Model 6610

1Hz to 10MHz
Precision Phasemeter

KROHN-HITE CORPORATION

Operating Manual

Service and Warranty

Krohn-Hite Instruments are designed and manufactured in accordance with sound engineering practices and should give long trouble-free service under normal operating conditions. If your instrument fails to provide satisfactory service and you are unable to locate the source of trouble, contact our Service Department at (508) 580-1660, giving all the information available concerning the failure.

DO NOT return the instrument without our written or verbal authorization to do so. After contacting us, we will issue a Return Authorization Number which should be referenced on the packing slip and purchase order. In most cases, we will be able to supply you with the information necessary to repair the instrument, avoiding any transportation problems and costs. When it becomes necessary to return the instrument to the factory, kindly pack it carefully and ship it to us prepaid.

All Krohn-Hite products are warranted against defective materials and workmanship. This warranty applies for a period of one year from the date of delivery to the Original Purchaser. Any instrument that is found within the one year warranty period not to meet these standards, will be repaired or replaced. This warranty does not apply to electron tubes, fuses or batteries. No other warranty is expressed or implied.

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Modifications to this instrument must not be made without the written consent of an authorized employee of Krohn-Hite Corporation.

MODEL 6610

1Hz TO 10MHz
PRECISION PHASEMETER

OPERATING AND
MAINTENANCE MANUAL

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SECTION 1
GENERAL DESCRIPTION

1.1 INTRODUCTION

The Model 6610 Precision Phasemeter measures the phase angle between two waveforms of coincident frequency, over a range of 10Hz to 10MHz with a typical accuracy of 0.05° and 0.01° resolution. It will accept a wide range of input signal levels automatically without range switching from 10 millivolts to 320 volts rms, and input waveforms of sine, square, triangle, and pulses of >50ns. A 5 digit, LED display provides continuous direct read-out of phase angles between 0.00° and 360.00°. An analog output provides a dc voltage equal to 10mV/° for use with an external meter or recorder.

The 6610 also provides a RELATIVE measurement mode which allows the monitoring of phase deviations, front panel indicators to indicate a too low/high input voltage range.

The model 6610 is carefully inspected, aged, and adjusted before shipment, and ready for operation when unpacked. If it has been damaged in shipment, make a claim with the carrier and notify Krohn-Hite immediately.

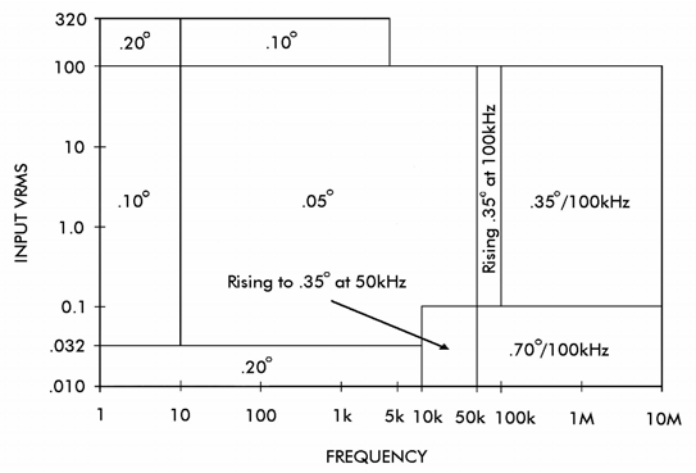
1.2 SPECIFICATIONS

FREQUENCY RANGE: 10Hz to 10MHz (1Hz Optional)

PHASE MODE: Absolute or Relative.

ACCURACY:

Sine Wave:



Square Wave: Double the sine wave specification.

INPUT

Signal Amplitude: Auto ranging from 0.01V to 320Vrms.

Waveforms: Sine, triangle, square and >50ns pulse. (The phasemeter is triggered on the positive going transition of the input waveform. A sine wave on the reference input and a square wave on the signal input is allowed).

Impedance: 1 Meg ohm in parallel with a 50pf.

MAXIMUM DC COMPONENT: ±200 volts.

RESPONSE

Time Constant: >10Hz, less than 500msec; <10Hz, less than 5sec.

Settling Time: To within specified accuracy, within 1 to 8 seconds, dependent on input amplitude and frequency (>10Hz).

DRIFT

Vs. Time: (30 days without CALIBRATE reset) Sine Wave, ±0.025° from 20Hz to 100kHz; ±0.1° at 10Hz; ±0.1° per 100kHz above 100kHz. Square Wave, ±0.025° from 10Hz to 5kHz; ±0.05° to 100kHz; ±0.1° per 100kHz above 100kHz.

Vs Temperature: (Without CALIBRATE reset) ±0.01°/°C, 10Hz to 100kHz; ±0.05°/°C to 1MHz; ±0.05°/°C per MHz above 1MHz.

ANALOG OUTPUT: (for use with an external meter or recorder) 0-3.6 volts DC, 10mV DC/dgree phase, impedance 50 ohms.

DISPLAY: 0.5”, 7 segment, green LED>

DISPLAY RANGES: 0.00° to 360.00° or ±180.00°.

RESOLUTION: 0.01°.

REPEATABILITY: Better Than 0.01°.

POWER CABLE: 7 feet, removable.

DIMENSIONS: 3.5”/(9cm) high, 16.5”/(41.9cm) wide, 16:/(40.6cm) deep.

WIEGHTS: Net 15 lbs/(6.75kg), Shipping 19 lbs/(8.1kg).

AMBIENT TEMPERATURE RANGE: 0°C to 50°C.

FRONT PANEL CONTROLS: POWER, METER RANGE Reference Waveform, Signal Waveform, REL PHASE, CALIBRATE, phase adjust (0°, 180° and 360°).

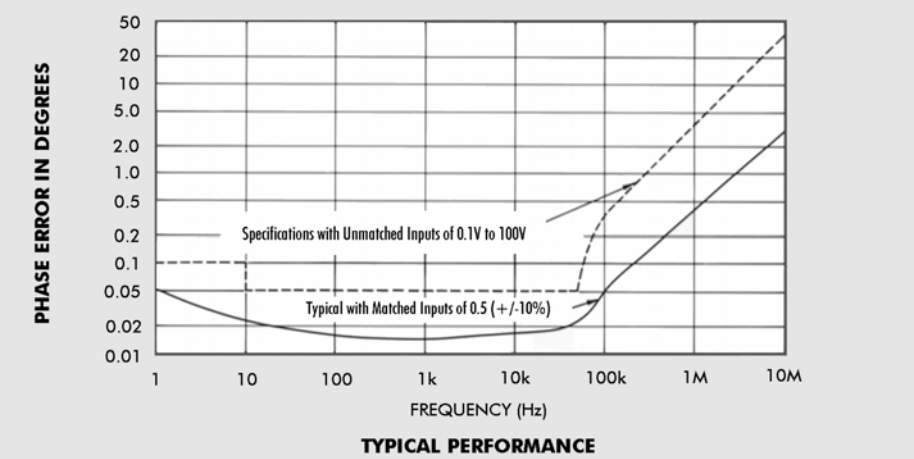
POWER REQUIREMENTS: 90-132V or 198-264V, single phase, 50-400Hz, 40W.

OPTIONS

RK-316: Rack Mount Kit for a standard 19” rack spacing.
Option 001: BCD Output.
Option 002: 1Hz operation.
Option 003: Rear panel BNC connectors for REFERENCE and SIGNAL inputs.

1.3 TYPICAL PERFORMANCE

Typical performance of the Model 6610 is shown in Figure 1.1 with matched inputs. The graph with interrupted lines is the specified response with unmatched inputs over the input range of 0.1 to 100V.



TYPICAL PERFORMANCE

1.4 FACTORS AFFECTING PHASEMETER ACCURACY

1.4.1 INCONSISTENCIES IN METER READING NEAR 0° AND 360°

A problem affecting Phasemeter’s accuracy is the inability of the phasemeter circuit to detect relatively small phase angles, resulting in meter fluctuations or inconsistencies in meter readings. The 6610 overcomes this inconsistency (or ambiguity as it is sometimes referred to) by using a specially designed network that permits measurements as small as 0.01° to be made without meter fluctuations or repeatability errors, and eliminates the need for multiple meter ranges, or shifting of the meter scale.

1.4.2 Noise Present On The Input Signals

Another problem affecting phase accuracy is random noise. If there is a sufficient noise level on either or both inputs, false triggering will occur and a phase error is introduced. The 6610 uses special circuits plus filtering to minimize the effects of noise on the phase accuracy. Typically, any broadband noise present on both inputs 40dB down from the input signals will produce only a 0.05° error. Figure 1.2 gives a typical curve for phase error versus input frequency, for a signal to noise ratio of 10:1 on both inputs.

Figure 1 shows the maximum phase error introduced versus the percentage of harmonic distortion present on each input channel.

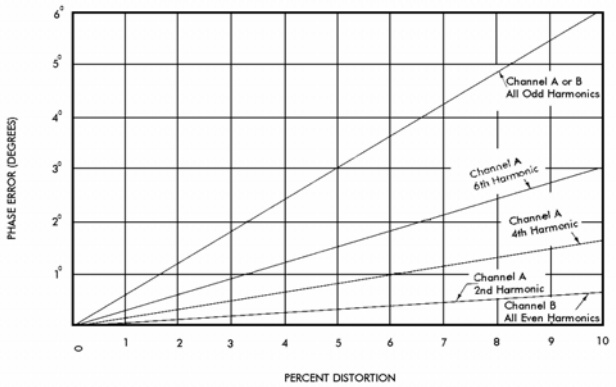


Figure 1 - Maximum Phase Error * vs. % Harmonic Distortion

* (Worst case would occur when the maximum amount of harmonic coincides with the positive zero crossing the fundamental.)

Figure 2 gives a typical curve for phase error vs. input frequency, for a signal-to-noise ratio of 10:1 on both inputs.

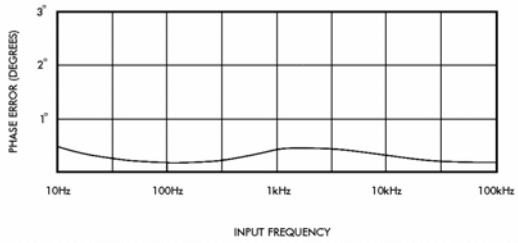


Figure 2 - Phase Error vs. Random Noise

1.4.3 Distortion Present On The Input Signal

If there is distortion present on one of the input signals, a phase error may be introduced, depending upon the relationship between the fundamental and its harmonics. If the amplitude of all the odd or even harmonics add up to zero at the positive zero crossing of the fundamental, then the harmonics will produce no phase error. If the resultant of the amplitudes is not zero, however, it will cause a shift in the zero crossing of the input waveform. Worst case would occur when the maximum of the harmonic coincides with the positive zero crossing of the fundamental. The effect of an even harmonic will not only shift the zero crossing of the waveform, but also alter the symmetry of the comparator or detector output. If the symmetry control loop is added to the phase circuit, the effect of the even harmonic on accuracy can be minimized. The 6610 uses the type of symmetry loop mentioned above.

The effect of an odd order harmonic is not as easily corrected. An odd order harmonic simply shifts the phase of the output of the comparator or detector loop. Since the symmetry is not affected, there is no way to detect any phase error. Figure 1.3 shows the maximum phase error introduced versus the percentage of harmonic distortion present on each input channel.

SECTION 2
OPERATION

2.1 INTRODUCTION

This section describes the basic operation of the Model 6610. It includes the proper ac power requirements, the recommend turn-on procedure and a detailed explanation of all operating controls and modes of operation.

2.2 POWER REQUIRMENTS

The Model 6610 is designed to operate from a single phase, 50-400Hz ac power source of 90-110, 108-132, 198-244 or 216-264 volts. Line switches on the rear panel allow it to be powered from one of the above 4 voltage ranges. The ac power receptacle, on the rear panel, is a standard 3-pin connector and complies with the European I.E.C. standard. The fuse receptacle contains a ¾ ampere slo-blow fuse for 120V operation and a 3/8 ampere slo-blow fuse for 240V operation. A detachable line cord is provided with the instrument.

2.3 TURN-ON PROCEDURE

1. Set the line switches for the correct voltage range and check to see that a fuse with the correct rating is in the fuse receptacle.

   For 90-110 volts, set the 120V/240V switch to 120V and the NORM/LO switch to LO. The fuse should be ¾ amp.

   For 108-132 volts, set the 120V/240V switch to 120V and the NORM/LO switch to NORM. The fuse should be 3/4 amp.

   For 198-244 volts, set the 120V/240V switch to 240V and the NORM/LO switch to LO. The fuse should be 3/8 amp.

   For 216/264 volts, set the 120V/240V switch to 240V and the NORM/LO switch to NORM. The fuse should be 3/8 amp.

2. Make sure that the POWER switch is in the OFF position.

3. Plug the line cord into the unit and into an ac outlet.

4. Turn the power on and allow it to warm-up for several minutes.

CAUTION
For safety purposes, the line cord must be connected to a grounded 3 terminal ac outlet. Because of potentially dangerous voltages that exist within the unit, the cover should be removed by qualified personnel only.

2.4 FRONT PANEL CONTROLS, CONNECTORS AND INDICATORS

POWER:	On/Off toggle switch.
DISPLAY:	5 digit, green LED, 0.55” high.
DISPLAY RANGE:	Selects desired range of AUTO, 0-360°, or ±180°.
LED INDICATORS:	Indicates display range in use; AUTO, 0-360° or ±180°.
REL PHASE:	Indicates phase deviations. When pressed, the DISPLAY will indicate 0.00°.
WAVEFORM:	Selects desired waveform applied to REFERENCE input.
REFERENCE INPUT:	BNC, 10mV to 320Vrms.
LEC INDICATOR:	Indicates REFERENCE input is <10mVrms.
LED INDICATOR:	Indicates REFERENCE input is >320Vrms.
CALIBRATE:	When pressed, the 0° LED indicator will light intermittently. Adjust screwdriver control positioned below 0° LED so DISPLAY indicates 0.00°. When pressed again, the 180° LED indicator will light intermittently. Adjust screwdriver control positioned below 180° LED so that DISPLAY indicates 180.00°. When the 360° adjustment is made in a similar manner, pressing the [CALIBRATE] key will return the unit to normal operation.
0° CONTROL & LED INDICATOR	Indicates control for 0° calibration can be adjusted.
180° CONTROL & LED INDICATOR	Indicates control for 180° calibration can be adjusted.
360° CONTROL & LED INDICATOR	Indicates control for 360° calibration can be adjusted.

WAVEFORM SELECT: Selects desired waveform applied to the SIGNAL input.

SIGNAL INPUT: BNC, 10mV to 320Vrms.

LED INDICATOR: Indicates SIGNAL input is <10mVrms.

LED INDICATOR: Indicates SIGNAL input is >320Vrms.

2.5 REAR PANEL CONTROLS AND CONNECTORS

SIGNAL INPUT: BNC (optional), 10mV to 320Vrms.

REFERENCE INPUT: BNC (optional), 10mV to 320Vrms.

ANALOG OUTPUT: BNC, -1.8Vdc to 3.6Vdc, 10mV/°. Impedance 50 ohms.

LINE: Slide switches to select 120V or 240V operation, and NORMAL or LOW ac lines.

FUSE RECEPTACLE: ¾ amp for 120V operation, 3/8 amp for 240V operation.

AC POWER RECEPTACLE: Standard 3 Pin Receptacle.

2.6 OPERATION

To operate the Model 6610 proceed as follows:

1. Make the appropriate power connections to the unit. Turn the power on and let the unit warm up for at least 30 minutes to achieve the rated accuracy and eliminate any drift that may be caused due to temperature variations.

2. Pressing the key in the CALIBRATE section momentarily will light the 0° LED indicator intermittently. Adjust the screwdriver control below the LED so display indicates 0.00°/

3. Pressing the key momentarily again will light the 180° LED intermittently. Adjust the screwdriver control below the 180° LED so DISPLAY indicates 180.00°.

4. Pressing the key momentarily again will light the 360° LED intermittently. Adjust the screwdriver control below the 360° LED so DISPLAY indicates 360.00°. When the [MAN] key is momentarily pressed, the DISPLAY will return to normal operation.

After the unit has warmed up and the initial calibration was done to the phasemeter, connect the reference signal to the REFERENCE INPUT and the signal to be measured to the SIGNAL INPUT.

NOTE
It is recommended that matched, equal length, coaxial cables be used, as a difference in length may affect the phasemeter accuracy, especially at higher frequencies. As an example, two cables of the same type (approximately 30pf/ft), but differing in length by one foot will create an error at 100kHz of about 0.06°.

When the input cables are connected to the proper inputs, press the WAVEFORM key on each channel to select the desired input waveform. If the [sine] is selected, the phasemeter will measure phase angles between sine waves, a sine and triangle wave, or triangle waves. If the [square] is selected, the phasemeter will measure squarewaves and/or pulses. Pulse widths must be >50ns. It is recommended, however, that when a [sine] is selected with a [square], that the sine wave, which will be the cleanest signal, be connected to the REFERENCE INPUT. If a sinewave is used when [square] is selected, an error of several degrees can be expected.

After selecting the proper WAVEFORM, check to see that the LED above the REFERENCE and SIGNAL inputs are off. When the input voltage is less than 10mV rms (<.01V) or greater than 320V rms (>320V), the appropriate LED will light to indicate the too low/high condition. If either LED is on, adjust the input voltage level until the LED turns off.

When the input voltages are adjusted to within the limits of the phasemeter, select the METER RANGE. There are three modes of operation; AUTO, 0-360°, and ±180°.

1. AUTO In this mode, the phasemeter will switch ranges automatically between 0-360 or ±180. If the phasemeter is in the 0-360 range, and the phase angle being measured is approaching 10.00° or 350.00°, the phasemeter will automatically switch to ±180 range. When in the ±180° range and the phase angle being measured approaches +170.00° or –170.00°, the phasemeter will automatically switch to the 0-360° range. This feature allows the user to continuously measure phase angles without interruption.

2. 0-360 This range will measure phase angles between approximately –5.00° and 365.00°. For phase angle measurements exceeding 360.00°, the DISPLAY will remain in the 360.00° range until the reading is approximately 365.00°. The phasemeter will then switch to the low end of the range, and the display will indicate a phase of approximately 5.00°.

   Conversely, if the phase angle being measured is less than 0.00°, the DISPLAY will remain in the 0.00° range until the reading is approximately –5.00°. The phasemeter will then switch to the high end of the range, and the DISPLAY will indicate approximately 355.00°.

3. ±180 This range operates in the same manner as the 0-360° range, and will measure phase angles between approximately –185.00° and +185.00°. For phase angle measurements exceeding +180.00°, the DISPLAY will remain in this range until the phase is approximately +185.00°. The phasemeter will then switch to the –180.00° range and the DISPLAY will indicate approximately –175.00°.

   Conversely, if the phase angle being measured exceeds –180.00°, the DISPLAY will remain in the –180.00° range until the reading is approximately –185.00°. The phasemeter will then switch to the +180° range, and the DISPLAY will indicate approximately +175.00°.

2.7 DEVIATION MEASUREMENTS

The Model 6610 provides a mode for measuring relative phase deviations. When the [REL PHASE] key is pressed, the phasemeter display will indicate 0.00°. This is the reference point of the phasemeter. When the signal changes in phase, the DISPLAY will indicate phase deviation of the signals being measured.

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SECTION 3
DIGITAL INTERFACE

3.1 BCD OPTION

The Model 6610 with the BCD option is equipped with a digital data connector (Amp type 206604-1), mounted on the rear panel, that provides an equivalent BCD output of the front panel display, including polarity. A total of 15 data lines, 4 control lines, plus 5 lines of ground return are provided.

A total of 14 lines are used to provide the BCD equivalent output of the 4 digit, front panel display. Each digit, with the exception of the 100's digit, is represented by 4 output lines, and is binary-coded in a 1-2-4-8 format. The 100's digit is represented by 2 lines, coded in a 1-2 format.

3.2 OUTPUT CONNECTOR PIN CONNECTIONS

Pin #	Function	Description
1	Chassis Ground	
2	Digital Ground	
3	Digit 1 Disable (LSD)	
4	Digit 2 Disable	
5	Digit 3 Disable	
6	Digit 4 Disable (MSD)	
7	Digit Ground	
8	000.1	
9	000.2	
10	000.4	
11	000.8	
12	Digital Ground	
13	Digital Ground	
14	001.0	
15	002.0	
16	004.0	
17	008.0	
18	010.0	
19	020.0	
20	040.0	
21	080.0	
22	100.0	
23	200.0	
24	Polarity (+/-)	"High" for positive angle. "Low" for negative angle.
25	No Connection	

The logic levels for all OUTPUT lines are 0V < Low > 0.5V; Isink = 10ma.
2.4V < High > 5.0V; Isource = .5ma.

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SECTION 4
INCOMING ACCEPTANCE

4.1 INTRODUCTION

The following procedure should be used to verify that the Model 6610 phasemeter is operating within specifications. These tests may be used for incoming acceptance and periodic performance checks. The procedure should be followed in sequence, with the covers in place, and the phasemeter operating for ½ hour to reach thermal equilibrium.

Before testing, follow the operation procedure in Section 2 of this manual. If not operating within specifications, refer to Section 5, Calibration, before attempting any detailed maintenance.

NOTE
As an alternate to the following procedure, a Primary Phase Angle Standard, such as the Dytronics Model 311/RT-1/717S may be used for accuracy measurements between 30Hz and 0kHz. Another alternative is the use of a Computing Counter System, such as the HP Model 5360A when used with a suitable phase shifting circuit.

4.2 TEST EQUIPMENT REQUIRED

The test equipment below is required to perform the following tests.

a. Low Distortion Oscillator: frequency range from 1Hz to 100kHz with quadrature output. Distortion <0.01% from 10Hz to 20kHz rising to 0.1% at 100kHz. Krohn-Hite Model 4024A or equivalent.
b. RC Oscillator: frequency range from 10Hz to 10MHz with balanced output. Two Krohn-Hite Model 4300B (operating in synchronism as shown in Figure 4.1) or HP Model 654A.
c. Variable Phase Generator: adjustable phase angle from 0° to 360°. HP Model 203A or equivalent.
d. DVM: Fluke Model 8012A or equivalent.
e. Matched set of coaxial cables (BNC) of the same type and length.

4.3 PROCEDURE

4.3.1 Display Calibration

After the Model 6610 has been operating for a minimum of ½ hour, with covers in place, proceed with calibration.

1. Pressing the key in the CALIBRATE section momentarily; will light the 0° LED indicator intermittently. Adjust the screwdriver control below the LED so DISPLAY indicates 0.00°.
2. Pressing the key momentarily again, will light the 180° LED intermittently. Adjust the screwdriver control below the 180° LED so DISPLAY indicates 180.00°.
3. Pressing the key momentarily again, will light the 360° LED intermittently. Adjust the screwdriver control below the 360° LED so DISPLAY indicates 360.00°. When the key is momentarily pressed again, the DISPLAY will return to normal operation.

4.3.2 Low Frequency Sinewave Check

Connect the output of the low-distortion oscillator, with matched cables (same type and length), to both the REFERENCE and SIGNAL inputs. Set both waveform selectors of the phasemeter to the sinewave mode, the oscillator frequency to 100Hz and its amplitude to 0.5Vrms. Set the phasemeter to the ±180° meter range. The DISPLAY should indicate 0.00° ±0.05°. Set the phasemeter to the 0-360° meter range. The DISPLAY should indicate 0.00° ±0.05°. Press the key in the CALIBRATE section until the 360° LED lights intermittently. Wait for a few seconds for the DISPLAY to stabilize and then press the key momentarily to return the phasemeter to normal operation. The DISPLAY should indicate 360.00° ±0.05°. Repeat this procedure to 10Hz, 1kHz, 10kHz and 50kHz, and amplitude of 1.5Vrms and 5Vrms.

4.3.3 High Frequency Sinewave Check

Connect the output of the RC oscillator, with matched cables to both inputs. Set the oscillator frequency to 100kHz and its amplitude to 0.5Vrms. Set the phasemeter to the ±180° meter range. The DISPLAY should indicate 0.00° ±0.35°. Set the phasemeter to the 0-360° meter range. The DISPLAY should indicate 0.00° ±0.35°. Press the key in the CALIBRATE section until the 360° LED lights intermittently. Wait a few seconds for the DISPLAY to stabilize and then press the key momentarily to return the phasemeter to normal operation. The display should indicate 360.00° ±0.35°. The same specifications apply when the above procedure is repeated at an amplitude of 1.5Vrms. Repeat the above procedure at 500kHz and 1MHz. The DISPLAY tolerance should be ±2° at 500kHz and ±4° at 1MHz.

4.3.4 Quadrature Low Frequency Sinewave Check

Connect the output of the low distortion oscillator to the REFERENCE input and the quadrature output to the SIGNAL input. Set the meter range of the phasemeter to 0-360°, the oscillator to 100Hz and the amplitude of both outputs to 0.5Vrms. Record the phase reading.

Reverse the inputs and record the phase readings. The sum of both readings should be 360° ±0.10°. The tolerance of this sum is twice the specified accuracy of 0.05°. Repeat this procedure at 1kHz, 10kHz and 50kHz.

4.3.5 Balanced High Frequency Sinewave Check

Connect the output of one RC oscillator to the REFERENCE input of the phasemeter and the output of another RC oscillator to the SIGNAL input. Set both RC oscillators to the sine wave mode. Balanced output, as shown in Figure 4.1, is obtained by synchronizing the two oscillators. Set the meter range of the phasemeter to 0-360°, both oscillators to 100kHz and their amplitudes to 0.5Vrms. Fine tune one oscillator, by monitoring both oscillators on a suitable scope, to obtain balanced output. Record the phase reading.

Reverse the two inputs and record the phase reading. The sum of both readings should be 360.0° ±0.7°. The tolerance of this sum is twice the specified accuracy of 0.35°. Repeat this procedure at 500kHz and 1MHz. Tolerance of the total reading is ±3.5° at 500kHz and ±7° at 1MHz.

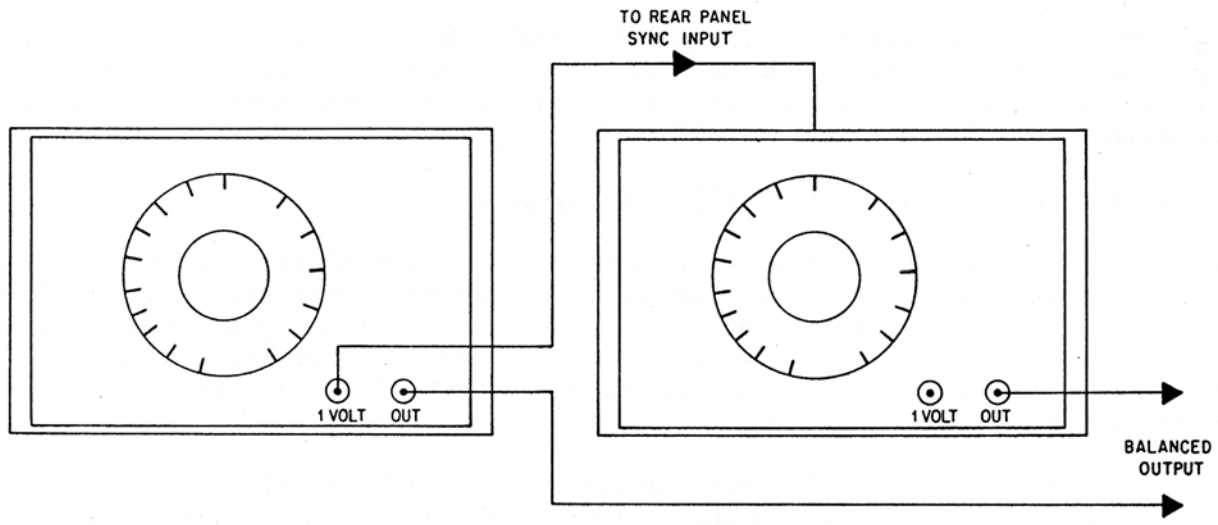

Figure 4.1 Synchronized RC Oscillators

4.3.6 Balanced Low Frequency Squarewave Check

Connect two RC oscillators as in 4.3.5. Set both oscillators to the square wave mode, both oscillators to 100Hz and their amplitudes to 1.5Vrms. Fine tune one oscillator, by monitoring both oscillators on a suitable scope, to obtain balanced output. Record the phase reading.

Reverse the two inputs and record the phase reading. The sum of both readings should be 360.00° ±0.2°. This tolerance of this sum is twice the specified accuracy of 0.1°. Repeat this procedure at 10Hz, 1kHz, 10kHz and 50kHz. Tolerance for the sum of these frequencies is also 30° ±0.2°.

4.3.7 Balanced High Frequency Squarewave Check

Connect two RC oscillators as in 4.3.5. Set both oscillators to square wave mode at a frequency of 100kHz and their amplitudes to 1.5Vrms. Fine tune one oscillator, by monitoring both oscillators on a suitable scope, to obtain balanced output. Record the phase reading.

Reverse the two inputs and record the phase readings. The sum of both readings should be 360.00° ±1.4°. The tolerance of this sum is twice the specified accuracy of 0.7°. Repeat this procedure at 500kHz and 1MHz. Tolerance of the total reading is ±7° at 500kHz and ±14° at 1MHz.

4.3.8 Analog Output Check

Connect the sinewave outputs of a variable phase generator, or two Krohn-Hite Model 4300B oscillators operating in synchronism, to the phasemeter inputs. Set both oscillators or variable phase generator to 1kHz at 1Vrms. Connect the DVM in the DC mode to the rear panel analog output connector. Set the variable phase generator for 180° or adjust one of the Model 4300B oscillators to obtain 180° phase shift, as shown on the DISPLAY of the phasemeter. The DVM should indicate 1.8Vdc. When the oscillators or generator are set to 170°, as shown on the phasemeter, the analog output should drop to 1.7Vdc or 10mV/degree. This will apply to any phase angle between 0° and 360°.

4.3.9 Relative Phase Check

If the phasemeter is set to the RELATIVE PHASE mode, the DISPLAY should switch from its initial phase to 000.00° and permit phase deviation measurements relative to its initial phase. When returned to normal mode, the DISPLAY should indicate the original phase.

4.3.10 BCD Output Check (Optional)

The BCD output can be checked out by inputting a known phase and monitoring the appropriate pin-out on the rear panel BCD output connector. Section 3.8 provides detailed information about the BCD and its output pin connections. If a suitable variable phase generator is not available, two Krohn-Hite Model 4300B RC oscillators, synchronized as shown in Figure 4.1, will provide variable phase over a limited range.

Set the phasemeter to 0-360° range and both oscillators to 1kHz at 5Vrms output. Monitor pin 3 of the BCD output connector with a DVM and fine tune one oscillator so DISPLAY varies from 180.00° to 180.01°. Pin 3 should be "low" at 180.00° and "high" at 180.01°. It will also be "high" when the least significant digit is 3, 5, 7 or 9. This procedure can be used to provide phase variation up to approximately±80° to check out all pin-outs.

A simple procedure that uses only the 360° front panel screwdriver calibration control of the phasemeter, will check out most pin-outs simultaneously. If the phasemeter is set to the 0-360° range and the [CALIBRATE] key is pressed until 360° LED is on intermittently, the DISPLAY should indicate 360.00° and the 200, 100, 40 and 20 pin-outs should be in the "high" position. If the 360° screwdriver control is then adjusted for a DISPLAY of 359.77°, the 200, 100, 40, 10, 8, 1, 0.4, 0.2, 0.04, 0.02 and 0.01 pin-outs should be "high". By adjusting the control for a DISPLAY of 359.99°, the 200, 100, 40, 10, 89, 1, 0.8, 0.1, 0.08 and 0.01 pin-outs should be "high". This procedure, repeated in the ±180° meter range, will check out all the pin-outs except 2 and 4.