

Model 3215/3216
STANDARD SIGNAL GENERATOR
SERVICE MANUAL

All informations for the Model 3216
are indicated by [--] in this manual
unless otherwise noted.

<<WARNING>>
This service manual is for use by qualified
personnel only. To avoid electrical shock,
do not perform any service in this manual
unless qualified to do so.

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1. SPECIFICATIONS

- (1) **Frequency**
- Range: 100 kHz to 140 MHz
- Resolution: 100 Hz (100 kHz to 29.9999 MHz)
1 kHz (30MHz to 140 MHz)
- Setting: By key operation as well as the digit select keys and the up/down switch
- Accuracy: Within $\pm 5 \times 10^{-5}$
- Display: 6 digits, digital display
- (2) **Output**
- Range: -20 to 126 dB μ (0 dB = 1 μ V open circuit)
- Resolution: 0.1 dB
- Setting: Key operation as well as 1 dB and 0.1 dB up/down switch
- Reference level accuracy: Within ± 1 dB (at 126 dB μ output)
- Attenuator accuracy: Within ± 1.5 dB (≤ 0 dB μ)
Within ± 2 dB (< 0 dB μ)
- Impedance: 50 Ω , VSWR: less than 1.3
- Spurious output: Harmonic: 30 dBc
Non-harmonic: 50 dBc (within band)
- Display: 4 digits, digital display
- (3) **Modulation**
- **FM**

Frequency deviation: 0 to 99.9 kHz

Display: 3 digits, digital display

Resolution: 0.1 kHz

Modulation accuracy: Within $\pm 10\%$

Distortion factor: Less than 0.05% (10.7 MHz ± 1 MHz, 74 to 108 MHz)
Less than 0.1% (other frequencies)
(1 kHz, 75 kHz deviation, demodulation band 50 Hz to 15 kHz, de-emphasis 50 μ s)

Residual FM 73 dB or greater S/N for 75 kHz deviation
(Frequency ≤ 110 MHz)
(Demodulation band 50 Hz to 15 kHz, de-emphasis 50 μ s)
 - **FM Stereo (applicable only to Model 3216)**

Pilot signal

Frequency deviation: 0 to 10.0 kHz

Display: 3 digits, digital display

Resolution: 0.1 kHz

Modulation accuracy: $\pm 10\%$

Frequency: 19 kHz ± 2 Hz

Left-right separation: 55 dB or greater (kHz, 75 kHz deviation, 74 to 110 MHz)

Modes: MAIN, SUB, L, R

• **AM**

Modulation factor:	0 to 60.0%
Display:	3 digits, digital display
Resolution:	0.1%
Modulation accuracy:	±10% of display value
Distortion factor:	Less than 0.5% (150 kHz to 29.9999 MHz) Less than 1.5% (30 MHz to 140 MHz) (1 kHz 30% modulation, demodulation band 50 Hz to 15 kHz)
Residual AM:	55 dB or greater S/N for 30% modulation (Demodulation band 50 Hz to 15 kHz)

Internal modulation

frequency: 400 Hz, 1 kHz ±5%

External modulation

Input impedance:	10 kΩ
Reference input voltage:	1.0 Vrms
Frequency range	FM: 20 Hz to 100 kHz AM: 20 Hz to 10 kHz
Frequency response:	Within ±1 dB (1 kHz reference)

(4) Preset

Frequency, modulation, and output level data can be stored as a set in the internal Memory, which is capable of up to 100 such presettings.

(5) Miscellaneous

Power supply:	100, 120, 220, and 240 V AC ±10%
Power consumption:	Approx. 35 VA (Model 3215), 40 VA (Model 3216)
Size and Weight:	426(W) × 100(H) × 300(D)mm, Approx. 7.5 kg
Accessories:	BNC-BNC, 3D2V (50Ω) cable (1 m) 1 Power cord 1 Fuse 1

2. TEST EQUIPMENT REQUIRED

The following test equipment is required for calibration and servicing of the Model 3215/3216. The suggested specifications are the minimum necessary for proper calibration of this instrument.

Test Equipment	Minimum Specifications
- Multimeter	Accuracy: <1% *LEADER Model LDM-853A
- Oscilloscope	Sensitivity: 5mV Bandwidth: 200MHz Low capacitance probe
- Frequency Counter	Bandwidth: 150MHz *LEADER Model LDC-823A
- Audio Generator	Frequency range: 10Hz to 200kHz Distortion: <0.05% at 1kHz *LEADER Model LAG-126
- Function Generator	Frequency range: 10kHz to 200kHz Sweep mode provided *LEADER Model LFG-1310
- Distortion Meter	Full scale: 0.1% 400Hz, 1kHz
- AC Millivoltmeter	Sensitivity: 0.1Vrms Bandwidth: 1MHz *LEADER Model LMV-181A
- RF Millivoltmeter	Sensitivity: 1V(120dBu) Bandwidth: 200MHz

- Spectrum Analyzer Frequency range: 100kHz to 200kHz

- FM Linear Detector Frequency range: 30MHz to 150MHz
Full scale: 100kHz
Separation: >50dB

- AM Linear Detector Frequency range: 150kHz to 30MHz
Full scale: 100%, 30%

- FM Stereo Demodulator Separation: >70dB

- Terminator 50 ohm feed-through
 *LEADER Model LT-2049

3. CALIBRATION PROCEDURE

3.1 General

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 adjustments 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 circuits at constant operating temperature.

When connecting the oscilloscope to the test point, use a low capacitance probe.

*** WARNING ***

Electrical shock hazards exist inside this instrument when covers are removed.

3.2 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.

MODULATION

SOURCE	INT/1kHz
OPTION	Off
MOD ON	Off
DISPLAY	MOD(Model 3216)
STEREO	L(Model 3216)

FREQUENCY

10MHz

OUTPUT LEVEL

126dBu

3.3 Power Supply

- Connect the DC voltmeter between test point on the main board, T-4087 and chassis.
- Check the voltages according to Table 3-1.

Test point	Voltage	Tolerance
TP201	+5V(Vcc)	+4.75V to +5.25V
TP202	+5V	+4.75V to +5.25V
TP203	+15V	+14.25V to +15.75V
TP204	-15V	-14.25V to -15.75V

Table 3-1

3.4 AF Oscillator

- Set: MODULATION
SOURCE INT/1kHz
- Connect the oscilloscope to TP51(T-4087, main board).
- Adjust VR51, INT AF DIST(T-4087, main board) for a ripple amplitude of 150mVp-p or less.
- Connect the frequency counter to TP52(T-4087, main board).
- Confirm that the frequency accuracy within tolerance according to Table 3-2.

Frequency	Tolerance
1kHz	970 to 1030Hz
400Hz	388 to 420Hz

Table 3-2

3.5 RF Oscillator

- *NOTE* RF board, T-4089 is located inside a RF shielded package. If it is necessary to open this package, take care to close unit every time an adjustment is need and allow temperature to stabilize once again.

- (1) Reference Oscillator
 - Connect the frequency counter to TP1(T-4089, RF board).
 - Adjust VC1, REF OSC(T-4089, RF board) for a frequency reading of 10.000MHz within +100Hz(9.99990MHz to 10.00010MHz).

- (2) Local Oscillator
 - Set: FREQUENCY 1MHz
 - Connect the spectrum analyzer to test connector, P201 (T-4089, RF board).
 - Adjust L209, LOCAL OSC(T-4089, RF board) for maximum amplitude.
 - Remove the spectrum analyzer.

- (3) Frequency Check
 - Set: MODULATION Off
 - MOD ON
 - OUTPUT LEVEL 126dBu
 - Connect the frequency counter to OUTPUT connector.
 - Confirm that the frequency should be within tolerance on entire range.

- (4) Output Level

NOTE The OUTPUT display indicates the voltage as EMF (voltage into open circuit). Therefore, the actual output voltage into 50 ohm load is minus 6dB from the displayed voltage.

 - Set: MODULATION Off
 - MOD ON
 - FREQUENCY 70MHz
 - OUTPUT LEVEL 122.1dBu
 - Connect the RF millivoltmeter to OUTPUT connector, via 50 ohm terminator as needed.
 - Adjust VR153, 116.1dBu ADJ(T-4087, main board) for an output level of 116.1dBu(+9.1dBm).

- Set: OUTPUT LEVEL 126dBu
- Adjust VR154, 120dBu ADJ(T-4087, main board) for an output level of 120dBu(+13dBm).
- Repeat above adjustment if necessary.

(5) Spurious

NOTE This step mentions a spurious adjustment, however, it is very critical. Therefore, if problem is not evident, do not attempt the following adjustment.

- Connect the spectrum analyzer to OUTPUT connector.
- The spurious should be -30dBc or better on entire range.
- If not, adjust VR202, SPURIOUS(T-4089, RF board) for a spurious of -30dBc or less.

(6) Mixer Nulling

NOTE This step mentions a double balanced mixer nulling, however, the adjustment is very critical. Therefore, if problem is not evident, do not attempt the following adjustment.

- Set: MODULATION
MOD ON Off
FREQUENCY 29.9MHz
OUTPUT LEVEL 126dBu
- Connect the spectrum analyzer to OUTPUT connector.
- Adjust VR201 and VC202, MIXER NULL(T-4089, RF board) for a minimum spurious level between 100kHz and 29.9MHz.
- *NOTE* Set the input attenuator of the spectrum analyzer for appropriate sensitivity to avoid the signal distortion.

(7) VCO/FM

NOTE This step mentions a VCO adjustment, however, the adjustment of the coils is very critical. Therefore, if problem is not evident, do not attempt the following adjustment.

- Set: MODULATION

MOD ON

On

FM

On

FREQUENCY

39MHz

OUTPUT LEVEL

126dBu

- Connect the audio generator to EXT[EXT MOD, L or AF] INPUT connector and set the frequency to 1kHz, output voltage to 1Vrms.

- Connect the FM linear detector to OUTPUT connector and set the controls as follows;

High pass filter 50Hz
Low pass filter 15kHz
De-emphasis 50us

- Adjust following adjustment to obtain a frequency deviation as shown in Table 3-3.

FREQUENCY set	Freq deviation	Adjustment
(VCO-1)		
39MHz	75kHz	VR152, FM DEV(T-4087)
30MHz	78kHz	L101, VCO(T-4089)
(VCO-2)		
60MHz	75kHz	VR1, FM DEV(T-4089)
48MHz	80kHz	L103, VCO(T-4089)
(VCO-3)		
90MHz	75kHz	VR2, FM DEV(T-4089)
74MHz	74.5kHz	L105, VCO(T-4089)
(VCO-4)		
120MHz	75kHz	VR3, FM DEV(T-4089)
140MHz	71kHz	L107, VCO(T-4089)

Table 3-3

3.6 Modulation

(1) EXT MOD Level Indicator

- Set: MODULATION

SOURCE

EXT AF

- Connect the audio generator to EXT[EXT MOD, L or AF] INPUT connector and set the frequency to 1kHz, output voltage to 1Vrms.

- The EXT LEVEL, HIGH/LOW lamps on the front panel should be off.
If not, adjust VR101, EXT MOD LAMP(T-4087, main board) to obtain a following conditions when varying the generator output.

HIGH lamp on: $\geq 1.02V_{rms}$
LOW lamp on: $\leq 0.98V_{rms}$.

(2) FM(INT AF level)

- Set: MODULATION

SOURCE	INT/1kHz
MOD ON	On
FREQUENCY Display	90MHz
- Adjust VR52, INT AF LEVEL, FM(T-4087, main board) for a frequency deviation of 75kHz.

(3) AM

- Set: MODULATION

SOURCE	INT/1kHz
MOD ON	On
AM	On
MODULATION Display	30.0%
FREQUENCY	10MHz
- Connect the AM linear detector to OUTPUT connector via 50 ohm terminator and set the controls as follows;

High pass filter	50Hz
Low pass filter	15kHz
- Adjust VR151, AM(T-4087, main board) for a modulation factor of 30.0% on the AM linear detector.

3.7 FM Stereo Generator(Model 3216 only)

- Set: FREQUENCY 90MHz
- Enter the data to indicate the MODULATION Display as follows;

67.5kHz	for subcarrier
7.5kHz	for pilot signal

(1) Low Pass Filter

NOTE This step mentions a low pass filter adjustment of the composite stereo signal generator, however, the adjustment is very critical. Therefore, if problem is not evident, do not attempt the following adjustment.

- Setup

Connect the audio sweep generator to TP201(T-4088, stereo generator board) and set the frequency range from 50Hz to 200kHz, output level for 1Vp-p.

Connect the oscilloscope as follows and set the operation mode for X-Y;

Y-axis to TP203(T-4088, stereo generator board).
X-axis to SYNC OUT of the function generator.

- Adjust L201 to L204, LOW PASS FILTER(T-4088, stereo generator board) to obtain a frequency response as shown in Table 3-4.

Frequency	Attenuation
10kHz	0dB(reference)
100kHz	-0.4dB
120kHz	-3dB
140kHz	-10dB
160kHz	-20dB

Table 3-4

(2) Matrix

- Set: MODULATION

SOURCE	INT/1kHz
STEREO	MAIN
MOD ON	Off
FM	On
PILOT	Off

- Connect the AC millivoltmeter to TP51(T-4087, main board).
- Note the amplitude, approximately 1Vrms, as reference for next step.

- a. L
- Set: MODULATION
STEREO L
 - Adjust VR2, AF LEVEL, L(T-4088, stereo generator board) precisely for an amplitude of exactly half of the reference amplitude as noted above.
- b. L-R
- Set: MODULATION
STEREO EXT L, R
 - Connect the oscilloscope to TP52(T-4088, stereo generator board).
 - Connect the audio generator to both L INPUT and R INPUT connectors in parallel and set the frequency to 1kHz, output voltage to 1Vrms
 - Adjust VR53, L-R BAL(T-4088, stereo generator board) for a minimum amplitude.
- c. L+R
- Set: MODULATION
STEREO EXT L, R
 - Connect the audio generator to L INPUT connector and set the frequency to 1kHz, output voltage to 1Vrms.
 - Connect the AC millivoltmeter to TP51(T-4088, stereo generator board).
 - Note the voltage reading.
 - Move the audio generator to R INPUT connector without any changes.
 - Adjust VR51, L+R BAL(T-4088, stereo generator board) precisely for a voltage reading of exactly the same as noted above.

(3) Pilot Frequency

- Set: MODULATION

MOD ON	Off
FM	On
PILOT	On

- Confirm that the frequency reading at P101(T-4088, stereo generator board) should be 19.000kHz within +2Hz(18.998kHz to 19.002kHz).
If not, adjust VC101, PILOT FREQ(T-4088, stereo generator board) for a frequency reading of 19.000kHz.

(4) Balanced Modulator

- Connect the oscilloscope to TP203(T-4088, stereo generator board).

a. Nulling

- Set: MODULATION

SOURCE	EXT AF
STEREO	SUB
MOD ON	On
FM	On
PILOT	Off
EXT MOD INPUT connector	Open

- Adjust VR152, 38kHz NULL(T-4088, stereo generator board) for a minimum subcarrier leakage.

b. Balance

- Set: MODULATION

SOURCE	INT/1kHz
--------	----------

- Adjust VR151, SUB BAL(T-4088, stereo generator board) for a symmetrical sub-channel signal as shown in Figure 3-1.
- Repeat step "a" and "b" if necessary.

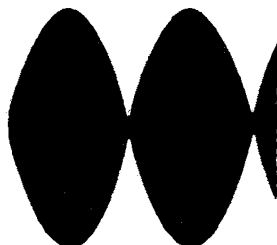


Figure 3-1

(5) Phase between Pilot and Subcarrier

a. Preparation

- Set: MODULATION

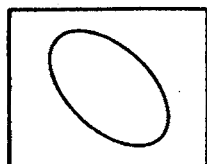
SOURCE	INT/1kHz
STEREO	SUB
MOD ON	Off
FM	On
PILOT	On

- Connect the oscilloscope as follows and set the operation mode for X-Y.

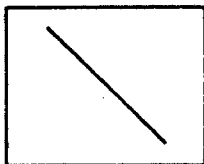
NOTE The low capacitance probes must be compensated with square wave.

CH-1 INPUT to P101 (T-4088, stereo generator board).
CH-2 INPUT to TP151(T-4087, main board).

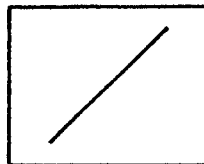
- Adjust VR102, SCOPE PHASE(T-4088, stereo generator board) for a lissajous pattern as shown in Figure 3-2 (b).



(a)



(b)
Correct



(c)

Figure 3-2

b. Adjustment

- Set: MODULATION

STEREO	SUB
PILOT	Off
MOD ON	On

CH-1 INPUT to TP101(T-4088, stereo generator board).
CH-2 INPUT to TP151(T-4087, main board).

- Adjust VR101, PILOT PHASE(T-4088, stereo generator board) for a cross point of the lissajous pattern as shown in Figure 3-3.

- Repeat step "a" and "b" for the best phase matching.

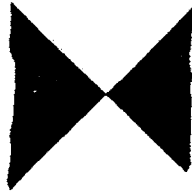


Figure 3-3

(6) Separation

- Set: MODULATION

SOURCE	EXT AF
STEREO	L
MOD ON	On
FM	On
PILOT	On

- Setup

Connect the audio generator to EXT MOD, L INPUT connector and set the frequency to 1kHz, output voltage to 1Vrms.

Connect the stereo demodulator to TP151(T-4087, main board) and set the controls as follows;

Input mode: Stereo

Output mode: L

Input level control: Pilot Meter indication of 10%.

Connect the AC millivoltmeter to the Output Connector of the stereo demodulator.

- Set: MODULATION

STEREO	R
--------	---

NOTE The millivoltmeter indicates the leakage of channel R.

- Adjust following adjustment on the stereo generator board, T-4088 for a minimum channel-R leakage.

Generator frequency	Adjustment
1kHz	VR54, MAIN/SUB BAL
10kHz	VR52, PHASE, HI FREQ
30Hz	VR56, PHASE, LOW FREQ

Table 3-5

(7) FM Deviation

- Set: MODULATION

SOURCE	INT/1kHz
STEREO	MAIN
PILOT	OFF
FM MOD	ON
FREQUENCY	90MHz

- Connect the stereo demodulator to OUTPUT connector.

- The FM deviation should be 67.5kHz.

- Set: MODULATION

PILOT	ON
-------	----

- Adjust VR103, PILOT LEVEL(T-4088, stereo generator board)
for a total deviation of 75kHz.

4. TROUBLESHOOTING PROCEDURE

4.1 General

Confirm that the any equipment used with the Model 3215/3216 is operating correctly.

Check all control settings, an incorrect setting can make a good unit appear defective. If there is any question about the function, refer to the Instruction Manual for correct operation.

Check all circuit for visual defects such as broken component, loose connection, open wire, poor soldering etc.

Some troubles can be solved with proper adjustment.

Check the voltage and waveform as shown in the Schematic Diagram to locate the defective circuit. Start with the power supply.

*** WARNING ***

Electrical shock hazards exist inside this instrument when covers removed.

4.2 Theory of Operation

The Model 3215 and 3216 are a synthesized AM, FM signal generators covering a frequency range of 100kHz to 140MHz. The instrument is divided into five major sections; a RF oscillator, an AF oscillator, a modulator, a controller and a display. The Model 3216 also contains a stereo signal generator.

(1) RF section

The RF oscillator provides a conventional indirect synthesis technique which consists of voltage controlled oscillator (VCO) in conjunction with a phase locked loop(PLL). Simplified block diagram shows the overall synthesizer. Refer to the Figure 4-1.

- Frequency

An output frequency of the VCO is converted to the sub-harmonic of the PLL, 50Hz, at program counter before entering the phase detector.

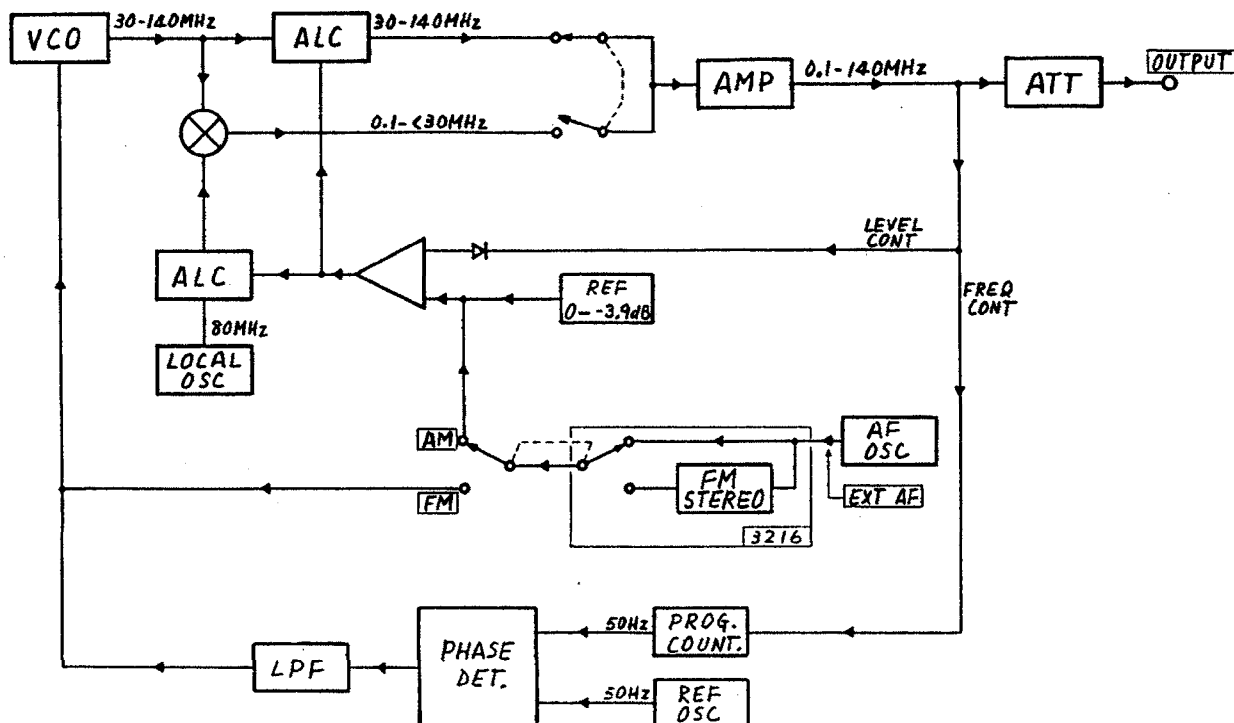


Figure 4-1

The phase detector detects any phase difference between the output signal of the VCO and crystal controlled reference frequency. The detector outputs a control voltage so that the VCO frequency tracks the reference frequency. Thus, phase locked loop is accomplished.

Four VCOs generate the frequency range of 30MHz to 140MHz (called High band) as follows.

- VCO-1: 30MHz to <48MHz
VCO-2: 48MHz to <74MHz
VCO-3: 74MHz to <111MHz
VCO-4: 111MHz to 140MHz

The mixer circuit derives lower than 30MHz (called Low band) with the heterodyne technique from the two signals, output of the VCO-3 and 80MHz local oscillator.

- Level

Output signal of the VCO is filtered, amplified and attenuated to obtain the desired amplitude and frequency output.

The output level flatness is controlled by a comparator and ALC loop. A detected RF signal is applied to one input of the comparator and the other input signal comes from the reference voltage generator.

The output variations from the detected RF sample compared to the reference voltage generator are applied to the PIN diode attenuators to form an ALC loop to control these RF variations for best flatness of the output signal.

The output attenuator consists of two sections; resistor networks are used 4dB or more attenuation, and PIN diode attenuators are used for fine attenuation from 0.1dB up to 3.9dB.

(2) Modulation

AF Oscillator

Amplitude and frequency modulation can be provide internally for modulation source which is applied from the AF oscillator. A Wien-bridge type oscillator generates 400Hz or 1kHz sine wave.

AM Modulation

The ALC loop is used to control the amplitude of the RF signal for generating the AM.

FM Modulation

Frequency modulation is carried out by applying the modulation signal to the VCO, to control the frequency deviation of the RF signal output.

(3) Control

Front panel operation is performed by direct keyboard entry. GPIB control is also available as an option.

(4) FM Stereo Generation (Model 3216 only)

The generator uses multiplex technique to create the FM stereo signal output. Refer to Figure 4-2.

AF signals, L and R are applied to the matrix circuit to produce L+R(Main) and L-R signals.

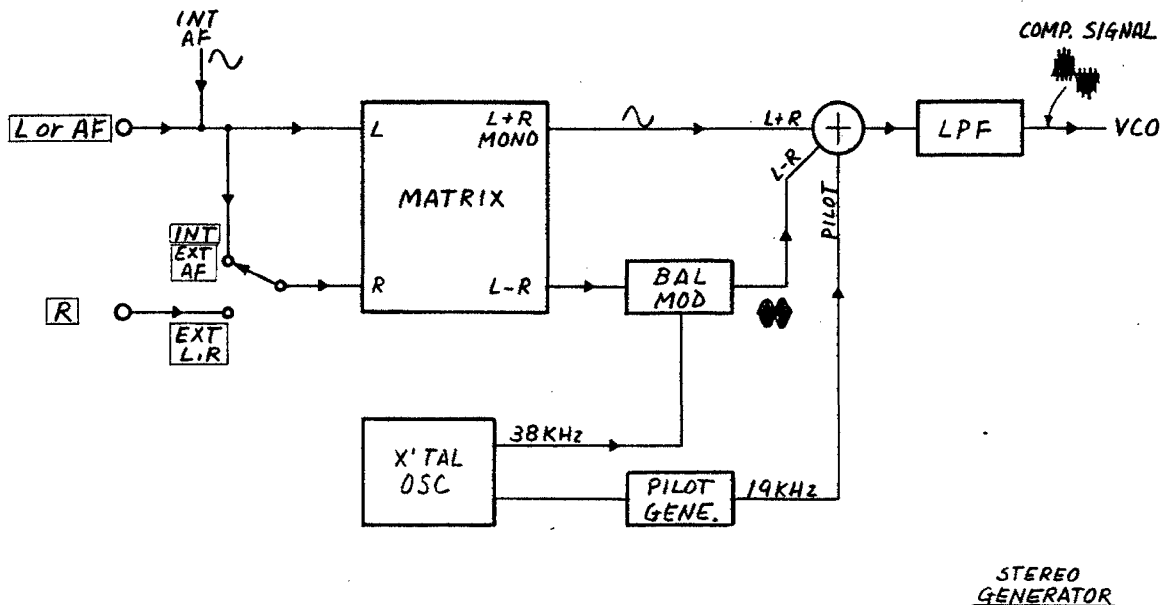


Figure 4-2

The 38kHz subcarrier and 19kHz pilot signal are produced by stepping down the frequencies from a 4.864MHz crystal controlled oscillator.

The 38kHz subcarrier modulates the L-R signal at the balanced modulator to produce the sub-channel signal.

The adder receives Main, sub-channel and pilot signals to produce the composite stereo signal. A low pass filter is used to suppress undesirable spurious components on the stereo signal.

4.3 Troubleshooting Aid

*** WARNING ***

Electrical shock hazards exist inside this instrument when covers removed.

- (1) Overall operation is not satisfactory, or no signal output.

Check the following points.

Line fuse.

0.63A time lag fuse for 100V to 120V operation.

0.315A time lag fuse for 200V to 240V operation.

CAUTION Use specified fuse only. Refer to section "9. Parts list".

Secondary voltage of the power transformer.

Regulated DC power supplies on the main board, T-4087.
Refer to Table 4-1.

Test point	Voltage	Tolerance
TP201	+5V(Vcc)	+4.75V to +5.25V
TP202	+5V	+4.75V to +5.25V
TP203	+15V	+14.25V to +15.75V
TP204	-15V	-14.25V to -15.75V

Table 4-1

Yes: Proceed to step "(2)".

No: Troubleshoot regulated power supplies

+5V(Vcc): D201, IC101(T-4087, main board) and associated circuit.

+5V: D201, IC202(T-4087, main board) and associated circuit.

+15V: D202, IC102(T-4087, main board) and associated circuit.

-15V: D202, IC204(T-4087, main board) and associated circuit.

- (2) No output, High band signal(30MHz to 140MHz)

- a. Check for signal at output connector of RF module for 30MHz to 140MHz.

Yes: Troubleshoot attenuator and control circuit.

No: Check for signal at output of C214(T-4089, RF board) for 30MHz to 140MHz.

yes- Proceed to step "b", output circuit.

no- Proceed to step "c", VCO.

b. Output circuit

*** WARNING ***

Q359(transistor with heat sink) is very hot when instrument is operating normally.

Check for signal at collector of Q359(T-4089, RF board).
Yes: Troubleshoot attenuators and its control circuit.
No: Troubleshoot PIN diode attenuator, output amplifier, high/low band selector and associated circuit.

c. VCO

Check that the state of VCO select signal at the following points for Lo, approx. -15Vdc.

VCO-1(30MHz to <48MHz): Collector of Q7(T-4089, RF board)

VCO-2(48MHz to <74MHz): Collector of Q9(T-4089, RF board)

VCO-3(74MHz to <111MHz): Collector of Q11(T-4089, RF board)

VCO-4(111MHz to 140MHz): Collector of Q13(T-4089, RF board)

Yes: Proceed to step "d".

No: Troubleshoot VCO control circuit.

d. Check for 50Hz square wave at TP501(T-4089, RF board).

Yes: Troubleshoot program counter and associated circuit.

No: Troubleshoot 10MHz reference oscillator and associated circuit.

Check that voltage at TP503(T-4089, RF board) varies from +3Vdc to +10Vdc in proportion to the oscillation frequency of the each VCO.

Yes: Troubleshoot VCO and associated circuit.

No: Troubleshoot program counter and associated circuit.

(3) No output, Low band signal(100kHz to <30MHz)

Confirm that the High band works properly before proceed to troubleshoot the Low band.

a. Check that <30MHz signal is present at junction of L207 and C238(T-4089, RF board).

Yes: Troubleshoot, PIN diode attenuator, output amplifier, high/low band selector and associated circuit.

No: Check the collector of Q205(T-4089, RF board) for <30MHz signal.

yes- Proceed to step "b", 80MHz local oscillator.

no- Troubleshoot VCO-3 and associated circuit. Refer to step "(2)".

- b. 80MHz local oscillator
Check that 80MHz signal is present at connector, P201 (T-4089, RF board) for 300mVp-p.
Yes: Troubleshoot PIN diode attenuator, mixer, low pass filter and associated circuit.
No: Troubleshoot 80MHz crystal oscillator and control circuit. Adjust L209(T-4089, RF board) as necessary. Refer to paragraph "3.5 (2)".

(4) Modulation

- a. AF Oscillator
 - Check that the 5Vp-p sine wave is present at TP52(T-4087, main board).
Yes: Proceed to step "b" or "c", modulation circuit.
No: Troubleshoot AF oscillator and control circuit.
 - Frequency incorrect
Check IC51(T-4087, main board) and associated circuit

- b. AM Modulation
Check that the 2Vp-p sine wave present at TP152(T-4087, main board) at 30% modulation.
Yes: Troubleshoot ALC loop and associated circuit.
No: Troubleshoot multiplying DAC and associated circuit.

- c. FM Modulation
Check that the 5Vp-p sine wave present at TP151(T-4087, main board) at 75kHz deviation.
Yes: Troubleshoot VCO and associated circuit.
No: Troubleshoot multiplying DAC and associated circuit.

- (5) Stereo Generator Section(Model 3216 only)
Confirm that the FM mode works properly before proceed to troubleshoot the stereo modulation.

- a. No stereo signal output
 - Main channel
Check that the Main channel signal present at TP51(T-4088, stereo generator board) for 3.6Vp-p.
Yes: Troubleshoot adder, low-pass filter and associated circuit.
No: Check that the waveform at pin 14 of IC51(T-4088, stereo generator board) for 3.6Vp-p.
yes- Troubleshoot matrix and associated circuit.
no- Troubleshoot AF oscillator and associated circuit.

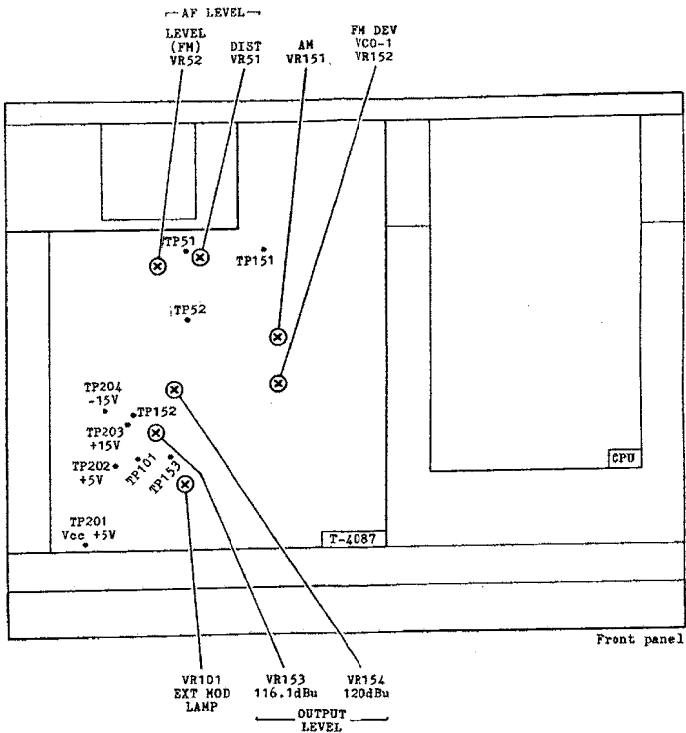
- Sub-channel
 - Check that the sub-channel signal is present at TP52(T-4088, stereo generator board) for 14Vp-p sine wave.
 - Yes: Proceed to step "b", balanced modulator.
 - No: Check that the waveform at pin 4 of IC51(T-4088, stereo generator board)
 - yes- Troubleshoot matrix and associated circuit.
 - no- Troubleshoot AF oscillator and associated circuit.

- b. Balance modulator/Sub-channel Signal
 - Check that the sub-channel signal is present at TP151 (T-4088, stereo generator board).
 - Yes: Troubleshoot adder, low-pass filter and associated circuit.
 - No: Troubleshoot balanced modulator and associated circuit.
Proceed to step "c", subcarrier generator.

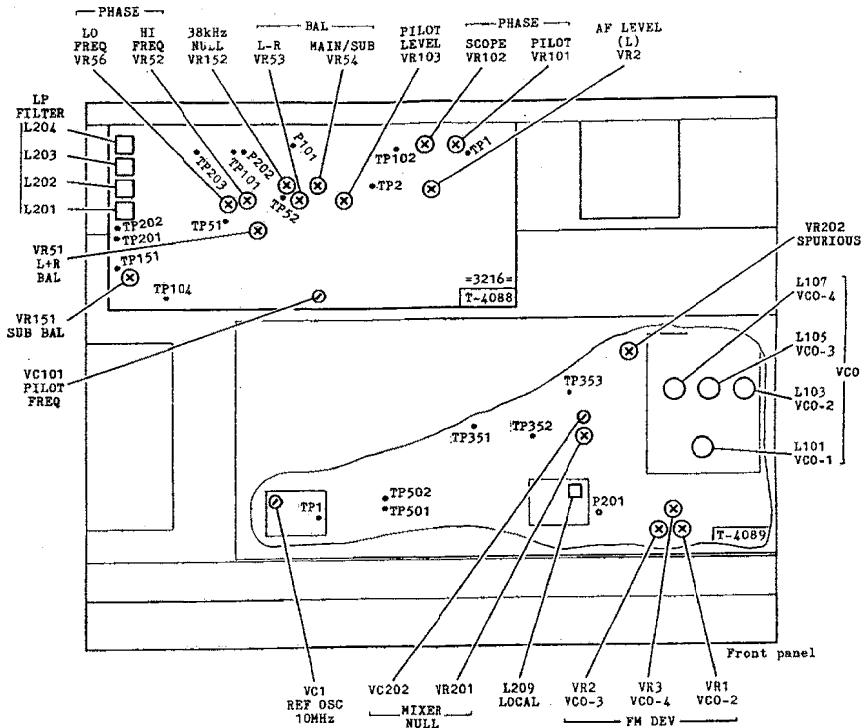
- c. Subcarrier generator
 - Check that the 4.864MHz, signal is present at TP104(T-4088, stereo generator board).
 - Yes: Troubleshoot frequency divider and associated circuit.
 - No: Troubleshoot 4.864MHz crystal oscillator.

- d. Pilot signal generator
 - Check that the 19kHz, 0.8Vp-p pilot signal is present at TP102 (T-4088, stereo generator board).
 - Yes: Troubleshoot adder, low-pass filter and associated circuit.
 - No: Troubleshoot pilot signal generator and associated circuit.

5. ADJUSTMENT LOCATIONS

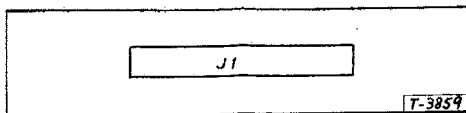


Top View

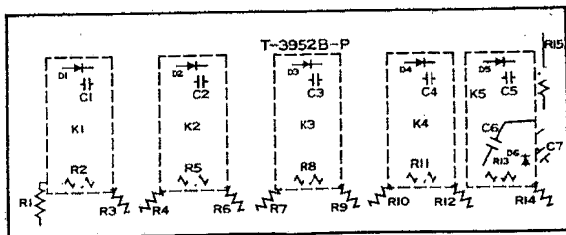


Bottom View

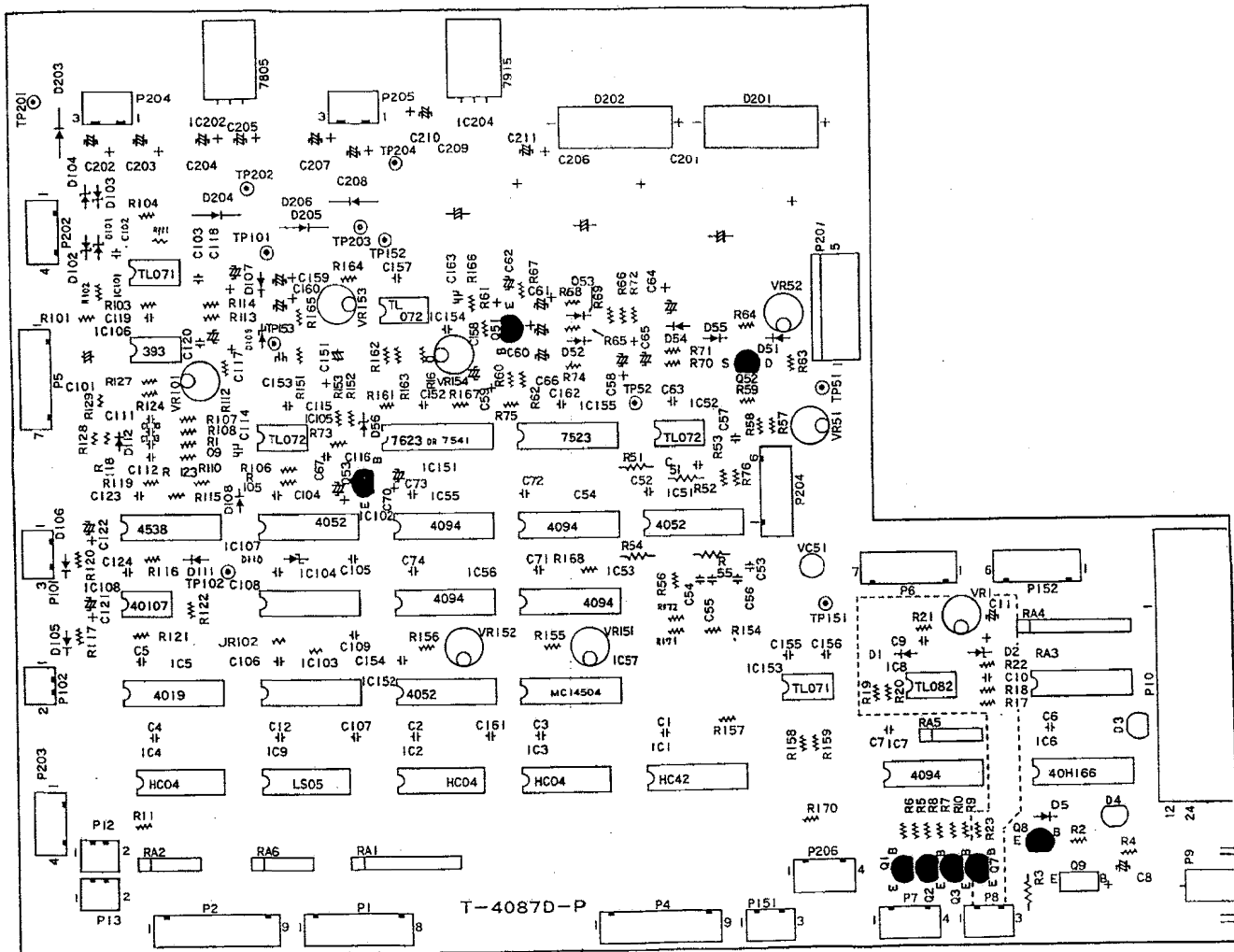
6. PRINTED CIRCUIT BOARD

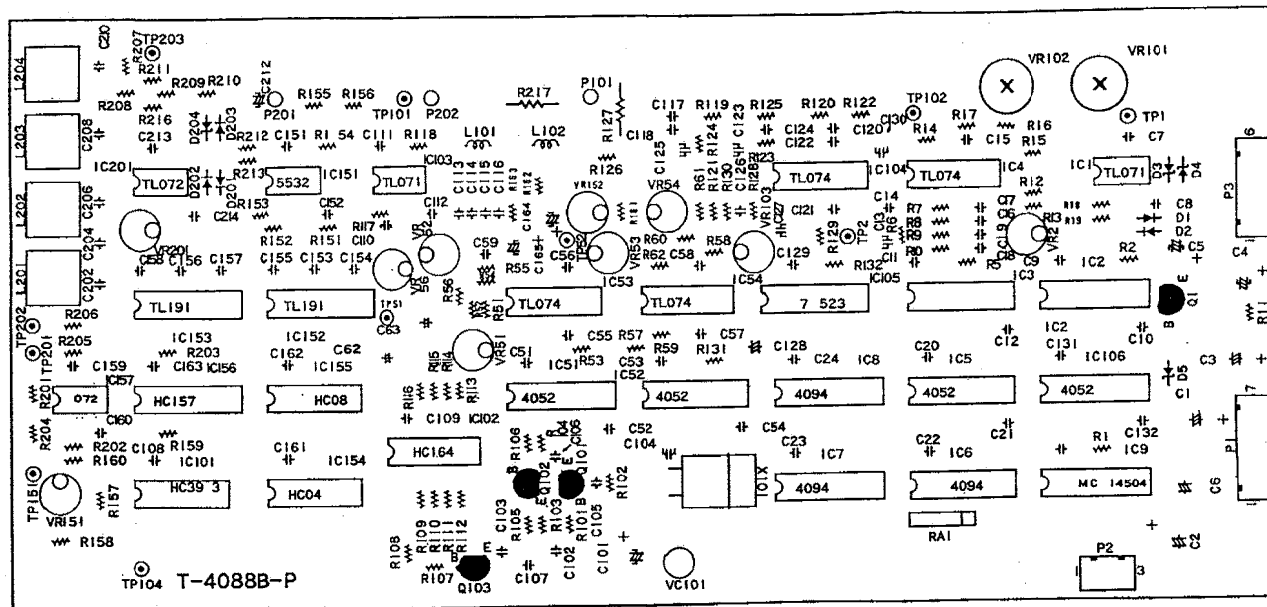


T-3859 CPU Sub-board

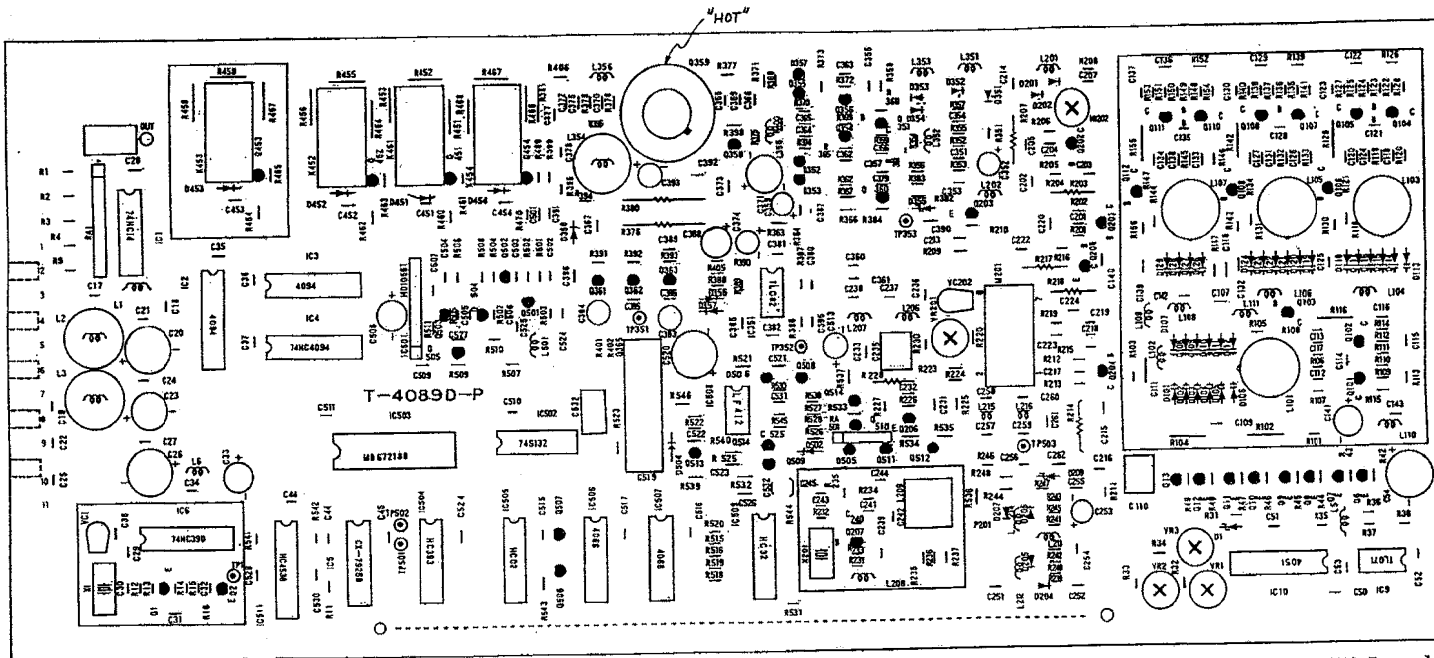


T-3952 Attenuator Board

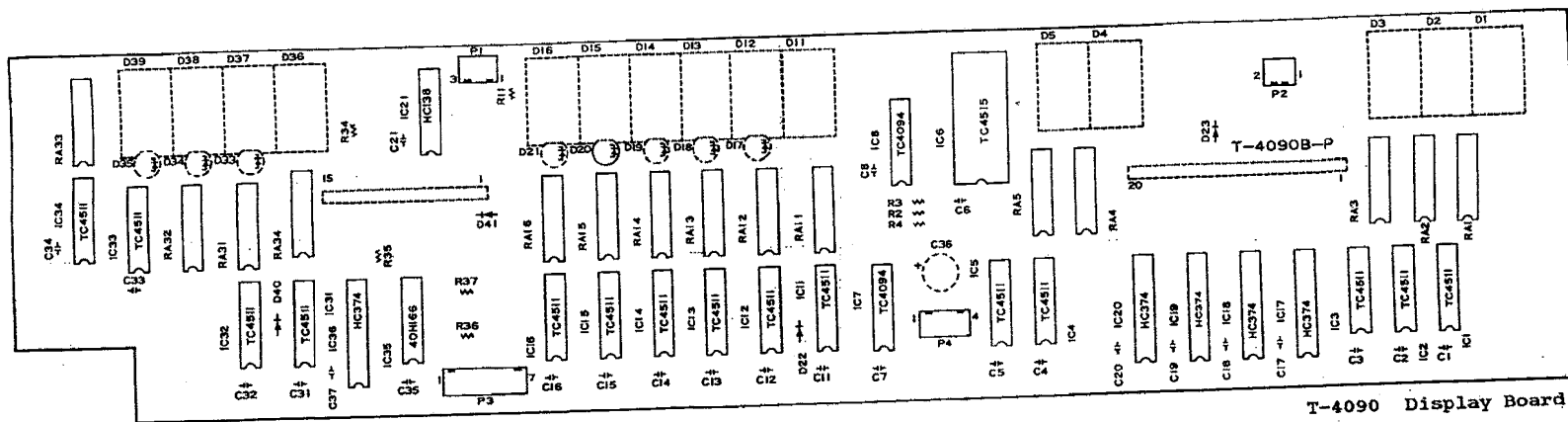




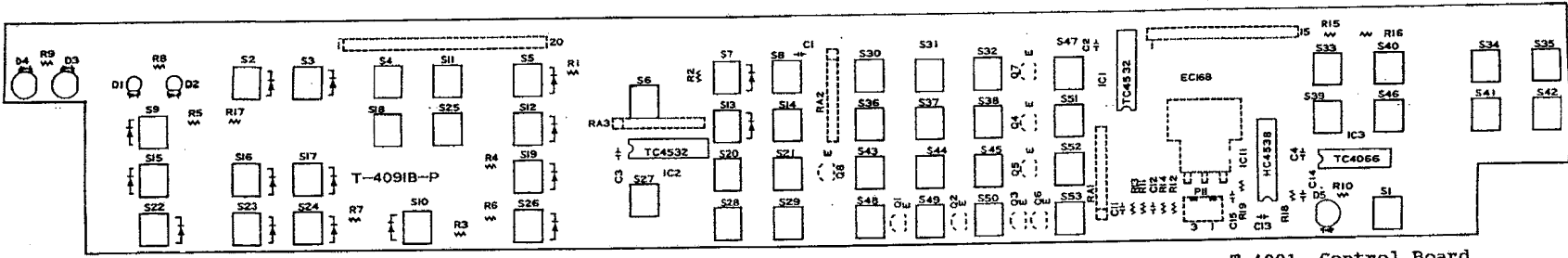
T-4088 Stereo Generator Board
=Model 3216=



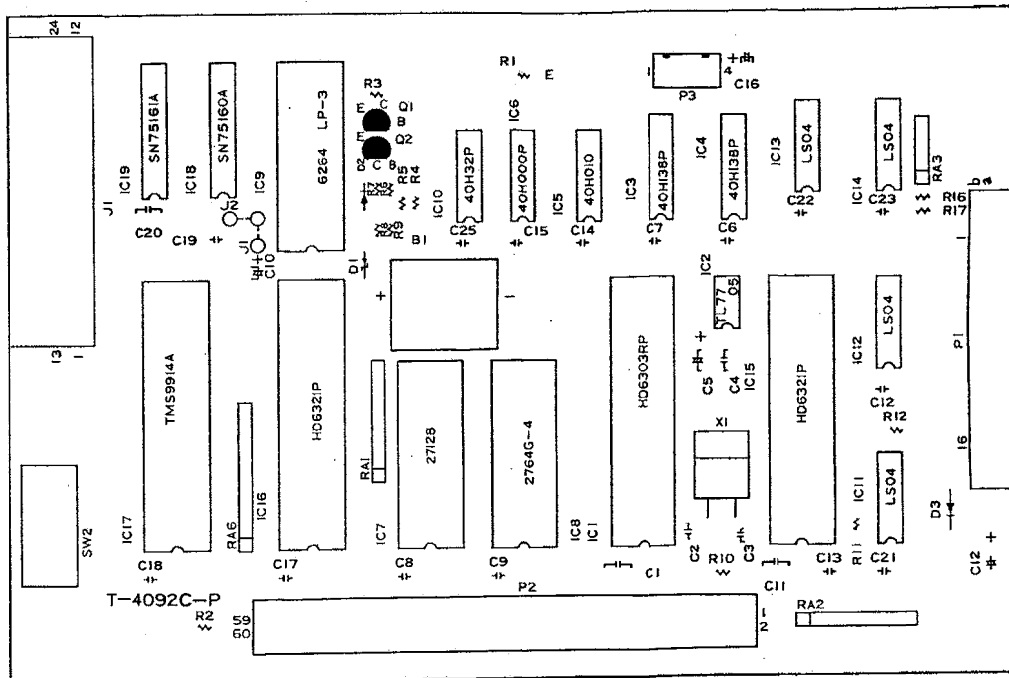
T-4089 RF Board



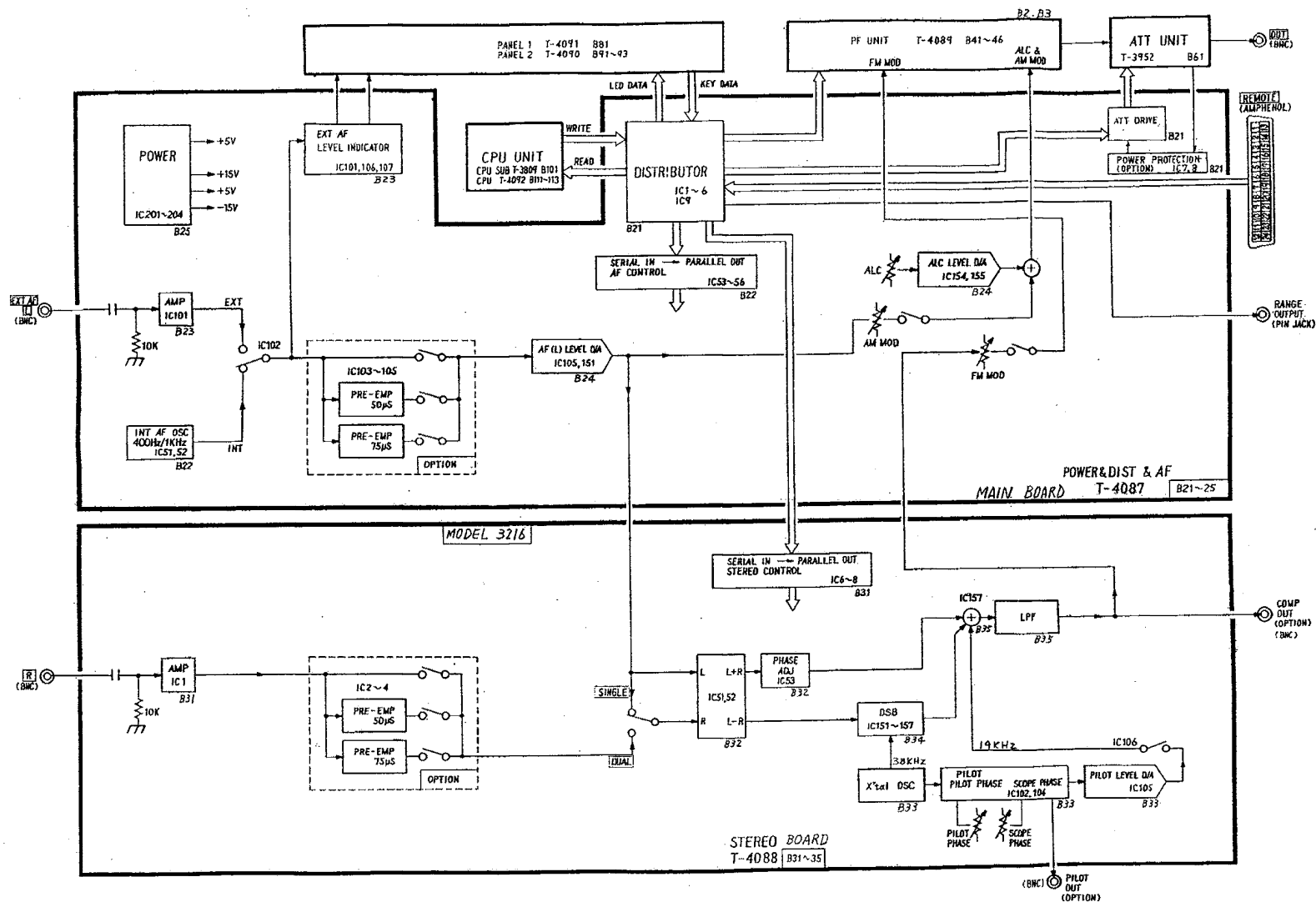
T-4090 Display Board



T-4091 Control Board

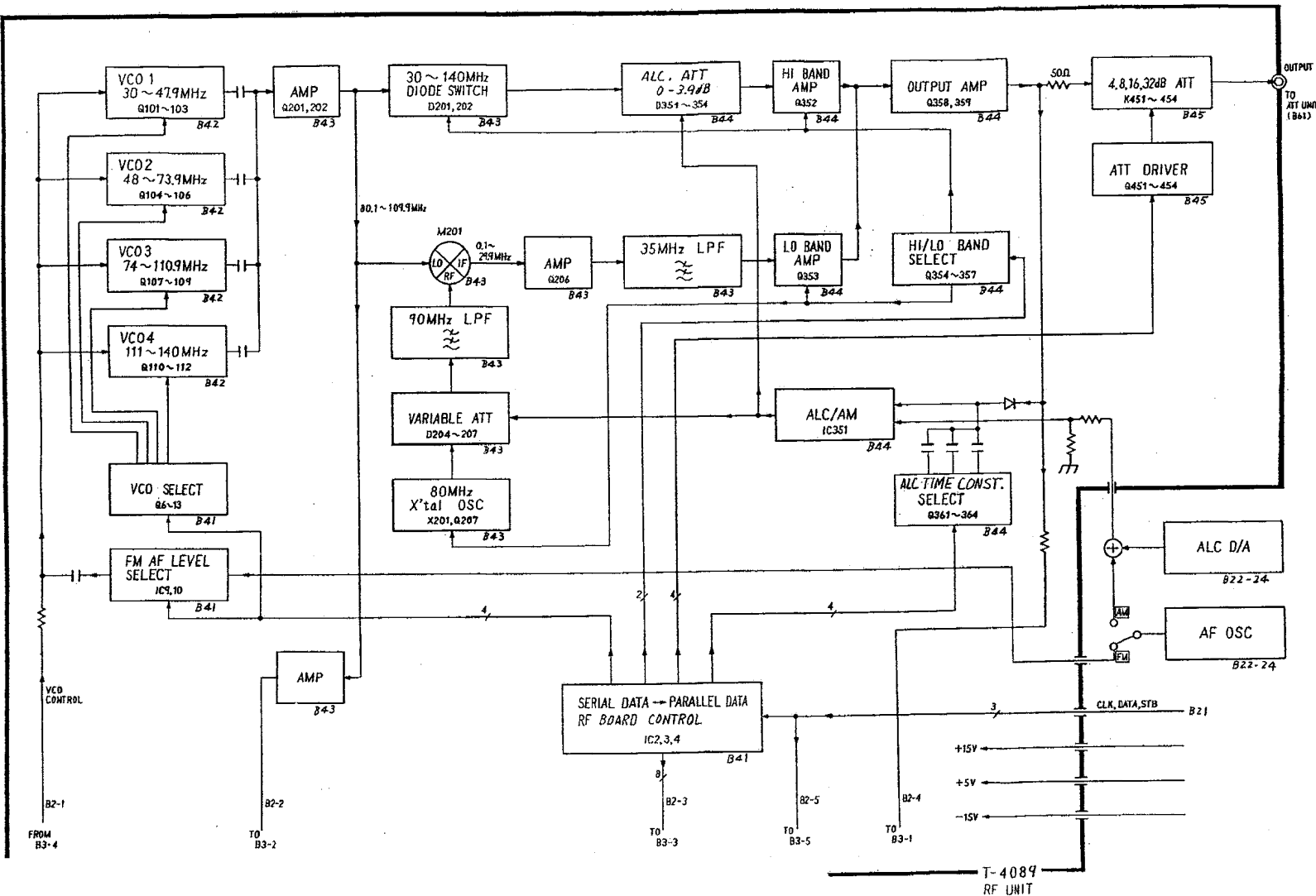


T-4092 CPU Board

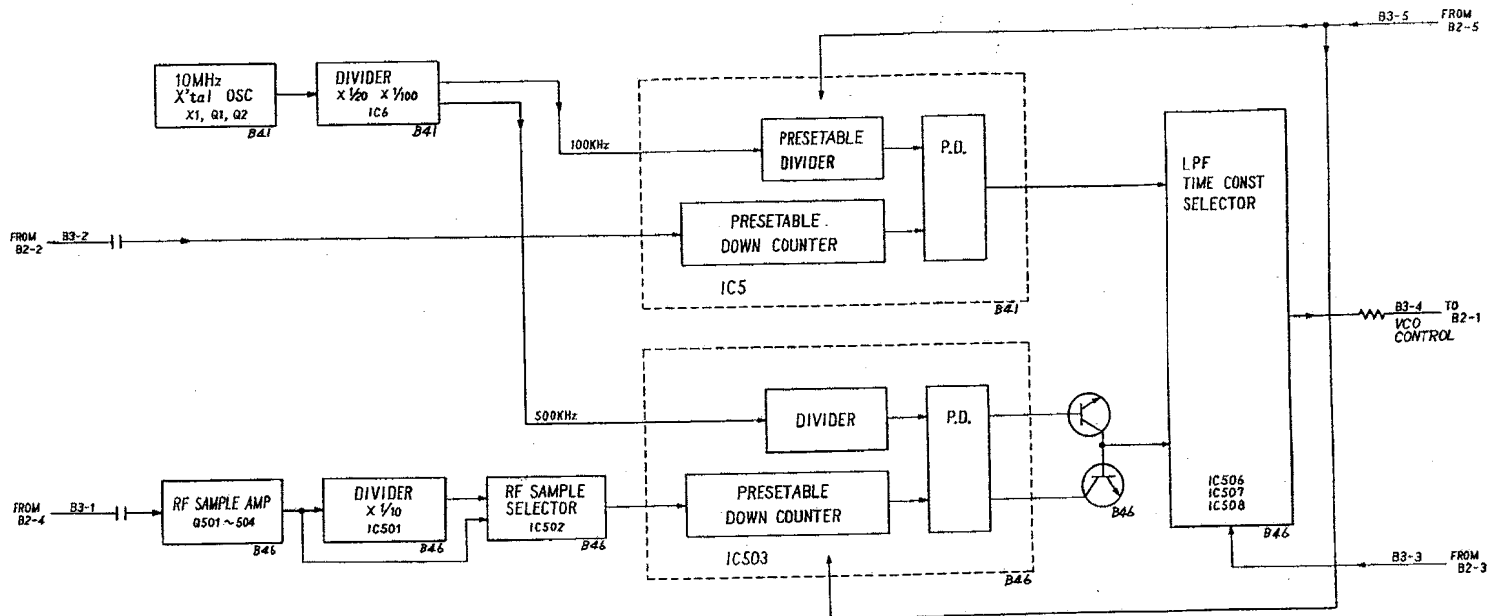


Block Diagram (Mod, Stereo Section)

B1

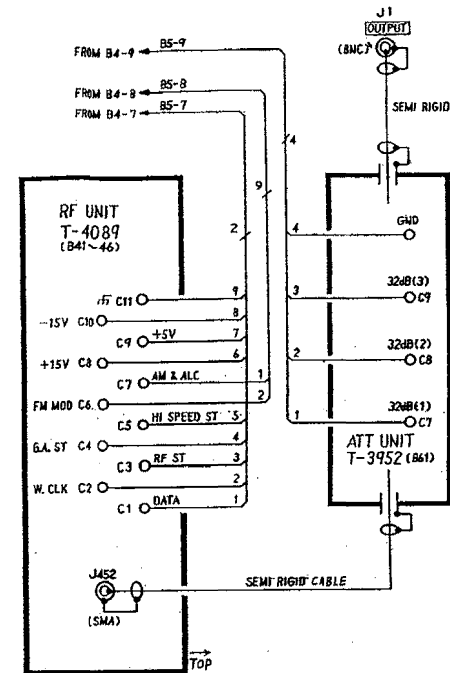
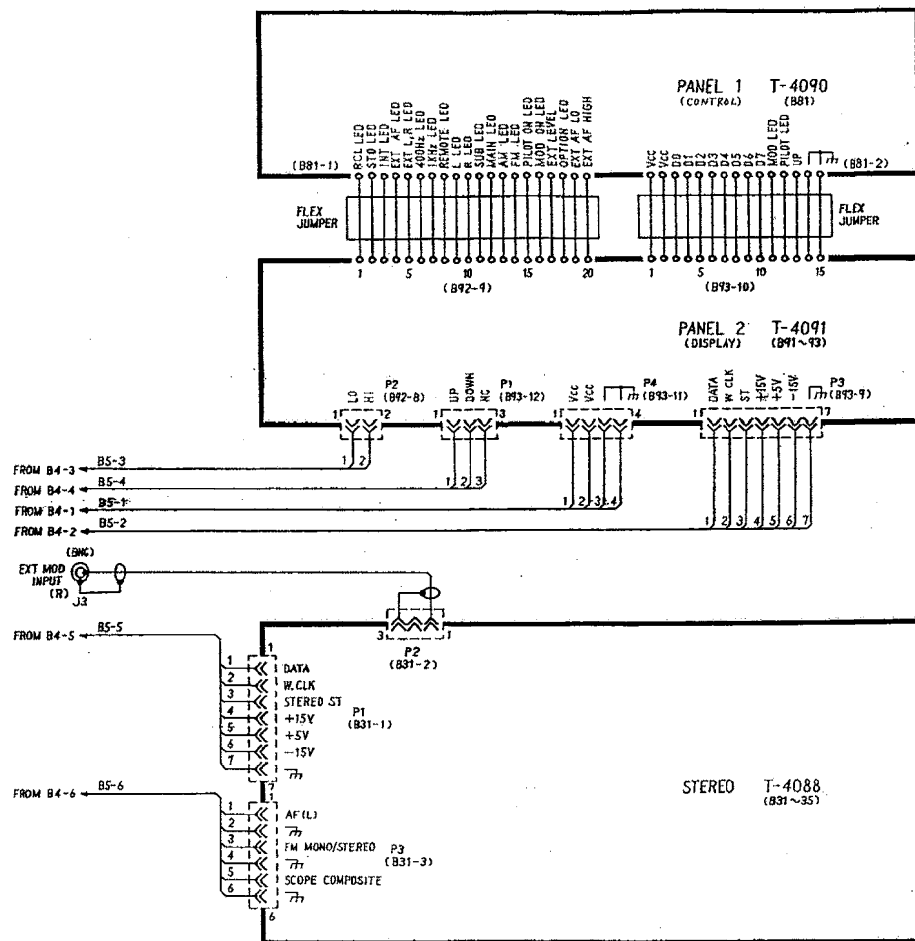


Block Diagram (RF Section-1)
B2

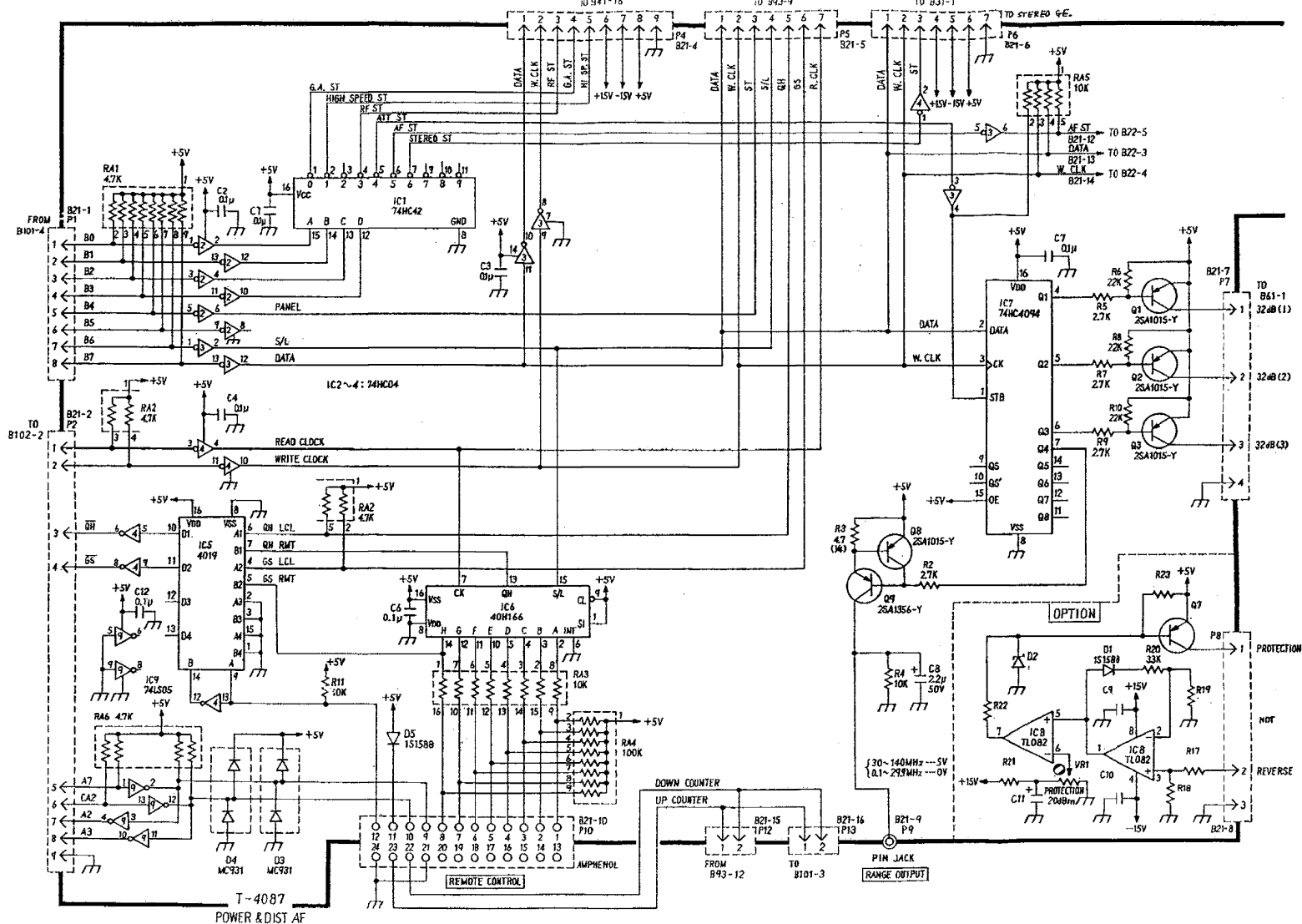


T-4089
RF UNIT

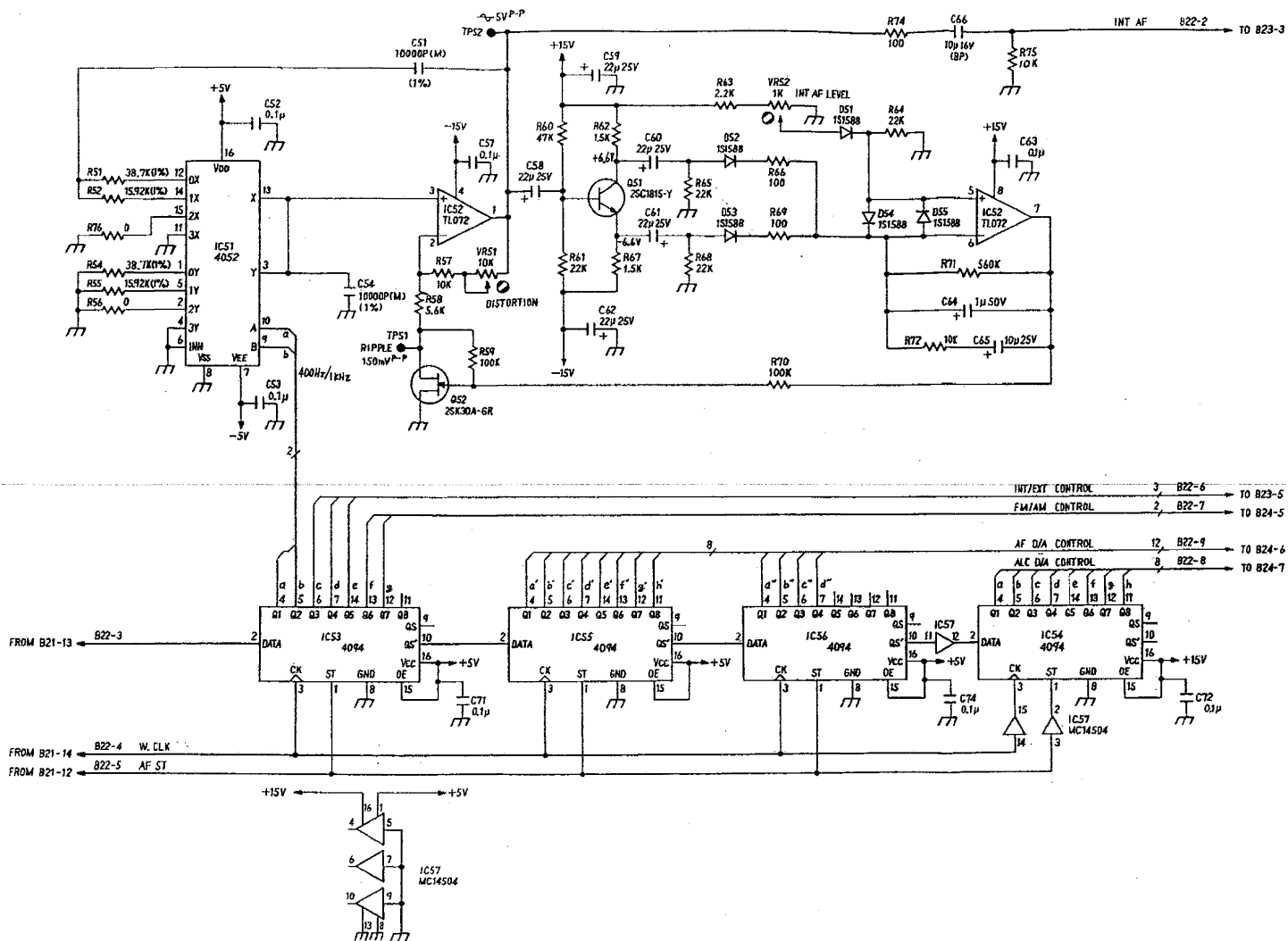
Block Diagram (RF Section-2)
B3



Pc Board Interconnections-2
B5

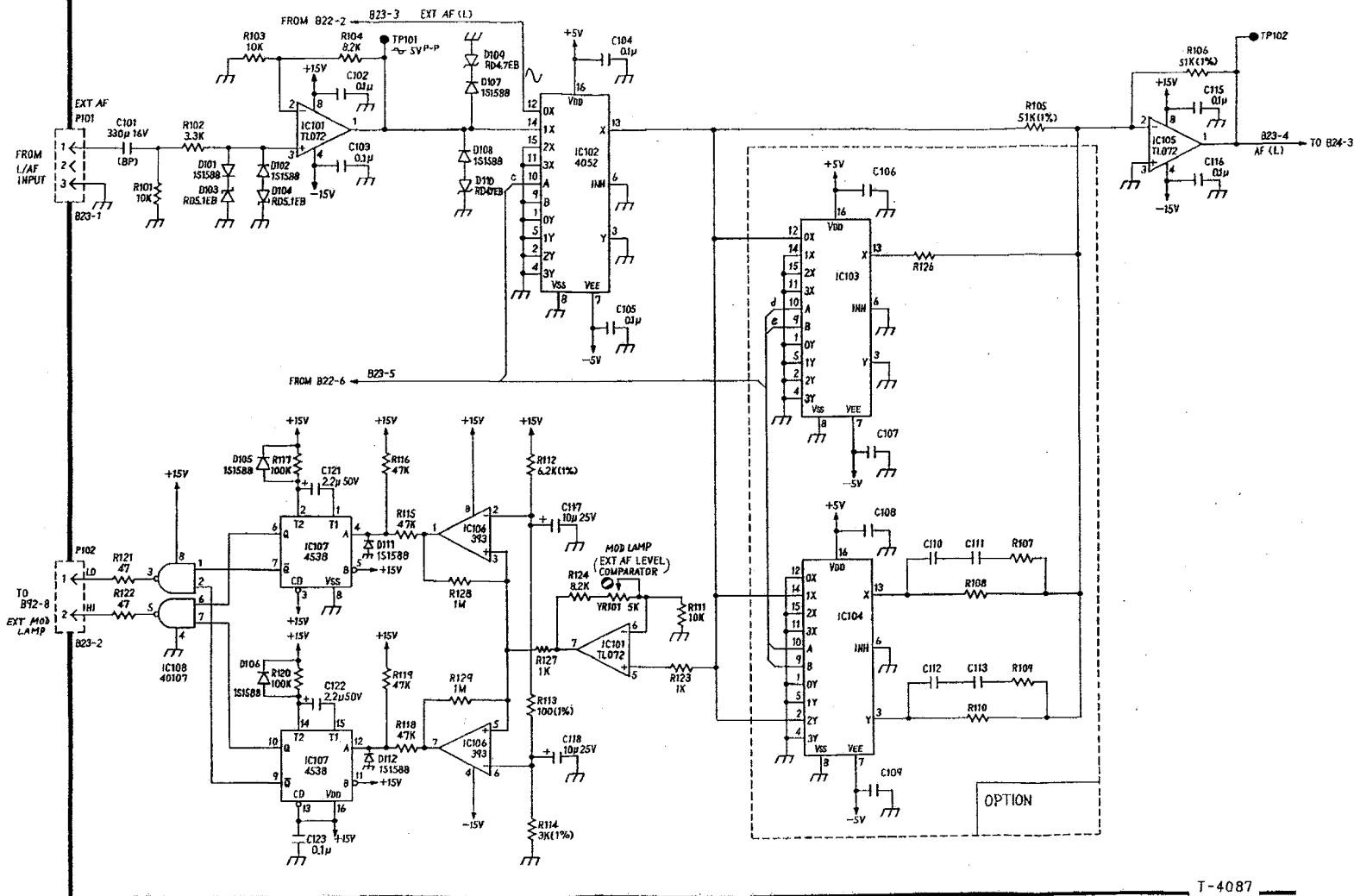


Distributor
B21



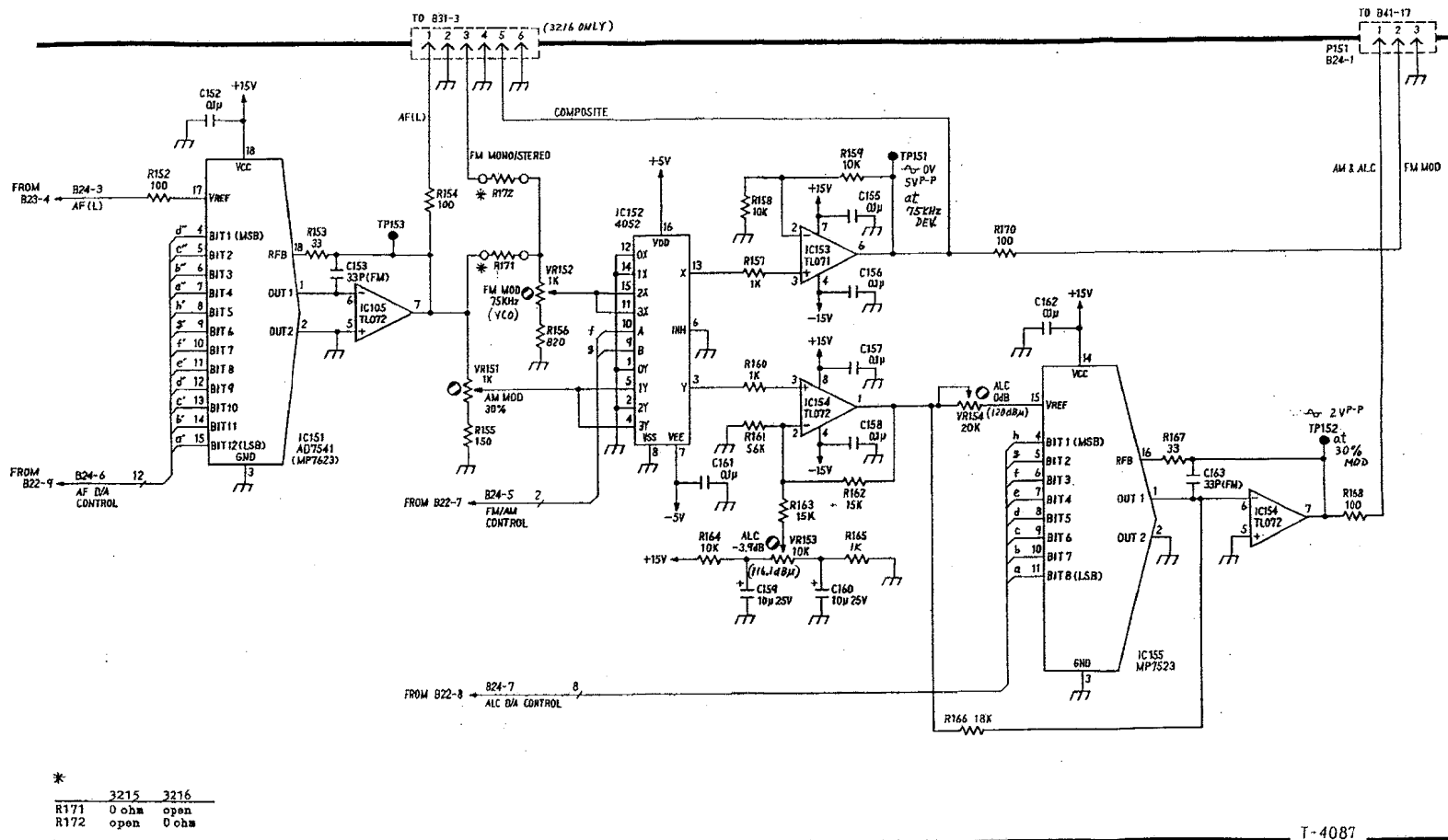
T-4087

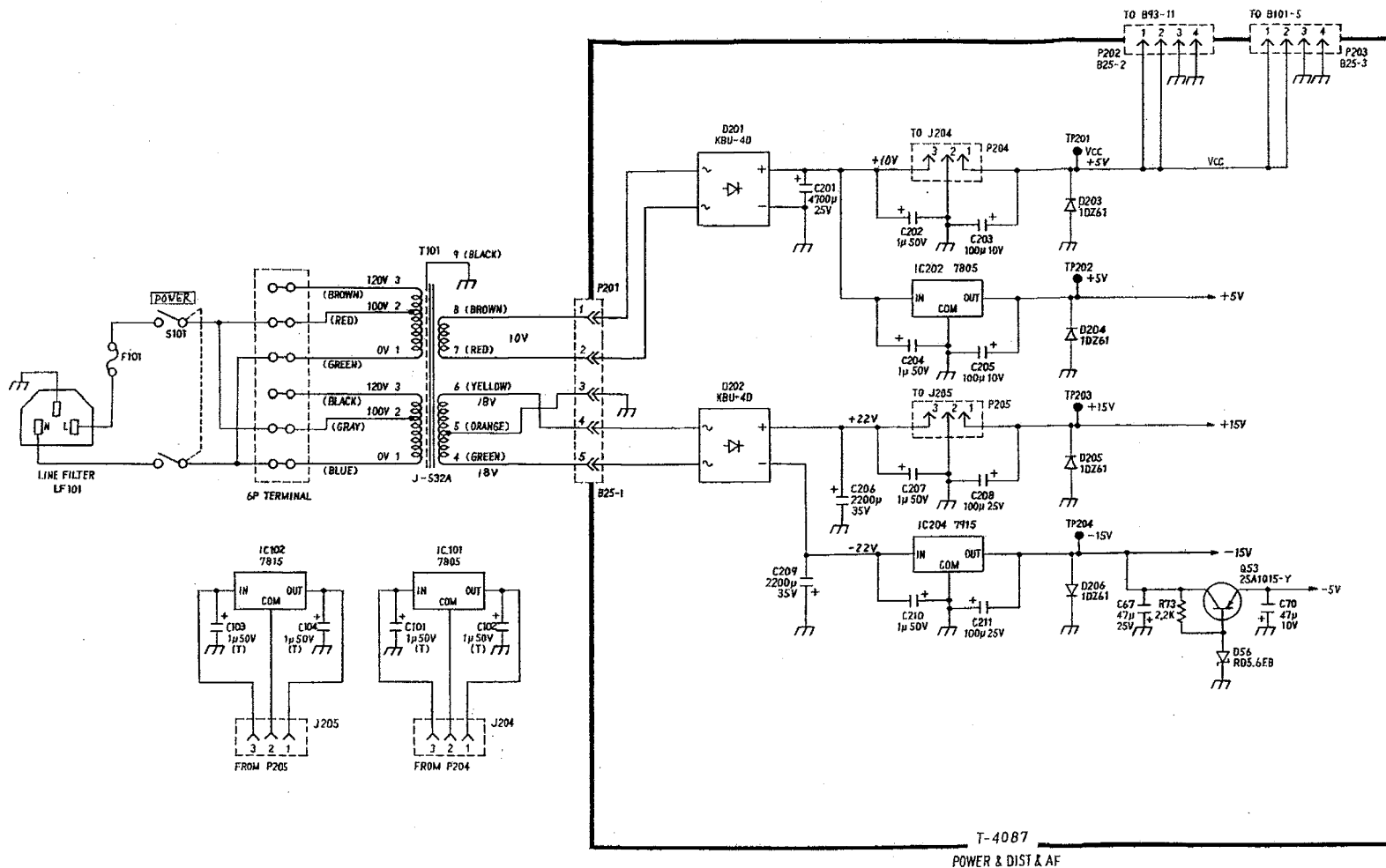
AF Oscillator
B22



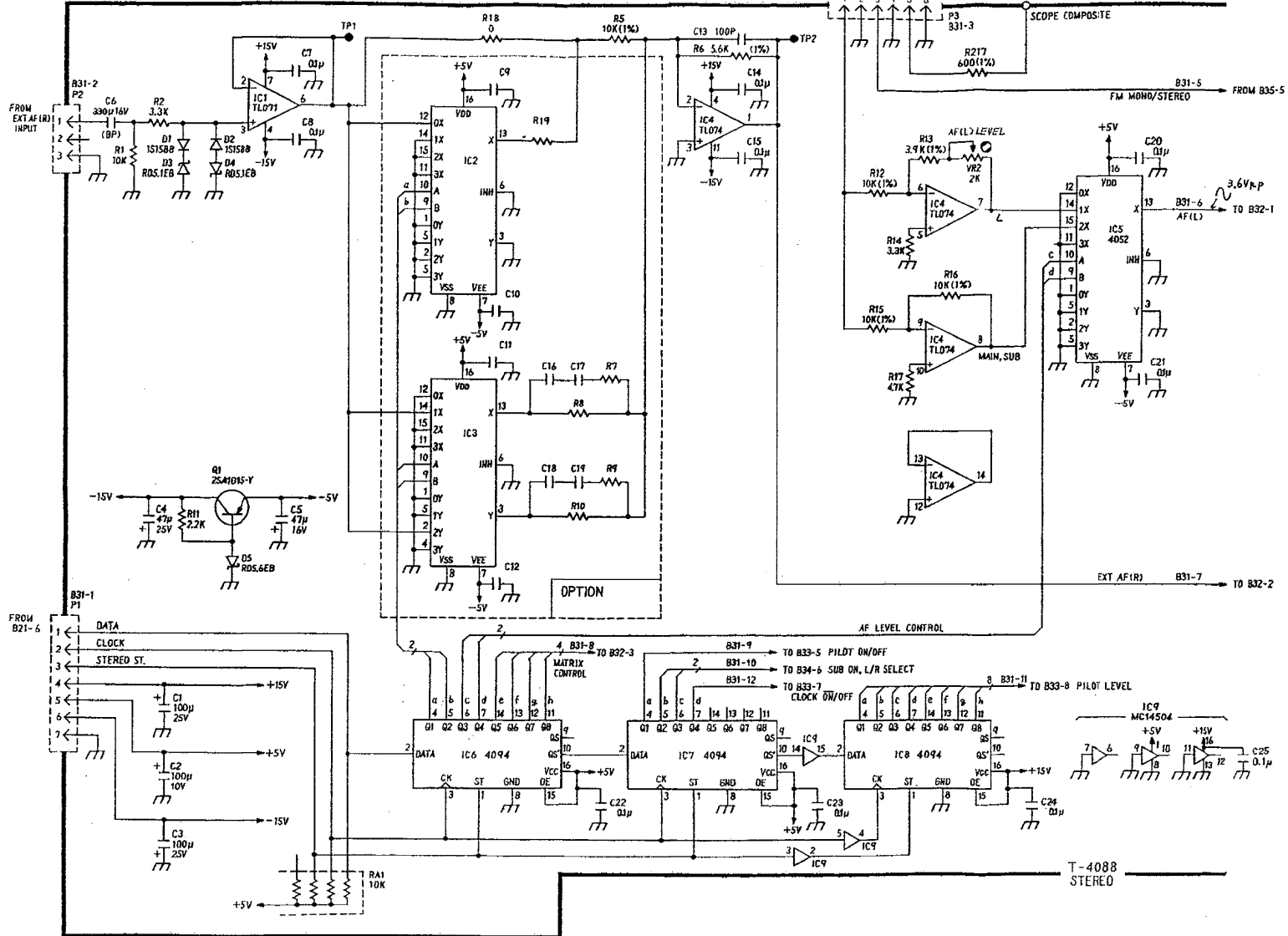
T-4087
POWER & DIST & AF

EXT AF(L), Mod Input Indicator
B23

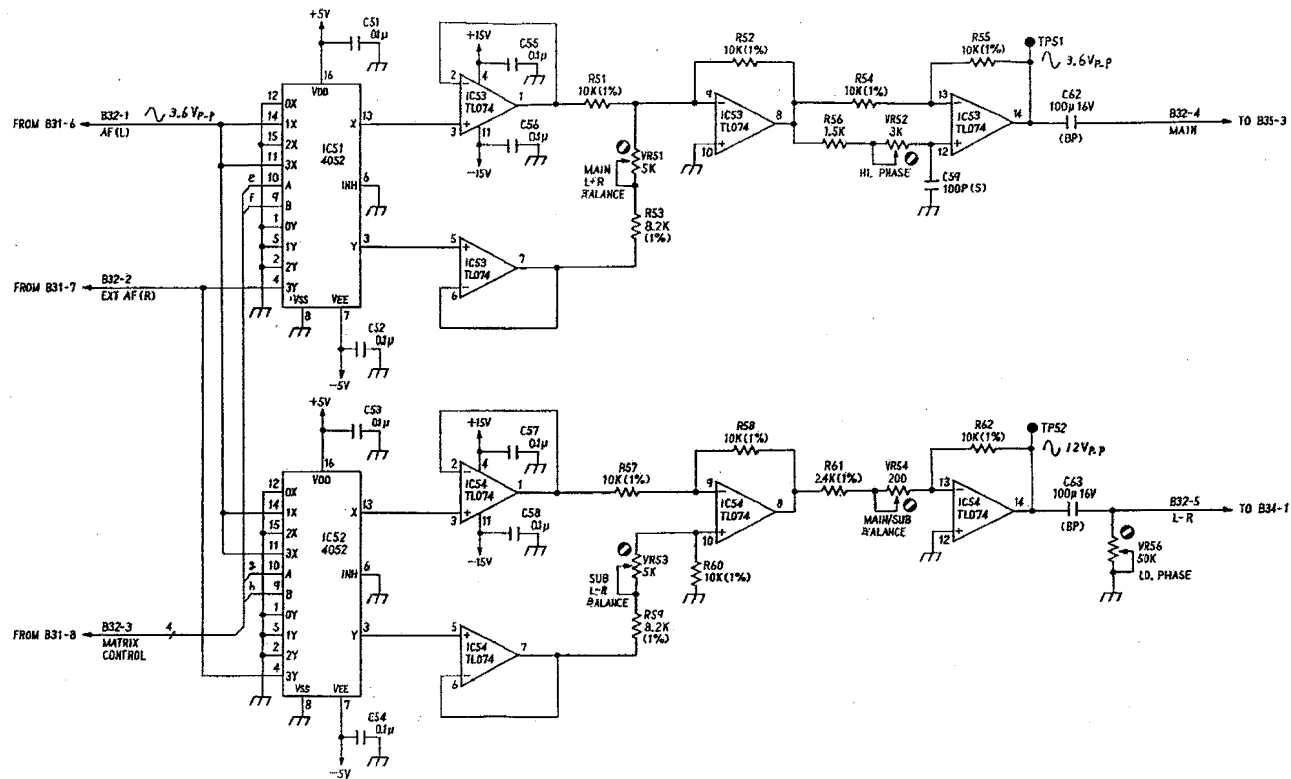




Power Supply
B25

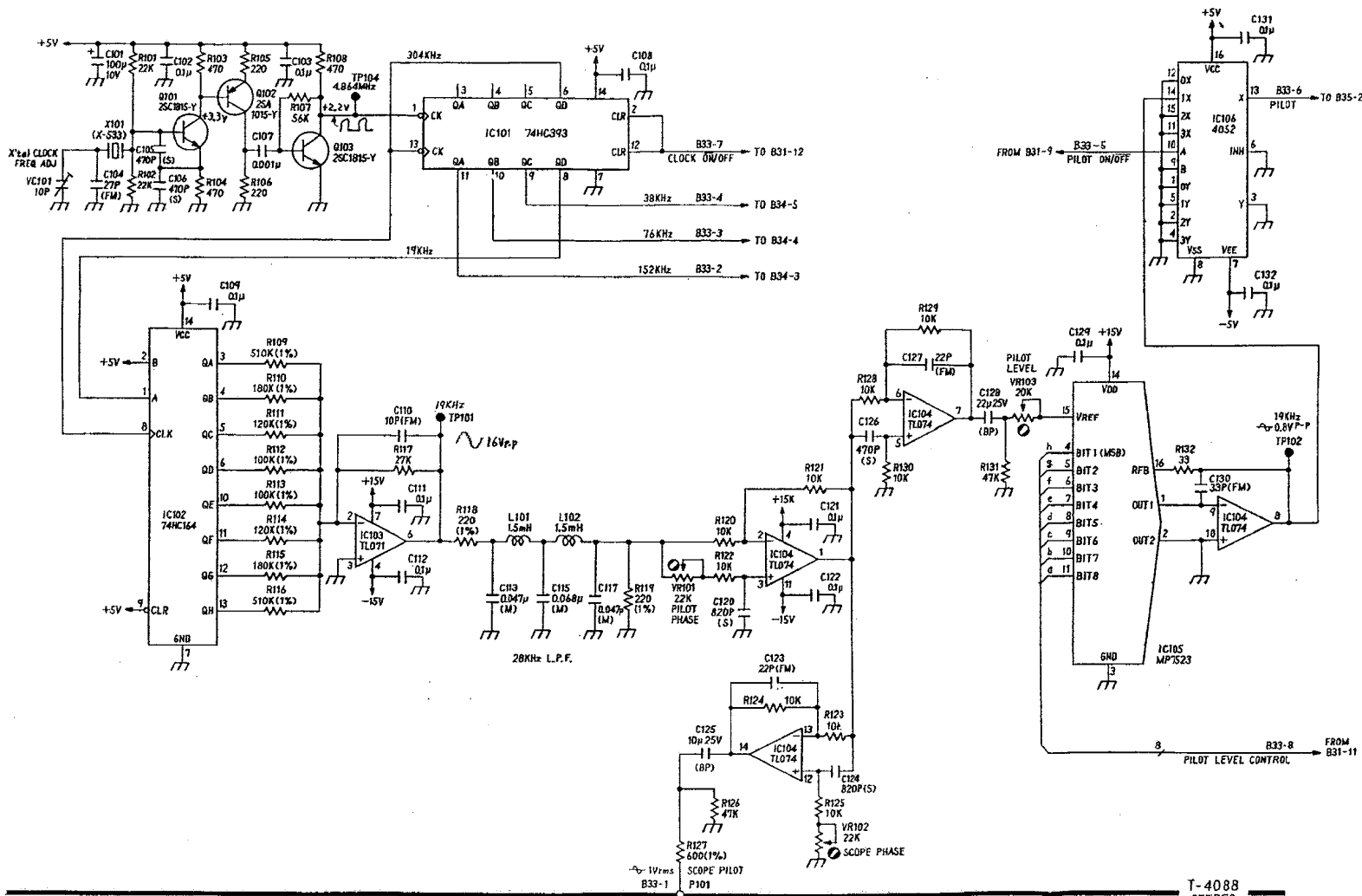


=Model 3216=
EXT AF(R) Input
B31



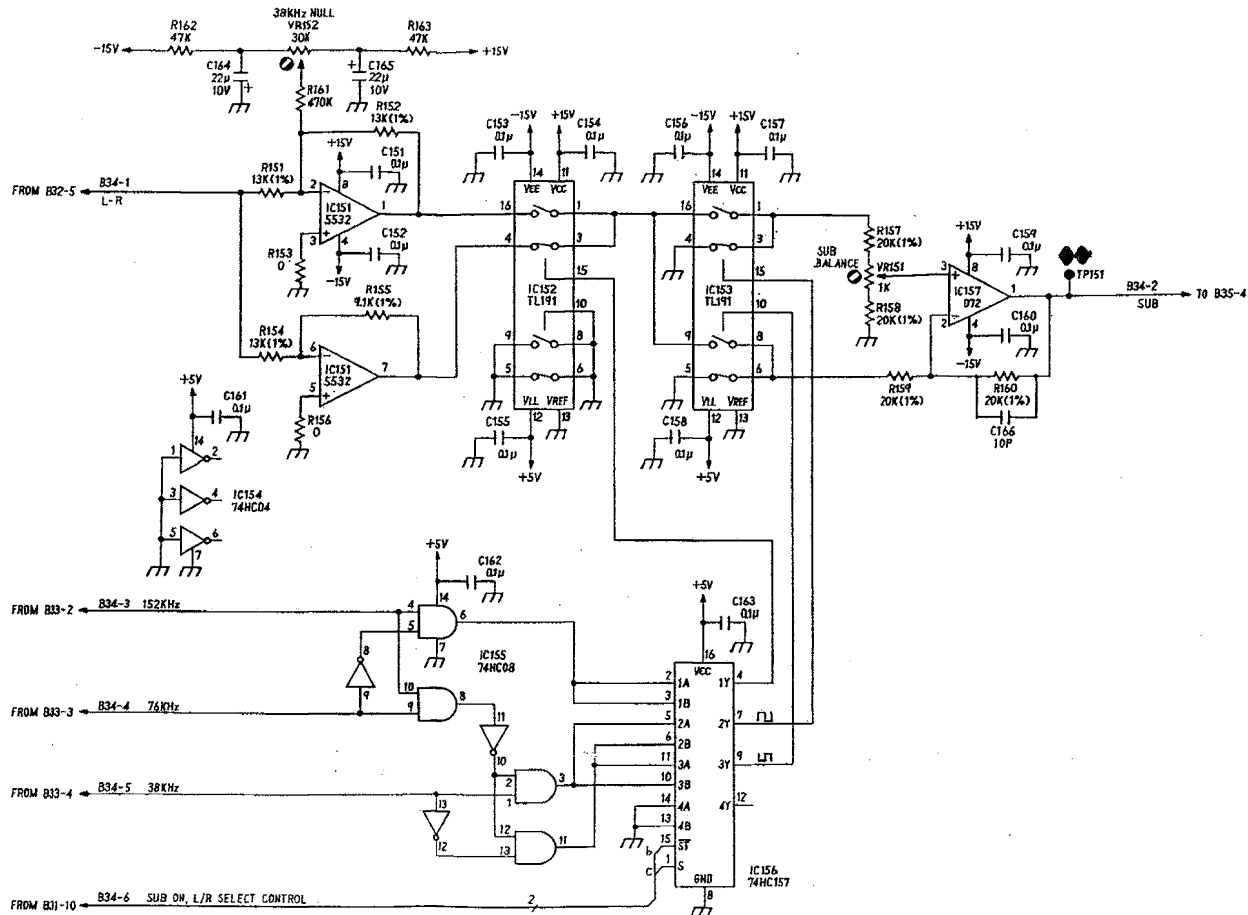
T-4088
STEREO

=Model 3216=
Matrix
B32



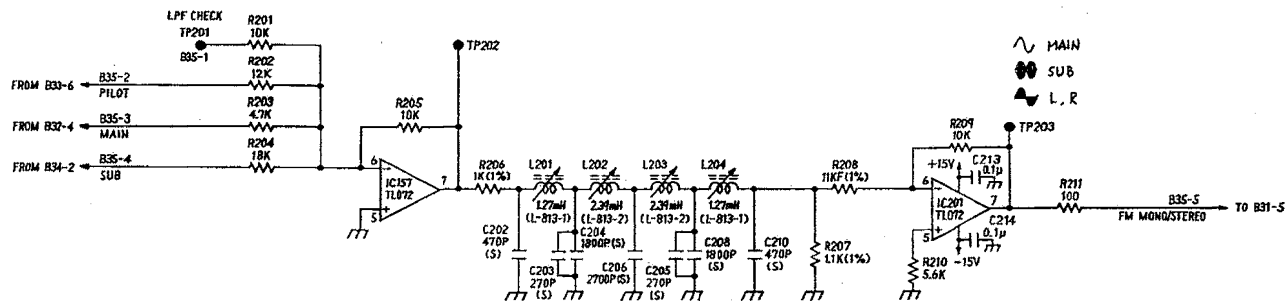
T-4088
STEREO

=Model 3216=
Pilot/Subcarrier Oscillator
B33



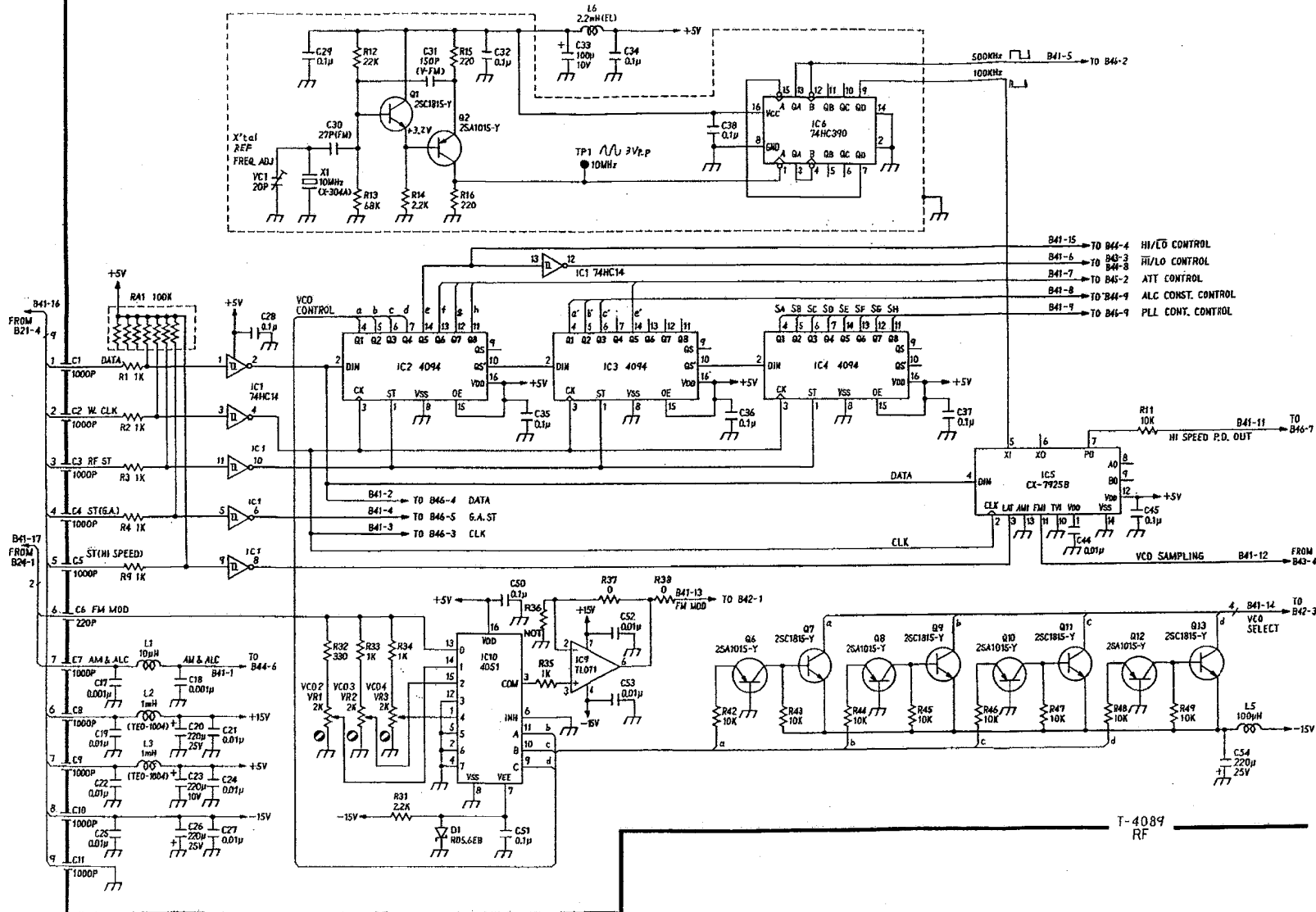
T-4088
STEREO

=Model 3216=
Balanced Modulator
B34

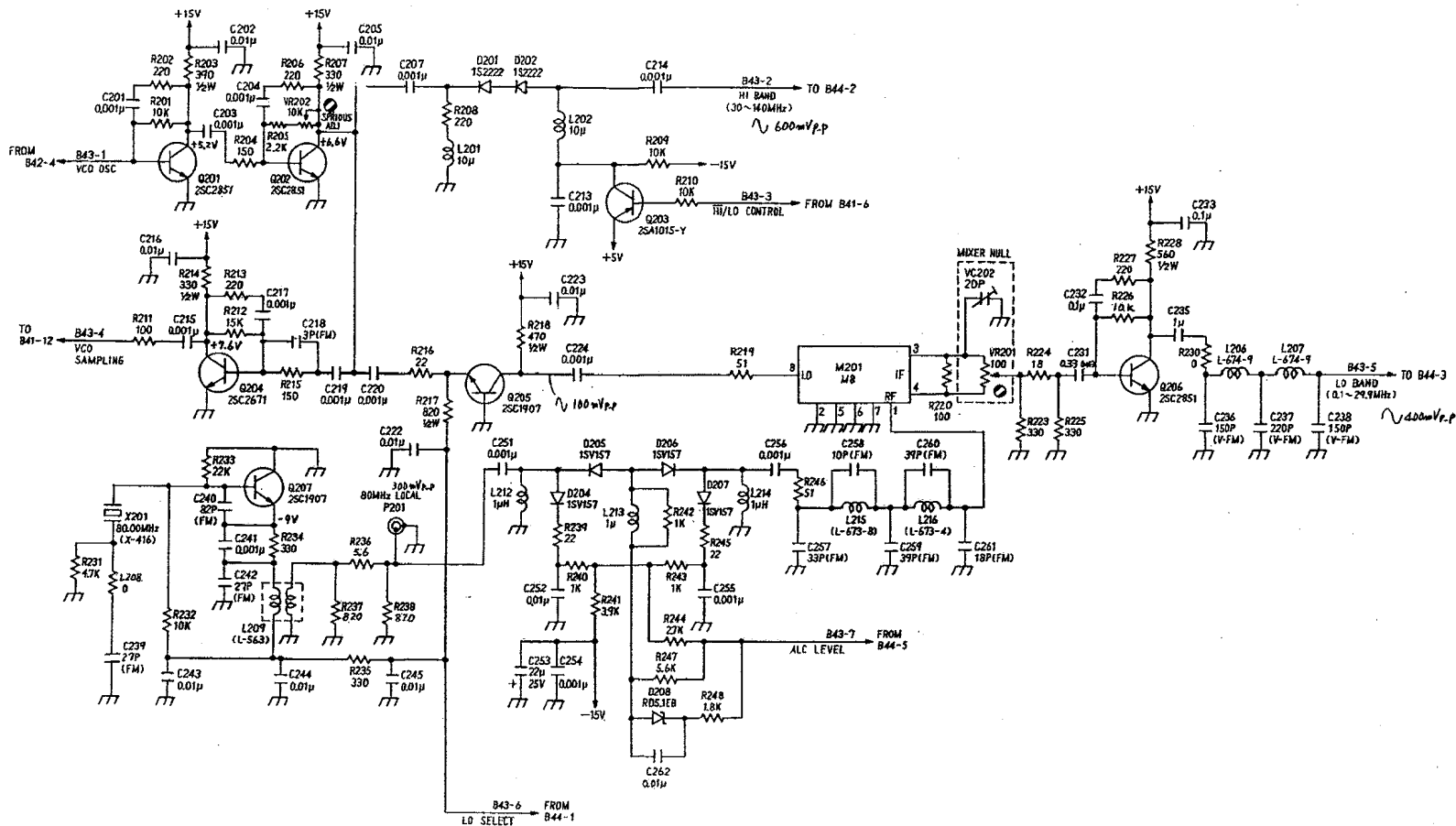


T-4088
STEREO

=Model 3216=
Adder, Low Pass Filter
B35



Reference Osc, VCO Controller
B41

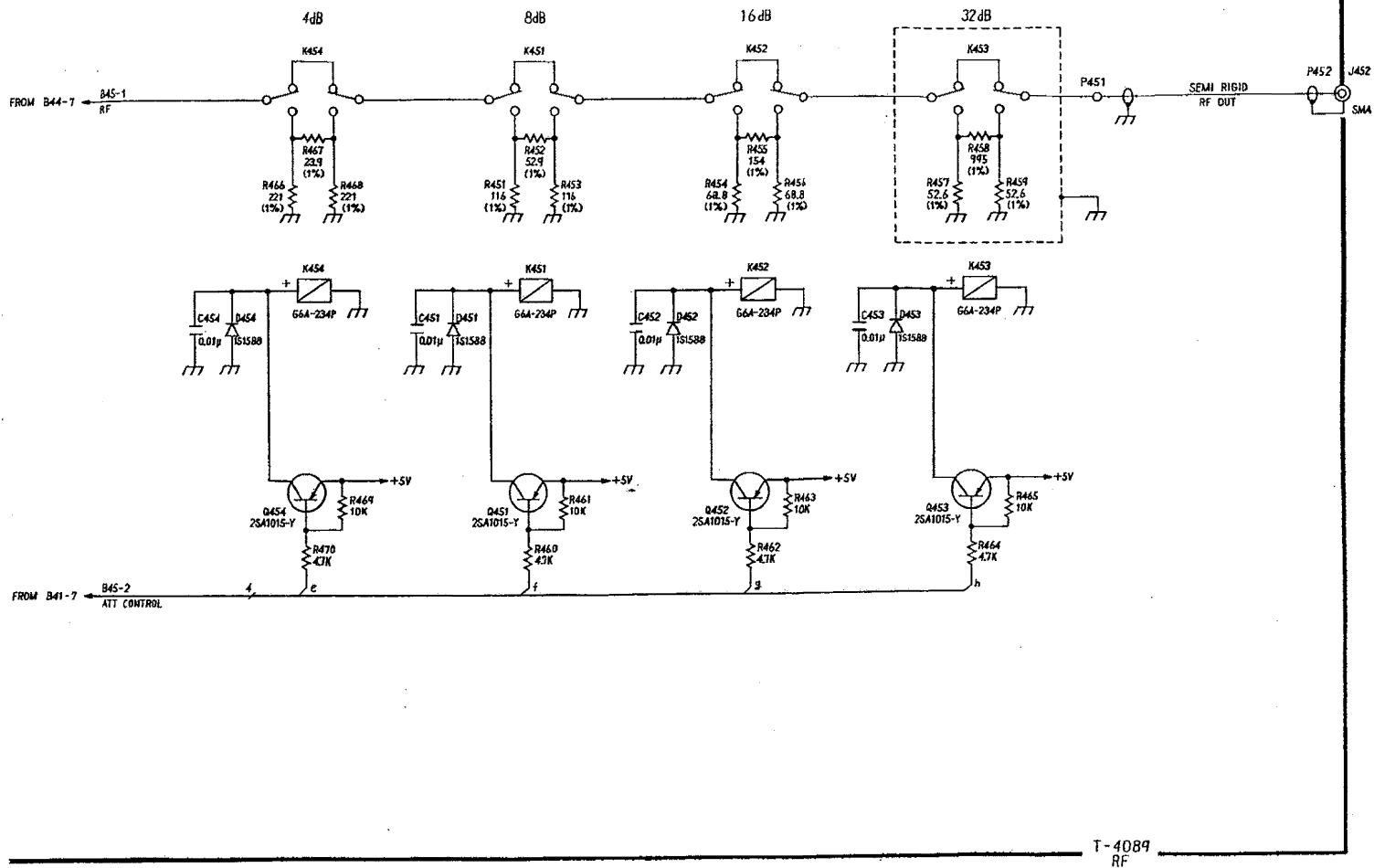


T-4089
RF

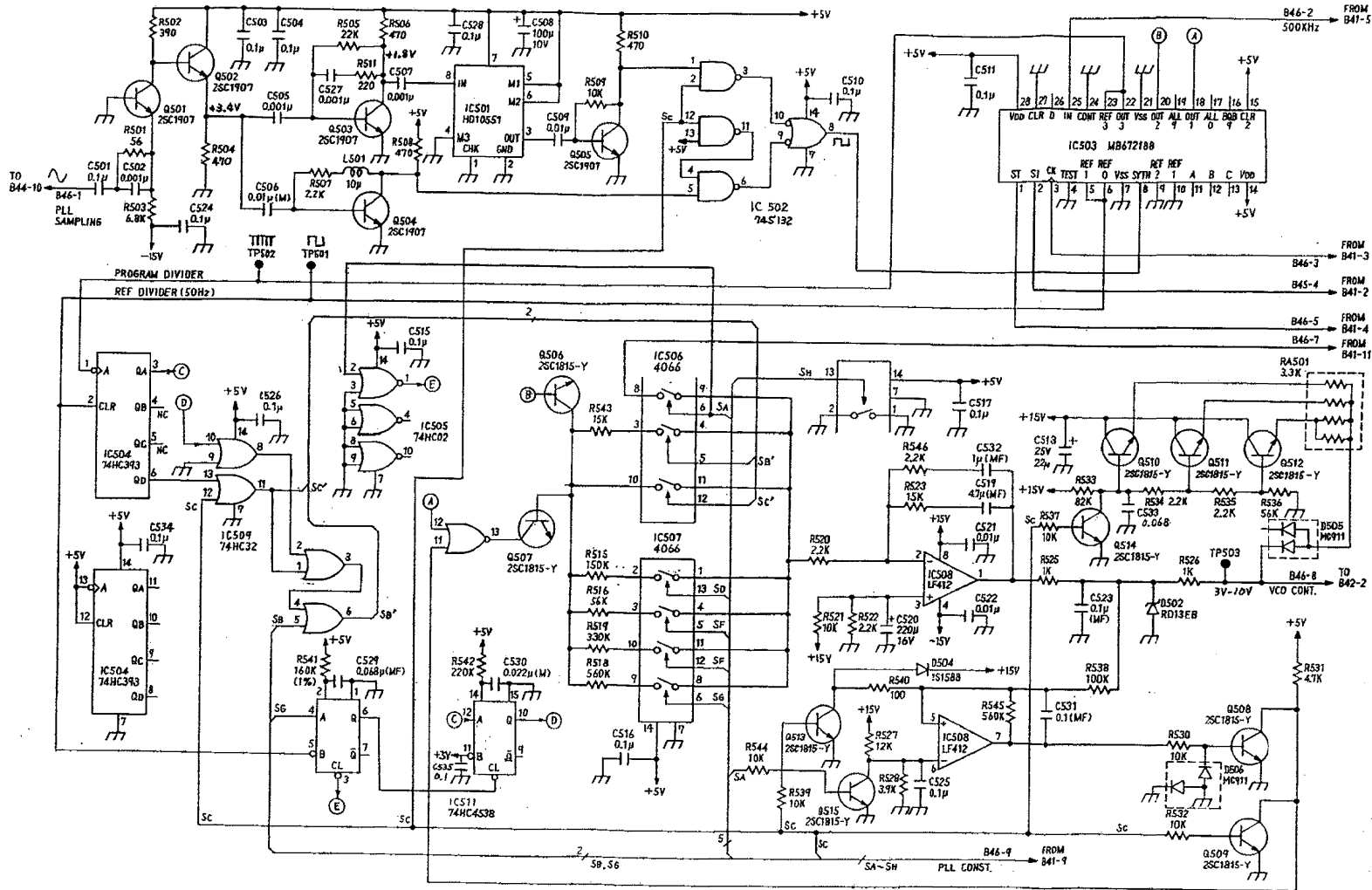
Local Oscillator, Mixer
B43



7-19
3215/3216

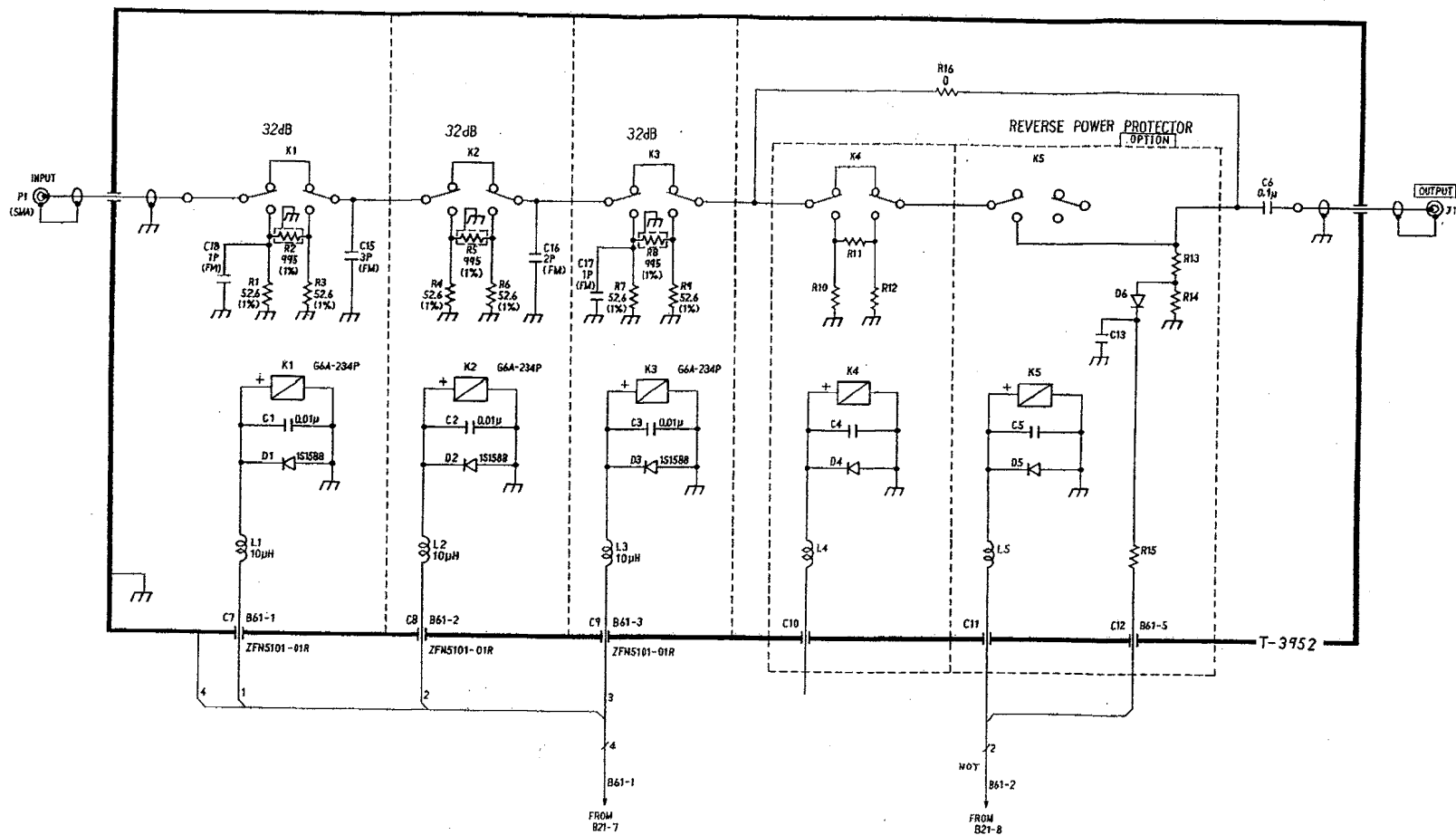


Attenuator-1
B45

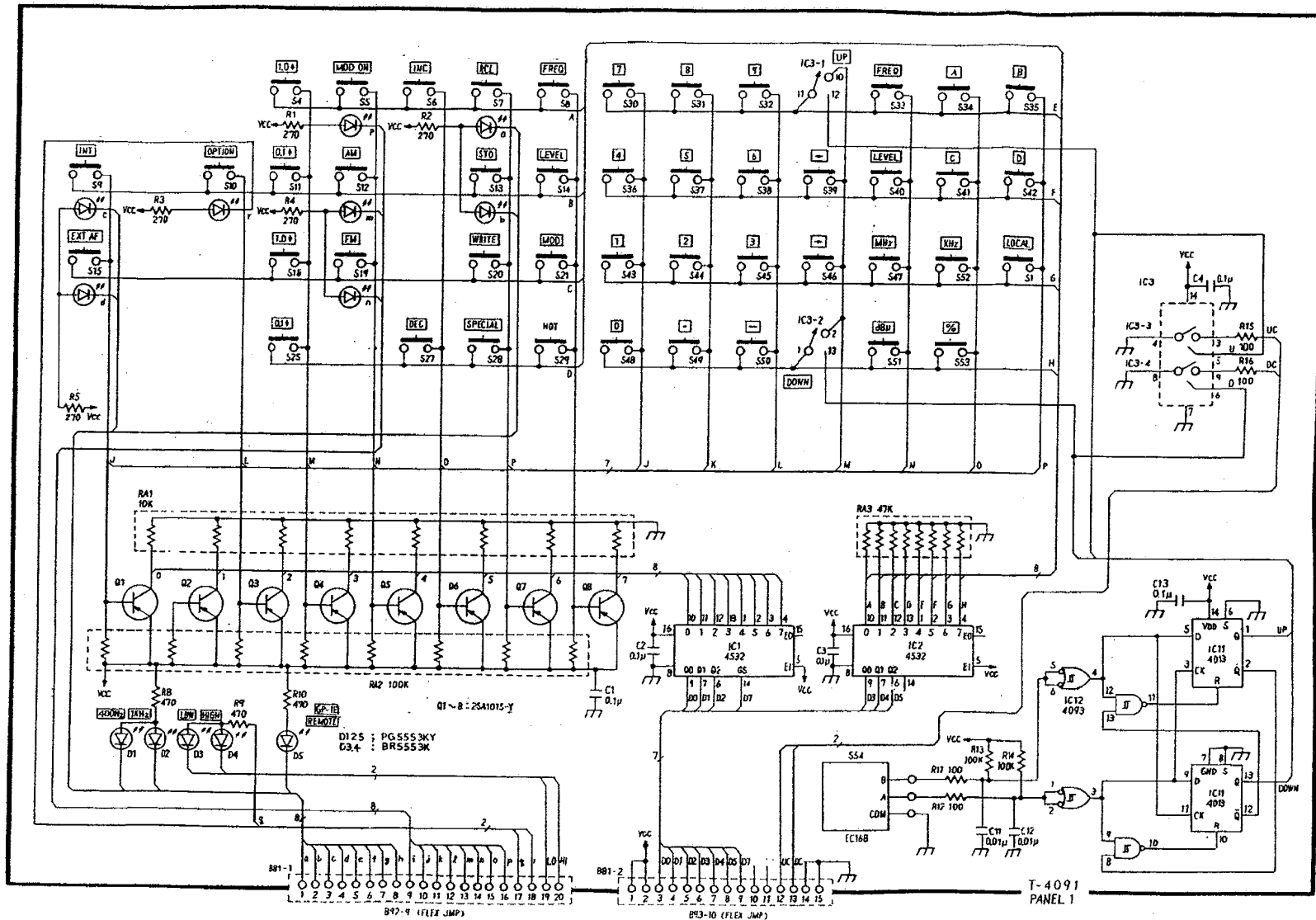


T-4089
RF

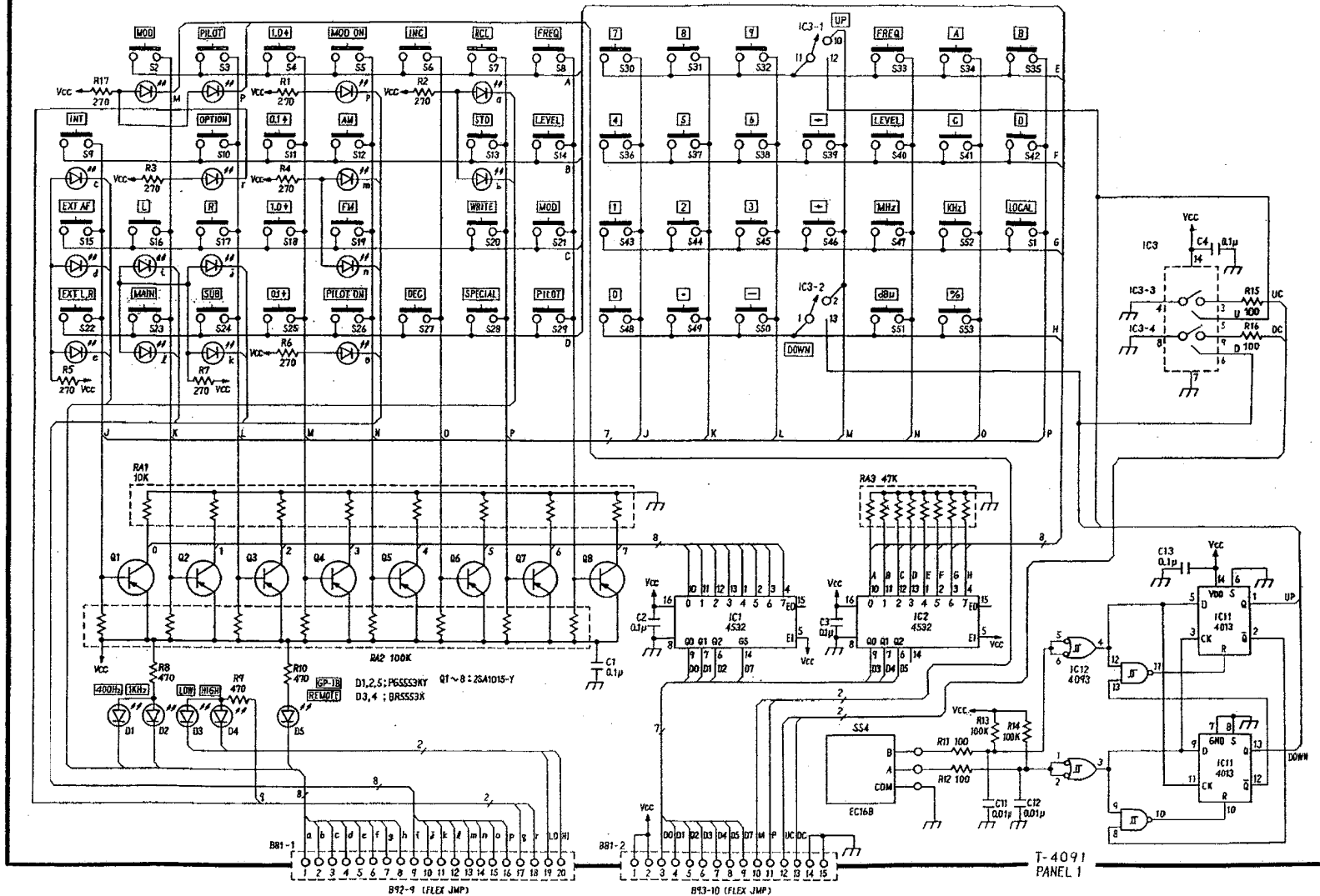
PLL
B46



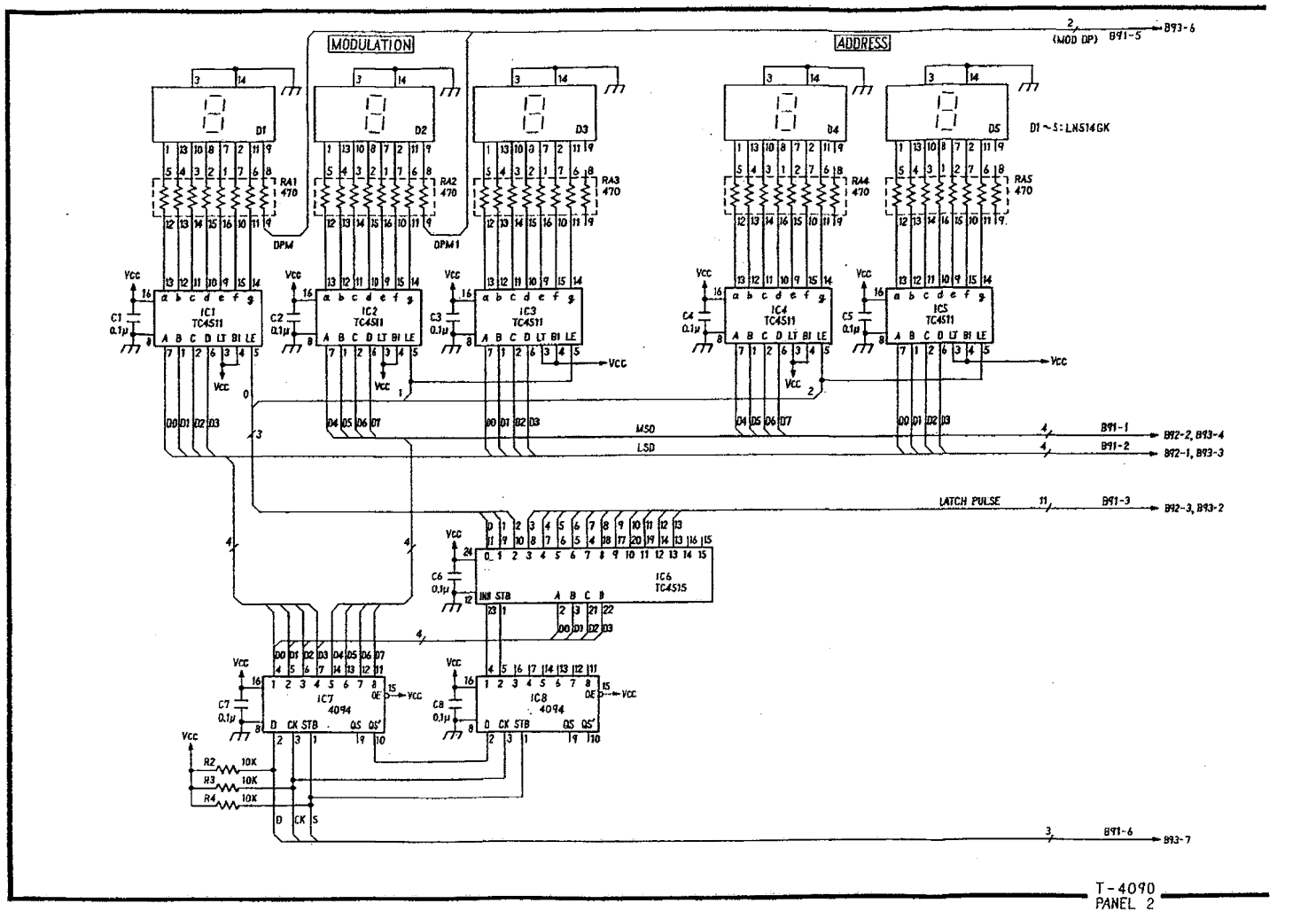
Attenuator-2
B61



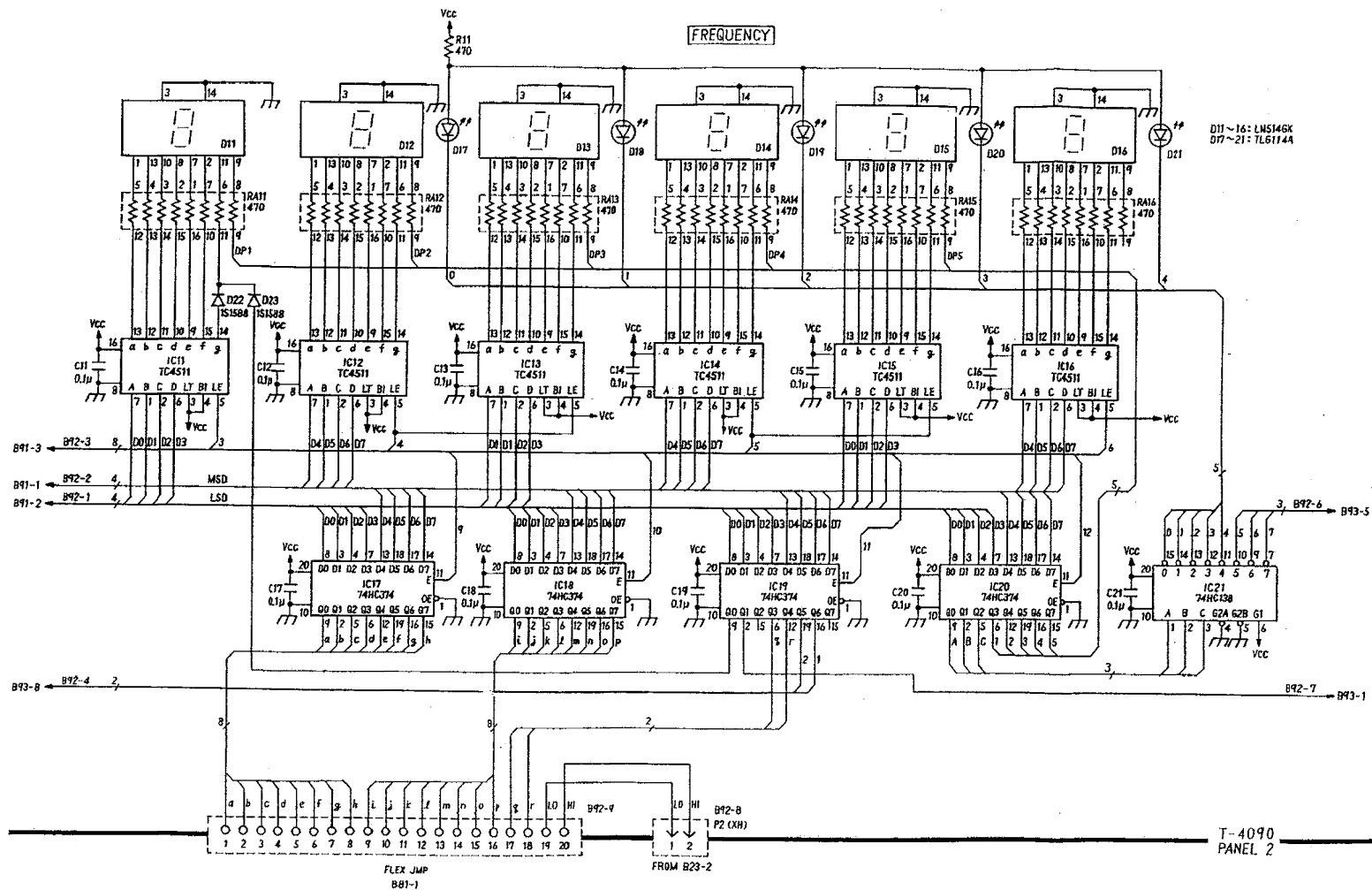
=Model 3215=
Front Panel Controls-1
B81A



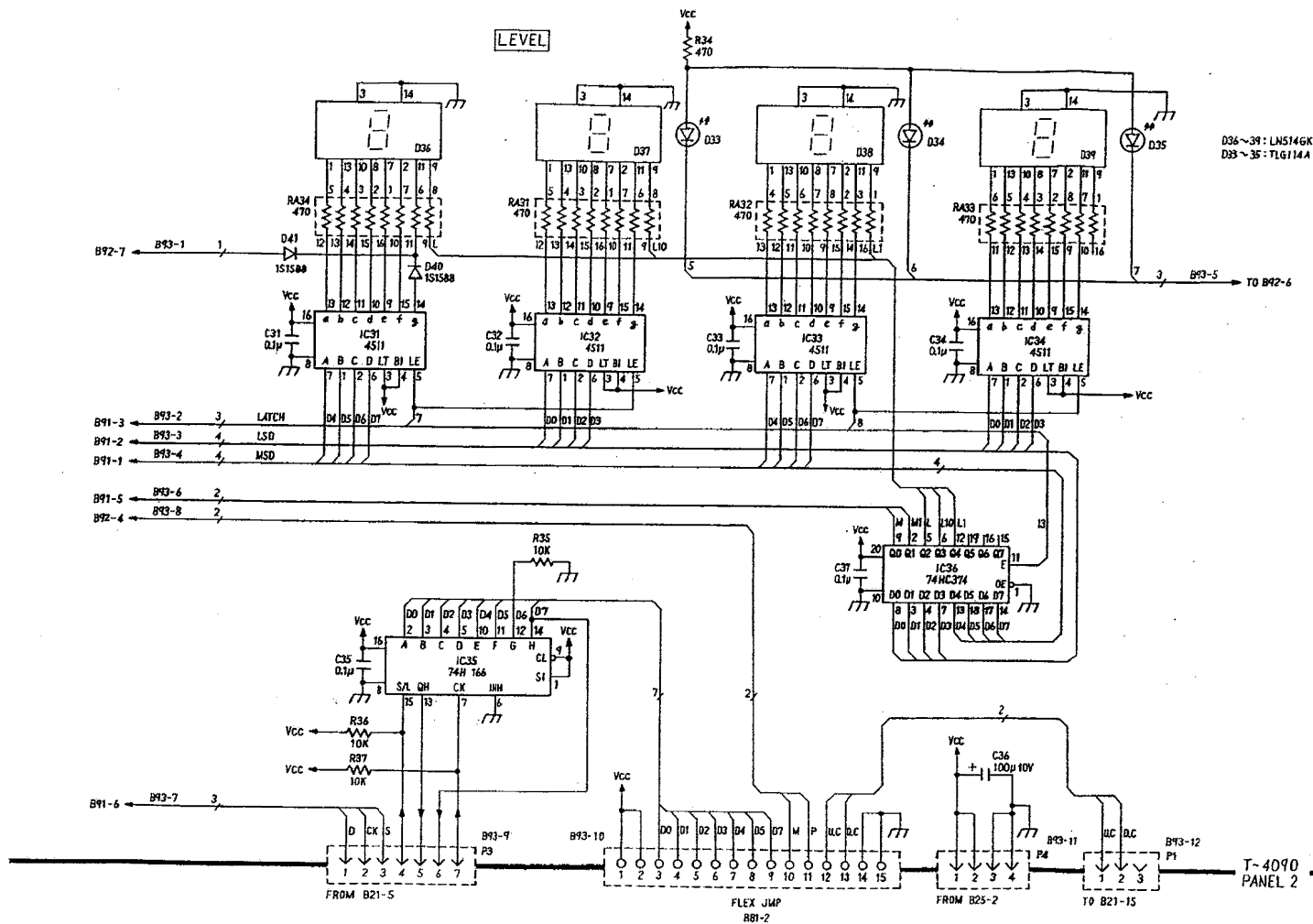
=Model 3216=
Front Panel Controls-2
B81B



Display-1(MODULATION, ADDRESS)
B91

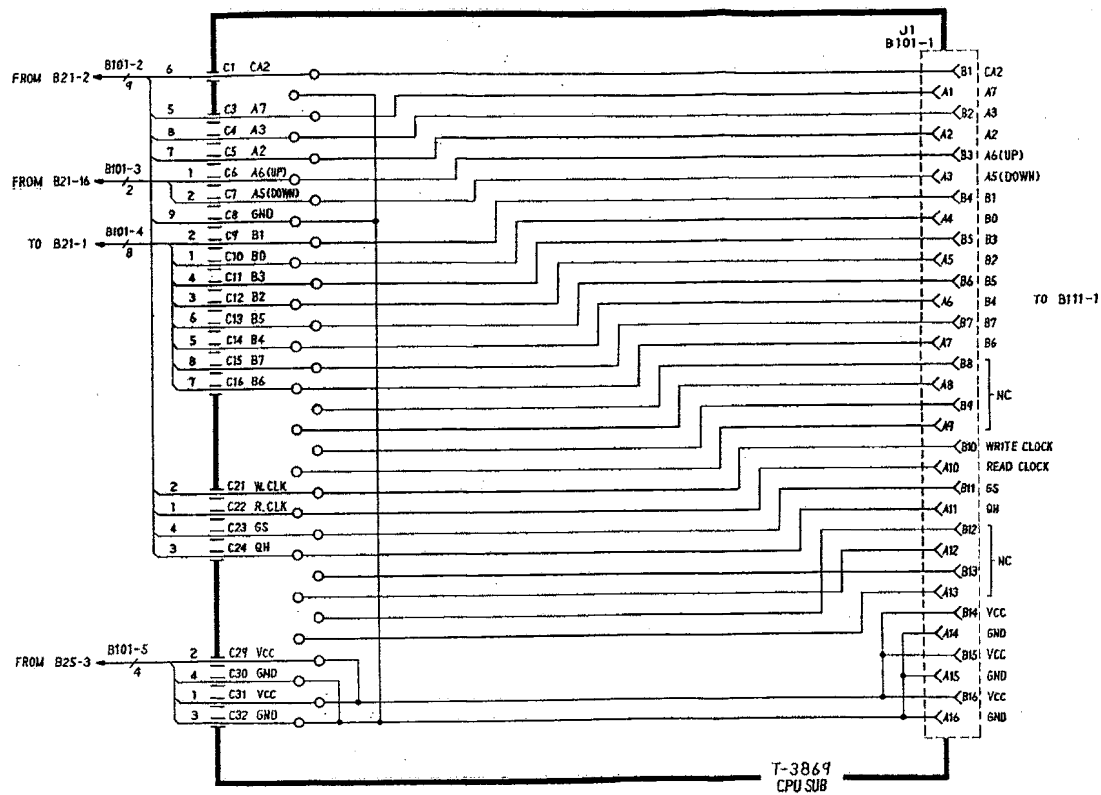


Display-2 (FREQUENCY)
B92



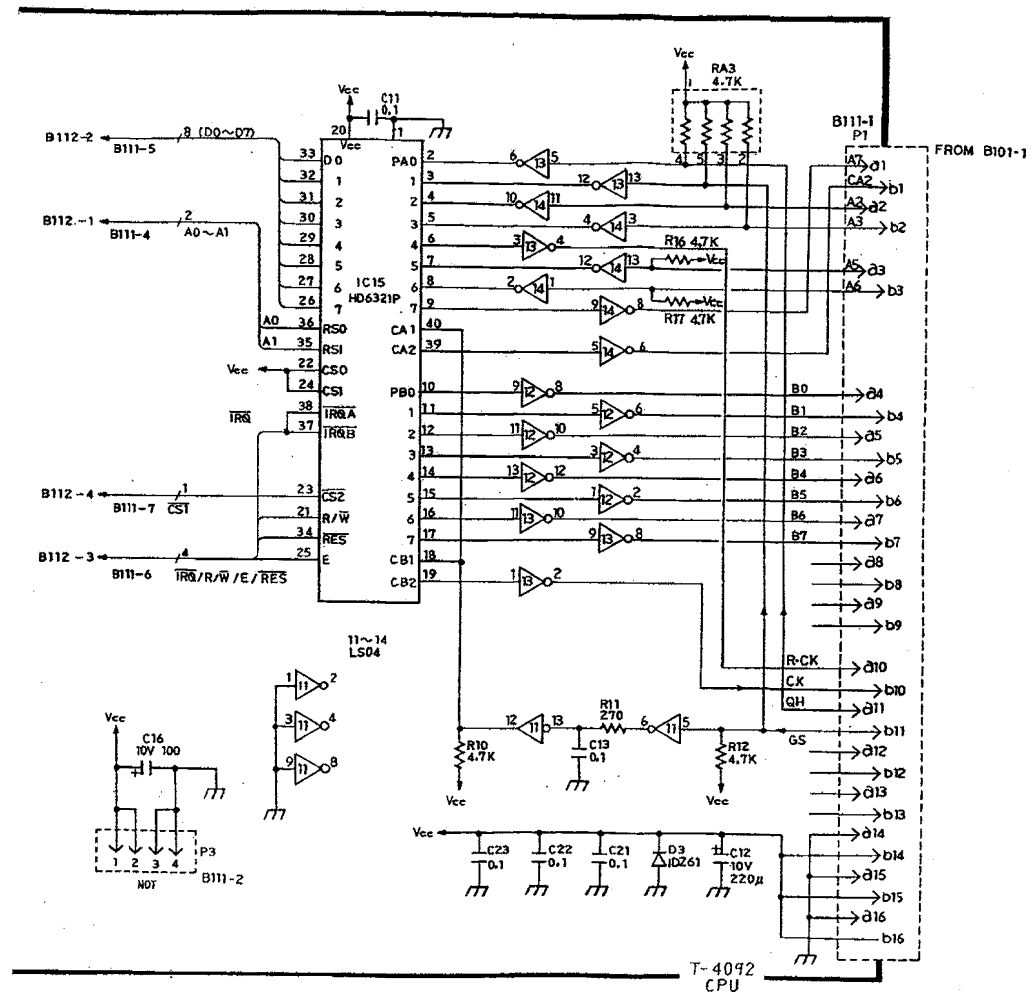
D36~39: LMS146K
D35~35: TLG114A

Display-3 (LEVEL)
B93

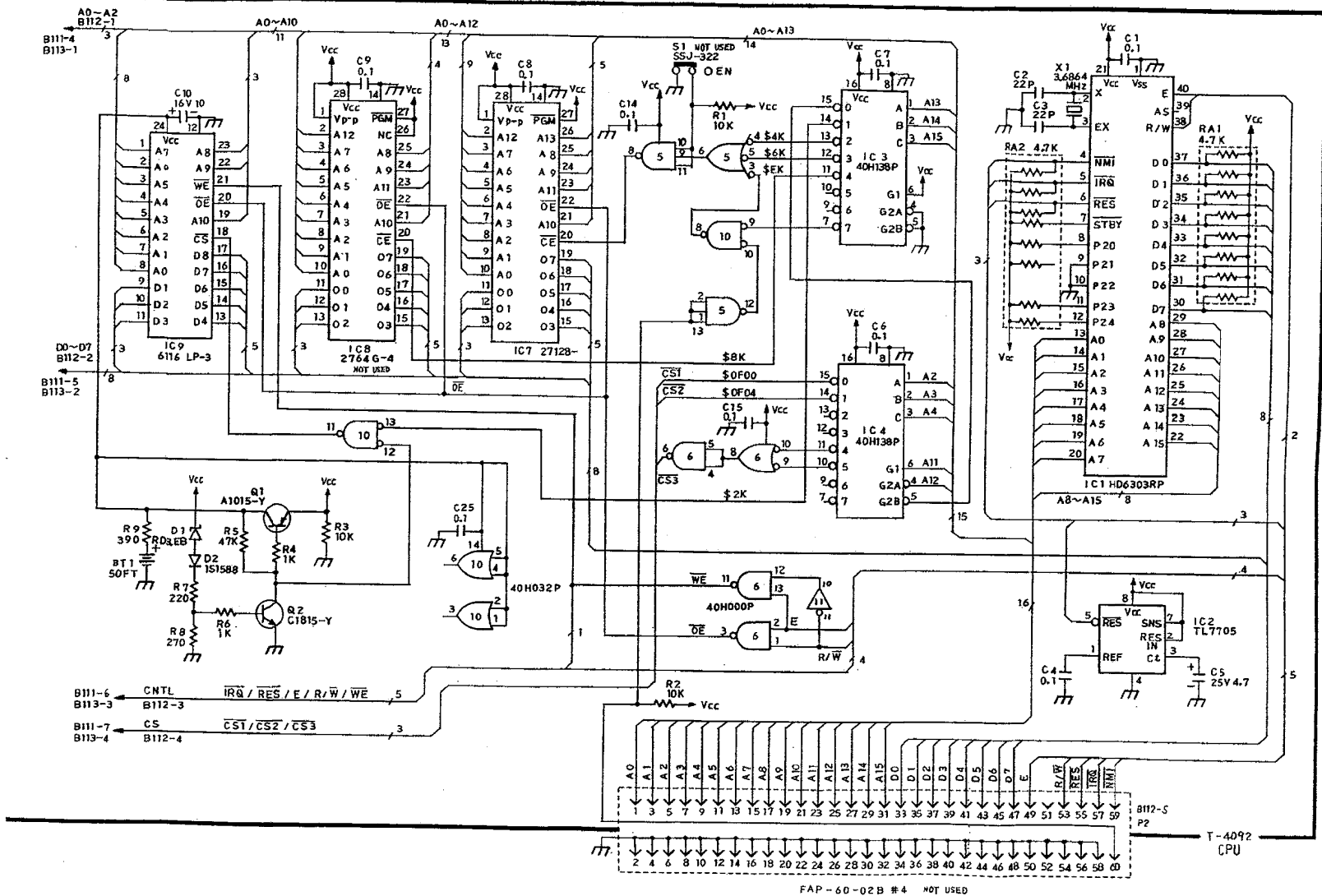


C1, 3~16, 22~24, 30~32 ; 1000 P

CPU Sub-board
B101



CPU-1
B111



CPU-2
B112

- Take four screws, holding cord winder, to remove the Top and Bottom covers.

