TECHNICAL MANUAL

for

AUTOMATIC FREQUENCY CONTROL

MODELS AFC-2A AND AFC-3

THE TECHNICAL MATERIEL CORPORATION
MAMARONECK, N. Y. OTTAWA, CANADA

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IN 4003B

Issue Date: 1 March 1963

THE TECHNICAL MATERIEL CORPORATION
COMMUNICATIONS ENGINEERS
700 FENIMORE ROAD
MAMARONECK, N. Y.

Warranty

The Technical Materiel Corporation, hereinafter referred to as TMC, warrants the equipment (except electron tubes,* fuses, lamps, batteries and articles made of glass or other fragile or other expendable materials) purchased hereunder to be free from defect in materials and workmanship under normal use and service, when used for the purposes for which the same is designed, for a period of one year from the date of delivery F.O.B. factory. TMC further warrants that the equipment will perform in a manner equal to or better than published technical specifications as amended by any additions or corrections thereto accompanying the formal equipment offer.

TMC will replace or repair any such defective items, F.O.B. factory, which may fail within the stated warranty period, PROVIDED:

1. That any claim of defect under this warranty is made within sixty (60) days after discovery thereof and that inspection by TMC, if required, indicates the validity of such claim to TMC's satisfaction.

2. That the defect is not the result of damage incurred in shipment from or to the factory.

3. That the equipment has not been altered in any way either as to design or use whether by replacement parts not supplied or approved by TMC, or otherwise.

4. That any equipment or accessories furnished but not manufactured by TMC, or not of TMC design shall be subject only to such adjustments as TMC may obtain from the supplier thereof.

Electron tubes*furnished by TMC, but manufactured by others, bear only the warranty given by such other manufacturers. Electron tube warranty claims should be made directly to the manufacturer of such tubes.

TMC's obligation under this warranty is limited to the repair or replacement of defective parts with the exceptions noted above.

At TMC's option any defective part or equipment which fails within the warranty period shall be returned to TMC's factory for inspection, properly packed with shipping charges prepaid. No parts or equipment shall be returned to TMC, unless a return authorization is issued by TMC.

No warranties, express or implied, other than those specifically set forth herein shall be applicable to any equipment manufactured or furnished by TMC and the foregoing warranty shall constitute the Buyers sole right and remedy. In no event does TMC assume any liability for consequential damages, or for loss, damage or expense directly or indirectly arising from the use of TMC Products, or any inability to use them either separately or in combination with other equipment or materials or from any other cause.

*Electron tubes also include semi-conductor devices.

PROCEDURE FOR RETURN OF MATERIAL OR EQUIPMENT

Should it be necessary to return equipment or material for repair or replacement, whether within warranty or otherwise, a return authorization must be obtained from TMC prior to shipment. The request for return authorization should include the following information:

1. Model Number of Equipment.
2. Serial Number of Equipment.
3. TMC Part Number.
4. Nature of defect or cause of failure.
5. The contract or purchase order under which equipment was delivered.

PROCEDURE FOR ORDERING REPLACEMENT PARTS

When ordering replacement parts, the following information must be included in the order as applicable:

1. Quantity Required.
2. TMC Part Number.
3. Equipment in which used by TMC or Military Model Number.
4. Brief Description of the Item.
5. The *Crystal Frequency* if the order includes crystals.

PROCEDURE IN THE EVENT OF DAMAGE INCURRED IN SHIPMENT

TMC's Warranty specifically excludes damage incurred in shipment to or from the factory. In the event equipment is received in damaged condition, the carrier should be notified immediately. Claims for such damage should be filed with the carrier involved and not with TMC.

All correspondence pertaining to Warranty Claims, return, repair, or replacement and all material or equipment returned for repair or replacement, within Warranty or otherwise, should be addressed as follows:

THE TECHNICAL MATERIEL CORPORATION
Engineering Services Department
700 Fenimore Road
Mamaroneck, New York

RECORD OF CORRECTIONS MADE

Change No.	Date of Change	Date Entered	Entered By
1	4/11/63	INCORPORATED IN MANUAL	9/65

CHANGE NO. 2 AFC-2A/3 (Sheet 1 of 2)

INSTRUCTION BOOK CHANGE NOTICE

Date June 23, 1964

Manual affected: Automatic Frequency Control Models AFC-2A and AFC-3 IN -4003B

1. [redacted] Incorporated in manual

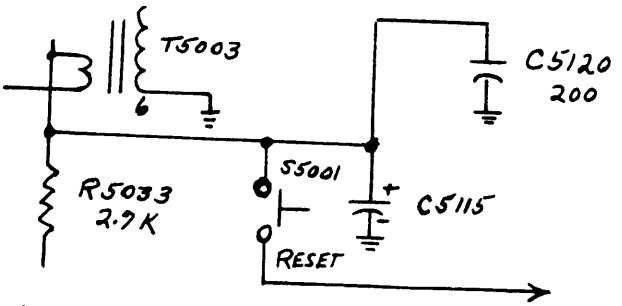
2. Page 1-2. Table 1-1.

Change entry for Input Power to read:

INPUT POWER	6.3 VAC, 115/230 VAC, -105 VDC (regulated), and +200 VDC (regulated)

3. Page 4-4. Figure 4-3.

Add capacitor C5120 as follows: (EMN 10313)



4. Page 4-5. Figure 4-4. (EMN 11050)

a. Change value of Y5000 from 1.25 mc to 1.250130 mc.

b. Change value of L5009 from 820 uh to 390 uh.

5. Page 4-7. Figure 4-5.

Change value of C5063 to: (EMN 11638)

5 uuf for AFC-2A
3 uuf for AFC-3

CHANGE NO. 2 AFC-2A/3 (Sheet 2 of 2)

INSTRUCTION BOOK CHANGE NOTICE

Date June 23, 1964

Manual affected: Automatic Frequency Control Models AFC-2A and AFC-3 (cont) IN -4003B

6. Page 7-3. Parts List.

a. Change description and TMC part number for C5036 as follows: (EMN 10042)

C5036	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 0.1 uf; +80-20%; 300 vdcw.	CC-100-37

b. Change C5019 to C5120 and complete entry for C5120 as follows: (EMN 10313)

SYM	DESCRIPTION	TMC PART NO.
C5120	CAPACITOR, FIXED, ELECTROLYTIC: 200 uf; -10 + 150%; 15 vdcw	CE-105-200-15

7. Page 7-8. Parts List.

Change description and TMC part number for L5009 as follows: (EMN 11050)

L5009	COIL, RADIO FREQUENCY: FIXED; 390 uh, ±5%; 6.2 ohms dc resistance; 240 ma current rating; molded case. (Supplied with A5001)	CL-275-391

8. Page 7-14. Parts List. (EMN 11638)

Change value of R5109 from 10 ohms to 33 ohms; change part number of R5109 from RC20GF100K to RC20GF330K.

9. Page 7-16. Parts List. (EMN 11050)

Change frequency of Y5000 from 1.25 mc to 1.250130 mc.

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Figure 1-1. Automatic Frequency Control AFC-2A,3, Front Angle View

SECTION 1

GENERAL DESCRIPTION

1-1. PHYSICAL DESCRIPTION.

Automatic Frequency Control Models AFC-2A and AFC-3 are identical in appearance and are shown in figure 1-1. The AFC unit is mounted on a standard width 19 inch panel for installation into an equipment rack. Physical dimensions are given in paragraph 1-3. For easy accessibility to maintenance parts, dust covers, equipped with Dzus fasteners, are provided for the top and bottom of the unit. All switches, controls, meters, and indicators necessary for operation of the AFC unit are mounted on the front panel. All electrical connections are made at the rear of the unit.

1-2. FUNCTIONAL DESCRIPTION.

The AFC unit is used in the i-f section of a receiver system to compensate for a combined frequency drift in the receiver and distant transmitter. Figure 1-2 illustrates the function of the AFC unit in relation to the receiver converter and the receiver product detector. The AFC functions to maintain the audio output error from the receiver product detector to within ±1 cycle during a carrier frequency drift of up to ±1 kc. The AFC contains two oscillators generating two outputs: the 250-kc product detector oscillator output to the receiver product detector and the converter injection output to the receiver converter. The converter injection frequency depends upon the receiver i-f input to the converter and is such as to produce 250 kc as a difference frequency when mixed with the receiver i-f. The AFC-2A and AFC-3 differ only in this respect and receiver i-f and converter injection frequencies are as follows:

Model	Receiver i-f	Converter Injection Frequency
AFC-2A	455 kc	705 kc
AFC-3	1.75 mc	2 mc

A sample of the 250-kc carrier and sidebands from the receiver converter is fed to the AFC unit. The 250-kc carrier is compared with the 250 kc from the product detector oscillator in a phase detector in the AFC unit. As a result of a drift in the receiver carrier, the phase detector changes the frequencies of the product detector oscillator and the converter injection oscillator. The converter injection oscillator changes slowly to bring the output from the receiver converter back towards 250 kc and keeps it within the acceptance band of the AFC carrier input filter. The product detector changes immediately to match the error in the 250-kc carrier coming into the receiver product detector from the receiver converter. Thus, by preserving the correct frequency relationship between the two receiver product detector inputs, the audio output is maintained at its correct frequency within 1 cycle. For a more detailed description of AFC functioning characteristics, see paragraph 4-2 in section 4, Theory of Operation.

Other features of the AFC are a CARRIER LEVEL meter, a CARRIER FADE warning light, a carrier DRIFT meter and a drift ALARM light. A memory circuit holds AFC outputs constant during a temporary carrier fade in order that the carrier may be "recaptured" by the AFC upon its return. AGC is provided to maintain a relatively constant level of carrier reconstruction over a 40-db dynamic range.

Plate, filament and bias power supplies are furnished the AFC by the associated equipment in the TMC systems in which the AFC unit is employed.

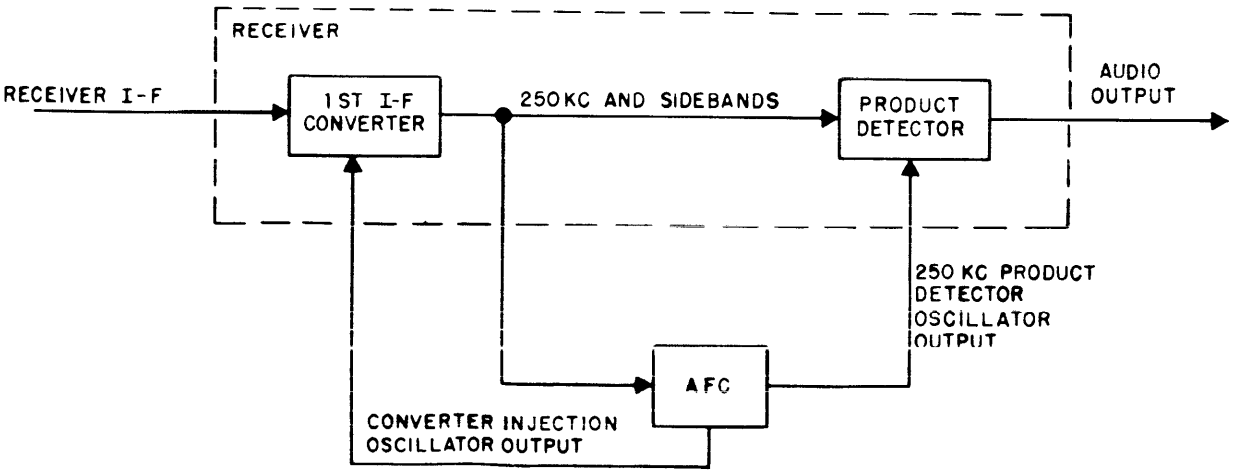


Figure 1-2. AFC Function In Receiver

TABLE 1-1. TECHNICAL SPECIFICATIONS OF AFC-2A AND AFC-3.

CHARACTERISTICS:	Synchronizes with a 250-kc carrier suppressed down to 100 uv minimum, with a receiver i-f (455 kc or 1.75 mc) having an error of ±3 kc maximum. Follows a maximum drift rate of ±10 cps/second. Stays synchronized over a total drift of ±1000 cps in the receiver i-f.
ACCURACY:	The AFC circuit maintains accurate frequency control so that the audio output of the associated units will have a maximum error of 1 cycle in the transmitted intelligence.
CONVERTER INJECTION OUTPUT TUNING RANGE:	± 3 kc electrical bandspread tuning range.
METERING:	a. AFC drift indicator b. Carrier level indicator
DRIFT ALARM:	Drift alarm indicator lights when carrier error exceeds approximately ±750 cps.
FADE ALARM:	Fade alarm indicator lights when carrier is interrupted or fades below approximately 100 uv. Connections for a remote indicator are available at the rear of the unit.
AGC:	AGC is derived from the carrier and is available for receiver control when desired.
SENSITIVITY:	A continuously adjustable gain control is provided for reducing system sensitivity when excess noise is encountered.
INPUT POWER:	6.3 VAC, 115 VAC, -105 VDC (regulated), and +200 VDC (regulated).
UNCRATED DIMENSIONS:	3-1/2" h x 19" w x 16-3/4" d.
CRATED DIMENSIONS:	10-1/2" h x 22-3/4" w x 31-1/4" d.
UNCRATED WEIGHT:	12 lbs.
SHIPPING WEIGHT AND VOLUME:	57 lbs. and 4.32 cu. ft.
COMPONENT AND CONSTRUCTION:	All equipment manufactured in accordance with JAN/MIL specifications wherever practicable.

TABLE 1-2. VACUUM TUBE COMPLEMENT.

SYMBOL	TYPE	FUNCTION
V5000	6DC6	Carrier amplifier
V5001	6DC6	Carrier amplifier
V5002	6AH6	Carrier amplifier
V5003	6AH6	Low frequency amplifier
V5004	6AH6	Low frequency amplifier
V5005	6C4	Low frequency buffer amplifier
V5006	12AT7	Oscillator
V5007	6U8A	Alarm/Relay amplifier
V5008	6U8A	Alarm/Meter amplifier
V5009	6AH6	High frequency amplifier
V5010	6AH6	High frequency amplifier
V5011	6C4	High frequency buffer amplifier
V5012	12AT7	Oscillator

SECTION 2

INSTALLATION

2-1. INITIAL INSPECTION.

Each AFC unit has been calibrated and tested at the factory before shipment. Upon arrival at the operating site, inspect the packing case and its contents immediately for possible damage. Unpack the equipment carefully. Inspect all packing material for parts which have been shipped as "loose items". Although the carrier is liable for any damage to the equipment, Technical Materiel Corporation will assist in describing and providing for repair or replacement of damaged items.

The equipment is shipped with all tubes and other plug-in components installed. Check that all such components are properly seated in their sockets.

2-2. MECHANICAL INSTALLATION.

a. The AFC unit is equipped with a standard 19 inch rack panel. Approximately 15 inches of clearance from the back of the panel to the rear of the rack is required. Refer to figure 2-1 for outline dimensions.

b. In installations in which vibration is prevalent, or upon special order, the AFC unit is supplied with drawer slides. Normally, for stationary conditions, the AFC unit may be supported by the front panel alone.

c. To install an AFC unit without slides place the unit into a suitable housing and secure the front panel to the housing with screws.

d. To install an AFC unit equipped with slides, proceed as follows:

(1) Set the AFC unit in position on the tracks.

NOTE

It may be necessary to hold the tracks in the extended position while positioning the unit.

(2) Slide the AFC unit on the tracks until the release buttons catch.

(3) Press the release buttons and push the AFC unit into the equipment rack until the release buttons engage the holes in the unit.

(4) Secure the front panel to the equipment rack with screws.

2-3. ELECTRICAL INSTALLATION.

Electrical installation of the AFC unit is made by means of the four jacks, J5000 through J5003, located on the rear of the unit. When the AFC is shipped as part of a TMC system, mating interconnecting cables for these jacks are included in the shipment of the system and directions for installing the cables are included in the system manual. When the AFC is shipped by itself, the following mating plugs are included for making interconnecting cables:

Jack Symbol	Mating Plug (TMC Part No.)
J5000	UG-88/U
J5001	PL-212-2
J5002	UG-88/U
J5003	UG-88/U

Reference may then be made to figure 2-2 for a guide for connecting the AFC into a standard receiver system.

2-4. INITIAL ADJUSTMENT.

No initial adjustment is required. Before any AFC unit is shipped, it is aligned and thoroughly checked against the manufacturers specifications. The AFC unit is operable immediately upon installation. However, for more precise operation, a 24-hour warm-up period for stabilization of the ovens is recommended.

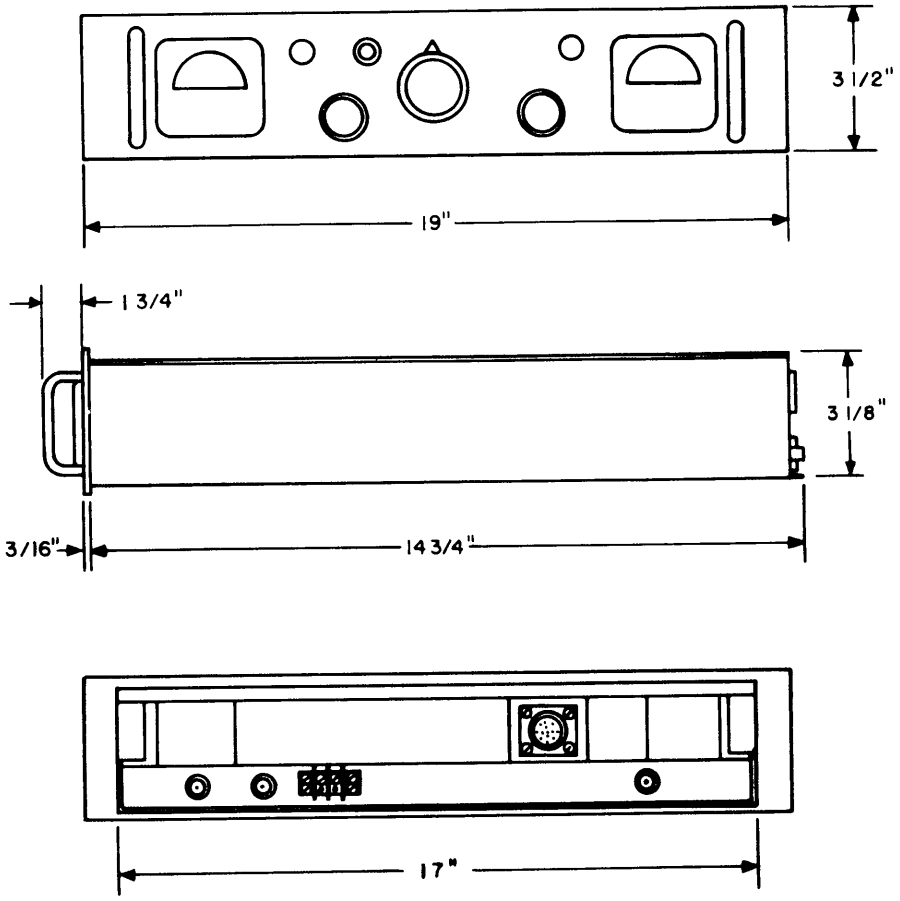


Figure 2-1. Outline Dimensional Drawing, AFC-2A,3

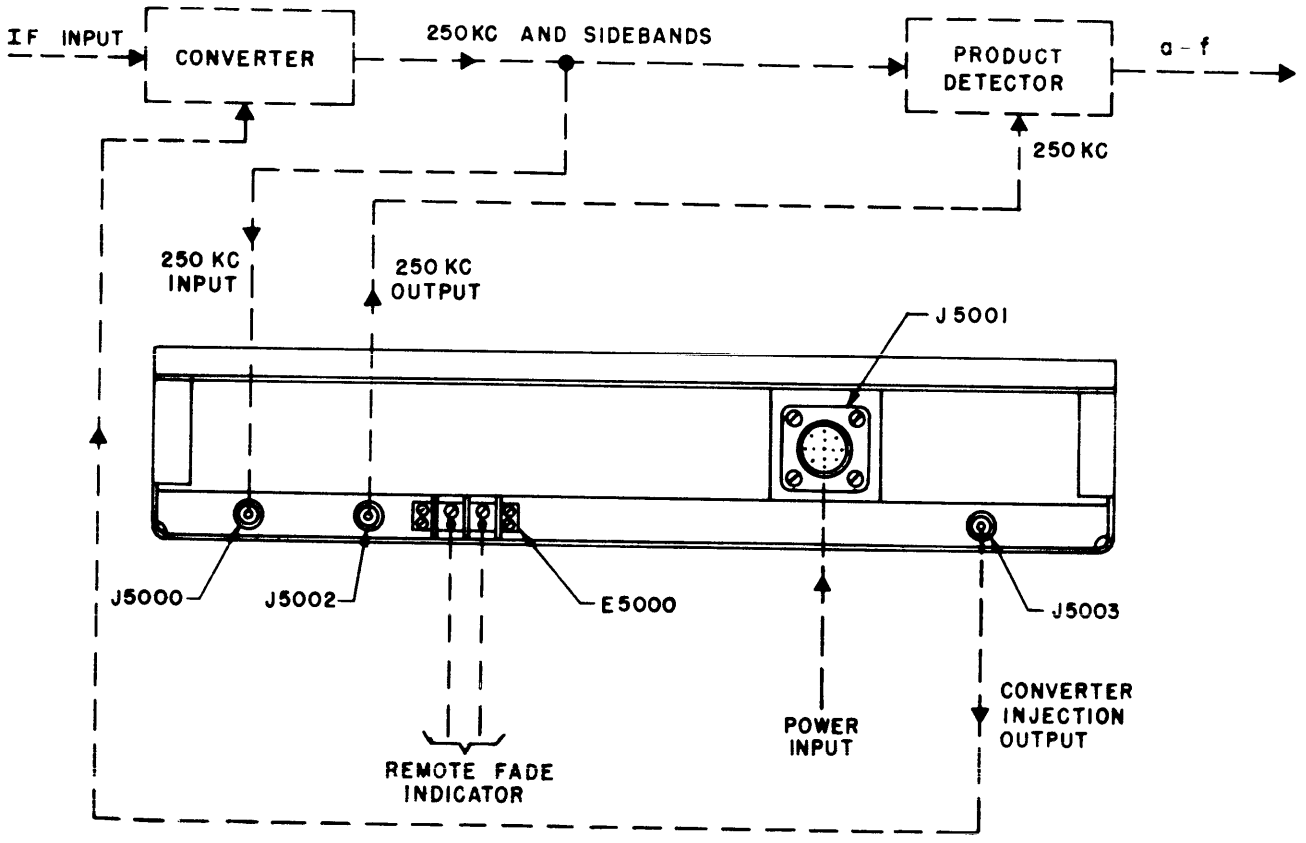


Figure 2-2. Cable Connection Diagram, AFC Installation

SECTION 3

OPERATOR'S SECTION

3-1. GENERAL.

Table 3-1 provides the functions and equivalent control designations for operating controls shown in figure 3-1. Table 3-2 is an operating chart to be used in conjunction with figure 3-1 and table 3-1.

3-2. CARRIER SELECTOR SWITCH.

The AFC is normally operated with the CARRIER SELECTOR switch in OSC position. Referring to figure 4-1, it is seen that, with the switch in this position, the receiver product detector receives a corrected 250-kc injection frequency from the AFC product detector oscillator. Also, in this position, the AFC responds to correct for carrier drift at the speed rated (10 cps/second maximum); the 250-kc injection frequency will be in phase with the carrier input within 1 cycle (or 360°). In cases where phase is of primary importance, however, it may be elected to place the CARRIER SELECTOR switch in RCC (reconstructed carrier) position. This effectively strips the 250-kc carrier of its sidebands, amplifies it, and feeds it back into the receiver product detector as the injection frequency.

3-3. OPERATOR'S MAINTENANCE.

The operator should keep the equipment clean, note the general condition of panel switches, observe whether the panel indicator lamps and meters function properly, and check the condition of the tubes. If, while the majority of tube filaments glow, any tube filament fails to glow, remove the questionable tube and test it with a reliable tube tester. Reinstall tube shields after testing or replacing tubes.

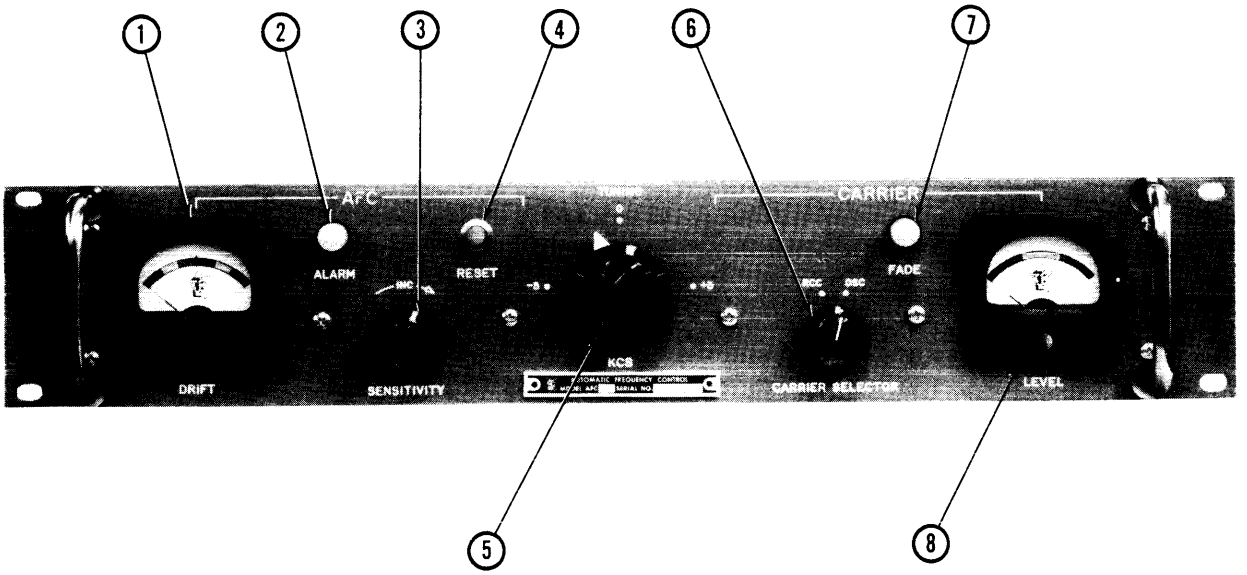


Figure 3-1. Panel View of AFC-2A,3, Showing Operating Controls

TABLE 3-1. TABLE OF EQUIVALENT CONTROL DESIGNATIONS.

Serial Designation	Panel Designation	Function	Component Reference Designation on Schematic Diagram
1	DRIFT meter	Indicates total drift of receiver i-f carrier. Center scale reading is zero drift. The dial is color coded as follows: Color — Drift (approx.) Green — 500 cps Yellow — 500 cps-1 kc Red — 1 kc +	M5001
2	ALARM light	Light indicates carrier drift has exceeded approximately ± 750 CPS off center.	I5000
3	SENSITIVITY control	Controls gain of carrier amplifier stage. May be backed off to eliminate noise.	R5024
4	RESET	Re-centers AFC oscillators when operator is required to tune to another station or re-synchronize due to a drifted signal.	S5001
5	TUNING-KCS control	Tunes AFC units converter injection oscillator to enable operator to synchronize to the received signal.	C5096
6	CARRIER SELECTOR switch	See paragraph 3-2.	S5000
7	FADE light	Light indicates deep fade of received carrier.	I5001
8	LEVEL meter	Indicates level of carrier.	M5000

TABLE 3-2. AFC-2A,3 OPERATION CHART

STEP	CONTROL	OPERATION	PURPOSE
1	TUNING-KCS knob (5)	Set to 0 position.	Centers converter injection frequency output to receiver converter.
2	SENSITIVITY knob (3)	Rotate fully clockwise.	Preadjustment.
3	CARRIER SELECTOR switch (6)	Set to OSC position.	Feeds 250 kc to receiver product detector from AFC oscillator.

TABLE 3-2. AFC-2A,3 OPERATION CHART. (Cont.)

STEP	CONTROL	OPERATION	PURPOSE
4	RESET button (4)	While holding RESET button down, tune receiver r-f stage for carrier frequency. * **	Disconnects correction voltage from AFC oscillators while tuning RF stage.
5	RESET button (4), TUNING-KCS knob (5), CARRIER LEVEL meter (8)	Hold RESET button down and adjust TUNING-KCS knob to obtain peak reading on CARRIER LEVEL meter.	Adjusts converter injection oscillator to compensate for frequency error in transmitted and/or received carrier.
6	RESET button (4), DRIFT meter (1)	Release RESET button and observe DRIFT meter. Needle will remain steady through tone frequency variations in signal if AFC is locked on carrier. If this condition is not realized, repeat step 5.	To insure that AFC is locked on carrier instead of sideband.
7	SENSITIVITY knob (3)	Rotate SENSITIVITY knob counterclockwise, if necessary, to eliminate noise without losing signal clarity.	Elimination of noise.

* If there are other injection frequency sources available for the receiver product detector and converter, it may be more convenient for the operator to switch the AFC unit out of the circuit while tuning the r-f stage. This will eliminate having to hold down the RESET button. When the r-f stage has been tuned, the AFC unit may be switched back in and tuned per steps 5, 6 and 7.

** In the case of tuning the r-f stage for a continuous tone signal with a suppressed carrier, the operator should resort to monitoring by speaker sound or zero beat if available, in order to single out the carrier. Otherwise, in the subsequent tuning of the AFC unit, the AFC may be locked on to the sideband tone frequency instead of the carrier.

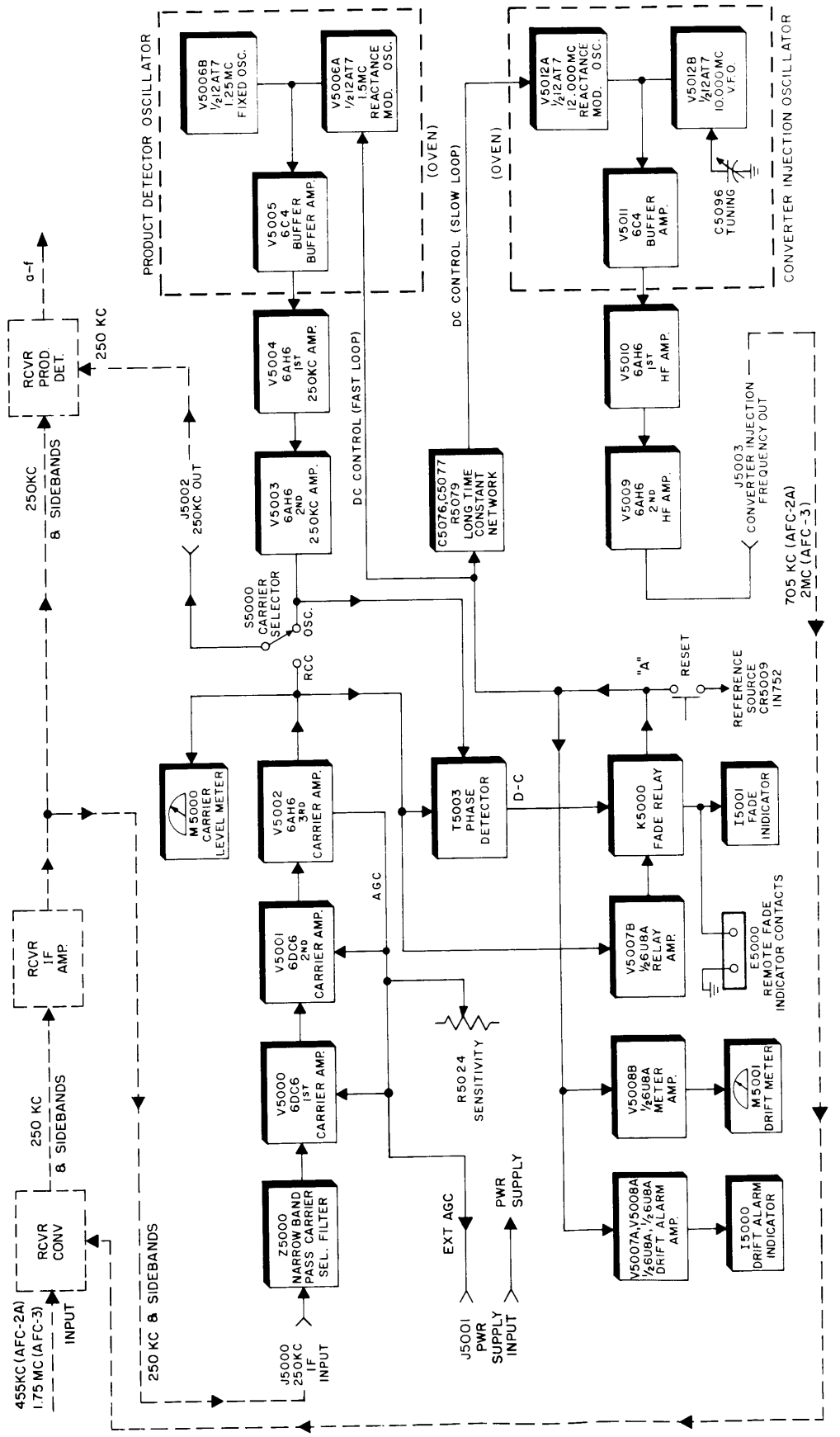


Figure 4-1. Functional Block Diagram, AFC-2A,3

SECTION 4

PRINCIPLES OF OPERATION

4-1. INTRODUCTION.

The following descriptions pertain to the AFC-2A and AFC-3. Where the information pertains to both, reference is made to AFC unit. Where the information pertains to the AFC-2A or the AFC-2 only, it is so referenced. To supplement the individual schematic diagrams accompanying each description, reference should be made to the overall schematic diagram figure 8-1.

4-2. GENERAL.

Figure 4-1 shows the functional block diagram of the AFC and the IF and product detector sections of the associated receiver. The function of the AFC unit is to prevent the 250 kc IF carrier frequency from changing the a-f output from the receiver product detector as a result of frequency drift in the receiver converter input. Ordinarily without AFC, a change in frequency in the converter input would appear in the converter 250 kc carrier and sideband output. A consequent comparison in the product detector with an injection frequency of exactly 250 kc would produce a distorted a-f output since the sidebands have shifted in the same amount as the carrier. With AFC, and with CARRIER SELECTOR switch in OSC position, the converter injection frequency from J5003 is changed in such a way as to keep the 250 kc output from the converter within the acceptance band of the carrier filter from relatively large changes (±1 kc max.) in converter input. In addition, the AFC keeps the 250 kc from J5002 to the product detector at exactly the same frequency as the 250 kc coming from the receiver IF amplifier. As a result the a-f issuing from the product detector is stable to within ±1 cycle. In summation, when the AFC is switched into the receiver circuit, C5096 front panel TUNING control is adjusted until the 250 kc issuing from the receiver converter falls within the 250-kc carrier filter acceptance range set by the Z5000 narrow bandpass filter. This is indicated by a maximum reading on the CARRIER LEVEL meter and zero center scale reading on the DRIFT meter and represents a "capture" of the 250 kc issuing from the receiver amplifier. Since C5096 may be adjusted to change the converter injection oscillator by ±3 kc, the receiver converter input may be off by 3 kc and still be captured. Any consequent drift in the receiver converter input frequency will be reflected by a change in the converter 250 kc output and create a phase difference in T5003 phase detector. The dc sent to the two oscillators first acts on the fast loop and causes the output at J5002 to immediately change to match the error appearing at the receiver product detector input from the receiver i-f amplifier. After a delay, caused by the time constant network, the slow loop goes into action to change the output at J5003 in such a way as to bring the receiver converter output back towards 250 kc. The timing is calculated to keep the receiver i-f frequency within the acceptance band of the carrier filter as long as the rate of change appearing at the receiver converter input does not exceed 10 cps/second and the total drift at that point does not exceed 1 kc. When either of these limits has been exceeded, the AFC loses control of the receiver i-f. With CARRIER SELECTOR switch in RCC (reconstructed carrier) position (see paragraph 3-2) the incoming carrier is amplified and sent directly to receiver product detector, with the result that some of the frequency control is lost but the two product detector inputs are in phase. Upon carrier fade below a certain level, the relay amplifier energizes the fade relay which acts to light the fade indicator and disconnect the phase detector d-c output from the oscillators. As this happens, the long time constant network acts as a memory network and stores the d-c voltage appearing from the phase detector at the time of fade. This voltage holds the converter injection oscillator at the frequency at the time of fade. When the carrier re-appears, the fade relay is de-energized and the frequency control takes over again as before. Usually the carrier has not wandered much from the frequency at the time of fade and it remains captured under AFC control without retuning the AFC unit. The phase detector also sends the representative d-c error voltage to the DRIFT meter The meter is calibrated to represent the total frequency drift appearing at the receiver converter input. When the total drift has exceeded approximately 750 cps, the drift ALARM indicator lights.

a. CARRIER AMPLIFIER. The 250 kc carrier IF enters the carrier amplifier from a low impedance line, and is coupled through a narrow bandpass crystal filter that eliminates the sideband information. The carrier is then amplified by a three-stage, AGC-controlled amplifier. The gain of the carrier amplifier is varied by means of the front panel SENSITIVITY control. The output of the carrier amplifier is used as the injection to the receiver product detector. It is monitored on the front panel by the LEVEL meter.

b. PHASE DETECTOR. The phase detector is supplied with the 250 kc carrier IF and the 250 kc output of the product detector oscillator. The DC output voltage controls the frequencies of the two oscillators and provides the information necessary to monitor carrier drift.

c. PRODUCT DETECTOR OSCILLATOR. The 250 kc output of the product detector oscillator is obtained by heterodyning two individual oscillators, one fixed at 1.25 mc and the other operating with a center frequency of 1.5 mc. The 1.5 mc oscillator is reactance-

modulated by the DC control voltage, and responds to rapid changes in voltage. The combination of the two oscillators produce a 250 kc signal which will follow rapid changes in any phase difference between itself and the 250 kc carrier IF. The entire circuitry of the product detector oscillator is contained within a temperature-stable oven to assure basic frequency stability.

d. CONVERTER INJECTION OSCILLATOR. The converter injection frequency is determined by the particular receiver used with the AFC unit, as the converter injection frequency must combine with the converter input frequency to produce the 250 kc carrier and sidebands to the receiver i-f amplifier. The converter injection frequency is obtained by heterodyning two oscillators, a VFO and a "varicap"-control oscillator that is reactance-modulated for AFC control. The reactance-modulated oscillator operates at a center frequency of 10.705 mc (for AFC-2A) and 12 mc (for AFC-3). The VFO is adjusted by a manually operated tuning capacitor to center the AFC control range frequency. The front panel RESET button, when depressed, holds the DC control voltage at a fixed level, so that only the VFO changes in frequency when tuning the AFC unit. The converter injection oscillator is also enclosed in a temperature-stable oven to provide frequency stability.

e. FADE ALARM. The fade alarm circuit has two primary functions. The first provides the operator with a visual indication that the carrier has gone into a fade, or that it has decreased below a pre-determined level. The second switches the AFC unit into memory operation while the carrier is in a fade condition. It accomplishes both of these functions by a tube-operated relay, which lights a front panel indicator and releases the DC control line from the phase detector during carrier fade. When the DC control line is released from the phase detector, a long time constant remains in the circuit and establishes the control voltage until the carrier returns from fade.

f. DRIFT METER. The DRIFT meter permits the operator to monitor AFC control. The meter indication is a measure of the total amount of drift appearing at the receiver converter input. As an approximation the green sector of the dial represents 500 cps drift on either side of the center, yellow sectors from 500 cps to 1 kc, and red sectors extend from about 1 kc. Red indicates the limit of the synchronization range. The information for the DRIFT meter is obtained from the phase detector and is applied to the meter in the cathode circuit of V5008B, the meter amplifier.

g. DRIFT ALARM. The drift ALARM light alerts the operator whenever the AFC is about to lose synchronization. The alarm circuit obtains information from the phase detector and this output is compared in a differential amplifier with a reference voltage.

4-3. DETAILED THEORY OF OPERATION.

a. CARRIER AMPLIFIER. The 250 kc carrier IF is supplied to the AFC unit by a low-impedance coaxial cable at J5000 (figure 4-2). The carrier IF enters the narrow bandpass crystal filter Z5000. The crystal filter bandwidth eliminates most of the sideband information and noise. This prevents the AFC from locking on to some signal other than the carrier. The 250 kc signal is amplified by two identical AGC-controlled tuned stages, V5000 and V5001, and by a third stage, V5002. The output is applied to T5000 transformer which transfers the amplified carrier to a low-impedance output and is routed to the CARRIER SELECTOR switch and LEVEL meter circuit. Another 250-kc output from V5002 plate goes to the phase detector.

The purpose of AGC in the AFC carrier amplifier section is to maintain receiver output relatively constant despite a widely varying input signal level. The AGC developed by the AFC has two applications: (1) internally to V5000 and V5001, and (2) externally, to the associated receiver.

The operator may control the receiver gain either with the SENSITIVITY control (R5024) or with AGC. When the SENSITIVITY control is fully counterclockwise, a maximum negative voltage on the grids of V5000 and V5001 will produce minimum output. As the SENSITIVITY control is turned clockwise, the gain increases up to a point where the AGC voltage is greater than the manual bias. The gain of the receiver will now be determined by the AGC produced by the AFC; the sensitivity should be reduced when excess noise is encountered. The a-c voltage for AGC is taken from the plate of the third stage, V5002, and is fed to a voltage quadrupler circuit, consisting of diodes CR5001 through CR5004, and capacitors C5033, 5114, 5117 and 5112. The AGC voltage is divided by R5023 and R5022 for use in the first two stages. Another AGC control is R5020 threshold potentiometer mounted on the chassis. R5020 delays creation of AGC. On the very weakest signals, it would be undesirable for AGC to be produced, thereby reducing receiver gain. At the other extreme, strong signals demand immediate AGC. R5020 is set for optimum reception. At the TMC factory it is adjusted for 1 volt output with an input of 250 kc at 3000 microvolts with the SENSITIVITY knob fully clockwise.

b. PHASE DETECTOR. The phase detector is comprised of T5003, CR5007, CR5008, R5030, and potentiometer R5031 (figure 4-3). The 250 kc carrier IF is connected to the wiper arm of R5031 and is about 10 volts rms at that point. The 250 kc from the product detector oscillator is fed into terminal 3 and 6 of T5003, and is stepped up from 3 volts to 30 volts at terminals 4 and 5. If both of the 250 kc signals are in-phase, no correction voltage is produced. If the two signals are out of phase, a correction voltage is produced and the amount is proportional to the phase difference. The d-c voltage developed is taken from the phase detector at the wiper arm of R5031. The d-c voltage may either be positive or negative, depending upon the phase relationship of the two signals. The phase detector is referenced at a positive 2.7-volt level. The usual range of the phase detector output is

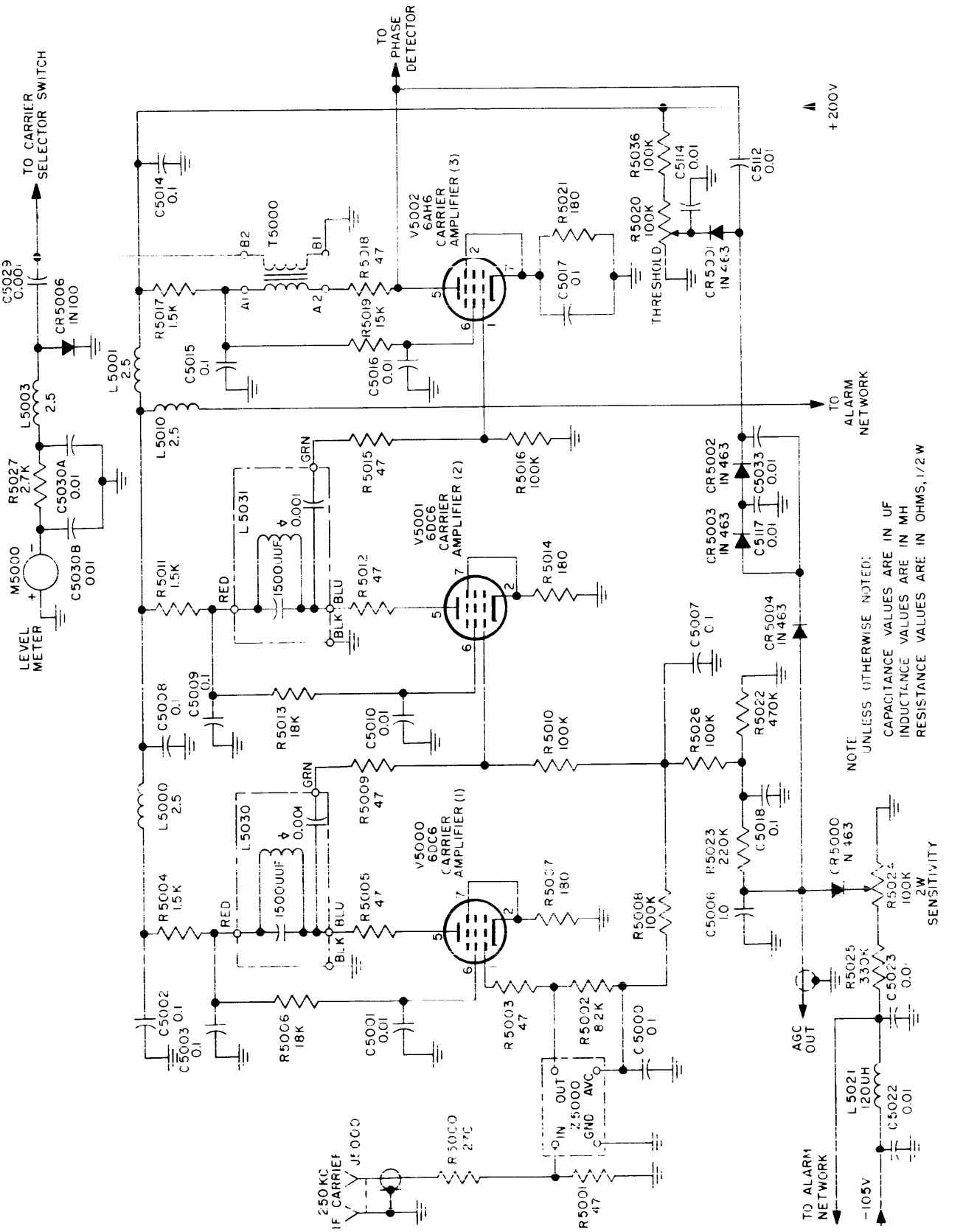


Figure 4-2. Carrier Amplifier, Simplified Schematic Diagram

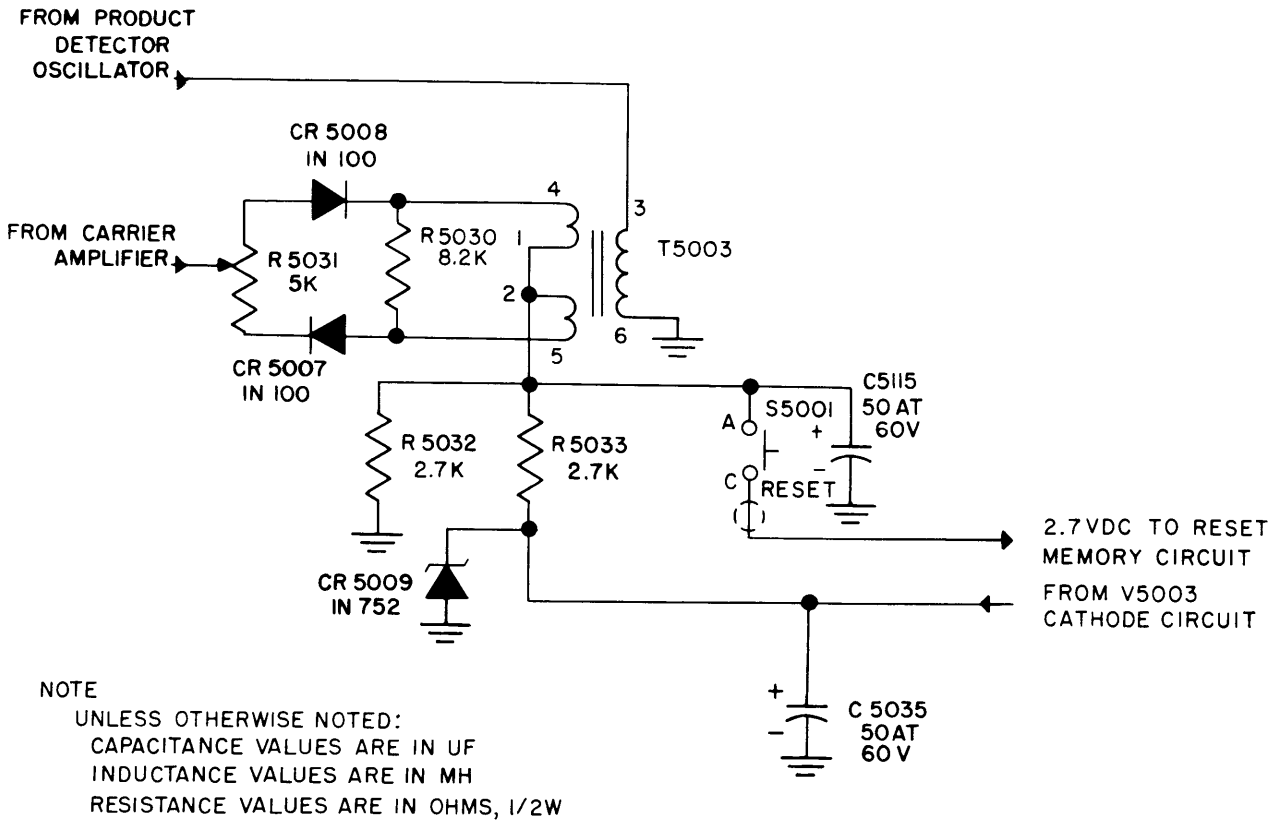


Figure 4-3. Phase Detector, Simplified Schematic Diagram

between 3.7 volts and 1.7 volts. These two voltages correspond to the ±1 kc frequency range of the converter injection oscillator and the ±50 cps range of the product detector oscillator. The 2.7-volt center point corresponds to the center frequency of both oscillators, and is the voltage applied to the control line when the RESET button is depressed. The 2.7-volt reference is obtained from CR5009, a 5.4-volt zener diode conducting in the reverse direction. The zener diodes uses about 10 ma of current from the cathode circuit of V5003. R5032 and R5033 form a voltage divider to obtain 2.7 volts and C5035 and C5115 act as heavy filter capacitors.

c. PRODUCT DETECTOR OSCILLATOR. The product detector oscillator and its buffer amplifier and associated circuitry are contained in an oven to maintain temperature stability (figure 4-4). V5006 serves as two oscillators and a mixer. V5006B is the 1.25-mc oscillator. The four oscillators in the AFC unit are modified Colpitts-type circuits. The oscillators each utilize a grounded plate and feedback from ground to cathode and from cathode to grid. The grid circuit is crystal controlled. The crystal operates in the circuit as an inductor. L5008 provides series compensation for the crystal so that frequency adjustment is possible. L5008 is initially adjusted for an output of exactly 250 kc when V5006A is held to the 2.7-volt reference from the phase detector for center frequency. V5006A has the same type of circuit as V5006B with the exception that series compensation is provided by a voltage variable capacitor (C5060). The voltage variable capacitor (varicap) is a silicon p-n junction device which changes circuit capacitance by bias voltage control. The varicap is specified by the value of capacitance in micromicrofarads with a bias of 4 volts. The bias voltage must be applied in the reverse direction. The "varicap" in the grid circuit of V5006A performs the function of a reactance modulator. The positive connection of the "varicap" is referenced to the 5.4 volts developed across the zener reference diode, CR5009 (see figure 4-3). The output of the phase detector is applied to the negative side of the "varicap". The bias circuit from the phase detector is isolated from the converter injection oscillator by R5079 (see figure 4-6). The isolation prevents the product detector oscillator from being affected by the long time constant of R5079, C5076, and C5077. The bias control line to the product detector oscillator is, therefore, free to follow rapid excursions. The oscillator is designed to shift at least ±50 cps. When the product detector oscillator has been shifted by 50 cps, the time constant of the converter injection oscillator has allowed it to start correcting, and as a result, the product detector oscillator returns to center frequency. It can now be seen that when the converter oscillator has completed its total shift of 1 kc, the product detector oscillator will also have completed its maximum shift of 50 cps. Any further shift in the same direction will fall outside of the crystal filter, and the AFC unit will necessarily lose control, unless recentered by the manually-operated tuning control. C5064 provides the only circuit connection of V5006A and V5006B, and, therefore, facilitates the mixing action of 1.5 mc and 1.25 mc. The 250 kc output is taken from the plate of V5006B. The network of C5058, C5059, L5007, C5057, and R5056 form a low-pass filter. V5005 is a buffer amplifier to prevent circuitry external to the oven

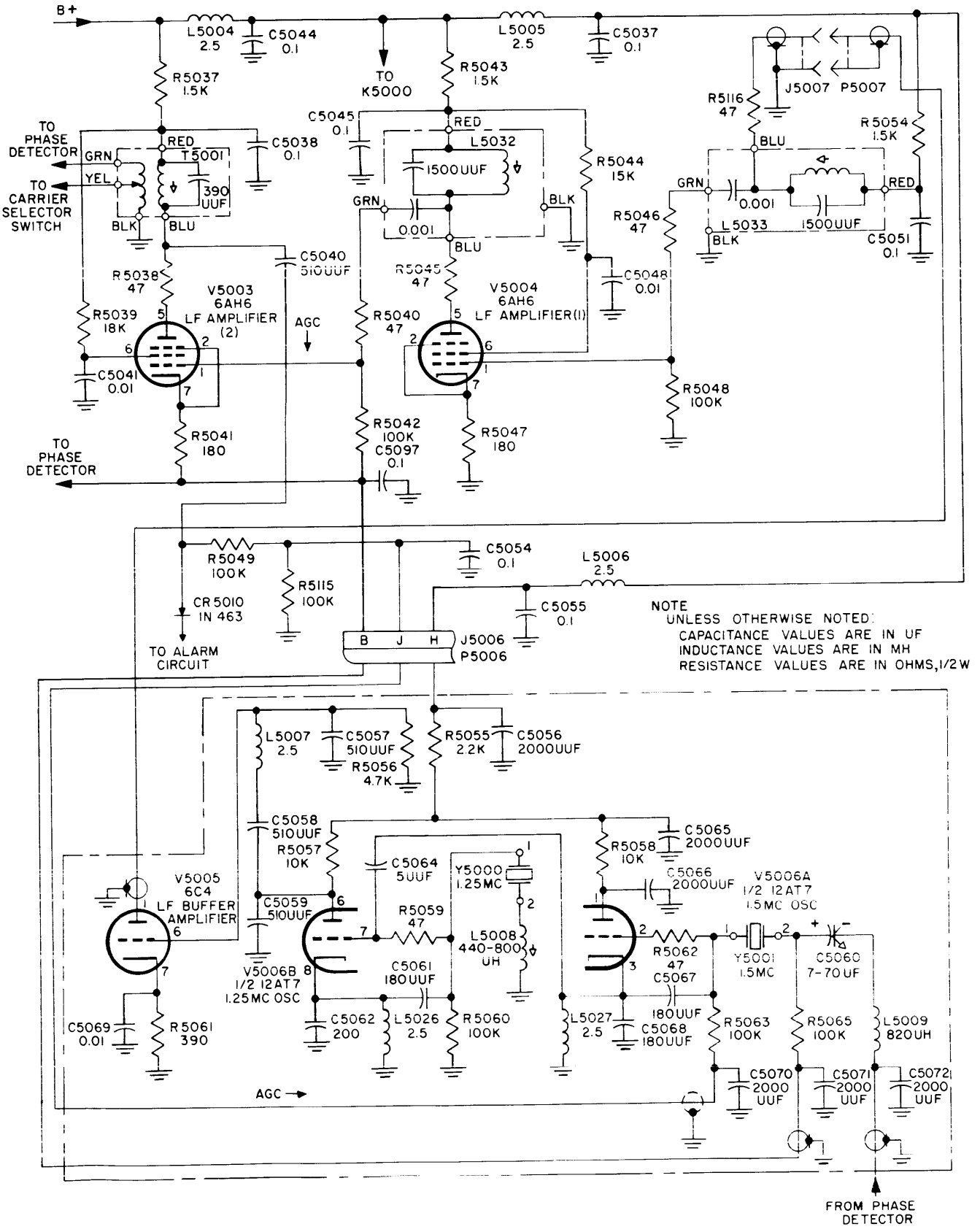


Figure 4-4. Product Detector Oscillator, Simplified Schematic Diagram

from affecting the oscillator frequencies. The tank circuit for V5005 is mounted externally, and feeds a two-stage tuned amplifier consisting of V5003 and V5004. An AGC voltage, derived from the plate of V5003, is applied to the grid of the reactance-modulated oscillator V5006A. The AGC voltage performs a function of maintaining a constant output of 1 volt to the CARRIER SELECTOR switch and 3 volts to the phase detector.

d. CONVERTER INJECTION OSCILLATOR. The converter injection oscillator utilizes two clapp oscillators, V5012A and V5012B, and a buffer amplifier, V5011 (figure 4-5). The entire circuit is oven-mounted for stability. V5012B is actually a variable frequency oscillator, since the crystal series compensation is the TUNING capacitor (C5096) controlled from the front panel. The tuning capacitor will change frequency by at least ±3000 cps. L5018 increases the frequency range of the TUNING capacitor C5096, and L5029 is adjusted for centering of the frequency range. Y5003 crystal for this oscillator is determined by the output frequency required, so that a signal of 250 kc is produced when mixed with the receiver output. V5012A is the varicap control oscillator, which is similar in performance to the product detector oscillator except that the "varicap" is referenced to ground potential. A low pass filter is again used, and the tank for the buffer amplifier is mounted external to the oven. Z5001, Z5002, and Z5003 are plug-in circuits to accomodate the particular frequency output. The frequency of operation for Z5001, Z5002, and Z5003 may be identified by the last digits of the part number, which is read in kc. V5009 and V5010 is the amplifier for the converter injection frequency. An AGC voltage is developed to maintain a constant output of 1 volt.

e. ALARM CIRCUITS. The fade alarm circuit consists of V5007B and relay K5000 (figure 4-6). A rectifier circuit, consisting of CR5005, R5034, R5035, and C5079, produces a negative voltage proportional to the output of the carrier amplifier. This negative voltage holds V5007B cut-off until the carrier IF drops below the level, determined by R5034 and R5035, at which V5007B conducts. Relay K5000 is the plate load for the tube. Thus, when conduction occurs, the relay is activated. The relay releases the DC control line from the phase detector, and at the same time switches a panel-mounted neon bulb (I5001 FADE alarm) to the B+ line, thereby giving a visual indication of carrier fade. The relay also closes a pair of contacts, which are made available on the rear apron for remote indication of fade.

The phase detector output is made available to a VTVM circuit which operates the DRIFT meter (M5001). The cathode of V5008B drives the panel-mounted DRIFT meter. The plate voltage for the tube is lowered considerably by R5076 and R5077, and a diode, CR5011, is shunted across the meter to provide linearity. R5074 adjusts for a zero center scale position when the RESET button is depressed.

The drift alarm circuit operates as a differential amplifier, with one input remaining constant, and the other being drift information from the phase detector. V5007A and V5008A comprise a bridge circuit. The control grid of V5007A contains the alarm zero adjust potentiometer R5064 in a voltage divider network. A neon lamp, I5000 ALARM light, is connected between V5007A and V5008A plates. With no correction voltage from the phase detector, R5064 is adjusted for zero; both tubes conduct equally and there is no difference of potential across the lamp. A correction voltage from the phase detector unbalances the conduction of the two tubes and unequal plate voltages are developed. A drift of approximately 750 cps will cause sufficient unbalance to light the neon bulb.

The rectified dc from V5003 output is used as a part of the plate supply for V5007A, V5008A, and V5008B to insure operation of alarm circuits only when the product detector oscillator is issuing output. R5079 serves to isolate the product detector oscillator from the long time constant (C5076 and C5077) in the converter injection oscillator loop.

f. OVENS. The ovens used for both oscillators are similar. Each oven is heated by two 20 watt elements which are controlled by a snap-action type thermostat. R5109, C5110, R5114, and C5111 form arc suppressor networks for the thermostats.

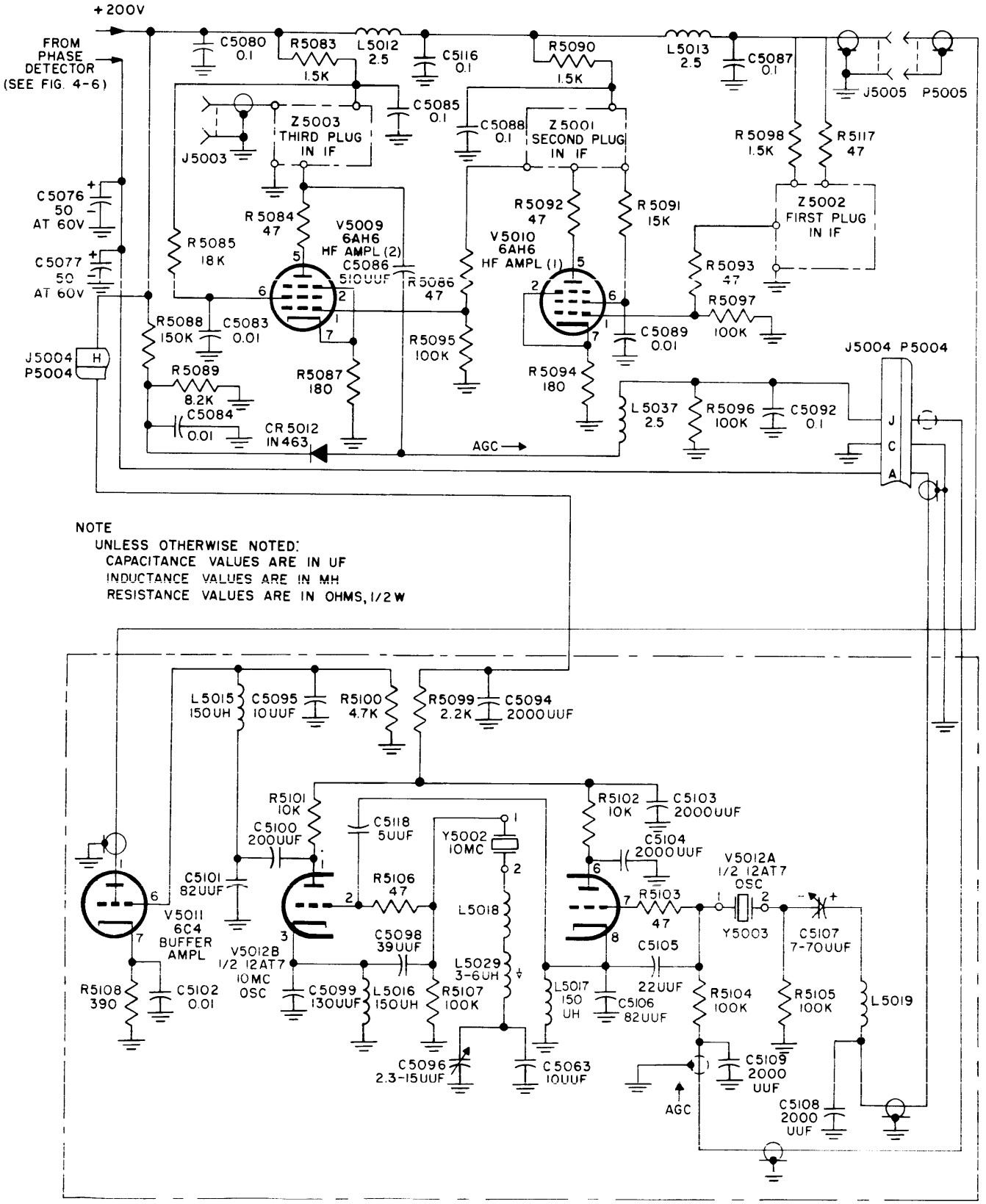
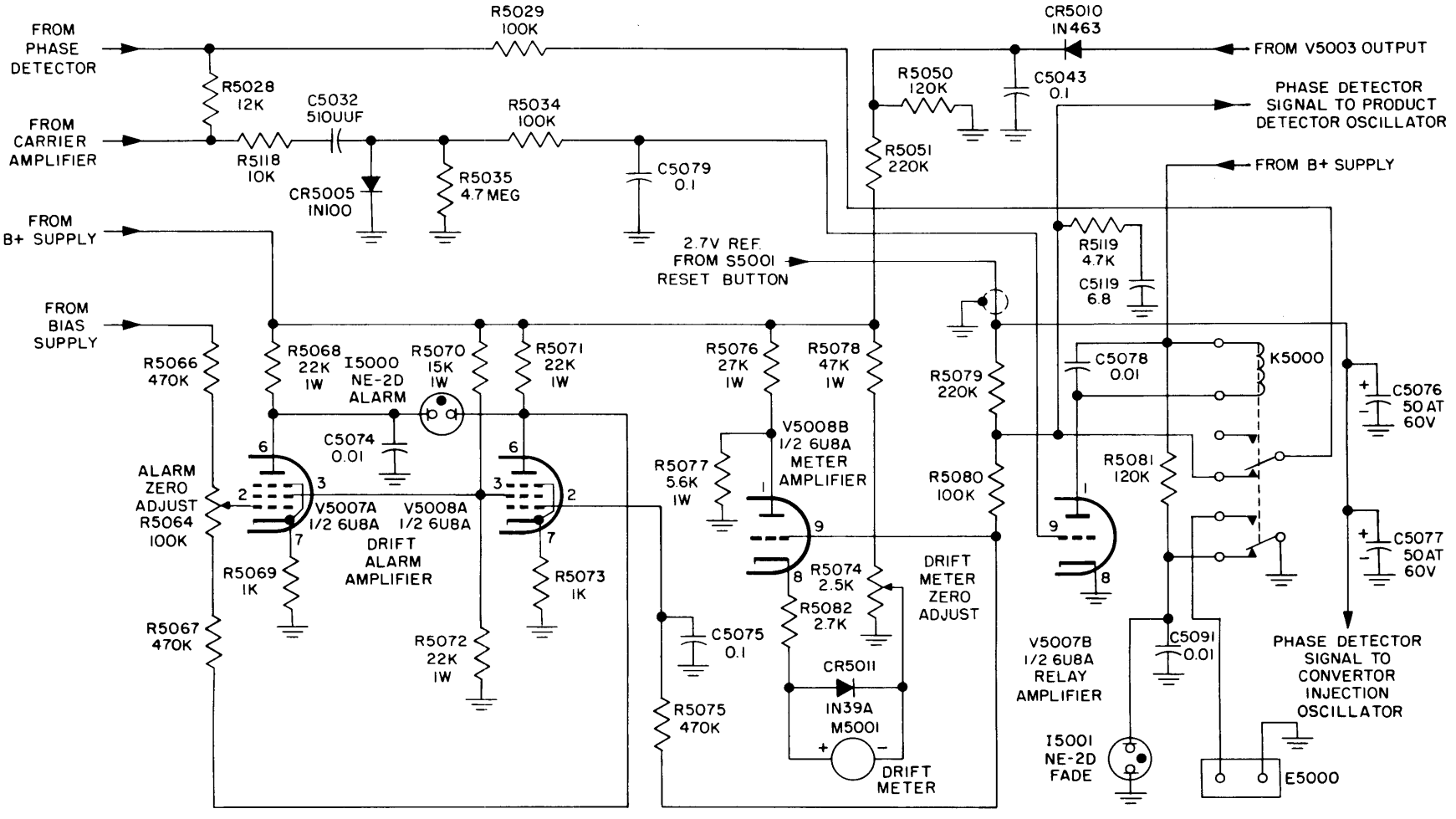


Figure 4-5. Converter Injection Oscillator, Simplified Schematic Diagram



NOTE
UNLESS OTHERWISE NOTED:
CAPACITANCE VALUES ARE IN UF
INDUCTANCE VALUES ARE IN MH
RESISTANCE VALUES ARE IN OHMS, 1/2W

Figure 4-6. Alarm Circuits, Simplified Schematic Diagram

SECTION 5

TROUBLE-SHOOTING

5-1. INTRODUCTION.

This section explains how to locate and diagnose equipment troubles and maladjustments. The information necessary to remedy the troubles and maladjustments will be found in Section 6 of this manual under the heading "Maintenance".

The following aids to troubleshooting are provided:

a. Schematic diagram.

b. Voltage table.

c. Tube location data.

d. Troubleshooting techniques.

e. Troubleshooting chart.

5-2. TROUBLE-SHOOTING TECHNIQUES.

a. GENERAL CONSIDERATIONS. When a piece of equipment has been working satisfactorily and suddenly fails, the cause of failure may be apparent either because of circumstances occuring at the time of failure or because of symptoms analogous to past failures. In this case, it is unnecessary to follow a lengthy and orderly course of troubleshooting in order to localize and isolate the faulty part.

A second short cut in troubleshooting is to ascertain that all tubes are in proper working order; also that the equipment receives proper supply voltages. This may eliminate further investigation.

A third short cut is to examine the equipment section by section, for burned out elements, charring, corrosion, arcing, excessive heat, dirt, dampness, etc. Component defects may be internally or externally caused.

b. TROUBLESHOOTING TABLE BASED ON TYPES OF OPERATION. The general purposes of this chart is to narrow the area of trouble to one or more sections of the equipment in order to minimize the labor of locating the source of trouble. When the trouble is localized to a section use should be made of the voltage chart and also the information contained in the alignment instruction for that section in Section 6 of this manual.

c. VOLTAGE TABLE. The table gives nominal values of voltage-to-chassis at tube elements. Large deviations from the nominal values should be carefully investigated. During this process, accurate schematic diagrams and location data are essential. A schematic diagram of the AFC unit is found in Section 8.

5-3. AUTOMATIC FREQUENCY CONTROL AFC-2A AND AFC-3.

a. TROUBLESHOOTING TABLE BASED ON TYPES OF OPERATION. Table 5-1 outlines procedures to localize troubles to a section of the AFC unit based on the type of operation being employed.

b. VOLTAGE TABLE. Table 5-2 lists the voltage-to-chassis measurements at tube pins in the AFC unit.

c. TUBE LOCATION DATA. Figure 5-1 locates the tubes of the AFC unit by reference designations.

TABLE 5-1. TROUBLE-SHOOTING BASED ON TYPES OF OPERATION.

SYMPTOM	PROBABLE CAUSE	REMEDY
Abnormal carrier level as indicated on LEVEL meter.	Defective carrier amplifier stage.	Check V5001, V5002, and V5003. Check their associated circuitry.
	Defective AGC network.	Check all network components.
DRIFT meter, ALARM light, and FADE light not functioning properly.	Defective phase detector network.	Check T5003 and associated components.

TABLE 5-1. TROUBLE-SHOOTING BASED ON TYPES OF OPERATION. (Cont.)

SYMPTOM	PROBABLE CAUSE	REMEDY
ALARM light not functioning properly.	Defective drift alarm amplifier network.	Check V5007A and V5008A. Check their associated circuitry.
DRIFT meter not functioning properly.	Defective meter amplifier network.	Check V5008B and associated circuitry.
FADE light not functioning properly.	Defective relay network.	Check V5007B and relay K5000. Check their associated components.
Abnormal converter injection frequency output.	Defective high frequency amplifier.	Check V5009 and V5010. Check their associated components.
	Defective oven.	Check operation of oven.
	Defective converter injection oscillator stage.	Check V5011 and V5012. Check their associated components.
Excessive drift.	Defective low frequency amplifier.	Check V5003 and V5004. Check their associated components.
	Defective oven.	Check operation of oven.
	Defective product detector oscillator stage.	Check V5005 and V5006. Check their associated components.

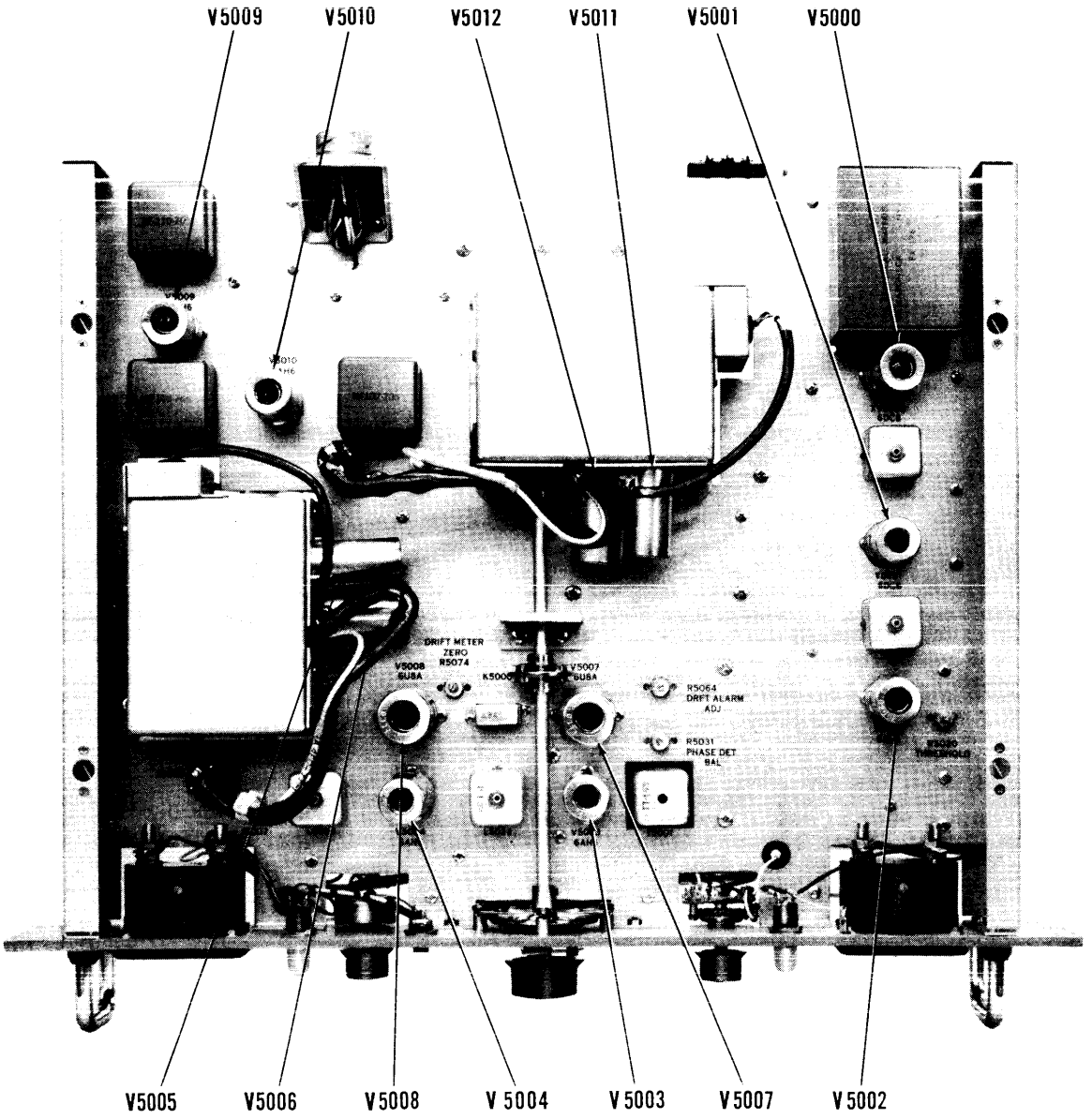


Figure 5-1. AFC-2A,3, Tube Locations

TABLE 5-2. AFC-2A,3, VOLTAGE MEASUREMENTS

TUBE SYMBOL	FUNCTION	TYPE	PIN 1 VOLTS	PIN 2 VOLTS	PIN 3 VOLTS	PIN 4 VOLTS	PIN 5 VOLTS	PIN 6 VOLTS	PIN 7 VOLTS	PIN 8 VOLTS	PIN 9 VOLTS
V5000	CARRIER AMPLIFIER	6DC6	0	2	0	6.3 AC	185	130	2	NA	NA
V5001	CARRIER AMPLIFIER	6DC6	0	2	0	6.3 AC	185	130	2	NA	NA
V5002	CARRIER AMPLIFIER	6AH6	0	2	0	6.3 AC	185	160	2	NA	NA
V5003	LOW FREQUENCY AMPLIFIER	6AH6	5.8	7.4	0	6.3 AC	185	154	7.4	NA	NA
V5004	LOW FREQUENCY AMPLIFIER	6AH6	0	2	0	6.3 AC	185	145	2	NA	NA
V5005	LOW FREQUENCY BUFFER AMPLIFIER	6C4	175	NC	0	6.3 AC	NC	0	4.8	NA	NA
V5006A	1.5 MC OSCILLATOR	1/2 12AT7	150	-4	0	0	0	NA	NA	NA	6.3 AC
V5006B	1.25 MC OSCILLATOR	1/2 12AT7	NA	NA	NA	NA	NA	135	-2	0	NA
V5007A	ALARM AMPLIFIER	1/2 6U8A	NA	4.3	97	6.3 AC	0	100	4.6	NA	NA
V5007B	RELAY AMPLIFIER	1/2 6U8A	84	NA	NA	NA	NA	NA	NA	0	-.64
V5008A	ALARM AMPLIFIER	1/2 6U8A	NA	2.8	97	6.3 AC	0	100	4.6	NA	NA
V5008B	METER AMPLIFIER	1/2 6U8A	36	NA	NA	NA	NA	NA	NA	4.3	3.0
V5009	HIGH FREQUENCY AMPLIFIER	6AH6	.15	2	0	6.3 AC	185	148	2	NA	NA
V5010	HIGH FREQUENCY AMPLIFIER	6AH6	0	2	0	6.3 AC	185	150	2	NA	NA
V5011	HIGH FREQUENCY BUFFER AMPLIFIER	6C4	175	NC	0	6.3 AC	NC	0	3.8	NA	NA
V5012A	OSCILLATOR	1/2 12AT7	NA	NA	NA	0	0	150	-1.6	0	6.3 AC
V5012B	OSCILLATOR	1/2 12AT7	135	-1.1	0	NA	NA	NA	NA	NA	NA

NOTES:

1. CONDITIONS:

   Power supply connected at J5001
   No signal in, no connections at J5002 or J5003
   CARRIER SELECTOR switch at OSC
   SENSITIVITY knob fully clockwise
   RESET switch shorted
   Measurements made between pin and chassis ground, with
   Hewlett-Packard Model 410B VTVM or equivalent.

2. All values are d-c unless noted otherwise.

3. NA: not applicable

4. NC: no connection

SECTION 6

MAINTENANCE

6-1. INTRODUCTION.

Maintenance may be divided into three categories: operator's maintenance, preventive maintenance, and corrective maintenance. Corrective maintenance is sometimes considered as consisting of information useful in locating and diagnosing equipment troubles and maladjustments, existing and/or pending, and information necessary to remedy the equipment troubles and maladjustments. Corrective procedures in this section are those necessary to correct a trouble due to a maladjustment of an alignment control or adjustment. By using these procedures with those presented in Section 5 a trouble may also be localized to a particular section. Operator's maintenance is included in Operator's Section (Section 3).

The AFC unit has been designed to provide long-term trouble-free operation under continuous duty conditions. It is recommended that any necessary maintenance be done by a competent maintenance technician familiar with trouble-shooting techniques. If the trouble cannot be corrected by following the procedures presented in this section and Section 5, it is recommended that the AFC unit be returned to the Technical Materiel Corporation for servicing.

6-2. PREVENTIVE MAINTENANCE.

a. In order to prevent failure of the equipment due to corrosion, tube failure, dust, or other destructive elements it is suggested that a schedule of preventive maintenance be set up and adhered to.

b. At periodic intervals (at least every six months) the equipment should be removed from the rack for cleaning and inspection. All accessible covers should be removed and the wiring and all components inspected for dirt, corrosion, charring, discoloring, or grease; in particular, the tube sockets should be carefully inspected for deterioration. Dust may be removed with a soft brush or a vacuum cleaner if one is available. Remove dirt or grease from electrical parts with trichlorethylene. Remove dirt or grease from other parts with any good dry cleaning fluid.

WARNING

When using trichloroethylene, make certain that adequate ventilation exists. Avoid prolonged contact with skin.

c. While unit is out of the rack and covers are removed, check the tubes, all of which are accessible from the top of the chassis.

d. Carefully inspect for loose solder connections or screws, especially those on solder lugs. Recommended time interval is every 6 to 12 months, depending on the amount of vibration encountered in service.

6-3. CORRECTIVE MAINTENANCE.

The corrective maintenance procedure is essentially Technical Materiel Corporation's factory alignment procedures modified for use in the field. Table 6-1 lists the test equipment necessary for alignment. The alignment procedures are outlined in tables 6-2 through 6-5. For a complete alignment, the procedures must be performed in sequence beginning with table 6-2 and ending with table 6-5. However, the procedures are so arranged that if it is necessary to align only a particular section the procedures in the table covering that section need only be performed. Figure 6-1 locates the alignment controls and adjustments. Procedures are performed with the AFC unit complete and operating power applied by means of J5001. Remove the cables from J5000, J5002, and J5003.

TABLE 6-1. TEST EQUIPMENT FOR ALIGNMENT

ITEM	MANUFACTURER
Signal Generator	Measurements Model 82 or equivalent
Vacuum tube voltmeter	Hewlett-Packard 410B or equivalent
Counter	Hewlett-Packard 524C or equivalent
Variable bias supply	
50-ohm resistor	
Regulated power supply	Lamda Electronics Model 25 or equivalent

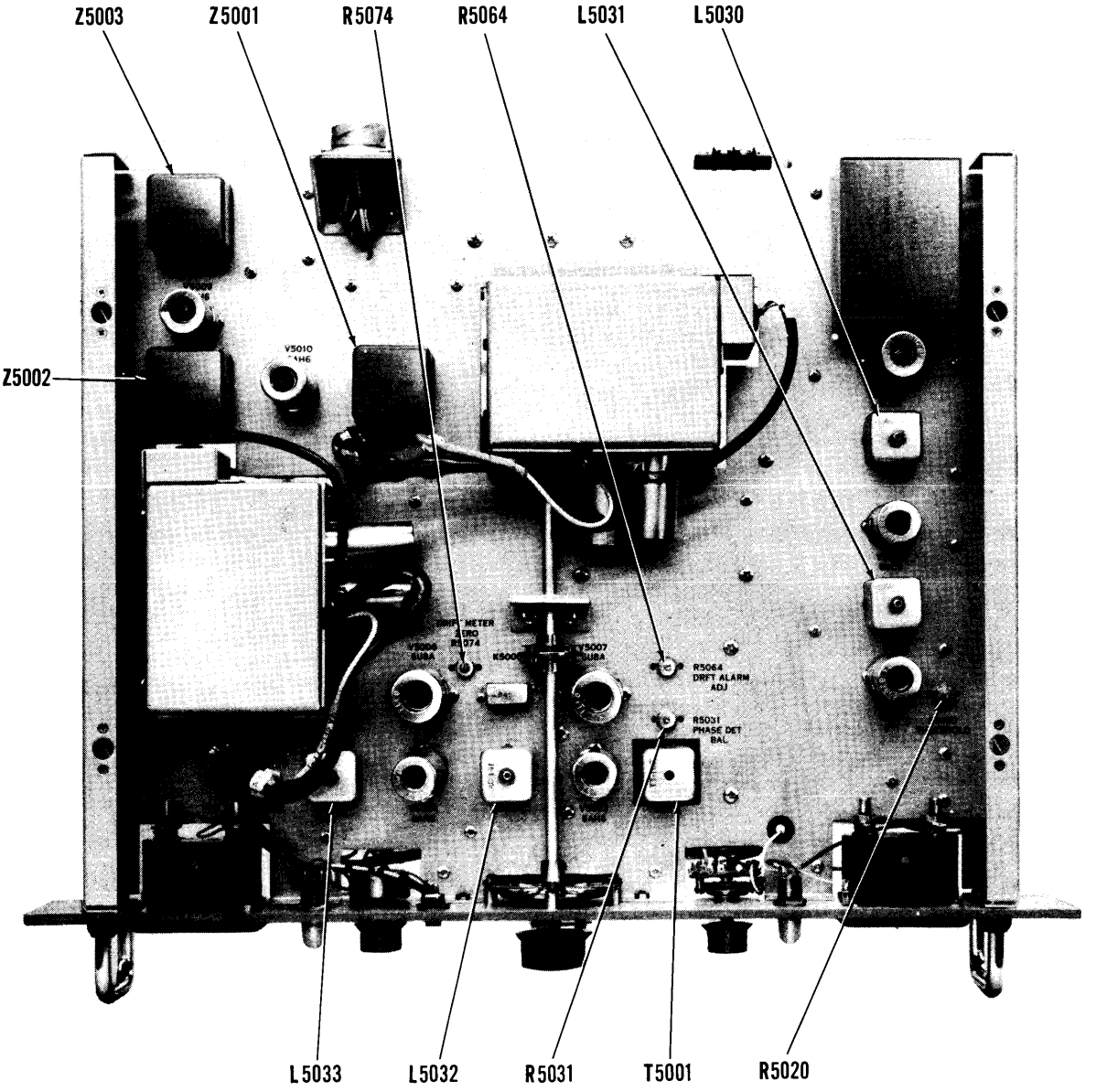


Figure 6-1. Location of AFC-2A,3, Alignment Controls and Adjustments

TABLE 6-2. CARRIER AMPLIFIER ALIGNMENT.

STEP	OPERATION
1	Set the CARRIER SELECTOR switch to RCC, the SENSITIVITY control fully clockwise, and the threshold control R5020 fully counterclockwise.
2	Using the counter, adjust the signal generator to 250 kc ± 5 cps. Adjust the signal generator for an output of 0.3 volt and connect it to J5000.
3	Connect a 50-ohm resistor across J5002.
4	Set the VTVM for A-C operation and connect it between pin 1 of V5001 and ground. Adjust L5030 for the maximum indication on the VTVM.
5	Connect the VTVM between pin 1 of V5002 and ground. Adjust L5031 for the maximum indication on the VTVM.
6	Adjust the signal generator for an output of 3000 uv. Connect the VTVM to J5002. Adjust the threshold control R5020 for 1.0 volt indication on the VTVM.
7	Remove the VTVM. Set it for D-C operation and connect it between pin 1 of V5001 (-) and ground. Indication should be -5 volts ±1.5 volts.
8	Observe the LEVEL meter. It should indicate in the green portion of the scale.
9	Increase the signal generator output to 30 mv. The VTVM should indicate between -6 and -9 volts.
10	Reduce the signal generator output until the fade relay and FADE indicator operate. LEVEL meter indicates in red portion of scale. Signal generator output level should be 100 uv or less.
11	Remove VTVM and signal generator.

TABLE 6-3. DRIFT ALARM AND METER ALIGNMENT.

STEP	OPERATION
1	With a jumper across the terminals of the RESET switch, set the VTVM for D-C operation and connect it between pin 6 of V5008 (+) and ground. Note the indication on the VTVM. It should be approximately 130 volts.
2	Remove the VTVM and connect it between pin 6 of V5007 (+) and ground. Adjust the drift alarm adjust control R5064 until the indication on the VTVM is the same as the indication noted in step 1.
3	Adjust the drift meter zero control R5074 until the DRIFT meter needle is at the center line. Remove all test equipment.

TABLE 6-4. PRODUCT DETECTOR OSCILLATOR AND PHASE DETECTOR ALIGNMENT.

STEP	OPERATION
1	Set OSC/RCC switch at OSC. Disconnect P5007 plug from J5007 jack and P5006 plug from J5006 receptacle. Using the counter, adjust the signal generator to 250 kc $\pm\frac{5}{3}$00 cps. Adjust the siganl generator for an output of mc and connect it to J5007 jack. **CAUTION** Feed RF generator output through a blocking capacitor as B plus is present at J5007." Connect a jumper across RESET switch. Terminate J5002 with a 50-ohm load.
2	Set the VTVM for A-C operation and connect it between pin 1 of V5004 and ground. Adjust L5033 for maximum indication on the VTVM.
3	Connect the VTVM between pin 1 of V5003 and ground. Adjust L5032 for maximum indication on the VTVM.
4	Connect the VTVM across J5002. Adjust T5001 for maximum indication on the VTVM.
5	Remove signal generator from J5007 jack. Reconnect P5007 plug to J5007 and P5006 plug to J5006 receptacle.
6	Oscillator oven must have stabilized (cycled for one hour) before the following steps can be carried out.
7	Remove the VTVM from J5002 jack and connect the counter to this jack. Adjust L5008 for a reading of 250 kc ±1 cps on counter.
8	Connect the VTVM between pin 1 of V5003 and ground. Re-adjust T5001 for minimum indication on the VTVM.
9	Remove counter from J5002 jack and connect the VTVM across this jack. VTVM should read between 1 and 1.3 VRMS.
10	Set the VTVM for D-C operation and connect it between R5115 and ground. VTVM should read approximately 2 VDC (AGC).
11	Remove jumper across RESET switch. Set the VTVM for A-C operation and connect it between terminal 3 of T5003 and ground. VTVM should read approximately 3 VRMS.
12	Set the VTVM for D-C operation and connect it between the wiper arm of R5031 and terminal 2 of T5003. Adjust R5031 for 0 VDC.
13	Connect the VTVM between terminal 1 of T5003 and ground. VTVM should read approximately 2.7 VDC.
14	Remove the VTVM from T5003. Using the counter, adjust signal generator to 250-kc ±1 cps at 100 microvolts. Connect the generator at J5000 jack. Connect the counter at J5002 jack.
15	Vary the signal generator by 50 cps above and below 250-kc. Counter should follow at J5002.

TABLE 6-5. CONVERTER INJECTION OSCILLATOR ALIGNMENT.

STEP	OPERATION
1	Disconnect P5005 plug from J5005 jack and P5004 plug from J5004 receptacle. Using the counter, adjust the signal generator to the center frequency of the oscillator (705 kc for AFC-2A, 2 mc for AFC-3) to within ±5 cps. Adjust the signal generator for an output of 300 mv and connect it to J5005 jack. Connect a jumper across RESET switch. Terminate J5003 with a 50-ohm load.
2	Set the VTVM for A-C operation and connect it between pin 1 of V5010 and ground. Adjust Z5002 for maximum indication on the VTVM.
3	Connect the VTVM between pin 1 of V5009 and ground. Adjust Z5001 for maximum indication on the VTVM.
4	Connect the VTVM across J5003. Adjust Z5003 for maximum indication on the VTVM.
5	Remove signal generator from J5005 jack. Reconnect P5005 plug to J5005 and P5004 plug to J5004 receptacle.
6	Oscillator oven must have stabilized (cycled for one hour) before the following steps can be carrier out.
7	Remove the VTVM from J5003 and connect the counter to this jack. Adjust tuning capacitor C5096 (TUNING knob on front panel) for lowest frequency reading on counter. Loosen coupling of tuning shaft and adjust the knob pointer to coincide with the +3 mark on the panel. Retighten shaft coupling.
8	Adjust TUNING knob to the zero marking on the panel. Then adjust L5029 to obtain the oscillator center frequency.
9	Observe counter and turn TUNING knob to +3 mark on panel. Counter should read center frequency plus approximately 3 kc. Turn TUNING knob to -3 mark on panel. Counter should read center frequency minus approximately 3 kc.
10	Remove counter from J5003 jack, and connect VTVM between pin 1 of V5009 and ground. Readjust Z5003 for minimum indication on the VTVM.
11	Connect the VTVM across J5003. It should read approximately 1 VRMS.
12	Set the VTVM for D-C operation, and connect it between the junction of L5037 and R5096 and ground. Reading shouldbe approximately 2 VDC.

SECTION 7

PARTS LIST

7-1. INTRODUCTION.

Reference designations have been assigned to identify all maintenance parts of the equipment. They are used for marking the equipment (adjacent to the part they identify) and are included on drawings, diagrams, and the parts list. The letters of a reference designation indicate the kind of part (generic group), such as resistor, amplifier, electron tubes, etc. The number differentiates between parts of the same generic group. Parts of the AFC unit are numbered in the 5000 and 5100 series. Sockets associated with a particular plug-in device, such as electron tubes, are identified by a reference designation which includes the reference designations of the plug-in device. For example, the socket for tube V5000 is designated XV5000. Column 1 lists the reference designations of the various parts in alphabetical and numerical order. Column 2 gives the name and describes the various parts. Major part assemblies are listed in their entirety; sub-parts of a major assembly are listed in alpha-betical and numerical order with reference to its major assembly. Column 3 indicates how the part is used within a major component, Column 4 lists each Technical Materiel Corporation part number.

PARTS LIST, AFC-2A,3 AUTOMATIC FREQUENCY CONTROL

SYM.	DESCRIPTION	FUNCTION	TMC DWG OR PART NO.
A5000 (AFC-2A)	TERMINAL BOARD ASSY: printed circuit type; consists of symbol numbers C5095, 5098, 5099, 5101, 5105, 5106, 5107, 5108, 5109, L5015, 5016, 5017, 5018, 5019, R5100, 5103, 5104, 5105, 5106, 5107, Y5002, 5003. (Supplied with Z5005) (NON REPAIRABLE ITEM)	Converter Injection Oscillator Sub-assembly	A-2447-2
A5000 (AFC-3)	TERMINAL BOARD ASSY: printed circuit type; consists of symbol numbers C5095, 5098, 5099, 5101, 5105, 5106, 5107, 5108, 5109, L5015, 5016 5017, 5018, 5019, R5100, 5103, 5104, 5105, 5106, 5107, Y5002, 5003. (Supplied with Z5005) (NON REPAIRABLE ITEM)	Converter Injection Oscillator Sub-assembly	A-2447-1
A5001	TERMINAL BOARD ASSY: printed circuit type; consists of symbol numbers C5057, 5058, 5060, 5061, 5062, 5067, 5068, 5070, 5071, 5072, L5007, 5009, 5026, 5027, R5056, 5059, 5060, 5062, 5063, 5065, Y5000, 5001. (Supplied with Z5004) (NON REPAIRABLE ITEM)	Product Detector Oscillator Sub-assembly	A-2446-4
C5000	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 0.1 uf; +80 -20%; 500 vdcw.	RF Bypass	CC-100-32
C5001	CAPACITOR, FIXED, CERAMIC DIELECTRIC: .01 uf; GMV: 500 vdcw.	SG Bypass	CC-100-16
C5002	Same as C5000.	B+ Decoupling	
C5003	Same as C5000.	B+ Bypass	
C5004	DELETED		
C5005	DELETED		
C5006	CAPACITOR, FIXED, PLASTIC DIELECTRIC: 1.0 uf; ±10%; 200 vdcw.	p/o Delay Netwk	CN112A105K2
C5007	Same as C5000.	RF Bypass	
C5008	Same as C5000.	B+ Bypass	
C5009	Same as C5000.	B+ Bypass	
C5010	Same as C5001.	SG Bypass	
C5011	DELETED		
C5012	DELETED		
C5013	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 100, 000 uuf; GMV; 500 vdcw.	RF Bypass	CC-100-28
C5014	Same as C5000.	B+ Bypass	
C5015	Same as C5000.	B+ Bypass	
C5016	Same as C5001.	SG Bypass	
C5017	Same as C5000.	Cathode Bypass	

PARTS LIST, AFC-2A,3 AUTOMATIC FREQUENCY CONTROL

SYM.	DESCRIPTION	FUNCTION	TMC DWG OR PART NO.
C5018	Same as C5000.	RF Bypass	
C5019	DELETED		
C5020	Same as C5001.	RF Bypass	
C5021	Same as C5001.	B+ Bypass	
C5022	Same as C5001.	B- Bypass	
C5023	Same as C5001.	B- Bypass	
C5024	Same as C5001.	AC Bypass	
C5025	Same as C5001.	AC Bypass	
C5026	Same as C5001.	AC Bypass	
C5027	Same as C5001.	AC Bypass	
C5028	Same as C5000.	Fil. Bypass	
C5029	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 1000 uuf; GMV: 500 vdcw.	Coupling	CC-100-29
C5030 A,B	CAPACITOR, FIXED, CERAMIC DIELECTRIC: dual section, 10,000 uuf each section; GMV; 1000 vdcw.	RF Bypass	CC-100-23
C5031	DELETED		
C5032	CAPACITOR, FIXED, MICA DIELECTRIC: 510 uuf; ±10%; 500 vdcw.	Coupling	CM15C511K
C5033	Same as C5001.	Coupling	
C5034	Same as C5000.	B+ Bypass	
C5035	CAPACITOR, FIXED, ELECTROLYTIC: tantalum; 50 uf; +50 -15%; 60 vdcw; polarized; tubular case.	Filter	CE-107-1
C5036	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 20,000 uuf; +60 -40%; 150 vdcw.	Coupling	CC-100-35
C5037	Same as C5000.	B+ Bypass	
C5038	Same as C5000.	p/o Plate Tank	
C5039	DELETED		
C5040	Same as C5032.	Coupling	
C5041	Same as C5001.	SG Bypass	
C5042	DELETED		
C5043	Same as C5013.	RF Bypass	
C5044	Same as C5000.	B+ Bypass	
C5045	Same as C5000.	B+ Bypass	

SYM.	DESCRIPTION	FUNCTION	TMC DWG OR PART NO.
C5046	DELETED		
C5047	DELETED		
C5048	Same as C50001.	SG Bypass	
C5049	DELETED		
C5050	Same as C5013.	RF Bypass	
C5051	Same as C5000.	B+ Bypass	
C5052	DELETED		
C5053	DELETED		
C5054	Same as C5013.	RF Bypass	
C5055	Same as C5000.	B+ Bypass	
C5056	CAPACITOR, FIXED, MICA DIELECTRIC: 2000 uuf; ±10%; 500 vdcw. (Supplied with Z5004)	B+ Bypass	CM20C202K
C5057	Same as C5032. (Supplied with A5001)	Filter	
C5058	Same as C5032. (Supplied with A5001)	Coupling	
C5059	Same as C5032. (Supplied with Z5004)	Plate Bypass	
C5060	CAPACITOR, VOLTAGE VARIABLE, SILICON: 14-70 uuf; hermetically sealed glass to metal; 20 vdcw. (Supplied with A5001)	Freq. Control	CX-106-11
C5061	CAPACITOR, FIXED, MICA DIELECTRIC: 180 uuf; ±2%; 500 vdcw. (Supplied with A5001)	Coupling	CM15C181G
C5062	CAPACITOR, FIXED, MICA DIELECTRIC: 200 uuf; ±10%; 500 vdcw. (Supplied with A5001)	Cathode Bypass	CM15C201K
C5063	CAPACITOR, FIXED, MICA DIELECTRIC: 10 uuf; ±10%; 500 vdcw. (Supplied with Z5005)	p/o Tuning	CM15C100K
C5064	Same as C5063. (Supplied with Z5004)	Coupling	
C5065	Same as C5056. (Supplied with Z5004)	B+ Bypass	
C5066	Same as C5056. (Supplied with Z5004)	Coupling	
C5067	Same as C5061. (Supplied with A5001)	Coupling	
C5068	Same as C5061. (Supplied with A5001)	Cathode Bypass	
C5069	Same as C5001. (Supplied with Z5004)	Cathode Bypass	
C5070	CAPACITOR, FIXED, MICA DIELECTRIC: 2000 uuf; ±10%; 300 vdcw; straight type. (Supplied with A5001)	RF Bypass	CM112E202K3C
C5071	Same as C5070. (Supplied with A5001)	RF Bypass	

SYM.	DESCRIPTION	FUNCTION	TMC DWG OR PART NO.
C5072	Same as C5070. (Supplied with A5001)	RF Bypass	
C5073	Same as C5000.	B+ Bypass	
C5074	Same as C5001.	Plate Bypass	
C5075	Same as C5013.	RF Bypass	
C5076	Same as C5035.	Memory	
C5077	Same as C5035.	Memory	
C5078	Same as C5001.	RF Bypass	
C5079	Same as C5000.	RF Bypass	
C5080	Same as C5000.	B+ Bypass	
C5081	DELETED		
C5082	DELETED		
C5083	Same as C5001.	Cathode Bypass	
C5084	Same as C5001.	RF Bypass	
C5085	Same as C5000.	B+ Bypass	
C5086	Same as C5032.	Coupling	
C5087	Same as C5000.	B+ Bypass	
C5088	Same as C5000.	RF Bypass	
C5089	Same as C5001.	SG Bypass	
C5090	DELETED		
C5091	Same as C5001.	RF Bypass	
C5092	Same as C5000.	RF Bypass	
C5093	DELETED		
C5094	Same as C5056. (Supplied with Z5005)	B+ Bypass	
C5095	CAPACITOR, FIXED, MICA DIELECTRIC: 10 uuf; ±10%; 500 vdcw. (Supplied with A5000)	Filter	CM15C100K
C5096	CAPACITOR, VARIABLE, AIR DIELECTRIC: 2.3 uuf to 15 uuf; 600 vac peak. (Supplied with Z5005)	Tuning	CT-104-2
C5097	Same as C5000.	RF Bypass	
C5098	CAPACITOR, FIXED, MICA DIELECTRIC: 39 uuf; ±10%; 500 vdcw. (Supplied with A5000)	Coupling	CM15C390K
C5099	CAPACITOR, FIXED, MICA DIELECTRIC: 130 uuf; ±10%; 500 vdcw. (Supplied with A5000)	Cathode Bypass	CM15C131K
C5100	Same as C5062. (Supplied with Z5005)	Coupling	

PARTS LIST, AFC-2A,3 AUTOMATIC FREQUENCY CONTROL

SYM.	DESCRIPTION	FUNCTION	TMC DWG OR PART NO.
C5101	CAPACITOR, FIXED, MICA DIELECTRIC: 82 uuf; ±10%; 500 vdcw. (Supplied with A5000)	Filter	CM15C820K
C5102	Same as C5001. (Supplied with Z5005)	Cathode Bypass	
C5103	Same as C5056. (Supplied with Z5005)	B+ Bypass	
C5104	Same as C5056. (Supplied with Z5005)	Coupling	
C5105	CAPACITOR, FIXED, MICA DIELECTRIC: 22 uuf; ±10%; 500 vdcw. (Supplied with A5000)	Coupling	CM15C220K
C5106	Same as C5101. (Supplied with A5000)	Cathode Bypass	
C5107	Same as C5060. (Supplied with A5000)	Frequency Control	
C5108	Same as C5070. (Supplied with A5000)	RF Bypass	
C5109	Same as C5070. (Supplied with A5000)	RF Bypass	
C5110	Same as C5000.	Arc Suppressor	
C5111	Same as C5110. (Also supplied with Symbol E5002)	Arc Suppressor	
C5112	Same as C5001.	Coupling	
C5113	Same as C5001.	Coupling	
C5114	Same as C5001.	RF Bypass	
C5115	Same as C5035.	Filter	
C5116	Same as C5000.	B+ Bypass	
C5117	Same as C5001.	RF Bypass	
C5118	Same as C5063. (Supplied with Z5005)	Coupling	
C5119	CAPACITOR, FIXED, TANTALUM: 6.8 uf, ±20%; 6 vdcw; solid electrolyte.	p/o Filter	CE-106
CR5000	SEMICONDUCTOR DEVICE, DIODE: silicon; max peak inverse volts 175 v; max rms volts 125 v; 30 milliampere at 150°C; peak recurrent 120 ma; max surge current 0.5 amps.	Isolation Diode	1N463
CR5001	Same as CR5000.	p/o RF Quadrupler Rectifier	
CR5002	Same as CR5000.	p/o RF Quadrupler Rectifier	
CR5003	Same as CR5000.	p/o RF Quadrupler Rectifier	
CR5004	Same as CR5000.	p/o RF Quadrupler Rectifier	

SYM.	DESCRIPTION	FUNCTION	TMC DWG OR PART NO.
CR5005	SEMICONDUCTOR DEVICE, DIODE: germanium; max peak inverse volts 100 v; min forward current 20 ma; 50/ua at 50 v max inverse current; average rectified current 60 ma wire lead terminals.	RF Rectifier	1N100
CR5006	Same as CR5005.	RF Rectifier	
CR5007	Same as CR5005.	p/o Phase Detector	
CR5008	Same as CR5005.	p/o Phase Detector	
CR5009	SEMICONDUCTOR DEVICE, DIODE: silicon; voltage 5.6 v; max dynamic resistance 11 ohms; max inverse current, 1 ua at 25°C, 20 ua at 150°C.	Voltage Reg.	1N752
CR5010	Same as CR5000.	RF Rectifier	
CR5011	SEMICONDUCTOR DEVICE, DIODE: germanium; max peak reverse volts 225 v; min forward milliampere 1 ma.	Compensator	1N39A
CR5012	Same as CR5000.	RF Rectifier	
E5000	TERMINAL BOARD: barrier type; two single screw terminals and feedthru solder lugs, 6-32 thd; phenolic body.	Ext. Fade Alarm Indicator	TM-100-2
E5001	TERMINAL BOARD ASSEMBLY, HEATER: consists of one switch symbol no. S5003; two heating elements symbol no. R5112, 5113; one fixed resistor symbol no. R5114; one fixed capacitor symbol no. C5111. (Part of Z5004) (Interchangeable with E5002)	Heater Assy.	A-2330
E5002	TERMINAL BOARD ASSEMBLY, HEATER: consists of one switch symbol no. S5002; two heating elements symbol no. R5110, 5111; one fixed resistor symbol no. R5109; one fixed capacitor symbol no. C5110. (Part of Z5005) (Interchangeable with E5001)	Heater Assy.	A-2330
I5000	LAMP, GLOW: 110/125 v, 1/15 watts; midget flange base; T-2 bulb.	Drift Indicator	BI-111-1
I5001	Same as I5000.	Fade Alarm	
J5000	CONNECTOR, RECEPTACLE, ELECTRICAL: RF type; one round female contact; straight type; series BNC.	Input	UG-625/U
J5001	CONNECTOR, RECEPTACLE, ELECTRICAL: 14 male contacts; rated at 17.0 amps.	Power Input	JJ-200-2
J5002	Same as J5000.	250 Kcs Osc. Output	
J5003	Same as J5000.	2 Mcs Osc. Output	
J5004	CONNECTOR, RECEPTACLE, ELECTRICAL: #20 female contacts; polarized, straight type; 2000 v rms, contacts rated 7.5 amps.	Oven Disconnect	JJ-193-9S

SYM.	DESCRIPTION	FUNCTION	TMC DWG OR PART NO.
J5005	CONNECTOR, RECEPTACLE, ELECTRICAL: RF type; 1 male contact; straight type; series BNC coaxial.	Oven Disconnect	JJ-211
J5006	Same as J5004.	Oven Disconnect	
J5007	Same as J5005.	Oven Disconnect	
K5000	RELAY, ARMATURE: coil operating voltage, 110 vdc; coil resistance, 9100 ohms dc; contact rating 26.5 vdc; 3 amps, non-inductive; double pole, double throw.	Fade Relay	RL-143-1
L5000	COIL, RADIO FREQUENCY: fixed; 2.5 mh, ±10%; 26 ohms dc resistance; 100 ma current rating; molded case.	RF Choke	CL-140-1
L5001	Same as L5000.	RF Choke	
L5002	Same as L5000.	RF Choke	
L5003	Same as L5000.	RF Choke	
L5004	Same as L5000.	RF Choke	
L5005	Same as L5000.	RF Choke	
L5006	Same as L5000.	RF Choke	
L5007	Same as L5000. (Supplied with A5001)	RF Choke	
L5008	COIL, RADIO FREQUENCY: tuned; 440-800 uh; 11 dc resistance. (Supplied with Z5004)	Frequency Adjust	CL-283-10
L5009	COIL, RADIO, FREQUENCY: fixed; 820 uh, ±5%; 3.8 ohms dc resistance; 150 ma current rating; molded case. (Supplied with A5001)	Frequency Compensator	CL-275-821
L5010	Same as L5000.	RF Choke	
L5011	NOT USED.		
L5012	Same as L5000.	RF Choke	
L5013	Same as L5000.	RF Choke	
L5014	DELETED		
L5015	COIL, RADIO FREQUENCY: fixed; 150 uh, ±5%; 3.3 ohms dc resistance; 315 ma current rating; molded case. (Supplied with A5000)	p/o Low Pass Filter	CL-275-151
L5016	Same as L5015. (Supplied with A5000)	Cathode Choke	
L5017	Same as L5015. (Supplied with A5000)	Cathode Choke	
L5018 (AFC-2A)	COIL, RADIO FREQUENCY: fixed; 18.0 uh, +10%; 0.80 ohms dc resistance; molded case. (Supplied with A5000)	Frequency Compensator	CL-270-18
L5018 (AFC-3)	COIL, RADIO FREQUENCY: fixed; 22.0 uh, ±10%; 0.90 ohms dc resistance; molded case. (Supplied with A5000)	Frequency Compensator	CL-270-22

PARTS LIST, AFC-2A,3 AUTOMATIC FREQUENCY CONTROL

SYM.	DESCRIPTION	FUNCTION	TMC DWG OR PART NO.
L5019 (AFC-2A)	Same as L5018 for AFC-2A.		
L5019 (AFC-3)	COIL, RADIO FREQUENCY: fixed; 15.0 uh, ±10%; 0.50 ohms dc resistance; molded case. (Supplied with A5000)	Frequency Compensator	CL-270-15
L5020	COIL, RADIO FREQUENCY: fixed; 120.0 uh, ±10%; 3.2 dc resistance; molded case.	RF Choke	CL-240-120
L5021	Same as L5020.	RF Choke	
L5022	Same as L5020.	RF Choke	
L5023	Same as L5020.	RF Choke	
L5024.1	CORE, TOROID: bead type; powdered iron.	RF Choke	CL-120-1
L5024.2	Same as L5024.1.	RF Choke	
L5024.3	Same as L5024.1.	RF Choke	
L5024.4	Same as L5024.1.	RF Choke	
L5024.5	Same as L5024.1.	RF Choke	
L5025.1	Same as L5024.1.	RF Choke	
L5025.2	Same as L5024.1.	RF Choke	
L5025.3	Same as L5024.1.	RF Choke	
L5025.4	Same as L5024.1.	RF Choke	
L5025.5	Same as L5024.1.	RF Choke	
L5026	Same as L5000. (Supplied with A5001)	Cathode Choke	
L5027	Same as L5000. (Supplied with A5001)	Cathode Choke	
L5028	DELETED		
L5029	COIL, RADIO FREQUENCY: tuned; inductance, 3 uh to 6 uh; ±10%; 1 ohm dc resistance; 5 ma current rating; operating frequency 10 mc; ceramic coil form; supplied with tuning slug. (Supplied with Z5005)	Frequency Adjust	CL-294
L5030	COIL, RADIO FREQUENCY: tuned; 250 kc operating frequency; consists of two capacitors, one 1500 uuf and one 1000 uuf.	p/o Plate Tank	AC-141
L5031	Same as L5030.	p/o Plate Tank	
L5032	Same as L5030.	p/o Plate Tank	
L5033	Same as L5030.	p/o Plate Tank	
L5034	NOT USED		
L5035	NOT USED		
L5036	DELETED		

SYM.	DESCRIPTION	FUNCTION	TMC DWG OR PART NO.
L5037	Same as L5000.	RF Choke	
M5000	METER, ARBITRARY SCALE: movement 0-500 microamps; approximate resistance 200 ohms; multi color scale, red, yellow, green; rectangular case.	Carrier Level	MR-158
M5001	METER, ARBITRARY SCALE: movement 0-500 micro amps; approximate resistance 200 ohms; multi color scale, red, yellow, green, green, yellow, red; rectangular case.	Drift	MR-156
P5000	DELETED		
P5001	DELETED		
P5002	NOT USED		
P5003	NOT USED		
P5004	CONNECTOR, PLUG: miniature type; 9 #20 female contacts; straight type; with cable clamp. (Supplied with Z5005)		PL-189-9P
P5005	CONNECTOR, PLUG: RF type; 1 female coaxial contact; straight type, series miniature bayonet lock. (Supplied with Z5005)		PL-204
P5006	Same as P5004. (Supplied with Z5004)		
P5007	Same as P5005. (Supplied with Z5004)		
R5000	RESISTOR, FIXED, COMPOSITION: 270 ohms; ±10% 1/2 watt.	p/o RF Attenuator	RC20GF271K
R5001	RESISTOR, FIXED, COMPOSITION: 47 ohms; ±10%; 1/2 watt.	p/o RF Attenuator	RC20GF470K
R5002	RESISTOR, FIXED, COMPOSITION: 8200 ohms; ±10%; 1/2 watt.	Grid Leak	RC20GF822K
R5003	Same as R5001.	Parasitic Suppressor	
R5004	RESISTOR, FIXED, COMPOSITION: 1500 ohms; ±10%; 1/2 watt.	Voltage Dropping	RC20GF152K
R5005	Same as R5001.	Parasitic Suppressor	
R5006	RESISTOR, FIXED, COMPOSITION: 18000 ohms; ±10% 1/2 watt.	Screen Grid Dropping	RC20GF183K
R5007	RESISTOR, FIXED, COMPOSITION: 180 ohms; ±10%; 1/2 watt.	Cathode Dropping	RC20GF181K
R5008	RESISTOR, FIXED, COMPOSITION: 100,000 ohms; ±10%; 1/2 watt.	p/o Decoupling	RC20GF104K
R5009	Same as R5001.	Parasitic Suppressor	
R5010	Same as R5008.	Grid Leak	
R5011	Same as R5004.	Plate Dropping	

PARTS LIST, AFC-2A,3 AUTOMATIC FREQUENCY CONTROL

SYM.	DESCRIPTION	FUNCTION	TMC DWG OR PART NO.
R5012	Same as R5001.	Parasitic Suppressor	
R5013	Same as R5006.	Screen Grid Dropping	
R5014	Same as R5007.	Cathode Dropping	
R5015	Same as R5001.	Parasitic Suppressor	
R5016	Same as R5008.	Grid Leak	
R5017	Same as R5004.	Plate Dropping	
R5018	Same as R5001.	Parasitic Suppressor	
R5019	RESISTOR, FIXED, COMPOSITION: 15,000 ohms; ±10%; 1/2 watt.	Screen Grid	RC20GF153K
R5020	RESISTOR, VARIABLE, COMPOSITION: 100000 ohms; ±10%; 1/2 watt.	AGC Threshold Adjustment	RV106UX9B104A
R5021	Same as R5007.	Cathode Dropping	
R5022	RESISTOR, FIXED, COMPOSITION: 470,000 ohms; ±10%; 1/2 watt.	p/o Voltage Divider	RC20GF474K
R5023	RESISTOR, FIXED, COMPOSITION: 220,000 ohms; ±10%; 1/2 watt.	p/o Voltage Divider	RC20GF224K
R5024	RESISTOR, VARIABLE: 100,000 ohms; ±20%; 2 watts.	Sensitivity	RV4ATRD104B
R5025	RESISTOR, FIXED, COMPOSITION: 330,000 ohms; ±10%; 1/2 watt.	B- Dropping	RC20GF334K
R5026	Same as R5008.	p/o Decoupling	
R5027	RESISTOR, FIXED, COMPOSITION: 2700 ohms; ±5%; 1/2 watt.	Multiplier	RC20GF272J
R5028	RESISTOR, FIXED, COMPOSITION: 12,000 ohms; ±10%; 1/2 watt.	Isolation	RC20GF123K
R5029	Same as R5008.	Isolation	
R5030	Same as R5002.	Loading	
R5031	RESISTOR, VARIABLE, COMPOSITION: 5000 ohms; ±10%; 1/2 watt.	Phase Detector Balance	RV106UX8B502A
R5032	Same as R5027.	p/o Divider	
R5033	Same as R5027.	p/o Divider	
R5034	Same as R5008.	Decoupling	
R5035	RESISTOR, FIXED, COMPOSITION: 4.7 megohms; ±10%; 1/2 watt.	Diode Load	RC20GF475K
R5036	Same as R5008.	Voltage Dropping	
R5037	Same as R5004.	Plate Dropping	
R5038	Same as R5001.	Parasitic Supp.	

SYM.	DESCRIPTION	FUNCTION	TMC DWG OR PART NO.
R5039	Same as R5006.	Screen Grid Dropping	
R5040	Same as R5001.	Parasitic Supp.	
R5041	Same as R5007.	Cathode Dropping	
R5042	Same as R5008.	Grid Leak	
R5043	Same as R5004.	Plate Dropping	
R5044	Same as R5019.	Screen Grid Dropping	
R5045	Same as R5001.	Parasitic Supp.	
R5046	Same as R5001.	Parasitic Supp.	
R5047	Same as R5007.	Cathode Dropping	
R5048	Same as R5008.	Grid Leak	
R5049	Same as R5008.	p/o Voltage Div.	
R5050	RESISTOR, FIXED, COMPOSITION: 120,000 ohms; ±10%; 1/2 watt.	p/o Voltage Div.	RC20GF124K
R5051	Same as R5023.	p/o Voltage Div.	
R5052	Same as R5001.	RF Load	
R5053	Same as R5001.	RF Load	
R5054	Same as R5004.	Plate Dropping	
R5055	RESISTOR, FIXED, COMPOSITION: 2200 ohms; ±10%; 1/2 watt. (Supplied with Z5004)	Decoupling	RC20GF222K
R5056	RESISTOR, FIXED, COMPOSITION: 4700 ohms; ±10%; 1/2 watt. (Supplied with A5001)	Grid Leak	RC20GF472K
R5057	RESISTOR, FIXED, COMPOSITION: 10,000 ohms; ±10%; 1/2 watt. (Supplied with Z5004)	Plate Dropping	RC20GF103K
R5058	Same as R5057. (Supplied with Z5004)	Plate Dropping	
R5059	Same as R5001. (Supplied with A5001)	Parasitic Supp.	
R5060	Same as R5008. (Supplied with A5001)	Grid Leak	
R5061	RESISTOR, FIXED, COMPOSITION: 390 ohms; ±10%; 1/2 watt. (Supplied with Z5004)	Cathode Dropping	RC20GF391K
R5062	Same as R5001. (Supplied with A5001)	Parasitic Supp.	
R5063	Same as R5008. (Supplied with A5001)	Grid Leak	
R5064	Same as R5020.	Drift Alarm Adj.	
R5065	Same as R5008. (Supplied with A5001)	Decoupling	

SYM.	DESCRIPTION	FUNCTION	TMC DWG OR PART NO.
R5066	RESISTOR, FIXED, COMPOSITION: 470,000 ohms; ±5%; 1/2 watt.	B- Dropping	RC20GF474J
R5067	Same as R5066.	Coupling	
R5068	RESISTOR, FIXED, COMPOSITION: 22,000 ohms; ±5%; 1 watt.	Plate Dropping	RC32GF223J
R5069	RESISTOR, FIXED, COMPOSITION: 1000 ohms; ±10%; 1/2 watt.	Cathode Dropping	RC20GF102K
R5070	RESISTOR, FIXED, COMPOSITION: 15,000 ohms; ±10%; 1 watt.	Screen Grid Dropping	RC32GF153K
R5071	Same as R5068.	Plate Dropping	
R5072	Same as R5068.	p/o Volt. Div.	
R5073	Same as R5069.	Cathode Dropping	
R5074	RESISTOR, VARIABLE, COMPOSITION: 2500 ohms; ±10%; 1/2 watt.	Drift Meter Adj.	RV106UX8B252A
R5075	Same as R5022.	Isolation	
R5076	RESISTOR, FIXED, COMPOSITION: 27,000 ohms; ±10%; 1 watt.	Plate Dropping	RC32GF273K
R5077	RESISTOR, FIXED, COMPOSITION: 5600 ohms; ±10%; 1 watt.	p/o Divider	RC32GF562K
R5078	RESISTOR, FIXED, COMPOSITION: 47,000 ohms; ±10%; 1 watt.	p/o Divider	RC32GF473K
R5079	Same as R5023.	p/o Time Constant	
R5080	Same as R5008.	Isolation	
R5081	Same as R5050.	B+ Dropping	
R5082	RESISTOR, FIXED, COMPOSITION: 2700 ohms; ±10%; 1/2 watt.	Cathode Dropping	RC20GF272K
R5083	Same as R5004.	Plate Dropping	
R5084	Same as R5001.	Parasitic Supp.	
R5085	Same as R5006.	Screen Grid Dropping	
R5086	Same as R5001.	Parasitic Supp.	
R5087	Same as R5007.	Cathode Dropping	
R5088	RESISTOR, FIXED, COMPOSITION: 150,000 ohms; ±10%; 1/2 watt.	p/o Divider	RC20GF154K
R5089	Same as R5002.	p/o Divider	
R5090	Same as R5004.	Plate Dropping	
R5091	Same as R5019.	SG Dropping	
R5092	Same as R5001.	Parasitic Supp.	

PARTS LIST, AFC-2A,3 AUTOMATIC FREQUENCY CONTROL

SYM.	DESCRIPTION	FUNCTION	TMC DWG OR PART NO.
R5093	Same as R5001.	Parasitic Supp.	
R5094	Same as R5007.	Cathode Dropping	
R5095	Same as R5008.	Grid Leak	
R5096	Same as R5008.	Diode Load	
R5097	Same as R5008.	Grid Leak	
R5098	Same as R5004.	Plate Dropping	
R5099	Same as R5055. (Supplied with Z5005)	Decoupling	
R5100	Same as R5056. (Supplied with A5000)	Grid Leak	
R5101	Same as R5057. (Supplied with Z5005)	Plate Dropping	
R5102	Same as R5057. (Supplied with Z5005)	Plate Dropping	
R5103	Same as R5001. (Supplied with A5000)	Parasitic Supp.	
R5104	Same as R5008. (Supplied with A5000)	Grid Leak	
R5105	Same as R5008. (Supplied with A5000)	Isolation	
R5106	Same as R5001. (Supplied with A5000)	Parasitic Supp.	
R5107	Same as R5008. (Supplied with A5000)	Grid Leak	
R5108	Same as R5061. (Supplied with Z5005)	Cathode Dropping	
R5109	RESISTOR, FIXED, COMPOSITION: 10 ohms; ±10%; 1/2 watt. (Supplied with Symbol E5001)	Arc Suppressor	RC20GF100K
R5110	HEATING ELEMENT, ELECTRICAL: electrical rating 115 v; 20 watts; 2 wire lead type terminals. (Supplied with Symbol E5001)	Heater	RR-102-1
R5111	Same as R5110. (Supplied with Symbol E5001)	Heater	
R5112	Same as R5110. (Supplied with Symbol E5002)	Heater	
R5113	Same as R5110. (Supplied with Symbol E5002)	Heater	
R5114	Same as R5109. (Supplied with Symbol E5002)	Arc Suppressor	
R5115	Same as R5008.	p/o Volt. Divider	
R5116	Same as R5001.	Parasitic Supp.	
R5117	Same as R5001.	Parasitic Supp.	
R5118	Same as R5057.	Isolation	
R5119	Same as R5056.	p/o Filter	
S5000	SWITCH, ROTARY: 1 section; 2 position; 30° throw; non-shorting contacts; 1 amp, 28 volts or 5 amp at 110 volts ac.	Carrier Selector	SW-119

SYM.	DESCRIPTION	FUNCTION	TMC DWG OR PART NO.
S5001	SWITCH, PUSH: ratings - 250 ma, non-inductance, AC, 30 watt max SPST break before make.	Drift Reset	SW-296-1
S5002	SWITCH, THERMOSTATIC: SPST: normally closed; opening temperature 70°C; electrical ratings 230 VAC max 2.5 amp nom current rating, 4.5 amp nom current 230 v, two solder lug terminals. (Supplied with Symbol E5001)	Thermostat	SS-106-1
S5003	Same as S5002. (Supplied with Symbol E5002)	Thermostat	
T5000	TRANSFORMER, RADIO FREQUENCY: frequency response, 150 kc to 4 mc within 3 db; primary impedance 50 ohms; secondary impedance 5000 ohms; polarized.	Carrier Output	TZ 107
T5001	TRANSFORMER, RADIO FREQUENCY: tuned; 250 kc operating frequency; consists of one capacitor 1500 uuf.	250 Kcs Output	TT-163
T5002	DELETED		
T5003	TRANSFORMER, PULSE: 3 windings; winding no. 1, 4.7 mh; turns ratio 5:5:1.	p/o Phase Detector	TF-228-K15
V5000	TUBE, ELECTRON: semiremote-cutoff pentode; 7 pin miniature.	1st Carrier Amplifier	6DC6
V5001	Same as V5000.	2nd Carrier Amplifier	
V5002	TUBE, ELECTRON: sharp-cutoff pentode; 7 pin miniature.	3rd Carrier Amplifier	6AH6
V5003	Same as V5002.	2nd Low Freq. Amplifier	
V5004	Same as V5002.	1st Low Freq. Amplifier	
V5005	TUBE, ELECTRON: HF power triode; 7 pin miniature. (Supplied with Z5004)	Low Frequency Buffer	6C4
V5006 A,B	TUBE, ELECTRON: high-mu twin-triode; 9 pin miniature. (Supplied with Z5004)	Product Detector Oscillator	12AT7
V5007 A,B	TUBE, ELECTRON: medium-mu triode; 9 pin miniature.	DC Amplifier	6U8A
V5008 A,B	Same as V5007A,B.	DC Amplifier	
V5009	Same as V5002.	2nd HF Amplifier	
V5010	Same as V5002.	1st HF Amplifier	
V5011	Same as V5005. (Supplied with Z5005)	HF Buffer	
V5012 A,B	Same as V5006A,B. (Supplied with Z5005)	Converter Injection Oscillator	

PARTS LIST, AFC-2A,3 AUTOMATIC FREQUENCY CONTROL

SYM.	DESCRIPTION	FUNCTION	TMC DWG OR PART NO.
XI5000	LIGHT, INDICATOR: with white lens; accepts T-3-1/4 single contact, midget flange lamp.	Drift Alarm	TS-154-5
XI5001	Same as XI5000.	Fade Indicator	
XV5000	SOCKET, ELECTRON TUBE: 7 pin miniature.	Socket for V5000	TS102P01
XV5001	Same as XV5000.	Socket for V5001	
XV5002	Same as XV5000.	Socket for V5002	
XV5003	Same as XV5000.	Socket for V5003	
XV5004	Same as XV5000.	Socket for V5004	
XV5005	Same as XV5000.	Socket for V5005	
XV5006	SOCKET, ELECTRON TUBE: 9 pin miniature.	Socket for V5006	TS103P01
XV5007	Same as XV5006.	Socket for V5007	
XV5008	Same as XV5006.	Socket for V5008	
XV5009	Same as XV5000.	Socket for V5009	
XV5010	Same as XV5000.	Socket for V5010	
XV5011	Same as XV5000.	Socket for V5011	
XV5012	Same as XV5006.	Socket for V5012	
XZ5000	NOT USED		
XZ5001 A,B,C,D	JACK, TIP: nominal rms voltage at 60 cps, 1250 v; 0.4 uuf; with white teflon body.	Filter Socket for Z5001	JJ-219-1-9
XZ5002 A,B,C,D	Same as XZ5001A,B,C,D.	Filter Socket for Z5002	
XZ5003 A,B,C,D	Same as XZ5001A,B,C,D.	Filter Socket for Z5003	
Y5000	CRYSTAL UNIT, QUARTZ: 1.250 mc, ±.002%; +70° to +80°C operating temperature range; parallel resonance; 32 uuf, ±0.5 uuf load capacitance; fundamental operation; type HC-6/U holder. (Supplied with A5001)	Oscillator	CR-109-1
Y5001	CRYSTAL UNIT, QUARTZ: 1.500 mc, ±.002%; +70° to +80°C operating temperature range; parallel resonance; 32 uuf ±0.5 uuf load capacitance; fundamental operation; type HC-6/U holder. (Supplied with A5001)	Oscillator	CR-109-2
Y5002	CRYSTAL UNIT, QUARTZ: 10.000 mc, ±.002%; +70° to +80°C operating temperature range; parallel resonance; 32 uuf, ±0.5 uuf load capacitance; fundamental operation; type HC-6/U holder. (Supplied with A5000)	Oscillator	CR-109-3

PARTS LIST, AFC-2A,3 AUTOMATIC FREQUENCY CONTROL

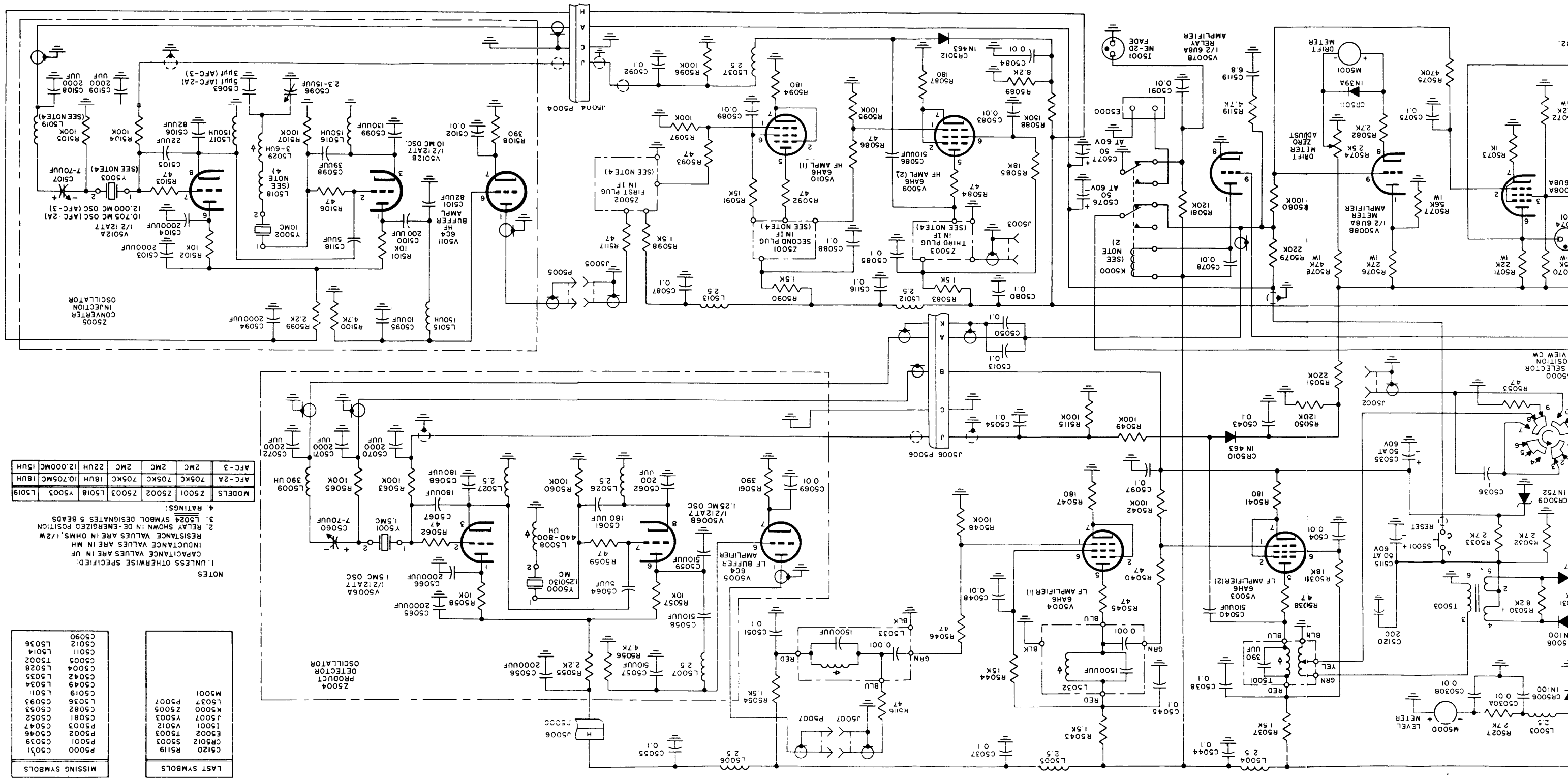
SYM.	DESCRIPTION	FUNCTION	TMC DWG OR PART NO.
Y5003 (AFC-2A)	CRYSTAL UNIT, QUARTZ: 10.705 mc, ±.002%; +70° to +80°C operating temperature range; parallel resonance; 32 uuf, ±0.5 uuf load capacitance; fundamental operation; type HC-6/U holder. (Supplied with A5000)	Oscillator	CR-109-4
Y5003 (AFC-3)	CRYSTAL UNIT, QUARTZ: 12.000 mc, ±.002% parallel resonance; +70° to +80°C operating temperature range; 32uuf, ±0.5 uuf load capacitance. (Supplied with A5000)	Oscillator	CR-109-5
Z5000	FILTER, CARRIER: operating frequency 250.000 kc; 50 ohm input, 8.2 k ohm output.	Filter Carrier	FX-176
Z5001 (AFC-2A)	FILTER, BAND PASS: operating frequency 705 kc; impedance 70000 ohms; bandwidth 10 kc.	Filter Band Pass	NF-108-705
Z5001 (AFC-3)	FILTER, BAND PASS: operating frequency 2000 kc; impedance 7000 ohms; bandwidth 34 kc.	Filter Band Pass	NF-108-2000
Z5002 (AFC-2A)	FILTER, BAND PASS: operating frequency 705 kc; impedance 7500 ohms; bandwidth 12 kc.	Filter Band Pass	NF-107-705
Z5002 (AFC-3)	FILTER, BAND PASS: operating frequency 2000 kc; impedance 7500 ohms; bandwidth 27 kc.	Filter Band Pass	NF-107-2000
Z5003 (AFC-2A)	FILTER, BAND PASS: operating frequency 705 kc; bandwidth 25 kc; input impedance 20,000 ohms; output impedance 50 ohms.	Filter Band Pass	NF-110-705
Z5003 (AFC-3)	FILTER, BAND PASS: operating frequency 2000 kc; bandwidth 60 kc; input impedance 20,000 ohms; output impedance 50 ohms.	Filter Band Pass	NF-110-2000
Z5004	OSCILLATOR, RF: operating frequency 250 kc; crystal controlled; consists of two terminal boards, symbol numbers A5001, E5001; other components, symbol numbers C5056, 5059, 5064, 5065, 5066, 5069, L5008, R5055, 5057, 5058, 5061, V5005, 5006A,B, P5006, 5007; two tube shields and various insulation, metal plates, and hardware.	Product Detector Oscillator	AO-109
Z5005 (AFC-2A)	OSCILLATOR, RF: operating frequency 705kc; crystal controlled; consists of oven assembly including two terminal boards A5000, E5002; other components, symbol number C5063, 5094, 5096, 5100, 5102, 5103, 5104, 5118, L5029, R5099, 5101, 5102, 5108; V5011, V5012, P5004, P5005; two tube shields and various insulation, metal plates and hardware.	Converter Injection Oscillator	AO-112

SYM.	DESCRIPTION	FUNCTION	TMC DWG OR PART NO.
Z5005 (AFC-3)	OSCILLATOR, RF: operating frequency 2 mc; crystal controlled; consists of oven assembly including two terminal boards A5000, E5002; other components, symbol number C5063, 5094, 5096, 5100, 5102, 5103, 5104, 5118, L5029, R5099, 5101, 5102, 5108; V5011, V5012, P5004, P5005; two tube shields and various insulation, metal plates and hardware.	Converter Injection Oscillator	AO-110

SECTION 8

SCHEMATIC DIAGRAMS

Figure 8-1. Automatic Frequency Control AFC-2A and AFC-3, Schematic Diagram



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(A) REMOVE JUMPERS MARKED XXX FROM TERMINALS 1,5,2 & 6 OF E5001 & E5002.
(B) ADD JUMPER MARKED - - - BETWEEN TERMINALS 1 & 6 OF E5001 & E5002.

FOR 230 VAC OPERATION

REF:
CK-587 REV G
CK-594 REV F

J5006 P5006

P5004

J5004

L5023 120UH
L5022 120UH
C5026 0.01
C5027 0.01
C5024 0.01
C5025 0.01

C5110 0.1
R5109 33
R5110
R5111
S5002 70°C
NC
E5002
CONVERTER INJECTION OSC COVEN Z5005

R5114 33
R5112
R5113
S5003 70°C
NC
E5001
PRODUCT DETECTOR OSC COVEN Z5004

V5011
V5012
V5006
V5005

P5004 J5004
J5006 P5006

V5010 V5009 V5008 V5007 V5004 V5003 V5000 V5001 V5002

C5028 0.1

L5024
L5025
(SEE NOTE 3)

L5020 120UH
C5021 0.01
C5020 0.01

J5001

B	115/230V
A	
L	GND
F	6.3 VOLTS AC
E	
K	+200V REG.
J	AGC OUT
H	-105V REG.

C5073 0.1

R5066 470K
R5067 470K
ALARM ZERO ADJUST R5064 100K

V5007A 1/2 6U8A
V5008A 1/2 6U8A
DRIFT ALARM AMPLIFIER

R5069 1K
R5073 1K
R5072 22K 1W
R5068 22K 1W
R5070 15K 1W
R5071 22K 1W
R5077 56K 1W
R5076 47K 1W
C5074 0.01
15000 NE-20 ALARM

R5053 47
S5000 CARRIER SELECTOR RCC POSITION REAR VIEW CW

R5052 47
C5079 0.1
R5035 4.7MEG
R5034 100K
R5029 100K
C5032 .01UUF
CR5005 IN 100
R5018 10K
R5028 12K
C5113 0.01

CR5009 IN 752
R5032 2.7K
R5033 2.7K
C5036 .1
C5112 0.01
CR5001 IN 463
C5114 0.01
R5020 100K THRESHOLD
R5036 100K
R5021 180
C5017 0.1

CR5007 IN 100
CR5008 IN 100
R5031 5K
R5030 8.2K
T5003
C5030A 0.01
CR5006 IN 100
C5030B 0.01
M5000
R5027 2.7K
L5003 2.5
C5029 0.001
C5034 0.1
L5002 2.5

V5002 6AH6 CARRIER AMPLIFIER (3)

T5000
A1
A2
B1
B2
C5015 0.1
L5010 2.5
R5019 15K
C5016 0.01
R5018 47
R5017 1.5K
C5014 0.1
L5001 2.5

CR5004 IN 463
CR5003 IN 463
CR5002 IN 463
C5117 0.01
C5033 0.01
R5022 470K
R5023 220K
C5018 0.1
C5007 0.1
R5026 100K
C5006 1.0
R5024 100K 2W SENSITIVITY
CR5000 IN 463
R5025 330K
C5023 0.01
C5022 0.01
L5021 120UH

V5000 6DC6 CARRIER AMPLIFIER (1)
V5001 6DC6 CARRIER AMPLIFIER (2)

R5016 100K
R5014 180
R5010 100K
R5007 180
R5008 100K
C5000 0.1
R5002 8.2K
R5003 47
Z5000 IN GND OUT AVC
R5001 47
R5000 270
J5000
25OKC IF CARRIER

R5015 47
R5012 47
R5009 47
R5005 47
BLK BLU GRN RED
150UUF
0.001
L5031
L5030
C5010 0.01
C5009 0.1
C5008 0.1
R5013 18K
R5006 18K
R5011 1.5K
R5004 1.5K
L5000 2.5
C5003 0.1
C5001 0.01