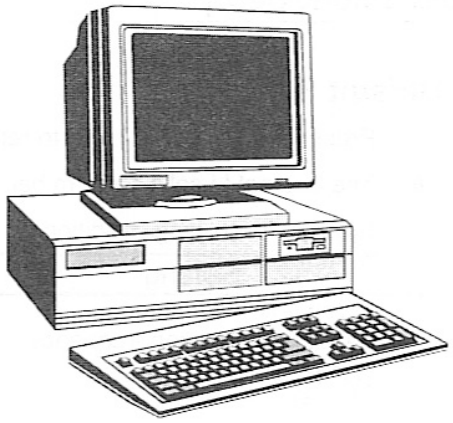
2) Example of Waveform



5. Architecture

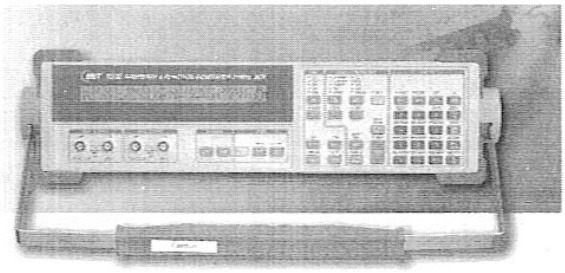
S/W for Arbitrary Waveform generation
[Arbitrary Waveform Composer] Use

- Arbitrary Waveform generation
- Waveform Download



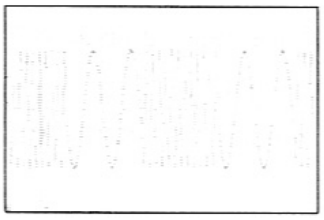
Arbitrary & Function Generator 31 MHz

- Waveform output in CH1 / CH2
- Basic waveform / Modulation waveform Selection
- Frequency Selection
- Output Level Selection

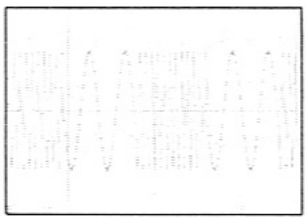


Used in various application fields

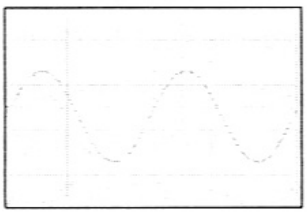
- Audio, Images
- Communication equipments
- Measuring instruments
- Electronic parts
- Construction
- Civil Engineering, Machinery
- Communication facilities
- Automotive - Industrial
- Biomedical
- Simulation
- Manufacturing Test



Test of Sound-Image Device



Standard Generator of Communication facilities



Electronic Equipment Production Adjustment

Instrument Setup

1. Default Setting

- Press [SHIFT] → [DEF] Key to return to initialization.
- The internal Li cells perform backup, and it memorizes all information even in power off.
- Initialization setting condition

Setting	Default Value
Frequency	20MHz
Arbitrary sampling frequency	20MHz
Amplitude	10Vp-p
Offset	0v
Inversion	Off
Phase (only available in Burst)	0°
Modulation function	Off
Modulation rate	0.1kHz
Modulation mode	AM
Modulation waveform	Sine
Sweep parameters	1 kHz start frequency and start marker 10MHz stop frequency and stop marker
AM parameters	100% depth, SINE
FM parameters	1MHz span, SINE
PM parameters	0° span, SINE
Burst parameters	10 cycle
Trigger Source	INT RATE
Trigger rate	0.001s
Interface (RS232, GPIB)	Off

2. Storing Setup

If you want to store the current setup, press [STO] Key and set from 0 to 15. Enter 0~15 numbers and press Unit Key to set the number of memory location.

3. Recalling Stored Setting

To reproduce the stored values, press [RCL] Key and enter stored numbers from 0 to15 of the numbers of memory location, and press Unit Key.

4. RS232 Setup

In order to set RS232 Interface, set the RS232/GPIB Selection switch on the rear panel to 1(↑). And then press [SHIFT] → [RS232j Key, set RS232 Interface to ON with STEP UP / DOWN [▲/▼] Key and set the communication speed. The communication speed is selected among 2400BPS, 4800BPS, 9600BPS and 19200BPS.

5. GPIB Setup (Option)

In order to set GPIB Interface, set the RS232/GPIB Selection switch on the rear panel to 0(↓). And then press [SHIFT] → [GPIB] Key and set GPIB Interface to ON with STEP UP / DOWN [▲/▼] Key. GPIB Address assignment is available of setting 0 ~ 30 address by using AO to A4 of Dip switch on the rear panel. Each switch has 0(↓) / 1(↑) value. Set address with the following formula.

Address	A0 (1)	A1 (2)	A2 (4)	A3 (8)	A4 (16)
0	0	0	0	0	0
1	1	0	0	0	0
2	0	1	0	0	0
3 - 29	1 - 1	1 - 0	0 - 1	0 - 1	0 - 1
30	0	1	1	1	1

Trouble Shooting

1. Power ON

- Check whether the power supply voltage converter of the rear panel is set to the required voltage.
- Check whether the fuse is installed exactly and the capacity.
- Check power cord connection.

2. Error Messages

The following list describes all Error Messages that may happen in this equipment.

MESSAGE	MEANING
Function ERROR	Function setting is incorrect.
DC-AC ERROR	Output is under [Vac]+[Vdc] > 5V. Offset or Amplitude should be set again.
FREQ. ERROR	Frequency out of a limit permitted of the current function is set.
VOLT ERROR	Output voltage out of 50mVp-p ~ 10Vp-p is set
INPUT ERROR	Input setting is incorrect.
NO APPLICATION	Function not coinciding with the current parameter is set.
REMOTE ERROR	External communication setting is incorrect.
OFFSET ERROR	DC output offset is set out of ±5V.
SELFTEST ERROR	It happens for self-test of this equipment and any problem occurs in the Hardware. If this error is displayed repeatedly, it means the electrical problem of the equipment.
Calibrate ERROR	Calibrate data of RAM has any problem. Data stored in ROM are used automatically. Unless this message is displayed periodically, it doesn't cause any problem.

3. RS232 Problems

Check whether RS232 interface is installed and whether the RS232/GPIB Selection switch on rear panel is 1(↑). Press [SHIFT]→[RS232] Key to check if proper Baud rate is set.

4. GPIB Problems

Check if GPIB interface is installed and whether the RS232/GPIB Selection switch on rear panel is 0(↓). Press [SHIFT]→[GPIB] Key, and if GPIB is not "ON", turn on GPIB with STEP key. Next, set GPIB address of the equipment to coincide with the address required by the control computer. You can set address from 0 to 30 with Dip switch on the rear panel.

Programming

1. Introduction

1) Setting of each mode
2) Reading and writing of data

2. Remote Control

1) Command mode
   "A0XXCRLF" A0: 2 characters of ASCII code
   XX: When data is required
   CRLF: Carriage Return & Line Feed (0D0AH)
2) Error output and Remote operation: When communication error or remote error occurs, "*REMOTE ERROR" is displayed and the buzzer sounds.
3) Because more than 10ms is required for processing a command, you should avoid continuous commands, if possible.
4) Under Remote status, key entry is available.

3. RS232 Specification

1) Synchronization: ASYNC
2) Stop Bit: 2
3) Parity: None
4) Data Length: 8bit
5) Communication Speed: 2400, 4800, 9600, 19200 BPS

4. RS232 Signal Line and Pin No.

1) When using RS232, use 9pin DSUB cable.

9301/9302 (9 pin)		
Pin*	Signal	
3	RxD	9301/02 ← Computer
2	TxD	9301/02 → Computer
7	CTS	9301/02 ← Computer
8	RTS	9301/02 → Computer
5	GND	-

2) RS232 Interface: Transmitting and receiving of data applies RTS / CTS control system.

5. GPIB Common Command

*IDN?	Return the identity "AWG9301/2,x.xxx"
*RST	Initialize the device ([SHIFT]-[DEF])
*ESR?	Return the contents of SESR
*CLS	Clear the contents of SESR
*TRG	Correspond to [TRIG] key

Contents of SESR

bit 7	PON	Set when Power ON
bit 6	URQ	Set when any key occurred
bit 5	CME	Set when received command is not recognized
bit 4	EXE	Set when received command is not performed
bit 3	DDE	NOT USED
bit 2	QYE	NOT USED
bit 1	RQC	NOT USED
bit 0	OPC	Set after one waveform

6. Frequency and Level Setting

1) Frequency setting: COMMAND + DATA(ASCII) + CR + LF

- In setting output frequency to 12.3456789MHz.

  Input: "E012.3456789" CRLF

- In setting output level to 8.2345Vrms,

  Input: "E>8.2345" CRLF

2) When you output the setting status: COMMAND + ? + CR + LF

- In outputting start frequency data

  Input: "E3?" CRLF
  Output: "1.23456" CRLF
  → This means 1.23456MHz of start frequency is set.

- In outputting offset level

  Input: "EA?" CRLF
  Input:"-1.2345" CRLF
  → This means -1.2345V of offset is set.

7. Function Mode Setting

1) Mode setting: COMMAND + CR + LF

- In setting Noise mode
  Input: "A5" CRLF

2) When you output the mode setting status: COMMAND + ? + CR + LF

- In outputting mode setting status
  Input: "A0?" CRLF
  Output: "5" CRLF
  → This means Noise mode is set.

8. Arbitrary Mode Setting

1) Setting Mode

Point Mode	COMMAND + ASCII DATA + CR + LF
Vector Mode	COMMAND + X(ASCII) + CR + LF, COMMAND + Y(ASCII) + CR + LF
Data Clear	COMMAND + X(ASCII) + CR+ LF

2) Read Setting Mode

Point Mode	ASCII DATA + CR + LF
Vector Mode	X(ASCII) + CR + LF, Y(ASCII) + CR + LF
Data Clear	X(ASCII) + CR + LF

9. Command Code

(* mark means default!)

1) Function Mode

Code	Meaning
*A0	Sets SINE mode
A1	Sets SQUARE mode
A2	Sets TRIANGLE mode
A3	Sets RAMP mode
A4	Sets ARBITRARY mode
A5	Sets NOISE mode
A0?	Outputs Setting mode

2) Modulation/Sweep Mode

Code	Meaning
*B0	Sets AW mode
B1	Sets FM mode
B2	Sets BURST mode
B3	Sets PM mode
B4	Sets LIN SWEEP mode
B5	Sets LOG SWEEP mode
B0?	Outputs Setting mode

3) Modulation/Sweep Wave Mode

Code	Meaning
*C0	Sets SINE mode
C1	Sets SQUARE mode
C2	Sets TRIANGLE mode
C3	Sets RAMP mode
C4	Sets SINGLE mode
C5	Sets ARBITRARY mode
C0?	Outputs Setting mode

4) Modulation/Sweep On Mode

Code	Meaning
*D0	Sets OFF mode
D1	Sets ON mode
D0?	Outputs Setting mode

5) Data Setting

Code	Meaning	Unit
*E0	Sets Out Frequency Data	MHz
E1	Sets Arbitrary Frequency Data	MHz
E2	Sets Frequency Modulation Span Data	MHz
E3	Sets Start Frequency Data	MHz
E4	Sets Stop Frequency Data	MHz
E5	Sets Sweep Center Frequency Data	MHz
E6	Sets Sweep Span Frequency Data	MHz
E7	Sets Start Marker Frequency Data	MHz
E8	Sets Stop Marker Frequency Data	MHz
E9	Sets Center Marker Frequency Data	MHz
E:	Sets Span Marker Frequency Data	MHz
E;	Sets Modulation Rate	kHz
E<	Sets Modulation Phase	DEG
E=	Sets Wave Phase	DEG
E>	Sets Amplitude Level	Vpp
E?	Sets Amplitude Level	Vrms
E@	Sets Amplitude Level	DBm
EA	Sets Offset Level	V
EB	Sets Amplitude Depth	%
EC	Sets Burst Counter	COUNT
ED	Trigger Rate	SEC
EE	Sets Arbitrary Point	
EF	Sets Arbitrary Vector	
EG	Sets Calibrate #	
EH	Sets Store Memo #	
EI	Sets Recall Memo #	
EJ	Sets Wave Data #	
E*?	Outputs Setting data	

6) CH1/CH2 Mode

Code	Meaning
*F0	Sets CH1 mode
F1	Sets CH2 mode
F0?	Outputs Setting mode

7) Arbitrary Mode

Code	Meaning
*G0	Sets CH1 mode
G1	Sets CH2 mode
G0?	Outputs Setting mode

8) Trigger Mode

	CH1	CH2
*H0	Sets POS EXT1	Sets POS EXT2
H1	Sets NEG EXT1	Sets NEG EXT2
H2	Sets LINE	Sets INT CH1
0H3	Sets INT RATE	Sets INT RATE
H4	Sets SINGLE	Sets INT/SINGLE
H0?	Outputs Setting mode	

9) Size Mode

Code	Meaning
*I0	SIZE mode OFF
I1	SIZE mode ON
I0?	Outputs Setting mode

10) Arbitrary and Calibrate Data Setting Mode

	Arbitrary Point	Vector	Calibrate
*J0	Address mode	Address mode	Address mode
J1	Data mode	X Data mode	Data mode
J2	N/A	Y Data mode	N/A
J0?	Outputs Setting mode		

11) Up / Down Mode

Code	Meaning
L0	Up Operation
L1	Down Operation
L0?	Outputs Setting Mode

12) Span = Marker Mode

Code	Meaning
M0	Set Span Data as Marker Data.
N0	Set Marker Data as Span Data.

13) Wave Data Store / Recall Mode

Code	Meaning
O0	Enters Store mode
P0	Enters Recall mode

14) Menu Data Display Mode

Code	Meaning
K0	Displays Out Frequency
K1	Displays Arbitrary Frequency
K2	Displays Frequency Modulation Span
K3	Displays Start Frequency
K4	Displays Stop Frequency
K5	Displays Sweep Center Frequency
K6	Displays Sweep Span Frequency
K7	Displays Start Marker Frequency
K8	Displays Stop Marker Frequency
K9	Displays Center Marker Frequency
K:	Displays Span Marker Frequency
K;	Displays Modulation Rate
K<	Displays Modulation Phase
K=	Displays Wave Phase
K>	Displays Amplitude Level
K?	Displays Amplitude Level
K@	Displays Amplitude Level
KA	Displays Offset Level
KB	Displays Amplitude Depth
KC	Displays Burst Counter
KD	Displays Trigger Rate
KE	Displays Arbitrary Point
KF	Displays Arbitrary Vector
KG	Displays Calibrate #
KH	Displays Store Memo #
KI	Displays Recall Memo #
KJ	Displays Wave Date #
K0?	Setting Output

15) Setting Store / Recall

Code	Meaning
Q0	Stores in the set No
R0	Recalls from the set No

16) Data Default Setting

Code	Meaning
*S0	Initialization

17) Arbitrary Data All Clear

Code	Meaning
*T0	Initializes all Arbitrary data

18) TTL, ECL Level Setting

Code	Meaning
*U0	Sets TTL level
U1	Sets ECL level

19) Arbitrary Data Setting

Code	Meaning
*V0	Sets data in the address set currently
V1	Sets data in the address set currently, and then adds 1 to the address.
V2	Outputs data of the address set currently
V0?	Outputs data of from address 0 to the currently set address

20) Single Trigger Mode Setting

Code	Meaning
*W0	SINGLE Trigger setting

21) Wave Phase 0DEG Setting

Code	Meaning
X0	Sets Wave Phase to 0 DEG

22) Wave Invert Setting

Code	Meaning
Y0	Wave Invert OFF
Y1	Wave invert ON

10. Program example

'Language: QuickBasic
'COM1, Baud: 9600, Data Bits: 8Bit, Parity: NONE, Stop Bits: 1 Bit
'The following is an example to download 100 data of Sine waveform in Arbitrary Point Mode.
'There are ASCII type and Binary type to download data.
'While ASCII type is generally available of programming easily, the transmission speed is slower than Binary type.

- **ASCII Type**

```
DECLARE SUB delay ()
CLS   'Clear Screen
CONST Pi = 3.14159
CrLf$ = CHR$(13) + CHR$(10)
OPEN "COM1:9600, N, 8, 2, CS5000, DS5000, BIN" FOR RANDOM AS #1   ' Port Open
```

```
PRINT #1, "F0" + CrLf$; ' Select CH1
delay
PRINT #1, "A4" + CrLf$; ' Select Arb. Mode
delay
PRINT #1, "G0" + CrLf$; ' Select Point Mode
delay
PRINT #1, "T0" + CrLf$; ' Clear all Arbitrary Data
delay
PRINT #1, "EE0" + CrLf$;
' Enter address setting to 0 in Arbitrary Point, then address is set to 0.
delay
' Sending data to download
'  Available input data range in the equipment: -2048 ~ 2047
'  For V1 command, set data to the set current address, and adds to Address +1.
'  V1 command sets data to the set current address and Address=Address + 1

slice = 2* Pi / 100
FOR addr = 0 to 99
      datapoint = INT(2047.5 * SIN(addr * slice))
      REM     PRINT #1, "V1" + STR$(dataPoint) + CrLf$;
      strlmsi$ = "V1" + LTRIM$(STR$(datapoint))
      PRINT slice, addr, datapoint, STR$(datapoint), strlmsi$
      PRINT #1, strlmsi$ + CrLf$;
      delay
NEXT

' To check the downloaded data from 0 address, set Address to 0'.
PRINT #1, "EE0" + CrLf$;
CLOSE #1
' Port Close

'Interval time in sending the next data after sending the command.
SUB delay
      start = TIMER
      DO UNTIL check >= start + .1
            check = TIMER
      LOOP
END SUB
```

- **Binary Type**

```
DECLARE SUB delay ()
CLS   'Clear Screen

CONST Pi = 3.14159
CrLf$ = CHR$(13) + CHR$(10)

OPEN "COM1:9600, N, 8, 2, CS5000, DS5000, BIN" FOR RANDOM AS #1   ' Port Open

PRINT#1, "F0" + CrLf$;  ' Select CH1
delay
PRINT #1, "A4" + CrLf$; ' Select Arb. Mode
delay
PRINT #1, "G0" + CrLf$; ' Select Point Mode
delay
PRINT #1, "T0" + CrLf$; ' Clear all Arbitrary Data
delay
PRINT#1, "EE0" + CrLf$;
'Enter address setting to 0 in Arbitrary Point Mode, then the address is set to
0.
delay
' "V2100": Outputs 1 data to the current address
'This means it inputs 100 data from 0 to 99 address.
PRINT #1, "V2100" + CrLf$;
Delay

'Sending data to download.
'When sending data in Binary Type
'to express data range of -2048 ~ 2047
'Change data expression range from 0 to 4095 as Data + 2048 and send it.
'When sending data in Binary Type, send continuously them without Delay Time.
slice = 2*Pi/100
FOR addr = 0 TO 99
      datapoint = INT(2047.5 * SIN(addr * slice)) + 2048
      a = datapoint MOD 256
      b=INT(datapoint/256)
      strData$ = strData$ + CHR$(a) + CHR$(b)
```

```
NEXT
PRINT #1, strData$

'A little delay time is required so that data be written in memory of the equipment.
FOR i = 0 TO 4
      delay
NEXT

'Set address to 0 to check the downloaded data from 0 address.
PRINT #1, "EE0" + CrLf$;

Port Close
CLOSE #1

'Interval time in sending the next data after sending the command
SUB delay
      start = TIMER
      DO UNTIL check >= start + .1
            check = TIMER
      LOOP
END SUB
```

Product Management

1. Warranty

This equipment is shipped and comes into the market through the rigid quality control and inspections. If this product is broken in normal use, we repair it on the basis of "Warranty" mentioned in this manual.

2. A/S

This equipment was made in consideration of various conditions for the use, so is designed, produced and examined in order to get a better operating condition by performing several environmental tests. If this product is broken, contact a sales office of our company or the agency you bought it, and request A/S.

3. Damage Precautions

1) Power cord use: Use the specified power cord in this equipment to prevent it from fire.
2) Overvoltage protection: Don't use out of the specified range in this terminal to prevent it from electrical shock and fire.
3) Product ground: This equipment is grounded through the earth of power cord. To avoid electrical shock, the ground of connector should be connected in earth ground. Before connecting to input/output terminal of this equipment, be sure that it is grounded properly.
4) Don't operate without the case: To avoid electrical shock and fire, don't operate this equipment when the case and panel are removed.
5) Use the standard fuse: To prevent fire, use only the specified type of a fuse in this equipment.
6) Avoid the operation in damp places or room covered with dust: To avoid electrical shock, don't operate it in damp places or room covered with dust.

4. Maintenance and Repair

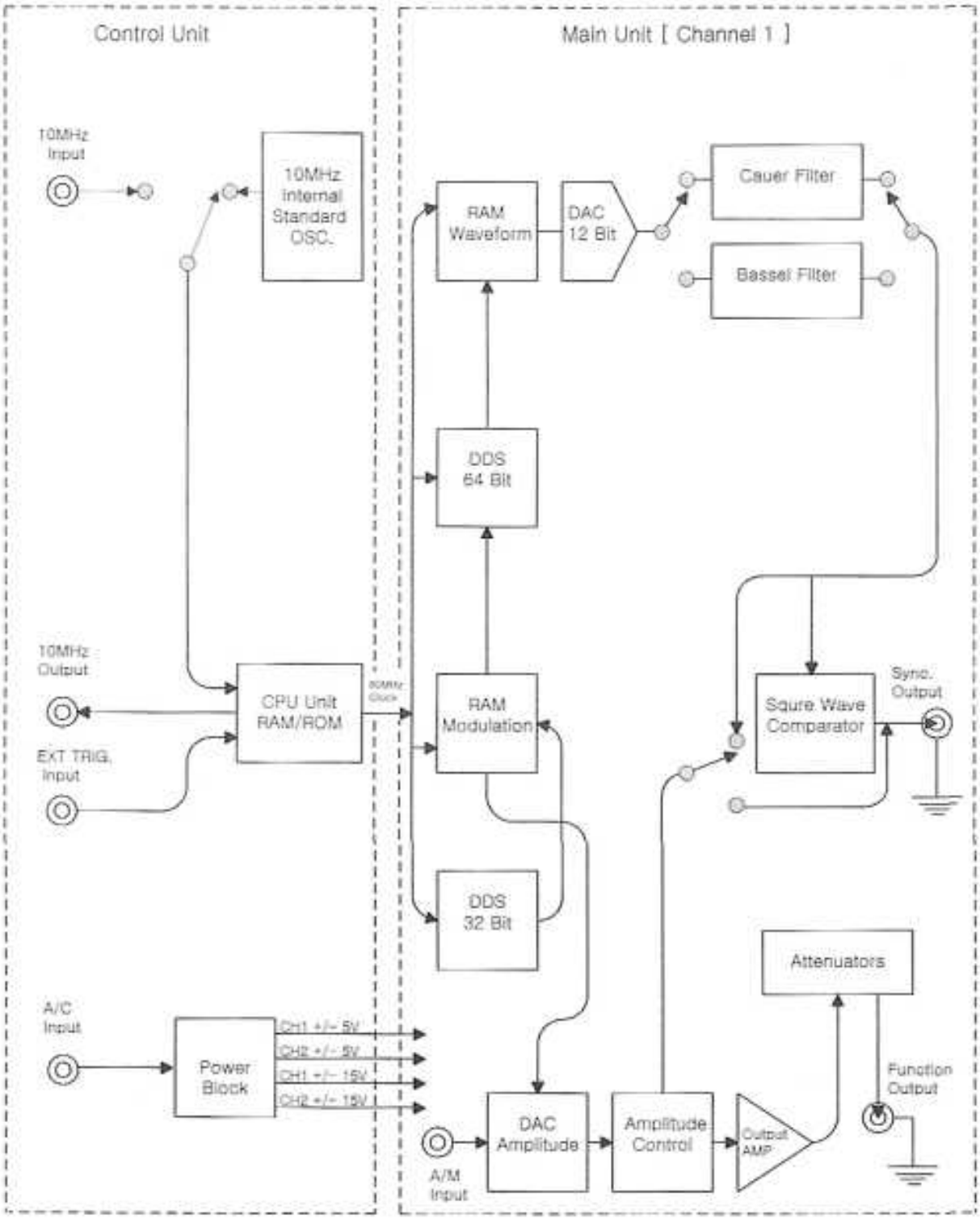
This equipment consists of many high-precision parts. In treating and maintaining this equipment, be careful not to damage them. The optimum keeping temperature is -10°C ~ +60°C. If the panel side is dirty, rub the part with a clean and soft cloth and if the dirt isn't removed well, clean the part softly with a cloth damped in a neutral detergent or alcohol. Never use high volatile solvent such as benzene or thinner. This equipment contains extra two fuses in shipping.

5. Calibration Period

In order to keep this equipment in the stable and effective operating condition, calibrate it every 1,000 hours operation or every six months.

Appendix

1. Block Diagram



2. What is modulation?

1. Amplitude Modulation (AM)

Amplitude Modulation means to transmit by changing amplitude of carrier with modulation (information) signal to send, and generally AM means DSB-LC (Double SideBand-Large Carrier) that frequency spectrum has two sidebands and the modulated wave contains carrier.

If Carrier is $e_c = E_c \sin \omega_c t$. and Signal wave is $e_s = E_s \sin \omega_s t$.
The process to load the signal wave on the carrier is as the following equation;

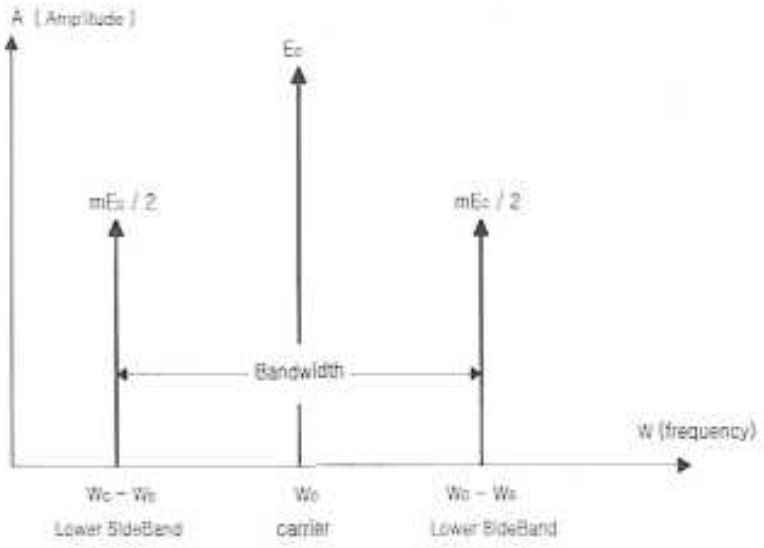
$$E_c = E_c + E_s \sin \omega_s t$$

Amplitude-modulated signal (Modulated wave) **e** is

$$e = (E_c + E_s \sin \omega_s t) \sin \omega_c t$$
$$= E_c \sin \omega_c t + m/2 * E_c \cos(\omega_c - \omega_s)t - m/2 * E_c \cos(\omega_c + \omega_s)t$$

Carrier Lower Sideband Upper Sideband

(Here, **m** indicates modulation level and $m - E_s/E_c$)



[Frequency Spectrum of Amplitude Modulation (In modulating single frequency)]

Amplitude Modulation consists of three separated frequencies, and center frequency of carrier has the highest amplitude and the other two sidebands (upper, lower) are similar to carrier but their amplitude may not exceed half of the carrier.

2. Frequency Modulation (FM)

FM is to change frequency of carrier according to signal wave, keeping the amplitude of carrier constant.

If Carrier is $e_c = E_c \sin \omega_c t$ and Signal wave is $e_s = E_s \cos \omega_s t$,

If Changing by the amount, $k - E_s \cos \omega_s t$, in proportion to signal wave centered on angular frequency of carrier (ω_c),

Instantaneous angular frequency is $\omega = \omega_c + k * E_s \cos \omega_s t$

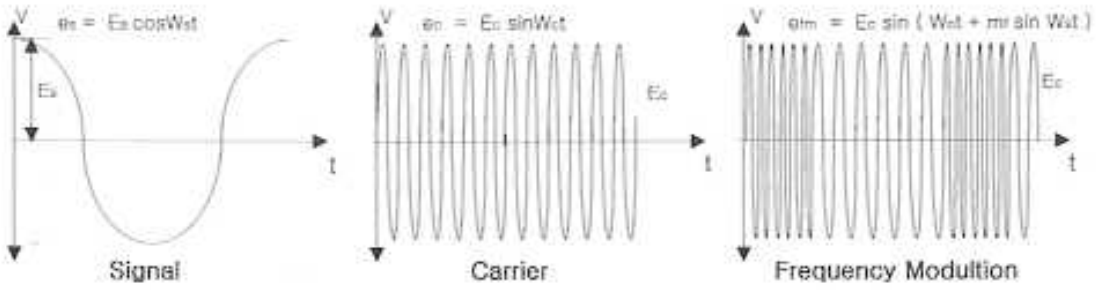
Since of the above formula changes depending on signal wave, if assuming the former angular displacement as,

$$\omega = d\theta/dt = \omega dt = \omega_c t + k * E_s / \omega_s * \sin \omega_s t$$

Consequently, frequency-modulated wave e_{fm} is

$$e_{fm} = E_c \sin(\omega_c t + k * E_s / \omega_s * \sin \omega_s t)$$
$$= E_c \sin(\omega_c t + m_f \sin \omega_s t)$$

[m_f (Modulation Degree) = f_d (Maximum Angular Frequency Deviation) / f_s (Frequency of Signal wave)]



3. Phase Modulation (PM)

Phase Modulation means to change phase of carrier according to amplitude of signal wave, keeping the amplitude of carrier constant.

If Carrier is $e_c = E_c \sin(\omega_c t + \theta_c)$ and Signal Wave is $e_s = E_s \sin \omega_s t$,

If changing the phase of earner by the amount, KE_s in proportion to E_s, amplitude of signal wave according to ω_s,

Then, phase instantaneous value θ_c is
$\theta = \theta_c + KE_s \cos \omega_s t = \omega_c dt + \theta = \omega_c t + \theta c + KE_s \cos \omega_s$
so you can calculate angular displacement.

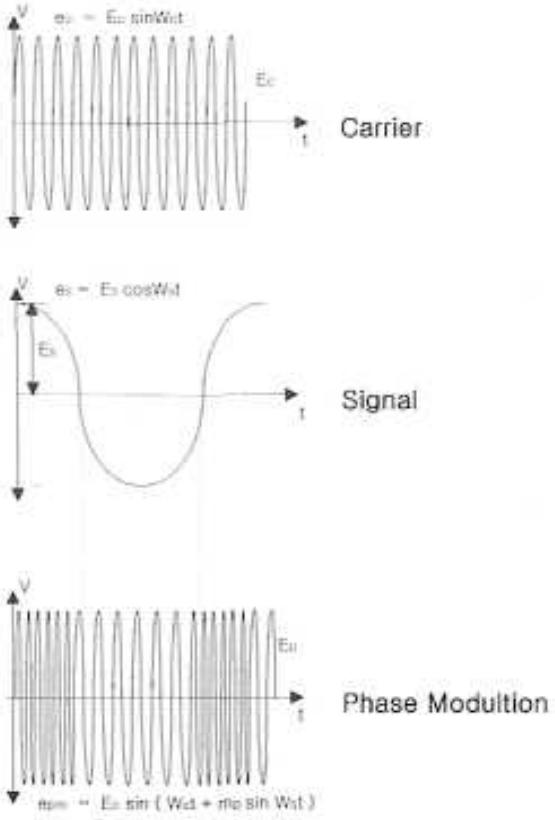
Since θ_c in the above formula is fixed depending on adjusting the standard of t with phase angle in $t = 0$,

Assuming $\theta_c = 0$,

Phase-modulated wave e_{pm} is as follows;

$$e_{pm} = E_c \sin(\omega_c t + m_p \cos \omega_s t)$$

[m_p (Phase Modulation Exponent) = $KE_s = \theta$]



3. DATA SHEET

PRODUCT NAME	**Arbitrary & Function Generator 31 MHz**			
MODEL NAME	**MIT 9302**		**INSPECTOR**	
SERIAL NO			**DATE**	**200**

NO	TEST ITEM		SPECIFICATION			CH1 DATA	CH2 DATA
1	**INITIAL**		OK				
2	**LCD Display**		OK				
3	**KEY, LED**		OK				
4	**FREQUENCY ACCURACY**	1kHz	±3 PPM	±0.003Hz		kHz	KHz
		10MHz		±30Hz		MHz	MHz
		31MHz		±90Hz		MHz	MHz
5	**SINE AMPLITUDE ACCURACY**	1KHz/1V	±0.4dB	1.05	0.95	V	V
		1KHZ/10V	±0.2dB	10.23	9.77	V	V
		31MHz/1V	+ 0.8dB	1.10	0.90	V	V
		31MHz/ 10V	±0.9dB	11.09	8.91	V	V
6	**SQUARE AMPLITUDE ACCURACY**	1KHZ/1V	±5%	1.05	0.95	V	V
		1 KHz/10V	±3%	10.30	9.70	V	V
		31MHZ/1V	±16%	1.16	0.84	V	V
		31MHz/ 10V	±15%	11.50	8.50	V	V
7	**TRIANGLE /RAMP AMPLITUDE ACCURACY**	1kHz/1V	±5%	1.05	0.95	V	V
		1kHz/10V	±4%	10.40	9.60	V	V
		2MHz/ 1V	±9%	1.09	0.91	V	V
		2MHZ/10V	±8%	10.80	9.20	V	V
8	**ARB POINT AMPLITUDE ACCURACY**	1KHZ/1V	±5%	1.05	0.95	V	V
		1KHZ/10V	±4%	10.40	9.60	V	V
		40MHz/1V	±9%	1.09	0.91	V	V
		40MHz/10V	±8%	10.80	9.20	V	V

[1/2] A4(210x297)