LCR-745
LCR METER

SERVICE MANUAL

2nd edition Mar., 1987

CONTENTS

****

NOTE

These servicing instructions are for use by
qualified personnel only. To avoid electrical
shock, do not perform any servicing other than
that contained in the service manual unless
you are qualified to do so.

****

1. Test Equipment Required

The following test equipment is required for calibration and servicing of the Model LCR-745. The suggested specifications are the minimum necessary for proper calibration of this instrument.

Test Equipment	Minimum spec.
- Digital voltmeter	$4\frac{1}{2}$ digit
- Oscilloscope	5mV sensitivity 10MHz bandwidth
- Frequency counter	5MHz bandwidth
- AC millivoltneter	1.5V full scale
- Distortion meter	120Hz/1kHz 0.1% full scale
- Standard resistor	1, 10, 100, 1k, 10k, 100k 1M, 10M ohm
- Standard capacitor	0.05μF D < 0.0009
- Variable resistor	10k ohm

2. Calibration Procedure

* Calibration should be performed after a 30 minute warm-up period. It should also be confirmed that the unit is connected to the rated power line voltage.

* All adjustment should be completed in the given order, because some adjustments interact with others.

* During the adjustment procedure, remove the case only when necessary and replace immediately after making an adjustment. This will maintain all circuit at constant operating temperature.

1) Initial Control Settings

The initial control settings to be used for each check and adjustment are listed below. Any variations from these settings are stated in the applicable procedure.

OFFSET	OFF
FUNCTION	R
CIRCUIT MODE	AUTO
RANGE	AUTO
DC BIAS	OFF
FREQUENCY	1kHz
UNKNOWN terminal	

```
                   ─────────── UNKNOWN ───────────
      GUARD    L cur    L poten    H poten    H cur
        O        O         O          O         O
                           OPEN
```

2) Power Supply

a) Connect the DC voltmeter between test point and chassis.

b) Check the voltage according to Table-1

Test point	Voltage
IC1 pin2 (T-2683)	+5V
IC2 pin2 (T-2683)	+5V
IC3 pin2 (T-2683)	-5V

Table-1

** Test fixture connection

The test fixture (TF) may be user designed for a following
adjustment. (See page 35 for reference)

a) Remove connectors (J10 for ALG-1, J7 for ALG-2) on the
   analog board.

b) Connect the TF to appropriate connector (ALG-1 and ALG-2)
   respectively.

c) Set the switches as follows.

ALG-1	a1	a3	a4	a6	ca2
	0	0	0	0	0

ALG-2	b0	b1	b2	cb2
	0	0	0	0

3) Oscillator Adjustment

   a) Stability

   - Connect the oscilloscope to TP8.

   - Set the VR1 as shown in Figure-1.
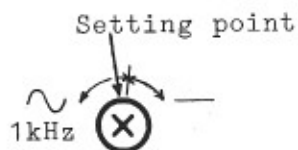

Figure-1

   b) Output Voltage
   - Connect the AC millivoltmeter between H CUR and GUARD terminal.

   - Set: TF   ALG-2   b0 b1 b2 cb2
                            0   1   0   0

   - Adjust VR2 for a reading of 1.05Vrms.

   * Note: During make an adjustment, output voltage should not
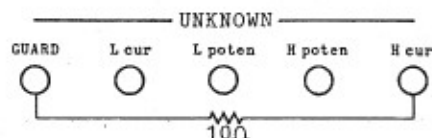   exceed 1.1Vrms.

c) Frequency Check

- Connect the frequency counter between H CUR and GUARD
  terminal.

- The frequency reading should be 1kHz ±50Hz (950Hz to 1050Hz).

- Set: TF   ALG-1

a1	a3	a4	a6	ca2
0	0	0	0	0

ALG-2

b0	b1	b2	cb2
0	0	0	1

- The frequency reading should be 120Hz ±6Hz (114Hz to 126Hz).

d) Distortion Check

- Set: -745


```
            ———————— UNKNOWN ————————
   GUARD     L cur    L poten   H poten    H cur
     O         O        O         O          O
     └─────────────────────/\/\/\─────────────┘
                            10Ω
```

TF   ALG-1

a1	a3	a4	a6	ca2
0	0	0	0	0

ALG-2

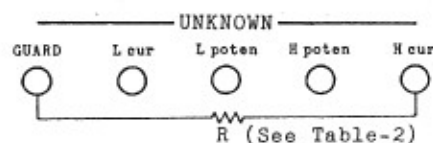| b0	b1	b2	cb2
1	0	0	0

- Connect the distortion meter to H CUR and GUARD terminal.

- The distortion should be 0.03% or less at 1kHz.

- Set: TF   ALG-1

a1	a3	a4	a6	ca2
0	0	0	0	0

ALG-2

b0	b1	b2	cb2
1	0	0	1

- The distortion should be 0.05% or less at 120Hz.

4) Ranging Check

- Set: -745

```
            ———————— UNKNOWN ————————
   GUARD     L cur    L poten   H poten    H cur
     O         O        O         O          O
     └──────────────────────/\/\/\────────────┘
                          R (See Table-2)
```

```
TF      ALG-1    a1   a3   a4   a6   ca2
                  0    0    0    0    0
        ALG-2    b0   b1   b2  cb2
                 └─────────┘
                 See Table-2    0
```
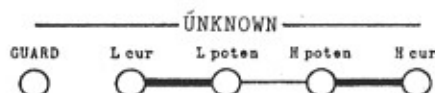
- Connect the oscilloscope to H CUR and GUARD terminal.
  (Parallel with R)

- Check the sine wave amplitude according to Table-2.

R	TF				Sinewave amplitude
	ALG-2			Range	
	b0	b1	b2		
10ohm	1	0	·0	10ohm	$\simeq$ 1.1Vp-p
100ohm	0	1	1	100ohm	$\simeq$ 1.5Vp-p
1kohm	0	1	0	1kohm	
10kohm	0	0	1	10kohm	
100kohm	0	0	0	100kohm	

Table-2

- Set: -745

```
        ─────── UNKNOWN ───────
  GUARD   L cur  L poten  H poten  H cur
    ○       ○       ○       ○       ○
```

```
TF      ALG-1    a1   a3   a4   a6   ca2
                  0    0    0    0    0
        ALG-2    b0   b1   b2  cb2
                 └─────────┘
                 See Table-3    0
```

- Connect the oscilloscope to TP3.

- Check the sine wave amplitude according to Table-3.

TF				Sinewave amplitude
ALG-2			Range	
b0	b1	b2		
1	0	0	10ohm	$\simeq$ 2.5Vp-p
0	1	1	100ohm	$\simeq$ 3Vp-p
0	1	0	1kohm	
0	0	1	10kohm	
0	0	0	100kohm	

Table-3

5) DC Bias Adjustment

- Set: -745

```
                    ────────── UNKNOWN ──────────
              GUARD    L cur   L poten   H poten   H cur
                O        O        O         O        O
                                 OPEN
```

TF   ALG-1   a1   a3   a4   a6   ca2
                   0   0   0   0   0
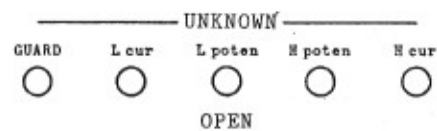
         ALG-2   b0   b1   b2   cb2
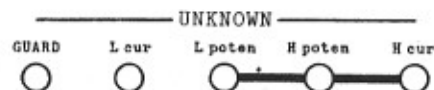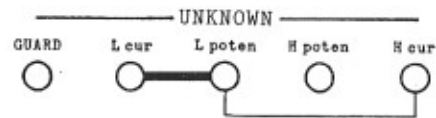   0   0   0   0

- Connect the digital voltmeter to TP6.

- Adjust VR3 for a reading of 1.50V $\pm$50mV.

6) Reference Voltage Adjustment

- Set: Same as 5)

- Connect the digital voltmeter to TP16.

- Adjust VR12 for a reading of +1.800V $\pm$0.9mV.

7) CMRR Adjustment

- Set: -745

```
                    ────────── UNKNOWN ──────────
              GUARD    L cur   L poten   H poten   H cur
                O        O        O━━━━━━━O━━━━━━━O
```
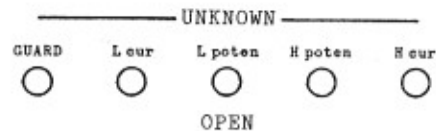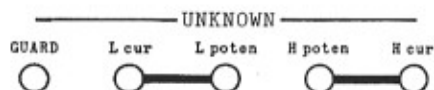
TF   ALG-1   a1   a3   a4   a6   ca2
                   1   0   0   0   0

         ALG-2   b0   b1   b2   cb2
                   1   0   0   0

- Connect the oscilloscope to TP2.   (Use AC couple)

- Adjust VR4 for minimum display amplitude.

8) Offset Adjustment

   a) UNKWN Amplifier

      - Set: -745

      ```
      ────────── UNKNOWN ──────────
      GUARD    L cur   L poten  H poten   H cur
        O        O       O━━━━━━O         O
      ```

TF	ALG-1	a1	a3	a4	a6	ca2
		1	0	0	0	0
	ALG-2	b0	b1	b2	cb2	
		1	0	0	0	

      - Connect the oscilloscope to TP2. Use DC coupled input.

      - Adjust VR5 until DC level of displayed waveform is 0.00V ±15mV.

   b) UNKWN Invert Amplifier

      - Set: -745

      ```
      ────────── UNKNOWN ──────────
      GUARD    L cur   L poten  H poten   H cur
        O        O        O        O        O
                        OPEN
      ```

TF	ALG-1	a1	a3	a4	a6	ca2
		0	0	0	0	0
	ALG-2	b0	b1	b2	cb2	
		1	0	0	0	

   - Connect the DC voltmeter to TP2.

   - Note the voltage reading.

   - Connect the DC voltmeter to TP9.

   - Adjust VR6 for a reading of the same voltage as TP2 with opposite polarity.

c) UNKWN Smoothing Circuit

- Set: -745

```
                    ———————— UNKNOWN ————————
         GUARD     L cur    L poten   H poten   H cur
          O         O━━━━━━━━O         O         O
                             └─────────────────┘
```

	TF	a1	a3	a4	a6	ca2
	ALG-1	a1	a3	a4	a6	ca2
		0	0	0	1	0
	ALG-2	b0	b1	b2	cb2	
		1	0	0	0	

- Connect the oscilloscope to TP13.

- Adjust VR8 until DC level of displayed waveform is 0.00V ±0.5mV.

d) REF Amplifier

- Set: -745

```
                    ———————— UNKNOWN ————————
         GUARD     L cur    L poten   H poten   H cur
          O         O         O         O         O
                            OPEN
```

	TF	a1	a3	a4	a6	ca2
	ALG-1	a1	a3	a4	a6	ca2
		0	1	0	0	0
	ALG-2	b0	b1	b2	cb2	
		0	1	0	0	

- Connect the oscilloscope to TP4.

- Adjust VR13 until DC level of displayed waveform is 0.00V ±15mV.

e) REF Invert Amplifier

- Set: -745

```
                    ———————— UNKNOWN ————————
         GUARD     L cur    L poten   H poten   H cur
          O         O         O         O         O
                            OPEN
```

```
TF      ALG-1   a1  a3  a4  a6  ca2
                 0   1   0   0   0
        ALG-2   b0  b1  b2  cb2
                 0   0   1   0
```

- Connect the DC voltmeter to TP4

- Note the voltage reading.

- Connect the DC voltmeter to TP10.

- Adjust VR7 for a reading of the same voltage as TP4 with
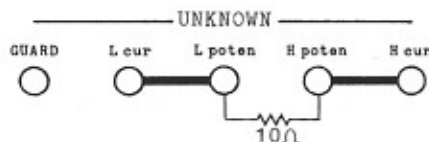 opposite polarity.

f) REF Smoothing Circuit

- Set: -745

```
    ───────── UNKNOWN ─────────
GUARD   L cur   L poten   H poten   H cur
  O       O───────O         O───────O
```

```
TF      ALG-1   a1  a3  a4  a6  ca2
                 0   0   0   0   0
        ALG-2   b0  b1  b2  cb2
                 1   0   0   0
```

- Connect the oscilloscope to TP14.

- Adjust VR9 until DC level of displayed waveform is 0.00V
  ±0.5mV.

9) Phase Adjustment

- Set: -745

```
    ───────── UNKNOWN ─────────
GUARD   L cur   L poten   H poten   H cur
  O       O───────O         O───────O
                      └──www──┘
                        10Ω
```

TF	ALG-1	a1	a3	a4	a6	ca2
		0	0	1	1	0
	ALG-2	b0	b1	b2	b3	
		1	0	0	0	

- Connect the oscilloscope to TP14.

- Adjust VR10 until DC level of displayed waveform is 0.00V ±2mV.

10) Comparator Level Adjustment

- Set: -745
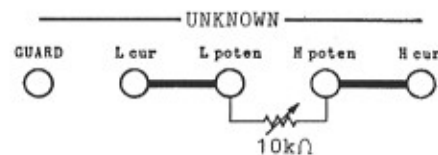
TF	ALG-1	a1	a3	a4	a6	ca2
		0	1	0	0	0
	ALG-2	b0	b1	b2	cb2	
		0	1	1	0	

- Connect the digital voltmeter to TP14.

- Adjust 10kohm variable resistor for a reading of -1850mV.

- Turn VR11 to fully clockwise.

- Connect the oscilloscope to TP15.

- Set the ca2 switch of ALG-1 to 1.
- Set the cb2 switch of ALG-2 to 1.

- The level of TP15 should be stayed at 0.

- Turn VR11 to counterclockwise slowly until level of TP15 is 1.
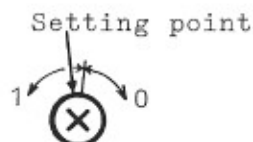
Figure-2

** Test fixture removal

    a) Remove the connectors of the TF from -745.

    b) Insert the connectors (J10 for ALG-1, J7 for ALG-2) to
       original position on the analog board.

11) Clock Oscillator Adjustment

    - Connect the frequency counter to TP1 (T-2680).

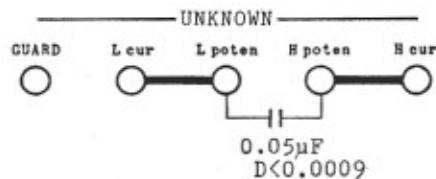   - Adjust C14 for a frequency reading of 3.6864MHz.

12) Offset and Phase Adjustment

    - Set: FUNCTION   C
            CIRCUIT MODE   PARA
            RANGE   HOLD
              UP   µF lamp on
            FREQUENCY   1kHz
            DC BIAS   OFF
            UNKNOWN

                        —————— UNKNOWN ——————
                        GUARD   L cur L poten H poten H cur
                        ○   ○——○   ○——○
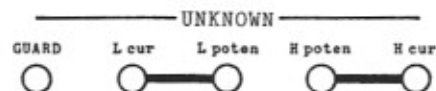
    - Adjust VR9 precisely for a C reading of .000µF.

    - Set: RANGE   AUTO
            UNKNOWN

                        —————— UNKNOWN ——————
                        GUARD   L cur L poten H poten H cur
                        ○   ○——○   ○——○
                                    ⊢⊣
                              0.05µF
                              $D < 0.0009$

    - Adjust VR10 for a D reading of .000.

- Control settings

FUNCTION	L
CIRCUIT MODE	SER
RANGE	HOLD
UP	mH lamp on. (No decimal point)
FREQ	1kHz
DC BIAS	OFF
UNKNOWN	

```
─────────UNKNOWN─────────
GUARD    L cur  L poten  N poten  N cur
  ◯      ◯━━━━◯      ◯━━━━◯
```
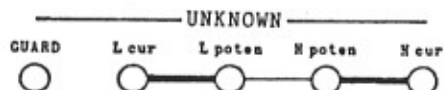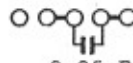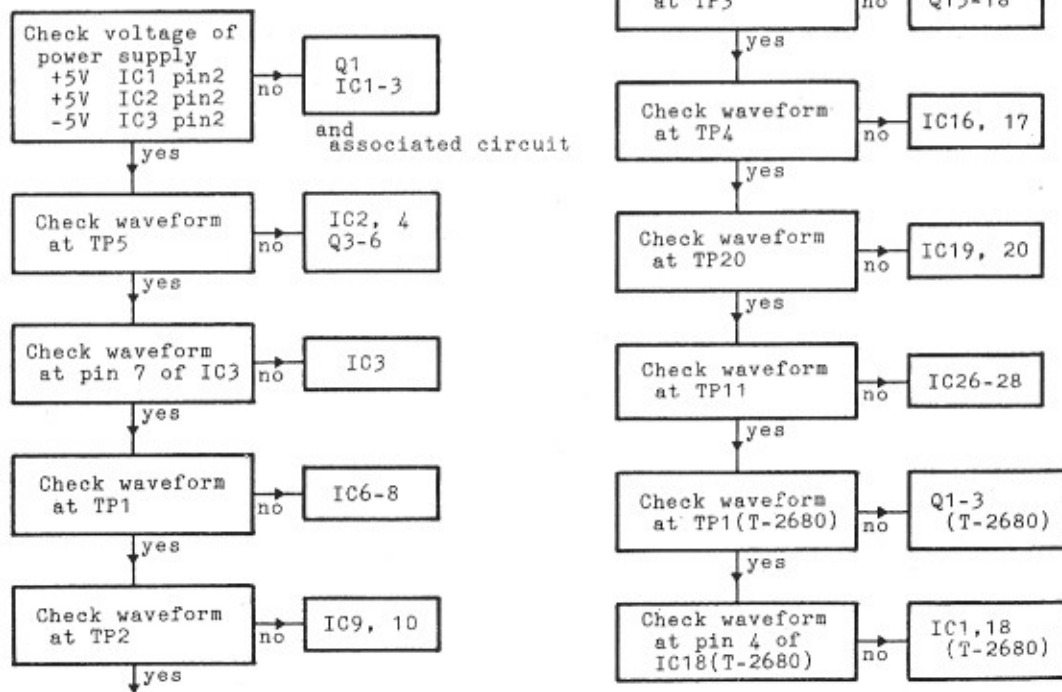
- Adjuat VR8 for a L reading of ± OmH.

3. Troubleshooting Procedure

1) Check all control settings, because an incorrect setting can make a good unit appear defective.

2) Some trouble can be solved with proper adjustment.

3) Check the DC voltage and waveform as shown in the schematic diagram to locate the defective circuit.
Start with the power supply.

4) Check all circuit for visual defects such as broken components, loose connections and poor soldering which could be a cause of trouble.

5) Troubleshooting Chart

Control Settings
- FUNCTION   C
- CIRCUIT MODE   AUTO
- RANGE   AUTO
- FREQUENCY   1kHz
- UNKNOWN   ○ ○-○ ○-○

0.05µF
D<0.0009

```
Check voltage of
power supply
+5V  IC1 pin2      no    Q1
+5V  IC2 pin2    ──────► IC1-3
-5V  IC3 pin2
                        and
          │ yes        associated circuit
          ▼
Check waveform     no    IC2, 4
at TP5           ──────► Q3-6
          │ yes
          ▼
Check waveform     no
at pin 7 of IC3  ──────► IC3
          │ yes
          ▼
Check waveform     no
at TP1           ──────► IC6-8
          │ yes
          ▼
Check waveform     no
at TP2           ──────► IC9, 10
          │ yes
          ▼
```

```
          │
          ▼
Check waveform     no
at TP19          ──────► IC18,20
          │ yes
          ▼
Check waveform     no    IC11-15
at TP3           ──────► Q15-18
          │ yes
          ▼
Check waveform     no
at TP4           ──────► IC16, 17
          │ yes
          ▼
Check waveform     no
at TP20          ──────► IC19, 20
          │ yes
          ▼
Check waveform     no
at TP11          ──────► IC26-28
          │ yes
          ▼
Check waveform     no    Q1-3
at TP1(T-2680)   ──────► (T-2680)
          │ yes
          ▼
Check waveform     no    IC1,18
at pin 4 of      ──────► (T-2680)
IC18(T-2680)
```

6) Error message
   ROM version: 1.3 and after.
   Message indication: LSD of the LCR display will flicker.

Message	Description	Probable cause
0	No data comes out from UAD(IC23, T-2679)	Check IC23(T-2679) and associated circuit. Check IC7(T-2680) and associated circuit.
1	No data comes out from RAD(IC24, T-2679)	Check IC24(T-2679) and associated circuit. Check IC7(T-2680) and associated circuit.
2	Wrong data at UAD	Check IC23(T-2679) and associated circuit. Check IC7(T-2680) and associated circuit.
3	Wrong data at RAD	Check IC24(T-2679) and associated circuit. Check IC7(T-2680) and associated circuit.
4	RAD, UAD not working	Check IC7(T-2680) and associated circuit. No clock signal for A/D converter.
5	No data comes out from PTM(IC17, T-2680)	Check IC17(T-2679) and associated circuit. Check IC18(T-2680) and associated circuit. No 120Hz/1kHz oscillation
6	Wrong data from 5000H ROM	Check ROM and associated circuit. No data in the ROM.

   * UAD: Unknown A/D converter
     RAD: Reference A/D converter

VR8
UNKWN
AC-DC
OFFSET

VR9
REF
AC-DC
OFFSET

IC1
Pin2
+5V

IC3
Pin2
-5V

IC2
Pin2
+5V

C14
3.6864MHz

T-2683

T-2679

T-2680

ALG-1

TP1

TP17

TP11

TP12

TP13

TP14

TP1

VR10
PHASE

TP18

TP20

TP19

TP8

VR6
UNKWN
INV
OFFSET

TP9

TP10

TP2

TP15

TP4

VR7
REF INV
OFFSET

TP1

TP3

TP16

TP5

VR5
UNKWN
OFFSET

TP6

ALG-2

TP7

VR4
UNKWN
CMRR

VR13
REF
OFFSET

VR11
AMP COMP

VR12
A/D REF
+1.800V

VR3
INT BIAS
+1.50V

VR2
OSC AMP

VR1
OSC STAB
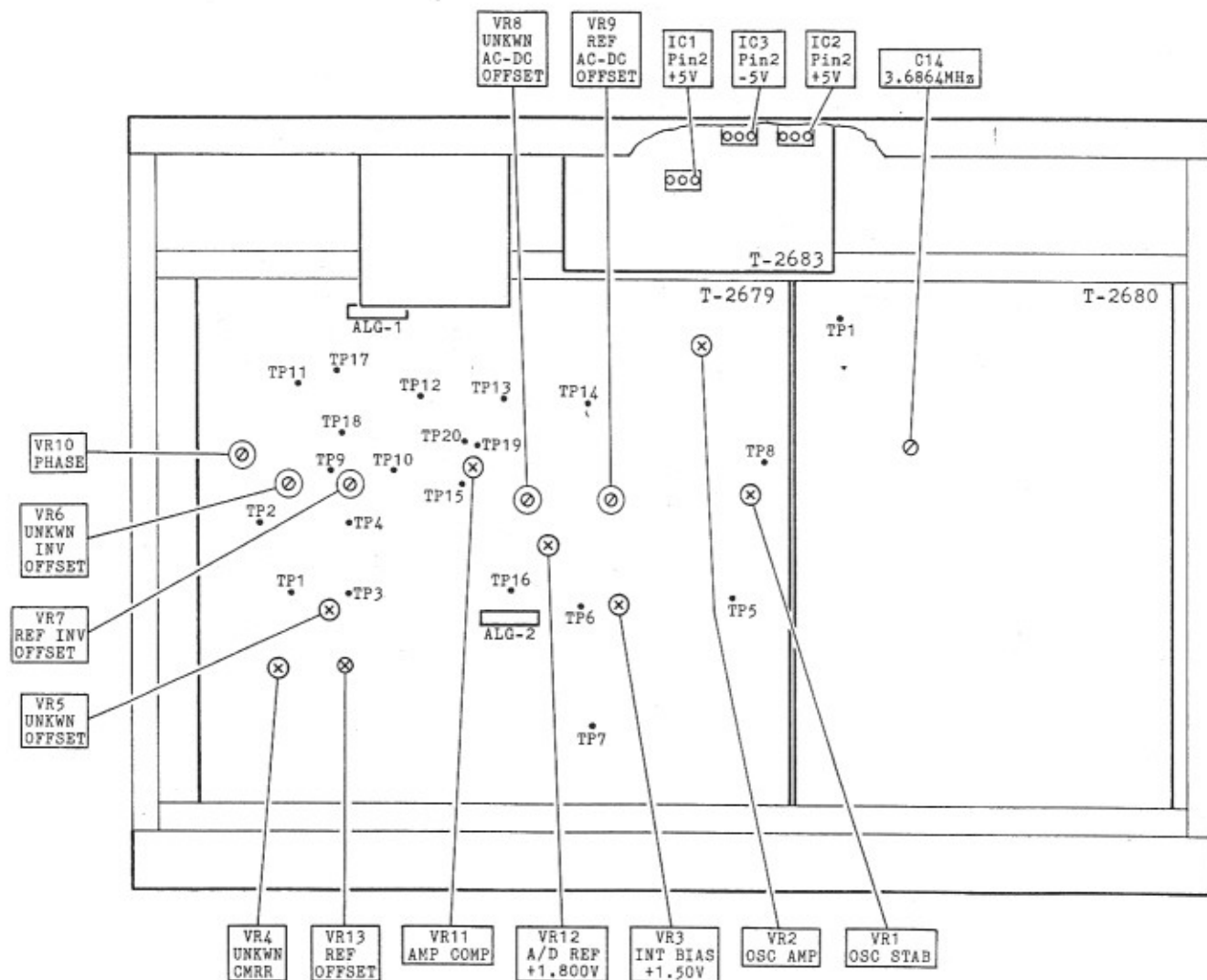
5. Printed Circuit Board

T-2679

T-2683

T-2680

-18-

LCR-745

(1/15)

Block diagram

* Waveforms obtained under
  conditions given in page 14.
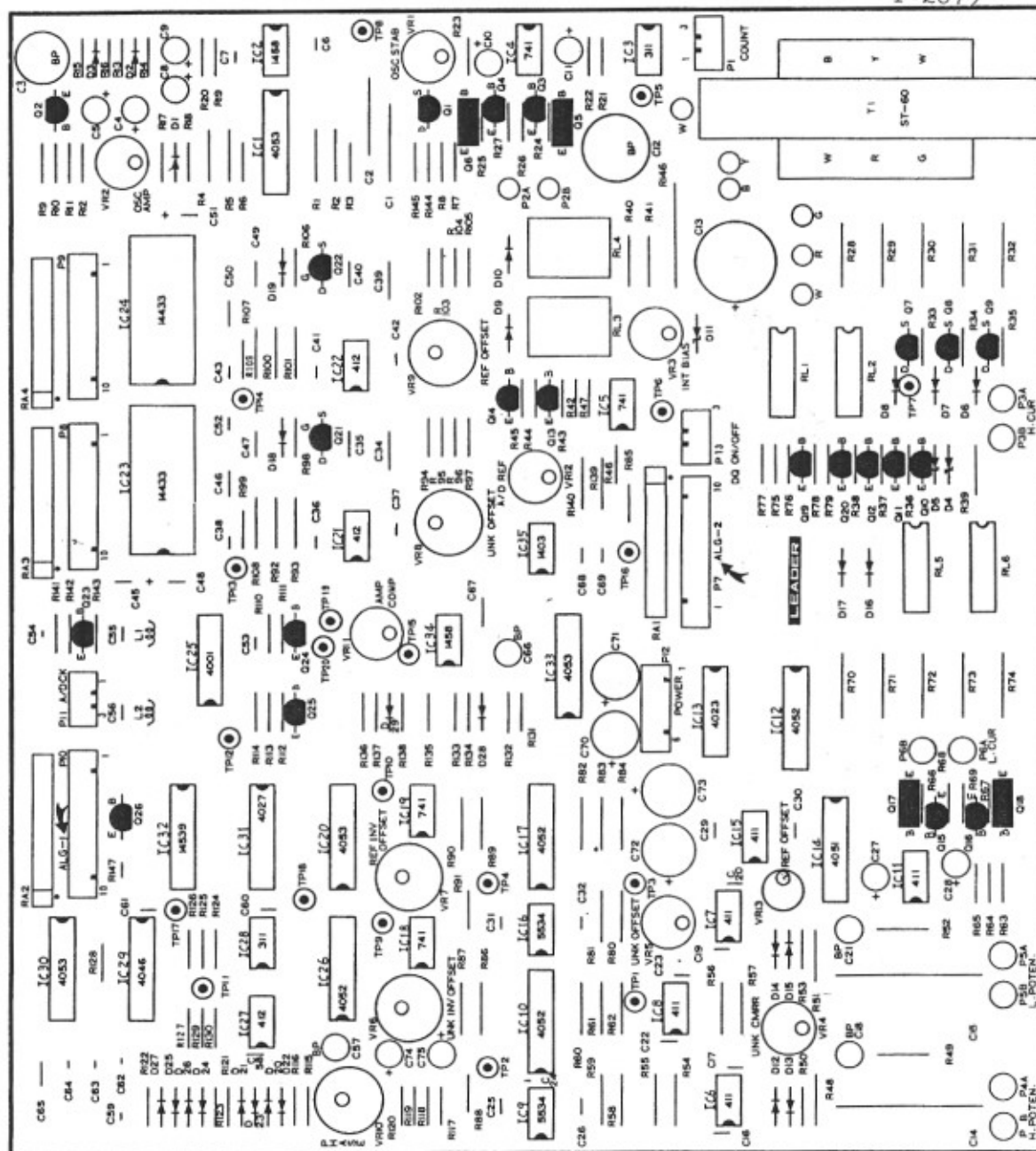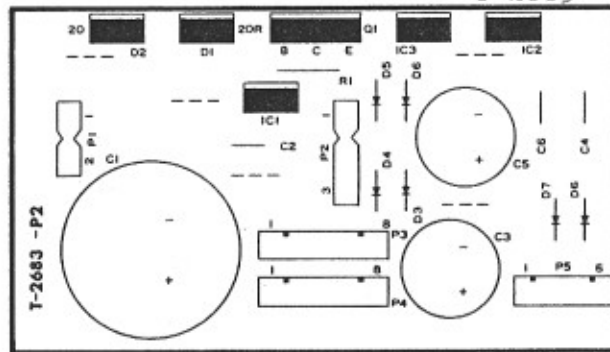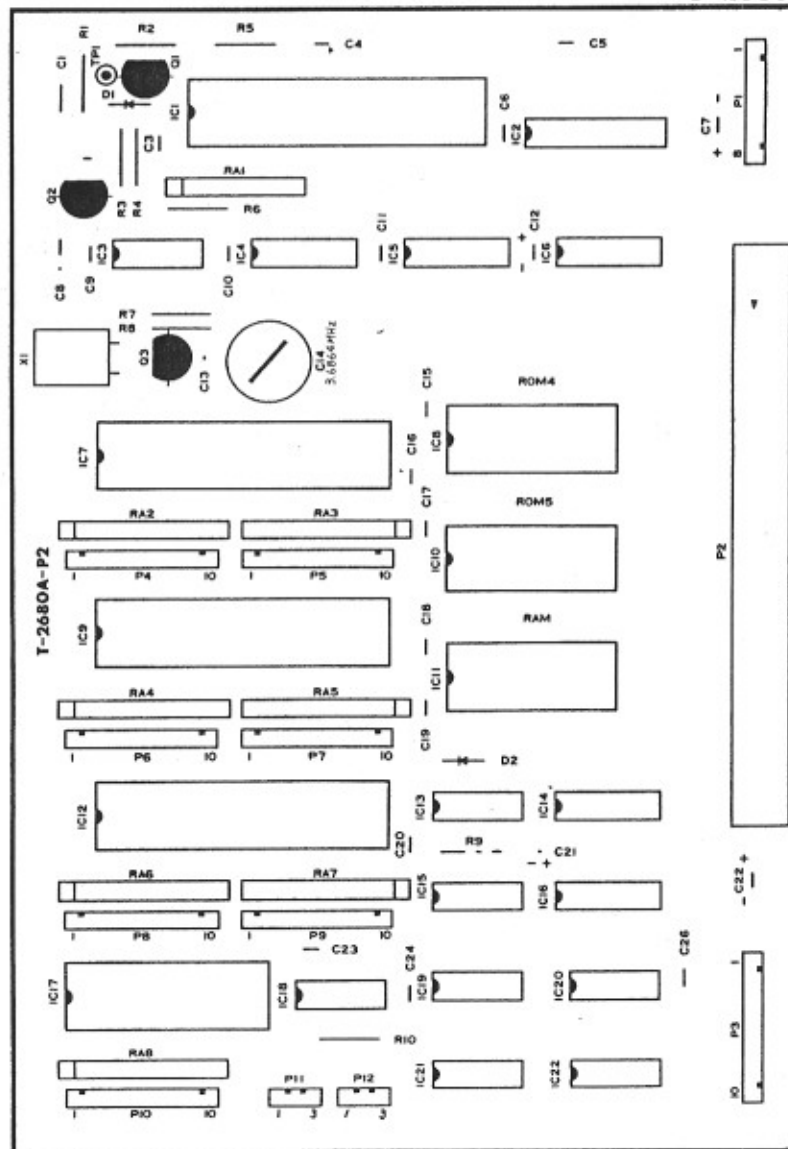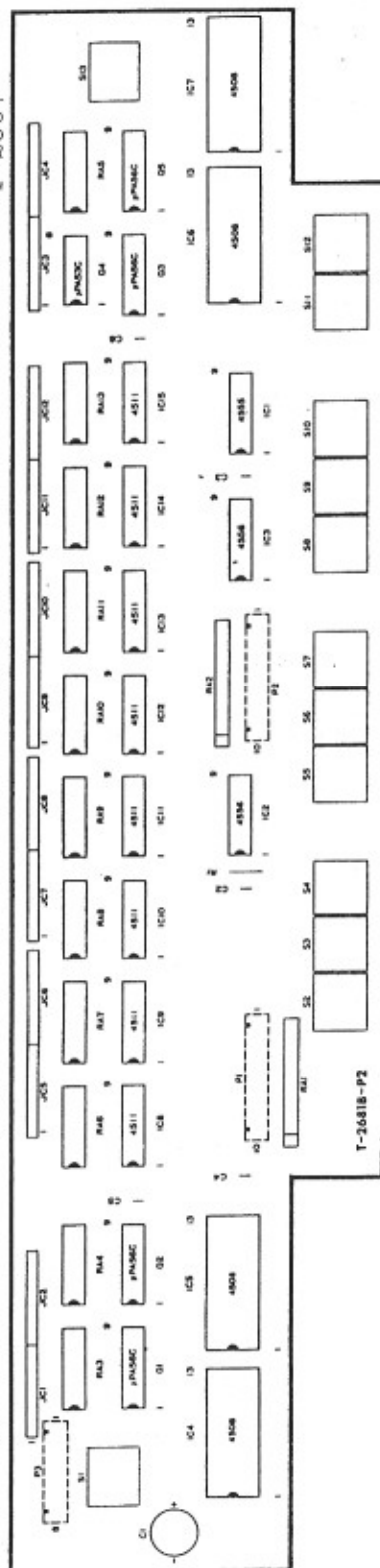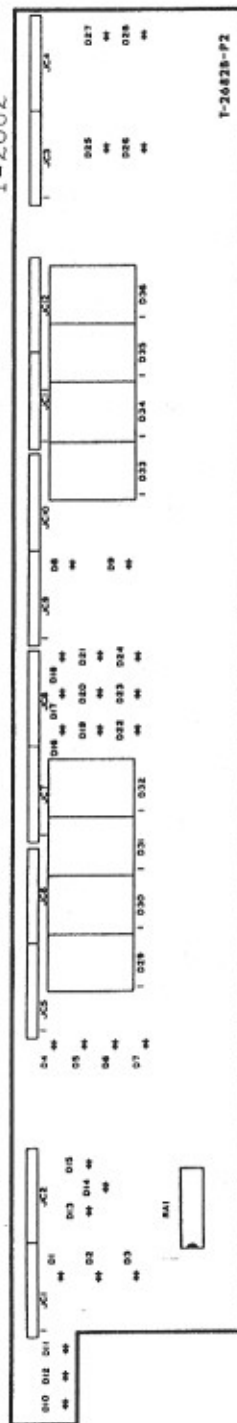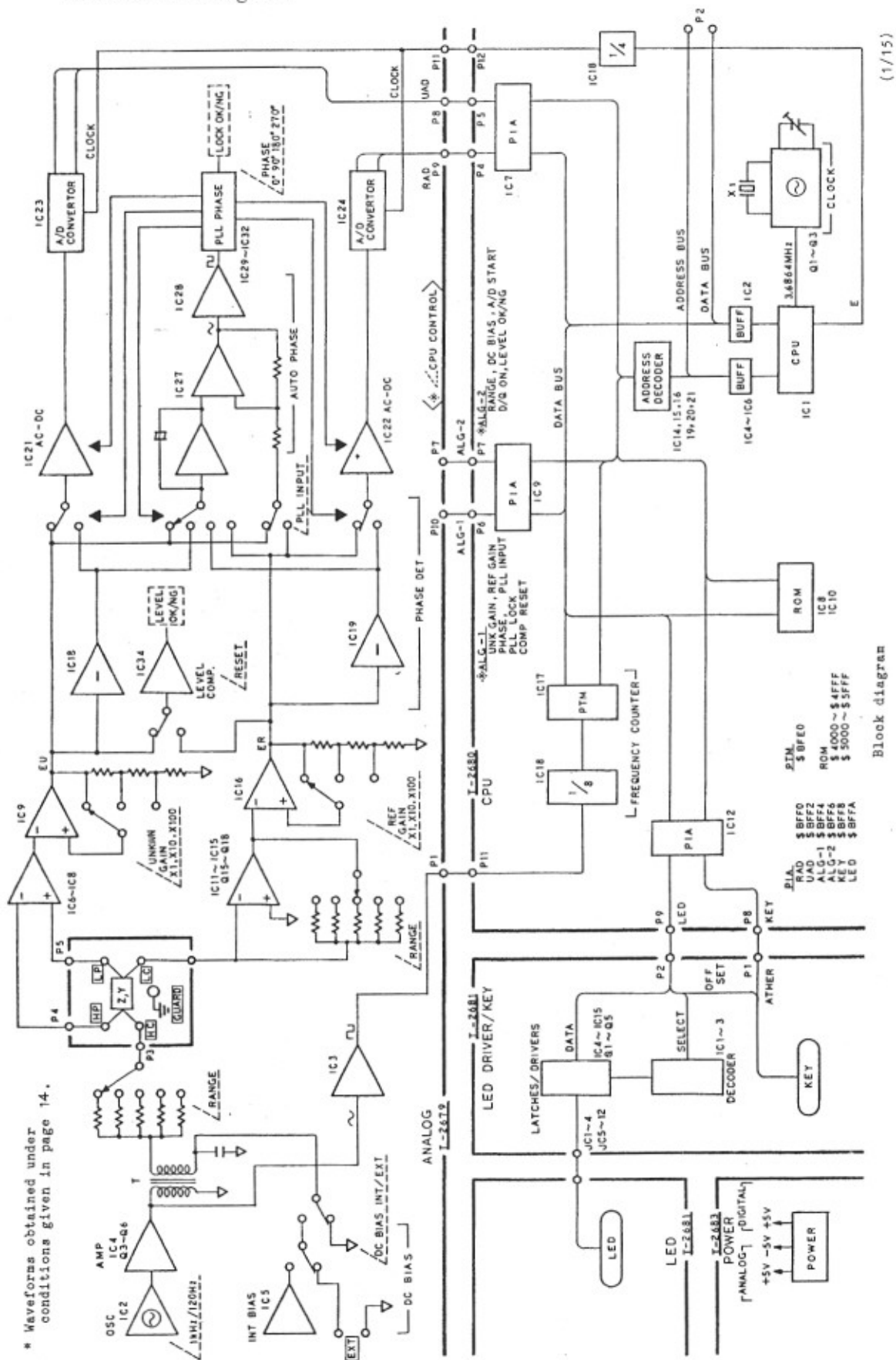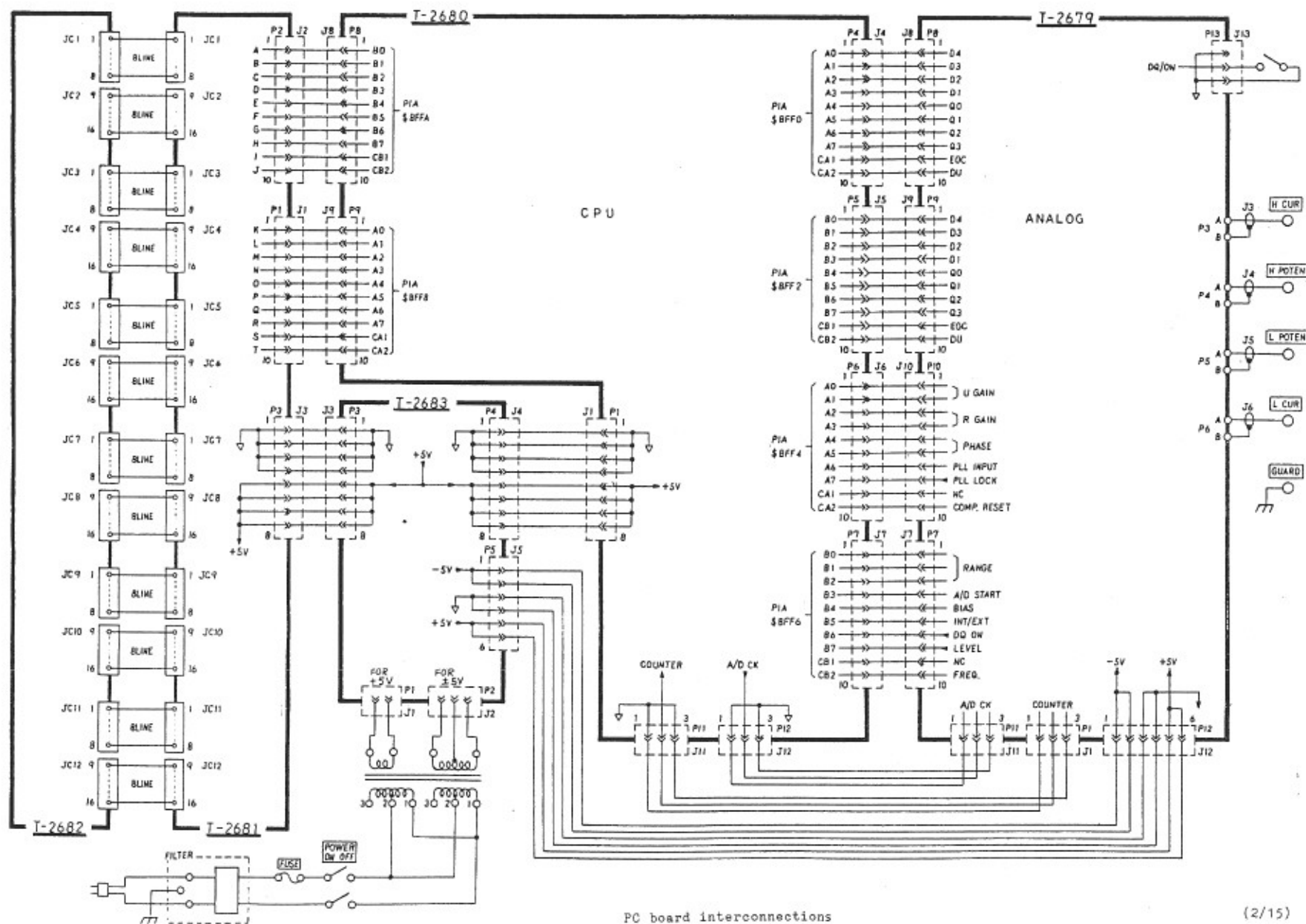
PC board interconnections

Display

LED driver-1/3
Switch

(4/15)

T-2681

LCR-745

-24-

JC1 (3/15)   JC2 (3/15)   JC3 (3/15)   JC4 (3/15)

JC1 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 JC2   JC3 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 JC4

RA4 220
RA3 220
RA5 220

P1 P2 P3 P4 P5 P6 P7 P8 P9 P10 P10 P10   P15 P20 P21 P22 P23 P24 P25   P26 P27 P28 P29

P1 P2 P3   P4 P5 P6 P7 +5V   P8 P9 P10   P11 P12 P13 P14 +5V   P15 P6 P17 P18 P19 +5V   P20 P21 P22   P23 P24 P25   P26 P27 P28 P29 +5V

POINT C (6/15)

| Q1 µPA56C | Q2 µPA56C | Q3 µPA56C | Q4 µPA53C | Q5 µPA56C |

IC4 4508   IC5 4508   IC6 4508   IC7 4508

SELECT   S2   S3   S1   S4   S5   S7   S6   S0   SELECT D (6/15)

(4/15) A SELECT
(4/15) B DATA

A B C D ...   DATA E (6/15)

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PIA
AO : C̄	BO :	
A1 : R̄	B1 :	DATA
A2 : PARA	B2 :	
A3 : SER	B3 :	
A4 : AUTO	B4 :	
A5 : DC BIAS ON	B5 :	LED SELECT
A6 : DC BIAS EXT	B6 :	
A7 : FREQ 120Hz	B7 :	
CA0 : DOWN	CB0 : OFFSET	
CA1 : UP	CB1 : NC	

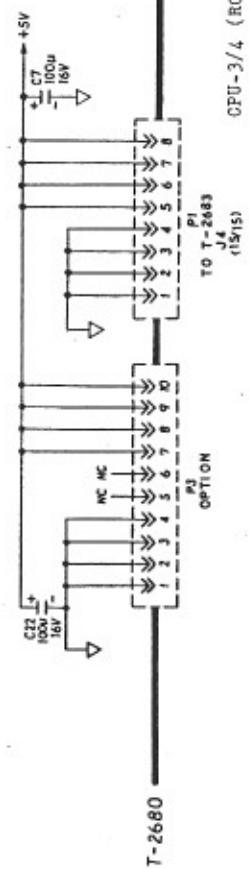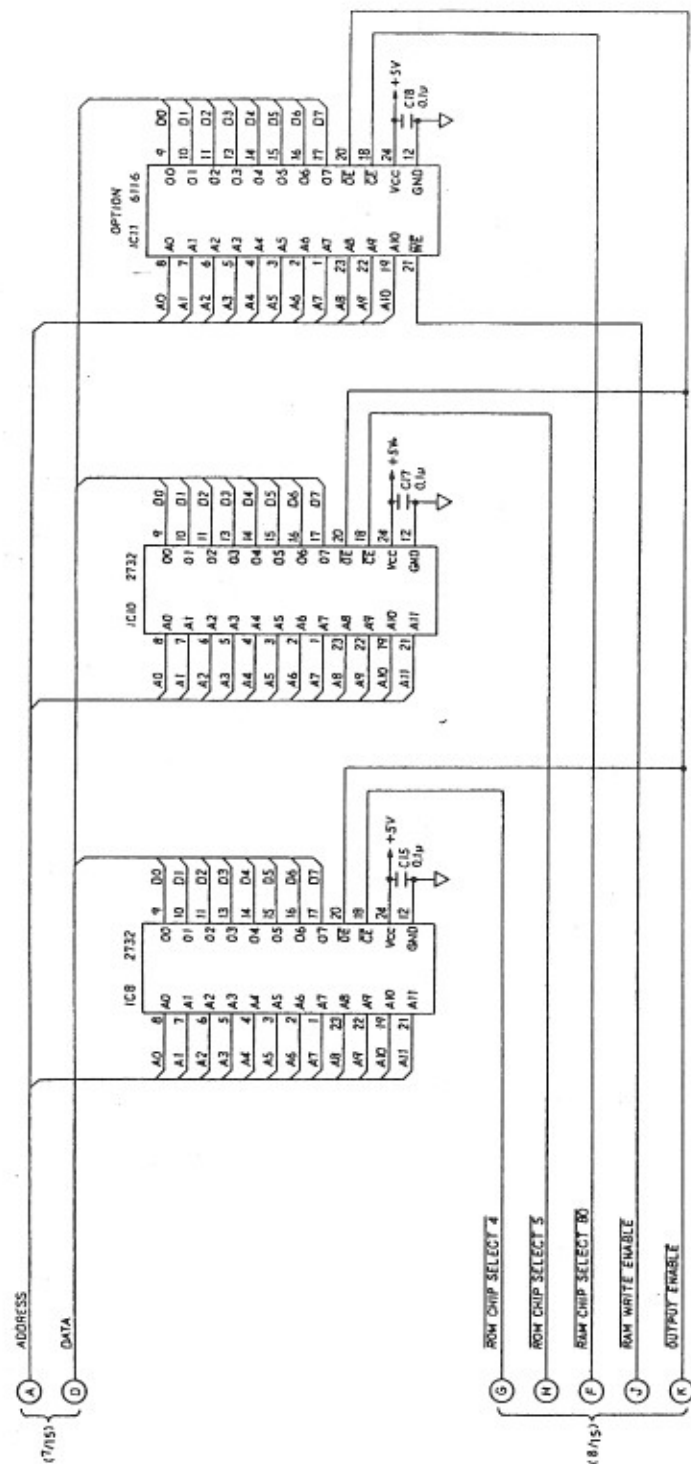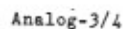|	D0	D1	D2	D3		
S0	EXT	INT	120	1k	S8	
S1	Q	D	OFFSET	RANGE HOLD	S9	DATA LCR
S2	HI	GO	LO		S10	
S3					S11	
S4		POINT	LCR		S12	
S5		POINT	QD		S13	DATA QD
S6	µ p	m n k	µ M	—	S14	
S7	H	F	Ω	—	S15	

LCR MSB
DATA 2 = −, 4 = 1, 8 = −1

LED driver-2/3

(5/15)

LED driver-3/3

(6/15)

CPU-3/4 (ROM, RAM)

CPU-4/4 (PIA, PTM)

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Analog-1/4

Analog-2/4

T-2679

(12/15)

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LCR-745

Analog-3/4

(13/15)

Power supply

** Test fixture