FIELD STRENGTH METER

EDITED

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PRINTED

by JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

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FIELD STRENGTH METER

Measurement of Field Strength

Field strength is obtained by measuring the induced voltage in an antenna of known effective length, located in the field with a measuring receiver.

As for an antenna of known effective length, the loop antenna and the half-wave doublet antenna are normally applied to HF band and VHF-UHF band, respectively.

On the other hand, as to measuring receivers, the following characteristics are required.

- Able to select required wave under measurement among many waves without obstruction of ther waves.
- Able to measure down to very fine voltage.
- No interference to high frequency portion caused by entering of waves by-passing normal measuring circuits in strong field, resulting in measuring errors.
- Able to measure correctly induced voltages of an antenna (signal source voltage).

For these purposes, meters must have tuning amplifiers in the high frequency portion, must be excellent in linearity, selectability and stability and must be completely shielded and highly sensitive. In addition those shall be provided with referential voltage generators (comparison oscillator) for the accurate measurement of a signal voltage.

Field strength is calculated by dividing the measured induced voltage of an antenna (V) by the effective length of antenna (m) and is indicated in terms of (V/m) or dB, where 0 dB is defined at 1μ V/m.

In case that an antenna is applied apart from a measuring

receiver, for instance in case of an doublet antenna, connected cable loss and matching loss must be taken into consideration in addition to the effective length of the antenna. These values, i.e. the conversion factor between voltage and field strength is called the calibration coefficient which is a function of frequency. Except for the special cases, the calibration coefficient is calibrated to enable direct reading of the field strength by the circuits or the measuring scales of the measuring meters.

As described above, a field strength meter consists of the combination of a measuring antenna and a voltage measuring receiver. However, a measuring receiver only can be used as a very fine voltage measuring instrument having excellent selectability, so that it can be applied to various kinds of applications as described below.

Applications

- ☐ It is used for the measurement whether the wave transmitted from a position reaches the destination with sufficient field strength. In particular, unexpected wave propagating properties are often observed due to the influences of land shape, buildings and climate condition. So this measurement is required.
  In case of diatant propagation, it is used for measuring and recording fading condition for a long period.

- ☐ Also used for the power measurement of transmission waves of radio and TV, service area survey and plotting of field strength map. Various points are selected in this case for the measurement.

- ☐ Noise nuisance is raised recently with regard to waves originating from electrical and electronic machines. Field strength meters are used as so-called disturbing wave measuring instrument, in order to survey or regulate such interfering waves. In this

case, condition of frequency distribution can be investigated in addition to the strength of the disturbing waves.

- □ Applicable to the measurement of the spurious radiation disturbing communication lines. However, the field strength of the spurious waves is different depending on the antenna, land shape, distance, etc. Therefore, a directional coupler is inserted in the feeder between the transmitter and the antenna to measure the spurious power radiation of the antenna.
- □ Applicable to the measurement of the directivity of the antenna.
- □ Applicable to the measurement of the shielding effect of the shield room.
- □ Applicable to the measurement of the leakage waves from a signal generator, etc.

Also, there are various applications as a selecting voltmeter of high-frequency without employing an antenna, as follows.

- ■ Applicable to the measurement of an arbitrary specific frequency component selected among the mixture of many frequency components.
- ■ Applicable to the measurement of especially low voltages.
- ■ Analysis of the spectrum.
- ■ Measurement of harmonic wave inclusive ratio.
- ■ Applicable to the high sensitivity selecting voltmeter during adjustment of transmitters and receivers.
- ■ Measurement of the transmission properties of various equipment and circuits.

■ Detection of fine voltages, e.g. bridge zero detection.

■ Adjustment of antenna.

Required Properties

● Frequency Range

Frequency range is required as wide as possible. In case of measuring spurious radiation, in particular, it is required up to 2 - 3 times the fundamental wave at least.

● Lowest Measurable Value

There are some cases where very weak wave or very fine voltage must be measured. Therefore, high sensitivity is particular required. The sensitivity is restricted by the internal noise of the measuring receiver. In order to decrease the effect of the internal noise, it is effective to make the width of the selecting characteristic (IF band width) as narrow as possible. However, the adverse effect accompany, e.g. difficulty of tuning, tendency of detuning or failure of measuring all energies of the occupied frequency range of waves. Therefore, in some receivers the IF band width can be changed over wide or narrow performance, depending on the requirement.

If noises are included in the measured values, measuring error is caused. If we presume the permissible measuring error due to noises down to 1 dB in general, measurement becomes possible until the ratio between the measured carrier wave voltage (C) and the noise voltage (N) reaches 6 dB. In other words, the lowest measurable value of the field strength meter is specified by the condition of C /N = 6 dB.

● Input Impedance

The value 50 Ω indicated in the column of the input impedance in the specification means "the device is adjusted so as to

exhibit the maximum voltage sensitivity when connected to an device having an output impedance of 50 Ω (e.g. signal generator) and, in addition, the voltage level indicated when used as a voltage meter is equivalent to the open-circuit voltage level of the signal generator having 50 Ω output impedance". However, the output impedance of antenna turns out actually 60 - 65 Ω if a doublet antenna is employed, therefore complete matching condition is not realized. Thus, the error caused by the impedance unmatching is expected in case of field strength measurement. This value is included in the calibration coefficient.

- Measurement Accuracy

As for the standard field strength, standard magnetic field generator and the standard antenna are used in HF band or less and VHF band or more, respectively for calibration purposes. However, the absolute value of the field strength differs depending on the measuring condition, e.g. location of measuring instrument, environmental condition, etc., so that the measurement accuracy is approximately 2 dB.

- Antenna Type

If the antenna directive pattern is not adequate, measuring error may be caused. Therefore, symmetry or shielded type is applied to the loop antenna. Also, to the doublet antenna, a balun (balance /unbalance converter) is attached to correct the directive property.

In addition, the logarithmic period antenna is applied to the panoramic reception, because of its flat gain characteristic on a wide-range of frequencies.

- Selectivity Characteristics

Pass band width of the intermediate frequency amplifier is

required wide or narrow depending on the case.

- Detection System

The indicating meter circuit of the field strength meter incorporates mean value detecting system and its scale is calibrated by the effective value.

However, in case of noise measurement, quasi-peak value is required and will be described later.

- Comparison Oscillator

As described in the above, the field strength meter needs the tuning amplifier of high frequency. Therefore, even if the gain of IF portion is stabilized, it is unavoidable that there exists a gain deviation depending on the frequency. Also, it is difficult to keep overall gain stable for a long period.

Therefore, the field strength meter is checked on every measurement with regard to the overall gain of the measuring receiver portion, by the referential voltage to adjust it to the rated gain.

The comparison oscillator generates this referential voltage and is built in the measuring receiver.

Since the gain check must be carried out for every measuring frequency, the output frequency of the comparison oscillator must be identified to the frequency of the measured wave or voltage. Thus the measuring operation becomes somewhat complicated. In some cases, the noise generator or the pulse generator is applied to the comparison oscillator, which can provide uniform level voltage spectrum over a wide range of frequencies in order to eliminate the tuning operation.

- Amplifier for Recorder

In some instruments, DC output is provided for the recorder

to generate logarithmic linear output, in order to facilitate long-time recording of the wave propagating properties.

- Power Source Portion

The measurement of the field strength is often carried out in the field without any provision of power source, so that the device is designed to be operable by the dry cells or storage batteries.

- Quasi-peak Value Meter

Receiving interference of the broadcasting is currently appealed in terms of wave nuisance. Therefore, it has been required to measure the high frequency noise and the field strength of the noise emitted from electrical machines which constitute the source of the noise.

In measuring the noise, the result differs depending on the values of frequency band of the meter, time constant and dynamic range of the detecting circuit, so that the evaluation of the noise becomes difficult. For this reason, a standard specification is determined for the noise meters and the measured result of it is used for the quantitative evaluation.

In Japan, there is the standard of the Japanese Radio Technology Commission (JRTC), which is identical to the international standard of CISPR (Special Committee of International Radio Interference).

Table 2 Standard of interference wave meter

Name of standard		JRTC (CI SPR)	
Frequency range		25 - 1000 MHz	
IF band width (-6 dB)		120 kHz	
Time constant of detecting circuit	Quasi-peak value	Charge	1 ms
		Discharge	550 ms
Overload coefficient		43.5 dB	