◆ PRECISION INSTRUMENTS FOR TEST AND MEASUREMENT ◆

MODEL 1423
Precision Decade Capacitor

Equivalent to IET HACS Series

User and Service Manual

1423 im/May, 2002

IET LABS, INC.
formerly manufactured by
GenRad

534 Main Street, Westbury, NY 11590 www.ietlabs.com
TEL: (516) 334-5959 • (800) 899-8438 • FAX: (516) 334-5988

WARRANTY

We warrant that this product is free from defects in material and workmanship and, when properly used, will perform in accordance with applicable IET specifications. If within one year after original shipment, it is found not to meet this standard, it will be repaired or, at the option of IET, replaced at no charge when returned to IET. Changes in this product not approved by IET or application of voltages or currents greater than those allowed by the specifications shall void this warranty. IET shall not be liable for any indirect, special, or consequential damages, even if notice has been given to the possibility of such damages.

THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMITED TO, ANY IMPLIED WARRANTY OF MERCANTIBILITY OR FITNESS FOR ANY PARTICULAR PURPOSE.

IET-IM-HACS-A-B2/HACSIM/19 December 5, 1989

Contents

Figures

WARNING

OBSERVE ALL SAFETY
RULES WHEN WORKING WITH HIGH VOLTAGES OR LINE VOLTAGES.

CONNECT THE G (GND) TERMINAL TO EARTH OR OTHER SUITABLE GROUND IN ORDER TO MAINTAIN THE CASE AT A SAFE VOLTAGE.

WHENEVER HAZARDOUS VOLTAGES (>45 V) ARE USED, TAKE ALL MEASURES TO AVOID ACCIDENTAL CONTACT WITH ANY LIVE COMPONENTS:

USE MAXIMUM INSULATION AND MINIMIZE THE USE OF BARE CONDUCTORS.

REMOVE POWER WHEN ADJUSTING SWITCHES.

POST WARNING SIGNS AND KEEP PERSONNEL SAFELY AWAY.

****

CAUTION

DO NOT APPLY ANY VOLTAGES OR CURRENTS TO THE TERMINALS OF THIS INSTRUMENT IN EXCESS OF THE MAXIMUM LIMITS INDICATED ON THE FRONT PANEL OR THE OPERATING GUIDE LABEL.

This page includes the specifications for the Model 1423-A (equivalent to the IET HACS Series). If there are any differences, this page is the governing document.

1423-A Precision Decade Capacitor

- **100 pF to > 1 μF**
- **±0.05% accuracy**
- **two- or three-terminal connection**

This capacitor is a versatile tool for calibration laboratories and production-line testing. With it a bridge can be standardized to an accuracy exceeded only by that of the highest quality, individually certified laboratory standards such as the GR 1404 and 1408 Reference Standard Capacitors. Used with a limit bridge, such as the GR 1654 Impedance Comparator, the 1423 facilitates fast and accurate production-line measurements of arbitrary capacitance values with minimum setup time.

Any value of capacitance from 100 pF to 1.111 μF, in steps of 100 pF, can be set on the four decades and will be known to an accuracy of 0.05%. The terminal capacitance values are set precisely to the nominal value and can be readjusted later at calibration intervals, if necessary, without disturbance of the main capacitors.

The 1423 consists of four decades of high-quality silvered-mica capacitors similar to those used in the GR 1409 Standard Capacitors. The capacitors and associated switches are mounted in an insulated metal compartment, which in turn is mounted in a complete metal cabinet. This double-shielded construction ensures that capacitance at the terminals is the same for either the three-terminal or the two-terminal method of connection (except for a constant difference of about one picofarad). This external capacitance can be included in the two-terminal calibration by the adjustment of a single trimmer.

SPECIFICATIONS

Nominal Values: 100 pF to 1.111 μF in steps of 100 pF.

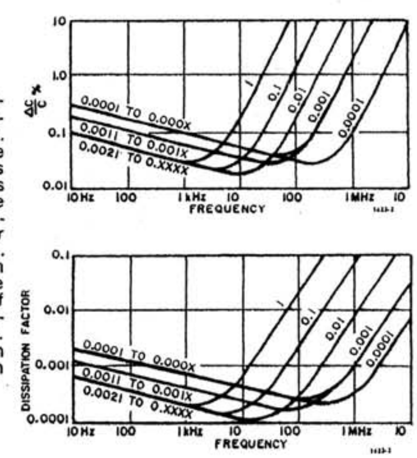
Accuracy: ±(0.05% + 0.05pF) at 1 kHz, calibrated in the three-terminal connection. Two-terminal connection (capacitor inserted into Type 777-Q3 Adaptor) adds about 1.3 pF.

Stability: ±(0.01% + 0.05pF) per year.

Certificate: A certificate is supplied certifying that each component capacitor was adjusted by comparison, to a precision better than ±0.01%, with working standards whose absolute values are known to an accuracy typically ±0.01%, determined and maintained in terms of reference standards periodically calibrated by the National Bureau of Standards.

Frequency: See curves for typical variation of capacitance and dissipation factor with frequency.

(Top) Change in capacitance as a function of frequency. These changes are referred to the values that the capacitors would have if there were neither interfacial polarization nor series inductance. The 1-kHz value on the plot should be used as a basis of reference in estimating frequency errors. (Bottom) Dissipation factor as a function of frequency.



Dissipation Factor: Not greater than 0.001, 0.0005, and 0.0003 for capacitances of 100 to 1000 pF, 1100 to 2000 pF, and 2100 pF to 1.1110 μF, respectively.

Temperature Coefficient of Capacitance: Approx +20 ppm per degree between 10° and 50°C.

Insulation Resistance: >5 × 10^{10} Ω to 0.1 μF and >5 × 10^{9} Ω from 0.1 μF to 1.111 μF.

Maximum Voltage: 500 V peak, up to 10 kHz.

Supplied: Two Type 777-Q3 Adaptors.

Mechanical: Rack-bench cabinet. DIMENSIONS (wxhxd): Bench, 19x7.25x10.5 in. (483x184x267 mm); rack, 19x7x8.5 in. (483x178x216 mm). WEIGHT: 26 lb (12 kg) net, 39 lb (18 kg) shipping.

Description	Catalog Number
1423-A Precision Decade Capacitor	
Bench Model	**1423-9801**
Rack Model	**1423-9811**

Chapter 1

INTRODUCTION

1.1 General Description

The HACS series decade capacitor (Figure 1.1) is a calibration grade capacitance substituter capable of meeting exacting requirements for fixed or adjustable calibration capacitance or any applications requiring precise stable capacitance values. It features high accuracy and excellent stability from 100 pF to 1.111 µF in 100 pF steps. It may be used on the bench or rack mounted.

The capacitors are manufactured with the highest grade India Ruby mica capacitors, especially selected for optimum electrical characteristics and excellent stability.

These capacitors are sealed in low loss electrical grade molding material to prevent the intrusion of moisture into the capacitor packages.

The stability of the capacitors is such that the instrument would not require readjustment with proper care and normal use. Should recalibration become necessary, easily accessible trimmer capacitors are provided for the lower two decades. The other decades may also be calibrated with padders.

1.2 Switches

Custom designed switches are used to connect four capacitors, in a parallel circuit for each decade. These are weighted in a 1-2-5-2 code to provide all the necessary combinations for ten equal steps for each decade.

The stability of the switches is assured by the use of large gaps and secure mechanical construction.

For convenience to the user, the switches permit continuous rotation. There are one or two blank positions on each dial to allow this.

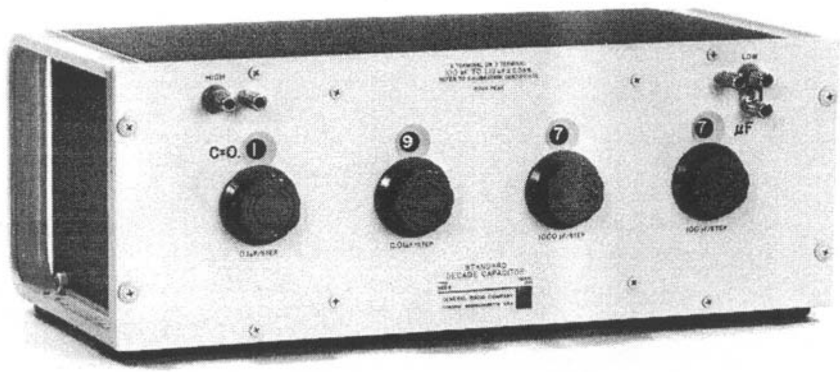


Figure 1.1. HACS Series Decade Capacitor

1.3 Double Shielded Construction

In the HACS series precision capacitor, the two-terminal measurement is virtually equal to the three-terminal measurement, different by about 1 pF, a feature useful for various bridges, test procedures, and calibration applications.

Figure 1.2 demonstrates the need for the double shielded construction. It shows that a capacitor C_{HL} would be shunted by the series combination of the capacitances from the HIGH and LOW terminals to the case. The net two-terminal capacitance becomes:

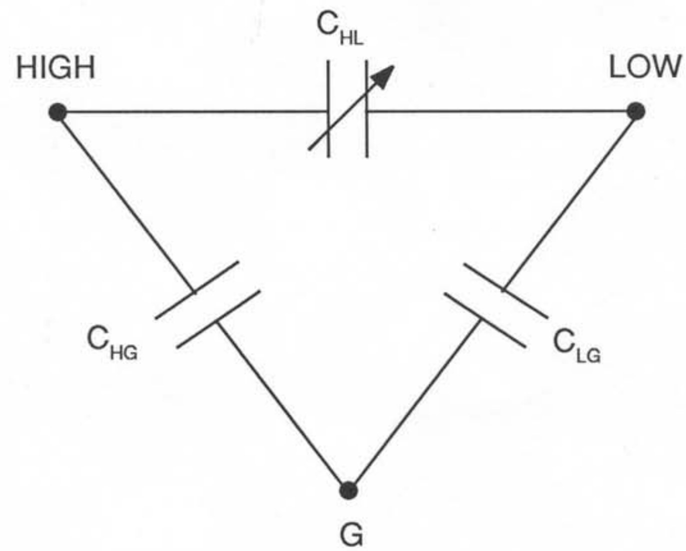
$$C_{2\text{-terminal}} = C_{HL} + (C_{HG} \text{ in series with } C_{LG})$$

With a three terminal measurement, the case (G) is connected to the measurement instrument guard terminal which essentially eliminates almost all the capacitance to case, and the three-terminal capacitance becomes:

$$C_{3\text{-terminal}} = C_{HL}$$

It is therefore difficult to obtain equivalent two and three terminal capacitances as long as case capacitance is present as it must be.

The double shielded construction, conceptually shown in Figure 1.3 solves this problem. It effectively blocks the electric field between the capacitor and the outer case. This makes C_{HG}, the capacitance between the HIGH terminal and the outer case, very small. Since C_{HG} is in series with C_{LG}, the series combination is also very small. Due to this fact the difference between the two-terminal and three-terminal capacitance is very small, essentially limited to the C_{HG} remaining from capacitance of the HIGH binding post to the front panel of the case.



Net Capacitance = C_{HL} + (C_{HG} in series with C_{LG})

Figure 1.2 Effect of Capacitance to Case

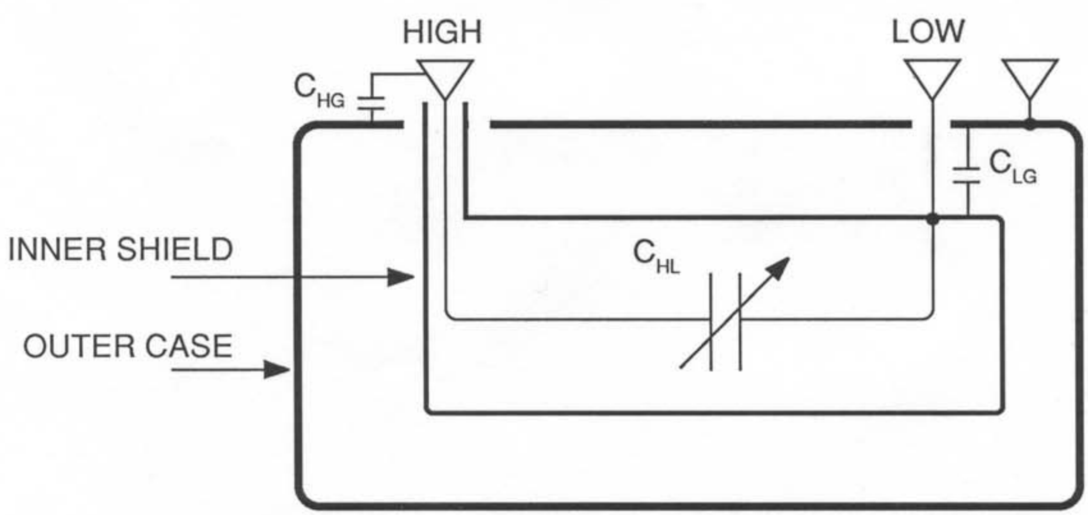


Figure 1.3 Double Shielded Construction

HACS IMFIG1.2/2-88-2

Chapter 2

SPECIFICATIONS

For convenience to the user, the pertinent specifications are given in an <u>OPERATING GUIDE</u>, shown in Figure 2.1, affixed to the case of the instrument.

Model: HACS-A-4E-100pF-S

Capacitance Type: Potted highest grade India Ruby silvered-mica capacitors.

Range: 100 pF to 1.111 µF in 100 pF steps.

Accuracy: Better than ±(0.05% + 0.05 pF), at 1 kHz, at 23°C. Two-terminal connection capacitance is (1.3 ± 0.1) pF higher.

Dissipation Factor at 1kHz:
<0.003 for 100 pF to 1000 pF
<0.0006 for 1100 pF to 2000 pF
<0.0003 for 2100 pF to 0.1 µF
<0.0004 for 0.1 µF to 1.111 µF

Stability: Better than ±(100 ppm + 0.1 pF) per year.

Maximum Voltage: 500 V peak up to 10 kHz.

Temperature Coefficient:
<+35 ppm/°C, between 10 and 40°C.

Capacitance Adjustment:
Easily accessible adjustable air capacitors are provided for the lower two decades. The other decades may also be calibrated with padders.

Frequency Characteristics:
Typical changes of capacitance and dissipation factor are given in Figures 2.2 and 2.3 respectively.

Shielding: Double shielded construction to minimize HIGH terminal to case capacitance and make two and three-terminal capacitance equal to within (1.3 ± 0.1) pF.

1423-A HIGH-ACCURACY DECADE CAPACITANCE SUBSTITUTER

CAPACITOR TYPE: Stabilized sealed silvered mica.

RANGE: 100 pF to 1.111 µF in 100 pF steps.

ACCURACY: ±(0.05% + 0.5 pF), absolute - no zerosubtraction required, at 1 kHz, 3-terminal measurement, 1 Vrms, 23°C; traceable to NIST. 2-terminal connection adds almost 1.3 pF.

DISSIPATION FACTOR at 1 kHz: ≤0.001 for 100 pF to 1000 pF;
≤0.000 5 for 1100 pF to 2000 pF;
≤0.000 3 for 2100 pF to 1.111 µF.

MODEL: 1423-A **SN: 919**

TEMPERATURE COEFFICIENT: ≈20 ppm/°C from 10 to 50°C.

STABILITY: ±(0.01% + 0.05 pF) per year.

MAXIMUM VOLTAGE: 500 V peak dc up to 10 kHz.

INSULATION RESISTANCE: >5 x 10^{10} Ω up to 0.1 µF,
>5 x 10^{9} Ω above 0.1 µF.

CONNECTION TO CAPACITOR: Two- or three-terminal connection using binding posts. The shielding is divided into two parts: an inner shield that minimizes the terminal-to-guard capacitance, and an outer shield (the case) that minimizes the detector input capacitance and noise. The 2-terminal and 3-terminal capacitance become almost identical to about 1 pF.

WARNING

Observe all safety rules when working with high voltages or line voltages. Connect the (G) terminal to earth ground in order to maintain the case at a safe voltage. Whenever hazardous voltages (>45 V) are used, take all measures to avoid accidental contact with any live components: a) Use maximum insulation and minimize the use of bare conductors. b) Remove power when adjusting switches. c) Post warning signs and keep personnel safely away.

formerly made by GenRad

IET LABS, INC. • 534 Main Street, Westbury, NY 11590 • (800) 475-1211 • (516) 334-5959 • Fax: (516) 334-5988
CAGE CODE: 62015 **www.ietlabs.com**

1423-A lbl /03-02

Figure 2.1 Operating Guide for 1423-A High-Accuracy Decade Capacitance Substituter

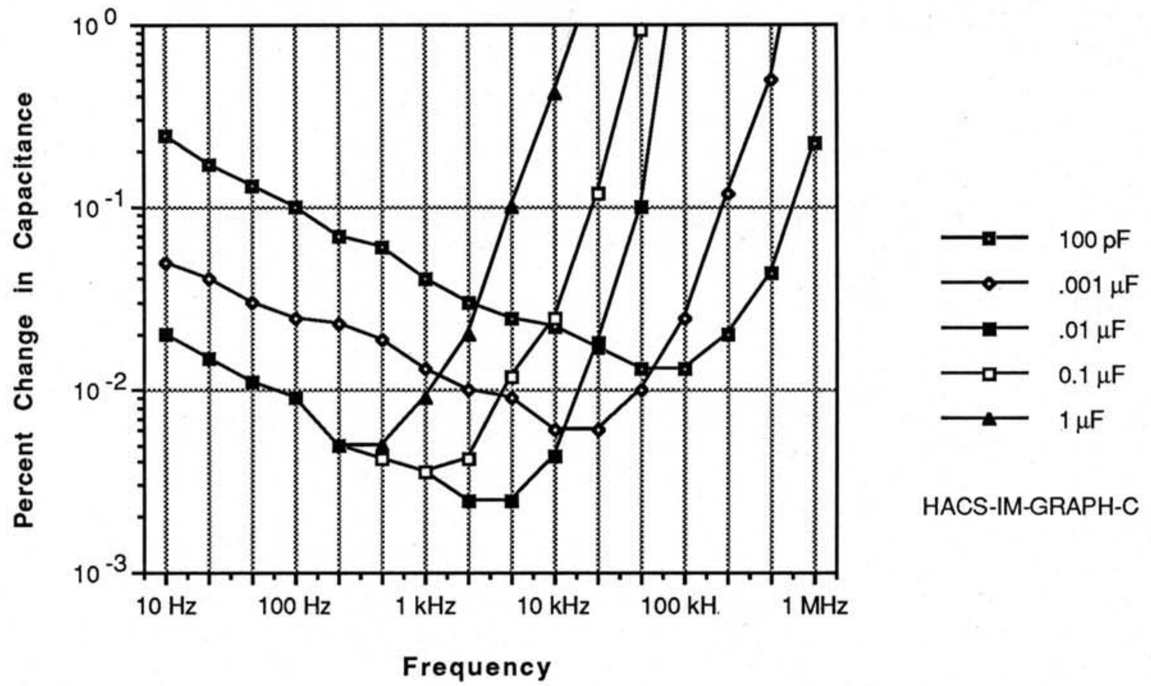


Figure 2.2. Typical Capacitance Change versus Frequency

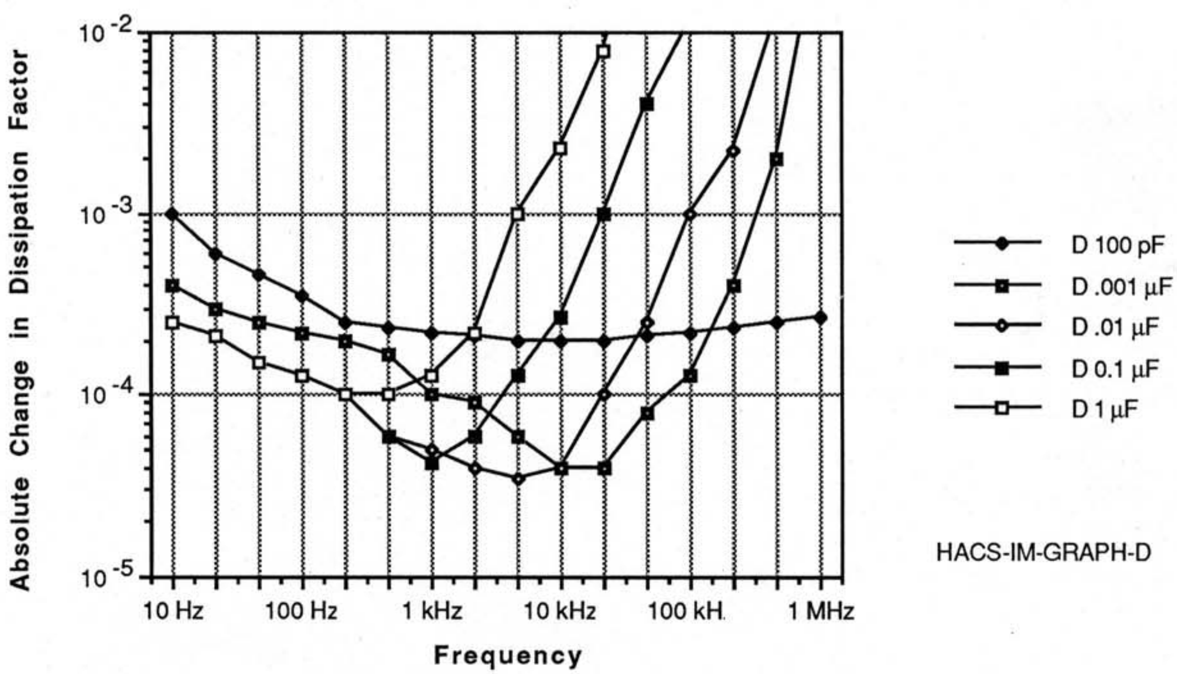


Figure 2.3. Typical Dissipation Factor Change versus Frequency

Connection to Capacitor:

The two-terminal capacitance is obtained when the LOW terminal is connected to an adjacent ground terminal with a shorting link. The three-terminal capacitance is present across the HIGH and LOW terminals when the case is connected to a guard point and at least one lead is completely shielded.

The two-terminal capacitance shall exceed the three-terminal capacitance by (1.3 ± 0.1) pF.

Insulation Resistance:

>50,000 MΩ up to 0.1 μF and >5,000 MΩ for 0.1 μF and over.

Operating Temperature Range:

$0^{o}C$ to $+50^{o}C$

Dimensions: 43.2 cm W x 17.8 cm H x 23.9 cm D (17" x 7" x 9.4")

Weight: 6.8 kg (15 lb)

Chapter 3

Installation

3.1 Initial Inspection

The HACS Series decade capacitor receives a careful mechanical and electrical inspection before shipment. Upon receipt , verify that the contents are intact and as ordered. The instrument should be given a visual and operational inspection.

If any shipping damage is found, contact the carrier and IET Labs. If any operational problems are encountered, refer to the warranty at the beginning of this manual.

Save all original packing material for convenience in case shipping of the instrument should become necessary

3.2 Installation

For a rack mounted model, installation on a 19 inch rack may be made using the slots in the rack mounting ears. A mounting location that does not expose the unit to excessive heat is recommended.

For bench models, no installation as such is required. The HACS Series is not powered. Since it is a high accuracy instrument, it is recommended that a bench space be provided that would not expose it to abuse and keep it protected from temperature extremes and contaminants.

3.3 Repackaging for Shipment

If the instrument is to be returned to IET Labs, contact the Service Department at the number or address, shown on the front cover, to obtain a "Returned Material Authorization" (RMA) number and any special shipping instructions or assistance. Proceed as follows:

1. Attach a tag to the instrument identifying the owner and indicate the service or repair to be accomplished. Include the model number, the full serial number of the instrument, the RMA number, and shipping address.

2. Wrap the instrument in heavy paper or plastic.

3. Protect the front panel and any other protrusions with cardboard or foam padding.

4. Place instrument in original container or equally substantial heavy carton.

5. Use packing material around all sides of instrument.

6. Seal with strong tape or bands.

7. Mark shipping container "DELICATE INSTRUMENT," "FRAGILE," etc.

3.4 Storage

If the HACS Series decade capacitor is to be stored for any extended period of time, it should be sealed in plastic and stored in a dry location. It should not be exposed to temperatures below $-55^{o}C$ or above $+85^{o}C$.

Chapter 4

OPERATION

4.1 Switch Setting

The HACS Precision Capacitor has four capacitance decades. The actual capacitance for each decade is the product of the switch setting and the **CAPACITANCE PER STEP** indicated below each switch on the front panel. The setting may be read numerically on the dials in microfarads simply observing the decimal point on the front panel. No switch should be left on a null or blank position

The following must be noted however. There is no zero setting, and the 100 pF steps or least significant digit (LSD) range between 1 and 10. If set on 10, a 1 is added to the next or 1000 pF/step decade. The most significant or 0.1 µF/step decade ranges between 1 to 10, i.e. from 0.1 to 1.0 µF.

If, for example, the dials are set to 10-9-9-10, the capacitance setting is:

```
               10
               9
              9
            1.0
Total:      1.1000 µF
```

In order to obtain a zero in the 100 pF position, set the 100 pF decade to 10, i.e. 1000 pF, and take the 1000 pF into consideration in the next decade. To get 0.2300 µF, for example, the switches should be arranged to show 2-2-9-10.

4.2 Connection to Terminals

4.2.1 Three-Terminal Capacitance

In order to employ the HACS capacitance in the three-terminal capacitance mode, one of the case terminals on the front panel must be connected to a guard point. At least one lead must be completely shielded. The capacitance at the specified accuracy is present between the HIGH and the LOW terminals.

4.2.2 Two-Terminal Capacitance

To use the HACS as a two-terminal capacitor, connect the LOW terminal to the adjacent ground terminal with a shorting link. The two-terminal capacitance is now available between the HIGH and the ground terminal next to it.

This capacitance will be higher than the three-terminal value by approximately the capacitance between the HIGH terminal and the case plus any external capacitance from connections. This difference shall be less than (1.3 ± 0.1) pF without any external additions.

It is possible to adjust the calibration trimmer for the 100 pF setting to effectively change the zero or offset capacitance to make the unit a two-terminal capacitor at the specified accuracy.

Chapter 5

MAINTENANCE

5.1 Preventive Maintenance

The HACS Series decade capacitor is packaged in a closed case which will limit the entry of contaminants and dust to the inside of the instrument. If it is maintained in a generally clean or air conditioned environment, cleaning will be seldom required. In a contaminated atmosphere, cleaning may be required.

Should cleaning be needed, open the instrument as described below and remove any dust from the variable air capacitors and around the fixed capacitors.

In normal service, the switches require no additional lubrication. During the manufacturing process, a light lubrication is applied which in most instances is sufficient for the service life of the switches, and yet will not tend to collect dust.

5.2 Verification of Performance

5.2.1 Calibration Interval

The HACS Series instruments should be verified for performance at a calibration interval of twelve (12) months. This procedure may be carried out by the user, if a calibration capability is available, by IET Labs, or by a certified calibration laboratory. If the user should choose to perform this procedure, then the considerations below should be observed.

5.2.2 General Considerations

It is important, whenever testing the HACS series decade units, to be very aware of the capabilities and limitations of the test instruments used. A bridge may be employed, and there are a few direct reading automatic meters or automatic bridges available that can verify the accuracy of these units. Such instruments may of course also be used with capacitance transfer standards with higher resulting accuracies.

Such instruments would have to be <u>significantly</u> more accurate than ±(0.05% + 0.05 pF) for all applicable ranges, in order to perform this task, allowing for a band of uncertainty of the testing instrument itself. A few commercial models, bridges and meters, do exist that can do this; consult IET Labs for information.

It is important to allow both the testing instrument and the HACS Substituter to stabilize for a number of hours at the nominal operating temperature of 23°C, and at nominal laboratory conditions of humidity. There should be no temperature gradients across the unit under test.

Three-terminal measurement should be used to obtain accurate low capacitance readings.

Proper metrology practices should be followed in performing this verification.

5.2.3 Verification Procedure

1. Determine the allowable upper and lower limits for each capacitance setting of each decade following the specified accuracy. For the HACS Series, these limits for capacitance C are [C ±(.0005 C + 0.05 pF)].

2. Confirm that the capacitance readings fall within these limits.

3. If any capacitances fall outside these limits, they may be calibrated as described below.

5.2.4 Calibration Procedure

Recalibration adjustment is not frequently required. It is however convenient to perform. To access these adjustments, remove the top and bottom covers of the unit. To do so, place the instrument on a flat surface and remove the 3 screws from the top surface of the top cover, and then the 3 screws from the rear edge of the top cover. The top cover may now be removed. Turn the instrument upside down and repeat the procedure with the bottom cover.

Observe the labels on the inner shield. All settings for the lower two decades are adjustable with variable air capacitors accessible to screwdriver blade adjustment through holes in the top and bottom of the inner shield. It is best to use a non-metallic tool to perform this task. See Figures 5.1 and 5.2.

All adjustments are labeled and should be made in increasing order. It is necessary to note that the least significant decade does not go to zero, and that it will be in the "1" or some other non-zero position when calibrating the three upper decades. Care should be taken to always calibrate the higher decades with the 100 pF decade considered in the value being set. Be careful not to leave any switches set to a blank or null position.

For the upper two decades, the capacitors, as shown in Figure 5.1, are arranged in 1-2-5-2 pattern, with each nominal capacitor having a padder as shown in Figure 5.2. These padders may added to, or subtracted from, to adjust the capacitance value. If it is necessary to add to the padders, mica capacitors should be used.

To perform a calibration on the upper two decades, proceed as follows:

1. See Figure 5.2 to locate the referenced components that follow.
2. Set the decade to be adjusted to position "1". Adjust the padder capacitor, as necessary, for capacitors C3-1 (0.01 µF steps decade) or C4-1 (0.1 µF steps decade).
3. Set the decade to be adjusted to position "2". Adjust the padder capacitor, as necessary, for capacitors C3-2 (0.01 µF steps decade) or C4-2 (0.1 µF steps decade).
4. Set the decade to be adjusted to position "4". Adjust the padder capacitor, as necessary, for capacitors C3-3 (0.01 µF steps decade) or C4-3 (0.1 µF steps decade).
5. Set the decade to be adjusted to position "5". Adjust the padder capacitor, as necessary, for capacitors C3-4 (0.01 µF steps decade) or C4-4 (0.1 µF steps decade).

Proper metrology practices should be followed in performing this verification.

5.3 Schematic and Replacement Parts

Refer to Figure 5.1 for a schematic of the HACS decade unit. In order to locate any particular replacement part, refer to Figures 5.2a, 5.2b, and 5.2c for the assembly diagram, and to Table 5.1 for the parts list of the unit.

It is recommended that service be performed only by IET Labs or qualified personnel.

5.4 Troubleshooting

In the case of a calibration failure, i.e., where it is not possible to calibrate a particular setting as described above, use the schematic diagram of Figure 5.1 to determine the suspect capacitor. To do this, find the lowest setting for any decade that exhibits a failure and refer to the schematic to determine the particular major capacitor and trimmer capacitor that become active in the circuit at that setting. Disassemble the unit as described below, and locate the suspect capacitors using Figure 5.2. Examine them along with their associated switch and cabling to determine which component may need replacement.

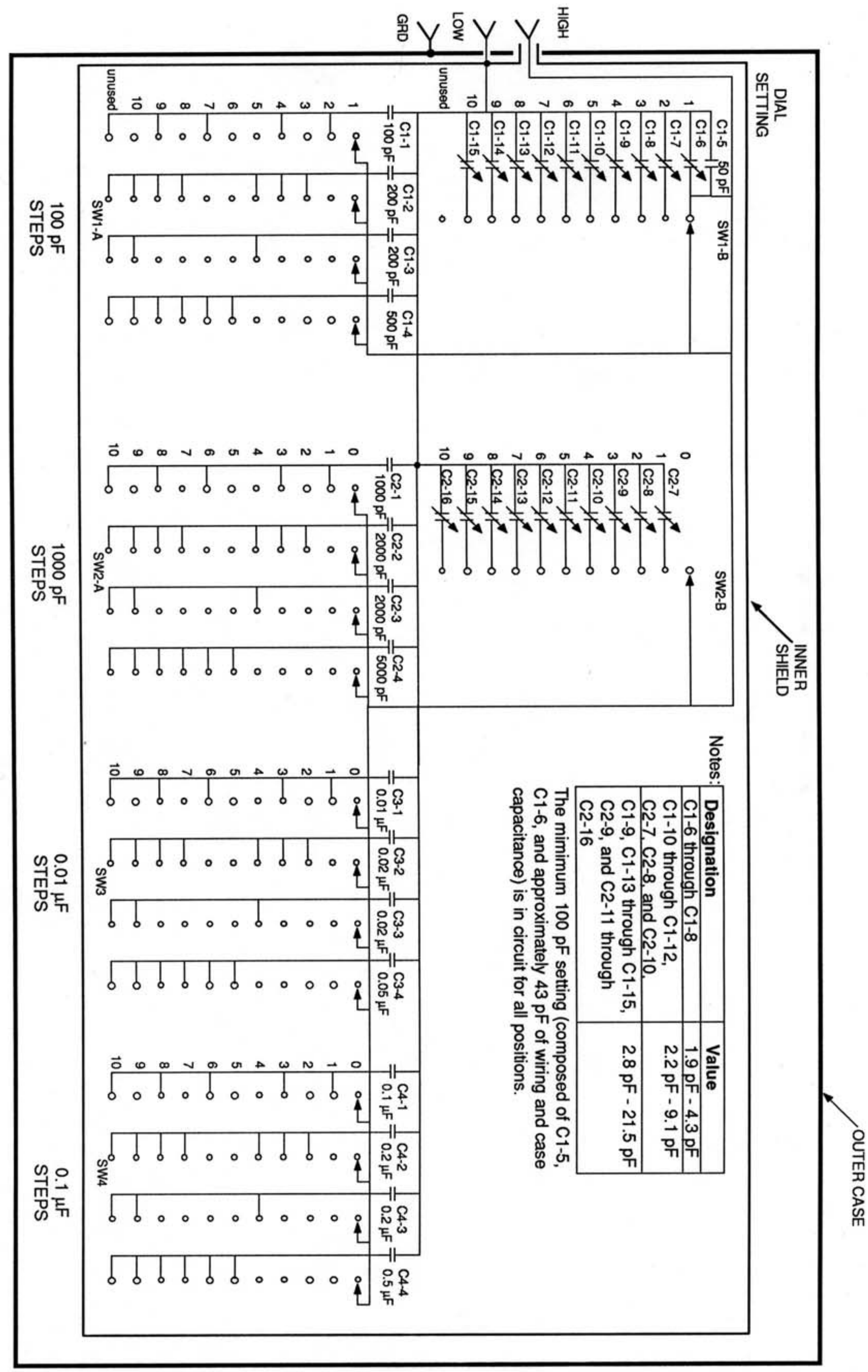


FIGURE 5.1 HACS Series Schematic Diagram

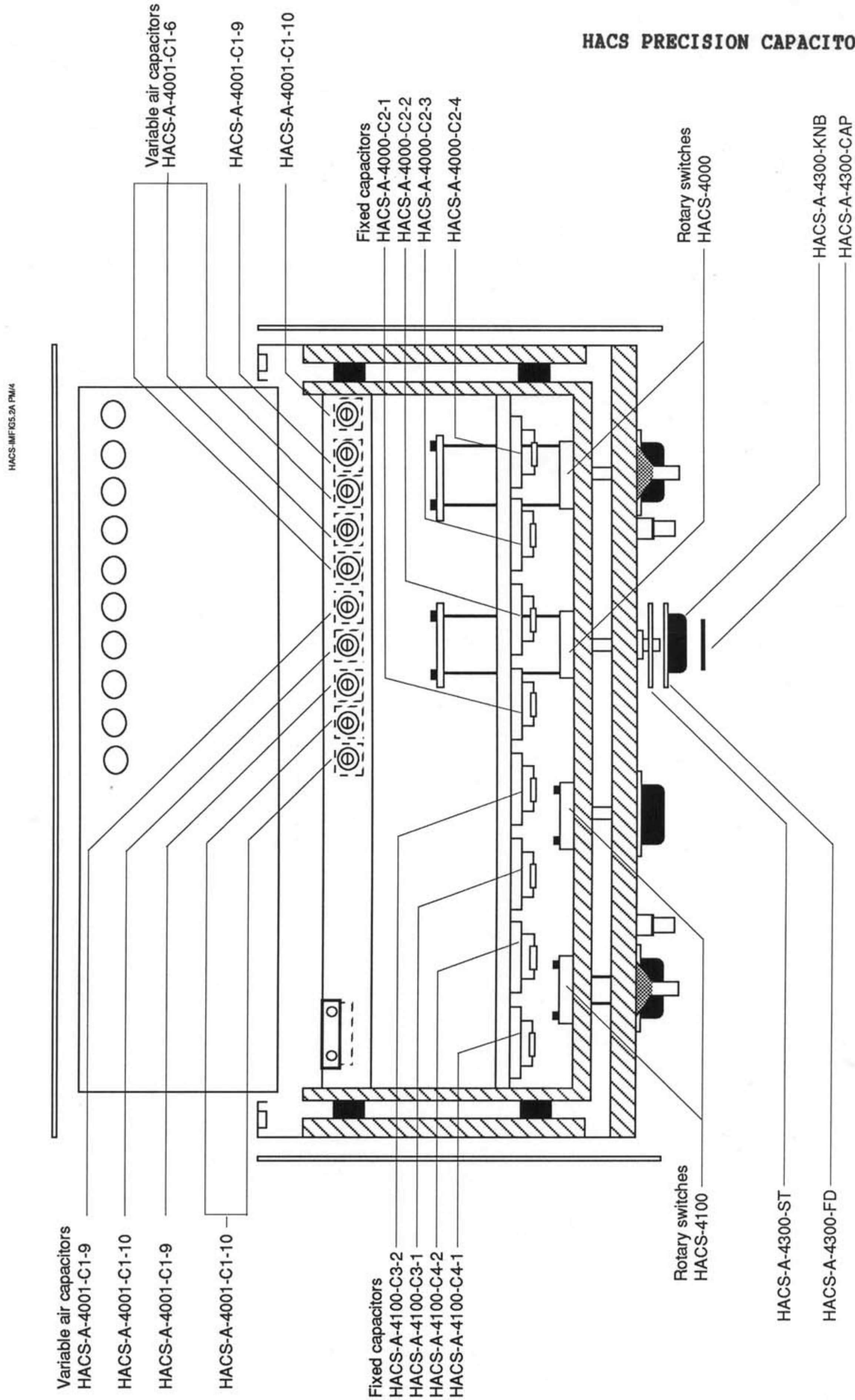


Figure 5.2a HACS Series Assembly Diagram (Top View Part 1)

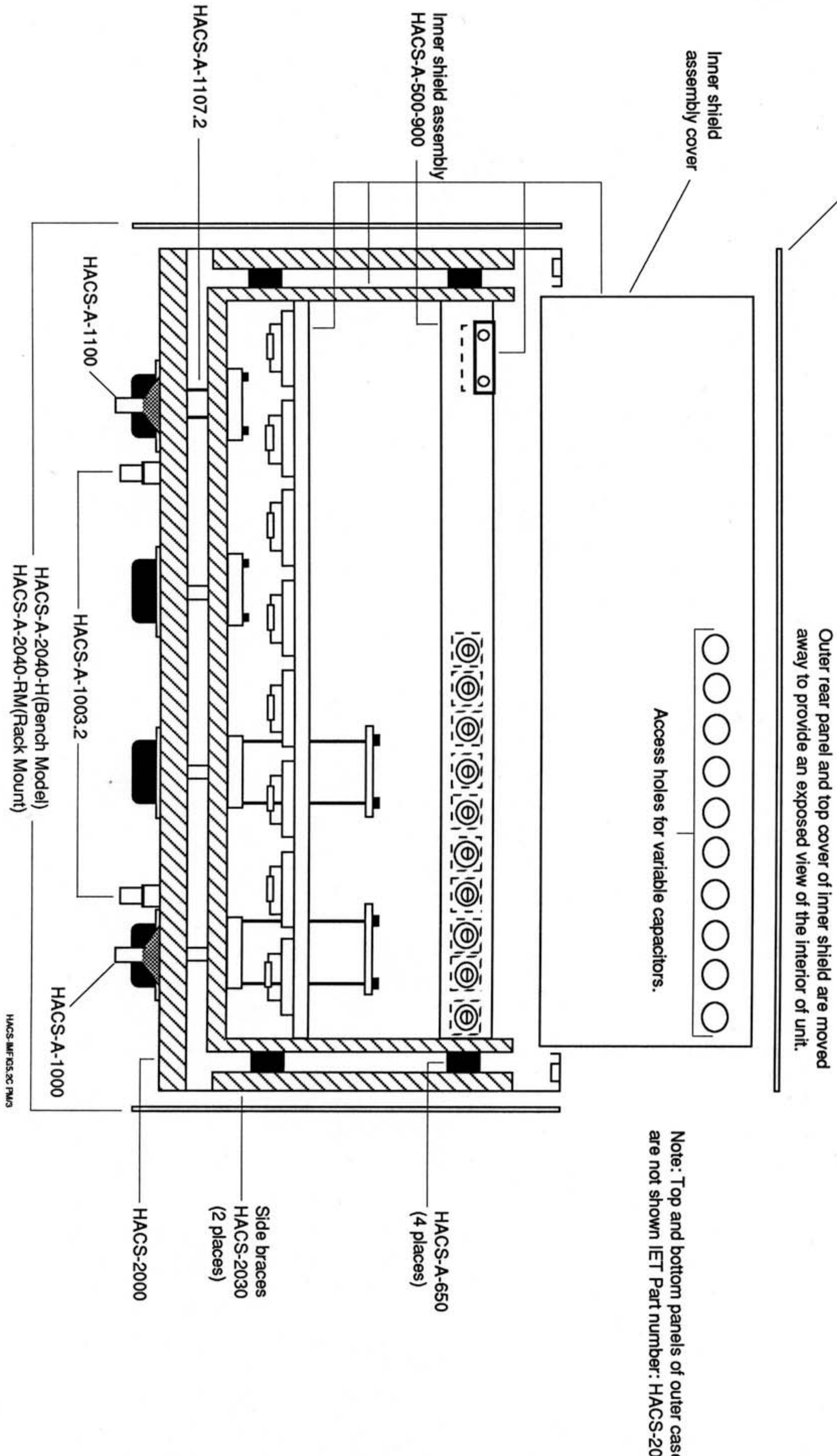


Figure 5.2b HACS Series Assembly Diagram (Top View - Part 2)

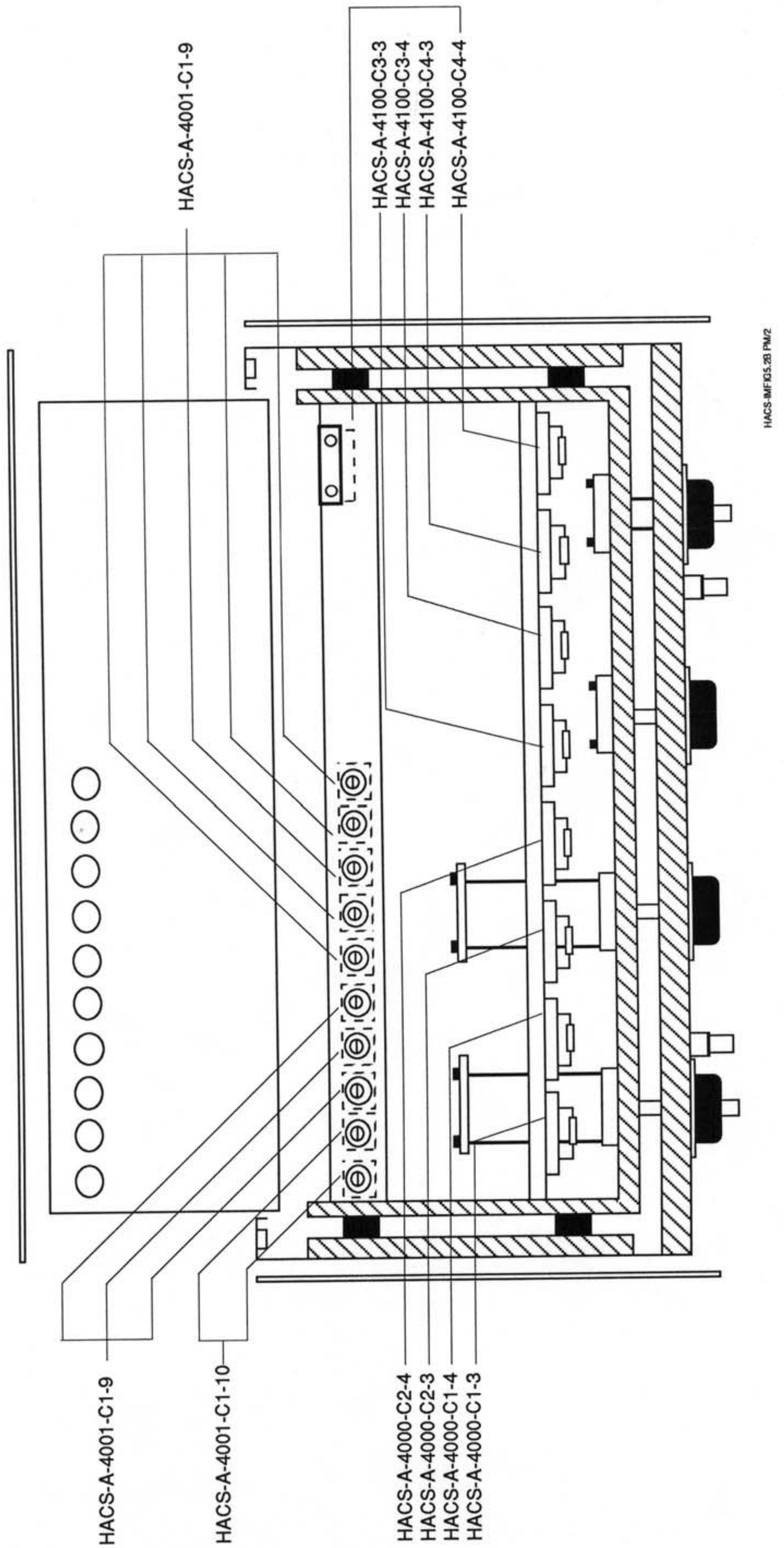


Figure 5.2c HACS Series Assembly Diagram (Bottom View)

Table 5.1 Replacement Parts List

Ref Des.	IET Part No.	Description	Qty	Fed. Mfr. Code	Mfr. Part No.
C1-5	HACS-A-4000-C1-5	Precision capacitor 56 pF nominal	1	62015	Same as IET No.
C1-1	HACS-A-4000-C1-1	Precision capacitor 100 pF nominal	1	62015	Same as IET No.
C1-2	HACS-A-4000-C1-2	Precision capacitor 200 pF nominal	1	62015	Same as IET No.
C1-3	HACS-A-4000-C1-3	Precision capacitor 200 pF nominal	1	62015	Same as IET No.
C1-4	HACS-A-4000-C1-4	Precision capacitor 500 pF nominal	1	62015	Same as IET No.
C2-1	HACS-A-4000-C2-1	Precision capacitor 1000 pF nominal	1	62015	Same as IET No.
C2-2	HACS-A-4000-C2-2	Precision capacitor 2000 pF nominal	1	62015	Same as IET No.
C2-3	HACS-A-4000-C2-3	Precision capacitor 2000 pF nominal	1	62015	Same as IET No.
C2-4	HACS-A-4000-C2-4	Precision capacitor 5000 pF nominal	1	62015	Same as IET No.
C3-1	HACS-A-4100-C3-1	Precision capacitor 0.01 µF nominal	1	62015	Same as IET No.
C3-2	HACS-A-4100-C3-2	Precision capacitor 0.02 µF nominal	1	62015	Same as IET No.
C3-3	HACS-A-4100-C3-3	Precision capacitor 0.02 µF nominal	1	62015	Same as IET No.
C3-4	HACS-A-4100-C3-4	Precision capacitor 0.05 µF nominal	1	62015	Same as IET No.
C4-1	HACS-A-4100-C4-1	Precision capacitor 0.1 µF nominal	1	62015	Same as IET No.
C4-2	HACS-A-4100-C4-2	Precision capacitor 0.2 µF nominal	1	62015	Same as IET No.
C4-3	HACS-A-4100-C4-3	Precision capacitor 0.2 µF nominal	1	62015	Same as IET No.
C4-4	HACS-A-4100-C4-4	Precision capacitor 0.5 µF nominal	1	62015	Same as IET No.
C1-6 thru C1-8	HACS-A-4001-C1-6	Variable air capacitor 1.9 pF - 4.3 pF	3	62015	Same as IET No.
C1-10 thru C1-12, C2-7, C2-8, C2-10	HACS-A-4001-C1-10	Variable air capacitor 2.2 pF - 9.1 pF	6	62015	Same as IET No.
C1-9, C1-13 thru C1-15, C2-9, C2-11 thru C2-16	HACS-A-4001-C1-9	Variable air capacitor 2.8 pF - 21.5 pF	11	62015	Same as IET No.

Table 5.1 Replacement Parts List (cont'd)

SW1-SW2	HACS-4000	Rotary switch	2	62015	Same as IET No.
SW3-SW4	HACS-4100	Rotary switch	2	62015	Same as IET No.
	HACS-A-1000	Low terminal binding post assembly	1	62015	Same as IET No.
	HACS-A-1100	High terminal binding post assembly	1	62015	Same as IET No.
	HACS-A-1003.2	Guard terminal binding post assembly	2	62015	Same as IET No.
	HACS-A-1107.2	Threaded tubing	1	62015	Same as IET No.
	HACS-A-4300-KNB	Knob	4	62015	Same as IET No.
	HACS-A-4300-CAP	Knob cap	4	62015	Same as IET No.
	HACS-A-4300-FD	Figure dial	4	62015	Same as IET No.
	HACS-A-4300-ST	Stator	4	62015	Same as IET No.
	HACS-2000	Front panel	1	62015	Same as IET No.
	HACS-2010	Rear panel	1	62015	Same as IET No.
	HACS-2020	Top or bottom panel	2	62015	Same as IET No.
	HACS-2030	Side braces	2	62015	Same as IET No.
	HACS-2040-H	Side plate with handle	2	62015	Same as IET No.
	HACS-2040-RM	Side plate rack mount	2	62015	Same as IET No.
	HACS-A-500-900	Inner shield assembly	1	62015	Same as IET No.
	HACS-A-650	Phenolic seperator	4	62015	Same as IET No.

Code	Manufacturer
62015	IET Labs, Inc., 534 Main St., Westbury, NY 11590

HACSTBL5.1/2

5.5 Disassembly, Component Replacement, and Reassembly

5.5.1 Disassembly

Referring to Figure 5.2a, b, and c, proceed as follows. The part numbers indicated below may be located in the figures for convenience:

1. Place the instrument on a flat surface and remove the 3 screws from the top surface of the top cover, and then the 3 screws from the rear edge of the top cover. The top cover may now be removed.

2. Turn the instrument upside down and repeat the procedure with the bottom cover. At this point the trimmer capacitors are accessible for adjustment.

3. Remove the 4 flat head screws attaching the rear panel to the side braces (HACS-2030). The rear panel can be removed at this point.

4. Remove all 10 screws holding the inner shield cover onto the inner shield assembly (HACS-A-500-900). Slide the cover out to the rear of the instrument until free.

5.5.2 Component Replacement

Determine and locate any faulty component that requires replacement as described in the troubleshooting section 5.4.

To remove a variable air capacitor (HACS-A-4001-C1-X), proceed as follows:

1. Desolder the bus wire connecting the air capacitor to the associated rotary switch (HACS-4000).

2. Remove the nut attaching the air capacitor to the inner shield assembly.

3. Replace the air capacitor by reversing the above steps.

To remove a fixed capacitor (HACS-A-4000-X-X or HACS-A-4100-X-X), proceed as follows:

1. Desolder the bus wire connecting the fixed capacitor to the associated rotary switch (HACS-4000 or HACS-4100).

2. Remove the screws holding the capacitor to the inner shield assembly.

3. Replace the capacitor by reversing the above steps.

5.5.3 Reassembly

To reassemble the instrument reverse the disassembly steps, taking care to assure that the inner shield assembly cover is replaced so the calibration access holes match the air capacitors.