Agilent 75000 SERIES C

Agilent E1446A
Summing Amplifier/DAC Module

Service Manual

Agilent Technologies

E1446-90010
E0706

Manual Part Number: E1446-90010

Printed: July 2006 Edition 2 Rev 2
Printed in Malaysia E0706

Certification

Agilent Technologies certifies that this product met its published specifications at the time of shipment from the factory. Agilent Technologies further certifies that its calibration measurements are traceable to the United States National Institute of Standards and Technology (formerly National Bureau of Standards), to the extent allowed by that organization's calibration facility, and to the calibration facilities of other International Standards Organization members.

Warranty

This Agilent Technologies product is warranted against defects in materials and workmanship for a period of one (1) year from date of shipment. Duration and conditions of warranty for this product may be superseded when the product is integrated into (becomes a part of) other Agilent products. During the warranty period, Agilent Technologies will, at its option, either repair or replace products which prove to be defective.

For warranty service or repair, this product must be returned to a service facility designated by Agilent Technologies. Buyer shall prepay shipping charges to Agilent and Agilent shall pay shipping charges to return the product to Buyer. However, Buyer shall pay all shipping charges, duties, and taxes for products returned to Agilent from another country.

Agilent warrants that its software and firmware designated by Agilent for use with a product will execute its programming instructions when properly installed on that product. Agilent does not warrant that the operation of the product, or software, or firmware will be uninterrupted or error free.

Limitation Of Warranty

The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenance by Buyer, Buyer-supplied products or interfacing, unauthorized modification or misuse, operation outside of the environmental specifications for the product, or improper site preparation or maintenance.

The design and implementation of any circuit on this product is the sole responsibility of the Buyer. Agilent does not warrant the Buyer's circuitry or malfunctions of Agilent products that result from the Buyer's circuitry. In addition, Agilent does not warrant any damage that occurs as a result of the Buyer's circuit or any defects that result from Buyer-supplied products.

NO OTHER WARRANTY IS EXPRESSED OR IMPLIED. Agilent SPECIFICALLY DISCLAIMS THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

Exclusive Remedies

THE REMEDIES PROVIDED HEREIN ARE BUYER'S SOLE AND EXCLUSIVE REMEDIES. Agilent SHALL NOT BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER BASED ON CONTRACT, TORT, OR ANY OTHER LEGAL THEORY.

Notice

The information contained in this document is subject to change without notice. Agilent Technologies MAKES NO WARRANTY OF ANY KIND WITH REGARD TO THIS MATERIAL, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. Agilent shall not be liable for errors contained herein or for incidental or consequential damages in connection with the furnishing, performance or use of this material. This document contains proprietary information which is protected by copyright. All rights are reserved. No part of this document may be photocopied, reproduced, or translated to another language without the prior written consent of Agilent Technologies, Inc. Agilent assumes no responsibility for the use or reliability of its software on equipment that is not furnished by Agilent.

U.S. Government Restricted Rights

The Software and Documentation have been developed entirely at private expense. They are delivered and licensed as "commercial computer software" as defined in DFARS 252.227- 7013 (Oct 1988), DFARS 252.211-7015 (May 1991) or DFARS 252.227-7014 (Jun 1995), as a "commercial item" as defined in FAR 2.101(a), or as "Restricted computer software" as defined in FAR 52.227-19 (Jun 1987)(or any equivalent agency regulation or contract clause), whichever is applicable. You have only those rights provided for such Software and Documentation by the applicable FAR or DFARS clause or the Agilent standard software agreement for the product involved.

Agilent E1446A Summing Amplifier/DAC Module Service Manual
Edition 1 Rev 2

Printing History

The Printing History shown below lists all Editions and Updates of this manual and the printing date(s). The first printing of the manual is Edition 1. The Edition number increments by 1 whenever the manual is revised. Updates, which are issued between Editions, contain replacement pages to correct the current Edition of the manual. Updates are numbered sequentially starting with Update 1. When a new Edition is created, it contains all the Update information for the previous Edition. Each new Edition or Update also includes a revised copy of this printing history page. Many product updates or revisions do not require manual changes and, conversely, manual corrections may be done without accompanying product changes. Therefore, do not expect a one-to-one correspondence between product updates and manual updates.

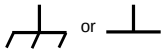
Edition 1 (Part Number E1446-90010). . . . . January 1993

Edition 1 Rev 2 (Part Number E1446-90010) . . . . . July 2006

Safety Symbols

Instruction manual symbol affixed to product. Indicates that the user must refer to the manual for specific WARNING or CAUTION information to avoid personal injury or damage to the product.

Indicates the field wiring terminal that must be connected to earth ground before operating the equipment—protects against electrical shock in case of fault.



Frame or chassis ground terminal—typically connects to the equipment's metal frame.

Alternating current (AC).

Direct current (DC).

Indicates hazardous voltages.

WARNING Calls attention to a procedure, practice, or condition that could cause bodily injury or death.

CAUTION Calls attention to a procedure, practice, or condition that could possibly cause damage to equipment or permanent loss of data.

WARNINGS

The following general safety precautions must be observed during all phases of operation, service, and repair of this product. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the product. Agilent Technologies assumes no liability for the customer's failure to comply with these requirements.

Ground the equipment: For Safety Class 1 equipment (equipment having a protective earth terminal), an uninterruptible safety earth ground must be provided from the mains power source to the product input wiring terminals or supplied power cable.

DO NOT operate the product in an explosive atmosphere or in the presence of flammable gases or fumes.

For continued protection against fire, replace the line fuse(s) only with fuse(s) of the same voltage and current rating and type. DO NOT use repaired fuses or short-circuited fuse holders.

Keep away from live circuits: Operating personnel must not remove equipment covers or shields. Procedures involving the removal of covers or shields are for use by service-trained personnel only. Under certain conditions, dangerous voltages may exist even with the equipment switched off. To avoid dangerous electrical shock, DO NOT perform procedures involving cover or shield removal unless you are qualified to do so.

DO NOT operate damaged equipment: Whenever it is possible that the safety protection features built into this product have been impaired, either through physical damage, excessive moisture, or any other reason, REMOVE POWER and do not use the product until safe operation can be verified by service-trained personnel. If necessary, return the product to an Agilent Technologies Sales and Service Office for service and repair to ensure that safety features are maintained.

DO NOT service or adjust alone: Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present.

DO NOT substitute parts or modify equipment: Because of the danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modification to the product. Return the product to an Agilent Technologies Sales and Service Office for service and repair to ensure that safety features are maintained.

Agilent Technologies	**DECLARATION OF CONFORMITY** According to ISO/IEC Guide 22 and CEN/CENELEC EN 45014	CE

Manufacturer's Name: Agilent Technologies, Incorporated
Manufacturer's Address: 815 – 14th St. SW
Loveland, Colorado 80537
USA

Declares, that the product

Product Name: Summing Amplifier/DAC
Model Number: E1446A
Product Options: *This declaration covers all options of the above product(s).*

Conforms with the following European Directives:

The product herewith complies with the requirements of the Low Voltage Directive 73/23/EEC and the EMC Directive 89/336/EEC (including 93/68/EEC) and carries the CE Marking accordingly.

Conforms with the following product standards:

	Standard	**Limit**
EMC		
	CISPR 11:1990 / EN 55011:1991	*Group 1 Class A*
	IEC 801-2 :1991 / EN50082-1 : 1992	*4kV CD, 8kV AD*
	IEC 801-3 :1984 / EN50082-1 : 1992	*3 V/m*
	IEC 801-4 :1988 / EN50082-1 : 1992	*0.5kV signal lines, 1kV power lines*
	The produt was tested in a typical configuration with Agilent Technologies or Hewlett-Packard Company test systems	
Safety	*IEC 1010-1:1990+A2:1996 / EN 61010-1:1993*	
	Canada: CSA C22.2 No. 1010.1:1992	
	UL 3111-1	

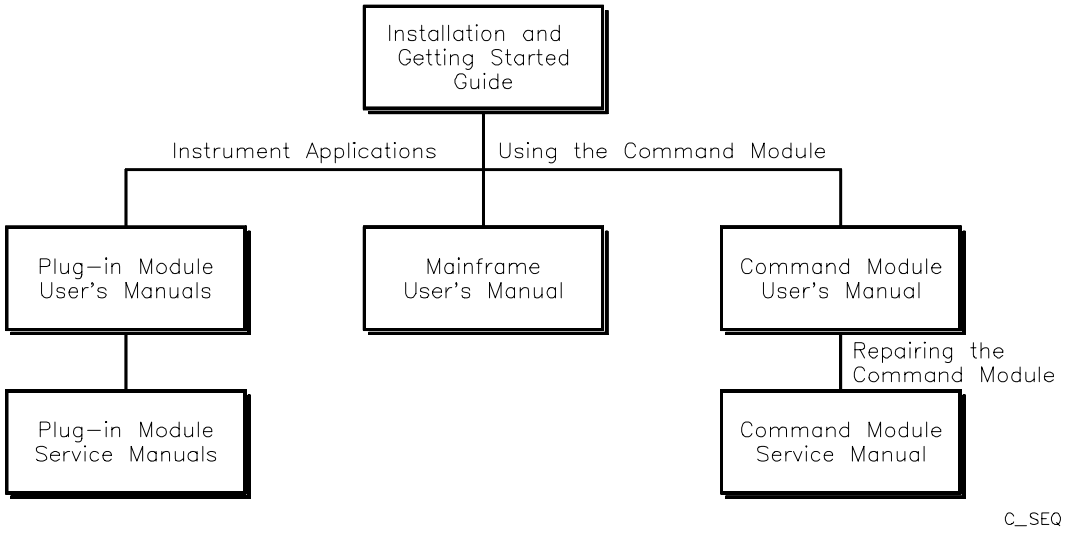
3 May 2001
Date

Ray Corson
Product Regulations Program Manager

For further information, please contact your local Agilent Technologies sales office, agent or distributor.
Authorized EU-representative: Agilent Technologies Deutschland GmbH, Herrenberger Strabe 130, D 71034 Böblingen, Germany

Agilent 75000 Series C Service Documentation

Suggested Sequence to Use Manuals



Manual Descriptions

Title	Description
Series C Installation and Getting Started Guide	Step-by-step instructions for all aspects of plug-in module, mainframe, and command module installation. Also contains introductory programming information and examples.
Mainframe User's Manual	Information to prepare the mainframe and to install plug-in modules.
Command Module User's Manual	Programming information for the command module and general programming information for instruments installed in the mainframe.
Command Module Service Manual	Command module service information. Includes information and procedures for functional verification, operation verification, performance verification, troubleshooting, and repair.
Plug-In Module User's Manuals	Plug-in module programming and configuration information. Contains programming examples and SCPI command reference for the module.
Plug-In Module Service Manuals	Plug-in module service information. Depending on the module, includes information and procedures for functional verification, operation verification, performance verification, adjustment, troubleshooting, and repair.

What's in this Manual

Manual Overview

This manual shows how to service the Agilent E1446A Summing Amplifier/DAC. See the *Agilent E1446A User's Manual* for additional information on installing, configuring, and operating the instrument. Consult the appropriate mainframe manual for information on configuring and operating the mainframe.

Manual Content

Chap	Title	Content
1	General Information	Lists basic instrument descriptions, tools and test equipment required for service, and procedures to inspect and ship the instrument.
2	Verification Tests	Describes functional verification, operation verification, and performance verification tests for the instrument.
3	Replaceable Parts	Lists part numbers of replaceable parts for the instrument. Also includes information to order spare parts and to exchange/replace instruments.
4	Service	Procedures to aid in fault isolation and repair of the instrument.

Contents

Chapter 1 - General Information

Chapter 2 - Verification Tests

Chapter 3 - Replaceable Parts

Chapter 4 - Service

1
General Information

Introduction

This manual contains information required to test, troubleshoot, and repair the Agilent E1446A C-Size VXI Summing Amplifier/DAC (amplifier). See the *Agilent E1446A User's Manual* for additional information. Figure 1-1 shows the Agilent E1446A. This chapter includes the following sections:

- Introduction
- Safety Considerations
- Inspection/Shipping
- Environment
- Amplifier Description
- Recommended Test Equipment

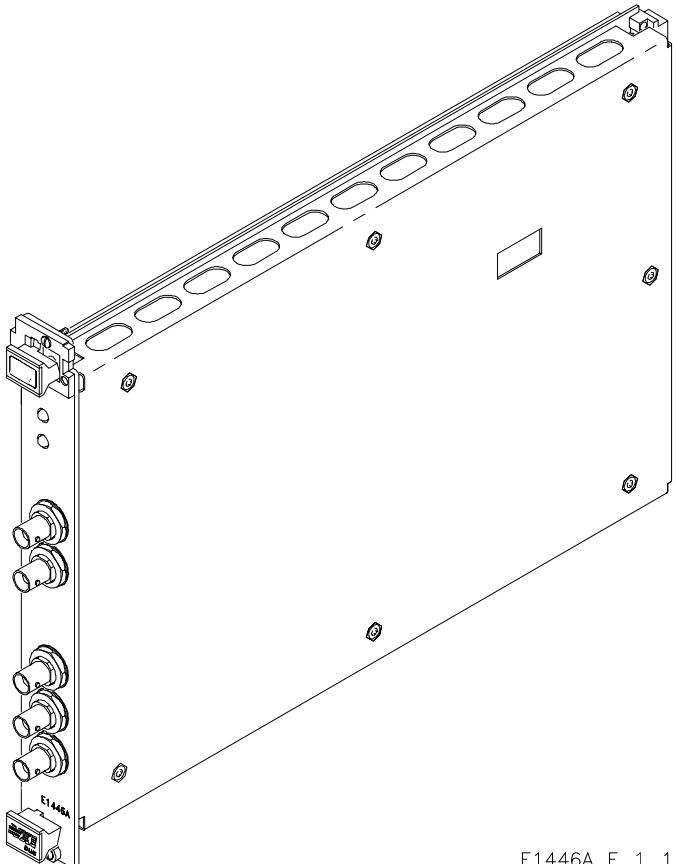


Figure 1-1. Agilent E1446A Summing Amplifier/DAC

Safety Considerations

This product is a Safety Class I instrument that is provided with a protective earth terminal when installed in the mainframe. The mainframe, amplifier, and all related documentation should be reviewed for familiarization with safety markings and instructions before operation or service.

Refer to the WARNINGS page (page iii) in this manual for a summary of safety information. Safety information for preventive maintenance, testing, and service follows and is also found throughout this manual.

Warnings and Cautions

This section contains WARNINGS which must be followed for your protection and CAUTIONS which must be followed to avoid damage to the equipment when performing instrument maintenance or repair.

WARNING

SERVICE-TRAINED PERSONNEL ONLY. The information in this manual is for service-trained personnel who are familiar with electronic circuitry and are aware of the hazards involved. To avoid personal injury or damage to the instrument, do not perform procedures in this manual or do any servicing unless you are qualified to do so.

CHECK MAINFRAME POWER SETTINGS. Before applying power, verify that the mainframe setting matches the line voltage and that the correct fuse is installed. An uninterruptible safety earth ground must be provided from the main power source to the supplied power cord set.

GROUNDING REQUIREMENTS. Interruption of the protective (grounding) conductor (inside or outside the mainframe) or disconnecting the protective earth terminal will cause a potential shock hazard that could result in personal injury. (Grounding one conductor of a two-conductor outlet is not sufficient protection.)

IMPAIRED PROTECTION. Whenever it is likely that instrument protection has been impaired, the mainframe must be made inoperative and be secured against any unintended operation.

WARNING

REMOVE POWER IF POSSIBLE. Some procedures in this manual may be performed with power supplied to the mainframe while protective covers are removed. Energy available at many points may, if contacted, result in personal injury. (If maintenance can be performed without power applied, the power should be removed.)

USING AUTOTRANSFORMERS. If the mainframe is to be energized via an autotransformer (for voltage reduction) make sure the common terminal is connected to neutral (that is, the grounded side of the main's supply).

CAPACITOR VOLTAGES. Capacitors inside the mainframe may remain charged even when the mainframe has been disconnected from its source of supply.

USE PROPER FUSES. For continued protection against fire hazard, replace the line fuses only with fuses of the same current rating and type (such as normal blow, time delay, etc.). Do not use repaired fuses or short-circuited fuseholders.

CAUTION

Static electricity is a major cause of component failure. To prevent damage to the electrical components in the amplifier, observe anti-static techniques whenever working on the amplifier.

Inspection/ Shipping

This section describes initial (incoming) inspection and shipping guidelines for the amplifier.

Initial Inspection

Use the steps in Figure 1-2 as guidelines to perform initial inspection of the amplifier.

WARNING

To avoid possible hazardous electrical shock, do not perform electrical tests if there are signs of shipping damage to the shipping container or to the instrument.

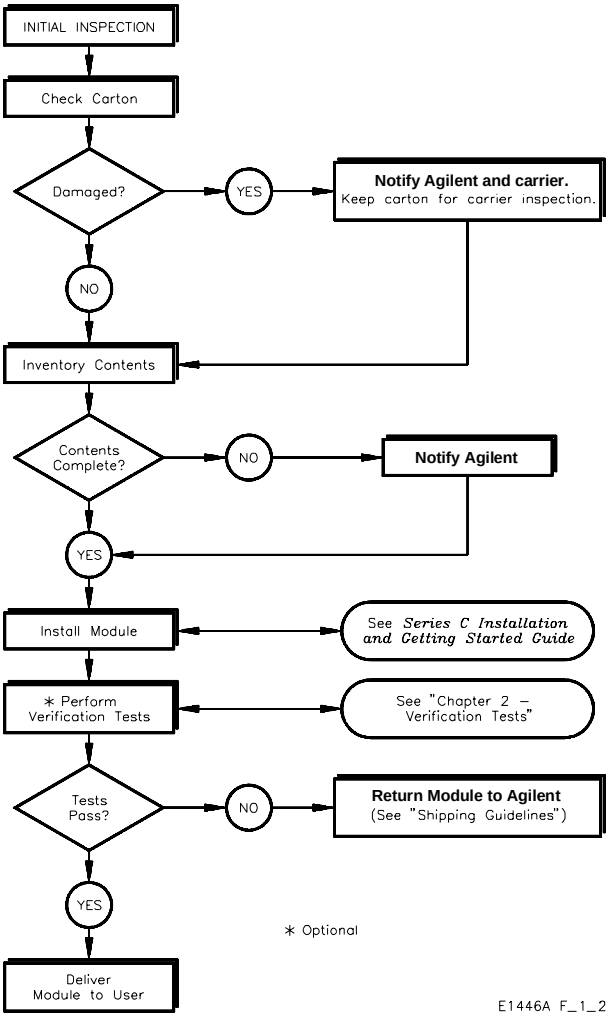
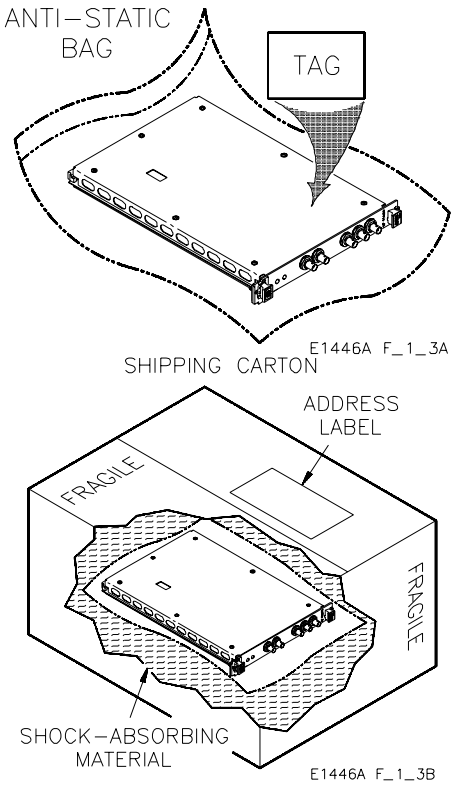


Figure 1-2. Initial (Incoming) Inspection Guidelines

Shipping Guidelines

Follow the steps in Figure 1-3 to return the amplifier to a Agilent Technologies Sales and Support Office or Service Center.



1 Prepare the Module

- Attach tag to module that identifies
  - owner
  - Model Number/Serial Number
  - Service Required
- Place tagged device in anti-static bag

2 Package the Module

- Place packaged module in shipping carton*
  Place 75 to 100 mm (3 to 4 inches) of shock-absorbing shock-absorbing material around the module
- Seal the shipping carton securely
- Mark the shipping carton FRAGILE

3 Ship the Module to Agilent Technologies

- Place address label on shipping carton **
- Send carton to Agilent Technologies

*We recommend you use the same shipping materials as those used in factory packaging (available from Agilent Technologies). For other (commercially-available) shipping materials, use a double-wall carton with minimum 2.4 MPa (350 psi) test.

Figure 1-3. Packaging/Shipping Guidelines

Environment

The recommended operating environment for the Agilent E1446A amplifier is:

Environment	Temperature	Humidity
Operating	0°C to +55°C	<65% relative (0°C to +40°C)
Storage and Shipment	-40°C to +75°C	<65% relative (0°C to +40°C)

Amplifier Description

The Agilent E1446A amplifier is a VXIbus C-size, register-based instrument. The amplifier can operate in a C-size VXIbus mainframe using an Agilent E1405/E1406 Command Module and Standard Commands for Programmable Instruments (SCPI). If the amplifier address is within the Servant Area of an Agilent E1445A Arbitrary Function Generator, then the amplifier can operate without a Command Module.

Amplifier Specifications

Amplifier specifications are listed in Appendix A of the *Agilent E1446A User's Manual*. These specifications are the performance standards or limits against which the instrument may be tested.

Amplifier Serial Numbers

Figure 1-4 shows Agilent Technologies serial number structure. Amplifiers covered by this manual are identified by a serial number prefix listed on the title page.

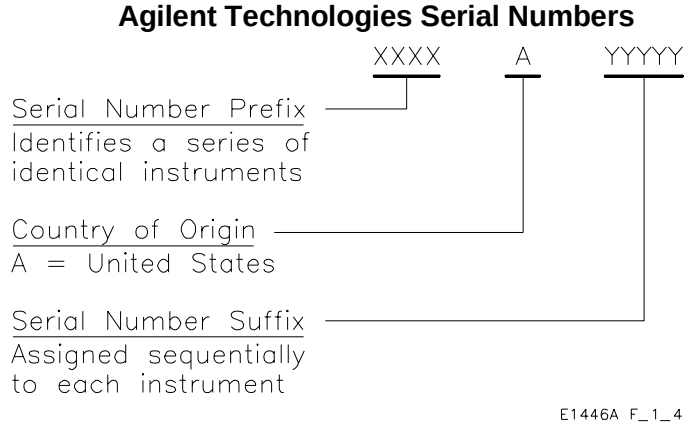


Figure 1-4. Agilent Technologies Serial Numbers

Recommended Test Equipment

Table 1-1 lists the test equipment recommended for testing and servicing the amplifier. Essential requirements for each piece of test equipment are described in the Requirements column.

Table 1-1. Recommended Test Equipment

Instrument	Requirements	Recommended Model	Use*
Controller, GPIB	GPIB compatibility as defined by IEEE Standard 488-1988 and the identical ANSI Standard MC1.1: SH1, AH1, T2, TE0, L2, LE0, SR0, RL0, PP0, DC0, DT0, and C1, 2, 3, 4, 5.	HP 9000 Series 300	F,O, P,T
Mainframe	Compatible with amplifier	Agilent E1400B/T or Agilent E1401A	F,O, P,T
Command Module	TTL compatible Trig Out	Agilent E1405B or Agilent E1406A	F,O, P,T
Digital Multimeter	DCV	Agilent 3458A	O,P
Function Generator	DCV	Agilent 3325A/B	O,P
Spectrum Analyzer	Frequency Range: 100 Hz - 40 MHz Tracking Generator: -10 dBm (nominal)	Agilent 3585A/B	P

* F = Functional Verification, O = Operation Verification Tests, P = Performance Verification Tests, T = Troubleshooting

2
Verification Tests

Introduction

The three levels of test procedures described in this chapter are used to verify that the Agilent E1446A:

- is fully functional (Functional Verification)
- meets selected testable specifications (Operation Verification)
- meets all testable specifications (Performance Verification)

WARNING

Do not perform any of the following verification tests unless you are a qualified, service-trained technician and have read the WARNINGS and CAUTIONS in Chapter 1.

Test Conditions/ Procedures

See Table 1-1 for test equipment requirements. You should complete the Performance Verification tests at least once a year. For heavy use or severe operating environments, perform the tests more often. Before performing these tests, allow the amplifier to warm up for at least one hour. The temperature should be between 18°C and 28°C.

The verification tests assume that the person performing the tests understands how to operate the mainframe, the amplifier, and specified test equipment. The test procedures do not specify equipment settings for test equipment, except in general terms. It is assumed that a qualified, service-trained technician will select and connect the cables, adapters, and probes required for the test.

Performance Test Record

The results of each Performance Verification test may be recorded in Table 2-4, *Agilent E1446A Performance Test Record*. This form can be copied, if desired.

Verification Test Examples

Each verification test procedure includes an example program that performs the test. All example programs assume the following configuration:

- Controller is an HP 9000 Series 200/300 computer
- Programming language is BASIC
- Amplifier address is 70911 (logical address is 88)
- Amplifier Commander is an Agilent E1405/E1406
- DMM is an Agilent 3458A at address 722

Using an Agilent E1445A as the Commander

The procedures and examples in this chapter assume that the amplifier is configured as a stand-alone instrument. (i.e., it is not a servant of an Agilent E1445A Arbitrary Function Generator). To use an Agilent E1445A as the commander, make sure that the amplifier is placed in the servant area of the E1445A, then send all commmands to the E1445A address (see the *Agilent E1446A User's Manual* for more information).

The procedures and examples in this chapter can be modified to work with an E1445A as the Commander by changing the following keywords as shown and sending all commands to the E1445A.

Agilent E1446A Commands

Agilent E1405/E1406 Commander	Agilent E1445A Commander
INPut[1] :ATTenuation :IMPedance	INPut[1] :ATTenuation :IMPedance
INPut2 :ATTenuation :IMPedance	INPut2 :ATTenuation :IMPedance
OUTPut1 :ATTenuation :IMPedance :OVERload? [:STATe] :ACTual?	OUTPut2 :ATTenuation :IMPedance :OVERload? [:STATe] :ACTual?
OUTPut2 :IMPedance	OUTPut3 :IMPedance
OUTPut3 :IMPedance	OUTPut4 :IMPedance
SOURce:VOLTage [:LEVel][:IMMediate]:OFFSet	SOURce2:VOLTage [:LEVel][:IMMediate]:OFFSet

Functional Verification

The purpose of this test is to verify communication with the mainframe or command module. No attempt is made to verify that the amplifier is meeting specifications. Functional Verification for the amplifier is accomplished by performing the Self-Test described below.

Self-Test Procedure

1. Remove any connections to the amplifier front panel.
2. Reset the amplifier:

   *RST;*CLS — *Reset amplifier and clear status registers*
3. Execute the amplifier self-test:

   *TST? — *Self-test command*
4. Read the result. A "0" indicates that the test passed. If a failure occurs, the amplifier returns a "1" and generates an error message that identifies the cause of the failure.

Example Program

```
10 !  RE-STORE "SELF_TEST"
20    DIM Result$[255]
30    ASSIGN @Amp TO 70911
40    !
50    OUTPUT @Amp;"*RST;*CLS"!Reset amplifier
60    OUTPUT @Amp;"*TST?"!Perform Self-test
70    ENTER @Amp;Result$
80    PRINT Result$
90    END
```

Operation Verification

Operation Verification is a subset of the Performance Verification tests that follow. For the amplifier, Operation Verification consists of the following tests:

- Test 2-3: Low-level Outputs Test
- Test 2-4: Main Output Test
- Test 2-5: Offset DAC Test

Performance Verification

The procedures in this section are used to test the amplifier's electrical performance using the specifications in Appendix A of the *Agilent E1446A User's Manual* as the performance standards. These tests are suitable for incoming inspection, troubleshooting, and preventive maintenance. The results of the Performance Verification tests should be recorded in the Performance Test Record (Table 2-4).

Performance Verification includes the following tests:

Test #	Test Name
2-1	Input Attenuation Test
2-2	Output Attenuation Test
2-3	Low-Level Outputs Test
2-4	Main Output Test
2-5	Offset DAC Test
2-6	Bandwidth Test

Test 2-1: Input Attenuator Test

Description

The purpose of this test is to verify that the amplifier meets its specifications for input attenuator accuracy.

Equipment Setup

- Set Source to: DCV
- Set DMM to: DCV, autorange
- Connect the DMM to the amplifier as shown in Figure 2-1

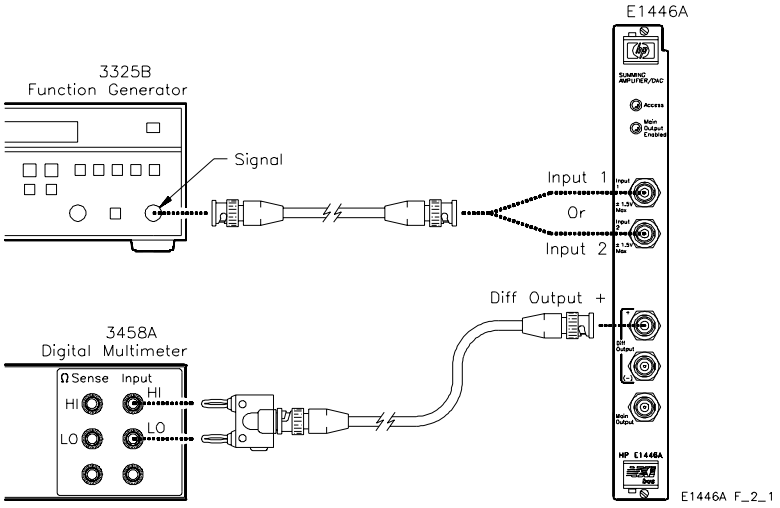


Figure 2-1. Input Attenuation Test Setup

Test Procedure

1. Reset the amplifier:

   *RST;*CLS — *Reset amplifier and clear status registers*

2. Set the amplifier Input1 attenuation:

   INP1:ATT 0

3. Connect the Source to Input1 as shown in Figure 2-1.

4. Set the Source to + 0.5 VDC and measure the amplifier output with the DMM. Repeat with the Source set to -0.5 VDC. Average the two readings to get a reference level:

$$\text{Reference Level (V)} = \frac{\text{Positive Reading (V)} - \text{Negative Reading (V)}}{2}$$

5. Set the amplifier Input1 attenuation to 1 dB:

   INP1:ATT 1

6. Measure a + 0.5 VDC signal and a -0.5 VDC signal as in step 4. Average the two readings:

$$\text{Averaged Reading (V)} = \frac{\text{Positive Reading (V)} - \text{Negative Reading (V)}}{2}$$

7. Calculate the attenuation using the results from steps 4 and 6. Record the result in Table 2-4.

$$\text{Attenuation (dB)} = 20 \cdot \log\left(\frac{\text{Averaged Reading (V)}}{\text{Reference Level (V)}}\right)$$

8. Repeat steps 5 - 7 for the attenuations shown below, changing step 5 as specified:

Attenuation Setting (dB)	Step 5 Command
2	INP1:ATT 2
4	INP1:ATT 4
8	INP1:ATT 8
16	INP1:ATT 16

9. Set the amplifier Input2 attenuation:

   INP2:ATT 0

10. Connect the Source to Input2 as shown in Figure 2-1.

11. Repeat steps 4 - 8 for Input2, changing step 5 as shown below.

Attenuation Setting (dB)	Step 5 Command
1	INP2:ATT 1
2	INP2:ATT 2
4	INP2:ATT 4
8	INP2:ATT 8
16	INP2:ATT 16

Example Program

```
10 !   RE-STORE "INPUT_ATTN"
20     !
30     !---------- Set up I/O path ----------
40     ASSIGN @Amp TO 70911
50     ASSIGN @Dmm TO 722
60     !
70     !---------- Initialize variables ----------
80     Vin= .5
90     !
100    !---------- Set up DMM ----------
110    DISP "Connect DMM to Diff +  Output, then press 'Continue'"
120    PAUSE
130    CLEAR SCREEN
140    OUTPUT @Dmm;"PRESET NORM;DCV;RANGE AUTO"
150    WAIT 1
160    !
170    !---------- Set up amplifier ----------
180    OUTPUT @Amp;"*RST;*CLS"   !Reset amplifier
190    WAIT .5
200    !
210    !---------- Perform test ----------
220    FOR Ch= 1 TO 2
230       OUTPUT @Amp;"INP"&VAL$(Ch)&":ATT 0"
240       !
250       DISP "Connect Source to Input"&VAL$(Ch)&", then press 'Continue'"
260       PAUSE
270       DISP
280       !
290       GOSUB Measure
300       Ref_level= (Pos_rdg-Neg_rdg)/2
310       !
320       PRINT TAB(12);"Input "&VAL$(Ch)
330       PRINT
340       PRINT USING "10A,10X,12A";"Atten (dB)","Reading (dB)"
350       PRINT
360       FOR I= 0 TO 4  !Loop through attenuations
370          Attn= 2^  I
380          OUTPUT @Amp;"INP"&VAL$(Ch)&":ATT "&VAL$(Attn)
400          WAIT .5
410          !
420          GOSUB Measure
430          Ave_rdg= (Pos_rdg-Neg_rdg)/2
```

Continued on next page

```
440         Result_db= 20*LGT(Ave_rdg/Ref_level)
450         Result_db= PROUND(Result_db,-4)
460         PRINT USING "4X,DD,16X,MDD.4D";Attn,Result_db
470       NEXT I    !Next attenuation
480       PRINT
490       PRINT
500     NEXT Ch  !Next input
510     !
520 Quit:   !
530     ASSIGN @Amp TO *
540     ASSIGN @Dmm TO *
550     STOP
560     !
570 Measure:   !
580     !Measure positive signal
590     DISP "Set Source to "&VAL$(Vin)&" VDC, then press 'Continue'"
600     PAUSE
610     DISP
620     OUTPUT @Dmm;"TRIG SGL"
630     ENTER @Dmm;Pos_rdg
640     !
650     !Measure negative signal
660     DISP "Set Source to "&VAL$(-Vin)&" VDC, then press 'Continue'"
670     PAUSE
680     DISP
690     OUTPUT @Dmm;"TRIG SGL"
700     ENTER @Dmm;Neg_rdg
710     RETURN
720     !
730     END
```

Test 2-2: Output Attenuator Test

Description

The purpose of this test is to verify that the amplifier meets its specifications for output attenuator accuracy.

Equipment Setup

- Set Source to: DCV
- Set DMM to: DCV, autorange
- Connect the DMM to the amplifier as shown in Figure 2-2

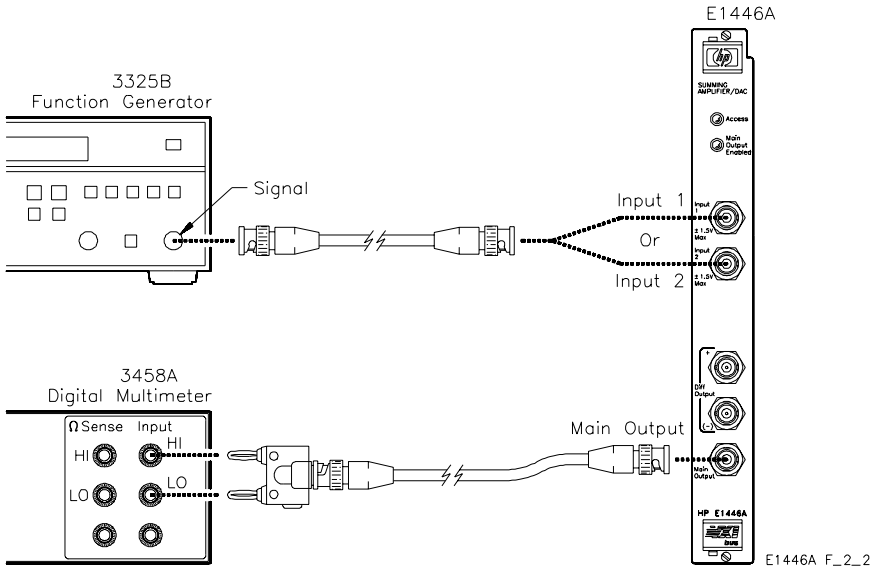


Figure 2-2. Output Attenuation Test Setup

Test Procedure

1. Reset the amplifier:

   *RST;*CLS — *Reset amplifier and clear status registers*

2. Connect the Source to Input1 as shown in Figure 2-2.

3. Set the amplifier output attenuation to 0 dB:

   OUTP1:ATT 0

4. Set the Source to + 0.5 VDC and measure the amplifier output with the DMM. Repeat with the Source set to -0.5 VDC. Average the two readings to get a reference level:

$$\text{Reference Level (V)} = \frac{\text{Positive Reading (V)} - \text{Negative Reading (V)}}{2}$$

5. Set the amplifier Output attenuation to 20 dB:

   OUTP1:ATT 20

6. Measure a + 0.5 VDC signal and a -0.5 VDC signal as in step 4. Average the two readings:

$$\text{Averaged Reading (V)} = \frac{\text{Positive Reading (V)} - \text{Negative Reading (V)}}{2}$$

7. Calculate the attenuation using the results from steps 4 and 6. Record the results in Table 2-4:

$$\text{Attenuation (dB)} = 20 \cdot \log\left(\frac{\text{Averaged Reading (V)}}{\text{Reference Level (V)}}\right)$$

8. Connect the Source to Input2 as shown in Figure 2-2.

9. Repeat steps 4 - 7 for Input2.

Example Program

```
10 !   RE-STORE "OUTPUT_ATTN"
20     !
30     !---------- Set up I/O path ----------
40     ASSIGN @Amp TO 70911
50     ASSIGN @Dmm TO 722
60     !
70     !---------- Initialize variables ----------
80     Vin= .5
90     !
100    !---------- Set up DMM ----------
110    DISP "Connect DMM to Main Output, then press 'Continue'"
120    PAUSE
130    CLEAR SCREEN
140    OUTPUT @Dmm;"PRESET NORM;DCV;RANGE AUTO"
150    WAIT 1
160    !
170    !---------- Set up amplifier ----------
180    OUTPUT @Amp;"*RST;*CLS" !Reset amplifier
190    WAIT .5
200    !
210    !---------- Perform test ----------
220    FOR Ch= 1 TO 2
230       DISP "Connect Source to Input"&VAL$(Ch)&", then press 'Continue'"
240       PAUSE
250       DISP
260       !
270       !20 dB attenuator OFF
280       OUTPUT @Amp;"OUTP1:ATT 0"
290       WAIT .5
300       GOSUB Measure
310       Ref_level= (Pos_rdg-Neg_rdg)/2
320       !
330       PRINT TAB(12);"Input "&VAL$(Ch)
340       PRINT
350       !
360       !20 dB attenuator ON
370       OUTPUT @Amp;"OUTP1:ATT 20"
380       WAIT .5
390       GOSUB Measure
400       Ave_rdg= (Pos_rdg-Neg_rdg)/2
410       !
```

Continued on next page

```
420       Result_db= 20*LGT(Ref_level/Ave_rdg)
430       Result_db= PROUND(Result_db,-4)
440       PRINT "Reading (dB) =  ";Result_db
450       PRINT
460       PRINT
470    NEXT Ch !Next input
480    !
490 Quit:   !
500    ASSIGN @Amp TO *
510    ASSIGN @Dmm TO *
520    STOP
530    !
540 Measure:   !
550    !Measure positive signal
560    DISP "Set Source to "&VAL$(Vin)&" VDC, then press 'Continue'"
570    PAUSE
580    DISP
590    OUTPUT @Dmm;"TRIG SGL"
600    ENTER @Dmm;Pos_rdg
610    !
620    !Measure negative signal
630    DISP "Set Source to "&VAL$(-Vin)&" VDC, then press 'Continue'"
640    PAUSE
650    DISP
660    OUTPUT @Dmm;"TRIG SGL"
670    ENTER @Dmm;Neg_rdg
680    RETURN
690    !
700    END
```

Test 2-3: Low-level Outputs Test

Description The purpose of this test is to verify that the amplifier meets its accuracy specifications for low-level (differential) outputs.

Equipment Setup

- Set Source to: DCV
- Set DMM to: DCV, 10 V range

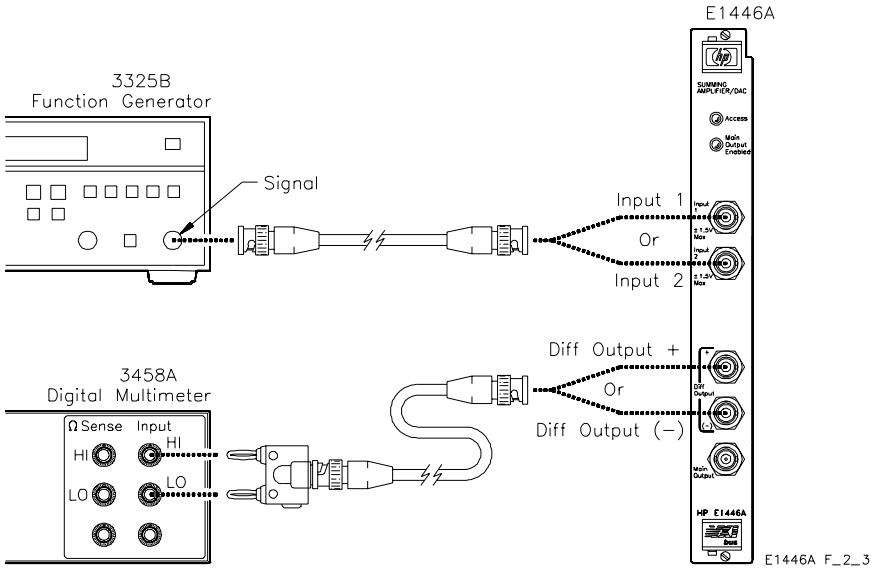


Figure 2-3. Low-level Outputs Test Setup

Test Procedure

1. Reset the amplifier:

```
*RST;*CLS                    Reset amplifier and clear status registers
```

Repeat steps 2-5 for each entry listed in Table 2-1:

2. Connect the DMM to the amplifier output specified in Table 2-1 (see Figure 2-3).
3. Connect the Source to the amplifier input specified in Table 2-1 (see Figure 2-3).
4. Set the Source to the input voltage specified in Table 2-1.
5. Measure the amplifier output with the DMM. Record the results in Table 2-4.

Table 2-1. Low-level Outputs Test

Connect DMM to:	Connect Source to:	Input Voltage (VDC)	Expected Output (VDC)
Diff+	Input1	0.5	1.0
Diff+	Input1	0.75	1.5
Diff+	Input1	-0.75	-1.5
Diff+	Input2	0.5	1.0
Diff-	Input1	0.5	1.0
Diff-	Input1	0.75	1.5
Diff-	Input1	-0.75	-1.5
Diff-	Input2	0.5	1.0

Example Program

```
10 !   RE-STORE "LL_OUT"
20     DIM Nominal(1:4),Input$(1:4)[10]
30     !
40     !---------- Set up I/O path ----------
50     ASSIGN @Amp TO 70911
60     ASSIGN @Dmm TO 722
70     !
80     !---------- Initialize variables ----------
90     Gain= 2.0
100    RESTORE Data_nominal
110    READ Nominal(*)
120    !
130    RESTORE Data_input
140    READ Input$(*)
150    !
160    !---------- Set up DMM and source ----------
170    OUTPUT @Dmm;"PRESET NORM;DCV;RANGE 10"
190    !
200    !---------- Set up amplifier ----------
210    OUTPUT @Amp;"*RST;*CLS"  !Reset amplifier
220    WAIT .5
230    !
240    !---------- Perform test ----------
250    FOR J= 1 TO 2
260       IF J= 1 THEN
270          Output$= "DIFF+ "
280       ELSE
290          Output$= "DIFF-"
```

Continued on next page

```
300       END IF
310       !
320       DISP "Connect DMM to "&Output$&", then press 'Continue'"
330       PAUSE
340       DISP
350       PRINT TAB(23);Output$
360       PRINT
370       PRINT USING "5A,6X,9A,4X,11A,4X,11A";"Input","Input (V)","Nominal (V)","Reading (V)"
380       PRINT
390       FOR I= 1 TO 4
400          Input_v= Nominal(I)/(Gain*((-1)^  (Output$= "DIFF-")))
410          !Test connections
420          IF I= 1 OR I= 4 THEN
430             DISP "Connect Source to "&Input$(I)&", then press 'Continue'"
440             PAUSE
450          END IF
460          DISP
470          GOSUB Measure
480          PRINT USING "6A,6X,MD.3D,8X,MD.3D,9X,MD.5D";Input$(I),Input_v,Nominal(I),Rdg
490       NEXT I
500       PRINT
510       PRINT
520    NEXT J
530 Quit:   !
540    ASSIGN @Amp TO *
550    ASSIGN @Dmm TO *
560    STOP
570 Measure:   !
580    !SET SOURCE
590    DISP "Set Source to "&VAL$(Input_v)&" VDC, then press 'Continue'"
600    PAUSE
610    DISP
620    !Measure output
630    OUTPUT @Dmm;"TRIG SGL"
640    ENTER @Dmm;Rdg
650    Rdg= PROUND(Rdg,-5)
660    RETURN
670 Data_nominal:   !
680    DATA 1.0,1.5,-1.5,1.0
690 Data_input:     !
700    DATA INPUT1,INPUT1,INPUT1,INPUT2
710    END
```

Test 2-4: Main Output Test

Description

The purpose of this test is to verify that the amplifier meets its accuracy specifications for the main output.

Equipment Setup

- Set Source to: DCV
- Set DMM to: DCV, autorange
- Connect the DMM to the amplifier as shown in Figure 2-4

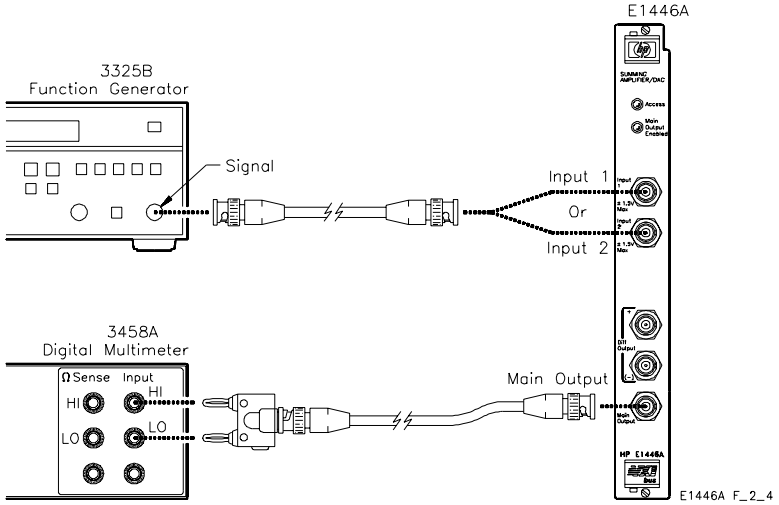


Figure 2-4. Main Output Test Setup

Test Procedure

1. Reset the amplifier:

   ```
   *RST;*CLS
   ```

   Reset amplifier and clear status registers

2. Connect the Source to the amplifier Input1 as shown in Figure 2-4.

3. Set the Source to + 1 VDC and measure the amplifier output. Record the result in Table 2-4.

4. Set the Source to -1 VDC and measure the amplifier output. Record the result in Table 2-4.

5. Repeat steps 3 and 4 with Source connected to Input2. Record the results in Table 2-4.

Example Program

```
10 !   RE-STORE "MAIN_OUT"
20     DIM Nominal(1:2)
30     !
40     !---------- Set up I/O path ----------
50     ASSIGN @Amp TO 70911
60     ASSIGN @Dmm TO 722
70     !
80     !---------- Initialize variables ----------
90     Gain= 20.0
100    RESTORE Data_nominal
110    READ Nominal(*)
120    !
130    !---------- Set up DMM and Source ----------
140    OUTPUT @Dmm;"PRESET NORM;DCV;RANGE AUTO"
150    WAIT .5
160    DISP "Connect DMM to Main Output of amplifier, then press 'Continue'"
170    PAUSE
180    CLEAR SCREEN
190    !
200    !---------- Set up amplifier ----------
210    OUTPUT @Amp;"*RST;*CLS"  !Reset amplifier
220    WAIT .5
230    !
240    !---------- Perform test ----------
250    FOR Ch= 1 TO 2
260       DISP "Connect Source to Input"&VAL$(Ch)&", then press 'Continue'"
270       PAUSE
280       DISP
290       !
300       PRINT TAB(17);"INPUT"&VAL$(Ch)
310       PRINT
320       PRINT USING "9A,5X,11A,4X,11A";"Input (V)","Nominal (V)","Reading (V)"
330       PRINT
340       !
350       FOR I= 1 TO 2
360          Input_v= Nominal(I)/Gain
370          !
```

Continued on next page

```
380         GOSUB Measure
390         PRINT USING "1X,SD.3D,9X,SDD.3D,7X,SDD.5D";Input_v,Nominal(I),Rdg
400       NEXT I
410       PRINT
420       PRINT
430     NEXT Ch
440     !
450 Quit:   !
460     ASSIGN @Amp TO *
470     ASSIGN @Dmm TO *
480     STOP
490     !
500 Measure:   !
510     !Set Source
520     DISP "Set Source to "&VAL$(Input_v)&" VDC, then press 'Continue'"
530     PAUSE
540     DISP
550     !
560     !Measure output
570     OUTPUT @Dmm;"TRIG SGL"
580     ENTER @Dmm;Rdg
590     Rdg= PROUND(Rdg,-5)
600     RETURN
610     !
620 Data_nominal:   !
630     DATA 20.0,-20.0
640     END
```

Test 2-5: Offset DAC Test

Description The purpose of this test is to verify that the amplifier meets its offset DAC accuracy specifications.

Equipment Setup

- Set DMM to: DCV, autorange
- Connect the DMM to the amplifier as shown in Figure 2-5

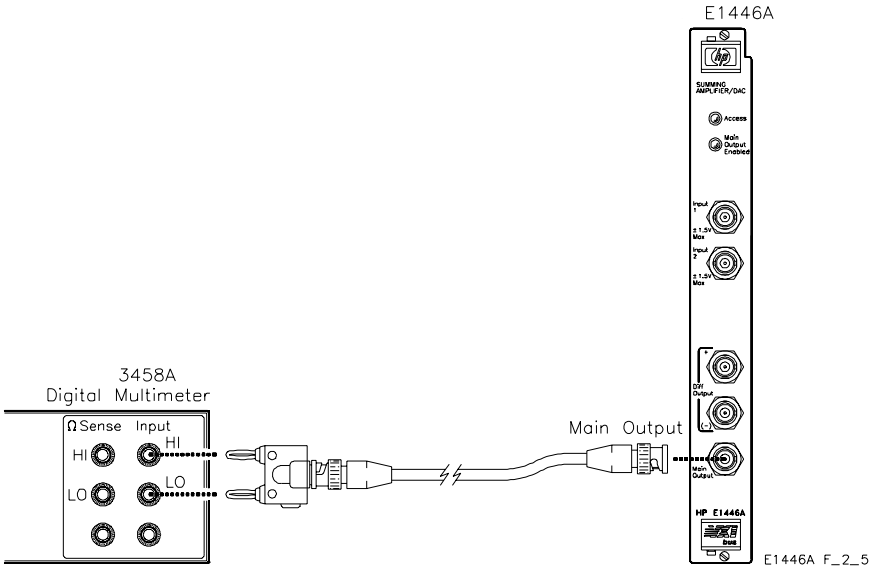


Figure 2-5. Offset DAC Test Setup

Test Procedure

1. Reset the amplifier:

   *RST;*CLS — *Reset amplifier and clear status registers*

Repeat steps 2 and 3 for each entry in Table 2-2:

2. Set the amplifier offset voltage:

   VOLT:OFFS < *offset voltage*>

   where < *offset voltage*> is the value specified in Table 2-2.

3. Measure the amplifier output with the DMM and record the result in Table 2-4.

NOTE

Because the DMM is a high-impedance load, the reading should be equal to twice the amplifier's offset voltage setting.

Table 2-2. Offset DAC Test Points

Offset Voltage (VDC)	Expected reading (VDC)
-10.0	-20.0
-5.0	-10.0
0.0	0.0
5.0	10.0
9.9996	19.9992

Example Program

```
10 !   RE-STORE "OFFSET_DAC"
20     DIM Nominal(1:5)
30     !
40     !---------- Set up I/O path ----------
50     ASSIGN @Amp TO 70911
60     ASSIGN @Dmm TO 722
70     !
80     !---------- Initialize variables ----------
90     READ Nominal(*)
100    !
110    !---------- Set up DMM ----------
120    OUTPUT @Dmm;"PRESET NORM;DCV;RANGE AUTO"
130    DISP "Connect DMM to Main Output, then press 'Continue'"
140    PAUSE
150    CLEAR SCREEN
160    !
170    !---------- Set up amplifier ----------
180    OUTPUT @Amp;"*RST;*CLS"   !Reset amplifier
190    WAIT .5
200    !
```

Continued on next page

```
210   !---------- Perform test ----------
220   PRINT USING "11A,8X,11A";"Nominal (V)","Reading (V)"
230   PRINT
240   !
250   FOR I= 1 TO 5
260      Dac_v= (Nominal(I)/2.0)
270      GOSUB Measure
280      Result= PROUND(Rdg,-6)
290      PRINT USING "1X,SDD.4D,11X,SDD.5D";Nominal(I),Result
300   NEXT I
310   !
320 Quit:   !
330   ASSIGN @Amp TO *
340   ASSIGN @Dmm TO *
350   STOP
360   !
370 Measure:   !
380   !Measure output
390   OUTPUT @Amp;"VOLT:OFFS "&VAL$(Dac_v)
400   OUTPUT @Dmm;"TRIG SGL"
410   ENTER @Dmm;Rdg
420   RETURN
430   !
440 Data_nominal:   !
450   DATA -20.0,-10.0,0.0,10.0,19.9992
460   END
```

Test 2-6: Bandwidth Test

Description The purpose of this test is to verify that the amplifier meets its bandwidth specifications.

Equipment Setup

- Set Spectrum Analyzer's tracking generator to -10 dBm (nominal)

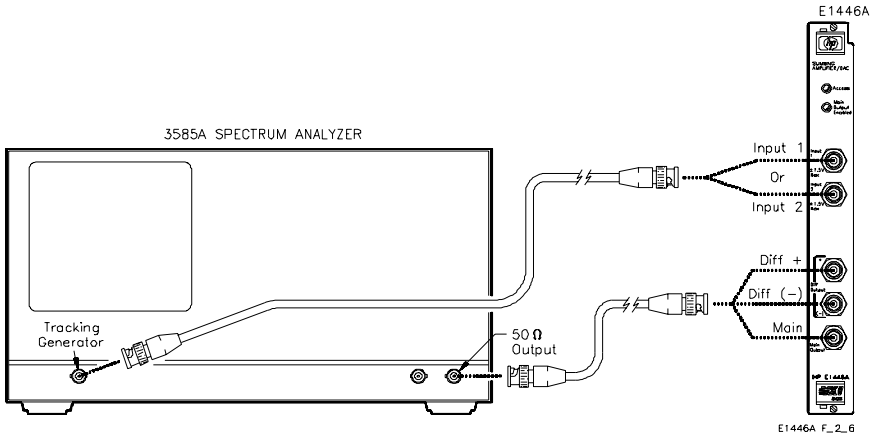


Figure 2-6. Bandwidth Test Setup

Test Procedure

1. Reset the amplifier:

```
*RST;*CLS                    Reset amplifier and clear status registers
```

Repeat steps 2 - 8 for each entry in Table 2-3:

2. Connect the Spectrum Analyzer tracking generator output to the amplifier input specified in Table 2-3 (see Figure 2-6).
3. Set the Spectrum Analyzer range to the value specified in Table 2-3.
4. Connect the Spectrum Analyzer 50 Ω input to the amplifier output specified in Table 2-3 (see Figure 2-6).

5. Set the Spectrum Analyzer as follows:

   - Resolution bandwidth: 30 Hz
   - Video bandwidth: 100 Hz
   - Sweep mode: Manual
   - Manual frequency: 100 Hz

6. Note the amplitude reading at 100 Hz. This value will be used as the reference level in step 8.

7. Set the Spectrum Analyzer as follows:

   - Resolution bandwidth: 10 kHz
   - Video bandwidth: 10 kHz
   - Sweep mode: Continuous

8. Starting from 100 Hz, move the marker to the right until the amplitude reading is 3 dB below the reference level found in step 6. The amplifier bandwidth is equal to the marker frequency at this point. Record the result in Table 2-4.

NOTE

If the maximum frequency of the Spectrum Analyzer is reached before the 3 dB frequency, record the result as '> F_{max}', where F_{max} is the maximum frequency of the Spectrum Analyzer. If the Spectrum Analyzer is an Agilent 3585A, for example, the result should be written as '> 40E6'.

Table 2-3. Bandwidth Test Points

Connect tracking generator to:	Connect Spectrum Analyzer input to:	Spectrum Analyzer Range:
Input1	Main	15 dB
Input1	Diff+	-5 dB
Input1	Diff-	-5 dB
Input2	Main	15 dB
Input2	Diff+	-5 dB
Input2	Diff-	-5 dB

Example Program

```
10 !   RE-STORE "BANDWIDTH"
20     DIM Output$(1:3)[10]
30     !
40     !---------- Set up I/O paths ----------
50     ASSIGN @Amp TO 70911
60     !
70     !---------- Initialize variables ----------
80     Max_freq= 4.0E+ 7
90     !
100    RESTORE Data_output
110    READ Output$(*)
120    !
130    !---------- Set up amplifier ----------
140    OUTPUT @Amp;"*RST;*CLS"  !Reset amplifier
150    WAIT .5
160    !
170    !---------- Perform test ----------
180    DISP "Set Analyzer Tracking Generator to -10 dBm (nominal), then press 'Continue'"
190    PAUSE
200    !
210    FOR Ch= 1 TO 2
220       DISP "Connect Analyzer Tracking Generator to INPUT"&VAL$(Ch)&", then press 'Continue'"
230       PAUSE
240       DISP
250       !
260       FOR I= 1 TO 3
270          DISP "Connect "&Output$(I)&" to Analyzer 50ohm input, then press 'Continue'"
280          PAUSE
290          DISP
300          !
310          IF Output$(I)= "MAIN" THEN
320             Range$= "15dBm"
330          ELSE
340             Range$= "-5dBm"
350          END IF
360          !
370          PRINT "Set up Analyzer:"
380          PRINT
390          PRINT "    Range:  "&Range$
400          PRINT "    Resolution BW:  30 Hz"
410          PRINT "    Video BW:  100 Hz"
```

Continued on next page

```
420         PRINT "    Sweep Mode:  Manual"
430         PRINT "    Manual Frequency:  100 Hz"
440         INPUT "Enter amplitude at 100 Hz (in dBm):",Ref_level
450         CLEAR SCREEN
460         !
470         GOSUB Meas_bw
480         PRINT "Bandwidth (Hz) =  "&VAL$(Bandwidth)
490         DISP "Press 'Continue' when ready"
500         PAUSE
510         CLEAR SCREEN
520       NEXT I
530   NEXT Ch
540   !
550 Quit:   !
560   ASSIGN @Amp TO *
570   STOP
580   !
590 Meas_bw:   !
600   PRINT "Set up Analyzer:"
610   PRINT
620   PRINT "    Resolution BW:  10 kHz"
630   PRINT "    Video BW:  10 kHz"
640   PRINT "    Sweep Mode:  Continuous"
650   DISP "Press 'Continue' when ready"
660   PAUSE
670   CLEAR SCREEN
680   !
690   PRINT "INPUT"&VAL$(Ch)&"/"&Output$(I)&" OUTPUT"
700   PRINT
710   PRINT "Reference Level (dBm) =  ";Ref_level
720   PRINT
730   DISP "Move marker until amplitude is 3dB below the reference, then press 'Continue'"
740   PAUSE
750   INPUT "Enter marker frequency (in Hz)",Bandwidth
760   RETURN
770   !
780 Data_output:  !
790   DATA MAIN,DIFF+ ,DIFF-
800   END
```

Performance Test Record

Table 2-4, *Performance Test Record for the Agilent E1446A Amplifier*, is a form you can copy and use to record performance verification test results for the amplifier. Table 2-4 shows amplifier accuracy, measurement uncertainty, and test accuracy ratio (TAR) values.

Amplifier Test Limits

Test limits are defined using the specifications in Appendix A of the *Agilent E1446A User's Manual*. The specifications for Bandwidth are single-sided (i.e., there is a lower limit but no upper limit). In the Performance Test Record, the Maximum column will be blank for the Bandwidth Test.

Measurement Uncertainty

For the performance verification tests in this manual, the measurement uncertainties are based on the accuracy specifications for the following test equipment:

Performance Test	Test Equipment
1. Input Attenuation	Agilent 3458A
2. Output Attenuation	Agilent 3458A
3. Low-Level Outputs	Agilent 3325B Agilent 3458A
4. Main Output	Agilent 3325B Agilent 3458A
5. Offset DAC	Agilent 3458A
6. Bandwidth	Agilent 3585A

Test Accuracy Ratio (TAR)

Test Accuracy Ratio (TAR) for the Agilent E1446A is defined as: Amplifier Accuracy divided by Measurement Uncertainty, i.e.,

$$TAR = \frac{\text{Maximum} - \text{Expected Reading}}{\text{Measurement Uncertainty}}$$

For single-sided measurements, Test Accuracy Ratio is not defined, so 'NA' (Not Applicable) will appear in the TAR column. For TARs that exceed 10:1, the entry is '> 10:1'.

Table 2-4. Performance Test Record for the Agilent E1446A (Page 1 of 4)

Test Facility:

Name _____ Report No. _____

Address _____ Date _____

City/State _____ Customer _____

Phone _____ Tested by _____

Model _____ Ambient temperature _____ °C

Serial No. _____ Relative humidity _____ %

Options _____ Line frequency _____ Hz (nominal)

Firmware Rev. _____

Special Notes:

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Table 2-4. Performance Test Record for the Agilent E1446A (Page 2 of 4)

Model _____	Report No. _____	Date _____

Test Equipment Used: Description	Model No.	Trace No.	Cal Due Date
1. _____	_____	_____	_____
2. _____	_____	_____	_____
3. _____	_____	_____	_____
4. _____	_____	_____	_____
5. _____	_____	_____	_____
6. _____	_____	_____	_____
7. _____	_____	_____	_____
8. _____	_____	_____	_____
9. _____	_____	_____	_____
10. _____	_____	_____	_____
11. _____	_____	_____	_____
12. _____	_____	_____	_____
13. _____	_____	_____	_____
14. _____	_____	_____	_____
15. _____	_____	_____	_____
16. _____	_____	_____	_____
17. _____	_____	_____	_____
18. _____	_____	_____	_____
19. _____	_____	_____	_____
20. _____	_____	_____	_____

Table 2-4. Performance Test Record for the Agilent E1446A (Page 3 of 4)

Model _____ **Report No.** _____ **Date** _____

Test Description	Minimum	Measured Reading	Maximum	Meas Uncert	TAR
Test 2-1. Input Attenuator Test (Values in dB)					
Input1:					
1 dB attenuator	-1.1	_____	-0.9	5.4E-5	> 10:1
2 dB attenuator	-2.1	_____	-1.9	5.5E-5	> 10:1
4 dB attenuator	-4.1	_____	-3.9	5.8E-5	> 10:1
8 dB attenuator	-8.1	_____	-7.9	6.6E-5	> 10:1
16 dB attenuator	-16.1	_____	-15.9	9.9E-5	> 10:1
Input2:					
1 dB attenuator	-1.1	_____	-0.9	5.4E-5	> 10:1
2 dB attenuator	-2.1	_____	-1.9	5.5E-5	> 10:1
4 dB attenuator	-4.1	_____	-3.9	5.8E-5	> 10:1
8 dB attenuator	-8.1	_____	-7.9	6.6E-5	> 10:1
16 dB attenuator	-16.1	_____	-15.9	9.9E-5	> 10:1
Test 2-2. Output Attenuator Test (Values in dB)					
Input1:					
20 dB attenuator	-20.1	_____	-19.9	5.3E-5	> 10:1
Input2:					
20 dB attenuator	-20.1	_____	-19.9	5.3E-5	> 10:1
Test 2-3. Low-level Outputs Test (Values in Vdc)					
Diff+ Output:					
0.5 V input (Input1)	0.990	_____	1.010	6.1E-6	> 10:1
0.75 V input (Input1)	1.485	_____	1.515	8.9E-6	> 10:1
-0.75 V input (Input1)	-1.515	_____	-1.485	8.9E-6	> 10:1
0.5 V input (Input2)	0.990	_____	1.010	6.1E-6	> 10:1
Diff- Output:					
-0.5 V input (Input1)	0.990	_____	1.010	6.1E-6	> 10:1
-0.75 V input (Input1)	1.485	_____	1.515	8.9E-6	> 10:1
0.75 V input (Input1)	-1.515	_____	-1.485	8.9E-6	> 10:1
-0.5 V input (Input2)	0.990	_____	1.010	6.1E-6	> 10:1

Table 2-4. Performance Test Record for the Agilent E1446A (Page 4 of 4)

Model _____ **Report No.** _____ **Date** _____

Test Description	Minimum	Measured Reading	Maximum	Meas Uncert	TAR
Test 2-4. Main Output Test (Values in Vdc)					
Input1:					
1 V input	19.8	_____	20.2	1.6E-4	> 10:1
-1 V input	-20.2	_____	-19.8	1.6E-4	> 10:1
Input2:					
1 V input	19.8	_____	20.2	1.6E-4	> 10:1
-1 V input	-20.2	_____	-19.8	1.6E-4	> 10:1
Test 2-5. Offset DAC Test (Values in Vdc)*					
Offset Voltage:					
-10 V	-20.24	_____	-19.76	4.8E-5	> 10:1
-5 V	-10.17	_____	-9.83	2.5E-5	> 10:1
0 V	-0.10	_____	0.10	1.0E-6	> 10:1
5 V	9.83	_____	10.17	2.5E-5	> 10:1
9.9996 V	19.76	_____	20.24	4.8E-5	> 10:1
Test 2-6. Bandwidth Test (Values in Hz)**					
Input1:					
Main Output	10E6	_____		4.0E4	NA
Diff+ Output	30E6	_____		4.0E4	NA
Diff- Output	30E6	_____		4.0E4	NA
Input2:					
Main Output	10E6	_____		4.0E4	NA
Diff+ Output	30E6	_____		4.0E4	NA
Diff- Output	30E6	_____		4.0E4	NA

* Due to the high impedance load, the expected reading is equal to twice the selected offset voltage.

** Single-sided test -- Maximum is not applicable

3
Replaceable Parts

Introduction

This chapter contains information for ordering replaceable parts for the Agilent E1446A amplifier.

Exchange Assemblies

Table 3-1 lists assemblies that may be replaced on an exchange basis (NEW/EXCHANGE ASSEMBLIES). Exchange assemblies are available only on a trade-in basis. Defective assemblies must be returned for credit. Assemblies required for spare parts stock must be ordered by the new assembly part number.

Ordering Information

To order a part listed in Table 3-1, specify the Agilent Technologies part number and the quantity required. Send the order to your nearest Agilent Technologies Sales and Support Office. A list of Sales and Support Offices can be found at the end of this manual.

Replaceable Parts List

Table 3-1 lists the replaceable parts for the Agilent E1446A amplifier. See Figure 3-1 for locations of replaceable parts. Table 3-2 lists the reference designators for the amplifier. Table 3-3 is the code list of manufacturers.

Table 3-1. Agilent E1446A Replaceable Parts

Reference Designator	Agilent Part Number	Qty	Part Description	Mfr. Code	Mfr. Part Number
			NEW/EXCHANGE ASSEMBLIES		
	E1446-66201	1	E1446A (NEW)	28480	E1446-66201
	E1446-69201	1	E1446A (EXCHANGE)	28480	E1446-69201
A1	**E1446-66501**	**1**	**PRINTED CIRCUIT ASSEMBLY**	**28480**	**E1446-66501**
A1CR301	1990-0966	2	LED-LAMP LUM-INT=3MCD IF=20MA-MAX BVR=5V GRN LENS	28480	HLMP-5050
A1CR601	1990-0966		LED-LAMP LUM-INT=3MCD IF=20MA-MAX BVR=5V GRN LENS	28480	HLMP-5050
A1F201-F206	2110-0665	6	FUSE-SUBMINIATURE 1A 125V NTD AX UL CSA	75915	R251001T1
A1J701-J702	1250-1842	5	CONNECTOR-RF BNC RCPT PC-W-STDFS 50-OHM	00779	227677-1
A1J901-J902	1250-1842		CONNECTOR-RF BNC RCPT PC-W-STDFS 50-OHM	00779	227677-1
A1J1001	1250-1842		CONNECTOR-RF BNC RCPT PC-W-STDFS 50-OHM	00779	227677-1
A1P1-P2	1252-1596	2	CONNECTOR-POST TYPE 2.54-PIN-SPCG 96-CONTACT	06776	DIN-96CPC-SRI-TR
A1SP301	3101-3066	1	SWITCH-DIP ROCKER 8-1A 0.15A 30VDC	81073	76YY22968S
			HARDWARE AND MISCELLANEOUS PARTS		
	3050-0604	5	WASHER-FL 7/16 IN .5-IN-ID .75-IN-OD	86928	5710-94-16
HDL1	E1400-84105	1	EXT HANDLE KIT-BOTTOM	28480	E1400-84105
HDL2	E1400-84106	1	EXT HANDLE KIT-TOP	28480	E1400-84106
HDW1-HDW5	2950-0054	5	NUT-HEX-DBL-CHAM 1/2-28-THD .125-IN-THK	28480	2950-0054
MP1	8160-0686	1	RFI STRIP-FINGERS BE-CU TIN-PLATED	30817	00786-185
PNL1	E1446-00201	1	FRONT COVER	28480	E1446-00201
SCR1-SCR2	0515-1968	2	SCREW-PH M2.5 X 11TX	28480	0515-1968
SCR3-SCR4	0515-0368	2	SCREW-MACHINE M2.5 X 0.45 12MM-LG PAN-HD	28480	0515-0368
SCR5-SCR6	0515-1375	2	SCREW-MACHINE M2.5 X 0.45 6MM-LG FLAT-HD	83486	343-300-02506
SCR7-SCR13	0515-1135	7	SCREW-MACHINE M3 X 0.5 25MM-LG FLAT-HD	28480	0515-1135
SHD1	E1446-00601	1	TOP SHIELD	28480	E1446-00601
SHD2	E1446-00602	1	BOTTOM SHIELD	28480	E1446-00602
	E1446-60000	1	E1446A MANUAL KIT	28480	E1446-60000
	E1400-90021	1	INSTALLATION NOTE-DRIVER DOWNLOAD	28480	E1400-90021
	E1446-10031	1	INSTR. DRIVER, LIF 3.5"	28480	E1446-10031
	E1446-10032	1	INSTR. DRIVER, DOS 3.5"	28480	E1446-10032
	E1446-90001	1	AMPLIFIER/DAC SUMMING USER'S MANUAL	28480	E1446-90001

Table 3-2. Agilent E1446A Reference Designators

Agilent E1446A Reference Designators	
A ..... assembly	MP ..... mechanical part
CR ..... diode	P ..... electrical connector (plug)
HDL ..... handle	PNL ..... panel
HDW ..... hardware	SCR ..... screw
J ..... electrical connector (jack)	SHD ..... shield
JM ..... jumper	SP ..... switch
F.....fuse	

Table 3-3. Agilent E1446A Code List of Manufacturers

Mfr. Code	Manufacturer's Name	Manufacturer's Address	Zip Code
00779	AMP INC	HARRISBURG, PA US	17111
06776	ROBINSON NUGENT INC	NEW ALBANY, IN US	47150
28480	AGILENT TECHNOLOGIES - CORPORATE	PALO ALTO, CA US	94304
30817	INSTRUMENT SPECIALTIES INC	DEL WATER GAP, PA US	18327
46384	PENN ENGINEERING & MFG CORP	DOYLESTOWN, PA US	18901
55210	GETTIG ENGINEERING & MFG CO INC	SPRING MILLS, PA US	16875
75915	LITTELFUSE INC	DES PLAINES, IL US	60016
81073	GRAYHILL INC	LA GRANGE, IL US	60525
83486	ELCO INDUSTRIES INC	ROCKFORD, IL US	61125
86928	SEASTROM MFG CO	GLENDALE, CA US	91201

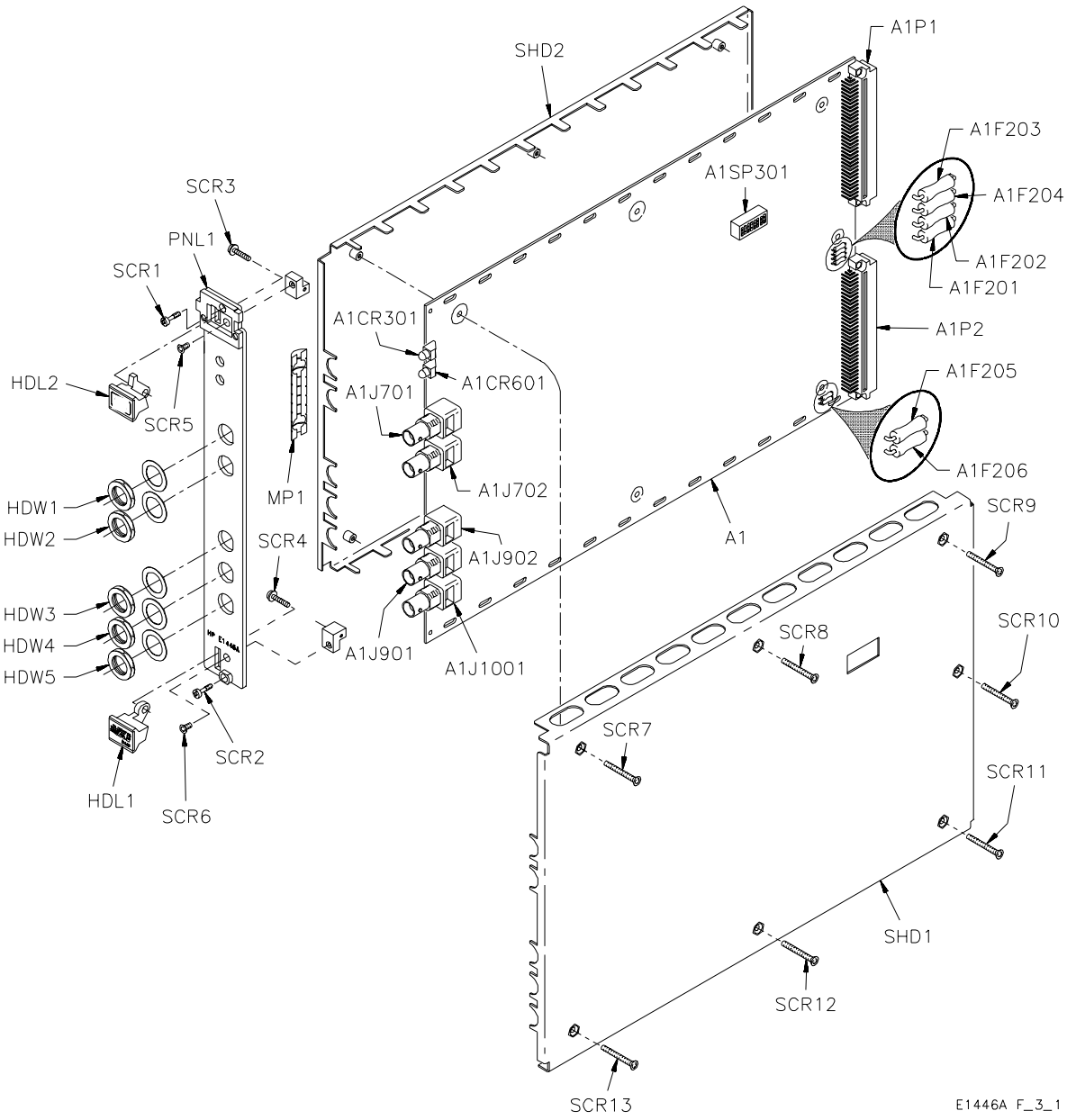


Figure 3-1. Agilent E1446A Replaceable Parts

4
Service

Introduction

This chapter contains service information for the Agilent E1446A amplifier, including troubleshooting guidelines and repair/maintenance guidelines.

WARNING

Do not perform any of the service procedures shown unless you are a qualified, service-trained technician, and have read the WARNINGS and CAUTIONS in Chapter 1.

Equipment Required

Equipment required for amplifier troubleshooting and repair is listed in Table 1-1, *Recommended Test Equipment*. Any equipment that satisfies the requirements given in the table may be substituted. To avoid damage to the screw head slots, use T8 and T10 Torx drivers as described in the disassembly instructions later in this chapter.

Service Aids

See Chapter 3 for descriptions and locations of Agilent E1446A replaceable parts. Service notes and service literature for the amplifier may be available through Agilent Technologies. For information, contact your nearest Agilent Technologies Sales and Support Office. A list of Sales and Support Offices can be found at the end of this manual.

Repair Strategy

If an amplifier problem cannot be isolated to one or more of the parts listed in Table 3-1, order an exchange assembly (part number E1446-90010). The defective assembly must be returned for credit.

Troubleshooting Techniques

To troubleshoot an Agilent E1446A problem, you should first identify the problem, and then isolate the cause to a replaceable part.

Identifying the Problem

Amplifier problems can be divided into three general categories:

- Operator errors
- Catastrophic failures
- Performance out of specification

Operator Errors

Apparent failures may result from operator errors. See Appendix B in the *Agilent E1446A User's Manual* for information on operator errors.

Catastrophic Failure

If a catastrophic failure occurs, see "Testing the Assembly" to troubleshoot the amplifier.

Performance Out of Specification

If the amplifier fails any of its Performance Tests, check test equipment and connections, then repeat the test. If the amplifier continues to fail one or more of the Performance Tests, the module may need to be sent in for exchange.

Testing the Assembly

You can use the tests and checks in Table 4-1 to isolate the problem. See Figure 3-1 in Chapter 3 for locations of replaceable parts.

Table 4-1. Agilent E1446A Tests/Checks

Test/Check	Reference Designator	Check:
Heat Damage	- - - - - - - - - -	Discolored PC boards Damaged insulation Evidence of arcing
Amplifier Configuration	A1SP301	LADDR setting (factory set to 88)
Amplifier PCA	A1F201 - A1F206 A1J701 - A1J702 A1J901 - A1J902 A1J1001 A1P1 - A1P2	Fuse continuity Damaged connectors

Checking for Heat Damage

Inspect the amplifier for signs of abnormal internally generated heat such as discolored printed circuit boards or components, damaged insulation, or evidence of arcing. If there is damage, do not operate the amplifier until you have corrected the problem.

Checking Switches/Jumpers

Verify that the logical address setting is set correctly (factory set at 88). See the *Agilent E1446A User's Manual* for information.

Checking the Amplifier PCAs

Check fuse continuity and inspect all connectors for bent pins or damaged contacts.

Disassembly

Use the following procedure to disassemble the amplifier (see Figure 4-1):

1. Remove the seven T10 Torx screws on the right side panel.
2. Remove the nuts and washers from the front panel BNC's.
3. Remove the front panel handles.

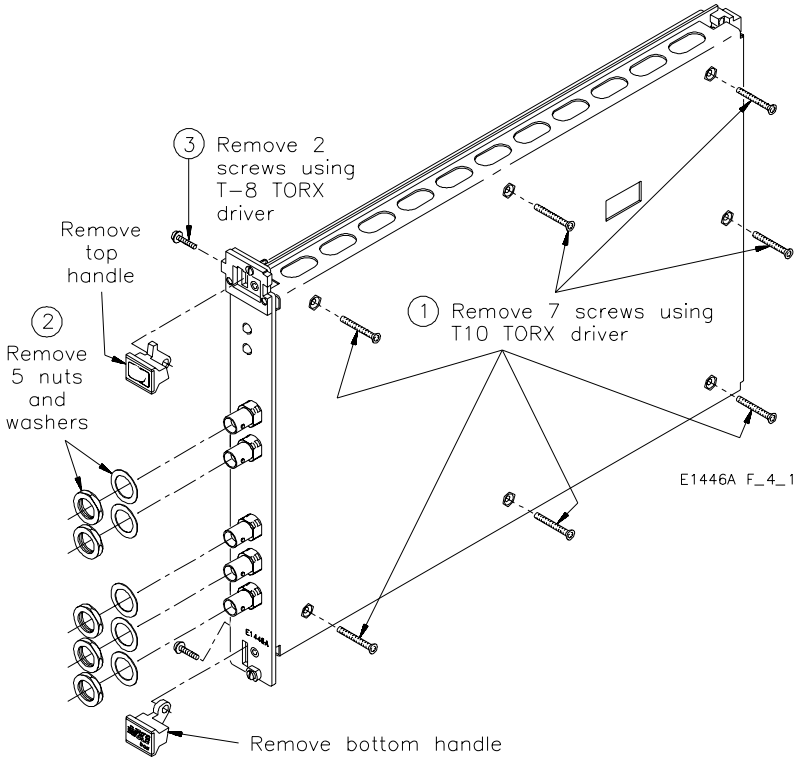


Figure 4-1. Agilent E1446A Disassembly

Repair/ Maintenance Guidelines

This section provides guidelines for repairing and maintaining the Agilent E1446A amplifier, including:

- ESD precautions
- Soldering printed circuit boards
- Post-repair safety checks

ESD Precautions

Electrostatic discharge (ESD) may damage static sensitive devices in the Agilent E1446A amplifier. This damage can range from slight parameter degradation to catastrophic failure. When handling amplifier assemblies, follow these guidelines to avoid damaging amplifier components:

- Always use a static-free work station with a pad of conductive rubber or similar material when handling amplifier components.
- If a device requires soldering, be sure the assembly is placed on a pad of conductive material. Also, be sure that you, the pad, and the soldering iron tip are grounded to the assembly.

Soldering Printed Circuit Boards

When soldering to any circuit board, keep in mind the following guidelines:

- Avoid unnecessary component unsoldering and soldering. Excessive replacement can result in damage to the circuit board and/or adjacent components.
- Do not use a high power soldering iron on etched circuit boards, as excessive heat may lift a conductor or damage the board.
- Use a suction device or wooden toothpick to remove solder from component mounting holes. When using a suction device, be sure that the equipment is properly grounded.

Post-Repair Safety Checks

After making repairs to the Agilent E1446A amplifier, inspect the amplifier for any signs of abnormal internally generated heat, such as discolored printed circuit boards or components, damaged insulation, or evidence of arcing. Determine and correct the cause of the condition. Then perform the Self-Test described in Chapter 2 to verify that the amplifier is functional.