

High Accuracy Capacitance Substituter

HACS-Z Series

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The HACS-Z Decade Capacitance System is capable of meeting exacting requirements for fixed or adjustable calibration capacitance or any applications requiring precise stable capacitance values. It provides a wide range of capacitance in increments as low as 1 pF and a total capacitance of up to 10,000 μF . With its high-quality, tight-tolerance capacitors, it is an ideal part of a test or calibration system.

- High accuracy: 0.05%
- Low zero capacitance: <0.1 pF
- Trimmable capacitors for lower decades
- 3-Terminal shielded construction for low values
- 5-Terminal construction for high values
- Excellent stability - 100 ppm/year
- Excellent TC - begins at 20 ppm/ $^{\circ}\text{C}$

See Also:

- For GenRad version - [1413 Series](#)
- For Programmable version - [PCS Series](#)

SELECTION OF VARIOUS HACS-Z MODELS



*HACS-Z Capacitance Substituter:
6-decade, 1 pF through 0.1 μF steps with Rack Mount Option*



*HACS-Z High-Capacitance Substituter:
4-decade, 1 μF through 1000 μF steps*



*HACS-Z Capacitance Substituter:
9-decade, 10 pF through 1000 μF steps*



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HACS-Z/04-29-11

High Accuracy Capacitance Substituter

HACS-Z Series

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SPECIFICATIONS: LOW VALUES

Zero Capacitance:

≤0.1 pF maximum capacitance obtained with all dials set to zero;

Temperature Coefficient:

<20 ppm/°C

Insulation Resistance:

>50,000 MΩ

Operating Temperature Range:

10°C to 40°C

Shielding:

Double-shielded construction; see below.

Connection to Capacitor:

Two bnc connectors labeled **HI** and **LO** are located on front panel.



HACS-Z Capacitance Substituter:
6-decade, 1 pF through 0.1 μF steps with Rack Mount Option

| Capacitance per step | Total decade capacitance | Accuracy* | Stability | Max voltage | Dissipation factor* | Capacitor type |
|----------------------------|--------------------------|--|------------------------------|-----------------------------|---|----------------|
| HACS-Z-1pF Variable Decade | 1 pF+ | ±0.1 pF | ±(100 ppm + 0.1 pF) per year | 500 V peak max up to 10 kHz | <0.003 typical | Air capacitors |
| 1 pF | 10 pF | <0.002 | | | | |
| 10 pF | 100 pF | Position 1: <0.002 All others: <0.001 | | | Silvered mica Mechanically stabilized Hermetically sealed | |
| 100 pF | 1 nF | Position 1: <0.001 Position 2: <0.0005 All others: <0.0003 | | | | |
| 1,000 pF | 10 nF | <0.0003 | | | | |
| 0.01 μF | 100 nF | <0.0003 | | | | |
| 0.1 μF | 1 μF | <0.0004 | | | | |



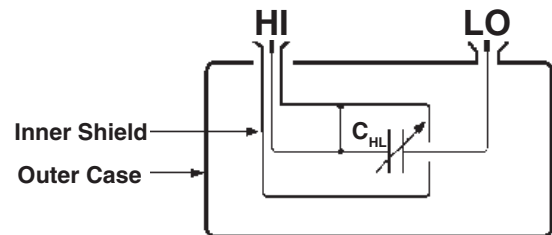
HACS-Z Variable decade:
1 pF+, plugs into the main unit, adds continuous 0-1pF parallel capacitance

*1 kHz, 3-terminal measurement; series model; 1 Vrms, 23°C; traceable to SI
No zero-subtraction required

DOUBLE SHIELDED CONSTRUCTION

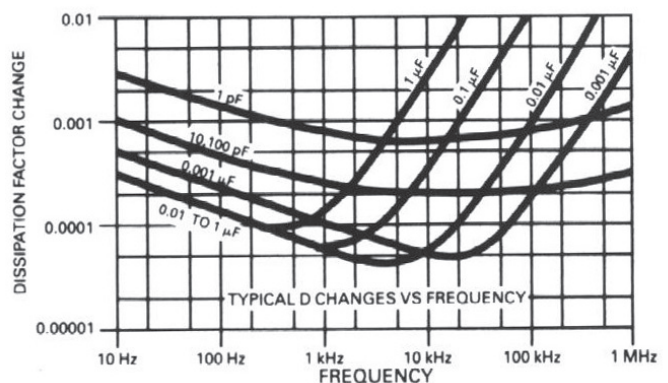
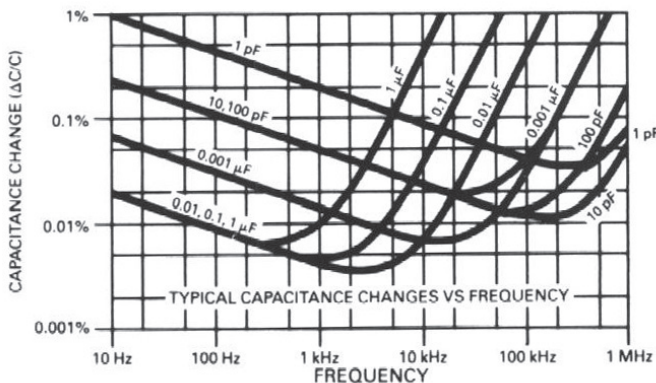
The shielding is divided into two different parts: an inner shield that minimizes the low terminal-to-guard capacitance, and an outer shield (the case) that minimizes the detector input capacitance and noise.

The outer shell of the **HI** connector is connected to the switch shaft. The outer shell of the **LO** connector is connected to the outer case. When these two shields are connected together, the HACS-Z becomes an excellent 3-terminal capacitance substituter with low zero capacitance.



Double Shielded Construction

FREQUENCY CHARACTERISTICS



High Accuracy Capacitance Substituter

HACS-Z Series

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SPECIFICATIONS: HIGH VALUES

Zero Capacitance:

≤0.5 pF maximum capacitance obtained with all dials set to zero;
5-terminal measurement

Temperature Coefficient:

-50 ppm/°C

Insulation Resistance:

>50,000 MΩ

Operating Temperature Range:

10°C to 40°C

Connection to Capacitor:

Five 5-way binding posts labeled **HI CURRENT**, **LO CURRENT**, **HI SENSE**, **LO SENSE** and **GND** are located on the front panel. Special wiring and low-resistance conductors in this 4-terminal connection circuit minimize dissipation and parasitic inductance, and improve frequency characteristics. To use as a 2-terminal capacitor, connect to only the two **SENSE** terminals.



HACS-Z High-Capacitance Substituter:
4-decade, 1 μF through 1000 μF steps

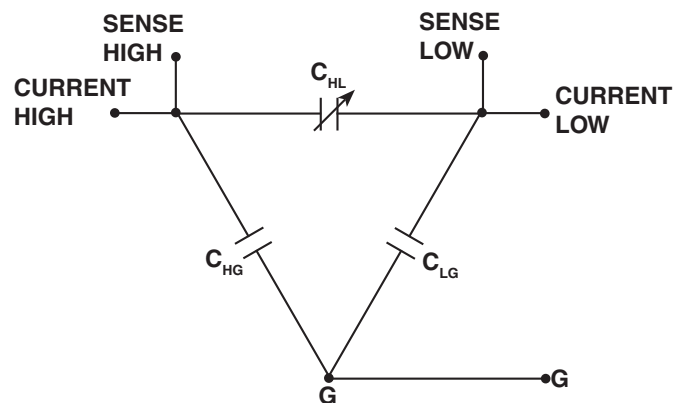
| Capacitance per step | Total decade capacitance | Max voltage | Accuracy* | Test Frequency | Stability | Dissipation factor | Capacitor Type |
|----------------------|--------------------------|--|-------------------|----------------|---------------|--------------------|--|
| 1 μF | 10 μF | 50 V peak max | ±(0.05% + 0.5 pF) | 1 kHz | ±200 ppm/year | <0.0005 | Sealed metallized polyphenylene sulfide (MPPS) |
| 10 μF | 100 μF | (Vdc+Vac) < 30 V or (Vac) < 22 V | | 100 Hz | | <0.002 | |
| 100 μF | 1,000 μF | 50 V peak max | ±1% | | ±500 ppm/year | <0.02 | |
| 1,000 μF | 10 mF | 25 V peak max | ±10% | - | - | - | Polyphenylene |
| | | - | - | - | - | - | Electrolytic** |

* 5-terminal measurement; series model; 1 Vrms, 23°C; traceable to SI; No zero-subtraction required

** For this option, add -EC at the end of part number.



HACS-Z Capacitance Substituter:
4-decade, 1 μF through 1000 μF steps with electrolytic capacitor option



HACS-Z Model as a 4 or 5-terminal capacitor
You may use this as a 2-terminal capacitor,
by connecting to only the two **SENSE** terminals



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ORDERING INFORMATION

STANDARD MODELS

| Models | Total capacitance | No. of decades | Resolution |
|-------------------|-------------------|----------------|------------|
| HACS-Z-A-3E-1pF | 1,110 pF | 3 | 1 pF |
| HACS-Z-A-3E-10pF | 11,100 pF | 3 | 10 pF |
| HACS-Z-A-3E-100pF | 111,000 pF | 3 | 100 pF |
| HACS-Z-A-3E-1nF | 1.11 μF | 3 | 1 nF |
| HACS-Z-A-3E-10nF | 11.1 μF | 3 | 10 nF |
| HACS-Z-A-3E-100nF | 111 μF | 3 | 100 nF |
| HACS-Z-A-3E-1μF | 1,110 μF | 3 | 1 μF |
| HACS-Z-A-3E-10μF | 11,100 μF | 3 | 10 μF |
| HACS-Z-A-4E-1pF | 11,110 pF | 4 | 1 pF |
| HACS-Z-A-4E-10pF | 0.1111 μF | 4 | 10 pF |
| HACS-Z-A-4E-100pF | 1.111 μF | 4 | 100 pF |
| HACS-Z-A-4E-1nF | 11.11 μF | 4 | 1 nF |
| HACS-Z-A-4E-10nF | 111.1 μF | 4 | 10 nF |
| HACS-Z-A-4E-100nF | 1,111. μF | 4 | 100 nF |
| HACS-Z-A-4E-1μF | 11,110 μF | 4 | 1 μF |
| HACS-Z-A-5E-1pF | 0.111 11 μF | 5 | 1 pF |
| HACS-Z-A-5E-10pF | 1.111 1 μF | 5 | 10 pF |
| HACS-Z-A-5E-100pF | 11.111 μF | 5 | 100 pF |
| HACS-Z-A-5E-1nF | 111.11 μF | 5 | 1 nF |
| HACS-Z-A-5E-10nF | 1,111.1 μF | 5 | 10 nF |
| HACS-Z-A-5E-100nF | 11,111 μF | 5 | 100 nF |

| Models | Total capacitance | No. of decades | Resolution |
|-------------------|-------------------|----------------|------------|
| HACS-Z-A-6E-1pF | 1.111 11 μF | 6 | 1 pF |
| HACS-Z-A-6E-10pF | 11.111 1 μF | 6 | 10 pF |
| HACS-Z-A-6E-100pF | 111.111 μF | 6 | 100 pF |
| HACS-Z-A-6E-1nF | 1,111.11 μF | 6 | 1 nF |
| HACS-Z-A-6E-10nF | 11,111.1 μF | 6 | 10 nF |
| HACS-Z-A-7E-1pF | 11.111 11 μF | 7 | 1 pF |
| HACS-Z-A-7E-10pF | 111.111 1 μF | 7 | 10 pF |
| HACS-Z-A-7E-100pF | 1, 111.111 μF | 7 | 100 pF |
| HACS-Z-A-7E-1nF | 11,111.11 μF | 7 | 1 nF |
| HACS-Z-A-8E-1pF | 111.111 11 μF | 8 | 1 pF |
| HACS-Z-A-8E-10pF | 1,111.111 1 μF | 8 | 10 pF |
| HACS-Z-A-8E-100pF | 11,111.111 μF | 8 | 100 pF |
| HACS-Z-A-9E-1pF | 1,111.111 11 μF | 9 | 1 pF |
| HACS-Z-A-9E-10pF | 11,111.111 1 μF | 9 | 10 pF |
| HACS-Z-A-10E-1pF | 11,111.111 11 μF | 10 | 1 pF |

Options:

- RM for rack mount option
- RO for rear output option
- EC for electrolytic capacitors in 1,000 μF decade

HACS-Z-1pF: Variable air-capacitor decade that attaches to the main unit for resolution finer than 1 pF

OPTIONAL MODELS

In order to satisfy any requirement for a HACS-Z Series capacitor, generate a part number from the chart below.

