Tettex INSTRUMENTS

3320

Standard Air Capacitors

USE

These standard fixed and variable capacitors are apt especially for precision measurements of high accuracy. Because of their high insulation resistance, small self-inductance and dissipation factor, these standards may be used within large frequency ranges up too very high frequencies.

DESCRIPTION

The standard capacitors of series types 3320 are said “three-poles“-capacitors, as they are provided with three electrodes. Solid dielectric used for their construction, is applied to part capacitances C_{10} and C_{20}. Only those named C_{12} having no solid dielectric and being practically loss-free.
As protection against dust and moisture, fixed capacitors are enclosed in housings filled with dry air (water content of dry air: 75 ... 100 ppm resp. 60 ... 80 ... mg/m3).
We have equipped our standard air capacitors (<1000 pF) with a drying agent (Silica gel). With the humidity indicator, mounted at the side, the humidity in the interior of the instrument can be controlled.

CONSTRUCTION

Up to 10’000 pF electrodes of standard capacitors are made of specially treated Invar steel, while above 2000 pF the plates consist of polished aluminium.
Distance between plates is 3 mm for all types, so that the operating voltage may reach a maximum of 2000 V R.M.S.
Every edge of metallic parts is rounded to avoid dispersion loss.

MAINTENANCE

Standard capacitors are of strong construction and show no mobile parts, with the exception of variable capacitors, they no need maintenance. However, with the aim of keeping constant their value, it is advisable to protect it against vibrations, shocks and impacts. If they are used for high precision measurements, they should be periodically checked, for instance every year, by an official testing board.

Within the scope of design improvements, the reference air capacitors of type series 3320/1000 pF have been equipped with a drying agent (Silica gel). Two bags, of about 80 ... 100 g are supplied with the capacitors.
The hygroscopic indicator mounted on the side, monitors the humidity inside the unit. It indicates three relative humidity values: 30, 40 or 50 %.
Blue colour: relative humidity is lower than indicated.
Rose colour: relative humidity is higher than indicated.
If the relative humidity reaches a value of 50 %, the dry agents should be regenerated.
The dry agents are replaced by rotating and removing the labelled rubber base. The two bags contain the dry agent can then be removed.
With the two supplied replacement bags the measurements can be continued after only a short interruption. The replacement bags has to be removed from the protective plastic sheath (observe test indicator) and inserted in the unit. The cap should be screwed on tightly.
The removed bags containing the dry agent are regenerated by drying them at 120 °C for approx. 12 hours.

TECHNICAL DATA

Dissipation factor tan δ_{12}:	< 1 x 10^{-5}
Operating voltage, max.:	2000 V R.M.S.
Temperature coefficient	
$C_{12} \leq 1000$ pF:	about + 10 x 10^{-6}/°C
$C_{12} > 1000$ pF:	about + 20 ... 30 x 10^{-6}/°C
Inductance:	about 2 ... 5 x 10^{-8} H
Stability:	< 50 x 10^{-6}/year
Depending of frequency up to 10 kHz:	< 1 x 10^{-5}
Depending of voltage with regard to C_{12} and tan δ_{12}:	< 1 x 10^{-6}

ACCURACY

Fix capacitors: Please see table at page 4
The value of main capacitance C_{12} = calibrated capacitance is given with an accuracy of ± 0.001 % in the test certificate delivered with the standards. Further, for fixed capacitors the label indicates part capacitances C_{10} and C_{20} with an accuracy of ± 0.1 pF.

On request the standard capacitors may be delivered with an official report from a laboratory of metrology.

CALIBRATION

Main capacitance C_{12} is calibrated at 23°C and a rel. air humidity by 20 %.

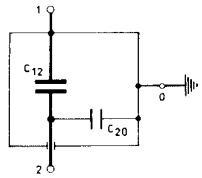
ACCESSORIES

Each capacitor is supplied with the following accessories:

2 spare bags of dry agent	no. 08189-00
but only for types up to 3320/1000 pF	
As connection cable unipolar, shielded cables	no. 101 W or no. 111 W
(furnished with shielded plugs) are available.	
Standard lengths 1, 2, 5, 10 and 20 m.	
Unipolar sockets for shielded plugs are available:	
Socket without insulation	no. 10691-00
Socket without insulation	no. 12361-00
Dissipation factor tan δ-standard	type 3721

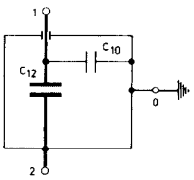
EQUIVALENT CIRCUITS FOR CAPACITORS

For absolute precision measurements, only the calibrated capacitance C_{12} has to be used, the partial capacitances C_{10} and C_{20} being eliminated.



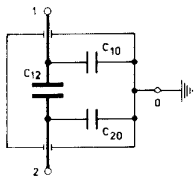
$C_{11} = C_{12} + C_{20}$

C_{12} = Eichkapazität
C_{10} - C_{20} = Teilkapazitäten
C_{11} - C_1 - C_0 - C = Betriebskapazitäten

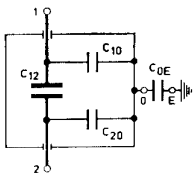


$C_1 = C_{12} + C_{10}$

C_{12} = Capacité d'étalonnage
C_{10} - C_{20} = Capacités partielles
C_{11} - C_1 - C_0 - C = Capacités de service



$C_0 = C_{12} + \frac{C_{10} \cdot C_{20}}{C_{10} + C_{20}}$



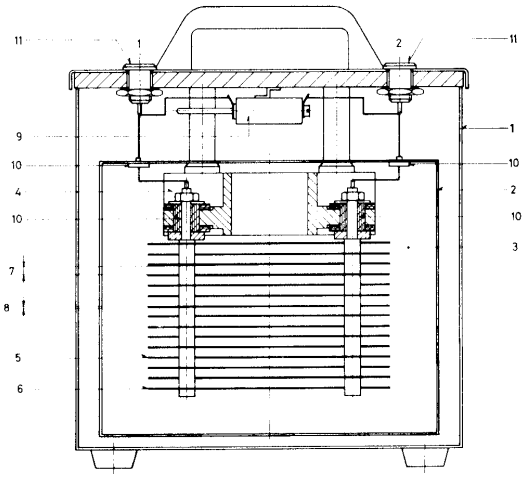
$C = C_{12} + \frac{C_{10} \cdot C_{20}}{C_{10} + C_{20} + C_{0E}}$

C_{12} = Calibration capacity
C_{10} - C_{20} = Partial capacities
C_{11} - C_1 - C_0 - C = Working capacities

TEST CONNECTIONS

While using this capacitors for precision measurements in bridge combinations, it is indispensable to make use of a potential regulating device with a guard-potential regulator (Fig.1), or better of a Wagner's auxiliary arm (Fig.2), in order to eliminate, among others, the partial capacitances of the bridge and cables with respect to earth, as well as both partial capacitances C_{10} and C_{20} of the capacitor. In such case, the housing 0 is connected to earth and the indicator corner points of the bridge will be submitted earth potential.
While using, a guard-potential regulator P, the capacitance C_{10} is external to the bridge. C_{20} is inoperative, because of the lock of potential difference when the bridge is balanced (Fig. 1).
In case of measurements with the aid of a Wagner's auxiliary guard circuit W the capacitance C_{10} is external to the bridge. C_{20} is inoperative because of the lack of potential difference when the bridge is balanced (Fig. 1).
In case of measurements with the aid of a Wagner's auxiliary guard circuit W, the capacitance C10 is parallel to the arm C_a of this circuit; C_{20} is inefficient, no potential difference appearing at balance (Fig. 2).
If the lowest bridge point is connected to earth - that means that the measuring voltage has one grounded pole, - the housing of the standard capacitor as well as the indicator corner point c of the auxiliary circuit have to be connected to the shielding of the bridge, which is disconnected from the earth. In such case the guard-potential regulator will be connected between the shield and earth.
For measurements without Wagner's guard circuit or guard-potential regulator the capacitor housing should be connected to the earthed point of the bridge, respectively to point v (Fig. 3). Both of partial capacitances, C_{10} lays parallel to voltage source, having so far no influence on measurements. C_{20} is in parallel with one of the lower arm resistance and has an effect only on the phase of the bridge. Those effects can be considered by a correction (the capacitance of the lead-in cables, etc., should also be taken into consideration!).

CONSTRUCTION AND VIEW



Legend:

1.	External Housing (screen)
2	Internal Housing (screen)
3	Dry air
4	Base Plate (screen)
5	Electrode Plates 2
6	Electrode Plates 1
7	Plate Distance = 3mm
8	Plate Thickness = 1 resp. 1.5 mm
9	Tune Capacitor
10	Insulators
11	Junction Bushings 1 and 2

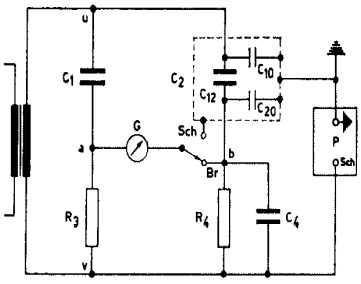


Fig. 1

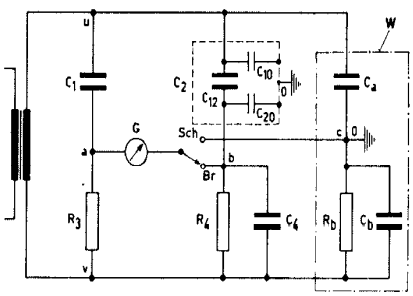


Fig. 2

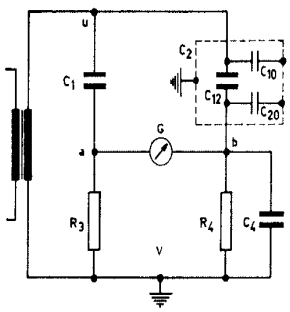


Fig. 3

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LIST OF TYPES

Type	Capacitance C_{12}	Accuracy C_{12}	Partial capacitace C_{10} - C_{20}	Dimensions	Net weights	
No.	pF	%	~ pF	mm/ (in)	~ kg	~ lbs
3320/10	10	± 0.02 %	60 - 70	260x260x310 (10.2x10.2x12.2)	10	22
3320/20*)	20	± 0.01%	60 - 80	260x260x310 (10.2x10.2x12.2)	10	22
3320/50 *)	50	± 0.005 %	60 - 80	260x260x310 (10.2x10.2x12.2)	10	22
3320/100	100	± 0.005 %	60 - 80	260x260x310 (10.2x10.2x12.2)	10	22
3320/200 *)	200	± 0.005 %	60 - 80	260x260x310 (10.2x10.2x12.2)	11	24
3320/500 *)	500	± 0.005 %	60 - 90	260x260x310 (10.2x10.2x12.2)	12	26.4
3320/1'000	1'000	± 0.005 %	70 - 90	260x260x310 (10.2x10.2x12.2)	13	28.6
3320/2'000 *)	2'000	± 0.01 %	140 -200	360x360x450 (14.2x14.2x17.7)	24	53
3320/5'000 *)	5'000	± 0.02 %	140 - 200	360x360x450 (14.2x14.2x17.7)	29	64
3320/10'000	10'000	± 0.02 %	170 - 250	360x360x450 (14.2x14.2x17.7)	35	72

* special design

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