



**LA Techniques Ltd**

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## LA19-13-04B 8.5 GHz Vector Network Analyser

### Overview and Data Sheet

The LA19-13-04B is a 8.5 GHz USB controlled Vector Network Analyser capable of providing professional performance and capability at an unprecedented level of affordability. The instrument uses a four-receiver architecture allowing support for 8 error terms calibration techniques as well as traditional 12 error terms correction.

The LA19-13-04B uses a highly integrated design in order to provide a uniquely affordable solution which nevertheless boasts exceptional performance such frequency translation measurements, close to 124 dB of dynamic range, 0.006 dB rms trace noise at its maximum operating bandwidth of 140 kHz, a maximum measurement speed of 190  $\mu$ s per point for all 4 s-parameters and 10 Hz frequency setting resolution. All of this in a compact package with a footprint of 29 cm x 17 cm.

The LA19-13-04B can be supported by most commercially available calibration kits as well as LA Technique's precision PC3.5 calibration kits. These are TRL referred offering excellent accuracy and value.



### Take anywhere professional performance

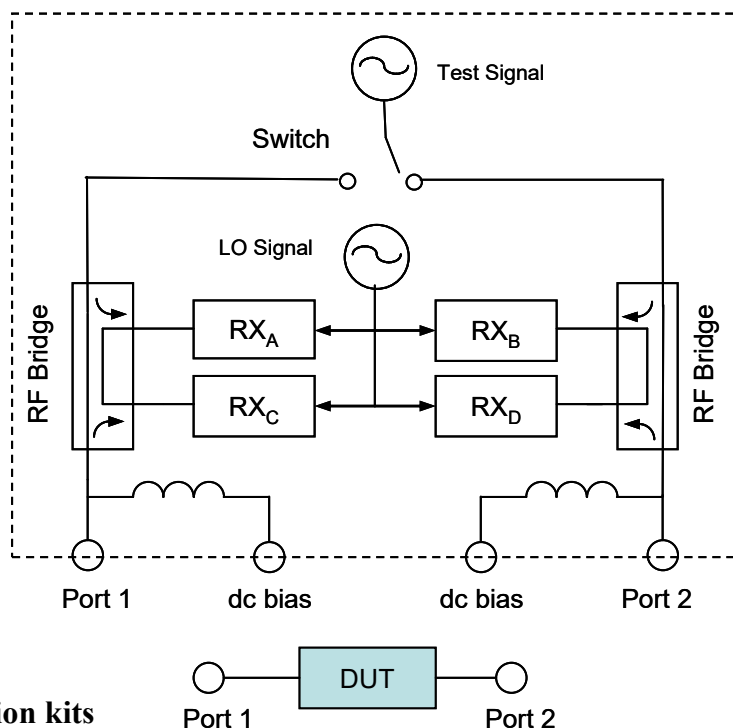
- Fast speed of 190  $\mu$ s per frequency point for all 4 s-parameters measurements
- TRL/TRM Calibration
- Network de-embedding and reference plane extension
- Up to 124 dB of dynamic range
- Unique Save on Trigger facility allows capture of over 1000 sweeps
- Time domain transmission and reflectometry
- EasyCal Electronic calibration module support
- Signal generator (CW and frequency sweep) utility

## Four receiver architecture

At the centre of the instrument is a four receiver architecture. This approach is more complex than traditional three or even two receiver arrangements but has the benefit that the imperfections of the forward / reverse switch can be removed mathematically. This in turn allows 8-term calibration methods such as the ‘unknown thru’ and TRL/TRM to be implemented.

The forward / reverse switch has been designed to achieve very fast settling times so that both forward and reverse measurements can be taken at every frequency point tuned by the signal synthesizers. Some competing instruments require two frequency sweeps as the switch is too slow, taking tens of milliseconds to settle.

The hardware implementation provides sweep trigger signals to allow synchronised measurements to be carried out. Another feature of the hardware is the provision of bias-Ts which provide a means of powering up active devices under test.



## Precision mechanical and electronic calibration kits

Precision PC3.5 calibration kits are available as optional accessories. These kits are data based. That means that each of the standards (Short, Open, Load and Thru) is defined by measured data rather than the more traditional approach of model parameters. The advantage of measured data is of lower cost but without sacrificing accuracy. The LA19-17-01 EasyCal electronic calibration kit allow accurate, fast and convenient calibration to be performed in seconds.

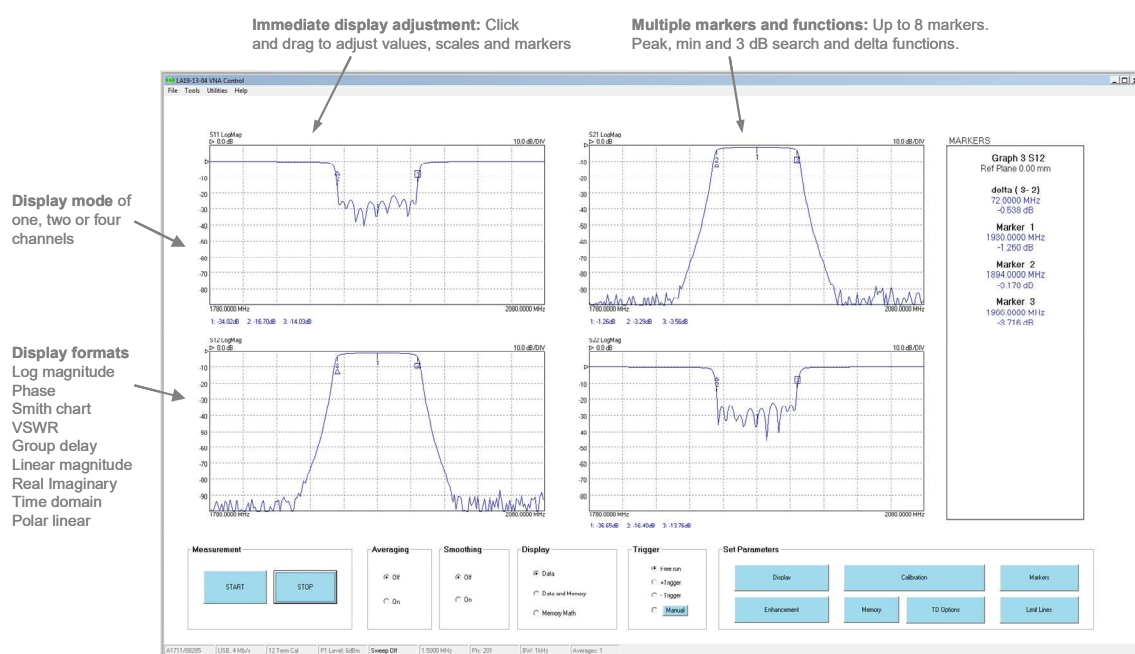
Each of the standards is characterised over the range 1 MHz to 8.5 GHz in two bands. From 1 MHz to 1.0 GHz they are measured using a reference VNA with a commercial precision calibration kit and SOLT (Short/Open/Load/Thru) calibration. Above 1.0 GHz a TRL calibration is employed to carry out very accurate measurements referred to a precision air line. A further refinement is the application of post-measurement processing to remove systematic errors introduced by small variations of the characteristic impedance of the air line associated with effects of skin depth, particularly at the lower microwave frequencies.



## Comprehensive and easy to use software

The user interface software was developed by experienced users of VNAs with ease of use being the key driver. The main tasks such as calibration, display set up and measured data saving are simple and straightforward to carry out.

The combination of professional grade performance, small size, weight and cost make the LA19-13-04B ideal for a range of applications including research and development, production, field service, installation test, and classroom applications. With its support for remote automation, the LA19-13-04B is also ideal for ATE applications. With respect to production testing, there is the ability to set up limit lines with up to 11 segments over the measurement band for limit line testing. Visual and audio limit fail alarms are provided.



Reference plane extension (manual and automatic) together with network de-embedding provide very useful aids to measurement of, for example, surface mount components.

Support for Unknown Thru calibration, an efficient method for measuring devices which are not 'insertable', for example, typical evaluation boards fitted with female SMA connectors at both ends.

LA Techniques have been designing and manufacturing USB driven VNAs for close to 20 years and all versions of the software have included a simple to use calibration kit editor. The editor with the LA19-13-04B allows for very quick creation of calibration kits from either model data or measured data. This versatility allows kits to be created for most commercially available calibration kits. Using the editor, the user can also quickly create "clone" kits from precision kits using low cost parts.

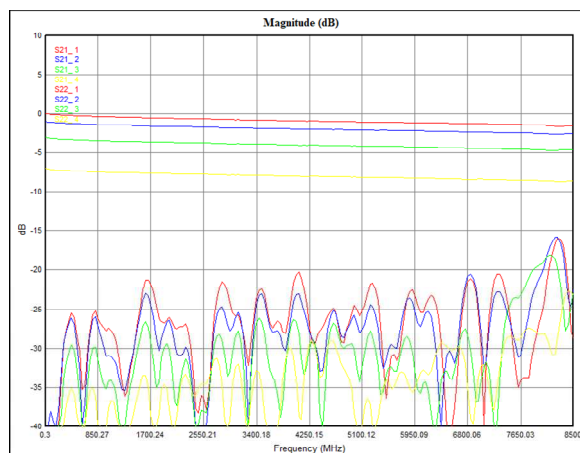
Other useful utilities include Data Compare (compares measured data with reference data loaded from disk), P1dB gain compression measurement, AM to PM conversion measurement and a signal generator function able to operate in CW or frequency sweep modes. Sweep plans of up to 1001 points are allowed with adjustable dwell times of between 250  $\mu$ s and 60,000  $\mu$ s.

## Save on Trigger

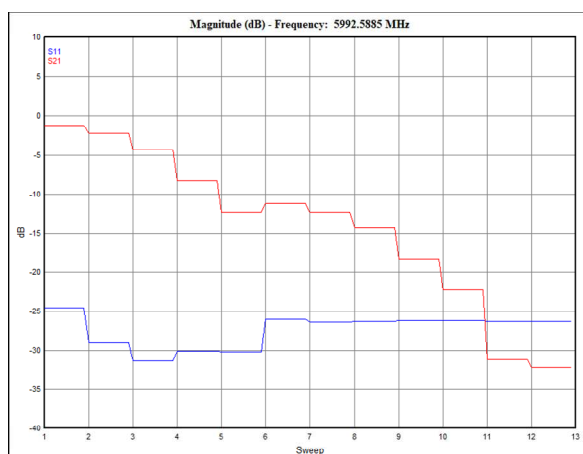
The save on trigger facility on the LA19-13-04B provides a unique and convenient way of capturing measurement data from multi-state devices such as variable attenuators, phase shifters or variable gain amplifiers. The instrument can be set up to store up to 1024 triggered sweep measurements which can then be inspected, re-ordered and saved to disk in a number of formats.

Captured measurement sweeps can be selectively plotted in a number of formats. The default mode is as shown on the right where the various sweep measurements are all plotted over the band of operation. The user can choose to plot from one s-parameter to all four s-parameters with up to 64 traces being displayed at any time. The sweeps plotted can be any sub-set of all the captured sweeps.

It is possible to plot data normalised to one of the captured sweeps. A useful way of examining changes from sweep to sweep.



Capture and inspect multiple measurement sweeps



Captured data can be plotted for a single frequency

Another way of examining the data is to plot it for a single frequency. The plot here on the left shows the S21 and S11 values (magnitude in dBs) at 5.992 GHz of 12 states of a programmable attenuator. In the graph, the horizontal axis shows the measurement sweep number which represents a unique state of the attenuator. The frequency at which data is plotted is chosen by the user and can be any of the sweep points in the set calibration plan. All 4 s-parameters can be displayed simultaneously in this way on the graph.

The captured sweep data can be saved to disk in a number of formats including Touchstone© for use with third party applications.

Data can also be saved ordered by s-parameter. For example, the file list here on the right shows the files created for a stepping attenuator. The user simply enters the name 'Step\_Attn' when saving the data and the family of files shown is automatically created. In each of these files each column contains the s-parameter data for a given sweep. So, the first column after the frequency column contains data from the first sweep, the second has data from the second sweep and so on.

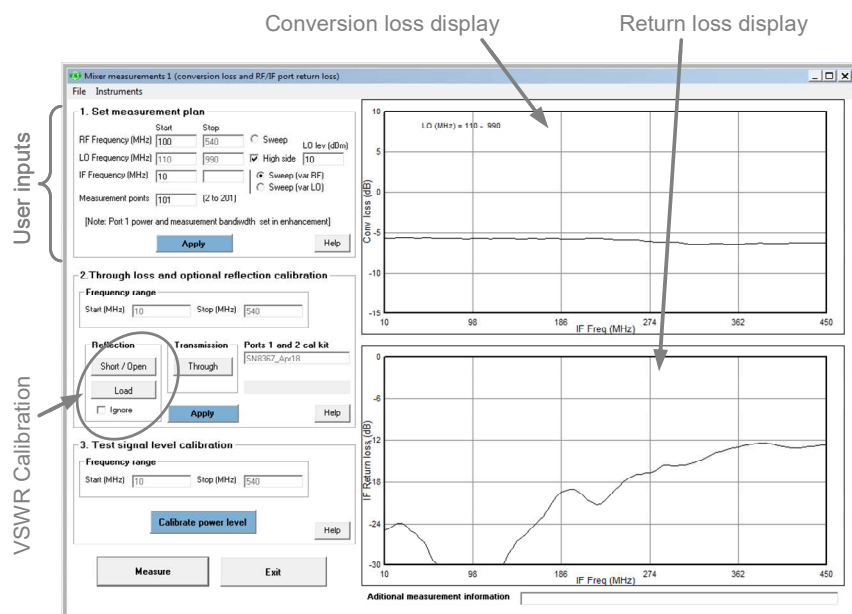
### Name

Step\_Attn\_S11.dat  
Step\_Attn\_S12.dat  
Step\_Attn\_S21.dat  
Step\_Attn\_S22.dat

Data can be saved to disk ordered by s-parameter

The data can also be saved for any single frequency within the sweep range used to capture the data. In addition, the other save option is to save the entire set of captured data so that it can be re-loaded later for plotting and or re-saving.

## Mixer measurements



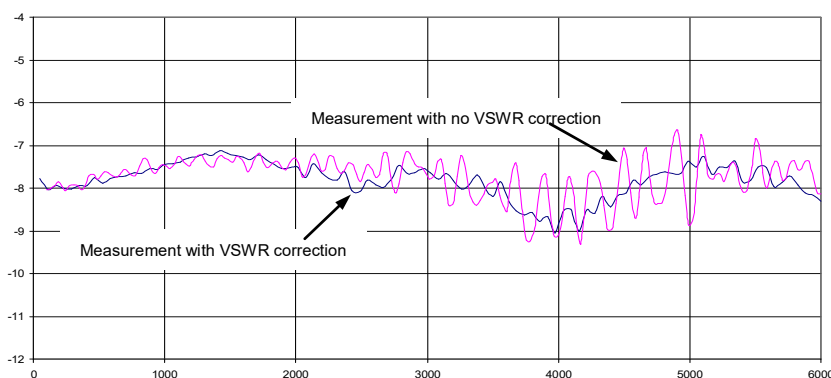
- External LO support
- External Power Meter support

A wide range of mixer measurements can be carried out including swept RF or IF with a choice of low or high side LO. Support for an external LO source and power meter is provided. Contact the factory for your choice of external LO generator to be considered.

In addition to the above, port to port isolation measurements can also be carried out.

- VSWR Correction

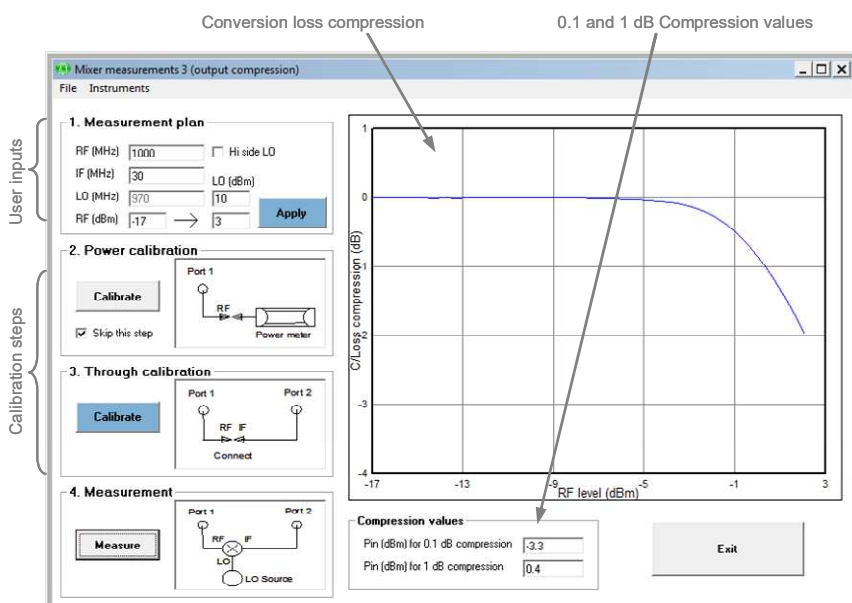
Mixers with high port VSWRs can be difficult to measure accurately. The LA19-13-04B mixer measurement calibration includes the option of VSWR error correction. This reduces the conversion loss measurement uncertainty as shown in the diagram.



- Mixer compression

Conversion loss variation as a function of the input RF level can easily be carried out. Level calibration can be done using an external power meter or the internal sensitivity of the instrument receiver.

The 0.1 and 1 dB compression points are displayed on completion.



## Specification

The instrument's specification is given below. Unless otherwise stated, the figures apply with a 10Hz resolution bandwidth, at 0dBm test power using a 12-term calibration with no averaging and no interpolation and at an ambient temperature of between 20°C and 30°C but within 1°C of the calibration temperature and 60 minutes after power up. Where applicable, the figures apply to the use of LA's calibration kits DW97157 Iss.2.0 and DW97158 Iss.2.0 or better precision kits. TRL calibrations with up to two reference transmission lines supported.

### Receiver Characteristics

Measurement Bandwidth (Hz):  
140 k, 70 k, 35 k, 15 k, 10 k, 5 k,  
1 k, 500, 100, 50, 10

**Average displayed noise floor**, across the band specified, dB below the test signal level set to maximum power after an S21 calibration with ports terminated as during the isolation calibration step

Band (MHz)	Typical	Max
0.3 - 1	-100	-90
1 – 6000	-124	-110
> 6000	-120	-100

**Dynamic Range**, with 10Hz bandwidth, maximum test power and no averaging: see graph (typical, excludes crosstalk)

**Temperature stability**, measured after an S21 calibration, typical:

0.02 dB/ ° C for  $F < 4$  GHz

0.04 dB/ ° C for  $F \geq 4$  GHz

**Trace noise, dB rms**, measured using a 201 points sweep covering 0.3 MHz to 8.5 GHz and test power set to 0 dBm

Bandwidth	Typical	Max
10 kHz	0.0006	0.002
70 kHz	0.003	0.005
140 kHz	0.006	0.01

### Measurement Uncertainty

In addition to the conditions outlined earlier in this section, the figures apply for a 12 error term calibration (insertable device) carried out with a good quality 3.5 mm calibration kit capable of achieving the performance specified.

#### Reflection measurements

Range	Magnitude	Phase
-15 dB to 0 dB Freq < 2MHz Freq > 2MHz	0.7 0.5	8° 4°
-25 dB to -15 dB Freq < 2MHz Freq > 2MHz	0.8 1.0	6° 10°
-30 dB to -25 dB Freq < 2MHz Freq > 2MHz	3.0 3.0	20° 20°

#### Transmission measurements

Range	Magnitude	Phase
+0 dBm to +10 dBm Freq < 2MHz Freq > 2MHz	0.4 0.2	6° 2°
-40 dBm to 0 dBm Freq < 2MHz Freq > 2MHz	0.2 0.1	2° 1°
-60 dBm to -40 dBm Freq < 2MHz Freq > 2MHz	0.5 0.2	8° 4°
-80 dBm to -60 dBm Freq < 2MHz Freq > 2MHz	2.0 1.5	15° 12°

## Spurious responses

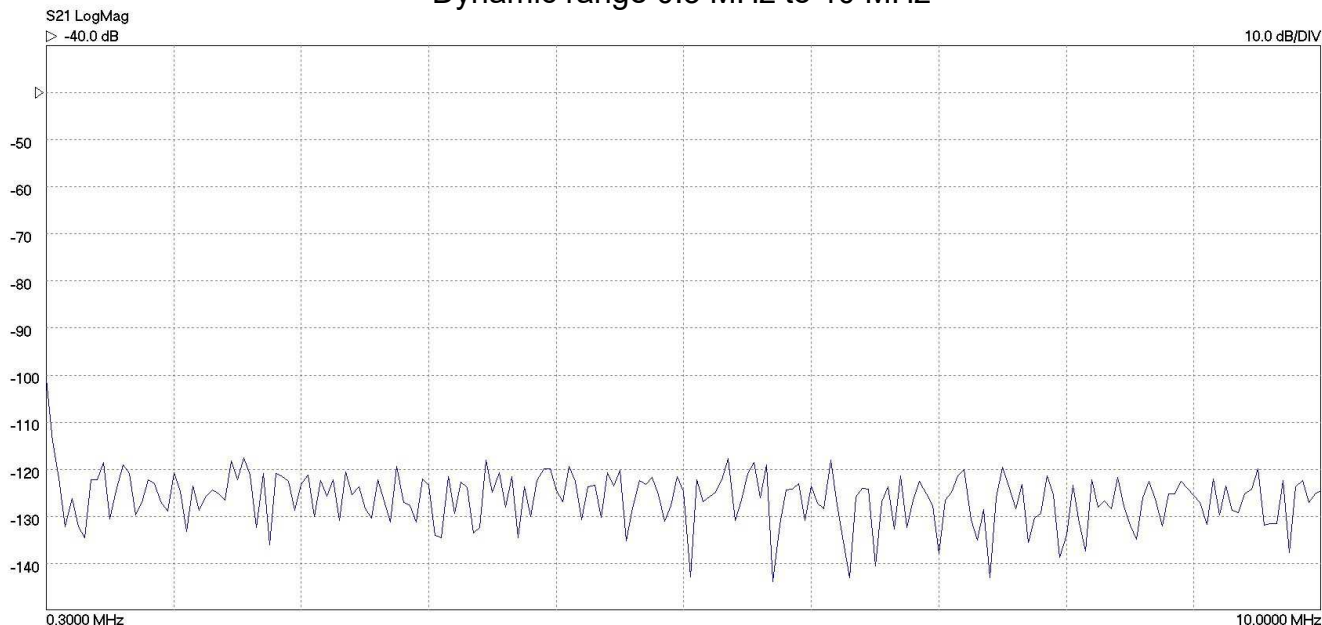
The main spurious responses occur at close to  $(3 \times \text{RF} + 2.6)$  MHz, where RF is the test frequency in MHz. For example, when testing a band-pass filter with a centre frequency of, say 1900 MHz, then an unwanted response may occur around 632.47 MHz. There may also be spurious responses close to  $(2 \times \text{RF} + 1.3)$  MHz. In all known cases the levels will be as follows:

-76 dBc typical, -70 dBc max

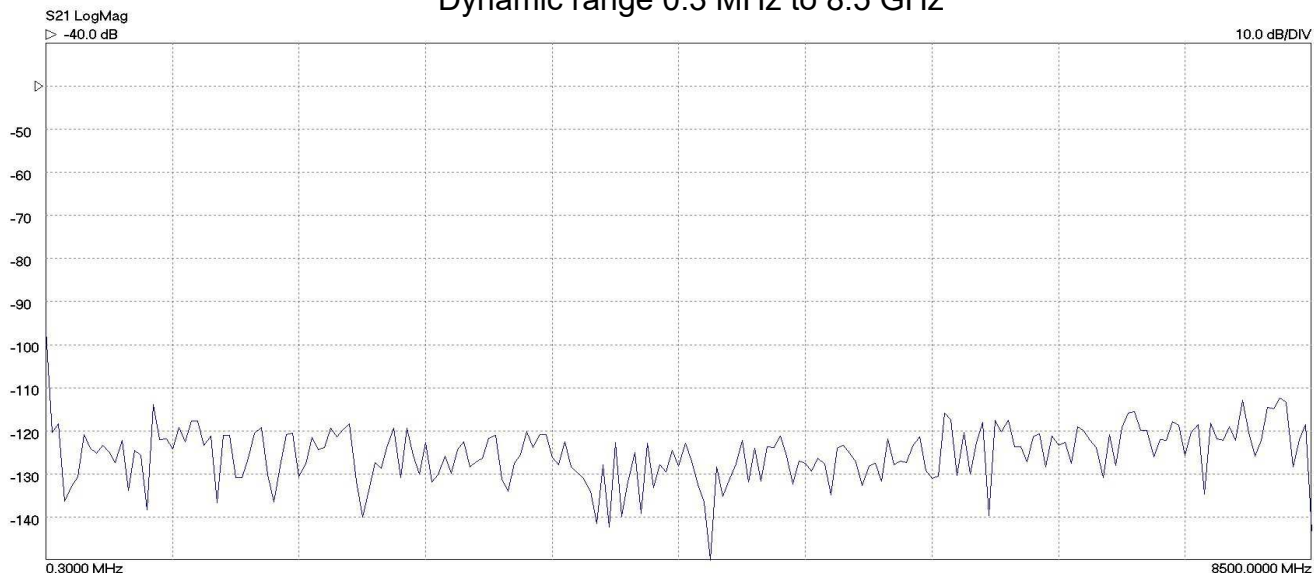
## Dynamic range

Typical, excludes crosstalk, after a 12-term calibration, with the test signal level set to maximum, the IF bandwidth set to 10 Hz and a sweep plan of 201 points. See also the related average displayed noise floor table previously shown.

Dynamic range 0.3 MHz to 10 MHz



Dynamic range 0.3 MHz to 8.5 GHz



## Test port characteristics

### Load match

Uncorrected: 15 dB, typical

Corrected: 46 dB, typical  
40 dB, min

### Source match

Uncorrected: 15 dB, typical

Corrected: 46 dB, typical  
40 dB, min

### Directivity

Corrected: 47 dB, typical  
40 dB, min

### Crosstalk

Corrected, measured with both calibrated ports terminated in short circuits after isolation calibration over band specified.

Band	Typical	Max
< 2 MHz	-100	-90
2 MHz – 6 GHz	-110	-90
6 GHz – 8.5 GHz	-100	-90

### Maximum input level

0.1 dB compression: +10 dBm, typ

### Maximum input level

No damage: +23 dBm

## Measuring functions

### Measuring parameters

S11, S21, S22, S12

Mixer conversion loss, return loss, isolation and compression

P1dB, 1dB gain compression

AM-PM conversion factor

### Error correction

12 error term full s-parameter correction and TRL/TRM correction (insertable DUT)

12 error term full s-parameter correction (non-insertable DUT using calibrated thru adaptor)

8 error term full s-parameter unknown thru adaptor correction (non-insertable DUT)

### Test port connectors

Type N, female

### Bias-T maximum current

250 mA (7.5Ω path resistance, typ)

### Bias-T maximum dc voltage

±15 V

### Bias-T current protection

Built-in resettable fuse

### Bias-T dc port connectors

SMB

### Sweep trigger output voltage

Low: 0 V to 0.8 V

High: 2.2 V to 3.6 V

### Sweep trigger input voltage

Low: -0.1 V to 1 V

High: 2.0 V to 4 V

### Sweep trigger input voltage

No damage: ±6 V

### Sweep trigger in/out connectors

BNC, female on back panel

S11 (1 port correction)

de-embed (2 embedding networks may be specified), impedance conversion

S21 (normalise, normalise + isolation)

S21 (source match correction + normalise + isolation)

Averaging, smoothing,

Hanning and Kaiser Bessel filtering on time domain measurements,

electrical length compensation (manual),  
electrical length compensation (auto),

effective dielectric constant correction,

## Display channels

4 channels

## Traces

2 traces per display channel

## Display formats

Amplitude (logarithmic and linear)  
Phase, Group Delay, VSWR, Real,  
Imaginary, Smith Chart, Polar, Time  
Domain

## Memory trace

One per display channel

## Limit lines

6 segments per channel (overlap allowed)

## Markers

8 markers

## Marker functions

Normal,  $\Delta$  marker, fixed marker, peak /  
min hold, 3 dB and 6 dB bandwidth

## Sweep functions

### Sweep type

Linear sweep  
CW sweep (timed sweep)  
Power sweep (P1dB utility)

### Sweep times

140 kHz bandwidth  
10 MHz to 8.5 GHz sweep  
201 points (12-term cal): 38 ms  
201 points (S21 cal): 25 ms

### Number of sweep points

51, 101, 201, 401, 801, 1024, 2001, 4001,  
9001, 10001

## Signal Source Characteristics

### Frequency range:

300 kHz to 8.5 GHz

### Frequency setting resolution:

10 Hz

### Frequency accuracy:

with ambient of  $23 \pm 3$  °C  
10 ppm max

### Frequency temperature stability:

$\pm 0.5$  ppm/°C max over the range  
 $+15$  °C to  $+35$  °C

### Harmonics:

With test power set to  $< -3$  dBm  
 $-20$  dBc max

### Non-harmonic spurious:

$-40$  dBc typical

### Phase noise (10 kHz offset):

$-90$  dBc/Hz [0.3 MHz to 1 GHz]  
 $-80$  dBc/Hz [1 GHz to 4 GHz]  
 $-76$  dBc/Hz [ $> 4$  GHz]

### Test signal power:

$\leq 6$  GHz:  $+10$  to  $-20$  dBm  
 $> 6$  GHz:  $+6$  to  $-20$  dBm

### Power setting resolution:

0.1 dB

### Power setting accuracy:

$\pm 1.5$  dB

### Reference input frequency:

10 MHz  $\pm 6$  ppm

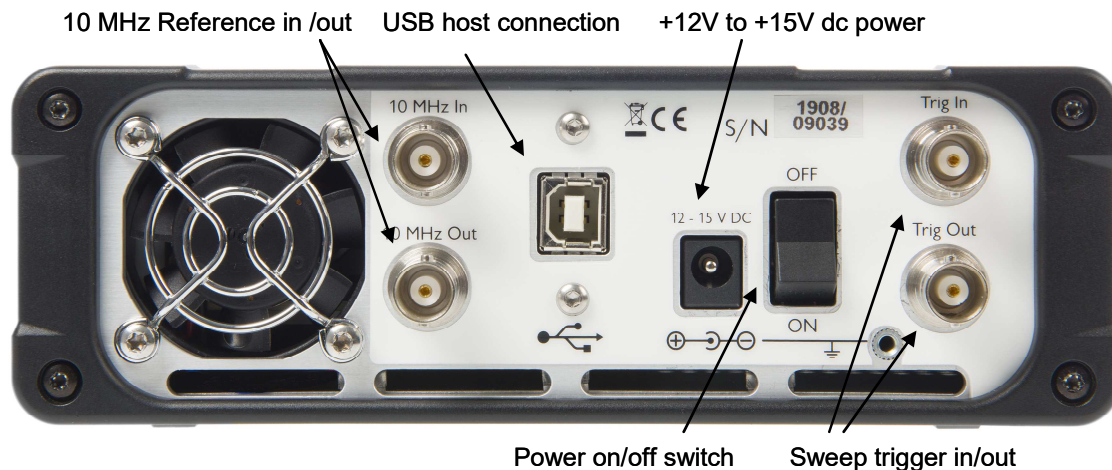
### Reference input level:

$0 \pm 3$  dBm

### Reference output level:

$0 \pm 3$  dBm

## Rear panel connections



## Miscellaneous

**Controlling PC data interface:**  
USB 2.0

**Support for third party test software:**  
Dynamic Link Library (DLL) as part of user interface software

**External dimensions (mm):**  
286 x 174 x 61 (L x W x H)  
Excluding connectors

**Weight:**  
2.1 kg

**Temperature range (operating):**  
+15 °C to +35 °C

**Temperature range (storage):**  
-20 °C to +50 °C

**Humidity:**  
80% max, non-condensing

**Vibration (storage):**  
0.5G, 5 Hz to 300 Hz

**Power source and current:**  
+12 Vdc to +15 Vdc, 1.9A max  
with +15 Vdc supply.

**Power source connector:**  
5.5 mm diameter hole, 2.1 mm diameter  
centre contact pin. Centre pin is positive.

**Host PC requirements:**  
MS Windows© XP or later  
2 GB RAM or more  
Screen resolution 1680x1050 or higher  
A high-performance graphics card is  
recommended for larger (>1001 points)  
sweep points.

## Ordering information

The prices given may exclude any local taxes and shipping costs. Please contact the factory or your local LA Techniques Ltd representative for more information.

The LA19-13-04B is supplied in a carry case, with the operating software in a CD ROM or USB memory stick and with a universal AC to DC power supply capable of operating with a mains voltage of between 90 VAC and 250 VAC.



### Vector Network Analyzer

Item	Description	GBP
LA19-13-04B	VNA, carry case, universal power supply and operating software in a CD ROM (or USB memory stick)	6205

### Calibration Kits

Item	Description	GBP
LA19-17-01 'EasyCal'	Electronic calibration kit suitable for non-insertable and insertable calibrations. Fitted with female or male (option 1) connectors. Supplied with a calibrated adaptor to deal with either female-male or male-female insertable devices. All factory data is stored internally in the device and loaded when needed by the user interface software. The module connects to the host PC via a USB link and includes temperature control to ensure accurate and stable calibrations. The unit is fitted with SMA connectors and characterised using a system fitted with PC3.5 connections.	1250



Item	Description	GBP
DW97157 Iss.2.0	PC3.5 Female calibration kit including female Short, Open, Load and a female to female adaptor all in a presentation case. Kit data in a CD ROM or USB memory stick.	590

Item	Description	GBP
DW97158 Iss.2.0	PC3.5 Male calibration kit including male Short, Open, Load and a male to male adaptor all in a presentation case. Kit data in a CD ROM or USB memory stick.	590

Item	Description	GBP
DW97157 + DW97158	DW97157 and DW97158 (Iss.2.0) in a single presentation case with all kit data in a single CD ROM or USB memory stick	1140

## Test cables

Item	Description	GBP
VcableSet1	Set of two economy flexible test cable, N (male) to PC3.5 (male), 500 to 600 mm long. Flexing phase stability < 3° at 8 GHz	500

Item	Description	GBP
VcableSet2	Set of two precision flexible test cable, N (male) to PC3.5 (male), approximately 600 mm long. Flexing phase stability < 1° at 8 GHz	1000

## Torque spanner

Item	Description	GBP
TSpan1	Suitable for PC3.5 and SMA connectors	149

## Verification device

The DW97194 Iss.4 is an insertable verification device with PC3.5 connectors. It consists of a section of 25Ω transmission line that provides a consistent means of verifying the correct performance of the VNA.

The device is ideal for use with the LA19-13-04B's Compare Data utility as quick and easy way of checking the correct operation of the VNA, associated calibration kits and test cables.



Item	Description	GBP
DW97194 Iss.4	Mismatched line verification device supplied with reference factory data including uncertainty values.	tbd

## Post sales calibration

Item	Description	GBP
VNACal	Factory calibration of LA19-13-04B with up to two calibration kits. Calibration certificate, test report and instrument sticky labels.	305