RIGOL

Calibration Guide

DG5000 Series Function / Arbitrary Waveform Generator

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Document Overview

This chapter gives a detailed introduction of the calibration notices and calibration process of DG5000.

Subjects in this Manual

Chapter 1 Calibration Notices

This chapter gives a detailed introduction of the recommended calibration interval, calibration safety, the method to stop the calibration and the related information, how to acquire the calibration service, the recommended test devices and the notices during the test.

Chapter 2 Calibration Process

This chapter gives a detailed introduction of the calibration interface and the calibration process of each calibration item of DG5000.

Format Conventions in this Manual

1. **Button:**
   The button at the front panel is denoted by the format of "Text Box + Button Name (Bold)" in the manual, for example, **Utility** represents the Utility button.

2. **Menu:**
   The menu item can be denoted by the format of "Menu Word (Bold) + Character Shading", for example, **I/O Setup** denotes the "**I/O Setup**" item under **Utility**.

3. **Operation Steps:**
   The next step of the operation is denoted by an arrow "→" in the manual. For example, **Utility** → **I/O Setup** represents pressing **Utility** at the front panel and then pressing the menu item **I/O Setup**.

Contents

Chapter 1 Calibration Notices

Calibration Interval

Regular calibration can ensure the performance specifications of DG5000. You are recommended to calibrate the instrument at a one-year calibration interval. You can choose a proper calibration interval according to your requirement of the performance accuracy but the calibration interval can not exceed 2 years (otherwise, the specifications can not be guaranteed).

You are recommended to perform a complete calibration at the calibration interval to ensure that the instrument will remain within specifications before the next calibration.

Calibration Safety

You need to input the correct password before calibration each time you want to calibrate the instrument. The password is used to prevent accidental or unauthorized calibration of the instrument.

Press **Utility** → ▷ → **Test/Cal** → **Secure Code**, input the correct password using the knob and direction keys. Then, users can press **Secure** to turn off the calibration safety protection. At this time, press **Manual Cal** to enter the calibration interface or press **Preset** to restore the calibration values to their default values.

The calibration password is “2010”. The password is stored in the non-volatile memory and will not change at power-off or remote interface reset.

Note: please press **Secure** to turn on the calibration safety protection after finishing the calibration to avoid the mis-operation.

To Stop the Calibration

You can power off the instrument to stop the calibration at any time during the calibration. The calibration data stored will not be cleared when the calibration is stopped and you do not need to calibrate the items already calibrated again in the next calibration.

CAUTION

If the calibration is stopped when the instrument is writing the new calibration constants into the Flash, you may lose all the calibration constants and you need to perform the calibration again.

To Acquire the Calibration Service

RIGOL does not recommend manual calibration by users. If calibration is required, please contact **RIGOL** customer service department or the local distributor.

Recommended Test Devices

It is recommended that you use the test devices listed in the table below or other test devices whose performance specifications satisfy the "Performance Requirement" listed in the table below for calibration.

Table 1-1 Recommended Test Devices

Device	Performance Requirement	Recommended
Digital Multimeter	$6^1/_2$	**RIGOL** DM3068
Digital Oscilloscope	Sample Rate: 1GHz Support duty cycle, rise time and fall time measurement function	**RIGOL** DS6104
Frequency Counter	>10MHz Accuracy: 0.1ppm	Agilent 53131A
Power Meter	-30dBm to +20dBm Accuracy: ±0.02dB Resolution: 0.01dB	Agilent E4418B
Cable	BNC (m) – dual banana (m)	--
Cable	BNC (m) – BNC (m)	--
Power Sensor	-30dBm to +20dBm	Agilent N8482A
Power Sensor Cable	Used to connect the power meter and power sensor	--
50Ω Load	50Ω/1W	--

Test Notices

For optimum performance, all procedures should comply with the following recommendations.

1) Make sure the environment temperature is stable and between 18℃ and 28℃. Ideally, the calibration should be performed at 23℃±1℃.
2) Make sure the environment relative humidity is less than 80%.
3) Make sure that the instrument has been warmed up for at least 30 minutes before the calibration.
4) Keep the test cables as short as possible and make sure that the impedance of the cable is consistent with the requirement.

Chapter 2 Calibration Process

Warm the DG5000 up for at least 30 minutes. Press **Utility** → ▷ → **Test/Cal** → **Secure Code**, use the knob and direction keys to enter the correct password, and then turn off the calibration safety protection by pressing **Secure**. Press **Manual Cal** to enter the calibration interface as shown in the figure below.

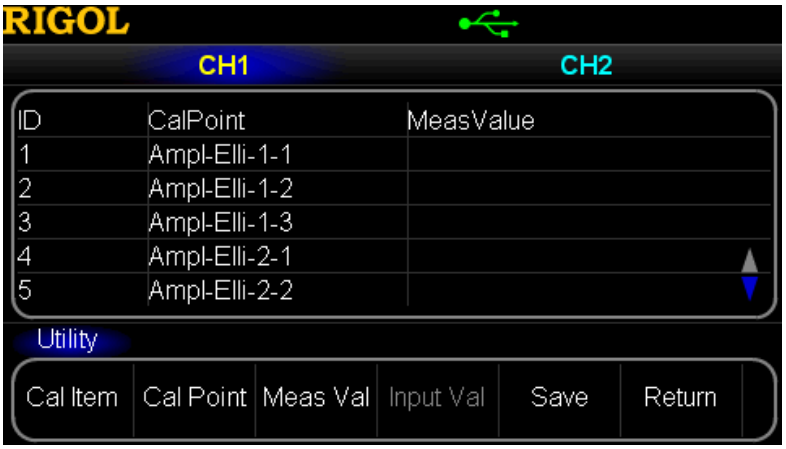

Figure 2-1 Calibration Interface

1. Cal Item

Press this softkey to select the desired calibration item. The calibration items of DG5000 manual calibration are listed in the table below. You can select one or more calibration items, but it is recommended to perform a complete calibration.

Table 2-1 Calibration Items

No.	Item
1	Freq Accuracy
2	Duty (duty cycle)
3	Rise Time
4	Fall Time
5	Offset (DC offset accuracy)
6	Offset Comp (offset compensation)
7	Ampl Ellipse (AC amplitude accuracy)
8	Ampl Square (AC amplitude accuracy)
9	Ampl Line (AC amplitude accuracy)
10	Lflat Ellipse (ellipse low-frequency flatness)
11	Lflat Line (line low-frequency flatness)
12	Inner Imped (output impedance)
13	Hflat Ellipse (ellipse high-frequency flatness)
14	Hflat Line (line high-frequency flatness)

Note: the amplitude calibration must be prior to the low-frequency flatness calibration and the inner impedance calibration must be prior to the high-frequency flatness calibration.

2. Cal Point

Press this softkey and the specified calibration point in the ID column is highlighted (do not apply to "Freq Accuracy" calibration item). At this point, you can rotate the knob to select the current calibration point.

Note: in inner impedance (output impedance) calibration, users are not allowed to select the current calibration point free, the specified calibration method please refer to "**Inner Impedance (Output Impedance) Calibration**".

3. Meas Val

After selecting a calibration point (do not apply to "Freq Accuracy" calibration item), press this softkey and the MeasValue column of the corresponding point becomes editable. At this point, use the numeric keyboard or the knob and direction keys to input the measurement value.

4. Input Val

After selecting a calibration point (do not apply to "Freq Accuracy" calibration item) and inputing the measurement value, press this softkey to input the measurement value to the system and finish the calibration of the point selected.

5. Save

Press this softkey to save the current calibration value.

The calibration method of each calibration item is introduced in detail in the following part.

CAUTION

You need to calibrate each item following the sequence below.

Frequency Accuracy Calibration

1. Make sure that DG5000 has been warmed up for at least 30 minutes. Connect the channel output terminal (take CH1 as an example; the calibration method is also applicable to CH2) of DG5000 with the signal input terminal of the frequency counter using the dual-BNC cable as shown in the figure below.

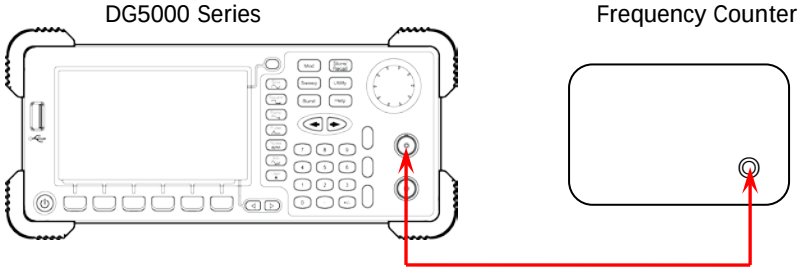

Figure 2-2 Connect DG5000 and the Frequency Counter

2. Press the **Output** softkey corresponding to CH1 at the front panel of DG5000 to enable the channel output.

3. Set the input impedance of the frequency counter to HighZ.

4. Enter the DG5000 calibration interface and press **Cal Item** to select **Freq Accuracy**.

5. According to the prompt messages in the calibration interface, press **Start** to start the frequency accuracy calibration.

6. Observe the measurement value of the frequency counter. If the current measurement value is lower than 10 MHz, press **Upward adjust** to increase the output frequency of DG5000; and if the current measurement value is greater than 10 MHz, press **Dnward adjust** to reduce the output frequency of DG5000 until the absolute value of the difference between the measurement value of the frequency counter and 10 MHz is lower than 1 Hz.

7. Press **Save** and the frequency accuracy calibration is finished.

Duty Cycle Calibration

1. Make sure that DG5000 has been warmed up for at least 30 minutes. Connect the channel ouput terminal (take CH1 as an example; the calibration method is also applicable to CH2) of DG5000 with the signal input terminal of the digital oscilloscope using the dual-BNC cable as shown in the figure below.

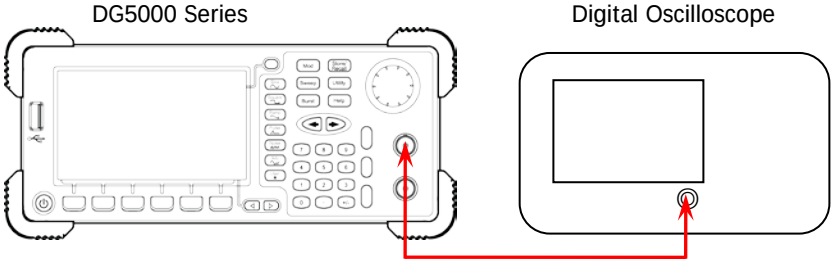

Figure 2-3 Connect DG5000 and the Digital Oscilloscope

2. Press the **Output** softkey corresponding to CH1 at the front panel of DG5000 to enable the channel output.

3. Turn on the digital oscilloscope and the corresponding channel. Set the trigger type to “Edge” and the edge type to “Rising Edge” and select “Positive Duty Cycle” measurement item.

4. Enter the DG5000 calibration interface and press **Cal Item** to select **Duty**.

5. Press **Cal Point** and the cursor switches to the first calibration point in the ID column.

6. Press **Meas Val** and the MeasValue column of the point selected becomes editable. At this point, use the numeric keyboard or the knob and direction keys to input the current measurement value of the digital oscilloscope.

7. Press **Input Val** to input the measurement value to the system and finish the calibration of the point currently selected. The cursor switches to the ID column.

8. Select the next calibration point using the knob. Repeat step 6 and 7 until all the calibration points are calibrated.

9. Press **Save** and the duty cycle calibration is finished.

Rise Time Calibration

1. Make sure that DG5000 has been warmed up for at least 30 minutes. Connect the channel ouput terminal (take CH1 as an example; the calibration method is also applicable to CH2) of DG5000 with the signal input terminal of the digital oscilloscope using the dual-BNC cable as shown in Figure 2-3.

2. Press the **Output** softkey corresponding to CH1 at the front panel of DG5000 to enable the channel output.

3. Turn on the digital oscilloscope and the corresponding channel. Set the trigger type to “Edge” and the edge type to “Rising Edge” and select “Rise Time” measurement item.

4. Enter the DG5000 calibration interface and press **Cal Item** to select **Rise Time**.

5. Press **Cal Point** and the cursor switches to the first calibration point in the ID column.

6. Press **Meas Val** and the MeasValue column of the point selected becomes editable. At this point, use the numeric keyboard or the knob and direction keys to input the current measurement value of the digital oscilloscope.

7. Press **Input Val** to input the measurement value to the system and finish the calibration of the point currently selected. The cursor switches to the ID column.

8. Select the next calibration point using the knob. Repeat step 6 and 7 until all the calibration points are calibrated.

9. Press **Save** and the rise time calibration is finished.

Fall Time Calibration

1. Make sure that DG5000 has been warmed up for at least 30 minutes. Connect the channel ouput terminal (take CH1 as an example; the calibration method is also applicable to CH2) of DG5000 with the signal input terminal of the digital oscilloscope using the dual-BNC cable as shown in Figure 2-3.

2. Press the **Output** softkey corresponding to CH1 at the front panel of DG5000 to enable the channel output.

3. Turn on the digital oscilloscope and the corresponding channel. Set the trigger type to “Edge” and the edge type to “Falling Edge” and select “Fall Time” measurement item.

4. Enter the DG5000 calibration interface and press **Cal Item** to select **Fall Time**.

5. Press **Cal Point** and the cursor switches to the first calibration point in the ID column.

6. Press **Meas Val** and the MeasValue column of the point selected becomes editable. At this point, use the numeric keyboard or the knob and direction keys to input the current measurement value of the digital oscilloscope.

7. Press **Input Val** to input the measurement value to the system and finish the calibration of the point currently selected. The cursor switches to the ID column.

8. Select the next calibration point using the knob. Repeat step 6 and 7 until all the calibration points are calibrated.

9. Press **Save** and the fall time calibration is finished.

Amplitude Ellipse (AC Amplitude Accuracy) Calibration

1. Make sure that DG5000 has been warmed up for at least 30 minutes. Connect the channel output terminal (take CH1 as an example; the calibration method is also applicable to CH2) of DG5000 with the voltage input terminals of the digital multimeter using the BNC - dual banana cable as shown in the figure below.

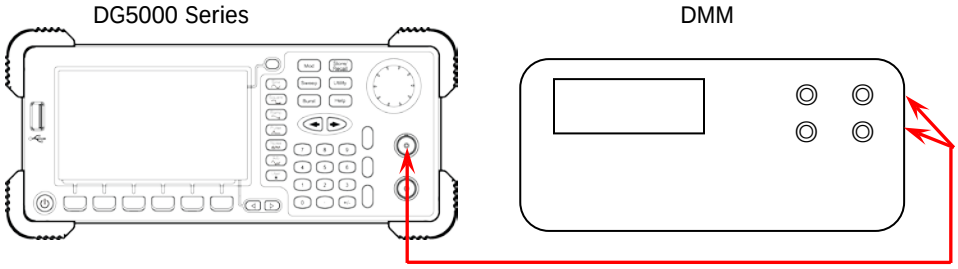

Figure 2-4 Connect DG5000 and the Digital Multimeter

2. Press the **Output** softkey corresponding to CH1 at the front panel of DG5000 to enable the channel output.

3. Turn on the digital multimeter. Select the AC voltage (ACV) measurement function and set the range to “Auto”.

4. Enter the DG5000 calibration interface and press **Cal Item** to select **Ampl Ellipse** (the default item).

5. Press **Cal Point** and the cursor switches to the first point in the ID column.

6. Press **Meas Val** and the MeasValue column of the point selected becomes editable. At this point, use the numeric keyboard or the knob and direction keys to input the current measurement value of the digital multimeter.

7. Press **Input Val** to input the measurement value to the system and finish the calibration of the point currently selected. The cursor switches to the ID column.

8. Select the next calibration point using the knob. Repeat step 6 and 7 until all the calibration points are calibrated.

9. Press **Save** and the amplitude ellipse (AC amplitude accuracy) calibration is finished.

Amplitude Square (AC Amplitude Accuracy) Calibration

1. Make sure that DG5000 has been warmed up for at least 30 minutes. Connect the channel output terminal (take CH1 as an example; the calibration method is also applicable to CH2) of DG5000 with the voltage input terminals of the digital multimeter using the BNC - dual banana cable as shown in Figure 2-4.

2. Press the **Output** softkey corresponding to CH1 at the front panel of DG5000 to enable the channel output.

3. Turn on the digital multimeter. Select the AC voltage (ACV) measurement function and set the range to "Auto".

4. Enter the DG5000 calibration interface and press **Cal Item** to select **Ampl Square**.

5. Press **Cal Point** and the cursor switches to the first point in the ID column.

6. Press **Meas Val** and the MeasValue column of the point selected becomes editable. At this point, use the numeric keyboard or the knob and direction keys to input the current measurement value of the digital multimeter.

7. Press **Input Val** to input the measurement value to the system and finish the calibration of the point currently selected. The cursor switches to the ID column.

8. Select the next calibration point using the knob. Repeat step 6 and 7 until all the calibration points are calibrated.

9. Press **Save** and the amplitude square (AC amplitude accuracy) calibration is finished.

Amplitude Line (AC Amplitude Accuracy) Calibration

1. Make sure that DG5000 has been warmed up for at least 30 minutes. Connect the channel output terminal (take CH1 as an example; the calibration method is also applicable to CH2) of DG5000 with the voltage input terminals of the digital multimeter using the BNC - dual banana cable as shown in Figure 2-4.

2. Press the **Output** softkey corresponding to CH1 at the front panel of DG5000 to enable the channel output.

3. Turn on the digital multimeter. Select the AC voltage (ACV) measurement function and set the range to "Auto".

4. Enter the DG5000 calibration interface and press **Cal Item** to select **Ampl Line**.

5. Press **Cal Point** and the cursor switches to the first point in the ID column.

6. Press **Meas Val** and the MeasValue column of the point selected becomes editable. At this point, use the numeric keyboard or the knob and direction keys to input the current measurement value of the digital multimeter.

7. Press **Input Val** to input the measurement value to the system and finish the calibration of the point currently selected. The cursor switches to the ID column.

8. Select the next calibration point using the knob. Repeat step 6 and 7 until all the calibration points are calibrated.

9. Press **Save** and the amplitude line (AC amplitude accuracy) calibration is finished.

Ellipse Low-frequency Flatness Calibration

1. Make sure that DG5000 has been warmed up for at least 30 minutes. Connect the channel output terminal (take CH1 as an example; the calibration method is also applicable to CH2) of DG5000 with the voltage input terminals of the digital multimeter using the BNC - dual banana cable as shown in Figure 2-4.

2. Press the **Output** softkey corresponding to CH1 at the front panel of DG5000 to enable the channel output.

3. Turn on the digital multimeter. Select the AC voltage (ACV) measurement function and set the range to “Auto”.

4. Enter the DG5000 calibration interface and press **Cal Item** to select **Lflat Ellipse**.

5. Press **Cal Point** and the cursor switches to the first point in the ID column.

6. Press **Meas Val** and the MeasValue column of the point selected becomes editable. At this point, use the numeric keyboard or the knob and direction keys to input the current measurement value of the digital multimeter.

7. Press **Input Val** to input the measurement value to the system and finish the calibration of the point currently selected. The cursor switches to the ID column.

8. Select the next calibration point using the knob. Repeat step 6 and 7 until all the calibration points are calibrated.

9. Press **Save** and the ellipse low-frequency flatness calibration is finished.

Line Low-frequency Flatness Calibration

1. Make sure that DG5000 has been warmed up for at least 30 minutes. Connect the channel output terminal (take CH1 as an example; the calibration method is also applicable to CH2) of DG5000 with the voltage input terminals of the digital multimeter using the BNC - dual banana cable as shown in Figure 2-4.

2. Press the **Output** softkey corresponding to CH1 at the front panel of DG5000 to enable the channel output.

3. Turn on the digital multimeter. Select the AC voltage (ACV) measurement function and set the range to "Auto".

4. Enter the DG5000 calibration interface and press **Cal Item** to select **Lflat Line**.

5. Press **Cal Point** and the cursor switches to the first point in the ID column.

6. Press **Meas Val** and the MeasValue column of the point selected becomes editable. At this point, use the numeric keyboard or the knob and direction keys to input the current measurement value of the digital multimeter.

7. Press **Input Val** to input the measurement value to the system and finish the calibration of the point currently selected. The cursor switches to the ID column.

8. Select the next calibration point using the knob. Repeat step 6 and 7 until all the calibration points are calibrated.

9. Press **Save** and the line low-frequency flatness calibration is finished.

Offset (DC Offset Accuracy) Calibration

1. Make sure that DG5000 has been warmed up for at least 30 minutes. Connect the channel output terminal (take CH1 as an example; the calibration method is also applicable to CH2) of DG5000 with the voltage input terminals of the digital multimeter using the BNC - dual banana cable as shown in Figure 2-4.

2. Press the **Output** softkey corresponding to CH1 at the front panel of DG5000 to enable the channel output.

3. Turn on the digital multimeter. Select the DC voltage (DCV) measurement function and set the range to "Auto".

4. Enter the DG5000 calibration interface and press **Cal Item** to select **Offset**.

5. Press **Cal Point** and the cursor switches to the first point in the ID column.

6. Press **Meas Val** and the MeasValue column of the point selected becomes editable. At this point, use the numeric keyboard or the knob and direction keys to input the current measurement value of the digital multimeter.

7. Press **Input Val** to input the measurement value to the system and finish the calibration of the point currently selected. The cursor switches to the ID column.

8. Select the next calibration point using the knob. Repeat step 6 and 7 until all the calibration points are calibrated.

9. Press **Save** and the offset (DC offset accuracy) calibration is finished.

Offset Compensation Calibration

1. Make sure that DG5000 has been warmed up for at least 30 minutes. Connect the channel output terminal (take CH1 as an example; the calibration method is also applicable to CH2) of DG5000 with the voltage input terminals of the digital multimeter using the BNC - dual banana cable as shown in Figure 2-4.

2. Press the **Output** softkey corresponding to CH1 at the front panel of DG5000 to enable the channel output.

3. Turn on the digital multimeter. Select the DC voltage (DCV) measurement function and set the range to “Auto”.

4. Enter the DG5000 calibration interface and press **Cal Item** to select **Offset Comp**.

5. Press **Cal Point** and the cursor switches to the first point in the ID column.

6. Press **Meas Val** and the MeasValue column of the point selected becomes editable. At this point, use the numeric keyboard or the knob and direction keys to input the current measurement value of the digital multimeter.

7. Press **Input Val** to input the measurement value to the system and finish the calibration of the point currently selected. The cursor switches to the ID column.

8. Select the next calibration point using the knob. Repeat step 6 and 7 until all the calibration points are calibrated.

9. Press **Save** and the offset compensation calibration is finished.

Inner Impedance (Output Impedance) Calibration

1. Make sure that DG5000 has been warmed up for at least 30 minutes. Connect the channel output terminal (take CH1 as an example; the calibration method is also applicable to CH2) of DG5000 with the voltage input terminals of the digital multimeter using the BNC - dual banana cable as shown in Figure 2-4.

2. Press the **Output** softkey corresponding to CH1 at the front panel of DG5000 to enable the channel output.

3. Turn on the digital multimeter. Select the AC voltage (ACV) measurement function and set the range to “Auto”.

4. Enter the DG5000 calibration interface and press **Cal Item** to select **Inner Imped**.

5. Press **Cal Point** and the cursor switches to the first point in the ID column.

6. You need to calibrate each calibration point twice (otherwise, you can not select the next calibration point).
   a) Calibration without the 50Ω load:
   Press **Meas Val** and the MeasValue column of the point selected becomes editable. At this point, use the numeric keyboard or the knob and direction keys to input the current measurement value of the digital multimeter. Press **Input Val** to input the measurement value to the system and the prompt message telling you to connect the 50Ω load is displayed. The cursor switches to the CalPoint column. At this point, please connect the 50Ω load as shown in the figure below.

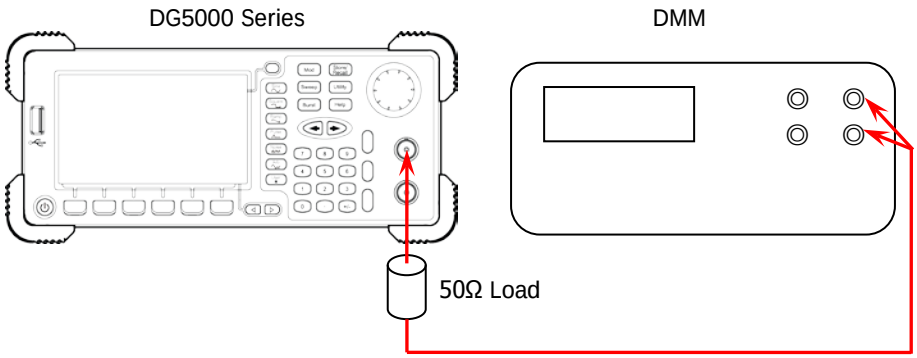

Figure 2-5 Connect DG5000 and the Digital Multimeter (with the 50Ω Load)

   b) Calibration with the 50Ω load:
   Press **Meas Val** and the MeasValue column of the point selected becomes editable. At this point, use the numeric keyboard or the knob and direction

keys to input the current measurement value of the digital multimeter. Press **Input Val** to input the measurement value to the system and the prompt message telling you to remove the 50Ω load is displayed. The cursor switches to the CalPoint column.

7. Select the next calibration point using the knob. Repeat step 6 until all the calibration points are calibrated.

8. Press **Save** and the inner impedance (output impedance) calibration is finished.

Ellipse High-frequency Flatness Calibration

1. Make sure that DG5000 has been warmed up for at least 30 minutes. Connect the power meter and the power sensor; connect the power sensor with the channel output terminal (take CH1 as an example; the calibration method is also applicable to CH2) of DG5000 as shown in the figure below.

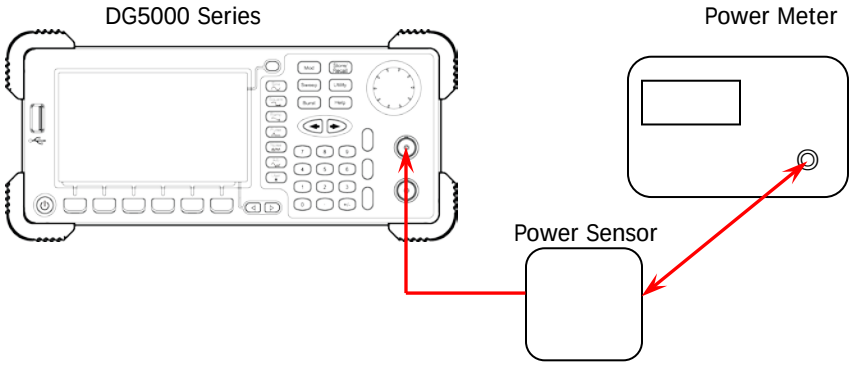

Figure 2-6 Connect DG5000 and the Power Meter

2. Press the **Output** softkey corresponding to CH1 at the front panel of DG5000 to enable the channel output.

3. Enter the DG5000 calibration interface and press **Cal Item** to select **Hflat Ellipse**.

4. Press **Cal Point** and the cursor switches to the first point in the ID column.

5. The frequency of the first calibration point is 100 kHz. Set an appropriate frequency calibration factor for the power meter according to the ratio of the power sensor.

6. Press **Meas Val** and the MeasValue column of the point selected becomes editable. At this point, use the numeric keyboard or the knob and direction keys to input the current measurement value of the power meter.

7. Press **Input Val** to input the measurement value to the system and finish the calibration of the point currently selected. The cursor switches to the ID column.

8. Select the next calibration point using the knob. Repeat step 5 to step 7 (for each calibration point, please set an appropriate frequency calibration factor for the power meter) until all the calibration points are calibrated.

9. Press **Save** and the ellipse high-frequency flatness calibration is finished.

Line High-frequency Flatness Calibration

1. Make sure that DG5000 has been warmed up for at least 30 minutes. Connect the power meter and the power sensor; connect the power sensor with the channel output terminal (take CH1 as an example; the calibration method is also applicable to CH2) of DG5000 as shown in Figure 2-6.

2. Press the **Output** softkey corresponding to CH1 at the front panel of DG5000 to enable the channel output.

3. Enter the DG5000 calibration interface and press **Cal Item** to select **Hflat Line**.

4. Press **Cal Point** and the cursor switches to the first point in the ID column.

5. The frequency of the first calibration point is 100 kHz. Set an appropriate frequency calibration factor for the power meter according to the ratio of the power sensor.

6. Press **Meas Val** and the MeasValue column of the point selected becomes editable. At this point, use the numeric keyboard or the knob and direction keys to input the current measurement value of the power meter.

7. Press **Input Val** to input the measurement value to the system and finish the calibration of the point currently selected. The cursor switches to the ID column.

8. Select the next calibration point using the knob. Repeat step 5 to step 7 (for each calibration point, please set an appropriate frequency calibration factor for the power meter) until all the calibration points are calibrated.

9. Press **Save** and the line high-frequency flatness calibration is finished.