DOPPLER CORR.

TECHNICAL MANUAL

for

DOPPLER CORRECTOR

WORLD WIDE SUPPLIERS OF ELECTRONIC COMMUNICATIONS EQUIPMENT

THE TECHNICAL MATERIEL CORPORATION

MAMARONECK, N. Y. OTTAWA, CANADA

TECHNICAL MANUAL

for

DOPPLER CORRECTOR

THE TECHNICAL MATERIEL CORPORATION

MAMARONECK, N. Y. OTTAWA, CANADA

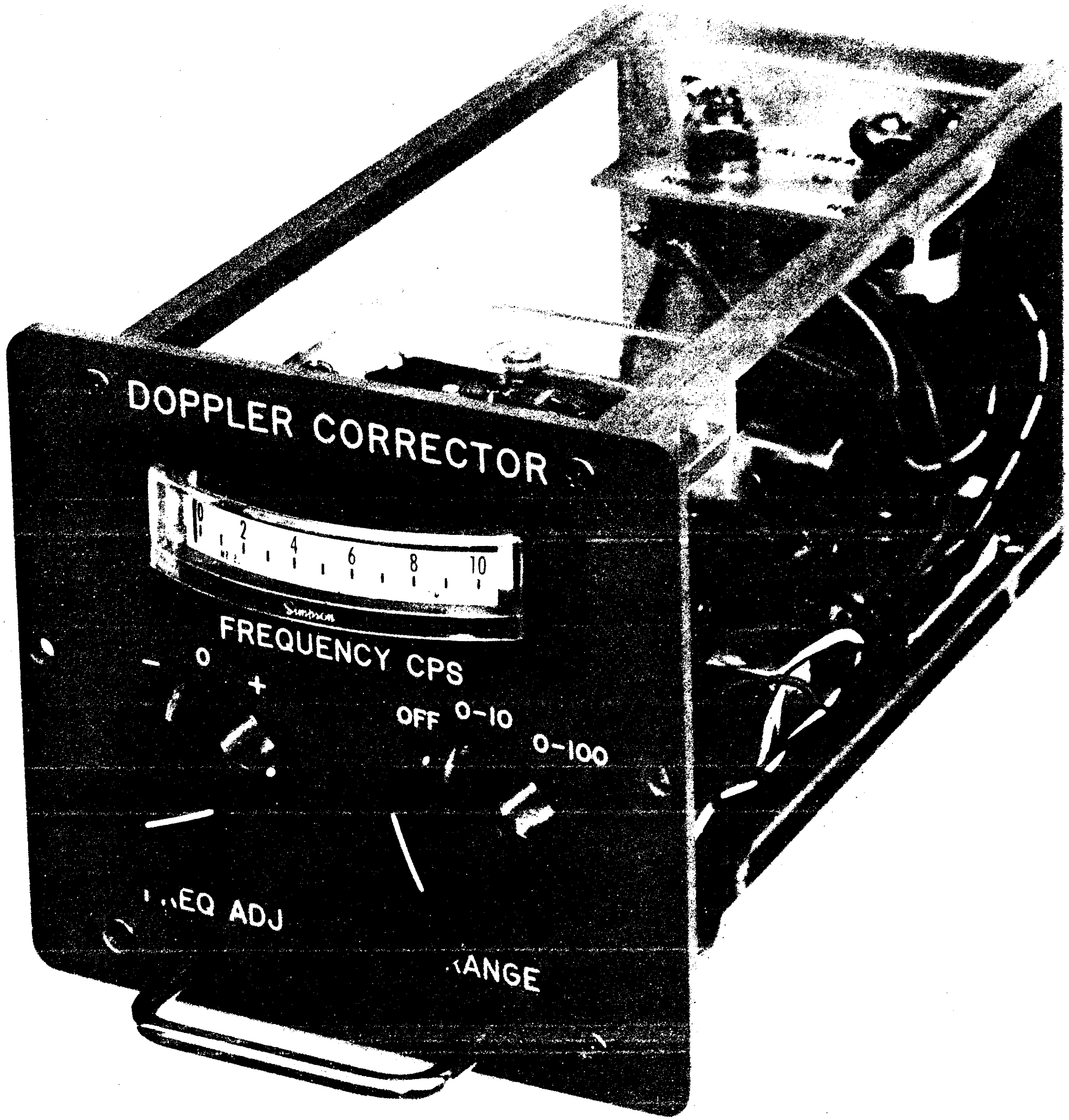


Figure 1-1. Doppler Corrector

SECTION 1

GENERAL INFORMATION

1-1. PURPOSE OF EQUIPMENT.

The Doppler Corrector (figure 1-1), is a highly precise doppler frequency corrector which operates as part of TMC model PFCB-1, Precision Frequency Comparator (hereafter referred to as the PFCB). It serves to compensate for doppler effects being received by a receiving site, such as a ship moving to and from the transmitting origin. The magnitude of doppler error is manually adjusted for and displayed in cycles by a front panel meter. Since the Doppler Corrector is considered to be an accessory unit for the PFCB, reference should be made to the PFCB Technical Manual for a better understanding of the integrated system.

1-2. DESCRIPTION OF EQUIPMENT.

The Doppler Corrector is a compact transistorized unit which mounts in an accessory compartment of the PFCB. It is comprized of two front panel controls, two internal controls, a front panel meter and a printed board containing eight transistor stages. These components are housed and secured to the main frame of the Doppler Corrector.

All wiring on the printed circuit board (or module) terminates in a multiple-conductor connector. The connector mates with a compatible jack on the main chassis of the PFCB, when the module is properly positioned.

All operating controls including a doppler frequency indicating type meter are located on the front panel. Power for the transistor circuits mounted on the printed circuit board is normally controlled by RANGE switch S801.

Dimensionally, the Doppler Corrector measures __ inches high by_____ inches deep on a___ inches wide front panel. Unit weight is approximately_____ lbs.

1-3. ELECTRICAL CHARACTERISTICS.

Correction Range:	0 to 50 knots.
Frequency Range:	±100 cycles at 1 mc.
Outputs:	
Frequency Meter	0 to 10 cycles or 0 to 100 cycles.
Electronic	1 volt peak-to-peak minimum available for use with digital counter.
Correction:	1,000,000 to 1,000,200 cycles per second.
Environmental:	
Temperature	Between 0 to 50 degrees C.
Humidity	Between 0 to 90 percent relative humidity.
Power Requirements:	Operates on plus and minus source potentials of 12 volts dc.

1-4. TRANSISTOR AND DIODE COMPLEMENT.

Table 1-1 lists the transistors and diodes for the Doppler Corrector.

TABLE 1-1. TRANSISTOR AND DIODE COMPLEMENT

REFERENCE SYMBOL	TYPE	FUNCTION
Q801	2N706	Buffer amplifier
Q802	2N706	Oscillator
Q803	2N706	Buffer amplifier
Q804	2N396A	Mixer-Amplifier
Q805, Q806	2N706	Multivibrator
Q807, Q808	2N706	Schmitt trigger
CR801	1N3022	12-volt Zener diode
CR802	1N34A	Rectifier
CR803	1N34A	Rectifier

SECTION 2

INSTALLATION

2-1. INITIAL INSPECTION.

Each Doppler Corrector has been calibrated and tested at the factory before shipment. Upon arrival at the operating site, inspect the packaging case and its contents immediately for possible damage. Unpack the equipment carefully. Inspect all packing material for parts which may have been shipped as loose items.

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.

The Doppler Corrector is wired at the factory to operate with source potentials of plus and minus 12 volts dc. These potentials are readily available when the Doppler Corrector is installed as part of the PFCB.

2-3. INSTALLATION.

The Doppler Corrector is designed for installation as a PFCB accessory unit. To install the Doppler Corrector, proceed as follows:

NOTE

> This procedure assumes that the PFCB has been previously installed into a 19-inch equipment rack and is in good order.

a. Set POWER switch S101 on the PFCB to lower (off) position.

b. If necessary, remove accessory interconnect module from accessory compartment.

c. Install Doppler Corrector into accessory compartment.

d. Set RANGE switch S801 to OFF.

e. Adjust FREQ ADJ control C823 to 0.

SECTION 3

OPERATOR'S SECTION

3-1. GENERAL.

This section contains instructions for operating the Doppler Corrector when installed with the accessory compartment of the PFCB. All instructions assume that the Doppler Corrector as well as the PFCB have both been checked and are in good working order.

3-2. OPERATING CONTROLS, AND INDICATORS.

Figure 3-1 shows front panel callouts with index numbers for locating the controls and indicators of the Doppler Corrector. The function of each control and indicator, the locating index number, together with their nomenclature and reference designation are given in table 3-1.

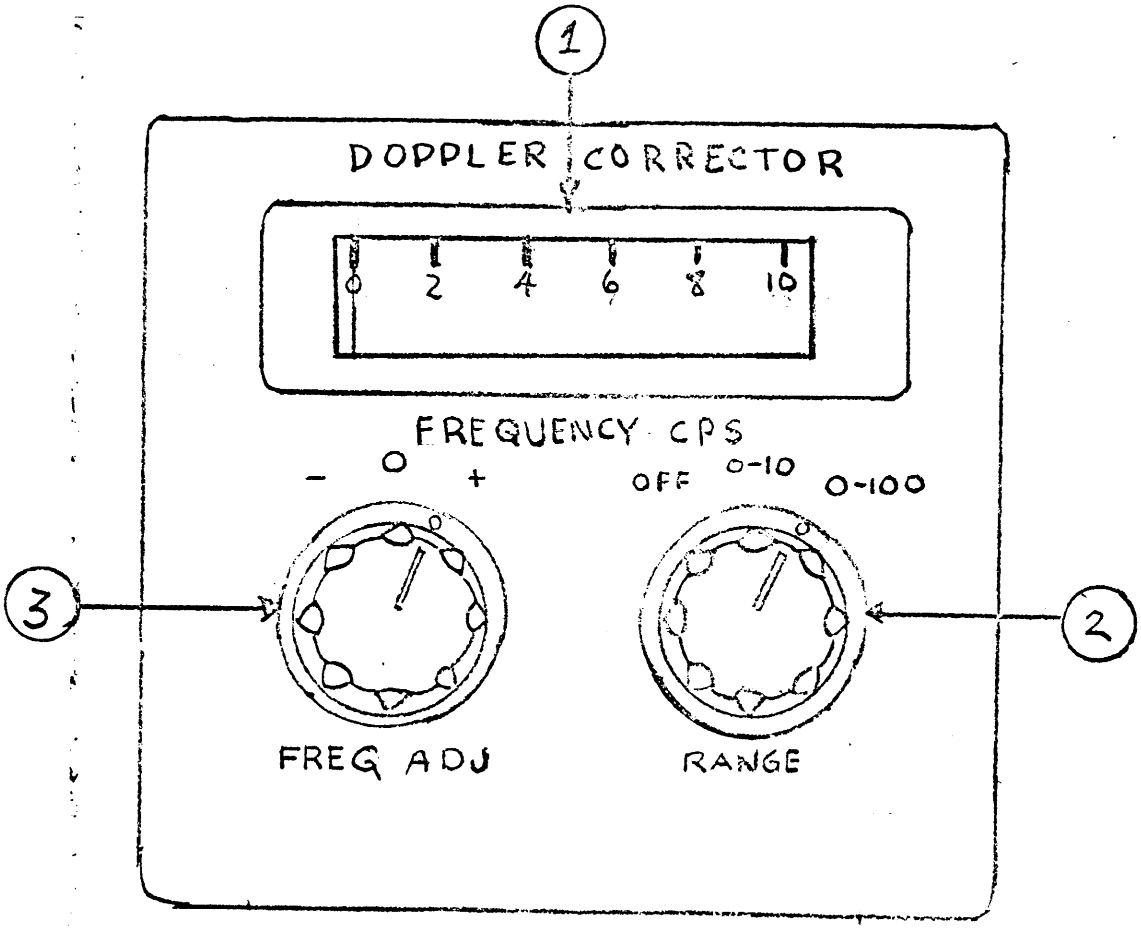


Figure 3-1. Front Panel Controls and Indicators

TABLE 3-1. FRONT PANEL CONTROLS AND INDICATORS

INDEX NO.	CONTROL OR INDICATOR	FUNCTION
1	FREQUENCY CPS meter M801	Monitors the doppler correction frequency in cycles, in the frequency range as selected by RANGE switch S801.
2	RANGE switch S801	A three position switch, the positions of which are as follows: OFF, 0-10 and 0-100. The switch is manually operated in conjunction with FREQUENCY CPS meter M801 to monitor the doppler correction frequency within the 0-10 or 0-100 cycle range. In the OFF position, disconnects FREQUENCY CPS meter M801 and the -12 volts dc from the Doppler Corrector.
3	FREQ ADJ control C823	Adjusted to doppler correction frequency. Varies 1 mc frequency of internal oscillator between 1 mc and 1 mc plus 200 cycles.

3-3. OPERATING INSTRUCTIONS.

The Doppler Corrector when used on board ship as part of a Very Low Frequency Standard Comparison System, such as the TMC Model VLFC-1, can perform one additional function other than correcting for doppler effects within the system. That is, obtaining ship's exact speed. In both instances, (when correcting for doppler effects or obtaining ship's exact speed) the Doppler Corrector is best suited for short term measurements.

Since operation of the Doppler Corrector cannot be entirely divorced from that of the PFCB, certain procedures pertaining to the PFCB will be given in the instructions to follow. Refer to Section 3 of the PFCB technical manual which provides the function and location of PFCB operating controls and indicators.

a. CORRECTING FOR DOPPLER ERROR. - There are three important factors which are used in deriving doppler error. These are, ship's course, position and speed. Prior to operating the Doppler Corrector, this information must be available to the operator and be as accurate as is possible. For valid results, the above mentioned factors must be held constant during the measuring period. The instructions for correcting for doppler error are as follows.

(1) Set RANGE switch S801 to OFF.

(2) Set FREQ ADJ control to 0.

(3) Make certain that POWER switch S101 and RECORDER switch S104 are set to lower (off) position.

(4) Set METER SCALE switch S103 and MULTIPLIER switch S104 to 5 PARTS FULL SCALE and PARTS IN 10^6, respectively.

(5) Connect Frequency Standard under test to TEST IN jack J101.

(6) Connect reference Frequency Standard to REF IN jack J102.

(7) Set POWER switch S101 and RECORDER switch S104 to ON and observe for the following:

(a) POWER indicator DS101 should go on.

(b) Recorder chart should move.

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

(8) Set MULTIPLIER switch S104 and METER scale switch S103 for convenient recorder pen deflection.

(9) Plot ship's position and course to obtain angle θ. (See figures 3-2A and B).

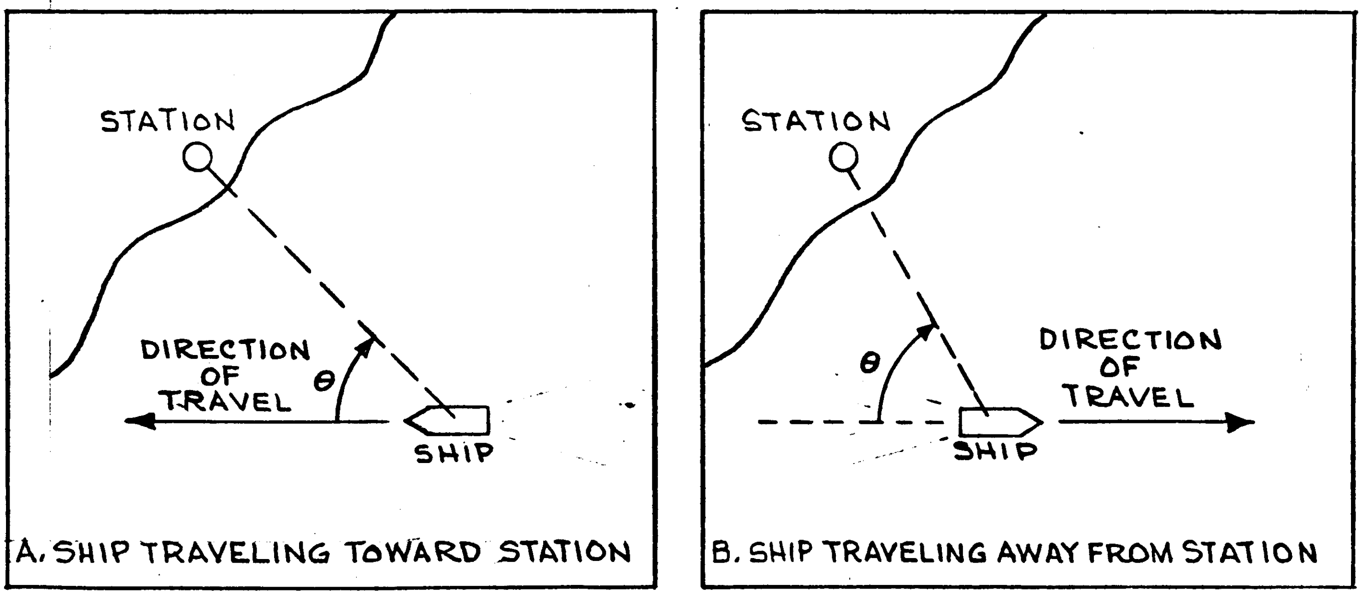


FIGURE 3-2 SHIP'S COURSE AND POSITION RELATIVE TO TRANSMITTING STATION

(10) With the use of a natural table of trigonometric functions, obtain cosine of θ and knowing ship's speed, calculate doppler error by using the following formula:

$$\epsilon = 0.001715 \, V\cos\theta$$

Where ϵ = Error frequency due to doppler shift

V = Ship's speed in knots

and θ = Angle between ship's present course and VLF transmitting station

(11) Multiply calculated doppler error frequency (ϵ) obtained in step (10) by the MULTIPLIER switch S104 setting in use. The multiplication factor vs MULTIPLIER switch S104 settings are as follows:

MULTIPLIER SWITCH SETTING	MULTIPLICATION FACTOR
PARTS IN 10^6	1
10^7	10
10^8	100
10^9	1,000
10^{10}	10,000

NOTE

For greater accuracy it is possible to measure doppler correction frequency by connecting a counter to COUNTER OUT jack J112, located on rear panel of PFCB.

(12) Using the information (doppler correction frequency) obtained in step (11), set RANGE switch S801 to appropriate frequency range setting (0-10 or 0-100).

(13) Adjust FREQ ADJ control C823 from its 0 setting, clockwise or counterclockwise (corresponding to ship's direction towards or away from transmitting station) until FREQUENCY CPS meter M801 reads doppler correction frequency calculated in step (11).

NOTE

At this point the doppler error has been corrected for and the operator proceeds to use the PFCB in the same manner as though he would ashore.

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

(15) Set MULTIPLIER switch S104 and METER SCALE switch S103 to the highest setting possible for convenient recorder pen deflection. Then, repeat step (14).

(16) At the completion of operation, perform the following turn-off procedures:

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

(b) Set MULTIPLIER switch S104 to PARTS IN 10^6.

(c) Set METER SCALE switch S103 to OFF.

(d) Disconnect cabling between both Frequency Standards and PFCB.

b. OBTAINING SHIP'S EXACT SPEED. - The instructions for obtaining ship's exact speed are as follows:

(1) Repeat steps (1) through (9) of paragraph 3-3a, except that the Frequency Standard used in step (5) is connected as a reference source (with a known stability and accuracy of 1 part in 10^8 or 10^9 per day) rather than as a Frequency Standard under test.

(2) Set RANGE switch S801 to 0-100

(3) Adjust FREQ ADJ control C823 clockwise or counterclockwise from its 0 setting (corresponding to ship's direction towards or away from transmitting station), until recorder pen deflections on recorder chart are centered at mid-scale. Then, observe FREQUENCY CPS meter M801. If doppler error frequency on FREQUENCY CPS meter M801 falls below 10 cycles, set RANGE switch S801 to the 0-10 position.

(4) Set MULTIPLIER switch S104 and METER SCALE switch S103 to highest sensitivity settings possible for convenient recorder pen deflection on recorder chart.

(5) Adjust FREQ ADJ control C823 until recorder pen deflections are centered at mid-scale on recorder chart.

(6) Record frequency indicated on FREQUENCY CPS meter M801.

NOTE

For greater frequency accuracy it is possible to measure doppler error with the use of a counter connected to COUNTER OUT jack J112, located on rear panel of the PFCB.

(7) With the use of a natural table of trigonometric functions, obtain cosine of θ and using the doppler error frequency recorded in step (6), calculate exact ship's speed using the following formula:

$$V = \frac{\epsilon}{0.001715 \cos \theta}$$

where V = Ship's exact speed in knots

ϵ = Error frequency due to doppler shift

and θ = Angle between ship's present course and VLF transmitting station

(8) At completion of operation, perform the following turn-off procedures:

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

(b) Set MULTIPLIER switch S104 to PARTS IN 10^6.

(c) Set METER SCALE switch S103 to OFF.

(d) Disconnect cabling between both Frequency Standard and PFCB.

3-4. OPERATOR'S MAINTENANCE.

The operator may at times be required to perform operator's maintenance. This may consist of merely observing for unit cleanliness and condition. See figures 3-1, 5-1 and 5-2 for identification and location of the various controls and indicators of the Doppler Corrector.

SECTION 4

TROUBLESHOOTING

4-1. OVERALL FUNCTIONAL DESCRIPTION AND TROUBLESHOOTING OF UNIT.

a. INTRODUCTION. - The Doppler Corrector operates in conjunction with the PFCB to correct or compensate for apparent changes in the transmitted frequency, as received by a receiving site, such as a ship moving to or from the transmitting origin. The apparent change in the transmitted frequency is commonly known as the doppler effect. The formula used for deriving this effect, with the transmitting station in line with ship's direction of travel, is as follows:

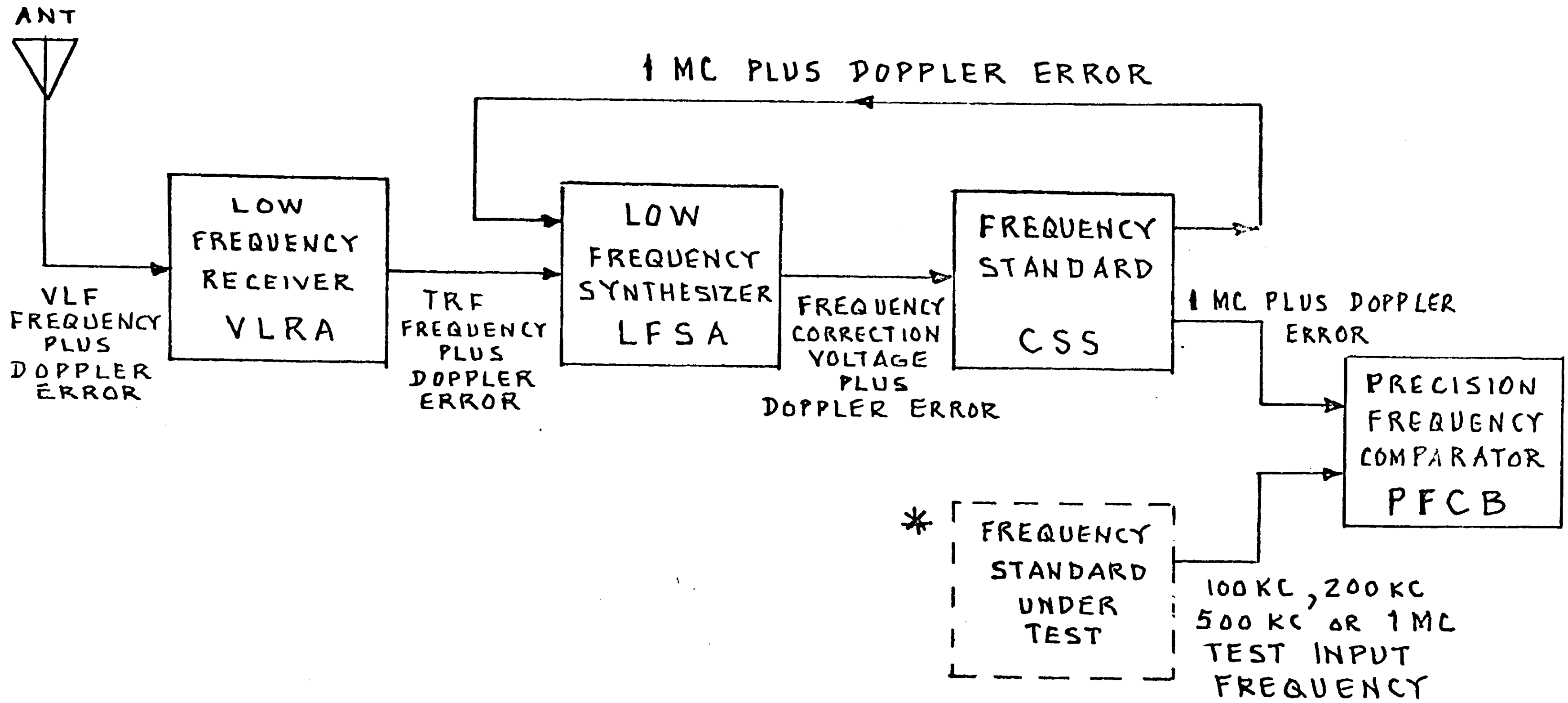
$$\frac{\Delta f}{f} = 1.715 \times 10^{-9} V$$

where Δf = apparent frequency change at receiver

f = transmitter frequency

and V = velocity of ship in knots

In high accuracy applications, such as precision frequency measurements, any degree of doppler error could seriously impair the accuracy of the measurement. Such is the case of TMC model VLFC-1, VLF Comparison System (figure 4-1) when aboard ship. Using this system as an example, and referring to figure 4-1, it can readily be seen that any doppler error present within the system would provide a coresponding error in the frequency measure ments taken. Therefore, this error must be corrected for, before



*Not included as part of VLF system.

Figure 4-1. VLF Comparison System, Block Diagram.

precise frequency measurements are made. The Doppler Corrector operates to perform this function.

Since it is unlikely that a ship operating with a VLFC system will always travel in a straight line towards or away from the transmitting station. The equation used previously in deriving doppler error must be modified to cover any direction of ship's travel and is as follows:

$$\frac{\Delta f}{f} = 1.715 X 10^{-9} V \text{ Cos } \theta$$

Where angle θ represents a line corresponding to ship's course as bisected by a line drawn between the ship's position relative to the transmitting station.

Also, since the PFCB operates as a 1 mc comparator, the equation for doppler error requires additional modification, as follows:

$$\epsilon = 1.715 X 10^{-3} \text{ Cos } \theta$$

where ϵ = doppler error in cycles per second

The correction frequency due to the multiplication factor of PFCB operation is as follows:

$$n\epsilon = n\ 1.715 X 10^{-3}\ V \text{ Cos } \theta$$

where $n = 10^0$ for parts in 10^6
$= 10^1$ for parts in 10^7
$= 10^2$ for parts in 10^8
$= 10^3$ for parts in 10^9
$= 10^4$ for parts in 10^{10}

b. FUNCTIONAL DESCRIPTION. - The Doppler Corrector (figure 4-2), is a transistorized unit comprised of two buffer amplifier stages Q801 and Q803, an oscillator stage Q802 and a mixer stage Q804. It contains controls for adjusting, calibrating and metering the doppler correction frequency.

Range selector switch S801, when manually operated, performs three distinct functions. Each function corresponds to a switch position on the selector switch. In the OFF position, it disconnects the signal path between multivibrator stages Q807 and Q808 and FREQUENCY CPS meter M801, and provides a signal jumper path for PFCB Mixer Amplifier Module. The 0-10 and 0-100 positions of the switch sets the respective frequency limits for adjusting, calibrating and monitoring the doppler correction frequency.

Initial conditions are such that the doppler error frequency has been calculated (refer to paragraph 4-1a) and RANGE switch S801 is set to the appropriate 0-10 or 0-100 position. In either of the swltch positions, a 1 mc+100 cps signal form the PFCB Mixer-Amplifier Module is applied as an input to buffer amplifier stage Q801 where the signal is amplified.

Oscillator stage Q802 utilizes a highly stable oscillator Y801. The oscillator frequency (1 mc+100 cps $\pm n\epsilon$), is manually tuned by adjusting FREQ ADJ control C328 to the calculated correction frequency. The phase of the output frequency is dependent upon

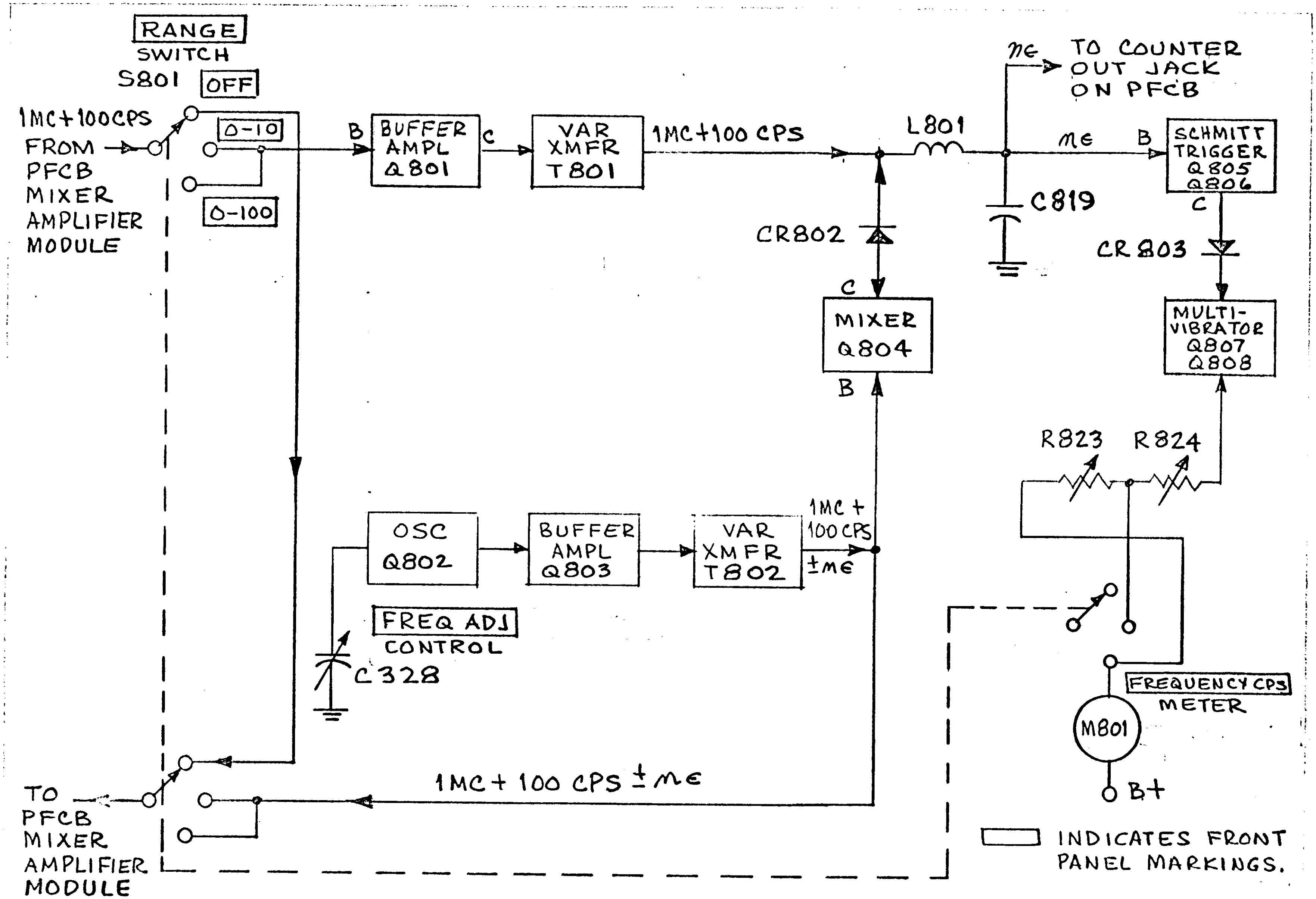


FIGURE 4-2 DOPPLER CORRECTOR, FUNCTIONAL BLOCK DIAGRAM

ship's direction of travel in relation to the transmitting station. This is compensated for when adjusting FREQ ADJ control C328 in a clockwise direction with ship's travel toward the transmitting station and in a counterclockwise direction when the ship is travelling in the opposite direction.

Mixer stage Q804 receives the 1 mc+100 cps +nϵ frequency from the internal oscillator and the amplified 1 mc+100 cps frequency supplied by buffer amplifier stage Q801. These inputs are heterodyned within the mixer stage to produce a difference frequency in terms of doppler error or nϵ.

The output of mixer stage Q804 is fed across a filter network consisting of inductor L801 and capacitor C819, which serves to filter the 1 mc and 2 mc frequency components, while passing the nϵ difference frequency. The nϵ frequency is then supplied to the COUNTER OUT jack on the PFCB rear panel for monitoring purposes and as an input to SCHMITT trigger stages Q805 and Q806.

Schmitt trigger stages Q805 and Q806 function as a trigger generator when properly conditioned by the nϵ correction frequency. The resulting output triggers generated by stages Q805 and Q806 are rectified by diode CR803 into a series of positive triggers. These triggers in turn serve to trigger multivibrator stages Q807 and Q808, whose output frequency is dependent upon the frequency of the incoming trigger pulses. During operation, FREQUENCY CPS meter M801 is manually switched with the use of RANGE switch S801 to monitor the output frequency of stages Q807 and Q808. When aligning the Doppler Corrector, controls R823 and R824 are used to calibrate the 0-10 and 0-100 cycle frequency limits of nϵ.

c. TROUBLESHOOTING. - When troubleshooting the PFCB, refer to table 4-1 which lists the typical voltages for the transitors that are included in the Doppler Corrector.

If trouble exists within the PFCB rather than the Doppler Corrector, refer to the troubleshooting section of the PFCB manual for the necessary troubleshooting instructions. When troubleshooting the PFCB, it is suggested that the Doppler Corrector be replaced with the Accessory Interconnect module, to facilitate maintenance.

Faulty Doppler Corrector operation is usually apparent by the abnormal indications on the FREQUENCY CPS meter M801. These indications may be due to a defective RANGE switch S801 or the FREQUENCY CPS meter M801. To localize trouble to a defective stage, first connect a counter to COUNTER OUT jack on PFCB rear panel. This step checks whether stages Q801 through Q804 are operating properly. If the counter indication is normal, then stages Q805 through Q808 should be investigated. If the counter indication is abnormal, signal trace stages Q801 through Q804.

SECTION 5

MAINTENANCE

5-1. GENERAL.

Maintenance may be divided into three categories: operator's maintnenance, preventive maintenance and corrective maintenance. Corrective maintenance is sometimes considered as consisting of information useful in locating and diagnosing equipment troubles and maladjustments, existing and/or pending, and information necessary to remedy the equipment troubles and maladjustments. In this section, corrective maintenance procedures are those necessary to correct a trouble due to a maladjustment of a control or adjustment. By using these procedures along with the troubleshooting information presented in Section 4, a trouble may be localized to a particular area. Operator's maintenance is included in Section 3.

The Doppler Corrector has been designed to provide long-term, trouble-free operation under continuous duty conditions. It is recommended that any necessary maintenance done by a competent technician familiar with troubleshooting techniques. If the trouble cannot be corrected by utilizing the information presented in this section and in Section 4,it is recommended that the Doppler Corrector be returned to the Technical Materiel Corporation.

5-2. PREVENTIVE MAINTNENANCE.

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

At periodic intervals, the Doppler Corrector should be removed from its accessory compartment and wiring and components inspected for dirt, corrosion, charring, discoloring and 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 tetrachlorethelyne or methyl chloroform may be used, providing 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 repeatedcontact with skin. Flammable solvents shall not be used on energized equipment or near any equipment.

CAUTION

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

5-3. CORRECTIVE MAINTENANCE.

CAUTION

> The Doppler Corrector is a solid state device. Any indiscriminate resistance measurements may damage the trensistors mounted on the printed circuit board.

The corrective maintenance procedures are essentially Technical Materiel Corporation's factory alignment procedures modified for use in the field. Refer to paragraphs 5-4 and 5-5 for the test equipmnet and preliminary instructions for aligning and testing the Doppler Corrector, respectively. Figures 5-1 jand 5-2 illustrate the location of major components of the unit.

5-4. SPECIAL TOOLS AND TEST EQUIPMENT.

The test equipment required to perform the corrective maintenance procedures in paragraph 5-5 through 5-7 are listed on table 5-1. There is only one special tool required for corrective maintenance. That is, TMC part number TP-129.

TABLE 5-1. TEST EQUIPMENT

ITEM	DESCRIPTION
Precision Frequency Comparator	TMC model PFCB-1
Frequency Counter	Hewlett-Packard model 524L or equivalent.
Oscilloscope	Tektronix model 545A with L type plug-in unit or equivalent.
Frequency Standard	TMC model CSS-2 or equivalent.
VTVM	Hewlett-Packard 410B or equivalent.

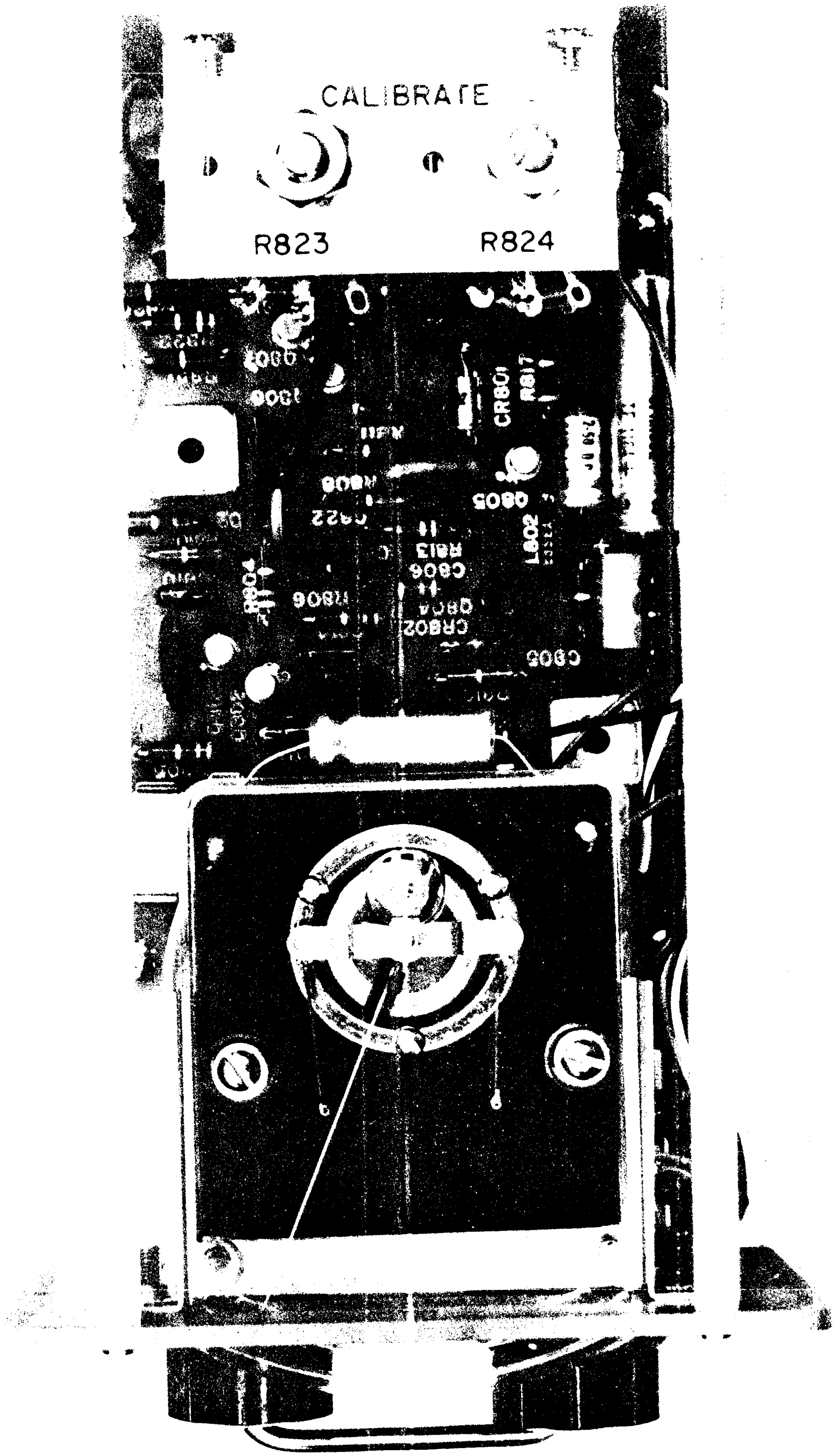


Figure 5-1. Doppler Corrector, Top View

Figure 5-2. Doppler Corrector, Bottom View

5-5. PRELIMINARY INSTRUCTIONS.

Prior to aligning the Doppler Corrector, perform the following:

NOTE

These instructions assume that the unit has just been repaired. Therefore, the unit should be on a work bench ready for installation into a PFCB Precision Frequency Comparator that is know to be in good operating condition.

a. On the PFCB, set front panel POWER switch to lower off position.

b. Install Doppler Corrector into accessory compartment of the PFCB.

c. On the PFCB perform the following:

(1) Set RECORDER switch to lower (off position.

(2) Set rear panel BATTERY switch to OUT.

(3) Connect a-c power cable between rear panel MAIN AC jack and a-c source receptacle.

(4) Set POWER switch to ON. POWER indicator DS101 should go on.

d. On Doppler Corrector, perform the following:

(1) Set RANGE switch S801 to OFF.

(2) Set FREQ ADJ control C823 to 0.

5-6. DC POWER CHECK.

To perform the d-c power check, proceed as follows:

a. Perform the preliminary instructions as given in paragraph 5-5.

b. Set POWER switch on PFCB to lower (off) position.

c. Set RANGE switch S801 to 0-10.

d. Connect VTVM between jack pins J111-7 and J111-6 on PFCB.

e. Set POWER switch on PFCB to ON. Associated POWER indicator should go on and VTVM should indicate approximately -12 volts dc.

f. Dssconnect VTVM from jack pin J111-7 on PFCB and connect to jack pin J111-1. VTVM should indicate approximately +12 volts dc.

g. Set POWER switch on PFCB to lower (off) position.

h. Disconnect VTVM connected between jack pins J111-6 and J111-1 on PFCB.

i. Set RANGE switch to OFF.

j. Disconnect ac power cable from MAIN AC jack on rear panel of PFCB.

5-7. OVERALL ALIGNMENT.

The overall alignment procedures of the Doppler Corrector are performed to insure that the operational capabilities of the unit are within acceptable limits. To perform overall alignment, proceed as follows:

a. Apply power to Frequency Standard and allow for a 24 hour warm-up period. Then turn on power for oscilloscope and counter.

b. Perfrom the preliminary instructions as given in paragraph 5-5.

c. Set POWER switch on PFCB to lower (off) position.

d. Connect Tee-connector to 1 mc source output jack on Frequency Standard. Then, connect coaxial cables between Tee-connector on Frequency Standard and TEST IN and REF IN jacks on PFCB.

e. Set MULTIPLIER switch on PFCB to PARTS IN 10^6.

f. Set POWER switch on PFCB to ON.

g. Set RANGE switch S801 to 0-100.

h. Adjust internal controls R823 and R824 in a fully clockwise direction (maximum resistance).

i. Connect oscilloscope probe to junction of capacitors C806 and C813.

j. Adjust transformer T802 for maximum signal indication on oscilloscope.

k. Disconnect oscilloscope probe from junction of capacitors C806 and C813.

l. Adjust oscilloscope for dc operation.

m. Connect oscilloscope probe to junction of capacitors C816 and C817 and C819 and inductor L801. D-c voltage level should be 3 volts, (varying between 8 and 11 volts dc.)

n. Disconnect oscilloscope from junction of capacitors C816, C817, and C819 and inductor L801.

o. Adjust FREQ ADJ control C823 until dial pointer on FREQUENCY CPS meter M801 reads 0. If necessary, loosen set screw on FREQ ADJ control C823, so that control pointer lines up with the 0 control setting. Then, tighten control set screw. Check setting of control pointer by rotating FREQ ADJ control C823 in a counterclockwise direction noting a corresponding increase in the capacitance of variable capacitor C823.

p. Adjust FREQ ADJ control C823 to 0.

q. Connect counter to COUNTER OUT jack on rear panel of PFCB.

r. ADJUST FREQ ADJ control C823 one full turn, while observing counter. Counter should indicate at least 100 cycles in either the +0 or -0 settings of FREQ ADJ control C823.

s. Adjust FREQ ADJ control C823 until counter indicates 10 cycles.

t. Set RANGE switch S801 to 0-10

u. Adjust internal control, R823 until dial pointer on FREQUENCY CPS meter M801 reads 10 (full scale).

v. Set RANGE switch S801 to 0-100.

w. Adjust FREQ ADJ control C823 until counter indicates 50 cycles.

x. Adjust internal control, R824 until pointer of M801 FREQUENCY CPS meter reads 5.

y. Using counter and FREQ ADJ control C823, check RANGE switch S801 settings, 0-10 and 0-100 for proper frequency linearity readings on FREQUENCY CPS meter M801. If readings on FREQUENCY CPS meter M801 appear to be excessively non-linear, check tuning components, capacitor C820 and resistor R822 for proper tolerances.

z. Turn off power to the counter, oscilloscope and Frequency Standard.

aa. Set POWER switch on PFCB to lower (off) position.

ab. Disconnect coaxial cables connected between Frequency Standard and REF IN and TEST IN jacks on PFCB.

ac. Disconnect counter from COUNTER OUT jack on PFCB.

ad. Set RANGE switch to OFF.

ae. Set FREQ ADJ control C823 to 0.

SECTION 6
PARTS LIST

6-1. INTRODUCTION

Reference designations have been assigned to identify all maintenance parts of the equipment. They are used for marking the equipment (adjacent to the part they identify) and are included on drawings, diagrams, and the parts list. The letters of a reference designation indicate the kind of part (generic group), such as resistor, amplifier, electron tubes, etc. The number differentiates between parts of the same generic group. Sockets associated with a particular plug-in device, such as electron tube or fuse, are identified by a reference designation which includes the reference designation of the plug-in device. The parts for each major unit are grouped together. Column 1 lists the reference series of each major unit, followed by the reference designations of the various parts in alphabetical and numerical order. Column 2 gives the name and describes the various parts. Major part assemblies are listed in their entirety; subparts of a major assembly are listed in alphabetical and numerical order with reference to its major assembly. Column 3 lists each Technical Materiel Corporation part number.

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C801	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 2,200 uuf; GMV; 500 WVDC.	CC100-11
C802	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 10,000 uuf; GMV; 500 WVDC.	CC100-16
C803	Same as C802.	
C804	Same as C802.	
C805	Same as C801.	
C806	Same as C801.	
C807	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 200,000 uuf, +80% -20%; 25 WVDC.	CC100-33
C808	Same as C807.	
C809	CAPACITOR, FIXED, MICA DIELECTRIC: 120 uuf, ±5%; 500 WVDC; straight wire leads.	CM111F121J5S
C810	Same as C809.	
C811	CAPACITOR, FIXED, MICA DIELECTRIC: 510 uuf, ±5%; 500 WVDC; straight wire leads.	CM111F511J5S
C812	CAPACITOR, FIXED, MICA DIELECTRIC: 100 uuf, ±5%; 500 WVDC; straight wire leads.	CM111F101J5S
C813	CAPACITOR, FIXED, MICA DIELECTRIC: 150 uuf, ±5%; 500 WVDC; straight wire leads.	CM111F151J5S
C814	CAPACITOR, FIXED, MICA DIELECTRIC: 15 uuf, ±5%; 500 WVDC; straight wire leads.	CM111F150J5S
C815	Same as C813.	
C816	CAPACITOR, FIXED, ELECTROLYTIC: 2.0 uf, -10% +150% at 120 cps at 25°C; 50 WVDC; polarized; insulated tubular case.	CE105-2-50
C817	CAPACITOR, FIXED, ELECTROLYTIC: 200 uf, -10% +150% at 120 cps at 25°C; 15 WVDC; polarized; insulated tubular case.	CE105-200-15
C818	Same as C817.	

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C819	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 100,000 uuf, +80% -20%; 100 WVDC.	CC100-28
C820	CAPACITOR, FIXED, METALIZED PLASTIC: 1.0 uf, ±1%; 100 WVDC.	CN112A105F1
C821	CAPACITOR, FIXED, MICA DIELECTRIC: 220 uuf, ±5%; 500 WVDC; straight wire leads.	CM111F221J5S
C822	Same as C807.	
C823	CAPACITOR, VARIABLE, AIR DIELECTRIC: 100 uuf max.; rated at 600 V RMS, 60 cps; 1/2" long round shaft x 1/4" dia.	CB132-100B
C824	CAPACITOR, FIXED, ELECTROLYTIC: 50 uf, -10% +150% at 120 cps at 25°C; 25 WVDC; polarized; insulated tubular case.	CE105-50-25
CR801	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.	1N3022
CR802	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
CR803	Same as CR802.	
L801	COIL, RADIO FREQUENCY: fixed; 1,000 uh, ±5%; 16.0 ohms DC resistance; current rating 140 ma; molded case.	CL275-102
L802	COIL, RADIO FREQUENCY: fixed; 68.0 uh, ±10%; 2.2 ohms DC resistance; molded case.	CL240-68
M801	METER: calibration 0-10; 0-25 ua.	MR185
Q801	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

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
Q802	Same as Q801.	
Q803	Same as Q801.	
Q804	TRANSISTOR: 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 rating -65°C to +100°C; metal case.	2N396A
Q805	Same as Q801.	
Q806	Same as Q801.	
Q807	Same as Q801.	
Q808	Same as Q801.	
R801	RESISTOR, FIXED, COMPOSITION: 1,800 ohms, ±10%; 1/2 watt.	RC20GF182K
R802	Same as R801.	
R803	RESISTOR, FIXED, COMPOSITION: 3,300 ohms, ±10%; 1/2 watt.	RC20GF332K
R804	Same as R803.	
R805	Same as R803.	
R806	Same as R803.	
R807	RESISTOR, FIXED, COMPOSITION: 10,000 ohms, ±10%; 1/2 watt.	RC20GF103K
R808	Same as R807.	
R809	RESISTOR, FIXED, COMPOSITION: 100 ohms, ±10%; 1/2 watt.	RC20GF101K
R810	Same as R809.	
R811	RESISTOR, FIXED, COMPOSITION: 5,600 ohms, ±10%; 1/2 watt.	RC20GF562K
R812	RESISTOR, FIXED, COMPOSITION: 6,800 ohms, ±10%; 1/2 watt.	RC20GF682K

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
R813	RESISTOR, FIXED, COMPOSITION: 100,000 ohms, ±10%; 1/2 watt.	RC20GF104K
R814	RESISTOR, FIXED, COMPOSITION: 1,000 ohms, ±10%; 1/2 watt.	RC20GF102K
R815	Same as R814.	
R816	Same as R807.	
R817	RESISTOR, FIXED, COMPOSITION: 4,700 ohms, ±10%; 1/2 watt.	RC20GF472K
R818	Same as R817.	
R819	RESISTOR, FIXED, COMPOSITION: 560 ohms, ±10%; 1/2 watt.	RC20GF561K
R820	RESISTOR, FIXED, COMPOSITION: 2,200 ohms, ±10%; 1/2 watt.	RC20GF222K
R821	Same as R820.	
R822	RESISTOR, FIXED, COMPOSITION: 3,900 ohms, ±10%; 1/2 watt.	RC20GF392K
R823	RESISTOR, VARIABLE, COMPOSITION: 50,000 ohms, ±10%; 2 watts; linear taper A.	RV4LAYSA503A
R824	RESISTOR, VARIABLE, COMPOSITION: 35,000 ohms, ±10%; 2 watts; linear taper A.	RV4LAYSA353A
R825	RESISTOR, FIXED, COMPOSITION: 22,000 ohms, ±10%; 1/2 watt.	RC20GF223K
R826	RESISTOR, FIXED, COMPOSITION: 18,000 ohms, ±10%; 1/2 watt.	RC20GF183K
S801A,B,C,D	SWITCH, ROTARY: 2 pole; 2 sections, 3 positions, 30° angle of throw; non-shorting type contacts; maximum voltage rating 110 VAC; maximum current rating .5 amp.	SW372
T801	TRANSFORMER, RADIO FREQUENCY: adjustable.	TT251
T802	Same as T801.	

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
XY801	SOCKET, CRYSTAL: clip type; 2 cadmium plated contacts; 3/64" x 5/32" tail slots.	TS167-1
Y801	CRYSTAL UNIT, QUARTZ: nom. frequency range 800-20,000 Kc, ±.005%; operating temperature range -55°C to +90°C; crystal unit max. capacitance 7.0 uuf; load capacitance 32.0 uuf, ±0.5 uuf; parallel resonance; metal case; HC-6/U holder.	CR18A/U1.000,000
Z801	PRINTED CIRCUIT BOARD ASSEMBLY: consists of C801 thru C822, CR801 thru CR803, L801, L802, Q801 thru Q808, R801 thru R822, R825, R826, T801, T802, XY801 and Y801.	A3841

SECTION 7

SCHEMATIC DIAGRAMS

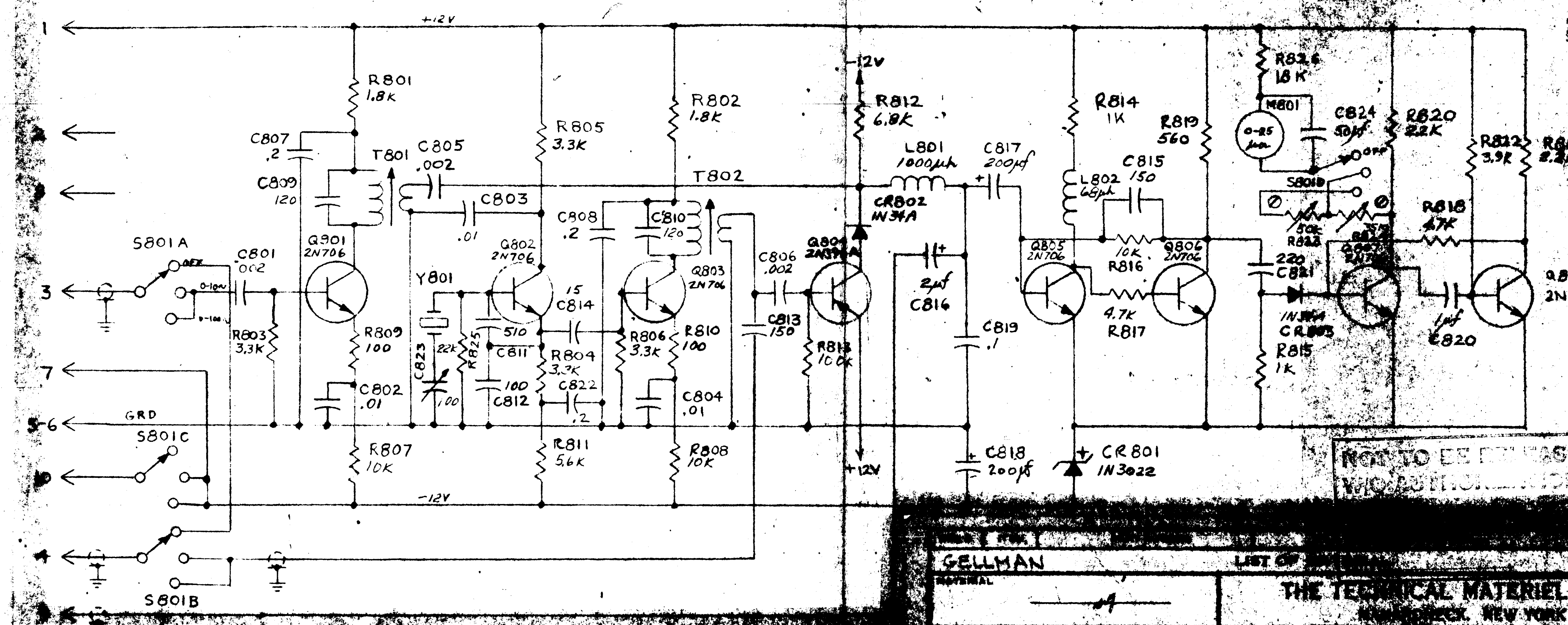
NOTE:

1. K = 1000
2. ALL WHOLE NUMBER CAPACITORS μf UNLESS OTHERWISE NOTED.
3. ALL ITEMS EXCEPT C823, 824, M801, S801, R823 & R824 ARE P/O Z801, PC BOARD.

CK790 X3

REV	DESCRIPTION				
X	EXPER. RELEASE				
X1	WIRING TO S1-D REVISED, R2 ...			NP	
X2	J1 DELETED, PIN NOS ON BOARD ...			NP	
X3	IN PICT. "0862" ...				

NOT TO BE RELEASED W/O AUTHORIZATION
AUTH. BY ...
DATE ...



GELLMAN	LIST OF MATERIAL
MATERIAL	THE TECHNICAL MATERIEL CORP. MAMARONECK, NEW YORK
FINISH	TITLE: SCHEMATIC DIAGRAM DOPPLER CORRECTOR

Q'TY./UNIT	NO. EL. USED ON	ASSY. NO.
	PFCB-1	AX5?9

SCALE | CODE A

THE CONTENTS OF THIS DRAWING ARE THE EXCLUSIVE PROPERTY OF THE TECHNICAL MATERIEL CORP. ITS UNAUTHORIZED USE OR REPRODUCTION IN WHOLE OR IN PART IS STRICTLY FORBIDDEN.

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE CHEMICALLY APPLIED OR PLATED FINISHES

TOLERANCES: FRACTIONS ± 1/64, ANGLES ± 0° 30'

DRAWN | CHECKED | DATE

CK790 | X3

NOTES

TMC FORM 100