SYNTHESIZED FUNCTION GENERATORS

7061
Synthesized Function Generators
FG200 & FG300

FG220 (706112)
213 × 132 × 350mm 5kg
(8-3/8 × 5-1/4 × 13-3/4" 11.0 lbs)

FG320 (706122)
213 × 132 × 350mm 5kg
(8-3/8 × 5-1/4 × 13-3/4" 11.0 lbs)

CE GP-IB

★ Safety Standards; EN61010-1
EMC Standard; Certified by EMC Projects Limited
(U.K. Competent Body)
EN55081-1: 1992 (EN55022 Class B)
Immunity Standard; EN50082-1: 1992

The FG200 Series function generators feature sweep and modulation capabilities with outstanding ease of operation. The FG300 Series adds arbitrary sweep and simple arbitrary waveform definition capabilities, plus sequencing functions, giving you high performance along with ease of use.

The powerful sweep and modulation capabilities of these instruments make them ideal for applications in mechatronics, and vehicle design and testing.
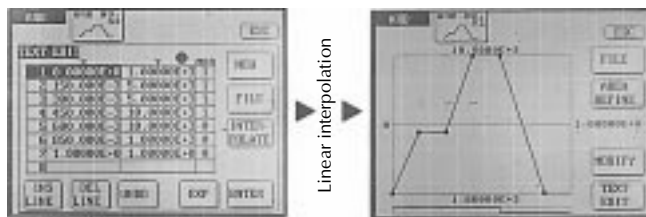
FEATURES

- **Frequencies from 1 μHz to 15 MHz**
  Frequency range: 1 μHz to 15 MHz (Sine, Square)
  1 μHz to 200 kHz (Triangle, Pulse, Arbitrary waveform)
  High resolution: 1 μHz or 9 digits max
- **Easy Setup and Display of Arbitrary Sweep Patterns and Simple Arbitrary Waveforms (FG310/FG320)**
  You define the waveforms by entering points within the scaled ranges for the X (time) and Y (parameter) axes. The waveform can be generated using linear, step, or spline interpolation between the points. Moreover, you can load the data in ASCII format from an MS-DOS floppy disk—so you can set up the data in Excel or the spread-sheet of your choice. You can use arbitrary waveforms thus defined as output waveforms or as sweep patterns.
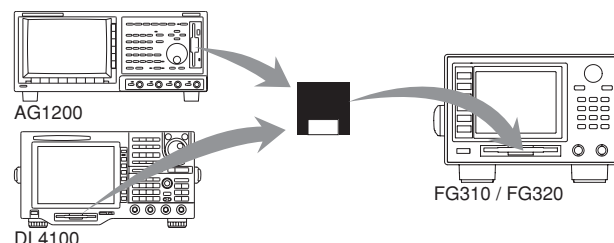
Text data input window   Linear interpolation   Arbitrary wavefom display screen

- **Load and Modify Waveforms on Floppies from Other Instruments (FG310/FG320)**
  You can also use the floppy interface to load waveforms created with YOKOGAWA AG Series arbitrary waveform generators, or captured with YOKOGAWA digital oscilloscopes such as the

DL4100, or DL5140/DL5180. You can then either output them as is, or, with the FG300 Series, make further modifications before use.

AG1200

DL4100

FG310 / FG320

- **Output Terminals**
  You can set all parameters, such as output on/off, waveform type, frequency, amplitude, sweep, and modulation, independently for each of the channels. Maximum output voltage is ±10 V into open, and the wide frequency range extends from 1 μHz to 15 MHz (sine or square wave).

- **Intuitive Touchscreen Based Operation**
  In the past, high-performance function generators were not very easy to operate. With conventional key-based front panels there were just too many keys.
  Thanks to the large LCD display and touchscreen features of the FG200 & FG300 Series, we've solved that problem by putting adequate information on each display, and giving them a much more user-friendly interface.
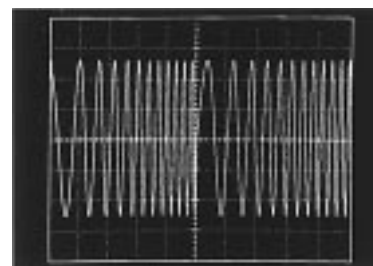
Waveform select key   WAVE screen   Waveform select window

FUNCTIONS

- **Versatile Sweep and Modulation Functions**
  With these instruments you can sweep not only frequency, but also other parameters as well, such as phase, amplitude, offset voltage, or duty cycle, with linear, log, linear step, log step, or arbitrary (FG310/FG320) sweep patterns. You can even sweep frequency and amplitude at the same time.
  Modulation capabilities include not only AM/FM, but also DSB-AM, phase modulation (PM), offset modulation, and PWM.The modulation waveform can be sine or triangle (with variable symmetry), pulse, (with variable duty cycle), or an arbitrary user-defined waveform (FG310/FG320).
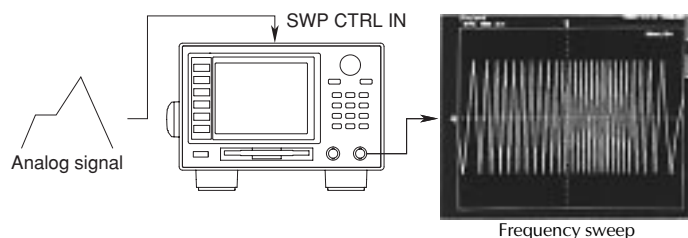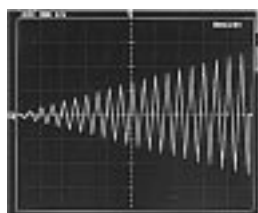
Frequency sweep

● **External Control of Sweep by Analog or Digital Signals (/R1 Option)**

Although these are digital function generators, you can still control the sweep parameters with an external analog signal. You can also control them directly with external digital signals. And you enjoy the high accuracy and repeatability that you can only get with digital technologies.
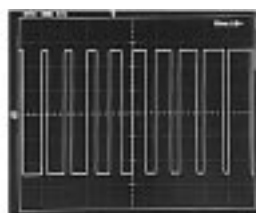
SWP CTRL IN

Analog signal

Frequency sweep

● **Amplitude and Duty Cycle Continuously Variable**

With the FG200 & FG300 Series, the output signal is not disrupted even if you continuously vary a parameter such as frequency, phase, amplitude, offset voltage, or duty cycle. Duty cycle setting range is 0% to 100%, with 0.01% resolution.
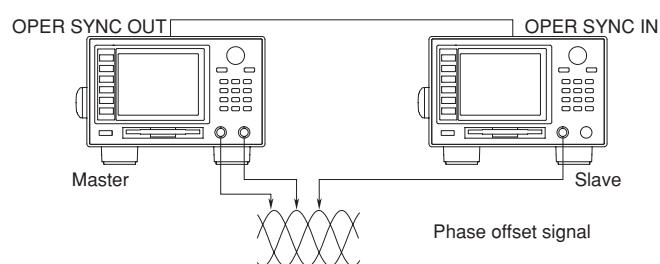
Continuously variable amplitude   Continuously variable duty cycle
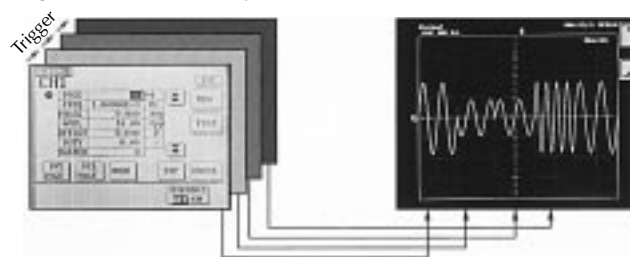
● **Multichannel Output Via Synchronized Operation**

By linking multiple units in parallel with the accessory connecting cables, you can obtain three or even more channels of phase-synchronized signals, and even synchronize the sweep.
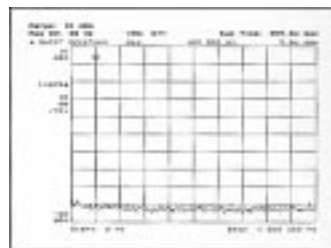
OPER SYNC OUT   OPER SYNC IN

Master   Slave

Phase offset signal

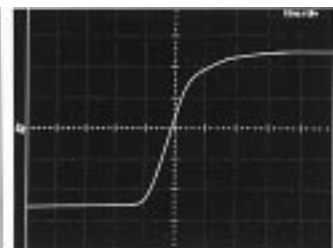● **Up to 256 Programmed Sequence Steps (FG310/FG320)**

The sequencing function lets you define sets of parameters for the frequency, phase, amplitude, offset voltage, and duty cycle and select them sequentially via trigger events. You can also specify sets of parameters directly with external digital control signals (with the /R1 option).

Trigger

■ **OUTSTANDING BASIC PERFORMANCE**

Spectrum purity
Sine waveform at 100kHz into 50 load, amplitude setting 20 Vp-p

Pulse characteristics at rise time 18.6ns (actual value)
Square waveform at 500kHz into 50 load, amplitude setting 20 Vp-p

■ **FG200 & FG300 SERIES FUNCTION COMPARISON**

Function	FG210	FG220	FG310	FG320
Output channels	1	2	1	2
Sweep	Yes	Yes	Yes	Yes
Arbitrary sweep	No	No	Yes	Yes
Modulation	Yes	Yes	Yes	Yes
Arbitrary waveform generation	No	No	Yes	Yes
Sequencing	No	No	Yes	Yes
Built-in 3.5" floppy drive	No	No	Yes	Yes
External analog/digital Signal-controlled sweep	*	*	*	*

*: Comes with option /R1

■ APPLICATION EXAMPLE

OPER SYNC Out — OPER SYNC In

FG320 MASTER   **FG320** SLAVE

Input | ABS module

Vehicle speed signal

Antilock Braking System module testing using FG320

TC110/TC120
Universal Counter
with /D1 option

or
F/V converter

Engines
motors

Data recorder
Field data
collection

Data recorder
R & D
Data playback

Frequency
sweep

SWP CTRL IN (/ R1)

Simulated
test signal

RPM
limiter
circuit

RPM limiter circuit testing using FG200/FG300 Series and data recorder

■ OUTPUT WAVEFORM EXAMPLE

Damped waveform

AM

Trigger burst waveform

Frequency & amplitude sweep waveform

PWM (pulse width modulation)

FSK (frequency shift keying)

FG310 / FG320 / R1

VCF (voltage controlled frequency)

VCA (voltage controlled amplitude)

Electrocardiogram waveform

FG210 / FG220 / FG310 / FG320 / R1

FG310 / FG320

SPECIFICATIONS

● Waveform Output

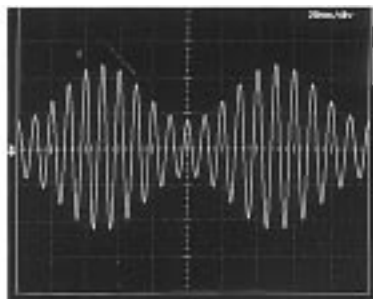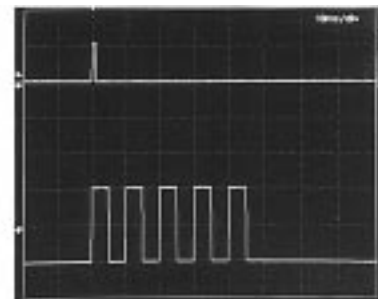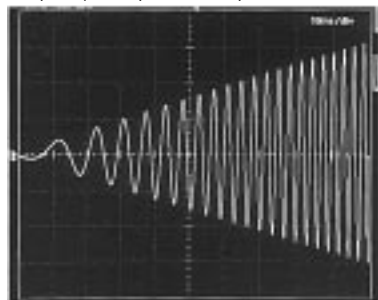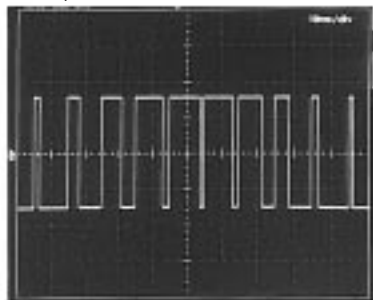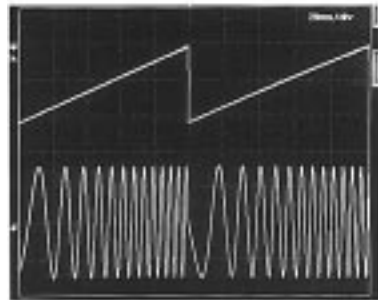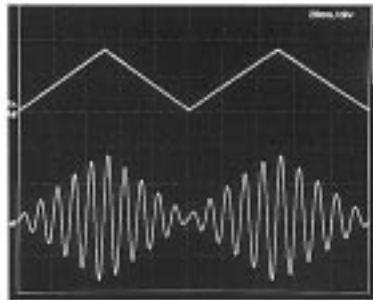|	
Output channels	**FG220/FG320**: 2 channels **FG210/FG310**: 1 channel
Output waveforms	Sine, Square (fixed 50% duty cycle), Triangle (variable symmetry), Pulse (variable duty cycle), or Arbitrary waveform (**FG310/FG320**)
Output signal	Continuous output(CONT): Waveform output continuously **FG220/FG320**: Switchable between phase-continuous and internal-channel synchronized output **FG210/FG310**: Phase-continuous only Triggered output (TRIG) Output preset number (integer) of burst waveforms on trigger sync Gated output (GATE) Output integer number of burst waveforms while enabled by gate DC output (DC) Output DC voltage

● Frequency

Frequency range	Sine or Square waveform	1 μHz to 15 MHz
	Triangle or Pulse waveform	1 μHz to 200 kHz
	Arbitrary waveform (FG310/FG320)	1 μHz to 200 kHz
Resolution	1 μHz or 9 digits max.	
Frequency accuracy	±20 ppm	
Frequency stability	±20 ppm (at ambient temperature of 5 to 40°C)	
Reference clock	40.2107 MHz	

● Output Characteristics

Maximum output voltage***	±10 V
Amplitude setting range***	±20 Vpp (setting resolution 1 mVpp) (negative amplitude represents inverted waveform)
Amplitude accuracy*** (1 kHz sine wave)	±(0.8% of setting + 14 mVrms)
Amplitude frequency characteristics*	Sine waveform ≤100 kHz ±0.1 dB ≤1 MHz ±0.2 dB ≤10 MHz ±0.5 dB ≤15 MHz ±1 dB Square/Pulse waveform (50% duty cycle) ≤10 kHz ±2% Triangle waveform (50% symmetry) ≤10 kHz ±3%
Offset voltage setting range***	±10 V (setting resolution 1 mV)
Offset voltage accuracy***	±(0.3% of setting + 0.5% of amplitude setting +40 mV)
Output impedance	50 Ω ±1% (open when output OFF)
DC output setting range***	±10 V (setting resolution 1mV)
DC output accuracy***	±(0.3% of setting + 20 mV)
Output attenuator setting range	1/1, 1/10, 1/100
Output attenuator accuracy***	0.2%
Interchannel crosstalk**(**FG220/FG320**)	-65 dB max.

*   Rms measurements referenced to output at 1 kHz into 50 Ω load, amplitude setting 20 Vpp, offset voltage 0V
** Crosstalk between channels 1 and 2 with 50 Ω load, amplitude setting 20 Vpp, offset voltage 0V, Ch1 set for 15 MHz sine wave, Ch2 set for 10 MHz sine wave.
*** High-impedance load

● Sine Waveform Purity

Harmonics* (maximum of 2nd to 5th harmonic components)	100 kHz -55 dBc max. 1 MHz -45 dBc max. 10 MHz -35 dBc max. 15 MHz -25 dBc max.
Harmonic distortion* (rms value of 2nd to 5th harmonic components)	100 kHz 0.3% max.
Spurious* (1 kHz to 100 MHz frequency range)	100 kHz -55 dBc max.

* Measured with amplitude setting 20 Vpp, offset voltage 0V, into 50 Ω load

● Square, Pulse and Triangle Waveform Characteristics

Rise time*	Square waveform 30 ns max. (10% to 90%) Pulse waveform 100 ns max. (10% to 90%)
Overshoot*	±5% max. of output peak-to-peak value
Duty cycle setting* (pulse waveform)	Setting range 0% to 100% (setting resolution 0.01% or 25 ns) Time accuracy ≤10 kHz ±0.2% of (1/frequency setting) Jitter 1 clock period
Symmetry* (Triangle waveform)	Setting range 0% to 100% (setting resolution 0.01% or 25 ns) Jitter 1 clock period

* Measured with amplitude setting 20 Vpp, offset voltage 0V, into 50 Ω load

● Phase

Utilization	Starting/stopping phase of triggered or gated output. Channel-to-channel phase difference setting during 2-channel output
Setting range	-10000 deg to + 10000 deg (setting resolution 0.01 deg)

● Sweep Characteristics

Sweep types	Linear, Log, Linear step, Log step, or Arbitrary pattern (**FG310/FG320**)
Sweepable parameters	Frequency, phase, amplitude, offset voltage, duty cycle, or simultaneous frequency and amplitude (sweepable range for each parameter is same as setting range during normal output)
Sweep time setting range	1 ms to 10000 s (setting resolution 10 μs or 5 digits max.)
Sweep ratio	0% to 100% (setting resolution 0.01% or 1.6 μs)
Sweep modes	Continuous mode (REP) Perform continuously repeating sweep of each parameter Single sweep (SINGLE) Perform single sweep synchronized to trigger Single & hold sweep (SGL&HLD) Perform single sweep synchronized to trigger, continuing when finished to output waveform with final parameter values

● Modulation Characteristics

Carrier	Sine, Square (fixed 50% duty cycle), Triangle (variable symmetry), Pulse (variable duty cycle), or Arbitray waveform (**FG310/FG320**), Output characteristics same as during continuous output
Modulation types	AM Modulation setting range 0% to 100% (setting resolution 0.01%) DSB-AM FM Max. deviation setting range 0 Hz to 7.5 MHz (setting resolution 1 μHz or 9 digits) Phase modulation (PM) Max. deviation setting range 0 deg to 360 deg (setting resolution 0.01 deg) Offset modulation Max. deviation setting range 0 V to 10 V (setting resolution 1 mV) PWM Max. deviation setting range 0% to 50% (setting resolution 0.01%)
Modulation waveform	Sine, Triangle (variable symmetry), Pulse (variable duty cycle), or Arbitrary waveforms (**FG310/FG320**)
Modulation frequency	1 mHz to 50 kHz (setting resolution 1 mHz)

● Sequence (FG310/FG320)

Sequence mode	Sequential switching of output waveform sets of parameters under trigger control
Affected parameters	Can set frequency, phase, amplitude, offset voltage, and duty cycle for each step
Number of steps	1 to 256 (returns to step 1 after last step)

● Arbitrary Waveform (FG310/FG320)

Output amplitude resolution	12 bits	
Memory length	8192 points (not all points will be output if frequency exceeds 4.9 kHz)	
Waveform definition functions	Definable waveforms	Output waveform, sweep pattern
	Number of settings	8
	Interpolation	Linear, step, or spline

● Trigger/Gate

Trigger source	External trigger, Internal trigger, Manual trigger, or GP-IB command
Internal trigger frequency setting range	1 mHz to 50 kHz (setting resolution 1 mHz)
Burst cycle setting range	1 to 65535 cycles (in 1-cycle steps)
Gate source	External gate, or Manual gate

● Synchronized Operation

Number of units	Up to eight units can be operated in synchronization
Output delay	70 ns (typ.) for each unit [25 ns (typ.) for each unit when triggered]

● Other Functions

Setup data retention	10 sets of parameters can be saved to and recalled from non-volatile memory
Preset TTL	Sets amplitude 5 V, offset voltage 2.5 V (with high-impedance load)
Waveform output ON/OFF	Output can be switched ON/OFF independently for each channel
Parameter copy (**FG220/FG320**)	Copies setup parameters between channels (CH1→CH2/CH2→CH1)
Dual setup (**FG220/FG320**)	Setup parameters can be changed simultaneously on both channels

● Built-in Floppy Disk Drive (FG310/FG320)

Drive type	3.5" floppy disk drive
Number of drives	1
Formats	MS-DOS: 640 KB, 720 KB, 1.2 MB, and 1.44 MB

● GP-IB Communication Interface

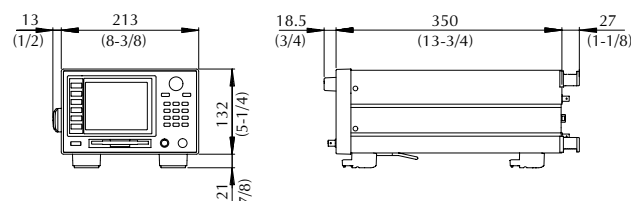|	
Electrical & mechanical specifications	Conforms to IEEE St'd 488-1978
Functional specifications	SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT1, C0
Protocol	Conforms to IEEE St'd 488.2-1987

● General Specifications

Warm-up time	30 minutes minimum
Operating temperature range	5°C to 40°C
Operating humidity range	20% RH to 80% RH (max. wet bulb temperature 29°C, non-condensing)
Storage temperature range	-20°C to 60°C
Rated power voltage range	100 V AC to 240 V AC
Allowable range of power voltage variation	90 V AC to 264 V AC
Rated power frequency	50 Hz to 60 Hz
Allowable range of power frequency variation	48 Hz to 63 Hz
Power consumption	125 VA max.
Signal grounding	Ground sides of all I/O connectors are connected to case ground
Dimensions	Approx. 213(W) × 132(H) × 350(D) mm (not including projections)
Weight	Approx. 5 kg (main unit only)

The above performance is obtained at reference operating conditions after the specified warm-up time has elapsed.
Reference operating conditions: Ambient temperature 23°C±2°C, ambient humidity 50% RH±10% RH, power voltage 100 V±1%.

DIMENSIONS

Unit: mm(inch)

AVAILABLE MODELS

Model	Suffix Code	Description
706111		FG210: 1-channel model
706112		FG220: 2-channel model
706121		FG310: 1-channel model (with arbitrary sweep and simple arbitrary waveform generator functions)
706122		FG320: 2-channel model (with arbitrary sweep and simple arbitrary waveform geneator functions)
Power Cord	**-D**	UL, CSA Standard
	-F	VDE Standard
	-R	AS Standard
	-J	BS Standard
	-H	GB Standard
Option	**/R1**	External sweep control

■ OPTIONAL ACCESSORIES

Name	Model	Description
Parallel connection cable	**705926**	26-pin (1 m)
BNC cable	**366924**	BNC-BNC (1 m)
BNC cable	**366925**	BNC-BNC (2 m)
BNC-alligator cable	**366926**	BNC-alligator clip (1 m)
Adapter	**366921**	BNC plug to banana jack
Adapter	**366927**	BNC plug to RCA jack
Adapter	**366928**	BNC plug to RCA plug