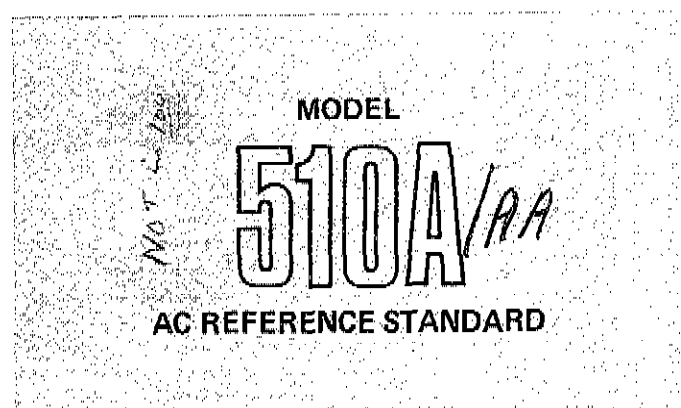
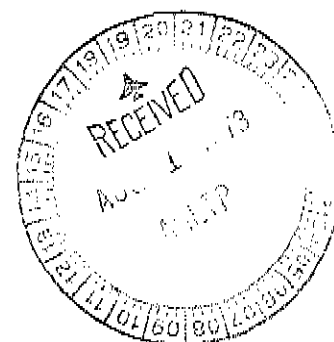
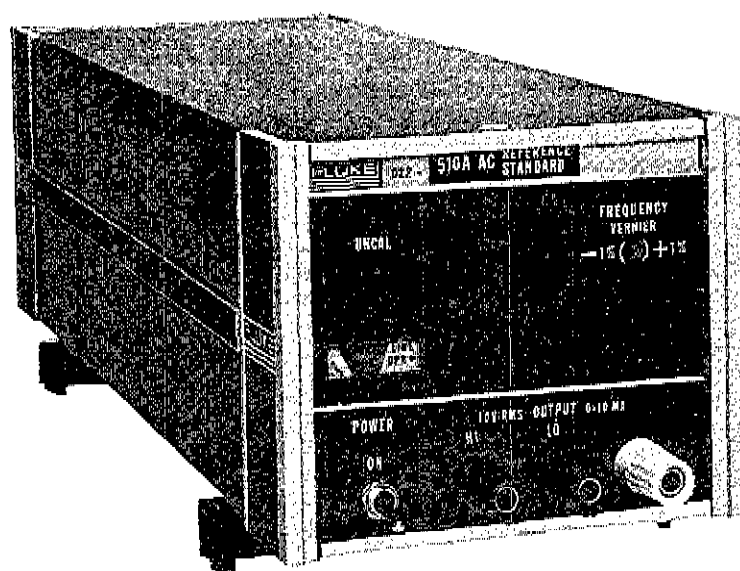


FLUKE 510A/AA

JOHN FLUKE MFG. CO., INC.

P. O. Box 7428
Seattle, Washington 98133



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THIS DOCUMENT CONTROLS SPECIFICATIONS AND FABRICATION
OF A SPECIAL INSTRUMENT MANUFACTURED BY THE JOHN FLUKE
MANUFACTURING COMPANY, INCORPORATED.

MODEL 510A/AA

		FLUKE JOHN FLUKE MFG CO., INC. P.O. BOX 742B, SEATTLE, WN.		510A/AA-130
		SPECIFICATION CONTROL DRAWING SPECIAL PRODUCTS DIVISION		
		510A/AA-130		
PROJ. ENG. <i>[Signature]</i>	DATE 11-6-71			
MKTG. <i>[Signature]</i>	DATE <i>[Signature]</i>			
ENG. APPD. <i>[Signature]</i>	DATE 11-9-71			
		JF NO. 298018	NO. OF PAGES 5	REV. 4

DOCUMENT CHANGE RECORD

REV. LTR.	PAGE	DESCRIPTION OF CHANGE
1	5,6	Added Serial number references
	7	Added page 7 (3rd page of Documentation Index)
2	4	Add: Section 4.1
	6	Delete: Item 3
3	6	Add: Item 2
4	4	Correct: OECO Transformer # from 17537 to 17584 and Dwg. # from 510A/AA-6001 to 510A/AN-6001 Section 4.1
5	4	Correct dwg. number, Sect. 4.1 from 510A/AN-6001 to 510A/AN-8001
		JOHN FLUKE MANUFACTURING CO., INC.
		510A/AA-130
		REV 5
		PAGE 2

- 1.0 GENERAL - Similar to 510A-04 with the following exceptions:
- 1.1 Capable of being phase locked to an external 400Hz 26V RMS reference.
 - 1.2 Provides eight separate transformer isolated outputs at 10V RMS into 100K ohms.
 - 1.3 Each output has programmable phase control of 0 or 180 degrees.
 - 1.4 Housed in 3-1/2 inch high full rack width package.
- 2.0 ELECTRICAL - All electrical specifications apply with each output loaded into 100K ohms.
- 2.1 Phase reference input: 26V RMS $\pm$ 10%, 380 to 420Hz, 30K ohm input impedance.
 - 2.2 Outputs: Eight, transformer coupled, at 10V RMS $\pm$.05%. Phase relationship to phase reference input 0 $\pm$ 1 degree or 180 $\pm$ 1 degrees programmable. Total harmonic distortion 0.15% isolation between any two outputs or input to any output: 300V DC or peak AC; 1100pf maximum capacitance.
 - 2.3 Phase programming inputs: Power required 5V DC $\pm$ 5% at 150ma per input (1.2 Amp maximum for all inputs paralleled). Logic levels for phase programming (7400 series TTL): Logic "0", V in $<$ 0.8V, I in - 3.2ma. Logic "1"; V in $>$ 2V, I in $<$ 1ma. On a logic "1" to logic "0" transition at the phase control enable input, the output phase will be programmed according to phase control input status. Logic "0" corresponds to 180 degrees phase logic "1" corresponds to 0 degrees phase with respect to phase reference input.

		JOHN FLUKE MANUFACTURING CO., INC.	
		510A/AA-130	REV PAGE 3

3.0 MECHANICAL

- 3.1 Chassis size 3-1/2 in. high, 19 in. wide (rack mountable), 15 1/2 in. depth behind front panel.
- 3.2 Input and outputs located on rear panel. Input, binding posts on 3/4 in. centers. Outputs 8-8 terminal barrier strips.
- 3.3 Power switch and overload indicator on front panel.

4.0 PARTS LIST - See Bills of Material and Engineering Drawings listed in Section 5.2 MFG Column.

- 4.1 Purchased Parts
 - (1) OECO transformer 17534 per 510A/AN-8001

5.0 DOCUMENTATION

- 5.1 Standard 510A Manual with 510A/AA-130 Specification Control Drawing and Drawings listed in Section 5.2 MNLS Column.

		JOHN FLUKE MANUFACTURING CO., INC.	
		510A/AA-130	REV PAGE 5 4

5.2		DOCUMENTATION INDEX				MODEL: 510A/AA			
ITEM	DRAWING NUMBER	DRAWING TITLE	SHEETS	B/MTL	USAGE				Applies to instruments with Serial numbers:
					MFG	MNLS			
1	510A/AA-160	Acceptance Test Procedure			X	X			All
2	510A/AA-1001	Schematic, 8 Output AC Ref Std.	1		X	X			through S/N 128
3									
4	510A/AA-2001	Front Panel Punch	1		X				All
5	510A/AA-2002	Rear panel punch	1		X				All
6	510A/AA-2003	Front Panel screened	1		X				All
7	510A/AA-2004	Rear Panel screened	1		X				All
8	510A/AA-2005	Inner Panel LH	1		X				All
9	510A/AA-2006	Inner Panel RH	1		X				All
10	510A/AA-2007	Bracket Xformer Mtg.	1		X				through S/N
11	510A/AA-2008	Hold Down, Transformer	1		X				All
12	510A/AA-2009	Pad, Transformer Mtg.	1		X				All
13									
14	510A/AA-3001	Drill Detail Phase Lock PCB Assy.	2		X				Through S/N 128
15									
16	510A/AA-4001	Phase Lock PCB Assy.	1	X	X	X			Through S/N 128
17	510A/AA-4002	Main PCB Assy. (Modifications)	1	X	X	X			Through S/N 128
18									
19	510A/AA-4451	Front Panel Assy.	1	X	X				All
20	510A/AA-4452	Rear Panel Assy.	1	X	X				All
		JOHN FLUKE MANUFACTURING CO., INC.							
		510A/AA-130						REV PAGE 1 5	

5.2		DOCUMENTATION INDEX				MODEL: 510A/AA			
ITEM	DRAWING NUMBER	DRAWING TITLE	SHEETS	B/MTL	USAGE				Applies to instruments with serial numbers;
					MFG	MNLS			
1	510A/AA-5001	Final Assy.	2	X	X				Through S/N 128
2	510A/AA-6510	Power Transformer							
3									
4									
5	510A/AA	Test & Button-up	1	X	X				All
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									
			JOHN FLUKE MANUFACTURING CO., INC.						
Applicable Drawings			510A/AA-130						REV PAGE 3 6

5.2		DOCUMENTATION INDEX				MODEL: 510A/AA			
ITEM	DRAWING NUMBER	DRAWING TITLE	SHEETS	B/MTL	USAGE			Applies to instruments with serial numbers:	
					MFG	MNLS			
1	510A/AA-1003	Schematic, 8 output AC Ref Std.	1		X	X		129 & on	
2									
3	510A/AA-2010	Support	1		X			129 & on	
4	510A/AA-2011	Support	1		X			129 & on	
5	510A/AA-2012	Support	1		X			129 & on	
6	510A/AA-2013	Support	1		X			129 & on	
7									
8	510A/AA-3003	Drill Detail Phase Lock PCB	3		X			129 & on	
9									
10	510A/AA-4003	Phase Lock PCB Assy.	2	X	X	X		129 & on	
11	510A/AA-4004	Main PCB Assy (rework)	1	X	X	X			
12									
13	510A/AA-5002	Final Assy.	2	X	X	X		129 & on	
14									
15									
16									
17									
18									
19									
20									
			JOHN FLUKE MANUFACTURING CO., INC.						
Applicable Drawings			510A/AA-130					REV PAGE 1 7	

6.0 TEST PROCEDURE - See 510A/AA-160

		JOHN FLUKE MANUFACTURING CO., INC.	
		510A/AA-130	REV PAGE / 8

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T EST

P ROCEDURE

DOCUMENT NO: 510A/AA-160 REV. 1

TITLE: 510A/AA REFERENCE STANDARD (8 OUTPUT)

Number of Pages: 20

PREPARED

RJ Lewandowski
(Project Engineer)

DATE

12-8-72

TOOL PROOFED

(Test Supervisor)

DATE

APPROVED

James J. Spitzer
(Manufacturing Engineer)

DATE

12-11-72

APPROVED

(Engineering Section Head)

DATE

APPROVED

(Quality Assurance)

DATE

FLUKE

DOCUMENT CHANGE RECORD

REV. LTR.	PAGE	DESCRIPTION OF CHANGE
1	5	ADD: Sections 2.1 and 2.2
		ADD: "(S/N 001 through 128)" to Section 3.0
	13	ADD: "for instruments with S/N 001 through 128" to Section 3.4.7
	Accept. Test Record	ADD: Notation on top of page.
	14 - 20	ADD: New Section 4.0
		ADD: Additional "ACCEPTANCE TEST RECORD"
		Prepared By: <u>Robert J. Lewandowski</u> <u>12-8-72</u> Robert J. Lewandowski Date
		JOHN FLUKE MANUFACTURING CO., INC.
		510A/AA-160
REV	PAGE	
1	2	

TABLE OF CONTENTS

SECTION	PARA.	DESCRIPTION	PAGE(S)
		Title Page	a
		Document Change Record	2
		Table of Contents	3
		Reference & Test Equipment Required	4
1.0		Purpose	5
2.0		Scope	5
3.0		General Procedure S/N001 - 128	5
	3.1	Turn-On 510A	5
	3.2	Calibration 510Basic	7
	3.3	Operational Alignment 510A/AA	8
	3.4	Final Calibration 510A/AA	11
4.0		General Procedure S/N 129 & On	14
	4.1	Turn-on 510A	14
	4.2	Calibration 510A Basic	15
	4.3	Operational Alignment 510A/AA	17
	4.4	Final Calibration 510A/AA	19

JOHN FLUKE MANUFACTURING CO., INC.	
510A/AA-160	REV 1
	PAGE 3

The following is a list of equipment required to test the 510A/AA.

Multimeter	Fluke 8100A
Variac	1A Minimum
AC Ammeter	0-100ma
AC/DC Differential Voltmeter	Fluke 887A
Oscilloscope	Tektronix 545 with 1A1 Plug in and 10X attenuator probe or equiv.
Thermal Transfer Standard	Fluke 540B
DC Calibrator	10V and 14.14214 volts $\pm$ 20 ppm @ 5ma, Fluke 343A
Load resistors	(1) 700 ohms, (1) 1.3K ohms, (8) 100K ohms $\pm$ 1%, and (1) 110K ohms $\pm$ 1%.
Continuously variable Frequency Counter	DC Power Supply 0 to $\pm$ 10V @ 1.5 Amp. 300-400Hz with 1Hz resolution.
Phase Reference Source	26V RMS, 350 to 450Hz.
RMS Voltmeter	Fluke 931B calibrated to $\pm$ 0.02% See 3.2.9.
Phase Meter	Wiltron 351
Distortion Analyzer	HP333A or
Wave Analyzer	HP3590A

		JOHN FLUKE MANUFACTURING CO., INC.	
		510A/AA-160	REV PAGE 4

1.0 PURPOSE

The purpose of the Test Procedure is to define requirements and procedures for production testing of the Model 510A/AA Reference Standard.

2.0 SCOPE

This procedure defines tests to be performed on all instruments.

2.1 Section 3 applies to instruments with serial numbers 001 through 128.

2.2 Section 4 applies to instruments with serial numbers above 128.

3.0 TEST PROCEDURE (Serial Numbers 001 through 128)

NOTE: All references to 510A are to the 510A-4001 (307869) PCB assembly. All references to the 510A/AA are to the 510A/AA-4001 PCB assembly. All measurements are made to circuit common (black binding post, TP 8 & 10 on 510A/AA or 510A shield cover) unless otherwise specified.

3.1 Turn-On - 510A Basic

NOTE: All referenced test points and adjustments are on 510A, unless otherwise noted. Referenced output terminals are TP 12 & TP 11 (common) on 510A/AA.

3.1.1 Disconnect red, blue and violet leads from 510A. Disconnect orange and yellow leads on 510A/AA.

3.1.2 AC Power Input Receptacle

Verify that the AC power input receptacle is installed with the grounding pin up and that the high side of the line (pin marked L on back of receptacle) is connected to the center post of the fuse holder.

		JOHN FLUKE MANUFACTURING CO., INC.	
		510A/AA-160	REV PAGE 1 5

3.1.3 Isolation Check

Set the multimeter to the 10M ohm range and measure the resistance between the rear panel WHITE and BLACK binding posts. The resistance should be infinite.

3.1.4 Output Transistor Check

Set the multimeter to the 1K ohm range. Connect the + lead to Q28 base and the - lead to Q28 emitter. The meter should read between 800 and 1500 ohms.

Repeat for Q25.

Connect the + lead to Q27 emitter and the - lead to Q27 base. The meter should read between 800 and 1500 ohms.

NOTE: If resistance is greater than 1500 ohms, the wrong transistors are installed.

3.1.5 Adjustment Preset

Set the 115-230V switch on the rear panel to 115V. Set R100 and R27 fully ccw and center all 9 remaining posts (including R96 at the front panel).

3.1.6 Plug In

Plug the instrument into the variable line voltage source. Monitor TP2 (+18V) with a DC voltmeter and the output with a scope (5V/cm sensitivity). Bring up the line voltage slowly. The +18V should come up but there may be no AC output depending on the setting of R90. Set the line to 115V. Input current should not exceed 50ma AC.

3.1.7 FET Bias Set

Monitor TP5 for +.6 to -.6.0V and adjust R90 to produce -.2.3V to -.2.7V. With no output present, TP5 should be at -.6.0V. If the output is >10V rms, TP5 will be approximately +3V.

JOHN FLUKE MANUFACTURING CO., INC.

510A/AA-160

REV PAGE
6

3.2 Calibration - 510A Basic

3.2.1 -18V Regulated Supply (TP4)

-18V $\pm$.5V

3.2.2 +18V Regulated Supply (TP2)

Set to +18V $\pm$.2V with R9

3.2.3 Reference Voltage +14.14214V (TP10)

Measure TP10 with the 887A. Use internal circuit common (shield cover). Clip jumpers A and B per table.

<u>V_{REF} - 14.14214V</u>	<u>Clip Jumper</u>
0 to .00571	None
.00572 to .01141	A
.00142 to .01712	B
.01713 to .02182	A & B,

Next set reference with R27 to 14.14214V $\pm$ 200uV.

This step must be preceded by 3.1.5.

3.2.4 V3, V4, Zero Set

Use internal circuit common (shield cover)

Monitor TP6. Set R49 to 0 $\pm$ 100uV.

Monitor TP7. Set R72 to 0 $\pm$ 100uV.

3.2.5 Output Stage Bias Current Set

Short TP14 to circuit common. (Oscillator will stop.) Adjust R100 for +250mV between TP4 and TP12. Disconnect voltmeter from TP4 and TP12. Remove short.'

3.2.6 Detector Diode Bias Set

With DC coupled scope and X10 probe, set R60 for + 100mV + 10mV peak at TP8. Use 50mV or 100mV vertical sensitivity.

JOHN FLUKE MANUFACTURING CO., INC.

510A/AA-160

REV PAGE
7

3.2.7 Amplitude Determining Resistor Balance

Monitor output TP12 & TP11 on 510A/AA board with AC Diff. VM with max null sensitivity. Adjust R37 for "0" shift in output level when A252 is switched (adjust R37 for half the shift and switch A252 to check setting). Repeat if necessary. Set for < 50uV shift.

3.2.8 Uncalibrated Indicator Check

Apply 700 ohm load to output. Uncalibrated indicator should come on. Apply 1.3K ohms. Indicator should not be on.

3.2.9 Inherent Absolute Calibration Check

Using a 540B, perform an AC-DC transfer on the 510A/AA. Error should be less than 0.02%.

Record the error with sign (+ or -).

NOTE: This calibrated signal level can be used as a reference for calibrating the 910B used in final output level adjustment of the 510A/AA.

3.3 Operational Alignment - 510A/AA

3.3.1 Turn Instrument OFF

Reconnect red lead to TP2 & violet lead to TP4, turn instrument on. Observe that + and - 18 volts on 510A/AA are correct. Low level of + or - 18 volts indicates excessive loading or short circuit on 510A/AA. Disconnect red and violet leads and troubleshoot. Reconnect Orn & yel leads on 510A/AA blue lead to pin near Q21 on 510A.

3.3.2 On 510A/AA set R52, R54 and R88 to mid range and R49 max ccw. Remove U1 from its socket and apply +10 volts to TP5, and TP10 (common) on 510A/AA. Monitor voltage at TP5 on 510A.

JOHN FLUKE MANUFACTURING CO., INC.	
510A/AA-160	REV PAGE 8

- 3.3.3 Adjust R88 on 510A/AA for equal voltages at TP5 on 510A when polarity of 10 volt signal is reversed. R90 on 510A may have to be adjusted to maintain the voltage at TP5 on 510A between zero and -5 volts to maintain the 510A in linear operation.
- 3.3.4 Vary applied voltage at TP5 on 510A/AA from -10V through 0 to +10V while monitoring the voltage change at TP5 on the 510A. Change should be less than 2V. Adjust R90 on the 510A to center the voltage change about -2.5VDC. Remove voltmeter from TP5 on 510A.
- 3.3.5 Connect frequency counter to output TP12 and TP11 (common). With zero volts at TP5 on 510A/AA adjust R95 on 510A for $400 \pm 1\text{Hz}$, with +10 volts at TP5 the output frequency must be greater than 435Hz; with -10 volts at TP5 output frequency must be less than 365Hz.
- 3.3.6 Apply +3 volts to TP5 on 510A/AA and adjust R52 for $420 \pm 2\text{Hz}$. With -3 volts at TP5 frequency should be $380 \pm 3\text{Hz}$. Disconnect frequency counter. Monitor TP6 on 510A/AA with oscilloscope while adjusting R54 for minimum dc shift with voltage at TP5 on 510A/AA is changed from +10V to -10V. Shift should be less than 100mV.
- 3.3.7 Remove dc supply and short TP5 to TP10 on 510A/AA. Monitor TP9 with voltmeter and adjust R49 for $4 \pm .05\text{V DC}$.
- 3.3.8 Trigger oscilloscope externally from output at TP12 & TP11 (common). Observe that signal at TP2 is a symmetrical square wave of approximately 10 volts peak to peak centered about 0V DC and is 180° out of phase with the output.

		JOHN FLUKE MANUFACTURING CO., INC.	
		510A/AA-160	REV PAGE 9

- 3.3.9 Observe that the waveform at TP3 is a symmetrical square wave at 1/2 the output frequency, the amplitude should be 0V to -10V peak to peak.
- 3.3.10 Apply 26V RMS 400Hz phase reference signal to the rear panel phase reference input. Trigger oscilloscope externally from phase reference signal. Observe that signal at TP1 is a symmetrical square wave of approximately 10 volts peak to peak centered about 0 VDC and is in phase with the phase reference signal.
- 3.3.11 With power off replace U1. Remove short from TP5 on 510A/AA. Turn power on. Monitor TP3 on 510A/AA with oscilloscope the waveform should become a symmetrical square wave within a few seconds indicating the 510A/AA is phase locked to the reference signal.
- 3.3.12 Change the reference signal frequency to 370Hz and then to 430Hz observing that the square wave signal appears at TP3 on the 510A/AA indicating phase lock.
- 3.3.13 Apply a variable 5V DC source to terminals C and D of TB1 through TB8 in parallel. Connect all terminal A's of TB1 through TB8 together, this will be a common phase control function for all outputs.
- 3.3.14 Connect the phase control buss to +5V (terminal C) and alternately connect the phase control enable input (terminal B) of TB1 through TB8 to ground (terminal D) to set all phases to 0 degrees.
- 3.3.15 Externally trigger an oscilloscope from the phase reference input and check each output, terminals E & F (common) observing an in-phase condition with the phase reference.

		JOHN FLUKE MANUFACTURING CO., INC.	
		510A/AA-160	REV PAGE 10

3.3.16 Connect the phase control buss to Gnd, and alternately connect each phase control enable input to ground to set all phase to 180 degrees. Check each output with oscilloscope observing the 180 degree phase condition.

3.3.17 Reduce the voltage across terminals C & D to 4.5V. Repeat 3.3.13 to 3.3.15 above. All relays must function correctly with 4.5 volts applied.

3.4 Final Calibration 510A/AA

3.4.1 Terminate each output with 100K ohm + 1% load. Calibrate using a 931B RMS Voltmeter accurate to + .02% or better at 10VRMS 400Hz. Set output levels at E (high) and F (low) on TB1 through TB8 to 10.00V RMS + .005%, using R67 through R74 respectively. See 3.2.9.

NOTE: The input impedance of the 931B is 1M ohm, this paralleled with the 100K ohm load impedance will reduce the actual load on the measured output to approximately 91K causing the indicated reading to be approximately 100 to 150 ppm low. To compensate for this error the load resistor on the measured output must be changed to 110K ohm. All outputs must be terminated into 100K ohm for proper level out of any channel due to transformer primary impedance loss with output loading.

3.4.2 Calibrate and zero phase meter for 0 degrees with resolution of 0.1 degree maximum. Connect input 1 (reference input) of phase meter to signal at phase reference input of 510A/AA. Connect input 2 (test input) to an output channel using a cable approximately the same length as on input 1. Set the phase to 0 + 0.1 degrees using R42 on 510A/AA. Reverse the input leads to the phase meter and observe the meter reads 0 + 0.1 degrees.

JOHN FLUKE MANUFACTURING CO., INC.

510A/AA-160

REV PAGE

11

3.4.3 Vary the phase reference input signal frequency from 380Hz to 420Hz and observe the phase error after settling is less than ± 0.5 degrees.

3.4.4 Check each output channel with phase meter, maximum phase difference between any two channels must be less than 0.1 degrees.

NOTE: The effects of phase meter input loading on 100K ohms loads will be insignificant for phase meter input impedances of 1M ohms or greater. Load resistor on measured output channel need not be changed to 110K ohms.

3.4.5 Set phase reference frequency to 400Hz. Connect distortion analyzer or wave analyzer to an output (terminals E & F). Measure total harmonic distortion less than 0.15% or using a wave analyzer the second and third harmonics should be less than 10mV (60db below the level of the fundamental). Repeat for 2 additional outputs.

NOTE: DC Magnetization of the output transformer can cause an increase in harmonic distortion. This may be brought about by the application of a dc current through an output winding or by recovery transients generated by the 510A when an output is repeatedly shorted. This effect is not permanent and can be reduced by applying a variable dc source to an output through a 3K ohm resistor while monitoring the distortion. By varying the voltage both positive and negative a null of distortion will be observed, if the applied voltage is removed at the time, the null is observed the distortion should remain at or near the minimum level noted. Several attempts may be required to achieve a minimum level.

JOHN FLUKE MANUFACTURING CO., INC.

510A/AA-160

REV PAGE
12

3.4.6 Repeat 3.4.5 above for 380 Hz and 420 Hz.

3.4.7 Remove all test equipment, this concludes the Acceptance Test for instruments with Serial Number 001 through 128.

	JOHN FLUKE MANUFACTURING CO., INC.		
	510A/AA-160	REV 1	PAGE 13

4.0 TEST PROCEDURE (Serial Numbers 129 and on)

NOTE: All references to 510A are to the 510A/4001 (307868) PCB assembly. All references to the 510A/AA are to the 510A/AA-4003 PCB assembly. All measurements are made to circuit common (black binding post, TP 8 and TP 12 on 510A/AA or 510A shield cover) unless otherwise specified.

4.1 Turn-On - 510A Basic

NOTE: All referenced test points and adjustments are on 510A, unless otherwise noted. Referenced output terminals are TP 11 and TP 12 (common) on 510A/AA.

4.1.1 Disconnect red, blue and violet leads from 510A. Disconnect orange leads on 510A/AA.

4.1.2 AC Power Input Receptacle

Verify that the AC power input receptacle is installed with the grounding pin up and that the high side of the line (pin marked L on back of receptacle) is connected to the center post of the fuse holder.

4.1.3 Isolation Check

Set the multimeter to the 10M ohm range and measure the resistance between the rear panel WHITE and BLACK binding posts. The resistance should be infinite.

4.1.4 Output Transistor Check

Set the multimeter to the 1K ohm range. Connect the + lead to Q28 base and the - lead to Q28 emitter. The meter should read between 800 and 1500 ohms.

Repeat for Q25.

Connect the + lead to Q27 emitter and the - lead to Q27 base. The meter should read between 800 and 1500 ohms.

JOHN FLUKE MANUFACTURING CO., INC.	
510A/AA-160	REV PAGE 1 14

NOTE: If resistance is greater than 1500 ohms,
the wrong transistors are installed.

4.1.5 Adjustment Preset

Set the 115-230V switch on the rear panel to 115V.
Set R 100 and R 27 fully ccw and center all 8 remaining
pots (including R 96 at the front panel).

4.1.6 Plug In

Plug the instrument into the variable line voltage
source. Monitor TP 2 (+18V) with a DC voltmeter
and the output with a scope (5 V/cm sensitivity).
Bring up the line voltage slowly.
The +18V should come up but there may be no AC output
depending on the setting of R 90. Set the line to 115V.
Input current should not exceed 50 ma AC.

4.1.7 FET Bias Set

Monitor TP 5 and adjust R90 to produce -2.3V to -2.7V.
With no output present, TP 5 should be at -6.0V.
If the output is > 10V rms, TP 5 will be approximately
+3V.

4.2 Calibration - 510A Basic

4.2.1 -18V Regulated Supply (TP 4)

-18V $\pm$.5V

4.2.2 +18V Regulated Supply (TP 2)

Set to + 18V $\pm$.2V with R9.

4.2.3 Reference Voltage +14.14214V (TP 10)

Measure TP 10 with 887A. Use internal circuit common
(shield cover). Clip jumpers A and B per table.

V_{REF} -14.14214V

Clip Jumper

0 to .00571

None

.00572 to .01141

A

.00142 to .01712

B

.01713 to .02182

A & B

JOHN FLUKE MANUFACTURING CO., INC.

510A/AA-160

REV	PAGE
1	15

Next set reference with R 27 to $14.14214V \pm 200 \mu V$.
This step must be preceded by 4.1.5.

4.2.4 V3, V4, Zero Set

Use internal circuit common (shield cover).
Monitor TP 6. Set R 49 to $0 \pm 100 \mu V$.
Monitor TP 7. Set R 72 to $0 \pm 100 \mu V$.

4.2.5 Output Stage Bias Current Set

Short TP 13 to circuit common. (Oscillator will stop).
Adjust R 100 for $+25mV$ between TP 4 and TP 11.
Disconnect voltmeter from TP 4 and TP 11.
Remove short.

4.2.6 Detector Diode Bias Set

With DC coupled scope and X10 probe, set R 60
for $+100 mv \pm 10 mv$ peak at TP 8.
Use 50 mv or 100 mv vertical sensitivity.

4.2.7 Amplitude Determining Resistor Balance

Monitor output TP 11 and TP 12 on 510A/AA board with
AC Differential Voltmeter with maximum null sensitivity.
Adjust R 37 for "0" shift in output level when A 252 is
switched (adjust R 37 for half the shift and switch A 252
to check setting).
Repeat if necessary. Set for $< 50\mu V$ shift.

4.2.8 Uncalibrated Indicator Check

Apply 700 ohm load to output.
Uncalibrated indicator should come on.
Apply 1.3K ohms. Indicator should not be on.

4.2.9 Inherent Absolute Calibration Check

Using a 540B, perform an AC - DC transfer on the
510A/AA. Error should be less than 0.02%.

Record the error with sign (+ or -).

NOTE: This calibrated signal level can be used as a
reference for calibrating the 910B used in final output
level adjustment of the 510A/AA.

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510A/AA-160

REV	PAGE
1	16

4.3 Operational Alignment - 510A/AA

4.3.1 Turn Instrument OFF

Reconnect red lead to TP 2 and violet lead to TP 4, turn instrument On. Observe that + and - 18 volts on 510A/AA are correct. Low level of + or - 18 volts indicates excessive loading or short circuit on 510A/AA. Disconnect red and violet leads and troubleshoot. Reconnect orange lead on 510A/AA, blue lead to pin near Q 21 on 510A.

4.3.2 On 510A/AA set R 34 and R 44 to mid-range. Short TP 5 to TP 8. Monitor TP 7 (Hi), TP 8 (Low) and operate R 34 across full range. Observe voltage varies from $> +3.8$ to < -3.8 .

4.3.3 Connect frequency counter to 510A/AA output. Short 510A/AA TP 5, TP 7, and TP 8. Adjust R 95 on 510A for 400 ± 1 Hz on counter. Remove short from TP 8 to TP 7. Leave short between TP 5 and TP 8 connected.

4.3.4 Monitor voltage at 510A, TP 5, while varying 510A/AA, R 34, from one extreme to the other. Adjust the 510A/AA R 44 for equal voltages ($\pm 0.2V$) at TP 5 at the extremes of R 34 adjustment. 510A R90 may have to be adjusted to maintain the voltage at 510A TP 5 between 0 and -5V to maintain the 510A in linear operation.

4.3.5 Slowly vary the setting of 510A R 34 observing the voltage at 510A TP 5. The voltage change should be less than 1 volt. Adjust 510A R90 to center the voltage range at TP 5 about -2.5 volts.

4.3.6 Observe output frequency with R 34 set to extremes of adjustment. The maximum frequency must be greater than 415 Hz and the minimum frequency must be less than 385 Hz. Remove short.

4.3.7 Monitor voltage at 510A/AA TP 7. Adjust 510A/AA R 34 for 0 ± 0.1 VDC at TP 7.

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		510A/AA-160	REV PAGE 1 17

- 4.3.8 Apply 26V RMS 400 Hz phase reference signal to the rear panel phase reference input. Trigger oscilloscope externally from phase reference signal. Observe that signal at TP 1 is a symmetrical square wave of approximately 0 to +5 volts peak to peak and is in phase with the phase reference signal.
- 4.3.9 Connect oscilloscope to 510A/AA TP 2 and observe that signal is a symmetrical square wave of approximately 0 to +5 volts peak to peak and is in phase with the phase reference signal.
- 4.3.10 Change the reference signal frequency to 370 Hz and then to 430 Hz observing that the signal at 510A/AA TP 2 comes into phase with the reference signal at each extreme indicating phase locked condition.
- 4.3.11 Apply a variable 5V DC source to terminals C and D of TB 1 through TB 8 in parallel. Connect all terminal A's of TB 1 through TB 8 together. This will be a common phase control function for all outputs.
- 4.3.12 Connect the phase control buss (Term. A) to +5V (Term. C) and alternately connect the phase control enabling input (Term. B) of TB 1 through TB 8 to ground (Term. D) to set all phases to 0 degrees.
- 4.3.13 Externally trigger an oscilloscope from the phase reference input and check each output, terminals E and F (common), observing an in-phase condition with the phase reference.
- 4.3.14 Connect the phase control buss (Terminal A) to ground and alternately connect each phase control enable input to ground to set all phase to 180 degrees. Check each output with oscilloscope observing the 180 degrees phase condition.
- 4.3.15 Reduce the voltage across terminals C and D to 4.5V. Repeat 4.3.15 above. All relays must function correctly with 4.5 volts applied.

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		510A/AA-160	REV PAGE 1 18

4.4 Final Calibration - 510A/AA

- 4.4.1 Terminate each output (terminals E and F) with 100K ohm $\pm 1\%$ load. Calibrate using a 931B RMS Voltmeter accurate to $\pm .02\%$ or better at 10V RMS, 400 Hz. Set output levels at E (Hi) and F (Low) on TB 1 through TB 8 to 10.00V RMS $\pm .005\%$ using R 48 through R 63 respectively. See 4.2.9.

NOTE: The input impedance of the 931B is 1M ohm. This, paralleled with 100K ohm load impedance, will reduce the actual load on the measured output to approximately 91K causing the indicated reading to be approximately 150 to 250 ppm low. To compensate for this error the load resistor on the measured output must be changed to 110K ohm. All outputs must be terminated into 100K ohm for proper level out of any channel due to output impedance loss with output loading.

- 4.4.2 Calibrate and zero phase meter 0 degrees with resolution of 0.1 degree maximum. Connect input 1 (reference input) of phase meter to signal at phase reference input of 510A/AA. Connect input 2 (test input) to an output channel using a cable approximately the same length as on input 1. Set the phase to 0 ± 0.1 degrees using R 31 on 510A/AA. Reverse the input leads to the phase meter and observe the meter reads 0 ± 0.1 degrees.
- 4.4.3 Vary the phase reference input signal frequency from 380 Hz to 420 Hz and observe that the phase error after settling is less than ± 0.5 degrees.
- 4.4.4 Check each output channel with phase meter. Maximum phase difference between any two channels must be less than 0.1 degrees.

NOTE: The effects of phase meter input loading on 100K ohms loads will be insignificant for phase meter input impedance of 1M ohm or greater. Load resistor on measured output channel need not be changed to 110K ohms.

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		510A/AA-160	REV PAGE 1 19

- 4.4.5 Set phase reference frequency to 400 Hz.
Connect distortion analyzer or wave analyzer to an output (Terminals E and F).
Measure total harmonic distortion less than 0.15% or using a wave analyzer the second and third harmonics should be less than 10 mV (60 db below the level of the fundamental). Repeat for 2 additional outputs.
- 4.4.6 Repeat 4.4.5 above for 380 Hz and 420 Hz.
- 4.4.7 Remove all test equipment. This concludes the Acceptance Test for instrument with Serial Numbers 129 and on.

		JOHN FLUKE MANUFACTURING CO., INC.	
		510A/AA-160	REV PAGE 1 20



ACCEPTANCE TEST RECORD

APPLICABLE TO SERIAL NUMBERS 129 AND ON

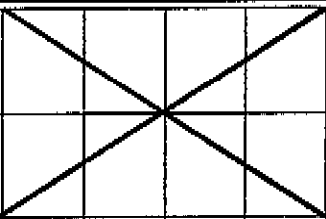
MODEL NO. 510A/AA SERIAL NO. DATE

TEST	LIMITS	ACTUAL	T	TEST	LIMITS	ACTUAL	T
4.1 TURN ON - 510A				4.3.13 1K Ω Phase Check	0° Phase	-	
4.1.1 Disconnect 510A/AA leads.				4.3.14 180° Phase Check	180° Phase	-	
4.1.2 AC Pwr. Input Recept.				4.3.15 4.5V Operation	-	-	
4.1.3 Isol. Check				4.4 FINAL CAL. 510A/AA			
4.1.4 Output Transistor Ck.				4.4.1 10V RMS Cal R48-R63	10VRMS $\pm$ 0.05%	-	
4.1.5 Adj. Preset				4.4.2 Phase Adj. R31	0 $\pm$ 0.1 degrees	-	
4.1.6 Plug In	< 50 ma AC			4.4.3 Phase Ck. 380Hz	$\pm$ 0.5 degrees	-	
4.1.7 FET Bias Set R90	-2.3 to -2.7V			4.4.4 Phase Ck. each output	$\pm$ 0.5 degrees	-	
4.2 CALIBRATION - 510A				4.4.4 Phase Ck. each output	$\pm$ 0.1 degrees difference		
4.2.1 -18V TP4	-18 $\pm$ 0.5V			4.4.5 Harmonic Dist.	0.15% or		
4.2.2 +18V TP2 R9	+18 $\pm$ 0.2V			Second Harmonic	< 10mV (-60db)		
4.2.3 V REF TP10 R27	14.14214V $\pm$ 200 μ V			Third Harmonic	< 10mV (-60db)		*
4.2.4 TP6, R49; TP7, R72	0 $\pm$ 100 μ V			Record worst value			*
4.2.5 Bias Current TP4				4.4.6 H. D. 380Hz 420Hz			
TP12 R100	250 $\pm$ 20 mV						
4.2.6 Detector Diode Bias	+100 $\pm$ 10 mV						
TP 8, R 60	peak						
4.2.7 Res. Bal. TP11 & 12	< 50 μ V AC						
R37	shift						
4.2.8 Uncal. Indic.	ON 700 Ω						
	OFF 1.3K Ω						
4.2.9 Absolute Cal	< $\pm$ 0.02%		*				
4.3 OPER. ALIGN. 510A/AA							
4.3.1 + & - 18V supply ck.							
4.3.2 TP7 Voltage R34	> +3.8V; < -3.8V						
4.3.3 R95 Set	400 $\pm$ 1 Hz						
4.3.4 R44 Set TP5	$\pm$ 0.2V Diff.						
4.3.5 R90 Set TP5	Center at -2.5V						
4.3.6 Freq. Range	> 415Hz; < 385Hz						
4.3.7 R34 Set TP7	0 $\pm$ 0.1 VDC						
4.3.8 TP1 Check	0 to +5V p-p						
4.3.9 TP2 Check	0 to +5V p-p						
4.3.10 Phase Lock Check	370Hz, 430Hz						
Q.C. INSP.				PAGE 1 OF 1 REV. 1			

PHASE LOCK PCB ASSY

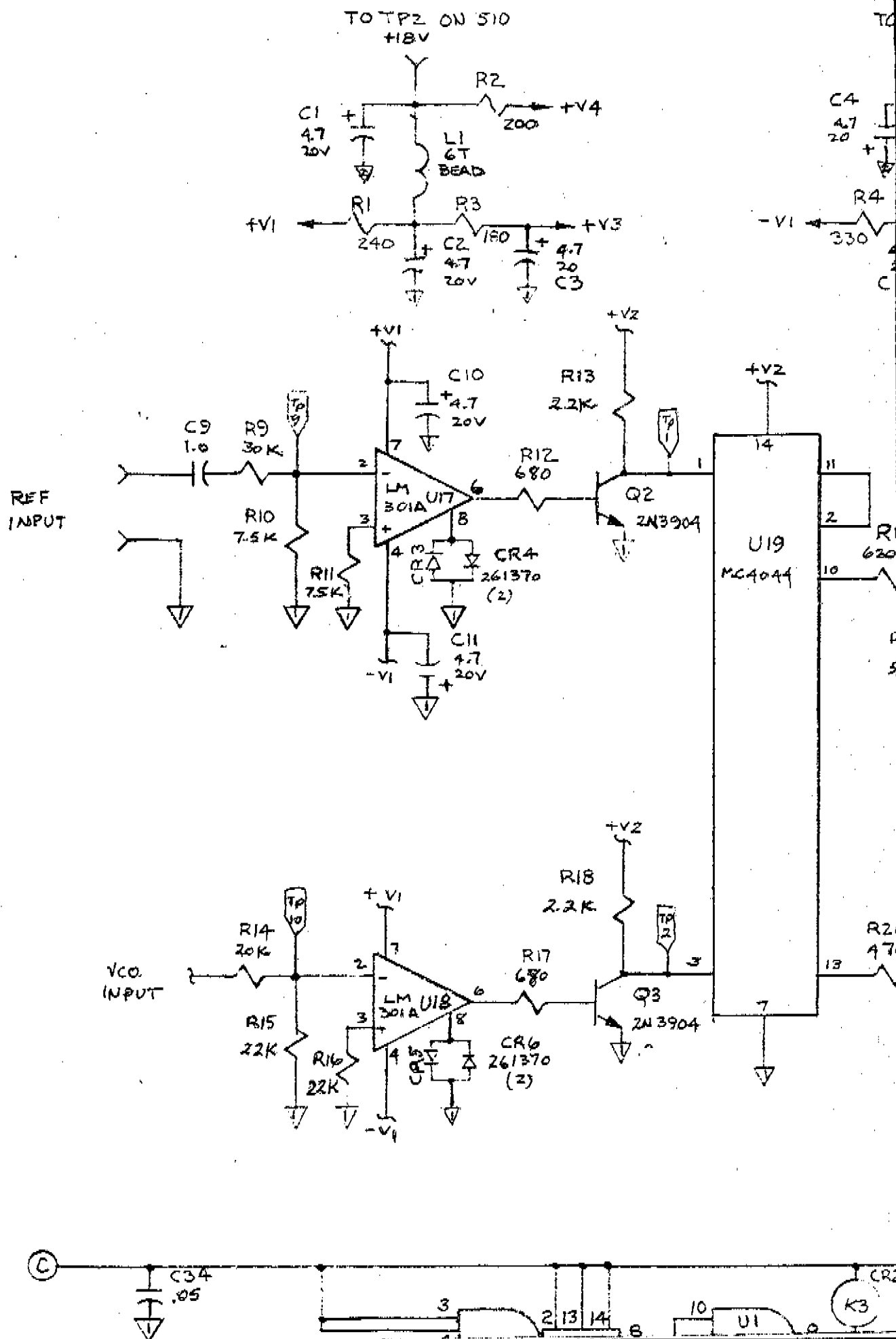
MODEL 510A/AA

DIAGRAM LAYOUT

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4	5	6				

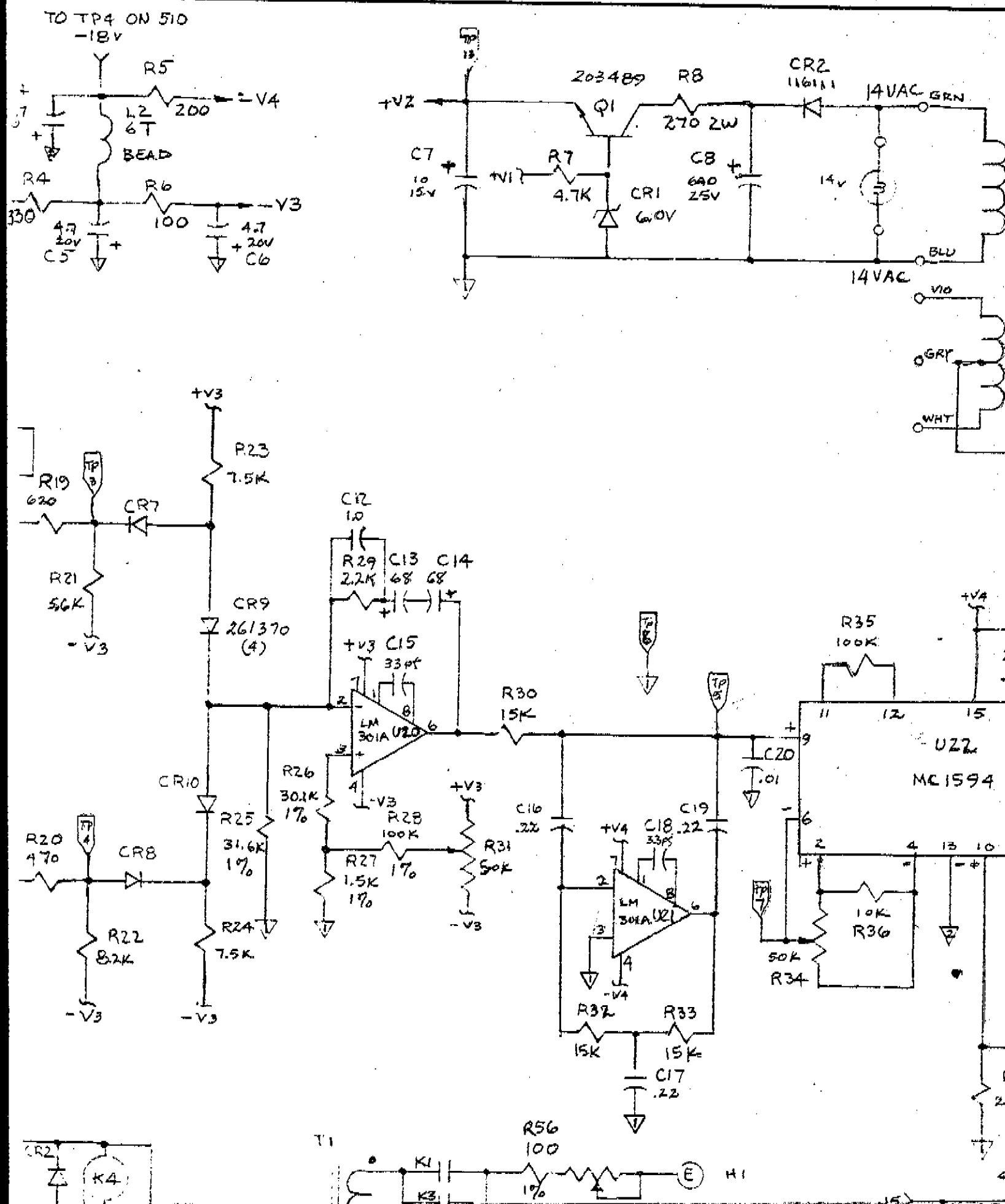
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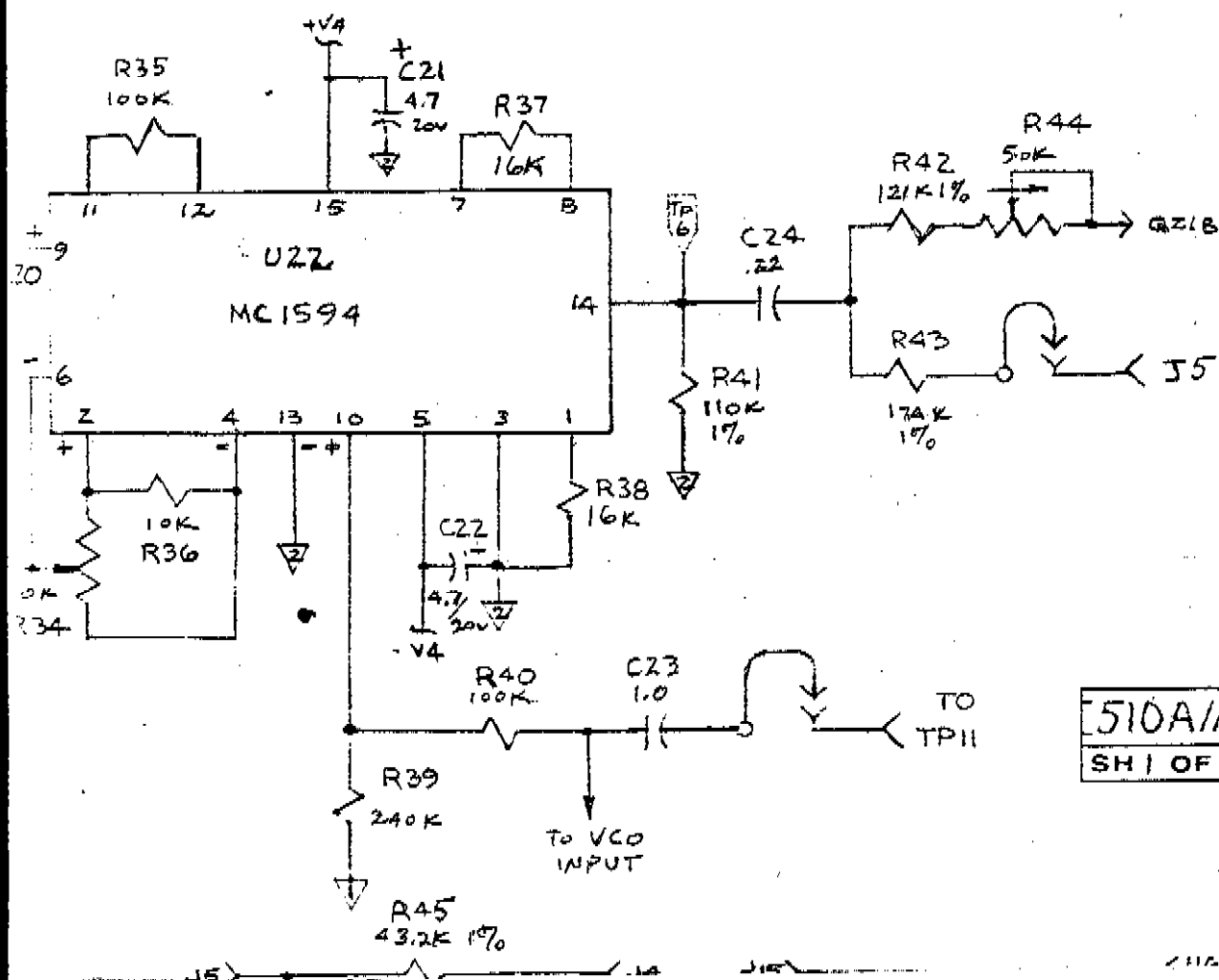
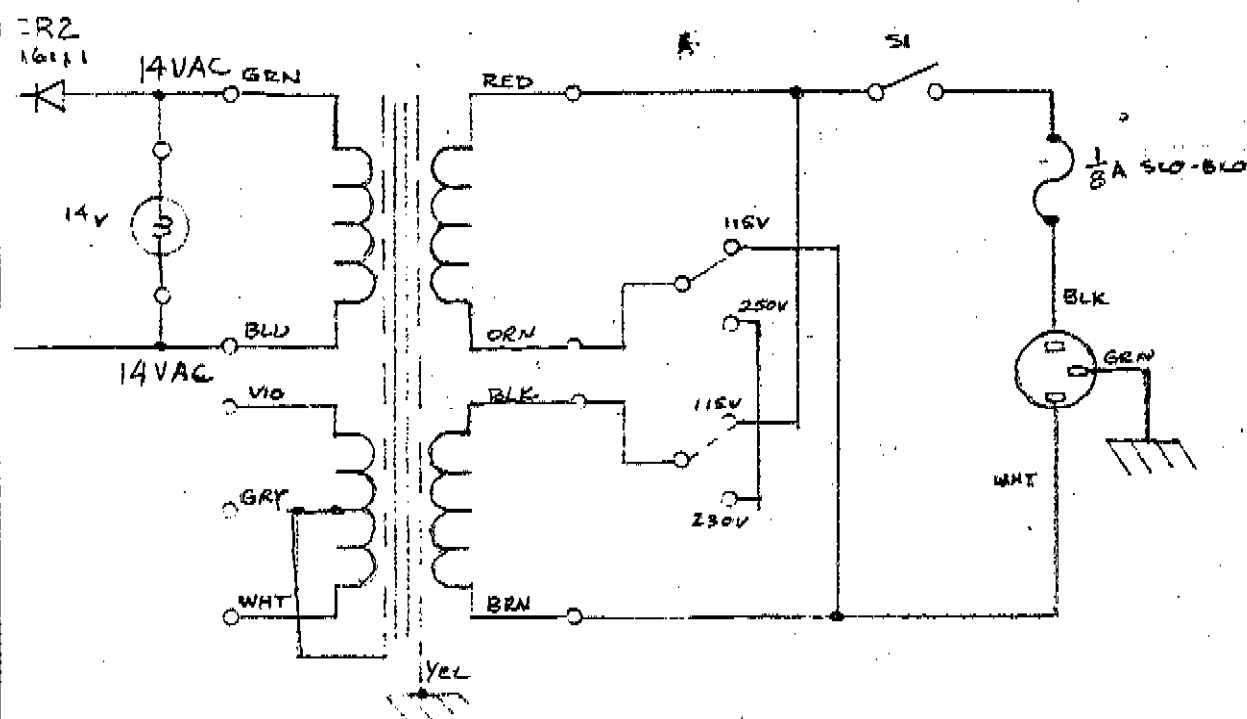


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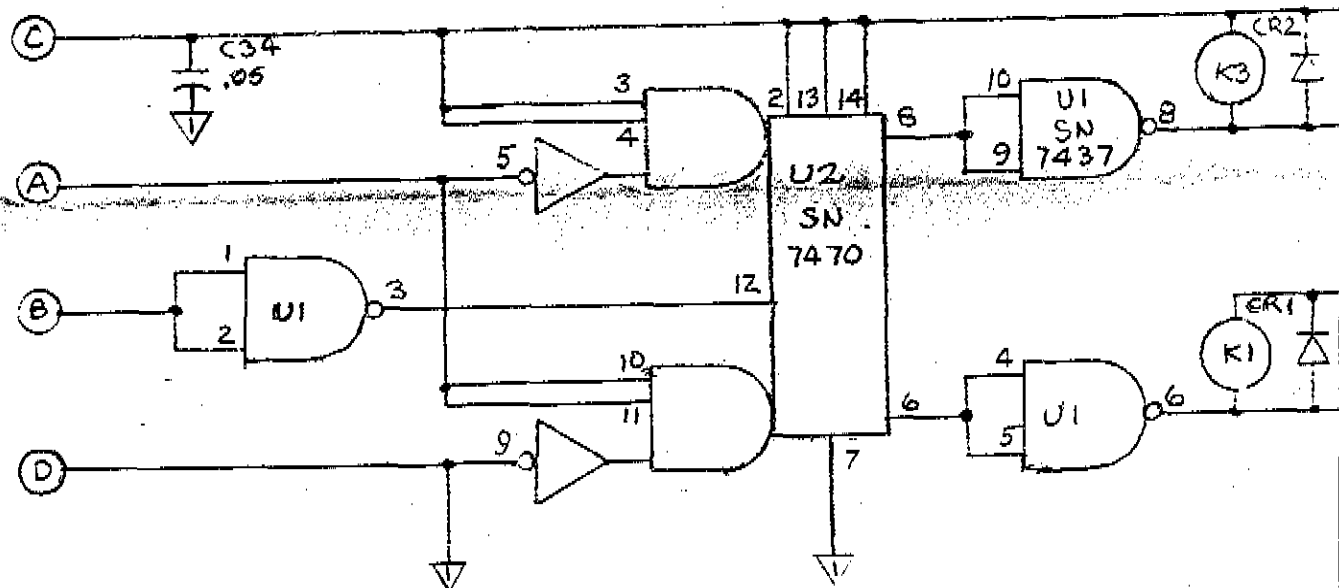
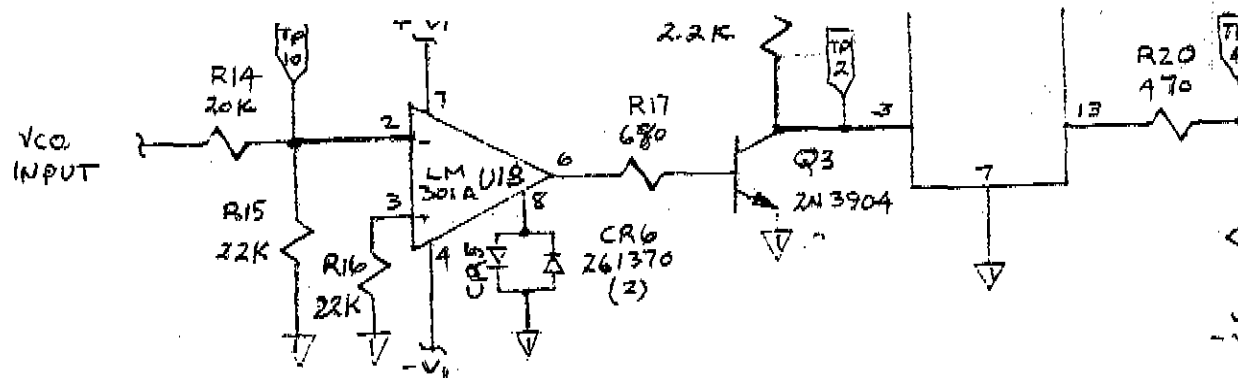
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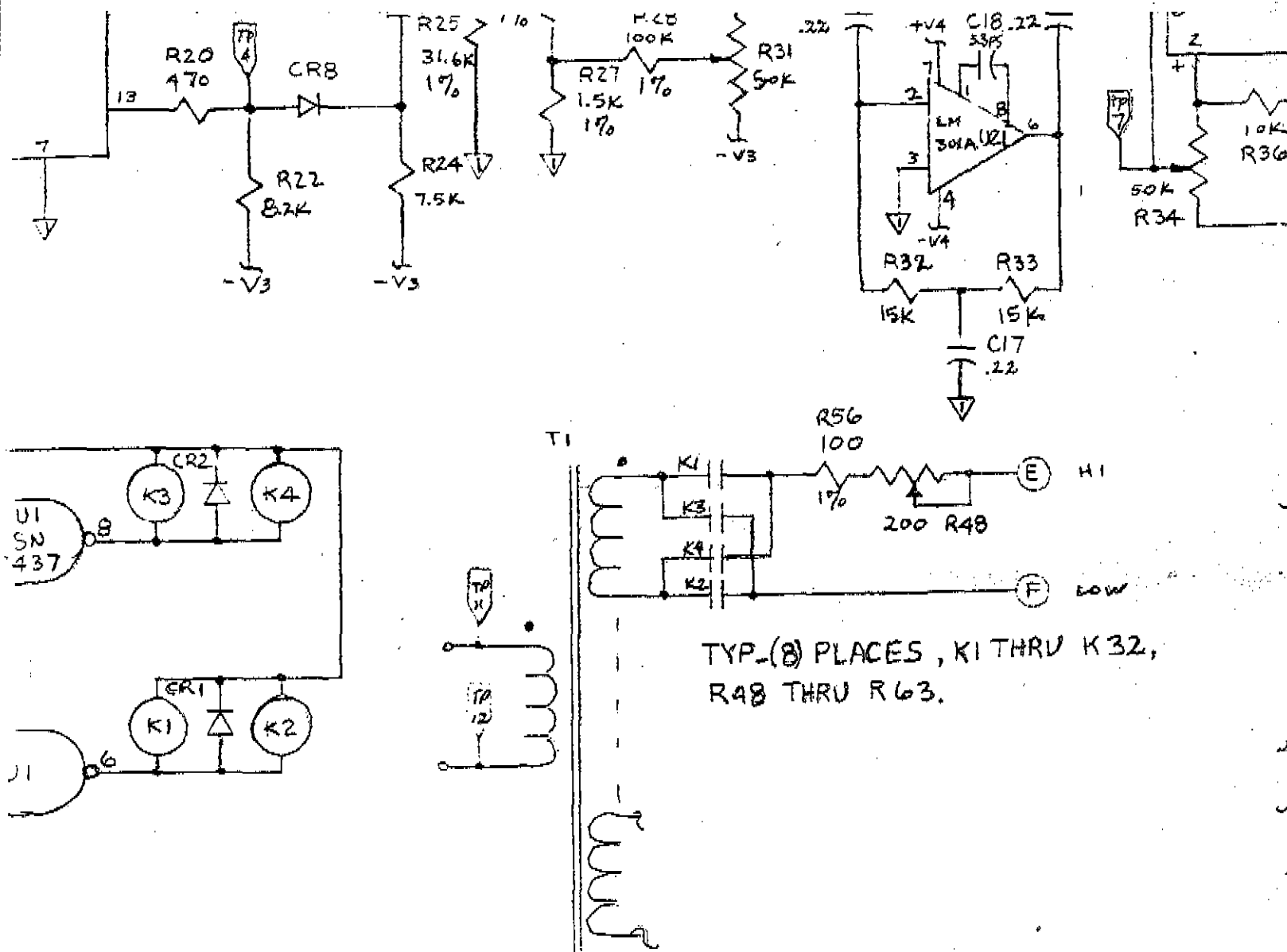
510A/AA-1003		
SH	OF	REV



TYP. (8) PLACES, U1 THRU U16,
C34 THRU C41, CR11 THRU CR26,
K1 THRU K32.

LAST USED:

U22
K32
R63
C41
CR26
TP13



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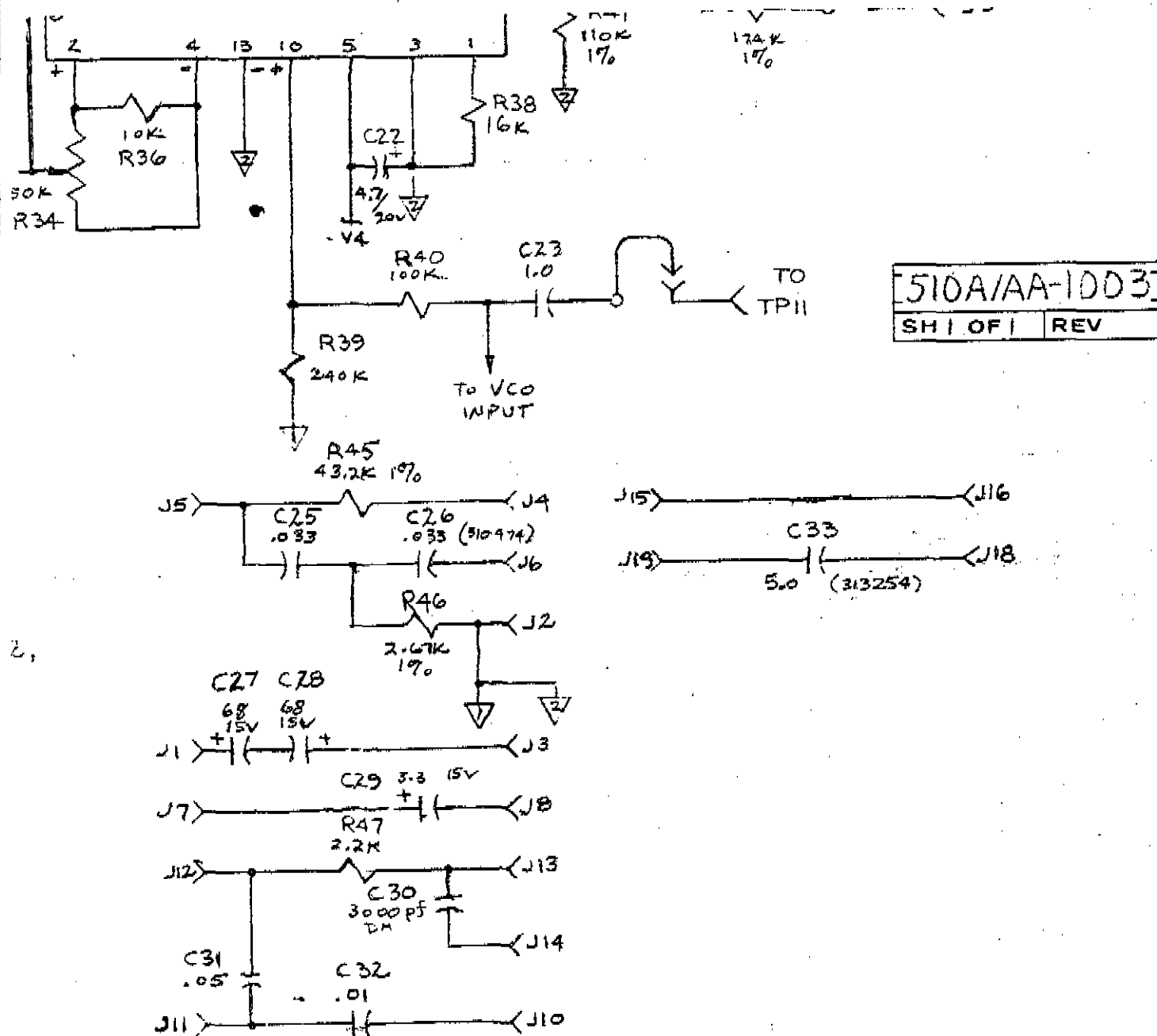
89536

DO NOT SCALE DRAWING
DIMENSIONS IN INCHES

TOLERANCES

.XX ±.020	.000-.100 DIA	+.003-.002
.XXX ±.010	.010-.200 DIA	+.004-.002
ANGLES ±	.201-.500 DIA	+.006-.003
X _C =	.501-1.00 DIA	+.010-.005

DR
CHK
ENG
ENG
MA
FIN



510A/AA-1003
SHI OFI REV

B

X	NEW PART PER ECO 6322 SPECIALS RELEASE		EJK	10/3/72	
	REV	CHANGE DESCRIPTION	DR	CHK	APPR
PHASE LOCK PCB ASSY					
PART NO		SIZE	DRAWING NO		
—		C	510A/AA-1003		
SCALE		SHT	OF	REV	

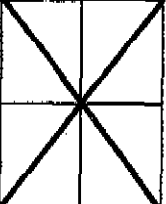
A

O., INC.	DR GEORGE KIRCHNER	10-31-72
E. WA.	CHK	
AWING	ENG <i>George Kirchner</i>	11-15-72
CHES	ENG	
MATERIAL		
FINISH		

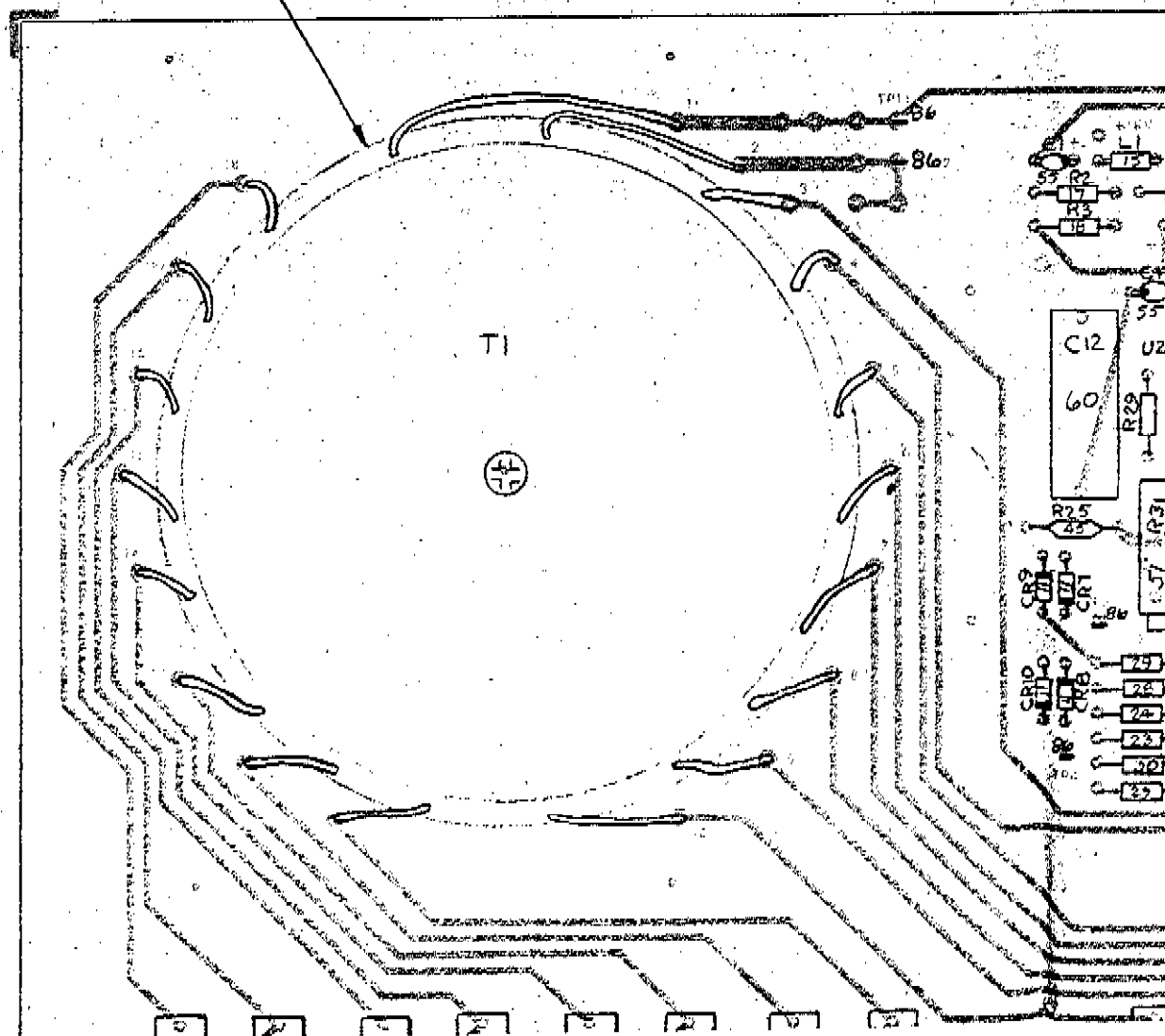
DIST 933

PHASE LOCK ASSY
MODEL 510A/AA

DIAGRAM LAYOUT

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6	7	8	9	10		

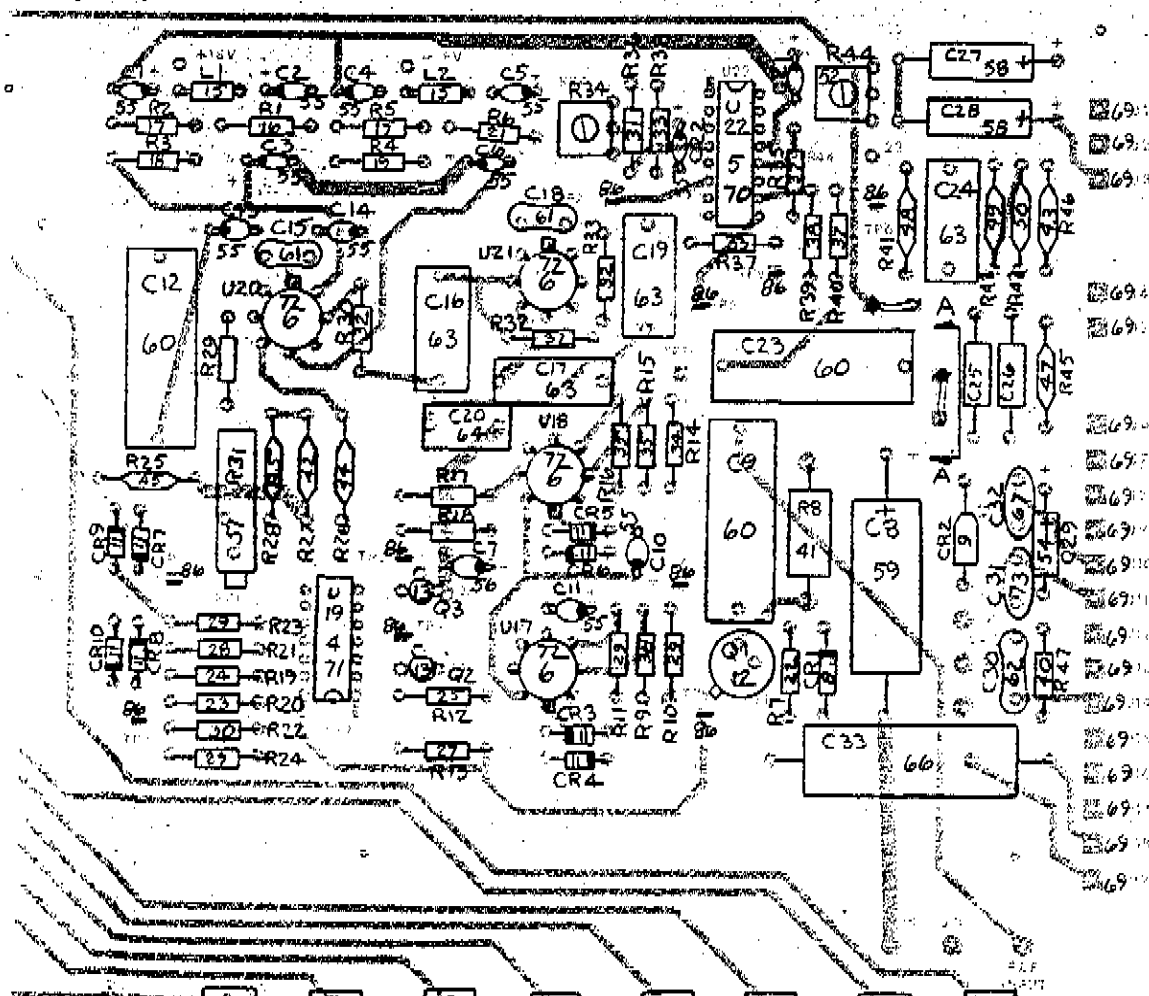
SEE DETAIL I FOR INSTALLATION
OF TI.



5

INSTALL ITEM 69 FROM CKT1 SIDE
AFTER FLOW SOLDERING.

ON



3
5

4

3

DE

ITEM	REF	P/N	NOMENCLATURE
38	R39	218016	RESISTOR 1/4W
39			
40	R47	198390	"
41	R8	110189	" 2W
42	R27	313098	" 1/8W
43	R46	312173	"
44	R26	168286	"
45	R25	261610	"
46	R56-63	168195	"
47	R45	312223	"
48	R41	234708	"
49	R42	229369	"
50	R43	235184	"
51	R31	268581	" VA
52	R34.44	335778	"
53	R48-55	275743	"
54	C29	182808	CAPACITOR
55	C1,2,3,4,5, 6,10,11,21,22	161943	"
56	C7	193623	"
57	C13.14	193615	"
58	C27.28	182824	"
59	C8	218172	"
60	C9,12,23	190330	"
61	C15.18	160317	" D
62	C30	161786	"
63	C16,17,19,24	194803	" M
64	C20	325548	" P

4

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2

510A/AA-4003

SH / OF / REV

NOMENCLATURE	QTY	ITEM	REF	P/N	NOMENCLATURE
RESISTOR 1/4W C.C. 5% 240K	1	1			510A/AA-3003 PHASE LOCK PCB
" " 2.2M	1	2	U1, 3, 5, 7, 9, 11, 13, 15	296228	I.C. SN743
" 2W C.C. 10% 270	1	3	U2, 4, 6, 8, 10, 12, 14, 16	293035	" SN747
" 1/8W M.F. 1% 1.5K	1	4	U19	320721	" MC4044
" " 2.67K	1	5	U22		" MC1594
" " 30.1K	1	6	U17, 18, 20, 21	271502	" LM301A
" " 31.6K	1	7	K1-32	354639	RELAY - ZESTRON 13
" " 100 Ω	8	8	CR1	325795	DIODE ZENER
" " 43.2K	1	9	CR2	116111	" IN4817
" " 110K	1	10	CR11-26	203323	" IN4148
" " 121K	1	11	CR3-10	261370	"
" " 174K	1	12	Q1	203489	TRANSISTOR
" VAIR 100K	1	13	Q2, 3	218396	" ZN3904
" " 50K	2	14			
" " 200 Ω	8	15	L1, 2	320911	CHOKE 6T REAC
CAPACITOR TANT 3.3 μ F	1	16	R1	221895	RESISTOR 1/4W CC 5%
" " 4.7 μ F	10	17	R2, 5	193482	" "
" " 10 μ F	1	18	R3	147942	" "
" " 68 μ F	2	19	R4	147967	" "
" " 68 μ F	2	20			
" ELECT 640 μ F	1	21	R6	147926	" "
" FILM 1.0 μ F	3	22	R7	148072	" "
" DIP MICA 33PF	2	23	R20	147983	" "
" " 3000PF	1	24	R19	221903	" "
" MYLAR 22 μ F	4	25	R12, 17	148007	" "
" POLYEST. .01 μ F	1	26			
		27	R13, 18, 29	148049	" "

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510A/AA-4003

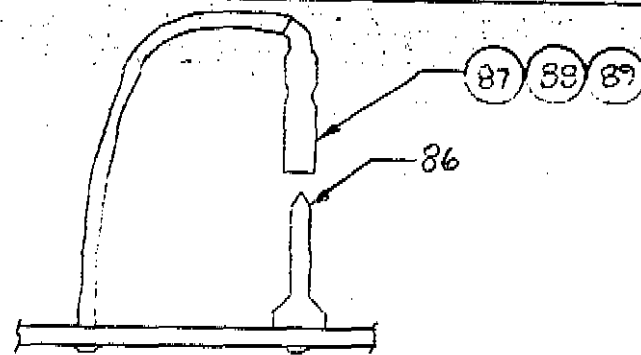
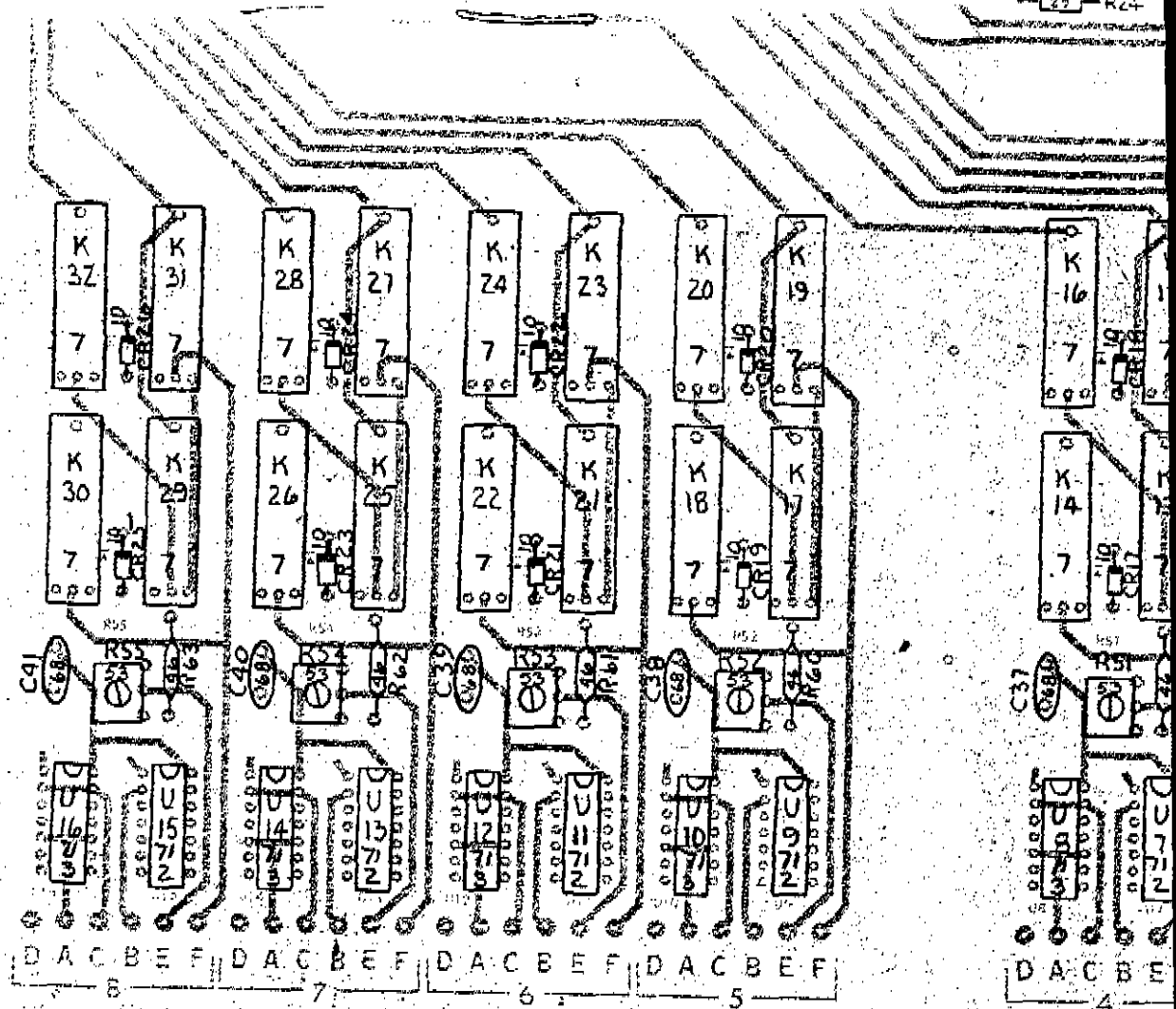
SH / OF / REV

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	2	U1,3,5,7,9,11, 13,15	296228	I.C. SN7437N	8
1	3	U2,4,6,8,10, 12,14,16	293035	" SN7470	8
1	4	U19	320721	" MC4044	1
1	5	U22		" MC1594	1
1	6	U17,18,20, 21	271502	" LM301A	4
1	7	K1-32	354639	RELAY - ZESTRON 1300-4-1A	32
1	8	CR1	325795	DIODE ZENER 60V	1
8	9	CR2	116111	" IN4817	1
1	10	CR11-26	203323	" IN4148	16
1	11	CR3-10	261370	"	8
1	12	Q1	203489	TRANSISTOR	1
1	13	Q2,3	218396	" ZN3904	2
1	14				
2	15	L1,2	320911	CHOKE 6T BEAD	2
8	16	R1	221895	RESISTOR 1/4W CC 5% 240	1
1	17	R2,5	193482	" " 200	2
10	18	R3	147942	" " 180	1
1	19	R4	147967	" " 330	1
2	20				
2	21	R6	147926	" " 100	1
1	22	R7	148072	" " 4.7K	1
3	23	R20	147983	" " 470 Ω	1
	24	R19	221903	" " 620 Ω	1
	25	R12,17	148007	" " 680 Ω	2
1	26				
	27	R13,18,29	148049	" " 2.2K	2

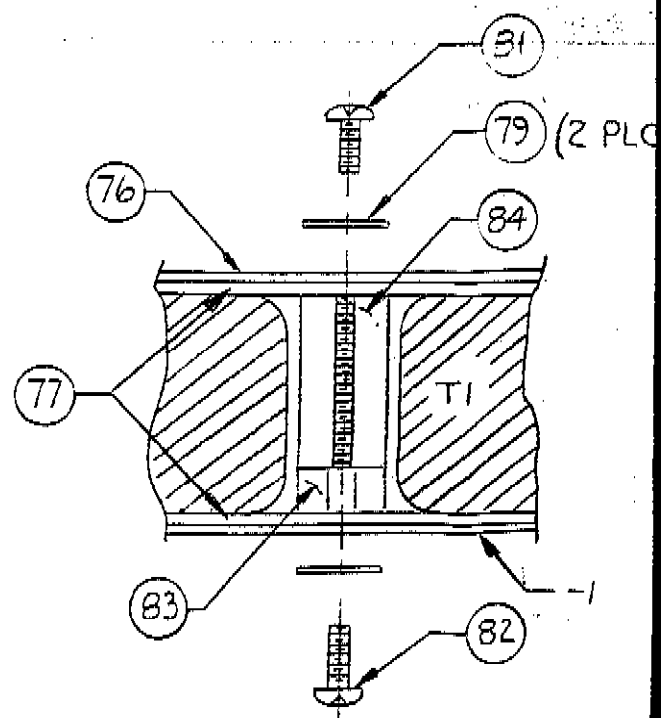
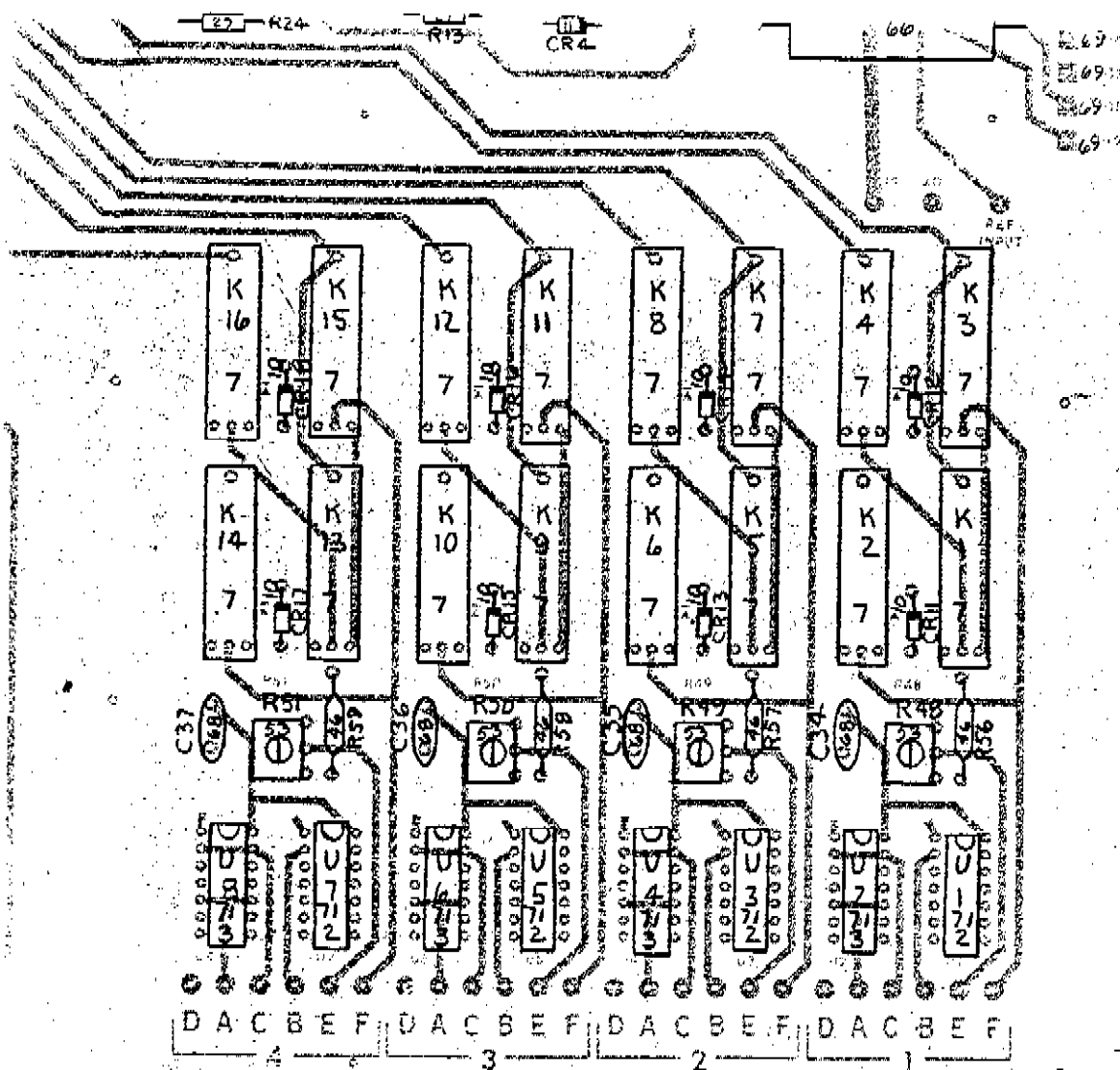
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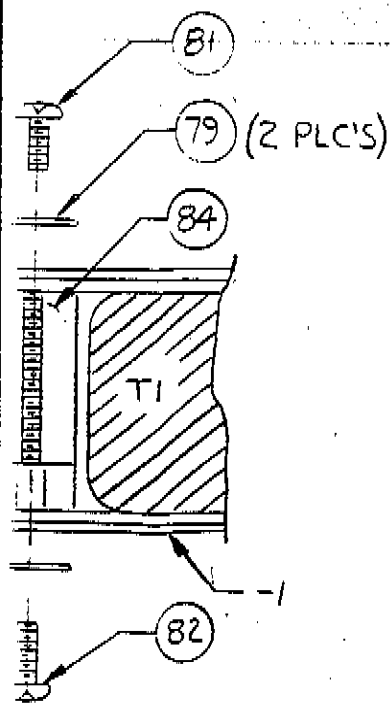
PHASE LOCK ASSY
S10A/AA-4003 CKT2 REV



VIEW A-A
TYPE 2 PLACES



DETAIL I
T1 MOUNTING OF OECO
FURNISHED TRANSFORMER.



L I
G OF OECD
TRANSFORMER.

8

60	C15.18	160317	"	DIP
61	C30	161786	"	"
62	C16,17,19,24	194803	"	MYL
63	C20	325548	"	POLY
64	C25.26	310474	"	POLY
65	C33	313254	"	"
66	C32	149153	"	CER.
67	C34-41	148924	"	"
68	P1-16	267591	CONNECTOR	RE
69	U22	291534	SOCKET	I.C.
70		291542	"	"
71		289843	"	"
72	C31	149161	CAP.	CER DI
73		285262	SOCKET	TRANSIS
74	TI		TRANSFORMER	510
75			PLATE	XFORMER.
76			PAD	XFORMER. 5
77				
78		110320	LOCK WASHER	IN
79				
80		114983	SCREW	#8-32 X 5
81		276477	"	" X
82		158634	SPACER	
83		101642	"	, THREA
84	R23	248807	RESISTOR	1/8W M
85	TP1-13	277415	AMP PIN	
86		267542	AMP SOCKET	AW
87		200733	WIRE	TEFLON. AW
88		144410	SHRINK TUBING	

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FLUKE

89536

.XX ± .020
.XXX ± .010
ANGLES ±
X_C

"	FILM	100MT	5	23	R20	147983	"	"	470
"	DIP MICA	33PF	2	24	R19	221903	"	"	620
"	"	3000PF	1	25	R12.17	148007	"	"	680
"	MYLAR	.22 μ t	4	26					
"	POLYEST.	.01 μ t	1	27	R13.18,29	148049	"	"	2.2K
"	POLYCARB.	.033 μ t	2	28	R21	148080	"	"	5.6K
"	"	5.0 μ t	1	29	R10,11,23, 24	193326	"	"	7.5K
"	CER. DISC	.01 μ t	1	30	R22	160796	"	"	8.2K
"	"	.05 μ t	8	31	R36	148106	"	"	10K
CONNECTOR RECEPTACLE			19	32	R30,32,33	148114	"	"	15K
CKET. I.C. 16 PIN			1	33	R38,37	221606	"	"	16K
"	"	14 PIN	17	34	R14	221614	"	"	20K
"	"	8 PIN	4	35	R15,16	148130	"	"	22K
P. CER DISC.		.05 μ t	1	36	R9	193417	"	"	30K
CKET. TRANSISTOR			3	37	R35.40	148189	"	"	100K
TRANSFORMER. 510A/AA-6001			1						
TRANSFORMER. 510A/AA-2008			1						
TRANSFORMER. 510A/AA-2009			2						
WASHER. INT TOOTH #8			2						
REW. #8-32 X 5/8. PHP			1						
"	"	X 3/4	1						
ACER			1						
"		THREADED	1						
ISTOR 1/2W M.F 170		100K	1						
P PIN			14						
P SOCKET. AWG #26			2						
E. TEFLON. AWG #26. ORN			2 IN.						
PINK TUBING			1 IN.						

9

JOHN FLUKE MFG. CO., INC. P.O. BOX 7428, SEATTLE, WA.		89536 DO NOT SCALE DRAWING DIMENSIONS IN INCHES		DR. GENE KIRCHNER 8-18-72		ECO 6322 REPLACES 510A/AA-4001 SPECIALS RELEASE	
		TOLERANCES XX $\pm$.020 XXX $\pm$.010 ANGLES $\pm$ X_C "		CHK 11-15-72		PHASE LOCK CHANGE DESCRIPTION	
MATERIAL —		ENG —		PART NO —		SIZE D	
FINISH —		SCALE 2:1 —		SHT 1 OF 1		DRAWN 510A/AA	

+	2	24	R19	221903	"	"	620-2	1
+	1	25	R12.17	148007	"	"	680-2	2
+	4	26						
+	1	27	R13,18,29	148049	"	"	2.2K	3
+	2	28	R21	148080	"	"	5.6K	1
+	1	29	R10,11,23, 24	193326	"	"	7.5K	4
+	1	30	R22	160796	"	"	8.2K	1
+	8	31	R36	148106	"	"	10K	1
	19	32	R30,32,33	148114	"	"	15K	3
	1	33	R38,37	221606	"	"	16K	2
	17	34	R14	221614	"	"	20K	1
	4	35	R15,16	148130	"	"	22K	2
+	1	36	R9	193417	"	"	30K	1
	3	37	R35,40	148189	"	"	100K	2

	1
3	1
	2
3	2
	1
	1
	1
	1
1	1
	14
	2
	2 IN.
	1 IN.

10

ECO 6322		EJK		10/31/72		11-15-72	
REPLACES 510A/AA-4001							
SPECIALS RELEASE							
REV	CHANGE DESCRIPTION	DR	CHK	APPR			
DR GENE KIRCHNER		8-18-72		PHASE LOCK ASSY			
CHK							
ENG <i>Gene Dorsch</i>		11-15-72					
ENG							
MATERIAL				PART NO		SIZE	
				D		DRAWING NO	
FINISH				510A/AA-4003			
				SCALE 2:1		SHT 1 OF 1 REV	

510A/AA-4003

DWG. 510A/AA-4004

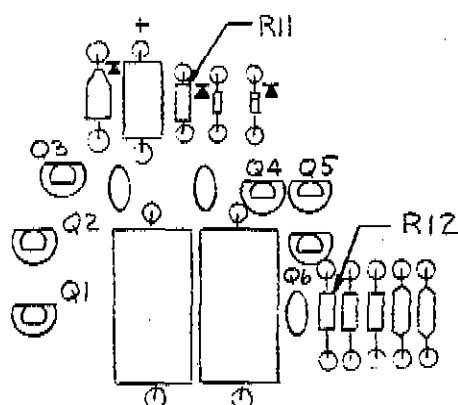
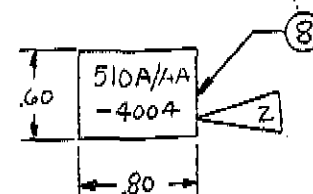
SHT. 1 OF 2

REWORK* 510A-4001 PCB ASSY:

1. REMOVE DS1 & DS2.
2. REPLACE Q1 WITH 2N4890 (269076).
3. REPLACE Q4 WITH (203489).
4. CHANGE R11 FROM 22K TO 10 Ω . (147868).
5. CHANGE R12 FROM 5.6K TO 2.2K (148049).
6. ADD TP TO R94-R89 JUNCTION (SEE DETAIL).
7. CHANGE C33 FROM 10 P $\pm$ DM TO 33 P $\pm$ DM (160317).

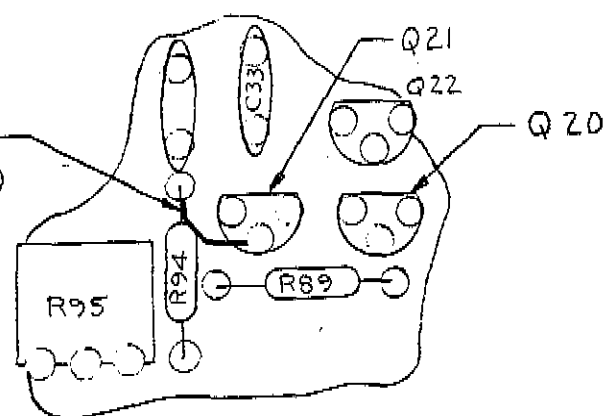
510A/AA-4004
SHT. 1 OF 1 REV

ITEM
1
2
3
4
5
6
7
8

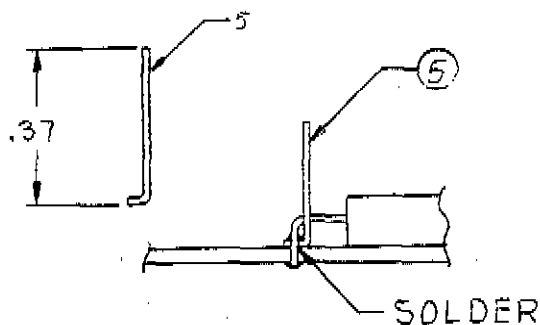


R11 & R12 LOCATION

ADD TP
(SEE DETAIL)



TP LOCATION



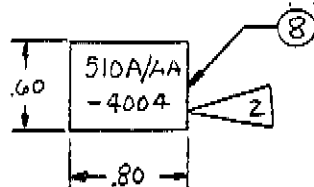
TP DETAIL

PROPRIETARY NOTICE			JOHN FLUKE MFG. CO., INC.		DR GEN
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89536		DO NOT SCALE DRAWING DIMENSIONS IN INCHES		ENG 7/12	
TOLERANCES					ENG
.XX ± .020	.000-.100 DIA	+.003-.002		MATERIAL 510A FINISH	
.XXX ± .010	.010-.200 DIA	+.004-.002			
ANGLES ±	.201-.500 DIA	+.006-.003			
X _C =	.501-1.00 DIA	+.010-.005			

DWG. 510A/AA-4004
SHT. 2 OF 2

510A/AA-4004
SHT 1 OF 1 REV

ITEM	REF	P/N	NOMENCLATURE	QTY
1	Q4	203489	TRANSISTOR, NPN	1
2	R11	147868	RESISTOR, 1/4W 5% 10 Ω	1
3	R12	148049	" " " 2.2K	1
4	—	307868	MAIN PCB ASSY, 510A-4001	1
5	—	171744	WIRE AWG#22 GOLD PL	1 IN.
6	Q1	269076	TRANSISTOR, 2N4890	1
7	C33	160317	CAPACITOR, 33pf PM	1
8	—	—	DECAL, WHITE VINYL, ADHESIVED BACKED	1



DETAIL I

CUT OFF AMP PINS
THIS AREA ONLY
.020 MAX H.T.

NOTES:

1. ALL COMPONENT LEADS INCLUDING SI SHALL BE TRIMMED TO .020 MAX. SEE DETAIL I.

2. TYPE NEW PART NUMBER ON ITEM 8 APPLY OVER OLD PART NUMBER & NAME.

TION

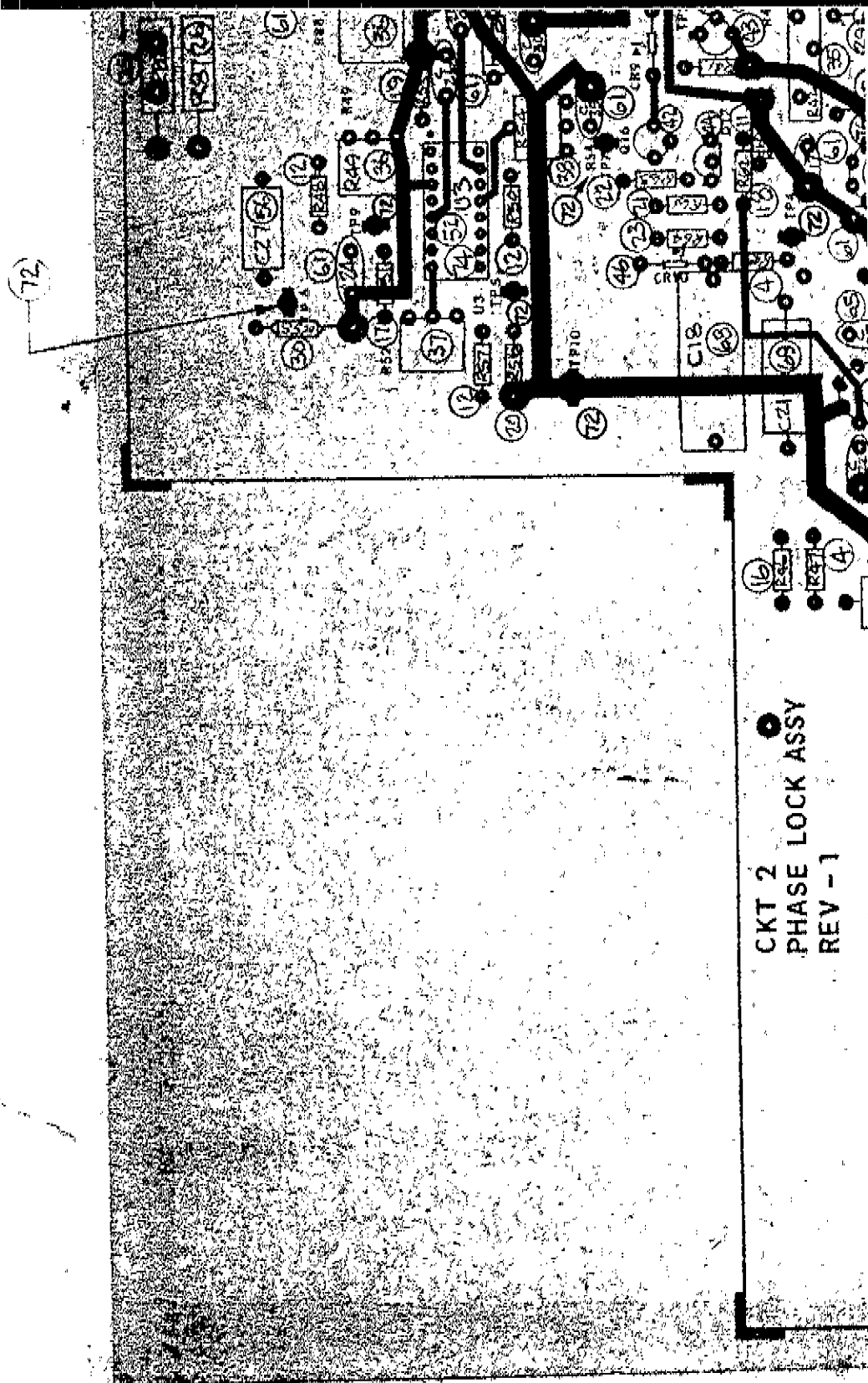
JOHN FLUKE MFG. CO., INC. P.O. BOX 7428, SEATTLE, WA.		DR GENE KIRCHNER CHK W. R. MACLAREN		NEW PART PER ECO 6322 SPECIALS RELEASE		ESK 10/31/72		MEM 10/31/72		15/5/72	
DO NOT SCALE DRAWING DIMENSIONS IN INCHES		ENG <i>[Signature]</i> ENG		REV		CHANGE DESCRIPTION		DR		CHK APPR	
TOLERANCES		MATERIAL MAKE FROM 510A-4001		PART NO		SIZE		DRAWING NO		B 510A/AA-4004	
.000-.100 DIA +.003-.002		FINISH		SCALE NONE		SHT 1 OF 1		REV		DIST 933	
.010-.200 DIA +.004-.002											
.201-.500 DIA +.006-.003											
.501-1.00 DIA +.010-.005											

PHASE LOCK PCB ASSEMBLY

DIAGRAM LAYOUT

1	2	3	4			
5	6	7	8			
9	10	11	12			

CKT 2
PHASE LOCK ASSY
REV -1



6

5

4

2

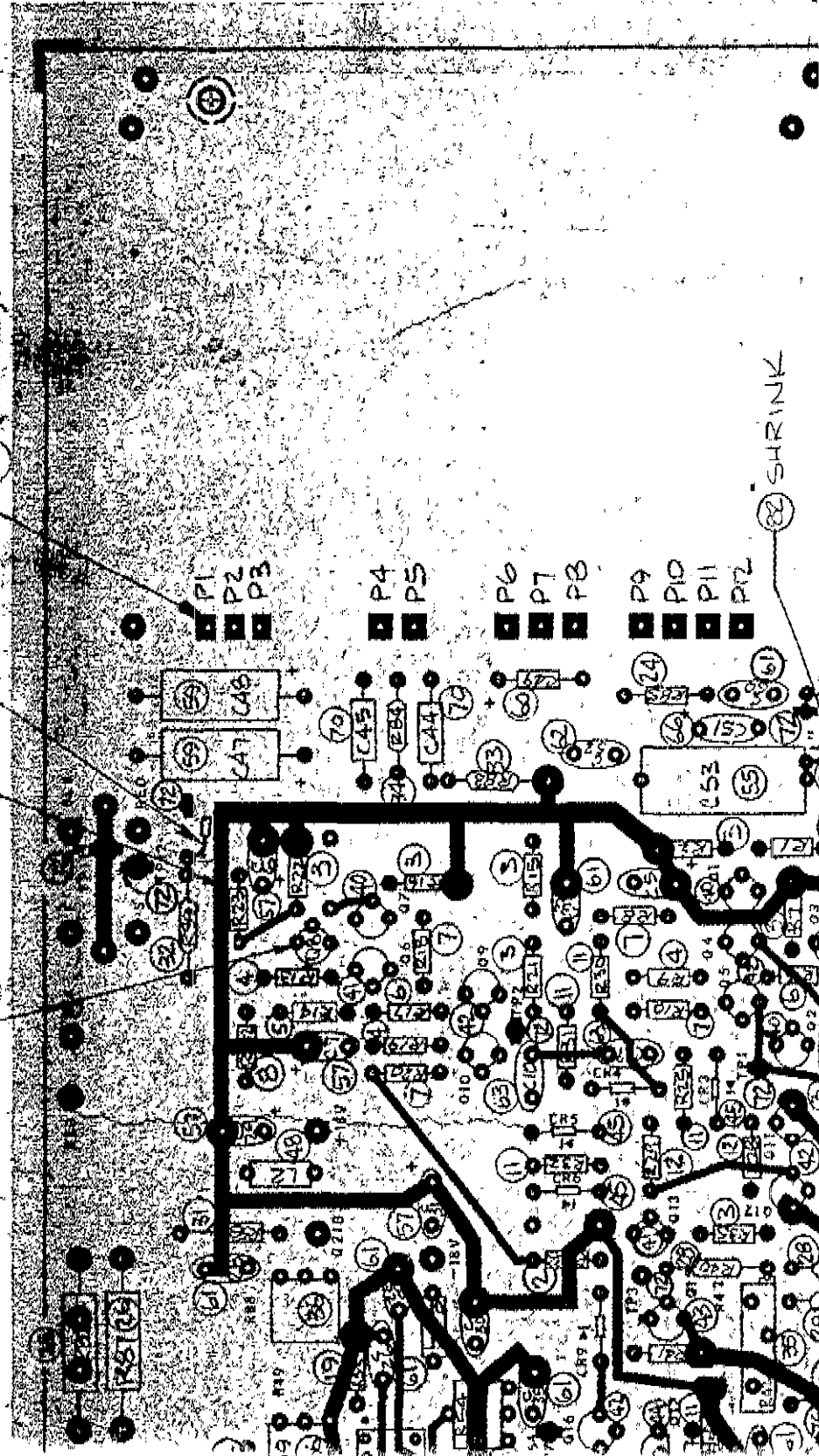
ITEM	REP
40	Q1, Q2, Q
41	Q3, Q6, Q
42	3
43	Q15
44	Q17
45	CR-CR6 CR11-C1
46	CR7, CR
47	CR8
48	L1-L
49	K1-K
50	K1-K
51	U1, U
52	U3
53	4
54	5
55	C1, C
56	C27
57	6

77 USED WITH
Q1 THRU Q16



79 90 81

73 (16 PL)



3

 510A/AA-4001
 SH OFF 1 REV 3

ITEM	REF	P/N	NOMENCLATURE	QTY
40	Q1, Q2, Q7, Q8	288761	TRANSISTOR, PNP, RS-204B	4
41	Q3, Q6, Q13	195974	PNP, 2N3906	3
42		218396	NPN, 2N3904	3
43	Q15	261578	FET, U1897E	1
44	Q17	268110	UNI JUNCT, 2N6027	1
45	CR-CR6, CR9 CR11-CR16	203323	DIODE, SILICON, 1N4148	23
46	CR7, CR10	246611	" ZENER, 1N961B	2
47	CR8	260695	" " 1N754A	1
48	L1-L3	320911	CHOKE, 6TURN	3
49	K1-K16	267708	RELAY, REED	16
50	K1-K16	288357	COIL, REED RELAY	16
51	U1, U2	271502	INTEGRATED CIRCUIT, LM301A	1
52	U3	—	MC1594L	1
53		293035	SN7470N	3
54		296228	SN7437N	3
55	C1, C53	190330	CAPACITOR, FF 1uF	2
56	C27	194803	" " .22	1
57		161943	CAPACITOR, TANT. 20V 47uF	3

ITEM	REF	P/N
1	—	—
2	R1, R26, R27 R36, R41	221614
3		148106
4		159731
5	R4, R14	193367
6	R6, R17	193334
7	R8, R10 R18, R20	193508
8	R12, R65	234252
9	R23	193433
10	R24	221952
11	R25, R30, R34 R32, R60	220533
12	R28, R29, R40 R60, R57	148189
13	R34	193342
14	R37	148148
15	R44	148130
16	R46	221911
17	R51	148023
18	R67	221937

4

3

2

1

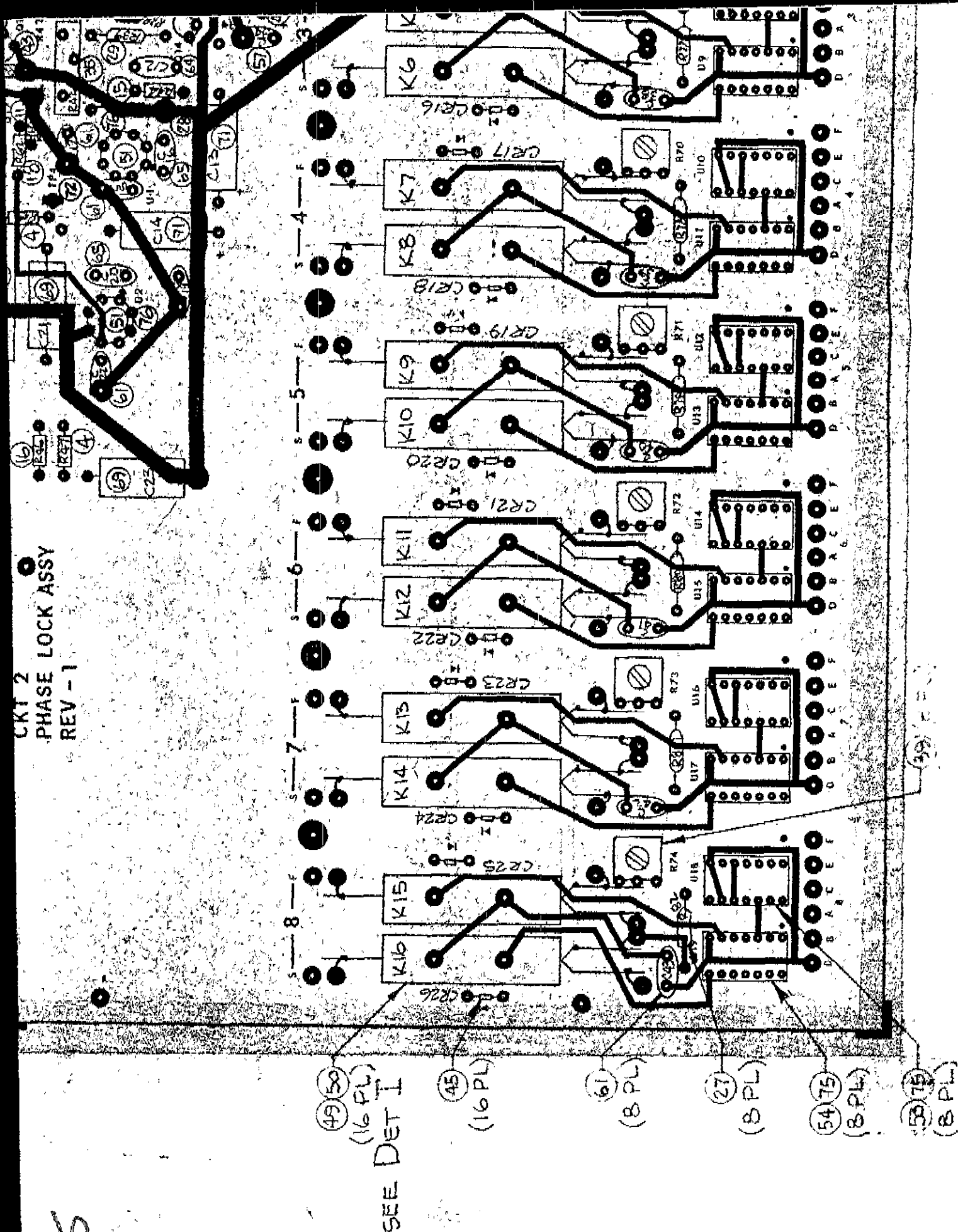
U10A/AA-40011
SH / OF 1 REV 3

DESCRIPTION	QTY
R, PNP, RS-204B	4
PNP, 2N3906	3
NPN, 2N3904	3
FET, U1897E	1
DIODE, 2N6027	1
CON, 1N4148	23
DIODE, 1N961B	2
IC, 1N754A	1
TRANS	3
RELAY	16
CIRCUIT, LM301A	1
MC1596L	1
SN7470N	3
SN7437N	3
FF	2
1 .22	1
20V 4.7uf	3

ITEM	REF	P/N	NOMENCLATURE	QTY
1	—	—	PHASE LOCK PCB 510A/AA-3001	1
2	R1, R26, R27 R36, R41	221614	RESISTOR, CC, 1/4W, 5%, 20K	5
3	1	148106	10K	9
4	2	159731	12K	6
5	R4, R14	193367	43K	2
6	R6, R17	193334	51K	2
7	R8, R10 R18, R20	193508	3K	4
8	R12, R65	234252	1.3K	2
9	R23	193433	2.4K	1
10	R24	221952	3M	1
11	R25, R30, R31 R32, R60	220533	560K	5
12	R28, R29, R48 R60, R57	148189	100K	5
13	R34	193342	5.1K	1
14	R37	148148	27K	1
15	R44	148130	22K	1
16	R46	221911	6.2K	1
17	R51	148023	1K	1
18	R67	221937	750K	1

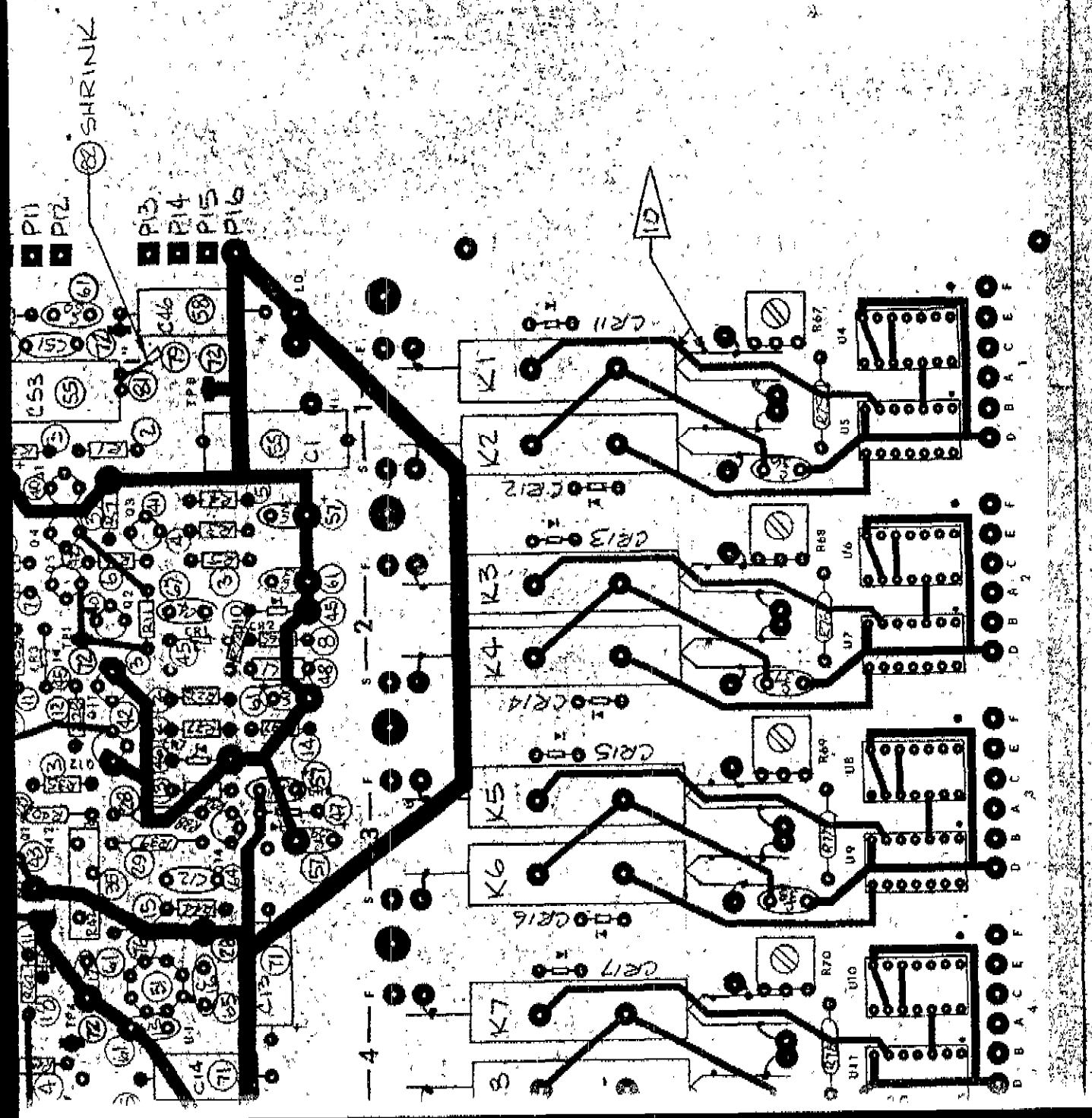
D

CKT 2
PHASE LOCK ASSY
REV - 1



60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77

8 9 11



7

57	6	161943	CAPACITOR, TANT, 20V, 4.7 μ f	e
58	C46	182840		220 μ f 1
59	C47, C48	182824		68 μ f 2
60	C49	182808		3.3 μ f 1
61	7	149161	CAPACITOR, FIXED, CD, .05	21
62	C52	149153	" " " .01	1
63	C9, C10	148460	CAPACITOR, FIXED, DM, 180 μ f	2
64	C12	170431		560 μ f 1
65	C16, C20	160317		33 μ f 2
66	C51	161786		3000 μ f 1
67	C4	148387		1000 μ f 1
68	C18	—	CAPACITOR, FIXED, MYLAR, 82 μ f	1
69	C21, C23	246017	CAPACITOR, FIXED, POLY, 39 μ f	2
70	C44, C45	310474	" " " .033 μ f	2
71	C13, C14	106492	CAPACITOR, AL ELECT, 16V, 30 μ f	2
72	TP1-TP12	277418	CONNECTOR POST	14
73	P1-P16	267591	CONNECTOR, RECEPTACLE	16
74	—	291534	SOCKET, I.C., 16 PIN	1
75	—	291542	" " 14 PIN	16
76	—	289343	" " 8 PIN	2
77	—	285262	SOCKET, TRANSISTOR	16
78	—	115469	WIRE, BUS, AWG # 22	1.5 FT
79	—	267542	AMP SOCKET, AWG # 26	2

8

9

11

18	R62	
19	R53	
20	R56	
21	R61	
22	R63	
23	R64	
24	R85	
25	R86	
26	R87	
27	R75-R82	
28	R38, R40, R43	
29	R39	
30	R55	
31	R58	
32	R59	
33	R83	
34	R84	
35	R42	
36	R49, R88	
37	R52	
38	R54	
39	R67-R74	

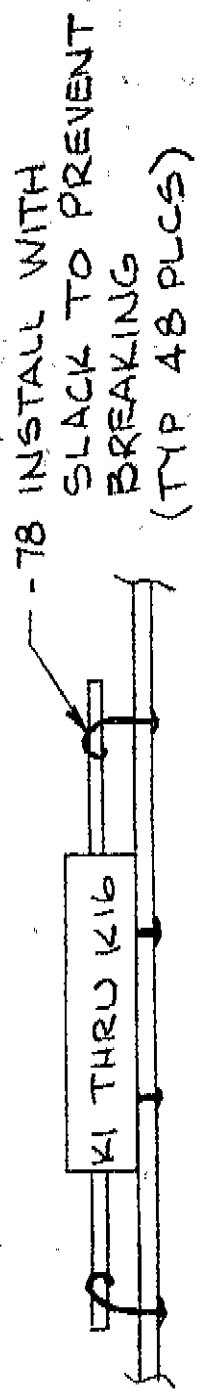
C



B

1	17	R51	148023			1K	1
8	18	R62	221537			750K	1
1	19	R53	221606			16K	1
2	20	R56	218016			240K	1
1	21	R61	193226			7.5K	1
21	22	R63	148155			33K	1
1	23	R64	289623			1.8M	1
2	24	R85	199390	1		2.2M	1
1	25	R86	218834	RESISTOR, CC, 2W, 5%, 2.4K		2.4K	1
2	26	R87	110148	RESISTOR, CC, 2W 10%		2.7K	1
1	27	R15-R82	245373	RESISTOR, MF, 1/8W, 1%, 402R		8	
1	28	R38, R40, R43	291872			20K	3
1	29	R39	163260			10K	1
2	30	R55	234708			110K	1
2	31	R58	229369			121K	1
2	32	R59	235184			174K	1
14	33	R83	289587			2.67K	1
16	34	R84	272153	1		45.2K	1
1	35	R42	190363	RESISTOR, WW, TRIMMER, 1K		1K	1
16	36	R49, R88		RESISTOR, VAR CERMET 50K		50K	2
2	37	R52				20K	1
16	38	R54	309674			10K	1

50 (8 PL)
50 (8 PL)



DET I

NOTES:

- 1 ▷ R2, R5, R7, R11, R15, R16, R21, R22, R35
- 2 ▷ R3, R9, R13, R19, R45, R47
- 3 ▷ Q4, Q5, Q9, Q10, Q11, Q12, Q14, Q16
- 4 ▷ U4, U6, U8, U10, U12, U14, U16, U18
- 5 ▷ U5, U7, U9, U11, U13, U15, U17, U19
- 6 ▷ C2, C5, C6, C7, C11, C29, C31, C34
- 7 ▷ C3, C8, C15, C17, C19, C22, C24, C25, C26, C28, C30, C33, C35-C43, C50
- 8 ▷ INSTALL ITEM 72 FROM CKT 2 SIDE BEFORE INSTALLING COMPONENTS. (14 PL)
- 9 ▷ INSTALL ITEM 73 FROM CKT 1 SIDE AFTER FLOW SOLDERING.
- 10 ▷ ALIGN BLUE SPOT ON REED RELAY WITH DOT ON PCB.



INSTALL ITEM 77 SO PCB BEFORE INSTALL ITEM 40, 41, 42 & 43.



75	—
76	—
77	—
78	—
79	—
80	—
81	—
82	—

75	—	291542	"	"	14 PIN	16
76	—	289843	"	"	8 PIN	2
77	—	285262	SOCKET, TRANSISTOR			16
78	—	115469	WIRE, BUS, AWG # 22			1.5 FT
79	—	267542	AMP SOCKET, AWG # 26			2
80	—	200733	WIRE, TEFLON, AWG # 26, ORN			.2 FT
81	—	200725	WIRE, TEFLON, AWG # 26, YEL			.2 FT
82	—	144410	SHRINK TUBING			.1 FT



11 INSTALL ITEM 77 SOCKET ON
PCB BEFORE INSTALLING
ITEM 40, 41, 42 & 43.



14 PL)

//

36	R49, R8
37	R52
38	R54
39	R67-27

FLUKE JOHN FLUKE MFG CO., INC. P.O. BOX 7428, SEATTLE, WN.		DO NOT SCALE DFT MWR MAC LAC
UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCHES		PROJ ENG MFG ENG
3 PLACE DECIMALS ± .010 2 PLACE DECIMALS ± .02 FRACTIONS ± ANGLES ±		MATERIAL:
X CONST.		FINISH:

"	14 PIN	16
"	8 PIN	2
ET, TRANSISTOR	16	
BUS, AWG # 22	1.5 FT	
CKET, AWG # 26	2	
TEFLON, AWG # 26, ORN	.2 FT	
EFLON, AWG # 26, YEL	.2 FT	
< TUBING	.1 FT	

36	R49, R88	RESISTOR, VAC CERMET 50K	2
37	R52	20K	1
38	R54	10K	1
39	R67-R74	2000	8

NOT TO BE USED FOR
CURRENT PRODUCTION
4003 5/12/79
AND ON. 11-13-79
WAKK

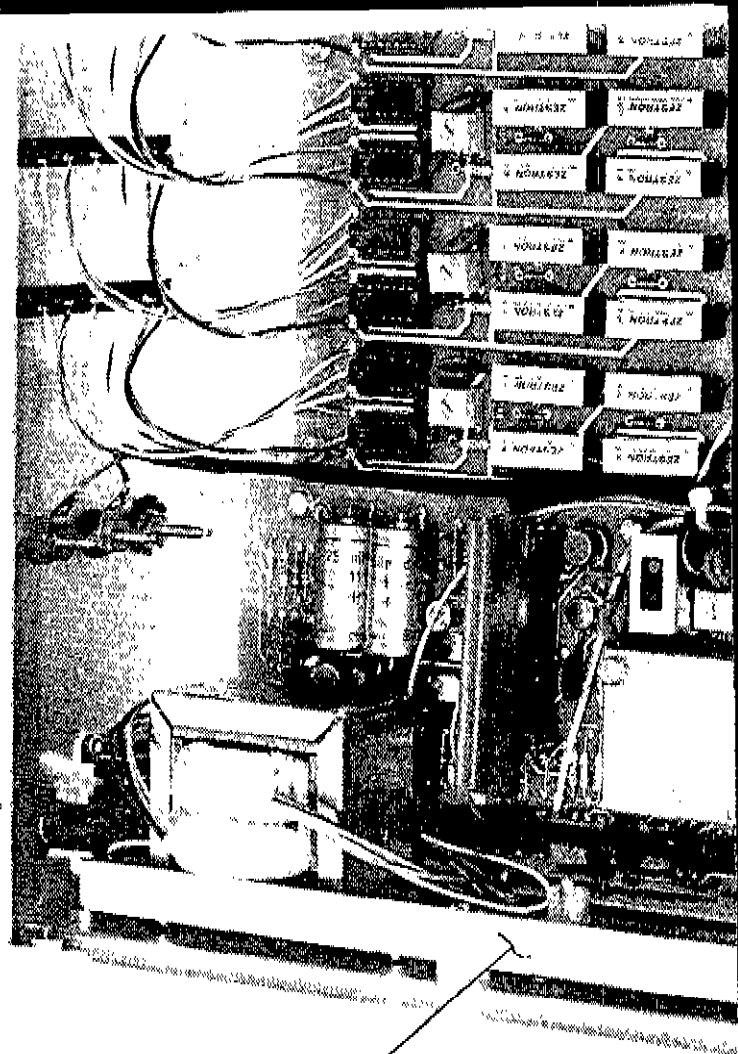
ZONE	REV	DESCRIPTION	DATE	BY	APP
B/M	3	ADDED TO PCB - 14 PL. ITEM 12 QTY. FROM 1 TO 14	12-9-71	WEM	WEM
	2	REVISED PER 2ND RUN	11-9-71	WEM	WEM
	1	REVISED FOR 2ND RUN	8-16-71	WEM	WEM
	-	SPECIALS RELEASE	6-10-71	WEM	WEM
			DWN	OKD	APRO

FLUKE JOHN FLUKE MFG CO., INC. P.O. BOX 7428, SEATTLE, WN.		DO NOT SCALE DRAWING	
UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCHES		DFTM.V.R. MACLAREN 6-10-71	
3 PLACE DECIMALS ± .010 2 PLACE DECIMALS ± .02 FRACTIONS ± ANGLES ± X CONST.		PROJ ENG 11-10-71 MFG ENG 11-10-71	
MATERIAL:		PART NO SIZE DRAWING NUMBER	
FINISH:		D 510A/AA-4001	
SCALE FULL		SHEET 1 OF 1 REV 3	

FINAL ASSY, AC REF. STD.
8 OUTPUT
MODEL 510A/AA

DIAGRAM LAYOUT

1	2	3	4			
5	6					
7	8	9				



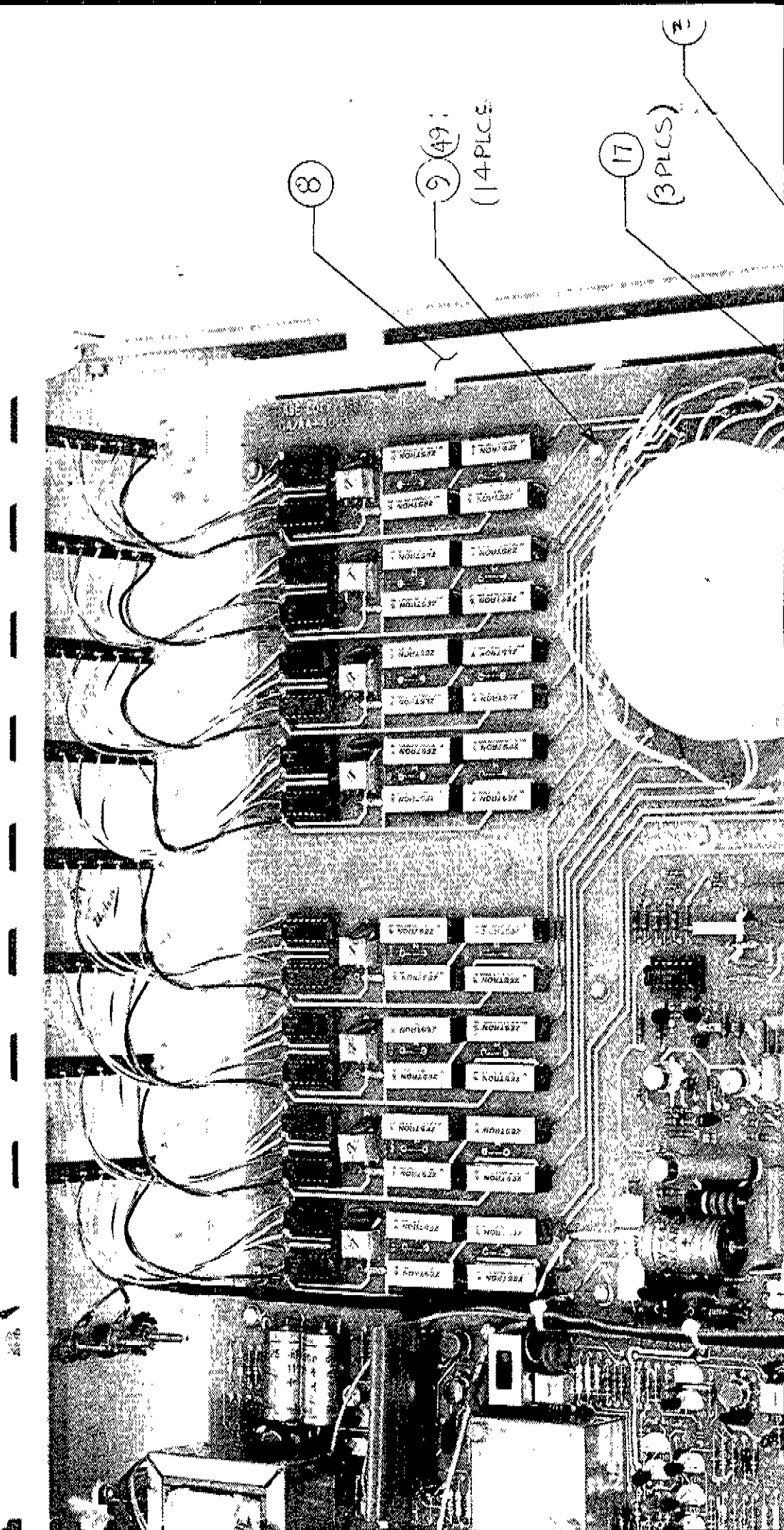
2

6 (2 PL)

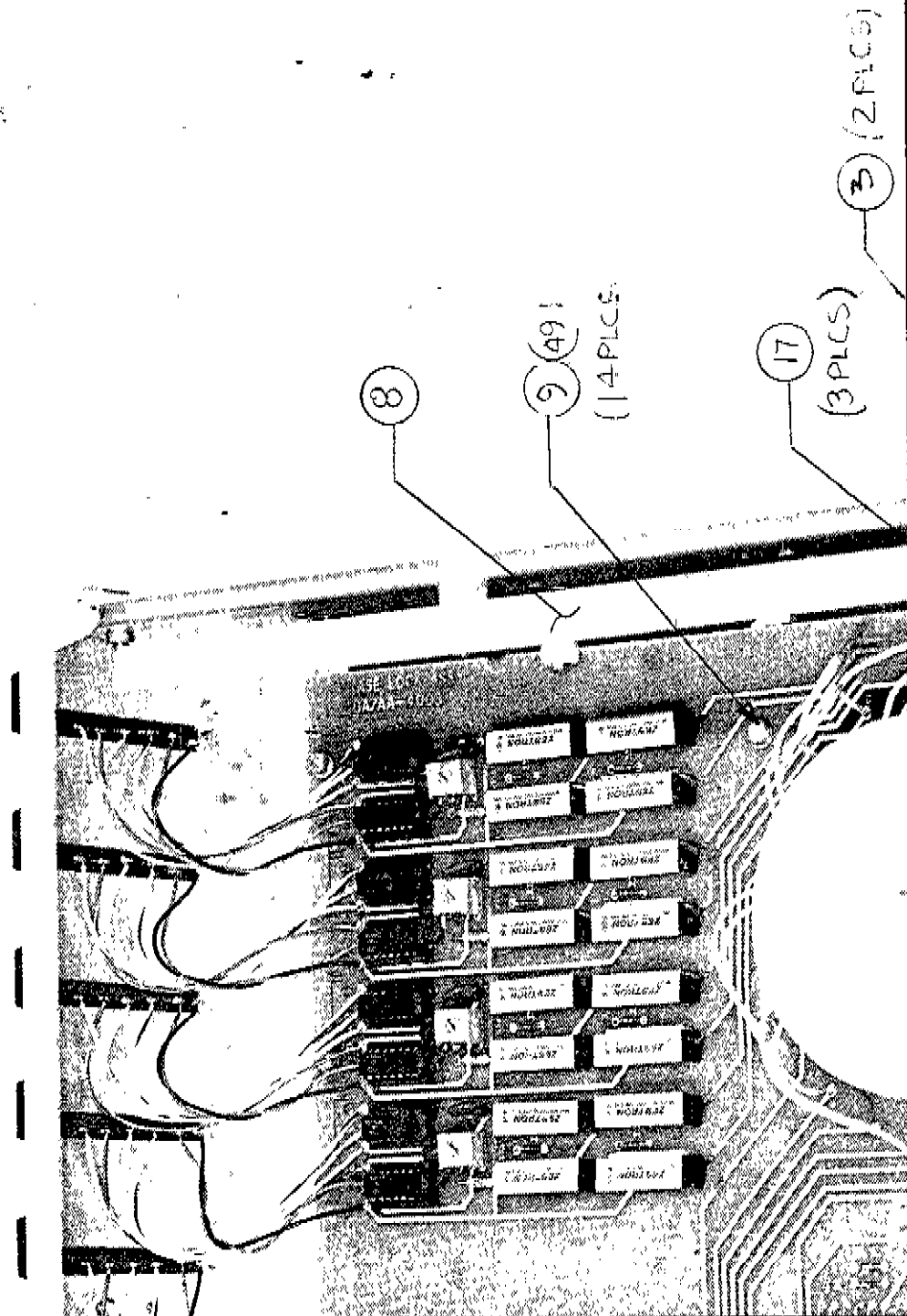
7

2

2



3



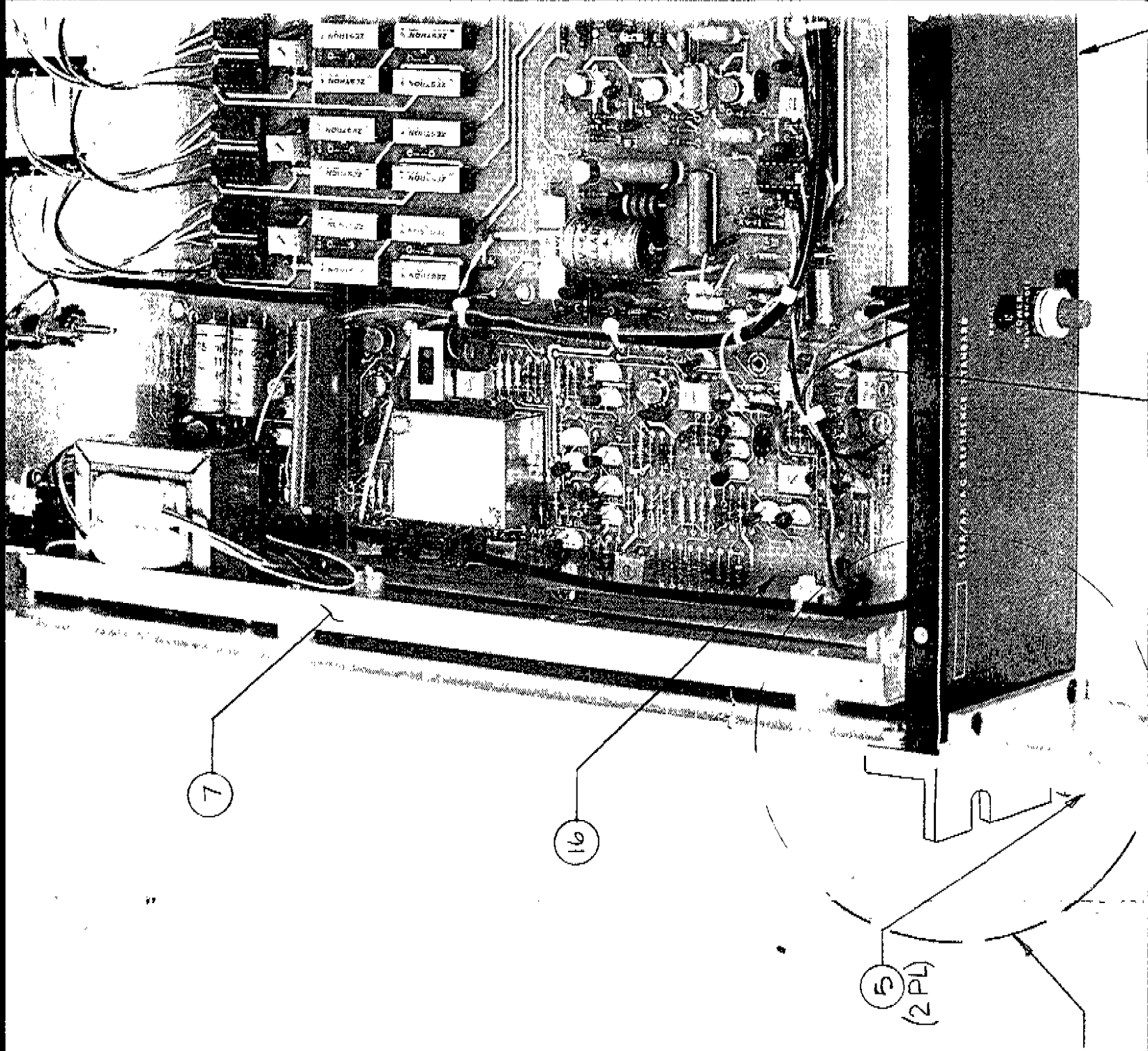
4

510A/AA-5002
SH OF 2 REV 2

ITEM	PART NO.	NOMENCLATURE	QTY
1	—	FRONT PANEL ASSY, 510A/AA-4451	1
2	—	REAR PANEL ASSY, 510A/AA-4452	1
3	297283	CHASSIS SIDE, 730A-2003	2
4	292136	CORNER BRKT, MO3-200-309	2
5	295659	HANDLE MO3-800-303	2
6	295972	CORNER, MO3-800-300	2
7	—	INNER PANEL, L.H, 510A/AA-2005	1
8	—	INNER PANEL, R.H, 510A/AA-2006	1
9	177022	SCREW, #6-32 X 1/4 PHP	21
10	222406	SPACER, SNAP IN	8
11	306233	SCREW, #8 X 1/2"	8
12	114116	SCREW, #8-32 X 3/8, PHP	12
13	295105	SCREW, #8-32 X 3/8, SOCHD CAP	4
14	228890	SCREW, #8-32 X 1/4, PHP	2
15	—	PHASE LOCK PCB ASSY, 510A/AA-4003	1
16	—	MAIN PCB MOD, 510A/AA-4004	1
17	115089	SCREW, #6 X 1/2, THP	3
18	115139	SCREW, #6-32 X 3/8, THP	6
19	303081	RACK EAR, MO3-205-206	2
20	184994	SCREW, #8-32 X 5/8, PHP	4
49	111005	WASHER, #6	20

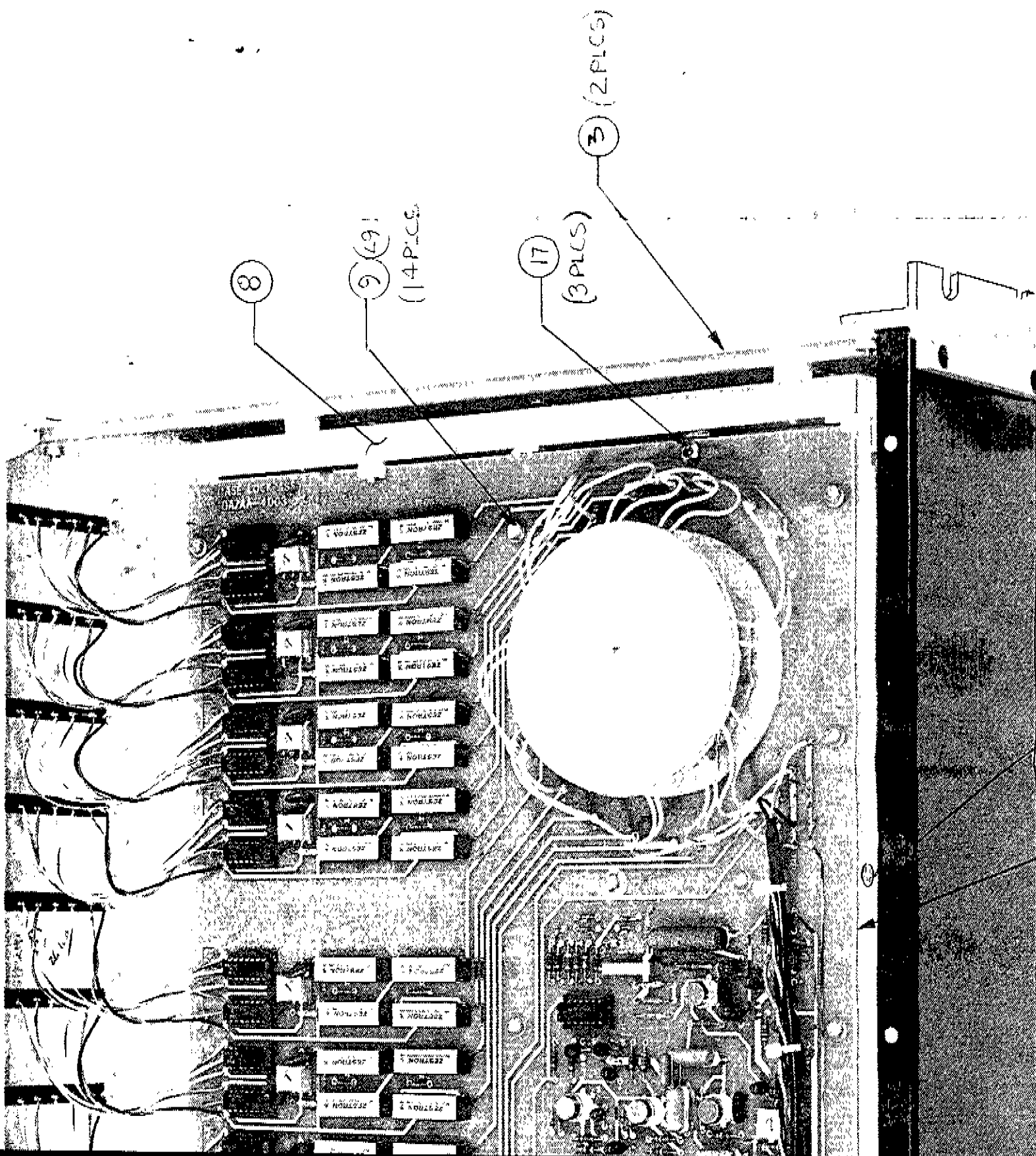
D

C

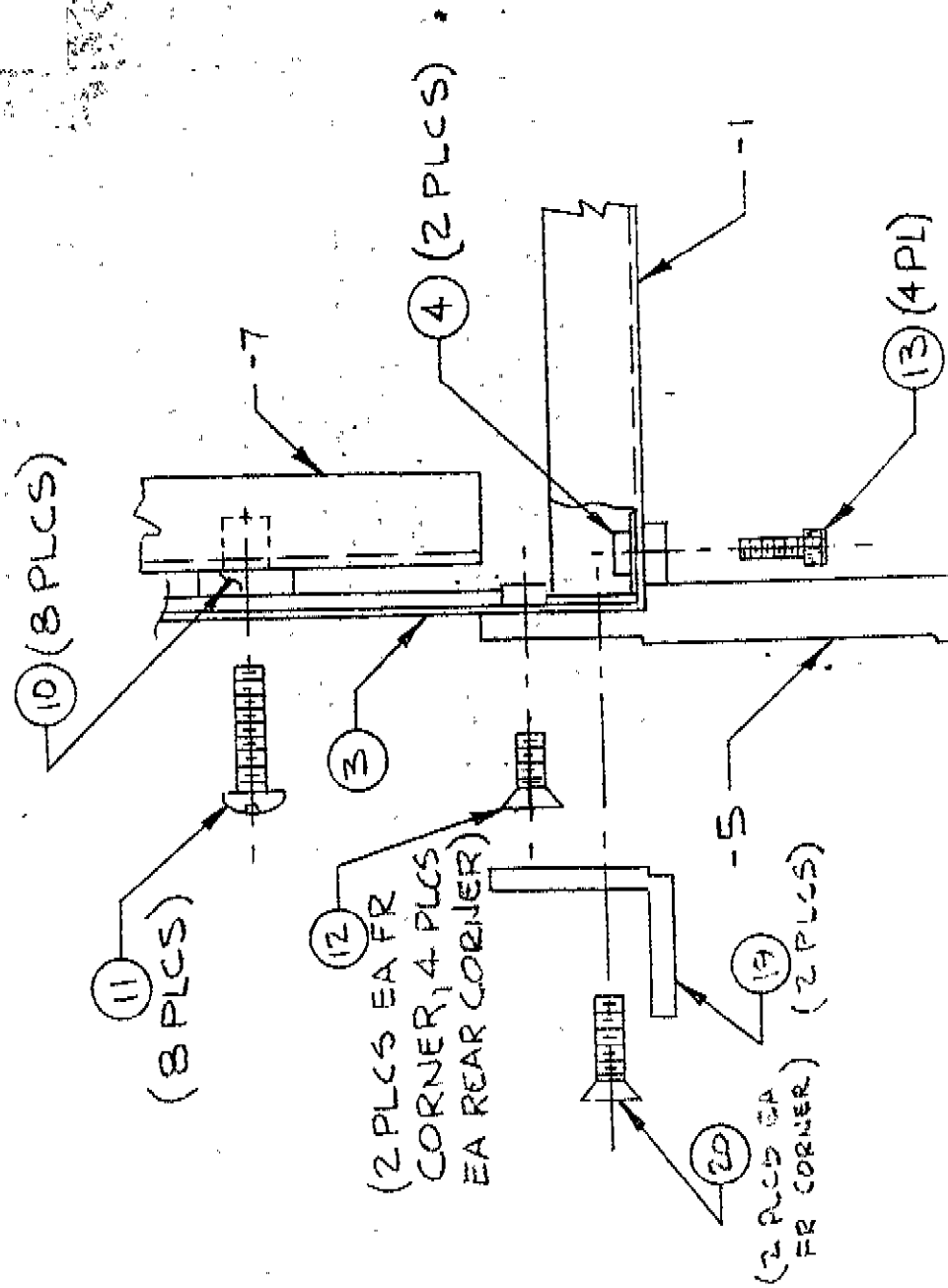


SEE DETAIL I

6



SEE DETAIL I



NOTE: PHA
PUT IN PL
ARE FASTEN
SEE
MO

DETAIL I

ASSEMBLY VIEW

NOTE: PHASE LOCK PCB (ITEM 15) MUST BE PUT IN PLACE BEFORE INNER PANELS (ITEMS 7 & 8) ARE FASTENED DOWN SECURELY

SEE SH 2 FOR TRANSFORMER MOUNTING & ALL WIRING

B

A

FLUKE JOHN FLUKE MFG CO., INC.
P.O. BOX 7428, SEATTLE, WN.

UNLESS OTHERWISE SPECIFIED
ALL DIMENSIONS ARE IN INCHES

3 PLACE DECIMALS $\pm$.010
2 PLACE DECIMALS $\pm$.02
FRACTIONS $\pm$
ANGLES $\pm$ X CONST.

DO NOT SCALE DRAWING

DFTM R. MAC LAREN 8-20-71
PROJ ENG W. J. JONES 11-12-71
MFG ENG ELMER 11-12-71

MATERIAL: SEE B/M
FINISH: ---

ZONE	REV	DESCRIPTION	DWN	CKD	APPD
	2	ECO 6322, EXTENSIVELY REVISED TO SHOW INSTALLATION OF NEW 510A/AA-4003 PCB	EJM 10/24/70		
	1	ADDED ITEMS 19 & 20	WEM 11-12-71		
B/M	-	SPECIALS RELEASE	WEM 11-12-71		

FINAL ASSY, AC REF STD

8 OUTPUT

PART NO SIZE DRAWING NUMBER

D 510A/AA-5002

SCALE NONE SHEET 1 OF 2 REV 2

DIST - 79

FINAL ASSY
AC REFERENCE STD
MODEL 510A/AA

DIAGRAM LAYOUT

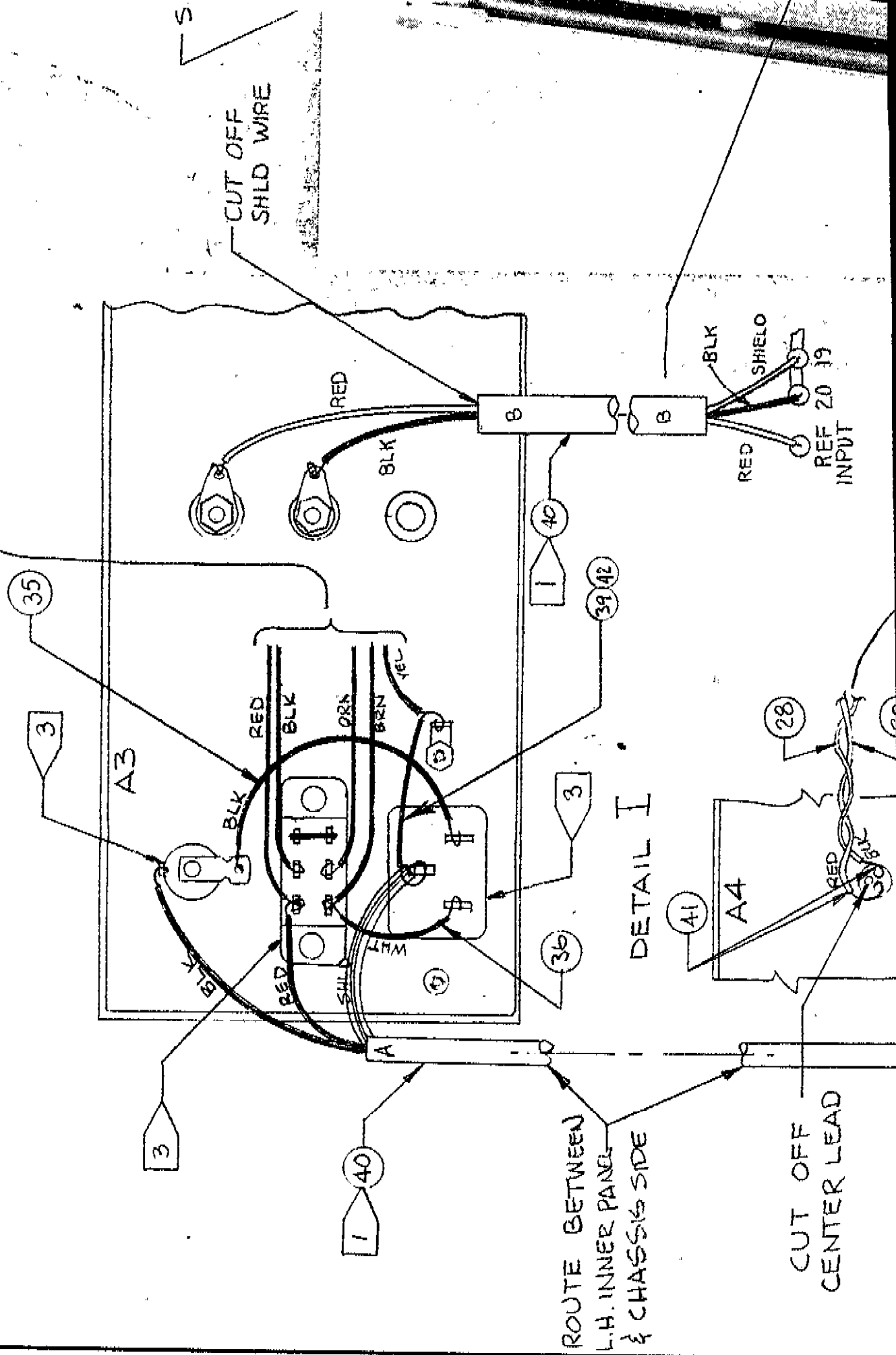
1	2	3	4			
5	6	7	8			
9	10	11	12			

8

7

6

THESE WIRES ARE FROM TI
ITEM 22 SEE DETAIL III



D

C

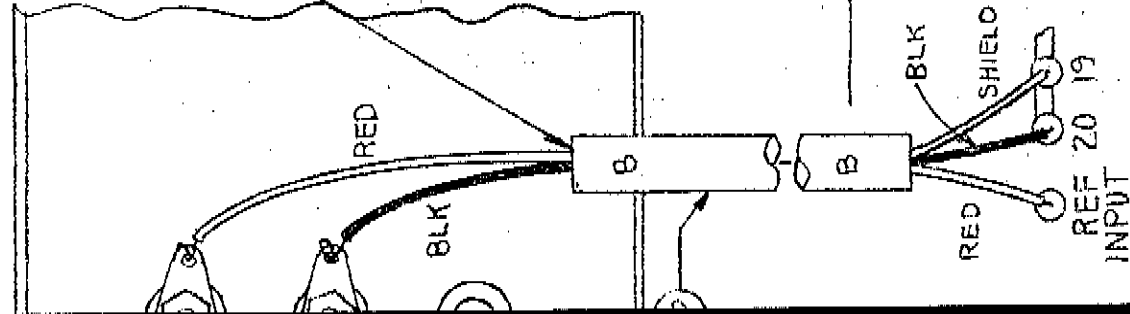
2

6

5



{ THESE WIRES ARE FROM T1 XFORMER
ITEM 22 SEE DETAIL III



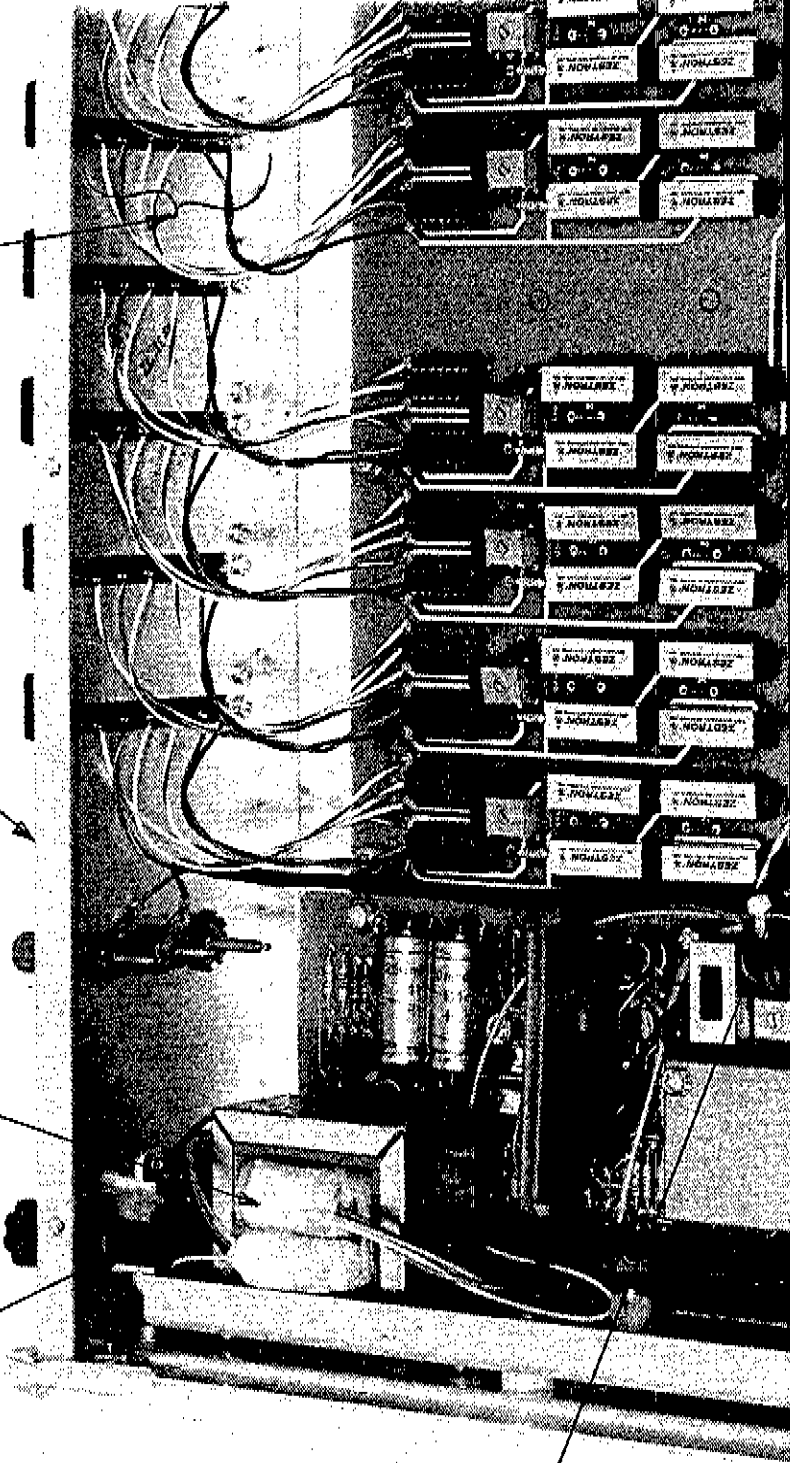
CUT OFF
SHLD WIRE

SEE DETAIL I

SEE DETAIL III

A3

WIRE A TO
(8 PLACE
30 31 32
2



3

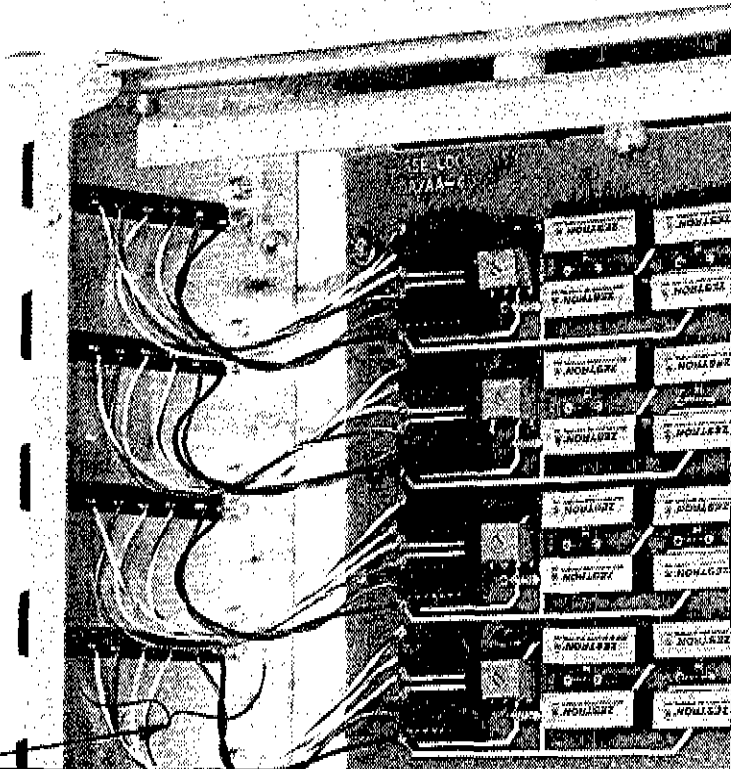
4

3

WIRE 'A' TO 'A', 'B' TO 'B' ETC.
(8 PLACES)

30 31 32 33 34 35

2



510A/AA-5002
SH 2 OF 2 REV 2

ITEM
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39

3

2

1

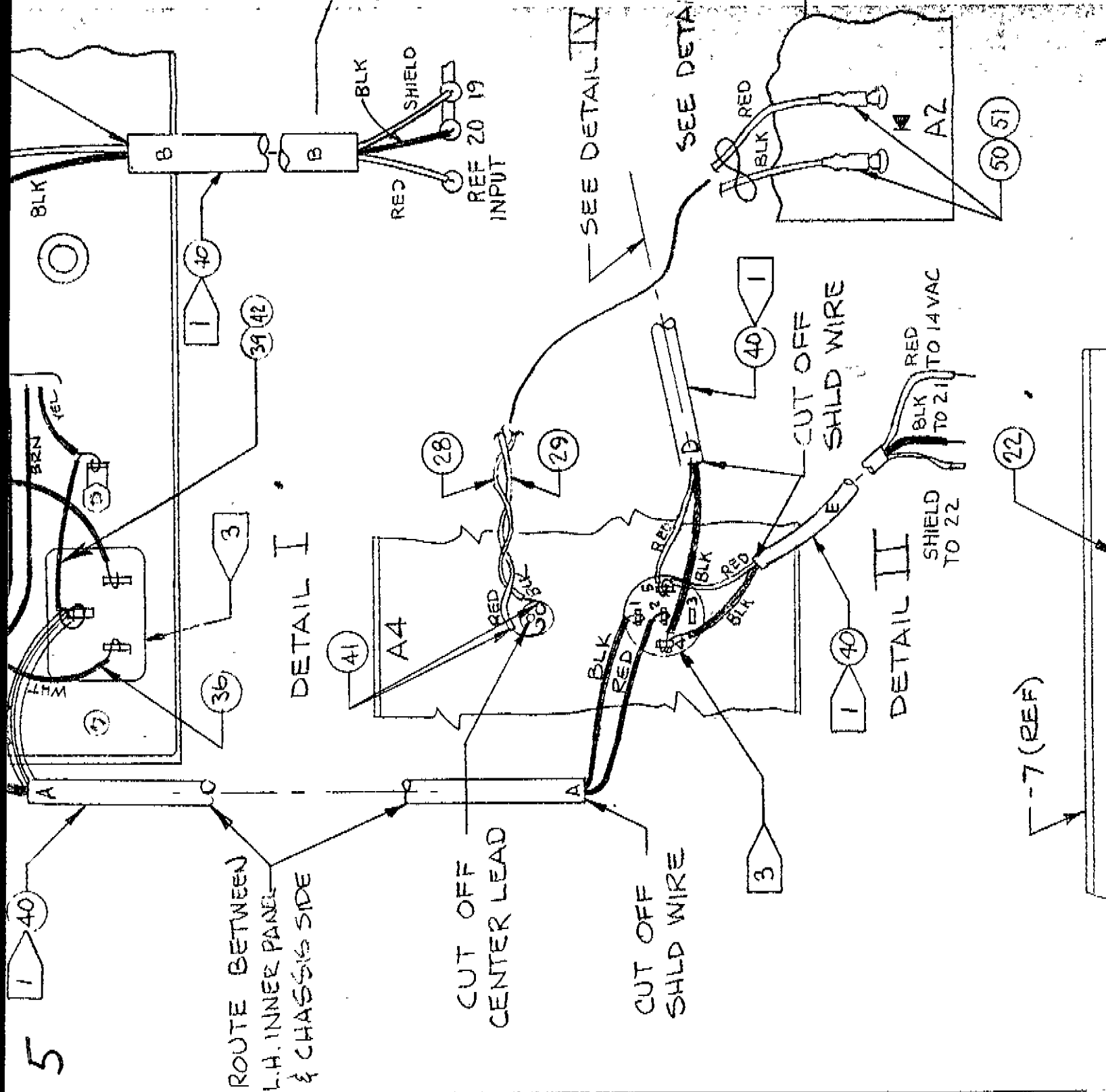
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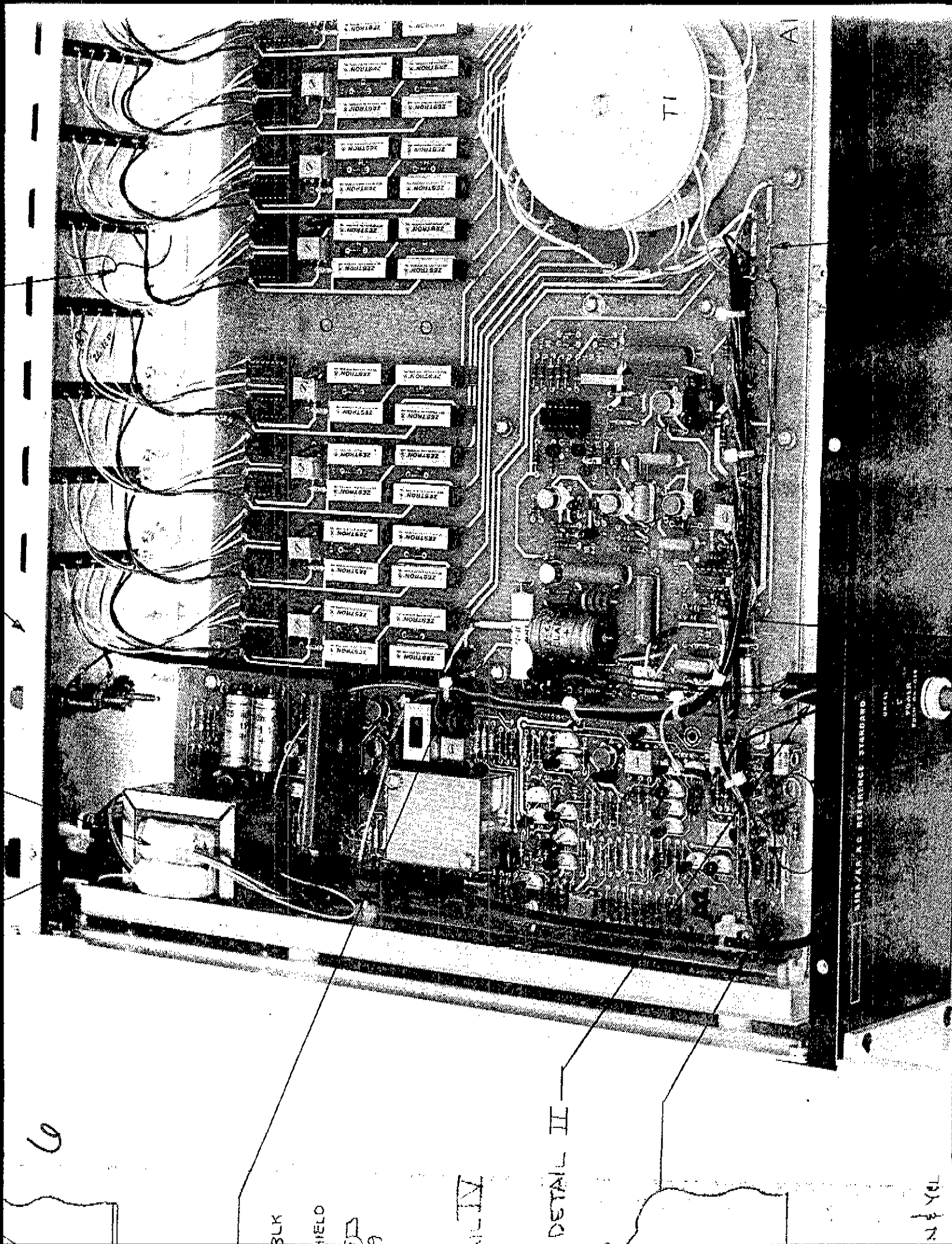
510A/AA-5002
SH2 OF 2 REV 2

ITEM	PART NO.	NOMENCLATURE
21		
22	—	TRANSFORMER, PWR, 510A/AA-6510 1
23		
24		
25		
26		
27		
28	170217	WIRE, TEFLON, AWG #26, RED 1 FT
29	200766	BLK 1 FT
30	200725	YEL 2.5 FT
31	200667	BLK/WHT 2.5 FT
32	236448	GRN/WHT 2.5 FT
33	236455	BLU/WHT 2.5 FT
34	115576	AWG #22, RED 4 FT
35	115774	BLK 3 FT
36	115667	WHT .5 FT
37	115808	VIO 1 FT
38	115675	BLU .5 FT
39	115469	WIRE, BUSS, 1 .2 FT

D

C





60

BLK

WELD

IV

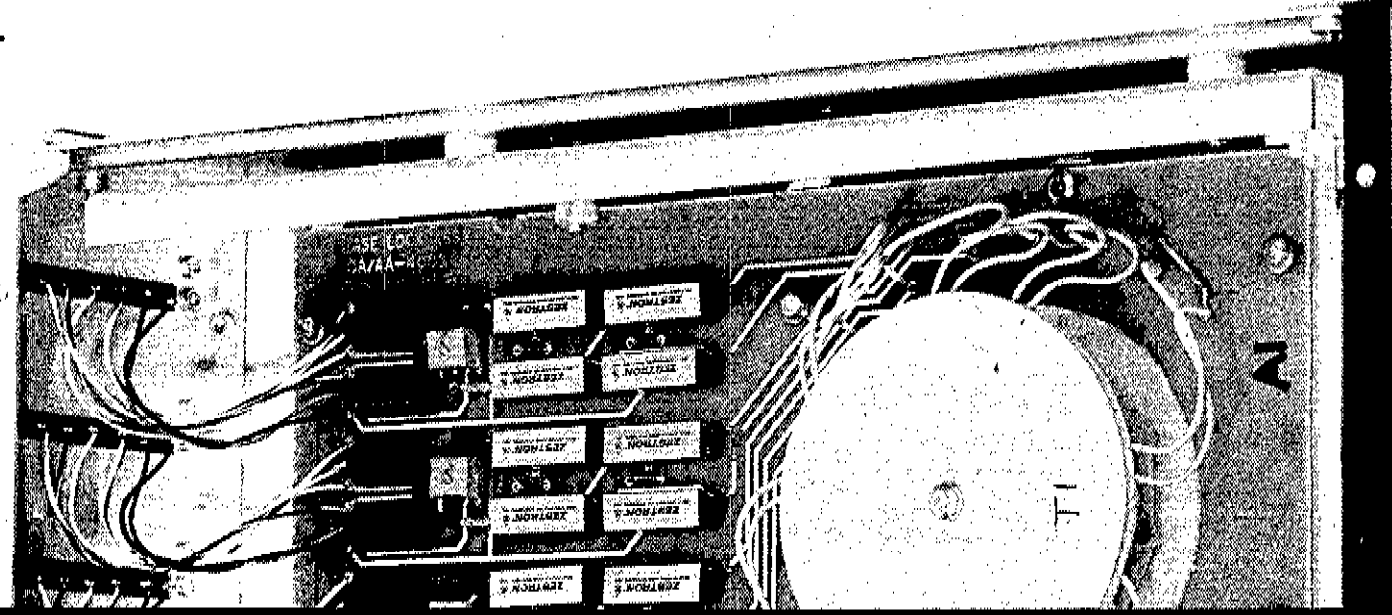
DETAIL II

IV

MINIMUM AC REFERENCE STANDARD

100%
100%
100%

7

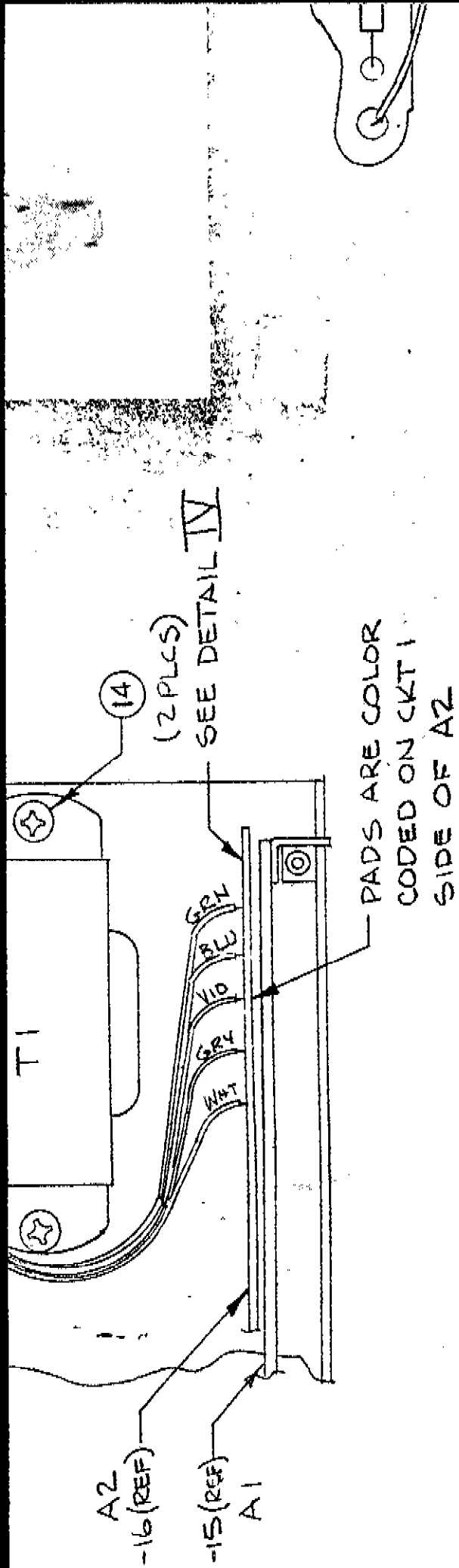


1

29	200760
30	200765
31	200667
32	236448
33	236453
34	115376
35	115774
36	115607
37	115808
38	115675
39	115469
40	135772
41	175976
42	196717
43	271734
44	
45	
46	
47	
50	267534
51	144410

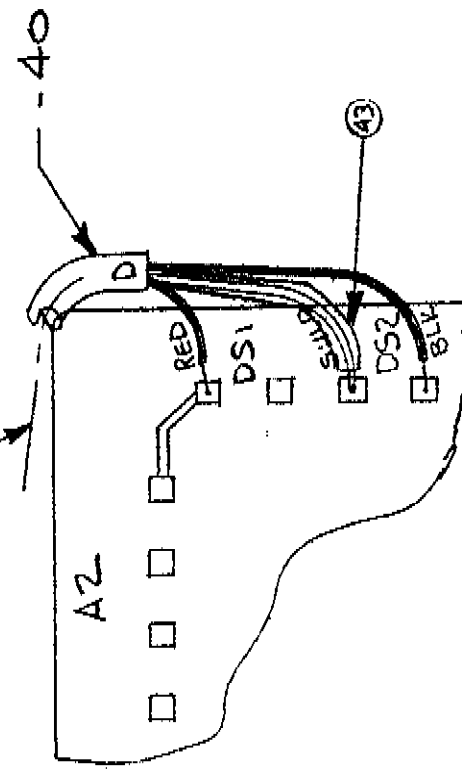
31	200667					BLK/NUT 2.5 FT
32	236448					GEN/NUT 2.5 FT
33	236455					BLU/NUT 2.5 FT
34	115576				AWG #22, RED	4 FT
35	115774				BLK	3 FT
36	115607				WHT	.5 FT
37	115808				VIO	1 FT
38	115675				BLU	.5 FT
39	115469				WIRE, BUSS,	.2 FT
40	135772				CABLE, SHIELDED, 2 CONDUCTOR	5.5 FT
41	175976				SLEEVING, TEFLON, #18	2 FT
42	196717				SLEEVING, TEFLON, #22	.2 FT
43	271734				TUBING, SHRINKABLE, 1/4"	1 FT
44						
45						
46						
47						
50	267534				AMP SOCKET, AWG #22	5
51	144410				SHRINK TUBING	4 IN.

1 THERE ARE 5 CABLES MADE OF ITEM 40, CABLE, 2 COND, (135772)
 LTR FROM TO LENGTH
 A A3 A4 22"

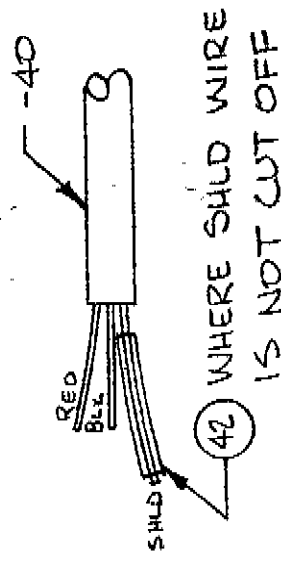


DETAIL III

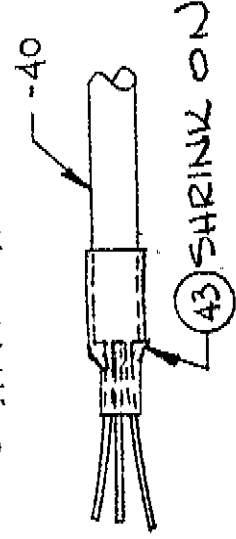
SEE DET II



DETAIL IV



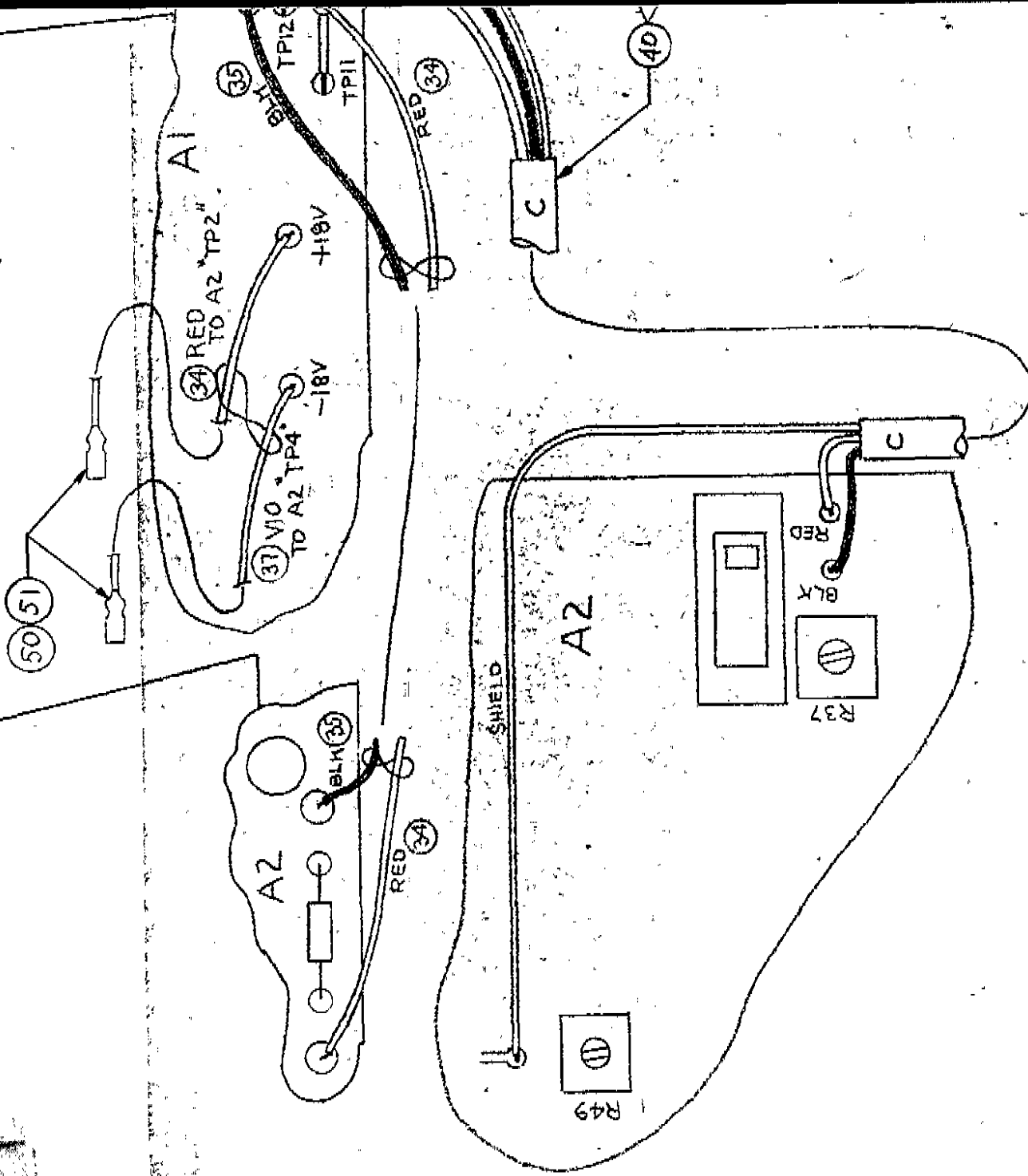
DETAIL V



DETAIL VI
TYP BOTH ENDS OF
ALL ITEM 40 CABLES

A4

(38) (50) (51) FROM POINT 23
ADJACENT TO R44, TO GOLD WIRE
ADJACENT TO Q23 ON A2.



(14)

2 PLCS)

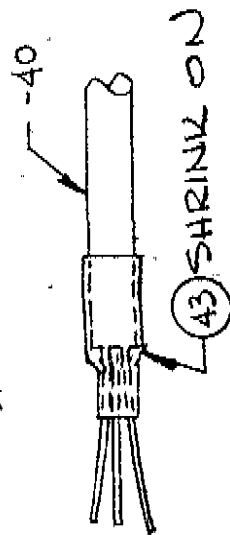
SEE DETAIL IV

COLOR
KIT 1
2



(42) WHERE SHLD WIRE
IS NOT CUT OFF

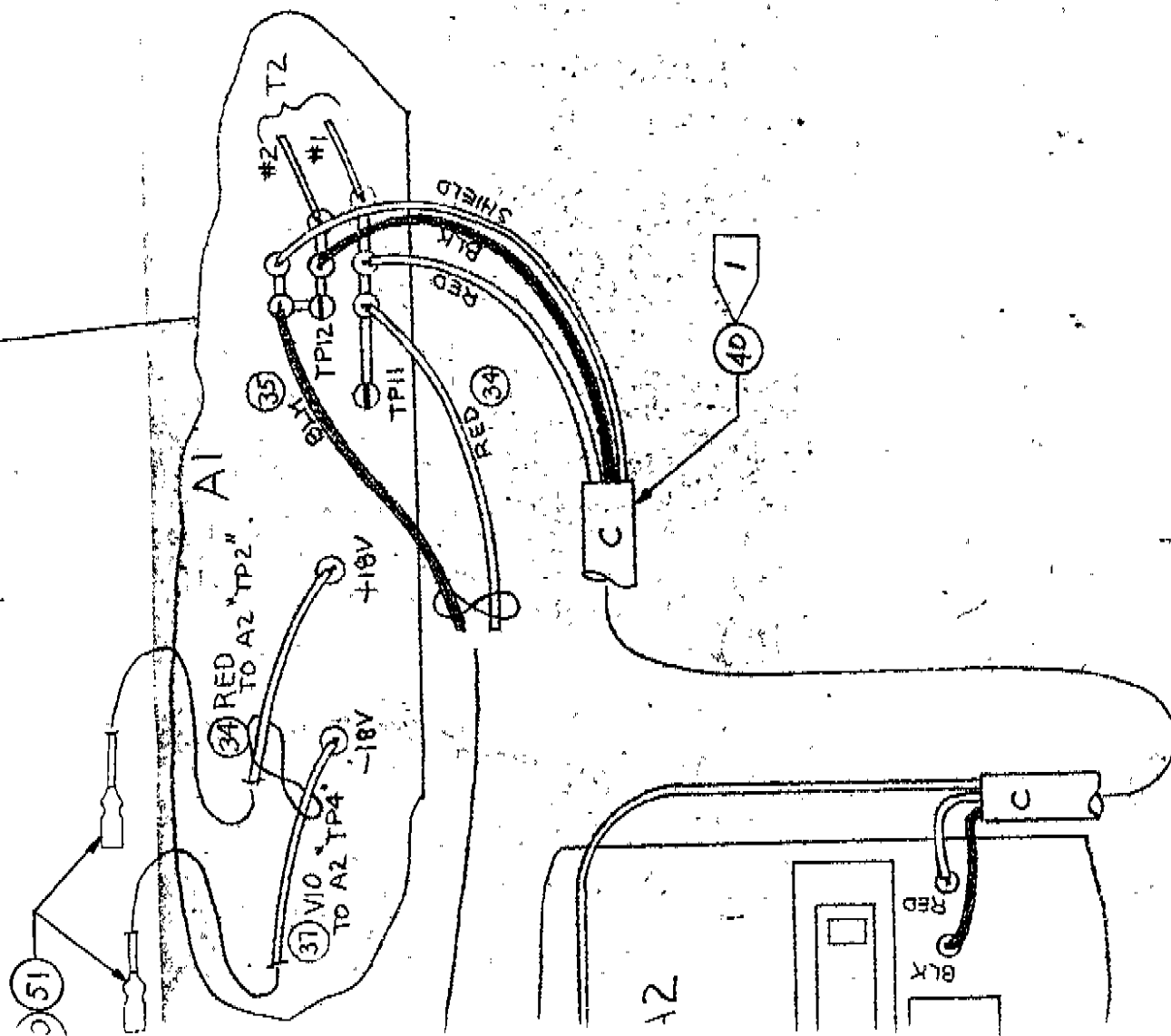
DETAIL IV



DETAIL V

TYP BOTH ENDS OF
ALL ITEM 40 CABLES

ADJACENT TO R44, TO GOLD WINE
ADJACENT TO Q23 ON A2.



2

BLK
RED

FLUKE

**UNLES
ALL DI**

3 PLACE
2 PLACE
FRACTION
ANGLES

—

←

1 THERE ARE 5 CABLES MADE OF ITEM 40, CABLE, 2 COND (135772)

LTR	FROM	TO	LENGTH
A	A3	A4	22"
B	A3	A1	9"
C	A1	A2	18"
D	A4	A2	22"
E	A4	A1	6"

SEE DETAIL V & VI FOR END PREP.

2 WIRE LENGTHS OF ITEMS 30 THRU 35

ITEM	COLOR	LENGTH
30	GRN/WHT	3"
31	BLK/WHT	2 ³ / ₄ "
32	YEL	2 ³ / ₄ "
33	BLU/WHT	2 ¹ / ₂ "
34	RED 22	12 ³ / ₄ "
35	BLK 22	12 ³ / ₄ "

TWISTED PR

3 > APPLY SHRINK TUBING ITEM 51 TO ALL CONNECTIONS.

[illegible]

Table of Contents

SECTION	TITLE	PAGE
1	INTRODUCTION AND SPECIFICATIONS	1-1
	1-1. Introduction	1-1
	1-6. Specifications	1-1
2	OPERATING INSTRUCTIONS	2-1
	2-1. Introduction	2-1
	2-3. Shipping Information	2-1
	2-6. Input Power	2-1
	2-8. Installation	2-1
	2-10. Operating Features	2-1
	2-12. Operating Notes	2-1
	2-22. Operating Procedures	2-3
	2-25. Applications	2-4
3	THEORY OF OPERATION	3-1
	3-1. Introduction	3-1
	3-3. Block Diagram Analysis	3-1
	3-7. Circuit Descriptions	3-2
4	MAINTENANCE	4-1
	4-1. Introduction	4-1
	4-3. Service Information	4-1
	4-6. General Maintenance	4-1
	4-14. Maintenance Access	4-2
	4-20. Performance Checks	4-4
	4-34. Calibration Procedures	4-7
	4-44. Comparator Balance	4-9
	4-47. Compensating Component Selection	4-10
	4-49. Troubleshooting	4-11

(Continued on page ii)

TABLE OF CONTENTS, *continued*

SECTION	TITLE	PAGE
5	LIST OF REPLACEABLE PARTS	5-1
	5-1. Introduction	5-1
	5-4. Parts List Column Descriptions	5-1
	5-5. Manufacturers' Cross Reference List Column Descriptions	5-2
	5-6. How to Obtain Parts	5-2
	5-9. Serial Number Effectivity	5-3
6	OPTION AND ACCESSORY INFORMATION	6-1
	6-1. Introduction	6-1
	6-3. Accessory Information	6-1
	6-5. Option Information	6-1
	RACK MOUNTING FIXTURES	6-1
	6-1. Introduction	6-1
	OPTION -01 RECHARGEABLE BATTERY PACK	6-1
	6-1. Introduction	6-1
	6-3. Installation	6-2
	APPENDIX A - FEDERAL SUPPLY CODE FOR MANUFACTURERS	
	APPENDIX B - LIST OF ABBREVIATIONS	
	APPENDIX C - SALES REPRESENTATIVES AND SERVICE CENTERS	
	SCHEMATIC DIAGRAM	

List of Illustrations

FIGURE	TITLE	PAGE
1-1	Typical Short Term Stability	1-2
1-2	Total Harmonic Distortion	1-3
1-3	Load Regulation	1-3
1-4	Outline Drawing	1-4
2-1	Operating Features	2-2
2-2	Load Connections	2-3
2-3	Automated Test System AC Reference	2-4
2-4	Model 510A/AA Block Diagram	2-4
3-1	Model 510A Block Diagram	3-1
3-2	Peak AC to DC Converter (Simplified)	3-4
4-1	Adjustment and Test Point Locations	4-3
4-2	Assembly Locations (Bottom Cover Removed)	4-3
4-3	Load Regulation	4-4
4-4	DC Reference Equipment Connections	4-6
4-5	Thermal Transfer Equipment Connections	4-7
4-6	DC Reference Equipment Connections	4-8
4-7	Thermal Transfer Equipment Connections	4-10
4-8	V _{REF} Jumper Locations	4-10

(Continued on page iv)

LIST OF ILLUSTRATIONS, *continued*

FIGURE	TITLE	PAGE
4-9	Operating Voltage Check Points	4-11
4-10	A3 Battery Pack PCB Checks	4-12
4-11	Circuit Isolation Checks	4-13
5-1	AC Reference Standard	5-4
5-2	Front Panel Assembly	5-6
5-3	Main PCB Assembly	5-8
5-4	PCB Assembly, 50 Hz (-02 Option)	5-14
5-5	PCB Assembly, 60 Hz (-03 Option)	5-15
5-6	PCB Assembly, 400 Hz (-04 Option)	5-16
5-7	PCB Assembly, 1000 Hz (-05 Option)	5-17
5-8	PCB Assembly, 2400 Hz (-06 Option)	5-18
5-9	PCB Assembly, 5000 Hz (-07 Option)	5-19
5-10	PCB Assembly, 19.2 kHz (-08 Option)	5-20
5-11	PCB Assembly, 100 kHz (-09 Option)	5-21
5-12	Rechargeable Battery Kit (-01 Option)	5-22
5-13	Rear Panel Assembly	5-24
6-1	Rack Mounting Configurations	6-1
6-2	Rack Ear Installation	6-2
6-3	Dual, Triple and Quad Mount	6-3
6-4	Combining with Half-Rack Instruments	6-1
6-1	510A-01K Battery Pack	6-1
6-2	Battery Pack Kit Locations	6-2

List of Tables

TABLE	TITLE	PAGE
1-1.	Standard Frequencies and Accuracy	1-1
4-1.	Required Test Equipment	4-2
4-2.	Output Amplitude Accuracy	4-5
4-3.	A & B Jumper Selection	4-11

Section 1

Introduction & Specifications

1-1. INTRODUCTION

1-2. The Model 510A is a precision ac reference standard. It produces a fixed frequency output having an amplitude of 10V rms. Standard frequencies and accuracies are given in Table 1-1. Other frequencies are available upon special request. The center frequency can be varied $\pm 1\%$ with a control on the front panel. Frequency resolution with this control is better than $\pm 0.05\%$.

Table 1-1. STANDARD FREQUENCIES AND ACCURACY

24 HOUR ACCURACY	30 DAY ACCURACY	STANDARD FREQUENCY
$\pm 0.01\%$	$\pm 0.015\%$	50 Hz, 60 Hz, 400 Hz, 1 kHz, 2.4 kHz, 5 kHz, 19.2 kHz
$\pm 0.04\%$	$\pm 0.05\%$	100 kHz

1-6. SPECIFICATIONS

OUTPUT VOLTAGE
OUTPUT CURRENT
SINGLE FIXED FREQUENCY OUTPUT

1-3. Output current is fully protected from overloads and short circuits. Maximum load current for rated accuracy is 10 mA. Visual indication of an overload is provided by a light emitting diode (LED) on the front panel. Two sets of parallel connected binding posts on the front and rear panel provide load connection.

1-4. The ac reference standard can be operated from line power or it can be battery powered through an optional rechargeable battery pack. Line voltage requirement is 115/230 vac, 50 to 500 Hz, single phase. The rechargeable battery pack is available as the -01 Option. It allows at least 16 hours of continuous operation without line power. Battery charging is done whenever line power is applied.

1-5. The Model 510A is designed for bench top use or it can be installed in a standard 19 inch equipment rack. Rack mounting kits are available as accessories to permit single, dual, triple, and quadruple side-by-side rack installation

10V rms
10 mA rms, short circuit protected
Any single fixed frequency from 50 Hz to 100 kHz. Standard frequencies are: 50; 60; 400; 1,000; 2,400; 5,000; 19,200 and 100,000 Hertz.

Amplitude Accuracy	24 Hours	30 Days	90 Days
50 Hz - 20 kHz	$\pm 0.01\%$	$\pm 0.015\%$	$\pm 0.02\%$
20 kHz - 50 kHz	$\pm 0.015\%$	$\pm 0.025\%$	$\pm 0.035\%$
50 kHz - 100 kHz	$\pm 0.04\%$	$\pm 0.05\%$	$\pm 0.06\%$

Above accuracy applies after 10 minutes warmup, operating temperature of $23 \pm 2^\circ\text{C}$, and includes worst case deviations of the output caused by line, load, stability, and noise conditions. Assumes calibration against an AC-DC transfer standard with an AC-DC difference of 50 ppm from 50 Hz to 50 kHz and 300 ppm from 50 kHz to 100 kHz.

Amplitude Accuracy Using DC Calibration . . .

Using a DC reference accurate to ± 15 ppm and standard laboratory equipment, the 510A may be calibrated to achieve the following accuracies at standard operating temperatures of $23 \pm 2^\circ\text{C}$, and worst case deviations caused by line, load, stability and noise conditions.

	<u>30 Days</u>	<u>90 Days</u>	
50 Hz – 5 kHz	$\pm 0.01\%$	$\pm 0.02\%$	
5 kHz – 10 kHz	$\pm 0.02\%$	$\pm 0.03\%$	
10 kHz – 30 kHz	$\pm 0.05\%$	$\pm 0.07\%$	
30 kHz – 100 kHz	$\pm 0.15\%$	$\pm 0.17\%$	
Amplitude Stability	<u>24 Hours</u>	<u>30 Days</u>	<u>90 Days</u>
50 Hz – 20 kHz	$\pm 0.002\%$	$\pm 0.005\%$	$\pm 0.01\%$
20 kHz – 100 kHz	$\pm 0.004\%$	$\pm 0.01\%$	$\pm 0.02\%$

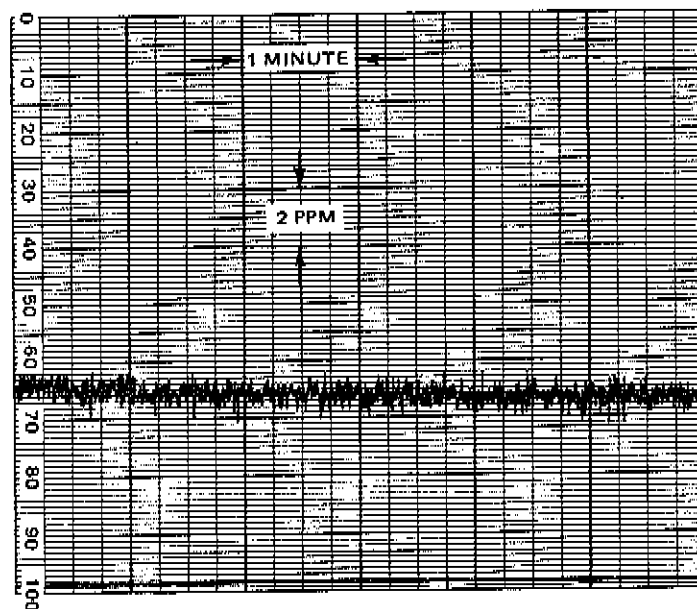


Figure 1-1. TYPICAL SHORT TERM STABILITY

AMPLITUDE NOISE

Amplitude deviation due to noise is less than 20 ppm peak-to-peak through a 1 Hz bandwidth over a 1 minute interval.

AMPLITUDE TEMPERATURE COEFFICIENT

	15° - 50°C	0° - 15°C
50 Hz - 5 kHz	5 ppm/°C	12 ppm/°C
5 kHz - 10 kHz	7 ppm/°C	15 ppm/°C
10 kHz - 30 kHz	10 ppm/°C	17 ppm/°C
30 kHz - 100 kHz	15 ppm/°C	22 ppm/°C

TOTAL HARMONIC DISTORTION	(See Figure 1-2).
CENTER FREQUENCY ACCURACY	$\pm 0.1\%$
FREQUENCY RESOLUTION	$\pm 0.05\%$ using front panel vernier
FREQUENCY VERNIER	Screwdriver adjustment, $\pm 1\%$ of center frequency
FREQUENCY STABILITY	500 ppm per month
Frequency Temperature Coefficient	Less than 150 ppm/ $^{\circ}\text{C}$
Common Mode Rejection	Common Mode Rejection is defined as the affect on the rms or average value of the 10V rms output due to a common mode signal between the low terminal and chassis. This rejection is: Greater than 100 db for common mode signals from 1 Hz to 500 Hz, 10V peak-to-peak maximum. Greater than 70 db for common mode signals from 500 Hz to 1 MHz, 3V peak-to-peak maximum.
LOAD REGULATION	Maximum allowable dc potential between output low and chassis ground is 100 volts. (See Figure 1-3).

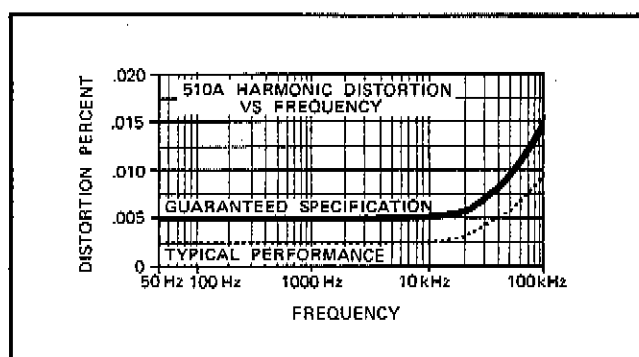


Figure 1-2. TOTAL HARMONIC DISTORTION

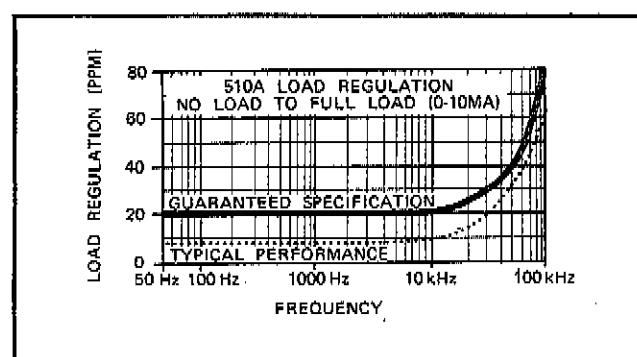


Figure 1-3. LOAD REGULATION

LINE REGULATION	< 10 ppm, $\pm 10\%$ line change
OUTPUT CONNECTIONS	High, Low and Chassis binding posts on front and rear panels.
UNCALIBRATED INDICATION	Front panel display labeled "UNCAL" indicates when load exceeds 10 mA.
ENVIRONMENTAL	
Operating Temperature Range	0°C to 50°C
Storage Temperature	-40°C to $+75^{\circ}\text{C}$; -40°C to $+60^{\circ}\text{C}$ with batteries
Humidity Range	Up to 80% relative humidity, 0°C to 35°C Up to 70% relative humidity, 35°C to 50°C
Shock	20g, 11 millisecc half-sine wave
Vibration	4.5g, 10 Hz – 55 Hz
Altitude	0 to 10,000 feet – Operating 50,000 feet – Non-Operating
INPUT POWER	An optional rechargeable battery pack will power the AC Reference Standard for 16 hours. The battery pack is field installable.
115/230V ac $\pm 10\%$, 50 – 500 Hz, Single Phase	
SIZE	3-1/2" high x 4-1/4" wide x 12" deep
MOUNTING	Up to four 510A's can be mounted side by side and installed in a standard 19" EIA rack with optional accessory ears.

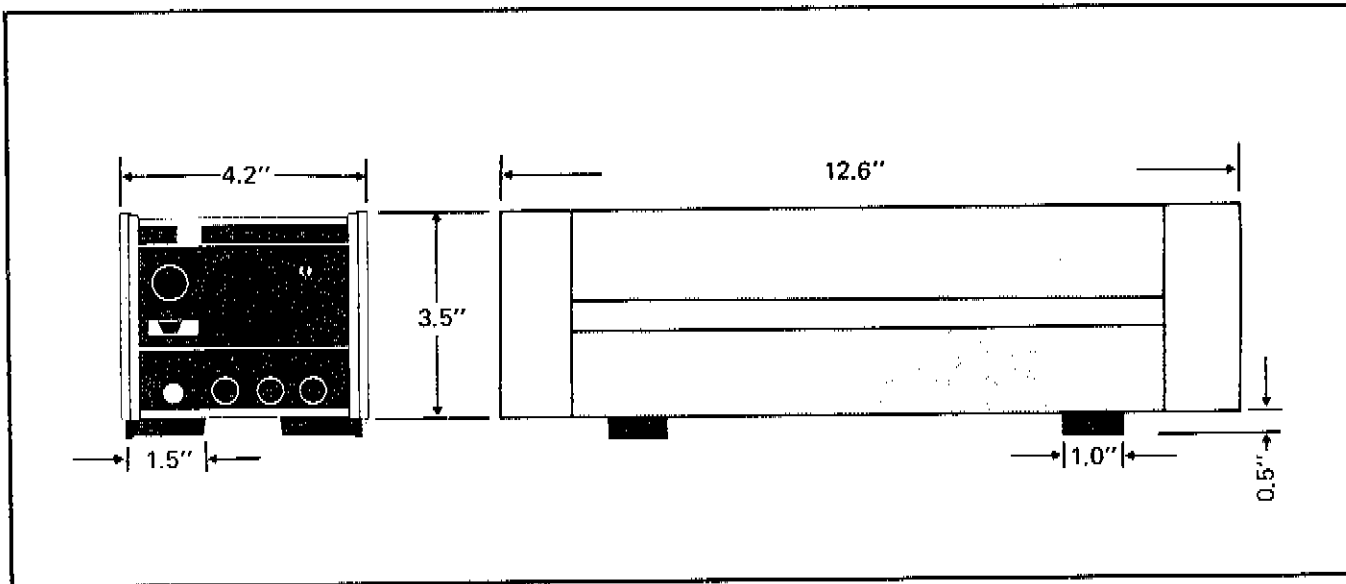


Figure 1-4. OUTLINE DRAWING

Section 2

Operating Instructions

2-1. INTRODUCTION

2-2. This section contains operating instructions for the Model 510A. If any difficulties are encountered, contact the nearest John Fluke Sales Representative or write directly to the John Fluke Mfg. Co., Inc. Please include the instrument serial number when writing.

2-3. SHIPPING INFORMATION

2-4. The Model 510A was packaged and shipped in a foam packed cardboard carton. Upon receipt, a thorough inspection should be performed to reveal any damage in transit. Special instructions for inspection and claims are included in the carton.

2-5. If reshipment is necessary, the original container should be used. If the original container is not available, a new one can be obtained from the John Fluke Mfg. Co., Inc. Please reference the Model number when requesting a new container.

2-6. INPUT POWER

2-7. This instrument can be operated from either a 115 or 230V ac, 50 to 500 Hz, single phase power line. A slide switch on the rear panel allows selection of the appropriate line voltage. The rated value of the rear panel fuse F1 is as follows:

<u>115 VAC</u>	<u>230 VAC</u>
1/4A, 3AG	1/8A, 3AG

2-8. INSTALLATION

2-9. The Model 510A is designed for bench-top use or it can be installed in a standard 19 inch equipment rack with Accessory rack mounting brackets. Up to four units can be rack mounted in side-by-side positions. Rack installation procedures are located in Section 6.

2-10. OPERATING FEATURES

2-11. The location and function of all controls, connectors, and indicators is shown in Figure 2-1.

2-12. OPERATING NOTES

2-13. AC Line Connection

2-14. The input power cord has a three prong, polarized connector. This plug allows connection to either a 115 or 230V ac, 50 to 500 Hz, single phase power line. The round pin connects the chassis to earth ground; therefore, ensure that the round pin is connected to a high quality earth ground. The instrument is energized through a POWER switch on the front panel. A front panel meter indicates LINE OPR when the instrument is energized.

2-15. Battery Power (-01 Option)

2-16. When the -01 Option is installed, the Model 510A can be operated from an internal rechargeable battery. Battery operation is activated by disconnecting the power

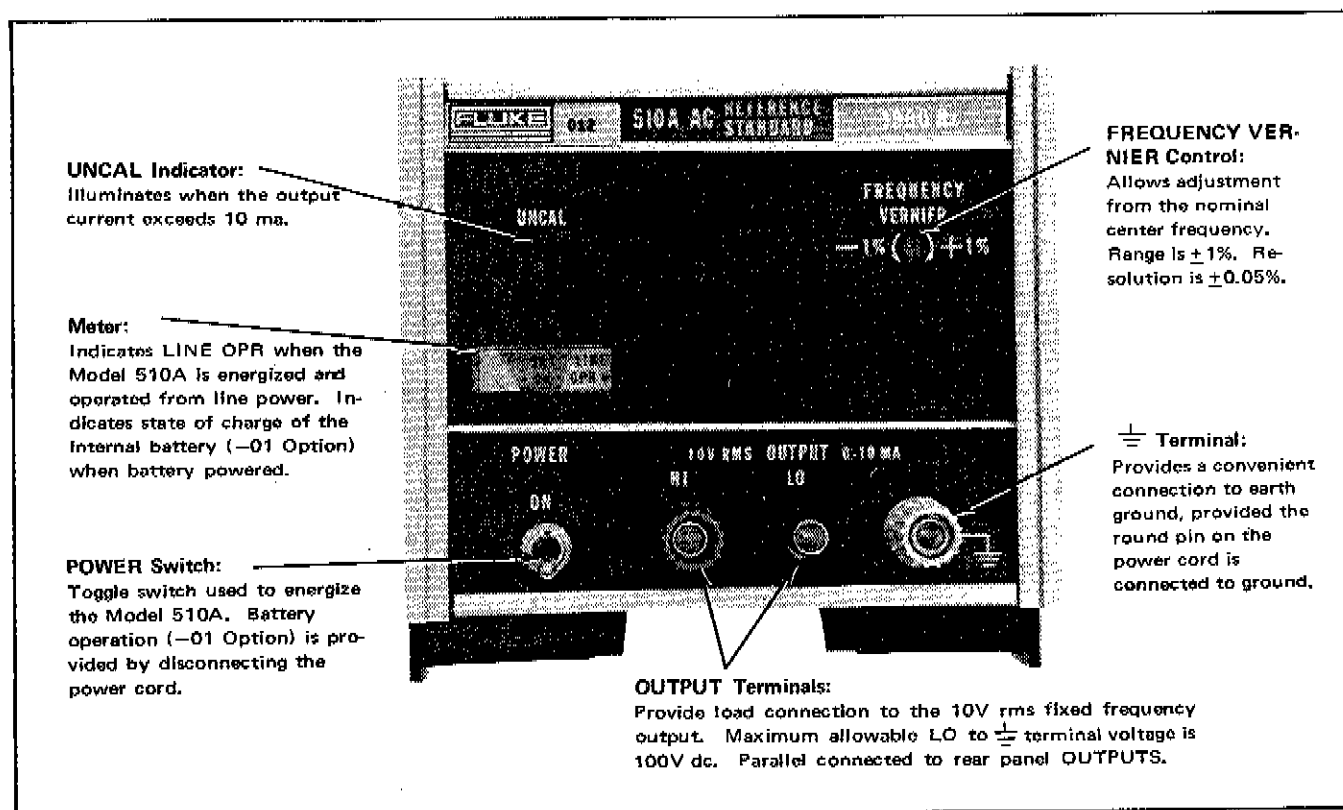


Figure 2-1. OPERATING FEATURES (1 of 2)

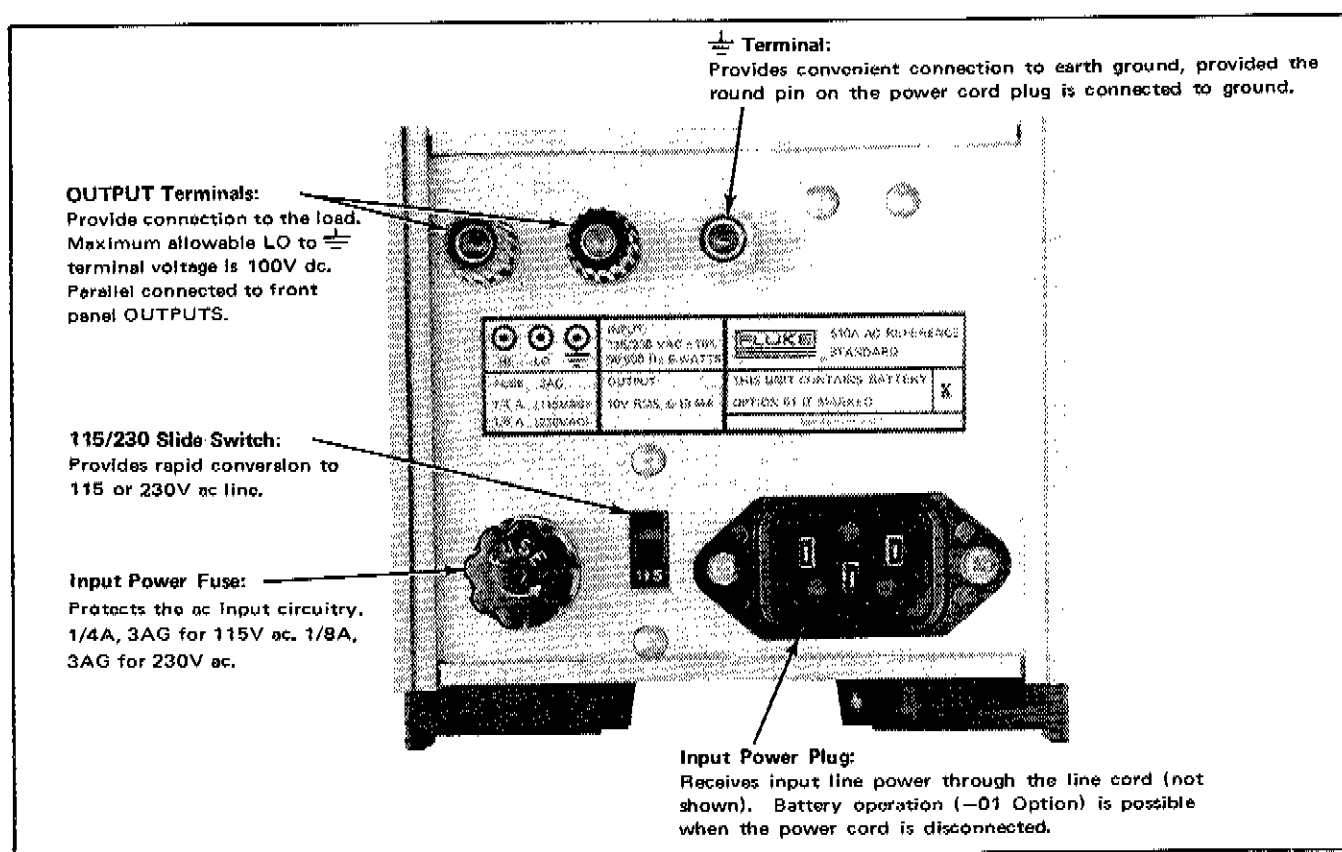


Figure 2-1. OPERATING FEATURES (2 of 2)

cord from line power and turning the instrument on with the POWER switch on the front panel. Relative state of charge (BAT OK) is indicated by a meter on the front panel. The battery is automatically charged whenever the instrument is operated from line power.

NOTE!

The chassis of the instrument and the $\frac{1}{2}$ terminal are connected to ground through the power cord. When battery operation is used and the chassis is isolated from ground, this ground connection will be broken.

2-17. Load Connections

2-18. Output load connection is done using HI and LO OUTPUT terminals on the front or rear panel. These OUTPUT terminals are parallel connected and only one set should be connected to a load at one time. A $\frac{1}{2}$ terminal is included for convenient connection to ground (see preceding note). Maximum allowable potential between the LO OUTPUT and $\frac{1}{2}$ terminal is 100V dc.

2-19. The following rules should be observed for all load connections.

- AC power to the Model 510A and associated equipment should be derived from the same power line. Line power connections should be as close together as possible.
- Shielded, twisted pair load cables should be used. Typical load connections are shown in Figure 2-2.
- Load cables should be kept as short as possible. Maximum lead resistance should be less than 20 m Ω .

2-20. Overload Protection

2-21. The maximum output current is limited by the power capability of the internal circuitry. This circuitry will not be damaged even if the OUTPUT terminals are short circuited. However, when the output current exceeds 10 mA, the output will not be within its specified accuracy. Visual indication of an output current greater than 10 mA is provided by an UNCAL lamp (LED) on the front panel.

2-22. OPERATING PROCEDURES

2-23. The Model 510A produces a fixed frequency output having an amplitude of 10V rms. Frequency accuracy is

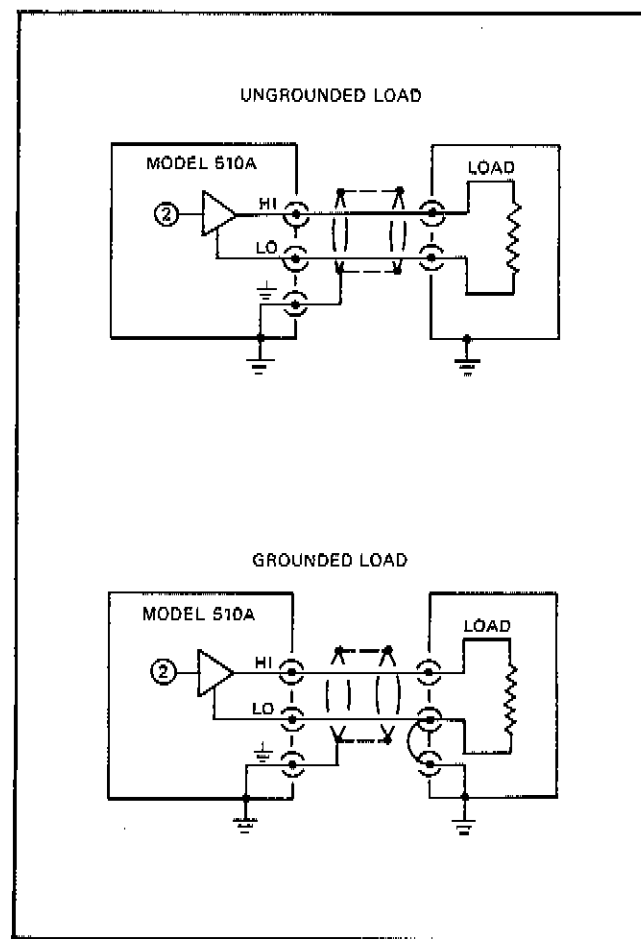


Figure 2-2. LOAD CONNECTIONS

$\pm 0.1\%$, adjustable $\pm 1\%$ with a FREQUENCY VERNIER on the front panel. Amplitude accuracy is given in Section 1.

2-24. To operate the instrument, proceed as follows:

- Connect the power cord to line power. See paragraph 2-6 and 2-13.
- Make the desired load connections at the front or rear panel OUTPUT terminals.
- Set the POWER switch to ON and allow the instrument to operate for ten minutes. The meter on the front panel should indicate LINE OPR and the UNCAL indicator should be out.
- After ten minutes of operation, the output is at its specified accuracy.

NOTE!

Battery operation (-01 Option) is described in paragraph 2-15.

2-25. APPLICATIONS

2-26. Introduction

2-27. The Model 510A can be used in a number of ways as a precise ac reference. The following paragraphs describe a few of its applications.

2-28. Precision AC Source for Automatic Test Systems

2-29. Automated test systems containing Fluke 4200 series voltage sources can use the Model 510A as an external reference to produce precise ac voltages. Figure 2-3 shows such a system. System ac output is from 0 to 45V ac rms at up to 0.7 amperes rms. Overall system accuracy of $\pm 0.02\%$ can be achieved for frequencies up to 5 kHz.

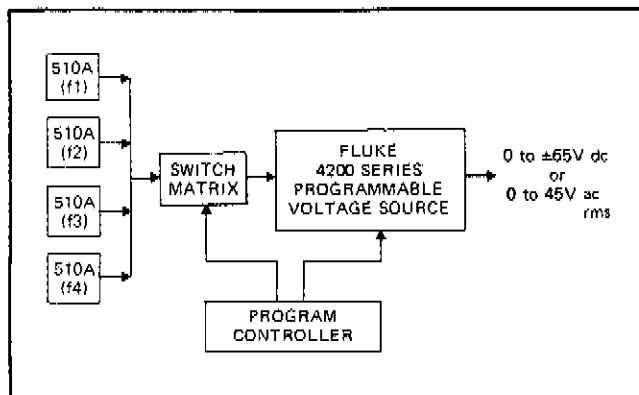


Figure 2-3. AUTOMATED TEST SYSTEM AC REFERENCE

2-30. Phase Locked AC Reference Standard

2-31. A Model 510A can be modified to phase lock with an external signal and provide multiple outputs. Figure 2-4 shows the modified Model 510A/AA which is designed to synchronize with an external 400 Hz signal and provide eight transformer coupled outputs. Programmable phase reversal at each output is also provided. The outputs can be used as external references in the system application described in paragraph 2-28. Typical specifications for the Model 510A/AA are as follows:

FREQUENCY	400 Hz $\pm 5\%$ (other frequencies can be specified)
OUTPUT VOLTAGE	10V rms (eight outputs, transformer coupled)
OUTPUT ACCURACY	$\pm 0.1\%$
OUTPUT PHASE RELATIONSHIP	$0^\circ \pm 1^\circ$ or $180^\circ \pm 1^\circ$ (programmable)
TOTAL HARMONIC DISTORTION	0.2%
PHASE LOCK CAPTURE RANGE	$\pm 5\%$ about center frequency
SYNC INPUT VOLTAGE	24V rms

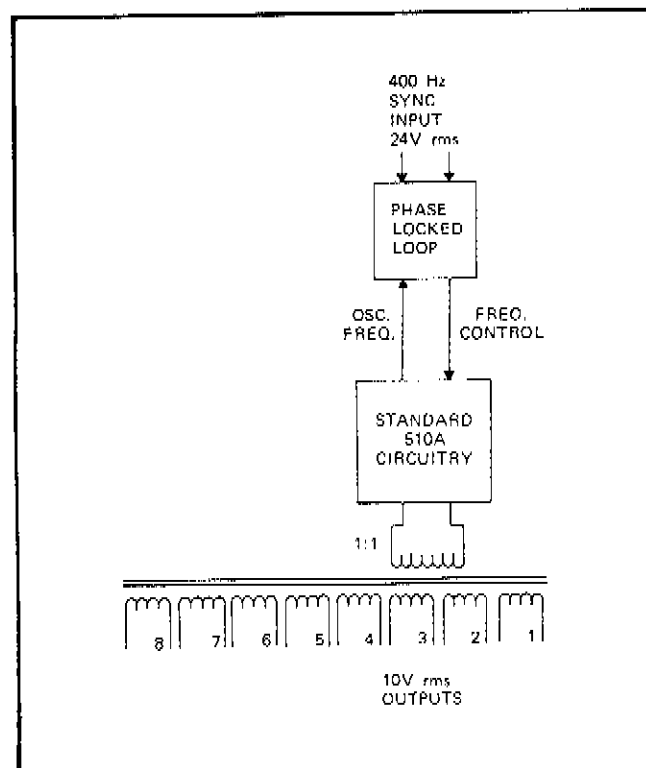


Figure 2-4. MODEL 510A/AA BLOCK DIAGRAM

Section 3

Theory of Operation

3-1. INTRODUCTION

3-2. This section contains the theory of operation for the Model 510A. The information is arranged under headings of "BLOCK DIAGRAM ANALYSIS and CIRCUIT DESCRIPTIONS." It is recommended that this section be thoroughly read and understood before any attempt is made at servicing this instrument.

3-3. BLOCK DIAGRAM ANALYSIS

3-4. The Model 510A produces an extremely stable 10V rms signal at a fixed frequency. Five major circuits are used to produce and control the output. These circuits and their interconnection are shown in Figure 3-1.

3-5. The DC Reference Supply produces an accurate, low temperature coefficient, dc voltage of +14.14214V. This voltage is applied to one end of a divider at the input of the Peak AC to DC Converter and also functions as a reference for the ~ 18 V Regulator. The other end of the divider receives the 10V rms output of the Model 510A, thus producing a 0V condition at its center when the peak of the output signal is equal to minus the Reference Supply voltage. The Peak AC to DC Converter produces an amplified signal that is equal to the negative difference between the output signal and the +14.14214V reference. This signal charges a capacitor at the output of the Peak AC to DC Converter which is then transferred to a capacitor at the input of the Integrator by the Sample and Hold. Transfer is done only during the positive peak excursion of

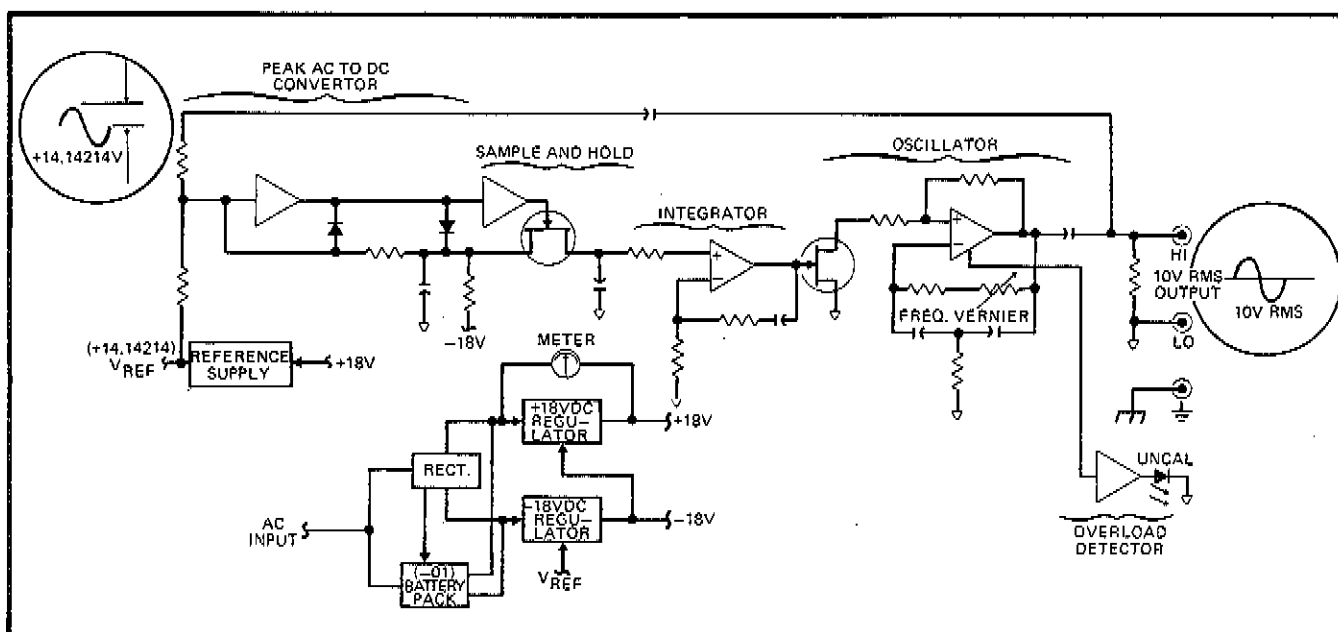


Figure 3-1. MODEL 510A BLOCK DIAGRAM

the signal. The Integrator produces a dc output proportional to the time integral of the voltage stored on its input capacitor. This dc output is applied to the Oscillator where it causes the peak output amplitude to maintain a near 0V condition at the input to the Integrator. The Overload Detector monitors the output of the Model 510A and turns on the UNCAL indicator when the output current exceeds 10 mA.

3-6. All operating voltages are produced by the $\pm 18V$ DC Regulators. Reference voltage for the +18V DC Regulator is derived from the -18V DC Regulator. The -18V DC Regulator receives a reference voltage from the Reference Supply. Unregulated inputs to each regulator are derived from the Rectifier or the -01 Option Battery Pack. The Battery Pack operates in the absence of line power to the Rectifier. Relative charge state of the batteries is indicated by a meter connected across the +18V DC Regulator. A rectifier located in the -01 Battery Pack circuitry provides recharging of the batteries whenever line power is applied.

3-7. CIRCUIT DESCRIPTIONS

3-8. The following paragraphs describe the circuitry in the Model 510A. Each description is keyed to the schematic diagram located at the rear of the manual.

3-9. Input Power

3-10. AC line power from A4J1 is applied to A4T1 through the POWER switch A1S1A and the 115/230 slide switch A4S1. The primary of A4T1 consists of two windings which are interconnected through A4S1 for operation from either a 115 or 230V ac line. Parallel connection is used for 115V ac line operation while series connection is used for 230V ac line operation. Both primary windings are completely shielded to reduce capacitive coupling between the power line and the floating circuitry in the instrument. The shield is connected to chassis ground and power line ground through the power cord. The secondary of A4T1 consists of two separate windings both of which are shielded to eliminate the generation of common mode signals that could appear at the OUTPUT terminals. This shield is connected to the center-tap of a secondary winding and power supply common. The center-tapped secondary winding provides ac power to rectifiers CR2 and CR3, CR4. The other secondary winding supplies ac power to the Battery Pack PCB (-01 Option) and the meter, A1M1. Diode CR1 rectifies the ac voltage present during line operation to provide a full-scale LINE OPR indication on A1M1. A2DS1 and DS2 function to stabilize and limit the maxi-

mum current used by the Battery Pack PCB during charging of the batteries.

3-11. A3 Battery Pack

3-12. The A3 Battery Pack is installed as the -01 Option. It consists of a Battery Pack PCB and two batteries, BT1 and BT2. This circuitry provides operation from the batteries in absence of line power, disconnects the batteries when they are in a low charge-state to prolong battery life, limits the maximum battery current drain should a circuit malfunction occur, and disconnects the batteries from the instrument circuitry and recharges them during line operation.

3-13. BATTERY OPERATION. When line power is removed and the POWER switch is ON, the batteries BT1 and BT2 are connected to the inputs of the $\pm 18V$ Regulators through the Battery Pack PCB. The positive output of BT1 is applied through S1B to J5 where a divider consisting of R2, CR3 and R4 supplies the base of Q2 with a positive voltage. This voltage turns on Q2 which supplied base current to Q1 and also turns it on. Conduction of Q1 applies the positive output of BT1 through the series transistor Q3 to the input of the +18V Regulator. The diode connection of Q3 prevents reverse current flow from the +18V Regulator to the battery. The negative output of BT2 is applied through S1C to the series transistors Q5. Since a positive voltage is available at the emitter of Q4 through R8, Q4 is turned on in sequence with the conduction of Q1. This condition turns on Q5 and applies the negative output of BT2 through the series transistor Q6 to the input of the -18V Regulator. The diode connection of Q6 prevents reverse current flow from the -18V Regulator to the battery.

3-14. Should the batteries discharge to a state where they can no longer furnish adequate power, the series transistors Q1 and Q5 are automatically switched off. This is made possible through the use of zener diode CR3. As the output of BT1 decreases, the voltage at the base of Q2 reaches a point where the transistor can no longer furnish enough base current for Q1 to maintain conduction. Q1 is therefore cut-off and disconnects the output of BT1 from the -18V Regulator. Sharp cut-off for Q1 is ensured by R6 which provides some of the base current for Q2. Once the voltage at the collector of Q1 begins to drop, base current to Q2 is further reduced, this sharply cutting-off Q1. Since the conduction of Q4 and Q5 is slaved to the conduction of Q1, as described in the preceding paragraph, the negative output of BT2 is also disconnected from the -18V Regulator.

3-15. The maximum current drain from the batteries is limited by the selection of the value of R5 and R9. These resistors limit the maximum base current to Q1 and Q5. Should a short circuit appear at either output, the maximum current is therefore dependent upon the base current of Q1 or Q5 times their current gain.

3-16. **LINE OPERATION.** When line power is applied, the batteries are disconnected from the $\pm 18V$ Regulators and are recharged. Battery disconnection is caused by a $-22V$ battery disconnect voltage produced by CR3, CR4 and C1. This voltage is applied to a divider consisting of R3 and R4 in the Battery Pack PCB. Presence of a negative voltage at the base of Q2 turns it off and causes Q1 to turn off. Since Q4 and Q5 are slaved to Q1, they are also turned off and both batteries are disconnected from the $\pm 18V$ Regulators. Diodes CR4 and CR5 limit the maximum negative base and emitter voltage at Q2 and Q5 during line operation.

3-17. Charging of the batteries is provided through full-wave rectifier CR1 in the Battery Pack PCB. AC power for this rectifier is derived from the untapped secondary of T1. A2DS1 and DS2 function as a ballast to limit the maximum charging current. Zeners CR2 and CR6 in the Battery Pack PCB limit the maximum battery voltage during charging.

3-18. $\pm 18V$ Regulator

3-19. The $\pm 18V$ Regulators produce low ripple operating voltages for the instrument. Input voltage to the regulators is derived from full-wave rectifiers when the instrument is line powered or from batteries if the -01 Option is installed. The $-18V$ Regulator receives its reference from the Reference Supply. Reference voltage for the $+18V$ Regulator is derived from the $-18V$ Regulator; thus, should any malfunction occur in one supply, all will be affected.

3-20. **$+18V$ REGULATOR.** The $+18V$ Regulator consists of Q1 through Q3. Q1 is the series-pass element. Q2 and Q3 control the base current of Q1 to maintain the $+18V$ dc output. Resistor R3 ensures initial turn-on of Q2 and Q3. The base of Q3 is referenced to the $-18V$ Regulator through R10 and receives a sample of the $+18V$ dc output through R8 and R9. Any change in the $+18V$ dc output is therefore amplified by Q2 and Q3, which then alters the conduction of Q1 to maintain the regulated output. Variable resistor R9 allows adjustment of the $+18V$ dc output.

3-21. **$-18V$ REGULATOR.** The $-18V$ Regulator consists of Q4 through Q6. Q4 is the series-pass element. Q5 and Q6 control the base current of Q4 to maintain the $-18V$ dc output. R12 ensures initial turn-on of Q5 and Q6.

The base of Q6 is referenced to the Reference Supply (V_{REF}) through R18, CR5, and CR6 and receives a sample of the $-18V$ dc output through R17. CR5 and CR6 compensate for the voltage temperature coefficient at the base of Q6 as well as its base emitter voltage drop. Output voltage from this supply is therefore dependent upon V_{REF} and the ratio of R17 to R18.

3-22. Reference Supply

3-23. The Reference Supply produces an extremely stable reference voltage (V_{REF}) upon which the accuracy and stability of the rms output is based. It consists of a high gain, high input impedance, differential amplifier U1 and a reference amplifier U2. The temperature coefficient of the base/emitter voltage for U2 is accurately matched to the temperature coefficient of the zener element through factory selection of R22 and R23. Output voltage of this supply is scaled to $+14.14214V$ dc through selection of R30 and R31. Variable resistor R27 allows adjustment of V_{REF} . The adjustment range of R27 is compensated through jumper selection of R25 and R29. The resulting stable reference at the collector of U2 is applied to the non-inverting input of U1. The other input to U1 receives an equivalent voltage from the divider composed of R20 and R21. Any change in V_{REF} is sensed at the base of U2 which produces an amplified change at the non-inverting input to U1. This change then alters the conduction of U1 such that V_{REF} is maintained at $+14.14214V$ dc.

3-24. Peak AC to DC Convertor

3-25. The Peak AC to DC Convertor is a video amplifier which compares the amplitude of the output signal to V_{REF} and produces a dc voltage equal to four times any negative difference. The circuitry consists of input divider R37 through R42, differential amplifiers U3 and Q8 through Q10, and emitter followers Q11, Q12. A simplified diagram is shown in Figure 3-2.

3-26. The input divider R37 through R42 receives the rms output signal and V_{REF} through S2. The center of this divider is tapped at the junction of R40 and R41 and applied to one input of U3. Unity ratio is made possible at this tap by reversal of the inputs through S2 and adjustment of R37. Except for a small interval of time during the negative most peak of the rms signal, a positive current is flowing into the input of the video amplifier; however, since the input resistance of U3 is extremely high and the current is of proper polarity of forward bias CR9, it is conducted through CR9 and Q11 to $-18V$. When the peak of the rms signal is more negative than V_{REF} , the input cur-

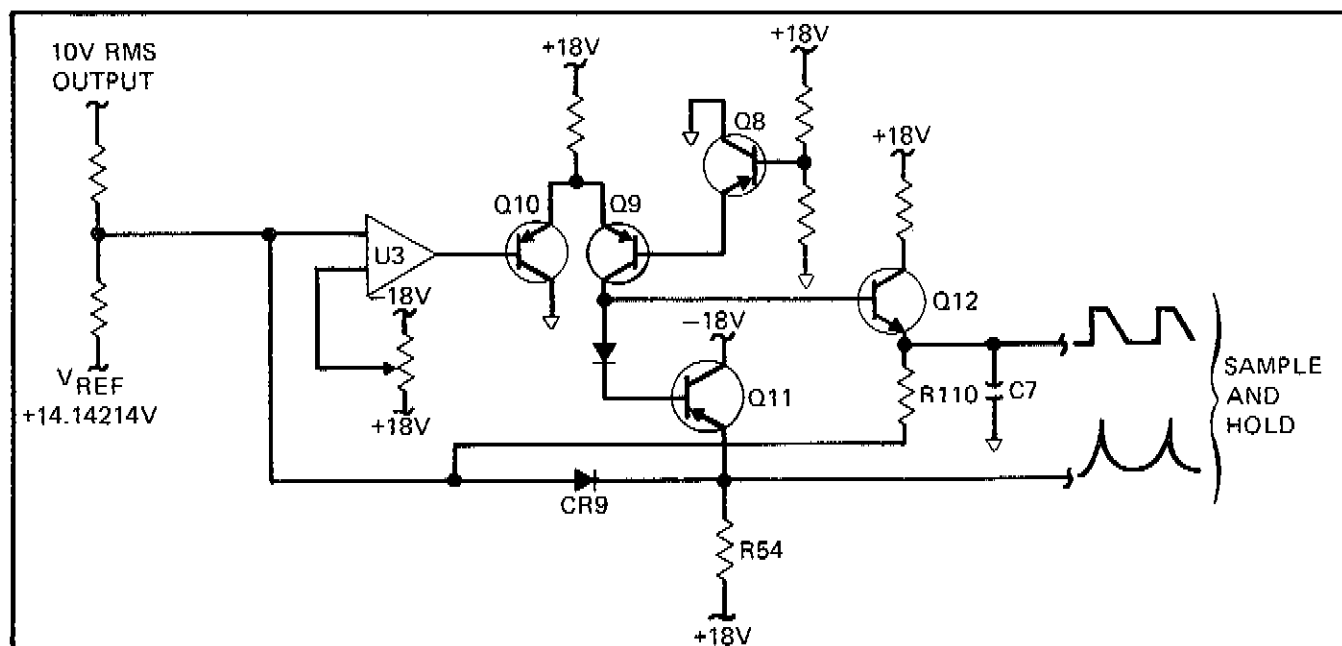


Figure 3-2. PEAK AC TO DC CONVERTOR (SIMPLIFIED)

rent reverses direction and CR9 is cut-off. This signal condition is then amplified by U3 and Q8 through Q10, which produces an emitter current in Q12. The resulting current produces a voltage charge on C7 in the A2A1 PCB that is four times the negative peak difference between the rms output and V_{REF} . Variable resistor R60 allows adjustment of the bias on CR9. R49 allows zero adjustment of the video amplifier input offset voltage.

3-27. Sample and Hold

3-28. The Sample and Hold circuit transfers the charge on C7 in the A2A1 PCB to the input of the Integrator. This circuit is operational only at output frequencies below 20 kHz. It is disabled on output frequencies above 20 kHz because the overall detection is sufficiently fast without sample and hold. The circuitry consists of Schmitt Trigger Q13, Q14, inverter amplifiers Q7 and Q15, Q16, and FET gate Q17.

3-29. Positive excursions of the pulse wave form at the base of Q13 correspond to when CR9 in the Peak AC to DC Convertor is cut-off and a negative peak difference signal is being stored on C7 in the A2A1 PCB. This positive going pulse is shaped by Schmitt Trigger Q13 and Q14. Normally, Q14 is conducting and Q13 is cut-off. Presence of a positive going input to Q13 turns it on and turns off Q14. The resulting positive pulse at the collector of Q14 subsequently has a duration equal to the conduction interval of Q13. This pulse is coupled through C29 and turns on inverter Q15, Q16. The conduction of Q15 and the clamping action of Q16 produces a positive pulse through C8 in

the A2A1 PCB and CR13, which is applied to the gate of Q17. This positive pulse occurs at the trailing edge of the Schmitt Trigger pulse and turns on Q17. Conduction of Q17 then transfers the voltage charge on C7 in the A2A1 PCB to C9, which is at the input of the Integrator. The rectifier action of CR13 and C40 produces a zero volt turn on signal at the gate of Q17 in the absence of pulses from the Schmitt Trigger. This is necessary because the Schmitt Trigger of Q13 and Q14 is disabled on output frequencies above 20 kHz by a jumper between P9 and P17. Inverter Q7 provides a positive pulse to Q17 which compensates for the small error caused by the gate to drain capacitance.

3-30. Integrator

3-31. The Integrator consisting of U4 and associated components produces an amplitude control voltage for the Oscillator that is dependent upon the error signal from Peak AC to DC Convertor. U4 is a high gain, non-inverting amplifier. One input is derived from C9 in the A2A1 PCB and the other from divider R72 through R75. Variable resistor R72 allows offset voltage compensation for U4. The network consisting of CR14 through CR16 and R78 functions as a clamping circuit which limits the maximum output voltage from U4. This circuit improves the recovery time of the Integrator upon initial turn-on and fault (UNCAL) conditions.

3-32. Oscillator

3-33. The Oscillator produces the constant amplitude 10V rms, fixed frequency output signal. It is a bridge "T"

oscillator formed by input amplifier Q18 through Q24, voltage controlled resistor FET Q26, and output amplifier Q25, Q27, Q28. Output amplitude is precisely maintained at 10V rms by the integrator output voltage applied to Q26. Output frequency is dependent upon the component values in the bridge "T" feedback network.

3-34. Input amplifier Q18 through Q24 is the heart of the Oscillator. The differential pair of Q19 and Q21 receives two inputs derived from feedback networks connected to the Oscillator output. The input to the base of the Q19 is through a bridge "T" network in the A2A1 PCB. Component values of A2A1C1 C2, R1 and R2 determine the center output frequency. The input to the base of Q21 is through the positive feedback network composed of R95 and R96. This feedback signal together with the conduction level of Q26 controls the output amplitude. Adjustment of R95 and R96 allows offsetting the output frequency. Conduction of Q26 is dependent upon the voltage control signal applied to its gate. This signal is derived from the Integrator and is of such a level as to maintain the output signal at precisely 10V rms. Q18 and Q20 combine the collector signals of Q19 and Q20 in the appropriate phase so that the output signal to Q22 base is twice that of what is normally obtained from a differential input stage. This configuration provides minimum ac current flow in Q19 and Q21. The collector signal at Q23 is the first point at which a 10V rms signal is available. Emitter follower Q24 drives the following output stage of Q27 and Q28. AC current in Q23 and Q24 is minimized by bootstrapping R88 and the emitter load of Q24 through C35 to

the output. Overall open loop forward gain of the input amplifier is determined by the ratio of C33 (X_C) in ratio with the sum of R82 and R83 times two.

3-35. The output amplifier of Q25 and Q27, Q28 is a complementary output stage. Temperature compensation of the bias current for Q27 and Q28 is provided through Q25 and the divider network of R99 through R101. Variable resistor R100 allows adjustment of this bias current. Output amplifiers Q27 and Q28 produce the output signal of the instrument. Maximum output current is limited by the collector load resistors and the supply voltage. The output signal is specified to 10 mA, above which clipping and distortion may result.

3-36. Overload Indicator

3-37. The Overload Indicator consists of Q29 and the light emitting diode CR23. This circuit illuminates the UNCAL indicator whenever the output current exceeds 10 mA.

3-38. Q29 monitors the voltage drop across R106. When the output current is greater than 10 mA, the voltage drop across R106 will be greater than 0.6 volts. This voltage turns on Q29 whose conduction path is through the UNCAL indicator CR23. Since CR23 acts similar to a zener, the first 1 mA of collector current of Q29 is bypassed around CR23 through R113. Any further increase in current is through CR23, thus assuring rapid turn on of the UNCAL indicator.

Section 4

Maintenance

4-1. INTRODUCTION

4-2. This section contains service and maintenance information for the Model 510A. The information is arranged under headings of "SERVICE INFORMATION, GENERAL MAINTENANCE, MAINTENANCE ACCESS, PERFORMANCE CHECKS, CALIBRATION PROCEDURES, COMPENSATING COMPONENT SELECTION, and TROUBLESHOOTING." Equipment required to service this instrument is listed in Table 4-1. If the recommended equipment is not available, substitute equipment having equivalent specifications can be used.

4-3. SERVICE INFORMATION

4-4. Each instrument that is manufactured by the John Fluke Mfg. Co., Inc. is warranted for a period of one year upon delivery to the original purchaser. The WARRANTY is located at the front of the manual.

4-5. Factory authorized calibration and service for each Fluke product is available at various world-wide locations. A complete list of these authorized service centers is located at the rear of the manual. Shipping information is given in Section 2 paragraph 2-3. If requested, an estimate will be provided to the customer before any repair work is begun on instruments that are beyond the warranty period.

4-6. GENERAL MAINTENANCE

4-7. Cleaning

4-8. The Model 510A should be cleaned periodically to remove accumulation of any dust or other contaminants. The exterior should be cleaned using a cloth moistened with ordinary soap and water. Cleaning of the interior should be done with clean, dry air at low pressure. If the printed circuit boards require cleaning, first spray them with Freon T.F. Degreaser (Miller Stephenson Co., Inc.) and then remove the dirt with clean, dry air at low pressure.

4-9. Fuse Replacement

4-10. Input line power to the instrument is overload protected by a fuse installed on the rear panel. A decal giving the type and rating of the fuse is also located on the rear panel. If replacement is necessary, use only the type fuse specified on the decal for 115 or 230V ac line power.

4-11. Lamp Replacement

4-12. An UNCAL status indicator (LED) is located on the front panel. This indicator is accessible after removing the top dust cover and requires no special tools to replace. If replacement is necessary, use a Fairchild, type FLV 102 (FLUKE PART NO. 309617) or equivalent.

TABLE 4-1. REQUIRED TEST EQUIPMENT

NOMENCLATURE	RECOMMENDED EQUIPMENT	TEST FUNCTION
Autotransformer	Variac	Performance checks Calibration Troubleshooting
Multimeter	FLUKE 853A	Troubleshooting
AC/DC Differential Voltmeter	FLUKE 887AB	Performance checks Calibration Troubleshooting
DC Voltage Standard/Null Detector	FLUKE 335D	Performance checks Calibration
Thermal Transfer Standard	FLUKE 540B, A54-2 (Certified to $\pm 0.04\%$ at 50 kHz – 100 kHz)	Performance checks Calibration
Frequency Counter	HP 5245L	Performance checks Calibration Troubleshooting
Oscilloscope	Tektronix 543, 1A1, X10 Probe	Calibration Troubleshooting
Resistive Loads	700, 900, 1k $\pm 2\%$ (Usable to 100 kHz)	Performance checks

4-13. Two ballast lamps designated DS1 and DS2 that are part of the -01 Option are installed on the A2 Main PCB. These lamps are mounted in clip holders attached to the inner rear panel. Access to the lamps is provided after removal of the top dust cover. Replacement requires no special tools. If replacement is necessary, use only GE757 (FLUKE PART NO. 175265) or equivalent.

4-14. MAINTENANCE ACCESS

4-15. The following procedure is to be used to gain access to the interior sections of the Model 510A.

4-16. Major Section Access

- Turn off the Model 510A and remove the top dust cover. Access is provided to all adjustments and test points shown in Figure 4-1.
- Remove the bottom dust cover. Access is now provided to assemblies shown in Figure 4-2.

4-17. Plug-In Assembly Removal and Installation

- Locate the assembly to be removed using Figure 4-2.
- Disconnect any wiring and then remove mounting screws.
- Remove the plug-in assembly using a gentle rocking motion and an even pulling force.
- Install the plug-in assembly in its correct position using a gentle rocking motion and steady downward pressure. Ensure that each mating connector is correctly aligned during installation.
- Reconnect any wiring disconnected in step c. Each wire is labeled with a number which corresponds to a connector on the PCB.

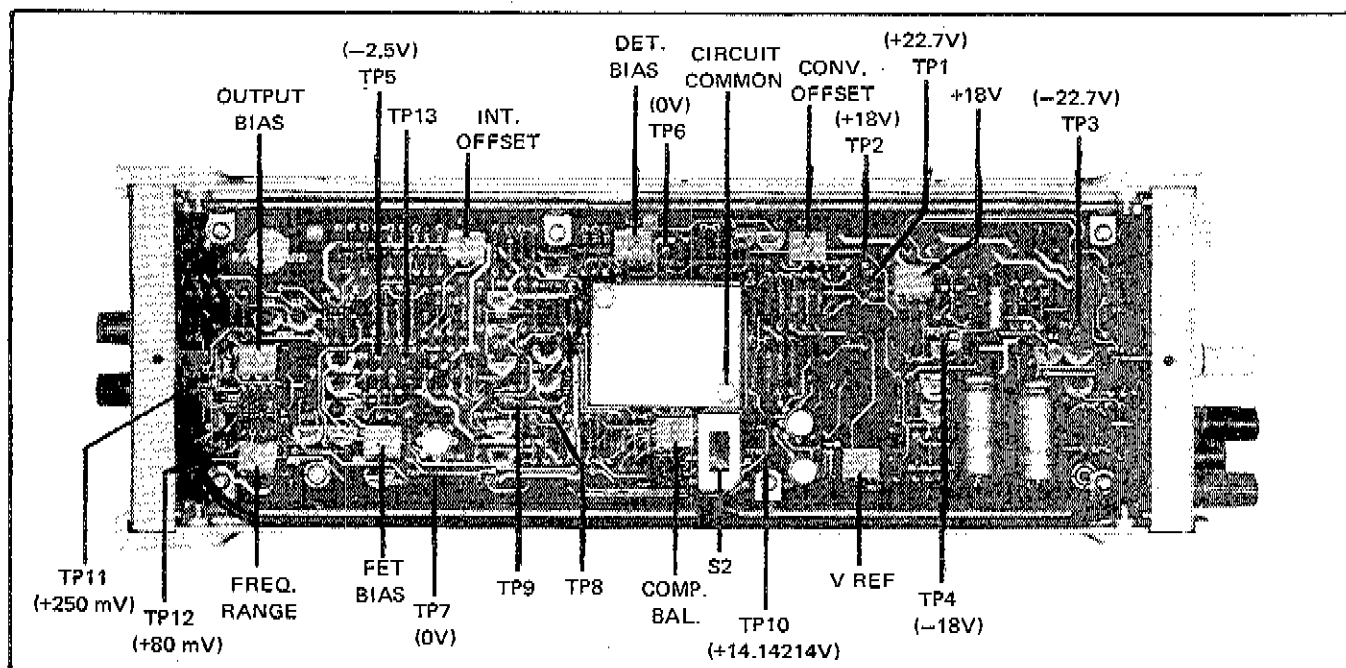


Figure 4-1. ADJUSTMENT AND TEST POINT LOCATIONS

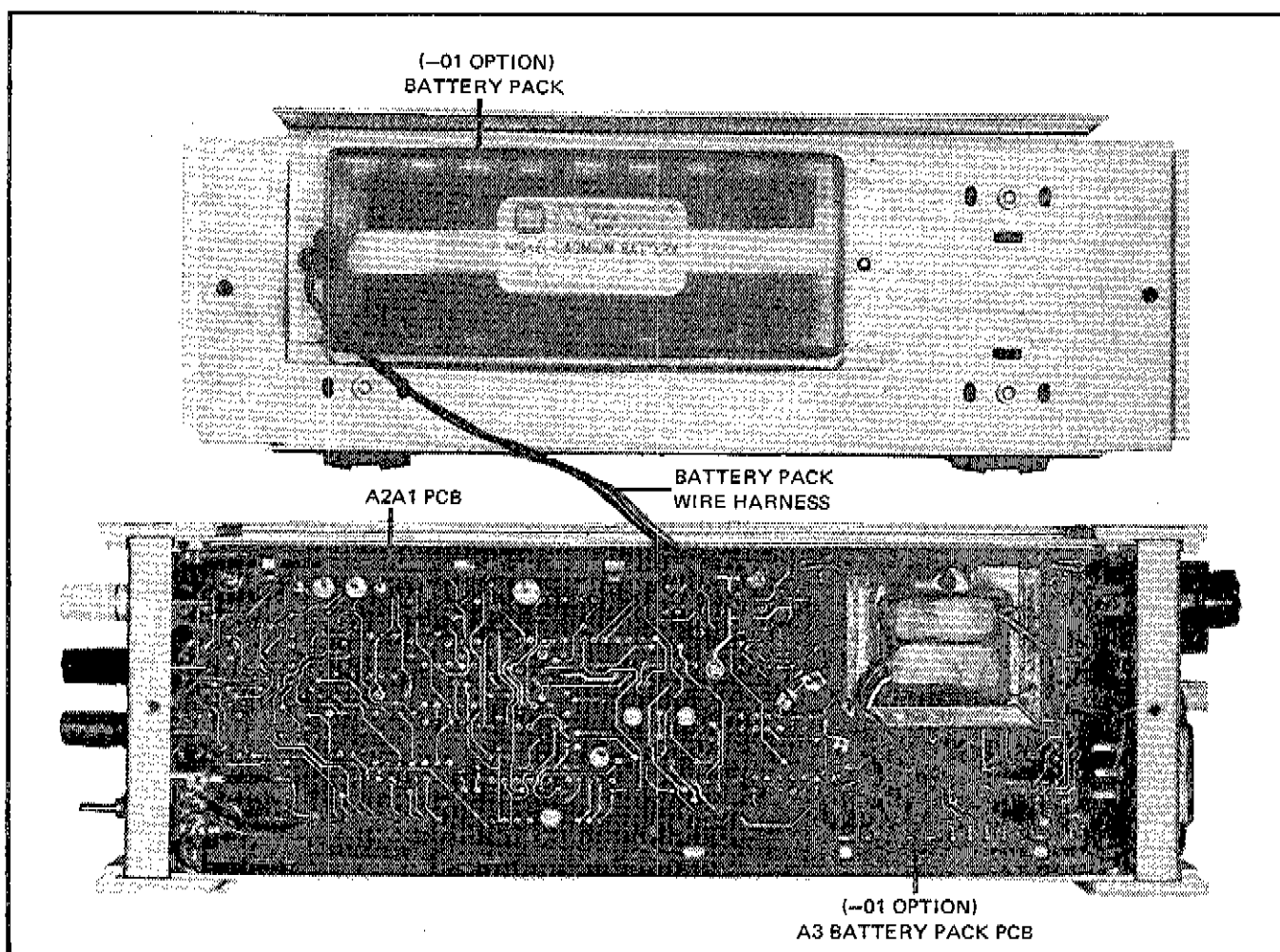


Figure 4-2. ASSEMBLY LOCATIONS (BOTTOM COVER REMOVED)

4-18. Battery Removal and Replacement (-01 Option)

4-19. The batteries for the -01 Option are installed on the inside of the bottom dust cover as shown in Figure 4-2. If replacement is necessary, the entire Battery Pack, FLUKE PART NO. 284356, should be replaced. Proceed as follows:

- Disconnect the four wires labeled 1 through 4 from A3 Battery Pack PCB. Refer to Figure 4-2 for location.
- Remove the screws which secure the Battery Pack to the bottom dust cover and then remove the Battery Pack.
- Install a new Battery Pack, FLUKE PART NO. 284356, on the bottom dust cover using the mounting screws removed in step b.
- Connect the four Battery Pack wires to the A3 Battery Pack PCB. Each wire is labeled with a number which corresponds to a connector on the PCB.

4-20. PERFORMANCE CHECKS

4-21. The following checks can be used to verify most electrical specifications on the Model 510A. Each check includes an introduction which states the objectives and lists the required test equipment. Refer to Table 4-1 for the recommended equipment.

4-22. Should a trouble be discovered, first determine that the instrument does not require calibration. If calibration does not correct the problem, troubleshoot the instrument and repair as necessary.

4-23. Preliminary Operation

- Connect the power cord through an autotransformer to line power. Set the autotransformer output to 115V ac.
- Set the POWER switch on the front panel to ON. The meter should indicate LINE OPR.
- Allow the instrument to operate for at least 10 minutes.

4-24. Line and Load Regulation Checks

4-25. This check provides a means of verifying the line and load regulation performance. Line voltage changes should not cause output variations greater than 10 ppm under full load. No load to full load changes should not cause output variations greater than those given in Figure 4-3. The following test equipment is required to perform these checks:

- Autotransformer
- AC Differential Voltmeter
- 1k Resistive Load

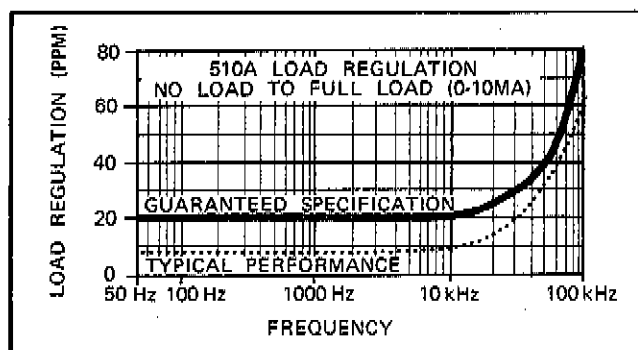


Figure 4-3. LOAD REGULATION

- Perform the steps given in paragraph 4-23.
- Connect the 1k load to the front panel OUTPUT terminals.
- Connect an ac differential voltmeter to the front panel OUTPUT terminals and record its indication.
- Vary the autotransformer output setting from 102 to 128V ac, observing that the output voltage does not change more than ± 100 uV.
- Return the autotransformer setting to 115V ac and disconnect the 1k load from the OUTPUT terminals.
- Record the OUTPUT terminal voltage with the ac differential voltmeter.
- Reconnect the 1k load to the OUTPUT terminals, observing that the output voltage does not change more than the limit specified in Figure 4-3.
- Disconnect the test equipment from the front panel OUTPUT terminals.
- Repeat steps b through g at the rear panel OUTPUT terminals.

- j. Disconnect the test equipment.

4-26. UNCAL Indicator Check

4-27. This check verifies correct operation of the UNCAL indicator on the front panel. This indicator should illuminate when the output load current exceeds 10 ma. The test equipment required to perform this check is a 700 and 900 ohm resistive load.

- a. Connect a 700 ohm load to the OUTPUT terminals, observing that the UNCAL indicator illuminates.
- b. Disconnect the 700 ohm load.
- c. Connect a 900 ohm load to the OUTPUT terminals, observing that the UNCAL indicator remains out.
- d. Disconnect the 900 ohm load.

4-28. Frequency Accuracy and Resolution Checks

4-29. This check provides a means of verifying the output frequency accuracy and resolution capability. The output frequency should be within $\pm 0.1\%$ of its specified value. It should be adjustable $\pm 1\%$ with the FREQUENCY VERNIER control on the front panel. Resolution capability of this adjustment is $\pm 0.05\%$. The only equipment required to perform this check is a frequency counter.

- a. Connect the frequency counter to the front panel OUTPUT terminals. The output frequency should be within $\pm 0.1\%$ of the frequency labeled on the front panel.

NOTE!

Use period mode on the frequency counter to increase measurement resolution.

- b. Adjust the FREQUENCY VERNIER control on the front panel to each limit, observing that the output frequency changes $\pm 1\%$. Resolution with this control should be $\pm 0.05\%$.
- c. Adjust the FREQUENCY VERNIER control for the output frequency labeled on the front panel.
- d. Disconnect the frequency counter.

4-30. Output Accuracy Check

4-31. This check provides a means of verifying the amplitude accuracies given in Table 4-2. It consists of two different methods: dc reference and thermal transfer. The test equipment required to perform these checks is listed at the beginning of each method.

TABLE 4-2. OUTPUT AMPLITUDE ACCURACY

DC REFERENCE			
OUTPUT FREQ.	AMPLITUDE ACCURACY		
	30 days	90 days	
50 Hz—5 kHz	±0.01%	±0.02%	
5 kHz—10 kHz	±0.02%	±0.03%	
10 kHz—30 kHz	±0.05%	±0.07%	
30 kHz—100 kHz	±0.15%	±0.17%	

THERMAL TRANSFER			
OUTPUT FREQ.	AMPLITUDE ACCURACY		
	24 Hrs	30 days	90 days
50 Hz—20 kHz	±0.01%	±0.015%	±0.02%
20 kHz—50 kHz	±0.015%	±0.025%	±0.035%
50 kHz—100 kHz	±0.04%	±0.05%	±0.06%

4-32. DC REFERENCE.

TEST EQUIPMENT:

1. DC Voltage Standard/Null Detector

- a. Turn off the Model 510A and remove the top dust cover.
- b. Make the equipment connections shown in Figure 4-4.
- c. Set the dc voltage standard output to $+14.14214\text{V}$ dc with a null detector sensitivity of 1V .
- d. Turn on the Model 510A and allow it to operate for at least 10 minutes.
- e. Increase the null detector sensitivity and record its indication. Maximum offset is $\pm 140\text{ uV}$.
- f. Turn off the Model 510A and disconnect the test equipment. Replace the upper dust cover.

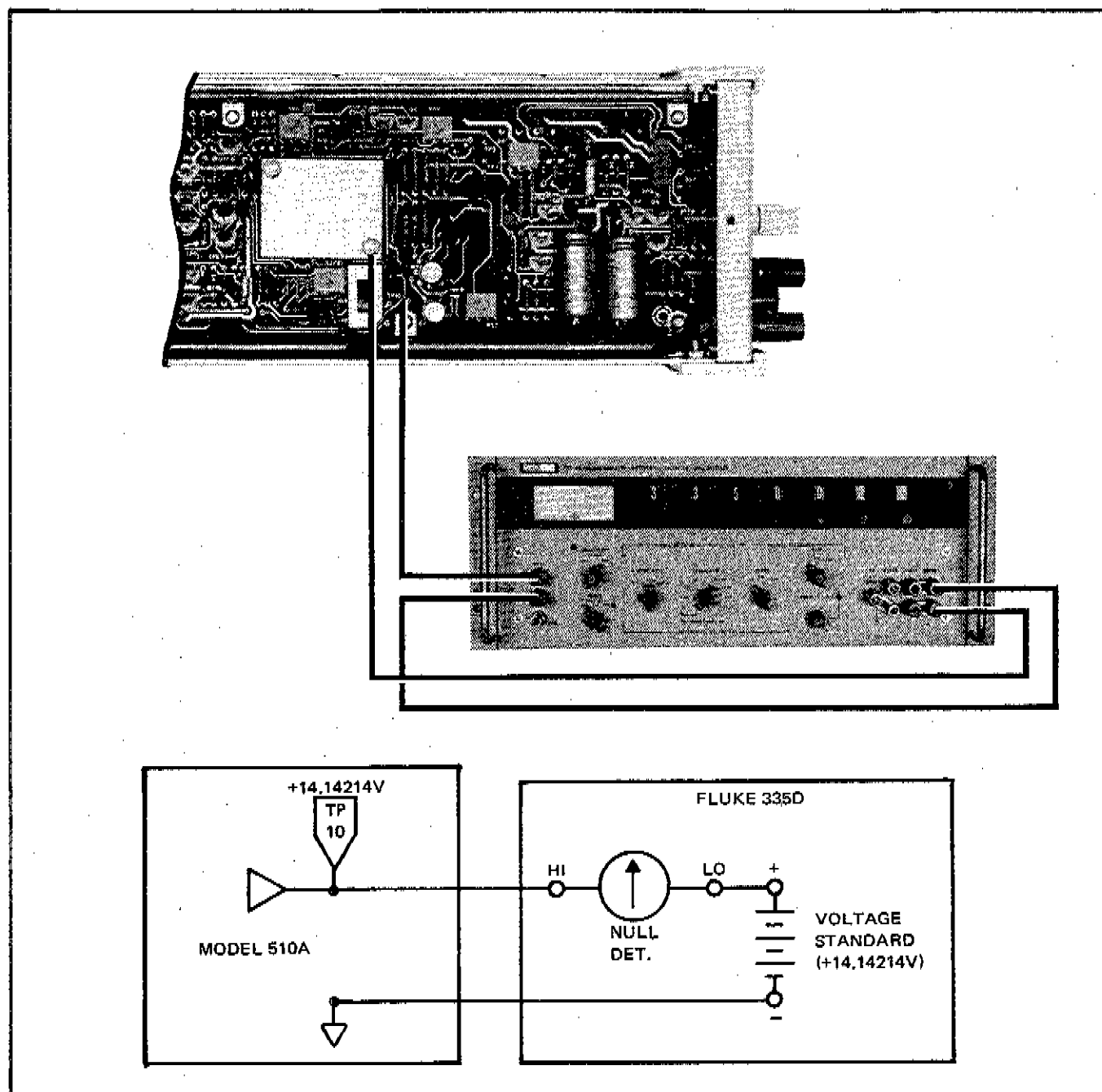


Figure 4-4. DC REFERENCE EQUIPMENT CONNECTIONS

4-33. THERMAL TRANSFER.

TEST EQUIPMENT:

1. DC Voltage Standard
2. Thermal Transfer Standard (Certified to $\pm 0.04\%$ at 50 KHz - 100 KHz)

- a. Make the equipment connections shown in Figure 4-5.

- b. Set the dc voltage standard output to 10V dc.
- c. Perform dc to ac transfer, observing that the thermal transfer, amplitude accuracy given in Table 4-2 is achieved.
- d. Disconnect the test equipment.

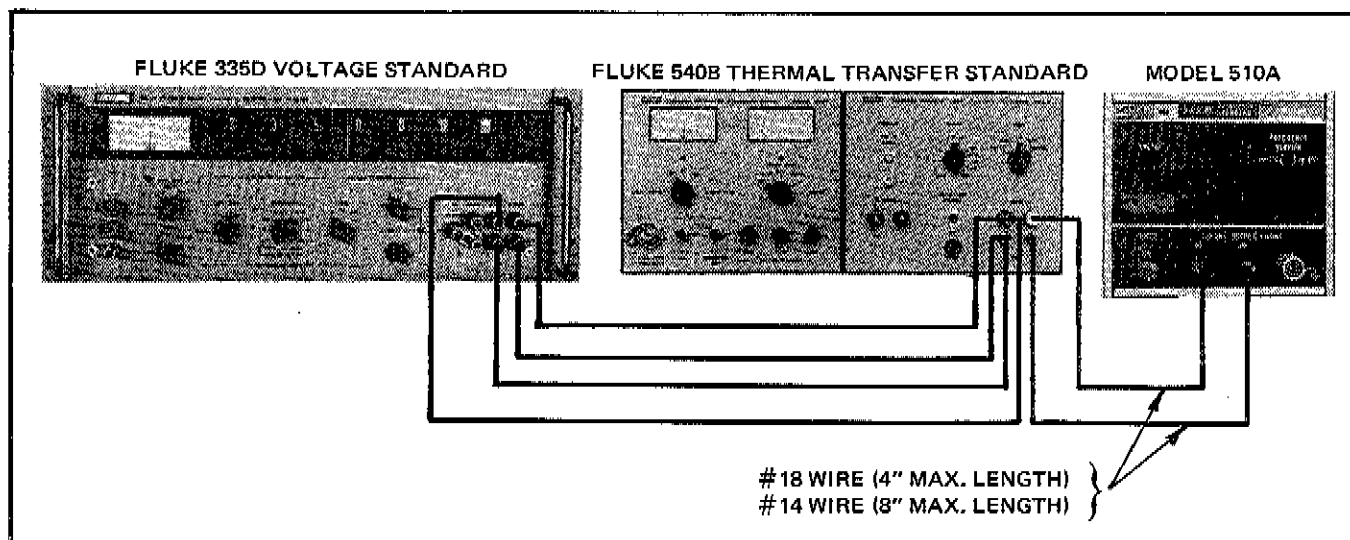


Figure 4-5. THERMAL TRANSFER EQUIPMENT CONNECTIONS

4-34. CALIBRATION PROCEDURES

4-35. Introduction

4-36. The Model 510A should be checked for calibration every 24 hours or 60 or 90 days, as desired, or whenever repairs have been made which affect the electrical characteristics. Calibration should be performed after a 10 minute operating period and at an ambient temperature of $23^{\circ}\text{C} \pm 5^{\circ}$.

4-37. All calibration test points and adjustments are shown in Figure 4-1. These calibration points are accessible after removal of the top dust cover. Required test equipment is listed in Table 4-1.

4-38. Regulator Alignment

- a. Remove the top dust cover. Adjustment and test point locations are shown in Figure 4-1.

- b. Connect the power cord through an autotransformer to line power. Set the autotransformer output to 115V ac.
- c. Turn on the Model 510A and allow it to operate for 10 minutes.
- d. Connect the input of a dc voltmeter to TP2 (+) and circuit common.
- e. Adjust +18V (R9) for $+18 \pm 0.2\text{V}$ dc at TP2.
- f. Connect the dc voltmeter input to TP4, observing that the voltage is $-18 \pm 0.5\text{V}$ dc.
- g. Disconnect the dc voltmeter input from TP4.

4-39. Reference Supply Alignment

- a. Make the equipment connections shown in Figure 4-6.
- b. Set the voltage standard output to +14.14214V dc with a null detector sensitivity of 1V.
- c. Increase the null detector sensitivity and adjust

V REF (R27) for a 0 ± 70 uV indication on the null detector.

NOTE!

If this adjustment cannot be made, refer to paragraph 4-47 for range compensation of R27.

- d. Disconnect the test equipment.

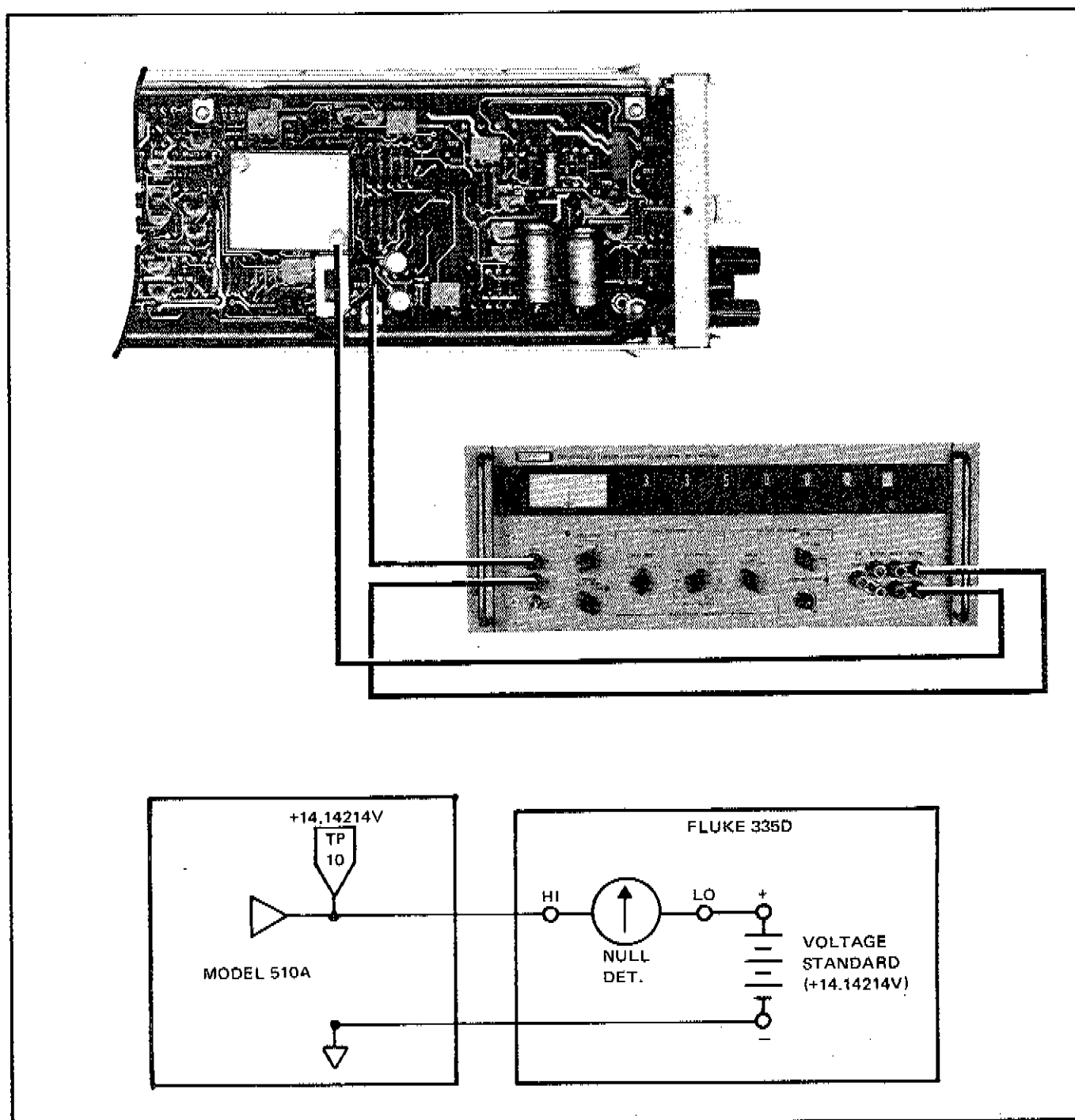


Figure 4-6. DC REFERENCE EQUIPMENT CONNECTIONS

4-40. FET Bias

- a. Connect the input of the dc voltmeter to TP5 (+) and circuit common.
- b. Adjust FET BIAS (R90) for $-2.5 \pm 0.2V$ dc at TP5.
- c. Disconnect the dc voltmeter input from TP5.

4-41. Zero Set

- a. Connect the dc voltmeter input to TP6.
- b. Adjust CONV. OFFSET (R49) for 0 ± 100 uV at TP6.
- c. Connect the dc voltmeter input to TP7.
- d. Adjust INT. OFFSET (R72) for 0 ± 100 uV at TP7.
- e. Disconnect the dc voltmeter from the instrument.

4-42. Output Bias

- a. Connect a shorting jumper between TP13 and circuit common.
- b. Connect the input for a dc voltmeter to TP11 (+) and TP4 (-).
- c. Adjust OUTPUT BIAS (R100) for +250 mV dc between TP11 and TP4.
- d. Disconnect the dc voltmeter and shorting jumper from the instrument.

4-43. Detector Bias

- a. Set the controls of a dc coupled oscilloscope to provide a .01V vertical sensitivity with an established 0V reference (Model 510A circuit common) on the display.

- b. Connect the input through X10 probe to TP8. Connect the probe ground clip to circuit common.
- c. Adjust the oscilloscope sweep speed to view at least two complete cycles of the peaked waveform at TP8.
- d. Adjust DET BIAS (R60) until the peak of the waveform is at 100 ± 10 mV in respect to circuit common.

- e. Disconnect the oscilloscope.

4-44. Comparator Balance

- a. Connect the input of an ac differential voltmeter to the front panel OUTPUT terminals.
- b. Record the ac output voltage.
- c. Switch S2 to the opposite position (white dot not showing) and record the ac voltmeter indication.
- d. Adjust COMP BAL (R37) for a maximum shift of 0 ± 50 uV in output voltage of each setting of S2.
- e. Set S2 to "white dot position" and disconnect the ac differential voltmeter.

4-45. Frequency Adjust

- a. Connect the input of a frequency counter to the front panel OUTPUT terminals. Use period mode for maximum resolution.
- b. Set the FREQUENCY VERNIER control (R96) on the front panel to the center of its adjustment range.
- c. Adjust FREQ. RANGE (R95) for the output frequency labeled on the front panel. If necessary, refine the FREQUENCY VERNIER setting slightly to obtain the appropriate frequency.
- d. Disconnect the frequency counter.

4.46. The Model 510A is now calibrated to meet amplitude accuracy specifications related to a dc reference accurate to ± 15 ppm. If an amplitude accuracy related to a thermal transfer is required, perform the following procedure:

- Make the equipment connections shown in Figure 4-7.
- Set the dc voltage standard output to the 10V dc.
- Perform dc to ac transfer, observing the ac amplitude error.

- Adjust COMP. BAL. (R37) for a 10V rms output from the Model 510A.

NOTE!

Transfer accuracy of the thermal transfer standard must be certified to at least $\pm 0.04\%$ from 50 KHz to 100 KHz.

- Disconnect the test equipment and replace the top dust cover. The Model 510A is now fully calibrated.

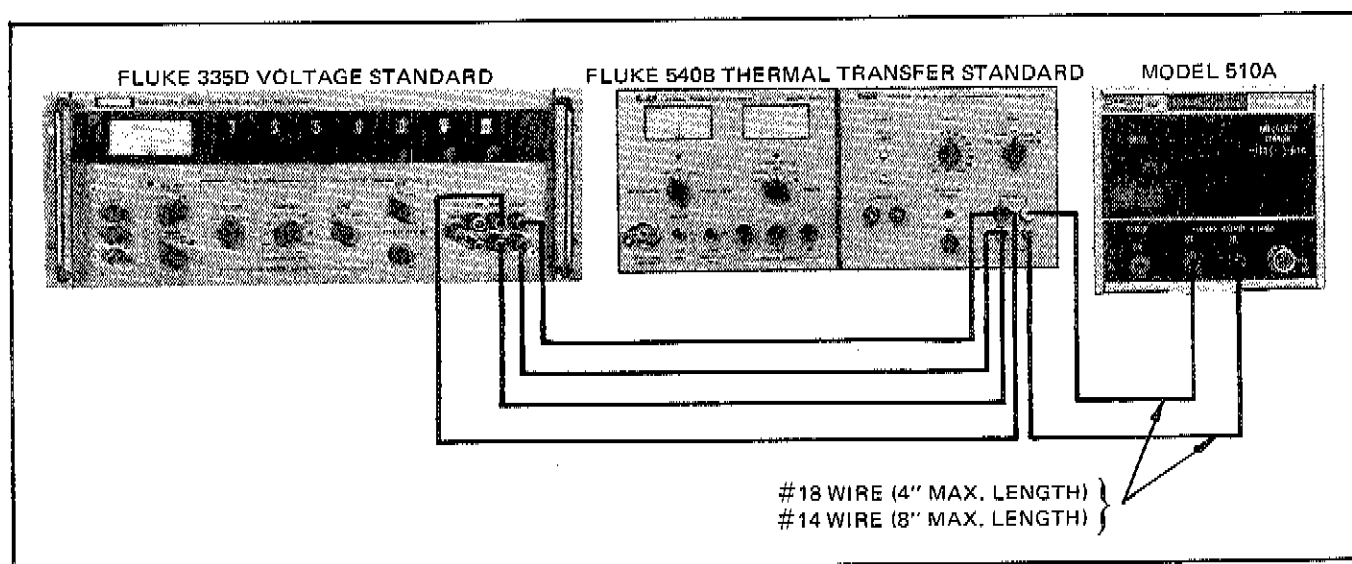


Figure 4-7. THERMAL TRANSFER EQUIPMENT CONNECTIONS

4-47. COMPENSATING COMPONENT SELECTION

4.48. Replacement of U2 and associated matched components in the Reference Supply will require selection of jumpers A and B. These jumpers compensate the adjustment range of V_{REF} (R27). Selection of jumpers is done as follows:

- Turn off the Model 510A and set V_{REF} (R27) fully counterclockwise.
- Locate jumpers A and B using Figure 4-8 and reconnect any cut jumpers.
- Turn on the Model 510A and make the equipment connections shown in Figure 4-6.
- Set the voltage standard output to +14.14214V dc with a null sensitivity of 1V.

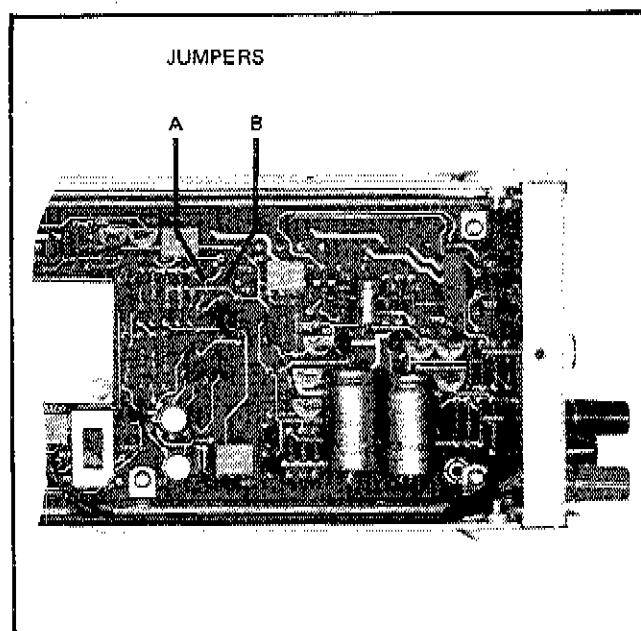


Figure 4-8. V_{REF} JUMPER LOCATIONS

- e. Increase the null detector sensitivity and record the offset voltage.
- f. Cut jumpers A and B per Table 4-3.
- g. Adjust V REF (R27) for a $0 \pm 70 \mu\text{V}$ indication on the null detector.

TABLE 4-3. A & B JUMPER SELECTION

OFFSET VOLTAGE (TP 10)	CLIP JUMPER
0 to 0.00571	None
0.00572 to 0.01141	A
0.00142 to 0.01712	B
0.01713 to 0.02182	A and B

NOTE!

The Model 510A should be recalibrated using the procedures given in paragraph 4-34 through 4-46.

4-49. TROUBLESHOOTING

4-50. The following information is provided to assist in locating troubles in the Model 510A. It is recommended that the theory of operation in Section 3 be completely understood before attempting any troubleshooting.

4-51. Initial Troubleshooting

4-52. Troubleshooting begins by first performing a thorough inspection for improperly seated plug-in assemblies, loose wires, physically damaged parts, or other obvious problems. The next step is to insure that the instrument is being operated correctly, but fails to meet specifications. Performance checks especially designed for this purpose are given in paragraphs 4-20 through 4-33.

4-53. Once it is determined that a malfunction exists, all operating voltages should be checked as shown in Figure 4-9. During these checks, the instrument must be operated from nominal line power. If the Rechargeable Battery Pack (-01 Option) is installed, the optional circuitry can be checked using the information in paragraph 4-54.

TEST POINT	VOLTAGE (VDC)	CIRCUITRY CHECKED
① TP1	+23V	AC INPUT (T1, CR2)
② TP3	-23V	AC INPUT (T1, CR2)
③ TP4	$-18 \pm 0.5\text{V}$	-18V REGULATOR
④ TP2	$+18 \pm 0.2\text{V}$	+18V REGULATOR
⑤ TP10	+14.14 $\pm$ 14V	REFERENCE SUPPLY

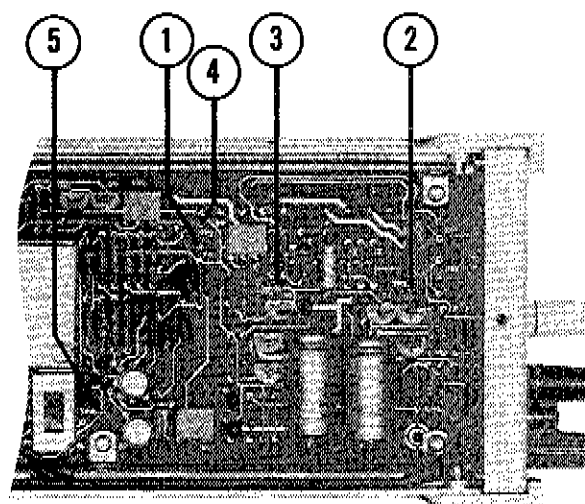


Figure 4-9. OPERATING VOLTAGE CHECK POINTS

4-54. Rechargeable Battery Pack (-01 Option)

4-55. Operating voltages for the optional battery pack circuitry can be checked using the following procedure:

- a. Connect the power cord through an autotransformer to line power. Set the autotransformer output to 0V.
- b. Make the voltage checks on the A3 Battery Pack PCB as shown in Figure 4-10.

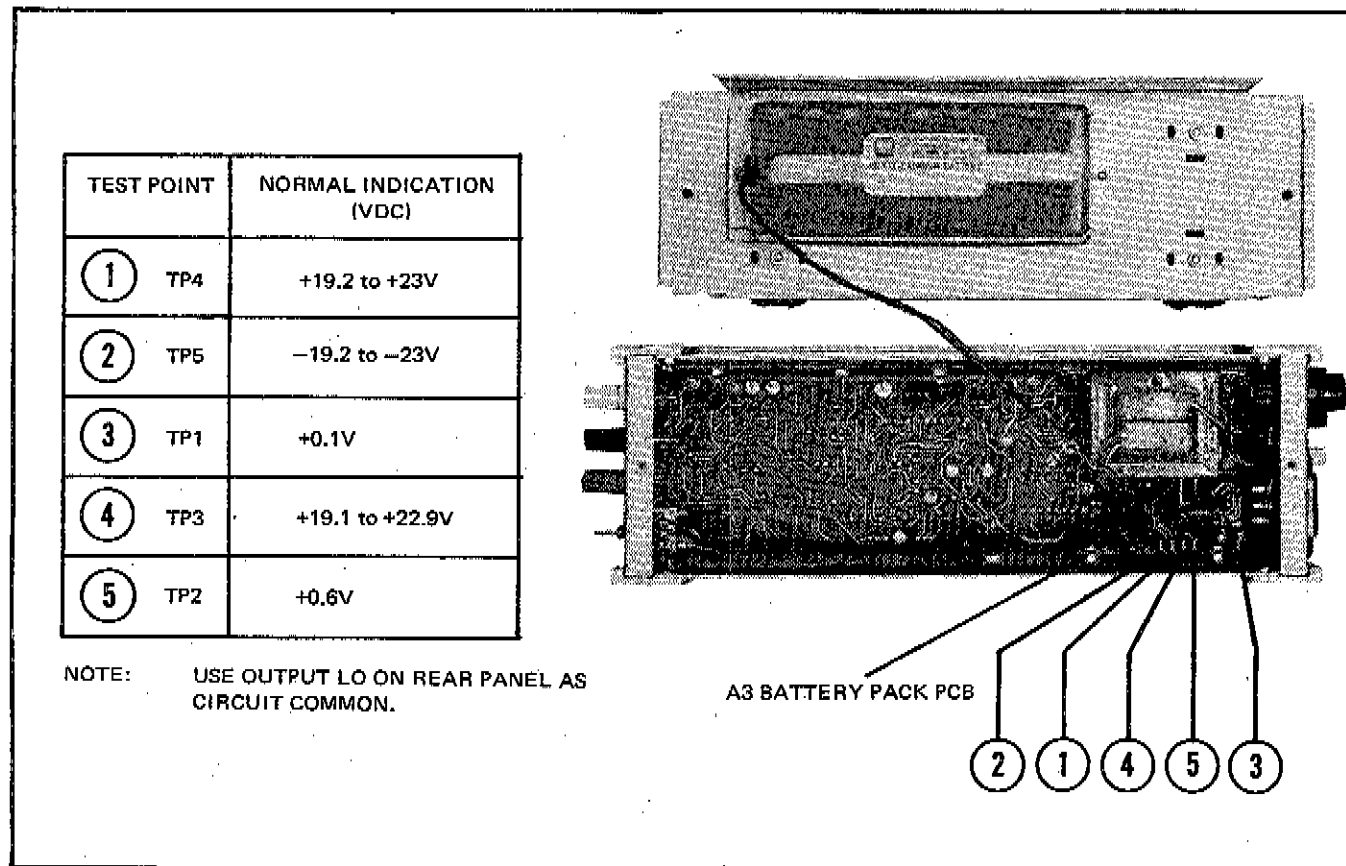


Figure 4-10. A3 BATTERY PACK PCB CHECKS

- c. Connect the dc voltmeter to A3TP1 and slowly increase the autotransformer output. The voltage at TP1 should increase from +0.1V dc to approximately +25V dc at a line voltage between 30 and 90V ac.
- d. Set the autotransformer output to 115V ac.
- e. Connect the dc voltmeter input to A3TP2 and slowly decrease the autotransformer output. The voltage at TP2 should increase from -25V dc to +0.6V dc at a line voltage between 90 and 30V ac.
- f. Turn off the Model 510A and disconnect the power cord.
- g. Disconnect wire #1 from P1 on the A3 Battery Pack PCB.
- h. Connect the output of a dc power supply set to +24V dc to P1 on the A3 Battery Pack PCB.
- i. Turn on the Model 510A and slowly decrease the power supply output until the meter on the front panel swings abruptly to the left.
- j. Record the power supply output voltage. The Model 510A should turn-off at a power supply output between 18.5 and 19.5V dc.
- k. Increase the power supply output until the meter on the front panel abruptly swings to the right. The Model 510A should turn on at a power supply output that is 1.2V above the value recorded in step j.
- l. Turn off the Model 510A and disconnect the power supply. Reconnect wire #1 to P1 on the A3 Battery Pack PCB.

4-56. Circuit Isolation Checks

4-57. The voltage checks given in Figure 4-11 can be used to isolate a trouble to a major circuit. General troubleshooting of the major circuit should then reveal the exact source of trouble. Circuit voltages are given on the schematic diagram.

CHECK POINT	NORMAL INDICATION	FAULT ANALYSIS
① TP12	10V RMS	IF ABNORMAL CHECK ②, TP5.
② TP5	$-2.5 \pm 0.2V$ dc	A. IF TP12 IS HIGH OR LOW AND TP5 IS $\pm 0.6V$, TROUBLE IS IN THE OSCILLATOR. B. CHECK ③, TP7, IF TP5 IS AT SOME OTHER VOLTAGE.
③ TP7	$0 \pm 100 \mu V$	A. IF TP5 IS NOT $+0.6V$ AND TP7 IS $+10$ mV OR MORE, TROUBLE IS IN THE INTEGRATOR. B. IF TP5 IS MORE POSITIVE THAN $-5V$ AND TP7 IS -10 mV OR MORE, TROUBLE IS IN THE INTEGRATOR. C. IF TP5 IS NOT $+0.6V$ AND TP7 IS $0V$ OR NEGATIVE, TROUBLE IS IN THE PEAK AC TO DC CONVERTER. D. IF TP5 IS MORE POSITIVE THAN $-5V$ AND TP7 IS $0V$ OR POSITIVE, TROUBLE IS IN THE PEAK AC TO DC CONVERTER.

NOTE!

SAMPLE AND HOLD IS CONSIDERED PART OF PEAK AC TO DC CONVERTER.

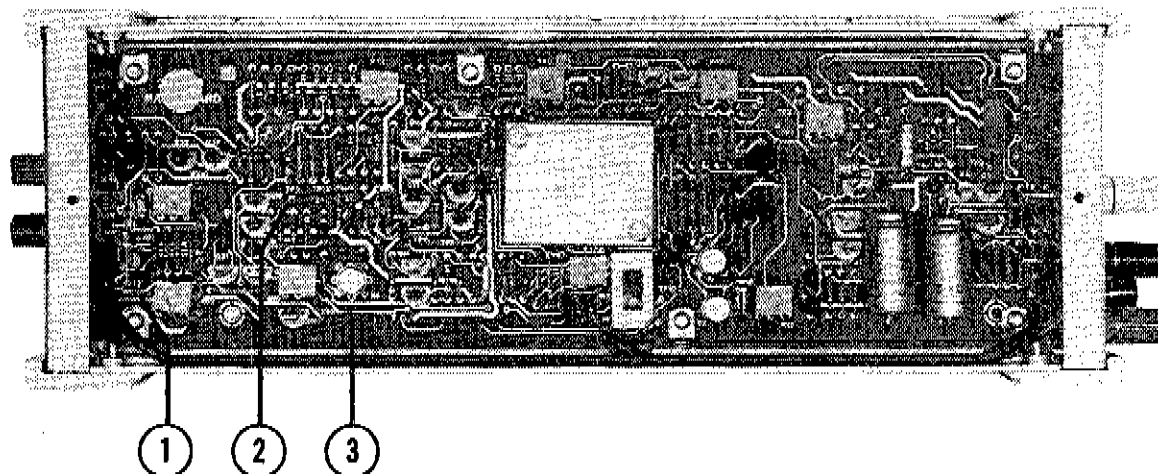


Figure 4-11. CIRCUIT ISOLATION CHECKS

Section 5

List of Replaceable Parts

5-1. INTRODUCTION

5-2. This section contains an illustrated parts breakdown list of the instrument and a Cross Reference List of FLUKE stock numbers to original MANUFACTURERS' part numbers. It also lists recommended spare parts and contains part ordering information. The starting page number of each major listing is given in the Table of Contents.

5-3. The parts list shows the location of all assemblies and the replaceable components. Major assemblies are identified by a designation beginning with the letter A followed by a number (e.g., A1 etc). Subassemblies are identified in the same manner; however, the parent assembly designator precedes this designator (e.g., A1A1 etc.). Electrical components are identified by their schematic diagram designator and listed hardware parts are identified by the FLUKE stock number. All listed components are described, and the FLUKE stock number is given. The original MANUFACTURER'S part number for each listed item is given in the Cross Reference List at the rear of this section.

5-4. PARTS LIST COLUMN DESCRIPTIONS

- a. The REF DESIG column indexes the item description to the associated illustration. In general the reference designations are listed under each assembly in alpha-numeric order. Subassemblies of minor proportions are sometimes listed with the assembly of which they are a part. In this case, the reference designations may appear out of order.
- b. The DESCRIPTION column describes the salient characteristics of the component. Indention of the description indicates the relationship to other assemblies, components, etc. In many cases it is necessary to abbreviate in this column. For abbreviations and symbols used, refer to Appendix B located at the rear of the manual.
- c. The six-digit part number, by which the item is identified at the John Fluke Mfg. Co., Inc. is listed in the STOCK NO. column. Use this number when ordering parts from the factory or authorized representatives. In the case where a flag note is used, special ordering is required. Flag note explanations are located as close as possible to the flag note.
- d. The TOT QTY column lists the total quantity of the item used in each particular assembly. This quantity reflects only the latest Use Code. Second and subsequent listings of the same item are referenced to the first listing with the abbreviation REF.
- e. Entries in the REC QTY column indicate the recommended number of spare parts necessary to support one to five instruments for a period of two years. This list presumes an availability of common electronic parts at the maintenance site. For maintenance for one year or more at an isolated site, it is recommended that at least one of each assembly in the instrument be stocked. In

the case of optional subassemblies, plug-ins, etc. that are not always part of the instrument, or are deviations from the basic instrument model, the REC QTY column lists the recommended quantity of the item in that particular assembly.

- f. The USE CODE column identifies certain parts which have been added, deleted or modified during the production of the instrument. Each part for which a Use Code has been assigned may be identified with a particular instrument serial number by consulting the Serial Effectivity List, paragraph 5-9. Sometimes when a part is changed, the new part can and should be used as a replacement for the original part.

5-5. MANUFACTURERS' CROSS REFERENCE LIST COLUMN DESCRIPTIONS

- a. The six-digit part number, by which the item is identified at the John Fluke Mfg. Co., Inc. is listed in the FLUKE STOCK NO. column. Use this number when ordering parts from the factory or authorized representatives.
- b. The Federal Supply Code for the item manufacturer is listed in the MFG column. An abbreviated list of Federal Supply Codes is included in Appendix A.
- c. The part number which uniquely identifies the item to the original manufacturer is listed in the MFG PART NO. column. If a component must be ordered by description, the type number is listed.

5-6. HOW TO OBTAIN PARTS

5-7. Standard components have been used whenever possible. Standard components may be ordered directly from the manufacturer by using the manufacturer's part number, or parts may be ordered from the John Fluke Mfg. Co., Inc. factory or authorized representative by using the FLUKE stock number. In the event the part you order has been replaced by a new or improved part, the replacement will be accompanied by an explanatory note and installation instructions, if necessary.

5-8. You can insure prompt and efficient handling of your order to the John Fluke Mfg. Co., Inc. if you include the following information:

- a. Quantity.
- b. FLUKE Stock Number.
- c. Description.
- d. Reference Designation.
- e. Instrument model and serial number.

Example: 2 each, 215897, Transistor, 2N4126
A2A1Q1 & Q2 for 645A, S/N 123.

If you must order structural parts not listed in the parts list, describe the part as completely as possible. A sketch of the part, showing its location to other parts of the instrument is helpful.

5-9. SERIAL NUMBER EFFECTIVITY

5-10. A Use Code column is provided to identify certain parts that have been added, deleted or modified during production of the Model 510A. Each part for which a use code has been assigned may be identified with a particular instrument serial number by consulting the Use Code Effectivity List below. All parts with no code are used on all instruments with serial numbers above 123.

USE CODE	SERIAL NUMBER EFFECTIVITY
-------------	---------------------------

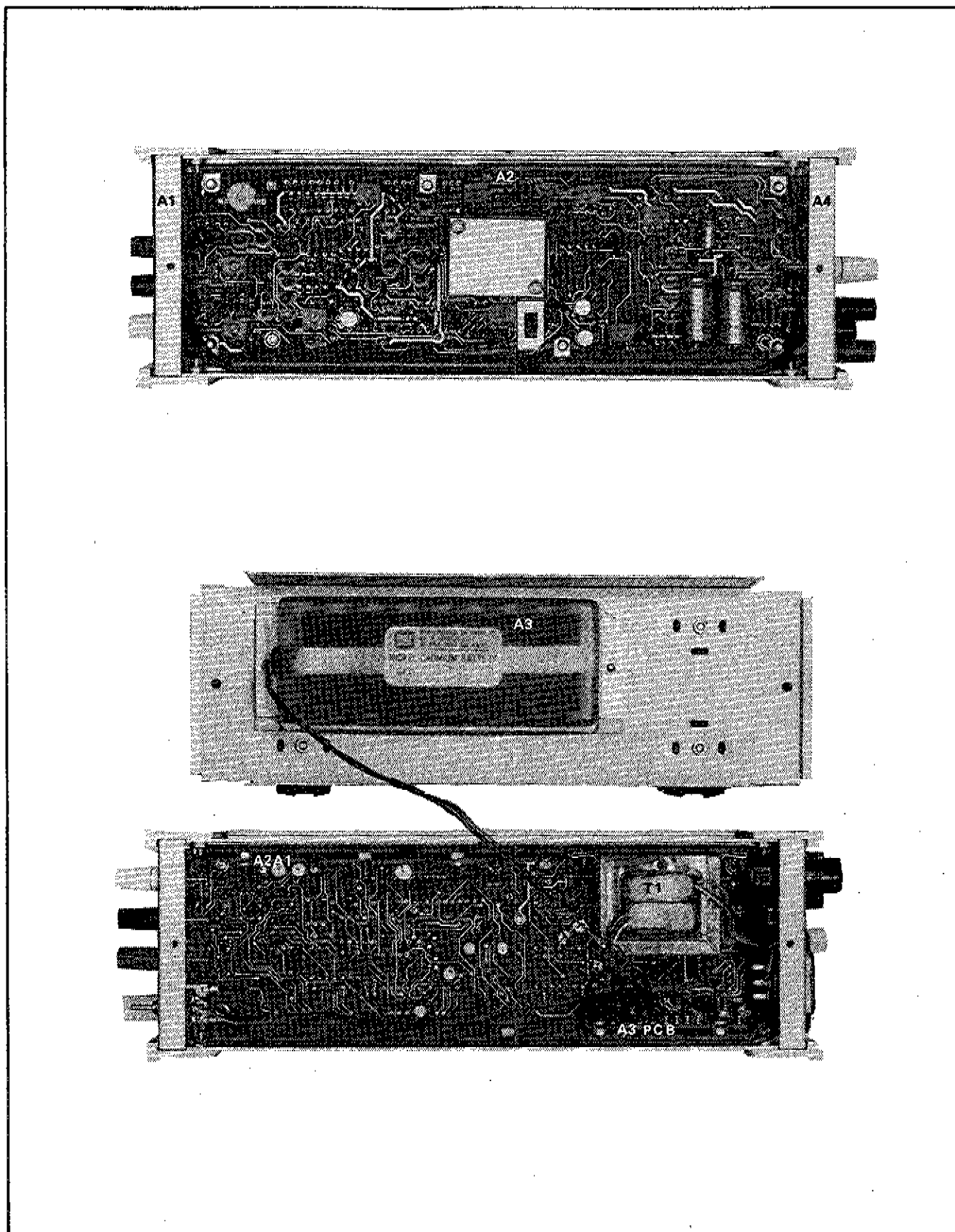


Figure 5-1. AC REFERENCE STANDARD

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
	AC REFERENCE STANDARD Figure 5-1	510A			
A1	Front Panel Assembly (Figure 5-2)	307884	1		
A2	Main PCB Assembly (Figure 5-3)	307868	1		
A2A1	PCB Assembly, 50 Hz, 60 Hz, 400 Hz, 1000 Hz, 2400 Hz, 5000 Hz, 19.2 KHz, 100 KHz (Figure 5-4)		1		
A3	Rechargeable Battery Kit (-01 Option) Figure 5-5				
A4	Rear Panel Assembly (Figure 5-6)	307892	1		
T1	Xfmr, Power	304097	1		
	 Field installation Kit P/N is 510A-Q1k				

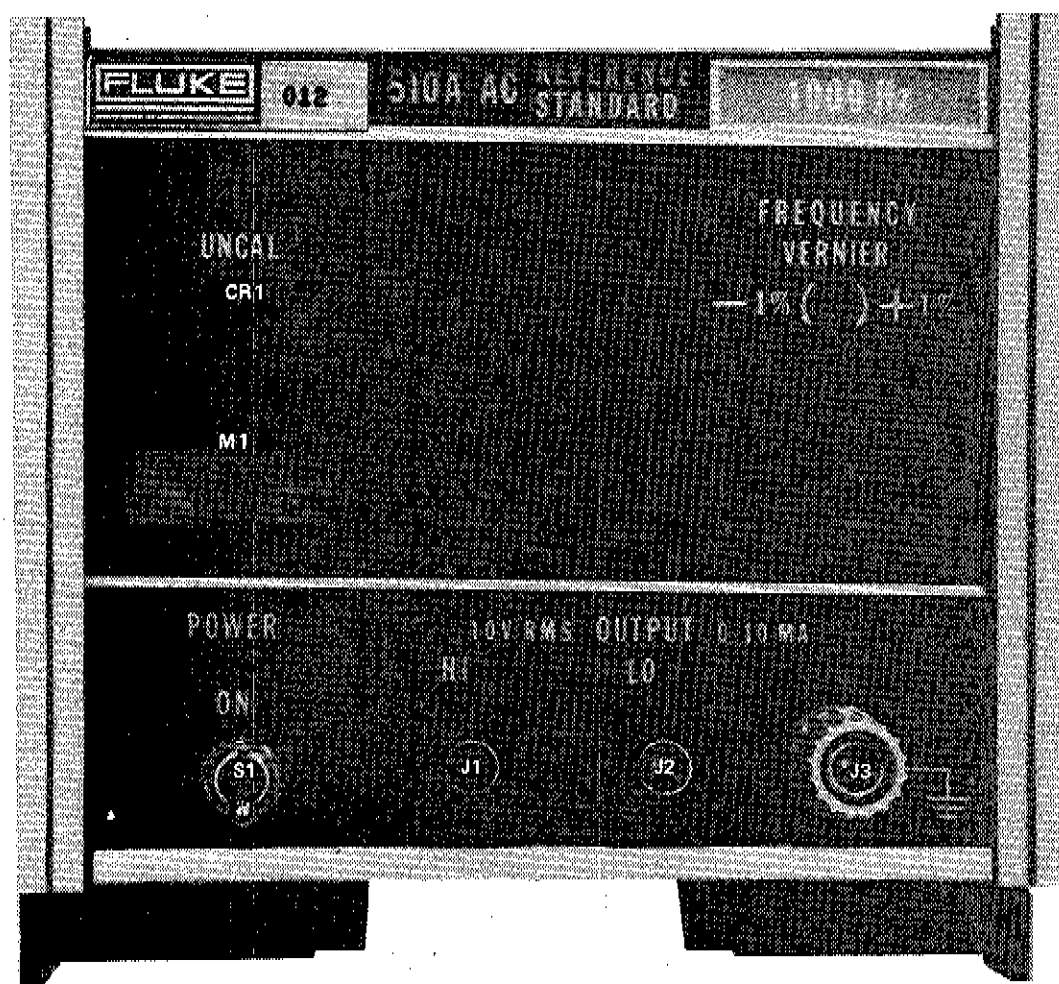


Figure 5-2. FRONT PANEL ASSEMBLY

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
A1	FRONT PANEL ASSEMBLY Figure 5-2	307686	REF		
CR1	Diode, light emitting, 50 mA	309617	1	1	
J1	Binding post, red, HI	275552	1		
J2	Binding post, black, LO	275560	1		
J3	Binding post, white	275586	1		
M1	Meter, 0-1 mA, $\pm 10\%$	266494	1		
S1	Switch, toggle, mini, 3 PDT	284299	1	1	
	Decal, front panel	309351	1		
	Meter, retainer	307322	1		

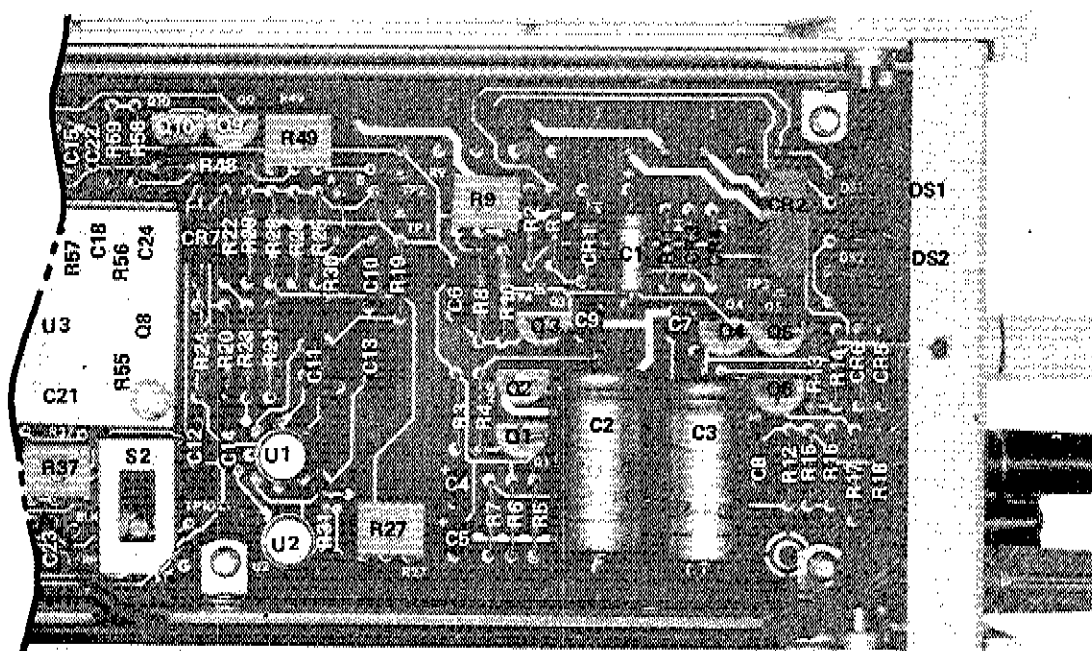
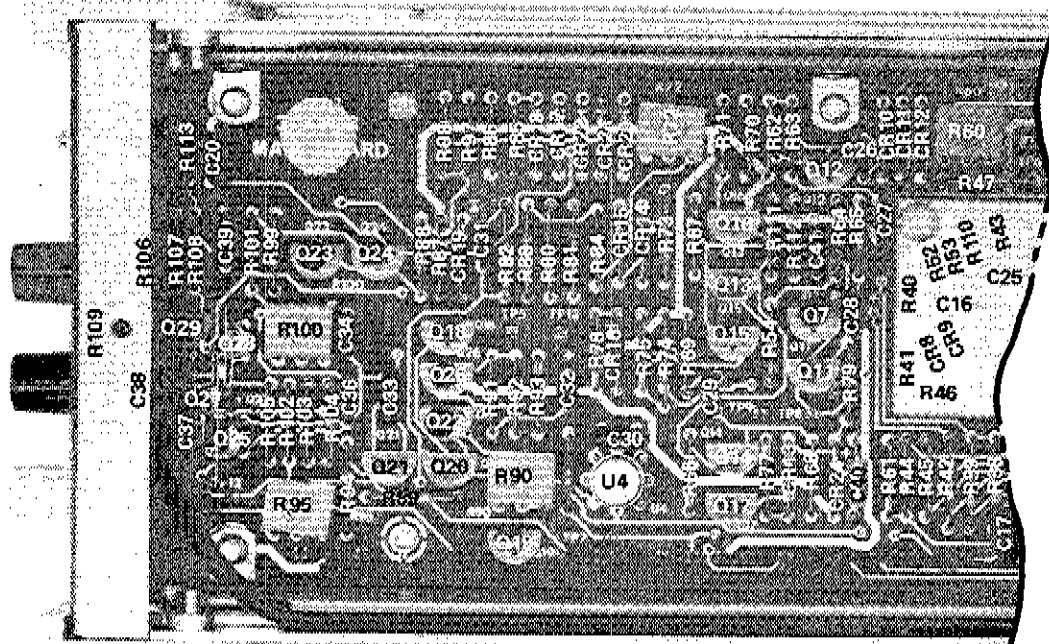


Figure 5-3. MAIN PCB ASSEMBLY

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
A2	MAIN PCB ASSEMBLY Figure 5-3	307868	REF		
C1	Cap, elect, 2 uf +75/-10%, 50V	105197	1	1	
C2, C3	Cap, elect, 250 uf +50/-10%, 40V	178616	2	1	
C4, C5, C7, C9, C28, C32	Cap, Ta, 2.2 uf ±20%, 20V	161927	6	1	
C6, C8, C10, C12 thru C14, C17, C20, C23, C37, C38	Cap, cer, 0.05 uf +80/-20%, 25V	148924	11	1	
C11, C18, C30	Cap, mica, 33 pf ±5%, 500V	160317	3	1	
C15, C21, C22, C24, thru C26, C34, C36	Cap, fixed, cer, 0.01 uf ±20%, 100V	149153	8	1	
C16	Cap, mica, 4 pf ±5%, 500V	190397	1	1	
C19	Not used				
C27	Cap, mica, 47 pf ±5%, 500V	148536	1	1	
C29	Cap, cer, 180 pf ±10%, 1 kV	105890	1	1	
C31	Cap, cer, 20 pf ±10%, 500V	106369	1	1	
C33	Cap, mica, 10 pf ±10%, 500V	175216	1	1	
C35	Cap, Ta, 4.7 uf ±20%, 20V	161943	1	1	
C39	Cap, Ta, 39 uf ±20%, 20V	163915	1	1	
C40	Cap, Ta, 3.3 uf ±10%, 15V	182808	1	1	
C41	Cap, cer, 3.3 uf ±10%, 500V	106377	1	1	
CR1, CR7	Diode, silicon, 1 amp, 100 piv	116111	2		
CR2	Diode, bridge, 2 amp, 100 piv	296509	1		
CR3 thru CR6, CR13, thru CR15, CR17, CR18, CR20 thru CR22, CR24	Diode, silicon, 150 MA	203323	13	2	
CR8	Diode, semicon, silicon, 100 MA at 1.5V	161810	1	1	
CR9	Diode, high speed, switching	256339	1	2	

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
CR10, CR11, CR12	Diode, germanium, 80 MA, 100 piv	149187	3		
CR16, CR19	Diode, zener, 6.2V	180497	2	1	
CR23	Not used				
DS1, DS2	Lamp, incandesant, 28V, 80 MA	175265	2	1	
Q1, Q5, Q7 thru Q10, Q27	Tstr, silicon, PNP	195974	7	1	
Q2, Q4, Q12 thru Q16, Q24, Q25, Q28	Tstr, silicon, NPN	218396	10	2	
Q3, Q19, Q21	Tstr, semicon, silicon NPN	218081	3	1	
Q6, Q11, Q18, Q20, Q29	Tstr, silicon, PNP	229898	5	1	
Q17, Q26	Tstr, FET, N-channel	261388	2	1	
Q22, Q23	Tstr, silicon, PNP	225599	2	1	
R1, R2, R65, R67, R78, R87, R91, R92, R109	Tes, comp, 10k $\pm 5\%$, 1/4w	148106	9		
R3, R7, R16, R68, R107, R108, R113	Res, comp, 1.8k $\pm 5\%$, 1/4w	175042	7		
R4, R13, R101	Res, comp, 6.8k $\pm 5\%$, 1/4w	148098	3		
R5, R14, R19	Res, comp, 270 Ω $\pm 5\%$, 1/4w	160804	3		
R6, R15	Res, comp, 180k $\pm 5\%$, 1/4w	193441	2		
R8	Res, met flm, 54.9k $\pm 1\%$, 1/8w	271353	1	1	
R9, R95	Res, var, cermet 10k $\pm 10\%$, 1/2w	309674	2	1	
R10	Res, met flm, 63.4k $\pm 1\%$, 1/8w	235382	1	1	
R11, R75, R76, R84, R88	Res, comp, 22k $\pm 5\%$, 1/4w	148130	5		

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
R12, R97	Res, comp, 5.6k $\pm 5\%$, 1/4w	148080	2		
R17	Res, met flm, 57.6k $\pm 1\%$, 1/8w	289116	1	1	
R18	Res, met flm, 45.3k $\pm 1\%$, 1/8w	234971	1	1	
R20	Res, met flm, 51.1k $\pm 1\%$, 1/8w	309757	1	1	
R21	Res, met flm, 49.9k $\pm 1\%$, 1/8w	293456	1	1	
R22, R23, R30, R31	Res, ref amp, matched set	1	1	1	
R24	Res, met flm, 2.49k $\pm 1\%$, 1/8w	309732	1	1	
R25	Res, met flm, 1.05k $\pm 1\%$, 1/8w	293530	1	1	
R26	Res, met flm, 107 Ω $\pm 1\%$, 1/8w	309716	1	1	
R27	Res, var, 100 Ω $\pm 10\%$, 1/2w	275735	1		
R28	Res, met flm, 200 Ω $\pm 1\%$, 1/8w	309724	1	1	
R29	Res, met flm, 10 Ω $\pm 1\%$, 1/8w	268789	1	1	
R32 thru R36	Not used				
R37	Res, var, cermet, 20 Ω $\pm 20\%$, 1/2w	275727	1	1	
R38	Res, met flm, 40.2 Ω $\pm 1\%$, 1/8w	245373	1	1	
R39	Res, met flm, 100 Ω $\pm 1\%$, 1/8w	168195	1	1	
R40, R41	Res, network (2 resistors)	293506	1	1	
R42	Res, met flm, 33.2 Ω $\pm 1\%$, 1/8w	199950	1	1	
R43, R54, R57, R64	Res, comp, 100k $\pm 5\%$, 1/4w	148189	4		
R44, R45 R93	Res, comp, 1k $\pm 5\%$, 1/4w	148023	3		

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
R46	Res, met flm, 13.7k $\pm 1\%$, 1/8w	236752	1	1	
R47, R74	Res, met flm, 453 Ω $\pm 1\%$, 1/8w	267393	2	1	
R48, R73	Res, met flm, 1M $\pm 1\%$, 1/8w	268797	2	1	
R49, R72	Res, var, 1M $\pm 10\%$, 1/2w	276691	2	1	
R50, R51	Not used				
R52	Res, comp, 2.4M $\pm 5\%$, 1/4w	221945	1	1	
R53	Res, comp, 470k $\pm 5\%$, 1/4w	188441	1		
R55, R58, R70, R111, R112	Res, comp, 47k $\pm 5\%$, 1/4w	148163	5		
R56	Res, comp, 360k $\pm 5\%$, 1/4w	234690	1		
R59	Res, comp, 12k $\pm 5\%$, 1/4w	159731	1		
R60, R90	Res, var, cermet, 1k $\pm 10\%$, 1/2w	275750	2	1	
R61	Res, comp, 27k $\pm 5\%$, 1/4w	148148	1		
R62, R85, R99	Res, comp, 8.2k $\pm 5\%$, 1/4w	160796	3		
R63, R105	Res, comp, 100 Ω $\pm 5\%$, 1/4w	147926	2		
R66	Res, comp, 91 Ω $\pm 5\%$, 1/4w	221887	1		
R69	Res, comp, 820k $\pm 5\%$, 1/4w	220541	1		
R71	Res, comp, 6.2k $\pm 5\%$, 1/4w	221911	1		
R77	Res, comp, 2.2M $\pm 5\%$, 1/4w	198390	1		
R79	Res, comp, 36k $\pm 5\%$, 1/4w	221929	1		
R80, R81	Res, met flm, 1k $\pm 1\%$ 1/8w	168229	2	1	
R82, R83	Res, met flm, 1.47k $\pm 1\%$, 1/8w	293654	2	1	
R86	Res, comp, 510 Ω $\pm 5\%$, 1/4w	218032	1		
R89	Res, met flm, 4.53k $\pm 1\%$, 1/8	260331	1	1	

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
R94	Res, met flm, 41.2k $\pm 1\%$, 1/8w	289538	1	1	
R96	Res, var, cermet, 2k $\pm 10\%$, 1/2w	285163	1	1	
R98	Res, comp, 4.7k $\pm 5\%$, 1/4w	148072	1		
R100	Res, var, cermet, 2k $\pm 10\%$, 1/4w	309666	1	1	
R102, R104	Res, comp, 5.6 Ω $\pm 5\%$, 1/4w	208033	2		
R103	Res, comp, 10 Ω $\pm 5\%$, 1/4w	147868	1		
R106	Res, met flm, 84.5 Ω $\pm 1\%$, 1/8w	236851	1	1	
R110	Res, comp, 56k $\pm 5\%$, 1/4w	170738	1		
S1	Switch, double pole, double throw	234278	1	1	
U1	IC, operational amplifier	271502	1	1	
U2	Ref, amp assembly, matched set		1	1	
U3, U4	IC, operational amplifier	306266	2	1	
	Socket, tstr	285262	25		
	R22, R23, R30, R31 and U2 are a matched set. For replacement order ref amp set P/N 4842-307918.				

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
A2A1	PCB ASSEMBLY 50 Hz (-02 Option) Figure 5-4	307926	REF		
C1, C2	Cap, fxd, met poly, 0.27 uf $\pm 5\%$, 100V	310466	2	1	
C3	Cap, Ta, 330 uf $\pm 10\%$, 6V	193011	1	1	
C4, C5	Cap, Ta, 220 uf $\pm 10\%$ 10V	182840	2	1	
C6	Cap, Ta, 5.6 uf $\pm 10\%$ 6V	198259	1	1	
C7	Cap, Ta, 0.47 uf $\pm 10\%$ 250V	184366	1	1	
C8	Cap, cer, 0.025 uf $\pm 2\%$, 100V	168435	1	1	
C9	Cap, cer, 0.1 uf $\pm 20\%$, 100V	149146	1	1	
C10	Cap, plstc 0.1 uf $\pm 10\%$, 250V	161992	1	1	
J1 thru J19	Amp, receptacle	267617	19	5	
R1	Res, met flm, 2.67k $\pm 1\%$, 1/8w	312173	1	1	
R2	Res, met flm, 42.2k $\pm 1\%$, 1/8w	312215	1	1	
R3	Res, comp, 47k $\pm 5\%$, 1/4w	148163	1		
R4	Res, comp, 2.2M $\pm 5\%$, 1/4w	198390	1		

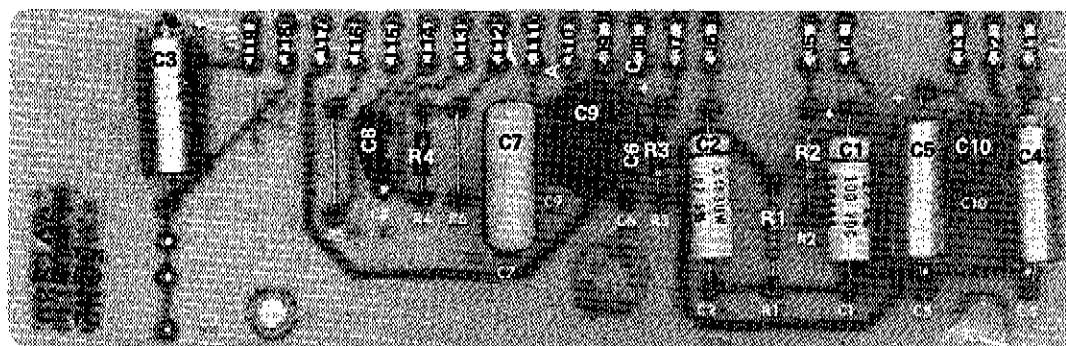


Figure 5-4. PCB ASSEMBLY, 50 Hz (-02 Option)

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
A2A1	PCB Assembly, 60 Hz (-03 Option) Figure 5-5	307934	REF		
C1, C2	Cap, fxd, met poly, 27 uf $\pm 5\%$, 100V	310466	2	1	
C3	Cap, Ta, 330 uf $\pm 10\%$, 6V	193011	1	1	
C4, C5	Cap, Ta, 220 uf $\pm 10\%$, 10V	182840	2	1	
C6	Cap, Ta, 5.6 uf $\pm 10\%$, 6V	198259	1	1	
C7	Cap, Ta, 0.47 uf $\pm 10\%$, 250V	184366	1	1	
C8	Cap, cer, 0.025 uf $\pm 2\%$, 100V	168435	1	1	
C9	Cap, cer, 0.1 uf $\pm 20\%$, 100V	149146	1	1	
C10	Cap, plstc, 0.1 uf $\pm 10\%$, 250V	161992	1	1	
J1 thru J19	Connector, receptacle	267617	19	5	
R1	Res, met flm, 2.21k $\pm 1\%$, 1/8w	310508	1	1	
R2	Res, met flm, 34.8k $\pm 1\%$, 1/8w	312181	1	1	
R3	Res, comp, 47k $\pm 5\%$, 1/4w	148163	1		
R4	Res, comp, 2.2M $\pm 5\%$, 1/4w	198390	1		

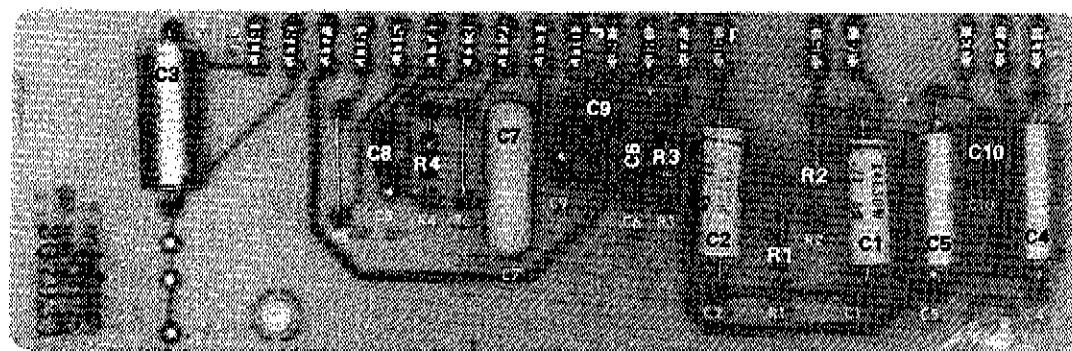


Figure 5-5. PCB ASSEMBLY, 60 Hz (-03 Option)

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
A2A1	PCB Assembly, 400 Hz (-04 Option) Figure 5-6	307942	REF		
C1, C2	Cap, fxd, met poly, 0.033 $\pm$ 5%, 100V	310474	2	1	
C3	Cap, fxd, met poly, 5 uf $\pm$ 10%, 50V	313254	1	1	
C4, C5	Cap, Ta, 68 uf $\pm$ 10%, 15V	182824	2	1	
C6	Cap, Ta, 3.3 uf $\pm$ 10%, 15V	182808	1	1	
C7	Cap, cer, 0.05 uf $\pm$ 20%, 100V	149161	1	1	
C8	Cap, mica, 3000 pf $\pm$ 5%, 500V	161786	1	1	
C9	Cap, fxd, cer, 0.01 uf $\pm$ 20%, 100V	149153	1	1	
J1 thru J19	Connector, receptacle	267617	19	5	
R1	Res, met flm, 2.67k $\pm$ 1%, 1/8w	312173	1	1	
R2	Res, met flm, 43.2k $\pm$ 1%, 1/8w	312223	1	1	
R3	Not used				
R4	Res, comp, 2.2M $\pm$ 5%, 1/4w	198390	1		

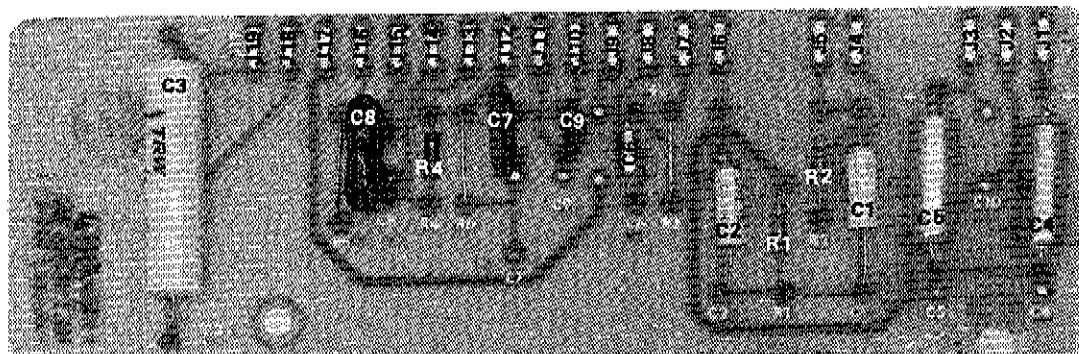


Figure 5-6. PCB ASSEMBLY, 400 Hz (-04 Option)

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
A2A1	PCB Assembly, 1000 Hz (-05 Option) Figure 5-7	307959	REF		
C1, C2	Cap, fxd, met poly, 0.015 uf $\pm 5\%$, 100V	310482	2	1	
C3	Cap, fxd, met poly, 2 uf $\pm 10\%$, 50V	284687	1	1	
C4, C5	Cap, Ta, 68 uf $\pm 10\%$, 15V	182824	2	1	
C6	Cap, Ta, 2.2 uf $\pm 20\%$, 20V	161927	1	1	
C7	Cap, cer, 0.05 uf $\pm 20\%$, 100V	149161	1	1	
C8	Cap, mica, 1200 pf $\pm 5\%$, 500V	148379	1	1	
C9	Cap, fxd, cer, 0.01 uf $\pm 20\%$, 100V	149153	1	1	
J1 thru J19	Connector, receptacle	267617	19	5	
R1	Res, met flm, 2.43k $\pm 1\%$, 1/8w	310524	1	1	
R2	Res, met flm, 39.2k $\pm 1\%$, 1/8w	312207	1	1	
R3	Not used				
R4	Res, comp, 1.2M $\pm 5\%$, 1/4w	188425	1		

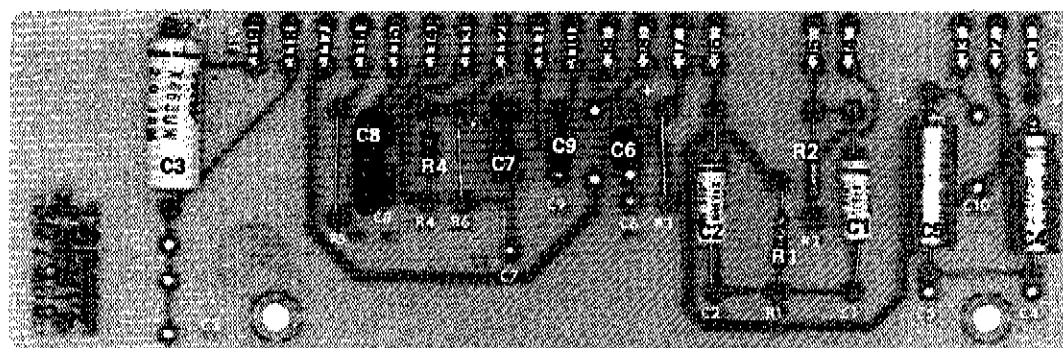


Figure 5-7. PCB ASSEMBLY, 1000 Hz (-05 Option)

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
A2A1	PCB ASSEMBLY, 2400 Hz (-06 Option) Figure 5-8	307967	REF		
C1, C2	Cap, mica, 6200 pf $\pm 5\%$, 300V	310490	2	1	
C3	Cap, fxd, met poly, 1.0 uf $\pm 10\%$, 100V	313262	1	1	
C4, C5	Cap, Ta, 68 uf $\pm 10\%$, 15V	182824	2	1	
C6	Cap, Ta, 0.68 uf $\pm 10\%$, 35V	182790	1	1	
C7	Cap, cer, 0.05 uf $\pm 20\%$, 100V	149161	1	1	
C8	Cap, mica, 510 pf $\pm 5\%$, 500V	148411	1	1	
C9	Cap, Fxd, cer, 0.01 uf $\pm 20\%$, 100V	149153	1	1	
J1 thru J19	Connector, receptacle	267617	19	5	
R1	Res, met flm, 2.43k $\pm 1\%$, 1/8w	310524	1	1	
R2	Res, met flm, 39.2k $\pm 1\%$, 1/8w	312207	1	1	
R3	Not used				
R4	Res, fxd, comp, 750k $\pm 5\%$, 1/4w	221937	1		

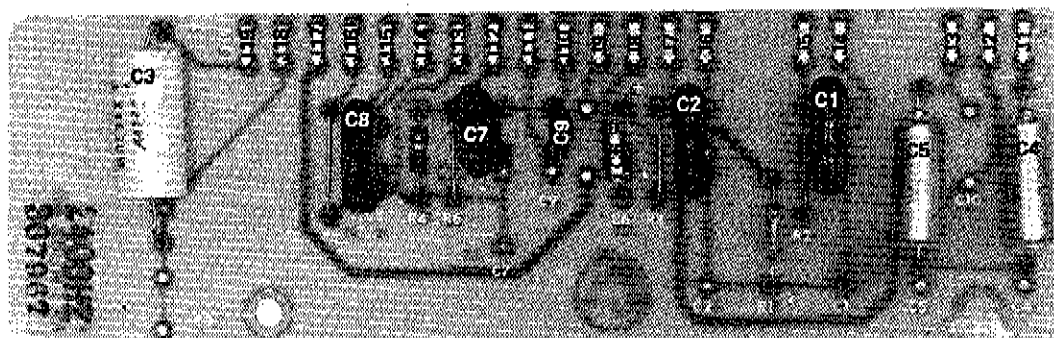


Figure 5-8. PCB ASSEMBLY 2400 Hz (-06 Option)

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
	PCB Assembly, 5000 Hz (-07 Option) Figure 5-9	307975	REF		
C1, C2	Cap, mica, 3000 pf $\pm 5\%$, 500V	161786	2	1	
C3	Cap, fxd, met poly, 1 uf $\pm 10\%$, 100V	313262	1	1	
C4, C5	Cap, Ta, 68 uf $\pm 10\%$, 15V	182824	2	1	
C6	Cap, Ta, .33 uf $\pm 5\%$, 20V	271338	1	1	
C7	Cap, cer, 0.05 uf $\pm 20\%$, 100V	149161	1	1	
C8	Cap, mica, 220 pf $\pm 5\%$, 500V	170423	1	1	
C9	Cap, fxd, cer, 0.01 uf $\pm 20\%$, 100V	149153	1	1	
J1 thru J19	Connector, receptacle	267617	19	5	
R1	Res, met flm, 2.43k $\pm 1\%$, 1/8w	310524	1	1	
R2	Res, met flm, 39.2k $\pm 1\%$, 1/8w	*312207	1	1	
R3	Not used				
R4	Res, comp, 360k $\pm 5\%$, 1/4w	234690	1		

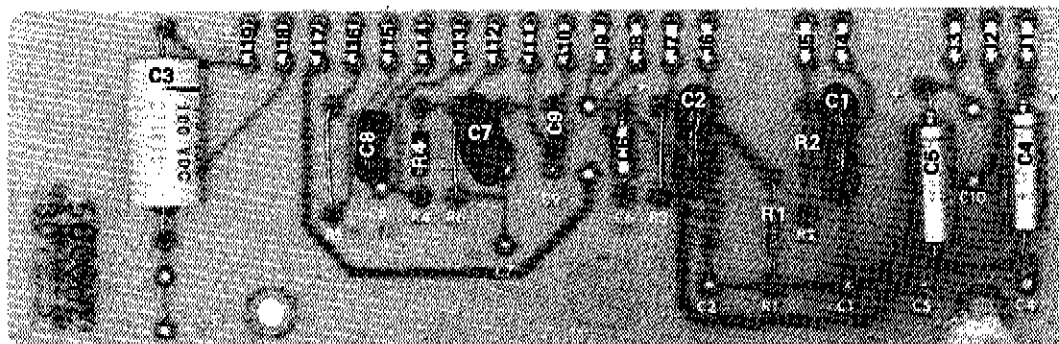


Figure 5-9. PCB ASSEMBLY, 5000 Hz (-07 Option)

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
	PCB Assembly, 19.2 KHz (-08 Option) Figure 5-10	307983	REF		
C1, C2	Cap, mica, 750 pf $\pm 5\%$, 500V	208983	2	1	
C3	Cap, fxd, met poly, 1 uf $\pm 10\%$, 100V	313262	1	1	
C4, C5	Cap, Ta, 68 uf $\pm 10\%$, 15V	182824	2	1	
C6	Cap, plstc, 0.068 uf $\pm 10\%$, 100V	182170	1	1	
C7	Cap, cer, 0.05 uf $\pm 20\%$, 100V	149161	1	1	
C8	Cap, mica, 68 pf $\pm 5\%$, 500V	148510	1	1	
C9	Cap, fxd, cer, 0.01 uf $\pm 20\%$, 100V	149153	1	1	
J1 thru J19	Connector, receptacle	267617	19	5	
R1	Res, met flm, 2.49k $\pm 1\%$, 1/8w	309732	1	1	
R2	Res, met flm, 39.2k $\pm 1\%$, 1/8w	312207	1	1	
R3	Not used				
R4	Res, comp, 100k $\pm 5\%$, 1/4w	148189	1		
R5	Not used				
R6	Res, comp, 5.1 Ω $\pm 5\%$, 1/4w	281832	1		

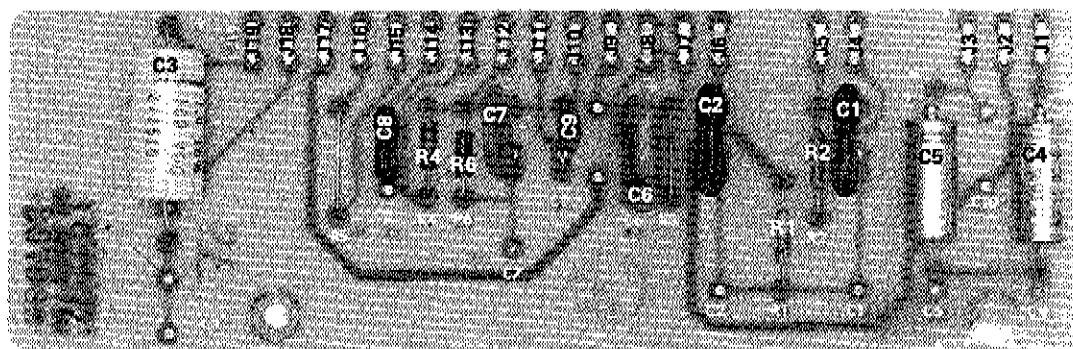


Figure 5-10. PCB ASSEMBLY, 19.2 kHz (-08 Option)

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
	PCB Assembly, 100 KHz (-09 Option) Figure 5-11	307991	REF		
C1, C2	Cap, mica, 150 pf $\pm 5\%$, 500V	148478	2	1	
C3	Cap, fxd, met poly, 1 uf $\pm 10\%$, 100V	313262	1	1	
C4, C5	Cap, Ta, 68 uf $\pm 10\%$, 15V	182824	2	1	
C6	Cap, cer, 0.05 uf $\pm 20\%$, 100V	149161	1	1	
C7, C9	Cap, fxd, cer, 0.01 uf $\pm 20\%$, 100V	149153	2	1	
C8	Not used				
J1 thru J19	Connector, receptacle	267617	19	5	
R1	Res, fxd, met flm, 2.26k $\pm 1\%$, 1/8w	310516	1	1	
R2	Res, fxd, met flm, 36.5k $\pm 1\%$, 1/8w	312199	1	1	
R3	Not used				
R4	Res, comp, 4.7M $\pm 5\%$, 1/4w	220046	1	1	

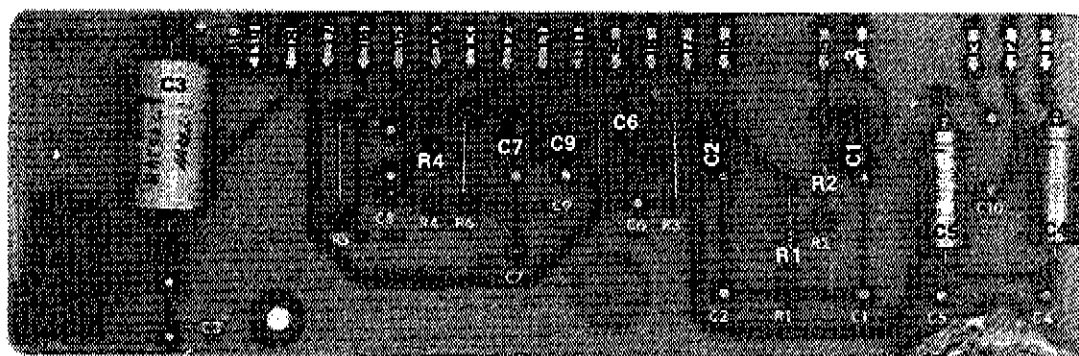


Figure 5-11. PCB ASSEMBLY, 100 kHz (-09 Option)

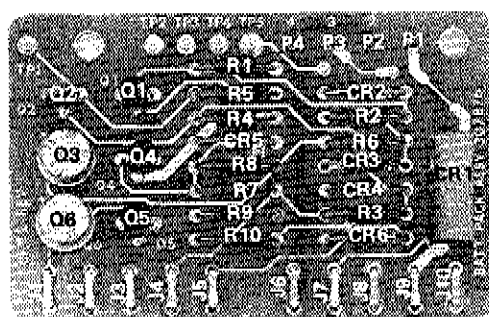
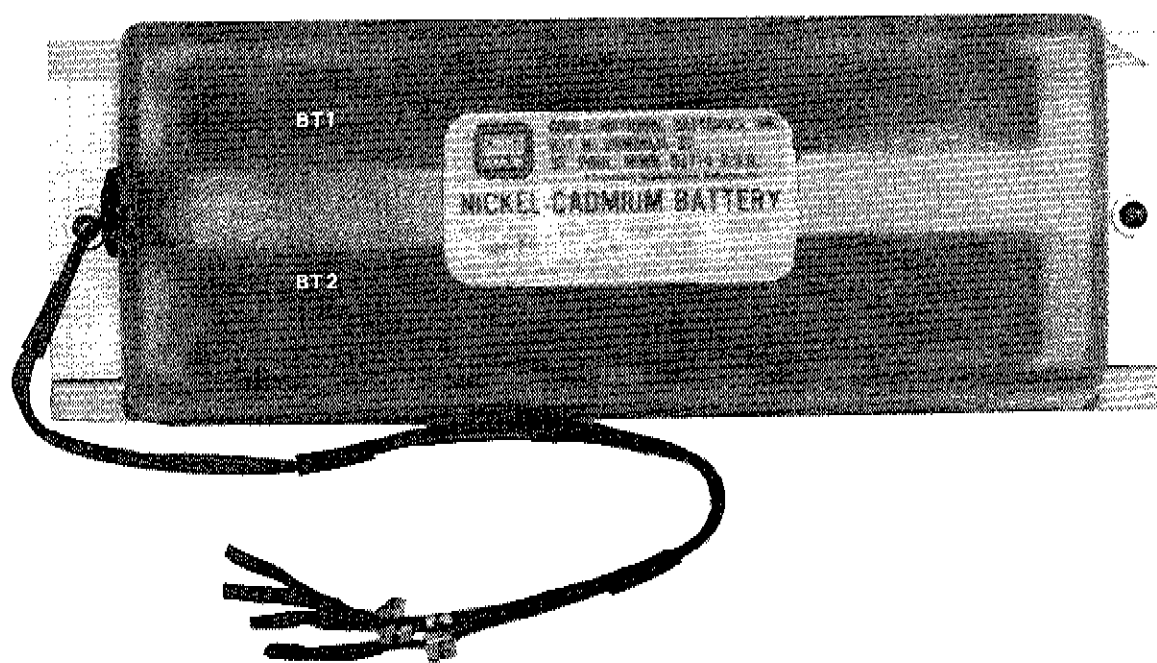


Figure 5-12. RECHARGEABLE BATTERY KIT (-01
OPTION)

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
A3	RECHARGEABLE BATTERY Kit (-01 Option) Figure 5-12	510A-01K	Ref		
	Battery Pack	307900	1		
BT1, BT2	Battery	284356	1	2	
	Battery Pack PCB	307876	1	1	
CR1	Diode, bridge, 2 amp, 200 piv	296509	1		
CR2, CR6	Diode, zener, 36V $\pm 5\%$, 1w	284364	2	1	
CR3	Diode, zener, 18.5V	309450	1	1	
CR4, CR5	Diode, silicon, 150 mA	203323	2	1	
J1 thru J10	Connector, receptacle	267617	10	3	
P1 thru P4	Connector, post	267500	4		
Q1, Q4	Tstr, silicon, PNP	195974	2	1	
Q2, Q5	Tstr, silicon, NPN	218396	2	1	
Q3, Q6	Tstr, semicon, germanium, PNP	148619	2	1	
R1, R10	Res, comp, 1M $\pm 5\%$, 1/4w	182204	2		
R2	Res, comp, 15k $\pm 5\%$, 1/4w	148114	1		
R3	Res, comp, 27k $\pm 5\%$, 1/4w	148148	1		
R4	Res, comp, 150k $\pm 5\%$, 1/4w	182212	1		
R5, R8	Res, comp, 56k $\pm 5\%$, 1/4w	170738	2		
R6, R7	Res, comp, 330k $\pm 5\%$, 1/4w	192948	2		
R9	Res, comp, 68k $\pm 5\%$, 1/4w	148171	1		

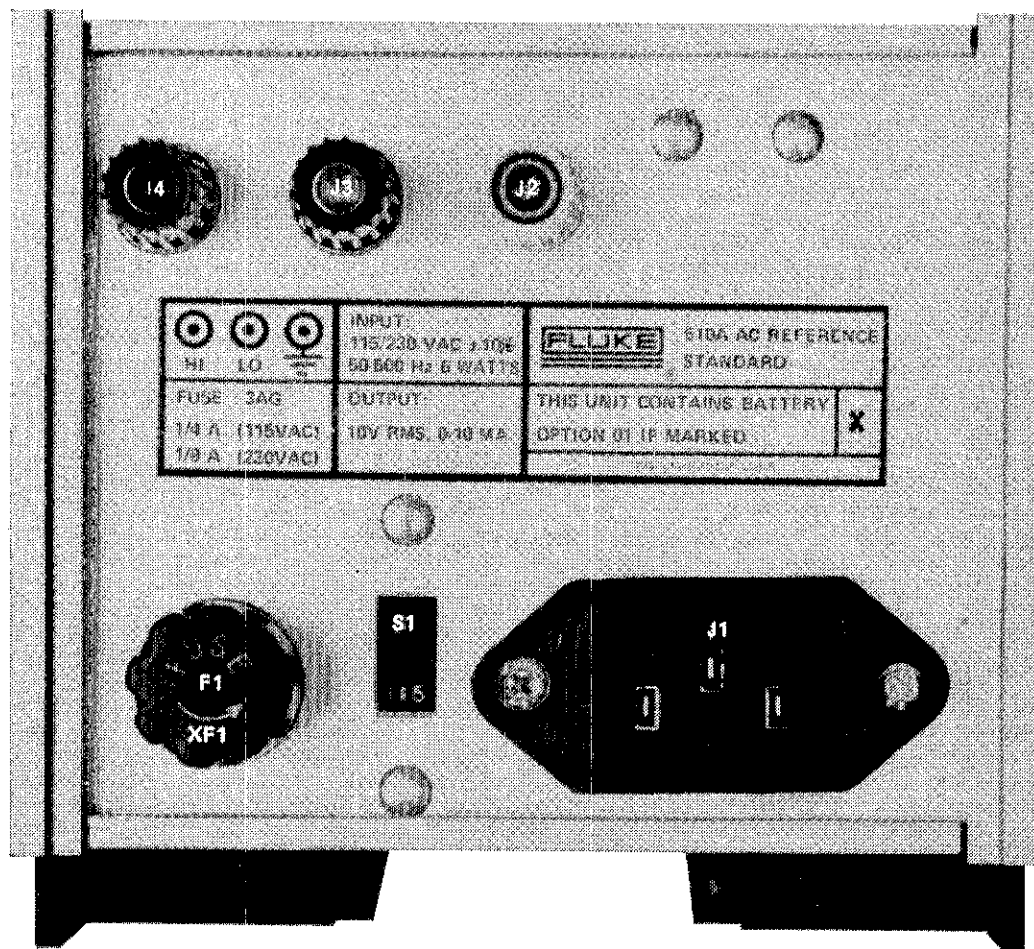


Figure 5-13. REAR PANEL ASSEMBLY

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
A4	REAR PANEL ASSEMBLY Figure 5-13	307884	REF		
F1	Fuse, fast acting, 1/4 amp, 250V (for 115V operation)	109314	1		
F1	Fuse, fast acting, 1/8 amp, 250V (for 230V operation)	196790			
J1	Connector, male, 3 pin	284166	1		
J2	Binding post, white	275586	1		
J3	Binding post, black, LO	275560	1		
J4	Binding post, red, HI	275552	1		
S1	Switch, slide	226274	1		
XF1	Fuse holder	160846	1		
	Decal	313064	1		
	Rear panel	307694	1		

MANUFACTURERS' CROSS REFERENCE LIST					
FLUKE STOCK NO.	MFR.	MFR. PART NO.	FLUKE STOCK NO.	MFR.	MFR. PART NO.
105197	56289	30D205G-050BA4	160804	01121	CB2715
105890	71590	BB60181KS3N	161810	03877	SG5658
106369	32897	831-000-T2HO-200	161927	56289	196D225X0020
106377	32897	861-000-T2HO-3R3	161943	56289	196D475X0020
1166111	05279	1N4817	161992	73445	C280AEA100K
147868	01121	CB1005	163915	56289	196D396X0006
147926	01121	CB1015	168195	91637	TYPE MFF 1/8
148023	01121	CB1025	168229	91637	TYPE MFF1/8
148072	01121	CB4725	168435	56289	C128B101H253M
148080	01121	CB5625	170423	14655	CD15F221J
148098	01121	CB6825	170738	01121	CB5635
148106	01121	CB1035	175042	01121	CB1825
148114	01121	CB1535	175216	14655	CD15C200K
148130	01121	CB2235	175265	08806	757
148148	01121	CB2735	178616	73445	C437ARG250
148163	01121	CB4735	180497	07910	1N753
148171	01121	CB6835	182170	14655	DMF1568
148189	01121	CB1045	182204	01121	CB1055
148379	14655	CD19F122J	182212	01121	CB1545
148478	14655	CD15F151J	182790	56289	150D684X9035A2
148510	14655	CD15F680J	182808	56289	150D330X9A2
148536	14655	CD15E470J	182824	56289	150D686X9015R2
148619	01295	2N1303	182840	56289	150D227X9010S2
148924	72982	5855-Y5U-5032	184366	73445	C280AE/A470K
149146	56289	33C41B6	188441	01121	CB4745
149153	56289	C023B101F103M	190397	14655	CD15C40K
149161	56289	55C23A1	192948	01121	CB3315
149187	93332	1N270	193011	56289	150D330X9006S2
159731	01121	CB1235	193441	01121	CB1845
160317	14655	CD15E330J	195974	04713	2N3906
160796	01121	CB8225	196790	71400	TYPE AGC

MANUFACTURERS' CROSS REFERENCE LIST					
FLUKE STOCK NO.	MFR.	MFR. PART NO.	FLUKE STOCK NO.	MFR.	MFR. PART NO.
198390	01121	CB2255	275560	32767	820-45
199950	91637	TYPE MFF1/8	275586	32767	820-25
203323	03508	DHD1105	275727	11236	360T200B
208033	01121	CB5615	275735	11236	360T101A
208983	14655	CD19F751J	275750	11236	360T102A
218032	01121	CB5115	276691	11236	360T105A
218081	04713	MPS6520	281832	01121	CB5105
218396	04713	2N3904	284166	82389	EAC301
220046	01121	CB4755	284299	09353	7301
220541	01121	CB8245	284364	12969	UZ8736
221911	01121	CB6225	285163	11236	360S202A
221929	01121	CB3635	285262	71785	133-23-92-039
221937	01121	CB7545	289116	91637	TYPE MFF1/8
221945	01121	CB2415	289538	91637	TYPE MFF1/8
229898	04713	MPS6522	293456	91637	TYPE MFF1/8
234690	01121	CB3645	293506	18612	310865
234971	91637	TYPE MFF1/8	293530	91637	TYPE MFF1/8
235382	91637	TYPE MFF1/8	293654	91637	TYPE MFF1/8
236752	91637	TYPE MFF1/8	296509	09423	FB100
236851	91637	TYPE MFF1/8	309450	15818	TD333379
245373	91637	TYPE MFF1/8	309617	31718	FLV102
256339	28480	5082-2900	309666	11236	360T202A
260331	91637	TYPE MFF1/8	309674	11236	360T103A
266494	32539	TYPE TS-10	309716	91637	TYPE MFF1/8
267393	91637	TYPE MFF1/8	309724	91637	TYPE MFF1/8
267617	00779	85863-5	309732	91637	TYPE MFF1/8
268789	91637	TYPE MFF1/8	309757	91637	TYPE MFF1/8
271338	56289	150DX5020A2	310466	01281	X4630W27
271353	91637	TYPE MFF1/8	310474	01281	X463UW33351
271502	12040	LM301A	310482	01281	X4630W15051
275552	32767	820-65	310490	14655	CD19F622J

MANUFACTURERS' CROSS REFERENCE LIST

FLUKE STOCK NO.	MFR.	MFR. PART NO.	FLUKE STOCK NO.	MFR.	MFR. PART NO.
310508	91637	TYPE MFF1/8			
310524	91637	TYPE MFF1/8			
312173	91637	TYPE MFF1/8			
312181	91637	TYPE MFF1/8			
312207	91637	TYPE MFF1/8			
312215	91637	TYPE MFF1/8			
312223	91637	TYPE MFF1/8			
313262	01281	X4630W10091			

Section 6

Option & Accessory Information

6-1. INTRODUCTION

6-2. This section of the manual contains information pertaining to the accessories and options available for your instrument.

6-3. ACCESSORY INFORMATION

6-4. The accessory information, if applicable, will contain details concerning accessories that may be used with this particular instrument.

6-5. OPTION INFORMATION

6-6. Option descriptions contain applicable field installation procedures.

Accessory Rack Mounting Fixtures

6-1. INTRODUCTION

6-2. The FLUKE quarter-rack instruments can be installed in a 19 inch equipment rack in various combinations and in conjunction with other FLUKE half-rack instruments. Figure 6-1 shows various mounting configurations.

6-3. Instructions for attaching rack mounting brackets are given in Figure 6-2. Figure 6-3 gives instructions for dual, triple, quadruple rack mounting. Instructions for combining quarter-rack with half-rack instruments are given in Figure 6-4.

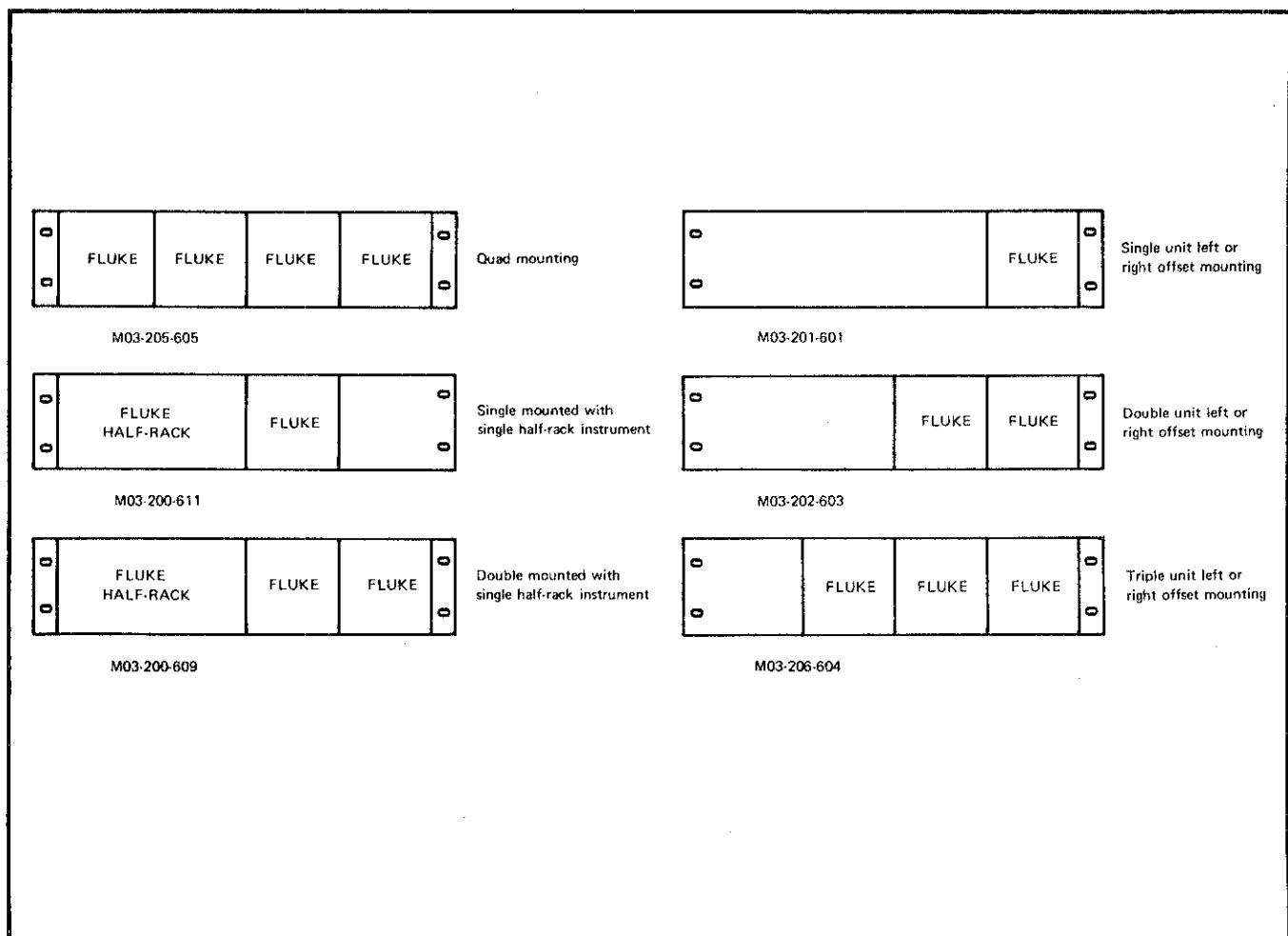
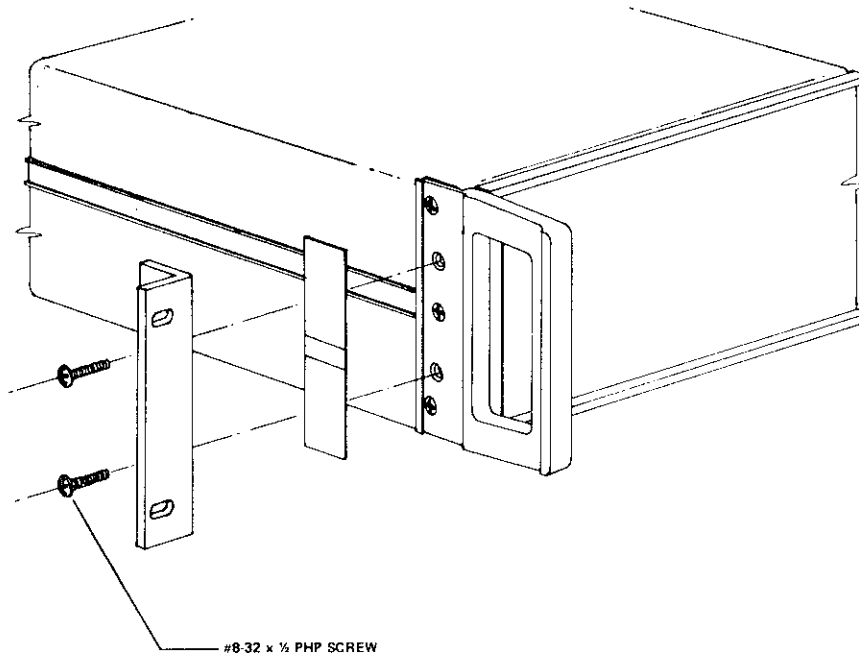


Figure 6-1. RACK MOUNTING CONFIGURATIONS

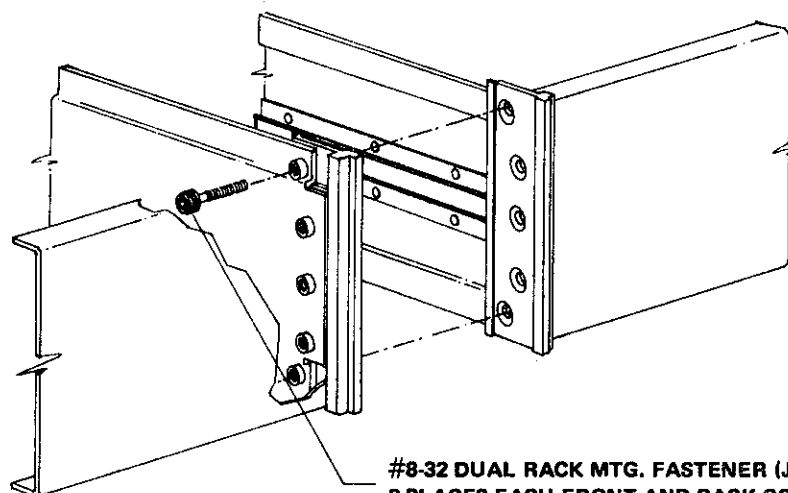
RACK MOUNTING PROCEDURE FOR MODULAR SERIES INSTRUMENTS



1. REMOVE THE FOUR MOLDED FEET AND BAIL FROM BOTTOM COVER.
2. REMOVE THE NAMEPLATE DECALS FROM THE FRONT CORNERS.
3. REMOVE THE SCREWS FROM CORNERS WHICH MATCH HOLE PATTERNS IN RACK MOUNTING EARS.
4. ATTACH RACK MOUNTING EARS WITH PAN HEAD SCREWS (ENCLOSED).

Figure 6-2. RACK EAR INSTALLATION

DUAL, TRIPLE & QUAD MOUNTING FOR MODULAR SERIES INSTRUMENTS



#8-32 DUAL RACK MTG. FASTENER (J.F. #309708)
2 PLACES EACH FRONT AND BACK CORNERS.

FLUKE PART NO.	DESCRIPTION	QUANTITY		
		DUAL RACK KIT #304816 #304808 #304782 #304360	TRIPLE RACK KIT #308130	QUAD RACK KIT #304980
#309708	DUAL RACK MTG. FASTENER	4	8	12

1. REMOVE TOP & BOTTOM COVERS FROM BOTH INSTRUMENTS.
2. REMOVE NAMEPLATE DECALS FROM CORNERS.
3. REMOVE TOP & BOTTOM SCREWS FROM BOTH FRONT & REAR CORNERS ON THE MATING SIDE OF THE INSTRUMENTS.
4. INSERT NO. 8-32 DUAL MOUNTING FASTENER, THROUGH THE P-NUTS IN BOTH FRONT & REAR CORNERS.
5. REMOVE FEET FROM BOTTOM COVERS AND REPLACE TOP & BOTTOM COVERS.

Figure 6-3. DUAL, TRIPLE AND QUAD MOUNT

Not available at this printing

Option -01

Rechargeable Battery Pack

OPTION -01 RECHARGEABLE BATTERY PACK

INTRODUCTION

6-2. The Rechargeable Battery Pack shown in Figure 6-1 is installed as the -01 Option. It provides at least 16 hours of continuous operation in the absence of line power. The battery is automatically recharged during line operation.

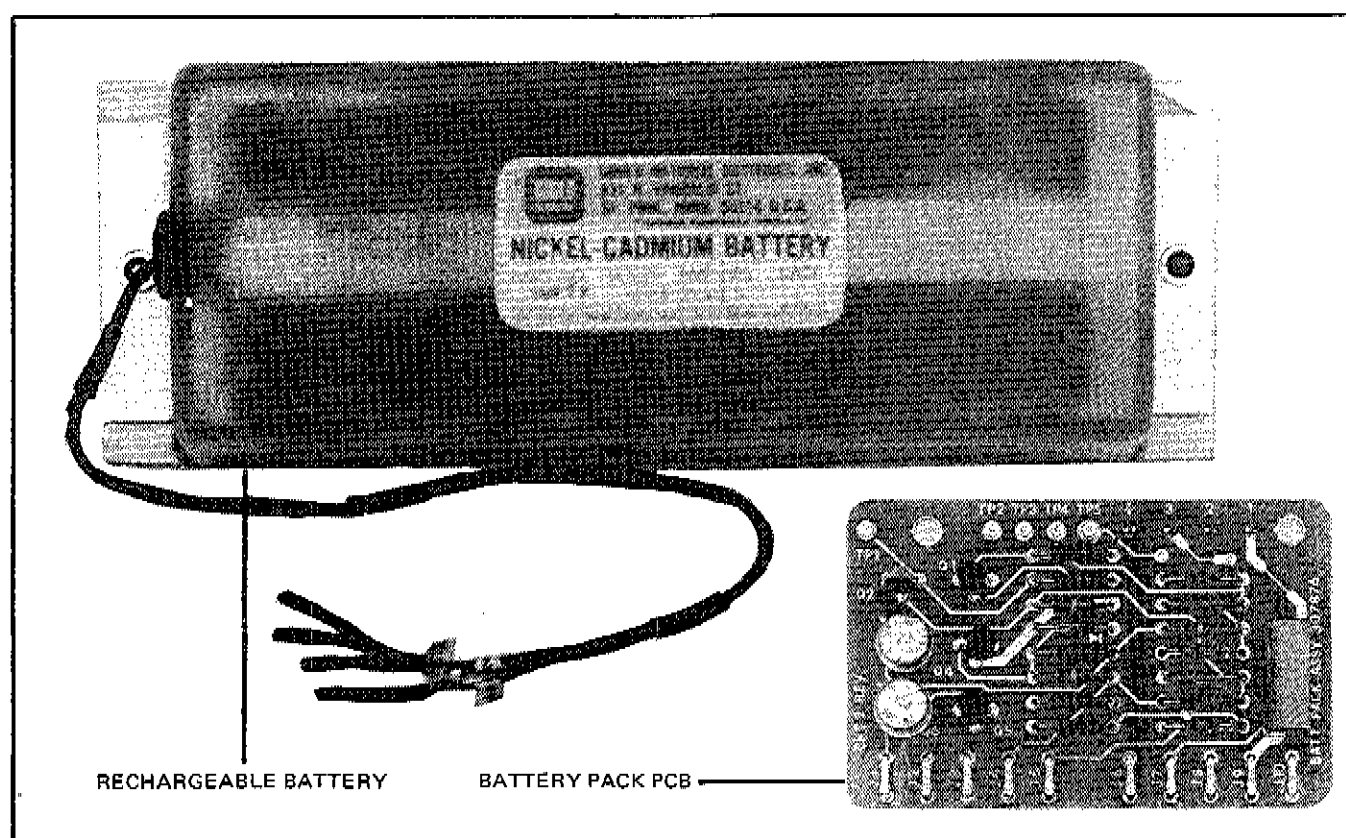


Figure 6-1. 510A-01K BATTERY PACK

6-3. INSTALLATION

6-4. The Rechargeable Battery Pack can be ordered installed at the factory during manufacture by requesting the -01 Option. Field installation of this option is also possible at any time. The field installation kit can be obtained by ordering FLUKE KIT 510A-01K. Installation is as follows:

- a. Turn off the Model 510A and disconnect the power cord.
- b. Remove the bottom dust cover.
- c. Install the Battery Pack (BT1, BT2) on the bottom dust cover as shown in Figure 6-2.

- d. Install the Battery Pack PCB in the position shown in Figure 6-2. Ensure that the mating connectors are correctly aligned during installation.
- e. Connect the four (4) Battery Pack wires to the Battery Pack PCB. Each wire is labeled with a number which corresponds to a connector on the PCB.
- f. Install the bottom dust cover.

NOTE!

Operating instructions, theory of operation maintenance, and parts list are located in the Model 510A Instruction Manual.

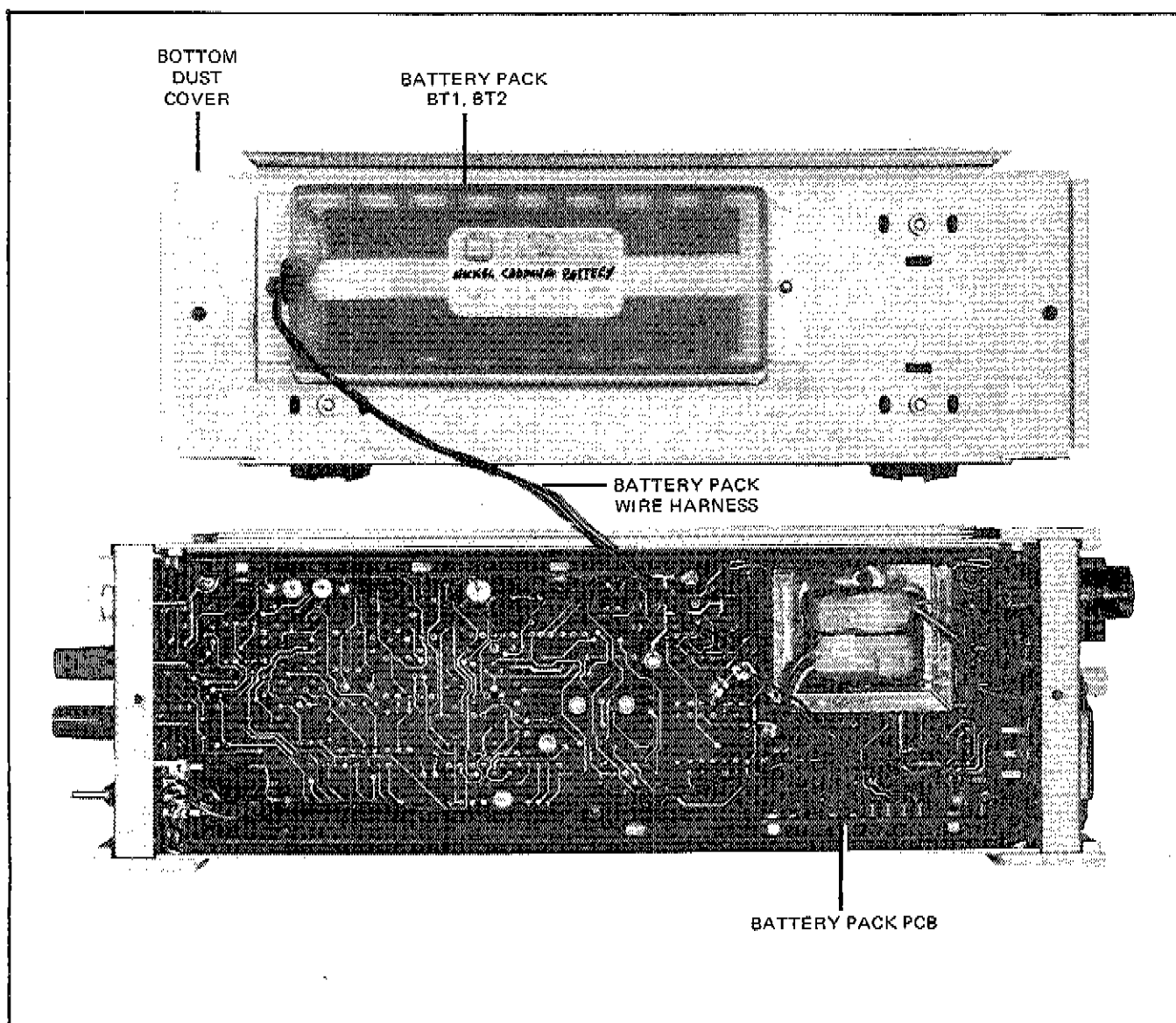


Figure 6-2. BATTERY PACK KIT LOCATIONS

Appendix A

Federal Supply Code for Manufacturers

A-1. CODE TO NAME

A-2. The following five digit code numbers are listed in numerical sequence along with the manufacturer's

name and address to which the code has been assigned. The Federal Supply Code has been taken from Cataloging Handbook H 4-2, Code to Name.

00213	Sage Electronics Corp. Rochester, New York	03877	Transitron Electronic Corp. Wakefield, Massachusetts	05397	Union Carbide Corp. Electronics Div. New York, New York	07263	Fairchild Semiconductor Div. of Fairchild Camera & Instrument Corp. Mountain View, California
00327	Welwyn International, Inc. Westlake, Ohio	03888	Pyrofilm Resistor Co., Inc. Cedar Knolls, New Jersey	05571	Sprague Electric Co. Pacific Div. Los Angeles, California	07344	Bircher Co., Inc. Rochester, New York
00656	Aerovox Corp. New Bedford, Massachusetts	03911	Clairex Corp. New York, New York	05704	Alav, Inc. Glendale, California	07792	Lorma Engineering Corp. Northampton, Massachusetts
00686	Film Capacitors Passaic, New Jersey	03980	Muirhead Instruments, Inc. Mountainide, New Jersey	05820	Wakefield Engineering Ind. Wakefield, Massachusetts	07910	Teledyne Corp. (Continental Device) Hawthorne, California
00779	AMP Inc. Harrisburg, Pennsylvania	04009	Arrow Hart and Hegemon Electronic Company Hartford, Connecticut	06001	General Electric Company Capacitor Department Irmo, South Carolina	08225	Industro Transistor Corp. Long Island City, New York
01121	Allen-Bradley Co. Milwaukee, Wisconsin	04062	Replaced by 72136	06136	Replaced by 63743	08530	Reliance Mica Corp. Brooklyn, New York
01281	TRW Semiconductors Lawndale, California	04202	Replaced by 81312	06473	Amphenol Space & Missile Sys. Chatsworth, California	08792	Discontinued
01295	Texas Instruments, Inc. Semiconductor Components Div. Dallas, Texas	04217	Essex Wire Corp. Wire & Cable Div. Anaheim, California	06555	Beebe Electrical Instrument Co. Pensacola, New Hampshire	08806	General Electric Co. Miniature Lamp Dept. Cleveland, Ohio
01686	RCL Electronics Inc. Manchester, New Hampshire	04221	Aemco, Div. of Midtex Inc. Mankato, Minnesota	06739	Electron Corp. Littleton, Colorado	08863	Nylomatic Corp. Norrisville, Pennsylvania
01730	Deleted	04222	Aerovox Corp. (H-Q) Myrtle Beach, South Carolina	06743	Clevite Corp. Cleveland, Ohio	08988	Skottic Electronics Inc. Archbald, Pennsylvania
01884	Dearborn Electronics Inc. Orlando, Florida	04645	Replaced by 75376	06751	Semcor Div. Components Phoenix, Arizona	09353	C and K Components Watertown, Massachusetts
02114	Ferroxcube Corp. Saugerties, New York	04713	Motorola Semiconductor Products Inc. Phoenix, Arizona	06860	Gould National Batteries Inc. City of Industry, California	09423	Scientific Components, Inc. Santa Barbara, California
02606	Replaced by 15801	05082	Replaced by 94154	06980	Varian	09922	Burndy Corp. Norwalk, Connecticut
02660	Amphenol-Dorg Elect. Corp. Broadview, Illinois	05236	Jonathan Mfg. Co. Fullerton, California	06980	Varian-Elmac San Carlos, California	11236	CTS of Berne Berne, Indiana
02799	Arco Capacitors, Inc. Torrence, California	05277	Westinghouse Electric Corp. Semiconductor Dept. Youngwood, Pennsylvania	07115	Replaced by 14674	11237	Chicago Telephone of Calif., Inc. (CTC) Paso Robles, California
03508	General Electric Co. Semiconductor Products Syracuse, New York	05278	Replaced by 43543	07138	Westinghouse Electric Corp., Electronic Tube Division Elmira, New York	11358	Discontinued
03614	Replaced by 71400	05397	Union Carbide Corp. Electronics Div. Cleveland, Ohio	07256	Silicon Transistor Corp. Garden City, New York	11403	Best Products Co. Chicago, Illinois
03651	Replaced by 44655	05279	Southwest Machine & Plastic Co. Los Angeles, California				

11503	Keystone Mfg. Div. of Avis Industrial Corp. Warren, Michigan	15909	Replaced by 12870	28478	Detroit Controls Corp. Milwaukee, Wisconsin	66150	Window Tele-Tronics Inc. Asbury Park, New Jersey
11726	Qualidyne Corp. Santa Clara, California	16299	Corning Glass Raleigh, North Carolina	28480	Hewlett Packard Co. Palo Alto, California	70563	Amperic Company Union City, New Jersey
12014	Chicago River & Machine Co. Bellwood, Illinois	16332	Replaced by 28478			70903	Belden Mfg. Co. Chicago, Illinois
12040	National Semiconductor Corp. Danbury, Connecticut	16473	Cambridge Scientific Ind. Inc. Cambridge, Maryland	28520	Heyman Mfg. Co. Kenilworth, New Jersey	71002	Blanchard Radio Co., Inc. New York, New York
12060	Diodex, Inc. Chatsworth, California	16742	Paramount Plastics Downey, California	29083	Monsanto, Co., Inc. Santa Clara, California	71236	"ELEMCO" Williamantic, Connecticut
12136	Philadelphia Handle Co. Camden, New Jersey	16758	Delco Radio Div. of General Motors Kokomo, Indiana	30323	Illinois Tool Works, Inc. Chicago, Illinois	71400	Bussmann Mfg. Div. of McGraw - Edison Co. Saint Louis, Missouri
12223	Presin Co., Inc. Shelton, Connecticut	17069	Circuit Structures Lab. Upland, California	32539	Mura Corp. Great Neck, New York	71450	CTS Corp. Elkhart, Indiana
12327	Freeway Washer & Stamping Co. Cleveland, Ohio	17856	Siliconix, Inc. Sunnyvale, California	32767	Griffith Plastic Products Co. Burlingame, California	71468	ITT Cannon Electric Inc. Los Angeles, California
12400	Replaced by 75042	17870	Daven-Div of Thomas A. Edison Ind. - McGraw - Edison Co. Manchester, New Hampshire	32879	Advanced Mechanical Components Northridge, California	71482	Clare, C. P. & Co. Chicago, Illinois
12617	Hamlin Inc. Lake Mills, Wisconsin	18083	Deleted	32897	Eric Technological Products, Incorporated Frequency Control Div. Carlisle, Pennsylvania	71590	Centralab Div. of Globe Union Inc. Milwaukee, Wisconsin
12697	Clorostat Mfg. Co. Dover, New Hampshire	18178	Vactec Inc. Maryland Heights, Missouri	33173	General Electric Co., Tube Dept. Owensboro, Kentucky	71707	Coto Coil Co., Inc. Providence, Rhode Island
12749	James Electronics Chicago, Illinois	18612	Vishay Intertechnology Inc. Malvern, Pennsylvania	34333	Silicon General Westminster, California	71744	Chicago Miniature Lamp Works Chicago, Illinois
12856	Micrometals Sierra Madre, California	18736	Voltronics Corp. Hanover, New Jersey			71785	Cinch Mfg. Co. & Howard B. Jones Div. Chicago, Illinois
12954	Dickson Electronics Corp. Scottsdale, Arizona	19429	Discontinued, use 89536	34335	Advanced Micro Devices. Sunnyvale, California	72005	Driver, Wilber B., Co. Newark, New Jersey
12969	Unitrode Corp. Watertown, Massachusetts	19451	Perine Machinery & Supply Co. Seattle, Washington	37942	Mallory, P. R. & Co., Inc. Indianapolis, Indiana	72092	Replaced by 06980
13103	Thermalloy Co. Dallas, Texas	19701	Electra Mfg. Co. Independence, Kansas	42498	National Company Melrose, Massachusetts	72136	Electro Motive Mfg. Co. Williamantic, Connecticut
13511	Amphenol Corp. Los Gatos, California	20584	Enochs Mfg. Co. Indianapolis, Indiana	43543	Nytronics Inc. Transformer Co. Div. Alpha, New Jersey	72259	Nytronics Inc. Berkeley Heights, New Jersey
13606	Sprague Electric Co. Transistor Div. Concord, New Hampshire	20891	Self-Organizing Systems. Inc. Dallas, Texas	44655	Ohmite Mfg. Co. Skokie, Illinois	72354	Deleted
13839	Replaced by 23732	22767	ITT Semiconductors Div. of ITT Palo Alto, California	49671	Radio Corp. of America New York, New York	72619	Dialight Corp. Brooklyn, New York
14099	Semtech Corp. Newbury Park, California	23732	Tracor Rockville, Maryland	49956	Raytheon Company Lexington, Maine	72653	G. C. Electronics Rockford, Illinois
14193	California Resistor Corp. Santa Monica, California	23880	Stanford Applied Engrng. Santa Clara, California	53021	Sanamo Electric Co. Springfield, Illinois	72665	Replaced by 90303
14298	American Components, Inc. Crimmshocken, Pennsylvania	24248	Southco Div. of South Chester Corp. Lester, Pennsylvania	55026	Simpson Electric Company Chicago, Illinois	72794	Dryas Fastener Co., Inc. West Islip, New York
14655	Cornell-Dublier Electronics Newark, New Jersey	24655	General Radio Co. West Concord, Massachusetts	56289	Sprague Electric Co. North Adams, Massachusetts	72928	Gudeman Co. (Gulton Industries) Chicago, Illinois
14674	Discontinued, use 16299	24759	Lenox-Tuple Electronics Plainfield, New Jersey	58474	Superior Electric Co. Bristol, Connecticut	72982	Eric Tech. Products Inc. Eric, Pennsylvania
14752	Electro Tube Inc. San Gabriel, California	25403	Amperex Electronic Corp. Semiconductor & Receiving Tube Division Slatersville, Rhode Island	60399	Torrington Mfg. Co. Torrington, Connecticut	73138	Beckman Instruments Inc. Helipot Division Fullerton, California
14869	Replaced by 96853	27014	National Semiconductor Corp. Santa Clara, California	62460	Deleted	73293	Hughes Aircraft Co. Electron Dynamics Div. Torrence, California
15636	Electrol Inc. Northridge, California	27264	Moley Products Downers Grove, Illinois	63743	Ward Leonard Electric Co. Mount Vernon, New York	73445	Amperex Electronic Corp. Hicksville, New York
15801	Tenwal Electronics Inc. Framingham, Massachusetts	28435	Bohannon Industries Fort Worth, Texas	64831	West Mfg. Co. San Francisco, California	73559	Carling Electric Inc. Hartford, Connecticut
15818	Amelen Semiconductor Div. of Teledyne Inc. Mountain View, California			65092	Weston Instruments Inc. Newark, New Jersey	73586	Circle Industries Trenton, New Jersey
15849	USECO, Inc. Mt. Vernon, New York					73734	Federal Screw Products, Inc. Chicago, Illinois
15898	International Business Machines (IBM) Essex Junction, Vermont						

73743	Fischer Special Mfg. Co. Cincinnati, Ohio	80145	API Instruments Co. Chesterland, Ohio	86684	Radio Corp. of America Electronic Components & Devices Harrison, New Jersey	95263	Leecraft Mfg. Co. Long Island City, New York
73899	JFD Electronics Co. Brooklyn, New York	80183	Sprague Products North Adams, Massachusetts	86689	Deleted	95264	Replaced by 98278
73949	Guardian Electric Mfg. Co. Chicago, Illinois	80294	Bourns Inc. Riverside, California	87034	Marco-Oak Inc. Anaheim, California	95275	Vitramon Inc. Bridgeport, Connecticut
74199	Quam Nichols Co. Chicago, Illinois	80583	Hammarlund Co., Inc. Mays Hill, North Carolina	88245	Litton Products Inc. Van Nuys, California	95303	Radio Corp. of America Solid State & Receiving Tube Div. Cincinnati, Ohio
74217	Radio Switch Corp. Marlboro, New Jersey	80640	Stevens, Arnold Inc. Boston, Massachusetts	88419	Use 14655	95354	Methode Mfg. Corp. Rolling Meadows, Illinois
74276	Signalite Inc. Neptune, New Jersey	81073	Gra, Bill Inc. La Grange, Illinois	88690	Replaced by 04217	95712	Dage Electric Co., Inc. Franklin, Indiana
74306	Piezo Crystal Co. Carlisle, Pennsylvania	81590	Korby Mfg. Co. Seattle, Washington	89536	Fluke, John Mfg. Co., Inc. Seattle, Washington	95987	Weekender Co., Inc. Chicago, Illinois
74542	Hoyt Elect. Instr. Works Pewaukee, New Hampshire	81312	Winchester Electronics Div. of Litton Industries Oakville, Connecticut	89730	Replaced by 08806	96733	San Fernando Electric Mfg. Co. San Fernando, California
74970	Johnson, E. F., Co. Waseca, Minnesota	81439	Therm-O-Disc Inc. Mansfield, Ohio	90215	Best Stump & Mfg. Co. Kansas City, Missouri	96853	Rustrak Instrument Co. Manchester, New Hampshire
75042	IRC Inc. (Div. of TRW) Philadelphia, Pennsylvania	81483	International Rectifier Corp. Los Angeles, California	90211	Square D Co. Chicago, Illinois	96881	Thomson Industries, Inc. Manhasset, New York
75376	Kure-Kaseh, Inc. Dayton, Ohio	82376	Deleted	90303	Mallory Battery Co. Tarrytown, New York	97540	Master Mobile Mounts Div. of Whitehall Electronics Corp. Los Angeles, California
75382	Kulka Electric Corp. Mount Vernon, New York	82389	Switchcraft Inc. Chicago, Illinois	91293	Johanson Mfg. Co. Brenton, New Jersey	97913	Industrial Electronic Hardware Corp. New York, New York
75915	Littlefuse Inc. Des Plaines, Illinois	82415	Price Electric Corp. Frederick, Maryland	91407	Replaced by 58474	97945	White, S. S. Co. Plastics Div. New York, New York
76854	Oak Mfg. Co. Crystal Lake, Illinois	82872	Ronanwell Corp. New York, New York	91502	Associated Machine Santa Clara, California	97966	Replaced by 11358
77342	Potter & Brumfield Div. of Amer. Machine & Foundry Princeton, Indiana	82877	Rotron Mfg. Co., Inc. Woodstock, New York	91637	Dale Electronics Inc. Columbus, Nebraska	98094	Replaced by 49956
77969	Rubbercraft Corp. of Calif. LTD. Torrance, California	82879	ITT Wire & Cable Div. Pawtucket, Rhode Island	91662	Elec Corp. Willow Grove, Pennsylvania	98159	Rubber-Teck, Inc. Gardena, California
78189	Shakeproof Div. of Illinois Tool Works Elgin, Illinois	83003	Varo Inc. Garland, Texas	91737	Gremar Mfg. Co., Inc. (ITT) Woburn, Massachusetts	98278	Microdot Inc. Pasadena, California
78277	Sigma Instruments, Inc. South Braintree, Massachusetts	83298	Bendix Corp. Electric Power Division Eatontown, New Jersey	91802	Industrial Devices, Inc. Edgewater, New Jersey	98291	Sealectro Corp. Conhex Div. Mamaroneck, New York
78488	Stackpole Carbon Co. Saint Marys, Pennsylvania	83330	Smith, Herman H., Inc. Brooklyn, New York	91836	King's Electronics Tuckahoe, New York	98388	Accurate Rubber & Plastics Culver City, California
78553	Tinnerman Products Cleveland, Ohio	83478	Rubbercraft Corp. of America New Haven, Connecticut	91929	Honeywell Inc. Micro Switch Div. Freeport, Illinois	98743	Replaced by 12749
79136	Waldex Kolmogor Inc. Long Island City, New York	83594	Burroughs Corp. Electronic Components Div. Plainfield, New Jersey	91934	Miller Electric Co., Inc. Pawtucket, Rhode Island	98925	Deleted
79497	Western Rubber Company Goshen, Indiana	83740	Union Carbide Corp. Consumer Products Div. New York, New York	93332	Sylvania Electric Products Semiconductor Products Div. Woburn, Massachusetts	99120	Plastic Capacitors, Inc. Chicago, Illinois
79963	Zierick Mfg. Corp. New Rochelle, New York	84171	Arco Electronics, Inc. Great Neck, New York	94145	Replaced by 49956	99217	Southern Electronics Corp. Burbank, California
80031	Mopco Div. of Sessions Clock Co. Morristown, New Jersey	84411	TRW Omaha, Nebraska	94154	Tung-Sol Div. of Wagner Electric Corp. Newark, New Jersey	99515	Marshall Industries Capacitor Div. Monrovia, California
		86577	Precision Metal Products Stoneham, Massachusetts	95146	Alco Electronics Products Inc. Lawrence, Massachusetts	99779	Barnes Corp. Lansdowne, Pennsylvania

Appendix B

List of Abbreviations

A, amp	ampere(s) (2.1A, 2.1 amp)	met film	metal film
ampl	amplifier	MOS	metal oxide silicon
ac	alternating current	μ	micro or 10^{-6} (60 μ V)
assy	assembly	m	milli or 10^{-3}
@	at	mA	milliampere(s)
BCD	binary coded decimal	mm	millimeter
cap	capacitor	n	nano or 10^{-9}
cm	centimeter	neg	negative
C	clear; reset	Ω	ohm
$^{\circ}$ C	celsius or centigrade (0° C)	scope	oscilloscope
cer	ceramic	ppm	parts per million
clk	clock	prv	peak inverse voltage
cw	clockwise	p-p	peak to peak
CMRR	common mode rejection ratio	p	pico or 10^{-12} (300pF)
cbn cmpsn	carbon composition	plstc	plastic
ccw	counterclockwise	$\pm$	plus or minus
conn	connector	pos	positive
cbn film	carbon film	pps	pulses per second
CRT	cathode ray tube	PCB	printed circuit board
cps	cycles per second (Hz preferred)	QTY	quantity
db	decibel	rf	radio frequency
dep cbn	deposited carbon	rfi	radio frequency interference
dvm	digital voltmeter	RECM	recommended
dio	diode	REF	reference
dc	direct current	RH	relative humidity
dpdt	double-pole, double-throw	res	resistor
dpst	double-pole, single-throw	rms	root mean square
elctit	electrolytic	rtry	rotary
elek	electronic (equip.)	s	second
elox	electronics (science)	sect	section
ext	external	SERNO	serial number
$^{\circ}$ F	fahrenheit (32° F)	Si	silicon
F	farad	scr	semiconductor controlled rectifier
FET	field effect transistor	spdt	single-pole, double-throw
Ge	germanium	spst	single-pole, single-throw
g	giga or 10^9	sw	switch
G	gravity	Ta	tantalum
gnd	ground	TC	temperature coefficient
gmV	guaranteed minimum value	t	tera or 10^{12}
gd	guard	xfmr	transformer
h	henry	xstr	transistor
Hz	Hertz (60Hz, 60gHz, 60 gigahertz)	tvm	transistor voltmeter
hf	high frequency	uhf	ultra high frequency
"	inch(es) (6 3/4" or 0.575 feet)	vtvm	vacuum tube voltmeter
IC	integrated circuit	var	variable
if	intermediate frequency	vs	versus
intl	internal	vhf	very high frequency
kc	kilocycle (kilohertz preferred)	vlf	very low frequency
k	kilo or 10^3	V	volt (115Vac)
lf	low frequency	VCO	voltage controlled oscillator
mc	megacycle (megahertz preferred)	w	watt
M	meg or mega or 10^6	ww	wire wound
met	metal		

Appendix C

Sales Representatives

ALABAMA

HUNTSVILLE
BSC Associates, Inc.
3322 S. Memorial Parkway
P.O. Box 1273
Tel. (205) 881-6220
Zip 35807

ALASKA

SEATTLE
Showalter-Judd, Inc.
1806 S. Bush Place
Seattle, Washington 98144
Tel. (206) 324-7911

ARIZONA

PHOENIX
Barnhill Associates
537 E. Osborn Road, Suite 4
Tel. (602) 263-1250
Zip 85012

CALIFORNIA

LOS ANGELES
Instrument Specialists, Inc.
1109 S. Central Ave.
Glendale, California 91204
Tel. (213) 245-9404

SANTA CLARA

Instrument Specialists, Inc.
2359 De La Cruz Blvd.
Tel. (408) 244-1505
Zip 95050

SAN DIEGO

Instrument Specialists, Inc.
1909 State St.
Tel. (714) 232-2017
Zip 92101

COLORADO

DENVER
Barnhill Associates
1170 S. Sheridan Blvd.
Tel. (303) 934-5505
Zip 80226

CONNECTICUT

HARTFORD
Instrument Representatives, Inc.
P. O. Box 165
Glastonbury, Connecticut 06033
Tel. (203) 633-0777

FLORIDA

ORLANDO
BCS Associates, Inc.
940 N. Fern Creek Ave.
P.O. Box 6578
Tel. (305) 843-1510
Zip 32803

GEORGIA

ATLANTA
BCS Associates, Inc.
1230 Briar Hill Dr.
Tel. (404) 874-9925
Zip 30306

HAWAII

HONOLULU
Industrial Electronics, Inc.
646 Queen Street
P.O. Box 135
Tel. (808) 533-6095
Zip 96817

ILLINOIS

CHICAGO
Cozzens & Cudahy, Inc.
9501 W. Devon Ave.
Rosemont, Illinois 60018
Tel. (312) 825-1144

INDIANA

INDIANAPOLIS
Cozzens & Cudahy, Inc.
Port O'Call Executive Ctr.
21 Beachway Drive
Tel. (317) 244-2456
Zip 46234

MARYLAND

BALTIMORE
Electronic Marketing Assoc. Inc.
11501 Huff Court
Kensington, Maryland 20795
Tel. (301) 881-5300, 744-7700

MASSACHUSETTS

BOSTON
Instrument Representatives, Inc.
1046 Massachusetts Avenue
Arlington, Massachusetts 02174
Tel. (617) 646-1034

MICHIGAN

DETROIT
WKM Associates, Inc.
1474 East Outer Dr.
Tel. (313) 892-2500
Zip 48234

MINNESOTA

MINNEAPOLIS
Cozzens & Cudahy, Inc.
7450 France Ave. So.
Tel. (612) 920-1022
Zip 55435

MISSOURI

ST. LOUIS
Cozzens & Cudahy, Inc.
P. O. Box 10013
Lambert Field - Zip 63145
Tel. (314) 423-1234

NEW JERSEY

NEWARK
SBM Representatives
1519 Stuyvesant Avenue
Union, New Jersey 07083
Tel. (201) 687-8737

NEW MEXICO

ALBUQUERQUE
Barnhill Associates
1410—D Wyoming N.E.
Tel. (505) 299-7658
Zip 87110

NEW YORK

NEW YORK
SBM Representatives
28 Hobby Street
Pleasantville, N.Y. 10570
Tel. (914) 769-1811

ROCHESTER

SBM Representatives
4515 Culver Rd.
Tel. (716) 226-1400
Zip 14622

NORTH CAROLINA

GREENSBORO
BCS Associates, Inc.
1039 E. Wendover Ave.
P.O. Box 6426
Tel. (919) 273-1918
Zip 27405

OHIO

CLEVELAND
WKM Associates, Inc.
16141 Puritas Ave.
Tel. (216) 267-0445
Zip 44135

DAYTON

WKM Associates, Inc.
6073 Far Hills Ave.
Tel. (513) 434-7500
Zip 45429

OREGON

PORTLAND
Showalter-Judd, Inc.
1445 N. E. Arrington
Hillsboro, Oregon 97123
Tel. (503) 648-6372

PENNSYLVANIA

PHILADELPHIA
Electronic Marketing Assoc.
210 Goddard Blvd.—Suite 100
King of Prussia, Pennsylvania
Tel. (215) 248-5050
Zip 19406

PITTSBURGH

WKM Associates, Inc.
90 Clairton Blvd.
Tel. (412) 892-2953
Zip 15236

TEXAS

DALLAS
Barnhill Associates
Suite 220
312 N. Central Express Wy.
Richardson, Texas 75080
Tel. (214) 231-2573

HOUSTON

Barnhill Associates
Suite 332
3810 Westheimer
Tel. (713) 621-0040
Zip 77027

EASTERN VIRGINIA

WILLIAMSBURG
BCS Associates, Inc.
107 Rich Neck Road
Tel. (703) 229-5108
Zip 23185

WASHINGTON

SEATTLE
Showalter-Judd, Inc.
1806 S. Bush Place
Seattle, Washington 98144
Tel. (206) 324-7911

CANADA

BRITISH COLUMBIA

VANCOUVER
Allan Crawford Associates, Ltd.
1820 Pandora St.
Tel. (604) 253-7136

ONTARIO

MALTON
Allan Crawford Associates, Ltd.
6427 Northam Drive.
Tel. (416) 678-1500

OTTAWA, 3
Allan Crawford Associates, Ltd.
376 Churchill Ave. — Suite 106
Tel. (613) 725-3354

QUEBEC

LONGUEUIL
Allan Crawford Associates, Ltd.
157 (rue) St. Charles Street W.
Tel. (514) 670-1212

INTERNATIONAL REPRESENTATIVES

ARGENTINA Coasin S.A. Virrey del Pino 4071 Buenos Aires, Argentina	GREECE Marios Dalleggio Representations 2 Alopekis Street Athens 19 Greece	MEXICO Moxitek, S.A. Eugenia 408 Departments 1 y 5 Mexico 12, D.F.	SPAIN Rema Leo Haag, S.A. General Sanjurjo 18 Madrid 3, Spain
AUSTRALIA Elmeasco Instruments 7 Chard Road P.O. Box 334 Brookvale, N.S.W. Australia 2100	HONG KONG Gliman & Co. Ltd. P.O. Box 56 Hong Kong	THE NETHERLANDS C.N. Rood N.V. Post Office Box 4542 Rijswijk (Z.H.) 2100 The Netherlands Fluke (Nederland) N.V. Post Office Box 5053 Industrieterrein Noord Tilburg, The Netherlands	SWEDEN Erik Ferner AB Box 56 Snormakarvagen 35 161.26 Stockholm-Bromma Sweden
AUSTRIA Kontron GMBH & Co., Kg. Lederergasse 16 1080 Wien Austria	INDIA Hinditron Services Pvt. Ltd. 69/A Nepean Sea Road Bombay 6, India		SWITZERLAND Kontron Electronic A.G. Hardstrasse 235 P.O. Box 193 8031 Zurich Switzerland
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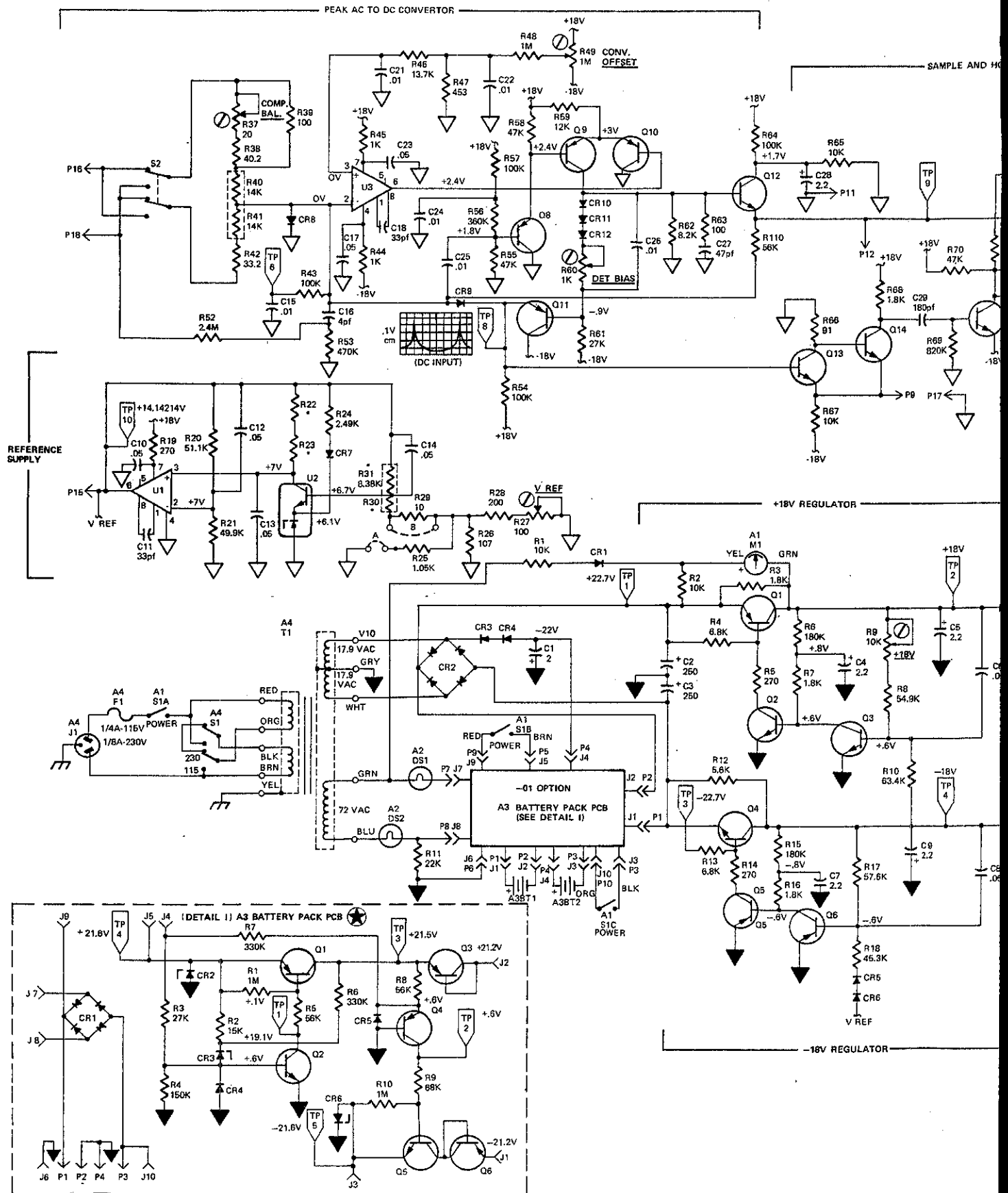
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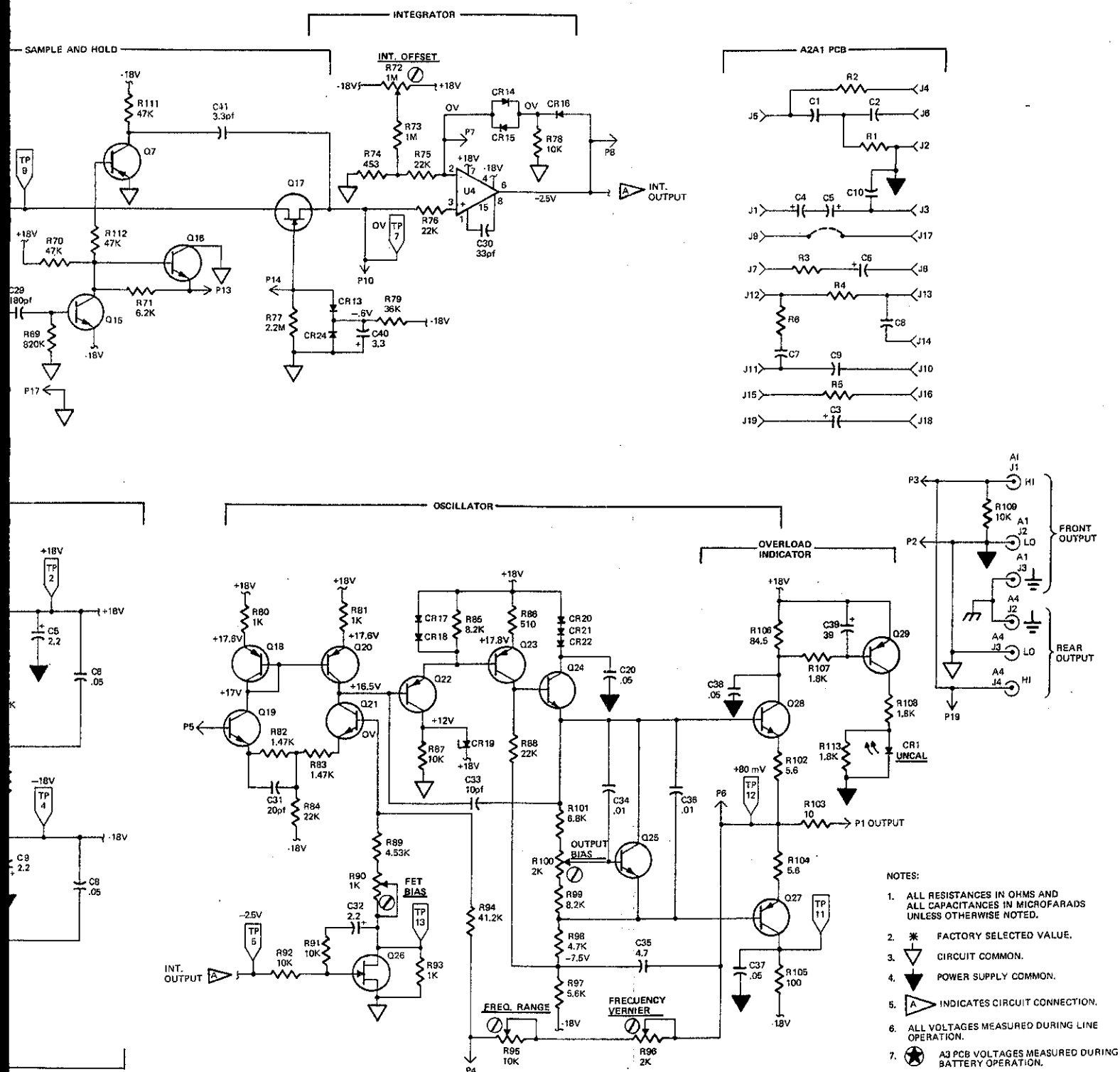
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DWG. 510A-1002
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FUNCTIONAL SCHEMATIC DIAGRAM	
MODEL 510A	
AC REFERENCE STANDARD	
Drawing No. 510A-1002	REV. A
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