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HP References in this Manual

This manual may contain references to HP or Hewlett-Packard. Please note that Hewlett-Packard's former test and measurement, semiconductor products and chemical analysis businesses are now part of Agilent Technologies. We have made no changes to this manual copy. In other documentation, to reduce potential confusion, the only change to product numbers and names has been in the company name prefix: where a product number/name was HP XXXX the current name/number is now Agilent XXXX. For example, model number HP8648A is now model number Agilent 8648A.

User's Guide

HP 85097A Electronic Calibration System



HP Part Number: 85091-90007

Supersedes 85091-90001

Printed in USA

July 1999

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1 **General Information**

The HP 85097A electronic calibration system (ECal) is a precision, single-connection, one-port or two-port calibration technique, that uses fully traceable electronic standards. ECal provides repeatable, accurate measurements, while bringing convenience and simplicity to your calibration routine. ECal replaces the traditional calibration technique that uses mechanical standards.

The ECal system allows you to use one or two modules with your vector network analyzer (VNA). ECal will use the results of the uncorrected measurements to produce error coefficients. It provides these error coefficients to the VNA for use by the VNA's accuracy enhancement algorithms. The VNA uses this data for a model of the measurement system, to measure a device, and utilize vector mathematics to compute actual device response by removing error contributions.

About This Manual

This manual applies to the HP 85097A PC-based ECal system. For operation information about the HP 85060C control unit-based system, refer to [Appendix A](#) in this manual, or refer to your HP 85060C manual.

NOTE

This manual refers to the HP 8509X family as RF modules (lowband) and the HP 8506X family as microwave modules (highband). For more information about these modules, see the *Electronic Calibration Module Reference Guide* (HP part number 85091-90008).

ECal System

ECal systems consist of one or more ECal modules, and the HP 85097A PC interface kit. You must supply your own PC equipped with an HP-IB (IEEE-488) interface card.

The ECal modules calibrate VNA systems for measurements with 3.5 mm, type-N 50 Ω , 7 mm, type-N 75 Ω , 7-16 and type-F connectors.

Configurations

The ECal system has two configurations:

- A PC-based system
- A control unit-based system

Both configurations allow RF and microwave calibrations, depending on which module is used.

ECal Modules

HP 8509X Modules

A single 8509X module is capable of calibrating a VNA over the following frequency ranges:

Connector Type	Freq Range
3.5 mm	30 kHz–6 GHz
Type-N 50 Ω	30 kHz–6 GHz
7 mm	30 kHz–6 GHz
Type-N 75 Ω	30 kHz–3 GHz
7-16	30 kHz–7.5 GHz
Type-F	30 kHz–3 GHz

RF Ecal modules are specified to operate from 300 kHz, with typical performance down to 30 kHz.

There are options available for measurement calibration of both insertable and non-insertable VNA setups. See [Table 1-4 on page 1-10](#) for more information.

HP 8506X Modules

HP 8506X modules are available with type-N and 7 mm connectors for VNAs with operating frequencies from 1 GHz to 18 GHz, or with 3.5 mm connectors for frequencies from 1 GHz to 26.5 GHz.

There are options available for measurement calibration of both insertable and non-insertable VNA setups. See [Table 1-4 on page 1-10](#) for more information.

Option 001 adds an HP 8509X module for calibrations below 1 GHz.

NOTE

ECal modules cannot be used to calibrate for frequencies outside the operating frequency range of the VNA being used.

Vector Network Analyzer

Hewlett-Packard VNAs measure the magnitude and phase characteristics of networks, and of components such as filters, amplifiers, attenuators and antennas. See [Table 1-1](#) for model numbers of VNAs and firmware revisions that are supported by the ECal software.

Table 1-1 VNA Models and Supported Firmware Revisions

Network Analyzer	Firmware Revision
HP 8753C	4.13
HP 8753D	6.14 or higher
HP 8753E	7.12 or higher
HP 8510B	6.54
HP 8510C	7.00 or higher
HP 8719C	1.05
HP 8719D	6.14 or higher
HP 8720C	1.05
HP 8720D	6.14 or higher
HP 8722C	1.05
HP 8722D	6.14 or higher
HP 8753ES	7.60 or higher
HP 8753ET ¹	7.60 or higher
HP 8719ES	7.60 or higher
HP 8719ET ¹	7.60 or higher
HP 8720ES	7.60 or higher
HP 8720ET ¹	7.60 or higher
HP 8722ES	7.60 or higher
HP 8722ET ¹	7.60 or higher

1. ET model analyzers do not have the capability to accommodate full 2-port calibrations. Therefore, the only ECal calibration selection valid for these analyzers is "S11 1-Port" which is equivalent to selecting "Reflection 1-Port" on an ET analyzer.

PC Interface Unit

The PC interface unit (shown in the center of [Figure 1-1](#)) functions as the digital control for the ECal modules. It can control up to two modules and contains circuitry that supplies power to the ECal module control ports only when modules are connected. It automatically turns the power off when you disconnect an ECal module.

NOTE

If you have an HP 8506XA module, a jumper can be installed to make it compatible with the PC interface unit. Contact the nearest HP sales or service office for information about returning your module for this modification. Sales and service offices are listed on [page 5-5](#).

Figure 1-1 HP 85097A PC Interface Kit Contents (ECal module not pictured)



Table 1-2 HP 85097A PC Interface Kit Replaceable Parts

Description	Quantity	HP Part Number
PC Interface Unit	1	85097-60002
PC Interface Software	1 (2 disk set)	85097-10001
Electronic Calibration System User's Guide	1	85091-90007
Power Supply	1	0950-3331
Shielded DB25 Cable	3	8120-8710

ECal Power Supply Unit

The ECal power supply unit is used to provide a 24 VDC supply to the PC interface unit. It also allows for the supply of power to the ECal modules.

WARNING

To prevent electrical shock, disconnect from mains before cleaning. Use a dry cloth or one slightly dampened with water to clean the external case parts. Do not attempt to clean internally.

CAUTION

Always use the three-prong ac power cord supplied with this product. Failure to insure adequate earth grounding by not using this cord may cause product damage.

WARNING

The detachable power cord is the instrument disconnecting device. It disconnects the mains circuits from the mains supply before other parts of the instrument.

ECal PC Interface Software

ECal software offers two interfaces that use Windows 95^{®1}, Windows 98[®] and Windows NT 4.0[®] as compatible PC operating systems.

- A graphical user interface (GUI) and VNA softkeys for conducting calibrations.
- The software programming interface (SPI) for programming and controlling ECal processes.

1. Windows is a U.S. registered trademark of Microsoft Corporation.

Listed below are the file names and versions of the ECal software used in the HP 85097A ECal system.

Table 1-3

Software

Software	Version
Ecal.exe	01.008
EcalSPI.dll	01.002
Ecal.dll	01.08

IEEE-488 Interface

The customer-supplied IEEE-488 interface card allows the PC software to control the VNA during the calibration process. Compatible interfaces include:

- HP 82341C/D (recommended interface)
- HP 82340A/B
- National Instruments AT-GPIB/TNT
- National Instruments AT-GPIB/TNT (Plug and Play)
- National Instruments PCI-GPIB

ECal Module Options and Operating Characteristics

Table 1-4 ECal Modules and Options Available

Module Model Number	Connector Type ¹	Frequency Range	Options Available
HP 85091A	7 mm	30 kHz to 6 GHz ²	1BN, 1BP, 910, UK6
HP 85092A	Type-N (50 Ω)	30 kHz to 6 GHz ²	00M, 00F, 00A, 1BN, 1BP, 910, UK6
HP 85093A	3.5 mm	30 kHz to 6 GHz ²	00M, 00F, 00A, 1BN, 1BP, 910, UK6
HP 85096A	Type-N (75 Ω)	30 kHz to 3 GHz ²	00M, 00F, 00A, 1BN, 1BP, 0B1, UK6
HP 85098A	7-16	30 kHz to 7.5 GHz ²	00M, 00F, 00A, 1BN, 1BP, 0B1, UK6
HP 85099A	Type-F	30 kHz to 3 GHz ²	00M, 00F, 00A, 1BN, 1BP, 0B1, UK6
HP 85060B	7 mm	1 to 18 GHz	001, 1BN, 1BP, 910, UK6
HP 85062B	3.5 mm	1 to 26.5 GHz	001, 00M, 00F, 00A, 01F, 01M, 1BN, 1BP, 910, UK6
HP 85064B	Type-N (50 Ω)	1 to 18 GHz	001, 00M, 00F, 00A, 01F, 01M, 1BN, 1BP, 910, UK6

1. For ECal modules with sexed connectors, the standard modules have one female connector and one male connector.
2. RF ECal modules are specified to operate from 300 kHz, with typical performance down to 30 kHz.

Table 1-5 ECal Module Option Descriptions

Option	Description
001	Adds a 30 kHz to 6 GHz RF ECal module ¹
00M	ECal Module(s) with 2 male connectors
00F	ECal Module(s) with 2 female connectors
00A	Adds male-to-male and female-to-female adapters (also adds 5/16-inch, 90 N-cm (8 in-lb) torque wrench to 3.5 mm kits)
01M ²	Adds a 30 kHz to 6 GHz RF ECal Module with 2 male connectors
01F ²	Adds a 30 kHz to 6 GHz RF ECal Module with 2 female connectors
1BN	MIL-STD 45662A calibration certificate
1BP	MIL-STD 45662A calibration certificate with measurement data
910	Additional set of ECal manuals
0B1	Additional set of ECal manuals
UK6	Commercial calibration certificate with measurement data

1. RF ECal modules are specified to operate from 300 kHz, with typical performance down to 30 kHz.
2. Only available on HP 85062B and HP 85064B.

HP 85097A PC Interface System Characteristics and Requirements

NOTE

This product is designed for use in INSTALLATION CATEGORY II and POLLUTION DEGREE 2, per IEC 1010 and 664 respectively. Enclosure protection according to IEC 529, IP Code 2 0.

Environmental

CAUTION

When installing the product in a cabinet, the convection in and out of the product must not be restricted. The ambient temperature (outside the cabinet) must be less than the maximum operating temperature of the system by 4 °C for every 100 watts dissipated in the cabinet. If the total power dissipated in the cabinet is greater than 800 watts, then forced convection must be used.

CAUTION

Install the instrument according to the enclosure protection provided. This instrument does not protect against the ingress of water. This instrument protects against finger access to hazardous parts within the enclosure.

Table 1-6 Environmental Requirements (indoor use only)

Characteristics	Limits
Altitude:	up to 3000 meters (10,000 feet)
Temperature:	5 °C to 40 °C (41 °F to 104 °F)
Maximum Relative Humidity: decreasing linearly to	80% for temperatures up to 31 °C (88 °F) 50% for temperatures to 40 °C (104 °F)

Electrical

CAUTION The power supply has auto-ranging line voltage input; be sure the supply voltage is within the specified range.

Table 1-7 **Electrical and Mechanical Characteristics**

Characteristics	Limits
Power Requirements:	
Line Voltage	100 to 240 Vac
Line Frequency	50 to 60 Hz
Power Output:	
	24 Vdc 1 A
Power Dissipation:	
	192 VA Maximum
Safety:	
	IEC 950
Weights:	
Net Weight	0.7 kg (1.5 lbs)
Shipping Weight	3 kg (6.5 lbs)
Dimensions:	
Height	41 mm (1.6 in)
Width	158 mm (6.2 in)
Length	97 mm (3.8 in)

Preparation for Use

Installation Checklist

Check the following conditions before plugging your PC interface module into the ac power line:

- ❑ Check the ac power line voltage to verify compatibility requirements (refer to [Table 1-7 on page 1-13](#) for power requirements).
- ❑ Check the label on the bottom of the power supply. Verify that your power supply is for ac voltages from 100 Vac to 240 Vac, at 50 to 60 Hz.

Warranty

Certification

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

Warranty

This Hewlett-Packard product is warranted against defects in materials and workmanship for a period of one year. During the warranty period, Hewlett-Packard Company will, at its option, either repair or replace products that prove to be defective.

Warranty service for products installed by HP and certain other products designated by HP will be performed at Buyer's facility at no charge within HP service travel areas. Outside HP service travel areas, warranty service will be performed at Buyer's facility only upon HP's prior agreement and Buyer shall pay HP's round trip travel expenses. In all other areas, products must be returned to a service facility designated by HP.

For products returned to HP for warranty service, Buyer shall prepay shipping charges to HP and HP shall pay shipping charges to return the product to Buyer. However, Buyer shall pay all shipping charges, duties, and taxes for products returned to HP from another country.

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

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

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Assistance

Product maintenance agreements and other customer assistance agreements are available for Hewlett-Packard products.

For assistance, call the nearest local Hewlett-Packard sales or service office (refer to [“Service and Support”](#) on page 5-4).

Safety and Regulatory Information

Review this product and related documentation to familiarize yourself with safety markings and instructions before you operate the instrument. This product has been designed and tested in accordance with international standards.










WARNING

The WARNING notice denotes a hazard. It calls attention to a procedure, practice, or the like, that, if not correctly performed or adhered to, could result in personal injury. Do not proceed beyond a WARNING notice until the indicated conditions are fully understood and met.

CAUTION

The CAUTION notice denotes a hazard. It calls attention to an operating procedure, practice, or the like, which, if not correctly performed or adhered to, could result in damage to the product or loss of important data. Do not proceed beyond a CAUTION notice until the indicated conditions are fully understood and met.

Instrument Markings

	When you see this symbol on your instrument, you should refer to the instrument's instruction manual for important information.
	This symbol indicates hazardous voltages.
	The laser radiation symbol is marked on products that have a laser output.
	This symbol indicates that the instrument requires alternating current (ac) input.
	The CE mark is a registered trademark of the European Community. If it is accompanied by a year, it indicates the year the design was proven.
	The CSA mark is a registered trademark of the Canadian Standards Association.
ISM1-A	This text indicates that the instrument is an Industrial Scientific and Medical Group 1 Class A product (CISPER 11, Clause 4).
	This symbol indicates that the power line switch is ON.
	This symbol indicates that the power line switch is OFF or in STANDBY position.
 N279	The C-Tick mark is a registered trademark of the Australian Spectrum Management Agency.

WARNING

If this product is not used as specified, the protection provided by the equipment could be impaired. This product must be used in a normal condition (in which all means for protection are intact) only.

Safety Earth Ground



This is a Safety Class I product (provided with a protective earthing terminal). An uninterruptible safety earth ground must be provided from the main power source to the product input wiring terminals, power cord, or supplied power cord set. Whenever it is likely that the protection has been impaired, the product must be made inoperative and secured against any unintended operation.

NOTE

This product has been designed and tested in accordance with IEC Publication 1010, Safety Requirements for Electronic Measuring Apparatus, and has been supplied in a safe condition. The instruction documentation contains information and warnings which must be followed by the user to ensure safe operation and to maintain the product in a safe condition.

Before Applying Power

Verify that the product is configured to match the available main power source as described in the input power configuration instructions in this manual. If this product is to be powered by autotransformer, make sure the common terminal is connected to the neutral (grounded) side of the ac power supply.

WARNING

Install the instrument so that the detachable power cord is readily identifiable and is easily reached by the operator. The detachable power cord is the instrument disconnecting device. It disconnects the mains circuit from the mains supply before other parts of the instrument. The front panel switch is only a standby switch and is not a LINE switch. Alternatively, an externally installed switch or circuit breaker (which is readily identifiable and is easily reached by the operator) may be used as a disconnecting device.

WARNING

This is a Safety Class 1 Product (provided with a protective earthing ground incorporated in the power cord). The mains shall only be inserted in a socket outlet provided with a protective earth contact. Any interruption of the protective conductor inside or outside of the product is likely to make the product dangerous. Intentional interruption is prohibited.

Compliance Notices

Compliance With German Noise Requirements

This is to declare that this instrument is in conformance with the German Regulation on Noise Declaration for Machines (Laermangabe nach der Maschinenlaermrerordnung -3.GSGV Deutschland).

Acoustic Noise Emission/Geraeuschemission

LpA <70 dB Operator position Normal position per ISO 7779	LpA <70 dB am Arbeitsplatz normaler Betrieb nach DIN 45635 t.19
--	--

Compliance With EEC Directives

See the declaration of conformity on the following page.

DECLARATION OF CONFORMITY

According to ISO/IEC Guide 22 and EN 45014

Manufacturer's Name: Hewlett-Packard Co.

Manufacturer's Address: 1400 Fountaingrove Parkway
Santa Rosa, CA 95403-1799

Declares that the product:

Product Name: PC Interface Kit

Model Number: HP 85097A

Product Options: This declaration covers all options of the above products.

Conform to the following Product specifications:

Safety: IEC 61010-1:1990 / EN 61010-1:1993
CAN/CSA-C22.2 No. 1010.1-92

EMC: CISPR 11:1990/EN 55011:1991 Group 1, Class A
IEC 801-2:1984/EN 50082-1:1992 4 kV CD, 8 kV AD
IEC 801-3:1984/EN 50082-1:1992 3 V/m, 27-500 MHz
IEC 801-4:1988/EN 50082-1:1992 0.5 kV sig. lines, 1 kV power lines

Supplementary Information:

The product herewith complies with the requirements of the Low Voltage Directive 73/23/EEC and the EMC Directive 89/336/EEC and carries the CE-marking accordingly.

This product was tested with HP Electronic Calibration Modules and HP Network Analyzers.



Santa Rosa, CA, USA 25 June 1999

Greg Pfeiffer/Quality Engineering Manager

European Contact: Your local Hewlett-Packard Sales and Service Office or Hewlett-Packard GmbH Department HQ-TRE, Herrenberger Strasse 130, D71034 Boblingen, Germany (FAX +49-7031-14-3143)

2 **Operating an ECal System**

General Information

This chapter describes setting up and operating your ECal system. The information includes connecting the equipment, installing the software and using the ECal system to calibrate an HP vector network analyzer (VNA). This chapter also illustrates and explains the features and functions of the ECal system. Instructions for setting up the PC and using the PC software are also located in this chapter.

Theory of Operation

The ECal system determines systematic errors of a VNA through a single connection of the ECal module to the VNA test ports.

ECal modules are solid state, two-port devices that are capable of calibrating your VNA for a variety of calibration routines. The calibration routines generate error correction data that are stored within the VNA. The data is then used to compute actual device response by eliminating systematic error contributions.

Compatible Vector Network Analyzers

The ECal system is designed to work with a variety of HP vector network analyzers. Compatible models are listed in [Table 1-1 on page 1-6](#).

Electrostatic Discharge (ESD)

Protecting from ESD Damage

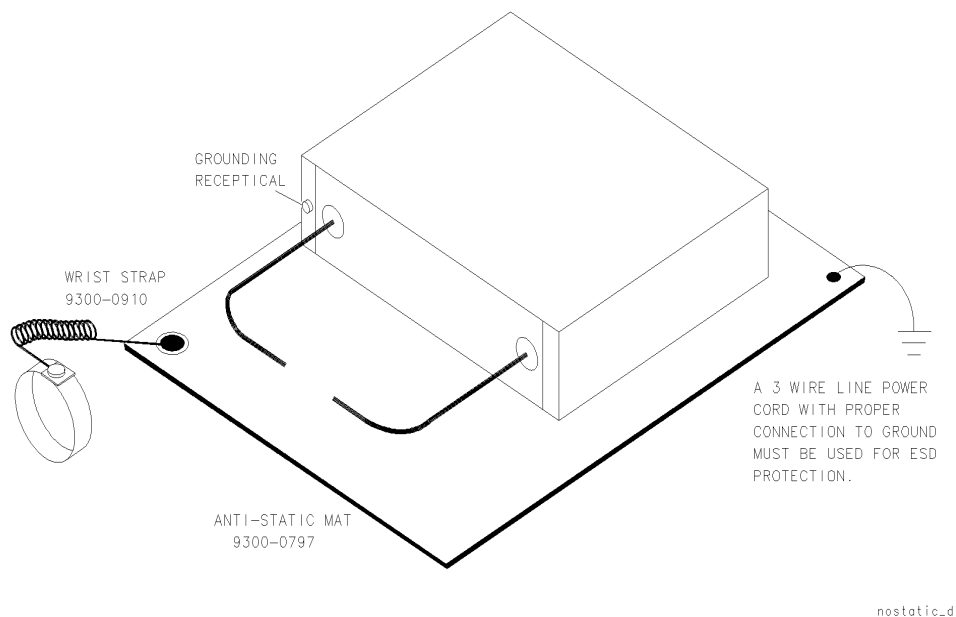
Protection against electrostatic discharge (ESD) is essential while cleaning, inspecting, or making any connections around static sensitive circuits (such as those found in VNA port connectors and ECal modules).

CAUTION

Always use an antistatic wrist strap when calibrating or verifying VNA performance, or when using the VNA to measure devices. Unless ESD precautions are taken, never touch test port connectors, ECal module center conductors, or the parallel port on the ECal module.

Figure 2-1 shows the configuration for proper ESD precautions using a grounded mat, wrist strap, and grounded power cord.

Figure 2-1 ESD Protection Using Mat, Wrist Strap and Grounded Power Cord



Static electricity builds up on the body, and can easily damage sensitive circuits when discharged by contact with the center conductor of a connector. Static discharges too small to be sensed can cause permanent damage to devices. Devices such as calibration and verification components and devices-under-test (DUTs) can also carry electrostatic discharge potential.

ESD Guidelines

Use the following guidelines before connecting devices, modules, or test ports.

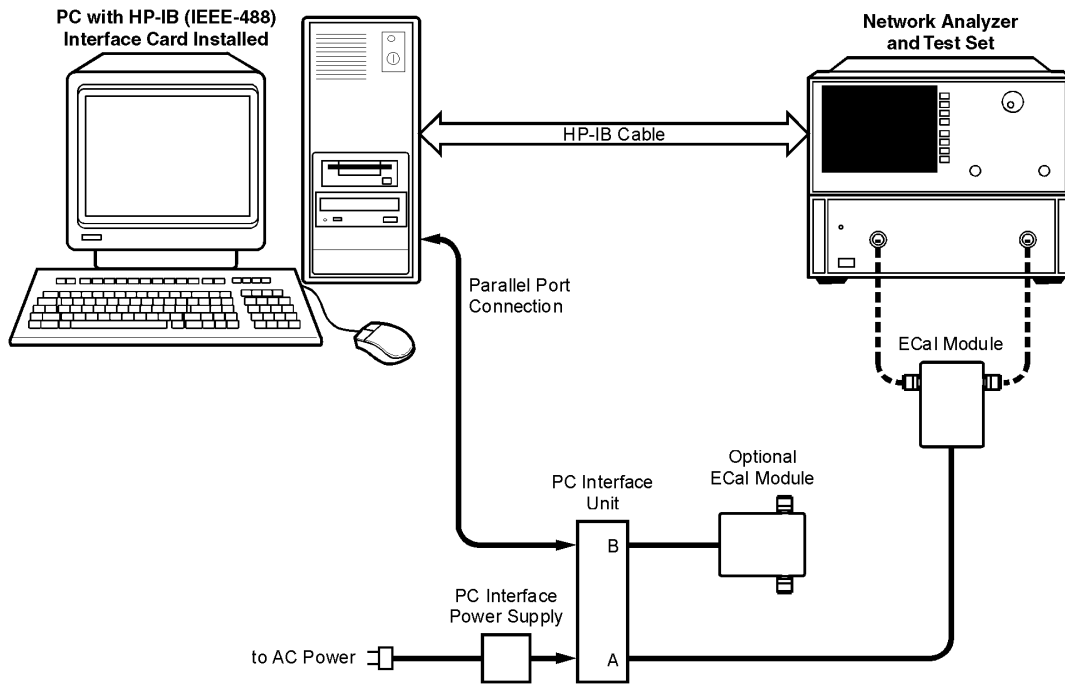
- Always have a grounded antistatic mat in front of your test equipment and wear a grounded wrist strap attached to it (see [Figure 2-1](#)).
- Ground yourself before you clean, inspect, or make a connection to a static-sensitive device or test port. You can, for example, grasp the grounded outer shell of the VNA port connector briefly to discharge static from your body.
- Discharge static electricity from a device before connecting it: touch the device briefly (through a resistor of at least 1 M Ω) to either the outer shell of the test port, or to another exposed ground. This discharges static electricity and protects test equipment circuitry.

Refer to the *Electronic Calibration Module Reference Guide* (HP part number 85091-90008) for the HP part numbers of ESD supplies.

Setting Up an ECal System

Figure 2-2 shows the set up for a VNA with the PC interface unit, and an ECal module.

Figure 2-2 System Diagram Using PC Interface Unit



Connecting and Disconnecting Modules

Unused calibration modules or modules that have been used to complete a calibration process may remain connected to the PC interface unit and will remain warmed up when required for another calibration. To learn about correctly connecting and disconnecting calibration modules to the VNA, refer to the *Electronic Calibration Module Reference Guide* (HP part number 85091-90008).

NOTE

Since the PC interface unit is capable of controlling the power supplied to a module, the module may be connected/disconnected while power is supplied to the PC interface unit. This does not apply to the older HP 85060C control unit.

Installing and Using the Software

To use the PC-based ECal system, a PC with an installed IEEE-488 board is required. Ensure that the IEEE interface has been installed and tested as per the manufacturer's documentation, before loading the PC-based ECal software.

PC Requirements

Verify that your PC meets the following minimum requirements:

- A PC with a 486 or higher processor.
- Microsoft Windows 95[®] or Windows 98[®] operating system or later, or Microsoft Windows NT[®] Workstation operating system 4.0 or later.
- 16 MB of memory for use on Windows 95 and Windows 98, or 32 MB for use on Windows NT.
- 10 MB of unused hard-disk space.
- A compatible mouse or other pointing device.
- An available parallel port.

HP-IB Card and Software

- Check that the interface card and software have been installed in the PC and are operational. Refer to your HP-IB (IEEE-488) documentation for installation instructions.
- Use any of the following interface cards:
 - HP 82340A/B
 - HP 82341C/D (recommended interface)
 - National Instruments AT-GPIB/TNT
 - National Instruments AT-GPIB/TNT (Plug and Play)
 - National Instruments PCI-GPIB

Installation and System Setup

ECal Software Installation

1. Turn on the PC and wait until the Windows environment presents itself on the screen.
2. Insert the PC interface software disk into the PC disk drive.
3. Start the installation by selecting **Start** and then **Run**. When the Run window appears, enter `a:\setup.exe`. Make sure that the path gives the correct drive letter of the inserted installation disk.
4. Follow the instructions on the screen to finish the installation.

CAUTION

Always use an anti-static wrist strap when calibrating or verifying the VNA or when using the VNA to measure devices. Unless ESD precautions have been taken, never touch the test port or ECal module center conductors or the exposed pins of the connecting cables.

System Setup

1. Connect the system according to [Figure 2-2 on page 2-5](#). Refer to your vector network analyzer (VNA) manual for the VNA setup.
2. First, turn on the system components and test equipment, *then* turn on the PC.
3. Allow the ECal modules to warm up for at least 10 minutes before doing a calibration. This allows maximum accuracy.

Starting the ECal Software

ECal Turn-on Procedure

1. On the VNA, enter the desired settings (i.e. frequency range, number of points, sweep mode, etc.) *before starting the software*.

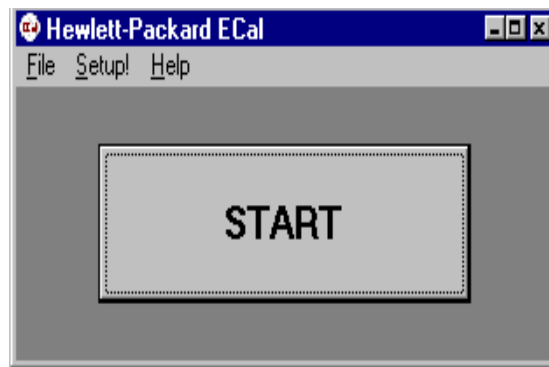
CAUTION

Do not change any VNA settings or press any VNA front-panel keys during an ECal calibration procedure. Since the PC software returns the VNA to its original settings after performing a calibration, all VNA settings must be made prior to starting a calibration. *Any setting changes made after starting the software will be lost.*

2. From the Windows environment, select the following keys to start the ECal program.
 - a. Select **Start** (located in the lower left-hand corner of the display).
 - b. Select **Programs**.
 - c. Locate the ECal program name and select it.
 - d. Wait for the ECal program main window to open. See [Figure 2-3](#).
3. Select **Setup!** in the ECal menu bar to open the setup dialog box. See [Figure 2-4](#).
4. Enter the system configuration settings, then select **OK**.

Figure 2-3

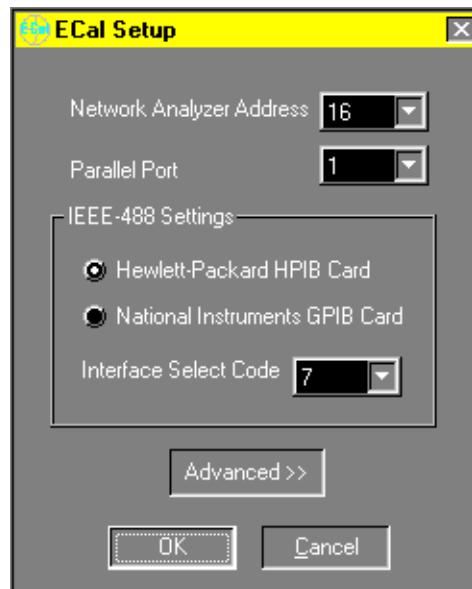
ECal Software Interface Main Window on PC Display



ECal PC Graphical User Interface (GUI)

The following figures show you the dialog boxes that you will see on your PC after the ECal software has been installed.

Figure 2-4 **The ECal Setup Dialog Box**



Calibration Procedure

1. Enter the configuration settings into the dialog box to match the hardware settings.

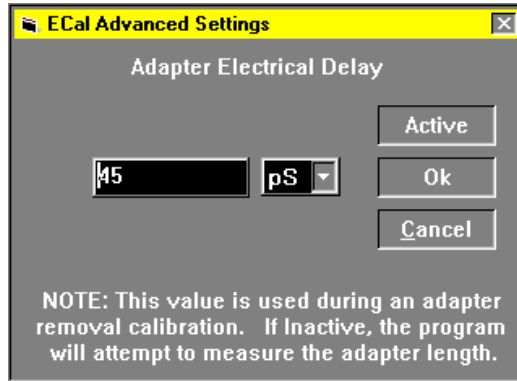
NOTE

The button labeled **Advanced** (shown in [Figure 2-4](#)), is used for entering the adapter delay settings. It is only used when performing an adapter removal calibration. Review the information in the “[Adapter Calibrations](#)” on page 2-25.

If you are performing an adapter removal calibration for a VNA span of less than 150 MHz, select **Advanced** to open the ECal advanced settings dialog box. See [Figure 2-5 on page 2-11](#).

- Enter and activate the **Adapter Electrical Delay** from the ECal Advanced Settings dialog box.
- Enter the adapter electrical delay data then select **Active** and **OK**.

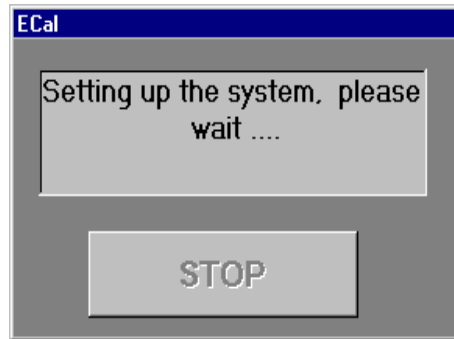
Figure 2-5 The Adapter Electrical Delay Dialog Box



2. Select the **Start** button in the ECal main window to begin the calibration process.

Figure 2-6 ECal Dialog Box During System Setup

After entering the configuration information, wait for the ECal software to configure the system.

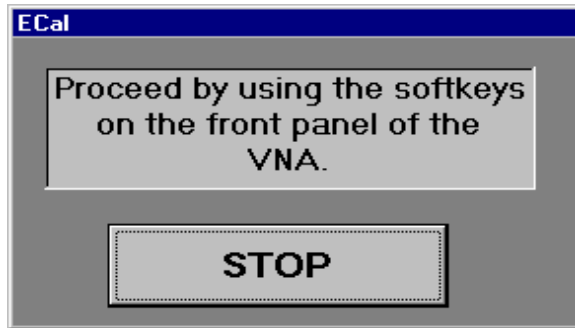


3. Complete the calibration process using the softkey menus displayed on the VNA. See [Figure 2-8](#) for VNA menu

NOTE

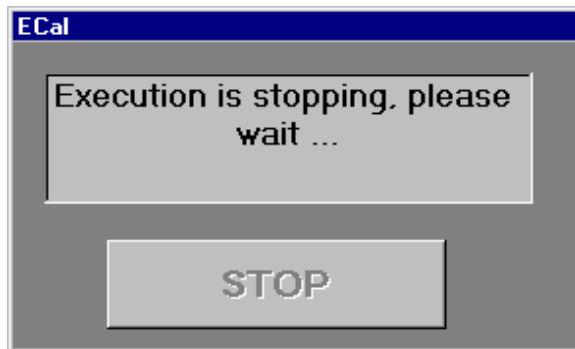
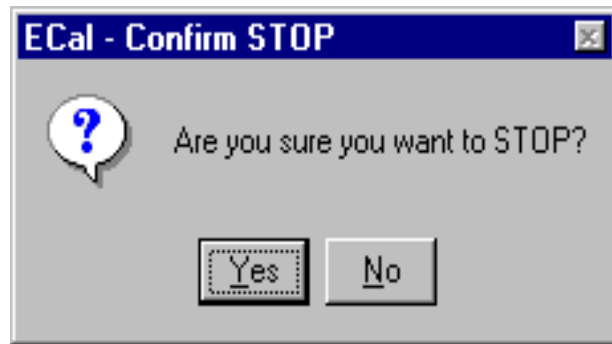
To release the ECal software's control of the VNA, press any HP 87XX front-panel key. For an HP 8510X, press any of its main menu keys.

Figure 2-7 ECal Menus During the Calibration Routine



Use the network analyzer softkeys to select the calibration type you need, and to complete your calibration procedures.

If you really want to stop, select Yes from this screen. Otherwise, select No and continue with the calibration.

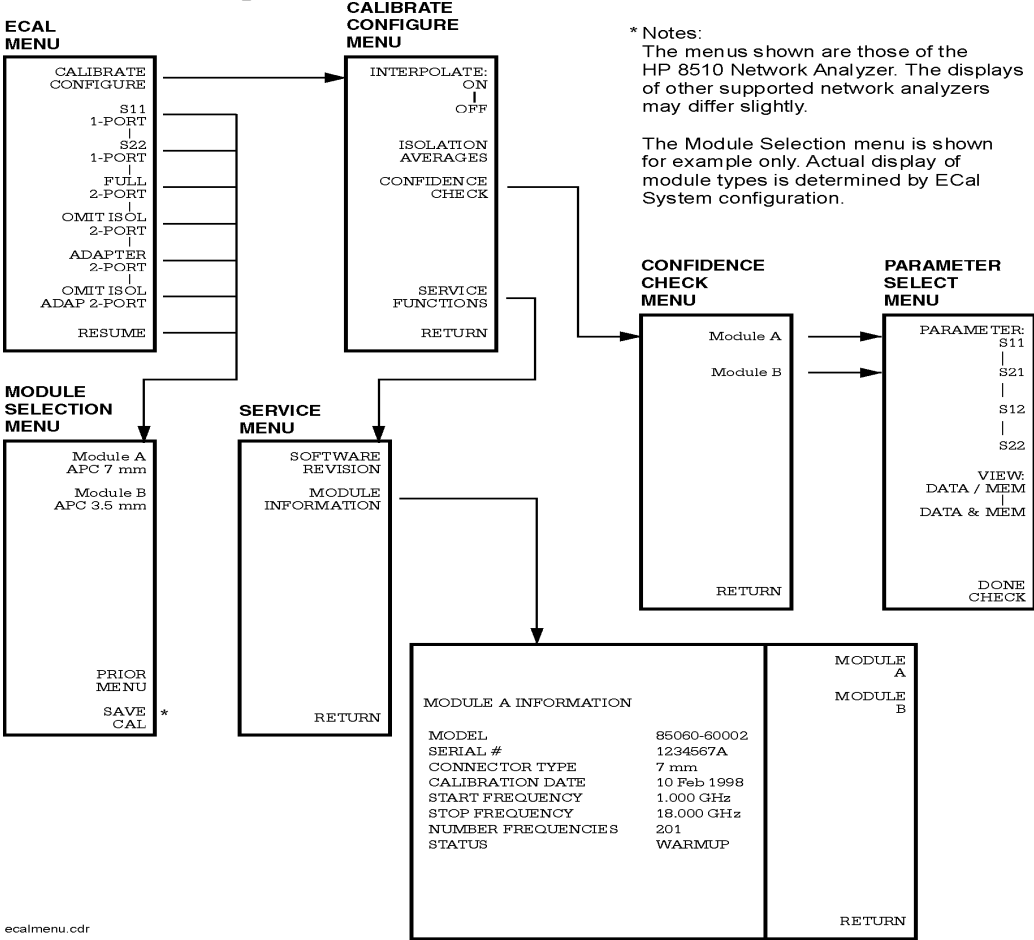


At the completion of the stop process, you will see the ECal main window reappear.

Calibration Menus on VNAs

This section explains the calibration menus and their structure as they appear on the vector network analyzer display. Calibrations are performed using the VNA configuration settings (such as averages), with the exception of isolation calibrations. Isolation calibrations use the number of averages set in the ECal configuration menu.

Figure 2-8 Example Calibration Menu from an HP 8510 VNA



VNA Main Menu Keys

After selecting the **Start** button of the ECal software, the following menu keys appear on the network analyzer display.

Calibrate Configure Menu

This key accesses the menu for selecting the calibration configuration you want.

1. Configure the calibration using the following softkeys.

- **INTERPOLATE: ON/OFF**
- **ISOLATION AVERAGES**
- **CONFIDENCE CHECK**
- **SERVICE FUNCTIONS**
- **RETURN**

INTERPOLATE < ON | OFF >

Select **INTERPOLATE < ON | OFF >** to enable or disable the frequency interpolation capability of the ECal system.

- With interpolation on, you can measure any frequency within the span of the characterized modules.
- With interpolation off, only frequencies that correspond to characterization frequencies of the modules are allowed.

ISOLATION AVERAGES

Select **ISOLATION AVERAGES** and set the desired number of averages on the VNA keypad. Values from 1 to 4096 are valid for the HP 8510 VNA. Values from 1 to 999 are valid for the HP 87xx VNA series.

NOTE

The speed of the calibration is determined by the number of isolation averages.

For all VNA calibration measurements (other than isolation), you perform measurements with the averaging value specified in the VNA setup. You may want to increase the number of averages significantly for isolation measurements.

2. Once completed, select **RETURN** to return to the ECal menu.

ECal Menu

3. Select one of the calibration types defined in the following paragraphs.

S11 1-PORT

NOTE

This is the *only* calibration selection that is valid for the following analyzers: HP 8719ET, HP 8720ET, HP 8722ET, and HP 8753ET. These analyzers only make transmission and reflection measurements; selecting “S11 PORT” is equivalent to selecting “Reflection 1-Port” on these analyzers.

This calibration achieves high accuracy reflection measurements for one-port devices using Port 1 of the test set. This calibration determines directivity, source match, and reflection tracking error terms. The VNA uses these terms in the vector error correction of reflection measurements.

S22 1-PORT

This calibration is the same as S11 1-port calibration, except it uses Port 2 of the test set.

FULL 2-PORT

This calibration achieves high accuracy magnitude and phase measurements (including isolation) of insertable two-port devices. A full 2-port calibration requires measurement of all four S-parameters and needs more time to complete than a one-port calibration. This 12-term calibration provides correction for these types of errors:

- directivity
- isolation/crosstalk
- source match
- load match
- transmission tracking
- reflection tracking

OMIT ISOL 2-PORT

This calibration provides all of the functionality of the full 2-port calibration, except the isolation measurements are not made. This calibration is faster than the full 2-port calibration.

ADAPTER 2-PORT

This calibration achieves high accuracy magnitude and phase measurements (including isolation) of non-insertable two-port configurations. This calibration is similar to the full 2-port calibration. The difference is in the optional metrology-grade adapters used to provide a full 2-port calibration for devices with same-sex connectors.

This calibration removes the effects of the adapter and is referred to as an adapter removal calibration. This 12-term calibration provides correction for these types of errors:

- directivity
- isolation/crosstalk
- source match
- load match
- transmission tracking
- reflection tracking

When you perform adapter-removal calibrations, there are two possible mathematical solutions (due to the square-root operation in the equation). The adapter electrical delay is used to choose between the two solutions.

NOTE

The ECal software cannot measure the adapter electrical delay if the frequency spacing between any two adjacent points is less than 50 MHz and/or there are less than 4 points selected within a span of 150 MHz.

If the conditions in the above note are not met, then you can enter the delay via the ECal software, Advanced menu. The value you enter is used to choose the correct solution.

NOTE

Check the delay entered via the PC software prior to any adapter removal calibration to avoid unexpected results. This value does not affect other calibration methods. See [Figure 2-5 on page 2-11](#) for an illustration of the adapter-delay dialog box.

OMIT ISOL ADAP 2-PORT

This calibration provides all of the functionality of the adapter 2-port calibration, except the isolation measurements are not made. This calibration is faster than the adapter 2-port calibration method.

Module Selection Menu

The “Module Selection” menu appears after choosing the calibration type from the ECAL menu.

4. Select the ECal module according to connector type and the frequency range of the DUT.
5. Select **Module A** or **Module B** (if present) to select that module.

NOTE

Module selection begins the calibration process. If the menu shows that neither module is connected, check the ECal module and power connections at the PC interface unit. Also, check the cables from the PC to the PC Interface Unit, as well as the module.

6. Select **PRIOR MENU** to return to the ECal menu if you need to use a second module to complete your calibration.
7. When the calibration is complete, select **SAVE CAL** to save the calibration information in VNA memory.

Confidence Check Menu

NOTE

You must calibrate the VNA prior to a confidence check. Also, the calibration type should be appropriate for the parameter being checked. For example, S_{22} cannot be checked if an S_{11} 1-port cal is active.

The “Confidence Check” menu opens after selecting **CONFIDENCE CHECK** from the “Calibrate Configure” menu.

The confidence check provides a comparison of current ECal module measurements versus the factory characterization measurements. The VNA displays the compared results.

Confidence Check

1. Select a module type to open the “Confidence Check” selection menu for that module.
2. Select **S11**, **S21**, **S12**, or **S22** to select the parameter and start the check.
3. Select a view option from **DATA/MEM** or **DATA&MEM**.
 - **DATA** displays the current ECal module measurement results.
 - **MEM** contains factory characterization measurements.
 - **DATA/MEM** shows the ratio of the pre-measured data to the

currently acquired data.

- **DATA&MEM** shows both the pre-measured and current data for on-screen visual comparison.
4. Select **DONE CHECK** to return to the “Confidence Check” menu.
 5. Select **RETURN** to return to the “Calibrate Configure” menu.
 6. Select **RETURN** to return to the main ECal menu.

Service Menu

The “Service” menu opens after selecting **SERVICE FUNCTIONS** in the “Calibrate Configure” menu.

1. Press **SOFTWARE REVISION** to see revision information on the ECal software.
2. Press **MODULE INFORMATION** to see information on any connected calibration modules.
3. Press **RETURN** to return to the “Calibrate Configure” menu.

Calibrations

The calibration type and procedure you use depends upon the kind of measurement desired for the device-under-test (DUT) and the accuracy needed for the measurement. Both the connection methodology and the VNA used have a direct effect on these factors.

For information about gaging and making connections with ECal modules, refer to the *Electronic Calibration Module Reference Guide* (HP part number 85091-90008).

For information about specific VNAs, refer to the appropriate VNA user's guide.

Calibration Constants

It is not necessary to load calibration constants into the VNA. Each electronic calibration module stores its own calibration data, which is traceable to NIST (National Institute of Standards and Technology).

Changing the Calibration Data

The calibration data stored in each ECal module is unique to that module, and can only be changed when the module is recertified or repaired. This recertification or repair can only be performed at a Hewlett-Packard authorized service center. Refer to “[Service and Support](#)” on page 5-4 in this manual.

Setting Calibration Parameters

Calibration parameters define specific calibration settings, or provide the user with information about the ECal setup. Select **CALIBRATION CONFIGURE** in the top level ECal menu displayed on the VNA to access the “Configuration” menu ([Figure 2-8 on page 2-13](#)).

NOTE

Valid calibration data can only be guaranteed when ECal modules have been properly warmed up. Allow modules at least 10 minutes to completely warm up.

Calibrations are performed using the VNA configuration settings (such as number of averages). There is an exception for isolation calibrations that are performed using the number of averages set in the ECal “Configuration” menu.

Ramp-Sweep With an HP 8510B/C

When using HP 8510 series VNAs, calibrations cannot be performed in the ramp-sweep mode. If ramp sweep *is* required during measurements, calibrate the system in step mode, then perform measurements in ramp sweep mode. When switching from step to ramp-sweep mode, the following message will be displayed.

CAUTION: CORRECTION MAY BE INVALID

To determine whether the mode change invalidates the calibration, compare the DUT response in step versus its response in ramp mode. In general, ramp-sweep is only recommended for tuning purposes; for accurate device measurements, use step-sweep mode.

Calibrating Across Overlapping Frequency Ranges

Calibration kits may contain two modules (an RF module and a microwave module) that overlap in frequency coverage. For example, the HP 85060B Option 001 contains an RF (30 kHz to 6 GHz) module and a microwave (1 to 18 GHz) module. In the overlapping frequency range, the module specifications may vary.

NOTE

To perform broadband calibrations across overlapping frequency ranges, the ECal system uses the data gathered from the *last* module connected during the calibration sequence to apply to the overlapped range.

For the best performance, select the module which has specifications that best meet the frequency range requirements of the calibration to be performed and connect this module last. See the *Electronic Calibration Module Reference Guide* (HP part number 85091-90008) for the RF and microwave module's electrical specifications.

Performing ECal Calibrations

Determine which calibration type you need to perform. Locate the information about that type of calibration on the following pages, then proceed with the required steps.

NOTE

The ECal system starts the calibration process. Upon completion, the selected module is underlined in the VNA menu. The VNA will give you the message to `Connect Std.` If one module covers the frequency range setting of the VNA, disregard this message as you have completed this part of the process and may proceed to save the calibration.

Required Procedure for All Calibrations

For any calibration type, complete the following steps before starting the calibration procedure.

Use Port A on the ECal module

For each calibration procedure, unless otherwise specified, use Port A on the calibration module for all 1-port calibrations. Although module Ports A and B are interchangeable for single port measurements, the preferred port is Port A.

Enter all VNA settings

1. Set up the VNA as required.

Refer to the appropriate VNA user's guide for more information.

Choose the ECal module

2. Select the appropriate ECal module(s) for frequency range and connector type.

Refer to [Table 1-4 on page 1-10](#) for a listing of module types.

Attach the ECal module

3. Connect the ECal module(s) to the PC interface and allow the module(s) to warm up for at least 10 minutes.

NOTE

Sweep-mode calibrations are possible on the HP 8720 series VNAs. However, the calibration will be degraded relative to step-mode calibration.

CAUTION RF ECal modules can be damaged if you apply excessive torque to the RF connectors. Do *not* exceed the recommended torque indicated in the *Electronic Calibration Module Reference Guide* (HP part number 85091-90008) when making connections.

CAUTION Do not perform the following procedure unless you have cleaned and visually inspected the connectors and have taken the necessary ESD precautions.

Performing an S11 1-PORT Calibration

1. Complete the steps in “[Required Procedure for All Calibrations](#)” on [page 2-22](#).
2. Connect Port A on the calibration module to Port 1 of the VNA.
3. Tighten the test-port connector to the ECal connector with the torque wrench provided in the module kit.

NOTE The type-F and type-N 75 Ω connector module kits do not include a torque wrench. To order a torque wrench, contact the nearest HP sales or service office. A 12 mm 170 N-cm (15 in-lb) torque wrench can be used with type-F modules.

4. Start the ECal software on the PC, then select **Start**.
5. Select **S11 1-PORT** from the network analyzer’s top level menu to access the “Module Selection” menu (see the menu structure in [Figure 2-8 on page 2-13](#)).
6. Select the module type from the list. Select the appropriate softkey corresponding to the desired module.
7. Repeat the above steps as necessary using all modules required to cover the desired frequency range.

Save the calibration data

1. Select **SAVE S11 1-PORT** in the network analyzer menu.
2. Select a storage register or Cal Set from the VNA “Save Register” menu (depending on the VNA model you are using).
3. Select **SAVE STATE** or **CAL SET #**.

The calibration is complete and the calibration data is saved in the storage register selected.

4. Verify the calibration accuracy with a confidence check. Refer to [“Performing the Confidence Check” on page 2-31](#).

Performing an S22 1-PORT Calibration

1. Complete the steps in [“Required Procedure for All Calibrations” on page 2-22](#).
2. Connect Port A on the calibration module to Port 2 of the VNA.
3. Tighten the test port connector to the ECal connector with the torque wrench provided in the module kit.

NOTE

The type-F and type-N 75 Ω connector module kits do not include a torque wrench. To order a torque wrench, contact the nearest HP sales or service office. A 12 mm 170 N-cm (15 in-lb) torque wrench can be used with type-F modules.

4. Start the ECal software on the PC, then select **Start**.
5. Select **S22 1-PORT** from the top level network analyzer menu to access the “Module Selection” menu (see [Figure 2-8 on page 2-13](#)).
6. Select the module type from the list. Press the appropriate softkey corresponding to the desired module.
7. The calibration is complete and the calibration data is saved in the storage register selected.
8. Repeat the above steps as necessary using all modules required to cover the desired frequency range.

Save the calibration data

1. Select **SAVE S22 1-PORT** in the network analyzer menu.
2. Select a storage register or Cal Set from the VNA “Save Register” menu (depending on the VNA model you are using).
3. Select **SAVE STATE** or **CAL SET #**.

The calibration is complete and the calibration data is saved in the storage register selected.

4. Verify the calibration accuracy with a confidence check. Refer to [“Performing the Confidence Check” on page 2-31](#).

Adapter Calibrations

Adapter 2-Port Calibrations

When using multiple modules for adapter calibrations, you must measure all ECal modules for each step before using the adapters.

NOTE

Adapter 2-Port Calibrations are only for use with Option 00A.

If the VNA is set such that the frequency spacing between any two measurement points is less than 50 MHz or if less than four measurement points are selected, make certain an adapter-delay value has been entered and is activated in the ECal software menu. To avoid unexpected results, check the adapter-delay value before beginning the adapter-removal calibration. Select the ECal “Advanced” menu to display the “Adapter Delay” dialog box.

Insertable Devices

Insertable devices are those with mating connectors of the same type (type-N or 3.5 mm, for example) but are opposite in gender (male or female). An example of an insertable device is one having a 3.5 mm male input-connector and a 3.5-mm female output-connector.

Noninsertable Devices

Noninsertable devices are those with mating connectors of the same type and gender. An example of a noninsertable device is one having a 3.5-mm male input-connector and a 3.5-mm male output-connector.

Performing Adapter 2-Port Calibrations

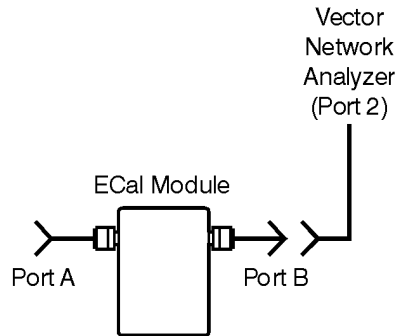
1. Complete the steps in [“Required Procedure for All Calibrations”](#) on [page 2-22](#).
2. Connect the ECal module directly to Port 2 of the VNA. This will require using either Port A or Port B of the ECal module.
Do not connect the adapter yet. See [Figure 2-9](#).
3. Start the ECal software on the PC, then click **Start**.
4. Select **ADAPTER 2-PORT** from the top level network analyzer menu to access the “Module Selection” menu (see [Figure 2-8](#)).
5. Select the appropriate module key for the module type connected.

The ECal system begins the calibration process. Upon calibration completion, the selected module and calibration appear underlined

in the VNA menu.

6. Repeat as necessary using all modules required to cover the desired frequency range.
7. Press **NEXT MENU** to continue.

Figure 2-9 Adapter Removal Calibration, Step 1



1. Connect module directly to the port of the vector network analyzer, that will eventually have the adapter connected to it.

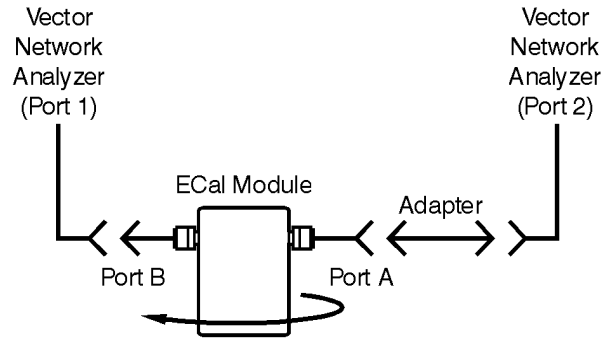
Connect the adapter

1. Connect the adapter to Port 2 on the VNA.
2. Connect the module between Port 1 of the VNA and the adapter attached to Port 2. See Step 2 in [Figure 2-10](#).
3. Select the appropriate softkey for the module type connected. At completion, the selected module and calibration appear underlined in the VNA menu.
4. Repeat as necessary using all modules required to cover the desired frequency range.

When you have completed the connection procedure, save the calibration data (refer to [“Save the calibration data”](#) on page 2-27).

Figure 2-10

Adapter Removal Calibration, Step 2



2. Turn module over, add adapter to end of module *not* connected to port in step one, then re-connect to vector network analyzer.

noninsrt

Save the calibration data

1. Press **SAVE ADAPTER 2-PORT** in the network analyzer menu.
2. Select a storage register or Cal Set from the VNA “Save Register” menu (depending on the type of VNA you are using).
3. Select **SAVE STATE** or **CAL SET #**.

The calibration is complete and the calibration data is saved in the storage register selected.

4. Verify the calibration accuracy with a confidence check. Refer to [“Performing the Confidence Check”](#) on page 2-31.

Performing an OMIT ISOL ADP 2-PORT Calibration

1. Connect the module to Port 2 of the VNA (see [Figure 2-9 on page 2-26](#)).

NOTE

If the VNA is set such that the frequency spacing between any two measurement points is less than 50 MHz or if less than four measurement points are selected, make certain an adapter-delay value has been entered and is activated in the ECal software menu. To avoid unexpected results, check the adapter-delay value before beginning the adapter-removal calibration. Select the ECal “Advanced” menu to display the “Adapter Delay” dialog box.

2. Start the ECal software on the PC, then select **Start**.
3. Select **OMIT ISOL ADP 2-PORT** from the top level network analyzer menu to access the “Module Selection” menu (see [Figure 2-8 on page 2-13](#)).
4. Select the appropriate software key for the module type connected.
The Ecal system begins the calibration process. Upon calibration completion, the selected module and calibration appear underlined in the VNA menu.
5. Repeat as necessary using all modules required to cover the desired frequency range.
6. Select **Next Menu** to continue.

Connect the adapter

1. Connect the adapter to Port 2 of the VNA (see [Figure 2-10 on page 2-27](#)).
2. Connect the module between Port 1 of the VNA and the adapter.
3. Press the appropriate software key for the module type connected.
The Ecal system begins the calibration process. Upon calibration completion, the selected module and calibration appear underlined in the VNA menu.
4. Repeat as necessary using all modules required to cover the desired frequency range.

When you have completed the connection procedure, save the calibration data (refer to [“Save the calibration data” on page 2-29](#)).

Save the calibration data

1. Press **SAVE OMIT ISOL ADP 2-PORT** in the network analyzer menu.
2. Select a storage register or Cal Set from the VNA “Save Register” menu (depending on the type of VNA you are using).
3. Press **SAVE STATE** or **CAL SET#**.

The calibration is complete and the calibration data is saved in the storage register selected.

4. Verify the calibration accuracy with a confidence check. Refer to [“Performing the Confidence Check” on page 2-31](#).

Calibration-Data Confidence Checking

The confidence check is a means of visually inspecting and comparing two traces of measured responses.

- One trace is the data from premeasured calibration information stored in the module's nonvolatile memory.
- The other trace is from the results generated by an actual calibration procedure.

The confidence check can be used after a one-port calibration, as long as the unused ECal module port is terminated with 75 Ω (for type-F or type-N 75 Ω) or 50 Ω (for all other connectors) and return loss is no more than -30 dB.

When the confidence check is selected for the PC-based system, the ECal software does the following:

- Reads the premeasured corrected data.
- Stores the data in the VNA memory.
- Select the confidence state for the module and compare its measured performance with the data in the memory of the VNA.

The trace display depends on the type of calibration being checked.

- If the confidence check is used for a two-port calibration, all four S-parameters are available.
- If the confidence check is used for a one-port calibration, reflection traces S_{11} or S_{22} are available, depending on the calibration type.

The data may be displayed in one of two ways:

- Select **Memory & Data** to view the premeasured data with respect to the currently measured data.
- Select **Data/Mem** to view a ratio only, of the premeasured data to the currently measured data.

The confidence check changes many VNA parameters in preparation for data presentation. Choose **DONE CHECK** to complete the procedure and restore previous VNA parameters (with the exception of the data in memory before the confidence check was invoked).

NOTE

To release the ECal software's control of the VNA, press any HP 87XX front-panel key. For an HP 8510X, press any of its main menu keys.

Performing the Confidence Check

The following steps should be performed after completing a calibration.

CAUTION

Before you perform this procedure, follow the necessary ESD precautions, and clean and visually inspect the connectors. Refer to [“Electrostatic Discharge \(ESD\)” on page 2-3](#) for more information.

CAUTION

RF ECal modules can be damaged if you apply excessive torque to the connectors. Do *not* exceed the recommended torque indicated in the *Electronic Calibration Module Reference Guide* (HP part number 85091-90008).

1. Connect the appropriate calibration module(s) to the VNA test port.
2. Start the ECal software on the PC, then select **Start**.
3. Select **CALIBRATE CONFIGURE** from the softkeys on the network analyzer to access the “Calibrate Configure” menu (see [Figure 2-8 on page 2-13](#)).
4. Select **CONFIDENCE CHECK**.
5. Select the module type and wait until the “Parameter Select” menu appears.
6. Select a parameter and/or a **VIEW** data option from the “Parameter Select” menu.

A series of events begin, which include downloading the corrected premeasured parameter data and the measurement of the confidence state. The data is presented in the parameter or view method selected.

7. If another parameter or display option is desired, repeat [step 6](#); otherwise, continue to [step 8](#).
8. When finished, select **DONE CHECK** to complete the confidence check.

Selecting **DONE CHECK** resets the VNA to the conditions in effect before the confidence check was invoked. If **DONE CHECK** is not selected, noncritical scales, parameters and display options may remain active.

NOTE

To release the ECal software’s control, press any HP 87XX front-panel key. For an HP 8510X, press any of its main menu keys.

3 Software Programming Interface

General Information

NOTE

This chapter assumes that the reader has some programming experience.

The ECal software programming interface (SPI) is programmer's tool for adding automated VNA calibration capability within an application. The SPI is a self-registering, OLE 2.0 compliant, in-process DLL server. It can be accessed by any programming language or environment that supports OLE.

By using the SPI, the application can direct a calibration in one of two ways:

1. The SPI initiates the calibration and displays ECal menus on the VNA for the users to complete the calibration. Users can select the type of calibration and module to use. The application that is delivered with this system, `ECal.exe`, uses the SPI in this manner.
2. The SPI initiates the calibration and programmatically controls each step of the calibration. The application selects the type of calibration and module to use. In this case, menus are not displayed on the front panel of the VNA, and there is no user interaction with the analyzer.

OLE Interface File (ECalSPI.dll)

The SPI (called `ECalSPI.dll`) is stored in a Windows directory during installation of the ECal software. There are no user interface components in the SPI; custom applications must provide the user interface. The intent of the ECal SPI is to allow calibration of the VNA using the ECal system from within other software applications. You need to know how to program using OLE objects to use the ECal SPI.

DLL Interface File (StdSPI.dll)

There is a second interface to the SPI implemented in the file `StdSPI.dll`. This DLL exports all of the SPI functions through more traditional C-style function calls. All aspects of SPI programming documented here apply to both `StdSPI.dll` and the OLE implementation `ECalSPI.dll` except for the actual function "NAME" and "PARAMETERS TYPES". Refer to "[Standard SPI \(StdSpi.dll\)](#)" on [page 3-15](#).

ECal SPI Functions

The functions within the ECal SPI control and measure ECal modules that are attached to the system. The VNA stores measurement data in the form of error terms.

The functions within the SPI do not set up VNA parameters such as frequency range, number of points, sweep type, etc. VNA parameters must be set either by a custom application, or manually through the front panel of the VNA prior to initiating a calibration. Once the SPI has started a calibration, no other application should try to send commands to the VNA or any other instruments on the HP-IB bus.

ECal SPI Format

Each ECal command description (provided in [“ECal SPI Function Reference” on page 3-18](#)) follows a standard format which includes the purpose of the command, the command format for each supported development environment, input and output parameters, and a description of the input and output parameters.

The C++ command formats a pass string using the pointer-basic-string (BSTR), which is not available in some development environments. BSTRs are part of the component object model (COM). They pass binary data between COM objects.

BSTRs are wide, double-byte (Unicode) strings on 32-bit Windows platforms. A BSTR is a pointer to a set of null-terminated Unicode characters. The number of characters is stored in the DWORD preceding the characters in memory, and the set of characters may contain embedded nulls.

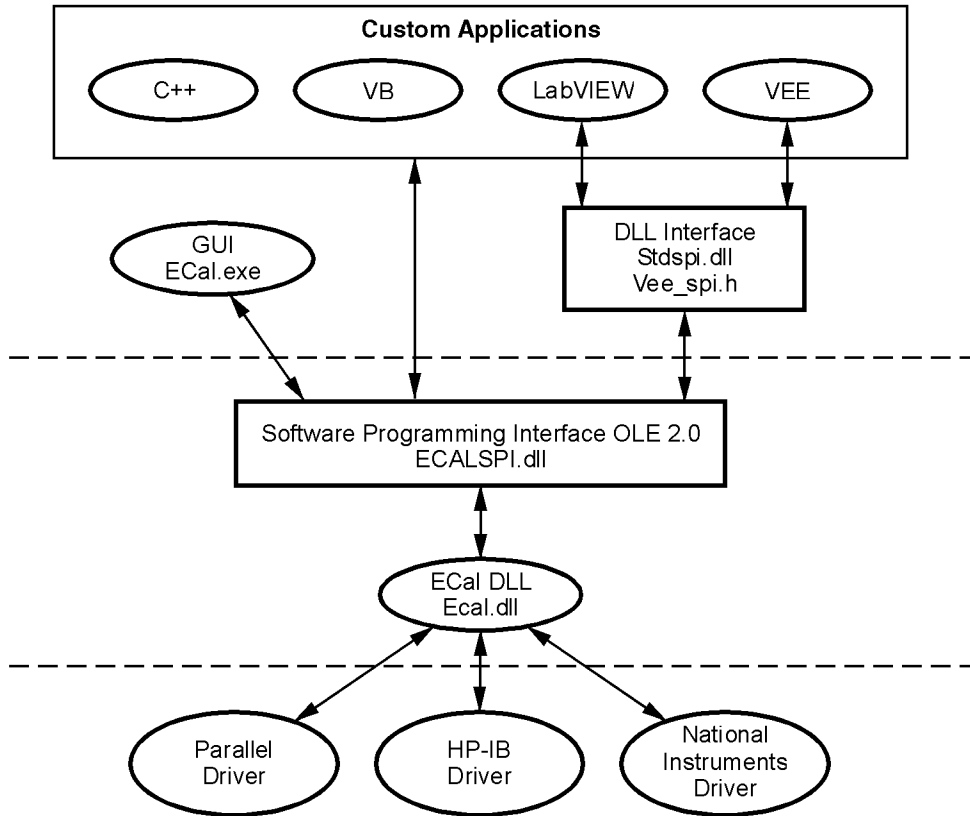
If BSTR is not available in your C++ environment, use an appropriate substitute.

In the standard SPI `StdSPI.dll`, all function calls use traditional C-string pointers rather than BSTRs.

ECal Software Structure

Application programmers can use the SPI to interface with the ECal software. The SPI is the second of *three* layers as shown by the dotted lines in [Figure 3-1](#).

Figure 3-1 ECal SPI Software Architecture



architec

The following table shows the programming versions supported by ECal.

Table 3-1

Supported Versions of Software

Software Program	Version Number
C++	5.0
VB (Visual Basic)	5.0
LabVIEW	3.1
VEE	4.0

Starting Up Software

Confirm that the `Ecal_SPI.dll` and other software components have been correctly installed before trying to program with the SPI by successfully running the ECal GUI `Ecal.exe`.

Before sending other commands to the ECal hardware via the SPI, you must initialize the ECal system by sending a CONFIG command. Refer to “CONFIG” on page 3-19 for more information.

Checking Errors

Check for errors at two levels:

- Check the return code of the function that was called
- *and*
- Call the SPI function `SYST_ERR`

Use the return code of the function to determine whether the pass-parameter syntax is correct, and whether the SPI has access to the lower level DLLs required for proper system function. The call, `SYST_ERR`, is used to determine if a function generated an error as a result of its completion.

ECal software maintains an error queue that is three errors deep in a first-in-first-out (FIFO) configuration. If more than three errors occur between readings, the most recent errors are lost, and the last error message is replaced with a `QUEUE_OVERFLOW` message.

The only way to clear the error queue is to read all the errors using the `SYST_ERR` function. It is strongly recommended that software using the SPI read the error queue after every command. The return value of an SPI function does not indicate successful completion of the function. Use a looping structure keyed to exit the loop when “0, NO ERRORS” is returned.

Programming Examples

This section describes the operation of the main ECal application `ECal.exe` for informational purposes only. The SPI can be used in many different ways, as any OLE object can, but programmers may find it useful to see how `ECal.exe` uses the `ECalSPI.dll`.

`ECal.exe` is a multi-threaded application, as described here:

- The main thread handles user interaction.
- A secondary thread performs the calibration.
- When the user clicks the **Start** button, a thread launches and a calibration starts in the new thread.
- The first thread presents an **Abort** button that allows users to abort the calibration from the computer.

Having two threads allows both the **Abort** button and the calibration to run at the same time.

The program starts the following sequence of events when you click the ECal Start button:

1. Starts the calibration thread.
2. Tells the SPI what type of HP-IB (IEEE-488) card is in use, selects the code of the card, the VNA address, and the number of the parallel port connected to the ECal module (use CONFIG).
3. Checks for errors in the setup using `SYST_ERR`, displays errors, and exits the thread.
4. Displays the ECal menu on the VNA screen using `DISP_MENU` (the SPI handles VNA menus and key presses).
5. Checks for and displays any errors resulting from the calibration using `SYST_ERR`.
6. Exits the calibration thread.

NOTE

The C++, LabVIEW and VEE examples are discussed, the software also includes a VB example.

Microsoft Visual C++

This section provides hints about programming in the Microsoft C++ environment.

An example of the Visual C++ program is provided in the <root ecal>\install directory under examples\cpp\.

Read the file example_cpp.txt for a walkthrough of how to build the basic skeleton in C++ code.

A workspace complete with all source files is provided under <root ecal>\examples\cpp.

NOTE

Please note that <root ecal>\examples\cpp has several hard-coded values, such as the type and logical number of the HP-IB (IEEE-488) card, VNA address, and so forth. You need to recompile the application for your specific setup to have it work for your application.

The hard-coded values of interest appear in line 199 of spi_exampleDlg.cpp:

```
board_type=2;
board_num=0;
vna_address=16;
printer_port=1;
```

These hard-coded values specify a National Instruments IEEE-488 card with parallel port one. If your system values do not match, correct the values. Then you must recompile the example to make it work. Refer to [“CONFIG” on page 3-19](#).

Some BSTR conversion functions are provided in the example code to make accessing the OLE object easier. Please note that the MakeBstrFromStr function allocates memory, which the caller must deallocate when finished using the string. Refer to the example code and example_cpp.txt for more information.

Troubleshooting Example C++ File

If the C++ example file doesn't compile, input the following to correct the compile problem:

ecalspi.h file fix:

```
// Machine generated IDispatch wrapper class (es) created with
// ClassWizard

////////////////////////////////////
_clsEcalSPI wrapper class

class _clsEcalSPI : public COleDispatchDriver
{
public:
    _clsEcalSPI () {} // Calls COleDispatchDriver default
        constructor
    _clsEcalSPI (LPDISPATCH pDispatch) : COleDispatchDriver
        (pDispatch) {}
    _clsEcalSPI (const _clsEcalSPI& dispatchSrc) :
COleDispatchDriver (dispatchDrc {})
// Attributes
public:
// Operations
public:
    void SPI_VERSION(BSTR* version);
    long CONFIG(short* BoardType, short* BoardNumber,
        short* VNAddress, short* PrinterPort);
    long ECAL_DELAY(double* AdapterDelayInSeconds,
        short* MeasureDelay);
    long ECAL_MENU(BSTR* strMenu);
    long ECAL_FINT(BSTR* strOnOff, BSTR* strReturn);
    long ECAL_IAV(BSTR* strAvg, BSTR* strReturn);
    long ECAL_ABORT();
    long ECAL_CLEAN();
    long SENS_CORR_COLL_METH(BSTR* strMethod);
    long SENS_CORR_COLL_PAR(BSTR* strParameter);
    long SENS_CORR_COLL_ACQ(BSTR* strModule);
    long SENS_CORR_COLL_SAVE(BSTR* strCalSet);
```

```
long SENS_CORR_COLL_DONE ();  
long SENS_CORR_COLL_NEXT ();  
long SENS_CORR_COLL_PRIOR ();  
long SENS_CORR_COLL_RES ();  
long SENS_CORR_COLL_VIEW(BSTR* strView);  
long SYST_ERR(BSTR* strErrorNumAndMessage);  
long CMD_IDN(BSTR* strReturn);  
};
```

ecalspi.cpp file fix :

```
// Machine generated IDispatch wrapper class (es) created with  
// ClassWizard  
  
#include "stdafx.h"  
#include "ecalspi.h"  
  
#ifdef _DEBUG  
#define new DEBUG_NEW  
#undef THIS_FILE  
static char THIS_FILE[] = __FILE__;  
#endif  
  
////////////////////////////////////  
_clsECalSPI properties  
  
////////////////////////////////////  
_clsECalSPI operations  
  
void _clsECalSPI::SPI_VERSION(BSTR* version)  
{  
    static BYTE parms{} =  
        VTS_[BSTR;  
        InvokeHelper(0x60030000, DISPATCH_METHOD, VT_EMPTY, TY,  
        NULL, parms, version);  
}  
  
long _clsECalAPI::CONFIG(short* BoardType, short* BoardNumber,  
short* VNAAAddress, short* PrinterPort)  
{
```

```
        long result;
        static BYTE parms[] =
            VTS_PI2 VTS_PI2 VTS_PI2;
        InvokeHelper(0x60030001, DISPATCH_METHOD, VT_I4,
            (void*)&result, parms, BoardType, BoardNumber,
            VNAAddress, PrinterPort);
        return result;
    }
long _clsECalSPI::ECAL_DELAY (double* AdapterDelayInSeconds,
    short* MeasureDelay)
{
    long result;
    static BYTE parms[] =
        VTS_Pr8 VTS_PI2;
    InvokeHelper(0x60030002, DISPATCH_METHOD, VT_I4,
        (void*)&result, parms, AdapterDelayInSeconds,
        MeasureDelay);
    return result;
}

long _clsECalSPI::DISP_MENU(BSTR* strMenu)
{
    long result;
    static BYTE parms[] =
        VTS_PBSTR;
    InvokeHelper(0x60030003, DISPATCH_METHOD, VT_I4,
        (void*)&result, parms, strMenu);
    return result;
}

long _clsECalSPI::ECAL_FINT(BSTR* strOnOff, BSTR* strReturn)
{
    long result;
    static BYTE parms[] =
        VTS_PBSTR VTS_PBSTR;
    InvokeHelper(0x60030004, DISPATCH_METHOD, VT_I4,
        (void*)&result, parms, strOnOff, strReturn);
    return result;
}
```

```

}

long _clsECalSPI::ECAL_IAV(BSTR* strAvg, BSTR* strReturn)
{
    long result;
    static BYTE parms[] =
        VTS_PBSTR VTS_PBSTR;
    InvokeHelper(0x60030005, DISPATCH_METHOD, VT_I4,
        (void*)&result, parms, strAvg, strReturn);
    return result;
}

long _clsECalSPI::ECAL_ABORT()
{
    long result;
    InvokeHelper(0x60030006, DISPATCH_METHOD, VT_I4,
        (void*)&result, NULL);
    return result;
}

long _clsECalSPI::ECAL_CLEAN()
{
    long result;
    InvokeHelper(0x60030007, DISPATCH_METHOD, VT_I4,
        (void*)&result, NULL);
    return result;
}

long _clsECalSPI::SENS_CORR_METH(BSTR* strMethod)
{
    long result;
    static BYTE parms[] =
        VTS_PBSTR;
    InvokeHelper(0x60030008, DISPATCH_METHOD, VT_I4,
        (void*)&result, parms, strAvg, strMethod);
    return result;
}

long _clsECalSPI::SENS_CORR_COLL_PAR(BSTR* strParameter)
{

```

```
        long result;
        static BYTE parms[] =
            VTS_PBSTR;
        InvokeHelper(0x60030009, DISPATCH_METHOD, VT_I4,
            (void*)&result, parms, strParameter);
        return result;
    }
long _clsECalSPI::SENS_CORR_COLL_ACQ(BSTR* strModule)
{
    long result;
    static BYTE parms[] =
        VTS_PBSTR;
    InvokeHelper(0x6003000a, DISPATCH_METHOD, VT_I4,
        (void*)&result, parms, strModule);
    return result;
}
long _clsECalSPI::SENS_CORR_COLL_SAVE(BSTR* strCalSet)
{
    long result;
    static BYTE parms[] =
        VTS_PBSTR;
    InvokeHelper(0x6003000b, DISPATCH_METHOD, VT_I4,
        (void*)&result, parms, strCalSet);
    return result;
}
long _clsECalSPI::SENS_CORR_COLL_DONE()
{
    long result;
    InvokeHelper(0x6003000c, DISPATCH_METHOD, VT_I4,
        (void*)&result, NULL);
    return result;
}
long _clsECalSPI::SENS_CORR_COLL_NEXT()
{
    long result;
    InvokeHelper(0x6003000d, DISPATCH_METHOD, VT_I4,
        (void*)&result, NULL);
    return result;
}
```

```

}
long _clsECalSPI::SENS_CORR_COLL_PRIOR()
{
    long result;
    InvokeHelper(0x6003000e, DISPATCH_METHOD, VT_I4,
        (void*)&result, NULL);
    return result;
}
long _clsECalSPI::SENS_CORR_COLL_RES()
{
    long result;
    InvokeHelper(0x6003000f, DISPATCH_METHOD, VT_I4,
        (void*)&result, NULL);
    return result;
}
long _clsECalSPI::SENS_CORR_COLL_VIEW(BSTR* strView)
{
    long result;
    static BYTE parms[] =
        VTS_PBSTR;
    InvokeHelper(0x60030010, DISPATCH_METHOD, VT_I4,
        (void*)&result, parms, strView);
    return result;
}
long _clsECalSPI::SYST_ERR(BSTR* strErrorNumAndMessage)
{
    long result;
    static BYTE parms[] =
        VTS_PBSTR;
    InvokeHelper(0x60030011, DISPATCH_METHOD, VT_I4,
        (void*)&result, parms, strErrorNumAndMessage);
    return result;
}
long _clsECalSPI::CMD_IDN(BSTR* strReturn)
{
    long result;
    static BYTE parms[] =

```

```
VTS_PBSTR;  
InvokeHelper(0x60030012, DISPATCH_METHOD, VT_I4,  
            (void*)&result, parms, strReturn);  
return result;  
}
```

When you have completed inputting the program information, your C++ example files will compile.

HP-VEE and LabVIEW

Standard SPI (StdSpi.dll)

This section describes the standard SPI used by HP-VEE and LabVIEW.

A translation layer is included that allows the graphical programming languages used by Hewlett-Packard's VEE and National Instrument's LabVIEW to connect to OLE objects.

This layer converts traditional C-style parameters to and from the BSTR types used by the SPI. The programmer's view of StdSpi.dll is that it implements the exact functionality of ECalSPI.dll, except the functions are DLL-exports, and all BSTR parameters are C-string pointers.

For example, the ECalSPI.dll implements the following OLE function (or method):

```
long ECAL_FINT (BSTR*strOnOff,BSTR*strReturn);
```

In the StdSpi.dll, the function is:

```
long Ecal_Fint(unsigned char*strOnOff,unsigned char*strReturn);
```

Consider letter case for StdSpi.dll function names

StdSpi.dll function names are case-sensitive. In the OLE object, function names are all capitals. The standard SPI uses the same names, but only initial-capital letters in each word.

All StdSpi functions use the Pascal calling convention, `_stdcall` and are exported from the 32 bit 'StdSpi.dll'. For example:

The function in ECalSPI (OLE) is:

```
long SENS_CORR_COLL_ACQ (BSTR*strModule);
```

The stdcall function in StdSpi.dll is:

```
long Sens_Corr_Coll_Acq (unsigned char*strModule);
```

The use of the standard SPI is demonstrated in the VEE and LabVIEW examples of the directory, `<root ecal>\examples\cpp`. The standard SPI can also be used by programmers unfamiliar with OLE or who wish to interface the SPI from software that does not support OLE. You can find many examples of accessing exported DLL functions in the compiler literature.

Pointer parameters must be allocated by the calling function

In the `StdSpi.dll`, all parameters which are passed as a pointer must be allocated by the caller. An `'unsigned char*'` should exist in the caller's address space or on the heap, and allocated large enough to hold the return value.

NOTE

The functions do *not* attempt to deallocate or reallocate any pointers passed to them. Make sure that you have enough space allotted to the pointer before you call any DLL functions. Both VEE and LabVIEW follow this behavior. You also must follow it to remain compatible with those environments.

A prototype for each function exported from the `StdSpi.dll` can be found in the file `<root ecal>/vee_spi.h`. This file is used by HP VEE, and can be used by C or other compilers as a header file if you need to access the SPI via DLL exports rather than through OLE.

NOTE

The `'vee_spi.h'` file does not specify the Pascal or `_stdcall` calling convention, even though all the functions are `_stdcall`. You may need to add these specifiers if you use this header file in some C applications. These specifiers are left out in this file because HP VEE assumes the `_stdcall` calling convention by default.

HP VEE Example

This section describes how to interface between the graphical programming environment, HP VEE, and the ECal system.

To interface to HP VEE, you need to use the compiled function calling objects within VEE. You will be calling functions that are exported from `StdSpi.dll`. The header file `vee_spi.h` is the template VEE uses to make sure the parameters are correct.

See the walkthrough for setting up a VEE application using ECal in the `<root ecal>\examples\example_VEE.txt` file. For a VEE application example, go to `<root ecal>\examples\VEE`.

When using the VEE example, you may need to change the file paths for the Import Library Object, because the files may not be in the same directory in your installation. You need to change the parameters to the CONFIG function to reflect your system setup. Refer to ["CONFIG" on page 3-19](#).

NOTE

When using the National Instruments card, use the GPIB-32.DLL and Nat.h to directly control the VNA.

LabVIEW Example

This section describes how to interface between the graphical programming environment, LabVIEW, and the ECal system.

With LabVIEW, you must specify each parameter to the function in the Function Call Object. Strings are passed as C-string pointers, and the *short* parameters to the CONFIG function are passed as 16 bit integer pointers.

For a LabVIEW program example using the ECal SPI, go to the directory, `examples\labview`.

Refer to `examples\example_labview.txt` for step-by-step instructions about building the example.

To run the example, set the parameters for the CONFIG command as specified in the function reference for your system. The following pass parameters should be typed into the string or integer controls in the LabVIEW window. Refer to the examples (`examples\labview`) and text file (`examples\example_labview.txt`) for clarification.

Sens_Corr_Coll_Meth

The parameter passed to this function should be the string *full* to do a full 2-port calibration.

Sens_Corr_Coll_Acq

The parameter passed to this function should be *a* or *b*, depending on where you have connected your ECal module.

```
long SYST_ERR(BSTR* strErrorNumAndMessage);  
long CMD_IDN(BSTR* strReturn);
```

ECal SPI Function Reference

This section describes the function commands available via the SPI. Function commands are listed in alphabetical order.

CAUTION

Function return values indicate successful execution of the function. They do indicate errors in the format of the pass parameters in the case of a -1, and installation problems when you get a -2. If you get a -1, check the function-call pass parameters closely. If you get a -2, re-install the ECal software.

CMD_IDN

Purpose

To return a string with the current version of SPI software.

CMD_IDN Function Format Options

C++ (EcalSPI.dll)	long CMD_IDN (BSTR* strReturn);
Visual Basic (EcalSPI.dll)	CALL CMD_IDN (strReturn As String) <i>or</i> status&=CMD_IDN (strReturn As String)
VEE (StdSPI.dll)	long Cmd_Idn (unsigned char*strReturn);
LabVIEW (StdSPI.dll)	long Cmd_Idn (unsigned char*strReturn);

Input

None

Output

strReturn contains the current revision of the ECal software in the format: Hewlett-Packard,85098A DLL,0,XX.XX. Where XX.XX is the revision of the ECal DLL.

Function Return, 0=syntax OK, -2=DLL access error

CONFIG

Purpose

Configures the ECal system by setting values for the:

- type of HP-IB card in use in the host computer.
- select code of the HP-IB card.
- HP-IB address of the VNA.
- number of the parallel port that is connected.

CONFIG Function Format Options

C++ (ECalSPI.dll)	long CONFIG (short*BoardType, short*BoardNumber, short*VNAAddress, short*PrinterPort);
Visual Basic (ECalSPI.dll)	CALL CONFIG (BoardType As Integer, BoardNumber As Integer, VNAAddress As Integer, PrinterPort As Integer) <i>or</i> status&=CONFIG (BoardType As Integer, BoardNumber As Integer, VNAAddress As Integer, PrinterPort As Integer)
VEE (StdSPI.dll)	long CONFIG (short*BoardType, short*BoardNumber, short*VNAAddress, short*PrinterPort);
LabVIEW (StdSPI.dll)	long CONFIG (short*BoardType, short*BoardNumber, short*VNAAddress, short*PrinterPort);

Input

Board Type:

- 1=Hewlett-Packard
- 2=National Instruments

Board number:

- Usually 7 for Hewlett-Packard Cards
- Usually 0 for National Instruments Cards

VNA Address:

VNA HP-IB (IEEE-488) address from 0 to 30, normally 16.

Printer Port:

(Connected to the PC Interface Unit) 1=LPT1, 2=LPT2, 3=LPT3, 4=LPT4, normally 1.

Output

Function Return, 0=syntax OK, -1=syntax error, -2=DLL access error

DISP_MENU

Purpose

To display an ECal menu on the VNA from the list of available menus.

DISP_MENU Function Format Options

C++ (ECalSPI.dll)	long DISP_MENU (BSTR* strMenu);
Visual Basic (ECalSPI.dll)	CALL DISP_MENU (strMenu As String) <i>or</i> status&=DISP_MENU (strMenu As String)
VEE (StdSPI.dll)	long Disp_Menu (unsigned char*strMenu);
LabVIEW (StdSPI.dll)	long Disp_Menu (unsigned char*strMenu);

Input

strMenu can be any of the following strings.

strMenu Strings

ADAP	Display the MODULE SELECT MENU menu for adapter 2-port calibration.
CCH	Display the MODULE SELECT MENU for confidence check.
CCHA	Display the PARAMETER SELECT MENU for module A confidence check.
CCHB	Display the PARAMETER SELECT MENU for module B confidence check.
CONF	Display the CONFIGURATION MENU.
ECAL	Display the top level ECal menu.
FULL	Display the MODULE SELECT MENU for full 2-port calibration.
MODI	Display the MODULE INFORMATION MENU.
SERV	Display the SERVICE MENU.
S11C	Display the MODULE SELECT MENU for S11 1-port calibration.
S22C	Display the MODULE SELECT MENU S22 1-port calibration.
QAD	Display the MODULE SELECT MENU for omit isolation adapter 2-port calibration.
OFUL	Display the MODULE SELECT MENU for omit isolation 2-port calibration.

Output

Function Return, 0=syntax OK, -1=syntax error, -2=DLL access error

ECAL_ABORT

Purpose

This command is used in a multi-threaded application to abort a calibration in progress in another thread.

For example, in the `ECal.exe` application provided, **Start** initiates the application in one thread, then opens a window with the **Abort** button in another thread. The two threads allow the **Abort** button to be selectable while the calibration is in progress.

When the **Abort** button is pressed, the `ECAL_ABORT` function is called. This signals the other thread (which is running the calibration) to abort when possible. There may be some delay in aborting the calibration if the calibration is in the middle of a sweep.

ECAL_ABORT Function Format Options

C++ (ECalSPI.dll)	<code>long ECAL_ABORT ();</code>
Visual Basic (ECalSPI.dll)	<code>CALL ECAL_ABORT or status&=ECAL_ABORT</code>
VEE (StdSPI.dll)	<code>long Ecal_Abort ();</code>
LabVIEW (StdSPI.dll)	<code>long Ecal_Abort ();</code>

Input

None

Output

Function Return, 0=syntax OK, -2=DLL access error

ECAL_CLEAN

Purpose

Unloads the ECal DLLs and frees up the memory used during a calibration. It has no effect on the calibration itself. It is intended to allow an application to regain some PC resources after a calibration.

This function should always be called after an application uses the SPI and before the application exits.

ECAL_CLEAN Function Format Options

C++ (ECalSPI.dll)	long ECAL_CLEAN ();
Visual Basic (ECalSPI.dll)	CALL ECAL_CLEAN <i>or</i> status&=ECAL_CLEAN
VEE (StdSPI.dll)	long Ecal_Clean ();
LabVIEW (StdSPI.dll)	long Ecal_Clean ();

Input

None

Output

Function Return, 0=syntax OK, -2=DLL access error

ECAL_DELAY

Purpose

Sets the adapter electrical delay value for an adapter removal calibration, or specifies whether the software should try to measure the delay instead.

The software can measure the delay if there are at least 4 frequency points and the spacing is ≥ 50 MHz between any 2 adjacent points.

This function has no effect on other calibration methods.

ECAL_DELAY Function Format Options

C++ (ECalSPI.dll)	long ECAL_DELAY (double *AdapterDelayInSeconds, short *MeasureDelay);
Visual Basic (ECalSPI.dll)	CALL ECAL_DELAY (AdapterDelayInSeconds As Double, MeasureDelay as Integer) <i>or</i> status&=ECAL_DELAY (AdapterDelayInSeconds As Double, MeasureDelay as Integer)
VEE (StdSPI.dll)	long Ecal_Delay (double *AdapterDelayIn Seconds, short *MeasureDelay);
LabVIEW (StdSPI.dll)	long Ecal_Delay (double *AdapterDelayInSeconds, short *MeasureDelay)

Input

AdapterDelayInSeconds:

The electrical delay of the adapter (in seconds).

MeasureDelay

= 1 if the software should measure the adapter length

= 0 if the software uses the AdapterDelayInSeconds parameter rather than attempting to measure the adapter delay

Output

Function Return, 0=syntax OK, -1=syntax error, -2=DLL access error

ECAL_FINT

Purpose

Turns frequency interpolation on or off.

- With frequency interpolation on, any frequencies within the span of the characterized ECal module can be measured.
- With frequency interpolation off, only those frequencies that correspond to the actual characterization frequencies of the ECal module are allowed.

ECAL_FINT Function Format Options

C++ long ECal_FINT (BSTR*strReturn);
(ECalSPI.dll)

Visual Basic CALL ECal_FINT (strOnOff As String, Optional strReturn as String) *or*
(ECalSPI.dll) status&=ECAL_FINT (strOnOff As String, Optional strReturn as String)

VEE long Ecal_Fint (unsigned char*stOnOff, unsigned char*strReturn);
(StdSPI.dll)

LabVIEW long Ecal_Fint (unsigned char*stOnOff, unsigned char*strReturn);
(StdSPI.dll)

Input

strOnOff can be on or off

Output

strReturn is the result of the operation, 1 if interpolation is ON; 0 if interpolation is off.

Function Return, 0=syntax OK, -2=DLL access error

ECAL_IAV

Purpose

Allows the ECal system to override the averaging value specified in the VNA setup for isolation calibrations.

Isolation calibrations typically require significantly higher than normal averaging. Use ECAL_IAV to pass a value to the VNA indicating the desired number of averages.

If the value is null, the user is prompted for a value using the active entry capability of the VNA (softkeys).

ECAL_IAV Function Format Options

C++ (ECalSPI.dll)	long ECAL_IAV (BSTR* strAvg, BSTR* strReturn);
Visual Basic (ECalSPI.dll)	CALL ECAL_IAV (strAvg As String, Optional strReturn As String) <i>or</i> status&=ECAL_FIAV (strAvg As String, Optional Return As String)
VEE (StdSPI.dll)	long Ecal_Iav (unsigned char*strAvg, unsigned char*strReturn);
LabVIEW (StdSPI.dll)	long Ecal_Iav (unsigned char*strAvg, unsigned char*strReturn);

Input

strAvg can be an integer-averaging value from 1 to 4096 or a “?” (to query the VNA for the actual averaging setting), or null to prompt the user for an averaging value.

Output

strReturn equals the current averaging value resulting from a “?” query.

Function Return, 0=syntax OK, -1=syntax error, -2=DLL access error

SENS_CORR_COLL_ACQ

Purpose

Initiates the measurement of a specific ECal module to acquire calibration error coefficients.

NOTE

Before initiating this command, call the functions `CONFIG` and `SENS_CORR_COLL_METH`, otherwise this command functions improperly.

SENS_CORR_COLL_ACQ Function Format Options

C++ (ECalSPI.dll)	<code>long SENS_CORR_COLL_ACQ BSTR* strModule);</code>
Visual Basic (ECalSPI.dll)	<code>CALL SENS_CORR_COLL_ACQ (strModule as String) or status&=SENS_CORR_COLL_ACQ (strModule As String)</code>
VEE (StdSPI.dll)	<code>long Sens_Corr_Coll_Acq (unsigned char*strModule);</code>
LabVIEW (StdSPI.dll)	<code>long Sens_Corr_Coll_Acq (unsigned char*strModule);</code>

Input

`strModule`

= A to calibrate with the module connected to Port A of the PC interface

= B to calibrate with the module connected to Port B of the PC Interface

Output

Function Return, 0=syntax OK, -1=syntax error, -2=DLL access error.

SENS_CORR_COLL_DONE

Purpose

Indicates the completion of a confidence check, sets the ECal module to its idle state, and restores the VNA display.

SENS_CORR_COLL_DONE Function Format Options

C++ (ECalSPI.dll)	long SENS_CORR_COLL_DONE();
Visual Basic (ECalSPI.dll)	CALL SENS_CORR_COLL_DONE <i>or</i> status&=SENS_CORR_DONE
VEE (StdSPI.dll)	long Sens_Corr_Coll_Done ();
LabVIEW (StdSPI.dll)	long Sens_Corr_Coll_Done ();

Input

None

Output

Function Return, 0=syntax OK, -2=DLL access error

SENS_CORR_COLL_METH

Purpose

Selects the type of calibration to perform. The calibration can subsequently be initiated by a call to SENS_CORR_COLL_ACQ.

SENS_CORR_COLL_METH Function Format Options

C++ (ECalSPI.dll)	long SENS_CORR_COLL_METH (BSTR* strMethod);
Visual Basic (ECalSPI.dll)	CALL SENS_CORR_COLL_METH (strMethod As String) <i>or</i> status&=SENS_CORR_COLL_METH (strMethod As String)
VEE (StdSPI.dll)	long Sens_Corr_Coll_METH (unsigned char* strMethod);
LabVIEW (StdSPI.dll)	long Sens_Corr_Coll_METH (unsigned char* strMethod);

Input

strMethod Calibration Types

ADAP	Adapter 2-port calibration. Adapter 2-port calibration is a two-step process for performing noninsertable calibrations using an insertable ECal module with an adapter. <ol style="list-style-type: none">1. Use SENS_CORR_COLL_NEXT to advance from step one to step two. Refer to the ECAL_DELAY command for more information.2. Connect the ECal module directly to Port 2 of the VNA to establish the S22 reference plane in step one.3. In the next step, connect the Ecal module to Port 1 of the VNA and an appropriate adapter between the ECal module and Port 2 of the VNA.
CCH	Confidence check.
FULL	Full 2-port calibration of the VNA including the isolation terms. After initiating this function, connect and measure all the necessary modules before saving the calibration coefficients in the VNA's calibration registers.
QAD	Omit isolation adapter 2-port calibration. This calibration is the same as the ADAP calibration method, except isolation measurements are omitted.
QFUL	Omit isolation 2-port calibration. This calibration is the same as the FULL calibration method, except isolation measurements are omitted.
S11C	S11 1-port calibration using Port 1 of the VNA. After initiating this function, connect and measure all the necessary modules before saving the calibration coefficients in the VNA's calibration registers.
S22C	S22 1-port calibration using Port 2 of the VNA. After initiating this function, connect and measure all the necessary modules before saving the calibration coefficients in the VNA's calibration registers.

Output

Function Return, 0=syntax OK, -1=syntax error, -2=DLL access error

SENS_CORR_COLL_NEXT

Purpose

Used to progress from step one to step two for an adapter calibration. All step one measurements must be completed before issuing the function SENS_CORR_COLL_NEXT, otherwise errors result. See ADAP under SENS_CORR_COLL_METH for a description of the steps.

SENS_CORR_COLL_NEXT Function Format Options

C++ (ECalSPI.dll)	long SENS_CORR_COLL_NEXT ();
Visual Basic (ECalSPI.dll)	CALL SENS_CORR_COLL_NEXT <i>or</i> status&=SENS_CORR_COLL_NEXT
VEE (StdSPI.dll)	long Sens_Corr_Coll_Next();
LabVIEW (StdSPI.dll)	long Sens_Corr_Coll_Next();

Input

None

Output

Function Return, 0=syntax OK, -2=DLL access error

SENS_CORR_COLL_PAR

Purpose

Determines which S-parameter to display when responding to SENS_CORR_COLL_ACQ.

SENS_CORR_COLL_PAR Function Format Options

C++ (ECalSPI.dll)	long SENS_CORR_COLL_PAR (BSTR* strParameter);
Visual Basic (ECalSPI.dll)	CALL SENS_CORR_COLL_PAR (strParameter As String) <i>or</i> status&=SENS_CORR_COLL_PAR (strParameter As String)
VEE (StdSPI.dll)	long Sens_Corr_Coll_Par (unsigned char* strParameter);
LabVIEW (StdSPI.dll)	long Sens_Corr_Coll_Par (unsigned char* strParameter);

Input

strParameter can be S_{11} , S_{21} , S_{12} , or S_{22}

Output

Function Return, 0=syntax OK, -1=syntax error, -2=DLL access error

SENS_CORR_COLL_PRIOR

Purpose

Used to return from step two to step one of an adapter calibration. Any completed step-one measurements are lost.

SENS_CORR_COLL_PRIOR Function Format Options

C++ (ECalSPI.dll)	long SENS_CORR_COLL_PRIOR ();
Visual Basic (ECalSPI.dll)	CALL SENS_CORR_COLL_PRIOR <i>or</i> status&=SENS_CORR_COLL_PRIOR
VEE (StdSPI.dll)	long Sens_Corr_Coll_Prior ();
LabVIEW (StdSPI.dll)	long Sens_Corr_Coll_Prior ();

Input

None

Output

Function Return, 0=syntax OK, -2=DLL access error

SENS_CORR_COLL_RES

Purpose

Used to resume a calibration in progress.

SENS_CORR_COLL_RES Function Format Options

C++ (ECalSPI.dll)	long SENS_CORR_COLL_RES ();
Visual Basic (ECalSPI.dll)	CALL SENS_CORR_COLL_RES <i>or</i> status&=SENS_CORR_COLL_RES
VEE (StdSPI.dll)	long Sens_Corr_Coll_Res ();
LabVIEW (StdSPI.dll)	long Sens_Corr_Coll_Res ();

Input

None

Output

Function Return, 0=syntax OK, -2=DLL access error

SENS_CORR_COLL_SAVE

Purpose

Ends the calibration process and loads the coefficients into the VNA.

SENS_CORR_COLL_SAVE Function Format Options

C++ (ECalSPI.dll)	long SENS_CORR_COLL_SAVE (BSTR* strCalSet);
Visual Basic (ECalSPI.dll)	CALL SENS_CORR_COLL_SAVE (strCalSet As String) <i>or</i> status&=SENS_CORR_COLL_SAVE (strCalSet As String)
VEE (StdSPI.dll)	long Sens_Corr_Coll_Save(unsigned char* strCalSet);
LabVIEW (StdSPI.dll)	long Sens_Corr_Coll_Save(unsigned char* strCalSet);

Input

The value of strCalSet depends on the VNA and, in some cases, the calibration. Refer to your VNA literature for more information. Error coefficients are stored in the corresponding register in the VNA.

Output

Function Return, 0=syntax OK, -1=syntax error, -2=DLL access error

SENS_CORR_COLL_VIEW

Purpose

Sets the display mode to show either data and memory (BOTH) or data divided by memory (DIV) when SENS_CORR_ACQ is executed.

SENS_CORR_COLL_PRIOR Function Format Options

C++ (ECalSPI.dll)	long SENS_CORR_COLL_VIEW (BSTR* strView);
Visual Basic (ECalSPI.dll)	CALL SENS_CORR_COLL_VIEW (strView As String) <i>or</i> status&=SENS_CORR_COLL_VIEW (strView Set As String)
VEE (StdSPI.dll)	long Sens_Corr_Coll_View (unsigned char* strView);
LabVIEW (StdSPI.dll)	long Sens_Corr_Coll_View (unsigned char* strView);

Input

strView can be either BOTH or DIV. Use BOTH to display the data and the memory. Use DIV to view the data divided by memory.

Output

Function Return, 0=syntax OK, -1=syntax error, -2=DLL access error

SPI_VERSION

Purpose

Returns the version number of the SPI.

SPI_VERSION Function Format Options

C++ (ECalSPI.dll)	void SPI_VERSION (BSTR* version);
Visual Basic (ECalSPI.dll)	CALL SPI_VERSION (version As String)
VEE (StdSPI.dll)	void Spi_Version (unsigned char* version);
LabVIEW (StdSPI.dll)	void Spi_Version (unsigned char* version);

Input

None

Output

SPI version string. No function return.

SYST_ERR

Purpose

Returns the error number and message associated with the latest action of the ECal system.

ECal software maintains a three-error deep queue in a first-in-first-out (FIFO) configuration. If more than three errors occur between readings, the most recent errors are lost, and the last error message is replaced with the message `QUEUE_OVERFLOW`.

The only way to clear the queue is to read the errors with `SYST_ERR`.

NOTE

It is strongly recommended after each command that the software using the SPI reads the error queue. Use a looping structure keyed to exit the loop when `0, NO_ERRORS` is returned.

See the ECal online help for information about error messages.

SYST_ERR Functions Format Options

C++ (ECalSPI.dll)	<code>long SYST_ERROR (BSTR* strErrorNumberAndMessage);</code>
Visual Basic (ECalSPI.dll)	<code>CALL SYST_ERROR (strErrorNumberAndMessage As String) or status&=SYST_ERROR (strErrorNumberAndMessage As String)</code>
VEE (StdSPI.dll)	<code>long Syst_Error (unsigned char* strErrorNumberAndMessage);</code>
LabVIEW (StdSPI.dll)	<code>long Syst_Error (unsigned char* strErrorNumberAndMessage);</code>

Input

None

Output

Error number and message string.

Function Return, 0=syntax OK, -2=DLL access error

4 Recertifying ECal Kits

General Information

Recertification of your calibration kit can only be performed at a Hewlett-Packard authorized service center, (see “[Service and Support](#)” on page 5-4).

The equipment and calibration standards required to certify the specification limits of the devices in this kit have been specially manufactured, and are not commercially available.

Hewlett-Packard recognizes its responsibility to provide you with procedures to reconfirm the published specifications of any product offered. That commitment applies equally to the electronic calibration kit. If however, it is imperative that the performance test processes for this kit be explained or made available to you, contact the nearest Hewlett-Packard sales or service office listed in “[Service and Support](#)” on page 5-4 of this manual.

Recertification

What Recertification Provides

Recertified kits include the following:

- A new calibration sticker affixed to the case
- A “Certificate of Calibration”
- A list of NIST (United States National Institute of Standards and Technology) traceable numbers
- A calibration report for each traceable device in the kit listing values, specifications, and uncertainties
- A new set of S-parameter data (embedded in module memory) if the old set of S-parameter data no longer allows for a calibration that meets all performance specifications

The following is available by request:

- MIL-STD-45662A or equivalent certification

For more information, contact the nearest Hewlett-Packard sales or service office.

How Often to Recertify

The suggested initial interval for recertification is 12 months or sooner, depending on the use of the kit. After reviewing the results of the initial recertification, you may establish a different recertification interval that reflects the usage and wear of your kit.

NOTE

In some cases, a kit may not get used for some time after the actual recertification date. In that case, the recertification interval should begin on the date the kit’s use is re-established.

Where to Send a Kit for Recertification

Contact the nearest Hewlett-Packard sales or service office for information about where to send your kit for recertification. Be sure to include the information described in [Chapter 5, “Troubleshooting”](#) with the kit when you return it.

How Hewlett-Packard Verifies Kit Devices

Hewlett-Packard verifies the specifications of these devices as follows:

1. Residual microwave error terms of the test system are verified using precision airlines and shorts, or low frequency resistance.

The low-frequency resistance is traceable to the United States National Institute of Standards and Technology (NIST).

The airline and short characteristics are developed from mechanical measurements. The mechanical measurements and material properties are carefully modeled to give a very accurate electrical representation.

The mechanical measurements are traceable to NIST through various plug and ring gauges, and other mechanical measurements.

2. Each calibration device is electrically tested on this system to the specifications listed in the "Specifications" section of the *Electronic Calibration Module Reference Guide*.

The previous two steps establish a traceable link to NIST for Hewlett-Packard to the extent allowed by the Institute's calibration facility. The devices in this kit are traceable to NIST through Hewlett-Packard.

5 Troubleshooting

General Information

If you suspect a bad calibration, or if your VNA does not pass the performance verification, follow the steps as shown in [Figure 5-1 on page 5-3](#).

Returning a Kit or Device to HP

If your calibration kit or device requires service, contact the Hewlett-Packard office nearest you for information about where to send it.

If you are returning the product to Hewlett-Packard for service, please include the following information (attached to the product if possible):

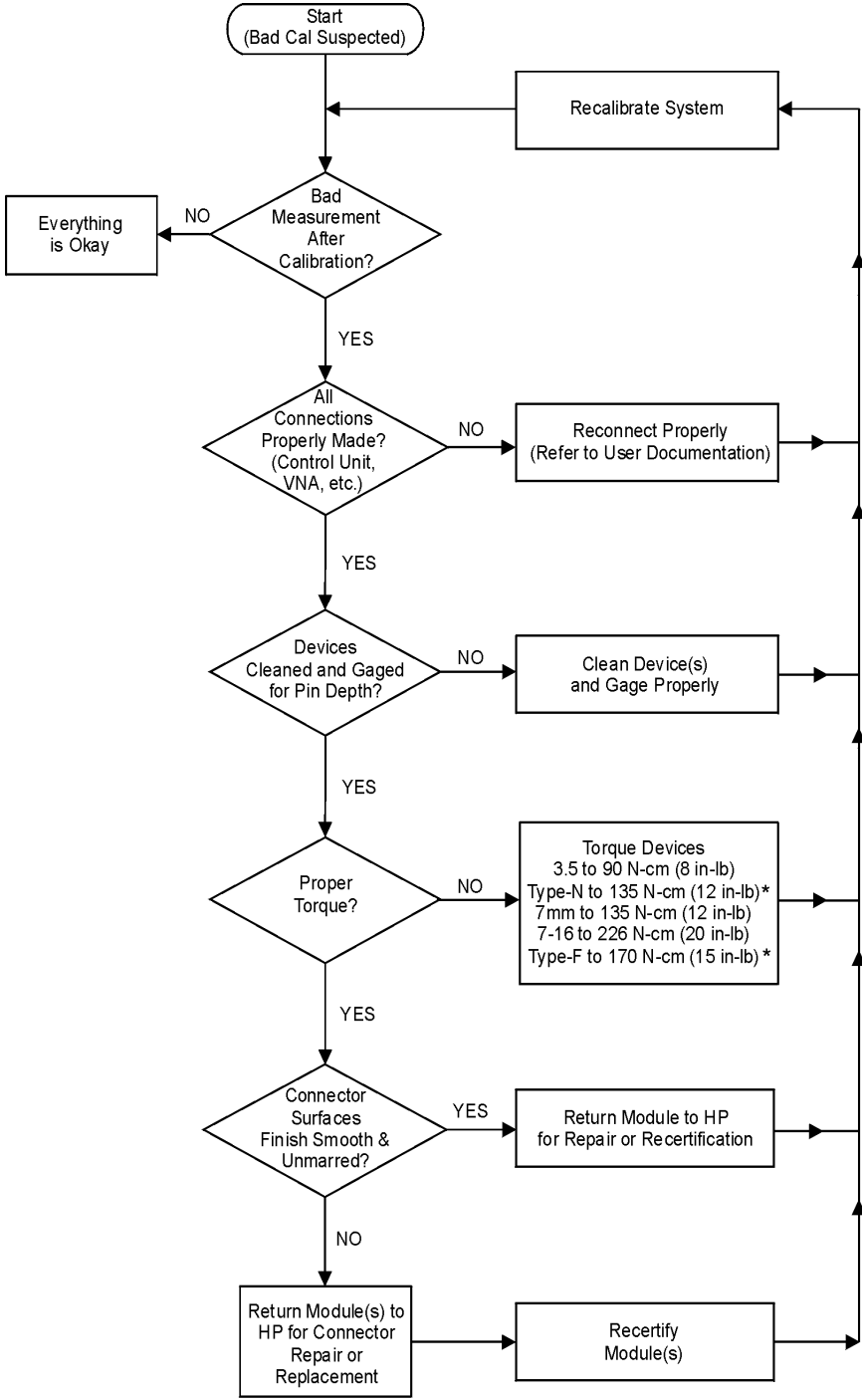
- Your company name and address
- A technical contact person's name
- A telephone number and extension
- The model number of the kit/product
- The serial number of the kit/product
- Your purchase order number
- The current date
- Any accessories (any as adapters)
- The type of service required
- A specific description of problem(s)
- Any other applicable information

More Information

This manual contains limited information about VNA system operation. For complete information, refer to the VNA's documentation.

If you need additional information, contact your local Hewlett-Packard representative. Sales and service offices are listed in ["Service and Support" on page 5-4](#) of this manual.

Figure 5-1 Troubleshooting Flowchart



* HP does not supply torque wrenches for 75Ω type-N or Type-F connectors. Finger tighten if no torque wrench is available.

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Service and Support

Any adjustment, maintenance, or repair of this product must be performed by qualified personnel. Contact the nearest HP service office. You can find a list of HP Service Centers on the web at <http://www.hp.com/go/tmdir>.

If you do not have access to the Internet, one of these HP centers can direct you to your nearest HP representative:

Hewlett-Packard Sales and Service Offices

UNITED STATES		
<p>Instrument Support Center Hewlett-Packard Company (800) 403-0801</p>		
EUROPEAN FIELD OPERATIONS		
<p>Headquarters Hewlett-Packard S.A. 150, Route du Nant-d'Avril 1217 Meyrin 2/ Geneva Switzerland (41 22) 780.8111</p> <p>Great Britain Hewlett-Packard Ltd. Eskdale Road, Winnersh Triangle Wokingham, Berkshire RG41 5DZ England (44 118) 9696622</p>	<p>France Hewlett-Packard France 1 Avenue Du Canada Zone D'Activite De Courtaboeuf F-91947 Les Ulis Cedex France (33 1) 69 82 60 60</p>	<p>Germany Hewlett-Packard GmbH Hewlett-Packard Strasse 61352 Bad Homburg v.d.H Germany (49 6172) 16-0</p>
INTERCON FIELD OPERATIONS		
<p>Headquarters Hewlett-Packard Company 3495 Deer Creek Rd. Palo Alto, CA 94304-1316 USA (415) 857-5027</p> <p>Japan Hewlett-Packard Japan, Ltd. 9-1 Takakura-Cho, Hachioji Tokyo 192, Japan (81 426) 60-2111</p> <p>China China Hewlett-Packard Co. 38 Bei San Huan X1 Road Shuang Yu Shu Hai Dian District Beijing, China (86 1) 256-6888</p>	<p>Australia Hewlett-Packard Australia Ltd. 31-41 Joseph Street Blackburn, Victoria 3130 (61 3) 895-2895</p> <p>Singapore Hewlett-Packard Singapore (Pte.) Ltd. 150 Beach Road #29-00 Gateway West Singapore 0718 (65) 291-9088</p>	<p>Canada Hewlett-Packard (Canada) Ltd. 17500 South Service Road Trans-Canada Highway Kirkland, Quebec H9J 2X8 Canada (514) 697-4232</p> <p>Taiwan Hewlett-Packard Taiwan 8th Floor, H-P Building 337 Fu Hsing North Road Taipei, Taiwan (886 2) 712-0404</p>

A **HP 85060C Information**

HP 85060C Control Unit-Based ECal System

This appendix is for use with the HP 85060C control unit. The control unit based ECal system provides one module control method for electronic calibration of VNAs. It houses a central processing unit with built-in firmware and controls the entire calibration process from either the front panel of the VNA, or through an external system controller. This control unit is capable of handling up to four ECal modules.

The HP 85060C is compatible with the HP 8506XA/B and HP 8509XA series of ECal modules.

Please refer to the *HP 85060C Operating and Service Manual* (HP part number 85060-90002) for more complete information about the use of the HP 85060C control unit.

Environmental Specifications

The environmental specifications for the HP 85060C control unit are given in [Table A-1](#). (See the *Electronic Calibration Module Reference Guide* (HP part number 85091-90008) for characteristics for the HP 85097A PC interface unit.)

Table A-1 Control Unit Environmental Specifications

Specification	Limits
Operating Temperature¹	20 to 26 °C (68 to 79 °F)
Error-Corrected Temperature Range²	±1 °C of measurement calibration temperature
Storage Temperature	-40 to +75 °C (-40 to +167 °F)
Barometric Pressure Altitude	
Operation	<4,5000 meters (15,000 feet)
Storage	<15,000 meters (50,000 feet)
Relative Humidity	<i>Non-condensing at all times</i>
Operation	0 to 80% (26 °C maximum dry bulb)
Storage	0 to 95% (26 °C maximum dry bulb)
EMI	
Conducted Susceptibility	CETM 765
Radiated Susceptibility	EN 50082-1/IEC 801-3
Radiated Emissions	CISPR11
Magnetic Emissions	CETM 765

1. The temperature at which the calibration standards maintain performance at their specifications.
2. The allowable VNA ambient temperature drift during measurement calibration and during measurements when the VNA correction is turned on. Also, the range over which the VNA maintains its specified performance while correction is turned on.

Characteristics and Specifications

Electrical and Mechanical

Table A-2 HP 85060C Electrical and Mechanical Characteristics

Characteristics	Limits
Power Requirements	
Line Voltage	90 to 250 Vac
Line Frequency	47 to 63 Hz
Power Dissipation	200 VA Maximum
Fuse Ratings	
Line Voltage	115/120 VAC <i>or</i> 230/240 VAC
Fuse Rating	4 Amperes 2 Amperes
Safety	Meets requirements of IEC 348 and CETM 755
Weights	
Net Weight	40 kg (18 lbs)
Shipping Weight	50 kg (22.5 lbs)
Dimensions	
Height	100 mm (3.875 in)
Width	458 mm (18 in)
Length	569 mm (22.375 in)

Line Voltage and Fuse Selection

Verify that the fuse rating in use matches the power source needs. Refer to [Table A-2](#) for fuse ratings.

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