BC2000
Voltage/Current Calibrator

OPERATOR'S MANUAL

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WARNING
Before attempting to interface the BC2000 with any other device, carefully read the following instructions.
GENERAL DESCRIPTION

The MARTEL BC2000 Calibrator is an economical voltage and current source for electronic testing which has the high accuracy required for most calibration functions. It is an affordable alternative to large, stationary laboratory grade calibrators, and can be used throughout product design, production, testing, quality control, and process operations. The compact size, light weight, and low cost of the BC2000 also makes it a good choice for Field Service Applications. Standard output ranges of 0 to 200 mV, 2 V, 20 V, and 0 to 2 mA, 20 mA, and 200 mA are provided to accommodate all of the most commonly used DC voltage and current calibration ranges. Output accuracy is 0.025% of full scale resolution (F.S.R.) on all six output ranges. Outputs can be quickly selected using individual up/down scroll controls for each decade of the required output range and viewed on the large 5/8" BC2000 LED display. All function controls are front mounted and are individually selectable, providing efficient operation and operator convenience.

The BC2000 incorporates sophisticated electronic circuitry which allows the unit to be simple to use; but at the same time, maintains high accuracy and multi-range flexibility. This unique combination of Analog and Digital circuitry can be seen in the BC2000 Block Diagram (See Figure 1). The heart of the circuitry is a laser trimmed Digital to Analog converter of monolithic design, which yields good reliability with low long term drift. A precision temperature compensated reference circuit provides the voltage reference that all outputs are derived from and is monitored against a second reference, which will warn the operator if any of the main reference circuitry or power supply circuitry fails. The Digitally controlled reference output is then passed through a precision decade divider circuit which scales the signal for a given output range. Overload protected output stages take the ranged signal and provide the correct output to the device under calibration.

INSTALLATION

UNPACKING

1. Upon receipt of shipment, inspect the container and equipment for any signs of damage. Take particular note of any evidence of rough handling in transit. Immediately report any damage to the shipping agent.

NOTE

The carrier will not honor any claims unless all shipping material is saved for their examination. After examining and removing contents, save packing material and carton in the event re-shipment is necessary.

2. Remove the Packing List and verify that all equipment has been received. If there are any questions about the shipment, please call Martel Electronics at 1-800-821-0023.

3. Check to see if your calibrator is complete. It should include:

   - BC2000
   - Test leads (1-red, 1-black)

SET-UP

1. Become familiar with the designations and polarities of the four input/output jacks of the BC2000, refer to Figure 1 in this manual or the back panel label of the unit.

OPERATING PROCEDURE

VOLTAGE MODE OPERATION

The BC2000 incorporates three voltage output ranges: 200 mV, 2 V, and 20 V, which can supply currents of up to 5 mA into the device under calibration. The Operating Procedure for these ranges is as follows:
1. Turn on BC2000 and allow at least a 5 minute warm-up period (30 min. is recommended for maximum accuracy).

2. Select the desired output range.

3. Connect the test leads to the device under test or calibration (red jack is +).

**CAUTION**

Like any precision electronic instrument, the user must exercise care when connecting the BC2000 to any other device. The outputs of the BC2000 are protected against typical mis-connections that might occur involving low voltage DC devices (50 VDC Max.). However, connecting the BC2000 to any high voltage DC or AC power source will cause serious damage to the calibrator.

4. Select the desired voltage output by depressing the appropriate scroll key (up or down) for each decade. Holding the scroll key down will allow the incrementing or decrementing to continue and the counting sequence will loop around when "0" or "9" is reached.

5. Once the correct voltage is set, check to make sure that the "OVL" (overload) light is not on. If it is on, more than 5 mA is being delivered to the load and the load should be removed. The calibrator is not damaged by an overload condition, and in fact, can be left with the output shorted indefinitely with the maximum short circuit current being 20 mA.
SPECIAL VOLTAGE MODE CONSIDERATIONS

Test Lead Voltage Drop

When using the BC2000 on the lower voltage ranges, care should be taken to insure that the current being delivered to the load is not causing a significant voltage drop; especially when the load current is greater than 1mA and the signal being generated is only in the millivolt range. The following table illustrates various test lead wire types and their associated resistance.

<table>
<thead>
<tr>
<th>Test Lead Wire Gauge AWG</th>
<th>Milliohms Per Foot</th>
<th>Voltage Drop Error for a pair of 3 foot leads 1mA Load</th>
</tr>
</thead>
<tbody>
<tr>
<td>#16</td>
<td>4.02</td>
<td>0.024mV</td>
</tr>
<tr>
<td>#18</td>
<td>6.39</td>
<td>0.038mV</td>
</tr>
<tr>
<td>#20</td>
<td>10.70</td>
<td>0.063mV</td>
</tr>
<tr>
<td>#22</td>
<td>16.20</td>
<td>0.096mV</td>
</tr>
<tr>
<td>#24</td>
<td>25.70</td>
<td>0.154mV</td>
</tr>
</tbody>
</table>

To calculate the test lead voltage drop, use the following equation:

\[ V_{TL} = I_{LOAD} \times R_{TL} \]

Where:

\( V_{TL} \) = Voltage Drop on Test Lead
\( I_{LOAD} \) = Load Current
\( R_{TL} \) = Resistance of Test Lead

CURRENT MODE OPERATION

The BC2000 incorporates three current output ranges, 2 mA, 20 mA, and 200 mA, which can drive loads up to the rate compliance voltage of the calibrator. The General Operating Procedure for current mode operation is as follows:

1. Turn on the BC2000 and select the desired output range.

2. Allow at least a 5 minute warm-up period (30 minutes is recommended for maximum accuracy).

3. If the BC2000 is already in operation from use in the voltage mode, it is still recommended that several minutes be allowed for the instrument to stabilize when switching from voltage to current mode operation. This is especially important when the lowest current range (2mA) is being used.

4. Connect the test leads to the device under test or calibration (red jack is +).

CAUTION

Like any precision electronic instrument, the user must exercise care when connecting the BC2000 to any other device. The outputs of the BC2000 are protected against typical mis-connections that might occur involving low voltage DC devices (50 VDC Max.). However, connecting the BC2000 to any high voltage DC or AC power source will cause serious damage to the calibrator.
5. Select the desired current output by depressing the appropriate scroll key (up or down) for each decade. Holding the scroll key down will allow the incrementing or decrementing to continue and the counting sequence will loop around when "9" or "0" is reached.

SPECIAL CURRENT MODE CONSIDERATIONS

High Current Output Calibration

When using the BC2000 for current outputs of 100 mA or more for extended periods of time, be aware that heat generated internally will cause the output to drift to the specified limits. Also, when calibrating current measuring devices such as DVM's that use a series resistor to monitor current will themselves exhibit some internal drift; therefore, it is best to make any high current calibration as quickly as possible to avoid calibration errors.

Two-Wire Transmitter Simulation

In many process control applications, two-wire transmitters are used to transmit transducer signals via 4 to 20 mA current loops. These transmitters derive their power directly from the signal loop which is powered by an external power supply (typically 24 VDC). The BC2000 can be used as a two-wire 4-20 mA simulator as shown in Figure 2. The maximum external voltage used should not be more than 30VDC and the maximum current simulated should not exceed 25 mA. When connected as shown in Figure 2, follow the current mode operating procedure for setting the output.

FIGURE 2 - Two-Wire Transmitter Simulation
# SPECIFICATIONS

| OUTPUT RANGES/RESOLUTION VOLTAGE                  | 19.99 VDC/0.01V  |
|                                                 | 1.999 VDC/0.001V |
|                                                 | 199.9mVDC/0.1mV |
| CURRENT                                         | 199.9mADC/0.1mA |
|                                                 | 19.99mADC/0.01mA |
|                                                 | 1.999mADC/0.001mA |
| ACCURACY                                        | Basic accuracy (effects of Nonlinearity and short-term drift) 0.025% of F.S.R. (1/2 LSB) on all ranges. |
| LOAD DRIVING CAPABILITY VOLTAGE RANGE           | 5mA on all ranges |
| VOLTAGE COMPLIANCE CURRENT RANGE                | 15VDC |
| TEMPERATURE STABILITY                           | 50 ppm/ C |
| TEMPERATURE RANGE                                |                                      |
| OPERATING                                       | 0 to 40 C |
| STORAGE                                         | -20 to +50 C |
| OUTPUT IMPEDANCE                                | <.5 ohm (voltage range only) |
| POWER                                           | 115 VAC 10% |
|                                                 | 230 VAC optional |
| FUSE TYPE                                       | 5 x 20mm (.250 Amp.) |
| SIZE                                            | 7-1/2" x 5-1/2" x 2-3/4" |
| WEIGHT                                          | 4 lbs. |

## ACCURACY

The BC-2000 is checked against a NBS traceable standard before shipment and should yield the specified accuracy. Remember to take into account changes in ambient temperature when making accuracy calculations.

## MAINTENANCE

Generally, with normal usage, the calibrator should hold its rated specifications for at least 6 months. Beyond this, it should remain within 0.05% of FSR over its useful life, provided it is not abused or tampered with. If after the stated warranty period, the device falls out of calibration, it can be returned to Martel Electronics for re-calibration. Please call for pricing and return information.

## WARRANTY

Martel Electronics Corporation warrants all products against material defects and workmanship for a period of twelve (12) months after the date of shipment. Problems or defects that arise from misuse or abuse of the instrument are not covered. If any product is to be returned, a "Return Material Authorization" number must be obtained by calling our Customer Service Department at (603) 893-0886.
DESCRIPTION

The Martel BC-2000 DC Calibrator is an economical voltage and current source for electronic testing that offers the high accuracy required for most calibration functions. It is an affordable alternative to large, laboratory grade calibrators, and can be used throughout product design, production, testing, quality control, process operations, and for field service.

The BC-2000 is ideal for voltage and current source applications where accuracy and stability are critical operating parameters. A wide range of electronic instruments and control apparatus can be calibrated.

Standard output ranges of 0 to 200mV, 2V, 20V and 0 to 2mA, 20mA, and 200mA are provided.

All function controls are front mounted and are individually selectable, providing efficient operation and operator convenience.

FEATURES

- Large, Easy to Read 5/8-Inch, LED Digital Display
- Rear-mounted ON/OFF Switch and Fuse Assembly
- 115Vac Power Input Standard
- Durable, High Impact Case
- Output Range Selection Switches

SPECIFICATIONS

<table>
<thead>
<tr>
<th>VOLTAGE OUTPUT</th>
<th>CURRENT OUTPUT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ranges:</td>
<td></td>
</tr>
<tr>
<td>19.99Vdc</td>
<td>199.9mA dc</td>
</tr>
<tr>
<td>1.999Vdc</td>
<td>19.99mA dc</td>
</tr>
<tr>
<td>199.3mVdc</td>
<td>1999mA dc</td>
</tr>
<tr>
<td>Resolution:</td>
<td></td>
</tr>
<tr>
<td>0.01V</td>
<td>0.1mA</td>
</tr>
<tr>
<td>0.001V</td>
<td>0.01mA</td>
</tr>
<tr>
<td>0.1mV</td>
<td>0.001mA</td>
</tr>
<tr>
<td>Accuracy:</td>
<td>0.025% on all ranges ±1 LSD</td>
</tr>
<tr>
<td>Load Driving Capability:</td>
<td>±5mA on all ranges (voltage range)</td>
</tr>
<tr>
<td>Voltage Compliance:</td>
<td>15Vdc (current range)</td>
</tr>
<tr>
<td>Temperature Stability:</td>
<td>.005%/°C</td>
</tr>
<tr>
<td>Temperature Range:</td>
<td>Operating: 0 to 40°C; Storage: -20 to +50°C</td>
</tr>
<tr>
<td>Output Impedance:</td>
<td>&lt;.5 ohm (voltage range only)</td>
</tr>
<tr>
<td>Power Requirements:</td>
<td>115Vac ±10%, 230Vac optional</td>
</tr>
<tr>
<td>Size:</td>
<td>7.5&quot; x 5.5&quot; x 2.75&quot;</td>
</tr>
<tr>
<td>Weight:</td>
<td>4lbs.</td>
</tr>
</tbody>
</table>

Specifications subject to change without notice
1.0 Equipment Required:

1.1 Fluke 8840A DMM
1.2 100ohm Shunt

2.0 Test and Calibration Procedure:

3.0 Initial Set-Up:

3.1 Turn unit ON and let unit warm-up for 20 minutes.

3.2 Probe TP1 and adjust trimpot R12 for a reading of 0.00VDC (±0.05mV). Verify the display reads 0.00000 ±0.0005.

3.3 Probe TP2 and adjust trimpot R14 for a reading of 0.00VDC (±0.05mV). Verify the display reads .0000 ±0.0005.

4.0 Current Mode Test and Calibration:

4.1 Attach 100ohm Shunt to unit under test.

4.2 Connect the Fluke 8840A to the mA output jacks on the BC2000 under test.

4.3 Set the unit to the 2mA range. Verify unit displays 0.00.

4.4 Using the UP or DOWN scroll keys, set the display to read .001mA.

4.5 Adjust R43 for a reading of .00010 (±0mA) on the 8840A.

4.6 Using the UP or DOWN scroll keys, set the display to read 1.900mA and adjust trimpot R31 for a reading of .19000 on the 8840A ±0.00010.

4.7 Repeat steps 4.4 to 4.6 and verify or readjust trimpots as necessary.

4.8 Set the unit to the 20mA range and select the 20mA range on the 8840A.

4.9 Using the UP or DOWN scroll keys, set the display to read 19.00 and adjust trimpot R34 for a reading of 1.9000 ± 0.0010 on the 8840A.

4.10 Set the unit to the 200mA range and select 200mA range on the 8840A.
4.11 Using the UP or DOWN scroll keys, set the display to read 100.00mA and adjust trimpot R37 for a reading of 10.000 ±0.010 on the 8840A.

4.12 Repeat steps 4.6 to 4.11 and verify or readjust trimpots as necessary.

5.0 Voltage Mode Test and Calibration:

5.1 Remove Shunt from unit under test.

5.2 Connect the 8840A to the VOLTS output jacks on the BC2000 under test.

5.3 Select the 200mV range on the unit and set the 8840A to the 200mV scale.

5.4 With the display reading of 000.0, adjust trimpot R53 for a reading of 00.00mV (±0.01mV) on the 8840A.

5.5 Using the UP or DOWN scroll keys, set the display to read 190.0mV and adjust trimpot R27 for a reading of .19000 (±0.00010) on the 8840A.

5.6 Repeat steps 5.4 to 5.5 and verify or readjust trimpots as necessary.

5.7 Select the 2V range on the unit and also set the 8840A to 2V.

5.8 Using the UP or DOWN scroll keys, set the display to read 1.900 and adjust trimpot R24 for a reading of 1.9000 (±0.0010).

5.9 Select the 20V range on the unit and set the 8840A to 20V.

5.10 Using the UP or DOWN scroll keys, set the display to read 19.00 and adjust trimpot R21 for a reading of 19.000 (±0.010).

5.11 Repeat steps 5.7 to 5.10 and verify or readjust trimpots as necessary.

6.0 Overload LED Test:

6.1 Short the voltage output test leads and verify the "OVL" LED is lit.

6.2 Turn unit OFF.

6.3 Apply appropriate Calibration Sticker to unit just calibrated.