

**BK PRECISION®**

---

**Instruction Manual**

Model 391A Test Bench® Handheld Digital Multimeter



## FEATURES

- True RMS reading.
- 4-1/2 digit LCD display with large 0.7" digits.
- Basic accuracy: DCV  $\pm 0.05\%$ .
- Resolution of 10  $\mu\text{V}$ , 10  $\text{nA}$ , 0.01 $\Omega$ .
- Single function and range control.
- Auto power off prolongs battery life.
- Five dc voltage ranges: 200 mV to 1000 V.
- Five ac voltage ranges: 200 mV to 750 V.
- Five dc current ranges: 200  $\mu\text{A}$  to 20 A.
- Five ac current ranges: 200  $\mu\text{A}$  to 20 A.
- Six resistance ranges: 200  $\Omega$  to 20 M $\Omega$ .
- Logic probe function: indicate logic high or low.
- Diode test function: measures forward voltage drop.
- Visual and audible continuity tester.
- Audible warning buzzer if probe inserted into wrong jack.
- Data hold function freezes value on display.
- Auto polarity, auto zero.
- Overrange indication on all ranges.
- High energy fuses.
- Fused 20 A range.
- Safety type test leads.
- Shock resistant case in holster withstands 10-foot drop.
- Tilt stand. Hanger strap.

## SAFETY

### WARNING

*An electrical shock causing 10 millamps of current to pass through the heart will stop most human heartbeats. Voltage as low as 35 volts dc or ac rms should be considered dangerous and hazardous since it can produce a fatal current under certain conditions. Higher voltages are even more dangerous. Observe the following precautions.*

1. Do not exceed the following input ratings. Personal injury or damage to the instrument may result.

DC VOLTS 1000 V (dc + ac peak)

500 V (dc + ac peak) on 200 mV range

AC VOLTS 750 V rms

500 V (dc + ac peak) on 200 mV range

OHMS 500 V (dc + ac peak)

mA  $\mu$ A 200 mA (fuse protected)

20 A 20 A (fuse protected)

COM Do not float more than 500 volts from earth ground.

LOGIC 500 V (dc + ac peak)

2. Remove test leads before replacing batteries or fuses, and before performing any servicing on the instrument.
3. Use only the safety type test leads supplied with the multimeter.
4. Turn off equipment while making test connections in high voltage circuits. Discharge high-voltage capacitors after removing power.
5. For voltage or current measurements in high voltage equipment, do not touch equipment, meter or test leads while power is applied.
6. If possible, familiarize yourself with the equipment being tested and the location of its high voltage points. However, remember that high voltage may appear at unexpected points in defective equipment.

7. Use an insulated floor material or floor mat to stand on, and an insulated work bench surface; make certain such surfaces are not damp or wet.
8. Keep "one hand in the pocket" while handling an instrument probe. Be particularly careful to avoid contacting a nearby metal object that could provide a good ground return path.
9. When using a probe, touch only the insulated portion. Never touch the exposed tip portion.
10. Some equipment with a two-wire ac power cord, including some with polarized power plugs, in the "hot chassis" type. This includes most recent television receivers and audio equipment. A plastic or wooden cabinet insulates the chassis to protect the customer. When the cabinet is removed for servicing, a serious shock hazard exists if the chassis is touched. Not only does this present a dangerous shock hazard, but damage to test instruments or the equipment under test may result. To make measurements in "hot chassis" equipment, always connect an isolation transformer between the ac outlet and the equipment under test. The **B+K Precision** Model TR-110 or 1604 Isolation Transformer, or Model 1653 or 1655 AC Power Supply is suitable for most applications. To be on the safe side, treat all two-wire ac powered equipment as "hot chassis" unless you are sure it has an isolated chassis or an earth ground chassis.
11. When testing ac powered equipment, remember that ac line voltage is usually present on some power input circuits such as on-off switch, fuses, power transformer, etc. any time the equipment is connected to an ac outlet, even if the equipment is turned off.
12. Never work alone. Someone should be nearby to render aid if necessary. Training in CPR (cardiopulmonary resuscitation) first aid is highly recommended.

## MAINTENANCE

### WARNING

*Remove test leads before changing battery or fuse or performing any servicing.*

#### BATTERY REPLACEMENT

A low battery is indicated when the  symbol in the upper right hand corner is on. The low battery indication first appears when the battery is about 90% depleted. The meter may be operated a few more hours but the battery should be replaced soon thereafter.

1. Remove two screws from back of unit securing the tilt stand.
2. Remove tilt stand.
3. Remove two screws securing case back, then carefully lift back off to gain access to battery. Remove and save the battery insulator.
4. Replace the dead battery with a fresh 9 volt "transistor" battery. Replace the battery insulator. Use alkaline batteries such as the NEDA 1604 or equivalent for longer life. To prolong battery life set the **POWER** switch to the OFF position when not making measurements.
5. Reinstall back cover, tilt stand.

#### FUSE REPLACEMENT

If no current measurements are possible, check for a blown overload protection fuse. Two fuses are used; F1 for the mA/µA input and F2 for the 20 A input. A quick check for a blown 20 A fuse can be performed by inserting the test lead into the 20 A jack and setting the function switch to any other position except 20 A then pressing the POWER switch to turn the meter on. If no warning tone is heard, the fuse is probably blown. This procedure can also be used for the µA/mA jack fuse by inserting the test lead into the µA/mA jack and setting the function switch to any position other than one of the µA or mA positions then pressing the POWER switch to turn the meter on. For access to fuses remove the case back as described for battery replacement. Replace F1 only with the original type 0.5 A, 500 V, fast blow ceramic fuse (**B+K Precision** Part No. 194-045-9-001). Replace F2 only with the original type 20 A, 600 V, fast acting ceramic fuse (**B+K Precision** Part No. 194-043-9-001).

#### TEST LEADS

*Use only safety type leads, like those supplied.* Periodically examine the test leads to ensure that the conductors are not intermittent or broken. Also make sure that good contact pressure exists at the test receptacles and fuseholder, and keep these areas free from dirt and corrosion.

## SPECIFICATIONS

*Specifications apply from + 18°C to + 28°C at relative humidity up to 75% unless otherwise noted.*

#### DC VOLTAGE Manual ranging.

Range	Resolution	Accuracy	Over voltage Protection
200 mV	10 µV	$\pm (0.05 \% \text{ rdg} + 3 \text{ dcts})$	500 VDC or peak AC 1000 VDC or peak AC
2 V	100 µV		
20 V	1 mV		
200 V	10 mV		
1000 V	100 mV		

Input Impedance ..... 10 MΩ

Normal Mode Rejection ..... Greater than 48 dB (50/60 Hz)

Common Mode Rejection ..... Greater than 100 dB (50/60 Hz)

#### AC VOLTAGE Manual ranging. True RMS, AC Coupled

Range	Resolution	Accuracy (50 Hz to 500 Hz)	Accuracy (500 Hz to 2 kHz)	Over voltage Protection
200 mV	10 µV	$\pm (1.0 \% \text{ rdg} + 10 \text{ dcts})$	$\pm (2.0 \% \text{ rdg} + 20 \text{ dcts})$	500 VDC or peak AC 1000 VDC or peak AC
2 V	100 µV			
20 V	1 mV			
200 V	10 mV			
750 V	100 mV		$\pm (2.0 \% \text{ rdg} + 10 \text{ dcts})$	

Input Impedance ..... 10 MΩ/less than 100 pF

Crest Factor ..... 3

#### DC CURRENT Manual ranging.

Range	Resolution	Accuracy	Burden Voltage
200 $\mu$ A	10 nA	$\pm (0.5\% \text{ rdg} + 5 \text{ dcts})$	600 mV max.
2 mA	100 nA		
20 mA	1 $\mu$ A		
200 mA	10 $\mu$ A		
* 20 A	1 mA	$\pm (2.0\% \text{ rdg} + 10 \text{ dcts})$	900 mV max.

Overload Protection ..... 0.5 A (500 V) fast blow ceramic fuse  
on mA input

20 A (600 V) fast blow ceramic fuse,  
on 20 A input

\* 20 A Range Maximum Current ..... 10 A continuous,  
20 A for 30 sec. max.

#### AC CURRENT Manual ranging, True RMS, AC Coupled.

Range	Resolution	Accuracy (50 Hz to 1 kHz)	Burden Voltage
200 $\mu$ A	10 nA	$\pm (1.2\% \text{ rdg} + 10 \text{ dcts})$	600 mV rms max.
2 mA	100 nA		
20 mA	1 $\mu$ A		
200 mA	10 $\mu$ A		
* 20 A	1 mA	$\pm (2.5\% \text{ rdg} + 20 \text{ dcts})$	900 mV rms max.

Overload Protection ..... 0.5 A (500 V) fast blow ceramic fuse  
on mA input

20 A (600 V) fast blow ceramic fuse,  
on 20 A input

\* 20 A Range Maximum Current ..... 10 A continuous,  
20 A for 30 sec. max.

#### RESISTANCE Manual ranging.

Range	Resolution	Accuracy	Max Open Circuit Voltage
200 $\Omega$	10 m $\Omega$	$\pm (0.25\% \text{ rdg} + 10 \text{ dcts})$	3.3 V
2 k $\Omega$	0.1 $\Omega$		
20 k $\Omega$	1 $\Omega$		
200 k $\Omega$	10 $\Omega$		
2 M $\Omega$	100 $\Omega$	$\pm (0.25\% \text{ rdg} + 3 \text{ dcts})$	
20 M $\Omega$	1 k $\Omega$	$\pm (1.0\% \text{ rdg} + 10 \text{ dcts})$	

Overload Protection ..... 500 V DC or peak AC

#### FREQUENCY COUNTER Manual ranging.

Range	Resolution	Accuracy	Sensitivity (sine wave)	Min Input Freq.
2 kHz	0.1 Hz	$\pm (0.5\% \text{ rdg} + 3 \text{ dcts})$	50 mV rms	$> 10 \text{ Hz}$
20 kHz	1 Hz			$> 60 \text{ dcts}$
200 kHz	10 Hz			$> 60 \text{ dcts}$

Sensitivity at  $>30\%$  and  $<70\%$  duty cycle ..... 400 mV rms

Pulse Width:  $>2 \mu\text{s}$

Overvoltage Protection ..... 500 V DC or peak AC

#### DUTY CYCLE

Range	Resolution	Pulse Width	Accuracy (5V Logic)
0 to 90.0 %	0.1%	$> 10 \mu\text{s}$	$\pm (2.0\% \text{ rdg} + 10 \text{ dcts})$

Frequency range: 40 Hz to 20 kHz

Overload Protection: 500 V DC or peak AC

**DIODE CHECK**

Range	Resolution	Accuracy	Max Test Current	Max Open Circuit Voltage
►	0.1 mV	± (1.0 % rdg + 10 dgt)	1.0 mA	3.3 V DC

Overload Protection ..... 500 V DC or peak AC

**CONTINUITY TEST**

Range	Response Time	Description	Max Open Circuit Voltage
●	Approx 100 ms	Buzzer sounds below approx. 100 Ω	3.3 V DC

Overload Protection ..... 500 V DC or peak AC

**LOGIC LEVEL**

LCD Displays Number "1" when selected

Test voltage	.....	5 V DC
Detector	.....	AC coupled
Logic Threshold	.....	
Logic 1 (high)	.....	2.8 V ±0.8 V
Logic 0 (low)	.....	0.8 V ±0.5 V
Duty Cycle	.....	>20% and <80%
Indications	.....	40 ms beep at logic high
Pulse Width	.....	25 ns min.
Pulse Rep Rate	.....	1 Mpps max.
Pulse Rise Time	.....	10 µs max.
Input Impedance	.....	120 kΩ/100 pF
Input Overvoltage Protection	.....	500 V DC or peak AC

**GENERAL SPECIFICATIONS**

Display: 4-1/2 digit liquid crystal display (LCD) with a maximum reading of 19999.

Polarity: Automatic (-) negative polarity indication.

Overrange Indication: "1" or "-1".

Low Battery Indication:  displayed.

Sampling rate: 2.5 measurements per second, nominal, 1 time per second for frequency measurements.

Temperature.

Full Operation ..... 0 to +50°C &lt;70% R.H.

Power: Single standard 9V battery, NEDA 1604.

Battery life: 500 hours typical (alkaline).

Auto Power Off: Meter automatically shuts down after approx. 45 minutes of inactivity.

Dimensions (H × W × D): 7.8" × 3.6" × 1.7" (198 × 90 × 44 mm).

Weight: 14.1 oz. (400 g) including battery.

Supplied Accessories: Test leads (pair), battery, instruction manual.

## Warranty and Service Information

B&K Precision Corp. warrants to the original purchaser that its product and the component parts thereof, will be free from defects in workmanship and materials for a period of three years from the date of purchase. B&K Precision Corp. will, without charge, repair or replace, at its' option, defective product or component parts. Returned product must be accompanied by proof of the purchase date in the form a sales receipt. To obtain warranty coverage in the U.S.A., this product must be registered by completing and mailing the enclosed warranty card to B&K within fifteen (15) days from proof of purchase.

**Exclusions:** This warranty does not apply in the event of misuse or abuse of the product or as a result of unauthorized alterations or repairs. It is void if the serial number is altered, defaced or removed.

B&K Precision Corp. shall not be liable for any consequential damages, including without limitation damages resulting from loss of use. Some states do not allow limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you.

This warranty gives you specific rights and you may have other rights, which vary from state-to-state.

Model Number: \_\_\_\_\_ Date Purchased: \_\_\_\_\_

**Warranty Service:** Please return the product in the original packaging with proof of purchase to the below address. Clearly state in writing the performance problem and return any leads, connectors and accessories that you are using with the device.

**Non-Warranty Service:** Return the product in the original packaging to the below address. Clearly state in writing the performance problem and return any leads, connectors and accessories that you are using with the device. Customers not on open account must include payment in the form of a money order or credit card. For the most current repair charges contact the factory before shipping the product.

Return all merchandise to B&K Precision Corp. with pre-paid shipping. The flat-rate repair charge includes return shipping to locations in North America. For overnight shipments and non-North America shipping fees

Include with the instrument your complete return shipping address, contact name, phone number and description of problem.

## SYMBOLS



See instruction manual for further precautionary information.



High voltage terminal; up to 1000 volts may be present if connected to high voltage.

COM

Common input terminal.



Diode test.



Double insulation.

1000 V---

MAX

750 V~

Maximum input rating or V- $\Omega$  terminal with respect to COM input terminal.



Continuity test.

V ~

ACV.

V ---

DCV.

A ~

ACA.

A ---

DCA.



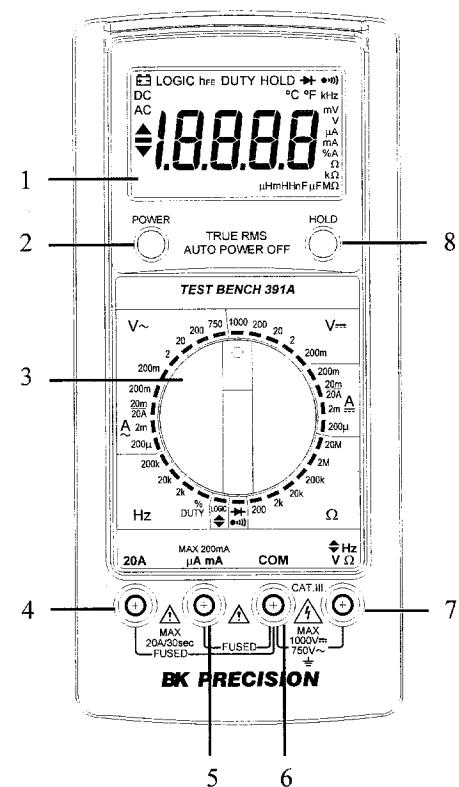
## OPTIONAL ACCESSORIES

Replacement Test Leads .....	Model TL-1
Deluxe Test Leads .....	Model TL-2A
Accessory Tips for Deluxe Test Leads .....	Model TL-3
High Voltage Probe (40 k VDC) .....	Model PR-28A
Temperature Adapter. Type K thermocouple .....	Model TP-30B



## CONTROLS AND INDICATORS

1. **Display.** 4-1/2 digit display (19999 maximum) with automatic decimal point, high and low logic indicators, (-) sign and low battery. Indicates measured value unit of measurement and whether dc or ac is selected (for current and voltage readings).
2. **POWER Switch.** Turns instrument on and off.
3. **Function/Range Switch.** Selects function and range; V  $\sim$  (200 mV, 2 V, 20 V, 200 V or 750 V), V  $=$  (200 mV, 2 V, 20 V, 200 V or 1000 V), LOGIC ( $\blacktriangle$  or  $\blacktriangledown$ ), A  $=$  (200  $\mu$ A, 2 mA, 20 mA/20 A or 200 mA),  $\Omega$  (200  $\Omega$ , 2 k $\Omega$ , 20 k $\Omega$ , 200 k $\Omega$ , 2 M $\Omega$  or 20 M $\Omega$ ),  $\text{Hz}$  (DUTY %, 2 kHz, 20 kHz, 200 kHz), or A  $\sim$  (200  $\mu$ A, 2 mA, 20 mA/20 A or 200 mA).
4. **20 A Jack.** Input for up to 20 A dc or ac current range. For measurements greater than 3 A high current test leads are recommended.
5. **mA/ $\mu$ A Jack.** Input for dc or ac current up to 200 mA.
6. **COM Jack.** Input for common or reference test lead for all measurements. Connect to earth ground or reference point not more than 500 V MAX (dc + ac peak) from earth ground.
7.  **$\text{Hz} \triangle \text{V} \Omega \text{Hz}$  Jack.** Input for dc or ac diode, logic, voltage, resistance, or frequency.
8. **DATA HOLD Switch.** Selects data hold.



#### RANGE SELECTION

1. If the quantity to be measured is unknown, start with the highest range.
2. When an overrange is indicated (most significant digit "1" on and all other digits blank) switch to the next highest range.

#### CAUTION

*Do not switch between ranges while connected to a high voltage.*

#### AUTO POWER OFF

1. The meter will automatically shut off if the Function/Range switch position is not changed within 45 minutes.
2. To restore operation, rotate the Function/Ranges switch to any other position.

#### VOLTAGE MEASUREMENTS

1. To measure dc voltage, set function switch to the desired  $V_{DC}$  range.
2. To measure ac voltage, set function switch to the desired  $V_{AC}$  range.
3. Connect red test lead to  $\blacktriangle \blacktriangledown V \Omega Hz$  jack and black test lead to **COM** jack.
4. Connect test leads to points of measurements.
5. For dc, a (-) sign is displayed for negative polarity; (+) positive polarity is implied.

#### RESISTANCE MEASUREMENTS

1. Set the function switch to the desired resistance range.
2. Remove power from equipment under test.
3. Connect red test lead to  $\blacktriangle \blacktriangledown V \Omega Hz$  jack and the black test lead to the **COM** jack. Red lead is (+) polarity.
4. Connect test leads to the points of measurements.

#### CONTINUITY MEASUREMENTS

1. Set the function switch to  $\blacktriangle \bullet \square$  position.
2. Perform "Resistance Measurements" procedure, steps 2 thru 4. Buzzer sounds when resistance is less than about 150Ω.

#### DIODE TEST

1. Set function switch to  $\blacktriangle$  position.
2. Connect red test lead to the  $\blacktriangle \blacktriangledown V \Omega Hz$  jack and black test lead to **COM** jack. Red lead is (+) polarity.
3. To check forward voltage ( $V_f$ ), connect the red test lead to anode and black test lead to the cathode of the diode. Diodes and semiconductor junctions with normal  $V_f$  of less than approximately 3.0 V can be checked.
4. Display indicates the forward voltage. Normal diode voltages are approximately 0.4 V for germanium diodes, 0.7 V for silicon diodes, and 1.6 V for light emitting diodes (LED). An overrange indicates an open diode. A shorted diode reads near 0 V.
5. Reverse test lead connections to diode. Reading should be the same as with open test leads (an overrange indication). Lower readings indicate a leaky diode.

## OPERATING INSTRUCTIONS

### CAPACITANCE MEASUREMENTS

#### WARNING

*For current measurements, the meter must be connected in series with the load. If incorrectly connected in parallel with the load, the meter presents a very low impedance (almost a short), which may blow the fuse or damage the equipment under test.*

#### NOTE

A warning tone will be heard if the test lead is connected to  $\mu$ A mA input jack while the knob is not set to mA or  $\mu$ A range. A warning tone will also be heard if the test lead is connected to 20 A input jack while the knob is not set to 20 A range.

1. To measure dc current, set function switch to desired A<sub>DC</sub> range.
2. To measure ac current, set function switch to the desired A<sub>AC</sub> range.
3. For current measurements under 200 mA, connect the red test lead to the mA/ $\mu$ A jack and the black test lead to the **COM** jack.
4. For current measurements above 200 mA, connect the red test lead to the 20 A jack and the black test lead to the **COM** jack (set the Function/Range switch to the 20 A position). For current measurements greater than 3 A, high current test leads are recommended.
5. Remove power from the circuit under test and open the normal circuit path where the measurement is to be taken. Connect the meter *in series* with the circuit.
6. Apply power and read the value from the display.

### LOGIC MEASUREMENTS

1. Set the function switch to **LOGIC** position.
2. Connect red test lead to  $\blacktriangleright \blacktriangleleft V \Omega$  Hz jack.
3. Connect black test lead to **COM** jack.
4. Connect black test lead to circuit ground.
5. Connect red test lead to point of logic test.
6. A  $\blacktriangle$  arrow (HI) indicates high logic level. A  $\blacktriangledown$  arrow (LO) indicates low logic level. A high logic level will also have an audio tone. When both indicators are on, the point of measurement is toggling between HI and LO.

### FREQUENCY OR DUTY CYCLE MEASUREMENTS

1. Set the **Function/Range** switch to the desired Hz frequency range for frequency measurements or DUTY % for duty cycle measurement.
2. Connect the red test lead to the  $\blacktriangleright \blacktriangleleft V \Omega$  Hz jack and the black test lead to the **COM** jack.
3. Connect the test leads to the point of measurement and read the frequency or duty cycle % from the display.

### DATA HOLD

Data hold can be used when making voltage, current, or frequency measurements. When switched to the ON position the display will freeze. The test leads can then be disconnected without affecting the data display.