LSG-216
STANDARD SIGNAL GENERATOR
SERVICE MANUAL

2nd edition Mar., 1987

CONTENTS

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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.

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1. Specifications

1) Frequency

Range	2 ranges;	0.1 to 30 MHz and 75 to 115 MHz
Indication		6-digit digital indication
	Resolution:	0.1 to 30 MHz 100 Hz
		75 to 115 MHz 1 kHz
Accuracy		within ± (5×10^{-5} + 1 count)
Drifting		within ± 5×10^{-5}

2) RF Output

Range	−9 to 99 dBμ(0 dB=1 μV) into open circuit
Indication	2-digit digital indication
Reference level accuracy	within ± 1 dB at 99 dBμ
Attenuator accuracy	within ± 1.5 dB (more than 0 dB)
	within 2 dB (less than 0 dBμ)
Output impedance	50 Ω, VSWR less than 1.2
Spurious	less than −30 dB

3) Modulation

Internal modulation frequency	400 Hz, 1 kHz within ±1%
External modulation input impedance	approx. 10 kΩ (L, R)

FM

Frequency deviation	0 to 100 kHz (carrier of more than 1 MHz)
Deviation indicator	30, 100 kHz full scale
Accuracy	1 to 30 MHz, 75 to 110 MHz; ± 10% of full scale
	100 to 115 MHz; ± 20% of full scale
Distortion	1 to 30 MHz, 75 to 110 MHz; less than 0.1% for 75-kHz deviation
	110 to 115 MHz; less than 0.2% for 75-kHz deviation (demodulation band 80 Hz to 100 kHz)
External modulation frequency range	20 Hz to 100 kHz
External modulation frequency response	± 1 dB (reference 1 kHz)

FM Stereo

Pilot frequency	19 kHz, within ± 2 Hz
L & R separation	more than 40 dB (1 kHz)
Functions	L, R, MAIN, and SUB

AM

Modulation rate	0 to 50%
Modulation meter	30%, 100% full scale
Accuracy	± 10% of full scale
Distortion	0.1 to 30 MHz, less than 0.5% at 30% modulation
	75 to 115 MHz, less than 3% at 30% modulation
External modulation frequency range	20 Hz to 10 kHz
External modulation frequency response	± 1 dB (reference 1 kHz)

Residual Modulation (S/N)

FM component	more than 70 dB in S/N for 75-kHz deviation (FM linear detector: demodulation band, 80 Hz to 20 kHz)
AM component	more than 50 dB in S/N for 30% modulation rate

4) Preset

- Using the internal memory, 100 points of presettings can be stored for combinations of frequency, modulation type, and output level.
- Separately available memory unit, EPROM, can be ordered.

5) General

Power voltage	100, 120, 220, and 240 V
Power consumption	approx. 25 VA
Size and weight	400(W) x 100(H) x 300(D) mm
	7 kg
Accessory	output cable 1 (50Ω BNC 3D−2V)

2. Test Equipment Required

The following test equipment is required for calibration and servicing of the Model LSG-216. The suggested specifications are the minimum necessary for proper calibration of this instrument.

Test Equipment	Minimum Spec.
- Multimeter	Accuracy <1%
- Frequency Counter	120MHz
- RF Millivoltmeter	120MHz bandwidth 0dBm sensitivity
- Oscilloscope	20MHz bandwidth 10mV sensitivity
- Distortion Meter	400Hz/1kHz
- FM Linear Detector	120MHz 75kHz deviation
- AM Linear Detector	120MHz
- Sine Wave Generator	1kHz
- Spectrum Analyzer	120MHz

3. 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.

METER RANGE	100
MODULATION	OFF
FREQUENCY	10.0000MHz
OUTPUT	99dBμ

2) Adjustment of Meter Mechanical Zero

a) Turn the instrument off and allow 30 second for all capacitors discharge.

b) Rotate zero adjustment screw clockwise or counterclockwise so that pointer indicates exactly zero.

c) After pointer is exactly at zero, rotate the screw slightly opposite direction to release tension of meter suspension.

3) Power supply

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

b) Adjust as required, using the adjustment shown in Table-1.

Test point	Voltage	Tolerance	Adjustment
Q4 emitter (T-2627)	+15V	-	VR1 (T-2627)
Q8 emitter (T-2627)	-15V	-14.7V to -15.3V	-
Q1 collector(T-2627)	+5V	+4.75V to +5.25V	-

Table-1

4) Adjustment of PLL UNIT

a) Reference Osillator Adjustment

- Connect the frequency counter to the collector of Q2 (T-2538).

- Adjust VC1 (T-2538) for a frequency reading of 10.0000MHz.

5) Adjustment of RF UNIT

a) Output Voltage Adjustment

- Set: FREQUENCY 95MHz

- Connect the RF millivoltmeter to OUTPUT connector via 50 ohm termination.

- Adjust VR401 (T-2584) for a meter reading of 93dBμ (-14dBm, 44.7mV).

b) Sprious

- Set: FREQUENCY 115MHz

- Connect the spectrum analyzer to OUTPUT connector via 50 ohm termination.

- Adjust VC1 (T-2584) for minimum sprious output.

6) AF Osillator Adjustment

a) Connect the oscilloscope to pin 1 of IC4 (T-2627).

b) Adjust VR6 (T-2627) for stable oscillation as shown in Figure-1.

Figure-1

c) Connect the distortion meter to the pin 1 of IC4.

d) The distortion should be 0.05% or less.

7) Adjustment of FM Function

a) Deviation Adjustment-1 (VCO)

- Set: FREQUENCY 90MHz
  MODULATION
  FM On
  1kHz INT On
  ST/MONO MONO

- Connect the FM linear detector to OUTPUT connector via 50 ohm termination.

- Adjust FM control (screw driver adjustment on the front panel) for a frequency deviation of 75kHz on the FM linear detector.

- Set: FREQUENCY 75MHz

- Adjust L1 (T-2584) for a frequency deviation of approx. 81.5kHz.

- Repeat above steps if necessary.

b) Deviation Adjustment-2 (EXT/INT)

- Set: FREQUENCY 90MHz
  MODULATION
  FM On
  EXT On

- Connect the FM linear detector to OUTPUT connector via 50 ohm termination.

- Connect the sine wave generator to EXT MOD INPUT connector and set the frequency to 1kHz, output voltage to 1Vrms.

- Connect the oscilloscope to pin 5 of IC3 (T-2627).

- Adjust VR3 (T-2627) for an amplitude of 14Vp-p.

- Depress 1kHz key of MODULATION.

- Adjust VR7 (T-2627) for a deviation reading of 75kHz on the FM linear detector.

c) Modulation Meter Adjustment

- Set: MODULATION INT 1kHz

- Connect the FM linear detector to OUTPUT connector via 50 ohm termination.

- Set the FM control for a deviation reading of 75kHz on the FM linear detector.

- Adjust VR4 (T-2627) for a meter reading of 75kHz.

- Set the FM control for a deviation of 22.5kHz on the FM linear detector.

- Set: METER RANGE 30kHz

- Adjust VR5 (T-2627) for a meter reading of 22.5kHz.

8) Adjustment of AM Function

a) AM Distortion Adjustment

- Set: FREQUENCY 30MHz
  MODULATION
  AM On
  1kHz INT On

- Connect the AM linear detector to OUTPUT connector via 50 ohm termination.

- Set the AM control (screw driver adjustment on the front panel) for a modulation reading of 30% on the AM linear detector.

- Connect the distortion meter to the output connector of the AM linear detector.

- Adjust L4 (T-2584) for a minimum distortion.

b) Modulation Meter Adjustment

- Set: FREQUENCY 1MHz
  METER RANGE 30%
  MODULATION
  AM On
  1kHz INT On

- Connect the oscilloscope to OUTPUT connector via 50 ohm termination.

- Set the AM control to obtain a waveform as shown in Figure-2

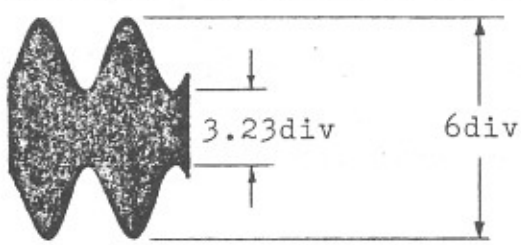


Figure-2

- Adjust VR2 (T-2627) for a meter reading of 30%.

9) Adjustment of FM Stereo Signal Generator

a) Balanced Modulator

- Set: MODULATION

FM	On
ST/MONO	ST
EXT	On
EXT MOD INPUT	Open

- Connect the oscilloscope to TP2.

- Adjust VR5 and VR6 (T-2711) alternately to obtain a maximum sub-carrier suppression. (The sub-carrier leakage should be less than 10mVp-p)

b) Phase Adjustment of Pilot Signal and Sub-carrier

- Set: MODULATION

FM	On
400Hz/1kHz	1kHz
ST/MONO	ST
PILOT	On

- Set the oscilloscope for X-Y operation and connect the X-INPUT to TP1, Y-INPUT to TP2.

- Adjust VR4 (T-2711) to obtain a single slanted line as shown in Figure-3.

NG OK

Figure-3

- Set: MODULATION

PILOT	Off
SUB	On

- Adjust VR3 (T-2711) to obtain a lissajous pattern as shown in Figure-4.

Figure-4

c) Separation

The channel separation is determined by the amplitude ratio of composite signal (A) and base line (B) as shown in Figure-5.

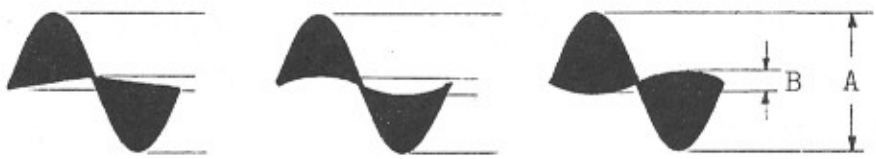
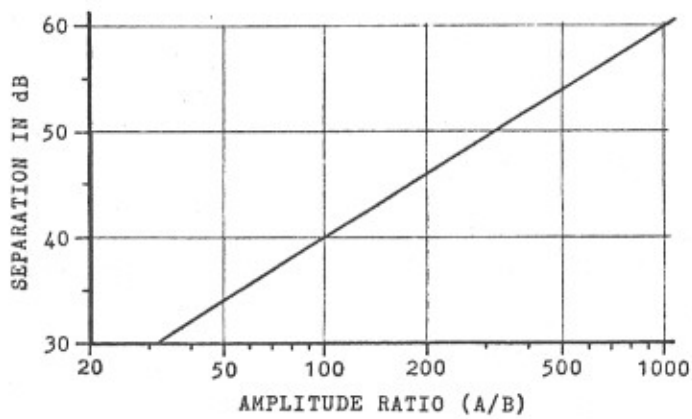


Figure-5

The separation is given by following equation or graph.

$$\text{Separation in dB} = 20 \log \frac{A}{B}$$



- Set: MODULATION

PILOT	Off
L	On

- Connect the oscilloscope to TP2. (The oscilloscope must be completely phase compensated)

- Adjust VR7, L3 and L4 (T-2711) precisely so that the base line becomes as flat as possible to obtain a maximum channel separation as shown in Figure-6.

Figure-6

d) Phase Checking of Pilot Signal

- Set: MODULATION

PILOT	On
L	On

- Connect the oscilloscope to TP2.

- Confirm the waveform as shown in Figure-7 (L).

- Depress R key of MODULATION.

- Confirm the waveform as shown in Figure-7 (R).

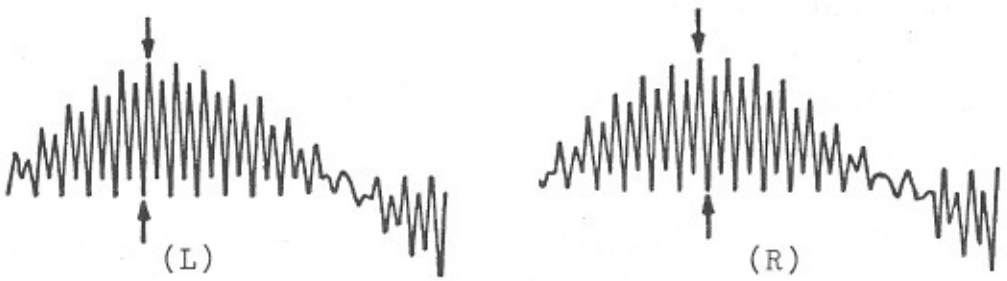


Figure-7

e) Deviation Adjustment

- Set: MODULATION

ST/MONO	MONO
METER RANGE	100kHz

- Connect the FM linear detector to OUTPUT connector via 50 ohm termination.

- Adjust the FM control for a frequency deviation of 75kHz on the FM linear detector.

- Set: MODULATION

ST/MONO	ST
PILOT	Off
MAIN	On

- Adjust VR8 (T-2711) for a frequency deviation of 67.5kHz on the FM linear detector.

- Set: MODULATION

PILOT	On

- Adjust VR1 (T-2711) for a frequency deviation of 75kHz on the FM linear detector.

- Set: MODULATION

PILOT	Off
METER RANGE	30kHz

- Adjust the FM control for a frequency deviation of 20.25kHz on the FM linear detector.

- Set: MODULATION

PILOT	On

- Adjust VR2 (T-2711) for a frequency reading of 27.75kHz on the FM linear detector.

4. Troubleshooting Procedure

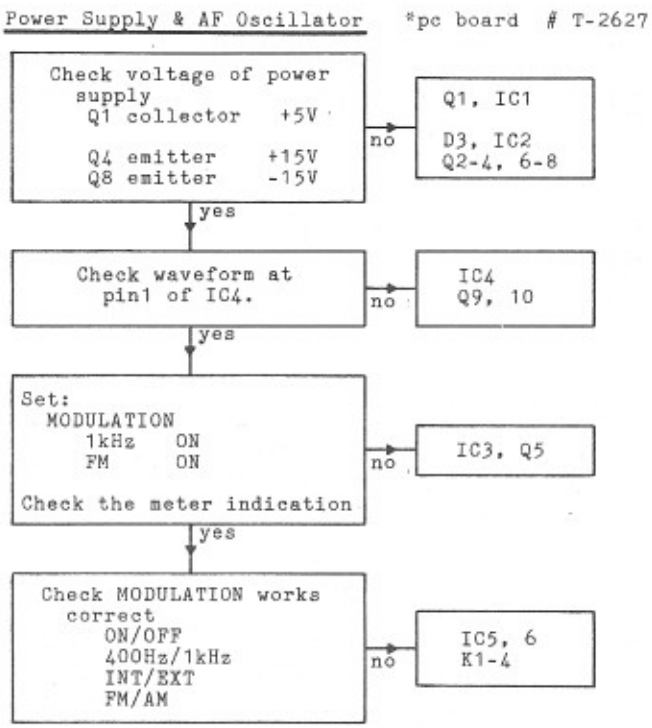
1) Check all control settings, because an incorrect setting can make a good unit appear defective.

2) Some trouble can be solved with proper adjustment.

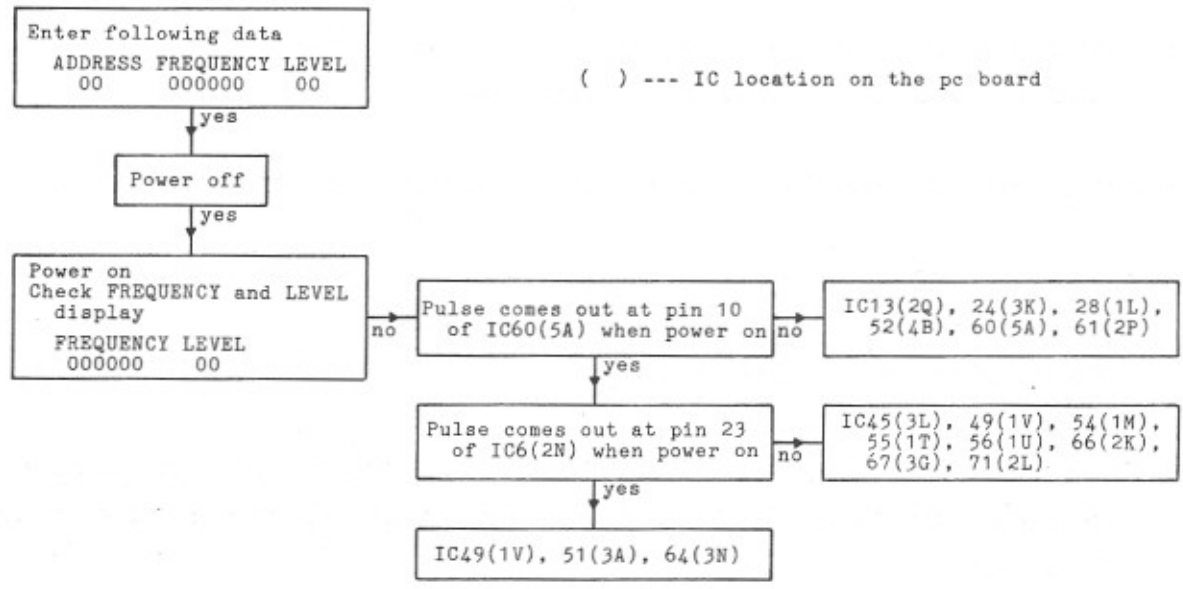
3) Check the DC voltage and waveform as shown in the schematic diagram to locate the defective circuit.
Start with the power supply.

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

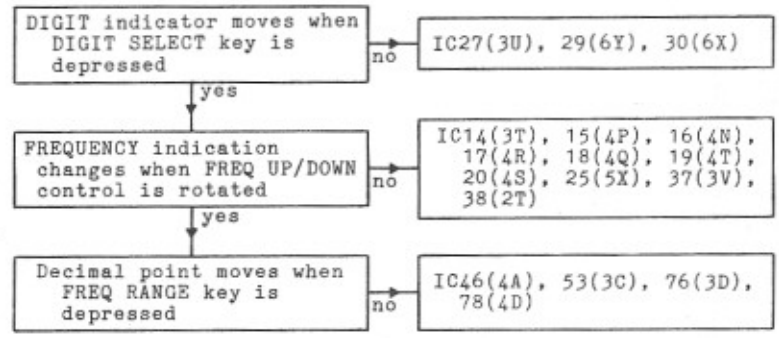


Initial Settings *pc board # T-2628

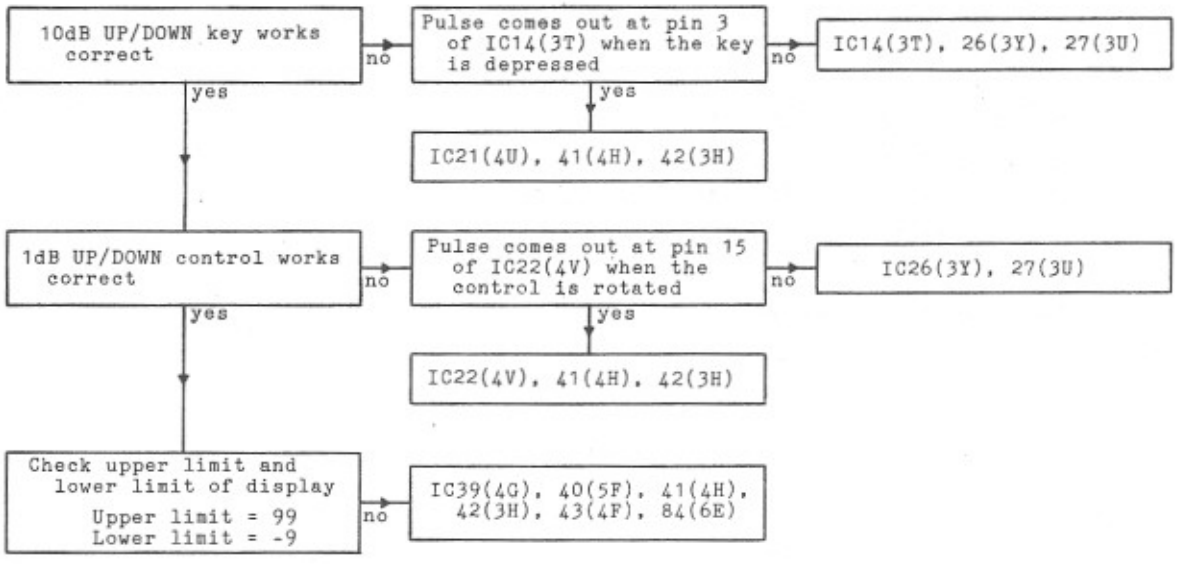


( ) --- IC location on the pc board

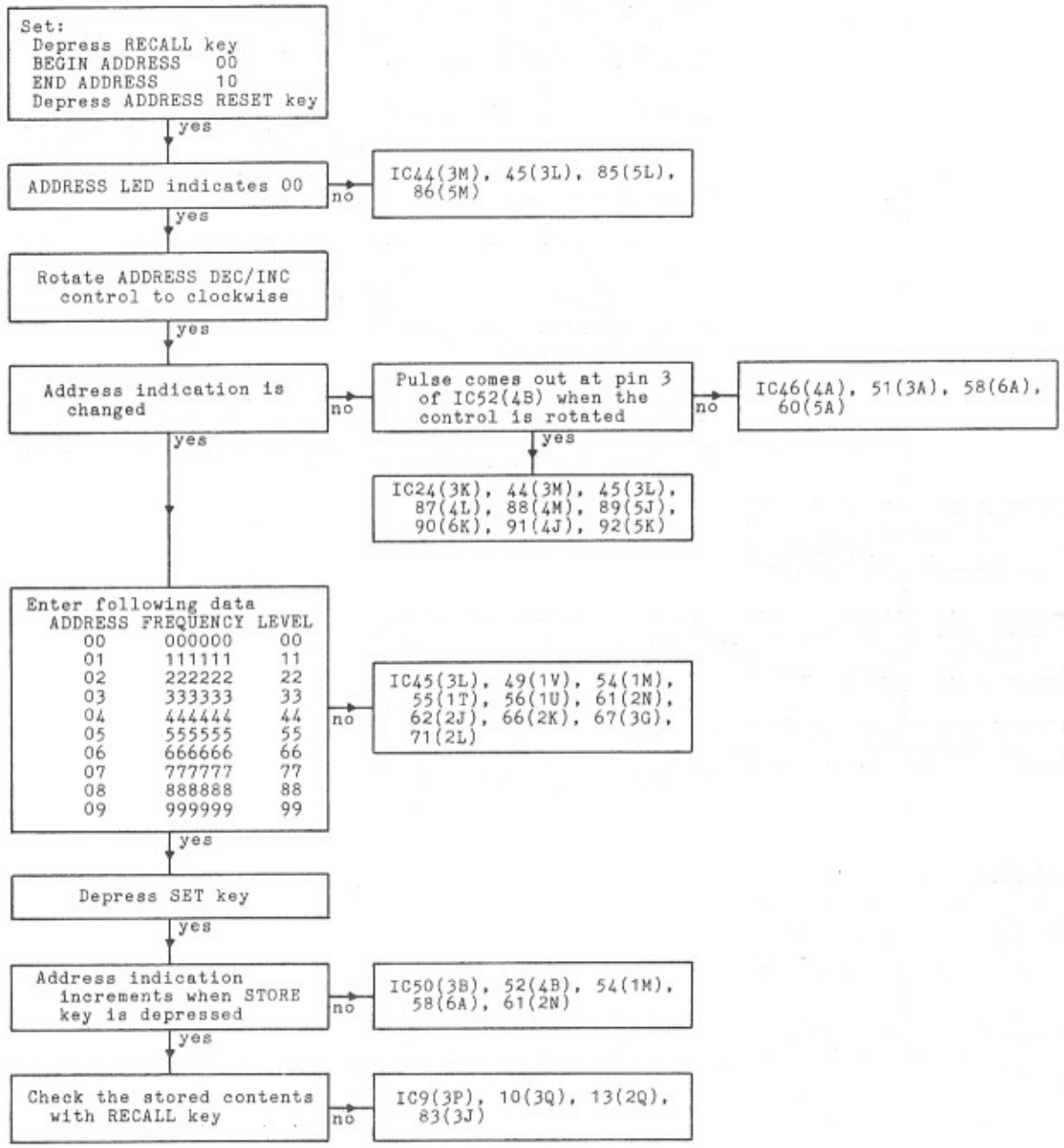
Control Circuit (Frequency) *pc board # T-2628 # T-2768



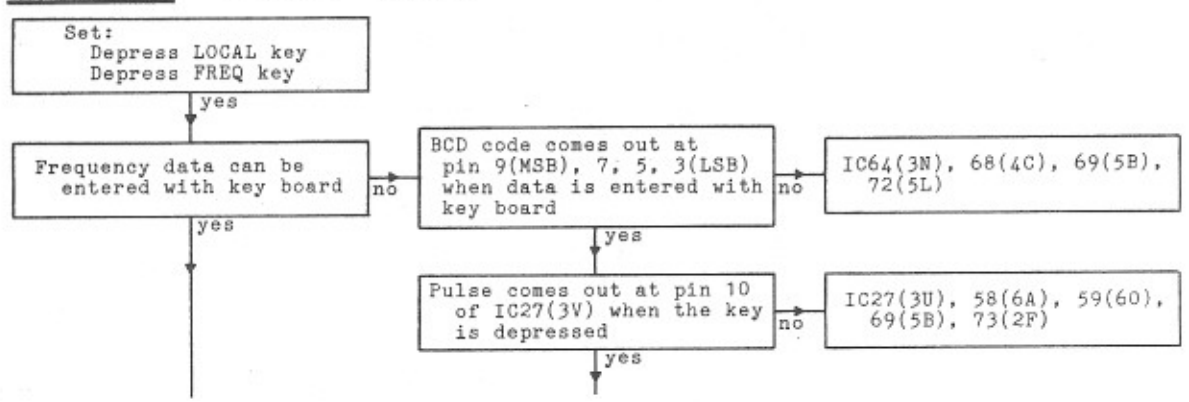
Control Circuit (Level) *pc board # T-2628

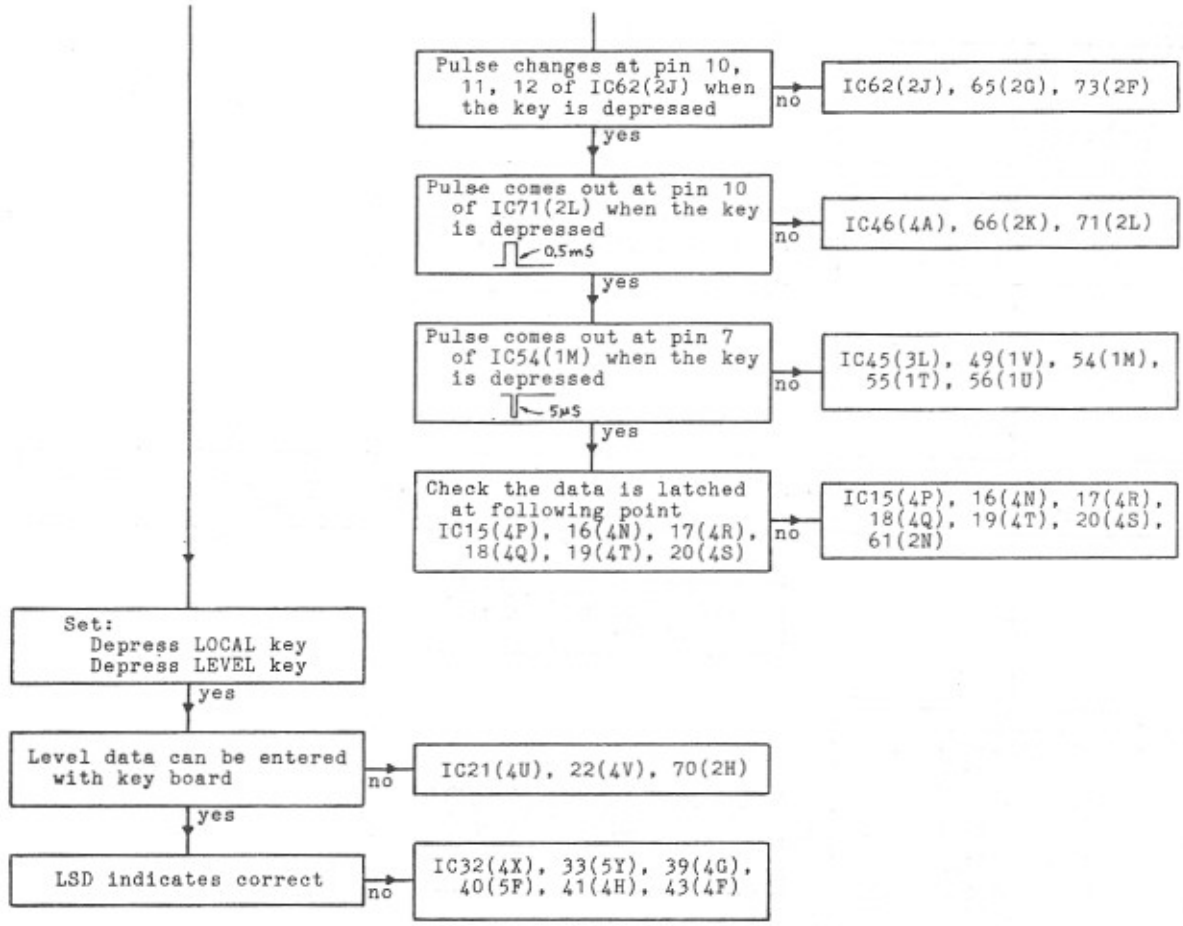


Control Circuit (Memory) *pc board # T-2628

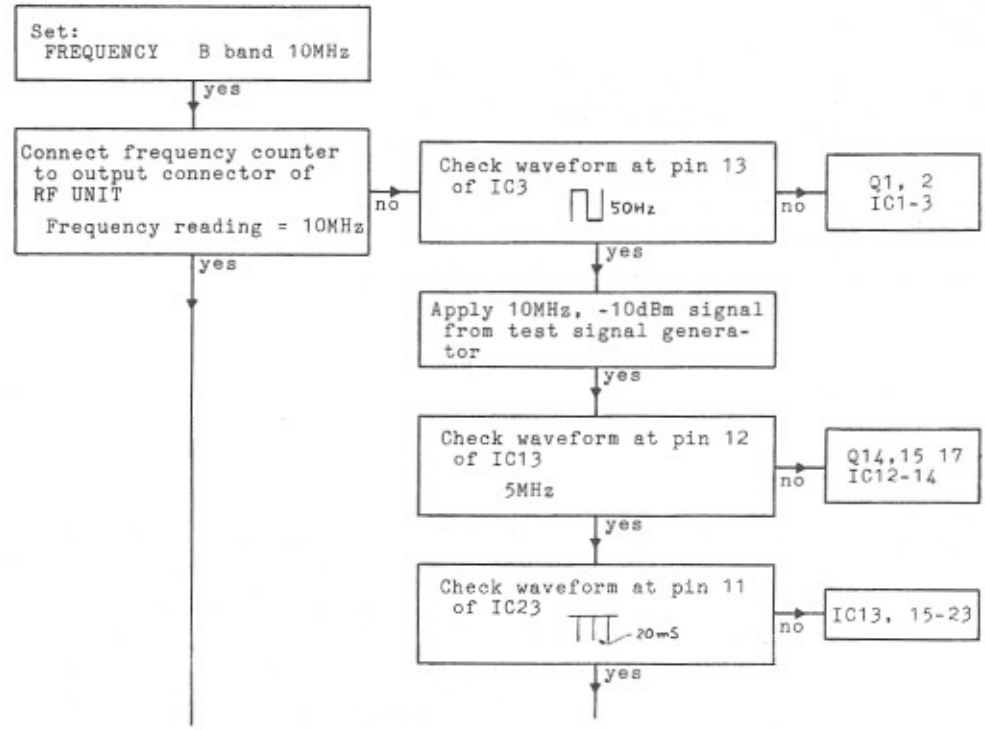


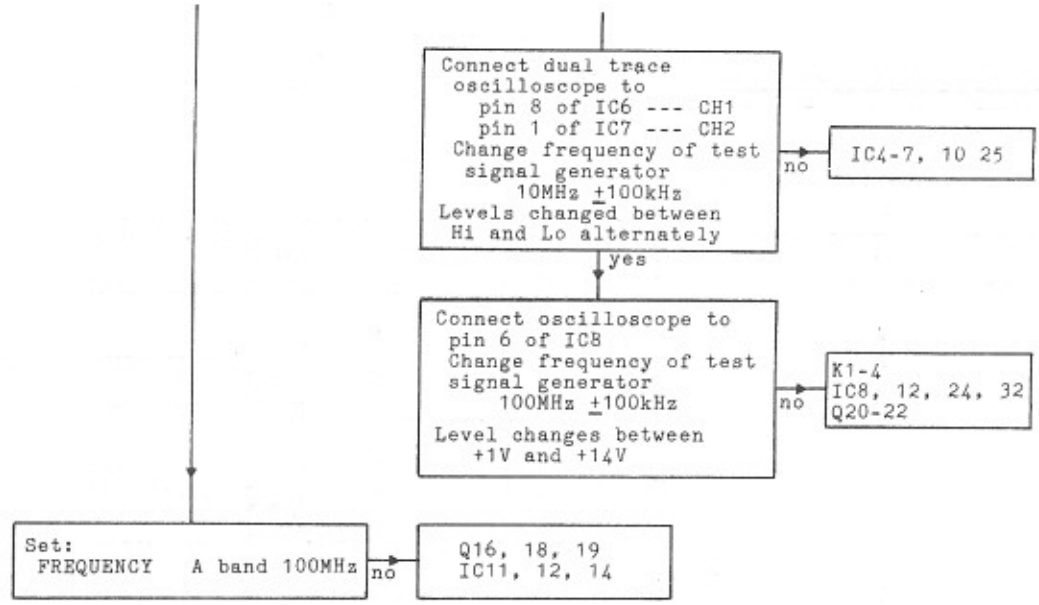
Ten-key Board *pc board # T-2628



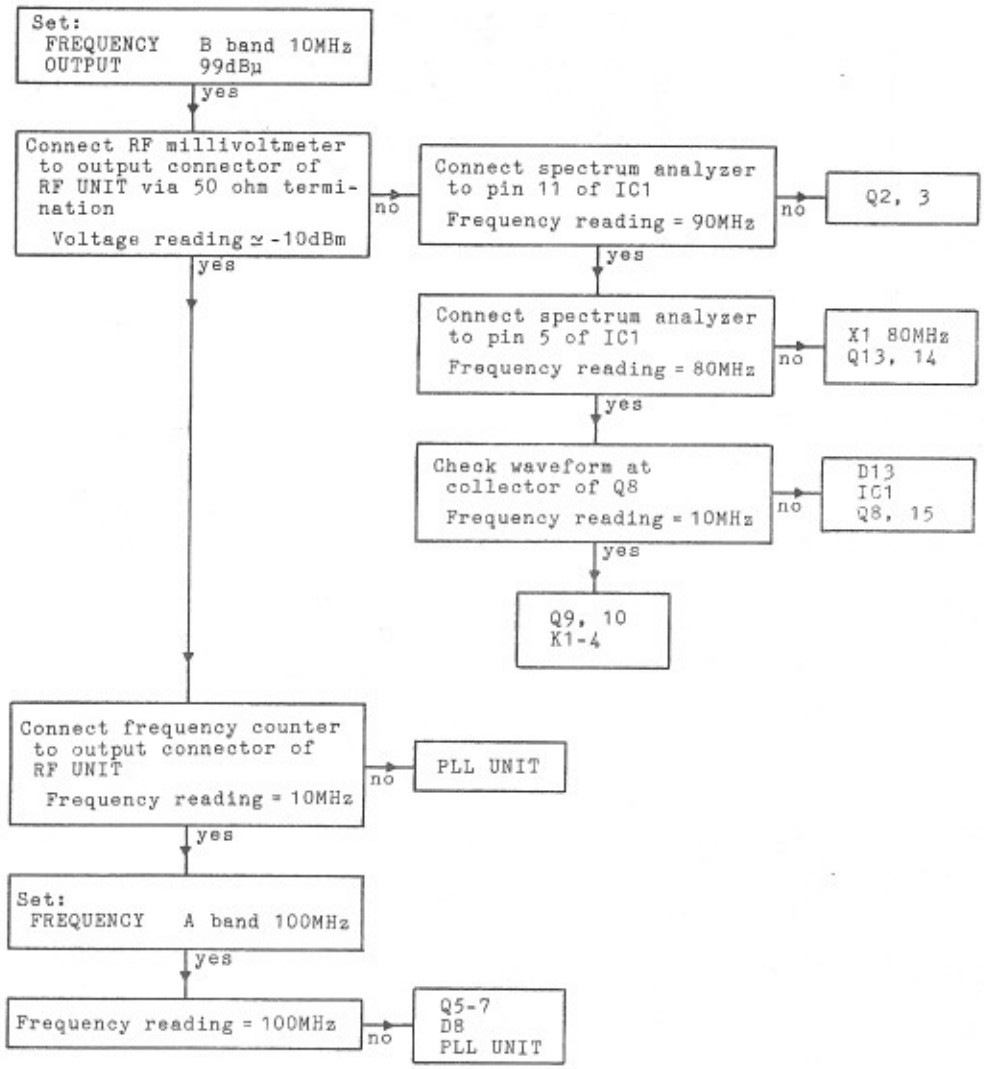

Pulse changes at pin 10, 11, 12 of IC62(2J) when the key is depressed
no
IC62(2J), 65(2G), 73(2F)
yes
Pulse comes out at pin 10 of IC71(2L) when the key is depressed
0.5mS
no
IC46(4A), 66(2K), 71(2L)
yes
Pulse comes out at pin 7 of IC54(1M) when the key is depressed
5μS
no
IC45(3L), 49(1V), 54(1M), 55(1T), 56(1U)
yes
Check the data is latched at following point IC15(4P), 16(4N), 17(4R), 18(4Q), 19(4T), 20(4S)
no
IC15(4P), 16(4N), 17(4R), 18(4Q), 19(4T), 20(4S), 61(2N)
Set:
Depress LOCAL key
Depress LEVEL key
yes
Level data can be entered with key board
no
IC21(4U), 22(4V), 70(2H)
yes
LSD indicates correct
no
IC32(4X), 33(5Y), 39(4G), 40(5F), 41(4H), 43(4F)

PLL UNIT

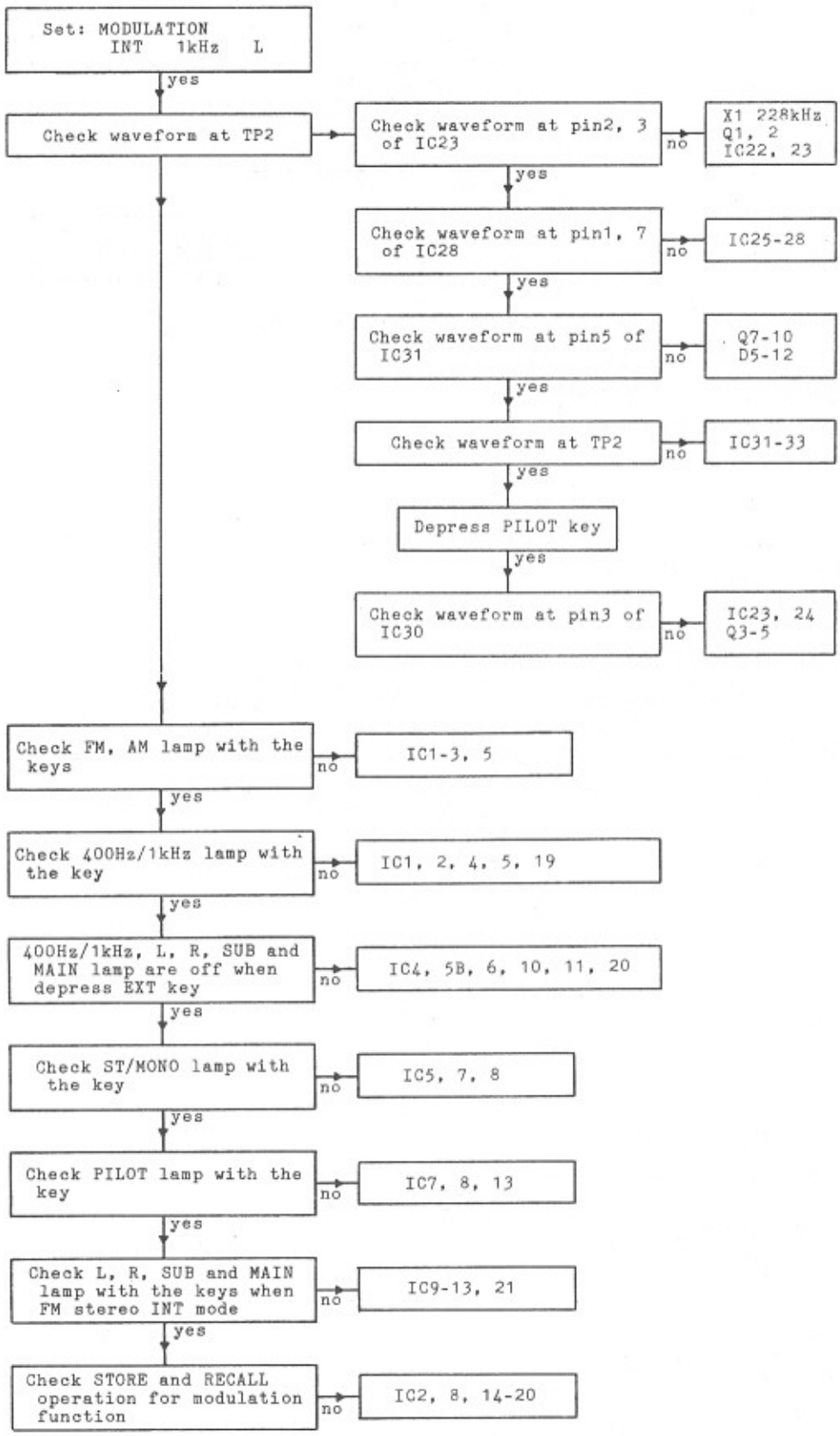

Set:
FREQUENCY B band 10MHz
yes
Connect frequency counter to output connector of RF UNIT
Frequency reading = 10MHz
no
Check waveform at pin 13 of IC3
50Hz
no
Q1, 2
IC1-3
yes
Apply 10MHz, -10dBm signal from test signal generator
yes
Check waveform at pin 12 of IC13
5MHz
no
Q14,15 17
IC12-14
yes
Check waveform at pin 11 of IC23
20mS
no
IC13, 15-23
yes


Connect dual trace oscilloscope to
pin 8 of IC6 --- CH1
pin 1 of IC7 --- CH2
Change frequency of test signal generator
10MHz ±100kHz
Levels changed between Hi and Lo alternately
no
IC4-7, 10 25
yes
Connect oscilloscope to pin 6 of IC8
Change frequency of test signal generator
100MHz ±100kHz
Level changes between +1V and +14V
no
K1-4
IC8, 12, 24, 32
Q20-22
Set:
FREQUENCY A band 100MHz
no
Q16, 18, 19
IC11, 12, 14

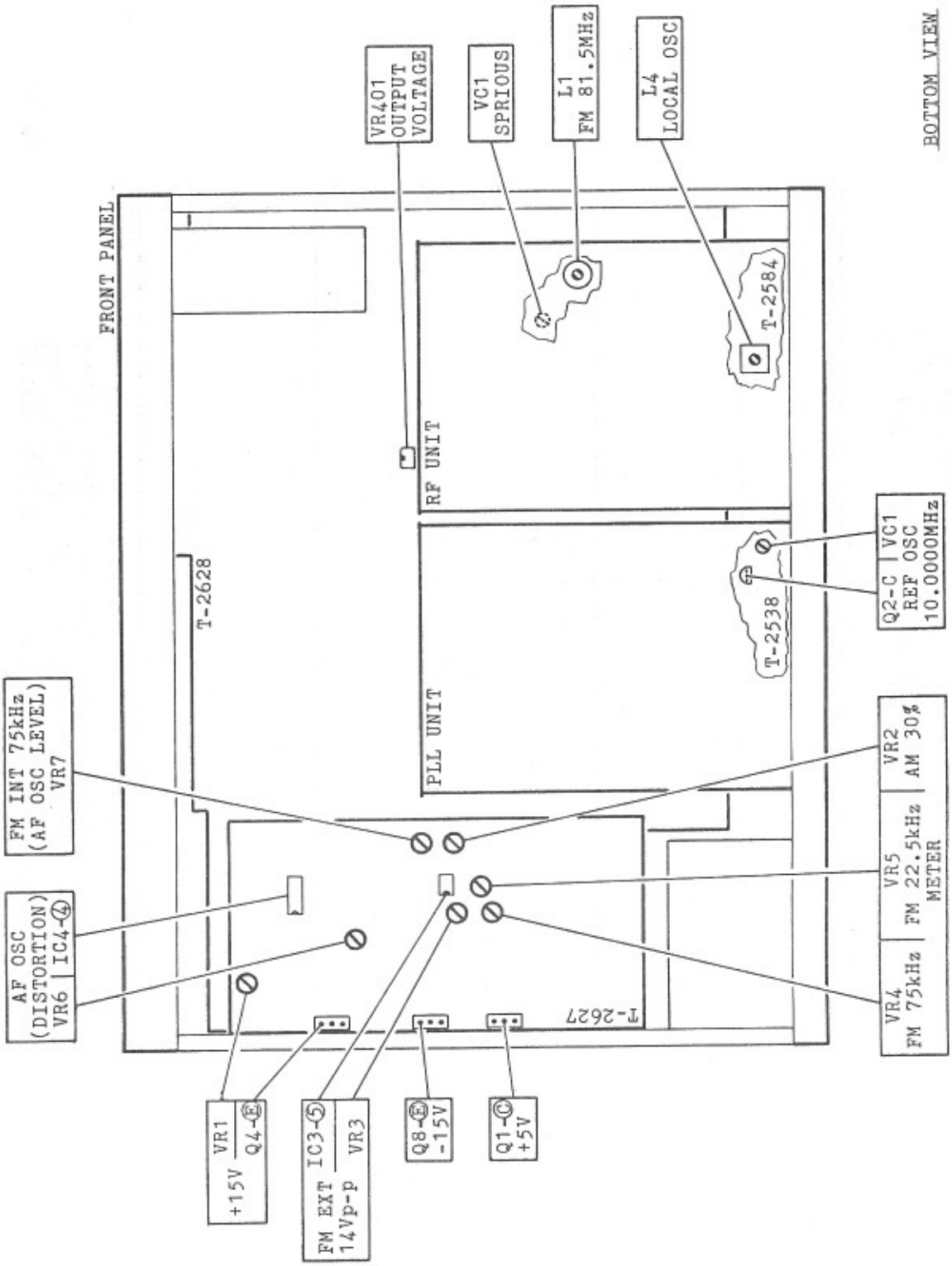
RF UNIT

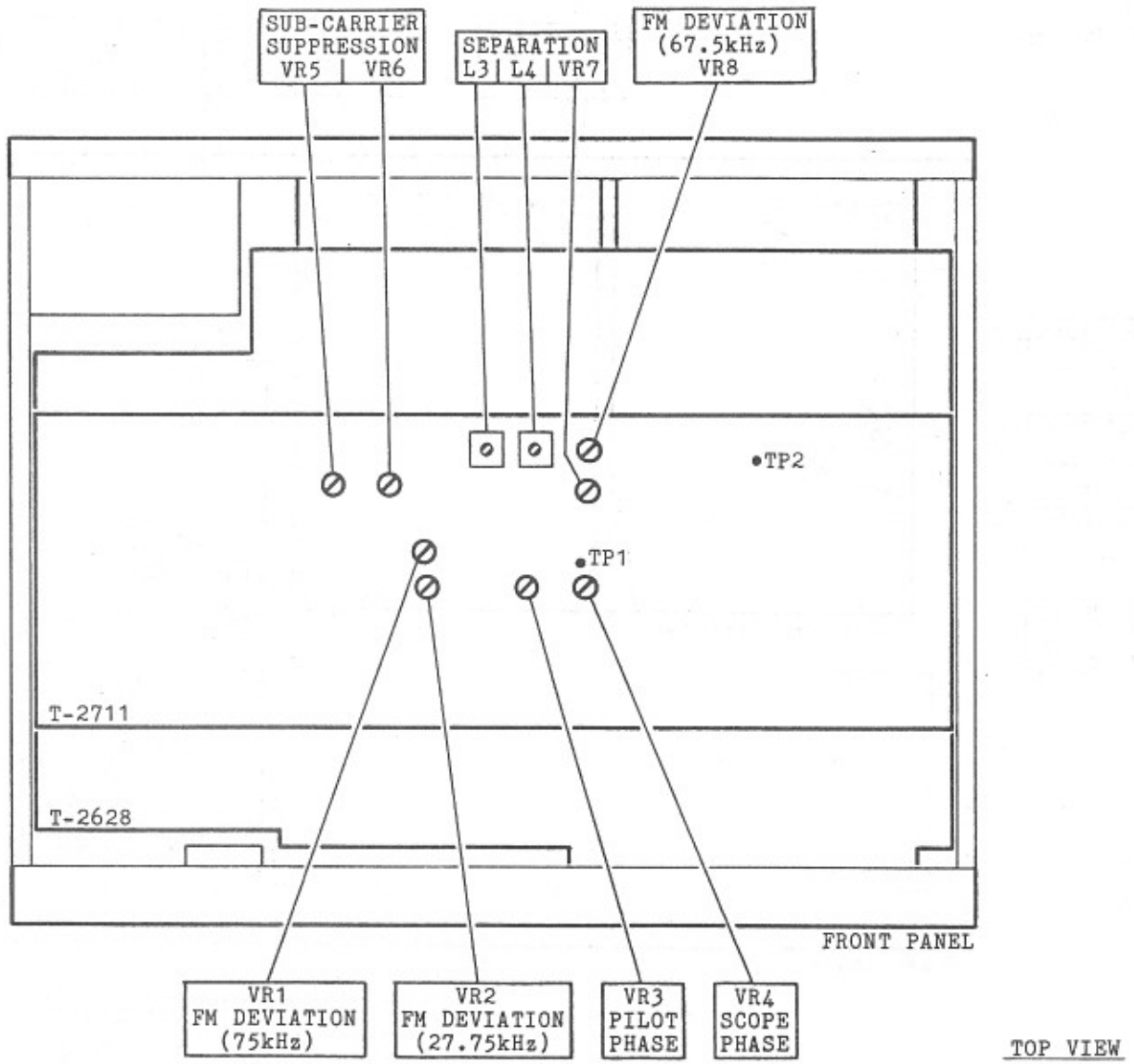

Set:
FREQUENCY B band 10MHz
OUTPUT 99dBμ
yes
Connect RF millivoltmeter to output connector of RF UNIT via 50 ohm termination
Voltage reading ≃ -10dBm
no
Connect spectrum analyzer to pin 11 of IC1
Frequency reading = 90MHz
no
Q2, 3
yes
Connect spectrum analyzer to pin 5 of IC1
Frequency reading = 80MHz
no
X1 80MHz
Q13, 14
yes
Check waveform at collector of Q8
Frequency reading = 10MHz
no
D13
IC1
Q8, 15
yes
Q9, 10
K1-4
yes
Connect frequency counter to output connector of RF UNIT
Frequency reading = 10MHz
no
PLL UNIT
yes
Set:
FREQUENCY A band 100MHz
yes
Frequency reading = 100MHz
no
Q5-7
D8
PLL UNIT

FM Stereo Signal Generator *pc board # T-2711



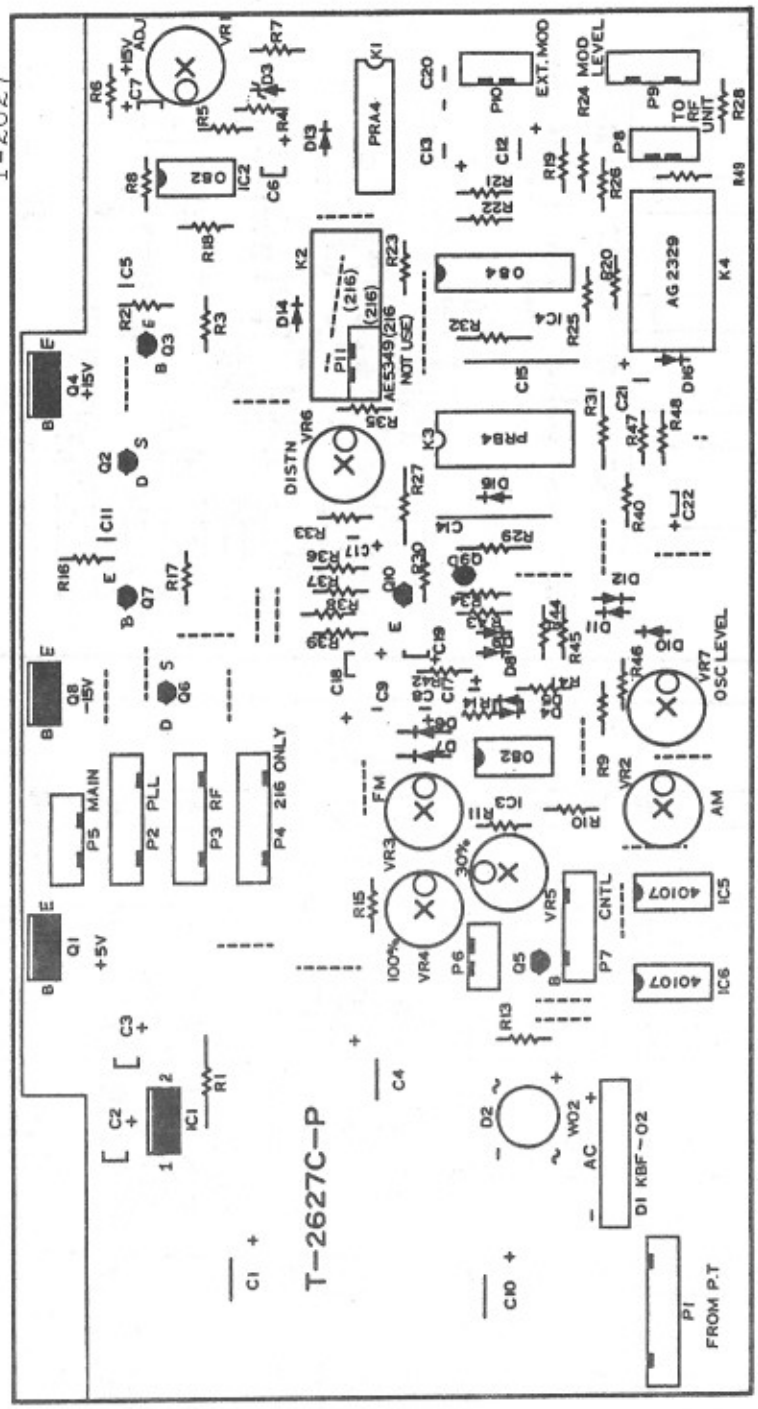
5. Location of Adjustment



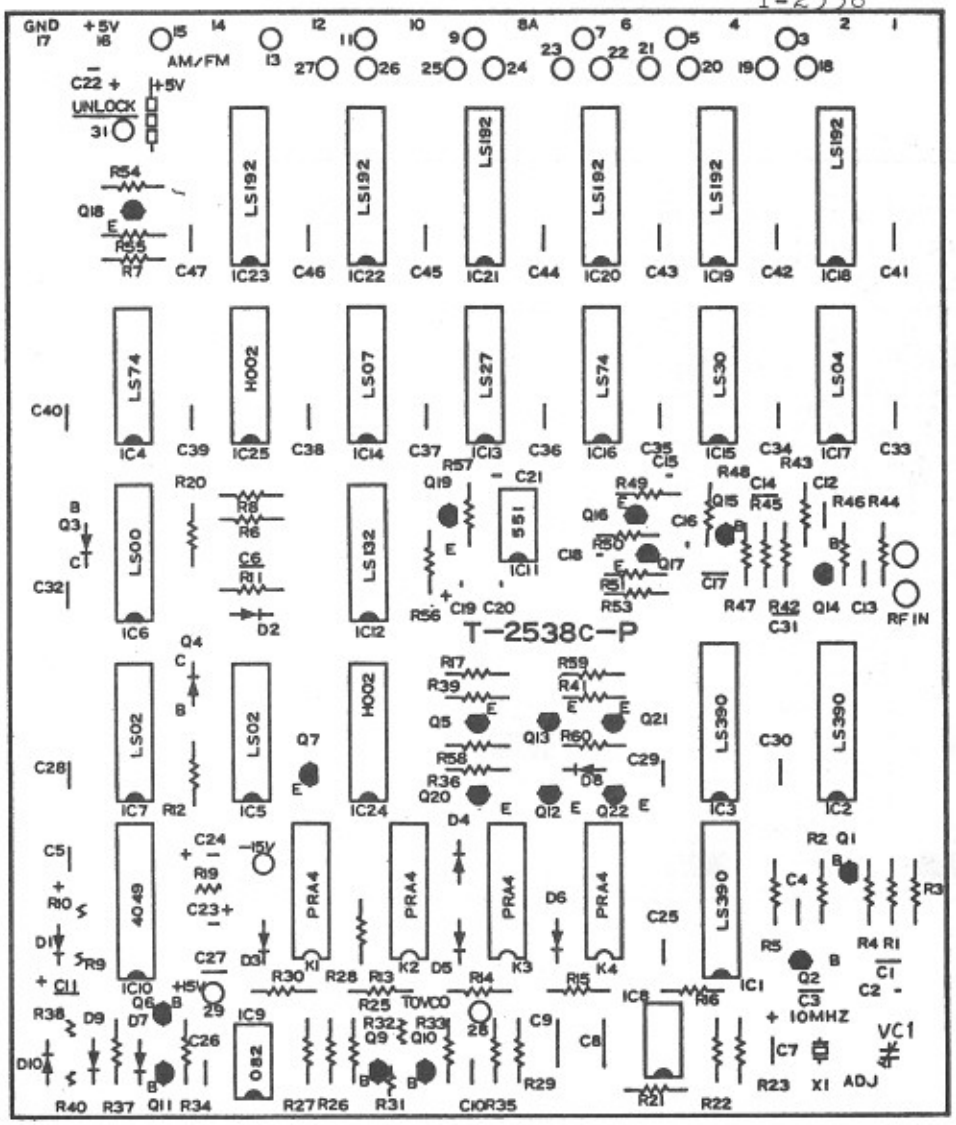

SUB-CARRIER SUPPRESSION
VR5 | VR6
SEPARATION
L3 | L4 | VR7
FM DEVIATION (67.5kHz)
VR8
•TP2
•TP1
T-2711
T-2628
FRONT PANEL
VR1 FM DEVIATION (75kHz)
VR2 FM DEVIATION (27.75kHz)
VR3 PILOT PHASE
VR4 SCOPE PHASE

TOP VIEW

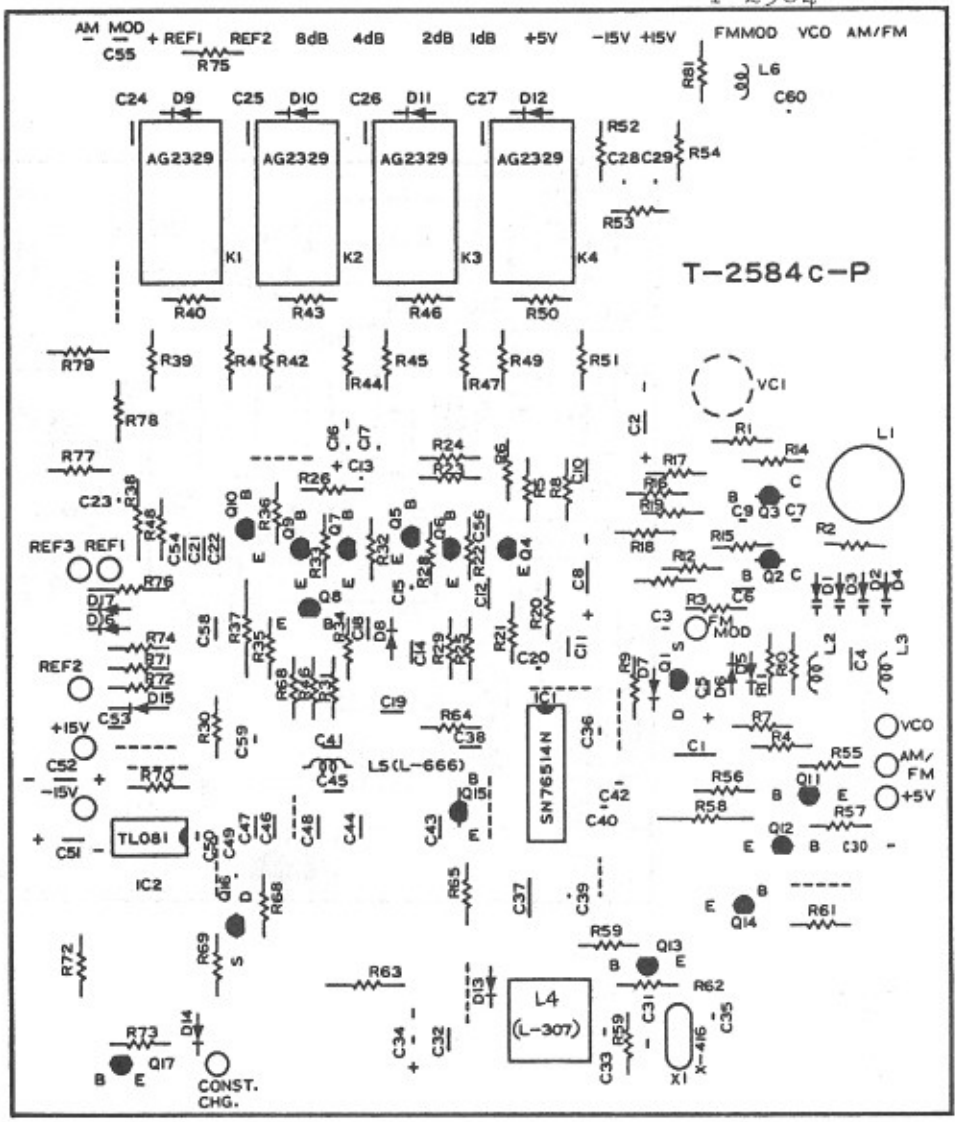
6. Printed Circuit Board

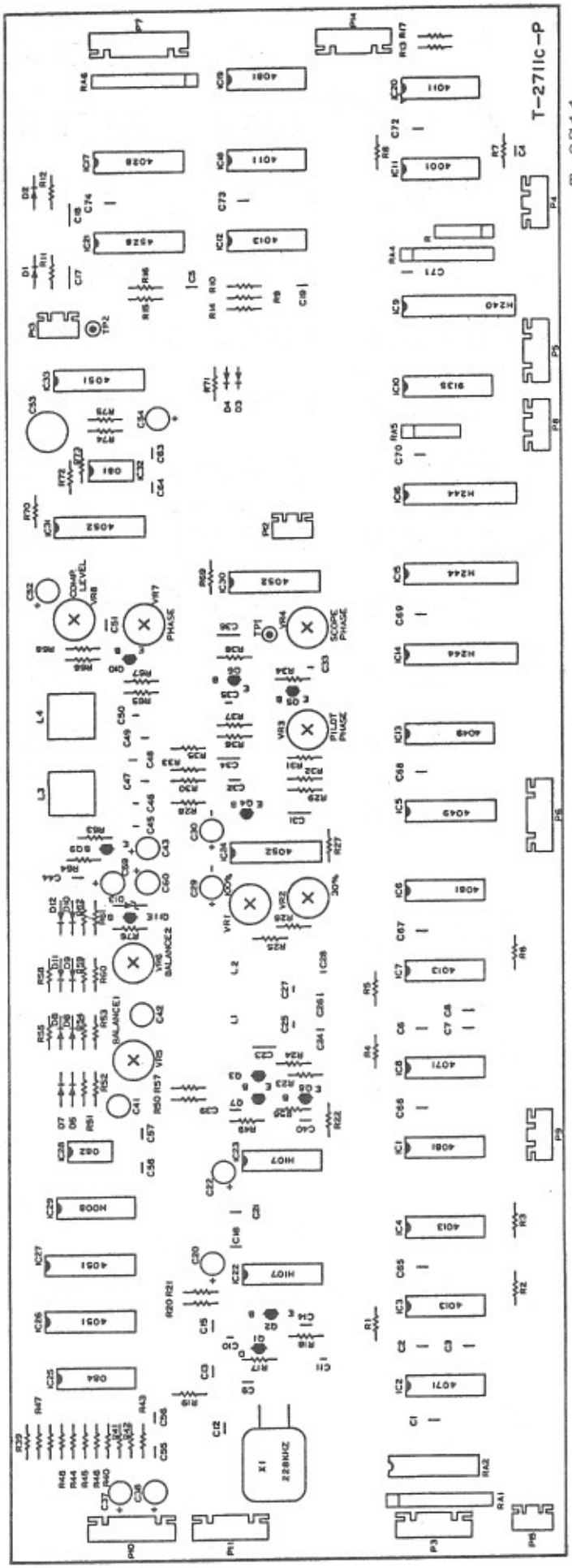


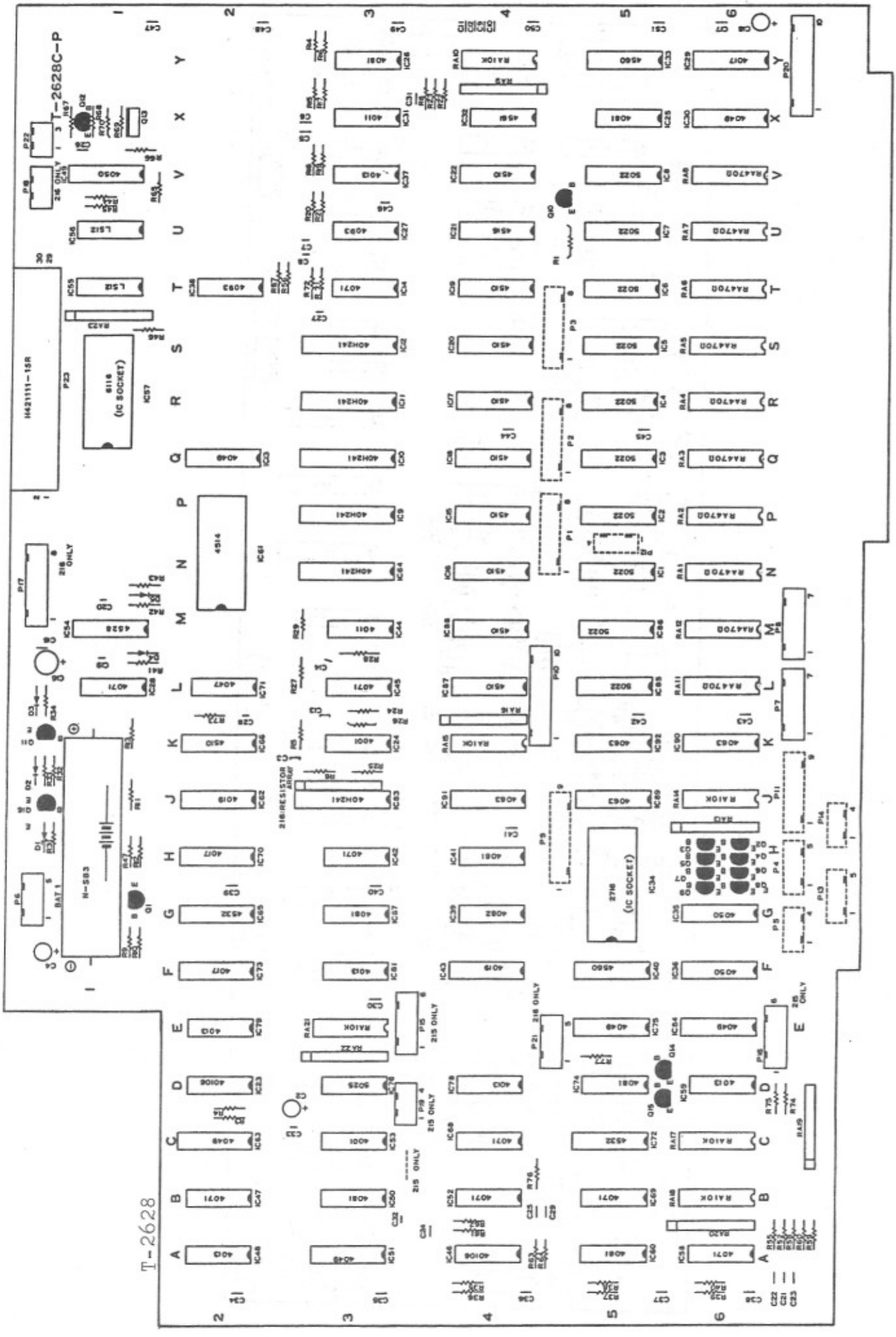
T-2538

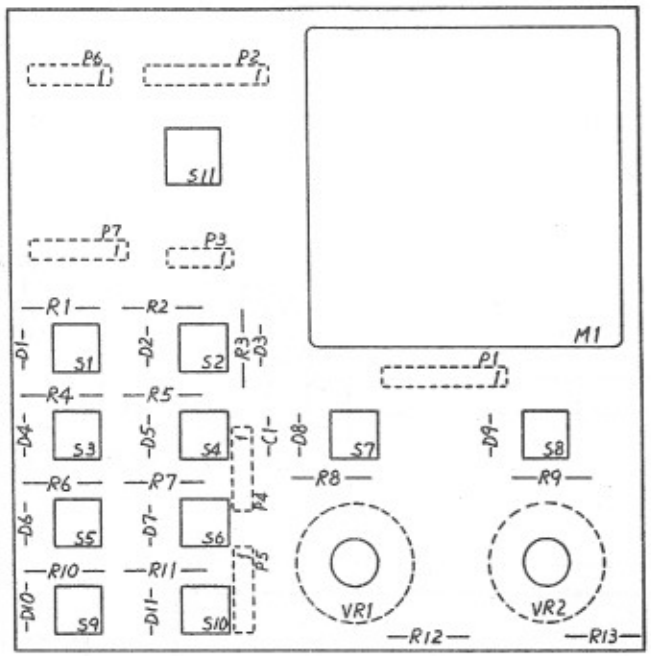

T-2538C-P
AM/FM
UNLOCK
+5V
LS192
LS74
H002
LS07
LS27
LS04
LS00
LS32
LS02
LS390
4049
PRA4
TOVCO
10MHZ
ADJ
VC1
RF IN
CONST. CHG.

T-2584


T-2584C-P
AM MOD
REF1
REF2
8dB
4dB
2dB
1dB
+5V
-15V +15V
FMMOD
VCO
AM/FM
AG2329
TL081
SN76514N
L5(L-666)
L4
(L-307)
FM MOD
CONST. CHG.

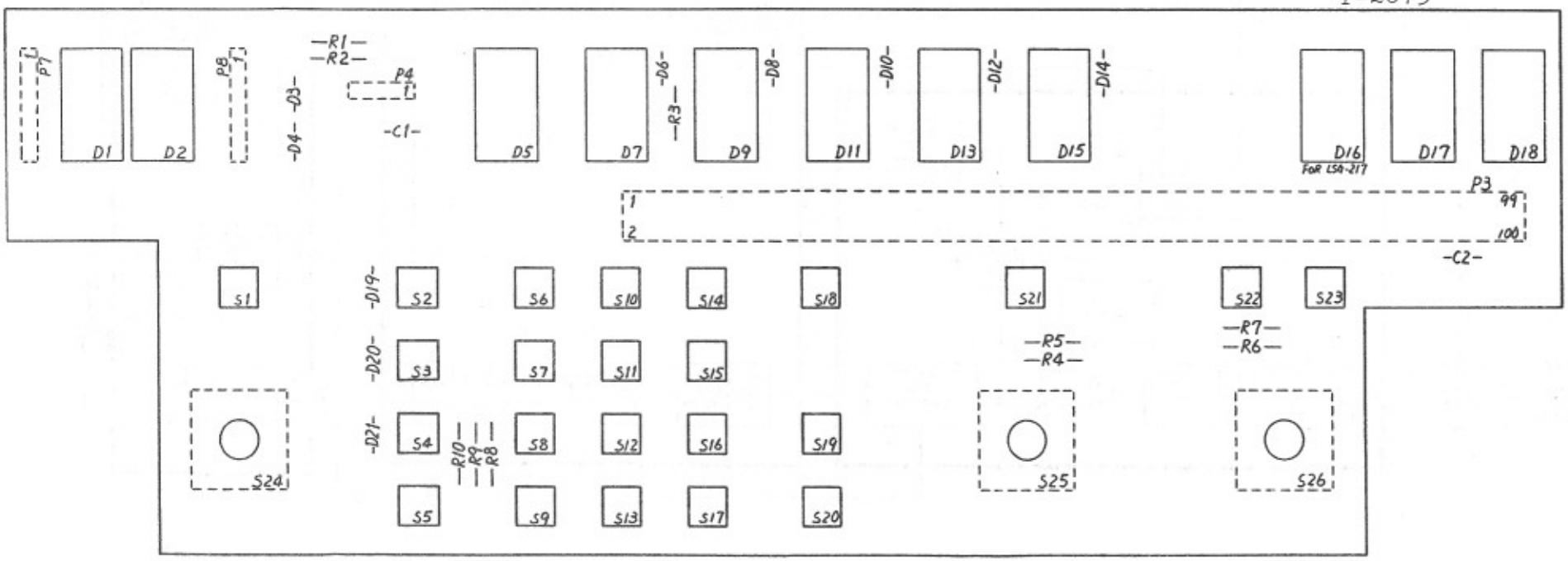

T-2711c-P
T-2711
COMP LEVEL
PHASE
SCOPE PHASE
PILOT PHASE
BALANCE2
BALANCE1
228KHZ

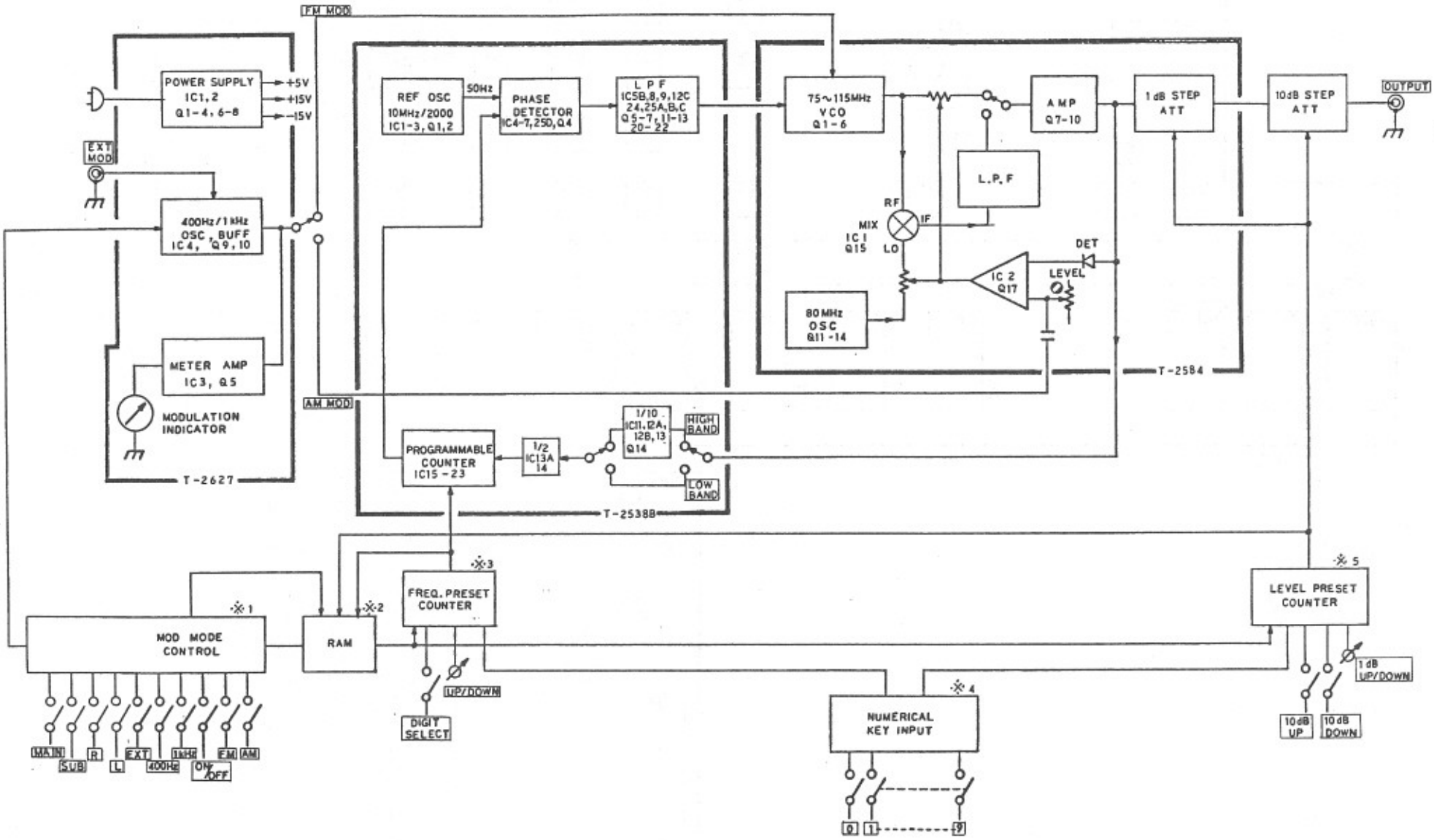

T-2628C-P
T-2628


P6
P2
S11
P7
P3
R1
R2
D1
S1
D2
S2
R3
D3
M1
P1
R4
R5
D4
S3
D5
S4
C1
D8
S7
D9
S8
R6
R7
D6
S5
D7
S6
P4
P5
R8
R9
R10
R11
D10
S9
D11
S10
VR1
VR2
R12
R13

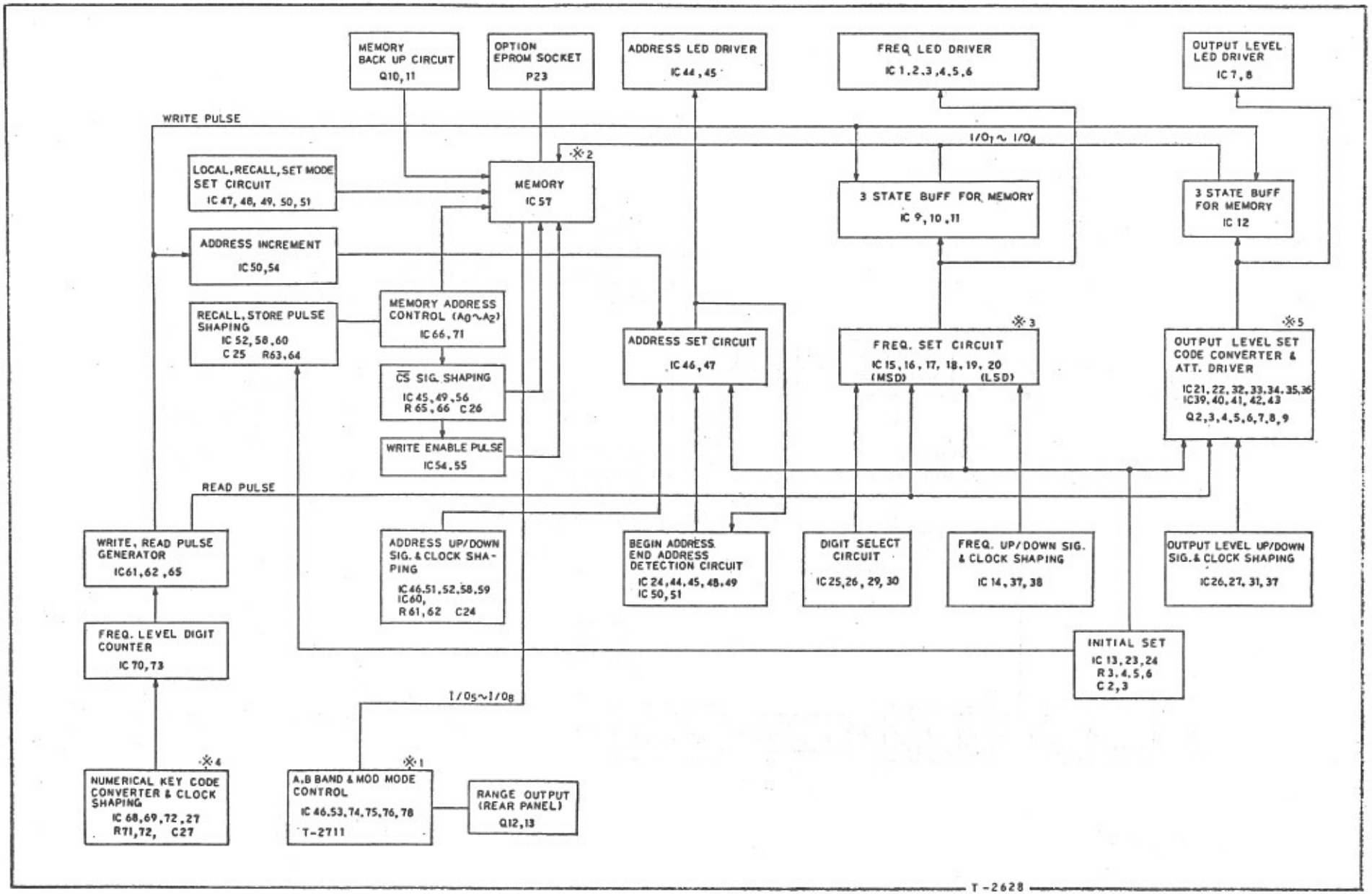
T-2674

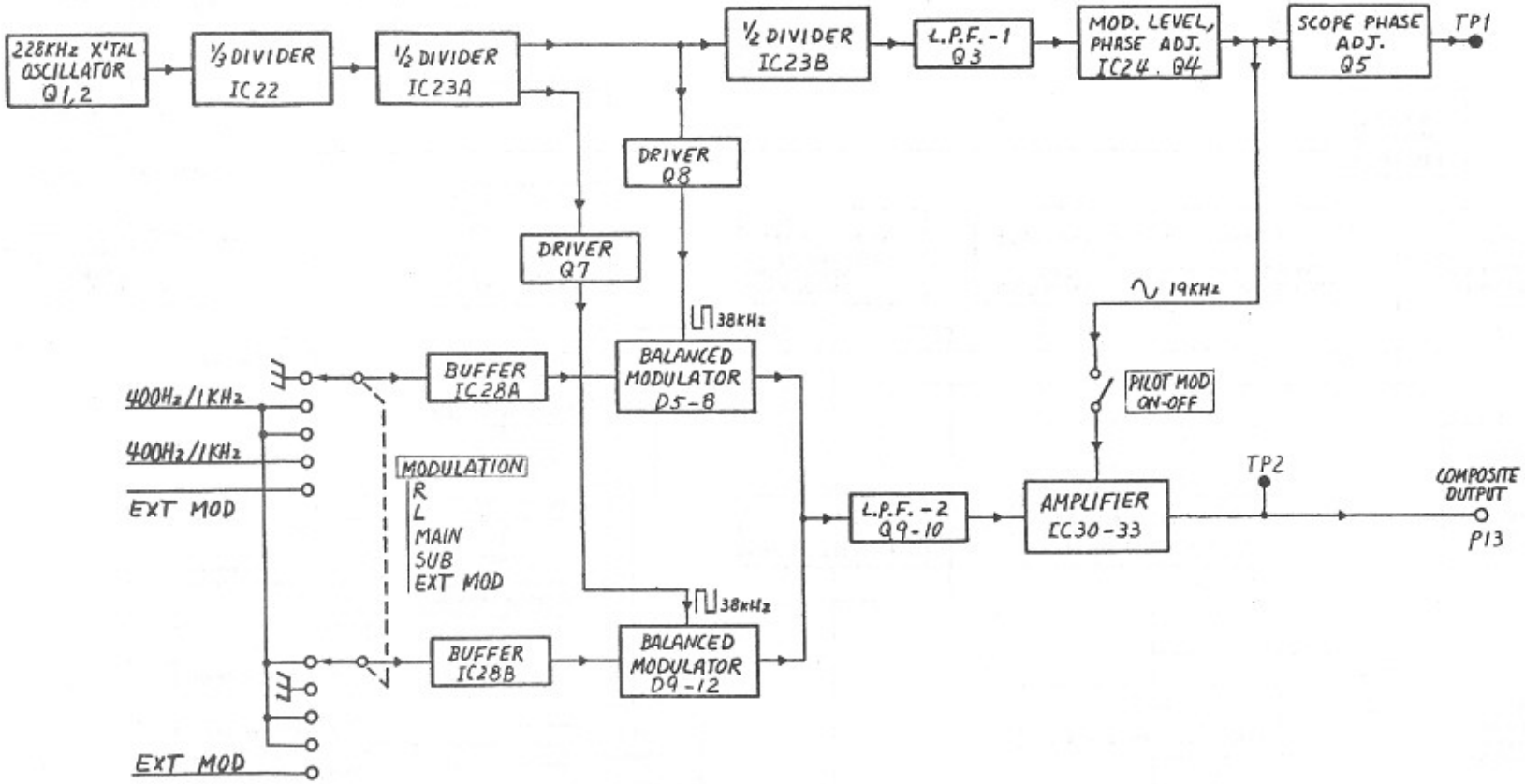
T-2673

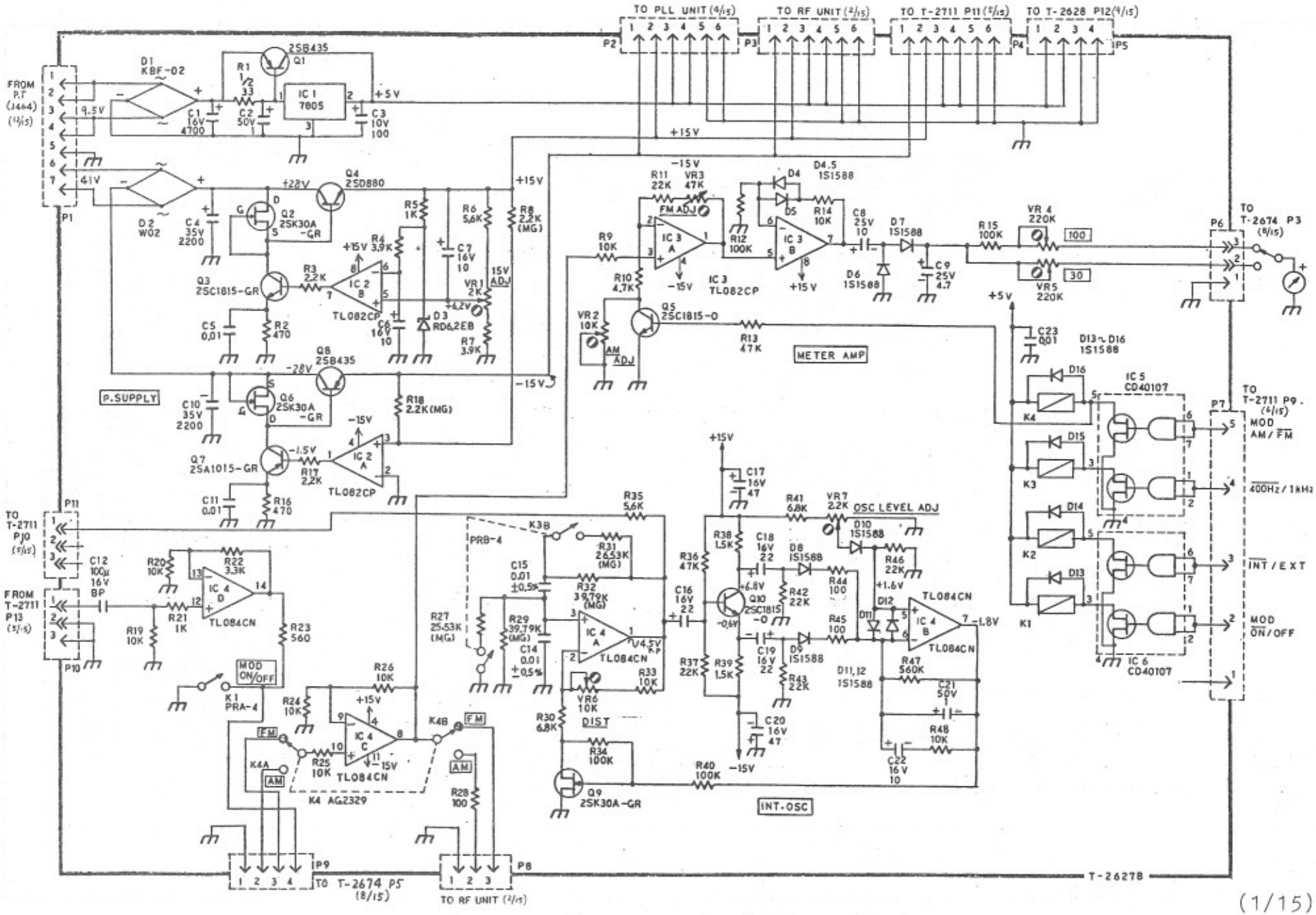

P1
P8
R1
R2
P4
C1
D1
D2
D3
D4
D5
D7
D6
R3
D9
D8
D11
D10
D13
D12
D15
D14
D16
FOR LSG-217
D17
D18
P3
1
2
99
100
C2
S1
D19
S2
S6
S10
S14
S18
S21
S22
S23
D20
S3
S7
S11
S15
R5
R4
R7
R6
D21
S4
S8
S12
S16
S19
R10
R9
R8
S24
S25
S26
S5
S9
S13
S17
S20



※ SEE BLOCK DIAGRAM OF CONTROL BOARD

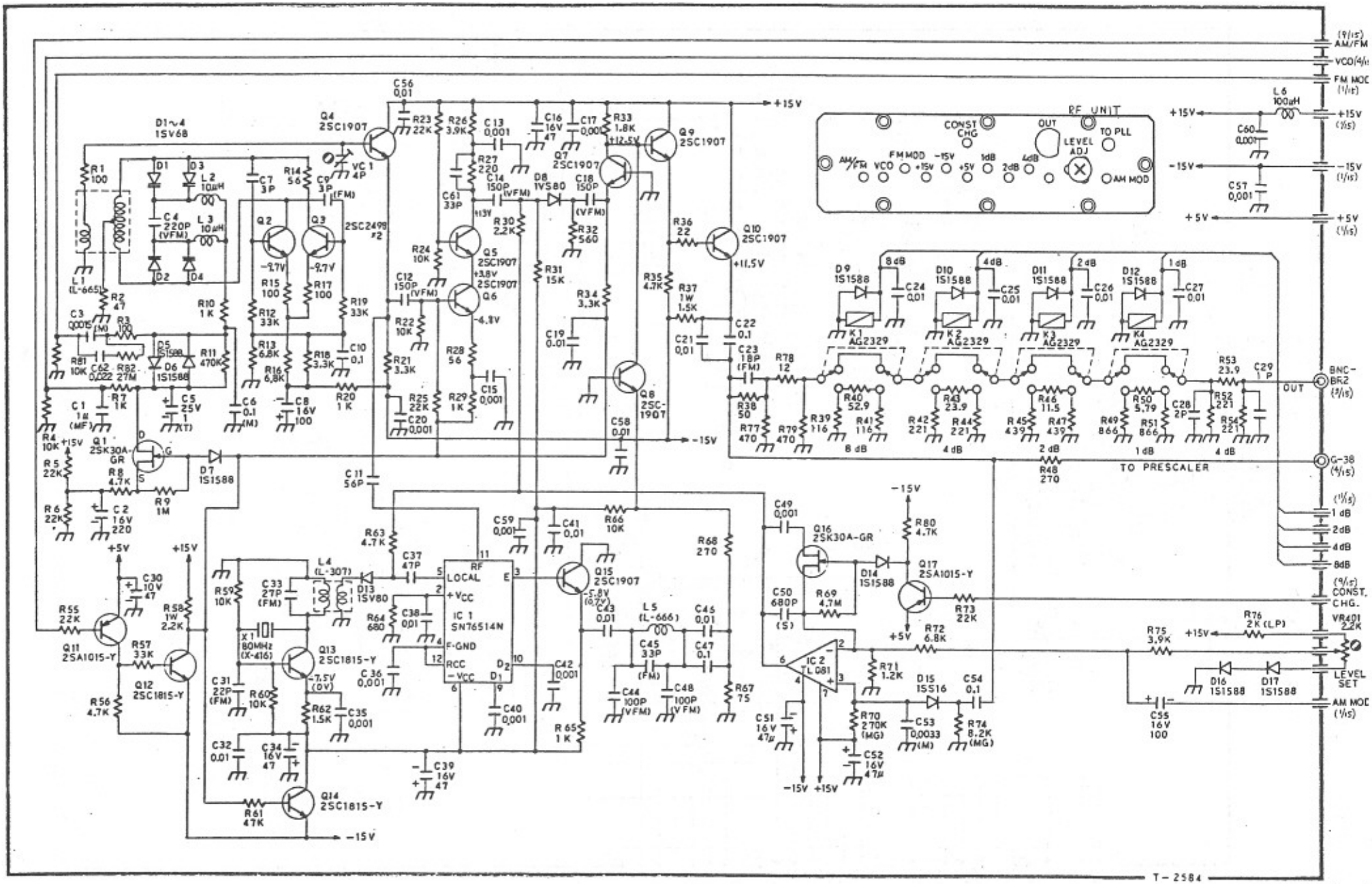

MEMORY BACK UP CIRCUIT Q10, 11
OPTION EPROM SOCKET P23
ADDRESS LED DRIVER IC 44, 45
FREQ LED DRIVER IC 1, 2, 3, 4, 5, 6
OUTPUT LEVEL LED DRIVER IC 7, 8
WRITE PULSE
I/O1 ~ I/O4
※2
LOCAL, RECALL, SET MODE SET CIRCUIT IC 47, 48, 49, 50, 51
MEMORY IC 57
3 STATE BUFF FOR MEMORY IC 9, 10, 11
3 STATE BUFF FOR MEMORY IC 12
ADDRESS INCREMENT IC 50, 54
RECALL, STORE PULSE SHAPING IC 52, 58, 60 C 25 R63, 64
MEMORY ADDRESS CONTROL (A0~A2) IC 66, 71
ADDRESS SET CIRCUIT IC 46, 47
※3
FREQ. SET CIRCUIT IC 15, 16, 17, 18, 19, 20 (MSD) (LSD)
※5
OUTPUT LEVEL SET CODE CONVERTER & ATT. DRIVER IC 21, 22, 32, 33, 34, 35, 36 IC 39, 40, 41, 42, 43 Q 2, 3, 4, 5, 6, 7, 8, 9
CS SIG. SHAPING IC 45, 49, 56 R 65, 66 C 26
WRITE ENABLE PULSE IC 54, 55
READ PULSE
WRITE, READ PULSE GENERATOR IC 61, 62, 65
ADDRESS UP/DOWN SIG. & CLOCK SHAPING IC 46, 51, 52, 58, 59 IC 60, R 61, 62 C 24
BEGIN ADDRESS END ADDRESS DETECTION CIRCUIT IC 24, 44, 45, 48, 49 IC 50, 51
DIGIT SELECT CIRCUIT IC 25, 26, 29, 30
FREQ. UP/DOWN SIG. & CLOCK SHAPING IC 14, 37, 38
OUTPUT LEVEL UP/DOWN SIG. & CLOCK SHAPING IC 26, 27, 31, 37
FREQ. LEVEL DIGIT COUNTER IC 70, 73
INITIAL SET IC 13, 23, 24 R 3, 4, 5, 6 C 2, 3
I/O5~I/O8
※4
※1
NUMERICAL KEY CODE CONVERTER & CLOCK SHAPING IC 68, 69, 72, 27 R 71, 72, C 27
A, B BAND & MOD MODE CONTROL IC 46, 53, 74, 75, 76, 78 T-2711
RANGE OUTPUT (REAR PANEL) Q 12, 13
T-2628


228KHz X'TAL OSCILLATOR Q1,2
1/3 DIVIDER IC22
1/2 DIVIDER IC23A
1/2 DIVIDER IC23B
L.P.F.-1 Q3
MOD. LEVEL, PHASE ADJ. IC24, Q4
SCOPE PHASE ADJ. Q5
TP1
DRIVER Q8
DRIVER Q7
19KHz
38KHz
BUFFER IC28A
BALANCED MODULATOR D5-8
PILOT MOD ON-OFF
400Hz/1KHz
400Hz/1KHz
EXT MOD
MODULATION
R
L
MAIN
SUB
EXT MOD
TP2
COMPOSITE OUTPUT
P13
L.P.F.-2 Q9-10
AMPLIFIER IC30-33
38KHz
BUFFER IC28B
BALANCED MODULATOR D9-12
EXT MOD



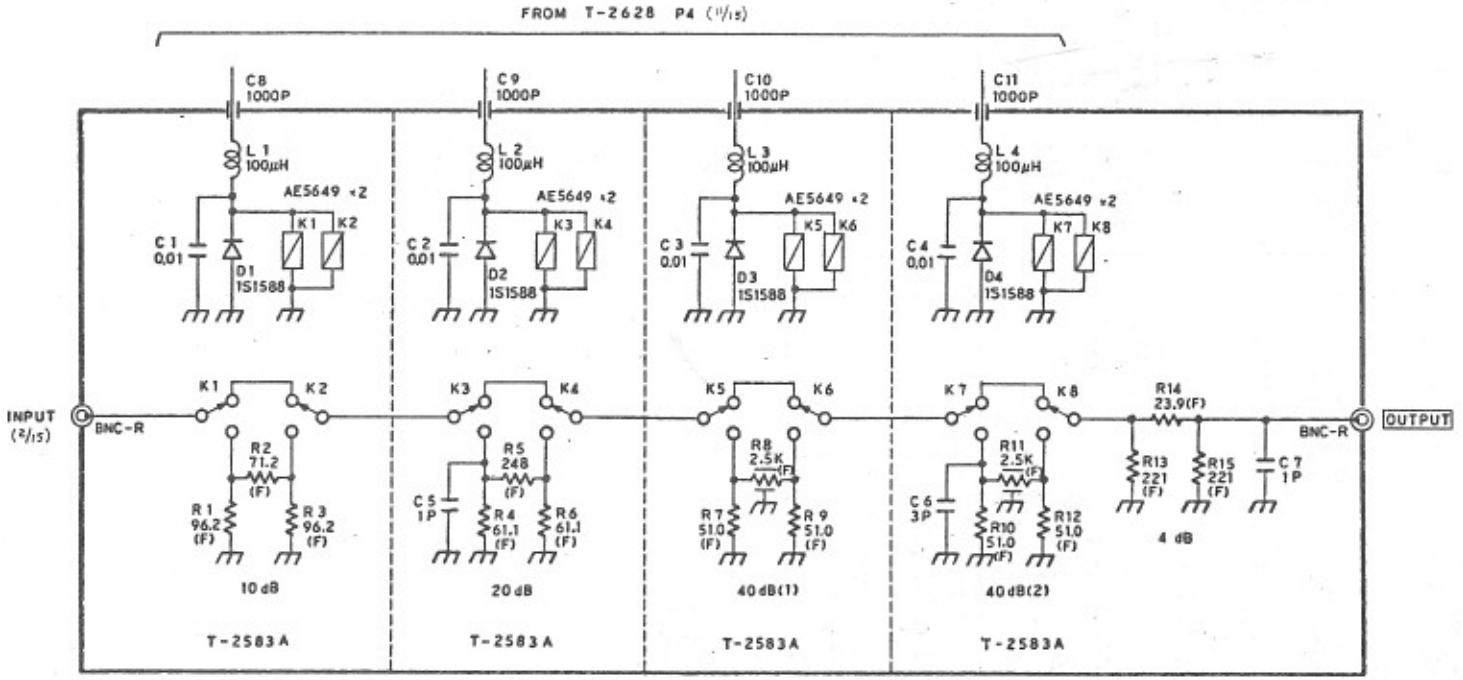
(1/15)

Power supply & AF oscillator


RF UNIT
CONST CHG
OUT
TO PLL
LEVEL ADJ
AM/FM
VCO
FM MOD
-15V
+15V
+5V
1dB
2dB
4dB
AM MOD
TO PRESCALER
BNC-BR2
G-38
CONST. CHG.
VR401 2.2K
LEVEL SET
AM MOD
IC 1 SN76514N
IC 2 TL081
T-2584

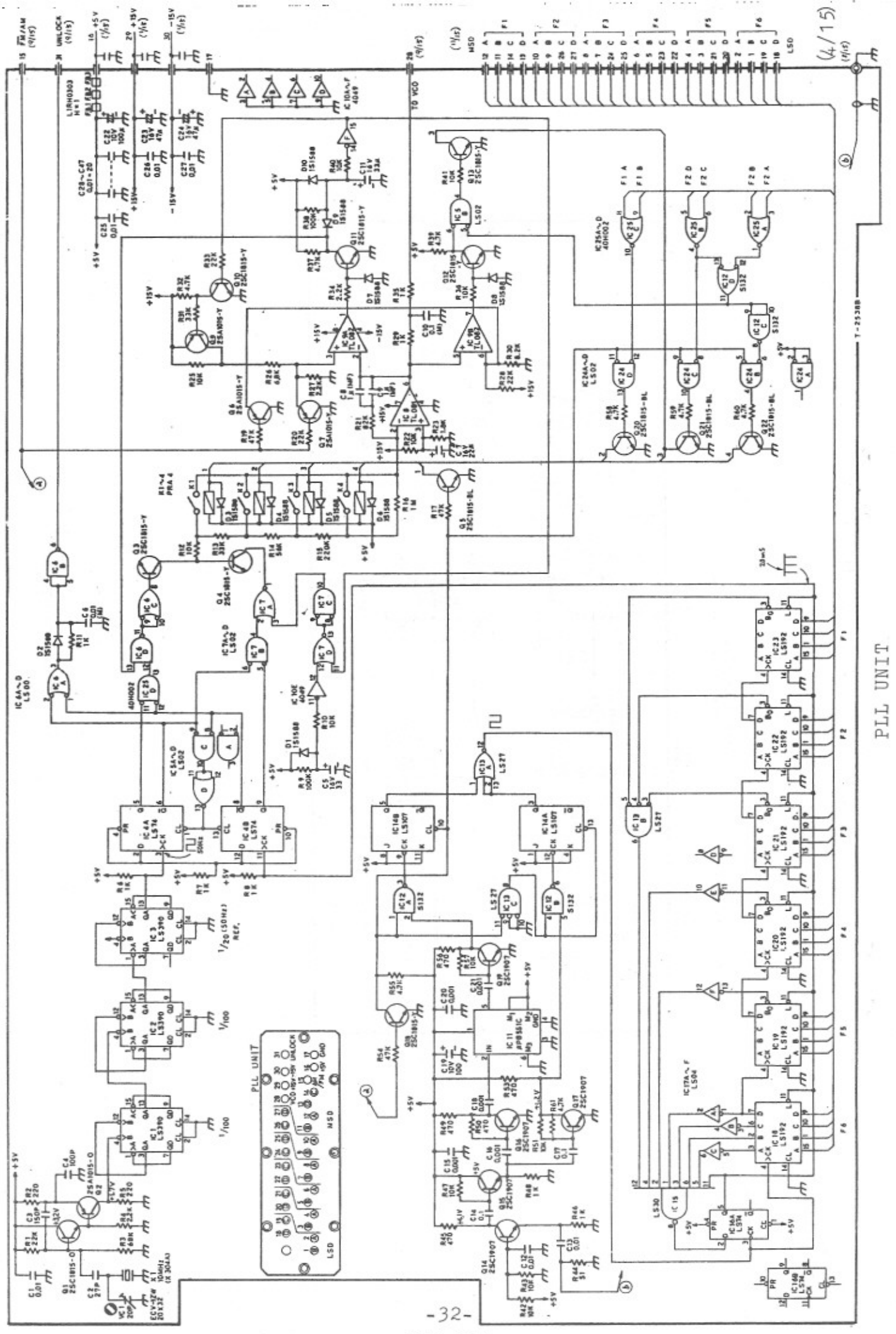
(2/15)

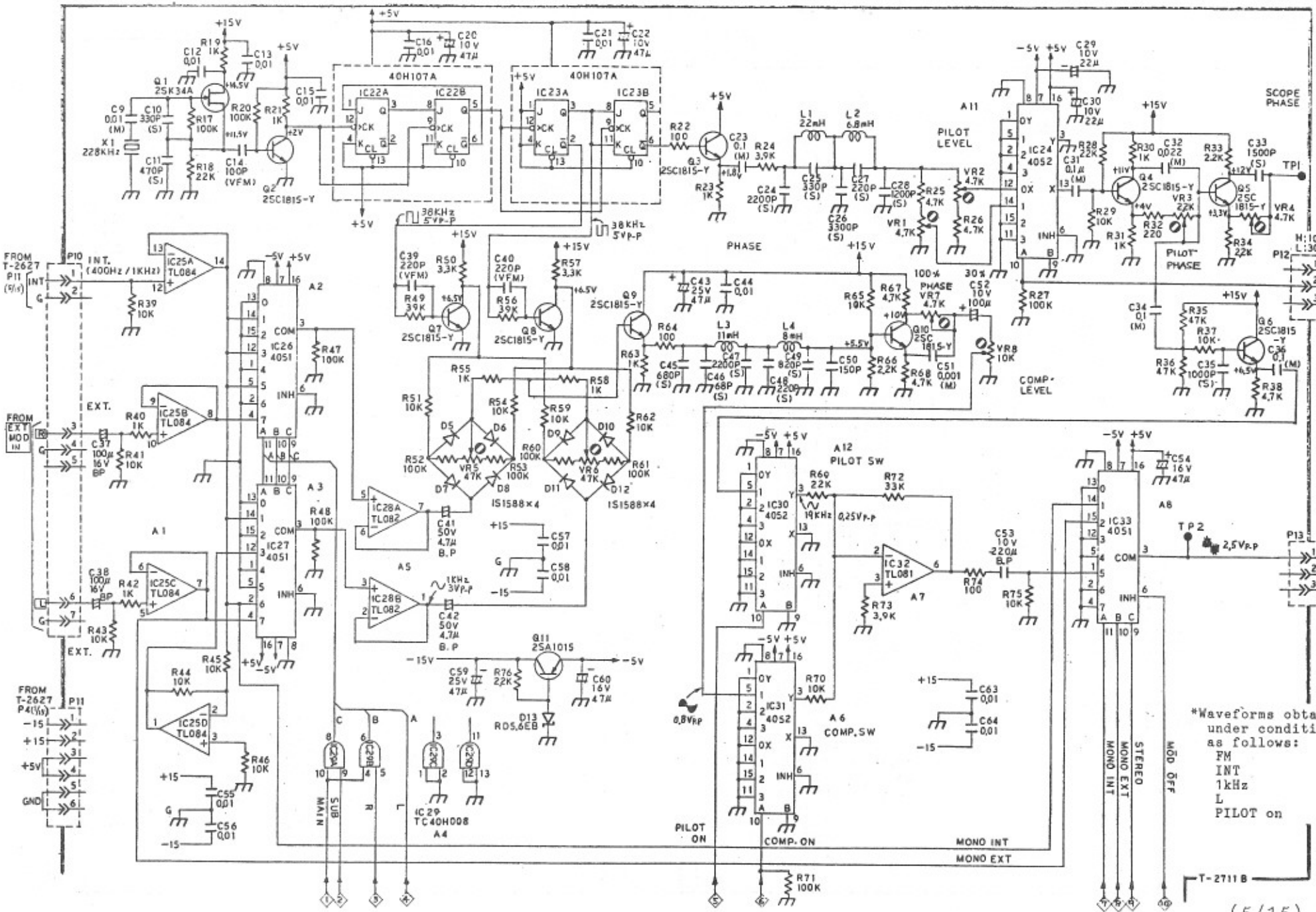
RF UNIT



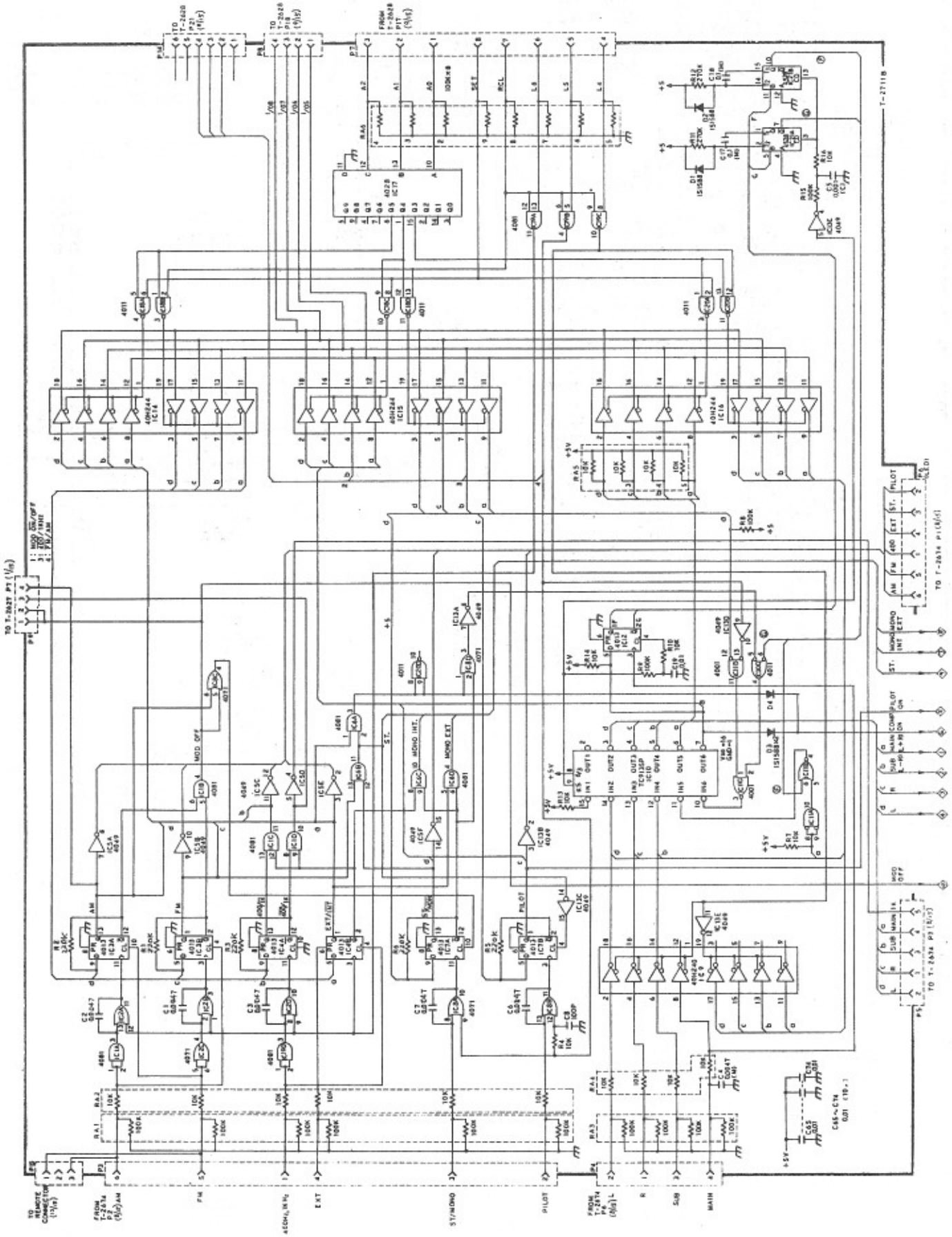
(3/15)

10dB step attenuator

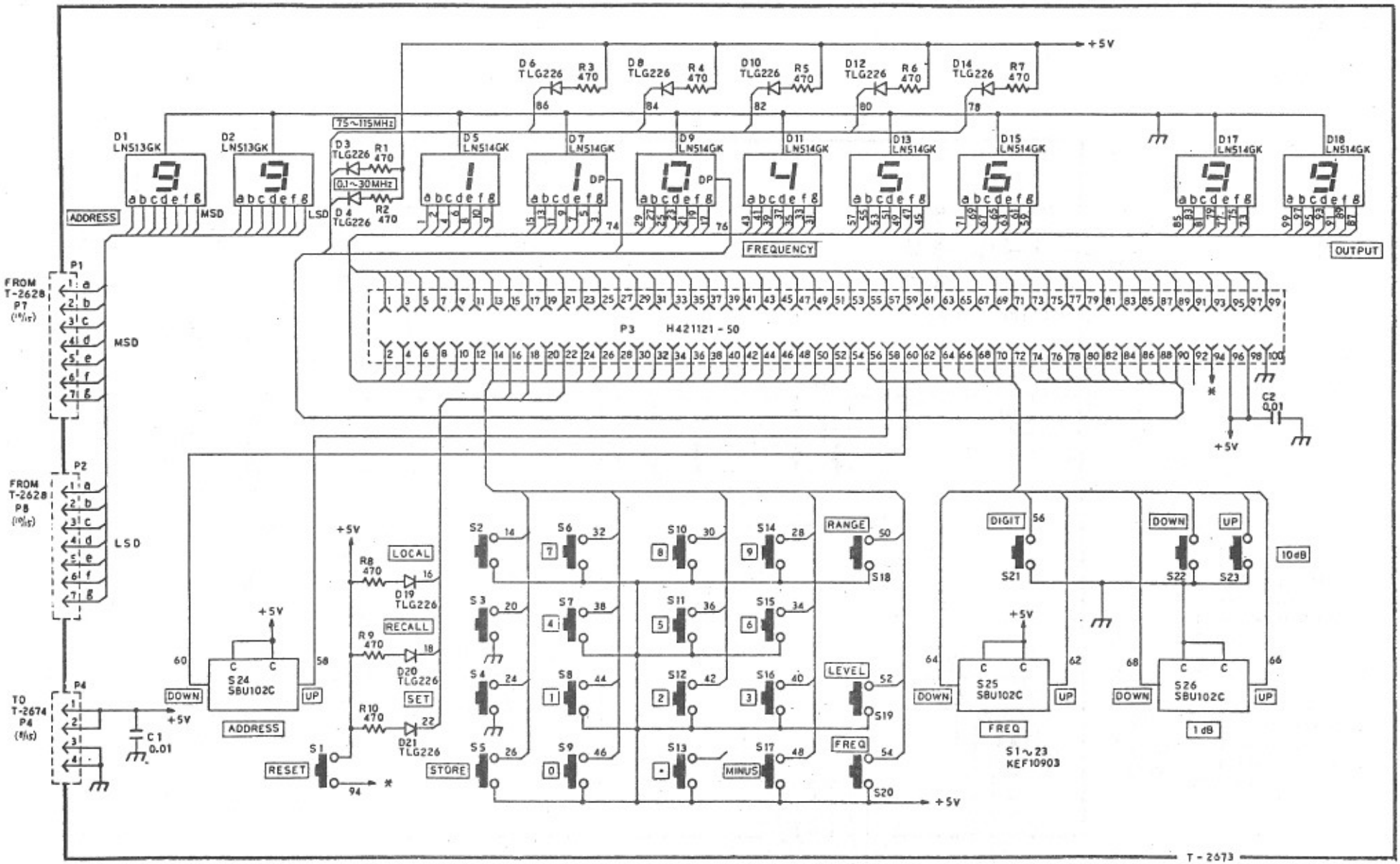

PLL UNIT
(4/15)
T-25388



Stereo signal generator - 1/2



Stereo signal generator



LED display

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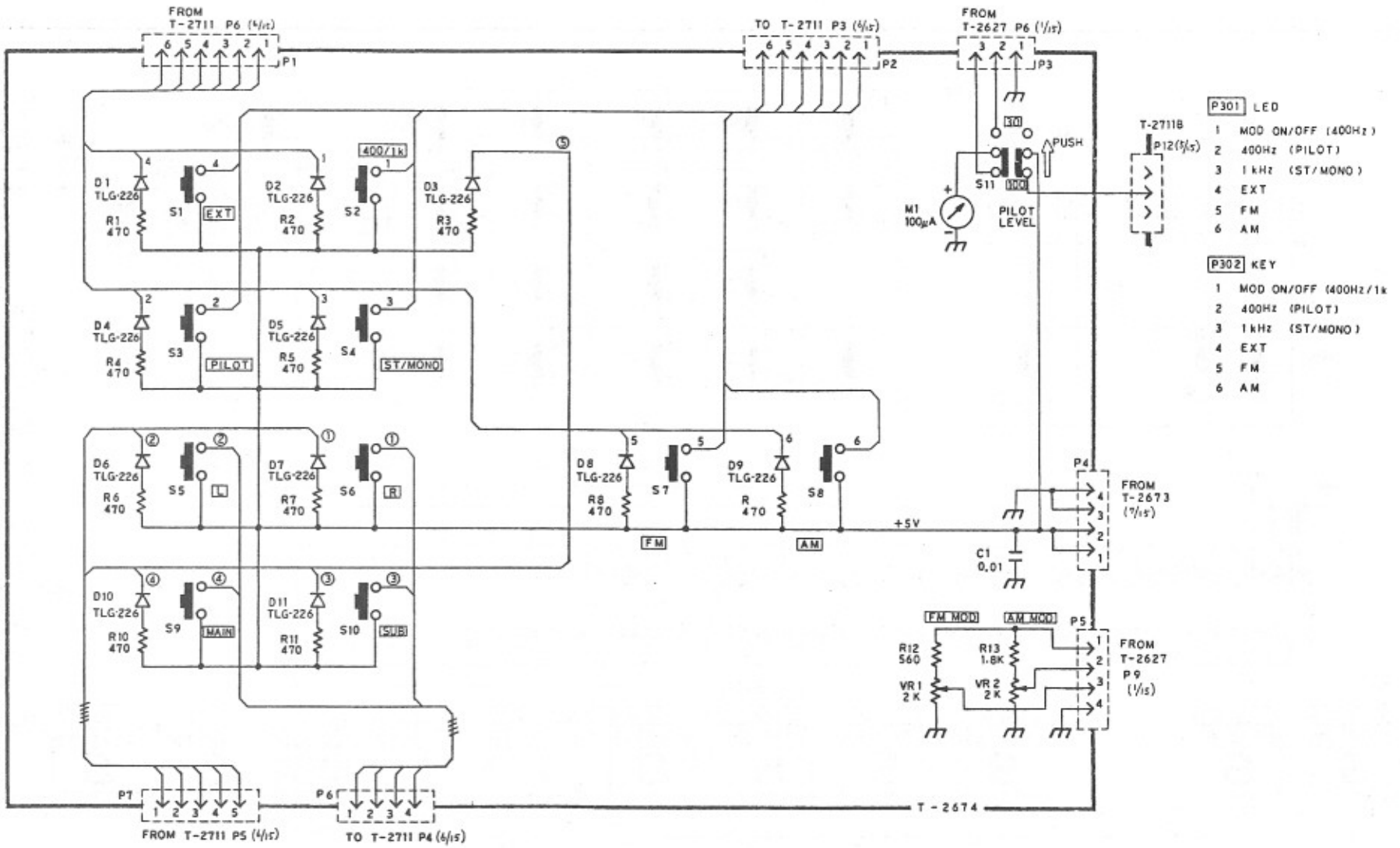
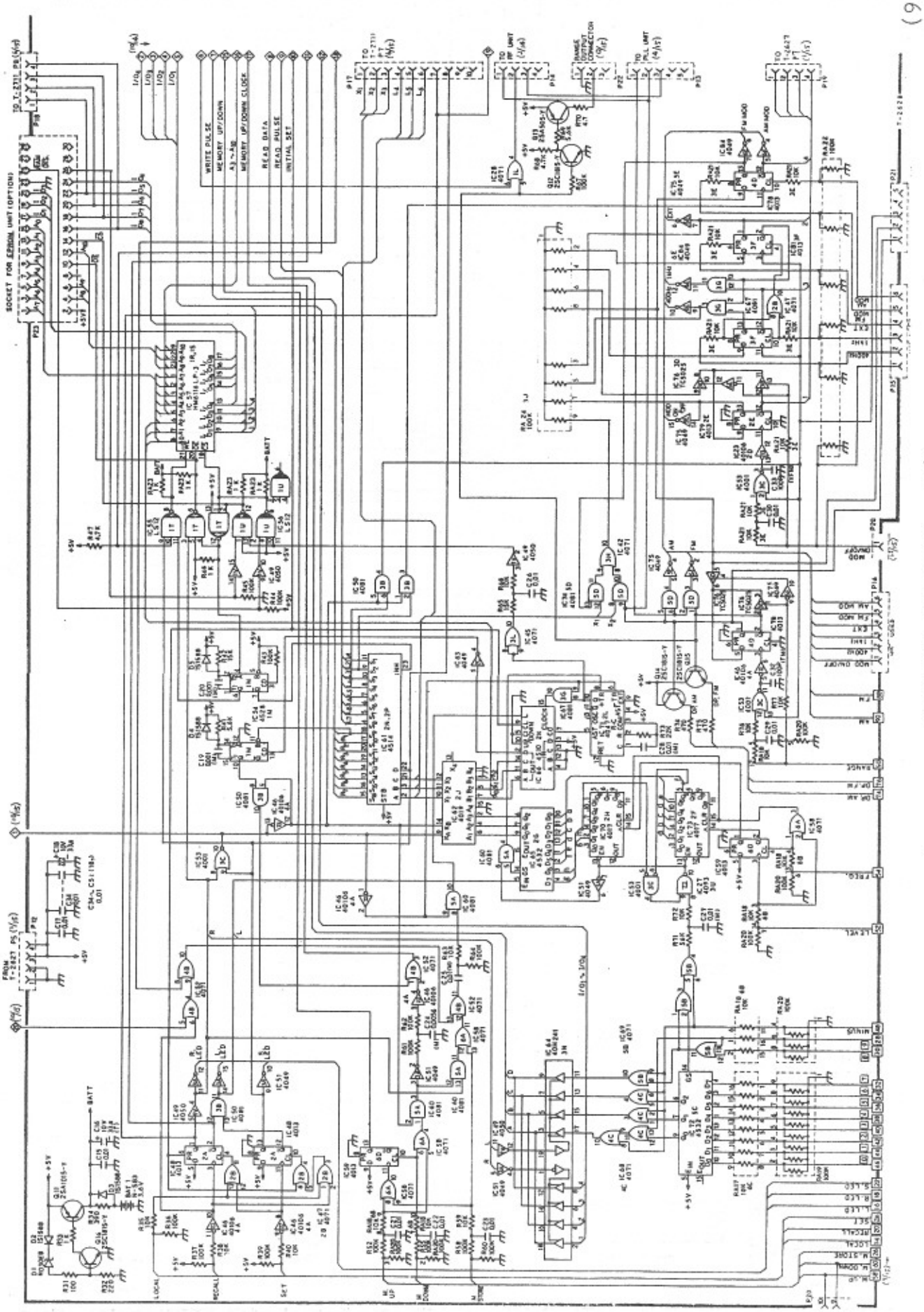


(8/15)

Modulation mode



Control circuit - 1/3

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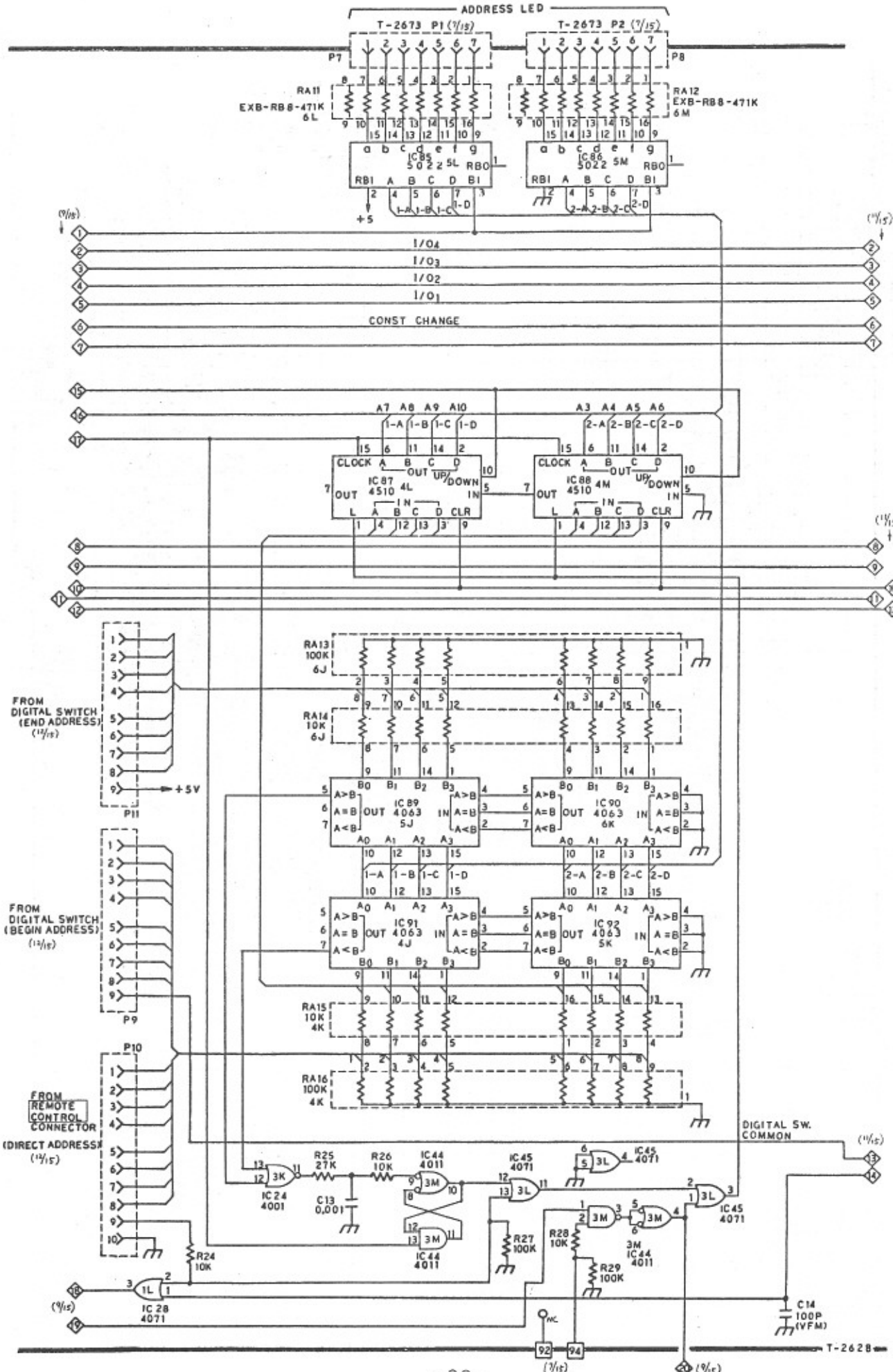
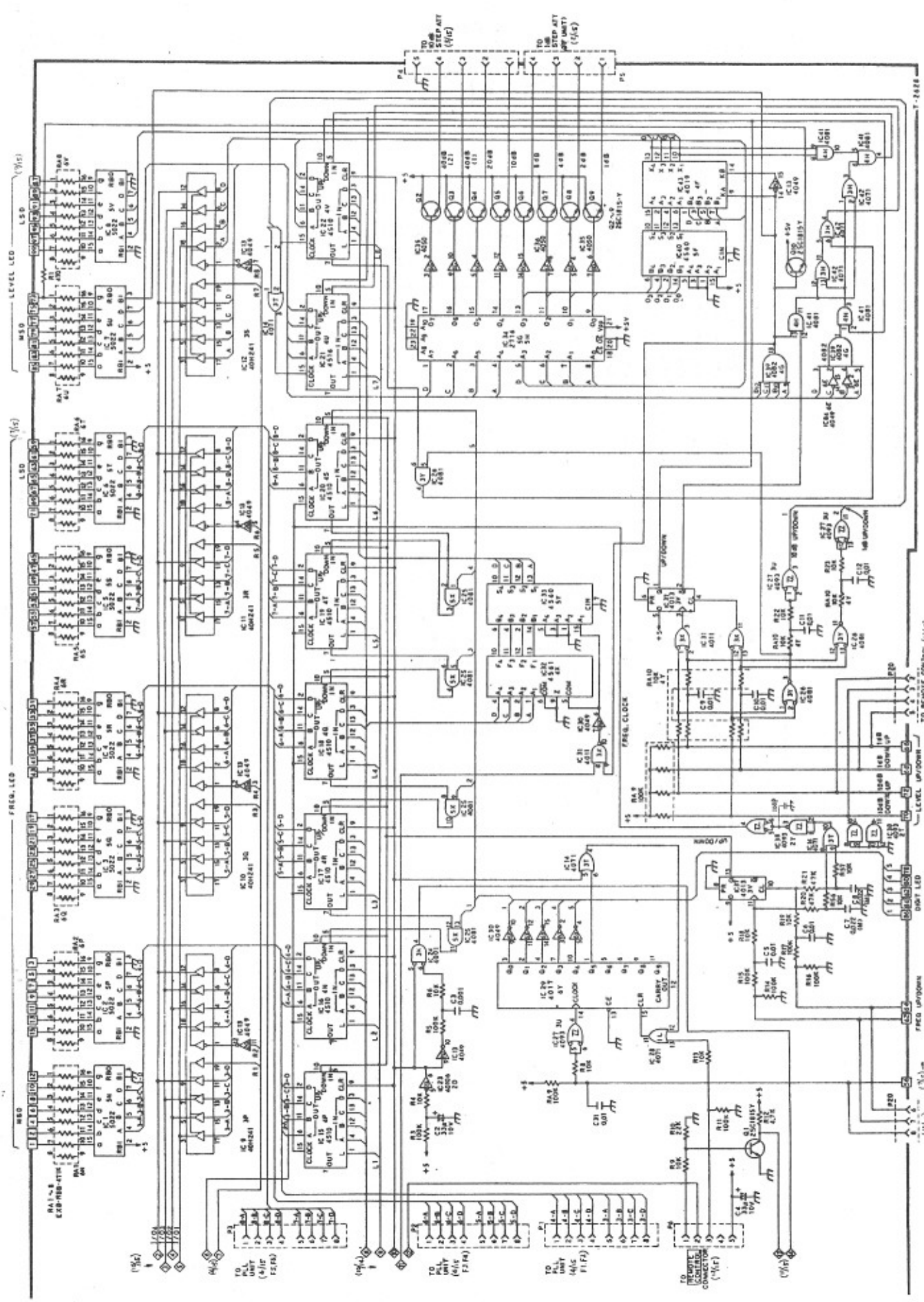
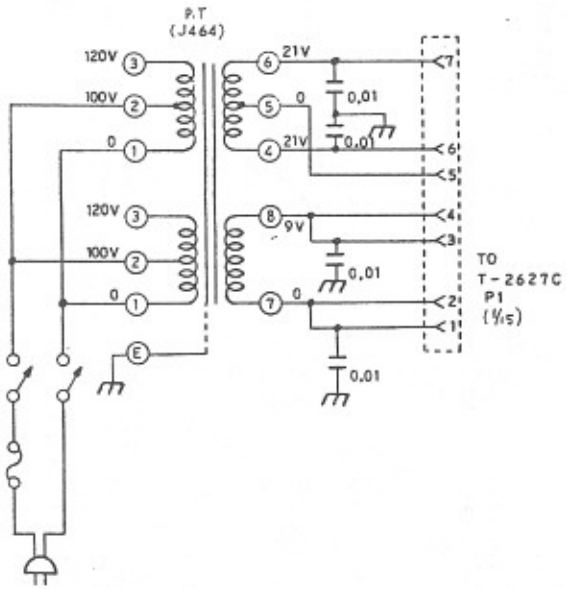
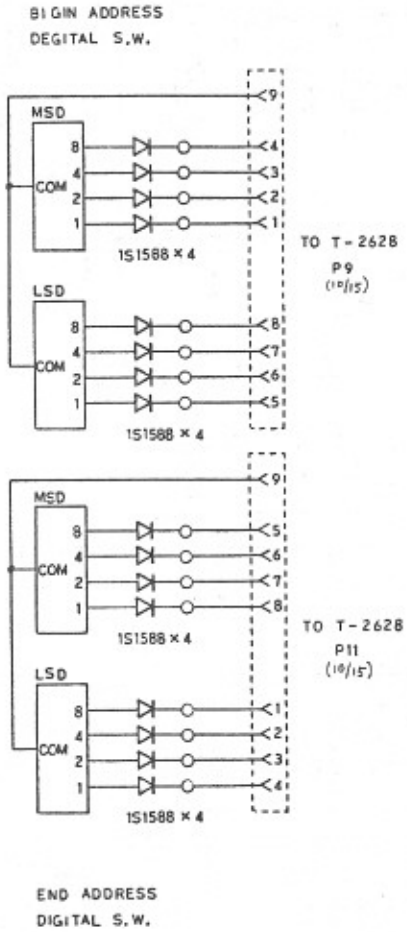


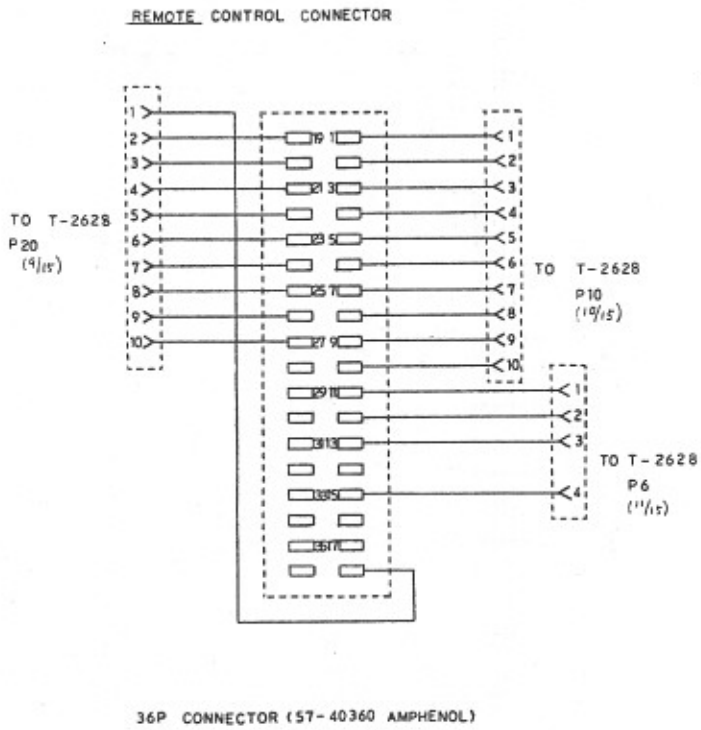
Control circuit - 2/3



Control circuit - 3/3







Power transformer
Digital switch
Remote control connector

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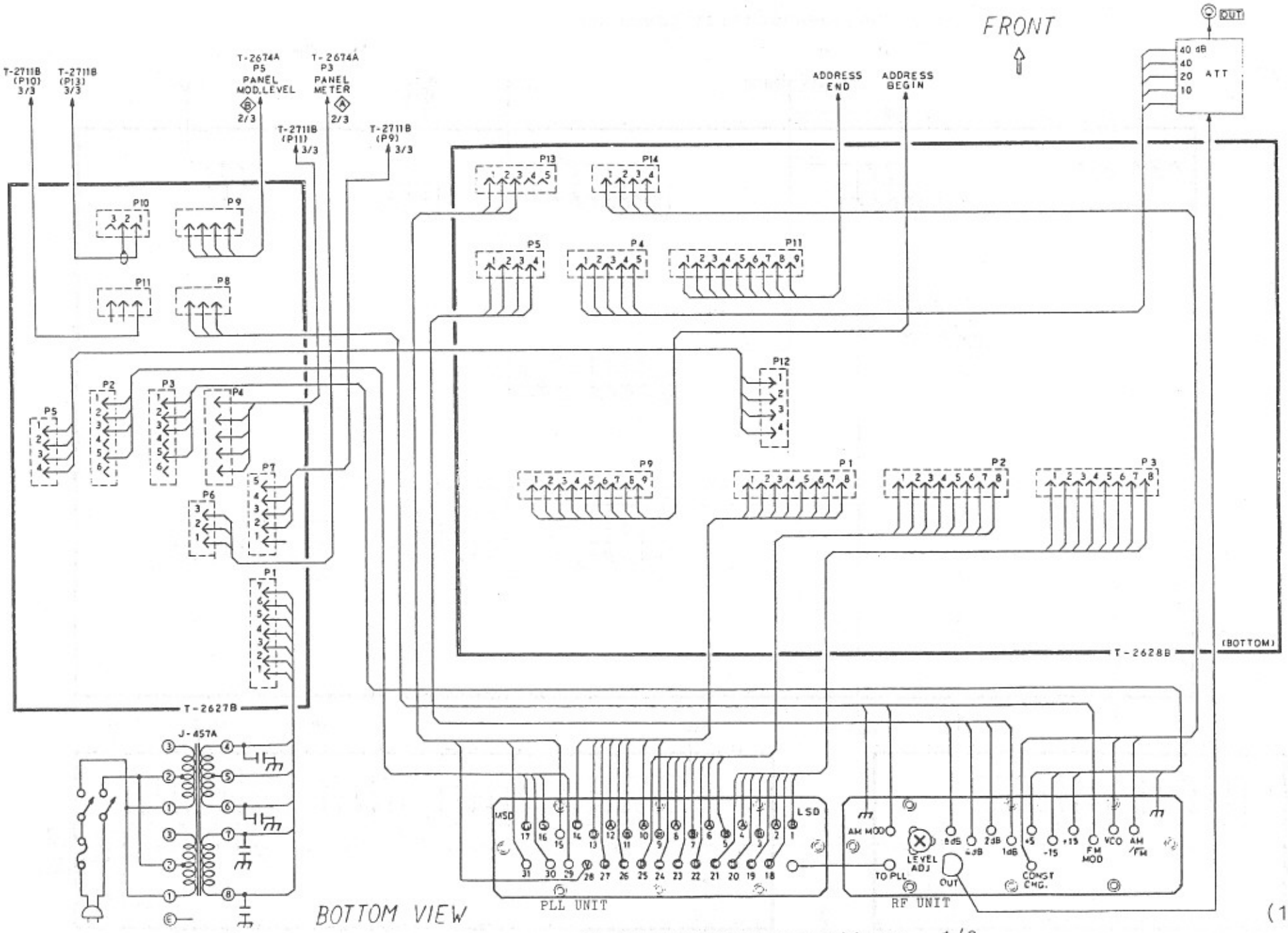

Pc board interconnections - 1/3

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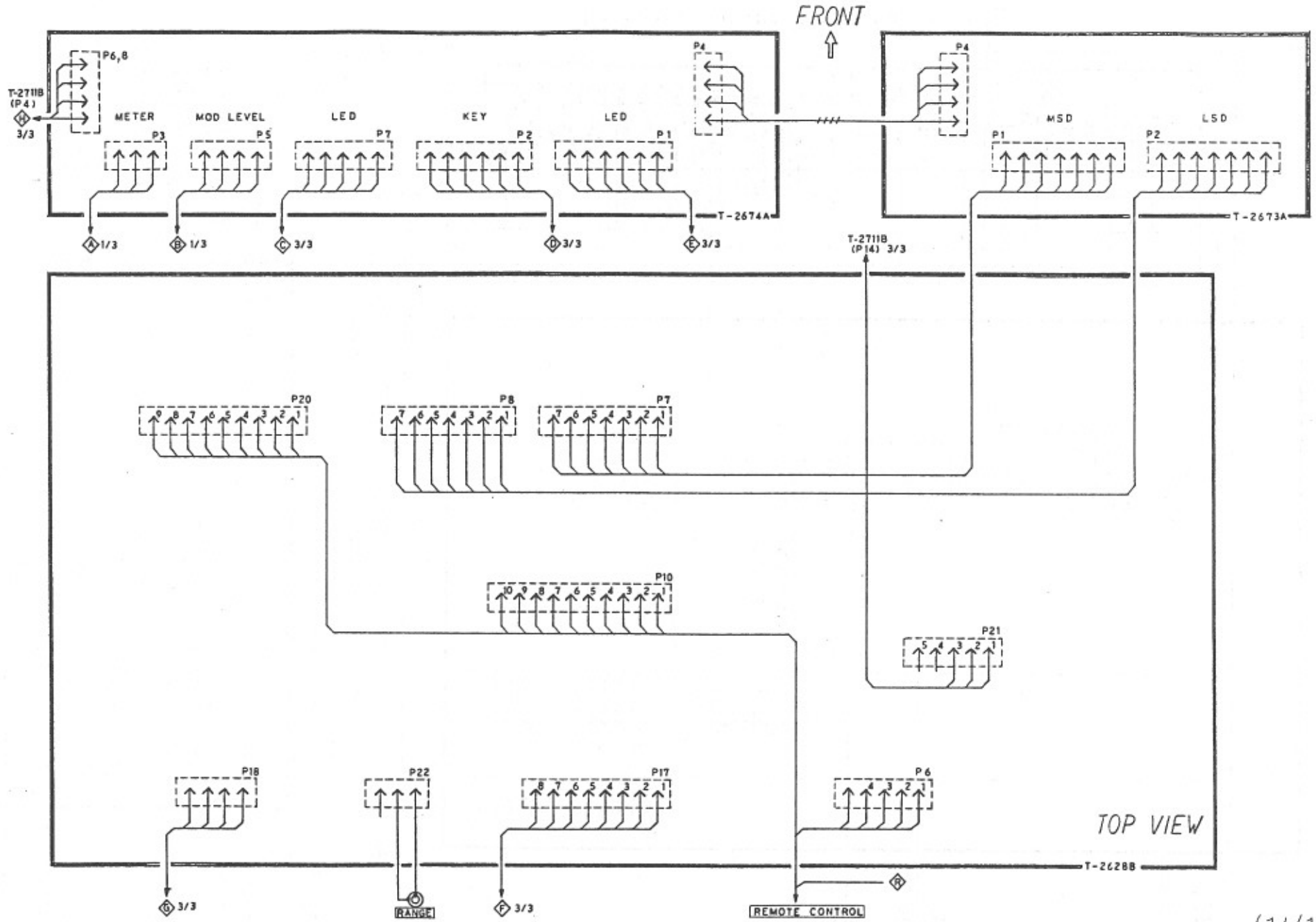

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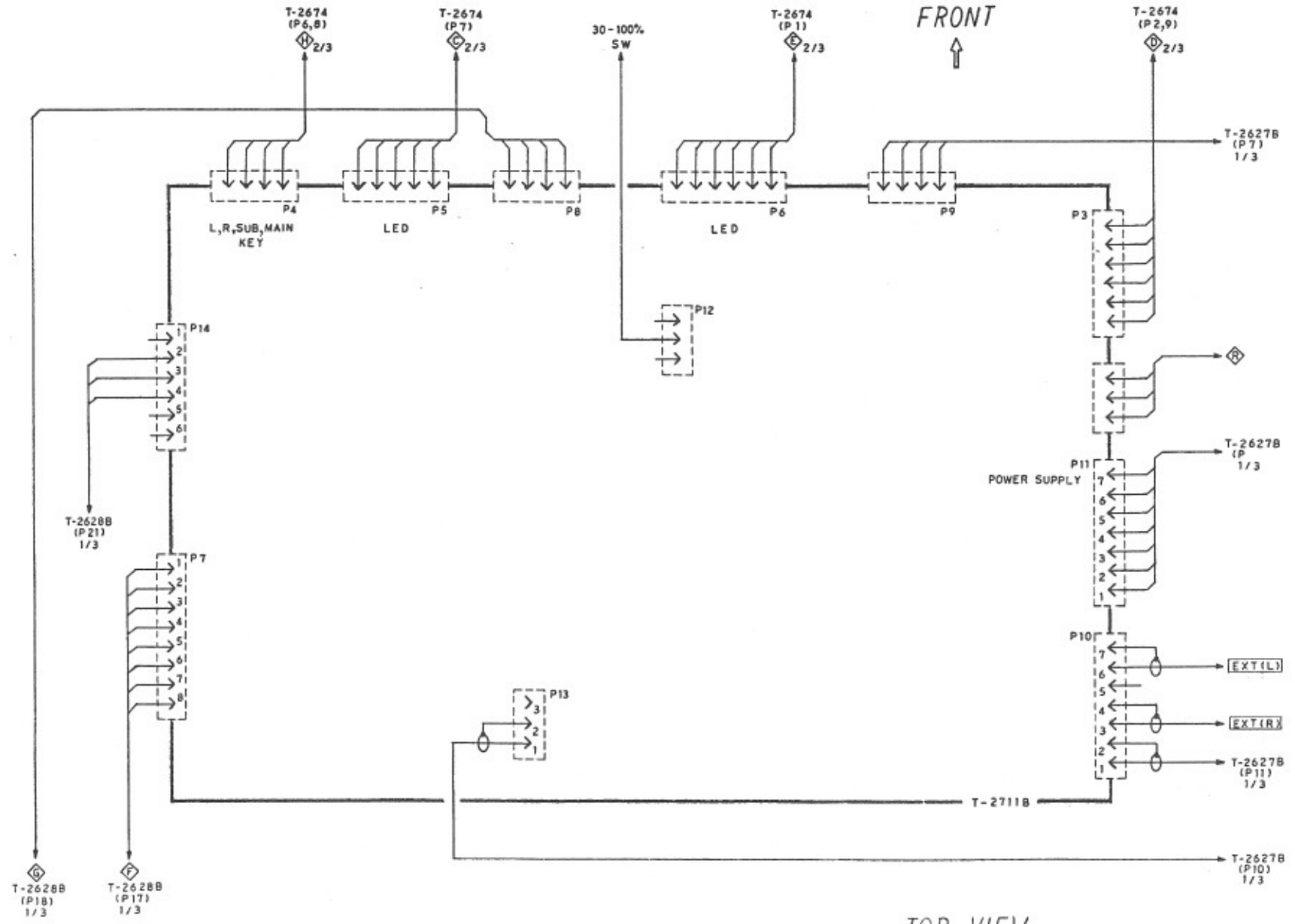
Pc board interconnections - 2/3



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Pc board interconnections - 3/3