MFG-2000 Series
Multi-Channel Function Generator

FEATURES

- Maximum Five Output Channels
  - 2 Equivalent Performance Arbitrary Channels Frequency: 1μHz–10/20/30/60MHz
  - RF Channel Frequency (FG/ARB/MOD): 160/320MHz
  - Pulse Generator Frequency: 25MHz
  - Power Amplifier: Low Frequency, 5Hz–100kHz, 20dB/20W (limited by current setting)
- True Point by Point Output Arbitrary Waveform Function: 200MSa/s, 100MHz Repetition Rate, 14-bit Resolution, 16k Points Memory Depth
- Earth Ground Isolation Design among I/O Terminals and Instrument Chassis
- Frequency Counter: 150MHz, 8-bit Frequency Resolution
- AM/FM/PM/ASK/FSK/PSK/SUM/PWM Modulation
- USB Host/USB Device/LAN (MFG-22XX only)
- 4.3 Inch TFT Color Display
GW Instek rolls out the MFG-2000 series multi-channel function generator, which has up to 5 simultaneous output channels, including CH1 and CH2 equivalent performance dual channel arbitrary function generator with the maximum 60MHz for both channels; RF signal generator, a standard AFG, which produces the maximum 320MHz sine wave and various modulation RF signals; pulse generator, whose frequency reaches 25MHz; power amplifier, which is ideal for audio range. The above-mentioned five different functionality channels are separately or totally allocated on 10 models, which extend from the basic single-channel AFG with pulse generator models to five-channel models so as to satisfy various educational and industrial applications.

The AFG channel of the MFG-2000 series outputs sine, square, and triangle, etc. The series features true point by point output arbitrary waveform characteristics of 200 MHz sample rate, 100MHz waveform repetition rate, 14-bit resolution, and 16k points memory depth. Some models provide various modulation methods such as AM/FM/PM/FSK/PWM, Sweep, Burst, Trigger, 150MHz Frequency Counter. Synchronized dual channel models provide correlated functions, including synchronization, delay, sum, and coupling. RF signal generator, a complete AFG signal source (including ARB), features various modulations, Sweep, and digital modulations such as ASK and PSK and its sine wave frequency is up to 320MHz. A full-function pulse generator with 25 MHz is equipped to all models and its pulse width, rise edge time, fall edge time are adjustable that can be applied as trigger signals. Independent input/output power amplifier with 20W, 20dB, 5Hz~100KHz bandwidth, and distortion less than 0.1% can be applied to the audio application.

The overall design of the MFG-2000 series is earth ground isolation among output/input terminals and instrument chassis that can only be found in high-level signal sources. The output channels can sustain maximum isolation voltage up to ±42Vpk (DC+ AC peak value) to earth ground that is ideal for floating circuit tests. Multi-unit outputs can be executed without factoring in grounding reference issue. There is no additional isolation requirement for experiments such as “full-wave rectification” and “voltage doubler” which are easy and safe. An external power supply can bring up the DC bias voltage to ±42Vpk to meet the requirements of higher DC bias voltage such as automotive and educational applications.

The MFG-2000 series can maximally and simultaneously output five functional channels. The functionalities of each channel are as follows:

<table>
<thead>
<tr>
<th>Channel 1</th>
<th>Channel 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>5Hz~62MHz</td>
<td>5MHz~122MHz</td>
</tr>
<tr>
<td>max. FG With</td>
<td>max. FG With</td>
</tr>
<tr>
<td>200MSa/s ARB</td>
<td>200MSa/s ARB</td>
</tr>
<tr>
<td>AM, FM, PM, FSK, PPM, Sweep, Burst, Trigger, 150KHz Frequency Counter</td>
<td>AM, FM, PM, FSK, PPM, Sweep, Burst, Trigger, 150KHz Frequency Counter</td>
</tr>
</tbody>
</table>

The AFG of the MFG-2000 series collocating with AWES (Arbitrary Waveform Editing Software) allows users to easily and quickly edit arbitrary waveforms. DWR (Direct Waveform Reconstruction) allows users to collocate with GDS series digital oscilloscopes to retrieve waveforms and upload them to arbitrary generator to achieve direct waveform reconstruction. 66 built-in waveforms allow users to edit arbitrary waveforms and to output the whole segment or divided segments.

With the multi-functionality channels, the MFG-2000 series provides different industrial sectors with special dual channel waveforms, IQ modulation signals, low-frequency vibration simulation, automotive sensors, AM/FM broadcast signals, PWM motor or fan control signals, pulse synchronized signals, pulse noise, audio circuit or devices such as speaker tests. The series is ideal for various fields, including scientific research, education, research and development, production and quality control.
**A. CIRCUIT DESIGN FOR GROUND ISOLATION AMONG OUTPUT/INPUT TERMINALS AND INSTRUMENT CHASSIS**

Output channels, synchronization and modulation input/output connector grounding are isolated from instrument chassis. These connectors can sustain maximum isolation voltage up to ±42Vpk (DC+ AC peak value) to earth ground that is ideal for floating circuit tests. Multi-unit outputs can be executed without factoring in grounding reference issue.

The built-in DC bias voltage of the MFG-2000 series can be applied on various waveforms. The DC bias voltage is ±5V under 50 ohm load. An external power supply can be used to bring up the DC bias voltage to ±42Vpk (DC+ AC peak value) for higher DC bias applications.

Connection diagram for MFG connecting with a power supply to increase D.C. bias voltage to ±42Vpk (DC+ AC peak value).

**B. PULSE GENERATOR**

Each model of the series has a built-in pulse generator and its output frequency reaches 25 MHz. Users can set pulse width, duty cycle, rise edge time, and fall edge time to support trigger signal.

**C. RF SIGNAL GENERATOR**

RF signal generator is a full function AFG signal source. Identical to CH1/CH2, it can output sine, square, ramp, pulse, noise, etc. Its sine wave frequency reaches 160MHz or 320MHz. And its true point by point output arbitrary waveform function supports 200 MHz sample rate, 100MHz waveform repetition rate, 14 bit resolution, 16k point memory depth, frequency sweep and various modulation methods such as AM/FM/PM/FSK/PWM/PSK/ASK. RF signal generator can be applied as a high frequency arbitrary waveform generator, simulated signals of analog or digital broadcast stations or carrier signals of local oscillator.

**D. POWER AMPLIFIER**

20W/20dB power amplifier, which has a bandwidth of DC–100kHz and less than 0.1% distortion. The low frequency power amplifier can be applied as an audio amplifier or a driver amplifier for piezoelectric components (collocating with an impedance transformer, 20W output) and conducts power component characteristics tests, magnetization characteristics tests (B-H curve) of magnetic materials such as ferrite and amorphous materials (collocating with an impedance transformer, 20W output).

Users can connect a speaker with the low frequency power amplifier of the MFG-2000 series to realize various physics experiments.
**E. VERSATILE OUTPUT WAVEFORM SELECTIONS**

There are standard waveforms for the series such as sine, square, triangle, ramp, pulse, noise, DC voltage. In addition, 66 built-in waveforms allow users to easily select desired waveforms.

**F. VARIOUS MODULATION FUNCTION**

The series supports AM, FM, PM, FSK, PWM and SUM modulation. RF channel not only has the above-mentioned modulation capabilities but also supports advanced modulations such as ASK and PSK Modulation. The most modulation sources can be internal or external. Applications include communications systems' base band, motor control and light adjustment.

**G. SWEEP FUNCTION**

The series supports frequency sweep that can also integrate other functions, including linear/logarithm and INT/EXT/Manual trigger to meet various application requirements. Frequency sweep carries out tests on the frequency response of electronic components such as filter and low frequency amplifier.

**H. BURST FUNCTION**

The series supports N-period or gated trigger. Phase angle, duration time, frequency, waveform infinite can be adjusted to meet non-continuous output applications.
J. FOUR METHODS TO OBTAIN ARBITRARY WAVEFORMS

Front Panel Operation
Via single unit’s panel, arbitrary waveforms can be selected, edited, stored, recalled, output, triggered from 66 built-in waveforms.

CSV File Upload
Support CSV file upload produced by MATLAB and Excel.

Direct Waveform Reconstruction
Collocate with GDS series digital oscilloscopes to retrieve waveforms and upload them to arbitrary generator to achieve direct waveform reconstruction. (DSO LINK is only for MFG-22XX Series)

Arbitrary Waveform Editing PC Software
Use AWES to edit complex waveforms. The software supports waveform mathematical operation. The waveform series includes Uniform Noise, Gaussian Noise, Rayleigh Noise, various digital codes such as non zero code, Manchester and RS-232, etc.

K. FLEXIBLE ARBITRARY EDITING

Other Brand’s ARB Operation
User only want to output this segment.

GW Instek ARB Operation
User can select any segment from the entire waveforms for output and after the output the edited waveforms still exist.
## SPECIFICATIONS

### CH1/CH2

<table>
<thead>
<tr>
<th>Waveforms</th>
<th>Standard</th>
<th>Sine, Square, Triangle, Ramp, Pulse, Noise</th>
</tr>
</thead>
</table>

### Arbitrary Functions

<table>
<thead>
<tr>
<th>Function</th>
<th>Arb Function</th>
<th>Built-in</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample Rate</td>
<td>200 MSa/s</td>
<td></td>
</tr>
<tr>
<td>Repetition Rate</td>
<td>100MHz</td>
<td></td>
</tr>
<tr>
<td>Waveform Length</td>
<td>16k points</td>
<td></td>
</tr>
<tr>
<td>Amplitude Resolution</td>
<td>14 bits</td>
<td></td>
</tr>
<tr>
<td>Non-volatile Memory</td>
<td>10sets 16k points (1)</td>
<td></td>
</tr>
<tr>
<td>User-defined Output Section</td>
<td>From point 2 ~ 16384 (user-defind)</td>
<td></td>
</tr>
<tr>
<td>User-defined Output Marker Section</td>
<td>From point 2 ~ 16384 (user-defind)</td>
<td></td>
</tr>
<tr>
<td>Output Mode</td>
<td>1~1048575 cycles or infinite mode</td>
<td></td>
</tr>
</tbody>
</table>

### Frequency Characteristics

| Range | Sine 60MHz (max) |
| Resolution | Square 25MHz (max) |
| Accuracy Stability | Triangle, Ramp 1MHz |
| Aging | ±20 ppm |
| Tolerance | ±1 ppm, per 1 year |
| < 1 μHz | |

### Output Characteristics (2)

| Amplitude Range | ±mVpp to 10 Vpp (into 50Ω) |
| Resolution | ±2% of setting ±1 mVpp (±1 kHz/into 50Ω without DC offset) |
| Flatness | ±1% (0.1dB) ±1 MHz ; ±3% (0.3dB) ±50 MHz ; ±10% (0.9dB) ±160MHz ; ±30% (3dB) ±320MHz |
| Units | (sinewave relative to 1 kHz/into 50Ω) |

### Offset

| Range | ±Vpk AC + DC (into 50Ω) ; ±10Vpk AC + DC (output disabled) |
| Accuracy | 1% of setting + 5mV + 0.5% of amplitude |

### Waveform Output

| Impedance | 50Ω typical (fixed) ; >10MΩ (output disabled) |
| Protection | Short-circuit protected ; Overload relay automatically disables main output |
| Ground Isolation | 42Vpk max. |

### Sync Output

| Impedance | TTL-compatible into >1kΩ |
| Ground Isolation | 50Ω standard |
| Range | 42Vpk max. |

### Sine Wave Characteristics (3)

| Harmonic Distortion | -60 dBc DC ~ 200kHz, Ampl > 0.1 Vpp |
| Harmonic Distortion | -55 dBc 200kHz ~ 1 MHz, Ampl > 0.1 Vpp ; -45 dBc 1MHz ~ 10 MHz, Ampl > 0.1Vpp ; -30 dBc 10MHz ~ 320MHz, Ampl > 0.1Vpp |
| Total Harmonic Distortion | < 0.1% (Ampl>1Vpp) DC~100 kHz |

### Square Wave Characteristics

| Rise/Fall Time | <35ns |
| Asymmetry | <5% |
| Variable duty Cycle | 1% of period + 5 ns |
| Jitter | 0.01% to 99.99% (limited by the current frequency setting) |
| 20ppm +500ps(4) | |

### Ramp Characteristics

| Linearity | < 0.1% of peak output |
| Variable Symmetry | 0% ~ 100% |

### Pulse Characteristics

| Frequency | ±1kHz ~ 25MHz |
| Pulse Width | ±20ns |
| Variable duty Cycle | 0.01% ~ 99.99% (limited by the current frequency setting) |
| Jitter | <5% |
| 20ppm +500ps(4) | |

### Pulse Generator

| Amplitude | ±1mVpp ~ 2.5 Vpp (into 50Ω) |
| Offset | ±1 Vpk AC + DC (into 50Ω) |
| Frequency | ±2Vpk AC + DC (open circuit) |
| Pulse Width | ±1Hz ~ 25MHz |
| Variable duty Cycle | 20ns ~ 999.9ks (limited by the current frequency setting) |
| Leading and Trailing Edge Time(5) | 0.01% ~ 99.99% (limited by the current frequency setting) |
| Overshoot | 10ns ~ 205(1ns resolution) (limited by the current frequency and pulse width settings) |
| Jitter | <5% |
| 100ppm +500ps(4) | |
## Specifications

### RF Generator

**Waveforms**
- Sine, Square, Ramp, Pulse, Noise, ARB
- Modulation (into 50Ω)

**Amplitude (into 50Ω)**
- 1mVpp to 2 Vpp (MFG-2XXXMF); 1mVpp to 1 Vpp (MFG-2XXXMR)

**Offset Frequency**
- 1uHz ~ 160MHz (MFG-2XXXMF); 1uHz ~ 320MHz (MFG-2XXXMR)

### Modulation/Sweep

**Modulation Type**
- AM, FM, PM, FSK, PWM (The detail same as CH1 modulation specification)

**Sweep Type**
- Frequency

**Source**
- INT/EXT (INT only for AM, FM, PM, PWM)

### PSK

**Carrier Waveforms**
- Sine, Square, Triangle, Ramp, Pulse

**Modulating Waveforms**
- 50% duty cycle square

**Internal Frequency**
- 2mHz to 1 MHz

**Phase Range**
- 0˚˚ ~ 360.0˚˚

**Source**
- Internal/External

### ASK

**Carrier Waveforms**
- Sine, Square, Triangle, Ramp, Pulse

**Modulating Waveforms**
- 50% duty cycle square

**Internal Frequency**
- 2mHz to 1 MHz

**Amplitude Range**
- 0% ~ 100.0%

**Source**
- Internal/External

### ARB Function

**Sample Rate**
- 200 MSa/s

**Waveform Length**
- 16k points

**User-defined output section**
- 14 bits

**Jitter**
- From point 2 ~ 16384 (optional)

**20ppm +5ns**

### Power Amplifier

**Input Impedance**
- 10kΩ

**Input Voltage**
- 1.25Vpmax

**Working Mode**
- Constant Voltage

**Gain**
- 20dB

**Output Power (RL=8Ω)**
- 20W (Square)

**Output Voltage**
- 12.5Vpmax

**Output Current**
- 1.6Amax

**Rise/Fall Time**
- <2.5μS

**Full Power Bandwidth**
- DC ~ 100kHz

**Overshoot**
- 5%

**Total Harmonic Distortion**
- < 0.1% (Ampl >1Vpp); 20Hz ~ 20 kHz

**Input Voltage**
- 1.25Vpmax

**Working Mode**
- Constant Voltage

**Gain**
- 20dB

**Output Power**
- 42Vpk max

**Output Voltage**
- 12.5Vpmax

**Output Current**
- 1.6Amax

**Rise/Fall Time**
- <2.5μS

**Full Power Bandwidth**
- DC ~ 100kHz

**Overshoot**
- 5%

**Total Harmonic Distortion**
- < 0.1% (Ampl >1Vpp); 20Hz ~ 20 kHz

### Advanced Functions

#### AM Modulation

**Carrier Waveforms**
- Sine, Square, Triangle, Ramp, Pulse, ARB

**Modulating Waveforms**
- Sine, Square, Triangle, Upramp, Dnramp

**Modulating Frequency**
- 2mHz ~ 20kHz (Int) DC ~ 20kHz (Ext)

**Depth Source**
- Internal/External

**Fm Modulation**

**Carrier Waveforms**
- Sine, Square, Triangle, Ramp

**Modulating Waveforms**
- Sine, Square, Triangle, Upramp, Dnramp

**Modulating Frequency Source**
- Internal/External

**Modulation Frequency Source**
- Internal/External

**FM Modulation Frequency**
- 2mHz ~ 20kHz (Int) DC ~ 20kHz (Ext)

**Phase Deviation Depth**
- 0˚˚ ~ 360.0˚˚

**PM**

**Carrier Waveforms**
- Sine, Square, Triangle, Ramp

**Modulating Waveforms**
- Sine, Square, Triangle, Upramp, Dnramp

**Modulation Frequency Source**
- Internal/External

**Modulation Frequency Depth**
- Internal/External

**Sum**

**Carrier Waveforms**
- Sine, Square, Triangle, Ramp

**Modulating Waveforms**
- Sine, Square, Triangle, Upramp, Dnramp

**Modulation Frequency Source**
- Internal/External

**Modulation Frequency Depth**
- Internal/External

**Output Power**
- 0% ~ 100.0% pulse width

**PWM**

**Carrier Waveforms**
- Sine, Square, Triangle, Ramp

**Modulating Waveforms**
- Sine, Square, Triangle, Upramp, Dnramp

**Modulation Frequency Source**
- Internal/External

**Modulation Frequency Depth**
- Internal/External

**FSK**

**Carrier Waveforms**
- Sine, Square, Triangle, Ramp, Pulse

**Modulating Waveforms**
- 50% duty cycle square

**Internal Frequency**
- 2mHz to 1 MHz

**Frequency Range Source**
- Internal/External

**Sweep**

**Waveforms**
- Sine, Square, Triangle, Ramp

**Sweep Direction**
- Linear or Logarithmic

**Start/Stop Freq**
- Threshold to max frequency

**Sweep Time**
- 1ms to 500s

**Source**
- Internal/External

**Trigger Mode**
- Single, External, Internal

**Marker Source**
- Marker signal on falling edge (programmable)

**BURST**

**Waveforms**
- Sine, Square, Triangle, Ramp

**Frequency**
- 1uHz ~ Max Frequency

**Pulse Count**
- 1~1000000 Cycles or infinite

**Start/Stop Phase**
- -360.0˚˚ ~ +360.0˚˚

**Internal Frequency**
- 1 us ~ 500 s

**Gate Source**
- External Trigger

**Trigger Source**
- Single, External, Internal
### SPECIFICATIONS

<table>
<thead>
<tr>
<th>Trigger Delay</th>
<th>NCycle, Infinite</th>
<th>0s – 100 s</th>
</tr>
</thead>
<tbody>
<tr>
<td>External Trigger Input</td>
<td>Type</td>
<td>For FSK, Burst, Sweep</td>
</tr>
<tr>
<td></td>
<td>Input Level</td>
<td>TTL Compatibility</td>
</tr>
<tr>
<td></td>
<td>Slope</td>
<td>Rising or Falling (Selectible)</td>
</tr>
<tr>
<td></td>
<td>Pulse Width</td>
<td>&gt;100ns</td>
</tr>
<tr>
<td></td>
<td>Input Impedance</td>
<td>10kΩ, DC coupled</td>
</tr>
<tr>
<td>External Modulation Input</td>
<td>Type</td>
<td>For AM, FM, PM, SUM, PWM</td>
</tr>
<tr>
<td></td>
<td>Voltage Range</td>
<td>±5V full scale</td>
</tr>
<tr>
<td></td>
<td>Input Impedance</td>
<td>DC to 20kHz</td>
</tr>
<tr>
<td></td>
<td>Frequency</td>
<td>42Vpp max</td>
</tr>
<tr>
<td></td>
<td>Ground Isolation</td>
<td></td>
</tr>
<tr>
<td>Trigger Output</td>
<td>Type</td>
<td>For FSK, Burst, Sweep</td>
</tr>
<tr>
<td></td>
<td>Level</td>
<td>TTL Compatible into 50Ω</td>
</tr>
<tr>
<td></td>
<td>Pulse Width</td>
<td>&gt;450ns</td>
</tr>
<tr>
<td></td>
<td>Maximum Rate</td>
<td>1MHz</td>
</tr>
<tr>
<td></td>
<td>Fan-out</td>
<td>&gt;4 TTL Load</td>
</tr>
<tr>
<td></td>
<td>Impedance</td>
<td>50Ω Typical</td>
</tr>
<tr>
<td>Frequency Counter</td>
<td>Range</td>
<td>5Hz – 150MHz</td>
</tr>
<tr>
<td></td>
<td>Accuracy</td>
<td>Time Base accuracy ±1 count</td>
</tr>
<tr>
<td></td>
<td>Time Base</td>
<td>±20ppm (23°C ±5°C)</td>
</tr>
<tr>
<td></td>
<td>Resolution</td>
<td>The maximum resolution is: 100MHz for 1Hz, 0.1Hz for 100MHz</td>
</tr>
<tr>
<td></td>
<td>Input Impedance</td>
<td>1kΩ/1pF</td>
</tr>
<tr>
<td></td>
<td>Sensitivity</td>
<td>35mVrms – 30Vms (5Hz – 150MHz)</td>
</tr>
<tr>
<td></td>
<td>Ground Isolation</td>
<td>42Vpp max</td>
</tr>
</tbody>
</table>

### Dual Channel Function (CH1/CH2)

- Phase: -180° ~ +180°
- Track: Synchronize phase
- Coupling: CH2=CH1
- Coupling: Frequency (Ratio or Difference)
- Coupling: Amplitude & DC Offset

### Other

- Store/Recall: 10 Groups of Setting Memories
- Interface: LAN (MFG-22XX Series only), USB
- Display: 4.3 inch TFT LCD

### General Specifications

| Power Source | AC 100~240V, 50~60Hz |
| Power Amplifier Source | DIP switch, AC 100~120V AC 220~240V, 50~60Hz |
| Power Consumption | 30W or 80W (With power amplifier) |
| Operating Environment | Temperature to satisfy the specification: -18 ~ 28°C; Operating temperature: 0 ~ 40°C; Relative humidity: < 80%, 0 ~ 40°C, < 70%, 35 ~ 40°C; Installation category: CAT II |
| Storage Temperature | 2000 Meters |
| Dimensions & Weight | IEC 61010 degree 2, Indoor use |
| Dimensions & Weight | -10 ~ 70°C, Humidity: ≤ 80% |
| Dimensions & Weight | Approx. 2.5kg |

### Ordering Information

- MFG-2110: 10MHz Single Channel Arbitrary Function Generator with Pulse Generator
- MFG-2120: 20MHz Single Channel Arbitrary Function Generator with Pulse Generator
- MFG-2120MA: 20MHz Single Channel Arbitrary Function Generator with Pulse Generator, Modulation, Power Amplifier
- MFG-2130M: 30MHz Single Channel Arbitrary Function Generator with Pulse Generator, Modulation
- MFG-2160MF: 60MHz Single Channel Arbitrary Function Generator with Pulse Generator, Modulation, 160MHz RF Signal Generator
- MFG-2160MR: 60MHz Single Channel Arbitrary Function Generator with Pulse Generator, Modulation, 320MHz RF Signal Generator
- MFG-2230M: 30MHz Dual Channel Arbitrary Function Generator with Pulse Generator, Modulation, 160MHz RF Signal Generator, Power Amplifier
- MFG-2260M: 60MHz Dual Channel Arbitrary Function Generator with Pulse Generator, Modulation, 320MHz RF Signal Generator, Power Amplifier
- MFG-2260MRA: 60MHz Dual Channel Arbitrary Function Generator with Pulse Generator, Modulation, 320MHz RF Signal Generator, Power Amplifier

### ACCESSORIES

- Quick Start Guide x 1, CD-ROM with MFG Software and User Manual x 1
- CTL-101: BNC-Alligator test lead x 1 (MFG-2110/2120/2120MA/2130M/2160MF/2160MR)
- CTL-101: BNC-Alligator test lead x 2 (MFG-2230M/2260M/2260MRA)

### OPTIONAL ACCESSORIES

- CTL-246: USB Type A to Type B cable

### FREE DOWNLOAD

Arbitrary Waveform Editing Software