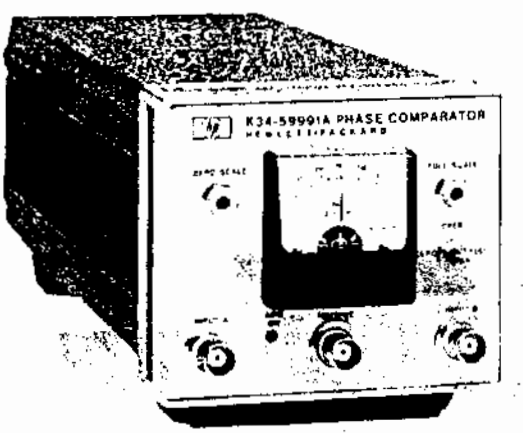
HEWLETT PACKARD

OPERATING AND SERVICE MANUAL

K34-59991A

BROADBAND LINEAR PHASE COMPARATOR

H-P K34-5999I-A



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HEWLETT-PACKARD COMPANY 5301 STEVENS CREEK BLVD., SANTA CLARA, CALIF. 95050

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

This manual contains operating and service information for the K34-59991A Broadband Linear Phase Comparator. Included is a general description, specifications, operating information, adjustments, theory of operation, replaceable parts list, and schematic diagram.

DESCRIPTION

The K34-59991A is a special instrument, which compares the phase relationship of two input frequencies and outputs a DC voltage, which varies in a linear fashion with any change in phase between the inputs. A front panel meter provides a direct indication of the phase difference in degrees (0° to 360°). Front panel adjustments "Zero Scale" and "Full Scale" allow the instrument to be adjusted to operate over a wide range of output requirements for both voltage and current, as follows:

1. When operating with a high impedance load (100 KΩ or greater), the DC output which corresponds to zero indication on the meter may be adjusted through the range of Ø volts to -1.0 volt; and full scale, through the range of 0 volts to +1.0 volt.
2. When operating with a low impedance load (100Ω or less) the output adjustment range is Ø mA to -1.0 mA for zero scale and Ø mA to +1.0 mA for full scale.

The output range of the K34-59991A is normally preset at the factory for a zero scale DC output of 0 volts and full scale DC value of +1.0 volt. The phase comparator is configured at the factory for a high input impedance (>500Ω). The instrument may be ordered (or modified) for a 50Ω input impedance, however, the modification must be performed at the factory.

SPECIFICATIONS

The instrument specifications for the Special K34-59991A, Broadband Linear Phase Comparator are listed in *Table 1*.

Table 1. K34-59991A Specifications

Frequency Range: 100 kHz to 10 MHz; useful down to 10 kHz and up to 50 MHz.

Input Level: 100 mV rms minimum.
10V rms maximum.

Input Impedance: ≥500Ω
(May be modified for 50Ω)

Output: DC voltage, settable to provide any 1-volt swing within the limits +1 and -1-volt into Hi-impedance load (100 KΩ or greater);
or DC Current, settable to provide any one milliampere swing within the limits +1 and -1 mA into a low impedance load (100Ω or less).

NOTE

Both inputs and the outputs are DC isolated from each other and the instrument case (floating common) to minimize ground loop effects caused by low frequency AC and DC ground currents.

Ground circuit potential differences should not exceed 100 volts.

Power Requirements: **115/230V ac, 48-66Hz, +5%,-10%.**
100/220V ac, 30 VA maximum.

Operating Temperature: Ø° to 40°C.

OPERATING INFORMATION

The K34-59991A Phase Comparator is generally used in conjunction with a strip chart recorder, to determine the change (or rate-of-change) of phase between two signal sources of the same nominal frequency. When the full scale output of the Phase Comparator is adjusted to drive the strip chart recorder over its full scale width, then the width of the chart is equal to the period of the input signals (i.e., for 1 MHz inputs, the full chart width represents 1 μs). The following examples demonstrate typical operational applications:

Example I.

To compute the frequency difference for any given period of time, use the relationship:

$$\frac{\Delta f}{f} = \frac{\Delta t}{t}$$

where:

$\frac{\Delta f}{f}$ = Fractional Frequency Difference

Δt = Measured Phase change, expressed as a multiple or a fraction of the period of the input frequency (in seconds).

t = Selected Time period (in seconds)
For example, if the strip chart recorder indicates one-half width variation (0.5 μs if the input frequencies are 1 MHz) during an elapsed time period of 8 hours, the frequency difference is:

$$\frac{\Delta f}{f} = \frac{\Delta t}{t} = \frac{0.5 \times 10^{-6}}{8\ (\text{hrs}) \times 60\ (\text{min}) \times 60\ (\text{sec})} = \frac{0.5 \times 10^{-6}}{28800} = 1.74 \times 10^{-11}$$

or 1.74 parts in 10^{11}.

Example II.

The two input signals are a nominal 5 MHz. The strip chart recording trace crosses the chart width and retraces three times, over a 24-hour period. The frequency difference between the two signals is computed as follows:

$$\text{Strip chart recorder full scale} = \frac{1}{5\ \text{MHz}} = 0.2\ \mu\text{s}$$

$$\frac{\Delta f}{f} = \frac{\Delta t}{t} = \frac{3 \times 0.2 \times 10^{-6}}{24\ (\text{hrs}) \times 60\ (\text{min}) \times 60\ (\text{sec})} = 6.9 \times 10^{-12}$$

The frequency difference is 6.9 parts in 10^{12}.

OPERATING PROCEDURE

The following steps provide the recommended operating procedure.

1. Connect the AC power line cord and verify the amber "power-on" indicator is lighted.
2. Connect the phase comparator OUTPUT to a Strip Chart Recorder.
3. Adjust the "Zero Scale" and "Full Scale" front panel adjustments (as described in OPERATOR ADJUSTMENTS) for the corresponding zero scale and full scale trace on the chart recorder.
4. Connect the reference signal and test signal to Input A and Input B, respectively.
5. Adjust the speed of the chart recorder for the desired measurement.

OPERATOR ADJUSTMENTS

Perform the following procedure to adjust the DC output. Refer to the specifications table for the range of adjustment. Use a 1/10" wide flat blade screwdriver to make these adjustments.

NOTE

Inputs A and B need not be present, but do not need to be removed if connected.

1. Set "Zero-Oper-Full" front panel mounted toggle switch to "Zero".
2. Adjust "Zero Scale" control for the desired Zero Scale output, typically a zero scale trace on strip chart recorder.
3. Set switch to "Full" and adjust "Full Scale" control for the desired output level, typically a full scale trace on strip chart recorder.
4. Again check both "Zero" and "Full" scale outputs and readjust if necessary. The output may be measured for these adjustments with any suitable HI-impedance voltmeter, milliameter, recorder, or plotter.
5. Set switch to "Oper" for normal operation.

CAUTION

Before connecting the instrument to AC power lines, be sure that the voltage selector is properly positioned as described below.

LINE VOLTAGE REQUIREMENTS

The K34-59991A is equipped with a power module that contains a printed-circuit line voltage selector board, to select 100, 115/120, 220, 230/240 volt AC operation. Before applying power, the pc selector board must be set the correct position and the correct fuse must be installed as described below.

Power line connections are selected by the position of the plug-in circuit board in the module. When the board is plugged into the module, the only visible markings on the board indicate the line voltage to be used. The correct value of line fuse, with the 250-volt rating, must be installed after the board is inserted. This instrument uses a .30A fuse (HP Part No. 2110-0044) for 100/120-volt operation; a 0.15A fuse (HP Part No. 2110-0320) for 220/240-volt operation.

The power cord must be disconnected from the power module before the sliding window, covering the fuse and pc board compartment, can be moved to expose the fuse and circuit card. See *Figure 1*.

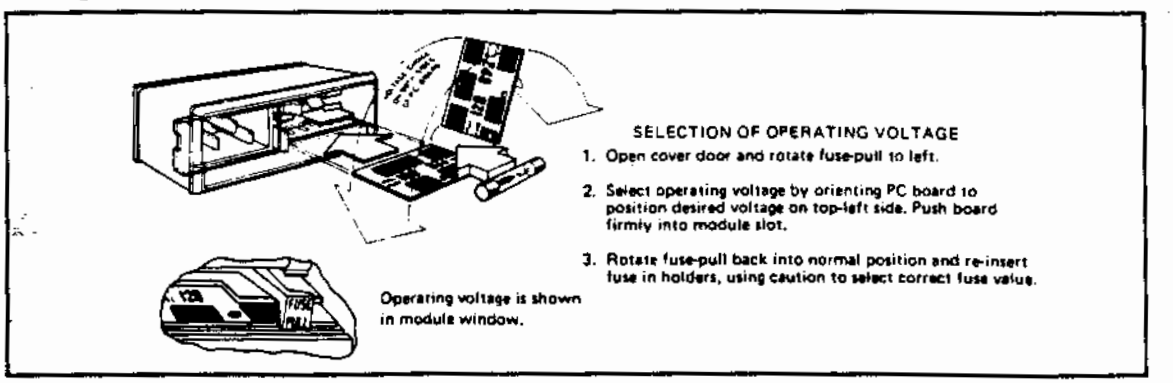

Figure 1. Line-Voltage Selection

INTERNAL ADJUSTMENTS

Only two nonoperating adjustments are provided; the mechanical "Zero" adjust, and the meter full scale calibration adjustment A1R44.

WARNING

THE ADJUSTMENTS ARE PERFORMED WITH POWER SUPPLIED TO THE INSTRUMENT, AND PROTECTIVE COVERS REMOVED. SUCH MAINTENANCE SHOULD BE PERFORMED ONLY BY SERVICE-TRAINED PERSONNEL WHO ARE AWARE OF THE HAZARDS INVOLVED (FOR EXAMPLE, FIRE AND ELECTRICAL SHOCK). WHERE ADJUSTMENTS CAN BE PERFORMED WITHOUT POWER APPLIED, THE POWER CORD SHOULD BE REMOVED.

To set the mechanical meter "Zero" adjust:

1. Remove the AC power cord from the rear power receptacle.
2. Place the instrument on a level surface and note the position of the meter pointer. It should be pointing exactly at the 180° division line. If not, use a small screwdriver to turn the slotted adjustment on the meter case until the pointer indicates correctly.
3. Reconnect the AC line power. The amber indicator lamp on the front panel should now be lighted indicating the the instrument is turned on.
4. Set the "Zero-Oper-Full" switch to "Full". The meter should swing to full scale, indicating 360°. If not, A1R44 requires adjustment.

To adjust A1R44: A1R44 is accessible after removing instrument top cover and is located on the main circuit board halfway between front and rear panels.

1. Use a small screwdriver to adjust R44 to obtain a Full scale indication as described above. Placing switch "Zero" position should cause meter to indicate 0°.
2. If Zero degree indication is slightly off, readjust A1R44 so that best compromise setting is made which will provide the closest indication for both Zero and Full scale since A1R44 affects both ends of meter range. Changing R44 does not affect the DC "output" nor can the Zero scale and Full scale adjustments affect the front panel meter indication.

THEORY OF OPERATION

For the following description, refer to the Phase Comparator Waveforms, *Figure 2*, and Schematic Diagram, *Figure 3*. Any combination of AC or pulse signals (at or near the same frequency) are applied as signals to INPUT A and INPUT B. The high gain trigger circuits U1 and U2, develop sharply defined logic level transitions as the input signals cross the threshold level. These logic signals are applied as clock signals to edge-trigger the flip-flops U3 and U4. Flip-flop U3 simply toggles so that its output frequency is half that of the A input. Flip-flop U4 follows the state of flip-flop U3 by changing state, if necessary, when the clock on U4 pin 9 makes its transition from zero to one state. The exclusive-OR gate U5, compares the outputs of the flip-flops, producing a one-state output whenever the one states of the two flip-flop outputs do not overlap. This results in a pulse train whose duty cycle is proportional to the phase difference between the positive-going threshold-crossings of the two input signals. The low-pass filter, consisting of R34, R36, and C30, removes the AC component of the pulse train leaving the DC component whose voltage is proportional to the input signal phase difference. This is buffered by U6 and output to both front and rear panels. The gain of U6 is set by the Full scale potentiometer, R1. Zero Scale potentiometer, R22, sets the DC output level by applying an offset DC voltage to U6, pin 3. The phase comparator inputs and outputs are isolated from DC and low frequency AC components, to avoid ground loop discrepancies. Circuit common is not chassis ground. The power supply produces a regulated -5V DC (with the more positive output of regulator U1 as circuit common) and an unregulated +5V DC voltages.

Table 2. K34-59991A Replaceable Parts

REFERENCE DESIGNATION	DESCRIPTION	PART NUMBER
A1	MOTHERBOARD ASSEMBLY	59991-91000
A1C1	CAPACITOR, .047U	0160-4424
A1C2	CAPACITOR, .047U	0160-4424
A1C3	CAPACITOR, .047U	0160-4424
A1C4	CAPACITOR, .047U	0160-4424
A1C5	CAPACITOR, .1U	0160-0576
A1C6	CAPACITOR, .1U	0160-0576
A1C7	CAPACITOR, .1U	0160-0576
A1C8	CAPACITOR, .1U	0160-0576
A1C9	CAPACITOR, .1U	0160-0576
A1C10	CAPACITOR, .1U	0160-0576
A1C11	CAPACITOR, .1U	0160-0576
A1C12	CAPACITOR, .1U	0160-0576
A1C13	CAPACITOR, .1U	0160-0576
A1C14	CAPACITOR, .1U	0160-0576
A1C15	CAPACITOR, .1U	0160-0576
A1C16	CAPACITOR, .1U	0160-0576
A1C17	CAPACITOR, 4000U	0160-2101
A1C18	CAPACITOR, .1U	0160-0576
A1C19	CAPACITOR, .1U	0160-0576
A1C20	CAPACITOR, .1U	0160-0576
A1C21	CAPACITOR, .1U	0160-0576
A1C22	CAPACITOR, .1U	0160-0576
A1C23	CAPACITOR, .1U	0160-0576
A1C24	CAPACITOR, .1U	0160-0576
A1C25	CAPACITOR, .1U	0160-0576
A1C26	CAPACITOR, .1U	0160-0576
A1C27	CAPACITOR, 470 pF (Optional)	0160-3455
A1C28	CAPACITOR, .1	0160-0576
A1C29	CAPACITOR, .1U	0160-0576
A1C30	CAPACITOR, .1U	0160-0576
A1C31	CAPACITOR, .1U	0160-0576
A1C32	CAPACITOR, 100 pF	0160-2204
A1CR1	DIODE, SWITCHING 80V 200MA	1901-0050
A1CR2	DIODE,SWITCHING 80V 200MA	1901-0050
A1CR3	DIODE, SWITCHING 80V 200MA	1901-0050
A1CR4	DIODE, SWITCHING 80V 200MA	1901-0050
A1CR5	DIODE, PWR RECT 50V 1.5A	1901-0415
A1CR6	DIODE, PWR RECT 50V 1.5A	1901-0415
A1DS1	LED, YELLOW	1990-0487
A1J1	CONNECTOR, BNC-INSULATED	1250-1032
A1J2	CONNECTOR, BNC-INSULATED	1250-1032
A1J3	CONNECTOR, BNC-INSULATED	1250-1032
A1J4	CONNECTOR, BNC-INSULATED	1250-1032
A1R1	RESISTOR, 261Ω	0698-3132
A1R2	RESISTOR, 261Ω	0698-3132
A1R3	RESISTOR, 261Ω	0698-3132
A1R4	RESISTOR, 261Ω	0698-3132
A1R5	RESISTOR, 464Ω	0698-0082
A1R6	RESISTOR, 261Ω	0698-3132
A1R7	RESISTOR, 261Ω	0698-3132
A1R8	RESISTOR, 261Ω	0698-3132
A1R9	RESISTOR, 261Ω	0698-3132
A1R10	RESISTOR, 464Ω	0698-0082

Table 2. K34-59991A Replaceable Parts (Continued)

REFERENCE DESIGNATION	DESCRIPTION	PART NUMBER
A1R11	RESISTOR, 261Ω	0698-3132
A1R12	RESISTOR, 261Ω	0698-3132
A1R13	RESISTOR, 51.1Ω	0757-0394
A1R14	RESISTOR, 10Ω	0757-0346
A1R15	RESISTOR, 261Ω	0698-3132
A1R16	RESISTOR, 261Ω	0698-3132
A1R17	RESISTOR, 51.1Ω	0757-0394
A1R19	RESISTOR, 10Ω	0757-0346
A1R19	RESISTOR, 100Ω	0757-0401
A1R20	RESISTOR, 100Ω	0757-0401
A1R21	RESISTOR, 10KΩ	0757-0442
A1R22	RESISTOR, 10KΩ	0757-0442
A1R23	RESISTOR, 10KΩ	0775-0442
A1R25	RESISTOR, 10KΩ	0757-0442
A1R25	RESISTOR, 261Ω	0698-3132
A1R26	RESISTOR, 261Ω	0698-3132
A1R27	RESISTOR, 261Ω	0698-3132
A1R28	RESISTOR, 261Ω	0698-3132
A1R29	RESISTOR, 1MΩ (Optional)	0698-8827
A1R30	RESISTOR, 300Ω	0757-1108
A1R31	RESISTOR, 6.81KΩ	0757-0439
A1R32	RESISTOR, 6.81KΩ	0757-0439
A1R33	RESISTOR, 261Ω	0698-3132
A1R34	RESISTOR, 7.5KΩ	0757-0440
A1R35	RESISTOR, 261Ω	0698-3132
A1R36	RESISTOR, 7.5Ω	0757-0440
A1R37	RESISTOR, 10KΩ	0757-0442
A1R38	RESISTOR, 10KΩ	0757-0442
A1R39	RESISTOR, 21.5KΩ	0757-0199
A1R40	RESISTOR, 178Ω	0698-3439
A1R41	RESISTOR, 147Ω	0698-3438
A1R42	RESISTOR, 178Ω	0698-3439
A1R43	RESISTOR, 6.81KΩ	0757-0439
A1R44	RESISTOR, 10K VARIABLE	2100-3210
A1R45	RESISTOR, 2.61KΩ	0698-0085
A1R46	RESISTOR, 825Ω	0775-0421
A1U1	IC, LINE RECEIVER	1820-1224
A1U2	IC, LINE RECEIVER	1820-1224
A1U3	IC, D-FLIP-FLOP	1820-0794
A1U4	IC, D-FLIP-FLOP	1820-0794
A1U5	IC, TRIPLE EXCLUSIVE-OR/NOR GATE	1820-0805
A1U6	IC, OPERATIONAL AMPLIFIER	1826-0035
A1T1	TRANSFORMER, POWER	9100-3039
A1W1	FRONT CABLE, COAX	59991-91030
A1W2	REAR CABLE, COAX	59991-91031
A2	INPUT POWER MODULE	0960-0444
A2F1	FUSE, 0.3 AT/250V	2110-0044
A1F2	FUSE, 0.15 AT/250V	2110-0320
	LABEL, INFO	7120-6289

Table 2. K34-59991A Replaceable Parts (Continued)

REFERENCE DESIGNATION	DESCRIPTION	PART NUMBER
	CHASSIS PARTS	
C1	CAPACITOR, .005U	0160-3333
C2	CAPACITOR, .005U	0160-3333
C3	CAPACITOR, .22U	0180-1735
L1	INDUCTORS, 22UH	9140-0115
L2	INDUCTORS, 22UH	9140-0115
M1	METER 50-0-50 uA	1120-1472
R1	RESISTOR, VARIABLE 10KΩ	2100-3103
R2	RESISTOR, VARIABLE 1KΩ	2100-3154
S1	SWITCH, DPDT	3101-0939
U1	REGULATOR, +5V LM309K	1820-0430
W1	LINE CORD	8120-1378
	MISCELLANEOUS PARTS	
	COVER, TOP	5040-7210
	COVER, BOTTOM	5040-7211
	COVER, SIDE (QTY 2)	5040-7212
	TRIM, SIDE (QTY 2)	5001-0438
	TRIM, TOP	5040-7204
	TRIM PANEL, FRONT	59991-91009
	SUB PANEL, FRONT	59991-91001
	PANEL, REAR	59991-91003
	FRAME	5020-8823
	ADAPTOR, PANEL MOUNT (QTY 2)	2100-3447
	FOOT, (QTY 2)	5040-7205
	BRACKET	59991-91008
	METER FACE	59991-91009
	HEAT SINK, PLATE	1200-0043
	BUSHING, NYLON (QTY 2)	1200-0081

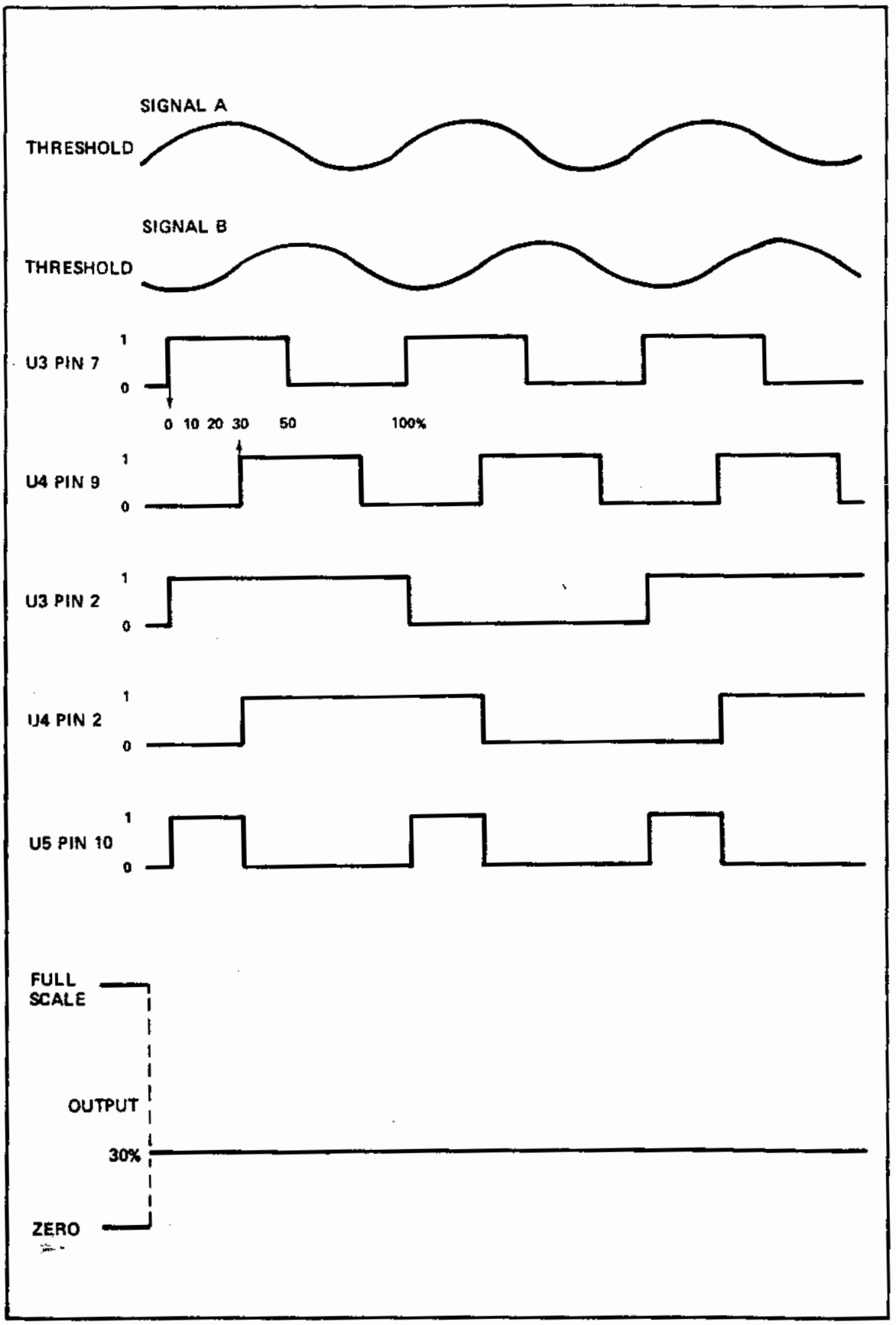

Figure 2. Phase Comparator Waveforms

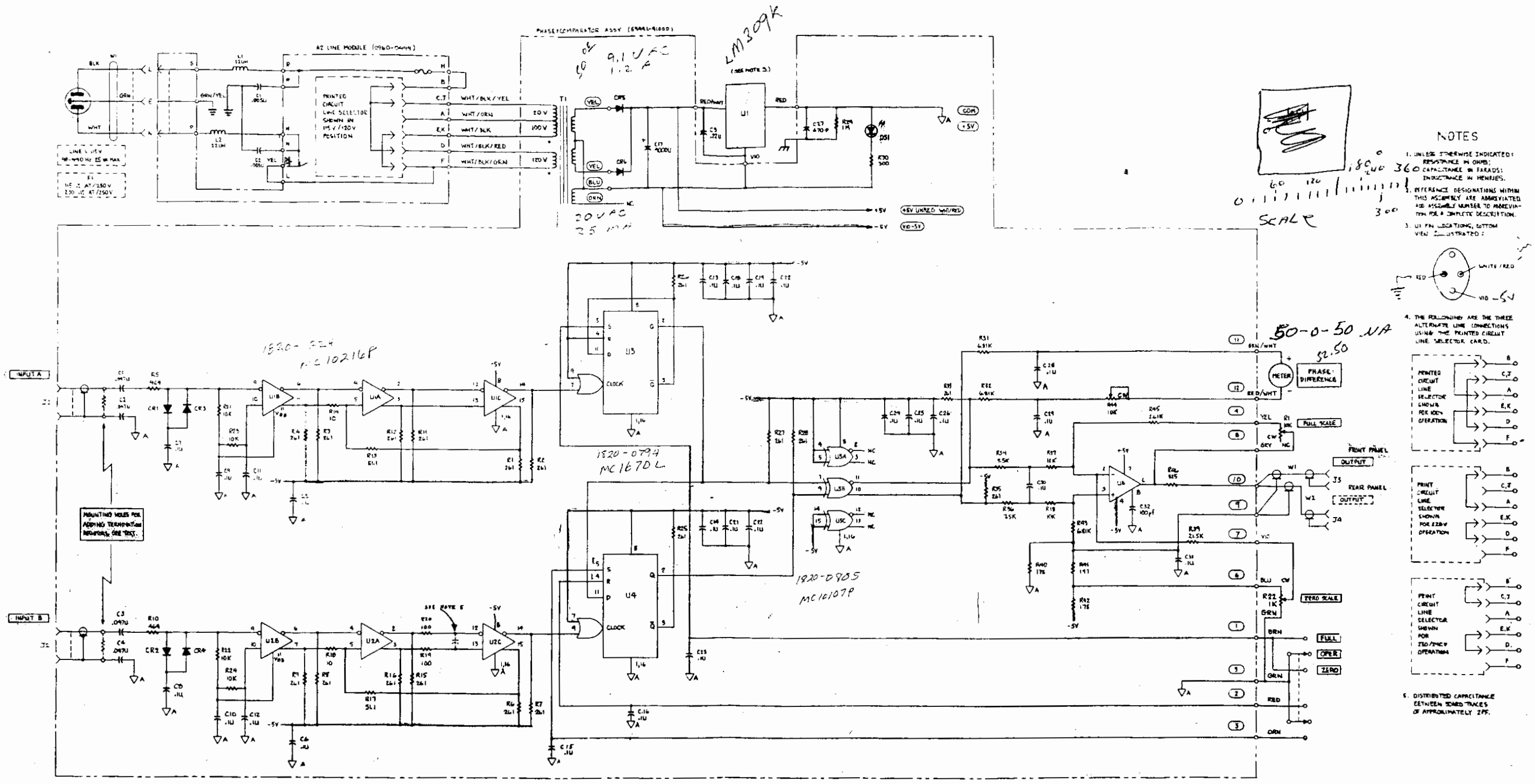

Figure 3. Schematic Diagram