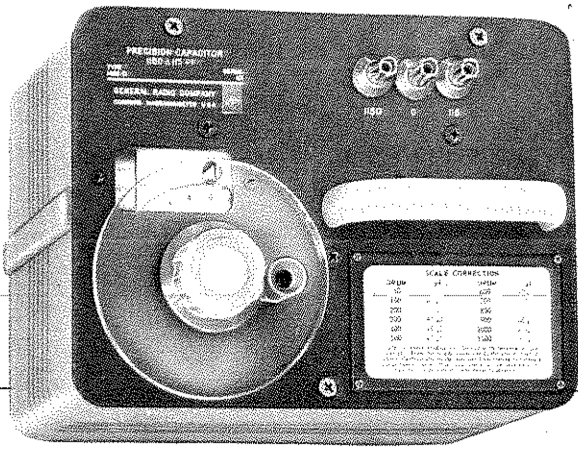
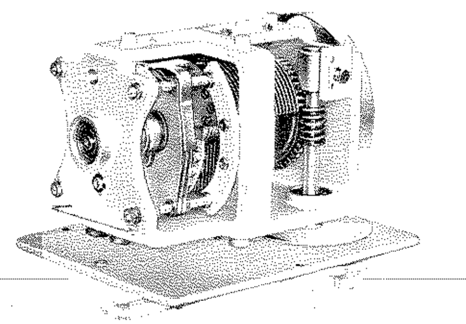
PRECISION CAPACITOR

Type 1422

- variable air capacitor
- stability: better than 0.02% full scale per year
- settable to 40 ppm
- low temperature coefficient, low losses
- wide selection to suit needs





Panel and interior views of 1422-D Precision Capacitor.

The 1422 is a stable and precise variable air capacitor intended for use as a continuously adjustable standard of capacitance.

One of the most important applications is in ac bridge measurements, either as a built-in standard or as an external standard for substitution measurements. It is available in a variety of ranges, terminal configurations, and scale arrangements to permit selection of precisely the required characteristics.

TWO-TERMINAL

The 1422-D is a dual-range, two-terminal capacitor, direct reading in total capacitance at the terminals. For high-frequency use, the 1422-N, similar to the high-capacitance section of the 1422-D, is designed to have low residual inductance and resistance.

For convenience in making substitution measurements, two 1422's have scales reading in capacitance removed, i.e., the capacitance is maximum at the zero reading. These, the 1422-MD and 1422-ME, are also dual-range, two-terminal capacitors.

THREE-TERMINAL

The 1422-CB, -CC, -CL, -CD, and -CE are three-terminal capacitors with shielded coaxial terminals for use in three-terminal measurements. The calibrated direct capacitance is independent of terminal capacitances to ground, and losses are very low. The 1422-CL has approximately the same maximum capacitance as the -CC, but with more constant and much lower terminal capacitances so that it can be used in measurement circuits where higt capacitance to guard can not be tolerated.

CONSTRUCTION

The capacitor assembly is mounted in a cast frame fo rigidity. This frame and other critical parts are made o aluminum alloys selected to give the strength of brass with the lightness of aluminum. The plates of most models are also aluminum, so that all parts have the same temperature coefficient of linear expansion.

A worm drive is used to obtain high precision of setting. To avoid eccentricity, the shaft and the worm are accurately machined as one piece. The worm and worm whee are also lapped into each other to improve smoothness The dial end of the worm shaft runs in a self-aligning bal bearing, while the other end is supported by an adjustable spring mounting, which gives positive longitudinal anchoring to the worm shaft through the use of a pair of sealed, self-lubricating, preloaded ball bearings. Similar pairs o preloaded ball bearings provide positive and invariant axial location for the main or rotor shaft. Electrical connection to the rotor is made by means of a silver-alloy brush bearing on a silver-overlay drum to assure a low-noise electrical contact.

Stator insulation in all models is a cross-linked thermosetting modified polystyrene having low dielectric losses and very high insulation resistance. Rotor insulation, where used (Types 1422-CB, -CL, and -N), is grade L-4 steatite, silicone treated.

specifications

Initial Accuracy: See table. The errors tabulated are possible errors, i.e., the sum of error contributions from setting, adjustment, calibration, interpolation, and standards. When the capacitor is in its normal position with the panel horizontal, the actual errors are almost always smaller. The accuracy is improved when the readings are corrected using the 12 calibrated values of capacitance given on the correction chart on the capacitor panel and interpolating linearly between calibrated points. Better accuracy can be obtained from a precision calibration of approximately 100 points on the capacitor dial, which permits correction for slight residual eccentricities of the worm drive and requires interpolation over only short intervals. This precision calibration is available for all models at an extra charge. Models so calibrated are listed with the additional suffix letter, P, in the type number. A plastic-enclosed certificate of calibration is supplied, giving corrections to one more figure than the tabulated accuracy.

Stability: The capacitance change with time is less than 1 scale division (0.02% of full scale) per year. The long-term accuracy can be estimated from the stability and the initial accuracy specifications.

Calibration: The measured values are obtained by comparison at 1 kHz, with working standards whose absolute values are known to an accuracy of $\pm(0.01\% + 0.0001$ pF). Each comparison is made to a precision better than ±0.01%. The values of the working standards are determined and maintained in terms of reference standards periodically calibrated by the National Bureau of Standards.

The indicated value of total capacitance of a two-terminal capacitor is the capacitance added when the 1422 Capacitor is plugged into a 777-Q3 Adaptor. The uncertainty of this method of connection is approx ±0.03 pF.*

Resolution: Dial can be read and set to 1/5 of a small division. The backlash is less than 1/5 small division, corresponding to 0.004% of full-scale value. If the desired setting is always approached in the direction of increasing scale reading, no error from this cause will result.

Temperature Coefficient: Approx +20 ppm/°C, for small temperature changes.

Residual Parameters: See table. The series resistance varies as the square root of the frequency above 100 kHz. Its effect is negligible below this frequency.

Frequency Characteristic: See curves for two-terminal models. The resonance frequency for the -CB and -CC models is approximately 20 MHz; for the -CD model, 60 MHz for each section; -CL, 40 MHz.

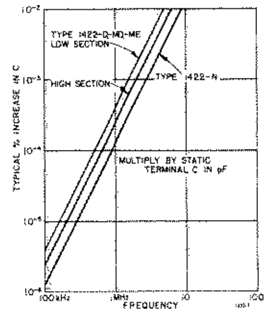
Dissipation Factor: The losses in the two-terminal capacitors are primarily in the stator supports, which are of low-loss polystyrene (DC = 0.01×10^{-12}).

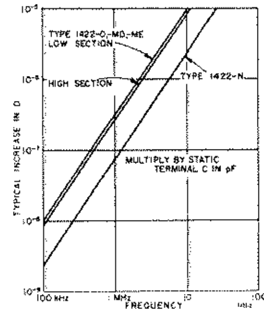
The very small dissipation factor of the direct capacitance of the three-terminal capacitors is difficult to measure and is estimated to be not greater than 20×10^{-6} for -CB and -CL, and 10×10^{-6} for -CC, -CD, and -CE.

Insulation Resistance: Under standard conditions (23°C, less than 50% RH), greater than 10^{12} ohms.

Max Voltage: All models, 1000 V, peak.

* John F. Hersh, "A Close Look at Connection Errors in Capacitance Measurements," General Radio Experimenter, July 1959.





Variation with frequency of effective capacitance and dissipation factor per pF of capacitance for two-terminal 1422 Precision Capacitors.

Terminals: Jack-top binding posts are provided on 2-terminal models; standard ¾-inch spacing is used. The rotor terminal is connected to the panel and shield. Locking GR874 Coaxial Connectors are used on three-terminal models.

Accessories Required: For connection to 3-terminal models, 2 GR874 Patch Cords or equivalent.

Accessories Available: 777-Q3 Adaptor (see Calibration above), for two-terminal units.

Mounting: Lab-Bench Cabinet.

Dimensions (width x height x depth): 9½ x 7 x 8½ in. (245 x 180 x 220 mm).

Weight: Net, 10½ to 12½ lb (4.8 to 5.7 kg), depending on model; shipping, all models, 15 lb (7 kg).

	Two-Terminal							Three-Terminal						
			RF	Reads Capacitance Removed										
TYPE 1422	**-D**		**-N**	**-MD**		**-ME**		**-CB**	**-CC**	**-CL**	**-CD**		**-CE**	
CAPACITANCE RANGE, pF — Min	100	35	100	0	0	0	0	50	5	10	0.5	0.05	0.05	0.005
CAPACITANCE RANGE, pF — Max	1150	115	1150	1050	105	105	10.5	1100	110	110	11	1.1	1.1	0.11
SCALE, pF/Division:	0.2	0.02	0.2	0.2	0.02	0.02	0.002	0.2	0.02	0.02	0.002	0.0002	0.0002	0.00002
INITIAL ACCURACY: ± Picofarads Direct-Reading (Adjustment): Total Capacitance	0.6*	0.1*	0.6*	Differences from Zero				0.6	0.15	0.1	0.04	0.008	0.008	0.0016
Capacitance Difference	1.2	0.2	1.2	1	0.2	0.2	0.05	1.2	0.3	0.2	0.08	0.016	0.016	0.0032
With Corrections from Calibration Chart (supplied): Total Capacitance	0.3*	0.04*	0.3*					0.3	0.04	0.04	0.01	0.002	0.002	0.0004
Capacitance Difference†	0.6	0.08	0.6	0.6	0.08	0.08	0.02	0.6	0.08	0.08	0.02	0.004	0.004	0.0008
With Corrections from Precision Calibration (extra charge): Total Capacitance	0.1*	0.01*	0.1*					0.1	0.01	0.01	0.001	0.0002	0.0002	0.00004
Capacitance Difference†	0.2	0.02	0.2	0.2	0.02	0.02	0.004	0.2	0.02	0.02	0.002	0.0004	0.0004	0.00008
RESIDUALS (typical values): Series Inductance, μH	0.06	0.10	0.032	0.06	0.10	0.06	0.10	0.14	0.17	0.13	0.17	0.17	0.17	0.17
Series Resistance, ohms at 1 MHz	0.04	0.05	0.012	0.04	0.05	0.04	0.05	0.1		0.1				
Terminal Capacitance, pF: high terminal to case, min scale								36	850	34	98	25	37	28
Terminal Capacitance, pF: high terminal to case, max scale								35	560	33	74	23	35	28
Terminal Capacitance, pF: low terminal to case, min scale								58	920	58	117	115	81	81
Terminal Capacitance, pF: low terminal to case, max scale								53	600	55	92	93	67	67
Capacitance at Zero Scale Setting, pF:				1140	135	145	35							

* Total capacitance is the capacitance added when the capacitor is plugged into a 777-Q3 Adaptor. † Divide error by 2 when one setting is made at a calibrated point.

Catalog Number	Description
	Precision Capacitors
	with precision calibration
1422-9904	**1422-DP**
1422-9913	**1422-MDP**
1422-9955	**1422-MEP**
1422-9880	**1422-NP**
1422-9902	**1422-CBP**
1422-9903	**1422-CCP**
1422-9508	**1422-CLP**
1422-9925	**1422-CDP**
1422-9580	**1422-CEP**

Catalog Number	Description
	with standard calibration
1422-9704	**1422-D**
1422-9854	**1422-MD**
1422-9855	**1422-ME**
1422-9714	**1422-N**
1422-9916	**1422-CB**
1422-9809	**1422-CC**
1422-9933	**1422-CL**
1422-9823	**1422-CD**
1422-9833	**1422-CE**
0777-9803	**777-Q3 Adaptor**