Model 21
11 MHz Stabilized Function Generator

Simplified Operator’s Manual
SIMPLIFIED OPERATOR'S MANUAL

MODEL 21

11 MHz STABILIZED FUNCTION GENERATOR

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SAFETY

This instrument is wired for earth grounding via the facility power wiring. Do not bypass earth grounding with two wire extension cords, plug adapters, etc.

BEFORE PLUGGING IN the instrument, comply with installation instructions.

MAINTENANCE may require power on with the instrument covers removed. This should be done only by qualified personnel aware of the electrical hazards.

The instrument power receptacle is connected to the instrument safety earth terminal with a green/yellow wire. Do not alter this connection. (Reference: ☀️ or ⚠️ stamped inside the rear panel near the safety earth terminal.)

WARNING notes call attention to possible injury or death hazards in subsequent operations.

CAUTION notes call attention to possible equipment damage in subsequent operations.
1.1 MODEL 21

Model 21 is a closed loop frequency stabilized function generator. Both short term and long term frequency accuracies are 0.09% over Model 21’s 100μHz to 11 MHz frequency range.

Modes are continuous, triggered and gated and output levels are to 20V peak-to-peak (10 Vp-p into 50Ω).

Waveforms are sine, triangle and square, ramp up, ramp down, haversine, havertriangle and dc. Above 1.1 kHz waveforms are analog generated, below, waveforms are digitally synthesized. Synthesized waveforms can be held at any point and continued from that point.

Synthesized output signal frequency is 1/1000 a reference clock frequency, which can be internal or external. By use of an external reference clock, the output range can be extended to ultra-low frequencies.

An LCD display shows frequency (3½ digits plus unit of measure) and annunciators that point to selected operating modes, etc. Output is reverse power protected.

1.2 SPECIFICATIONS

1.2.1 Versatility

Waveforms

Bidirectional switch selects sine $\sim$, triangle $\Delta$, square $\Box$, and dc. For frequencies below 1100Hz ramp up $\searrow$ and ramp down $\nearrow$ and, on Model 21, havertor waves $\searrow \Delta$ are also available.

Operational Modes

Continuous: Generator runs continuously at selected frequency.

Triggered: Generator is quiescent until triggered by external signal or manual trigger, then generates one complete waveform cycle at selected frequency.

Gated: As triggered mode, except output continues for duration of gate signal. Last waveform started is completed.

Frequency Range

100μHz to 11 MHz in 9 overlapping decade ranges. Range switching with bidirectional switch with frequency digits; decimal and units displayed on LCD display. Each decade range capable of 1100:1 frequency change. Ranges are as follows:

<table>
<thead>
<tr>
<th>Specified *Range</th>
<th>Lowest Obtainable Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>11.00 MHz to 1.00 MHz</td>
<td>10 kHz</td>
</tr>
<tr>
<td>1100 kHz to 100 kHz</td>
<td>1 kHz</td>
</tr>
<tr>
<td>110.0 kHz to 10.0 kHz</td>
<td>100 Hz</td>
</tr>
<tr>
<td>11.00 kHz to 1.00 kHz</td>
<td>10 Hz</td>
</tr>
<tr>
<td>1100 Hz to 100 Hz</td>
<td>1 Hz</td>
</tr>
<tr>
<td>110.0 Hz to 10.0 Hz</td>
<td>100 mHz</td>
</tr>
<tr>
<td>11.00 Hz to 1.00 Hz</td>
<td>10 mHz</td>
</tr>
<tr>
<td>1100 mHz to 100 mHz</td>
<td>1 mHz</td>
</tr>
<tr>
<td>110.0 mHz to 10.0 mHz</td>
<td>100μHz</td>
</tr>
</tbody>
</table>

*Waveform specifications are applicable.

Function Output

Waveform amplitude variable over a 20 dB range up to 20 Vp-p (10 Vp-p into 50Ω) at Function Out. Waveform also present at Function Out (-20 dB) with a fixed 20 dB attenuation relative to the Function Out for a full 40 dB of amplitude range. Peak output current is 100 mA maximum at Function Out. Source impedance of both outputs is 50Ω.

DC Offset and DC Output

Waveform offset and dc output variable with DC Offset control with off position for calibrated zero offset. Function Out is ±10V maximum (±5V into 50Ω) as offset or Vdc output. Signal peak plus offset limited to ±10V (±5V into 50Ω). DC offset plus waveform attenuated proportionately at Function Out (-20 dB).

Sync Output

TTL pulse (50% duty cycle) at generator frequency. Will drive 10 LS TTL loads.
VCG — Voltage Controlled Generator
Up to 1100:1 frequency change with external 0 to ± 5V signal applied to VCG In connector. Upper and lower frequencies limited to maximum and minimum of selected range. Input impedance is 5kΩ and maximum slew rate is 0.1V/1μs. VCG In is disconnected when the Stabilizer is engaged.

Trigger and Gate
External TTL compatible signal at Trig In BNC triggers or gates generator output when generator is in trigger or gate mode. Generator triggers on positive edge of input or gates on for duration of high level input. External signal pulse width is 50 ns minimum with a maximum repetition rate of 5 MHz.

Stabilizer
When selected, the generator frequency is stabilized at the displayed frequency to a crystal-controlled reference. The Stabilizer improves long term frequency stability for all durations to be equal to the 10 min. short term value.

When the stabilizer is on, the generator frequency is corrected to the displayed frequency ± 0.09% of range over the entire operating temperature range of 0 to +50°C. The stabilizer is automatically turned off when the mode is taken out of continuous or Ext Ref. is enabled.

Display
1100 count LCD frequency display with frequency ranging units (mHz, Hz, kHz, and MHz) and decimal point. Annunciators indicate selection of waveform, stabilizer and external reference status, haverwave selection and generator mode.

External Reference
External Reference switch provides selection of internal or external control of waveform output frequency and also provides a means of holding or releasing the waveform manually, electrically or through external contact closure. External Reference connector accepts either a TTL compatible signal (1.1 MHz maximum repetition rate, 200 ns minimum pulse width) or contact closure. External reference provides four modes of operation as follows:

1. **Int Ref** Normal waveform function generator operation when in internal reference and the Ext Ref BNC is either left unconnected or connected to +5 Vdc or a TTL high.

2. **Ext Ref** External Reference operation by applying frequency to the Ref In BNC with external reference selected. Frequency input controls frequency of the selected waveform at the output. The output frequency will be 1/1000 the reference frequency. Maximum output frequency is 1100 Hz. When external reference is selected, the display is disabled and blanked.

3. **Manual Hold** at any point on the output waveform by use of the Ref button. Reference mode must be “Int Ref” as above. When Ref button is pressed, the output is stopped. When pressed again, the waveform will start again exactly where it stopped.

4. **Electrical Hold** at any point on the output waveform:

   - When in “Int Ref” operation and 1.1 kHz or below, hold the waveform by applying 0 Vdc or a TTL low to the Ext Ref BNC or through remote contact closure shorting out the BNC.
   - When in “Ext Ref” operation, hold the waveform by removing the external signals at Ext Ref BNC or bringing it to 0 Vdc.

1.2.2 Frequency Precision
Frequency Display Accuracy
±1 count of 1100 counts, which is 0.09% of range. Stabilizer maintains same reading indefinitely.

Time Symmetry
Square waveform variation from 1100 to 100 counts on display less than:

- ± 0.1% to 1100.00 Hz (across bottom five specified ranges),
- ± 1% to 110.00 kHz,
- ± 5% to 11.00 MHz.

1.2.3 Amplitude Precision
Sine Variation with Frequency
Less than:

- ± 0.2 dB on all ranges up through the 10.0 to 110.0 kHz range,
- ± 1.5 dB to 11.00 MHz.

Referenced to 1 kHz.

1.2.4 Waveform Characteristics
Sine Distortion
Less than 0.5% THD up through the 1.00 kHz to 11.00 kHz range and less than 1% THD up through the 10.0 kHz to 110.0 kHz range. All harmonics at least 40 dB
down from the fundamental across the 100 kHz to 1100 kHz range and 28 dB across the 1.00 MHz to 11.00 MHz range.

**Triangle Linearity**
Greater than 99% to 110 kHz.

**Square Wave Rise and Fall Times**
Less than 22 ns at Function Out with 10 Vp-p output into 50Ω.

**Square Wave Total Aberrations**
Each peak less than 5% of p-p amplitude.

1.2.5 **General**
**Output Protection**
Function outputs are protected against a short circuit to any voltage between ±10V dc and also have internal fused protection (both output and common conductors) against accidental application of up to 250 Vac or 350V dc.

**Stability**
**Amplitude, Frequency (Non-Stabilized) and DC Offset:**

After 30 minute warm-up:
± 0.10% of range for 10 minutes,
± 0.50% of range for 24 hours.

**Frequency (Stabilized):**
± 0.10% of range for ≥10 minutes, 0 to 50°C.

**Environmental**
**Temperature Range:** 25°C ± 10°C for spec operation, operates 0°C to 50°C, −20°C to +75°C for storage.

**Warm-up Time:** 20 minutes for specified operation.

**Altitude:** Sea level to 10,000 ft for operation. Sea level to 40,000 ft for storage.

**Relative Humidity:** 95% at 25°C and at sea level (non-condensing).

**Dimensions** — 211 mm (8.3 in.) wide, 86 mm (3.4 in.) high, 305 mm (12 in.) deep.

**Weight** — 3.4 kg (7 lb 1/2 lb) net, 4.5 kg (10 lb) shipping.

**Power** — 90 to 128, 180 to 256V, 48 to 66 Hz, less than 35 VA.

**NOTE**
All specifications apply for display between 1100 and 100 frequency counts; amplitude at 10 Vp-p into 50Ω.
2.1 UNPACKING INSPECTION

After carefully unpacking the instrument, visually inspect all external parts for possible damage to knobs, switches, dials, indicator, connectors, surface area, etc. If damage is discovered, file a claim with the carrier who transported the instrument. The shipping container and packing material should be saved in case reshipment is required.

2.2 ELECTRICAL INSTALLATION

2.2.1 Power Connection

NOTE

Unless otherwise specified at the time of purchase, this instrument was shipped from the factory with the power transformer connected for operation on a 115 Vac line supply and with a 3/8 amp fuse.

Figure 2-1. Fuse and Connector Access
An inspection slot is provided on the top of the guard plate located under the top cover. Remove the top cover by removing the two screws (figure 2-1) securing the wrap-around cover to the guard plate. Look through the inspection slot and check the voltage stamped on the connector. If 115V is visible, the power transformer is connected for operation on a 90 to 128 Vac line supply. If 220V is visible, the power transformer is connected for operation on a 180 to 265 Vac line supply. Make certain the voltage stamped on the connector matches the voltage line supply that is to be used.

If the voltage stamped on the connector does not match the input voltage to be used it will require the rotation of the connector and changing of the fuse according to the following procedure:

1. Remove the three screws attaching the guard plate.
2. Remove the guard plate.
3. Remove the connector from the circuit board, turn it over and reconnect it to the circuit board.
4. Remove the fuse and replace with proper fuse.

Instrument BCN connectors are:
VCG IN — 0 to ±5V; 5kΩ impedance; 0.1V/μs maximum slew rate.
TRIG IN — External TTL compatible signal; 50 ns minimum signal pulse width with a maximum repetition rate of 5 MHz.
EXT REF — External TTL compatible signal; 1.1 MHz maximum repetition rate, 200 ns minimum pulse width. Will also accept contact closure.
SYNC OUT — TTL compatible symmetrical square wave at generator frequency.
FUNC OUT (-20 dB) — Up to 1.00Vp-p into 50Ω impedance; up to 2.00Vp-p into an open circuit.
FUNC OUT (50Ω) — Up to 10 Vp-p into 50Ω impedance; up to 20 Vp-p into an open circuit.

NOTE
Signal ground may be floated up to ±42V with respect to chassis ground. Be aware that all signal grounds are common and must all be floated together.

2.2.3 Initial Checkout

The initial checkout procedure in table 2-2 can be used as a receiving inspection and as a post-repair checkout. This procedure verifies that the instrument is functionally operating correctly (but does not verify correct instrument calibration).

Required tools and test equipment are given in table 2-1.

<table>
<thead>
<tr>
<th>Table 2-1. Tools and Test Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oscilloscope, dual channel, 100 MHz bandwidth</td>
</tr>
<tr>
<td>BNC coax cable, RG58U, 3 ft length (3 each)</td>
</tr>
<tr>
<td>Voltage source, 5 Vdc</td>
</tr>
<tr>
<td>TTL generator, 200 Hz to 1.1 MHz, 5 ms pulses</td>
</tr>
<tr>
<td>50Ω feedthrough, ±0.1% accuracy, 2W</td>
</tr>
<tr>
<td>BNC tee, 1 male, 2 female connectors</td>
</tr>
</tbody>
</table>

Preset the generator front panel controls as follows:

<table>
<thead>
<tr>
<th>Control</th>
<th>Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency knob</td>
<td>cw</td>
</tr>
<tr>
<td>D.C. Offset knob</td>
<td>Off</td>
</tr>
<tr>
<td>Amplitude knob</td>
<td>cw</td>
</tr>
</tbody>
</table>

Connect as in figure 2-2.
Figure 2-2.

Figure 2-3.
<table>
<thead>
<tr>
<th>Step</th>
<th>Control</th>
<th>Operation</th>
<th>Observation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Power button</td>
<td>On</td>
<td>CH1: 10 Vp-p sine</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>CH2: TTL square</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Display: Approximately 1.1 kHz, Sine, Cont, Int. Ref., Haver Off, Stab Off.</td>
</tr>
<tr>
<td>2</td>
<td>Func button</td>
<td>Step to right</td>
<td>CH1: Functions match display.</td>
</tr>
<tr>
<td>3</td>
<td>Func button</td>
<td>Select DC</td>
<td>CH1: 0 Vdc</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Display: 0 kHz</td>
</tr>
<tr>
<td>4</td>
<td>D.C. Offset knob</td>
<td>cw</td>
<td>CH1: $\leq -5$ Vdc</td>
</tr>
<tr>
<td>5</td>
<td>D.C. Offset knob</td>
<td>ccw (not in detent);</td>
<td>CH1: $\geq +5$ Vdc</td>
</tr>
<tr>
<td></td>
<td></td>
<td>return to detent</td>
<td>CH1: 0 Vdc</td>
</tr>
<tr>
<td>6</td>
<td>Function button</td>
<td>Select sine</td>
<td>CH1: 10 Vp-p sine</td>
</tr>
<tr>
<td>7</td>
<td>Frequency knob</td>
<td>ccw; return cw</td>
<td>Display: 1100:1 frequency change</td>
</tr>
<tr>
<td>8</td>
<td>Frequency range</td>
<td>Step right</td>
<td>Display: Frequency increments by decades to 11 MHz</td>
</tr>
<tr>
<td>9</td>
<td>Frequency range</td>
<td>Step left; return to</td>
<td>Display: Frequency decrements by decades to 110 mHz</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.1 kHz range</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Amplitude knob</td>
<td>ccw; return cw</td>
<td>CH1: Approximately 1.00 Vp-p sine</td>
</tr>
<tr>
<td>11</td>
<td></td>
<td>Connect scope as in figure 2-3.</td>
<td>CH1: Approximately 1.00 Vp-p sine</td>
</tr>
<tr>
<td>12</td>
<td></td>
<td>Connect scope as in figure 2-2.</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Func button</td>
<td>Select triangle</td>
<td>CH1: 10 Vp-p triangle</td>
</tr>
<tr>
<td>14</td>
<td>Mode button</td>
<td>Select Trig</td>
<td>CH1: 0 Vdc</td>
</tr>
<tr>
<td>15</td>
<td></td>
<td>Connect scope in figure 2-4.</td>
<td>CH1: Triggered triangle</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>CH2: Trigger input</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Display: Trig selected, numbers blanked</td>
</tr>
<tr>
<td>16</td>
<td>Mode button</td>
<td>Select Gate</td>
<td>CH1: Gated triangle</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>CH2: Trigger input</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Display: Gate</td>
</tr>
<tr>
<td>17</td>
<td>Haver button</td>
<td>On; reset Haver to Off</td>
<td>CH1: Gated Haver triangle</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>CH2: Trigger input</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Display: Hav selected</td>
</tr>
</tbody>
</table>
Figure 2-4.

Figure 2-5.

Figure 2-6.
<table>
<thead>
<tr>
<th>Step</th>
<th>Control</th>
<th>Operation</th>
<th>Observation</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td></td>
<td>Disconnect trigger input (trigger on and display CH1 of scope)</td>
<td>CH1: 0 Vdc</td>
</tr>
<tr>
<td>19</td>
<td>Trigger button</td>
<td>Push</td>
<td>CH1: Continuous triangle as button is pushed</td>
</tr>
<tr>
<td>20</td>
<td>Mode button</td>
<td>Select continuous</td>
<td>—</td>
</tr>
<tr>
<td>21</td>
<td>Func button</td>
<td>Select square</td>
<td>—</td>
</tr>
<tr>
<td>22</td>
<td>Ref button</td>
<td>Select external</td>
<td>Display: Ext Ref, numbers blanked</td>
</tr>
<tr>
<td>23</td>
<td></td>
<td>Connect scope as in figure 2-5</td>
<td>CH1: 1 kHz square (1 cycle)</td>
</tr>
<tr>
<td>24</td>
<td>Ref button</td>
<td>Select internal</td>
<td>CH1: 10 Vp-p square</td>
</tr>
<tr>
<td>25</td>
<td></td>
<td>Connect scope as in figure 2-2</td>
<td>—</td>
</tr>
<tr>
<td>26</td>
<td>Frequency knob</td>
<td>Select 500 Hz</td>
<td>CH1: 500 Hz square (1 cycle)</td>
</tr>
<tr>
<td>27</td>
<td>Scope</td>
<td>X10 magnification.- Adjust position for edge of square wave at center of graticule</td>
<td>CH1: One edge of square</td>
</tr>
<tr>
<td>28</td>
<td>Stab button</td>
<td>Select Stab On</td>
<td>Display: Stab On</td>
</tr>
<tr>
<td>29</td>
<td>Frequency knob</td>
<td>Quickly turn cw until edge moves 2 divisions on scope</td>
<td>CH1: Edge slowly moves back to center of graticule</td>
</tr>
<tr>
<td>30</td>
<td>Frequency knob</td>
<td>Quickly turn cw until edge moves 2 divisions on scope</td>
<td>CH1: Edge begins to move toward center then jumps to left side of graticule. Display: Stab Off</td>
</tr>
<tr>
<td>31</td>
<td>Frequency knob</td>
<td>ccw</td>
<td>Display: Approximately 0.001 kHz</td>
</tr>
<tr>
<td>32</td>
<td></td>
<td>Connect scope as in figure 2-6.</td>
<td>Display: Approximately 1.1 kHz</td>
</tr>
</tbody>
</table>
3.1 OPERATION DEMONSTRATION
These steps display the flexibility and versatility of the Model 21 by demonstrating each front panel control. An external generator and an oscilloscope are needed to verify operation as the Model 21 capabilities are demonstrated.

1. POWER-UP

The three front panel knobs are control potentiometers. They control frequency setting within a range, amplitude of output waveform and dc offset. There is no power-up setting of these three controls, however, all other power-up states are fixed.

Sync Out is a TTL level square wave, TTL compatible signal driven from a TTL gate. It is capable of driving 10 standard LS TTL loads, and is used for synchronizing a scope or driving TTL or CMOS logic directly. Therefore, it can be either a synchronization output or an auxiliary output.

2. FUNCTIONS

<table>
<thead>
<tr>
<th>Setup</th>
<th>Observation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Func button: On right then left</td>
<td>1. CH1: Functions match display annunciator positions.</td>
</tr>
</tbody>
</table>

Comments

Look at the bottom edge of the LCD display and check the functions. The Func button selects sine, square, triangle, ramp up, ramp down or dc by pressing either on the left or right side of the switch. The function annunciator on the display shows your selection.

The power-up frequency range is the highest frequency range that has all functions and all waveforms available. There are four higher ranges and four lower ranges (see paragraph 1.2). In the top four ranges, the Model 21 is a basic analog sine/triangle/square function generator. The ramps and haver functions are not available.

In the lower five ranges, the waveforms are no longer produced by the function generator directly. The function generator runs 1000 times the output frequency. It is a clock source to clock a digital waveform synthesizer. The waveforms are then synthesized so that instead of smooth analog waveforms, each waveform is made up of 1000 steps derived from a counter and digital to analog converter. All functions on the front panel are then available: dc, sine, triangle, square, and the two ramps. In addition, the sine and triangle may be output as haversine and havertriangle.

The Model 21 powers up in a specific mode. When ac power is applied to the instrument a sine wave will be output. The power-up frequency range is the 1100 Hz maximum.
3. DC

Setup  | Observation
1. Func button: DC  | 1. CH1: 0 Vdc  
   | Display: 0 kHz
2. D.C. Offset knob: cw | 2. CH1: ≤ −5 Vdc
4. D.C. Offset knob: Off | 4. CH1: 0 Vdc

Comments
DC voltage and dc offset of waveforms may be as great as ±5V maximum (into 50Ω load). The Off position ensures no offset.

4. FREQUENCY

Setup  | Observation
1. Func button: Select sine | 1. CH1: 10 Vp-p sine
2. Frequency knob: ccw | 2. Display: 1 Hz
3. Frequency knob: cw | 3. Display: 1100:1 frequency change, approximately 1100 Hz

Comments
The breadth of each individual range is 1100:1; therefore, frequency will go from 1 on the display to 1100 as the frequency knob is turned.

Setup  | Observation
1. Freq Range button: Step right | 1. Frequency increments by decades to 11 MHz
2. Freq Range button: Step left | 2. Display: Frequency decrements by decades to 110 mHz
3. Freq Range button: Return to 1.1 kHz range | 3. Display: 1100 Hz

Comments
This generator is capable of going up to 11 MHz, and it downranges in decades so that the top of each range is 11 MHz, then 1.1 MHz, 110 kHz, 10 kHz, 1.1 kHz, 110 Hz, 11 Hz, 1.1 Hz and 110 mHz, the latter is the top of the bottom range. Each one of these ranges has a 1100:1 span. The "in spec" portion of each range extends from 100 to 1100 counts on the display, overlapping and providing continuous "in spec" frequency from 10 mHz all the way up to 11 MHz.

5. AMPLITUDE

Setup  | Observation
1. Amplitude knob: ccw | 1. CH1: Approximately 1.00 Vp-p sine
2. Amplitude knob: Return to cw | 2. CH1: Approximately 10 Vp-p sine

Comments
At Func Out (50Ω) a maximum of 10V peak-to-peak amplitude into a 50Ω load (or 20 Vp-p into open circuit) will be present.

6. TRIGGER AND GATE

Setup  | Observation
1. Func button: Select Triangle | 1. CH1: 10 Vp-p triangle
2. Mode button: Select Trig | 2. CH1: 0 Vdc
Comments

The output is in continuous mode at power-up. The modes gated, continuous, and triggered, can be selected by pressing either on the left or right side of the Mode button. In a mode other than continuous, waveforms will not be output until triggered.

The trigger baseline (Trigger or Gate mode) is at some dc level. If dc offset is zero, baseline is 0 Vdc for the sine or the triangle. For the square wave the trigger baseline is at the lower level of the square wave. For ramp up, the baseline is at the lower level of the ramp. For ramp down, the baseline is at the upper level of the ramp.

Notice the LCD frequency display is blanked when not in continuous mode.

---

Setup  | Observation
---  | ---
1. Mode button: Select Gate  | 1. Gated triangle
2. CH2: Trigger input  | CH2: Trigger input
3. Notice CH1/2 phase relationship  | Notice CH1/2 phase relationship
4. Display: Gate selected, numbers blanked

Comments

Gating occurs starting with the rising edge of the trigger signal and has a duration the same as the width of the positive portion of that trigger waveform. Therefore, it is gated on during the time the waveform is high plus the time required to complete the final cycle.

Setup  | Observation
---  | ---
1. Disconnect trigger at Trig In  | 1. CH1: 0 Vdc
2. Trigger button: Push  | 2. CH1: Continuous triangle as long as button is pushed

Comments

The manual Trigger button produces one complete waveform cycle each time it is pressed when in trigger mode. In gate mode the waveforms are generated continuously as long as the Trigger button is held in.

---

7. HAVERWAVES

Setup  | Observation
---  | ---
1. Haver button: Select On  | 1. CH1: Gated havertriangle
2. CH2: Trigger input  | CH2: Trigger input
3. Notice CH1/2 phase relationship  | Notice CH1/2 phase relationship
4. Display: Haver selected, numbers blanked

Comments

Haver button operates in trigger or gated modes when the generator is in the 1100 Hz range or lower. The haver function can be a triangle or a sine with the trigger baseline down at the bottom of the waveform, −90° phase instead of 0° phase at the center of the waveform. Ramps cannot be selected for haver operation.
8. INTERNAL/EXTERNAL REFERENCE MODES

Setup
1. Connect scope as shown above.
   Mode: Cont
   Func: Sine
   Haver: Select Off
   Ref button: Int

Observation
1. 10 Vp-p sine

Comments
With the Ref button selected to Int and the Ext Ref connector left open or connected to +5 Vdc or a TTL high, the generator is in the normal waveform generation mode with frequency determined by the frequency control and displayed on the LCD display.

Setup
1. Ref button: Ext

Observation
1. Some DC level

Comments
With Ext Ref selected and the Ext Ref connector left open, or brought to dc, waveform generation will hold at an instantaneous point until the external frequency is reactivated. Since there is no reference signal, there is no function output. Change the Ref to Int and the output will start. Change back to Ext Ref and the output will stop. The Ref button is the manual hold switch.
Setup
1. Ref button: Ext
   Function: Square
   TTL Generator: 1 MHz

Comments
With an external frequency applied to the Ext Ref connector and with Ext Ref selected the external frequency will control the frequency of the selected waveform at the output. The external frequency at Ref In will be divided by 1000 to produce the output frequency, for a maximum output frequency of 1100 Hz. When Ext Ref is selected, the frequency display is disabled and blanked.

9. STABILIZER

4. Frequency knob:
   Quickly turn frequency knob cw until edge moves 2 div.

4. Edge slowly moves back to center of graticule

Setup
1. Frequency knob: 1 kH square
   (1 cycle)

Comments
When the stabilizer is turned on, the frequency locks at the display frequency reading. Stabilizer circuits maintain generator frequency at this setting over a range of several percent. Thus, both long and short term frequency stability are improved from their open-loop values to ±1 count (±0.09%) and over the full 0°C to +50°C operating range of the instrument.

Setup
1. Frequency knob:
   Quickly turn cw until edge moves two divisions on scope

2. CH1: Edge begins to move toward center
   than jumps to left side of graticule

Display: Stab Off

Comments
If the stabilizer lock-in range is exceeded by moving the frequency control or by subjecting the instrument to excessive environmental conditions or if generator mode is taken out of continuous or placed in external reference, the generator will automatically deselect stability. While stability is selected the VCG In connector is internally disconnected and cannot modify generator frequency.

10. VCG

Setup
1. Freq knob: ccw
   2. Connect voltage source as shown above

2. Display: Approximately 0.001 kHz

3. Display: Approximately 1.1 kHz
Comments
The VCG (Voltage Control of Generator) is an electronic means of controlling frequency. Zero to ±5 Vdc at VCG in (5kΩ input impedance) controls the frequency across one full range. Therefore, with the frequency control turned fully ccw for 1/1100 of full range frequency, and +5 V applied to VCG in, the frequency is driven to the top of the range.

3.2 CONTROLS AND CONNECTORS
For quick reference, individual control and connector explanations are keyed to figure 3-1.

1 Display
A four digit (1100 count) LCD frequency display. Incorporates annunciators that indicate waveform selection, stabilizer on/off, haverwave on/off, mode, and internal/external reference.

2 Frequency Control
Frequency knob sets the frequency within one of nine ranges set by Freq. Range button. Frequency output is monitored and shown on the LCD display. Control ratio is 1100:1 in each range.

3 D.C. Offset Control
DC voltage and offset of waveforms are controlled by the D.C. Offset knob. Center of the waveform reference (figure 3-2) is skewed positive (up) with clockwise rotation, negative (down) with counterclockwise rotation. Offset and dc voltage maximums are ±5 V (50Ω terminated). A full counterclockwise detent position ensures zero offset.

4 Amplitude Control
The Amplitude knob controls waveform amplitude, dc amplitude and waveform with dc offset amplitude. Maximum amplitude is with the knob fully clockwise (see table 3-1). Amplitude is decreased 20 dB with the knob fully counterclockwise.

<table>
<thead>
<tr>
<th>Function</th>
<th>Open Circuit</th>
<th>50 Termination</th>
</tr>
</thead>
<tbody>
<tr>
<td>~ ~ ~ ~ ~</td>
<td>20 Vp-p</td>
<td>10 Vp-p</td>
</tr>
<tr>
<td>DC</td>
<td>±10 V</td>
<td>±5 V</td>
</tr>
</tbody>
</table>

Table 3-1. Maximum Voltage at 0 dB

Figure 3-1. Controls and Connectors
5 Power Switch
Power is turned on and off with the Power button. The frequency display becomes active when power is turned on. Power-up conditions are:

- Stab: Off
- Func: Sine
- Mode: Cont
- Freq Range: 1100 Hz
- Ref: Int
- Haver: Off
- Trigger: (N.A.)
- Power: On

6 Function Output Connector (50Ω)
The selected function signals 16 are output at the Func Out (50 Ω) connector. Amplitude is controlled by the Amplitude knob. Maximum output is 10 Vp-p into a 50Ω load (20 Vp-p into open circuit). Source impedance is 50Ω.

7 Trigger Switch
In triggered and gated modes 14, the Trigger button triggers a single cycle of waveform output and, in gated mode, gates the output until released. The quiescent output depends on the waveform selection and dc offset (see figure 3-2). A gated cycle started prior to button release is completed.

8 Function Output Connector (−20 dB)
The selected function signals are output at the Func Out (−20 dB) connector. Amplitude is controlled by the Amplitude knob and has a fixed 20 dB attenuation relative to Func Out (50Ω). Source impedance is 50Ω.

9 Haver Switch
The Haver button selects normal 0° (Haver Off) or −90° (Haver On) start/stop phase of triggered sine and triangle (a haverwave; figure 3-2). When the button is pressed the annunciator arrow on the display indicates Haver On or Off. Haver On can be selected only in the trigger or gated modes 14, in the 1100 Hz or lower frequency ranges 13 and with sine and triangle function 16 only.
10 Sync Output Connector
Output is fixed amplitude (0 to about 5V) TTL pulse at
generator frequency. This output can be used as a
synchronizing reference for the Function Outputs.
Phase of the waveforms relative to the sync output is
shown in figure 3-2.

11 Reference Switch
The button provides the selection of internal or exter-
nal reference of waveform output frequency and a
means of holding or releasing the waveform manually.
When this switch is pressed an annunciator arrow on
the display indicates Int or Ext Ref operation. When
operation in the 1100 Hz or lower range with no input
to Ref In connector, this button acts as an instant-
aneous hold; press again to start the waveform at the
same point that it was held. Also see 12.

12 External Reference Connector
The Ext Ref connector accepts either a TTL compati-
ble signal (1.1 MHz maximum repetition rage, 200 ns
minimum pulse width) or contact closure. External
reference allows four modes of operation; two modes
require a signal or switch closure at Ext Ref connec-
tor. The modes are:

Normal waveform function generator operation when
in internal reference 11 and the Ext Ref BNC is either
left unconnected or connected to +5 Vdc or a TTL
high.

External Reference operation by applying frequency
to the Ref In BNC with external reference selected 11.
Frequency input controls frequency of the selected
waveform at the output. The output frequency will be
1/1000 the reference frequency. Maximum output fre-
quency is 1100 Hz. When external reference is
selected, the display is disabled and blanked.

Manual Hold at any point on the output waveform by
use of the Ref button. Reference mode must be “Nor-
mal” as above. When Ref button is pressed, the out-
put is stopped. When pressed again, the waveform
will start again exactly where it stopped.

Electrical Hold at any point on the output waveform:
1. When in “Normal” operation and 1.1 kHz or below,
hold by applying 0 Vdc or a TTL low to the Ext Ref BNC
or through remote contact closure shorting out the
BNC.
2. When in “External Reference” operation, hold by
removing or bringing input to 0 Vdc.

13 Frequency Range Switch
Freq Range stepping switch, when pushed on the left
or right, steps through the sine ranges. The Fre-
quency knob selects the frequency within a range.
Frequency output is monitored by the LCD display.
Each range has an 1100:1 breadth. Refer to
paragraph 1.2 for range specifications. The “in spec”
portion of each range extends from 100 through 1100
counts on the display. “In spec” operation extends
from 100 Hz through 11 MHz. Power-up state is the
1100 Hz range.

14 Mode Switch
The Mode stepping switch, when pushed on the left or
right, steps through the three modes of operation. The
mode selected on the display is indicated by an
annunciator. The modes are:
Continuous — Waveform or dc output is present
unless a hold 11 is applied
Triggered — Output is at 0 Vdc (for square wave,
untriggered output is at lower level of the square)
until triggered 7, 15, at which time one cycle of
waveform is output.
Gated — As for triggered except output continuous
for the duration of the trigger (gate) signal. When
the signal stops, the last waveform cycle started is
completed.

15 Trigger In Connector
The Trig In connector accepts TTL level inputs that
trigger and gate the generator in trigger and gated
modes 14, respectively. A positive-going excursion
triggers or gates the generator operation. A negative-
going excursion ends gated operation. Figure 3-2
shows triggering and gating of the generator
waveforms at time t. When triggered, a full cycle of
the selected waveform is output to its completion.
When gated, and gating is removed (time t2) the last
cycle started is completed (time t3).

16 Function Switch
The Func stepping button, when pushed on the left or
right, steps through sine \( \bigcirc \), triangle \( \bigtriangleup \), square
\( \Box \), ramp up \( \downarrow \), ramp down \( \uparrow \), and dc.
Waveform output is indicated by an annunciator ar-
row on the display. The ramps are not available in the
top four frequency ranges. In these ranges, the Model
21 is a conventional analog generator. When in the
lower five ranges, the waveforms are no longer pro-
duced by the function generator directly. The function
generator runs 1000 times the apparent output fre-
quency and becomes a clock source to clock a digital
waveform synthesizer. The waveforms are then synthesized so that instead of continuous waveforms, each waveform is made up of 1000 steps from a counter. All functions on the front panel are then available — dc, sine, triangle, square, and the two ramps. If haver is selected 9 only sine and triangle functions may be selected. The power-up function is sine.

17 VCG In Connector
DC voltage excursions of up to 0 to ±5 volts at the VCG In connector summed with the Frequency knob control frequency within the selected range. Positive inputs increase and negative inputs decrease frequency. Frequency excursions of 1100:1 are possible when the Frequency knob is either fully clockwise or counterclockwise. VCG allows external sweeping by applying a ramp or external modulating by an alternating signal such as a sine wave. Input impedance is 5kΩ. If frequency stabilization is selected, the VCG In connector is internally disconnected. The generator frequency can follow changes in VCG In voltage with slew rates up to 0.1 volts per μs. This corresponds to maintaining full deviation in frequency for a 1 Vp-p square wave at VCG In with frequencies up to 50 kHz.

18 Stabilizer Switch
The Stab button maintains the generator frequency within ±1 LSD. An annunciator arrow on the display indicates Stab or Off. The stabilizer is automatically deselected whenever the generator mode is taken out of continuous or the external reference is On.