MANUAL CALIBRATION PROCEDURE

P/N   0600011   PRODUCT: Martel 3001 Precision Calibrator

Released By: Greg Lindstrom **ECO NO:**2007-0038

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Approved By: Tom Fatur

Overveiw

You should recalibrate the 3001 at the end of the required calibration interval. The 3001 Precision Calibrator has an user friendly electronic calibration procedure using a PC connected through RS232 serial port. There are no mechanical adjustments and the calibration is done with the case closed.
The calibration is menu driven and each step can be performed independently with the exception of the TC calibration. During each step the needed information is displayed on the PC.
   Make sure the calibrator has warmed up for at least 30 minutes. This is the time it takes the unit to warm up to normal, stable operating temperature. If the unit has been repaired or is new it should be given 24 hours to burn in.

Test Equipment

The test equipment listed in the table below is recommended for calibration of the 3001. If the equipment listed in the table is not available, equipment with the same or better specifications can be substituted. The calibration functionality of ohms read was designed to be especially flexible to allow the use of fixed precision resistors.

Table 1-1 Consolidated List of Test Equipment				
Quantity.	**Manufacturer**	**Model**	**Equipment**	**Purpose**
1	Martel	3001/LEADS	Test Lead Set	All Functions
1	Fluke	742A-10	Resistance Standard, 10 Ω	100 mA source calibration
1	Fluke	742A-100	Resistance Standard, 100 Ω	Low Ohms Measure and SPRT Calibration.
1	Fluke	742A-10K	Resistance Standard, 10K Ω	Hi Ohms Measure Calibration
1	Fluke	5520	Calibrator	Low Ohms Measure and SPRT

				Calibration. Hi Ohms Measure Calibration.
1	Wavetek	1281	DMM	All functions except CJC
1			Ohms Shorting Connector	SPRT Calibration. Hi Ohms Measure Calibration.
1			RTD Probe	TC CJC Calibration
1	Hart Scientific	1521	Precision Thermometer	TC CJC Calibration
1	Omega		J Thermocouple Probe	TC CJC Calibration
1			Lag Bath	TC CJC Calibration

Procedure

Calibrating the digital to analog converter:

This calibrates the digital to analog converter less significant bits and it is normally needed only once in the instrument lifetime but if the unit has been repaired it is recommended to re-calibrate the DAC.

To initiate this calibration you have to send the serial command "CAL_DAC". Make sure no leads are connected to 3001. The message "Dac calibration in progress" is displayed on the 3001 screen and it takes about 45 seconds to complete. If the calibration fails, the message "Dac calibration failure" will be displayed and the unit needs to be returned to the factory for repair.

Initiating Communication

Connect the 3001 Calibrator to the PC RS232 serial port by using a 9 pin null modem cable (pins 2 and 3 swapped).
Use Hyperteminal under Windows or a similar serial communication program.
Set the terminal as follows:
- Bits per second: 9600
- Data bits: 8
- Parity: None
- Stop bits: 1
- Flow control: None
- Local echo on

To initiate the calibration mode use the terminal to send the CAL_START command. The following will be displayed on the terminal.

```
Calibration is password protected
Enter Password:
```

The password is 525. Enter the password correctly and the following menu will be displayed on the terminal.

```
Calibration Menu

         1:  100 mV Source
         2:  1 V Source
         3:  10 V Source
         4:  100 V Source
         5:  100 mA Source
         6:  Hi Ohms Source
         7:  Low Ohms Source
         8:  Hi Ohms Measure
         9:  1K Ohms Measure
        10:  Low Ohms Measure
        11:  100 Ohms Measure
        12:  TC SOURCE
        13:  TC READ
        14:  TC CJC
        15:  mA Read
        16: 10V Read
        17: 100V Read
        18: Exit


        Enter Selection:
```

Follow the steps in the calibration menu. It is recommended to perform the calibration in the order specified in the menu but each step is independent and can be performed separately if needed, with the exception of the TC function. The TC calibration needs to be performed in the order indicated in the menu (steps 12, 13,14). TC read is using the internal source mode and it has to be done after TC source. Do not source with an external instrument while calibrating TC Read. You have to connect a DMM and adjust the output to the needed value using the computer keypad.

You can exit the calibration mode at any time by typing 18.

1..4 Calibrating Voltage Output:
Test Equipment:

Table 1-2 List of Test Equipment For Calibrating Voltage Output			
Quantity	Manufacturer	Model	Equipment
1	Martel	3001/LEADS	Test lead set
1	Wavetek	1281	DMM

Connections:
Use the test lead set to attach the voltage output of the 3001 to the voltage input of the DMM.

Procedure:
Calibration of voltage output in broken up into four distinct ranges, each range can be calibrated separately using menu selections 1 through 4. The calibration of each range uses the same procedure. The example below is for the 1 volt range, the other ranges are the same but the voltage values are different.

Type 2 followed by ENTER to choose the 1V Source Calibration.
The value for the first calibration point (around 0 V) will be sourced by 3001. When the output is stable type the value read on the DMM. After the value has be entered , the value for the second calibration point (around 1V) will be sourced by 3001. Type the new value to complete the 1V Source calibration.

5. Calibrating Current Output:

Test Equipment:

Table 1-3 List of Test Equipment For Calibrating Current Output			
Quantity	Manufacturer	Model	Equipment
1	Martel	3001/LEADS	Test lead set
1	Fluke	742A-10	Resistance Standard, 10 Ω
1	Wavetek	1281	DMM

Connections: Using the Test lead set for the following connections. Connect the high side of the current output of the 3001 to the high side of the current input of the Resistance Standard. Connect the low side of the current output of the 3001 to the low side of the current input of the Resistance Standard. Connect the high side of the sense output of the resistance standard to the high side of the voltage input of the DMM. Connect the low side of the sense output of the resistance standard to the low side of the voltage input of the DMM.

Procedure:

The calibration procedure for current output is similar to voltage output except there is only one range and the voltage is measured across a 10 Ohm shunt resistor instead of measuring current directly. Readings taken off the DMM have to be converted to mA (multiplied by 100) before they can be entered in at the terminal.

6, 7 Calibrating Ohms Source:
Test Equipment:

Table 1-4 List of Test Equipment For Calibrating High Ohms Source			
Quantity	Manufacturer	Model	Equipment
1	Martel	3001/LEADS	Test lead set
1	Wavetek	1281	DMM

Connections:

Connect the high side of the 3001 Ohms Source to the high side of the ohms measure sense jacks on the DMM. Connect the low side of Ohms Source to the low side of the ohms measure sense jacks on the DMM. Connect the high side of Ohms Source to the high side of the ohms measure current source jacks on the DMM. Connect the low side of Ohms Source to the low side of the ohms measure current source jacks on the DMM. It is important that the sense leads be on the bottom of the stack on the 3001 ohms source jacks.

Procedure:

The calibration of the 5..4000 ohm output range (High Ohms Source) is similar to the voltage source calibration. The 3001 outputs 2 calibration points. After the output becomes stable the values are entered at the terminal.
It is recommended to lock the DMM in the proper range (first range greater than 4000 Ohms).
The maximum excitation current of the DMM is 1mA.
Enter the ohms displayed on the DMM into the terminal.
3001 will source the maximum value.
Enter the ohms displayed on the DMM into the terminal. After you have entered the value for the second calibration point you will return to the main calibration menu.

The calibration of the 5..400 ohm output range (Low Ohms Source) is similar.
The maximum excitation current of the DMM is 3mA.

8..11 Calibrating Ohms Measure:

The Ohms measure calibration allows the use of a medium quality resistor decade in conjunction with a good quality DMM by using flexible calibration points. This way, if you do not have Resistance Standards , you can set the resistor decade to 1K, read the actual value with the DMM (let say that the actual value is 1002.45 Ohms) and type this value when asked 1000 Ohms.
You will need a resistor decade box adjustable in 25..4000 Ohms range to cover all the values you are asked for (25, 50, 100, 200, 400, 1000, 2000, 4000 Ohms, max 5% tolerance).

The following procedure is given using the Fluke 5520 for Ohms source and Resistance Standards to adjust the DMM reading.

Test Equipment:

Table 1-5 List of Test Equipment for Calibrating High Ohms Measure			
Quantity	Manufacturer	Model	Equipment
1	Martel	3001/LEADS	Test lead set
1	Fluke	742A-10K	Resistance Standard: 100 Ohms, 10K Ω
1	Fluke	5520	Calibrator
1	Wavetek	1281	DMM

Connections:

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Connect channel A of the 1281 to the Resistance Standard using the 4 wire method.

Connect channel B of the 1281 to the 5520 using the 4 wire method and set 5520 to 4 wire compensation.

Connect 3001 to the 5520 using the 4 wire method:

Procedure:
Follow the steps in the menu.
Use a shorting connector when asked to enter zero Ohms.

Use the 5520 to enter the asked value.   Using the two channels on the DMM, calculate the actual value of the 5520's output.   This is done by using the ratio of a known standard to the output of the 5520 . You can use the 1281 to calculate the ratio or proceed as follows.

Ratio=A/B
$R_A = R_S/Ratio$

Where:
A=The reading taken from channel A on the DMM.
B=The reading taken from channel B on the DMM.
R_S=The value of the resistance standard (in this case 10K).
R_A=The actual output of the 5520.

Use the 5520 to enter 4000 Ohms (nominal) and enter the actual value calculated as described above.

Repeat for all the calibration points.

12. **Calibrating TC SOURCE:**
    Test Equipment:

Table 1-6 List of Test Equipment for Calibrating TC SOURCE			
Quantity	**Manufacturer**	**Model**	**Equipment**
1	Martel	3001/LEADS	Test lead set
1	Wavetek	1281	DMM

Connections:
Use a copper TC mini-plug cable with low thermal EMF jacks on the other end to connect the 3001 to the DMM. Make certain the polarity is correct.

Procedure:
The calibration of the TC Source output range is similar to the first part of the voltage source calibration, the 3001 outputs 2 calibration points, after the output becomes stable the values are entered at the terminal.
After you enter the mV read on the DMM you will be prompted to enter the second calibration point.

13. **Calibrating TC Read:**
    Test Equipment:

Table 1-7 List of Test Equipment for Calibrating TC Read			
Quantity	Manufacturer	Model	Equipment
1	Martel	3001/LEADS	Test lead set
1	Wavetek	1281	DMM

Connections: Use the same connection as TC Source.

Procedure:
The calibration of the TC Read input range is based on the TC source, so make sure that TC source is calibrated first.
3001 unit will source 5 calibration points: -10mV, 15mV, 40mV, 65mV amd 75mV.
For each point use the 8 and 2 key to adjust the output if needed. Use the reading on the 1281 to monitor this voltage. After the output is within 1uV of the desired value press enter to go to the next calibration point.

14. **Calibrating TC CJC:**
    Test Equipment:

Table 1-8 List of Test Equipment for Calibrating TC CJC			
Quantity	Manufacturer	Model	Equipment
1	Hart Scientific	1521	Precision Thermometer
1	Omega		J Thermocouple Probe
1			Lag Bath
1			RTD Probe

Connections:
The Precision Thermometer's probe should already be in the lag bath along with the J Thermocouple Probe. Plug the miniplug on the J Thermocouple Probe into the TC jack on the 3001.
Procedure:
The calibration of the TC CJC (Cold junction compensation) is a critical part of the calibration process, it is important that the thermocouple junction be allowed to completely stabilize.
After the TC junction has stabilized enter the temperature from the temperature reference.
Press ENTER to return to the calibration menu.

15. **Calibrating mA Read:**
    Test Equipment:

Table 1-9 List of Test Equipment for Calibrating mA Read			
Quantity	Manufacturer	Model	Equipment
1	Martel	3001/LEADS	Test lead set
1	Fluke	742A-10K	Resistance Standard: 10 Ohms
1	Fluke	5520	Calibrator
1	Wavetek	1281	DMM

Connections:

Connect 5520 mA source jacks to 3001 isolated jacks and introduce the 10 Resistance Standard in series. Use the sense jacks of the resistor to monitor the voltage drop on the resistor using the 1281 DMM.

Procedure:
You will be asked to source 5 calibration points from 5520 unit: 0, 13, 26, 39 and 52mA.
For each calibration point adjust the current for the maximum accuracy using the DMM reading as feedback. Press ENTER when stable to go to the next calibration point.

16. **Calibrating 10V Read:**
    Test Equipment:

Table 1-10 List of Test Equipment for Calibrating 10V Read			
Quantity	Manufacturer	Model	Equipment
1	Martel	3001/LEADS	Test lead set
1	Fluke	5520	Calibrator
1	Wavetek	1281	DMM

Connections:
Connect 5520 V source jacks to 3001 isolated jacks. Use the 1281 DMM to monitor the voltage.

Procedure:
You will be asked to source 2 calibration points from 5520 unit: 0 and 10V.
For each calibration point adjust the voltage for the maximum accuracy using the DMM reading as feedback. Press ENTER when stable to go to the next calibration point.

16. **Calibrating 100V Read:**
    Test Equipment:

Table 1-11 List of Test Equipment for Calibrating 100V Read			
Quantity	Manufacturer	Model	Equipment
1	Martel	3001/LEADS	Test lead set
1	Fluke	5520	Calibrator
1	Wavetek	1281	DMM

Connections:
Connect 5520 V source jacks to 3001 isolated jacks. Use the 1281 DMM to monitor the voltage.

Procedure:
You will be asked to source 2 calibration points from 5520 unit: 0 and 100V.
For each calibration point adjust the voltage for the maximum accuracy using the DMM mV reading as feedback.(divide mV by 10.0 to get mA). Press ENTER when stable to go to the next calibration point.