RADIOMETER A/S

EMDRUPVEJ 72
COPENHAGEN NV
DENMARK

Cables: Radiometer, Copenhagen
Telephone: SØborg 5000
Telex: 5411

Represented by:

PRINTED IN DENMARK
20-4-67
IB MAGNUSSON 18724

TYPE CMB 1 / OSF 2

CAPACITANCE BRIDGE

0.001 μμF to 1.1 μF

RADIOMETER

SPECIFICATIONS

CAPACITANCE RANGE

0.001 μμF to 1.111 μF absolute in 5 ranges, viz.:

0–0.1 μμF
0–1111 μμF
0–11110 μμF
0–0.1111 μF
0–1.111 μF

ACCURACY

0.1% of reading + 0.005 μμF above 0.1 μμF.
0.0005 μμF below 0.1 μμF.
The bridge can be used with full accuracy from 200 cps to 5,000 cps.
At 50 cps and 10,000 cps the accuracy has decreased to about 0.2%.
The maximum capacitance, which can be measured with full accuracy decreases above 2 kc according to the expression $C_{max} = 4/f^2$, where f is the frequency in kc and C_{max} the capacitance in μF.

POWER FACTOR AT 1000 cps

Range

0 to 110×10^{-3}.

Accuracy

2% of reading + 0.5×10^{-3}.
The accuracy stated applies to values above 100 μμF; at lower values the accuracy is somewhat lower. In the ×0.01 range, balance can be achieved, but power factor measurements cannot be made.

INPUT

Unbalanced, high impedance (about 10 kilohms at 1000 cps).
The maximum input voltage is 50 volts but at frequencies below 500 cps it should not exceed 0.1 volt per cps.

OSCILLATOR

Frequency: 1000 cps ± 10 cps.
Output: 0 to 50 volts continuously adjustable, when connected to the bridge.
Distortion: About 2% at 50 volts output across 10 kilohms.
Hum: Below 20 millivolts.
Output impedance: Approx. 25 kilohms.

AMPLIFIER

Amplification: 0 to 60 dB continuously adjustable.
Selective Response: 3 dB down at ± 100 cps.
Flat Response: 3 dB down at 200 cps and 9 kc.
Hum: Below 1 millivolt with selective response.
Below 5 millivolts with flat response.
Output Impedance: Approx. 10 kilohms.
Output: Limited to 0.5–1 volt.

INDICATOR

Built-in electron ray indicator with two sections of different sensitivity.

POWER SUPPLY

Voltages: 110, 115, 127, 200, 220, 240 volts.
Line Frequencies: 50 to 60 cps.
Consumption: 40 watts.

TUBES

1	ECC83 (12AX7)	2	EF86 (6267)
1	EL83 (6CK6)	1	EM34 (6CD7)

MOUNTING AND FINISH

The Capacitance Bridge and the Oscillator-Amplifier are mounted on separate front panels, but are inserted in a common cabinet. The two units are connected by shielded wires. The front panels are compatible with a 19″ standard rack.

DIMENSIONS

Height	Width	Depth
380	565	260 mm
15	22	10¼ inches

WEIGHT

25 kilos net (55 lbs.).

ACCESSORIES SUPPLIED

1 type 1A1 single-shielded cable, 1 m long.
1 type 1F11 double-shielded cable, 1 m long.
Both cables fit into the shielded outlets from the Capacitance Bridge.
1 type 12K21-1.5 power cord.

Data subject to change without notice.

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capacitors, C_1, C_2, and C_3 of 10,000, 1000, and 100 μμF and a 0–10 μμF variable capacitor C_4. All capacitors can be connected individually to the tappings 0–10 on the right half of the inductor. In this manner, a capacitance standard of, e.g., 100 μμF represents a most accurate decade capacitor of 0, 10, 20, ----, 100 μμF. To extend the capacitance range upwards, a multiplier switch connects the unknown capacitor across 1/10 or 1/100 of the left half of L, corresponding to the positions ×10 and ×100.

The bridge can be used for capacitance measurements with full accuracy (about 0.1%) from 200 cps to 5,000 cps, and with about 0.2% accuracy from 50 cps to 10,000 cps. The readings are made directly in μμF on 3 decade switches and a continuous dial times a multiplier (positions ×0.1, ×1, ×10, and ×100). In the ×0.01 position of the multiplier switch only the continuous dial is operative. The decades have steps of 1000, 100, and 10 μμF, and the continuous dial is calibrated from 0 to 10 μμF with divisions for each 0.1 μμF.

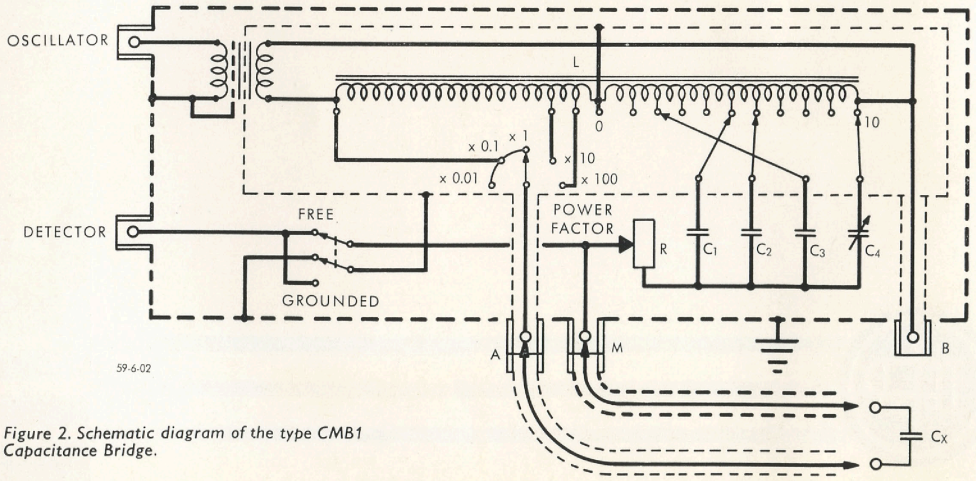

Figure 2. Schematic diagram of the type CMB1 Capacitance Bridge.

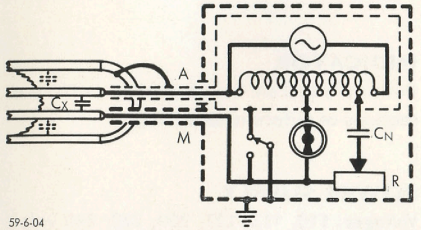

Figure 3. Measurement of a mutual capacitance in a 2-conductor shielded cable.

Power factor readings from 0 to 110×10^{-3} are obtained by means of a decade switch with positions for 0, 10, 20, ---, 100×10^{-3} in conjunction with a continuous dial from 0 to 12×10^{-3} with divisions for each 0.2×10^{-3}. The power factor calibration is correct at 1000 cps in the standard version, but a special version with correct readings at 800 cps is supplied on request. Although the readings may not be correct, the dial can be used for comparative measurements at other frequencies.

The special shielding system employed in the type CMB1/OSF2 is responsible for its extraordinary properties of measuring direct and ground capacitances in complex networks. To illustrate the principle of operation two examples are given below for measuring on a shielded two-conductor cable.

In the set-up of figure 3 only the capacitance C_X between the conductors is measured while all other capacitances to the cable shield or in the measuring cables are without effect on the balance of the bridge as they appear in parallel to the inductor or the detector.

Figure 4 shows the set-up for measuring the capacitance between one core and the cable shield. As can be seen, only the desired capacitance enters into the balance.

At terminal B, see figure 2, an external capacitance standard can be connected. The terminal is also useful, for example, when adjusting two sections of a variable capacitor to correct ganging. The reference section is connected to B while the other one is connected to A, and correct ganging has been

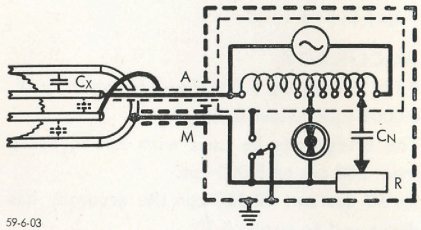

Figure 4. Measurement of a ground capacitance in a 2-conductor shielded cable.

achieved when, regardless of the capacitor setting, the detector output never exceeds a specified level which depends on the tolerance required.

As shown in the illustration, the capacitance bridge proper occupies the lower part of the cabinet while the upper part is occupied by an oscillator, detector-amplifier, and indicator.

The oscillator is of the RC phase-shift type and delivers about 50 volts across 10 kilohms. The frequency is 1000 cps in the standard version, but 800 cps in the special version, type CMB1/OSF2L.

The amplifier is used as a detector-amplifier with a maximum gain of 60 dB. The frequency response can be set either to be flat within the audio frequency range or to be selective to the oscillator frequency.

The amplifier output can be fed to a built-in electron ray indicator or to a pair of binding posts for external indicators such as a pair of headphones, a vacuum-tube voltmeter, or an oscilloscope. A built-in limiter prevents the output voltage from exceeding 0.5–1 volt.

GENERAL

The type CMB1/OSF2 Capacitance Bridge is a unique high-precision instrument, which in addition to the bridge proper includes an oscillator, detector-amplifier, and indicator. The type CMB1/OSF2 is direct reading in capacitance from 0.001 μμF to 1.1 μF over the entire audio frequency range and also direct reading in power factor from 0 to 110x10^{-3} at the frequency of the built-in oscillator, which is 1000 cps in the standard version and 800 cps in the type CMB1/OSF2L.

A remarkable feature of this bridge is its ability to measure directly the single capacitance components of a complex capacitance network. Further, shielded cables can be used between the bridge and the unknown capacitor without influencing the measurement.

Due to these properties, the bridge can be used, for example, to measure inter-electrode capacitances in vacuum-tubes, to distinguish between mutual and ground capacitances in multiconductor cables and to measure the temperature coefficients even of small capacitors, which are placed in a conventional thermostat-controlled oven and connected to the bridge by means of shielded cables.

In addition, the type CMB1/OSF2 is simple to operate, reliable, and stable.

SPECIAL FEATURES

- *Accuracy of 0.1%.*
- *Measures directly single capacitances from complex capacitance networks.*
- *Shielded cables can be used without introducing errors.*
- *Direct measurement of power factor.*
- *Built-in oscillator, detector-amplifier, and indicator.*

APPLICATIONS

- *High-precision measurements of capacitance.*
- *Measurement of capacitances in transformers, tubes, cables, etc.*
- *Useful for adjusting two variable capacitors for correct ganging.*

TYPE CMB1/OSF2

CAPACITANCE BRIDGE

0.001 μμF to 1.1 μF

DESCRIPTION

The operating principle of the type CMB1/OSF2 Capacitance Bridge is outlined in figure 1. Instead of the ratio resistors used in conventional bridges, a specially designed ratio inductor (autotransformer) L, with very low leakage coefficients is employed. The tapped inductor holds a number of advantages over ratio resistors: for example, the accuracy of the voltage ratios can be made better than 0.001% so that the measuring accuracy depends entirely on the capacitance standards. Further, the inductor offers a high impedance to the oscillator voltage, while the output impedance of the tappings is low so that the voltage ratios are practically unaffected by loading.

The variable resistor, R, is necessary to obtain balance if the unknown capacitor, C_X, has losses.

Figure 2 shows a more detailed schematic diagram of the bridge. The capacitance standard consists of three high-stability mica

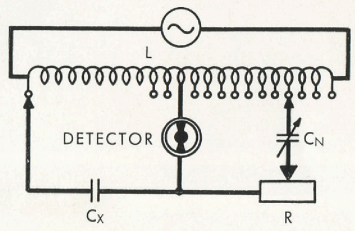

Figure 1. Simplified schematic diagram of the type CMB1/OSF2.

capacitors, C_1, C_2, and C_3 of 10,000, 1000, and 100 μμF and a 0–10 μμF variable capacitor C_4. All capacitors can be connected individually to the tappings 0–10 on the right half of the inductor. In this manner, a capacitance standard of, e.g., 100 μμF represents a most accurate decade capacitor of 0, 10, 20, ----, 100 μμF. To extend the capacitance range upwards, a multiplier switch connects the unknown capacitor across 1/10 or 1/100 of the left half of L, corresponding to the positions ×10 and ×100.

The bridge can be used for capacitance measurements with full accuracy (about 0.1%) from 200 cps to 5,000 cps, and with about 0.2% accuracy from 50 cps to 10,000

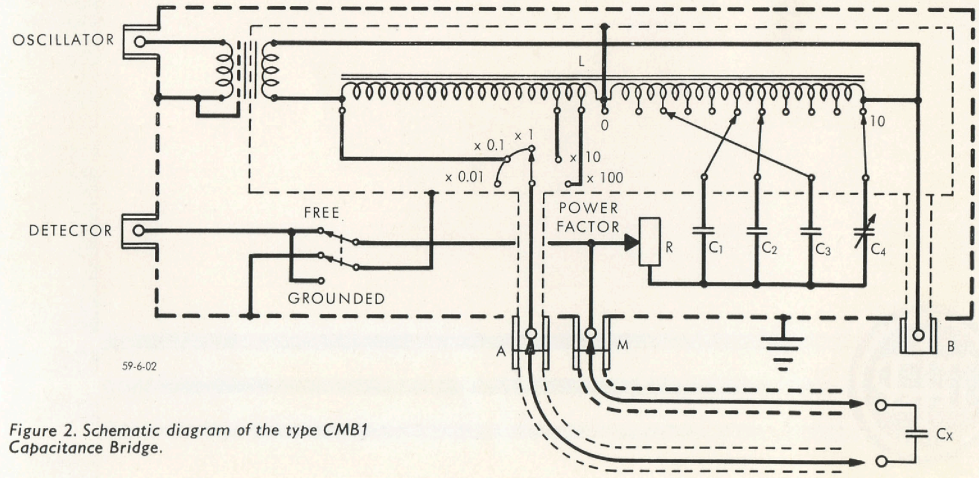

Figure 2. Schematic diagram of the type CMB1 Capacitance Bridge.