# Instruction Manual

# for

# Model 3011B

# 2 MHz
# DIGITAL DISPLAY
# FUNCTION GENERATOR


MAXTEC INTERNATIONAL CORP.
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## SPECIFICATIONS

(AR specifications apply with coarse frequency dial between 0.2 and 2 times range).

**Basic Outputs:** Sine Wave, Triangle Wave, Square Wave, TTL Pulse, and CMOS Pulse.

**Frequency Range:** 0.2 Hz to 2 MHz (7 ranges). Four digit frequency counter display.

**Frequency Control:** Separate coarse and fine tuning controls.

**Maximum** Amplitude: 20 V p-p (open circuit). 10 V p-p (into 50 Ω load).

Amplitude **Control:** Continuously variable, 20 dB range typical.

Attenuator: -20 dB ±1 dB.

Output Impedance: 50 Ω ±6%.

DC **Offset:** Continuously variable, from -10 V to +10 V (open circuit), -5 V to +5 V into 50 Ω.

Duty **Cycle Control:** Continuously variable from 1:1 to 10:1.

**Sine Wave Function:**

Distortion: 0.2 Hz to 20 kHz; ⩽1%, 20 kHz to 200 kHz; ⩽ 2%.

Frequency Response: 0.2 Hz to 100 kHz, GO.2 dB, 100 kHz to 2 MHz; ⩽1 dB.

**Square Wave Function:**

Symmetry: 0.2 Hz to 100 kHz; ⩽2%.

Rise Time: 6 120 ns.

**Triangle Wave Linearity:** 0.2 Hz to 100 kHz; 98%, 100 kHz to 2 MHz; 95%.

**TTL Output:**

Level: ⩾3 v p-p.

Rise Time: ⩽30 ns.

**CMOS Output:**

Level: Continuously adjustable from 4 V p-p (±1 v p-p) to 14.5 v p-p (to.5 v p-p).

Rise Time: ⩽120 ns.

## SPECIFICATIONS

**VCF (Voltage controlled Frequency) Input:**

| | |
|---|---|
| Input Voltage: | Approximately +10 V (±1 V) causes 10:1 frequency change. |
| Impedance: | Approximately 10 kΩ. |

**Frequency Counter (Internal Only):**

| | |
|---|---|
| Accuracy: | ±Time Base Accuracy ±1 Count. |
| Time Base Accuracy: | ±10 PPM (23° C ±5° C). |

**Power Source:** 120/220/240 V AC ±10%, 50/60 Hz.

**Weight:** 5.5 lb (2.5 kg).

**Dimensions (W x H x D):** 9.65 x 3.75 x 11", 245 x 95 x 280 mm.

**Accessories Supplied:**
One cable, BNC to insulated clips.
Power Cord.
Spare Fuse.
Instruction Manual.
Schematic Diagram & Parts List.

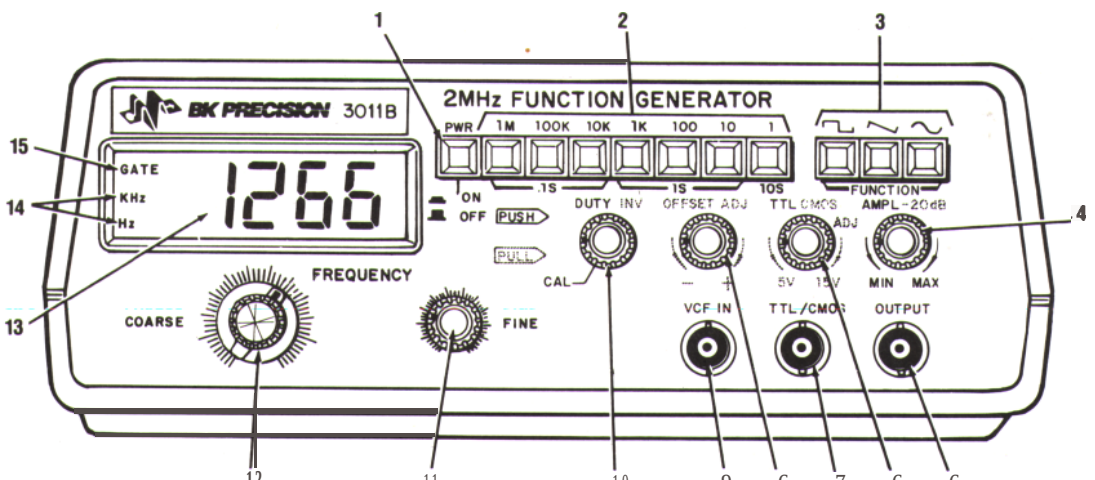


**Fig. 1. Controls And Indicators.**

## CONTROLS AND INDICATORS

1. **PWR Switch.** Turns power on and off.

2. **Range Selectors.** Selects frequency range. Decade frequency type, seven ranges from 1 Hz to 1 MHz. Frequency can be adjusted from 0.2 to 2 times the range selected. For example, if the **100 K** range is selected, frequency can be adjusted (see Frequency Control) from 20 **kHz** to 200 **kHz.** Numbers under pushbuttons indicate gate time (see **GATE** LED).

3. **Function Selectors.** Selects square, triangle, or sine waveform at OUTPUT jack.

4. **AMPL Control.** Controls amplitude of signal at **OUTPDT** jack. When control is pulled out, signal is attenuated 20 **dB** (PULL **-20dB).**

5. OUTPUT Jack. Waveform selected by FUNCTION switches **as** well as the superimposed DC **OFFSET** voltage is available at this jack.

6. **TTL/CMOS.** When control is pushed in, a TTL signal is present at the **TTL/CMOS** jack. Level is fixed at 3 V p-p and turning control has no effect. When the control is pulled out (PULL CMOS), a CMOS signal is present at the **TTL/CMOS** jack. Turning the control clockwise increases the amplitude and turning the control counterclockwise decreases amplitude (amplitude is adjustable from approximately 4 V p-p to 14.5 V p-p).

7. **TTL/CMOS Jack.** Square wave selected by **TTL/CMOS** control (either TTL or CMOS) is available at this **jack.** The output is independent of the **AMPL** and **OFFSET** controls.

8. **OFFSET ControL** When control is pushed in, DC offset is set at zero. When control is pulled out (PULL ADJ), clockwise rotation changes DC offset in a positive direction and counterclockwise rotation changes DC offset is a negative direction. Full clockwise rotation gives approximately **+5** V into 50 **Ω** load **(+10** V open circuited). Full counterclockwise rotation gives approximately -5 V into 50 **Ω** load (-10 V open circuit).

9. VCF IN **Jack.** Voltage Controlled Frequency input. Permits external sweep or frequency control. Positive voltage decreases the output frequency.

10. DUTY ControL Rotation adjusts the duty cycle of both the main **OUTPUT** signal and the **TTL/CMOS** signal. Fully counterclockwise rotation is the **CAL** position (normal duty cycle). Duty cycle changes when control is rotated away from **CAL** position. When control is pulled out (PULL **INV),** the square wave at the main OUTPUT and the TTL or CMOS signal are inverted.

11. FINE Frequency ControL Vernier adjustment of output frequency for ease of setting to a precise frequency.

12. COARSE Frequency ControL Coarse adjustment of output frequency (main output and **TTL/CMOS** output) from **.2** to 2 times the selected range.

13. Frequency Counter **Display.** Displays frequency of internally generated frequency.

14. Hz and **kHz LED.** Indicates whether display is showing Hz or **kHz.**

15. GATR **LED.** Indicates when frequency counter display is updated. When the 10 **K** through 1 **M** frequency switches are selected, the LED will flash 10 times per second (every 0.1 second). When the 10 through 1 K switches are selected, the LED will flash once each second and when the 1 switch is selected, the LED will light every 10 seconds. As the LED turns off, the **dis-**play is updated.

## FREQUENCY AND WAVEFORM SELECTION

1. With the unit plugged into a power source, depress the PWR switch.
2. Select the desired frequency range by depressing the appropriate range switch. The output frequency is displayed, with the appropriate decimal point, on the LCD display. The Hz or **kHz** indicator is also lit.
3. Rotation of the COARSE frequency control will quickly set the output frequency to the approximate desired value. The **FINE** frequency control should then be used to easily set the output to the specific desired value. The frequency selected is available at both the **TTL/** CMOS jack and the OUTPUT jack.
4. Select the waveform desired (square, triangle, or sine) by depressing the appropriate FUNCTION switch. The phase relationships of the waveforms available are shown in Fig. 2. Be sure that the **DUTY** control is set to CAL.
5. The amplitude of the selected output signal at the main OUTPUT. jack is adjusted with the AMPL control. Maximum signal level is 10 V p-p (into 50 Ω), and signal level can be decreased by turning the control counterclockwise, or pulling the control out for an additional 20 dB step of attenuation (PULL -20dB).
6. For information on the TTL and CMOS signals, see the "**TTL/CMOS** OUTPUT" section of this manual.
7. A DC component can be added to the signal at the main OUTPUT jack by use of the OFFSET **control.** The DC component introduced is independent of the AMPL control and does not apply to the **TTL/CMOS** jack. The level of DC can be varied by ±10 volts open circuited or ±5 volts into 50 Ω.

## CONSIDERATIONS

1. The COARSE frequency control adjusts from approximately two-tenths to two times the indicated range value. For example, if the **10** K range is selected and the COARSE frequency control is set to the most counterclockwise major line, the output frequency is approximately 2 kHz. When the COARSE frequency control is set to the most clockwise major line, the output frequency is approximately 20 kHz. Fig. 3 shows these major lines.
2. It is best not to set the COARSE frequency control beyond either the 0.2 or 2 position. Instead, select the next lower or higher range. When the COARSE control is set to such a position, erratic operation could occur.

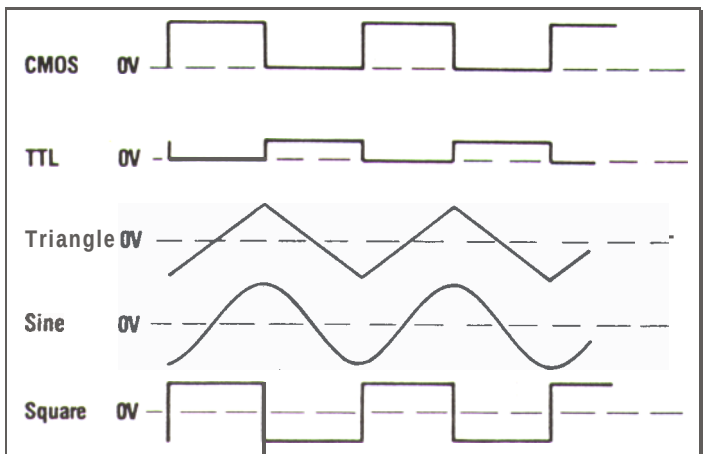


Fig. 2. Output Waveform And Phase Relationship.

3. It is advisable to set the **FINE** frequency control to the approximately center of its range before setting the **COARSE** frequency control. This assures that the **FINE** control will not reach its limit of rotation while trying to finalize the frequency setting.

4. The **PINE** frequency control spans about 10% of the range. This gives a fine tuning capability so that it is easy to set the frequency to a precise value.

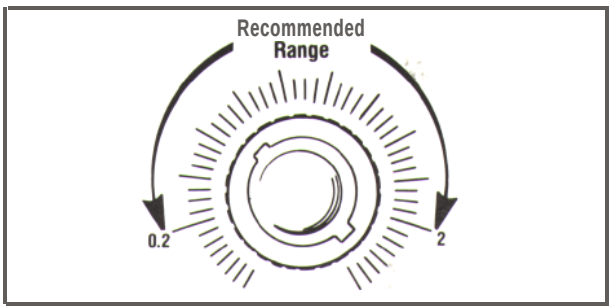


Fig. 3. COARSE Frequency Control.

5. When the 1 **Hz** range is selected, the gate time is 10 seconds. This means that the display is updated once every 10 seconds, and that the resolution is 0.1 second. However, the result of a frequency change may not be displayed until 10 seconds later. Keep adjusting the frequency in progressively smaller steps and waiting for the display update until the desired frequency is obtained.

6. When using the higher output frequencies and when using the square wave output, terminate the cable into 50 Ω to minimize ringing. Also, keep cables as short as possible.

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

**50 Ω.** This applies to the combined signal and DC offset. Clipping occurs slightly above these levels. Fig. 4 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 combination is obtained without undesirable clipping.

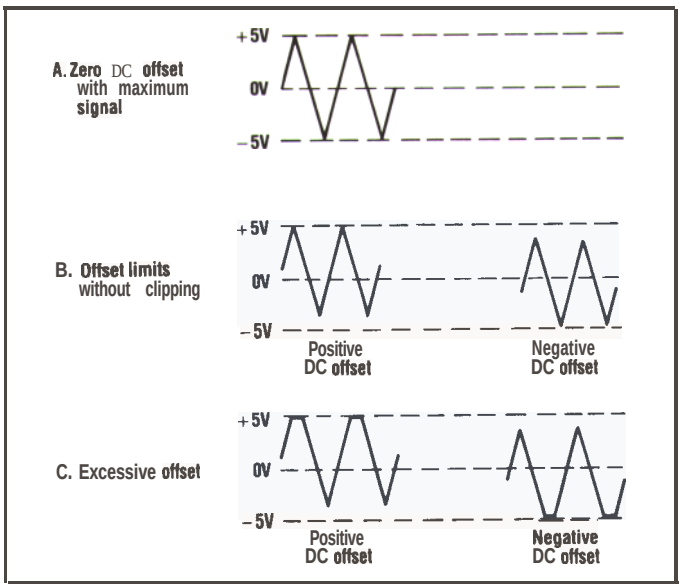


Fig. 4. Use of DC OFFSET Control.

## VOLTAGECONTROLLEDFREQUENCYOPERATION

The Model 3011B can be operated as a voltage-controlled oscillator (VCO) by. using an external control voltage applied to the VCF IN jack. The externally applied voltage will vary the frequency which is preselected by the range switches and the frequency control controls. Applying approximately +10 V will cause the frequency to decrease by about 10 times (a 10:1 ratio).

**CAUTION**

Do not apply more than ±15 volts (dc or dc + ac peak) to the VCP IN jack. Inputs of more than 15 volts will not cause any further shift in the frequency and could cause damage to the Function Generator.

1. Select the desired frequency range and function.
2. Set the DC offset, if required.
3. Set the starting frequency and amplitude to the desired level.

NOTE

Keep the (starting) COARSE frequency control between the 0.2 and 2 positions (see Fig. 3).

4. To operate the function generator as a sweep generator, apply a positive going ramp signal to the VCF IN jack. As the voltage increases, the frequency decreases. A

ramp that goes from 0 to +10 V will cause the frequency to decrease by a factor of 10 (i.e., if the starting frequency is 10 kHz, when the ramp reaches +10 V, the output frequency will be 1 kHz). The rate of sweep can be adjusted by varying the frequency of the ramp signal.

5. Specific frequencies can be selected by applying a fixed dc voltage to the VCF IN jack or the frequencies can be stepped by applying a stepped dc voltage.

### TTL/CMOS OUTPUT

The TTL/CMOS output jack provides a fast rise time square wave output (no triangle or sine output available). Either a fixed 3 V p-p TTL or a variable (approximately 4 V p-p to 14.5 V p-p) CMOS output are available. The output pulses always go positive with respect to ground. This signal can be used as an external sync pulse for oscillscopes or as a variable frequency signal source for exercising logic circuits.

**NOTE**

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 AMPL and OFFSET controls have no effect on the signal at the TTL/CMOS jack.

2. Select a TTL signal by pushing in the TTL/CMOS control. Select a CMOS signal by pulling out the TTL/CMOS control (PULL CMOS) and adjust the level of the CMOS signal by rotating the control (the TTL level is fixed).

### DUTY CYCLE CONTROL

The Model 3011B Function Generator has a variable duty cycle control to provide ramps (sawtooth) or pulses. The duty cycle control affects both the main OUTPUT and the TTL/CMOS output. If a standard square, triangle, or sine waveform are desired (normal duty cycle) the DUTY control should be set to CAL (fully counterclockwise). Fig. 5 illustrates the function of the DUTY control.

**NOTE**

As the DUTY cycle is changed, the frequency will decrease. Be sure to set the desired frequency after the DUTY cycle has been adjusted.

1. Select the desired function (either square or triangle wave if the main OUTPUT is to be used or TTL or CMOS if the TTL/CMOS output is to be used) and frequency range.

2. Adjust the amplitude and DC offset if the main OUTPUT is to be used or adjust the CMOS level if a CMOS signal is to be used (the TTL has a fixed level).

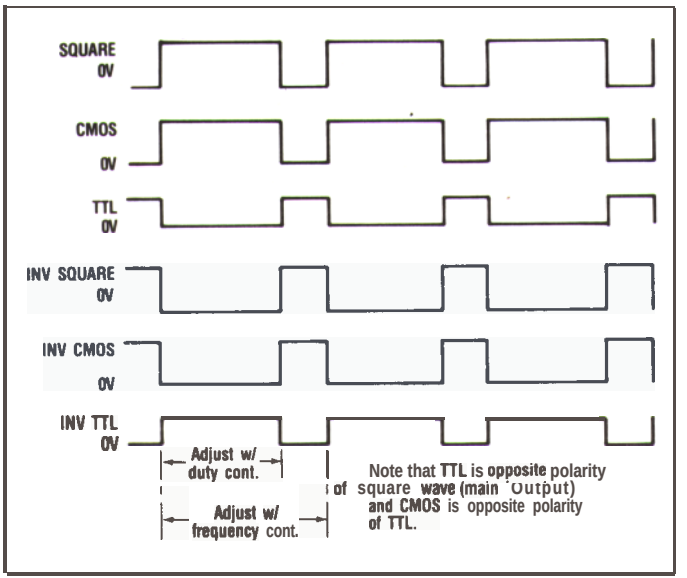


Fig. 5. Effect Of **DUTY** Control On Square Wave, TTL, And CMOS Signal.

3. Adjust the DUTY control so that the desired duty cycle is obtained (display on an oscilloscope for set-up if desired).

4. Adjust the frequency of the signal using the COARSE and FJNE frequency controls. The DUTY control can be pulled out to cause a negative going pulse (PULL **INV**) at either the main OUTPUT jack (for square wave only) or the **TTL/CMOS** jack (the triangle and sine wave cannot be inverted).

## **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 3011B.

## OUTPUT PROTECTION CONSIDERATIONS

Use care when connecting the function generator output to a signal injection point. Excessive voltage at the point of signal injection is fed into the function generator and causes internal damage. The TTL output is particularly susceptible to damage from external voltage greater than +6 volts or any negative polarity 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, 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 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 ADJust as instructed in the manual.

5. When the function generator is used by students or other inexperienced users, the following circuit 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.

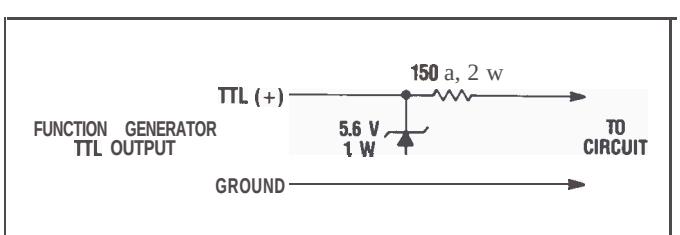


Fig. 6. Circuit for Protection of TTL Output.

**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 fuse and the line voltage selector, the top half of the case must be removed. Disassembly and reassembly procedures are as follows:

**Disassembly**

1. Unplug the function generator and swing the handle so that it is flat against the top of the case.
2. Turn the unit upside down.
3. Remove the four screws from the bottom of the case. It may be necessary to gradually remove the case bottom in order to free the screws. If so, replace the bottom once the screws are removed.
4. Turn the unit over (right side up).
5. Swing the handle to the front of the unit.
6. Lift the top cover off. Note that the handle and four case separators (cylindrical plastic standoffs) are now loose. They do not need to be removed.

**Reassembly**

1. Make sure that the handle and four case separators are positioned properly.
2. Line up the slots in the top case half with the front panel (and sub-panel immediately behind it) and the back panel.
3. Carefully push the top half down onto the bottom half. The. handle may need to be readjusted to **accomodate** the fit.
4. Holding the two halves together, turn the unit over. Replace the four screws.

## LINE VOLTAGE SELECTION

1. If the line voltage needs to be changed, disassemble the function generator case (see the **DISASSEMBLY** section above) and unplug the plastic connector by pulling it straight up (see Fig. 7 for location).

2. Align the plastic connector with the desired voltage selector pin and push the plug down over the pin. Be sure that the correct fuse is installed (0.5 A for 110 V operation and 0.3 A for 220 or 240 V operation) in the fuse holder. Reassemble the case.

## FUSE REPLACEMENT

1. To replace the fuse, disassemble the case and remove the blown fuse (see Fig. **7** for location).

2. 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 (0.5 A for 110 V operation and 0.3 A for 220 or 240 V operation). Reassemble the case.

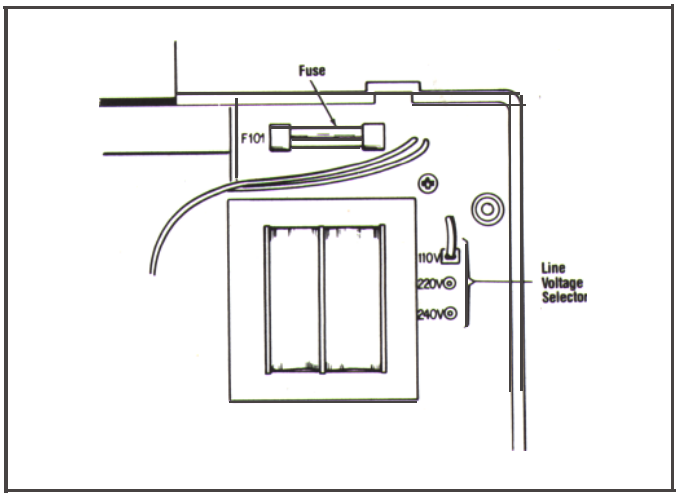


Fig. 7. Fuse And Line Voltage Selector Location.

## 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.