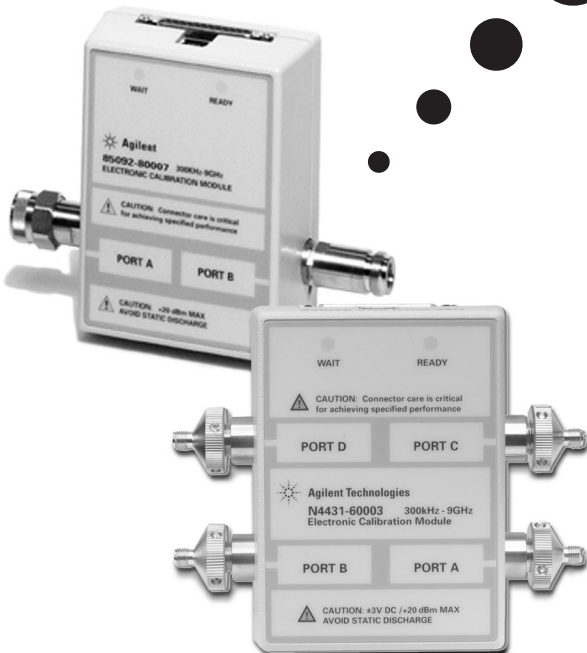


Agilent Electronic Calibration (ECal) Modules for Vector Network Analyzers

85060 series, 2-port microwave ECal
85090 series, 2-port RF ECal
N4431A, 4-port RF ECal

Product Overview



- **Control ECal directly from the PNA or ENA Series VNAs**
- **300 kHz to 9 GHz module**
- **1 GHz to 26.5 GHz module**
- **Six connector types available**
- **Ideal calibration technique for manufacturing**
- **Mixed connectors available (Type-N 50 ohm, 3.5 mm and 7-16)**

Introduction

Electronic calibration (ECal) is a precision, single-connection, one-, two-, three-, or four-port calibration technique for your vector network analyzer. ECal modules use fully traceable and verifiable electronic impedance standards. The modules are state-of-the-art, solid-state devices with programmable and highly repeatable impedance states. ECal modules are transfer standards that provide consistent calibrations and eliminate operator errors while bringing convenience and simplicity to your calibration routine. Consistent calibrations provide consistent measurements.

ECal replaces the traditional calibration technique, which uses mechanical standards. With mechanical standards you are required to make numerous connections to the test ports for a single calibration. These traditional calibrations require intensive operator interaction, which is prone to error. With ECal, a full one- to four-port calibration can be accomplished with a single connection to the ECal module and minimal operator interaction. This results in faster and more repeatable calibrations.

Mixed connector options are available for the 85092C, 85093C, 85098C, and N4431A. The available connectors are Type-N 50 ohms, 3.5 mm and 7-16.

Accurate transfer standards

The ECal modules are transfer standards capable of transferring the factory calibration accuracy to your network analyzer. They are characterized by Agilent using a precision calibration technique (similar in accuracy to TRL) that is traceable to the National Institute of Standards and Technology (NIST). Each calibration module's unique S-parameter data is stored in the module's memory. During calibration, ECal uses this data to calculate the error terms for your network analyzer. All measurements on either insertable or non-insertable devices are traceable to NIST.

Faster calibration with a single connection

Unlike the traditional mechanical technique, ECal only requires one connection to perform a full one- to four-port calibration from the calibration module to the test ports.

By reducing the number of connections required for a calibration, you can

- calibrate faster, so you save time and make measurements sooner
- reduce the chance of operator error, for greater confidence in your calibrations
- reduce the wear on connectors, for lower repair costs on both the test port connectors and calibration standards

Network analyzer compatibility

The 85090 family of RF ECal modules provides calibration across the complete frequency range of the RF PNA series, ENA series, and the 8753E/ES/ET vector network analyzers. The 85060 family of microwave ECal modules provides calibrations through 26.5 GHz for the 8719/20/22/D/ES/ET vector network analyzers. The N4431A four-port ECal module provides calibration for the ENA series and in mid-2002 will support the N338x series of three-port PNAs.

ECal and network analyzer/firmware compatibility

Agilent VNA model number	ECal module model number	85097B Required
8753E/ES/ET ¹	85090 series	Y
RF PNA series ^{2,3}	85090 Series	N
8719D/ES/ET ¹	85060 Series	Y
8720D/ES/ET ¹	85060 series	Y
8722D/ES/ET ¹	85060 series	Y
ENA series ⁴	N4431A	N

1. Analyzer firmware control available with firmware rev. 7.68.

2. RF PNA series consists of the E8356/7/8A, E8801/2/3A and N3381/2/3A.

3. N4431A will support N3381/2/3A PNAs starting with firmware revision 2.5 around mid 2002.

4. ENA series consists of E5070/1B.

ECal and Agilent network analyzer configurations

PNA and ENA series¹

ECal modules are controlled directly from the PNA and ENA series network analyzers. No external PC is required. Simply connect the ECal module to the USB port on the network analyzer. You can control your calibration from the front panel keys of the PNA series or automatically by your user program.



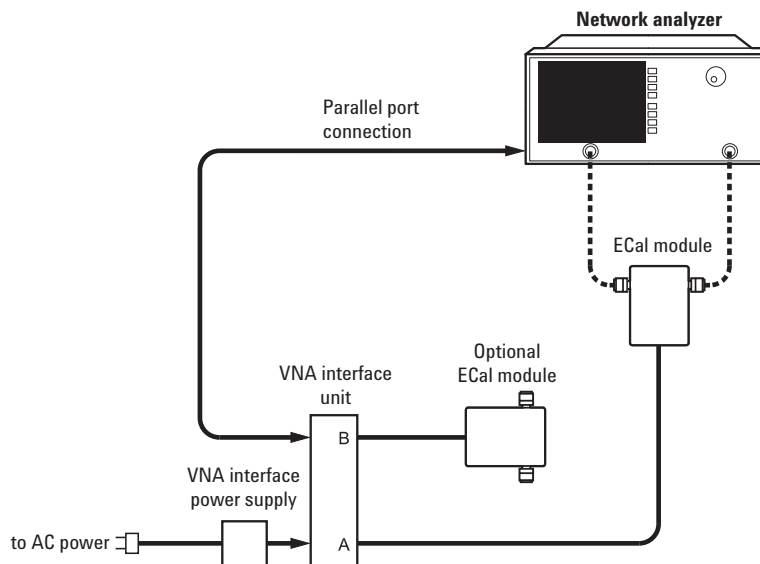
Calibration configuration using the PNA series

8719, 8720, 8722 and 8753 product families

ECal modules are controlled manually or automatically via the 85097B interface module. The 85097B consists of an interface module and a power supply.

The interface module is the interface between the parallel port on your VNA, the parallel port of the ECal module and the external power supply.

Firmware revisions of 7.68 or higher in the 8753 and 8720 families allow for VNA control of ECal modules. The 85097B interface module, with the analyzer's internal firmware control, provides digital control and supplies power to one or two ECal modules. Calibration control is available via the front panel keys or from a user program.



Calibration configuration using the 85097B ECal module

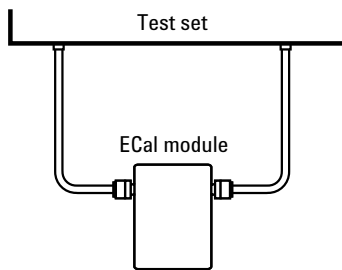
1. RF PNA series consists of the E8356/7/8A, E8801/2/3A and N3381/2/3A. ENA series consists of E5070/1B.

Simple non-insertable calibrations

Most common RF and microwave components have non-insertable connectors; for example, devices with female connectors on both ports. These devices require an adapter removal calibration, which adds an uncertainty factor to the measurement. Most modern vector network analyzers use an adapter removal technique, which compensates for adapter-caused errors.

The simplest and fastest non-insertable calibration method uses an ECal module with connectors that match your device, and the same calibration method as insertable devices. Simply order your ECal module with connectors that match your device under test:

- Option 00M, male connectors on both ports
- Option 00F, female connectors on both ports.
- Option MOF with one male and one female connector.



Perform adapter removal calibrations faster

Some analyzers, such as later versions of the 8753 and 8720, offer adapter removal calibration for non-insertable and mixed connector measurement capability. Since this method requires two full two-port calibrations, it is often time consuming and prone to operator errors. Using ECal to perform the two-port calibrations addresses both of these concerns by reducing the calibration time and the number of connections, simplifying the overall adapter removal process.

Power limits

Maximum input power +20 dBm

Minimum input power -45 dBm

Electrical typical corrected performance (Residual e-terms)

2-port ECal modules

Type-F

85099C (RF)¹

Frequency range	300 kHz to 300 MHz	300 MHz to 1 GHz	1 to 3 GHz
Directivity (dB)	50	48	43
Source match (dB)	48	45	38
Reflection tracking (\pm dB)	0.03	0.07	0.15
Transmission tracking (\pm dB)	0.08	0.10	0.17
Load match (dB)	43	41	39

85099C (RF)²

Frequency range	300 kHz to 300 MHz	300 MHz to 1 GHz	1 to 3 GHz
Directivity (dB)	48	43	32
Source match (dB)	46	41	26
Reflection tracking (\pm dB)	0.06	0.09	0.35
Transmission tracking (\pm dB)	0.08	0.12	0.35
Load match (dB)	43	40	29

1. When mated with male connectors with a 0.77 mm (0.030 in) to 0.86 mm (0.034 in) pin diameter

2. Typical values when mated with male connectors with a 0.56 mm (0.022 in) to 1.07 mm (0.042 in) pin diameter

Type-N (50 ohms)

85092C (RF)

Frequency range	300 kHz to 1 GHz	1 to 3 GHz	3 to 6 GHz	6 to 9 GHz
Directivity (dB)	52	54	52	47
Source match (dB)	45	44	41	36
Reflection tracking (\pm dB)	0.04	0.04	0.06	0.07
Transmission tracking (\pm dB)	0.04	0.04	0.07	0.14
Load match (dB)	47	47	44	39

85064B (microwave)

Frequency range	1 to 2 GHz	2 to 8 GHz	8 to 18 GHz
Directivity (dB)	50	49	46
Source match (dB)	46	45	40
Reflection tracking (\pm dB)	0.034	0.046	0.065
Transmission tracking (\pm dB)	0.043	0.050	0.14
Load match (dB)	46	44	40

Option 001	Add RF ECal module (300 kHz to 9 GHz)	See 85092C specifications
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Type-N (75 ohms)

85096C (RF)

Frequency range	300 kHz to 300 MHz	300 MHz to 1 GHz	1 to 3 GHz
Directivity (dB)	50	48	43
Source match (dB)	48	45	38
Reflection tracking (\pm dB)	0.03	0.06	0.10
Transmission tracking (\pm dB)	0.08	0.09	0.16
Load match (dB)	43	41	39

3.5 mm¹

85093C (RF)

Frequency range	300 kHz to 1 GHz	1 to 3 GHz	3 to 6 GHz	6 to 9 GHz
Directivity (dB)	52	52	50.5	47
Source match (dB)	44	44	39	34
Reflection tracking (\pm dB)	0.03	0.03	0.05	0.07
Transmission tracking (\pm dB)	0.04	0.05	0.07	0.12
Load match (dB)	47	47	44	40

1. 3.5 mm modules have precision slotless connectors that guarantee the best calibration accuracy is transferred to your system.

3.5 mm¹ (continued)

85062B (microwave)

Frequency range	1 to 2 GHz	2 to 8 GHz	8 to 20 GHz	20 to 26.5 GHz
Directivity (dB)	48	49	46	44
Source match (dB)	45	43	40	37
Reflection tracking (\pm dB)	0.041	0.041	0.064	0.088
Transmission tracking (\pm dB)	0.048	0.068	0.13	0.17
Load match (dB)	45	43	40	38

Option 001	Add RF ECal module (300 kHz to 9 GHz)	See 85093C specifications
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7 mm

85091C (RF)

Frequency range	300 kHz to 1 GHz	1 to 3 GHz	3 to 6 GHz	6 to 9 GHz
Directivity (dB)	52	56	55	45
Source match (dB)	45	44	41	34
Reflection tracking (\pm dB)	0.04	0.04	0.07	0.1
Transmission tracking (\pm dB)	0.060	0.06	0.130	0.23
Load match (dB)	47	47	46	39

85060B (microwave)

Frequency range (GHz)	1 to 2 GHz	2 to 8 GHz	8 to 18 GHz
Directivity (dB)	50	49	46
Source match (dB)	46	45	40
Reflection tracking (\pm dB)	0.032	0.046	0.065
Transmission tracking (\pm dB)	0.043	0.050	0.14
Load match (dB)	46	44	40

Option 001	Add RF ECal module (300 kHz to 9 GHz)	See 85091C specifications
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7-16

85098C (RF)

Frequency range	300 kHz to 1 GHz	1 to 3 GHz	3 to 6 GHz	6 to 7.5 GHz
Directivity (dB)	47	50	46	45
Source match (dB)	43	43	38	37
Reflection tracking (\pm dB)	0.03	0.03	0.05	0.06
Transmission tracking (\pm dB)	0.05	0.06	0.08	0.10
Load match (dB)	42	43	41	38

1. 3.5 mm modules have precision slotless connectors that guarantee the best calibration accuracy is transferred to your system.

4-port modules

Type-N 50 ohm

N4431A (RF), option 020

Frequency range	300 kHz to 1 GHz	1 to 3 GHz	3 to 6 GHz	6 to 8 GHz	8 to 9 GHz
Thru paths AB, CD, AD, BC					
Directivity (dB)	55	52	47	44	42
Source match (dB)	47	43	42	40	39
Reflection tracking (dB)	±0.03	±0.04	±0.04	±0.05	±0.06
Transmission tracking (dB)	±0.07	±0.1	±0.14	±0.2	±0.22
Load match (dB)	47	45	40	38	35
Thru paths AC, BD					
Directivity (dB)	55	52	47	44	42
Source match (dB)	47	43	42	40	39
Reflection tracking (dB)	±0.03	±0.04	±0.04	±0.05	±0.06
Transmission tracking (dB)	±0.07	±0.09	±0.13	±0.15	±0.16
Load match (dB)	47	45	40	38	36

3.5 mm

N4431A (RF), option 010

Frequency range	300 kHz to 1 GHz	1 to 3 GHz	3 to 6 GHz	6 to 8 GHz	8 to 9 GHz
Thru paths AB, CD, AD, BC					
Directivity (dB)	57	55	52	50	47
Source match (dB)	50	47	45	44	43
Reflection tracking (dB)	±0.03	±0.03	±0.04	±0.04	±0.05
Transmission tracking (dB)	±0.06	±0.09	±0.12	±0.14	±0.2
Load match (dB)	47	46	45	44	42
Thru paths AC, BD					
Directivity (dB)	57	55	52	50	47
Source match (dB)	50	47	45	44	43
Reflection tracking (dB)	±0.03	±0.03	±0.04	±0.04	±0.05
Transmission tracking (dB)	±0.06	±0.08	±0.1	±0.12	±0.14
Load match (dB)	47	46	45	45	43

Ordering information ECal modules and available options ^{1,2}

1. Select an ECal module based on the connector type required and the frequency range of your vector network analyzer (refer to table below).
2. Order the 85097B interface module if you will be using ECal with your 8719, 8720, 8722 or 8753. (Please reference the ECal and network analyzer/firmware compatibility table on page 3.) The 85097B consists of an interface module and a power supply. If you will be using the 85097B to control an older 85060 series module with a serial number below 800, the module will require a slight modification by an Agilent service center.

2-port

Connector Type ³	Frequency range	ECal module model number	Available options
Type-F	300 kHz to 3 GHz ⁴	85099C	00A, 00F, 00M, UK6, M0F
Type-N 50 ohms	300 kHz to 9 GHz ⁴	85092C	00A, 00F, 00M, UK6, M0F, mixed connectors
Type-N 50 ohms	1 GHz to 18 GHz	85064B	001, 00A, 00F, 00M, UK6, M0F
Type-N 75 ohms	300 kHz to 3 GHz ⁴	85096C	00A, 00F, 00M, UK6, M0F
3.5 mm	300 kHz to 9 GHz ⁴	85093C	00A, 00F, 00M, UK6, M0F, mixed connectors
3.5 mm	1 GHz to 26.6 GHz	85062B	001, 00A, 00F, 00M, UK6, M0F
7 mm	300 kHz to 9 GHz ⁴	85091C	UK6
7 mm	1 GHz to 18 GHz	85060B	001, UK6
7-16	300 kHz to 7.5 GHz ⁴	85098C	00F, 00M, UK6, M0F, mixed connectors

4-port

Connector Type ³	Frequency range	ECal module model number	Available options
3.5 mm or Type-N 50 ohms	300 kHz to 9 GHz	N4431A	010, 020, UK6, mixed connectors

Options

Option	Description
001	Adds a 300 kHz to 9 GHz RF module ⁴
00F	Replace f-m connectors on ECal module(s) with f-f connectors
00M	Replace f-m connectors on ECal module(s) with m-m connectors
00A	Adds male-to-male and female-to-female adapters (also adds a 5/16" 90 N-cm (8 in-lb) torque wrench to 3.5 mm modules)
UK6	Commercial calibration certificate with measured data
M0F	f-m connectors on ECal module(s) ⁵
010	Four female, 3.5 mm connectors
020	Four female, Type-N 50 ohm connectors

1. 85060 series modules cover a frequency range of 1 GHz to either 18 or 26.5 GHz. The upper frequency is limited by the connector cutoff frequency. Each module is supplied with a torque wrench and foam-padded wood storage box.
2. 85090 series modules cover a frequency range of 300 kHz to 3 GHz, 7.5 GHz or 9 GHz. Each module is supplied with a torque wrench and foam-padded wood storage box.
3. The standard ECal modules, except 7 mm modules, have one female and one male connector. (This is option M0F for 8509x modules).
4. RF ECal module performance is typical from 300 kHz to 3 GHz, 7.5 GHz, or 9 GHz.
5. This option is required to receive one male and one female connector for 85062B/4B, as of July 2002.

Mixed connector options

2-port (85092C/3C/8C ECal modules only)

Model number	Port A option			Port B option					
	Type	(f)	(m)	Type	(f)	(m)	Type	(f)	(m)
85092C	Type-N 50 ohm	103	104	3.5 mm	201	202	7-16 ¹	205	206
85093C	3.5 mm	101	102	Type-N 50 ohm	203	204	7-16 ¹	205	206
85098C	7-16 ¹	105	106	3.5 mm	201	202	Type-N 50 ohm	203	204

4-port (N4431A ECal module only)

Connector type	Port A option	Port B option	Port C option	Port D option
3.5 mm (f)	101	201	301	401
3.5 mm (m)	102	202	302	402
Type-N 50 ohm (f)	103	203	303	403
Type-N 50 ohm (m)	104	204	304	404
7-16 (f) ¹	105	205	305	405
7-16 (m) ¹	106	206	306	406

1. Limits ECal module high frequency to 7.5 GHz.

Additional web resources

ECal web page:

www.agilent.com/find/ecal

Other application and product information:

www.agilent.com/find/test



Agilent Email Updates

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Product specifications and descriptions in this document subject to change without notice.

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Printed in USA April 9, 2002

5963-3743E

