AN/PRM-1A Radio Test Set

A previous article on adjusting the peak control of AN/PRM-1 and AN/PRM-2 was published in the Bureau of Ships Journal of January 1956.

For radio interference surveys, the AN/PRM-1A radio test set is good equipment to determine the source of radiated or conducted interference from any source within a frequency range of 150 kilocycles to 25 megacycles.

Field intensity measurement surveys may be made with the AN/PRM-1A for adjusting directive antennas or for exploring radiation patterns when the values of the field intensity vary over a wide range. The equipment may also be used as a sensitive radiofrequency (RF) microvoltmeter.

The set is portable and suitable for operation aboard naval vessels, at shore stations, in the field, in aircraft, and in military vehicles. The set is composed of the radio interference-field intensity meter IM-37A/PRM-1 and its accessories (figures 1 and 2). The IM-37A/PRM-1, the control and metering unit of the AN/PRM-1A, is referred to in this article as the RI-FI meter.

The AN/PRM-1A is used to measure the field intensity of a given radio transmission or to measure the intensity of radiated or conducted radio interference. Some reference to the nature of these quantities is given in this article, with a brief description of the method of measurement.

The position of a transmitting antenna in space determines the polarization of the emitted wave. A vertical antenna radiates a wave consisting of a vertical electric field vector and a horizontal magnetic field vector. A horizontal antenna radiates a horizontally polarized wave consisting of a horizontal electric field and a vertical magnetic field.

The radiated field can propagate in two major paths. One path follows the curvature of the earth and the other radiates at an angle toward the sky. That portion of the radiated field that follows the earth is the ground wave; the portion that propagates upward is the sky wave.

In general, at the very low frequencies the ground wave energy suffers little attenuation with distance as compared with ground wave energy at high frequencies. On the other hand, at the very low frequencies little energy returns to the earth by reflection from the ionosphere. As the frequency is increased, a greater portion of the sky wave energy returns to the earth.

The reflection of the sky wave results in phenomena called skip distance and fading.

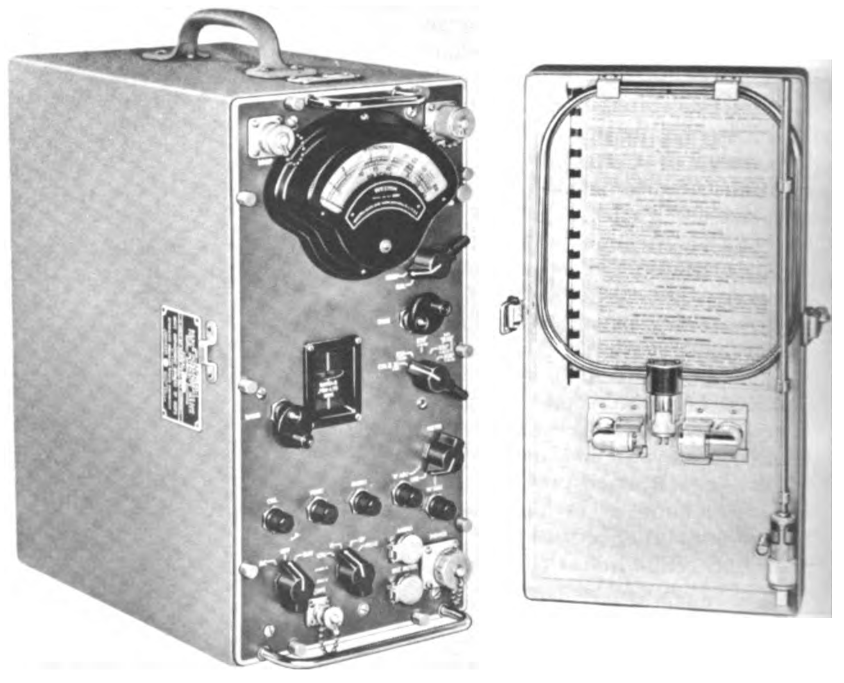
The skip distance is the area at a distance from the transmitting antenna depending on the transmitting frequency, where the ground wave of the transmitting antenna is too weak to be detected and the sky wave is not present, because of the angle of radiation from the transmitting antenna and the angle of reflection of the sky wave from the ionosphere. The extent of the area depends to a large degree on the condition of the ionosphere at the time.

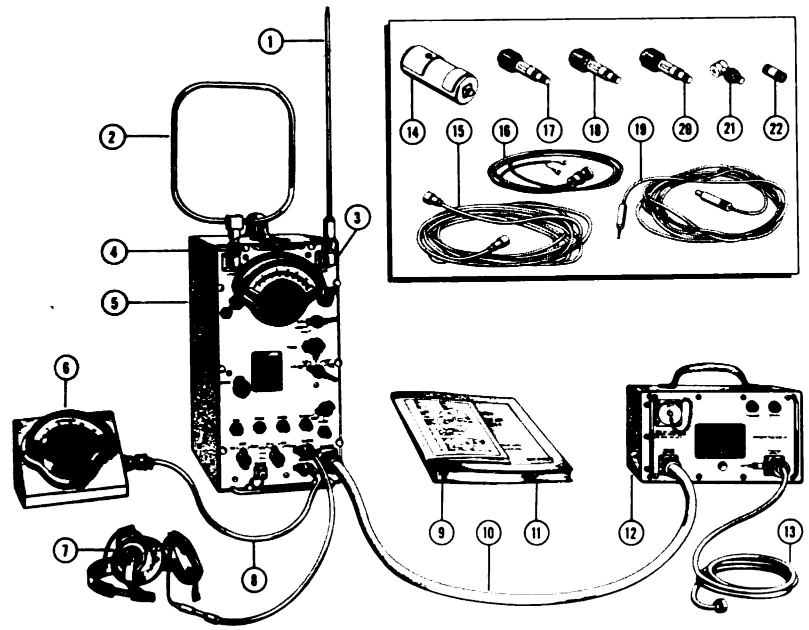
There is also an area of fading where large variations in field intensity may be observed within a short time. This fading takes place where the ground wave and sky wave begin to equal each other in intensity. The size of the area depends greatly on the ionosphere. The large variation in field intensity is called fading and is a result of the phase relationship of the sky wave to the ground wave at the point of reception.

The phase relationship is affected by the difference in the distance traversed by the ground and sky waves and by the shift in phase of the sky wave reflected from the ionosphere. Fading is common in the upper portion of the low frequencies and in the lower portion of the medium frequencies.

A radiated field intercepted by a vertical antenna will set electrons in motion in the antenna. This electron flow constitutes a current that varies in accordance with the variations of the field. The induced current in the antenna is not uniform but becomes zero at the top. The voltage effective in producing the current measured at the antenna base is equal to an effective height times the electric intensity of the field.

Figure 1. Radio interference-field intensity meter IM-37A/PRM is the control and metering unit of the AN/PRM-1A.





1. Antenna AT-213/PRM-1.
2. Antenna AT-212/PRM-1.
3. Adapter connector UG-537/U.
4. Adapter connector UG-104/U.
5. Radio interference-field intensity meter IM-37A/PRM-1.
6. Ammeter ME-33/U.
7. Headphones Navy type 49507A.
8. Special purpose cable assembly CG-571/U(20'0").
9. Chart set PT-117/PRM-1.
10. Special-purpose cable assembly CADV-62481(10'0").
11. Instruction book.
12. Power supply PP-472B/PRM-
13. Power cable assembly CADV-62480(6'0").
14. RF probe MX-980/PRM-1.
15. Loop cable assembly CG-444/U(20'0").
16. Special-purpose cable assembly CG-573/U(3'0").
17. Impedance matching network CU-195/PRM-1.
18. Impedance matching network CU-196/PRM-1.
19. Special-purpose cable assembly CG-572/U(20'0").
20. Impedance matching network CU-197/PRM-1.
21. Antenna AT-211/PRM-1.
22. Adapter connector UG-105/U.

Figure 2. Radio test set AN/PRM-1A, showing relationship of the different units.

When a loop antenna is used, the magnetic component of the radiated field induces a voltage in the loop. The loop output voltage is a function of its shape, area, number of turns, and frequency of excitation.

Vertical and loop antennas may be used for field intensity measurements in the portion of the radio spectrum in which the AN/PRM-1A can be used.

Field intensity is the value of the electric field at a given point and is measured in terms of volts-per-meter. A volt-per-meter is equivalent to a potential of 1 volt induced in an antenna having an effective length of 1 meter.

There are two principal methods of making field intensity measurements with the AN/PRM-1.

One method is by substitution in which a loop antenna is connected to a receiver and metering circuits give an indication of the receiver input. The receiver is tuned to the desired signal, the loop is rotated to give maximum signal, and then the indicated value of the received signal is recorded.

The loop is then rotated to give minimum received signal, and a signal generator is inserted in series with the loop. The signal generator is tuned to the received frequency, and its output is adjusted to obtain the same reading of signal input as was obtained with maximum loop signal.

The field intensity is computed from a formula.

When a vertical antenna is used for field intensity measurements, the effective height is determined experimentally by comparison with results obtained with a loop.

In the second method of field intensity measurement, a specially designed sensitive receiver is used with built-in attenuators and a comparison (calibrating) voltage source.

The RI-FI meter is tuned to the desired frequency, and the calibrating voltage is applied to the RF input. The gain of the IF section is then adjusted to give a standard value of calibrator signal input. The calibrating voltage is turned off and the antenna is connected to the RI-FI meter input.

The attenuators are adjusted for a meter indication at the upper half of the indicating meter dial; and the meter reading thus obtained, times the attenuator setting and the effective height of the antenna used, is the field intensity in microvolts-per-meter of the received signal.

The advantage of the second method is that the accuracy is independent of signal frequency, depending primarily on the attenuator and the linearity of the RI-FI meter input circuits.

Radio interference disrupts the use of radio receivers. Interference includes many forms of disturbances that may be roughly classified as continuous and discontinuous.

Continuous disturbances include random interference such as thermal agitation. Random interference resembles atmospheric interference, or static, originating in lightning discharges in local storms and in more distant tropical storms. The frequent impulses overlap, and have sharp peaks exceeding the average level. If interference impulses follow each other rapidly and are not clearly distinguishable, the interference is said to be random.

Discontinuous interference is made up of sharp pulses, the pulse frequency determining the character of the interference. If the pulses are relatively infrequent and clearly separated, the interference is termed impulsive. Impulse interference may be generated by an internal combustion engine ignition system, power line discharges, motor brush sparking, electronic equipment, and by other electrical and electromechanical devices.

Because the frequency spectrum of continuous and discontinuous interference can be extremely wide, the interference magnitude will depend on the bandwidth of the measuring equipment. For impulse interference, peak voltages are proportional to the bandwidth, and average voltages are independent of the bandwidth.

For random interference, both peak and average voltages are proportional to the square root of the bandwidth. If interference is determined to be largely impulsive or random, a correction factor can be determined by applying formulas to the meter reading.

The bandwidth characteristics of AN/PRM-1A are supplied in the calibration of the equipment and are used in obtaining interference readings in terms of a bandwidth that is a kilocycle wide.

The procedure for interference measurement is similar to that for field intensity measurement. Average, peak, and quasi-peak readings of interference are needed to determine the type of disturbance.

RF voltage from a microvolt to a volt may be measured with the various input provisions incorporated in the system. In terms of field intensity, 2 microvolts per meter to 2 volts per meter may be measured, depending on the type of antenna used.

Operation of the AN/PRM-1A is flexible because of the nature of the accessories supplied. The RI-FI meter has a self-contained dry-battery pack to be used for short periods of operation. The separate a.c. power supply PP-472B/PRM-1 (figure 3) is used for longer or continuous periods of operation. An external source of a.c. power is required when the PP-472B/PRM-1 is used.

The equipment can be operated on a bench or table, or simply placed on the ground. The rod and loop antennas can be connected directly to the RI-FI meter front panel. Mounting provisions for the antennas are such that they mount vertically, whether the equipment is operated on a bench with front panel vertical or on the ground with front panel horizontal.

Figure 3. General view of the power supply PP-472B/PRM-1 with the protective panel removed.

Hand-held probes are connected to the RI-FI meter input by means of a 20-foot cable. When connected in this manner, the line probe is used for measuring conducted interference on power and transmission lines, and the loop probe and loop antenna are used for locating the source of radiated interference.

Signal monitoring provisions are possible from panel-mounted headphone, oscilloscope, and external meter receptacles. Measurements are made by using the panel-mounted meter or the remote meter ME-33/U. Graphic recordings can be obtained by connecting a suitable milliammeter-recorder to the external meter receptacle.

As a highly sensitive two-terminal voltmeter, the RI-FI meter can be used--

- As a null instrument in conjunction with RF bridges such as Navy type 60094 RF impedance bridge.
- For measuring the gain of a radiofrequency stage in radio equipment by measuring the signal input to the stage and the signal output of the stage.
- For checking the voltage of any 20-ohm, 50-ohm, or higher transmission line up to a volt, provided the transmission line is properly terminated.
- For determining the loss in a coaxial line connected to a signal generator by comparing the signal levels at the input and output ends of the line.

The AN/PRM-1A is conveniently packed in two carrying cases. The cases are adequate for storing the equipment and for moving it from one survey site to another, but they are not suitable packing for transport by common carrier. The cases, although drip-proof, are not designed to withstand severe exposure to the elements. They may be left in the open overnight only if they are covered with tarpaulin.

The transit case contains equipment needed for the simplest survey. The accessory case contains accessories for maximum use of the set.

Operator's maintenance procedures are simple. They are limited to emergency tube and battery changes and replacement of line fuses in the RI-FI meter and power supply units.

The self-contained, plate-and-filament batteries have a life expectancy of approximately 5 hours continuous operation. The operator will detect battery depletion at the time the A and B voltages are checked before every reading of interference or field intensity.

The end of useful life of the bias batteries is determined by the "shelf life." This type of battery should be replaced within 8 months from the date of manufacture.

The condition of the bias batteries can be checked by measuring the terminal voltage with a 100-ohm-per-volt voltmeter, having the 5-volt scale. The batteries should be replaced when the terminal voltage of the 4.5-volt battery measures less than 4.4 volts and that of the 1.5-volt battery measures less than 1.4 volts.

Opening the RI-FI meter and power supply can be kept to a minimum because--

- There is little likelihood of moisture or dirt accumulating inside the units to cause breakdown since they are drip-proof.
- Components used in the equipment, including the electron tubes, have long life under normal conditions of operation.
- No parts in the basic equipment require lubrication.

Careful handling while setting up the equipment and when operating it should prevent most breakdowns that are likely to occur.

An article in the Bureau of Ships Journal for January 1956 explained how to adjust the peak control on this type of equipment.

The Strobotac Shows Slow Motion

The strobotac, type 631-B, is used for stroboscopic observations of moving objects. It is a stroboscopic tachometer with which rotating, vibrating, or reciprocating objects can be viewed intermittently.

The strobotac produces the optical effect of slowing down or stopping motion. Through the apparent slow motion, which is an exact replica of the original higher speed motion, the movements of a high-speed machine can be analyzed while the machine is operating under normal conditions.

The stroboscope is particularly adapted for measuring speed if the end of a shaft is not accessible or if power is limited for devices. Since mechanical contact with the mechanism being measured is not required, no power is absorbed from the drive.

The strobotac is used to determine speed of electromechanical equipment or to "stop the motion" of rotational or repetitive motions to study them.

A typical strobotac.

MAGNETOIONIC SPLITTING

The lines of force of the earth's magnetic field are concentrated at the geomagnetic poles and are spread far apart at the equator.

An electromagnetic wave cutting these lines of force is split into two components of opposite rotation, the relative intensity of which is determined by the frequency of the wave.

At the gyromagnetic frequency, about 1500 kilocycles for the United States, electromagnetic waves incident normal to the lines of force are almost completely absorbed, and essentially no sky waves are returned. Near the gyrofrequency it is possible to control the distance coverage of transmissions since only the ground wave is involved.

At high frequencies, the two components are returned from different heights in the ionosphere and may arrive at the receiver delayed, one with respect to the other, by as much as 3 to 4 milliseconds.