ROHDE & SCHWARZ

Test and
Measurement Division

Service Manual Instrument

SPECTRUM ANALYZER

FSEA20/30
1065.6000.20/.25/35

FSEB20/30
1066.3010.20/.25/35

FSEM20/30
1080.1505.20/.21/.25
1079.8500.30/.31/.35

FSEK20/30
1088.1491.20/.21/.25
1088.3494.30/.31/.35

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1065.6016.82-14-

Tabbed Divider Overview

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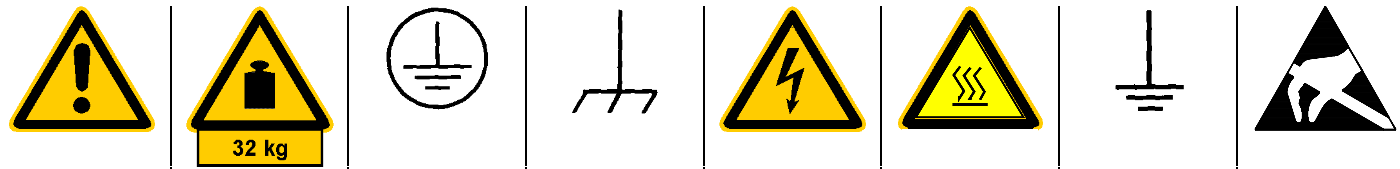
Safety Instructions

This unit has been designed and tested in accordance with the EC Certificate of Conformity and has left the manufacturer's plant in a condition fully complying with safety standards.

To maintain this condition and to ensure safe operation, the user must observe all instructions and warnings given in this operating manual.

Safety-related symbols used on equipment and documentation from R&S:



Observe operating instructions	Weight indication for units >18 kg	PE terminal	Ground terminal	Danger! Shock hazard	Warning! Hot surfaces	Ground	Attention! Electrostatic sensitive devices require special care

1. The unit may be used only in the operating conditions and positions specified by the manufacturer. Unless otherwise agreed, the following applies to R&S products:

   IP degree of protection 2X, pollution severity 2 overvoltage category 2, only for indoor use, altitude max. 2000 m.

   The unit may be operated only from supply networks fused with max. 16 A.

   Unless specified otherwise in the data sheet, a tolerance of ±10% shall apply to the nominal voltage and of ±5% to the nominal frequency.

2. For measurements in circuits with voltages V_{rms} > 30 V, suitable measures should be taken to avoid any hazards.

   (using, for example, appropriate measuring equipment, fusing, current limiting, electrical separation, insulation).

3. If the unit is to be permanently wired, the PE terminal of the unit must first be connected to the PE conductor on site before any other connections are made. Installation and cabling of the unit to be performed only by qualified technical personnel.

4. For permanently installed units without built-in fuses, circuit breakers or similar protective devices, the supply circuit must be fused such as to provide suitable protection for the users and equipment.

5. Prior to switching on the unit, it must be ensured that the nominal voltage set on the unit matches the nominal voltage of the AC supply network.

   If a different voltage is to be set, the power fuse of the unit may have to be changed accordingly.

6. Units of protection class I with disconnectible AC supply cable and appliance connector may be operated only from a power socket with earthing contact and with the PE conductor connected.

7. It is not permissible to interrupt the PE conductor intentionally, neither in the incoming cable nor on the unit itself as this may cause the unit to become electrically hazardous.

   Any extension lines or multiple socket outlets used must be checked for compliance with relevant safety standards at regular intervals.

8. If the unit has no power switch for disconnection from the AC supply, the plug of the connecting cable is regarded as the disconnecting device. In such cases it must be ensured that the power plug is easily reachable and accessible at all times (length of connecting cable approx. 2 m). Functional or electronic switches are not suitable for providing disconnection from the AC supply.

   If units without power switches are integrated in racks or systems, a disconnecting device must be provided at system level.

9. Applicable local or national safety regulations and rules for the prevention of accidents must be observed in all work performed.

   Prior to performing any work on the unit or opening the unit, the latter must be disconnected from the supply network.

   Any adjustments, replacements of parts, maintenance or repair may be carried out only by authorized R&S technical personnel.

   Only original parts may be used for replacing parts relevant to safety (eg power switches, power transformers, fuses). A safety test must be performed after each replacement of parts relevant to safety.

   (visual inspection, PE conductor test, insulation-resistance, leakage-current measurement, functional test).

continued overleaf

10. Ensure that the connections with information technology equipment comply with IEC950 / EN60950.
11. Lithium batteries must not be exposed to high temperatures or fire.

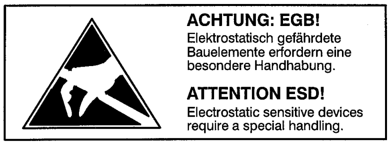
    Keep batteries away from children.

    If the battery is replaced improperly, there is danger of explosion. Only replace the battery by R&S type (see spare part list).

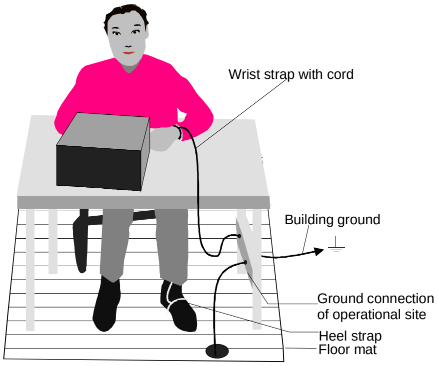
    Lithium batteries are suitable for environmentally-friendly disposal or specialized recycling. Dispose them into appropriate containers, only.

    Do not short-circuit the battery.
12. Equipment returned or sent in for repair must be packed in the original packing or in packing with electrostatic and mechanical protection.
13. Electrostatics via the connectors may damage the equipment. For the safe handling and operation of the equipment, appropriate measures against electrostatics should be implemented.
14. The outside of the instrument is suitably cleaned using a soft, lint-free dustcloth. Never use solvents such as thinners, acetone and similar things, as they may damage the front panel labeling or plastic parts.
15. Any additional safety instructions given in this manual are also to be observed.

The instrument contains components which are hazardous to electrostatic exposure and which are marked by the following symbol:



- To avoid damage of electronic components, the operational site must be protected against electrostatic discharge (ESD).



The following two methods of ESD protection may be used together or separately:

- Wrist strap with cord to ground connection
- Conductive floor mat and heel strap combination

The batteries used in the instrument are high-power lithium cells with a life utility of approx. 5 years. If you do not handle them properly, there is a danger of explosion. Therefore, observe the following safety instructions:

- Avoid short-circuit and loading of the battery
- Do not expose lithium batteries to high temperature or fire.
- Do not open used batteries
- Keep batteries away from children.
- Replace battery only by R&S type battery (R&S ordering number 0565.1687.00)
- Make sure to connect the battery to the appropriate terminals when replacing
- Lithium batteries are suitable for environmentally-friendly disposal or specialized recycling. Dispose them into appropriate containers, only.

Spare Parts Express Service

Phone: **+49 89 4129 - 12465**

Fax: **+49 89 4129 - 13306**

E-mail:werner.breidling@rsd.rohde-schwarz.com

In case of urgent spare parts requirements for this Rohde & Schwarz unit, please contact our spare parts express service.

Outside business hours, please leave us a message or send a fax or e-mail. We shall contact you promptly.

Contents of Manuals for Signal Analyzer FSE

Service Manual - Instrument

The service manual - instrument informs on how to check compliance with rated specifications (performance test), on instrument function, and on selftest of FSE.

The service manual comprises the following chapters:

Chapter 1 provides all the information necessary to check FSE for compliance with rated specifications. The required test equipment is included, too.

Chapter 2 describes the adjustment.

Chapter 3 describes the function of the instruments and the selftest.

Chapter 4 contains information on the extension and modification of FSE by installing instrument software and retrofitting options.

Chapter 5 describes the shipping of the instrument and ordering of spare parts. It contains the documents for the basic instrument.

Service Manual

The service manual modules is not delivered with the instrument but may be obtained from your R&S service department.

The service manual informs on instrument function, repair, troubleshooting and fault elimination. It contains all information required for repairing the FSE by the replacement of modules.

The service manual contains information about the individual modules of FSE. This comprises the test and adjustment of the modules, fault detection within the modules and the interface description.

Operating Manual

In the operating manual for FSE you will find information about the technical specifications of FSE, the controls and connectors on the front and rear panel, necessary steps for putting the instrument into operation, the basic operating concept, manual and remote control.

For introduction typical measurement tasks are explained in detail using the functions of the user interface and program examples.

The operating manual further provides hints on preventive maintenance and fault diagnosis by means of warnings and error messages output by the unit.

Service and Repair

Please contact your Rohde & Schwarz support center or our spare parts express service if you need service or repair of your equipment or to order spare parts and modules.

The list of the Rohde & Schwarz representatives and the address of our spare parts express service are provided at the beginning of this service manual.

We require the following information in order to answer your inquiry fast and correctly and to decide whether the warranty still applies for your instrument:

- Instrument model
- Serial number
- Firmware version
- Detailed error description in case of repair
- Contact partner for checkbacks

Rohde & Schwarz offers the following calibrations:

- Calibration on R&S-type test systems. The calibration documentation meets the requirements of the quality management system ISO 9000.
- Calibration at an R&S calibration center approved by the German Calibration Service (DKD). The calibration documentation consists of the DKD calibration certificate.

Refer to Chapter 5 for a detailed description on shipping of the instrument and ordering of spare parts.

Contents - Chapter 1 "Checking the Rated Specifications"

1 Checking the Rated Specifications

Measuring Equipment and Accessories

Table 1-1 Measuring Equipment and Accessories

Item	Type of equipment	Specifications recommended	Equipment recommended	R&S Order No.	Page
1	Frequency counter	error < 1x10^{-9}, frequency range up to 10 MHz	Advantest R5361B with option 23		1.4
2	Signal generator	FSEA: 10 MHz to 3.5 GHz FSEB: 10 MHz to 7 GHz FSEM: 10 MHz to 26.5 GHz FSEK: 10 MHz to 40 GHz	SMHU SMP02 SMP03 SMP04	0835.8011.52 1035.5005.02 1035.5005.03 1035.5005.04	1.5 1.7 1.9
3	Signal generator	phase noise at 498 MHz: < -100 dBc/Hz @ 100 Hz < -115 dBc/Hz @ 1 kHz < -127 dBc/Hz @ 10 kHz < -130 dBc/Hz @ 100 kHz < -142 dBc/Hz @ 1MHz	SMHU	0835.8011.52	1.4 1.9 1.10 1.12 1.16
4	Signal generator (FSEB / FSEM / FSEK)	FSEB: 10 MHz to 7 GHz FSEM: 10 MHz to 26.5 GHz FSEK: 10 MHz to 40 GHz	SMP02 SMP03 SMP04	1035.5005.02 1035.5005.03 1035.5005.04	1.9 1.16
5	3-dB coupler (power combiner)	decoupling > 12 dB FSEA: 10 MHz to 3.5 GHz FSEB: 10 MHz to 7 GHz FSEM: 10 MHz to 26.5 GHz FSEK: 10 MHz to 40 GHz			1.9
6	6-dB divider (power splitter)	level imbalance 1MHz to 1GHz ≤ 0.15 dB 1GHz to 7GHz ≤ 0.2 dB 7GHz to 18GHz ≤ 0.3 dB 18GHz to 26.5GHz ≤ 0.4 dB 26.5GHz to 40GHz ≤ 0.4 dB FSEA: 10 MHz to 3.5 GHz FSEB: 10 MHz to 7 GHz FSEM: 10 MHz to 26,5 GHz FSEK: 10 MHz to 40 GHz			1.16
7	50-Ω termination	Return loss > 20 dB FSEA: up to 3.5 GHz FSEB: up to 7 GHz FSEM: up to 26.5 GHz FSEK: up to 40 GHz	 RNA RNA Wiltron 28S50 Wiltron 28K50	 0272.4510.50 0272.4510.50	1.15
8	Power meter		NRVD	0857.8008.02	1.3 1.5 1.16

Item	Type of equipment	Specifications recommended	Equipment recommended	R&S Order No.	Page
9	Power sensor	1 MHz to 3.5 GHz RSS ≤ 0.8% Meter noise ≤ 20 pW	NRV-Z4	0828.3618.02	1.3 1.5 1.16
10	Power sensor (FSEB / FSEM / FSEK)	RSS referred to indicated Power: 1 MHz to 1 GHz ≤ 1.5 % 1 GHz to 7 GHz ≤ 2 % 7 GHz to 26.5 GHz ≤ 3.5 % 26.5 GHz to 40 GHz ≤ 4 % FSEB: 10 MHz to 7 GHz FSEM: 50 MHz to 26.5 GHz FSEK: 1 MHz to 40 GHz	 NRV-Z2 NRV-Z6 NRV-Z55	 0828.3218.02 0828.5010.02 1081.2005.02	1.5 1.16
11	Reflection coefficient VSWR bridge (FSEA / FSEB)	directivity > 30 dB FSEA / FSEB: 10 MHz to 3.5 GHz FSEB: 3.5 GHz to 7 GHz	 ZRC Wiltron 87A50 (also required: adapter 34AN50, open/short 22NF50)	1039.9492.55	1.5
12	Network analyzer (FSEM / FSEK)	FSEM: 10 MHz to 26,5 GHz FSEK: 10 MHz to 40 GHz			1.5
13	Step attenuator	variable attenuation 0 dB to 100 dB, 1-dB steps attenuation error < 0.05 dB (f = 5 MHz)	RSP	0831.3515.02	1.18 1.19 1.20
14	Attenuator (2 x)	fixed attenuation 10 dB FSEA: 10 MHz to 3.5 GHz FSEB: 10 MHz to 7 GHz FSEM: 10 MHz to 26.5 GHz FSEK: 10 MHz to 40 GHz	 DNF DNF Wiltron 43KB-10 Wiltron 43KC-10	 0272.4210.50 0272.4210.50	1.9
15	Lowpass[1)]	cut-off frequency: 10 kHz, 40 kHz, 100 kHz, 20 MHz, 29 MHz, 108 MHz, 263 MHz, 454 MHz, 641 MHz, 1.1 GHz, 1.3 GHz, 1.8 GHz			1.10
16	N-connecting cables Tracking RF input	Attenuation up to 7 GHz < 0.1dB			1.24
17	2 DC sources for I and Q	can be set between ±0.5V	NGT35	0191.2019.02	1.24
18	2 DC voltmeters		URE	0350.5315.02	1.25

1) The lowpass filters improve the harmonics suppression of the test signal. If the harmonics suppression at the signal generator output is already large enough, no filters are required for the frequency ranges concerned (see section "Second-Order Harmonic Distortion" for harmonics suppression required)

Test Instructions

The rated specifications of the analyzer are tested after a warm-up time of at least 30 minutes and overall calibration. Only in this case can the compliance with the guaranteed data be ensured.

Values given in the following sections are not guaranteed. Only the technical specifications of the data sheet are binding.

Conventions for setting the FSE during measurements:

[**<KEY>**]	Press a key on the front panel, eg [SPAN]
[<SOFTKEY>]	Press a softkey, eg [MARKER -> PEAK]
[<nn unit>]	Enter a value and terminate by entering the unit, eg [**12 kHz**]

Successive entries are separated by [:], eg [**SPAN**: **15 kHz**]

Checking the Calibration Source at 120 MHz

Note: *If option FSE-B22 is installed see chapter "Test Instructions (option FSE-B22 included)" for test instructions.*

Test equipment:

- signal generator (table 1-1, item 3):
  frequency 120 MHz
  level -40 dBm
- power meter (table 1-1, item 8)
- power sensor (table 1-1, item 9)
  frequency 120 MHz
  maximum power $P_{max} \geq 1\ \mu W$
  meter noise ≤ 20 pW
  RSS ≤ 0.8% referred to indicated power
  impedance Z = 50 Ω

Power meter settings:

➢ connect power sensor to power meter and carry out function ´ZERO´ when no signal is applied to the power sensor.
➢ connect power sensor to RF output of signal generator.

Signal generator settings:

- frequency 120 MHz
- level –40 dBm ± 0.1 dB
  Use power meter for exact level adjustment.

Test setup:

➢ connect RF output of the signal generator to RF input of the FSE

FSE settings:

- [**SYSTEM PRESET**]
- [**FREQUENCY CENTER** : **120 MHz**]
- [**FREQUENCY SPAN** : **15 kHz**]
- [**SWEEP COUPLING** : RES BW MANUAL : **5 kHz**]
- [**LEVEL REF** : REF LEVEL : **-10 dBm**]
- [**INPUT** : RF ATTEN MANUAL : **20 dB**]

➢ set marker to peak of signal
[**MARKER SEARCH** : PEAK]

➢ set reference to peak of signal
[**MARKER DELTA** : REFERENCE FIXED]

➢ switch internal reference generator to RF input
[**CONFIGURATION SETUP** : SERVICE : INPUT CAL]

➢ set marker to peak of signal
[**MARKER SEARCH** : PEAK]

Evaluation: The reading ´Delta 1 [T1 FXD]´ displays the difference between the output level of the signal generator and the level of the calibration source < 0.3 dB

Note: *The level of the calibration source can be adjusted with R22 on FracSyn module.*

Checking the Frequency Accuracy of the Reference Oscillator

Test equipment: frequency counter (table 1-1, item 1):
error < $1x10^{-9}$
frequency range up to 10 MHz

Test setup: - connect frequency counter to 10-MHz reference output of the FSE (rear panel)

FSE settings: - [**CONFIGURATION SETUP** : REFERENCE INT / EXT]
toggle to internal reference (INT)

Measurement: measure frequency with frequency counter

nominal frequency:
Model 20 without OCXO (option B4) ....10 MHz ± 10 Hz
Model 30 or 20 with OCXO (option B4)...................10 MHz ± 1 Hz

Checking the Return Loss at the RF Input

Test equipment:

FSEA / FSEB:

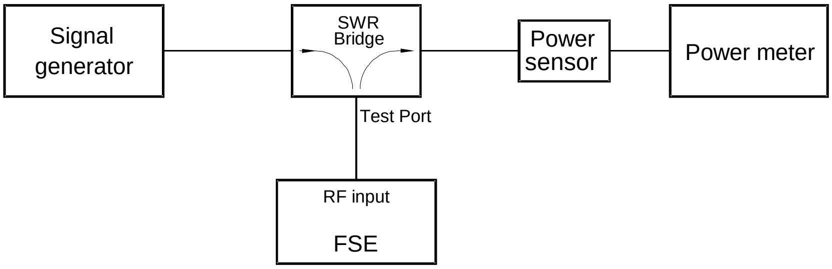
- signal generator (table 1-1, item 2)
  - frequency range FSEA: 10 MHz to 3.5 GHz
  - FSEB: 10 MHz to 7 GHz
  - maximum level ≥ 0 dBm
- power meter (table 1-1, item 8)
- power sensor (table 1-1; FSEA: item 9; FSEB: item 10)
  - frequency range FSEA: 10 MHz to 3.5 GHz
  - FSEB: 10 MHz to 7 GHz
- reflection coefficient bridge (table 1-1, item 11)
  - frequency range FSEA: 10 MHz to 3.5 GHz
  - FSEB: 10 MHz to 7 GHz
  - directivity ≥ 30 dB

FSEM / FSEK:

- network analyzer (table 1-1, item 12)
  - frequency range FSEM: 10 MHz to 26.5 GHz
  - FSEK: 10 MHz to 40 Ghz

Test setup:

FSEA / FSEB:



FSEM / FSEK:
Connect port 1 of network analyzer to RF input of the FSE.

Signal generator settings:
(FSEA / FSEB)

- level 0 dBm
- frequency {f_{in}}

See table 1-2 (item 3) of performance test report for values of f_{in}.

FSE settings:

- [**SYSTEM PRESET**]
- [**INPUT** : RF ATTEN MANUAL : **10 dB**]

Calibration:

FSEA / FSEB:
Use total reflection (OPEN or SHORT) at the test port of the SWR bridge as a reference:
Remove cable from RF input of the FSE and connect precision short or open to the cable. Determine reflected power with the power meter and store measured level L_{Ref} as reference. Repeat this procedure for every measurement over the whole frequency range.

FSEM / FSEK:
See operating manual of the network analyzer for detailed information about calibration for S_{11} measurement.

Measurement

FSEA / FSEB:
Connect the RF input of the FSE to the test port of the SWR bridge. Measure reflected power L_r with the power meter. The return loss a_r of the RF input of the FSE can be calculated as

$$a_r = L_{Ref} - L_r \, .$$

The SWR can be calculated as

$$s = \frac{10^{0.05a_r} + 1}{10^{0.05a_r} - 1} \, .$$

FSEM / FSEK:
Determine S_{11} of the FSE at the frequencies shown in table 1-2 (item 3) of performance test report. See operating manual of the network analyzer for detailed information about S_{11} measurement.

a_r / dB	s
6	3.0
7.4	2.5
8	2.3
9.5	2.0
10	1.9
12	1.7
14	1.5
16	1.4
18	1.3
20	1.2

Checking Imunity to Interference

Test equipment: signal generator (table 1-1, item 2):

frequency range	FSEA:	10 MHz to 3.5 GHz
	FSEB:	10 MHz to 7 GHz
	FSEM / FSEK:	10 MHz to 8 GHz

maximum level ≥ -10 dBm

Test setup: connect RF output of the signal generator to RF input of the FSE.

Signal generator settings: level -10 dBm ± 0.5 dB

FSE settings:

- [**SYSTEM PRESET**]
- [**INPUT** : RF ATTEN MANUAL : **0 dB**]
- [**LEVEL REF** : REF LEVEL : **-30 dBm**]
- [**FREQUENCY SPAN** : **100 kHz**]
- [**SWEEP COUPLING** : RES BW MANUAL : **2 kHz**]

1st IF Image Frequency Rejection

Additional signal generator settings:

- frequency f_{in} + 2 x 1st IF

FSEA	f_{in} + 8682.8 MHz
FSEB	f_{in} + 15.8828 GHz
FSEM / FSEK	f_{in} + 15.8828 GHz (f_{in} < 7 GHz)

See table 1-2 (item 4) of performance test report for values of f_{in}

Additional FSE settings:

- [**FREQUENCY CENTER** : {f_{in}}]

See table 1-2 (item 4) of performance test report for values of f_{in}

- set marker to peak of signal
  [**MARKER SEARCH** : PEAK]

Evaluation: The image frequency rejection is the difference between the output level of the signal generator and the level reading of marker 1 (L_{dis}):

Image frequency rejection = -10dBm – L_{dis}

Unit	1st IF image frequency rejection
FSEA20	> 75 dB
FSEA30	> 80 dB
FSEB / FSEM / FSEK	> 80 dB

2nd IF Image Frequency Rejection

Additional signal generator settings: - frequency f_{in} + 2 x 2nd IF

f_{in} + 1482.8 MHz

See table 1-2 (item 5) of performance test report for values of f_{in}.

Additional FSE settings: - [**FREQUENCY CENTER** : {f_{in}}]

See table 1-2 (item 5) of performance test report for values of f_{in}.

- set marker to peak of signal
  [**MARKER SEARCH** : PEAK]

Evaluation: The image frequency rejection is the difference between the output level of the signal generator and the level reading of marker 1 (L_{dis}):

Image frequency rejection = –10dBm – L_{dis}

Unit	2nd IF image frequency rejection
FSEA20	> 75 dB
FSEA30	> 80 dB
FSEB / FSEM / FSEK	> 80 dB

1st IF Rejection

Additional signal generator settings: - frequency = 1st IF

FSEA	4341.4 MHz
FSEB	7941.4 GHz
FSEM / FSEK	7941.4 GHz (f_{in} < 7 GHz) 741.4 MHz ($f_{in} \geq$ 7 GHz)

Additional FSE settings: - [**FREQUENCY CENTER** : {f_{in}}]

See table 1-2 (item 6) of performance test report for values of f_{in}.

- set marker to peak of signal
  [**MARKER SEARCH** : PEAK]

Evaluation: The IF rejection is the difference between the output level of the signal generator and the level reading of marker 1 (L_{dis}):

IF rejection = –10dBm – L_{dis}

Unit	1st IF rejection
FSEA20	> 80 dB
FSEA30	> 100 dB
FSEB / FSEM	> 75 dB
FSEK	> 80 dB

Checking Non-linearities

Third-Order Intercept

Test equipment:

- 2 signal generators (FSEA: table 1-1, item 2 and 3; FSEB / M / K: table 1-1, item 2 and 4)
  frequency range
  FSEA: 10 MHz to 3.5 GHz
  FSEB: 10 MHz to 7 GHz
  FSEM: 10 MHz to 26.5 GHz
  FSEK: 10 MHz to 40 GHz
  maximum level ≥ 0 dBm
- 2 attenuators (table 1-1, item 14)
  attenuation a_{ATT} = 10 dB
  frequency range
  FSEA: 10 MHz to 3.5 GHz
  FSEB: 10 MHz to 7 GHz
  FSEM: 10 MHz to 26.5 GHz
  FSEK: 10 MHz to 40 GHz
- 3-dB coupler (table 1-1, item 5)
  frequency range
  FSEA: 10 MHz to 3.5 GHz
  FSEB: 10 MHz to 7 GHz
  FSEM: 10 MHz to 26.5 GHz
  FSEK: 10 MHz to 40 GHz
  decoupling > 12 dB

Test setup:

- connect RF outputs of the signal generators via 10-dB attenuators to the inputs of the 3-dB coupler
- connect output of the 3-dB coupler to RF input of the FSE.

Signal generator settings: (both generators)

- frequency: generator 1 $f_{g1} = f_{in}$
  generator 2 $f_{g2} = f_{in}$ + 100 kHz

  See table 1-2 (item 7) of performance test report for values of f_{in}
- level: 0 dBm

FSE settings:

- [**SYSTEM PRESET**]
- [**INPUT** : RF ATTEN MANUAL : **0 dB**]
- [**LEVEL REF** : **-10 dBm**]
- [**FREQUENCY SPAN** : **50 kHz**]
- [**SWEEP COUPLING** : RES BW MANUAL : **2 kHz**]
- [**FREQUENCY CENTER** : {f_{in}}]

  See table 1-2 (item 7) of performance test report for values of f_{in}
- [**MARKER SEARCH** : PEAK]

  Adjust the output level of signal generator 1 until the level reading of marker 1 is -10 dBm ± 0.1 dB.

- [**FREQUENCY CENTER** : {f_{in} + 100 kHz}]

  See table 1-2 (item 7) of performance test report for values of f_{in}

- [**MARKER SEARCH** : PEAK]

  Adjust the output level of signal generator 2 until the level reading of marker 1 is -10 dBm ± 0.1 dB.

- set reference to peak of signal
  [**MARKER DELTA** : REFERENCE FIXED]
- set center frequency to intermodulation product (2 x f_{g2} - f_{g1})
  [**FREQUENCY CENTER** : {f_{in} - 100 kHz}]

- [**MARKER SEARCH** : PEAK]

  The intermodulation ratio IMR_1 is displayed by the reading ´Delta 1 [T1 FXD]´

- set center frequency to intermodulation product (2 x f_{g1} - f_{g2})
  [**FREQUENCY CENTER** : {f_{in} + 200 kHz}]

- [**MARKER SEARCH** : PEAK]

  The intermodulation ratio IMR_2 is displayed by the reading ´Delta 1 [T1 FXD]´

Evaluation:

The third order intercept point (T.O.I) referred to the input signal can be caculated as

$$T.O.I. = \frac{IMR}{2} - 10dBm \; ,$$

where IMR is the lower of IMR_1 and IMR_2

Unit	Frequency range	T.O.I.
FSEA	f ≤ 50 MHz	≥ 7 dBm
	f > 50 MHz	≥ 12 dBm
FSEB / FSEM / FSEK	f ≤ 150 MHz	≥ 7 dBm
	f > 150 MHz	≥ 12 dBm
FSEK	f > 7 GHz	≥ 10 dBm

Second-Order Harmonic Distortion

Test equipment:

- signal generator (table 1-1, item 3)
  frequency range
  FSEA: 9 kHz to 1.7 GHz
  FSEB / FSEM / FSEK: 9 kHz to 3.4 GHz

- to improve the harmonic suppression of the generator it is recommended to insert a lowpass filter with a suitable cut-off frequency (table 1-1, item 15) after the generator.

The required suppression of the second harmonics is listed in the table at the end of this section. As a result, the error for the entire frequency range is < 1dB.

Test setup:

- connect RF output of the signal generator to the input of the lowpass
- connect the output of the lowpass to the RF input of the FSE

Note: *If the harmonic suppression of the signal generator is sufficient, the lowpass can be left out. The RF output of the generator can be connected directly to the RF input of the FSE in this case.*

Signal generator settings:

- frequency: f_{in}

  see table 1-2 (item 8) of performance test report for values of f_{in}

- level: -10 dBm

FSE settings:

- [**SYSTEM PRESET**]
- [**INPUT** : RF ATTEN MANUAL : **0 dB**]
- [**LEVEL REF** : **-10 dBm**]
- [**FREQUENCY SPAN** : **3 kHz**]
- [**SWEEP COUPLING** : RES BW MANUAL : **1 kHz**]
- [**FREQUENCY CENTER** : {f_{in}}]

  See table 1-2 (item 8) of performance test report for values of f_{in}

- set marker to peak of signal
  [**MARKER SEARCH** : PEAK]
- set reference to peak of signal
  [**MARKER DELTA** : REFERENCE FIXED]
- set center frequency of the FSE to the frequency of the 2nd harmonic
  [**FREQUENCY CENTER** : {2 x f_{in}}]

  See table 1-2 (item 8) of performance test report for values of f_{in}

- set marker to peak of the 2nd harmonic
  [**MARKER SEARCH** : PEAK]

Evaluation:

The reading ´Delta 1 [T1 FXD]´ displays the second harmonic suppression (a_{k2}). The exact input level L_{in} is displayed by the reading ´FXD {level} dBm´.
The second order harmonic distortion can be calculated as

$$IP_{k2} / \text{dBm} = a_{k2} + L_{in}$$

Unit	Frequency range	IP_{k2}	**Required suppression of the second harmonics**
FSEA	f ≤ 50 MHz	> 25 dBm	45 dBc
	f > 50 MHz	> 45 dBm	65 dBc
FSEB / FSEM / FSEK	f ≤ 150 MHz	> 25 dBm	45 dBc
	f > 150 MHz	> 40 dBm	60 dBc

Checking IF Filters

Test equipment: signal generator (table 1-1, item 3):
frequency 120 MHz
level ≥ -10 dBm

Test setup: connect RF output of the signal generator to the RF input of the FSE.

Checking the Level Error

Note: *If option FSE-B22 is installed see chapter "Test Instructions (option FSE-B22 included)" for test instructions.*

Reference Measurement (RBW 5 kHz)

Signal generator settings:
- frequency: 120 MHz
- level: -20 dBm

FSE settings:
- [**SYSTEM PRESET**]
- [**INPUT** : RF ATTEN MANUAL : **10 dB**]
- [**LEVEL REF** : **0 dBm**]
- [**FREQUENCY CENTER** : **120 MHz**]
- [**SWEEP COUPLING** : COUPLING RATIO : RBW/VBW SINE [1]]
- [**SWEEP COUPLING** : COUPLING RATIO : SPAN/RBW MANUAL : **5** : **ENTER**]
- resolution bandwidth 5 kHz
  [**FREQUENCY SPAN** : **25 kHz**]
- set marker to peak of signal
  [**MARKER SEARCH** : PEAK]
- set reference to peak of signal
  [**MARKER DELTA** : REFERENCE FIXED]

Checking the Level Error

FSE settings:
- [**FREQUENCY SPAN** : {5 x RBW}]

  See table 1-2 (item 9) of performance test report for values of RBW.
- [**SWEEP COUPLING** : RES BW MANUAL : {RBW}][1]

  [1] ***Note:*** *To check the level error of the 5-MHz and the 10-MHz filter, the resolution bandwidth has to be set manually to 5 MHz or 10 MHz. All other bandwidths will be set automatically by changing the frequency span.*
- set marker to peak of signal
  [**MARKER SEARCH** : PEAK]

  The level error is displayed by the reading ´Delta 1 [T1 FXD] {level error} dB´.

Evaluation: See table 1-2 (item 9) of performance test report for upper and lower limits of level error.

Checking 3-dB Bandwidths

Signal generator settings:
- frequency: 120 MHz
- level: -20 dBm

FSE settings:
- [**SYSTEM PRESET**]
- [**INPUT** : RF ATTEN MANUAL : **10 dB**]
- [**LEVEL REF** : **0 dBm**]
- [**FREQUENCY CENTER** : **120 MHz**]
- [**SWEEP COUPLING** : COUPLING RATIO : RBW/VBW SINE [1]]
- [**SWEEP COUPLING** : COUPLING RATIO : SPAN/RBW MANUAL : **5** : **ENTER**]

- determine 3-dB bandwidth
  [**MARKER SEARCH** : **MENU** ⇒ : N DB DOWN : **3 dB**]

- [**FREQUENCY SPAN** : {5 x RBW}]
  See table 1-2 (item 10) of performance test report for values of RBW.

- [**SWEEP COUPLING** : RES BW MANUAL : {RBW}][1]

[1] ***Note:*** *To check the bandwidth of the 5-MHz and the 10-MHz filter, the resolution bandwidth has to be set manually to 5 MHz or 10 MHz. All other bandwidths will be set automatically by changing the frequency span.*

- [**MARKER SEARCH** : PEAK]

The 3-dB bandwidth is displayed by the reading ´BW {bandwidth}´.

Evaluation: See table 1-2 (item 10) of performance test report for upper and lower limits of 3dB-bandwidths.

Note: *Due to the phase noise, measurements on models 20 can only be carried with IF filters of a bandwidth ≥5 kHz.*

Checking the Shape Factor

Signal generator settings:
- frequency: 120 MHz
- level: –10 dBm

FSE settings:
- [**SYSTEM PRESET**]
- [**INPUT** : RF ATTEN MANUAL : **10 dB**]
- [**LEVEL REF** : **0 dBm**]
- [**FREQUENCY CENTER** : **120 MHz**]
- [**SWEEP COUPLING** : VBW MANUAL : **100 Hz**]
- [**SWEEP COUPLING** : COUPLING RATIO : SPAN/RBW MANUAL : **30** : **ENTER**]

- determine shape factor
  [**MARKER SEARCH** : **MENU** ⇒ : SHAPE FACT 60/3 DB]

- [**FREQUENCY SPAN** : {30 x RBW}]

  See table 1-2 (item 11) of performance test report for values of RBW.

- [**SWEEP COUPLING** : RES BW MANUAL : {RBW}][1]

  [1] ***Note:*** *To check the shape factor of the 5-MHz and the 10-MHz filter the resolution bandwidth has to be set manually to 5 MHz or 10 MHz. All other bandwidths will be set automatically by changing the frequency span.*

- [**MARKER SEARCH** : PEAK]

  The shape factor is displayed by the reading ´SH3 {shape factor}´.

Evaluation: See table 1-2 (item 11) of performance test report for upper and lower limits of shape factor.

Checking LO Feedthrough, Noise Display

Test equipment: 50-Ω termination (table 1-1, item 7)

frequency range	FSEA	up to 3.5 GHz
	FSEB	up to 7 GHz
	FSEM	up to 26.5 GHz
	FSEK	up to 40 GHz
return loss	> 20 dB	

Test setup: terminate the RF input of the FSE with 50 Ω

FSE settings:

- [**SYSTEM PRESET**]
- [**INPUT** : RF ATTEN MANUAL : **0 dB**]
- [**FREQUENCY SPAN** : **0 Hz**]

LO Feedthrough

Note: *This measurement is only possible with model 30. The LO feedthrough of model 20 can be checked by measuring the noise display near f = 0 Hz (see "Noise Display").*

Additional FSE settings:

- [**LEVEL REF** : **-10 dBm**]
- [**FREQUENCY CENTER** : **0 Hz**]
- start calibration of LO compensation
  [**SYSTEM CAL** : CAL LO SUP]
- set marker to peak
  [**MARKER SEARCH** : PEAK]

Evaluation: The LO feedthrough is displayed by the level reading of marker 1.

Noise Display

Additional FSE settings:

- - [**SWEEP COUPLING** : RES BW MANUAL : **10 Hz**]
- [**SWEEP COUPLING** : VIDEO BW MANUAL : **1 Hz**]
- [**SWEEP COUPLING** : SWEEP TIME MANUAL : **0.1 s**]
- [**TRACE 1** : AVERAGE]
- [**TRACE 1** : SWEEP COUNT : **30 ENTER**]
- [**LEVEL REF** : **-60 dBm**]
- [**FREQUENCY CENTER** : {f_n}]

  See table 1-2 (item 13) of the performance test report for values of f_n. On models 20 set the reference level to 30 dBm for receive frequencies less than 100 kHz since the instrument can be overdriven by the LO (message IFOVL).

- set marker to peak
  [**MARKER SEARCH** : PEAK]

f_n	**20 Hz**	**1 kHz**	**9,9 kHz**	**≥ 95 kHz**
Model 20	-		-30 dBm	-60 dBm
Model 30	-30 dBm	-30 dBm	-60 dBm	-60 dBm

Evaluation: The noise level is displayed by the level reading of marker 1.

Checking the Frequency Response

Test equipment:

- signal generator (FSEA: table 1-1, item 3; FSEB / M / K: table 1-1, item 3 and item 4)

frequency range	FSEA:	1 MHz to 3.5 GHz
	FSEB:	1 MHz to 7 GHz
	FSEM:	1 MHz to 26.5 GHz
	FSEK:	1 MHz to 40 GHz
maximum level	≥ -10 dBm	

- power meter (table 1-1, item 8)
- power sensor (FSEA: table 1-1, item 9; FSEB / M: table 1-1, item 9 and 10; FSEK: table 1-1, item 10)

frequency range	FSEA:	1 MHz to 3.5 GHz
	FSEB:	1 MHz to 7 GHz
	FSEM:	1 MHz to 26.5 GHz
	FSEK:	1 MHz to 40 GHz
maximum power	P_{max} ≥ 100 µW	

RSS referred to indicated power
1 MHz to 1 GHz .... ≤ 1.5 %
1 GHz to 7 GHz............. ≤ 2 %
7 GHz to 26.5 GHz..... ≤ 3.5 %
26.5 GHz to 40 GHz...... ≤ 4 %

impedance Z = 50 Ω

- 6-dB divider (table 1-1, item 6)

frequency range	FSEA:	1 MHz to 3.5 GHz
	FSEB:	1 MHz to 7 GHz
	FSEM:	1 MHz to 26.5 GHz
	FSEK:	1 MHz to 40 GHz
level imbalance[1]	1 MHz to 1 GHz	≤ 0.15 dB
	1 GHz to 7 GHz	≤ 0.2 dB
	7 GHz to 18 GHz	≤ 0.3 dB
	18 GHz to 26.5 GHz	≤ 0.4 dB
	26.5 GHz to 40 GHz	≤ 0.4 dB

[1]If a power splitter with higher level imbalance is used correction of the measured frequency response is recommended.

Determining the absolute error at 120 MHz

Test setup:

- connect power sensor (table 1-1, item 9) to the power meter and execute function ´ZERO´ when there is no signal applied to the power sensor
- connect power sensor to RF output of signal generator

Signal generator settings:

- frequency 120 MHz
- level -10 dBm

Measurement:

- determine output power of the signal generator with the power meter
- connect RF output of the signal generator to RF input of the FSE

FSE settings:

- [**SYSTEM PRESET**]
- [**INPUT** : RF ATTEN MANUAL : **10 dB**]
- [**LEVEL REF** : **-7 dBm**]
- [**FREQUENCY SPAN** : **15 kHz**]
- [**SWEEP COUPLING** : RES BW MANUAL : **5 kHz**]
- [**FREQUENCY CENTER** : **120 MHz**]

- set marker to peak of signal
  [**MARKER SEARCH** : PEAK]

Evaluation:

The deviation between the signal levels measured with the power meter and the FSE (level reading of marker 1) reflects the absolute level error of the FSE. It can be calculated as

$$\text{absolute error}_{120MHz} = L_{FSE} - L_{powermeter}$$

Checking the frequency response

Test setup:

- connect RF output of the signal generator to input of the divider
- connect output 1 of the divider to the power sensor of the power meter
- connect output 2 of the divider to RF input of the FSE

Signal generator settings:

- level -10 dBm
- frequency f_{fresp}

see table 1-2 (item 14) of performance test report for values of f_{fresp}

FSE settings:

- [**SYSTEM PRESET**]
- [**INPUT** : RF ATTEN MANUAL : **10 dB**]
- [**LEVEL REF** : **-7 dBm**]
- [**FREQUENCY SPAN** : **30 kHz**]
- [**SWEEP COUPLING** : RES BW MANUAL : **5 kHz**]
- [**FREQUENCY CENTER** : {f_{fresp}}]

see table 1-2 (item 14) of performance test report for values of f_{fresp}

- activate ´preselector peak´ if center frequency is higher than 7 GHz (only available for FSEM and FSEK)
  [**SYSTEM CAL** : PRESEL PEAK]

- set marker to peak of signal
  [**MARKER SEARCH** : PEAK]

The signal level L_{FSE} is displayed by the level reading of marker 1.

Power meter settings:

Determine signal level $L_{powermeter}$. To achive higher accuracy it is recommended to compensate the frequency response of the power sensor.

Evaluation:

The frequency response can be calculated as

$$\text{Frequency response} = L_{FSE} - L_{powermeter} - \text{absolute error}_{120\,MHz}$$

Note: *If option FSE-B22 is installed see also chapter "Test Instructions (option FSE-B22 included)" for additional test instructions.*

Checking the Display Linearity

Note: *If option FSE-B22 is installed see chapter "Test Instructions (option FSE-B22 included)" for test instructions.*

Test equipment:

- signal generator (table 1-1, item 3)
  frequency 5 MHz
  maximum level ≥ 6 dBm
- step attenuator (table 1-1, item 13)
  frequency 5 MHz
  attenuation 0 to 95 dB
  steps 1 dB
  maximum attenuation error < 0.05 dB

Test setup:

- connect RF output of the signal generator to RF input of the step attenuator
- connect RF output of the step attenuator to RF input of the FSE

Signal generator settings:

- frequency 5 MHz
- level +6 dBm

Step attenuator settings: attenuation 16 dB

FSE settings:

- [**SYSTEM PRESET**]
- [**INPUT** : RF ATTEN MANUAL : **10 dB**]
- [**LEVEL REF** : **0 dBm**]
- [**FREQUENCY CENTER** : **5 MHz**]
- [**FREQUENCY SPAN** : **500 Hz**]
- [**SWEEP COUPLING** : RES BW MANUAL : **3 kHz**]
- [**SWEEP COUPLING** : VIDEO BW MANUAL : **100 Hz**]
- [**LEVEL RANGE** : LOG 100 dB]

- set marker to peak of signal
  [**MARKER SEARCH** : PEAK]

- set reference to peak of signal
  [**MARKER DELTA** : REFERENCE FIXED]

Measurement

Step attenuator settings: attenuation $\{a_{ATT}\}$

see table 1-2 (item 15) of performance test report for values of a_{ATT}.

Evaluation:

The difference between the level of the input signal of the FSE and the reference (about 10 dB below the reference level) is displayed by the reading ´Delta 1 [T1 FXD]´. Compare the measured values with the limits given in table 1-2 (item 15) of performance test report.

Checking the Attenuator

Note: *If option FSE-B22 is installed see chapter "Test Instructions (option FSE-B22 included)" for test instructions.*

Test equipment:

- signal generator (table 1-1, item 3)
  frequency 5 MHz
  maximum level ≥ 6 dBm
- step attenuator (table 1-1, item 13)
  frequency 5 MHz
  attenuation 0 to 70 dB
  steps 10 dB
  maximum attenuation error < 0.05 dB

Test setup:

- connect RF output of the signal generator to RF input of the step attenuator
- connect RF output of the step attenuator to RF input of the FSE

Signal generator settings:

- frequency 5 MHz
- level 0 dBm

Step attenuator settings: attenuation 60 dB

FSE settings:

- [**SYSTEM PRESET**]
- [**FREQUENCY CENTER** : **5 MHz**]
- [**FREQUENCY SPAN** : **500 Hz**]
- [**SWEEP COUPLING** : RES BW MANUAL : **3 kHz**]
- [**SWEEP COUPLING** : VIDEO BW MANUAL : **100 Hz**]
- [**INPUT** : RF ATTEN MANUAL : **10 dB**]
- [**LEVEL REF** : **-30 dBm**]
- [**MARKER SEARCH** : PEAK]

adjust output level of the signal generator until the level reading of marker 1 is exactly -60.0 dBm.

Measurement

Step attenuator settings: attenuation {a_{ATT}}

see table below for values of a_{ATT}.

FSE settings:

- [**INPUT** : RF ATTEN MANUAL : {a_{FSE}}]
- [**LEVEL REF** : {reference level} **dBm**]
- [**MARKER SEARCH** : PEAK]

see table below for values of a_{FSE} and reference level.

Evaluation: Compare level reading of marker 1 with the limits given in table 1-2 (item 16) of performance test report.

a_{ATT}	70 dB	60 dB	50 dB	40 dB	30 dB	20 dB	10 dB	0 dB
a_{FSE}	0 dB	10 dB	20 dB	30 dB	40 dB	50 dB	60 dB	70 dB
reference level	-40 dBm	-30 dBm	-20 dBm	-10 dBm	0 dBm	+10 dBm	+20 dBm	+30 dBm

Checking the IF Gain Switching

Test principle:	The IF gain of the FSE can be switched from 0 to 50 dB by changing the reference level at fixed RF attenuation. To prevent the IF gain errors to be mixed up with the log amplifier error it is determined by comparison using an external precision attenuator.

Test equipment:

- signal generator (table 1-1, item 3)
  - frequency 5 MHz
  - maximum level ≥ -10 dBm
- step attenuator (table 1-1, item 11)
  - frequency 5 MHz
  - attenuation 0 to 50 dB
  - steps 1 dB
  - maximum attenuation error < 0.05 dB

Test setup:

- connect RF output of the signal generator to RF input of the step attenuator
- connect RF output of the step attenuator to RF input of the FSE

Signal generator settings:

- frequency 5 MHz
- level -10 dBm

Step attenuator settings: attenuation 30 dB

FSE settings:

- [**SYSTEM PRESET**]
- [**FREQUENCY CENTER** : **5 MHz**]
- [**FREQUENCY SPAN** : **2 kHz**]
- [**SWEEP COUPLING** : RES BW MANUAL : **1 kHz**]
- [**SWEEP COUPLING** : VIDEO BW MANUAL : **100 Hz**]
- [**INPUT** : RF ATTEN MANUAL : **10 dB**]
- [**LEVEL REF** : **-30 dBm**]
- [**MARKER SEARCH** : PEAK]

adjust output level of the signal generator until the level reading of marker 1 is exactly -40.0 dBm.

Measurement

Step attenuator settings: attenuation {a_{ATT}}

see table below for values of a_{ATT}.

FSE settings:

- [**LEVEL REF** : {reference level} **dBm**]

  see table below for values of reference level.

- [**MARKER SEARCH** : PEAK]

Evaluation: Compare level reading of marker 1 with the limits given in table 1-2 (item 17) of performance test report.

10-dB gain steps:

a_{ATT}	reference level	Marker level
0 dB	0 dBm	-10 ± 0.2 dBm
10 dB	-10 dBm	-20 ± 0.2 dBm
20 dB	-20 dBm	-30 ± 0.2 dBm
30 dB	-30 dBm	-40 ± 0.2 dBm
40 dB	-40 dBm	-50 ± 0.2 dBm
50 dB	-50 dBm	-60 ± 0.2 dBm

1-dB gain steps:

a_{ATT}	reference level	Marker level
30 dB	-30 dBm	-40.0 ± 0.2 dBm
31 dB	-31 dBm	-41 ± 0.2 dBm
32 dB	-32 dBm	-42 ± 0.2 dBm
33 dB	-33 dBm	-43 ± 0.2 dBm
34 dB	-34 dBm	-44 ± 0.2 dBm
35 dB	-35 dBm	-45 ± 0.2 dBm
36 dB	-36 dBm	-46 ± 0.2 dBm
37 dB	-37 dBm	-47 ± 0.2 dBm
38 dB	-38 dBm	-48 ± 0.2 dBm
39 dB	-39 dBm	-49 ± 0.2 dBm

Checking the Phase Noise

Test equipment: signal generator (table 1-1, item 3)

frequency	498 MHz
level	≥ 0 dBm
phase noise at 498 Mhz:	< -100 dBc/Hz @ 100 Hz
	< -115 dBc/Hz @ 1 kHz
	< -127 dBc/Hz @ 10 kHz
	< -130 dBc/Hz @ 100 kHz
	< -142 dBc/Hz @ 1MHz

Test setup:

- connect RF output of the signal generator to RF input of the FSE
- connect signal generator EXT REF input to the EXT REF output of the FSE and set the generator to external reference

Signal generator settings:

- frequency 498 MHz
- level 0 dBm

FSE settings:

- [**SYSTEM PRESET**]
- [**CONFIGURATION SETUP** : REFERENCE INT / EXT] toggle to internal reference (INT)
- [**FREQUENCY CENTER** : **498 MHz**]
- [**REF LEVEL** : **0 dBm**]
- [**INPUT** : RF ATTEN MANUAL : **10 dB**]
- [**FREQUENCY SPAN** : {span}]

  depending on offset, see table below for values of span.
- [**SWEEP COUPLING** : COUPLING RATIO : RBW/VBW NOISE]
- [**SWEEP COUPLING** : RBW MANUAL : {RBW}]

  depending on offset, see table below for values of RBW.
- [**TRACE 1** : AVERAGE]
- [**SWEEP** : SWEEP COUNT : **20** : **ENTER**]
- [**MARKER NORMAL**]
- set marker to peak of signal [**MARKER SEARCH**: PEAK]
- activate phase noise marker [**MARKER DELTA**: PHASE NOISE]
- [**FREQUENCY CENTER** : {498 MHz + offset}]

  see table below for values of offset.
- [**REF LEVEL** : {reference level}]

  depending on offset, see table below for values of reference level.
- [**INPUT** : RF ATTEN MANUAL : {a_{FSE}}]

  depending on offset, see table below for values of a_{FSE} .

- set phase noise marker
  [**MARKER DELTA** : {offset}]

  see table below for values of offset.

***Note**: Make sure not to measure on a spurious signal. The switching frequency may cause interference especially at an offset of 100 kHz. In this case measure at an offset of 95 kHz.*

Evaluation: The phase noise is displayed by the reading ´Delta 1 [T1 NOI]´. Compare the measured values with the limits given in table 1-2 (item 18) of performance test report

Phase noise measurement settings				
Offset	**Span**	**RBW**	**Reference Level**	**a_{FSE}**
100 Hz	20 Hz	10 Hz	0 dBm	10 dB
1 kHz	200 Hz	100 Hz	0 dBm	10 dB
10 kHz	2 kHz	500 Hz	-10 dBm	10 dB
100 kHz	10 kHz	3 kHz	-20 dBm	0 dB
1 MHz	100 kHz	30 kHz	-20 dBm	0 dB

***Notes:** To obtain a precise measurement of the phase noise at high offsets the level used at the FSE input is 20 dB higher than the reference level. To reduce the measurement time the phase noise is measured with a small span around the frequency offset. This prevents the FSE from being overloaded.*

Checking the Tracking Generator – Option FS-B8/B9/B10/B11

Checking the Output Level

Test equipment: N-connecting cable (Table 1-1, item no. 16)

Test setup:
➢ Connect output of tracking generator to RF-input of FSE.

FSE settings:

- [**MODE TRACKING**]
- [**FREQUENCY CENTER** : **120 MHz**]
- [**FREQUENCY SPAN** : **0 MHz**]
- [**SWEEP COUPLING** : RBW MANUAL : **20 kHz**]
- [**SWEEP COUPLING** : VBW MANUAL : **20 kHz**]
- [**LEVEL RANGE** : LOG 50 dB]
- [**MODE TRACKING** : SOURCE ON]
- [**MODE TRACKING** : SOURCE POWER {level}]

Values for {level} : 0 dBm; -3 dBm; -6 dBm; -10 dBm; -20 dBm

Test setup:
➢ Compare measured values with values from Table 1-2, item no. 19.

Checking the Frequency Response

Test equipment: N-connecting cable (Table 1-1, item no. 16)

Test setup:
➢ Connect output of tracking generator to RF-input of FSE.

FSE settings:

- [**MODE TRACKING**]
- [**FREQUENCY START** : **1 MHz**]
- [**FREQUENCY STOP** : **3.5(7) MHz**]
- [**SWEEP COUPLING** : RBW MANUAL : **20 kHz**]
- [**SWEEP COUPLING** : VBW MANUAL : **20 kHz**]
- [**SWEEP COUPLING** : SWEEP TIME MANUAL : **100 ms**]
- [**LEVEL RANGE** : LOG 50 dB]
- [**MODE TRACKING** : SOURCE ON]
- [**MODE TRACKING** : SOURCE POWER 0 dBm]

Evaluation:
➢ Compare measured values with limits from Table 1-2, item no. 20.

Checking the I/Q Modulator

Test equipment:
- 2 DC power sources (Table 1-1, item no. 17)
- 2 DC-voltmeters (Table 1-1, item no. 18)

Test setup:
- ➢ Connect DC power sources to the I and Q input of the analyzer.
- ➢ Use DC-voltmeter to measure voltage at the I and Q inputs.

Power source settings
- ➢ Set voltage to 250 mV ± 3 mV.

FSE settings:
- [**MODE TRACKING**]
- [**FREQUENCY CENTER** : **120 MHz**]
- [**FREQUENCY SPAN** : **0 MHz**]
- [**SWEEP COUPLING** : RBW MANUAL : **20 kHz**]
- [**SWEEP COUPLING** : VBW MANUAL : **20 kHz**]
- [**REF** : REF LEVEL : **0 dBm**]
- [**MODE TRACKING** : SOURCE POWER 0 dBm]
- [**MARKER NORMAL**]
- ➢ Rated value: -6 dBm ± 0.5 dB
  This value serves as a reference for the following measurements.

Measurements

Measurement of the residual carrier
- [**LEVEL RANGE** : 100 dB]
- ➢ Short-circuit I and Q voltages (do not remove!)
  The voltmeter must indicate a value < 0.1 mV.
- ➢ Rated value: < -50 dBm

Imbalance measurement (imbalance between the I and Q paths)
- [**LEVEL RANGE** : 10 dBm]
- ➢ Apply ±250 mV at the Q input, short-circuit at the I input.
- ➢ Rated value: (reference value – 3 dB) ±0.5 dB.
- ➢ Apply ±250 mV at the I input, short-circuit at the Q input.
- ➢ Rated value: (reference value - 3dB) ±0.5 dB.

Measurement of the quadrature offset
- ➢ Apply +250 mV at the I input, -250 mV at the Q input.
- ➢ Rated value: (reference value ±0.5 dB.
- ➢ Apply +250 mV at the Q input, -250 mV at the I input.
- ➢ Rated value: (reference value ± 0.5 dB.

Performance Test Report

Note: *The values given in the datasheet are the guaranteed limits. Due to measurement errors these limits must be extended by the tolerance of the measuring equipment used in this performance test.*

Table 1-2 Performance test report

Item No.	Characteristic	Test to page	Min. value	Actual value	Max. value	Unit
1	Calibration source at 120 MHz	1.3	-0.3	__________	+0.3	dB
2	Frequency accuracy Reference oscillator	1.4				
	Model 20		9.99999	_________	10.00001	MHz
	Model 30 or Model 20 with B4		9.999999	_________	10.000001	MHz
3	Return loss RF input f_{in}	1.5				
	FSEA / FSEB / FSEM / FSEK:					
	10 MHz		14	________	-	dB
	250 MHz		14	________	-	dB
	500 MHz		14	________	-	dB
	750 MHz		14	________	-	dB
	1000 MHz		14	________	-	dB
	1250 MHz		14	________	-	dB
	1500 MHz		14	________	-	dB
	1750 MHz		14	________	-	dB
	2000 MHz		14	________	-	dB
	2250 MHz		14	________	-	dB
	2500 MHz		14	________	-	dB
	2750 MHz		14	________	-	dB
	3000 MHz		14	________	-	dB
	3250 MHz		14	________	-	dB
	3500 MHz		14	________	-	dB
	3250 MHz		14	________	-	dB
	3500 MHz		14	________	-	dB
	FSEB / FSEM / FSEK:					
	3750 MHz		9.5	________	-	dB
	4000 MHz		9.5	________	-	dB
	4250 MHz		9.5	________	-	dB
	4500 MHz		9.5	________	-	dB
	4750 MHz		9.5	________	-	dB
	5000 MHz		9.5	________	-	dB
	5250 MHz		9.5	________	-	dB
	5500 MHz		9.5	________	-	dB
	5750 MHz		9.5	________	-	dB
	6000 MHz		9.5	________	-	dB
	6250 MHz		9.5	________	-	dB
	6500 MHz		9.5	________	-	dB
	6750 MHz		9.5	________	-	dB

Item No.	Characteristic	Test to page	Min. value	Actual value	Max. value	Unit
3	Return loss RF input RF ATT: 10 dB	1.5				
	FSEM / FSEK:		**FSEM / K:**			
	7000 MHz		6 / 7.4	________	-	dB
	8000 MHz		6 / 7.4	________	-	dB
	9000 MHz		6 / 7.4	________	-	dB
	10 GHz		6 / 7.4	________	-	dB
	11 GHz		6 / 7.4	________	-	dB
	12 GHz		6 / 7.4	________	-	dB
	13 GHz		6 / 7.4	________	-	dB
	14 GHz		6 / 7.4	________	-	dB
	15 GHz		6 / 7.4	________	-	dB
	16 GHz		6 / 7.4	________	-	dB
	17 GHz		6 / 7.4	________	-	dB
	18 GHz		6 / 7.4	________	-	dB
	19 GHz		6 / 7.4	________	-	dB
	20 GHz		6 / 7.4	________	-	dB
	21 GHz		6 / 7.4	________	-	dB
	22 GHz		6 / 7.4	________	-	dB
	23 GHz		6 / 7.4	________	-	dB
	24 GHz		6 / 7.4	________	-	dB
	25 GHz		6 / 7.4	________	-	dB
	26 GHz		6 / 7.4	________	-	dB
	26.5 GHz		6 / 7.4	________	-	dB
	FSEK:					
	27 GHz		7.4	________	-	dB
	28 GHz		7.4	________	-	dB
	29 GHz		7.4	________	-	dB
	30 GHz		7.4	________	-	dB
	31 GHz		7.4	________	-	dB
	32 GHz		7.4	________	-	dB
	33 GHz		7.4	________	-	dB
	34 GHz		7.4	________	-	dB
	35 GHz		7.4	________	-	dB
	36 GHz		7.4	________	-	dB
	37 GHz		7.4	________	-	dB
	38 GHz		7.4	________	-	dB
	39 GHz		7.4	________	-	dB
	39.9 GHz		7.4	________	-	dB

Item No.	Characteristic	Test to page	Min. value	Actual value	Max. value	Unit
4	1st IF image frequency rejection f_{in}	1.7				
	FSEA:		**Mod. 20 / 30**			
	11 MHz		75 / 80	________	-	dB
	100 MHz		75 / 80	________	-	dB
	1701 MHz		75 / 80	________	-	dB
	3499 MHz		75 / 80	________	-	dB
	FSEB / FSEM / FSEK:					
	11 MHz		80	________	-	dB
	100 MHz		80	________	-	dB
	1701 MHz		80	________	-	dB
	3499 MHz		80	________	-	dB
	6999 MHz		80	________	-	dB
5	2nd IF image frequency rejection f_{in}	1.8				
	FSEA:		**Mod. 20 / 30**			
	999 MHz		75 / 80	________	-	dB
	FSEB / FSEM / FSEK:					
	999 MHz		80	________	-	dB
	7999 MHz		80	________	-	dB

Item No.	Characteristic	Test to page	Min. value	Actual value	Max. value	Unit
6	1st IF rejection	1.8				
	f_{in}					
	FSEA:		**Mod. 20 / 30**			
	100 MHz		80 / 100		-	dB
	1701 MHz		80 / 100		-	dB
	3500 MHz		80 / 100		-	dB
	FSEB / FSEM / FSEK:		**FSEB,M / K**			
	100 MHz		75 / 80		-	dB
	1701 MHz		75 / 80		-	dB
	3500 MHz		75 / 80		-	dB
	FSEM / FSEK:		**FSEM / K**			
	7001 MHz		75 / 80		-	dB
7	3rd order intercept, f_{in}	1.9				
	FSEA / FSEB / FSEM / FSEK:		**FSEA / B,M,K**			
	10 MHz		7 / 7		-	dBm
	28 MHz		7 / 7		-	dBm
	106 MHz		12 / 7		-	dBm
	261 MHz		12 / 12 *) 12		-	dBm
	640 MHz		/ 12 *)		-	dBm
	1 GHz		12 / 12 *)		-	dBm
	1.7 GHz		12 / 12 *)		-	dBm
	2.5 GHz		12 / 12 *)		-	dBm
	3.48 GHz		12 / 12 *)		-	dBm
	FSEB / FSEM / FSEK:					
	6.98 GHz		12		-	dBm
	FSEM / FSEK:		**FSEM / K**			
	7.5 GHz		12 / 10		-	dBm
	15 GHz		12 / 10		-	dBm
	25 GHz		12 / 10		-	dBm
	FSEK:					
	30 GHz		10		-	dBm
	35 GHz		10		-	dBm
	39 GHz		10		-	dBm

*) 15 dBm for FSEB models 25 / 35 . 17 dBm for FSEM / FSEK models 25 / 35

Item No.	Characteristic	Test to page	Min. value	Actual value	Max. value	Unit
	2nd order harmonic distortion	1.10				
	f_{in}					
	FSEA / FSEB / FSEM / FSEK:		**FSEA / B,M,K**			
	9 kHz		25 / 25	———	-	dBm
	35 kHz		25 / 25	———	-	dBm
	99 kHz		25 / 25	———	-	dBm
	19 MHz		25 /25	———	-	dBm
	28 MHz		25 / 25	———	-	dBm
	107 MHz		45 / 25	———	-	dBm
	262 MHz		45 / 40	———	-	dBm
	453 MHz		45 / 40	———	-	dBm
	640 MHz		45 / 40	———	-	dBm
	1 GHz		45 / 40	———	-	dBm
	1,25 GHz		45 / 40	———	-	dBm
	1,7 GHz		45 / 40	———	-	dBm
	FSEB / FSEM / FSEK:					
	3,4 GHz		40	———	-	dBm

Item No.	Characteristic	Test to page	Min. value	Actual value	Max. value	Unit
9	IF bandwidths	1.12				
	Level error					
	reference (Ref):					
	5 kHz		-	________	-	dBm
	100 Hz		-0.2	________	+0.2	dB
	1 kHz		-0.2	________	+0.2	dB
	2 kHz		-0.2	________	+0.2	dB
	3 kHz		-0.2	________	+0.2	dB
	10 kHz		-0.2	________	+0.2	dB
	20 kHz		-0.2	________	+0.2	dB
	30 kHz		-0.2	________	+0.2	dB
	50 kHz		-1.0	________	+1.0	dB
	100 kHz		-0.2	________	+0.2	dB
	200 kHz		-0.2	________	+0.2	dB
	300 kHz		-0.2	________	+0.2	dB
	500 kHz		-0.2	________	+0.2	dB
	1 MHz		-0.3	________	+0.3	dB
	2 MHz		-0.3	________	+0.3	dB
	3 MHz		-0.3	________	+0.3	dB
	5 MHz		-0.3	________	+0.3	dB
	10 MHz		-0.3	________	+0.3	dB

Item No.	Characteristic	Test to page	Min. value	Actual value	Max. value	Unit
10	IF bandwidths	1.13				
	3-dB bandwidth					
	100 Hz		-10 %-	________	+10 %	-
	1 kHz		-10 %-	________	+10 %	-
	2 kHz		-10 %-	________	+10 %	-
	3 kHz		-10 %-	________	+10 %	-
	5 kHz		-10 %-	________	+10 %	-
	10 kHz		-10 %-	________	+10 %	-
	20 kHz		-10 %-	________	+10 %	-
	30 kHz		-10 %-	________	+10 %	-
	50 kHz		-10 %-	________	+10 %	-
	100 kHz		-10 %-	________	+10 %	-
	200 kHz		-10 %-	________	+10 %	-
	300 kHz		-10 %-	________	+10 %	-
	500 kHz		-10 %-	________	+10 %	-
	1 MHz		-10 %-	________	+10 %	-
	2 MHz		-10 %-	________	+10 %	-
	3 MHz		-10 %-	________	+10 %	-
	5 MHz		-15 %-	________	+15 %	-
	10 MHz		-10 %-	________	+25 %	-
11	IF bandwidths	1.13			**Mod. 20 / 30**	
	Shape factor					
	100 Hz		-	________	- / 6	-
	1 kHz		-	________	- / 12	-
	2 kHz		-	________	- / 12	-
	3 kHz		-	________	- / 12	-
	5 kHz		-	________	15 / 12	-
	10 kHz		-	________	15 / 12	-
	20 kHz		-	________	15 / 12	-
	30 kHz		-	________	15 / 12	-
	50 kHz		-	________	15 / 12	-
	100 kHz		-	________	15 / 12	-
	200 kHz		-	________	15 / 12	-
	300 kHz		-	________	15 / 12	-
	500 kHz		-	________	15 / 12	-
	1 MHz		-	________	15 / 12	-
	2 MHz		-	________	15 / 12	-
	3 MHz		-	________	7 / 7	-
	5 MHz		-	________	7 / 7	-
	10 MHz		-	________	7 / 7	-

Item No.	Characteristic	Test to page	Min. value	Actual value	Max. value	Unit
12	LO feedthrough	1.15				
	(only model 30)		-	________	-20	dBm
13	Noise display	1.15				
	f_n					
	FSEA:				**Mod. 20 / 30**	
	20 Hz		-	________	- / -80	dBm
	1 kHz		-	________	- / -110	dBm
	9.9 kHz		-	________	-90 / -125	dBm
	95 kHz		-	________	-110 / -135	dBm
	999 kHz		-	________	-130 / -145	dBm
	9.99 MHz		-	________	-145 / -145	dBm
	19.99 MHz		-	________	-145 / -145	dBm
	49.99 MHz		-	________	-145 / -145	dBm
	99.99 MHz		-	________	-145 / -145	dBm
	199.99 MHz		-	________	-145 / -145	dBm
	499.99 MHz		-	________	-145 / -145	dBm
	999.9 MHz		-	________	-145 / -145	dBm
	1999.9 MHz		-	________	-145 / -145	dBm
	3499.9 MHz		-	________	-145 / -145	dBm
	FSEB:				**Mod. 20 / 30**	
	20 Hz		-	________	- / -74	dBm
	1 kHz		-	________	- /-104	dBm
	9.9 kHz		-	________	-84 / -119	dBm
	95 kHz		-	________	-104 / -129	dBm
	999 kHz		-	________	-125 / -142	dBm
	9.99 MHz		-	________	-142 / -142	dBm
	19.99 MHz		-	________	-142 / -142	dBm
	49.99 MHz		-	________	-142 / -142	dBm
	99.99 MHz		-	________	-142 / -142	dBm
	199.99 MHz		-	________	-142 / -142	dBm
	499.99 MHz		-	________	-142 / -142	dBm
	999.9 MHz		-	________	-142 / -142	dBm
	1999.9 MHz		-	________	-142 / -142	dBm
	3499.9 MHz		-	________	-142 / -142	dBm
	5999.9 MHz		-	________	-142 / -142	dBm
	6999.9 MHz		-	________	-139 / -139	dBm

Item No.	Characteristic	Test to page	Min. value	Actual value	Max. value	Unit
13	**FSEM:**	1.15			**Mod. 20 / 30**	
	20 Hz		-	________	- / -74	dBm
	1 kHz		-	________	- /-104	dBm
	9.9 kHz		-	________	-84 / -119	dBm
	95 kHz		-	________	-104 / -129	dBm
	999 kHz		-	________	-124 / -142	dBm
	9.99 MHz		-	________	-138 / -138	dBm
	19.99 MHz		-	________	-138 / -138	dBm
	49.99 MHz		-	________	-138 / -138	dBm
	99.99 MHz		-	________	-138 / -138	dBm
	199.99 MHz		-	________	-138 / -138	dBm
	499.99 MHz		-	________	-138 / -138	dBm
	999.9 MHz		-	________	-138 / -138	dBm
	1999.9 MHz		-	________	-138 / -138	dBm
	3499.9 MHz		-	________	-138 / -138	dBm
	5999.9 MHz		-	________	-138 / -138	dBm
	6999.9 MHz		-	________	-135 / -135	dBm
	7199.9 MHz		-	________	-138 / -138	dBm
	11999.9 MHz		-	________	-138 / -138	dBm
	17999.9 MHz		-	________	-138 / -138	dBm
	21999.9 MHz		-	________	-135 / -135	dBm
	26399.9 MHz		-	________	-135 / -135	dBm
	FSEK:				**Mod. 20 / 30**	
	20 Hz		-	________	- / -74	dBm
	1 kHz		-	________	- /-104	dBm
	9.9 kHz		-	________	-84 / -119	dBm
	95 kHz		-	________	-104 / -129	dBm
	999 kHz		-	________	-124 / -142	dBm
	9.99 MHz		-	________	-138 / -138	dBm
	19.99 MHz		-	________	-138 / -138	dBm
	49.99 MHz		-	________	-138 / -138	dBm
	99.99 MHz		-	________	-138 / -138	dBm
	199.99 MHz		-	________	-138 / -138	dBm
	499.99 MHz		-	________	-138 / -138	dBm
	999.9 MHz		-	________	-138 / -138	dBm
	1999.9 MHz		-	________	-138 / -138	dBm
	3499.9 MHz		-	________	-138 / -138	dBm
	5999.9 MHz		-	________	-138 / -138	dBm
	6999.9 MHz		-	________	-135 / -135	dBm
	7199.9 MHz		-	________	-134 / -134	dBm
	11999.9 MHz		-	________	-134 / -134	dBm
	17999.9 MHz		-	________	-134 / -134	dBm
	21999.9 MHz		-	________	-131 / -131	dBm
	26499.9 MHz		-	________	-131 / -131	dBm
	27000 MHz		-	________	-120 / -120	dBm
	29999 MHz		-	________	-120 / -120	dBm
	30000 MHz		-	________	-116 / -116	dBm
	35000 MHz		-	________	-116 / -116	dBm
	40000 MHz		-	________	-116 / -116	dBm

Item No.	Characteristic	Test to page	Min. value	Actual value	Max. value	Unit
14	Frequency response	1.16				
	FSEA / FSEB / FSEM / FSEK:					
	120 MHz (absolute error)		-0.3	________	+0.3	dB
	f_{fresp}					
	1 MHz		-0.5	________	+0.5	dB
	10 MHz		-0.5	________	+0.5	dB
	50 MHz		-0.5	________	+0.5	dB
	100 MHz		-0.5	________	+0.5	dB
	200 MHz		-0.5	________	+0.5	dB
	300 MHz		-0.5	________	+0.5	dB
	400 MHz		-0.5	________	+0.5	dB
	500 MHz		-0.5	________	+0.5	dB
	600 MHz		-0.5	________	+0.5	dB
	700 MHz		-0.5	________	+0.5	dB
	800 MHz		-0.5	________	+0.5	dB
	900 MHz		-0.5	________	+0.5	dB
	1000 MHz		-0.5	________	+0.5	dB
	1500 MHz		-1	________	+1	dB
	2000 MHz		-1	________	+1	dB
	2500 MHz		-1	________	+1	dB
	3000 MHz		-1	________	+1	dB
	3499 MHz		-1	________	+1	dB
	FSEB / FSEM / FSEK:					
	4000 MHz		-1	________	+1	dB
	4500 MHz		-1	________	+1	dB
	5000 MHz		-1	________	+1	dB
	5500 MHz		-1	________	+1	dB
	6000 MHz		-1	________	+1	dB
	6500 MHz		-1	________	+1	dB
	6999 MHz		-1	________	+1	dB

Item No.	Characteristic	Test to page	Min. value	Actual value	Max. value	Unit
14	**FSEM / FSEK:**	1.16				
	8000 MHz		-2	________	+2	dB
	9000 MHz		-2	________	+2	dB
	10000 MHz		-2	________	+2	dB
	11000 MHz		-2	________	+2	dB
	12000 MHz		-2	________	+2	dB
	13000 MHz		-2	________	+2	dB
	14000 MHz		-2	________	+2	dB
	15000 MHz		-2	________	+2	dB
	16000 MHz		-2	________	+2	dB
	17000 MHz		-2	________	+2	dB
	18000 MHz		-2	________	+2	dB
	19000 MHz		-2.5	________	+2.5	dB
	20000 MHz		-2.5	________	+2.5	dB
	21000 MHz		-2.5	________	+2.5	dB
	22000 MHz		-2.5	________	+2.5	dB
	23000 MHz		-2.5	________	+2.5	dB
	24000 MHz		-2.5	________	+2.5	dB
	25000 MHz		-2.5	________	+2.5	dB
	26000 MHz		-2.5	________	+2.5	dB
	26499 MHz		-2.5	________	+2.5	dB
	FSEK:					
	27000 MHz		-3	________	+3	dB
	28000 MHz		-3	________	+3	dB
	29000 MHz		-3	________	+3	dB
	30000 MHz		-3	________	+3	dB
	31000 MHz		-3	________	+3	dB
	32000 MHz		-3	________	+3	dB
	33000 MHz		-3	________	+3	dB
	34000 MHz		-3	________	+3	dB
	35000 MHz		-3	________	+3	dB
	36000 MHz		-3	________	+3	dB
	37000 MHz		-3	________	+3	dB
	38000 MHz		-3	________	+3	dB
	39000 MHz		-3	________	+3	dB
	40000 MHz		-3	________	+3	dB

Item No.	Characteristic	Test to page	Min. value	Actual value	Max. value	Unit
15	Display linearity	1.18				
	a_{ATT}					
	6 dB		9.7	________	10.3	dB
	8 dB		7.7	________	8.3	dB
	10 dB		5.7	________	6.3	dB
	12 dB		3.7	________	4.3	dB
	14 dB		1.7	________	2.3	dB
	16 dB		-	Reference	-	-
	18 dB		-2.3	________	-1.7	dB
	20 dB		-4.3	________	-3.7	dB
	22 dB		-6.3	________	-5.7	dB
	24 dB		-8.3	________	-7.7	dB
	26 dB		-10.3	________	-9.7	dB
	28 dB		-12.3	________	-11.7	dB
	30 dB		-14.3	________	-13.7	dB
	32 dB		-16.3	________	-15.7	dB
	34 dB		-18.3	________	-17.7	dB
	36 dB		-20.3	________	-19.7	dB
	38 dB		-22.3	________	-21.7	dB
	40 dB		-24.3	________	-23.7	dB
	42 dB		-26.3	________	-25.7	dB
	44 dB		-28.3	________	-27.7	dB
	46 dB		-30.3	________	-29.7	dB
	48 dB		-32.3	________	-31.7	dB
	50 dB		-34.3	________	-33.7	dB
	52 dB		-36.3	________	-35.7	dB
	54 dB		-38.3	________	-37.7	dB
	56 dB		-40.3	________	-39.7	dB
	61 dB		-45.5	________	-44.5	dB
	66 dB		-50.5	________	-49.5	dB
	71 dB		-55.5	________	-54.5	dB
	76 dB		-60.5	________	-59.5	dB
	81 dB		-66.0	________	-64.0	dB
	86 dB		-71.0	________	-69.0	dB
	only models 30					
	91 dB		-76.0	________	-74.0	dB
	96 dB		-81.0	________	-79.0	dB
	101 dB		-86.0	________	-84.0	dB

Item No.	Characteristic	Test to page	Min. value	Actual value	Max. value	Unit
16	Attenuator	1.19				
	a_{ATT}					
	70		-70.3	________	-69.7	dBm
	60		-60.3	________	-59.7	dBm
	50		-50.3	________	-49.7	dBm
	40		-40.3	________	-39.7	dBm
	30		-30.3	________	-29.7	dBm
	20		-20.3	________	-19.7	dBm
	10		-10.3	________	-9.7	dBm
	0		-0.3	________	+0.3	dBm
17	IF gain switching	1.20				
	Reference level					
	0 dBm		-10.2	________	-9.8	dBm
	-10 dBm		-20.2	________	-19.8	dBm
	-20 dBm		-30.2	________	-29.8	dBm
	-30 dBm		-40.2	________	-39.8	dBm
	-40 dBm		-50.2	________	-49.8	dBm
	-50 dBm		-60.2	________	-59.8	dBm
	-31 dBm		-41.2	________	-40.8	dBm
	-32 dBm		-42.2	________	-41.8	dBm
	-33 dBm		-43.2	________	-42.8	dBm
	-34 dBm		-44.2	________	-43.8	dBm
	-35 dBm		-45.2	________	-44.8	dBm
	-36 dBm		-46.2	________	-45.8	dBm
	-37 dBm		-47.2	________	-46.8	dBm
	-38 dBm		-48.2	________	-47.8	dBm
	-39 dBm		-49.2	________	-48.8	dBm

Item No.	Characteristic	Test to page	Min. value	Actual value	Max. value	Unit
18	Phase noise offset:	1.20				
	FSEA20 without B4 :					
	1 kHz		-	———	–85	dBc/Hz
	10 kHz		-	———	–95	dBc/Hz
	100 kHz		-	———	–119	dBc/Hz
	1 MHz		-	———	–135	dBc/Hz
	FSEA30 or FSEA20 with B4 :					
	100 Hz		-	———	–87	dBc/Hz
	1 kHz		-	———	–107	dBc/Hz
	10 kHz		-	———	–120	dBc/Hz
	100 kHz		-	———	–117 / 119 *)	dBc/Hz
	1 MHz		-	———	–135 / 138 *)	dBc/Hz
	FSEB/M/K 20 without B4:					
	1 kHz		-	———	–79	dBc/Hz
	10 kHz		-	———	–90	dBc/Hz
	100 kHz		-	———	–113	dBc/Hz
	1 MHz		-	———	–129	dBc/Hz
	FSEB/M/K 30 or FSEB/M/K20					
	withB4:		-	———	–81	dBc/Hz
	100 Hz		-	———	–100	dBc/Hz
	1 kHz		-	———	–114	dBc/Hz
	10 kHz		-	———	–111 / 113 *)	dBc/Hz
	100 kHz		-	———	–129 / 132 *)	dBc/Hz
	1 MHz					
*) The better values apply to models 25 / 35						
19	option tracking generator	1.24				
	output level					
	0 dBm		- 1	———	+ 1	dBm
	–3 dBm		-4	———	-2	dBm
	–6 dBm		-8	———	-4	dBm
	–10 dBm		-12	———	-8	dBm
	–20 dBm		- 21	———	- 19	dBm

Item No.	Characteristic	Test to page	Min. value	Actual value	Max. value	Unit
20	option tracking generator frequency response	1.24				
	1 MHz to 1 GHz		-2	———	2	dBm
	1 GHz to 3.5 GHz		-3	———	3	dBm
	3.5 GHz to 7 GHz		-3	———	3 (typ)	dBm
21	option tracking generator I/Q-modulator	1.24				
	residual carrier		-	———	-46	dBm
	imbalance		-10	———	-8	dBm
	quadrature offset		- 7	———	-5	dBm

Test Instructions (option FSE-B22 included)

The rated specifications of the analyzer are tested after a warm-up time of at least 30 minutes and overall calibration. Only in this case can the compliance with the guaranteed data be ensured.

Values given in the following sections are not guaranteed. Only the technical specifications of the data sheet are binding.

Additional equipment required for performance test (option FSE-B22 included)

Table 1-3 Additional equipment required for performance test (option FSE-B22 included)

Item	Type of equipment	Specifications recommended	Recommended equipment	R&S Order No.	Page
1	Power sensor	frequency 1 MHz to 2 GHz RSS referred to indicated power ≤ 0.8 %	NRV-Z51	0857.9004.02	1.43
2	6-dB divider (power splitter)	frequency 1 MHz to 2 GHz level imbalance ≤ 0.1 dB	RVZ	0800.6612.52	1.43

Checking the Calibration Source at 120 MHz

Test equipment:
- signal generator (table 1-1, item 3):
  frequency 120 MHz
  level -40 dBm
- power meter (table 1-1, item 8)
- power sensor (table 1-1, item 9)
  frequency 120 MHz
  maximum power $P_{max} \geq 1\ \mu W$
  meter noise ≤ 20 pW
  RSS ≤ 0.8% referred to indicated power
  impedance Z = 50 Ω

Power meter settings:
- connect power sensor to power meter and carry out function ´ZERO´ when no signal is applied to the power sensor.
- connect power sensor to RF output of signal generator.

Signal generator settings:
- frequency 120 MHz
- level -40 dBm ± 0.1 dB
  Use power meter for exact level adjustment.

Test setup: connect RF output of the signal generator to RF input of the FSE

FSE settings:
- [**SYSTEM PRESET**]
- [**FREQUENCY CENTER** : **120 MHz**]
- [**FREQUENCY SPAN** : **15 kHz**]
- [**SWEEP COUPLING** : RES BW MANUAL : **5 kHz**]
- [**LEVEL REF** : REF LEVEL : **-10 dBm**]
- [**INPUT** : RF ATTEN MANUAL : **20 dB**]

- set marker to peak of signal
  [**MARKER SEARCH** : PEAK]
- set reference to peak of signal
  [**MARKER DELTA** : REFERENCE FIXED]
- switch internal reference generator to RF input
  [**CONFIGURATION SETUP** : SERVICE : INPUT CAL]
- set marker to peak of signal
  [**MARKER SEARCH** : PEAK]

Evaluation: The reading ´Delta 1 [T1 FXD]´ displays the difference between the output level of the signal generator and the level of the calibration source .... < 0.2 dB

Note: *The level of the calibration source can be adjusted with R22 on FracSyn module.*

Checking IF Filters

Test equipment: signal generator (table 1-1, item 3):
frequency 120 MHz
level ≥ -10 dBm

Test setup: connect RF output of the signal generator to the RF input of the FSE.

Checking the Level Error

Reference Measurement (RBW 5 kHz)

Signal generator settings:
- frequency: 120 MHz
- level: -20 dBm

FSE settings:
- [**SYSTEM PRESET**]
- [**INPUT** : RF ATTEN MANUAL : **10 dB**]
- [**LEVEL REF** : **0 dBm**]
- [**FREQUENCY CENTER** : **120 MHz**]
- [**SWEEP COUPLING** : COUPLING RATIO : RBW/VBW SINE [1]]
- [**SWEEP COUPLING** : COUPLING RATIO : SPAN/RBW MANUAL : **5** : **ENTER**]
- resolution bandwidth 5 kHz
  [**FREQUENCY SPAN** : **25 kHz**]
- set marker to peak of signal
  [**MARKER SEARCH** : PEAK]
- set reference to peak of signal
  [**MARKER DELTA** : REFERENCE FIXED]

Checking the Level Error

FSE settings:

- [**FREQUENCY SPAN** : {5 x RBW}]

  See table 1-4 (item 2) of performance test report for values of RBW.

- set marker to peak of signal
  [**MARKER SEARCH** : PEAK]

  The level error is displayed by the reading
  ´Delta 1 [T1 FXD] {level error} dB´.

Evaluation:

See table 1-4 (item 2) of performance test report for upper and lower limits of level error.

Checking the Frequency Response

Test equipment:

- signal generator (table 1-1, item 3)
  frequency range 1 MHz to 2 GHz
  maximum level ≥ -10 dBm
- power meter (table 1-1, item 8)
- power sensor (table 1-3, item 1)
  frequency range 1 MHz to 2 GHz
  maximum power P_{max} ≥ 100 µW
  RSS referred to indicated power ≤ 0.8 %
  impedance Z = 50 Ω
- 6-dB divider (table 1-3, item 2)
  frequency range 1 MHz to 2 GHz
  level imbalance[1] ≤ 0.1 dB

  [1]If a power splitter with higher level imbalance is used correction of the measured frequency response is recommended.

Determining the absolute error at 120 MHz

Test setup:

- connect power sensor (table 1-3, item 1) to the power meter and execute function ´ZERO´ when there is no signal applied to the power sensor
- connect power sensor to RF output of signal generator

Signal generator settings:

- frequency 120 MHz
- level -10 dBm

Measurement:

- determine output power of the signal generator with the power meter
- connect RF output of the signal generator to RF input of the FSE

FSE settings:

- [**SYSTEM PRESET**]
- [**INPUT** : RF ATTEN MANUAL : {a_{FSE}} **dB**]
  See
- [**LEVEL REF** : **-7 dBm**]
- [**FREQUENCY SPAN** : **15 kHz**]
- [**SWEEP COUPLING** : RES BW MANUAL : **5 kHz**]
- [**FREQUENCY CENTER** : **120 MHz**]

- set marker to peak of signal
  [**MARKER SEARCH** : PEAK]

Evaluation:

The deviation between the signal levels measured with the power meter and the FSE (level reading of marker 1) reflects the absolute level error of the FSE. It can be calculated as

$$\text{absolute error}_{120MHz} = L_{FSE} - L_{powermeter}$$

Checking the frequency response

Test setup:

- connect RF output of the signal generator to input of the divider
- connect output 1 of the divider to the power sensor of the power meter
- connect output 2 of the divider to RF input of the FSE

Signal generator settings:

- level -10 dBm
- frequency f_{fresp}

  see table 1-3 (item 3) of performance test report for values of f_{fresp}

FSE settings:

- [**SYSTEM PRESET**]
- [**INPUT** : RF ATTEN MANUAL : **10 dB**]
- [**LEVEL REF** : **-7 dBm**]
- [**FREQUENCY SPAN** : **30 kHz**]
- [**SWEEP COUPLING** : RES BW MANUAL : **5 kHz**]
- [**FREQUENCY CENTER** : {f_{fresp}}]

  see table 1-3 (item 3) of performance test report for values of f_{fresp}

- activate ´preselector peak´ if center frequency is higher than 7 GHz (only available for FSEM and FSEK)
  [**SYSTEM CAL** : PRESEL PEAK]

- set marker to peak of signal
  [**MARKER SEARCH** : PEAK]

  the signal level L_{FSE} is displayed by the level reading of marker 1.

Power meter settings:

Determine signal level $L_{powermeter}$. To achive higher accuracy it is recommended to compensate the frequency response of the power sensor.

Evaluation:

The frequency response can be calculated as

$$\text{Frequency response} = L_{FSE} - L_{powermeter} - \text{absolute error}_{120\,MHz}$$

Checking the Display Linearity

Test equipment:	- signal generator (table 1-1, item 3) frequency 5 MHz maximum level ≥ 6 dBm - step attenuator (table 1-1, item 13) frequency 5 MHz attenuation 0 to 95 dB steps 1 dB maximum attenuation error < 0.01 dB
Test setup:	- connect RF output of the signal generator to RF input of the step attenuator - connect RF output of the step attenuator to RF input of the FSE
Signal generator settings:	- frequency 5 MHz - level +6 dBm
Step attenuator settings:	attenuation 16 dB
FSE settings:	- [**SYSTEM PRESET**] - [**INPUT** : RF ATTEN MANUAL : **10 dB**] - [**LEVEL REF** : **0 dBm**] - [**FREQUENCY CENTER** : **5 MHz**] - [**FREQUENCY SPAN** : **500 Hz**] - [**SWEEP COUPLING** : RES BW MANUAL : **3 kHz**] - [**SWEEP COUPLING** : VIDEO BW MANUAL : **100 Hz**] - [**LEVEL RANGE** : LOG 100 dB] - set marker to peak of signal [**MARKER SEARCH** : PEAK] - set reference to peak of signal [**MARKER DELTA** : REFERENCE FIXED]

Measurement

Step attenuator settings:	attenuation $\{a_{ATT}\}$ See table 1-4 (item 4) of performance test report for values of a_{ATT}.
Evaluation:	The difference between the level of the input signal of the FSE and the reference (about 10 dB below the reference level) is displayed by the reading ´Delta 1 [T1 FXD]´. Compare the measured values with the limits given in table 1-4 (item 4) of performance test report.

Checking the Attenuator

Test equipment:

- signal generator (table 1-1, item 3)
  frequency 5 MHz
  maximum level ≥ 6 dBm
- step attenuator (table 1-1, item 13)
  frequency 5 MHz
  attenuation 0 to 70 dB
  steps 10 dB
  maximum attenuation error < 0.05 dB

Test setup:

- connect RF output of the signal generator to RF input the step attenuator
- connect RF output of the step attenuator to RF input of the FSE

Signal generator settings:

- frequency 5 MHz
- level 0 dBm

Step attenuator settings: attenuation 60 dB

FSE settings:

- [**SYSTEM PRESET**]
- [**FREQUENCY CENTER** : **5 MHz**]
- [**FREQUENCY SPAN** : **500 Hz**]
- [**SWEEP COUPLING** : RES BW MANUAL : **3 kHz**]
- [**SWEEP COUPLING** : VIDEO BW MANUAL : **100 Hz**]
- [**INPUT** : RF ATTEN MANUAL : **10 dB**]
- [**LEVEL REF** : **-30 dBm**]
- [**MARKER SEARCH** : PEAK]

adjust output level of the signal generator until the level reading of marker 1 is exactly -60.0 dBm.

Measurement

Step attenuator settings: attenuation {a_{ATT}}

See table below for values of a_{ATT}.

FSE settings:

- [**INPUT** : RF ATTEN MANUAL : {a_{FSE}}]
- [**LEVEL REF** : {reference level} **dBm**]
- [**MARKER SEARCH** : PEAK]

see table below for values of a_{FSE} and reference level.

Evaluation: Compare level reading of marker 1 with the limits given in table 1-4 (item 5) of performance test report.

a_{ATT}	40 dB	30 dB	20 dB	10 dB
a_{FSE}	30 dB	40 dB	50 dB	60 dB
reference level	-10 dBm	0 dBm	+10 dBm	+20 dBm

Performance Test Report (option FSE-B22 included)

Note: *The values given in the datasheet are the guaranteed limits. Due to measurement errors these limits must be extended by the tolerance of the measuring equipment used in this performance test.*

Table 1-4 Performance test report

Item No.	Characteristic	Test to page	Min. value	Actual value	Max. value	Unit
1	Calibration source at 120 MHz	1.41	-0.2	________	+0.2	dB
2	IF bandwidths Level error	1.4				
	reference (Ref): 5 kHz		-	________	-	dBm
	100 Hz		-0.15	________	+0.15	dB
	1 kHz		-0.15	________	+0.15	dB
	2 kHz		-0.15	________	+0.15	dB
	3 kHz		-0.15	________	+0.15	dB
	5 kHz		-0.15	________	+0.15	dB
	10 kHz		-0.15	________	+0.15	dB
	20 kHz		-0.15	________	+0.15	dB
	30 kHz		-0.15	________	+0.15	dB
	300 kHz		-0.15	________	+0.15	dB

Item No.	Characteristic	Test to page	Min. value	Actual value	Max. value	Unit
3	Frequency response	1.43				
	RF-Attenuation					
	a_{FSE} = 10 dB					
	120 MHz		-0.3	________	+0.3	dB
	(absolute error)					
	f_{fresp}					
	1 MHz		-0.3	________	+0.3	dB
	10 MHz		-0.3	________	+0.3	dB
	50 MHz		-0.3	________	+0.3	dB
	100 MHz		-0.3	________	+0.3	dB
	200 MHz		-0.3	________	+0.3	dB
	300 MHz		-0.3	________	+0.3	dB
	400 MHz		-0.3	________	+0.3	dB
	500 MHz		-0.3	________	+0.3	dB
	600 MHz		-0.3	________	+0.3	dB
	700 MHz		-0.3	________	+0.3	dB
	800 MHz		-0.3	________	+0.3	dB
	900 MHz		-0.3	________	+0.3	dB
	1000 MHz		-0.3	________	+0.3	dB
	1100 MHz		-0.3	________	+0.3	dB
	1200 MHz		-0.3	________	+0.3	dB
	1300 MHz		-0.3	________	+0.3	dB
	1400 MHz		-0.3	________	+0.3	dB
	1500 MHz		-0.3	________	+0.3	dB
	1600 MHz		-0.3	________	+0.3	dB
	1700 MHz		-0.3	________	+0.3	dB
	1800 MHz		-0.3	________	+0.3	dB
	1900 MHz		-0.3	________	+0.3	dB
	2000 MHz		-0.3	________	+0.3	dB

Item No.	Characteristic	Test to page	Min. value	Actual value	Max. value	Unit
3	Frequency response	1.43				
	RF-Attenuation					
	a_{FSE} = 20 dB					
	120 MHz		-0.3	________	+0.3	dB
	(absolute error)					
	f_{fresp}					
	1 MHz		-0.45	________	+0.45	dB
	10 MHz		-0.45	________	+0.45	dB
	50 MHz		-0.45	________	+0.45	dB
	100 MHz		-0.45	________	+0.45	dB
	200 MHz		-0.45	________	+0.45	dB
	300 MHz		-0.45	________	+0.45	dB
	400 MHz		-0.45	________	+0.45	dB
	500 MHz		-0.45	________	+0.45	dB
	600 MHz		-0.45	________	+0.45	dB
	700 MHz		-0.45	________	+0.45	dB
	800 MHz		-0.45	________	+0.45	dB
	900 MHz		-0.45	________	+0.45	dB
	1000 MHz		-0.45	________	+0.45	dB
	1100 MHz		-0.45	________	+0.45	dB
	1200 MHz		-0.45	________	+0.45	dB
	1300 MHz		-0.45	________	+0.45	dB
	1400 MHz		-0.45	________	+0.45	dB
	1500 MHz		-0.45	________	+0.45	dB
	1600 MHz		-0.45	________	+0.45	dB
	1700 MHz		-0.45	________	+0.45	dB
	1800 MHz		-0.45	________	+0.45	dB
	1900 MHz		-0.45	________	+0.45	dB
	2000 MHz		-0.45	________	+0.45	dB

Item No.	Characteristic	Test to page	Min. value	Actual value	Max. value	Unit
3	Frequency response	1.43				
	RF-Attenuation					
	a_{FSE} = 30 dB					
	120 MHz		-0.3	________	+0.3	dB
	(absolute error)					
	f_{fresp}					
	1 MHz		-0.45	________	+0.45	dB
	10 MHz		-0.45	________	+0.45	dB
	50 MHz		-0.45	________	+0.45	dB
	100 MHz		-0.45	________	+0.45	dB
	200 MHz		-0.45	________	+0.45	dB
	300 MHz		-0.45	________	+0.45	dB
	400 MHz		-0.45	________	+0.45	dB
	500 MHz		-0.45	________	+0.45	dB
	600 MHz		-0.45	________	+0.45	dB
	700 MHz		-0.45	________	+0.45	dB
	800 MHz		-0.45	________	+0.45	dB
	900 MHz		-0.45	________	+0.45	dB
	1000 MHz		-0.45	________	+0.45	dB
	1100 MHz		-0.45	________	+0.45	dB
	1200 MHz		-0.45	________	+0.45	dB
	1300 MHz		-0.45	________	+0.45	dB
	1400 MHz		-0.45	________	+0.45	dB
	1500 MHz		-0.45	________	+0.45	dB
	1600 MHz		-0.45	________	+0.45	dB
	1700 MHz		-0.45	________	+0.45	dB
	1800 MHz		-0.45	________	+0.45	dB
	1900 MHz		-0.45	________	+0.45	dB
	2000 MHz		-0.45	________	+0.45	dB

Item No.	Characteristic	Test to page	Min. value	Actual value	Max. value	Unit
3	Frequency response	1.43				
	RF-Attenuation					
	a_{FSE} = 40 dB					
	120 MHz		-0.3	________	+0.3	dB
	(absolute error)					
	f_{fresp}					
	1 MHz		-0.45	________	+0.45	dB
	10 MHz		-0.45	________	+0.45	dB
	50 MHz		-0.45	________	+0.45	dB
	100 MHz		-0.45	________	+0.45	dB
	200 MHz		-0.45	________	+0.45	dB
	300 MHz		-0.45	________	+0.45	dB
	400 MHz		-0.45	________	+0.45	dB
	500 MHz		-0.45	________	+0.45	dB
	600 MHz		-0.45	________	+0.45	dB
	700 MHz		-0.45	________	+0.45	dB
	800 MHz		-0.45	________	+0.45	dB
	900 MHz		-0.45	________	+0.45	dB
	1000 MHz		-0.45	________	+0.45	dB
	1100 MHz		-0.45	________	+0.45	dB
	1200 MHz		-0.45	________	+0.45	dB
	1300 MHz		-0.45	________	+0.45	dB
	1400 MHz		-0.45	________	+0.45	dB
	1500 MHz		-0.45	________	+0.45	dB
	1600 MHz		-0.45	________	+0.45	dB
	1700 MHz		-0.45	________	+0.45	dB
	1800 MHz		-0.45	________	+0.45	dB
	1900 MHz		-0.45	________	+0.45	dB
	2000 MHz		-0.45	________	+0.45	dB

Item No.	Characteristic	Test to page	Min. value	Actual value	Max. value	Unit
4	Display linearity	1.45				
	a_{ATT}					
	16 dB		-	Reference	-	-
	18 dB		-2,2	________	-1,8	dB
	20 dB		-4,2	________	-3,8	dB
	22 dB		-6,2	________	-5,8	dB
	24 dB		-8,2	________	-7,8	dB
	26 dB		-10,2	________	-9,8	dB
	28 dB		-12,2	________	-11,8	dB
	30 dB		-14,2	________	-13,8	dB
	32 dB		-16,2	________	-15,8	dB
	34 dB		-18,2	________	-17,8	dB
	36 dB		-20,2	________	-19,8	dB
	38 dB		-22,2	________	-21,8	dB
	40 dB		-24,2	________	-23,8	dB
	42 dB		-26,2	________	-25,8	dB
	44 dB		-28,2	________	-27,8	dB
	46 dB		-30,2	________	-29,8	dB
	48 dB		-32,2	________	-31,8	dB
	50 dB		-34,2	________	-33,8	dB
	52 dB		-36,2	________	-35,8	dB
	54 dB		-38,2	________	-37,8	dB
	56 dB		-40,2	________	-39,8	dB
5	Attenuator	1.46				
	a_{ATT}					
	40		-40,2	________	-39,8	dBm
	30		-30,2	________	-29,8	dBm
	20		-20,2	________	-19,8	dBm
	10		-10,2	________	-9,8	dBm

Contents - Chapter 2 "Adjustment"

2 Adjustment

All boards have been adjusted before being supplied and do not require readjustment after a board replacement in the instrument.
The correction and setting data for the boards are contained in an EEPROM on each board and are thus replaced with board replacement.

Switch off the instrument before replacing a board.

Some boards provide additional adjustment facilities which should be checked with servicing:

- Fracsyn: adjustment for calibration level -40dBm
- RF-Converter Unit: adjustment of the YIG oscillator characteristic and dynamic
- MW-Converter Unit: adjustment of the YIG filter characteristic and dynamic
- 2nd IF-Converter: no adjustment
- IF filter: no adjustment, all values are determined with calibration
- Detector: no adjustment
- LowPhaseNoise: no adjustment

Adjustment of the reference frequency is explained in Section 8 (Maintenance) of the Operating Manual.

Contents - Chapter 3 "Function Description/Selftest"

3 Function Description/Selftest

3 Function Description/Selftest

This chapter describes the design of the FSE and simple measures for monitoring the function of the instrument. A selftest is available for troubleshooting and diagnosis.

The firmware update and the installation of options are described in chapter 4 in this service manual.

Function Description of Overall Instrument

This section informs on the theory of operation of this instrument.

Modules of the Analog Unit

All modules of the analog unit contain an individually programmed EEPROM indicating the model and correction data, such as frequency response, filter parameters, insertion gain. The analog unit consists of the following modules:

- RF modules with RF converter and YIG sampler forming part of the RF module
- MW converter modules (for instruments with a frequency range > 7 GHz)
- 2nd IF converter
- IF filter
- Digital IF
- I/Q-demodulator (option FSE-B7)
- Fracsyn with static transputer module
- Low phase noise for instrument model 30
- Detector board with dynamic transputer module and DSP module
- Analog motherboard

Modules of the Digital Unit

The boards of the digital unit do not contain any particular correction data. The digital unit is independent of the type of instrument, the only difference is the amount and type of plug-in boards fitted such as network board or IEC/IEEE board. The digital unit consists of the following modules:

- Main processor
- Graphic board
- Digital motherboard (containing the interface drivers such as IEC bus, LPT and COM)
- Hard disk
- Floppy disk
- LC display
- Keypad
- Option VGA board
- Option 2nd IEEE-bus
- Option LAN interface

Description of the Analog Unit

The FSE has been conceived as analyzer with triple conversion. Special importance has been attached to reaching high display dynamics, i.e., the individual amplifier stages have not only been trimmed to minimum displayed noise level but adjusted such that they provide good intermodulation characteristics with an acceptable noise factor.

The input signal passes a switchable input divider (attenuation range 0 to 70dB in steps of 10dB), which also switches the internal calibration and test signal.

In the RF converter, the signal (7.9414 to 14.9414 GHz ;FSEA: 4,3414 to 7,8414GHz) is converted to the 1st IF (7.9414, FSEA: 4.3414)), using the 1st LO after having passed the input lowpass in the 1st mixer. Following the 1st IF filter and the IF gain, the signal is converted to the 2nd IF of 741.4MHz.

By those FSE models having a frequency range greater than 7 GHz, the signal is divided, after the input divider, in a switchable diplexer. The portions of the signal below 7 GHz are further processed in the RF converter. The portions of the signal above 7 GHz are fed via a YIG filter to the MW converter. The conversion of the IF of 741.4 MHz takes place in this module. The LO required for the conversion comes from the RF converter and, depending on the frequency range, is either fed directly or via a doubler to the mixer.

The next module in the signal path is the 2nd IF Converter, which provides for conversion of the second IF to the third IF of 21.4 MHz and generation of the second and third LO. Apart from several amplifiers it contains a filter on 741.4 MHz with a 3-dB bandwidth of 10 MHz. This filter serves as resolution filter if the resolution bandwidth is 10 MHz and it reflects the image frequency which might be generated by the third conversion.

The resolution filters for bandwidths between 1 kHz and 5 MHz are located on the IF filter board . With the 10-MHz bandwidth, the filter stages of the board are bypassed. Crystal filters are used for bandwidths between 1 and 30 kHz, LC filters are provided for bandwidths of 50 kHz or above. The individual filter stages have been decoupled from each other by means of amplifiers which is why they act as Gaussian filter. Subsequent to the first two filter stages, switchable IF amplifiers (Step Gain) and two independent calibration amplifiers are fitted. The step gain can be switched in 0.1-dB steps from 0 to 50 dB and is used to amplify the signal on the reference level. One of the two calibration amplifiers is used to compensate for the deviations of amplification with different bandwidth or step-gain settings. This amplifier is controlled via the serial interface of the level transputer and a D/A converter on the IF filter board. The second calibration amplifier is controlled by an analog voltage, which is modified by the frequency transputer during the sweep according to the frequency response of the input stages.

The IF filters are followed by the log module, which provides for a dynamic of 90 or 110 dB depending on the model. The video signal thus created is passed to the detector board. There, it is through-connected to the rear panel.

If resolution bandwidths are < 1kHz, the signal path via the log module remains unused. The signal is still filtered by the IF filter board to a bandwidth of 3 kHz, but then converted to a 25-kHz IF and filtered digitally on the module. An 18-bit A/D converter is provided on the digital IF for sampling with the 25-kHz IF.

A measuring A/D converter with a sampling rate of 20 MHz is provided on the detector board. Due to the high sampling rate of the A/D converter the analog peak detectors are not required, they are digitally simulated following the converter. Video filtering is carried out digitally, too, in the noise filter gate-array on the detector board. For video bandwidths ≤ 20 kHz, additional filtering is carried out using a DSP, which remains disabled above 20 kHz.

Processor Structure

Apart from a 586 CPU, the FSE is provided with three T805-32-bit transputers and a 32-bit transputer T425 (formerly 16-bit transputer T225). Two DSPs are provided in the basic instrument for digital signal processing.

The 586 CPU controls the complete data exchange with the periphery, such as keybaord entry, representation of the softkeys and operation via the IEC bus. The transputers independently control the test procedure, calculate correction factors and display the measuring curve on the screen. The transputers are provided with the current instrument settings by the 586 CPU via a link adapter, which connects the ISA bus of the CPU board with a transputer link of the T805 on the graphic board (called GTP = graphic transputer in the following). Other transputer links couple the T425 on the graphics board and the two T805 on the detector board (LTP = level transputer) and the Fracsyn (FTP = frequency transputer) to the GTP. T425 is exclusively used as interface between the GTP and the chipset for graphics.

Tasks of the Level Transputer

The PTP receives the level-dependent settings from the graphic transputer and causes the corresponding switchovers in the hardware to be made via a serial interface. The PTP has the following functions: making the level-dependent settings such as attenuation of the attenuator, the bandwidths on the IF filter and level correction with the calibration frequency (120 MHz) and, on the other hand, programming of the DSPs, obtaining the measured values and passing the measured values to the graphic transputer via the transputer link. To meet these requirements, the PTP is provided with its individual serial bus to those boards which require level-dependent settings. I.e., the modules IF filter, digital IF, attenuator control board.

Tasks of the Frequency Transputer

The FTP receives the current sweep setting from the graphic transputer via the PTP and calculates the required synthesizer settings. For settings which have to be made during a sweep, the FTP is fitted with a fast parallel bus on the fracsyn module, which also addresses the sweep synthesizer. The subsequent settings have to be made: the frequency-dependent level correction, coarse tuning of the YIG oscillator and control of the sweep output. The fracsyn module therefore accommodates D/A converters which are programmed parallely during the sweep and which provide control voltages. The voltage for the sweep output is applied to the rear panel where it provides a sawtooth voltage which starts at 0V at the sweep start and increases to 10 V at the end of sweep. The voltage for frequency-response correction is passed to a voltage-controlled amplifier on the IF filter board which compensates for the frequency-dependent attenuation characteristic of the input stages. The third tuning voltage leads to the RF module where the main coil of the YIG oscillator which is integrated in the YIG sampler is controlled by means of a voltage-controlled current source, thus controlling the coarse tuning of the first LO. D/A converters which are required for options are provided in the basic FSE model. A serial bus is available for the FTP to use when controlling time-critical settings.

Monitoring the Function of the FSE

Switch-on Test

Following switch-on of the instrument a selftest of the processor functions is executed first. Subsequently, the transputer net is initialized, which adopts control of the analog modules.

Monitoring of the Synthesizers and Signal Levels

The FSE is provided with a large amount of selftest points which can be switched to an A/D converter via multiplexer. Most of these test points are located on the analog modules and, by means of level detectors, allow for monitoring the levels in the signal path, the output levels of the LO drivers and the tuning voltages of the oscillators. The selftest voltages which are required for proper functioning, are additionally monitored by comparators. The output signals of these comparators are stored and checked by the level transputer during each request of a measured value. If one of these comparators responds, one of the following error messages is output:

Message	**Meaning**	**see Section**
Reference unlock	Reference osxillator not synchronized	"Error Messages of the Synthesizer"
LO UNL	First LO not synchronized	"Error Messages of the Synthesizer"
2nd/3rd LO unlock	Second and third LO not synchronized	"Error Messages of the Synthesizer"
Level 1st LO	LO level at first mixer too small	"Error Messages of the Synthesizer"
Level 2nd LO	LO level at second mixer too small	"Error Messages of the Synthesizer"
Level 3rd LO	LO level at third mixer too small	"Error Messages of the Synthesizer"
OVLD	Input signal too large	"Overload Messages"
IF OVLD	Signal following IF amplifier too large	"Overload Messages"

Error Messages of the Synthesizer

When the message LO UNL is displayed, the instrument continues operating, however, the signals indicated may have been shifted on the frequency axis. In particular, when the instrument is operated at about the maximum or minimum operating temperature, it may occur, after ageing of the instrument, that the tuning voltage of the voltage-controlled oscillators drift at the limit of the permitted range. Therefore, correction of the pretuning is provided for the first LO (YIG oscillator) and the third LO (VCO) which is performed during total calibration of the instrument, thus eliminating the error. Correction is not required for the second LO, since it is obtained by multiplication of the third LO. For measuring accuracy reason, it is recommended with very cold or hot environment to call the total calibration of the instrument (after a warm-up period of at least 30 minutes).

When the message "Reference unlock" is output and if the analyzer is set to external reference, check that the latter is applied with the correct frequency and sufficient level at connector EXT REF IN/OUT. If the instrument is set to internal reference, the message should only occur during a short warm-up phase following switch-on.
The message Level Lo means that the level at the LO gate of one of the mixers is too low, which may lead to dips in the conversion attenuation. In any case, this message indicates a fault inside the instrument.

Overload Messages

The messages OVLD and IF-OVLD indicate an overload in the signal path of the instrument. These messages are a warning that the instrument indication will seem to be wrong, because one stage in the signal path is operated with the 1-dB compression or above.
The message OVLD indicates that one stage preceding the variable IF amplifier is operated with an exceeded level. The level can only be reduced by an increased attenuation of the input attenuator (RF Attenuation). Overload at the input mixer and in the subsequent stages frequently occurs, if pulsed or highly modulated signals are applied. Such signals have a high peak value compared to the input bandwidth and this may lead to compression of these stages.
If this message is output without an input signal being applied, the input mixer is defective. The LO feedthrough (= the level display with input frequency zero) depends to a large extent on the balance of the input mixer. Since a partially faulty mixer becomes very unbalanced, thus providing very high LO feedthrough, this may lead to overload of the subsequent stages and thus to output of the message OVLD.
The message IF-OVLD indicates compression in one stage following the switchable IF amplifier. This can be remedied even with fixed input attenuation by increasing the reference level. In analyzer mode, the IF amplification depends on the reference level and the RF attenuation.

Selftest

The selftest allows for checking the instrument functions without using additional test instruments. When an instrument error occurs, the module which caused the error is indicated on the screen. The following measures are taken to localize an error:

- An additional A/D converter is provided which allows for measuring voltages on the various modules.
- While the selftest is being performed, important dc voltages, on-board supply voltages and amplifier operating points are measured and compared to their rated values.
- Level detectors check the oscillator levels required for operating the mixers
- The calibration generator generates a 120-MHz signal with a level of 0 dBm at the RF input of the instrument. The on-board level detectors in the signal path allow for processing of the input signal in the individual RF and IF stages.

Operation

Operation of the selftest is explained in the Operation Manual , Chapter 2, Section "Selftest Functions".

Testing the Processor Functions

The test of the processor functions comprises testing of the interface chips and the dynamic RAM, test of the graphic board and the connected transputers.
If the CPU, the dynamic RAM or the hard disk are defective, the instrument may not be able any more to output a detailed error message.

Testing the Synthesizers

Correct functioning of all oscillators is absolutely necessary for checking the signal path. Therefore, all synthesizer modules are checked next. The synthesizer modules are tested in the following order:

1. Test of the reference frequencies with 10 MHz and 120 MHz and the derived signals with 20, 30 and 60 MHz.
2. Measurement of the signals applied to the YIG sampler (output signal of fracsyn and output signal of sampler)
3. Test of the YIG main loop with the cutoff frequencies by measuring the YIG tuning voltage
4. Check of the LO levels and of the operating points of the LO drivers

In case of an error the selftest is aborted since it does not make sense measuring the signal path if e.g., no LO level is provided.

Testing the Signal Path

Subsequently, the modules in the signal path are checked. The fracsyn module accommodates a 120-MHz calibration generator, the output power of which is checked using individual test points. This signal is connected into the signal path via a changeover switch in the input attenuator of the FSE. The test sequence is as follows:

1. Check of the RF attenuator
2. Check of the RF converter by testing the operating points of the amplifiers
3. Check of the 2nd IF converter by testing the operating point of the amplifier for the second IF and reading out of the level detectors in the signal path.
4. Check of the IF filters by testing the supply voltages for the individual filter circuits, the tuning voltages for the filter bandwidths and the level detectors.
5. Check of detector board

Though the selftest provides high measuring depth, it cannot be assumed that the module which has been found out to be faulty is always really faulty. A faulty cable, e.g., has the same effect as an interrupt in the input attenuator. Therefore, have the faulty function checked by an R&S servicing shop when an error message occurs.

Contents - Chapter 4 "Software Update/Installing Options"

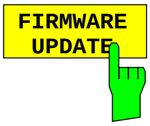
4 Software Update/Installing Options

This chapter contains information on extension and modification of the FSE. Additional manuals obtained together with a software/firmware update or with subsequently acquired options can be filed here.

New Installation of the FSE Software

The installation of a new firmware version can be performed using the built-in diskette drive. The firmware update kit contains several diskettes.
The installation program is called up in the *SETUP* menu.

CONFIGURATION SETUP sidemenu:



The *FIRMWARE UPDATE* softkey starts the installation program and leads the user through the remaining steps of the update

Performing the update:

➢ Insert diskette 1 into the drive.

➢ Press the *SETUP* key.

➢ Press the menu change key .
The *SETUP* side menu is called

➢ Press the *FIRMWARE UPDATE* key.
The update is started.

The *RESTORE FIRMWARE* softkey restores the previous firmware version

Installing the Options

The following options are available with the FSE:

Tracking Generator 3.5 GHz	FSE-B8	1066.4469.02
Tracking Generator 3.5 GHz with I/Q Modulator	FSE-B9	1066.4617.02
Tracking Generator 7 GHz	FSE-B10	1066.4769.02
Tracking Generator 7 GHz with I/Q Modulator	FSE-B11	1066.4917.02
Switchable Attenuator for Tracking Generator	FSE-B12	1066.5065.02
External Mixer Output	FSE-B21	1084.7243.02
1-dB Attenuator	FSE-B13	1119.6499.02
Ethernet Interface 15-contact AUI connector	FSE-B16	1073.5973.02
Thin-wire BNC connector	FSE-B16	1073.5973.03
2nd IEC/IEEE Bus Interface	FSE-B17	1066.4017.02

For retrofitting, please note the mounting instructions enclosed with the options.
These mounting instructions can be filed at this place in the service manual and are thus easily available whenever they are required.

Caution!

Disconnect the instrument from the mains before opening the casing. Also note the safety instructions at the beginning of this manual.

The components used in the instrument are sensitive to electrostatic discharges which is why they are to be dealt with according to the ESD regulations.

When installing hardware options note the following:

- Switch off instrument and pull the mains plug.
- Unscrew the rear feet on left and right
- Push the top and bottom cover backwards using a thin screwdriver.
- After installing the option replace the tube and fasten the rear panel feet again.

Caution!

When replacing the covers take care not to damage or pull off cables.

- Switch on FSE.
- Install additional software, if supplied, according to the instructions enclosed with the option.
- If an adjustment is required for this option, the appropriate hints are to be found in the installation instructions for the option.

Contents - Chapter 5 "Documents"

5 Documents

5 Documents

This chapter provides information on the ordering of spare parts and contains the documents for the FSE basic unit. The replacement of modules and the spare part list is described in the service manual, order number 1065.6016.24 (not included).

Shipping of Instrument and Ordering of Spare Parts

Please contact your Rohde & Schwarz support center or our spare parts express service if you need service or repair of your equipment or to order spare parts and modules.

The list of the Rohde & Schwarz representatives and the address of our spare parts express service are provided at the beginning of this service manual.

We require the following information in order to answer your inquiry fast and correctly and to decide whether the warranty still applies for your instrument:

- Instrument model
- Serial number
- Firmware version
- Detailed error description in case of repair
- Contact partner for checkbacks

Shipping of Instrument

When shipping the instrument, be careful to provide for sufficient mechanical and antistatic protection

- ➢ Repack the instrument as it was originally packed when transporting or shipping. The two protective caps for the front and rear panels prevent the control elements and connectors from being damaged. The antistatic packing foil avoids any undesired electrostatic charging to occur.
- ➢ If you do not use the original packaging, provide for sufficient padding to prevent the instrument from slipping inside the package. Wrap antistatic packing foil around the instrument to protect it from electrostatic charging.

Shipping of a Module

When shipping a module, then, also be also careful to provide for sufficient mechanical and antistatical protection

- ➢ Ship the module in a sturdy, padded box.
- ➢ Wrap the board into antistatic foil.
  If the packaging is only antistatic but not conductive, additional conductive packaging is required. The additional packaging is not required if the enclosed packaging is conductive.
  Exception: If the module contains a battery, the tightly fitting packaging must always consist of antistatic, non-chargeable material to protect the battery from being discharged.

Ordering Replacement Parts

To deliver replacement parts promptly and correctly we need the following indications:

- Stock number (see component lists in this chapter)
- Designation
- Component number according to component list
- Number of pieces
- Instrument type the replacement part belongs to
- Contact person for possible questions

The stock numbers necessary for ordering replacement parts and modules as well as power cables can be found further down.

Replaced Modules

Replaced modules are an economic alternative for original modules. It should be kept in mind that replaced modules are not new, but repaired and fully tested parts. They may have traces from use but they are electrically and mechanically equivalent to new modules.

To find out which replaced modules are available, please refer to your Rohde & Schwarz representative (or to the central service division, Rohde & Schwarz Munich).

Ordering and Delivery of Replaced Modules

For ordering replaced modules, the same indications as for ordinary parts are required.

Taking back Defective Replaced Modules

Defective modules of the replacement program which can be repaired are taken back within 3 months after delivery of the replaced module. A repurchasing value is credited.

Excluded are parts which can not be repaired, e.g. PCBs that are burnt, broken or damaged by repair attempts, incomplete modules, parts which are heavily damaged mechanically.

The defective parts must be sent back with a returned accompanying document containing the following information:

- Stock number, serial number and designation of the dismounted part,
- Precise description of the error,
- Stock number, serial number and designation of the instrument the part was dismounted from,
- Date of dismounting,

Name of the technician who exchanged the part.

A returned accompanying document is provided with each replacement module.

Cable Exchange

Table 5-1 at lists all power cables available. The stock numbers necessary for ordering replacement parts and modules can be found in the component lists further down.

Important Note!

When replacing a module please note the safety instructions and the repair instructions given in chapter 3 and at the beginning of this service manual.

Available Power Cables

Table 5-1   List of power cables available

Stock No.	Earthed-contact connector	Preferably used in
DS 006.7013	BS1363: 1967’ complying with IEC 83: 1975 standard B2	Great Britain
DS 006.7020	Type 12 complying with SEV-regulation 1011.1059, standard sheet S 24 507	Switzerland
DS 006.7036	Type 498/13 complying with US-regulation UL 498, or with IEC 83	USA/Canada
DS 006.7107	Type SAA3 10 A, 250 V, complying with AS C112-1964 Ap.	Australia
DS 0025.2365 DS 0099.1456	DIN 49 441, 10 A, 250 V, angular DIN 49 441, 10 A, 250 V, straight	Europe (except Switzerland)

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Documents for FSE

Overall Instrument

Circuit Diagram