How can you replicate real world signals?
Precisely

FG400 Series
Arbitrary/Function Generator

• 0.01 μHz to 30 MHz, 20 Vp-p, 1 or 2 channels
• Intuitive operation with a 3.5” LCD screen
• Synchronize up to 6 units to provide up to 12 output channels
• A variety of sweeps and modulations
Features and benefits

Easily generate basic, application specific and arbitrary waveforms.

The FG400 Arbitrary/Function Generator provides a wide variety of waveforms as standard and generates signals simply and easily.

There are one channel (FG410) and two channel (FG420) models. As the output channels are isolated, an FG400 can also be used in the development of floating circuits. (up to 42 V)

Basic waveforms

<table>
<thead>
<tr>
<th>Waveform</th>
<th>Description</th>
<th>Frequency Range</th>
<th>Amplitude</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sine</td>
<td></td>
<td>0.01 μHz to 30 MHz</td>
<td>±10 V/open</td>
</tr>
<tr>
<td>Square</td>
<td></td>
<td>0.01 μHz to 15 MHz, variable duty</td>
<td></td>
</tr>
<tr>
<td>Pulse</td>
<td></td>
<td>0.01 μHz to 15 MHz, variable leading/trailing edge time</td>
<td></td>
</tr>
<tr>
<td>Ramp</td>
<td></td>
<td>0.01 μHz to 5 MHz, variable symmetry</td>
<td></td>
</tr>
</tbody>
</table>

Advanced functions

<table>
<thead>
<tr>
<th>Function</th>
<th>Description</th>
<th>Setting Items</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sweep &amp; Modulation</td>
<td>Frequency sweep</td>
<td>start/stop frequency, time, mode (continuous, single, gated single), function (one-way/shuttle, linear/log)</td>
<td></td>
</tr>
</tbody>
</table>
For trouble shooting

Arbitrary waveforms (16 bits amplitude resolution) of up to 512 K words per waveform can be generated. 128 waveforms with a total size of 4 M words can be saved to the internal non-volatile memory. Waveforms can be selected from the displayed list. Waveforms can be created in the FG400 or with the editor software.

Acquire signal noise in the field, and then recreate it in the lab

The FG400 can generate signals as arbitrary waveforms that have been acquired by measuring instruments. Trouble shooting is made easier as the FG400 can generate waveforms that are difficult to reproduce. For example noise that only occurs on site.

With the XviewerLITE software (freeware), waveform (binary data) that is acquired using a YOKOGAWA DL850E or DLM4000 can be analyzed on the PC to find the abnormal waveform. This abnormal part can then be clipped, saved and generated using the FG400.

[Application]
Clipping the abnormal signal, then adding it to the normal signal

Connect the clipped abnormal signal output of channel 2 to the additional input terminal of channel 1, and then press the Manual trigger key. The abnormal signal is added to the normal pulse waveform that is set on channel 1.
Application-specific waveforms are also standard

Parameter-Variable Waveforms
In some cases engineers need application-specific waveforms like those needed to evaluate the response characteristics of mechanical/electrical circuits and to emulate power supply circuits. The FG400 provides 25 different types of waveform as standard. As the parameters of application-specific waveforms can be changed like those of basic waveforms, waveforms are quicker and easier to generate.
Manually program waveform patterns

**Sequence function**

Sequences of different waveform patterns can be generated by programming the parameters. Complex sequences can be easily created using the “Sequence Edit Software”.

Available parameters include:
- waveform, frequency, phase, amplitude, DC offset,
- square wave duty, step time, hold operation,
- jump destination, number of jumps, step stop phase,
- branch operation, step termination control,
- step sync code output

**When 2 channels are linked (FG420 only)**

In the FG420 the two output channels can be linked.

- Independent: Independent setting
- 2-phase: Holds the same frequency
- Constant frequency difference:
  - Holds the frequency difference as a constant value
- Constant frequency ratio:
  - Holds the frequency ratio as a constant value
- Differential output:
  - Same frequency, amplitude, and DC offset. Reverse phase waveform

**When you need more than 2 channels**

By synchronizing multiple FG410 and FG420s, a generator of up to 12 phases (using six FG420s) can be created.

The phase of each channel is synchronized to the master unit and can be individually adjusted.

**Greater accuracy and stability**

The FG400 has an external input terminal to increase frequency accuracy and stability by using a frequency reference with better accuracy than the built-in reference (for example, a rubidium frequency standard).
Input/output terminal and Specification of FG400

FG400 Series

Input/output terminal

FG410 (1 ch)

- CH1 I/O terminals
  1. Waveform output
  2. Sync/sub-output
  3. External modulation/addition input
  4. External trigger input

FG420 (2 ch)

- CH2 I/O terminals
  1. Waveform output
  2. Sync/sub-output
  3. External modulation/addition input
  4. External trigger input

Common I/O terminals

- External 10 MHz frequency reference input
- Frequency reference output
- Multi-I/O connector
- GPIB connector
- USB connector

Common I/O terminals

- External 10 MHz frequency reference input
- Frequency reference output
- Multi-I/O connector
- GPIB connector
- USB connector

 specification of FG400

Output and Oscillation Modes

- Number of channels: FG410: 1 channel, FG420: 2 channels
- Output waveforms: Sine, square, pulse, ramp, parameter-variable waveform, noise (log-normal distribution), DC, arbitrary waveform
- Oscillation modes: Continuous, modulation, sweep, burst, sequence

Frequency

<table>
<thead>
<tr>
<th>Oscillation mode</th>
<th>Sweep (Continuous), Single-Shot</th>
<th>Burst</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sine</td>
<td>0.01 μHz to 30 MHz</td>
<td>0.01 μHz to 10 MHz</td>
</tr>
<tr>
<td>Square</td>
<td>0.01 μHz to 15 MHz</td>
<td>0.01 μHz to 10 MHz</td>
</tr>
<tr>
<td>Pulse</td>
<td>0.01 μHz to 5 MHz</td>
<td>0.01 μHz to 5 MHz</td>
</tr>
<tr>
<td>Parameter-variable waveform</td>
<td>0.01 μHz to 5 MHz</td>
<td>0.01 μHz to 5 MHz</td>
</tr>
<tr>
<td>Noise</td>
<td>Fixed to 20 MHz equivalent bandwidth</td>
<td></td>
</tr>
</tbody>
</table>

Output Characteristics

- Amplitude
  - Setting range: 0 Vpp-p to 20 Vpp-p/50 Ω, 0 Vpp-p to 10 Vpp-p/50 Ω
  - AC/DC: ±10 Vpp-p

- Frequency
  - Frequency setting resolution: ±0.01 μHz
  - Frequency accuracy: ±0.01 μHz/year

- Phase setting range: ±180°.000° to ±180°.000°

- Duty cycle
  - Setting range: 0% to 100%
  - Pulse width
  - DC offset
  - DC offset range

- Non-harmonic spurious
  - 1 MHz or lower: −50 dBc or lower
  - 1 MHz to 10 MHz: −40 dBc or lower
  - 10 MHz to 30 MHz: −60 dBc or lower

- Harmonic spurious
  - 1 MHz or lower: −50 dBc or lower
  - 1 MHz to 10 MHz: −40 dBc or lower
  - 10 MHz to 30 MHz: −60 dBc or lower

- DC offset
  - Setting range: −500 μV to 500 μV

- Jitter
  - 300 ps rms or less typ.

- Rise/fall time
  - 17 ns or less

- Overall cost
  - 5% or less typ.

- Pulse wave
  - Duty cycle setting
  - Pulse width
  - Leading edge time, trailing edge time

- Ramp wave
  - Symmetry setting range
  - Duty cycle setting
  - Rise time
  - Fall time

- Output impedance
  - 50 Ω, unbalanced

- Specification of FG400: Output and Oscillation Modes
  - Number of channels: FG410: 1 channel, FG420: 2 channels
  - Output waveforms: Sine, square, pulse, ramp, parameter-variable waveform, noise (log-normal distribution), DC, arbitrary waveform
  - Oscillation modes: Continuous, modulation, sweep, burst, sequence

- Frequency
  - Oscillation mode
  - Continuous, modulation, sweep, burst, sequence

- Output Characteristics
  - Amplitude
    - Setting range: 0 Vpp-p to 20 Vpp-p/50 Ω, 0 Vpp-p to 10 Vpp-p/50 Ω
    - AC/DC: ±10 Vpp-p
  - Frequency
    - Frequency setting resolution: ±0.01 μHz
    - Frequency accuracy: ±0.01 μHz/year
  - Phase setting range: ±180°.000° to ±180°.000°
  - Duty cycle
    - Setting range: 0% to 100%
    - Pulse width
    - DC offset
    - DC offset range
  - Non-harmonic spurious
    - 1 MHz or lower: −50 dBc or lower
    - 1 MHz to 10 MHz: −40 dBc or lower
    - 10 MHz to 30 MHz: −60 dBc or lower
  - Harmonic spurious
    - 1 MHz or lower: −50 dBc or lower
    - 1 MHz to 10 MHz: −40 dBc or lower
    - 10 MHz to 30 MHz: −60 dBc or lower
  - DC offset
    - Setting range: −500 μV to 500 μV
  - Jitter
    - 300 ps rms or less typ.
  - Rise/fall time
    - 17 ns or less
  - Overall cost
    - 5% or less typ.
  - Pulse wave
    - Duty cycle setting
    - Pulse width
    - Leading edge time, trailing edge time
  - Ramp wave
    - Symmetry setting range
    - Duty cycle setting
    - Rise time
    - Fall time

- Output impedance
  - 50 Ω, unbalanced
**Parameter-variable waveform**

- **Modulation**
  - Type: FM
  - Carrier waveform: Standard waveform other than noise, pulse wave and DC, and arbitrary waveform
  - Peak deviation: 0.0% to less than 15 MHz
  
- **PSK**
  - Carrier waveform: Standard waveform other than noise, pulse wave and DC, and arbitrary waveform
  - Hop frequency: Within settle carrier waveform frequency and DC, and arbitrary waveform
  
- **FM**
  - Carrier waveform: Standard waveform other than noise and DC, and arbitrary waveform
  - Deviation: 1800.000% to 1800.000%

- **AM**
  - Carrier waveform: Standard waveform other than DC, and arbitrary waveform
  - Modulation depth: 0.0% to 150.0%

- **FSK**
  - Carrier waveform: Square wave, pulse wave, and arbitrary waveform
  - Peak deviation: 0 V to 10 V

**Sweep**

- **Sweep types**
  - Frequency, phase, amplitude, DC offset, duty

- **Sweep functions**
  - One-way (ramp waveform shape), shuffle (triangular waveform shape) (selectable)
  - Linear, log (frequency sweep only) (selectable)

- **Sweep range setting**
  - Start value and stop value specification or Center value and span value specification

- **Sweep time setting range**
  - 0.1 ms to 1000 s (4 digits or 0.01 ms)

- **Sweep mode**
  - Continuously, single-shot, gated single-shot (selectable)
  - During gated single-shot, oscillation occurs only during sweep execution

- **Source**
  - Internal, external, selectable

- **Internal trigger oscillator**
  - Period setting range: 0.01 μs to 100.0 s (0.1 μs or 1 μs)

- **Stop level setting**
  - Specification of signal level while oscillation is stopped during gated single-shot sweep
  - Setting range: –100.0% to +100.0% of amplitude full scale or off

- **Sweep trigger**
  - Sweep synchronizer output, Sweep X drive output, Sweeplevel external control, Sweeplevel external trigger input

- **Burst**
  - Burst mode: Auto burst, trigger burst, gate, triggered gate (synchronized switch can be off by gate upon trigger)

**Operation**

- Number of Mark/Space: 0.5 cycles to 999,999 cycles in 0.5-cycle units

**Display**

- **Display unit and memory**
  - 7-segment display
  - Number of saved memory sequences: 10 sequences (saved to non-volatile memory)

**Channel modes**

- **Sweep operation**
  - Set two channels at the same time.

**Other functions**

- **External 10 MHz frequency reference input**
  - Voltage waveform: 0.5 Vp-p to 5 Vp-p, sine wave or square wave

**Power supply**

- **AC 100 V to 230 V ±10% (50/60 Hz ±1 Hz)

**Operating environment**

- **Operating temperature**
  - 0°C to 40°C ( Absolute humidity of 1 g/m³ to 25 g/m³, no condensation)

- **Display**
  - 3.5 inch TFT color LCD

**Display functions**

- **Zoom in/out**

**Editing functions**

- **Initializes, copies, pastes, inserts, and deletes steps**
- **Cuts, copies, and pastes some part of waveform**

**User interface**

- **GPIB, USBTMC (SCPI-1999, IEEE-488.2)**

**Dimensions**

- 216 (W) × 88 (H) × 332 (D) mm (excluding protrusions)
- Weight: Approx. 2.1 kg (main unit excluding accessories)

**Accessories**

- *1: Guaranteed numerical value. Other numerical values are nominal or typical (typ.) values.
- *2: Used after converted into arbitrary waveform.
- *3: If it can be downloaded from the web site.
- *4: Conditions: 1 kHz sine, amplitude setting of 20 mVp-p/50 Ω or higher.
- *5: The LCD may include a few defective dots (5 dots or less).
- *6: The LCD may include 5 defective dots (5 dots or less).

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**2-channel operated function (FG400 only)**

**Channel modes**

- Independent, 2-phase (has same frequency), Constant frequency difference, Constant frequency ratio, Differential output (Same frequency, amplitude, and DC offset, Reverse phase waveform)

**Equivalent setting, same operation**

- Set two channels at the same time.

**Frequency difference setting range**

- CH1 frequency – CH2 frequency

**Frequency ratio N:M setting range**

- 1 to 999,999 (for each CH1, N:M = 1 CH1 frequency : CH1 frequency)

**Phase synchronization**

- Automatically executed during channel mode switching
Notice
Before operating the product, read the user’s manual thoroughly for proper and safe operation.
If this product is for use with a system requiring safeguards that directly involve personnel safety, please contact the Yokogawa offices.

This is a Class A instrument based on Emission standards EN61326-1, and is designed for an industrial environment. Operation of this equipment in a residential area may cause radio interference, in which case users will be responsible for any interference which they cause.

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### Related Products

#### ScopeCorder
**DL850E/DL850EV**
- 17 types of plug-in modules (voltage, temperature, strain, acceleration, frequency, logic, CAN, LIN)
- High-speed (up to 100 MS/s), High resolution (up to 16-bit), Isolated (up to 1 kV)
- 128-CH voltage/temperature, 128-bit logic measurement

#### Mixed Signal Oscilloscope
**DLM4000**
- 8 analog channels/7 analog channels + 8-bit logic
- 350 MHz, 500 MHz analog bandwidth
- Large 12.1-inch LCD display
- Long memory: Up to 125 M points

**DLM2000**
- Lightweight and compact
- 200 MHz, 350 MHz, 500 MHz analog bandwidth
- 4 analog channels/3 analog channels + 8-bit logic
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### Table: Model Suffix Code Description

<table>
<thead>
<tr>
<th>Model</th>
<th>Suffix Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>FG410</td>
<td>Arbitrary/Function Generator: 1-Channel, 30 MHz</td>
<td></td>
</tr>
<tr>
<td>FG420</td>
<td>Arbitrary/Function Generator: 2-Channel, 30 MHz</td>
<td></td>
</tr>
</tbody>
</table>

**Power cord**
- **D**: UL/CSA standard, PSE
- **F**: VDE standard
- **Q**: BS standard
- **H**: GIB standard
- **N**: NBR standard

### Standard Accessories:
- Power cord (1 set), User’s manuals and application software (1 set)

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### Table: Model/Part Number - Product Description

<table>
<thead>
<tr>
<th>Model/Part Number</th>
<th>Product</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>709928</td>
<td>Multi input/output cable</td>
<td>For sweep/sequence control</td>
</tr>
<tr>
<td>751537-E2</td>
<td>Rack mount kit</td>
<td>Inch rack mounting (for 1 unit)</td>
</tr>
<tr>
<td>751538-E2</td>
<td>Rack mount kit</td>
<td>Inch rack mounting (for 2 units)</td>
</tr>
<tr>
<td>751537-J2</td>
<td>Rack mount kit</td>
<td>Millimeter rack mounting (for 1 unit)</td>
</tr>
<tr>
<td>751538-J2</td>
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