INSTRUMENT HANDBOOK

MODEL BWD 160A

1. INTRODUCTION. Model BWD 160A is a small high performance Function Generator providing six simultaneous output signals and a wide variety of waveforms over a frequency range of 0.02Hz to 2MHz.

The three basic waveforms are sine, square and triangle, all of which are available simultaneously as fixed level outputs at the rear panel. The symmetry of all these outputs is normally 1:1. However, by push button selection 20:1 or 1:20 is available from all the fixed outputs. For the phase relationship between the fixed outputs see Section 4.

Any one of the nine possible waveforms can be selected to appear at the main output terminals by push button selection. The main output waveform can be adjusted in both amplitude and DC offset to any required value within the specification.

By connecting a voltage source to the VCO input, the frequency of the output can be varied over four decades. A positive voltage increases the frequency producing up to 2 decades of control and a negative voltage decreases the frequency 2 decades. The maximum frequency on any range is that frequency indicated by 20 on the dial.

The auxiliary TTL compatible output is also provided on the front panel, this can be used as a syncronising pulse, pen lift voltage, etc.

All outputs are floating with respect to ground and may be taken to ±200V above ground.

2. PERFORMANCE

2.1 FREQUENCY RANGE AND ACCURACY

0.02Hz	to	2Hz	±10% of full scale
0.2Hz	to	20Hz	±10% of full scale
2Hz	to	200Hz	± 3% of full scale
20Hz	to	2kHz	± 3% of full scale
200Hz	to	20kHz	± 3% of full scale
2kHz	to	200kHz	± 3% of full scale
20kHz	to	2MHz	± 3% of full scale

2.2 FREQUENCY DIAL. Calibrated 1 to 20 with intermediate calibration points 1.0 per division. Also uncalibrated 0.2 point.

2.3 WAVEFORMS. Sine, Square, Triangle, TTL output. Symmetry 1:1, or 20:1 or 1:20.

2.4 OUTPUTS.
(a) Main Outputs (front panel) 0-20V p-p O/C 0-10V p-p into 50Ω. (Option 06 600Ω Zo).
(b) Auxiliary Outputs (rear panel) Sine, Square, Triangle >1V p-p O/C, Zo = 1kΩ.
(c) Vernier control (main output only) >100:1 range continuously variable.

2.5 DC OFFSET (Main Outputs Only). 0 ±10V O/C, 0 ±5V into 50Ω. Maximum output not to exceed maximum DC offset.

2.6 SINE WAVE DISTORTION.
<1% 10Hz to 200kHz (Range X10 to X10K)
<2% 5Hz to 1MHz.

2.7 SQUARE WAVE RISE TIME.
<100nSec into 50Ω.

2.8 TRIANGULAR WAVE LINEARITY.
<1% deviation from best straight line 1Hz to 100kHz.

2.9 SYMMETRY (all Outputs). <±2%.

2.10 LEVEL (All Main Outputs). ±2% into 50Ω 0.02Hz to 2MHz.

2.11 ISOLATED GROUND. Unit normally floating with 1MΩ paralleled with 0.47μF from instrument common to ground. Common may be raised to ±200V above ground.

2.12 VOLTAGE CONTROL OF FREQUENCY. See Fig. 1.

2.13 TTL OUTPUT RISE TIME. <50nSec.

2.14 OPERATING TEMPERATURE. The unit will remain within specification for an ambient temperature of +10°C to +35°C. For operation from 0°C to 50°C multiply all tolerances by 2.0.

2.15 POWER REQUIREMENTS. Two versions are available.

100-137V BWD 160A/115
200-265V BWD 160A/230

2.16 DIMENSIONS, WEIGHT.
21cm Wide, 9.5cm High, 21cm Deep.
Weight 1.8Kgm.

3. CONTROLS AND THEIR FUNCTIONS.

3.1 FREQUENCY RANGE SWITCH. Seven decade ranges are available multiplying the dial frequency by 0.1 to 100,000.

3.2 FREQUENCY DIAL. Calibrated from 1 to 20, with an additional uncalibrated point at 0.2.

3.3 WAVEFORM SELECTOR. The three right hand buttons select either square, triangle or sine wave output to appear at the front panel output terminals. The two left hand buttons select the symmetry of the output and alter all outputs simultaneously.

3.4 AMPLITUDE CONTROL AND POWER SWITCH. By pulling the knob outward the power switch is 'on' and rotation of the knob varies the amplitude of the selected waveform appearing at the output terminals.

3.5 DC OFFSET CONTROL. A DC offset can be applied to the output by pulling the knob outwards and rotating the knob to produce the required DC level. Pushing the knob in de-activates the control.

3.6 POWER INDICATOR. A LED inserted in one of the low voltage supplies indicates when power is being applied to the circuit. If the fuse blows the indicator will not glow.

3.7 OUTPUT TERMINALS. The BNC output socket supplies a 20V p-p signal into an open circuit and 10V p-p into a 50Ω load.

3.8 VOLTAGE CONTROLLED OSCILLATOR INPUT TERMINAL. The frequency of the instrument can be controlled externally by applying a voltage between common and this terminal.

3.9 TTL OUTPUT. A square wave output which is TTL compatible is available at this terminal.

NOTE: This output is referred to the COMMON terminal.

3.10 SQUARE WAVE OUTPUT (Rear Panel). Provides a 1V p-p square wave of identical frequency and phase as the main output.

NOTE: This output is referred to the COMMON terminal on the front panel.

3.11 TRIANGLE WAVE OUTPUT (Rear Panel). Provides a 1V p-p triangular wave of identical frequency and phase as the main output.

NOTE: This output is referred to the COMMON terminal on the front panel.

3.12 SINE WAVE OUTPUT (Rear Panel). Provides a 1V p-p sine wave of identical frequency and phase as the main output.

NOTE: This output is referred to the COMMON terminal on the front panel.

3.13 MAINS FUSE (Rear Panel). A 100mA Delay fuse connected in series with the primary of the power transformer.

4. OPERATION.

4.1 Check that the instrument is fitted with a transformer suitable for the mains supply. (i.e. 240V or 110V).

4.2 Check that the fuse rating on the rear panel is correct.

4.3 Connect the instrument to the mains supply and switch 'on'. The power on indicator should now light up.

4.4 See Figures 2, 3, 4, 5 and 6 for waveforms available at the output sockets.

4.5 OPERATION OF V.C.O. Set the controls as follows. Frequency Control to 0.2. Frequency range to x 10kHz. Waveform Selector to sine.

With the DC input equal to zero, the output frequency will be approximately 2kHz. Increasing the DC input to +10V will increase the output frequency to approx. 200kHz. Decreasing the DC input to 0.1V will decrease the output frequency to approx. 20Hz. For the graph of frequency versus DC input see Fig. 1.

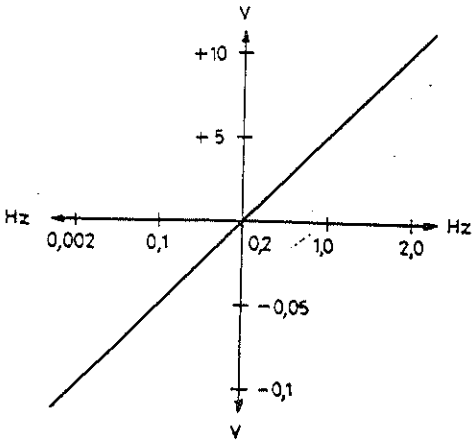

FIG. 1 VCO CHARACTERISTIC

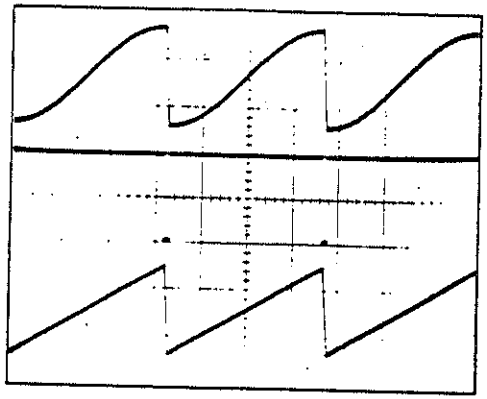

FIG. 3 WAVEFORMS WITH 20:1 SYMMETRY

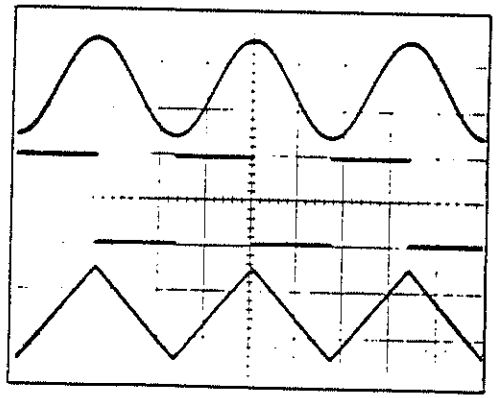

FIG. 2 WAVEFORM PHASE RELATIONSHIPS

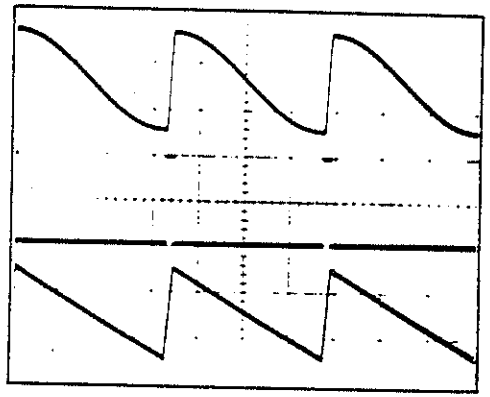

FIG. 4 WAVEFORMS WITH 1:20 SYMMETRY

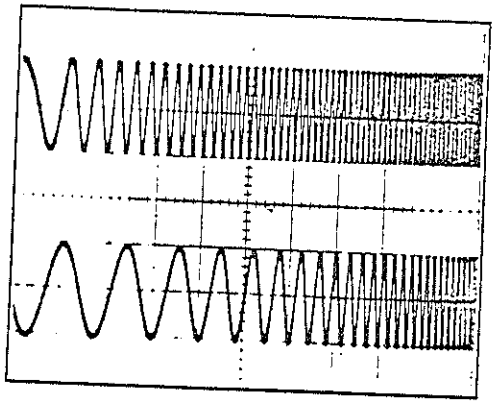

FIG. 5 FREQUENCY SWEEP WITH LINEAR & LOG RAMPS

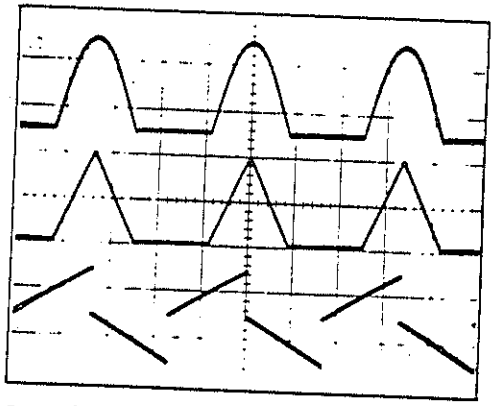

FIG. 6 MISCELLANEOUS WAVEFORMS - SINE & TRIANGLE WITH DC OFFSET - TRIANGLE & SQUARE SELECTED SIMULTANEOUSLY.

4.6 If a negative going ramp is required to control the frequency, set the desired maximum frequency by the frequency control dial and a negative going ramp will decrease the frequency. A 10V ramp will sweep the frequency from the maximum as set on the dial to two decades lower. Examples of linear and logarithmic sweep are shown in Fig. 5.

5. CIRCUIT DESCRIPTION.

5.1 TRIANGLE AND SQUARE WAVE GENERATOR.

The frequency control voltage from RV2 is taken via U1 and U2 to appear as two equal but opposite voltages to drive the current sources Q1-Q4. Q3, Q4 and R13 are connected to form a negative current source which always has twice the magnitude of the positive current source. D1 and D2 form a switch which allows the negative current to either be passed to the timing capacitors C1 to C7 or absorbed by the switch. The timing capacitors see either +1 or +1 + (-2I) = -I.

5.1 TRIANGLE AND SQUARE WAVE GENERATOR contd. The waveform at the timing capacitors is taken via buffer amplifier U4 to the comparator U3 which directly drives the current switch D1 and D2. A triangular waveform is present at the output of U4 and a square wave at the output of U3.

The TTL output is also taken from U3.

5.2 SINE WAVE CONVERTOR. U51 takes the triangular wave and converts it to a sine wave whose DC level, amplitude and distortion can be adjusted by RV53, 54, 51 and 52 respectively.

5.3 BUFFER AMPLIFIERS. Each of the three waveforms generated are passed through unity gain amplifiers to enable loading changes to take place without altering frequency or the waveshape of the waveforms. An output is taken from each of the buffer amplifiers via a 1000Ω resistor providing all three basic waveforms simultaneously at the rear panel.

5.4 OUTPUT AMPLIFIER. The triangle, square and sine wave outputs of the buffer amplifiers are selected by S51 waveform selector switch and the output amplitude is set by RV57.

Q57 and Q58 differential amplifier and Q59, Q60 output stage form a fixed gain wideband amplifier with Q151 to Q154 acting as a unity gain power stage.

5.5 POWER SUPPLIES. The secondary of the power transformer is rectified and filtered to provide ±25V unregulated. These voltages are used to supply the output amplifier and the regulated supplies.

U151 provides the +15V rail, U152 the -15V rail.

Similarly U153 and U154 provide the + and -6V rails.