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BFx-02 Frequency Extender Base Specifications

BFx-02-330	Base unit: 4 GHz to 20 GHz, max extender frequency 330 GHz
BFx-02-500	Base unit: 4 GHz to 20 GHz, max extender frequency 500 GHz
BFx-02-750	Base unit: 4 GHz to 20 GHz, max extender frequency 750 GHz
BFx-02-1000	Base unit: 4 GHz to 20 GHz, max extender frequency 1 THz
Software	S2VNA, Windows only

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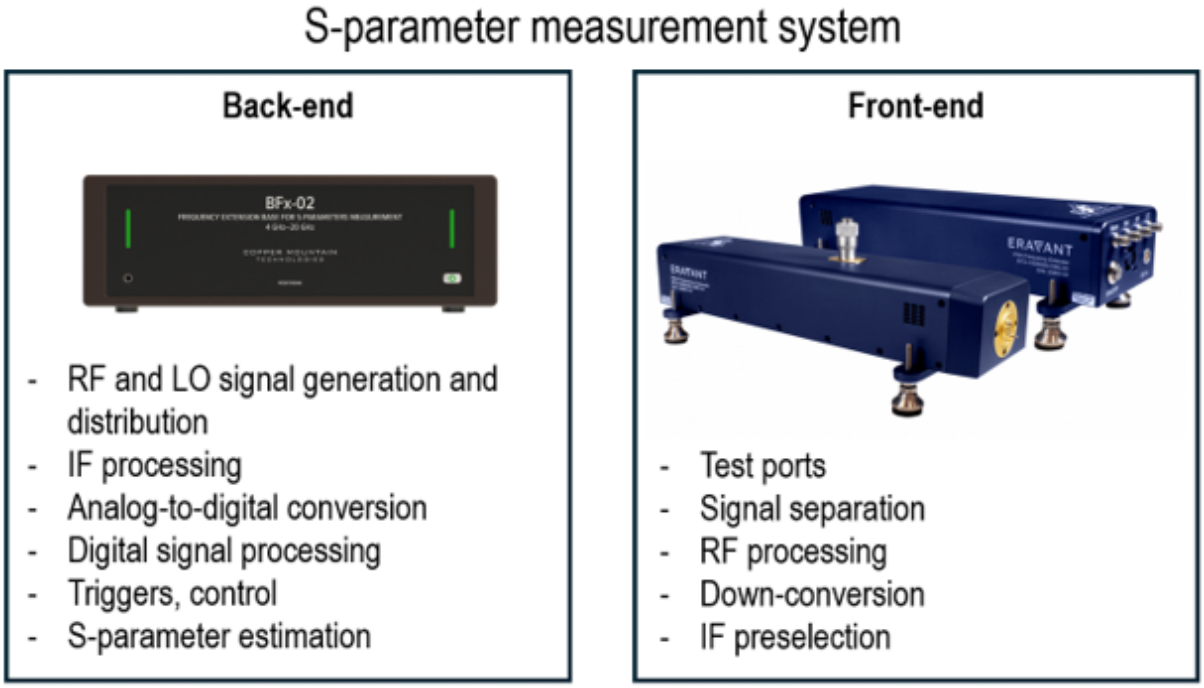
General Overview

BFx-02

Frequency range	4 GHz to 20 GHz
Software	S2VNA
S-parameter setup configuration	2-port, 2-path
Output power range	up to +16 dBm
Number of points	2 to 500,001
Measurement bandwidths with (1/1.5/2/3/5/7 steps)	1 Hz to 1 MHz
Receiver noise floor	-140 dBm/Hz
Connection	USB

Instrument Overview

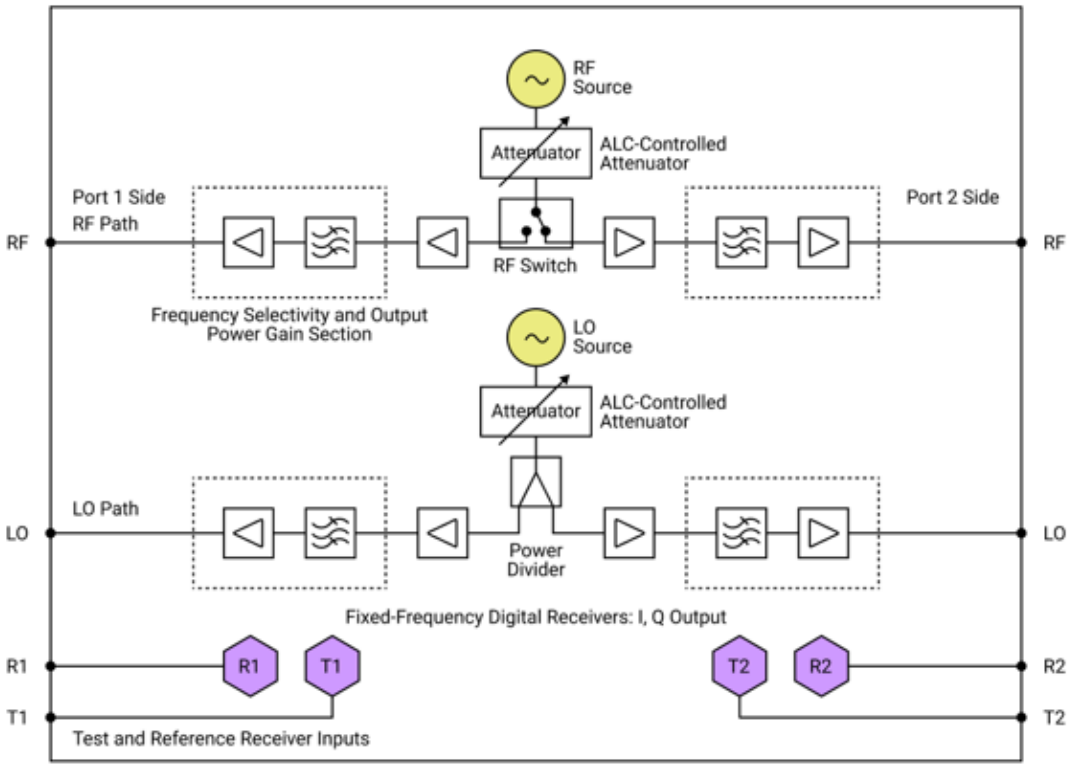
Conceptually, the frequency extension base for S-parameter measurements is derived from a vector network analyzer with the down-conversion mixers and directional bridges removed. In general terms, the base represents the back-end of a network analyzer. It provides generation of RF and LO signals within specified frequency and power ranges, reception of signals at a fixed intermediate frequency (4 receivers), as well as digital processing of the received signals.



Back-end and Front-end Functionalities

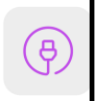
The base is a solution designed to simplify and reduce the cost of mmWave S-parameters measurement. By eliminating the need for a full-featured analyzer in frequency extension setups, the base enables a more streamlined and accessible approach to mmWave testing.

A functional diagram is shown in the figure below.



Functional Diagram of the BFx Frequency Extension Base

Technical Features of the BFx

	The operating frequency range has been selected in accordance with the requirements of the majority of frequency extender manufacturers and spans from 4 to 20 GHz. Eliminating synthesis in the lower frequency range, including switched filtering and ampl-fication stages, was the first step toward simplifying the overall design.
	The output power level has been increased to 16 dBm (20 dBm typical). This enables the use of frequency extenders at a considerable distance from the base without the need for additional booster amplifiers.
	The selective circuitry has been optimized to suppress subharmonic components in the output signal spectrum. These parasitic components are particularly critical when operating with harmonic mixers: when present at the input, they can generate false IF products and produce spurious responses within the operating frequency range of the extenders. As a result, measurement accuracy may be degraded and the system dynamic range can be limited.
	An improved reference frequency calculation algorithm for fractional synthesizers - this has reduced the level of non-harmonic spectral components. During frequency multiplication, components tend to increase in amplitude and lead to spikes in the measured responses. The implementation of the new algorithm has enabled nearly spike-free system performance at frequencies above 1 THz with RF and LO multiplication factors exceeding 100.
	The connectors are located on the side panels, enabling smoother cable bend radii when connecting frequency extenders. This greatly improves the ease of working with external modules in flexible placement scenarios on the work surface, including integration into measurement setups.
	The housing has been redesigned, enabling a compact instrument implementation. This has improved the convenience of positioning the base on the workbench and made the overall system more portable.

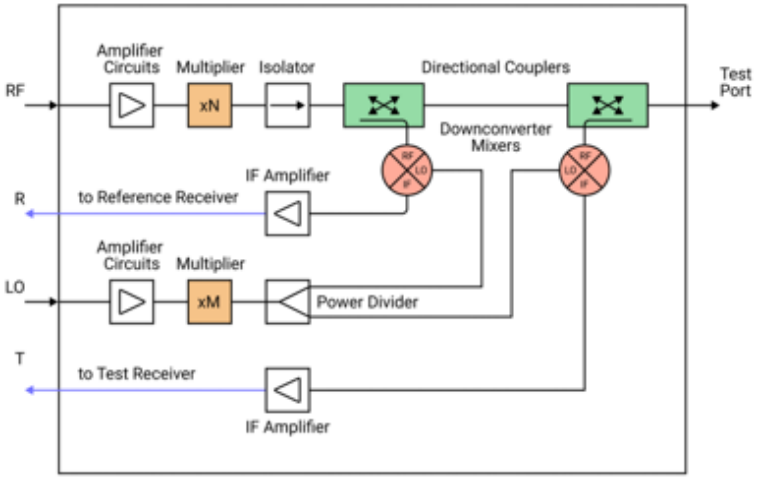
NOTE

The frequency extension base is not intended for standalone S-parameter measurements. Operation requires frequency extenders that perform up- and down-conversion and incorporate signal separation group based on directional couplers or bridges.
Only passive extenders are supported. Passive mode implies that no auxiliary control signals are required for switching internal signal paths or for the operation of automatic power control systems. In this case, RF and LO signals are generated solely by frequency multiplication or conversion.
The base can support simultaneous connection of one or two frequency extenders.

S-Parameter Measurement System

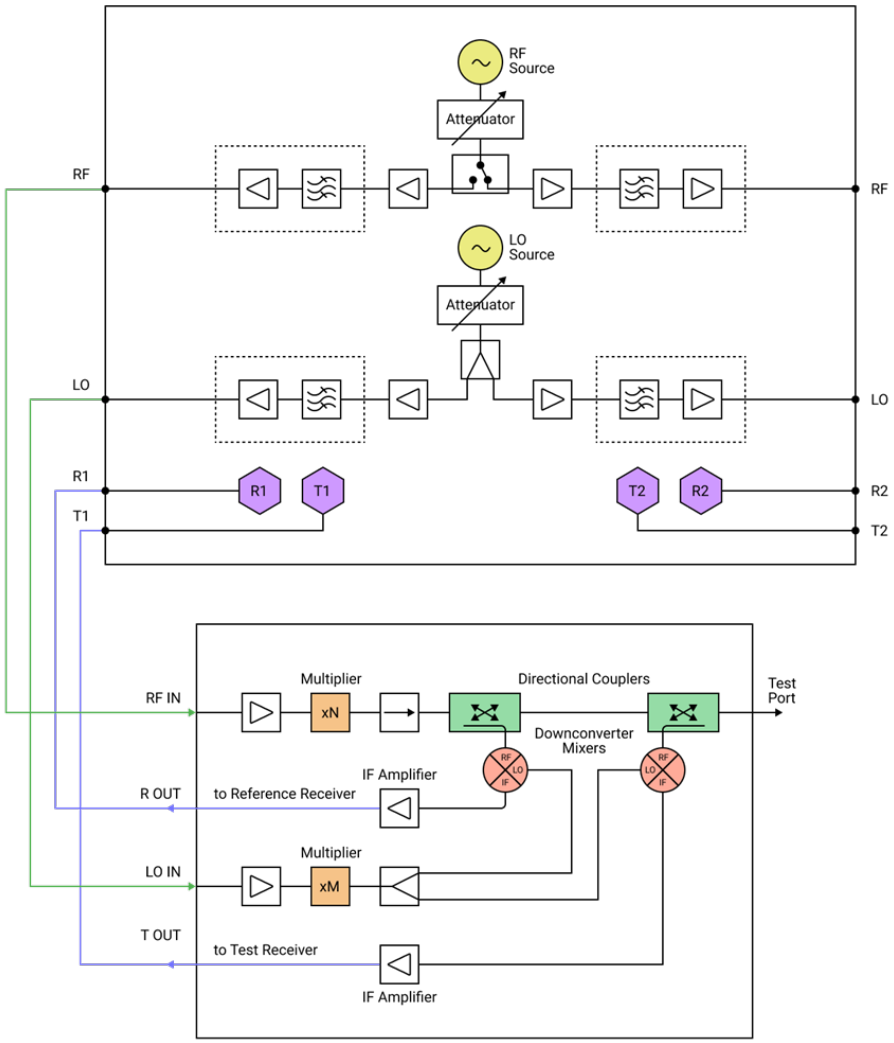
The system combines the frequency extension base with one or two frequency extenders to create a versatile and scalable solution for S-parameter measurements.

The base provides all the required RF and LO signals to drive frequency extenders and IF inputs to process the signals returned from them. Its purpose-built architecture eliminates the need for a traditional VNA in frequency extension setups.



This is the architecture of a typical frequency extender. Usually, this module includes frequency multipliers / up-converters in the RF and LO signal paths, a set of band-specific power amplifiers, waveguide directional couplers, and a pair of down-conversion mixers with IF amplifiers.

Frequency Extension Base and Extender Connection Diagram



Frequency Extension Base and Extender Connection Diagram

Hardware Specifications

BFx-02

Measurement Range[1]

Operating mode	Frequency extension
S-parameter setup configuration	2-port, 2-path
Signal sources	
Operating mode	PLL-based frequency synthesis
Frequency range	4 GHz to 20 GHz
Output power range	up to +16 dBm
Number of points	2 to 500,001
RF signal path	2 ports: switchable
LO signal path	2 ports: power splitting
Receiver	
Operating mode	Fixed frequency
Nominal frequency	109.75 MHz
Dynamic range[2]	130 dB
Measurement bandwidths (with 1/1.5/2/3/5/7 steps)	1 Hz to 1 MHz
Receiver path	4 ports
High sensitivity mode	Supported
Connection	USB
Software	S2VNA

[1] All specifications subject to change without notice.

[2] The dynamic range is defined as the difference between the specified 0.1 dB compression level and the specified noise floor. The specification applies at 10 Hz IF bandwidth.

Signal Sources: RF and LO ports

Frequency	
Range	4 GHz to 20 GHz
Accuracy	$\pm 2 \cdot 10^{-6}$
Resolution	1 Hz
Output power	
Range	-4 dBm to +16 dBm
Accuracy	
RF1, RF2 ports	±2.0 dB
LO1, LO2 ports	±2.5 dB
Resolution	0.05 dB
Temperature dependence	0.06 dB/°C
Sub-harmonic distortion	-45 dBc
Non-harmonic spurs	-40 dBc
Phase noise at 10 GHz	
Frequency offset from the carrier equal to the IF value	-140 dBc/Hz typ.
Output return losses	-10 dB

RF signal port designation	RF
LO signal port designation	LO
Damage level	+23 dBm
Damage DC voltage	25 V
Impedance	50 Ohm
Connector type	SMA, female

Receivers[3]

Nominal frequency	109.75 MHz
0.1 dB compression	
High sensitivity OFF	0 dBm
Low noise amplifier gain	12 dB nominal
Receiver noise floor	-140 dBm/Hz
Linearity within -10 to -70 dBm input range	0.1 dB typ.
Measurement bandwidths (with 1/1.5/2/3/5/7 steps)	1 Hz to 1 MHz
Trace noise magnitude[4]	0.002 dB rms
Temperature dependence	0.02 dB/°C
Input return losses	
High sensitivity OFF (amplifier OFF: bypass mode)	-12 dB
High sensitivity ON (amplifier ON)	-10 dB

[3] Unless otherwise specified, the parameters are given for the high sensitivity OFF mode.

[4] Trace noise is specified at -5 dBm with a 3 kHz IF bandwidth.

Test receiver port designation	T1, T2
Reference receiver port designation	R1, R2
Damage level	+13 dBm
Damage DC voltage	25 V
Impedance	50 Ohm
Connector type	SMA, female

Frequency Reference Input

Port designation	REF 10 MHz IN
External reference frequency	10 MHz
Input level	-2 dBm to 6 dBm
Input impedance	50 Ohm
Connector type	BNC, female

Frequency Reference Output

Port designation	REF 10 MHz OUT
Internal reference frequency	10 MHz
Output reference signal level at 50 Ohm impedance	0 dBm to 6 dBm
Connector type	BNC, female

Trigger Input

Number of ports	1
Port designation	TRIGGER IN
Input level	
Low threshold voltage	0.8 V
High threshold voltage	2.7 V
Input level range	0 V to +5 V
Pulse width	≥2 µs
Polarity	positive or negative
Input impedance	≥10 kOhm
Connector type	BNC, female

Trigger Output

Number of ports	1
Port designation	TRIGGER OUT
Maximum output current	20 mA
Output level	
Low level voltage	0.4 V
High level voltage	3.0 V
Polarity	positive or negative
Connector type	BNC, female

Measurement Speed

Time per point	15 µs typ.
Port switchover time	7 ms

Power and Control Connector

DC voltage	+6.5 V, 2 A max
Control voltage[5]	TTL-compatible
Connector type	LEMO EGG.0B.304.CLL

[5] Logic high indicates the mode where RF PORT 1 is the signal source.

System and Power

Operating system (min requirements)	Windows 10 and above
CPU	4 core 2.0 GHz (x64)
RAM	4 GB
Interface	USB 2.0
Connector type	Type C
Power supply (main outlet)	110-240 V, 50/60 Hz
Power consumption (main outlet)	30 W

Dimensions

Length	326 mm
Width	241 mm
Height	107 mm
Weight	5.2 kg

Environmental Specifications

Operating condition	
Temperature	+5 °C to +40 °C (41 °F to 104 °F)
Humidity	90 % at 25 °C (77 °F)
Storage	
Temperature	+0 °C to +40 °C (32 °F to 104 °F)
Humidity	80 % at 35 °C (95 °F)
Non-operating temperature[6]	-50 °C to +70 °C (-58 °F to 158 °F)
Atmospheric pressure	70.0 kPa to 106.7 kPa

[6] Non-operating temperature specifies the allowable environmental conditions for transporting the instrument. Storage conditions are listed separately in the table.