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Appendix A

Name and function of each control

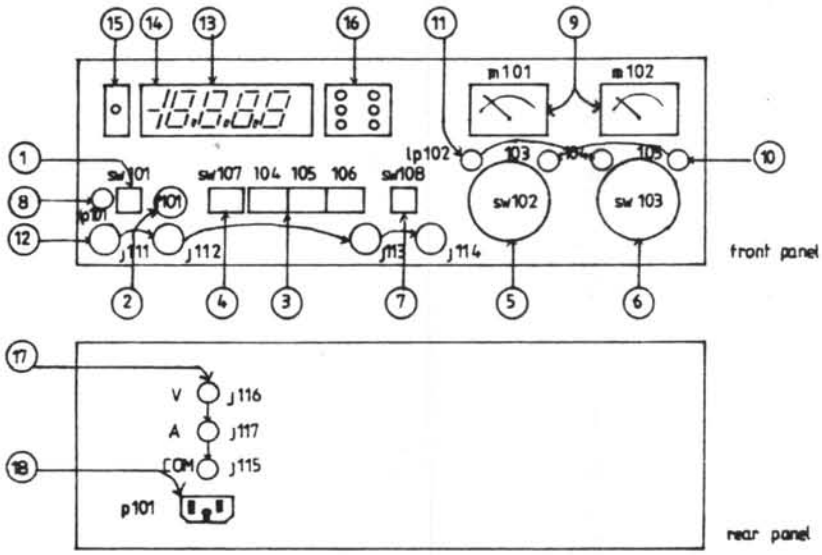


FIG. A-1 Front panel and Rear panel of the digital AC power meter

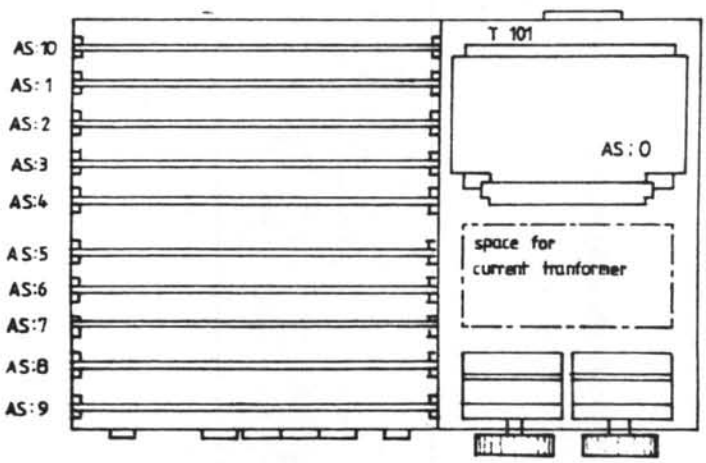


FIG. A-2 Assemblies and parts location

(On front panal)

1. Power switch

   ON-OFF switch. Power can be applied by push the botton toward ON position.

2. Fuse holder

   0.5Ais employed. To remove the fuse for replacement, turn the cap counterclockwise.

3. Function selector

   Function selector consists of push-bottons which select measuring modes of voltage (V), current (A), and single-phase wattage (W). Push any one according to the measuring object. Care must be taken not to simultaneously push two or more selectors.

4. Hold switched

   When depressing the hold switch, measurement stops and the preceding measured value is held. This does not hold the decimal point and unit mark. Hence, if the range is changed under hold selection, the decimal point and unit will also be changed.

5. Voltage range selector

   Voltage range selector is a switch which can select the range of 3/10/30/100/300/600V.

6. Current range selector

   Current range selector is a switch which can select the range of 0.1/0.3/1/3/6/10/30A.

7. Run switch

This is the switch for starting measurement. Normally after power switch is actuated in some seconds, measurement can be performed by depressing this switch.

8. Ready indicator

When this lamp is turned on,it shows that the measurement is ready for use. It always happens after RUN botton is depressed.

9. Input voltage and current level meters

These meters are graduated in percentage of approximate rms value of input voltage and current. Select a correct range until the indicator pointer comes within the green area.

10. Under range indicator

The lamp light and display show zero when rms value of the input voltage or current is lowered to less than 15% of the range. In this case, set the range selector at the next lower range.

Note : The under range lamp does not light in power measurement.

11. Over range indicator

The lamp light comes on when the absolute peak value of the input voltage or current exceeds three times the maximum voltage in the range. It also may light up according to types of input waveform even if the level meter shows within the green area. In this case, set the range selector at the next higher range.

12. Voltage input and current input terminals

By connecting respective wires to voltage and current input terminals, any voltage range from 3 to 600 V and any current range from 0.1 to 30 A can be selected with the range selector. Care should be taken not to misconnect the terminals.

13. Digital display

Display in four and a half digit (19999 maximum)including the decimal point. The decimal point is automatically positioned according to the selection of measuring range.

14. Polarity display

Positive sign "+" is not displayed and negative sign "-" is displayed only in wattage measurement.

15. Alarm display LED

The LED light comes on if the over range or under range indicator lamp lights.

16. Unit display

The unit is displayed in accordance with the operations of the function switch and the range selector.

(On rear panel)

17. AUX input terminals

With the voltage (current) selector set at "AUX" and 1V applied to the AUX input terminals, 100.00 V (10.000 A) is displayed. The terminal is used for checking normal operation.

18. AC power supply connector

Three-pin connector with ground terminal is used for the AC power supply.

Appendix B

Interconnection and wiring list

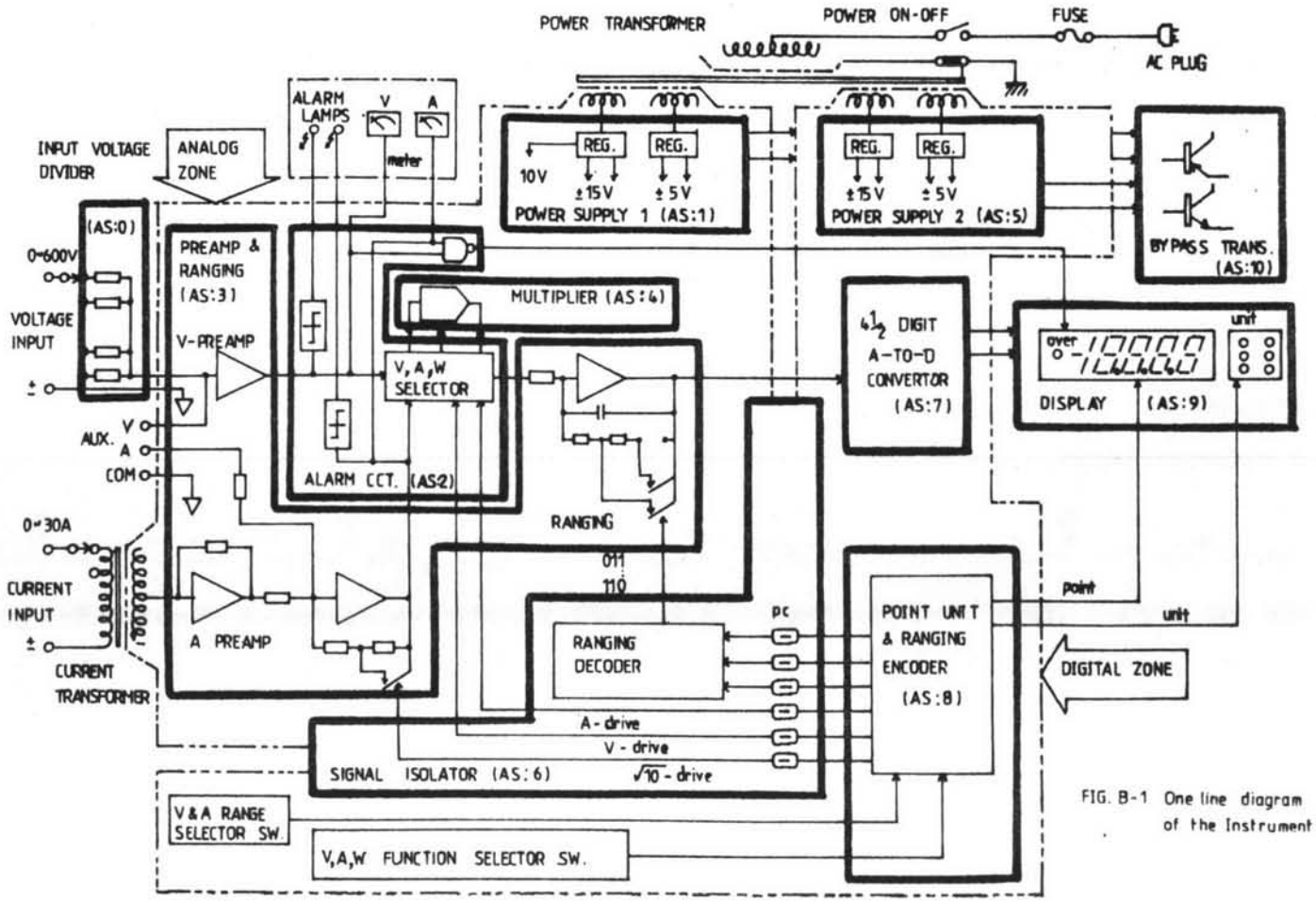


FIG. B-1 One line diagram of the Instrument

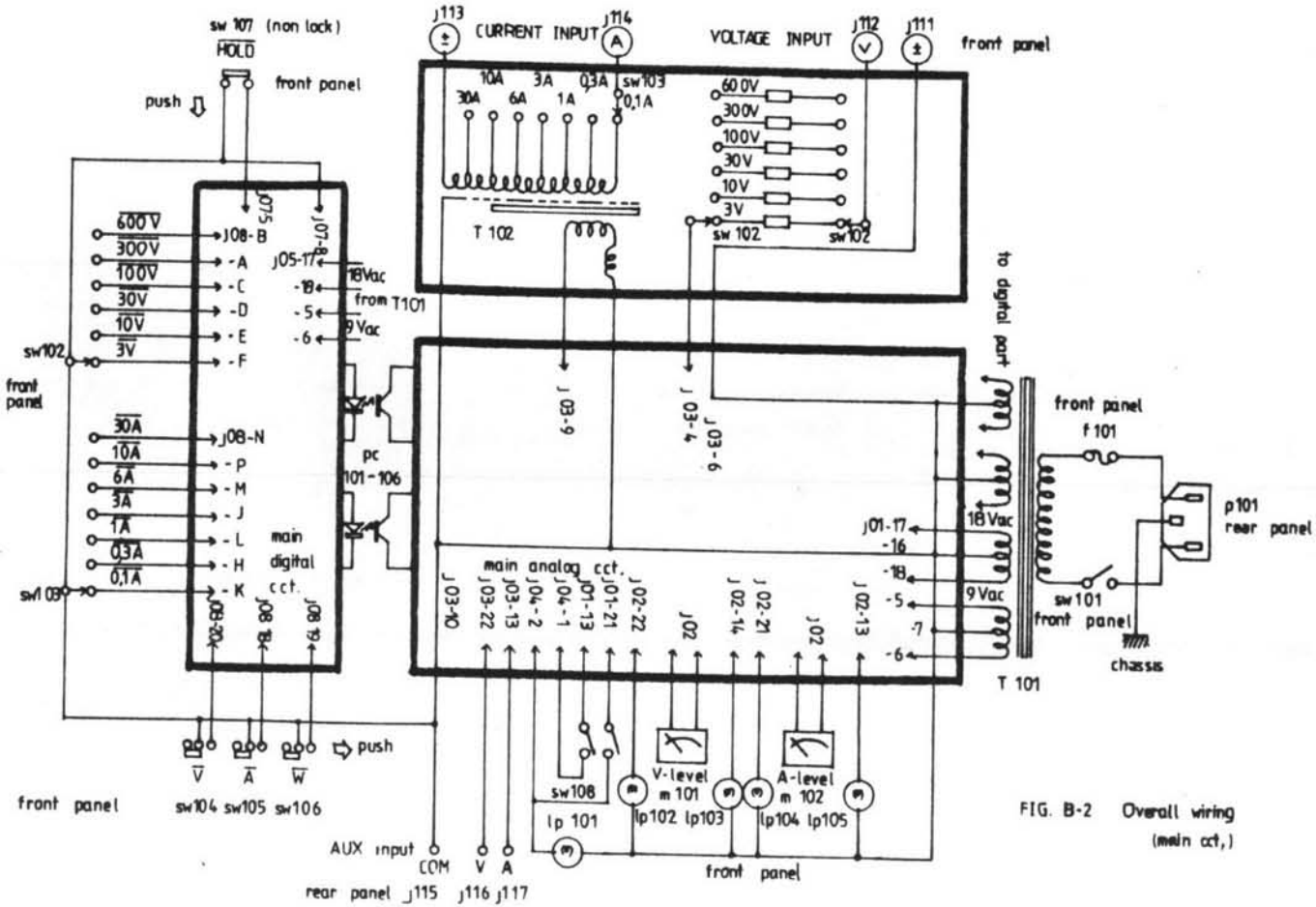


FIG. B-2 Overall wiring (main cct,)

AS:10 J10 PIN NO.	BYPASS TRANSISTOR	CONNECTED TO
1	Q7-E	J05-2
2	Q3-E	J01-2
3	Q3-C	J01-3
4	Q3-B	J01-4
5	Q7-C	J05-3
6	Q7-B	J05-4
7	Q5-C	J05-19
8	-	-
9	Q4-C	J01-9
10	Q4-B	J01-10
11	Q4-E	J01-11
12	Q5-E	J05-22
13	Q2-C	J01-13
14	Q2-B	J01-14
15	Q2-E	J01-15
16	Q6-B	J05-14
17	Q6-E	J05-15
18	Q6-C	J05-13
19	Q1-C	J01-19
20	Q1-B	J01-20
21	Q5-B	J05-20
22	Q1-E	J01-21

AS:1 J1 PIN NO.	POWER SUPPLY-1	CONNECTED TO
1	+5 VDC OUT	J02-19
2	Q3-E	J10-2
3	Q3-C	J10-3
4	Q3-B	J10-4
5	9 VAC IN	T101
6	9 VAC IN	T101
7	AC CENTER TAP	J01-16
8	-5 VDC OUT	J02-20
9	Q4-C	J10-9
10	Q4-B	J10-10
11	Q4-E	J10-11
12	-10 VDC OUT	J04-19
13	-15 VDC OUT (Q2-C)	J10-13
14	Q2-B	J10-14
15	Q2-E	J10-15
16	AC CENTER TAP	J01-7
17	18 VAC IN	T101
18	18 VAC IN	T101
19	Q1-C	J10-19
20	Q1-B	J10-20
21	+15 VDC OUT	J02-11
22	Q1-E	J10-22

AS:2 J02 PIN NO.	V,A,W SELECTOR AND ALARM	CONNECTED TO
1	V-INPUT	J03-5
2	V-OUTPUT (X1)	J04-4
3	A-OUTPUT (Y1)	J04-21
4	A-INPUT	J03-21
5	V-DRIVE	J06-20
6	A-DRIVE	J06-21
7	COM	J01-7
8	COM	701-16
9	$\bar{V}$,$\bar{A}$ OUTPUT (Y2)	J04-22
10	$\bar{V}$,$\bar{A}$ OUTPUT (X2)	J04-7
11	+15 VDC	J01-21
12	-15 VDC	J01-13
13	A-OVER ALARM	LP105
14	V-OVER ALARM	LP103
15	RMS.W OUTPUT	J03-12
16	MULTI OUT	J04-20
17	COM	J01-16
18	ALARM OUT	J09-D
19	+5 VDC	J01-1
20	-5 VDC	J01-8
21	A-UNDER ALARM	LP104
22	V-UNDER ALARM	LP102

AS:3 J03 PIN NO.	PREAMPLIFIER AND RANGING CIRCUIT	CONNECTED TO
1	+15 VDC	J01-21
2	COM	J01-7
3	-15 VDC	J01 13
4	V-INPUT	SW102
5	V-OUTPUT	J02-1
6	COM	J01-7
7	-15 VDC	J01-13
8	+15 VDC	J01-21
9	A-INPUT	SW103
10	COM	J01-7
11	COM	J01-7
12	RMS.W INPUT	J02-15
13	A-AUX. INPUT	J116
14	RANGE OUT	J07-7
15	COM	J01-16
16	$2\sqrt{10}/3$	J06-13
17	4/3	J06-14
18	$\sqrt{10}/3$	J06-15
19	2/3	J06-16
20	$\sqrt{10}$ DRIVE	J06-19
21	A-OUTPUT	J02-4
22	V-AUX.INPUT	J117

AS:4 J04 PIN NO.	MULTIPLIER	CONNECTED TO
1	-15 VDC	J01-13
2	+15 VDC	J01-21
3	+15 VDC	J01-21
4	V-INPUT (X1)	J02-2
5	-	-
6	-	-
7	$\bar{V}$,$\bar{A}$ INPUT (X2)	J02-10
8	-	-
9	-	-
10	-	-
11	-	-
12	-15 VDC	501-13
13	-	-
14	COM	J01-16
15	-	-
16	-	-
17	+5 VDC	J01-1
18	-5 VDC	J01-8
19	-10 VDC	J01-2
20	MULTI OUT	J02-16
21	A-INPUT (Y1)	J02-3
22	$\bar{V}$,$\bar{A}$ INPUT (Y2)	J02-9)

AS:5 J05 PIN NO.	POWER SUPPLY-2	CONNECTED TO
1	+5 VDC OUT	J06-6
2	Q7-E	J10-1
3	Q7-C	J10-5
4	Q7-B	J10-6
5	9 VAC IN	T101
6	9 VAC IN	T101
7	AC CENTER TAP	J01-16
8	-5 VDC OUT	-
9	Q8-C	*
10	Q8-B	*
11	Q8-E	*
12	-	-
13	-15 VDC OUT (Q6-C)	J10-18
14	Q6-B	J10-16
15	Q6-E	J10-17
16	AC ECNTER TAP	T101
17	18 VAC IN	T101
18	18 VAC IN	T101
19	Q5-C	J10-7
20	Q5-B	J10-21
21	+15 VDC OUT	J07-3
22	Q5-E	J10-12

AS:6 J06 PIN NO	SIGNAL ISOLATOR	CONNECTED TO
1	10 DRIVE IN	J08-2
2	+5 VDC	J01-1
3	A-DRIVE IN	J08-14
4	V-DRIVE IN	J08-V
5	COM	J05-7
6	+5 VDC	J05-1
7	$\bar{2}^2$ IN	J08-X
8	$\bar{2}^1$ IN	J08-17
9	$\bar{2}^0$ IN	J08-W
10	COM	J05-16
11	-	-
12	(111)	-
13	2 $\sqrt{10}$/3 (110)	J03-16
14	4/3 (101)	J03-17
15	$\sqrt{10}$/3 (100)	J03-18
16	2/3 (011)	J03-19
17	(010)	-
18	(001)	-
19	$\sqrt{10}$ DRIVE OUT	J03-20
20	V-DRIVE OUT	J02-5
21	A-DRIVE OUT	J02-6
22	-	-

AS:7 J07 PIN NO.	A-TO-D Converter	CONNECTED TO
1	POLARITY (-)	J09-20
2	OVER RANGE	*
3	+15 VDC	J05-21
4	COM	J05-7
5	HOLD/RUN	SW107
6	-15 VDC	J05-13
7	ANALOG INPUT	J03-15
8	COM	J05-7
9	POLARIRY	*
10	CO-5	J09-19
11	CO-1	J09-8
12	CO-2	J09-S
13	CO-3	J09-P
14	CO-4	J09-R
15	f	J09-5
16	g	J09-6
17	a	J09-4
18	b 7-SEGMENT	J09-3
19	c DRIVE OUT	J09-7
20	d	J09-9
21	e	J09-10
22	+5 VDC	J05-1

CONNECTED TO	POINT, UNIT, AND RANGING ENCODER	AS:8 J08 PIN NO.	AS:8 J08 PIN NO	POINT, UNIT, AND RANGING ENCODER	CONNECTED TO
Sw102	300 V	A	1	+5 VDC	J05-1
Sw102	600 V	B	2	$\sqrt{10}$ DRIVE OUT	J06-1
Sw102	100 V	C	3	-	-
Sw102	30 V	D	4	A UNIT OUT	J09-Z
Sw102	10 V	E	5	mW UNIT OUT	J09-W
Sw102	3 V	F	6	-	-
Sw103	0,3 A	H	7	W RMS (-) ERASE	*
Sw103	3 A	J	8	INT V	Sw104
Sw103	0.1 A	K	9	INT W	Sw106
Sw103	1 A	L	10	INT A	Sw105
Sw103	6 A	M	11	W UNIT OUT	J09-V
Sw103	30 A	N	12	kW UNIT OUT	J09-X
Sw103	10 A	P	13	V-DRIVE	J06-4
J05-21	+15 VDC	R	14	A-DRIVE	J06-3
J09-B	DP-1 OUT	S	15	-	-
J09-A	DP-2 OUT	T	16	-	-
J05-1	-5 VDC	U	17	$\overline{2}^2$ OUT	J06-8
J09-U	V-DRIVE (V-UNIT	V	18	-	-
J06-9	$\overline{2}^0$ OUT	W	19	-	-
J06-7	$\overline{2}^2$ OUT	X	20	-	-
J09-Y	mA UNIT OUT	Y	21	-5 VDC	J05-8
J09-C	DP-3 OUT	Z	22	COM	J05-16

CONNECTED TO	DISPLAY	AS:9 J09 PIN NO.	AS:9 J09 PIN NO.	DISPLAY	CONNECTED TO
J08-T	DP-2 IN	A	1	COM	K05-7
J08-S	DP-1 IN	B	2	-	-
J08-Z	DP-3 IN	C	3	b	J07-18
J02-18	ALARM IN	D	4	a	J07-17
-	-	E	5	f (7-SEGMENT DRIVE IN)	J07-15
-	-	F	6	g	J07-16
-	-	H	7	c	J07-19
-	-	J	8	CO-1	J07-11
-	-	K	9	d (7-SEGMENT	J07-20
-	-	L	10	e DRIVE IN)	J07-21
-	-	M	11	-	-
-	-	N	12	-	-
J07-13	CO-3	P	13	-	-
J07-14	CO-4	R	14	-	-
J07-12	CO-2	S	15	-	-
-	-	T	16	-	-
J08-V	V	U	17	-	-
J08-11	W	V	18	-	-
J08-5	mW (UNIT IN)	W	19	CO-5	J07-10
J08-12	kW	X	20	POLARITY (-)	J07-1
J08-Y	mA	Y	21	OVER RANGE	*
J08-4	A	Z	22	+5 VDC	J05-1

Appendix C

Components list

MEASURING VOLTAGE DIVIDER (AS:0)		
ITEM	COMPONENT	REMARKS
R101	21.623 kΩ 1%	1/2 W
R102	90.00 kΩ 1%	1/2 W
R103	306.0 kΩ 1%	1/2 W
R104	990.0 kΩ 1%	1/2 W
R105, 106	1.0 MΩ 1%	1/2 W
R107	4.6462 kΩ 1%	1/2 W
R108	1.8812 kΩ 1%	1/2 W
C101	82 PF/100 WV	CERAMIC
C102	470 PF/100 WV	CERAMIC
C103	820 PF/100 WV	DIPPED MICA

POWER SUPPLY 1 (AS:1)		
ITEM	COMPONENT	REMARKS
R101	1.9 kΩ 5%	1/4-1/2 W
R102, 106, 112	0.4 Ω 5%	3 W
R116		
R103	3.3 kΩ 5%	1/4-1/2 W
R104, 109	1.0 kΩ	10T. POT
R105	3.0 kΩ 5%	1/4-1/2 W
R107	75 Ω 5%	1/4-1/2 W
R108, 118	2.43kΩ 1%	1/4-1/2 W
R110	6.8 kΩ 5%	1/4-1/2 W
R111, 117	62 Ω 5%	1/4-1/2 W
R113, 120	2.2 kΩ 5%	1/4-1/2 W
R114, 119	500 Ω	10T. POT
R115	850 Ω 5%	1/4-1/2 W
R121	100 Ω 1%	1/4-1/2 W
C101, 102, 104	2500 µF/15 WV	ELECTROLYTE
C105		
C103, 106, 111	4.7 µF/50 WV	TANTALUM
C112		
C107	500 PF/100 WV	DIPPED-MICA
C108, 110, 119	.22 µF/50 WV	TANTALUM
C109, 118	3.3 µF/16 WV	TANTALUM
C113, 114	40 µF/50 WV	ELECTROLYTE
C115, 116	100 µF/100 WV	ELECTROLYTE
C117	10 µF/50 WV	ELECTROLYTE
D101, 102, 103	IN3939	RECTIFIER
D104, 105, 106		DIODE
D107, 108		24 400 V
D109	BZY 93 (10V, 5 W)	ZENER
Q105, 106	2N 3740	PNP
U101, 103	LM723	DIP PKG
U102, 104	LM304 H	TO-5 PKG

V,A,W SELECTOR & ALARM (AS:2)		
ITEM	COMPONENT	REMARKS
R101, 106, 107	180 Ω 5%	1/4-1/2 W
R108, 112, 129		
R130, 163, 164		
R167		
R102, 109, 111	10 kΩ 5%	1/4-1/2 W
R103, 110, 122	4.7 kΩ 5%	1/4-1/2 W
R104, 105	3.3 kΩ 5%	1/4-1/2 W
R113, 117	20 kΩ	10 T. POT
R114	9.1 kΩ 5%	1/4-1/2 W
R115	430 kΩ 5%	1/4-1/2 W
R116, 119, 120	10 kΩ 1%	1/4-1/2 W
R118	5.1 kΩ 5%	1/4-1/2 W
R121	2.2 MΩ 5%	1/4-1/2 W
R123, 126	1.0 MΩ 1%	1/4-1/2 W
R124	20 kΩ 1%	1/4-1/2 W
R125	30 kΩ 1%	1/4-1/2 W
R127	1.0 kΩ 5%	1/4-1/2 W
R128	1.5 kΩ 5%	1/4-1/2 W
R140, 141	4.7 kΩ 1%	1/4-1/2 W
R142, 143, 150	2.2 kΩ 1%	1/4-1/2 W
R153		
R146, 147	8.2 kΩ 5%	1/4-1/2 W
R148, 149	470 Ω 5%	1/4-1/2 W
R151, 152	3.3 kΩ 1%	1/4-1/2 W
R155, 159	10 kΩ	VARIABLE
R156, 160	8.2 kΩ 1%	1/4-1/2 W
R157, 158, 161	5.6 kΩ 1%	1/4-1/2 W
R162		
R165, 166	500 Ω	10 T. POT
C101	0.68 µF/200 WV	POLYE-FLM
C102, 103, 104	33 PF/100 WV	DIPPED-MICA
C110, 111	10 µF/50 WV	ELECTROLYTE
C112, 113	3.3 µF/16 WV	TANTALUM
D101, 102, 103	IN914 B	SIGNAL
D104, 106, 107		DIODE
D108, 110, 111		
D112, 120, 121		
D122, 123, 124		
D125		
D105, 109	(10V1/2W)	ZENER
Q101, 102	2 SC 943	NPN
Q103	2 N 2405	NPN
Q104	2 N 2222	NPN
U101	7402 N	DIP
U102, 107, 108	7400 N	DIP
U109		
U103, 104, 105	LM 301 A	DIP
U106	LM 339 N	DIP
RL101-RL106	MD-1 (12 VDC)	SP-DT

PREAMPLIFIER & RANGING CCT. (AS:3)

ITEM	COMPONENT	REMARKS
R101, 103, 114	10 kΩ 1%	1/4-1/2 W
R102, 115	30 kΩ 1%	1/4-1/2 W
R104	8.2 kΩ 5%	1/4-1/2 W
R105, 113	1.0 MΩ 5%	1/4-1/2 W
R106	300 Ω 1%	1/4-1/2 W
R107	1.0 kΩ 5%	1/4-1/2 W
R108	120 kΩ 5%	1/4-1/2 W
R109, 112	16 Ω 5%	1/4-1/2 W
R110, 111	13 Ω 5%	1/4-1/2 W
R116	28.46 kΩ 1%	1/4-1/2 W
R117	10 kΩ 5%	1/4-1/2 W
R118	1.54 kΩ 1%	1/4-1/2 W
R119	20 kΩ 1%	1/4-1/2 W
R120	40 kΩ 1%	1/4-1/2 W
R121	220 kΩ 5%	1/4-1/2 W
R123	4.0 kΩ 5%	1/4-1/2 W
R124, 151	220 kΩ 5%	1/4-1/2 W
R125, 152	910 Ω 5%	1/4-1/2 W
R126	4.0 kΩ 1%	1/4-1/2 W
R129	2.325 kΩ 1%	1/4-1/2 W
R130	1.675 kΩ 1%	1/4-1/2 W
R131	4.649 kΩ 1%	1/4-1/2 W
R132	7.351 kΩ 1%	1/4-1/2 W
R133, 134	3.3 kΩ 5%	1/4-1/2 W
R135, 136, 137	10.0 kΩ 5%	1/4-1/2 W
R138, 149		
R139, 140	100 Ω 1%	1/4-1/2 W
R141, 142, 143		
R144, 150	4.7 kΩ 5%	1/4-1/2 W
R145, 146, 147	5.0 kΩ	10T. POT
R148		
C101	470 PF/100 WV	CERAMIC
C102	150 PF/100 WV	DIPPED-MICA
C103, 104, 105	33 PF/100 WV	DIPPED-MICA
C107		
C106	0.1 μF/35 WV	TANTALUM
C108	27 PF/100 WV	CERAMIC
C109	2.2 μF/200 V	POLYE-FLM
D101, 102, 103	1N 914 B	SIGNAL
D104, 105, 106		DIODE
D107, 110, 111		
D112, 113		
Q101	2SC943	NPN
Q102	2SA603	PNP
Q103, 106, 107	2SC943	NPN
Q108, 109		
U101, 102, 103	LM 301 A	
U104		
RL101, 102, 103	MJ-1 (12 VDC)	SP-ST
RL104, 105		

MULTIPLIER (AS:4)

ITME	COMPONENT	REMARKS
R102, 109, 111	10.0 kΩ 1%	1/4-1/2 W
R112, 131, 132		
R136, 140, 142		
R149, 150		
R103, 108, 120	2.2 Ω 5%	1/4-1/2 W
R121, 124, 125		
R126, 127, 128		
R134, 135, 143		
R146, 154, 155		
R163		
R106	820 Ω 5%	1/4-1/2 W
R107, 147	1.8 kΩ 5%	1/4-1/2 W
R110, 113, 148	20.0 kΩ 1%	1/4-1/2 W
R153		
R114, 115	40.0 kΩ 1%	1/4-1/2 W
R116, 137	2.2 MΩ 5%	1/4-1/2 W
R117, 118, 138	33.0 kΩ 1%	1/4-1/2 W
R139, 157, 158		
R119, 133	3.3 kΩ 5%	1/4-1/2 W
R122	15 kΩ 5%	1/4-1/2 W
R129, 130	560 Ω 5%	1/4-1/2 W
R151	100 kΩ 1%	1/4-1/2 W
R156	4.7 MΩ 5%	1/4-1/2 W
R159, 160	1.0 kΩ 5%	1/4-1/2 W
R161, 162, 165	330 Ω 5%	1/4-1/2 W
R167		
R164, 166, 169	10.0 kΩ 5%	1/4-1/2 W
R168	18.0 kΩ 5%	1/4-1/2 W
R171, 172, 176	10.0 kΩ	10T. POT
R174	500 Ω	1/4-1/2 W
R175	20.0 kΩ	1/4-1/2 W
R177	680 Ω 5%	1/4-1/2 W
R178	10 Ω 5%	1/4-1/2 W
C101, 102, 103	10 μF / 25 WV	ELECTROLYTE
C104, 105, 106		
C107		
C109, 177, 130	150 PF / 100 WV	DIPPED-MICA
C126, 136		
C110, 111, 119	0.01 μF/50 WV	CERAMIC
C120, 121, 122		
C123, 124, 125		
C128, 129, 132		
C133, 134, 135		
C112	15 μF/16 WV	TANTALUM
C113, 114	5 μF/100 WV	DIPPED-MICA
C115, 116	120 PF/100 WV	DIPPED-MICA
C117	1000 PF/100 WV	CERAMIC
C137	0.68 μF/200 WV	POLYE-FLM
C138, 139	330 PF/100 WV	CERAMIC
C140-141	0.001 μF/100 WV	CERAMIC
C142, 143	33 PF/100 WV	DIPPED-MICA
C144, 145, 146	0.1 μF/50 WV	POLYE-FLM

C147, 148, 149	20 PF/100 WV	CERAMIC
C150, 151	4.5 PF C 15 PF	VAR CER
C152	6.8 PF/100 WV	CERAMIC
D101	(8.2V 1/4 W)	ZENER
D104, D105	IN 914B	SIGNAL
D106, D107	(9.1V,1 W)	ZENER
L101, 102, 103	100 μH ± 20%	
L104, 105, 106		
L106		
Q101, 102, 103	2SK 23A	N-CH FET
Q104, 105, 106		
Q107, 108		
U101, 102, 106	LM301A	
U107, 108		
U103	LM710	
U104	75110 N	
U105	7403 N	

POWER SUPPLY 2 (AS:5)

ITEM	COMPONENT	REMARKS
R101	1.9 kΩ 5%	1/4-1/2 W
R102, 106, 112	0.4 Ω 5%	3 W
R116		
R103	3.3 kΩ 5%	1/4-1/2 W
R104, 109	1.0 kΩ	10T. POT
R105	3.0 kΩ 5%	1/4-1/2 W
R107	75 Ω 5%	1/4-1/2 W
R108, 118	2.43 kΩ 1%	1/4-1/2 W
R110	6.8 kΩ 5%	1/4-1/2 W
R111, 117	62 Ω 5%	1/4-1/2 W
R113, 120	2.2 kΩ 5%	1/4-1/2 W
R114, 119	500 Ω	10T. POT
R115	850 Ω 5%	1/4-1/2 W
C101, 102, 104	2500 μF/16 WV	ELECTROLYTE
C105		
C103, 106, 111	4.7 μF/50 WV	TANTALUM
C112		
C107	500 PF/100 WV	DIPPED-MICA
C108, 110, 119	.22 μF/50 WV	TANTALUM
C109, 118	3.3 μF/16 WV	TANTALUM
C113, 114	40 μF/50 WV	ELECTROLYTE
C115, 116	100 μF/100 WV	ELECTROLYTE
D101, 102, 103	IN 3939	RECTIFIER DIODE 2A 400V
D104, 105, 106		
D107, 108		
Q109, 110	2 N 3740	PNP
U101, 103	LM 723	DIP PKG
U102, 104	LM 304 H	TO-5 PKG

SIGNAL ISOLATOR (AS:6)

ITEM	COMPONENT	REMARKS
R101, 102, 103	4.7 kΩ 5%	1/4-1/2 W
R104, 105, 106		
R107, 108, 109	180 kΩ 5%	1/4-1/2 W
R110, 111, 112		
R113, 114, 115	100 Ω 5%	1/4-1/2 W
R116, 117, 118		
C101, 102, 103	25 μF /25 WV	ELELTROLYTE
C104		
C105	30 μF /25 WV	ELELTROLYTE
Q101, 102, 103	2N3566	NPN
Q104, 105, 106		
U101	7443 A	
U102, 103	7404 N	
U104	7417 J	
PC101, 102, 103	4N26	PHOTO COUPLER
PC104, 105, 106		

A TO D CONVERTER (AS:7)

ITEM	COMPONENT	REMARKS
R101	510 Ω 1%	1/4-1/2 W
R102	1.0 kΩ	10T. POT
R103, 104	100 kΩ 1%	1/4-1/2 W
R105	300 kΩ 1%	1/4-1/2 W
R106, 107	36 kΩ 1%	1/4-1/2 W
R108, 109, 110	150 Ω 5%	1/4-1/2 W
R111, 112, 113		
R114		
R115, 116	20 kΩ 1%	1/4-1/2 W
R117	39 kΩ 1%	1/4-1/2 W
R118	910 Ω 1%	1/4-1/2 W
R119	15 kΩ 1%	1/4-1/2 W
R120	820 Ω 5%	1/4-1/2 W
R121	300 Ω 5%	1/4-1/2 W
R122	4.7 kΩ 5%	1/4-1/2 W
R123, R124	150 Ω 5%	1/4-1/2 W
C101	300 PF/100 WV	DIPPED-MICA
C102	10 μF/25 WV	TANTALUM
C103	0.1 μF/35 WV	TANTALUM
C104, 105	1 μF/35 WV	TANTALUM
C106	0.22 μF/200 WV	POLYE-FLM
C107	1500 PF/100 WV	DIPPED-MICA
C108	0.22 μF/25 WV	POLYPROP
D101, 102, 103	IN 914 B	SIGNAL DIODE

Q101	2N3819	N-CH FET
Q102	2N2608	P-CH FET
Q103	2N2405	NPN
Q104, 105, 106	2N5189	NPN
Q107, 108, 109		
Q110		
U101	8052 A	
U102	7103 A	
U103	7447 N	
U104	LM 311 N	

POINT, UNIT & RANGING ENCODER (AS:8)-1

ITEM	COMPOVENT	REMARKS
R101 - R137	5.6 kΩ 5%	1/4 W
U101, 102, 103	74L04 OR 7404 N	
U104, 105	7408 N	
U106, 107	7425 N	
U108, 109, 110	74L10 OR 7410 N	
U111, 112, 113	74L30 OR 7430 N	
U131		
U114, 115, 116	74L03 OR 7403 N	
U117, 118, 119		
U120, 121, 122		
U123, 124, 125		
U126, 127		
U128, 130, 133	74L00 OR 7400 N	
U129	7427 N	
U132	74L20 OR 7420 N	
U134	74157 N	

POINT, UNIT, RANGING ENCODER (AS:8)-2

ITEM	COMPONENT	REMARKS
R101 - R115	180 Ω 5%	1/4 W
C101	0.1 µF / 15 WV	TANTALUM
C102	0.22 µF / 15 WV	TANTALUM
U101	LM 340-12	+12V REG.
U102, 103, 104	7440 N	
U105	7440 N	
U106	74157 N	
U107, 114	7408 N	
U108	7402 N	
U109	7400 N	
U110	MM2708	1024x8 BITS EPROM
U111	7442 N	
U112, 113	7404 N	

DISPLAY (AS:9)

ITEM	COMPOVENT	REMARKS
R101 - R110	180 Ω 5%	1/4-1/2 W
D101 - R107	RED LED	3 V
U101, 102	7404	
U103, 104, 105	LT 502	COMMON
U106, 107	7-SEG. DISPLAY	ANODE

BY PASS TRANSISTERS CARD (AS:10)

ITEM	COMPONENT	REMARKS
Q101, 103, 104	2N3055	NPN
Q105, 107, 108		
Q102, 106	2N5880	PNP

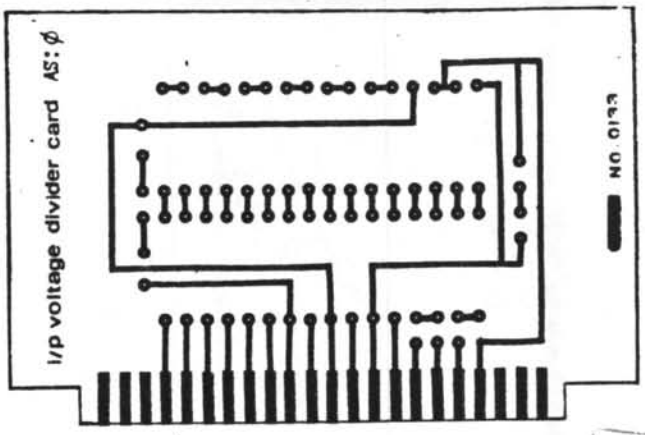
OVERALL WIRING

ITEM	COMPONENT	REMARKS
P101	RELEPTACLE AC SUPPLY CORD	3 PINS
T101	POWER TRANS	
T102	CURRENT TRANS	
F101	FUSE & HOLDER	0.5 A
SW101	PUSH BOTTON TYPE	FOR POWER INPUT
SW102	2 LAYER ROTARY SW	12 POSITIONS
SW103	2 LAYER ROTARY SW	12 POSITIONS
SW104, 105, 106	PUSH BOTTON TYPE DEPENDENT	FOR V, A, W SELECTOR
SW107	PUSH BOTTON TYPE	SPST SW
SW108	PUSH BOTTON TYPE	DPST SW
J00-J11	CONN. RECEPTACLE	22 PINS
J111, 113	CONN. RECEPTACLE	BLACK
J112, 114	CONN. RECEPTACLE	RED
J115, 116	CONN. RECEPTACLE	BLACK
J117	CONN. RECEPTACLE	RED
AS:0-AS10	PCB. ASSEMBLIES	
LP101-LP105	LAMPS & LAMP HOLDER	10 VDC, 20 mA
M101-M102	VU METER	500 µA FS.

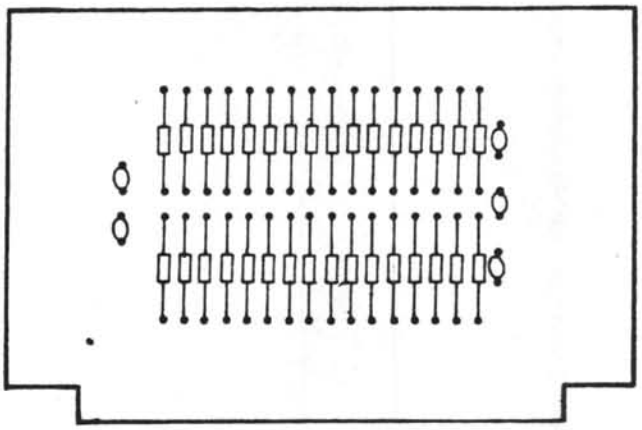
Appendix D

Printed circuit assembly and components lay out

Printed circuit side



Components lay out



Fig, D-1 measuring Voltage divider (AS:0

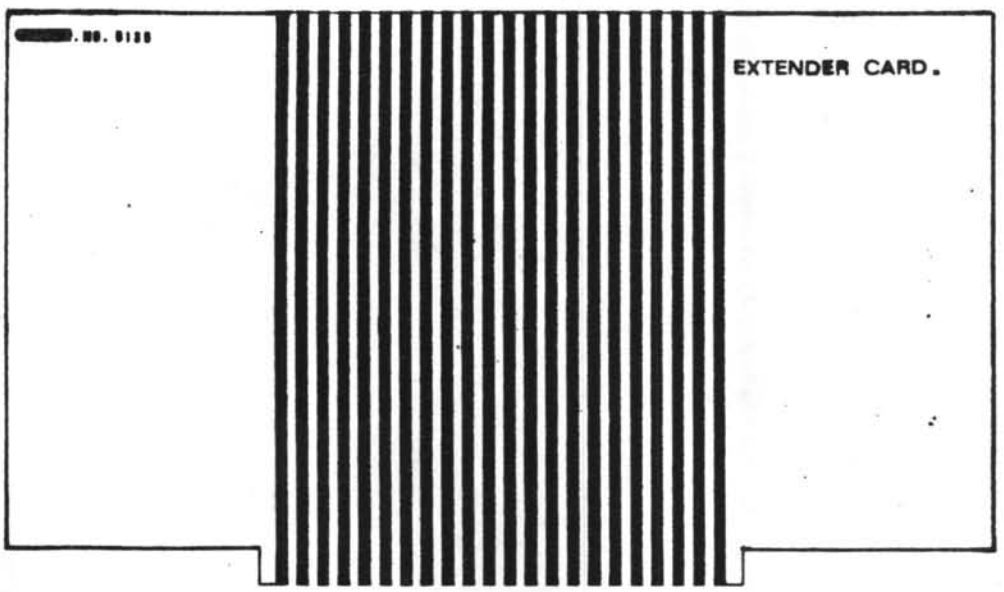


Fig. D-26 Extender card

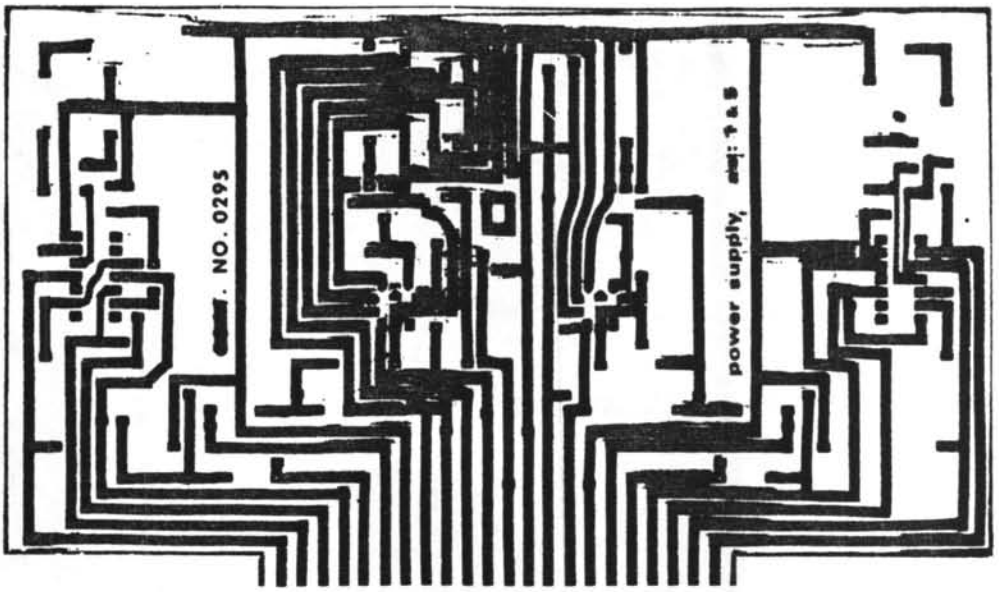


Fig. D-2 Power supply - 1 (AS : 1) ; Printed circuit side

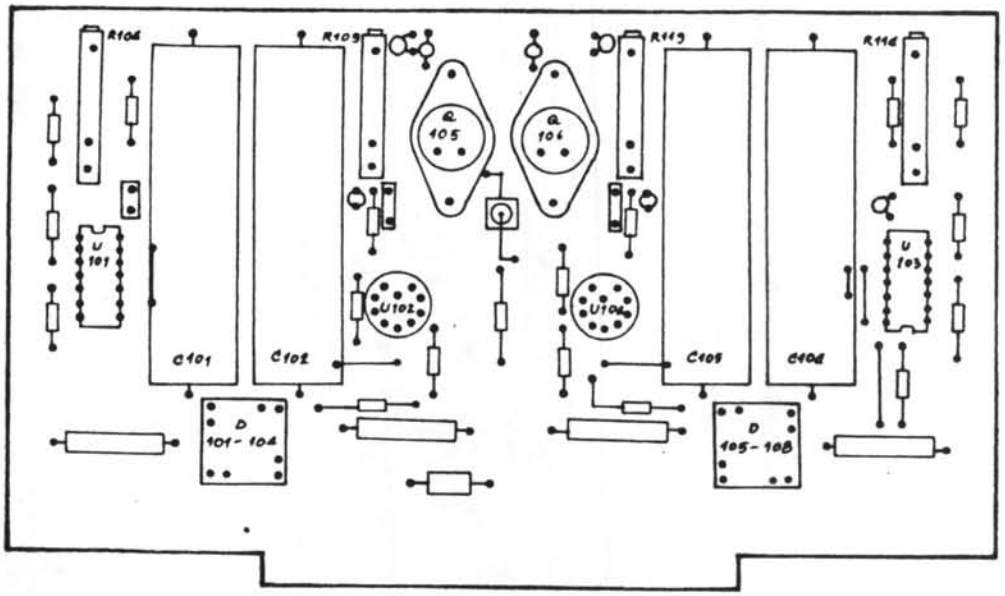


Fig. D - 3 Power supply - 1 (AS : 1) ; Components lay out

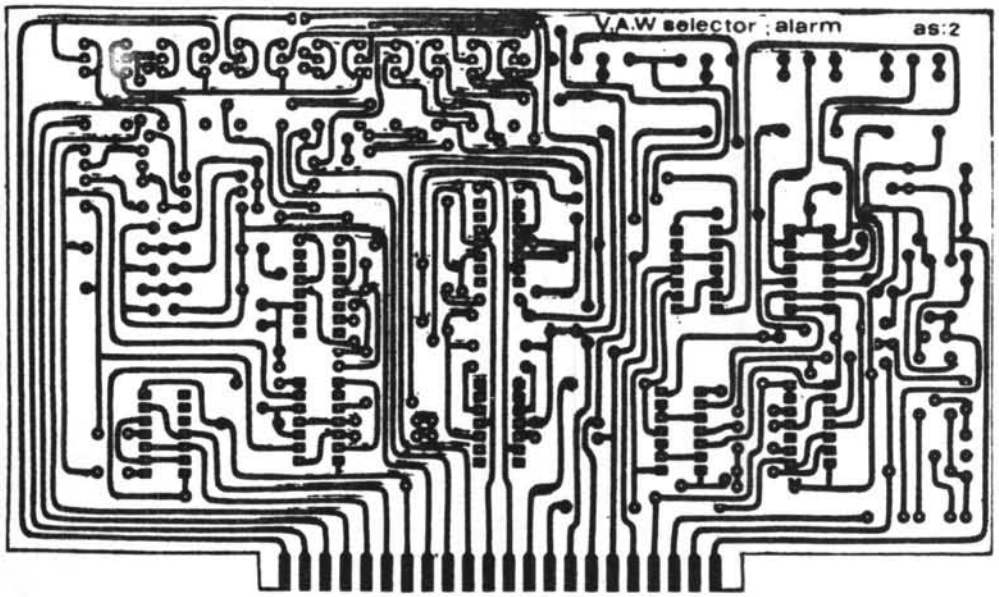


Fig. D-4 V,A,W Selector and alarm (AS:2) ; Printed circuit side

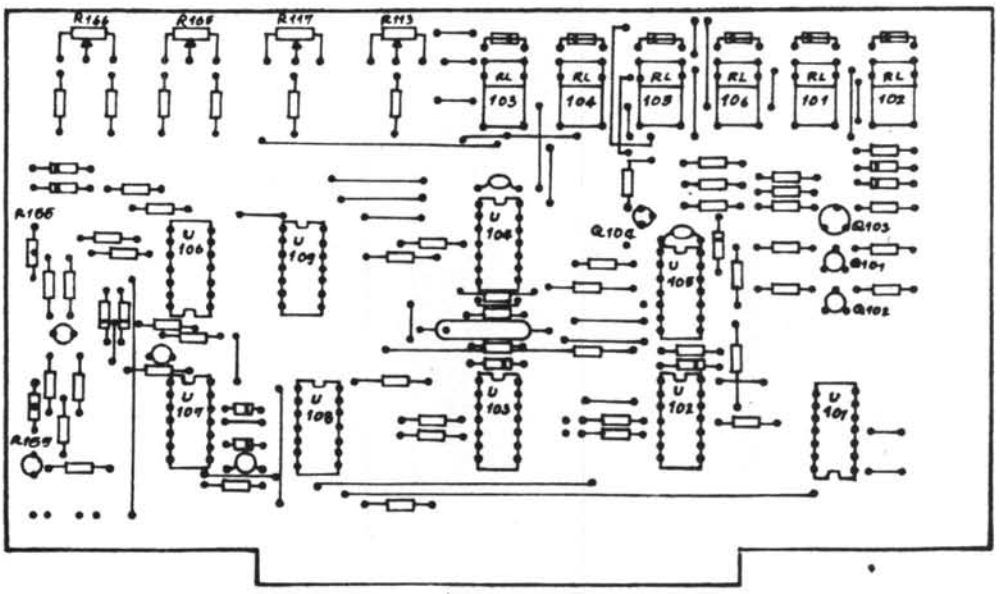


Fig. D-5 V,A,W selector and alarm (AS:2) ; Camponents lay out

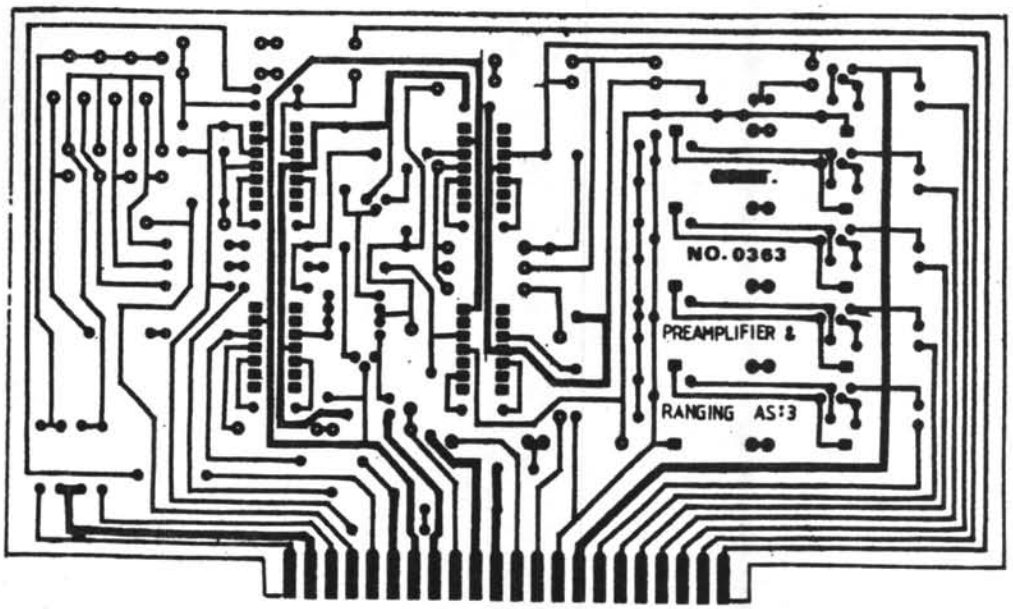


Fig. D - 6 Preamplifier and ranging circuit (AS:3) ; Printed circuit side

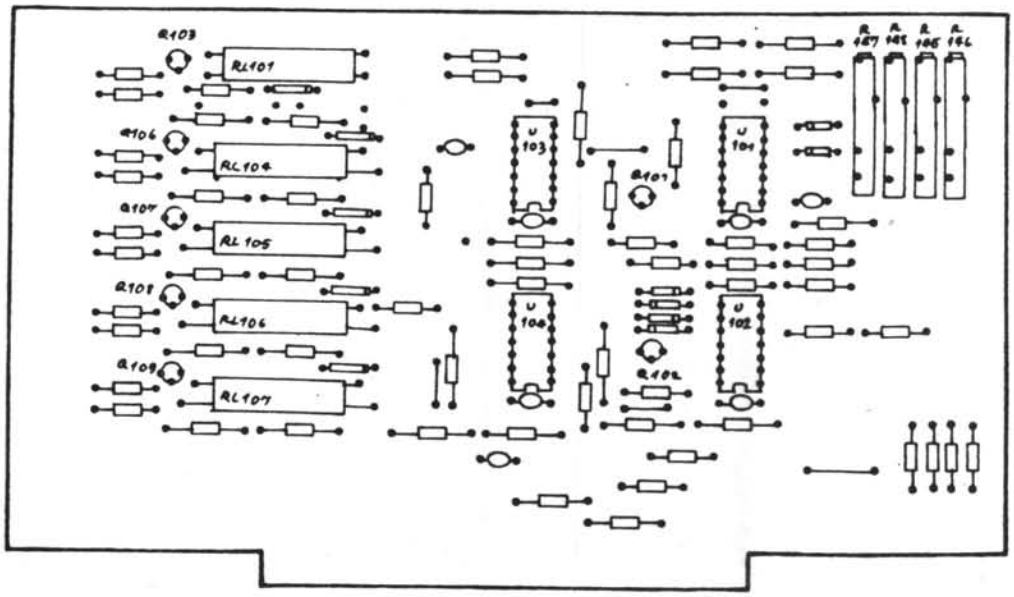


Fig. D - 7 Preamplifier and ranging circuit (AS:3) ; Components lay out

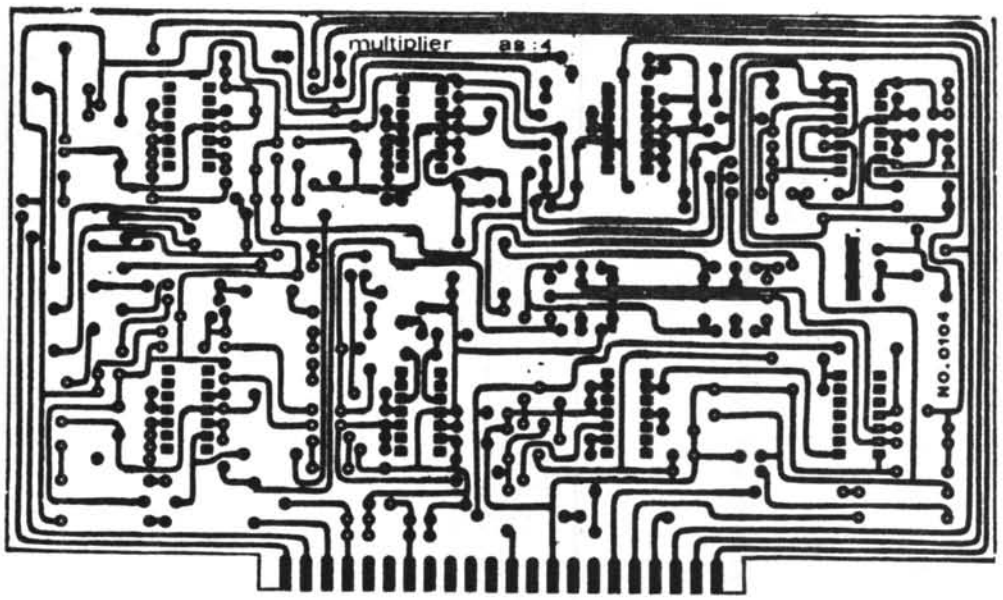


Fig. D - 8 Multiplier (AS:4) ; Printed circuit side

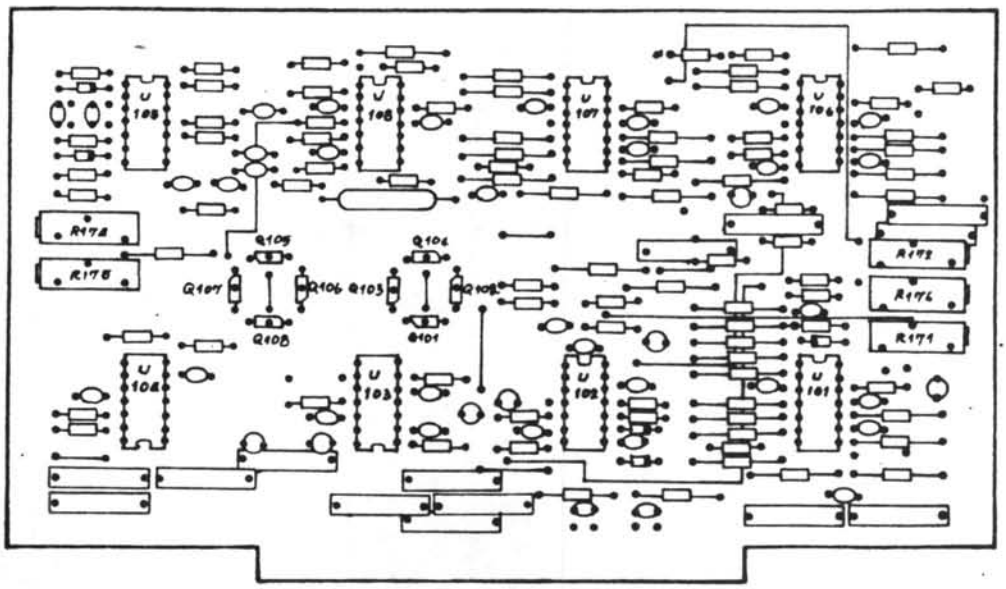


Fig. D - 9 Multiplier(AS:4) ; Components lay out

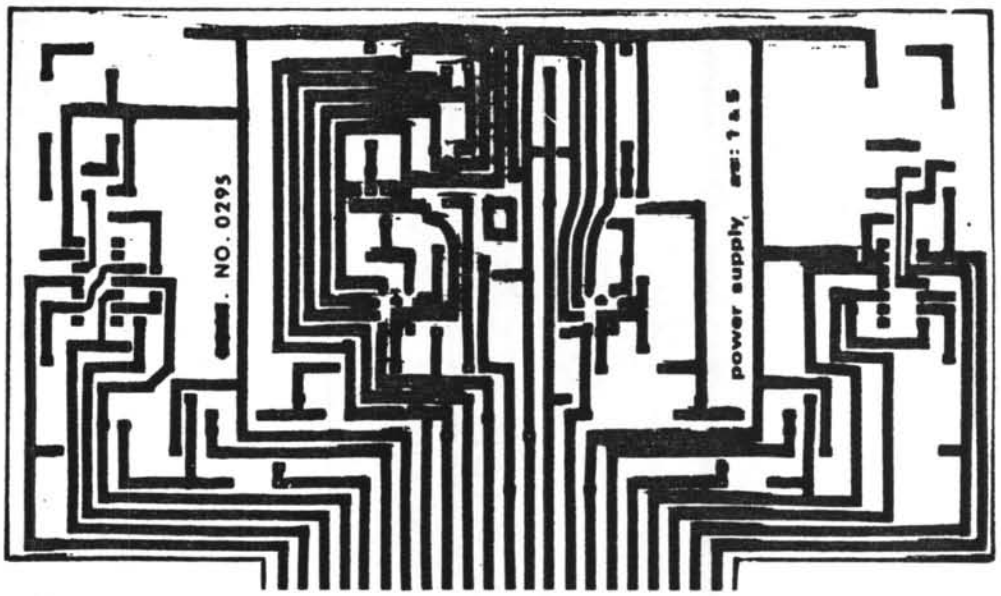


Fig. D - 10 Power supply - 2 (AS:5) ; Printed circuit side

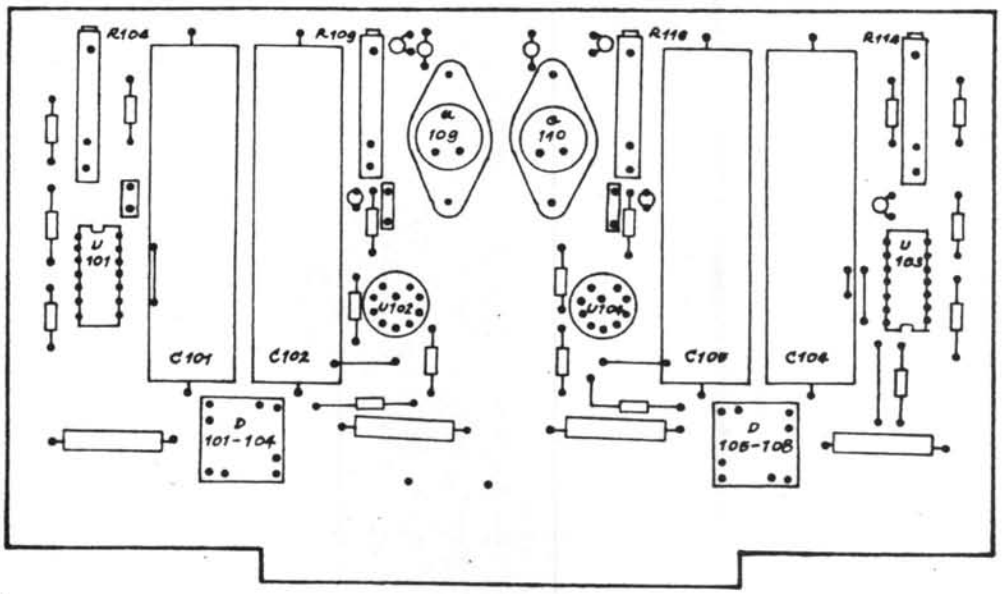


Fig. D - 11 Power supply - 2 (AS:5) ; Components lay out

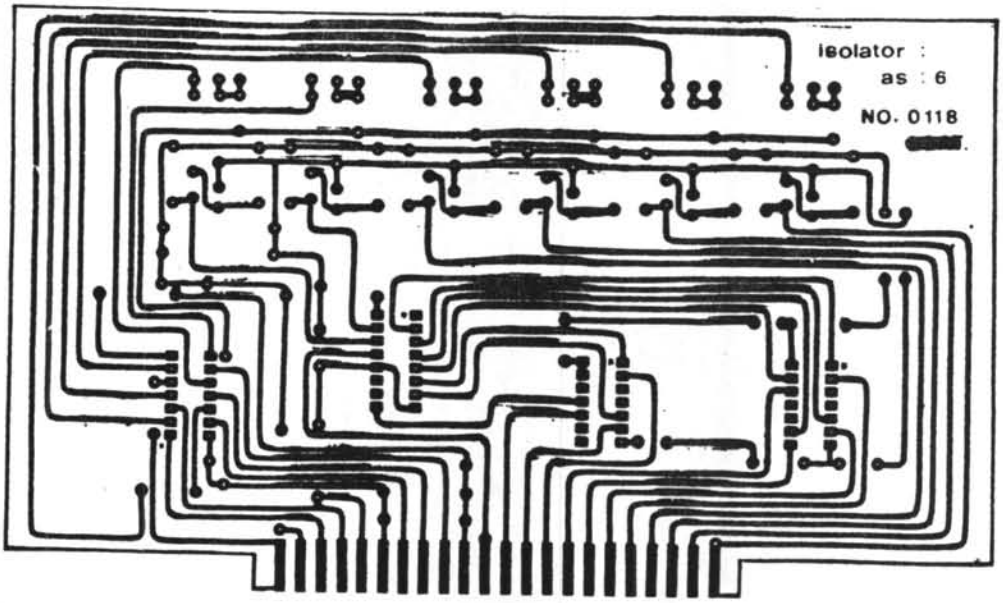


Fig. D - 12 Signal isolator (AS:6) ; Printed circuit side

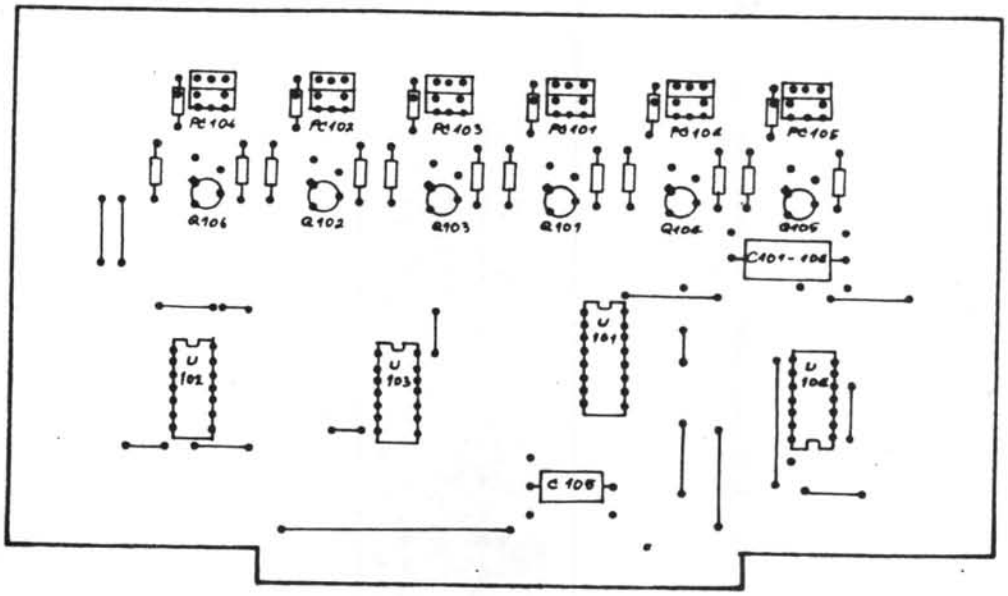


Fig. D - 13 Signal isolator (AS:6) ; Components lay out

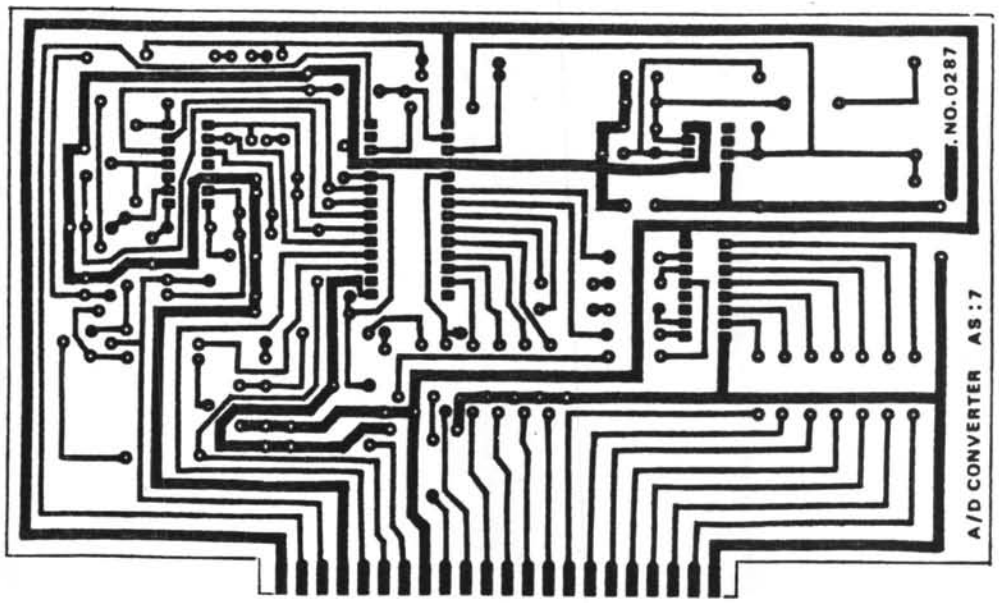


Fig. D - 14 A-to-D converter (AS:7) ; Printed circuit side

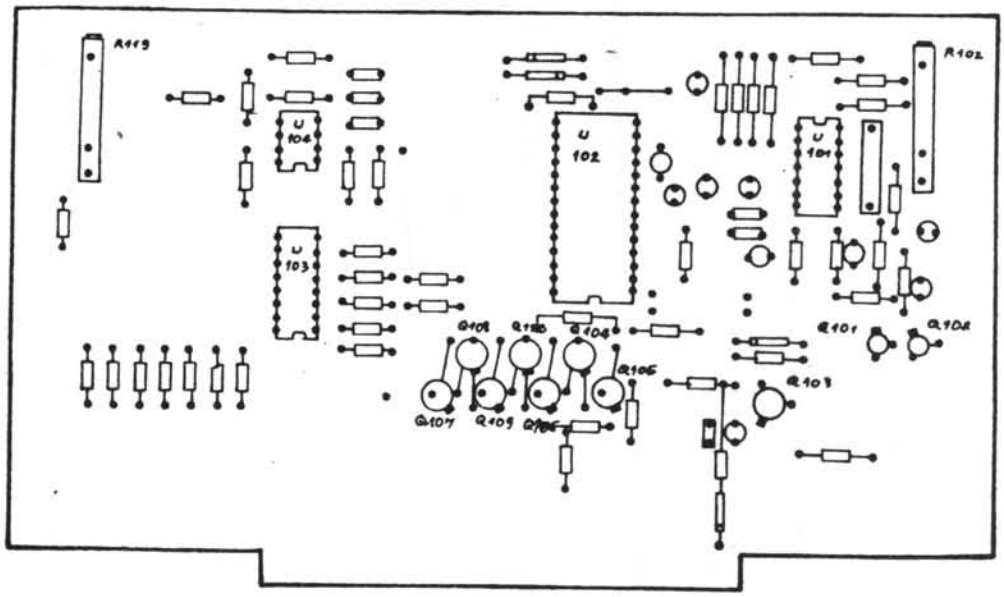


Fig. D - 15 A-to-D converter (AS:7) ; Components lay out

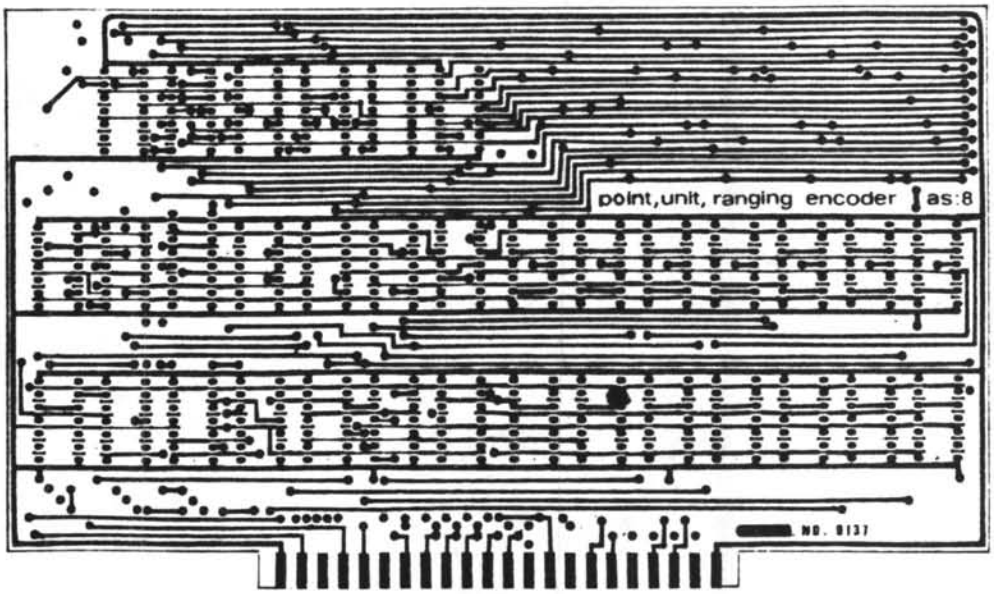


Fig. D-16 Point, unit, and ranging encoder (AS:8)-1 ; Printed circuit side

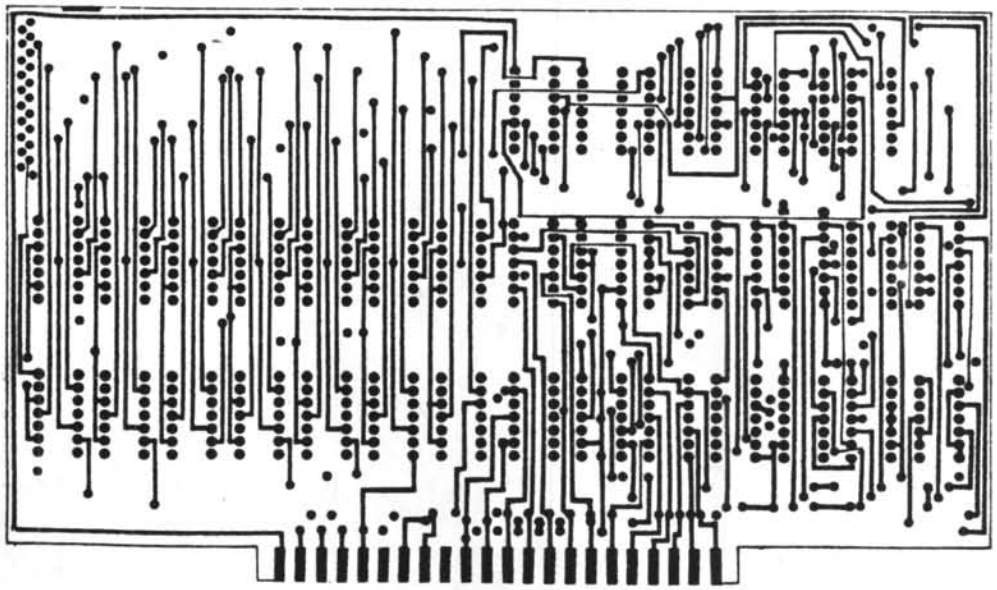


Fig. D-17 Point, unit, and ranging encoder (AS:8)-1 ; Component side

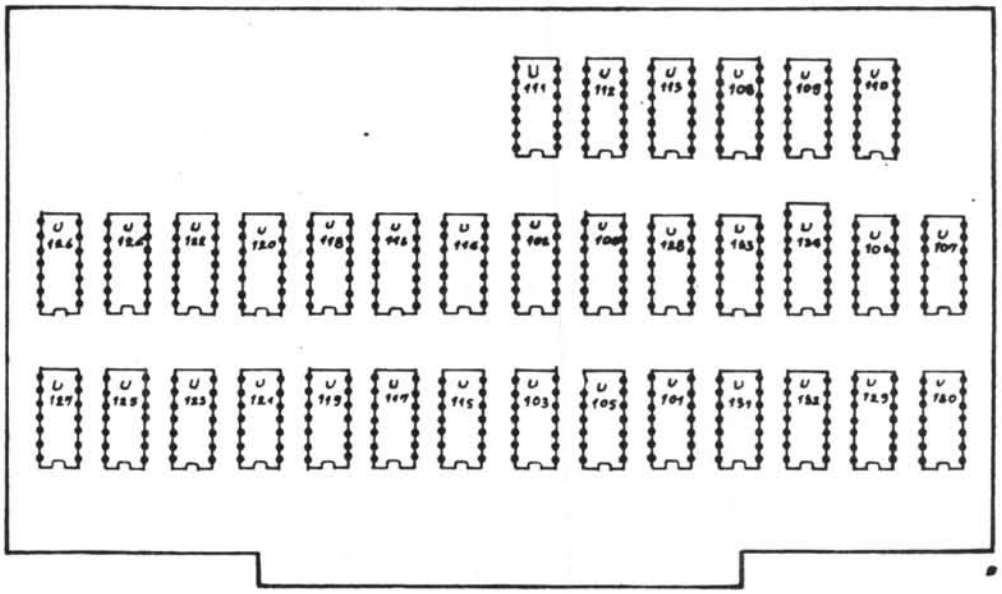


Fig. D-18 Point, unit, and ranging encoder (AS:8)-1, Components lay out

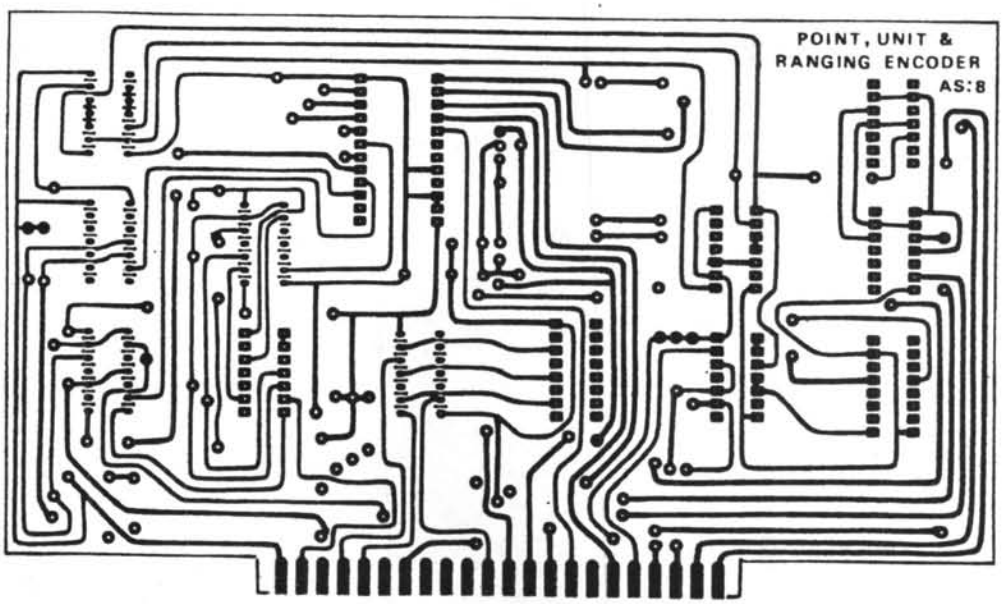


Fig. D-19 Point, unit, and ranging encoder (AS:2)-2; Printed circuit side

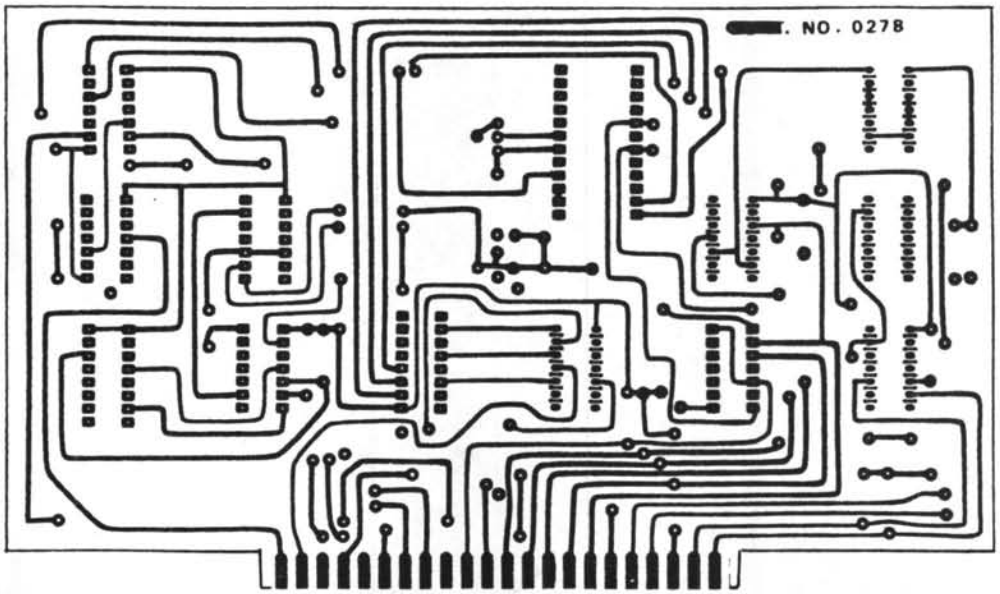


Fig. D-20 Point, unit, and ranging encoder (AS:8)-2, Component side

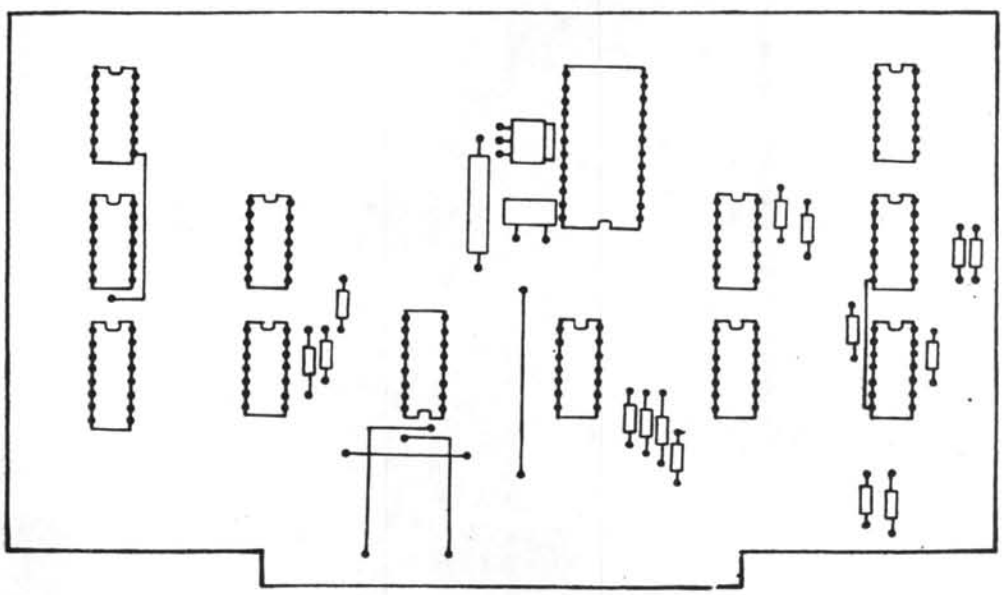
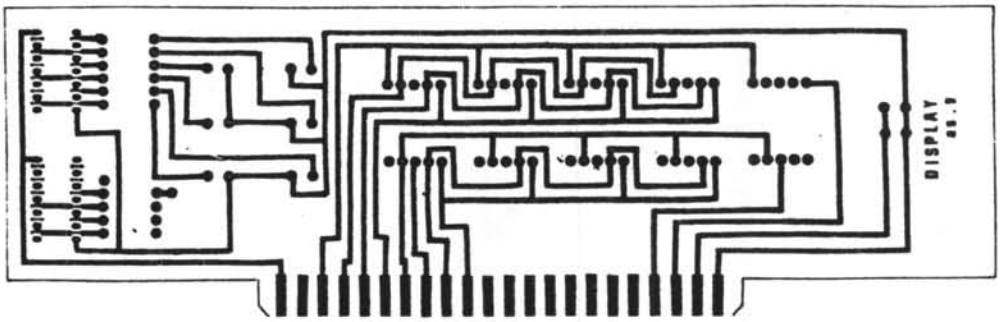


Fig. D-21 Point, unit and ranging encoder (AS:8)-2 ; Components lay out

Printed circuit side



Component side

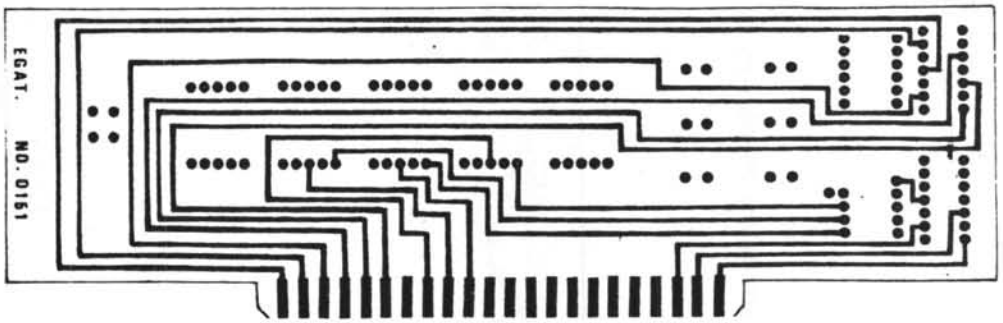


Fig. D-22 Display (AS:9) ; Printed circuit and component side

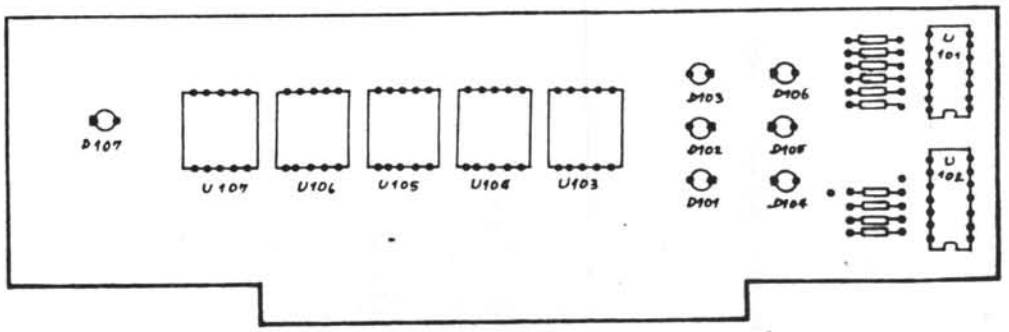


Fig. D-23 Display (AS:9) ; Components lay out

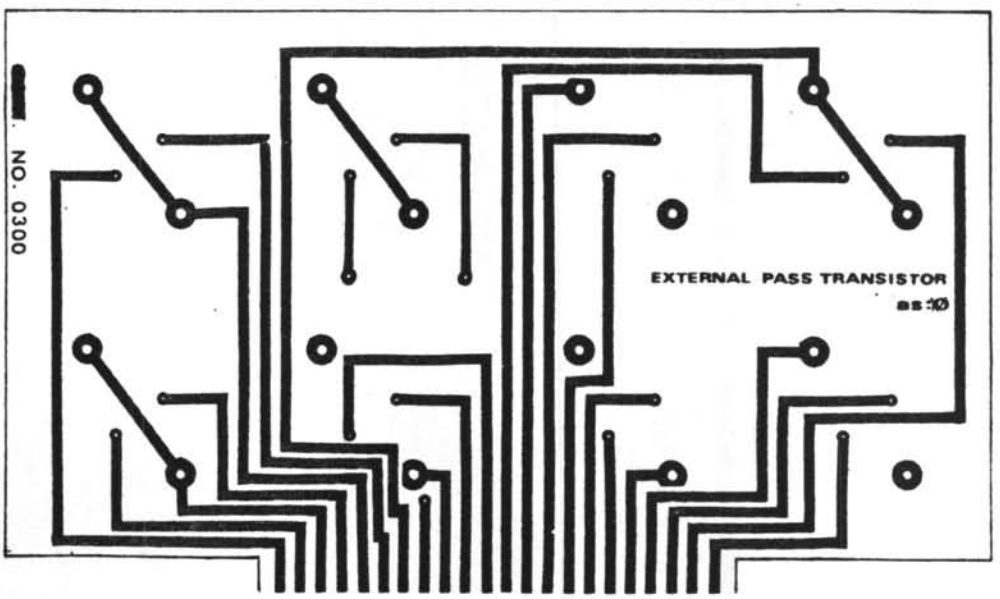


Fig. D-24 Bypass transistor card (AS:10) ; Printed circuit side

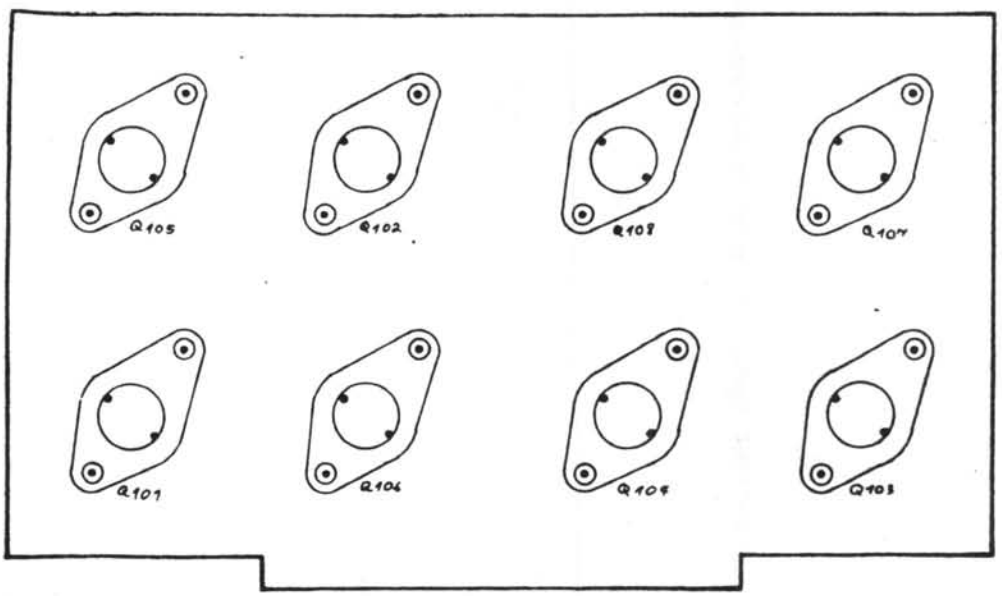


Fig. D-25 Bypass transistor card (AS:10) ; Components lay out

Appendix E

Manual change

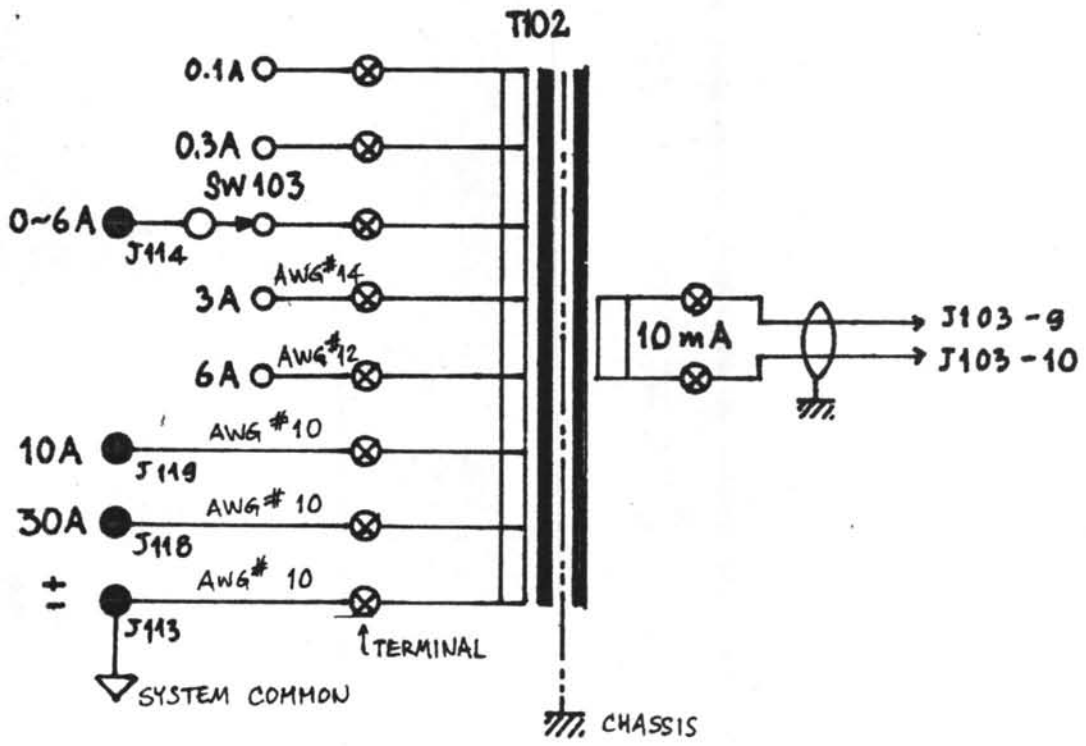
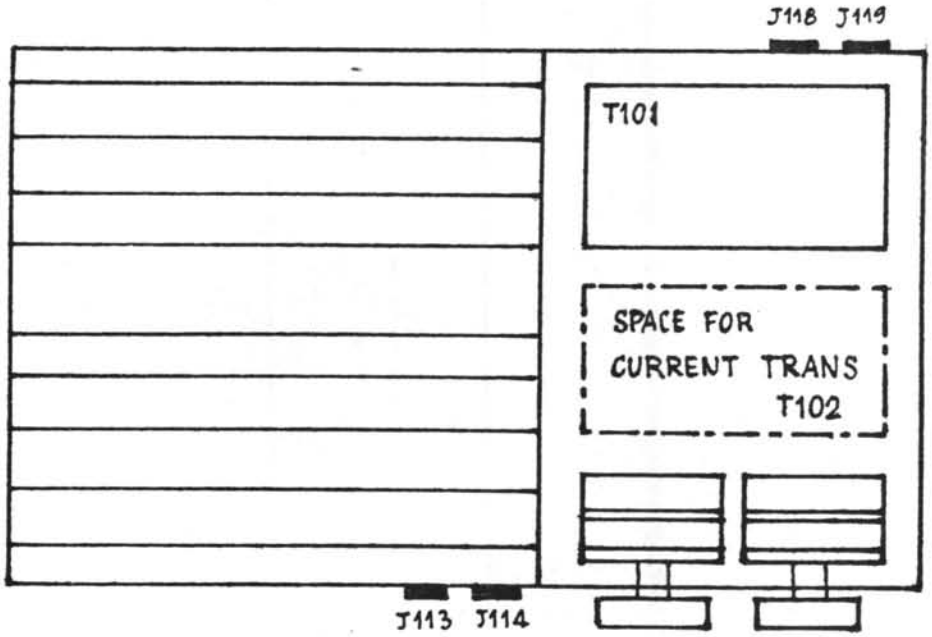


Fig.E-1 Current transformer T102 installation



Appendix F

Test data and curves

1.) Test for the Multiplier (AS:4) accuracy

1.1 Linearity test (4-quadrants multiplication)

input X , Y (V)	desired output Z (V)	output Z =XY/3 (V)	output Z =(-X)(Y)/3 (V)	outputZ =(X)(-Y)/3 (V)	outputZ =(-X)(-Y)/3 (V)
0.600	0.120	-0.123	0.115	0.115	-0.120
0.900	0.270	-0.271	0.269	0.271	-0.269
1.200	0.480	-0.482	0.472	0.479	-0.478
1.500	0.750	-0.756	0.746	0.745	-0.749
1.800	1.080	-1.084	1.076	1.080	-1.077
2.100	1.470	-1.476	1.466	1.470	-1.467
2.400	1.920	-1.929	1.916	1.910	-1.916
2.700	2.430	-2.436	2.426	2.418	-2.423
3.000	3.000	-3.000	2.997	0.994	-2.992
3.300	3.630	-3.614	3.628	3.627	-3.621

1.2 Freqency characteristic test with sine wave

Test frequencies (Hz)	input X , Y (V)	desired output Z (V)	output Z =XY/3 (V)	difference (V)	reading accuracy (%)
30	1.732	1.000	1.0004	0.0004	0.04
40	1.732	1.000	1.0006	0.0006	0.06
50	1.732	1.000	1.0008	0.0008	0.08
100	1.732	1.000	1.0009	0.0009	0.09
300	1.732	1.000	1.0017	0.0017	0.17
500	1.732	1.000	1.0023	0.0023	0.23
700	1.732	1.000	1.0044	0.0044	0.44
1000	1.732	1.000	1.0047	0.0047	0.47
1200	1.732	1.000	1.0050	0.0050	0.50
1500	1.732	1.000	1.0052	0.0052	0.52

2.) DC Voltage Measuring

Linearity test from 1 to 600 Vdc

(test for the ranging circuit linearity)

Range Setling (V)	% of full scale (%)	Master reading (V)	Object reading (V)	difference (V)	reading accuracy (%)
3	30	0.900	0.892	-0.008	-0.89
3	50	1.500	1.486	-0.014	-0.93
3	100	3.000	2.884	-0.016	-0.53
10	30	3.000	2.874	-0.026	-0.87
10	50	5.000	4.955	-0.045	-0.90
10	100	10.000	9.953	-0.047	-0.47
30	30	9.00	8.90	-0.08	-0.89
30	50	15.00	14.96	-0.14	-0.93
30	100	30.00	29.85	-0.15	-0.50
100	30	30.00	29.72	-0.28	-0.93
100	50	50.00	49.52	-0.48	-0.96
100	100	100.00	99.45	-0.55	-0.55
300	30	90.0	89.2	-0.8	-0.89
300	50	150.0	148.5	-1.5	-1.00
300	100	300.0	298.3	-1.7	-0.56
600	30	180.0	178.2	-1.8	-1.00
600	50	300.0	296.9	-3.1	-1.03
600	100	600.0	593.7	-6.3	-1.05

3.) AC Voltage Measuring

3.1 Linearlity test from 1 to 600 V rms, 50 Hz

(Test with sinusoidal waveform distortion 5% maximum)

Range setting (V)	% of full scale (%)	Master reading (V)	Object reading (V)	differrence (V)	reading accuracy (%)
3	30	0.900	0.898	-0.002	-0.22
3	50	1.500	1.497	-0.003	-0.20
3	100	3.000	2.996	-0.004	-0.13
10	30	3.000	2.998	-0.002	-0.07
10	50	5.000	2.997	-0.003	-0.06
10	100	10.000	9.996	-0.004	-0.04
30	80	9.00	8.97	-0.03	-0.22
30	50	15.00	14.96	-0.04	-0.27
30	100	30.00	29.95	-0.05	-0.16
100	30	30.00	29.96	-0.04	-0.13
100	50	50.00	49.95	-0.05	-0.10
100	100	100.00	99.93	-0.07	-0.07
300	30	90.0	89.8	-0.4	-0.44
300	50	150.0	140.3	-0.6	-0.40
300	100	300.0	299.0	-1.0	-0.33
600	30	180.0	179.1	-0.9	-0.50
600	50	300.0	297.7	-2.3	-0.76
600	100	600.0	594.4	-5.6	-0.93

3.2 Frequency characteristic test from 20 Hz to 1500 Hz

Test Frequencies (Hz)	Master reading (V)	Object reading (V)	difference (V)	reading accuracy (%)
20	10.00	9.992	-0.008	-0.08
30	10.00	9.995	-0.005	-0.05
40	10.00	9.998	-0.002	-0.02
50	10.00	9.999	-0.001	-0.01
60	10.00	10.002	0.002	0.02
70	10.00	10.003	0.003	0.03
80	10.00	10.002	0.002	0.02
90	10.00	10.002	0.002	0.02
100	10.00	10.005	0.005	0.05
200	10.00	10.007	0.007	0.07
300	10.00	10.008	0.008	0.08
400	10.00	10.009	0.009	0.09
500	10.00	10.007	0.007	0.07
600	10.00	10.005	0.005	0.05
700	10.00	10.006	0.006	0.06
800	10.00	10.003	0.003	0.03
900	10.00	10.002	0.002	0.02
1000	10.00	9.999	-0.001	-0.01
1100	10.00	9.997	-0.003	-0.03
1200	10.00	9.994	-0.006	-0.06
1300	10.00	9.990	-0.010	-0.10
1400	10.00	9.986	-0.014	-0.14
1500	10.00	9.983	-0.017	-0.17

3.3 True RMS measuring test with distored waveforms

3.3.1 Rectified sine (half wave), 50 Hz

Range setting (V)	% of full scale (%)	Master reading (V)	Object reading (V)	difference (V)	reading accuracy (%)
3	30	0.900	0.895	-0.005	-0.59
3	50	1.500	1.494	-0.006	-0.40
3	70	2.100	2.090	-0.006	-0.29
3	90	2.700	2.693	-0.007	-0.26
3	100	3.000	2.992	-0.008	-0.27
10	30	3.000	2.989	-0.011	-0.37
10	50	5.000	4.985	-0.015	-0.30
10	70	7.000	6.983	-0.017	-0.24
10	90	9.000	8.979	-0.021	-0.23
10	100	10.000	9.975	-0.025	-0.25

3.3.2 Square wave, 500 Hz

Range setting (V)	% of full scale (%)	Master reading (V)	Object reading (V)	difference (V)	reading accuracy (%)
3	30	0.900	0.894	-0.006	-0.66
3	50	1.500	1.487	-0.013	-0.87
3	70	2.100	2.082	-0.018	-0.86
3	90	2.700	2.680	-0.020	-0.74
3	100	3.000	2.977	-0.023	-0.77
10	30	3.000	2.979	-0.021	-0.70
10	50	5.000	4.968	-0.032	-0.64
10	70	7.000	6.946	-0.054	-0.77
10	90	9.000	8.933	-0.067	-0.74
10	100	10.000	9.929	-0.071	-0.71

3.3.3 Regtangular pulse (75% duty cycle), 50 Hz

Range setting (V)	% of full scale (%)	Master reading (V)	Object reading (V)	difference (V)	reading accuracy (%)
3	30	0.900	0.880	-0.020	-2.20
3	50	1.500	1.475	-0.025	-1.67
3	70	2.100	2.073	-0.027	-1.29
3	90	2.700	2.672	-0.028	-1.04
3	100	3.000	2.970	-0.030	-1.00
10	30	3.000	2.940	-0.060	-2.00
10	50	5.000	4.932	-0.068	-1.36
10	70	7.000	6.920	-0.080	-1.14
10	90	9.000	8.910	-0.090	-1.00
10	100	10.000	9.905	-0.095	-0.95

3.3.4 Triangle and sawtooth, 50 Hz

Range setting (V)	% of full scale (%)	Master reading (V)	Object reading (V)	difference (V)	reading accuracy (%)
3	30	0.900	0.894	-0.006	-0.67
3	50	1.500	1.496	-0.004	-0.27
3	70	2.100	2.095	-0.005	-0.24
3	90	2.700	2.695	-0.005	-0.18
3	100	3.000	2.996	-0.004	-0.13
10	30	3.000	2.985	-0.015	-0.50
10	50	5.000	4.989	-0.011	-0.22
10	70	7.000	6.986	-0.014	-0.20
10	90	9.000	8.985	-0.015	-0.16
10	100	10.000	9.990	-0.010	-0.10

4.) AC Current Measuring (test without current transformer)

4.1 Test with sinewave, 50 Hz

Range setting (A)	% of full scale (%)	Master reading (A)	Object reading (A)	difference (A)	reading accuracy (%)
1	30	0.300	0.298	-0.002	-0.67
1	40	0.400	0.398	-0.002	-0.50
1	50	0.500	0.498	-0.002	-0.40
1	60	0.600	0.598	-0.002	-0.33
1	70	0.700	0.698	-0.002	-0.29
1	80	0.800	0.797	-0.003	-0.37
1	90	0.900	0.897	-0.003	-0.33
1	100	1.000	0.996	-0.004	-0.40
1	110	1.100	1.095	-0.005	-0.45

4.2 Test with squarewave, 50 Hz

Range setting (A)	% of full scale (%)	Master reading (A)	Object reading (A)	difference (A)	reading accuracy (%)
1	30	0.300	0.299	-0.001	-0.33
1	40	0.400	0.399	-0.001	-0.25
1	50	0.500	0.499	-0.001	-0.20
1	60	0.600	0.598	-0.002	-0.33
1	70	0.700	0.698	-0.002	-0.29
1	80	0.800	0.797	-0.003	-0.37
1	90	0.900	0.896	-0.004	-0.44
1	100	1.000	0.995	-0.005	-0.50
1	110	1.000	1.095	-0.005	-0.45

5.) AC Wattage Measuring

5.1 Test for power factor = 1.0 with sine wave, 50 Hz

5.1.1 Voltage fixed at 10 V rms, current varies from 3 to 10 mA

A-range setting (A)	current input (mA)	Expected values (W)	Object reading (W)	difference (W)	reading accuracy (%)
10	3	30	29.9	-0.1	-0.33
10	4	40	39.9	-0.1	-0.25
10	5	50	49.8	-0.2	-0.40
10	6	60	59.8	-0.2	-0.33
10	7	70	69.8	-0.2	-0.29
10	8	80	79.7	-0.3	-0.37
10	9	90	89.7	-0.3	-0.33
10	10	100	99.7	-0.3	-0.30
10	11	110	109.7	-0.3	-0.33

5.1.2 Current fixed at 10 mA, voltage varies from 3 to 10 V rms

A-range setting (A)	voltage input (V)	Expected values (W)	Object reading (W)	difference (W)	reading accuracy (%)
10	3	30	29.9	-0.1	-0.33
10	4	40	39.9	-0.1	-0.25
10	5	50	49.9	-0.1	-0.20
10	6	60	59.9	-0.1	-0.17
10	7	70	69.8	-0.2	-0.29
10	8	80	79.8	-0.2	-0.25
10	9	90	89.8	-0.2	-0.22
10	10	100	99.8	-0.2	-0.20
10	11	110	109.7	-0.3	-0.33

5.2 Test for influence by power factor with sine wave

10 Vrms full scale, 50 Hz

5.2.1 Power factor = 0.5 (Cos $\phi = \pm 60^{\circ}$)

A-range setting (A)	current input (mA)	Expected values (W)	Object reading (W)	difference (W)	reading accuracy (%)
10	3	15	14.9	-0.1	-0.66
10	4	20	19.9	-0.1	-0.50
10	5	25	24.9	-0.1	-0,40
10	6	30	29.9	-0.1	-0.33
10	7	35	34.9	-0.1	-0.29
10	8	40	39.9	-0.1	-0.25
10	9	45	44.9	-0.1	-0.22
10	10	50	49.9	-0.1	-0.20
10	11	55	54.9	-0.1	-0.18

5.2.2 Power factor = 0.707 (Cos $\phi = \pm 45^{\circ}$)

A-range setting (A)	current input (mA)	Expected values (W)	Object reading (W)	difference (W)	reading accuracy (%)
10	3	21.21	21.1	-0.11	-0.52
10	4	28.28	28.2	-0.08	-0.28
10	5	35.35	35.2	-0.15	-0.42
10	6	42.42	42.3	-0.12	-0.28
10	7	49.49	49.4	-0.09	-0.18
10	8	56.56	56.4	-0.16	-0.28
10	9	63.63	63.5	-0.13	-0.20
10	10	70.70	70.6	-0.10	-0.14
10	11	77.77	77.6	-0.17	-0.22

5.3 Actual test with current transformer and power factor =1

5.3.1 Voltage input fixed at 30 V rms, current varies from 1 to 3 A, 50 Hz

voltage input (V)	current input (A)	Expected value (W)	Object reading (W)	difference (W)	reading accuracy (%)
30	1.00	30.00	30.2	0.2	0.67
30	1.25	37.50	37.6	0.1	0.27
30	1.50	45.00	45.0	0.0	0.00
30	1.75	52.50	52.5	0.0	0.00
30	2.00	60.00	59.8	-0.2	-0.33
30	2.25	67.50	67.1	-0.4	-0.60
30	2.50	75.00	74.5	-0.5	-0.67
30	2.75	82.50	82.0	-0.5	-0.61
30	3.00	90.00	89.4	-0.6	-0.67

5.3.2 Voltage input fixed at 220 V rms, current varies from 1 to 3 A, 50 Hz

voltage input (V)	current input (A)	Expected value (W)	Object reading (W)	difference (W)	reading accuracy (%)
200	1.00	220.0	221.4	1.4	0.64
220	1.25	275.0	276.3	1.3	0.47
220	1.50	330.0	330.8	0.8	0.24
220	1.75	385.0	385.0	0.0	0.00
220	2.00	440.0	438.5	-1.5	-0.34
220	2.25	495.0	492.9	-2.1	-0.42
220	2.50	550.0	546.7	-3.3	-0.60
220	2.75	505.0	600.8	-4.2	-0.69
220	3.00	660.0	655.6	-4.4	-0.67

6.) Test for environmental effect

6.1 Power fluctuation effect test

Power voltage (V)	V-input (V)	A-input (A)	desired output (W)	Object reading (W)	reading accuracy (%)
253 (+15%)	10.00	1.000	10.000	-	-
242 (+10%)	10.00	1.000	10.000	9.977	-0.23
231 (+ 5%)	10.00	1.000	10.000	9.975	-0.25
220 (± 0%)	10.00	1.000	10.000	9.975	-0.25
209 (- 5%)	10.00	1.000	10.000	9.973	-0.27
198 (-10%)	10.00	1.000	10.000	9.973	-0.27
187 (-15%)	10.00	1.000	10.000	9.951	-0.49

6.2 Temperature diviation effect test

temperature (°C)	V-input (V)	A-input (V)	desired output (W)	Object reading (W)	reading accuracy (%)
10	10.00	1.000	10.000	-	-
15	10.00	1.000	10.000	-	-
20	10.00	1.000	10.000	9.977	-0.23
25	10.00	1.000	10.000	9.975	-0.25
30	10.00	1.000	10.000	9.975	-0.25
35	10.00	1.000	10.000	9.971	-0.29
40	10.00	1.000	10.000	9.968	-0.32

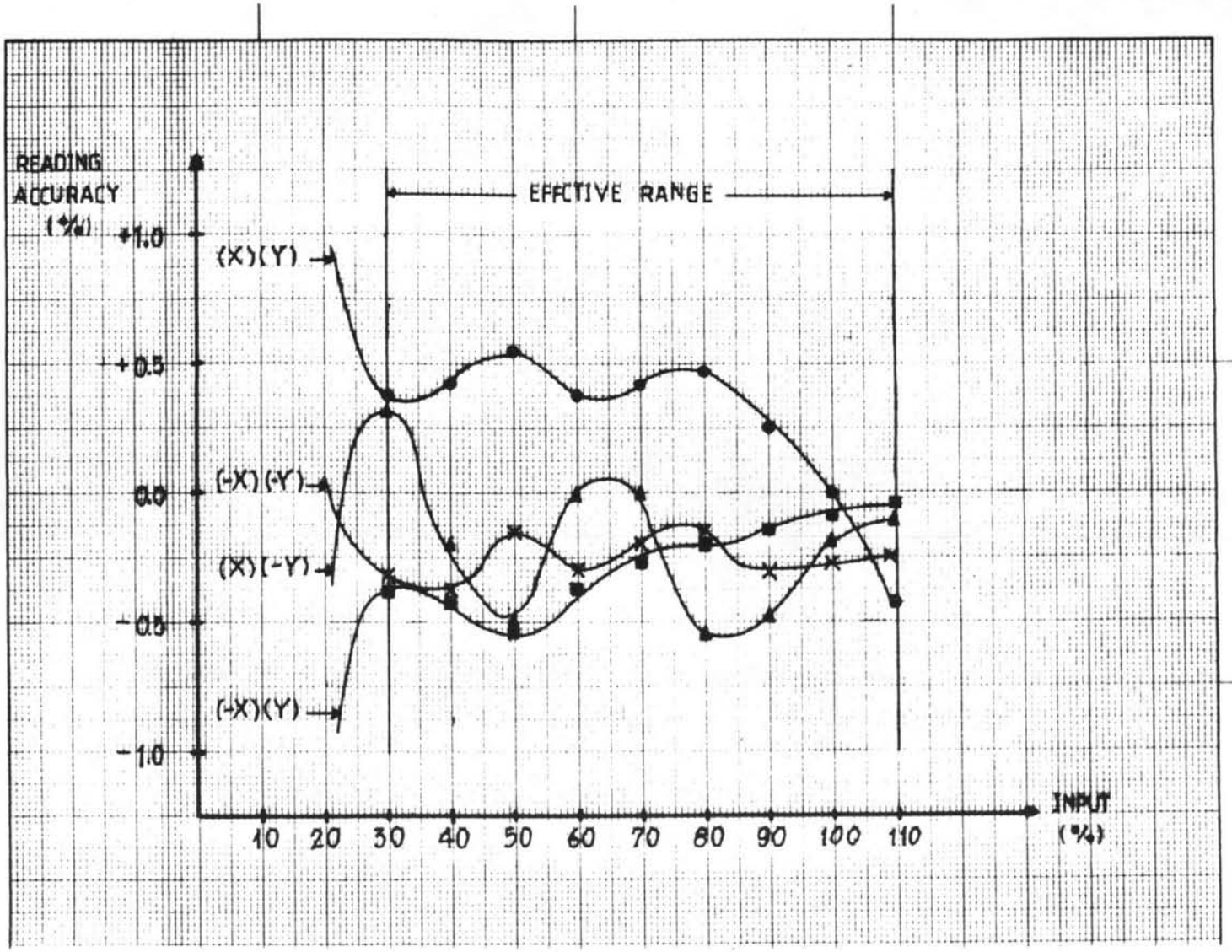


Fig. F-1 Linearity test for the Multiplier (AS:4) accuracy

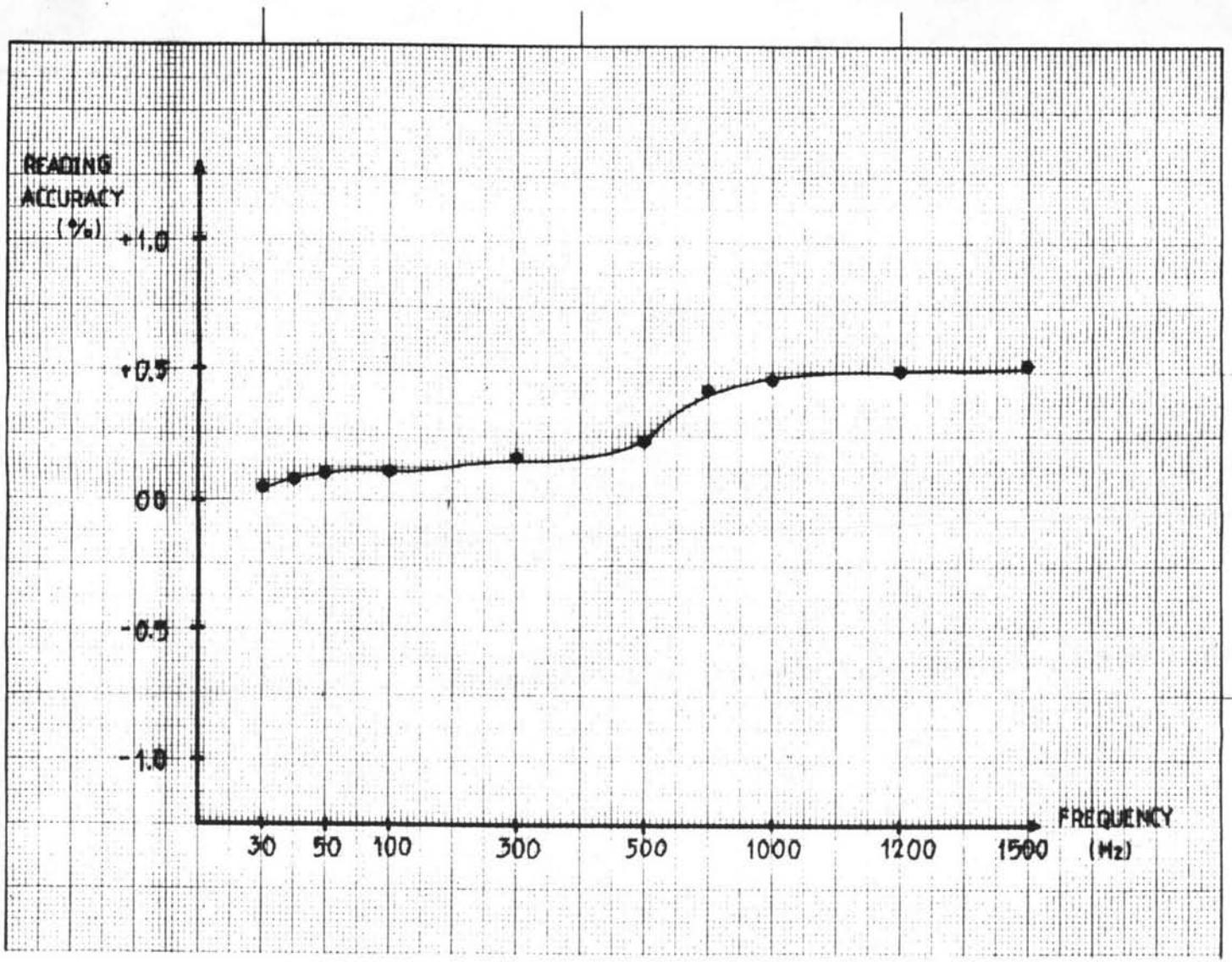


Fig. F-2 Freqency characteristic test for the Multiplier (AS:4)

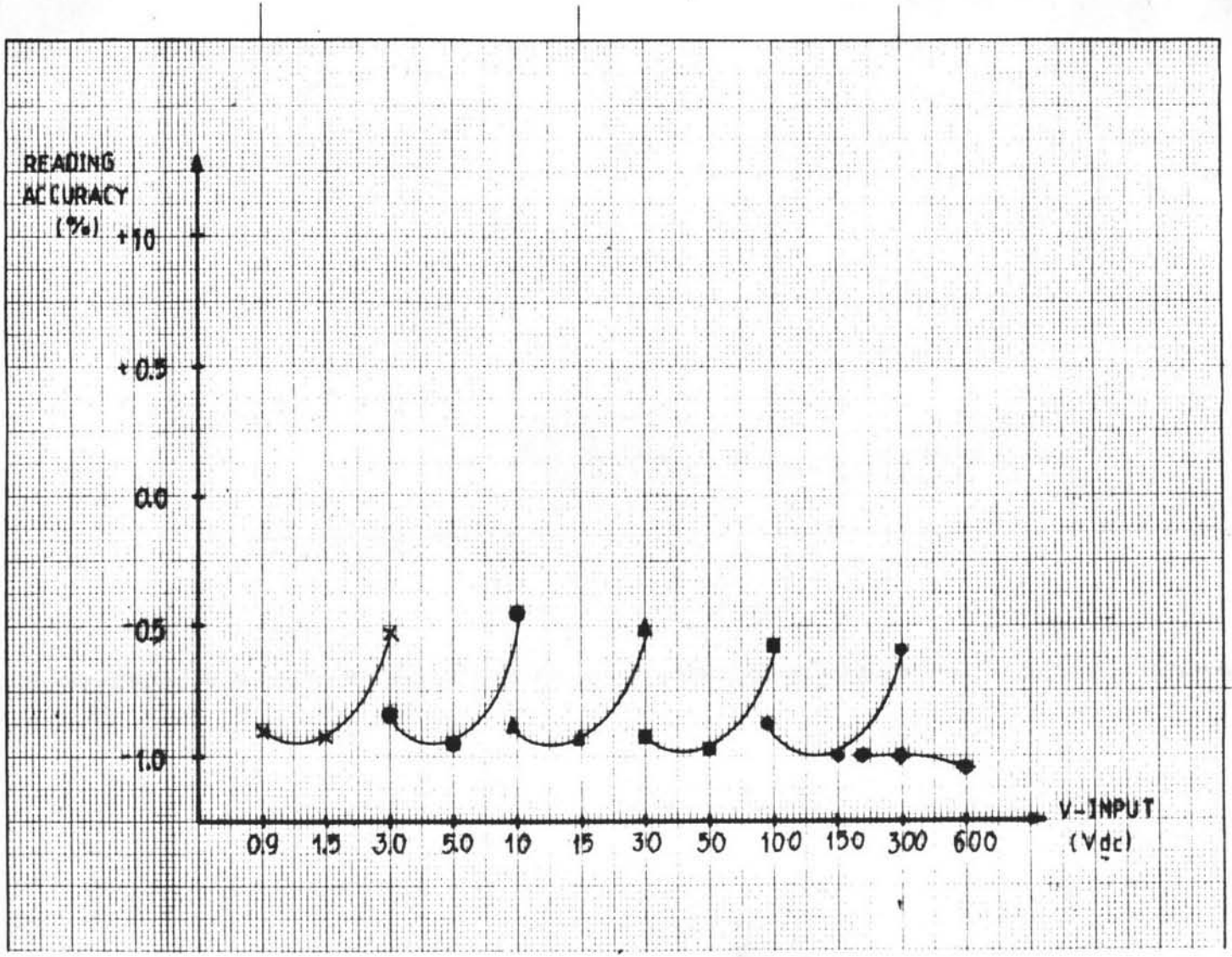


Fig. F-3 Linearity test for DC Voltage Measuring

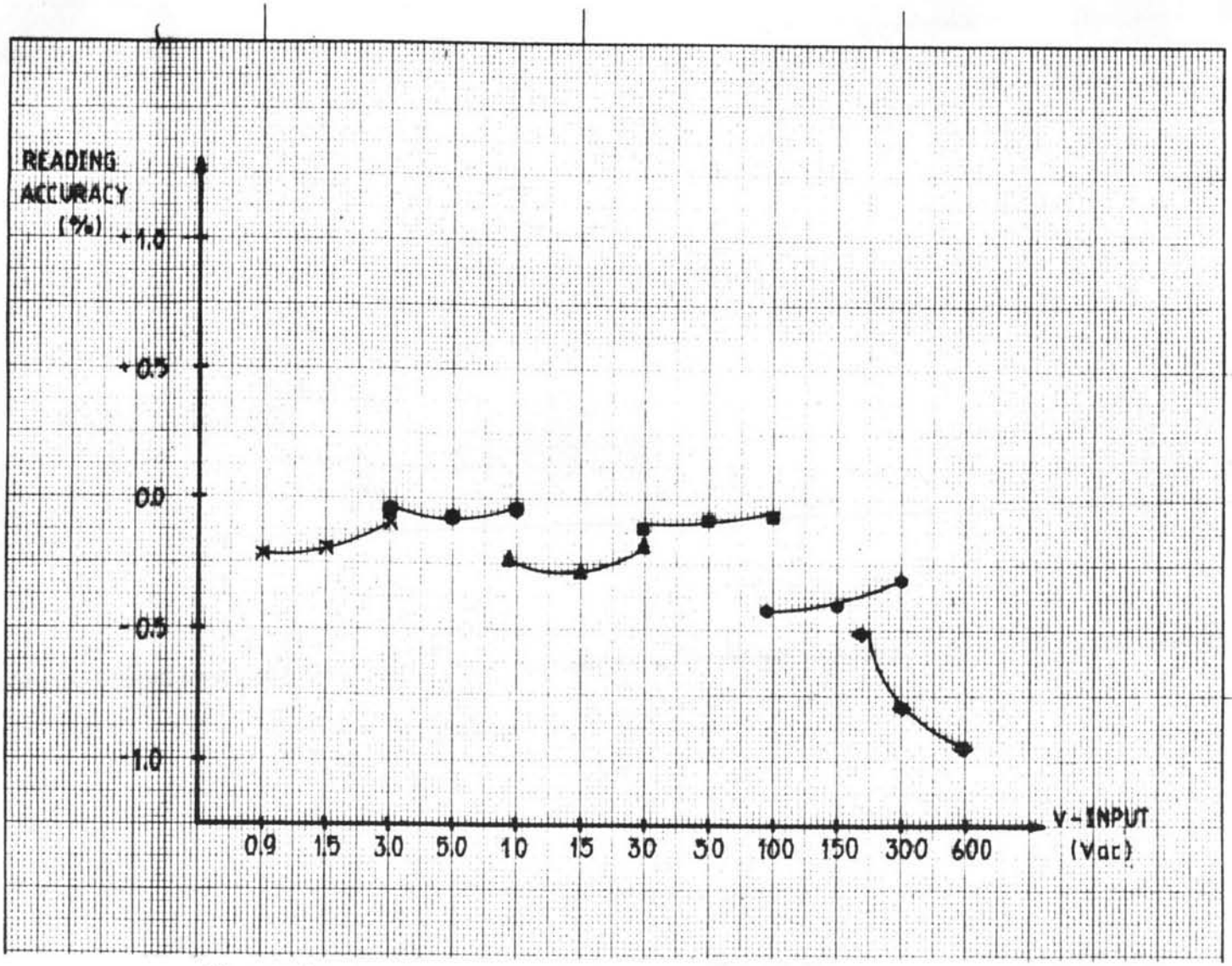


Fig. F-4 Linearlity test for AC Voltage Measuring

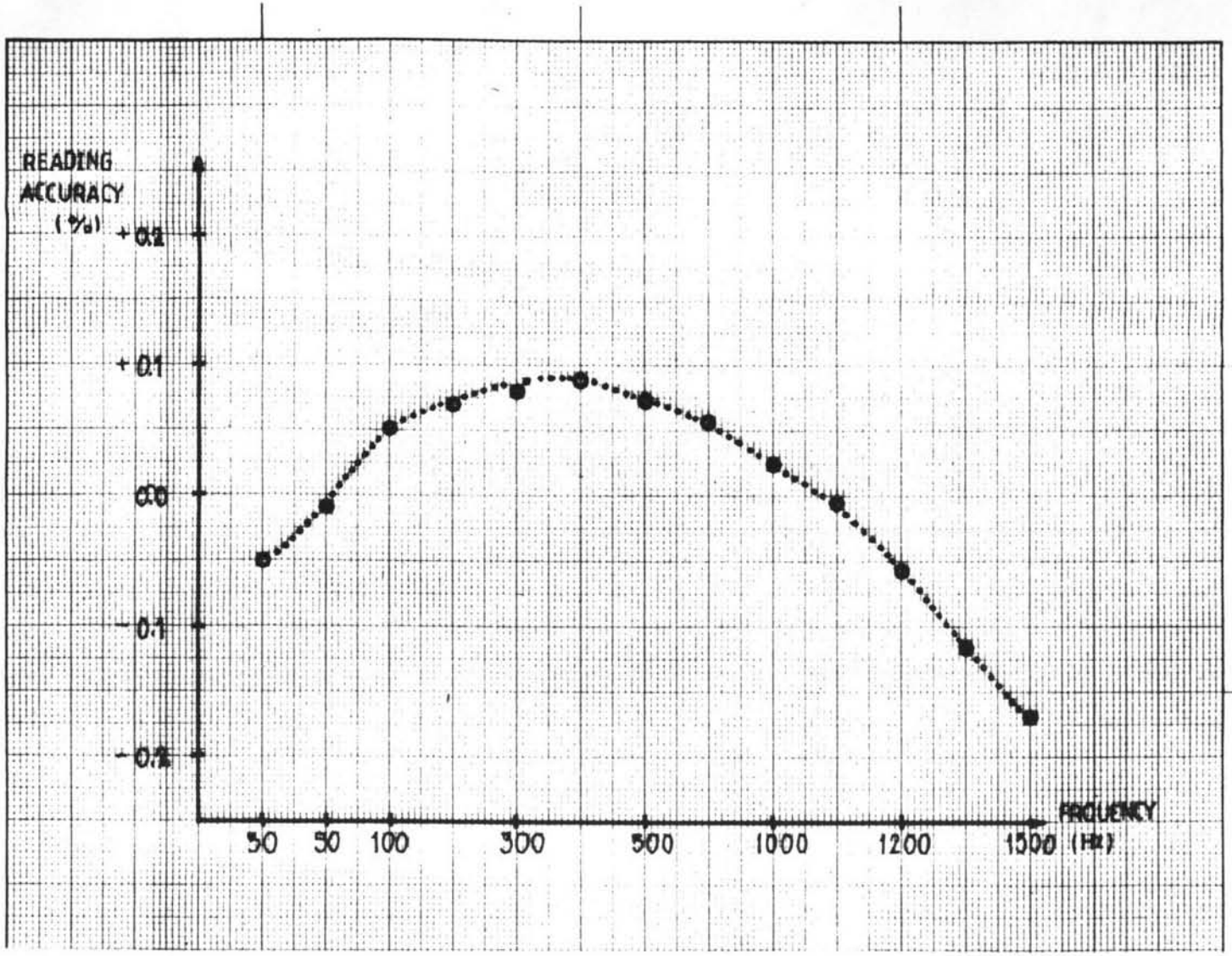


Fig. F-5 Frequency characteristic test for AC Voltage Measuring

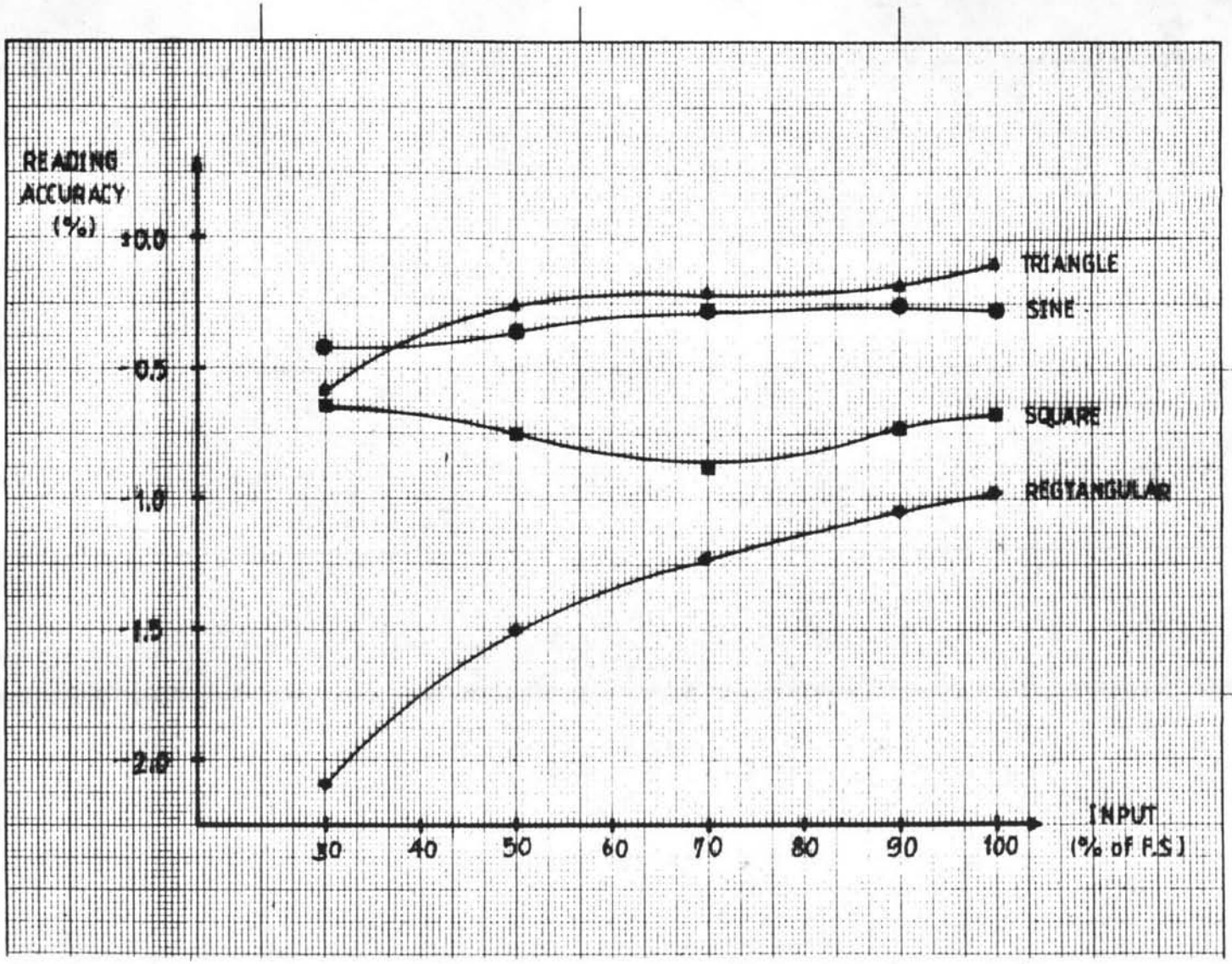


Fig. F-6 True RMS measuring test with distored waveforms

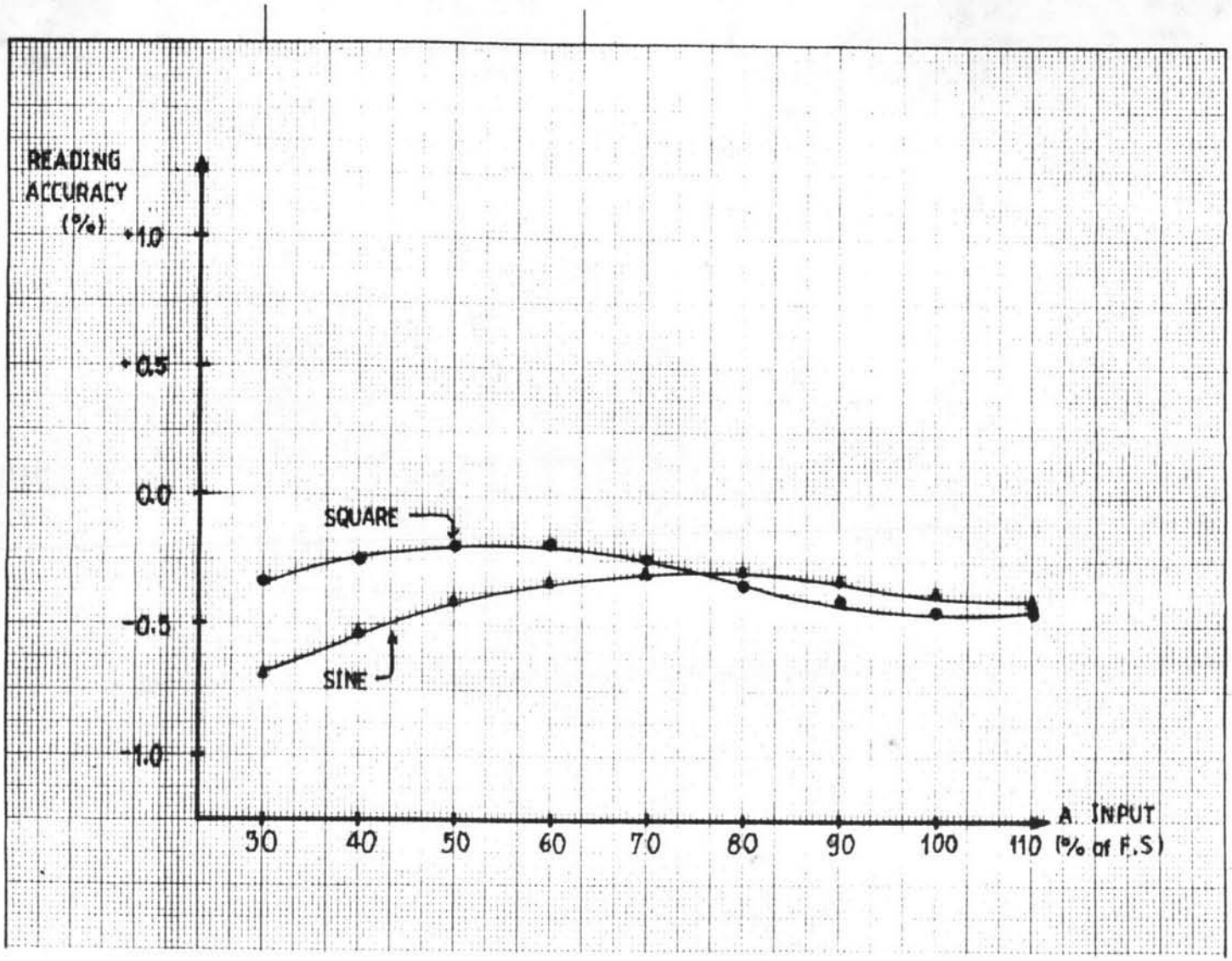


Fig. F-7 AC Current Measuring (test without current transformer T102)

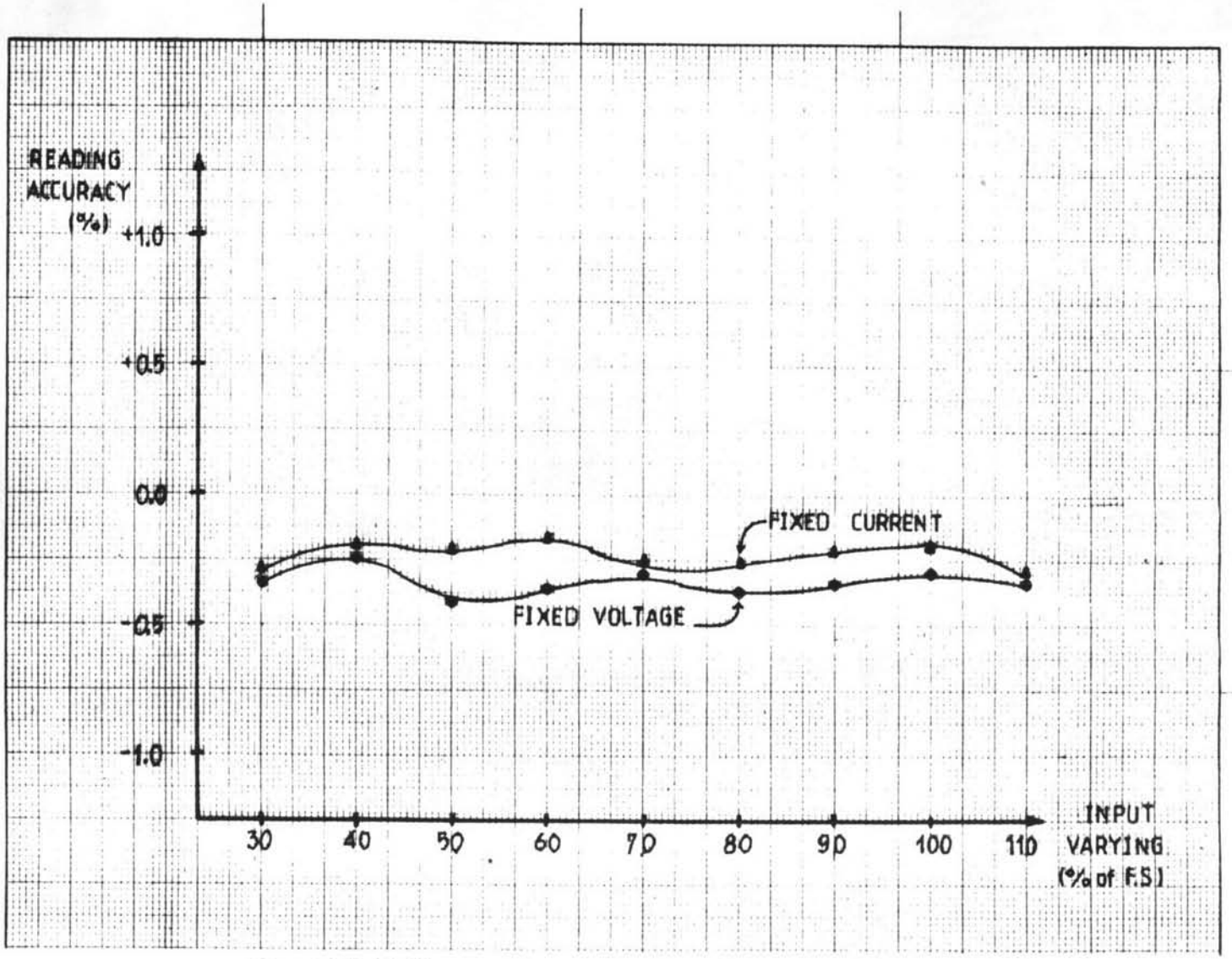


Fig. F-8 AC Wattage Measuring Test for power factor = 1.0

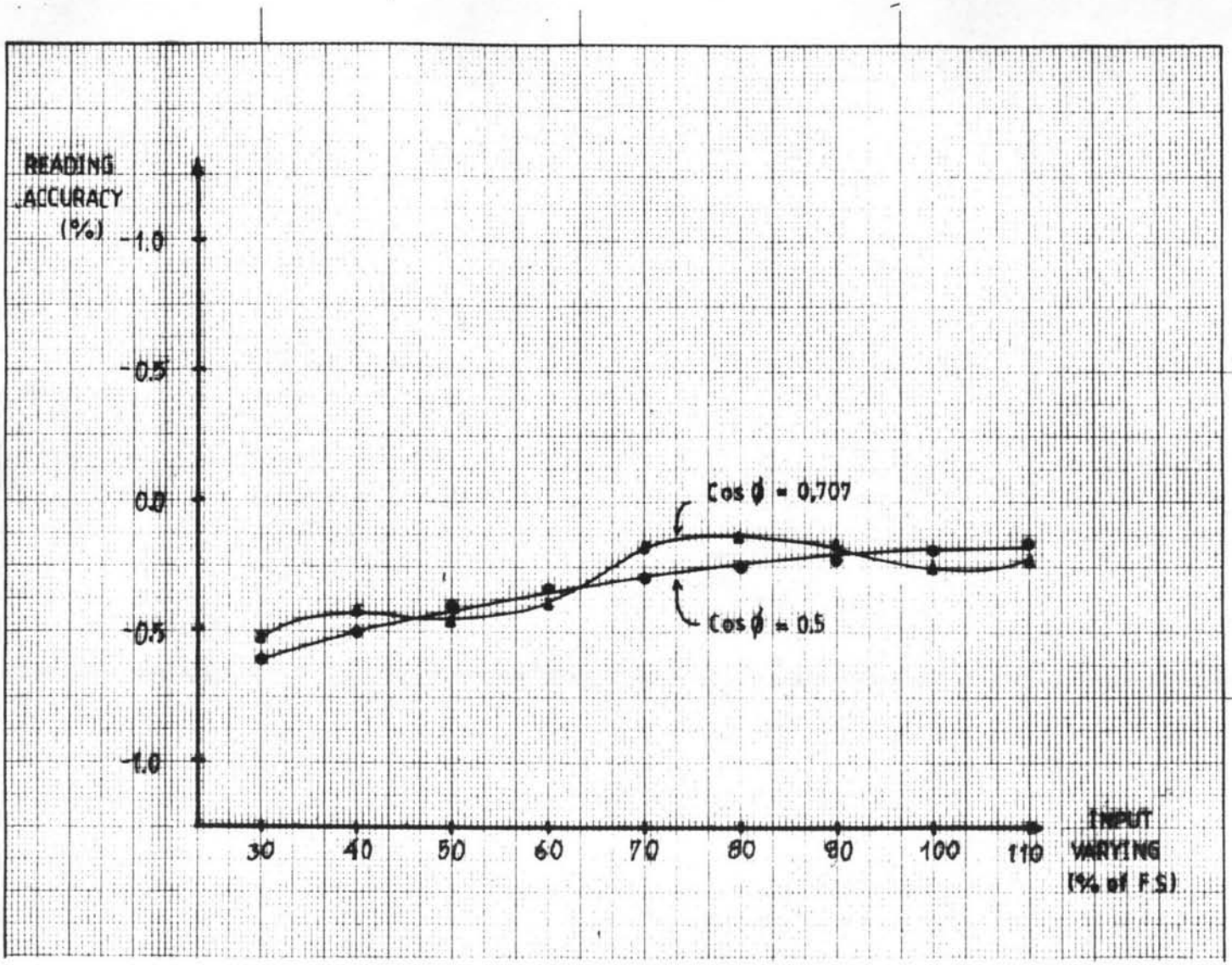


Fig. F-9 AC Wattage Measuring Test for influence by power factor

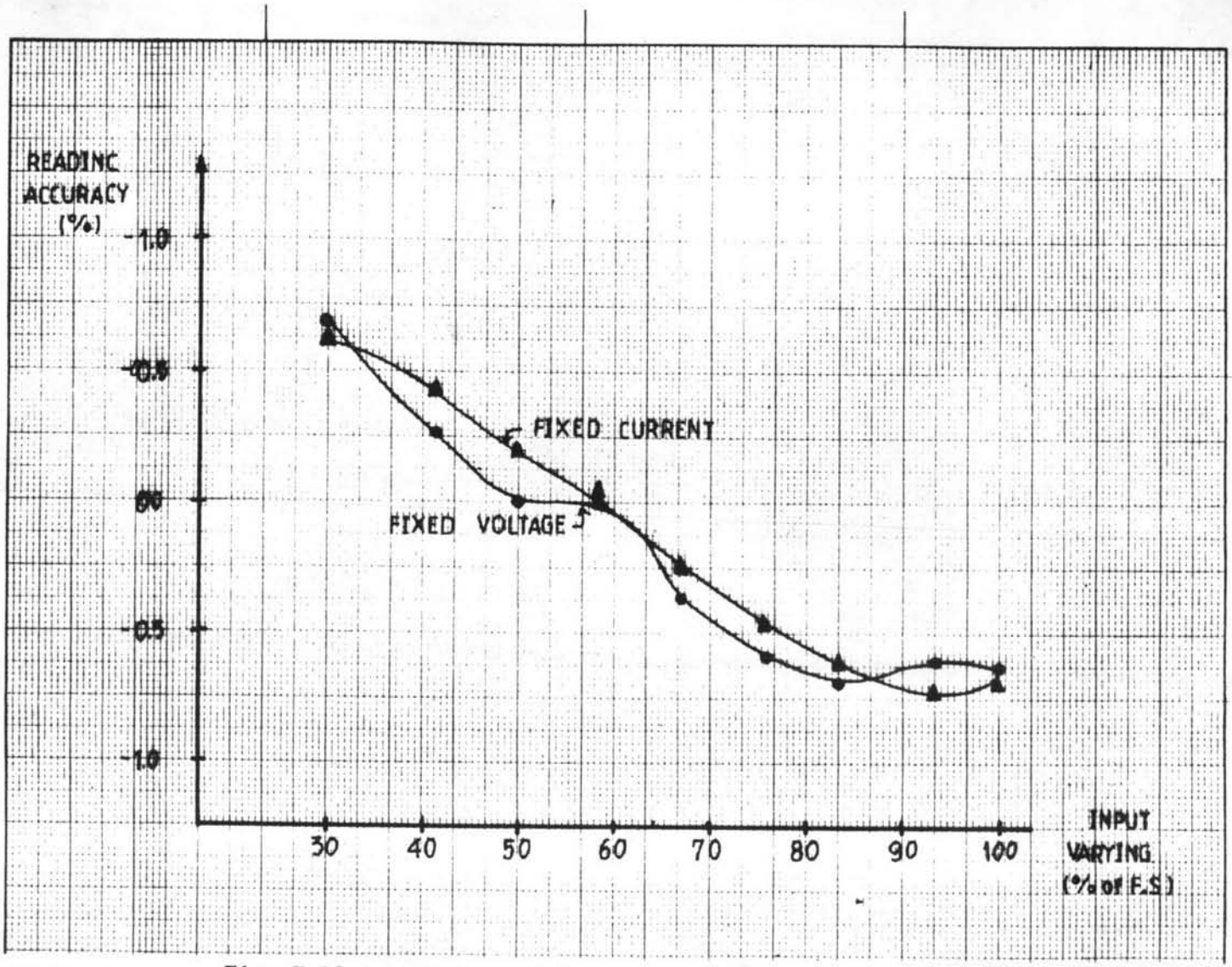


Fig. F-10 Actual test with current transformer (T102)

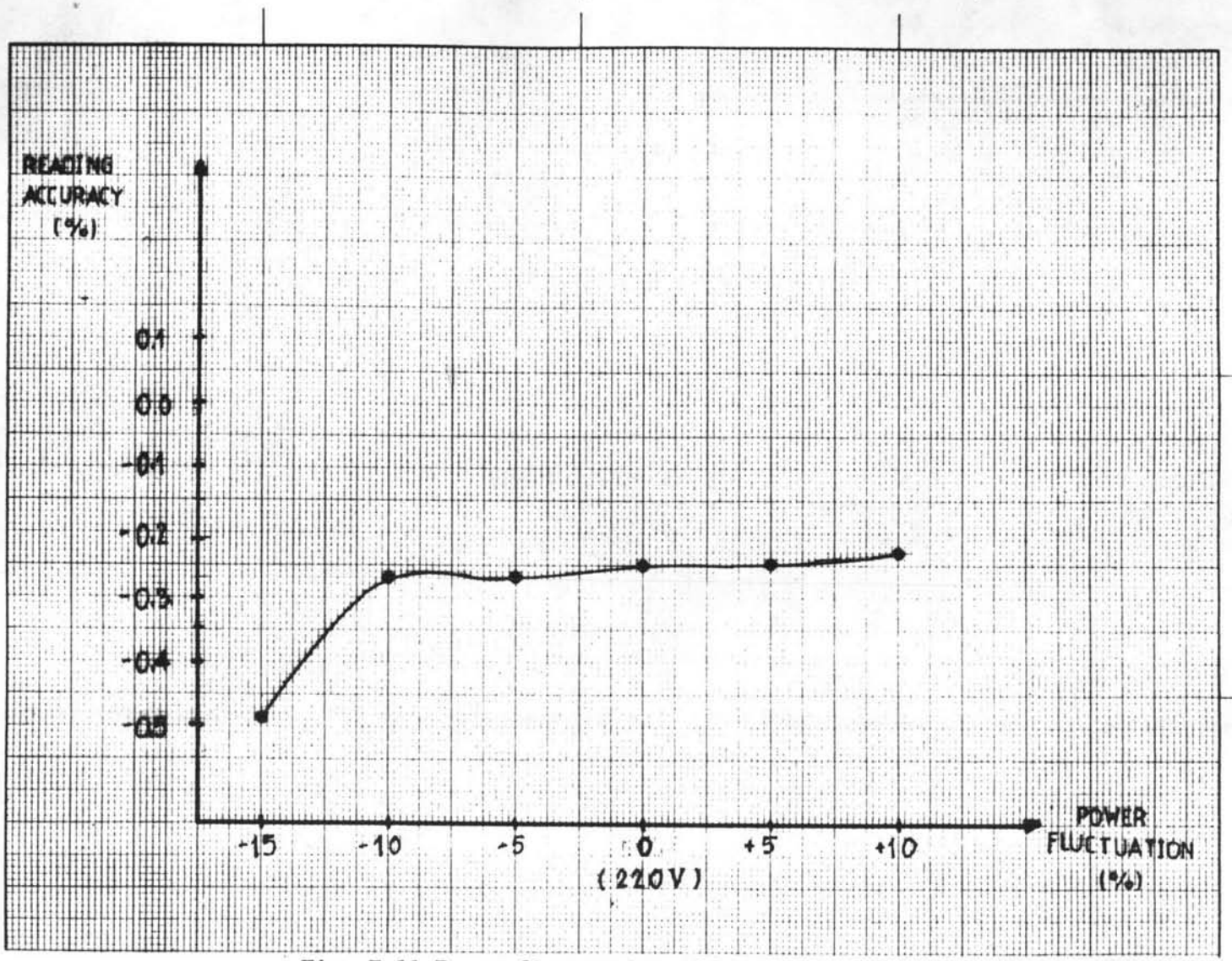


Fig. F-11 Power fluctuation effect test

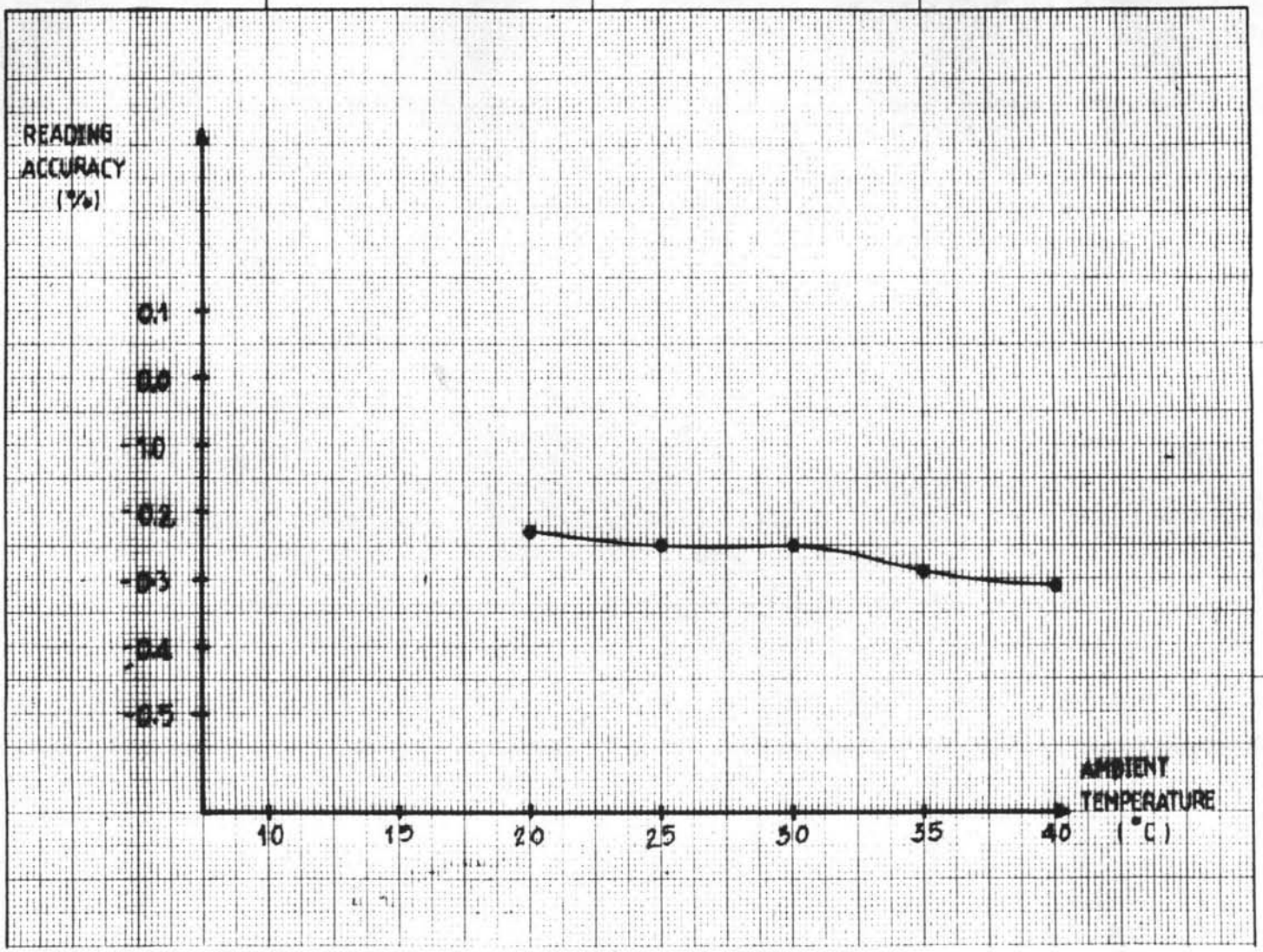


Fig. F-12 Temperature diviation effect test

VITA

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