

RIGOL DP832 / DP832A

SCPI CALIBRATION USER'S GUIDE

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This document attempts to explain how to calibrate a Rigol DP800 power supply using SCPI commands over the USB or LAN interface. This document is based on information gleaned by reverse engineering and bus sniffing.

The calibration process requires the DP800 to be connected to an accurate multi-meter, preferably 6.5 digits. A lower precision meter can be used if you're not extremely fussy. Decide for yourself. The DMM should be able to measure up to 3.4 Amps DC.

1. SCPI Calibration Commands

These are the calibration specific commands currently not documented in Rigol's DP800 Programming Guide. These commands can be sent one at a time using Rigol's UltraSigma console or can be incorporated onto some other program that can send and receive SCPI commands over USB or Lan.

Start Command.

This command puts the DP832 into calibration mode.

"11111" is the factory calibration password. Select CH1, CH2, or CH3

```
:CALibration:Start 11111,<ch>  
<ch> = "CH1", "CH2", "CH3"
```

Examples:

```
:CALibration:Start 11111,CH1  
:CALibration:Start 11111,CH2  
:CALibration:Start 11111,CH3
```

There is no response for this command.

Clear Command

This command clears out the current calibration data tables. Execute this command before any of the Set or Measure commands.

```
:CALibration:Clear <ch>,<type>  
<ch> = "CH1", "CH2", "CH3"  
<type> = "V", "C", "ALL"
```

Examples:

```
:CALibration:Clear CH1,ALL  
:CALibration:Clear CH2,V
```

```
:CALibration:Clear CH3,C
```

Selecting "V" clears the ADC and DAC voltage calibration tables

Selecting "C" clears the ADC and DAC current calibration tables.

Selecting "ALL" clears both the Voltage and Current calibration tables.

Set Command

This command sets up the DP832 for a particular measurement. There are four tables that can be calibrated for each power supply channel: DAC voltage, DAC current, ADC voltage, ADC current. Each table has multiple steps numbered 0 to n where n is #Cal_steps – 1 (see the table in section 2)

```
:CALibration:Set <ch>,<mode>,<step>,<tgt_val>,<dev>
<ch> = "CH1", "CH2", "CH3"
<mode> = "V" or "C"
<step> = 0..n
<tgt_val> ideal value (e.g. 0.0V or 0.1A)
<dev> : 0 = ADC, 1 = DAC
```

When calibrating DAC voltage, select <mode> = "V" and <dev> = "1"

When calibrating ADC voltage, select <mode> = "V" and <dev> = "0"

When calibrating DAC current, select <mode> = "C" and <dev> = "1"

When calibrating ADC current, select <mode> = "C" and <dev> = "0"

See Section 2 for the table of target values to use in the <tgt_val> field.

Examples:

```
:CALibration:Set CH1,V,0,0.1V,1
:CALibration:Set CH1,V,8,3.4V,1
:CALibration:Set CH1,V,9,5V,0
:CALibration:Set CH1,C,6,2A,1
:CALibration:Set CH1,C,1,0.1A,0
```

There is no response for this command.

Measure Command

The measure command feeds the measurement you make with an external DMM back into the DP800. (You are making the measurement, not the DP800) After you have selected a calibration point with the Set command, you measure the voltage or current at the DP800's terminals and send that measurement back into the DP800 with this command. The Measure command stores the calibration reading in the DP800's memory.

```
:CALibration:MEAS <ch>,<mode>,<step>,<val>,<dev>
<ch> = "CH1", "CH2", "CH3"
<mode> = "V" or "C"
```

```
<step> = 0..n
<val> actual measurement as read from the multi-meter.
<dev> : 0 = ADC, 1 = DAC
```

Examples:

```
:CALibration:MEAS CH3,C,5,3.19964011,0
:CALibration:MEAS CH1,V,8,7.41256890,1
```

There is no response for this command.

The <val> field can be formatted as 0.055 or 5.5e-02, 10.123 or 1.0234e+01

End Command

The End command stops the calibration session and records a calibration date.

```
:CALibration:End <date>,<ch>
<ch> = "CH1", "CH2", "CH3"
<date> (e.g. 11/22/2014)
```

Examples:

```
:CALibration:End 11/22/2014,CH3
```

There is no response for this command.

Note: If you make a mistake during the calibration, don't send the End command, that would make your mistake permanent. Just power-cycle the DP800 to clear the bad, unsaved, data.

Related Commands

The following commands are not unique to calibration. They are generic commands used during calibration. See Rigol's DP800 Programming Guild for details.

Reset

A reset command can be sent to the DP800 to clear any error condition left over from a previous SCPI command. Send a *RST before sending the :CALibration:Start and :OUTPUT commands.

*RST

There is no response for this command.

Output On/Off Commands

The Output ON command must be sent to enable the output for a channel before sending the first Set command. Turning an output off at the end of the calibration process is optional.

```
:OUTPUT <ch>,<state>
<ch> = "CH1", "CH2", "CH3"
```

<state> = "ON" or "OFF"

Examples:

```
:OUTPUT CH1,ON  
:OUTPUT CH3,OFF
```

There is no response for these commands.

2. DP832 Calibration Points

This is a table of target values <tgt_val> to use with the Set command for the DP832 and DP832A. Enter the values exactly as shown. Note: <step> starts at zero, not one.

Examples:

The 3rd cal point for CH3 ADC-I would be :CALibration:Set CH3,C,2,1A,0

The 11th cal point for CH2 DAC-V would be :CALibration:Set CH2,V,10,10.1V,1

The 36th cal point for CH1 DAC-V would be :CALibration:Set CH1,V,35,32V,1

<step>	CH1 & CH2				CH3			
	DAC-V <dev>=1	ADC-V <dev>=0	DAC-I <dev>=1	ADC-I <dev>=0	DAC-V <dev>=1	ADC-V <dev>=0	DAC-I <dev>=1	ADC-I <dev>=0
0	0.2V	0V	0.1A	0A	0.1V	0V	0.1A	0A
1	0.5V	0.05V	0.25A	0.01A	0.2V	0.005V	0.5A	0.1A
2	1.2V	0.1V	0.5A	0.1A	0.4V	0.01V	1A	1A
3	2V	0.5V	0.8A	1A	0.85V	0.02V	1.25A	2A
4	3.2V	1V	1A	2A	1.2V	0.05V	1.5A	3A
5	4.1V	5V	1.25A	3A	1.8V	0.1V	1.75A	3.2A
6	5.2V	10V	1.5A	3.2A	2.55V	0.5V	2A	
7	6.9V	12.8V	1.75A		3.1V	1V	2.25A	
8	7.5V	20V	1.9A		3.4V	3V	2.5A	
9	8.7V	30V	2.15A		4.1V	5V	2.75A	
10	10.1V	32V	2.35A		4.5V	5.3V	3A	
11	11.8V		2.5A		5V		3.2A	
12	12.6V		2.75A		5.3V			
13	13.5V		3A					
14	15V		3.2A					
15	15.8V							
16	16.5V							
17	17.3V							

18	18.5V							
19	19.1V							
20	19.9V							
21	20.2V							
22	20.8V							
23	21.8V							
24	22.4V							
25	22.7V							
26	23.9V							
27	24.3V							
28	25.7V							
29	26.9V							
30	27.9V							
31	28.5V							
32	28.9V							
33	29.8V							
34	30.2V							
35	32V							

3. Calibration Sequence

Each output channel of the DP800 has four tables that need to be calibrated. These tables are DAC-V, ADC-V, DAC-I, and ADC-I. The DAC-V and ADC-V calibration steps require the multi-meter to be setup to read DC voltage. The DAC-I and ADC-I calibration steps require the multi-meter to be setup to measure DC current.

The basic steps of the calibration is a series of SET and MEAS command pairs. The SET command tells the DP800 to output a particular voltage or current. You then measure that voltage or current with your DMM and feed the actual value back into the DP800 with the MEAS command. There is be one SET/MEAS command pair for every value in the above table. For example, CH3 has 13 DAC-V values, 11 ADC-V values, 12 DAC-I values, and 6 ADC-I values. So to calibrate all of CH3, you need to make 24 voltage measurements and 18 current measurements.

Here is a sequence to calibrate DAC-V for Channel 3:

```
:CALibration:Start 11111,CH3
:CALibration:Clear CH3,ALL

*RST

:OUTPUT CH3,ON

:CALibration:Set CH3,V,0,0.1V,1 (step 0)
:CALibration:MEAS CH3,V,0, 0.059676422,1 (0.059676422 read from DMM)DA
```

```
:CALibration:Set CH3,V,1,0.2V,1 (step 1)
:CALibration:MEAS CH3,V,1, 1.54488047e-01,1 (0.154488047 read from DMM)
:CALibration:Set CH3,V,2,0.4V,1 (step 2)
:CALibration:MEAS CH3,V,2, 3.52552828e-01,1 (0.352552828 read from DMM)
:CALibration:Set CH3,V,3,0.85V,1 (step 3)
:CALibration:MEAS CH3,V,3, 8.02295247e-01,1 (0.802295247 read from DMM)
:CALibration:Set CH3,V,4,1.2V,1 (step 4)
:CALibration:MEAS CH3,V,4, 1.14897341 (1.14897341 read from DMM)
:CALibration:Set CH3,V,5,1.8V,1 (step 5)
:CALibration:MEAS CH3,V,5, 1.74399821,1 (1.74399821 read from DMM)
```

<and so on...> (...)

```
:CALibration:Set CH3,V,12,5.3V,1 (step 12)
:CALibration:MEAS CH3,V,12, 5.22247904e+00
```

```
:OUTPUT CH3,OFF
:CALibration:End 10/20/2014,CH3
```

The calibration for CH3's ADC-V would start with

```
:CALibration:Set CH3,V,0,0V,0 (step 0)
:CALibration:MEAS CH3,V,0, 0.004,0 (0.004 read from DMM)
```

And end with

```
:CALibration:Set CH3,V,10,5.3V,0 (step 10)
:CALibration:MEAS CH3,V,10, 5.29803,0 (5.29803 read from DMM)
```

The calibration for CH3's DAC-I would start with

```
:CALibration:Set CH3,C,0,0.1A,1 (step 0)
:CALibration:MEAS CH3,C,0, 0.098,1 (0.098 read from DMM)
```

And end with

```
:CALibration:Set CH3,C,10,3.2A,1 (step 10)
:CALibration:MEAS CH3,C,10,3.198,1 (3.198 read from DMM)
```

The calibration for CH3's ADC-I would start with

```
:CALibration:Set CH3,C,0,0A,0 (step 0)
:CALibration:MEAS CH3,C,0, 0.007,0 (0.007 read from DMM)
```

And end with

```
:CALibration:Set CH3,C,5,3.2A,0 (step 10)
:CALibration:MEAS CH3,C,5,3.198,0 (3.198 read from DMM)
```