# SCHWARZBECK MESS - ELEKTRONIK

An der Klinge 29 D-69250 Schönau Tel.: 06228/1001 Fax.: (49)6228/1003


## Präzisions - Halbwellendipole
## VHAP (-10dB) 30 - 300 MHz
## UHAP (-10dB) 0.3 - 1 GHz

Field strength measurements in the VHF-UHF range are usually based on half-wave dipoles, which have the same directional diagram at all frequencies when adjusted to 0.45 λ to 0.5 λ; this is important because of the considerable influence of earth reflection - the frequency-dependent diagram of all broadband antennas allows different effects of earth and surroundings to be effective.

On the other hand, broadband antennas offer great advantages in automated measurement. Often there is therefore the task of calibrating a broadband antenna by means of high-precision dipoles on a specific measuring section.

Furthermore, there is a requirement to check the suitability of a measuring section in such a way that measured and calculated values of the dipole antenna section attenuation are compared. The results can either be used to determine the suitability of the measuring section, or corrections can be determined which allow good measuring accuracy even in less suitable terrain (see also CISPR 16 Appendix G).

Simple half-wave dipoles have the disadvantage that their radiation resistance differs more or less from the measuring device system resistance by 50 Ω. An extremely slim half-wave dipole in free space has a radiation resistance of 73 Ω, which can drop to 60 Ω with thick dipoles. Via an electrically reflective earth (or metal floor), the radiation resistance depends on the height of the dipole and the direction of polarization. The base point resistance oscillates between minimum and maximum values.

If the half-wave dipole is used as a power reference, a matching Pi-filter could be used to achieve perfect power matching at every frequency and at every level. However, this would cause an intolerable difficulty in operation, and the loss of the matching circuit would have to be measured individually for each setting and frequency.

Loading the dipole with an ohmic symmetrical attenuator with the "theoretical" radiation resistance 73 Ω, on whose output side there is a balun whose mean loss can be included in the attenuation of the attenuator, is simpler and more manageable. On the symmetrical side, a specially calculated The calibration divider has an input resistance of 73 Ω with a load on the output side of 50 Ωm. On the asymmetrical side of the balun there is a further 50 Ω attenuator, which reduces the total attenuation at an average frequency to 10 dB or the voltage division in the desired direction to 3.16: 1 (at different impedances).

A pair of such dipoles, coupled head to head, then results in a total attenuation of power or voltage of 20 dB (+/- a small correction) and only largely real connection resistances of 50 Ω.
Such pairs can be designed according to two aspects: If a voltage reference is preferred (field strength measurement), a design with 3.16: 1 voltage division each is recommended. Both dipoles in cascade, as they act as transmitting and receiving dipoles on a test section, then have 20 dB additional attenuation for voltage and power, just like two dipoles, each with 10 dB (10: 1) power division. In the latter case, there are two similar dipoles, but when there is a voltage reference, two different dipoles arise, both 3.16: 1 voltage division, but each in a different direction. With the sending dipole the voltage is divided from 50 Ω to 73 Ω in the ratio 3.16: 1, with the receiving dipole from the 73 Ω side after the 50 Ω output likewise 3.16: 1.

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These voltage-related dipoles therefore have an additional designation that indicates the type of use: VHAP-E and UHAP-E are receive dipoles, VHAP-S and UHAP-S are transmit dipoles that fill up the total additional attenuation to 20 dB.

When measuring the attenuation of a dipole section, it does not matter whether the dipoles dimensioned to 10 dB (10: 1) power division or the voltage-related ones dimensioned to (3.16: 1) are used on both sides, the total additional attenuation remains 20 dB.

Antenna factors are only available for antennas for reception. With the types VHAP-E and UHAP-E, the data required for the field strength measurement were supplied, the agreement between measured and calculated values was, with deviations below 1 dB, significantly better than the state of the art with simple dipoles. There was a certain risk if the transmitting dipoles were accidentally used instead of the receiving dipoles with the antenna factors of the VHAP-E and UHAP-E.

The power-related precision dipoles VHAP (-10dB) and UHAP (-10dB) eliminate this risk because they are identical. For them, the division of services was set at 10: 1 for both copies and in both directions. This interpretation is on the transmission side for the generation of a defined radiated power and on the reception side as a dipole reference for gain measurement.

In the case of field strength measurements with half-wave dipoles, the problem of measurement accuracy is unsolved. In practice, reflections arise both in the electrical system due to mismatches and in the measuring field due to reflection from the earth.
At the dipole one must expect impedances that depend on the height above ground, the extension length and the slenderness. Additional mismatching and attenuation arise in the balancing transformer. Furthermore, very considerable reflections occur at the receiver input if no attenuation is switched on at high sensitivity.

Reflections in the measurement field from the addition of the floor reflection and the direct radiation, which are variable in phase, likewise produce a wavy variation in the coupling between a transmitting and a receiving dipole. However, this is a peculiarity of the measurement setup and cannot be suppressed. The use of broadband directional antennas is not a solution, because their antenna correction, which is determined in the far field, is not correct at the usual measuring distances. One possibility of perfect adaptation is the use of reactive Pi filters.

This enables perfect power matching under all impedance conditions. This method is impracticable in practice, since 3-4 adjustments would be required for each frequency or altitude change. To do this, the loss of the matching filter would have to be taken into account at each frequency.

An almost ideal adjustment is possible at all frequencies and mounting heights if the dipole works in a constant, reflection-free resistive load of 73 Ω. This is the radiation resistance of a slim, matched half-wave dipole a few wavelengths above ground. This load resistance must be offered symmetrically and converted into 50Ω asymmetrically with a known damping that is as constant as possible. Due to the low reflection of the 50 Ω der output, the mismatch loss is low even if the receiver input exhibits increased reflection due to the zeroing of the RF attenuator. In practice it is beneficial if the total attenuation from the dipole to the coaxial connection is exactly 10.0 dB. The series of precision dipoles VHAP (30-300 MHz) and UHAP (300-1000 MHz) is the ideal aid to improve the accuracy of field strength measurements. They offer the above-mentioned properties in a perfect way. - If 2 dipoles each are procured (transmitting and receiving antenna), an individual measurement diagram is created for the total attenuation from the transmitting dipole. Input to the receiving dipole output included.