MODEL 4030

RC OSCILLATOR

OPERATION MANUAL

KIKUSUI ELECTRONICS CORPORATION

CONTENTS

1. GENERAL

The Model 4030 is a Wien bridge oscillator which generates sine and square wave from 20 Hz to 200 kHz. Frequency range is divided into four decade ranges.

The output amplitude of sine-wave is stabilized with AGC circuit using FET. Square-wave is converted from sine wave with schmitt trigger circuit having fast rise-time.

For convenience of output control, the Model 4030 employs continuously variable control and fixed -20 dB/ -40 dB attenuators.

2. SPECIFICATIONS

Power Requirement	90 V ~ 132 V, 50/60 Hz Approx. 3 VA (At AC 100 V)
Weight	Approx. 2 kg
Dimensions	200W x 140H x 120D mm (7.87W x 5.51H x 4.72D in.)
(maximum)	205W x 170H x 150D mm (8.07W x 6.69H x 5.91D in.)
Ambient temperature	5°~ 35° C (41° ~ 95° F), (Humidity: less than 85%)
Frequency Range	20 Hz ~ 200 kHz, 4 ranges x1 20 ~ 200Hz x10 200 ~ 2000Hz x100 2k ~ 20kHz x1k 20k ~ 200kHz
Frequency Accuracy	± (3% + 2Hz)
Output impedance	600Ω ± 10%
Output attenuator	Continuously variable with -20dB (1/10) and -40dB (1/100)
Output terminals	5 way type, 19mm (3/4 in.)
Output waveform	Sine-wave and square-wave
Sine-wave	(At maximum output voltage)
Output voltage	More than 4 V rms (At no load, 25°C (77°F) ambient temp.)
Frequency Characteristics	Within ± 0.5 dB (2kHz reference, 600Ω load)
Distortion (At LOW DIST)	100 Hz ~ 30 kHz less than 0.2% 20 Hz ~ 200 kHz " " 0.5%
Square-wave	(At maximum output voltage)
Output voltage	More than 8 Vp-p (At no load)
Rise time	Less than 0.5μ sec
Overshoot	Less than 2%
Sag	Less than 6% (At 50 Hz)
Accessaries	Instruction manual 1

3. OPERATION

3.1 Explanation of Panel

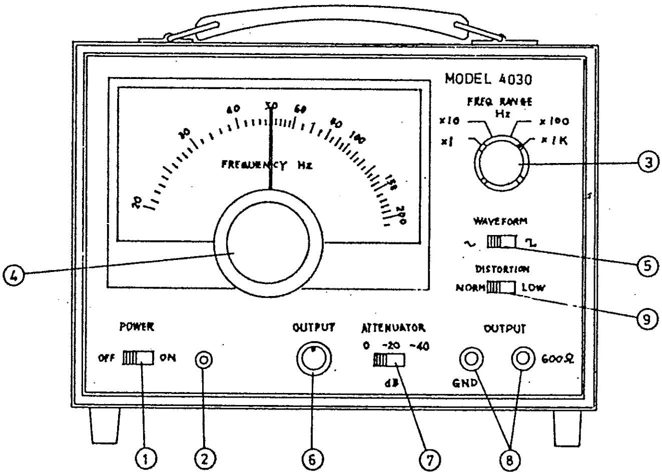


Fig. 1 Panel

① POWER	Power switch. When switching it to the ON position, the power is turned on.
② Power Indicator	When the power on, LED lamp lights.
③ FREQ RANGE Hz	Select for oscillation frequency range. Oscillation frequency is signified by the dial reading multiplied by the factor selected by the FREQ RANGE selector ③ .
④ Frequency Dial	Frequency is continuously variable up to 10 times by this knob.
⑤ WAVEFORM	Selector for output waveform. At left position, sine-wave is obtained. At right position, square-wave is obtained.
⑥ OUTPUT	Output voltage is continuously variable by this knob, and it increases by clockwise rotation.
⑦ ATTENUATOR	Attenuator for output level. 0 dB, -20 dB or -40 dB signifies the attenuator.
⑧ GND, 600Ω	Output terminals. Its output impedance is 600Ω, the black terminal (GND) is grounded to the chassis.

⑨ DISTORTION — When this selector is set in the LOW position, the sine-wave distortion is reduced for the x1 range and x10 range. However, a longer response time is required when the FREQUENCY dial is turned or the RANGE switch is changed, as compared with the NORM mode of operation.
When fast response is required, set the DISTORTION switch in the NORM position.

3.2 Operation

1. Set the POWER switch ① in the ON position, the pilot lamp (LED) lights, and the MODEL 4030 will become the stabilized oscillating state within a few seconds.
2. Setting of frequency
   Set the oscillation frequency required by the FREQ RANGE selector ③ and the dial ④ . The oscillation frequency is signified by the product obtained by multiplying the dial reading by the FREQ RANGE reading.
   Example 1 When selecting 50 kHz
   (1) Set the FREQ RANGE selector in the x1K position.
   (2) Adjust the dial so that scale 50 of it coincides the position.
3. Selection of waveform
   Set the WAVEFORM selector ⑤ to (∼) or (⊓) .
4. Setting of output voltage
   Output voltage is adjusted by the OUTPUT control ⑥ . Output voltage increases with clockwise rotation. Output voltage is decreased by the ATTENUATOR ⑦ . Output voltage adjusted by the output control 6 is decreased by the ATTENUATOR ⑦ (-20 dB, 1/10 or -40 dB, 1/100).

3.3 Caution on Operation

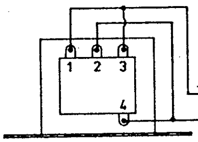
(1) Use the MODEL 4030 within the range of AC 90V ~ 132V.
(2) The specified output voltage-frequency characteristics and so on may become unattainable, when lead wire connected to output terminals is too long. Use short lead wire as long as possible.
(3) The output voltage is affected a little by ambient temperature.
If a constant voltage is required for a long period, check the output voltage with a voltmeter at appropriate intervals.

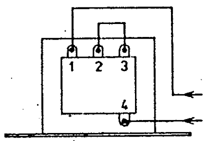
(4) Do not apply DC voltage to the output terminals. Reject DC component by using a capacitor, if neccessary.

(5) Avoid using the MODEL 4030 in dusty environment or highly humid atmosphere.

(6) The MODEL 4030 can be operated with AC 180V ~ 264V by changing the wiring of the transformer.

In this case, change the indication of AC line voltage on the rear panel.





3.4 Example

3.4.1 Measurement of characteristics of audio amplifier

(1) Application of sine-wave signal

The WAVEFORM selector (5) is set in ∿ position

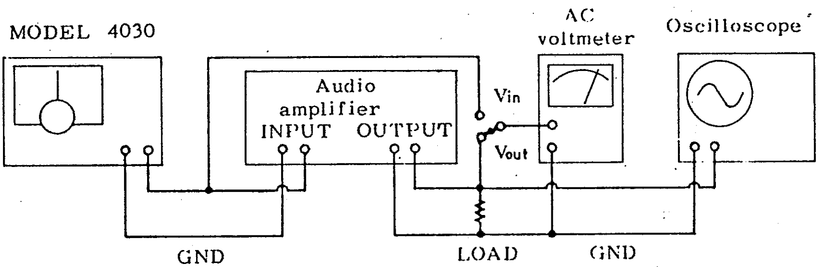


Fig. 2

(a) Input- output characteristics

Set the oscillation frequency to 1 kHz.

Increase slowly the output voltage of the oscillator (input voltage of amplifier) from 0 V and measure the output voltage of the amplifier.

When the input voltage of the amplifier is small. output voltage increases in proportional to input voltage.

The voltage gain G is signified as follows.

$$G = 20 \log_{10} \frac{\text{Output voltage (V)}}{\text{Input voltage (V)}} \text{ (dB)}$$

Output voltage (Vout)

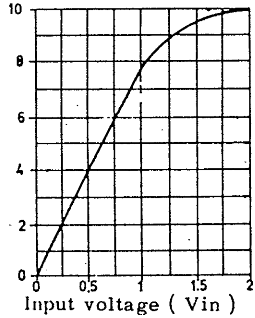


Fig. 3
Input-output characteristics

When input voltage is increased moreover, distortion of output voltage increases. Therefore, the output voltage is not proportional to input voltage in this condition.
The output shortly before begining of increase of distortion is called undistorted maximum output power.
Maximum output power is shown as follows

$$W = \frac{[\text{Undistorted maximum output power (V)}]^2}{\text{Load resistance } (\Omega)}$$

(b) Frequency response

Adjusted the input voltage for appropriate output level within a range in which the output voltage is proportional to input voltage.(Generally,it is selected approximately a half of undistorted maximum output power.)
Frequency response characteristics curve is made by plotting the each output voltage for some inputs of different frequency on semi-logarithm graphic paper.

Output response (dB)

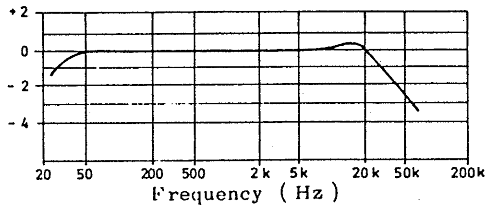


Fig. 4 Frequency response charavteristics

(2) Application of square-wave signal

Apply a square-wave to the input of an amplifier, and observe the output waveform with an oscilloscope. Approximate frequency characteristic can be checked with the waveform.

Set the WAVEFORM selector ⑤ in the ┐└ position, and adjust the input to appropriate level within maximum allowable input voltage.

The characteristics is measured by the same connection as it of item 2.4.1.

Confirm that the quality of the input waveform is right, and observe the output waveform.

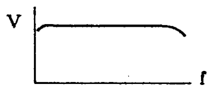
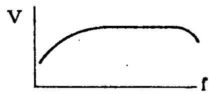
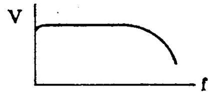
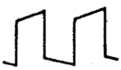
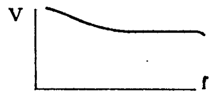
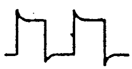
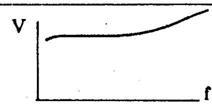
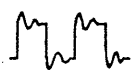
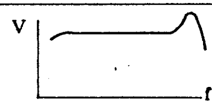
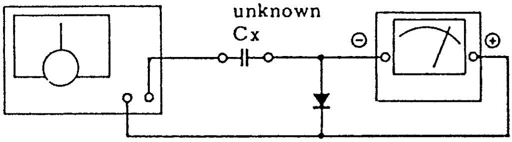
Output waveform	Frequency characteristic of amplifier	
	Flat in a wide range	
	Low frequency attenuation	
	High frequency attenuation	
	Low frequency boost	
	High frequency boost	
	A peak at high frequency	

Fig. 5 Observation of frequency response by square-wave

3.4.2 Utilization as a capacitance meter

A direct-reading capacitance meter is made by connecting a MODEL 4030, a diode and a DC ammeter one another.
Both sine-wave and square-wave are utilized as a signal.
Though meter indication is not in direct proportion to capacitance for a sine-wave, it is in direct proportion to capacitance as shown in Fig. 7, for a square-wave.



OUTPUT ⑥ At maximum clockwise position in general.
WAVEFORM ⑤ ∼ or ⊓⊔
FREQ RANGE ③ } Determined by the capacitance measured.
FREQUENCY ④

Fig. 6 Utilization as a capacitance meter

Scale is calibrated by using some capacitors of which capacitance is known.
It is calibrated by adjusting the frequency of MODEL 4030 so that a meter indicates an appropriate value.
An example of frequency is shown in Table 1.
Its frequency may be changed by set or ambient temperature.

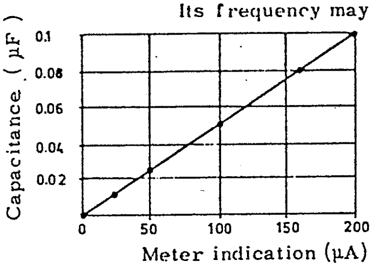


Fig. 7 Example by a squarewave

Full scale	Sine-wave	Square-wave
1000 pF	15.4 kHz	20.5 kHz
0.01 µF	2.01 kHz	2.53 kHz
0.1 µF	215 Hz	374 Hz
1.0 µF	21 Hz	27 Hz

Table 1

4. Principle of Operation

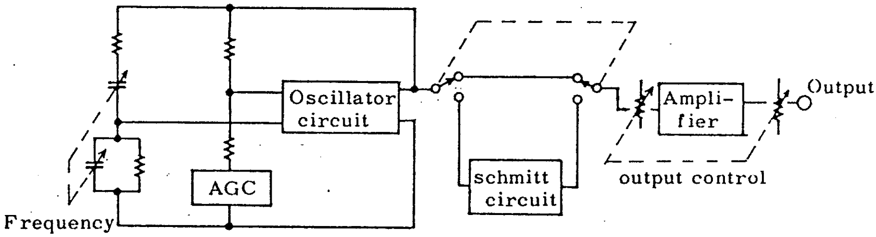


Fig. 8 Block diagram

Among low frequency oscillators, RC oscillators which employ R and C as frequency determing elements are most common. Wien bridge type is most popular. The Wien bridge type has may advantages over other cscillator circuit. Its frequency is easily variable, and it provides a stable output signal waveform with very small distortion.
The MODEL 4030 also employs a Wien bridge circuit. The operating principle of the Wien bridge oscillator circuit is shown in Fig. 9.

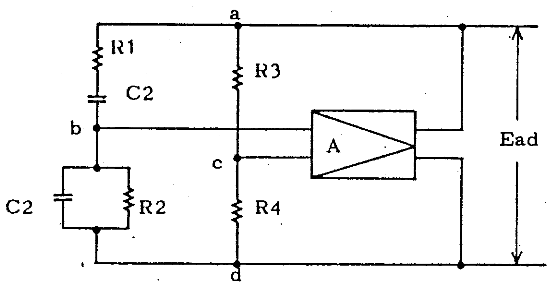


Fig. 9 Wien bridge

Referring to Fig. 9, the phase of Ebc becomes the same with that of Ead . When the below condition is satisfied.

$$f = \frac{1}{2\pi\sqrt{R_1R_2C_1C_2}} \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots \quad (1)$$

The circuit oscillates when the below condition is satisfied.

$$Ebc = \left(\frac{1}{1 + \frac{R_1}{R_2} + \frac{C_2}{C_1}} - \frac{R_4}{R_3 + R_4} \right) Ead \quad \cdots\cdots\cdots\cdots (2)$$

$$\frac{1}{1 + \frac{R_1}{R_2} + \frac{C_2}{C_1}} - \frac{R_4}{R_3 + R_4} \geqq \frac{1}{A} \quad \cdots\cdots\cdots (3)$$

The amplitude of oscillator is stable when the below condition is satisfied.

$$\frac{1}{1 + \frac{R_1}{R_2} + \frac{C_2}{C_1}} - \frac{R_4}{R_3 + R_4} = \frac{1}{A} \quad \cdots\cdots\cdots\cdots (4)$$

The conditions of oscillation are determined by equation (1) and (3), and they do not determine the oscillation amplitude. Therefore, the condition of equation (3) must be maintained until the oscillation builds up to the required amplitude, and then, the circuit must satisfy the condition of equation (4). To accomplish this requirement, the resistance of R_3 or R_4 must automatically vary in response to the oscillation amplitude. This is accomplished by AGC circuit by a FET as R_3.

5. MAINTENANCE

5.1 Internal inspection

To gain access to the chassis, remove 6 screws in the upper side, left side and right side. The case can be removed, and inspection of parts and the other components is easily accomplished.

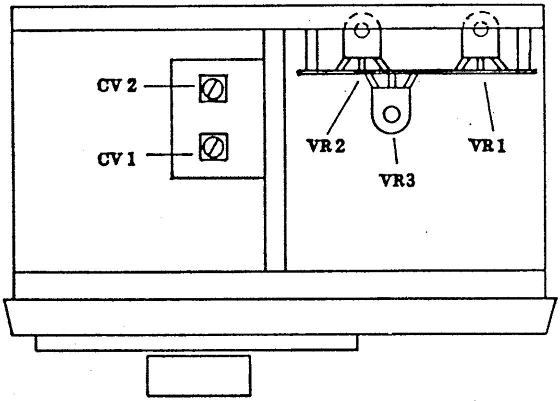


Fig. 10 Location of controls

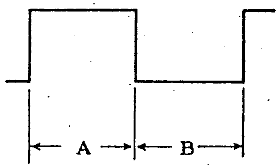
VR1	GAIN ADJ
VR2	Adjustment of distortion
VR3	Adjustment of symmetry of square-wave.
CV1 CV2	Adjustment of frequency and output level of the scale "200" on the frequency dial.

5.2 Adjustment

1. Adjustment of symmetry of square-wave

   Set the FREQ RANGE switch on the panel in the x100 position, and set the WAVEFORM switch in the ⅂L position.

   Observing the output waveform with an oscilloscope, adjust the output waveform by means of semi-fixed resistor VR3 so that length of A and B illustrated below are made equal.



2. Adjustment of frequency

   (a) Setting of scale pointer position

   Set the FREQ RANGE switch in the x100 position, and adjust frequency of output signal with frequency dial knob so as to be 2 kHz. If necessary, reset the scale pointer so as to point the scale 20, and fix it.

   (b) Adjustment of frequency on the scale 200

   Set the scale pointer so as to point the scale 200.

   Adjust the variable capacitors CV1 and CV2 so that the output level is made the same level as the scale 20 on item (a) and the output frequency is made 20 kHz.