V. TECHNICAL PAPER

# A new equipment for the measurement of ionospheric absorption

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The measurement of ionospheric absorption with the method A3 started in the Geophysical Observatory Nagycenk in 1966 [1]. Method A3 of the measurement of ionospheric absorption is based on the recording of the field strength of once reflected waves, propagating from a distant transmitter by oblique incidence. As the data are required for the investigation of the lower ionosphere, transmitters in the long and middle wave band have been chosen [2]. The number of stations is limited by the conditions of applicability of the method A3. Thus, only few stations are available. The measurements began with the recording of the reflected wave field strength of the transmitters Československo (272 kHz) and Budapest (539 kHz). At that time standard measuring receivers, available in commerce, have been applied. Later it became inevitable to stop the recording of the transmitter Budapest, because of the steady alteration of the transmitter's power. Meanwhile the search for other appropriate transmitters began.

The field strength of several stations has been regularly measured by means of a field strength meter to study the receiving conditions at the observatory. The wearing out of the standard measuring receivers necessitated the construction of new equipments. Besides the fulfilment of conditions mentioned above and a site free of disturbances, the reliable measurement of ionospheric absorption requires a very stable receiver. As it is known, the field strength of the reflected wave decreases in day-time by several orders of magnitude as compared to its night-time value. This is the case especially in summer, when the sky wave is highly attenuated in day-time due to ionospheric absorption.

To enable the measurement of ionospheric absorption even in day-time, thus, a receiver of high sensitivity, as well as of high and stable amplification is needed. These conditions can be best satisfied by a heterodyn receiver. From the point of view of stable operation, the most essential part of such a receiver is the beat oscillator. The new equipment has been constructed by considering these principles.

The first unit of the receiver (1) (Fig. 1) is a radiofrequency amplifier, which is feeded by the voltage induced in the antenna. The input and output circuits of the radio frequency amplifier are tuned to the carrier frequency of the transmitter, which assure a band width of 300 Hz. The output voltage of this unit is mixed in the converter (2) with the voltage from the beat oscillator (5), the frequency of which is chosen to give the intermediate frequency of 30 kHz. An active analog multiplier circuit constitutes the converter, and the beat frequency is produced by a digital crystal oscillator. A thermostat, surrounding the oscillator, the temperature of which is held constant to 0,1 °C by special electronics (6), assures a frequency stability better than $10^{-6}$ Hz/°C. The temperature of the thermostat (50°C) has been selected so that it should be always greater than the ambient temperature. The output voltage of the converter is amplified in the intermediate-frequency amplifier (3). The band width of this unit is smaller than 100 Hz and thus enables the almost complete elimination of modulation. This is the reason why the frequency of the beat oscillator must be stabilized.

The subsequent part of the equipment consists of two channels. One of these is designed for the recording of night-time absorption, while the other is suitable to the measurement of day-time absorption. The last unit of the first channel is the demodulator unit (4), where the intermediate frequency is rectified. It consists of an active demodulator and a high pass filter. The latter provides for the removal of the rest modulation. An indicator, built into this unit, enables to find quickly the zero position turning the loop aerial. A compensograph connected to the output of the first channel produces continuous records of the field strength variations of the reflected wave.

In the second channel of the receiver first a converter (8) provides for the production of a separate intermediate frequency (5,8 kHz). This frequency arises from the mixing of the former intermediate frequency (30 kHz) and the beat frequency, supplied by the digital crystal oscillator and subsequently produced in a digital-frequency divider (7). The intermediate-frequency voltage is amplified by a selective, active RC amplifier stage (9), whose band width is 10 Hz. Since this channel is used for the registration of the weak field strength of the reflected wave in day-time, an additional amplification is needed. The gain of channel No 2 is three orders of magnitude higher than that of channel No 1. At the end of the second channel a demodulator (10), similar to that used in the first channel, provides for the rectification of the signal. The output voltage is recorded in this case with a dot printer.

A power supply unit (11) produces the stable voltages necessary for the operation of the equipment.

Fig. 2. shows a record of the output voltage of channel No 1. illustrating the variation of the reflected wave field strength around sunrise. The illustration shows the record from the beginning of transmission in the morning at 04 30 UT to 09 30 UT, when the scaling has been made. At 08 20 the gain was increased to enable the determination of day-time absorption.

The equipment is built with integrated circuits.

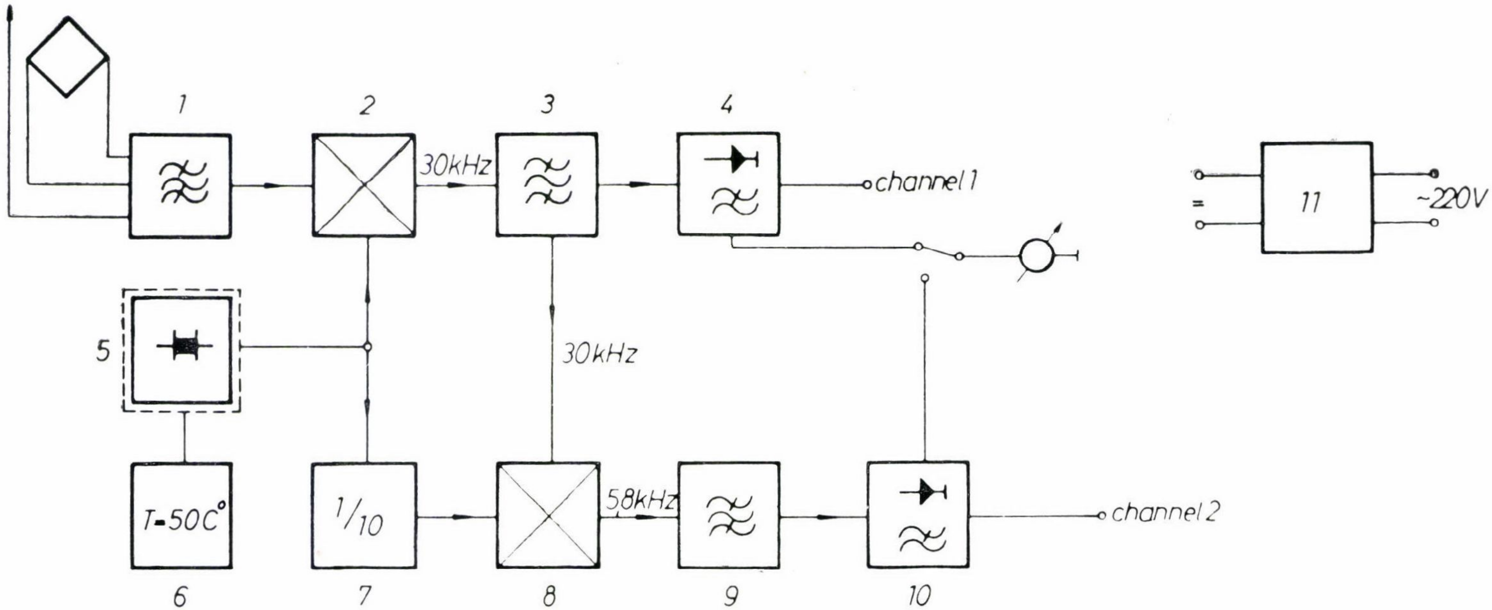
1
2
3
4
30kHz
channel 1
11
=
~220V
5
30kHz
T-50C°
1/10
5,8kHz
channel 2
6
7
8
9
10

Fig. 1.

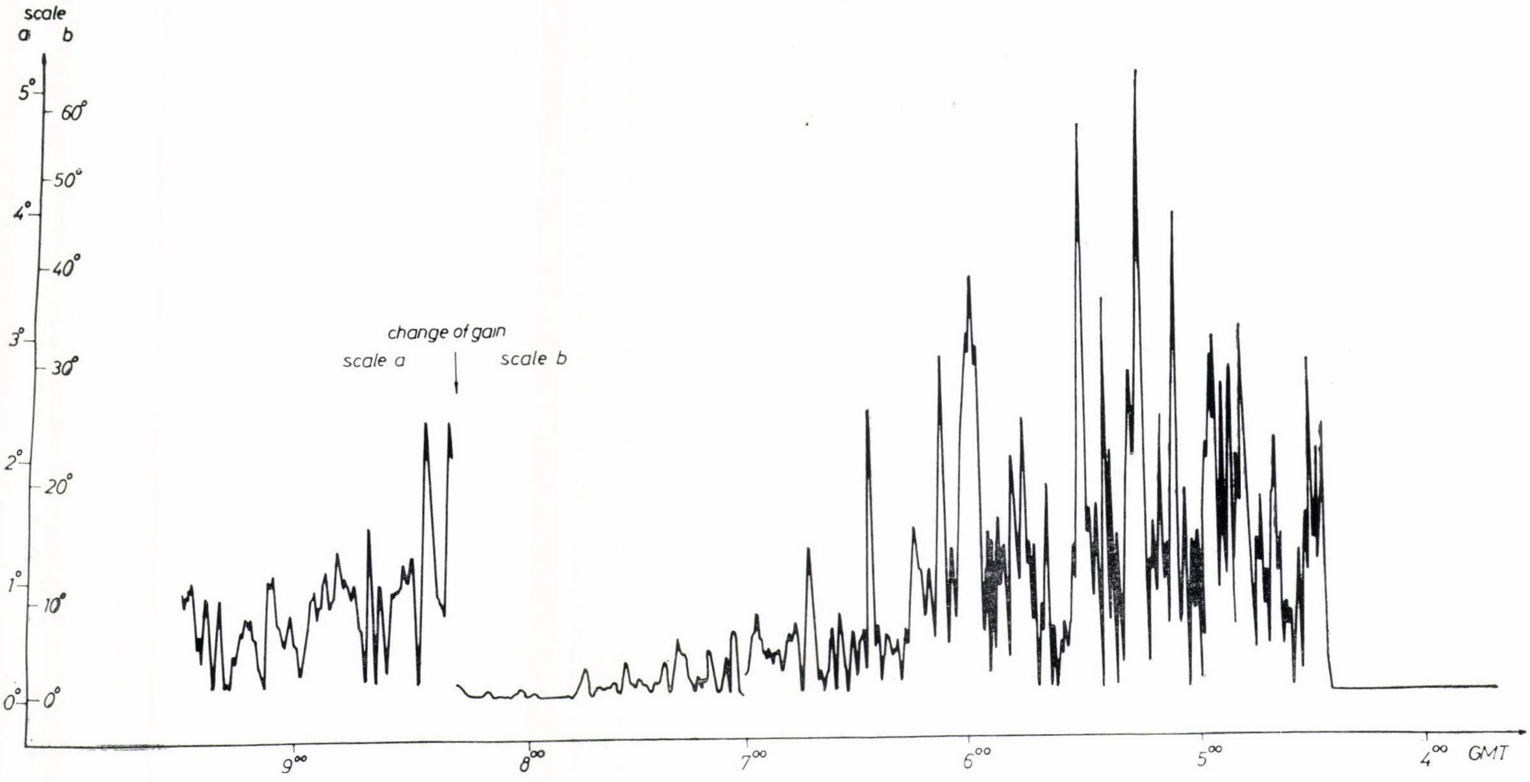
scale
a b
5°
60°
50°
4°
40°
3°
30°
2°
20°
1°
10°
0° 0°
change of gain
scale a
scale b
9⁰⁰
8⁰⁰
7⁰⁰
6⁰⁰
5⁰⁰
4⁰⁰ GMT

Fig. 2.

REFERENCES:

1. Bencze, P. und Märcz F.: Atmosphärish-elektrische und ionosphärische Messungen im Observatorium bei Nagycenk. Observatoriumsberichte des Geophysikalischen Forschungslaboratoriums der Ungarischen Akademie der Wissenschaften vom Jahre 1966. Sopron, 1967.

2. Bencze, P. und Märcz, F.: Über die Messungen der ionosphärischen Absorption im Lang- und Mittelwellenbereich mit der Methode A3. Acta Geodaet. Geophys. et Montanist. Acad. Sci. Hung. 2, 409 (1967).