■ SPECIFICATIONS

Unless otherwise spesified, the value assumes the following conditions:continuous oscillation, load of 50Ω, oscillation setting of 10 Vp-p/50Ω, DC offset setting of 0 V, auto range, waveform amplitude range of ±FS, external addition turned off, AC voltage is the rms value.
*1 : Guaranteed numeric value. Other numeric values are norminal or typical (typ.) values.

■ Waveform and Oscillation Mode

Output waveform	Standard waveform (sine, square, pulse, ramp, parameter-variable, noise (Gaussian distribution), DC), and arbitrary waveform.
Oscillation mode	Continuous, modulated, burst, sweep, sequence In burst mode, modulation function is available, in sweep mode modulation function is available

■ Frequency, Phase

Frequency setting range

Oscillation mode /Function Waveform	Continuous, modulation, sweep (continuous and single)	Sweep (gated single), burst, sequence
Sine	0.01µHz to 200MHz	0.01µHz to 100MHz
Square	0.01µHz to 70MHz	
Pulse	0.01µHz to 70MHz (not available for sequence)	
Ramp	0.01µHz to 20MHz	
Parameter-variable	0.01µHz to 20MHz	
Noise	Equivalent bandwidth: Select from 100M/30M/10M/3M/1M/300k/100kHz	
DC	Frequency setting is invalid	
Arbitrary	0.01µHz to 20MHz	

Frequency setting resolution	0.01µHz (< 50MHz), 0.1µHz (50MHz≤)
Frequency setting with a period	Setting with frequency that is inverse number of set period (less than 0.01µHz is rounded half up)
Frequency accuracy at shipping time*1	±(3ppm of setting + 6pHz)
Frequency aging rate*1	±1ppm/year

Phase setting range

Main-output	-1800.000° to +1800.000°(resolution 0.001°)
Sub-output/Sub-waveform	-180.000° to +180.000°(resolution 0.001°)

■ Output Characteristics

Amplitude

Setting range	0Vp-p to 20Vp-p/open, 0Vp-p to 10Vp-p/50Ω AC+DC≤±10V/open or less, ±2V/open (exceeding 110MHz)
Setting resolution	999.9mVp-p or less: 4 digits or 0.1mVp-p 1Vp-p or more: 5 digits or 1mVp-p
Accuracy*1	±(1% of amplitude setting [Vp-p] + 2mVp-p)/open (1kHz sine wave, load open, amplitude setting 20mVp-p or greater)
Setting unit	Vp-p, Vpk, Vrms, dBV, dBm
Resolution of waveform amplitude	Approx. 16 bit (8mVp-p or greater / open)

DC offset

Setting range	±10V/open, ±5V/50Ω AC+DC≤±10V open/or less, ±2V/open(exceeding 110MHz)
Setting resolution	±499.9mV or less : 4 digits or 0.1mV ± 0.5V or more : 5 digits or 1mV
Accuracy*1	±(|1% of DC offset setting [V]|+10mV +0.5% of amplitude setting [Vp-p])/open (10MHz or less, sine wave, load open, 20°C to 30°C)

Waveform output（Main-output）　<FCTN OUT>

Output on/off control	On/Off (switch) (output terminal is released when out put off)
Output impedance	50Ω, unbalanced
Signal GND	Insulated from enclosure, maximum 42Vpk (DC + AC-peak)Each channel independent. Between channels is also maximum 42Vpk.

Synchronization/Sub-output　<SYNC/SUB OUT>

Output signals	Reference phase synchronization, internal modulation synchronization, burst synchronization, sweep synchronization, sub-waveform, internal modulation signal, sweep X drive and off switching.
Sub-waveform	Analog waveform output synchronized with the main-output. Phase is variable to the reference phase synchronization signal, and the amplitude and offset are also adjustable. Available waveform : sine, square (duty 50%), triangle (symmetry 50%), rising ramp, falling ramp, noise and arbitrary waveform.
Internal modulation waveform	Modulation waveform at the time of internal modulation oscillation. Phase is variable to the reference phase synchronization signal, and which amplitude and offset are also adjustable independent from the modulation depth.
Output voltage	Each type of synchronized signal • TTL level (low level 0.4V/open or less, high level 2.7V/open or more) Sub-waveform/internal modulation waveform • Amplitude setting range: 0Vp-p to 6Vp-p/open, setting resolution 1mVp-p • DC offset setting range: ±3V/open, setting resolution 1mVp-p • A peak value combining waveform amplitude and DC offset is limited to ±3V/open or less. Sweep X drive : 0Vp-p to 6Vp-p/open
Output impedance	50Ω, unbalanced

■ Signal Characteristics

Sine wave

Amplitude frequency characteristics*1	Up to 100kHz : ±0.1dB 100kHz to 5MHz : ±0.15dB 5MHz to 20MHz : ±0.2dB 20MHz to 50MHz : ±0.5dB 50MHz to 100MHz : ±0.7dB 100MHz to 200MHz : ±0.8dB	50mVp-p to 10Vp-p/50Ω, when 100MHz or greater, 50mVp-p to 2Vp-p/50Ω, reference frequency 1kHz
Total harmonic distortion*1	20Hz to 20kHz: 0.04% or less (1Vp-p/50Ω, sum up to 7th harmonic,noise is not included)	
Harmonic spurious*1	Up to 1MHz : −60dBc or less 1MHz to 5MHz : −50dBc or less 5MHz to 30MHz : −40dBc or less 30MHz to 200MHz : −30dBc or less	1Vp-p/50Ω, sum up to 5th harmonic
Non-harmonic spurious*1	Up to 8MHz : −55dBc or less 8MHz to 80MHz : −55dBc+20dB/dec or less 80MHz to 200MHz : −35dBc or less (2Vp-p/50Ω, measured at 500MHz bandwidth)	

Square wave

Duty variable	Normal : setting range 0.0100% to 99.9900%(resolution 0.0001%) Upper limit(%): 100−frequency[Hz]/1,400,000 Lower limit(%): frequency[Hz]/1,400,000 Jitter 85ps rms or less typ.(100Hz or more) Extended: setting range 0.0000% to 100.0000%(resolution 0.0001%) Jitter 700ps rms or less typ.
Duty accuracy*1	Up to 300kHz : ±0.1% of period (duty setting is 1% to 99%) 300kHz to 3MHz : ±1% of period (duty setting is 5% to 95%) 3MHz to 10MHz : ±3% of period (duty setting is 40% to 60%)
Rising/Falling time	4.6ns or less,*1 4.4ns or less typ. (2Vp-p/50Ω)
Overshoot	5% or less typ.

Pulse wave

Pulse width	Duty setting range:0.0001% to 99.9999% (resolution 0.0001%) Time setting range:6.88ns to 99.9999Ms (resolution 0.001% or less of period or 0.01ns)
Leading/Trailing time	Setting range: 4.21ns to 58.8Ms (resolution 3 digits or 0.01ns or 1ppm of period) Leading/Trailing time independently set Minimum setting value: 1ppm or 4.21ns, whichever is larger
Overshoot	5% or less typ.
Jitter	90ps rms or less typ. (100Hz or more)

Ramp wave

Setting range of symmetry	Setting range of symmetry : 0.00% to 100.00% (resolution 0.01%) At sub-output, symmetry is 0%, 50%, 100% only

Noise

Noise equivalent bandwidth setting range	Select from 100M/30M/10M/3M/1M/300k/100kHz

Parameter-variable waveform

Steady sine group	Unbalance sine, clipped sine, CF controlled sine, conduction angle controlled sine, staircase sine and multiple-cycle sine
Transient sine group	On-phase controlled sine, off-phase controlled sine, chatter-ing-on sine and chattering-off sine
Pulse waveform group	Gaussian pulse, lorentz pulse, haversine, half-sine pulse, trap-ezoid pulse and Sin(x)/x
Transient response group	Exponential rise, exponential fall, second order LPF step re-sponse and damped oscillation
Surge group	Oscillation surge, pulse surge
Other group	Trapezoid with offset, half-sine edge pulse and bottom refer-enced ramp
Use of waveform	Can be used after converted into arbitrary waveform with se-quence function (sub-output is not selectable)

Arbitrary waveform　＊Ki and Mi represent 2^10=1024 and 2^20=1048576, respectively. IEC 60027-2/IEEE 1541-2002

Waveform length	Number of control points 2 to 10,000 or 4Ki to 1Mi words (2^n, n=12 to 20)(Conrol points are linearly interpolated)
Total amount of saved waveforms	Maximum 128 waves or 4Mi words (total of channnels 1 and 2). Wave-forms can be saved in the nonvolatile memory or external USB memory
Resolution of wave-form date amplitude	16bit
Sampling rate	420MS/s

■ Modulation

Operation in the burst/sweep mode	Partly possible in the burst and sweep oscillation mode.
Modulation type	FM, FSK, PM, PSK, AM, DC offset modulation and PWM • Frequency setting is higher than 160MHz, external modulation of FM, FSK and AM are only selectable. • Simultaneously using the sweep function, FSK, PSK and the same modulation type as the sweep type are not se-lectable. • Simultaneously using the burst function, FSK, PSK can select in auto burst mode only.
Modulation source	Internal/External (selectable) • CH2 (WF1968 only) can select internal/external/CH1. (When trigger source of CH1 is external, CH1 is not available other than FSK and PSK) • Simultaneously using the sweep function, internal modulation source is not selectable.

Internal modulation

Internal modulation waveform	Other than FSK, PSK :Sine, square (duty 50%), triangle (symmetry 50%), rising ramp, falling ramp, noise, arbitrary waveforms FSK, PSK: Square wave (duty 50%) Noise equivalent bandwidth: Select from 100M/30M/10M/3M/1M/300k/100kHz
Internal modulation frequency	Other than FSK, PSK:0.1mHz to 20MHz (resolution 12 digits or 1μHz) FSK, PSK: 0.1mHz to 5MHz (resolution 11 digits or 1μHz)
Internal modulation synchronization output	Output waveform : A square wave with duty 50% rising at the zero phase of the internal modulation waveform. When internal modulation waveform is noise, the level is fixed to low. Output connector : Shared with synchronization/sub-output connector
Internal modulation waveform output	Output voltage : -3V to +3V/open. Output connector: Shared with synchronization/sub-output connector

External modulation

External modulation input	Other than FSK, PSK	Input voltage range: ±1V full scale Maximum allowable input: ±2V Input impedance: 10kΩ, unbalanced Input frequency: DC to 400 kHz (-3 dB) Input connector: BNC receptacle (MOD/ADD IN)
	FSK, PSK	Polarity: Positive/Negative (switch) Input frequency: DC to 5MHz Input connector: External trigger input (TRIG IN)
Signals selectable for synchronization/sub-output		Reference phase synchronization, internal modulation synchronization (when modulation source is internal), internal modulation signal (when modulation source is internal and other than FSK and PSK). Off (forcibly turned off also when the oscillation frequency may exceed 160MHz)

Modulation types and conditions

FM	Carrier waveform : Standard waveform except for noise, pulse wave and DC, and arbitrary waveform. Peak deviation : 0.00μHz to less than 100MHz (resolution 8 digits or 0.01μHz).
FSK	Carrier waveform : Standard waveform except for noise, pulse wave and DC, and arbitrary waveform. Hop frequency : Within the allowable range of frequency for each carrier waveform (resolution 8 digits or 0.01μHz).
PM	Carrier waveform :Standard waveform except for noise and DC, and arbitrary waveform Peak deviation: 0.000° to 180.000° (resolution 0.001°)
PSK	Carrier waveform :Standard waveform except for noise and DC, and arbitrary waveform Deviation : -1800.000° to +1800.000° (resolution 0.001°)
AM	Carrier waveform : Standard waveform except for DC, and arbitrary waveform Modulation depth: 0.0 % to 100.0 % (resolution 0.1%) (DSB-SC and Non-DSB-SC)
DC offset modulation	Carrier waveform : Standard waveform and arbitrary waveform Peak deviation : 0V to 10V/open Setting resolution : 4 digits or 0.1mV (499.9mV or less), 5 digits or 1mV (0.5V or more).
PWM	Carrier waveform : Square wave and pulse wave Peak deviation : Square wave Duty variable range standard 0.0000% to 49.9900% (resolution 0.0001%) Duty variable range extend 0.0000% to 50.0000% (resolution 0.0001%) Pulse wave 0.0000% to 49.9000%(resolution 0.0001%)

■ Sweep

Sweep types	Frequency, phase, amplitude, DC offset and duty. When the upper limit exceeds 160MHz, only frequency and phase are available
Sweep function	One way (ramp waveform), shuttle (triangular waveform) (switch). Linear, logarithmic (switch). Common regardless of sweep type. However, logarithmic can use only frequency sweep.
Sweep range setting	Start and stop values or the center and span values are specified. Center value is simple average of start and stop value during frequency logarithmic sweep. Assigning a marker value to a center value is possible (inverse setting possible).
Setting range of sweep time	0.1ms to 10,000s (resolution 4 digits or 0.1ms)
Sweep mode	Continuous / Single-shot / Gated single-shot selectable Oscillation only occurs during sweep execution in the gated single-shot mode Gated single-shot is not available at DC waveform.
Operation	Start, stop, hold/resume, starting value output and stop value output.
Trigger source	Used for single-shot sweep and gated single-shot sweep Internal/External input terminal selecatble (CH2 can select from the same trigger source as CH1). Manual trigger is available. Triger delay setting is invalid.
Internal trigger	Used for single-shot sweep and gated single-shot sweep Period setting range:100.0μs to 10,000s (resolution 5 digits or 0.1μs)
Stop level setting	Specifies the signal level when gated single-sweep is stopped. Setting range : -100.00% to +100.00% (amplitude full-scale reference and resolution 0.01%) or off
Oscillation stop unit when gated single	Cycle/Half cycle (selectable)
Sweep input/output	Sweep synchronization/marker output (synchronization/sub-output connector) Sweep X drive output (synchronization/sub-output connector) Sweep external control input (synchronization/sub-output connector) Sweep external trigger input (external trigger input terminal)
Signals selectable for synchronization/sub-output	Reference phase synchronization sweep synchronization/ marker sweep X drive off
Use of modulation function	External modulation other than sweep type is simultaneously available (other than FSK, PSK)

■ Burst/Gate/Trigger

Burst/Gate

Burst mode	Auto burst, trigger burst, gate and triggered gate
Target waveform	Auto, trigger burst : Standard waveform except for noise and DC, and arbitrary waveform Gate, triggered gete : standard waveform except for DC, and arbitrary waveform
Mark/Space wave number setting range	0.5 to 999,999.5 cycles, 0.5 cycle unit
Oscillation stop unit at gate	Cycle/Half cycle (selectable)
Phase setting range	-1800.000° to +1800.000° (resolution 0.001°)
Stop level	The signal level is specified when oscillation is stopped. Setting range : -100.00% to +100.00% (with reference to the full scale of amplitude, resolution 0.01%) or off. Oscillation stops at the set oscillation start/stop phase when the stop level is set to off.
Trigger source	Internal trigger oscillator, external input terminal (selectable) CH2 can select the same trigger source as CH1. (WF1968) Manual trigger available. Used except for auto burst
Internal trigger	Period setting range: 1.0μs to 1,000s (resolution 5 digits or 0.1μs) Used except for auto burst
External trigger input	Positive, negative, disabled (selectable) Input connector: External trigger input terminal. Used except for auto burst
Trigger delay	Setting range: 0.0ns to 1000.0000s (resolution 8 digits or 0.1ns) Additional delay approx. 380ns Valid in the trigger burst only, valid in the internal and external trigger source
Trigger jitter	0.2ns rms or less typ.
Use of modulation function	Internal modulation or external modulation can use simultaneously with the burst oscillation. FSK nad PSK can be selected in auto burst mode only

Trigger

External trigger input	Independent for each channel, however CH1 input can be shared with CH2
Input voltage	TTL level (low level is 0.8V or lower, high level is 2.6V or higher)
Maximum allowable input	-0.5V to +5.5V
Minimum pulse width	5ns
Input impedance	10kΩ (pull up to +3.3V), unbalanced
Input connector	BNC receptacle (TRIG IN)
Internal trigger oscillator	For sweep, trigger and independent for each channel (Not available for synclator)
Manual trigger	Used for single-shot sweep, gated single-shot sweep, trigger burst, gate and triggered gate. Panel key operation. (Not available for synclator).

■ Synclator Function

Frequency range	20Hz to 10MHz (Synclator function available)
Synchronization target	External trigger input terminal CH2 can select the same trigger source as CH1(WF1968 only) Trigger delay setting is invalid
Synchronization source input	Positive/Negative (selectable)
Phase difference	The phase difference between the signal input from the synchronization source and the main-output signal is adjustable.

■ Sequences

Step control parameters	Step time, hold operation, jump destination, jump count, step stop phase, branch operation, step termination control and step synchronization code output
Channel parameters in step	Waveform, frequency, phase, amplitude, DC offset and square wave duty
Available waveforms	Sine, square, noise and arbitrary waveform (the ramp and parameter-variable waveforms can be used after being saved as arbitrary waveform)
Maximum number of waveforms	128
Number of saving sequences	10 sequences (saved in the built-in non volatile memory) Allowed saving external USB memory
Maximum number of steps	Maximum 255 steps per sequence
Step time	0.1 ms to 1,000s (resolution 4 digits or 0.01ms)
Operation in step	Constant, keep and linear interpolation (except for waveform switching)
Number of jumps	1 to 9999 or unlimited.
Step stop phase setting range	0.000° to 360.000° (CH1 reference phase. resolution 0.001°) or invalid.
Branch operation	Branches to the specified step when the branch signal is input.

■ 2-Channel Ganged Operation (WF1968 only)

Channel mode	Two channels independent, 2-phases (same frequency), constant frequency difference, constant frequency ratio, differential output (same frequency, amplitude and DC offset at reverse phase waveform), differential output2(same frequency and amplitude. DC offset is reverse phase waveform, reversed polarity)
Equivalent setting, same operation	Set two channels at the same time availabe.
Frequency difference setting range	0.00 µHz to less than 200 MHz (resolution: 0.01 µHz) CH2 frequency - CH1 frequency
Frequency ratio N: M setting range	1 to 9,999,999 (for each of N and M) N: M= CH2 frequency : CH1 frequency
Phase synchronization	Function to restart from the phase where the output waveforms for all the channels are set, automatic execution at channel mode switching
Time difference between channels for 2-phase	±10ns or less typ. ±20ns or less[*1] Same waveform (sine wave or square wave)

■ Other Input/Output

External 10 MHz frequency reference input

Input voltage	0.5Vp-p to 5Vp-p
Maximum allowable input	10Vp-p
Input impedance	1kΩ, unbalanced, AC coupled
Input frequency	10MHz (±0.5% : ±50kHz)
Input waveform	Sine or square wave (50%±5% duty)
Input connector	BNC receptacle (10MHz REF IN)

Frequency reference output (for synchronize multiple units)

Output voltage	1Vp-p/50Ω square wave
Output impedance	50Ω, AC coupled
Output frequency	10MHz
Output connector	BNC receptacle (REF OUT)

External addition input

Addition gain	x0.4, x2, x10 or off selactable The maximum output voltage range is fixed to 0.8Vp-p (x0.4) , 4Vp-p (x2) and 20Vp-p (x10) During external modulation, it is dedicated to external modulation input.
Input voltage	-1V to +1V
Maximum allowable input	±2V
Input frequency	DC to 100MHz (-3dB)
Input impedance	10kΩ, unbalanced
Input connector	BNC receptacle (MOD/ADD IN)

Multi-I/O

Multi-I/O connector	Used for sweep external control and sequence external control (Multi-I/O cable is optional)

■ Other Functions

Synchronization of multiple units		Up to 6 units can be connected in the form of master/slave (including master unit) Connected with BNC cables by using the frequency reference output (REF OUT) and external 10 MHz frequency reference input (10MHz REF IN)
User defined unit	Function	Sets and displays the value in any unit, using a specified conversion expression.
	Setting target	Frequency(Hz), period(sec), amplitude(Vp-p, Vpk), DC offset(V), phase(deg), and duty(%)
	Conversion expression	[(internal setting)+n]×m, [log_{10}(internal setting)+n]×m Specify a conversion formula and values of n and m. (internal setting : the value of setting target)
	Unit character string	Up to four characters
Setting memory		10 sets (saved in the built-in non volatile memory) Allowed saving to external USB memory
Control and setting at power-on operation		Parameter setting(the operation state just before when the power was turned off bnc is restored, the contents of setting memory No.1). Output on/off setting, sequence auto run setting on/off setting
External control interface		GPIB IEEE-488.1/USB USBTMC, USB 1.1 Full-speed SCPI-1997/IEEE-488.2

■ General Characteristics

Display	4.3 inch TFT color LCD
Input/Output ground	• The signal grounds for waveform output, sync/sub output and external modulation/addition input are insulated from the enclosures. (These signal grounds are common within the same channel.) • The signal ground for external 10 MHz frequency reference input is insulated from the enclosures. • Each signal ground for CH1, CH2 and external 10 MHz frequency reference input is independent. • Maximum withstand voltage 42Vpk(DC + ACpeak)
Power supply	AC100V to 230V ±10%(250V or lower.) 50Hz/60Hz±2Hz
Power consumption	WF1967 : 65VA or lower. WF1968 : 85VA lower.
Operation temperature/ humidity range	0°C to +40°C, 5% to 85% RH (Absolute humidity: 1 g/m³ to 25 g/m³, no condensation)
Dimensions(mm)	216(W)×132.5(H)×332(D)(not including protrusions)
Weight	Approx. 3.0kg (main unit excluding accessories)

Accessories	• Instruction Manual (operation)
	• CD
	– PDF manuals
	  Operation, external control, arbitrary waveform editor and sequence editor
	– Application software
	  Arbitrary waveform editor, sequence editor
	  IVI(I Interchangeable Virtual Instruments) driver
	• Power code set (2m with 3-prong plug)