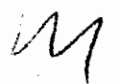


HERMAN McRUSKIN



MAIN GENERATOR

Waveforms: Sine, square, triangle, positive and negative pulses and ramps, AM, suppressed carrier AM, FM, sweep, phase lock, gate, trigger.

Frequency Range: 0.003Hz to 30MHz in 8 ranges.

Frequency Control: Dial calibrated linearly from 1 to 30, and an 8 position pushbutton multiplier switch.

BAND	MULTIPLIER	FREQUENCY RANGE	LOCK CAPTURE AND SWP RANGE
1	.1	0.003Hz-3Hz	0.03Hz-3Hz
2	1	0.03Hz-30Hz	0.3Hz-30Hz
3	10	0.3Hz-300Hz	3Hz-300Hz
4	100	3Hz-3kHz	30Hz-3kHz
5	1K	30Hz-30kHz	300Hz-30kHz
6	10K	300Hz-300kHz	3kHz-300kHz
7	100K	3kHz-3MHz	30kHz-3MHz
8	1M	30kHz-30MHz	300kHz-30MHz

Frequency Accuracy: 2% of full scale on bands 1-7, 3.5% of full scale on band 8.

Frequency Stability:

10 minutes	0.05% bands 1-7
24 hours	0.25% bands 1-6, 1% bands 7-8
vs line	0.01% for 10% line change
jitter (cycle to cycle)	0.025%

Maximum Output: 30V p-p (15V p-p into 50 ohms).

Impedance: Constant 50 ohms, $\pm 2\%$.

Amplitude Control: Pushbutton attenuator calibrated in 20dB steps to 60dB and vernier, dB attenuator accuracy ± 0.2 dB. Minimum output less than 2mV.

DC Component: Zero ± 100 mV, ± 4 mV/ $^{\circ}$ C, reduced in proportion to dB attenuator setting.

Frequency Response: Sinewave, 0.1dB to 300kHz, 0.2dB to 3MHz, 1dB to 30MHz. Triangle, 0.1dB to 300kHz, 1dB to 3MHz, 3.5dB to 30MHz.

Sinewave Distortion: Less than 0.5% 0.1Hz to 300kHz, 2% to 3MHz. All harmonics at least 22dB down to 30MHz.

Squarewave and Pulse: Rise and fall time less than 10ns, total aberrations less than 5% with 50 ohm matching load.

Triangle Linearity: 99% 0.1Hz to 300kHz, 98% to 3MHz, 90% to 30MHz.

Time Symmetry: 99% on bands 1-7, 90% on band 8.

VARIABLE SYMMETRY: Potentiometer for adjusting negative duration of pulses and positive slope of ramps. Main tuning dial controls positive duration of pulses and negative slope of ramps. Symmetry ratio adjustable 100:1.

VC (EXTERNAL VOLTAGE CONTROL): Frequency controlled about the dial setting with zero to ± 3 volts. Range 1000:1. Slew rate 0.2V/us. Impedance 6k ohms. Upper frequency limited to maximum of selected band.

DC OFFSETS:

Fixed offset sets the waveform to one half its p-p amplitude and sets the plus peak at zero for negative offset, and the minus peak at zero for plus offset. Variable offset allows setting about ground to ± 15 volts peak. (Fixed and variable offsets may be used simultaneously; Maximum peak output limited to ± 15 volts).

AUXILIARY GENERATOR

Waveforms: Sine, square, triangle, pulses and ramps.

Frequency Range: 0.3Hz to 300kHz in 5 ranges.

Frequency Control: Single turn dial calibrated linearly from 3 to 30, and a 5 position, pushbutton multiplier switch.

BAND	MULTIPLIER	FREQUENCY RANGE
1	1	0.3Hz-30Hz
2	10	3Hz-300Hz
3	100	30Hz-3kHz
4	1K	300Hz-30kHz
5	10K	3kHz-300kHz

Frequency Accuracy: 10% of full scale.

Maximum Output: 20V p-p (10V p-p into 50 ohms).

Impedance: Constant 50 ohms, $\pm 2\%$.

Amplitude Control: Single turn vernier. Minimum output less than 100mV.

Frequency Response: 0.1dB to 100kHz, 0.2dB to 300kHz.

Sine Wave Distortion: $< 1\%$ to 10kHz, $< 2\%$ to 100kHz, $< 3\%$ to 100kHz.

Square Wave and Pulse: Rise and fall times less than 500ns.

Triangle Linearity: 99%, bands 1-4, 90% on band 5.

Time Symmetry: 98%, bands 1-4, 90% on band 5.

SYMMETRY CONTROL: Sets waveform duty cycle for 10% or 90% and divides output frequency by factor of 10.

MODULATION CHARACTERISTICS

AM and SUPPRESSED CARRIER AM

Modulation Factor: 0% to $> 100\%$.

Modulation Frequency: 0.3Hz to 300kHz, internal. DC to 2MHz external.

Carrier 3dB Bandwidth: .003Hz to 30MHz.

Carrier Distortion (0% MOD): Less than 1% to 300kHz, 2% to 3MHz.

External Input Sensitivity: 4V peak for 100% modulation.

Impedance, 10K ohms.

FM

Deviation: 0% to 20%.

Modulation Frequency: 0.3Hz to 300kHz.

SWEEP CHARACTERISTICS

Range: 100:1

Rate: 0.3Hz to 10kHz (3.33s to 0.1ms)

Start and stop frequencies independently selected by SWP START and SWP STOP controls. Auxiliary Generator frequency and waveform controls determine sweep parameters.

PHASE LOCK CHARACTERISTICS

Locking Frequency Range: $\pm 90^{\circ}$ 10Hz to 300kHz, internal; $\pm 90^{\circ}$ 10Hz to 1MHz, $\pm 75^{\circ}$ to 3MHz, $< \pm 75^{\circ}$ to 30MHz, external.

Capture Range: 1/3 to 30 times Main Generator MULTIPLIER.

External Input: Control calibrated for 4V peak sine or triangle. Minimum voltage, .8V peak. Input Impedance, 100K ohms.

TRIG/GATE CHARACTERISTICS

Manual, internal or external. Waveform start/stop point adjustable $\pm 90^{\circ}$ to 15MHz. Input trigger level variable from -4V to +4V. Triggers on positive slope. Maximum trigger frequency 5MHz. Maximum triggered output frequency, 10MHz. Input impedance 100K ohms.

AUXILIARY OUTPUTS

MAIN GENERATOR:

CV (control voltage) OUT: 2mV to 3 volts, proportional to generator frequency. Accuracy 1% bands 1-7. Impedance, 2.4K ohms.

TTL OUT: Frequency and symmetry same as Main Output. Drives up to 10 TTL loads. Rise and fall time less than 6ns. Total aberrations less than 10%. 180° out of phase with Main squarewave output. Impedance 50 ohms.

AUXILIARY GENERATOR:

TTL OUT: Frequency and symmetry same as Aux Output. Drives up to 10 TTL loads. Rise and fall time less than 50ns. Total aberrations less than 10%. 180° out of phase with Auxiliary squarewave output. Impedance 50 ohms.

GENERAL

Operating Temperature Range: 0° C to 50° C

Power Requirements: Switch selectable 90-110, 108-132, 180-220 or 216-264 volts, single phase, 50-400Hz, 60 watts.

Floating Ground Operation (Rear Panel): Switch disconnects signal ground from chassis ground.

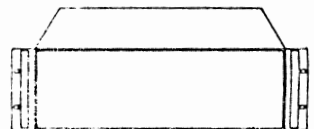
Dimensions and Weights:

Cabinet Size/Weight	H	W	D	Net	Gross
US	5 1/4"	16 5/8"	11 1/2"	13 lbs	15 lbs
Metric	13.3cm	42.2cm	29.2cm	5.9 kgs	6.8 kgs

Specifications apply at 25° C $\pm 5^{\circ}$ C, CONT mode, Main and Auxiliary Generators at maximum output voltage, Main dial set between 1 and 30, Auxiliary dial set between 3 and 30 and both SYMMETRY controls off.

Optional Rack Mounting Kit:

Part No. RK-519; permits installation of the Model 2400 into a standard 19" rack spacing.



Specifications subject to change without notice.

KROHN-HITE
CORPORATION

Avon Industrial Park/Bodwell Street, Avon, Massachusetts 02322
Telephone 617-580-1660 - TWX 710-345-0831

Printed in the U.S.A. --B-80

MAIN GENERATOR

Waveforms: Sine, square, triangle, positive and negative pulses and AM, suppressed carrier AM, FM, sweep, phase lock, gate, trigger.

Frequency Range: 0.003Hz to 30MHz in 8 ranges.

Frequency Control: Dial calibrated linearly from 1 to 30, and an 8 position pushbutton multiplier switch.

BAND	MULTIPLIER	FREQUENCY RANGE	LOCK CAPTURE AND SWP RANGE
1	1	0.003Hz-3Hz	0.03Hz-3Hz
2	1	0.03Hz-30Hz	0.3Hz-30Hz
3	10	0.3Hz-300Hz	3Hz-300Hz
4	100	3Hz-3kHz	30Hz-3kHz
5	1K	30Hz-30kHz	300Hz-30kHz
6	10K	300Hz-300kHz	3kHz-300kHz
7	100K	3kHz-3MHz	30kHz-3MHz
8	1M	30kHz-30MHz	300kHz-30MHz

Frequency Accuracy: 2% of full scale on bands 1-7, 3.5% of full scale on band 8.

Frequency Stability:

10 minutes	0.05% bands 1-7
24 hours	0.25% bands 1-6, 1% bands 7-8
vs line	0.01% for 10% line change
jitter (cycle to cycle)	0.025%

Maximum Output: 30V p-p (15V p-p into 50 ohms).

Impedance: Constant 50 ohms, $\pm 2\%$.

Amplitude Control: Pushbutton attenuator calibrated in 20dB steps to 60dB and vernier, dB attenuator accuracy ± 0.2 dB. Minimum output less than 2mV.

DC Component: Zero ± 100 mV, ± 4 mV/ $^{\circ}$ C, reduced in proportion to dB attenuator setting.

Frequency Response: Sinewave; 0.1dB to 300kHz, 0.2dB to 3MHz, 1dB to 30MHz, Triangle, 0.1dB to 300kHz, 1dB to 3MHz, 3.5dB to 30MHz.

Sinewave Distortion: Less than 0.5% 0.1Hz to 300kHz, 2% to 3MHz. All harmonics at least 22dB down to 30MHz.

Squarewave and Pulse: Rise and fall time less than 10ns, total aberrations less than 5% with 50 ohm matching load.

Triangle Linearity: 99% 0.1Hz to 300kHz, 98% to 3MHz, 90% to 30MHz.

Time Symmetry: 99% on bands 1-7, 90% on band 8.

VARIABLE SYMMETRY: Potentiometer for adjusting negative duration of pulses and positive slope of ramps. Main tuning dial controls positive duration of pulses and negative slope of ramps. Symmetry ratio adjustable 100:1.

VC (EXTERNAL VOLTAGE CONTROL): Frequency controlled about the dial setting with zero to ± 3 volts, Range 1000:1. Slew rate 0.2V/us. Impedance 6k ohms. Upper frequency limited to maximum of selected band.

DC OFFSETS:

Fixed offset sets the waveform to one half its p-p amplitude and sets the plus peak at zero for negative offset, and the minus peak at zero for plus offset. Variable offset allows setting about ground to ± 15 volts peak. (Fixed and variable offsets may be used simultaneously; Maximum peak output limited to ± 15 volts).

AUXILIARY GENERATOR

Waveforms: Sine, square, triangle, pulses and ramps.

Frequency Range: 0.3Hz to 300kHz in 5 ranges.

Frequency Control: Single turn dial calibrated linearly from 3 to 30, and a 5 position, pushbutton multiplier switch.

BAND	MULTIPLIER	FREQUENCY RANGE
1	1	0.3Hz-30Hz
2	10	3Hz-300Hz
3	100	30Hz-3kHz
4	1K	300Hz-30kHz
5	10K	3kHz-300kHz

Frequency Accuracy: 10% of full scale.

Maximum Output: 20V p-p (10V p-p into 50 ohms).

Impedance: Constant 50 ohms, $\pm 2\%$.

Amplitude Control: Single turn vernier. Minimum output less than 100 ~~10~~mV.

Frequency Response: 0.1dB to 100kHz, 0.2dB to 300kHz.

Sine Wave Distortion: $< 1\%$ to 10kHz, $< 2\%$ to 100kHz, $< 3\%$ to 100kHz.

Square Wave and Pulse: Rise and fall times less than 500ns.

Triangle Linearity: 99%, bands 1-4, 90% on band 5.

Time Symmetry: 98%, bands 1-4, 90% on band 5.

SYMMETRY CONTROL: Sets waveform duty cycle for 10% or 90% and divides output frequency by factor of 10.

MODULATION CHARACTERISTICS

AM and SUPPRESSED CARRIER AM

Modulation Factor: 0% to $> 100\%$.

Modulation Frequency: 0.3Hz to 300kHz, internal, DC to 2MHz external.

Carrier 3dB Bandwidth: 0.003Hz to 30MHz.

Carrier Distortion (0% MOD): Less than 1% to 300kHz, 2% to 3MHz.

External Input Sensitivity: 4V peak for 100% modulation.

Impedance, 10K ohms.

FM

Deviation: 0% to 20%.

Modulation Frequency: 0.3Hz to 300kHz.

SWEEP CHARACTERISTICS

Range: 100:1

Rate: 0.3Hz to 10kHz (3.33s to 0.1ms)

Start and stop frequencies independently selected by SWP START and SWP STOP controls. Auxiliary Generator frequency and waveform controls determine sweep parameters.

PHASE LOCK CHARACTERISTICS

Locking Frequency Range: $\pm 90^{\circ}$ 10Hz to 300kHz, internal; $\pm 90^{\circ}$ 10Hz to 1MHz, $\pm 75^{\circ}$ to 3MHz, $< \pm 75^{\circ}$ to 30MHz, external.

Capture Range: 1/3 to 30 times Main Generator MULTIPLIER.

External Input: Control calibrated for 4V peak sine or triangle. Minimum voltage, .8V peak, Input Impedance, 100K ohms.

TRIG/GATE CHARACTERISTICS

Manual, internal or external. Waveform start/stop point adjustable $\pm 90^{\circ}$ to 15MHz. Input trigger level variable from -4V to +4V. Triggers on positive slope. Maximum trigger frequency 5MHz. Maximum triggered output frequency, 10MHz. Input impedance 100K ohms.

AUXILIARY OUTPUTS

MAIN GENERATOR:

CV (control voltage) OUT: 2mV to 3 volts, proportional to generator frequency. Accuracy 1% bands 1-7. Impedance, 2.4K ohms.

TTL OUT: Frequency and symmetry same as Main Output. Drives up to 10 TTL loads. Rise and fall time less than 6ns. Total aberrations less than 10%. 180° out of phase with Main squarewave output. Impedance 50 ohms.

AUXILIARY GENERATOR:

TTL OUT: Frequency and symmetry same as Aux Output. Drives up to 10 TTL loads. Rise and fall time less than 50ns. Total aberrations less than 10%. 180° out of phase with Auxiliary squarewave output. Impedance 50 ohms.

GENERAL

Operating Temperature Range: 0° C to 50° C

Power Requirements: Switch selectable 90-110, 108-132, 180-220 or 216-264 volts, single phase, 50-400Hz, 60 watts.

Floating Ground Operation (Rear Panel): Switch disconnects signal ground from chassis ground.

Dimensions and Weights:

Cabinet Size/Weight	H	W	D	Net	Gross
US	5 1/4"	16 5/8"	11 1/2"	13 lbs	15 lbs
Metric	13.3cm	42.2cm	29.2cm	5.9 kgs	6.8 kgs

Specifications apply at 25° C $\pm 5^{\circ}$ C, CONT mode, Main and Auxiliary Generators at maximum output voltage, Main dial set between 1 and 30, Auxiliary dial set between 3 and 30 and both SYMMETRY controls off.

Optional Rack Mounting Kit:

Part No. RK-519; permits installation of the Model 2400 into a standard 19" rack spacing.



Specifications subject to change without notice.

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Printed in the U.S.A. -- 8-80

SECTION 1

GENERAL DESCRIPTION

1.1 INTRODUCTION

The Krohn-Hite Model 2400, shown in Figure 1-1, is a versatile, AM/FM Phase Lock Generator designed for applications in the sub-audio (.003Hz) to high frequency (30MHz) range.

The Model 2400 is actually two complete generators in one. The Main generator provides sine, square, triangle, ramp and pulse waveforms from .003Hz to 30MHz. The Main Output is 30Vp-p, open circuit, controlled by a calibrated, pushbutton dB attenuator and vernier. Dual DC offset controls provide fixed and/or variable offset capability. The variable SYMMETRY control provides a 100:1 adjustment of the Main Output waveform symmetry ratio, to generate additional pulse and sawtooth waveforms.

The Auxiliary generator provides sine, square, triangle, ramp and pulse waveforms from 0.3Hz to 300kHz. The output is adjustable up to 20Vp-p, open circuit. The SYMMETRY control provides a selection of 90:10, 50:50, or 10:90 duty-cycle for generating additional pulse and sawtooth waveforms.

Each generator may be operated independently, or combined to generate the following functions:

Internally or externally generated AM or suppressed carrier AM signals, with modulation adjustable from 0-100%; FM signals with modulation adjustable from 0-20%; internally, externally, or manually generated pulse and burst type signals, with variable width and rep-rate; continuous, up-frequency or down-frequency sweeps, over a 100:1 range; internally, and externally controlled phase-locked outputs, with locking-capture range of 100:1 and $\pm 90^\circ$ adjustable phase control.

Model 2400 has been carefully inspected, tested, and aged before shipment. If the generator appears to have been damaged in shipment inform the freight carrier of the damage and notify KROHN-HITE or its nearest sales office immediately.

SECTION 2

OPERATION

2.1 INTRODUCTION

This section describes the basic operation of the Model 2400. It includes the proper AC power requirements, the recommended turn-on procedure and a detailed explanation of all operating controls, modes of operation and special features.

2.2 POWER REQUIREMENTS

The 2400 is designed to operate from a single phase, 50-60Hz AC power source of 90-110, 108-132, 180-220, or 216-264 volts. Complementary line switches on the rear panel allow the 2400 to be powered from one of the above 4 voltage ranges. The AC power receptacle, located on the rear panel, is a standard 3-pin connector, and complies with the European I.E.C. standard. A detachable, 3-wire line cord is provided with the instrument.

The fuse receptacle contains a properly rated fuse for the instrument's point of destination power requirements.

2.3 TURN-ON PROCEDURE

a) Check the line switches to make sure they are set for the correct voltage range. Also check to see that a fuse with the correct rating is secured in the fuse receptacle.

<u>AC Line</u>	<u>120V/240V Switch</u>	<u>Norm/Lo Switch</u>	<u>Fuse</u>
90-110	120V	Lo	3/4 Ampere
108-132	120V	Norm	3/4 Ampere
180-220	240V	Lo	3/8 Ampere
216-264	240V	Norm	3/8 Ampere

b) Check to see that the POWER switch on the front panel is in the OFF position.

- c) Secure the 3-wire line cord to the rear panel AC receptacle and plug the line cord into the AC outlet.

WARNING!

The chassis of this instrument is connected to the 3rd wire (earth) ground. For safety purposes, connect the line cord to a suitably grounded, 3 terminal AC outlet.

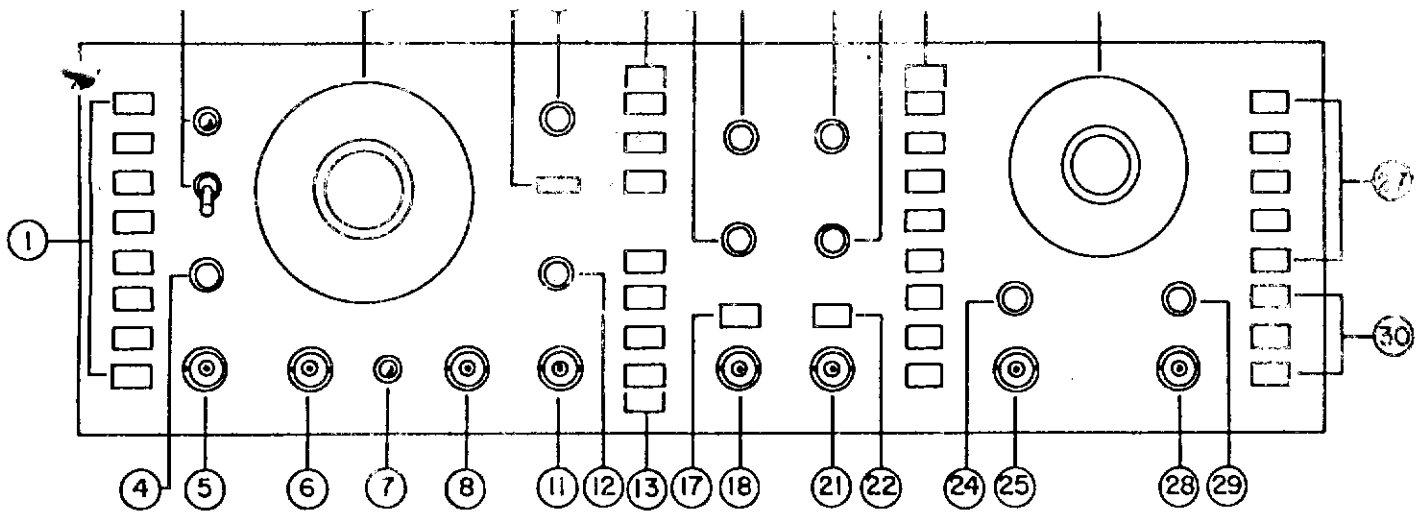
- d) Turn the POWER switch on, and allow the unit to warm up for several minutes.

CAUTION!

The covers of this instrument should not be removed while the instrument is connected to an AC power source because of the potentially dangerous voltages that exist within the unit.

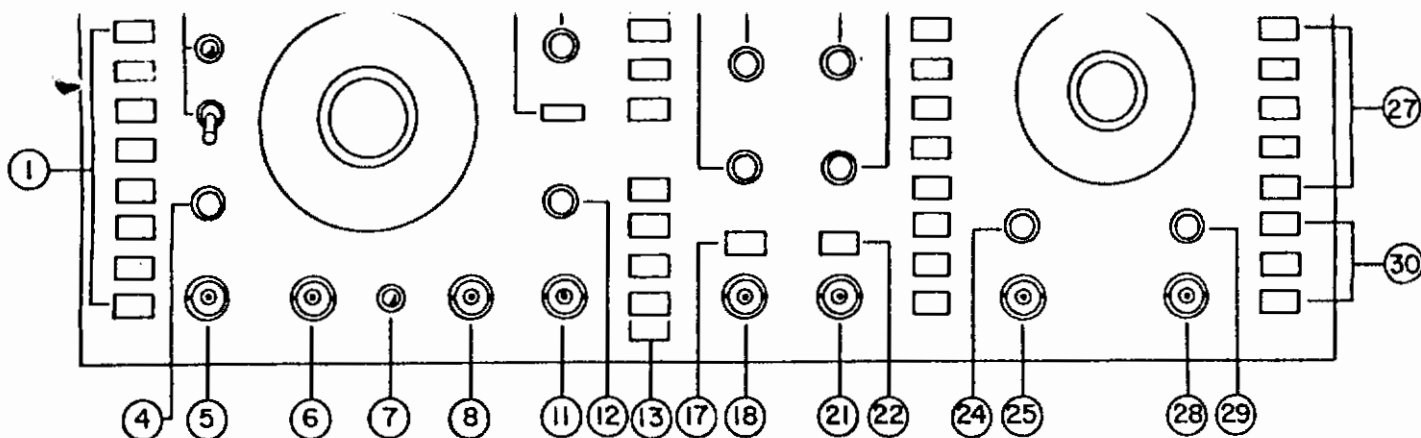
2.4 OPERATING CONTROLS, CONNECTORS AND DISPLAYS (See Figure 2-1)

- (1) MULTIPLIER: 8 station pushbutton control, calibrated in decade steps from 0.1 to 1M, multiplies FREQUENCY Hz dial setting.
- (2) POWER: On-Off toggle switch with power-on indicator.
- (3) FREQUENCY Hz/pos duration/SWP START dial: Adjusts frequency of Main generator in non-sweep mode; adjusts positive waveform duration when Main Generator SYMMETRY used, adjusts start frequency in SWP mode.
- (4) SYMMETRY: Pull-on variable control. Adjusts Main Generator negative waveform symmetry duration, independent of positive duration. Range, 100:1.
- (5) TTL OUT: TTL compatible pulse coincident with Main Generator

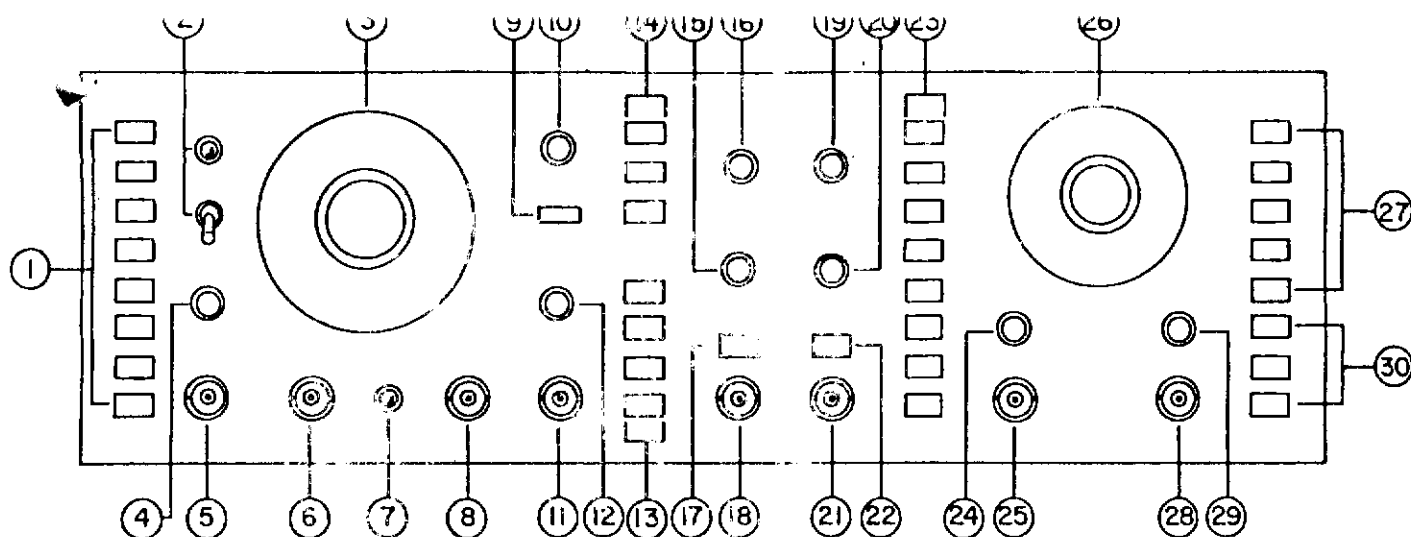


frequency, inverted with respect to MAIN OUT. Rise and fall less than 6ns. Impedance, 50 ohms.

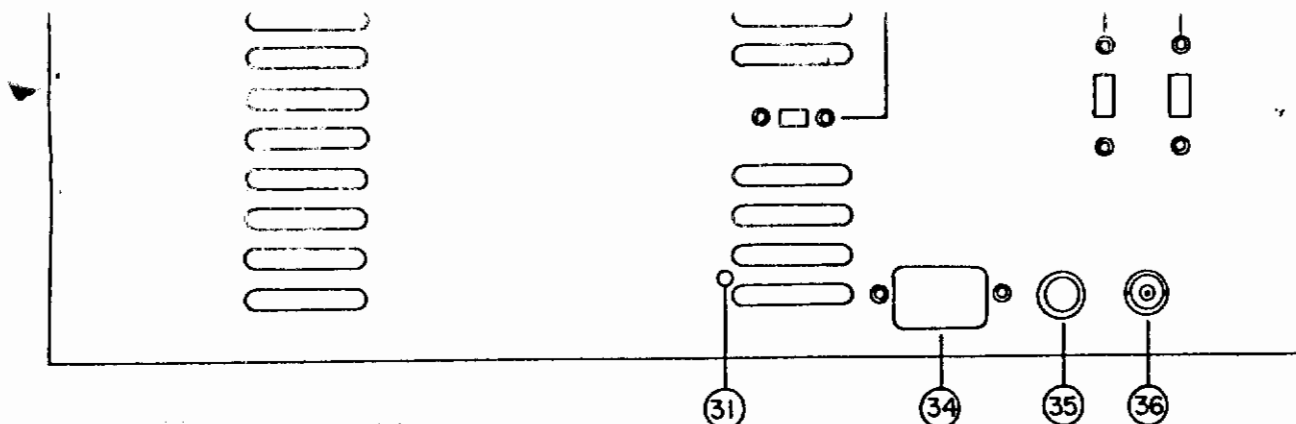
- (6) VC IN: Input for external voltage control of Main Generator frequency. Zero to ± 3 volts gives 1000:1 frequency control, within dial range. Input impedance, 6K ohms. Operative in all modes except \emptyset Lock.
- (7) \emptyset LOCK: LED, indicates when Main and Auxiliary Generator frequencies are phase-locked.
- (8) CV OUT: DC voltage, proportional to main generator frequency, + .2mV to + 3 volts, 1% accuracy over calibrated portion of FREQUENCY Hz dial. Output impedance, 2.4K ohms.
- (9) FIXED DC OFFSET: 3 position slide switch selects zero, or fixed positive or negative offset.
- (10) VARIABLE DC OFFSET: Single turn, pull-on control provides variable adjustment of MAIN OUTPUT offset, ± 15 volts.
- (11) MAIN OUT: Main Generator output, maximum 30V p-p, open-circuit. Impedance, 50 ohms.
- (12) PEAK VOLTS: Single turn potentiometer for controlling the MAIN OUTPUT voltage in each position of the AMPLITUDE ATTENUATOR.
- (13) ATTENUATOR (dB): 4 position pushbutton attenuator, calibrated in dB steps from 0dB to -60dB. Attenuator accuracy, ± 0.2 dB. Minimum output, less than 2 millivolts.



- (14) WAVEFORM: 3 station pushbutton control selects sine, triangle or square waveforms. The selected waveform appears at the MAIN OUTPUT.
- (15) %AM: Single-turn control, adjusts modulation depth, 0%-100% in AM mode; adjusts modulation envelope 0-100% in SUPP CARRIER mode.
- (16) %FM/SWP STOP: Single-turn control, adjusts deviation of Main Generator frequency, 0-20%, in FM mode; adjusts sweep stop frequency in SWP mode.
- (17) Pushbutton Control, depress for external AM mode.
- (18) AM IN: Input for external AM. 4V peak gives 100% modulation, DC to 2MHz. Impedance, 10K ohms.
- (19) TRIG LEVEL/MAN TRIG: Combined single-turn control and push-release switch. Switch manually triggers single cycle of Main Generator dial frequency in (external) TRIG mode; gates Main Generator frequency on in (external) GATE mode. Control varies threshold level at \emptyset LOCK/GATE/TRIG input for (external) TRIG or GATE signal; varies burst on-time in (internal) GATE mode; varies MAIN OUT pulse or single cycle waveform delay with respect to AUX OUT in (internal) TRIG mode.
- (20) LOCK \emptyset /START \emptyset : Single-turn control, varies phase between Main and Auxiliary outputs, $\pm 90^\circ$, in \emptyset LOCK mode; adjusts start/stop point of Main Generator sine or triangle, $\pm 90^\circ$, in TRIG or GATE mode.

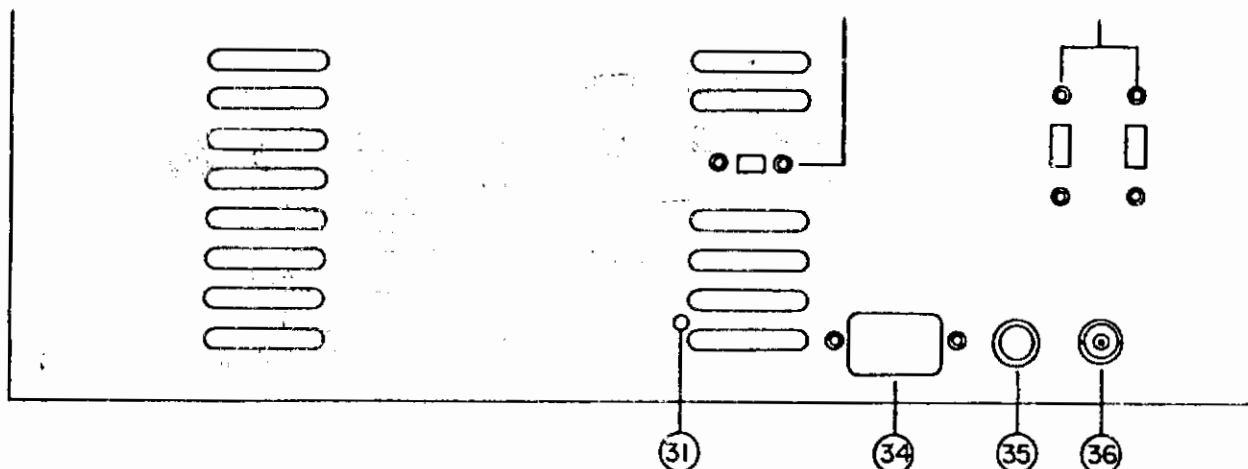


- (21) \emptyset LOCK/GATE/TRIG IN: Input for external \emptyset LOCK, GATE, or TRIG control signal. Input impedance, 100K ohms. For \emptyset LOCK mode, 4V peak in calibrates LOCK \emptyset control range. For TRIG or GATE mode, input trigger level -4V to +4V, maximum rep-rate 4MHz.
- (22) Pushbutton control, depress for external \emptyset LOCK, GATE or TRIG mode.
- (23) MODE: 8-station, pushbutton control selects generator mode of operation. See Section 2.5.3.
- (24) SYMMETRY: 3 position switch, sets duty cycle of Auxiliary Generator waveform at approximately 90:10, 50:50 or 10:90 (Auxiliary generator frequency divided by approximately factor of 10 in 90:10 and 10:90 positions).
- (25) TTL OUT: TTL compatible pulse, coincident with Auxiliary Generator frequency, inverted with respect to AUX OUT squarewave. Rise and fall less than 50ns. Impedance, 50 ohms.
- (26) FREQUENCY Hz DIAL: Adjust Auxiliary Generator frequency; adjusts modulating frequency of Main Generator in AM and SUPP CARRIER modes; adjusts modulation and sweep rates of Main Generator frequency in FM and SWP modes respectively; captures and locks to Main Generator frequency in \emptyset LOCK mode; adjusts pulse and burst rep-rate of Main Generator output in internal TRIG and GATE modes, respectively.
- (27) MULTIPLIER: 5-station pushbutton control calibrated in decade



steps from 1 to 10K, multiplies Auxiliary FREQUENCY HZ dial setting.

- (28) AUX OUT: Auxiliary generator output. Maximum 20V p-p, open-circuit. Impedance, 50 ohms.
- (29) AMPLITUDE, PEAK VOLTS: Single-turn control adjust amplitude of Auxiliary output, up to 20V p-p, open-circuit. Minimum output less than 10mV.
- (30) WAVEFORM: 3 station pushbutton control selects sine, triangle or square waveforms. The selected waveform appears at the AUX OUT.
- (31) DC LEVEL ADJ: Single turn screwdriver adjust for adjusting MAIN OUT DC level.
- (32) CHASSIS/FLOATING: 2 position slide switch that disconnects signal ground ($\frac{1}{\infty}$) from chassis ground (///) when in the FLOATING position.
- (33) Complimentary slide switches for selecting 120 or 240 volt operation, and normal or low line conditions. The 120/240V LINE switch determines the proper voltage range (90-132V or 180-264V), while the NORM/LO LINE switch selects normal (108-132V, 216-264V) or low (90-110V, 180-220V) line voltage.
- (34) AC POWER RECEPTACLE: Standard 3-prong connector. A detachable 3-wire line cord is included.



(35) FUSE RECEPTACLE: 3/4A slow blow fuse for 90-132V operation, 3/8A slow blow fuse for 180-264V operation.

(36) SYNC INPUT: A 2 volt p-p signal applied to this input will lock the Main Generator frequency to the external SYNC frequency within 1 3% locking range. (Not applicable to \emptyset Lock mode).




2.5 OPERATION

2.5.1 Main Generator

- a) The Main Generator produces sine, triangle and square waveforms, and covers a frequency range of .003Hz to 30MHz. The FREQUENCY Hz dial is a single turn dial with a concentric 5:1 vernier, and is calibrated in Hertz on a linear scale from 1 to 30 (.03 to 1 uncalibrated). The effective dial range is 1000:1. The MULTIPLIER is an 8-station, pushbutton control calibrated in decade steps from 0.1 (10^{-1}) to 1M (10^6).

The FREQUENCY Hz dial and MULTIPLIER determine the frequency or period of the MAIN OUTPUT waveform in the AM, SUPP CARRIER, CONT, FM, GATE and TRIG modes. In the SWP mode, the dial determines the sweep start frequency. In the \emptyset LOCK (phase-lock) mode, the dial has no effect; the Main Generator frequency is controlled by the Auxiliary Generator.

The dial also independently controls the squarewave positive duration and sine and triangle negative slopes, when the SYMMETRY-neg duration control is engaged, in all modes except SWP and \emptyset LOCK.

- b) The Main Generator frequency may also be controlled by an external voltage applied to the VC (voltage control) input connector. A control voltage range of zero to 3 volts will vary the Main Generator frequency about the dial setting (within the dial range) up to a maximum of 1000:1 limited by the maximum dial frequency on the MULTIPLIER range selected. The VC voltage will vary the dial frequency at a ratio of approximately 10Hz per volt times the MULTIPLIER setting. The VC has slew rate of 0.2V/us; input impedance is 6k ohms.
- c) The SYMMETRY-neg duration control is a single-turn control that independently varies the Main Generator square wave negative duration and sine and triangle positive slopes. The SYMMETRY ratio is adjustable 100:1 on each MULTIPLIER range. The SYMMETRY control can be used to generate additional pulse or sawtooth waveforms.
- d) The output of the Main Generator is determined by the pushbutton waveform selector. The selected waveform appears at the MAIN OUT connector.
- e) The MAIN OUTPUT voltage is controlled by a single turn PEAK VOLTS control and pushbutton attenuator calibrated 0, 20, 40, and 60 dB steps. Maximum output is 30Vp-p, open-circuit. Output impedance is 50 ohms.
- f) The FIXED DC OFFSET control is a 3 position slide switch that selects fixed positive () , zero () or fixed negative () DC offset. When the FIXED OFFSET is used, the amplitude of the MAIN OUTPUT waveform is halved; the negative peak of the waveform is set at zero for positive offset, and the positive peak of the waveform is set to zero for negative offset.
- g) The VARIABLE DC OFFSET control is a pull-on potentiometer that varies the MAIN OUTPUT DC level $\pm 15V$. The maximum combined peak AC plus DC should not exceed $\pm 15V$, otherwise clipping of the waveform will occur. When both the FIXED and VARIABLE offset controls are used the amplitude of the MAIN OUTPUT waveform will be halved, and is positive or negative peak may be set between zero

and ± 15 volts with the VARIABLE OFFSET control. A particular application for this would be to generate ECL or TTL compatible pulses.

- h) The CV (control voltage) OUTPUT is a DC voltage proportional to the Main Generator frequency. Output is ± 2 mV to ± 3 volts. Accuracy is approximately 1% of output frequency, on bands 1-7 (.1 to 100k) of the MULTIPLIER. Output impedance is 2.4k ohms.

2.5.2. Auxiliary Generator

- a) The Auxiliary Generator produces sine, triangle, and square waveforms and covers a frequency range of 0.3Hz to 300kHz. The FREQUENCY Hz dial is a single turn dial, calibrated in Hertz on a linear scale from 3 to 30 (.3 to 3 uncalibrated). The effective dial range is 100:1. The MULTIPLIER is a 5 station, pushbutton control, calibrated in decade steps from 1 to 10k.

The Auxiliary Generator operates independent of the Main Generator in the CONT mode of operation; in all other modes, the Auxiliary Generator controls the Main Generator as described under Operating Modes, Section 2.3.3.

The Auxiliary SYMMETRY control is a 3 position switch that selects the symmetry of the Auxiliary waveform to 90:10 (\nearrow), 50:50 (\wedge) or 10:90 (\searrow). When the 90:10 or 10:90 position is used the frequency of the Auxiliary generator, as indicated by the dial and MULTIPLIER is divided by 10. The SYMMETRY control is useful for generating additional pulse and sawtooth waveforms.

- b) The output of the Auxiliary generator is determined by the pushbutton WAVEFORM selector. The selected waveform appears at the AUX OUT connector.
- c) The Auxiliary output voltage is controlled by a single turn PEAK VOLTS CONTROL that covers approximately 60 dB of attenuation. Maximum output is 20Vp-p, open-circuit. Output impedance is 50 ohms.

2.5.3. Operating Modes

The Model 2400 provides a selection of 8 basic modes of operation, as determined by the pushbutton MODE selector: AM, SUPP CARRIER, CONT, FM, SWP, Ø LOCK, GATE and TRIG. The AM, Ø LOCK, GATE and TRIG modes may be generated internally by the Auxiliary Generator, or by an external source applied to the respective external input connectors.

- 1) AM MODE: The Main Generator determines the carrier frequency, waveform and amplitude; the Auxiliary Generator determines the modulating frequency and waveshape. The modulation factor (modulation depth) is controlled by the % AM control; the range is 0%-100%. The amplitude modulated wave is at the MAIN OUT connector.

For external AM control, the INT/EXT pushbutton above the external input labelled "AM IN" is depressed; applying a 4V peak AC signal to the AM IN connector will calibrate the % AM control for 100% modulation; the modulation factor may then be controlled by varying the % AM control.

The external voltage to % modulation is approximately linear in relationship, i.e. zero to 4V peak gives 0%-100% modulation.

- 2) SUPP CARRIER MODE: For suppressed carrier operation, depress the SUPP CARRIER mode in addition to the AM mode, and adjust all controls as above.
- 3) CONT MODE: In the CONT (continuous) mode, the Main Generator and Auxiliary Generator are independent of each other.
- 4) FM MODE: In the FM mode, the Main Generator determines the carrier frequency, amplitude, and waveform; the Auxiliary generator determines the modulating frequency and waveshape. The FM deviation is controlled by the % FM/SWP STOP CONTROL, and has a range of 0-20%. The frequency modulated wave is at the MAIN OUT connector.