

NOTE

This manual documents the Model 752A and its assemblies at the revision levels shown in Appendix 7A. If your instrument contains assemblies with different revision letters, it will be necessary for you to either update or backdate this manual. Refer to the supplemental change/errata sheet for newer assemblies, or to the backdating sheet in Appendix 7A for older assemblies.

752A Reference Divider

Instruction Manual

P/N 645069
MAY 1983 Rev. 1 4/84

©1993 Fluke Corporation. All rights reserved. Printed in U.S.A.
All product names are trademarks of their respective companies



LIMITED WARRANTY & LIMITATION OF LIABILITY

Each Fluke product is warranted to be free from defects in material and workmanship under normal use and service. The warranty period is one year and begins on the date of shipment. Parts, product repairs and services are warranted for 90 days. This warranty extends only to the original buyer or end-user customer of a Fluke authorized reseller, and does not apply to fuses, disposable batteries or to any product which, in Fluke's opinion, has been misused, altered, neglected or damaged by accident or abnormal conditions of operation or handling. Fluke warrants that software will operate substantially in accordance with its functional specifications for 90 days and that it has been properly recorded on non-defective media. Fluke does not warrant that software will be error free or operate without interruption.

Fluke authorized resellers shall extend this warranty on new and unused products to end-user customers only but have no authority to extend a greater or different warranty on behalf of Fluke. Warranty support is available if product is purchased through a Fluke authorized sales outlet or Buyer has paid the applicable international price. Fluke reserves the right to invoice Buyer for importation costs of repair/replacement parts when product purchased in one country is submitted for repair in another country.

Fluke's warranty obligation is limited, at Fluke's option, to refund of the purchase price, free of charge repair, or replacement of a defective product which is returned to a Fluke authorized service center within the warranty period.

To obtain warranty service, contact your nearest Fluke authorized service center or send the product, with a description of the difficulty, postage and insurance prepaid (FOB Destination), to the nearest Fluke authorized service center. Fluke assumes no risk for damage in transit. Following warranty repair, the product will be returned to Buyer, transportation prepaid (FOB Destination). If Fluke determines that the failure was caused by misuse, alteration, accident or abnormal condition of operation or handling, Fluke will provide an estimate of repair costs and obtain authorization before commencing the work. Following repair, the product will be returned to the Buyer transportation prepaid and the Buyer will be billed for the repair and return transportation charges (FOB Shipping Point).

THIS WARRANTY IS BUYER'S SOLE AND EXCLUSIVE REMEDY AND IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. FLUKE SHALL NOT BE LIABLE FOR ANY SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES OR LOSSES, INCLUDING LOSS OF DATA, WHETHER ARISING FROM BREACH OF WARRANTY OR BASED ON CONTRACT, TORT, RELIANCE OR ANY OTHER THEORY.

Since some countries or states do not allow limitation of the term of an implied warranty, or exclusion or limitation of incidental or consequential damages, the limitations and exclusions of this warranty may not apply to every buyer. If any provision of this Warranty is held invalid or unenforceable by a court of competent jurisdiction, such holding will not affect the validity or enforceability of any other provision.

Fluke Corporation
P.O. Box 9090
Everett WA
98206-9090

Fluke Europe B.V.
P.O. Box 1186
5602 B.D. Eindhoven
The Netherlands

Table of Contents

SECTION	TITLE	PAGE
1	INTRODUCTION AND SPECIFICATIONS	1-1
	1-1. INTRODUCTION	1-1
	1-7. SPECIFICATIONS AND ACCESSORIES.....	1-1
2	OPERATION	2-1
	2-1. INTRODUCTION	2-1
	2-3. SHIPPING INFORMATION	2-1
	2-5. INSTALLATION	2-1
	2-7. INPUT LINE POWER	2-1
	2-9. FRONT AND REAR PANEL FEATURES	2-1
	2-11. OPERATING NOTES	2-1
	2-12. Introduction	2-1
	2-14. Guard/Ground Terminals	2-1
	2-17. Self-Calibration Procedure	2-1
	2-19. OPERATION	2-4
	2-20. Introduction	2-4
	2-22. Calibration System Operation	2-4
	2-24. Stand Alone Operation	2-4
3	THEORY OF OPERATION	3-1
	3-1 INTRODUCTION	3-1
	3-3. OVERALL FUNCTIONAL DESCRIPTION	3-1
	3-6. System Operation	3-1
	3-8. Stand-Alone Operation	3-2
	3-10. VOLTAGE DIVIDER CIRCUIT	3-2
	3-14. MODE SWITCH	3-2
	3-16. SELF-CALIBRATION CIRCUIT	3-2
	3-23. GUARD CIRCUITS	3-4
	3-26. ERROR ANALYSIS	3-4

(continued on page ii)

TABLE OF CONTENTS, *continued*

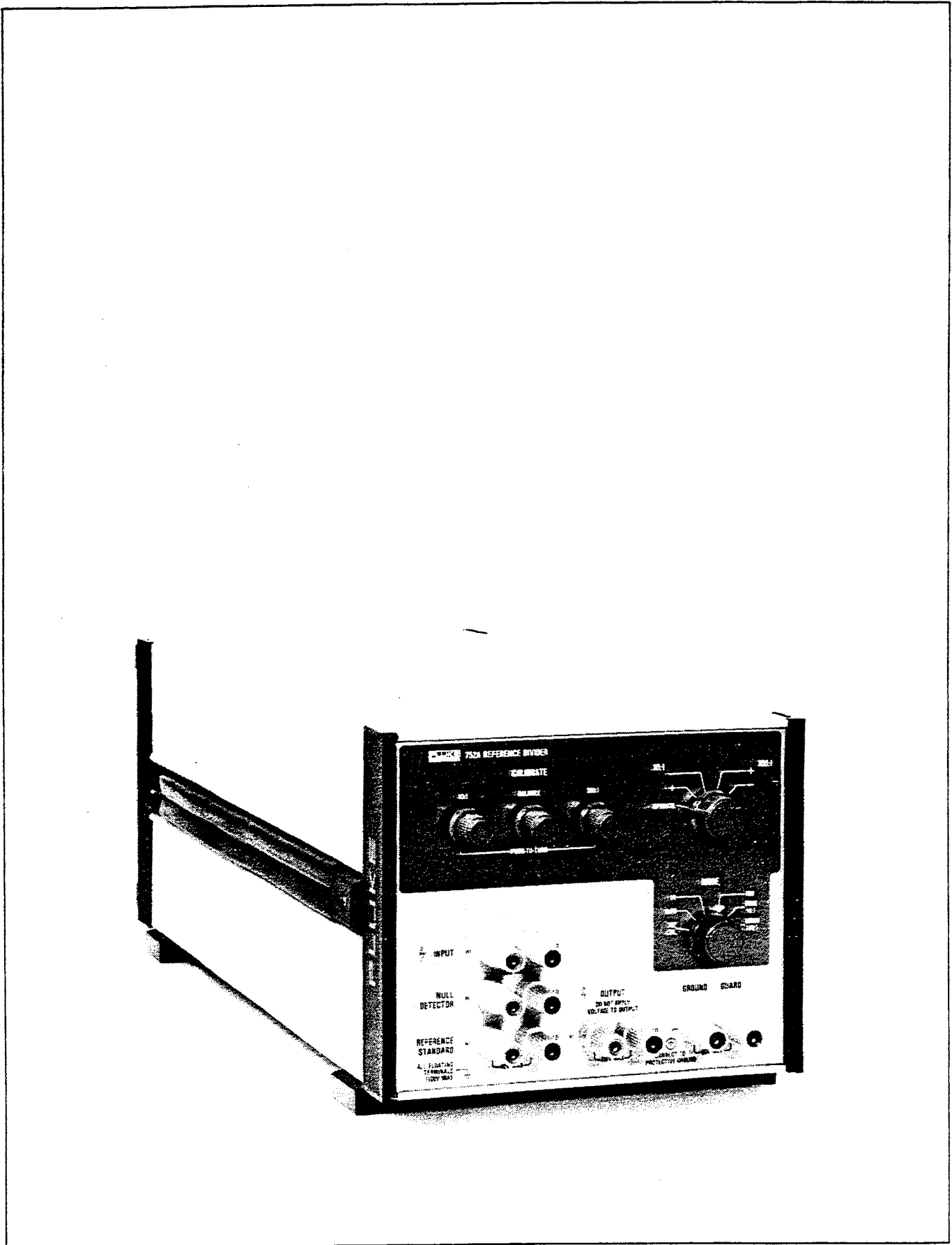
SECTION	TITLE	PAGE
4	MAINTENANCE	4-1
4-1.	INTRODUCTION	4-1
4-5.	SERVICE INFORMATION	4-1
4-9.	GENERAL MAINTENANCE	4-2
4-10.	Introduction	4-2
4-12.	Cleaning	4-2
4-16.	Internal Repair	4-2
4-18.	Access Procedure	4-2
4-30.	PERFORMANCE CHECKS	4-7
4-32.	INTERNAL CALIBRATION (Long-Term Drift Corr.)	4-7
4-34.	Self-Calibration Bridge Long-Term Drift Correction Procedure	4-7
4-36.	Self-Calibration Bridge Long-Term Drift Correction Example	4-7
4-39.	10:1 Divider Long-Term Drift Correction Procedure	4-8
4-41.	10:1 Divider Drift Correction Example	4-9
4-44.	100:1 Divider Long-Term Drift Correction Procedure	4-10
4-46.	TROUBLESHOOTING	4-11
5	LIST OF REPLACEABLE PARTS	5-1
5-1.	INTRODUCTION	5-1
5-4.	HOW TO OBTAIN PARTS	5-2
6	ACCESSORIES	6-1
	INTRODUCTION	6-1
6-3.	DUAL MOUNTING FASTENERS (M00-800-5237)	6-1
6-5.	HALF-WIDTH RACK MOUNT KIT (M07-203-601)	6-1
6-7.	FULL-WIDTH RACK MOUNT KIT (M07-200-603)	6-1
7	GENERAL INFORMATION	7-1
7A	MANUAL BACKDATING INFORMATION	7A-1
8	SCHEMATIC DIAGRAMS	8-1
	INDEX	8-12

List of Tables

TABLE	TITLE	PAGE
1-1.	Accessories	1-1
1-2.	752A Specifications	1-2
2-1.	752A Front Panel Controls and Connectors	2-2
2-2.	Equipment Required for Self-Calibration	2-3
4-1.	Test Equipment Required	4-1
4-2.	Self-Calibration Bridge Drift Correction Network	4-8
4-3.	10:1 Divider Drift Correction Network	4-10
4-4.	100:1 Divider Drift Correction Network	4-11
4-5.	Front Panel Resistance Measurements	4-12

List of Illustrations

FIGURE	TITLE	PAGE
Frontispiece	Model 752A Reference Divider	<i>vi</i>
1-1.	Model 752A External Dimensions	1-5
2-1.	Front Panel Controls and Connectors	2-2
2-2.	Self-Calibration Setup	2-4
2-3.	Mode Switch Configurations Block Diagram	2-5
2-4.	Calibration System Operation	2-6
2-5.	Stand Alone Operation	2-6
3-1.	752A Block Diagram	3-1
3-2.	System Operation Block Diagram	3-2
3-3.	Stand-Alone Operation	3-3
3-4.	10:1 Voltage Divider	3-3
3-5.	100:1 Voltage Divider	3-3
3-6.	Calibrate Mode Switching	3-4
3-7.	10:1 Divider and Calibration Circuit	3-5
3-8.	100:1 Divider and Calibration Circuit	3-5
3-9.	100:1 Divider Driven Guard	3-6
3-10.	Simplified Schematic of the 10:1 Calibration Circuit	3-7
4-1.	Cover Screw Locations	4-3
4-2.	Printed Circuit Board Jumper Access	4-4
4-3.	PCB Access	4-5
4-4.	Resistor Module Access	4-6



Model 752A Reference Divider

Section 1

Introduction and Specifications

1-1. INTRODUCTION

1-2. The John Fluke Model 752A is a self-calibrating, precision dc voltage divider with two ranges of division: 10:1 and 100:1. In addition to the two divider ranges, the 752A incorporates switching modes used in the cardinal point calibration of dc voltage calibrators. The points provided on the 752A are 0.1V, 1V, 10V, 100V, and 1000V. When the 752A is combined with a dc voltage calibrator, a 10V reference standard, and a null detector, the 752A switches the equipment to standardize the dc voltage calibrator without having to physically change the leads.

1-3. The 752A is self-calibrated before each use. This procedure requires a stable source and a null detector. The 752A is a ratio device only, and does not have to be included in a calibration cycle that is traceable to an external standard.

1-4. The front panel MODE switch selects between self-calibration and normal operation. In the Self-Calibration mode, the voltage divider resistors are compared using an external null detector to an internal, self-calibrating bridge to precisely set their overall value, and hence, the division ratio of the 752A. The three push-to-turn CALIBRATE controls adjust the 10:1 divider, 100:1 divider, and the self-calibration bridge. The CALIBRATE switch selects the divider to be calibrated and interchanges the two resistors in the self-calibration bridge to check that they are of equal value. If not, the BALANCE control adjusts one of these resistors by a small amount to make both self-calibration bridge resistors equal in value.

1-5. In normal operation, the MODE switch settings correspond to the cardinal calibration points of a dc

voltage calibration system. The MODE switch now interconnects the external equipment in one of three ways (refer to Figure 2-3):

1. The voltage divider of the 752A is connected between the reference standard and the null detector as shown in Figures 2-3a and 2-3b.
2. The voltage divider is out of the circuit and the reference standard is compared directly with the UUT (unit under test) as shown in Figure 2-3c.
3. The voltage divider is connected between the UUT and the null detector as shown in Figures 2-3d and 2-3e.

1-6. The OUTPUT terminals are always connected to the output of the Voltage Divider. The OUTPUT terminals are used when the 752A is used as a stand-alone voltage divider.

1-7. SPECIFICATIONS AND ACCESSORIES

1-8. The accessories available for the 752A are listed in Table 1-1 and described in more detail in Section 6 of this manual. The specifications for the 752A are listed in Table 1-2.

Table 1-1. Accessories

MODEL NUMBER	DESCRIPTION
M00-800-523	Dual Mounting Fastener
M07-203-603	Half Width Rack Mount Kit
M07-200-601	Full Width Rack Mount Kit
5440A-7002	Low Thermal EMF Cable Assembly

Table 1-2. 752A Specifications

RATIO RANGES 10:1, 100:1

RATIO ACCURACY* 18°C to 28°C

Range	Input Voltage	Accuracy Of Output
10:1	100V	0.2 ppm
100:1	1000V	0.5 ppm

INPUT RESISTANCE

100:1 Divider
 DIVIDER 4 Megohms
 DRIVEN GUARD 4 Megohms
 TOTAL 2 Megohms ±1%

10:1 Divider 380 kilohms ±1%

MAXIMUM INPUT VOLTAGE

10:1 Ratio 200V maximum**
100:1 Ratio 1100V maximum

POWER COEFFICIENT EFFECT ON RATIO***

10:1 Ratio <0.05 ppm of input @ 100V
100:1 Ratio <0.3 ppm of input @ 1000V

DIMENSIONS (HxWxD) 19.1 cm x 22.1 cm x 60.3 cm
 (7.5 in x 8.5 in x 23.7 in) (See Figure 1-1)

WEIGHT 8.4 kg (18 lbs 8 oz)

COMPLIANCE WITH EXTERNAL STANDARDS

ANSI C39.5 Draft #8
 IEC 348 2nd edition, 1978
 CSA Bulletin 556B, 17 Sept. 1973
 VDE 0411-1973
 UL 1244

OPERATING TEMPERATURE 0°C to 40°C

ALTITUDE

Non-operating 0-12,200 meters (40,000 feet)
Operating 0-3,050 meters (10,000 feet)

TEMPERATURE AND HUMIDITY

Condition	Temperature (°C)	% Relative Humidity (Non-condensing)
Non-operating	-40 to +75	Not Controlled
	0 to 50	95 ±5%
Operating	0 to 30	80 ±5%
	30 to 40	75 ±5%
	40 to 50	45 ±5%

Table 1-2. 752A Specifications (cont)

VIBRATION Per MIL 28800C Class 5

*Ratio accuracy specification applies for eight (8) hours following self-calibration, provided that the instrument is operated at a constant temperature equal to the calibration temperature $\pm 1^{\circ}\text{C}$ and provided that the instrument was allowed to stabilize for a period of not less than four (4) hours prior to self-calibration in a thermally stable environment.

**This specification applies to the safety of the 752A only. The maximum voltage for best accuracy is 100V.

***This is included in the 100:1 Ratio Accuracy specification.

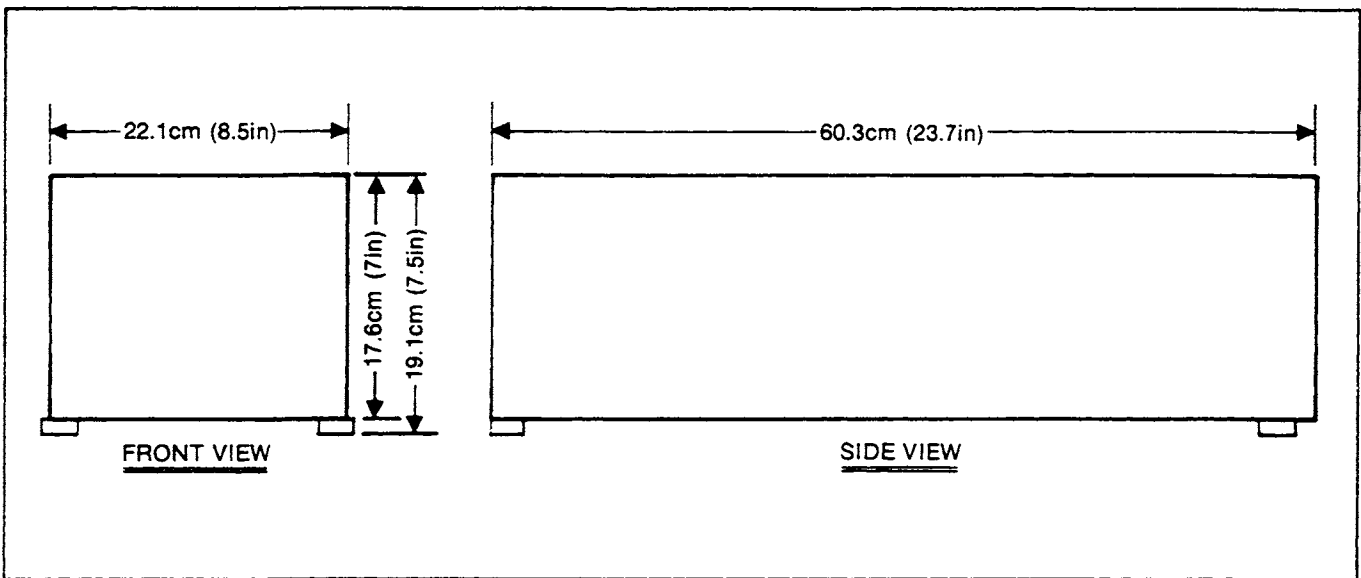


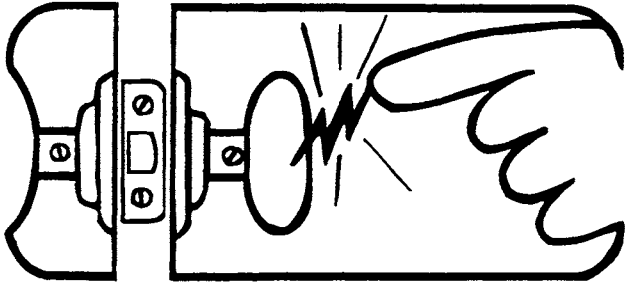
Figure 1-1. Model 752A External Dimensions



static awareness



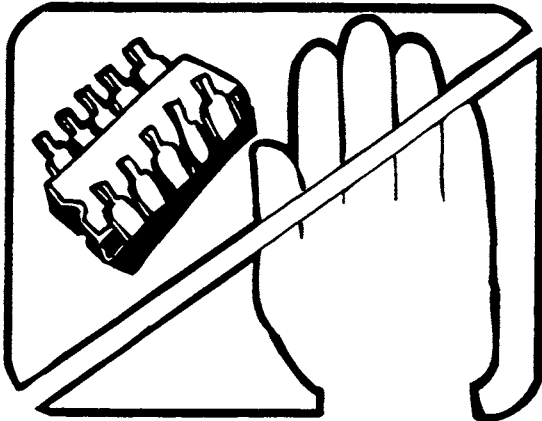
A Message From
John Fluke Mfg. Co., Inc.



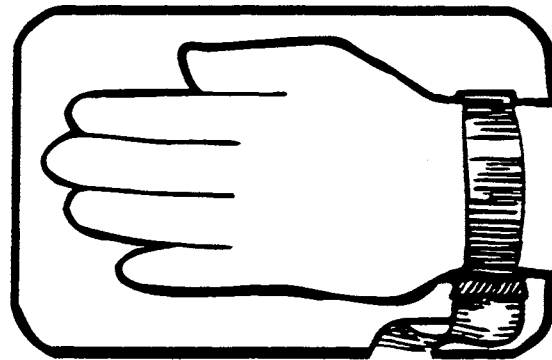
Some semiconductors and custom IC's can be damaged by electrostatic discharge during handling. This notice explains how you can minimize the chances of destroying such devices by:

1. Knowing that there is a problem.
2. Learning the guidelines for handling them.
3. Using the procedures, packaging, and bench techniques that are recommended.

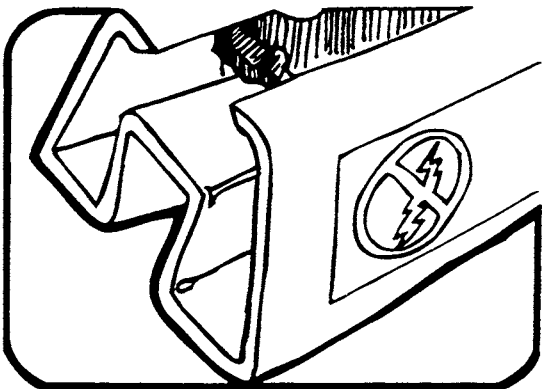
The following practices should be followed to minimize damage to S.S. (static sensitive) devices.



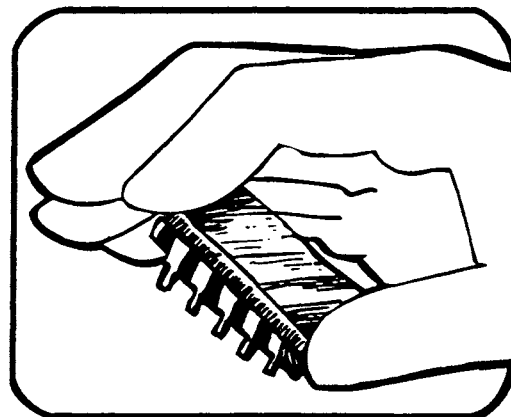
1. MINIMIZE HANDLING



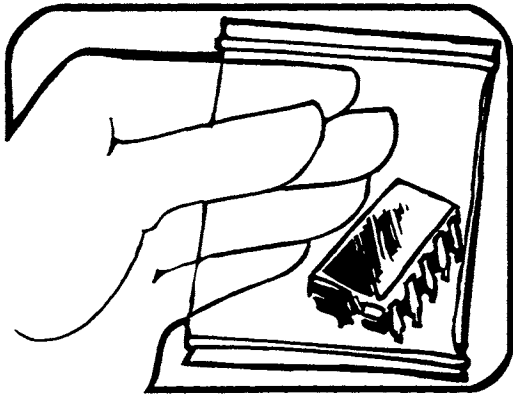
3. DISCHARGE PERSONAL STATIC BEFORE HANDLING DEVICES. USE A HIGH RESISTANCE GROUNDING WRIST STRAP.



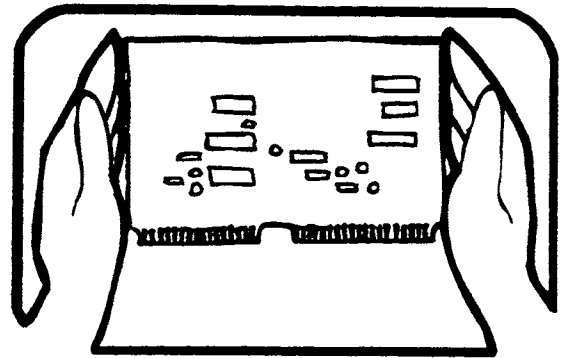
2. KEEP PARTS IN ORIGINAL CONTAINERS UNTIL READY FOR USE.



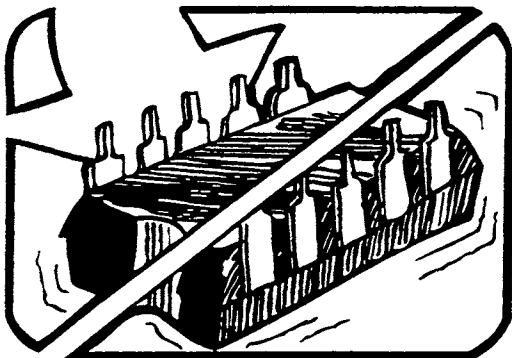
4. HANDLE S.S. DEVICES BY THE BODY.



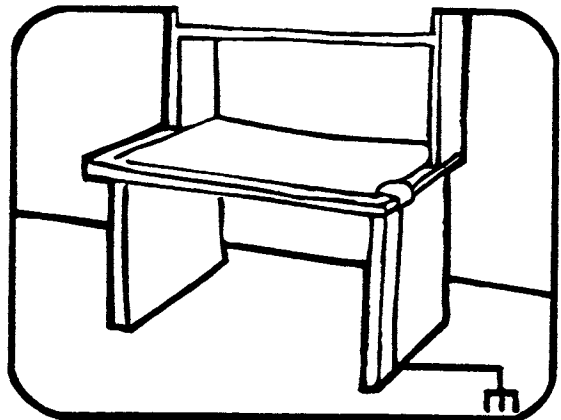
5. USE STATIC SHIELDING CONTAINERS FOR HANDLING AND TRANSPORT.



8. WHEN REMOVING PLUG-IN ASSEMBLIES HANDLE ONLY BY NON-CONDUCTIVE EDGES AND NEVER TOUCH OPEN EDGE CONNECTOR EXCEPT AT STATIC-FREE WORK STATION. PLACING SHORTING STRIPS ON EDGE CONNECTOR HELPS PROTECT INSTALLED S.S. DEVICES.



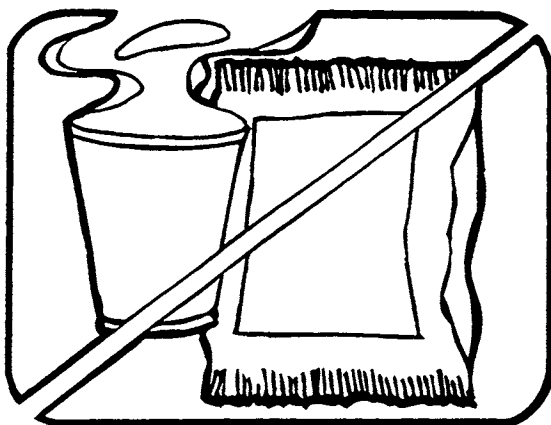
6. DO NOT SLIDE S.S. DEVICES OVER ANY SURFACE.



9. HANDLE S.S. DEVICES ONLY AT A STATIC-FREE WORK STATION.

10. ONLY ANTI-STATIC TYPE SOLDER-SUCKERS SHOULD BE USED.

11. ONLY GROUNDED-TIP SOLDERING IRONS SHOULD BE USED.



7. AVOID PLASTIC, VINYL AND STYROFOAM® IN WORK AREA.

PORTIONS REPRINTED
WITH PERMISSION FROM TEKTRONIX INC.
AND GENERAL DYNAMICS, POMONA DIV.

Section 2 Operation

2-1. INTRODUCTION

2-2. The information in this section describes the installation and operation of the Model 752A. It is recommended that the contents of this section be read and understood before any attempt is made to operate the instrument. Should any difficulties arise during operation, contact your nearest John Fluke Sales Representative, or the factory. Our mailing address is: John Fluke Mfg. Co., Inc.; P.O. Box C9090; Everett, WA 98206 (206) 347-6100.

2-3. SHIPPING INFORMATION

2-4. The 752A is shipped in a foam-packed container. Upon receipt of the instrument, a thorough inspection should be made to reveal any possible shipping damage. Special instructions for inspection and claims are included on the shipping carton. If reshipment of the instrument is necessary, the original container or equivalent should be used.

2-5. INSTALLATION

2-6. The 752A may be operated free standing or rack mounted. A rack mount accessory for the 752A is described in Section 6.

2-7. INPUT LINE POWER

2-8. The 752A is a passive device requiring no external line power.

2-9. FRONT AND REAR PANEL FEATURES

2-10. The front panel features are shown in Figure 2-1. The various controls and connections are listed and explained in Table 2-1. The only connection on the rear panel is a chassis ground connection.

2-11. OPERATING NOTES

2-12. Introduction

2-13. This section describes the use of the guard and

ground terminals on the 752A. The Self-Calibration Procedure for the 752A is described at the end of the Operating Notes.

2-14. Guard/Ground Terminals

2-15. Ordinarily, the GUARD and GROUND terminals are strapped together. They may be unstrapped when it is desirable to reference the internal guard circuit to a different potential than ground.

WARNING

LETHAL VOLTAGES MAY BE PRESENT WHEN OPERATING THE 752A WITH THE GUARD AND CHASSIS GROUND CONNECTIONS SEPARATED.

CAUTION

A MAXIMUM POTENTIAL DIFFERENCE OF 60V RMS MAY APPEAR BETWEEN THE GUARD AND CHASSIS GROUND TERMINALS. IF THIS LIMITATION IS EXCEEDED, DAMAGE TO THE INSTRUMENT MAY RESULT.

2-16. Separating the GUARD and GROUND terminals may be necessary to minimize the effect of circulating currents in the ground system of a calibration setup. The GUARD terminals may also be referenced to a different potential than GROUND to minimize the effects of electrical leakage on the characteristics of the 752A's voltage divider.

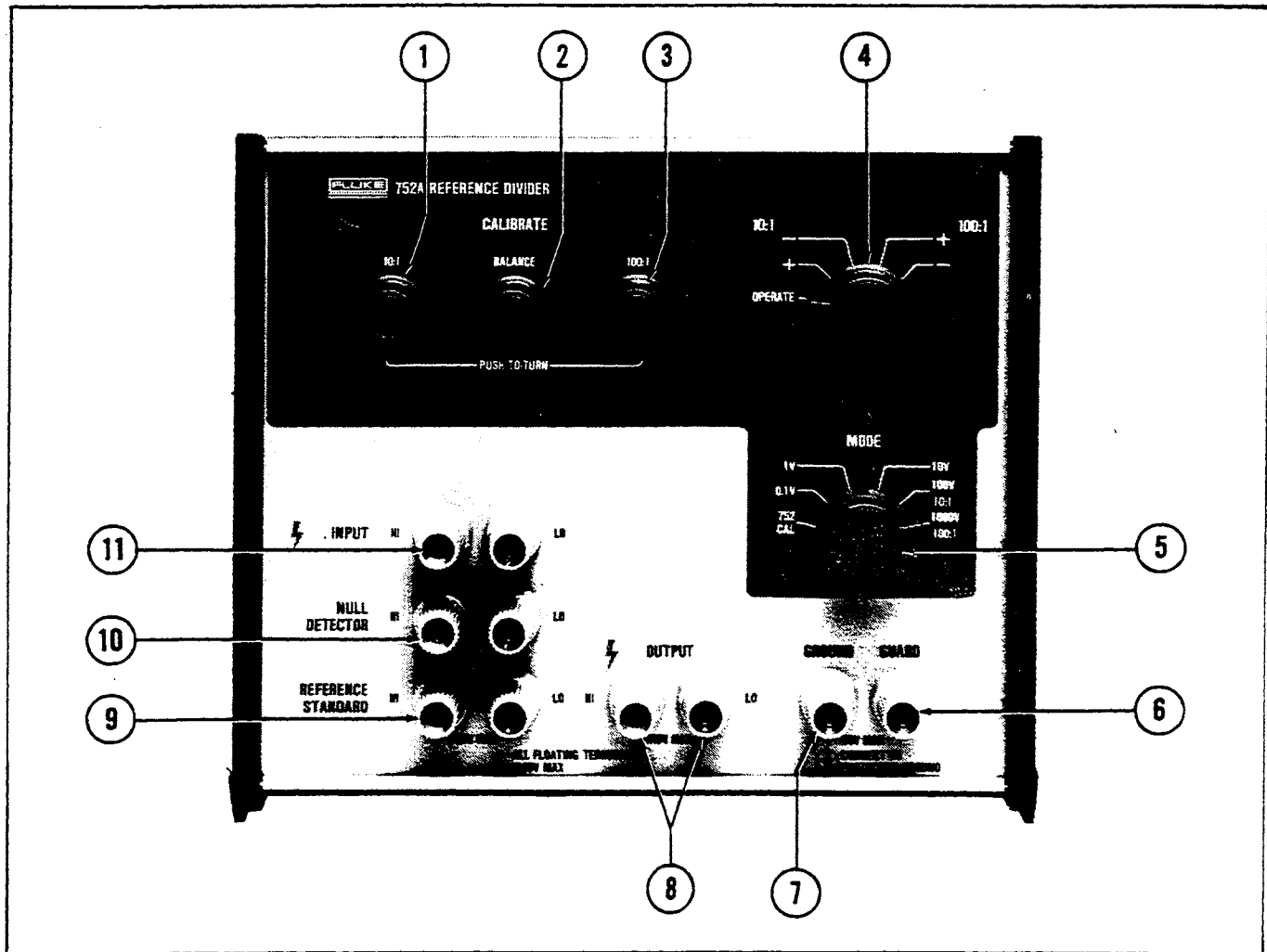


Figure 2-1. Front Panel Controls and Connectors

Table 2-1. 752A Front Panel Controls and Connectors

ITEM NO.	FEATURE NAME	DESCRIPTION
1	10:1 calibration potentiometer	Calibrates 10:1 divider.
2	BALANCE calibration potentiometer	Calibrates internal calibration bridge.
3	100:1 calibration potentiometer	Calibrates 100:1 divider.
4	CALIBRATE switch	Selects normal operation or divider to be calibrated.
5	MODE switch	Selects divider ratio or Cal mode.
6	GUARD terminal	Guard circuit connection.
7	GROUND terminal	Chassis ground connection.
8	OUTPUT terminals	Voltage Divider output.
9	REFERENCE STANDARD terminals	Input from reference standard voltage source.
10	NULL DETECTOR terminals	Output to null detector.
11	INPUT terminals	Instrument input.

Table 2-2. Equipment Required For Self-Calibration

NAME	REQUIRED SPECIFICATIONS	TYPE
Voltage Source	20V, 10 mA	Fluke 5440A
Null Detector	1 μ V full scale sensitivity 10 M Ω input resistance	Fluke 845 Null Detector
NOTE		
The leakage resistance to the case of the Null Detector should be greater than $10 \times 10^{12} \Omega$. Use the same null detector for both self-calibration and operation.		

2-17. Self-Calibration Procedure

2-18. Complete the following procedure to self-calibrate the 752A. The test equipment required is shown in Table 2-2. Equivalent test equipment may be substituted providing it meets the minimum specification given in Table 2-2. Connect the equipment as shown in Figure 2-2.

CAUTION

TO INSURE OPERATION WITHIN THE SPECIFICATIONS LISTED IN SECTION 1, DO NOT ADJUST THE 10:1 OR 100:1 CALIBRATE CONTROLS AT ANY TIME OTHER THAN AS A PART OF THE SELF-CALIBRATION PROCEDURE. THESE CONTROLS ARE PART OF THE DIVIDER CIRCUIT REGARDLESS OF THE POSITION OF THE MODE SWITCH.

CAUTION

TO AVOID CRACKING THE PLASTIC BINDING POST INSULATOR, TIGHTEN ONLY WITH FINGER PRESSURE. DO NOT USE TOOLS.

1. Allow the 752A to thermally stabilize for at least 4 hours in a thermally stable environment ($\pm 1^\circ\text{C}$).
2. Adjust the Voltage Source for 20V output. Leave the output de-energized at this time.
3. Connect the 752A as shown in Figure 2-2.
4. Set the MODE switch to the 752 CAL position.
5. Set the CALIBRATE switch to the 10:1+ position.

6. Energize the Voltage source.
7. Set the Null Detector to the most sensitive range that allows an onscale reading.
8. Note the reading on the Null Detector.
9. Set the CALIRATE switch to the 10:1- position.
10. Note the Null Detector reading. If there is a difference between the reading in the '+' and '-' switch positions, adjust the BALANCE potentiometer such that the Null Detector readings are the same in both the '+' and '-' switch positions.
11. If the Null Detector reading after step 10 is not zero, adjust the 10:1 potentiometer for a null on the Null Detector.
12. Repeat steps 7-11 until the Null Detector has a null reading equal to $0 \pm 0.5 \mu\text{V}$. If it is not possible to achieve equal Null Detector readings, or if the Null Detector reading exceeds the stated limits, perform the Long Term Drift correction procedure on the self-calibrate bridge as described in Section 4 of this manual.
13. Set the Null Detector to the 1 mV range.
14. Set the CALIBRATE switch on the 752A to the 100:1+ position.
15. Set the Null Detector to the most sensitive scale allowing an onscale reading.
16. Note the reading on the Null Detector.
17. If the Null Detector reading after step 16 is not zero, adjust the 100:1 potentiometer so that the Null Detector indicates a null reading of $0 \pm 1 \mu\text{V}$.
18. Repeat steps 13-18 until the Null Detector has a null reading equal to $0 \pm 1 \mu\text{V}$.

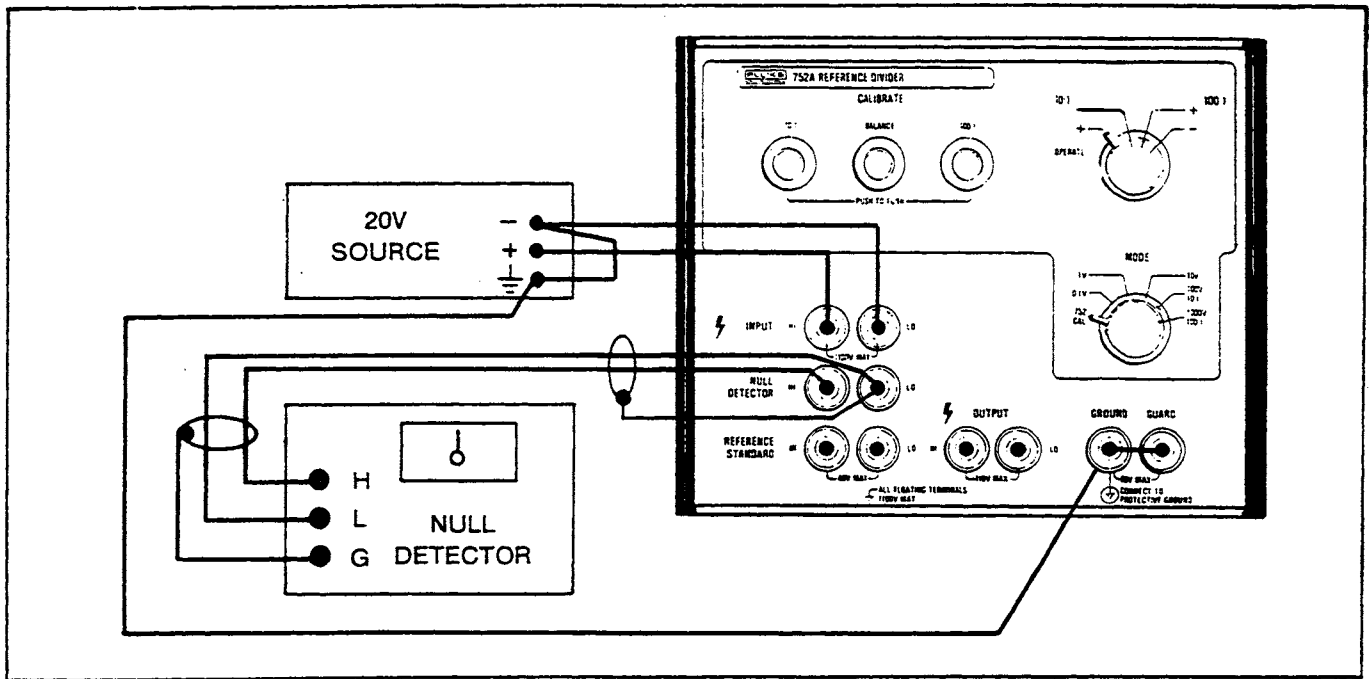


Figure 2-2. Self-Calibration Setup

19. Set the CALIBRATE switch to the 100:1- position and verify the null. If the difference between the 100:1+ and 100:1- switch settings is greater than $0.5 \mu\text{V}$, repeat the self-calibration procedure beginning with step 5.

20. If the Null Detector reading exceeds the $0 \pm 1 \mu\text{V}$ limits, perform the Long Term Drift Correction procedure described in Section 4 of this manual. Note the value of the Null Detector reading before proceeding to the Drift Correction procedure.

21. Set the Null Detector to the 10V range.

22. De-energize the Voltage Source.

23. Set the 752A CALIBRATE switch to the OPERATE position.

24. Set the 752A MODE switch to the desired position.

25. The 752A is now ready for use.

2-19. OPERATION

2-20. Introduction

2-21. The following paragraphs describe operation of the 752A in a dc voltage calibration system and as a stand-alone divider. Figure 2-3 shows the various test configurations possible using the internal switching of the 752A. Perform the Self-Calibration Procedure described earlier in this section before using the 752A.

NOTE

To insure performance to the specifications listed in section 1, the 752A must be calibrated and operated in an environment whose temperature change is less than $\pm 1^\circ\text{C}$ from the time of self-calibration to use.

NOTE

To minimize noise effects the null detector terminals are reversed in the 0.1V and the 1V configurations; i.e., an input which is low will cause a positive null detector reading.

2-22. Calibration System Operation

2-23. When the 752A is used as part of a calibration system (Figure 2-4), the Unit Under Test (UUT) is connected to the INPUT terminals, the Null Detector to the NULL DETECTOR terminals, and the Reference Standard to the REFERENCE STANDARD terminals. After self-calibration, set the CALIBRATE switch to OPERATE. The MODE switch then determines the interconnection of the precision divider portion of the 752A, Null Detector, UUT and Reference Standard.

2-24. Stand-Alone Operation

2-25. If the 752A is to be used for stand-alone operation, the input should be connected to the INPUT terminals and the output should come from the OUTPUT terminals. After self-calibration, set the 752A MODE switch to either the 10:1 or 100:1 positions. Set the CALIBRATE switch to OPERATE. Figure 2-5 shows the 752A used in a typical stand-alone configuration.

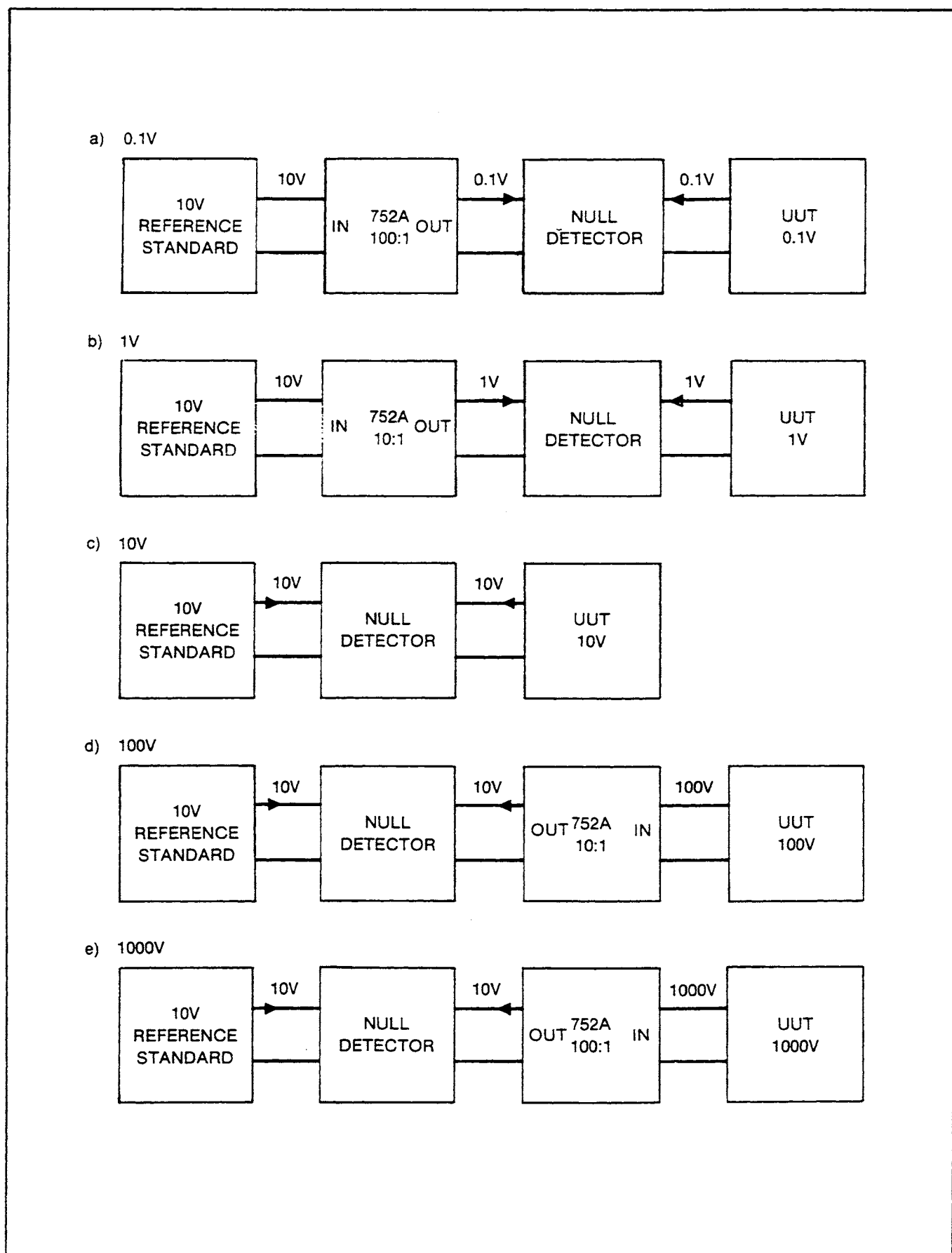


Figure 2-3. Mode Switch Configurations Block Diagram

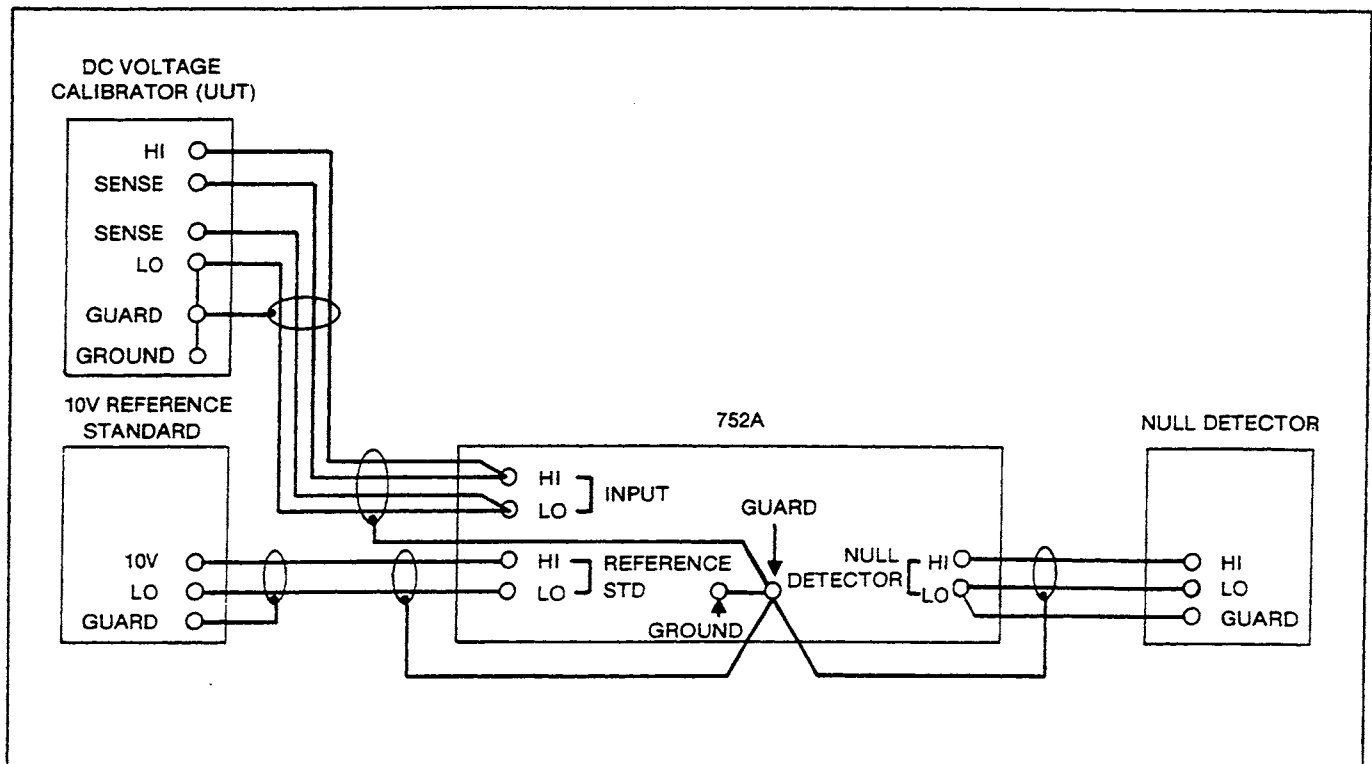


Figure 2-4. Calibration System Operation

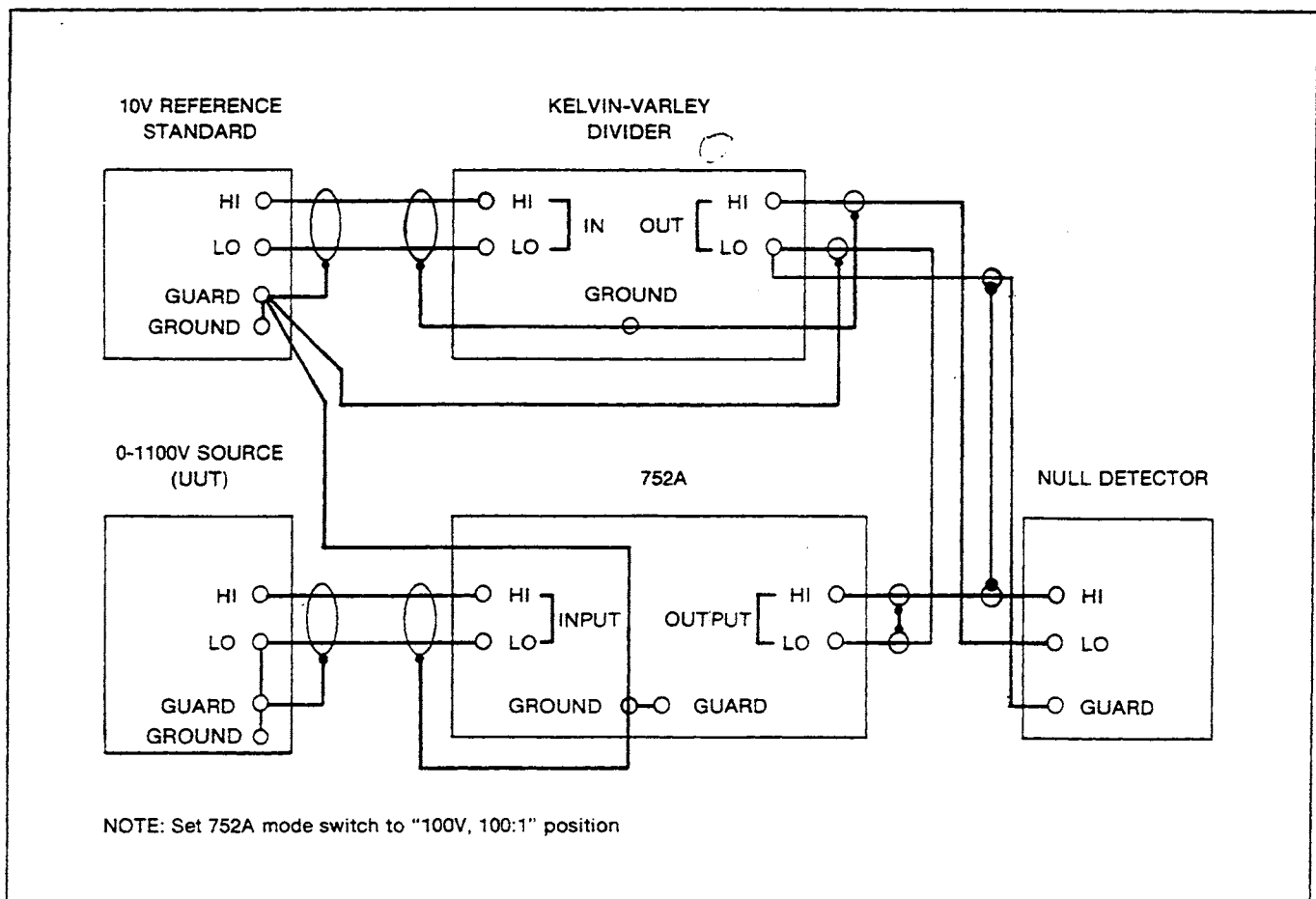


Figure 2-5. Stand-Alone Operation

Section 3 Theory of Operation

3-1. INTRODUCTION

3-2. The information in this section describes the theory of operation for the 752A. The discussion is supported by a block diagram and simplified schematics in this section and the detailed schematics found in Section 8.

3-3. OVERALL FUNCTIONAL DESCRIPTION

3-4. Refer to Figure 3-1. The 752A is a precision, self-calibrating, 10:1 and 100:1 voltage divider. The 752A has three modes of operation: part of a calibration system, stand-alone 10:1 or 100:1 voltage divider, and Self-Calibration. Dual guard circuits (one driven, one passive) minimize the effects of leakage on the performance of the instrument.

3-5. The effects of short- and long-term drift on the resistors in the 752A is compensated in two ways. Short-term drift is minimized by the Self-Calibration procedure. Long-term drift is corrected by internal strapping on the internal printed circuit assembly. Both dividers and calibration resistors have individual drift compensation networks. The Drift Correction procedure is described in Section 4.

3-6. System Operation

3-7. In this mode, the 752A is used with an external dc reference standard and null detector for the cardinal point calibration of dc voltage calibrators. As shown in Figure 3-2, the MODE switch determines connections to and

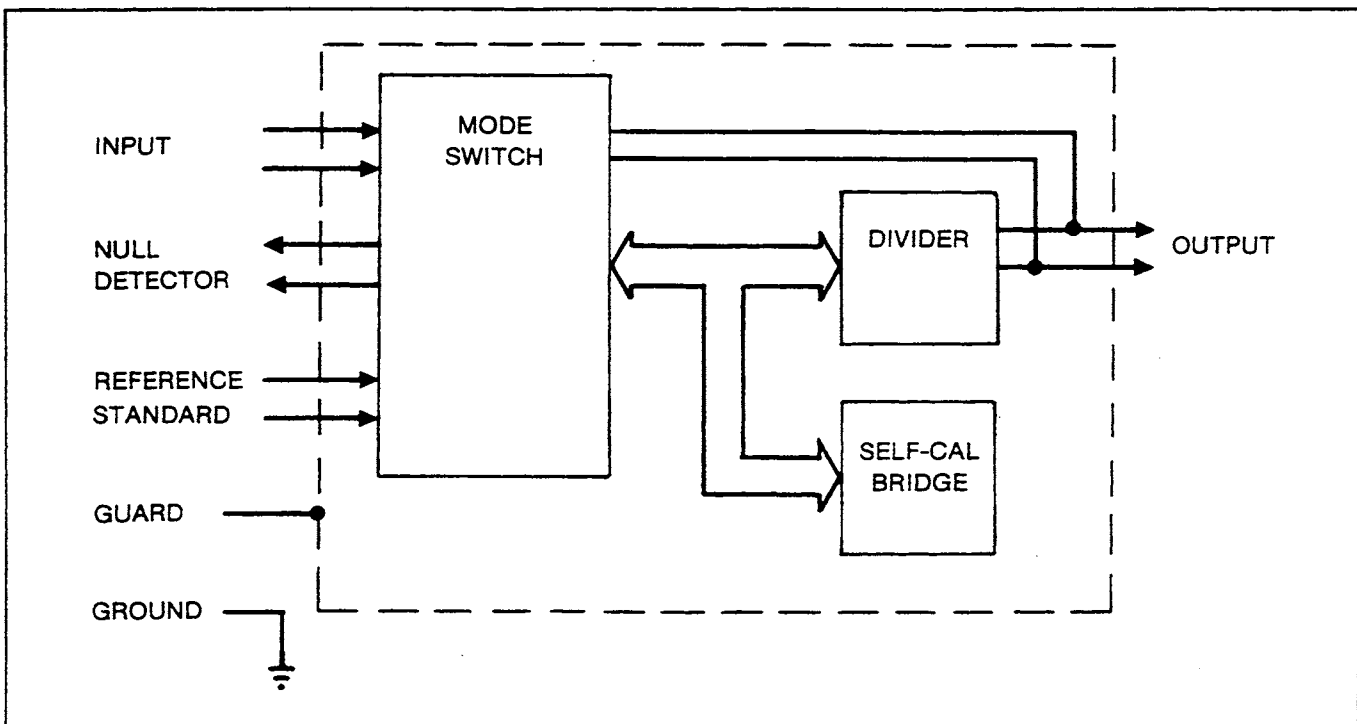


Figure 3-1. 752A Block Diagram

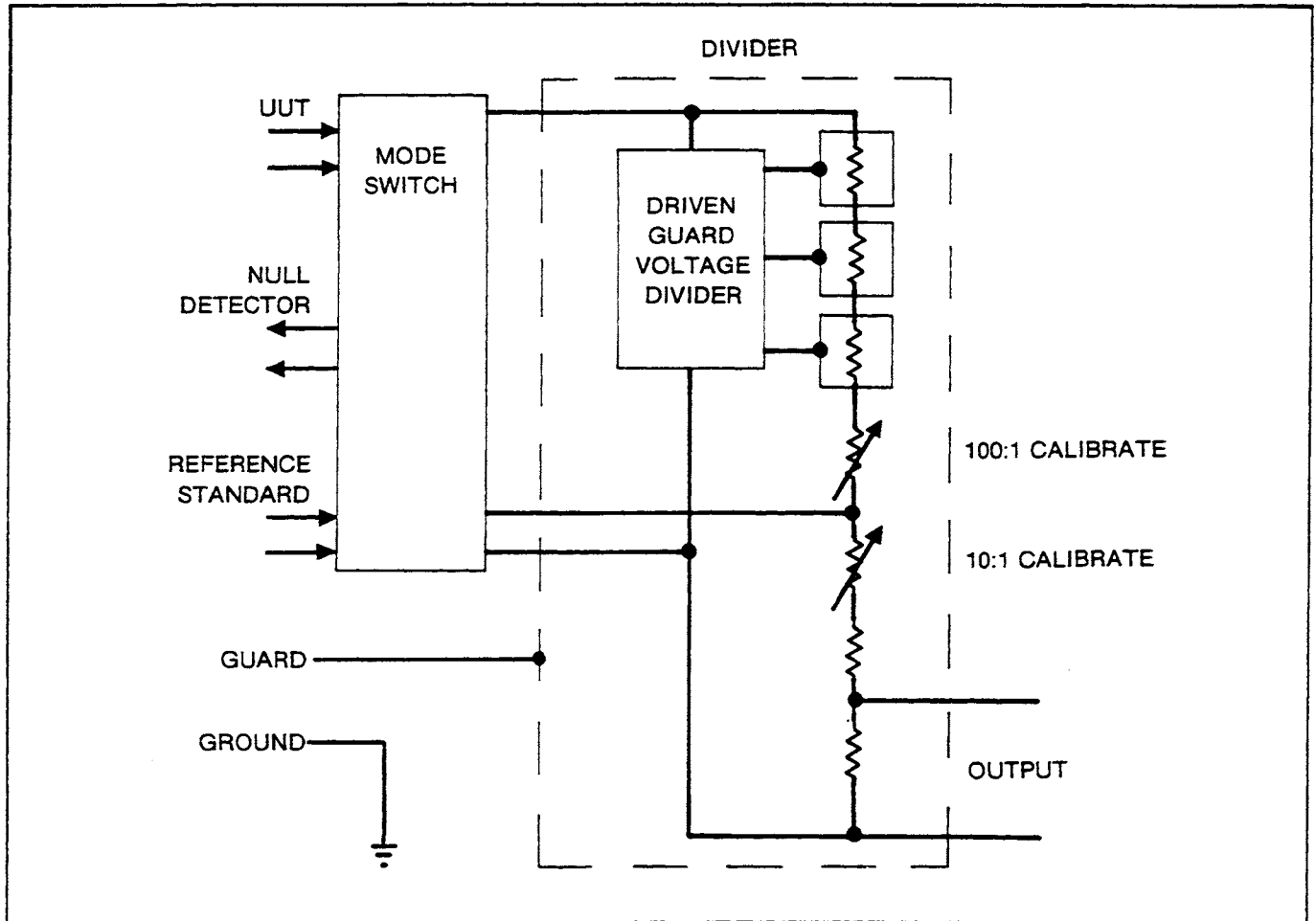


Figure 3-2. System Operation Block Diagram

from the 100:1 and 10:1 dividers, the UUT, dc reference standard, and null detector. This simplifies test procedures by eliminating lead switching for various equipment configurations.

3-8. Stand-Alone Operation

3-9. The 752A may also be used as a stand-alone 10:1 and 100:1 self-calibrating, precision voltage divider (Figure 3-3). The MODE switch connects the INPUT terminals to the 100:1 or 10:1 divider input. The divider output is available at the OUTPUT terminals.

3-10. VOLTAGE DIVIDER CIRCUIT

3-11. The 752A design is based on the concept of a resistive voltage divider. In Figure 3-4, $9R$ is the input or series resistor, and R is the output or shunt resistor.

3-12. The output resistor is $40\text{ k}\Omega$. The input resistor is 9 times the output resistor, or $360\text{ k}\Omega$. (Figure 3-4). In the 752A, the input resistor is a group of three resistors, each with a nominal value of $3R$, or $120\text{ k}\Omega$. The input resistance of the 10:1 divider is $400\text{ k}\Omega$.

3-13. In the 100:1 divider, the input resistor is $99R$ or $3.96\text{ M}\Omega$ and the output resistor is $40\text{ k}\Omega$ (Figure 3-5). The input resistance is $2\text{ M}\Omega$ rather than $4\text{ M}\Omega$ due to the driven guard circuit.

3-14. MODE SWITCH

3-15. The MODE switch determines the various internal and external connections for the precision divider, external reference standard, null detector, and the UUT in self-calibrate and operate modes. This is shown in Figure 2-3.

3-16. SELF-CALIBRATION CIRCUIT

3-17. The self-calibration circuit used in the 752A uses a technique based on the Wheatstone bridge to accurately and precisely set the ratios of the internal divider resistors. The switching necessary to perform self-calibration is supplied by the MODE switch.

3-18. The input resistor of each of the two voltage dividers is divided into three groups of values $3R$ or $30R$. As shown in Figure 3-6, the CALIBRATE switch

connects the resistors in each group in series (OPERATE mode) or in parallel (CALIBRATE mode). In the CALIBRATE mode, the input resistors have a value of R or 10R allowing their values to be compared using a resistance bridge and an external null detector.

3-19. The Calibration Bridge is composed of two resistors of nominally equal value (120 kΩ). The polarity reversing positions of the CALIBRATE switch allow

these two resistors to be electrically interchanged in their positions in the calibration bridge. Any value difference between the two calibration bridge resistors shows up on a null detector as a difference in the reading when the polarity switch is changed from '+' to '-'.

3-20. The BALANCE control allows the user to zero the difference between the calibration bridge resistor values. Note that the degree of balance between the calibrate and

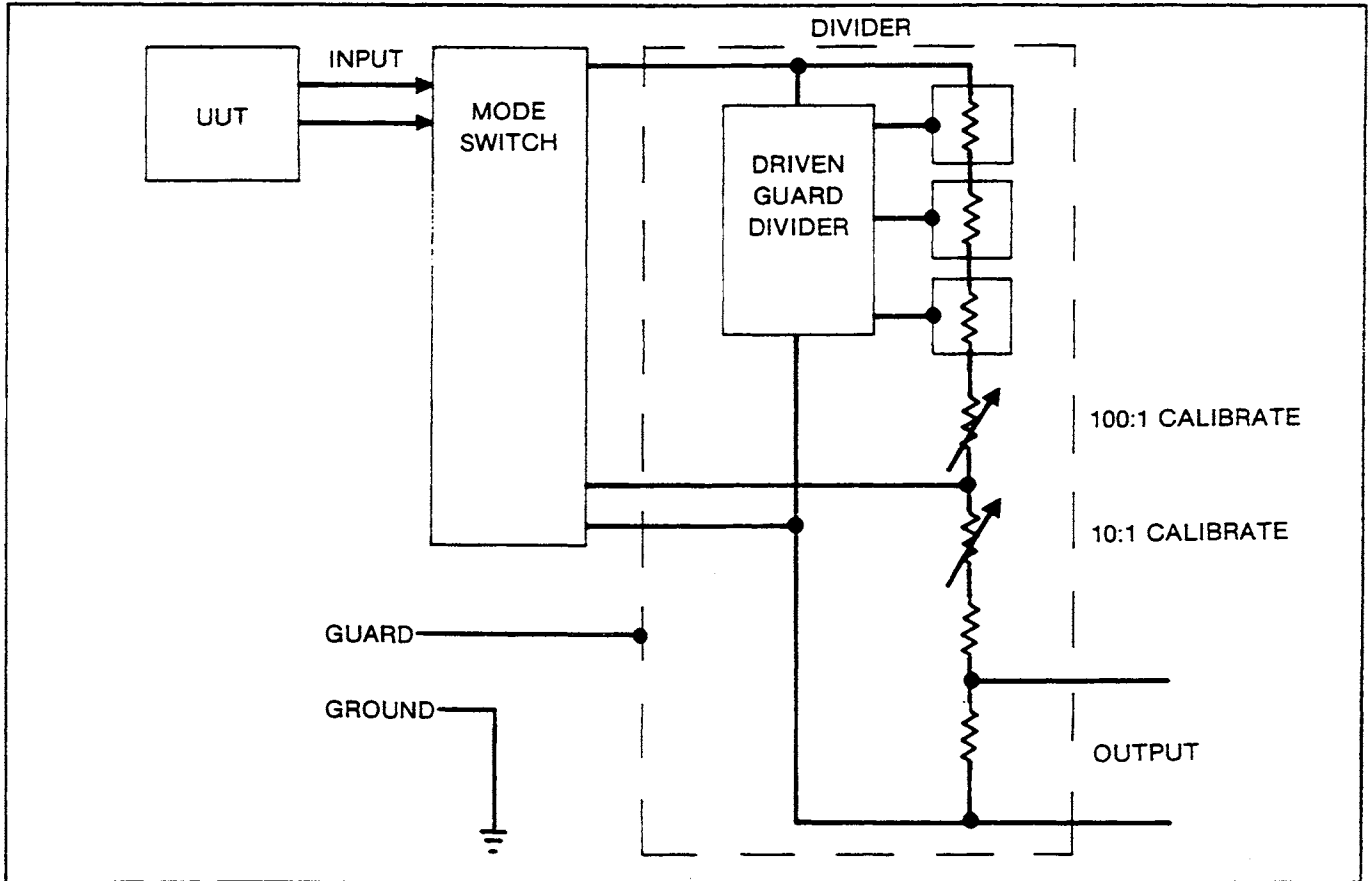


Figure 3-3. Stand-Alone Operation

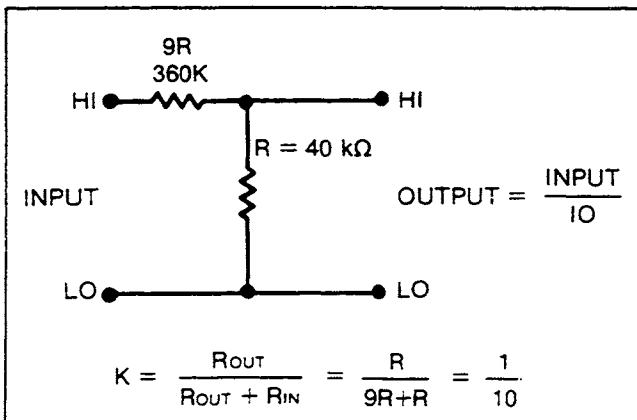


Figure 3-4. 10:1 Voltage Divider

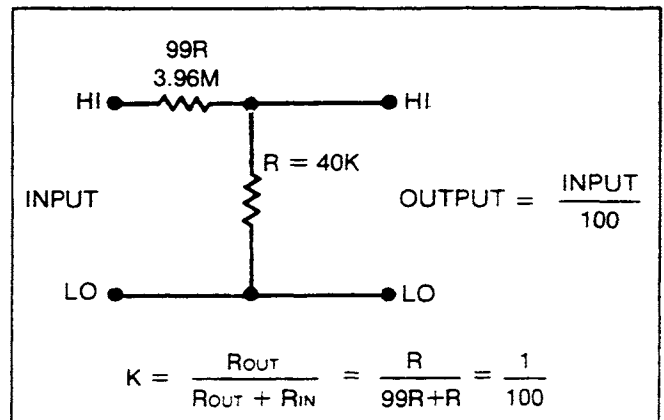


Figure 3-5. 100:1 Voltage Divider

unknown sides of the bridge does not degrade the ability to accurately match the two resistors in the calibration bridge in value.

3-21. The calibrate side of this bridge is adjusted such that both resistors are equal in value as described above. The bridge is then balanced by adjusting one of the 3R resistors in the 10:1 divider input resistor group for a null (Figure 3-7). The three parallel connected resistors are now equal to the output resistor. When the calibration switches are opened as shown in Figure 3-6, the resistance between the INPUT HI and OUTPUT HI terminals is exactly nine times the resistance between the OUTPUT HI and LO terminals.

3-22. The 100:1 Self-Calibration procedure is an extension of the 10:1 procedure. The calibration bridge is now used to compare the value of the entire 10:1 divider, previously calibrated, and the parallel configuration of the three 30R resistors in the 100:1 divider to the two equal value resistors of the calibration bridge (Figure 3-8). When the null detector indicates a null, the parallel resistor string is equal in value to the previously calibrated 10:1 divider.

NOTE

The 10:1 and 100:1 calibration controls are part of the 10:1 and 100:1 divider circuits regardless of the position of the MODE switch. Adjustment of either of these controls after self-calibration will result in out of specification performance.

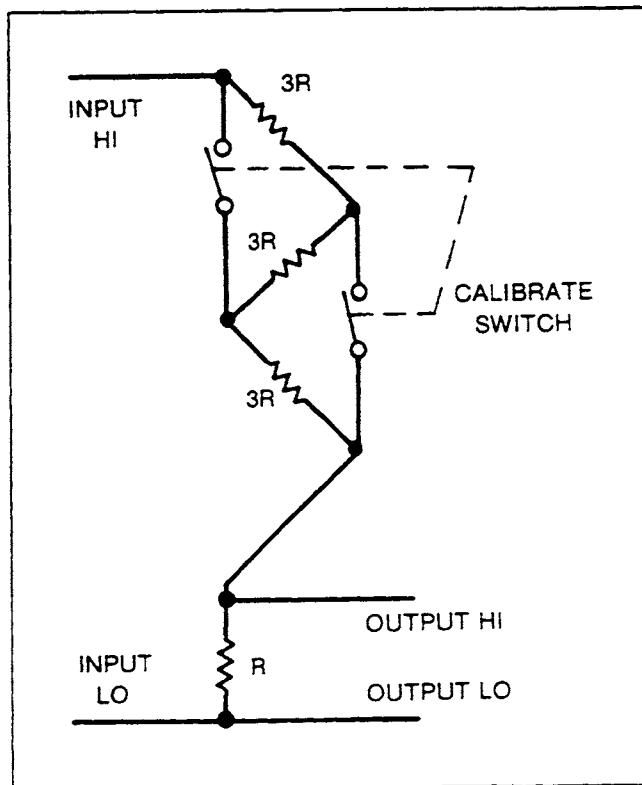


Figure 3-6. Calibrate Mode Switching (10:1)

3-23. GUARD CIRCUITS

3-24. The effects of leakage resistance can cause significant error in a 0.2 ppm precision divider. The 752A uses a driven guard circuit to reduce these effects on the resistor groups used in the 100:1 divider circuit (Figure 3-9). In addition, a passive guard circuit surrounds the entire resistor and switch network. Connection to the passive guard is made via the front panel GUARD terminal.

3-25. The driven guard operates from the input voltage applied to the 100:1 divider. The three groups of resistors comprising the 100:1 divider input resistor are enclosed in separate metal enclosures. The driven guard minimizes the effects of leakage by elevating the enclosure around a resistor group to a voltage equal to one-half of the voltage drop across that resistor group. This minimizes leakage effects by minimizing the potential difference between the resistor group and the nearest conductor.

3-26. ERROR ANALYSIS

3-27. The 752A functions as a very accurate voltage divider. Since it is not calibrated to an external traceable standard, a discussion of the sources of error is pertinent to the theory of operation. There are several major sources of error in the 752A. Fortunately, each of these sources has been addressed and controlled to within the necessary specifications. These sources are:

1. Switch contact resistance for switch contacts in series with the divider string.
2. Switch contact resistance for switch contacts involved in the series to parallel switching for self calibration.
3. Resistor mismatching errors
4. Errors in the Null Detector readings during self calibration.
5. Errors due to Temperature Coefficient of the resistors.
6. Leakage resistance in the materials used to fabricate the instrument (particularly the switches).

3-28. The error associated with switch contacts in series with the divider resistors shows up in the upper leg of the divider. The contact resistance adds to the resistance of the upper leg and its effect is shown in equation 3-1.

$$V_o/V_i = [1 / \{ N + (\Delta R/R) \}] \quad (3-1)$$

where: N = ratio (e.g. 10:1 ratio, $N=10$)

R = output resistance

ΔR = switch contact resistance

3-29. The worst case occurs in the 10:1 divider where the output resistance is 40K ohms and the ratio is 10:1. In this

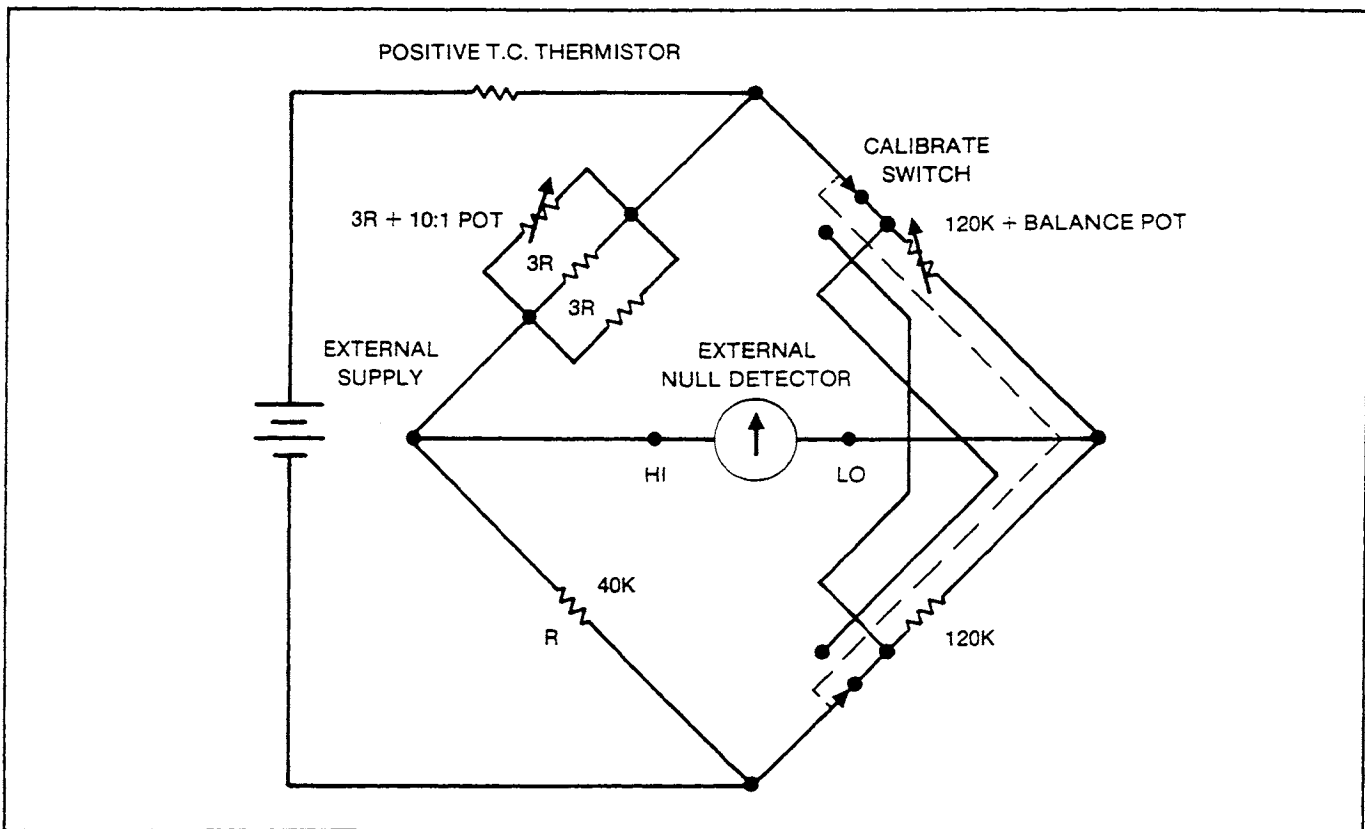


Figure 3-7. 10:1 Divider and Calibration Circuit

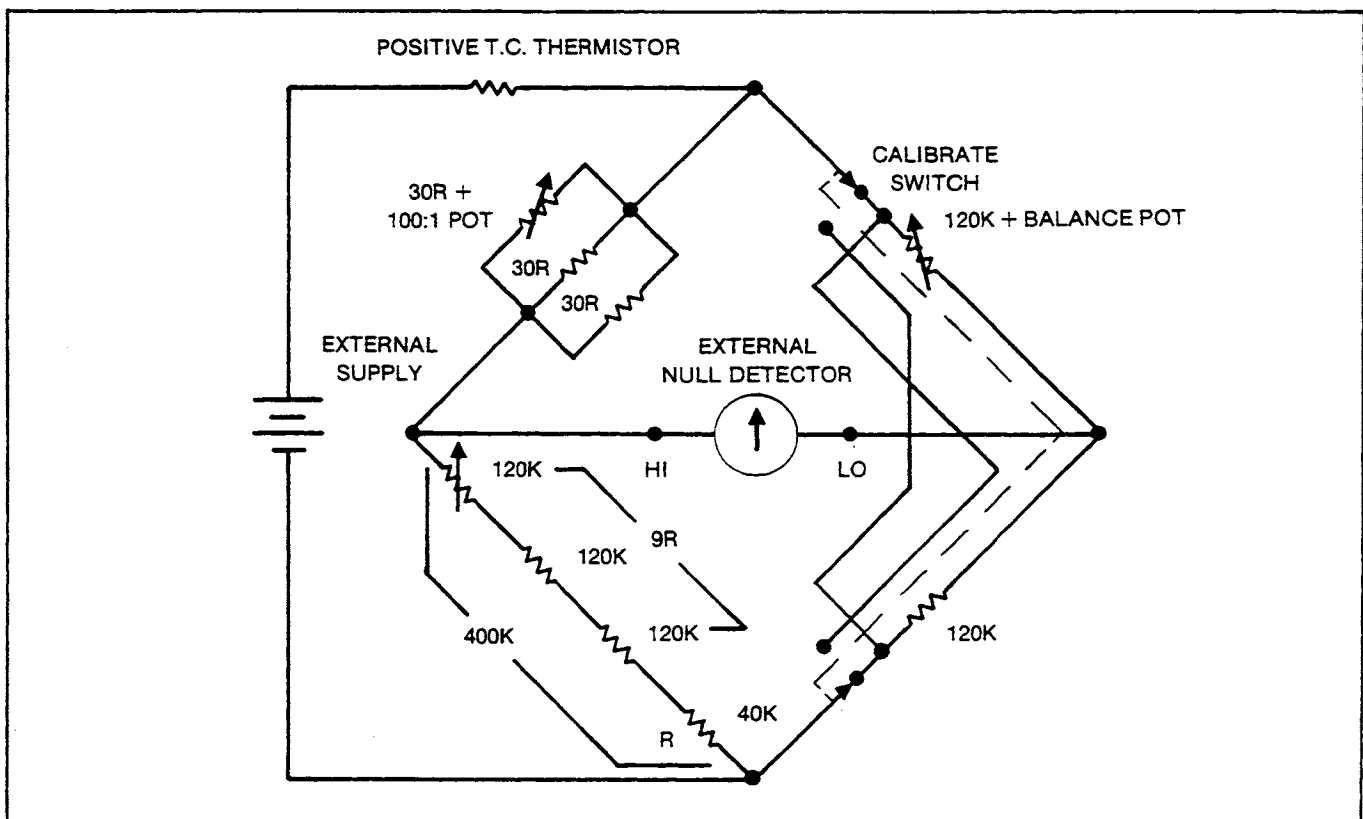


Figure 3-8. 100:1 Divider and Calibration Circuit

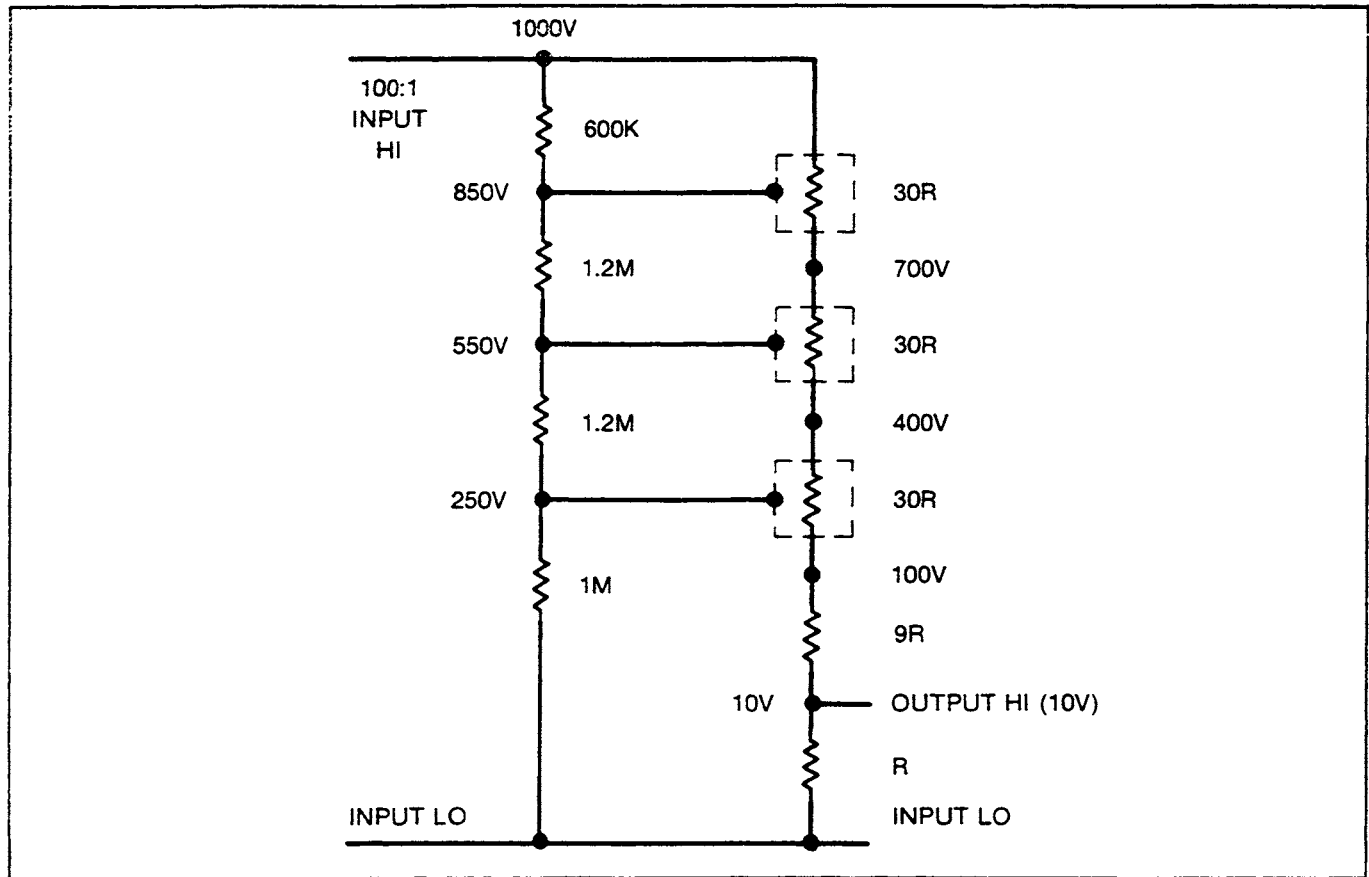


Figure 3-9. 100:1 Divider Driven Guard

case the error causes the output voltage to be lower than it should be by an amount ΔV_o , where $\Delta V_o = \text{Ideal output voltage} - \text{Actual output voltage}$. The designed value for this switch resistance is less than 10 milliohms. Thus for the actual instrument the error associated with the series switch resistance is -0.025 ppm.

3-30. The output error associated with RS1 and RS2 switch contacts switching between the series configuration and the parallel configuration is somewhat more difficult to calculate (refer to Figure 3-10). The design of the instrument is such that most of the effects of this error are reduced by adjusting the interconnection resistances. Thus the worst case error due to these switch contacts is 0.042 ppm for the 10:1 and 0.044 ppm for the 100:1.

3-31. The error associated with resistor mismatches is negligible due to the close matching performed in the factory

3-32. The error due to the Null Detector readings depends upon the type and accuracy of the Null Detector used. The Null Detector used in design testing had an uncertainty of 0.2 μV . This error translates into an adjustment error of 0.04 ppm for both 10:1 and 100:1 ranges.

3-33. Errors in the divider ratio due to the temperature coefficient of the resistors has been limited to less than 0.05 ppm on the 10:1 ratio and to less than 0.3 ppm on the 100:1 ratio through the use of the Fluke Dynamic Resistor Matching technique.

3-34. Leakage resistance is the last source of error and perhaps the most important. The components most susceptible to these errors are the switches. For this reason, the switches have been cleaned and handled with care to reduce any surface contamination during production. Non Activated solder flux has been used to reduce the possibility of introducing ionic surface contaminants to the switch. A properly handled switch with proper solder connections will ensure that the ratio error due to leakage is less than 0.057 ppm on the 10:1 range and less than 0.38 ppm on the 100:1 range.

3-35. Using statistical summing techniques, the net errors are:

10:1 - Error less than 0.2 ppm
100:1 - Error less than 0.5 ppm

3-36. According to the values for each of the error sources, the net errors are within the specifications for the instrument.

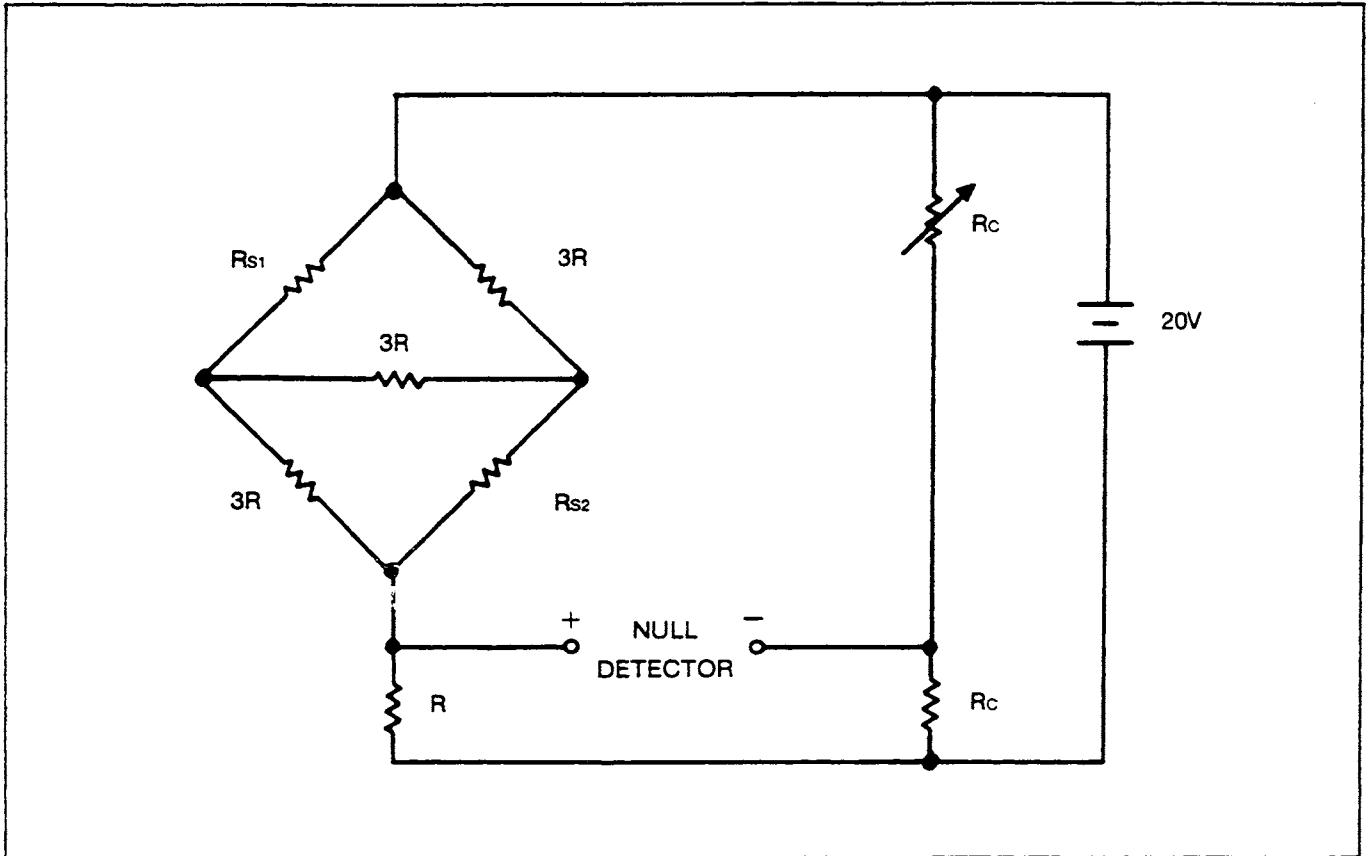


Figure 3-10. Simplified Schematic of 10:1 Calibration Circuit

Section 4 Maintenance

WARNING

THESE SERVICING INSTRUCTIONS ARE FOR USE BY QUALIFIED PERSONNEL ONLY. TO AVOID ELECTRICAL SHOCK, DO NOT PERFORM ANY SERVICING OTHER THAN THAT CONTAINED IN THE OPERATING INSTRUCTIONS UNLESS YOU ARE QUALIFIED TO DO SO.

4-1. INTRODUCTION

4-2. The following paragraphs describe the calibration cycle requirements, maintenance procedures, performance checks, internal calibration, and troubleshooting for the 752A.

4-3. The 752A is self-calibrating, so it does not need to be included in a calibration cycle traceable to an external standard. An in-house calibration cycle is optional as the Self-Calibration Procedure will detect out-of-specification performance. The Internal Calibration Procedure provides a means of compensating for the long-term drift of the internal divider and calibration bridge resistors that cannot be compensated for in the Self-Calibration Procedure.

4-4. Self-Calibration and the resistance measurements described in the following section are recommended as an acceptance test when the instrument is first received. The

equipment required for performance verification and calibration is shown in Table 4-1. Equivalent test equipment may be substituted providing it meets the minimum specification given in Table 4-1.

4-5. SERVICE INFORMATION

4-6. The 752A is warranted for a period of one (1) year upon delivery to the original purchaser. The WARRANTY is given on the back of the title page located in the front of this manual.

4-7. Factory authorized calibration and service for each Fluke product is available at various worldwide locations. A list of these service centers is located in Section 7 of this manual. Shipping information is given in Section 2 of this manual. If requested, an estimate will be provided to the customer before any repair work is begun on instruments that are beyond the warranty period.

Table 4-1. Test Equipment Required

TYPE	REQUIRED SPECIFICATIONS	RECOMMENDED MODEL
Null Detector	1 μ V full-scale sensitivity 10 M Ω input resistance	Fluke 845AB/AR
Multimeter	4.5 digit display 200 Ω to 2 M Ω resistance ranges, \pm 0.25% accuracy	Fluke 8050A, 8060A
Voltage Source	20V, 10 mA	Fluke 5440A
Cloth Gloves	Clean nylon or cotton	Fluke P/N 684720

4-8. The resistor modules (and the resistors therein) and the Bridge and Calibration PCB assembly are matched to each other during manufacture. The individual resistors are not replaceable separately. The resistor modules and Bridge and Calibration PCB assembly must be replaced as a set.

4-9. GENERAL MAINTENANCE

4-10. Introduction

4-11. The following paragraphs describe the general maintenance procedures for the 752A. These procedures should be completed only by qualified personnel.

4-12. Cleaning

CAUTION

TO PREVENT POSSIBLE DAMAGE TO THE FRONT PANEL, DO NOT USE AROMATIC HYDROCARBON OR CHLORINATED SOLVENTS ON THE FRONT PANEL OF THE 752A.

4-13. When the 752A is properly cared for and kept in a controlled atmosphere, cleaning is seldom required. Any contamination, particularly oil, in the instrument can contribute to an increase in leakage which may impair accuracy. Cleanliness of the switches is critical because low leakage resistance between switch contacts would shunt a part of the resistor string. This is also true of other internal wiring and, to a lesser extent, on the printed circuit assembly.

4-14. Clean the exterior and front panel with a soft cloth dampened in a mild solution of detergent and water.

CAUTION

TO INSURE CONTINUED PERFORMANCE WITHIN THE SPECIFICATIONS LISTED IN SECTION 1, USE EXTREME CAUTION WHEN CLEANING THE 752A. IN PARTICULAR, DO NOT USE COMPRESSED AIR TO REMOVE DUST FROM THE INSIDE OF THE INSTRUMENT. AVOID OIL CONTAMINATION OF THE INTERIOR OF THE INSTRUMENT. WEAR CLEAN CLOTH GLOVES (FLUKE P/N 684720 OR EQUIVALENT) WHEN WORKING INSIDE THE INSTRUMENT. DO NOT USE SPRAY CLEANERS ON THE SWITCHES OR POTENTIOMETERS INSIDE THE INSTRUMENT.

4-15. The switches used in the 752A are sealed units. They cannot be cleaned by 'normal' methods. Replace the switch(es) if it is determined that cleaning is necessary.

4-16. Internal Repair

4-17. When making wiring repairs or replacing a component, use 63/37 alloy, non-activated rosin core

solder (Fluke P/N 961480 or equivalent) for all connections. Do not use a spray-type cleaner. If replacing a switch or other component, do not remove flux residue from the connection.

4-18. Access Procedure

4-19. Use the following procedures to disassemble the 752A for adjustment or repair.

CAUTION

TO INSURE CONTINUED INSTRUMENT PERFORMANCE TO THE SPECIFICATIONS LISTED IN SECTION 1 OF THIS MANUAL, DO NOT ALLOW THE INTERIOR OF THE INSTRUMENT TO ACCUMULATE DUST, OIL OR OTHER CONTAMINANTS WHILE OPEN FOR SERVICE. WEAR CLEAN CLOTH GLOVES WHILE SERVICING.

4-20. COVER REMOVAL

4-21. Use the following procedure to remove the top and bottom covers from the 752A. Refer to Figure 4-1.

1. Remove all screws securing the top and/or bottom cover(s).
2. Lift the cover(s) off the instrument.

4-22. Printed Circuit Board Jumper Access

4-23. Use the following procedure to access the printed circuit board jumpers. Refer to Figure 4-2.

1. Remove the top cover.
2. Remove the screws from the guard cover and remove it.
3. Remove the screws securing the service cover and remove it.
4. The jumpers on the printed circuit board are now accessible for servicing.

4-24. PRINTED CIRCUIT ASSEMBLY REMOVAL

4-25. Use the following procedure to remove the printed circuit board from the 752A. Refer to Figure 4-3.

1. Remove both covers and the guard cover.
2. Remove the screws securing the rear bulkhead located near the rear of the 752A and slide to the rear of the instrument.
3. Slide the entire circuit board assembly towards the rear of the instrument, until the retaining tabs are clear of the plastic card holders.

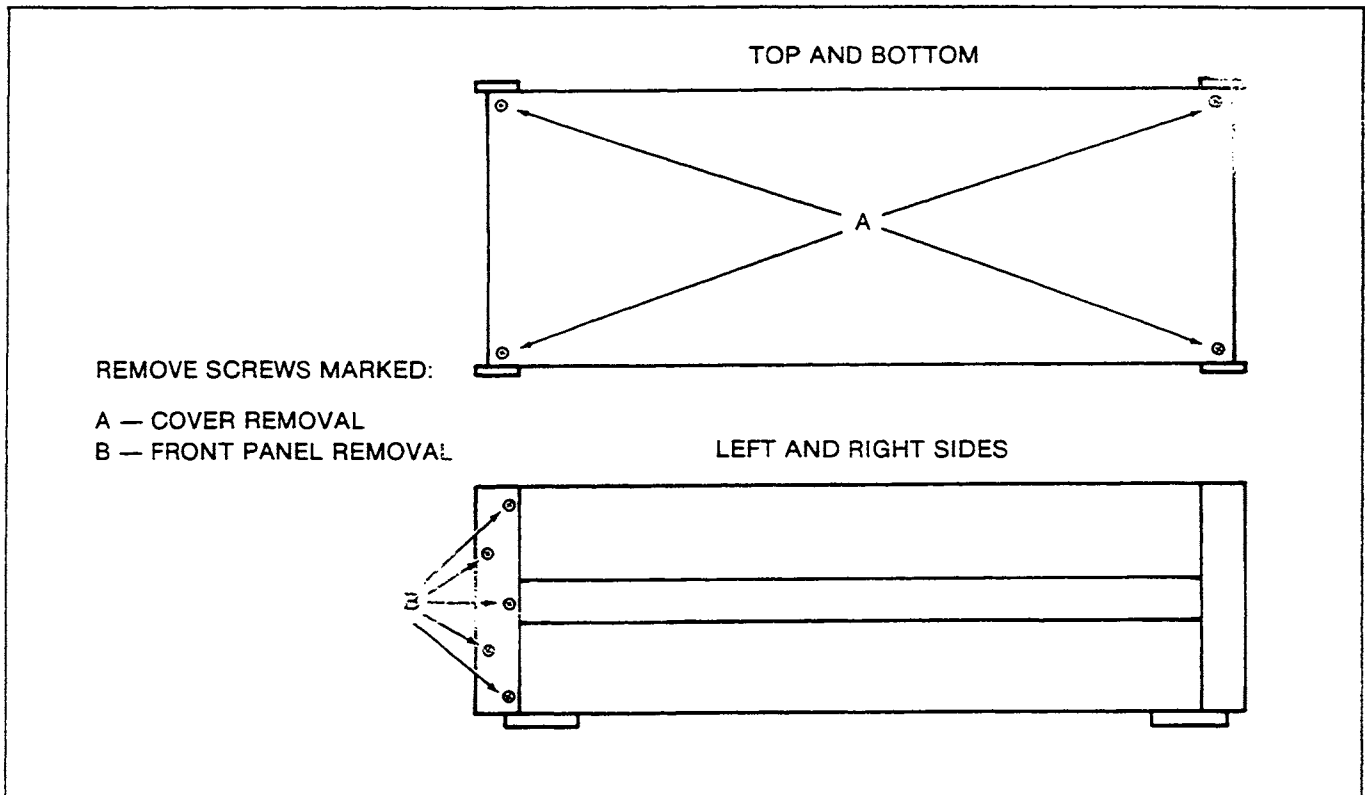


Figure 4-1. Cover Screw Locations

4. Remove the assembly by pushing the side corresponding to the wire harness exit down, to clear the card holders and lifting the opposite side up, to clear the card holders. Lift the assembly clear of the chassis.

CAUTION

DO NOT STRESS OR EXCESSIVELY BEND THE WIRE HARNESS CONNECTED TO THE PRINTED CIRCUIT BOARD ASSEMBLY. THE WIRES USE SOLID CONDUCTORS AND BREAK EASILY.

5. Remove screws securing the service cover housing and lift the housing clear.

6. Remove the screws securing the printed circuit board.

7. The printed circuit board is now accessible.

4-26. RESISTOR MODULE REMOVAL

4-27. Use the following procedure to remove the resistor modules from 752A Refer to Figure 4-4.

1. Remove both covers and the guard cover.

2. Remove the entire printed circuit board assembly. Fold the assembly towards the front of the 752A.

3. Slide the rear resistor module towards the rear of the instrument, until the cover tabs clear the plastic card holders, then lift up and out.

4. To access the front resistor modules, remove both rear modules and the center bulkhead. Remove the front modules as described in step 3 of this procedure.

4-28. FRONT PANEL REMOVAL

4-29. Use the following procedure to detach the front panel from the 752A:

1. Remove the top and bottom covers.

2. Peel the decal from each of the front moldings, and remove the exposed screws. Remove the molding.

3. Remove the knobs from the three calibrate pots. When removing the knobs, be careful not to lose the springs and washers located under the knobs.

4. Remove the knobs from the MODE and CALIBRATE switches.

5. Pull the front panel free from the chassis.

6. Remove the screws securing the front panel sub-chassis. The sub-chassis will now fold down flat against the table top.

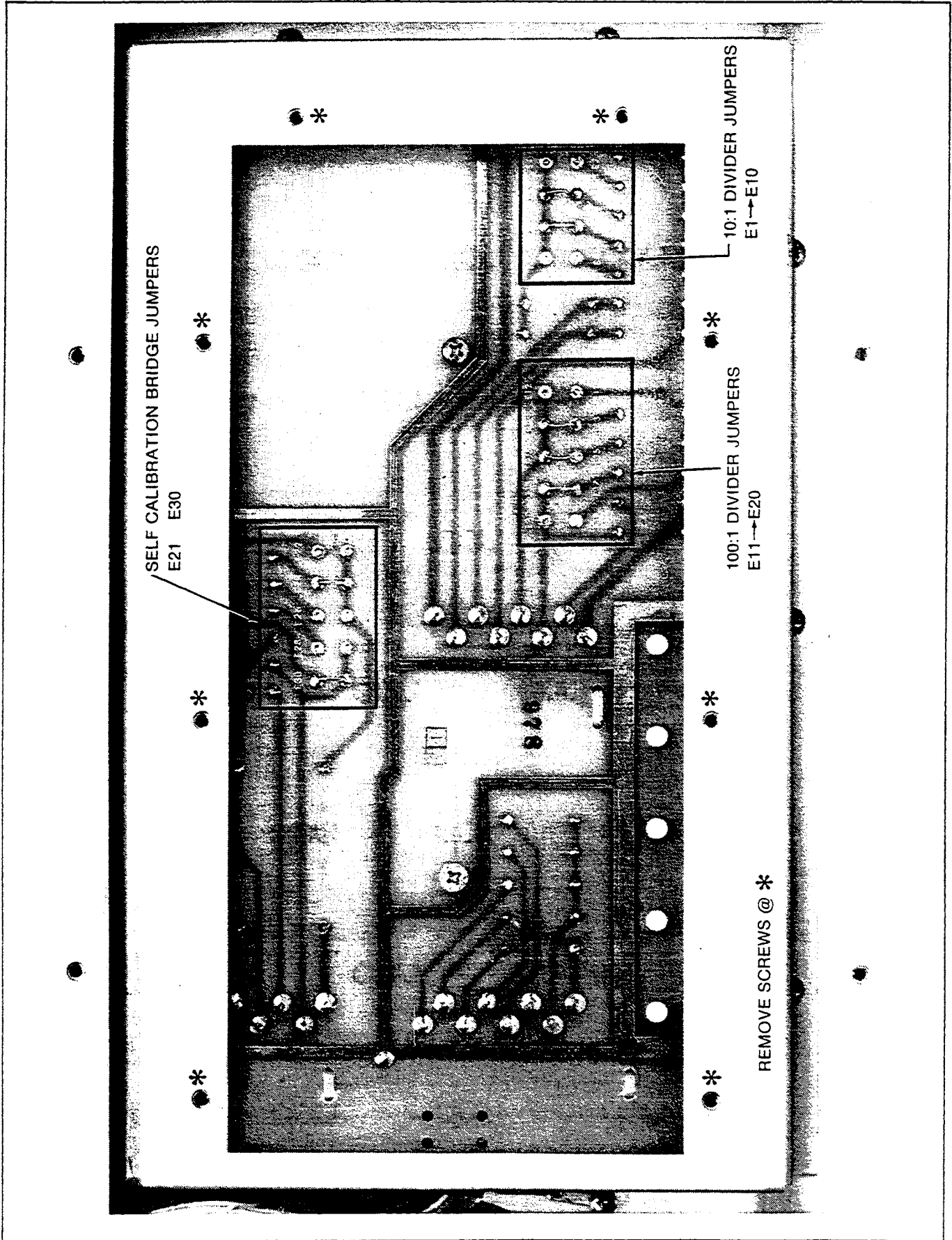


Figure 4-2. Printed Circuit Board Jumper Access

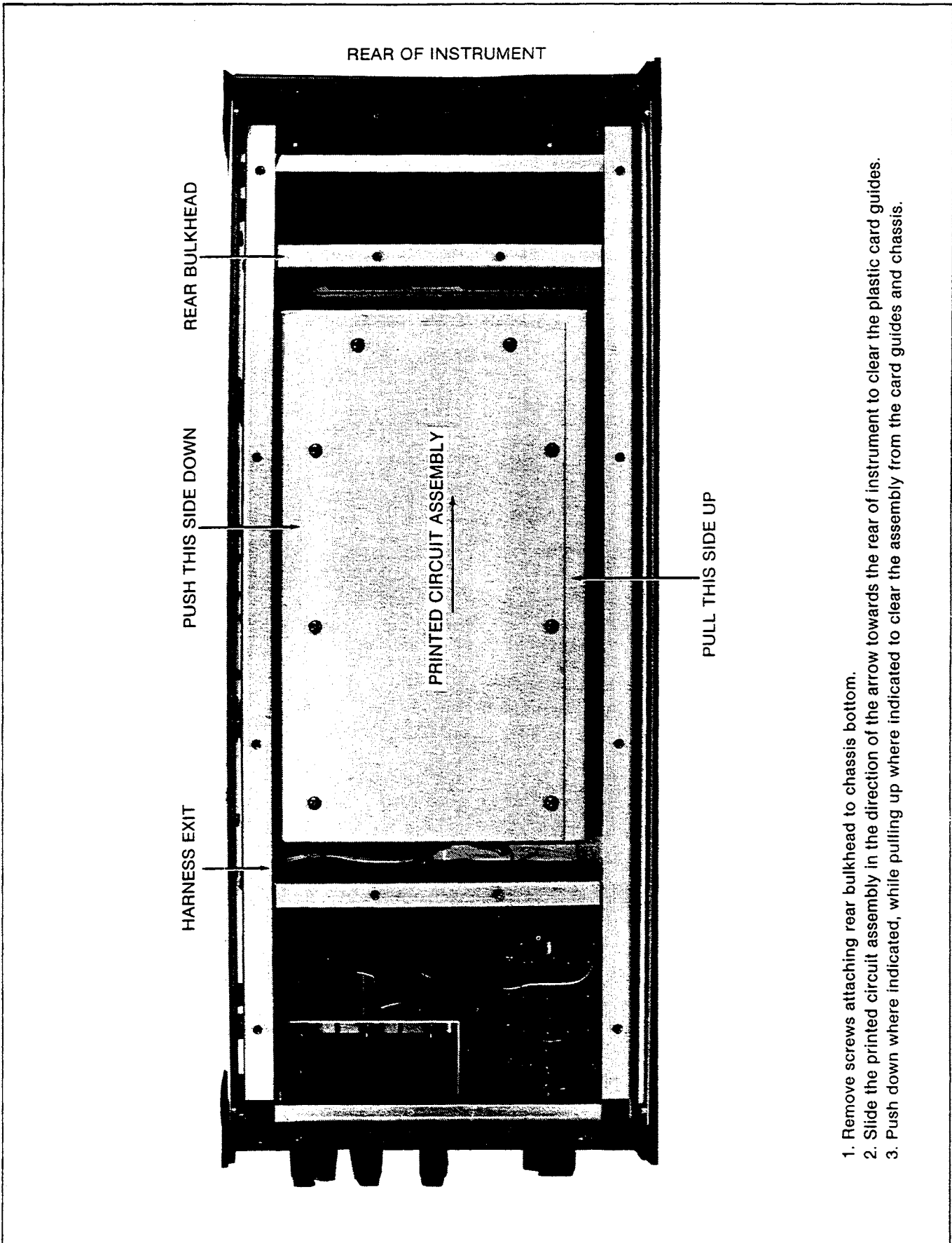


Figure 4-3. PCB Access

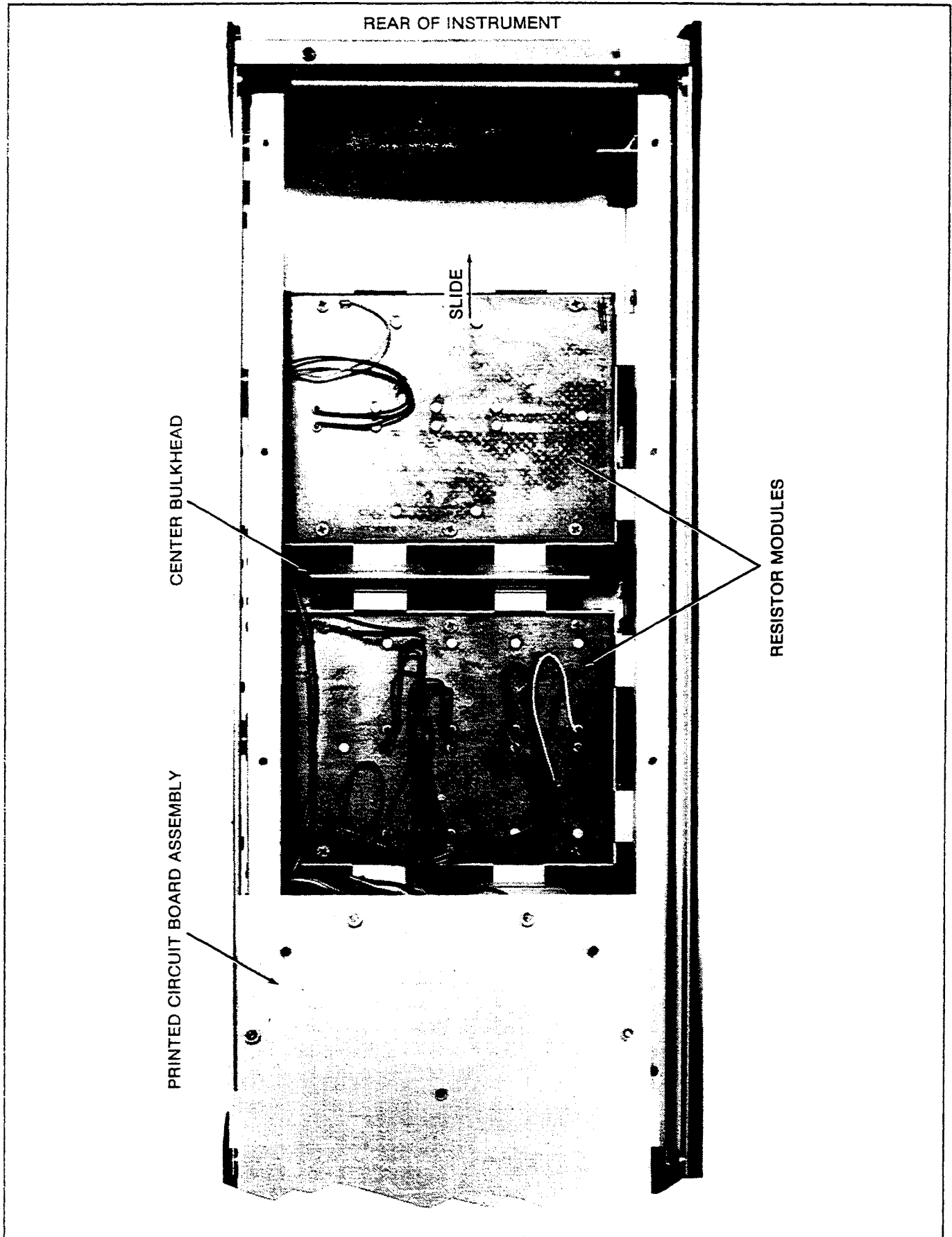


Figure 4-4. Resistor Module Access

4-30. PERFORMANCE CHECKS

4-31. Front panel resistance measurements and self-calibration are recommended as a means of verifying the specifications listed Section 1. The various front panel resistances are listed in this section under Troubleshooting. The Self-Calibration procedure described in Section 2 checks all internal resistor networks against each other.

4-32. INTERNAL CALIBRATION (Long-Term Drift Correction)

4-33. The Self-Calibration Procedure compensates for normal day to day drift of the voltage divider and bridge resistor networks. Over extended periods of time, it is possible for the values of the resistor networks to drift beyond the capabilities of the Self-Calibration potentiometers. Perform the appropriate calibration procedure when either of the following occur:

1. It is not possible to achieve equal readings on the Null Detector between the + and - positions of the CALIBRATE switch. Use the Self-Calibration Bridge Long-Term Drift Correction Procedure to correct this condition.
2. It is not possible to obtain an acceptable Null Detector reading using the 10:1 or 100:1 pots after obtaining equal Null Detector readings on the + and - CALIBRATE switch positions. Perform the drift correction procedure on the appropriate divider.

4-34. Self-Calibration Bridge Long-Term Correction Procedure

4-35. Use this procedure when it is impossible to achieve equal readings on the Null Detector between the + and - positions of the CALIBRATE switch.

1. Perform the 10:1 Self-Calibration procedure (steps 1 through 13) in Section 2. Minimize the V_d term in the following expression such that the Calibrate pot is at one end of its rotation:

$$V_d = -(D_p - D_m)/2$$

where: V_d = Corrected Null Detector deflection

D_p = Null Detector deflection in μV in the 10:1+ switch position

D_m = Null Detector deflection in μV in 10:1- switch position

2. Note the value of V_d .
3. Place the CALIBRATE switch to the 10:1+ position.

4. Algebraically add the value of V_d obtained during the Self-Calibration procedure to one-half of the value of the pot window (292 μV). The pot window is defined as the total adjustment range of the potentiometer, as seen at the Null Detector terminals.

$$V = (V_p/2) + |V_d|$$

where: V = correction voltage

V_p = pot window Voltage (292 μV)

$|V_d|$ = absolute value of corrected Null Detector deflection

5. Apply the following formula to find the amount of correction needed.

$$\Delta R_p = k(0.024)(V)$$

where: V = correction voltage in μV

$k = -1$ if $V_d < 0$

$k = 1$ if $V_d > 0$

ΔR_p = change in resistance in ohms

6. Disassemble the 752A and inspect the Bridge and Compensation PCB assembly. Determine the status of jumpers E21 through E30 inclusive. The jumper locations are shown in Figure 4-3. Use Table 4-2 to find the present compensation value (R_c).

7. Add R_c to ΔR_p to find the new compensation value (R_c').

8. Use Table 4-2 to find the new jumper configuration. Select the closest value in Table 4-2. Reinstall the jumpers per Table 4-2 and R_c' .

9. Reassemble the instrument.

4-36. Self-Calibration Bridge Long-Term Drift Correction Example

4-37. While performing the Self-Calibration procedure, the BALANCE control cannot be adjusted for equal Null Detector readings between the + and - settings of the CALIBRATE switch. The closest possible readings are +15 μV at the + setting and -5 μV at the - setting, with the BALANCE control set a one extreme.

4-38. The adjustment window for the 10:1 CALIBRATE pot has drifted outside of the range of the control. The adjustment window must be shifted 10 μV in

the opposite direction plus one-half of the value of the pot window. Thus:

$$V_d = -[(D_p - D_m)/2]$$

$$= -[15 - (-5)]/2$$

$$= -10 \mu V$$

and

$$V = V_p/2 + |V_d|$$

$$= 292/2 + 10$$

$$= 156 \mu V$$

Solving for ΔR_p

$$\Delta R_p = k(0.024)(V) \quad V_d < 0, \Rightarrow k = (-1)$$

$$= -(0.024)(156)$$

$$= -3.744$$

After inspecting jumpers E21 through E30, the present jumper configuration using Table 4-2 is:

$$00101 = 10 \text{ ohms}$$

Adding ΔR_p to this value:

$$10 - 3.744 = 6.256 \text{ ohms}$$

Looking at Table 4-2, the nearest possible values are:

$$01101 = 5 \text{ ohms}$$

$$00101 = 10 \text{ ohms}$$

Interpolation gives 01101 = 5 ohms as the best choice. The new jumper configuration is:

Jumper	Condition
E21-E22	Open
E23-E24	Short
E25-E26	Short
E27-E28	Open
E29-E30	Short

The necessary correction is to add jumpers at E23-E24. This new configuration gives a shift of:

$$\Delta R_p = 10 - 5$$

$$= +5 \text{ ohms}$$

and

$$D = (41.7)(+5)$$

$$= +208.5 \mu V$$

This shift is sufficient to move the pot window as close to its centered position as possible.

4-39. 10:1 Divider Long-Term Drift Correction Procedure

4-40. Use the following procedure when the best possible null on the Null Detector exceeds the stated limits at completion of the 10:1 Self-Calibration procedure and there is no difference between the 10:1+ and 10:1- CALIBRATE switch readings on the Null Detector.

Table 4-2. Self-Calibration Bridge Drift Correction Network

JUMPERS					NET RESISTANCE
E21 to E22	E23 to E24	E25 to E26	E27 to E28	E29 to E30	Rc (ohms)
1	0	0	0	1	0
0	1	1	0	1	5
0	1	0	0	1	10
0	0	1	0	1	10
1	0	0	1	0	15
0	1	1	1	0	20
0	1	0	1	0	25
0	0	1	1	0	25

1 = jumper installed
0 = no jumper

1. Perform the Self-Calibration procedure and set the 10:1 calibrate pot for the best possible null. Note this value in μV .

2. Algebraically add the Null Detector reading obtained during the Self-Calibration procedure to one-half of the value of the Pot Window ($83 \mu\text{V}$). Let this sum equal V.

$$V = (V_p/2) + V_n$$

where: $V =$ correction voltage in μV

$V_p =$ Pot Window Voltage
($83 \mu\text{V}$)

$V_n =$ Null Detector reading
in μV .

3. Apply the following formula to find the amount of correction needed.

$$\Delta R_p = (0.072)(V)$$

where:

$V =$ correction voltage in μV

$\Delta R_p =$ change in
resistance in ohms

4. Remove the top cover, guard cover, and service cover. Inspect the Bridge and Compensation PCB assembly to determine the status of jumpers E1 through E10 inclusive. The jumper locations are shown in Figure 4-3. Use Table 4-3 to find the present compensation value (R_c).

5. Add R_c to ΔR_p to find the new compensation value (R_c').

6. Use Table 4-3 to find the new jumper configuration. Select the closest value in Table 4-3. Reinstall the jumpers per Table 4-3 and R_c' .

7. Perform the Self-Calibration Procedure described in Section 2 of this manual.

8. Reassemble the instrument.

4-41. 10:1 Divider Drift Correction Example

4-42. In this example, assume that after performing the Self-Calibration Procedure, the 10:1 divider can not be satisfactorily nulled. The closest possible null is $20 \mu\text{V}$ with the 10:1 CALIBRATE pot turned to its extreme.

4-43. The adjustment window for the 10:1 CALIBRATE pot has drifted outside of the range of the control. The adjustment window must be shifted $20 \mu\text{V}$ in

the opposite direction plus one-half of the value of the pot window. Thus:

$$V = (83/2) + 20$$

$$= 61.5 \mu\text{V}$$

and

$$\Delta R_p = (0.072)(61.5)$$

$$= 4.43 \text{ ohms}$$

After inspecting jumpers E1 through E10, the present jumper configuration using Table 4-3 is:

01010 or 38.710 ohms.

Adding ΔR_p to this value:

$$38.710 + (4.43) = 43.14 \text{ ohms}$$

Looking at Table 4-3, the nearest possible values are:

00100 = 43.796 ohms

00101 = 42.857 ohms

Interpolation gives 00101 (42.857 ohms) as the best choice.

The new jumper configuration is:

<u>Jumper</u>	<u>Condition</u>
E9-E10	open
E7-E8	open
E5-E6	short
E3-E4	open
E1-E2	short

The necessary correction is to remove the jumpers from E3 to E4 and E7 to E8. Then add jumpers from E1 to E2 and E5 to E6.

$$\Delta R_p = 42.857 - 38.710$$

$$= 4.147 \text{ ohms}$$

and

$$D = (-13.89)(4.150) \quad \text{where: } D = \text{shift in window in } \mu\text{V}.$$

$$= -57.16 \mu\text{V}.$$

Table 4-3. 10:1 Divider Drift Correction Network

JUMPERS					NET RESISTANCE
E9 to E10	E7 to E8	E5 to E6	E3 to E4	E1 to E2	Rc
0	0	0	0	0	48.000
0	0	0	0	1	46.875
0	0	0	1	0	45.802
0	0	0	1	1	44.776
0	0	1	0	0	43.796
0	0	1	0	1	42.857
0	0	1	1	0	41.958
0	0	1	1	1	41.096
0	1	0	0	0	40.268
0	1	0	0	1	39.474
0	1	0	1	0	38.710
0	1	0	1	1	37.975
0	1	1	0	0	37.267
0	1	1	0	1	36.585
0	1	1	1	0	35.928
0	1	1	1	1	35.294
1	0	0	0	0	34.682
1	0	0	0	1	34.091
1	0	0	1	0	33.520
1	0	0	1	1	32.967
1	0	1	0	0	32.432
1	0	1	0	1	31.915
1	0	1	1	0	31.414
1	0	1	1	1	30.928
1	1	0	0	0	30.457
1	1	0	0	1	30.000
1	1	0	1	0	29.557
1	1	0	1	1	29.126
1	1	1	0	0	28.708
1	1	1	0	1	28.302
1	1	1	1	0	27.907
1	1	1	1	1	27.523

1 = jumper installed
0 = no jumper

4-44. 100:1 Divider Long-Term Drift Correction Procedure

4-45. Use this procedure when the residual reading on the Null Detector exceeds the stated limits at completion of the 100:1 Self-Calibration Procedure. It is assumed that the 10:1 Self-Calibration procedure has been performed satisfactorily. The methods used in the preceding example may also be used here, the only

exceptions being the substitution of Table 4-4 for Table 4-3 and substitution of the correct value of the pot window.

1. Perform the 100:1 Self-Calibration Procedure and set the 100:1 calibrate pot for the best possible null. Note this value in μV .
2. Algebraically add the Null Detector reading obtained during the Self-Calibration Procedure to

one-half of the value of the pot window. Let this sum equal V.

$$V = (V_p/2) + V_n$$

where:

V = Correction Voltage

V_p = Pot Window Voltage
143 μV

V_n = Null Detector Reading

3. Apply the following formula to find the amount of correction needed.

$$\Delta R_p = (0.72)(V)$$

4. Remove the top cover, guard cover and service cover from the 752A as described in the Access Procedure section of this manual. Inspect the Bridge and Compensation PCB assembly to determine the status of jumpers E11 through E20, inclusive. The jumper locations are shown in Figure 4-3. Use Table 4-4 to find the present compensation value (R_c).

5. Add R_c to ΔR_p to find the new compensation value (R_c'). Select the closest value from Table 4-4.

6. Use Table 4-4 to find the new jumper configuration. Reinstall the jumpers per Table 4-4 and R_c'.

7. Perform the Self-Calibration Procedure described in Section 2 of this manual.

8. Reassemble the instrument.

4-46. TROUBLESHOOTING

4-47. The physical construction of the 752A lends itself to ease of troubleshooting. Use the resistance ranges of the Multimeter to isolate gross defects to within a module. Use the resistance ranges of the Multimeter on the various combinations of front panel terminals to isolate switching problems. Some of the correct resistance values are listed in Table 4-5. Inspect the internal wiring and solder connections. Proper soldering with non-activated flux solder (Fluke P/N 961480 or equivalent) and low wiring resistance are critical in this instrument.

Table 4-4. 100:1 Divider Drift Correction Network

JUMPERS					NET RESISTANCE
E11 to E12	E13 to E14	E15 to E16	E17 to E18	E19 to E20	R _c (ohms)
1	0	0	0	1	0
0	1	1	0	1	30
0	1	0	0	1	60
0	0	1	0	1	60
1	0	0	1	0	90
0	1	1	1	0	120
0	1	0	1	0	150
0	0	1	1	0	150

1 = jumper installed
0 = no jumper

Table 4-5. Front Panel Resistance Measurements

FROM	TO	CAL SWITCH	MODE SWITCH	RESISTANCE VALUE (Ω)
INPUT HI	INPUT LO	OPR	10:1	380K
INPUT HI	INPUT LO	OPR	100:1	2M
REFERENCE STANDARD HI	REFERENCE STANDARD LO	OPR	1V	380K
REFERENCE STANDARD HI	REFERENCE STANDARD LO	OPR	0.01V	2M
REFERENCE STANDARD HI	NULL DETECTOR LO	OPR	10V	0
INPUT HI	NULL DETECTOR HI	OPR	10V	0
INPUT HI	INPUT LO	10:1+	CAL	61K
INPUT HI	INPUT LO	10:1-	CAL	61K
INPUT HI	INPUT LO	100:1+	CAL	177.5K
INPUT HI	INPUT LO	100:1-	CAL	177.5K
INPUT HI	NULL DETECTOR LO	10:1+	752CAL	76K
INPUT HI	NULL DETECTOR LO	10:1-	752CAL	76K
INPUT HI	NULL DETECTOR LO	100:1+	752CAL	107K
INPUT HI	NULL DETECTOR LO	100:1-	752CAL	107K

Section 5 List of Replaceable Parts

TABLE OF CONTENTS

ASSEMBLY NAME	DRAWING NO.	TABLE		FIGURE	
		NO.	PAGE	NO.	PAGE
752A Final Assembly	752A	5-1	5-3	5-1	5-5

INTRODUCTION

This section contains the parts list of the 752A Reference Divider. Components are listed alphanumerically.

Parts lists include the following information:

1. Reference Designation.
2. Description of each Part.
3. FLUKE Stock Number.
4. Federal Supply Code for Manufacturers.
5. Manufacturer's Part Number.
6. Total Quantity of Components Per Assembly.

Although Fluke recommends module exchange in place of component-level repair, this manual also includes schematics and a discussion of the theory of operation. Service by non-factory personnel voids the warranty. Use of parts not approved by Fluke may compromise board specifications and operation.

HOW TO OBTAIN PARTS

Components may be ordered directly from the John Fluke Mfg. Co., Inc. or its authorized representative by using the Fluke Stock Number or from the manufacturer by using the manufacturer's part number.

In the event the part you order has been replaced by a new or improved part, the replacement will be accompanied by an explanatory note and installation instructions, if necessary.

To ensure prompt handling of your order, include the following information:

1. Quantity.
2. Fluke Stock Number.
3. Description.
4. Reference Designation.
5. Printed Circuit Board Part Number and Revision Letter.

Parts price information is available from the John Fluke Mfg. Co., Inc. or from its representatives.

Table 5-1. 752A Final Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO.	TOT QTY	REC QTY	NOTE
FINAL ASSEMBLY 752A FIGURE 5-1 (752A-T&B)							
A1	RESISTOR MODULES, MATCHED ASSEMBLY	Module Exchange Recommended			1		
E1-E4	BINDING POST ASSEMBLY, RED	637892	89536	637892	4		
E5-E8	BINDING POST ASSEMBLY, BLACK	637900	89536	637900	4		
E9	BINDING POST ASSEMBLY, BLUE	637876	89536	637876	1		
E10	BINDING POST ASSEMBLY, GREEN	637868	89536	637868	1		
E11	BINDING POST, GROUNDING	102707	20584	1444	1		
E12	BINDING POST, KNURLED	102889	20584	1445	1		
E13	LUG, SOLDER	101501	79963	327	1		
H1	SPRING, TENSION	163170	89536	163170	4		
H2	WASHER, FLAT, NYLON	682385	89536	682385	5		
H3	WASHER, FLAT, SS, 0.254 ID	649772	86928	5710-299-10	6		
H4	SCREW, PHP, 6-32 X 1/4	152140	89536	152140	10		
H5	SCREW, FHP, 8-32 X 1/2	114355	89536	114355	2		
H6	WASHER, FLAT, SS, 0.254 ID	649772	86928	5710-299-10	6		
H7	NUT, NYLON, PUSH-IN	222414	83058	PC-97726	16		
H8	NUT, HEX, 1/4-28	110619	89536	110619	1		
H9	WASHER, FLAT	312538	89536	312538	1		
H10	WASHER, SPLIT LOCK, 1/4	111518	89536	111518	1		
H11	SCREW, PHP, 6-32 X 1/4	152140	89536	152140	8		
H12	SCREW, RHP, 8-32 X 5/8	114983	89536	114983	4		
H13	SCREW, FHP, 8-32 X 5/16	281725	89536	281725	8		
H14	SCREW, FHP, 8-32 X 7/16	306159	89536	306159	12		
H15	SCREW, PHP, THD/FORM, 8-32 X 1/2	306233	89536	306233	16		
H16	SCREW, PHP, 6-32 X 1/4	152140	89536	152140	18		
H17	SCREW, PHP, 6-32 X 1/2	152173	89536	152173	4		
H18	SCREW, FHP, UNDERCUT, 6-32 X 1/4	320093	89536	320093	4		
H19	SCREW, FHP, 6-32 X 1/4	320093	89536	320093	4		
H20	SCREW, PHP, 6-32 X 1/4	152140	89536	152140	16		
MP1	FRONT PANEL	645077	89536	645077	1		
MP2	BUSHING, NYLON	339978	89536	339978	2		
MP3	BULKHEAD, FRONT	645143	89536	645143	1		
MP4	CLUTCH, VARIABLE RESISTOR	645655	89536	645655	6		
MP5	SHAFT, VARIABLE RESISTOR	645663	89536	645633	3		
MP6	BRACKET, VARIABLE RESISTOR	645671	89536	645671	1		
MP7	ISOLATOR, SWITCH	645648	89536	645648	1		
MP8	EXTENSION, SHAFT INSULATOR	645044	89536	645044	2		
MP9	BUSHING, PANEL	649756	89536	649756	3		
MP10	RING, RETAINING	168922	89536	168922	3		
MP11	REAR PANEL	645085	89536	645085	1		
MP12	CHASSIS, SIDE	645101	89536	645101	2		
MP13	CHASSIS, GUARD	645135	89536	645135	1		
MP14	BULKHEAD, CENTER	645150	89536	645150	1		
MP15	TRIM, SIDE	642298	89536	642298	2		
MP16	INSERT, SIDE TRIM	642306	89536	642306	1		
MP17	HANDLE	642314	89536	642314	1		
MP18	STRAP, HANDLE	644880	89536	644880	1		

Table 5-1. 752A Final Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO.	TOT QTY	REC QTY	NOTE
MP19	ADHESIVE, SIDE TRIM	680850	89536	680850	2		
MP20	HANDLE RETAINER	579052	89536	579052	2		
MP21	BRACKET, HANDLE SUPPORT	632414	89536	632414	2		
MP22	INSULATOR, CHASSIS	644906	89536	644906	4		
MP23	SPRING, COIL, SS	649764	83553	00300-022-0690S	3		
MP24	CORNER ANGLE BRACKET	298166	89536	298166	2		
MP25	NAMEPLATE, SERIAL	472795	89536	472795	1		
MP26	CORNER, PLASTIC	656231	89536	656231	4		
MP27	FOOT, REAR PANEL	657064	89536	657064	4		
MP28	KNOB, KNURLED, DARK PEWTER	683805	89536	683805	3		
MP29	KNOB, POINTER, DARK PEWTER	683813	89536	683813	2		
MP30	CLAMP, CABLE	172080	89536	172080	5		
MP31	BOTTOM COVER	645127	89536	645127	1		
MP32	BULKHEAD, REAR	645168	89536	645168	1		
MP33	PARTITION, MODULE	645630	89536	645630	1		
MP34	MODULE COVER, LARGE	645531	89536	645531	1		
MP35	FOOT, SINGLE BAIL TYPE (DARK UMBER)	653923	89536	653923	4		
MP36	BAIL INSTRUMENT	605931	89536	605931	2		
MP37	TOP, COVER	645119	89536	645119	1		
MP38	GUARD, COVER	645176	89536	645176	1		
MP39	ACCESS PLATE, MODULE	645549	89536	645549	1		
MP40	DECAL, FRONT CORNER	659235	89536	659235	2		
MP41	DECAL, REAR CORNER	685206	89536	685206	2		
MP42	MODULE SERVICE KIT (not shown)	644872	89536	644872		AR	
MP43	NON-ACTIVATED FLUX SOLDER (not shown)	961480	89536	961480		AR	
R55	RES, VAR, 200 +/-3%, 2W	542928	80294	3500-2-201	3		
R455	RES, VAR, 200 +/-3%, 2W	542928	80294	3500-2-201		REF	
R555	RES, VAR, 200 +/-3%, 2W	542928	80294	3500-2-201		REF	
RT1	THERMISTOR, 1K +/-40%	494740	50157	180Q10215	1		
S1	SWITCH ASSEMBLY, MODE	644963	89536	644963	1		
S2	SWITCH ASSEMBLY, CALIBRATE	644971	89536	644971	1		
TM1	INSTRUCTION MANUAL, 752A	645069	89536	645069	1		
W1	WIRE, SILVER PLATED, #18 AWG (not shown)	203059	89536	203059		A/R	
W2	WIRE, BUS, #22 AWG	115469	89536	115469		AR	
W3	HARNESS ASSEMBLY	650986	89536	650986	1		

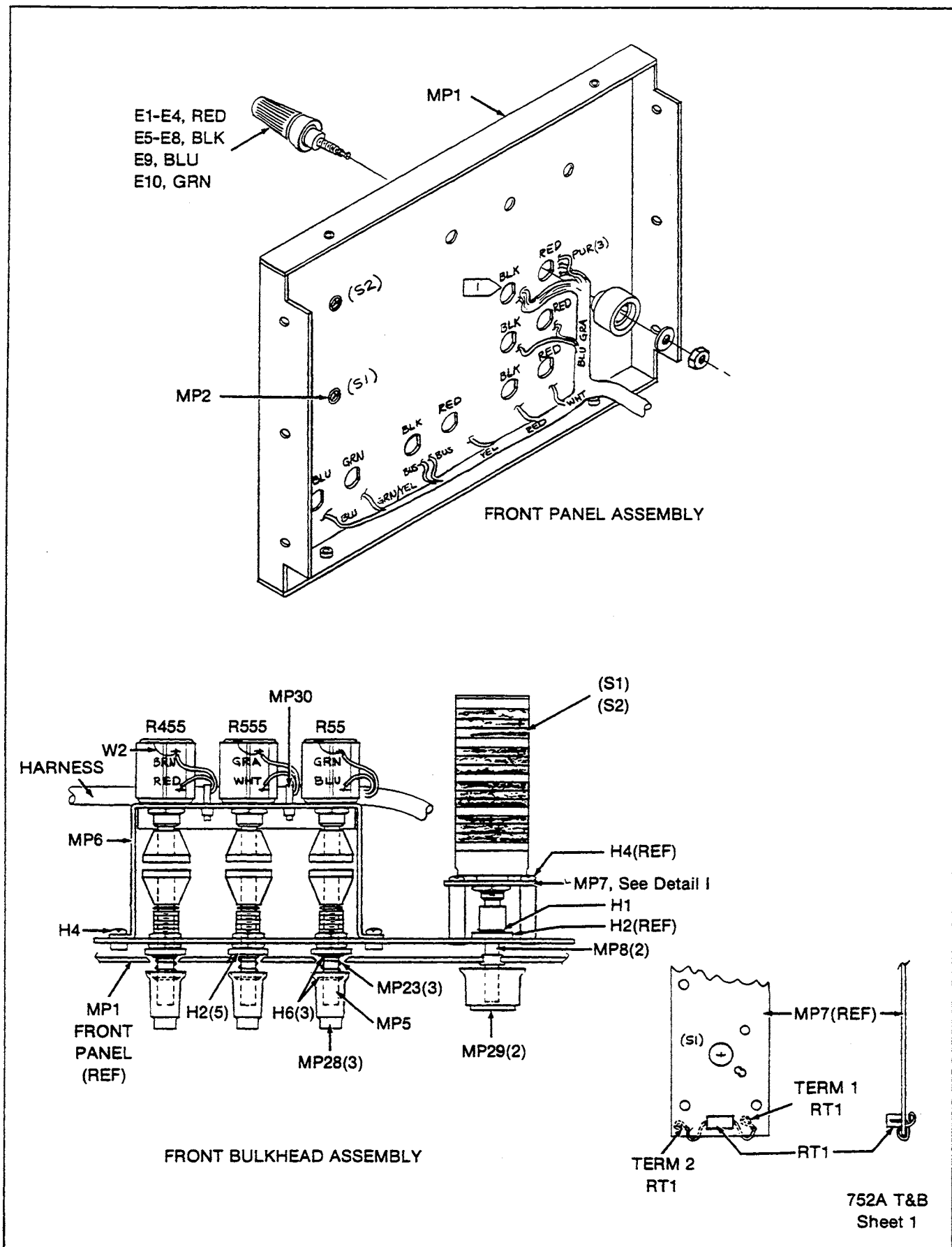
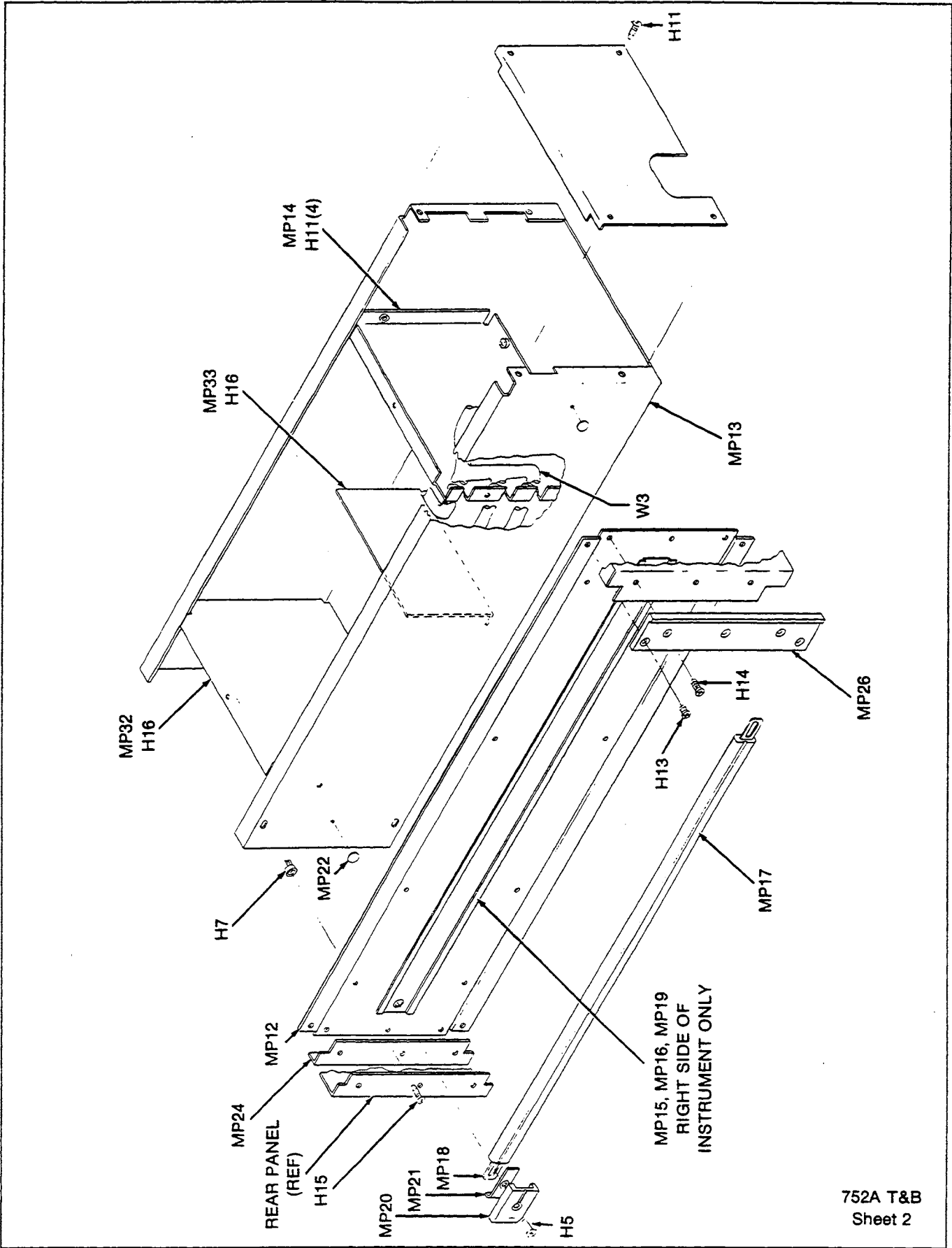


Figure 5-1. 752A Final Assembly



752A T&B
Sheet 2

Figure 5-1. 752A Final Assembly (cont)

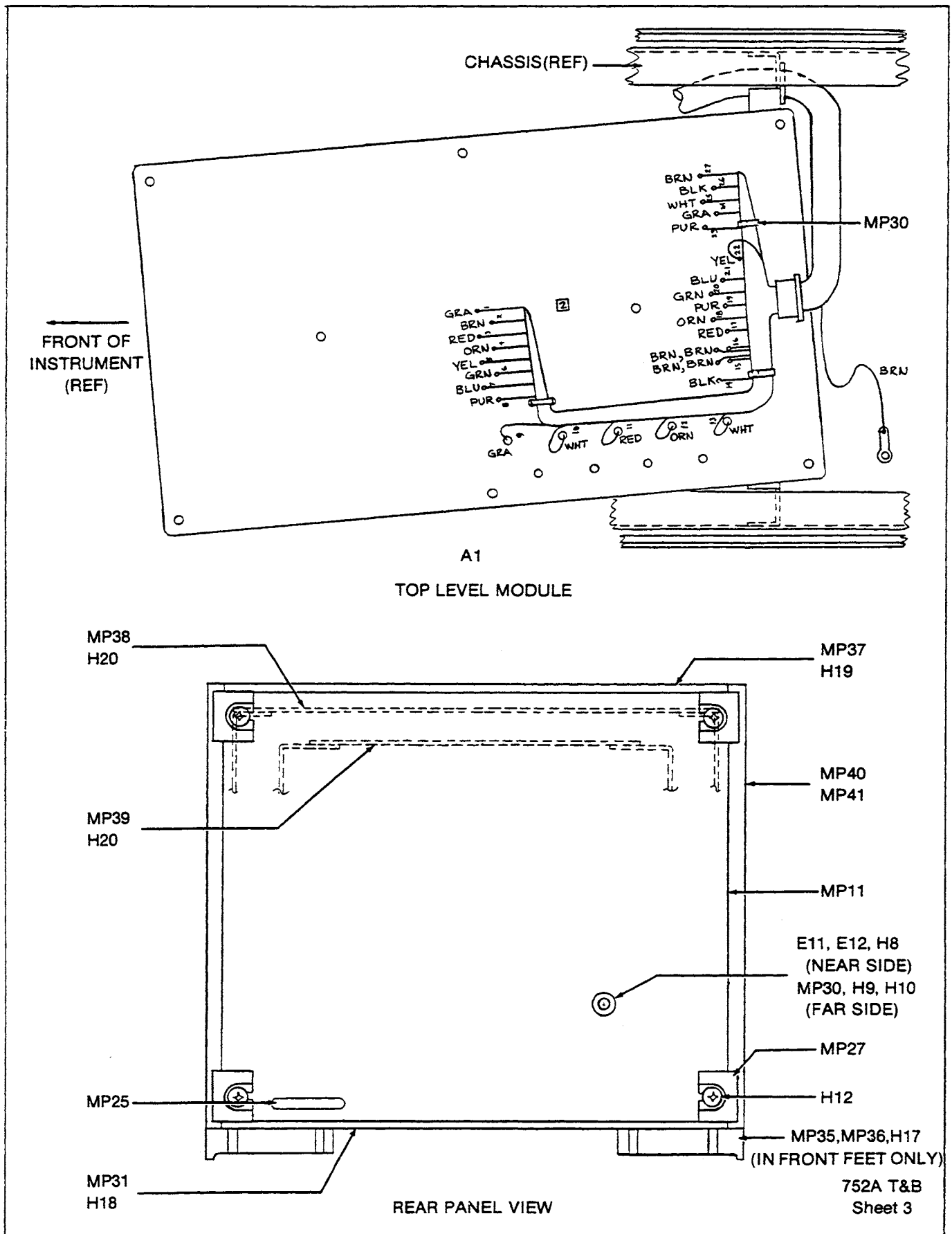


Figure 5-1. 752A Final Assembly (cont)

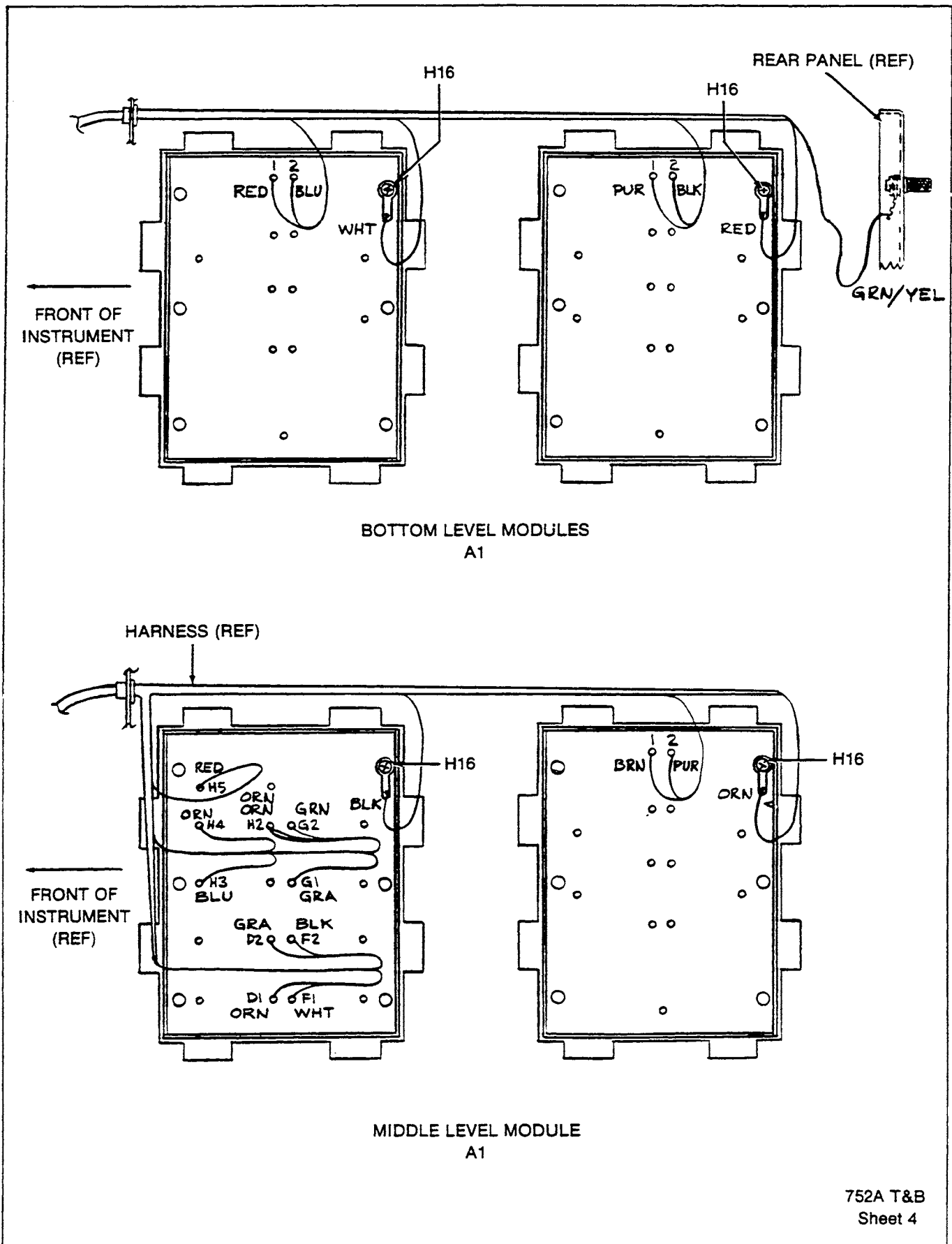


Figure 5-1. 752A Final Assembly (cont)

Section 6

Accessories

6-1. INTRODUCTION

6-2. This section of the manual describes the accessories available for use with the model 752A.

6-3. DUAL MOUNTING FASTENER (M00-800-523)

6-4. The Dual Mounting Fastener is a 8-32 threaded fastener designed for bolting two half-rack width instruments together. The Dual Mounting Fasteners may be used for either dual rack mounting applications (as used in the M07-200-603 Full-Width Rack Mount Kit) or dual table top applications. Four M00-800-523 fasteners are required for each pair of half-rack width instruments.

6-5. HALF-WIDTH RACK MOUNT KIT (M07-203-601)

6-6. The Half-Width Rack Mounting kit permits the 752A to be rack mounted. A blank filler panel is supplied, allowing left or right hand offset mounting. Assembly instructions are supplied with the kit.

6-7. FULL- WIDTH RACK MOUNT KIT (M07-200-603)

6-8. The Full Width Rack Mounting kit permits the 752A to be rack mounted side-by-side with another half rack width instrument. This rack mounting method requires the 752A to be bolted to the adjacent instrument. To facilitate bolting the instruments together, four M00-800-523, Dual Mounting Fasteners are included with the kit. Assembly instructions are supplied with the kit.

6-9. LOW THERMAL EMF CABLE ASSEMBLY (5440A-7002)

6-10. The Low Thermal EMF Cable Assembly minimizes the effects of thermal emf errors in test and calibration setups. The plugs used are made of the same material as the jacks used in the instrument. Connections between the cables and plugs are carefully made to minimize generation of thermal errors.

Section 7

General Information

7-1. This section of the manual contains generalized user information as well as supplemental information to the List of Replaceable Parts contained in Section 5.

Federal Supply Codes for Manufacturers

D9816 Westermann Wilhelm Augusta-Anlage Mannheim-Nackarau Germany	01101 Wabash Inc (Formerly Wabash Magnetics) Wabash, IN	02697 Parker-Hannifin Corp. O-Ring Div Lexington, KY	04423 Telonic Berkley Inc. Laguna Beach, CA
S0482 Sony Corp. Tokyo, Japan	01121 Allen Bradley Co. Milwaukee, WI	02735 RCA-Solid State Div. Somerville, NJ	04713 Motorola Inc. Semiconductor Group Phoenix, AZ
S3774 Oshino Electric Lamp Works Tokoyo, Japan	01281 TRW Electronics & Defense Sector RF Devices Lawndale, CA	02768 ITW (IL Tool Works) Fastex Division Des Plaines, IL	04946 Standard Wire and Cable Rancho Dominguez, CA
0AD86 IN General El Paso, TX	01295 TX Instruments Inc. Semiconductor Group Dallas, TX	02799 Arco Electronics Inc. Chatsworth, CA	05173 General Radio NY, NY. Replaced by:
0AE89 Autosplice Inc. Woodside, NY	01526 Genicom Waynesboro, VA	03296 Nylon Molding Corp. Monrovia, CA	24655 Genrad, INC. Concord, MA
0BW21 Noritake Co. Inc. Burlington, MA	01537 Motorola Communications & Electronics Inc. Franklin Park, IL	03445 Larcon Electronics Inc Burbank, CA	05236 Jonathan Mfg. Co. Fullerton, CA
0ANF0 Topaz Semiconductor Inc San Jose, CA	01686 RCL Electronics/Shallcross Inc. Electro Components Div. Manchester, NH	03508 General Electric Co. Semiconductor Products & Batteries Auburn, NY	05245 Corcom Inc. Libertyville, IL
0DSM7 Conductive (Pkg) Containers Inc. Brookfield, WI	01884 Sprague Electric Co. (Now 56289)	03797 Genisco Technology Corp. Eltronics Div. Rancho Dominguez, CA	05276 ITT Pomona Electronics Div. Pomona, CA
0CLN7 Emhart Fastening Group Shelton, CT	01961 Varian Associates Inc. Pulse Engineering Div. Convoy, CT	03877 Gilbert Engineering Co. Inc Incon Sub of Transatron Electronic Corp. Glendale, AZ	05277 Westinghouse Elec. Corp. Semiconductor Div. Youngwood, PA
0FB81 S-Mos Systems Inc. San Jose, CA	01963 Cherry Electrical Products Corp Waukegan, IL	03888 KDI Electronics Inc. Pyrofilm Div. Whippany, NJ	05347 Ultronix Inc Grand Junction, CO
0FFP1 Eveready LTD Ever Ready Special Battery Div. Dawley Telford Salop UK	02111 Spectrol Electronics Corp. City of Industry, CA	03911 Clairex Corp. Clairex Electronics Div. Mount Vernon, NY	05397 Union Carbide Corp. Materials Systems Div. Cleveland, OH
00199 Marcon Electronics Corp Keamy, NJ	02114 Amperex Electronic Corp. Ferrox Cube Div. Saugerties, NY	03980 Muirhead Inc. Mountainside, NJ	05571 Sprague Electric Co. (Now 56289)
00213 Nytronics Comp. Group Inc. Dartlington, NC	02131 General Instrument Corp. Government Systems Div. Westwood, MA	04009 Cooper Industries, Inc. Arrow Hart Div. Hartford, CT	05574 Viking Connectors Inc Sub of Criton Corp. Chatsworth, CA
00327 Welwyn International Inc. Westlake, OH	02395 Sonar Radio Corp. Hollywood, FL	04217 Essex International Inc. Wire & Cable Div. Anaheim, CA	05791 LYN-TRON Burbank, CA
00656 Aerovox Corp. New Bedford, MA	02533 Leigh Instruments Ltd. Frequency Control Div. Don Mills, Ontario, Canada	04221 Midland-Ross Corp. Midtex Div. N. Mankato, MN	05820 EG & G Wakefield Engineering Wakefield, MA
00686 Film Capacitors Inc. Passaic, NJ	02606 Fenwal Labs Division of Travenal Labs Morton Grove, IL	04222 AVX Corp. AVX Ceramics Div. Myrtle Beach, SC	05839 Advance Electrical Chicago, IL
00779 AMP, Inc. Harrisburg, Pennsylvania	02660 Bunker Ramo-Eltra Corp. Amphenol NA Div. Broadview, IL		05972 Loctite Corp. Newington, CT

Federal Supply Codes for Manufacturers (cont)

06001 General Electric Co. Electric Capacitor Product Section Columbia, SC	07047 Ross Milton Co., The Southampton, PA	08111 MF Electronics New Rochelle, NY	1B715 (United Shoe & Nylock Corp) -Nylock Fastener Corp.- Paramus, NJ
06141 Fairchild Weston Systems Inc. Data Systems Div. Sarasota, FL	07138 Westinghouse Electric Corp. Industrial & Government Tube Div. Horseheads, NY	08235 Industro Transistor Corp. Long Island City, NY	10059 Barker Engineering Corp. Kenilworth, NJ
06192 La Deau Mfg. Co. Glendale, CA	07233 Benchmark Technology Inc. City of Industry, CA	08261 Spectra-Strip An Eltra Co. Garden Grove, CA	10389 IL Tool Works Inc. Licon Div. Chicago, IL
06229 Electrovert Inc. Elmsford, NY	07239 Biddle Instruments Blue Bell, PA	08445 Electri-Cord Mfg., Inc Westfield, PA	11236 CTS Corp. Resistor Products Div. Beme, IN
06383 Panduit Corp. Tinley Park, IL	07256 Silicon Transistor Corp. Sub of BBF Inc. Chelmsford, MA	08530 Reliance Mica Corp. Brooklyn, NY	11237 CTS Corp of CA Electro Mechanical Div. Paso Robles, CA
06473 Bunker Ramo Corp. Amphenol NA Div. SAMS Operation Chatsworth, CA	07261 Avnet Corp. Culver City, CA	08718 ITT Cannon Electric Phoenix Div. Phoenix, AZ	11295 ECM Motor Co. Schaumburg, IL
06540 Mite Corp Amatom-Electrical Div	07263 Fairchild Semiconductor North American Sales Ridgeview, CT	08806 General Electric Co. Miniature Lamp Products Cleveland, OH	11358 Columbia Broadcasting System CBS Electronic Div. Newburyport, MA
06555 Beede Electrical Instrument Penacook, NH	07344 Bircher Co. Inc., The Rochester, NY	08863 Nylomatic Fallsington, PA	11403 Vacuum Can Co. Best Coffee Maker Div. Chicago, IL
06665 Precision Monolithics Sub of Boums Inc. Santa Clara, CA	07374 Optron Corp Woodbridge, CT	08988 Skottie Electronics Inc. Archbald, PA	11502 (can also use 35009) TRW Inc. TRW Resistive Products Div. Boone, NC
06666 General Devices Co. Inc. INpolis, IN	07557 Campion Co. Inc. Philadelphia, PA	09021 Airoo Inc. Airoo Electronics Bradford, PA	11503 Keystone Columbia Inc. Freemont, IN
06739 Electron Corp. Littleton, CO	07597 Bundy Corp. Tape/Cable Div. Rochester, NY	09023 Cornell-Dublier Electronics Fuquay-Varina, NC	11532 Teledyne Relays Teledyne Industries Inc. Hawthorne, CA
06743 Gould Inc. Foil Div. Eastlake, OH	07716 TRW Inc. (Can use 11502) IRC Fixed Resistors/ Burlington Burlington, VT	09214 General Electric Co. Semiconductor Products Dept. Auburn, NY	11711 General Instrument Corp. Rectifier Div. Hicksville, NY
06751 Components Inc. Semcor Div. Phoenix, AZ	07792 Lerma Engineering Corp. Northampton, MA	09353 C and K Components Inc. Newton, MA	11726 Qualidyne Corp. Santa Clara, CA
06776 Robinson Nugent Inc. New Albany, IN	07810 Bock Corp. Madison, WI	09423 Scientific Components Inc. Santa Barbara, CA	12014 Chicago Rivet & Machine Co. Naperville, IL
06915 Richeo Plastic Co. Chicago, IL	07910 Teledyne Semiconductor Min. View, CA	09922 Bundy Corp. Norwalk, CT	12020 Ovenaire Div. of Electronic Technologies Charlottesville, VA
06961 Vernitron Corp. Piezo Electric Div. Bedford, OH	07933 Raytheon Co. Semiconductor Div. Mountain View, CA	09969 Dale Electronics Inc. Yankton, SD	12038 Simco (Div of Ransburg Corp) Hatfield, PA
06980 EIMAC (See Varian) San Carlos, CA	08FG6 Calmos Systems Inc. Kanata, Ont. Canada	09975 Burroughs Corp. Electronics Components Detroit, MI	12040 National Semiconductor Corp. Danbury, CT
	080A9 Dallas Semiconductor Dallas, TX	1A791 LFE Electronics Danvers, MA	

Federal Supply Codes for Manufacturers (cont)

12060 Diodes Inc. Northridge, CA	13050 Potter Co. Wesson, MS	14704 Crydom Controls (Division of Int Rectifier) El Segundo, CA	16473 Cambridge Scientific Industries Div. of Chemed Corp. Cambridge, MD
12136 PHC Industries Inc. Formerly Philadelphia Handle Co. Camden, NJ	13103 Thermalloy Co., Inc. Dallas, TX	14752 Electro Cube Inc. San Gabriel, CA	16733 Cablewave Systems Inc. North Haven, CT
12300 AMF Canada Ltd. Potter-Bramfield Guelph, Ontario, Canada	13327 Solitron Devices Inc. Tappan, NY	14936 General Instrument Corp. Discrete Semi Conductor Div. Hicksville, NY	16742 Paramount Plastics Fabricators Inc. Downey, CA
12323 Practical Automation Inc. Shelton, CT	13511 Bunker-Ramo Corp. Amphenol Cadre Div. Los Gatos, CA	14949 Trompeter Electronics Chatsworth, CA	16758 General Motors Corp. Delco Electronics Div. Kokomo, IN
12327 Freeway Corp. Cleveland, OH	13606 Sprague Electric Co. (Use 56289)	15412 Amtron Midlothian, IL	17069 Circuit Structures Lab Burbank, CA
12406 Elpac Electronics Inc. Santa Ana, CA	13689 SPS Technologies Inc. Hatfield, NJ	15542 Scientific Components Corp. Mini-Circuits Laboratory Div. Brooklyn, NY	17117 Electronic Molding Corp. Woonsocket, RI
12443 Budd Co.,The Plastics Products Div. Phoenixville, PA	13764 Micro Plastics Flippin, AZ	15636 Elec-Trol Inc. Saugus, CA	17338 High Pressure Eng. Co. Inc. OK City, OK
12581 Hitachi Metals International Ltd. Hitachi Magna-Lock Div. Big Rapids, MO	13919 Burr-Brown Research Corp. Tucson, AZ	15782 Bausch & Lomb Inc. Graphics & Control Div. Austin, TX	17504 Aluminum Filter Co. Carpinteria, CA
12615 US Terminals Inc. Cincinnati, OH	14099 Semtech Corp. Newbury Park, CA	15801 Fenwal Electronics Inc. Div. of Kidde Inc. Framingham, MA	17545 Atlantic Semiconductors Inc. Asbury Park, NJ
12617 Hamlin Inc. LaKe Mills, WI	14140 McGray-Edison Co. Commercial Development Div. Manchester, NH	15818 Teledyne Inc. Co. Teledyne Semiconductor Div. Mountain View, CA	17745 Angstrom Precision, Inc. Hagerstown, MD
12673 Wesco Electrical Greenfield, MA	14189 Ortronics, Inc. Orlando, FL	15849 Useco Inc. (Now 88245)	17856 Siliconix Inc. Santa Clara, CA
12697 Clarostat Mfg. Co. Inc. Dover, NH	14193 Cal-R-Inc. Santa Monica, CA	15898 International Business Machines Corp. Essex Junction, VT	18178 E G & Gvactee Inc. St. Louis, MO
12749 James Electronic Inc. Chicago, IL	14301 Anderson Electronics Hollidaysburg, PA	16068 International Diode Div. Harrison, NJ	18235 KRL/Bantry Components Inc. Manchester, NH
12856 MicroMetals Inc. Anahcim, CA	14329 Wells Electronics Inc. South Bend, IN	16162 MMI Southfield, MI	18310 Concord Electronics New York, NY
12881 Metex Corp. Edison, NJ	14482 Watkins-Johnson Co. Palo Alto, CA	16245 Conap Inc. Olean, NY	18324 Signetics Corp. Sacramento, CA
12895 Cleveland Electric Motor Co. Cleveland, OH	14552 Microsemi Corp. (Formerly Micro-Semiconductor) Santa Ana, CA	16258 Space-Lok Inc. Burbank, CA	18377 Paxtex Corp. Methuen, MA
12954 Microsemi Corp. Components Group Scottsdale, AZ	14604 Elmwood Sensors, Inc Pawtucket, RI	16352 Codi Corp. Linden, NJ	18520 Sharp Electronics Corp. Paramus, NJ
12969 Unitrode Corp. Lexington, MA	14655 Cornell-Dublier Electronics Div. of Federal Pacific Electric Co. Govt Cont Dept. Newark, NJ	16469 MCL Inc. LaGrange, IL	18542 Wabash Inc. Wabash Relay & Electronics Div. Wabash, IN

Federal Supply Codes for Manufacturers (cont)

18565 Chometrics Inc. Woburn, MA	2Y384 North American Philips Lighting Corp. Van Wert, OH	23732 Tracor Applied Sciences Inc. Rockville, MD	26402 Lumex Inc. Bayshore, NY
18612 Vishay Intertechnology Inc. Vishay Resistor Products Group Malvern, PA	20584 Enochs Mfg. Inc. INpolis, IN	23880 Stanford Applied Engineering Santa Clara, CA	26629 Frequency Sources Inc. Sources Div. Chelmsford, MA
18632 Norton-Chemplast Santa Monica, CA	20891 Cosar Corp. Dallas, TX	23936 William J. Purdy Co. Pamotor Div. Burlingame, CA	26806 American Zenler Inc. Irvine, CA
18677 Scanbe Mfg. Co. Div. of Zero Corp. El Monte, CA	21317 Electronics Applications Co. El Monte, CA	24347 Penn Engineering Co. S. El Monte, CA	27014 National Semiconductor Corp. Santa Clara, CA
18736 Voltronics Corp. East Hanover, NJ	21604 Buckeye Stamping Co. Columbus, OH	24355 Analog Devices Inc. Norwood, MA	27167 Coming Glass Works Coming Electronics Wilmington, NC
18786 Micro-Power Long Island City, NY	21845 Solitron Devices Inc. Semiconductor Group Rivera Beach, FL	24444 General Semiconductor Industries, Inc. Tempe, AZ	27264 Molex Inc. Lisle, IL
18927 GTE Products Corp. Precision Material Products Business Parts Div. Titusville, PA	21847 Aartech Now TRW Microwave Inc. Sunnyvale, CA	24546 Bradford Electronics Bradford, PA	27440 Industrial Screw Products Los Angeles, CA
19080 Robinson Electronics Inc. San Luis Obispo, CA	21962 Vectron Corp. Replaced by: S.W. Electronics	24618 Transcon Mfg. Now: D.J. Associates Inc.	27494 Staffall, Inc. Providence, RI
19112 Garry Corp. Langhorne, PA	22526 DuPont, El DeNemours & Co. Inc. DuPont Connector Systems Advanced Products Div. New Cumberland, PA	24655 Genrad Inc. (Replaced General Radio 05173) Concord, MA	27745 Associated Spring Bames Group Inc. Syracuse, NY
19315 Bendix Corp., The Navigation & Control Group Terboro, NJ	22626 Micro Semiconductor (Now 14552)	24759 Lenox-Fugle Electronics Inc. South Plainfield, NJ	27918 Component Parts Corp. Bellmore, NY
19451 Perine Machine Tool Corp. Kent, WA	22670 GM Nameplate Seattle, WA	24796 AMF Inc. Potter & Brumfield Div. San Juan Capistrano, CA	27956 Relcom (Now 14482)
19482 Delta Electronics Alexandria, VA	22767 ITT Semiconductors Palo Alto, CA	24931 Specialty Connector Co. Greenwood, IN	28175 Alpha Metals Chicago, IL
19613 MN Mining & Mfg. Co. Textool Products Dept. Electronic Product Div. Irving, TX	22784 Palmer Inc. Cleveland, OH	24995 ECS Grants Pass, OR	28198 Positronic Industries Springfield, MO
19647 Caddock Electronics Inc. Riverside, CA	23050 Product Comp. Corp. Mount Vernon, NY	25088 Siemen Corp. Isilen, NJ	28213 MN Mining & Mfg. Co. Consumer Products Div. 3M Center Saint Paul, MN
19701 Mepco/Centralab Inc. A N. American Philips Co. Mineral Wells, TX	23223 CTS Microelectronics Lafayette, NY	25099 Cascade Gasket Kent, WA	28309 Kaiser Minette, AL
2B178 Wire Products Cleveland, OH	23237 I.R.C., Inc. Microcircuits Division Philadelphia, PA	25403 Amperex Electronic Corp. Semiconductor & Micro-Circuit Div. Slatersville, RI	28425 Serv-O-Link Eulless, TX
2K262 Boyd Corporation Portland, OR	23302 S.W. Electronics & Mfg. Corp. Cherry Hill, NJ	25435 Moldtronics, Inc Downers Grove, IL	28478 Deltrol Corporation Deltrol Controls Div. Milwaukee, WI
	23730 Mark Eyelet and Stamping Inc. Wolcott, CT	25706 Daburn Electronic & Cable Corp. Norwood, NJ	28480 Hewlett Packard Co. Corporate HQ Palo Alto, CA

Federal Supply Codes for Manufacturers (cont)

<p>28484 Emerson Electric Co. Gearmaster Div. McHenry, IL</p>	<p>31433 Kemet Electronics Corp. Simpsonville, NC</p>	<p>33246 Epoxy Technology Inc. Billerica, MA</p>	<p>36701 Van Waters & Rogers Valley Field, Quebec, Canada</p>
<p>28520 Heyco Molded Products Kenilworth, NJ</p>	<p>31448 Army Safeguard Logistics Command Huntsville, AL</p>	<p>33292 Pioneer Sterilized Wiping Cloth Co. Portland, OR</p>	<p>37942 Mallory Capacitor Corp. Sub of Emhart Industries INpolis, IN</p>
<p>28932 Lumax Industrials, Inc Altoona, PA</p>	<p>31471 Gould Inc Semiconductor Div Santa Clara, CA</p>	<p>33297 NEC Electronics USA Inc. Electronic Arrays Inc. Div. Mountain View, CA</p>	<p>39003 Maxim Industries Middleboro, MA</p>
<p>29083 Monsanto Co. Santa Clara, CA</p>	<p>31522 Metal Masters Inc. Baldwin, MS</p>	<p>33919 Nortek Inc. Cranston, RI</p>	<p>4F434 Plastic Sales Los Angeles, CA</p>
<p>29604 Stackpole Components Co. Raleigh, NC</p>	<p>31746 Cannon Electric Woodbury, TN</p>	<p>34114 Oak Industries Rancho Bernardo, CA</p>	<p>40402 Roderstein Electronics Inc. Statesville, NC</p>
<p>29907 Omega Engineering Inc. Stamford, CT</p>	<p>31827 Budwig Ramona, CA</p>	<p>34263 CTS Electronics Corp. Brownsville, TX</p>	<p>42498 National Radio Melrose, MA</p>
<p>3D536 Airmco Inc. Seattle, WA</p>	<p>31918 ITT-Schadow Eden Prairie, MN</p>	<p>34333 Silicon General Inc. Garden Grove, CA</p>	<p>43543 Nytronics Inc. (Now 53342)</p>
<p>30035 Jolo Industries Inc. Garden Grove, CA</p>	<p>32293 Intersil Cupertino, CA</p>	<p>34335 Advanced Micro Devices (AMD) Sunnyvale, CA</p>	<p>43744 Panasonic Industrial Co. San Antonio, TX</p>
<p>30045 Solid Power Corp. Farmingdale, NY</p>	<p>32539 Mura Corp. Westbury, Long Island, N.Y.</p>	<p>34359 MN Mining & Mfg. Co. Commercial Office Supply Div. Saint Paul, MN</p>	<p>43791 Datron Systems Wilkes Barre, PA</p>
<p>30146 Symbex Corp. Painesville, OH</p>	<p>32559 Bivar Santa Ana, CA</p>	<p>34371 Harris Corp. Harris Semiconductor Products Group Melbourne, FL</p>	<p>44655 Ohmite Mfg. Co. Skokie, IL</p>
<p>30148 AB Enterprise Inc. Ahoskie, NC</p>	<p>32719 Siltronics Santa Ana, CA</p>	<p>34576 Rockwell International Corp. Newport Beach, CA</p>	<p>47001 Lumberg Inc. Richmond, VA</p>
<p>30161 Aavid Engineering Inc. Laconia, NH</p>	<p>32767 Griffith Plastics Corp. Burlingame, CA</p>	<p>34641 Instrument Specialties Eules, TX</p>	<p>47379 ISOCOM Campbell, CA</p>
<p>30315 Iron Corp. San Diego, CA</p>	<p>32879 Advanced Mechanical Components Northridge, CA</p>	<p>34649 Intel Corp. Santa Clara, CA</p>	<p>49569 IDT (International Development & Trade) Dallas, TX</p>
<p>30323 IL Tool Works Inc. Chicago, IL</p>	<p>32897 Murata Erie North America Inc. Carlisle Operations Carlisle, Pennsylvania</p>	<p>34802 Electromotive Inc. Kenilworth, NJ</p>	<p>49671 RCA Corp. New York, NY</p>
<p>30800 General Instrument Corp. Capacitor Div. Hicksville, NY</p>	<p>32997 Bourns Inc. Trimpot Div. Riverside, CA</p>	<p>34848 Hartwell Special Products Placentia, CA</p>	<p>49956 Raytheon Company Executive Offices Lexington, MA</p>
<p>30838 Fastec Chicago, ILL</p>	<p>33025 M/A ComOmni Spectra, Inc. (Replacing Omni Spectra) Microwave Subsystems Div. Tempe, AZ</p>	<p>35009 Renfrew Electric Co. Ltd. IRC Div. Toronto, Ontario, Canada</p>	<p>5D590 Mostek Corp. Replaced by: SGS Thompson Microelec- tronics</p>
<p>31019 Solid State Scientific Inc. Willow Grove, PA</p>	<p>33096 CO Crystal Corp. Loveland, CO</p>	<p>35986 Amrad Melrose Park, IL</p>	<p>5F520 Panel Components Corp. Santa Rosa, CA</p>
<p>31091 Alpha Industries Inc. Microelectronics Div. Hatfield, PA</p>	<p>33173 General Electric Co. Owensboro, KY</p>	<p>36665 Mitel Corp. Kanata, Ontario, Canada</p>	<p>5P575 Nobel Electronics Suffern, NY</p>
<p>31323 Metro Supply Company Sacramento, CA</p>			<p>5W664 NDK Div. of Nihon Dempa Kogyo LTD Lynchburg, VA</p>

Federal Supply Codes for Manufacturers (cont)

5U802 Dennison Mfg. Co. Frammingham, MA	51499 Amtron Corp. Boston, MA	52840 Western Digital Corp. Costa Mesa, CA	54937 DeYoung Mfg. Bellevue, WA
50088 SGS - Thomson Microelectronics Inc. Carrollton, TX	51506 Accurate Screw Machine Co. (ASMCO) Nutley, NJ	53021 Sangamo Weston Inc. (See 06141)	54590 RCA Corp. Electronic Components Div. Cherry Hill, NJ
50120 Eagle-Picher Industries Inc. Electronics Div. CO Springs, CO	51605 CODI Semiconductor Inc. Kenilworth, NJ	53036 Textool Co. Houston, TX	55026 American Gage & Machine Co. Simpson Electric Co. Div. Elgin, IL
50157 Midwest Components Inc. Muskegon, MS	51642 Centre Engineering Inc. State College, PA	53184 Xciton Corp. Lathan, NY	55112 Plessey Capacitors Inc. (Now 60935)
50356 Teac Corp. of America Industrial Products Div Montebello, CA	51705 ICO/Rally Palo alto, CA	53217 Technical Wire Products Inc. Santa Barbara, CA	55261 LSI Computer Systems Inc. Melville, NY
50364 MMI, Inc.(Monolithic Memories Inc) Military Products Div. Santa Clara, CA	51791 Statek Corp. Orange, CA	53342 Opt Industries Inc. Phillipsburg, NJ	55285 Beroquist Co. Minneapolis, MN
50472 Metal Masters, Inc. City of Industry, CA	51984 NEC America Inc. Falls Church, VA	53673 Thompson CSF Components Corp. (Semiconductor Div) Conaga Park, CA	55322 Santech Inc. New Albany, IN
50541 Hypertronics Corp. Hudson, MA	52063 Exar Integrated Systems Sunnyvale, CA	53718 Airmold/W. R. Grese & Co. Roanoke Rapids, NC	55408 STI-CO Industries Co Buffalo, NY
50558 Electronic Concepts, Inc. Eatontown, NJ	52072 Circuit Assembly Corp. Irvine, CA	53848 Standard Microsystems Hauppauge, NY	55464 Central Semiconductor Corp. Hauppauge, NY
50579 Litronix Inc. Cupertino, CA	52152 MN Mining & Mfg. Saint Paul, MN	53894 AHAM Inc. RanchoCA, CA	55557 Microwave Diode Corp. W.Stewartstown, NH
50891 Semiconductor Technology Stuart, FL	52333 API Electronics Hauppauge, Long Island, NY	53944 Glow-Lite Pauls Valley, OK	55566 R A F Electronic Hardware Inc. Seymour, CT
50934 Tran-Tec Corp Columbus, NE	52361 Communication Systems Piscataway, NJ	54178 Plasmetex Industries Inc. San Marcos, CA	55576 Synertek Santa Clara, CA
51167 Aries Electronics Inc. Frenchtown, NJ	52500 Amphenol, RF Operations Burlington, MA	54294 Shallcross Inc. Smithfield, NC	55680 Nichicon/America/Corp. Schaumburg, IL
51284 Mos Technology Norristown, PA	52525 Space-Lok Inc. Larco Div. Burbank, CA	54453 Sullins Electronic Corp. San Marcos, CA	55943 D J Associates, Inc (Replaced Transcon Mfg.-24618) Fort Smith, AZ
51249 Heyman Mfg. Co. Cleveland, OH	52531 Hitachi Magnetics Edmore, MO	54473 Matsushita Electric Corp. (Panasonic) Secaucus, NJ	56282 Utek Systems Inc. Olathe, KS
51372 Verbatim Corp. Sunnyvale, CA	52745 Timco Los Angeles, CA	54492 Cinch Clamp Co., Inc. Santa Rosa, CA	56289 Sprague Electric Co. North Adams, MA
51398 MUPAC Corp. Brockton, MA	52763 Siettner-Electronics Inc. Chattanooga, TN	54583 TDK Garden City, NY	56365 Square D Co. Corporate Offices Palatine, IL
51406 Murata Erie, No. America Inc. (Also see 72982) Marietta, GA	52769 Sprague-Goodman Electronics Inc. Garden City Park, NY	54590 RCA Corp Distribution & Special Products Cherry Hill, NY	56375 WESCORP Div. Dal Industries Inc Mountain View, CA
	52771 Moniterm Corp. Amatrom Div. Santa Clara, CA	54869 Pihier International Corp. Arlington Heights, IL	

Federal Supply Codes for Manufacturers (cont)

56481 Shugart Associates Sub of Xerox Corp. Sunnyvale, CA	59610 Souriau Inc Valencia, CA	60911 Inmos Corp. CO Springs, CO	64537 KDI Electronics Whippany, NJ
56637 RCD Components Inc. Manchester, NH	59635 HV Component Associates Howell, NJ	60935 Westlake Capacitor Inc. Tantalum Div. Greencastle, IN	64782 Precision Control Mfg. Inc. Bellevue, WA
56708 Zilog Inc. Campbell, CA	59640 Supertex Inc. Sunnyvale, CA	60958 ACIC Intercomp Wire & Cable Div. Hayesville, NC	64834 West M G Co. San Francisco, CA
56856 Varnistor Corp. of TN Sevierville, TN	59660 Tusonix Inc. Tucson, AZ	61271 Fujitsu Microelectronics Inc San Jose, CA	64961 Electronic Hardware LTD North Hollywood, CA
56880 Magnetics Inc. Baltimore, MD	59730 Thomas and Betts Corp. IA City, IA	61394 SEEQ Technology Inc. San Jose, CA	65092 Sangamo Weston Inc. Weston Instruments Div. Newark, NJ
57026 Endicott Coil Co. Inc. Binghamton, NY	59831 Semtronics Corp. Watchung, NJ	61429 Fox Electronics Cape Coral, FL	65786 Cypress Semi San Jose, CA
57053 Gates Energy Products Denver, CO	61053: American Components Inc. an Insilco Co. RPC Div. Hayesville, NC	61529 Aromat Corp. New Providence, NJ	65940 Rohm Corp & Whatney Irvine, CA
57170 Cambridge Thermionic Cambridge, MA Replaced by: 71279 Interconnection Products Inc.	6L611 Allen, Robert G. Inc. Van Nuys, CA	61752 IR-ONICS Inc Warwick, RI	65964 Evovx Inc. Bannockburn, IL
57668 R-ohm Corp Irvine, CA	6U850 Burgess Switch Co., Inc Northbrook, IL	61772 Integrated Device Technology Santa Clara, CA	66150 Entron Inc. Winslow Teltronics Div. Glendale, NY
57962 SGS - Thomson Microelectronics Inc Montgomeryville, PA	6U095 AMD Enterprises, Inc. Roswell, GA	61802 Toshiba Houston, TX	66302 VLSI Technology Inc. San Jose, CA
58014 Hitachi Magnalock Corp. (Now 12581)	6X403 SGS/ATES Semiconductor Corp. INpolis, IN	61857 SAN-O Industrial Corp. Bohemia, Long Island, NY	66419 Exel San Jose, CA
58104 Simco Atlanta, GA	6Y440 Micron Technology Inc. Boise, ID	61935 Schurter Inc. Petaluma, CA	66450 Dyna-Tech Electronics, Inc Walled Lake, MI
58364 BYCAP Inc. Chicago, IL	60046 Power Dynamics Inc West Orange, NJ	62351 Apple Rubber Lancaster, NY	66608 Bezing Industries Freemont, CA
58451 Precision Lamp Cotat, CA	60197 Precicontact Inc. Langhome, PA	62643 United Chemicon Rosemont, IL	66891 BKC International Electronics Lawrence, MA
58474 Superior Electric Co. Bristol, CT	60386 Squires Electronics Inc Cornelius, OR	62712 Seiko Instruments Torrance, CA	66958 SGS Semiconductor Corp. Phoenix, AZ
58614 Communications Instruments Inc. Fairview, NC	60395 Xicor Inc. Milpitas, CA	62793 Lear Siegler Inc. Energy Products Div. Santa Ana, CA	66967 Powerex Inc Auburn, NY
59124 KOA-Speer Electronics Inc. Bradford, PA	60399 Torin Engineered Blowers Div. of Clevepak Corp. Torrington, CT	63743 Ward Leonard Electric Co.Inc. Mount Vernon, NY	67183 Altera Santa Clara, CA
59422 Holmberg Electronics Irvine, CA	60496 Micrel Inc. Sunnyvale, CA	64154 Lamb Industries Portland, OR	68919 WIMA % Harry Levinson Co. Seattle, WA
	60705 Cera-Mite Corp. (formerly Sprague) Grafton, WI	64155 Linear Technology Milpitas, CA	

Federal Supply Codes for Manufacturers (cont)

7F361 Richmond-Division of Dixico % Zellerbach Paper Co. Seattle, WA	71468 ITT Cannon Div. of IIT Fountain Valley, CA	73138 Beckman Industrial corp. Helipot Div. Fullerton, CA	75042 TRW Inc. IRC Fixed Resistors Philadelphia, PA
7F844 Moore Business Forms, Inc Seattle, WA	71482 General Instrument Corp. Clare Div. Chicago, IL	73168 Fenwal Inc. Ashland, MA	75297 Kester Solder Div. Litton Systems, Inc Des Plaines, IL
7G902 Textron Inc. Camcar Div. Rockford, IL	71590 Mepco/Centralab A North American Philips Co. Fort Dodge, IA	73293 Hughes Aircraft Co. Electron Dynamics Div. Torrance, CA	75376 Kurz-Kasch Inc. Dayton, OH
7J395 Universal Plastics Welshpool, WA	71707 Coto Corp. Providence, RI	73445 Amperex Electronic Corp. Hicksville, NY	75378 CTS Knights Inc. Sandwich, IL
7J696 AMD Plastics East Lake, OH	71744 General Instrument Corp. Lamp Div/Worldwide Chicago, IL	73559 Carlingswitch Inc. Hartford, CT	75382 Kulka Electric Corp. (Now 83330) Mount Vernon, NY
7K354 Omni Spectra Inc Los Altos, CA	71785 TRW Inc. Cinch Connector Div. Elk Grove Village, IL	73586 Circle F Industries Trenton, NJ	75569 Performance Semiconductor Corp. Sunnyvale, CA
7Z884 ALPS Seattle, WA	71984 Dow Corning Corp. Midland, MI	73734 Federal Screw Products Inc. Chicago, IL	75915 Littelfuse Tracor (Formerly: Tracor-Littelfuse) Des Plaines, IL
7X634 Duracell USA Div. of Dart & Kraft Inc. Valdese, NC	72005 AMAX Specialty Metals Corp. Newark, NJ	73743 Fischer Special Mfg. Co. Cold Spring, KY	76854 Oak Switch Systems Inc. Crystal Lake, IL
70290 Almetal Universal Joint Co. Cleveland, OH	72136 Electro Motive Mfg. Corp. Florence, NC	73893 Microdot Mt. Clemens, MS	77122 TRW Assemblies & Fasteners Group Fastener Div. Moutainside, NJ
70485 Atlantic India Rubber Works Inc. Chicago, IL	72228 AMCA International Corp. Continental Screw Div. New Bedford, MA	73899 JFD Electronic Components Div. of Murata Erie Oceanside, NY	77342 AMF Inc. Potter & Brumfield Div. Princeton, IN
70563 Amperite Company Union City, NJ	72259 Nytronics Inc. New York, NY	73905 FL Industries Inc. San Jose, CA	77542 Ray-O-Vac Corp Madison, WI
70903 Cooper-Belden Corp. Geneva, IL	72619 Amperex Electronic Corp. Dialight Div. Brooklyn, NY	73949 Guardian Electric Mfg. Co. Chicago, IL	77638 General Instrument Corp. Rectifier Div. Brooklyn, NY
71002 Bimbach Co. Inc. Farmingdale, NY	72653 G C Electronics Co. Div. of Hydrometals Inc. Rockford, IL	74199 Quam Nichols Co. Chicago, IL	77900 Shakeproof Lock Washer Co. (Now 78189)
71034 Bliley Electric Co. Erie, PA	72794 Dzus Fastner Co. Inc. West Islip, NY	74217 Radio Switch Co. Marlboro, NJ	77969 Rubbercraft Corp. of CA Ltd. Torrance, CA
71183 Westinghouse Electric Corp. Bryant Div. Bridgeport, CT	72928 Gulton Industries Inc. Gudeman Div. Chicago, IL	74306 Piezo Crystal Co. Div. of PPA Industries Inc. Carlisle, PA	78189 IL Tool Works Inc. Shakeproof Div. Elgin, IL
71279 Interconnection Products Inc. Formerly Midland-Ross Cambion Div. Santa Ana, CA	72962 Elastic Stop Nut Div. of Harrard Industries Union, NJ	74445 Holo-Krome Co. Elmwood, CT	78277 Sigma Instruments Inc. South Braintree, MA
71400 Bussman Manufacturing Div. McGraw-Edison Co. St. Louis, MO	72982 Eric Specialty Products, Inc Formerly: Murata Erie Erie, PA	74542 Hoyt Elect.Instr. Works Inc. Penacook, NH	78290 Struthers Dunn Inc. Pitman, NJ
71450 CTS Corp. Elkhart, IN		74840 IL Capacitor Inc. Lincolnwood, IL	78553 Eaton Corp. Engineered Fastener Div. Cleveland, OH

Federal Supply Codes for Manufacturers (cont)

78592 Stoeger Industries South Hackensack, NJ	81439 Therm-O-Disc Inc. Mansfield, OH	83315 Hubbell Corp. Mundelein, IL	87034 Illuminated Products Inc. (Now 76854)
79497 Western Rubber Co. Goshen, IN	81483 International Rectifier Corp. Los Angeles, CA	83330 Kulka Smith Inc. A North American Philips Co. Manasquan, NJ	87516 Standard Crystal KS City, KS
79727 C - W Industries Southampton, PA	81590 Korry Electronics Inc. Seattle, WA	83478 Rubbercraft Corp. of America West Haven, CT	88044 Aeronautical Standards Group Dept. of Navy & Air Force
79963 Zierick Mfg. Corp. Mount Kisco, NY	81741 Chicago Lock Co. Chicago, IL	83553 Associated Spring Barnes Group Gardena, CA	88219 GNB Inc. Industrial Battery Div. Langhorne, PA
8C798 Ken-Tronics, Inc. Milan, IL	82227 Airpax Corp. Cheshire Div. Cheshire, CT	83740 Union Carbide Corp. Battery Products Div. Danbury, CT	88245 Winchester Electronics Liton Systems-Useco Div. Van Nuys, CA
8D528 Baumgartens Atlanta, GA	82240 Simmons Fastener Corp. Albany, NY	84171 Arco Electronics Commack, NY	88486 Triangle PWC Inc. Jewitt City, CT
8F330 Eaton Corp. Cutler Hammer Product Sales Office Mountain View, CA	82305 Palmer Electronics Corp. South Gate, CA	84411 American Shizuki TRW Capacitors Div. Ogallala, NE	88690 Essex Group Inc. Wire Assembly Div. Dearborn, MI
8T100 Tellabs Inc. Naperville, IL	82389 Switchcraft Inc. Sub of Raytheon Co. Chicago, IL	84613 FIC Corp. Rockville, MD	88786 Atlantic India Rubber Co. Goshen, IN
80009 Tektronix Beaverton, OR	82415 Airpax Corp. Frederick Div. Frederick, MD	84682 Essex Group Inc. Peabody, MA	88978 Phillips (Now Fluke) Mahwah, NJ
80031 Mepco/Electra Inc. Morristown, NJ	82872 Roanwell Corp. New York, NY	84830 Lee Spring Co. Inc Brooklyn, NY	89020 Amerace Corp. Buchanan Crimp Tool Products Div. Union, NJ
80032 Ford Aerospace & Communications Corp. Western Development Laboratories Div. Palo Alto, CA	82877 Rotron Inc. Custom Div. Woodstock, NY	85367 Bearing Distributing Co. San Francisco, CA	89265 Power-Brunfield (Sec 77342)
80145 LFE Corp. Process Control Div. Clinton, OH	82879 ITT Royal Electric Div. Pawtucket, RI	85372 Bearing Sales Co. Los Angeles, CA	89462 Waldes Truare, Inc. Long Island, NY
80183 Sprague Products (Now 56289)	83003 Varo Inc. Gadland, TX	85480 W. H. Brady Co. Industrial Product Milwaukee, WI	89536 John Fluke Mfg. Co., Inc. Everett, WA
80294 Boums Instruments Inc. Riverside, CA	83014 Hartwell Corp. Placentia, CA	85840 Brady WH Co Industrial Products Div Milwaukee, WI	89597 Fredericks Co. Huntingdon Valley, PA
80583 Hammerlund Mfg. Co. Inc. Paramus, NJ	83055 Signalite Fuse Co. (Now 71744)	85932 Electro Film Inc. Valencia, CA	89709 Bunker Ramo-Eltra Corp. Amphenol Div. Broadview, IL
80640 Computer Products Inc. Stevens-Arnold Div. South Boston, MA	83058 TRW Assemblies & Fasteners Group Fasteners Div. Cambridge, MA	86577 Precision Metal Products Co. Peabody, MA	89730 General Electric Lamp Div. Newark, NJ
81073 Grayhill Inc. La Grange, IL	83259 Parker-Hannifin Corp. O-Seal Div. Culver City, CA	86684 Radio Corp. of America (Now 54590)	9R216 Data Composition Svc, Inc Laurel, MD
81312 Liton Systems Inc. Winchester Electronics Div. Watertown, CT	83298 Bendix Corp. Electric & Fluid Power Div. Eatonville, NJ	86928 Seastrom Mfg. Co. Inc. Glendale, CA	9S171 Port Plastics Tukwila, WA

Federal Supply Codes for Manufacturers (cont)

9W423 Amatom El Mont, CA	91934 Miller Electric Co. Woonsocket, RI	95573 Campion Laboratories Inc. Detroit, MI	98278 Malco A Microdot Co. South Pasadena, CA
90201 Mallory Capacitor Co. Sub of Emhart Industries Inc. Indianapolis, IN	91967 National Tel-Tronics Div. of electro Audio Dynamics Inc Meadville, PA	95712 Bendix Corp. Electrical Comp. Div. Franklin, IN	98291 Selectro Corp. BICC Electronics Trumbull, CT
90215 Best Stamp & Mfg. Co. KS City, MO	91984 Maida Development Co. Hampton, VA	95987 Weckesser Co. Inc. (Now 85480)	98372 Royal Industries Inc. (Now 62793)
90303 Duracell Inc. Technical Sales & Marketing Bethel, CT	91985 Norwalk Valve Co. S. Norwalk, CT	96733 SFE Technologies San Fernando, CA	98388 Lear Siegler Inc. Accurate Products Div. San Deigo, CA
91094 Essex Group Inc. Suflex/IWP Div. Newmarket, NH	92218 Wakefield Corp., The Wakefield, ME	96853 Gulton Industries Inc. Measurement & Controls Div. Manchester, NH	98978 IERC (International Electronic Research Corp.) Burbank, CA
91247 IL Transformer Co. Chicago, IL	92527 VTC Inc. Bloomington, MN	96881 Thomson Industries Inc. Port WA, NY	99120 Plastic Capacitors Inc. Chicago, IL
91293 Johanson Mfg. Co. Boonton, NJ	92607 Tensolite Co. Div. of Carlisle Corp. Buchanan, NY	97464 Industrial Retainer Ring Irvington, NJ	99217 Bell Industries Inc. Elect. Distributor Div. Sunnyvale, CA
91462 Alpha Industries Inc. Logansport, IN	92914 Alpha Wire Corp. Elizabeth, NJ	97525 EECO Inc. Santa Ana, CA	99378 ATLEE of DE Inc. N. Andover, MA
91502 Associated Machine Santa Clara, CA	93332 Sylvania Electric Products Semiconductor Products Div. Woburn, MA	97540 Whitehall Electronics Corp. Master Mobile Mounts Div. Fort Meyers, FL	99392 Mepco/Electra Inc. Roxboro Div. Roxboro, NC
91506 Augat Alcoswitch N. Andover, MA	94144 Raytheon Co. Microwave & Power Tube Div. Quincy, MA	97913 Industrial Electronic Hardware Corp. NY, NY	99515 Electron Products Inc. Div. of American Capacitors Duarte, CA
91507 Froeliger Machine Tool Co. Stockton, CA	94222 Southco Inc. Concordville, PA	97945 Pennwalt Corp. SS White Industrial Products Piscataway, NJ	99779 Bunker Ramo- Eltra Corp. Barnes Div. Lansdown, PA
91637 Dale Electronics Inc. Columbus, NE	94988 Wagner Electric Corp. Sub of McGraw-Edison Co. Whippany, NJ	97966 CBS Electronic Div. Danvers, MA	99800 American Precision Industries Delevan Div. East Aurora, NY
91662 Elco Corp. A Gulf Western Mfg. Co. Connector Div. Huntingdon, PA	95146 Alco Electronic Products Inc. Switch Div. North Andover, MA	98094 Machlett Laboratories Inc. Santa Barbara, CA	99942 Mepco/Centralab A North American Philips Co. Milwaukee, WI
91737 ITT Cannon/Gremar (Now 08718)	95263 Leecraft Mfg. Co. Long Island City, NY	98159 Rubber-Teck Inc. Gardena, CA	
91802 Industrial Devices Inc. Edgewater, NJ	95275 Vitramon Inc. Bridgeport, CT		
91833 Keystone Electronics Corp. NY, NY	95303 RCA Corp. Receiving Tube Div. Cincinnati, OH		
91836 King's Electronics Co. Inc. Tuckahoe, NY	95348 Gordo's Corp. Bloomfield, NJ		
91929 Honeywell Inc. Micro Switch Div. Freeport, IL	95354 Methode Mfg. Corp. Rolling Meadows, IL		

Service Centers

USA

California

Fluke Service Center
46610 Landing Parkway
Fremont, CA 94538
TEL: (510) 651-5112
FAX: (510) 651-4962

Fluke Service Center

16715 Von Karman Avenue
Suite 110
Irvine, CA 92714
TEL: (714) 863-9031
FAX: (714) 757-7556

Florida

Fluke Service Center
550 S. North Lake Blvd.
Altamonte Springs, FL 32701-5227
TEL: (407) 331-2929
FAX: (407) 331-3366 or 331-7710

Illinois

Fluke Service Center
1150 W. Euclid Avenue
Palatine, IL 60067
TEL: (708) 705-0500
FAX: (708) 705-9989

New Jersey

Fluke Service Center
W. 75 Century Rd
or P.O. Box 930
Paramus, N.J. 07652
TEL: (201) 599-9500 (599-0919)
FAX: (201) 599-2093

Texas

Fluke Service Center
2104 Hutton Drive
Suite 112
Carrollton, TX 75006
TEL: (214) 406-1000
FAX: (214) 406-1072

Washington

Fluke Service Center
Fluke Corporation
Building #4
1420 - 75TH St. S.W.
M/S 6-30
Everett WA 98203
TEL: (206) 356-5560
FAX: (206) 356-6390

INTERNATIONAL

Argentina

Coasin S.A.
Virrey del Pino 4071
1430 CAP FED
Buenos Aires
TEL: 54-1-552-5248
FAX: 54-1-11-1427

Viditec S.A

Lacarra 234
Buenos Aires CP 1407
TEL: 54-1-636-1199
FAX: 54-1-636-2185

Australia

Phillips Customer Support
Scientific and Industrial
23 Lakeside Drive
Tally Ho Technology Park
East Burwood
Victoria 3151
TEL: 61-3-881-3666
FAX: 61-3-881-3636

Phillips Customer Support

Scientific and Industrial
Block F, Centrecourt
34 Waterloo Road
North Ryde, N.S.W. 2113
TEL: 61-2-888-0416
FAX: 61-2-888-0440

Austria

Fluke Vertriebsges. m.b.H.
SudrandstraBe 7
P.O. Box 10
A-1232 Vienna
TEL: 43-1-614-100
FAX: 43-1-61410-10

Belgium

N.V. Fluke Belgium/S.A.
T&M Customer Support
Langeveldpark - Unit 5 & 7
P.Basteleusstraat 2-4-6
1600 St. Pieters - Leeuw
TEL: 218-2-331-2777
FAX: 32-2-331-1489

Bolivia

Coasin Bolivia S.R.L.
Casilla 7295
La Paz, Bolivia
TEL: 591-2-340962
FAX: 591-2-359268

Canada

Fluke Electronics Canada Inc.
400 Britannia Road East, Unit #1
Mississauga, Ontario
L4Z 1X9
TEL: 905-890-7600
FAX: 905-890-6866

Chile

Intronica
Instrumentacion Electronica,
S.A.C.I.
Guardia Vieja 181 Of. 503
Casilla 16500
Santiago 9
Chile
TEL: 56-2-232-3888
FAX: 56-2-231-6700

China

Fluke Service Center
Room 2111 Scite Tower
Jiangumenwai Dajie
Beijing 100004
TEL: 86-1-512-3435 or 6351
FAX: 86-1-512-3437

Colombia

Sistemas E Instrumentacion,
Ltda.
Carrera 21, NO. 39A-21, OF.
101
Ap. Aereo 29583
Bogota
TEL: 57-1-287-5424
FAX: 57-1-287-248

Costa Rica

Electronic Engineering, S.A.
Carretera de Circunvalacion
Sabanilla Av. Novena
P.O. Box 4300-1000
San Jose
TEL: 506-253-3759
FAX: 506-225-1286

Danmark

Fluke Danmark A/S
T&M Customer Support
Ejby Industrivej 40
DK 2600 Glostrup
TEL: 45-43-44-1900
FAX: 45-43-43-9192

Ecuador

Proteco Coasin Cia., Ltda.
Av. 12 de Octubre 2449 y
Orellana
P.O. Box 17-03-228-A
Quito
TEL: 593-2-230283 or 520005
FAX: 593-2-561980

Fiji

Communications Pacific, Ltd.
37 Freeston Road
Walu Bay
G.P.O. Box 858
Suva
TEL: 679 312744
FAX: 679 300379

Finland

Fluke Finland Oy
Sinikalliontie 3
SF-02631 Espoo
TEL: 358-0-5026-6247
FAX: 358-0-5026-414

France

Fluke France S.A.
37 Rue Voltaire
BP 112
93700 Drancy,
TEL: 33-1-48-966361
FAX: 33-1-48-966330

Germany

Fluke Deutschland GmbH
Service & Calibration Lab.
Oskar-Messter-Strasse 18
85737 Ismaning/Munich
TEL: 49-89-99611-260
FAX: 49-89-99611-270

Fluke Deutschland

Test & Measurement
Meiendorferstrasse 205
22145 Hamburg 73
TEL: 49-40-6797-434
FAX: 49-40-6797-421

Hong Kong

Schmidt & Co (H.K.) Ltd.
1st Floor
323 Jaffe Road
TEL: 852-9223-5623
FAX: 852 834-1848

Ireland, Republic of

Fluke U.K. LTD.
Customer Support
Colonial Way
Watford
Hertfordshire WD2 4TT U.K.
TEL: 44-923-240511
FAX: 44-923-225067

India

Hinditron Services Pvt. Inc.
33/44 Rajmahal Vilas Extension
8th Main Rd.
Bangalore 560 080
TEL: 91-80-334-8266
FAX: 91-80-3345022

Hinditron Services Pvt. Ltd

1st Floor, 17-B,
Mahal Industrial Estate
Mahakali Road, Andheri East
Bombay 400 093
TEL: 91-22-837-0013
FAX: 91-22-837-0087

Hinditron Services Pvt. Ltd

Castle House, 5th Floor
5/1 A, Hungerford Street
Calcutta 700 017

Hinditron Services Pvt. Ltd

15 Harrington Road
Chetpet
Madras 600031

Service Centers (cont)

Hindtron Services Pvt. Ltd.
204-206 Hemkunt Tower
98 Nehru Place
New Delhi 110 019
TEL: 91-11-641-0380
FAX: 91-11-642-9118

Hinditron Services Pvt. Ltd.
Field Service Center
Emerald House
5th Floor
114 Sarojini Devi Road
Secunderabad 500 003
TEL: 91 842-844033

Indonesia

P. T. Daeng Brothers
Phillips House
J/n H.R. Rasuna Said Kav. 3-4
Jakarta 12950
TEL: 62-21-520-1122
FAX: 62-21-520-5189

R.D.T Equipment and Systems,
Ltd.
P.O. Box 58072
Tel Aviv 61580
TEL: 972-3-645-0745
FAX: 972-3-647-8908

Italy

Fluke Italia S.R.L.
T&M Customer Support
Viale Delle Industrie, II
20090 Vimodrone (MI)
TEL: 39-2-268434-435
FAX: 39-2-250-1645

Japan

Fluke Corporation
Sumitomo Higashi Shinbashi
Bldg.
1-1-11 Hamamatsucho
Minato-ku
Tokyo 105
TEL: 81-3-3434-0188
FAX: 81-3-3434-0170

Korea

B&P International Co., Ltd.
Geopung Tocon A-1809
203-1 Nonhyun-Dong
Kangnam-Ku
Seoul 135-010
TEL: 82 02 546-1457
FAX: 82 02 546-1458

IL MYOUNG, INC.
780-46, Yeogsam-Dong
Youngdong P.O. Box 1486
Kangnam-Ku
Seoul
TEL: 82 2 552-8582-4
FAX: 82 2 553-0388

Malaysia

CNN. SDN. BHD.
17D, 2nd Floor
Lebuhraya Batu Lancang
Taman Seri Damai
11600 Jelutong Penang
TEL: 60-4-657-9584
FAX: 60-4-657-0835

Mexico

Mexel Mexicana De Electronica
Industrial, S.A. De C.V.
Diagonal No. 27
Entra Calle de Eugenia Y Ave.
Col. Del Valle
C.P. 03100, Mexico D.F.
TEL: 52-5-682-8040
FAX: 52-5-687-8695

Mexicana De Electronica
Industrial, S.A.
F-14 Bassett Center #541
6001 Gateway West
EIPaso, TX 79925
TEL: 52-16-23-02-35
FAX: 52-16-23-02-35

Netherlands

Fluke Europe B.V.
Test & Measurement
Science Park
Eindhoven 5110
P.O. Box 1337
5602 BH Eindhoven
TEL: 31-40-644-226
FAX: 31-40-644-260

Fluke Netherland B.V.
Technische Service Prof. Act.
Herksestraat, 2C
Gebouw HBR
5652 AJ Eindhoven
TEL: 31-40-722-626
FAX: 31-40-723-337

New Zealand

Phillips Customer Support
Scientific & Industrial
Private Bag 41904
St. Lukes, 2 Wagener Place
Mt. Albert, Auckland 3
TEL: 64-9-894-4160
FAX: 64-9-849-7814

Norway

Fluke Norway A/S
Customer Support
P.O. Box 6054 Etterstad
N-0601 Oslo
TEL: 47-22-653400
FAX: 47-22-653407

Pakistan (Philips)

Philips Electrical Industries of
Pakistan, Ltd.
Islamic Chamber of Commerce
Industry and Commodity
Exchange Bldg.
St-2/A, Block 9, KDA Scheme 5,
Clifton, Karachi-75600
Pakistan

Peru

Importaciones &
Representaciones
Electronicas S.A.
JR. Pumacahua 955
Lima 11
TEL: 51-14-23-5099
FAX: 51-14-31-0707

Philippines

Spark Electronics Corp.
P.O. Box 610, Greenhills
Metro Manila 1502
TEL: 63-2-700-621
FAX: 63-2-721-0491

Portugal

Fluke Iberica, S.L.
IE Division - T&M Department
(Delegacao em Portugal)
Campo Grande, 35-7oB
1700 Lisboa
TEL: 351-1-795-1712
FAX: 351-1-795-1713

Singapore

Fluke Corporation
Singapore Representative Office
#27-03 PSA Building
460 Alexandra Road
Singapore 0511
TEL: 65-276-5161
FAX: 65-276-5759

South Africa

Spescom Measuregraph (PTY)
Ltd.
Spescom Park
Crn. Alexandra Rd. & Second St.
Halfway House, Midrand 1695
TEL: 27-11-315-0757
FAX: 27-11-805-1192

Spain

Fluke Iberica S.L.
Centro Empresarial Euronora
c/Ronda de Poniente, 8
28760-Tres Cantos
Madrid, Spain
TEL: 34-1-804-2301
FAX: 34-1-804-2496

Sweden

Fluke Sverige AB
T&M Customer Support
Kronborgsgrand 11
P.O. Box 61
S-164 94
TEL: 46-8-751-0235
FAX: 46-8-751-0480

Switzerland

Fluke Switzerland AG
T&M Customer Support
Rutistrasse 28
8952 Schlieven
Switzerland
TEL: 41-1-730-3310
FAX: 41-1-730-3932

Taiwan

Schmidt Electronics Corp.
5th Floor, Cathay Min Sheng
Commercial Building,
No. 178 Sec. 2
Min Sheng East Road
Taipei
TEL: 886-2-501-3468
FAX: 886-2-502-9692

Thailand

Measuretronix Ltd.
2102/31 Ramkamhang Road
Bangkok 10240
TEL: 66-2-375-2733, 375-2734
FAX: 66-2-374-9965

United Kingdom

Fluke U.K. LTD.
Customer Support
Colonial Way
Watford
Hertfordshire WD2 4TT
TEL: 44-923-240511
FAX: 44-923-225067

Uruguay

Coasin Uruguaya S.A.
Casilla de Correo 1400
Libertad 2529
Montevideo
TEL: 598-2-789-015
FAX: 598-2-492-199

Venezuela

Coasin C.A.
Calle 9 Con Calle 4, Edif.
Edinurbi
Apartado de Correos NR-70.136
Los Ruices
Caracas 1070-A
TEL: 58-2-241-0309, 241-1248
FAX: 58-2-241-1939

Vietnam

Schmidt-Vietnam Co., Ltd.
6/FI.Fedalogical College Bldg.
Dich Vong, KM 8 Highway 32
Tu Liem - Hanoi
TEL: 84-4-346186
FAX: 84-4-346188

Section 8 Schematic Diagrams

TABLE OF CONTENTS

FIGURE NO.	TITLE	PAGE
8-1.	752A Reference Divider Interconnect	8-3
8-2.	Bridge & Compen PCB	8-4
8-3.	Output & 10:1, 100:1	8-6