MULTIFUNCTION GENERATOR

WF1973/WF1974

Specifications

NF Corporation
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1. OVERVIEW

1.1 General
The WF1973 and WF1974 are multifunctional generators based on direct digital synthesizers (DDS).
The WF1973 is a 1-channel generator, while the WF1974 is a two-channel generator.

1.2 Features
- Highest frequency: 30 MHz (sine wave), 15 MHz (square wave, pulse)
- Frequency accuracy: ±(3 ppm + 2 pHz), high resolution of 0.01 µHz. 10 MHz external frequency reference can be used.
- Maximum output voltage: 20 Vp-p/open, 10 Vp-p/50 Ω
- Large number of standard parameter-variable waveforms: Sine wave, square wave (variable duty), pulse (variable pulse width/duty, leading edge time, trailing edge time), ramp wave (variable symmetry), CF controlled sine wave (variable crest factor), staircase sine wave (variable number of steps), Gaussian pulse (variable σ), Sin(x)/x (variable number of zero crossings), exponential rise/fall (variable time constant), damped oscillation (variable oscillation frequency, damping time constant), pulse surge (variable rising and duration times), trapezoid (variable rise, fall, and upper base width), and so on.
- Large-capacity arbitrary waveform memory: 512 K words max., saving capacity: 128 waveforms/4 M words
- Phase and waveform remain continuous even when frequency is changed or during frequency sweep.
- Square wave, pulse with variable duty and high resolution of 0.0001%
- Pulse with variable leading edge time and trailing edge time
- Various oscillation modes
  - Continuous oscillation
  - Modulation: FM, FSK, PM, PSK, AM, DC offset modulation, PWM
  - Sweep: Frequency, phase, amplitude, DC offset, duty
  - Burst oscillation: Auto burst, trigger burst, gate oscillation, triggered gate oscillation
  - Sequence oscillation: Variable waveform/frequency/phase/amplitude/DC offset/square wave duty, constant value/linear interpolation, jump/repeat/hold/branch
- Sequence function for easy test waveform creation and adjustment
  Flexible waveform creation possible through combination with standard parameter-variable waveforms
  Frequency, phase, amplitude, etc., can be rapidly changed and swept
- Intuitive user interface through use of high-resolution QVGA TFT color LCD
- Two-channel ganged function with 2 phases, constant frequency difference, constant frequency ratio, and differential output (only WF1974)
- Floated from housing for each channel to reduce effect of ground loop
- Multiple-phase oscillator can be configured by synchronizing multiple units
- USB and GPIB interfaces provided
- Thin and lightweight: Height of approx. 9 cm, weight of approx. 2.1 kg
2. CONFIGURATION

Main unit .......................................................................................................................... 1

Accessories

Instruction Manual (Basics) ................................................................. 1

CD (PDF instruction manuals, application software) ......................... 1

PDF instruction manuals:
Basics, Application, Remote Control, Arbitrary Waveform Editing
Software, Sequence Editing Software, LabVIEW Driver

Application software:
Arbitrary Waveform Editing Software,
Sequence Editing Software, LabVIEW Driver

Power cord set(2m, with 3-prong plug) .................................................. 1

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3. SPECIFICATIONS

The values of items marked with *1 are guaranteed values. All other values are either nominal values or typical (typ.) values, and are not guaranteed.

Conditions unless otherwise mentioned are as follows: Continuous oscillation, 50 Ω load, 10 Vp-p/50 Ω amplitude setting, 0 V DC offset setting, auto-range, ±FS waveform amplitude range, external addition off, AC voltage = RMS value measurement.

3.1 Oscillation Modes
Continuous, modulated, sweep, burst, sequence

3.2 Waveforms

3.2.1 Standard waveforms

Types Sine, square, pulse, ramp, parameter-variable waveform, noise (Gaussian distribution), DC

Polarity Normal, inverted (selectable) (excluding DC)

Amplitude range −FS/0, ±FS, 0/+FS (selectable) (excluding DC)

3.2.2 Arbitrary waveforms

Waveform length 4 K to 512 K words ($2^n$, n = 12 to 19) or
2 to 10,000 control points (linear interpolation between control points)

Total waveform saving capacity Up to 128 waveforms or 4 M words (combined total for channels 1 and 2)
Saved to non-volatile memory

Waveform data amplitude resolution 16 bits
Sampling rate 120MS/s

Polarity Normal, inverted (selectable)
Amplitude range −FS/0, ±FS, 0/+FS (selectable)
Output bandwidth 25 MHz, −3 dB
### 3.3 Frequency, Phase

**Frequency setting range**

<table>
<thead>
<tr>
<th>Oscillation Mode</th>
<th>Continuous, Modulated, Sweep (Continuous, Single-Shot)</th>
<th>Sweep (Gated Single-Shot), Burst</th>
<th>Sequence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waveform</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sine</td>
<td>0.01µHz to 30MHz</td>
<td>0.01µHz to 10MHz</td>
<td>0.01µHz to 10MHz</td>
</tr>
<tr>
<td>Square</td>
<td>0.01µHz to 15MHz</td>
<td>0.01µHz to 10MHz</td>
<td>Not usable</td>
</tr>
<tr>
<td>Pulse</td>
<td>0.01µHz to 15MHz</td>
<td>0.01µHz to 10MHz</td>
<td>Not usable</td>
</tr>
<tr>
<td>Ramp</td>
<td>0.01µHz to 5MHz</td>
<td>0.01µHz to 5MHz *2</td>
<td></td>
</tr>
<tr>
<td>Parameter-variable</td>
<td>0.01µHz to 5MHz</td>
<td>0.01µHz to 5MHz *2</td>
<td></td>
</tr>
<tr>
<td>Noise</td>
<td>Fixed to 26 MHz equivalent bandwidth</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DC</td>
<td>Frequency setting invalid</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arbitrary</td>
<td>0.01µHz to 5MHz</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*2 : Used through conversion to arbitrary waveform

- **Frequency setting resolution**: 0.01µHz
- **Frequency setting by period**: Setting equivalent to inverse number of the set period
- **Frequency accuracy at shipping** *1 : ±(3 ppm of setting + 2 pHz )
- **Frequency aging rate** *1 : ±1 ppm/year
- **Phase setting range**: −1800.000° to +1800.000° (0.001° resolution)

### 3.4 Output Characteristics

#### 3.4.1 Amplitude

- **Setting range**: 0 Vp-p to 20 Vp-p/open, 0 Vp-p to 10 Vp-p/50 Ω
  Peak value combining waveform amplitude and DC offset is limited to ±10 V/open or lower
- **Setting resolution**: 999.9 mVp-p or lower 4 digits or 0.1 mVp-p
  1 Vp-p or higher 5 digits or 1 mVp-p
- **Accuracy** *1 : ±1% of amplitude setting [Vp-p] + 2 mVp-p/open
  Condition: 1 kHz sine, amplitude setting of 20 mVp-p/open or higher
- **Setting units**: Vp-p, Vpk, Vrms, dBV, dBm
  Auto, hold (selectable)
- **Range**: Maximum output voltage range: 20 Vp-p, 4 Vp-p
  Amplitude attenuator range: 0 dB, −10 dB, −20 dB, −30 dB
- **Waveform amplitude resolution**: Approx. 14 bits
  Condition: Amplitude setting of 36 mVp-p/open or higher
3.4.2 DC offset
Setting range ±10 V/open, ±5 V/50 Ω
Setting resolution ±499.9 mV or lower 4 digits or 0.1 mV
                      ±0.5 V or higher   5 digits or 1 mV
Accuracy *1 ±(1% of DC offset setting [V] | + 5 mV
                      + 0.5% of amplitude setting [Vp-p]/open
Condition: Sine wave output of 10 MHz or lower, 20°C to 30°C
Outside 20°C to 30°C temperature range,
1 mV/°C typ. is added

3.4.3 Load impedance setting
Functions Setting and display of the amplitude and DC offset
Setting range for the output termination voltage under the specified
load condition
1 Ω to 10 kΩ (1 Ω resolution), 50 Ω, High-Z (load open)

3.4.4 Waveform output
Output on/off control On, Off (selectable) (When Off, output pin open state)
Output impedance 50 Ω, unbalanced
Short-circuit protection Protection against short circuit to signal GND
Output connector Front panel, BNC receptacle

3.4.5 Sync/sub output
Output signal Reference phase sync, internal modulation sync,
burst sync, sweep sync, sequence step sync, internal
modulation signal, sweep X drive (selectable)
Reference phase sync output waveform
Square waveform with 50% duty that rises at zero
phase position of reference phase (DDS oscillation
phase) of waveform output
Output voltage Sync signals: TTL level (low level of 0.4 V/open or
lower, high level of 2.7 V/open or higher)
Internal modulation signal: −3 V to +3 V/open
Sweep X drive: 0 V to +3 V/open
Output impedance 50 Ω, unbalanced
Load impedance 50 Ω or higher recommended
Output connector Front panel, BNC receptacle

3.5 Signal Characteristics
3.5.1 Sine wave
Amplitude frequency characteristics *1
100 kHz or lower ±0.1 dB
100 kHz to 5 MHz ±0.15 dB
5 MHz to 20 MHz ±0.3 dB
20 MHz to 30 MHz ±0.5 dB (±0.8 dB at amplitude setting of 2.8 Vp-p/50 Ω
or higher)
Condition: Amplitude setting 50 mVp-p to 10 Vp-p/50 Ω, reference frequency 1 kHz
### Total harmonic distortion *1

- **10 Hz to 20 kHz**: 0.2% or less
  - **Condition**: Amplitude setting of 0.5 Vp-p to 10 Vp-p/50 Ω

### Harmonic spurious *1

<table>
<thead>
<tr>
<th>Condition: Amplitude setting</th>
<th>0.5 Vp-p to 2 Vp-p/50 Ω</th>
<th>2 Vp-p to 10 Vp-p/50 Ω</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 MHz or lower</td>
<td>−60 dBC or lower</td>
<td>−60 dBC or lower</td>
</tr>
<tr>
<td>1 MHz to 10 MHz</td>
<td>−50 dBC or lower</td>
<td>−43 dBC or lower</td>
</tr>
<tr>
<td>10 MHz to 30 MHz</td>
<td>−40 dBC or lower</td>
<td>−30 dBC or lower</td>
</tr>
</tbody>
</table>

### Non-harmonic spurious *1

<table>
<thead>
<tr>
<th>Condition: Amplitude setting</th>
<th>0.5 Vp-p to 10 Vp-p/50 Ω</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 MHz or lower</td>
<td>−60 dBC or lower</td>
</tr>
<tr>
<td>1 MHz to 10 MHz</td>
<td>−50 dBC or lower</td>
</tr>
<tr>
<td>10 MHz to 30 MHz</td>
<td>−45 dBC or lower</td>
</tr>
</tbody>
</table>

### 3.5.2 Square wave

**Duty**

- Variable range selectable
  - **Normal range**: Duty can be changed in range with little jitter and no pulse loss. The higher the frequency, the narrower the duty setting range.
  - **Extended range**: With 2.5 ns rms or less typ. jitter, duty can be changed always in maximum range. In the case of a pulse width of 8.4 ns or less, loss may occur; on average, it is equal to the set duty.

**Setting range**

- **Normal range**: 0.0100% to 99.9900% (0.0001% resolution)
  - Upper limit (%): 100 – frequency (Hz) / 300,000
  - Lower limit (%): frequency (Hz) / 300,000
- **Extended range**: 0.0000% to 100.0000% (0.0001% resolution)

**Duty accuracy *1**

- **100 kHz or lower**: ±0.1% of period (duty setting 1% to 99%)
- **100 kHz to 1 MHz**: ±1% of period (duty setting 5% to 95%)
- **1 MHz to 3 MHz**: ±3% of period (duty setting 40% to 60%)

**Rising/falling time *1**

- 17 ns or less
  - However, approx. 20 ns in the case of burst oscillation with stop level setting, gated single-shot sweep with stop level setting, and sequence oscillation

**Overshoot**

- 5% or less typ.

**Jitter**

- Normal variable duty range: 300 ps rms or less typ. (100 Hz or higher)
- Extended variable duty range: 2.5 ns rms or less typ.
3.5.3  Pulse wave

Pulse width

Duty setting range  
0.0170% to 99.9830% (0.0001% resolution)

Time setting range  
25.50 ns to 99.9830 Ms (0.001% or less of period, or 0.01 ns resolution)

Leading edge time, trailing edge time

Setting range  
15.0 ns to 58.8 Ms (3 digits or 0.1 ns resolution)

Leading edge time and trailing edge time independently settable

Minimum setting value  
Largest of either 0.01% of period or 15 ns

Pulse width, leading edge time, trailing edge time limits

The pulse width time, leading edge time, trailing edge time, and period are mutually constrained by the following equations.

The duty is converted from pulse width time / period.

\[(\text{leading edge time} + \text{trailing edge time}) \times 0.85 \leq \text{pulse width time}\]

\[\text{pulse width time} \leq \text{period} - (\text{leading edge time} + \text{trailing edge time}) \times 0.85\]

Overshoot  
5% or less typ.

Jitter  
500 ps rms or less typ. (10 kHz or higher)

2.5 ns rms or less typ. (under 10 kHz)

3.5.4  Ramp wave

Symmetry setting range  
0.00% to 100.00% (0.01% resolution)

3.5.5  Parameter-variable waveforms

a) Steady sine group

<table>
<thead>
<tr>
<th>Waveform Name</th>
<th>Waveform Example</th>
<th>Description and Variable Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unbalanced sine</td>
<td><img src="image" alt="Unbalanced sine" /></td>
<td>Waveform for which the amplitudes of the first half cycle and second half cycle of a sine wave can be changed independently</td>
</tr>
<tr>
<td></td>
<td></td>
<td>First-half amplitude (−100.00% to 100.00%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Second-half amplitude (−100.00% to 100.00%)</td>
</tr>
<tr>
<td>Clipped sine</td>
<td><img src="image" alt="Clipped sine" /></td>
<td>Waveform obtained by clipping the top and bottom of the amplitude of a sine wave</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Clip rate (0.00% to 99.99%)</td>
</tr>
<tr>
<td>CF controlled sine</td>
<td><img src="image" alt="CF controlled sine" /></td>
<td>Waveform obtained by extracting only the 90° and 270° neighborhood of a sine wave and expanding the amplitude</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Crest factor (1.41 to 10.00)</td>
</tr>
<tr>
<td>Conduction angle controlled sine</td>
<td><img src="image" alt="Conduction angle controlled sine" /></td>
<td>Waveform obtained by extracting only the front or back of each half cycle of a sine wave</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Conduction angle (−180.00° to 180.00°)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Remark: In the case of a positive/negative conduction angle, back/front conduction angle</td>
</tr>
<tr>
<td>Staircase sine</td>
<td><img src="image" alt="Staircase sine" /></td>
<td>Staircase shaped sine wave</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Number of steps (2 to 100)</td>
</tr>
<tr>
<td>Multi-cycle sine</td>
<td><img src="image" alt="Multi-cycle sine" /></td>
<td>Waveform obtained by continuing sine for several cycles</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Number of cycles (0.01 to 50.00)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Start phase (−360.00° to 360.00°)</td>
</tr>
</tbody>
</table>
### b) Transient sine group

<table>
<thead>
<tr>
<th>Waveform Name</th>
<th>Waveform Example</th>
<th>Description and Variable Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>On-phase controlled sine</td>
<td><img src="image" alt="Waveform Example" /></td>
<td>Sine wave with slope into on state</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Complete-on phase (0.00° to 360.00°)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>On-slope time (0.00% to 50.00% of basic period)</td>
</tr>
<tr>
<td>Off-phase controlled sine</td>
<td><img src="image" alt="Waveform Example" /></td>
<td>Sine wave with slope into off state</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Off-phase (0.00° to 360.00°)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Off-slope time (0.00% to 50.00% of basic period)</td>
</tr>
<tr>
<td>Chattering-on sine</td>
<td><img src="image" alt="Waveform Example" /></td>
<td>Sine wave with chattering into on state</td>
</tr>
<tr>
<td></td>
<td></td>
<td>On-phase (0.00° to 360.00°)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Number of chatterings (0 to 3)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>On-state time (0.00% to 20.00% of basic period)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Off-state time (0.00% to 20.00% of basic period)</td>
</tr>
<tr>
<td>Chattering-off sine</td>
<td><img src="image" alt="Waveform Example" /></td>
<td>Sine wave with chattering into off state</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Off-phase (0.00° to 360.00°)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Number of chattering (0 to 3)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>On-state time (0.00% to 20.00% of basic period)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Off-state time (0.00% to 20.00% of basic period)</td>
</tr>
</tbody>
</table>

### c) Pulse group

<table>
<thead>
<tr>
<th>Waveform Name</th>
<th>Waveform Example</th>
<th>Description and Variable Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gaussian pulse</td>
<td><img src="image" alt="Waveform Example" /></td>
<td>Gaussian distribution waveform</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Standard deviation (0.01% to 100.00% of basic period)</td>
</tr>
<tr>
<td>Lorentz pulse</td>
<td><img src="image" alt="Waveform Example" /></td>
<td>Lorentz waveform</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Half value of width (0.01% to 100.00% of basic period)</td>
</tr>
<tr>
<td>Haversine</td>
<td><img src="image" alt="Waveform Example" /></td>
<td>Sin² pulse</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Width (0.01% to 100.00% of basic period)</td>
</tr>
<tr>
<td>Half-sine pulse</td>
<td><img src="image" alt="Waveform Example" /></td>
<td>Half-sine cycle pulse</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Width (0.01% to 100.00% of basic period)</td>
</tr>
<tr>
<td>Trapezoid pulse</td>
<td><img src="image" alt="Waveform Example" /></td>
<td>Trapezoid pulse</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Slope width (0.00% to 50.00% of basic period)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Upper base width (0.00% to 100.00% of basic period)</td>
</tr>
<tr>
<td>Sin(x)/x</td>
<td><img src="image" alt="Waveform Example" /></td>
<td>Sin(x)/x waveform</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Number of zero crossings (1 to 50)</td>
</tr>
</tbody>
</table>
### d) Transient response group

<table>
<thead>
<tr>
<th>Waveform Name</th>
<th>Waveform Example</th>
<th>Description and Variable Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exponential rise</td>
<td><img src="image" alt="Exponential rise waveform" /></td>
<td>First order LPF step response waveform&lt;br&gt;Time constant (0.01% to 100.00% of basic period)</td>
</tr>
<tr>
<td>Exponential fall</td>
<td><img src="image" alt="Exponential fall waveform" /></td>
<td>First order HPF step response waveform&lt;br&gt;Time constant (0.01% to 100.00% of basic period)</td>
</tr>
<tr>
<td>Second order LPF step</td>
<td><img src="image" alt="Second order LPF step response waveform" /></td>
<td>Second order LPF step response waveform&lt;br&gt;LPF natural frequency (1.00 to 50.00 times basic frequency) LPF Q (0.50 to 50.00)</td>
</tr>
<tr>
<td>Damped oscillation</td>
<td><img src="image" alt="Damped oscillation waveform" /></td>
<td>Oscillation waveform with an amplitude that decreases exponentially&lt;br&gt;Oscillation frequency (0.01 to 50.00 times basic frequency) Damping time constant (~100.00% to 100.00% of basic period) Remark: In the case of a negative damping time constant, oscillation waveform with an amplitude that increases exponentially</td>
</tr>
</tbody>
</table>

### e) Surge group

<table>
<thead>
<tr>
<th>Waveform Name</th>
<th>Waveform Example</th>
<th>Description and Variable Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oscillation surge</td>
<td><img src="image" alt="Oscillation surge waveform" /></td>
<td>Surge waveform with damped oscillation&lt;br&gt;Oscillation frequency (0.01 to 50.00 times basic frequency) Damping time constant (0.01% to 100.00% of basic period) Trailing time constant (0.01% to 100.00% of basic period)</td>
</tr>
<tr>
<td>Pulse surge</td>
<td><img src="image" alt="Pulse surge waveform" /></td>
<td>Pulsed surge waveform&lt;br&gt;Rising time (0.01% to 100.00% of basic period) Duration time (0.01% to 100.00% of basic period) Remark: The rising time represents the time from the 10% threshold to the 90% threshold of the rising edge. The duration time represents the time from 10% threshold of the rising edge to the 10% threshold of the next falling edge.</td>
</tr>
</tbody>
</table>

### f) Others group

<table>
<thead>
<tr>
<th>Waveform Name</th>
<th>Waveform Example</th>
<th>Description and Variable Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trapezoid with offset</td>
<td><img src="image" alt="Trapezoid with offset waveform" /></td>
<td>Trapezoid waveform with offset in the amplitude direction&lt;br&gt;Leading delay (0.00% to 100.00% of basic period) Rising-slope width (0.00% to 100.00% of basic period) Upper base width (0.00% to 100.00% of basic period) Falling-slope width (0.00% to 100.00% of basic period) Offset (0.00% to 100.00%)</td>
</tr>
<tr>
<td>Half-sine edge pulse</td>
<td><img src="image" alt="Half-sine edge pulse waveform" /></td>
<td>Pulse whose rise and fall are half-sine waveform&lt;br&gt;Leading edge time (0.00% to 100.00% of basic period) Trailing edge time (0.00% to 100.00% of basic period) Duty (0.00% to 100.00%)</td>
</tr>
<tr>
<td>Bottom referenced ramp</td>
<td><img src="image" alt="Bottom referenced ramp waveform" /></td>
<td>Ramp waveform with bottom level as reference&lt;br&gt;Symmetry (0.00% to 100.00%)</td>
</tr>
</tbody>
</table>
### 3.6 Modulated Oscillation Mode

#### 3.6.1 General

<table>
<thead>
<tr>
<th>Modulation type</th>
<th>FM, FSK, PM, PSK, AM, DC offset modulation, PWM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modulation source</td>
<td>Internal, external (selectable)</td>
</tr>
<tr>
<td>Internal modulation waveform</td>
<td>Sine wave, square wave (50% duty), triangular wave (50% symmetry), rising ramp wave, falling ramp wave, noise, arbitrary wave</td>
</tr>
<tr>
<td>FSK, PSK</td>
<td>Square wave (50% duty)</td>
</tr>
<tr>
<td>Internal modulation frequency</td>
<td>0.1 mHz to 100 kHz (5 digits or 0.1 mHz resolution)</td>
</tr>
<tr>
<td>Internal modulation sync output</td>
<td>Square wave with 50% duty that rises at zero phase position of internal modulation waveform</td>
</tr>
<tr>
<td></td>
<td>Fixed to low level while internal modulation waveform is noise</td>
</tr>
<tr>
<td>Output connector</td>
<td>Shared with sync/sub-output connector</td>
</tr>
<tr>
<td>Internal modulation signal output</td>
<td>−3 V to +3 V/open</td>
</tr>
<tr>
<td>Input voltage range</td>
<td>±1 V full scale</td>
</tr>
<tr>
<td>Maximum allowed input</td>
<td>±2 V</td>
</tr>
<tr>
<td>Input impedance</td>
<td>10 kΩ, unbalanced</td>
</tr>
<tr>
<td>Input frequency</td>
<td>DC to 25 kHz</td>
</tr>
<tr>
<td>Input connector</td>
<td>Front panel (WF1973) / rear panel (WF1974)</td>
</tr>
<tr>
<td></td>
<td>BNC receptacle</td>
</tr>
<tr>
<td></td>
<td>Shared with external addition input, cannot be used simultaneously with adding operation</td>
</tr>
</tbody>
</table>

**External modulation input (other than FSK, PSK)**

- **Input voltage range**: ±1 V full scale
- **Maximum allowed input**: ±2 V
- **Input impedance**: 10 kΩ, unbalanced
- **Input frequency**: DC to 25 kHz
- **Input connector**: Front panel (WF1973) / rear panel (WF1974) BNC receptacle

**External modulation input (FSK, PSK)**

- **Polarity**: Positive, negative (selectable)
- **Input frequency**: DC to 1 MHz
- **Input connector**: Use of external trigger input. Input voltage and input impedance follow the external trigger input specifications.

#### 3.6.2 Modulation conditions

- **FM**
  - **Carrier waveform**: Standard waveform other than noise, pulse wave and DC, and arbitrary waveform
  - **Peak deviation setting range**: 0.00 µHz to less than 15 MHz (8 digits or 0.01 µHz resolution)
### FSK
- **Carrier waveform**: Standard waveform other than noise, pulse wave and DC, and arbitrary waveform
- **Hop frequency setting range**: Within settable carrier waveform frequency range (8 digits or 0.01 µHz resolution)

### PM
- **Carrier waveform**: Standard waveform other than noise and DC, and arbitrary waveform
- **Peak deviation setting range**: 0.000° to 180.000° (0.001° resolution)

### PSK
- **Carrier waveform**: Standard waveform other than noise and DC, and arbitrary waveform
- **Deviation setting range**: −180.00.00° to +180.000.00° (0.001° resolution)
- **Remark**: The sine wave amplitude frequency characteristics during PSK are limited to 25 MHz, −3 dB.

### AM(non-DSB-SC)
- **Carrier waveform**: Standard waveform other than DC, and arbitrary waveform
- **Modulation depth setting range**: 0.0% to 100.0% (0.1% resolution)
- **Remark**: When the modulation depth is 0%, the amplitude is 1/2 of the set value.

### AM(DSB-SC) (Double Side Band - Suppressed Carrier)
- **Carrier waveform**: Standard waveform other than DC, and arbitrary waveform
- **Modulation depth setting range**: 0.0% to 100.0% (0.1% resolution)
- **Remark**: When the modulation depth is 100%, the maximum amplitude is equal to the set value. During DSB-SC, the carrier frequency component is zero.

### DC offset modulation
- **Carrier waveform**: Standard waveform and arbitrary waveform
- **Peak deviation setting range**: 0 V to 10 V/open

### PWM
- **Carrier waveform**: Square wave, pulse wave
- **Peak deviation setting range**:
  - **Square wave**
    - Normal variable duty range: 0.0000% to 49.9900% (0.0001% resolution)
    - Extended variable duty range: 0.0000% to 50.0000% (0.0001% resolution)
  - **Pulse wave**: 0.0000% to 49.9000% (0.0001% resolution)

### 3.7 Sweep Oscillation Mode

#### 3.7.1 General
- **Sweep types**: Frequency, phase, amplitude, DC offset, duty
- **Sweep functions**: One-way (ramp waveform shape), shuttle(triangular waveform shape) (selectable)
- **Sweep range setting**: Start value and stop value specification
- **Sweep time setting range**: 0.1 ms to 10,000s (4 digits or 0.1 ms resolution)
Sweep mode | Continuous, single-shot, gated single-shot (selectable)  
| During gated single-shot, oscillation occurs only during sweep execution  
Operation | Start, stop, hold/resume, start value output, stop value output  
Trigger source (used for single-shot sweep and gated single-shot sweep) | Internal, external (selectable)  
| Trigger delay setting is invalid. Manual trigger possible.  
Internal trigger oscillator for sweep (used for single-shot sweep and gated single-shot sweep)  
| Period setting range | 100.0 µs to 10,000 s (5 digits or 0.1 µs resolution)  
Stop level setting (used for gated single-shot sweep)  
| Function | Specification of signal level while oscillation is stopped during gated single-shot sweep  
| Setting range | −100.00% to +100.00% of amplitude full scale (0.01% resolution) or off  
Oscillation stop unit during gated single-shot | 1 cycle, 0.5 cycles (selectable)  
Sweep sync/marker output  
| Marker off, one-way sweep | Low level from sweep start value to half of sweep time.  
| High level at any other time.  
| Marker off, shuttle sweep | Low level from sweep start value to sweep stop value.  
| High level at any other time.  
| Marker on | Low level from sweep start value until marker value.  
| High level at any other time.  
Output connector | Shared with sync/sub-output connector  
Sweep X drive output  
| Output voltage | 0 V to +3 V/open  
| 0 V → +3 V during sweep value rise  
| +3 V → 0 V during sweep value fall  
Output connector | Shared with sync/sub-output connector  
Sweep external control input  
| Input connector | Use of 3 bits of multi-I/O connector  
| Control items | Start, stop, hold/resume  
Sweep external trigger input (used for single-shot sweep and gated single-shot sweep)  
| Polarity | Positive, negative, off (selectable)  
| Input connector | Use of external trigger input.  
| Input voltage and input impedance follow the external trigger input specifications.  

### 3.7.2 Sweep conditions

#### Frequency sweep

Waveform | Standard waveform other than noise, pulse wave, and DC, and arbitrary waveform  
Start, stop frequency setting range | 0.01 µHz to 30 MHz (0.01 µHz resolution)  

#### Phase sweep

Waveform | Standard waveform other than noise and DC, and arbitrary waveform  
Start, stop phase setting range | −1800.000° to 1800.000° (0.001° resolution)
- **Amplitude sweep**
  Waveform: Standard waveform other than DC, and arbitrary waveform
  Start, stop amplitude setting range: 0 Vp-p to 20 Vp-p/open

- **DC offset sweep**
  Waveform: Standard waveform and arbitrary waveform
  Start, stop DC offset setting range: −10 V to +10 V/open

- **Duty sweep**
  Waveform: Square wave, pulse wave
  Start, stop duty setting range:
  - Square wave
    - Normal variable duty range: 0.0100% to 99.9900% (0.0001% resolution)
    - Extended variable duty range: 0.0000% to 100.0000% (0.0001% resolution)
  - Pulse wave: 0.0170% to 99.9830% (0.0001% resolution)

### 3.8 Burst Oscillation Mode

#### Burst mode
- **Auto burst**
  Repeats oscillation of mark wave number and oscillation stop of space wave number.
  Trigger invalid.

- **Trigger burst**
  Performs oscillation of mark wave number in sync with trigger.

- **Gate**
  Performs oscillations in cycles of integers or integer multiples of half-cycles, in sync with the gate signal.
  However, if the waveform is noise, oscillation on/off operation is done through the gate signal.

- **Triggered gate**
  Gate oscillation switched on/off by gate upon trigger.

#### Target waveforms
- **Auto, trigger burst**
  Standard waveform other than noise and DC, and arbitrary waveform
- **Gate, triggered gate**
  Standard waveform other than DC, and arbitrary waveform

#### Setting range of mark wave number
- 0.5 cycles to 999,999.5 cycles, in 0.5-cycle units

#### Setting range of space wave number
- 0.5 cycles to 999,999.5 cycles, in 0.5-cycle units

#### Oscillation stop unit during gate
- 1 cycle, 0.5 cycles (selectable)

#### Oscillation start/stop phase setting range
- −1800.000° to +1800.000° (0.001° resolution)
  Remark: Same setting value as phase setting in section 3.3

#### Stop level setting range
- Specification of signal level when oscillation is stopped
- Setting range:
  - −100.00% to +100.00% of amplitude full-scale (0.01% resolution) or off
  - When the stop level is set to off, stop occurs at the set oscillation start/stop phase

#### Trigger source (used during other than auto burst)

#### Internal trigger oscillator for burst (used during other than auto burst)
- Period setting range: 1.0 µs to 1,000 s (5 digits or 0.1 µs resolution)
| Trigger delay setting range | 0.00 µs to 100.00 s (5 digits or 0.01 µs resolution)  
Latent delay of 0.55 µs  
Only valid for trigger burst (not valid for gate, triggered gate)  
Valid for both internal and external trigger sources  
Not valid for manual trigger |
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Trigger jitter</td>
<td>1 ns rms or less typ.</td>
</tr>
<tr>
<td>Burst sync output</td>
<td>Low level during oscillation. High level at all other times.</td>
</tr>
<tr>
<td>Polarity</td>
<td>Shared with sync/sub-output connector</td>
</tr>
<tr>
<td>Output connector</td>
<td></td>
</tr>
</tbody>
</table>

### 3.9 Triggers

**External trigger input**

- **Applications**: Used for single-shot sweep, gated single-shot sweep, trigger burst, gate, triggered gate, and sequence.
- **Input voltage**: TTL level (low level of 0.8 V or lower, high level of 2.6 V or higher).
- **Maximum allowed input**: −0.5 V to +5.5 V
- **Polarity**: Positive, negative, off (selectable)
- **FSK and PSK, sweep, sequence (independently settable)**
- **Minimum pulse width**: 50 ns
- **Input impedance**: 10 kΩ (pulled up to +3.3 V), unbalanced
- **Input connector**: Front panel (WF1973) / rear panel (WF1974) BNC receptacle

**Manual trigger**

- **Applications**: Used for single-shot sweep, gated single-shot sweep, trigger burst, gate, triggered gate

**Internal trigger oscillator**

- **Applications**: Independent for sweep and burst
- **Refer to internal trigger oscillator of each section**

### 3.10 Sequence

- **Number of saved sequences**: 10 sequences (saved to non-volatile memory)
- **Maximum number of steps**: Maximum of 255 steps per sequence (not including step of pre-start status)
- **Inter-channel operation**: In sequence mode, the mode of both channels is the sequence mode. Step control is done in common for both channels.
- **Step control parameters**: Step time, hold operation, jump destination, number of jumps, step stop phase, branch operation, step termination control, step sync code output
- **Intra-step channel parameters**: Waveform, frequency, phase, amplitude, DC offset, square wave duty
- **In-step operations**: Constant, keep, linear interpolation (except waveform switching)
Step time setting range 0.1 ms to 1,000 s (4 digits or 0.01 ms resolution)
Jump count setting range 1 to 999 or infinite
Step stop phase setting range 0.000° to 360.000° (CH1 reference phase. 0.001° resolution) or invalid

Branch operation
  State branch Check of state branch input from multi-I/O connector at step end. Upon branch input detection, branching to specified destination step.
  Event branch Immediate branching to specified destination step through event branch manipulation or input

Control of step termination
Step sync code output Output of 4-bit code specified for each step to multi-I/O connector
  LSB outputtable to sync/sub-output connector

Usable waveforms Sine wave, square wave, noise, DC, and arbitrary wave
  Ramp wave and parameter-variable waveform can be used through saving as arbitrary waveforms

Maximum number of usable waveforms 128
Step start phase Oscillation start from reference phase 0° of each channel at next step after DC or noise (excluding DC and noise)

Sequence manipulations Start, stop, hold/resume, event branch
Sequence external control
  Input connector Use of 4 bits of multi-I/O connector
  Control items Start or state branch, stop, hold/resume, event branch

Sequence external trigger input (start trigger)
  Polarity Positive, negative, off (selectable)
  Input connector Use of external trigger input on CH1 side. Input voltage and input impedance follow the external trigger input specifications.

3.11 Other I/Os
External 10 MHz frequency reference input
  Frequency reference selection External reference enable, disable (selectable)
  Input voltage 0.5 Vp-p to 5 Vp-p
  Maximum allowed input 10 Vp-p
  Input impedance 1 kΩ, unbalanced, AC coupled
  Input frequency 10 MHz (±0.5% ±50 kHz)
  Input waveform Sine wave or square wave (50 ±5% duty)
  Input connector Rear panel, BNC receptacle
**Frequency reference output (for synchronizing multiple WF1973, WF1974 units)**

- **Output voltage**: 1 Vp-p/50 Ω square wave
- **Output impedance**: 50 Ω, AC coupled
- **Output frequency**: 10 MHz
- **Output connector**: Real panel, BNC receptacle

**External addition input**

- **Addition gain**: ×2, ×10, off (selectable)
  - During ×2, the maximum output voltage range is fixed to 4 Vp-p, and during ×10, 20 Vp-p.
  - Off during sequence oscillation
- **Input voltage**: −1 V to +1 V
- **Maximum allowed input**: ±2 V
- **Input frequency**: DC to 10 MHz (−3 dB)
- **Input impedance**: 10 kΩ, unbalanced
- **Input connector**: Front panel (WF1973) / rear panel (WF1974) BNC receptacle
  - Shared with external modulation input, cannot be used during external modulation

**Multi-I/O**

- **Applications**: Sweep control, sequence control
- **Input voltage**: TTL level (low level of 0.8 V or lower, high level of 2.6 V or higher. Pulled up to +5 V through 10 kΩ)
- **Maximum allowed input**: −0.5V to +5.5 V
- **Output voltage**: TTL level (low level of 0.4 V/open or lower, high level of 2.7 V/open or higher)
- **Connector**: Rear panel, Mini-Dsub 15-pin multiconnector

### 3.12 2-channel ganged operation (WF1974 only)

**Channel modes**

<table>
<thead>
<tr>
<th>Channel modes</th>
<th>Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Independent</strong></td>
<td>Independent setting</td>
</tr>
<tr>
<td><strong>2-phase</strong></td>
<td>Holds same frequency. During frequency sweep, internal frequency modulation, and internal FSK, controls to hold the same frequency. Phase independently set for each channel.</td>
</tr>
<tr>
<td><strong>Constant frequency difference</strong></td>
<td>Holds the frequency difference as a constant value. During frequency sweep, internal frequency modulation, and internal FSK, controls to hold the frequency difference. External frequency modulation and external FSK are not possible.</td>
</tr>
<tr>
<td><strong>Constant frequency ratio</strong></td>
<td>Holds the frequency ratio as a constant value. During frequency sweep, internal frequency modulation, and internal FSK, controls to hold the frequency ratio. External frequency modulation and external FSK are not possible.</td>
</tr>
<tr>
<td><strong>Differential Output</strong></td>
<td>Same frequency, amplitude, and DC offset. Reverse phase waveform. Controls to hold differential output during all types of sweep and internal modulation. External modulation and external addition are not possible.</td>
</tr>
</tbody>
</table>
Common limiting conditions during 2-phase, constant frequency difference, constant frequency ratio, and differential output

- Oscillation in same oscillation mode (also same modulation type during modulated oscillation, and same sweep type during sweep oscillation)
- Applicable to standard waveform other than noise and DC, and arbitrary waveform
- Burst, gated single-shot sweep not possible

Same value setting, same manipulation

Yes

Frequency difference setting range 0.00 µHz to less than 30 MHz (0.01 µHz resolution)

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 Automatically executed during channel mode switching

Time difference between channels during 2-phase *1

±20 ns or less (±10 ns or less typ.)
Condition: Same waveform (sine or square)

3.13 Synchronous Operation of Multiple Units

Connection

Connection method 1

Master unit

Slave unit

Slave unit

Slave unit

External reference use possible

T divider

T divider

50 Ω termination resistor

Connection cable

Cable type Coaxial cable of characteristic impedance 50 Ω with BNC connector (RG-58A/U, etc.)

Cable length limit 1 m or less between units, total length of 3 m or less

Maximum number of connectable units Connection method 1: 6 units including master unit

Connection method 2: 4 units including master unit

Phase synchronization operation Manual operation
Time difference between units

Delay of each channel of nth slave unit in relation to each channel of the master unit
\((1 \leq N)\)

Connection method 1:

\[31 \text{ ns} + (N - 1) \times 6 \text{ ns} \pm 25 \text{ ns or less typ.}\]

Connection method 2:

\[31 \text{ ns} + (N - 1) \times 31 \text{ ns} \pm 25 \text{ ns or less typ.}\]

Condition: Same frequency, same phase, same waveform (sine or square), length of connection cable between frequency reference output and external frequency reference input = 1 m (RG-58A/U)

3.14 User - Defined Units

Function
Setting target
Conversion expression
Unit character string
Setting and display in arbitrary unit according to the specified conversion expression
Frequency (Hz), period (sec), amplitude (Vp-p, Vpk), DC offset (V), phase (deg), duty (%)
\[\{(\text{Setting target value}) + n\} \times m, \text{ or } \left[\log_{10}(\text{setting target value}) + n\right] \times m\]
Specification of conversion expression and values of n and m
Up to 4 characters can be set

3.15 Other Functions

Setting saving capacity
External control
10 settings (saved to non-volatile memory)
GPIB, USBTMC (SCPI-1999, IEEE-488.2)

3.16 Options

PA-001-1318 multi-I/O cable
Cable with connector on one end, for connection to multi-I/O connector on rear panel. 2 m length. Cut off at one end
3.17 General Characteristics

Display unit 3.5 inch TFT color LCD

I/O ground

The signal grounds for waveform output (FCTN OUT), sync/sub-output (SYNC/SUB OUT), and external modulation/addition input (MOD/ADD IN) are insulated from the housing. These signal grounds are shared within the same channel.
The signal ground for the external 10 MHz reference input (10 MHz REF IN) is insulated from the housing.
Each of the signal grounds of CH1, CH2, and 10MHz REF IN are independent.
The withstand voltage between insulated signal grounds and between housings is 42 Vpk max. (DC + AC peak)
The other signal grounds are connected to the housing.

Power supply

Power supply voltage range 100 V AC to 230 V AC ±10% (250 V or lower)
Power supply frequency range 50 Hz/60 Hz ±2 Hz
Power consumption WF1973: 50 VA or less
WF1974: 75 VA or less
Overvoltage category II

Ambient temperature and humidity ranges

Operation guarantee 0°C to +40°C, 5%RH to 85%RH
Absolute humidity of 1 g/m³ to 25 g/m³,
no condensation
Temperature range limitations apply for some specifications.

Storage conditions –10°C to +50°C, 5%RH to 95%RH
Absolute humidity of 1 g/m³ to 29 g/m³,
no condensation

Warm-up time 30 minutes or more typ.
Pollution degree 2
External dimensions 216 (W) × 88 (H) × 332 (D) mm (excluding projections)
Weight Approx. 2.1 kg (excluding accessories, weight of main unit only)

Safety and EMC

Applied only for models with CE marking on their rear panels
Safety EN61010-1:2001
Block diagram (WF1973)

Block diagram (WF1974)
External dimensions (WF1973)

Surface treatment:
- Front panel: Plastic ultra-light gray (Munsell 6PB9.2/0.1)
- Rear panel: Munsell 8.5PB2.6/0.2
- Covers: Light gray (leather tone) (Munsell 6PB7.6/0.2 leather tone)

[Diagram of external dimensions]
**External dimensions (WF1974)**

Surface treatment:
- Front panel: Plastic ultra-light grey (Munsell 6PB9.2/0.1)
- Rear panel: Munsell 8.5PB2.6/0.2
- Covers: Light grey leather tone (Munsell 6PB7.6/1.2 leather tone)