

Model 398B Test Bench® Handheld Digital Multimeter

Instruction Manual



**BK PRECISION®**

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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.

- Remove two screws from back of unit securing the tilt stand.
- Remove tilt stand.
- Remove two screws securing case back, then carefully lift back off to gain access to battery. Remove and save the battery insulator.
- 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 Function/Range switch to the OFF position when not making measurements.
- Reinstall back cover, tilt stand.

**FUSE REPLACEMENT**

If no current measurements are possible, check for a blown over-voltage protection fuse. There are two fuses, F1 for the mA/μA jack and F2 for the 20 A jack. A quick check for a blown 20 A fuse can be performed by inserting the probe into the 20 A jack and setting the function switch to any other position except 20 A or OFF. If no warning tone is heard the fuse is probably blown. This procedure can be used for the μA/mA jack fuse by inserting the probe in the μA/mA jack and setting the function switch to any position other than the OFF, μA or mA positions. For access to fuses, remove the case back as described for battery replacement. Replace F1 only with the original type 2 A, 600 V, fast acting ceramic fuse (B-K Precision Part No. 194-044-9-001). 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 fuselolder, and keep these areas

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
400 mV	100 μV	±(0.5% rdg + 1 dgt)	500 VDC or peak AC
4 V	1 mV		
40 V	10 mV	±(1.5% rdg + 3 dpts)	1000 VDC or peak AC
400 V	100 mV		
1000 V	1 V		

Input Impedance ..... 20 MΩ  
Normal Mode Rejection ..... Greater than 50 dB (50/60 Hz)  
Common Mode Rejection ..... Greater than 100 dB (50/60 Hz)

**AC VOLTAGE Manual ranging. Average responding, rms reading.**

Range	Resolution	Accuracy (50 Hz to 500 Hz)	Over voltage Protection
400 mV	100 μV	±(1.2% rdg + 3 dpts)	500 VDC or peak AC
4 V	1 mV		
40 V	10 mV	±(1.5% rdg + 3 dpts)	1000 VDC or peak AC
400 V	100 mV		
750 V	1 V		

Input Impedance ..... 20 MΩ/less than 100 pF

FEATURES

- Complete Handheld Test Bench
- 11 Functions, 41 Ranges
- Auto power off extends battery life
- Five dc voltage ranges: 400 mV to 1000 V
- Five ac voltage ranges: 400 mV to 750 V
- Six dc current ranges: 400 μA to 20 A
- Six ac current ranges: 400 μA to 20 A
- Six resistance ranges: 400 Ω to 40 MΩ
- Five capacitance ranges: 4 nF to 40 μF
- Four autoranging frequency ranges: 4 kHz to 4 MHz
- hFE transistor test function, measures dc gain (hFE) of NPN and PNP transistors
- Logic probe function: indicates logic high or logic low for TTL circuitry
- Diode test function, measures forward voltage drop
- Audible continuity buzzer
- Audible warning buzzer if probe inserted into wrong jack
- Extra large, easy to read 3 1/4 digit display with annunciators for polarity, decimal, frequency, ac/dc, capacitance, and logic battery
- Basic accuracy: ±0.5% (DCV)
- Resolution of 100 μV, 0.1 μA, 0.1 Ω, 1 pF, 1 Hz
- Auto polarity, auto zero
- Overrange indication on all ranges
- Overload protection
- High energy fuses
- Fused 20 A range
- Safety type test leads
- Tilt stand
- Hanger strap
- Protective holster (withstands 10 ft drop on concrete)
- Built-in probe storage

SAFETY

**WARNING**

An electrical shock causing 10 milliamps of current to pass through the heart will stop most human heartbeats. Voltage as low as 33 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:

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

DC VOLTS	1000 V (dc + ac peak)
AC VOLTS	500 V (dc + ac peak) on 400 mV range
AC VOLTS	750 V rms
OHMS	500 V (dc + ac peak)
mA μA	2000 mA (fuse protected)
20 A	10 A continuous, 20 A for 60 seconds max
COM	Does not float more than 500 volts from earth ground.
- Remove test leads before replacing batteries or fuses and before performing any servicing on the instrument.
- Use only the safety type test leads supplied with the instrument.
- Turn off equipment while making test connections in high voltage circuits. Discharge high voltage capacitors after removing power.
- For voltage or current measurements in high voltage equipment, do not touch equipment, meter or test leads while power is applied.
- Never apply an external signal to the Cx or hFE input jacks. Damage to the meter will result.
- 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.

- 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.
- 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.
- When using a probe, touch only the insulated portion. Never touch the exposed tip portion.
- 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 isolates 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.
- 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.
- Never work alone. Someone should be nearby to render aid if necessary. Training in CPR (cardiopulmonary resuscitation) first aid is highly recommended.

**DC CURRENT Manual ranging.**

Range	Resolution	Accuracy	Burden Voltage
400 μA	0.1 μA	±(1.0% rdg + 1 dgt)	600 mV max.
4 mA	1 μA		
40 mA	10 μA	±(1.5% rdg + 4 dpts)	900 mV max.
400 mA	100 μA		
2000 mA	1 mA		
* 20 A	10 mA		

Overload Protection ..... 2 A (600 V) fast blow ceramic fuse and 20 A (600 V) fast blow ceramic fuse.  
\* 20 A Range Maximum Current ..... 10 A continuous, 20 A for 60 sec. max.

**AC CURRENT Manual ranging. Average responding, rms reading.**

Range	Resolution	Accuracy (50 Hz to 500 kHz)	Burden Voltage
400 μA	0.1 μA	±(1.5% rdg + 4 dpts)	600 mV rms max.
4 mA	1 μA		
40 mA	10 μA	±(2.0% rdg + 4 dpts)	900 mV rms max.
400 mA	100 μA		
2000 mA	1 mA		
* 20 A	10 mA		

Overload Protection ..... 2 A (600 V) fast blow ceramic fuse and 20 A (600 V) fast blow ceramic fuse.  
\* 20 A Range Maximum Current ..... 10 A continuous, 20 A for 60 sec. max.

**RESISTANCE Manual ranging.**

Range	Resolution	Accuracy	Max Open Circuit Voltage
400 Ω	0.1 Ω	±(1.0% rdg + 4 dpts)	3.2 V
4 kΩ	1 Ω		
40 kΩ	10 Ω	±(0.75% rdg + 4 dpts)	0.6 V
400 kΩ	100 Ω		
4 MΩ	1 kΩ	±(2.0% rdg + 5 dpts)	
40 MΩ	10 kΩ		

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

**CAPACITANCE Manual ranging.**

Range	Resolution	Accuracy	Test Frequency
4 nF	1 pF	±(3.0% rdg + 4 dpts)	180 Hz
40 nF	10 pF		
400 nF	100 pF		
4 μF	1 nF		
40 μF	10 nF		

**FREQUENCY COUNTER Auto ranging.**

Range	Resolution	Accuracy	Sensitivity
4 kHz	1 Hz	±(0.1% rdg + 2 dpts)	250 mV rms (10 Hz to 1 MHz)
40 kHz	10 Hz		500 mV rms (1 MHz to 4 MHz)
400 kHz	100 Hz		
4000 kHz	1 kHz		

Overvoltage Protection ..... 500 V DC or peak AC  
Fuse/Cable ..... ±>10% and <10%

**DIODE CHECK**

Range	Resolution	Accuracy	Max Test Current	Max Open Circuit Voltage
	1 mV	±(1.5% rdg + 1 dgt)	1.0 mA	3.2 V DC

Overvoltage 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	3.2 V DC

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

**LOGIC**

LCD Displays Number "OL" when selected  
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 ..... at >20% and <80%  
Indicators ..... 40 ms beep at logic low  
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

**TRANSISTOR hFE (DC GAIN) MEASUREMENT**

Base Current ..... 10 μA  
Vce ..... 3.2 V  
Gain Measurement Range ..... 0 - 1000

Display: 3-3/4 digit liquid crystal display (LCD) with a maximum reading of 3999 counts. Large 0.7" digits.

Polarity: automatic (-) negative polarity indication.

Overrange Indication: "OL".

Functional Annunciator: AC, DC, V, A, F, kHz,  $\Omega$ , hFE, and Logic  $\rightarrow$  on LCD display.

Low Battery Indication: "BAT" is displayed when the battery drops below minimum operating voltage.

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

Operating temperature: 0°C to +50°C, 0 to 70% relative humidity.

Power: Single 9V battery, NEDA 1604.

Battery life: 500 hours typical (alkaline).

Auto Power Off: Automatic all shuts down after 45 minutes inactivity.

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

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

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 Precision Corp., 1031 Segovia Circle, Placentia, CA 92678 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 contact B&K Precision Corp.

B&K Precision Corp. Phone: 714-237-9220  
1031 Segovia Circle Fax: 714-237-9214  
Placentia, CA 92678 Email: service@bkprecision.com

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

4. The buzzer will sound when resistance is less than 150  $\Omega$ .

## DIODE TEST

- Set the Function/Range switch to the  $\rightarrow$  position.
- Connect the red test lead to the  $\rightarrow$   $\rightarrow$  V  $\Omega$  Hz jack and the black test lead to the COM jack.
- To check forward voltage (VF), connect the red test lead to the anode and the black test lead to the cathode of the diode. Diodes and semiconductor junctions with normal VF of less than approximately 3,000 V can be checked.
- The display indicates the forward voltage. Normal diode voltages are approximately 0.300 V for germanium diodes, 0.700 V for silicon diodes, and 1.600 V for light emitting diodes (LED's). A reading of approximately 3.45 V indicates an open diode. A shorted diode reads near 0 V.
- To check reverse voltage, reverse the test lead connections to the diode. The reading should be the same as with open test leads (approx. 3.45 V). Lower readings indicate a leaky diode.

## CURRENT MEASUREMENTS

### WARNING

For current measurements, the meter must be connected in series with the load. If incorrectly connected on 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 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.

- The annunciators in the lower left corner of the display indicate whether the ac or dc function is selected. The  $\mu$ A or mA annunciator on the lower right indicates that current is selected.
  - To measure ac current, set the AC/DC switch to the AC position.
  - To measure dc current, set the AC/DC switch to the DC position.



See instruction manual for further precautionary information.



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



Common input terminal.



Diode test.



Double insulation.



1000 VDC MAX  
750 VDC  
Maximum input rating or V-Q-Hz terminal with respect to earth ground.



Continuity test.



Logic high.



Logic low.



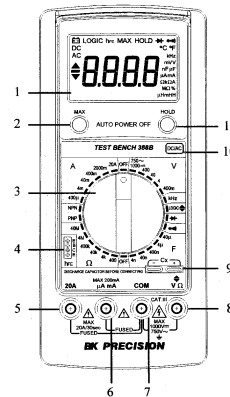
hFE Transistor gain test.

## OPTIONAL ACCESSORIES

- Replacement Test Leads: \_\_\_\_\_ Model TL-1  
Deluxe Test Leads: \_\_\_\_\_ Model TL-2A  
Accessory Ties for Deluxe Test Leads: \_\_\_\_\_ Model TL-3  
High Voltage Probe (40k VDC): \_\_\_\_\_ Model PP-28A  
Temperature Adapter: Type K Thermocouple: \_\_\_\_\_ Model TP-30B

## CONTROLS AND INDICATORS

- Display: 3-3/4 digit display (3999 maximum) with automatic decimal point, polarity indication, high-low logic indicators, and low battery indicator. Indicates measured value, unit of measurement, and whether dc or ac is selected (for current and voltage readings). Overrange is indicated by displaying OL.
- MAX Switch. Selects maximum hold or normal mode.
- Function/Range/Power Switch. Selects function and range; V/1000 DCV/750 ACV; 400 V, 40 V, 4 V, or 400 mV; kHz  $\rightarrow$  LOGIC, and  $\rightarrow$  continuity; F (40  $\mu$ F, 4 nF, 400 nF, 40 pF or 4 nF),  $\Omega$  (400  $\Omega$ , 4 k $\Omega$ , 40 k $\Omega$ , 400 k $\Omega$ , 4 M $\Omega$ , or 40 M $\Omega$ ), hFE (PNP or NPN)  $\rightarrow$  diode; A (400  $\mu$ A, 4 mA, 40 mA, 400 mA, 2000 mA, or 20 A) ac or dc. When knob is pointing left or right, TEST BENCH power is off.
- hFE Jacks. Input for direct insertion of NPN and PNP transistor leads. Emitter, collector, and base sockets are labeled.
- 20 A Jack. Input for dc or ac current measurements on the 20 A range (currents greater than 10 A not to be connected to TEST BENCH for longer than 60 seconds). For measurements greater than 3 A, high current test leads are recommended.
- mA/ $\mu$ A Jack. Input for dc or ac current up to 2 A.
- COM Jack. Input for common or reference test lead for measurements except Cx (capacitance) and hFE (transistor gain). Connect to earth ground or reference point not more than 500 V (dc - ac peak) from earth ground.
- $\rightarrow$  V/Hz Jack. Input for voltage, resistance, frequency, hFE, Logic, and continuity/diode test functions.
- Cx Socket. Input for capacitance measurements. Inputs are polarized for measuring polarized capacitors.
- AC/DC Switch. Selects ac or dc voltage and current ranges. When switch is set to DC position, all voltage and current ranges are for dc measurements. When switch is set to AC position, all voltage and current ranges are for ac measurements.
- Hold Switch. Activates data hold feature.



## RANGE SELECTION

- If the quantity to be measured is unknown, start with the highest range.
- When an overrange is indicated (OL displayed) switch to the next highest range.

### CAUTION

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

## AUTO POWER OFF

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

## VOLTAGE MEASUREMENTS

- The annunciators in the lower left corner of the display indicate whether the ac or dc function is selected. The mV or V annunciator on the right indicates that voltage is selected.
  - To measure ac voltage, set the AC/DC switch to the AC position.
  - To measure dc voltage, set the AC/DC switch to the DC position.

- Set the Function/Range switch to the desired voltage range.
- Connect the red test lead to the  $\rightarrow$   $\rightarrow$  V  $\Omega$  Hz jack and the black test lead to the COM jack.
- Connect the test leads to the points of measurements.
- For dc, a (-) sign is displayed for negative polarity; (+) positive polarity is implied.

## RESISTANCE MEASUREMENTS

- Set the Function/Range switch to the desired resistance range.
- Remove power from the equipment under test.
- Connect the red test lead to the  $\rightarrow$   $\rightarrow$  V  $\Omega$  Hz jack and the black test lead to the COM jack. The red lead is (+) polarity.
- Connect the test leads to the points of measurements and read the value from the display.

## CONTINUITY MEASUREMENTS

- Set the Function/Range switch to the  $\rightarrow$  position.
- Connect the red test lead to the  $\rightarrow$   $\rightarrow$  V  $\Omega$  Hz jack and the black test lead to the COM jack.
- Touch the test leads to the desired test point.

## OPERATING INSTRUCTIONS

- For current measurements less than 2 A, connect the red test lead to the mA/ $\mu$ A jack and the black test lead to the COM jack.
  - For current measurements of 2 A or greater, connect the red test lead to the 20 A jack and the black test lead to the COM jack. For current measurements greater than 3 A, high current test leads are recommended.
- NOTE**  
Maximum continuous input current is 10 A. For current measurements higher than 10 A, the current should not be connected to the inputs for longer than 60 seconds.
- 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.
  - Apply power and read the value from the display.

## CAPACITANCE MEASUREMENTS

### CAUTION

Never apply an external voltage to the Cx jacks. Damage to the meter may result. Always short capacitor leads together before connecting to meter.

- Set the Function/Range switch to the desired Cx (capacitance) range.
- Insert the capacitor leads directly into the slotted Cx test jacks. Observe polarity when measuring polarized capacitors. Insert one lead into the (+) jack and the other lead into the (-) jack.
- Read the capacitance directly from the display. A shorted capacitor will indicate an overrange. An open capacitor will indicate near zero on all ranges.

## USEFUL CONVERSIONS

pF	nF	$\mu$ F
1,000	1.0	0.001
10,000	10.0	0.01
100,000	100.0	0.1
1,000,000	1,000.0	1.0
	10,000.0	10.0
	100,000.0	100.0
	1,000,000.0	1000.0

pF = picofarads (10<sup>-12</sup>)

nF = nanofarads (10<sup>-9</sup>)

$\mu$ F = microfarads (10<sup>-6</sup>)

## FREQUENCY MEASUREMENTS

- Set the Function/Range switch to the kHz function.
- Connect the red test lead to the  $\rightarrow$   $\rightarrow$  V  $\Omega$  Hz jack and the black test lead to the COM jack.
- Connect the test leads to the point of measurement and read the frequency from the display.

## TRANSISTOR GAIN MEASUREMENTS

### CAUTION

Never apply an external voltage to the hFE sockets. Damage to the meter may result.

- Set the Function/Range switch to the desired hFE (dc transistor gain) range (PNP for pnp type transistors and NPN for npn type transistors).
- Place the transistor directly into the hFE socket. The sockets are labeled E, B, and C for emitter, base, and collector.
- Read the transistor hFE (dc gain) directly from the display.

## LOGIC MEASUREMENTS

- Set the Function/Range switch to LOGIC  $\rightarrow$  position.

- Connect the red test lead to the  $\rightarrow$   $\rightarrow$  V  $\Omega$  Hz jack and the black test lead to the COM jack.
- Connect the black test lead to the circuit ground (common).
- Connect the red test lead to the test point.
- A  $\rightarrow$  on the display indicates TTL logic high and a  $\rightarrow$  indicates a TTL logic low. Both indicators are on when the point of measurement is toggling high and low.

## MAX MEASUREMENTS

MAX is used to measure the maximum value of a changing voltage or current such as surge current when power is first turned on or peak audio.

- Set the meter to the desired function and range (MAX applies to all voltage and current measurement functions).
  - Connect test leads to read voltage or current. Set the MAX switch to the On (right) position. A MAX should be on the top of the display. Red lead must be connected to the more positive point of the current or voltage measurement points when reading dc values.
  - Read the measured value from the display.
  - To take another maximum measurement turn the MAX switch off to clear the previous maximum reading, then repeat steps 2 and 3.
- NOTE:** While the MAX switch is on, avoid touching the probes to fingers or any object that may hold a static charge. The maximum function is particularly susceptible to noise pickup when test leads are open circuited and the function range switch is in the 400 mV or 4 V range.