User’s Guide

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PA1000 Series Power Amplifier

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Safety Notices

Please review the following safety precautions carefully before using your new amplifier to avoid any personal injuries or damages to the instrument and products connected with.

The instrument should be serviced by qualified personnel only.

Please avoid Fire or Personal Injury.

Use Proper Power Cord. Use the power cord only designed for the instrument and authorized in your country.

Ground The Instrument. The power grounding conductor(s) of the instrument must be grounded properly before any connection to the input or output terminals of the amplifier in order to avoid electric shock.

Observe All Terminal Ratings. To avoid fire or shock hazard, please check all ratings and marks on the instrument, and refer this guide for further ratings information before any connection.

Do Not Operate Without Covers. Do not operate the instrument with covers or panels removed.

Avoid Circuit or Wire Exposure. Do not touch exposed connections and components when the power is on.

Do Not Operate With Suspected Failures. If suspected damage occurs with the instrument, have it inspected by qualified service personnel before further operations.

Keep Proper Ventilation.
Do Not Operate in Wet/Damp Conditions.

Do Not Operate in an Explosive atmosphere.

Keep Product Surfaces Clean and Dry.
Safety Terms and Symbols

Safety Notices in this Manual:

**WARNING**
Indicates a potentially hazardous situation or practice which, if not avoided, will result in serious injury or death.

**CAUTION**
Indicates a potentially hazardous situation or practice which, if not avoided, could result in damage to the product or loss of important data.

Safety Terms on the Product:

**DANGER** It calls attention to an operation, if not correctly performed, could result in injury or hazard immediately.

**WARNING** It calls attention to an operation, if not correctly performed, could result in potential injury or hazard.

**CAUTION** It calls attention to an operation, if not correctly performed, could result in damage to the product or other devices connected to the product.

Safety Symbols on the Product:

- [Hazardous Voltage](#)
- [Safety Warning](#)
- [Protective Earth Terminal](#)
- [Chassis Ground](#)
- [Test Ground](#)
PA1000 Power Amplifier Introduction

The amplifier is one of the options provided for RIGOL DG Series Function/Arbitrary Waveform Generators, with up to 1MHz full power bandwidth and higher than 80 V/µs slew rate, which can be used in fast constructions of a test platform in connection with all DG series products, and as a single power amplifier in coordination with other generators.

The power amplifier at present available in this series is PA1011.

Features:
- Easily and neatly communicate with DG and PC software through the USB interface;
- Enables to set the Gain (x1 or x10), Polarity (Invert or Normal), Output offset and the output status in connection with its software;
- Up to 50kΩ output impedance;
- The integrated output protection circuit (overcurrent protection and internal temperature abnormal protection) provided with ensures the instrument is working stably and safely;
- Compact size, easy to carry and use.
Document Overview

1 Quick Start
Guide you how to operate the front/rear panel and the user interface of PA1011 as well as the preparation works for the first time.

2 Operations
Give detailed information about how to operate the user interface of PA1011 and to set the output state of the instrument.

3 Application Examples
Introduce you the PA1011 functions and features by some examples.

4 Troubleshooting
Show some possible failures or faults in using the product as well as the corresponding trouble shootings.

5 Characteristics and Specifications
List the working curves and characteristics of the amplifier.

6 Appendix
Information about the accessories, warranties, services, supports and so on.
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Chapter 1 Quick Start

This chapter guides you how to operate the front/rear panel and the user interface of PA1011 as well as some preparation works when you first use the instrument.

General Inspection

Please inspect the Power Amplifier carefully following the guidelines below as soon as you get it.

1. **Inspect the packaging**
   If the packaging has been damaged, do not dispose the damaged packaging or cushioning materials until the shipment has been checked for completeness and has passed both electrical and mechanical tests. The consigner or carrier shall be liable for the damage to the instrument resulting from shipment. **RIGOL** would not be responsible for free maintenance/rework or replacement of the instrument.

2. **Inspect the instrument**
   In case of any mechanical damage, missing parts, or failure in passing the electrical and mechanical tests, contact your **RIGOL** sales representative.

3. **Check the accessories**
   Please check the accessories according to the packing lists. If the accessories are damaged or incomplete, please contact your **RIGOL** sales representative.
CAUTION

The input impedance of the instrument Zi is 50kΩ, and the range of voltage is -10V~+10V or -1.25V~+1.25V separately while the voltage gain is set to X1 or X10.

The inputs exceed these ranges may cause damages to the instrument or other hazards.

CAUTION

The output impedance of the instrument Zo is less than 2Ω, and the range of output voltage is -12V~+12V. Although the amplifier actually enables to output voltages up to ±12.5V, it may increase the total wave harmonic distortion.
Status Indicator

Power: On Red, indicating the successful power supply to the instrument.
Output: On Green, indicating the output is on.
Link: On Yellow, indicating the successful connection between USB device and the instrument.
Rear Panel

1. **Power In**
   Please plug with AC (12V, 4A) using the power cord provided in the accessories.

   ! CAUTION
   Do not use any other adapters to supply power for the PA1011, or else it may cause degradation or perpetual damage.

2. **USB Device**
   Connect the PA1011 to PC with the USB data cable.

   ! CAUTION
   Please make sure the vents at both sides and the fan aperture at the rear panel are visible in operation for normal working.
User Interface

See figure above, the user interface is a soft panel shown in the computer, users can select or set desired parameters and output status for the instrument by using the keyboard and mouse.
Installation

The PA1011 Power Amplifier consists of two components: the control software and the instrument module. Please correctly connect them together as following steps before use:

1. **Software Installation**
   Log in to RIGOL official website (www.rigol.com), and then click Product to select any one of the DG series from the Function/Arbitrary Waveform Generator menu to enter the webpage of the specified product. At the right section of the webpage, select PA1000 Software under "Software Download" to download the software for PA1011 Power Amplifier.

   (1) If the Labview has already been installed in your computer, please go to next step directly; if not, double click the file lv82runtime.msi to install it.

   (2) If the NI Visa library has already been installed, please go to next step directly; if not, double click the file NIVISAruntime.msi to install it.

   (3) Right click the file PA1000.inf and select “Install” from the pop-up menu.

   (4) Run PA1000Control.exe directly after the device is well connected. (see follows)

2. **Power on**
   Plug with AC power using the power cord provided in the accessories and turn on the instrument.

3. **USB Connection and Driver Installation**
Connect the instrument with computer using the USB data cable provided in the accessories. A Hardware Wizard dialog box will pop up to guide you to install the USB driver when connection succeeds for the first time.

![Found New Hardware Wizard dialog box](image)

**Figure 1-4 Pop-up Dialog Box**

Select “No, not this time” and click “Next” to enter the interface below:
Figure 1-5 Select to Install the Driver Automatically

Click "Next" to enter the interface below:

Figure 1-6 Select the Desired Driver

Click "Next" to enter the interface below:
The figure below will be shown after successful installation:

**Figure 1-7 Install the Driver**

**Figure 1-8 Finish the Installation**
After all above steps have been completed, you can use PA1011 to begin your work. For more operations, refer to Chapter 2.

**Note**
The instrument should be powered on before USB cable connection if you want to control the instrument by software. Wrong procedures may cause malfunction.
Chapter 2 Operations

How to Set the Output Status

See Figure 2-1, there are four groups of button on the panel, which separately represents a set of status parameter. Choose the one you want from each group and click “Send” to transmit these new settings into PA1011.

Figure 2-1 Control Panel

For the details of each selection on the control panel of PA1011, see table below:

<table>
<thead>
<tr>
<th><strong>Button</strong></th>
<th><strong>Setup</strong></th>
<th><strong>Explanation</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Gain</td>
<td>X1, X10</td>
<td>Sets the output gain. The input range of signals is different in different gain setting.</td>
</tr>
<tr>
<td>Polarity</td>
<td>Invert, Normal</td>
<td>Sets the desired output polarity.</td>
</tr>
<tr>
<td>DC Offset</td>
<td>ON, OFF</td>
<td>Turns on/off the offset setting.</td>
</tr>
<tr>
<td>ON-OFF</td>
<td>ON, OFF</td>
<td>Enables or disables the output.</td>
</tr>
</tbody>
</table>
Store | Saves the working state that has been transmitted currently.
---|---
Send | Transmits the state settings from the control panel into the instrument.

The input box at the right side of control panel is available only when DC Offset is On. The offset unit is V, the setting range is -12V to +12V and the default is 0V.

### How to Save the Instrument State

Click “Store” to save the current working state, and the instrument will start with the last stored working status automatically.

**Note:** The state saved here is actually the current working state of PA (status sent last time), but not for the options selected on the current control panel.
Chapter 3 Application Examples

Power Component Measurements

PA1011 could be used as the power amplifier of a generator to evaluate the performance of a power component. In virtue of its wide Bandwidth and High speed output, users can evaluate or test the components through various waves, pulses and arbitrary waves. See the measurement system of a power component below:
Magnetization Characteristic

Measurements

PA1011 can measure the magnetization characteristic (B-H curve) of magnetic material (10W driver, with additional impedance transformer), such as the ferrite or amorphous material etc.
Act as Driver of Piezoelectric Element

Besides, PA1011 could also be used as the driver of piezoelectric element (10W driver, with additional impedance transformer). Particularly the piezoelectric element with higher electrostatic capacity (up to 1000pF), better step responses are gainable from the PA1011 because of its tiny output impedance.

Furthermore, PA1011 could also be used as the driver amplifier in research and development or experiment of other technologies.
Chapter 4 Troubleshooting

This chapter lists some troubles that may occur when you use the power amplifier and the corresponding solutions. Please follow the appropriate steps to deal with; if the trouble still exists, please contact RIGOL for help.

1. **No response to the instrument when click "Send" on the control panel of software after power-on:**
   (1) Check if the power is correctly connected;
   (2) Check if the contact of USB data line is good;
   (3) After above checks, restart the instrument;
   (4) If it still cannot work properly, please contact your local RIGOL Support center.

2. **Circuit Protection**
   The instrument will start Overcurrent protection or Overtemperature protection once the output current is too high or the internal temperature of PA1011 is abnormal (Overtemperature) to avoid damages.

   The phenomenon of Circuit Protection is:
   - Overcurrent: The output relay is cutoff, and the yellow light is flashing.
   - Overttemperature: The output relay is cutoff, and the green light is flashing.

   PA1011 must be restarted after the Circuit Protection is launched.
We kindly suggest you to inspect the load of PA1011 or the ambient temperature and make sure both of these specifications are within the prescribed limits when the Circuit Protection is on.
Chapter 5 Characteristics and Specifications

Safety Curves

Please observe the curves below carefully and ensure your PA1011 works within the range of shaded areas to avoid degradation or damages to the instrument.

1. DC Working Range

![DC Working Range Diagram]

2. AC Working Range

![AC Working Range Diagram]
3. **Relationships between the Output current and the Working frequency**

4. **Relationships between the Output voltage and the Working frequency**

   If signals input is increasing in frequency (>100 kHz), you are suggested to reduce its amplitude. Please follow the relationship between output voltage and working frequency below when signals are input, in order to maintain the output voltage of PA1011 within curves.
**Remark**: The key parameters which determine the performance of the amplifier are Slew Rate and the Heat Extraction when a signal with high amplitude is input. Along with the frequency increase of the input signal, the working current and the power consumption of the instrument without loads as well as the signal distortion will be increased that may heat the amplifier and reduce the performance. Thus, we set limits on the relationships between the frequency and the amplitude of output signals which have high amplitude.
Specifications

All specifications listed in the table below can be met under following two conditions unless where noted:
- The instrument has been continuously operated for 30 minutes at the stated temperature.
- All the specifications are guaranteed except for the one marked “typical”.

### Signal Input

<table>
<thead>
<tr>
<th>Input Impedance</th>
<th>50kΩ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal Bias</td>
<td>+/-12V</td>
</tr>
<tr>
<td>(equivalent at the output terminals)</td>
<td></td>
</tr>
<tr>
<td>External Input</td>
<td>+/-10Vmax (Gain: X1)</td>
</tr>
<tr>
<td></td>
<td>+/-1.25Vmax (Gain: X10)</td>
</tr>
</tbody>
</table>

### Amplifier

<table>
<thead>
<tr>
<th>Working Mode</th>
<th>Constant Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gain</td>
<td>Switching in 10V/1V and 10V/10V (DC Gain error: &lt;5%)</td>
</tr>
<tr>
<td>Polarity Switching</td>
<td>Normal/Invert</td>
</tr>
<tr>
<td>Virtual Value of Sine</td>
<td>10W (typical, input: Sine, 100kHz, X10)</td>
</tr>
<tr>
<td>Output Power (RL=7.5Ω)</td>
<td></td>
</tr>
<tr>
<td>Output Voltage</td>
<td>12.5Vpeak (output: Sine, 100kHz)</td>
</tr>
<tr>
<td>Output Current</td>
<td>1.65Apeak (input: Sine, 100kHz)</td>
</tr>
<tr>
<td>Output Impedance</td>
<td>&lt;2Ω</td>
</tr>
<tr>
<td>Full Power Bandwidth</td>
<td>DC~1MHz[^Remark1]</td>
</tr>
</tbody>
</table>
### Characteristics and Specifications

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slew Rate</td>
<td>$\geq 80V/\mu s$ (typical) $^{[\text{Remark2}]}$</td>
</tr>
<tr>
<td>Overshoot</td>
<td>$&lt;7%$</td>
</tr>
</tbody>
</table>

#### Bias Voltage

<table>
<thead>
<tr>
<th>Bias Voltage</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gained Error</td>
<td>$5% \pm 100mV$</td>
</tr>
</tbody>
</table>

#### Others

<table>
<thead>
<tr>
<th>Others</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Supply</td>
<td>DC 12V$\pm 5%$, 4Apeak</td>
</tr>
<tr>
<td>Output Protection</td>
<td>Output Overcurrent protection, internal temperature abnormal protection</td>
</tr>
<tr>
<td>Working Temperature</td>
<td>$0 \degree C \sim +35 \degree C$ $^{[\text{Remark3}]}$</td>
</tr>
<tr>
<td>Dimension( W×H×D)</td>
<td>142.2mm×48.1mm×215.4mm</td>
</tr>
<tr>
<td>Net Weight</td>
<td>850g$\pm 20g$</td>
</tr>
</tbody>
</table>

**Remark 1** The Full-power bandwidth refers to the maximum frequency of signal generated with undistorted and utmost amplitude in AC output state from the Amplifier.

\[
FPB = \frac{SR}{2\pi V_{\text{max}}} 
\]

SR: Slew Rate

Vmax: Maximum undistorted output amplitude

**Remark 2** Slew Rate: When you send a large step signal to the amplifier, the output slope of signal will be stable as a constant at some certain point; this constant is named Slew Rate.

**Remark 3** All above specifications are formed at 25 \degree C, the working temperature is between $0 \degree C \sim +35 \degree C$. Reduce the output power and the working frequency of PA1011 when the ambient temperature exceeds 35 \degree C.
Chapter 6 Appendix

Appendix A: Accessories

Standards:
- A Power Cord that fits the standard of destination country
- An AC Adapter that fits the local standards
- A USB Data Cable
- A User’s Guide (Hard Copy)
- BNC cable

All the accessories below can be ordered from your local RIGOL office.
Appendix B: Warranty

RIGOL TECHNOLOGIES, INC. (hereinafter referred to as RIGOL) warrants that the product will be free from defects in materials and workmanship within the warranty period. If a product proves defective within the warranty period, RIGOL guarantees free replacement or repair for the defective product.

To get repair service, please contact with your nearest RIGOL sales or service office.

There is no other warranty, expressed or implied, except such as is expressly set forth herein or other applicable warranty card. There is no implied warranty of merchantability or fitness for a particular purpose. Under no circumstances shall RIGOL be liable for any consequential, indirect, ensuing, or special damages for any breach of warranty in any case.
Appendix C: Care and Cleaning

Care
Do not store or leave the instrument where it may be exposed to direct sunlight for long periods of time.

Cleaning
Clean the instrument regularly according to its operating conditions.
1. Disconnect the instrument from all power sources.
2. Clean the external surfaces of the instrument with a soft cloth dampened with mild detergent or water. When cleaning the LCD, take care to avoid scarifying it.

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CAUTION
To avoid damage to the instrument, do not expose it to caustic liquids.

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WARNING
To avoid short-circuit resulting from moisture or personal injuries, ensure that the instrument is completely dry before connecting it to the power supply.
Appendix D: Contact Us

If you have any problem or requirement when using our products or this manual, please contact RIGOL.
E-mail: service@rigol.com
Websites: www.rigol.com