

Instruction Manual
for
MODEL 4011A
5 MHz
FUNCTION
GENERATOR
with Digital Display



BK PRECISION®

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INTRODUCTION

The **B+K Precision Model 4011A Function Generator** is a versatile signal source which combines several functions into one unit. Additionally, the instrument provides the added convenience of a built-in frequency counter. This permits more accurate determination of output frequency than is possible with a simple calibrated dial. Coarse and fine tuning controls permit precision settability of the output frequency. High stability assures that the output frequency does not drift.

With this versatility, the unit has a vast number of applications in both analog and digital electronics in the engineering, manufacturing, servicing, educational, and hobbyist fields.

The heart of the function generator is a VCG (voltage-controlled generator) that produces precision sine, square, or triangle waves over the 0.5 Hz to 5 MHz range. This encompasses subaudible, audio, ultrasonic, and RF applications. A continuously variable dc offset allows the output to be injected directly into circuits at the correct bias level.

Variable symmetry of the output waveform converts the instrument to a pulse generator capable of generating rectangular waves or pulses, ramp or sawtooth waves, and slewed sine waves.

In addition to the above features, an external signal may be used to sweep the output frequency or control operating frequency. This is useful in situations where an externally controlled frequency is desirable.

SPECIFICATIONS

FREQUENCY CHARACTERISTICS

Waveforms

Sine, Square, Triangle, \pm Pulse, \pm Ramp

Range

0.5 Hz to 5 MHz in 7 ranges

Resolution

4 digits

Tuning Range

Coarse: 10:1, Fine: $\pm 5\%$ of Coarse Setting

Variable Duty Cycle

15:85:15 Continuously Variable

Operating Modes

Normal, VCG (Voltage Controlled Generator)

Frequency Stability

Output frequency will not change more than 0.09% in 15 minutes after 1 hour warmup

OUTPUT CHARACTERISTICS

Impedance

50 Ω $\pm 10\%$

Level

20 V p-p Open-circuit, 10V p-p into 50 Ω

Amplitude Control

Variable, 20 db range typical

Attenuation

-20 db ± 1 db

DC Offset

Preset: ± 0.1 V typical

Variable: ± 10 V open-circuit, ± 5 V into 50 Ω

SINE WAVE

Distortion

1% typical at 1 KHz

Flatness

$\pm 5\%$ (.45 dB)

SQUARE WAVE

Symmetry

0.5 Hz to 100 KHz $\leq 2\%$

Rise Time

≤ 20 nS

TRIANGLE WAVE

Linearity

$\geq 98\%$ to 100 KHz

SPECIFICATIONS

TTL OUTPUT

Level 0.8V to 2.4V
Rise Time ≤ 20 nS
Duty Cycle 50% typical

CMOS OUTPUT

Max Frequency 2 MHz
Level 4V to 14 V $\pm 0.5V$ p-p.
 Continuously variable
Rise Time ≤ 120 nS

VCG (Voltage Controlled Generator) INPUT

Input Voltage
0 - 10V $\pm 1V$ causes a 100:1 frequency change
Impedance
10K Ω $\pm 5\%$

FREQUENCY COUNTER

Accuracy
Time Base Accuracy ± 1 count

Time Base Accuracy
 ± 10 PPM (23°C $\pm 5^\circ$ C)
Display
4 digit LED

POWER SOURCE

120 / 230 VAC $\pm 10\%$, 50 / 60 Hz, internal jumper selectable

DIMENSIONS (H x W x D)

10-3/8" x 3-3/8" x 11-7/16" (26.4cm x 8.6cm x 29.1cm)

WEIGHT

4 lb. (1.8 kg.)

ACCESSORIES

Instruction Manual
Output Cable, BNC to Alligator Clips

The above specifications are subject to change without notice

CONTROLS AND INDICATORS

FRONT PANEL (Refer to Fig.1)

1. **POWER Switch.** Turns power on and off.
2. **RANGE Switch.** Selects output frequency range. Seven ranges from 5 Hz to 5 MHz. Switch indicates maximum frequency of range and is adjusted with **COARSE FREQUENCY** control to 0.1 times the maximum. For example, if the 500 KHz range is selected, the output frequency can be adjusted from 50 KHz to 500 KHz.
3. **FUNCTION Switch.** Selects sine, square, or triangle waveform at **OUTPUT** jack.
4. **OUTPUT LEVEL Control.** Controls the amplitude of the signal at the **OUTPUT** jack. Output level can be decreased by approximately 20db with this control.
5. **DC OFFSET Control.** Enabled by the **DC OFFSET Switch** (12). Clockwise rotation from center changes the **DC** offset in a positive direction while counterclockwise rotation from center changes the **DC** offset in a negative direction.
6. **OUTPUT Jack.** Waveform selected by **FUNCTION** switch as well as the superimposed **DC OFFSET** voltage is available at this jack.
7. **TTL/CMOS Jack.** TTL or CMOS square wave, depending on the position of the **CMOS LEVEL** switch (13) is output at this jack This output is independent of the **OUTPUT LEVEL** and **DC OFFSET** controls.
8. **CMOS LEVEL Control.** Rotating this control clockwise increases the amplitude of the CMOS square wave at the **TTL/CMOS** jack.
9. **VCG Jack.** Voltage Controlled Generator input. Permits external control of generator output frequency by a **DC** voltage input at this jack. A positive voltage will decrease frequency.
10. **DUTY CYCLE Control.** Enabled by the **DUTY CYCLE Switch** (14). Rotation from center position adjusts the duty cycle of the main **OUTPUT** signal.
11. **-20DB Switch.** When engaged, the signal at the **OUTPUT** jack is attenuated by 20db.
12. **DC OFFSET Switch.** When engaged, enables operation of the **DC OFFSET** control (5).
13. **CMOS LEVEL Switch.** When engaged, changes the **TTL** signal to **CMOS** signal at the **TTL/CMOS** jack.
14. **DUTY CYCLE Switch.** When engaged, enables operation of **DUTY CYCLE** control (10).
15. **FINE FREQUENCY Control.** Vernier adjustment of the output frequency for ease of setting frequency.
16. **COARSE FREQUENCY Control.** Coarse adjustment of the output frequency from 0.1 to 1 times the selected range.
17. **COUNTER DISPLAY.** Displays frequency of internally generated waveform.

CONTROLS AND INDICATORS

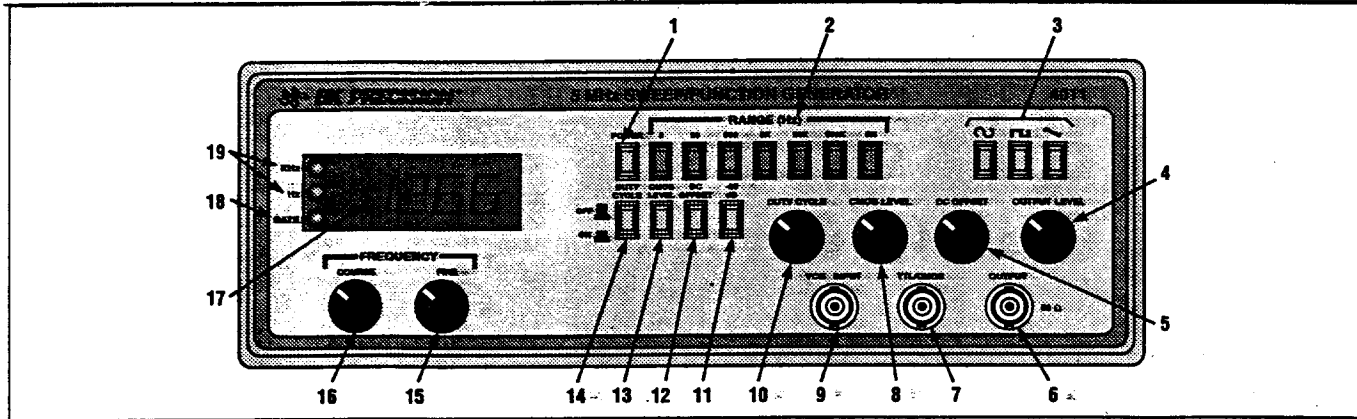


Figure 1. Model 4011 Controls and Indicators.

18. **GATE LED.** Indicates when the frequency counter display is updated. When the 50K through 5M ranges are selected, the LED will flash 10 times per second (every 0.1 seconds). When the 50 through 5K ranges are selected, the LED will flash once every

second and when the 5 range is selected, the LED will flash every 10 seconds. As the LED turns off, the display is updated.

19. **Hz and KHz LED.** Indicates whether the counter is reading in Hz or KHz.

OPERATING INSTRUCTIONS

The B+K PRECISION Model 4011A Function Generator is a versatile instrument, capable of producing a variety of output waveforms over a broad range of frequencies. To gain a working familiarity with the unit, it is recommended that it be connected initially to an oscilloscope, so that the effects of the various controls on the output waveforms can be observed. Use this manual as required for reference until becoming accustomed to the operating procedures.

FREQUENCY AND WAVEFORM SELECTION

1. Initially, verify that the **DUTY CYCLE** (14), **CMOS LEVEL** (13), **DC OFFSET** (12), **-20dB** (11), switches are in the OUT position (released). This will produce a symmetrical waveform unaffected by the other controls.
2. Plug the unit into an appropriate power source and turn it on by engaging the **POWER** switch (1).
3. Select the desired waveform (SINE, SQUARE, or TRIANGLE) by engaging one of the **FUNCTION** switches (3). Phase relationships of the waveforms are shown in Fig. 2.
4. Select the frequency of the waveform by engaging one of the **RANGE** switches (2). The output frequency is displayed, along with the appropriate measurement units, KHz or Hz (19), on the LED display.
5. Rotate the **COARSE** (16) frequency control to quickly set the output frequency to the approximate desired value. The **FINE** (15) frequency control can then be used to easily set the output to the specific desired value. The frequency selected is available at the **OUTPUT** jack (6). In addition, a digital signal, either TTL or CMOS is available at the **TTL/CMOS** jack (7) (refer to the "TTL/CMOS OUTPUT" section of this manual).

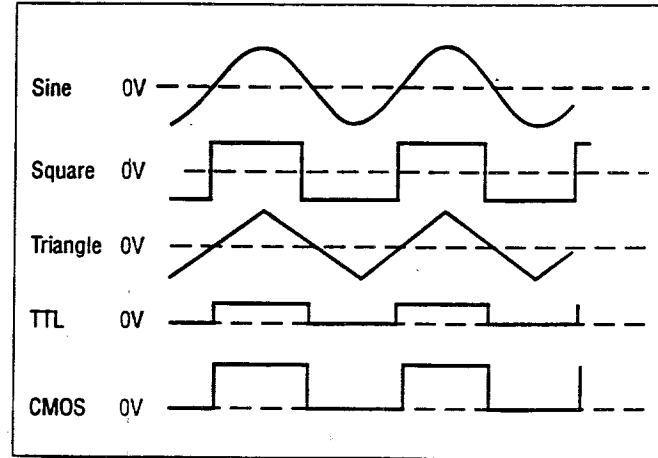


Figure 2. Output Waveform and Phase Relationship

6. Adjust the amplitude of the output as desired using the **OUTPUT LEVEL** control (4). Rotation of this control varies the amplitude from maximum to 20 db below maximum. An additional attenuation of -20db is available by pushing in the **-20dB** switch (11). The attenuation factors can be combined for a total of -40db. The maximum signal level is 10 V p-p (into 50 Ω).

7. A superimposed DC component can be added to the output signal by engaging the DC OFFSET switch (12) to enable operation of the DC OFFSET control (5). Rotation of this control adds a positive or negative DC component to the output signal. The DC component introduced is independent of the OUTPUT LEVEL control and can be varied by ± 10 volts open circuited or ± 5 volts into 50Ω . The DC Offset does not affect the TTL/CMOS output jack. The effect of DC OFFSET is shown in Fig. 3.

CONSIDERATIONS

1. Counterclockwise rotation of the COARSE frequency control decreases the output frequency to approximately one-tenth of the maximum for the range selected (10:1). For example, if the 50 K range is selected and the COARSE frequency control is set to full counterclockwise, the output frequency is approximately 5 kHz.
2. It is advisable to set the FINE frequency control to the approximate center of its rotation before setting the COARSE frequency control. This assures that the FINE control will not reach its limit while trying to finalize the frequency setting.
3. The FINE frequency control provides approximately $\pm 5\%$ frequency deviation from the COARSE control setting. This provides vernier adjustment to easily set the frequency to a precise value.
4. When the 5 Hz range is selected, the gate time is 10 seconds and the display is updated once every 10 seconds. The result of a frequency change will not be displayed until 10 seconds later. Adjust the frequency in progressively smaller steps, waiting for the display to update until the desired frequency is obtained.
5. When outputting square waves or when using the TTL output, terminate the cable into 50Ω to minimize ringing. Also, keep cables as short as possible.

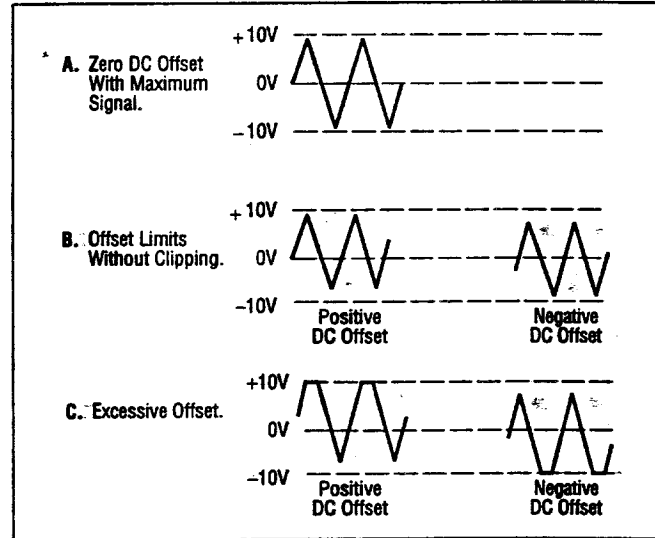


Figure 3. Use of DC OFFSET Control

6. Remember that the output signal swing of the generator is limited to ± 10 volts open circuited or ± 5 volts into 50Ω , and applies to the combined peak-to-peak signal and DC offset. Clipping occurs slightly above these levels. Fig. 3 illustrates the various operating conditions encountered when using the DC offset. If the desired output signal is large or if a large DC offset is required, an oscilloscope should be used to make sure that the desired signal is obtained without undesirable clipping.

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DUTY CYCLE CONTROL

The **DUTY CYCLE** control can be used to alter the symmetry of the output waveform, to produce waveshapes such as those shown in Fig. 4. For a square wave, symmetry variation amounts to changing the duty cycle (ratio of "high" to "low" time), effectively converting the instrument into a pulse generator. For a triangle wave, the result is a ramp, and with a sine wave, a distorted waveshape called a slewed sine is produced. The Model 4011A provides for symmetry variation from 15% to 85%.

1. Select the waveform desired either SINE, SQUARE or TRIANGLE.
2. Engage the **DUTY CYCLE** switch (14) and adjust the **DUTY CYCLE** control (10) for the desired waveshape. Clockwise rotation from center results in an increase in square wave duty cycle, and changes the sine and triangle waves as shown in the top waveform of each pair of Fig. 4. Counter-clockwise rotation results in the bottom waveform in each pair.
3. Varying the duty cycle setting results in a slight change in frequency. Adjust the **COARSE** and **FINE** frequency controls as required.

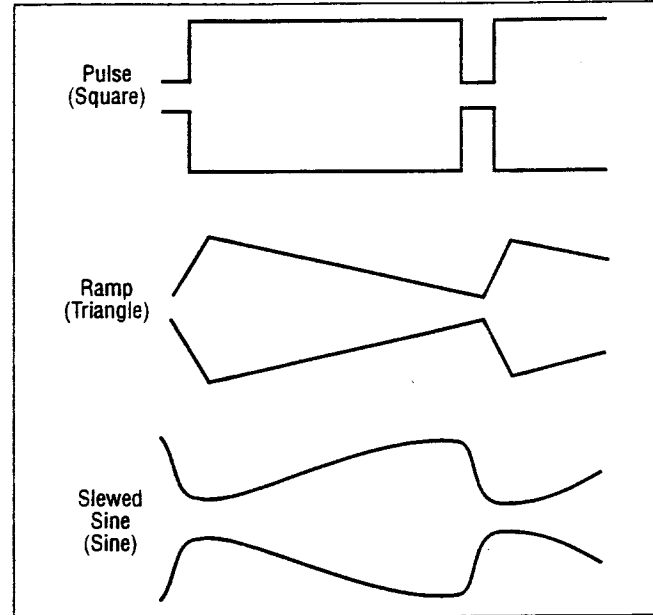


Figure 4. Effects of Symmetry Variation.

TTL/CMOS OUTPUT

The **TTL/CMOS** output jack provides a fast rise time square wave output. Either a fixed TTL or a variable CMOS output level is available. The output is positive with respect to ground and can be used as an external sync pulse for oscilloscopes or as a variable frequency signal source for exercising logic circuits. Because of the fast rise time of this output, cable length should be minimized to limit ringing and overshoot.

1. Select the desired frequency range and adjust the frequency controls as required. The **OUTPUT LEVEL** and **DC OFFSET** controls have no effect on the signal at the **TTL/CMOS** jack.
2. When the **CMOS LEVEL** switch (13) is **OFF**, a TTL signal is output at the **TTL/CMOS** jack. Select a CMOS signal by engaging the **CMOS LEVEL** switch and adjust the level of the signal by rotating the **CMOS LEVEL** control (8).

VOLTAGE CONTROLLED FREQUENCY OPERATION

The Model 4010A can be operated as a voltage-controlled generator by using an external control voltage applied to the **VCG INPUT** jack. The externally applied voltage will vary the frequency which is preselected by the range switches and the frequency controls. Applying approximately +10 V with the **COARSE** control at full clockwise decreases the output frequency by about 100 times (a 100:1 ratio).

1. Select the desired frequency range and waveform.
2. Set the starting frequency with the **COARSE** control. Apply a positive DC voltage to the **VCG INPUT** input jack (9) to decrease the frequency. A voltage from 0 to +10 V will cause the frequency to decrease by a factor of 100 if the **COARSE** frequency control is set at maximum CW rotation. For example, if the starting frequency

is 500 kHz, applying +10 V will change the output frequency to 5 kHz.

3. To operate the function generator as a sweep generator, apply a positive going ramp signal to the **VCG INPUT** jack. As the ramp voltage increases, the frequency decreases. The rate of sweep can be adjusted by varying the frequency of the ramp signal.
4. Specific frequencies can be selected by applying a fixed dc voltage to the **VCG INPUT** jack or the frequencies can be stepped by applying a stepped dc voltage.
5. Do not apply more than ± 15 volts (dc or dc + ac peak) to the **VCG INPUT** jack. Inputs of more than 15 volts will not cause any further shift in the frequency and could cause damage to the generator.

OUTPUT PROTECTION CONSIDERATIONS

Use care when connecting the function generator output to a signal injection point. Excessive voltage at the point of signal injection of the function generator can cause internal damage. Under normal operation, the generator output should never be connected to an external voltage other than low dc values that can be matched with the **DC OFFSET** control. The Model 4011A is overload protected so that shorting the output, even continuously, will not cause damage. A fuse has been added in series with the **OUTPUT** jack to help protect the instrument from damage by connection to excessive external voltage.

Damage of this type usually occurs by accidentally connecting the output of the function generator to a voltage in the equipment under test. The following protective measures are strongly recommended:

1. The user should understand the equipment under test well enough to identify valid signal injection points (ie: the base of a transistor,

OPERATING INSTRUCTIONS

- a logic input of a gate, etc.). The voltage at valid signal injection points is rarely high enough to damage the instrument.
2. If in doubt about the safety of a signal injection point, measure the voltage present at the intended point of signal injection before connecting the function generator output to that point.
 3. When applying the main output of the function generator to a circuit point containing a dc level, adjust the **DC OFFSET** control so that the dc level at the main output matches the circuit voltage.
 4. Connect the **TTL** output only to TTL-level circuits. Connect the **CMOS** output only to CMOS circuits. Measure the V_{cc} of the circuit under test and adjust the **CMOS LEVEL** control as instructed in the manual.
 5. When the function generator is used by students or other inexperienced users, the circuit of Fig. 5 could be added into your TTL output probe or test clip set. It will protect the TTL output of the generator against external voltages up to ± 20 volts.

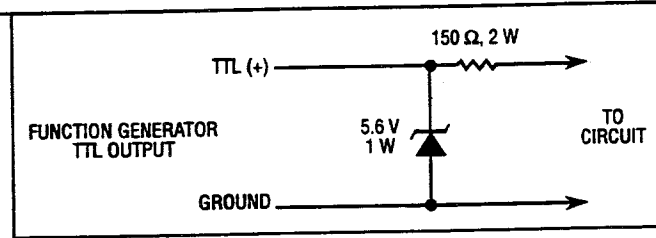


Figure 5. Circuit for Protection of TTL Output.

FUNCTION GENERATOR APPLICATIONS GUIDEBOOK

B+K Precision offers a "Guidebook to Function Generators" which describes numerous applications for this instrument, including hook-up details. It also includes a glossary of function generator terminology and an explanation of function generator circuit operation. It may be obtained free of charge by filling out and mailing the postage paid card enclosed with **The Model 4010A**

MAINTENANCE

WARNING

The following instructions are for use by qualified service personnel only. To avoid electrical shock, do not perform servicing other than contained in the operating instructions unless you are qualified to do so.

Remember that ac line voltage is present on line voltage input circuits any time the instrument is plugged into an ac outlet, even if turned off. Always unplug the function generator before performing service procedures.

DISASSEMBLY AND REASSEMBLY

In order to access the fuses and the line voltage selector, the bottom half of the case must be removed. Disassembly and reassembly procedures are as follows:

Disassembly

1. Unplug the function generator and turn the unit upside down.
2. Remove the four screws from the bottom of the case.
3. Lift off the bottom cover.

Reassembly

1. Line up the slots in the bottom case half with the front panel and the back panel.
2. Carefully push the bottom half down onto the top half.
3. Replace the four screws.

FUSE REPLACEMENT

1. To replace a fuse, disassemble the case as described above.
2. To replace the line fuse, locate the fuse holder. It is located at the rear of the circuit board, to the right of the power transformer. The fuse should not normally open unless a problem has developed with the unit. Try to determine and correct the cause of the blown fuse, then replace only with the correct value fuse (refer to fuse label near fuse holder).
3. To replace the Output fuse, locate the fuse holder. It is located on the output amplifier PC board mounted to the front panel. Replace only with the correct value fuse 0.2 A slow blow fuse.
4. Reassemble case as described above.

LINE VOLTAGE SELECTION

1. Disassemble the case as described above.
2. Locate the line voltage selection connector. It is located on the PC board behind the power transformer.

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3. Unplug the connector by pulling straight up.
4. Push the connector onto the desired voltage selection pin. Be sure that the correct fuse is installed in the fuse holder (refer to label near fuse holder).
5. Reassemble case as described above.

INSTRUMENT REPAIR SERVICE

Because of the specialized skills and test equipment required for instrument repair and calibration, many customers prefer to rely upon **B+K PRECISION** for this service. We maintain a network of **B+K PRECISION** authorized service agencies for this purpose. To use this service, even if the instrument is no longer under warranty, follow the instructions given in the **WARRANTY SERVICE INSTRUCTIONS** portion of this manual. There is a nominal charge for instruments out of warranty.

CUSTOMER SUPPORT 1-800-462-9832

B+K Precision offers courteous, professional technical support before and after the sale of their test instruments. The following services are typical of those available from our toll-free telephone number:

- Technical advice on the use of your instrument.
- Technical advice on special applications of your instrument.
- Technical advice on selecting the best instrument for a given task.
- Information on optional accessories for your instrument.
- Information on instrument repair and recalibration services.
- Replacement parts ordering.
- Availability of service publications.
- Information on other **B+K Precision** instruments.
- Requests for a new **B+K Precision** catalog.
- The name of your nearest **B+K Precision** distributor.

Call toll-free 1-800-462-9832
Monday through Friday, 8:00 A.M. to 5:00 P.M.

Pacific Standard time

WARRANTY SERVICE INSTRUCTIONS (For U.S.A. and its Overseas Territories)

1. Refer to the MAINTENANCE section of your **B+K Precision** instruction manual for adjustments that may be applicable.
2. If the above-mentioned does not correct the problem you are experiencing with your unit, pack it securely (preferably in the original carton or double-packed).
3. Enclose a letter describing the problem and include your name and address.
4. Enclose proof of purchase date; that is, a dated copy of the sales receipt.
5. Deliver to, or ship PREPAID (UPS preferred in U.S.A.) to the nearest **B+K Precision** authorized service agency (see list enclosed with unit).

If your list of authorized **B+K Precision** service agencies has been misplaced, contact your distributor for the name of your nearest service agency, or write to:

B+K Precision
Factory Service Operations
1031 Segovia Circle
Placentia, CA 92870
Tel (714) 237-9220

Also use this address for technical inquiries and replacement parts orders.

LIMITED TWO-YEAR WARRANTY

B & K Precision 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 two years from the date of purchase.

B & K Precision will, without charge, repair or replace, at its option, defective product or component parts upon delivery to an authorized **B & K Precision** service contractor or the factory service department, accompanied by proof of the purchase date in the form of a sales receipt.

To obtain warranty coverage in the U.S.A., this product must be registered by completing and mailing the enclosed warranty registration card to **B & K Precision**, 1031 Segovia Circle, Placentia, CA 92870-7137 within fifteen (15) days from the date 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 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 also have other rights which vary from state to state.

MODEL 4011A

DATE PURCHASED _____