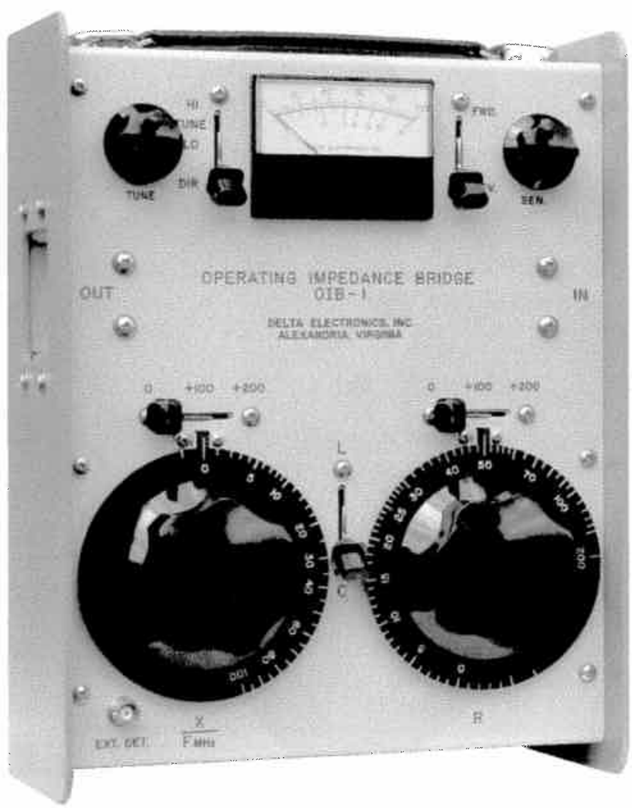
NEW MEASUREMENTS YOU CAN MAKE WITH THE OIB-1 OPERATING IMPEDANCE BRIDGE



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I. DESCRIPTION OF OPERATING IMPEDANCE BRIDGE

The Delta Electronics Model OIB-1 Operating Impedance Bridge is an instrument for impedance measurement and has two main characteristics that make it unique. These characteristics are, (1) its ability to handle a large through power (up to 5 kW with modulation, 10 kW unmodulated); and, (2) its very low insertion effect in the circuit being measured.

It is a characteristic of directional antenna systems that the impedance at each point throughout the antenna system varies according to the tuning of the antenna system. When an ordinary bridge is inserted in such a system, the impedance measured with that bridge is not the actual operating impedance since the insertion of the bridge greatly detunes the system. The OIB-1, on the other hand, can be inserted at any point throughout a directional antenna system. The insertion effect is so low (equal to 9" of 150 ohm line) that the antenna continues to function without significant detuning.

A description will be given below of several of the measurements that can be made with this bridge that cannot be made with an ordinary bridge. There are, of course, many other unique measurements that can be made, as well as measurements that can be made by both types of bridges.

II. FRONT PANEL CONTROLS OF THE OIB-1

The cover is a photograph of the front panel of the operating impedance bridge. The controls on the lower half of the front panel are for the measuring section of the bridge. Those on the upper half are for the detector section. The large dial on the lower right is the resistance dial. The dial on the lower left is the reactance dial. When a null is obtained by adjusting these two dials, the resistance and reactance can be read directly from the engravings on the dials. The lever switch between these two dials is the L-C switch. This switch must be in the L position for inductive loads, and in the C position for capacitive loads. The two lever switches immediately above the R & X dials are adder switches. When an adder switch is thrown in the +100 position, the measured value is the dial reading plus 100 ohms.

The meter in the top center is the null indicating meter. The sensitivity control for this meter is the knob to the right of the meter. The lever switch between this control and the meter is the Forward-Reverse switch. This switch is always in the "Rev." position, except during the SWR measurements described later. The lever switch immediately to the left of the meter is the Tune-Direct switch. When it is in the direct position, the null indicating meter is connected directly to the output of the bridge. When it is in the "Tune" position, a tuneable L network is inserted between the meter circuit and the bridge. This network is tuned by the "Tune" knob. Its use increases the sensitivity of the null measuring circuit.

Provision is made for attaching an external detector to the bridge. A BNC connector for this purpose is mounted on the lower left corner of the panel.

Two high power RF connectors are mounted in recess holes on either side of the bridge case. The connector on the right is the input connector and the one on the left is the output connector. It is to these connectors that the circuit to be measured is attached.

III. MEASURING OPERATING IMPEDANCE

Measurement of the operating impedance at any point in the antenna system can be accomplished as follows: the circuit to be measured is interrupted. A convenient way of doing this is the removal of a meter plug. The clip leads supplied with the bridge are attached to the input and output connectors on the bridge case. The bare leads from both sides are clipped to a good ground point. The insulated lead from the input connector is clipped to the meter jack terminal towards the transmitter. The other insulated lead is clipped to the terminal towards the antenna. Power is then applied to the circuit. The sensitivity control is advanced until an upscale reading is obtained on the null indicating meter. The R & X dials are then manipulated for a null. The sensitivity is then advanced and further adjustments of the dials are made to obtain a deep null. It will be found that the L-C switch must be placed in the proper position in order to obtain a null. It may also be found that one of the dials is rotated to its maximum position before a null is obtained. In this case, the adder switch must be used. When a null is obtained, the operating impedance looking towards the antenna is the dial readings plus the adder switch readings. The reactance value is positive with the L-C switch in the L position, and negative when in the C position. When measurements are made at 1 MHz, the reactance is the value indicated on the X dial (plus the adder switch). For frequencies other than 1 MHz, the reading must be multiplied by the measuring frequency in megahertz to obtain the actual load reactance.

IV. INCREASING SENSITIVITY WITH TUNE CIRCUIT

It will be found that with transmitters of a low power, especially at low frequencies, that it is desirable to have more sensitivity in the null indicating meter. This can be accomplished by throwing the "Tune-Dir." switch to the "Tune" position and rotating the "Tune" knob for maximum meter indication. A substantial increase in sensitivity can be obtained using this circuit.

V. USE OF EXTERNAL DETECTOR

For very low transmitter powers, or when a signal generator is used in place of the transmitter, an external null detector can be used to get the required sensitivity. A well shielded communications receiver can be connected to the external detector jack by a coaxial cable and used as an external detector. Since it is required that the bridge operate with a large through power, the attenuation between the bridge input and the detector circuit has purposely been made large in order to protect the adjustable standards in the bridge. This attenuation places a rigorous requirement on the shielding of an external detector. The adequacy of the external detector shielding can be determined by disconnecting the receiver cable from the external detector jack and putting the body of the plug in contact with the body of the external detector jack. The output indication should be lower than the null value.

VI. MEASURING NEGATIVE IMPEDANCE (Another Unique Feature of the OIB-1)

Occasionally it will be found that when the dials are manipulated for a null, a balance will be indicated below zero on the R dial. This indicates that that particular part of the antenna system has a negative operating resistance. This characteristic is frequently found in multi-element directional antenna systems. The value of the negative impedance can be measured with the OIB-1. It is accomplished merely by reversing the connection of the clip leads from the bridge. That is, the lead from the IN connector is connected to the circuit towards the antenna. The lead from the OUT connector is connected to the circuit near the transmitter. A bridge null is obtained in the normal manner and readings are taken from the bridge dials in the normal fashion. The actual impedance is the negative of the R & X values read from the bridge.

VII. ADJUSTING MATCHING NETWORKS

After the operating impedance of a single tower is obtained, proper values of network components can be computed by normal equations. When the network is installed, it is convenient to connect the bridge between the input of the network and the transmission line. With the power applied, the network impedance can be measured. The network components can then be trimmed to obtain an exact match for the transmission line. It will, of course, be necessary to re-establish the phase and current ratio each time a change is made in the matching network.

It has been found that if the networks and transmission lines are matched early in the directional antenna tuning procedure, a much better control is obtained with the antenna phasing equipment. This speeds the adjustment of the antenna parameters.

VIII. MEASURING THE COMMON POINT

Adjustments on the phasing equipment of the antenna system to obtain the desired pattern will, unfortunately, change the common point impedance of the system. This changes the input power to the antenna and leaves the engineer in the dark as to the actual radiated power during field measurements. It has been found quite convenient to connect the operating impedance bridge in the common point lead while adjustments are being made. When the phase and current adjustment is made, the engineer can observe the effect on the common point. If the common point resistance is changed substantially, it can be returned by adjusting the appropriate network components without removing the transmitter from operation. The engineer, therefore, has knowledge of the antenna power at all times during the antenna adjustment. Previously, it was often necessary to wait until midnight to determine the actual antenna power by conventional bridge measurements. On occasion it was found that the actual power differed so much from the required power that the field intensity measurements made that day were useless.

The final impedance measurements required by the FCC can be delayed until after the antenna is adjusted. These can, of course, be made in the usual manner with the usual equipment.

IX. LOCATING POWER LOSS

Quite frequently an antenna is adjusted and field intensity measurements reveal that the radiation in the main lobe is somewhat less than predicted. This can be due to several reasons, one of which is abnormal losses in the antenna networks. The Model OIB-1 is a very convenient tool for determining the source of these losses. The operating impedance of each radiator element is measured and the antenna current squared times the operating resistance of each element gives the power delivered to each tower. When these are all added they should very nearly equal the transmitter output power. If this is not the case, measurements can be made at successive points in the antenna system towards the transmitter. The total power at each point can be determined from the operating impedance and the current and the source of the power loss isolated.

X. RENOVATING AN ANTENNA SYSTEM

Sometimes a station will wish to rebuild their antenna phasing gear, transmission lines and networks. The proper design of the new equipment requires a knowledge of the operating impedance of each element of the antenna system. These values can very easily be determined with the Model OIB-1 Operating Impedance Bridge, using the existing networks.

XI. SWR MEASUREMENTS

It is often desirable to measure and record the SWR on the transmission lines of an antenna system. This can be done with the operating impedance bridge by installing the bridge at the input of the transmission line, as described above. The R dial is set to the characteristic impedance of the line, and the X dial is set to zero. The "For. -Rev." switch is thrown to the "Fwd." position and the sensitivity control is advanced until a full scale reading is obtained on the meter. The switch is then returned to the "Rev." position. The SWR on the line can then be read directly from the SWR scale on the meter.