APPLICATION BULLETIN NO. 2

INSTALLATION AND USE OF CPB-1 & CPB-1A COMMON POINT IMPEDANCE BRIDGE

DELTA ELECTRONICS

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I. DESCRIPTION OF COMMON POINT IMPEDANCE BRIDGES

The Delta Electronics Models CPB-1 and CPB-1A Common Point Impedance Bridges are instruments designed for permanent installation in the common point of a directional antenna, or at the input of any high power RF load. The CPB-1 will handle a through power of up to 5 kW - 100% amplitude modulated at any frequency between 540 and 1650 kHz. The CPB-1A is the same bridge with the coupler box designed to handle up to 50 kW of power over the same frequency range. These instruments can be installed permanently at the input of an RF load to be measured at any time during normal operating hours.

The bridge has an R dial and X dial, and a panel mounted null indicating meter. The two dials are manipulated as an ordinary bridge to obtain a null as indicated on the panel meter. The values of the load resistance and reactance can then be read directly from these two dials. Provision is made for mounting an RF ammeter on the bridge panel. The load current can be read from this meter and used along with the measured resistance to compute the total RF power delivered to the load. Both models of the common point impedance bridge have a very low insertion effect: that is, their installation will cause a very minor disturbance of the load being measured. The bridges can, therefore, be installed at the input of separate antenna transmission lines. The input impedance and the input power of the lines can then be measured. For example, if a directional antenna is a three-tower array, one bridge may be inserted at the common point for determining the total input power to the antenna system, and a bridge may be inserted in each transmission line to determine the power delivered to each tower. The engineer then has a complete picture of the total power and the power distribution of the antenna system.

It has been observed on many occasions, that the common point and line input impedances of directional antenna systems vary from time to time because of changes in ground conditions and minor variations in the tuning elements of the antenna. The ordinary procedure is to wait until after normal operating hours and re-measure the antenna common point impedances with a normal RF bridge. If this is not done frequently, the station may operate for extended periods with less than the licensed power. The procedure for measuring the power and impedance of the transmission lines to each antenna is quite complex. The CPB-1 and CPB-1A bridges make these measurements very simple. The station operator can measure the operating impedances and power at any time during normal operating hours. He can re-adjust his circuits to maintain his transmitter power at all times, thus assuring optimum service to the station's listeners. The knowledge of the operating impedances at all times further serves to alert him to any component failure or serious antenna detuning. This permits him to make corrections immediately and avoid citations for improper operation.

II. OPERATING PRINCIPLE

The CPB-1 and CPB-1A bridges operate on an extension of the directional coupler principle.* The coupler box contains the main transmission line which delivers the entire RF power through the bridge to the load, and a secondary line which collects a small sample of the RF power for impedance measurement. A sensitive RF voltmeter is self-contained in the bridge for connection to the secondary line to act as a null detector. Variable resistance and reactance standards are also connected to the secondary line. These standards are manipulated so that the voltmeter reading is brought to zero. Under this condition, a mathematical relation exists between the values of the variable standards and the load impedance being measured. The variable standards can, therefore, have front panel dials which are calibrated directly in the resistance and reactance of the load. The only interruption made to the RF circuit by the installation of this bridge is the 9" of primary transmission line within the coupler box (characteristic impedance of approximately 150 ohms for the CPB-1, and 70 ohms for the CPB-1A). Since only a very small sample is taken by the secondary line for measuring purposes, the bridges can handle very large through powers.

III. INSTALLATION

The CPB-1 and CPB-1A bridges are normally supplied mounted on a standard 19½ x 7" rack panel. A cutout can be made in the antenna phasing equipment for mounting this panel. Both bridges are also available without the rack panel. A drill template is then supplied, permitting the station engineer to mount the bridge in the existing panel of the antenna phasor. The connections to the primary line within the bridges are brought out by flexible straps to standoff insulators on the back of the bridge box. The output connection of the bridge is connected to the common point of the antenna system by copper tubing, flexible straps, or coaxial cable. The input is similarly connected to the transmitter. A large bolted clamp is supplied on the bridge box for properly grounding the instrument to the antenna and transmitter ground circuits. These connections should be made by a 2" copper strap or similar heavy conductor. Caution should be taken not to mount the bridge so that it will be directly in the high RF field of the antenna tank circuit, or another inductor carrying a large RF current. A front panel hole and recessed insulated mounting plate is supplied with the bridges for mounting the common point ammeter. These components are designed to fit standard Weston Type 308 meters, or any other meters having similar mounting holes.

IV. ADJUSTMENTS

The bridges are factory calibrated and have a resistance accuracy of ±2% ±1 ohm and a reactance of ±5% ±1 ohm. When the bridges are properly installed, no adjustments are necessary to measure the operating impedance within this accuracy range. Provision is made, however, for field adjustment of the bridges to make them agree exactly with the licensed common point resistance, as measured by conventional methods. Three holes are punched on top of the bridge cases. These holes are

* Patent Pending.

normally covered by snap-on cover plates. Screwdriver adjustments for the resistance and reactance scale are accessible through these holes. If the common point impedance has been accurately determined by conventional bridge methods, the common point bridges can be adjusted by positioning the R and X dials to the measured impedance values and then adjusting the screwdriver controls for an exact null, as indicated on the front panel meter of the CPB-1 and CPB-1A. One resistance control is provided for values near the low end of the resistance range, and another for values near the high end. The third adjustment is a reactance adjustment which can be used anywhere within the reactance range of the bridges. The bridges are, then, permanent references for returning to the correct common point impedance.

V. USE OF MODELS CPB-1 AND CPB-1A

The main use of the CPB-1 and CPB-1A is for continuous monitoring of the common point impedance, as described above. This permits the station operator to know and regulate his transmitter power at all times. It also permits him to detect changes in his antenna system which might otherwise go unnoticed. The instruments can be mounted in the input of any transmission line of a complex antenna system. They are then useful in determining the power distribution throughout the antenna system, the impedance match (and thus VSWR) on the transmission line, and isolating faults or changes in the antenna system. On some occasions, it has been found that the impedance of an antenna, or other RF load, is power sensitive; that is, the impedance measured at a very low power level is not correct when high powers are applied. This can be caused by dielectric changes in the ground system, intermittent bolted connections on the antenna towers, etc. Impedance measurements can be made at several different power levels with these instruments for investigating this effect. On some occasions, low efficiency or small intermittent changes in the antenna adjustments have been noted and attributed to loose tower bolts, rusty connections, etc. These are very difficult to locate by normal methods. With the instruments installed in that portion of the circuit, a rigger can climb the tower, tighten or move connections, and isolate these high resistance or intermittent joints. There are many other uses of the CPB-1 and CPB-1A which will become evident to the engineer, once he has become accustomed to them.

SPECIFICATIONS

FREQUENCY RANGE:
500 - 1650 kHz.

POWER RATING:
CPB-1 –5 kW - 100% amp. mod. continuous.
CPB-1A –50 kW - 100% amp. mod. continuous.

RESISTANCE RANGE:
30 - 100 ohms.

REACTANCE RANGE:
±50 ohms (1000 kHz)

ACCURACY:
Resistance ±2% ±1 ohm.
Reactance ±5% ±1 ohm.
(Provision is made for your consultant to adjust the calibration to agree exactly with your licensed resistance value.)

R.F. SOURCE:
Your transmitter operating at normal or reduced power acts as source - no generator is required.

DETECTOR:
Tuned internal detector with 25 μa panel meter – no external detector is required. BNC output connector for use with external detector.

R.F. AMMETER:
Panel hole is provided for Weston Model 308, 3½" square ammeter. A meter recessing bracket is supplied for high power applications. A matching meter for your power and resistance can be supplied.

TERMINALS:
Screw terminals or standoff insulators at rear of bridge box for connection to tubing, strap, or jumper to coax is provided.

MOUNTING:
Standard 7" x 19" engraved gray rack panel – can be supplied without panel for mounting behind your phasor panel (drill template supplied).

DIMENSIONS: Bridge box without panel
Height: 7"
Width: 9"
Depth: 9¼"
Panel Dimensions: 7" x 19"

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