RIGOL

Performance Verification Manual

DL3000 Series Programmable DC Electronic Load

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RIGOL TECHNOLOGIES CO.,LTD.

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General Safety Summary

Please review the following safety precautions carefully before putting the instrument into operation so as to avoid any personal injury or damage to the instrument and any product connected to it. To prevent potential hazards, please follow the instructions specified in this manual to use the instrument properly.

Use Proper Power Cord.
Only the exclusive power cord designed for the instrument and authorized for use within the local country could be used.

Ground the Instrument.
The instrument is grounded through the Protective Earth lead of the power cord. To avoid electric shock, connect the earth terminal of the power cord to the Protective Earth terminal before connecting any input or output terminals.

Connect the Probe Correctly.
If a probe is used, the probe ground lead must be connected to earth ground. Do not connect the ground lead to high voltage. Improper way of connection could result in dangerous voltages being present on the connectors, controls or other surfaces of the oscilloscope and probes, which will cause potential hazards for operators.

Observe All Terminal Ratings.
To avoid fire or shock hazard, observe all ratings and markers on the instrument and check your manual for more information about ratings before connecting the instrument.

Use Proper Overvoltage Protection.
Ensure that no overvoltage (such as that caused by a bolt of lightning) can reach the product. Otherwise, the operator might be exposed to the danger of an electric shock.

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

Do Not Insert Objects Into the Air Outlet.
Do not insert objects into the air outlet, as doing so may cause damage to the instrument.

Use Proper Fuse.
Please use the specified fuses.

Avoid Circuit or Wire Exposure.
Do not touch exposed junctions and components when the unit is powered on.

Do Not Operate With Suspected Failures.

If you suspect that any damage may occur to the instrument, have it inspected by **RIGOL** authorized personnel before further operations. Any maintenance, adjustment or replacement especially to circuits or accessories must be performed by **RIGOL** authorized personnel.

Provide Adequate Ventilation.

Inadequate ventilation may cause an increase of temperature in the instrument, which would cause damage to the instrument. So please keep the instrument well ventilated and inspect the air outlet and the fan regularly.

Do Not Operate in Wet Conditions.

To avoid short circuit inside the instrument or electric shock, never operate the instrument in a humid environment.

Do Not Operate in an Explosive Atmosphere.

To avoid personal injuries or damage to the instrument, never operate the instrument in an explosive atmosphere.

Keep Product Surfaces Clean and Dry.

To avoid dust or moisture from affecting the performance of the instrument, keep the surfaces of the instrument clean and dry.

Prevent Electrostatic Impact.

Operate the instrument in an electrostatic discharge protective environment to avoid damage induced by static discharges. Always ground both the internal and external conductors of cables to release static before making connections.

Use the Battery Properly.

Do not expose the battery (if available) to high temperature or fire. Keep it out of the reach of children. Improper change of a battery (lithium battery) may cause an explosion. Use the **RIGOL** specified battery only.

Handle with Caution.

Please handle with care during transportation to avoid damage to keys, knobs, interfaces, and other parts on the panels.

Document Overview

DL3000 series programmable DC electronic load (hereinafter referred to as the DL3000 series) is a cost-effective electronic load with high performance. This manual gives a detailed description of the test method of performance verification for the DL3000 series. The test is designed to verify whether DL3000 series can work normally and whether it can meet with the given specifications.

Main Topics of this Manual:

Chapter 1 Test Overview
This chapter introduces test preparations, recommended test devices, test precautions, and test result records.

Chapter 2 Specifications Test
This chapter introduces the test method for the specifications of the DL3000 series.

Appendix
The appendix provides the test record forms for all the models of the DL3000 series and its performance verification.

Content Conventions in this Manual:

The number of channels and the rated values of input parameters for the DL3000 series are listed in the following table. Unless otherwise specified, this manual takes DL3031A as an example to illustrate the test methods for the performance verification of the DL3000 series.

Model	No. of Channels	Voltage	Current	Power
DL3021/DL3021A	1	DC 150 V	40 A	200 W
DL3031/DL3031A	1	DC 150 V	60 A	350 W

Contents

Chapter 1   Test Overview

Contents in this chapter:
- Test Preparations
- Recommended Test Devices
- Test Precautions
- Test Result Records

Test Preparations

Before performing the performance verification test, make the following preparations.

1. Perform the self-inspection to make sure that the instrument can work normally.

    Plug the specified power cord available in the accessories into the AC power supply connector of the instrument, and then connect the instrument to the properly grounded AC power. Press the **Power** key 🔲, and then the instrument is launched and begins to perform the self-inspection. If the instrument passes the self-inspection, the instrument starts normally with a splashing screen. If the self-inspection fails, please turn off the instrument and then turn it on again to execute the self-inspection. If the problem still persists, contact **RIGOL**. Ensure that you locate the problem for self-inspection failure and resolve the problem properly. You are not allowed to perform the performance verification test until the instrument passes the self-inspection test.

    Note:
    1) Before connecting to power, make sure that the setting of the voltage selector on the rear panel of DL3000 series matches the AC power supply to be connected. Ensure that the fuse currently installed matches the input voltage. The specifications for AC input voltages and their matched fuses supported by the DL3000 series are as shown in Table 1-1.

        Table 1-1 AC Input Voltage and Fuse Rating

AC Selector	AC Input Voltage	Fuse Rating
115 Vac	±(10% of AC input + 115 Vac), 50 Hz to 60 Hz	T0.315 A/250 V
230 Vac	±(10% of AC input + 230 Vac) (max: 250 Vac), 50 Hz to 60 Hz	T0.20 A/250 V

        Note: The upper limit of the AC input voltage supported by the DL3000 series is 250 Vac.

    2) Before performing the self-inspection, make sure that no load is connected to the terminals on the front and rear panels of the instrument.

2. Make sure that the instrument is used within its calibration period (1 year). If calibration is required, please contact **RIGOL**.

3. Warm up the instrument for at least 30 minutes.

4. Make sure that the ambient temperature is between 18°C and 28°C, and the relative humidity is less than 80%.

5. Keep the cables of the test probe as short as possible.

> **CAUTION**
> The tests described in this manual are required to be carried out by the professionals. During the test, dangerous voltages might be present on the output terminals of the power supply and some test devices.

Recommended Test Devices

You are recommended to use the devices listed in Table 1-2 or other devices whose performance specifications meet the "Performance Requirement" listed in Table 1-2.

Table 1-2 Recommended Test Devices

Device	Performance Requirement	Recommended Model	Usage
Digital Multimeter	Readout Resolution: 6½	**RIGOL** DM3068	Measures DC voltage
DC Power Supply	DC 150 V/1 A DC 8 V/90 A	DSP-150-005HD DSP-008-090HD	Provides voltage and current
Current Sampling Resistor R_M	0.01 Ω (temperature drift: 1 ppm)	RUG-Z-R010-01-TK1	Measures programming accuracy and readback accuracy
USB Cable	--	--	Realizes remote control, measures programming accuracy and readback accuracy

Test Precautions

Connection methods for the input terminals (see Figure 1-1):
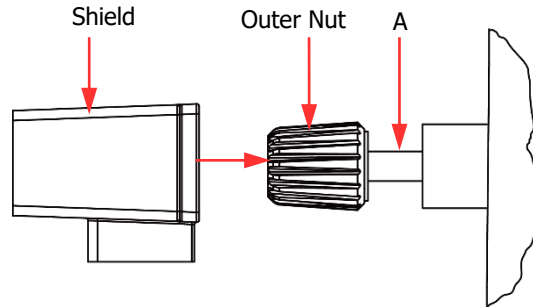
Figure 1-1 Connect Input Terminals

(1) Rotate the outer nut of the input terminal counterclockwise to remove it;

(2) Connect the test lead to Position A of the input terminal.

(3) Fasten the outer nut of the input terminal clockwise.

(4) Secure the shield to the terminal and then tighten the screw.

> **WARNING**
> To avoid electric shock, ensure that you have installed the shield when the DC voltage output from the DUT is equal to or greater than 70 V.

During the test, please shield the space radiation noise in the test environment to avoid its impact on the test.

Test Result Records

Please record and save the test results for each test item. The **"Appendix A: Test Record Forms"** in this manual provides the test record forms for all the models of the DL3000 series. The form lists the test item and its corresponding performance specification limits. You can record the test results in the form.

> **Tip**
> **RIGOL** recommends that you should copy a few pieces of the desired test record forms before each test. During the test, you can record the test results in the copied form to ensure that the form can be repeatedly used.

Chapter 2   Specifications Test

Contents in this chapter:
- CC Programming Accuracy and Readback Accuracy
- CV Programming Accuracy and Readback Accuracy
- CR Programming Accuracy

CC Programming Accuracy and Readback Accuracy

Preparations

Before performing the test, select the appropriate AC voltage via the "AC Selector" on the rear panel of the electronic load according to the AC voltage standard of your country (230 Vac is taken as an example in all the tests in this manual). At room temperature (25°C), connect the recommended devices specified in "**Recommended Test Devices**" according to the connection method in Figure 2-1. During the test process, please set the AC voltage according to the selected voltage in "AC Selector" on the rear panel of the electronic load.

In the CC tests, a current sampling resistor (required to be calibrated) should be serially connected between the DC power supply and the electronic load. It is used to convert the current signal under test to the voltage signal for the measurement of related parameters.
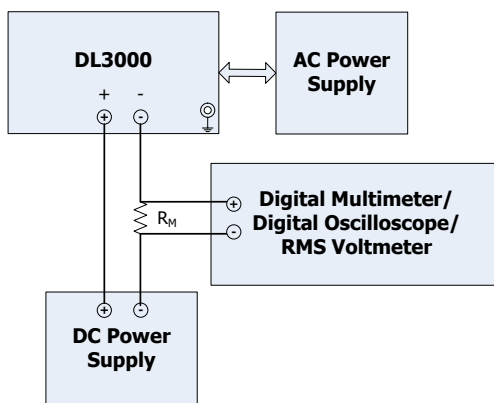

Figure 2-1 CC Test Connection

Test Procedures

CC programming accuracy refers to the error between the current setting of the channel and the actual input current value when the electronic load is in CC mode. CC readback accuracy refers to the error between the readback current value and the actual input current value when the electronic load is in CC mode.

The following section takes DL3031A as an example to test the CC programming accuracy and readback accuracy of the DL3000 series.

Note: During the test, please select the corresponding test record form according to the model of the DL3000 series under test to set the corresponding parameters, record and calculate the corresponding specifications.

Specification:

Annual Accuracy[1] (25°C ± 5°C), ±(% of Output + Offset)	
Programming	±(0.05%+0.05%FS[1])
Readback Value	±(0.05%+0.05%FS[1])

Note[1]: The accuracy specifications are acquired through calibration at 25°C after 1-hour warm-up.
Note[2]: FS indicates the full scale.

Procedures:
1. Power off DL3031A. Connect DL3031A, AC power supply, DC power supply, a current sampling resistor (with a resistance R_M 0.01 Ω), and a digital multimeter according to Figure 2-1 (Pay attention to the connection method for the current sampling resistor, the channel input terminals of DL3031A, and the digital multimeter). Connect the USB DEVICE interface on the rear panel of the electronic load to the PC via the USB cable.

2. Turn on the AC power supply, and then set its voltage to 230 V, the frequency to 50 Hz. Then, turn on the output.

   Note: The voltage setting of the AC power supply should be matched with the AC voltage selector on the rear panel of DL3031A.

3. Power on DL3031A, and restores all the settings of the electronic load to its factory default settings.

4. Turn on the DC power supply, and set its output voltage to 8 V and output current to 62 A.

5. Measure the CC programming accuracy and readback accuracy when the current range is 60 A.

   (1) Measure the CC programming accuracy and readback accuracy when the

current setting value is a low value.

a) Power on DL3031A. Send the following commands via the remote interface to set the current of the input channel, and then enable the channel input.

> :SOUR:CURR:RANG 60   /*Sets the current range of the electronic load to 60 A.*/
> :SOUR:CURR:LEV:IMM 8   /*Sets the input current of the electronic load to 8 A.*/
> :SOUR:INP:STAT 1   /*Enables the channel input.*/

b) Turn on the digital multimeter. Select the DC voltage (DCV) measurement function and set the range to "Auto". Make sure that the electronic load works in CC mode. Read the digital multimeter and record the reading (U_1) of the digital multimeter. Calculate the current value ($I_1 = U_1/R_M$).

c) Send the :MEAS:CURR? command via the remote interface, read and record the returned current value (I_2) of the query command.

d) Calculate the CC programming accuracy ($|I_1 - I_L|$) and the CC readback accuracy ($|I_2 - I_1|$). Compare them with the specified specifications in Table 2-4. Wherein, I_L is the low current value of the input channel.

(2) Measure the CC programming accuracy and readback accuracy when the current setting value is a rated value.

a) Power on DL3031A. Send the following commands via the remote interface to set the current of the input channel, and then enable the channel input.

> :SOUR:CURR:RANG 60   /*Sets the current range of the electronic load to 60 A.*/
> :SOUR:CURR:LEV:IMM 60   /*Sets the input current of the electronic load to 60 A.*/
> :SOUR:INP:STAT 1   /*Enables the channel input.*/

b) Turn on the digital multimeter. Select the DC voltage (DCV) measurement function and set the range to "Auto". Make sure that the electronic load works in CC mode. Read the digital multimeter and record the reading (U_2) of the digital multimeter. Calculate the current value ($I_3 = U_2/R_M$).

c) Send the :MEAS:CURR? command via the remote interface, read and record the returned current value (I_4) of the query command.

d) Calculate the CC programming accuracy ($|I_3 - I_0|$) and the CC readback accuracy ($|I_4 - I_3|$). Compare them with the specified specifications in Table 2-4. Wherein, I_0 is the rated current value of the input channel.

6. Measure the CC programming accuracy and readback accuracy when the current range is 6 A.

(1) Measure the CC programming accuracy and readback accuracy when the current setting value is a low value.

a) Power on DL3031A. Send the following commands via the remote interface to set the current of the input channel, and then enable the channel input.

:SOUR:CURR:RANG 6   /*Sets the current range of the electronic load to 6 A.*/
:SOUR:CURR:LEV:IMM 1   /*Sets the input current of the electronic load to 1 A.*/
:SOUR:INP:STAT 1   /*Enables the channel input.*/

b) Turn on the digital multimeter. Select the DC voltage (DCV) measurement function and set the range to "Auto". Make sure that the electronic load works in CC mode. Read the digital multimeter and record the reading (U_1) of the digital multimeter. Calculate the current value ($I_1 = U_1/R_M$).

c) Send the :MEAS:CURR? command via the remote interface, read and record the returned current value (I_2) of the query command.

d) Calculate the CC programming accuracy ($|I_1 - I_L|$) and the CC readback accuracy ($|I_2 - I_1|$). Compare them with the specified specifications in Table 2-4. Wherein, I_L is the low current value of the input channel.

(2) Measure the CC programming accuracy and readback accuracy when the current setting value is a rated value.

a) Power on DL3031A. Send the following commands via the remote interface to set the current of the input channel, and then enable the channel input.

:SOUR:CURR:RANG 6   /*Sets the current range of the electronic load to 6 A.*/
:SOUR:CURR:LEV:IMM 6   /*Sets the input current of the electronic load to 6 A.*/
:SOUR:INP:STAT 1   /*Enables the channel input.*/

b) Turn on the digital multimeter. Select the DC voltage (DCV) measurement function and set the range to "Auto". Make sure that the electronic load works in CC mode. Read the digital multimeter and record the reading (U_2) of the digital multimeter. Calculate the current value ($I_3 = U_2/R_M$).

c) Send the :MEAS:CURR? command via the remote interface, read and record the returned current value (I_4) of the query command.

d) Calculate the CC programming accuracy ($|I_3 - I_0|$) and the CC readback accuracy ($|I_4 - I_3|$). Compare them with the specified specifications in Table 2-4. Wherein, I_0 is the rated current value of the input channel.

7. Send the following command via the remote interface to disable the channel input.

   :SOUR:INP:STAT 0   /*Disables the channel input.*/

Test Record Forms:

Table 2-1 Test Record Form of DL3021 CC Programming Accuracy and Readback Accuracy

Model		DL3021 (150 V/40 A)
The current range is 40 A.		
Specification	Programming Accuracy	$\pm(0.1\%+0.04\ A)$
	Readback Accuracy	$\pm(0.1\%+0.04\ A)$
DL3021 Setting	Current	I_L[1]
Test Result	U_1	
	$I_1=U_1/R_M$[2]	
	I_2	
	Programming Accuracy: $\|I_1 - I_L$[1]$\|$	
	Readback Accuracy: $\|I_2 - I_1\|$	
DL3021 Setting	Current	I_0[3]
Test Result	U_2	
	$I_3=U_2/R_M$[2]	
	I_4	
	Programming Accuracy: $\|I_3 - I_0$[3]$\|$	
	Readback Accuracy: $\|I_4 - I_3\|$	
The current range is 4 A.		
Specification	Programming Accuracy	$\pm(0.1\%+0.004\ A)$
	Readback Accuracy	$\pm(0.1\%+0.004\ A)$
DL3021 Setting	Current	I_L[1]
Test Result	U_1	
	$I_1=U_1/R_M$[2]	
	I_2	
	Programming Accuracy: $\|I_1 - I_L$[1]$\|$	
	Readback Accuracy: $\|I_2 - I_1\|$	
DL3021 Setting	Current	I_0[3]
Test Result	U_2	
	$I_3=U_2/R_M$[2]	
	I_4	
	Programming Accuracy: $\|I_3 - I_0$[3]$\|$	
	Readback Accuracy: $\|I_4 - I_3\|$	

Note[1]: indicates the low current value of the input channel.
Note[2]: R_M = 0.01 Ω.
Note[3]: indicates the rated current of the input channel.

Table 2-2 Test Record Form of DL3021A CC Programming Accuracy and Readback Accuracy

Model		DL3021A (150 V/40 A)
The current range is 40 A.		
Specification	Programming Accuracy	±(0.05%+0.02 A)
	Readback Accuracy	±(0.05%+0.02 A)
DL3021A Setting	Current	I_L[1]
Test Result	U_1	
	$I_1=U_1/R_M$[2]	
	I_2	
	Programming Accuracy: $\|I_1 - I_L{}^{[1]}\|$	
	Readback Accuracy: $\|I_2 - I_1\|$	
DL3021A Setting	Current	I_0[3]
Test Result	U_2	
	$I_3=U_2/R_M$[2]	
	I_4	
	Programming Accuracy: $\|I_3 - I_0{}^{[3]}\|$	
	Readback Accuracy: $\|I_4 - I_3\|$	
The current range is 4 A.		
Specification	Programming Accuracy	±(0.05%+0.002 A)
	Readback Accuracy	±(0.05%+0.002 A)
DL3021A Setting	Current	I_L[1]
Test Result	U_1	
	$I_1=U_1/R_M$[2]	
	I_2	
	Programming Accuracy: $\|I_1 - I_L{}^{[1]}\|$	
	Readback Accuracy: $\|I_2 - I_1\|$	
DL3021A Setting	Current	I_0[3]
Test Result	U_2	
	$I_3=U_2/R_M$[2]	
	I_4	
	Programming Accuracy: $\|I_3 - I_0{}^{[3]}\|$	
	Readback Accuracy: $\|I_4 - I_3\|$	

Note[1]: indicates the low current value of the input channel.
Note[2]: R_M = 0.01 Ω.
Note[3]: indicates the rated current of the input channel.

Table 2-3 Test Record Form of DL3031 CC Programming Accuracy and Readback Accuracy

Model		DL3031 (150 V/60 A)
The current range is 60 A.		
Specification	Programming Accuracy	$\pm(0.1\%+0.06$ A$)$
	Readback Accuracy	$\pm(0.1\%+0.06$ A$)$
DL3031 Setting	Current	$I_L{}^{[1]}$
Test Result	U_1	
	$I_1=U_1/R_M{}^{[2]}$	
	I_2	
	Programming Accuracy: $\lvert I_1 - I_L{}^{[1]}\rvert$	
	Readback Accuracy: $\lvert I_2 - I_1\rvert$	
DL3031 Setting	Current	$I_0{}^{[3]}$
Test Result	U_2	
	$I_3=U_2/R_M{}^{[2]}$	
	I_4	
	Programming Accuracy: $\lvert I_3 - I_0{}^{[3]}\rvert$	
	Readback Accuracy: $\lvert I_4 - I_3\rvert$	
The current range is 6 A.		
Specification	Programming Accuracy	$\pm(0.1\%+0.006$ A$)$
	Readback Accuracy	$\pm(0.1\%+0.006$ A$)$
DL3031 Setting	Current	$I_L{}^{[1]}$
Test Result	U_1	
	$I_1=U_1/R_M{}^{[2]}$	
	I_2	
	Programming Accuracy: $\lvert I_1 - I_L{}^{[1]}\rvert$	
	Readback Accuracy: $\lvert I_2 - I_1\rvert$	
DL3031 Setting	Current	$I_0{}^{[3]}$
Test Result	U_2	
	$I_3=U_2/R_M{}^{[2]}$	
	I_4	
	Programming Accuracy: $\lvert I_3 - I_0{}^{[3]}\rvert$	
	Readback Accuracy: $\lvert I_4 - I_3\rvert$	

Note[1]: indicates the low current value of the input channel.
Note[2]: R_M = 0.01 Ω.
Note[3]: indicates the rated current of the input channel.

Table 2-4 Test Record Form of DL3031A CC Programming Accuracy and Readback Accuracy

Model		DL3031A (150 V/60 A)
The current range is 60 A.		
Specification	Programming Accuracy	±(0.05%+0.03 A)
	Readback Accuracy	±(0.05%+0.03 A)
DL3031A Setting	Current	I_L[1]
Test Result	U_1	
	$I_1=U_1/R_M$[2]	
	I_2	
	Programming Accuracy: |I_1 - I_L[1]|	
	Readback Accuracy: |I_2 - I_1|	
DL3031A Setting	Current	I_0[3]
Test Result	U_2	
	$I_3=U_2/R_M$[2]	
	I_4	
	Programming Accuracy: |I_3 - I_0[3]|	
	Readback Accuracy: |I_4 - I_3|	
The current range is 6 A.		
Specification	Programming Accuracy	±(0.05%+0.003 A)
	Readback Accuracy	±(0.05%+0.003 A)
DL3031A Setting	Current	I_L[1]
Test Result	U_1	
	$I_1=U_1/R_M$[2]	
	I_2	
	Programming Accuracy: |I_1 - I_L[1]|	
	Readback Accuracy: |I_2 - I_1|	
DL3031A Setting	Current	I_0[3]
Test Result	U_2	
	$I_3=U_2/R_M$[2]	
	I_4	
	Programming Accuracy: |I_3 - I_0[3]|	
	Readback Accuracy: |I_4 - I_3|	

Note[1]: indicates the low current value of the input channel.
Note[2]: R_M = 0.01 Ω.
Note[3]: indicates the rated current of the input channel.

CV Programming Accuracy and Readback Accuracy

Preparations

Before performing the test, select the appropriate AC voltage via the "AC Selector" on the rear panel of the electronic load according to the AC voltage standard of your country (230 Vac is taken as an example in all the tests in this manual). At room temperature (25℃), connect the recommended devices specified in "**Recommended Test Devices**" according to the connection method in Figure 2-2. During the test process, please set the AC voltage according to the selected voltage in "AC Selector" on the rear panel of the electronic load.
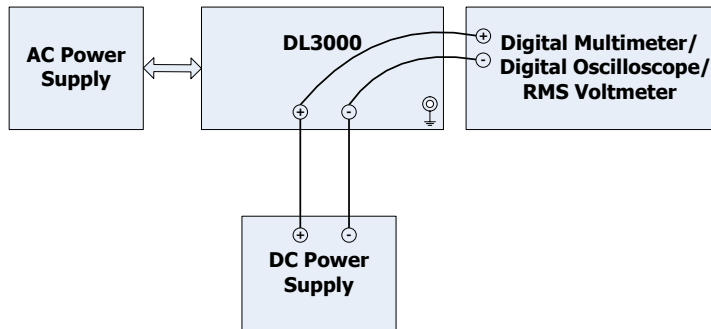

Figure 2-2 CV Test Connection

Note: In case of large current input, please use Sense terminal to compensate the voltage drop on the lead of the load.

Test Procedures

CV programming accuracy refers to the error between the voltage setting of the channel and the actual input voltage value when the electronic load is in CV mode. CV readback accuracy refers to the error between the readback voltage value and the actual input voltage value when the electronic load is in CV mode.

The following section takes DL3031A as an example to test the CV programming accuracy and readback accuracy of the DL3000 series.

Note: During the test, please select the corresponding test record form according to the model of the DL3000 series under test to set the corresponding parameters, record and calculate the corresponding specifications.

Specification:

Annual Accuracy[1] (25°C ± 5°C), ±(% of Output + Offset)	
Programming	±(0.05%+0.025%FS[1])
Readback Value	±(0.05%+0.02%FS[1])

Note[1]: The accuracy specifications are acquired through calibration at 25°C after 1-hour warm-up.
Note[2]: FS indicates the full scale.

Test Procedures:
1. Power off DL3031A. Connect DL3031A, AC power supply, DC power supply, and a digital multimeter according to Figure 2-2 (Pay attention to the connection method for the channel input terminals of DL3031A and the digital multimeter). Connect the USB DEVICE interface on the rear panel of the electronic load to the PC via the USB cable.

2. Turn on the AC power supply, and then set its voltage to 230 V, the frequency to 50 Hz. Then, turn on the output.

   Note: The voltage setting of the AC power supply should be matched with the AC voltage selector on the rear panel of DL3031A.

3. Power on DL3031A, and restores all the settings of the electronic load to its factory default settings.

4. Turn on the DC power supply, and set its output voltage to 152 V and output current to 0.1 A.

5. Measure the CV programming accuracy and readback accuracy when the voltage range is 150 V.

   (1) Measure the CV programming accuracy and readback accuracy when the voltage setting value is a low value.

a) Power on DL3031A. Send the following commands via the remote interface to set the voltage of the input channel, and then enable the channel input.

:SOUR:VOLT:RANG 150   /*Sets the voltage range of the electronic load to 150 V.*/
:SOUR:VOLT:LEV:IMM 18   /*Sets the input voltage of the electronic load to 18 V.*/
:SOUR:INP:STAT 1   /*Enables the channel input.*/

b) Turn on the digital multimeter. Select the DC voltage (DCV) measurement function and set the range to "Auto". Make sure that the electronic load works in CV mode. Read the digital multimeter and record the reading (U_1) of the digital multimeter.

c) Send the :MEAS:VOLT? command via the remote interface, read and record the returned voltage value (U_2) of the query command.

d) Calculate the CV programming accuracy ($|U_1 - U_L|$) and the CV readback accuracy ($|U_2 - U_1|$). Compare them with the specified specifications in Table 2-8. Wherein, U_L is the low current value of the input channel.

(2) Measure the CV programming accuracy and readback accuracy when the voltage setting value is a rated value.

a) Power on DL3031A. Send the following commands via the remote interface to set the voltage of the input channel, and then enable the channel input.

:SOUR:VOLT:RANG 150   /*Sets the voltage range of the electronic load to 150 V.*/
:SOUR:VOLT:LEV:IMM 150   /*Sets the input voltage of the electronic load to 150 V.*/
:SOUR:INP:STAT 1   /*Enables the channel input.*/

b) Turn on the digital multimeter. Select the DC voltage (DCV) measurement function and set the range to "Auto". Make sure that the electronic load works in CV mode. Read the digital multimeter and record the reading (U_3) of the digital multimeter.

c) Send the :MEAS:VOLT? command via the remote interface, read and record the returned voltage value (U_4) of the query command.

d) Calculate the CV programming accuracy ($|U_3 - U_0|$) and the CV readback accuracy ($|U_4 - U_3|$). Compare them with the specified

specifications in Table 2-8. Wherein, U_0 is the rated voltage value of the input channel.

6. Measure the CV programming accuracy and readback accuracy when the voltage range is 15 V.

   (1) Measure the CV programming accuracy and readback accuracy when the voltage setting value is a low value.

      a) Power on DL3031A. Send the following commands via the remote interface to set the voltage of the input channel, and then enable the channel input.

         :SOUR:VOLT:RANG 15   /*Sets the voltage range of the electronic load to 15 V.*/
         :SOUR:VOLT:LEV:IMM 4   /*Sets the input voltage of the electronic load to 4 V.*/
         :SOUR:INP:STAT 1   /*Enables the channel input.*/

      b) Turn on the digital multimeter. Select the DC voltage (DCV) measurement function and set the range to "Auto". Make sure that the electronic load works in CV mode. Read the digital multimeter and record the reading (U_1) of the digital multimeter.

      c) Send the :MEAS:VOLT? command via the remote interface, read and record the returned voltage value (U_2) of the query command.

      d) Calculate the CV programming accuracy ($|U_1 - U_L|$) and the CV readback accuracy ($|U_2 - U_1|$). Compare them with the specified specifications in Table 2-8. Wherein, U_L is the low current value of the input channel.

   (2) Measure the CV programming accuracy and readback accuracy when the voltage setting value is a rated value.

      a) Power on DL3031A. Send the following commands via the remote interface to set the voltage of the input channel, and then enable the channel input.

         :SOUR:VOLT:RANG 15   /*Sets the voltage range of the electronic load to 15 V.*/
         :SOUR:VOLT:LEV:IMM 15   /*Sets the input voltage of the electronic load to 15 V.*/
         :SOUR:INP:STAT 1   /*Enables the channel input.*/

      b) Turn on the digital multimeter. Select the DC voltage (DCV)

measurement function and set the range to "Auto". Make sure that the electronic load works in CV mode. Read the digital multimeter and record the reading (U_3) of the digital multimeter.

c) Send the :MEAS:VOLT? command via the remote interface, read and record the returned voltage value (U_4) of the query command.

d) Calculate the CV programming accuracy ($|U_3 - U_0|$) and the CV readback accuracy ($|U_4 - U_3|$). Compare them with the specified specifications in Table 2-8. Wherein, U_0 is the rated voltage value of the input channel.

7. Send the following command via the remote interface to disable the channel input.

:SOUR:INP:STAT 0 /*Disables the channel input.*/

Test Record Forms:

Table 2-5 Test Record Form of DL3021 CV Programming Accuracy and Readback Accuracy

Model		DL3021 (150 V/40 A)
The voltage range is 150 V.		
Specification	Programming Accuracy	$\pm(0.05\%+0.03$ V$)$
	Readback Accuracy	$\pm(0.05\%+0.03$ V$)$
DL3021 Setting	Voltage	$U_L^{[1]}$
Test Result	U_1	
	U_2	
	Programming Accuracy: $\|U_1 - U_L^{[1]}\|$	
	Readback Accuracy: $\|U_2 - U_1\|$	
DL3021 Setting	Voltage	$U_0^{[2]}$
Test Result	U_3	
	U_4	
	Programming Accuracy: $\|U_3 - U_0^{[2]}\|$	
	Readback Accuracy: $\|U_4 - U_3\|$	
The voltage range is 15 V.		
Specification	Programming Accuracy	$\pm(0.05\%+0.003$ V$)$
	Readback Accuracy	$\pm(0.05\%+0.003$ V$)$
DL3021 Setting	Voltage	$U_L^{[1]}$
Test Result	U_1	
	U_2	
	Programming Accuracy: $\|U_1 - U_L^{[1]}\|$	
	Readback Accuracy: $\|U_2 - U_1\|$	
DL3021 Setting	Voltage	$U_0^{[2]}$
Test Result	U_3	
	U_4	
	Programming Accuracy: $\|U_3 - U_0^{[2]}\|$	
	Readback Accuracy: $\|U_4 - U_3\|$	

Note[1]: indicates the low voltage value of the input channel.

Note[2]: indicates the rated voltage of the input channel.

Table 2-6 Test Record Form of DL3021A CV Programming Accuracy and Readback Accuracy

Model		DL3021A (150 V/40 A)
The voltage range is 150 V.		
Specification	Programming Accuracy	±(0.05%+0.0375 V)
	Readback Accuracy	±(0.05%+0.03 V)
DL3021A Setting	Voltage	$U_L^{[1]}$
Test Result	U_1	
	U_2	
	Programming Accuracy: $\|U_1 - U_L^{[1]}\|$	
	Readback Accuracy: $\|U_2 - U_1\|$	
DL3021A Setting	Voltage	$U_0^{[2]}$
Test Result	U_3	
	U_4	
	Programming Accuracy: $\|U_3 - U_0^{[2]}\|$	
	Readback Accuracy: $\|U_4 - U_3\|$	
The voltage range is 15 V.		
Specification	Programming Accuracy	±(0.05%+0.00375 V)
	Readback Accuracy	±(0.05%+0.003 V)
DL3021A Setting	Voltage	$U_L^{[1]}$
Test Result	U_1	
	U_2	
	Programming Accuracy: $\|U_1 - U_L^{[1]}\|$	
	Readback Accuracy: $\|U_2 - U_1\|$	
DL3021A Setting	Voltage	$U_0^{[2]}$
Test Result	U_3	
	U_4	
	Programming Accuracy: $\|U_3 - U_0^{[2]}\|$	
	Readback Accuracy: $\|U_4 - U_3\|$	

Note[1]: indicates the low voltage value of the input channel.
Note[2]: indicates the rated voltage of the input channel.

Table 2-7 Test Record Form of DL3031 CV Programming Accuracy and Readback Accuracy

Model		DL3031 (150 V/60 A)
The voltage range is 150 V.		
Specification	Programming Accuracy	±(0.05%+0.03 V)
	Readback Accuracy	±(0.05%+0.03 V)
DL3031 Setting	Voltage	$U_L^{[1]}$
Test Result	U_1	
	U_2	
	Programming Accuracy: $|U_1 - U_L^{[1]}|$	
	Readback Accuracy: $|U_2 - U_1|$	
DL3031 Setting	Voltage	$U_0^{[2]}$
Test Result	U_3	
	U_4	
	Programming Accuracy: $|U_3 - U_0^{[2]}|$	
	Readback Accuracy: $|U_4 - U_3|$	
The voltage range is 15 V.		
Specification	Programming Accuracy	±(0.05%+0.003 V)
	Readback Accuracy	±(0.05%+0.003 V)
DL3031 Setting	Voltage	$U_L^{[1]}$
Test Result	U_1	
	U_2	
	Programming Accuracy: $|U_1 - U_L^{[1]}|$	
	Readback Accuracy: $|U_2 - U_1|$	
DL3031 Setting	Voltage	$U_0^{[2]}$
Test Result	U_3	
	U_4	
	Programming Accuracy: $|U_3 - U_0^{[2]}|$	
	Readback Accuracy: $|U_4 - U_3|$	

Note[1]: indicates the low voltage value of the input channel.

Note[2]: indicates the rated voltage of the input channel.

Table 2-8 Test Record Form of DL3031A CV Programming Accuracy and Readback Accuracy

Model		DL3031A (150 V/60 A)
The voltage range is 150 V.		
Specification	Programming Accuracy	$\pm(0.05\%+0.0375$ V$)$
	Readback Accuracy	$\pm(0.05\%+0.03$ V$)$
DL3031A Setting	Voltage	U_L[1]
Test Result	U_1	
	U_2	
	Programming Accuracy: $|U_1 - U_L$[1]$|$	
	Readback Accuracy: $|U_2 - U_1|$	
DL3031A Setting	Voltage	U_0[2]
Test Result	U_3	
	U_4	
	Programming Accuracy: $|U_3 - U_0$[2]$|$	
	Readback Accuracy: $|U_4 - U_3|$	
The voltage range is 15 V.		
Specification	Programming Accuracy	$\pm(0.05\%+0.00375$ V$)$
	Readback Accuracy	$\pm(0.05\%+0.003$ V$)$
DL3031A Setting	Voltage	U_L[1]
Test Result	U_1	
	U_2	
	Programming Accuracy: $|U_1 - U_L$[1]$|$	
	Readback Accuracy: $|U_2 - U_1|$	
DL3031A Setting	Voltage	U_0[2]
Test Result	U_3	
	U_4	
	Programming Accuracy: $|U_3 - U_0$[2]$|$	
	Readback Accuracy: $|U_4 - U_3|$	

Note[1]: indicates the low voltage value of the input channel.
Note[2]: indicates the rated voltage of the input channel.

CR Programming Accuracy

Preparations

Before performing the test, select the appropriate AC voltage via the "AC Selector" on the rear panel of the electronic load according to the AC voltage standard of your country (230 Vac is taken as an example in all the tests in this manual). At room temperature (25℃), connect the recommended devices specified in

"**Recommended Test Devices**" according to the connection method in Figure 2-3. During the test process, please set the AC voltage according to the selected voltage in "AC Selector" on the rear panel of the electronic load.

In the CR tests, a current sampling resistor (required to be calibrated) should be serially connected between the DC power supply and the electronic load. It is used to convert the current signal under test to the voltage signal for the measurement of related parameters.
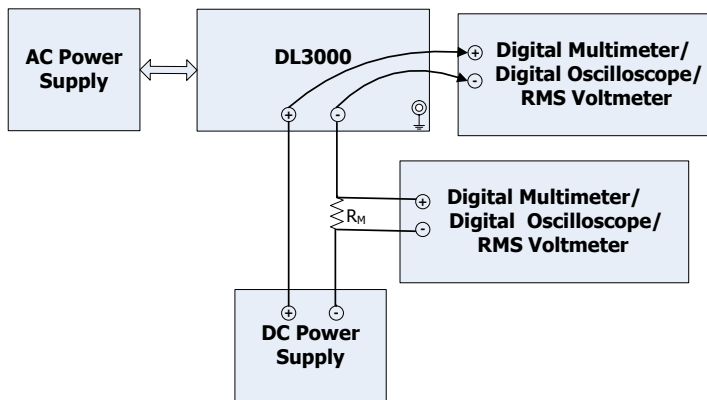
Figure 2-3 CR Test Connection

Note: In case of large current input, please use Sense terminal to compensate the voltage drop on the lead of the load.

Test Procedures

CR programming accuracy refers to the error between the resistance setting of the channel and the actual resistance value when the electronic load is in CR mode.

The following section takes DL3031A as an example to test the CR programming accuracy of the DL3000 series.

Note: During the test, please select the corresponding test record form according to the model of the DL3000 series under test to set the corresponding parameters, record and calculate the corresponding specifications.

Specification:

Annual Accuracy[1] (25°C ± 5°C), ±(% of Output + Offset)	
Programming	Vin/Rset*(0.2%)+0.2%IFS[2]

Note[1]: The accuracy specifications are acquired through calibration at 25°C after 1-hour warm-up.
Note[2]: FS indicates the full scale.

Test Procedures:
1. Power off DL3031A. Connect DL3031A, AC power supply, DC power supply, a current sampling resistor (with a resistance R_M 0.01 Ω), and a digital multimeter according to Figure 2-3 (Pay attention to the connection method for the current sampling resistor, the channel input terminals of DL3031A, and the digital multimeter). Connect the USB DEVICE interface on the rear panel of the electronic load to the PC via the USB cable.

2. Turn on the AC power supply, and then set its voltage to 230 V, the frequency to 50 Hz. Then, turn on the output.

    Note: The voltage setting of the AC power supply should be matched with the AC voltage selector on the rear panel of DL3031A.

3. Power on DL3031A, and restores all the settings of the electronic load to its factory default settings.

4. Turn on the DC power supply, and set its output voltage to 30 V and output current to 15 A.

5. Measure the CR programming accuracy when the resistance range is a low range (0.08 Ω to 15 Ω).

    (1) Measure the CR programming accuracy when the resistance is set to a low value.

        a) Power on DL3031A. Send the following commands via the remote

interface to set the resistance, and then enable the channel input.

:SOUR:RES:RANG 15   /*Sets the resistance range of the electronic
to a low range (0.08 Ω to 15 Ω).*/
:SOUR:RES:LEV:IMM   /*Sets the resistance value of the electronic
0.125   load to 0.125 Ω.*/
:SOUR:INP:STAT 1   /*Enables the channel input.*/

b) Turn on the digital multimeter. Select the DC voltage (DCV) measurement function and set the range to "Auto". Make sure that the electronic load works in CR mode. Read the digital multimeter and record the reading (U_1 and U_2) of the digital multimeter. Wherein, U_1 is the input voltage of the electronic load, and U_2 is the voltage of the current sampling resistance. Calculate the resistance of the electronic load according to the formula: $R_1 = U_1/(U_2/R_M)$.

c) Calculate the CR programming accuracy $|R_1 - R_L|$. Compare it with the specified specifications in Table 2-12. Wherein, R_L is the low resistance value.

(2) Measure the CR programming accuracy when the resistance is set to a high value.

a) Power on DL3031A. Send the following commands via the remote interface to set the resistance, and then enable the channel input.

:SOUR:RES:RANG 15   /*Sets the resistance range of the electronic
load to a low range (0.08 Ω to 15 Ω).*/
:SOUR:RES:LEV:IMM   /*Sets the resistance value of the electronic
15   load to 15 Ω.*/
:SOUR:INP:STAT 1   /*Enables the channel input.*/

b) Turn on the digital multimeter. Select the DC voltage (DCV) measurement function and set the range to "Auto". Make sure that the electronic load works in CR mode. Read the digital multimeter and record the reading (U_3 and U_4) of the digital multimeter. Wherein, U_3 is the input voltage of the electronic load, and U_4 is the voltage of the current sampling resistance. Calculate the resistance of the electronic load according to the formula: $R_2 = U_3/(U_4/R_M)$.

c) Calculate the CR programming accuracy $|R_2 - R_H|$. Compare it with the specified specifications in Table 2-12. Wherein, R_H is the high resistance value.

6. Measure the CR programming accuracy when the resistance range is a high range (2 Ω to 15 kΩ).

(1) Measure the CR programming accuracy when the resistance is set to a low value.

    a) Power on DL3031A. Send the following commands via the remote interface to set the resistance, and then enable the channel input.

        :SOUR:RES:RANG   /*Sets the resistance range of the electronic
        15000   load to a high range (2 Ω to 15 kΩ).*/
        :SOUR:RES:LEV:IMM   /*Sets the resistance value of the electronic
        18   load to 18 Ω.*/
        :SOUR:INP:STAT 1   /*Enables the channel input.*/

    b) Turn on the digital multimeter. Select the DC voltage (DCV) measurement function and set the range to "Auto". Make sure that the electronic load works in CR mode. Read the digital multimeter and record the reading (U_1 and U_2) of the digital multimeter. Wherein, U_1 is the input voltage of the electronic load, and U_2 is the voltage of the current sampling resistance. Calculate the resistance of the electronic load according to the formula: $R_1 = U_1/(U_2/R_M)$.

    c) Calculate the CR programming accuracy $|R_1 - R_L|$. Compare it with the specified specifications in Table 2-12. Wherein, R_L is the low resistance value.

(2) Measure the CR programming accuracy when the resistance is set to a high value.

    a) Power on DL3031A. Send the following commands via the remote interface to set the resistance of the input channel, and then enable the channel input.

        :SOUR:RES:RANG   /*Sets the resistance range of the electronic
        15000   load to a high range (2 Ω to 15 kΩ).*/
        :SOUR:RES:LEV:IMM   /*Sets the resistance value of the electronic
        15000   load to 15000 Ω.*/
        :SOUR:INP:STAT 1   /*Enables the channel input.*/

    b) Turn on the digital multimeter. Select the DC voltage (DCV) measurement function and set the range to "Auto". Make sure that the electronic load works in CR mode. Read the digital multimeter and record the reading (U_3 and U_4) of the digital multimeter. Wherein, U_3 is the input voltage of the electronic load, and U_4 is the voltage of the current sampling resistance. Calculate the resistance of the electronic load according to the formula: $R_2 = U_3/(U_4/R_M)$.

    c) Calculate the CR programming accuracy $|R_2 - R_H|$. Compare it with the

specified specifications in Table 2-12. Wherein, R_H is the high resistance value.

7. Send the following command via the remote interface to disable the channel input.

:SOUR:INP:STAT 0   /*Disables the channel input.*/

Test Record Forms:

Table 2-9 Test Record Form of DL3021 CR Programming Accuracy

Model		DL3021 (150 V/40 A)
The resistance range of the electronic load is from 0.08 Ω to 15 Ω.		
Specification	Programming Accuracy	Vin/Rset*(0.2%)+0.08 A
DL3021 Setting	Resistance	R_L[1]
Test Result	U_1	
	U_2	
	$R_1=U_1/(U_2/R_M$[2]$)$	
	Programming Accuracy: $\lvert R_1 - R_L$[1]$\rvert$	
DL3021 Setting	Resistance	R_H[3]
Test Result	U_3	
	U_4	
	$R_2=U_3/(U_4/R_M$[2]$)$	
	Programming Accuracy: $\lvert R_3 - R_H$[3]$\rvert$	
The resistance range of the electronic load is from 2 Ω to 15 kΩ.		
Specification	Programming Accuracy	Vin/Rset*(0.2%)+0.08 A
DL3021 Setting	Resistance	R_L[1]
Test Result	U_1	
	U_2	
	$R_1=U_1/(U_2/R_M$[2]$)$	
	Programming Accuracy: $\lvert R_1 - R_L$[1]$\rvert$	
DL3021 Setting	Resistance	R_H[3]
Test Result	U_3	
	U_4	
	$R_2=U_3/(U_4/R_M$[2]$)$	
	Programming Accuracy: $\lvert R_3 - R_H$[3]$\rvert$	

Note[1]**:** indicates the set low resistance value.
Note[2]**:** R_M = 0.01 Ω.
Note[3]**:** indicates the set high resistance value.

Table 2-10 Test Record Form of DL3021A CR Programming Accuracy

Model		DL3021A (150 V/40 A)
The resistance range of the electronic load is from 0.08 Ω to 15 Ω.		
Specification	Programming Accuracy	Vin/Rset*(0.2%)+0.08 A
DL3021A Setting	Resistance	R_L[1]
Test Result	U_1	
	U_2	
	$R_1=U_1/(U_2/R_M$[2]$)$	
	Programming Accuracy: $\|R_1 - R_L$[1]$\|$	
DL3021A Setting	Resistance	R_H[3]
Test Result	U_3	
	U_4	
	$R_2=U_3/(U_4/R_M$[2]$)$	
	Programming Accuracy: $\|R_3 - R_H$[3]$\|$	
The resistance range of the electronic load is from 2 Ω to 15 kΩ.		
Specification	Programming Accuracy	Vin/Rset*(0.2%)+0.08 A
DL3021A Setting	Resistance	R_L[1]
Test Result	U_1	
	U_2	
	$R_1=U_1/(U_2/R_M$[2]$)$	
	Programming Accuracy: $\|R_1 - R_L$[1]$\|$	
DL3021A Setting	Resistance	R_H[3]
Test Result	U_3	
	U_4	
	$R_2=U_3/(U_4/R_M$[2]$)$	
	Programming Accuracy: $\|R_3 - R_H$[3]$\|$	

Note[1]**:** indicates the set low resistance value.
Note[2]**:** R_M = 0.01 Ω.
Note[3]**:** indicates the set high resistance value.

Table 2-11 Test Record Form of DL3031 CR Programming Accuracy

Model		DL3031 (150 V/60 A)
The resistance range of the electronic load is from 0.08 Ω to 15 Ω.		
Specification	Programming Accuracy	Vin/Rset*(0.2%)+0.12 A
DL3031 Setting	Resistance	R_L[1]
Test Result	U_1	
	U_2	
	$R_1=U_1/(U_2/R_M$[2]$)$	
	Programming Accuracy: $\|R_1 - R_L$[1]$\|$	
DL3031 Setting	Resistance	R_H[3]
Test Result	U_3	
	U_4	
	$R_2=U_3/(U_4/R_M$[2]$)$	
	Programming Accuracy: $\|R_3 - R_H$[3]$\|$	
The resistance range of the electronic load is from 2 Ω to 15 kΩ.		
Specification	Programming Accuracy	Vin/Rset*(0.2%)+0.12 A
DL3031 Setting	Resistance	R_L[1]
Test Result	U_1	
	U_2	
	$R_1=U_1/(U_2/R_M$[2]$)$	
	Programming Accuracy: $\|R_1 - R_L$[1]$\|$	
DL3031 Setting	Resistance	R_H[3]
Test Result	U_3	
	U_4	
	$R_2=U_3/(U_4/R_M$[2]$)$	
	Programming Accuracy: $\|R_3 - R_H$[3]$\|$	

Note[1]: indicates the set low resistance value.
Note[2]: R_M = 0.01 Ω.
Note[3]: indicates the set high resistance value.

Table 2-12 Test Record Form of DL3031A CR Programming Accuracy

Model		DL3031A (150 V/60 A)
The resistance range of the electronic load is from 0.08 Ω to 15 Ω.		
Specification	Programming Accuracy	Vin/Rset*(0.2%)+0.12 A
DL3031A Setting	Resistance	R_L[1]
Test Result	U_1	
	U_2	
	$R_1=U_1/(U_2/R_M$[2]$)$	
	Programming Accuracy: $|R_1 - R_L$[1]$|$	
DL3031A Setting	Resistance	R_H[3]
Test Result	U_3	
	U_4	
	$R_2=U_3/(U_4/R_M$[2]$)$	
	Programming Accuracy: $|R_3 - R_H$[3]$|$	
The resistance range of the electronic load is from 2 Ω to 15 kΩ.		
Specification	Programming Accuracy	Vin/Rset*(0.2%)+0.12 A
DL3031A Setting	Resistance	R_L[1]
Test Result	U_1	
	U_2	
	$R_1=U_1/(U_2/R_M$[2]$)$	
	Programming Accuracy: $|R_1 - R_L$[1]$|$	
DL3031A Setting	Resistance	R_H[3]
Test Result	U_3	
	U_4	
	$R_2=U_3/(U_4/R_M$[2]$)$	
	Programming Accuracy: $|R_3 - R_H$[3]$|$	

Note[1]**:** indicates the set low resistance value.
Note[2]**:** R_M = 0.01 Ω.
Note[3]: indicates the set high resistance value.

Appendix

Appendix A: Test Record Forms

DL3021 Performance Verification Test Record Form

RIGOL DL3021 Programmable DC Electronic Load
Performance Verification Test Record Form

CC Programming Accuracy and Readback Accuracy

Model		DL3021 (150 V/40 A)
The current range is 40 A.		
Specification	Programming Accuracy	±(0.1%+0.04 A)
	Readback Accuracy	±(0.1%+0.04 A)
DL3021 Setting	Current	$I_L^{[1]}$
Test Result	U_1	
	$I_1=U_1/R_M^{[2]}$	
	I_2	
	Programming Accuracy: $|I_1 - I_L^{[1]}|$	
	Readback Accuracy: $|I_2 - I_1|$	
DL3021 Setting	Current	$I_0^{[3]}$
Test Result	U_2	
	$I_3=U_2/R_M^{[2]}$	
	I_4	
	Programming Accuracy: $|I_3 - I_0^{[3]}|$	
	Readback Accuracy: $|I_4 - I_3|$	
The current range is 4 A.		
Specification	Programming Accuracy	±(0.1%+0.004 A)
	Readback Accuracy	±(0.1%+0.004 A)
DL3021 Setting	Current	$I_L^{[1]}$
Test Result	U_1	
	$I_1=U_1/R_M^{[2]}$	
	I_2	
	Programming Accuracy: $|I_1 - I_L^{[1]}|$	
	Readback Accuracy: $|I_2 - I_1|$	
DL3021 Setting	Current	$I_0^{[3]}$
Test Result	U_2	
	$I_3=U_2/R_M^{[2]}$	

	I_4	
	Programming Accuracy: $\|I_3 - I_0^{[3]}\|$	
	Readback Accuracy: $\|I_4 - I_3\|$	

CV Programming Accuracy and Readback Accuracy

Model		DL3021 (150 V/40 A)
The voltage range is 150 V.		
Specification	Programming Accuracy	±(0.05%+0.03 V)
	Readback Accuracy	±(0.05%+0.03 V)
DL3021 Setting	Voltage	$U_L^{[4]}$
Test Result	U_1	
	U_2	
	Programming Accuracy: $\|U_1 - U_L^{[4]}\|$	
	Readback Accuracy: $\|U_2 - U_1\|$	
DL3021 Setting	Voltage	$U_0^{[5]}$
Test Result	U_3	
	U_4	
	Programming Accuracy: $\|U_3 - U_0^{[5]}\|$	
	Readback Accuracy: $\|U_4 - U_3\|$	
The voltage range is 15 V.		
Specification	Programming Accuracy	±(0.05%+0.003 V)
	Readback Accuracy	±(0.05%+0.003 V)
DL3021 Setting	Voltage	$U_L^{[4]}$
Test Result	U_1	
	U_2	
	Programming Accuracy: $\|U_1 - U_L^{[4]}\|$	
	Readback Accuracy: $\|U_2 - U_1\|$	
DL3021 Setting	Voltage	$U_0^{[5]}$
Test Result	U_3	
	U_4	
	Programming Accuracy: $\|U_3 - U_0^{[5]}\|$	
	Readback Accuracy: $\|U_4 - U_3\|$	

CR Programming Accuracy

Model		DL3021 (150 V/40 A)
The resistance range of the electronic load is from 0.08 Ω to 15 Ω.		
Specification	Programming Accuracy	Vin/Rset*(0.2%)+0.08 A
DL3021 Setting	Resistance	R_L[6]
Test Result	U_1	
	U_2	
	$R_1=U_1/(U_2/R_M$[2]$)$	
	Programming Accuracy: $\|R_1 - R_L$[6]$\|$	
DL3021 Setting	Resistance	R_H[7]
Test Result	U_3	
	U_4	
	$R_2=U_3/(U_4/R_M$[2]$)$	
	Programming Accuracy: $\|R_3 - R_H$[7]$\|$	
The resistance range of the electronic load is from 2 Ω to 15 kΩ.		
Specification	Programming Accuracy	Vin/Rset*(0.2%)+0.08 A
DL3021 Setting	Resistance	R_L[6]
Test Result	U_1	
	U_2	
	$R_1=U_1/(U_2/R_M$[2]$)$	
	Programming Accuracy: $\|R_1 - R_L$[6]$\|$	
DL3021 Setting	Resistance	R_H[7]
Test Result	U_3	
	U_4	
	$R_2=U_3/(U_4/R_M$[2]$)$	
	Programming Accuracy: $\|R_3 - R_H$[7]$\|$	

Note[1]: indicates the low current value of the input channel.
Note[2]: R_M = 0.01 Ω.
Note[3]: indicates the rated current of the input channel.
Note[4]: indicates the low voltage value of the input channel.
Note[5]: indicates the rated voltage of the input channel.
Note[6]: indicates the set low resistance value.
Note[7]: indicates the set high resistance value.

DL3021A Performance Verification Test Record Form

RIGOL DL3021A Programmable DC Electronic Load
Performance Verification Test Record Form

CC Programming Accuracy and Readback Accuracy

Model		DL3021A (150 V/40 A)
The current range is 40 A.		
Specification	Programming Accuracy	$\pm(0.05\%+0.02\ A)$
	Readback Accuracy	$\pm(0.05\%+0.02\ A)$
DL3021A Setting	Current	I_L[1]
Test Result	U_1	
	$I_1=U_1/R_M$[2]	
	I_2	
	Programming Accuracy: $|I_1 - I_L$[1]$|$	
	Readback Accuracy: $|I_2 - I_1|$	
DL3021A Setting	Current	I_0[3]
Test Result	U_2	
	$I_3=U_2/R_M$[2]	
	I_4	
	Programming Accuracy: $|I_3 - I_0$[3]$|$	
	Readback Accuracy: $|I_4 - I_3|$	
The current range is 4 A.		
Specification	Programming Accuracy	$\pm(0.05\%+0.002\ A)$
	Readback Accuracy	$\pm(0.05\%+0.002\ A)$
DL3021A Setting	Current	I_L[1]
Test Result	U_1	
	$I_1=U_1/R_M$[2]	
	I_2	
	Programming Accuracy: $|I_1 - I_L$[1]$|$	
	Readback Accuracy: $|I_2 - I_1|$	
DL3021A Setting	Current	I_0[3]
Test Result	U_2	
	$I_3=U_2/R_M$[2]	
	I_4	
	Programming Accuracy: $|I_3 - I_0$[3]$|$	
	Readback Accuracy: $|I_4 - I_3|$	

CV Programming Accuracy and Readback Accuracy

Model		DL3021A (150 V/40 A)
The voltage range is 150 V.		
Specification	Programming Accuracy	±(0.05%+0.0375 V)
	Readback Accuracy	±(0.05%+0.03 V)
DL3021A Setting	Voltage	U_L[4]
Test Result	U_1	
	U_2	
	Programming Accuracy: $\lvert U_1 - U_L$[4]$\rvert$	
	Readback Accuracy: $\lvert U_2 - U_1 \rvert$	
DL3021A Setting	Voltage	U_0[5]
Test Result	U_3	
	U_4	
	Programming Accuracy: $\lvert U_3 - U_0$[5]$\rvert$	
	Readback Accuracy: $\lvert U_4 - U_3 \rvert$	
The voltage range is 15 V.		
Specification	Programming Accuracy	±(0.05%+0.00375 V)
	Readback Accuracy	±(0.05%+0.003 V)
DL3021A Setting	Voltage	U_L[4]
Test Result	U_1	
	U_2	
	Programming Accuracy: $\lvert U_1 - U_L$[4]$\rvert$	
	Readback Accuracy: $\lvert U_2 - U_1 \rvert$	
DL3021A Setting	Voltage	U_0[5]
Test Result	U_3	
	U_4	
	Programming Accuracy: $\lvert U_3 - U_0$[5]$\rvert$	
	Readback Accuracy: $\lvert U_4 - U_3 \rvert$	

CR Programming Accuracy

Model		DL3021A (150 V/40 A)
The resistance range of the electronic load is from 0.08 Ω to 15 Ω.		
Specification	Programming Accuracy	Vin/Rset*(0.2%)+0.08 A
DL3021A Setting	Resistance	R_L[6]
Test Result	U_1	
	U_2	
	$R_1=U_1/(U_2/R_M$[2]$)$	
	Programming Accuracy: $\lvert R_1 - R_L$[6]$\rvert$	
DL3021A Setting	Resistance	R_H[7]
Test Result	U_3	
	U_4	
	$R_2=U_3/(U_4/R_M$[2]$)$	
	Programming Accuracy: $\lvert R_3 - R_H$[7]$\rvert$	
The resistance range of the electronic load is from 2 Ω to 15 kΩ.		
Specification	Programming Accuracy	Vin/Rset*(0.2%)+0.08 A
DL3021A Setting	Resistance	R_L[6]
Test Result	U_1	
	U_2	
	$R_1=U_1/(U_2/R_M$[2]$)$	
	Programming Accuracy: $\lvert R_1 - R_L$[6]$\rvert$	
DL3021A Setting	Resistance	R_H[7]
Test Result	U_3	
	U_4	
	$R_2=U_3/(U_4/R_M$[2]$)$	
	Programming Accuracy: $\lvert R_3 - R_H$[7]$\rvert$	

Note[1]: indicates the low current value of the input channel.
Note[2]: R_M = 0.01 Ω.
Note[3]: indicates the rated current of the input channel.
Note[4]: indicates the low voltage value of the input channel.
Note[5]: indicates the rated voltage of the input channel.
Note[6]: indicates the set low resistance value.
Note[7]: indicates the set high resistance value.

DL3031 Performance Verification Test Record Form

RIGOL DL3031 Programmable DC Electronic Load
Performance Verification Test Record Form

CC Programming Accuracy and Readback Accuracy

Model		DL3031 (150 V/60 A)
The current range is 60 A.		
Specification	Programming Accuracy	±(0.1%+0.06 A)
	Readback Accuracy	±(0.1%+0.06 A)
DL3031 Setting	Current	I_L[1]
Test Result	U_1	
	$I_1=U_1/R_M$[2]	
	I_2	
	Programming Accuracy: $\lvert I_1 - I_L$[1]$\rvert$	
	Readback Accuracy: $\lvert I_2 - I_1 \rvert$	
DL3031 Setting	Current	I_0[3]
Test Result	U_2	
	$I_3=U_2/R_M$[2]	
	I_4	
	Programming Accuracy: $\lvert I_3 - I_0$[3]$\rvert$	
	Readback Accuracy: $\lvert I_4 - I_3 \rvert$	
The current range is 6 A.		
Specification	Programming Accuracy	±(0.1%+0.006 A)
	Readback Accuracy	±(0.1%+0.006 A)
DL3031 Setting	Current	I_L[1]
Test Result	U_1	
	$I_1=U_1/R_M$[2]	
	I_2	
	Programming Accuracy: $\lvert I_1 - I_L$[1]$\rvert$	
	Readback Accuracy: $\lvert I_2 - I_1 \rvert$	
DL3031 Setting	Current	I_0[3]
Test Result	U_2	
	$I_3=U_2/R_M$[2]	
	I_4	
	Programming Accuracy: $\lvert I_3 - I_0$[3]$\rvert$	
	Readback Accuracy: $\lvert I_4 - I_3 \rvert$	

CV Programming Accuracy and Readback Accuracy

Model		DL3031 (150 V/60 A)
The voltage range is 150 V.		
Specification	Programming Accuracy	±(0.05%+0.03 V)
	Readback Accuracy	±(0.05%+0.03 V)
DL3031 Setting	Voltage	$U_L^{[4]}$
Test Result	U_1	
	U_2	
	Programming Accuracy: $|U_1 - U_L^{[4]}|$	
	Readback Accuracy: $|U_2 - U_1|$	
DL3031 Setting	Voltage	$U_0^{[5]}$
Test Result	U_3	
	U_4	
	Programming Accuracy: $|U_3 - U_0^{[5]}|$	
	Readback Accuracy: $|U_4 - U_3|$	
The voltage range is 15 V.		
Specification	Programming Accuracy	±(0.05%+0.003 V)
	Readback Accuracy	±(0.05%+0.003 V)
DL3031 Setting	Voltage	$U_L^{[4]}$
Test Result	U_1	
	U_2	
	Programming Accuracy: $|U_1 - U_L^{[4]}|$	
	Readback Accuracy: $|U_2 - U_1|$	
DL3031 Setting	Voltage	$U_0^{[5]}$
Test Result	U_3	
	U_4	
	Programming Accuracy: $|U_3 - U_0^{[5]}|$	
	Readback Accuracy: $|U_4 - U_3|$	

CR Programming Accuracy

Model		DL3031 (150 V/60 A)
The resistance range of the electronic load is from 0.08 Ω to 15 Ω.		
Specification	Programming Accuracy	Vin/Rset*(0.2%)+0.12 A
DL3031 Setting	Resistance	R_L[6]
Test Result	U_1	
	U_2	
	$R_1=U_1/(U_2/R_M$[2]$)$	
	Programming Accuracy: $\|R_1 - R_L$[6]$\|$	
DL3031 Setting	Resistance	R_H[7]
Test Result	U_3	
	U_4	
	$R_2=U_3/(U_4/R_M$[2]$)$	
	Programming Accuracy: $\|R_3 - R_H$[7]$\|$	
The resistance range of the electronic load is from 2 Ω to 15 kΩ.		
Specification	Programming Accuracy	Vin/Rset*(0.2%)+0.12 A
DL3031 Setting	Resistance	R_L[6]
Test Result	U_1	
	U_2	
	$R_1=U_1/(U_2/R_M$[2]$)$	
	Programming Accuracy: $\|R_1 - R_L$[6]$\|$	
DL3031 Setting	Resistance	R_H[7]
Test Result	U_3	
	U_4	
	$R_2=U_3/(U_4/R_M$[2]$)$	
	Programming Accuracy: $\|R_3 - R_H$[7]$\|$	

Note[1]: indicates the low current value of the input channel.
Note[2]: R_M = 0.01 Ω.
Note[3]: indicates the rated current of the input channel.
Note[4]: indicates the low voltage value of the input channel.
Note[5]: indicates the rated voltage of the input channel.
Note[6]: indicates the set low resistance value.
Note[7]: indicates the set high resistance value.

DL3031A Performance Verification Test Record Form

RIGOL DL3031A Programmable DC Electronic Load
Performance Verification Test Record Form

CC Programming Accuracy and Readback Accuracy

Model		DL3031A (150 V/60 A)
The current range is 60 A.		
Specification	Programming Accuracy	±(0.05%+0.03 A)
	Readback Accuracy	±(0.05%+0.03 A)
DL3031A Setting	Current	I_L[1]
Test Result	U_1	
	$I_1 = U_1/R_M$[2]	
	I_2	
	Programming Accuracy: $\lvert I_1 - I_L$[1]$\rvert$	
	Readback Accuracy: $\lvert I_2 - I_1\rvert$	
DL3031A Setting	Current	I_0[3]
Test Result	U_2	
	$I_3 = U_2/R_M$[2]	
	I_4	
	Programming Accuracy: $\lvert I_3 - I_0$[3]$\rvert$	
	Readback Accuracy: $\lvert I_4 - I_3\rvert$	
The current range is 6 A.		
Specification	Programming Accuracy	±(0.05%+0.003 A)
	Readback Accuracy	±(0.05%+0.003 A)
DL3031A Setting	Current	I_L[1]
Test Result	U_1	
	$I_1 = U_1/R_M$[2]	
	I_2	
	Programming Accuracy: $\lvert I_1 - I_L$[1]$\rvert$	
	Readback Accuracy: $\lvert I_2 - I_1\rvert$	
DL3031A Setting	Current	I_0[3]
Test Result	U_2	
	$I_3 = U_2/R_M$[2]	
	I_4	
	Programming Accuracy: $\lvert I_3 - I_0$[3]$\rvert$	
	Readback Accuracy: $\lvert I_4 - I_3\rvert$	

CV Programming Accuracy and Readback Accuracy

Model		DL3031A (150 V/60 A)
The voltage range is 150 V.		
Specification	Programming Accuracy	±(0.05%+0.0375 V)
	Readback Accuracy	±(0.05%+0.03 V)
DL3031A Setting	Voltage	U_L[4]
Test Result	U_1	
	U_2	
	Programming Accuracy: $\mid U_1 - U_L$[4]$\mid$	
	Readback Accuracy: $\mid U_2 - U_1 \mid$	
DL3031A Setting	Voltage	U_0[5]
Test Result	U_3	
	U_4	
	Programming Accuracy: $\mid U_3 - U_0$[5]$\mid$	
	Readback Accuracy: $\mid U_4 - U_3 \mid$	
The voltage range is 15 V.		
Specification	Programming Accuracy	±(0.05%+0.00375 V)
	Readback Accuracy	±(0.05%+0.003 V)
DL3031A Setting	Voltage	U_L[4]
Test Result	U_1	
	U_2	
	Programming Accuracy: $\mid U_1 - U_L$[4]$\mid$	
	Readback Accuracy: $\mid U_2 - U_1 \mid$	
DL3031A Setting	Voltage	U_0[5]
Test Result	U_3	
	U_4	
	Programming Accuracy: $\mid U_3 - U_0$[5]$\mid$	
	Readback Accuracy: $\mid U_4 - U_3 \mid$	

CR Programming Accuracy

Model		DL3031A (150 V/60 A)
The resistance range of the electronic load is from 0.08 Ω to 15 Ω.		
Specification	Programming Accuracy	Vin/Rset*(0.2%)+0.12 A
DL3031A Setting	Resistance	R_L[6]
Test Result	U_1	
	U_2	
	$R_1=U_1/(U_2/R_M$[2]$)$	
	Programming Accuracy: $\lvert R_1 - R_L$[6]$\rvert$	
DL3031A Setting	Resistance	R_H[7]
Test Result	U_3	
	U_4	
	$R_2=U_3/(U_4/R_M$[2]$)$	
	Programming Accuracy: $\lvert R_3 - R_H$[7]$\rvert$	
The resistance range of the electronic load is from 2 Ω to 15 kΩ.		
Specification	Programming Accuracy	Vin/Rset*(0.2%)+0.12 A
DL3031A Setting	Resistance	R_L[6]
Test Result	U_1	
	U_2	
	$R_1=U_1/(U_2/R_M$[2]$)$	
	Programming Accuracy: $\lvert R_1 - R_L$[6]$\rvert$	
DL3031A Setting	Resistance	R_H[7]
Test Result	U_3	
	U_4	
	$R_2=U_3/(U_4/R_M$[2]$)$	
	Programming Accuracy: $\lvert R_3 - R_H$[7]$\rvert$	

Note[1]: indicates the low current value of the input channel.
Note[2]: R_M = 0.01 Ω.
Note[3]: indicates the rated current of the input channel.
Note[4]: indicates the low voltage value of the input channel.
Note[5]: indicates the rated voltage of the input channel.
Note[6]: indicates the set low resistance value.
Note[7]: indicates the set high resistance value.

Appendix B: Specifications

All the technical specifications are guaranteed when the instrument has been working for more than 30 minutes under the specified operating temperature.

DC Input(0°C~ 40°C)				
Model	Voltage	Current	Maximum Power	Minimum Operating Voltage (DC)
DL3021	0 ~ 150 V	0 ~ 40 A	200 W	40 A@1 V
DL3021A				
DL3031	0 ~ 150 V	0 ~ 60 A	350 W	60 A@1.3 V
DL3031A				

CC Mode				
Model	Range	Programming Resolution	Programming Accuracy[1]	Programming Temperature Coefficient
DL3021	0 ~ 4 A	1 mA	±(0.1%+0.1%FS[2])	100 ppm/℃
DL3021A	0 ~ 40 A		±(0.05%+0.05%FS)	
DL3031	0 ~ 6 A	1 mA	±(0.1%+0.1%FS)	100 ppm/℃
DL3031A	0 ~ 60 A		±(0.05%+0.05%FS)	

CV Mode				
Model	Range	Programming Resolution	Programming Accuracy	Programming Temperature Coefficient
DL3021	0 ~ 15 V	1 mV	±(0.05%+0.02%FS)	50 ppm/℃
DL3021A	0 ~ 150 V	5 mV	±(0.05%+0.025%FS)	
DL3031	0 ~ 15 V	1 mV	±(0.05%+0.02%FS)	50 ppm/℃
DL3031A	0 ~ 150 V	5 mV	±(0.05%+0.025%FS)	

CR Mode			
Model	Range[3]	Programming Resolution	Programming Accuracy[4]
DL3021	0.08 Ω~15 Ω (0.0667 S~12.5 S)	2 mA/Vsense	Vin/Rset*(0.2%)+0.2%IFS
DL3021A	2 Ω~15 kΩ (0.0000667 S~0.5 S)		
DL3031	0.08 Ω~15 Ω (0.0667 S~12.5 S)	2 mA/Vsense	Vin/Rset*(0.2%)+0.2%IFS
DL3031A	2 Ω~15 kΩ (0.0000667 S~0.5 S)		

CP Mode

Model	Range	Resolution
DL3021	0 ~ 200 W	100 mW
DL3021A		
DL3031	0 ~ 350 W	100 mW
DL3031A		

Con Mode

Model	Frequency Range	Frequency Resolution	Frequency Accuracy	Duty Cycle Range
DL3021	0.001 Hz~15 kHz	0.8%	±0.5%	5%~95%, 1%
DL3021A	0.001 Hz~30 kHz			
DL3031	0.001 Hz~15 kHz			
DL3031A	0.001 Hz~30 kHz			

Current Slew Rate[5]

Model	Range	Resolution	Accuracy
DL3021	0.001 A/µs~0.25 A/µs 0.001 A/µs~2.5 A/µs (>5 V)[6]	0.001 A/µs	5%+10 µs
DL3021A	0.001 A/µs~0.3 A/µs 0.001 A/µs~3 A/µs (>5 V)		
DL3031	0.001 A/µs~0.25 A/µs 0.001 A/µs~2.5 A/µs (>5 V)	0.001 A/µs	5%+10 µs
DL3031A	0.001 A/µs~0.5 A/µs 0.001 A/µs~5 A/µs (>5 V)		

Current Readback

Model	Range	Resolution	Accuracy	Temperature Coefficient
DL3021	0 ~ 40 A	1 mA	±(0.1%+0.1%FS)	50 ppm/°C
DL3021A		0.1 mA	±(0.05%+0.05%FS)	
DL3031	0 ~ 60 A	1 mA	±(0.1%+0.1%FS)	50 ppm/°C
DL3031A		0.1 mA	±(0.05%+0.05%FS)	

Voltage Readback

Model	Range	Resolution	Accuracy	Temperature Coefficient
DL3021	0 ~ 150 V	0.1 mV	±(0.05%+0.02%FS)	20 ppm/°C
DL3021A				
DL3031	0 ~ 150 V	0.1 mV	±(0.05%+0.02%FS)	20 ppm/°C
DL3031A				

Resistance Readback		
Model	Range	Resolution
DL3021	0.08 Ω~15 kΩ (0.0667 S~0.5 S)	2 mA/Vsense
DL3021A		
DL3031	0.08 Ω~15 kΩ (0.0667 S~0.5 S)	2 mA/Vsense
DL3031A		

Power Readback		
Model	Range	Resolution
DL3021	0 ~ 200 W	100 mW
DL3021A		
DL3031	0 ~ 350 W	100 mW
DL3031A		

Protection Function
Overcurrent protection (OCP), overvoltage protection (OVP), overpower protection (OPP), overtemperature protection (OTP), as well as local/remote reverse voltage (LRV/RRV) protection.

Stability[7]		
Model	Current	Voltage
DL3021	±(0.01%±10 mA)	±(0.01%±10 mV)
DL3021A		
DL3031	±(0.01%±10 mA)	±(0.01%±10 mV)
DL3031A		

Input Resistance
350 kΩ

Mechanical	
Dimensions	239 mm(W) x 157 mm(H) x 442 mm(D)
Weight	Net weight: 7.58 kg

Power	
AC Input (50 Hz~60 Hz)	115 Vac±10%, 230 Vac±10% (max: 250 Vac)
Maximum Input Power	<30 VA

Interface	
USB Device Interface	1
USB HOST	1
LAN Interface	1 (optional)

RS232	1
Digital I/O	1 (optional)
GPIB	1 (optional, USB-GPIB interface converter)

Environment	
Cooling Method	Fan Cooled
Operating Temperature	0°C~40°C
Storage Temperature	-40°C~70°C
Humidity	5% to 80% RH (without condensation)
Altitude	Below 2,000 m

Certification Information	
EMC	Complies with the requirements of the following directive and standards: EMC Directive 2014/30/EU EN 61326-1 EN 61000-3-2 EN 61000-3-3
	Under following condition: The maximum length of all connecting cables and wires to the DL3000 series are less than 3 m.
Safety	Complies with the requirements of the following directive and standards: Low Voltage Directive 2014/35/EU EN 61010-1: 2010 IP Degree: IP20 Pollution Degree: PD 2 Over Voltage Category: OVC II Operation Location: Indoor use only; not for wet condition

Note[1]: Data measured after 30-second current sinking at the programming value (applicable to the programming accuracy in CC mode and CV mode).
Note[2]: FS indicates the full scale.
Note[3]: The input voltage for the low range in CR mode should be smaller than 8 V.
Note[4]: The programming accuracy in CR mode is also determined by the input voltage accuracy.
Note[5]: Current slew rate: rising slew rate for 10%~90% of the current (0-maximum current).
Note[6]: When the input voltage is greater than 5 V, the maximum current slew rate is 5 A/μs; when the input voltage is greater than 4 V, the maximum current slew rate is 2.5 A/μs; when the input voltage is greater than 2 V, the maximum current slew rate is 0.1 A/μs.
Note[7]: Following a steady 30-minute current sinking, change in current/voltage sinking over 8 hours under constant load, line, and ambient temperature.