15. Specifications

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Numeric values marked as *1 are guaranteed values. The other numeric values are not guaranteed values but nominal values or typical values (mark as typ.). If not specified, the condition is that oscillation is continuous, the load is 50Ω, the amplitude setting is 10Vp-p/50Ω, the DC offset setting is 0V, the auto range, the amplitude range of waveform is ±FS, the extend addition is off, and AC voltage is effective value measurement.

15.1 Oscillation mode
Continuous, modulation, sweep, burst

15.2 Waveform
15.2.1 Standard Waveform

<table>
<thead>
<tr>
<th>Types</th>
<th>Sine, Square, Pulse, Ramp, Noise (Gaussian distribution), DC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polarity</td>
<td>Normal, invert (Switch)</td>
</tr>
<tr>
<td>Amplitude range</td>
<td>-FS/0, ±FS, 0/+FS (switch)</td>
</tr>
</tbody>
</table>

15.2.2 Arbitrary Waveform

<table>
<thead>
<tr>
<th>Waveform length</th>
<th>Number of control points 2 to 10,000 or 4K to 512K word ($2^n$, n=12 to 19)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remarks</td>
<td>Liner interpolation is performed between control points.</td>
</tr>
<tr>
<td>Total amount of save waveforms</td>
<td>Maximum 128 waves or 4M words (common in CH1 and 2)</td>
</tr>
<tr>
<td></td>
<td>Saved in non-volatile memories</td>
</tr>
<tr>
<td>Resolution of waveform data amplitude</td>
<td>16bit</td>
</tr>
<tr>
<td>Sampling rate</td>
<td>120MS/s</td>
</tr>
<tr>
<td>Polarity</td>
<td>Normal, invert (Switch)</td>
</tr>
<tr>
<td>Amplitude range</td>
<td>-FS/0, ±FS, 0/+FS (switch)</td>
</tr>
<tr>
<td>Output bandwidth</td>
<td>25MHz -3dB</td>
</tr>
</tbody>
</table>
15.3 Frequency, phase

<table>
<thead>
<tr>
<th>Waveform</th>
<th>Frequency setting range</th>
<th>Oscillation mode</th>
<th>Sweep (gated single)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sine wave</td>
<td>0.01µHz~30MHz</td>
<td>Continuous, modulation,</td>
<td>0.01µHz~10MHz</td>
</tr>
<tr>
<td></td>
<td></td>
<td>sweep (continuous and single)</td>
<td></td>
</tr>
<tr>
<td>Rectangular wave</td>
<td>0.01µHz~20MHz</td>
<td>Sweep (gated single)</td>
<td>0.01µHz~10MHz</td>
</tr>
<tr>
<td>Pulse wave</td>
<td>0.01µHz~20MHz</td>
<td>Burst</td>
<td>0.01µHz~10MHz</td>
</tr>
<tr>
<td>Ramp wave</td>
<td>0.01µHz~5MHz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Noise</td>
<td>Fixed to equivalent bandwidth 26MHz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DC</td>
<td>Set the frequency invalid</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arbitrary waveform</td>
<td>0.01µHz~5MHz</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Frequency setting resolution:** 0.01µHz
- **Frequency setting with a period:** Setting with frequency that is inverse number of set period
- **Frequency accuracy at shipping time:** ± (3ppm + 2pHz of setting)
- **Frequency secular change:** ±1ppm/ year
- **Setting range of the phase:** -1800.000° to +1800.000° (resolution 0.001°)

Except for noise and DC

Remarks: A phase setting value at the continuous oscillation mode is corresponding to the phase of the waveform output at synchronization output.

15.4 Output Characteristics

15.4.1 Amplitude

- **Setting range:** 0Vp-p~20Vp-p/open
- 0Vp-p~10Vp-p/50Ω
- A peak value combined waveform amplitude and DC offset is limited to ±10V or lower/open.

- **Setting resolution:** 999.9mVp-p or lower 4 digits or 0.1mVp-p
- More than 1Vp-p 5 digits of 1mVp-p

- **Accuracy:** ±(Amplitude setting[Vp-p] * 0.8%+2mVp-p)/open
  Conditions: 1kHz sine wave, amplitude setting 20mVp-p or higher/open

- **Approval unit:** Vp-p, Vpk, Vrms, dBV, dBm
- **Range:** Auto, hold (switch)
- **Maximum output voltage range:** 20Vp-p, 4Vp-p, 0.8Vp-p
- **Amplitude attenuator range:** 0dB,-10dB,-20dB,-30dB

- **Resolution of waveform amplitude:** 16bit
  Conditions: Amplitude setting 8mVp-p or more/open standard waveform

Remarks: When the amplitude is below the setting
15.4 Output Characteristics

described above or during AM/amplitude sweep, the amplitude is reduced digitally, the amplitude resolution become lower.

15.4.2 DC Offset

Setting range: ±10V/open, ±5 V/50Ω

A peak value combined waveform amplitude and DC offset is limited to ±10V or lower/open.

Setting resolution: ±499.9mV or lower 4 digits or 0.1mV

±0.5V or higher 5 digits or 1mV

Accuracy*1: ± (|1% of the setting of the DC offset [V]|+5mV

+Amplitude setting[Vp-p] * 0.5%/open

Conditions: Continuous oscillation, 10MHz or lower, sine wave, load open, auto range, external addition off, and 20°C to 30°C

Beyond the temperature range of 20°C to 30°C, add 1mV/°C typ.

Range: Auto, hold (switch)

Maximum output voltage range: 20Vp-p, 4Vp-p, 0.8Vp-p

When waveform is DC, it applies to DC offset only. Otherwise, common in the amplitude range.

15.4.3 Load Impedance Setting

Function: Set and display the amplitude and the DC offset of the output terminal voltage at a specified load condition.

Setting range: 1Ω to 10kΩ (resolution 1Ω), 50Ω, High-Z (load open)

15.4.4 Waveform Output

Output On/Off control: On, off (switch)

Output impedance: approx. 100kΩ when off

50Ω, Unbalanced

Short protection: Protect against the signal GND short

Output connector: Front panel, BNC receptacle

15.4.5 Synchronization/Sub-output

Output signal: Reference phase synchronization, internal modulation synchronization, burst synchronization, seep synchronization, internal modulation signal, sweep X drive (switch)

Reference phase synchronization output waveform: Square wave that rises at zero degree of reference phase for waveform output and duty 50%.

When the waveform is noise or DC, fixed to low level.
### 15.5 Signal Characteristics

#### 15.5.1 Sine Wave

**Amplitude frequency characteristics**

<table>
<thead>
<tr>
<th>Frequency Range</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>~100kHz</td>
<td>±0.1dB</td>
</tr>
<tr>
<td>100kHz~5MHz</td>
<td>±0.15dB</td>
</tr>
<tr>
<td>5MHz~20MHz</td>
<td>±0.3dB</td>
</tr>
<tr>
<td>20MHz~30MHz</td>
<td>±0.5dB (amplitude setting 2.8Vp-p or higher/±0.8dB at 50Ω)</td>
</tr>
</tbody>
</table>

**Conditions:** Amplitude 50mVp-p to 10Vp-p/50Ω, and reference frequency 1kHz

**Total harmonic distortion (THD)**

<table>
<thead>
<tr>
<th>Frequency Range</th>
<th>THD</th>
</tr>
</thead>
<tbody>
<tr>
<td>20Hz~20kHz</td>
<td>0.04% or lower</td>
</tr>
</tbody>
</table>

**Harmonic spurious**

<table>
<thead>
<tr>
<th>Frequency Range</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>~1MHz</td>
<td>-60dBc or lower</td>
</tr>
<tr>
<td>1MHz~10MHz</td>
<td>-50dBc or lower</td>
</tr>
<tr>
<td>10MHz~30MHz</td>
<td>-40dBc or lower</td>
</tr>
</tbody>
</table>

**Non-harmonic spurious**

<table>
<thead>
<tr>
<th>Frequency Range</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>~1MHz</td>
<td>-65dBc or lower(^*1), -70dBc or lower typ.</td>
</tr>
<tr>
<td>1MHz~3MHz</td>
<td>-65dBc or lower(^*1)</td>
</tr>
<tr>
<td>3MHz~30MHz</td>
<td>-65dBc+6dB/oct or lower(^*1)</td>
</tr>
</tbody>
</table>

**Conditions:** Measured at amplitude setting 0.5Vp-p to 10Vp-p/50Ω, 250MHz bandwidth

#### 15.5.2 Rectangular Wave

**Duty**

<table>
<thead>
<tr>
<th>Variable range (switch)</th>
<th>Standard, extended (switch)</th>
</tr>
</thead>
</table>

Standard range: Duty can be changed within the range where jitter is low and a pulse does not disappear. The setting range of the duty narrows as the frequency rises. Duty is fixed to 50% at 20MHz
15.5 Signal Characteristics

Duty is variable at the range of 10 to 90% at 4MHz.
Extended range: There is jitter of 2.5ns rms or lower typ., and the duty can be always changed at the maximum range. Averagely, pulses are equal to the set duty, even though when the pulse width is narrower than 8.4ns, pulses may disappear.

Setting range:
- Standard range: 0.0100% to 99.9900% (resolution 0.0001%)
- Extended range: 0.0000% to 100.0000% (resolution 0.0001%)

Lower and upper limit of standard range setting:
- Upper limit (%): 100 - frequency (Hz)/400,000
- Lower limit (%): frequency (Hz)/400,000

Duty accuracy*1:
- ~100kHz: ±0.1% of period (duty setting is 1% to 99%)
- 100kHz~1MHz: ±1% of period (duty setting is 5% to 95%)
- 1MHz~3MHz: ±3% of period (duty setting is 40% to 60%)

Leading / Trailing time:
- 17ns or lower*1, 15.5ns or lower typ.
  However, for burst oscillation and gated single sweep with a stop level is set, it is approx. 20ns.
  Conditions: 50Ω load, DC offset setting 0V, and amplitude setting 10Vp-p/50Ω

Overshoot:
- 5% or less typ.

Jitter:
- Duty variable range standard 300ps rms or less typ. (100Hz or higher)
- Duty variable range extended 2.5ns rms or less typ.

15.5.3 Pulse Wave

Pulse width:
- Duty setting range: 0.0170% to 99.9830% (resolution 0.0001%)
- Time setting range: 24.00ns to 99.9830Ms (resolution 0.001% or less of period or 0.01ns)

Setting range of pulse width duty and pulse width time are limited by frequency, Leading time and Trailing time.

Upper or lower limit of time setting:
- Upper limit (s): period - (Leading time + Trailing time) * 0.8
- Lower limit (s): (Leading time + Trailing time) * 0.8
15.6 Modulated Oscillation Mode

### Leading time, Trailing time

**Setting range**

- Upper and lower limit of duty setting are computed by upper and lower value/period above.
- 15.0ns to 62.5Ms (resolution 3 digits or 0.1ns)
- Independent setting of Leading/Trailing time
- Leading time and Trailing time is limited by frequency, pulse width duty, and pulse width time.
- Minimum setting value
- Which is lower 0.01% of period or 15ns.
- Overshoot
- 5% or less typ.
- Jitter
- 500ps rms of higher typ. (10kHz or more)
- 2.5ns rms of higher typ. (less than 10kHz)

**15.5.4 Ramp Wave**

**Setting range of symmetry**

- 0.00% to 100.00% (resolution 0.01%)

### 15.6 Modulated Oscillation Mode

#### 15.6.1 General

**Modulation type**

- FM, FSK, PM, PSK, AM, DC offset modulation, PWM

**Modulation operation**

- Start and stop

**Modulation source**

- **Except for FSK and PSK**
  - Internal, external (switch)
  - Source of CH2 cannot be same as CH1
- **FSK, PSK**
  - CH1: Internal, CH1 external input terminal (switch)
  - CH2: Internal, CH1 and CH2 external input terminal (switch)
  - (CH1 external input on CH2 is enabled only when external input is selected on CH1.)
  - External input of FSK and PSK uses an external trigger input terminal.

**Internal modulation waveform**

- **Except for FSK and PSK**
  - Sine wave, square wave (duty 50%), triangle wave (symmetry 50%), rising ramp wave, falling ramp wave, noise, arbitrary wave
- **FSK, PSK**
  - Square wave (duty 50%)

**Internal modulation frequency**

- **Except for FSK, PSK, and DC offset modulation**
  - 0.1mHz to 1MHz (resolution 8 digits or 0.1mHz)
- **FSK, PSK**
  - 0.1mHz to 3MHz (resolution 8 digits or 0.1mHz)
- **DC offset modulation**
  - 0.1mHz to 100kHz (resolution 8 digits or 0.1mHz)

**Internal modulation synchronization output**

- **Output waveform**
  - A square wave with duty 50% rising at the zero phase of the internal modulation waveform.
Internal modulation signal output

Output connector: Shared with synchronization/sub-out connector

Output voltage: -3V to +3V/open

External modulation input (except for FSK and PSK)

Input voltage range: ±1V Full scale
Maximum allowable input: ±2V
Input impedance: 10kΩ, Unbalanced
Input frequency: DC~40kHz (-3dB)

Input connector: Front panel (WF1947)/ rear panel (WF1948), BNC receptacle

Shared with output addition input. It cannot be used with additional operation at a time

External modulation input (FSK and PSK)

Polarity: Positive, negative (switch)
Input frequency: DC~3MHz

Input connector: External trigger input is used
Input signal and input impedance depend on external trigger input specification

Signals Selectable for Synchronization/Sub-output

Reference phase synchronization
Internal synchronization (only when modulation source is internal)
Internal signal (only when modulation source is internal and not FSK and PSK)

15.6.2 FM

Carrier waveform: Standard waveform except for noise, pulse wave, and DC and an arbitrary waveform.

Peak deviation setting range: 0.00µHz to 15MHz or lower (resolution eight digits or 0.01µHz)
Carrier frequency ± peak deviation is limited within the allowable range of frequency for each carrier waveform.

15.6.3 FSK

Carrier waveform: Standard waveform except for noise, pulse wave, and DC and an arbitrary waveform.

Hop frequency setting range: Within the allowable range of frequency for each carrier waveform (resolution 8 digits or 0.01µHz)
15.6.4 PM  
Carrier waveform: Standard waveform except for noise and DC and an arbitrary waveform.  
Peak deviation setting range: 0.000° to 180.000° (resolution 0.001°)  
Carrier phase ± peak deviation is limited within the range of ±1800°.

15.6.5 PSK  
Carrier waveform: Standard waveform except for noise and DC and an arbitrary waveform.  
Deviation setting range: -1800.000° to +1800.000° (resolution 0.001°)  
Carrier phase ± deviation is limited within the range of ±1800°.  
Remarks: Amplitude frequency characteristic of sine wave during PSK is limited 25MHz to -3dB.

15.6.6 AM  
a) Non-DSB-SC  
Carrier waveform: Standard waveform except for DC and arbitrary waveform.  
Modulation depth setting range: 0.0% to 100.0% (resolution 0.1%)  
Remarks: When the modulation depth is 0%, amplitude becomes equal to 1/2 of setting.

b) DSB-SC (Double Side Band - Suppressed Carrier)  
Carrier waveform: Standard waveform except for DC and arbitrary waveform.  
Modulation depth setting range: 0.0% to 100.0% (resolution 0.1%)  
Remarks: When the modulation depth is 100%, maximum amplitude becomes equal to setting.  
The component of the carrier frequency is zero during DSB-SC.

15.6.7 DC Offset Modulation  
Carrier waveform: Standard waveform and arbitrary waveform.  
Peak deviation setting range: 0V to 10V/open  
Carrier DC offset ±peak deviation is limited within the allowable range of DC offset for each carrier waveform.

15.6.8 PWM  
Carrier waveform: Square wave and pulse wave  
Peak deviation setting range:  
Rectangular 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%)  
Carrier duty ± peak deviation is limited within the...
allowable range of duty for each carrier waveform.

15.7 Sweep Oscillation Mode

15.7.1 General

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sweep type</td>
<td>Frequency, phase, amplitude, DC offset, and duty</td>
</tr>
<tr>
<td>Sweep function</td>
<td>One way (lump waveform), two way (triangular wave) (switch)</td>
</tr>
<tr>
<td></td>
<td>Linear, logarithmic (switch)</td>
</tr>
<tr>
<td></td>
<td>Common regardless of sweep type</td>
</tr>
<tr>
<td></td>
<td>However, logarithmic can use only frequency sweep</td>
</tr>
<tr>
<td>Sweep range setting</td>
<td>Specify starting value and stopping value, or center value and span value.</td>
</tr>
<tr>
<td></td>
<td>However, the center value is also a simple average during frequency logarithmic sweep</td>
</tr>
<tr>
<td></td>
<td>Assigning to a center value of a marker value is possible (vice versa).</td>
</tr>
<tr>
<td>Setting range of Sweep Time</td>
<td>0.1ms to 10,000s (resolution 4 digits or 0.1ms)</td>
</tr>
<tr>
<td>Sweep Mode</td>
<td>Continuous, single, gated single (switch)</td>
</tr>
<tr>
<td></td>
<td>Common regardless of sweep type</td>
</tr>
<tr>
<td></td>
<td>For gated single, it oscillates only during running sweep</td>
</tr>
<tr>
<td></td>
<td>However, when the waveform is DC, gated single is not available.</td>
</tr>
<tr>
<td>Operation</td>
<td>Start, stop, hold, resume, starting value output, stopping value output</td>
</tr>
<tr>
<td>Trigger source</td>
<td>CH1: Internal, CH1 external input terminal (switch)</td>
</tr>
<tr>
<td></td>
<td>CH2: Internal, CH1 and CH2 external input terminal (switch)</td>
</tr>
<tr>
<td></td>
<td>(CH1 external input on CH2 is enabled only when external input is selected on CH1.)</td>
</tr>
<tr>
<td></td>
<td>Common regardless of sweep type</td>
</tr>
<tr>
<td></td>
<td>Trigger delay setting is invalid</td>
</tr>
<tr>
<td></td>
<td>Manual trigger available</td>
</tr>
</tbody>
</table>

Internal trigger oscillator for sweep (used for single sweep and gated sweep)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Setting range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Period setting range</td>
<td>100.0µs to 10,000s (resolution 5 digits or 0.1µs)</td>
</tr>
</tbody>
</table>

Stop level setting (used for gated single sweep)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Setting range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Function</td>
<td>Specify the signal level when gated single-shot sweep is stopped.</td>
</tr>
<tr>
<td>Setting range</td>
<td>-100.00% to +100.00% (amplitude full-scale reference and resolution 0.01%) or off</td>
</tr>
<tr>
<td></td>
<td>When stop level is set to off, stops by set starting oscillation/stop phase</td>
</tr>
</tbody>
</table>
15.7 Sweep Oscillation Mode

Remarks

Common regardless of sweep type
When the waveform is Noise, oscillation start/stop phase is invalid, stop level is always valid.
When the waveform is DC, oscillation start/stop phase is invalid, stop level is invalid.
For phase sweep, sweep starting value is oscillation start phase and sweep stop value is oscillation stop phase

Oscillation stop unit when gated single

One wave, 0.5 wave (switch)

Sweep synchronization/marker output

Marker off at one-way
Low level from sweep starting time to half of sweep time
Otherwise, high level

Marker off at two-way
Low level from sweep starting time to sweep stop time
Otherwise, high level

Marker on
Low level from sweep starting time to marker value
Otherwise, high level

Output connector
Shared with synchronization/sub-out connector

Sweep X drive output

Output voltage
0V to +3V/open
During sweep value rising, 0 to +3V, during falling, +3 to 0V

Output connector
Shared with synchronization/sub-out connector

Sweep outside trigger input (used for single sweep and gated sweep)

Polarity
Positive, negative, disable (switch)

Input connector
External trigger input is used
Input signal and input impedance depend on external trigger input specification

Signals Selectable for Synchronization/Sub-output

Reference phase synchronization
Sweep synchronization/marker
Sweep X drive

15.7.2 Frequency Sweep

Waveform
Standard waveform except for noise, pulse wave, and DC and an arbitrary waveform.

Setting range of start and stop frequency
0.01µHz to 30MHz (resolution 0.01µHz)
Limited within the allowed setting range of frequency for each waveform.

15.7.3 Phase Sweep

Waveform
Standard waveform except for noise and DC and an arbitrary waveform.
15.8 Burst oscillation mode

Setting range of start and stop phase -1800.000° to 1800.000° (resolution 0.001°)
Remarks: The setting value is same as the phase setting for other oscillation mode

15.7.4 Amplitude Sweep

Waveform Standard waveform except for DC and arbitrary waveform.
Setting range of start and stop amplitude 0Vp-p to 20Vp-p/open
Limited within the allowed setting range of amplitude for each waveform.

15.7.5 DC Offset Sweep

Waveform Standard waveform and arbitrary waveform.
Setting range of start and stop DC offset -10V to +10V/open
Limited within the allowed setting range of DC offset for each waveform.

15.7.6 Duty Sweep

Waveform Square wave and pulse wave
Setting range of start and stop duty
Rectangular wave
Duty variable range standard 0.0100% to 99.9900% (resolution 0.0001%)
Duty variable range extend 0.0000% to 100.0000% (resolution 0.0001%)
Pulse wave 0.0170% to 99.9830% (resolution 0.0001%)
Limited within the allowed setting range of duty for each waveform.

15.8 Burst oscillation mode

Burst mode
Auto burst Repeats oscillating the number of mark wave and stopping the number of space wave. Trigger becomes invalid.
Trigger burst Oscillates the number of mark wave with synchronizing trigger.
Gate Oscillates integral multiple of integer cycle or half cycle with synchronizing the gate signal. However, when the waveform is noise, it makes oscillation on/off by the gate signal.
Trigger gate Gate oscillation making gate on/off based on each trigger.
Target waveform
Auto and trigger burst Standard waveform except for noise and DC and an arbitrary waveform.
Auto and trigger gate Standard waveform except for DC and arbitrary
15.8 Burst oscillation mode

- **Mark wave number setting range**: 0.5 to 999,999.5, 0.5 wave unit
- **Number of space wave setting range**: 0.5 to 999,999.5, 0.5 wave unit
- **Stop oscillation unit at gate**: One wave, 0.5 wave (switch)
- **Setting range of start/stop oscillate**: -1800.000° to +1800.000° (resolution 0.001°)
  - **Remarks**: The setting value is same as the phase setting for other oscillation mode

- **Stop level setting range**
  - **Function**: Specify the signal level while oscillation is stopped
  - **Setting range**: -100.00% to +100.00% (amplitude full-scale reference and resolution 0.01%) or off
  - **Remarks**: The waveform is Noise, oscillation start/stop phase is invalid, stop level is always valid.

- **Trigger source (used for trigger burst)**
  - CH1: Internal, CH1 external input terminal (switch)
  - CH2: Internal, CH1 and CH2 external input terminal (switch)
  - **Manual trigger available**

- **Internal trigger oscillator for burst (used except for auto burst)**
  - **Phase setting range**: 1.0µs to 1,000s (resolution 5 digits or 0.1µs)
  - **Trigger delay setting range**: 0.00µs to 100.00s (setting resolution 8 digits or 0.01µs)
    - **External delay**: 0.55µs
    - **Remarks**: Enabled only for trigger burst (disabled for gate and triggered gate)

- **Trigger jitter**: 1ns rms or less typ.

- **Burst synchronization output**
  - **Polarity**: Low level during oscillation, otherwise high level
  - **Output connector**: Shared with synchronization/sub-out connector

- **Signals Selectable for Synchronization/Sub-output**
  - **Reference phase synchronization**
  - **Burst synchronization**
15.9 Triggers

External

Application
Used for single sweep, gated single sweep, trigger burst, gate, trigger gate

Input voltage
TTL level (low level 0.8V or lower, high level is 2.6V or higher)

Maximum allowable input*1
\[-0.5V \sim +5.5V\]

Polarity
Positive, negative, disable (switch)

Minimum pulse width*1
50ns

Input impedance
10kΩ (pull-up to+3.3V), unbalanced

Input connector
Front panel (WF1947)/ rear panel (WF1948), BNC receptacle

Manual trigger
Panel key operation

Application
Used for single sweep, gated single sweep, trigger burst, gate, trigger gate

Internal trigger oscillation
For sweep, burst, and independent among channels

See the internal trigger oscillation in each section

15.10 Other I/Os

External 10 MHz frequency reference input

Select frequency reference
Enabled and disabled of external reference (switch)

Input voltage
0.5Vp-p~5Vp-p

Maximum allowable input*1
10Vp-p

Input impedance
1kΩ, unbalanced, AC coupling

Input frequency
10MHz (±0.5% (±50kHz))

Input waveform
Sine or square wave (50±5% duty)

Input connector
Back panel, BNC receptacle

Frequency reference output (WF1947 and WF1948, to synchronize more than one device)

Output voltage
1Vp-p/50Ω Square wave

Output impedance
50 Ω, AC coupling

Output frequency
10MHz

Output connector
Back panel, BNC receptacle

External addition input

Additional gain
0.4 times, 2 times, 10 times, off (switch)

When 0.4 times is used, maximum output voltage range is fixed to 0.8Vp-p, when 2 times 4Vp-p, and when 10 times 20Vp-p.

During external modulation, it is dedicated to external modulation input.
<table>
<thead>
<tr>
<th>Specification</th>
<th>Specification Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input voltage</td>
<td>-1V~+1V</td>
</tr>
<tr>
<td>Maximum allowable input&lt;sup&gt;1&lt;/sup&gt;</td>
<td>±2V</td>
</tr>
<tr>
<td>Input frequency</td>
<td>DC~10MHz (-3dB)</td>
</tr>
<tr>
<td>Input impedance</td>
<td>Balanced/10kΩ, Unbalanced</td>
</tr>
<tr>
<td>Input connector</td>
<td>Front panel (WF1947)/ rear panel (WF1948), BNC receptacle</td>
</tr>
</tbody>
</table>

Shared with external modulation input. Cannot be used with external modulation and external addition at a time.
15.11 2-Channel Coordination (WF1948 Only)

Channel mode

<table>
<thead>
<tr>
<th>Channel mode</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Independent</td>
<td>Independent setting</td>
</tr>
<tr>
<td>2 phase</td>
<td>Keeps same frequency. Also controls to keep same frequency for frequency sweep, internal frequency modulation, and internal FSK. External frequency modulation and external FSK is not allowed. Phase is independent setting among each channel.</td>
</tr>
<tr>
<td>Constant frequency difference</td>
<td>Keep Difference of frequency constant. Also controls to keep frequency difference for frequency sweep, internal frequency modulation, and internal FSK. External frequency modulation and external FSK is not allowed.</td>
</tr>
<tr>
<td>Constant frequency ratio</td>
<td>Keep Ratio of frequency constant. Also controls to keep frequency ratio for frequency sweep, internal frequency modulation, and internal FSK. External frequency modulation and external FSK is not allowed.</td>
</tr>
<tr>
<td>Differential output</td>
<td>Same frequency, amplitude, DC offset. Reverse phase waveform. Controls to keep different output, even for each type of sweep and internal modulation. External modulation is not allowed. External addition is not allowed.</td>
</tr>
</tbody>
</table>

Common restriction conditions for 2 phase, constant frequency difference, constant frequency ratio, and differential output

- Oscillates on the same oscillation mode (for modulation oscillation, modulation type is also same. For sweep oscillation, sweep type is also same).
- Applies to standard waveform except for noise and DC and an arbitrary waveform.
- Burst, gated sweep is unavailable.

Same value setting and operation: Capable

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

CH2 frequency - CH1 frequency

Frequency ratio N:M setting range: 1 to 9,999,999 (each of N and M)

N:M = CH2 frequency: CH1 frequency

Frequency resolution is limited to N × 0.01µHz for CH1, M × 0.01µHz for CH2 (also for frequency sweep, internal frequency sweep, and internal FSK)

Phase synchronization: Auto run when the channel mode is changed

Interval between channels for 2 phase: ±20ns or lower *1, ±10ns or lower typ.

Conditions: Same waveform (sine wave and square wave)
15.12 Synchronization of Multiple Units

Connection

Connection Method 1

Connection cables
- Cable type: Characteristic impedance 50 Ω series coaxial cable with BNC connector (RG-58A/U etc.)
- Restriction to cable length: 1 m or less between units, total cable length is 3 m or less
- Maximum connection number:
  - Connection Method 1: 6 units including master unit
  - Connection Method 2: 4 units including master unit
- Phase synchronization: Manual operation
- Interval of waveforms among equipments
  - Delay of each channel against each of a master equipment on the Nth slave equipment \((1 \leq N)\)
    - Connection Method 1: \(31\text{ns} + (N-1) \times 6\text{ns} \pm 25\text{ns} \text{ typ.}\)
    - Connection Method 2: \(31\text{ns} + (N-1) \times 31\text{ns} \pm 25\text{ns} \text{ typ.}\)
- Conditions: Continuous oscillation, same frequency, same phase, same waveform (sine wave and square wave), load 50Ω, DC offset setting 0V, amplitude setting 10Vp-p/50Ω, and connecting cable length of frequency reference output between external frequency reference input is 1m (RG-58A/U)
15.13 User-defined unit

Function
Set and display settings in any unit based on a specified conversion expression.

Setting target
Frequency (Hz), period (sec), amplitude (Vp-p, Vpk), DC offset (V), phase (deg), and duty (%).

Conversion formula
\[(\text{setting target value}) + n] \times m, \text{ or } \left[\log_{10}(\text{setting target value}) + n\right] \times m\]
Specify a conversion expression and values of n and m.

Unit name string
Maximum 4 characters.

15.14 Other Functions

Setting save memory
10 sets (saved in non-volatile memories).

Parameter setting at power-on operation
Power-off with front panel operation
→ It is restored at power-on to the previous operation state.
Shut down with power line disconnect
→ The contents of setting memory number 1 are set.

Output On/Off setting at power-on operation. Last State, On, Off, switch

<table>
<thead>
<tr>
<th>Power Off method</th>
<th>Power-On Output setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Panel power supply Off operation</td>
<td>Power Off it is restored the state just before</td>
</tr>
<tr>
<td>Shut down with line</td>
<td>Output Off</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Power Off method</th>
<th>Power-On Output setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Last State</td>
<td>On</td>
</tr>
<tr>
<td>Panel power supply Off operation</td>
<td>Output On</td>
</tr>
<tr>
<td>Shut down with line</td>
<td>Output Off</td>
</tr>
</tbody>
</table>

External Control Interface
GPIB, USBTMC

External control command
SCPI-1999/IEEE-488.2
and (WF194x compatible) own command.
15.15 General Characteristics

Indicator 3.5 inch TFT color LCD

I/O ground
Signal grounds for waveform output (FCTN OUT), synchronize/sub-output (SYNC/SUB OUT), external modulation/add input (MOD/ADD IN) are insulated from the enclosure. These signal grounds within same channel is common.
Signal ground for external 10MHz reference input (10MHz REF IN) is insulated from the enclosure.
Each signal ground for CH1, CH2, and 10MHz REF IN is independent.
Withstand voltage between the enclosure and insulated signal ground is maximum 42Vpk (DC+ACpeak).
The other signal grounds connects to the enclosure.

Power Supply
Power voltage range: AC100V to 230V ±10% (250V or lower)
Power frequency range: 50Hz/60Hz ±2Hz
Power consumption
WF1947: 55VA or lower
WF1948: 75VA or lower

Overvoltage category II

Ambient temperature/humidity range conditions (See next image)
Guaranteed operation range 0°C~+40°C, 5~85%RH
Furthermore, AH 1 to 25g g/m³, no condensation
On some specifications, the temperature range limit is more strict.

Storage conditions -10°C~+50°C, 5~95%RH
Furthermore, AH 1 to 29g g/m³, no condensation

Warm-up time More than 30 minutes typ.
Pollution degree 2
External dimensions 216 (W) x 132.5 (H) x 288 (D) mm (without protrusions)
216 (W) x 149.5 (H) x 309 (D) mm (maximum dimension)
Weight Approx. 2.6kg (accessories are not included. The weight of equipment)
15.15 General Characteristics

Safety and EMC (Applied only to models with the CE marking displayed on the rear panel)

- EN 61010-1:2010
- EN 61326-1:2006 (Group 1, Class A)
- EN 61000-3-3:2008
- RoHS Directive 2011/65/EU
Outline dimensional drawing (WF1947)
Outline dimensional drawing (WF1948)

- Front view
- Side view
- Rear view
Inch rack mount dimensional drawing (for 1 unit)
15.15 General Characteristics

- Inch rack mount dimensional drawing (for 2 units)

**WARNING:** When mounting the unit in the rack, do not hold it only with the rack-mount adapters. Be sure to hold the main unit with brackets or shelves on the rack side.
Millimeter rack mount dimensional drawing (for 1 unit)
Millimeter rack mount dimensional drawing (for 2 units)