Volume II

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LESSON PLANS
FOR
MODEL DDR-5
RECEIVING SET

WORLD WIDE SUPPLIERS OF ELECTRONIC COMMUNICATIONS EQUIPMENT

THE TECHNICAL MATERIEL CORPORATION

MAMARONECK, N.Y. OTTAWA, ONTARIO

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LESSON PLANS

FOR

MODEL DDR-5 RECEIVING SET

THE

TECHNICAL MATERIEL CORPORATION

MAMARONECK, NEW YORK

ERRATA: Lesson Plans, Model DDR-5

To All Holders of this Publication: Please make the following corrections immediately.

1. Insert new Title Page.

2. Make the following pen and ink corrections:

AFC-3 page 13: para d — grounds the cathode of CR-5001 vice anode.

HFS-1	page 64:	TP-3303	10 KC selector 1 400 KC
		TP-3304	10 KC selector 5 360 KC
		TP-3305	10 KC selector 5 360 KC
	page 66:	TP-3405	10 KC selector 5 360 KC
		TP-3407	nixie selectors at 02.2500; receiver tuned to 2.25 mcs.
	page 67:	TP-3409	nixie selectors at 02.2500; receiver tuned to 2.25 mcs.
	page 69:	last para	2.25 mc vice 2.26 mcs.
	page 76:	para g	10 KC selector to 9 320 KC
HFR-1	page 1A	(block)	above RF level meter; should read: AGC to V-1201 vice V-1206.
			frequency from HFO V-1007 to IA V-1006 is 3.75 - 33.75 mcs.

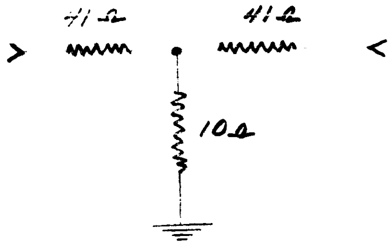
Note: Every effort has been made to keep errors to a minimum; however, should errors be discovered, please write to the address given below, giving page number, lesson number, and details.

The Technical Materiel Corporation
700 Fenimore Road
Mamaroneck, New York
Attention: Director of Engineering Services

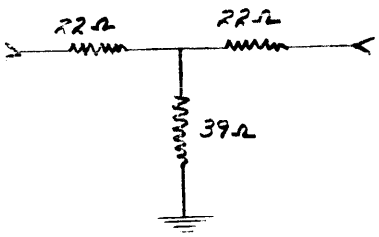
Model DDR-5 Receiver (AN/FRR-60(v)

Pads used in system checkout:

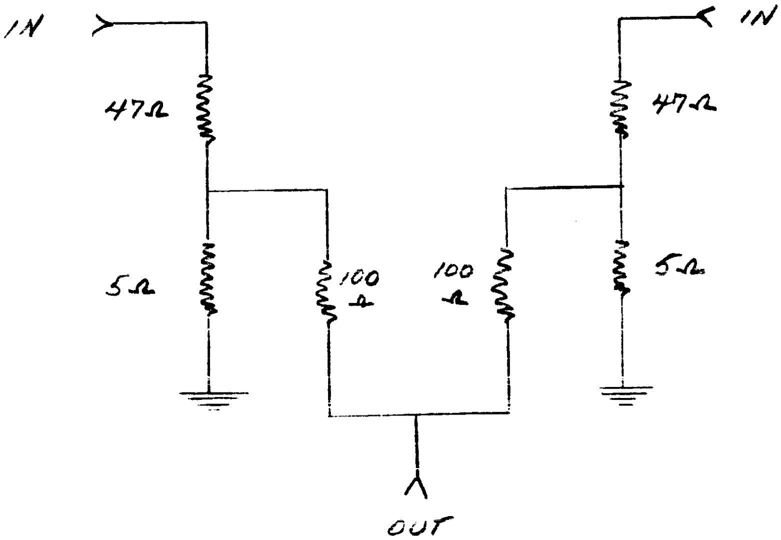
The following sketches show the configurations of the 20 DB, 10 DB, and the 30 DB mixing pads.



20 db



10 db



30db
MIXING PAD

31 January 1963

Measurement of Local Oscillator Radiation from Antenna Jack, J-1001, on Model HFR-1 Continuous RF Tuner in Model DDR-5 Installation.

1. Equipment Required:

    a) Signal Generator: Measurements Corp. Model 82 or equivalent.

    b) Communications Receiver: R-390A/URR, or equivalent.

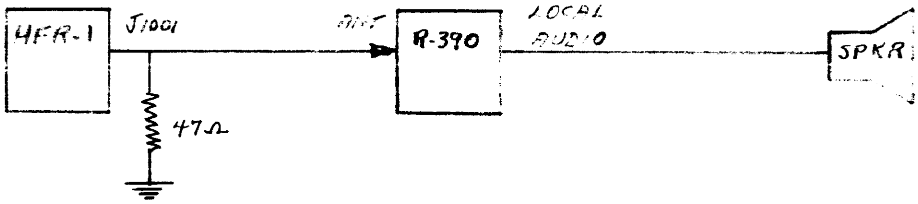
    c) Dummy Load: 50 ohms nominal, with BNC termination.

    d) Coaxial Adapter: C to BNC for R-390A/URR Antenna Jack.

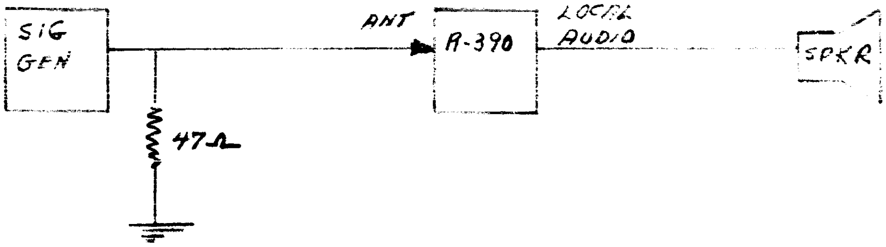
    e) Coaxial Cables: 50 ohm, with BNC connections.

    f) Coaxial Adapter: "T" connector, BNC type.

2. The equipment was set up initially as indicated in the figure below. The Model DDR-5 receiver was synthesized at the appropriate RF frequency. The Model R-390 receiver was tuned 1.75 mc above this, to the local oscillator frequency, and adjusted for maximum carrier level indication, which was recorded.



3. The equipment was then set up as shown in the sketch below. The signal generator was tuned and adjusted to provide the same carrier level indication on the R-390 as recorded previously. The signal generator attenuator was then noted; this reading was taken as the L.O. radiation.



4. The R-390 controls were set as follows:

a) LINE METER: "O"

b) ANT TRIM: adjusted for maximum carrier level indication at each frequency with DDR-5.

c) LIMITER: OFF.

d) BANDWIDTH: 1 KC

e) BFO: OFF

f) FUNCTION: AGC

g) LOCAL GAIN: MAX.

h) RF GAIN: MAX.

i) MC and KC CHANGE: adjusted for maximum carrier level indication at each frequency with DDR-5; Untouched during signal generator operation.

5. The following readings were obtained on the HFR-1 Prototype:

HFR-1 BAND	RF FREQ	L.O. FREQ	RADIATION FIGURE
1	2.00	3.75	12.5 uv
2	3.50	5.25	5.5 uv
3	5.00	6.75	7.0 uv
4	7.00	8.75	5.5 uv
5	10.00	11.75	1.8 uv
6	15.00	16.75	2.5 uv
7	20.00	21.75	50.0 uv
8	25.00	26.75	50.0 uv

W. P. Hennessey

(2) Voltages at V-302: BEAT switch ON. Master Oscillator Frequency at 4.0 mcs:

PIN	RF VOLTAGE	DC VOLTAGE	AC VOLTAGE
1	0.00	150.00	-
2	3.00	0.10	-
3	0.90	5.50	-
4	-	-	6.3
5	-	-	6.3
6	15.00	80.00	-
7	30.00	-18.50	-
8	11.50	7.60	-
9	GND	GND	GND

Title: Model HFS-1 Frequency Synthesizer and Standard

Military Nomenclature:

Generator, Reference Frequency: O-941/UR

Objectives:

a) to discuss the functions of the Model HFS-1 in the Model DDR-5 receiving system.

b) to explain the principles of operation of the following basic circuits in the Model HFS-1:

(1) Phantastron divider circuit.
(2) Blocking Oscillator circuit.
(3) Phase detector circuit.

c) to discuss the principles of operation of the Model HFS-1, pointing up significant circuit parameters.

d) to demonstrate, with appropriate test equipment, the alignment of the unit.

e) to illustrate the interconnection of the Model HFS-1 with other units of the Model DDR-5 system.

R ferences:

a) CK-582: schematic, 3100 deck.
b) CK-583: schematic, 3200 deck.
c) CK-580: schematic, 3300 deck.
d) CK-584: schematic, 3400 deck.
e) CK-585: schematic, 3500 -3600 deck.
f) CK-604: master schematic, Model HFS-1
g) CK-601: schematic, Model HFR-1 RF Tuner
h) CK-537: schematic, 3700 deck (regenerative divider)
i) CK-578: schematic, main chassis.

Training Aids:

a) Model DDR-5 receiving system, set up for operation.

b) Oscilloscope: Tektroniks model 545A, or equivalent.

c) VTVM: H.P. Model 410B, or equivalent.

d) Frequency Counter: H.P. Model 524C, or equivalent.

e) Measurements Corp. Model 82 Signal Generator, or equivalent.

Introduction:

The Model DDR-5 receiver, (AN/FRR-60-(v)), is a general coverage receiver designed for operation in the range 2 - 32 mcs.
The local oscillator, (HFO), in the Model HFR-1 "front end" may be precisely controlled over its entire range, 3.75 mc - 33.75 mc, in 100 cycle steps, assuring the frequency stability so necessary for SSB operation. The precise control of the HFO is accomplished by employing a synthesizer unit with a built in frequency standard having an accuracy of 1 part in 100,000,000 per day.
The synthesizer unit furnishes the HFO circuits with a DC control voltage, the amplitude and polarity of which depends on the error of the HFO. Illuminated "Nixie" lights on the synthesizer front panel are actuated by selector switches; the nixie lights are coded to provide a display of the receiver frequency.

Presentation:

A. General Description and Orientation:
(to be accomplished with an actual HFS-1 unit)

1. The Model HFS-1 synthesizer unit is divided into seven decks, or functional sections, as listed below:

a) 3000 Deck:

Drawer; input and output terminal connections; front panel; nixie lights; filter panel. In general, all components mounted on the main skeleton.

b) 3100 Deck:

Plug in unit; the .1 KC selector. The 1 mc standard and the phase comparator circuits are included. Call attention to the EXTERNAL - INTERNAL switch.

c) 3200 Deck:

Plug in unit; the 1 KC selector.

d) 3300 Deck:

Plug in unit; the 10 KC selector.

e) 3400 Deck:

Plug in unit; the 100 KC selector. The final phase detector circuit is also included; this circuit furnishes the DC control voltage to the HFO circuit.

f) 3500 - 3600 Deck:

Plug in unit; the "MC" selector unit. Also called the "high frequency loop". A 2nd harmonic generator is also included. The 3600 series was combined with the 3500 series because symbols in the 3500 series were exhausted.

g) 3700 Deck:

A regenerative divider circuit, which produces a 250 KC frequency, locked to the 1 mc standard, for use in another unit.

2. The Model HFS-1 may be considered to comprise:

a) a basic synthesizer unit composed of the 3100, 3200, 3300 and 3400 decks, which produces a reference frequency, locked to the 1 mc standard, in the range 4.25 - 3.2501 mc, in .1 KC steps.

b) a high frequency loop, which produces a frequency in the range 4.25 - 3.25 mcs; this frequency contains the error of the HFO circuit of the Model HFR-1 "front end". The high frequency loop is contained in the 3500 - 3600 deck.

c) a 1 mc standard, accurate to 1 part in 100,000,000 per day, which is used as the system reference. This is contained in the 3100 deck.

d) a phase detector circuit which compares the outputs of the basic synthesizer and the high frequency loop; these two frequency outputs should be the same. The phase detector produces a correction voltage proportional to the error between the two frequencies which is used to correct the frequency of the HFO. This circuit is included in the 3400 deck.

e) a regenerative divider circuit, which produces a 250 KC signal, locked to the 1 mc standard, for use as a re-inserted carrier in another unit. This is the 3700 deck.

f) a second harmonic generator circuit, which produces a 2 mc signal, locked to the 1 mc standard, for use as an injection frequency in another unit. This circuit is included in the 3500 - 3600 deck.

g) a phase comparator circuit, used to compare the phase of the internal 1 mc standard with the phase of an external standard, and show the result on a front panel meter. This circuit is included in the 3100 deck.

B. Principles of Operation:

Refer to the General Simplified Block Diagram, Model HFS-1.

1. The 1 mc standard circuit, with an accuracy of 1 part in 100,000,000 per day, is contained in the 3100 deck. The 1 mc reference is delivered to the 3400 deck, where, by means of frequency divider circuits, it is reduced to 100 KCS. The 100 KC reference is used to create synthesized frequencies in the 3400 deck; it is also delivered to the 3300 deck.

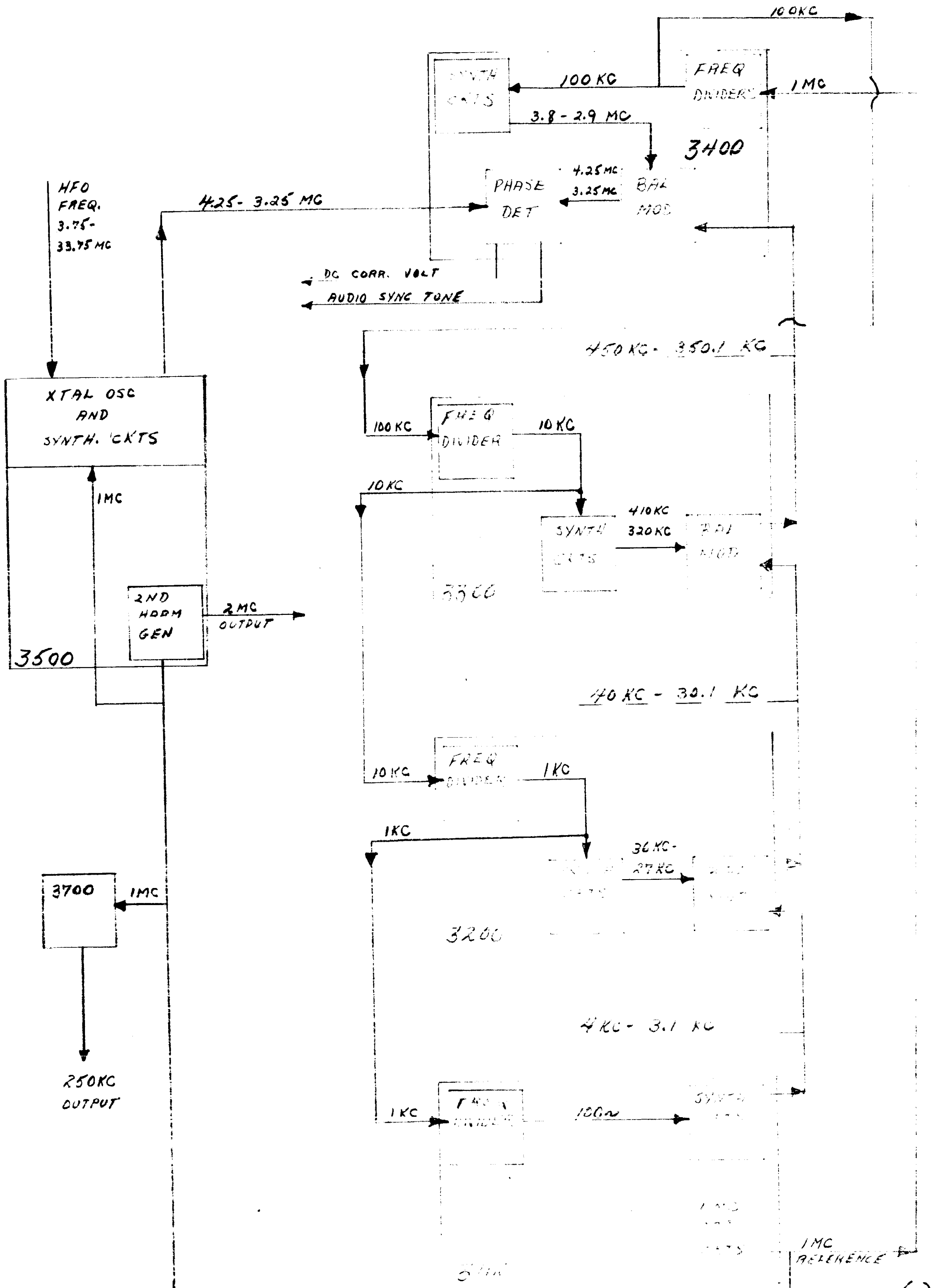
2. In the 3300 deck, the 100 KC input is reduced to 10 KC in a divider circuit. The resultant 10 KC signal is used as a reference for the synthesizer circuits of the 3300 deck. It is also delivered to the 3200 deck.

3. In the 3200 deck, the 10 KC input is reduced to 1 KC in a divider circuit. The 1 KC signal is used as a reference for the synthesizer circuits of the 3200 deck; it is also delivered to the 3100 deck.

4. In the 3100 deck, the 1 KC input is reduced to 100 cycles in a divider circuit. The 100 cycle signal is used in the synthesizer circuits to produce a frequency in the range 4 KC - 3.1 KC in ten 100 cycle steps. A selector switch determines the exact output frequency, and illuminates the appropriate numeral of the .1 KC nixie light on the front panel. The selected frequency in the range 4 KC-3.1 KC is delivered to a balanced modulator in the 3200 deck.

5. In the 3200 deck, the 1 KC signal is used in the synthesizer circuits to produce a frequency in the range 36 KC - 27 KC in ten 1 KC steps. A selector switch determines the exact frequency, and illuminates the appropriate numeral of the 1 KC nixie light on the front panel. A balanced modulator circuit adds the 36 KC - 27 KC frequency selected in the 3200 deck with the 4 KC - 3.1 KC frequency selected in the 3100 deck. The resultant output, a frequency in the range 40 KC - 30.1 KC, in .1 KC steps, is applied to the 3300 deck.

General Simplified Block Diagram, Model HFS-1:

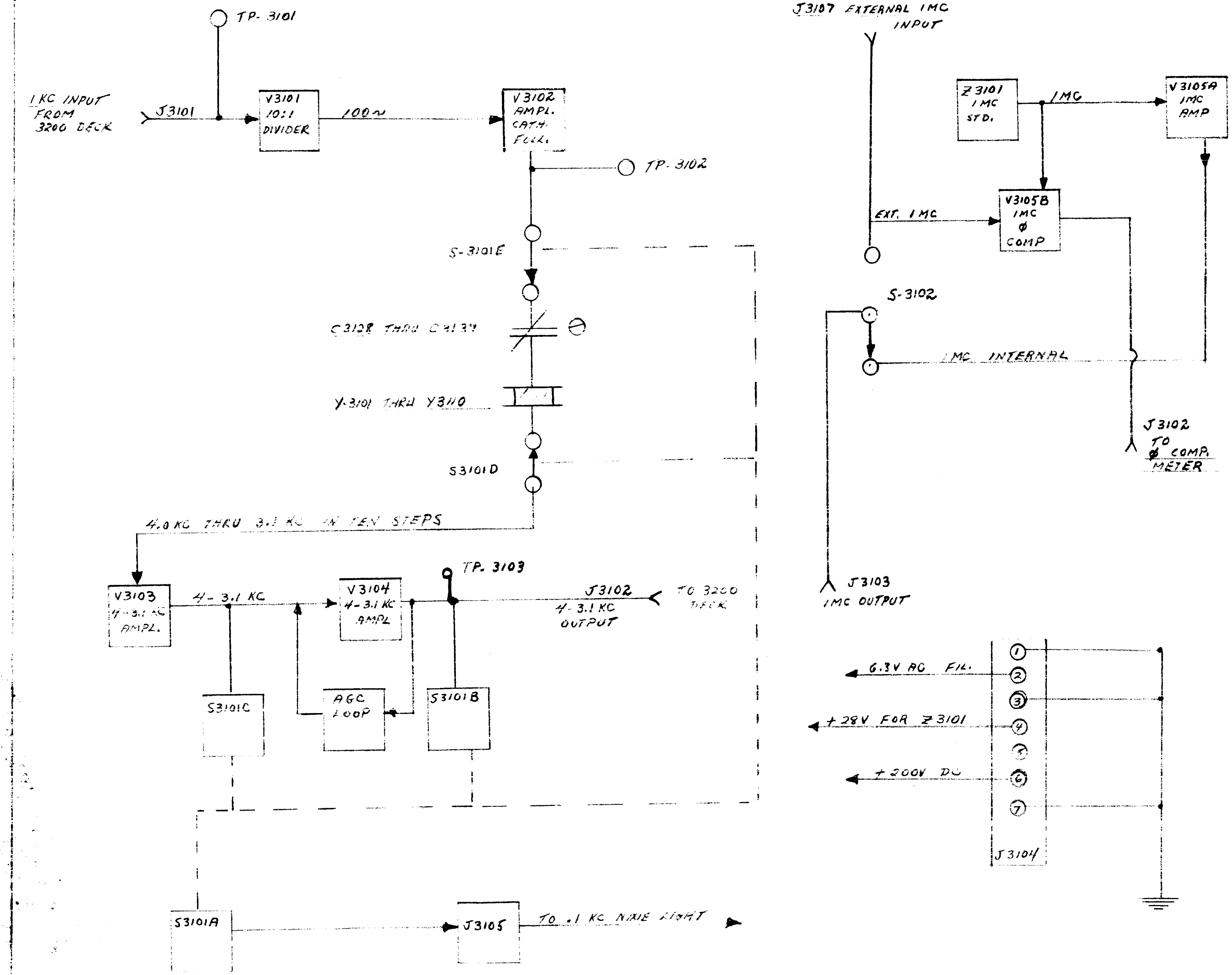


6. The 10 KC signal in the 3300 deck is used in the synthesizer circuits to produce a frequency in the range 410 KC - 320 KC in ten 10 KC steps. A selector switch determines the exact frequency and causes the appropriate numeral on the 10 KC nixie light to be illuminated.
A balanced modulator circuit adds the selected frequency in the range 410KC - 320 KC, with the 40 KC - 30.1 KC signal from the 3200 deck. The resultant, a frequency in the range 450 KC - 350.1 KC, in .1 KC steps, is delivered to the 3400 deck.

7. In the 3400 deck, the 100 KC signal is used in the synthesizer circuits to produce a frequency in the range 3.8 mc - 2.9 mc in ten 100 KC steps. A selector switch determines the exact frequency selected and causes the appropriate numeral on the 100 KC nixie light to be illuminated.
A balanced modulator circuit adds the selected frequency in the range 3.8 mc - 2.9 mc with the frequency from the 3300 deck in the range 450 KC - 350.1 KC. The resultant is a frequency in the range 4.25 mc - 3.2501 mc, in .1 KC steps. This is applied to a phase detector circuit in the 3400 deck.

8. The 1 mc standard signal arrives at the 3500 - 3600 deck, and is applied to a 2nd harmonic generator circuit. The 2 mc output, locked to the 1 mc standard, is delivered to the HFI-1 unit for use in the second converter.

9. The 1 mc input to the 3500 - 3600 deck is also used in the synthesizer circuits. These circuits also employ a 48.5 - 77.5 mc oscillator, operated by a selector switch in 30 one mc steps. Another input to the synthesizer circuits arrives from the HFO circuits of the Model HFR-1. Since the HFO is always operating 1.75 mc above the incoming signal, the HFO frequency input will range from 3.75 mc to 33.75 mcs.
The synthesizer circuits of the high frequency loop produce a frequency in the range 4.25 - 3.25 mcs, in 30 steps. The selector switch determining the exact frequency causes the appropriate numeral of the MC nixie lights to be illuminated. This 4.25 - 3.25 mc frequency contains the error, if any, of the HFO circuit. It is delivered to the phase detector circuit of the 3400 deck.
The phase detector compares the two nominally identical frequencies and develops a correction voltage, the amplitude and polarity of which is determined by the error of the HFO. The correction voltage is used to correct the HFO error. The phase detector circuit also produces an audio sync tone for tuning and alignment purposes. The tone frequency is proportional to the error voltage; no tone is produced when the error is zero.



TP-3101
1 KC INPUT FROM 3200 DECK
J3101
V3101 10:1 DIVIDER
100~
V3102 AMPL. CATH. FOLL.
TP-3102
S-3101E
C3128 THRU C3137
Y-3101 THRU Y3110
S3101D
4.0 KC THRU 3.1 KC IN TEN STEPS
V3103 4-3.1 KC AMPL.
4-3.1 KC
V3104 4-3.1 KC AMPL
TP. 3103
J3102 4-3.1 KC OUTPUT
TO 3200 DECK
S3101C
AGC LOOP
S3101B
S3101A
J3105
TO .1 KC NIXIE LIGHT
J3107 EXTERNAL 1MC INPUT
Z3101 1MC STD.
1MC
V3105A 1MC AMP
EXT. 1MC
V3105B 1MC ϕ COMP
S-3102
1MC INTERNAL
J3102 TO ϕ COMP. METER
J3103 1MC OUTPUT
6.3V AC FIL.
+28V FOR Z3101
+200V DC
J3104

10) Block Diagram, 3100 Deck, Model HFS-1:

The .1 KC Selector Deck, or 3100 Deck, receives pulses at a frequency of 1 KC from the 3200 deck. The 3100 deck delivers an output in ten .1 KC steps from 4.0 KC to 3.1 KC to the 3200 deck, in accordance with the setting of S-3101, the .1 KC selector switch on the front panel of the HFS-1.

One section of the .1 KC selector switch, S-3101A, causes the .1 KC "nixie" light on the front panel to illuminate the numeral corresponding to the selected frequency.

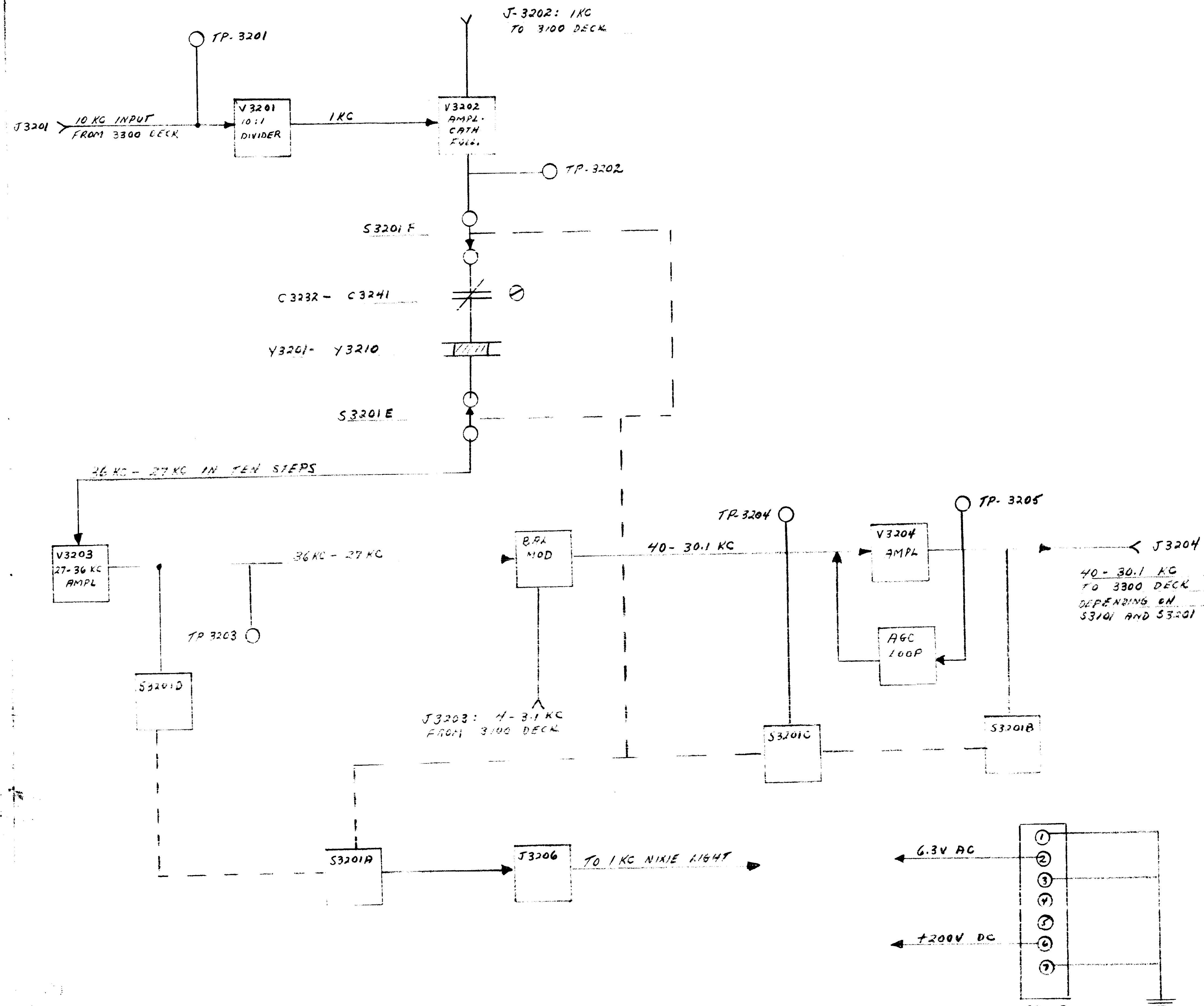
The 1 KC pulses from the 3200 deck enter at J-3101, and are applied to V-3101, a 10:1 Phantastron divider circuit. The 100 cycle pulses developed by V-3101 are applied to V-3102, an amplifier-cathode follower circuit. The 100 cycle pulse taken from the cathode of V-3102 is rich in harmonics; this pulse is applied to one of ten crystals, cut for frequencies between 4.0 KC and 3.1 KC. The 100 cycle pulse excites the appropriate crystal, and a frequency in the range 4.0 KC - 3.1 KC is applied to amplifier stage V-3103. The appropriate crystal, with its individual trimmer capacitor, is selected by switch sections S-3101E and S-3101D.

Switch section S-3101C inserts the proper value of capacitance in the plate circuit of V-3103 to tune this stage.

The output of V-3103 is applied to another amplifier, V-3104. Switch section S-3101B inserts the proper value of capacitance in the plate circuit to tune this stage.
Associated with the circuit of V-3104 is an AGC loop, designed to assure constant amplitude of the 4.0 - 3.1 KC signal regardless of the frequency selected.
The output of V-3104 is applied to J-3102, from which point it is delivered to the 3200 deck.

Included in the 3100 deck is the 1 mc standard, which acts as the reference for the entire system. The output of the standard, Z-3101, is applied to a 1mc amplifier, V-3105A; the output of this amplifier stage is connected to switch S-3102.
An external 1 mc standard may be connected at J-3107, if desired. S-3102 selects either the internal or external 1 mc signal, and applies it to the 1 mc output jack, J-3103.

* Both the internal and external 1 mc signals are connected to a phase comparator circuit, V-3105B; the output of this circuit is connected to J-3106, from which point it is delivered to the phase comparator meter of the HFS-1 on the front panel.



HFS-1 3200 DECK
5-62 HP

11) Block Diagram, 3200 Deck, Model HFS-1:

The 1 KC Selector Deck, or 3200 Deck, receives:

a) pulses at a frequency of 10 KC from the 3300 deck.
b) an output in the range 4KC-3.1 KC from the 3100 deck.

The 3200 deck delivers:

a) output pulses at a frequency of 1 KC to the 3100 deck.
b) an output in the range 40 KC-30.1 KC to the 3300 deck, in accordance with the settings of S-3101 on the 3100 deck and S-3201 on the 3200 deck.

The 10 KC pulses from the 3300 deck arrive at J-3201 and are applied to V-3201, a 10:1 Phantastron divider circuit. The 1 KC output of the divider circuit is applied to V-3202, an amplifier-cathode follower circuit.
The 1 KC output at the plate of V-3202 is applied to J-3202; from this point the 1 KC pulses are delivered to the 3100 deck.

The harmonic rich 1 KC pulses at the cathode of V-3202 are applied to one of ten crystals operated as narrow band filters. These crystals are cut for frequencies between 36 KC and 27 KC.
The 1 KC pulse excites the appropriate crystal and a frequency in the range 36-27 KC is applied to amplifier V-3203. The appropriate crystal, with its associated trimmer capacitor, is selected by switch sections S-3201F and S-3201E.

Switch section S-3201A causes the 1 KC "nixie" light on the front panel of the HFS-1 to illuminate the numeral corresponding to the selected frequency at this point.

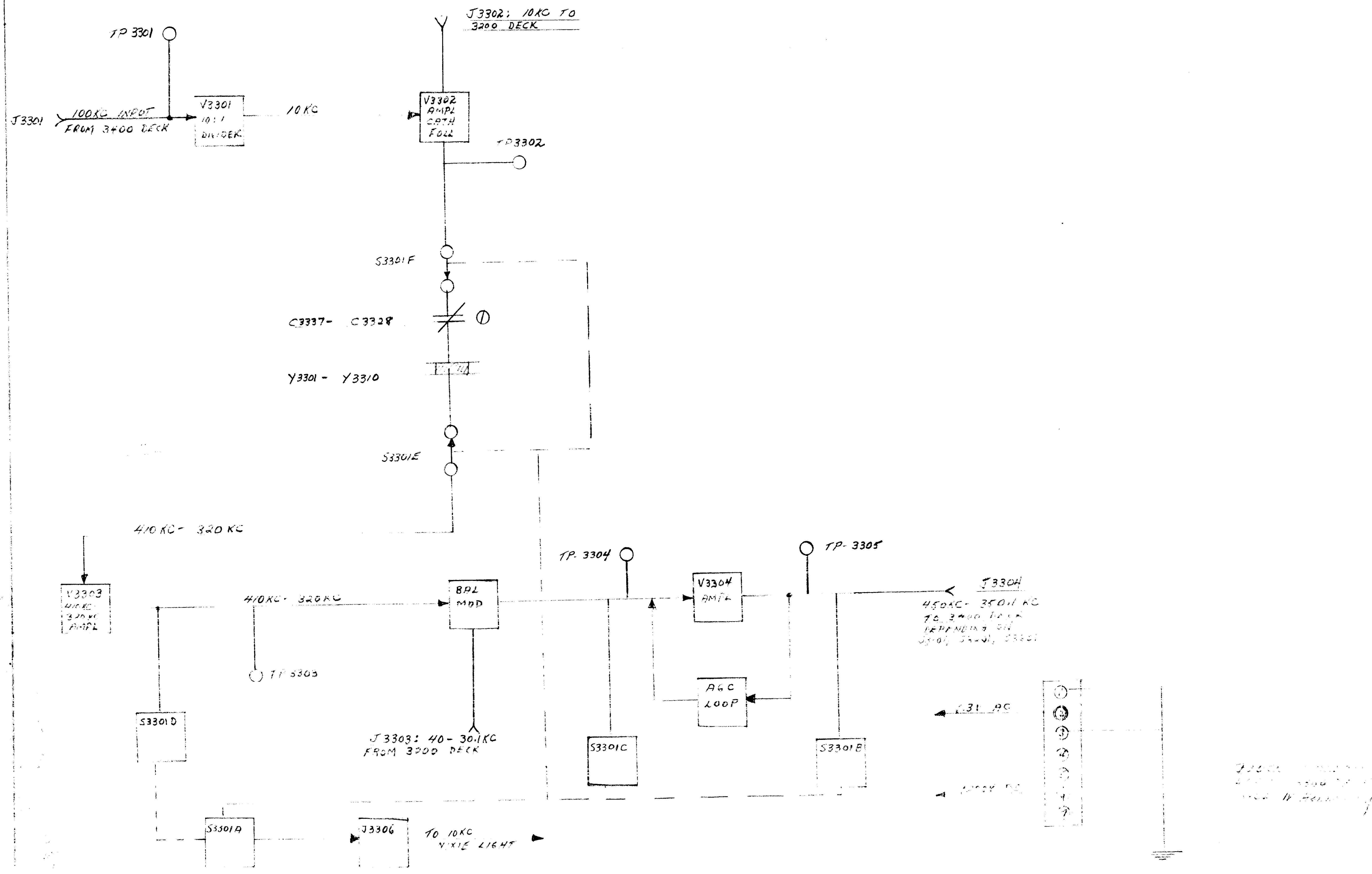
Switch section S-3201D inserts the proper value of capacitance to tune the plate circuit of V-3203.

The output of V-3203, in the range 36-27 KC, is applied to a balanced modulator circuit. The second input to this balanced modulator circuit arrives from the 3100 deck at J-3203; this is a frequency in the range 4 - 3.1 KC, as selected by S-3101.

The balanced modulator produces sum and difference frequencies, but subsequent circuits tune only to the sum frequencies. The output of the balanced modulator, them, may be considered as a range of frequencies between 40 KC and 30.1 KC, in .1 KC steps, according to the settings of S-3101 and S-3201.

The balanced modulator output is applied to amplifier V-3204, which is tuned by means of switch sections S-3201C and S-3201B. The stage has an associated AGC loop, designed to maintain a constant output amplitude regardless of the frequency selected.

The output of V-3204 is applied to J-3204, from which point it is delivered to the 3300 deck.


TP 3301
J3301
100KC INPUT
FROM 3400 DECK
V3301
10:1
DIVIDER
10 KC
J3302: 10KC TO
3200 DECK
V3302
AMPL
CATH
FOLL
TP3302
S3301F
C3337 - C3328
Y3301 - Y3310
S3301E
410 KC - 320 KC
V3303
410KC-
320 KC
AMPL
410KC - 320KC
BAL
MOD
TP 3303
J3303: 40 - 30.1KC
FROM 3200 DECK
S3301D
S3301A
J3306
TO 10KC
NIXIE LIGHT
TP- 3304
V3304
AMPL
AGC
LOOP
S3301C
TP- 3305
J3304
S3301B

12) Block Diagram, 3300 Deck, Model HFS-1:

The 10 KC Selector Deck, or 3300 Deck, receives:

a) pulses at a frequency of 100 KC from the 3400 deck.
b) an output in the range 40 - 30.1 KC from the 3200 deck, the exact frequency depending on the settings of S-3101 and S-3201.

The 3300 Deck delivers:

a) output pulses at a frequency of 10 KC to the 3200 deck.
b) an output in the range 450 - 350.1 KC to the 3400 deck; the exact frequency depends on the settings of S-3101, S-3201 and S-3301.

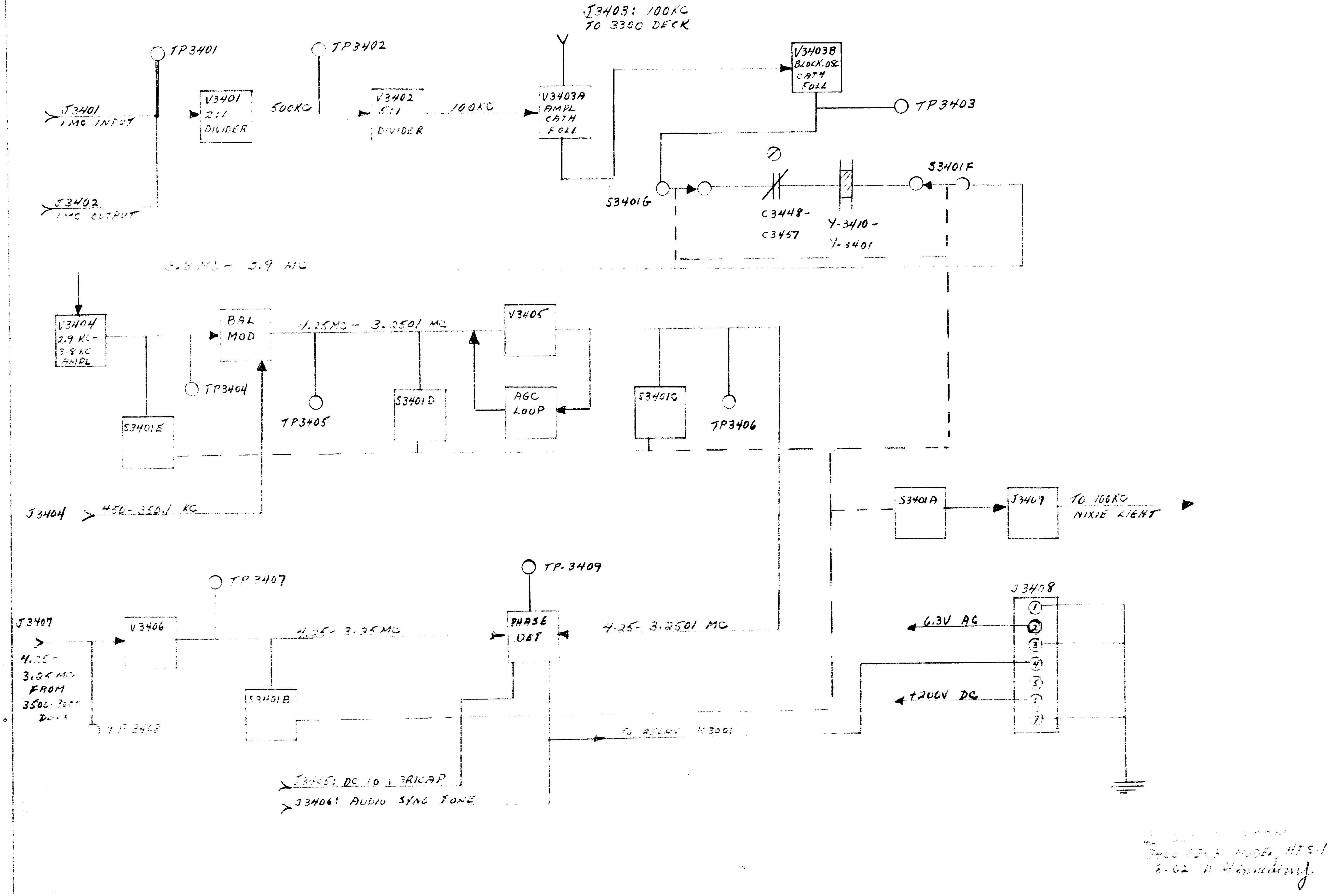
The 100 KC pulses from the 3400 deck arrive at J-3301, and are applied to V-3301, a 10:1 Phantastron divider circuit. The 10 KC output of the divider circuit is applied to V-3302, an amplifier-cathode follower circuit. The 10 KC output at the plate of V-3302 is applied to J-3302, for delivery to the 3200 deck.
The harmonic rich 10 KC pulses at the cathode of V-3302 are applied to one of ten crystals operated as narrow band filters. These crystals are cut for frequencies of 410 - 320 KC. The 10 KC pulses excite the appropriate crystals and a frequency in the range 410 - 320 KC is applied to amplifier stage V-3303. The appropriate crystal, with its associated trimmer capacitor, is selected by switch sections S-3301F and S-3301E.

Switch section S-3301A causes the 10 KC "nixie" light on the front panel of the HFS-1 to illuminate the numeral corresponding to the selected frequency at this point.

Switch section S-3301D inserts the proper value of capacitance to tune the plate circuit of V-3303.

The output of V-3303, in the range 410 - 320 KC, is applied to a balanced modulator circuit. The second input to this balanced modulator circuit arrives from the 3200 deck at J-3303; this is a frequency in the range 40 - 30.1 KC, as selected by S-3101 and S-3201.
The balanced modulator produces sum and difference frequencies, but subsequent circuits tune only to the sum frequencies. The output of the balanced modulator, then, may be considered as a range of frequencies between 450 KC and 350.1 KC, in .1 KC steps, according to the settings of S-3101, S-3201 and S-3301.

The balanced modulator output is applied to amplifier V-3304, which is tuned by means of switch sections S-3301C and S-3301B. This stage has an associated AGC loop, designed to maintain a constant output amplitude regardless of the frequency selected.
The output of V-3304 is applied to J-3304, from which point it is delivered to the 3400 deck.



J3403: 100KC
TO 3300 DECK
TP3401
TP3402
V3403B
BLOCK. OSC
CATH
FOLL
J3401
1 MC INPUT
V3401
2:1
DIVIDER
500KC
V3402
5:1
DIVIDER
100KC
V3403A
AMPL
CATH
FOLL
TP3403
J3402
1 MC OUTPUT
S3401G
C3448-
C3457
Y-3410-
Y-3401
S3401F
V3404
2.9 KC-
3.8 KC
AMPL
BAL
MOD
4.25MC - 3.2501 MC
V3405
AGC
LOOP
TP3404
TP3405
S3401D
S3401E
S3401C
TP3406
J3404
450-350.1 KC
S3401A
J3407
TO 100KC
NIXIE LIGHT
TP-3409
TP 3407
J3407
4.25-
3.25 MC
FROM
V3406
4.25- 3.25 MC
PHASE
DET
4.25- 3.2501 MC
J3408
6.3V AC
+200V DC
S3401B
TO RELAY K3001
J3406: AUDIO SYNC TONE

13) Block Diagram, 3400 Deck, Model HFS-1:

The 3400 deck, or 100 KC selector deck, receives:

a) a 1 mc signal from the frequency standard circuits.

b) a frequency in the range 450 KC - 350.1 KC from the 3300 deck; the exact frequency, in .1 KC steps, depends on the settings of S-3101, S-3201 and S-3301.

c) a frequency in the range 4.25 - 3.25 mc from the high frequency loop, or 3500 - 3600 deck. The exact frequency depends on the setting of S-3501 and the frequency of the HFO in the Model HFR-1.

The 3400 deck delivers:

a) a 1 mc signal to the 3500 - 3600 deck.

b) a DC correction voltage to the varicap control in the HFO circuits of the Model HFR-1.

c) an audio sync tone to the Model HFA-1 for tuning and alignment.

d) a control voltage for the "SYNC" light, at J-3408.

The 1 mc signal input from the 1 mc standard circuits arrives at J-3401; this signal is applied:

a) to a 2:1 divider multivibrator circuit, V-3401.

b) to a 1 mc output jack, J-3402.

V-3401 divides the 1 mc input by a factor of 2, and the resultant 500 KC signal is applied to V-3402, a 5:1 Phantastron divider circuit. The 100 KC output of V-3402 is coupled to V-3403A, an amplifier - cathode follower circuit. The output at the plate of V-3403A is applied to J-3403, for delivery to the 3300 deck. The cathode output of V-3403A is used to synchronize a blocking oscillator - cathode follower circuit, V-3403B. The blocking oscillator reshapes the 100 KC pulses to improve the harmonic content; these pulses are applied via selector switches S-3401G and S-3401F to one of ten crystals, in the range 3.8 mc - 2.9 mc; the crystals act as narrow band filters and respond to the 29th through the 38th harmonics of 100 KCS.

The crystal output is delivered to V-3404, an RF amplifier, the plate circuit of which is tuned by S-3401E; the signal is then applied to a balanced modulator circuit.

The second input to this balanced modulator circuit arrives at J-3404; this input originates in the 3300 deck.
This second input is a frequency in the range 450 KC - 350,1 KC, as determined by the settings of S-3101, S-3201 and S-3301.

The balanced modulator circuit produces sum and difference frequencies, but subsequent circuits select the sum frequencies only. The output range, then, may be considered to cover a range between 4.25 mc and 3.2501 mc, in .1 KC steps.

This signal is delivered to V-3405, an RF amplifier circuit with an associated AGC loop. The grid circuit is tuned by S-3401D and the plate circuit by S-3401C. The output of this stage is fed to a phase detector circuit, the final "modulation" circuit of the 3400 deck.

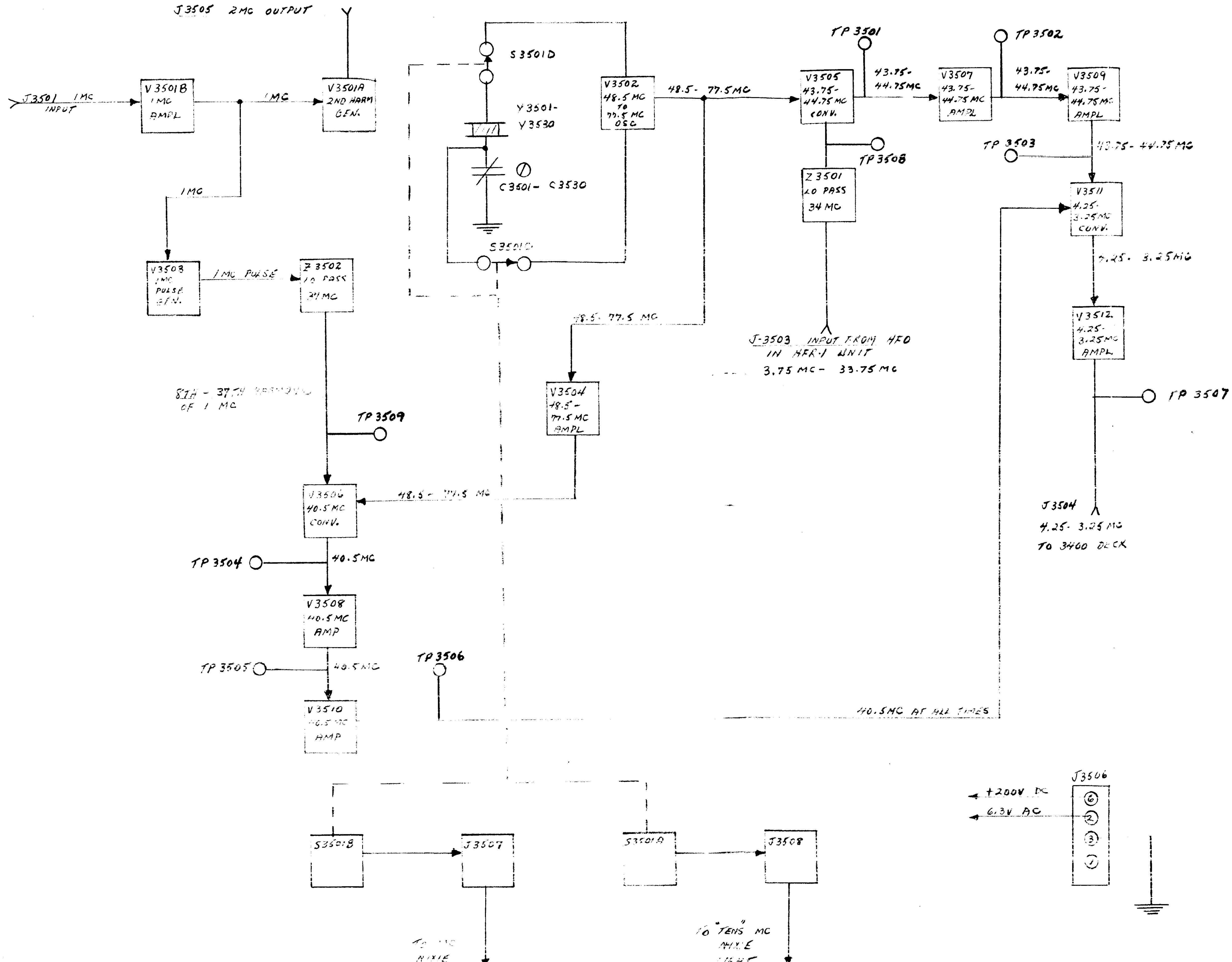
The second input to this final phase detector circuit arrives from J-3407 via RF tuned stage V-3406. This input is in the range 4.25 mc - 3.25 mc, and arrives from the high frequency loop.
The phase detector compares the phase of these two nominally identical frequencies, and produces:

a) a DC correction voltage, the amplitude and polarity of which is determined by the error between the two signals.

b) an audio sync tone, the frequency of which is proportional to the error between the two signals. The frequency of the tone decreases as the error decreases; when the two input frequencies are precisely identical, no audio tone is produced.

c) a control voltage to J-3408, from which point it is applied to a relay in the Model HFS-1 3000 deck; this relay controls the "SYNC" light in the Model HFR-1.

The frequency from the basic synthesizer is a truly synthesized reference frequency, locked to the 1 mc standard.
The frequency from the 3500 - 3600 deck is also synthesized, but it contains the error of the HFO.
The DC correction voltage developed in the final phase detector leaves at J-3405, and is used to correct the HFO frequency by changing the bias on a Varicap in that circuit.



J3505 2MC OUTPUT
J3501 1MC INPUT
V3501B 1MC AMPL
1MC
V3501A 2ND HARM GEN.
S3501D
Y3501- Y3530
C3501- C3530
S3501C
V3502 48.5 MC TO 77.5 MC OSC
48.5- 77.5MC
V3505 43.75- 44.75MC CONV.
TP3501
43.75- 44.75MC
V3507 43.75- 44.75MC AMPL
TP3502
43.75- 44.75MC
V3509 43.75- 44.75MC AMPL
TP3508
TP3503
43.75- 44.75MC
Z3501 LO PASS 34MC
V3511 4.25- 3.25MC CONV.
4.25- 3.25MC
1MC
V3503 1MC PULSE GEN.
1MC PULSE
Z3502 LO PASS 34MC
48.5- 77.5 MC
J-3503 INPUT FROM HFO IN HFR-1 UNIT
3.75 MC- 33.75 MC
V3512 4.25- 3.25MC AMPL
TP3507
OF 1 MC
TP3509
V3504 48.5- 77.5MC AMPL
V3506 40.5MC CONV.
J3504
4.25- 3.25 MC
TO 3400 DECK
TP3504
40.5MC
V3508 40.5MC AMP
TP3505
40.5MC
TP3506
V3510 40.5 MC AMP
40.5MC AT ALL TIMES
J3506
+200V DC
6.3V AC
S3501B
J3507
S3501A
J3508
TO "TENS" MC NIXIE

Block Diagram, 3500 - 3600 Deck, Model HFS-1:

The 3500 - 3600 deck, also known as the High Frequency Loop or 1 mc selector deck, receives:

a) a 1 mc signal from the frequency standard circuits.

b) a sample of the HFO circuit in the HFR-1 unit, in the range 3.75 - 33.75 mcs.

The 3500 - 3600 deck delivers:

a) a 2 mc signal for use in the second converter circuit of the Model HFI-1.

b) a frequency in the range 4.25 - 3.25 mcs; the exact frequency depends on the HFO frequency and the setting of S-3501. This output is delivered to a phase detector circuit in the 3400 deck.

The 1 mc input arrives at J-3501, and is amplified in V-3501B. The output of V-3501B is applied:

a) to 2nd harmonic generator circuit V-3501A, which provides a 2 mc output at J-3505.

b) to V-3503, which shapes the 1 mc signal to provide a large number of 1 mc harmonics.

The harmonic rich 1 mc pulses from V-3503 are applied to a low pass filter, Z-3502, the cutoff frequency of which is 37 mc. The 8th through the 37th harmonics of 1 mc are used. The output of Z-3502 is applied to a 40.5 mc converter stage, V-3506.

V-3502 is a crystal controlled oscillator operating in the range 48.5 - 77.5 mcs, in 30 1 mc increments. One of 30 crystals is selected by switch sections S-3501C and S-3501D, and the selected crystal determines the frequency of V-3502.

S-3501A and S-3501B are the "tens of mcs" and "mcs" selector switches. These connect to the "tens of mcs" and "mcs" nixie lights on the front panel of the Model HFS-1. These switches cause the appropriate "nixie" lights, corresponding to the crystal selected, to be illuminated.

The output of oscillator V-3502 is applied to amplifier stage V-3504; the output of V-3504 is the second input to 40.5 mc converter stage V-3506. The output of V-3506 is always a frequency of 40.5 mcs. Since the plate circuit of V-3506 is tuned to 40.5 mcs, the appropriate harmonic of 1 mc from Z-3502 will mix with the 48.5 - 77.5 mc signal from V-3504, and a difference frequency of 40.5 mc will result. This is shown in the examples on the following page.

Examples

S-3501	V-3502 Frequency	Z-3502 Harmonic	V-3506 Output Frequency
1	48.5 mc	8	40.5 mc
2	49.5	9	40.5 mc
3	50.5	10	40.5 mc
4	51.5	11	40.5 mc
5	52.5	12	40.5 mc

The 40.5 mc output of V-3506 is applied to two cascade amplifiers, V-3508 and V-3510. The output of V-3510 is delivered to converter stage V-3511.

The output of 48.5 - 77.5 mc oscillator V-3502 is also applied to a 43.75 - 44.75 mc converter stage, V-3505. The second input to this converter is the LO frequency from the HFO circuits of the HFR-1, applied via J-3503 and low pass filter Z-3501. The output of converter stage V-3505 will always be in the range 43.75 - 44.75 mcs.
The LO frequency is always 1.75 mc above the received signal; thus, the range of the signal arriving at J-3503 is 3.75 - 33.75 mcs.
The examples below show the relationship:

Examples:

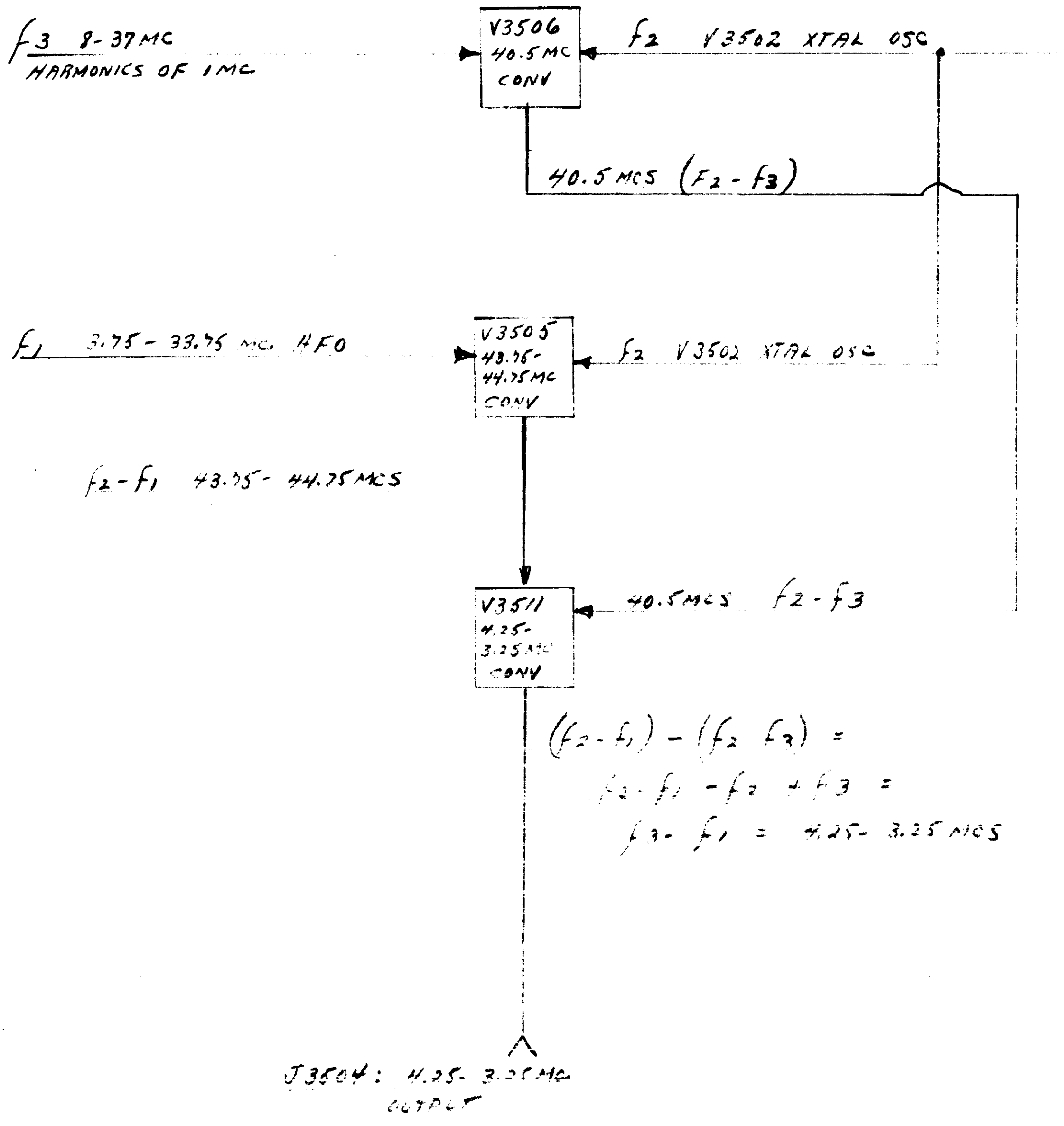
RCVR FREQ	LO FREQ	V-3502 FREQ	V-3505 OUTPUT
2 mc	3.75 mc	48.5 mc	44.75 mc
3mc	4.75 mc	49.5 mc	44.75 mc
4 mc	5.75 mc	50.5 mc	44.75 mc
4.2 mc	5.95 mc	50.5 mc	44.55 mc
4.8 mc	6.55 mc	50.5 mc	43.95 mc
4.9 mc	6.65 mc	50.5 mc	43.85 mc
4.95 mc	6.70 mc	50.5 mc	43.70 mc
4.99 mc	6.74 mc	50.5 mc	43.76 mc

The output of V-3505 undergoes amplification in two cascade stages, V-3507 and V-3509; the output of V-3509 is then applied to the 4.25 - 3.25 mc converter stage, V-3511. The second input to this converter stage arrives from V-3510, and is always a frequency of 40.5 mcs. The output of V-3511 is a frequency in the range 4.25 - 3.25 mcs; the exact frequency depends on the LO frequency and the setting of S-3501. The output, at J-3504, is delivered to the 3400 deck.

5) Drift Cancelling Feature of the 3500 - 3600 Deck:

The 3500 - 3600 deck contains a crystal oscillator circuit, V-3502, which operates in the range 48.5 - 77.5 mcs, in 1 mc steps. This circuit is independent, that is, it is not locked to the 1 mc standard. The frequency of this oscillator, then, is subject to drift.
It is desired that the output of the 3500 - 3600 deck be a frequency in the range 4.25 - 3.25 mcs, and that any error be due to the HFO circuits of the Model HFR-1 only. It is imperative, then, that any error introduced by the drift of the circuitry of V-3502 be cancelled out. The block diagram below illustrates how this objective is accomplished. Only the essential stages are shown.

F1 is the HFO frequency; F2 is the frequency output of V-3502; F3 is the appropriate harmonic of 1 mc.



16) Examples of Synthesizer Operation:

Refer to the Tables of Frequency Selection for the HFS-1, and the Block Diagram, 3500 - 3600 Deck.

The first example will be carefully explained by the instructor in detail, in the manner indicated in the following text. Subsequent examples will be worked out by the trainees, with instructor assistance. Sufficient examples are provided to assure adequate trainee comprehension.

Example #1:

Receiver Frequency: 2.0000 mc.

Determine the significant frequencies selected by individual decks; the HFO frequency, and determine the two final frequencies applied to the phase detector in the 3400 deck.

Nixie Lights: 0 2 . 0 0 0 0

Basic Synthesizer Frequency Selection:

Deck	Indicator	Frequency
3100	0	4 KC
3200	0	36 KC
3300	0	410 KC
3400	0	3800 KC
		4250 KC, or 4.25 mcs.

Frequency Selection, high frequency loop:

Indicator: 02

V-3502 Frequency	48.5 mc
Harmonic Z-3502	8.0 mc
V-3506 Diff.	40.5 mc
V-3502 Frequency	48.5 mc
HFO Frequency	3.75 mc
V-3505 Diff	44.75 mc
V-3511, input 1	44.75 mc
V-3511, input 2	40.5 mc
V-3511, Diff	4.25 mc

Thus: the basic synthesizer unit produces a frequency corresponding to the last four significant digits of the receiver frequency, as read on the Nixie indicator.

The high frequency loop produces a frequency corresponding to the megacycles digits of the receiver frequency as read on the Nixie indicators.
This frequency contains the error of the HFO circuit.

Example #2:

Receiver Frequency: 4.6300 mcs.

Basic Synthesizer Selection: Nixie Lights: 0 4 . 6 3 0 0

Indicator	Deck	Frequency
0	3100	4 KC
0	3200	36 KC
3	3300	380 KC
6	3400	3800 KC
		3620 KC, or 3.62 mcs.

High Frequency Loop selection:

Indicator: 04

V-3502 Frequency	50.5 mc
Harmonic, Z-3502	10.0 mc
Diff V-3506	40.5 mc
V-3502 Frequency	50.5 mc
HFO frequency	6.38 mc
V-3505 Diff	44.12 mc
V-3511, input 1	44.12 mc
V-3511, input 2	40.5 mc
V-3511 Diff	3.62 mc

Example #3:

Receiver Frequency: 12.5000 mc

Basic Synthesizer Selection: Nixie Lights: 1 2 . 5 0 0 0

Indicator	Deck	Frequency
0	3100	4 KC
0	3200	36 KC
0	3300	410 KC
5	3400	3300 KC
		3750 KC, or 3.75 mcs.

High Frequency loop selection:

Indicator: 12

V-3502 Frequency	58.5 mc
Harmonic, Z-3502	18.0 mc
V-3506 Diff	40.5 mc
V-3502 Frequency	58.5 mc
HFO frequency	14.25 mc
V-3505 Diff	44.25 mc
V-3511 input 1	44.25 mc
V-3511 input 2	40.50 mc
V-3511 Diff	3.75 mc

Example #4:

Receiver Frequency: 31.9999 mcs.

Basic Synthesizer Selection: Nixie Lights: 3 1 . 9 9 9 9

Indicator	Deck	Frequency	
9	3100	3.1	KC
9	3200	27.0	KC
9	3300	320.0	KC
9	3400	2900.0	KC
		3250.1	KC, or 3.2501 mcs.

High Frequency loop selection:

Indicator: 31

V-3502 Frequency	77.5	mc
Harmonic Z-3502	37.0	mc
V-3506 Diff	40.5	mc
V-3502 Frequency	77.5	mc
HFO frequency	33.7499	mc
V-3505 Diff	43.7501	mc
V-3511 input 1	43.7501	mc
V-3511 input 2	40.5000	mc
V-3511 Diff	3.2501	mc

Example #5:

Receiver Frequency: 23.5250 mcs.

Basic Synthesizer selection: Nixie lights: 2 3 . 5 2 5 0

Indicator	Deck	Frequency
0	3100	4 KC
5	3200	31 KC
2	3300	390 KC
5	3400	3300 KC
		3725 KC or 3.725 mcs.

High frequency loop selection:

Indicator: 23

V-3502 Frequency	69.5	mc
Harmonic, Z-3502	29.0	mc
V-3506 Diff	40.5	mc
V-3502 Frequency	69.5	mc
HFO frequency	25.275	mc
V-3505 Diff	44.225	mc
V-3511 input 1	44.225	mc
V-3511 input 2	40.5	mc
V-3511 Diff	3.725	mc

Example #6:

Receiver Frequency: 13.4524 mcs.

Basic Synthesizer selection: Nixie lights: 1 3 . 4 5 2 4

Indicator	Deck	Frequency
4	3100	3.6 KC
2	3200	34.0 KC
5	3300	360.0 KC
4	3400	3400.0 KC
		3797.6 KC or 3.7976 mcs.

High Frequency loop selection:

Indicator: 13

V-3502 Frequency	59.5 mc
Harmonic Z-3502	19.0 mc
V-3506 Diff	40.5 mc
V-3502 Frequency	59.5 mc
HFO frequency	25.2024 mc
V-3505 Diff	44.2976 mc
V-3511 input 1	44.2976 mc
V-3511 input 2	40.5 mc
V-3511 Diff	3.7976 mc

Example #7:

Receiver Frequency: 20.0001 mcs.

Basic Synthesizer selection: Nixie lights: 2 0 . 0 0 0 1

Indicator	Deck	Frequency
1	3100	3.9 KC
0	3200	36.0 KC
0	3300	410.0 KC
0	3400	3800.0 KC
		4249.9 KC or 4.2499 mcs.

High frequency loop selection:

Indicator: 20

V-3502 Frequency	66.5 mc
Harmonic, Z-3502	26.0 mc
V-3506 Diff	40.5 mc
V-3502 frequency	66.5 mc
HFO frequency	21.7501 mc
V-3505 Diff	44.7499 mc
V-3511 input 1	44.7499 mc
V-3511 input 2	40.5 mc
V-3511 Diff	4.2499 mc

C. Detailed Discussion of Model HFS-1 Circuitry:

1. The detailed discussion of the circuitry of the Model HFS-1 will be presented as follows:

   a) Blocking Oscillator Circuit.

   b) Phase Detector Circuit.

   c) Phantastron Divider Circuit.

   d) 3100 Deck.

   e) 3200 Deck.

   f) 3300 Deck.

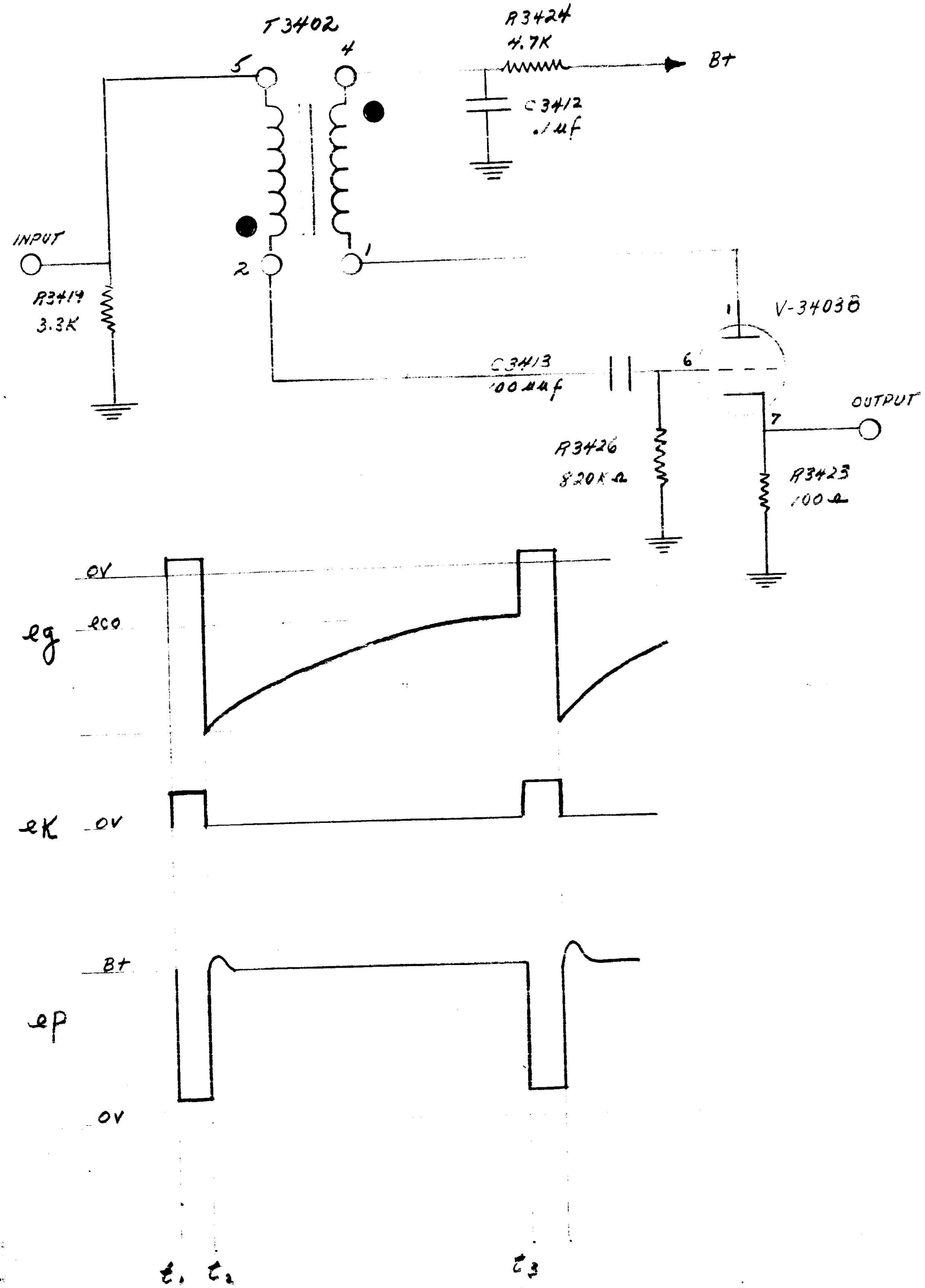
   g) 3400 Deck.

   h) 3500 - 3600 Deck.

   i) 3700 Deck. (Regenerative Divider)

2. Where necessary, simplified schematics and diagrams will be provided. It should be noted that all waveforms shown in this part of the lesson plan are idealized. Another section of the lesson plan will provide significant waveforms as actually observed on an oscilloscope, with peak to peak voltages indicated.

Circuit of the Blocking Oscillator - Cathode Follower Circuit of the 3400 Deck, with Idealized Waveforms.



3. Discussion of the Blocking Oscillator - Cathode Follower Circuit:

Assume that B Plus has just been applied, and that no triggers are present from the previous circuit, at R-3419.
Initially, ep is B Plus.
ip is zero.
eg is zero.
ek is zero.

As plate current commences to flow, a CEMF builds up in the plate winding of T-3402, of such polarity as to oppose any increase in plate current. This makes the end of the plate winding at the polarity dot positive.

Due to the polarity inversion of T-3402, a positive voltage appears at the grid of V-3403B, pin 6. This causes an increase in plate current, a decrease in plate voltage, an increase of CEMF, and an increase in the cathode voltage.

This increase of CEMF causes a further increase of the positive voltage applied to the grid, a further increase in plate current, a further decrease of plate voltage, and a further increase of the cathode voltage.

The action is cumulative and rapid; since the grid, pin 6, is positive with respect to the cathode, the conducting grid resistance shunts R-3426, greatly reducing the charging time constant of C-3413, which charges rapidly.

The charge path of C-3413 is via R-2423, $\overline{\text{rgk}}$, T-3402 and R-3419.

At time t1, ep is minimum, ip is maximum, ek is maximum, and CEMF is maximum. At this time, grid saturation is reached; that is, further increases in grid voltage fail to cause a corresponding increase in plate current.

The instant plate current becomes static, the field around the plate winding of T-3402 starts to collapse; the polarity of the CEMF reverses; the polarity inversion of T-3402 causes a large negative voltage to be applied to the grid; this voltage is in addition to the voltage stored in C-3413; the tube is driven far beyond cutoff almost instantly. This is time t2 on the waveform chart.
At this time, ek becomes zero, ip becomes zero, and the plate voltage rises to B Plus. The plate voltage may actually rise above B plus due to the CEMF of T-3402.

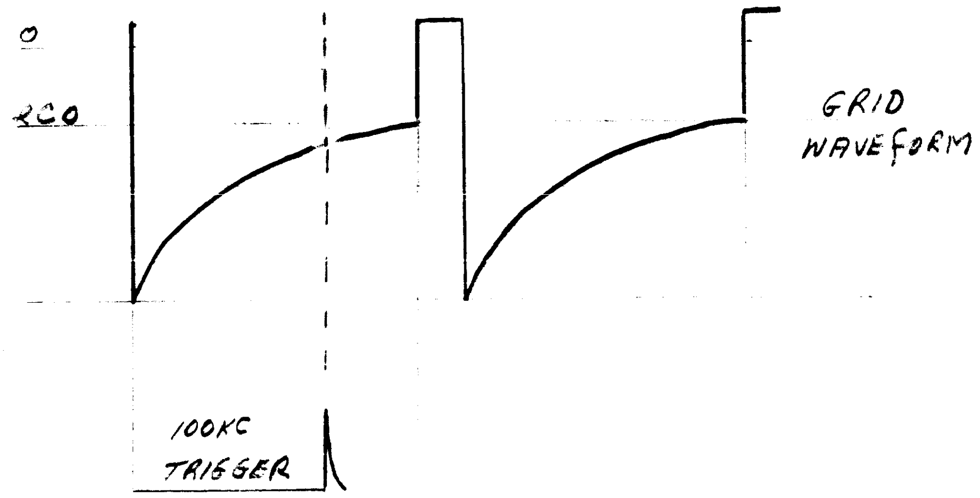
The grid is now negative with respect to the cathode. C-3413 starts discharging exponentially through the long time constant path of R-3426, R-3419 and T-3402. This is the period t2 - t3 on the waveform chart. At one point on the decay exponential, egk equals eco, and the tube is again able to conduct. The circuit re-cycles.

The result is a series of pulses of short duration at the cathode of the tube, at the natural resonant frequency of the circuit.

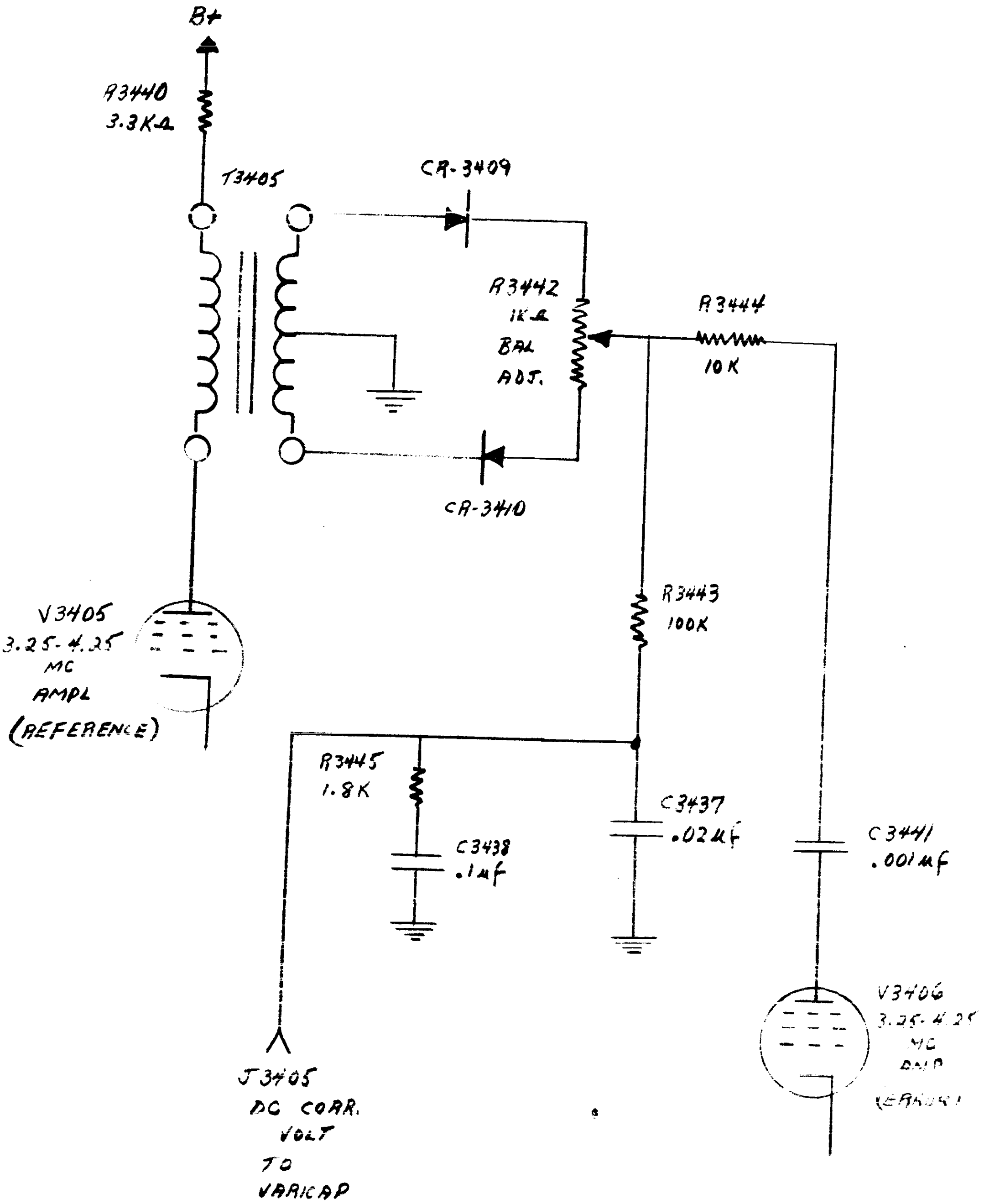
The circuit shown is designed such, that the pulses have a duration of about one microsecond. The time between pulses is in excess of ten microseconds. Thus, the natural frequency is lower than the actual triggered frequency.

In actual operation, triggers, locked to the 1 mc standard, at a frequency of 100 KCS, are applied to the circuit at R-3419. These triggers arrive before the instant of natural recycling. This locks the circuit to the 1 mc reference.

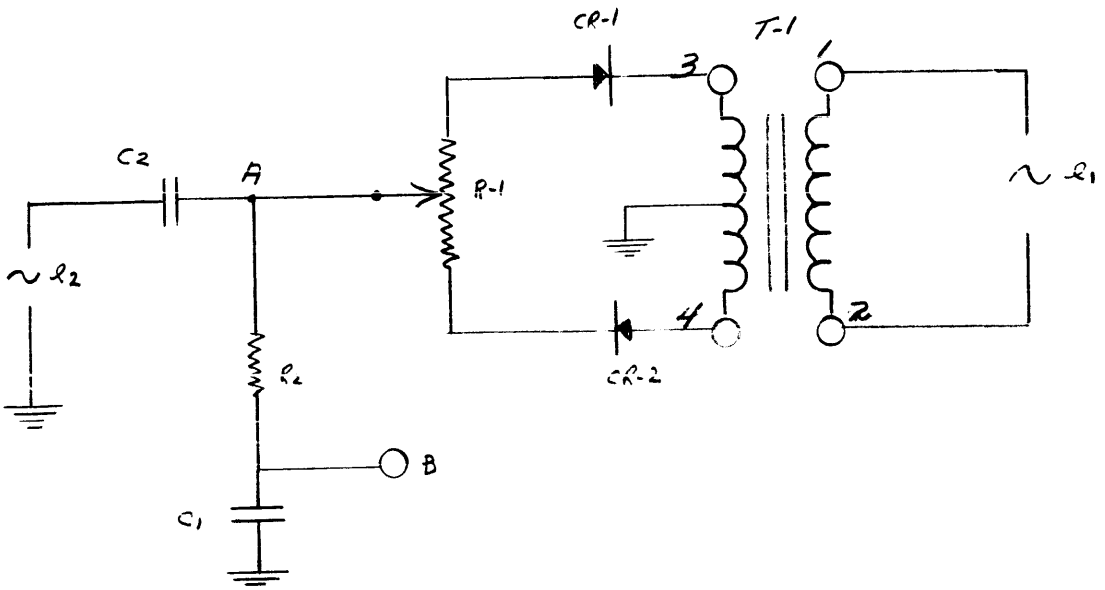
The re-shaping of the 100 KC triggers is necessary to assure sufficient harmonic content for the creation of the 29th through the 38th harmonics of 100 KC in subsequent circuits.

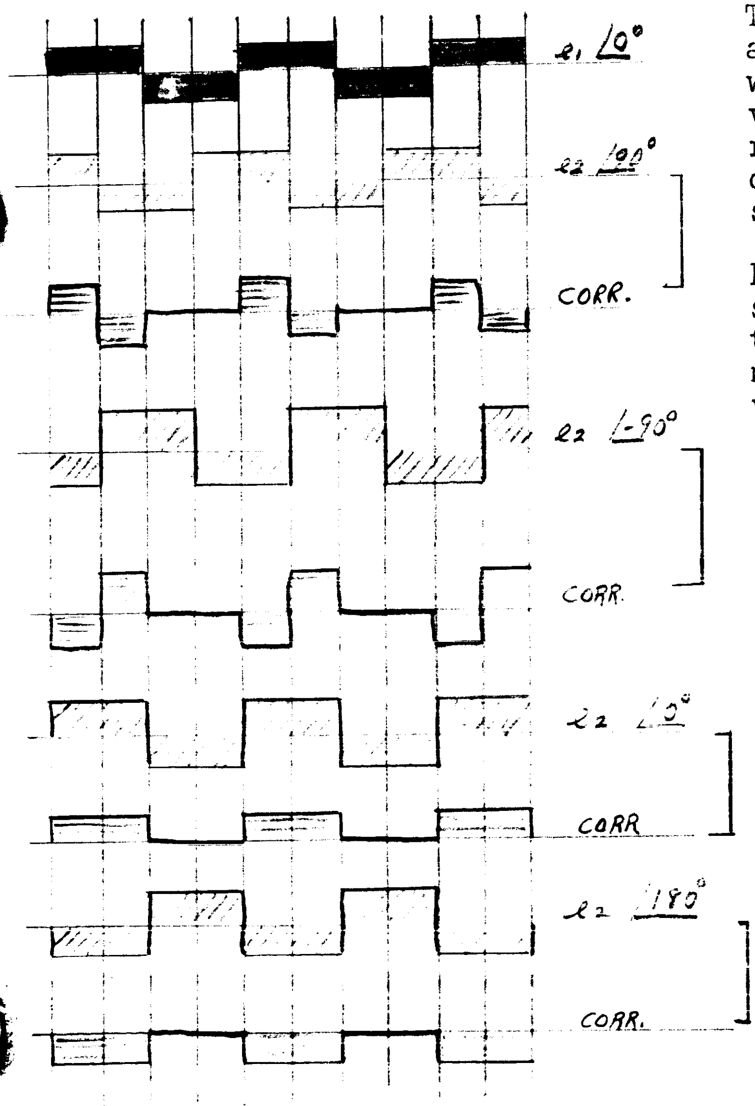


Simplified Circuit of the Phase Detector of the 3400 Deck:



Basic Phase Detector Circuit with Significant Waveforms:





The plot shows e-1, the standard, at a phase angle of 0 degrees, with e-2, the second input, at various phase angles with respect to e-1. relative values of correction voltage are shown.

For simplicity, the voltages are shown as square waves, even though, in actual practice, they may be sinusoidal. This in no way detracts from the validity of the discussion.

4. Discussion of the Basic Phase Detector Circuit:

a) the purpose of the phase detector circuit is to compare the phase difference between two nominally identical frequencies and to produce a correction voltage proportional to the amount of phase error.

b) one input to the phase detector is locked to a frequency standard or reference. This is termed the "reference" or "standard" input.

c) the second input to the phase detector is a source whose frequency it is desired to control.

d) the correction voltage produced by the phase detector is passed to control circuits, which act to correct the frequency of the second input.

e) in the typical TMC phase detector circuit, the two frequencies are "locked in" when their phase difference is plus or minus 90 degrees. In this situation, the average correction voltage produced by the phase detector is zero.

f) when the frequency of the non standard input drifts by an extremely small amount, a change of phase is seen by the phase detector, which immediately produces a correction voltage of the proper amplitude and polarity to correct the frequency.

g) the phase difference between the two inputs is continuously changing by small increments, but the average frequency of the corrected source is maintained constant.

h) refer to the simplified schematic and waveforms on the preceding page. An AC voltage, e-1, is applied to T-1; this is the reference signal, locked to an accurate standard.
This voltage is developed across terminals 3 and 4 of T-1, which is center-tapped to ground.

i) when terminal 3 of T-1 is positive, diodes CR-1 and CR-2 are back biased and no current flows in R-1. At point "A" is a high impedance to ground. When terminal 3 of T-1 is negative, diodes CR-1 and CR-2 conduct, developing a voltage across R-1.

j) at the electrical center of R-1, with the diodes conducting, there appears an effective ground, because of the center tapping of T-1. Thus, with conduction through R-1, the wiper is at ground if moved to electrical center, and any signal at point "A" will be lost.

k) the correction voltage is developed at point "A". This voltage is a portion of e-2, the non standard signal source, also connected at point "A". Whether this voltage is allowed to appear or not depends on the phase relationship between e-1 and e-2.

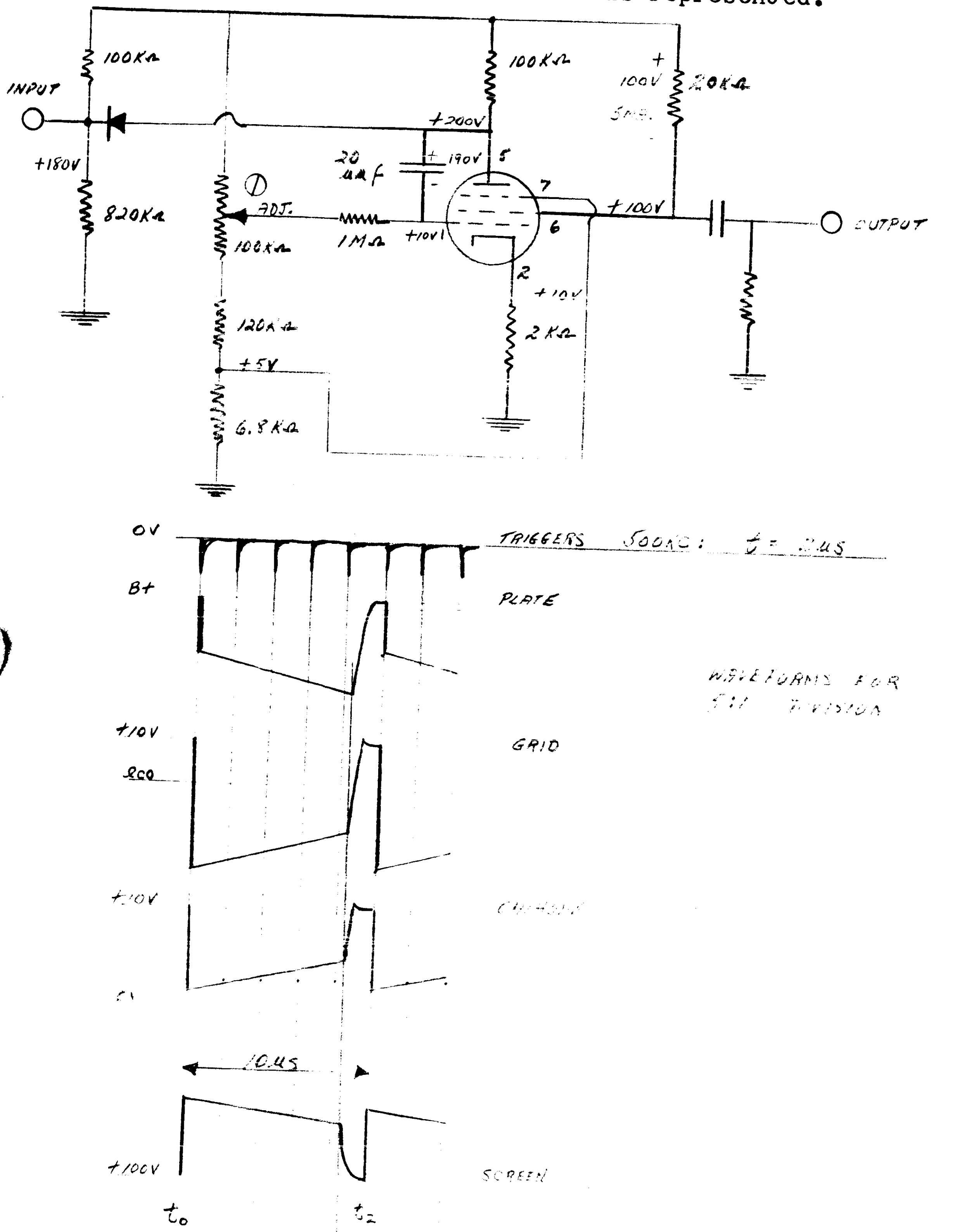
l) a simple relationship is given as an aid in analyzing the waveforms on the preceding page:

(1) when e-1 is positive at terminal 3 of T-1, e-2 will be developed at point "A".

(2) when e-1 is negative at terminal 3 of T-1, e-2 will not be developed at point "A".

Note the similarity between the basic phase detector circuit just discussed and the simplified circuit of the actual phase detector circuit of the 3400 deck on page 30 of this lesson plan.

Schematic of Basic Phantastron Divider Circuit, with Idealized Waveforms: Voltages and circuit values are for illustration purposes only; no particular circuit is represented.



5. The Basic Phantastron Divider Circuit:

All voltages and circuit values are for illustration only. The actual observed waveforms, with peak to peak voltages, will be found in another section of this lesson plan.

a) Static Condition:

(1) the screen grid is returned to B Plus through a 20 K ohm resistor; a large screen current, 5ma., flows; this places the screen voltage, esgn, at Plus 100 Volts.

(2) for all practical purposes, the screen current is total cathode current. This current places the cathode, pin 2, at Plus 10 Volts.

(3) the control grid, pin 1, is also returned to B Plus through a large value of resistance. A very small amount of control grid current flows. This places the control grid voltage, egn-1, at Plus 10 Volts.

(4) the suppressor grid, pin 7, is returned to a voltage divider circuit; this places the suppressor at Plus 5V. The suppressor, then, is -5 volts negative with respect to the cathode. This cuts off the plate current.

(5) with no plate current, static plate voltage is B Plus. Actually, the trigger diode conducts slightly, placing the plate just under B Plus.

(6) the feedback capacitor is charged to the difference between epn and egn-1, or Plus 190 volts.

(7) the negative triggers arrive at a stable rate; they are applied at the cathode of the trigger diode. Without triggers, the circuit remains in a static condition.

(8) the output is taken from the screen grid; it is applied to a differentiator network, which is not part of the Phantastron circuit proper.

b) Phases of Operation:

(1) Phase #1: (t0)

this is a rapid, almost instantaneous change in the condition of the circuit, similar to multivibrator action. It is initiated by the first trigger. This phase causes a sharp drop in ep, eg-1, ik, and ek, and a corresponding rise in esg.

(2) Phase #2: (to - t-1)

this is the linear period of operation, over which the rate of change of certain circuit values is constant. ep and esg fall; eg-1 and ek rise. It is this linear period which makes the Phantastron effective as a frequency divider.

(3) Phase #3: (t-1 - t-2)

this is the rapid recovery period; the circuit returns to its quiesent state just prior to the arrival of a predetermined trigger pulse. The other triggers in the interim do not affect the circuit.

c) Circuit Operation:

(1) Phase #1: (t-0)

when the initiating negative trigger arrives, it is passed by the diode and momentarily drops the plate voltage. The feedback capacitor attempts to discharge, driving down the control grid voltage. This reduces the screen - cathode current considerably; esg rises and ek falls. The amount of this change depends on circuit parameters and the tube characteristics.
Since the trigger diode anode voltage is now reduced, and the diode cathode voltage is approximately 180 volts, subsequent triggers will have no effect on the circuit.

(2) Phase #2: (t-0 - t-1)

the suppressor voltage, at Plus 5 volts, is no longer negative with respect to the cathode, and plate current commences to flow. As the feedback capacitor discharges, the control grid voltage rises; plate current increases; ek rises, esg falls, and ep falls. The fall of ep causes the feedback capacitor to see a new voltage change, and this action continues throughout the linear period, t-0 through t-1. The action has the effect of greatly increasing the discharge time constant of the feedback capacitor, so that the discharge takes place in the initially linear portion of the discharge exponential.

(3) Phase #3: (t-1 - t-2)

at a time determined by the discharge time constant of the feedback capacitor, the voltage ek will rise to a point where the suppressor grid is again negative with respect to the cathode. Plate current cuts off; plate voltage rises to B Plus, and the feedback capacitor quickly charges via the now positive control grid. Other circuit voltages quickly return to their static values. The recovery is accomplished, in the case of the 5:1 divider circuit shown, just prior to the arrival of the 5th trigger <u>after</u> the initial trigger. This is a period 10 usec after the initial trigger. Thus, triggers at a rate of 500 KC are applied, and one cycle of output is accomplished in 10 usec, corresponding to a frequency 100 KCS. The discharge time constant is controlled, to a degree, by the 100 K ohm divider adjust potentiometer in the control grid circuit.

d) Disposition of the screen grid output waveform:

the screen output is applied to a differentiator circuit, which produces spikes, as shown below. Subsequent circuits reduce the effect of the negative spikes, resulting in triggers at a new frequency of 100 KCS.

e) Application of the Phantastron in the Model HFS-1:

The Model HFS-1 contains four Phantastron circuits; the 3400 deck contains a 5:1 divider, and the 3100, 3200 and 3300 decks each contain a 10:1 divider.

6. Discussion of the 3100 Deck:

Refer to schematic CK-582:

a) pulses at a frequency of 1 KC arrive at J-3101 from the 3200 deck; these may be monitored at TP-3101. The pulses are applied to a 10:1 Phantastron divider circuit, V-3101. R-3104, the 100 cycle adjust potentiometer, is set for a frequency output of 100 cycles.

b) the 100 cycle output at pin 6, V-3101, is applied to V-3102 via a differentiator network, C-3104, R-3110. The time constant of this network is 500 usec; the period of the 100 cycle pulses is 10,000 usec. Positive and negative spikes, then, are applied at pin 6 of V-3102. The positive spikes occur at a frequency of 100 cycles; the negative spikes are removed by the grid clamping action of the circuit. The 100 cycle output appearing at the cathode of V-3102 is rich in harmonics of 100 cycles; this output may be monitored at TP-3102.

c) the harmonic rich 100 cycle pulses are applied to one of ten crystals in the range 4 KC - 3.1 KC in .1 KC steps; the individual crystals are selected by S-3101E and S-3101D. Each crystal has an associated trimmer capacitor connected in series. The crystals are operated as narrow band filters; they are tantamount to high Q resonant circuits, responding to the 31st through the 40th harmonics of 100 cycles.

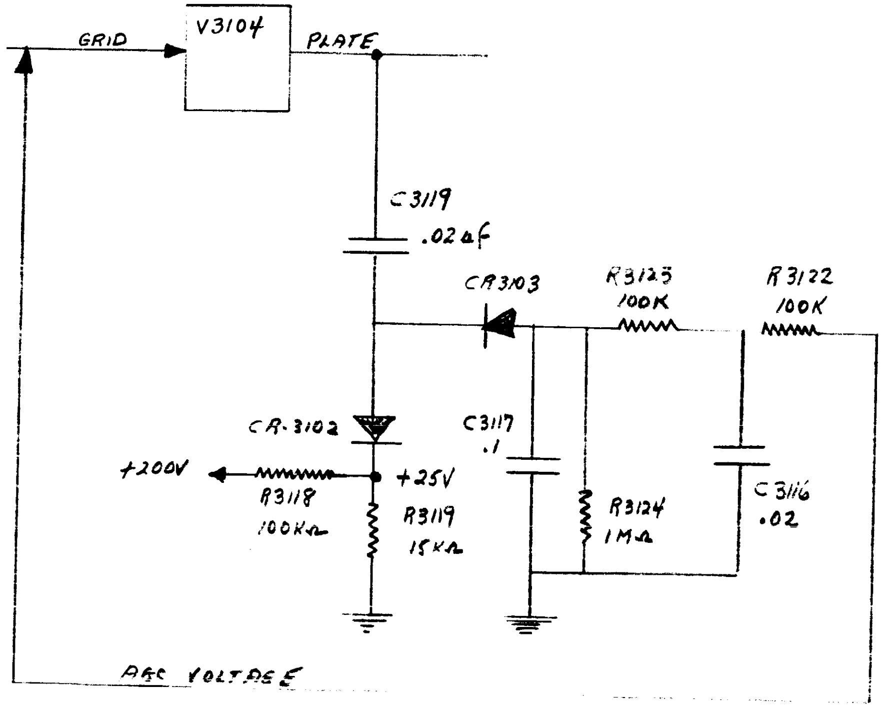
d) switch section S-3101A is arranged, together with J-3105 and the .1 KC nixie light on the 3000 deck, to illuminate the numeral corresponding to the selected frequency. B Plus is applied to pin "M" of J-3105; the wiper of S-3101A grounds the appropriate pin of J-3105 to complete the circuit through the proper nixie light.

e) the selected frequency from the wiper of S-3101D is applied to amplifier V-3103 via filter - coupling network C-3110, C-3109 and R-3114. C-3110 has a high reactance (90 K ohms) at a frequency of 4 KC but acts as a low impedance to ground for the much higher orders. C-3109 and R-3114 form a coupling circuit.

f) the grid circuit of V-3103 is untuned, since the frequencies are supplied in discrete steps over a small range. Effective cathode bypassing and bias is provided by R-3115 and C-3162. The plate circuit is tuned by means of a single inductor, L-3101, shunted by various values of capacity selected by S-3101C front and rear.

g) the output of V-3103 is applied, via C-3114, to output amplifier V-3104. Effective cathode bypassing and bias is provided by R-3126 and C-3163 in this stage. The plate circuit it tuned by shunting the primary of RF transformer T-3101 with various values of capacity selected by S-3101B front and rear. The output at the plate may be monitored at TP-3103. The output at the secondary of T-3101, at an impedance of 50 ohms, is applied to J-3102, from which point it is delivered to the 3200 deck.

h) V-3104 employs an AGC network to insure reasonably constant output amplitude regardless of the frequency selected. A simplified version of the circuit is shown below:



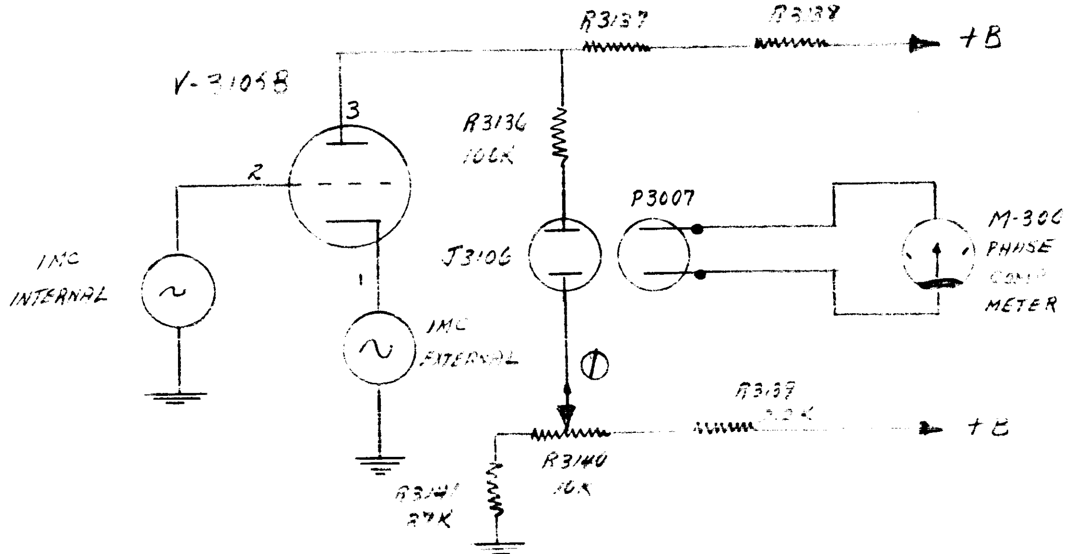
when the signal amplitude at C-3119 is less than 25 volts peak, no AGC voltage is developed since C-3119 is prevented from changing its charge; CR-3102 is back biased with 25 V, and CR-3103 is connected in such polarity that it prevents an increase of charge.
When the peak signal amplitude at C-3119 exceeds 25 V, C-3119 charges on the positive excursions via CR-3102 and discharges, via CR-3103, on the negative excursions, into C-3117. The pulsating AGC voltage is filtered by R-3125 and C-3116, and delivered to the grid of the tube.
The excess signal over 25 volts peak, and the ratio of C-3119 to C-3117 determine the voltage developed.
R-3124 allows C-3117 to discharge as required.

i) the 3100 deck also houses the 1 mc standard and comparator circuits. A James Knights sealed 1 mc standard is utilized. This is Z-3101, an octal socket plug in unit containing the crystal standard, transistor oscillator, oven circuits and trimmer adjustment. Pins 2 and 3 of Z-3101 connect to a 28 volt supply, which originates in the Model HFR-1. The standard supplies 1 mc, accurate to 1 part in 100,000,000 per day, at pin 6; this is applied, via C-3158, to:

(1) the 1 mc amplifier circuit, V-3105A.
(2) the 1 mc comparator circuit, V-3105B.

j) the 1 mc amplifier is conventional; it amplifies the 1 mc input and applies it to the "internal" - "external" standard switch, S-3102, a DPDT toggle. With S-3102 in the internal position, B Plus is applied to V-3105A and the output of the 1 mc amplifier connects to J-3103, the 1 mc output jack.
With S-3102 in the external position, B Plus is removed from V-3105A and the 1 mc signal from an external standard at J-3107 is connected to J-3103, the 1 mc output jack.

k) the phase comparator circuit, V-3105B, receives the internal 1 mc input at the control grid, pin 2; it receives the external standard input at the cathode circuit, via C-3161. The circuit is connected as shown below:



with no signal inputs, the voltage at pin 3 rests at some value of static plate voltage. R-3140 is adjusted to provide the same value, resulting in a zero center scale reading of the phase comparator meter on the 3000 deck. With two nominally identical 1 mc inputs applied, the plate voltage at pin 3 will swing higher and lower, as the two inputs swing in and out of phase. The rate of swing is a measure of the error, in cycles per second, of the internal standard. For example, if one complete swing occurs in 5 seconds, the error is 1/5 cycle.

7. Discussion of the 3200 Deck:

Refer to schematic CK-583:

a) triggers at a frequency of 10 KC arrive at J-3201 from the 3300 deck. These triggers, which may be monitored at TP-3201, are applied to V-3201, a 10:1 Phantastron divider circuit. R-3203, the divider adjust pot, is set for an output frequency from pin 6 of 1 KC.

b) the 1 KC output at pin 6 is applied to V-3202, an amplifier-cathode follower circuit, via differentiator network C-3204, R-3210. The plate output, consisting of negative triggers, is applied to 1 KC output jack J-3202 for delivery to the 3100 deck.

c) the cathode output, consisting of positive triggers, may be monitored at TP-3202. This output, rich in harmonics of 1 KC, is applied to one of ten crystals, in the range 27 KC - 36 KC, in 1 KC steps. The selection is made by switches S-3201F and S-3201E. Each crystal has an associated trimmer capacitor connected in series.

d) S-3201A, in conjunction with J-3206 and the 1 KC nixie light on the 3000 deck causes the numeral corresponding to the selected frequency to be illuminated.

e) the selected frequency at the wiper of S-3201E is applied to V-3203, an amplifier circuit. The plate circuit of this stage is tuned by the primary of T-3201 and selected values of capacity connected in shunt by S-3201D front and rear. Trimmer capacitor C-3272 is adjusted for best overall response in the frequency range 27 - 36 KC.
The plate output of V-3203, which may be monitored at TP-3203, is applied, via the secondary of T-3201, to a balanced modulator circuit, consisting of plug in diode unit CR-3202 and associated components.

f) the second input to the balanced modulator circuit is applied at the wiper of the balance adjust potentiometer, R-3219, from J-3203. This signal, the output of the 3100 deck, is a frequency in the range 3.1 - 4 KC, as selected by S-3101 on the 3100 deck.
The balanced modulator produces sum and difference frequencies, but only the sum frequencies are passed. The significant output, then, is a frequency in the range 30.1 - 40 KC, in .1 KC steps. The exact frequency depends on the setting of S-3101 on the 3100 deck and S-3201 on the 3200 deck.
This sum output is applied, via T-3202, to V-3204, the output amplifier. This range of frequencies represents an overall band width of 9.9 KC, with 100 possible discrete frequencies in 100 cycle steps.
The balance pot is set for minimum output from the balanced modulator of the 27 - 36 KC injection frequency.

g) the grid circuit of V-3204 is tuned by the secondary of T-3202 and selected capacities inserted by S-3201C front and rear. The grid input to V-3204 may be monitored at TP-3204. The plate circuit of V-3204 is tuned by the primary of T-3203 and selected capacities inserted by S-3201B front and rear. The plate output of V-3204 may be monitored at TP-3205.
Note that trimmer capacitors are inserted in both the grid (C-3273) and plate (C-3274) circuits.

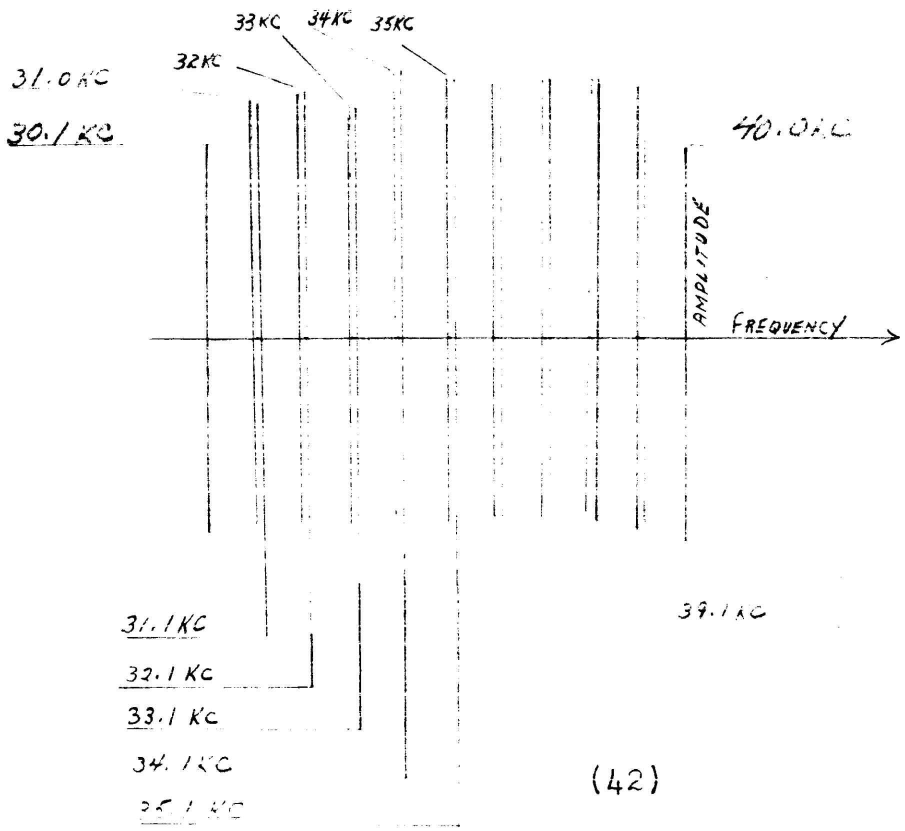
h) the tuning of these circuits hinges upon two important considerations:

(1) the overall bandwidth must be about 10 KC, to pass the range 30.1 - 40.0 KC.

(2) for each position of selector switch S-3201, the bandwidth must be at least 1 KC, since the input frequency from the 3100 deck covers the range 3.1 - 4 KC.

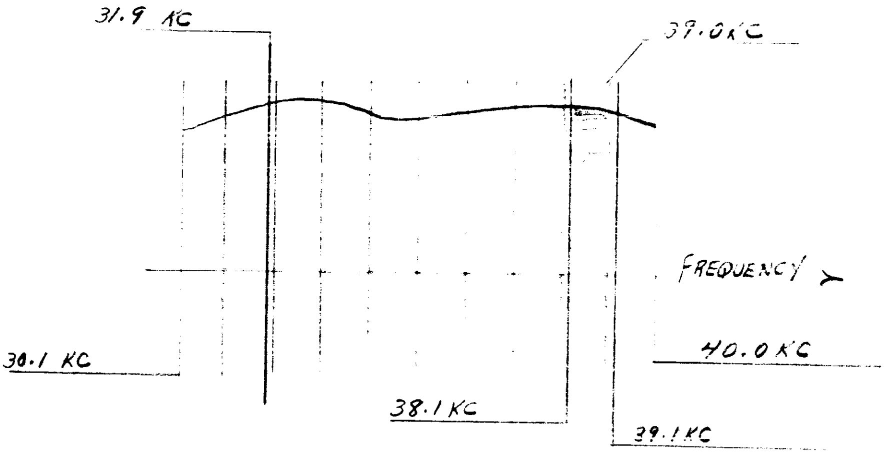
The correct tuning procedure will be discussed in detail in another section of this lesson plan.

An idealized version of the resulting response curve is shown below:



i) assume that S-3201 is placed in position 9, and that S-3101 on the 3100 deck is placed in position 9 also. The sum frequency from the balanced modulator is 30.1 KC and the difference frequency is 23.9 KC. In this case, the difference frequency is outside the overall bandpass.

j) assume that S-3201 is set to position 8, and S-3101 is set to position 9. The sum frequency from the balanced modulator is 38.1 KC and the difference frequency is 31.9 KC. For any given position of S-3201, the effective bandwidth of the tuned circuits of V-3204 is 1 KC. In this case, with S-3201 in position 8, the bandwidth is from 38.1 KC to 39 KC. The difference frequency is thus rejected.



k) the 30.1 - 40.0 KC output at the secondary of T-3203 is applied to output jack J-3204, from which point it is delivered to the 3300 deck.

l) associated with V-3204 is an AGC network similar to that encountered in the 3100 deck. The signal at the plate of V-3204 is presented to the network via C-3222. CR-3204 is the delay diode, biased back by voltage divider network R-3221 and R-3220. CR-3203 is the AGC diode; C-3218 is the AGC capacitor, which is allowed to discharge through R-3231, as necessary.

8. Discussion of the 3300 Deck:

Refer to schematic CK-580:

a) triggers at a frequency of 100 KC arrive at J-3301 from the 3400 deck. These triggers, which may be monitored at TP-3301, are applied to V-3301, a 10:1 Phantastron divider circuit. R-3303, the divider adjust pot, is set for an output frequency of 10 KC from pin 6.

b) the 10KC output from pin 6 is applied to V-3302, an amplifier-cathode follower circuit, via differentiating network C-3304, R-3310. The plate output, consisting of negative 10 KC triggers, is applied to 10 KC output jack J-3302 for delivery to the 3200 deck.

c) the cathode output, consiting of positive 10 KC triggers, may be monitored at TP-3302. This output, rich in harmonics of 10 KC, is applied to one of ten crystals in the range 320 KC - 410 KC, in 10 KC steps. The selection is made by switch sections S-3301F and S-3301E. Each crystal has an associated trimmer capacitor connected in series.

d) S-3301A, in conjunction with J-3306 and the 10 KC nixie light on the 3000 deck, causes the numeral corresponding to the selected frequency to be illuminated.

e) the selected frequency at the wiper of S-3301E is applied to V-3303, a 320 - 410 KC amplifier, the plate circuit of which is tuned by the primary of T-3301 and selected capacities inserted in shunt by S-3301D front and rear.
Trimmer capacitor C-3370 is adjusted for best overall response in the 320 - 410 KC range.
The plate output of V-3303, which may be monitored at TP-3303, is applied, via the secondary of T-3301, to a balanced modulator circuit consisting of plug in diode unit CR-3302 and associated components.

f) the second input to the balanced modulator circuit is applied at the wiper of balance adjust pot R-3330, from J-3303. This signal, the output of the 3200 deck, is a frequency in the range 30.1 - 40.0 KC, in .1 KC steps, as selected by S-3101 on the 3100 deck and S-3201 on the 3200 deck.
The balanced modulator produces sum and difference frequencies, but only the sum frequencies are passed. The significant output, then, is a frequency in the range 350.1 - 450 KC, in .1 KC steps. The exact frequency, which depends on the setting of S-3101, S-3201 and S-3301, is applied, via T-3302, to V-3304, the output amplifier. This range of frequencies represents an overall bandwidth of 100 KC.
The balance adjust pot is set for minimum output from the balanced modulator of the 320 - 410 KC input frequency.

g) the grid circuit of V-3304 is tuned by the secondary of T-3302 and selected capacities inserted by S-3301C front and rear. The grid input may be monitored at TP-3304. The plate circuit of V-3304 is tuned by the primary of T-3303 and various capacitors inserted by S-3301B front and rear. The plate circuit may be monitored at TP-3305. Note that trimmer capacitors are inserted in both the grid (C-3370) circuit and the plate (C-3372) circuit.

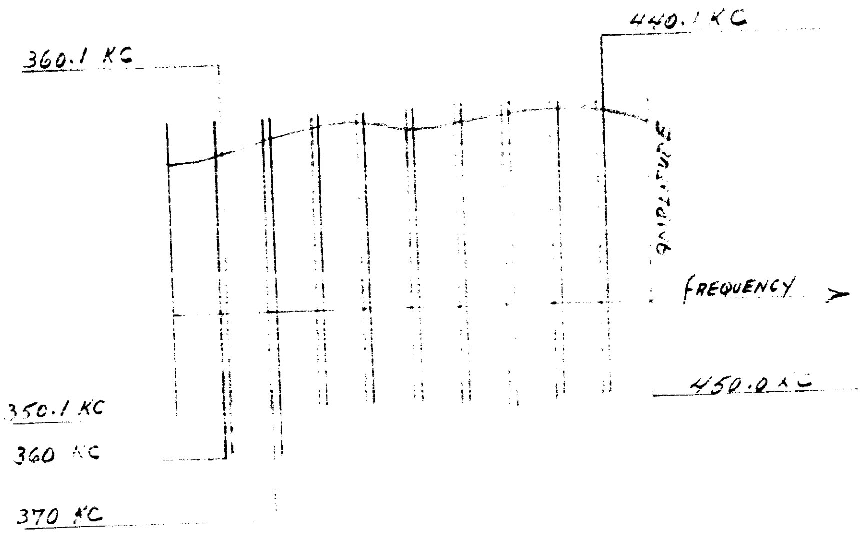
h) the tuning of these circuits hinges on two important considerations:

(1) the overall bandwidth must be about 100 KC, to pass the range 350.1 KC - 450 KC.

(2) for each position of selector switch S-3301, the bandwidth must be at least 10 KC, since the total input frequency range from the 3200 deck is 30.1 - 40.0 KCS.

The correct tuning procedure will be discussed in another section of this lesson plan.

An idealized version of the resulting response curve is shown below:



i) assume that S-3301, S-3201 and S-3101 are all set to position 9; the sum frequency from the balanced modulator is:

320 KC from the 3300 deck, plus
27 KC from the 3200 deck, plus
3.1 KC from the 3100 deck, or 350.1 KCS.

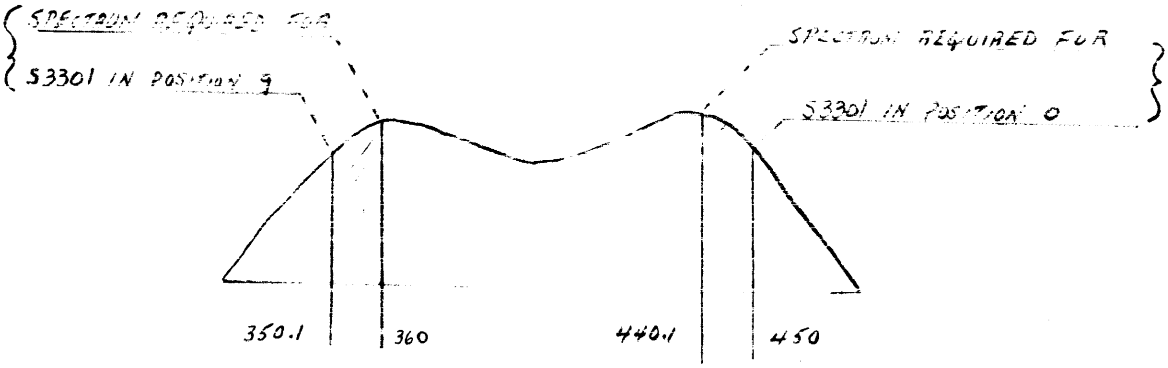
If S-3101 is now rotated through all its positions to 0, the sum frequencies from the balanced modulator become:

S-3101 position	8	350.2 KC
	7	350.3 KC
	6	350.4 KC
	5	350.5 KC
	4	350.6 KC
	3	350.7 KC
	2	350.8 KC
	1	350.9 KC
	0	351.0 KC

If S-3201 is now rotated through all its positions to 0, the sum frequencies from the balanced modulator become:

S-3201 position	8	352 KC
	7	353 KC
	6	354 KC
	5	355 KC
	4	356 KC
	3	357 KC
	2	358 KC
	1	359 KC
	0	360 KC

Thus, for each position of S-3301, 10 KC of the overall spectrum must be reserved. This is shown in the sketch below:



9. Discussion of the 3400 Deck:

Refer to schematic CK-584

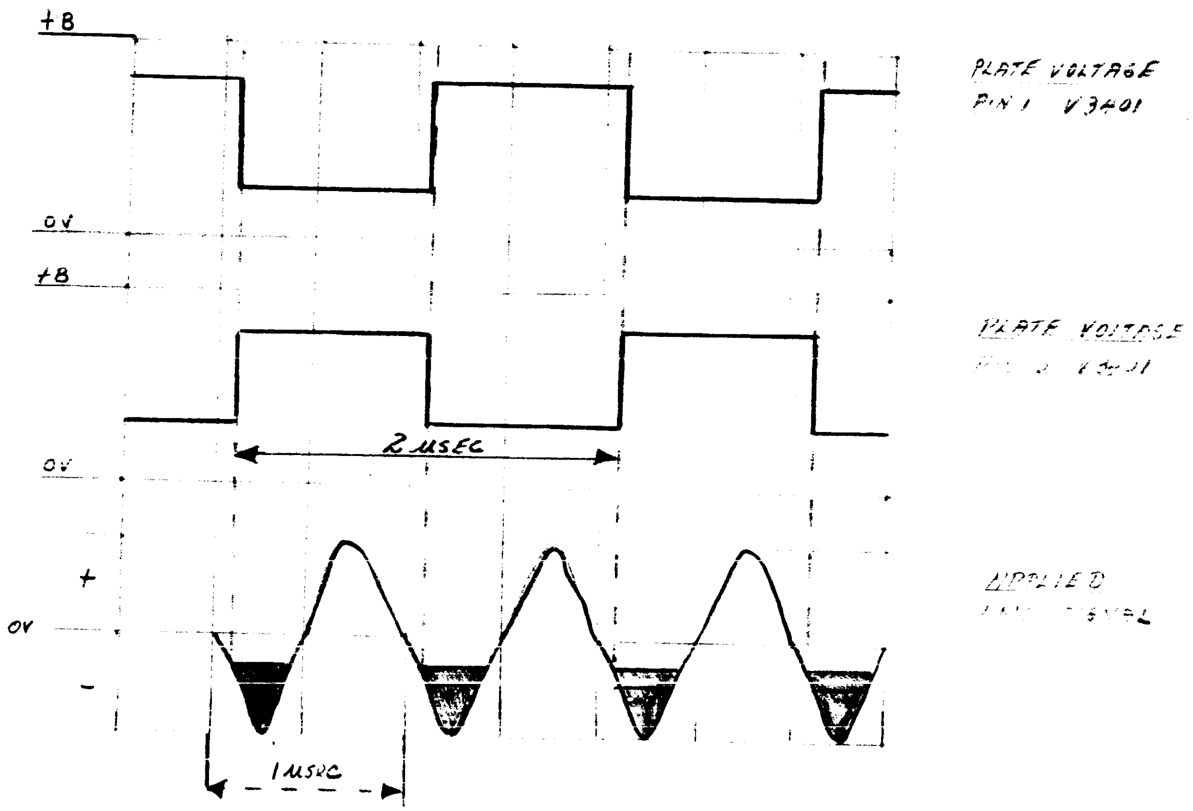
a) the 1 mc signal from the standard circuits in the 3100 deck arrives at J-3401; the input may be monitored at TP-3401. The 1 mc signal is applied simultaneously to:

(1) a 1 mc output jack, J-3402, from which point the 1 mc signal is delivered to the 3500 - 3600 deck.

(2) RF transformer T-3401, which incorporates a voltage step up of the 1 mc signal.

b) the 1 mc signal at the secondary of T-3401 is coupled via C-3402 and diodes CR-3401, CR-3402, to both grid circuits of an Eccles-Jordan type FLIP-FLOP multivibrator, V-3401. The characteristics of this multivibrator are such that a certain amplitude of negative voltage will cut off the conducting section, causing its plate voltage to rise. This action causes the other section to conduct, with a corresponding drop in its plate voltage. The circuit remains in this condition until the arrival of another negative trigger. The circuit is never free running.

c) the sketch below shows the relationship of the plate voltages at pins 1 and 6 of V-3401 to the applied 1 mc signal.



d) the output of the multivibrator is taken from pin 6; this is an essentially square waveform with a period of 2 usec, corresponding to a frequency of 500 KCS. The slight phase lag is due to the fact that a certain value of negative voltage is required to cause the circuit to flip or flop. The 500 KC output, however, is still phase locked to the 1 mc standard.

e) the square wave at 500 KC is applied, via C-3406, C-3407, R-3409 and CR-3403 to V-3402, a 5:1 Phantastron divider circuit. The cathode of CR-3403 is back biased by the positive excursions of the square wave. Only the negative triggers (leading edges of the negative excursions) are effective in triggering the Phantastron.
R-3411, the divider adjust pot, is set for an output frequency of 100 KC from pin 6 of V-3402. This 100 KC signal, differentiated by C-3409 and R-3418, is applied to an amplifier - cathode follower circuit, V-3403A.

f) the plate output of V-3403A, positive triggers at 100 KC, is applied to output jack J-3403, for delivery to the 3300 deck.

g) the cathode output of V-3403A, positive triggers at 100 KC, is applied to a blocking oscillator circuit, V-3403B.
The output of the blocking oscillator circuit at the cathode consists of harmonic rich 100 KC pulses, which may be monitored at TP-3403.
These triggers are applied to one of ten crystals, in the range 2.9 - 3.8 mcs, in 100 KC steps. The selection is accomplished by S-3401G and S-3401F. Each crystal has an associated trimmer capacitor connected in series.
The crystals respond to the 29th through the 38th harmonics of 100 KC. The crystal output, at the wiper of S-3401F, is applied to V-3404, an RF amplifier, via coupling circuit C-3499 and R-3429. The plate circuit of V-3404 is tuned by the primary of T-3403 and selected capacitors inserted by S-3401E front and rear. There are ten such capacitors, one for each position of S-3401. All are trimmers, with a nominal range of 1 to 12 uuf. Each capacitor is adjusted, in the appropriate position of S-3401, for maximum signal in the 2.9 - 3.8 mc range.
The output of V-3404 is applied, via the secondary of T-3403, to a balanced modulator circuit. The plate output may be monitored at TP-3404.

h) the second input to the balanced modulator circuit arrives at the wiper of the balance adjust pot, R-3432, from J-3404. This input arrives from the 3300 deck; it is a frequency in the range 350.1 - 450 KC, in .1 KC steps. The exact frequency depends on the setting of S-3101, S-3201 and S-3301.

i) the balanced modulator circuit produces sum and difference frequencies, but only the sum frequencies are passed. The significant output, then, is a frequency in the range 3.2501 mc - 4.25 mc, in .1 KC steps. The balance adjust pot is set for minimum 2.9 - 3.8 mc injection frequency output from the balanced modulator. R-3433 and R-3434 provide a "phantom ground" which effectively centertaps the secondary of T-3403 and the primary of T-3404 to ground.

j) the balanced modulator output is applied, via the secondary of T-3404, to V-3405, the basic synthesizer output tube. The grid input, which may be monitored at TP-3405, is tuned by the secondary of T-3404 and selected capacities inserted by S-3401D front and rear.
The plate output, which may be monitored at TP-3406, is tuned by the primary of T-3405 and selected capacities inserted by S-3401C front and rear. The plate and grid capacitors are all trimmers, with a nominal range of 1 to 12 uuf.

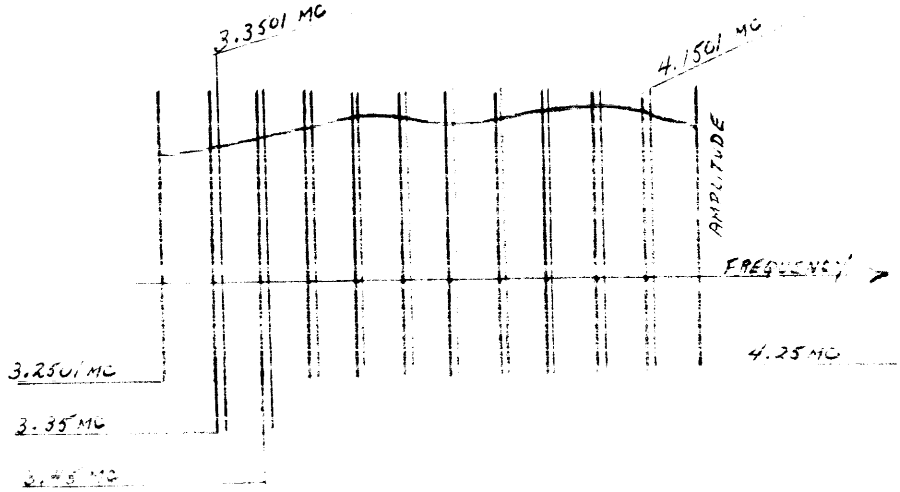
k) the tuning of the plate and grid circuits of V-3405 hinges on two important considerations:

(1) the overall bandwidth must cover a range of 1 mc, that is, from 3.2501 mc to 4.25 mc.

(2) for each position of S-3401, the effective bandwidth must be 100 KC, to cover the range 350.1 - 450 KC.

The tuning of these stages will be discussed in detail in another section of this lesson plan.

An idealized version of the required response curve is shown below:



l) associated with V-3405 is an AGC loop similar to those encountered in other decks. The signal at the plate of V-3405 is presented to the loop by C-3432; CR-3413 is the delay diode, back biased by a voltage divider network, R-3437 and R-3438.
CR-3412 is the AGC diode; R-3436 and C-3428 form a filter - storage network. R-3435 provides a path for C-3428 to discharge. The AGC voltage is applied to the grid of V-3405 via T-3404.

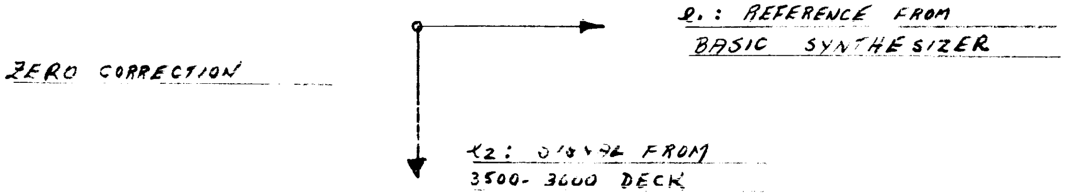
m) the output of V-3405 is applied to a phase detector circuit via T-3405.

n) the 3.25 - 4.25 mc output of the 3500 - 3600 deck arrives at J-3407, and is applied to T-3406. The output of the secondary of T-3406, which may be monitored at TP-3408, is applied to the grid circuit of V-3406, a 3.25 - 4.25 mc RF amplifier circuit. The plate circuit of this amplifier utilizes a single inductor, L-3401, and trimmer capacitors selected by S-3401B front and rear, for tuning.
The plate output of V-3406, which may be monitored at TP-3407, is applied:

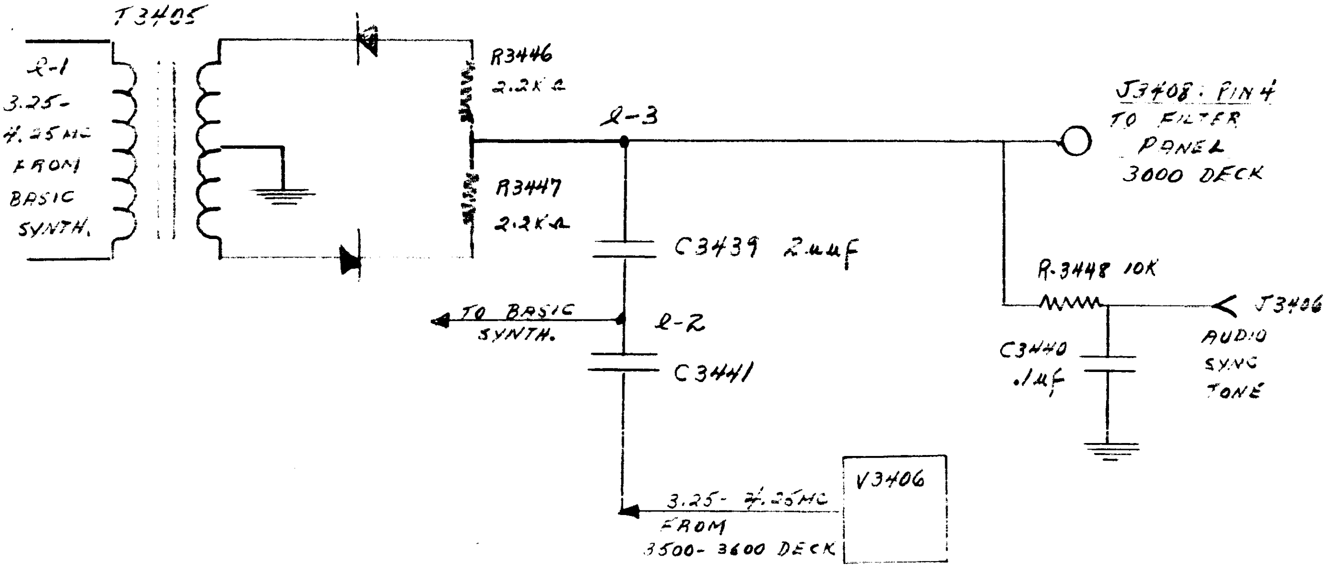
(1) via C-3441 to the basic phase detector, (CR-3409, CR-3410, R-3442)

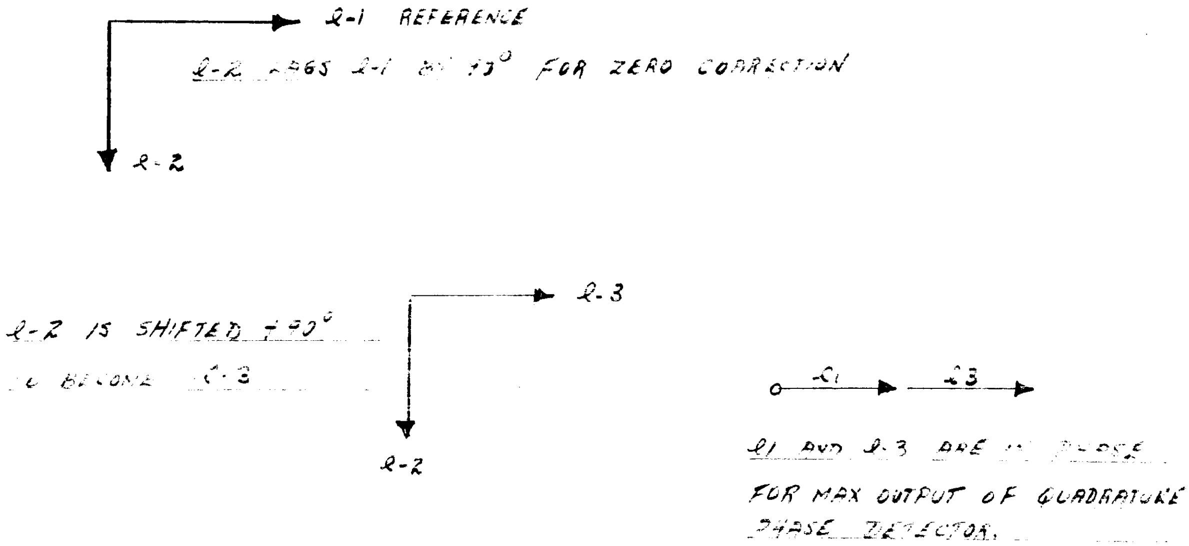
(2) via C-3441 and C-3439 to the tandem phase detector, (CR-3408, CR-3411, R-3446 and R-3447).

o) the basic phase detector compares the phase of the two input signals in the range 3.25 - 4.25 mcs. The signal from the basic synthesizer is locked to the 1 mc standard; this is the reference signal. The signal from the high frequency loop contains the error of the HFO circuit. This is the frequency to be corrected.
The correction voltage is developed at the wiper of the balance adjust pot, R-3444. The amplitude and polarity of the correction voltage depends on the direction and amount of the phase error. The correction voltage is applied to a low pass filter, R-3445, C-3438 and C-3437; the average DC correction voltage is made available at J-3405; from this point it is delivered to the VARICAP in the HFO circuits of the Model HFR-1.
It should be noted that, for zero correction voltage from the basic phase detector, the two input signals are 90 degrees out of phase, as illustrated below:



p) the sketch below shows the tandem or quadrature phase detector circuit, with significant phase relationships; the reference input, e-1, is applied at T-3405, as for the basic phase detector. The input from the 3500 - 3600 deck is applied via C-3439. This is input e-2.
The voltage output of the phase detector is e-3; this appears at the junction of R-3446 and R-3447.
The reactance of C-3439 is approximately 20 K ohms; this is ten times the resistance of R-3446 or R-3447. Voltage e-3, then, leads e-2 by 90 degrees.





q) the output at J-3408-4 is delivered to the filter panel on the 3000 deck. Here the voltage is used to control a transistor controlled relay, which operates the SYNC light. The relay will also control an automatic tuning device on a later model.

r) the output at J-3406, after processing by low pass filter R-3448, C-3440, is delivered to the Model HFA-1 Audio and Detector unit for use as a tuning and alignment signal.

10. Discussion of the 3500 - 3600 Deck (High Frequency Loop)

Refer to schematic CK-585:

a) the 1 mc standard input arrives at J-3501 and is coupled to the control grid of 1 mc amplifier V-3501B via C-3569, R-3506, and parasitic suppressor PS-3501.

b) the plate circuit of V-3501B is tuned by the primary of RF transformer T-3505. three outputs from the 1 mc amplifier are taken, as follows:

(1) one output from the secondary of T-3505 is applied to 1 mc output jack J-3502.

(2) one output from the plate of V-3501B is applied to a 2nd harmonic generator circuit, V-3501A, via C-3562.

(3) one output from the plate of V-3501B is applied to a 1 mc pulse generator via C-3607 and R-3528.

c) the plate circuit of V-3501A contains a tuned RF transformer, the primary of which is tuned to 2 mcs. The 2 mc output at the secondary of this transformer, T-3503, is applied to 2 mc output jack, J-3505.

d) the 1 mc signal applied to the 1 mc pulse generator, V-3503, is of large amplitude. This stage purposely distorts the sine wave input to provide a great number of harmonics of 1 mc, since the 8th through the 37th harmonics of the 1 mc input will be required.

e) the output of the 1 mc pulse generator is applied to Z-3502, a low pass filter, via differentiator network C-3610, R-3530. The differentiator network has an exceptionally short time constant in comparison with the 1 usec period of the 1 mc waveform. The cutoff frequency of the low pass filter is 37 mcs. The output of the low pass filter is delivered to the cathode circuit of 40.5 mc converter stage V-3506.

f) V-3502 is an independent oscillator circuit, operating in the frequency range 48.5 - 77.5 mcs. The feedback path is between the plate and control grid circuits; these points connect to selector switches S-3501D and S-3501C. These selector switch sections have 30 active contacts; As noted on the schematic, they select one of 30 crystals in the range 48.5 - 77.5 mcs, in 1 mc steps. Associated with each crystal is a series capacitor and a trimmer capacitor to ground. The capacitors form a voltage divider circuit; the ratio of the capacitors is adjusted by the trimmers.

g) the output of the 48.5 - 77.5 mc oscillator is applied to two circuits:

(1) to V-3505, a 43.75 - 44.75 mc converter, at the control grid.

(2) to V-3504, a 48.5 - 77.5 mc amplifier circuit.

h) selector switch sections S-3501A and S-3501B, in conjunction with the "MC" nixie lights on the 3000 deck, cause the nixie numerals corresponding to the selected crystal frequency to be displayed. The numerals progress from "02" to "31", corresponding to the 1 mc increments of the receiver frequency. Thus, when the 48.5 mc crystal is selected, the numerals "02" are displayed. When the 77.5 mc crystal is selected, the numerals "31" are displayed.

i) the output of amplifier V-3504, in the range 48.5 - 77.5 mc, is the second input to converter stage V-3506. The plate circuit of this converter is sharply tuned to pass a single frequency, 40.5 mcs. This frequency represents the difference between the selected crystal frequency and the appropriate harmonic of 1 mc passed by the low pass filter, Z-3502, to produce a frequency of 40.5 mcs.

j) the following examples show the relationships among the nixie lights, the selected crystal frequency and the appropriate harmonic of the 1 mc pulse:

Nixie Lights	Xtal Frequency	Harmonic	Difference
02	48.5 mc	8th	40.5 mc
03	49.5 mc	9th	40.5 mc
04	50.5 mc	10th	40.5 mc
05	51.5 mc	11th	40.5 mc
06	52.5 mc	12th	40.5 mc
07	53.5 mc	13th	40.5 mc
08	54.5 mc	14th	40.5 mc
09	55.5 mc	15th	40.5 mc
10	56.5 mc	16th	40.5 mc
31	77.5 mc	37th	40.5 mc

k) the 40.5 mc converter is followed by two stages of amplification; V-3508 and V-3510. Both are type 6AK5 pentode RF amplifiers. Parasitic suppressors are incorporated in the grid and plate circuits of these stages. Test points are provided as follows:

(1) TP-3504, between plate and grid circuits of V-3506 and V-3508 respectively.

(2) TP-3505, between plate and grid circuits of V-3508 and V-3510, respectively.

l) the plate circuits of these stages are tuned by fixed inductors and trimmer capacitors as follows:

(1) V-3506: L-3509, C-3623

(2) V-3508: L-3528, C-3628

(3) V-3510: L-3522, C-3625

m) the output of V-3510, the final 40.5 mc amplifier, which may be monitored at TP-3506, is delivered to the control grid circuit of V-3511, the final converter stage in the high frequency synthesizer.

n) a sample of the HFO frequency in the Model HFR-1 arrives at J-3503. This frequency encompasses the range 3.75 - 33.75 mcs, and is maintained 1.75 mc above the assigned receiver frequency. From J-3503 this signal is conducted to Z-3501, a low pass filter with a cutoff frequency of 34 mcs. The output of Z-3501 is applied to the cathode circuit of 43.75 - 44.75 mc converter stage V-3505.

o) V-3505 receives its companion input at the control grid; this is a frequency in the range 48.5 - 77.5 mc, selected by S-3501.

p) the plate circuit of V-3505 contains a double tuned circuit, configured by T-3501, C-3581, and C-3582. The circuit must be adjusted to pass, equally well, frequencies in the range 43.75 - 44.75 mcs. The plate output of V-3505 may be monitored at TP-3501.

q) the following examples show the relationships among the two input frequencies and the output frequency, for various assigned receiver frequencies:

RCVR FREQ	HFO FREQ	XTAL FREQ	NIXIE	V-3505 OUTPUT
02.0000	03.7500	48.5	02	44.75 mc
02.0001	03.7501	48.5	02	44.7499
02.0010	03.7510	48.5	02	44.7490
02.0100	03.7600	48.5	02	44.7400
02.1000	03.8500	48.5	02	44.6500
02.9999	04.7499	48.5	02	43.7501
03.0000	04.7500	49.5	03	44.7500

r) the output of converter V-3505 is applied to two stages in cascade, V-3507 and V-3509; both stages employ type 6AK5 pentodes. The plate circuit of V-3507 contains a double tuned RF transformer, configured by T-3502, C-3588 and C-3590. The plate circuit of V-3509 contains a resonant tank, configured by L-3520, C-3594 and trimmer C-3593. This tank is "swamped" by R-3519, a 10 K ohm resistance, to obtain the required bandpass characteristic. The plate outputs of these stages may be monitored at TP-3502 and TP-3503. The 43.75 - 44.75 mc signal is applied to grid #3, pin 7, of the final converter stage, V-3511.

s) V-3511 also receives the constant 40.5 mc signal at the control grid, pin 1. The stage develops a difference frequency in the plate circuit, in the range 3.25 - 4.25 mc; this is applied to V-3512, the output amplifier stage, via coupling circuit C-3644, R-3555. The plate circuit of this stage contains a tuned RF transformer, T-3504. The plate output may be monitored at TP-3507. The secondary of T-3504 delivers to output jack J-3504 a frequency in the range 3.25 - 4.25 mc, containing any error of the HFO circuit. This output is delivered to the phase detector circuit in the 3400 deck.

11. Discussion of the 3700 Deck: (Regenerative Divider)

Refer to schematic CK-537:

a) the 3700 deck is a regenerative divider circuit; it receives a 1 mc reference input and delivers an output, at 250 KC, locked to the standard.

b) the 250 KC output of the 3700 deck is used:

(1) as a synthesized reconstructed carrier in the Model HFA-1 Detector and Audio Unit.

(2) as a synthesized injection frequency in the alignment generator section of the Model HFR-1 "front end".

c) the 1 mc reference signal arrives at J-3701, and is applied to RF transformer T-3701. the signal at the secondary of T-3701 may be monitored at TP-3701.

d) from the secondary of T-3701, the signal is coupled, via C-3701, to the control grid circuit of cathode follower V-3701. The output at the cathode, pin 7, is delivered to the control grid circuit of converter stage V-3702 via coupling circuit C-3702, R-3705.

e) when power is first applied, V-3703A acts as a noise generator; after completion of initial transients, V-3703A operates as a tripler circuit. The tuned tank in the plate circuit of this stage is resonant to 750 KCS. This tank has a high Q, with resulting narrow band pass in the vicinity of 750 KCS. When power is applied, plate current flows; noise at 750 KC is amplified, and delivered to grid #3, pin 7, of converter V-3702. With 1 mc applied at the control grid of V-3702, mixing action produces a small 250 KC signal component at the plate of the converter stage; the plate tank of the converter stage is tuned to 250 KCS, and has a high Q. The output of this circuit is applied:

(1) to the grid circuit of 250 KC amplifier V-3703B.

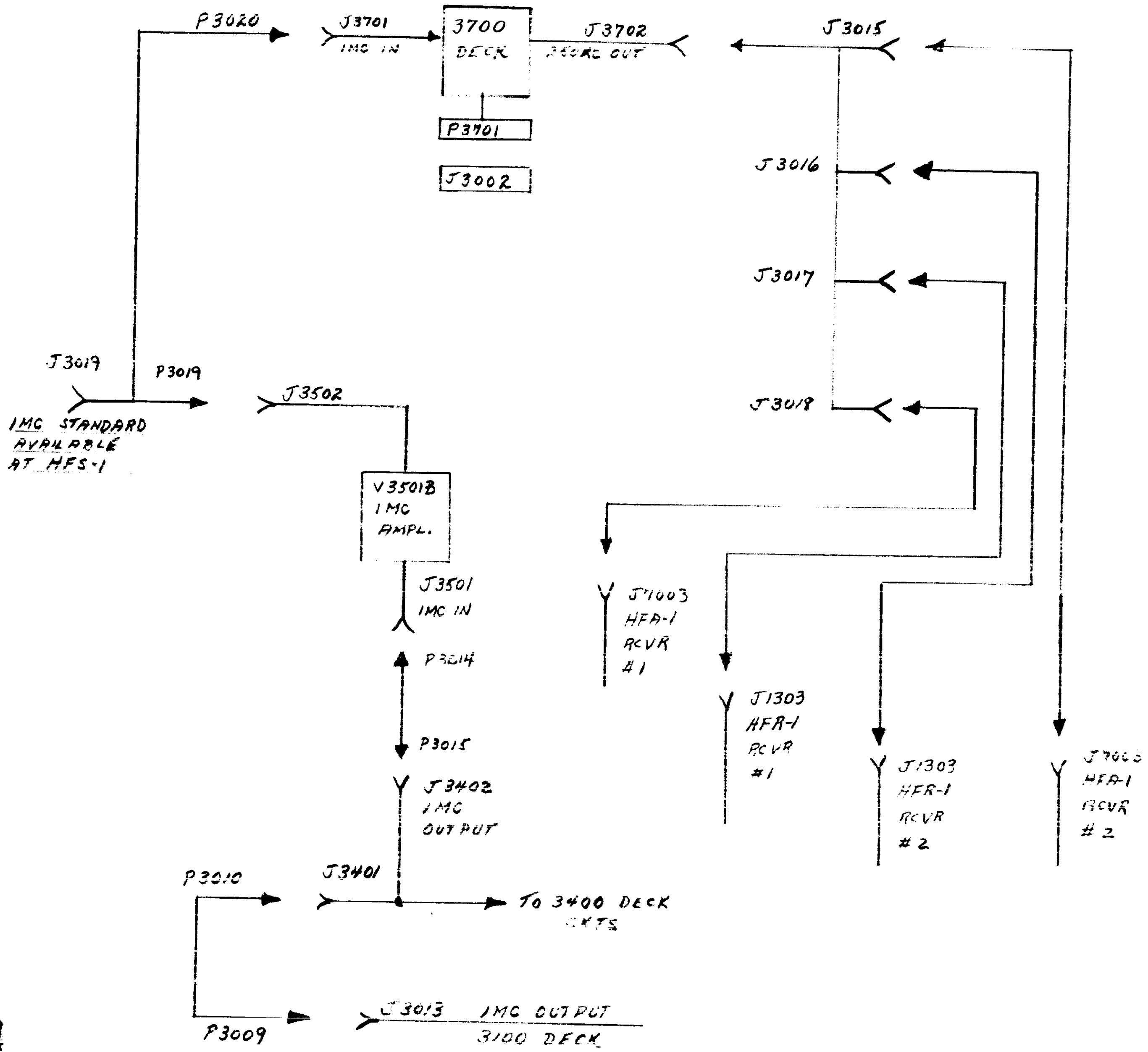
(2) to the control grid circuit of V-3703A.

f) the small component of 250 KC signal applied to the grid of V-3703A is tripled in this stage, to produce an increased value of 750 KC signal in the plate circuit; this output is fed back to pin 7 of V-3702, resulting in increased 250 KC output at this stage. The cycle continues; finally, a healthy 750 KC signal is produced at the plate of V-3703A; a strong 250 KC signal is produced at the plate Of V-3702. Final amplification is undertaken by 250 KC amplifier V-3703B, the plate circuit of which contains a high Q tank tuned to 250 KCS. The 250 KC output is applied to J-3702; this signal may be monitored at TP-3702.

g) when the circuit is properly aligned, the following condition should be realized:

with a signal generator set to 1 mc connected at J-3701, and with a VTVM connected to TP-3701 reading 3.0 V RMS, a VTVM connected to a 56 ohm dummy load at J-3702 should read 1 - 1.5 V RMS.

h) the complete interconnection scheme for the 3700 deck is sketched below:



12. Discussion of the 3000 Deck: (Main Chassis)

Refer to schematic CK-578:

a) the 3000 deck, or main chassis, contains:

(1) input and output terminal connections for the HFS-1.

(2) the nixie lights, cables and plugs.

(3) the phase comparator meter, M-3001, with cable and plug.

(4) the filter panel, which supplies B Plus and filament voltage to the various decks.

(5) the transistor operated sync relay, K-3001.

b) no discussion of items (1) through (4) will be undertaken, since these are self explanatory.

c) relay K-3001 is operated by a transistor circuit, Q-3001, in conjunction with the output voltage of the quadrature phase detector circuit in the 3400 deck.

d) the relay is shown in the energized position; this corresponds to an "in sync" condition. Contact "J" of J-3001 is grounded; contact "N" of J-3001 is open.

e) the grounding of contact "J" of J-3001 is of no significance in current models.

f) when contact "N" of J-3001 is open, the SYNC light on the HFR-1 is lighted. When the system is not in sync, K-3001 is de-energized; contact "N" is grounded, and the sync light is out.

g) with no input voltage from the quadrature phase detector circuit at J-3006-4, the collector circuit of Q-3001 passes insufficient current to energize K-3001; the collector is returned to a positive 28 volt supply, which back biases the collector circuit.
With a voltage from the quadrature phase detector at J-3006-4, for a "sync" condition, CR-3001 conducts, developing a voltage across R-3001 which forward biases the emitter-base circuit. Collector current increases, and K-3001 energizes.

D. Alignment, Testing and Troubleshooting of the Model HFS-1:

This section contains:

a) Oscilloscope Waveforms taken at significant test points.

b) Dynamic voltages at test points.

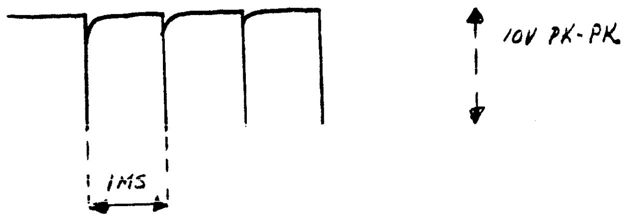
c) Field Alignment Instructions.

d) Resistance Checks.

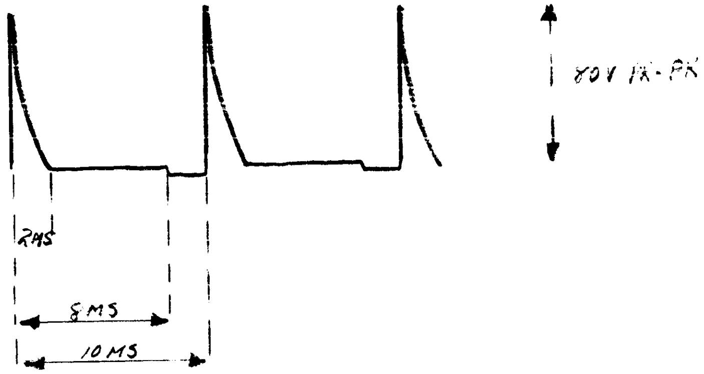
e) Voltage Checks.

Significant Test Point Waveforms, Model HFS-1.

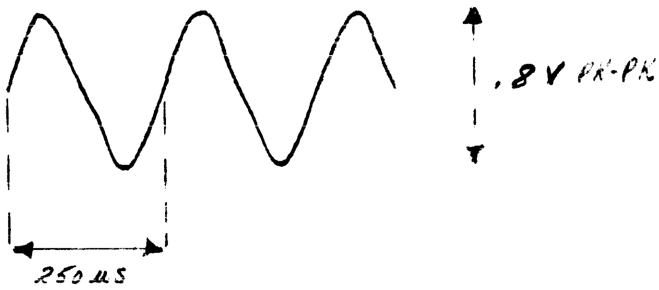
TP-3101: .5 MS/CM



TP-3102: 2 MS/CM



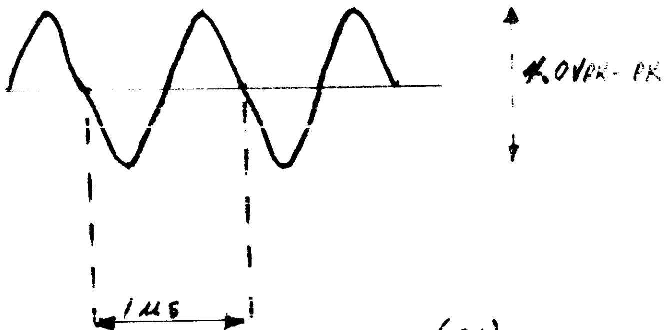
TP-3103: 50 μS/CM



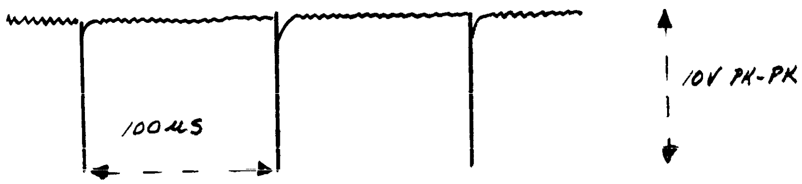
.1 KC SELECTOR AT "0"
4 KC: t = 250 μS

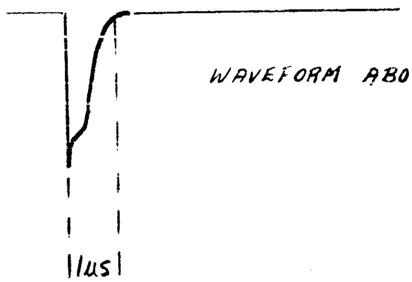
MOVING .1 KC SELECTOR THROUGH ALL POSITIONS PRODUCES SIMILAR WAVEFORM VARYING IN [illegible] BASE ONLY.

Z 3101, TERMINAL 6: .5 μS/CM



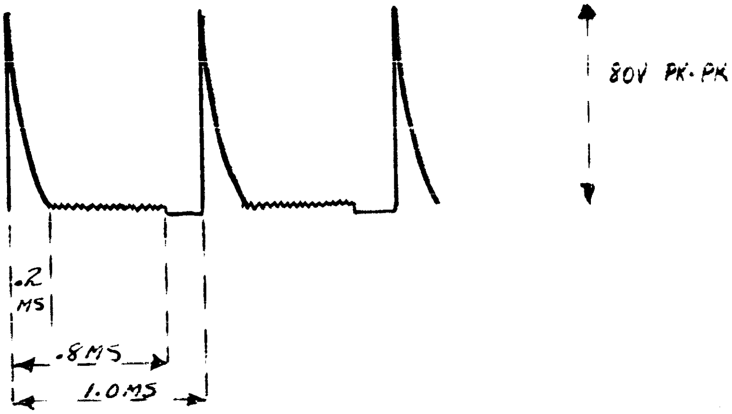
TP 3201: 20 µs/cm



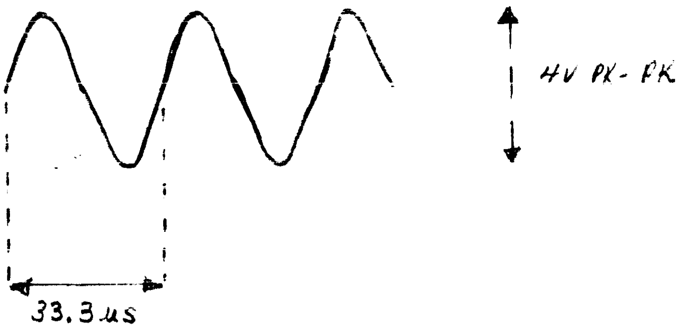


WAVEFORM ABOVE EXPANDED

TP-3202: .2 ms/cm

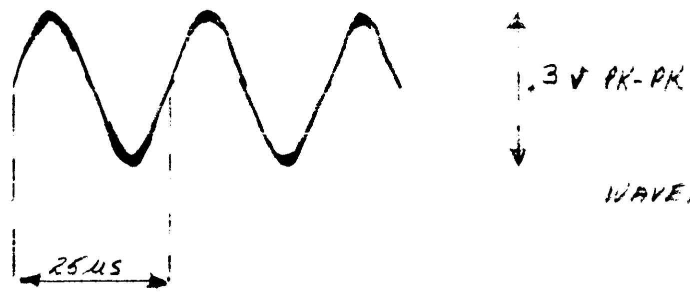


TP-3203: 5 µs/cm



1 KC SELECTOR TO "7"
30 KCS; τ = 33.3 µs.
MOVING 1 KC SELECTOR THROUGH ALL POSITIONS PRODUCES A SIMILAR WAVEFORM DIFFERING IN TIME BASE ONLY

TP- 3204: 5 µs / CM

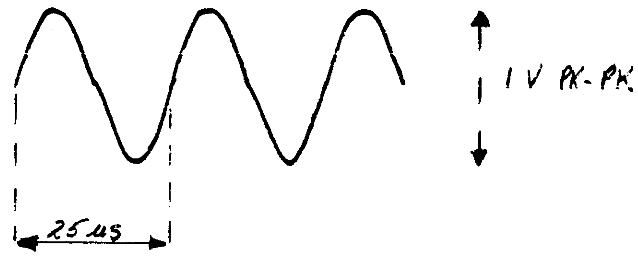


.1 KC SELECTOR 0 = 4 KC
1 KC SELECTOR 0 = 36 KC
40 KC
t = 25 µs

WAVEFORM NOT PURE SHARP

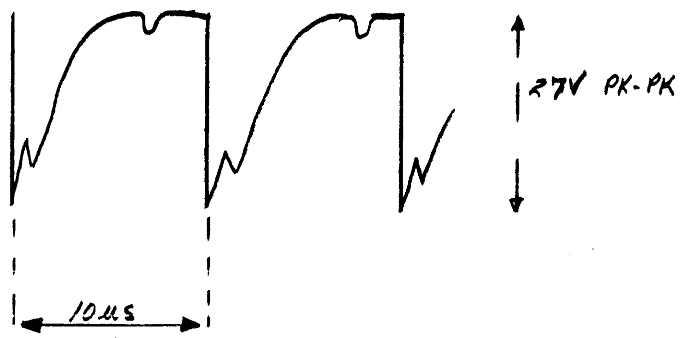
TP- 3204 : 1 MS/CM : WAVEFORM CRESTS MAY SHOW SLIGHT AMPLITUDE MODULATION.

TP- 3205: 5 µs / CM

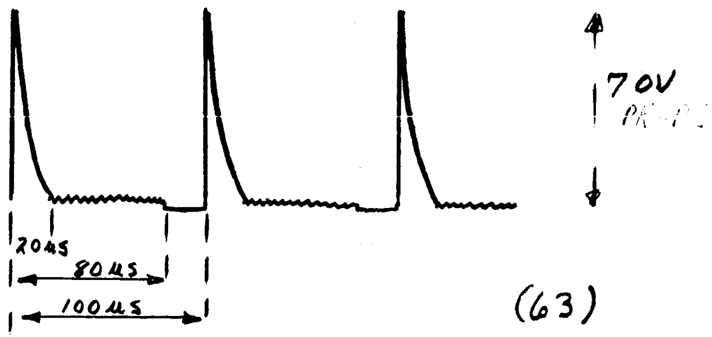


WAVEFORM SHARPER, PURER THAN AT TP 3204.

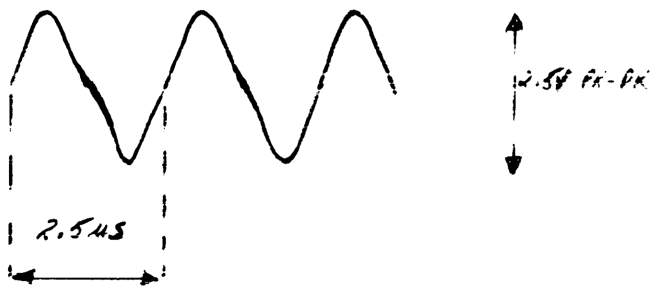
TP- 3301: 2 µs / CM



TP- 3302: 20 µs / CM



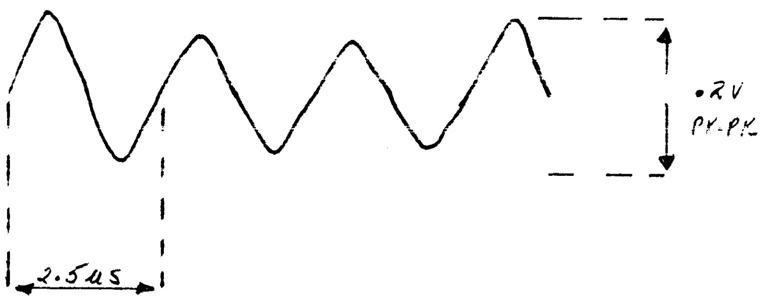
TP-3303: 1µs/cm



10 KC SELECTOR: 1 = 400 KC
t = 2.5µs

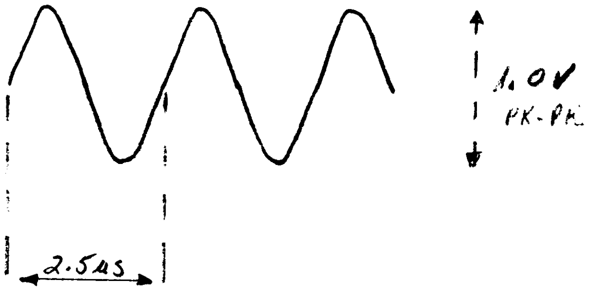
MOVING 10KC SELECTOR THROUGH OTHER POSITIONS PRODUCES SIMILAR WAVE FORM DIFFERING IN TIMEBASE ONLY.

TP-3304: 1µs/cm



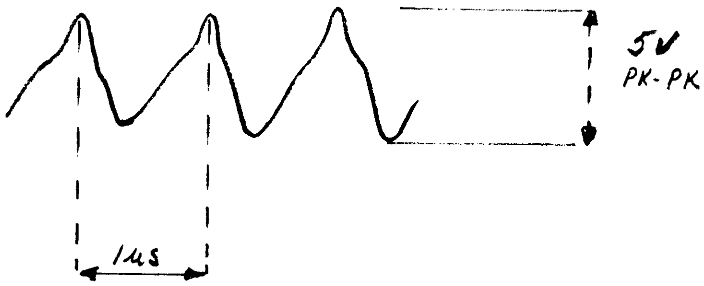
.1KC SEL.	0	4 KC
1 KC SEL	0	36 KC
10 KC SEL	5	360 KC
		400 KC
		t = 2.5µs

TP-3305: 1µs/cm

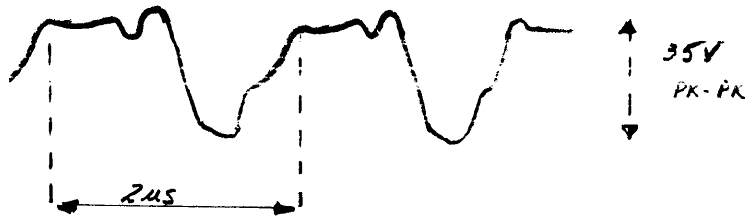


.1KC SEL	0	4 KC
1KC SEL	0	36 KC
10 KC SEL	5	360 KC
		400 KC
		t = 2.5µs

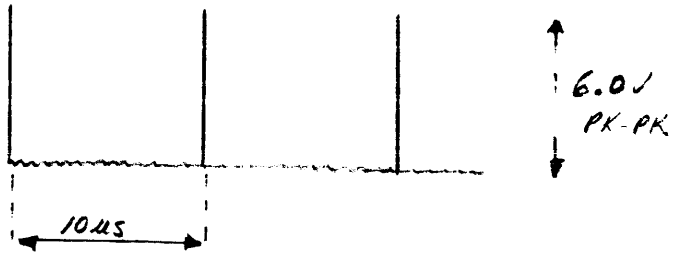
TP-3401: .5µs/cm



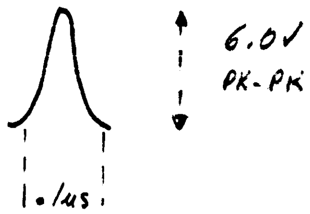
TP- 3402:   .5µs / cm



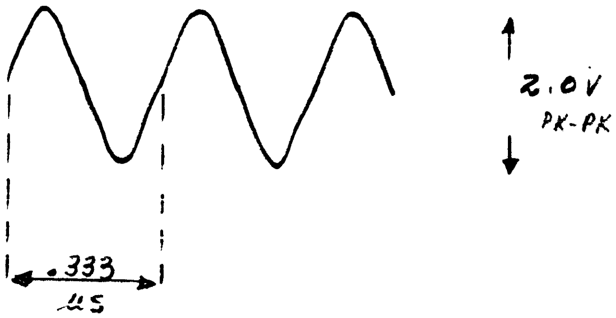
TP- 3403:   2µs / cm



IF THE WAVEFORM ABOVE IS EXPANDED WITH A TIME BASE OF .1 µs / CM, IT APPEARS THUS:

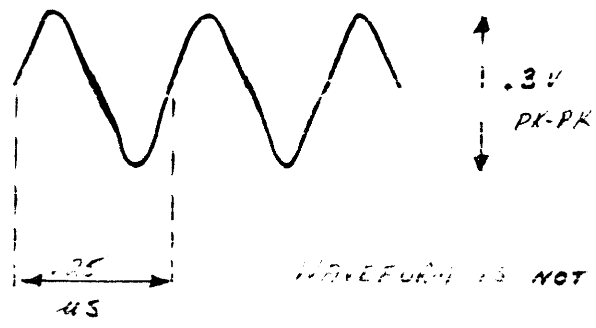


TP- 3404:   .1 µs / CM



100KC SEL: f = 3MCS
t = .333 µs

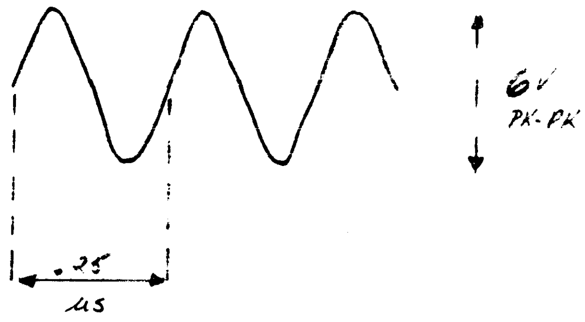
TP- 3405: .1 µs/CM



.1KC SEL	0	4 KC
1 KC SEL	0	36 KC
10KC SEL	5	360 KC
100KC SEL	2	3.600 MC
		4.000 MC
		T = .25 µs

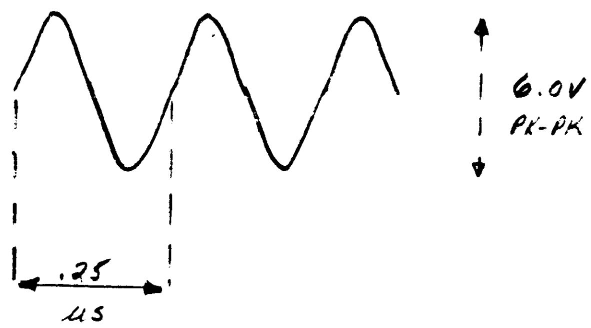
WAVEFORM IS NOT PURE, SHARP.

TP- 3406: .1 µs/CM



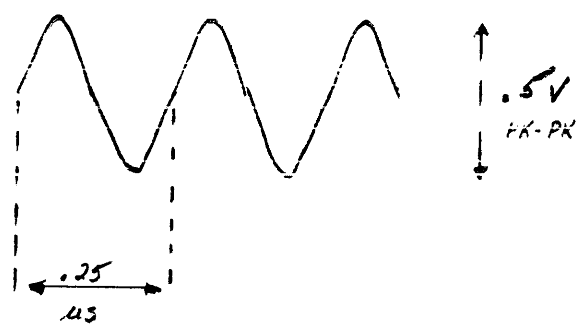
NIXIE SELECTORS SET AS ABOVE. WAVEFORM "CLEANER" THAN ABOVE.

TP- 3407: .1 µs/CM



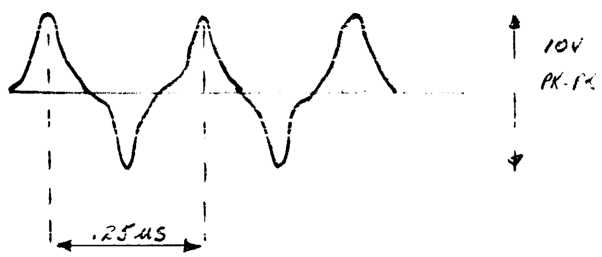
NIXIE SELECTORS SET AT 02.2500. RCVR TUNED TO 2.25 MCS; SYSTEM IN SYNC, TUNE-SYNC-OPERATE SWITCH IN OPERATE

TP- 3408: .1 µs/CM



NIXIE SELECTORS AND SYSTEM SET AS ABOVE.

TP-3409: .1 us/CM DC



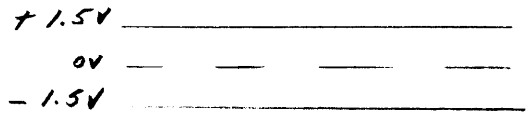
NIXIE SELECTORS: 02.2500; RCVR TUNED TO 2.5 MCS; SYSTEM SYNCHRONIZED; TUNE-SYNC-OPERATE SWITCH TO OPERATE; AS TUNE CONTROL IS MOVED IN EITHER DIRECTION, REFERENCE WILL SHIFT.

J-3008: SCOPE TO DC; NIXIE SELECTORS AND SYSTEM AS ABOVE.

a) ADJUST SCOPE VERTICAL POSITIONING TO CENTER TRACE WITH NO SIGNAL

b) CONNECT SCOPE TO J-3008.

c) MOVE TUNE CONTROL IN BOTH DIRECTIONS; THE REFERENCE WILL SHIFT AS SHOWN BELOW BEFORE THE SYSTEM DROPS OUT OF SYNC.

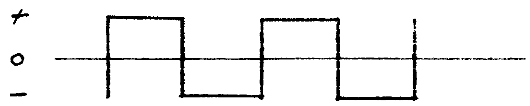


J-3014: 2MS/CM DC NIXIE SELECTORS AND SYSTEM SET UP AS ABOVE.

a) ESTABLISH SCOPE DC REFERENCE

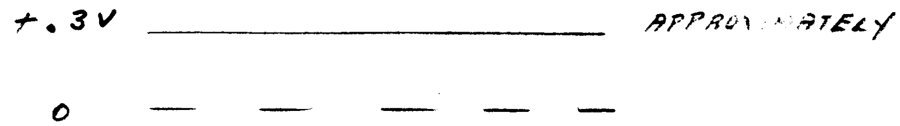
b) PLACE TUNE-SYNC-OPERATE SWITCH TO SYNC

c) A WAVEFORM SIMILAR TO THE ONE BELOW WILL BE OBSERVED

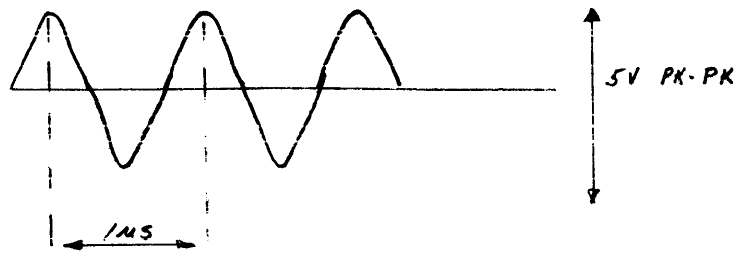


d) AS TUNE CONTROL IS ADJUSTED FOR ZERO BEAT, FREQUENCY DECREASES.

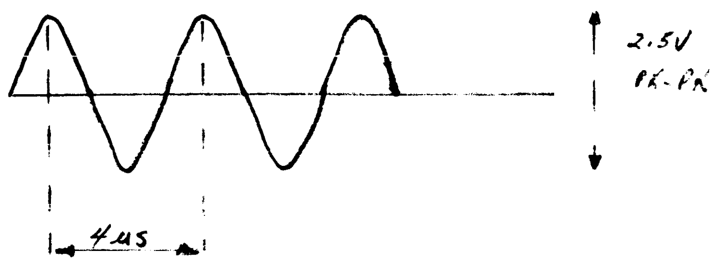
e) WHEN TUNE-SYNC-OPERATE SWITCH IS THROWN TO OPERATE, THE REFERENCE WILL BE POSITIVE.



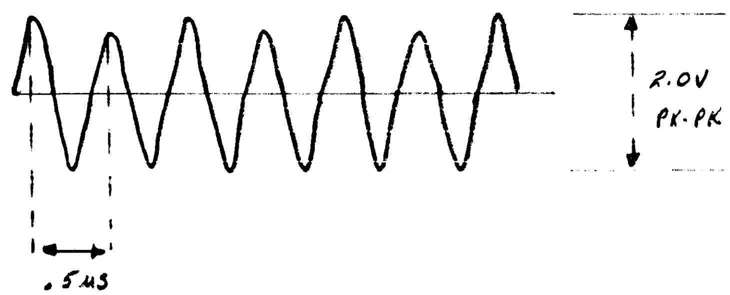
J 3019: .5us/CM 1MC INTERNAL STANDARD



J-3015, 16, 17, 18: 1us/CM 250 KC OUTPUT



J-3010, 11, 12, 13: 1.0us/CM 2MC OUTPUT



UNEQUAL PEAKS ON UPPER TRACE; LOWER PEAKS NEARLY EQUAL. ADJUST T 3503 FOR PROPER INDICATION.

J-3009: HFO INPUT: MEASURE WITH RF MILLIVOLTMETER

3.75 MC TO 33.75 MC, DEPENDING ON TUNE, BAND, CONTROLS.

AMPLITUDE: 20 mV TO 50 mV.

Model HFS-1 Synthesizer: Voltage Checks:

Notes:

1. All RF measurements were made with the Hewlett Packard Model 410B VTVM to ground.

2. The unit was completely interconnected in a receiver system known to be aligned and operating properly.

3. Maximum and minimum measurements are given for test points at which the voltage may vary with different settings of the nixie selectors.

TP-3101: .7 volt

TP-3102: 45.0 volts

TP-3103: .28 volt to .34 volt, depending on .1 KC selector

TP-3201: .2 volt

TP-3202: 52.0 volts

TP-3203: 2.2 volts

TP-3204: .1 volt to .32 volt, depending on .1 KC and 1 KC selectors

TP-3205: .45 volt

TP-3301: 3.0 volts

TP-3302: 40.0 volts

TP-3303: .8 volt to 1.2 volts, depending on .1 KC, 1 KC, and 10 KC selectors.

TP-3304: .1 volt to .38 volts, depending on .1 KC, 1 KC and 10 KC selectors

TP-3305: .44 volt to .5 volts, depending on .1 KC, 1 KC, and 10 KC selectors

At this point, the system was synchronized at a frequency of 2.25 mcs; this corresponds to a frequency from both the basic synthesizer and the high frequency synthesizer of 4.0 mcs; No nixie selectors were moved for these measurements. The RF head should be set at 2.25 mcs, and the sync light should be on. The TUNE SYNC OPERATE switch on the RF head should be in OPERATE.

TP-3401: 2.4 volts

TP-3402: 12.0 volts

TP-3403: 3.7 volts

TP-3404: .8 to 1.2 volts

TP-3405: .12 to .5 volts

TP-3406: 2.4 to 2.6 volts

TP-3407: 2.8 volts

TP-3408: .23 volt

TP-3409: 5.4 volts

Note: The DC voltage at TP-3409 will vary from approximately plus 1.5 volts to minus 1.5 volts as the TUNE control is slowly moved in both directions over the sync range.

TP-3501: .14 volt

TP-3502: .22 volt

TP-3503: .5 volt

TP-3504: .1 volt

TP-3505: .17 volt

TP-3506: .95 volt

TP-3507: .24 volt

TP-3701: 20.0 volts

TP-3702: .74 volt

Model HFS-1 Synthesizer: Field Alignment:

1. The alignment procedure presented here has been developed for field maintenance.

2. The following tools are required for the alignment:

   a) JFD Tool #5824: for piston capacitor adjustment.

   b) 3/16 hollow spintite with concentric screwdriver.

   c) 5/16 hollow spintite to receive concentric screwdriver.

3. The following test equipment is required:

   a) a good, high gain, wide band oscilloscope with calibrated time base and calibrated vertical amplifiers. A response of at least 5 mc will be required for the alignment of decks 3100, 3200, 3300 and 3400. The response should extend beyond 50 mc if the scope is to be employed in the alignment of the 3500 deck.

   b) a good VTVM, such as the H.P. Model 410B.

   c) a 50 ohm, 1/2 watt dummy load resistor, with miniature coaxial cable and plug. Cable: RG-174/U. Plug: TMC-PL-204.

   d) a good RF signal generator, such as the Measurements Corp. Model 82.

   e) a frequency Counter such as the H.P. Model 524C.

4. The waveform and voltage charts for the HFS-1 should be kept at hand, for reference.

5. In the adjustments of the dividers, the time bases are extremely important. The correct waveform shapes will be obtained with incorrect divider adjustment, but the time relationships will be wrong.

Alignment Procedure:

1. Check the following:

   a) unit is installed in the cabinet; all cables are connected; all interconnections are made.

   b) receiver system is in an OPERATE condition. The receiver must have had at least 6 hours warmup in a STANDBY condition before the alignment is attempted.

c) the voltage at TP-8001 and TP-8002 on the power supply must be 200 volts exactly. If it is not, adjust regulator potentiometers R-8014 and/or R-8025 as required.

d) connect the oscilloscope to J-3019. A 1 mc waveform should be observed. See the Waveform Chart.

2. Check the waveform at TP-3401. If it is correct, proceed; if it is not, check continuity between the 1 mc standard and the 3400 deck.

3. Check the waveform at TP-3402.

4. Check the waveform at TP-3403; if it is correct, proceed; if it is not correct, unlock R-3411 and adjust it for the proper indication. Leave R-3411 in the center of its lock in range and lock the adjustment.

5. Check the waveform at TP-3301.

6. Check the waveform at TP-3302. If it is correct, proceed; if it is not correct, unlock R-3303 and adjust it until the proper indication is obtained. Leave R-3303 in the center of its lock in range and lock the adjustment.

7. Check the waveform at TP-3201.

8. Check the waveform at TP-3202. If it is correct, proceed; if it is not correct, unlock R-3203 and adjust it until the correct indication is obtained. Leave R-3203 in the center of its lock in range and lock the adjustment.

9. Check the waveform at TP-3101.

10. Check the waveform at TP-3102. If it is correct, proceed; if it is not correct, unlock R-3104 and adjust it until the correct indication is obtained. Leave R-3104 in the center of its lock in range and lock the adjustment.

This completes the alignment of the divider chain.

11. Alignment of the 3100 Deck:

a) set the .1 KC nixie selector to "0".

b) connect the oscilloscope to TP-3103.

c) adjust C-3128 for maximum amplitude at TP-3103. (4 KC)

d) set the nixie selector to the positions indicated below, and adjust the corresponding capacitors for maximum indication at TP-3103:

1	C-3129	3.9 KC
2	C-3130	3.8 KC
3	C-3131	3.7 KC
4	C-3132	3.6 KC
5	C-3133	3.5 KC
6	C-3134	3.4 KC
7	C-3135	3.3 KC
8	C-3136	3.2 KC
9	C-3137	3.1 KC

e) remove P-3102 from J-3102. Connect the 50 ohm dummy load to J-3102. Connect the oscilloscope to the dummy load. Check the waveform for the "0" through "9" positions of the .1 KC selector. The waveshape should be sinusoidal; the peak to peak amplitude should b between .5 and .8 volts. If a VTVM is used, the voltage should be between .2 and .3 volts RMS.

f) remove the dummy load; reconnect P-3102 and J-3102.

12. Alignment of the 3200 D ck:

a) connect the oscilloscope probe to TP-3203.

b) s t th 1 KC nixie selector to position "0".

c) adjust C-3232 for maximum amplitude at TP-3203.

d) adjust C-3272 for maximum amplitude at TP-3203.

e) set the 1 KC nixie selector to the positions indicated below and adjust the corresponding capacitors for maximum indication at TP-3203.

1	C-3233	35 KC
2	C-3234	34 KC
3	C-3235	33 KC
4	C-3236	32 KC
5	C-3237	31 KC
6	C-3238	30 KC
7	C-3239	29 KC
8	C-3240	28 KC
9	C-3241	27 KC

f) set the 1 KC selector to "0". Run the selector through all positions, observing the amplitude of the waveform at TP-3203. Adjust C-3272 to maintain the amplitudes of the signals within plus or minus 1.5 db of each other.

g) remove P-3103 from J-3203.

h) connect the oscilloscope probe to J-3203.

i) adjust R-3219 for MINIMUM indication on the oscilloscope.

j) reconnect P-3103 and J-3203.

k) set the .1 KC selector on the 3100 deck to "8" (3.2 KC)

l) set the 1 KC selector to position "0" (36 KC)

m) connect the oscilloscope probe to TP-3204.

n) adjust C-3273 for maximum indication at TP-3204.

o) move the 1 KC selector through positions 1 through 9, observing the signal amplitude on the oscilloscope. If necessary, re-adjust C-3273 to maintain the amplitudes within plus or minus 1.5 db of each other.

p) connect the oscilloscope probe to TP-3205.

q) set the .1 KC nixie selector to position 1 (3.9 KC)

r) set the 1 KC nixie selector to position 0 (36 KC)

s) adjust C-3274 for maximum indication at TP-3205.

t) move the 1 KC selector through positions 1 through 9, observing the signal amplitude on the oscilloscope. If necessary, re-adjust C-3274 to assure that the amplitudes remain within plus or minus 1.5 db of each other.

u) remove P-3204 from J-3204. Connect the 50 ohm dummy load to J-3204. Connect the oscilloscope probe to the load.

v) set the 1 KC selector to "0". Set the .1 KC selector to "9". Rotate the .1 KC selector through all positions to "0". The output voltage must be at least .56 volts Pk-Pk or .2 volts RMS for the entire range.

w) rotate the 1 KC selector through all positions to "9". The conditions in (v) above should be repeated.

x) remove the oscilloscope probe and the dummy load from J-3204. Re-connect P-3204 and J-3204.

13. Alignment of the 3300 Deck:

a) connect the oscilloscope probe to TP-3303:

b) set the 10 KC Nixie Selector to position "C" (410 KC)

c) adjust C-3328, then C-3370 for maximum amplitude at TP-3303.

d) set the 10 KC NIXIE selector to the following positions, and adjust the corresponding capacitors for maximum indication at TP-3303:

1	C-3329	400 KC
2	C-3330	390 KC
3	C-3331	380 KC
4	C-3332	370 KC
5	C-3333	360 KC
6	C-3334	350 KC
7	C-3335	340 KC
8	C-3336	330 KC
9	C-3337	320 KC

e) move the 10 KC Nixie selector again through positions "9" through "0", observing the indications at TP-3303. If necessary, adjust C-3370 to maintain the amplitudes within 3 db of each other.

f) disconnect P-3203 from J-3303. Connect the oscilloscope probe to J-3303. Adjust R-3330 for MINIMUM indication on the oscilloscope. Remove the scope probe and reconnect P-3203 and J-3303.

g) set the NIXIE selectors as follows:

.1 KC selector to "0"	4 KC
1 KC selector to "9"	27 KC
10 KC selector to "9"	320 KC
	351 KC total

h) adjust C-3371 for maximum indication, with the scope probe connected at TP-3304.

i) move the 10 KC Nixie selector through the remaining nine positions, observing the amplitude of the signal at TP-3304. If necessary, readjust C-3371 to maintain the amplitudes within 3 db of each other.

j) move the oscilloscope probe to TP-3305.

k) set the nixie selectors as follows:

.1 KC selector to "0"	4 KC
1 KC selector to "1"	35 KC
10 KC selector to "0"	410 KC
	449 KC total

l) adjust C-3372 for maximum indication on the oscilloscope connected at TP-3305.

m) move the 10 KC selector through the remaining nine positions, observing the signal at TP-3305. If necessary, readjust C-3372 to maintain the signal amplitudes within 3 db of each other.

n) disconnect P-3304 from J-3304. Connect the 50 ohm dummy load to J-3304. Connect the oscilloscope probe to the dummy load.

o) set the nixie selectors as follows:

.1 KC selector to "0"
1 KC selector to "0"
10 KC selector to "0"

p) while observing the indication on the oscilloscope, rotate the .1 KC selector through all its positions to "9". Then rotate the 1 KC selector through all its positions to "9". The output amplitude for all positions must be .2 volts RMS or .56 volts Pk-Pk.

q) place the 10 KC selector to position 1.

r) repeat step (p), moving the selectors from "9" to "0". The indications should be the same.

s) move the 10 KC selector to position "2".

t) repeat step (p), moving the .1 KC and 1 KC selectors from "0" to "9". The indications should be the same.

u) continue this procedure for the remaining positions of the 10 KC selector.

v) remove the oscilloscope probe, and dummy load. Reconnect P-3304 and J-3304.

14. Alignment of the 3500 Deck:

Note:

The alignment of the 3500 deck is undertaken prior to the alignment of the 3400 deck in order to simplify the overall procedure.

a) disconnect P-3011 from J-3503. This removes the HFO input from the RF Tuner. Set MC nixie selector to a BLANK position.

b) disconnect P-3014 from J-3501. This removes the 1 mc input to the 3500 deck.

c) alignment of the 40.5 mc IF Amplifier Chain:

(1) connect an RF signal generator at 40.5 mc to TP-3509. In this and subsequent steps, reduce the signal generator output to the minimum required for an adequate indication to prevent overloading and to discourage oscillation.

(2) connect the indicator (VTVM or scope) to TP-3504. Adjust C-3623 for maximum indication.

(3) connect the indicator to TP-3505. Adjust C-3628 for maximum indication.

(4) connect the indicator to TP-3506. Adjust C-3634 for maximum indication.

(5) connect the frequency counter to TP-3506 after removing the indicator. The counter should read 40.5 mc plus or minus 3 KC.

(6) remove the signal generator and counter. This strip will be "peaked" again after the alignment of the 3400 deck.

d) set the MC nixie selector to "02". (48.5 mc)

e) connect the RF indicator to pin 6 of V-3505 by means of a tube socket adapter, with the tube inserted.

f) adjust C-3501 for maximum indication on the indicator.

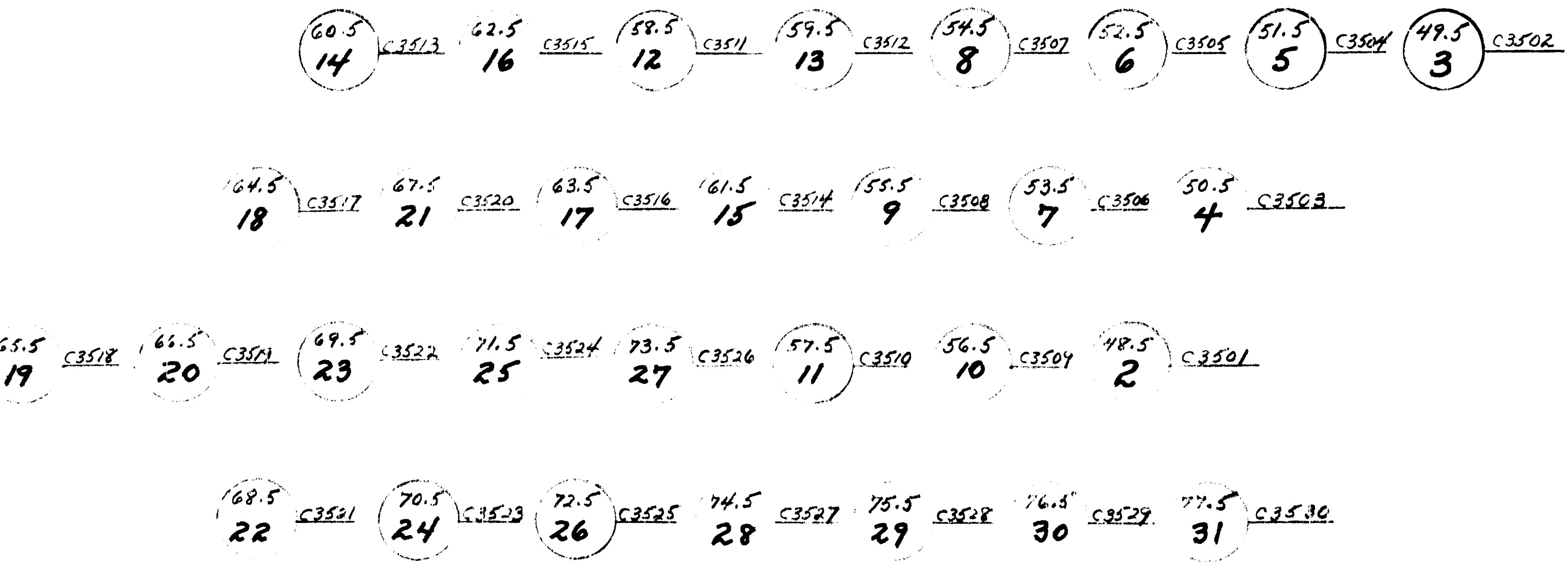
g) set the MC **nixie** selector to the positions listed below; adjust the corresponding capacitor for maximum indication on the RF indicator connected to pin 6 of V-3505.

3	C-3502	49.5 mc
4	C-3503	50.5 mc
5	C-3504	51.5 mc
6	C-3505	52.5 mc

7	C-3506	53.5 mc
8	C-3507	54.5 mc
9	C-3508	55.5 mc
10	C-3509	56.5 mc
11	C-3510	57.5 mc
12	C-3511	58.5 mc
13	C-3512	59.5 mc
14	C-3513	60.5 mc
15	C-3514	61.5 mc
16	C-3515	62.5 mc
17	C-3516	63.5 mc
18	C-3517	64.5 mc
19	C-3518	65.5 mc
20	C-3519	66.5 mc
21	C-3520	67.5 mc
22	C-3521	68.5 mc
23	C-3522	69.5 mc
24	C-3523	70.5 mc
25	C-3524	71.5 mc
26	C-3525	72.5 mc
27	C-3526	73.5 mc
28	C-3527	74.5 mc
29	C-3528	75.5 mc
30	C-3529	76.5 mc
31	C-3530	77.5 mc

Model HFS-1: Identification of Piston Capacitors on 3500 Deck:

Unit viewed from top, front. Upper numeral identifies crystal frequency; lower numeral identifies NIXIE indicator position.



h) alignment of the 43.75 - 44.75 mc IF amplifier chain:

(1) connect a signal generator at 44.25 mc (the mean frequency), to TP-3508. Maintain the generator output at the minimum required for an indication of tuning during subsequent steps. Set the MC nixie selector to a BLANK position.

(2) connect a VTVM to TP-3501.

(3) adjust C-3581 for maximum indication. Reduce the signal generator output to zero. The indication should drop to zero; if it does not, the stage is oscillating. Repeat step (3) at another point, until an indication can be obtained which follows the signal generator output amplitude.

(4) adjust C-3582 for MINIMUM indication.

(5) connect the RF indicator to TP-3502.

(6) adjust C-3588 for maximum indication and C-3590 for MINIMUM indication.

(7) connect the indicator to TP-3503. Adjust C-3593 for maximum indication. Remove the RF indicator.

(8) reconnect P-3011 to J-3503 and P-3014 to J-3501. Connect the frequency counter to TP-3503. Remove signal generator.

(9) set up the RF tuner at any even mc; say, for example: 2.0 mc.

(10) set up the nixie selectors to the same frequency: 02.0000.

(11) the counter should read in the vicinity of 44.75 mcs; move the tune control to 2.99 mcs; the counter should read in the vicinity of 43.75 mcs.

i) alignment of T-3504 and T-3406: (3400 and 3500 decks)

(1) connect the RF indicator to TP-3507.

(2) set the nixie selectors to 02.0000 and the RF tuner to 2.5 mcs.

(3) adjust T-3504 for maximum indication.

(4) connect the RF indicator to TP-3408.

(5) adjust T-3406 for maximum indication.

(6) rock the tune control from 2.0 to 2.99 mcs; the indication should be reasonably constant, with a peak at 2.5 mcs. if the dropoff at the ends is extreme, T-3504 and T-3406 may be adjusted to emphasize either the "highs" or "lows".

j) alignment of the 1 and 2 mc circuits, 3500 deck:

(1) connect the RF indicator to J-3019 (1 mc output)

(2) adjust T-3505 for maximum indication.

(3) connect the indicator to J-3010, 11, 12, or 13: (2 mc output)

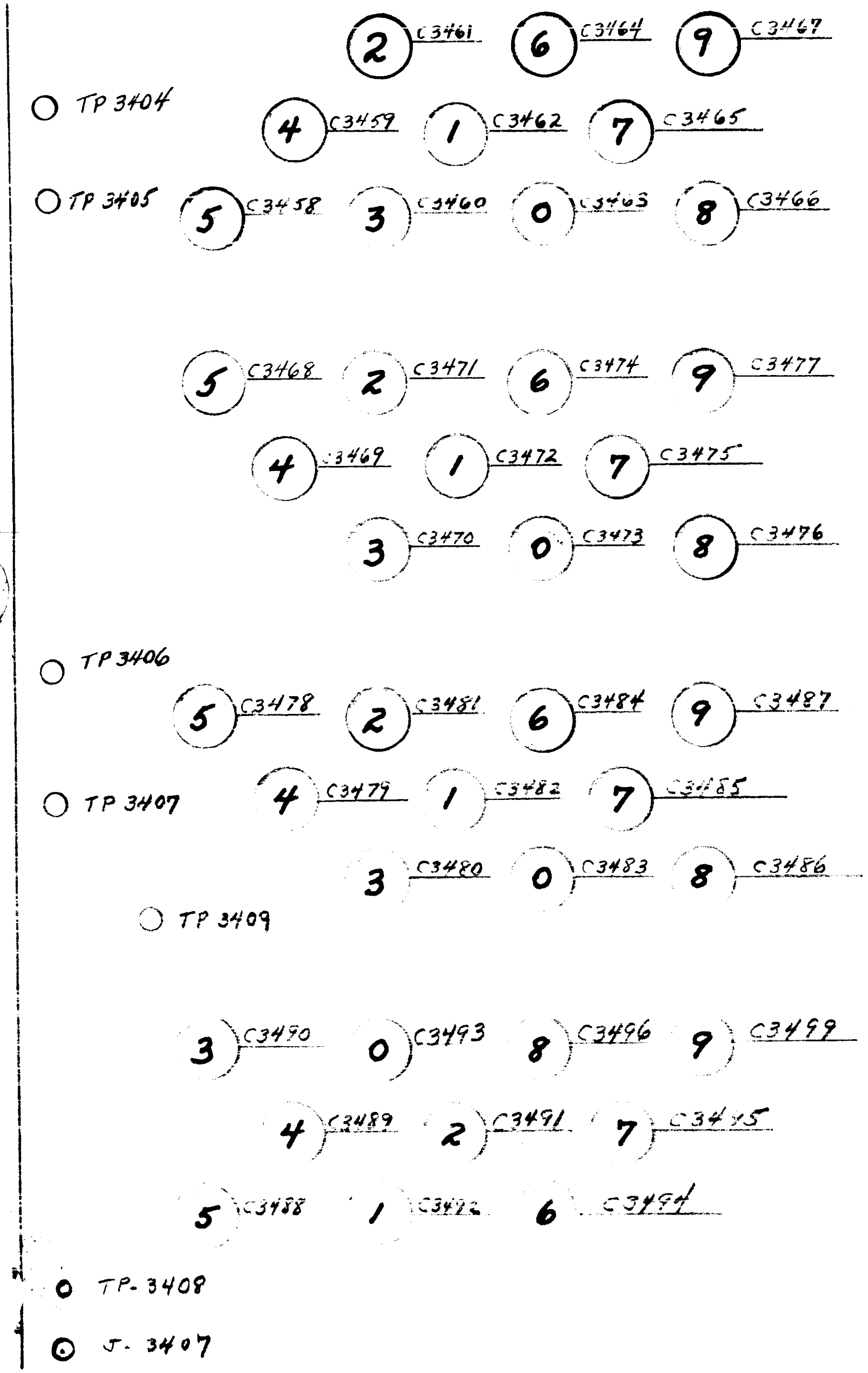
(4) adjust T-3503 for maximum indication. Note the waveform charts; an oscilloscope is preferred for this adjustment.

(5) remove the RF indicator.

This completes the alignment of the 3500 deck.

Mod 1 HFS-1: Identification of Piston Capacitors on 3400 Deck:

Unit viewed from top, front. Numerals in center indicate NIXIE indication at which capacitor is aligned.



15. Alignment of the 3400 deck:

a) connect the oscilloscope to TP-3404. Place the 100 KC nixie selector to position "0" (3.8 mc)

b) adjust C-3454, then C-3463, for maximum indication.

c) set the 100 KC nixie selector to the positions listed below, and adjust the corresponding capacitors for maximum indication.

1	C-3453	C-3462	3.7 mc
2	C-3452	C-3461	3.6 mc
3	C-3451	C-3460	3.5 mc
4	C-3450	C-3459	3.4 mc
5	C-3449	C-3458	3.3 mc
6	C-3448	C-3464	3.2 mc
7	C-3457	C-3465	3.1 mc
8	C-3456	C-3466	3.0 mc
9	C-3455	C-3467	2.9 mc

d) remove P-3303 from J-3404. Connect the oscilloscope to J-3404. Adjust R-3432 for MINIMUM indication on the oscilloscope . Remove the scope probe. Reconnect P-3303 and J-3404.

e) connect the scope probe to TP-3405.

f) set the nixie selectors as follows:

.1 KC selector	"0"	4 KC	
1 KC selector	"0"	36 KC	
10 KC selector	"9"	320 KC	
100 KC selector	"0"	3.8 MC	
		4.16 MC	total

g) locate the anode of CR-3413 on the terminal board, underneath the 3400 deck. Ground this point. This disables the AGC loop to obtain an indication of tuning.

h) adjust C-3473 for maximum indication on the oscilloscope.

i) set the 100 KC selector to the following positions, adjusting the indicated capacitors for maximum indication.

1	C-3472	4.06 mc
2	C-3471	3.96 mc
3	C-3470	3.86 mc
4	C-3469	3.76 mc
5	C-3468	3.66 mc
6	C-3474	3.56 mc
7	C-3475	3.46 mc
8	C-3476	3.36 mc
9	C-3477	3.26 mc

j) connect the scope probe to TP-3406. Set the nixie selectors as follows:

.1 KC selector	"0"	4 KC	
1 KC selector	"0"	36 KC	
10 KC selector	"1"	400 KC	
100 KC selector	"0"	3.8 MC	
		4.24 MC	total

adjust C-3483 for maximum indication.

k) advance the 100 KC selector to "1" (4.14 mc)
adjust C-3482 for maximum indication.

l) advance the 100 KC selector to the positions indicated below, to generate the total frequencies shown. Adjust the indicated capacitors for maximum indication on the oscilloscope.

2	4.04 mc	C-3481
3	3.94 mc	C-3480
4	3.84 mc	C-3479
5	3.74 mc	C-3478
6	3.64 mc	C-3484
7	3.54 mc	C-3485
8	3.44 mc	C-3486
9	3.34 mc	C-3487

m) remove the ground from the anode of CR-3413.
Leave the scope probe at TP-3406.
Set the 100 KC, 10 KC, 1 KC and .1 KC nixie selectors to "0".

n) while observing the oscillocope, advance the 10 KC, 1 KC and .1 KC selectors to "9", in succession. The amplitude should not change more than 3 db.

o) advance the 100 KC selector to "1". Then retard the 10 KC, 1 KC and .1 KC selectors to "0", in succession. The amplitude should not change more than 3 db.

p) advance the 100 KC selector to "2". Then advance the 10 KC, 1 KC and .1 KC selectors to "9", in succession. The amplitude should not change more than 3 db.

q) continue this procedure for the remaining positions of the 100 KC selector.

r) alignment of the 4.25 - 3.25 mc amplifier:

(1) set the 100 KC selector to "0", the MC selector to "02".

(2) on the RF tuner, set the band and tune controls for a frequency of 2.05 mcs. This corresponds to a synthesizer frequency of 4.2 mcs from the 3500 deck into J-3407.

(3) connect the RF indicator to TP-3407.

(4) adjust C-3493 for maximum indication.

(5) carefully rock the TUNE control plus and minus 50 KC around 2.05 mcs. The amplitude at TP-3407 should remain within 3 db.

(6) repeat this procedure for the remaining positions of the 100 KC selector. The associated RF tuner frequencies, capacitor adjustments, and synthesizer frequencies are listed.

1	2.15 mc	C-3492	4.1 mc
2	2.25 mc	C-3491	4.0 mc
3	2.35 mc	C-3490	3.9 mc
4	2.45 mc	C-3489	3.8 mc
5	2.55 mc	C-3488	3.7 mc
6	2.65 mc	C-3494	3.6 mc
7	2.75 mc	C-3495	3.5 mc
8	2.85 mc	C-3496	3.4 mc
9	2.95 mc	C-3497	3.3 mc

(7) remove the indicator from TP-3407.

Title: Model HFR-1 Continuous RF Tuner

Military Nomenclature:

Tuner, R.F.: TN-376/UR

Objectives:

a) to discuss the role of the Model HFR-1 in the DDR-5 receiving system.

b) to discuss the circuitry of the Model HFR-1, pointing up significant circuit parameters and characteristics.

c) to demonstrate, with appropriate test equipment, the alignment of the unit.

d) to discuss the interconnection of the Model HFR-1 with other units of the DDR-5 receiving system.

References:

a) CK-601: complete schematic, Model HFR-1.

b) CK-546: complete schematic, Model HFP-1 Power Supply.

Training Aids:

a) Model HFR-1 installed in complete receiving system, ready for operation.

b) VTVM: H.P. Model 410B, or equivalent.

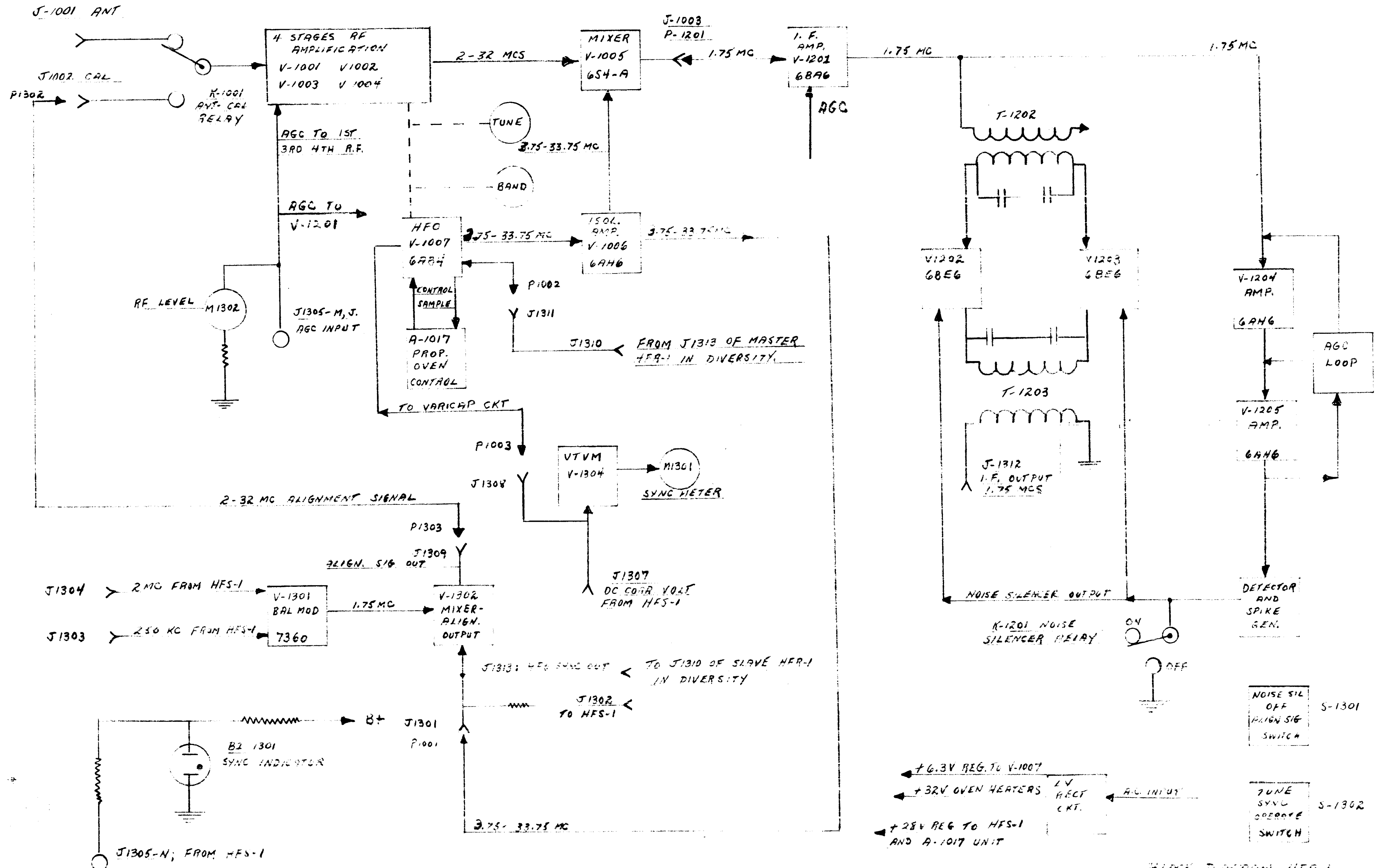
c) Oscilloscope: Tektronics Model 545A, or equivalent.

d) Signal Generator: Measurements Corp. Model 82, or equivalent.

e) Frequency Counter: H.P. Model 524C, or equivalent.

Introduction:

The Model HFR-1 is the "front end" of the Model DDR-5 receiving system. It contains, like other front ends, RF amplifier, mixer and oscillator circuits; these circuits are anything but "usual", however. They have been carefully refined to insure stability, excellent sensitivity, a good noise figure, excellent image and spurious frequency rejection, and ease of tuning with an absolute minimum of controls.



BLOCK DIAGRAM HFR-1
7-62

Presentation:

A. General Description and Orientation:
(to be accomplished with actual HFR-1 Unit and the General simplified block diagram)

1. The Model HFR-1 is an RF tuning unit designed for either synthesized operation in 100 cycle steps or non synthesized coverage in the frequency range 2-32 mcs, in eight bands, as listed below:

BAND	FREQUENCY RANGE
1	2 - 3 mc
2	3 - 4 mc
3	4 - 6 mc
4	6 - 8 mc
5	8 - 12 mc
6	12 - 16 mc
7	16 - 24 mc
8	24 - 32 mc

2. The BAND control mechanically rotates the slide rule type dial, mounted on an illuminated cylinder, and a drum type turret assembly, which engages the appropriate components for operation on the selected frequency band.

3. The TUNE control moves the hairline of the slide rule dial along the illuminated cylinder, and tunes a multi-gang capacitor in the RF and HFO circuits, to select a particular frequency. This control is fitted with a lock.

4. The input signal is applied to four stages of RF amplification. The input signal may arrive at the antenna jack, J-1001, or from an alignment generator at J-1002, depending on the position of K-1001, the ANT - CAL relay, which is controlled by the NOISE LIMITER - OFF - ALIGNMENT SIGNAL switch on the front panel.

5. AGC voltage is applied to the 1st, 3rd and 4th RF amplifiers; the AGC voltage is applied to the first stage via a delay network.

6. The output of the RF amplifier chain, in the range 2-32 mc, is applied to a mixer stage, V-1005. The second input to V-1005 arrives from the HFO circuit via an isolation amplifier stage, V-1006. The HFO input tracks 1.75 mc above the incoming RF signal. The significant output at the mixer plate is an IF signal at a frequency of 1.75 mcs.

7. The HFO circuit is contained in a carefully designed oven, regulated by a proportional oven control, A-1017. The temperature in the oven is maintained at 75 degrees, (C), plus or minus ½ degree, over an ambient temperature range of 0-50 degrees (C). The oscillator frequency is controlled, over a limited range, by a VARICAP circuit which receives a DC control voltage from the Model HFS-1 synthesizer unit.

8. A front panel RF LEVEL meter is calibrated in db above 1 microvolt. This meter is associated with the AGC circuit. The meter is operated by the AGC voltage, which increases with signal strength.

9. The alignment generator consists of two stages; V-1301, a special balanced modulator circuit, and V-1302, a mixer circuit. V-1301 receives two synthesized frequencies from the Model HFS-1: one at 250 KC, the other at 2.0 mcs. The resulting 1.75 mc synthesized frequency is fed to mixer V-1302. The second input to V-1302 arrives from the HFO isolation amplifier, V-1006, at J-1301. This is a signal in the range 2.75 - 33.75 mcs. The difference frequency output is a signal in the range 2-32 mcs. This signal leaves the alignment generator at J-1309, and is applied to the input circuit of the receiver at J-1002. Thus, the Model HFR-1 contains its own signal generator, which is used for calibration and sensitivity checks.

10. The HFO frequency from the isolation amplifier, V-1006, leaves the HFR-1 at J-1302; this output is applied to the Model HFS-1, for use in the high frequency deck.

11. Another HFO output is available at J-1313. For single receiver operation, this jack is terminated. For diversity operation, this output is connected to J-1310 of the slave HFR-1.

12. J-1310 connects to the HFO circuit via J-1311 and P-1002. For single receiver operation, this jack is terminated. For diversity operation, the HFO output from the master HFR-1 at J-1313 is inserted. In this manner, the master HFO controls both units.

13. The IF output of the mixer, V-1005, is applied to the IF output amplifier - noise silencer circuits via J-1003 and P-1201. The signal undergoes amplification in V-1201, and is then applied:

a) in push-pull to grid #3, pin 7, of IF output stages V-1202 and V-1203.

b) to AGC amplifier V-1204.

14. V-1204 and V-1205 are high gain, cascade stages tuned to 1.75 mcs. Associated with these stages is an AGC loop which affects only these two stages. The output of V-1205 is applied to a spike generator circuit; this circuit consists of a pulse detector which produces negative spikes corresponding to impulse noise. The spikes are applied to the control grid circuits of the IF output amplifiers, in parallel, nullifying the effects of impulse noise.

15. The push-pull output of V-1202 and V-1203 is converted to a single ended output in an RF transformer. This output is made available at the IF output jack, J-1312.

16. The noise silencer circuit may be circumvented by means of K-1201, the noise silencer relay, and a front panel switch. In the noise silencer OFF condition, K-1201 grounds the output of the spike generator circuit.

17. A SYNC indicator lamp is mounted on the front panel of the HFR-1. This indicator is controlled from the HFS-1 unit. When the system is synchronized, J-1305-N is ungrounded; B Plus is applied to the high side of the SYNC indicator, BI-1301, causing it to light. When the system is not synchronized, a ground is applied at J-1305-N. This reduces the voltage at the high side of BI-1301, and the lamp does not light.

18. A low voltage rectifier circuit is incorporated in the Model HFR-1 unit. This system furnishes:

a) regulated 6.3 volts DC to the HFO filament, V-1007.

b) Plus 32 volts for the HFO oven heater circuits.

c) regulated Plus 28 volts for the proportional oven control unit, A-1017, and the primary standard unit, Z-1301, in the Model HFS-1.

19. The DC correction voltage from the HFS-1 connects to a VTVM circuit, V-1304, the output of which is applied to the front panel SYNC meter, M-1301. The meter reads center scale when the unit is in sync. The offcenter reading of the meter is an indication of the amount of DC correction voltage required to maintain the HFO at the correct frequency.

20. The TUNE - SYNC - OPERATE switch, S-1302, performs the following functions:

a) TUNE position:

(1) grounds the DC correction voltage from the HFS-1 unit, causing the SYNC meter to read center scale and the HFO circuit to operate uncontrolled.

(2) de-energizes the AUDIO SYNC TONE relay in the Model HFA-1 unit, removing the audio sync tone.

b) SYNC position:

(1) grounds the DC correction voltage from the HFS-1.

(2) energizes the AUDIO SYNC TONE relay in the Model HFA-1; this inserts the sync tone from the HFS-1 into the audio chain of channel "A".

c) OPERATE position:

(1) applies the DC correction voltage from the HFS-1 to the HFO and SYNC meter circuits.

(2) de-energizes the AUDIO SYNC TONE relay.

21. The NOISE SILENCER - OFF - ALIGNMENT SIGNAL switch, S-1301, performs the following functions:

a) NOISE SILENCER position:

(1) energizes the NOISE SILENCER relay, K-1201. This inserts the noise silencer function.

(2) removes B Plus from the alignment generator circuits.

(3) de-energizes the ANT - CAL relay, K-1001. This connects the antenna input jack to the first RF amplifier circuit.

b) OFF position:

(1) de-energizes the noise silencer relay, grounding the output of the noise silencer circuit.

(2) removes B Plus from the alignment generator circuits.

(3) de-energizes the ANT - CAL relay, connecting the antenna input to the first RF stage.

c) ALIGNMENT SIGNAL position:

(1) de-energizes the noise silencer relay, removing the output of the noise silencer circuit.

(2) applies B Plus to the alignment generator circuits.

(3) energizes the ANT - CAL relay, K-1001, which inserts the output of the alignment generator at the receiver input and disconnects the antenna jack.

B. Detailed Discussion of HFR-1 Circuitry:

(refer to CK-601: complete schematic, Model HFR-1)

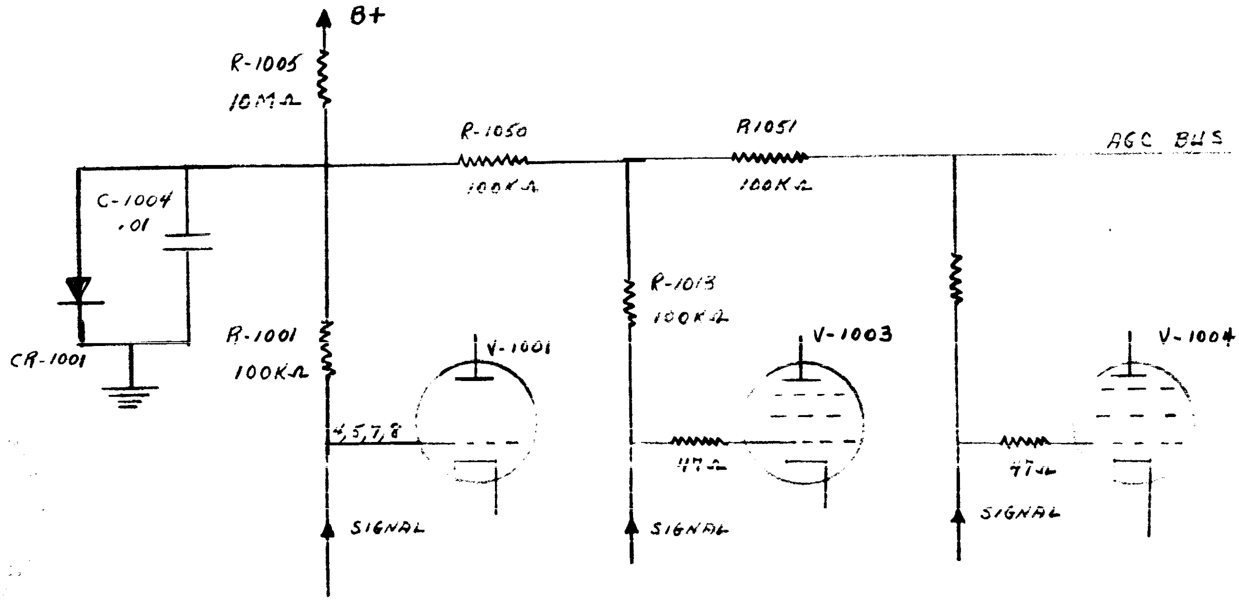
1. Input Circuits and RF Amplifier Chain:

a) the antenna input is connected at J-1001; the output of the alignment generator is connected at J-1002. The ANT - CAL relay, K-1001, determines which of these inputs is connected to the RF amplifier chain.

b) ANT - CAL relay K-1001 is operated by the NOISE SILENCER OFF ALIGNMENT SIGNAL switch, S-1301. In the ALIGNMENT SIGNAL position of this switch, the relay is energized and connects the output of the alignment generator to the receiver input circuits. This switch also applies B Plus to the alignment generator only in this position. In the other positions of S-1301, the antenna input is connected to the receiver and the alignment generator is inoperative.

c) the RF amplifier chain consists of four tuned RF stages, V-1001, V-1002, V-1003 and V-1004. V-1001 is a low noise triode connected in a cascode arrangement with V-1002. Low noise rather than gain is the primary consideration in these stages. V-1003 and V-1004 are conventional tuned RF stages. The plate circuit of V-1001 contains a fixed, broad tuned circuit, the signal from which is coupled to the cathode circuit of V-1002, operated as a grounded grid stage.

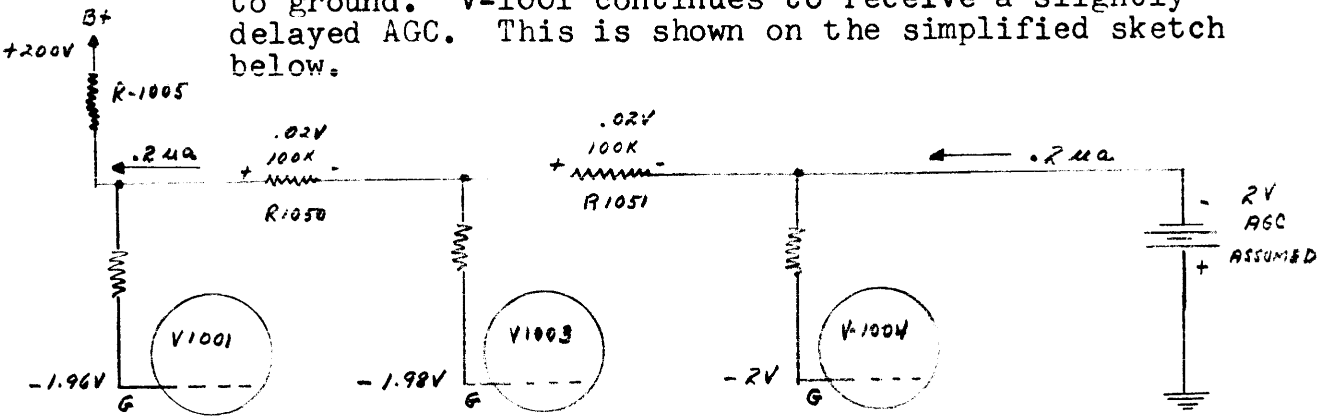
d) all four RF stages employ cathode bias. AGC from the AGC bus is applied to the control grid circuits of the 1st, 3rd and 4th RF stages. A delay circuit is incorporated, with maximum delay to V-1001. A simplified sketch of the AGC arrangement is shown below:



(1) CR-1001 and R-1005 form a voltage divider to B Plus. With no AGC input, this places the junction of R-1001 and R-1005 at a very slight positive potential.

(2) The effect of an AGC voltage developed by very weak signals is felt at V-1003 and V-1004 before it is realized at V-1001.

(3) with normal signal inputs, CR-1001 is cut off; the voltage divider network now extends from B Plus, through R-1005, R-1050, R-1051, and the AGC supply, to ground. V-1001 continues to receive a slightly delayed AGC. This is shown on the simplified sketch below.



e) the main tuning capacitor, C-1001, rotated by the TUNE control, is an eight section ganged unit. The eight sections are divided into four groups, each group containing a pair of sections, as follows:

SECTION	VALUE	USE
C-1001A	9 - 108 uuf	input tuned circuits
C-1001B	8 - 54 uuf	input tuned circuits
C-1001C	9 - 108 uuf	interstage, 2nd, 3rd RF
C-1001D	8 - 54 uuf	interstage, 2nd, 3rd RF
C-1001E	9 - 108 uuf	interstage, 3rd, 4th RF
C-1001F	8 - 54 uuf	interstage, 3rd, 4th RF
C-1001G	9 - 108 uuf	RF output
C-1001H	8 - 54 uuf	RF output

f) tuned circuit elements for each stage are mounted on a revolving turret. One removable circuit board is provided for each of the eight receiver bands. As the BAND control is rotated to expose the desired frequency range on the illuminated slide rule dial, the turret contacts engage fixed contacts on the main chassis, to engage the required elements.

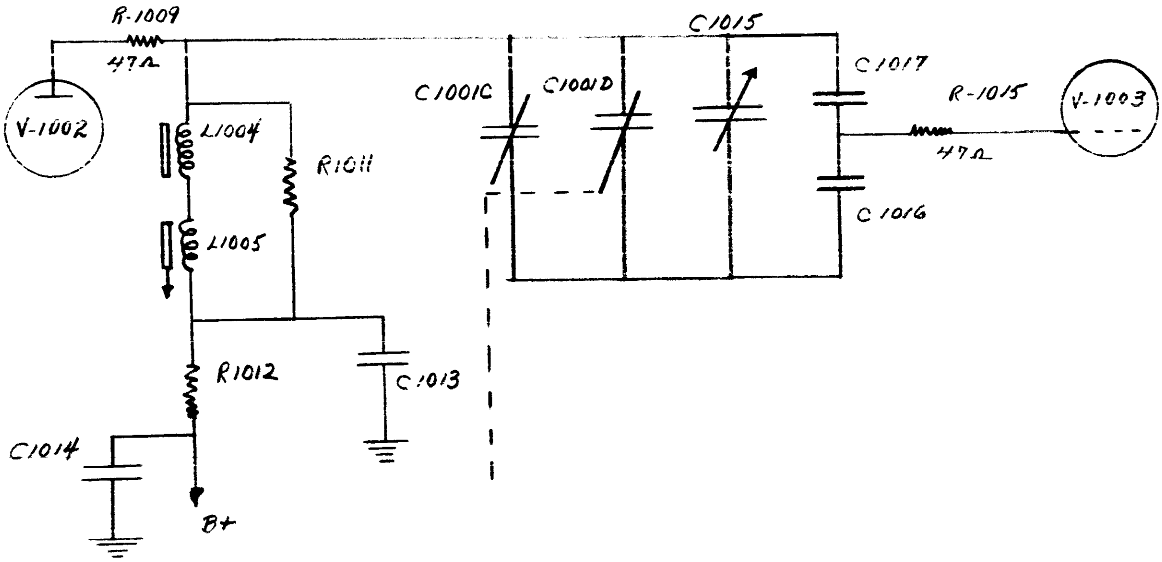
g) note that both capacitor sections may not be employed on each band. For example: consider bands 1, 2 and 6 with regard to the receiver input circuits:

(1) on Band 1, both C-1001A and B are used.

(2) on Band 2, only C-1001A is used.

(3) on Band 6, only C-1001B is used.

h) the simplified circuit below shows the components in the circuit between V-1002 and V-1003 in the Band 1 position.



(1) R-1009 and R-1015 are parasitic suppressors.

(2) L-1004 is a fixed toroid coil. L-1005 is a slug tuned coil, adjusted at the low end of the tuning range.

(3) R-1011 is a swamping resistor, to adjust the circuit Q for the required bandpass.

(4) C-1013 is an RF bypass capacitor. This element places the "bottom" of the tank at RF ground.

(5) R-1012 and C-1014 form a decoupling network.

(6) C-1001C and C-1001D are the main tuning capacitors inserted by the turret contacts.

(7) C-1015 is the trimmer adjustment for this section, paralleling the main tuning capacitor. It is adjusted at the high end of the tuning range.

(8) C-1016 and C-1017 form a capacitive voltage divider across the tuned tank. This determines the "drive" to the following stage, and the impedance presented to the following stage.

2. The First Mixer Circuit:

a) the HFO frequency, in the range 3.75 - 33.75 mcs, is applied at the cathode circuit of the mixer, V-1005.

b) the output of the RF amplifier chain, in the range 2-32 mcs, is applied to the control grid circuit of the mixer.

c) cathode bias places the control grid of V-1005 at about -11 volts negative with respect to the cathode. Both input signals are held below 1 volt RMS. This combination reduces intermodulation products in the converted output signal about 60 db below the desired output signal.

d) the converter plate circuit contains a tuned RF transformer, T-1002, resonant at 1.75 mcs, and designed to allow the full bandpass of more than 15 KCS. The low impedance secondary output is applied at J-1003, the 1.75 mc jack on the RF chassis.

3. The HFO (High Frequency Oscillator) and Isolation Amplifier:

a) V-1007 is the HFO; V-1006 is an isolation amplifier.

b) the oscillator tuning capacitor, C-1002, is a 2 gang section connected to the shaft of the RF tuning capacitor through the oven wall, by means of an insulated bushing.

c) a turret and circuit board arrangement similar to that in the RF amplifier chain is employed. The oscillator turret shaft is connected to the RF turret shaft through the oven wall.

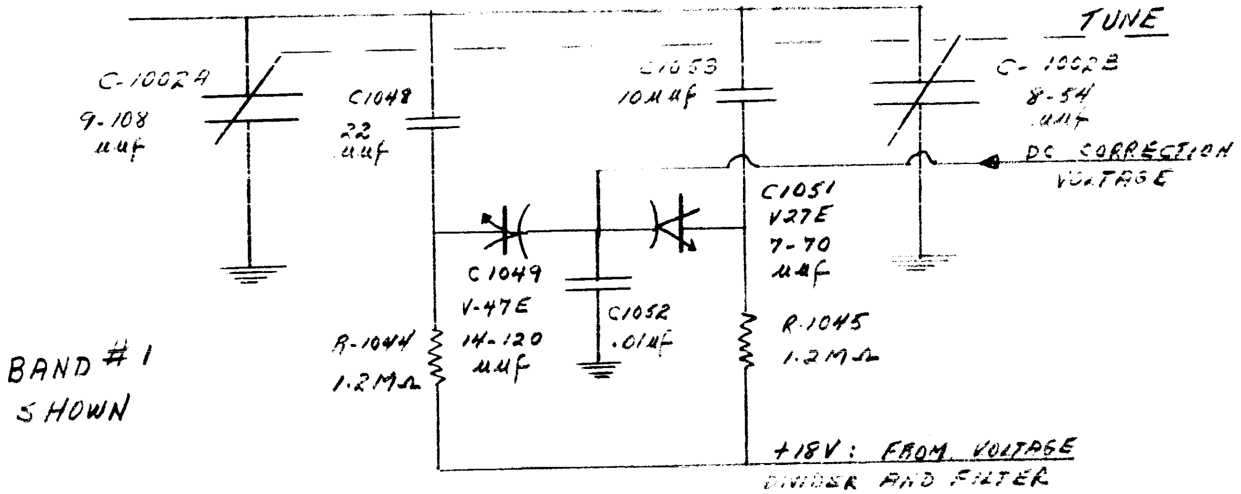
d) inductors L-1013, L-1021, L-1053, L-1054, L-1055, L-1042B, L-1047B and L-1052B are inserted on bands 1 through 8, respectively, to adjust the HFO frequency at the low ends of the bands.

e) trimmers C-1047, C-1073, C-1093, C-1113, C-1132, C-1151, C-1172 and C-1193 are inserted on bands 1 through 8, respectively, to adjust the HFO frequency at the high ends of the bands.

f) the adjustments referred to in (d) and (e) are reached via two orfices in the top cover of the oscillator oven. These orfices are marked "L" and "C". The special tools furnished should be used for adjustments. The BAND control should not be moved with these tools inserted.

g) the HFO is a modified Colpitts (Vackar) circuit enclosed in an oven. A proportional control amplifier regulates the oven temperature to 75 degrees Centigrade plus or minus ½ degree C for an ambient temperature range of 0 degrees to 50 degrees C.

h) the HFO frequency is controlled, in synthesized operation of the receiver, by a Varicap arrangement, the simplified circuit of which is shown below. The DC correction voltage from the synthesizer arrives at P-1003 from J-1308.



(1) a voltage divider and filter places 18 volts at one end of the 1.2 Megohm resistors, R-1044 and R-1045. The DC correction voltage changes the difference of potential across the Varicaps, thereby changing the capacity shunting C-1002.

(2) note that both sections of C-1002 are not always utilized. For example: consider Bands 1, 5 and 8:

On Band 1, both sections are used.
On Band 5, only C-1002A is used.
On Band 8, only C-1002B is used.

(3) regardless of the setting of the BAND control, at least 1 Varicap control is inserted to "pull" the frequency as required.

i) the output of the HFO at pin 6 is applied to the control grid circuit of isolation amplifier V-1006.

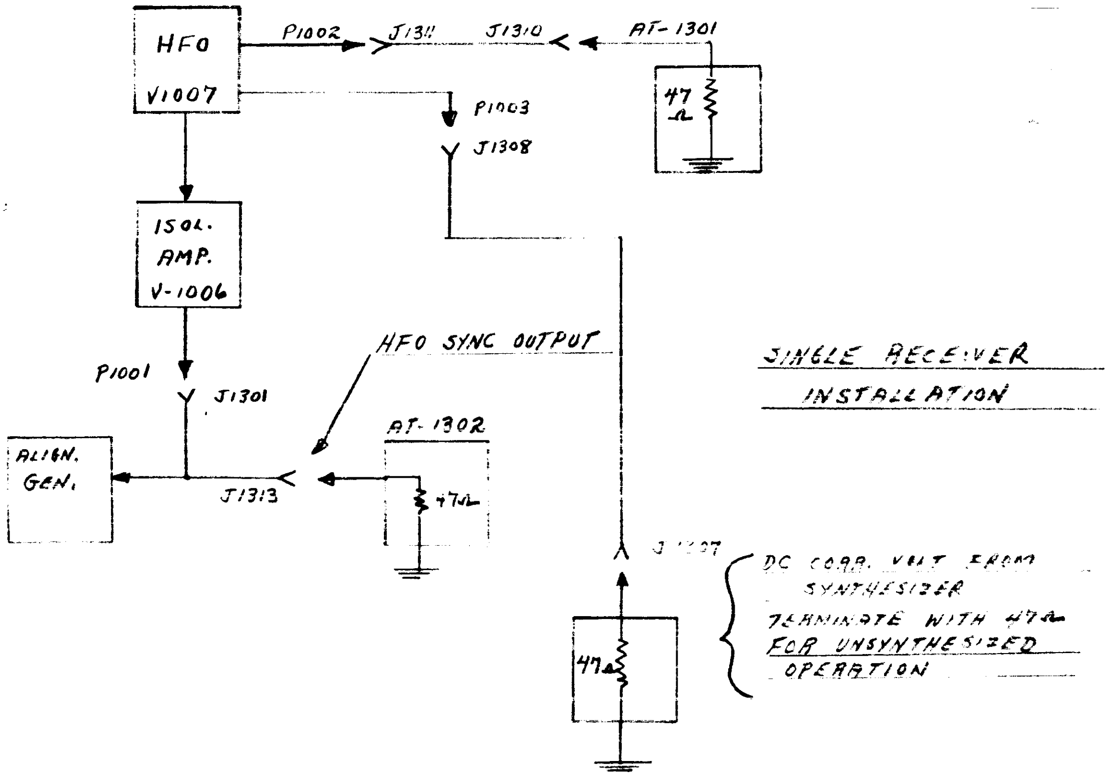
j) the output of the isolation amplifier, at the plate, is delivered to the cathode circuit of the first mixer.

k) the output of the isolation amplifier at the cathode is delivered to J-1301 via P-1001. This connection will be discussed subsequently.

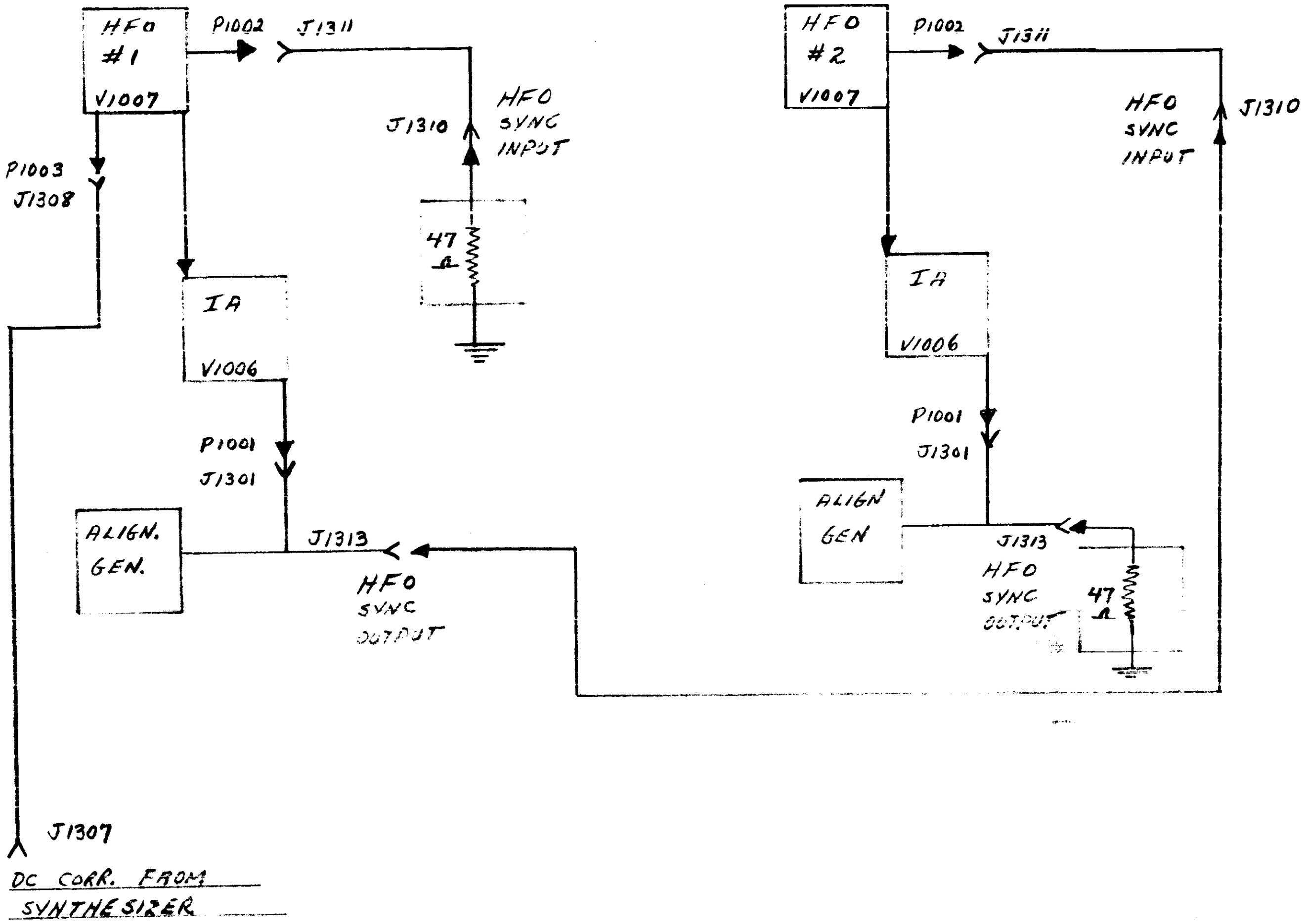
l) the connection at P-1002 should be noted. This may be an input, an output, or a terminated connection, depending on the configuration of the installation, as indicated below:

(1) in a single receiver installation, P-1002 connects to J-1311. J-1311 connects to J-1310, which is terminated with a 47 ohm resistor.

(2) in a dual receiver installation, the "slave" HFR-1, (RCVR #2), receives the HFO SYNC OUTPUT of the "master", (RCVR #1), at J-1310.



Dual Receiver Operation:



m) note the following with respect to the oven:

(1) RT-1001 is a thermistor, which changes its resistance with changes in the temperature surrounding it. This element senses changes in the oven temperature and transmits thes changes to the proportional oven control.

(2) HR-1001 and HR-1002 are the oven heater elements. The common side of these elements is connected to a plus 32 volt supply. The other sides are connected to outputs on the proportional oven control.

(3) the proportional oven control receives the "temperature change" information from the thermistor element, and changes the conduction through the oven heater elements in accordance with these changes, to maintain a constant oven temperature.

(4) the filament of the HFO, V-1007, is fed with 6.3 volts DC, regulated.

4. The IF and Noise Silencer Circuits:

a) the 1.75 mc first IF frequency, with full bandpass, arrives at T-1201 from the mixer circuit, via J-1003, and P-1201. T-1201 is peaked at 1.75 mcs; a 15 K ohm swamping resistor in the secondary assures that the full bandpass is preserved.

b) V-1201 is a 1.75 mc IF amplifier, which receives AGC from the AGC bus. T-1202 is a double tuned RF transformer, the secondary of which is configured to provide "push pull" inputs to the pin 7 grids of V-1202 and V-1203, the push pull output IF amplifier stage.

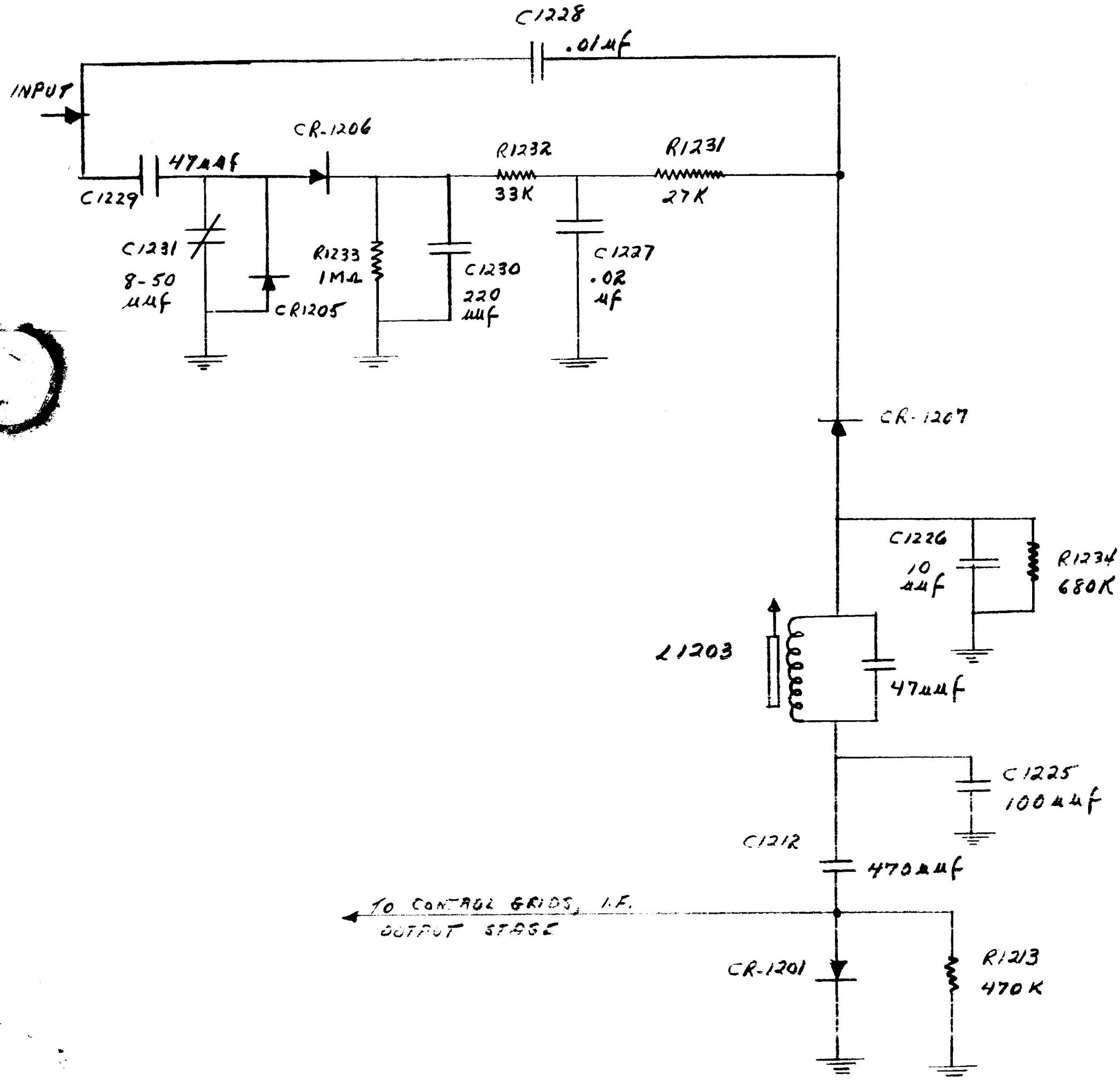
c) the control grids (pin 1) of V-1202 and V-1203 may receive negative spikes, corresponding to impulse noise, from the noise silencer circuits. When the NOISE SILENCER OFF ALIGNMENT SIGNAL switch, S-1301, is in the OFF position, the grids (pin 1) are grounded through 47 ohm resistors R-1211 and R1212 via the noise silencer relay, K-1201. In any event, the control grids do not affect the operation of this circuit, except in the prescence of impulse noise, with the NOISE SILENCER OFF ALIGNMENT SIGNAL switch in the NOISE SILENCER position. The negative spikes cut off V-1202 and V-1203 for the duration of the spikes.

d) the plate circuits of V-1202 and V-1203 connect to T-1203, an RF transformer configured to change the push pull output to a single ended 50 ohm output, which is made available at J-1312.

e) the output of the first IF amplifier, V-1201, is coupled to two high gain, cascade stages, V-1204 and V-1205, via coupling capacitor C-1205.

f) V-1204 and V-1205 are tuned RF circuits, incorporated to amplify the IF sufficiently to operate the pulse detector and spike generator circuits which follow. These two stages contain their own AGC loop, to improve stability.

g) the output of the two stage AGC amplifier chain is applied to a pulse detector and negative spike generator circuit, a simplified version of which is sketched below:



(1) the output at the plate of the second AGC amplifier, V-1205, is applied simultaneously to C-1228 and C-1229.

(2) on the negative excursions of the input signal, C-1229 discharges via CR-1205. On the positive excursions, a positive voltage is developed at the cathode of CR-1206. Filtering and voltage reduction takes place in the network composed of R-1233, C-1230, R-1232, C-1227 and R-1231. Since trimmer C-1231 shunts the charge path of CR-1206, this capacitor can be used to adjust the voltage output of this rectifier filter network.

(3) the positive voltage output of this circuit is applied as back bias on diode CR-1207. At this point, the signal from the plate of V-1205 is also applied.

(4) when impulse noise is present on the input signal, the positive impulses drive CR-1207 deeper into cutoff. If the impulse noise is of sufficient amplitude, the negative impulses develop sharp negative spikes, which are developed across C-1226 and R-1234. These are applied, via coupling circuit C-1212 and R-1213, to the control grid circuits of the push pull IF output amplifier tubes, V-1202 and V-1203.

(5) L-1203 is a 1.75 mc trap, peaked at that frequency to prevent feedback.

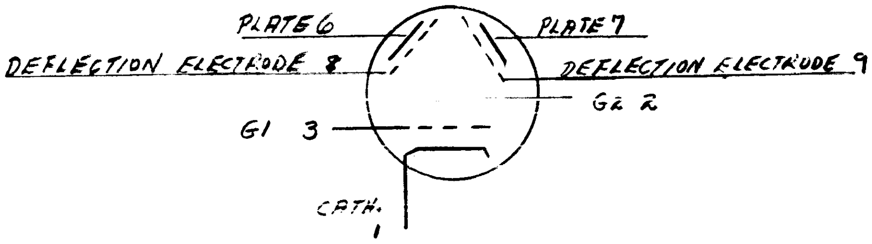
(6) CR-1201 is a negative clamper, clamping the negative spikes below the zero reference.

(7) the alignment of these circuits will be covered thoroughly in the alignment section.

5. The Alignment Generator Circuits:

a) the alignment generator contains two stages; V-1301 is a balanced modulator, and V-1302 is a mixer.

b) V-1301 employs a type 7360 beam deflection tube in a novel balanced modulator circuit. The sketch below shows the electrode arrangement of this tube.



(1) the total beam current is determined by the voltages on the two grids; the amount of beam current collected by each plate is determined by the difference of potential between the two deflection electrodes.

(2) In operation, the current passes through the two grids. If no deflection voltages are applied, this current passes between the two plates and there is no "plate current". Even if an RF signal is applied to the control grid, there will be no output; the current will vary at the RF rate, but it is the deflection voltages which determine the amount of current received at the plates.

(3) a 2 mc signal from the synthesizer unit arrives at J-1304, and is applied to the control grid.

(4) a 250 KC signal from the synthesizer arrives at J-1303; this is applied to one of the deflection plates, pin 8. Voltage divider networks fix the DC potentials on the deflection plates. With BALANCE adjust R-3109 properly set, only the 1.75 mc difference appears in the output. This is applied, via double tuned RF transformer T-1301, to the cathode circuit of mixer V-1302.

c) the output of the HFO isolation amplifier in the range 3.75 - 33.75 mcs arrives at J-1301; this is applied to the control grid circuit of mixer V-1302.

d) the plate output is coupled to J-1309, the SIG GEN OUTPUT jack. This is a frequency in the range 2 - 32 mcs. The exact frequency coincides with the setting of the TUNE control on the HFR-1. the output at J-1309 is applied to the ANT CAL relay on the HFR-1 at J-1002.

6. The Sync Meter Amplifier Circuit:

a) when pin 2 of V-1304 is grounded in positions 1 and 2 of S-1302, ZERO ADJUST pot R-1320 is adjusted to bring M-1301, the SYNCHRONIZE meter, to center scale.

b) in the OPERATE position, (3) of S-1302, the DC correction voltage from the synthesizer circuit to the Varicap circuits of the HFO is applied to pin 2. The amplitude and polarity of this voltage will cause the SYNC meter to indicate the amount and direction of the correction voltage required to keep the system in synchronism.

C. Alignment, troubleshooting and testing of the HFR-1:

This section contains:

a) a DC voltage chart of the main chassis and tuner.

b) a DC voltage chart of the proportional oven control.

c) an RF stage gain chart.

d) Field Alignment Instructions.

e) miscellaneous troubleshooting data.

D-C VOLTAGE CHART   HFR-1 (MAIN CHASSIS & TUNER)   CIRCUIT CK 601 SYMBOLS AS SHOWN

SYMBOL & TUBE	FUNCTION	PIN 1	PIN 2	PIN 3	PIN 4	PIN 5	PIN 6	PIN 7	PIN 8	PIN 9
V 1001 417 A	1st RF Amplifier	+118	-	0	+0.43	+0.43	+0.91	+0.43	+0.43	6.3 A-C
V 1002 6AH6	2nd RF Amplifier	0	0	0	6.3 A-C	+154	+145	+1.7	-	-
V 1003 6BA6	3rd RF Amplifier	+0.3	0	0	6.3 A-C	+159	+97	+0.95	-	-
V 1004 6BA6	4th RF Amplifier	+0.2	0	0	6.3 A-C	+155	+107	+0.92	-	-
V 1005 6S4A	1st Mixer	-	+10.5	0	6.3 A-C	0	0	-	-	+187
V 1006 6AH6	Isolation Amplifier	0	+1.72 (I)	0	6.3 A-C	+140	+140	+1.72 (I)	-	-
V 1007 6AB4	HF Oscillator	+112	-	0	+6.3	-1.5 to -2.5 (II)	-1.5 to -2.5 (II)	0	-	-
V 1201 6BA6	1.75 MC IF Amplifier	0 (III)	+1.1	6.3 A-C	0	+177	+103	+1.1	-	-
V 1202 6BE6	1.75 MC Push-Pull IF	0	+1.45 (IV)	6.3 A-C	0	+180	+83	0	-	-
V 1203 6BE6	1.75 MC Push-Pull IF	0	+1.45 (IV)	6.3 A-C	0	+180	+83	0	-	-
V 1204 6AH6	1st Noise Silencer Amp.	0	0	0	6.3 A-C	+170	+142	+1.6	-	-
V 1205 6AH6	2nd Noise Silencer Amp.	0	0	6.3 A-C	0	+170	+143	+1.6	-	-
V 1301 7360	Balanced Modulator	+3.5	+160	0	6.3 A-C	0	+165	+165	+38 (V)	+38 (V)
V 1302 6EW6	RF Align. Output	0	+3.	6.3 A-C	0	+186 (V)	+120 (V)	0	-	-
V 1303 0A2	+150V Voltage Regulator	+150	-	-	0	+150	-	0	-	-
V 1304 12AU7	Meter Sync.	+183	0 (VI)	+9.1 (VII)	0	0	+183	0	+9.1 (VII)	6.3 A-C

(I) J1313 terminated 47 Ω. (II) After Alignment, Band 1 to 8. (III) At Zero signal
(IV) R1210 Adjusted for balance. (V) R1309 Adjusted for balance, S1301 on Align. Signal.
(VI) S1302 on Tune. (VII) R1320 adjusted for balance. All voltages are ± 10%, and referred to ground.

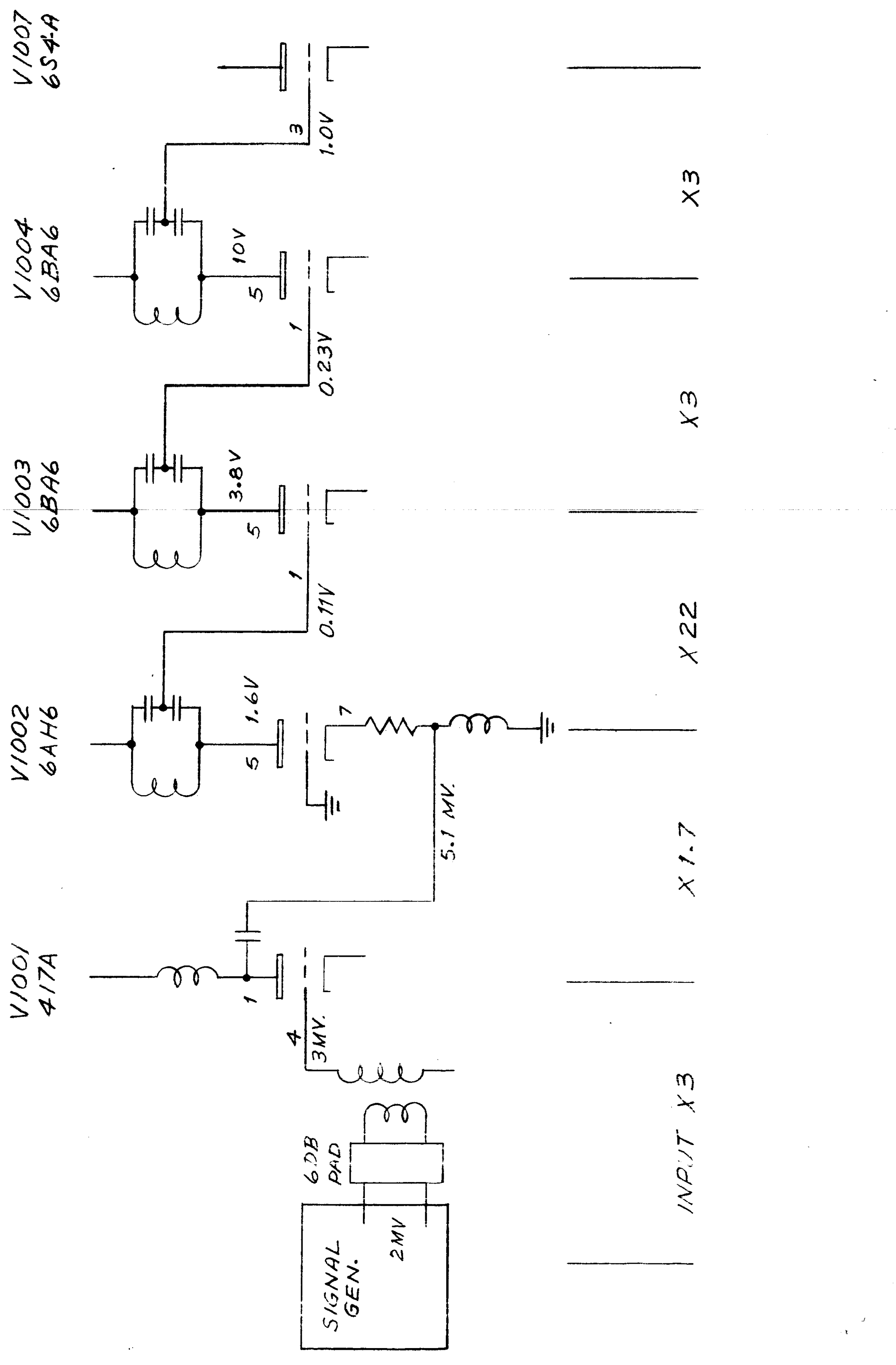
DC VOLTAGE CHART OVEN PROPORTIONAL CONTROL UNIT CIRCUIT CK 601 SYMBOL A1017 & RT1001,HR1001,HR1002

SYMBOL & TYPE	FUNCTION	EMITTER		BASE		COLLECTOR		DIODES	
		Room Temp.	Oven Temp.	Room Temp.	Oven Temp.	Room Temp.	Oven Temp.	Cathode	Anode
Q1 2N338	1st D-C Amplifier	+0.75	+0.75	+0.15	+1.3	+6.9	+3.6		
Q2 2N336	2nd D-C Amplifier	+6.0	+3.6	+6.9	+3.6	+6.8	+15.0		
Q3 2N1701	Driver	+5.3	+3.0	+6.0	+3.6	+5.4	+19.0		
Q4 2N1702	Output	+0.32	+0.17	+5.3	+3.0	+5.4	+19.0		
Q5 2N1702	Output	+0.32	+0.17	+5.3	+3.0	+9.2	+24.0		
CR-1 1N1820	Voltage Regulator							+18.0	0
CR-2 1N758	Voltage Regulator							+9.3	0
CR-3 SG22	Emitter Bias							0	0.75

J1	Connector	Pin A	Pin H	Pin C	Pin E	Pin J	Pin B		
		0	+0.15 to +1.3	+9.3	+28.0	+5.4 to +19.0	+9.2 to +24.0		

Room Temperature = 25°C approx. Voltages taken within the first 2 min. after energizing unit.
Oven Temperature = 72°C to 78°C. Initial setting stabilized to ±1/2°C. Voltages then taken.
All voltages are ±10% and referred to ground.

DATE November 20, 1962 SHEET 12 OF 14		TMC SPECIFICATION NO. S	
JA COMPILED	CHECKED	TITLE: HFR-1 TEST PROCEDURE	
APPROVED			



RF STAGE GAIN

Field Alignment Model HFR-1 RF Tuner:

1. The unit should be completely interconnected in a receiver system. The power should be applied, and the ovens should have had sufficient opportunity to stabilize.

2. The following tools are required:

   a) TMC TP-114 special tool for HFO

   b) TMC TP-115 special tool for HFO

   c) 3/16, 1/4, 5/16 spintites, modified with hole drilled in plastic handles to accomodate alignment screwdriver.

   d) narrow blade screwdriver, 8 inches long, for use with hollow spintites above.

   e) miniature tube pullers.

3. Alignment of the IF and Noise Silencer Circuits:

   Note:

   This alignment can be performed with the alignment generator, except for the adjustment of C-1231, which requires amplitude modulation. Therefore, an external generator will be specified.

   a) connect an RF signal generator to P-1201; set the generator to 1.75 mcs, unmodulated. Maintain the generator output to the minimum required for an adequate indication of tuning, unless a specific output is called for.

   b) connect an RF VTVM or oscilloscope to pin 5 of V-1201. Adjust T-1201 for maximum indication.

   c) connect a 50 ohm dummy load to J-1312. connect the RF indicator to the dummy load. Adjust T-1202 and T-1203 for maximum indication. Repeak T-1201, T-1202 and T-1203.

   d) connect a DC VTVM to pin 2 of V-1202, then V-1203; the DC voltages should be equal, at about 1,45 volts. If the voltages are not equal, adjust R-1210.

   e) reconnect the RF indicator to pin 5 of V-1201. Adjust the signal generator output to provide 1.0 volt RMS or 2.8 volts Pk - Pk at this point. NOTE THE GENERATOR OUTPUT.

   f) place the NOISE SILENCER OFF ALIGNMENT SIGNAL to the NOISE SILENCER position.

g) connect a VTVM set to measure - DC volts to pin 1 of V-1205. Adjust R-1230 for mechanical center. Check that the signal generator level is that observed in step (e).

h) adjust L-1201, then L-1202 for maximum negative voltage. The adjustment of L-1202 will be broad.

i) connect the RF VTVM or scope to pin 5 of V-1205. The amplitude will be approximately 7 volts RMS. Adjust R-1230 for an indication of 10 volts RMS.

j) connect a SENSITIVE VTVM or scope to the RED dot of L-1203. adjust L-1203 for minimum indication. at 1.75 mcs. If an RF indicator with sufficient sensitivity is not available, consult the "FINAL NOISE SILENCER CHECK" in the system checkout.

k) adjust the signal generator output for 1.75 mcs, 50% to 80% modulated with 1 KC. Adjust the output level to that previously observed in step (e).

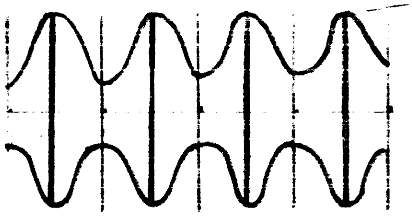
l) connect a sensitive oscilloscope across a 50 ohm dummy load at J-1312; carefully adjust C-1231 for a notch in the modulated signal, at the crest, as shown below.

m) adjust C-1231 until the notch JUST DISAPPEARS, as shown below.

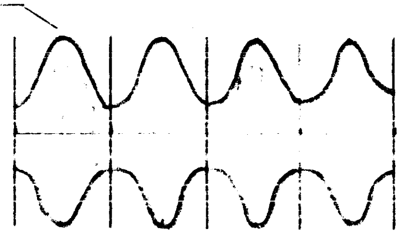
n) remove the dummy load and the signal generator. Reconnect P-1201, and the plug to J-1312. Remove the RF indicator. This completes the alignment of the IF and Noise Silencer Circuits.

o) AFTER ALL OTHER CIRCUITS OF THE HFR-1 HAVE BEEN ALIGNED, T-1201, T-1202 and T-1203 SHOULD BE REPEAKED, USING THE OUTPUT OF THE RF TURRET FROM J-1003, AND USING THE RF LEVEL METER AS AN INDICATOR.

NOTCH: FIRST ADJUSTMENT C1231



NOTCH JUST REMOVED BY SECOND ADJUSTMENT OF C-1231



4. Adjustment of the Alignment Generator:

a) the extremely small indications in this circuit require a SENSITIVE VTVM or oscilloscope. In addition, care must be taken to tune to the difference between 2.0 mc and 250 KC, for a resultant of 1.75 mcs.

b) connect a SENSITIVE RF indicator to pin 2 of V-1302.

c) remove the 2.0 mc input at J-1304 and the 250 KC input at J-1303.

d) connect the RF signal generator at 1.75 mcs, unmodulated, to J-1303. Use sufficient output for an indication at pin 2 of V-1302.

e) adjust the upper, then the lower slugs of T-1301 for maximum indication on the VTVM or scope.

f) adjust the signal generator to 2.0 mcs. adjust R-1309 for MINIMUM indication on the VTVM or scope. (-50db)

g) remove the signal generator and the VTVM. Reconnect the inputs to J-1303 and J-1304.

h) this completes the alignment of the Alignment Generator.

5. Alignment of the HFO Circuits:

a) the field alignment of the HFO circuits utilizes the synthesizer and the audio sync tone.

b) place the BAND control to Band #1 (2-3 mcs)

c) place the dial pointer at 2.0 mcs with the TUNE control

d) set the nixie selectors to 02.0000. Place the TUNE SYNC OPERATE switch to SYNC, and the NOISE SILENCER OFF ALIGNMENT SIGNAL switch to OFF.

e) if zero beat is obtained with the TUNE control at exactly 2.0 mcs, no adjustment is necessary. If zero beat is obtained with the dial pointer away from 2.0 mcs, insert the special "L" tuning tool in the orfice on top of the HFO oven, and set the dial pointer at exactly 2.0 mcs. adjust the tool until zero beat is obtained with the dial pointer at exactly 2.0 mcs.

f) set the nixie selectors to 03.0000; adjust the TUNE control to 3.0 mcs on Band #1. If necessary, insert the special "C" tool, and adjust "C" for a zero beat with the dial pointer at exactly 3.0 mcs.

g) repeat steps (d) (e) and (f) until no further adjustment is required.

h) repeat this procedure at the high and low ends of each band, and with the nixie selectors set to the corresponding frequencies. BE SURE TO REMOVE THE SPECIAL TUNING TOOLS BEFORE ATTEMPTING TO MOVE THE BAND CONTROLS.

i) remove the special tuning tools. This completes the alignment of the HFO circuits.

6. Alignment of the RF Circuits:

a) remove the top cover of the RF turret, to expose the "L" and "C" adjustments of the turret strips.

b) place the nixie selectors to 02.0000.

c) place the Band Control to Band #1, and the dial pointer to exactly 2.0 mcs.

d) Place the NOISE SILENCER OFF ALIGNMENT SIGNAL switch to the ALIGNMENT SIGNAL position.

e) while observing the RF LEVEL meter for indications, adjust inductors L-1001, L-1005, L-1007 and L-1009 for maximum indication on the RF LEVEL meter. Use the special tool provided. (L-1001 will be very broad).

f) synthesize the system at 3.0 megacycles; then adjust capacitors C-1009, C-1015, C-1023 and C-1031 for maximum indication on the RF LEVEL meter.

g) repeat steps (b) through (f) until no further peaking can be obtained.

h) repeat this procedure for the low and high ends of each band, adjusting the inductors at the low ends and the capacitors at the high ends. The input inductor will be extremely broad.

7. Adjustment of the Sync Meter Circuit:

With the TUNE SYNC OPERATE switch in TUNE OR SYNC, adjust R-1320 for zero center scale on the SYNC meter.

HFR-1: RF Tuner: Dynamic voltage measurements:

Alignment Generator:

V-1301: Balanced Modulator: 7360: ALIGNMENT GENERATOR ON

PIN	ELEMENT	RF READING
3	Control Grid	2.6
8	Deflection element	.68
6,7	Plates	.22

V-1302: Mixer: 6EW6:

PIN	ELEMENT	RF READING
2	Cathode	.005
1	Control Grid	.05
5	Plate	.028

TMC SPECIFICATION NO. S

TITLE: HFR-1

[illegible]. <u>Resistance Measurement</u>

Before connecting the power cable to J1305, a resistance [illegible]ould be made in order to prevent unnecessary damage to equ[illegible]t caused by shorted B+ and A-C lines, reduce shock hazard, and c[illegible]uit failures.

[illegible]g ohm meter - Simpson #260 - the following resistance to ground [illegible]ld result:

1. [illegible]F Power Plug P1004 disconnected.

   Pin "K" = 20K Ω , S1301 on "Alignment Signal"
   = 32K Ω , S1301 on "Off"

2. RF Power Plug P1004 connected.

   Pin "K" = 10K Ω , S1301 on "Alignment Signal"
   = 27K Ω , S1301 on "Off" and
   = 27K Ω , Band switch on band 1, Tune RF tuning from stop-to-stop. Also, turn band switch through 8 bands.

3. Pin "A" = Infinite (open)

4. Pin "B" = Infinite (open)

5. Pin "L" = 0 (short)

6. Pins "D" & "F" = 0 (short)

7. Pins "E" & "R" = 0 (short)

8. Pi[illegible] "C" = 85 Ω (ohm meter must be polarized positive).

9. Pin "[illegible]" = 125K Ω , S1301 on "Alignment"
   = 145K Ω , S1301 on "Off"

10. Pin "P" = infinite, S1302 on "Tune" and "Operate"
    = 125 Ω , S1302 on "Sync"

11. Pins "M" & "J" = 200K Ω (ohm meter must be polarized negative).

PERFORMANCE MEASUREMENTS

Sensitivity.

(a) Connect Signal Generator and VTVM as per connection diagram.

(b) Set receiver S1302 to "Tune" S1301 to "OFF" band switch and tuning to the test frequency.

(c) Set Signal Generator to test frequency, modulation off, attenuator to produce 1.0V output on VTVM. (Receiver must be tuned carefully to test frequency to obtain maximum output).

Output shall be 1.0V across R-1029 (mixer grid 6S4A V1005). Input shall be 1000 µv or less (read pad calibration mark). The gain shall be 1000 or more, exceptions are as shown on table.

BAND	FREQ. MC.	µV INPUT LIMITS (FOR 1.0V OUTPUT)	µV INPUT TYPICAL	TYP. GAINS (FOR REF.)
1	2	500 to 1000	800	1250
	3	450 to 1000	500	2000
2	3	800 to 1600	1600	625
	4	500 to 1200	1000	1000
3	4	500 to 1100	800	1250
	6	330 to 1000	330	3000
4	6	500 to 1100	1090	920
	8	450 to 1000	500	2000
5	8	500 to 1000	600	1675
	12	330 to 1000	330	3000
6	12	500 to 1000	600	1675
	16	330 to 1000	400	2500
7	16	500 to 1100	800	1250
	24	450 to 1000	500	2000
8	24	450 to 1000	500	2000
	32	500 to 1300	1200	835

In case of low gain use the stage by stage gain chart as an aid in localizing the fault.

2. HF Oscillator Output:

(a) Connect VTVM across R-1031, 270 ohm resistor in cathode circuit of 6S4A, V1005 mixer.

(b) Set band switch and tuning dial as per table.

(c) Set S-1302 to "Tune" and S-1301 to "OFF".

(d) Input to antenna jack J-1301 must be zero or disconnected.

Output across R-1031 shall be at least 0.75V and not more than 1.3V. Output across J-1313 shall be at least 0.2V and not more than 0.5V. Output across J-1302 shall be at least 40MV and not more than 100MV. Output across J-1310 shall be at least 20 MV and not more than 110MV.

BAND	DIAL FREQ.	R1031 VOLTS	OUTPUT ACROSS J1313 (AT1302) VOLTS	J1302 UV	J1310 (AT1301) UV
1	2	1.25	0.46	92	77
	2.5	1.25	0.49	96	61
	3	1.25	0.49	99	50
2	3	1.0	0.24	48	31
	3.5	1.1	0.26	51	29
	4	1.1	0.25	50	24
3	4	0.9	0.23	44	110
	5	0.9	0.23	45	84
	6	0.85	0.21	41	63
4	6	0.9	0.25	49	45
	7	0.95	0.24	47	35
	8	0.9	0.22	43	28
5	8	0.85	0.30	60	26
	10	0.85	0.28	56	38
	12	0.75	0.22	44	54
6	12	1.0	0.31	62	38
	14	1.05	0.29	58	29
	16	1.0	0.25	50	20
7	16	1.0	0.41	83	86
	20	1.0	0.43	87	62
	24	0.95	0.36	74	36
8	24	0.95	0.39	80	69
	28	0.95	0.35	73	47
	32	1.15	0.27	36	30

Appendix #1 to HFR-1 Lesson Plan:

This appendix contains:

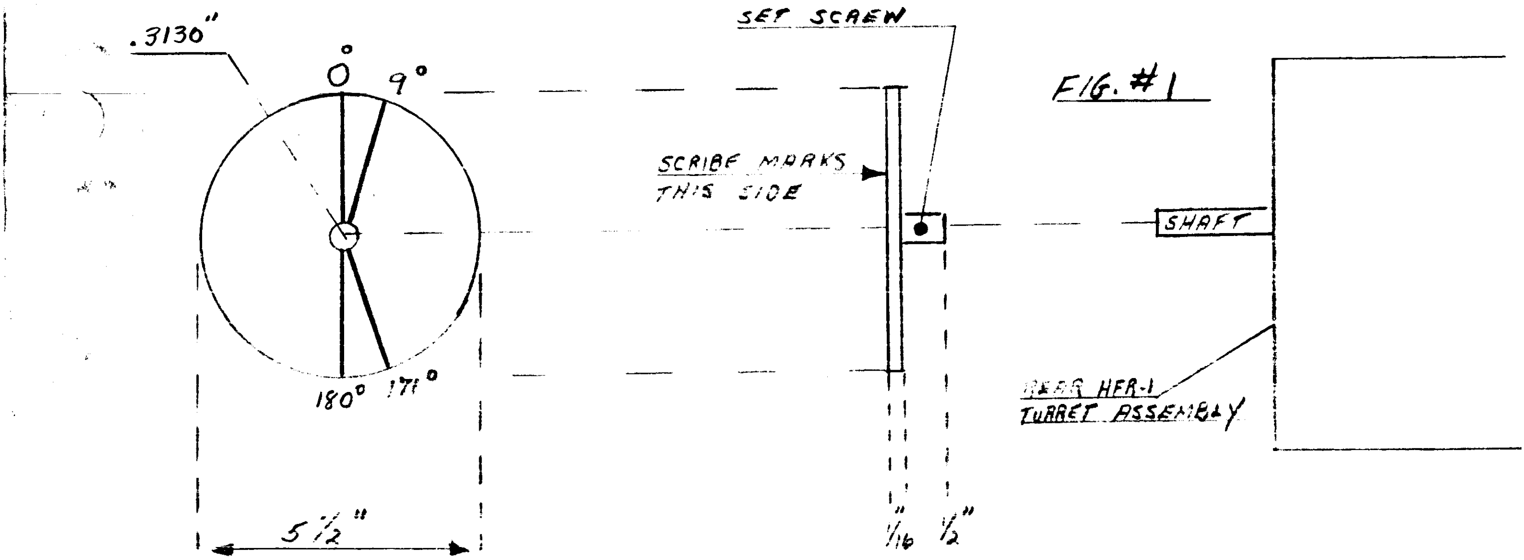
a) a procedure to check and adjust the alignment between the tuning capacitor and the front panel tuning dial.

b) a method of checking for Varicap leakage.

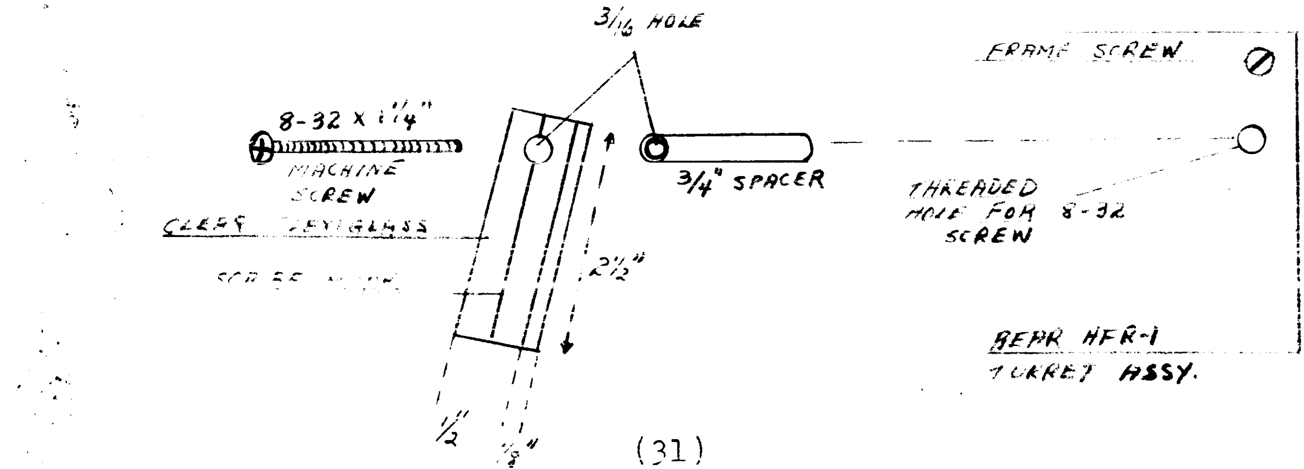
A. Checking and adjusting the alignment between the tuning capacitor and the front panel dial:

1. Before a complete alignment of the RF and HFO circuits of the HFR-1 is attempted, the mechanical alignment of the dial and tuning capacitor should be examined. The following equipment is required for this operation:

a) a circular dial, of convenient diameter, accurately scribed at 0, 9, 171 and 180 degrees. The dial should have a bushing with a .3130" hole to receive the HFR-1 capacitor shaft which extends out the rear of that unit. The bushing should be tapped for a set screw to hold the dial in a given position on the shaft. A typical arrangement is shown in Figure #1 below.



b) a detachable index, described below: (Figure #2)



c) set of long shank Allen wrenches: #4, #6 and #8.

2. Procedure:

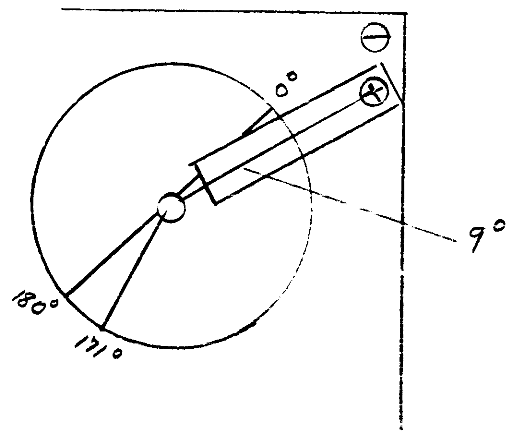
a) remove the HFR-1 Tuner from the installation and place on workbench. Remove the rear plate. Note the extension of the tuning capacitor shaft, and the position of the threaded hole, at the rear, upper right side of the turret assembly.

b) move the TUNE control until the dial index reaches its final travel position at the extreme left of the dial. At this time the tuning capacitor is fully meshed and is held in this position by a stop. The TUNE control continues to spin because of an automatic slip clutch.

c) slip the circular dial on the rear shaft of the tuner. Do not tighten the locknut.

d) assemble the detachable index using the threaded hole shown in figure #2.

e) line up the detachable index and the 0 degree marker on the circular dial with the tuning capacitor fully meshed. Tighten the detachable index and the set screw on the circular dial. See Figure #3.



f) move the TUNE control until the front panel dial pointer rests over the left hand index at 2, 3, 4, etc., mcs, depending on the BAND exposed.

g) note the position of the circular dial. It should be at exactly 9 degrees. If it is not, proceed as follows:

(1) carefully lock the TUNE control.

(2) loosen the two set screws on the threaded dial pulley in the mechanism behind the front panel. Move the pulley until the front panel dial pointer is aligned with the left hand index. Tighten the pulley set screws. Unlock the TUNE control.

h) move the TUNE control until the front panel dial pointer rests over the right hand dial index at 3, 4, 6, etc., mcs, depending on the BAND exposed. The circular dial should read 171 degrees. A tolerance of plus or minus 1 degree is allowable.

i) swing the TUNE control left and right over the entire dial range several times. Then repeat the check on mechanical dial alignment.

j) remove the detachable index and circular dial. Replace the rear plate. Install the tuner in the cabinet.

B. Checking for Varicap leakage.

1. Remove the plug from J-1307 at the rear of the HFR-1.

2. Connect a 100 K ohm resistor from the center conductor of J-1307 to ground.

3. Carefully zero a VTVM on the lowest range, and connect across the 100 K ohm resistor.

4. A voltage reading in excess of .05 volts indicates Varicap leakage.

Title: Model HFP-1 Power Supply

Military Nomenclature:

Power Supply: PP-3341/FRR-60(v)

Objectives:

a) to discuss the functions of the Model HFP-1 power supply in the Model DDR-5 receiving system.

b) to discuss the characteristics, capabilities and special features of the Model HFP-1 power supply.

c) to present a fuse locator chart for rapid location of fuses not identified on the front panel.

d) to identify significant test points, and controls for adjusting the regulated B Plus output.

e) to discuss interconnection, sequence of operations, timing, switching and panel indications.

R ferences:

a) CK-546: complete schematic, Model HFP-1

b) S-635: TMC specifications for Model HFP-1.

Training Aids:

a) Model DDR-5B1 system, set up for operation.

b) Simpson Model 260 VOM.

Presentation:

A. General:

Refer to schematic CK-546

1. the AC input is applied at J-8001. This is connected to a DPST STANDBY - OFF switch, S-8001, mounted on the rear of the HFP-1. This switch is followed by line fuses F-8001 and F-8002.

2. Unless the entire equipment is to be shut down for emergency or service reasons, the STANDBY - OFF switch should be left in the STANDBY position, because, in this position:

   a) line voltage is applied to J-8010, A and B, via fuses F-8003 and F-8004. J-8010 is the interconnecting jack for the HFR-1 RF Tuner. This connection supplies power to the low voltage power supply in the HFR-1, which supplies:

      (1) the HFO oven circuits

      (2) the circuits of the primary standard in the HFS-1.

      (3) the DC filament power for the HFO and Isolation Amplifier tubes, V-1006 and V-1007, in the HFR-1.

   b) line voltage is applied to J-8009, via fuses F-8003 and F-8004. This is the interconnection for the Model AFC-3; it supplies voltage for the oven heater circuits of the 250 KC and 2 mc oscillator circuits of the AFC-3.

   c) line voltage is applied, via F-8003 and F-8004, to T-8003 and T-8004. These are the filament transformers of the HFP-1.

   d) line voltage is applied, via F-8003 and F-8004, to T-8001, the secondary of which supplies low voltag to the power control, time delay and indicator circuits of the HFP-1.

   e) line voltage is applied to J-8002, which supplies the cabinet blower motor.

   f) line voltage is applied, via F-8003 and F-8004, to T-8002, which supplies oven heater voltage to J-8005, D and C. When the Model SBS-1 is used in place of the Model HFI-1, this supplies the oven heater circuits of that unit.

3. The power control, time delay and indicator circuits are shown in the STANDBY condition. Low voltage from T-8001 lights the STANDBY indicator. This voltage is also applied to one side of Control relay K-8001, on sid of OPERATE relay K-8002, and pin 1 of TIME DELAY relay, K-8003.

4. When the STANDBY - OPERATE switch on the Model HFA-1 is thrown to the OPERATE position, a ground is applied to the other side of control relay K-8001. This relay energizes, and:

   a) the STANDBY indicator goes out.

   b) line voltage is applied to AC outlets J-8003 (DVM-4), and J-8004, via F-8005.

   c) line voltage is applied to the open contacts of the OPERATE relay, K-8002.

   d) pin 6 of TIME DELAY relay K-8003 is grounded, and this relay energizes, commencing the time delay.

   e) the TIME DELAY indicator lights.

5. After time delay, approximately 1 minute, the tim delay relay closes contacts 3,4 and 8,9. This energizes K-8002, the OPERATE relay.

6. When the OPERATE relay shifts its contacts,

   a) the upper contact "holds in" the operate relay.

   b) the TIME DELAY indicator goes out.

   c) line voltage is applied to power supply transformers T-8005 and T-8006.

   d) the OPERATE indicator is lighted, due to secondary voltage at T-8006, 14 and 15.

7. The power supply furnishes, by means of two B Plus supplies and one B Minus supply:

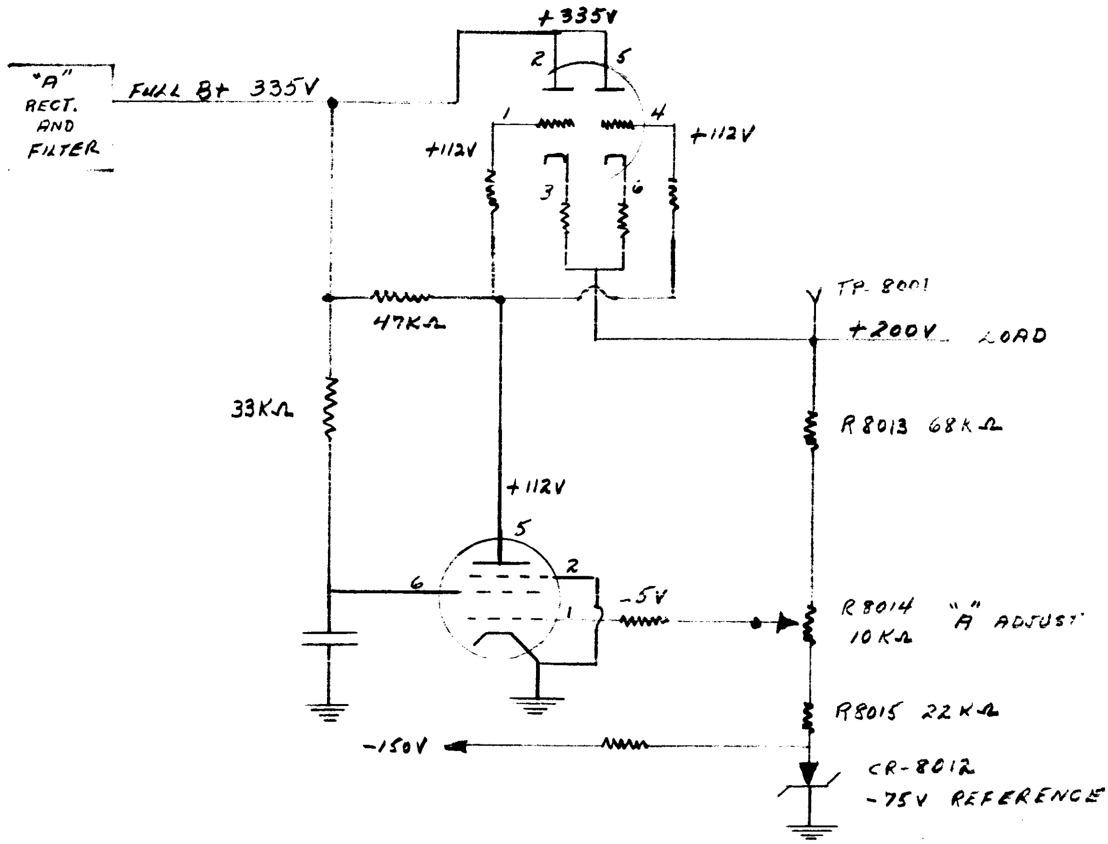
   a) regulated Plus 200 volts.

   b) regulated minus 150 volts.

8. The regulated 200 volts output may be sampled at test points TP-8001 and TP-8002. The voltage may be adjusted by means of adjust pots R-8014 and R-8025.

9. The B Plus supply consists of two identical sections, identified as "A" and "B". Each section contains a full wav bridge rectifier, a filter circuit, and a voltage regulator arrangement.

10. The sketch below is a simplified version of the "A" regulator circuit. (The "B" version is identical).



a) V-8001 is a series regulator tube, through which all of the load current must flow. The voltage difference between full B Plus and the 200 volts at TP-8001 is dropped across this tube.

b) V-8002 is a DC amplifier stage, which changes the resistance of V-8001 with changes in the 200 volt output at TP-8001.

c) with normal load conditions, and the circuit in equilibrium, full B Plus is about 335 volts. Test point 8001 is at 200 volts, therefore, V-8001 drops 135 volts.

d) R-8013, R-8014, R-8015 and CR-8012 form a divider network from r gulated B Plus to ground. The anode of CR-8012 is held at -75 volts. The voltage at the wiper of R-8014 may be varied; the voltage at the control grid of V-8002 is about - 5 volts, establishing the bias for this stage.

e) the voltage at the plate of V-8002 is about 112 volts; this voltage also appears at pins 1 and 4 of V-8001. V-8001, then, may be considered as a resistance equal to 135 volts / load current.

f) assume that the voltage at TP-8001 rises above 200 volts. The voltage at the wiper of R-8014 will become less negative, increasing the conduction of V-8002.

g) with increased conduction of V-8002, its plate voltage falls; this fall is felt at pins 1 and 4 of V-8001.

h) the resistance of V-8001 is now increased. The load current continues to flow in this stage, but through an increased resistance.

i) V-8001 will now "drop" more voltage; the increased drop will exactly compensate for the rise at TP-8001 above 200 volts.

11. The HFP-1 power supply has been designed to furnish regulation as follows:

a) B Plus and B Minus voltages are maintained within 1 % from no load to full load, and with plus or minus 10% line voltage variation.

b) the above regulation applies to a single phase, 115V or 230V input, in the frequency range 48 - 62 cycles.

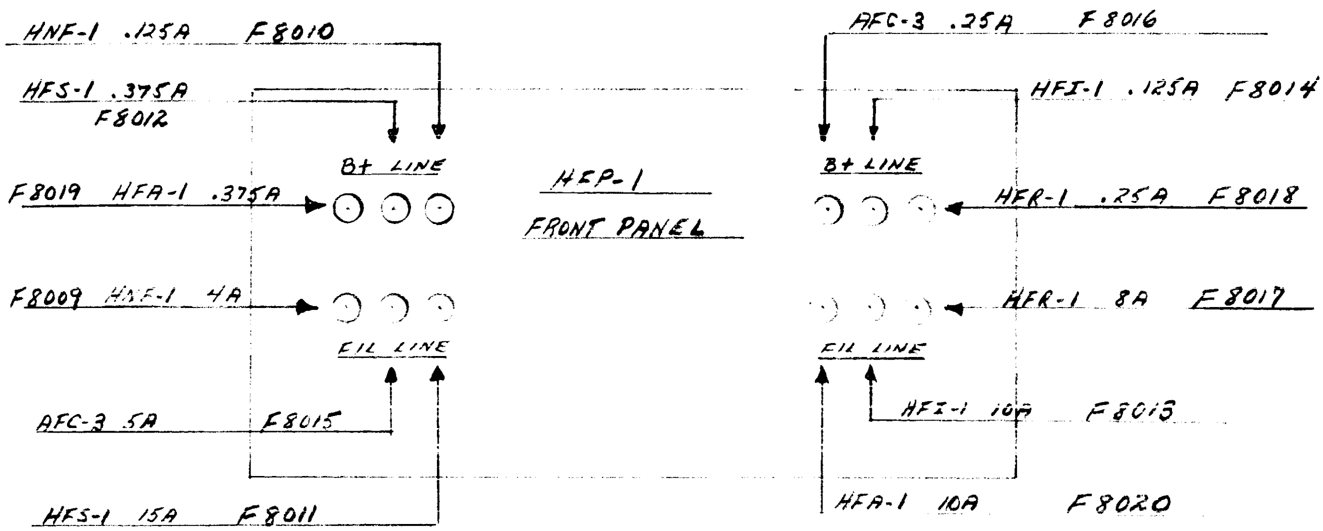
12. The B Plus ripple does not exceed 100 millivolts.

13. The B Minus ripple does not exceed 5 millivolts.

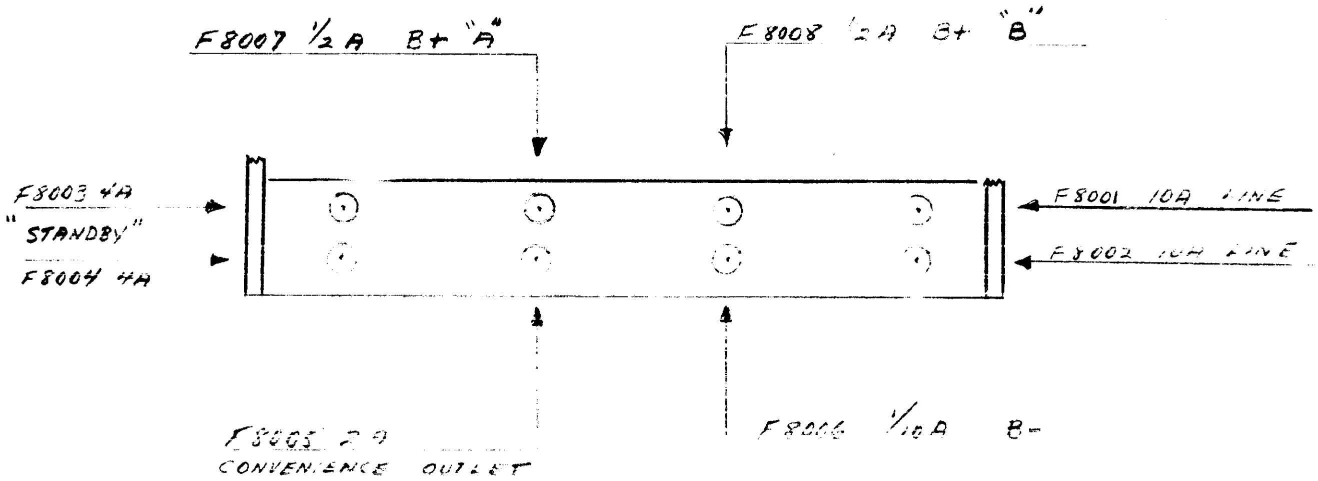
14. All voltage outputs are separately fused. Blown fuse indicator type holders are employed.

15. Fuse locations are shown on a chart on the following page.

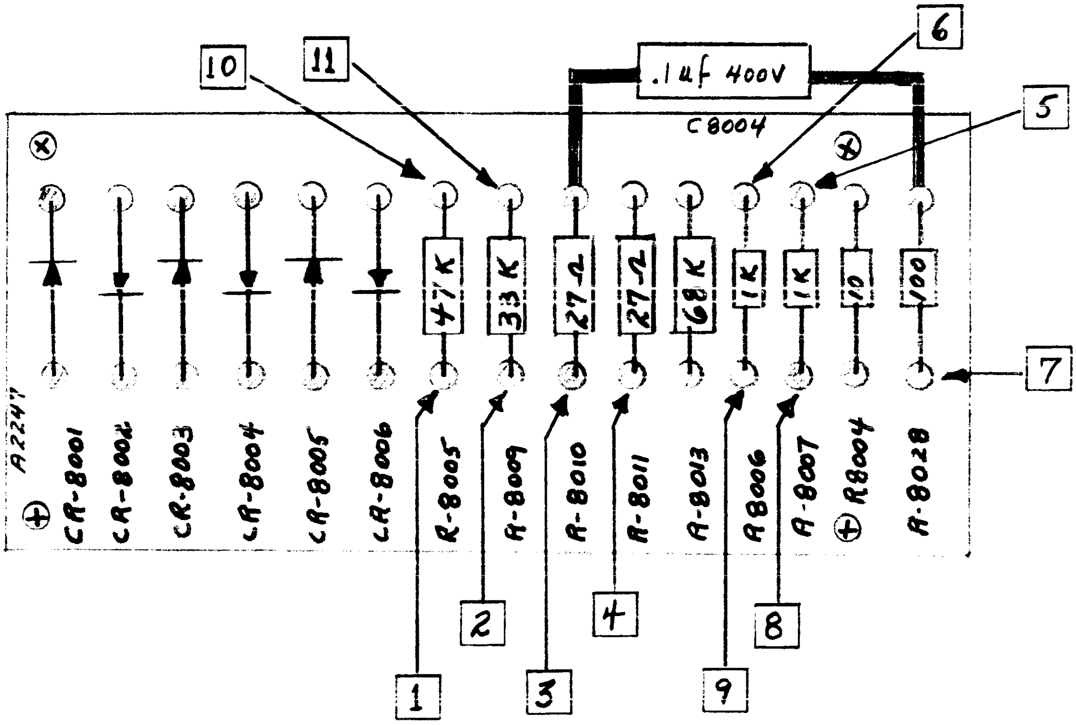
Fuse Locations and Identification: Model HFP-1:



The Sketch below shows the locations and identifications of fuses inside the HFP-1, at the top, front.

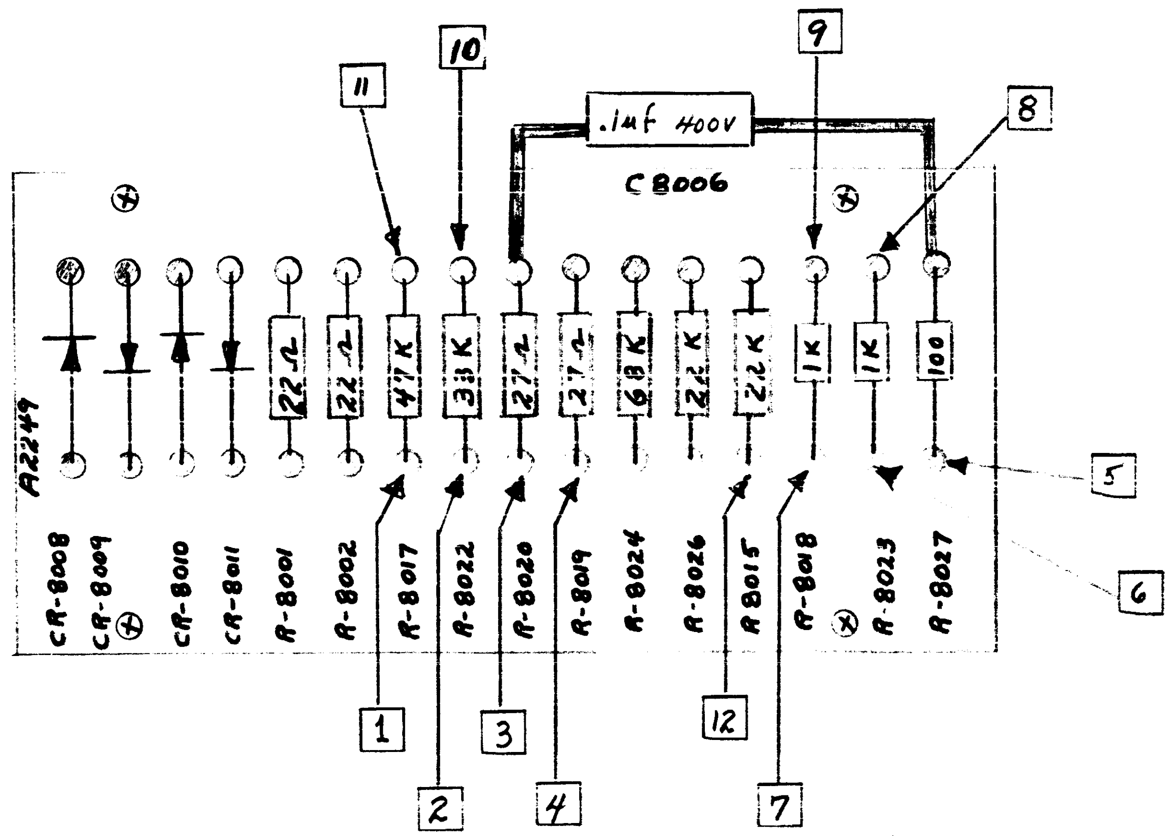


Mod 1 HFP-1 DC Voltage Chart for TB-8001:



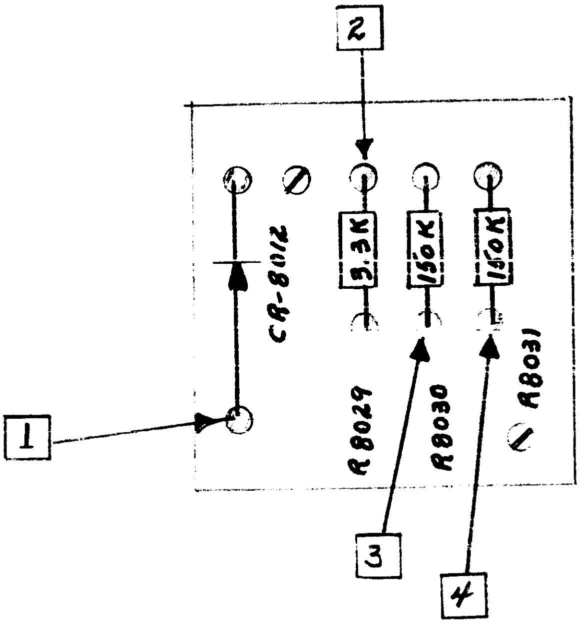
TEST POINT IDENTIF. NUMBER	CORRESPONDING TUBE AND PIN NUMBER	NORMAL DC VOLTAGE AT: NO LOAD	FULL LOAD
1	V-8001, 2,5.	380	290
2	V-8001, 2,5.	380	290
3	V-8001, 3.	200	205
4	V-8001, 6.	200	205
5	V-8001, 1.	130	195
6	V-8001, 4.	130	195
7	V-8002, 1.	-5.4	-5.7
8	V-8002, 5.	130	195
9	V-8002, 5.	130	195
10	V-8002, 5.	130	195
11	V-8002, 6.	320	270

Model HFP-1: DC Voltage Chart for TB-8002:



TEST POINT IDENTIF. NUMBER	CORRESPONDING TUBE AND PIN NUMBER	NORMAL DC VOLTAGE AT: NO LOAD	FULL LOAD
1	V-8004, 5.	130	195
2	V-8004, 6.	320	270
3	V-8003, 3.	200	205
4	V-8003, 6.	200	205
5	V-8004, 1.	-5.4	-5.7
6	V-8004, 5.	130	195
7	V-8004, 5.	130	195
8	V-8003, 1.	130	195
9	V-8003, 4.	130	195
10	V-8003, 2,5.	380	290
11	V-8003, 2,5.	380	290
12	CR-8012 ANODE	MINUS 75 volts, 5%.	

Mod 1 HFP-1: DC Voltage Chart for TB-8003:



Test Point 1: -75 volts, plus or minus 5%. This is the reference diode for the B Plus regulator circuits.

Test Point 2: -105 volts. This is the output of the B- Supply.

Test Point 3: This is the filtered DC output of the "A" rectifier, and the DC input to the "A" regulator. The voltage depends on line voltage and load current. The extremes are 260 volts and 420 volts. The average is approximately 340 volts.

Test Point 4: This is the filtered DC output of rectifier "B". They are identical to the voltages to be expected at Test Point 3.

Title: Operation of the Model DDR-5B1 Receiver

Objective:

To provid a sequence of operations for the starting, tuning and adjustment of the Model DDR-5B1 receiver.

References:

NONE

Training Aids:

a) Model DDR-5B1 receiver, set up for operation.

b) Antenna, 50 ohm coaxial cable with BNC termination for antenna lead-in.

Introduction:

It is difficult to set down a hard and fast procedure for starting, tuning and adjusting the Model DDR-5 series of receivers, due to the versatility of the equipment and to the hundreds of configurations in which the equipment may be supplied. This procedure is presented as a guide for personnel handling the Model DDR-5B1 (single unit) for the first time. Experienced operators will doubtless discover many short cuts and "kinks" adaptable to their own particular requirements and installation.

Presentation:

A. Preliminary:

1. Open the rear cabin t door and examine th POWER STANDBY OFF switch located on the rear apron, left, of the HFP-1 power supply. (PP-3341/FRR-60(v) Turn this switch to the STANDBY position.

Note:

Unless the equipment is to be shut down for emergency reasons or maintenance purposes, this switch should be left in the STANDBY position. In this position, power is applied:

a) to critical oven and filament circuits.

b) to the control, time delay and filament circuits of the power supply.

c) to the cabinet blower motor circuits.

2. With the POWER STANDBY OFF switch in the STANDBY position, the blowers should commence to operate, and the GREEN STANDBY indicator should come on.

3. If the equipment has been completely shut down for a considerable period, the ovens should be allowed to warm up before synthesized operation is attempted. A 24 hour period is ideal, but proper operation may be expected after an initial warmup of 6 hours.

4. Place the following switches and controls in the positions indicated:

a) RF Tuner Model HFR-1: TN-376/UR

(1) move the BAND control to rotate the slide rule dial to the band position containing the desired frequency. For example: for a frequency of 2 mcs, move the BAND control to expose Band #1: (2 - 3 mcs)

(2) move the TUNE control until the moving pointer of the slide rule dial coincides with the desired frequency. (in this case: 2.0 mcs)

(3) place the NOISE SILENCER OFF ALIGNMENT SIGNAL switch to the OFF position.

(4) place the TUNE SYNC OPERATE switch to the TUNE position.

b) Synthesizer Model HFS-1: 0-941/UR

(1) the positions of the controls on the synthesizer are insignificant at this time.

c) Automatic Frequency Control Model AFC-3: C-4099/FRR-60(v)

(1) place the TUNING KCS control at the "0" position.

(2) turn the SENSITIVITY control fully CW.

(3) place the RCC-OSC switch in the OSC position.

d) Speaker Panel Model HSP-2: SB-1865/FR

(1) place Receiver #1 SPEAKER CHANNEL SELECTOR to "A".

(2) place the Receiver #1 VOLUME control to the mid position.

Notes:

(a) for a single unit installation, the Receiver #2 controls and the AGC SEPARATE COMBINED control have no significance.

(b) the operator will adjust the monitor volume with the Receiver #1 VOLUME control to suit his convenience.

e) IF Amplifier Unit Model HFI-1: AM-3295/FRR-60(v)

(1) move the MANUAL GAIN control to the fully CCW position. In the fully CCW position, a switch will be felt to "click off".

(2) place the AFC ON OFF switch to the OFF position.

(3) place both Channel A and B AGC DECAY controls to the full CCW position. This is the position for minimum decay time.

(4) the settings of the Channel A and B IF BANDWIDTH SELECTOR switches depends on the character of the intelligence being received, and on the distribution of this intelligence in the spectrum.

(a) for initial synthesized tuning operations, these controls have no significance.

(b) for phase modulation, the 15 KC DSB position is recommend d.

(c) for AM operation, any of the DSB positions may be selected. The actual bandwidth selected will be determined by the width of the spectrum of the transmitted intelligence.

(d) for SSB operation, again, the bandwidth selected will depend on the character of the transmitted intelligence.

(e) it is possible that, for ISB reception, the IF BANDWIDTH SELECTOR switches will be placed in different positions.

(f) for CW operation, almost any bandwidth selection may be made, since the BFO control may be adjusted over a 10 KC range to produce an audio tone at some point. For noise and interference considerations, however, the 1 KC DSB position may be found most satisfactory.

f) Model HNF-1 Notch Filter: F-711/FRR-60(v)

(1) place the POWER ON OFF switch to the OFF position.

(2) place the NOTCH ADJUST control to the "O" position.

Note:

The ON OFF switch on the Notch Filter should be kept in the OFF positions at all times except when the unit is actually in operation.

g) Audio and Detector Unit Model HFA-1: AM-3296/FRR-60(v)

(1) place the Channel A and B LINE LEVEL controls to the mid position.

(2) place the Channel A and B BFO controls to the mid position.

(3) place the Channel A and B MONITOR controls to the fully CCW position.

(4) place the Channel A and B DETECTION switches to the positions corresponding to the type of intelligence to be received.

Note:

Ordinarily, the panel loudspeaker is used to monitor the audio output. The input to this loudspeaker is controlled by adjustments on the Speaker Panel Model HSP-2. If headphones are to be used, they should be plugged into the appropriate PHONE jack on the Audio unit. The MONITOR controls to the left of these jacks control the volume.

(5) the STANDBY OPERATE switch should be in the STANDBY position.

h) Audio Filter Model HAF-1: F-712/FRR-60(v)

place all four selector switches to the OUT position.

Note:

When these switches are placed on a BLANK position, the audio path is interrupted.

B. Operation:

1. Place the STANDBY OPERATE switch on the Audio Unit to the OPERATE position. The GREEN STANDBY indicator will go out, and the YELLOW TIME DELAY indicator will come on. After a period of about 60 seconds, the YELLOW TIME DELAY indicator will go out, and the RED OPERATE indicator will come on. At the same time, the NIXIE INDICATORS will register, and the slide rule dial on the RF Tuner will be illuminated.

2. Rotate the selector switches on the synthesizer unit until the NIXIE LIGHTS read the desired frequency to the hundreds of cycles digit. For a frequency of 2 mcs, the indicators will read: 0 2 . 0 0 0 0.

3. Place the TUNE SYNC OPERATE switch on the RF Tuner to the SYNC position.

4. As the TUNE control is carefully moved to shift the dial pointer around 2 mcs, an audio tone will be heard. The Channel A LINE LEVEL control and / or the Receiver #1 VOLUME control may be used to adjust the volume. THIS TONE IS APPLIED TO THE CHANNEL A AUDIO CIRCUITS ONLY.

5. Adjust the TUNE control for a zero beat; the SYNC indicator on the RF Tuner may chatter during this operation.

6. Place the TUNE SYNC OPERATE switch to the OPERATE position. The SYNC indicator will glow, and th SYNC METER will indicate zero center scale, or nearly so. Carefully move the TUNE control to bring the SYNC METER to zero center scale, and lock the Tune control with the locking device.

   The system is now operating synthesized, at a frequency of 2 mcs. The RF LEVEL meter on the RF Tuner will indicate incoming signal strength in DB above 1 micro-volt.

   The IF LEVEL meters will indicate about 1 volt. Over the normal dynamic range of the equipment, the IF LEVEL meters will indicate from .6 volt to 1.4 volts.

   The Channel A and B LINE LEVEL meters will indicate th audio output level in db or VU. The LEVEL ADJUST controls may be manipulated to bring the audio output to 0 VU on the LINE LEVEL meters. This sets up the standard audio output.

7. To monitor the Channel B audio output, place the Receiver #1 SPEAKER CHANNEL SELECTOR to "B".

8. For CW operation, the appropriate BFO control will be adjusted to shift the frequency of the beat frequency oscillator plus and minus 5 KC around 250 KC, to produce the required resultant audio tone.

9. The Variable Notch Filter may be used to "notch out" an interfering signal at any point in the passband. This unit has a gain of unity so that, with the unit ON or OFF, no insertion loss is presented to the system. To use the Notch Filter:

   a) place the ON OFF switch to the ON position.

   b) carefully manipulate the NOTCH ADJUST control to remove the interfering signal. This control is critical, due to the narrow notch width.

10. With the equipment operating as outlined in the preceding discussion, the Automatic Frequency Control feature may be utilized as follows:

   a) place the AFC ON OFF switch on the IF Unit to ON.

   b) hold down the RESET button on the AFC unit, and adjust the TUNING KCS control for a maximum on the CARRIER LEVEL meter and zero center scale on the DRIFT meter. Release the RESET button.

11. The AGC DECAY controls will be adjusted in accordance with the nature of the received signal. As a general rule, these controls ar adjusted by observing the LINE LEVEL meters on the Audio unit, and setting th AGC DECAY controls to prevent the LINE LEVEL meters from swinging above "O VU".

12. The Audio Filter Model HAF-1 is used when audio interference is experienced. Each Channel has an associated pair of controls; one control changes the LOW CUTOFF FREQUENCY, and the other control changes the HIGH CUTOFF FREQUENCY, for the appropriate channel. Thus, the audio bandpass may be narrowed or widened, at the option of the operator.

13. Under certain circumstances, it may be desired to use the MANUAL GAIN control. When this control is in th fully CCW position, it is out of the circuit. When the MANUAL GAIN control is moved slightly CW, a switch is turned on; this switch applies a negative voltage of large amplitude to the circuits normally receiving the AGC voltage. As the control is moved further clockwise, the negative voltage is reduced and the gain is increased. At some further clockwise point, the normal AGC voltage is stronger than the manual gain voltage, and the AGC circuits again assume control.

Titl : Interconnection of the Model DDR-5 Systems

Objective:

To discuss and illustrate the interconnection of the specific configuration of the Model DDR-5 with which trainees are to be associated.

References:

a) CK-607: Rack wiring assembly, Model DDR-5A1
b) CK-598: Rack wiring assembly, Model DDR-5B1
c) One complete set of schematics for all units to be included in the particular configuration to be discussed.

Training Aids:

An assembled and wired model of the configuration to be discussed.

Introduction and Presentation:

No formal lesson plan will be prepared for this phase of the Model DDR-5 course. The instructor will carefully illustrate the interconnection of the various units.

Model DDR-5A (AN/FRR-60(v))

SYSTEM CHECKOUT PROCEDURE

A. Preliminary:

1. Test Equipment Required:

a) Frequency Counter: H.P. Model 524C or equivalent.

b) Signal Generators: Measurements Corp. Model 82, or equivalent. (2 required)

c) AC VTVM: Ballentine Model 314, or equivalent.

d) Spectrum Analyzer.

e) 30 DB mixing pad. (described in two tone test)

f) 20 DB attenuator pad.

g) VOM: Simpson Model 260, or equivalent.

2. It is assumed that all units have been tested and installed in the cabinet; that all cables have been connected, and all interconnections made.

3. Remove the four screws holding the line filter in place at the rear center of the cabinet. Orient the filter so that the cover can be removed. Connect a three wire power cable as follows:

a) WHITE lead to line lug.

b) GREEN lug to grounding screw.

c) BLACK lead to line lug.

Connect the power cable to a 115 volt, 60 cycle, single phase source.

d) With a Simpson Model 260 VOM, measure the voltage at the convenience outlets on the front panel of the RCVR #1 rack. The reading should be 115 volts. Leave the filter cover off till after completion of the tests.

4. Place switches and controls in the following positions:

a) HFP-1: (both units)

STANDBY OFF switch at rear to STANDBY. The blowers on both racks should commence to operate.

b) HAF-1: (both units)

All switches to the OUT position.

c) HFA-1: (both units)

(1) DETECTOR switch: CW

(2) BFO control: "0"

(3) STANDBY OPERATE switch: STANDBY

(4) LINE LEVEL ADJUST control: mid position

d) HNF-1: (Both units)

(1) ON OFF switch: OFF

(2) NOTCH ADJUST control: "0"

e) HFI-1: (both units)

(1) MANUAL GAIN control: fully CCW until switch clicks OFF.

(2) AGC DECAY controls: Channel A and B: fully CCW.

(3) IF BANDWIDTH selectors: Channel A and B: 6 KC DSB.

(4) AFC ON OFF switch: OFF

f) HSP-2: (on RCVR #1 rack)

(1) RCVR #1 SPEAKER SELECTOR: Channel A

(2) RCVR #1 VOLUME control: fully CW

(3) RCVR #2 SPEAKER SELECTOR: Channel A

(4) RCVR #2 VOLUME control: fully CW

(5) AGC COMBINED SEPARATE switch: separate

g) AFC-3: (both units)

(1) SENSITIVITY control: fully CW.

(2) TUNING KCS control: "0"

(3) CARRIER SELECTOR switch: OSC

h) DVM-4: (RCVR #2 rack)

(1) RCVR SELECTOR: RCVR #1

(2) SWEEP RANGE switch: Plus or Minus 5 KC

(3) CALIBRATE FOR ZERO control: "0"

(4) POWER ON OFF switch: OFF.

i) HFS-1:

The controls are of no significance at this time.

j) HFR-1:

(1) RCVR #1:

BAND: Band 1 (2-3 mcs)

TUNE: 2.0 mcs

TUNE SYNC OPERATE switch: SYNC

NOISE SILENCER OFF ALIGNMENT SIGNAL switch: OFF

(2) RCVR #2:

BAND: Band 1 (2-3 mcs)

TUNE: away from 2 mcs

TUNE SYNC OPERATE switch: TUNE

NOISE SILENCER OFF ALIGNMENT SIGNAL switch: OFF

B. Checkout Procedure:

1. On both HFA-1 units, place the STANDBY OPERATE switches to OPERATE. The GREEN standby indicators will go out, and the YELLOW time delay indicators will come on. After time delay, approximately 60 seconds, the YELLOW indicators will go out and the RED operate indicators will come on. The NIXIE lights on the HFS-1 will indicate, and the slide rule dials on both HFR-1 units will be illuminated.

2. Pull out the HFP-1 units on both racks. With a Simpson Model 260 VOM, check the voltage at test points TP-8001 and TP-8002 on both units. It should be exactly 200 volts. If it is not, adjust R-8014 and/or R-8025 on the appropriate unit(s) until the proper voltage is obtained.

3. Check of Synthesizer, HFO circuits of both RF Heads, and Stability:

a) remove the plug from J-1313 on the RCVR #2 RF Head; connect the frequency counter to J-1313.

b) set the NIXIE selectors on the HFS-1 to 02.0000.

c) carefully move the TUNE control on the #1 head around 2.0 mcs until a zero beat is obtained. The SYNC light may chatter until the proper point is found.

Note:

References to the SYNC light are with respect to RCVR #1. The SYNC light on RCVR #2 will remain on at all times.

d) place the NOISE SILENCER OFF ALIGNMENT SIGNAL switch on RCVR #2 to the ALIGNMENT SIGNAL position.

e) carefully move the TUNE control on the #2 head until a "null" is found. On either side of the null, the SYNC light will chatter and a tone of increasing frequency will be heard.

f) place the TUNE SYNC OPERATE switch on the #1 head to OPERATE. Place the NOISE SILENCER switch on the #2 head to OFF. The system is in synchronism; the SYNC light on the #1 head will come on; read the counter; the reading should be 3.75 mcs.

g) place the TUNE SYNC OPERATE switch on the #1 head to SYNC; place the 100 KC NIXIE selector to position 1. carefully move the TUNE control on the #1 head for a zero beat, at 2.1 mcs.

h) place the NOISE SILENCER OFF ALIGNMENT SIGNAL switch on the #2 head to ALIGNMENT SIGNAL. Carefully move the TUNE control on the #2 head for a null, at 2.1 mcs.

i) place the TUNE SYNC OPERATE switch on the #1 head to OPERATE. Place the NOISE SILENCER switch on the #2 head to OFF. The system is in synchronism at 2.1 mcs. The SYNC light will come on; the counter should read 3.85 mcs.

j) continue this procedure for the remaining positions of the 100 KC NIXIE selector, as shown in the following table. Move the NIXIE selector to the position shown; with the #1 TUNE SYNC OPERATE switch in SYNC, and the #2 NOISE SILENCER switch at OFF, obtain a zero beat at the indicated frequency with the #1 TUNE control. Then place the #2 NOISE SILENCER switch to ALIGNMENT signal and obtain a null at the indicated frequency with the #2 TUNE control. Place the #1 TUNE SYNC OPERATE switch to OPERATE, the #2 NOISE SILENCER switch to OFF, and read the counter.

100 KC SELECTOR	TUNE CONTROL	FREQ. COUNTER
2	2.2 mcs	3.95 mcs
3	2.3 mcs	4.05 mcs
4	2.4 mcs	4.15 mcs
5	2.5 mcs	4.25 mcs
6	2.6 mcs	4.35 mcs
7	2.7 mcs	4.45 mcs
8	2.8 mcs	4.55 mcs
9	2.9 mcs	4.65 mcs

k) place the 10 KC NIXIE selector to position 1; repeat the foregoing procedure with the TUNE controls at 2.91 mcs; the counter should read 4.66 mcs. Continue this procedure through the remaining positions of the 10 KC selector switch, in accordance with the following table.

10 KC SELECTOR	TUNE CONTROL	FREQ. COUNTER
2	2.92 mcs	4.67 mcs
3	2.93 mcs	4.68 mcs
4	2.94 mcs	4.69 mcs
5	2.95 mcs	4.70 mcs
6	2.96 mcs	4.71 mcs
7	2.97 mcs	4.72 mcs
8	2.98 mcs	4.73 mcs
9	2.99 mcs	4.74 mcs

l) place the 1 KC NIXIE selector to position 1; repeat the foregoing procedure with the TUNE controls at 2.991 mcs; the counter should read 4.741 mcs. Continue this procedure through the remaining positions of the 1 KC selector switch, in accordance with the following table:

1 KC SELECTOR	TUNE CONTROL	FREQ. COUNTER
2	2.992 mcs	4.742 mcs
3	2.993 mcs	4.743 mcs
4	2.994 mcs	4.744 mcs
5	2.995 mcs	4.745 mcs
6	2.996 mcs	4.746 mcs
7	2.997 mcs	4.747 mcs
8	2.998 mcs	4.748 mcs
9	2.999 mcs	4.749 mcs

m) place the .1 KC NIXIE selector to position 1; repeat the foregoing procedure with the TUNE controls at 2.9991 mcs; the counter should read 4.7491 mcs. Continue this procedure through the remaining positions of the .1 KC selector switch, in accordance with the following table:

.1 KC SELECTOR	TUNE CONTROL	FREQ. COUNTER
2	2.9992 mcs	4.7492 mcs
3	2.9993 mcs	4.7493 mcs
4	2.9994 mcs	4.7494 mcs
5	2.9995 mcs	4.7495 mcs
6	2.9996 mcs	4.7496 mcs
7	2.9997 mcs	4.7497 mcs
8	2.9998 mcs	4.7498 mcs
9	2.9999 mcs	4.7499 mcs

n) place the NIXIE selectors to 03.0000. Repeat the synchronization procedure at this frequency. The counter should read 4.75 mcs.

o) move the BAND control on both RF heads to Band #2 (3-4 mcs). Repeat the synchronization procedure at 3 mcs; the counter should read 4.75 mcs.

p) continue this procedure for the remaining positions of the MC NIXIE selector switch, conducting the check at the high and low ends of each band. In each case, the counter should read 1.75 mc above the selected RF frequency.

MC SELECTOR	BAND	TUNE CONTROL	FREQ. COUNTER
4	2	4 mcs	5.75 mcs
4	3	4 mcs	5.75 mcs
5	3	5 mcs	6.75 mcs
6	3	6 mcs	7.75 mcs
6	4	6 mcs	7.75 mcs
7	4	7 mcs	8.75 mcs
8	4	8 mcs	9.75 mcs
8	5	8 mcs	9.75 mcs
9	5	9 mcs	10.75 mcs
10	5	10 mcs	11.75 mcs
11	5	11 mcs	12.75 mcs
12	5	12 mcs	13.75 mcs
12	6	12 mcs	13.75 mcs
13	6	13 mcs	14.75 mcs
14	6	14 mcs	15.75 mcs
15	6	15 mcs	16.75 mcs
16	6	16 mcs	17.75 mcs
16	7	16 mcs	17.75 mcs
17	7	17 mcs	18.75 mcs
18	7	18 mcs	19.75 mcs
19	7	19 mcs	20.75 mcs
20	7	20 mcs	21.75 mcs
21	7	21 mcs	22.75 mcs
22	7	22 mcs	23.75 mcs

MC SELECTOR	BAND	TUNE CONTROL	FREQ. COUNTER
23	7	23 mcs	24.75 mcs
24	7	24 mcs	25.75 mcs
24	8	24 mcs	25.75 mcs
25	8	25 mcs	26.75 mcs
26	8	26 mcs	27.75 mcs
27	8	27 mcs	28.75 mcs
28	8	28 mcs	29.75 mcs
29	8	29 mcs	30.75 mcs
30	8	30 mcs	31.75 mcs
31	8	31 mcs	32.75 mcs

q) place the NIXIE selectors to 15.0000. Place both BAND controls to Band 6 (12 - 16 mcs). Place the #1 TUNE SYNC OPERATE switch to SYNC. Place the #2 NOISE SILENCER switch to OFF. Move the TUNE control on RCVR #1 for a zero beat at 15 mcs. Place the NOISE SILENCER switch on RCVR #2 to ALIGNMENT SIGNAL. With the #2 TUNE control, find the null at 15 mcs. Place the RCVR #1 TUNE SYNC OPERATE switch to OPERATE. Place the RCVR #2 NOISE SILENCER switch to OFF. The system is now in sync at 15.0 mcs.

r) carefully move the TUNE control on RCVR #1 in both directions, checking for symmetrical swing of the RCVR #1 SYNC meter, from 0 to either side. If the swing is not symmetrical, adjust R-3442 on the 3400 deck of the HFS-1 for a symmetrical swing.

Note: in a dual receiver installation, the #2 SYNC meter, like the #2 SYNC light, is not used in the tuning operation.

s) remove the frequency counter from J-1313; replace the plug removed previously.

4. Check of AFC-3 Unit #1:

a) place the AFC ON OFF switch on HFI-1 #1 to ON.

b) place the NOISE SILENCER switch on RCVR #1 to ALIGNMENT SIGNAL.

c) depress and hold down the RESET button on AFC-3 #1; adjust the TUNING KCS control for maximum indication on the CARRIER LEVEL meter, and zero center scale on the DRIFT meter. The CARRIER LEVEL meter should read approximately in the center of the GREEN. Release the RESET button.

d) check the FADE and DRIFT ALARM lamps; they should be extinguished. The DRIFT METER should remain at zero center scale.

e) place the CARRIER SELECTOR switch to RCC; there should be no change in indications.

f) place the NOISE SILENCER switch on RCVR #1 to OFF. The CARRIER LEVEL meter should fall, and the FADE alarm should light. Return the NOISE SILENCER switch to ALIGNMENT SIGNAL position. Move the SENSITIVITY control fully CCW. The FADE indicator should light and the CARRIER LEVEL meter should fall. Return the SENSITIVITY control fully CW.

g) return the CARRIER SELECTOR switch to OSC.

h) place the AFC ON OFF switch on HFI-1 #1 to OFF.

5. Check of HFI-1 unit #1:

Note: this procedure also checks the HFA-1 #1 in the SSB mode of operation, and checks the tuning of the AFC-3 #1.

a) check the MANUAL GAIN control on the HFI-1 #1. It should be OFF (CCW).

b) place the Channel A IF BANDWIDTH selector to 1 KC DSB position.

c) place the Channel B IF BANDWIDTH selector to a BLANK position.

d) pull out the HFI-1 #1 unit; lock in position and remove the top cover.

e) note the markings on the input filters or RF XFRMR can; from left to right, with the operator facing the front panel, these should read: 1 KC SYM; 6 KC SYM; T-101; 3.5 KC USB; 3.5 KC LSB; 7.5 KC USB, and 7.5 KC LSB.

f) adjust R-116 on the 1 KC SYM strip for a reading of 1 volt on the Channel A IF LEVEL meter; this corresponds to a level of .707 volts RMS into a 50 ohm load at J-102 on the IF strip. Lock the adjustment.

g) place the Channel B IF BANDWIDTH selector to the 1 KC DSB position. Both IF LEVEL meters should read approximately 1 volt. Place the Channel B IF BANDWIDTH selector to a BLANK position.

h) place the Channel A IF BANDWIDTH selector to the 6 KC DSB position. Adjust R-116 on the 6 KC SYM strip for the 1 volt reading. Lock the adjustment.

i) place the Channel B IF BANDWIDTH SELECTOR to the 6 KC DSB position. Both IF LEVEL meters should read approximately 1 volt. Return the Channel B IF BANDWIDTH selector to a BLANK position.

j) place the Channel A IF BANDWIDTH selector to the 15 KC DSB position. Adjust R-116 on the 15 KC symmetrical strip for the 1 volt reading. Lock the adjustment.

k) place the Channel B IF BANDWIDTH selector to the 15 KC DSB position. Both IF LEVEL meters should read approximately 1 volt. Return the Channel B IF BANDWIDTH selector to a BLANK position.

l) place the AFC ON OFF switch on HFA-1 #1 to ON.

m) place the Channel A and B DETECTION switches on the HFA-1 #1 unit to the SSB position.

n) on AFC-3 #1, depress the RESET button for about 6 seconds; then move the TUNING KCS control midway between the "O" and "-3 KC" positions. The CARRIER LEVEL meter will fall and the FADE indicator will light.

o) place the Channel A IF BANDWIDTH selector to the 3.5 KC USB position. Adjust R-116 on the 3.5 KC USB strip for the 1 volt reading. Place the Channel B IF BANDWIDTH selector to the 3.5 KC USB position. Both IF LEVEL meters should read approximately 1 volt. Return the Channel B selector to a blank position and lock R-116.

p) place the Channel A IF BANDWIDTH selector to the 7.5 KC USB position. Adjust R-116 on the 7.5 KC USB strip for the 1 volt reading. Lock the adjustment. Place the Channel B IF BANDWIDTH selector to the 7.5 KC USB position. Both IF LEVEL meters should read approximately 1 volt. Return the Channel B selector to a BLANK position.

q) move the TUNING KCS control on AFC-3 #1 midway between the "O" and "plus 3 KC" positions.

r) place the Channel A IF BANDWIDTH selector to the 3.5 KC LSB position. Adjust R-116 on the 3.5 KC LSB strip for the 1 volt reading. Place the Channel B IF BANDWIDTH selector to the 3.5 KC LSB position. Both IF LEVEL meters should read approximately 1 volt. Lock the adjustment; return the Channel B IF BANDWIDTH selector to a BLANK position.

s) place the Channel A IF BANDWIDTH selector to the 7.5 KC LSB position. Adjust R-116 on the 7.5 KC LSB strip for the 1 volt reading. Lock the adjustment. Place the Channel B IF BANDWIDTH selector to the 7.5 KC LSB position. Both IF LEVEL meters should read approximately 1 volt.

t) place the AFC ON OFF switch on HFI-1 #1 to OFF. Return the TUNING KCS control on AFC-3 #1 to "0". Turn the NOISE SILENCER switch on RCVR #1 to OFF. Replace the cover on the HFI-1, and replace the drawer.

6. Check of AGC DECAY circuit, RCVR #1:

a) check that the following controls on HFI-1 #1 are in the indicated positions:

(1) AGC DECAY: (both channels) fully CCW.

(2) MANUAL GAIN: OFF (fully CCW)

b) move the MANUAL gain control slightly clockwise, until the switch clicks on. Note the RF LEVEL meter on HFR-1 #1; it should indicate maximum, and may be pegged.

c) rotate the MANUAL GAIN control slowly clockwise to the full clockwise position;the RF LEVEL meter should follow to zero. Return the MANUAL GAIN control to the "just on" position; this is the point just before the switch clicks off. The RF LEVEL meter should again read maximum.

d) turn both Channel A and Channel B AGC DECAY controls fully CW. Turn the MANUAL GAIN fully CCW to OFF. The RF LEVEL meter should decay to zero in approximately 15 to 20 seconds.

7. Check of HFA-1 unit #1:

a) check that the following controls on HFA-1 #1 are in the indicated positions:

(1) LEVEL ADJUST controls: (both channels) mid position.

(2) LOAD switches: (both channels) OUT when using HSP-2. These switches are on top, rear, inside HFA-1.

(3) DETECTION switches: (both channels) CW position.

b) place the NOISE SILENCER switch on RCVR #1 to the ALIGNMENT SIGNAL position.

c) adjust both BFO controls on HFA-1 #1 for maximum indication on their respective LINE LEVEL meters.

d) adjust both LEVEL ADJUST controls for "0 VU" indication on their respective LINE LEVEL meters.

e) turn the NOISE SILENCER switch on RCVR #1 to OFF.

f) place both DETECTION switches on HFA-1 #1 to AM position.

g) place both IF BANDWIDTH selectors on HFI-1 #1 to the 15 KC DSB position.

h) connect a signal generator to J-1001 on HFR-1 #1. Adjust the signal generator to a frequency of 15 mcs, modulated 30% with 1 KC. Adjust the signal generator output to 10 uv.

i) adjust the BAND and TUNE controls on HFR-1 #1 to receive a frequency of 15 mcs. Place the NIXIE selectors on the HFS-1 to 15.0000. Place the TUNE SYNC OPERATE switch on HFR-1 #1 to SYNC. Obtain a zero beat, and throw the switch to OPERATE.

j) with the RCVR #1 SPEAKER SELECTOR on the HSP-2 to Channel A, adjust the signal generator frequency till a 1 KC tone is heard. Note the RF LEVEL meter on the HFR-1. It will indicate about 20 db above 1 uv, which is 10 uv.

k) plug headphones into the Channel A PHONE jack on the HFA-1; note that the Channel A MONITOR control varies the volume of the 1 KC tone in the phones.

l) place the RCVR #1 SPEAKER SELECTOR on the HSP-2 to Channel B; a 1 KC tone should be heard. Plug headphones into the Channel B PHONE jack; note that the Channel B MONITOR control varies the volume of the 1 KC tone in the phones.

m) remove the signal generator from J-1001 on HFR-1 #1.

8. Check of HAF-1 #1:

a) place the NOISE SILENCER switch on HFR-1 #1 to ALIGNMENT SIGNAL position.

b) place both Channel A and B DETECTION switches on HFA-1 #1 to the CW position.

c) place both Channel A and B IF BANDWIDTH selector switches on HFI-1 #1 to the 15 KC DSB position.

d) place the RCVR #1 SPEAKER SELECTOR on the HSP-2 to Channel A.

e) place the Channel A HIGH and LOW CUTOFF switches on HAF-1 #1 to the 5 KC position.

f) adjust the Channel A BFO control for a peak on the Channel A LINE LEVEL meter on HFA-1 #1; the peak should occur with the BFO control at plus AND minus 5 KC approximately.

g) place the Channel A HIGH and LOW CUTOFF switches to 2.5 KC.

h) adjust the Channel A BFO control for a peak on the Channel A LINE LEVEL meter on the HFA-1; the peak should occur with the BFO control at plus AND minus 2.5 KC approximately.

i) continue this procedure for the 1 KC, 500 cycle, 250 cycle and 100 cycle positions of the Channel A CUTOFF switches. The adjustment of the BFO in the 250 cycle and 100 cycle positions will be critical, but sufficient indication to check out the filters will be obtained. Upon completion, return the Channel A HIGH and LOW CUTOFF switches to the OUT position.

j) place the RCVR #1 SPEAKER SELECTOR on the HSP-2 to Channel B.

k) repeat the HAF-1 check for Channel B, using the Channel B HIGH and LOW CUTOFF switches and the Channel B BFO control and LINE LEVEL meter.

l) upon completion, return the Channel B CUTOFF switches to the OUT position.

m) place the following controls and switches to the indicated positions:

(1) RCVR #1 NOISE SILENCER switch to OFF.

(2) RCVR #1 SPEAKER SELECTOR to Channel A.

(3) RCVR #1 AGC DECAY controls (both) fully CCW.

(4) MANUAL GAIN control on RCVR #1 OFF (fully CCW).

9. Receiver #1 Sensitivity and AGC Check:

a) set the HFR-1 #1 controls to the following positions:

(1) BAND: Band 1 (2-3 mcs)

(2) TUNE: 2.5 mcs

(3) TUNE SYNC OPERATE switch: SYNC

(4) NOISE SILENCER OFF ALIGNMENT SIGNAL switch: OFF.

b) set the NIXIE selectors on the HFS-1 to 02.50000.

c) set the Channel A IF BANDWIDTH selector on the HFI-1 #1 to 6 KC DSB position. Set the Channel B IF BANDWIDTH selector to a BLANK position.

d) set the Channel A DETECTION switch on the HFA-1 #1 to CW.

e) obtain a zero beat with the TUNE control at 2.5 mcs; place the TUNE SYNC OPERATE switch to OPERATE.

f) place the NOISE SILENCER switch to ALIGNMENT SIGNAL.

g) with the Channel A BFO control, obtain a zero beat; then turn the NOISE SILENCER switch to OFF.

h) connect a 20 db pad to the signal generator output; connect the output of the pad to J-1001 on HFR-1 #1.

i) adjust the signal generator to 2.5 mcs, unmodulated, at 100,000 uv output level. Vernier tune the signal generator for a zero beat in the loudspeaker. The RF LEVEL meter on the HFR-1 will read approximately 60 to 80 db above 1 uv.

j) reduce the signal generator output to zero. The RF LEVEL meter should fall to zero.

k) slowly increase the signal generator output; watch carefully the RF LEVEL meter. THE INSTANT THE METER DEFLECTS FROM ZERO, read the signal generator output. The deflection should occur at approximately 10 uv output from the signal generator; this corresponds to an actual sensitivity of 1 uv due to the 20 db pad. (actual sensitivity equals generator output divided by 10)

l) return the signal generator output to 100,000 uv. Adjust the Channel A BFO control for maximum indication on the Channel A LINE LEVEL meter. Adjust the Channel A LEVEL ADJUST control for 0 VU indication.

m) decrease the signal generator output to 10 uv; observe carefully the LINE LEVEL meter. It should not change more than 3 db from the 0 VU level.

n) repeat the sensitivity check and AGC check, (10 a - m), at the following frequencies:

3.5 mc; 5 mc; 7 mc; 10 mc; 14 mc; 20 mc and 28 mc.

10. RCVR #1 Signal Plus Noise/Noise Check:

a) set the NIXIE selectors to 02.5000. Place the #1 TUNE SYNC OPERATE switch to SYNC. Set the BAND and TUNE controls on RCVR #1 for a frequency of 2.5 mcs. Obtain a zero beat at 2.5 mcs, and place the TUNE SYNC OPERATE switch to OPERATE.

b) set the Channel A IF BANDWIDTH selector on HFI-1 #1 to the 15 KC DSB position. Place the Channel B IF BANDWIDTH selector to a BLANK position.

c) set the Channel A DETECTION switch on HFA-1 #1 to CW.

d) slide out the HFA-1 #1 drawer. Connect a Ballentine Model 314 AC VTVM to terminals 5 and 7 of Channel A terminal strip E-7000.

e) adjust the signal generator connected at the antenna input through the 20 db pad to 2.5 mcs, at 10 uv output.

f) turn the NOISE SILENCER switch on RF HEAD #1 to ALIGNMENT SIGNAL.

g) adjust the Channel A BFO control for a zero beat in the loudspeaker.

h) place the NOISE SILENCER switch on RCVR #1 to OFF.

i) adjust the signal generator output frequency to obtain, approximately, a 500 cycle tone in the loudspeaker.

j) adjust the Channel A LEVEL ADJUST control on HFA-1 #1 for 0 VU indication on the Channel A LINE LEVEL meter.

k) set the Ballentine meter for 10 volt full scale range.

l) set the MANUAL GAIN control on HFI-1 #1 for a full scale reading of 10 volts on the Ballentine meter.

m) disconnect the output of the signal generator.

n) note the decrease in the reading on the Ballentine meter; it should be down at least 15 db.

o) repeat the Signal plus Noise/Noise check at 14 mc and 28 mcs, using the above procedure at the appropriate frequencies.

p) remove the signal generator and the Ballentine meter; return the MANUAL GAIN control to the fully CCW position.

11. Final Noise Silencer Check, RCVR #1:

a) check that the following controls and switches are in the indicated positions:

(1) BAND: Band 6 (12 - 16 mcs)

(2) TUNE: 15 mcs

(3) NIXIE SELECTORS: 15.0000

(4) TUNE SYNC OPERATE: RCVR #1: SYNC

(5) NOISE SILENCER: RCVR #1: NOISE SILENCER

(6) RCVR #1 SPEAKER SELECTOR: Channel A

(7) RCVR #1 VOLUME: fully CW

(8) CHANNEL A IF BANDWIDTH SELECTOR: 15 KC DSB

(9) CHANNEL A DETECTION switch: CW

(10) CHANNEL A LEVEL ADJUST CONTROL: fully CW

(11) CHANNEL A BFO CONTROL: off "O" position, to obtain tone, if any.

b) with the RCVR #1 TUNE control, obtain a zero beat at 15 mcs; place the RCVR #1 TUNE SYNC OPERATE switch to OPERATE.

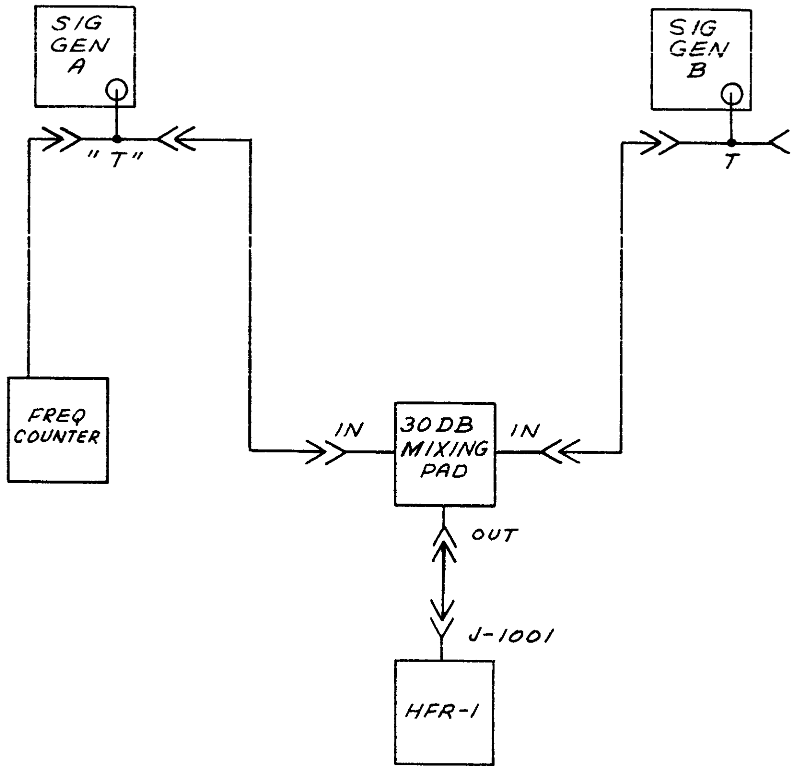
c) pull out the HFR-1 #1 drawer; loosen the locknut of L-1203; adjust L-1203 for minimum background noise and zero indication on the RF LEVEL meter. The background noise will increase on either side of the correct adjustment. Lock L-1203. R-1210 may also have some effect.

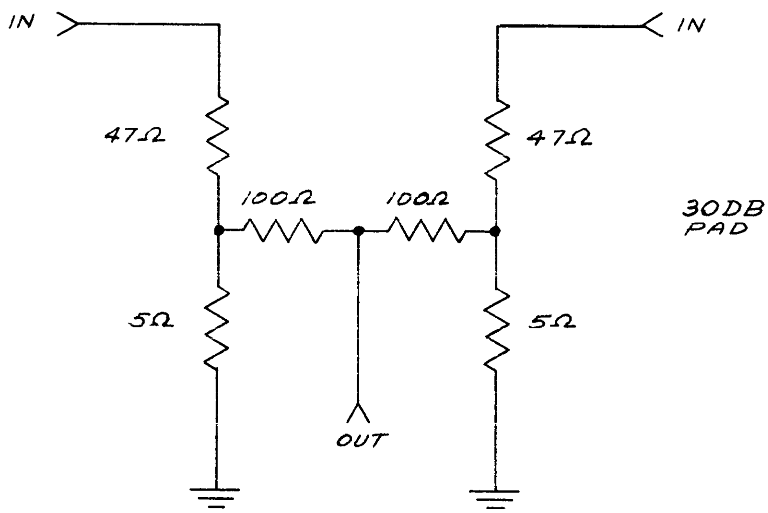
d) return the NOISE SILENCER switch to the OFF position.

12. Two Tone Test, RCVR #1:

a) set up the test equipment as shown below. As an alternate method, a Sideband Generator system, with Model CBE Sideband Exciter, may be used in place of the two signal generators.

TEST EQUIPMENT SETUP FOR TWO TONE TEST





b) set both AGC DECAY controls on HFI-1 #1 fully CW.

c) set signal generator "A" to 2.501 mcs, with .3 volts output.

d) connect the frequency counter to the "T" at signal generator "B". Adjust signal generator "B" to 2.501575 mcs, with .3 volts output.

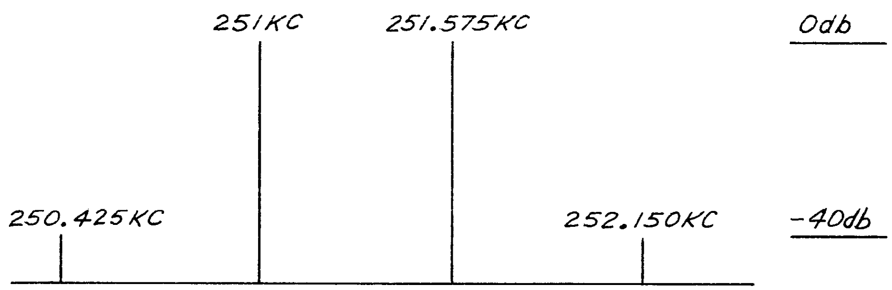
e) adjust controls and switches on the HFS-1 and HFR-1 #1 to synthesize RCVR #1 at 2.5 mcs; when the system is synchronized, place the TUNE SYNC OPERATE switch to OPERATE.

f) connect the Channel A IF output of HFI-1 #1 at J-6203 to the signal input jack of the spectrum analyzer.

g) place the CHANNEL A IF BANDWIDTH selector to the 3.5 KC USB position.

h) adjust the spectrum analyzer controls for an oscilloscope presentation.

i) measure the amplitude of the third order products; these should be down at least 40 db, as shown on the sketch below:



j) upon completion, leave the equipment set up for the test of HNF-1 #1.

13. Check of HNF-1 #1:

a) place the ON OFF switch on the HNF-1 #1 to ON.

b) slowly and carefully move the NOTCH ADJUST control to eliminate each tone in succession. This may be observed on the spectrum analyzer.

c) remove all test equipment; this completes the alignment checkout of the synthesizer, both RF heads, and the rest of RCVR #1. The check of RCVR #2 and functions common to both will now be conducted.

14. Check of AFC-3 unit #2:

conduct this check exactly as for AFC-3 #1, except that references to controls and functions on RCVR #1 should be changed to #2; the NOISE SILENCER switch on RCVR #2 should be in the ALIGNMENT SIGNAL position.

15. Check of HFI-1 #2:

conduct this check exactly as for the HFI-1 #1, except that references to controls and functions on RCVR #1 should be changed to #2.

16. Check of AGC DECAY circuit, RCVR #2:

conduct this check exactly as for RCVR #1, except that references to controls and functions on RCVR #1 should be changed to #2.

17. Check of HFA-1 unit #2:

conduct this check exactly as for RCVR #1, except that references to RCVR #1 should be changed to #2. For step (i), concerning synthesis at 15 mcs, use the general procedure to sync first #1 RF head, then #2 RF head. The #2 RF head TUNE SYNC OPERATE switch is left in TUNE at all times.

18. Check of HAF-1 #2:

conduct this check exactly as for RCVR #1, except that references to RCVR #1 should be changed to #2.

19. Receiver #2 Sensitivity and AGC Check:

conduct this check exactly as for RCVR #1, except that references to RCVR #1 should be changed to #2. Again, the RCVR #2 TUNE SYNC OPERATE switch is left in the TUNE position. All frequencies are set up as in the general synthesizer and RF checkout.

20. RCVR #2 Signal Plus Noise/Noise Check:

conduct this check exactly as for RCVR #1 except that references to RCVR #1 should be changed to #2.
All frequencies are set up as in the general synthesizer and RF check.

21. Final Noise Silencer Check RCVR #2:

conduct this check exactly as for RCVR #1, except that references to RCVR #1 should be changed to #2. Leave the RCVR #2 TUNE SYNC OPERATE switch in TUNE. Set up the required frequency by the method used previously.

22. Two Tone Test RCVR #2:

conduct this test exactly as for RCVR #1, except that references to RCVR #1 should be changed to #2. Leave the RCVR #2 TUNE SYNC OPERATE switch in the TUNE position. Set up the required frequency by the method employed previously.

23. Check of HNF-1 #2:

conduct this check exactly as for RCVR #2, except that references to RCVR #1 should be changed to #2.

24. Check of Model DVM-4 Diversity Visual Monitor:

a) both RF heads and the synthesizer should be synchronized at 2.5 mcs. Place the Channel A and B IF BANDWIDTH selectors on both receivers to the 15 KC DSB position.

b) place the NOISE SILENCER switches on both receivers to the ALIGNMENT SIGNAL position.

c) place the AFC ON OFF switches on both receivers to the ON position.

d) place the POWER ON OFF switch on the DVM-4 to ON. Wait about 5 minutes for warmup. Turn the RF GAIN control on this unit fully CW; adjust it as necessary during the check.

e) the SWEEP RANGE switch on the DVM-4 should be in the plus and minus 5 KC position.

f) press the PUSH TO CALIBRATE control; hold it down while centering the pulse on the screen with the CALIBRATE FOR ZERO adjustment. Release the PUSH TO CALIBRATE button.

g) on AFC-3 #1, press and hold down the RESET button for about 6 seconds; note that the CARRIER SELECTOR switch is in the OSC position.

h) with the Receiver Selector on the DVM-4 in RCVR #1 position, move the TUNING KCS control on the AFC-3 #1 toward the plus 3 KC position; the pulse on the DVM-4 should move left. Return the TUNING KCS control to "O". The pulse on the DVM-4 should center. Move the TUNING KCS control toward the -3 KC position; the pulse on the DVM-4 should move right. Return the TUNING KCS control to "O". The pulse on the DVM-4 should center.

i) on HFI-1 #1, place the Channel A and B IF BANDWIDTH selectors to a BLANK position. The pulse should disappear. Place Channel A selector to 15 KC DSB position; the pulse should re-appear. Return the Channel A selector to a BLANK position, and place the Channel B selector to the 15 KC DSB position. The pulse should re-appear.

j) place the SWEEP RANGE switch on the DVM-4 to plus - minus 1 KC position. Repeat step (h).

k) place the AFC ON OFF switch on HFI-1 #1 to OFF.

l) place the RECEIVER SELECTOR on the DVM-4 to RCVR #2:

m) repeat steps (e) through (k) for RCVR #2.

n) on completion, place the POWER ON OFF switch on the DVM-4 to OFF. Return the Channel A and B IF BANDWIDTH selectors on both receivers to the 15 KC DSB position. Place both AFC ON OFF switches OFF.

25. Check of AGC Combined - Separate switch on HSP-2:

a) leave RCVR #1 ALIGNMENT SIGNAL on. Turn RCVR #2 NOISE SILENCER switch to OFF.

b) place AGC COMBINED SEPARATE switch on HSP-2 to SEPARATE.

c) RF LEVEL meter #1 should indicate.

d) place the AGC COMBINED SEPARATE switch on HSP-2 to COMBINED.

e) both RF LEVEL meters should indicate.

f) place the RCVR #1 NOISE SILENCER SWITCH to OFF. Place RCVR #2 NOISE SILENCER switch to ALIGNMENT SIGNAL.

g) repeat steps (b) through (e). In step (c), only RCVR #2 RF LEVEL meter will indicate.

h) this completes the checkout of the Model DDR-5A receiver.

Model DDR-5B (AN/FRR-60(v))

SYSTEM CHECKOUT PROCEDURE

A. Preliminary:

1. Test Equipment Required:

   a) Frequency Counter: H.P. Model 524C or equivalent.

   b) Signal Generators: Measurements Corp. Model 82, or equivalent. (2 required)

   c) AC VTVM: Ballentine Model 314, or equivalent.

   d) Spectrum Analyzer.

   e) 30 DB mixing pad. (described in Two Tone Test)

   f) 20 DB attenuator pad.

   g) Simpson Model 260 VOM, or equivalent.

2. It is assumed that individual units have been tested and installed in the cabinet; that all cables have been connected, and that all interconnections have been made.

3. Remove the cover from the line filter located at the rear, left of the cabinet. Connect a three wire power cable as follows:

   a) WHITE lead to line lug.

   b) GREEN lead to grounding screw.

   c) BLACK lead to line lug.

   d) With a Simpson Model 260 VOM, check the voltage at the front panel convenience outlets; it should be 115 volts AC.

4. Place switches and controls in the following positions:

   a) HFP-1: STANDBY switch at the rear to STANDBY. The blowers should commence to operate.

   b) HAF-1: All switches to the OUT position.

c) HFA-1: (applies to Channel A and Channel B)

(1) DETECTION switches: CW position

(2) BFO controls: "0"

(3) STANDBY - OPERATE switch: STANDBY

(4) LINE LEVEL controls: mid position

d) HNF-1:

(1) ON-OFF switch: OFF

(2) NOTCH ADJUST "0"

e) HFI-1: (applies to Channel A and Channel B)

(1) MANUAL GAIN: fully CCW, switch OFF.

(2) AGC DECAY: fully CCW.

(3) IF BANDWIDTH selectors: 6 KC DSB

(4) AFC ON - OFF: OFF

f) HSP-2: (only RCVR #1 position is effective for a single unit installation)

(1) RCVR #1 SPEAKER CHANNEL selector: Channel A

(2) RCVR #1 VOLUME control: fully CW.

g) AFC-3:

(1) SENSITIVITY: fully CW.

(2) TUNING KCS control: "0"

(3) CARRIER SELECTOR switch: OSC

h) HFR-1:

(1) BAND: Band 1 (2-3 mcs)

(2) TUNE: 2.0 mcs

(3) NOISE SILENCER - OFF - ALIGNMENT SIGNAL switch: OFF

(4) TUNE - SYNC - OPERATE switch: OPERATE

B. Checkout Procedure:

1. On HFA-1, place STANDBY - OPERATE switch to OPERATE. On HFP-1, the GREEN standby indicator will go out, and the YELLOW time delay indicator will come on. After time delay, approximately 60 seconds, the YELLOW

indicator will go out and the RED operate indicator will come on. At the same time, the NIXIE lights on the HFS-1 will indicate.

2. Pull out the HFP-1; with a Simpson Model 260 VOM, measure the voltage at test points TP-8001 and TP-8002. It should be 200 volts. If it is not, adjust the appropriate potentiometers, R-8014 and/or R-8025, and lock the adjustments.

3. Check of Synthesizer, HFO Circuits and Stability:

   This procedure consists of checking the synthesizer and the HFO tracking simultaneously, for all positions of the NIXIE selector switches. Faulty crystals in the HFS-1 will show up during this check.

   a) Remove the 47 ohm termination from J-1313 on the HFR-1 and connect a frequency counter to this jack.

   b) With the NIXIE selectors set at 02.0000, and the RF Tuner set for 2.0 mcs, place the TUNE - SYNC - OPERATE switch to the SYNC position.

   c) Move the TUNE control around 2.0 mcs until the sync tone is heard; adjust the TUNE control for zero beat. The sync light may chatter during this operation. Place the TUNE SYNC OPERATE switch to OPERATE. The sync light will come on. The counter should read 3.75 mcs. Return the TUNE SYNC OPERATE switch to the SYNC position.

   d) Place the 100 KC NIXIE selector in position 1; move the TUNE control until a zero beat is obtained at 2.1 mcs. Place the TUNE SYNC OPERATE switch to OPERATE. The counter should read 3.85 mcs. Return the TUNE SYNC OPERATE switch to the SYNC position.

   e) Continue this procedure through the remaining positions of the 100 KC selector switch. For each position, move the TUNE control to obtain a zero beat as follows:

100 KC SELECTOR	TUNE CONTROL	FREQ. COUNTER
2	2.2 mcs	3.95 mcs
3	2.3 mcs	4.05 mcs
4	2.4 mcs	4.15 mcs
5	2.5 mcs	4.25 mcs
6	2.6 mcs	4.35 mcs
7	2.7 mcs	4.45 mcs
8	2.8 mcs	4.55 mcs
9	2.9 mcs	4.65 mcs

f) Place the 10 KC selector switch to position 1; move the TUNE control to obtain a zero beat at 2.91 mcs. Place the TUNE SYNC OPERATE switch to OPERATE. The counter should read 4.66 mcs. Return the TUNE SYNC OPERATE switch to the SYNC position.

g) Continue this procedure through the remaining positions of the 10 KC selector switch. For each position, move the TUNE control to obtain a zero beat as follows:

10 KC SELECTOR	TUNE CONTROL	FREQ. COUNTER
2	2.92 mcs	4.67 mcs
3	2.93 mcs	4.68 mcs
4	2.94 mcs	4.69 mcs
5	2.95 mcs	4.70 mcs
6	2.96 mcs	4.71 mcs
7	2.97 mcs	4.72 mcs
8	2.98 mcs	4.73 mcs
9	2.99 mcs	4.74 mcs

h) Place the 1 KC selector switch to position 1; move the TUNE control until a zero beat is obtained at 2.991 mcs. Place the TUNE SYNC OPERATE switch to the OPERATE position. The counter should read 4.741 mcs. Return the TUNE SYNC OPERATE switch to the SYNC position.

i) Continue this procedure through the remaining positions of the 1 KC selector switch. For each position, move the TUNE control to obtain a zero beat as follows:

1 KC SELECTOR	TUNE CONTROL	FREQ. COUNTER
2	2.992 mcs	4.742 mcs
3	2.993 mcs	4.743 mcs
4	2.994 mcs	4.744 mcs
5	2.995 mcs	4.745 mcs
6	2.996 mcs	4.746 mcs
7	2.997 mcs	4.747 mcs
8	2.998 mcs	4.748 mcs
9	2.999 mcs	4.749 mcs

j) Place the .1 KC selector switch in position 1; move the TUNE control until a zero beat is obtained at 2.9991 mcs. Place the TUNE SYNC OPERATE switch to the OPERATE position. The counter should read 4.7491 mcs. Return the TUNE SYNC OPERATE switch to the SYNC position.

k) Continue this procedure for the remaining positions of the .1 KC selector switch. For each position, move the TUNE control to obtain a zero beat as follows:

.1 KC SELECTOR	TUNE CONTROL	FREQ. COUNTER
2	2.9992 mcs	4.7492 mcs
3	2.9993 mcs	4.7493 mcs
4	2.9994 mcs	4.7494 mcs
5	2.9995 mcs	4.7495 mcs
6	2.9996 mcs	4.7496 mcs
7	2.9997 mcs	4.7497 mcs
8	2.9998 mcs	4.7498 mcs
9	2.9999 mcs	4.7499 mcs

l) Place the NIXIE selectors to 03.0000. Move the TUNE control to obtain a zero beat at 3.0 mcs. Place the TUNE SYNC OPERATE switch to the OPERATE position. The counter should read 4.75 mcs. Return the TUNE SYNC OPERATE switch to the SYNC position.

m) Place the BAND control to Band 2 (3-4 mc). Move the TUNE control to obtain a zero beat at 3.0 mcs. Place the TUNE SYNC OPERATE switch to the OPERATE position. The counter should read 4.75 mcs. Return the TUNE SYNC OPERATE switch to the SYNC position.

n) Continue this procedure for the remaining positions of the MC selector switch, conducting the check at the high and low ends of each band. In each case, the counter should read 1.75 mc above the selected RF frequency when the TUNE SYNC OPERATE switch is in place in the OPERATE position.

MC SELECTOR	BAND	TUNE CONTROL	COUNTER
4	2	4 mcs	5.75 mcs
4	3	4 mcs	5.75 mcs
5	3	5 mcs	6.75 mcs
6	3	6 mcs	7.75 mcs
6	4	6 mcs	7.75 mcs
7	4	7 mcs	8.75 mcs
8	4	8 mcs	9.75 mcs
8	5	8 mcs	9.75 mcs
9	5	9 mcs	10.75 mcs
10	5	10 mcs	11.75 mcs
11	5	11 mcs	12.75 mcs
12	5	12 mcs	13.75 mcs
12	6	12 mcs	13.75 mcs
13	6	13 mcs	14.75 mcs
14	6	14 mcs	15.75 mcs
15	6	15 mcs	16.75 mcs
16	6	16 mcs	17.75 mcs
16	7	16 mcs	17.75 mcs
17	7	17 mcs	18.75 mcs
18	7	18 mcs	19.75 mcs
19	7	19 mcs	20.75 mcs
20	7	20 mcs	21.75 mcs
21	7	21 mcs	22.75 mcs
22	7	22 mcs	23.75 mcs

MC SELECTOR	BAND	TUNE CONTROL	COUNTER
23	7	23 mcs	24.75 mcs
24	7	24 mcs	25.75 mcs
24	8	24 mcs	25.75 mcs
25	8	25 mcs	26.75 mcs
26	8	26 mcs	27.75 mcs
27	8	27 mcs	28.75 mcs
28	8	28 mcs	29.75 mcs
29	8	29 mcs	30.75 mcs
30	8	30 mcs	31.75 mcs
31	8	31 mcs	32.75 mcs

o) Place the NIXIE selectors to 15.0000,the BAND control to Band 6 (12-16 mc), and the TUNE control to 15 mcs. With the TUNE SYNC OPERATE switch at SYNC, obtain a zero beat. Place the TUNE SYNC OPERATE switch to OPERATE. Carefully move the TUNE control in both directions, checking for symmetrical swing of the sync meter from 0 to either side. If the swing is not symmetrical, adjust R-3442 on the 3400 deck of the HFS-1 until a symmetrical swing is achieved.

p) Remove the counter from J-1313; replace the 47 ohm termination.

4. Check of the AFC-3 Unit:

a) Place the AFC ON OFF switch on the HFI-1 to ON.

b) Place the NOISE SILENCER OFF ALIGNMENT SIGNAL switch to ALIGNMENT SIGNAL.

c) Depress and hold down the RESET button on the AFC-3; adjust the TUNING KCS control for maximum indication on the CARRIER LEVEL meter, and zero center scale on the DRIFT METER. The CARRIER LEVEL meter should read approximately in the center of the GREEN. Release the RESET button.

d) Check the FADE and DRIFT ALARM lamps; they should be extinguished. The DRIFT METER should remain at zero center scale.

e) Place the CARRIER SELECTOR switch to RCC. There should be no change in indications.

f) Place the NOISE SILENCER OFF ALIGNMENT SIGNAL switch to OFF. The CARRIER LEVEL meter should fall, and the FADE alarm should light. Return the NOISE SILENCER OFF ALIGNMENT SIGNAL switch to the ALIGNMENT SIGNAL position. Move the SENSITIVITY control fully CCW. The FADE indicator should light and the CARRIER LEVEL meter should fall. Return the SENSITIVITY control fully CW.

g) Return the CARRIER SELECTOR switch to OSC.

h) Place the AFC ON OFF switch on the HFI-1 to OFF.

5. Check of the HFI-1 Unit:

Note: this procedure also checks the HFA-1 in the SSB mode of operation, and checks the tuning of the AFC-3.

a) Check the MANUAL GAIN control. It should be OFF (CCW)

b) Place the Channel A IF BANDWIDTH selector switch to 1 KC DSB position.

c) Place the Channel B IF BANDWIDTH selector to a BLANK position.

d) Pull out the HFI-1; lock in position and remove the top cover.

e) Note the markings on the input filters or RF XFRMR can; From left to right, with the operator facing the front panel, these should read: 1 KC SYM; 6 KC SYM; T-101; 3.5 KC USB; 3.5 KC LSB; 7.5 KC USB, and 7.5 KC LSB.

f) Adjust R-116 on the 1 KC SYM strip for a reading of 1.0 volt on the Channel A IF level meter; this corresponds to a level of .707 volts RMS into a 50 ohm load at J-102 on the IF strip. Lock the adjustment.

g) Place the Channel B IF BANDWIDTH selector to the 1 KC SYM position. Both IF output level meters should read approximately 1 volt. Place the Channel B IF BANDWIDTH selector to a BLANK position.

h) Place the Channel A IF BANDWIDTH selector to the 6 KC DSB position. Adjust R-116 on the 6 KC SYM strip for the 1 volt reading on the Channel A IF level meter. Lock the adjustment.

i) Place the Channel B IF BANDWIDTH selector to the 6 KC DSB position. Both IF level meters should read approximately 1 volt. Place the Channel B IF BANDWIDTH selector to a BLANK position.

j) Place the Channel A IF BANDWIDTH selector to the 15 KC DSB position. Adjust R-116 on the 15 KC SYM strip for the 1 volt reading. Lock the adjustment.

k) Place the Channel B IF BANDWIDTH selector to the 15 KC DSB position. Both IF level meters should indicate approximately 1 volt.

l) Place the AFC ON OFF switch to ON.

m) Place the Channel A and B DETECTION switches on the HFA-1 to the SSB position.

n) On the AFC-3, depress the RESET button for about 6 seconds; then move the TUNING KCS control midway between the "0" and "-3KC" positions. The CARRIER LEVEL meter will fall and the FADE indicator will light.

o) Place the Channel A IF BANDWIDTH selector to the 3.5 KC USB position. Place the Channel B IF BANDWIDTH selector to a BLANK position. Adjust R-116 on the 3.5 KC USB strip for the 1 volt reading. Place the Channel B IF BANDWIDTH selector to the 3.5 KC USB position. Both IF level meters should indicate approximately 1 volt. Return the Channel B IF BANDWIDTH selector to a BLANK position. Lock the adjustment.

p) Place the Channel A IF BANDWIDTH selector to the 7.5 KC USB position. Adjust R-116 on the 7.5 KC USB strip for the 1 volt reading. Place the Channel B IF BANDWIDTH selector to the 7.5 KC USB position. Both IF level meters should indicate approximately 1 volt. Return the Channel B IF BANDWIDTH selector to a BLANK position. Lock the adjustment.

q) Move the TUNING KCS control on the AFC-3 midway between the "0" and plus 3 KC positions.

r) Place the Channel A IF BANDWIDTH selector to the 3.5 KC LSB position. Adjust R-116 on the 3.5 KC LSB strip for the 1 volt reading. Lock the adjustment. Place the Channel B IF BANDWIDTH selector to the 3.5 KC LSB position. Both IF level meters should indicate approximately 1 volt. Return the Channel B IF BANDWIDTH selector to a BLANK position.

s) Place the Channel A IF BANDWIDTH selector to the 7.5 KC LSB position. Adjust R-116 on the 7.5 KC LSB strip for the 1 volt reading. Lock the adjustment. Place the Channel B IF BANDWIDTH selector to the 7.5 KC LSB position. Both IF level meters should indicate approximately 1 volt.

t) Place the AFC ON OFF switch to OFF; return the TUNING KCS control to the "0" position; Turn the NOISE SILENCER OFF ALIGNMENT SIGNAL switch to OFF. Replace the cover on the HFI-1, and slide in the unit.

6. Check of AGC DECAY Circuits:

a) Check that the following controls on the HFI-1 are in the indicated positions:

(1) AGC DECAY: (both channels) fully CCW.

(2) MANUAL GAIN: OFF (fully CCW)

b) Move the MANUAL GAIN control slightly clockwise, until the switch clicks on. Note the RF LEVEL meter on the HFR-1; it should indicate maximum, and may be pegged.

c) Rotate the MANUAL GAIN control slowly clockwise to the full clockwise position; the RF LEVEL meter should follow to zero. Return the MANUAL GAIN control to the "just on" position. This is the point just before the switch clicks off. The RF LEVEL meter should again read maximum.

d) Turn both Channel A and Channel B AGC DECAY controls fully CW. Turn the MANUAL GAIN to OFF (fully CCW). The RF LEVEL meter should decay to zero in approximately 15 to 20 seconds.

7. Check of the HFA-1 Unit:

a) Check that the following controls on the HFA-1 are in the indicated positions:

(1) LEVEL ADJUST controls: (both channels) mid position.

(2) LOAD switches: (both channels) OUT when using HSP-2. These switches are on top, rear, inside HFA-1.

(3) DETECTION switches: (both channels) CW position.

b) Place the NOISE SILENCER OFF ALIGNMENT SIGNAL switch to the ALIGNMENT SIGNAL position.

c) Adjust both BFO controls for maximum indication on their respective LINE LEVEL meters.

d) Adjust both LEVEL ADJUST controls for "0 VU" on their respective LINE LEVEL meters.

e) Turn the NOISE SILENCER OFF ALIGNMENT SIGNAL switch to OFF.

f) Place both DETECTION switches to the AM position.

g) Place both IF BANDWIDTH selector switches on the HFI-1 to the 15 KC DSB position.

h) Connect a signal generator to J-1001 on the HFR-1. Adjust the generator to a frequency of 15 mcs, modulated 30% with 1 KC. Adjust the signal generator output to 10 uv.

i) Adjust the BAND and TUNE controls on the HFR-1 to receive a frequency of 15 mcs.

j) Place the RCVR #1 SPEAKER SELECTOR on the HSP-2 to Channel A. Adjust the signal generator until a 1 KC tone is heard. Note the RF LEVEL meter on the HFR-1: it will indicate about 20 DB above 1 uv, which is 10 uv.

k) Plug headphones into the Channel A PHONE jack on the HFA-1; note that the Channel A MONITOR control varies the volume of the 1 KC tone in the phones.

l) Place the RCVR #1 SPEAKER SELECTOR on the HSP-2 to Channel B. A 1 KC tone should be heard. Plug headphones into the Channel B PHONE jack; note that the Channel B MONITOR varies the volume of the 1 KC tone in the phones.

m) Remove the signal generator from J-1001 on the HFR-1.

8. Check of the HAF-1:

a) With the RF head operating at any frequency, turn the NOISE SILENCER OFF ALIGNMENT SIGNAL switch to ALIGNMENT SIGNAL.

b) Place both Channel A and Channel B DETECTION switches on the HFA-1 to the CW position.

c) Place both Channel A and Channel B IF BANDWIDTH selector switches on the HFI-1 to the 15 KC DSB position.

d) Place the RCVR #1 SPEAKER SELECTOR on the HSP-2 to Channel A.

e) Place the Channel A HIGH and LOW CUTOFF switches on the HAF-1 to the 5 KC position.

f) Adjust the Channel A BFO control for a peak on the Channel A LINE LEVEL meter on the HFA-1; the peak should occur with the BFO control at approximately plus AND minus 5 KCS.

g) Place the Channel A HIGH and LOW CUTOFF switches on the HAF-1 to 2.5 KC.

h) Adjust the Channel A BFO control for a peak on the Channel A LINE LEVEL meter on the HFA-1; the peak should occur with the BFO control at plus and minus 2.5 KC.

i) Continue this procedure for the 1 KC, 500 cycle, 250 cycle and 100 cycle positions of the Channel A CUTOFF switches. The adjustment of the BFO in the 250 cycle and 100 cycle positions will be critical, but sufficient indication to check out the filter will be obtained. Upon completion, return the Channel A HIGH and LOW CUTOFF switches to the OUT position.

j) Place the RCVR #1 SPEAKER SELECTOR switch on the HSP-2 to Channel B.

k) Repeat the HAF-1 check for Channel B, using the Channel B HIGH and LOW CUTOFF switches, and the Channel B BFO control and LINE LEVEL meter.

l) Upon completion:

(1) Return the Channel B CUTOFF switches to OUT.

(2) Turn the NOISE SILENCER OFF ALIGNMENT SIGNAL switch to OFF.

(3) Place the RCVR #1 SPEAKER SELECTOR to Channel A.

(4) Place both AGC DECAY controls fully CCW.

(5) Place the MANUAL GAIN control OFF (fully CCW)

9. Receiver Sensitivity and AGC Check:

a) Set the HFR-1 controls to the following positions:

(1) BAND: Band 1 (2-3 mcs)

(2) TUNE: 2.5 mcs

b) Set the NIXIE selectors to 02.5000.

c) Set the Channel A IF BANDWIDTH selector on the HFI-1 to the 6 KC DSB position, Channel B to a BLANK position.

d) Set the Channel A DETECTION switch on the HFA-1 to CW.

e) Place the TUNE SYNC OPERATE switch on the HFR-1 to SYNC.

f) Obtain a zero beat at 2.5 mcs; place the TUNE SYNC OPERATE switch to OPERATE.

g) Place the NOISE SILENCER OFF ALIGNMENT SIGNAL switch to the ALIGNMENT SIGNAL position. With Channel A BFO control, obtain a zero beat; then turn the NOISE SILENCER OFF ALIGNMENT SIGNAL switch to OFF.

h) Connect a 20 db pad to the signal generator output; connect the other arm of the pad to J-1001 on the HFR-1.

i) Adjust the signal generator to 2.5 mcs, at 100,000 uv output level. Vernier tune the signal generator for a zero beat in the loudspeaker. The RF LEVEL meter on the HFR-1 should read approximately 60 to 80 db above 1 uv.

j) Reduce the signal generator output to 1 uv. The RF LEVEL meter should fall to zero.

k) Slowly increase the signal generator output toward 10 uv, carefully watching the RF LEVEL meter. THE INSTANT THE METER DEFLECTS FROM ZERO, READ THE SIGNAL GENERATOR OUTPUT. The deflection should occur at approximately 10 uv output from the signal generator; this corresponds to an actual sensitivity of 1 uv due to the 20 db pad. (Actual sensitivity equals generator output divided by 10)

l) Return the signal generator output to 100,000 uv. Adjust the Channel A BFO control for maximum indication on the Channel A LINE LEVEL meter. Adjust the LEVEL ADJUST control for "0 VU".

m) Decrease the signal generator output to 10 uv, observing carefully the LINE LEVEL meter. It should not change more than 3 db from the 0 VU level.

n) Repeat the sensitivity and AGC check (a) through (m), at the following frequencies:

3.5 mc, 5 mc, 7 mc, 10 mc, 14 mc, 20 mc and 28 mc.

10. Signal Plus Noise/Noise Check:

a) Tune the RF Head to 2.5 mcs; set the NIXIE selectors to 2.5 mcs; with the TUNE SYNC OPERATE switch in SYNC, obtain a zero beat; place the TUNE SYNC OPERATE switch to OPERATE.

b) Set the Channel A IF BANDWIDTH selector on the HFI-1 to the 15 KC DSB position.

c) Set the Channel A DETECTION switch on the HFA-1 to the CW position.

d) Slide out the HFA-1 drawer. Connect a Ballentine Model 314 AC VTVM to terminals 5 and 7 of Channel A terminal strip, E-7000.

e) Adjust the signal generator connected at the antenna input through the 20 db pad to 2.5 mcs, at 10 uv output.

f) Turn the NOISE SILENCER OFF ALIGNMENT SIGNAL switch to ALIGNMENT SIGNAL.

g) Adjust the Channel A BFO control for a zero beat in the loudspeaker.

h) Place the NOISE SILENCER OFF ALIGNMENT SIGNAL switch to OFF.

i) Adjust the signal generator output frequency to obtain, approximately, a 500 cycle tone in the loudspeaker.

j) Adjust the Channel A LEVEL ADJUST control to obtain a 0 VU reading on the Channel A LINE LEVEL meter.

k) Set the Ballentine Meter at 10 volt full scale range.

l) Set the MANUAL GAIN control on the HFI-1 for full scale reading on the Ballentine Meter.

m) Disconnect the output of the signal generator.

n) Note the decrease in the reading on the Ballentine Meter; it should be down at least 15 db.

o) Repeat the Signal Plus Noise to Noise check at 14 mc and 28 mcs.

p) Upon completion, remove the signal generator and the Ballentine Meter. Return the MANUAL GAIN control to the extreme CCW position.

11. Final Noise Silencer Check:

a) Check that the following controls and switches are in the indicate positions:

(1) BAND: 6: (12 - 16 mcs)

(2) TUNE: 15 mcs

(3) NIXIE SELECTORS: 15.0000

(4) TUNE SYNC OPERATE: SYNC

(5) NOISE SILENCER OFF ALIGNMENT SIGNAL: NOISE SILENCER

(6) RCVR #1 SPEAKER SELECTOR: Channel A

(7) RCVR #1 VOLUME control: fully CW

(8) CHANNEL A IF BANDWIDTH selector: 15 KC DSB position.

(9) CHANNEL A DETECTION switch: CW position.

(10) CHANNEL A LEVEL ADJUST control: fully CW.

(11) CHANNEL A BFO control: off "0" position, either side, to obtain tone, if any.

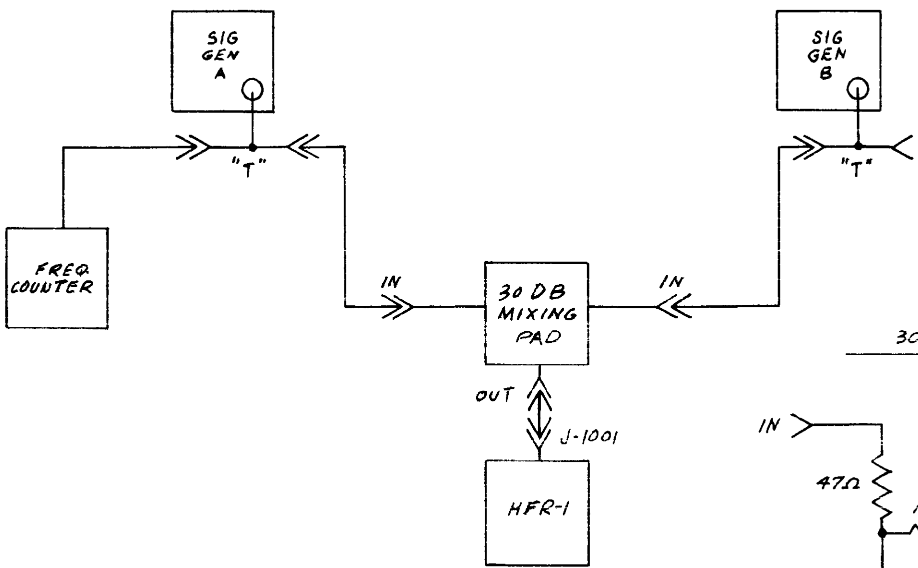
b) Obtain a zero beat at 15 mcs; place the TUNE SYNC OPERATE switch to OPERATE.

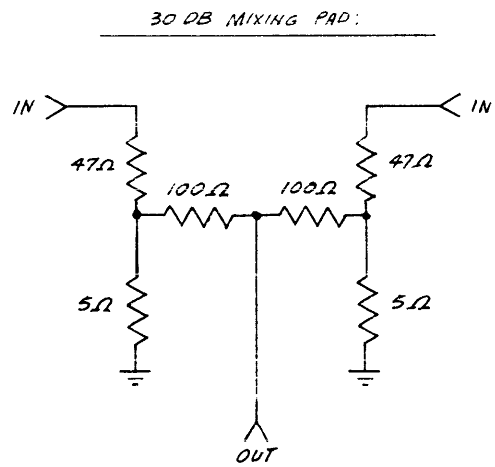
c) Pull out the HFR-1 drawer; loosen the locknut on L-1203; adjust L-1203 for minimum background noise and zero indication on the RF LEVEL meter. The background noise will increase on either side of the correct adjustment. Lock L-1203. R1210 may also have some effect.

d) Return the NOISE SILENCER OFF ALIGNMENT SIGNAL switch to the OFF position.

12. Two Tone Test:

a) Set up the test equipment as shown below. As an alternate method, a Sideband Generator System, with Model CBE Sideband Exciter, may be used in place of the two signal generators.





b) Set both AGC DECAY controls on the HFI-1 fully CW.

c) Set signal generator "A" to 2.501 mcs, .3 volts output.

d) Connect the frequency counter to the "T" at signal generator "B". Adjust signal generator "B" for .3 volts output at 2.501575 mcs.

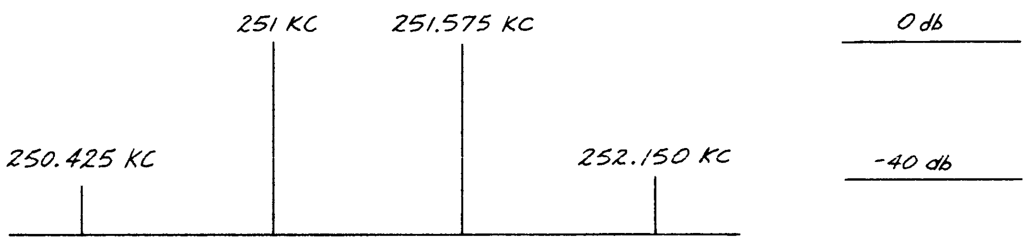
e) Adjust controls, selectors and switches on the HFS-1 and HFR-1 to synthesize the receiver at 2.5 mcs. When the system is synchronized, place the TUNE SYNC OPERATE switch to OPERATE.

f) Connect the Channel A IF output of the HFI-1 at J-6203 to the signal input jack of a spectrum analyzer.

g) Place the Channel A IF BANDWIDTH selector to the 3.5 KC USB position.

h) Adjust the spectrum analyzer controls for an oscilloscope presentation.

i) Measure the amplitude of the third order products; these should be down at least 40 db, as shown on the sketch below:



j) Upon completion of the two tone test, leave the equipment set up for the HNF-1 check.

13. HNF-1 Checkout:

a) Place the ON OFF switch on the HNF-1 to ON.

b) Slowly and carefully move the NOTCH ADJUST control to eliminate each tone in succession. This may be observed on the spectrum analyzer.

c) Place the ON OFF switch on the HNF-1 to OFF.

d) Remove all test equipment. This completes the checkout of the Model DDR-5B1 receiver.

Tester Checkoff Sheet:

STEP		INITIAL
A-3d	Line voltage at convenience outlets is 115 V.	________
A-4a	Blowers operate	________
B-1	Standby, Time delay and operate indicators function, with proper timing sequence.	________
B-2	Voltage at TP-8001 and TP-8002 is 200 volts	________
B-3	Synthesizer, HFO and Stability check	________
B-3o	Symmetrical swing of SYNC meter	________
B-4c,d,e	Carrier Level meter reads near center of GREEN. Drift Meter remains at zero center scale. Fade and Drift Alarm lamps extinguished. No change of indications in RCC position	________
B-4f	Carrier Level meter falls, and Fade indicator lights with SENSITIVITY control fully CCW.	________
B-5e	IF strips properly installed.	________
B-5f-k	1 volt reading obtain on symmetrical strips; both channels read approximately 1 volt; R-116 on symmetrical strips locked	________
B-5o-s	1 volt reading obtained on USB and LSB strips; HFA-1 operates in SSB mode; R-116 on USB and LSB strips locked.	________
B-6	AGC check	________
B-7d	0 VU level obtained in CW mode.	________
B-7j-l	HFA-1 operates in AM mode. Monitor circuits operate correctly.	________
B-8	HAF-1 check	________
B-9	Sensitivity 2.5 mcs — record reading	______uv
	AGC check 2.5 mcs — record reading	______DB
	Sensitivity 3.5 mcs	______uv
	AGC check 3.5 mcs	______DB
	Sensitivity 5 mcs	______uv
	AGC check 5 mcs	______DB

STEP		READING
	Sensitivity 7 mcs	______uv
	AGC check 7 mcs	______DB
	Sensitivity 10 mcs	______uv
	AGC check 10 mcs	______DB
	Sensitivity 14 mcs	______uv
	AGC check 14 mcs	______DB
	Sensitivity 20 mcs	______uv
	AGC check 20 mcs	______DB
	Sensitivity 28 mcs	______uv
	AGC check 28 mcs	______DB
B-10	Signal plus noise/noise 2.5 mcs (record)	______DB
	Signal plus noise/noise 14 mcs	______DB
	Signal plus noise/noise 28 mcs	______DB
B-11	Noise silencer check and final trap adjustment (initial)	______
B-12	Two tone test 2.5 mcs (record level of 3rd order products)	______DB
	14 mcs	______DB
	28 mcs	______DB
B-13	HNF-1 checkout (initial)	______