UNCLASSIFIED

TECHNICAL MANUAL

for

PRECISION FREQUENCY COMPARATOR MODEL PFCB

(CM-326/UR)

THE TECHNICAL MATERIEL CORPORATION

MAMARONECK, N.Y. OTTAWA, CANADA

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NOTICE

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

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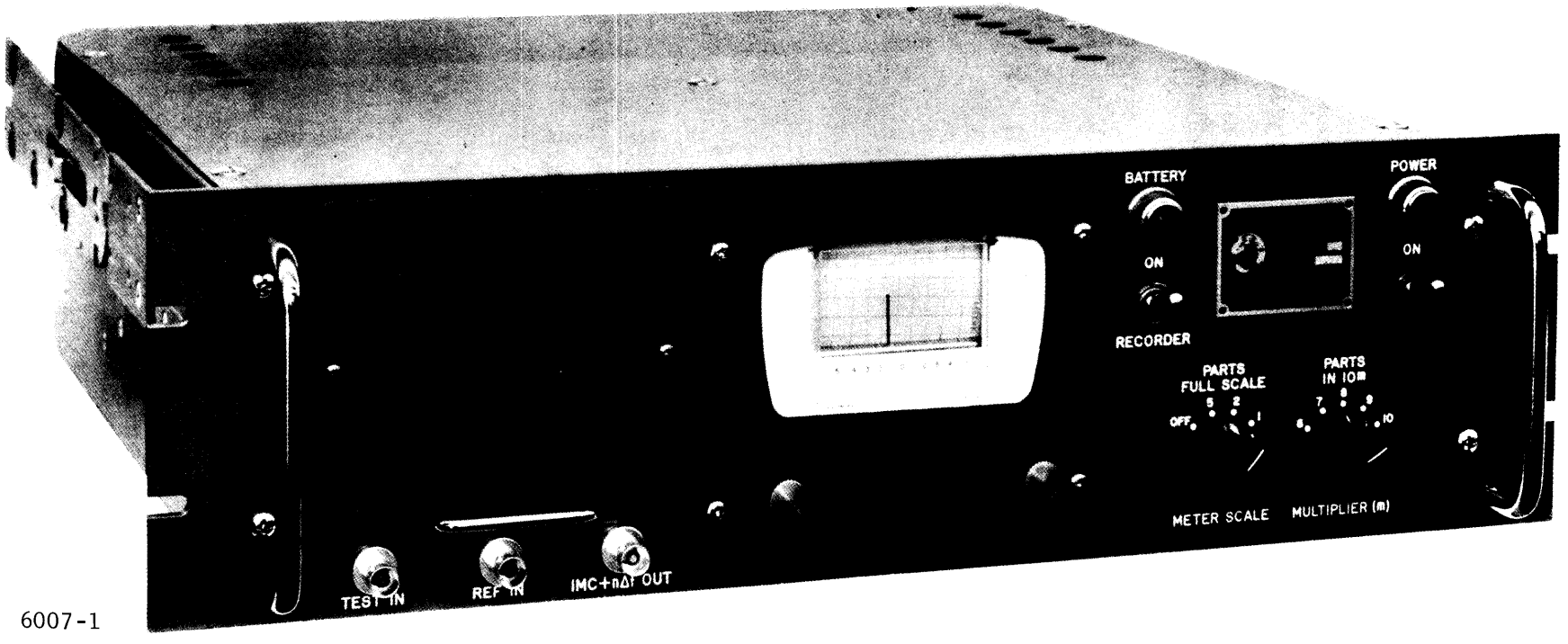

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Figure 1-1. Precision Frequency Comparator, Model PFCB-1

SECTION 1
GENERAL INFORMATION

1-1. PURPOSE OF EQUIPMENT.

Precision Frequency Comparator, Model PFCB-1 (figure 1-1), is a highly-precise frequency comparator that is capable of comparing the frequency error (in parts as minute as 1 part in 10^{11}) between a frequency standard under test and that of a frequency standard of known accuracy. A front panel chart recorder provides a permanent and continuous record and visual display of the frequency error.

The PFCB can be equipped with accessory units such as a doppler corrector, an oscilloscope, or a frequency standard. These units are self-contained and are mounted in a front-panel accessory compartment of the PFCB. When incorporated into the PFCB, the doppler corrector will correct for possible doppler effects in the signal being received by a moving receiver site (such as a ship moving to or from the transmitting origin). The oscilloscope and frequency standard accessory units are used respectively to: (1) monitor the phase angle of the frequency difference between the outputs of two externally connected frequency standards, (2) to provide a reference-signal source that is accurate to 1 part in 10^9. For additional information pertaining to any of the accessory units, refer to the applicable technical manual.

The PFCB can be used in conjunction with frequency standards manufactured by TMC or any other suitable frequency source that operates at 100 kc, 200 kc, 500 kc, or 1 mc with signal voltages between 0.1 and 3 volts peak-to-peak.

1-2. DESCRIPTION OF EQUIPMENT.

The PFCB is a compact, transistorized unit of modular construction. It can be mounted either in a cabinet or a 19-inch rack. Tilt-slide mechanisms mounted on the sides of the main chassis, facilitate in-service troubleshooting and maintenance procedures.

The PFCB consists of a main chassis that houses four X10 Multiplier modules, two Input-Output modules, one X9 Multiplier module, one Mixer-amplifier module, one Output module, one Power Supply module and a chart recorder. Also included is a front-panel blank that supports a printed-circuit board containing a multiple-conductor connector. The connector serves as a signal interconnect jumper that permits operation of the PFCB when an accessory unit is not employed.

The modules are plug-in printed circuit boards. All wiring in a module terminates in a multiple-conductor connector. Each connector mates with a compatible jack on the main chassis interconnecting board when the module is properly positioned. A module card extender mounted internally alongside the chart recorder is used to connect the modules to the main chassis so that components of the modules can be exposed for inspection during operation and maintenance.

All operating controls and indicators are located on the front panel. Three non-indicating type fuses are located on the rear panel. The TEST IN, REF IN, and 1 MC + $n\Delta f$ jacks located on the front panel are parallel connected with identical jacks located on the rear panel. MAIN AC, BATTERY, and REF OUT 1 MC jacks are located on the rear panel only. Power for the transistor circuits mounted on the main chassis and printed-circuit boards is normally controlled by operating POWER switch S101. In the event of an a-c power failure, the PFCB contains facilities for automatically switching to battery power.

The PFCB measures 5-1/4-inches high, 15-5/8-inches deep (excluding front panel controls), on a 19-inch wide front panel, and weighs approximately 17 lbs. Top and bottom dust covers are also supplied.

1-3. ELECTRICAL CHARACTERISTICS.

Test and Reference Inputs:	
Frequency	100 kc, 200 kc, 500 kc or 1 mc.
Signal level	0.1- to 3-volts peak-to-peak.
Input impedance	50 ohms (nominal).
Multiplication:	Difference between test and reference frequencies multiplied 1, 10, 100, 1000 and 10,000 times in five selected switch positions.

1-3. ELECTRICAL CHARACTERISTICS (CONT).

Minimum Measurable Error:	1 part in 10^{11}.
Source Stability:	
Short term	One order of magnitude greater than meter scale selected.
Long term	Dependent upon selected switch position of METER SCALE switch S103.
Outputs:	
Chart recorder	±1, 2, or 5-parts in 10^6 ±1, 2, or 5-parts in 10^7 ±1, 2, or 5-parts in 10^8 ±1, 2, or 5-parts in 10^9 ±1, 2, or 5-parts in 10^{10}
Frequency	1 mc $\pm n\Delta f$ where n = multiplication selected.
Chart Recorder:	
Microampere rating	0 to 10 (dc)
Accuracy	±2 percent of full scale
Recording time	31 days/recorder roll chart
Chart speed	1 inch/hour
Clamping rate	Once every 5 seconds
Drive motor power	115-volts ac, 50/60 cps, single phase, 3 watts.
Environmental:	
Temperature	Between 0- to 50-degrees C.
Humidity	Between 0- and 90-percent relative humidity.
A-C Power requirements:	115/230-volts ac, 50/60 cps, single phase.
D-C Power requirements: (For emergency use only.)	Except for recorder motor, unit capable of operating with externally connected 24-volt battery. Power consumption on battery operation is 6 watts (250 milliamperes).

1-4. TRANSISTOR AND DIODE COMPLEMENT.

Table 1-1 lists the transistors and diodes for the PFCB.

TABLE 1-1. TRANSISTOR AND DIODE COMPLEMENT

REFERENCE SYMBOL	TYPE	FUNCTION
MAIN CHASSIS (1)		
Q101	2N2143	-12-volt series regulator
Q102	2N2143	-6-volt regulator
CR106	VR101-24-S51	24-volt Zener diode
CR107	1N2976B	12-volt Zener diode
CR108	1N1819	18-volt Zener diode

TABLE 1-1. TRANSISTOR AND DIODE COMPLEMENT (CONT)

REFERENCE SYMBOL	TYPE	FUNCTION
POWER SUPPLY MODULE (1)		
CR101 thru CR104	2N2484	B+ bridge rectifier diodes
CR105	2N2484	In battery operation, disconnects battery supply line from relay K101.
IN-OUT MODULES (2)		
Q201	2N396A	Amplifier-multiplier
Q202	2N396A	1-mc amplifier
Q203	2N2084	1-mc amplifier
X10 MULTIPLIER MODULES (4)		
Q301	2N396A	Buffer amplifier
Q302	2N2084	X5 multiplier
Q303	2N2084	X2 multiplier
Q304	2N2084	9-mc buffer amplifier
Q305	2N396A	Mixer-amplifier
Q306	2N396A	1-mc amplifier
X9 MULTIPLIER MODULE (1)		
Q401	2N396A	Buffer amplifier
Q402	2N2084	X3 multiplier
Q403	2N2084	X3 multiplier
Q404	2N2084	1-mc amplifier
MIXER-AMPLIFIER MODULE (1)		
Q501, Q502	2N396A	1-mc amplifiers
Q503, Q504	2N396A	Mixer-amplifiers
Q505, Q506	2N706	Buffer amplifiers
Q507	2N706	1-mc oscillator
OUTPUT MODULE (1)		
Q601, Q603	2N706	Schmitt trigger
Q602, Q604	2N706	Schmitt trigger
Q605, Q607	2N706	Multivibrator
Q606, Q608	2N706	Multivibrator
CR601, CR602	1N34A	Schmitt trigger diodes
CR603, CR604	1N463	Schmitt trigger diodes
CR605	1N3022B	Schmitt trigger diodes

SECTION 2
INSTALLATION

2-1. INITIAL INSPECTION.

Each PFCB has been calibrated and tested at the factory before shipment. When it arrives 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 that may have been shipped as loose items. Also, check that all modules are properly seated in their respective connectors.

With respect to damage to 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. POWER REQUIREMENTS.

Unless otherwise specified, the PFCB is wired at the factory for 115-volts ac, 50/60 cycle, single-phase operation. For 230-volts a-c operation, make the necessary wiring changes as shown in figure 2-1. Also, with 230-volt a-c operation, change the ampere rating of AC fuse F101 from 1- to 1/2-ampere.

2-3. INSTALLATION.

The PFCB may be installed in a standard 19-inch wide rack as follows: (See figure 2-2.)

NOTE

The PFCB is designed for rack installation. When the PFCB is shipped as part of a system, tilt-slide mechanisms are provided. The tilt-slides permit the chassis to be pulled out of the equipment rack to expose the top or bottom of the chassis for greater accessibility and ease of maintenance.

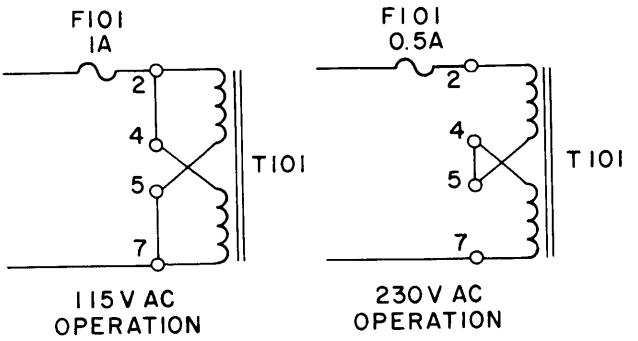

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Figure 2-1. Power Supply Changeover Connections

a. Install unit in rack and secure front panel to rack with four suitable bolts and washers.

b. Set POWER switch S101 at lower (off) position.

c. Connect a-c power cable between MAIN AC jack J108 and a-c power receptacle.

CAUTION

To avoid damage to components within the PFCB, observe for proper polarity when connecting battery to BATTERY jack J109.

d. If 24-volt dc battery source is available, observe for proper polarity and connect battery to BATTERY jack J109.

e. With a 24-volt dc battery connected as outlined in step d, set BAT switch S105 at IN. If battery is not used or ready for use at this time, set BAT switch S105 at OUT.

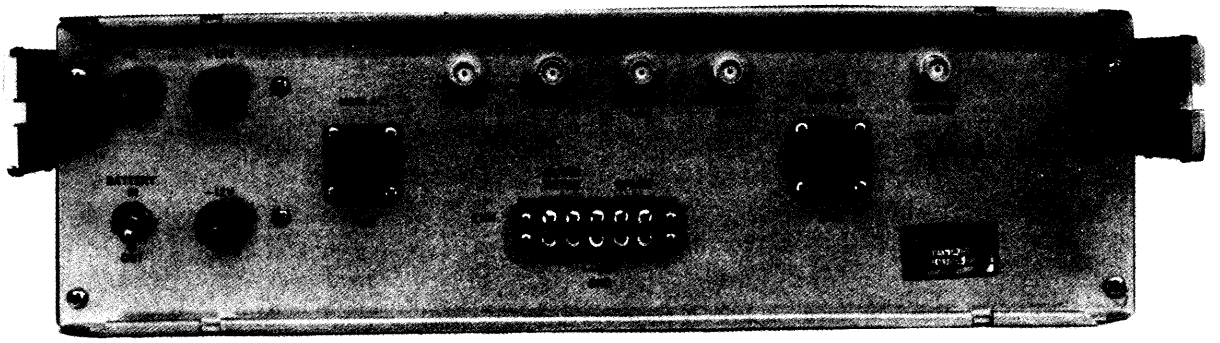

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Figure 2-2. PFCB, Rear View

2-4. PRE-OPERATIONAL CHECK.

After installing the PFCB, the following checkout procedure should be performed to insure that the unit is operational.

a. Set POWER switch S101 and RECORDER switch S102 at lower (off) position.

b. Set METER SCALE switch S103 at 5 PARTS FULL SCALE.

c. Set MULTIPLIER switch S104 at PARTS IN 10^6.

d. Adjust Hewlett-Packard 5245L frequency counter, or equivalent, to provide a 1-mc standard frequency.

e. Connect coaxial cable between 1-mc output jack of frequency counter and REF IN jack J102 of PFCB.

f. Connect Tee-connector to a tunable 1-megacycle oscillator. Then, connect coaxial cables between Tee-connector of oscillator, AC INPUT jack of frequency counter, and TEST IN jack J101.

g. Adjust frequency counter for a 10-second count.

h. Adjust oscillator until frequency counter indicates 1 cycle greater than 1 mc.

NOTE

The 1-mc plus 1-cycle indication in step h, should be exact before proceeding with remainder of check.

i. Set POWER switch S101 and RECORDER switch S102 at ON, and observe the following:

(1) POWER indicator DS101 should light.

(2) Recorder chart should move.

(3) Pen markings on recorder chart should indicate 1-part deflection to left.

NOTE

If any of the recorder indications as given in steps i through m are abnormal, it may be necessary to re-align the PFCB. (Refer to Section 5.)

j. Set METER SCALE switch S103 at 2. Pen markings on recorder chart should indicate 2-1/2 parts (1/2 scale) deflection to left.

k. Set METER SCALE switch S103 at 1. Pen markings on recorder chart should indicate full scale deflection to left.

l. Set MULTIPLIER switch S104 at PARTS IN 10^{10} Pen marings on recorder chart should indicate full-scale deflection to left.

m. Repeat steps a, b, c, and h through k with oscillator adjusted for a 1-mc minus 1 count on frequency counter and recorder pen deflecting towards right on recorder chart.

n. At completion of check, set POWER switch S101 and RECORDER switch S102 at lower (off) position, MULTIPLIER switch S104 at PARTS IN 10^6 and METER SCALE switch S103 at OFF. Then, disconnect coaxial cables connected in steps e and f.

SECTION 3
OPERATOR'S SECTION

3-1. OPERATING CONTROLS, INDICATORS, AND JACKS.

Before operating the PFCB, the operator should familiarize himself with all front-panel controls and indicators illustrated in figure 3-1 and listed in table 3-1.

3-2. OPERATING INSTRUCTIONS.

To operate the PFCB, proceed as follows:

a. Make certain that POWER switch S101 and RECORDER switch S102 are set at lower (off) position.

b. Set METER SCALE switch S103 at 5 and MULTIPLIER (m) switch S104 at 6.

c. Connect frequency standard under test to TEST IN jack J101.

d. Connect reference frequency standard to REF IN jack J102.

e. Set POWER switch S101 and RECORDER switch S104 at ON and observe for the following:

(1) POWER indicator DS101 should light.

(2) Recorder chart should move.

(3) Recorder pen should move with subsequent markings on recorder chart.

f. Set MULTIPLIER switch S104 and METER SCALE switch S103 for convenient recorder pen deflection.

NOTE

The recorder pen (polarity) markings to the right (minus) or left (plus) indicate the frequency difference of the test frequency relative to the reference frequency. Refer to table 3-2 as a quick guide for determining in cycles the full-scale (recorder) deflection parameters for the various switching combinations of METER SCALE switch S103 and MULTIPLIER switch S104. The ± cycles as given in table 3-2 are the actual full-scale frequency deviations with respect to 1 mc.

g. Adjust Frequency Standard under test until pen markings on recorder chart are centered at mid-scale.

h. Allow recorder chart to run for 24 hours. If at the end of the 24-hour period, the recorder pen indications remain centered at mid-scale, proceed to step i. If not, repeat step g.

NOTE

When the PFCB derives its reference standard input from a VLF transmission-corrected oscillator, two major changes on the recorder chart will be seen during long-term comparisons. These changes are normal, and occur at sunrise and sunset. Also, these changes are in direct opposition to each other.

i. Set POWER switch S101 and RECORDER switch S104 at lower (off) position.

j. Disconnect frequency standard under test and reference frequency standard from TEST IN jack J101 and REF IN jack J102.

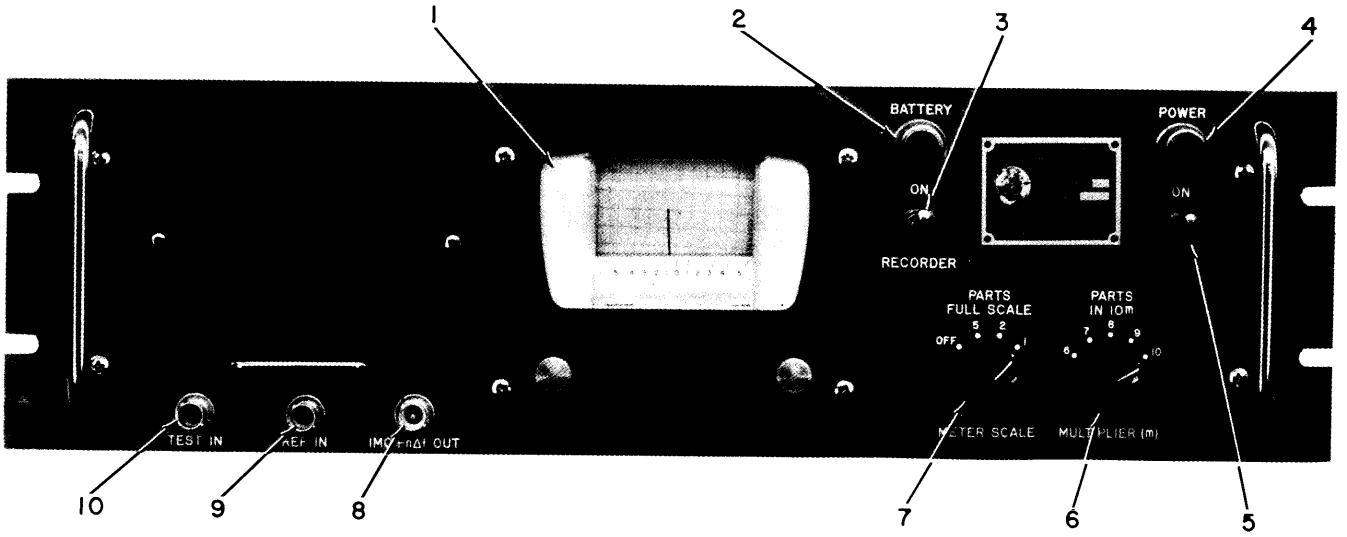

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Figure 3-1. PFCB, Front Panel Controls, Indicators, and Jacks

TABLE 3-1. FRONT PANEL CONTROLS, INDICATORS, AND JACKS

INDEX NUMBER	CONTROL OR INDICATOR	FUNCTION
1	Recorder	Monitors and permanently records error frequency of Frequency Standard under test in parts as minute as 1 part in 10^{11}.
2	BATTERY indicator DS102	Indicates power-supply circuit inoperative and unit is being operated from an external battery source.
3	RECORDER switch S102	Controls application of a-c power to recorder motor in conjunction with POWER switch (item 5).
4	POWER indicator DS101	Indicates a-c power is applied to power supply circuit.
5	POWER switch S101	ON position connects a-c power to power-supply circuit. Lower (off) position disconnects a-c power from power supply circuit.
6	MULTIPLIER switch S104	A five position selector switch. The switch positions correspond to the rate at which the error frequency ($n\Delta f$) is multiplied. For example, in position 6 the recorder will indicate parts in 10^6.
7	METER SCALE switch S103	A four position (OFF, 1, 2, and 5) switch; OFF position disconnects the output module from the recorder. Remaining switch positions select the full-scale readings of recorder. For example, in position 5, full scale reading is ±5 parts. Therefore, with suggested setting for MULTIPLIER switch S104, a full-scale deflection indicates ±5 parts in 10^6 difference between Frequency Standards.
8	1MC $+n\Delta f$ OUT jack J103	Permits monitoring 1 mc$+n\Delta f$ frequency as selected by MULTIPLIER switch S104.
9	REF IN jack J102	Permits monitoring input frequency of reference frequency standard.
10	TEST IN jack J101	Permits monitoring input frequency of frequency standard under test.

TABLE 3-2. RECORDER SWITCHING ARRANGEMENTS

METER SCALE (PARTS FULL SCALE) SWITCH S103	MULTIPLIER (PARTS IN 10^m) SWITCH S104	± CYCLES (FULL-SCALE DEFLECTION)*
5	6	5.0
2	6	2.0
1	6	1.0
5	7	0.5
2	7	0.2
1	7	0.1
5	8	0.05
2	8	0.02
1	8	0.01
5	9	0.005
2	9	0.002
1	9	0.001
5	10	0.0005
2	10	0.0002
1	10	0.0001

*The ± cycles are with respect to 1 mc.

3-3. LOADING OF RECORDER ROLL CHART.

The procedures for reloading a recorder roll chart are as follows:

a. Turn off power by setting POWER switch S101 at lower (off) position.

b. Loosen front-panel knobs attaching recorder to PFCB chassis.

c. Remove recorder from PFCB chassis by carefully pulling forward.

d. Lay recorder on work bench.

e. Swing recorder open on hinge (figure 3-2A), by holding top side of front panel down while lifting up on front of frame.

f. Noting position of guide roller assembly remove thumb nut (figure 3-2B) securing guide roller assembly to frame. Then remove guide roller assembly.

g. Turn knurled knob on top roller in a clockwise direction until complete recorder roll chart is wound on top roller.

h. Unlock both rollers by pivoting clamps on both sides of rollers in a clockwise direction; remove top (with recorder chart) and bottom rollers from frame.

i. Slide paper chart with cardboard sleeve off top roller.

j. Remove cardboard sleeve from bottom roller and slip onto top roller.

k. Place a new recorder roll chart with perforated side against disk side of bottom roller (figure 3-2C).

l. Replace top and bottom rollers into guide grooves on either side of frame.

m. Lock rollers by pivoting clamps until they engage roller studs.

n. Pull recorder roll chart on bottom roller over frame and onto cardboard sleeve on top roller. Then, tape edge of recorder chart roll squarely and neatly to cardboard sleeve on top roller.

o. Swing recorder back to original position on hinge (figure 3-2D).

p. Push paper chart down from top side, allowing slack between paper drive and top rollers.

q. Reinstall guide roller assembly to frame as shown in figures 3-2D and E; and holding guide roller assembly in place, secure to frame with thumb nut removed in step f.

r. Remove any slack from recorder roll chart by slightly turning top or bottom roller in a clockwise direction.

s. Carefully reinstall recorder into PFCB chassis and secure by tightening front-panel knobs.

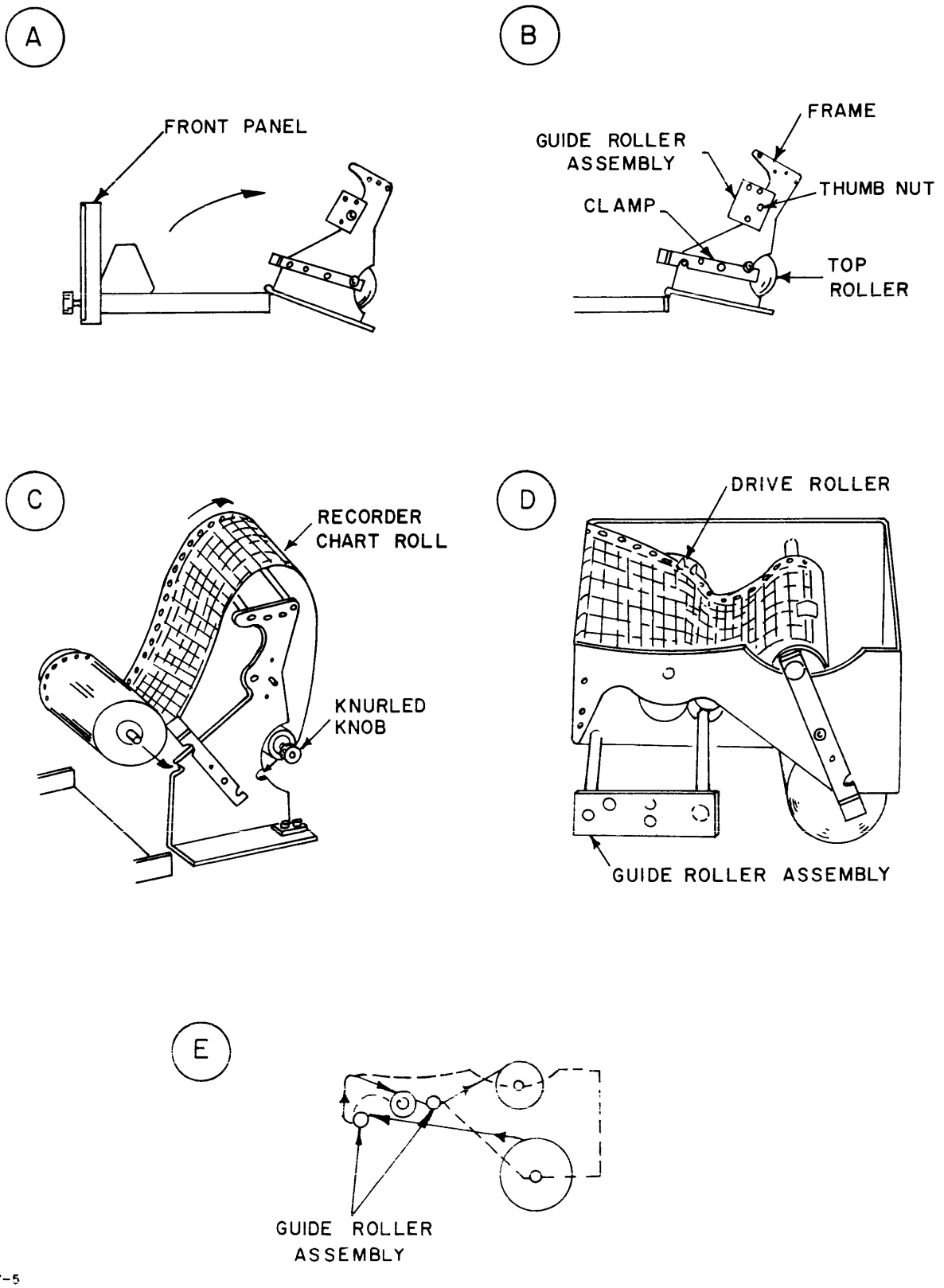

Figure 3-2. Recorder Roll Chart Replacement Guide

SECTION 4
PRINCIPLES OF OPERATION

4-1. OVERALL DESCRIPTION. (Figure 4-1.)

The PFCB is a precision frequency comparator that employs a heterodyning technique in conjunction with frequency multiplication to compare a difference in frequency (or error) between a frequency standard under test and that of a frequency standard of known accuracy. A front-panel recorder, operating in conjunction with front-panel switching controls, is used to accurately display and record the error frequency in parts in 10^6 to parts in 10^{11}.

Bascially the PFCB is a transistorized unit consisting of ten plug-in printed circuit boards or modules, with appropriate switching, calibration, and recorder monitoring circuits. The printed circuit boards (interconnected through jacks mounted on an interconnecting board) consist of four X10 (times ten) Multiplier modules, two Input-Output modules, one X9 (times nine) Multiplier module, one Mixer-Amplifier module, one Output module, and a Power Supply module.

4-2. X10 MULTIPLIER MODULES. (Figure 4-1 and 7-1)

The four X10 Multiplier modules used in the PFCB are connected in cascade and numerically designated as the Z300 series. Each X10 Multiplier module progressively multiplies (by 10) the frequency error (if any) of the Frequency Standard under test while maintaining a center frequency of 1 mc. In this manner, the frequency error appears ten times larger at the output of each successive X10 Multiplier, while the center frequency remains at a nominal 1 mc. Since each of the X10 Multiplier modules are similar, only the X10 (10^7) Multiplier will be discussed.

Initially, the X10 (10^7) Multiplier receives the 1-mc $\pm\Delta f$ and 9-mc frequencies from the test Input-Output and X9 Multiplier modules, respectively. The 1-mc input which includes the frequency error is multiplied by 10 to a frequency of 10 mc $\pm 10\Delta f$. This frequency converts back to 1 mc $\pm 10\Delta f$ when mixed with the 9-mc signal derived from the reference input frequency. When selected by MULTIPLIER switch S104, the output of the X10 (10^7) Multiplier is supplied as an input to the Test Input-Output module.

4-3. INPUT-OUTPUT MODULES. (Figure 4-1 and 7-1)

The Reference Input-Output module functions as an amplifier or a multiplier, depending upon the input frequency of the ultra-stable frequency standard. Operating as a multiplier, it converts input frequencies of 100 kc, 200 kc, or 500 kc to an exact frequency of 1 mc. However, with a 1-mc input it serves as an amplifier, amplifying the incoming signal to its proper operating level. In either case, a precise 1-mc output is supplied by the Reference Input-Output module as an input to the X9 Multiplier and Mixer-Amplifier modules and as an output available at REF OUT 1 MC jack J106.

The Test Input-Output module contains identical circuits as those included in the Reference Input-Output module. It functions as an amplifier or a multiplier, depending upon the input frequency. This results in a 1-mc output which includes the $\pm\Delta f$ or frequency error of the frequency standard under test. The 1-mc$\pm\Delta f$ output is supplied by the module as one of two input frequencies to the X10 (10^7) Multiplier module. The module also amplifies the selected X10 Multiplier signal (1 mc$\pm n\Delta f$). When amplified, the 1-mc$\pm n\Delta f$ signal is supplied as an output to be monitored at parallel connected 1 mc$\pm n\Delta f$ OUT jacks and as an input to the Mixer-Amplifier module.

4-4. X9 MULTIPLIER MODULE. (Figure 4-1 and 7-1)

The X9 Multiplier module functions as a times-nine multiplier; it multiplies the precise 1-mc frequency, derived from the reference input, to a frequency of 9 mc. During operation, the 9-mc frequency developed by the X9 Multiplier module is supplied as a mixing frequency to the X10 Multiplier modules.

4-5. MIXER-AMPLIFIER AND OUTPUT MODULES. (Figure 4-1 and 7-1)

The Mixer-Amplifier module consists of two identical mixer-amplifier channels and a 1-mc+100-cps oscillator which is common to both channels. Each channel is connected to receive either the selected X10 Multiplier output (1 mc$\pm n\Delta f$) or the 1-mc signal derived from the reference input. During operation, the two input frequencies are subtracted from the 1-mc+100-cps frequency derived from the oscillator, resulting in two output frequencies: an exact 100 cps and 100 cps$\pm n\Delta f$. Both outputs are channeled as inputs to the Output module, where they are further frequency compared.

The output module comprises two channel integrator and differential comparison circuits. Each integrator circuit receives and processes either the 100-cps reference or 100-cps $\pm n\Delta f$ frequencies supplied by the Mixer-Amplifier module. The resultant output of each integrator circuit is a series of continuous pulses that are frequency compared in a differential comparison circuit. This circuit generates a d-c comparison output voltage, whose amplitude and polarity is directly proportional

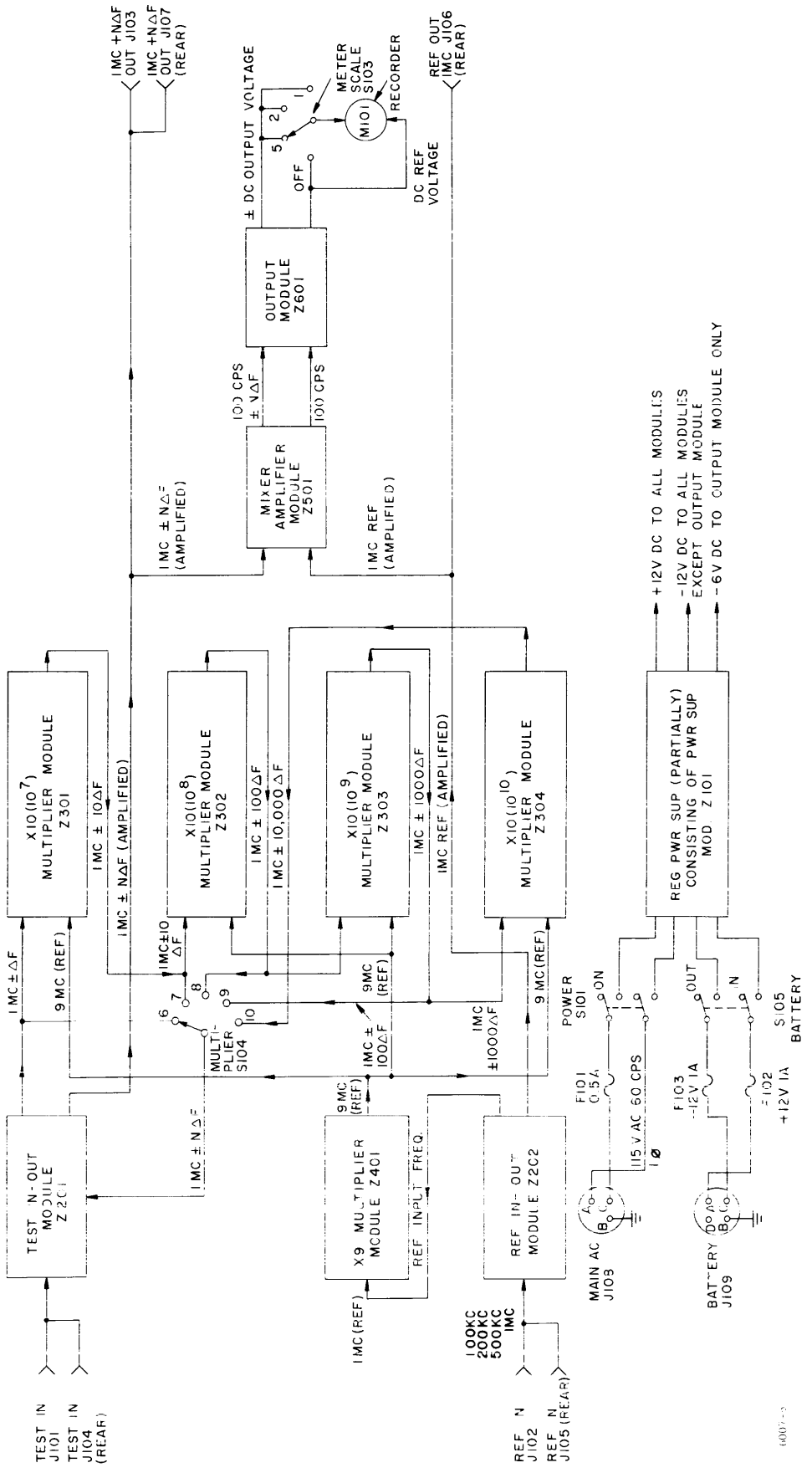

Figure 4-1. PFCB, Functional Block Diagram

to the frequency difference of the two sets of incoming pulses. The resultant d-c output voltage from the differential comparison circuit is then fed to a chart recorder that presents both the magnitude and sense of the frequency difference. A front-panel METER SCALE switch S103 is used in conjunction with the chart recorder to conveniently set the level of pen deflection.

4-6. POWER SUPPLY MODULE.

The regulated power supply comprises a power supply-module (Z101) and components externally mounted on the main chassis. It also contains facilities for automatically switching over to battery operation during emergencies.

In normal operation with POWER switch S104 set at ON, 115-volt, 50/60-cycle, single-phase power is appled between MAIN AC jack J108 and connected through AC fuse F101 to the input side of the regulated power supply circuits. These circuits produce regulated d-c operating potentials of +12 v, -12 v, and -6 v.

In the event of an a-c power failure the regulated power-supply circuits are automatically switched to 24-volt battery operation, assuming an external 24-volt battery is connected to BATTERY jack J109 and provided BATTERY switch S105 is set at IN. Under these conditions, 24 volts d-c is appled across -12V/ +12V fuses F102 and F103 as an input to the regulated power supply.

SECTION 5
MAINTENANCE

5-1. GENERAL.

To aid in equipment maintenance, the following references are provided: schematic diagram (section 7), component identification (figures 5-1 and 5-2), and tools and test equipment required (table 5-1).

5-2. PREVENTIVE MAINTENANCE.

a. GENERAL. - The PFCB has been designed to provide long term, trouble-free operation under continuous duty conditions. However, in order to prevent failure of the equipment due to corrosion, dust or other destructive elements, it is suggested that a schedule of preventive maintenance be set up and adhered to.

b. SCHEDULING. - At periodic intervals, the equipment should be removed from its mounting for cleaning and inspection. All accessible covers should be removed and the wiring and all components inspected for dirt, corrosion, charring, discoloring or grease. Remove dust with a soft brush or vacuum cleaner. Remove dirt or grease from other parts with any suitable cleaning solvent. Use of carbon tetrachloride should be avoided due to its highly toxic effects. Trichlorethylene or methylchloroform may be used, provided the necessary precautions are observed.

WARNING

When using toxic solvents, make certain that adequate ventilation exists. Avoid prolonged or repeated breathing of the vapor. Avoid prolonged or repeated contact with skin. Flammable solvents shall not be used on energized equipment or near any equipment from which a spark may be received. Smoking, "hot work", etc, is prohibited in the immediate area.

CAUTION

When using trichlorethylene, avoid contact with painted surfaces, due to its paint removing effects.

TABLE 5-1. TOOLS AND TEST EQUIPMENT REQUIRED

ITEM	DESCRIPTION
Frequency Counter	Hewlett-Packard 5245L, or equivalent
Oscilloscope	Tektronix 545A with L type plug-in unit, or equivalent
Crystal Oscillator	Any crystal oscillator with a long term stability of better than 1 part in 10^7 per day. Adjustable to ±5 cycles at 1 mc.
VTVM	Hewlett-Packard 410B, or equivalent
24-volt Nickel Cadmium Battery	Sonotone 10-S103, or equivalent
A-c Power Cable	3-wire cable (connectors MS3106A14S-1S and three-prong a-c plug connected on either end of cable).
D-c Power Cable	2-wire cable (connectors MS3106A14S-2S and battery clips connected on either end of cable).
Connector	MS3106A14S-1S
Connector	MS3106A14S-2S
Connector	3-prong a-c plug
Connector	Battery clips
Alignment Tool	TMC part number TP-129

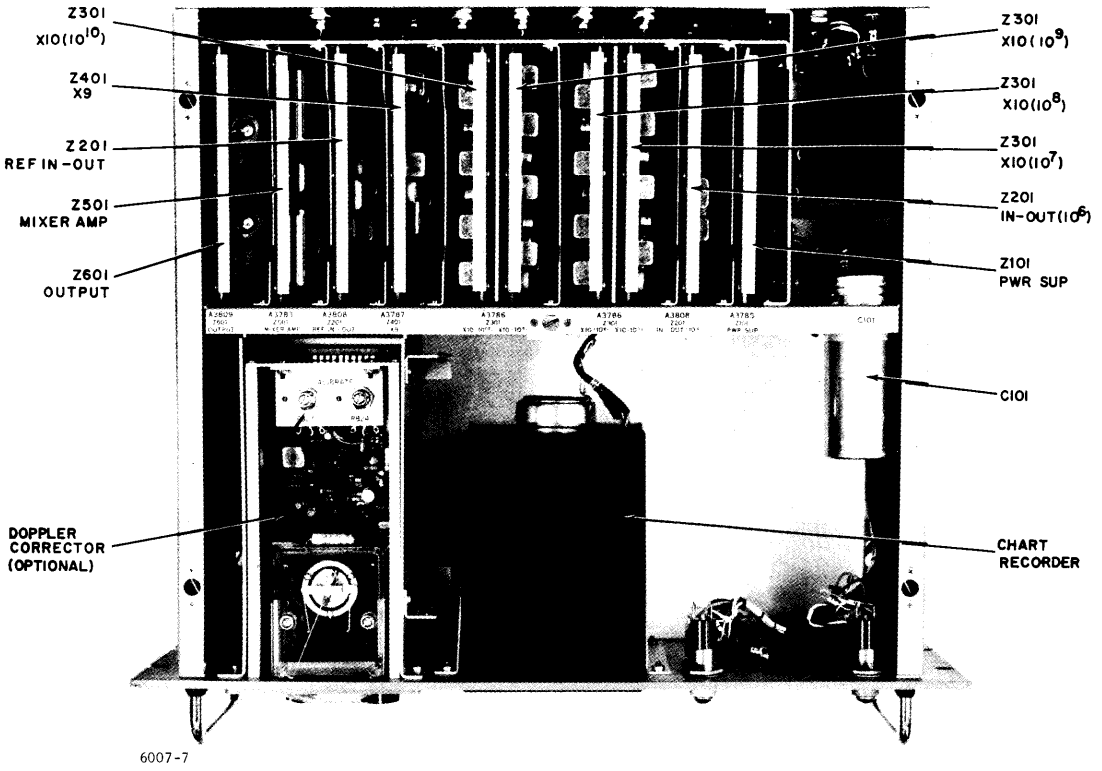

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Figure 5-1. Model PFCB, Precision Frequency Comparator, Top View

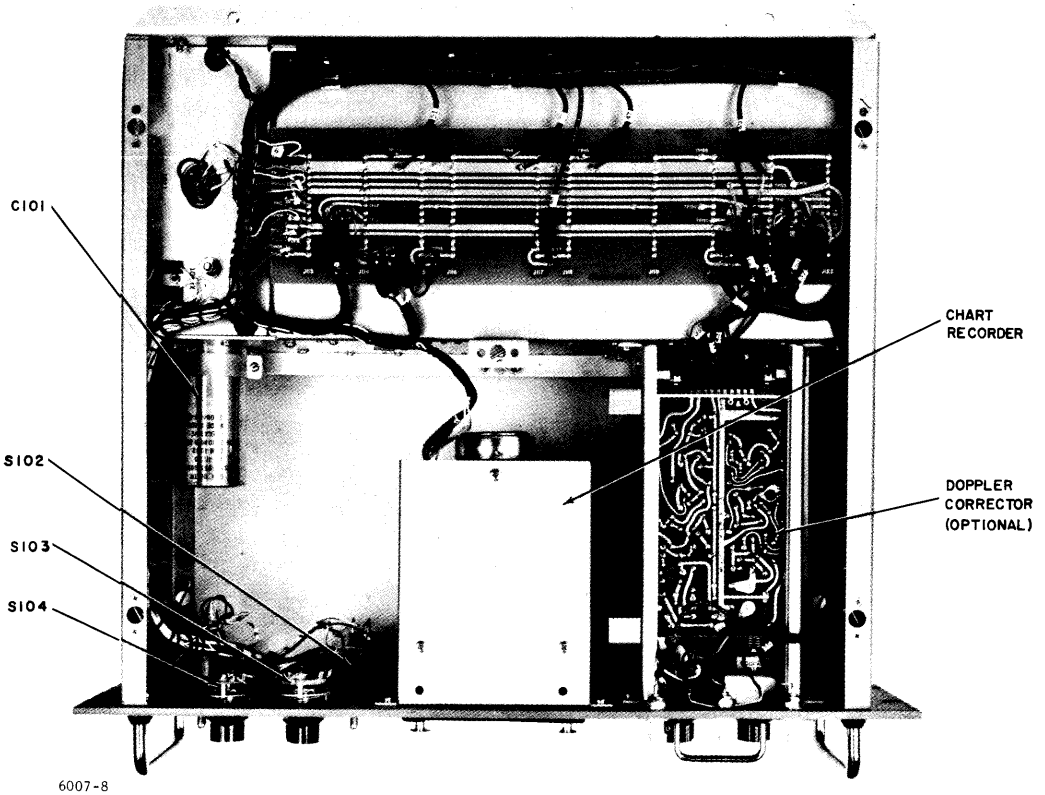

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Figure 5-2. Model PFCB, Precision Frequency Comparator, Bottom View

5-3. TROUBLESHOOTING.

Faulty PFCB operation is usually apparent by abnormal recorder chart indications, such as the recorder pen pinning to either side of center-scale, or a continuous straight line display on the recorder chart in all METER SCALE switch positions. Pinning of the recorder could be associated with a defective X10 Multiplier module, an Input-Output module or an X9 Multiplier module. One method of detecting whether pinning of the recorder is due to a defective X10 Multiplier module is to first set MULTIPLIER switch S104 to PARTS IN 10^{10} position. Then, successively rotate the switch towards the PARTS IN 10^{6} position, until pinning of the recorder pen ceases. The defective X10 multiplier module would be the one before switching to the position which provides normal operation. Another method of detecting a defective X10 Multiplier module would be to connect an oscilloscope to the rotor-arm of MULTIPLIER switch S104 and to monitor each switch position corresponding to the output of each multiplier module. The oscilloscope should indicate approximately 350 millivolts peak-to-peak in all switch positions except position 10, where approximately 500 millivolts should be indicated.

A quick method of checking for a defective Input-Output module when the recorder pen is pinning, is to switch positions of the two Input-Output modules on the interconnecting board, and to observe if the recorder pen pins in the opposite direction. If the recorder pen continues to pin in the same direction as formerly, trouble may lie in the X9 Multiplier module.

NOTE

It is important that a 1-mc frequency source be connected to both input channels during the above mentioned checks. A 1-mc source is available at a rear panel jack on the counter.

A fault in Mixer-Amplifier or Output module usually results in a continuous straight line regardless of the setting of METER SCALE switch S103. When this occurs, check the outputs of each module with an oscilloscope and/or counter.

For ease of troubleshooting the PFCB stages, connect the counter directly to the oscilloscope. Then use the oscilloscope probe for obtaining simultaneous frequency and amplitude indications. This method of test equipment hookup also eliminates improper loading of the stage being checked.

Check transistors by using the substitution method. Check fuses as necessary. A visual inspection of the unit should pinpoint burned or open parts.

When a defective component on a module (other than the power supply module), has been isolated, removed and replaced, it may be necessary to re-align the repaired module. System checks should first be performed in order to determine whether the repaired module requires alignment.

5-4. ALIGNMENT.

a. PRELIMINARY INSTRUCTIONS. - Prior to aligning the PFCB, perform the following:

NOTE

These instructions assume that the unit has just been repaired. Therefore, the unit should be on a work bench, with top and bottom covers removed, and all signal and power cables disconnected. This procedure also assumes that an external 24-volt d-c battery source is available for use at all times.

(1) Set POWER switch S101 and RECORDER switch S104 at lower (off) position.

(2) Connect d-c power cable between BATTERY jack J109 and battery.

(3) Set BATTERY switch S104 at IN; BATTERY indicator DS102 should light.

(4) Connect a-c power cable between MAIN AC jack J109 and a-c source receptacle.

(5) Set POWER switch S101 at ON. BATTERY indicator DS102 should go off and POWER indicator DS101 should light.

b. D-C POWER CHECK. - To perform the d-c power check, proceed as follows:

(1) Perform the preliminary instructions as given in paragraph 5-4a.

(2) Set POWER switch S101 at lower (off) position.

(3) Connect VTVM between test point TP108 (emitter of transistor Q101) on interconnecting board and ground.

(4) Set POWER switch S101 at ON. POWER indicator DS101 should light and VTVM should indicate approximately -12 volts.

(5) Disconnect VTVM from test point TP108 and connect to test point TP107 (cathode of Zener diode CR106) on interconnecting board. VTVM should indicate approximately 12 volts dc.

(6) Disconnect VTVM from test point TP107 and connect to test point TP102B (emitter of transistor Q102) on interconnecting board. VTVM should indicate approximately -6 volts dc.

(7) Disconnect VTVM connected between test point TP102B and ground.

(8) Disconnect a-c power from MAIN AC jack J108. BATTERY indicator DS102 should go off and POWER indicator DS101 should light.

(9) Repeat steps (4) through (7).

(10) Set BATTERY switch S105 at OUT.

c. INPUT-OUTPUT MODULE ALIGNMENT. - Proceed as follows:

(1) Perform the preliminary instructions as given in paragraph 5-4a.

(2) Set MULTIPLIER (m) switch S104 at PARTS IN 10^6.

(3) Adjust counter for 1-mc external standard frequency output. Counter output should be between the limits of 0.1 to 3 volts peak-to-peak.

(4) Connect Tee-connector to external standard frequency output jack on counter. Then, connect coaxial cables between tee-connector on counter and TEST IN and REF IN jacks J101 and J102, respectively.

(5) Set POWER switch S101 at lower (off) position.

(6) Remove Input-Output module from unit and connect module to extender card. Then, connect extender card into appropriate jack connector on interconnection board.

(7) Set POWER switch S101 at ON.

(8) Connect oscilloscope to test point TP1 (TP201 on figure 7-1). Oscilloscope should indicate approximately 200 millivolts peak-to-peak with slightly distorted sine wave.

(9) Disconnect oscilloscope from test point TP1 and connect to test point TP2 (TP202 on figure 7-1).

(10) Adjust transformer T201 until a sharp increase in voltage is indicated on oscilloscope. Then adjust transformer T201 one-quarter turn in clockwise direction.

(11) Disconnect oscilloscope from test point TP2, and connect to test point TP3 (TP203 on figure 7-3). Adjust capacitor C212 for a maximum signal indication on oscilloscope.

(12) Disconnect oscilloscope from test point TP3 and connect to test point TP4 (TP204 on figure 7-1). Adjust control R216 fully counterclockwise.

(13) Adjust transfer T202 until a sharp increase in voltage is indicated on oscilloscope. Then, adjust transformer T202 one-quarter turn in clockwise direction.

(14) Readjust capacitor C212 for a maximum signal indication on oscilloscope.

(15) Readjust control R216 until waveform on oscilloscope indicates approximately 350 millivolts, peak-to-peak.

NOTE

When aligning the Input-Output (10^6) module, readjust control R216 for a 2 volt peak-to-peak indication on oscilloscope.

(16) Disconnect oscilloscope from test point TP4 and connect to test point TP6 (TP206 on figure 7-1).

(17) Adjust transformer T203 for maximum signal indication on oscilloscope.

(18) Set POWER switch S101 at lower (off) position. Disconnect coaxial leads connected between tee-connector on counter and REF IN and TEST IN jacks J101 and J102, respectively.

(19) Disconnect oscilloscope from test point TP6.

(20) Remove extender card and mated module from unit. Then, disconnect extender card from module and re-install module into appropriate jack connector on interconnecting board.

d. X9 MULTIPLIER MODULE ALIGNMENT. - Proceed as follows:

(1) Repeat steps (1) through (5) of paragraph 5-4c.

(2) Remove X9 Multiplier module from unit and connect module to extender card. Then, connect extender card into appropriate jack connector on interconnection board. Set POWER switch S101 at ON.

(3) Connect oscilloscope to test point TP1 (TP401 on fugure 7-1). Waveform on oscilloscope should be almost sinusoidal at an amplitude of approximately 800 millivolts peak-to-peak.

(4) Disconnect oscilloscope from test point TP1 and connect to test point TP2 (TP402 on figure 7-1). Adjust transformer T401 until a sharp increase in

voltage is indicated on oscilloscope. Then, adjust transformer T401 one-quarter turn in clockwise direction. Amplitude of waveform on oscilloscope should be approximately 3.5 volts peak-to-peak.

(5) Disconnect oscilloscope from test point TP2 and connect to test point TP3 (TP403 on figure 7-1). Adjust transformer T402 until indication on oscilloscope conforms to figure 5-3A.

(6) Disconnect oscilloscope from test point TP3 and connect to test point TP4 (TP404 on figure 7-1). Adjust transformer T403 until indication on oscilloscope conforms to figure 5-3B.

(7) Disconnect oscilloscope from test point TP4 and connect to test point TP5 (TP405 on figure 7-1). Adjust capacitor C415 for a maximum signal indication on oscilloscope. Amplitude of waveform as indicated on oscilloscope should be approximately 100 millivolts peak-to-peak.

(8) Disconnect oscilloscope from test point TP5 and connect to test point TP6 (TP406 on figure 7-1). Readjust capacitor C415 for a maximum signal indication on oscilloscope. Amplitude of waveform as indicated on oscilloscope should be 200 millevolts peak-to-peak or greater.

(9) Set POWER switch S101 at lower (off) position. Disconnect coaxial leads connected between Tee-connector on counter and REF IN and TEST IN jacks J101 and J102, respectively.

(10) Disconnect oscilloscope from test point TP6.

(11) Remove extender card and mated module from unit. Then, disconnect extender card from module and re-install module into appropriate jack connector on interconnecting board.

e. X10 MULTIPLIER MODULE ALIGNMENT. - Proceed as follows:

NOTE

All X10 Multiplier modules are aligned in the X10 (10^7) jack position. This jack position is nearest to the Input-Output and Power Supply modules.

(1) Repeat steps (1) through (5) of paragraph 5-4c.

(2) Remove X10 Multiplier module from unit and connect module to extender card.

(3) Connect extender card into the X10 (10^7) jack position removing existing X10 Multiplier card, if necessary. Set POWER switch S101 at ON.

(4) Connect oscilloscope to test point TP1 (TP301 on figure 7-1). Amplitude of waveform on oscilloscope should be approximately 300 millivolts peak-to-peak. If amplitude of signal level is low, adjust control R216 on the Input-Output module until waveform on oscilloscope is approximately 300 millivolts.

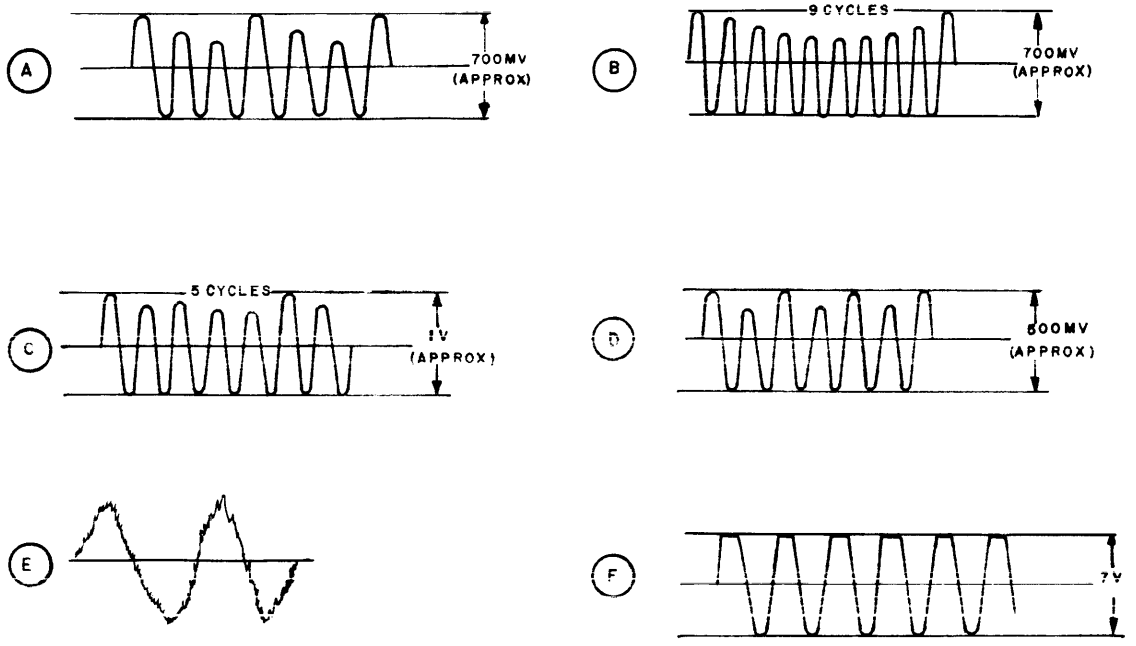

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Figure 5-3. PFCB Alignment Waveforms

NOTE

Control R216 is mounted on the Input-Output module located to the right of the X10 Multiplier modules.

(5) Disconnect oscilloscope from test point TP1, and connect to test point TP2 (TP302 on figure 7-1). Adjust transformer T301 until sharp increase in voltage is indicated on oscilloscope. Then adjust transformer T301 one-quarter turn clockwise; amplitude of waveform on oscilloscope should be approximately 350 millivolts peak-to-peak.

(6) Disconnect oscilloscope from test point TP2 and connect to test point TP3 (TP303 on figure 7-1). Adjust inductor L301 until indication on oscilloscope conforms to figure 5-3c.

(7) Disconnect oscilloscope from test point TP3 and connect to test point TP4 (TP304 on figure 7-1). Alternately adjust transformer T302 and inductor L301 until perfect sinusoidal waveform at approximately 450 millivolts peak-to-peak is indicated on oscilloscope.

(8) Disconnect coaxial cable from REF IN jack J102.

(9) Disconnect oscilloscope from test point TP4 and connect to test point TP5 (TP305 on figure 7-1). Adjust transformer T303 until indication on oscilloscope conforms to figure 5-3D.

(10) Disconnect coaxial cable from TEST IN jack J101 and connect to REF IN jack J102.

(11) Disconnect oscilloscope from test point TP5 and connect to emitter of transistor Q305. Adjust transformer T304 until perfect sinusoidal waveform at approximately 700 millivolts peak-to-peak is indicated on oscilloscope.

(12) Reconnect coaxial cable between Tee-connector on counter and TEST IN jack J101.

(13) Disconnect oscilloscope from emitter of Q305 and connect to test point TP6 (TP306 on figure 7-1). Adjust transformer T304 until indication on oscilloscope conforms to figure 5-4E.

(14) Disconnect oscilloscope from test point TP6 and connect to test point TP7 (TP307 on figure 7-1). Alternately adjust capacitor C324 and transformer T305 until amplitude of waveform on oscilloscope is peaked for maximum indication.

(15) Adjust control R323 fully clockwise.

(16) Disconnect oscilloscope from test point TP7 and connect to test point TP8 (TP308 on figure 7-1). Adjust transformer T306 until a sharp increase in voltage is indicated on oscilloscope. Then adjust transformer T306 one-quarter turn clockwise. Readjust control R323 until waveform on oscilloscope indicates approximately 350 millivolts peak-to-peak.

NOTE

The control setting for R323 given in step 16 is applicable to all X10 Multiplier modules with the exception of the X10 (10^{10}) Multiplier module. For this module (which does not contain a crystal), control R323 is adjusted for approximately 500 millivolts peak-to-peak.

(17) Set POWER switch S101 at lower (off) position. Disconnect coaxial leads between Tee-connector on counter and REF IN and TEST IN jacks J101 and J102, respectively.

(18) Disconnect oscilloscope from test point TP8.

(19) Remove extender card and mated module from unit. Then, disconnect extender card from module and re-install module into appropriate unit jack connector on interconnecting board.

(20) If necessary, replace X10 Multiplier module which may have been removed in step (3).

f. MIXER-AMPLIFIER MODULE ALIGNMENT. - Proceed as follows:

(1) Repeat steps (1) through (5) of paragraph 5-4c.

(2) Remove Mixer-Amplifier module from unit and connect module to extender card. Then, connect extender card into appropriate jack connector on interconnection board.

(3) Make certain accessory connector is connected to accessory connector jack J111 located in rear of accessory compartment. Set POWER switch S101 at ON.

(4) Connect oscilloscope to emitter of transistor Q503 on wired side of module. Adjust transformer T502 for a maximum signal indication on oscilloscope approximately 300 millivolts peak-to-peak.

(5) Disconnect oscilloscope from emitter of transistor Q503 and connect to emitter of Q504. Adjust transformer T501 for a maximum signal indication on oscilloscope (approximately 300 millivolts peak-to-peak).

(6) Set MULTIPLIER (m) switch S102 at PARTS IN 10^6.

(7) Disconnect oscilloscope from emitter of transistor Q504 and connect to emitter of Q501. Adjust capacitor C523 until frequency of waveform on oscilloscope is 100 cycles per second at approximately 7 volts peak-to-peak (figure 5-3F).

(8) Set POWER switch S101 at lower (off) position. Disconnect coaxial leads connected between Tee-connector on counter and REF IN and TEST IN jacks J101 and J102, respectively.

(9) Disconnect oscilloscope from emitter of Q501.

(10) Remove extender card and mated module from unit. Then, disconnect extender card from module and re-install module into appropriate unit jack connector on interconnecting board.

g. OVERALL CHECKS AND ALIGNMENTS. - The overall checks and alignment procedures of the PFCB are performed to insure that the operational capabilities of the unit are within acceptable limits.

(1) SIGNAL LEVEL CHECKS. - To check for normal internal signal parameters of the PFCB, proceed as follows:

(a) Repeat steps (1) through (5) of paragraph 5-4c.

(b) Remove Mixer-Amplifier module from unit and connect module to extender card. Then connect extender card into appropriate jack connector on interconnecting board.

(c) Connect oscilloscope to rotor arm of MULTIPLIER (m) switch S102.

(d) Set POWER SWITCH S101 at ON.

(e) Rotate MULTIPLIER (m) switch S102 to PARTS IN 10^6, 10^7, 10^8, 10^9, and 10^{10} in that order. Oscilloscope should indicate approximately 350 millivolts peak-to-peak in switch position PARTS IN 10^6, 10^7, 10^8, and 10^9. With S102 set at PARTS IN 10^{10}, oscilloscope should indicate approximately 500 milliwatts peak-to-peak.

(f) Disconnect oscilloscope from rotor arm of switch S102 and connect to emitter of Q501. Oscilloscope should indicate 100 cycles per second at approximately 7 volts peak-to-peak (figure 5-3F).

(g) Disconnect oscilloscope from emitter of transistor Q501 and connect to emitter of transistor Q502. Oscilloscope should indicate 100 cycles per second at approximately 7 volts peak-to-peak (figure 5-3F).

(h) Set POWER switch S101 at lower (off) position.

(i) Disconnect oscilloscope from emitter of transistor Q502.

(j) Remove extender card and mated Mixer-Amplifier module from unit. Then, disconnect extender card from module and re-install module into appropriate unit jack connector on interconnecting board.

(k) Remove Output module from unit and connect module to extender card. Then, connect extender card into appropriate jack connector on interconnecting board.

(l) Set POWER switch S101 at ON.

(m) Connect oscilloscope to collector of transistor Q608. Oscilloscope should indicate a series of square-waves at an amplitude of between 14 and 18 volts peak-to-peak.

(n) Repeat step m for other transistors (Q601 through Q607) of Output module; oscilloscope should indicate a series of square-waves at an amplitude of between 14 and 18 volts peak-to-peak.

(o) Set POWER switch S101 at lower (off) position.

(p) Disconnect oscilloscope from collector of transistor Q608.

(q) Disconnect coaxial leads connected between Tee-connector on counter and REF IN and TEST IN jacks J101 and J102, respectively.

(r) Remove extender card and mated output module from unit. Then, disconnect extender card from module and re-install module into appropriate jack connector on interconnecting board.

(2) RECORDER CALIBRATION. - After performing signal level checks, the recorder should be calibrated as follows:

(a) Set MULTIPLIER (m) switch S102 and METER SCALE switch S103 at PARTS IN 10^6 and 1 PARTS FULL SCALE, respectively.

(b) Connect Tee-connector to external standard frequency output jack on counter. Then connect coaxial cables between Tee-connector on counter and TEST IN and REF IN jacks J101 and J102, respectively.

(c) Remove output module from unit and connect module to extender card. Then, connect extender card into appropriate jack connector on interconnecting board.

(d) Set POWER switch S101 and RECORDER switch S102 at ON and observe for the following indications:

1. POWER indicator DS101 should light.
2. Recorder chart should move.
3. Recorder pen markings should be centered.

NOTE

If necessary, adjust R610 on Output module until recorder pen indicates center scale reading on chart.

(e) Set POWER switch S101 and RECORDER switch S102 at lower (off) position. POWER indicator DS101 should go off.

(f) Disconnect coaxial lead connected between Tee-connector on counter and TEST IN jack J101.

(g) Connect a Tee-connector to crystal oscillator. Then, connect coaxial cables between Tee-connector on crystal oscillator and TEST IN jack J101 of PFCB and input jack on counter.

(h) Adjust counter for a 10-second count.

(i) Adjust frequency of crystal oscillator until counter indicates exactly 5 cycles greater than 1 mc.

(j) Set METER SCALE switch S103 at 5 PARTS FULL SCALE.

(k) Set POWER switch S101 and RECORDER switch S102 at ON; POWER indicator lamp DS101 should light.

(l) Observe recorder pen markings for full-scale deflection to left of recorder chart. If this indication is not observed, adjust R609 on Output module until proper indication is obtained.

(m) Readjust frequency of crystal oscillator until counter indicates 2 cycles greater than 1 mc.

(n) Set METER SCALE switch S103 at 2 PARTS FULL SCALE.

(o) Observe recorder pen markings for full-scale deflection to left of recorder chart. If this indication is not observed, adjust R603 on Output module until proper indication is obtained.

(p) Set METER SCALE switch S103 at 1 PARTS FULL SCALE.

(q) Observe recorder pen markings for full-full-scale deflection to left of recorder chart. If this indication is not observed, adjust control R608 on Output module until proper indication is obtained.

(r) Repeat steps (i) through (q) with oscillator adjusted for negative (1mc-5 cycle, 1mc-2 cycle, and 1mc-1 cycle) rather than a positive frequency; recorder pen indication should be full-scale deflection to right, rather than left.

NOTE

When performing step (r) do not adjust controls R603, R608 or R609. These controls have been previously adjusted in steps (k), (o) and (g) at their proper settings. If improper pen recordings are indicated, it may be necessary to readjust control R610 on the Output module for a center-scale indication on recorder chart.

5-5. REPAIR OF PRINTED CIRCUITS.

a. GENERAL. - Although the troubleshooting procedure for printed circuits are similar to those for conventional circuits, the repair of printed circuits requires considerably more skill and patience. The printed circuits are small and compact; therefore, personnel should become familiar with the special servicing techniques required.

The defective parts should be pinpointed by a study of the symptoms and by careful and patient analysis of the circuit before attempting to trace trouble on a printed circuit board. Ascertain whether the conducting strips are coated with a protective lacquer, epoxy resin, or similar substance. If so, carefully scrape it away.

Breaks in the conducting strip (foil) can cause permanent or intermittent trouble. In many instances these breaks will be so small that they cannot be detected by the naked eye. These almost invisible cracks (breaks) can be located only with the aid of a powerful hand-or stand-held magnifying glass.

b. MULTIMETER CHECKOUT. - The most common cause of an intermittent condition is poorly soldered connections. Other causes are: broken boards, broken conducting strips, fused conducting strips, arc-over, loose terminals, etc.

To check out and locate trouble in the conducting strips of a printed circuit board, set up a multimeter (one that does not use a current in excess of 1 ma) for making point-to-point resistance tests, using needle point probes. Insert one point into the conducting strip, close to the end of terminal, and place the other probe on the opposite terminal end of the conducting strip. The multimeter should indicate continuity. If the multimeter indicates an open circuit, drag the probe along the strip (or if the conducting strip is coated, puncture the coating at intervals) until the multimeter indicates continuity. Mark this area then use a magnifying glass to locate the fault in the conductor.

CAUTION

Before using an ohmmeter for testing a circuit, transistors or other voltage-sensitive semiconductors, check the current it passes

under test on all ranges. DO NOT use a range that passes more than 1 ma.

c. HOW TO REPAIR THE BREAK. - If the break in the conducting strip is small, lightly scrape away any coating covering the area of the conducting strip to be repaired. Clean the area with a firm-bristle brush and approved solvent. Then repair the cracked or broken area of the conducting strip by flowing solder over the break. Considerable care must be exercised to keep the solder from flowing onto an adjacent strip.

If a strip is burned out, or fused, cut and remove the damaged strip. Connect a length of insulated wire across the breach or from solder-point to solder-point.

After the repairs are complete, clean the repaired area with a stiff brush and solvent. Allow the board to dry thoroughly, and then coat the repaired area with an epoxy resin or similar compound. This coating not only will protect the repaired area but will help to strengthen it.

CAUTION

After repairs, always scrutinize the board for solder droppings that may cause possible shorts.

Frequently, a low-resistance leakage path will be created by moisture and/or dirt that has carbonized onto the phenolic board. This leakage can be detected by measuring the suspected circuit with a multimeter. To overcome this condition, thoroughly clean the carbonized area with solvent and a stiff brush. If this does not remove it, use a scraping tool (spade end of a solder-aid tool or its equivalent) to remove the carbon, or drill a hole through the leakage path to break the continuity of the leakage. When the drilling method is used, be careful not to drill into a part mounted on the other side.

SECTION 6
PARTS LIST

6-1. INTRODUCTION.

The parts list presented in this section is a cross-reference list of parts identified by a reference designation and TMC part number. In most cases, parts appearing on schematic diagrams are assigned reference designations in accordance with MIL-STD-16. Wherever practicable, the reference designation is marked on the equipment, close to the part it identifies. In most cases, mechanical and electromechanical parts have TMC part numbers stamped on them.

To expedite delivery when ordering any part, specify the following:

a. Generic name.

b. Reference designation.

c. TMC part number.

d. Model and serial numbers of the equipment containing the part being replaced; this can be obtained from the equipment nameplate.

For replacement parts not covered by warranty (refer to warranty sheet in front of manual), address all purchase orders to:

The Technical Materiel Corporation
Attention: Sales Department
700 Fenimore Road
Mamaroneck, New York

Assembly or Sub-assembly

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PFCB-1 MODULAR COMPONENTS BREAKDOWN

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
A101	PFCB-1 SUB-ASSEMBLY	A3875
*A102	DOPPLER CORRECTOR ASSEMBLY	AX519
*A103	SCOPE	
Z101	PRINTED CIRCUIT BOARD ASSEMBLY: Power Supply.	A3785
Z102	PRINTED CIRCUIT BOARD ASSEMBLY: Test Card.	A3784
Z201	PRINTED CIRCUIT BOARD ASSEMBLY: Input-Output Module.	A3808
Z202	PRINTED CIRCUIT BOARD ASSEMBLY: Input-Output Module (REF).	A3808
Z301	PRINTED CIRCUIT BOARD ASSEMBLY: X10 Multiplier Module (10^7).	A3786
Z302	PRINTED CIRCUIT BOARD ASSEMBLY: X10 Multiplier Module (10^8).	A3786

*Units to be shipped with PFCB-1 upon customer request only.

PFCB-1 MODULAR COMPONENTS BREAKDOWN

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
Z303	PRINTED CIRCUIT BOARD ASSEMBLY: X10 Multiplier Module (10^9).	A3786
Z304	PRINTED CIRCUIT BOARD ASSEMBLY: X10 Multiplier Module (10^{10}) Y301 is not used.	A3786-1
Z401	PRINTED CIRCUIT BOARD ASSEMBLY: X9 Multiplier Module.	A3787
Z501	PRINTED CIRCUIT BOARD ASSEMBLY: Mixer Amplifier Module.	A3783
Z601	PRINTED CIRCUIT BOARD ASSEMBLY: Output Module.	A3809

MAIN CHASSIS ASSEMBLY

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C101	CAPACITOR, FIXED, ELECTROLYTIC: 2,600 uf, -10% +100%; 50 WVDC; 75 volts DC surge; plain aluminum case, uninsulated.	CE112-3
CR101 thru CR105	Part of power supply module for ref. See A3785.	
CR106	SEMICONDUCTOR DEVICE, DIODE: silicon; nom. Zener voltage 24 V; standard anode-to-stud polarity, negative-grounded application; tolerance ±5%; junction storage temperature rating -65°C to +175° C; power dissipation 10 watts DC; solder terminals; hermetically sealed metal and glass case.	VR101-24S51
CR107	SEMICONDUCTOR DEVICE, DIODE: silicon; 12 volts nom., ±5%; 10 watts max. dissipation at 25°C; max. current rating 210 ma; max. impedance 3.0 ohms; storage temperature 175°C.	1N2976B
CR108	SEMICONDUCTOR DEVICE, DIODE: Zener, silicon, diffused junction; reverse breakdown voltage 18 volts, ±10%; max. dynamic impedance 3 ohms; DC current rated at 500 ma; max. leakage current 10 ua at 5 volts; power dissipation 10 watts; hermetically sealed metal and glass case.	1N1819
CR109	SEMICONDUCTOR DEVICE, DIODE: Zener, nom. voltage 14 volts; power dissipation 10 watts at 25°C; current rating 180 ma; max. operating temperature 175°C; hermetically sealed.	1N2978
DS101	LAMP, INCANDESCENT: 28 volts; 0.04 amps; miniature bayonet base T-3-1/4 bulb.	BI101-1819
DS102	Same as DS101.	

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
F101	FUSE, CARTRIDGE: 1/2 amp; time delay; 1-1/4" lg. x 1/4" dia.; slow blow.	FU102-.5
F102	FUSE, CARTRIDGE: 1 amp; time lag; 1-1/4" lg. x 1/2" dia.; slow blow.	FU102-1
F103	Same as F102.	
J101	CONNECTOR, RECEPTACLE, BULKHEAD, ELECTRICAL: pressurized; 1-5/16" long; series BNC.	UG657*/U
J102	Same as J101.	
J103	Same as J101.	
J104	CONNECTOR, RECEPTACLE, ELECTRICAL: RF; 1 round female contact, straight type; 52 ohms; series BNC to BNC.	UG625*/U
J105 thru J107	Same as J104.	
J108	CONNECTOR, RECEPTACLE, ELECTRICAL: 3 number 16 male contacts; straight type.	MS3102A14S1P
J109	CONNECTOR, RECEPTACLE, ELECTRICAL: 4 number 16 male contacts; straight type.	MS3102A14S2P
J110	Same as J104.	
J111	CONNECTOR, RECEPTACLE, ELECTRICAL: 20 female, flat solid face contacts; for double sided 3/32" printed circuit board; continuous current rating 5 amps; 1800 V rms; float bushing.	JJ287-20
J112	Supplied as part of M101.	
J113	CONNECTOR, RECEPTACLE, ELECTRICAL: 15 female, flat solid face contacts; for single sided 3/32" printed circuit board; continuous current rating 5 amps; 1800 V rms; float bushing; threaded insert and dipped solder terminals.	JJ293-15STD
J114 thru J122	Same as J113.	
J123	CONNECTOR, RECEPTACLE, ELECTRICAL: 30 female, flat solid face contacts; for double sided 3/32" printed circuit board; continuous current rating 5 amps; 1800 V rms; float bushing; threaded insert and dipped solder terminals.	JJ293-15DTD
K101	RELAY, ARMATURE: DPDT; 700 ohms, ±10% DC resistance; operating voltage 24 VDC; current rating 35 ma, 700 mw at 25°C; contacts rated for 5 amps at 29 VDC; clear high impact styrene dust cover case.	RL156-1

MAIN CHASSIS ASSEMBLY

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
M101	MICROAMP METER: 10-0-10 DC range; 5-0-5 scale; voltage rating 110 VAC, 60 cycle; speed 1" per hour; resistance 1500 ohms, +5% -10%; 50 division chart paper; ±2% accuracy, full scale; clamping rate 5 second interval, black metal case.	MR184
Q101	TRANSISTOR: germanium; PNP; collector to base and emitter voltage 45 VDC at 300 ma, 30 VDC at 500 ma; emitter base voltage 25 V; collector current 3 amps; power dissipation 62.5 watts at 25°C; junction temperature range -65°C to +100°C.	2N2143
Q102	Same as Q101.	
R101 thru R104	Refer to Power Supply Assembly A3785.	
R105	RESISTOR, FIXED, COMPOSITION: 100 ohms, ±5%; 1/2 watt. Part of Z103.	RC20GF101J
R106	Same as R105. Part of Z103.	
R107	Same as R105. Part of Z103.	
R108	RESISTOR, FIXED, WIREWOUND: 100 ohms; current rating 223 ma; 5 watts. (Part of Power Supply circuit. For reference see A3785.)	RW107-18
R109	RESISTOR, FIXED, FILM: 1,500 ohms, ±1%; rated at 1/4 watt, 300 WVDC.	RN60D1501F
S101	SWITCH, TOGGLE: DPST; 2 amps rated at 250 volts, bat type handle.	ST22K
S102	Same as S101.	
S103	SWITCH, ROTARY: interlock; SPDT; rated at 15 amps for 120 or 250 VAC; .2 amps resistive at 250 VDC.	SW230
S104	SWITCH, ROTARY: 1 section, 5 positions, 30° angle of throw; non-shorting type contacts.	SW118
S105	Same as S101.	
T101	TRANSFORMER, POWER, ISOLATION, STEP-DOWN: primary input 105, 115, 125 or 210, 230, 250 V; frequency 50/60 cps, phase 1; secondary 28 V rated at 500 ma; 2-13/16" long x 2-11/16" wide x 2-3/8" high, hermetically sealed steel case.	TF269
TB101	TERMINAL BOARD, BARRIER: 5 terminals; 6-32 thread x 1/4" lg. binder head screws; phenolic black bakelite.	TM100-5
W101	WIRING HARNESS, BRANCHED, ELECTRICAL: consists of various lengths and sizes of MWC and LWC wire; coaxial cables RG174/U, and insulation sleeving.	CA900

MAIN CHASSIS ASSEMBLY

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
XDS101	LIGHT, INDICATOR: with red frosted lens; for miniature bayonet base T-3-1/4 bulb.	TS106-1
XDS102	LIGHT, INDICATOR: with green frosted lens; for miniature bayonet base T-3-1/4 bulb.	TS106-3
XF101	FUSEHOLDER: extractor post type; accommodates cartridge fuse 1/4" dia. x 1-1/4" long; rated at 15 amps, 250 V max.; o/a length 1-3/4"; bushing mounted.	FH103
XF102	Same as XF101.	
XF103	Same as XF101.	
XK101	SOCKET, RELAY: with retainer; 6 contacts, solder type terminals; black phenolic socket.	TS171-1
XQ101	SOCKET, SEMICONDUCTOR DEVICE: 2 pin contact accommodation; consisting of one socket, TMC part number TS166-S1, one chassis insulator, TMC part number TS166-M1, polarized; one terminal grounding strap; 1-37/64" x 1" max. o/a dimensions.	TS166-1
XQ102	Same as XQ101.	
Z103	PRINTED CIRCUIT BOARD ASSEMBLY: module interconnect consists of resistors, R105, R106, R107; connectors, J113 through J122.	A3810

POWER SUPPLY ASSEMBLY

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C101	Refer to Center Support Assembly A3881.	
C102	CAPACITOR, FIXED, ELECTROLYTIC: polarized; 500 uf; 15 WVDC; max. temperature range 0°C to 85°C; hermetically sealed aluminum case with clear vinyl plastic sleeve.	CE116-6VN
C103 thru C105	Same as C102.	
CR101	SEMICONDUCTOR DEVICE, DIODE: silicon; 600 volts; max. continuous DC current .50 amp at 100°C; surge current peak 75 amps; max. operating temperature 150°C; max. forward voltage drop 1.0 V; max. reverse current 1,000 ua.	1N2484
CR102 thru CR105	Same as CR101.	

POWER SUPPLY ASSEMBLY

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
R101	RESISTOR, FIXED, COMPOSITION: 470 ohms, ±10%; 1 watt.	RC32GF471K
R102	NOT USED.	
R103	RESISTOR, FIXED, COMPOSITION: 150 ohms, ±10%; 2 watts.	RC42GF151K
R104	RESISTOR, FIXED, COMPOSITION: 120 ohms, ±10%; 2 watts.	RC42GF121K
R105 thru R107	Refer to Interconnect Board Assembly A3810.	
R108	Refer to Main Chassis Center Support Assembly A3881.	

INPUT-OUTPUT MODULE

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C201	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 10,000 uuf; GMV; 500 WVDC.	CC100-16
C202 thru C204	Same as C201.	
C205	CAPACITOR, FIXED, MICA DIELECTRIC: 1,000 uuf, ±2%; 500 WVDC; straight wire leads.	CM111F102G5S
C206	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 100,000 uuf, +80% -20%; 100 WVDC.	CC100-28
C207	Same as C206.	
C208	CAPACITOR, FIXED, MICA DIELECTRIC: 120 uuf, ±5%; 500 WVDC; straight wire leads.	CM111F121J5S
C209	Same as C208.	
C210	Same as C208.	
C211	Same as C201.	
C212	CAPACITOR, VARIABLE, CERAMIC DIELECTRIC: 8-50 uuf; 500 min. Q at 1 Mc; 350 WVDC; operating temperature range -55°C to +85°C.	CV109-9
C213	CAPACITOR, FIXED, MICA DIELECTRIC: 510 uuf, ±5%; 500 WVDC; straight wire leads.	CM111F511J5S
C214	CAPACITOR, FIXED: MICA DIELECTRIC: 47 uuf, ±5%; 500 WVDC; straight wire leads.	CM111F470J5S

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
Q201	TRANSISTOR: PNP germanium, alloy junction; collector to base voltage 30 volts; collector to emitter, and emitter to base voltage 20 volts; collector current 200 ma; power dissipation 200 mw; storage temperature -65°C to +100°C; metal case.	2N396A
Q202	Same as Q201.	
Q203	TRANSISTOR: germanium, PNP; max. collector dissipation 125 mw; alpha cut-off frequency 100 mc; collector to emitter breakdown voltage, base open 20 v; max. collector current 10 ma; collector to base leakage current, emitter open 8 ma; forward current gain 100 mc.	2N2084
R201	NOT USED.	
R202	RESISTOR, FIXED, COMPOSITION: 100 ohms, ±10%; 1/2 watt.	RC20GF101K
R203	RESISTOR, FIXED, COMPOSITION: 4,700 ohms, ±10%; 1/2 watt.	RC20GF472K
R204	NOT USED.	
R205	RESISTOR, FIXED, COMPOSITION: 1,000 ohms, ±10%; 1/2 watt.	RC20GF102K
R206	Same as R205.	
R207	RESISTOR, FIXED, COMPOSITION: 2,200 ohms, ±10%; 1/2 watt.	RC20GF222K
R208	RESISTOR, FIXED, COMPOSITION: 10,000 ohms, ±10%; 1/2 watt.	RC20GF103K
R209	Same as R208.	
R210	Same as R208.	
R211	RESISTOR, FIXED, COMPOSITION: 47 ohms, ±10%; 1/2 watt.	RC20GF470K
R212	Same as R211.	
R213	RESISTOR, FIXED, COMPOSITION: 330 ohms, ±10%; 1/2 watt.	RC20GF331K
R214	RESISTOR, FIXED, COMPOSITION: 150 ohms, ±10%; 1/2 watt.	RC20GF151K
R215	Same as R214.	
R216	RESISTOR, VARIABLE, COMPOSITION: 500 ohms, ±10%; 0.25 watt at 70 C; operating temperature range -55°C to +120°C; linear taper.	RV111U501A
R217	Same as R202.	

INPUT-OUTPUT MODULE

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
T201	TRANSFORMER, RADIO FREQUENCY: adjustable; inductance rated at 790 Kc; primary 175 uh ±5%; 4 solder lug type terminals; copper can tin plated case.	TT248
T202	TRANSFORMER, RADIO FREQUENCY: adjustable; inductance rated at 790 Kc; primary 175 uh ±5%; 4 solder lug type terminals; copper can tin plated case.	TT251
T203	Same as T202.	
XY201	SOCKET, CRYSTAL: clip type; 2 cadmium plated contacts; 3/64" x 5/32" tail slots.	TS167-1
Y201	CRYSTAL UNIT, QUARTZ: nom. frequency range 800 - 20,000 Kc, ±.005%; operating temperature range -55°C to +90°C; xtal unit max. capacitance 7.0 uuf; load capacitance 32.0 ±0.5 uuf; parallel resonance; metal case and HC-6/U holder.	CR18A/U1.000,000MC

X 10 MULTIPLIER MODULE

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C301	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 10,000 uuf, GMV; 500 WVDC.	CC100-16
C302 thru C312	Same as C301.	
C313	CAPACITOR, FIXED, MICA DIELECTRIC: 120 uuf, ±5%; 500 WVDC; straight wire leads.	CM111F121J5S
C314	CAPACITOR, FIXED, MICA DIELECTRIC: 220 uuf, ±5%; 500 WVDC; straight wire leads.	CM111F221J5S
C315	CAPACITOR, FIXED, MICA DIELECTRIC: 82 uuf, ±5%; 500 WVDC; straight wire leads.	CM111F820J5S
C316	CAPACITOR, FIXED, MICA DIELECTRIC: 68 uuf, ±5%; 500 WVDC; straight wire leads.	CM111F680J5S
C317	Same as C313.	
C318	Same as C313.	
C319	Same as C314.	
C320	CAPACITOR, FIXED, MICA DIELECTRIC: 47 uuf, ±5%; 500 WVDC; straight wire leads.	CM111F470J5S
C321	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 100,000 uuf, +80% -20%; 100 WVDC.	CC100-28

X 10 MULTIPLIER MODULE

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C322	Same as C321.	
C323	CAPACITOR, FIXED, MICA DIELECTRIC: 10 uuf, ±10%; 500 WVDC; straight wire leads.	CM111C100K5S
C324	CAPACITOR, VARIABLE, CERAMIC DIELECTRIC: 8-50 uuf; 500 min. Q at 1 mc; 350 WVDC; operating temperature range -55°C to +85°C.	CV109-9
L301	COIL, RADIO FREQUENCY: adjustable; inductance rated at 7.9 mc; primary 5.5 uh, ±5%; 4 solder lug type terminals; copper can tin plated case.	AC207
L302	COIL, RADIO FREQUENCY: fixed; 33 uf, ±5%; 1.2 ohms DC resistance; current rating 520 ma; molded case.	CL275-330
Q301	TRANSISTOR: PNP, germanium, alloy junction; collector to base voltage 30 volts; collector to emitter and emitter to base voltage 20 volts; collector current 200 ma; power dissipation 200 mw; storage temperature -65°C to +100°C; metal case.	2N396A
Q302	TRANSISTOR: PNP, germanium; max. collector dissipation 125 mw; alpha cut-off frequency 100 mc; collector to emitter breakdown voltage, base open 20 V; max. collector current 10 ma; collector to base leakage current, emitter open 8 ma; forward current gain 100 mc.	2N2084
Q303	Same as Q302.	
Q304	Same as Q302.	
Q305	Same as Q301.	
Q306	Same as Q301.	
R301	RESISTOR, FIXED, COMPOSITION: 120 ohms, ±10%; 1/2 watt.	RC20GF121K
R302	RESISTOR, FIXED, COMPOSITION: 1,000 ohms, ±10%; 1/2 watt.	RC20GF102K
R303 thru R307	Same as R302.	
R308	RESISTOR, FIXED, COMPOSITION: 3,300 ohms, ±10%; 1/2 watt.	RC20GF332K
R309	RESISTOR, FIXED, COMPOSITION: 100 ohms, ±10%; 1/2 watt.	RC20GF101K
R310	Same as R309.	
R311	Same as R309.	
R312	RESISTOR, FIXED, COMPOSITION: 150 ohms, ±10%; 1/2 watt.	RC20GF151K

X 10 MULTIPLIER MODULE

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
R313	Same as R312.	
R314	Same as R312.	
R315	RESISTOR, FIXED, COMPOSITION: 220 ohms, ±10%; 1/2 watt.	RC20GF221K
R316	RESISTOR, FIXED, COMPOSITION: 330 ohms, ±10%; 1/2 watt.	RC20GF331K
R317	RESISTOR, FIXED, COMPOSITION: 10,000 ohms, ±10%; 1/2 watt.	RC20GF103K
R318 thru R320	Same as R317.	
R321	RESISTOR, FIXED, COMPOSITION: 15,000 ohms, ±10%; 1/2 watt.	RC20GF153K
R322	RESISTOR, FIXED, COMPOSITION: 27,000 ohms, ±10%; 1/2 watt.	RC20GF273K
R323	RESISTOR, VARIABLE, COMPOSITION: 500 ohms, ±10%; power rating 0.25 watt at 70°C; operating temperature -55°C to +120°C; linear taper.	RV111U501A
R324	RESISTOR, FIXED, COMPOSITION: 47 ohms, ±10%; 1/2 watt.	RC20GF470K
T301	TRANSFORMER, RADIO FREQUENCY: adjustable; inductance rated at 790 Kc; primary 175 uh, ±5%; 4 solder lug type terminals, copper can tin plated case.	TT251
T302	TRANSFORMER, RADIO FREQUENCY: adjustable; inductance rated at 7.9 mc; primary 5.5 uh, ±5%; 4 solder lug type terminals; copper can tin plated case.	TT250
T303	TRANSFORMER, RADIO FREQUENCY: adjustable; inductance rated at 7.9 mc; primary 3 uh, ±5%; 4 solder lug type terminals; copper can tin plated case.	TT249
T304	TRANSFORMER, RADIO FREQUENCY: adjustable; inductance rated at 7.9 mc; primary 4.5 uh, ±5%; 4 solder lug type terminals; copper can tin plated case.	TT247
T305	TRANSFORMER, RADIO FREQUENCY: adjustable; inductance rated at 790 Kc; primary 175 uh, ±5%; 4 solder lug type terminals; copper can tin plated case.	TT248
T306	Same as T301.	
XY301	SOCKET, CRYSTAL: clip type; 2 cadmium plated contacts; 3/64" x 5/32" tail slots.	TS167-1

X 10 MULTIPLIER MODULE

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
*Y301	CRYSTAL UNIT, QUARTZ: nom. frequency range 800 - 20, 000 Kc, ±.005%; operating temperature range -55° C to +90°C; xtal unit max. capacitance 7.0 uuf; load capacitance 32.0 uuf, ±0.5 uuf; parallel resonance; metal case and HC-6/U holder.	CR18A/U1.000,000MC

*Y301 shall be omitted and replaced with a jumper on A3786-1 sym. Z304.

X 9 MULTIPLIER MODULE

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C401	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 10,000 uuf; GMV; 500 WVDC.	CC100-16
C402 thru C408	Same as C401.	
C409	CAPACITOR, FIXED, MICA DIELECTRIC: 120 uuf, ±5%; 500 WVDC; straight wire leads.	CM111F121J5S
C410	CAPACITOR, FIXED, MICA DIELECTRIC: 330 uuf, ±5%; 500 WVDC; straight wire leads.	CM111F331J5S
C411	CAPACITOR, FIXED, MICA DIELECTRIC: 68 uuf, ±5%; 500 WVDC; straight wire leads.	CM111F680J5S
C412	Same as C411.	
C413	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 100,000 uuf, +80% -20%; 100 WVDC.	CC100-28
C414	Same as C413.	
C415	CAPACITOR, VARIABLE, CERAMIC DIELECTRIC: 8-50 uuf; 500 min Q at 1 Mc; 350 WVDC; operating temperature range -55°C to +85°C.	CV109-9
Q401	TRANSISTOR: PNP, germanium, alloy junction; collector to base voltage 30 volts; collector to emitter and emitter to base voltage 20 volts; collector current 200 ma; power dissipation 200 mw; storage temperature -65°C to +100°C; metal case.	2N396A
Q402	TRANSISTOR: germanium, PNP; max. collector dissipation 125 mw; alpha cut-off frequency 100 mc; collector to emitter breakdown voltage, base open 20 V; max. collector current 10 ma; collector to base leakage current, emitter open 8 ma; forward current gain 100 mc.	2N2084
Q403	Same as Q402.	
Q404	Same as Q402.	

X 9 MULTIPLIER MODULE

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
R401	RESISTOR, FIXED, COMPOSITION: 1,000 ohms, ±10%; 1/2 watt.	RC20GF102K
R402 thru R404	Same as R401.	
R405	RESISTOR, FIXED, COMPOSITION: 10,000 ohms, ±10%; 1/2 watt.	RC20GF103K
R406 thru R408	Same as R405.	
R409	RESISTOR, FIXED, COMPOSITION: 100 ohms, ±10%; 1/2 watt.	RC20GF101K
R410 thru R412	Same as R409.	
R413	RESISTOR, FIXED, COMPOSITION: 330 ohms, ±10%; 1/2 watt.	RC20GF331K
R414	RESISTOR, FIXED, COMPOSITION: 47 ohms, ±10%; 1/2 watt.	RC20GF470K
R415	RESISTOR, FIXED, COMPOSITION: 120 ohms, ±10%; 1/2 watt.	RC20GF121K
R416	RESISTOR, FIXED, COMPOSITION: 150 ohms, ±10%; 1/2 watt.	RC20GF151K
R417	Same as R416.	
T401	TRANSFORMER, RADIO FREQUENCY: adjustable; inductance rated at 790 Kc; primary 175 uh, ±5%; 4 solder lug type terminals; copper can tin plated case.	TT251
T402	TRANSFORMER, RADIO FREQUENCY: adjustable; inductance rated at 2.5 mc; primary 10 uh, ±5%; 4 solder lug type terminals; copper can tin plated case.	TT253
T403	TRANSFORMER, RADIO FREQUENCY: adjustable; inductance rated at 7.9 mc; primary 4.5 uh, ±5%; 4 solder lug type terminals; copper can tin plated case.	TT247
T404	Same as T403.	
XY401	SOCKET, CRYSTAL: clip type; 2 cadmium plated contacts; 3/64" x 5/32" tail slots.	TS167-1
Y401	CRYSTAL UNIT, QUARTZ: nom. frequency range 800-20,000 Kc, ±.005%; operating temperature range -55°C to +90°C; xtal unit max. capacitance 7.0 uuf; load capacitance 32.0 ±0.5 uuf; parallel resonance; metal case and HC-6/U holder.	CR18A/U9.000,000MC

MIXER-AMPLIFIER MODULE

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C501	CAPACITOR, FIXED, ELECTROLYTIC: 200 uuf, -10% +150% at 120 cps, at 25°C; 15 WVDC; polarized; insulated tubular case.	CE105-200-15
C502	Same as C501.	
C503	CAPACITOR, FIXED, ELECTROLYTIC: 20 uuf, -10% +150% at 120 cps, at 25°C; 25 WVDC; polarized; insulated tubular case.	CE105-20-25
C504 thru C505	Same as C503.	
C509	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 100,000 uuf, +80% -20%; 100 WVDC.	CC100-28
C510 thru C514	Same as C509.	
C515	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 10,000 uuf; GMV; 500 WVDC.	CC100-16
C516 thru C520	Same as C515.	
C521	CAPACITOR, FIXED, MICA DIELECTRIC: 390 uuf, ±5%; 500 WVDC; straight wire leads.	CM111F391J5S
C522	CAPACITOR, FIXED, MICA DIELECTRIC: 220 uuf, ±5%; 500 WVDC; straight wire leads.	CM111F221J5S
C523	CAPACITOR, VARIABLE, CERAMIC DIELECTRIC: 8-50 uuf; 500 min. Q at 1 Mc; 350 WVDC; operating temperature range -55°C to +85°C.	CV109-9
C524	CAPACITOR, FIXED, MICA DIELECTRIC: 100 uuf, ±10%; 500 WVDC; straight wire leads.	CM111C101K5S
C525	CAPACITOR, FIXED, MICA DIELECTRIC: 10 uuf, ±10%; 500 WVDC; straight wire leads.	CM111C100K5S
C526	CAPACITOR, FIXED, MICA DIELECTRIC: 1,000 uuf, ±5%; 300 WVDC; straight wire leads.	CM112F102J3S
C527	Same as C526.	
C528	Same as C509.	
C529	Same as C509.	
L501	COIL, RADIO FREQUENCY: fixed; 2,200 uh, ±5%; 33.7 ohms DC resistance; current rating 99 ma, molded case.	CL275-222
L502	Same as L501.	

MIXER-AMPLIFIER MODULE

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
L503	COIL, RADIO FREQUENCY: fixed; 1,000 uh, ±5%; 16.0 ohms DC resistance; current rating 140 ma; molded case.	CL275-102
L504	Same as L503.	
Q501	TRANSISTOR: PNP, germanium, alloy junction; collector to base voltage 30 volts; collector to emitter and emitter to base voltage 20 volts; collector current 200 ma; power dissipation 200 mw; storage temperature -65°C to +100°C; metal case.	2N396A
Q502 thru Q504	Same as Q501.	
Q505	TRANSISTOR: NPN diffused silicon; collector to base voltage 25 volts; collector to emitter voltage 20 volts; emitter to base voltage 3 volts; collector current 200 ma; power dissipation 1 watt at 25°C; junction temperature -65°C to +175°C; metal case.	2N706
Q506	Same as Q505.	
Q507	Same as Q505.	
R501	RESISTOR, FIXED, COMPOSITION: 47 ohms, ±10%; 1/2 watt.	RC20GF470K
R502 thru R504	Same as R501.	
R505	RESISTOR, FIXED, COMPOSITION: 150 ohms, ±10%; 1/2 watt.	RC20GF151K
R506	Same as R505.	
R507	RESISTOR, FIXED, COMPOSITION: 1,500 ohms, ±10%; 1/2 watt.	RC20GF152K
R508	Same as R507.	
R509	RESISTOR, FIXED, COMPOSITION: 3,300 ohms, ±10%; 1/2 watt.	RC20GF332K
R510	Same as R509.	
R511	RESISTOR, FIXED, COMPOSITION: 1,000 ohms, ±10%; 1/2 watt.	RC20GF102K
R512	Same as R511.	
R513	RESISTOR, FIXED, COMPOSITION: 2,200 ohms, ±10%; 1/2 watt.	RC20GF222K
R514	Same as R513.	
R515	RESISTOR, FIXED, COMPOSITION: 4,700 ohms, ±10%; 1/2 watt.	RC20GF472K

MIXER-AMPLIFIER MODULE

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
R516	Same as R515.	
R517	Same as R515.	
R518	Same as R511.	
R519	Same as R511.	
R520	RESISTOR, FIXED, COMPOSITION: 10,000 ohms, ±10%; 1/2 watt.	RC20GF103K
R521 thru R525	Same as R520.	
R526	RESISTOR, FIXED, COMPOSITION: 22,000 ohms, ±10%; 1/2 watt.	RC20GF223K
T501	TRANSFORMER, RADIO FREQUENCY: adjustable; inductance rated at 2.5 mc; primary 25.3 uh, ±5%; 4 solder lug type terminals; copper can tin plated case.	TT252
T502	Same as T501.	
XY501	SOCKET, CRYSTAL: clip type; 2 cadmium plated contacts; 3/64" x 5/32" tail slots.	TS167-1
Y501	CRYSTAL UNIT, QUARTZ: nom. frequency range 800-20,000 Kc, ±.005%; operating temperature range -55°C to +90°C; xtal unit max. capacitance 7.0 uuf; load capacitance 32.0 uuf, ±0.5 uuf; parallel resonance; metal case and HC-6/U holder.	CR18A/U1.000,000MC

OUTPUT MODULE

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C601	CAPACITOR, FIXED, ELECTROLYTIC: 10 uuf, -10%, +150% at 120 cps, at 25°C; 15 WVDC; polarized; insulated tubular case.	CE105-10-15
C602	Same as C601.	
C603	CAPACITOR, FIXED, MICA DIELECTRIC: 220 uuf, ±5%; 500 WVDC; straight wire leads.	CM111F221J5S
C604	Same as C603.	
C605	CAPACITOR, FIXED, ELECTROLYTIC: polarized; 2,000 uf; 12 WVDC; max. temperature range 0°C to +85°C; hermetically sealed aluminum case with vinyl plastic sleeve.	CE116-9VN
C606	Same as C605.	

OUTPUT MODULE

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C607	CAPACITOR, FIXED, METALIZED PLASTIC: 1.0 uf; ±1%; 100 WVDC.	CN112A105F1
C608	Same as C607.	
CR601	SEMICONDUCTOR DEVICE, DIODE: germanium; max. peak inverse voltage 60 V; continuous average forward current 50 ma; max. peak forward current 150 ma; max. surge current 500 ma; max. inverse current 500 ua at 50 volts or 30 ua at 10 volts.	1N34A
CR602	Same as CR601.	
CR603	SEMICONDUCTOR DEVICE, DIODE: silicon; max. peak inverse voltage 175 V; current rating 30 ma at 25°C or 15 ma at 150°C; two axial wire lead type terminals; hermetically sealed glass case.	1N463
CR604	Same as CR603.	
CR605	SEMICONDUCTOR DEVICE, DIODE: nom. Zener voltage 12 V rated at 21 ma; DC current rating 70 ma; power dissipation 1 watt; junction storage temperature rating -65°C to +175°C; polarized; hermetically sealed metal and glass case.	1N3022B
Q601	TRANSISTOR: NPN diffused silicon; collector to base voltage 25 volts; collector to emitter voltage 20 volts; emitter to base voltage 3 volts; collector current 200 ma; power dissipation 1 watt at 25°C; junction temperature -65°C to +175°C; metal case.	2N706
Q602 thru Q604	Same as Q601.	
*Q605	TRANSISTOR: NPN diffused silicon. (Match with Q606 only.)	TX102
*Q606	TRANSISTOR: NPN diffused silicon. (Match with Q605 only.)	
*Q607	TRANSISTOR: NPN diffused silicon. (Match with Q608 only.)	TX102
*Q608	TRANSISTOR: NPN diffused silicon. (Match with Q607 only.)	
R601	RESISTOR, FIXED, COMPOSITION: 10,000 ohms, ±5%; 1/2 watt.	RC20GF103J
R602	Same as R601.	
R603	POTENTIOMETER, PRECISION, NON-WIREWOUND: 10,000 ohms, ±10%; power rating, 1 watt at 85°C, derate to 0 at 175°C; pin type terminals; plastic housing.	RV115-1-103

*(Q605, Q606) and (Q607, Q608) are supplied as matched pairs, and should only be replaced as matched pairs.

OUTPUT MODULE

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
R604	RESISTOR, FIXED, COMPOSITION: 4,700 ohms, ±5%; 1/2 watt.	RC20GF472J
R605	Same as R604.	
R606	RESISTOR, FIXED, COMPOSITION: 560 ohms, ±5%; 1 watt.	RC32GF561J
R607	Same as R606.	
R608	POTENTIOMETER, PRECISION, NON-WIREWOUND: 5,000 ohms, ±10%; power rating, 1 watt at 85°C, derate to 0 at 175°C; pin type terminals; plastic housing.	RV115-1-502
R609	POTENTIOMETER, PRECISION, NON-WIREWOUND: 50,000 ohms, ±10%; power rating, 1 watt at 85°C, derate to 0 at 175°C; pin type terminals; plastic housing.	RV115-1-503
R610	POTENTIOMETER, PRECISION, NON-WIREWOUND: 100 ohms, ±10%; power rating, 1 watt at 85°C, derate to 0 at 175°C; pin type terminals; plastic housing.	RV115-1-101
R611	RESISTOR, FIXED, FILM: 4,700 ohms, ±1%; rated at 1/4 watt, 300 WVDC.	RN60D4701F
R612	RESISTOR, FIXED, FILM: 1,000 ohms, ±1%; rated at 1/4 watt, 300 WVDC.	RN60D1001F
R613	Same as R612.	
R614	Same as R611.	
R615	RESISTOR, FIXED, FILM: 15,000 ohms, ±1%; rated at 1/4 watt, 300 WVDC.	RN60D1502F
R616	Same as R615.	
R617	RESISTOR, FIXED, FILM: 560 ohms, ±1%; rated at 1/4 watt, 300 WVDC.	RN60D5600F
R618	Same as R617.	
R619	RESISTOR, FIXED, FILM: 270 ohms, ±1%; rated at 1/4 watt, 300 WVDC.	RN60D2740F
R620 thru R622	Same as R619.	
R623	NOT USED.	
R624	RESISTOR, FIXED, COMPOSITION: 1,000 ohms, ±5%; 1/2 watt.	RC20GF102J
R625	Same as R624.	

SECTION 7
SCHEMATIC DIAGRAMS

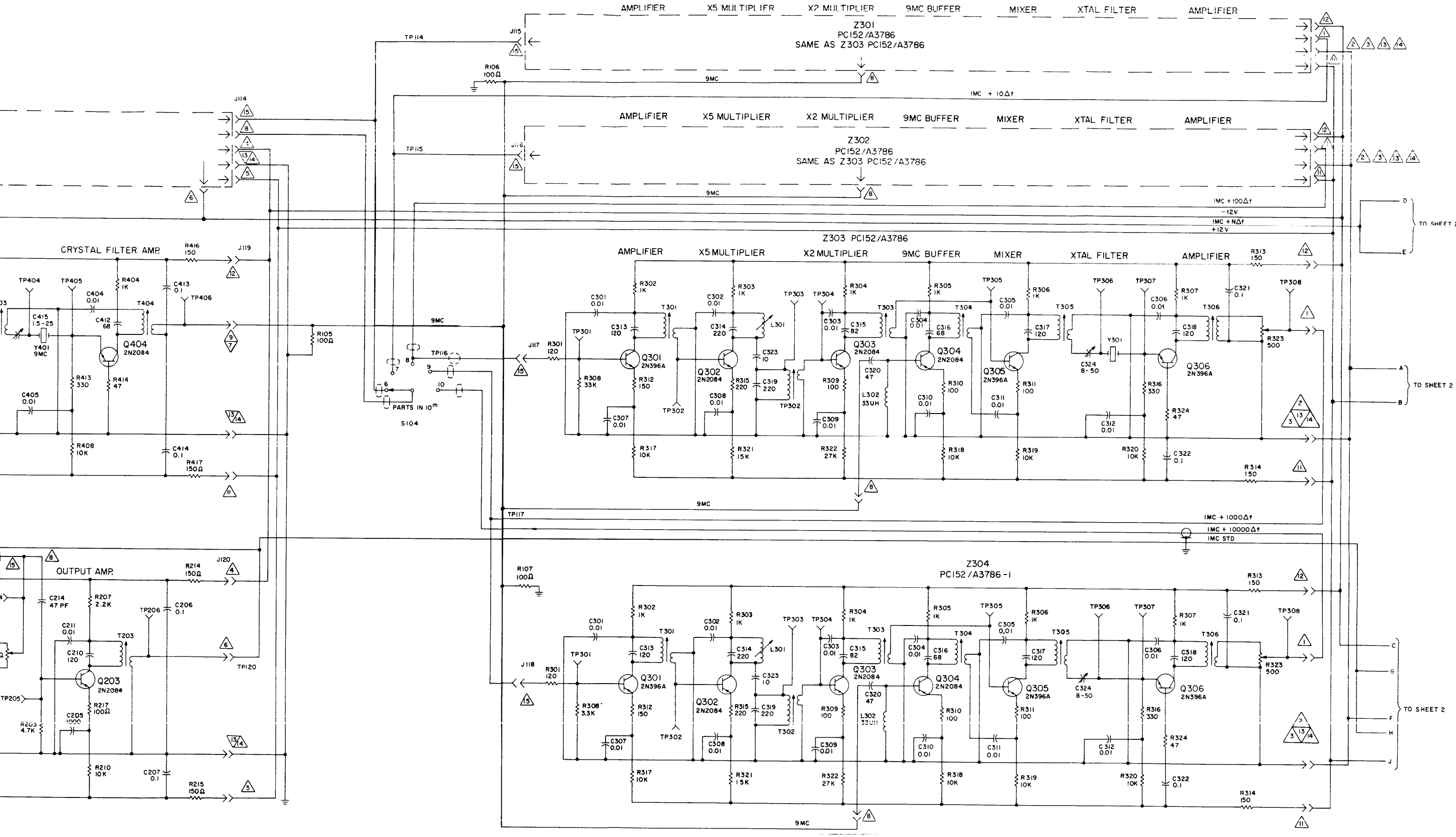
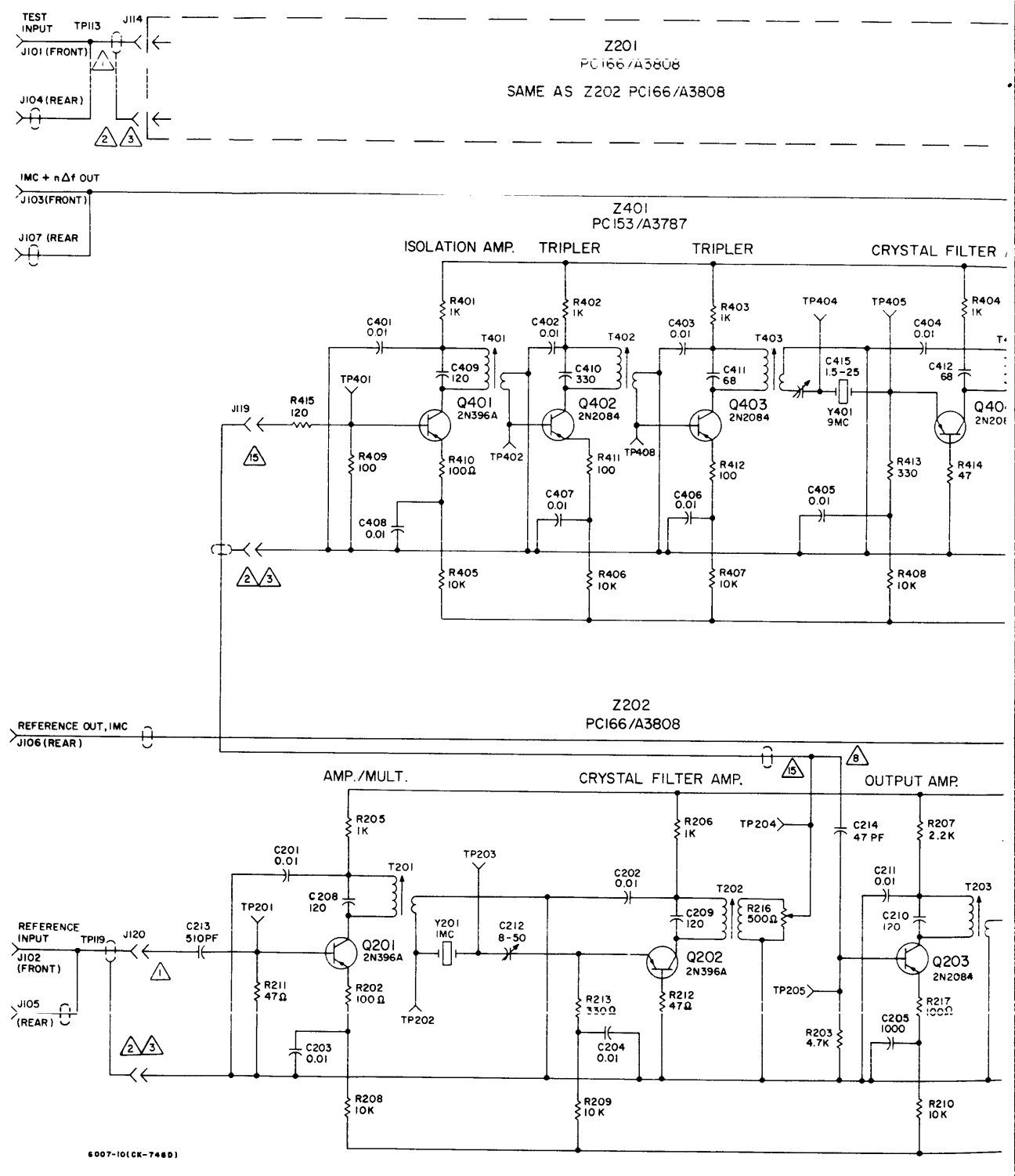
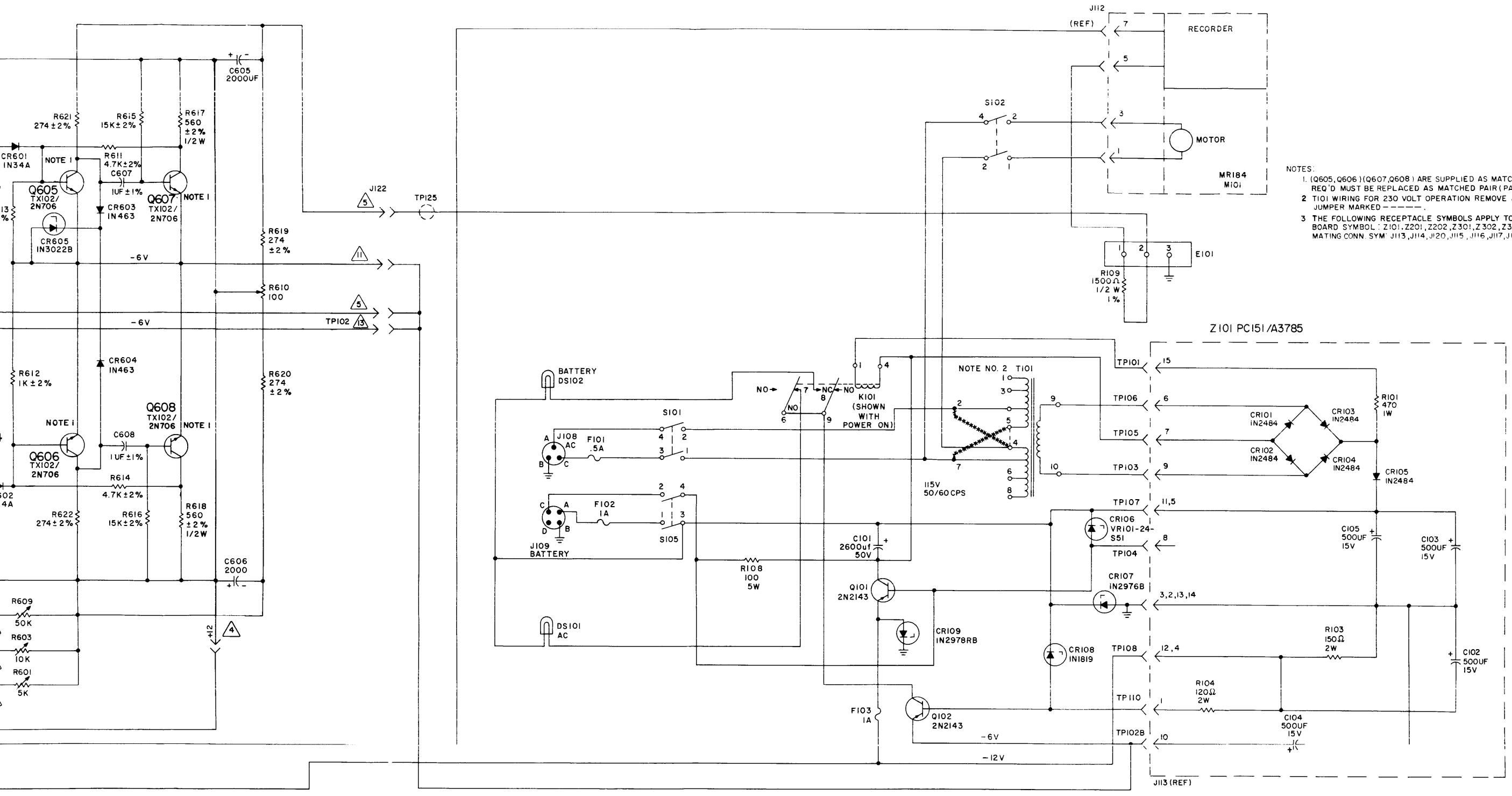


Figure 7-1. PFCB, Schematic Diagram
(Sheet 1 of 2)


TEST INPUT
TP113
J114
J101 (FRONT)
J104 (REAR)
Z201
PC166/A3808
SAME AS Z202 PC166/A3808
IMC + nΔf OUT
J103(FRONT)
J107 (REAR
Z401
PC153/A3787
ISOLATION AMP.
TRIPLER
TRIPLER
CRYSTAL FILTER
J119
R415 120
TP401
TP402
TP408
TP404
TP405
Q401 2N396A
Q402 2N2084
Q403 2N2084
Y401 9MC
C415 1.5-25
R401 1K
R402 1K
R403 1K
R404 1K
C401 0.01
C402 0.01
C403 0.01
C404 0.01
C409 120
C410 330
C411 68
C412 68
T401
T402
T403
R409 100
R410 100Ω
R411 100
R412 100
R413 330
R414 47
C405 0.01
C406 0.01
C407 0.01
C408 0.01
R405 10K
R406 10K
R407 10K
R408 10K
Z202
PC166/A3808
REFERENCE OUT, IMC
J106 (REAR)
AMP./MULT.
CRYSTAL FILTER AMP.
OUTPUT AMP.
REFERENCE INPUT
J102 (FRONT)
J105 (REAR)
TP119
J120
TP201
TP202
TP203
TP204
TP205
Q201 2N396A
Q202 2N396A
Q203 2N2084
Y201 IMC
C213 510PF
C212 8-50
R205 1K
R206 1K
C201 0.01
C202 0.01
C208 120
C209 120
C214 47 PF
R207 2.2K
C211 0.01
C210 120
T201
T202
T203
R216 500Ω
R211 47Ω
R202 100Ω
R212 47Ω
R213 330Ω
R217 100Ω
R203 4.7K
C205 1000
C203 0.01
C204 0.01
R208 10K
R209 10K
R210 10K
6007-101(CK-7465)

002666007

ONE SHOT M.V.



NOTES:

1. (Q605, Q606) (Q607, Q608) ARE SUPPLIED AS MATCHED PAIRS, AND IF REPLACEMENT REQ'D MUST BE REPLACED AS MATCHED PAIR (PART NO. TX102/2N706
2. T101 WIRING FOR 230 VOLT OPERATION REMOVE JUMPERS MARKED * * * * AND ADD JUMPER MARKED - - - - - .
3. THE FOLLOWING RECEPTACLE SYMBOLS APPLY TO THE PC BOARDS AS FOLLOWS:
   BOARD SYMBOL: Z101, Z201, Z202, Z301, Z302, Z303, Z304, Z401, Z501, Z601.
   MATING CONN. SYM: J113, J114, J120, J115, J116, J117, J118, J119, J121, J122.

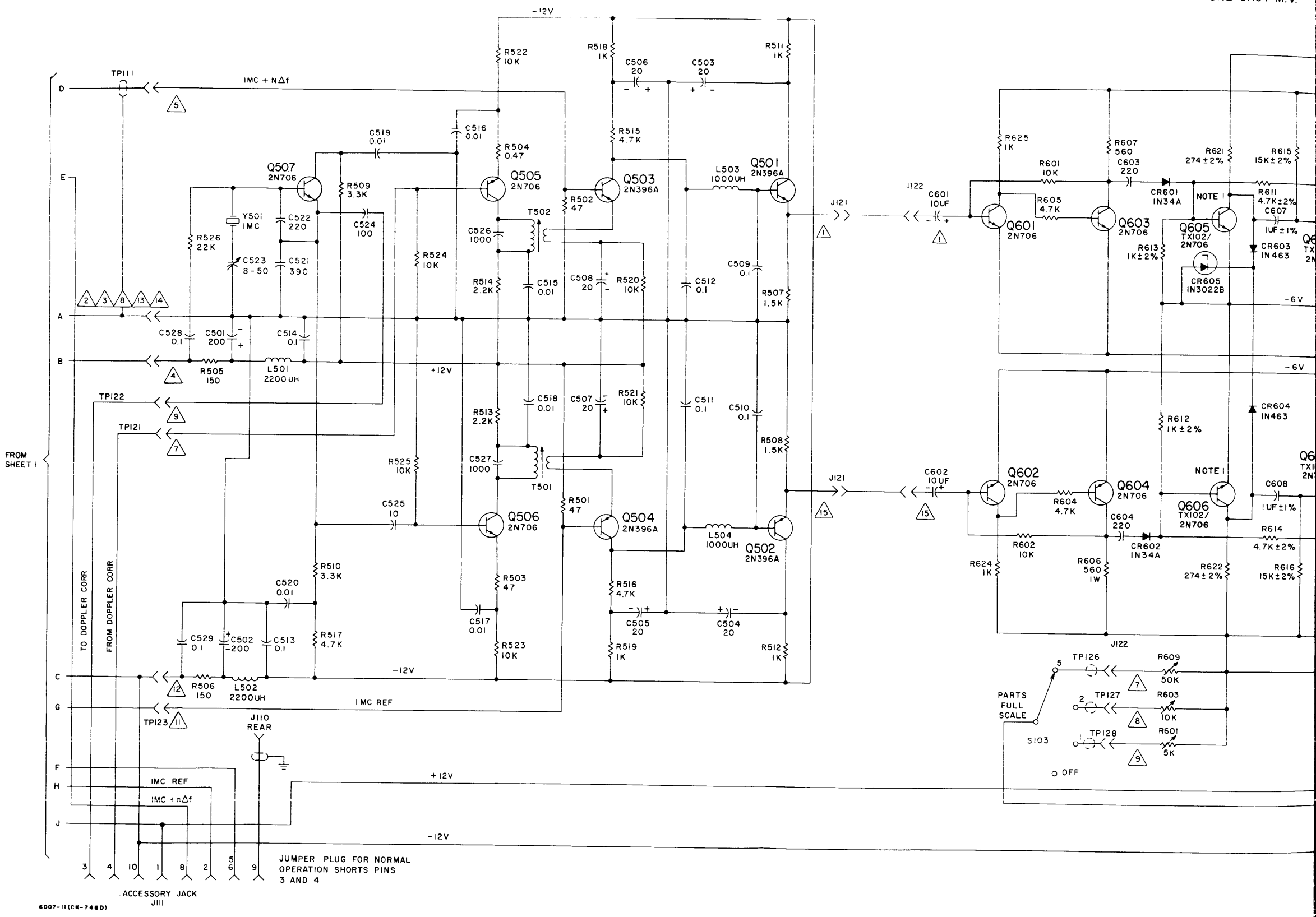
Figure 7-1. PFCB, Schematic Diagram (Sheet 2 of 2)

Z501
PC149/A3783

1 MC OSCILLATOR | BUFFER | MIXER | AMPLIFIER

Z601
PC167/A3809

SCHMITT TRIGGER | ONE SHOT M.V.



6007-11(CK-746D)

002666007