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Agilent 75000 Series C

Agilent E1446A
Summing Amplifier/DAC Module

User's Manual and SCPI Programming Guide

Where to Find it - Online and Printed Information:

System installation (hardware/software)	VXIbus Configuration Guide* Agilent VIC (VXI installation software)*
Module configuration and wiring	This Manual
SCPI programming	This Manual
SCPI example programs	This Manual
SCPI command reference	This Manual
Register-Based Programming	This Manual
VXI*plug&play* programming	VXI*plug&play* Online Help
VXI*plug&play* example programs	VXI*plug&play* Online Help
VXI*plug&play* function reference	VXI*plug&play* Online Help
Soft Front Panel information	VXI*plug&play* Online Help
VISA language information	Agilent VISA User's Guide
Agilent VEE programming information	Agilent VEE User's Manual

**Supplied with Agilent Command Modules, Embedded Controllers, and VXLink.*

Agilent Technologies

Manual Part Number: E1446-90001
Printed in Malaysia E0506

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Agilent E1446A Summing Amplifier/DAC User's Manual
Edition 1 Rev 2

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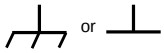
Safety Symbols



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.

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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	
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3 May 2001
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Ray Corson
Product Regulations Program Manager

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Notes

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Chapter 1
Getting Started

Chapter Contents

This chapter provides a description of the Agilent E1446A Summing Amplifier/DAC module and describes how to install, configure, and program it. The main sections of this chapter are:

- General Description 1-1
- Preparation for Use 1-3
- Basic Operation 1-8

General Description

The Agilent E1446A Summing Amplifier/DAC is a multifunction register-based VXIbus C-size module. It is designed to work with either the Agilent E1445A Arbitrary Function Generator (AFG) or to function stand-alone with the Agilent E1405/06 Command Module as a power amplifier/DAC. The Agilent E1446A allows you to amplify or attenuate, sum, and offset signals via the main output. The differential (small signal) output allows you to invert a signal.

Features

The Agilent E1446A Summing Amplifier/DAC has the following features:

- provides two input channels that have:
  - independently controlled input impedance
  - independently controlled input attenuators of 0 to 31 dB in 1 dB steps.
- sums the two input channels.
- provides output channels that include:
  - single-ended main output (power amplifier)
  - differential (small signal) output; one inverting, one non-inverting.
- functions as stand-alone offset DAC.
- provides a DAC for offset control of the main output
- acts as a servant to the Agilent E1445A AFG.
- has SCPI language commands using the Agilent E1405/06 Command Module or using the Agilent E1445A AFG.
- uses 1 slot in the Agilent 75000 Series C mainframe.

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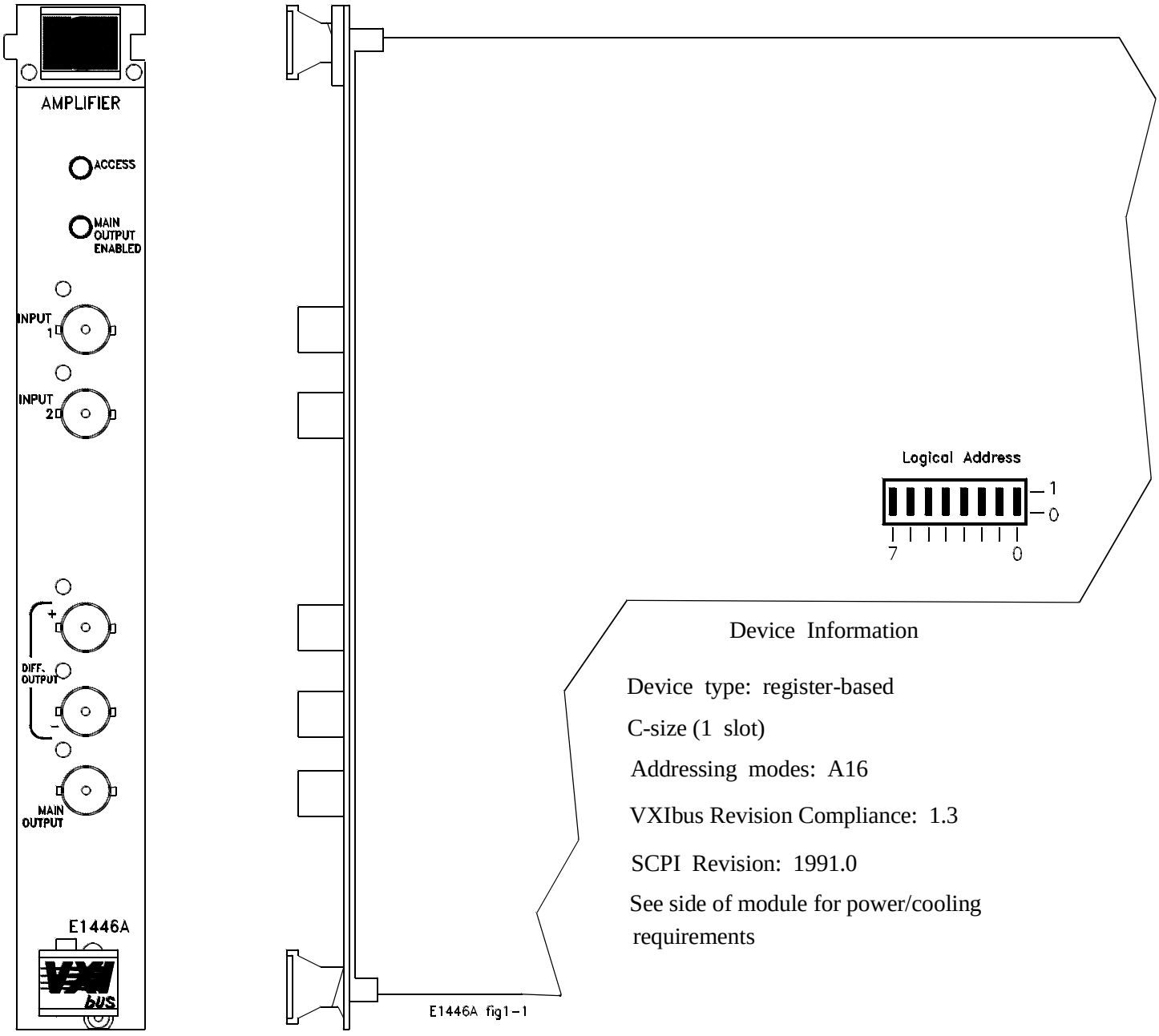


Figure 1-1. The E1446A Summing Amplifier/DAC.

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Preparation for Use

This section shows you how to configure the module, install it in the Agilent 75000 Series C mainframe, address the module, and download the SCPI driver.

Note The following VXIbus configuration information pertains to the Agilent E1446A Summing Amplifier/DAC. For more (VXIbus) system configuration information, refer to the C-Size VXIbus Systems "Installation and Getting Started Guide" (Agilent P/N E1405-90021).

Configuring the Amplifier

The Agilent E1446A Summing Amplifier/DAC can be configured as a servant of the Agilent E1445A Arbitrary Function Generator or as a stand-alone Power Amplifier/DAC.

Logical Address

The Agilent E1446A logical address is used as follows :

- to
  place the amplifier in the servant area of a commander such as the Agilent E1445A AFG, Agilent E1405 Command Module, or an embedded controller.

  In Agilent VXIbus systems, the servant area is defined as:

  Servant area = (logical address + 1) through (logical address + servant area switch setting)

  For example, to place the amplifier in the servant area of the Agilent E1445A:

  Agilent E1445A Logical address: 80
  Agilent E1445A Servant Area setting: 8
  Agilent E1446A Logical address: 88

  Servant Area = (80 + 1) through (80 + 8)

- to address the Agilent E1446A (see "Addressing the Amplifier" later in this chapter).

The logical address factory setting is 88. You can change the setting during module installation. Valid addresses are from 1 to 255. The amplifier's logical address switch is shown in Figure 1-2.

Note The Agilent E1446A can be set to any valid logical address (1 - 255). However, when used with the Agilent E1445A or Agilent E1405/06, the

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(Agilent E1446A) logical address or the (Agilent E1445A/E1405/06) servant area must be set such that the Agilent E1446A is in the servant area of its intended commander.

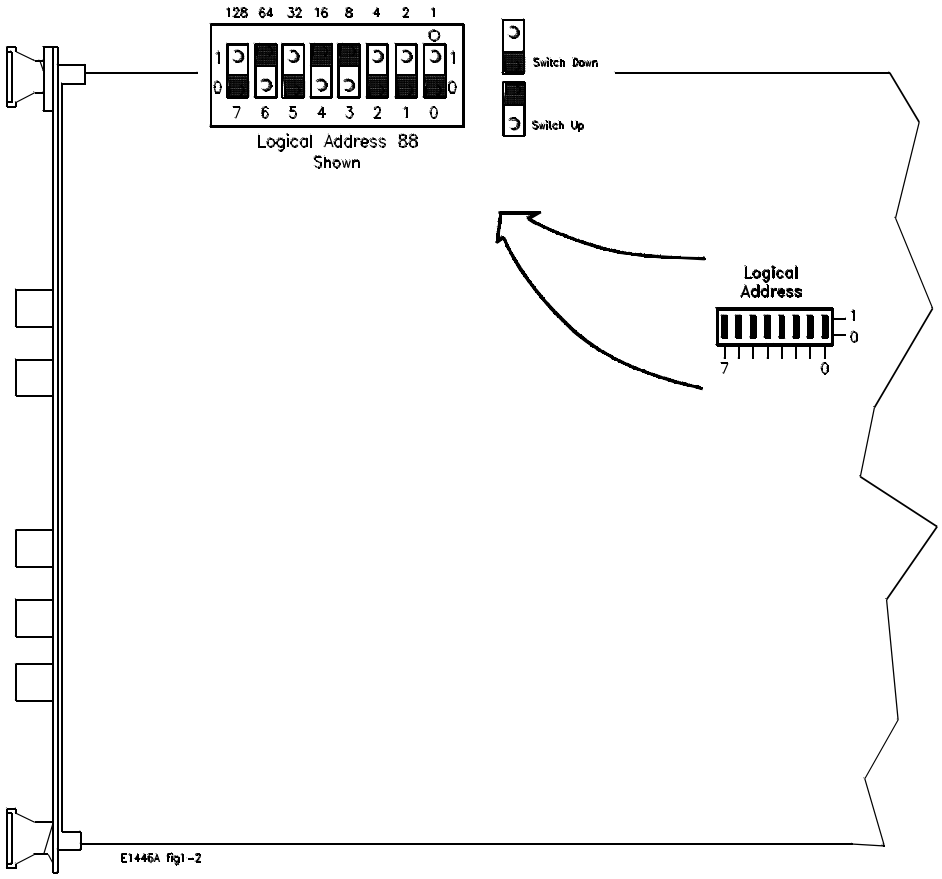


Figure 1-2. Setting the E1446A Logical Address.

Installing the Amplifier

The Agilent E1446A Amplifier/DAC can be installed in any mainframe slot, except slot 0. If the Agilent E1445A AFG is a part of your system, it is recommended that the Amplifier/DAC be installed in a slot adjacent to the AFG. Figure 1-3 shows how to install the module in the Agilent E1400 Series C mainframe.

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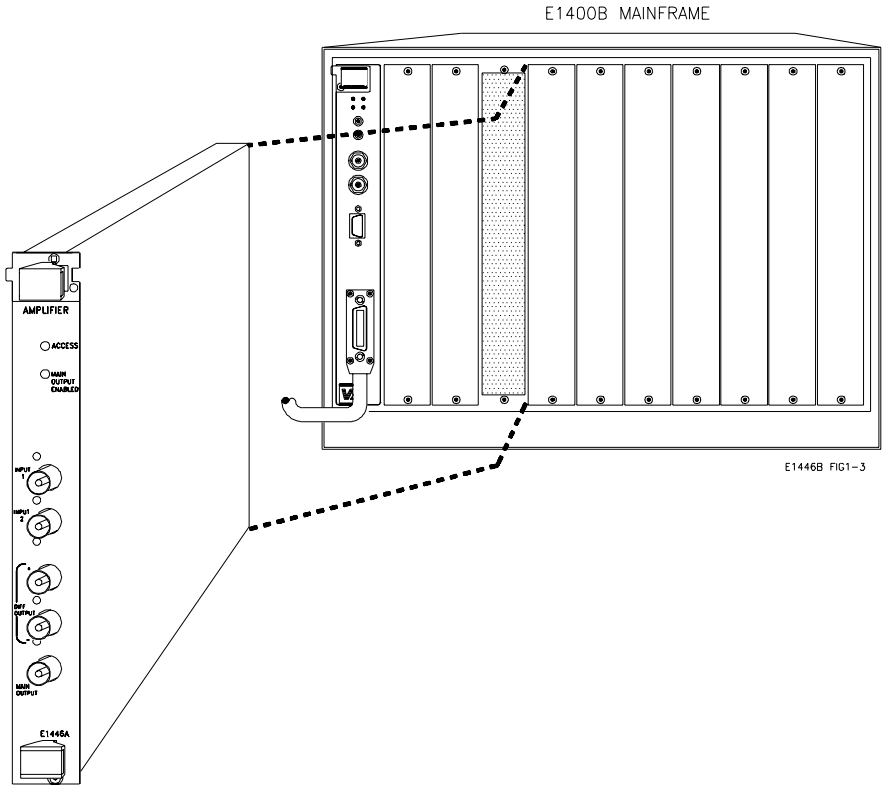


Figure 1-3. Installing the E1446A Summing Amplifier/DAC.

Addressing the Amplifier

The Agilent E1446A Summing Amplifier/DAC can be addressed by an external controller or by an embedded controller. This section describes how to address the amplifier using an external controller with the Agilent E1445A AFG, with the Agilent E1405/06 Command Module, and with an embedded controller.

Using an External Controller

The Agilent E1446A can be programmed from an external controller via the Agilent E1445A AFG or the Agilent E1405/06 Command Module. In an Agilent VXIbus system using an external controller, the amplifier is located by an (GPIB) address which consists of an interface select code, a primary GPIB address, and a secondary GPIB address:

Interface Select Code: Determined by the address of the GPIB interface card in the controller. For most Agilent Technologies controllers, this card has a factory set address of 7.

Primary GPIB Address: Determined by the address of the GPIB port on the Agilent E1405 Command Module. Valid addresses for the Command Module are 0 to 30. The Command Module has a factory set address of 9.

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Secondary GPIB Address : Determined by dividing the logical address of the device by 8. If the amplifier is used with the Agilent E1445A, the secondary address is the **E1445A logical address/8**. If the amplifier is used with the Agilent E1405/06 Command Module, the secondary address is the **E1446A logical address/8**.

Agilent E1445A AFG

An example of the GPIB address in an BASIC statement when the amplifier is a servant of the Agilent E1445A is:

```
OUTPUT 70910;"SOUR2:VOLT:OFFS  3"
```

Where:

Interface Select Code = **7**

(Command Module) Primary GPIB Address = **09**

Secondary GPIB address (Agilent E1445A logical address/8) = **10**

Agilent E1405/06 Command Module

An example of the GPIB address in an BASIC statement when the amplifier is a servant of the Agilent E1405/06 is:

```
OUTPUT 70911;"SOUR:VOLT:OFFS  3"
```

Where:

Interface Select Code = **7**

(Command Module) Primary GPIB Address = **09**

Secondary GPIB address (Agilent E1446A logical address/8) = **11**

Refer to Chapter 2, "Programming the Agilent E1446A", for more detailed information.

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Using an Embedded Controller

The Agilent E1446A Summing Amplifier/DAC can be programmed across the VXIbus backplane (select code 16) from an embedded controller, such as the Agilent E1480A V/360. With this configuration, communication with the register-based amplifier module can be accomplished via four paths:

1. Embedded controller across the VXIbus backplane to the Agilent E1445A AFG (SCPI programming only).
2. Embedded controller to the Agilent E1405/06 Command Module via the GPIB interface (SCPI or register-based).
3. Embedded controller to the Agilent E1405/06 over the GPIB and via the Agilent E1445A (SCPI only).
4. Embedded controller across the VXIbus backplane to the Agilent E1446A (register-based programming only).

Examples of how the amplifier is addressed in paths 1 through 3 are given below. Refer to Appendix C for information on addressing the amplifier during register-based programming.

1. OUTPUT 1680;"INP:IMP 75"

In this addressing configuration, the E1445A must be in the servant area of the embedded controller, and the E1446A must be in the servant area of the E1445A. Select code 16 is the only select code that can be used with this configuration.

2. OUTPUT 70911;"INP:IMP 75"

In this addressing configuration, the E1446 must be in the servant area of the E1405/06. Select code 7 (GPIB) is the only select code that can be used with this configuration.

3. OUTPUT 70910;"INP:IMP 75"

In this configuration, the E1445 must be in the servant area of the E1405/06. The E1446 must be in the servant area of the E1445A. Select code 7 (GPIB) is the only select code that can be used with this configuration.

Downloading the Agilent E1446A SCPI Driver

When using the Agilent E1445A AFG, the SCPI driver is resident in ROM and ready to control the Agilent E1446A. However, to use the Agilent E1405 Command Module, the SCPI driver must be downloaded into the Command Module's non-volatile memory from a disk. Both DOS and LIF formatted driver disks are shipped with the Agilent E1446A. The drivers can be downloaded from controllers running DOS, BASIC (workstation),

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IBASIC, or BASIC/UX. Downloadable driver capability is available on the Agilent E1406 and on the E1405 with firmware revision A.06.00 or later. To verify the firmware revision of the Command Module, you can use the ***IDN?** Command:

```
10  DIM A$[40]
20  OUTPUT 70900;"*IDN?"
30  ENTER 70900;A$
40  PRINT A$
50  END
```

***IDN?** returns identification information for the Agilent E1405 Command Module. The result of this command is:

HEWLETT-PACKARD,E1405B,0,A.06.00

Note For information on how to download the SCPI driver, refer to the "Downloading Device Drivers Installation Note" (Agilent P/N E1400-90021), or the "Agilent E1405B Command Module User's Manual" (Agilent P/N E1405-90004).

Basic Operation

This section provides a block diagram and description of the basic operation of the Agilent E1446A Summing Amplifier/DAC. The description is divided into three parts:

- Input
- Output
- Offset DAC

Additionally, the Output section is subdivided into two parts:

- Main Output
- Differential (small signal) Output.

Refer to Appendix A, "Agilent E1446A Specifications", for operating specifications.

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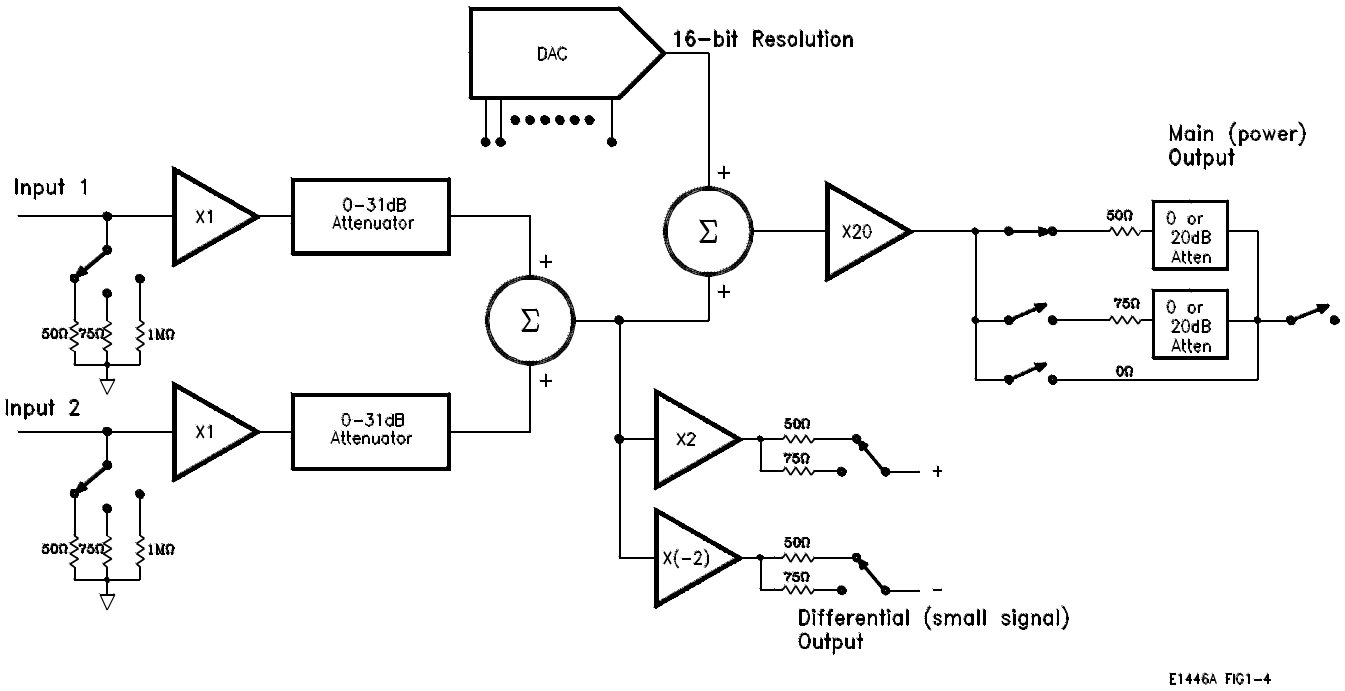


Figure 1-4. E1446A Summing Amplifier/DAC Block Diagram.

Amplifier Block Diagram

Figure 1-4 shows a block diagram of the Agilent E1446A Summing Amplifier/DAC.

Input

The Agilent E1446A Summing Amplifier/DAC has two input channels that have identical input amplifiers with independently controlled input impedance and input attenuation. The input amplifier attenuators provide independent level control prior to the summing node. The attenuation can range from 0 to 31 dB in 1 dB steps. The input impedance can be set to 50Ω, 75Ω, or 1 MΩ.

Output

The output channels provide the amplifier with the capability to boost the power output of a low-power signal source, and to provide low-level differential output. The output channels are:

- single-ended **main output** or **power amplifier**.
- **differential (small signal) output**; one inverting, one non-inverting.

Main Output

The power amplifier sums the two input channels plus the output of a 16-bit offset Digital-to-Analog Converter (DAC) to obtain output levels of ±10 Vpeak into a 50Ω or 75Ω load on the single-ended output or ±20 Vpeak into high impedance. The voltage gain of the power amplifier is set at 10 (20 dB) into a matched load, and at 20 (about 26 dB) into a high impedance. To obtain the desired output, the output attenuation and the output impedance can be independently selected. The output impedance can be set

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to 50Ω or 75Ω, or to 0Ω for driving into high impedance. The output voltage can be attenuated by either 0 or 20 dB when 50Ω or 75Ω output impedance is selected. Output attenuation is unavailable with the 0Ω mode (high impedance).

The main output terminal may be enabled or disabled under user control. When disabled, the output appears as an open circuit. This output is also overload protected via an output relay. The output relay automatically opens when an overload condition is detected and disconnects the output from the load. An overload occurs if the sum of the inputs, plus the output of the offset DAC, is excessive, or if the output current limit is reached. The relay remains open until the overload condition is corrected and the output is reset by the user. Refer to Appendix A of this manual for these specifications.

Differential (Small Signal) Output

The differential (small signal) output sums the two input channels to obtain a maximum output level of ±1 Vpeak into a 50/75Ω load. One of the outputs is a non-inverting amplifier (same polarity as the input); whereas the other is an inverting amplifier (opposite polarity as the input). Into a high impedance, each input has a maximum gain of two. The output impedance of each amplifier can be independently set to either 50Ω or 75Ω.

With two low level output terminals, output signals can be taken from either of the terminals with respect to ground, or across the two terminals (in series). Output signals taken across the two terminals will result in two times the input voltage. Figure 1-5 shows the circuitry of the output signal taken across the two terminals.

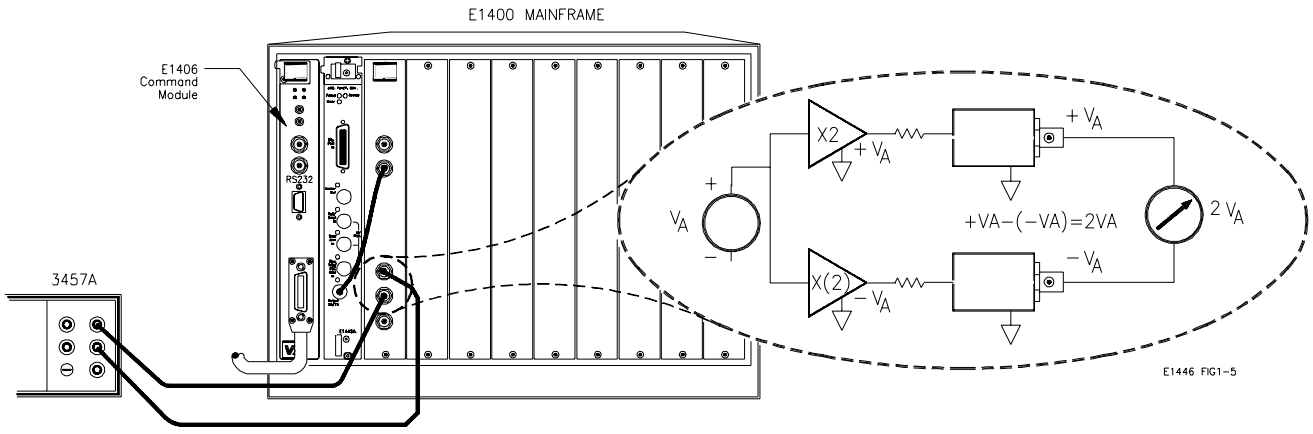


Figure 1-5. Measuring the Differential Output across both Terminals.

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Offset DAC A precision (DAC) allows the Agilent E1446A to provide DC offset voltage levels. The DAC input is a complementary offset binary code. The full scale output provides approximately ±10V into 50Ω or 75Ω load, or approximately ±20V into high impedance.

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Chapter 2
Programming the Agilent E1446A

Chapter Contents

This chapter shows you how to program the Agilent E1446A using SCPI Commands. The programming examples found in the chapter are written in BASIC. The main sections of the chapter are:

- Instrument and Programming Languages 2-1
- Introductory Programs 2-5
- Example Programs 2-8
- Generating and Amplifying Sine Waves 2-9
- Setting the Input Impedance 2-14
- Setting DC Voltage Offsets 2-20
- Using the Differential (small signal) Outputs 2-26
- Summing Two Signals 2-31

Instrument and Programming Languages

Though the E1446A amplifier is a register-based device, this module can be programmed with SCPI commands using the Agilent E1445A AFG or Agilent E1405 Command Module. This section describes the SCPI programming environment.

SCPI Programming

SCPI (Standard Commands for Programmable Instruments) is an ASCII-based instrument command language designed for test and measurement instruments. The Agilent E1445A AFG or the Agilent E1405 Command Module (with the amplifier driver installed) interprets the ASCII command strings and sets the amplifier accordingly. The AFG and Command Module do this by writing to the amplifier registers.

SCPI Command Structure

The Agilent E1446A SCPI command set is found in Chapter 3. SCPI commands are based on a hierarchical structure, also known as a tree system. In this system, associated commands are grouped together under a common node or root, thus, forming subtrees or subsystems. An example is the amplifier's 'OUTPut2' subsystem shown on the following page:

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```
OUTPut2
    :ATTenuation <attenuation>
    :IMPedance <impedance>
    :OVERload?                          [query only]
    [:STATe] <mode>
        :ACTual?                        [query only]
```

OUTPut2 is the root keyword of the command, :ATTenuation, :IMPedance, :OVERload?, and [:STATe] are second level keywords, and :ACTual? is the third level keyword. A colon (:) always separates a command keyword from a lower level keyword as shown below:

OUTP2:STAT:ACT?

A semicolon (;) is used to separate two or more commands within the same subsystem, and can also save typing. For example, sending this command message:

OUTP2:IMP 50;OUTP2:ATT 6;OUTP2:STAT ON

is the same as sending these three commands:

OUTP2:IMP 50

OUTP2:ATT 6

OUTP2:STAT ON

A semicolon (;) **and** a colon (:) are used to separate two or more commands from different subsystems in the same command message. For example:

INP1:IMP 50;:OUTP2:IMP 50

Command Coupling

The following amplifier commands are value coupled:

E1446 with E1405/06

OUTPut1:ATTenuation <*attenuation*>
OUTPut1:IMPedance <*impedance*>
SOURce:VOLTage[:LEVel][:IMMediate]:OFFSet <*voltage*>

E1446 with E1445

OUTPut2:ATTenuation <*attenuation*>
OUTPut2:IMPedance <*impedance*>
SOURce2:VOLTage[:LEVel][:IMMediate]:OFFSet <*voltage*>

This means that sending one of these commands can change the value set previously by another one of these commands. Often, this results in “Settings Conflict” errors when the program executes. To prevent these errors these commands must be executed in a "coupling group".

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Executing Coupled Commands

The list below identifies rules to follow when executing coupled commands:

- Coupled commands must be contiguous and executed in the same program statement. This done by placing the commands in the same program line, or by suppressing the end-of-line terminator until the last coupled command has been sent.

  To send multiple commands in a single line or in a single statement, the commands are linked (as described previously) with a semicolon (;) and a colon(:). For example:

  ```
  OUTP2:IMP 50;OUTP2:ATT 6
  ```

  or

  ```
  OUTP2:IMP 50;
  :OUTP2:ATT 6
  ```

  In BASIC programs, the end-of-line (EOL) terminator is suppressed by placing a semicolon (;) following the quotation mark (") which closes the command string. For example:

  ```
  OUTPUT 70910;"OUTP2:IMP 50;";
  OUTPUT 70910;":OUTP2:ATT 6"
  OUTPUT 70910;"OUTP2:STAT ON"
  ```

  As shown, the first two lines are coupled together. The third line is not a coupled command, therefore, the EOL terminator is not suppressed on the second line.

- Commands not in the coupling group must either preceed or follow commands in the coupling group.
- Un-coupled commands executed in a coupling group break the coupling.
- Error checking occurs at the end of the coupling group.
- Hardware updates occur at the end of the coupling group.

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Instrument Driver and Example Programs Disks

The E1446A instrument driver and the example programs contained in this manual are located on the following disks:

- **Agilent E1446A Instrument Driver and BASIC Example Programs - 3.5" 720 kbyte disk LIF Format (E1446-10031)**
- **Agilent E1446A Instrument Driver and BASIC Example Programs - 3.5" 1.44 Mbyte disk DOS Format (E1446-10032)**

The example programs are SCPI programs written in BASIC. On the LIF formatted disk (E1446-10031), the programs are in LOAD / STORE (PROG) format. On the DOS formatted disk (E1446-10032), the programs are in GET / SAVE (ASCII) format.

System Configuration

Each program in this chapter is written in BASIC. Except where noted, the programs were developed on the following system:

Controller:	HP 9000 Series 300
Mainframe:	Agilent 75000 Series C
Slot 0/Resource Manager:	Agilent E1405B Command Module
E1445A Logical Address:	80
E1445A Servant Area:	8
E1446A Logical Address:	88
Instrument Language:	SCPI

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Introductory Programs

The introductory programs in this section include:

- Executing the Agilent E1446A self-test.
- Resetting the Agilent E1446A and clearing the Error Queue.
- Querying the Agilent E1446A power-on/reset settings.

The introductory program examples in this section were written with the Agilent E1405 Command Module as the commander of the Agilent E1446A Summing Amplifier/DAC.

Executing the Self-Test

The amplifier self-test is executed with the command:

***TST?**

During the self-test, communication between the command module and the on-card registers is tested. The *TST? returns one of the self-test codes listed below:

- 0 = passed.
- 1 = failed. (An error message describes the failure.)

Executing the Self-Test

```
1     !Agilent E1446A  Self-test
10    !Send the self-test command, enter and display the result.
20    OUTPUT 70911;"*TST?"
30    ENTER 70911;Rslt
40    PRINT Rslt
50    END
```


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Resetting and Clearing the Agilent E1446A

The commands to reset and clear the amplifier are:

***RST**
***CLS**

Resetting the amplifier sets it to its power-on configuration. Clearing status on the amplifier clears the error queue.

Resetting and Clearing the Agilent E1446A

```
1     !Resetting and clearing the Agilent E1446A
10    !Assign an I/O Path for the computer, command module,  and the
20    !E1446A. Send the appropriate commands and wait for completion.
30    ASSIGN @Amp to 70911
40    OUTPUT @Amp;"*RST;*CLS;*OPC?"
50    ENTER @Amp;Complete
60    END
```

Querying the Power-on/Reset Configuration

The command used to query each Agilent E1446A setting is:

***LRN?**

The *LRN? command queries the power-on/reset configuration and returns a sequence of commands that may be re-sent to the amplifier.

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LRN

```
1     !RE-STORE "LRN"
10    !Assign an I/O path between the computer and the amplifier.
20    ASSIGN @Amp TO 70911
30    !Call the subprogram
40    Lrn_conf(@Amp)
50    END
60    !
70    SUB Lrn_conf(@Amp)
80 Lrn_conf:   !subprogram which queries the amp reset configuration
90      DIM Lrn$[1000]
100     OUTPUT @Amp;"*LRN?"
110     ENTER @Amp;Lrn$
120     Lrn$=Lrn$&";"
130     REPEAT
140       I=POS(Lrn$,";")
150       PRINT    Lrn$[1;I-1]
160       Lrn$=Lrn$[I+1]
170     UNTIL Lrn$=""
180   SUBEND
```

Table 2-1. E1446A Power-On/Reset Configuration (as returned by *LRN?).

Parameter	Command		Power-on/Reset Settings	
	Agilent E1446A	Agilent E1445A		
Input1 Attenuation	INP1:ATT	INP1:ATT	+0.00000000E+000	0 dB
Input1 Impedance	INP1:IMP	INP1:IMP	+5.00000000E+001	50Ω
Input2 Attenuation	INP2:ATT	INP2:ATT	+0.00000000E+0000	0 dB
Input2 Impedance	INP2:IMP	INP2:IMP	+5.00000000E+001	50Ω
Main Output Attenuation	OUTP1:ATT	OUTP2:ATT	+0.00000000E+000	0 dB
Main Output Impedance	OUTP1:IMP	OUTP2:IMP	+5.00000000E+001	50Ω
Main Output State	OUTP1:STAT	OUTP2:STAT	1	(on)
Diff "+" Impedance	OUTP2:IMP	OUTP3:IMP	+5.00000000E+001	50Ω
Diff "-" Impedance	OUTP3:IMP	OUTP4:IMP	+5.00000000E+001	50Ω
DC offset	SOUR:VOLT:LEV:IMM:OFFS	SOUR2:VOLT:LEV:IMM:OFFS	+0.00000000E+000	0V

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Example Programs

The example programs in this section include:

- Generating and amplifying sine waves
- Selecting the input impedance
- Using the differential (small signal) outputs
- Setting a DC offset voltage
- Summing two signals

These programs configure the amplifier according to the block diagram of Figure 2-1. The program descriptions will often refer to this figure. The programs were written with the amplifier configured as a servant of the Agilent E1445A AFG, and as a servant of the Agilent E1405 Command Module.

Refer to Chapter 3, "Command Reference" for a detailed description of the Agilent E1446A commands. Refer to Chapter 8 of the "*Agilent E1445A Arbitrary Function Generators User's Manual*" for a detailed description of the Agilent E1445A commands.

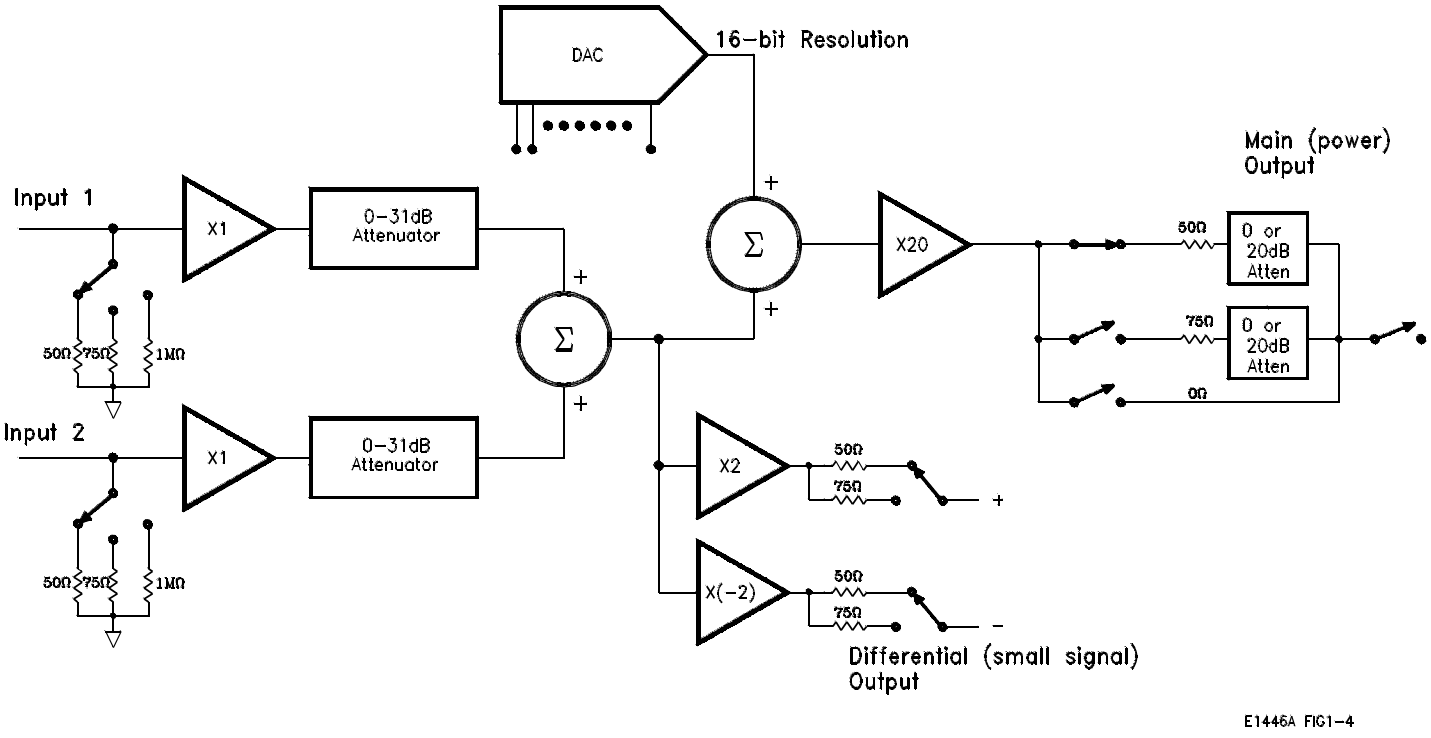


Figure 2-6. E1446A Functional Block Diagram.

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Generating and Amplifying Sine Waves

The examples in this section show you how to amplify a sine wave generated by the Agilent E1445A. In the first program, the E1446A is a servant of the E1445A AFG. In the second program, the E1446A amplifies the signal from the E1445A, however; the E1446A is in the servant area of the E1405 Command Module.

Amplifying Sine Waves (Agilent E1445A Commander)

This program uses the E1446A to amplify a 2 Vpp E1445A AFG signal to 14.15 Vpp. Since the intended output amplitude and the input amplitude are known, the amount of attenuation (0 - 31 dB attenuator) is determined as:

$attenuation_{(dB)} = 20 \text{ LOG } (V_o/(V_i * 10))$

where V_o is the output amplitude and V_i is the input signal amplitude (V_o and V_i units (Vpp, Vp) must be the same). Thus,

$attenuation_{(dB)} = 20 \text{ LOG } (14/20) = -3 \text{ dB}$

The (main) output of the AFG is connected to 'Input 1' of the amplifier.

The steps of this program are:

1. **Reset the E1445A AFG and E1446A amplifier.**

   *RST

2. **Set the AFG frequency, function, and amplitude.**

   [SOURce:]FREQuency[1][:CW|:FIXed] <*frequency*>

   [SOURce:]FUNCtion[:SHAPe] <*shape*>

   [SOURce:]VOLTage[:LEVel][:IMMediate][:AMPLitude] <*amplitude*>

3. **Couple the AFG output load value to the output impedance value.**

   OUTPut[1]:LOAD:AUTO <*mode*>

   OUTPut[1]:IMPedance <*impedance*>

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4. **Set the amplifier input impedance to match the AFG output load.**

   INPut[1]:IMPedance <*impedance*>

5. **Set the amplifier input attenuation.**

   INPut[1]:ATTenuation <*attenuation*>

6. **Set the amplifier output impedance.**

   OUTPut2:IMPedance <*impedance*>

7. **Set the amplifier output attenuation.**

   OUTPut2:ATTenuation <*attenuation*>

8. **Place the AFG in the wait-for-arm state.**

   INITiate:IMMediate

Note Resetting the amplifier sets many of the same conditions set by subsequent (amplifier) commands in the program. These commands are included, however, to show other parts of the amplifier configuration.

Note For more information on how to program the Agilent E1445A AFG, refer to the *Agilent E1445A Arbitrary Function Generator User's Manual.*

AMPL45

```
1    !RE-STORE"AMPL45"
2    !The following program uses the E1445A to generate a 1 kHz, 2Vpp
3    !sine wave. The Agilent E1446A amplifies the signal to approximately 14 Vpp.
4    !
10   !Assign I/O path between the computer and E1445A. As the commander of
20   !the Agilent E1446A, the E1445A sends the amplifier its commands.
30   ASSIGN @Afg TO 70910
40   COM @Afg
50   !
60   !Set up error checking
70   ON INTR 7 CALL Errmsg
80   ENABLE INTR 7;2
```

Continued on Next Page

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```
90   OUTPUT @Afg;"*CLS"
100  OUTPUT @Afg;"*SRE 32"
110  OUTPUT @Afg;"*ESE 60"
120  !
130  !Call the subprograms
140  Rst
150  Sine_wave
160  !
170  WAIT .1  !allow interrupt to be serviced
180  OFF INTR 7
190  END
200  !
210  SUB Sine_wave
220 Sine_wave:  !Subprogram which sets the E1445A to output a sine wave
230    COM @Afg
240    OUTPUT @Afg;"SOUR:FREQ1:FIX 1E3;";                    !frequency
250    OUTPUT @Afg;":SOUR:FUNC:SHAP SIN;";                   !function
260    OUTPUT @Afg;":SOUR:VOLT:LEV:IMM:AMPL 2VPP;"; !amplitude
270    OUTPUT @Afg;":OUTP:LOAD:AUTO ON;";                    !couple load to impedance
280    OUTPUT @Afg;":OUTP:IMP 50"                            !output impedance
290    !
300    !Set up the Agilent E1446A
310    OUTPUT @Afg;"INP1:IMP 50"            !input impedance
320    OUTPUT @Afg;"INP1:ATT 3"             !input attenuation (dB)
330    OUTPUT @Afg;"OUTP2:IMP 50;";         !main output impedance
340    OUTPUT @Afg;":OUTP2:ATT 0"           !main output attenuation
350    !
360    OUTPUT @Afg;"INIT:IMM"               !E1445A wait-for-arm state
370  SUBEND
380  !
390  SUB Rst
400 Rst:  !Subprogram which resets the E1445A and E1446A
410    COM @Afg
420    OUTPUT @Afg;"*RST;*OPC?"  !reset the AFG
430    ENTER @Afg;Complete
440  SUBEND
450  !
460  SUB Errmsg
470 Errmsg:  !Subprogram which displays E1445/E1446 programming errors
480    COM @Afg
490    DIM Message$[256]
500    !Read AFG status byte register and clear service request bit
510    B=SPOLL(@Afg)
520    !End of statement if error occurs among coupled commands
530    OUTPUT @Afg;""
540    OUTPUT @Afg;"ABORT"  !abort output waveform
```

Continued on Next Page

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```
550    REPEAT
560      OUTPUT @Afg;"SYST:ERR?"  !read AFG error queue
570      ENTER @Afg;Code,Message$
580      PRINT    Code,Message$
590    UNTIL Code=0
600    STOP
610  SUBEND
```

Amplifying Sine Waves (Agilent E1405 Commander)

This program uses the same commands and sequence as previously described, except for the OUTPut[1] commands shown below:

6. Set the amplifieroutput impedance.

OUTPut[1]:IMPedance <*impedance*>

7. Set the amplifier output attenuation.

OUTPut[1]:ATTenuation <*attenuation*>

In this example, the E1446A is a servant to the E1405. As such, commands sent to the amplifier (at secondary GPIB address 11) are parsed by the Command Module rather than by the E1445A.

AMPL05

```
1    !RE-STORE"AMPL05"
2    !The following program uses the Agilent E1445A to generate a 1 kHz, 2Vpp
3    !sine wave. The Agilent E1446A amplifies the signal to approximately 14 Vpp.
4    !
10   !Assign I/O paths between the computer and E1445A, and between the
20   !computer and E1405. As the commander of the E1446A, the E1405 sends the
30   !amplifier its commands.
40   ASSIGN @Afg TO 70910
50   ASSIGN @Amp TO 70911
60   COM @Afg,@Amp
70   !
80   !Set up error checking
90   ON INTR 7 CALL Errmsg
100  ENABLE INTR 7;2
110  OUTPUT @Afg;"*CLS"
120  OUTPUT @Afg;"*SRE 32"
130  OUTPUT @Afg;"*ESE 60"
140  !
```

Continued on Next Page

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```
150   OUTPUT @Amp;"*CLS"
160   OUTPUT @Amp;"*SRE 32"
170   OUTPUT @Amp;"*ESE 60"
180   !
190   !Call the subprograms
200   Rst
210   Sine_wave
220   !
230   WAIT .1  !allow interrupt to be serviced
240   OFF INTR 7
250   END
260   !
270   SUB Sine_wave
280 Sine_wave:  !Subprogram which sets the E1445A to output a sine wave
290     COM @Afg,@Amp
300     OUTPUT @Afg;"SOUR:FREQ1:FIX 1E3;";                    !frequency
310     OUTPUT @Afg;":SOUR:FUNC:SHAP SIN;";                   !function
320     OUTPUT @Afg;":SOUR:VOLT:LEV:IMM:AMPL 2VPP;"; !amplitude
330     OUTPUT @Afg;":OUTP:LOAD:AUTO ON;";                    !couple load to impedance
340     OUTPUT @Afg;":OUTP:IMP 50"                            !output impedance
350     !
360     !Set up the Agilent E1446A
370     OUTPUT @Amp;"INP1:IMP 50"             !input impedance
380     OUTPUT @Amp;"INP1:ATT 3"              !input attenuation (dB)
390     OUTPUT @Amp;"OUTP1:IMP 50;";          !main output impedance
400     OUTPUT @Amp;":OUTP1:ATT 0"            !main output attenuation
410     !
420     OUTPUT @Afg;"INIT:IMM"                !E1445A wait-for-arm state
430   SUBEND
440   !
450   SUB Rst
460 Rst:  !Subprogram which resets the E1445A and E1446A
470     COM @Afg,@Amp
480     OUTPUT @Afg;"*RST;*OPC?"  !reset the AFG
490     ENTER @Afg;Complete
500     OUTPUT @Amp;"*RST;*OPC?"  !reset the AMP
510     ENTER @Amp;Complete
520   SUBEND
530   !
540   SUB Errmsg
550 Errmsg:  !Subprogram which displays E1445/E1446 programming errors
560     COM @Afg,@Amp
570     DIM Message$[256]
580     !Read AFG (at sec addr 10) status byte register, clear service
590     !request bit
600     B=SPOLL(@Afg)
```

Continued on Next Page

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```
610    IF BIT(B,6) THEN     !AFG requested service
620    !End of statement if error occurs among coupled commands
630      OUTPUT @Afg;""
640      OUTPUT @Afg;"ABORT"   !abort output waveform
650      PRINT "E1445A errors"
660      PRINT
670      REPEAT
680        OUTPUT @Afg;"SYST:ERR?"   !read AFG error queue
690        ENTER @Afg;Code,Message$
700        PRINT Code,Message$
710      UNTIL Code=0
720      STOP
730    END IF
740    !
750    !Read AMP (at sec addr 11) status byte register, clear service
760    !request bit
770    B=SPOLL(@Amp)
780    IF BIT(B,6) THEN     !amplifier requested service
790    !End of statement if error occurs among coupled commands
800      OUTPUT @Amp;""
810      PRINT "E1446A errors"
820      PRINT
830      REPEAT
840        OUTPUT @Amp;"SYST:ERR?"!read AMP error queue
850        ENTER @Amp;Code,Message$
860        PRINT Code,Message$
870      UNTIL Code=0
880    END IF
890    STOP
900  SUBEND
```

Setting the Input Impedance

The examples in this section show you how to amplify a sine wave generated by the Agilent E1445A. In the first program, the E1446A is a servant of the E1445A AFG. In the second program, the E1446A amplifies the signal from the E1445A, however; the E1446A is in the servant area of the E1405 Command Module.

Setting the Input Impedance (Agilent E1445A Commander)

This program sets the E1446A's input impedance to match the output impedance of the E1445A. The signal supplied by the E1445A is a 1 Vpp, 2 MHz square wave. The signal is amplified to 6.3 Vpp. Again, when the intended output amplitude and the input amplitude are known, the amount of attenuation (0 - 31 dB attenuator) is determined by:

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$attenuation_{(dB)} = 20 \text{ LOG } (V_o/(V_i * 10))$

where V_o is the output amplitude and V_i is the input signal amplitude (V_o and V_i units (Vpp, Vp) must be the same). Thus,

$attenuation_{(dB)} = 20 \text{ LOG } (6.3/10) = -4 \text{ dB}$

Again, the (main) output of the AFG is connected to 'Input 1' of the amplifier.

The steps of this program are:

1. **Reset the E1445A AFG and E1446A amplifier.**

   *RST

2. **Set the AFG frequency, function, and amplitude.**

   [SOURce:]FREQuency[1][:CW|:FIXed] <*frequency*>

   [SOURce:]FUNCtion[:SHAPe] <*shape*>

   [SOURce:]VOLTage[:LEVel][:IMMediate][:AMPLitude] <*amplitude*>

3. **Set the AFG output load and output impedance values.**

   OUTPut[1]:LOAD <*load*>

   OUTPut[1]:IMPedance <*impedance*>

4. **Set the amplifier input impedance to match the AFG output load.**

   INPut[1]:IMPedance <*impedance*>

5. **Set the amplifier input attenuation.**

   INPut[1]:ATTenuation <*attenuation*>

6. **Set the amplifier output impedance.**

   OUTPut2:IMPedance <*impedance*>

7. **Set the amplifier output attenuation.**

   OUTPut2:ATTenuation <*attenuation*>

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8. **Place the AFG in the wait-for-arm state.**

INITiate:IMMediate

Note Resetting the amplifier sets many of the same conditions set by subsequent (amplifier) commands in the program. These commands are included, however, to show other parts of the amplifier configuration.

IN_IMP45

```
1    !RE-STORE"IN_IMP45"
2    !This program sets the AFG's output impedance and output load
3    !to 75 ohms. The Agilent E1446A amplifier's input impedance is set to
4    !75 ohms to match the AFG. The 1 Vpp AFG square wave is amplified
5    !to 6.3 Vpp.
6    !
10   !Assign I/O path between the computer and E1445A.
20   ASSIGN @Afg TO 70910
30   COM @Afg
40   !
50   !Set up error checking
60   ON INTR 7 CALL Errmsg
70   ENABLE INTR 7;2
80   OUTPUT @Afg;"*CLS"
90   OUTPUT @Afg;"*SRE 32"
100  OUTPUT @Afg;"*ESE 60"
110  !
120  !Call the subprograms
130  CALL Rst
140  CALL Out_load
150  !
160  WAIT .1  !allow interrupt to be serviced
170  OFF INTR 7
180  END
190  !
200  SUB Out_load
210 Out_load:  !Subprogram which sets the output load
220    COM @Afg
230    OUTPUT @Afg;"SOUR:FREQ1:FIX 2E6;";                    !frequency
240    OUTPUT @Afg;":SOUR:FUNC:SHAP SQU;";                   !function
250    OUTPUT @Afg;":SOUR:VOLT:LEV:IMM:AMPL 1VPP;";  !amplitude
260    OUTPUT @Afg;":OUTP:IMP 75;";                          !output impedance
270    OUTPUT @Afg;":OUTP:LOAD 75"                           !output load
```

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```
280    !
290    !Set up amplifier
300    OUTPUT @Afg;"INP1:IMP 75"           !input impedance
310    OUTPUT @Afg;"INP1:ATT 4"            !input attenuation (dB)
320    OUTPUT @Afg;"OUTP2:IMP 50"          !main output impedance
330    OUTPUT @Afg;"OUTP2:ATT 0"           !main output attenuation (dB)
340    !
350    OUTPUT @Afg;"INIT:IMM"              !E1445A wait-for-arm state
360  SUBEND
370  !
380  SUB Rst
390 Rst:  !Subprogram which resets the E1445 and E1446
400    COM @Afg
410    OUTPUT @Afg;"*RST;*OPC?"      !reset the AFG
420    ENTER @Afg;Complete
430  SUBEND
440  !
450  SUB Errmsg
460 Errmsg:  !Subprogram which displays E1445/E1446 programming errors
470    COM @Afg
480    DIM Message$[256]
490    !Read AFG status byte register and clear service request bit
500    B=SPOLL(@Afg)
510    !End of statement if error occurs among coupled commands
520    OUTPUT @Afg;""
530    OUTPUT @Afg;"ABORT"  !abort output waveform
540    REPEAT
550      OUTPUT @Afg;"SYST:ERR?"  !read AFG error queue
560      ENTER @Afg;Code,Message$
570      PRINT Code,Message$
580    UNTIL Code=0
590    STOP
600  SUBEND
```

Setting Input Impedance (Agilent E1405B Commander)

This program uses the same commands and sequence as previously described, except for the OUTPut[1] commands shown below:

6. Set the amplifier output impedance.

OUTPut[1]:IMPedance <*impedance*>

7. Set the amplifier output attenuation.

OUTPut[1]:ATTenuation <*attenuation*>

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In this example, the E1446A is a servant to the E1405. As such, commands sent to the amplifier (at secondary GPIB address 11) are parsed by the Command Module rather than by the E1445A.

IN_IMP05

```
1    !RE-STORE"IN_IMP05"
2    !This program sets the AFG's output impedance and output load
3    !to 75 ohms. The Agilent E1446A amplifier's input impedance is set to
4    !75 ohms to match the AFG. The 1 Vpp AFG square wave is amplified
5    !to 6.3 Vpp.
6    !
10   !Assign I/O paths between the computer and E1445A and E1405.
20   ASSIGN @Afg TO 70910
30   ASSIGN @Amp TO 70911
40   COM @Afg,@Amp
50   !
60   !Set up error checking
70   ON INTR 7 CALL Errmsg
80   ENABLE INTR 7;2
90   OUTPUT @Afg;"*CLS"
100  OUTPUT @Afg;"*SRE 32"
110  OUTPUT @Afg;"*ESE 60"
120  !
130  OUTPUT @Amp;"*CLS"
140  OUTPUT @Amp;"*SRE 32"
150  OUTPUT @Amp;"*ESE 60"
160  !
170  !Call the subprograms
180  CALL Rst
190  CALL Out_load
200  !
210  WAIT .1  !allow interrupt to be serviced
220  OFF INTR 7
230  END
240  !
250  SUB Out_load
260 Out_load:  !Subprogram which sets the output load
270    COM @Afg,@Amp
280    OUTPUT @Afg;"SOUR:FREQ1:FIX 2E6;";                    !frequency
290    OUTPUT @Afg;":SOUR:FUNC:SHAP SQU;";                   !function
300    OUTPUT @Afg;":SOUR:VOLT:LEV:IMM:AMPL 1VPP;";  !amplitude
310    OUTPUT @Afg;":OUTP:IMP 75;";                          !output impedance
320    OUTPUT @Afg;":OUTP:LOAD 75"                           !output load
330    !
```

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```
340    !Set up amplifier
350    OUTPUT @Amp;"INP1:IMP 75"            !input impedance
360    OUTPUT @Amp;"INP1:ATT 4"             !input attenuation (dB)
370    OUTPUT @Amp;"OUTP1:IMP 50"           !main output impedance
380    OUTPUT @Amp;"OUTP1:ATT 0"            !main output attenuation (dB)
390    !
400    OUTPUT @Afg;"INIT:IMM"               !E1445A wait-for-arm state
410   SUBEND
420   !
430   SUB Rst
440 Rst:  !Subprogram which resets the E1445 and E1446
450    COM @Afg,@Amp
460    OUTPUT @Afg;"*RST;*OPC?"       !reset the AFG
470    ENTER @Afg;Complete
480    OUTPUT @Amp;"*RST;*OPC?"       !reset the AMP
490    ENTER @Amp;Complete
500   SUBEND
510   !
520   SUB Errmsg
530 Errmsg:  !Subprogram which displays E1445/E1446 programming errors
540    COM @Afg,@Amp
550    DIM Message$[256]
560    !Read AFG (at sec addr 10) status byte register, clear service
570    !request bit
580    B=SPOLL(@Afg)
590    IF BIT(B,6) THEN     !AFG requested service
600    !End of statement if error occurs among coupled commands
610      OUTPUT @Afg;""
620      OUTPUT @Afg;"ABORT"!abort output waveform
630      PRINT "E1445A errors"
640      PRINT
650      REPEAT
660        OUTPUT @Afg;"SYST:ERR?"   !read AFG error queue
670        ENTER @Afg;Code,Message$
680        PRINT Code,Message$
690      UNTIL Code=0
700      STOP
710    END IF
720    !
730    !Read AMP (at sec addr 11) status byte register, clear service
740    !request bit
750    B=SPOLL(@Amp)
760    IF BIT(B,6) THEN     !amplifier requested service
770    !End of statement if error occurs among coupled commands
780      OUTPUT @Amp;""
790      PRINT "E1446A errors"
```

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```
800      PRINT
810      REPEAT
820        OUTPUT @Amp;"SYST:ERR?"   !read AMP error queue
830        ENTER @Amp;Code,Message$
840        PRINT Code,Message$
850      UNTIL Code=0
860    END IF
870    STOP
880  SUBEND
```

Setting DC Voltage Offsets

These examples show you how to use the amplifier to add a DC offset to a signal supplied by the E1445A. In the first example, the E1446A is a servant to the E1445A. In the second example, the E1446A is a servant to the E1405 Command Module.

Setting DC Offsets (Agilent E1445A Commander)

This program adds an 8V DC offset to a 0.4 Vpp E1445A signal. To maintain 0.4 Vpp at the output, the signal is attenuated by 20 dB at the amplifier input (Figure 2-1). The offset supplied by the E1446A DAC is added to the input signal and is amplified. Into 50W, the 0.4 Vpp signal is centered on 8V.

The steps of this program are:

1. **Reset the E1445A AFG and E1446A amplifier.**

   *RST

2. **Set the AFG frequency, function, and amplitude.**

   [SOURce:]FREQuency[1][:CW|:FIXed] <*frequency*>

   [SOURce:]FUNCtion[:SHAPe] <*shape*>

   [SOURce:]VOLTage[:LEVel][:IMMediate][:AMPLitude] <*amplitude*>

3. **Couple the AFG output load value to the output impedance value.**

   OUTPut[1]:LOAD:AUTO <*mode*>

   OUTPut[1]:IMPedance <*impedance*>

4. **Set the amplifier input impedance to match the AFG output load.**

   INPut[1]:IMPedance <*impedance*>

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5. **Set the amplifier input attenuation.**

   INPut[1]:ATTenuation <*attenuation*>

6. **Set the amplifier main output impedance.**

   OUTPut2:IMPedance <*impedance*>

7. **Set the amplifier main output attenuation.**

   OUTPut2:ATTenuation <*attenuation*>

8. **Set the DC offset value.**

   SOURce2:VOLTage[:LEVel][:IMMediate]:OFFSet <*offset*>

9. **Place the AFG in the wait-for-arm state.**

   INITiate:IMMediate

Note Resetting the amplifier sets many of the same conditions set by subsequent (amplifier) commands in the program. These commands are included, however, to show other parts of the amplifier configuration.

OFFS45

```
1    !RE-STORE"OFFS45"
2    !This program uses the E1446A to generate an 8V DC offset for a
3    !0.4 Vpp signal supplied by the E1445A AFG. To accomplish this, the
4    !AFG signal is attenuated by 20 dB at the amplifier input. The amplifier
5    !offset is set to 8V, the output impedance to 50 ohms, and the output
6    !attenuation to 0 dB. Into 50 ohms, the 0.4 Vpp signal is centered on
7    !8 volts.
8    !
10   !Assign I/O path between the computer and E1445A. As the commander of
20   !the Agilent E1446A, the E1445A sends the amplifier its commands.
30   ASSIGN @Afg TO 70910
40   COM @Afg
50   !
```

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```
60   !Set up error checking
70   ON INTR 7 CALL Errmsg
80   ENABLE INTR 7;2
90   OUTPUT @Afg;"*CLS"
100  OUTPUT @Afg;"*SRE 32"
110  OUTPUT @Afg;"*ESE 60"
120  !
130  !Call the subprograms
140  Rst
150  Offset
160  !
170  WAIT .1  !allow interrupt to be serviced
180  OFF INTR 7
190  END
200  !
210  SUB Offset
220 Offset:  !Subprogram which sets up the E1445A and E1446A
230    COM @Afg
240    OUTPUT @Afg;"SOUR:FREQ1:FIX 1E3;";                    !frequency
250    OUTPUT @Afg;":SOUR:FUNC:SHAP SIN;";                   !function
260    OUTPUT @Afg;":SOUR:VOLT:LEV:IMM:AMPL .4VPP;";  !amplitude
270    OUTPUT @Afg;":OUTP:LOAD:AUTO ON;";                    !couple load to impedance
280    OUTPUT @Afg;":OUTP:IMP 50"                            !impedance
290    !
300    !Set up the Agilent E1446A
310    OUTPUT @Afg;"INP1:IMP 50"                        !input impedance
320    OUTPUT @Afg;"INP1:ATT 20"                        !input attenuation (dB)
330    OUTPUT @Afg;"OUTP2:IMP 50;";                     !main output impedance
340    OUTPUT @Afg;":OUTP2:ATT 0;";                     !main output attenuation (dB)
350    OUTPUT @Afg;":SOUR2:VOLT:LEV:IMM:OFFS 8"  !DC offset
360    !
370    OUTPUT @Afg;"INIT:IMM"                  !E1445A wait-for-arm state
380  SUBEND
390  !
400  SUB Rst
410 Rst:  !Subprogram which resets the E1445A and E1446A
420    COM @Afg
430    OUTPUT @Afg;"*RST;*OPC?"  !reset the AFG
440    ENTER @Afg;Complete
450  SUBEND
460  !
470  SUB Errmsg
480 Errmsg:  !Subprogram which displays E1445/E1446 programming errors
490    COM @Afg
500    DIM Message$[256]
```

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```
510    !Read AFG status byte register and clear service request bit
520    B=SPOLL(@Afg)
530    !End of statement if error occurs among coupled commands
540    OUTPUT @Afg;""
550    OUTPUT @Afg;"ABORT"  !abort output waveform
560    REPEAT
570      OUTPUT @Afg;"SYST:ERR?"  !read AFG error queue
580      ENTER @Afg;Code,Message$
590      PRINT Code,Message$
600    UNTIL Code=0
610    STOP
620  SUBEND
```

Setting DC Offsets (Agilent E1405 Commander)

This program uses the same commands and sequence as previously described, except for the OUTPut[1] and SOURCe:VOLTage commands shown below:

6. Set the amplifier main output impedance.

OUTPut[1]:IMPedance <*impedance*>

7. Set the amplifier main output attenuation.

OUTPut[1]:ATTenuation <*attenuation*>

8. Set the DC offset value.

SOURce:VOLTage[:LEVel][:IMMediate]:OFFSet <*offset*>

In this example, the E1446A is a servant to the E1405. As such, commands sent to the amplifier (at secondary GPIB address 11) are parsed by the Command Module rather than by the E1445A.

OFFS05

```
1    !RE-STORE"OFFS05"
2    !This program uses the E1446A to generate an 8V DC offset for a
3    !0.4 Vpp signal supplied by the E1445A AFG. To accomplish this, the
4    !AFG signal is attenuated by 20 dB at the amplifier input. The amplifier
5    !offset is set to 8V, the output impedance to 50 ohms, and the output
6    !attenuation to 0 dB. Into 50 ohms, the 0.4 Vpp signal is centered on
7    !8 volts.
8    !
10    !Assign I/O path between the computer and E1445A and E1446A.
20    ASSIGN @Afg TO 70910
30    ASSIGN @Amp TO 70911
```

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```
40   COM @Afg,@Amp
50   !
60   !Set up error checking
70   ON INTR 7 CALL Errmsg
80   ENABLE INTR 7;2
90   OUTPUT @Afg;"*CLS"
100  OUTPUT @Afg;"*SRE 32"
110  OUTPUT @Afg;"*ESE 60"
120  !
130  OUTPUT @Amp;"*CLS"
140  OUTPUT @Amp;"*SRE 32"
150  OUTPUT @Amp;"*ESE 60"
160  !
170  !Call the subprograms
180  Rst
190  Offset
200  !
210  WAIT .1  !allow interrupt to be serviced
220  OFF INTR 7
230  END
240  !
250  SUB Offset
260 Offset:  !Subprogram which sets up the E1445A and E1446A
270    COM @Afg,@Amp
280    OUTPUT @Afg;"SOUR:FREQ1:FIX 1E3;";                    !frequency
290    OUTPUT @Afg;":SOUR:FUNC:SHAP SIN;";                   !function
300    OUTPUT @Afg;":SOUR:VOLT:LEV:IMM:AMPL .4VPP;";   !amplitude
310    OUTPUT @Afg;":OUTP:LOAD:AUTO ON;";                    !couple load to impedance
320    OUTPUT @Afg;":OUTP:IMP 50"                            !impedance
330    !
340    !Set up the Agilent E1446A
350    OUTPUT @Amp;"INP1:IMP 50"                          !input impedance
360    OUTPUT @Amp;"INP1:ATT 20"                          !input attenuation (dB)
370    OUTPUT @Amp;"OUTP1:IMP 50;";                       !main output impedance
380    OUTPUT @Amp;":OUTP1:ATT 0;";                       !main output attenuation (dB)
390    OUTPUT @Amp;":SOUR:VOLT:LEV:IMM:OFFS 8"  !DC offset
400    !
410    OUTPUT @Afg;"INIT:IMM"                             !E1445A wait-for-arm state
420  SUBEND
430  !
440  SUB Rst
450 Rst:  !Subprogram which resets the E1445A and E1446A
460    COM @Afg,@Amp
470    OUTPUT @Afg;"*RST;*OPC?"  !reset the AFG
480    ENTER @Afg;Complete
490    OUTPUT @Amp;"*RST;*OPC?"  !reset the AFG
```

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```
500     ENTER @Amp;Complete
510   SUBEND
520   !
530   SUB Errmsg
540 Errmsg:  !Subprogram which displays E1445/E1446 programming errors
550     COM @Afg,@Amp
560     DIM Message$[256]
570     !Read AFG (at sec addr 10) status byte register, clear service
580     !request bit
590     B=SPOLL(@Afg)
600     IF BIT(B,6) THEN     !AFG requested service
610     !End of statement if error occurs among coupled commands
620       OUTPUT @Afg;""
630       OUTPUT @Afg;"ABORT"   !abort output waveform
640       PRINT "E1445A errors"
650       PRINT
660       REPEAT
670         OUTPUT @Afg;"SYST:ERR?"   !read AFG error queue
680         ENTER @Afg;Code,Message$
690         PRINT Code,Message$
700       UNTIL Code=0
710       STOP
720     END IF
730     !
740     !Read AMP (at sec addr 11) status byte register, clear service
750     !request bit
760     B=SPOLL(@Amp)
770     IF BIT(B,6) THEN     !amplifier requested service
780     !End of statement if error occurs among coupled commands
790       OUTPUT @Amp;""
800       PRINT "E1446A errors"
810       PRINT
820       REPEAT
830         OUTPUT @Amp;"SYST:ERR?"!read AMP error queue
840         ENTER @Amp;Code,Message$
850         PRINT Code,Message$
860       UNTIL Code=0
870     END IF
880     STOP
890   SUBEND
```


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Using the Differential (small signal) Outputs

These examples show you how to use the amplifier's differential (small signal) outputs. Note the following when using the outputs:

- the differential (small signal) outputs are designed for high-frequency and low-power source applications.
- with no attenuation, the maximum input voltage (sum of Input1 and Input2) must not exceed 2 Vpp (Figure 2-1).

In the first example, the E1446A is a servant to the E1445A. In the second example, the E1446A is a servant to the E1405 Command Module.

Using the Differential Outputs (Agilent E1445A Commander)

Rather than amplify the input signal, this program attenuates the signal supplied by the E1445A to obtain an output amplitude of 10 mVpp. The output can be taken at either the 'Diff +' or 'Diff -' (inverted) output.

The steps of this program are:

1. **Reset the E1445A AFG and E1446A amplifier.**

   *RST

2. **Set the AFG frequency, function, and (minimum) amplitude.**

   [SOURce:]FREQuency[1][:CW|:FIXed] <*frequency*>

   [SOURce:]FUNCtion[:SHAPe] <*shape*>

   [SOURce:]VOLTage[:LEVel][:IMMediate][:AMPLitude] <*amplitude*>

3. **Couple the AFG output load value to the output impedance value.**

   OUTPut[1]:LOAD:AUTO <*mode*>

   OUTPut[1]:IMPedance <*impedance*>

4. **Set the amplifier input impedance to match the AFG output load.**

   INPut[1]:IMPedance <*impedance*>

5. **Set the amplifier input attenuation.**

   INPut[1]:ATTenuation <*attenuation*>

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6. **Set the amplifier 'Diff +' and 'Diff -' output impedances.**

   OUTPut3:IMPedance <*impedance*>

   OUTPut4:IMPedance <*impedance*>

7. **Place the AFG in the wait-for-arm state.**

   INITiate:IMMediate

Note Resetting the amplifier sets many of the same conditions set by subsequent (amplifier) commands in the program. These commands are included, however, to show other parts of the amplifier configuration.

DIFF45

```
1    !RE-STORE"DIFF45"
2    !This program uses the E1446A to generate a 10 mVpp signal from a
3    !0.323738 Vpp signal supplied by the E1445A AFG. To accomplish this, the
4    !AFG signal is attenuated by 30 dB at the amplifier input. The output is
5    !taken from the 'Diff +' and 'Diff - ' outputs whose output impedances
6    !are set to 50 ohms.
7    !
10   !Assign I/O path between the computer and E1445A. As the commander of
20   !the Agilent E1446A, the E1445A sends the amplifier its commands.
30   ASSIGN @Afg TO 70910
40   COM @Afg
50   !
60   !Set up error checking
70   ON INTR 7 CALL Errmsg
80   ENABLE INTR 7;2
90   OUTPUT @Afg;"*CLS"
100  OUTPUT @Afg;"*SRE 32"
110  OUTPUT @Afg;"*ESE 60"
120  !
130  !Call the subprograms
140  Rst
150  Diffout
160  !
```

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```
170   WAIT .1  !allow interrupt to be serviced
180   OFF INTR 7
190   END
200   !
210   SUB Diffout
220 Diffout:  !Subprogram which sets up the E1445A and E1446A
230     COM @Afg
240     OUTPUT @Afg;"SOUR:FREQ1:FIX 1E3;";                  !frequency
250     OUTPUT @Afg;":SOUR:FUNC:SHAP SQU;";                 !function
260     OUTPUT @Afg;":SOUR:VOLT:LEV:IMM:AMPL MIN;";   !amplitude (.161869 Vpk)
270     OUTPUT @Afg;":OUTP:LOAD:AUTO ON;";                  !couple load to impedance
280     OUTPUT @Afg;":OUTP:IMP 50"                          !impedance
290     !
300     !Set up the Agilent E1446A
310     OUTPUT @Afg;"INP1:IMP 50"                          !input impedance
320     OUTPUT @Afg;"INP1:ATT 30"                          !input attenuation (dB)
330     OUTPUT @Afg;"OUTP3:IMP 50"                         !Diff + output impedance
340     OUTPUT @Afg;"OUTP4:IMP 50"                         !Diff - output impedance
350     !
360     OUTPUT @Afg;"INIT:IMM"                             !E1445A wait-for-arm state
370   SUBEND
380   !
390   SUB Rst
400 Rst:  !Subprogram which resets the E1445A and E1446A
410     COM @Afg
420     OUTPUT @Afg;"*RST;*OPC?"  !reset the AFG
430     ENTER @Afg;Complete
440   SUBEND
450   !
460   SUB Errmsg
470 Errmsg:  !Subprogram which displays E1445/E1446 programming errors
480     COM @Afg
490     DIM Message$[256]
500     !Read AFG status byte register and clear service request bit
510     B=SPOLL(@Afg)
520     !End of statement if error occurs among coupled commands
530     OUTPUT @Afg;""
540     OUTPUT @Afg;"ABORT"  !abort output waveform
550     REPEAT
560       OUTPUT @Afg;"SYST:ERR?"  !read AFG error queue
570       ENTER @Afg;Code,Message$
580       PRINT Code,Message$
590     UNTIL Code=0
600     STOP
610   SUBEND
```


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Using the Differential Outputs (Agilent E1405 Commander)

This program uses the same commands and sequence as previously described, except for the OUTPut2 and OUTPut3 commands shown below:

6. Set the amplifier 'Diff +' and 'Diff -' output impedances.

OUTPut2:IMPedance <*impedance*>

OUTPut3:IMPedance <*impedance*>

In this example, the E1446A is a servant to the E1405. As such, commands sent to the amplifier (at secondary GPIB address 11) are parsed by the Command Module rather than by the E1445A.

DIFF05

```
1    !RE-STORE"DIFF05"
2    !This program uses the E1446A to generate a 10 mVpp signal from a
3    !0.323738 Vpp signal supplied by the E1445A AFG. To accomplish this, the
4    !AFG signal is attenuated by 30 dB at the amplifier input. The output is
5    !taken from the 'Diff +' and 'Diff - ' outputs whose output impedances
6    !are set to 50 ohms.
7    !
10   !Assign I/O path between the computer and E1445A, and E1446A.
20   ASSIGN @Afg TO 70910
30   ASSIGN @Amp TO 70911
40   COM @Afg,@Amp
50   !
60   !Set up error checking
70   ON INTR 7 CALL Errmsg
80   ENABLE INTR 7;2
90   OUTPUT @Afg;"*CLS"
100  OUTPUT @Afg;"*SRE 32"
110  OUTPUT @Afg;"*ESE 60"
120  !
130  OUTPUT @Amp;"*CLS"
140  OUTPUT @Amp;"*SRE 32"
150  OUTPUT @Amp;"*ESE 60"
160  !
170  !Call the subprograms
180  Rst
190  Diffout
200  !
210  WAIT .1  !allow interrupt to be serviced
220  OFF INTR 7
230  END
```

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```
240   !
250   SUB Diffout
260 Diffout:  !Subprogram which sets up the E1445A and E1446A
270     COM @Afg,@Amp
280     OUTPUT @Afg;":SOUR:FREQ1:FIX 1E3;";                    !frequency
290     OUTPUT @Afg;":SOUR:FUNC:SHAP SIN;";                    !function
300     OUTPUT @Afg;":SOUR:VOLT:LEV:IMM:AMPL MIN;";    !amplitude (.161869 Vpk)
310     OUTPUT @Afg;":OUTP:LOAD:AUTO ON;";                     !couple load to impedance
320     OUTPUT @Afg;":OUTP:IMP 50"                             !impedance
330     !
340     !Set up the Agilent E1446A
350     OUTPUT @Amp;"INP1:IMP 50"                    !input impedance
360     OUTPUT @Amp;"INP1:ATT 30"                    !input attenuation (dB)
370     OUTPUT @Amp;"OUTP2:IMP 50"                   !Diff + output impedance
380     OUTPUT @Amp;"OUTP3:IMP 50"                   !Diff - output impedance
390     !
400     OUTPUT @Afg;"INIT:IMM"       !E1445A wait-for-arm state
410   SUBEND
420   !
430   SUB Rst
440 Rst:  !Subprogram which resets the E1445A and E1446A
450     COM @Afg,@Amp
460     OUTPUT @Afg;"*RST;*OPC?"  !reset the AFG
470     ENTER @Afg;Complete
480     OUTPUT @Amp;"*RST;*OPC?"  !reset the amplifier
490     ENTER @Amp;Complete
500   SUBEND
510   !
520   SUB Errmsg
530 Errmsg:  !Subprogram which displays E1445/E1446 programming errors
540     COM @Afg,@Amp
550     DIM Message$[256]
560     !Read AFG (at sec addr 10) status byte register, clear service
570     !request bit
580     B=SPOLL(@Afg)
590     IF BIT(B,6) THEN     !AFG requested service
600     !End of statement if error occurs among coupled commands
610       OUTPUT @Afg;""
620       OUTPUT @Afg;"ABORT"!abort output waveform
630       PRINT "E1445A errors"
640       PRINT
650       REPEAT
660         OUTPUT @Afg;"SYST:ERR?"   !read AFG error queue
670         ENTER @Afg;Code,Message$
680         PRINT Code,Message$
690       UNTIL Code=0
```

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```
700     STOP
710    END IF
720    !
730    !Read AMP (at sec addr 11) status byte register, clear service
740    !request bit
750    B=SPOLL(@Amp)
760    IF BIT(B,6) THEN     !amplifier requested service
770    !End of statement if error occurs among coupled commands
780      OUTPUT @Amp;""
790      PRINT "E1446A errors"
800      PRINT
810      REPEAT
820        OUTPUT @Amp;"SYST:ERR?"   !read AMP error queue
830        ENTER @Amp;Code,Message$
840        PRINT Code,Message$
850      UNTIL Code=0
860    END IF
870    STOP
880  SUBEND
```

Summing Two Signals

This program uses the E1446A to sum the signals from two E1445A AFGs. The AFGs at logical addresses 80 and 88 (secondary GPIB addresses 10 and 11), generate 1 Vpp, 5 kHz and 100 kHz sine waves respectively. The signal from the AFG at logical address 80 is applied to E1446A 'Input 1'. The signal from the AFG at logical address 88 is applied to 'Input 2'. The E1446A is in the servant area of the AFG at logical address 80.

The steps of the program are as follows:

1. **Reset the E1445A AFGs and E1446A amplifier.**

   *RST

2. Set the E1445As' reference oscillator sources to CLK10.

   [SOURce:]ROSCillator:SOURce <*source*>

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3. **Set the AFG frequency, function, and amplitude.**

   [SOURce:]FREQuency[1][:CW|:FIXed] <*frequency*>

   [SOURce:]FUNCtion[:SHAPe] <*shape*>

   [SOURce:]VOLTage[:LEVel][:IMMediate][:AMPLitude] <*amplitude*>

4. **Couple the AFG output load value to the output impedance value.**

   OUTPut[1]:LOAD:AUTO <*mode*>

   OUTPut[1]:IMPedance <*impedance*>

5. **Set the amplifier input impedance to match the AFG output load.**

   INPut[1]:IMPedance <*impedance*>

   INPut2:IMPedance <*impedance*>

6. **Set the amplifier input attenuation.**

   INPut[1]:ATTenuation <*attenuation*>

   INPut2:ATTenuation <*attenuation*>

7. **Set the amplifier 'Diff +' output impedance.**

   OUTPut3:IMPedance <*impedance*>

8. **Place the AFGs in the wait-for-arm state.**

   INITiate:IMMediate

SUM45

```
1    !RE-STORE"SUM45"
2    !The following program uses the E1446A to sum the output signals of
3    !two E1445As. The E1445A at secondary address 10 (logical address 80)
4    !outputs a 1 Vpp, 5 kHz sine wave. The E1445A at secondary address 11
5    !(logical address 88) outputs a 1 Vpp, 100 kHz sine wave. To prevent
6    !the E1445A signals from drifting, both AFG's use CLK10 as their
7    !reference oscillator source. The E1446A sums these signals, and the
9    !output is taken at the 'Diff +' output.
10   !
```

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```
20   !Assign I/O paths between the computer and E1445As. The E1445A at
30   !secondary address 10 is the commander for the E1446A.
40   ASSIGN @Afg80 TO 70910
50   ASSIGN @Afg88 TO 70911
60   COM @Afg80,@Afg88
70   !
80   !Set up error checking
90   ON INTR 7 CALL Errmsg
100   ENABLE INTR 7;2
110   OUTPUT @Afg80;"*CLS"
120   OUTPUT @Afg80;"*SRE 32"
130   OUTPUT @Afg80;"*ESE 60"
140   !
150   OUTPUT @Afg88;"*CLS"
160   OUTPUT @Afg88;"*SRE 32"
170   OUTPUT @Afg88;"*ESE 60"
180   !
190   !Call the subprograms
200   Rst
210   Afg_setup
220   !
230   WAIT .1  !allow interrupt to be serviced
240   OFF INTR 7
250   END
260   !
270   SUB Afg_setup
280 Afg_setup:  !Subprogram which sets up the E1445As and E1446A
290     COM @Afg80,@Afg88
300     !Set up E1445A at secondary address 10
310     OUTPUT @Afg80;"SOUR:ROSC:SOUR CLK10;";              !ref osc source
320     OUTPUT @Afg80;":SOUR:FREQ1:FIX 5E3;";               !frequency
330     OUTPUT @Afg80;":SOUR:FUNC:SHAP SIN;";               !function
340     OUTPUT @Afg80;":SOUR:VOLT:LEV:IMM:AMPL 1VPP;";      !amplitude
350     OUTPUT @Afg80;":OUTP:LOAD:AUTO ON;";                !couple load to impedance
360     OUTPUT @Afg80;":OUTP:IMP 50"                        !impedance
370     !
380     !Setup E1445A at secondary address 11
390     OUTPUT @Afg88;"SOUR:ROSC:SOUR CLK10;";              !ref osc source
400     OUTPUT @Afg88;":SOUR:FREQ1:FIX 100E3;";             !frequency
410     OUTPUT @Afg88;":SOUR:FUNC:SHAP SIN;";               !function
420     OUTPUT @Afg88;":SOUR:VOLT:LEV:IMM:AMPL 1VPP;";      !amplitude
430     OUTPUT @Afg88;":OUTP:LOAD:AUTO ON;";                !couple load to impedance
440     OUTPUT @Afg88;":OUTP:IMP 50"                        !impedance
450     !
```

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```
460    !Set up the Agilent E1446A
470    OUTPUT @Afg80;"INP1:IMP 50"         !input 1 impedance
480    OUTPUT @Afg80;"INP1:ATT 0"          !input 1 attenuation (dB)
490    OUTPUT @Afg80;"INP2:IMP 50"         !input 2 impedance
500    OUTPUT @Afg80;"INP2:ATT 0"          !input 2 attenuation (dB)
510    OUTPUT @Afg80;"OUTP3:IMP 50"     !Diff + output impedance
520    !
530    OUTPUT @Afg80;"INIT:IMM"            !E1445A wait-for-arm state (10)
540    OUTPUT @Afg88;"INIT:IMM"            !E1445A wait-for-arm state (11)
550  SUBEND
560  !
570  SUB Rst
580 Rst:  !Subprogram which resets the E1445As and E1446A
590    COM @Afg80,@Afg88
600    OUTPUT @Afg80;"*RST;*OPC?"  !reset the AFG (sec addr 10)
610    ENTER @Afg80;Complete
620    !
630    OUTPUT @Afg88;"*RST;*OPC?"  !reset the AFG (sec addr 11)
640    ENTER @Afg88;Complete
650  SUBEND
660  !
670  SUB Errmsg
680 Errmsg:  !Subprogram which displays E1445/E1446 programming errors
690    COM @Afg80,@Afg88
700    DIM Message$[256]
710    !Read AFG (at sec addr 10) status byte register, clear service
720    !request bit
730    B=SPOLL(@Afg80)
740    !End of statement if error occurs among coupled commands
750    OUTPUT @Afg80;""
760    OUTPUT @Afg80;"ABORT"  !abort output waveform
770    PRINT "E1445A (secondary address 10)"
780    PRINT
790    REPEAT
800      OUTPUT @Afg80;"SYST:ERR?"  !read AFG error queue (sec addr 10)
810      ENTER @Afg80;Code,Message$
820      PRINT Code,Message$
830    UNTIL Code=0
840    PRINT
850    !
860    !Read AFG (at sec addr 11) status byte register, clear service
870    !request bit
```

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```
880    B=SPOLL(@Afg88)
890    !End of statement if error occurs among coupled commands
900    OUTPUT @Afg88;""
910    OUTPUT @Afg88;"ABORT"  !abort output waveform
920    PRINT "E1445A (secondary address 11)"
930    PRINT
940    REPEAT
950      OUTPUT @Afg88;"SYST:ERR?"  !read AFG error queue (sec addr 11)
960      ENTER @Afg88;Code,Message$
970      PRINT Code,Message$
980    UNTIL Code=0
990    STOP
1000  SUBEND
```


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Chapter 3
Command Reference

Chapter Contents

This chapter describes the **Standard Commands for Programmable Instruments** (SCPI) command set and the **IEEE 488.2 Common Commands** for the Agilent E1446A Summing Amplifier/DAC. Included in this chapter are the following sections:

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- SCPI Command Format 3-2
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- SCPI Command Reference 3-6
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Command Types

Commands are separated into two types: IEEE-488.2 Common Commands and SCPI Commands.

Common Command Format

The IEEE-488.2 standard defines Common Commands that perform functions like reset, self-test, status byte query, etc. Common commands are four or five characters in length, always begin with the asterisk character (*), and may include one or more parameters. The command keyword is separated from the first parameter by a space character. Some examples of Common commands are shown below:

*RST, *CLS, *ESE <unmask>, *OPC?, *STB?

SCPI Command Format

The functions of the summing amplifier/DAC are programmed using SCPI commands. SCPI commands are based on a hierarchical structure, also known as a tree system. In this system, associated commands are grouped together under a common node or root, thus, forming subtrees or subsystems. An example is the amplifier's 'OUTPut2' subsystem shown on the following page.

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```
OUTPut2
    :ATTenuation <attenuation>
    :IMPedance <impedance>
    :OVERload?                          [query only]
    [:STATe] <mode>
        :ACTual?                        [query only]
```

OUTPut2 is the root keyword of the command, :ATTenuation, :IMPedance, :OVERload?, and [:STATe] are second level keywords, and :ACTual? is the third level keyword.

Command Separator

A colon (**:**) always separates one command keyword from a lower level command keyword as shown below:

```
OUTP2:STAT:ACT?
```

Abbreviated Commands

The command syntax shows most commands as a mixture of upper and lower case letters. The upper case letters indicate the abbreviated spelling for the command. For shorter program lines, send the abbreviated form. For better program readability, you may send the entire command. The amplifier will accept either the abbreviated form or the entire command.

For example, if a command's syntax contains the keyword IMPedance, then IMP and IMPEDANCE are acceptable forms. Lower or upper case letters are also acceptable. Thus, IMPedance, impedance, IMP, or imp are all acceptable.

Implied (Optional) Keywords

Implied or optional keywords are those which appear in square brackets (**[ ]**) in the command syntax. The brackets are not part of the command, and are not sent to the amplifier. Suppose you send the following command:

```
OUTP2 ON
```

In this case, the amplifier responds as if the command was executed as:

```
OUTP2:STAT ON
```


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SCPI Command Parameters

The following information contains explanations and examples of the parameter types found in this chapter.

Parameter Types, Explanations, and Examples

- Numeric

  Accepts all commonly used decimal representations of numbers including optional signs, decimal points, and scientific notation:

  123, 123E2, -123, -1.23E2, .123, 1.23E-2, 1.23000E-01.

  Special cases include MIN, MAX, and INFinity. The Comments section within the Command Reference will state whether a numeric parameter can also be specified in hex, octal, and/or binary:

  #H7B, #Q173, #B1111011

- Boolean

  Represents a single binary condition that is either true or false. Any non-zero value is considered true:

  ON, OFF, 1, 0

- Discrete

  Selects from a finite number of values. These parameters use mnemonics to represent each valid setting.

- Arbitrary Block Program Data

  This parameter type is used to transfer a block of data in the form of bytes. The block of data bytes is preceded by a header which indicates either 1) the number of data bytes which follow (definite length block), or 2) that the following data block will be terminated upon receipt of a New Line message with the EOI signal true (indefinite length block). The syntax for data in the blocks is as follows:

  Definite length block:

  #<non-zero digit><digit(s)><data byte(s)>

  Where the value of <non-zero digit> equals the number of <digit(s)>. The value of <digit(s)> taken as a decimal integer indicates the number of <data byte(s)> in the block.

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Indefinite length block:

#0<data byte(s)><NL^END>

Examples of sending 4 data bytes:

#14<byte><byte><byte><byte>
#3004<byte><byte><byte><byte>
#0<byte><byte><byte><byte><NL^END>

Querying Parameter Settings

Unless otherwise noted in the reference section, parameter settings can be queried by adding a question mark (?) to the command which set the parameter. For example:

INP:IMP 50

sets the impedance of the 'Input 1' port to 50Ω. The value can be queried by executing:

INP:IMP?

The MINimum or MAXimum value of a parameter is determined as follows:

INP:IMP? MIN

INP:IMP? MAX

SCPI Command Execution

The following information should be remembered when executing SCPI commands.

Command Coupling

The following amplifier commands are value coupled:

E1446 with E1405/06

OUTPut1:ATTenuation <*attenuation*>
OUTPut1:IMPedance <*impedance*>
SOURce:VOLTage[:LEVel][:IMMediate]:OFFSet <*voltage*>

E1446 with E1445

OUTPut2:ATTenuation <*attenuation*>
OUTPut2:IMPedance <*impedance*>
SOURce2:VOLTage[:LEVel][:IMMediate]:OFFSet <*voltage*>

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This means that sending one of these commands can change the value set previously by another one of these commands. Often, this results in "Settings Conflict" errors when the program executes. To prevent these errors these commands must be executed in a "Coupling Group". Refer to Chapter 2 for information on executing coupled commands.

Linking Commands

Linking IEEE 488.2 Common Commands.

Use a semicolon between the commands. For example:

```
*RST;*CLS;*OPC?
```

Linking Multiple SCPI Commands.

Use a semicolon (;) and a colon (:) to link commands within different subsystems. For example:

```
INP:IMP 50;:OUTP2:IMP 50
```

Commands within the same subsystem are linked with a semicolon(;). For example:

```
INP:ATT 6;INP:IMP 50
```

SCPI Command Reference

This section describes the SCPI commands for the Agilent E1446A Summing Amplifier/DAC. Since the E1446A amplifier can be a servant of either the Agilent E1445A Arbitrary Function Generator or the Agilent E1405 Command Module, the section has been divided into three parts:

- Agilent E1446A/Agilent E1445A Command Reference
  (Agilent E1446A is a servant to the Agilent E1445A)
- Agilent E1446A/Agilent E1405 Command Reference
  (Agilent E1446A is a servant to the Agilent E1405)
- IEEE-488.2 Common Commands
  (same for either commander (Agilent E1445A or Agilent E1405)

In each part the commands are listed alphabetically by subsystem and alphabetically within each subsystem. A command guide is printed in the top margin of each page. The guide indicates the first command listed on that page.

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Agilent E1446 / E1445 Commands

SCPI Command Reference

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The INPut[1] subsystem controls the input attenuation and impedance of the Agilent E1446A's "Input 1" BNC.

SubSystem Syntax

```
INPut[1]
    :ATTenuation <attenuation>
    :IMPedance <impedance>
```

:ATTenuation

INPut[1]:ATTenuation <***attenuation***> controls the input attenuator of the "Input 1" BNC. Input attenuation can range from 0 to 31 dB in 1 dB steps.

Parameters

Parameter Name	Parameter Type	Range of Values	Default Units
impedance	numeric	0 through 31.0 | MINimum|MAXimum	dB
MINimum selects 0 dB attenuation; MAXimum selects 31 dB.			

Comments

- **Executable when initiated:** Yes
- **Coupling group:** none
- ***RST Condition:** INPut1:ATTenuation 0

Example **Setting 20 dB input attenuation**

```
INP:ATT 20                    Set 20 dB input attenuation
```

:IMPedance

INPut[1]:IMPedance <***impedance***> sets the input impedance of the "Input 1" BNC to either 50Ω, 75Ω, or 1 MΩ.

Parameters

Parameter Name	Parameter Type	Range of Values	Default Units
impedance	numeric	50|75|1.0E6| MINimum|MAXimum	Ohms
MINimum selects 50Ω input impedance; MAXimum selects 1 MΩ.			

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INPut[1] :IMPedance

Comments

- **Executable when initiated:** Yes
- **Coupling group:** none
- ***RST Condition:** INPut1:IMPedance 50

Example **Setting 75 Ω input impedance**

```
INP:IMP 75                    Set 75 Ω input impedance
```


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The INPut2 subsystem controls the input attenuation and impedance of the Agilent E1446A's "Input 2" BNC.

Subsystem Syntax

```
INPut2
    :ATTenuation <attenuation>
    :IMPedance <impedance>
```

:ATTenuation

INPut2:ATTenuation <*attenuation*> controls the input attenuator of the "Input 2" BNC. Input attenuation can range from 0 to 31 dB in 1 dB steps.

Parameters

Parameter Name	Parameter Type	Range of Values	Default Units
impedance	numeric	0 through 31.0 | MINimum|MAXimum	dB
MINimum selects 0 dB attenuation; MAXimum selects 31 dB.			

Comments

- **Executable when initiated:** Yes
- **Coupling group:** none
- ***RST Condition:** INPut2:ATTenuation 0

Example **Setting 20 dB input attenuation**

```
INP2:ATT 20                    Set 20 dB input attenuation
```

:IMPedance

INPut2:IMPedance <*impedance*> sets the input impedance of the "Input 2" BNC to either 50Ω, 75Ω, or 1 MΩ.

Parameters

Parameter Name	Parameter Type	Range of Values	Default Units
impedance	numeric	50|75|1.0E6| MINimum|MAXimum	Ohms
MINimum selects 50Ω input impedance; MAXimum selects 1 MΩ.			

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INPut2 :IMPedance

Comments

- **Executable when initiated:** Yes
- **Coupling group:** none
- ***RST Condition:** INPut2:IMPedance 50

Example **Setting 75 Ω input impedance**

```
INP2:IMP 75                    Set 75 Ω input impedance
```


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The OUTPut2 subsystem controls the characteristics of the Agilent E1446A's "Main Output" BNC. The subsystem sets the output attenuation, sets the output source impedance, monitors overload conditions, and enables or disables the output.

Subsystem Syntax

```
OUTPut2
    :ATTenuation <attenuation>
    :IMPedance <impedance>
    :OVERload?                    [query only]
    [:STATe] <mode>
        :ACTual?                  [query only]
```

:ATTenuation

OUTPut2:ATTenuation <*attenuation*> controls the output attenuator of the "Main Output" BNC. Either no attenuation or 20 dB may be selected when OUTPut2:IMPedance is set to either 50Ω or 75Ω. OUTPut2:ATTenuation must be set to 0 dB when OUTPut2:IMPedance is set to 0Ω.

Parameters

Parameter Name	Parameter Type	Range of Values	Default Units
impedance	numeric	0|20.0| MINimum|MAXimum	dB
MINimum selects 0 dB attenuation; MAXimum selects 20 dB.			

Comments

- **Executable when initiated:** Yes
- **Coupling group:** Power amplifier
- ***RST Condition:** OUTPut2:ATTenuation 0

Example **Setting 20 dB output attenuation**

```
OUTP2:ATT 20                  Set 20 dB output attenuation
```


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:IMPedance

OUTPut2:IMPedance <*impedance*> sets the output impedance of the "Main Output" BNC to either 0Ω, 50Ω, or 75Ω.

OUTPut2:IMPedance 0 should be selected when an open-circuit or high-impedance load is connected to the output of the Agilent E1446A. The matching impedance is removed from the amplifier output. Also, the offset voltage into an open-circuit is twice that into a matched load. Setting OUTPut2:IMPedance 0 compensates for this effect so that the SOURce2:VOLTage:LEVel:IMMediate:OFFSet command will output the specified voltage into an open circuit.

When OUTPut2:IMPedance is set to either 50Ω or 75Ω, either no output attenuation or 20 dB may be set. OUTPut2:ATTenuation must be set to 0 dB when OUTPut2:IMPedance is set to 0Ω.

Parameters

Parameter Name	Parameter Type	Range of Values	Default Units
impedance	numeric	0|50|75| MINimum|MAXimum	Ohms
MINimum selects 0Ω output impedance; MAXimum selects 75Ω.			

Comments

- **Executable when initiated:** Yes
- **Coupling group:** Power amplifier
- **Related commands:** SOURce:VOLTage:LEVel:IMMediate:OFFSet and OUTPUT2:ATTenuation
- ***RST Condition:** OUTPut2:IMPedance 50

Example **Setting 75 Ω output impedance**

```
OUTP2:IMP 75                    Set 75 Ω output impedance
```

:OVERload?

OUTPut2:OVERload? determines if an overload condition exists by reading bit 11 of the amplifier's Status register (Appendix C).

This command requires Agilent E1445A firmware revision A.02.00 or greater.

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Comments

- A one (1) returned in response to the query indicates an overload condition exists. A zero (0) indicates there is not an overload condition.
- **Coupling group:** none
- ***RST Condition:** none

Example **Determining if an overload condition exists**

```
OUTP2:OVER?                    determine if overload condition exists
```

[:STATe]

OUTPut2[:STATe] <*mode*> closes or opens the output relay of the "Main Output" BNC to enable or disable the analog output. When disabled, the output appears as an open circuit.

Parameters

Parameter Name	Parameter Type	Range of Values	Default Units
mode	boolean	OFF|0|ON|1	none

Comments

- **Executable when initiated: Yes**
- **Coupling group:** none
- ***RST Condition:** OUTPut2:STATe ON
- The output relay will open automatically if an output overload is detected.

Example **Disabling the output**

```
OUTP2 OFF                      Disable output
```

[:STATe]:ACTual?

OUTPut2[:STATe]:ACTual? determines if the amplifier's 'Main Output' BNC is enabled or has been disabled due to an overload condition. The determination is done by reading bit 8 of the amplifier's Status register (Appendix C).

This command requires Agilent E1445A firmware revision A.02.00 or greater.

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OUTPut2 [:STATe]:ACTual?

Comments

- A one (1) returned in response to the query indicates the 'Main Output' BNC is enabled. A zero (0) indicates the output is disabled.
- **Coupling group:** none
- ***RST Condition:** none

Example **Determining if the output is enabled**

```
OUTP2:STAT:ACT?                    determine if the output is enabled
```


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The OUTPut3 subsystem controls the output impedance of the Agilent E1446A's "Diff Output +" output.

Subsystem Syntax

OUTPut3
:IMPedance <*impedance*>

:IMPedance

OUTPut3:IMPedance <*impedance*> sets the output impedance "Diff Output +" BNC to either 50Ω or 75Ω.

Parameters

Parameter Name	Parameter Type	Range of Values	Default Units
impedance	numeric	50|75| MINimum|MAXimum	Ohms
MINimum selects 50Ω output impedance; MAXimum selects 75Ω.			

Comments

- **Executable when initiated:** Yes
- **Coupling group:** none
- ***RST Condition:** OUTPut3:IMPedance 50

Example **Setting 75 Ω output impedance**

```
OUTP3:IMP 75                    Set 75 Ω output impedance
```


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The OUTPut4 subsystem controls the output impedance of the Agilent E1446A's "Diff Output -" output.

Subsystem Syntax

OUTPut4
:IMPedance <*impedance*>

:IMPedance

OUTPut4:IMPedance <*impedance*> sets the output impedance "Diff Output -" BNC to either 50Ω or 75Ω.

Parameters

Parameter Name	Parameter Type	Range of Values	Default Units
impedance	numeric	50|75| MINimum|MAXimum	Ohms
MINimum selects 50Ω output impedance; MAXimum selects 75Ω.			

Comments

- **Executable when initiated:** Yes
- **Coupling group:** none
- ***RST Condition:** OUTPut4:IMPedance 50

Example **Setting 75 Ω output impedance**

```
OUTP4:IMP 75                    Set 75 Ω output impedance
```


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The SOURce2:VOLTage subsystem controls the output offset voltage at the Agilent E1446A's "Main Output" BNC.

Subsystem Syntax

```
SOURce2
    :VOLTage
        [:LEVel]
            [:IMMediate]
                :OFFSet <voltage>
```

[:LEVel][:IMMediate]:OFFSet

SOURce2:VOLTage[:LEVel][:IMMediate]:OFFSet <*voltage*> sets the offset voltage at the "Main Output" BNC. Output offset level is programmed in volts.

Parameters

Parameter Name	Parameter Type	Range of Values	Default Units
number	numeric	-9.999695 to +10.0| MINimum|MAXimum	volts
MINimum selects -9.999695; MAXimum selects +10.0. The above limits are doubled if OUTPut2:IMPedance 0 is set.			

The combination of input levels and offset voltage must produce a voltage that remains within the Agilent E1446A's output voltage specification. Significant distortion of the waveform will occur when the combination of input levels and offset voltage exceeds the specification.

Example **Setting offset voltage**

Comments

- **Executable when initiated:** Yes
- **Coupling group:** Power amplifier
- **Related commands:** OUTPut2:IMPedance
- ***RST Condition:** SOURce2:VOLTage:LEVel:IMMediate:OFFSet 0 V

Example **Setting offset voltage**

```
SOUR2:VOLT:OFFS 3          Set offset voltage to 3 volts
```


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The STATus subsystem controls the SCPI-defined Operation and Questionable Signal status registers. Each is comprised of a condition register, an event register, an enable mask, and negative and positive transition filters.

Each status register works as follows: when a condition occurs, the appropriate bit in the condition register is set or cleared. If the the corresponding transition filter is enabled for that bit, the same bit is set in the associated event register. The contents of the event register and the enable mask are logically ANDed bit-for-bit; if any bit of the result is set, the summary bit for that register is set in the status byte. The status byte summary bit for the Operation status register is bit 7; for the Questionable Signal status register, bit 3.

Operation Status Register

All bits are always 0. This register is implemented only for SCPI compatibility purposes.

Questionable Signal Status Register

All bits are always 0. This register is implemented only for SCPI compatibility purposes.

Subsystem Syntax

```
STATus
    :OPERation|QUEStionable
        :CONDition?                    [query only]
        :ENABle <unmask>
        [:EVENt]?                      [query only]
        :NTRansition <unmask>
        :PTRansition <unmask>
    :PRESet                            [no query]
```

:OPERation|QUEStionable:CONDition?

STATus:OPERation|QUEStionable:CONDition? returns the contents of the appropriate condition register. Reading the register does not affect its contents.

Comments

- **Executable when initiated:** Yes
- **Coupling group:** none
- **Related commands:** STATus subsystem, *SRE, *STB?
- ***RST Condition:** all bits of both condition registers are cleared as a result of the state present after *RST.

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Example **Querying the Operation condition register**

STAT:OPER? *Query Operation condition register*

:OPERation|QUEStionable:ENABle

STATus:OPERation|QUEStionable:ENABle <*unmask*> specifies which bits of the associated event register are included in its summary bit. The summary bit is the bit-for-bit logical AND of the event register and the unmasked bit(s).

Parameters

Parameter Name	Parameter Type	Range of Values	Default Units
unmask	numeric or non-decimal numeric	0 through +32767	none

The non-decimal numeric forms are the #H, #Q, or #B formats specified by IEEE-488.2.

Comments

- **Executable when initiated:** Yes
- **Coupling group:** none
- **Related commands:** STATus subsystem, *SRE, *STB?
- ***RST Condition:** unaffected
- **Power-on Condition:** STATUS:OPERation|QUEStionable:ENABLE 0

:OPERation|QUEStionable[:EVENt]?

STATus:OPERation|QUEStionable[:EVENt]? returns the contents of the appropriate event register. Reading the register clears it to 0.

Comments

- Both event registers are also cleared to 0 by the *CLS common command.
- **Executable when initiated:** Yes
- **Coupling group:** none
- **Related commands:** STATus subsystem, *SRE, *STB?
- ***RST Condition:** unaffected
- **Power-on Condition:** Both event registers are cleared to 0.

Example **Querying the Operation event register**

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STAT:EVEN? *Query Operation event register*

:OPERation|QUEStionable:NTRansition

STATus:OPERation|QUEStionable:NTRansition <*unmask*> sets the negative transition mask. For each bit unmasked, a 1-to-0 transition of that bit in the associated condition register will set the same bit in the associated event register.

Parameters

Parameter Name	Parameter Type	Range of Values	Default Units
unmask	numeric or non-decimal numeric	0 through +32767	none

The non-decimal numeric forms are the #H, #Q, or #B formats specified by IEEE-488.2.

Comments

- **Executable when initiated:** Yes
- **Coupling group:** none
- **Related commands:** STATus subsystem, *SRE, *STB?
- ***RST Condition:** unaffected
- **Power-on Condition:** STATUS:OPERation|QUEStionable:NTRansition 0

:OPERation|QUEStionable:PTRansition

STATus:OPERation|QUEStionable:PTRansition <*unmask*> sets the positive transition mask. For each bit unmasked, a 0-to-1 transition of that bit in the associated condition register will set the same bit in the associated event register.

Parameters

Parameter Name	Parameter Type	Range of Values	Default Units
unmask	numeric or non-decimal numeric	0 through +32767	none

The non-decimal numeric forms are the #H, #Q, or #B formats specified by IEEE-488.2.

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Comments

- **Executable when initiated:** Yes
- **Coupling group:** none
- **Related commands:** STATus subsystem, *SRE, *STB?
- ***RST Condition:** unaffected
- **Power-on Condition:** STATUS:OPERation|QUEStionable:PTRansition 32767

:PRESet

STATus:PRESet initializes the enable registers and transition masks for the Operation and Questionable Signal status registers and sets STATus:OPC:INITiate ON. For both status registers, the enable registers are set to 0, the negative transition masks are set to 0, and the positive transition masks are set to 32767.

Comments

- **Executable when initiated:** Yes
- **Coupling group:** none
- **Related commands:** STATus subsystem, *SRE, *STB?
- ***RST Condition:** none

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The SYSTem subsystem returns error messages and the SCPI version number to which the Agilent E1446A complies.

Subsystem Syntax

```
SYSTem
    :ERRor?          [query only]
    :VERSion?        [query only]
```

:ERRor?

SYSTem:ERROR? returns the error messages in the error queue. See Appendix B for a listing of possible error numbers and messages.

Comments

- The Agilent E1446A places any generated errors into the error queue. The queue is first-in, first out. With several errors waiting in the queue, the SYSTem:ERRor? returns the oldest unread error message first.
- The error queue can hold 30 error messages. If the Agilent E1446A generates more than 30 messages that are not read, it replaces the last error message in the queue with error -350,"Too many errors". No additional messages are placed into the queue until SYSTem:ERRor? reads some messages or the *CLS (clear status) command clears the queue.
- When the error queue is empty, SYSTem:ERRor? returns +0,"No error".
- **Executable when initiated:** Yes
- ***RST Condition:** unaffected
- **Power-On Condition:** no errors are in the error queue

Example **Reading the error queue**

```
SYST:ERR?                    Query the error queue
```

:VERSion?

SYSTem:VERSion? returns the SCPI version number to which the Agilent E1446A complies: “1991.0”.

Comment

- **Executable when initiated:** Yes
- ***RST Condition:** none

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Example **Querying the SCPI revision**

```
SYST:VERS?                    Query SCPI revision
```


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Table 3-1. Agilent E1446A/E1445A Command Quick Reference.

Subsystem	Commands
INPut[1]	INPut[1]:ATTenuation < attenuation> INPut[1]:IMPedance < impedance>
INPut2	INPut2:ATTenuation < attenuation> INPut2:IMPedance < impedance>
OUTPut2	OUTPut2:ATTenuation < attenuation> OUTPut2:IMPedance < impedance> OUTPut2:OVERload? OUTPut2[:STATe] < mode> OUTPut2[:STATe]:ACTual?
OUTPut3	OUTPut3:IMPedance < impedance>
OUTPut4	OUTPut4:IMPedance < impedance>
SOURce2:VOLTage	SOURce2:VOLTage[:LEVel][:IMMediate]:OFFSet < voltage>
STATus	STATus:OPERation| QUEStionable:CONDition? STATus:OPERation| QUEStionable:ENABle < unmask> STATus:OPERation| QUEStionable[:EVENt]? STATus:OPERation| QUEStionable:NTRansition < unmask> STATus:OPERation| QUEStionable:PTRansition < unmask> STATus:PRESet
SYSTem	SYSTem:ERRor? SYSTem:VERsion?

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Agilent E1446 / E1405/06 Commands

SCPI Command Reference

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The DISPlay subsystem enables the amplifier's settings (e.g. input impedance, input attenuation, output impedance, output attenuation, ...) to be monitored. When a display terminal is connected to the E1405 Command Module and monitor mode is enabled, the E1446A amplifier settings (and changes to the settings) are shown on the terminal.

Subsystem Syntax

```
DISPlay
    :MONitor
        [:STATe] <mode>
```

:MONitor[:STATe]

DISPlay:MONitor[:STATe] <*state*> enables/disables the monitor mode. Setting the *state* to 'ON' or '1' enables monitor mode. 'OFF' or '0' turns monitor mode off.

Parameters

Parameter Name	Parameter Type	Range of Values	Default Units
mode	boolean	OFF|0|ON|1	none

Comments

- **Coupling group:** none
- ***RST Condition:** DISPlay:MONitor:STATe OFF

Example **Enabling Monitor Mode**

```
DISP:MON:STAT ON          enable monitor mode
```


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The INPut[1] subsystem controls the input attenuation and impedance of the Agilent E1446A's "Input 1" BNC.

Subsystem Syntax

```
INPut[1]
    :ATTenuation <attenuation>
    :IMPedance <impedance>
```

:ATTenuation

INPut[1]:ATTenuation <***attenuation***> controls the input attenuator of the "Input 1" BNC. Input attenuation can range from 0 to 31 dB in 1 dB steps.

Parameters

Parameter Name	Parameter Type	Range of Values	Default Units
impedance	numeric	0 through 31.0 | MINimum|MAXimum	dB
MINimum selects 0 dB attenuation; MAXimum selects 31 dB.			

Comments

- **Coupling group:** none
- ***RST Condition:** INPut1:ATTenuation 0

Example **Setting 20 dB input attenuation**

```
INP:ATT 20                    Set 20 dB input attenuation
```

:IMPedance

INPut[1]:IMPedance <***impedance***> sets the input impedance of the "Input 1" BNC to either 50Ω, 75Ω, or 1 MΩ.

Parameters

Parameter Name	Parameter Type	Range of Values	Default Units
impedance	numeric	50|75|1.0E6| MINimum|MAXimum	Ohms
MINimum selects 50Ω input impedance; MAXimum selects 1 MΩ.			

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Comments

- **Coupling group:** none
- ***RST Condition:** INPut1:IMPedance 50

Example **Setting 75 Ω input impedance**

```
INP:IMP 75                    Set 75 Ω input impedance
```


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The INPut2 subsystem controls the input attenuation and impedance of the Agilent E1446A's "Input 2" BNC.

Subsystem Syntax

```
INPut2
    :ATTenuation <attenuation>
    :IMPedance <impedance>
```

:ATTenuation

INPut2:ATTenuation <*attenuation*> controls the input attenuator of the "Input 2" BNC. Input attenuation can range from 0 to 31 dB in 1 dB steps.

Parameters

Parameter Name	Parameter Type	Range of Values	Default Units
impedance	numeric	0 through 31.0 | MINimum|MAXimum	dB
MINimum selects 0 dB attenuation; MAXimum selects 31 dB.			

Comments

- **Coupling group:** none
- ***RST Condition:** INPut2:ATTenuation 0

Example **Setting 20 dB input attenuation**

```
INP2:ATT 20                    Set 20 dB input attenuation
```

:IMPedance

INPut2:IMPedance <*impedance*> sets the input impedance of the "Input 2" BNC to either 50Ω, 75Ω, or 1 MΩ.

Parameters

Parameter Name	Parameter Type	Range of Values	Default Units
impedance	numeric	50|75|1.0E6| MINimum|MAXimum	Ohms
MINimum selects 50Ω input impedance; MAXimum selects 1 MΩ.			

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Comments

- **Coupling group:** none
- ***RST Condition:** INPut2:IMPedance 50

Example **Setting 75 Ω input impedance**

```
INP2:IMP 75                    Set 75 Ω input impedance
```


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The OUTPut1 subsystem controls the characteristics of the Agilent E1446A's "Main Output" BNC. The subsystem sets the output attenuation, sets the output source impedance, monitors overload conditions, and enables or disables the output.

Subsystem Syntax

```
OUTPut1
    :ATTenuation <attenuation>
    :IMPedance <impedance>
    :OVERload?                    [query only]
    [:STATe] <mode>
        :ACTual?                  [query only]
```

:ATTenuation

OUTPut1:ATTenuation <***attenuation***> controls the output attenuator of the "Main Output" BNC. Either no attenuation or 20 dB may be selected when OUTPut1:IMPedance is set to either 50Ω or 75Ω. OUTPut1:ATTenuation must be set to 0 dB when OUTPut1:IMPedance is set to 0Ω.

Parameters

Parameter Name	Parameter Type	Range of Values	Default Units
impedance	numeric	0|20.0| MINimum|MAXimum	dB
MINimum selects 0 dB attenuation; MAXimum selects 20 dB.			

Comments

- **Coupling group:** Power amplifier
- ***RST Condition:** OUTPut1:ATTenuation 0

Example **Setting 20 dB output attenuation**

```
OUTP1:ATT 20                  Set 20 dB output attenuation
```

:IMPedance

OUTPut1:IMPedance <***impedance***> sets the output impedance of the "Main Output" BNC to either 0Ω, 50Ω, or 75Ω.

OUTPut1:IMPedance 0 should be selected when an open-circuit or high-impedance load is connected to the output of the Agilent E1446A. The matching impedance is removed from the amplifier output. Also, the OUTPUT1 offset voltage into an open-circuit is twice that into a matched load. Setting OUTPut1:IMPedance 0 compensates for this effect so that the SOURce:VOLTage:LEVel:IMMediate:OFFSet command will output the specified voltage into an open circuit.

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When OUTPut1:IMPedance is set to either 50Ω or 75Ω, either no output attenuation or 20 dB may be selected. OUTPut1:ATTenuation must be set to 0dB when OUTPut1:IMPedance is set to 0Ω.

Parameters

Parameter Name	Parameter Type	Range of Values	Default Units
impedance	numeric	0|50|75| MINimum|MAXimum	Ohms
MINimum selects 0Ω output impedance; MAXimum selects 75Ω.			

Comments

- **Coupling group:** Power amplifier
- **Related commands:** SOURce:VOLTage:LEVel:IMMediate:OFFSet and OUTPut1:ATTenuation
- ***RST Condition:** OUTPut1:IMPedance 50

Example **Setting 75Ω output impedance**

```
OUTP1:IMP 75          Set 75 Ω output impedance
```

:OVERload?

OUTPut1:OVERload? determines if an overload condition exists by reading bit 11 of the amplifier's status register (Appendix C).

Comments

- A one (1) returned in response to the query indicates an overload condition exists. A zero (0) indicates there is not an overload condition.
- **Coupling group:** none
- ***RST Condition:** none

Example **Determining if an overload condition exists**

```
OUTP1:OVER?           determine if overload condition exists
```


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[:STATe]

OUTPut1[:STATe] <*mode*> closes or opens the output relay of the "Main Output" BNC to enable or disable the analog output. When disabled, the output appears as an open circuit.

Parameters

Parameter Name	Parameter Type	Range of Values	Default Units
mode	boolean	OFF|0|ON|1	none

Comments

- **Coupling group:** none
- ***RST Condition:** OUTPut1:STATe ON
- The output relay will be opened automatically if an output current overload occurs.

Example **Disabling the output**

```
OUTP1 OFF                    Disable output
```

[:STATe]:ACTual?

OUTPut1[:STATe]:ACTual? determines if the amplifier's 'Main Output' BNC is enabled or has been disabled due to an overload condition. The determination is done by reading bit 8 of the amplifier's Status register (Appendix C).

Comments

- A one (1) returned in response to the query indicates the 'Main Output' BNC is enabled. A zero (0) indicates the output is disabled.
- **Coupling group:** none
- ***RST Condition:** none

Example **Determining if the output is enabled**

```
OUTP1:STAT:ACT?              determine if the output is enabled
```


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The OUTPut2 subsystem controls the output impedance of the Agilent E1446A's "Diff Output +" output.

Subsystem Syntax

```
OUTPut2
    :IMPedance <impedance>
```

:IMPedance

OUTPut2:IMPedance <*impedance*> sets the output impedance "Diff Output +" BNC to either 50Ω or 75Ω.

Parameters

Parameter Name	Parameter Type	Range of Values	Default Units
impedance	numeric	50|75| MINimum|MAXimum	Ohms
MINimum selects 50Ω output impedance; MAXimum selects 75Ω.			

Comments

- **Coupling group:** none
- ***RST Condition:** OUTPut2:IMPedance 50

Example **Setting 75 Ω output impedance**

```
OUTP2:IMP 75          Set 75 Ω output impedance
```


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The OUTPut3 subsystem controls the output impedance of the Agilent E1446A's "Diff Output -" output.

Subsystem Syntax

OUTPut3
:IMPedance <*impedance*>

:IMPedance

OUTPut3:IMPedance <*impedance*> sets the output impedance "Diff Output -" BNC to either 50Ω or 75Ω.

Parameters

Parameter Name	Parameter Type	Range of Values	Default Units
impedance	numeric	50|75| MINimum|MAXimum	Ohms
MINimum selects 50Ω output impedance; MAXimum selects 75Ω.			

Comments

- **Coupling group:** none
- ***RST Condition:** OUTPut3:IMPedance 50

Example

Setting 75 Ω output impedance

```
OUTP3:IMP 75          Set 75 Ω output impedance
```


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The SOURce:VOLTage subsystem controls the output offset voltage at the Agilent E1446A "Main Output" BNC.

Subsystem Syntax

```
[SOURce]
    :VOLTage
        [:LEVel]
            [:IMMediate]
                :OFFSet <voltage>
```

[:LEVel][:IMMediate]:OFFSet

SOURce:VOLTage[:LEVel][:IMMediate]:OFFSet <*voltage*> sets the offset voltage of the "Main Output" BNC. Output offset level is programmed in volts.

Parameters

Parameter Name	Parameter Type	Range of Values	Default Units
number	numeric	-9.999695 to +10.0| MINimum|MAXimum	volts
MINimum selects -9.999695; MAXimum selects +10.0. The above limits are doubled if OUTPut:IMPedance 0 is set.			

The combination of input levels and offset voltage must produce a voltage that remains within the Agilent E1446A's output voltage specification. Significant distortion of the waveform will occur when the combination of input levels and offset voltage exceeds the specification.

Comments

- **Coupling group:** Power amplifier
- **Related commands:** OUTPut1:IMPedance
- ***RST Condition:** SOURce:VOLTage:LEVel:IMMediate:OFFSet 0 V

Example **Setting offset voltage**

```
SOUR:VOLT:OFFS 3          Set offset voltage to 3 volts
```


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The STATus subsystem controls the SCPI-defined Operation and Questionable Signal status registers. Each is comprised of a condition register, an event register, an enable mask, and negative and positive transition filters.

Each status register works as follows: when a condition occurs, the appropriate bit in the condition register is set or cleared. If the the corresponding transition filter is enabled for that bit, the same bit is set in the associated event register. The contents of the event register and the enable mask are logically ANDed bit-for-bit; if any bit of the result is set, the summary bit for that register is set in the status byte. The status byte summary bit for the Operation status register is bit 7; for the Questionable Signal status register, bit 3.

Operation Status Register

All bits are always 0. This register is implemented only for SCPI compatibility purposes.

Questionable Signal Status Register

All bits are always 0. This register is implemented only for SCPI compatibility purposes.

Subsystem Syntax

```
STATus
    :OPERation|QUEStionable
        :CONDition?                    [query only]
        :ENABle <unmask>
        [:EVENt]?                      [query only]
        :NTRansition <unmask>
        :PTRansition <unmask>
    :PRESet                            [no query]
```

:OPERation|QUEStionable:CONDition?

STATus:OPERation|QUEStionable:CONDition? returns the contents of the appropriate condition register. Reading the register does not affect its contents.

Comments

- **Executable when initiated:** Yes
- **Coupling group:** none
- **Related commands:** STATus subsystem, *SRE, *STB?
- ***RST Condition:** all bits of both condition registers are cleared as a result of the state present after *RST.

Example **Querying the Operation condition register**

```
STAT:OPER?          Query Operation condition register
```


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:OPERation|QUEStionable:ENABle

STATus:OPERation|QUEStionable:ENABle <*unmask*> specifies which bits of the associated event register are included in its summary bit. The summary bit is the bit-for-bit logical AND of the event register and the unmasked bit(s).

Parameters

Parameter Name	Parameter Type	Range of Values	Default Units
unmask	numeric or non-decimal numeric	0 through +32767	none

The non-decimal numeric forms are the #H, #Q, or #B formats specified by IEEE-488.2.

Comments

- **Executable when initiated:** Yes
- **Coupling group:** none
- **Related commands:** STATus subsystem, *SRE, *STB?
- ***RST Condition:** unaffected
- **Power-on Condition:** STATUS:OPERation|QUEStionable:ENABLE 0

:OPERation|QUEStionable[:EVENt]?

STATus:OPERation|QUEStionable[:EVENt]? returns the contents of the appropriate event register. Reading the register clears it to 0.

Comments

- Both event registers are also cleared to 0 by the *CLS common command.
- **Executable when initiated:** Yes
- **Coupling group:** none
- **Related commands:** STATus subsystem, *SRE, *STB?
- ***RST Condition:** unaffected
- **Power-on Condition:** Both event registers are cleared to 0.

Example **Querying the Operation event register**

```
STAT:EVEN?                    Query Operation event register
```


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:OPERation|QUEStionable:NTRansition

STATus:OPERation|QUEStionable:NTRansition <*unmask*> sets the negative transition mask. For each bit unmasked, a 1-to-0 transition of that bit in the associated condition register will set the same bit in the associated event register.

Parameters

Parameter Name	Parameter Type	Range of Values	Default Units
unmask	numeric or non-decimal numeric	0 through +32767	none

The non-decimal numeric forms are the #H, #Q, or #B formats specified by IEEE-488.2.

Comments

- **Executable when initiated:** Yes
- **Coupling group:** none
- **Related commands:** STATus subsystem, *SRE, *STB?
- ***RST Condition:** unaffected
- **Power-on Condition:** STATUS:OPERation|QUEStionable:NTRansition 0

:OPERation|QUEStionable:PTRansition

STATus:OPERation|QUEStionable:PTRansition <*unmask*> sets the positive transition mask. For each bit unmasked, a 0-to-1 transition of that bit in the associated condition register will set the same bit in the associated event register.

Parameters

Parameter Name	Parameter Type	Range of Values	Default Units
unmask	numeric or non-decimal numeric	0 through +32767	none

The non-decimal numeric forms are the #H, #Q, or #B formats specified by IEEE-488.2.

Comments

- **Executable when initiated:** Yes
- **Coupling group:** none
- **Related commands:** STATus subsystem, *SRE, *STB?

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- ***RST Condition:** unaffected
- **Power-on Condition:** STATUS:OPERation|QUEStionable:PTRansition 32767

:PRESet

STATus:PRESet initializes the enable registers and transition masks for the Operation and Questionable Signal status registers and sets STATus:OPC:INITiate ON. For both status registers, the enable registers are set to 0, the negative transition masks are set to 0, and the positive transition masks are set to 32767.

Comments

- **Executable when initiated:** Yes
- **Coupling group:** none
- **Related commands:** STATus subsystem, *SRE, *STB?
- ***RST Condition:** none

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The SYSTem subsystem returns error messages and the SCPI version number to which the Agilent E1446A complies.

Subsystem Syntax

```
SYSTem
    :ERRor?          [query only]
    :VERSion?        [query only]
```

:ERRor?

SYSTem:ERROR? returns the error messages in the error queue. See Appendix B for a listing of possible error numbers and messages.

Comments

- The Agilent E1446A places any generated errors into the error queue. The queue is first-in, first out. With several errors waiting in the queue, the SYSTem:ERRor? returns the oldest unread error message first.
- The error queue can hold 30 error messages. If the Agilent E1446A generates more than 30 messages that are not read, it replaces the last error message in the queue with error -350,"Too many errors". No additional messages are placed into the queue until SYSTem:ERRor? reads some messages or the *CLS (clear status) command clears the queue.
- When the error queue is empty, SYSTem:ERRor? returns +0,"No error".
- **Executable when initiated:** Yes
- ***RST Condition:** unaffected
- **Power-On Condition:** no errors are in the error queue

Example **Reading the error queue**

```
SYST:ERR?                    Query the error queue
```

:VERSion?

SYSTem:VERSion? returns the SCPI version number to which the Agilent E1446A complies: “1991.0”.

Comment

- **Executable when initiated:** Yes
- ***RST Condition:** none

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Example **Querying the SCPI revision**

```
SYST:VERS?                    Query SCPI revision
```


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Table 3-1. Agilent E1446A/E1405/06 Command Quick Reference.

Subsystem	Commands
DISPlay	DISPlay:MONitor[:STATe] < mode>
INPut[1]	INPut[1]:ATTenuation < attenuation> INPut[1]:IMPedance < impedance>
INPut2	INPut2:ATTenuation < attenuation> INPut2:IMPedance < impedance>
OUTPut1	OUTPut1:ATTenuation < attenuation> OUTPut1:IMPedance < impedance> OUTPut1:OVERload? OUTPut1[:STATe] < mode> OUTPut1[:STATe]:ACTual?
OUTPut2	OUTPut2:IMPedance < impedance>
OUTPut3	OUTPut3:IMPedance < impedance>
SOURce:VOLTage	SOURce:VOLTage[:LEVel][:IMMediate]:OFFSet < voltage>
STATus	STATus:OPERation| QUEStionable:CONDition? STATus:OPERation| QUEStionable:ENABle < unmask> STATus:OPERation| QUEStionable[:EVENt]? STATus:OPERation| QUEStionable:NTRansition < unmask> STATus:OPERation| QUEStionable:PTRansition < unmask> STATus:PRESet
SYSTem	SYSTem:ERRor? SYSTem:VERsion?

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IEEE-488.2 Common Commands

and

SCPI Conformance Information

SCPI Command Reference

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IEEE-488.2 Common Commands

This section describes the IEEE-488.2 Common Commands implemented in the Agilent E1446A. The table below shows the commands listed by functional group; however, commands are listed alphabetically in the reference. Examples are shown in the reference when the command has parameters or returns a non-trivial response; otherwise, the command string is as shown in the table. For additional information, refer to IEEE Standard 488.2-1987.

Category	Command	Title
System Data	*IDN?	Identification Query
Internal Operations	*LRN? *RST *TST?	Learn Device Setup Query Reset Command Self Test Query
Synchronization	*OPC *OPC? *WAI	Operation Complete Command Operation Complete Command Wait-to-Continue Command
Macro	*DMC <*name*>,<*data*> *EMC <*enable*> *EMC? *GMC? <*name*> *LMC? *PMC *RMC <*name*>	Define Macro Command Enable Macro Command Enable Macro Query Get Macro Contents Query Learn Macro Query Purge Macros Command Remove Individual Macro Command
Status & Event	*CLS *ESE <*mask*> *ESE? *ESR? *SRE *SRE? *STB?	Clear Status Command Standard Event Status Enable Command Standard Event Status Enable Query Standard Event Status Register Query Service Request Enable Command Service Request Enable Query Read Status Byte Query
Stored Settings	*RCL *SAV	Recall Command Save Command

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*CLS

***CLS** clears the Standard Event Status Register, the Operation Status Register, the Questionable Signal Register, and the error queue. This clears the corresponding summary bits (3, 5, & 7) in the Status Byte Register. *CLS does not affect the enable masks of any of the status registers.

Comments

- **Executable when initiated:** Yes
- **Coupling group:** none
- **Related Commands:** STATus:PRESet
- ***RST Condition:** none

*DMC

***DMC <*name*>,<*data*>** creates a macro with the specified name and assigns zero, one, or a sequence of commands to the name. The sequence may be composed of SCPI and/or Common Commands. The sequence must be sent in IEEE-488.2 definite or indefinite block format.

Parameters

Parameter Name	Parameter Type	Range of Values	Default Units
name	string data	1 through 12 characters	none
data	block data *or* string	any valid command sequence	none

Comments

- Legal macro names must start with an alphabetic character and contain only alphabetic, numeric, and underscore ("_") characters. Alphabetic character case (upper vs. lower) is ignored.

  The name is allowed to be the same as a SCPI command, but may be not be the same as a Common Command. When the name is the same as a SCPI command, the macro rather than the command will be executed when the name is received if macro usage is enabled. The SCPI command will be executed if macro usage is disabled.

- **Executable when initiated:** Yes
- **Coupling group:** none
- **Related Commands:** *EMC, *GMC, *LMC, *RMC

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- ***RST Condition:** none; macro defintions are unaffected
- **Power-On Condition:** no macros are defined

Example **Define macro to set 'Input 1' impedance**

***DMC "RESTART","INP1:IMP 50"** *Define macro*

*EMC and *EMC?

EMC** <enable***> enables and disables macro usage. When *enable* is zero, macros usage is disabled. Any non-zero value enables macro usage.

The query form returns 1 if macro usage is enabled, 0 if disabled.

Comments

- Macro definitions are not affected by this command.
- **Executable when initiated:** Yes
- **Coupling group:** none
- ***RST Condition:** macro usage is disabled
- **Power-On Condition:** macro usage is enabled

*ESE and *ESE?

ESE** <mask***> enables one or more event bits of the Standard Event Status Register to be reported in bit 5 (the Standard Event Status Summary Bit) of the Status Byte Register. *Mask* is the sum of the decimal weights of the bits to be enabled.

The query form returns the current enable mask.

Parameters

Parameter Name	Parameter Type	Range of Values	Default Units
mask	numeric	0 through 255	none

A 1 in a bit position enables the corresponding event; a 0 disables it.

Comments

- **Executable when initiated:** Yes
- **Coupling group:** none
- **Related Commands:** *ESR?, *SRE, *STB?
- ***RST Condition:** unaffected

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- **Power-On Condition:** no events are enabled

Example **Enable all error events**

```
*ESE 60                    Enable error events
```

*ESR?

***ESR?** returns the value of the Standard Event Status Register. The register is then cleared (all bits 0).

Comments

- **Executable when initiated:** Yes
- **Coupling group:** none
- ***RST Condition:** none
- **Power-On Condition:** register is cleared

*GMC?

***GMC? <*name*>** returns the definition of the specified macro in IEEE-488.2 definite block format.

Parameters

Parameter Name	Parameter Type	Range of Values	Default Units
name	string data	*defined macro name*	none

Comments

- **Executable when initiated:** Yes
- **Coupling group:** none
- **Related Commands:** *DMC
- ***RST Condition:** none
- **Power-On Condition:** no macros are defined

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Example **Query macro definition**

***GMC? "RESTART"** *Query macro definition*

*IDN?

***IDN?** returns identification information for the E1446A. The response consists of four fields:

HEWLETT-PACKARD,E1446A,0,A.01.00

The first two fields identify this instrument as model number E1446A manufactured by Agilent Technologies. The third field is 0 since the serial number of the E1446A is unknown to the firmware. The last field indicates the revision level of the firmware.

Note The firmware revision field will change whenever the firmware is revised. A.01.00 is the initial revision. The first two digits indicate the major revision number, and increment when functional changes are made. The last two digits indicate bug fix level.

Comments

- **Executable when initiated:** Yes
- **Coupling group:** none
- ***RST Condition:** none

*LMC?

***LMC?** returns a comma-separated list of quoted strings, each containing the name of a macro. If no macros are defined, a single null string ("") is returned.

Comments

- **Executable when initiated:** Yes
- **Coupling group:** none
- **Related Commands:** *DMC
- ***RST Condition:** none
- **Power-On Condition:** no macros are defined

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*LRN?

***LRN?** returns a sequence of commands that may be resent to the Agilent E1446A to return it to its current programming state.

Note *LRN? should be sent singly in a program message, since the number of commands in the returned sequence is large, and may vary depending on firmware revision.

Comments

- **Executable when initiated:** Yes
- **Coupling group:** none
- **Related commands:** *RCL, *RST, *SAV
- ***RST Condition:** none

*OPC

***OPC** causes the E1446A to wait for all pending commands to complete. The Operation Complete bit (bit 0) in the Standard Event Status Register is then set.

Comments

- **Executable when initiated:** Yes
- **Coupling group:** none
- **Related commands:** *OPC?, *WAI
- ***RST Condition:** none

*OPC?

***OPC?** causes the E1446A to wait for all pending commands to complete. A single ASCII “1" is then placed in the output queue.

Comments

- **Executable when initiated:** Yes
- **Coupling group:** none
- **Related commands:** *OPC, *WAI
- ***RST Condition:** none

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*PMC

***PMC** purges all macro definitions.

Comments

- Use the *RMC command to purge an single macro definition.
- **Executable when initiated:** Yes
- **Coupling group:** none
- **Related commands:** *DMC, *RMC
- ***RST Condition:** none

*RCL

***RCL <*number*>** restores a previously stored programming state from one of the 10 possible stored state areas. *Number* indicates which of the stored state areas should be used.

Parameters

Parameter Name	Parameter Type	Range of Values	Default Units
number	numeric	0 through 9	none

Comments

- **Executable when initiated:** No
- **Coupling group:** none
- **Related Commands:** *LRN?, *RST, *SAV
- ***RST Condition:** unaffected
- **Power-on Condition:** all saved states set to the same state as the *RST state

*RMC

***RMC <*name*>** purges only the specified macro definition.

NOTE: At printing time, *RMC is a command proposed and accepted for a revision and re-designation of IEEE-488.2.

Comments

- Use the *PMC command to purge all macro definitions in one command.
- **Executable when initiated:** Yes
- **Coupling group:** none

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- **Related commands:** *DMC, *PMC
- ***RST Condition:** none

*RST

***RST** resets the Agilent E1446A as follows:

- Sets all commands to their *RST state.
- Aborts all pending operations including waveform generation.

***RST does not affect:**

- The output queue
- The Service Request Enable Register
- The Standard Event Status Enable Register
- The enable masks for the OPERation Status and Questionable Signal registers

Comments

- **Executable when initiated:** Yes
- **Coupling group:** none
- ***RST Condition:** none

*SAV

***SAV <number>** stores the current programming state into one of the 10 possible stored state areas. *Number* indicates which of the stored state areas should be used.

Parameters

Parameter Name	Parameter Type	Range of Values	Default Units
number	numeric	0 through 9	none

Comments

- **Executable when initiated:** No
- **Coupling group:** none
- **Related Commands:** *LRN?, *RCL, *RST
- ***RST Condition:** unaffected
- **Power-on Condition:** all saved states set to the same state as the *RST state

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*SRE and *SRE?

***SRE <_mask_>** specifies which bits of the Status Byte Register are enabled to generate a service request . Event and summary bits are always set and cleared in the Status Byte Register regardless of the enable mask. *Mask* is the sum of the decimal weights of the bits to be enabled.

The query form returns the current enable mask.

Parameters

Parameter Name	Parameter Type	Range of Values	Default Units
mask	numeric	0 through 255	none

A 1 in a bit position enables service request generation when the corresponding Status Byte Register bit is set; a 0 disables it.

Comments

- **Executable when initiated:** Yes
- **Coupling group:** none
- ***RST Condition:** unaffected
- **Power-On Condition:** no bits are enabled

Example **Enable service request on Message Available bit**

```
*SRE 16                    Enable request on MAV
```

*STB?

***STB?** returns the value of the Status Byte Register. Bit 6 (decimal weight 64) is set if a service request is pending. STB? should not be used to read the Status Byte register if a service request is generated by a message available (MAV) condition.

Comments

- *STB? is a query. Thus, sending the command in response to a MAV condition will generate Error -410 "Query interrupted".
- **Executable when initiated:** Yes
- **Coupling group:** none
- **Related commands:** *SRE
- ***RST Condition:** none

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*TST?

***TST?** causes the E1446A to execute its internal self-test and return a value indicating the results of the test. Only communication between the command module and the on-card registers is tested.

A zero (0) response indicates that the self-test passed. A one (1) response indicates that the test failed. The failure also generates an error message with additional information on why the test failed.

When the test completes, all other commands are restored to their current values when the E1446A is used with the E1405/06. When the E1446A is used with the E1445A, the commands are set to their *RST values.

Comments

- **Executable when initiated:** No
- **Coupling group:** none
- ***RST Condition:** none

*WAI

***WAI** causes the E1446A to wait for all pending commands to complete before executing any further commands.

Comments

- **Executable when initiated:** Yes
- **Coupling group:** none
- **Related commands:** *OPC, *OPC?
- ***RST Condition:** none

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SCPI Conformance Information

The Agilent E1446A Summing Amplifier/DAC conforms to the SCPI-1991.0 standard.

The following tables list all the SCPI confirmed, approved, and non-SCPI commands that the Agilent E1446A can execute.

Table 3-2. SCPI Confirmed Commands (E1446A/E1445A).

```
INPut[1]
     :ATTenuation  <attenuation>
     :IMPedance <impedance>

INPut2
     :ATTenuation  <attenuation>
     :IMPedance <impedance>

OUTPut2
     :ATTenuation <attenuation>
     :IMPedance <impedance>
     [:STATe] <mode>

OUTPut3
     :IMPedance <impedance>

OUTPut4
     :IMPedance <impedance>

SOURce2
     :VOLTage
          [:LEVel]
               [:IMMediate]
                    :OFFSet <voltage>

STATus
     :OPERation | QUEStionable
          :CONDition?
          :ENABle <unmask>
          :NTRansition <unmask>
          :PTRansition <unmask>
     :PRESet

SYSTem
     :ERRor?
     :VERSion?
```

Table 3-3. SCPI Confirmed Commands (E1446A/E1405/06).

```
INPut[1]
     :ATTenuation  <attenuation>
     :IMPedance <impedance>

INPut2
     :ATTenuation  <attenuation>
     :IMPedance <impedance>

OUTPut1
     :ATTenuation <attenuation>
     :IMPedance <impedance>
     [:STATe] <mode>

OUTPut2
     :IMPedance <impedance>

OUTPut3
     :IMPedance <impedance>

SOURce
     :VOLTage
          [:LEVel]
               [:IMMediate]
                    :OFFSet <voltage>

STATus
     :OPERation | QUEStionable
          :CONDition?
          :ENABle <unmask>
          :NTRansition <unmask>
          :PTRansition <unmask>
     :PRESet

SYSTem
     :ERRor?
     :VERSion?
```


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Table 3-4. Non-SCPI Commands.

Agilent E1446A/E1445A	Agilent E1446A/E1405/06
OUTPut2 :OVERload? [:STATe] ACTual?	DISPlay :MONitor [:STATe] OUTPut1 :OVERload? [:STATe] ACTual?

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Appendix A
Specifications

Appendix Contents

This appendix contains the Agilent E1446A Summing Amplifier/DAC operating specifications. Except as noted, the specifications apply under the following conditions:

- **Period:** 1 year
- **Temperature:** 0° - 55° C
- **Relative humidity:** ≤ 65% @ 0° - 40° C
- **Warm up time:** 1 hour

"Typical", "typ", or "nominal" values are non-warranted supplementary information provided for applications assistance.

Inputs

Number of Inputs: 2

Function: These inputs have independently adjustable attenuators (see below), and are summed into all outputs.

Connectors: BNC (ground-referenced)

Impedance: 50Ω, 75Ω, or 1 MΩ | | 20pF (nominal)

Outputs

Main Output

Connector: BNC (ground-referenced)

Impedance: 50Ω, 75Ω, or Low-Z (less than 1Ω) (nominal)

Drive Capability: ± 10 volts DC into 50 or 75 Ω (Rout= 50 or 75 respectively)
± 20 volts DC into > 100Ω (Rout= Low Z)
Output current ≥ 200 mA
Short-circuit maximum ≤ 400 mA

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Protection: Relay Trip. This disconnects the main output after either a voltage or a current overload of non-transient duration. The relay's state can be queried and reset by software control.

Differential Outputs

These are two outputs nominally out-of-phase.

Connectors: The + (in-phase) and - (antiphase) outputs have separate ground-referenced BNC connectors.

Impedance: 50 or 75 Ω, each side to ground

Drive Capability : ± 1V into 50 or 75 Ω

Gain Characteristics

Maximum voltage gain from either input (with all attenuators set to 0 dB; accuracies shown are for DC):

Output	50/75 Ω load	High-Z load
Main	10 ± 1.0 %	20 ± 1.0 %
Differential +	+ 1 ± 1.0 %	+ 2± 1.0 %
Differential -	-1 ± 1.0 %	-2 ± 1.0 %

Input channel attenuators: Each input channel has an independent attenuator adjustable from 0 to 31 dB in steps of 1 dB.

Main output attenuator: Two settings, 0 or 20 dB attenuation. (20 dB setting is not applicable when Rout = Low-Z.)

Attenuator DC accuracy: 0.1 dB for each attenuator

Offset

Main Output Offset is adjustable with a DAC:

Nominal Range : + to - maximum output voltage (i.e. ± 10V or ± 20V)

Resolution : 16 bits

Accuracy: ± 0.5% of full-scale plus ± 0.7% of setting

Differential Outputs : Offset accuracy is ± 1% of maximum output

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AC Characteristics

Frequency Response :

Full-Power Bandwidth:	10 MHz, all outputs
Small-Signal Bandwidth:	30 MHz, all outputs

General VXI Characteristics

Size :	C
Slots :	1
Connectors :	P1, P2
Weight (kg) :	1.4
Device Type :	Register, A16, D16 Servant
VXIbus Revision Compliance :	1.3
Register Level Documentation :	Yes
SCPI Revision :	1991.0
Manufacturer Code :	4095 Decimal
Model Code :	419 Decimal

Currents in Amps (typical)

+ 5v :	I(pm)	0.36
	I(dm)	0.04
+ 12v :	I(pm)	0.2
	I(dm)	0.06
-12v :	I(pm)	0.08
	I(dm)	0.05
+ 24v :	I(pm)	0.36
	I(dm)	0.27
-24v :	I(pm)	0.34
	I(dm)	0.27
-5.2v:	I(pm)	0.22
	I(dm)	0.04
-2v :	I(pm)	0
	I(dm)	0
+ 5vs :	I(pm)	0
	I(dm)	0

Typical Watts/Slot:	16
dPressure(mm H2O):	0.14
AirFlow (liters/s):	1.28

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Appendix B
Error Messages

Agilent E1446A Error Messages

This appendix contains a list of error messages that may be received when programming the Agilent E1446A.

- Table B-1. Agilent E1446A Error Messages B-2
- Table B-2. Agilent E1446A Settings Conflict Errors with the Agilent E1405/06 . . . . . B-4
- Table B-3. Agilent E1446A Settings Conflict Errors with the Agilent E1445A B-4

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Table B-1. Agilent E1446A Error Messages

Code	Message	Description
-101	Invalid character	Unrecognized character in parameter.
-102	Syntax error	Command is missing a space or comma between parameters.
-103	Invalid separator	Parameter is separated by a character other than a comma.
-104	Data type error	The wrong data type (number, character, string, expression) was used when specifying the parameter.
-108	Parameter not allowed	Parameter specified in a command which does not require one.
-109	Missing parameter	Command requires a parameter(s).
-112	Program mnemonic too long	Command keyword > 12 characters
-113	Undefined header	Command header (keyword) was incorrectly specified.
-121	Invalid character in number	A character other than a comma or number is in the middle of a number.
-123	Numeric overflow	A parameter value is greater than what can be represented with the number format.
-124	Too many digits	More than 256 digits were used to specify a number.
-128	Numeric data not allowed	A number was specified when a letter was required.
-131	Invalid suffix	Parameter suffix incorrectly specified (e.g. VO rather than VP).
-138	Suffix not allowed	Parameter suffix is specifed when one is not allowed.
-141	Invalid character data	Discrete parameter specified is not a valid choice.
-144	Character data too long	A segment or sequence name is too long, or a discrete parameter is > 12 characters. Segment and sequence names must be 12 characters or less.
-148	Character data not allowed	Discrete parameter was specified when another type (e.g. numeric, boolean) is required.
-158	String data not allowed	A string was specified when another parameter type (i.e. discrete, numeric, boolean) is required.
-161	Invalid block data	The number of bytes in a definite length data block does not equal the number of bytes indicated by the block header.
-168	Block data not allowed	Block data was specified when another parameter type (i.e. discrete numeric, boolean) is required.

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Table B-1. Agilent E1446A Error Messages (Con't.)

Code	Message	Description
-178	Expression data not allowed	Expression data was specified when another parameter type is required.
-183	Macro execution error	Macro program data sequence could not be executed due to invalid data inside the macro definition.
-221	Settings conflict	See "Settings Conflict Error Messages" at the end of this table.
-222	Data range error	Data out of range.
-270	Macro error	*RMC < name> was executed and name is not defined.
-272	Macro execution error	Macro program data sequence could not be executed due to a syntax error within the macro definition.
-273	Illegal macro label	The macro label defined in the *DMC command was too long, the same as a common command keyword, or contained invalid header syntax.
-276	Macro recursion error	A macro program data sequence could not be executed because the sequence leads to the execution of a macro being defined.
-277	Macro redefinition not allowed	A macro label in the *DMC command could not be executed because the macro label was already defined.
-330	Self-test failed	Note the information associated with the message for a description of the failure.
-350	Too many errors	The Agilent E1446A error queue is full and additional errors have occurred.
-410	Query INTERRUPTED	The Agilent E1446A was sent a command before it was finished responding to a query command.
-420	Query UNTERMINATED	The controller (computer) attempts to read a query response from the Agilent E1446A without having first sent a complete query command.
-430	Query DEADLOCKED	The Agilent E1446A's input and output buffers are full and the Amplifier cannot continue
-440	Query UNTERMINATED after indefinite response	Occurs when the *IDN? query is not the last query executed in a command string

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Table B-2. Agilent E1446A Settings Conflict Errors with the Agilent E1405/06 Command Module

OUTP:ATT 20 and OUTP:IMP 0; OUTP:IMP 50 set
SOUR:VOLT:OFFS < minimum; SOUR:VOLT:OFFS MIN set
SOUR:VOLT:OFFS > maximum; SOUR:VOLT:OFFS MAX set

Table B-3. Agilent E1446A Settings Conflict Errors with the Agilent E1445A AFG

OUTP2:ATT 20 and OUTP2:IMP 0; OUTP2:IMP 50 set
SOUR2:VOLT:OFFS < minimum; SOUR2:VOLT:OFFS MIN set
SOUR2:VOLT:OFFS > maximum; SOUR2:VOLT:OFFS MAX set

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Appendix C
Register-Based Programming

Appendix Contents

The Agilent E1446A Summing Amplifier/DAC (amplifier) is a register-based device which does not support the VXIbus word serial protocol. When a SCPI command is sent to the amplifier, the amplifier driver in the Agilent E1445A Arbitrary Function Generator (AFG) or in the Agilent E1405/06 Command Module parses the command and writes the information to the amplifier registers.

Register-based programming is a series of reads and writes **directly** to the amplifier registers. This increases throughput speed since command parsing is eliminated and the registers can be accessed from the VXI backplane (with an embedded controller or Instrument BASIC).

This appendix contains the information you need for register-based programming. The contents include:

- Register Addressing. C-1
- Computer Configurations. C-4
- Register Descriptions C-6
- Programming the Amplifier C-12
- Example Programs. C-17

Register Addressing

Register addresses for register-based devices are located in the upper 25% of VXI A16 address space. Every VXI device (up to 256 devices) is allocated a 32 word (64 byte) block of addresses. The amplifier uses six of the 32 (word) addresses allocated.

Figure C-1A shows the register address location within A16. Figure C-1B shows the location of A16 address space in the Agilent E1405/06 Command Module.

The Base Address

When you are reading or writing to an amplifier register, a hexadecimal or decimal register address is specified. This address consists of a A16 base address plus a register offset or register number.

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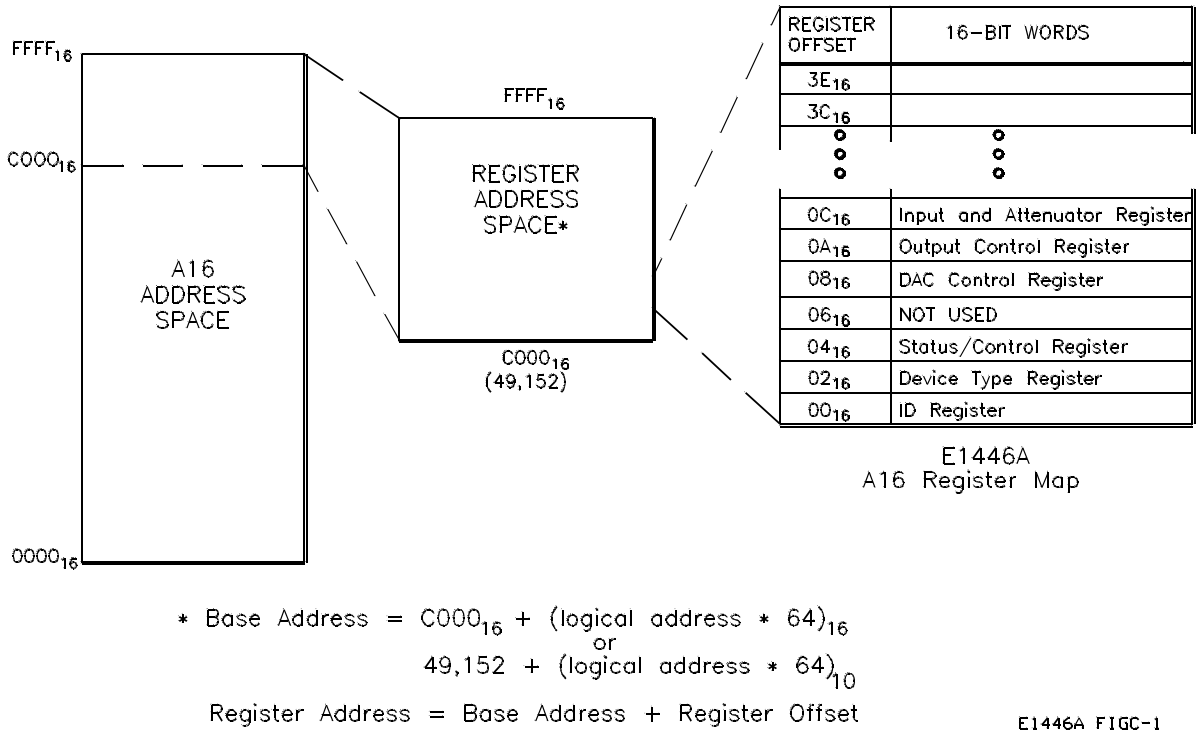


Figure C-1A. E1446A Amplifier Registers within A16 Address Space.

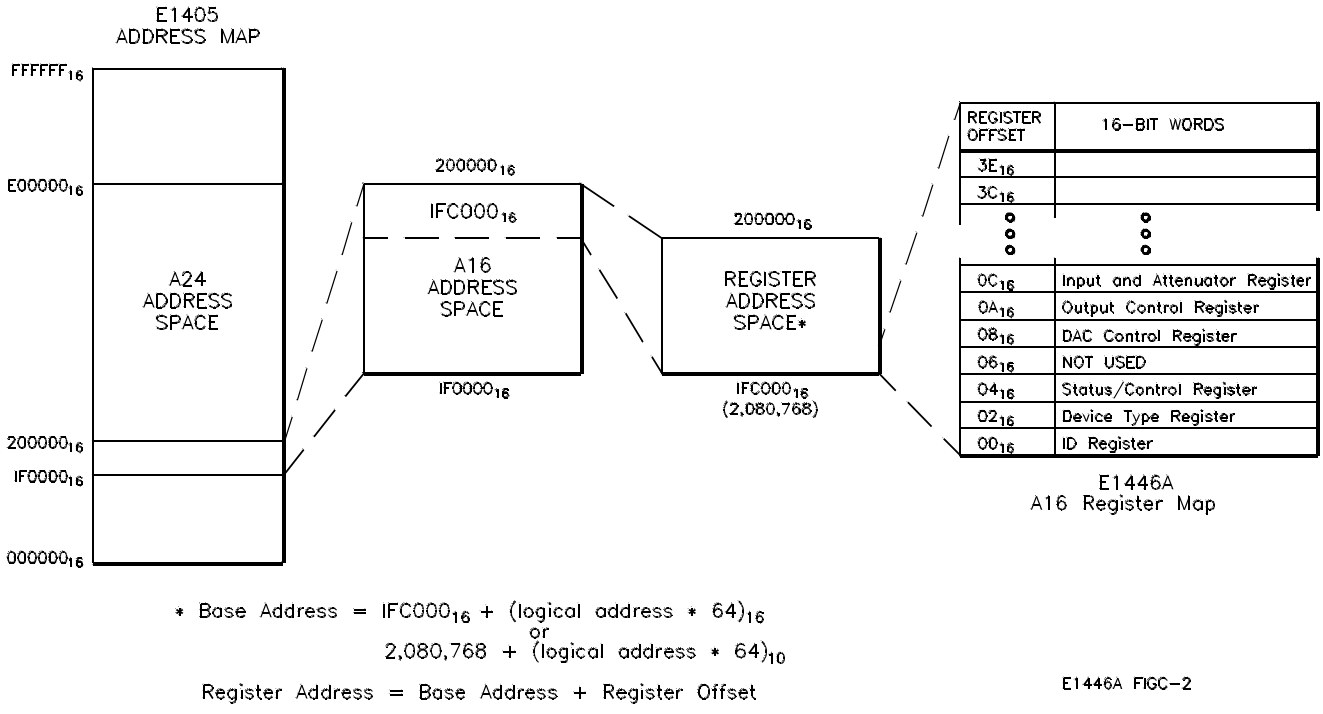


Figure C-1B. E1446A Amplifier Registers within E1405 A16 Address Space.

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The A16 base address used in register-based programming depends on whether the A16 address space is located inside the E1405/06 Command Module or elsewhere (e.g. embedded computer). Figures C-1A, C-1B, and Table C-1 enable you to determine the base address for the following computer configurations:

- Embedded Controller (V/360)
- Agilent E1405/06 Command Module Instrument BASIC (IBASIC)
- External Computer over GPIB to Command Module (E1405/06)

Table C-1. Computer Configurations used with the E1446A

Computer	Programming Method	Base Address
Agilent E1480 V/360 Embedded Computer	READIO (-16,Base_addr + offset) WRITEIO -16,Base_addr + offset;data (positive select code = byte read or write negative select code = word read or write)	Base_addr = $C000_{16}$ + $(LADDR * 64)_{16}$ or = 49,152 + (LADDR * 64) offset = register offset (Figure C-1B)
E1405/06 IBASIC (Absolute Addressing)	READIO (-9826,Base_addr + offset) WRITEIO -9826,Base_addr + offset;data (positive select code = byte read or write negative select code = word read or write)	Base_addr = $1FC000_{16}$ + $(LADDR * 64)_{16}$ or = 2,080,768 + (LADDR * 64) offset = register offset (Figure C-1A)
(Select Code 8)	READIO (8,Base_addr + reg number) WRITEIO 8,Base_addr + reg number;data	Base_addr = LADDR * 256 reg number = offset (Figure C-1A)/2
External Computer (over GPIB to E1405/06 Command Module)	VXI:READ? logical_address,offset VXI:WRITE logical_address,offset,data	Amplifier logical address setting (LADDR) offset = register offset (Figure C-1A)
	DIAG:PEEK? Base_addr + offset,width DIAG:POKE Base_addr + offset,width,data	Base_addr = $1FC000_{16}$ + $(LADDR * 64)_{16}$ or = 2,080,768 + (LADDR * 64) offset = register offset (Figure C-1A)
LADDR : Amplifier logical address. $(LADDR * 64)_{16}$: multiply quantity, then convert to a hexadecimal number (e.g. $88 * 64)_{16} = 1600_{16}$. When using DIAG:PEEK? and DIAG:POKE, the width (number of bits) is 8 or 16.		

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Computer Configurations

This section contains performance and functional information on the computer configurations that can be used with register-based programming.

Throughput Speed

Throughput speed is based on the amount of command parsing and whether the registers are accessed from the VXI backplane or from the GPIB. The computer configurations which allow faster throughput relative to each other are summarized below:

1. Agilent E1480A V/360 Controller with READIO and WRITEIO (register access is from VXI backplane).
2. E1405/06 IBASIC absolute addressing with READIO and WRITEIO (register access is from VXI backplane).
3. E1405/06 IBASIC select code 8 with READIO and WRITEIO (register access is from VXI backplane).
4. External Computer using DIAG:PEEK? and DIAG:POKE (register access is over GPIB).
5. External Computer using VXI:READ? and VXI:WRITE (register access is over GPIB).

Embedded Computer Programming (C-Size Systems)

The fastest throughput is achieved using an embedded computer such as the Agilent E1480 V/360. The embedded computer allows you to access the amplifier registers from the VXIbus backplane, and since READIO and WRITEIO are used, there is no parsing of SCPI command headers.

IBASIC Programming

When the E1446A amplifier is programmed using the E1405/06 Command Module's Instrument BASIC (IBASIC), two methods of accessing the registers are through absolute addressing or using select code 8.

Absolute Addressing and Select Code 8

Absolute addressing is faster than select code 8 since the complete register address (including the A16 starting location $1FC000_{16}$) is specified. When select code 8 is used, the IBASIC processor must calculate the complete register address based on the logical address specified (Table C-1).

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The Register Offset and Register Number

Depending on whether absolute addressing or select code 8 is used, either a register offset or register number is specified as part of the register address. Absolute addressing specifies a register offset, which is the register's location in the block of 64 address bytes. For example, the amplifier's DAC Control Register has an offset of 08_{16}. When you write to this register, the offset is added to the base address to form the register address (assuming a logical address of 88):

register address = base address + register offset

$= 1FC000_{16} + (88 * 64)_{16} + 08_{16}$

$= 1FC000_{16} + 1600_{16} + 08_{16} =$ **$1FD608_{16}$**

or

$= 2{,}080{,}768 + (88 * 64) + 8$

$= 2{,}080{,}768 + 5632 + 8 =$ **2,086,408**

Using select code 8 requires that you specify a **register number**. The register number is the register offset/2. Referring to Figure C-1A, the DAC Control register with an offset of 08 is register number 4.

Declaring IBASIC Variables in COM (common) Memory

When writing or modifying IBASIC programs, array variables can be declared in COM (common) memory. Variables not in COM memory reside in the IBASIC stack. The 'stack' is a 32 kByte (default) segment of memory which contains components such as pointers and local variables for subprograms and declarations. When too many variables (or too large an array) are in the stack, Error 2 - Memory Overflow will occur. If a memory overflow occurs, the stack size can be changed with the command PROGram:MALLocate < nbytes> (see the Instrument BASIC user's manual for more information).

External Computer Programming

When the amplifier is programmed by an external computer through the E1405/06 Command Module, the registers are accessed using DIAG:PEEK? and DIAG:POKE, or VXI:READ? and VXI:WRITE.

DIAG:PEEK?/DIAG:POKE and VXI:READ?/VXI:WRITE

Throughput speed using DIAG:PEEK? and DIAG:POKE is faster than VXI:READ? and VXI:WRITE because the complete register address (including the A16 starting location $1FC000_{16}$) is specified. VXI:READ? and VXI:WRITE specify the device logical address and register offset only. Thus, the E1405/06 processor must calculate the complete register address which decreases throughput speed.

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IBASIC programming using absolute addressing or select code 8 is faster than either DIAG:PEEK? and DIAG:POKE or VXI:READ? and VXI:WRITE because the registers are accessed from the VXIbus backplane rather than from the GPIB. Also, READIO and WRITEIO do not need to be repetitively parsed at runtime.

Register Descriptions

There are two READ and four READ/WRITE registers on the amplifier. This section contains a description and a bit map of each register.

The READ Registers

The following READ registers are located on the amplifier.

- ID Register (base + 00_{16})
- Device Type Register (base + 02_{16})

Examples and program statements in this appendix use 16-bit reads. In most cases, however, only the lower eight bits are used.

The ID Register

The amplifier's ID register indicates the classification, addressing mode, and the manufacturer of the device.

Address	15	14	13	12	11 - 0
base + 00_{16}	Device Class		Address Mode		Manufacturer ID

Device Classification. Bits 15 and 14 classify a device as one of the following:

0 0 memory device
0 1 extended device
1 0 message-based device
1 1 register-based device

The Agilent E1446 Summing Amplifier/DAC is a register-based device.

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Addressing Mode. Bits 13 and 12 indicate the addressing mode used by the device:

0 0 A16/A24 address mode
0 1 A16/A32 address mode
1 0 RESERVED
1 1 A16 address mode

The Agilent E1446 amplifier uses the A16 address mode.

Manufacturer ID. Bits 11 through 0 identify the manufacturer of the device. Agilent Technologie's ID number is 4095, which corresponds to bits 11 - 0 being set to "1".

Given the device classification, addressing space, and manufacturer of the Agilent E1446, reading the ID register returns $FFFF_{16}$.

The Device Type Register

The Device Type register contains a model code which identifies the device.

Address	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
base + 02_{16}	Model Code															

Model Code. The model code of the Agilent E1446 amplifier is $01A3_{16}$.

The READ/WRITE Registers

The following READ/WRITE registers are located on the amplifier.

- Status/Control Register (base + 04_{16})
- DAC Control Register (base + 08_{16})
- Output Control Register (base + $0A_{16}$)
- Input Attenuation Register (base + $0C_{16}$)

Examples and program statements in this appendix use 16-bit reads and writes.

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The Status Register

Reading the register at base + 04_{16} reads the amplifier's Status register. The Status register monitors the amplifier's input/output enable conditions and overload conditions.

Address	15	14	13 - 12	11	10	9	8	7 - 0
base + 04_{16}	not used (0)	MODID*	not used (0)	Main Output Ovld	Input 1 Enable	Input 2 Enable	Main Output State	FF_{16}

MODID. A zero (0) in bit 14 indicates that the amplifier is selected by a high state on the P2 MODID line. A one (1) indicates the amplifier is not selected via the P2 MODID line.

Main Output Ovld. A one (1) in bit 11 indicates an output signal (Main Output BNC) can not be produced with the current input conditions.

Input 1 Enable. A one (1) in bit 10 indicates the 'Input 1' BNC port is enabled. A zero (0) indicates the input port is disabled.

Input 2 Enable. A one (1) in bit 9 indicates the 'Input 2' BNC port is enabled. A zero (0) indicates the input port is disabled.

Main Output State. A one (1) in bit 8 indicates the 'Main Output' BNC port is enabled. A zero (0) indicates the output port is disabled.

At power-on, the inputs and output are disabled.

The Control Register

Writing to the register at base + 04_{16} writes to the amplifier's Control register. The Control register is used to perform a hardware reset of the amplifier.

Address	15 - 1	0
base + 04_{16}	not used	Reset

Resetting the Amplifier. Writing a one (1) to bit 0 (hardware) resets the amplifier. Writing a zero (0) turns the reset function off. Bit 0 must be a '1' for at least 2 µs for the reset to occur. Bit 0 must be set to 0 for normal operation.

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The DAC Control Register

The DAC control register sets the output level of the amplifier/DAC.

Address	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
base + 08_{16}	DAC Control Code															

DAC Control Code	DAC Output	Amplifier Output
0000_{16}	+ full scale	- full scale: -19.9992V
$7FFE_{16}$	+ 1 LSB	- 1 LSB: -.610 µV (open circuit)
$7FFF_{16}$	0	0
8000_{16}	- 1 LSB	+ 1 LSB: + .610 µV (open circuit)
$FFFF_{16}$	- full scale	+ full scale: + 20.0000V

At power-on the DAC control code is set to 0, which is - full scale.

The Output Control Register

The Output Control register controls the output attenuation and impedance of the amplifier's 'Main' and 'differential' outputs.

Address	15 - 8	7	6	5	4	3	2	1	0
base + $0A_{16}$	FF_{16}	0dB output path	20dB output path	50-75Ω output imped.	'Main' output enable / disable	50-75Ω out imp of non -inv amp	50-75Ω out imp of inv amp	0Ω output imped.	reserved (must be set to '1')

Bits 7 - 6. Bits 7 and 6 set the attenuation at the amplifiers's main output. Setting bit 7 to one (1) specifies the 0dB output path. Setting bit 7 to zero (0) opens the 0dB output path. Setting bit 6 to one (1) specifies the 20dB output path. Setting bit 6 to zero (0) opens the 20dB output path. At power-on, the output attenuation is undefined.

Bit 5. Setting bit 5 to one (1) sets the 'Main' output impedance to 50Ω. Setting bit 5 to zero (0) sets the 'Main' output impedance to 75Ω. At power-on, the output impedance is undefined.

Bit 4. Setting bit 4 to one (1) enables the amplifier's 'Main' output. Setting bit 4 to zero (0) disables the amplifier's 'Main' output. At power-on the bit value is undefined, but the output is disabled.

Bits 3 - 2. Bits 3 and 2 set the output impedance of the amplifier's non-inverting and inverting 'differential' outputs. Setting bit 3 to one (1) sets the impedance of the non-inverting output to 50Ω. Setting bit 3 to

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zero (0) sets the impedance to 75Ω. Setting bit 2 to one (1) sets the impedance of the inverting output to 50Ω. Setting bit 2 to zero (0) sets the impedance to 75Ω. At power-on, the impedance of both outputs is undefined.

Bit 1. Setting bit 1 to one (1) sets the 'Main' output impedance to 0Ω. Setting bit 1 to zero (0) opens the 0Ω path. The output attenuation must be set to 0 dB (bit 7) if the impedance is set to 0Ω. Bit 5 must also be set to one (1) to get 0Ω output impedance. At power-on, the 'Main' output impedance is undefined.

Bit 0. Bit 0 is a reserved bit and must remain set to one (1). At power-on, the bit setting is undefined.

The Input Attenuation Register

The Input Attenuation register controls the attenuation and impedance of the amplifier's inputs ('Input 1' and 'Input 2').

Address	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	Input 1 attenuation and impedance							X	Input 2 attenuation and impedance							
base + $0C_{16}$	16dB atten	8dB atten	4dB atten	2dB atten	1dB atten	75Ω in imp	50Ω in imp	not used	16dB atten	8dB atten	4dB atten	2dB atten	1dB atten	75Ω in imp	50Ω in imp	relay act.

Bits 15 - 11. Bits 15 - 11 set the 'Input 1' attenuation from 0dB to 31dB. Zeros (0) in bits 15 - 11 set 0dB attenuation. Ones (1) in bits 15 - 11 set up to 31dB of attenuation. At power-on, the input attenuation is undefined.

Bits 10 - 9. Bits 10 - 9 set the input impedance of 'Input 1'. Setting bit 10 to one (1) sets the impedance to 75Ω. Setting bit 9 to one (1) sets the impedance to 50Ω. If both bits are set to one (1), the impedance is 50Ω. Setting both bits to zero (0) sets the input impedance to 1 MΩ. At power-on, the input impedance is undefined.

Bits 7 - 3. Bits 7 - 3 set the 'Input 2' attenuation from 0dB to 31dB. Zeros (0) in bits 7 - 3 set 0dB attenuation. Ones (1) in bits 7 - 3 set up to 31dB of attenuation. At power-on, the input attenuation is undefined.

Bits 2 - 1. Bits 2 - 1 set the input impedance of 'Input 2'. Setting bit 2 to one (1) sets the impedance to 75Ω. Setting bit 1 to one (1) sets the impedance to 50Ω. If both bits are set to one (1), the impedance is 50Ω. Setting both bits to zero (0) sets the input impedance to 1 MΩ. At power-on, the input impedance is undefined.

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Bit 0. The attenuation relays (bits 15 - 11 and bits 7 - 3) are latching relays. When energized, these relays will "latch" to an open (bit = 0) or closed (bit = 1) state and remain in that state after the energizing power is removed.

Bit 0 is used to energize the latching relays. Setting bit 0 to zero (0) when setting the input attenuation energizes the relays. Setting bit 0 to one (1) after the attenuation has been set, removes the energizing source, thus, conserving power. Note that bits 15 - 11 and 7 - 3 should all be set to 0 as bit 0 is set to 1.

The relays associated with bits 10 - 9 and bits 2 - 1 are not latching relays. Therefore, when removing the energizing source (setting bit 0 to '1'), these bits must be written to again to preserve their intended setting.

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Programming the Amplifier

Figure C-2 is a block diagram of the Agilent E1446A Summing Amplifier/DAC. The diagram shows the portions of the summing amplifier/DAC configured with register-based programming. The following information covers the sequence used to program the amplifier.

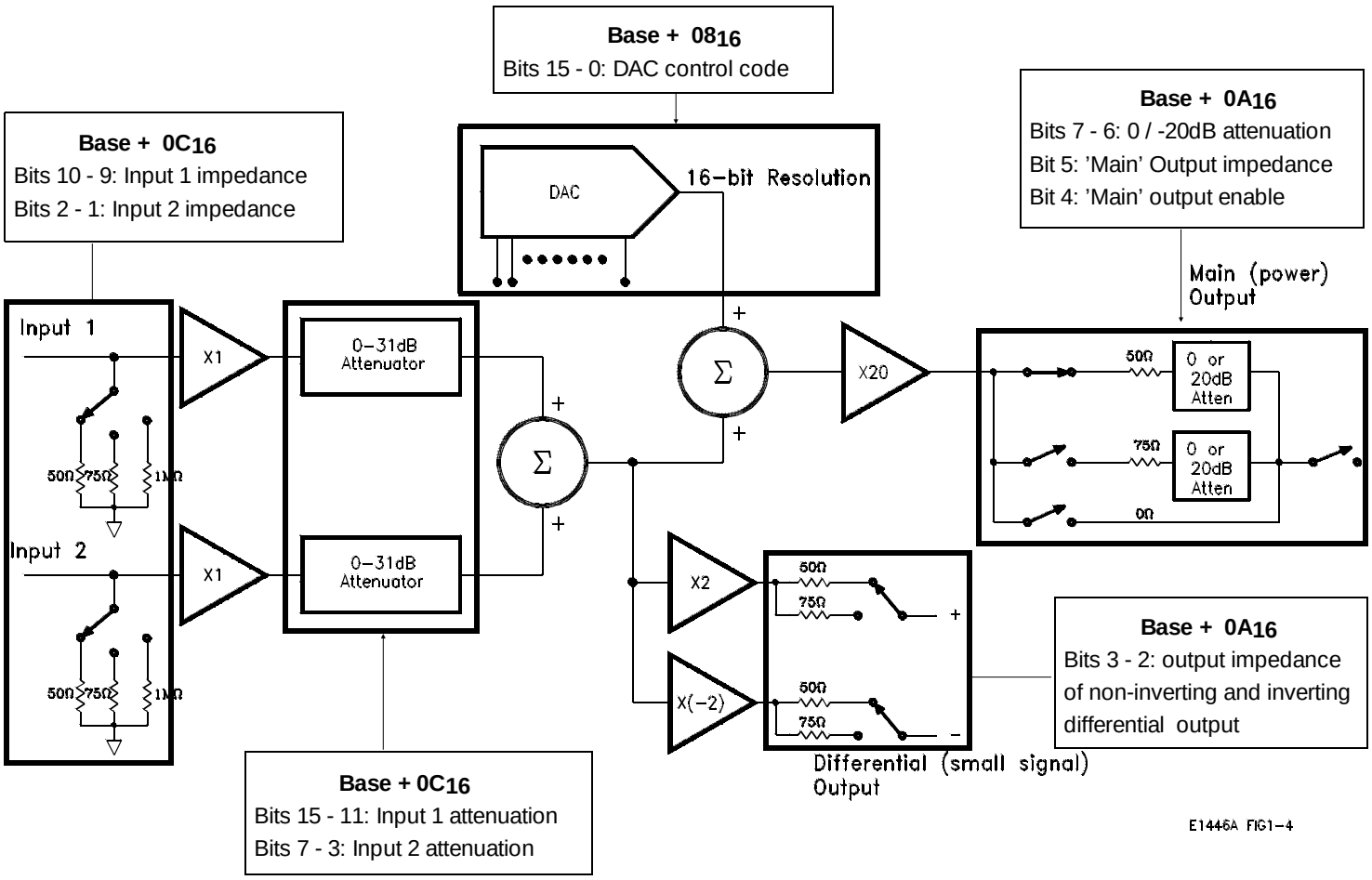


Figure C-2. Register Programming the Summing Amplifier/DAC.

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Table C-2. E1446A Register Bit Weights.

Address	15	14	13 - 12	11	10	9	8	7 - 0
Bit Weight	32768	16384		2048	1024	512	256	---
base + 04_{16} (status)	not used (0)	MODID*	not used (0)	Main Output Ovld	Input 1 Enable	Input 2 Enable	Main Output State	FF_{16}
* active low								

Address	15 - 1	0
Bit Weight		1
base + 04_{16}	not used	Reset

Address	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Bit Weight	32768	16384	8192	4096	2048	1024	512	256	128	64	32	16	8	4	2	1
base + 08_{16}	DAC Control Code															

Address	15 - 8	7	6	5	4	3	2	1	0
Bit Weight	- -	128	64	32	16	8	4	2	1
base + $0A_{16}$	FF_{16}	0dB output path	-20dB output path	50-75Ω output imped.	'Main' output enable / disable	50-75Ω out imp of non -inv amp	50-75Ω out imp of inv amp	0Ω output inped.	reserved (must be set to '1')

Address	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	Input 1 attenuation and impedance							X	Input 2 attenuation and impedance							
Bit Weight	32768	16384	8192	4096	2048	1024	512	256	128	64	32	16	8	4	2	1
base + $0C_{16}$	16dB atten	8dB atten	4dB atten	2dB atten	1dB atten	75Ω in imp	50Ω in imp	not used	16dB atten	8dB atten	4dB atten	2dB atten	1dB atten	75Ω in imp	50Ω in imp	relay act.

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Program Sequence and Execution

The recommended sequence of an E1446A register-based program is shown in Figure C-3.

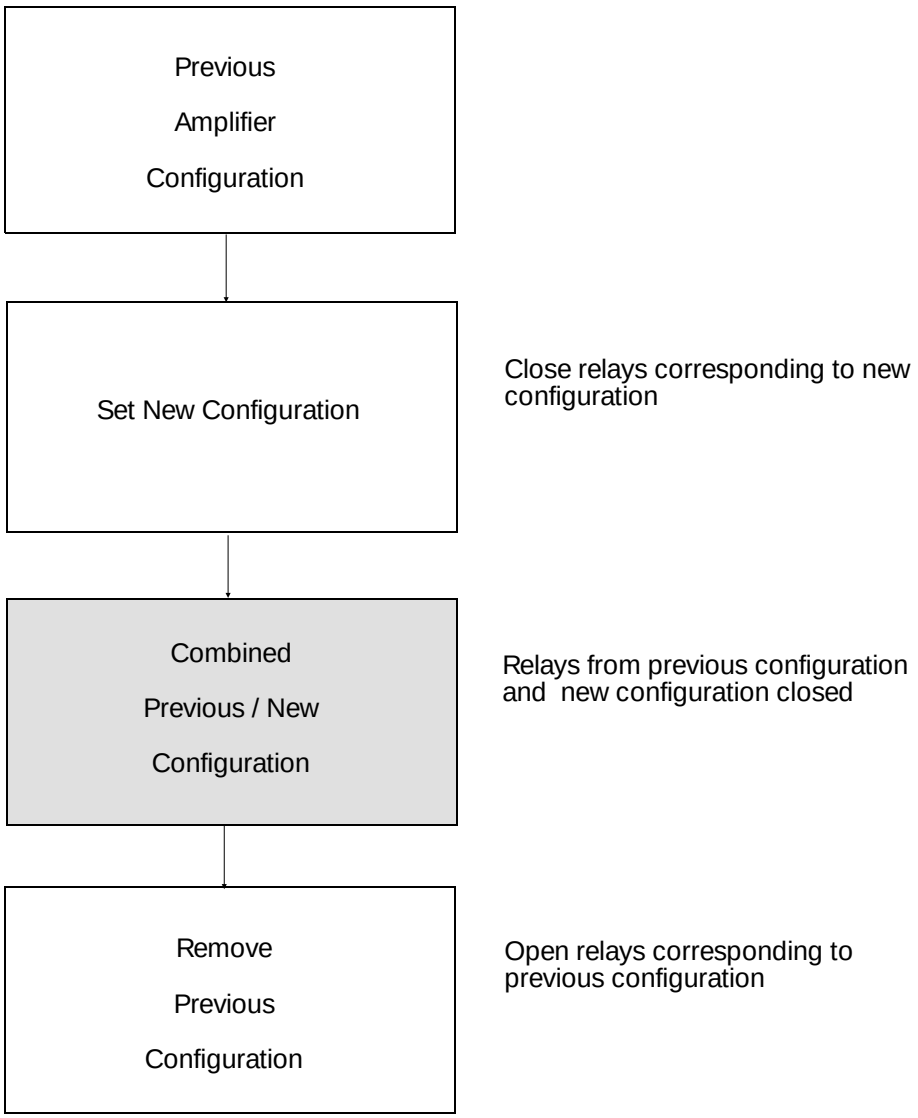


Figure C-3. Recommended Amplifier Configuration Sequence.

Programming begins with the amplifier in its previous (current) configuration. This may be the reset configuration or some other preset condition. The register-based program sets the new configuration while maintaining the previous configuration. This prevents a possible momentary all (relay) open situtation which could output a high-voltage glitch. Once the relays (especially the attenuation and impedance relays) of the new configuration are closed, the relays corresponding to the previous configuration are opened.

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Program Execution

The (new) amplifier configuration is set as shown in Figure C-4. The execution sequence shown configures the amplifier from right-to-left relative to Figure C-2.

Note

Unlike other register-based devices, there is not a status bit which can be monitored to determine when the amplifier registers can be written to (WRITEIO). To allow the relays to close (or open), a 5 mS 'wait' period (BASIC has 10 mS resolution) should be included following each WRITEIO.

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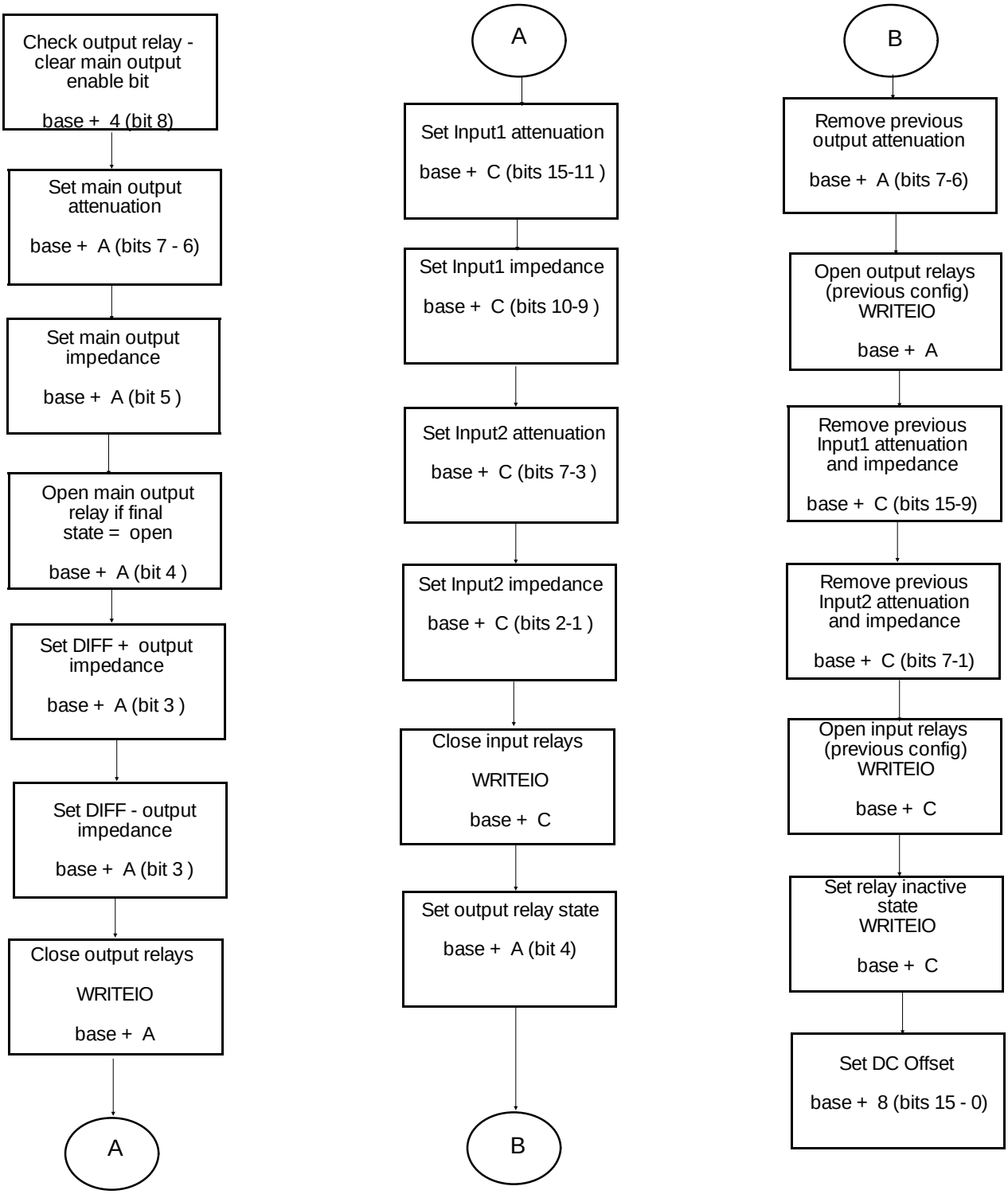


Figure C-4. Amplifier Register-based Programming Flowchart.

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Example Programs

The program listings in this section are BASIC programs in LOAD/STORE format and are contained on the example programs disk Agilent P/N E1446-10031. GET/SAVE versions of these programs are on example programs disk Agilent P/N E1446-10032.

The examples in this section include:

- Amplifying a Sine Wave
- Setting the (amplifier) Input Impedance
- Setting a DC Voltage Offset
- Using the Differential (small signal) Outputs
- Summing Two Signals

The programs in this section are the same as those in Chapter 2. However, the amplifer is programmed at the register level using the flowchart of Figure C-4 . Note also that the amplifier is in the servant area of the E1480A V/360 controller, and not in the servant area of the E1445A (see below).

System Configuration

The register-based programs in this section were developed using the following system configuration:

Controller:	Agilent E1480A V/360 Embedded Controller (select code 16)
Mainframe:	Agilent 75000 Series C
Slot 0/Resource Manager:	Agilent E1480A V/360
E1446A Logical Address:	88
E1445A Logical Address:	80
E1445A Servant Area:	0

Communication between the controller and E1445A/E1446A is through paths 1 and 4 mentioned under "Using an Embedded Controller" in Chapter 1.

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BASIC Subprograms

The subprograms used by each register-based program are stored/saved in a separate file (file name 'E46SUBS'). These subprograms are listed after the last example (Summing Two Signals).

Amplifying a Sine Wave

This program uses the E1446A to amplify a 2 Vpp E1445A AFG signal to 14.15 Vpp. Since the intended output amplitude and the input amplitude are known, the amount of attenuation (0 - 31 dB attenuator) is determined as:

$$attenuation_{(dB)} = 20 \text{ LOG } V_o/(V_i * 10)$$

where V_o is the output amplitude and V_i is the input signal amplitude (V_o and V_i units (Vpp, Vp) must be the same). Thus,

$$attenuation_{(dB)} = 20 \text{ LOG } 14.15/20 = -3 \text{ dB}$$

BASIC (RGBAMPL)

```
1   !RE-STORE "RGBAMPL"
2   LOADSUB ALL FROM "E46SUBS"
3   !
10  COM /E1446/ Base_addr,INTEGER In_ctrl,Out_imped
20  !
30   !SET UP E1445A
40   !
50   ASSIGN @Afg TO 1680  !E1445A and V/360 I/O path
60   !
70   !E1445A error checking
80   ON INTR 16 CALL Errmsg
90   ENABLE INTR 16;32
100  OUTPUT @Afg;"*CLS"
110  OUTPUT @Afg;"*SRE 32"
120  OUTPUT @Afg;"*ESE 60"
130  !
140  !Reset E1445A and clear status
150  OUTPUT @Afg;"*RST;*CLS;*OPC?"
160  ENTER @Afg;Ready
170  !
180  OUTPUT @Afg;"SOUR:FREQ1:FIX 1E3;";          !frequency
190  OUTPUT @Afg;":SOUR:FUNC:SHAP SIN;";         !function
200  OUTPUT @Afg;":SOUR:VOLT:LEV:IMM:AMPL 2VPP;"; !amplitude
210  OUTPUT @Afg;":OUTP:LOAD:AUTO ON;"; !couple load to impedance
220  OUTPUT @Afg;":OUTP:IMP 50"       !output impedance
230  !
```

Continued on Next Page

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```
240  WAIT .1
250  OFF INTR 16
260  !
270  ! BEGIN E1446A CONFIGURATION
280  !
290  !Declare and initialize program variables
300  !
310  REAL In1_atten,In1_imped,In2_atten,In2_imped  !input variables
320  REAL Out1_atten,Out1_imped,Out1_state         !main output variables
330  REAL Out2_imped,Out3_imped                    !diff out variables
340  REAL Offset                                   !DC offset variable
350  !
360  DATA 3.,50.,0.,50.
370  READ In1_atten,In1_imped,In2_atten,In2_imped  !input atten and imp
380  !
390  DATA 0.,50.,1   !main output attenuation, impedance, and state
400  READ Out1_atten,Out1_imped,Out1_state
410  !
420  DATA 50.,50.    !differential output impedances
430  READ Out2_imped,Out3_imped
440  !
450  Offset= 0.   !DC offset
460  !
470  !Set E1446A base address and initialize COM variables
480  Set_addr(88)
490  !
500  !Set up E1446A
510  Setup_e1446(In1_atten,In1_imped,In2_atten,In2_imped,Out1_atten,Out1_imped,
Out1_state,Out2_imped,Out3_imped,Offset)
520  !
530  OUTPUT @Afg;"INIT:IMM"   !E1445A wait-for-arm state
540  END
550  !
```

Setting the (amplifier) Input Impedance

This program sets the E1446A's input impedance to match the output impedance of the E1445A. The signal supplied by the E1445A is a 1 Vpp, 2 MHz square wave. The signal is amplified to 6.3 Vpp. Again, when the intended output amplitude and the input amplitude are known, the amount of attenuation (0 - 31 dB attenuator) is determined by:

$$\text{attenuation}_{(dB)} = 20 \text{ LOG } V_o/(V_i * 10)$$

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where V_o is the output amplitude and V_i is the input signal amplitude (V_o and V_i units (Vpp, Vp) must be the same). Thus,

$$\text{attenuation}_{(dB)} = 20 \text{ LOG } 6.3/10 = -4 \text{ dB}$$

BASIC (RGBIMP)

```
1    !RE-STORE "RGBIMP"
2    LOADSUB ALL FROM "E46SUBS"
3    !
10    COM /E1446/ Base_addr,INTEGER In_ctrl,Out_imped
20    !
30    ! SET UP E1445A
40    !
50    ASSIGN @Afg TO 1680  !E1445A and V/360 I/O path
60    !
70    !E1445A error checking
80    ON INTR 16 CALL Errmsg
90    ENABLE INTR 16;32
100   OUTPUT @Afg;"*CLS"
110   OUTPUT @Afg;"*SRE 32"
120   OUTPUT @Afg;"*ESE 60"
130   !
140   !Reset E1445A and clear status
150   OUTPUT @Afg;"*RST;*CLS;*OPC?"
160   ENTER @Afg;Ready
170   !
180   OUTPUT @Afg;"SOUR:FREQ1:FIX 2E6;";                    !frequency
190   OUTPUT @Afg;":SOUR:FUNC:SHAP SQU;";                   !function
200   OUTPUT @Afg;":SOUR:VOLT:LEV:IMM:AMPL 1VPP;"; !amplitude
210   OUTPUT @Afg;":OUTP:IMP 75;";                          !output impedance
220   OUTPUT @Afg;":OUTP:LOAD 75"                           !output load
230   !
240   WAIT .1
250   OFF INTR 16
260   !
270   ! BEGIN E1446A CONFIGURATION
280   !
290   !Declare and initialize program variables
300   !
310   REAL In1_atten,In1_imped,In2_atten,In2_imped  !input variables
320   REAL Out1_atten,Out1_imped,Out1_state        !main output variables
330   REAL Out2_imped,Out3_imped                  !diff out variables
340   REAL Offset                          !DC offset variable
350   !
```

Continued on Next Page

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```
360   DATA 4.,75.,0.,50.
370   READ In1_atten,In1_imped,In2_atten,In2_imped  !input atten and imp
380   !
390   DATA 0.,50.,1   !main output attenuation, impedance, and state
400   READ Out1_atten,Out1_imped,Out1_state
410   !
420   DATA 50.,50.    !differential output impedances
430   READ Out2_imped,Out3_imped
440   !
450   Offset= 0.   !DC offset
460   !
470   !Set E1446A base address and initialize COM variables
480   Set_addr(88)
490   !
500   !Set up E1446A
510  Setup_e1446(In1_atten,In1_imped,In2_atten,In2_imped,Out1_atten,Out1_imped,
Out1_state,Out2_imped,Out3_imped,Offset)
520   !
530   OUTPUT @Afg;"INIT:IMM"   !E1445A wair-for-arm state
540   END
550   !
```

Setting a DC Voltage Offset

This program adds an 8V DC offset to a 0.4 Vpp E1445A signal. To maintain 0.4 Vpp at the output, the signal is attenuated by 20 dB at the amplifier input (Figure 2-1). The offset supplied by the E1446A DAC is added to the input signal and is amplified. Into 50Ω, the 0.4 Vpp signal is centered on 8V.

BASIC (RGBOFFS)

```
1    !RE-STORE "RGBOFFS"
2    LOADSUB ALL FROM "E46SUBS"
3    !
10    COM /E1446/ Base_addr,INTEGER In_ctrl,Out_imped
20    !
30    ! SET UP E1445A
40    !
50    ASSIGN @Afg TO 1680  !E1445A and V/360 I/O path
60    !
70    !E1445A error checking
80    ON INTR 16 CALL Errmsg
90    ENABLE INTR 16;32
100   OUTPUT @Afg;"*CLS"
110   OUTPUT @Afg;"*SRE 32"
120   OUTPUT @Afg;"*ESE 60"
130   !
```

Continued on Next Page

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```
140  !Reset E1445A and clear status
150  OUTPUT @Afg;"*RST;*CLS;*OPC?"
160  ENTER @Afg;Ready
170  !
180  OUTPUT @Afg;"SOUR:FREQ1:FIX 1E3;";          !frequency
190  OUTPUT @Afg;":SOUR:FUNC:SHAP SIN;";         !function
200  OUTPUT @Afg;":SOUR:VOLT:LEV:IMM:AMPL .4VPP;"; !amplitude
210  OUTPUT @Afg;":OUTP:LOAD:AUTO ON;"; !couple load to impedance
220  OUTPUT @Afg;":OUTP:IMP 50"      !output impedance
230  !
240  WAIT .1
250  OFF INTR 16
260  !
270  ! BEGIN E1446A CONFIGURATION
280  !
290  !Declare and initialize program variables
300  !
310  REAL In1_atten,In1_imped,In2_atten,In2_imped  !input variables
320  REAL Out1_atten,Out1_imped,Out1_state       !main output variables
330  REAL Out2_imped,Out3_imped                  !diff out variables
340  REAL Offset                                 !DC offset variable
350  !
360  DATA 20.,50.,0.,50.
370  READ In1_atten,In1_imped,In2_atten,In2_imped  !input atten and imp
380  !
390  DATA 0.,50.,1   !main output attenuation, impedance, and state
400  READ Out1_atten,Out1_imped,Out1_state
410  !
420  DATA 50.,50.    !differential output impedances
430  READ Out2_imped,Out3_imped
440  !
450  Offset= 8.   !DC offset
460  !
470  !Set E1446A base address and initialize COM variables
480  Set_addr(88)
490  !
500  !Set up E1446A
510  Setup_e1446(In1_atten,In1_imped,In2_atten,In2_imped,Out1_atten,Out1_imped,
Out1_state,Out2_imped,Out3_imped,Offset)
520  !
530  OUTPUT @Afg;"INIT:IMM"   !E1445A wair-for-arm state
540  END
550  !
```


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Using the Differential (small signal) Outputs

Rather than amplify the input signal, this program attenuates the signal supplied by the E1445A to obtain an output amplitude of 10 mVpp. The output can be taken at either the 'Diff + ' or 'Diff -' (inverted) output.

BASIC (RGBDIFF)

```
1    !RE-STORE "RGBDIFF"
2    LOADSUB ALL FROM "E46SUBS"
3    !
10   COM /E1446/ Base_addr,INTEGER In_ctrl,Out_imped
20   !
30   ! SET UP E1445A
40   !
50   ASSIGN @Afg TO 1680  !E1445A and V/360 I/O path
60   !
70   !E1445A error checking
80   ON INTR 16 CALL Errmsg
90   ENABLE INTR 16;32
100  OUTPUT @Afg;"*CLS"
110  OUTPUT @Afg;"*SRE 32"
120  OUTPUT @Afg;"*ESE 60"
130  !
140  !Reset E1445A and clear status
150  OUTPUT @Afg;"*RST;*CLS;*OPC?"
160  ENTER @Afg;Ready
170  !
180  OUTPUT @Afg;"SOUR:FREQ1:FIX 1E3;";          !frequency
190  OUTPUT @Afg;":SOUR:FUNC:SHAP SQU;";         !function
200  OUTPUT @Afg;":SOUR:VOLT:LEV:IMM:AMPL MIN;"; !amplitude
210  OUTPUT @Afg;":OUTP:LOAD:AUTO ON;"; !couple load to impedance
220  OUTPUT @Afg;":OUTP:IMP 50"      !output impedance
230  !
240  WAIT .1
250  OFF INTR 16
260  !
270  ! BEGIN E1446A CONFIGURATION
280  !
290  !Declare and initialize program variables
300  !
310  REAL In1_atten,In1_imped,In2_atten,In2_imped  !input variables
320  REAL Out1_atten,Out1_imped,Out1_state       !main output variables
330  REAL Out2_imped,Out3_imped                  !diff out variables
340  REAL Offset                          !DC offset variable
350  !
360  DATA 30.,50.,0.,50.
370  READ In1_atten,In1_imped,In2_atten,In2_imped  !input atten and imp
```

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```
380  !
390  DATA 0.,50.,1   !main output attenuation, impedance, and state
400  READ Out1_atten,Out1_imped,Out1_state
410  !
420  DATA 50.,50.    !differential output impedances
430  READ Out2_imped,Out3_imped
440  !
450  Offset= 0.   !DC offset
460  !
470  !Set E1446A base address and initialize COM variables
480  Set_addr(88)
490  !
500  !Set up E1446A
510  Setup_e1446(In1_atten,In1_imped,In2_atten,In2_imped,Out1_atten,Out1_imped,
Out1_state,Out2_imped,Out3_imped,Offset)
520  !
530  OUTPUT @Afg;"INIT:IMM"   !E1445A wair-for-arm state
540  END
550  !
```

Summing Two Signals

This program uses the E1446A to sum the signals from two E1445A AFGs. The AFGs at logical addresses 72 and 80 generate 1 Vpp, 5 kHz and 100 kHz sine waves respectively. The signal from the AFG at logical address 72 is applied to E1446A 'Input 1'. The signal from the AFG at logical address 80 is applied to 'Input 2'. All three devices are in the servant area of the V/360 embedded controller.

Note that this program uses the subprograms contained in the file 'SUMSUBS'. A description of 'SUMSUBS' follows the listing of the example subprograms.

BASIC (RGBSUM)

```
1    !RE-STORE "RGBSUM"
2    LOADSUB ALL FROM "SUMSUBS"
3    !
10   COM /E1446/ Base_addr,INTEGER In_ctrl,Out_imped
20   !
30   ! SET UP E1445As
40   !
50   ASSIGN @Afg72 TO 1672  !E1445A and V/360 I/O paths
60   ASSIGN @Afg80 TO 1680
70   !
```

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```
80   !E1445A error checking
90   ON INTR 16 CALL Errmsg
100  ENABLE INTR 16;32
110  OUTPUT @Afg72;"*CLS"
120  OUTPUT @Afg72;"*SRE 32"
130  OUTPUT @Afg72;"*ESE 60"
140  !
150  OUTPUT @Afg80;"*CLS"
160  OUTPUT @Afg80;"*SRE 32"
170  OUTPUT @Afg80;"*ESE 60"
180  !
190  !Reset and clear the E1445As
200  OUTPUT @Afg72;"*RST;*CLS;*OPC?"
210  ENTER @Afg72;Ready
220  !
230  OUTPUT @Afg80;"*RST;*CLS;*OPC?"
240  ENTER @Afg80;Ready
250  !
260  !Set up E1445A at logical address 72
270  OUTPUT @Afg72;"SOUR:ROSC:SOUR CLK10;";       !ref osc source
280  OUTPUT @Afg72;":SOUR:FREQ1:FIX 5E3;";        !frequency
290  OUTPUT @Afg72;":SOUR:FUNC:SHAP SIN;";        !function
300  OUTPUT @Afg72;":SOUR:VOLT:LEV:IMM:AMPL 1VPP;"; !amplitude
310  OUTPUT @Afg72;":OUTP:LOAD:AUTO ON;"; !couple load to impedance
320  OUTPUT @Afg72;":OUTP:IMP 50"      !output impedance
330  !
340  !Set up E1445A at logical address 80
350  OUTPUT @Afg80;"SOUR:ROSC:SOUR CLK10;";       !ref osc source
360  OUTPUT @Afg80;":SOUR:FREQ1:FIX 100E3;";      !frequency
370  OUTPUT @Afg80;":SOUR:FUNC:SHAP SIN;";        !function
380  OUTPUT @Afg80;":SOUR:VOLT:LEV:IMM:AMPL 1VPP;"; !amplitude
390  OUTPUT @Afg80;":OUTP:LOAD:AUTO ON;"; !couple load to impedance
400  OUTPUT @Afg80;":OUTP:IMP 50"      !output impedance
410  WAIT .1
420  OFF INTR 16
430  !
440  ! BEGIN E1446A CONFIGURATION
450  !
460  !Declare and initialize program variables
470  !
480  REAL In1_atten,In1_imped,In2_atten,In2_imped  !input variables
490  REAL Out1_atten,Out1_imped,Out1_state       !main output variables
500  REAL Out2_imped,Out3_imped                  !diff out variables
510  REAL Offset                          !DC offset variable
520  !
```

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```
530   DATA 0.,50.,0.,50.
540   READ In1_atten,In1_imped,In2_atten,In2_imped  !input atten and imp
550   !
560   DATA 0.,50.,1   !main output attenuation, impedance, and state
570   READ Out1_atten,Out1_imped,Out1_state
580   !
590   DATA 50.,50.    !differential output impedances
600   READ Out2_imped,Out3_imped
610   !
620   Offset= 0.   !DC offset
630   !
640   !Set E1446A base address and initialize COM variables
650   Set_addr(88)
660   !
670   !Set up E1446A
680  Setup_e1446(In1_atten,In1_imped,In2_atten,In2_imped,Out1_atten,Out1_imped,
Out1_state,Out2_imped,Out3_imped,Offset)
690   !
700   OUTPUT @Afg72;"INIT:IMM"   !E1445A wait-for-arm state
710   OUTPUT @Afg80;"INIT:IMM"   !E1445A wait-for-arm state
720   END
730   !
```

Example Subprograms

The following file contains the subprograms used by the preceding example programs.

```
1     !Subprograms used for register-based programming (file name 'E46SUBS')
2     !
10    SUB Set_addr(Log_addr)
20 Set_addr:   !Subprogram which sets E1446A base address and initializes
30            !the COM variables.
40      COM /E1446/ Base_addr,INTEGER In_ctrl,Out_imped
50      !Access A16 address space with READIO and WRITEIO
60      CONTROL 16,25;2
70      !
80      !Set base address and initialize COM variables
90      Base_addr= (DVAL("C000",16)+ Log_addr*64)
100     In_ctrl= 0
110     Out_imped= 50.
120   SUBEND
130   !
140  SUB  Setup_e1446(In1_atten,In1_imped,In2_atten,In2_imped,Out1_atten,
Out1_imped,Out1_state,Out2_imped,Out3_imped,Offset)
150     COM /E1446/ Base_addr,INTEGER In_ctrl,Out_imped
160     INTEGER Out_ctrl !initialize output settings (att, imp, state) variable
170     !
```

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```
180   ! Look for illegal values and settings conflicts
190   !
200   IF In1_atten< 0 OR In1_atten> = 31.5 THEN
210     DISP "Invalid INP1:ATT value"
220     STOP
230   END IF
240   IF In1_imped< > 50. AND In1_imped< > 75. AND In1_imped< > 1.E+ 6 THEN
250     DISP "Invalid INP1:IMP value"
260     STOP
270   END IF
280   !
290   IF In2_atten< 0 OR In2_atten> = 31.5 THEN
300     DISP "Invalid INP2:ATT value"
310     STOP
320   END IF
330   IF In2_imped< > 50. AND In2_imped< > 75. AND In2_imped< > 1.E+ 6 THEN
340     DISP "Invalid INP2:IMP value"
350     STOP
360   END IF
370   !
380   IF Out1_atten< > 0. AND Out1_atten< > 20. THEN
390     DISP "Invalid OUTP1:ATT value"
400     STOP
410   END IF
420   IF Out1_imped< > 0. AND Out1_imped< > 50. AND Out1_imped< > 75. THEN
430     DISP "Invalid OUTP1:IMP value"
440     STOP
450   END IF
460   IF Out1_imped= 0 AND Out1_atten= 20 THEN
470     DISP "OUTP1:ATT 20 not allowed with OUTP1:IMP 0"
480     STOP
490   END IF
500   !
510   IF Out2_imped< > 50. AND Out2_imped< > 75. THEN
520     DISP "Invalid OUTP2:IMP value"
530     STOP
540   END IF
550   !
560   IF Out3_imped< > 50. AND Out3_imped< > 75. THEN
570     DISP "Invalid OUTP2:IMP value"
580     STOP
590   END IF
600   !
610   Out_imped= Out1_imped
620   Set_e46_offset(Offset)
630   !
```

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```
640   ! If output relay open (disabled) but should be closed, clear main
650   ! output enable bit.
660   !
670   IF Out1_state AND NOT BINAND(READIO(-16,Base_addr+ 4),256) THEN
680     WRITEIO -16,Base_addr+ 10;BINAND(READIO(-16,Base_addr+ 10),-17)
690   END IF
700   !
710   ! Set up output and input relays.  Close new relays, particularly the
720   ! attenuation and impedance relays, before opening old relays to prevent
730   ! a possible momentary all-open situation which could output a high-
740   ! voltage glitch.
750   !
760   ! Do output side first
770   !
780   SELECT Out1_atten                ! Set main output attenuation
790   CASE 0.
800     Out_ctrl= 128                  ! Close  0 dB path relay
810   CASE 20.
820     Out_ctrl= 64                   ! Close 20 dB path relay
830   END SELECT
840   !
850   SELECT Out1_imped                ! Set main output impedance
860   CASE 0.
870     Out_ctrl= BINIOR(Out_ctrl,34)      ! Close 0 Ohm relay
880   CASE 50.
890     Out_ctrl= BINIOR(Out_ctrl,32)      ! Close 50 Ohm relay
900   CASE 75.
910     Out_ctrl= BINIOR(Out_ctrl,0)       ! 75 Ohm - no action
920   END SELECT
930   !
940   ! If output relay was closed (enabled), set new state here. If it
950   ! was open, close it before previous configuration is removed.
960   !
970   IF BINAND(READIO(-16,Base_addr+ 4),256) THEN
980     IF Out1_state THEN
990       Out_ctrl= BINIOR(Out_ctrl,16)    ! Relay close
1000    ELSE
1010      Out_ctrl= BINAND(Out_ctrl,-17)   ! Relay open
1020    END IF
1030  END IF
1040  !
```

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```
1050   SELECT Out2_imped                ! Set Diff+  output impedance
1060   CASE 50.
1070     Out_ctrl= BINIOR(Out_ctrl,8)      ! Close 50 Ohm relay
1080   CASE 75.
1090     Out_ctrl= BINIOR(Out_ctrl,0)      ! 75 Ohm - no action
1100   END SELECT
1110   !
1120   SELECT Out3_imped                ! Set Diff- output impedance
1130   CASE 50.
1140     Out_ctrl= BINIOR(Out_ctrl,4)      ! Close 50 Ohm relay
1150   CASE 75.
1160     Out_ctrl= BINIOR(Out_ctrl,0)      ! 75 Ohm - no action
1170   END SELECT
1180   !
1190   WRITEIO -16,Base_addr+ 10;Out_ctrl ! Start output relay closings
1200   !
1210   ! Now do input side
1220   !
1230   In_ctrl= BINIOR(In_ctrl,SHIFT(In1_atten,-11)) !Set Input 1 attenuation
1240   !
1250   SELECT In1_imped                 ! Set Input 1 impedance
1260   CASE 50.
1270     In_ctrl= BINIOR(In_ctrl,512)      ! Close 50 Ohm relay
1280   CASE 75.
1290     In_ctrl= BINIOR(In_ctrl,1024)     ! Close 75 Ohm relay
1300   CASE 1.E+ 6
1310     In_ctrl= BINIOR(In_ctrl,0)        ! 1 MOhm - no action
1320   END SELECT
1330   !
1340   In_ctrl= BINIOR(In_ctrl,SHIFT(In2_atten,-3)) !Set Input 2 attenuation
1350   !
1360   SELECT In2_imped                 ! Set Input 2 impedance
1370   CASE 50.
1380     In_ctrl= BINIOR(In_ctrl,2)        ! Close 50 Ohm relay
1390   CASE 75.
1400     In_ctrl= BINIOR(In_ctrl,4)        ! Close 75 Ohm relay
1410   CASE 1.E+ 6
1420     In_ctrl= BINIOR(In_ctrl,0)        ! 1 MOhm - no action
1430   END SELECT
1440   !
1450   In_ctrl= BINAND(In_ctrl,-2)         ! Enable inverter
1460   WRITEIO -16,Base_addr+ 12;In_ctrl    ! Start input relay closings
1470   WAIT .01                         ! Wait for relay closings to finish
1480   !
1490   ! Remove previous configuration
1500   !
```

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```
1510   IF Out1_state THEN                ! Remove previous output relay state
1520     Out_ctrl= BINIOR(Out_ctrl,16)     ! Close output relay
1530   ELSE
1540     Out_ctrl= BINAND(Out_ctrl,-17)    ! Open output relay
1550   END IF
1560   !
1570   ! Relay opens start here
1580   !
1590   ! Do output relays first
1600   !
1610   SELECT Out1_atten              ! Remove previous output attenuation
1620   CASE 0.
1630     Out_ctrl= BINAND(Out_ctrl,-65) ! Open 20 dB relay
1640   CASE 20
1650     Out_ctrl= BINAND(Out_ctrl,127) ! Open  0 dB relay
1660   END SELECT
1670   !
1680   WRITEIO -16,Base_addr+ 10;Out_ctrl ! Start output relay openings
1690   !
1700   ! Now do input side
1710   !
1720   ! Remove previous input 1 attenuation and impedance
1730   In_ctrl= BINIOR(BINAND(In_ctrl,2047),SHIFT(In1_atten,-11))
1740   SELECT In1_imped
1750   CASE 50.
1760     In_ctrl= BINAND(In_ctrl,-1025)    ! Open 75 Ohm relay
1770   CASE 75.
1780     In_ctrl= BINAND(In_ctrl,-513)     ! Open 50 Ohm relay
1790   CASE 1.E+ 6
1800     In_ctrl= BINAND(In_ctrl,-1537)    ! Open both relays
1810   END SELECT
1820   !
1830   ! Remove previous input 2 attenuation and impedance
1840   In_ctrl= BINIOR(BINAND(In_ctrl,-249),SHIFT(In2_atten,-3))
1850   SELECT In2_imped
1860   CASE 50.
1870     In_ctrl= BINAND(In_ctrl,-5)       ! Open 75 Ohm relay
1880   CASE 75.
1890     In_ctrl= BINAND(In_ctrl,-3)       ! Open 50 Ohm relay
1900   CASE 1.E+ 6
1910     In_ctrl= BINAND(In_ctrl,-7)       ! Open both relays
1920   END SELECT
1930   !
1940   WRITEIO -16,Base_addr+ 12;In_ctrl  ! Start input relay closings
1950   WAIT .01                      ! Wait for relay closings to finish
1960   !
```

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```
1970   ! Set inactive state by turning off input attenuator control bits
1980   ! and disabling inverter
1990   !
2000   WRITEIO -16,Base_addr+ 12;BINIOR(BINAND(In_ctrl,1542),1)
2010  SUBEND
2020  SUB Set_e46_offset(Offset)
2030   COM /E1446/ Base_addr,INTEGER In_ctrl,Out_imped
2040   REAL Offset_dac
2050   !
2060   ! Look for settings conflict
2070   !
2080   IF Out_imped= 0 THEN
2090    Offset_dac= -Offset/.0006103515625
2100   ELSE
2110    Offset_dac= -Offset/.00030517578125
2120   END IF
2130   IF Offset_dac< -32768.5 OR Offset_dac> = 32767.5 THEN
2140    DISP "Invalid SOUR:VOLT:LEV:IMM:OFFS value"
2150    STOP
2160   END IF
2170   !
2180   ! Set offset
2190   !
2200   WRITEIO -16,Base_addr+ 8;BINEOR(Offset_dac,32767)
2210  SUBEND
2220  !
2230  SUB Errmsg
2240 Errmsg: !Subprogram which displays E1445/E1446 programming errors
2250   DIM Message$[256]
2260   !Read AFG status byte register and clear service request bit
2270   B= SPOLL(1680)
2280   !End of statement if error occurs among coupled commands
2290   OUTPUT 1680;""
2300   OUTPUT 1680;"ABORT"  !abort output waveform
2310   REPEAT
2320    OUTPUT 1680;"SYST:ERR?"  !read AFG error queue
2330    ENTER 1680;Code,Message$
2340    PRINT Code,Message$
2350   UNTIL Code= 0
2360   STOP
2370  SUBEND
```


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Errmsg Subprogram Used with 'SUMSUBS'

Program 'RGBSUM' loads/gets its subprograms from the file 'SUMSUBS', rather than from the file 'E46SUBS'. The only difference between these subprogram files is the subprogram 'Errmsg'. 'Errmsg' in the file 'SUMSUBS' reports errors from two E1445As rather than from one. Its listing is shown below.

```
2230  SUB Errmsg
2240 Errmsg: !Subprogram which displays E1445 programming errors
2250    DIM Message$[256]
2260    !Read AFG (at logical addr 72) status byte register, clear service
2270    !request bit
2280    B= SPOLL(1672)
2290    !End of statement if error occurs among coupled commands
2300    OUTPUT 1672;""
2310    OUTPUT 1672;"ABORT"  !abort output waveform
2320    PRINT   "E1445A (logical address 72)"
2330    PRINT
2340    REPEAT
2350      OUTPUT 1672;"SYST:ERR?"  !read AFG error queue
2360      ENTER 1672;Code,Message$
2370      PRInt   Code,Message$
2380    UNTIL Code= 0
2390    PRInt
2400    !
2410    !Read AFG (at logical addr 80) status byte register, clear service
2420    !request bit
2430    B= SPOLL(1680)
2440    !End of statement if error occurs among coupled commands
2450    OUTPUT 1680;""
2460    OUTPUT 1680;"ABORT"  !abort output waveform
2470    PRINT   "E1445A (logical address 80)"
2480    PRINT
2490    REPEAT
2500      OUTPUT 1680;"SYST:ERR?"  !read AFG error queue
2510      ENTER 1680;Code,Message$
2520      PRInt   Code,Message$
2530    UNTIL Code= 0
2540    STOP
2550  SUBEND
```


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