UNCLASSIFIED

TECHNICAL MANUAL

for

RECEIVER CONVERTER MODEL TTRR

THE TECHNICAL MATERIEL CORPORATION

MAMARONECK, N.Y. OTTAWA, CANADA

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IN-3010A *Issue Date:* 1 MAY 1965

NOTICE

FOREWORD

The Receiver Converter modules, Models TTRR-1, TTRR-2, TTRR-3, and TTRR-4, are physically and functionally similar. Since the operating principles for each module are the same (varying mainly in frequency range), only Model TTRR-1 is explained in this manual. The differences between the modules are appropriately noted in the text and tables.

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

IN-3010A
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RECORD OF CORRECTIONS MADE

Change No.	Date of Change	Date Entered	Entered By
1	3/15/66	Incorporated in manual	5/66

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SECTION 1

GENERAL INFORMATION

1-1. FUNCTIONAL DESCRIPTION.

Receiver Converter, Model TTRR (figure 1-1), is a transistorized, fixed-tuned, plug-in r-f module that is used with several types of single-sideband receivers. Four modules (Model TTRR-1, TTRR-2, TTRR-3, and TTRR-4) cover the frequency range from 2- to 32-megacycles. Limitations on the mode of operation are dependent upon the receiver in which the TTRR is used. The modules may be used for the reception of practically any type of signal, the only limitation being an r-f bandpass of approximately 0.5% of frequency to which the r-f amplifiers are tuned.

The TTRR contains three high-gain r-f amplifiers, a mixer, and a crystal-controlled local oscillator. The gain of the r-f amplifiers is controlled by an AGC (automatic gain control) voltage supplied by the associated receiver. The local oscillator has two operating frequencies selected by a front-panel switch that permit reception of either of two signal frequencies (F1 or F2) within the r-f bandpass of the TTRR, without necessitating realignment. A RECEIVER CLARIFIER control (located on front panel) provides fine-tuning of the oscillator. Frequency stability for the local oscillator is 1 part in 10^5 per day; crystal ovens are available on special order to provide even greater stability (refer to paragraph 1-4). The nominal r-f output of the TTRR is 1.75 mc.

1-2. PHYSICAL DESCRIPTION.

a. EXTERNAL. - The front panel of the TTRR is provided with a knob to facilitate handling the unit when inserting or removing it from the associated receiver. The F1/F2 frequency selector switch (screwdriver type switch) and the RECEIVER CLARIFIER control are located on the front panel; a plate above the F1/F2 switch identifies the input carrier frequencies associated with the two crystals in the TTRR. The plug-in interchangeability feature of TTRR is provided by an etched connector at the rear of the module; two slide latches on the front panel hold the TTRR in place after it has been plugged into the associated receiver. Side covers provide electrostatic shielding and protect TTRR components when the module is removed from the receiver. Each TTRR module weighs 1 1/2 pounds, and is 1 1/2 inches wide, 5 3/8 inches high, and 8 inches long.

b. INTERNAL. - Most of the smaller components in the TTRR are located on a printed circuit board mounted to the chassis; the remaining components are chassis-mounted. Table 1-1 lists the semiconductor complement of TTRR. (Also refer to the schematic diagrams, figures 7-1 through 7-4.) Each r-f section of the TTRR is shielded by removable metal dividers in order to minimize interaction between stages.

1-3. EQUIPMENT SUPPLIED.

Table 1-2 lists items optionally supplied with the TTRR.

TABLE 1-1. SEMICONDUCTOR COMPLEMENT

REFERENCE DESIGNATION	TYPE	FUNCTION
Q101	2N2495 *	1st r-f amplifier
Q102	2N2084	2nd r-f amplifier
Q103	2N2084	3rd r-f amplifier
Q104	2N2084	Mixer

* In TTRR-4: Q401, Q402, and Q403 are Type 2N22495

TABLE 1-1. SEMICONDUCTOR COMPLEMENT (CONT)

REFERENCE DESIGNATION	TYPE	FUNCTION
Q105 **	2N2084	Buffer Amplifier
Q106	2N2084	Local Oscillator
** In TTRR-4: Q405 Functions as a Frequency Doubler		

TABLE 1-2. EQUIPMENT SUPPLIED
(These items supplied in accordance with individual order.)

NOMENCLATURE		DESIGNATION	
Formal	Common	TMC/PN	SYMBOL
Crystal Oven, TCO-1	12 VDC Crystal oven	OC100-1	
Crystal Oven, TCO-2	24 VDC Crystal oven	OC100-2	Z101 Z201 Z301 Z401
Crystal Oven, TCO-3	115 VAC Crystal oven	OC100-3	
Crystal Oven, TCO-4	32 VDC Crystal oven	OC100-4	
	F1 Crystal	CR110-1-FREQ.* (For use without oven)	Y101 Y201
	F1 Crystal	CR110-3-FREQ.* (For use with oven)	Y301 Y401
	F2 Crystal	Same as F1 Crystal	Y102 Y202 Y302 Y402
NOTE: * Crystal frequency determined in accordance with information provided in Section 5.			

1-4. TECHNICAL SPECIFICATIONS.

Technical specifications for the TTRR are as follows:

Frequency range:

TTRR-1	2- to 4-mc
TTRR-2	4- to 8-mc
TTRR-3	8- to 16-mc
TTRR-4	16- to 32-mc

Tuning: Fixed-tuned.

Frequency control: Crystal-controlled oscillator, with selector switch and provision for two crystals.

Frequency stability: 1 part in 10^5 per day (without oven).
1 part in 10^6 per day (with optional crystal oven).

1-4. TECHNICAL SPECIFICATIONS (CONT).

R-F bandpass:	Approximately 0.5% of frequency to which module is tuned.
Noise figure:	15 db, or better.
Input impedance:	50 ohms (nominal), unbalanced.
Output:	1.75 mc i-f.
Power requirement:	Provided by associated receiver.

SECTION 2

INSTALLATION

2-1. INITIAL INSPECTION.

Each TTRR is tested at the factory and is carefully packaged to prevent damage during shipment. Upon receipt of the equipment, inspect the packaging case and its content for damage that might have occurred during transit. Unpack the equipment carefully, and inspect all packaging material for parts that may have been shipped as loose items. With respect to damage of the equipment for which the carrier is liable, The Technical Materiel Corporation will assist in describing methods of repair and the furnishing of replacement parts.

2-2. INSTALLATION PROCEDURE.

Since the TTRR is a plug-in module and can be installed in the associated receiver by inserting it into its respective position, no specific installation procedures are given in this manual. Initial installation and test procedures for the TTRR are, therefore, given in the associated receiver manual.

NOTE

Each TTRR module (refer to figure 1-1) is provided with a front panel knob to facilitate handling the unit when inserting or removing it from the receiver.

SECTION 3

OPERATOR'S SECTION

3-1. GENERAL.

Before attempting to operate the TTRR, the operator should familiarize himself with the controls listed in table 3-1. Refer to figure 1-1 for control locations.

NOTE

The descriptions given in table 3-1 are not operating instructions. Refer to the associated receiver manual for specific operating instructions.

TABLE 3-1. OPERATOR'S CONTROLS

ITEM	FUNCTION
F1/F2 switch	A two-position, screw driver-controlled switch that selects appropriate oscillator frequency for

TABLE 3-1. OPERATOR'S CONTROLS (CONT)

ITEM	FUNCTION
F1/F2 switch (cont)	reception on either F1 frequency or F2 frequency.
RECEIVER CLARIFIER	A trimmer capacitor for fine-tuning the local oscillator.

3-2. WARM-UP PERIOD.

When a crystal oven is used in the TTRR, a 30-minute warm-up period is required to attain proper frequency stability. When the TTRR is used without a crystal oven, no warm-up is required.

3-3. OPERATOR'S MAINTENANCE.

Operator's maintenance is not required on TTRR modules. Detailed maintenance, troubleshooting, repair, and alignment procedures are given in Section 5 of this manual.

SECTION 4

PRINCIPLES OF OPERATION

4-1. GENERAL.

With one exception (refer to the NOTE below), the operating principles for each TTRR module (TTRR-1, TTRR-2, TTRR-3, and TTRR-4) are similar, and therefore only TTRR-1 is explained in this section. Refer to the block diagrams, figures 4-1 through 4-4, and the schematic diagrams, figures 7-1 through 7-4.

NOTE

In TTRR-4 a frequency doubler multiplies the local oscillator output; the difference in operation is noted in the text.

4-2. CIRCUIT ANALYSIS.

NOTE

The following discussion, written for TTRR-1, will apply equally as well to TTRR-2 through TTRR-4 (refer to figure 4-1 through figure 4-4).

Refer to figure 7-1. The r-f signal applied to the TTRR is amplified by three common-emitter, tuned-collector, class A amplifiers (Q101, Q102, and Q103). Each of these amplifiers is fixed-tuned and will select only one particular signal.

The gain of each r-f amplifier is controlled by an externally generated AGC (automatic gain control) signal. The AGC input, a positive voltage, is supplied through the module connector to the emitters of the three amplifiers to forward bias the transistors. The AGC input to each of the three r-f amplifiers controls the individual stage gains so that the r-f input to mixer Q104 is constant regardless of signal strength.

When the r-f signal level is low, the AGC signal is at its minimum value and the transistors are biased to operate on the linear portion of their transfer curves. As the r-f signal level and the AGC signal level increases, the operating points of the amplifiers are shifted up the transfer curves into the non-linear region. As the transistors approach saturation, the gain decreases keeping the input to mixer Q104 relatively constant. If the AGC input is not connected to the TTRR, the gain of the r-f amplifiers is fixed by resistor R116 (refer to figures 7-2 through 7-4 for resistor designations for TTRR-2, TTRR-3, and TTRR-4).

The output of the third r-f amplifier is applied to mixer Q104; the mixer is also supplied with the output of local oscillator Q106 through buffer amplifier Q105, which ensures maximum stability of local oscillator.

In TTRR-1, TTRR-2, and TTRR-3 the oscillator operates 1.75 mc above the incoming r-f signal. In TTRR-4 the oscillator operates 1.75 mc above the incoming r-f signal. In TTRR-4 the oscillator operates between 8.875 and 16.875 mc; doubler Q405 multiplies the oscillator output to the range of 17.75 to 33.75 mc. Crystal Y101 or Y102 may be selected with the F1/F2 switch, permitting reception on one of two frequencies without removing and replacing crystal. RECEIVER CLARIFIER capacitor control is used to fine-tune the local oscillator.

The mixer produces the beat frequency of the r-f and local oscillator frequencies; the output circuit of mixer Q104 is tuned to 1.75 mc.

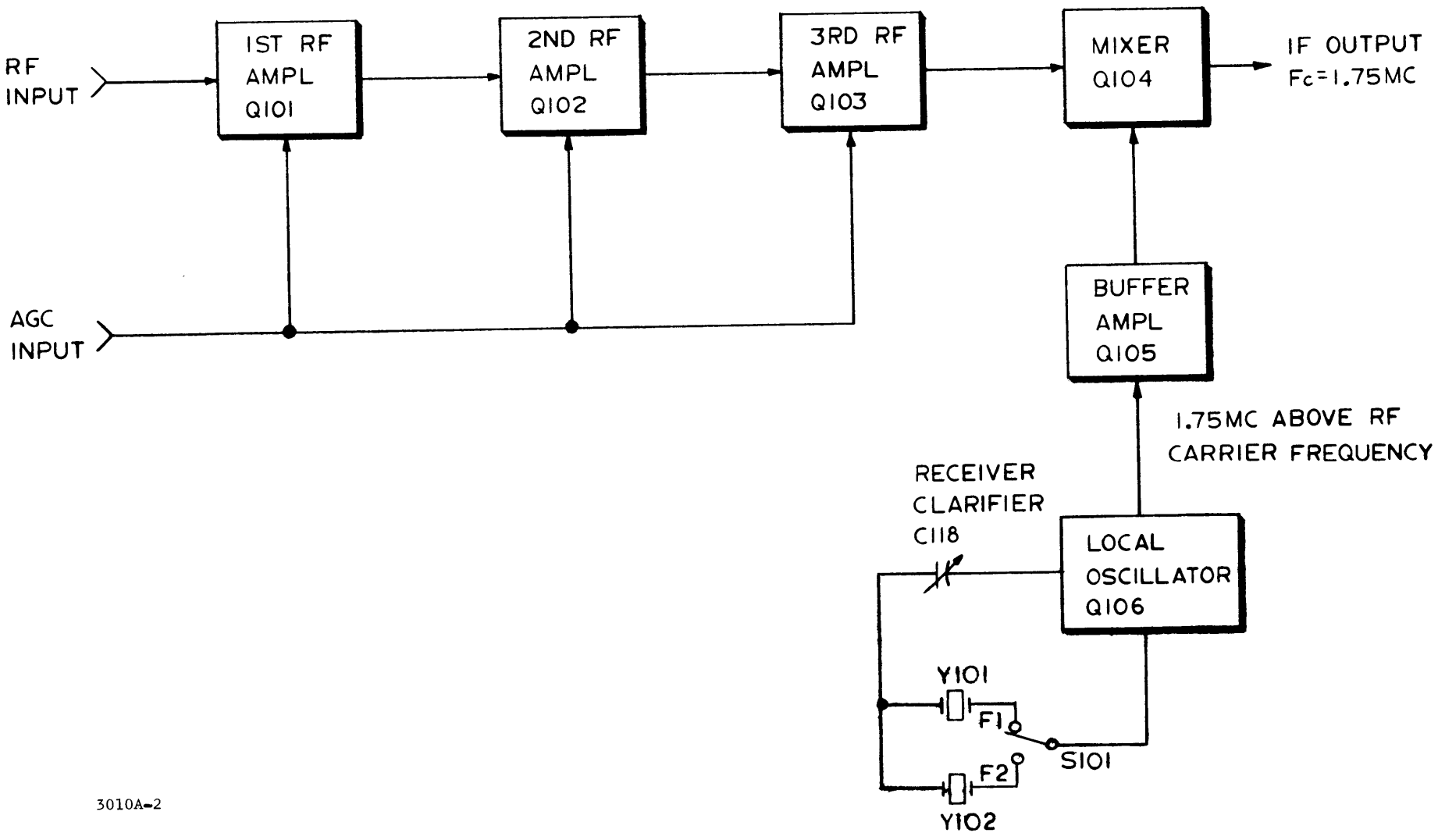

Figure 4-1. Simplified Block Diagram, TTRR-1

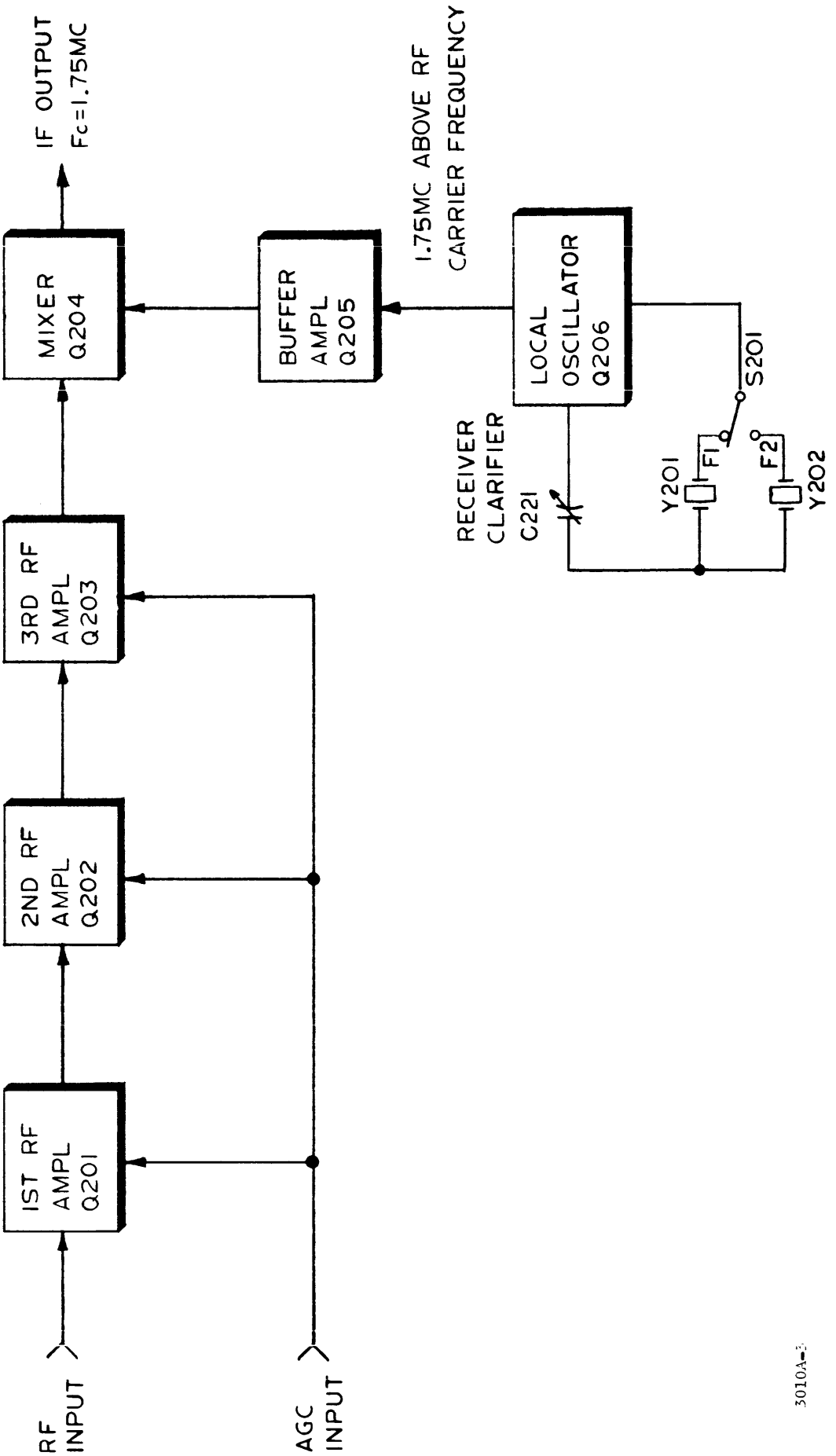

Figure 4-2. Simplified Block Diagram, TTRR-2

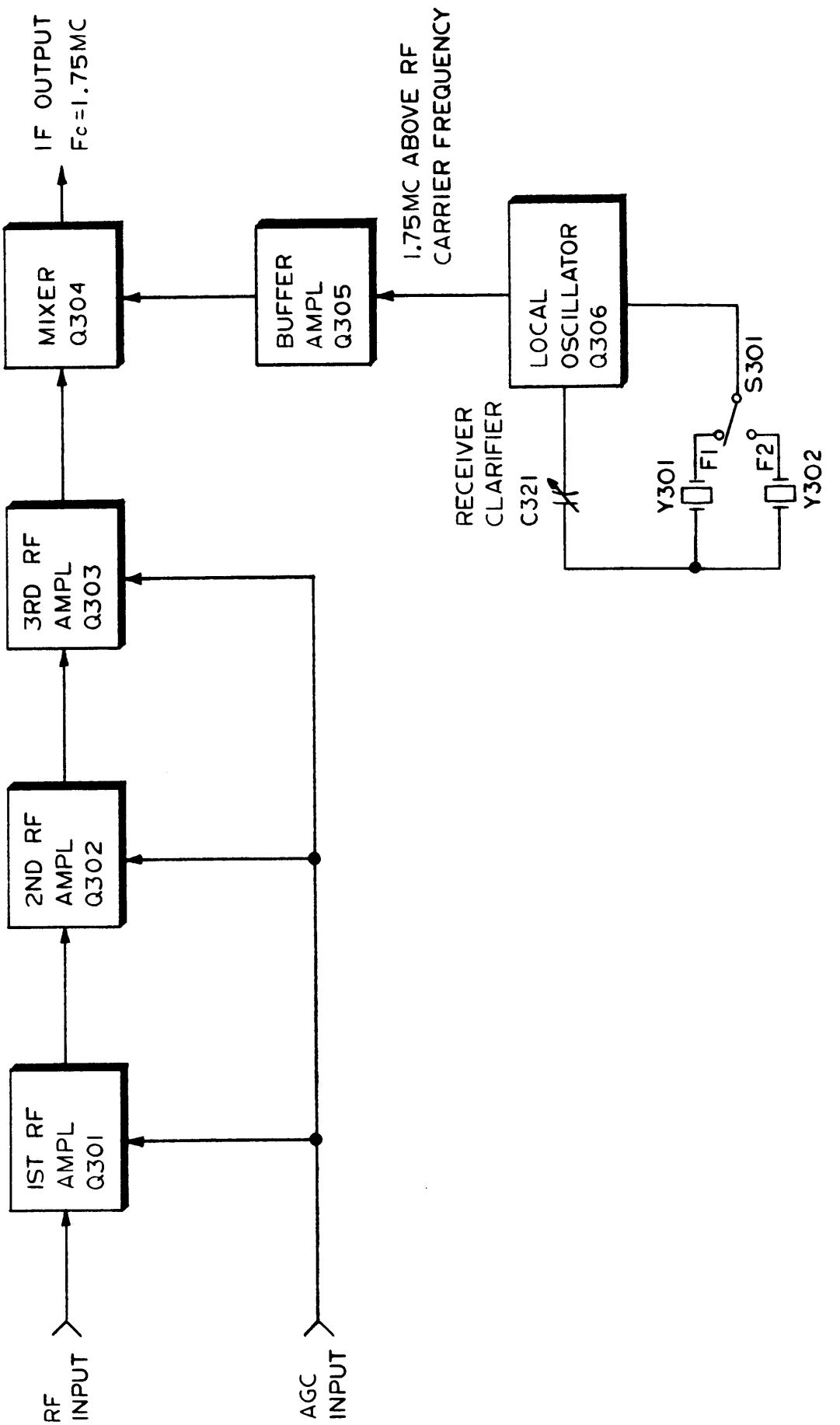

Figure 4-3. Simplified Block Diagram, TTRR-3

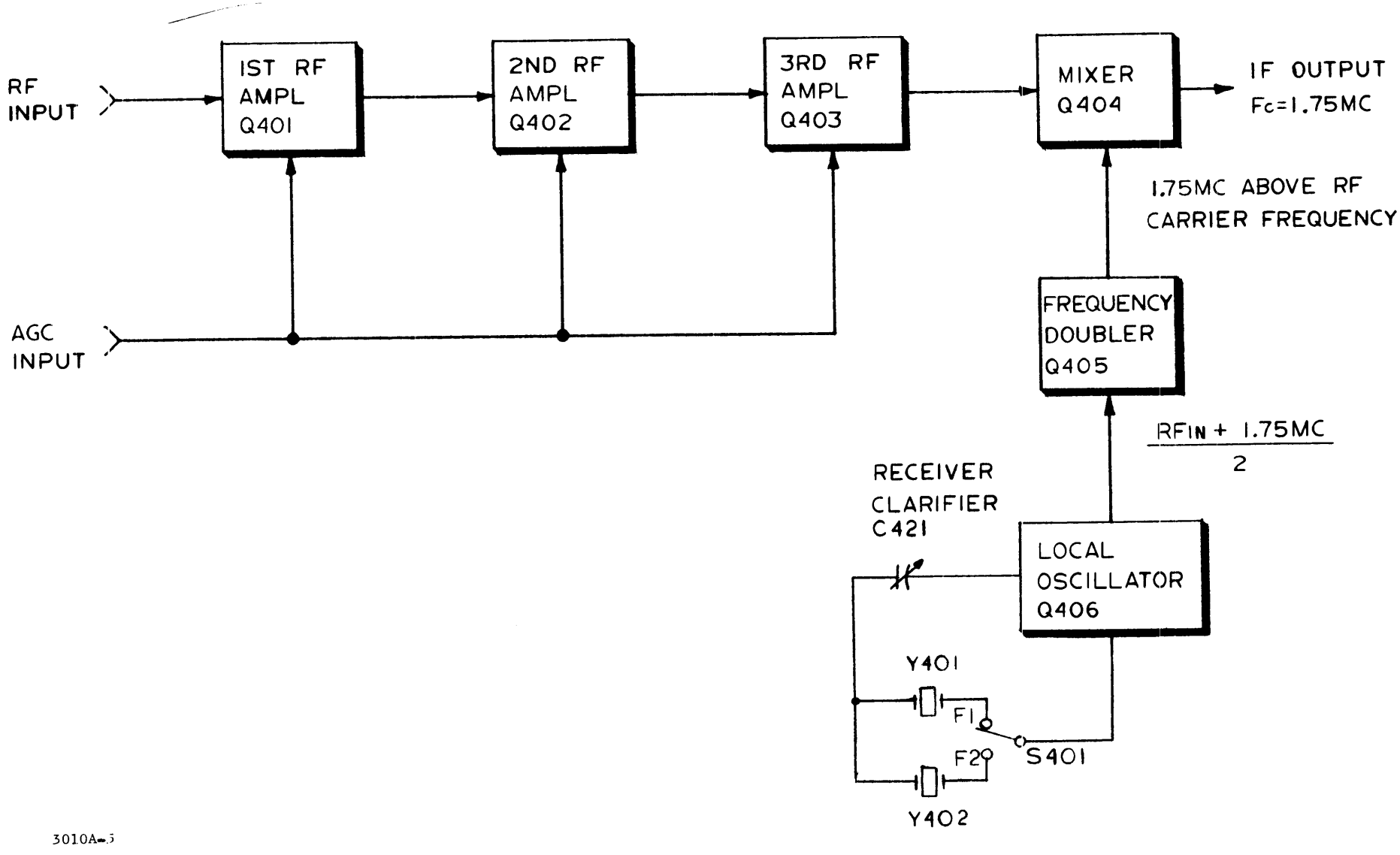

Figure 4-4. Simplified Block Diagram, TTRR-4

SECTION 5

MAINTENANCE

5-1. GENERAL.

With the exception of frequency doubling circuitry contained in the TTRR-4, all TTRR modules are physically and functionally similar. Therefore, only the TTRR-1 is described and illustrated in this section; differences between the TTRR-4 and other modules are appropriately noted in text.

NOTE

Reference symbols for TTRR components are assigned according to the particular module. For example, transistors in TTRR-1 are Q101 through Q106; transistors in TTRR-2 are Q201 through Q206. etc. (refer to figure 5-1 and the appropriate schematic diagram).

5-2. PREVENTIVE MAINTENANCE.

Periodically, remove the TTRR module from its associated receiver and inspect for general cleanliness and condition of etched connector at the rear of the unit. Remove side covers and check components for discoloration, damaged wiring, broken or loose solder connections, leaking capacitors, and warped printed circuit board. Clean the components with a soft brush, vacuum cleaner, or clean, dry, filtered, compressed air. Check all hardware for tightness.

5-3. TROUBLESHOOTING.

When a TTRR module is suspected of malfunction, the source of trouble may be located by the following procedures (required test equipment is listed in table 5-1):

TABLE 5-1. TEST EQUIPMENT

ITEM	FUNCTION
Frequency Counter (Hewlett Packard, Model 524C, or equiv.)	Used during troubleshooting and alignment procedures.
R-F Signal Generator (Hewlett Packard, Model 606A, or equiv.)	Same.
Oscilloscope (Tektronix, Model 545, or equiv.)	Same.
Volt-ohm-milli-ammeter (Simpson, Model 260, or equiv.)	Same.

a. Remove right-side cover of TTRR, and check +12 vdc and -12 vdc inputs at pins 1 and 8, respectively, of connector at rear of the module. (If necessary, use module extender supplied with the receiver.) If +12 vdc or -12 vdc are not present, check power supply circuitry in associated receiver.

b. Using an oscilloscope, measure signal level at TP2; level should be approximately 0.3 volts peak-to-peak.

c. Using a frequency counter, check frequency of signal at TP2; signal should be approximately 1.75 mc above operating frequency of TTRR (F1 or F2, dependent upon setting of F1/F2 switch.) If this signal is not obtained, check circuitry of local oscillator and buffer/doubler.

d. Remove local oscillator crystal Y101 and Y102 (refer to the schematic diagrams). Connect r-f signal generator to ANTENNA jack of receiver; adjust generator to deliver TTRR operating frequency (F1 or F2) at 100μv.

e. Measure signal level at TP1; level should be between 100 and 200 mv peak-to-peak. If this signal is not obtained, check circuitry of the three r-f amplifiers.

f. Replace local oscillator crystal removed in step d. Measure signal level at TP3; signal level should be approximately 500 mv peak-to-peak. If this signal is not obtained, check circuitry of the mixer stage.

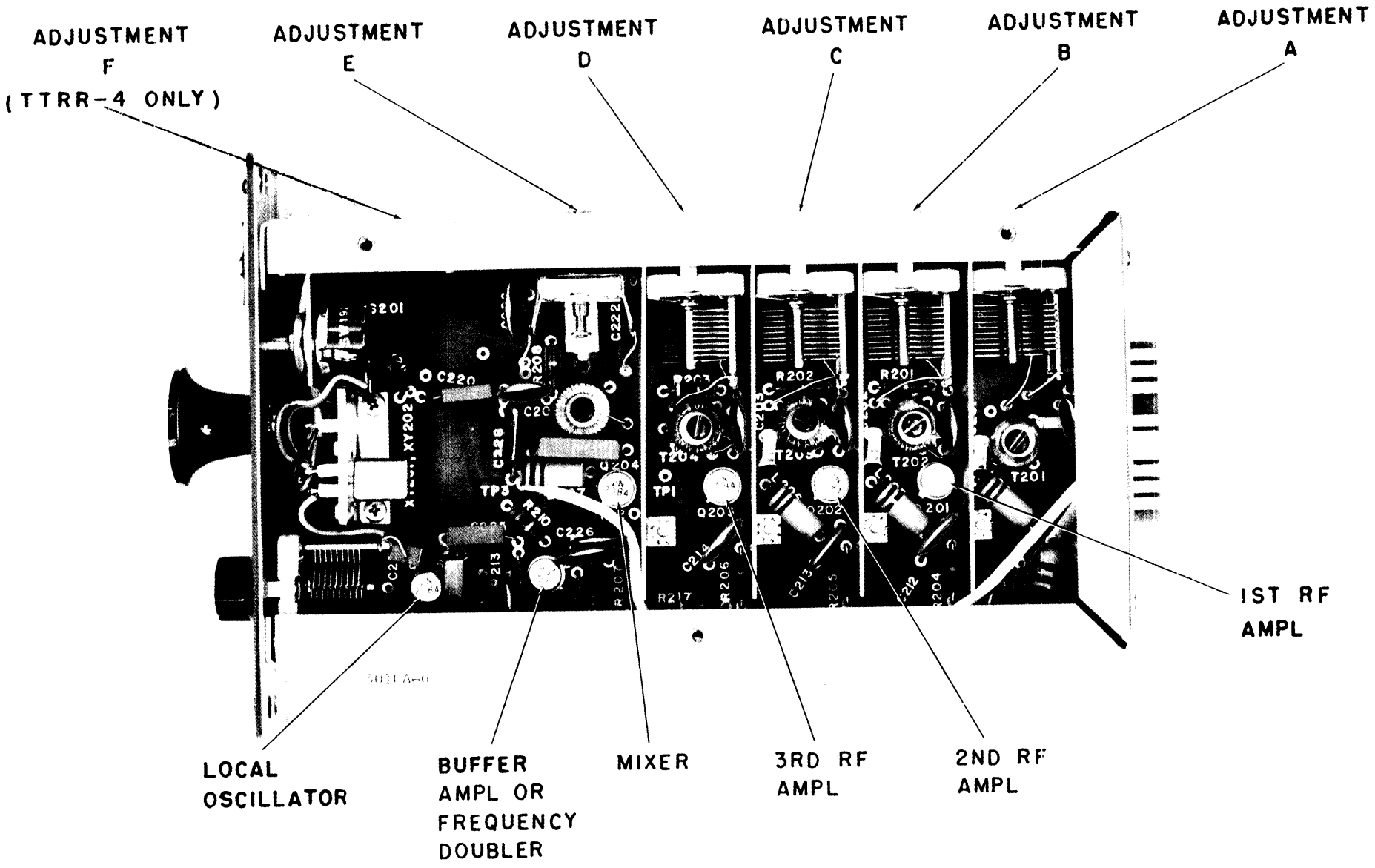

Figure 5-1. Right-Side Cover Removed, Module TTRR

5-4. REPAIR.

Repair of TTRR modules consists of component replacement and resoldering wire connections. The following precautions should be observed:

a. Use replacement components identical to defective component (same part number), and position the replacement component in exact place on the board.

NOTE

After a component has been repaired or replaced, the TTRR may require alignment (refer to paragraph 5-5.

b. Use long-nosed pliers or alligator clips when soldering wire leads in order to transfer heat from the junction and thus prevent damage to the component.

NOTE

Use 50-watt soldering iron for soldering all wire leads and connections. Use suitable flux remover to clean soldered joints.

CAUTION

Excess heat near the board surface may damage the printed-circuit wiring.

5-5. ALIGNMENT.

After repairing or replacing components in the TTRR, the unit must be checked for alignment. Also, when the operating frequency (F1, F2) of the module is to be changed, the alignment procedure given is to be followed. (Refer to paragraph 5-6 to determine local oscillator crystal frequency).

To align the r-f and i-f amplifier stages, proceed as follows:

a. Disconnect antenna from receiver, and connect r-f signal generator to antenna input. (If necessary, use module extender supplied with receiver).

b. Remove left-side cover of TTRR and local oscillator crystals (or crystal oven, if used).

NOTE

If only "peaking up" of amplifier is required, omit steps c through h.

c. Adjust generator to deliver desired operating frequency (mean frequency of F1, F2). Connect oscilloscope to stator of adjustment A capacitor (refer to table 5-2).

d. Adjust screw A on TTRR for maximum amplitude on oscilloscope.

e. Connect oscilloscope to stator of adjustment B capacitor (refer to table 5-2). Adjust screw A for maximum amplitude on oscilloscope, then adjust screw B for maximum amplitude.

f. Connect oscilloscope to stator of adjustment C capacitor (refer to table 5-2). Adjust screw A for maximum amplitude on oscilloscope; readjust screw B for maximum amplitude, then adjust screw C for maximum amplitude on oscilloscope.

g. Connect oscilloscope to stator of adjustment D capacitor (refer to table 5-2). Readjust screws A, B, and C (in that order) for maximum amplitude on oscilloscope. Adjust screw D for maximum amplitude on oscilloscope.

h. Connect oscilloscope to TP1 (mixer input), and set generator output at 1 microvolt.

i. Readjust screws A through D (in that order) for maximum amplitude on oscilloscope.

j. Insert local oscillator crystal (or crystal oven), and allow 30 minutes for crystal to warm up.

NOTE

For TTRR-4 alignment only: Connect oscilloscope to TP2; adjust screw F for maximum amplitude on scope. Check frequency with counter; frequency of signal TP2 should be approximately 1.75 mc above module operating frequency.

k. Connect oscilloscope to TP3, then adjust screw E for maximum amplitude on oscilloscope.

l. Replace right-side cover of TTRR.

m. Connect oscilloscope to i-f output (terminal 3 on receiver receptacle) and readjust screws A through E (in that order) for maximum amplitude on oscilloscope.

n. Disconnect test equipment, and install TTRR in receiver.

TABLE 5-2. TUNING CAPACITOR DESIGNATIONS

ADJUSTMENT	TTRR-1	TTRR-2	TTRR-3	TTRR-4
A	C114	C216	C316	C416
B	C115	C217	C317	C417
C	C116	C218	C318	C418
D	C117	C219	C319	C419

5-6. DETERMINATION OF LOCAL OSCILLATOR CRYSTAL FREQUENCY.

Each TTRR module may be equipped with two local oscillator crystals. Care should be taken that the desired reception frequencies fall within the r-f bandpass of the amplifier stages.

EXAMPLE: If a TTRR-2 module has been aligned at 4020 kc, appropriate crystals may be inserted for reception of any two signals between 4010 and 4030 kc.

NOTE

The desired sidebands of the signals to be received must also fall within the 0.5% r-f bandpass limits.

a. TTRR-1, TTRR-2, AND TTRR-3 CRYSTAL FREQUENCIES. - In Receiver Converter, Models TTRR-1, TTRR-2, and TTRR-3, the local oscillator operates approximately 1750 kilocycles above the signal to be received.

fx = fo + 1750 kc where:
fx = local oscillator crystal frequency in kilocycles.
fo = frequency of signal to be received in kilocycles.

b. TTRR-4 CRYSTAL FREQUENCIES. - Receiver Converter, Model TTRR-4, has a frequency doubler stage between its local oscillator and mixer; therefore, the formula is modified.

$$fx = \frac{fo + 1750 \text{ kc}}{2}$$

c. CRYSTAL FREQUENCIES FOR CW, FSK, AND FAX. - The receivers in which the TTRR modules are used may not be capable of detecting an i-f signal whose frequency is exactly 1750 kc. For CW, FSK, or FAX reception, the TTRR local oscillator frequency must be displaced slightly. For CW reception, the formula becomes:

fx = fo + 1750.5 kc
or
fx = fo + 1749.5 kc.

For FSK reception, the formula must be modified so as to place the audio output of the receiver in the designed center-frequency of the audio frequency shift converter.

EXAMPLE: If the audio frequency shift converter is designed to accept signals centered at 2550 cps, the formula becomes:

fx = fo + 1752.22 kc
or
fx = fo + 1747.45 kc.

For FAX reception, the formula becomes:

fx = fo + 1751.9 kc
or
fx = fo + 1748.1 kc.