SECTION I
GENERAL DESCRIPTION AND OPERATION

GENERAL

The WAVETEK Model 112 Triggered VCG and the Model 115 Trigger/Phase Lock VCG are semi-precision sources of waveforms from servo to video frequencies. These units are extremely rugged, completely transistorized portable packages. They feature complete plug-in printed circuit board construction with interchangeable individually calibrated PC boards utilizing silicon semiconductors throughout. The extremely clean and stable waveform signals from 0.0015 Hz to 1 MHz makes these generators highly versatile general purpose pieces of equipment for the laboratory or the field.

The Models 112 and 115 are identical in size and performance except that the Model 115 offers phase lock capabilities in addition to the trigger capabilities of the Model 112. Both models feature a main output with function selector switch and amplitude attenuator, and in addition, simultaneous 5 volt peak to peak 50Ω outputs of sine, square and triangle waveforms and 2.5 volt peak ramp waveform. In addition they offer a 1 volt 10 nsec. rise and fall time square wave and - 10 volt sync pulse. There is also a selectable differential output that provides signals identical to but 180° out of phase with the fixed sine, square, triangle and ramp output waveforms. The main output can be selected to be in phase or 180° out of phase with the fixed outputs. Frequency is controlled by an eight position range switch at 20:1 range thus providing good overlap.

All outputs may be shorted simultaneously and the generator will continue to oscillate internally with less than 0.5% change in frequency. Voltage may be applied back into the generator so long as this voltage does not exceed the maximum output voltage. Up to ± 50 volts may be applied to the VCG input without damage.

MODEL 112

The Model 112 features VCG voltage control of frequency by the internal frequency dial operating in parallel with the VCG input terminals. The generated frequency is the resultant sum of the VCG input voltage and the dial setting. Without an externally applied voltage, the dial governs and the generator operates like the basic WAVETEK function generator, the Model 110. By adding a positive voltage to the input terminals, the frequency is increased; by adding a negative voltage to the input terminals, the frequency is decreased. The applied voltage may be either a DC programming voltage or an AC frequency modulating voltage. The modulation band width is 100 KHz (it is possible to have a higher modulation frequency than carrier frequency, with a resultant triangle wave that may look like a staircase).

The frequency dial is a continuously variable quality composition potentiometer. An electronic frequency vernier is incorporated for extremely precise frequency adjustment. The vernier covers one minor dial division for one vernier rotation.

In addition to sine, square and triangle, the Model 112 also offers ramp functions. The base line of this ramp signal is 0 volts and the ramp duty cycle is 50%. The ramp available on the front panel binding post can be selected to be positive or negative going. The ramp on the fixed BNC connector on the rear panel is a negative ramp and the ramp available on the differential output on the rear panel when selected is a positive going ramp.

MODELS 112 and 115; MODELS 112B and 115B

The Models 112 and 115 incorporate a power amplifier which offers the maximum of 32.5 volts peak to peak (plus or minus 16.25 volt ramp) at the front panel binding post output. An attenuator is included on the input of this output amplifier. The amplifier will supply 30 volts peak to peak (15 volt ramp) into a 600n load at maximum output setting. Ten volts peak to peak (5 volt ramp) may be driven into a 50Ω load with undistorted waveform by rotating the output attenuator counter-clockwise until clipping no longer occurs. Very low impedance loads can be driven without distortion by further rotation of the output attenuator in the counter-clockwise direction.

NOTE

When a relatively low output signal is needed, it is recommended that the output be attenuated by an external pair of resistors to a level approximating that required and the internal attenuator be used as the amplitude vernier. Attenuating the output by 10:1, 100:1, or 1000:1, etc. The use of a pair of external resistors will insure clean waveform quality and good resolution by the internal attenuator in low level applications.

The Models 112B and 115B incorporate an internal battery charger in place of the power amplifier. These units will operate continuously for eight hours from the internal batteries. Both may be charged completely in 16 hours. The charger is designed so that charging occurs while the unit is in operation. A screwdriver adjustment enables the operator to set the desired charge rate. In the maximum clockwise position, the charge time from discharge to charge is 14 hours. Frequent operation with the instrument plugged into AC power with the charge rate set this high could result in damage to the batteries. The maximum counter-clockwise position of the rear control sets the charge rate to maintain the batteries at full charge without overcharge. The units are wired so that when plugged into AC power, but turned off, a trickle charge maintains the batteries at full charge setting.

The power amplifier used in the Model 112 and 115 is not utilized in the 112B and the 115B and is thus bypassed. The signal appearing on the binding post in the 112B and 115B is a maximum 5 volt peak to peak (2.5 volt ramp) at a 600Ω ±20% output impedance.

MODELS 112 and 112B; CONTROLS AND TERMINALS

Controls and outputs for the Models 112 and 112B are identical except for the output impedances and voltage levels at the binding posts. For the Model 112, these are 50Ω and 0.600 to 30 volts peak to peak (or, by removing one jumper, an impedance of 600Ω is obtained. Output impedance of the Model 112B is 600Ω ±20% at voltage levels of 0.100 to 5 volts peak to peak (zero to 2.5 volts peak to peak ramp). No zero adjustment is provided for this output on the Model 112B, but internal controls permit setting of the balance of each function independently.

POWER/DIAL MULTIPLIER SWITCH

This switch incorporates two ON positions, X. 3 and Xl. This switch in conjunction with the frequency range switch and the frequency dial, determines the generated frequency. For example, if the dial is set at 3.5, the. frequency range switch setting at X100, and the dial multiplier switch at Xl, the generated frequency is 350 Hz. With the dial multiplier switch at X. 3, the frequency is 105 Hz.

In the Model 112B, when the switch is in the OFF position, the batteries are disconnected from the instrument but connected to the charger. In this position, the charger is set for a trickle charge when the instrument is connected to line power. In the ON position, the batteries are connected to the instrument for normal operation. If the instrument is not connected to the line power, the batteries are discharging; but, if connected, the charger supplies sufficient current to operate the instrument and charge the batteries. The amount of charge current available is variable through the potentiometer at the rear panel. In the maximum counter-clockwise rotation, the charge current is minimum. In the maximum clockwise position, the charge current is maximum. The maximum counter-clockwise position is recommended for optimum battery life unless maximum charge rate is required due to duty use cycle.

CAUTION

If the batteries are allowed to completely discharge, the instrument power supply cannot provide adequate power to simultaneously operate and charge. If this condition exists, the instrument should be allowed to recharge for a period of time before it is used in the AC mode.

FREQUENCY RANGE SWITCH

The frequency range switch selects the appropriate timing resistor and capacitor for proper frequency range.

FREQUENCY DIAL AND FREQUENCY VERNIER

The frequency dial is a high quality composition potentiometer providing continuous frequency control. In addition, an electronic vernier control is provided for precise frequency setting. Complete rotation of the vernier changes the frequency approximately one minor dial division for all settings of the dial. The frequency vernier should be in the extreme clockwise position ("cal") for maximum dial accuracy.

FUNCTION SELECTOR SWITCH, OUTPUT ATTENUATOR, and DC ZERO ADJUST (rear-mounted screwdriver adjustment).

The main output impedance is 50Ω, but the output current is limited to drive approximately ±100 ma into a short circuit. The output at maximum clockwise attentuator position is 32.5 volts peak to peak open circuit and 30 volts peak to peak into a 600Ω load. If the load impedance is less than 600Ω, the attenuator must be rotated counter-clockwise or clipping will result. Maximum undistorted output into a 50Ω load is 10 volts peak to peak.

The output attenuator covers a 30 db range. For output voltages less than 20 db below maximum output, it is recommended that an external attenuator using a pair of resistors be used and the internal attenuator be used as a fine control. For a 10:1 attenuator, use a 470Ω resistor in series with a 56Ω resistor in shunt with the load. For a 100:1 attenuator. use a 1K resistor in series and a 10Ω resistor in shunt with the load; or, 4.7KΩ in series and a 51Ω resistor in shunt with the load (these values are indicative and not critical). The attenuator is located in the input of the output amplifier. As a result, the zero adjust will be most critical at minimum setting. The rear-mounted dc adjustment control should be adjusted with the attenuator in the maximum counter-clockwise position.

The function selector switch selects the function delivered to the main power amplifier and also selects the output available on the differential output BNC connector on the rear panel. The signal delivered to the selected differential output connector on the rear panel is-always 180° out of phase with the associated fixed output on the rear panel no matter what position the function selector switch is in. The output delivered to the front panel binding post, however, can be selected to be in phase or 180° out of phase with the signal delivered to the fixed output BNC connectors on the rear panel.

NOTE

Zero adjust control is a high resolution Zero Adjust Potentiometer, not a dc offset control. A minor modification, however, will allow this control to be used as a dc offset control (see detailed circuit description).

Switch selected sine, square, and triangle waves will have equal peak to peak amplitude for all attenuator settings.

THE 5V TRIANGLE, 5V SINE and 5V SQUARE OUTPUTS

These outputs are accurate 5 volt, 50Ω sources balanced about ground. They will drive 2. 5 volts peak to peak into a 50Ω load and supply ±50 ma peak into a short circuit.

THE 10 NSEC. SQUARE WAVE OUTPUT

The 10nsec. square wave output is approximately 1 volt peak to peak open circuit, and 0.5 volts peak to peak into a 50Ω load with better than 10nsec. rise and fall time. Always use a 50Ω cable and a 50Ω termination when using this output.

SYNC OUTPUT

At least -10 volts sync signal, less than 5 μsec. in pulse width (typically 1.5 μsec. pulse width). The pulse occurs once per cycle coincident with the positive transition of the 5 volt square wave and the positive peak of the sine and triangle waves.

NOTE

Due to its very narrow pulse width, the sync pulse is difficult to observe at low frequencies. However, it will trigger wide band oscilloscopes such as the Tektronix Model 453 at all frequencies.

MINUS 2.5 VOLT PEAK RAMP

The ramp output is a minus going 2. 5 volt output whose base line is at zero volts ±25 mv (5 mv, typical). Open circuit voltage is a 2.5 volt negative going ramp with a duty cycle of 50%. The negative ramp coincides in time with the negative going portion of the triangle wave and the positive half of the square wave.

VCG INPUT

The VCG input permits remote control of dial frequency and frequency modulation. The calibration factor is 0. 5 volts per major dial division. A positive voltage causes an increase in frequency and a negative voltage causes a decrease. The setting of the frequency dial (and the frequency vernier) determines the base frequency. The VCG input impedance is 10KΩ. Up to ±50 volts can be applied to the VCG input without damage.

GATED/CONTINUOUS/TRIGGER MODE SWITCH

The mode switch selects the desired mode of operation. In the continuous mode the generator runs continuously and cannot be gated or triggered. In the triggered mode the generator does not give an output until the manual trigger button is depressed or

an appropriate triggering signal is applied to the front panel. When a triggering signal is received or the manual trigger is depressed, one cycle will be generated on command, the starting point of which will be determined by the start-stop point potentiometer. The generator will complete one cycle and stop when it returns to the point at which it started. In the gated mode the generator is initially OFF. When a triggering signal is applied at the front panel, the generator will generate an integer number of cycles dependent upon the width of the triggering signal applied at the front panel. The starting and the stopping point of the cycles generated is once again determined by the start-stop point potentiometer.

MANUAL TRIGGER BUTTON

The manual trigger button generates one cycle on command when the generator is in the triggered mode. NOTE: Trigger level control should be in its extreme clockwise or counter-clockwise rotation.

TRIGGER INPUT CONNECTOR

A BNC connector on the front panel that allows the triggering signal to be applied to the trigger circuits of the Model 112.

TRIGGER SLOPE/LEVEL CONTROL

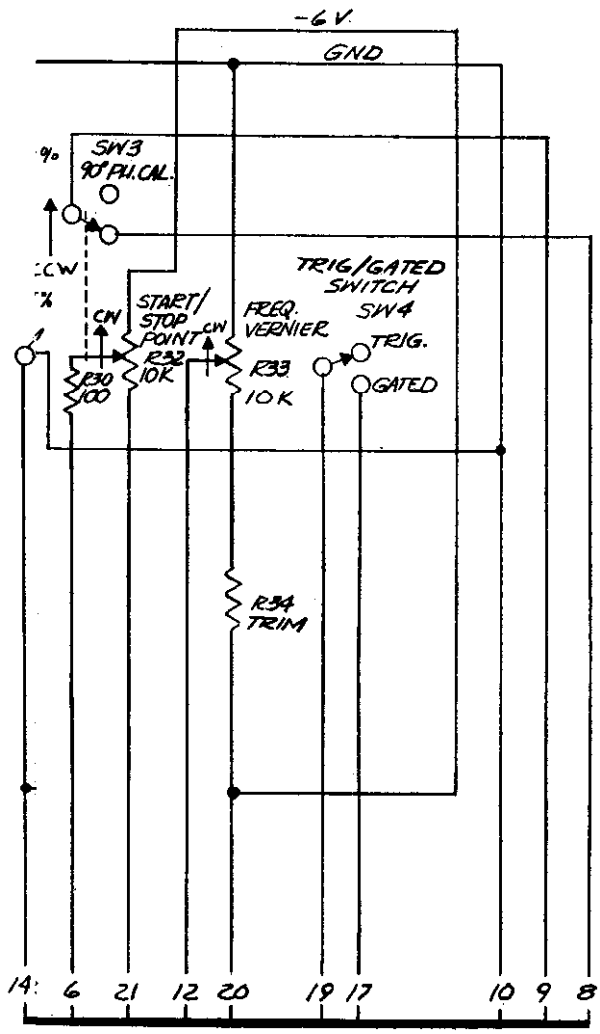
The trigger slope switch allows the operator to select the negative portion or the positive portion of a triggering signal on which it is desired to trigger. The level control allows the operator to select the point on the slope of the triggering signal at which it is desired to trigger. In the gated mode of operation with a sine wave, triangle, etc., as a triggering source, the trigger level control can be adjusted so that the trigger fires at different points on the input triggering signal and the generator will generate a different number of pulses for the same applied frequency and amplitude.

START-STOP POINT CONTROL

The start-stop point control allows the starting point of the integrator to be varied through $\pm 90^{o}$ when in the triggered or gated mode. The start-stop point potentiometer will allow the starting point to go beyond the -90^{o} position in the fully counter-clockwise rotation, and beyond the $+90^{o}$ starting point in the fully clockwise position. To start and stop at -90^{o}, the control can be rotated fully counter-clockwise and then backed-off until the starting point is -90^{o}. The same is true of the $+90^{o}$ position or rotation. This insures that in all frequency ranges the operator will be able to achieve a starting and stopping point of $\pm 90^{o}$. It should be noted that if a start-stop point of $+90^{o}$ is exceeded, the unit will free run.

MODELS 115 AND 115B, CONTROLS AND TERMINALS

The controls, inputs, and outputs of the Model 115 and Model 115B are identical to those discussed for the Model 112 and Model 112B with the following exceptions.



NOTE:

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SCHEMATIC - 2ND SUB PANEL

MODEL: 115 NO.: 115-231 A

PHASE LOCK CONTINUOUS TRIGGERED MODE SWITCH

The Model 115 has all the capabilities of the Model 112 to include the triggered and gated mode of operation. When the mode switch is in the triggered mode, the generator can be operated either in triggered or gated as a separate switch allows selection of either the triggered or gated mode. When the mode switch is in the phase lock mode, the generator can be phase locked to an external signal applied to the input ENC connector on the front panel marked "Trigger/Phase Lock In. " When in the phase lock mode, the trigger level control becomes the "Phase Adjust Control' allowing the phase of the generator signal to be varied from zero to 180° with respect to the signal applied at the front panel. The generator will frequency lock to the applied signal at the front panel and the phase of the generated signal can be varied with respect to the signal applied at the front panel.

TRIGGER PHASE LOCK SLOPE /LEVEL/PHASE CONTROL

In the triggered or gated mode of operation this control performs the same function as was discussed for the Model 112. When the mode switch is in the phase lock position, the slope switch should be placed in the minus slope position and the level control becomes the phase adjust control. In its extreme counter-clockwise rotation: the phase difference with respect to the applied signal at the front panel is zero degrees. In the extreme clockwise position of the phase adjust, the signal generated is 180° out of phase with respect to the signal applied at the front panel connector. Various degrees of phase difference are adjustable throughout this range. If it is desired for phase to be 180° to 360° with respect to the applied signal at the front panel, the out of phase power amplifier output on the front panel can be used or the selected differential output on the rear panel can be used; the phase of these output can be adjusted from 180° to 360° with respect to the signal applied at the front panel.

PHASE "UN-CAL" INDICATOR LIGHT

Although the Model 115 and Model 115B will remain frequency locked over the entire frequency decade, the phase adjust control is calibrated only for a limited range. If the generator is locking to a frequency of 5 KHz, the OFF X. 3 Xl switch should be in the Xl position, the frequency Hz switch in the X1K position, the frequency vernier in the "cal" position, and the dial of the Model 115 at the "5" position for maximum calibrated accuracy of the phase adjust control. The frequency it is desired to be phase locked to can be applied to the input connector on the front panel and the dial rotated through its range until the phase "un-cal" lamp goes out. Continuing to rotate the dial beyond this position will result in it lighting again. For maximum calibration accuracy it is best to have the dia.1 setting in the center of the range where the light is not lit. The phase adjust control can then be used to vary the phase of the output with respect to the applied signal at the front panel.

NOTE

The generator will still frequency lock to the applied signal even though the phase "un-cal" lamp is illuminated.

TRIGGER GATED SWITCH

The trigger gated switch on the Model 115 is concentric with the start-stop point potentiometer and performs the same function of selecting either the triggered or gated mode as discussed for the Model 112. The mode switch, however, must be in the triggered position for the trigger gated switch to be operative.

START-STOP POINT POTENTIOMETER

The start-stop point potentiometer performs the same function in the Model 115 and Model 115B as it did for the Model 112, and that is to select the starting and stopping point of the integrator in the triggered or gated mode. There is an added switch on the rear of the start-stop point potentiometer in the Model 115 and the Model 115B, however. When the start-stop point potentiometer is rotated to its most counter-clockwise rotation, a switch is thrown that places the instrument in the 90^{o} phase lock "cal" mode. The phase control has no effect when the instrument is in the 90^{o} "cal" position.

MODELS 116 and 116B, CONTROLS AND TERMINALS

The Models 116 and 116B controls and terminals are identical to the Models 115 and 115B controls and terminals with the following exception. The trigger gated switch in the Models 115 and 115B is replaced with the triggered cycle switch in the Models 116 and 116B. The external position of the triggered cycle switch in the Model 116 is identical to the gated position of the trigger gated switch with the Model 115. For phase lock operation, the triggered cycle switch should be in the one cycle position. In the triggered mode of operation of the Model 116, if it is desired to gate rather than trigger, the external position of the triggered cycle switch can be selected. If it is desired to generate one cycle, the one cycle position can be selected, and so on, up to 256 cycles. The Model 116 can be triggered either by an external trigger source or by depressing the manual trigger button and a discrete number of cycles generated depending on the setting of the triggered cycle switch. This makes a convenient tone burst generator without requiring an external source. The generator will produce an integer number of cycles as set by the triggered cycle switch.