CONSTRUCTION OF A GEOPHYSICAL RESISTIVITY METER AND APPLICATION IN SITE CHARACTERIZATION

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ABSTRACT

An automatic polarity reversing, short circuit protected adjustable output voltage resistivity meter (code named AFORE), was designed and constructed from locally available electronic and electrical materials. This was with the aim of building a resistivity meter that would be cheap and comparable both in quality and suitability with imported resistivity meter and whose circuitry would be understood and could be easily maintained.

A high voltage (up to 748 V AC peak to peak), low frequency (< 0.57 Hz) power supply unit was designed and constructed from multivibrator, high current, voltage switching, transformation and automatic polarity reversing circuits. The noise in the two output signals of the multivibrator was filtered with two inverting buffers. The gate and drain to ground voltages of the four high current MOSFET enhanced BJT switches were protected with zener diodes from the transformer spikes. All the outputs of multiple secondary tappings transformer were connected to rotary switch and each selected output voltage was filtered from high voltage spikes with an ac capacitor. The oscillated low and filtered transformed high voltage AC outputs were monitored on oscilloscope to a consistent mains frequency. The output voltage from the transformer was rectified with a bridge rectifier and filtered from AC ripples with electrolytic capacitor. The output current was buffered with zener diode protected avalanche switching MOSFET. Excessive current was limited with two linear switching transistors and two 5 W resistors. The output voltage was reversed automatically and controlled with two multivibrator circuits varied in two modes to allow for the measurements of electrical resistivity (ER) and induced polarization (IP). Circuit for Spontaneous Potential (SP) measurement or removal in ER mode was constructed from a voltage divider network. The constructed resistivity meter was tested and compared with imported ABEM, OMEGA. R50 Soil Test and PASI 16 g1 resistivity meters in geophysical site investigations.

The comparative field tests showed that the Vertical Electrical Sounding (VES) curves derived from AFORE resistivity meter and the other imported resistivity meters correlated very well. The inverted double dipole resistivity data from ABEM and AFORE resistivity meters identified similar positions of low resistivity seepage zone and a metallic bleeding pipe along the Opa dam embankment located in Obafemi Awolowo University (OAU) IIe-Ife southwestern Nigeria. The Natural History Museum borehole test site in OAU showed that the interpretation results of AFORE resistivity meter derived VES data compared well (83-97 %) with the borehole lithological log-derived depths. Its geoelectric section compared satisfactorily (85-100 %) with that of the other resistivity meter derived data. AFORE resistivity meter has a weight of 7.5 kg and could be used at an ambient temperature ranging from -15 to 40 ^{0}C. The cost of constructing the equipment was about 0.125 million (M) Naira, as against the market values of 2.3 M, 1.4 M, 2.5 M, 2.35 M and 2.1 M Naira for imported PASI 16 gl, OMEGA, ABEM SAS 300C, SYSCAL PRO and Soil Test resistivity meters respectively.

It was concluded that AFORE resistivity meter worked satisfactorily well and could be used for teaching, academic research and professional practice.