INSTRUCTION MANUAL

MANUAL DE INSTRUCCIONES

BK PRECISION

MODEL 4010A

MODELO 4010A

2 MHz FUNCTION GENERATOR

2MHz GENERADOR DE FUNCIONES

BK PRECISION

TEST INSTRUMENT SAFETY

WARNING

Normal use of test equipment exposes you to a certain amount of danger from electrical shock because testing must sometimes be performed where exposed voltage is present. An electrical shock causing 10 milliamps 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 lethal current under certain conditions. Higher voltages pose an even greater threat because such voltage can more easily produce a lethal current. Your normal work habits should include all accepted practices to prevent contact with exposed high voltage, and to steer current away from your heart in case of accidental contact with a high voltage. You will significantly reduce the risk factor if you know and observe the following safety precautions:

1. Don't expose high voltage needlessly. Remove housings and covers only when necessary. Turn off equipment while making test connections in high-voltage circuits. Discharge high-voltage capacitors after removing power.
2. 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.
3. Use an insulated floor material or a large, insulated floor mat to stand on, and an insulated work surface on which to place equipment; and make certain such surfaces are not damp or wet.
4. Use the time proven "one hand in the pocket" technique while handling an instrument probe. Be particularly careful to avoid contacting a nearby metal object that could provide a good ground return path.
5. When testing ac powered equipment, remember that ac line voltage is usually present on some power input circuits such as the on-off switch, fuses, power transformer, etc. any time the equipment is connected to an ac outlet, even if the equipment is turned off.

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Instruction Manual
for
MODEL 4010A

2 MHz
FUNCTION
GENERATOR

BK PRECISION

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INTRODUCTION

The **B+K Precision** Model 4010A Function Generator is a versatile signal source which combines several functions into one unit. A calibrated dial provides frequency accuracy within 5%. High stability assures that the output frequency does not drift.

The heart of the function generator is a VCG (voltage-controlled generator) that produces precision sine, square, or triangle waves over the 0.2 Hz to 2 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.

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.

SPECIFICATIONS

FREQUENCY CHARACTERISTICS

Waveforms
Sine, Square, Triangle, ± Pulse, ± Ramp
Range
0.2 Hz to 2 MHz in 7 ranges
Dial Accuracy
± 5%
Tuning Range
10:1
Variable Duty Cycle
15:85:15 Continuously Variable
Operating Modes
Normal, VCG (Voltage Controlled Generator)

OUTPUT CHARACTERISTICS

Impedance
50 Ω ± 10%
Level
20 V p-p Open-circuit, 10 V p-p into 50Ω
Amplitude Control
Variable, 20 dB range typical
Attenuation
-20 dB ±1 dB
DC Offset
Preset: ±0.1 V typical
Variable: ±10V open-circuit, ±5V into 50 Ω

SINE WAVE

Distortion
4% typical at 1 kHz
Flatness
±5% (0.45 dB)

SQUARE WAVE

Symmetry
≤2% 0.2 Hz to 100 kHz
Rise Time
≤120 nS

TRIANGLE WAVE

Linearity
≥98% to 100 kHz

SPECIFICATIONS

TTL OUTPUT

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

CMOS OUTPUT

Level	4 V to 14 V ±0.5V p-p, Continuously Variable
Rise Time	≤50 nS

VCG (Voltage Controlled Generator) INPUT

Input Voltage

0 - 10 V ±1 V causes a 100:1 frequency change

Impedance

10 kΩ ±5%

AC INPUT

120 / 230 VAC ±10%, 50 / 60 Hz, internal jumper selectable

DIMENSIONS (H x W x D)

4 1/2" x 10 1/2" x 12 1/4" (26.7cm x 11.4cm x 31.1cm)

WEIGHT

4.1 lb. (1.845 kg.)

ACCESSORIES

Instruction Manual
Output Cable, BNC to Alligator Clips

NOTE: Specifications and information are subject to change without notice. Please visit www.bkprecision.com for the most current product information.

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 2 Hz to 2 MHz. Switch indicates maximum frequency of range and is adjusted with FREQUENCY control to 0.1 times the maximum. For example, if the 200 kHz range is selected, the output frequency can be adjusted from 20 kHz to 200 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 20 dB 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. **-20 dB Switch**. When engaged, the signal at the OUTPUT jack is attenuated by 20 dB.
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. **FREQUENCY Control**. Adjustment of the output frequency from 0.1 to 1 times the selected range.
16. **INV**. Allows the user to invert the polarity of the normal output signal.

CONTROLS AND INDICATORS

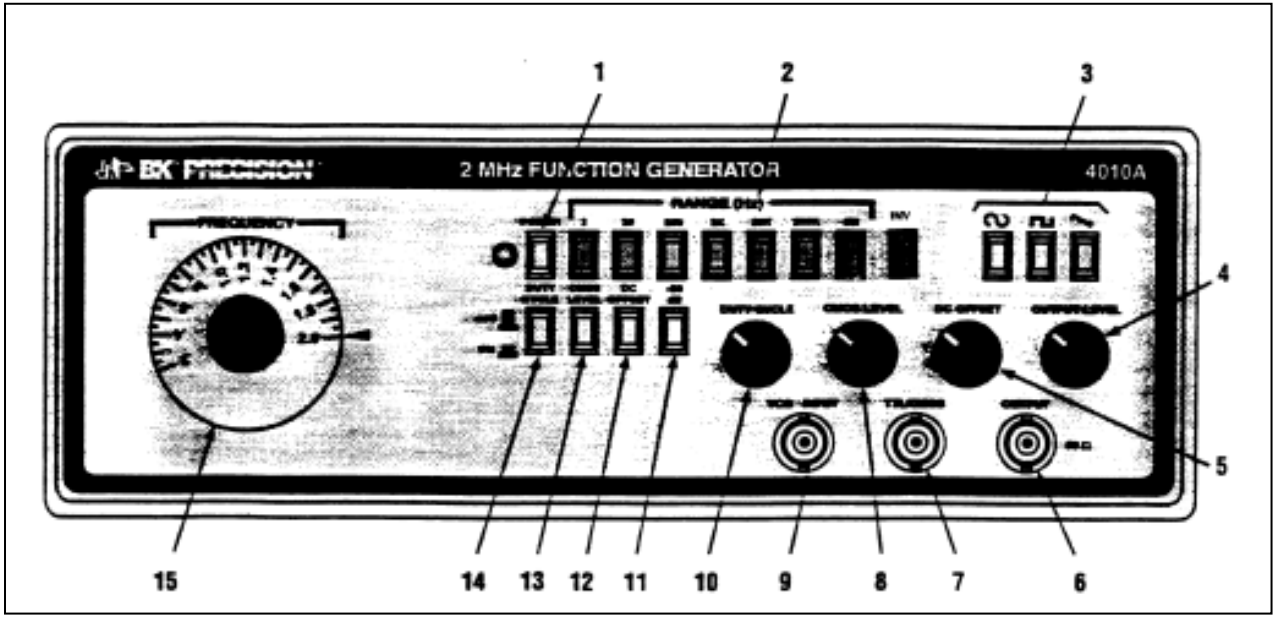

Figure 1. Model 4010A Controls and Indicators.

OPERATING INSTRUCTIONS

The **B+K Precision** Model 4010A 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

l. 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).

5. Rotate the **FREQUENCY** control (15) to set the output frequency to the 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).

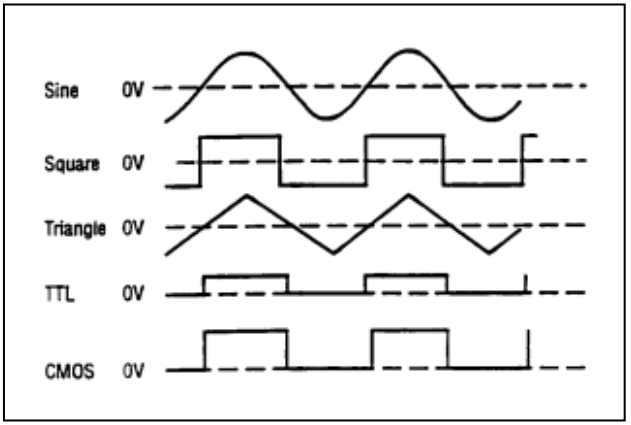

Figure 2. Output Waveform and Phase Relationship

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 -20 dB is available by pushing in the **-20dB** switch (11). The attenuation factors can be combined for a total of -40 dB. 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 50 Ω. The DC Offset does not affect the **TTL/CMOS** output jack. The effect of DC OFFSET is shown in Fig. 3.

CONSIDERATIONS

l. Counterclockwise rotation of the **FREQUENCY** control decreases the output frequency to approximately one-tenth of the maximum for the range selected (10:1). For example, if the **20K** range is selected and the **FREQUENCY** control is set to full counterclockwise (dial setting of .2), the output frequency is approximately 2 kHz.

2. Clockwise rotation of the **FREQUENCY** control increases the output frequency. At the fully clockwise setting (dial setting of 2.0), the output frequency will be equal to the **RANGE** selection. That is, when the **20K** range is selected and the dial is set to 2.0, the output will be 20 kHz.

3. When the dial is set to 1.0, the output frequency is one half of the maximum for the range selected. When the **20K** range is selected and the dial is set to 1.0, the output will be 10 kHz.

4. A more precise frequency setting may be achieved by connecting an external frequency counter to the TTL or output jack.

5. When outputting square waves or when using the TTL output, terminate the cable into 50 Ω to minimize ringing. Also, keep cables as short as possible.

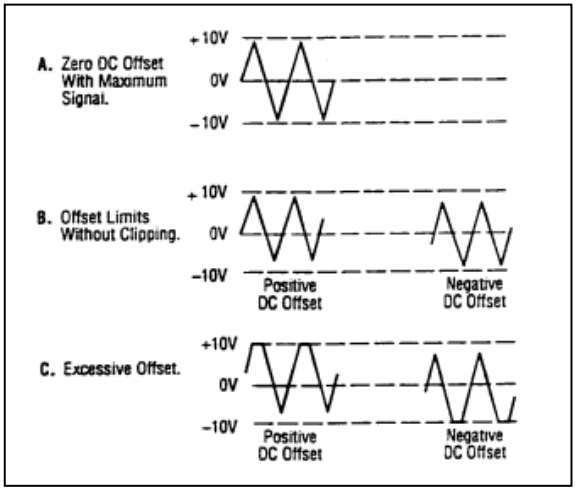

Figure 3. Use of DC OFFSET Control

6. Remember that the output signal swing of the generator is limited to ±10 volts open circuited or ±5 volts into 50 Ω, 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.

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 4010A 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 **FREQUENCY** control as required.

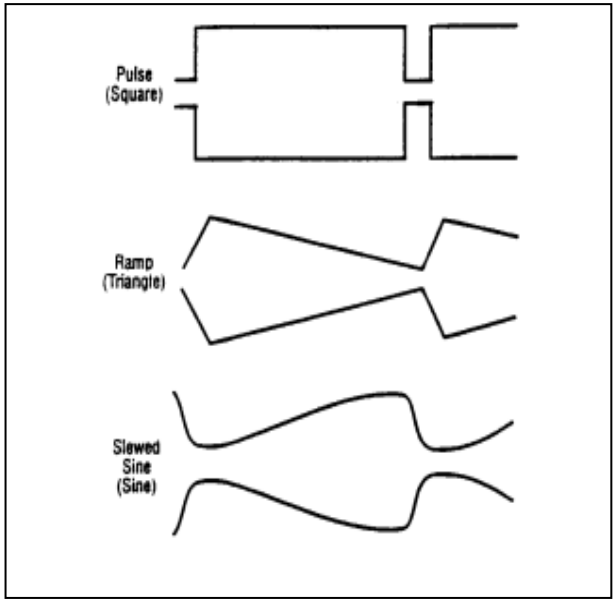

Figure 4. Effects of Symmetry Variation.

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 +l0 V with the **FREQUENCY** 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 **FREQUENCY** control. Apply a positive DC voltage to the **VCG 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 **FREQUENCY** control is set at maximum CW rotation. For example, if the starting frequency is 200 kHz, applying +10 V will change the output frequency to 2 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 4010A 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 (i.e.: the base of a transistor, 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 Vcc 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.

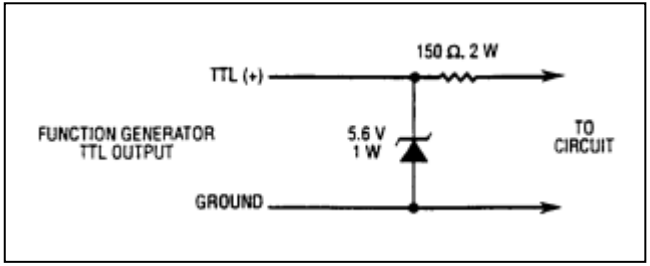

Figure 5. Circuit for Protection of TTL Output.

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 maybe downloaded for free off our website at www.bkprecision.com.

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.

FUSE REPLACEMENT

1. Locate the fuse holder on the input line receptacle.
2. Remove the fuse holder and replace the fuse with an equal value fuse

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.

AC LINE SELECTION

This instrument can operate on 120 or 230 VAC source at 50 or 60 Hz. The internal jumper allows you to select the line voltage. Before connecting the power plug to an AC line outlet, be sure to check that voltage selector plug is set in the correct position corresponding to the line voltage in your location and the fuse rating shown on the rear panel of the unit.