ROHDE&SCHWARZ

测试接收机基础

第一章
理论基础

罗 健

R&S 中国培训中心

www.rohde-schwarz.com.cn

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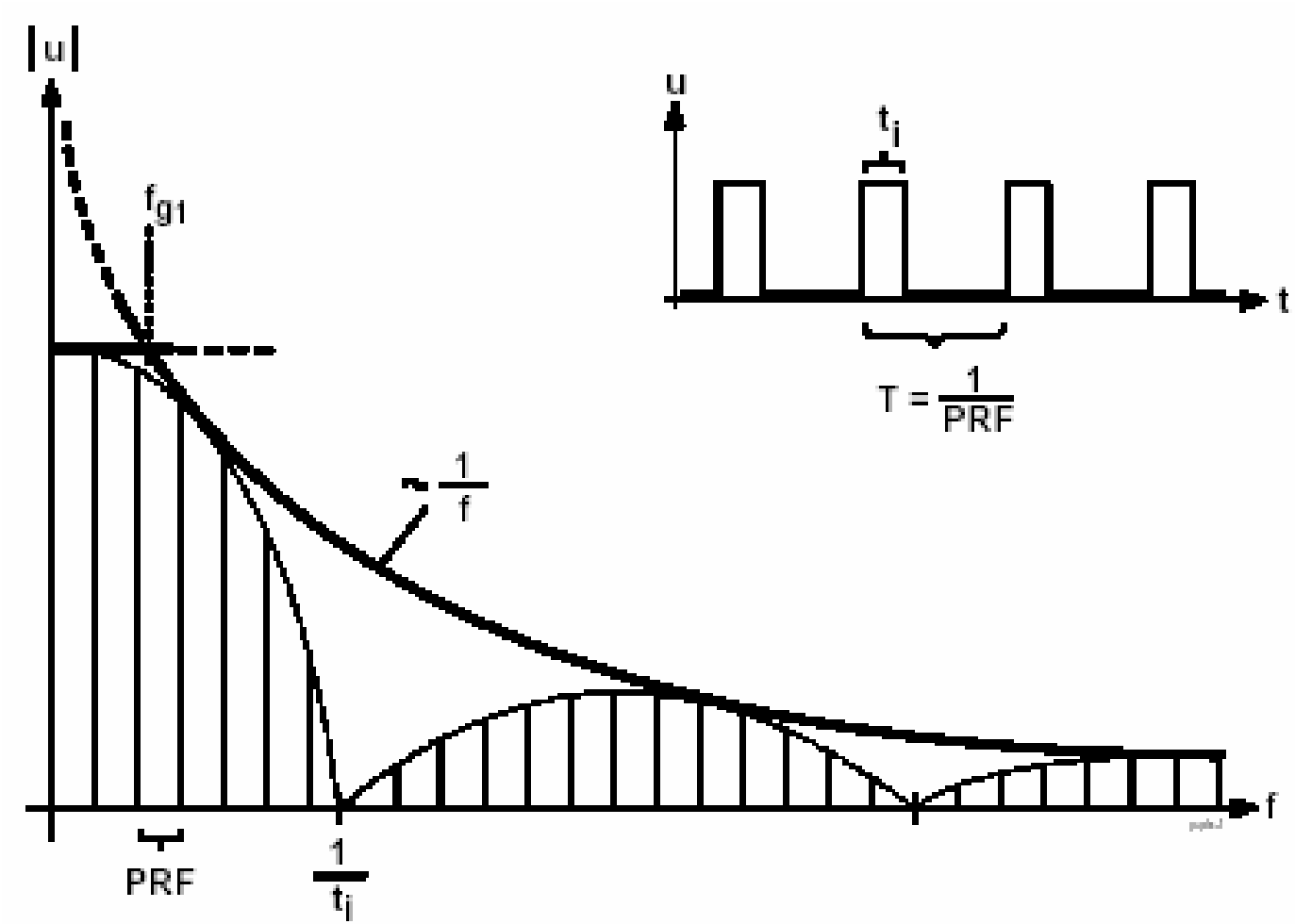
信号的检测



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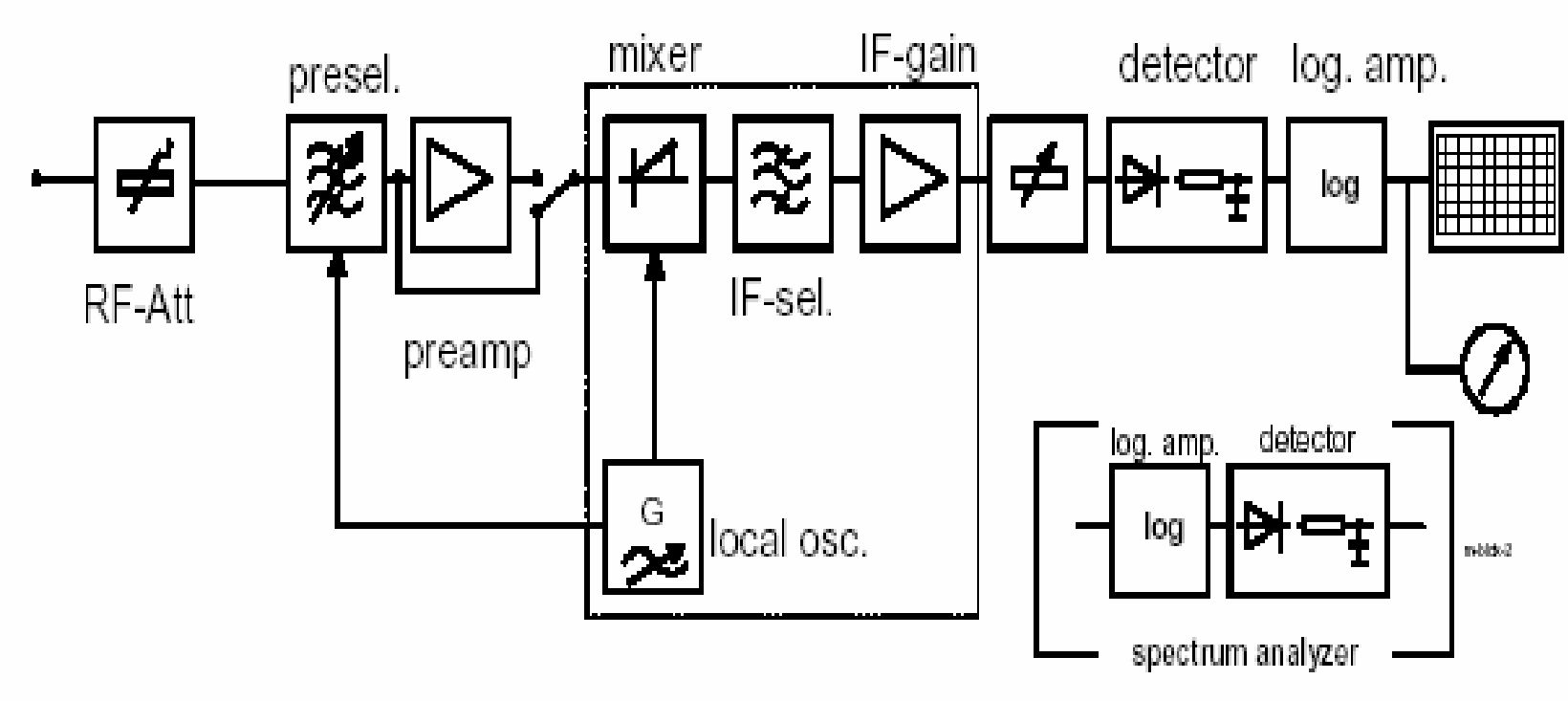
测试接收机基本结构



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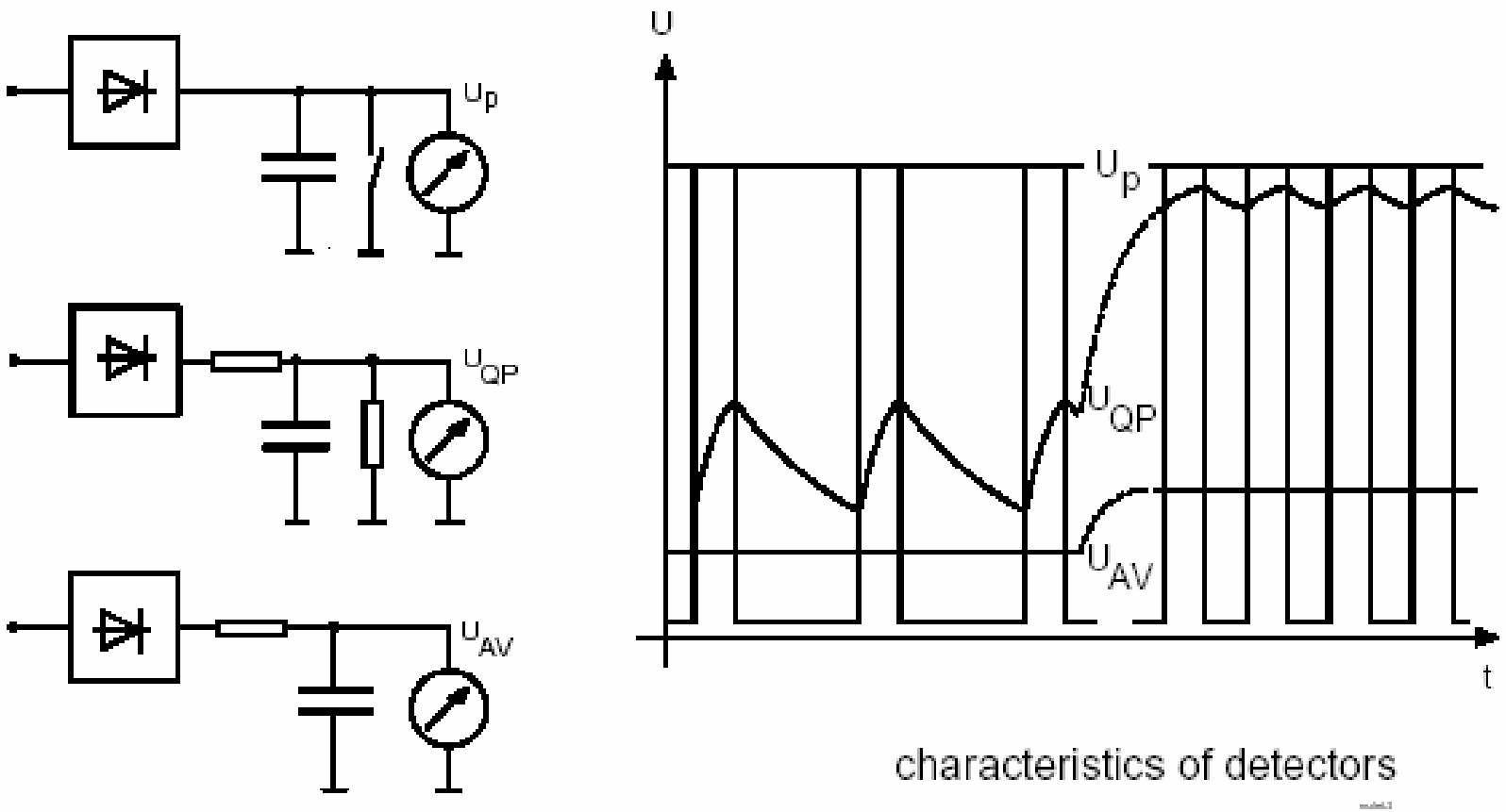
不同检波器对信号的响应



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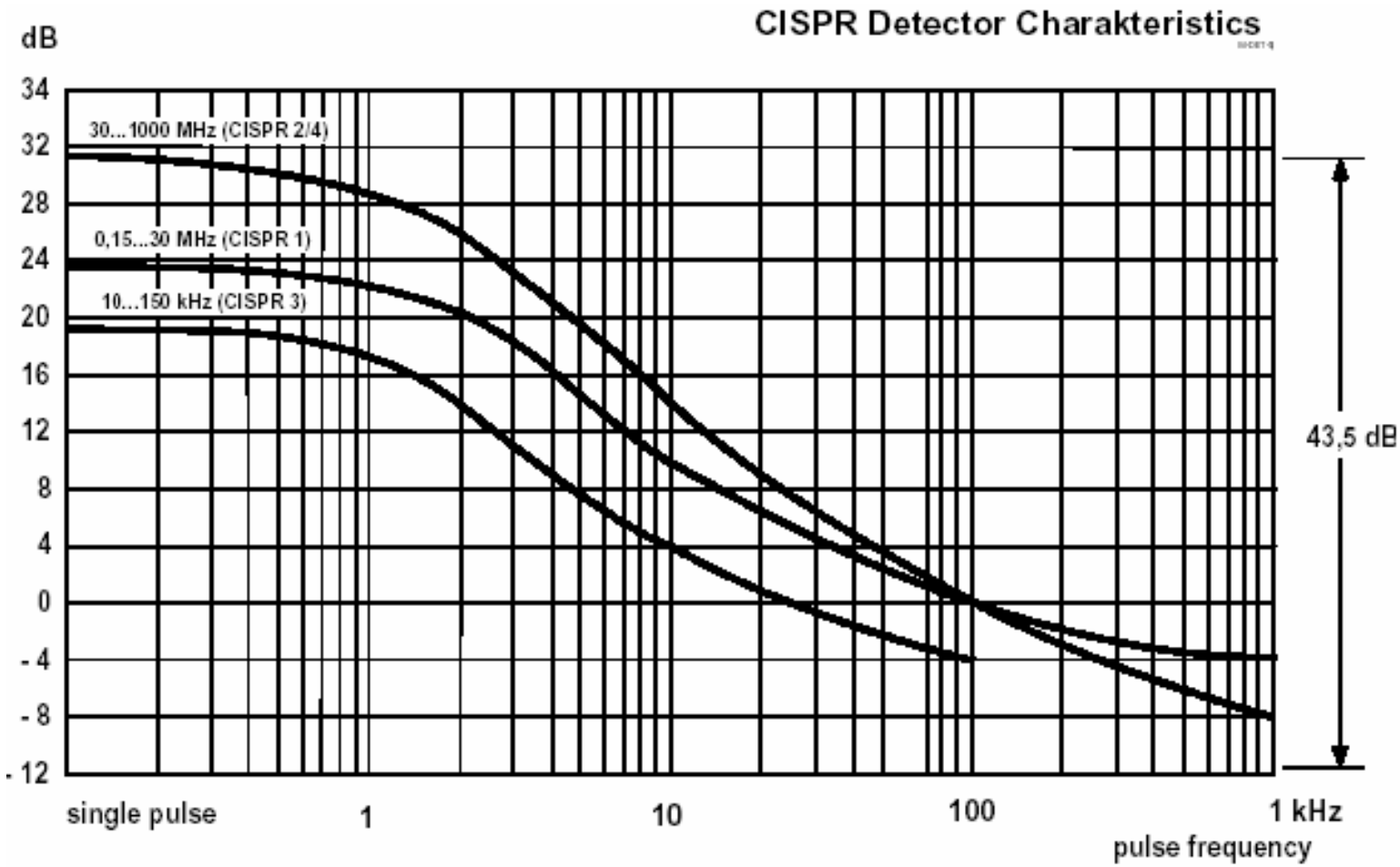
检波器对脉冲信号的响应特性要求



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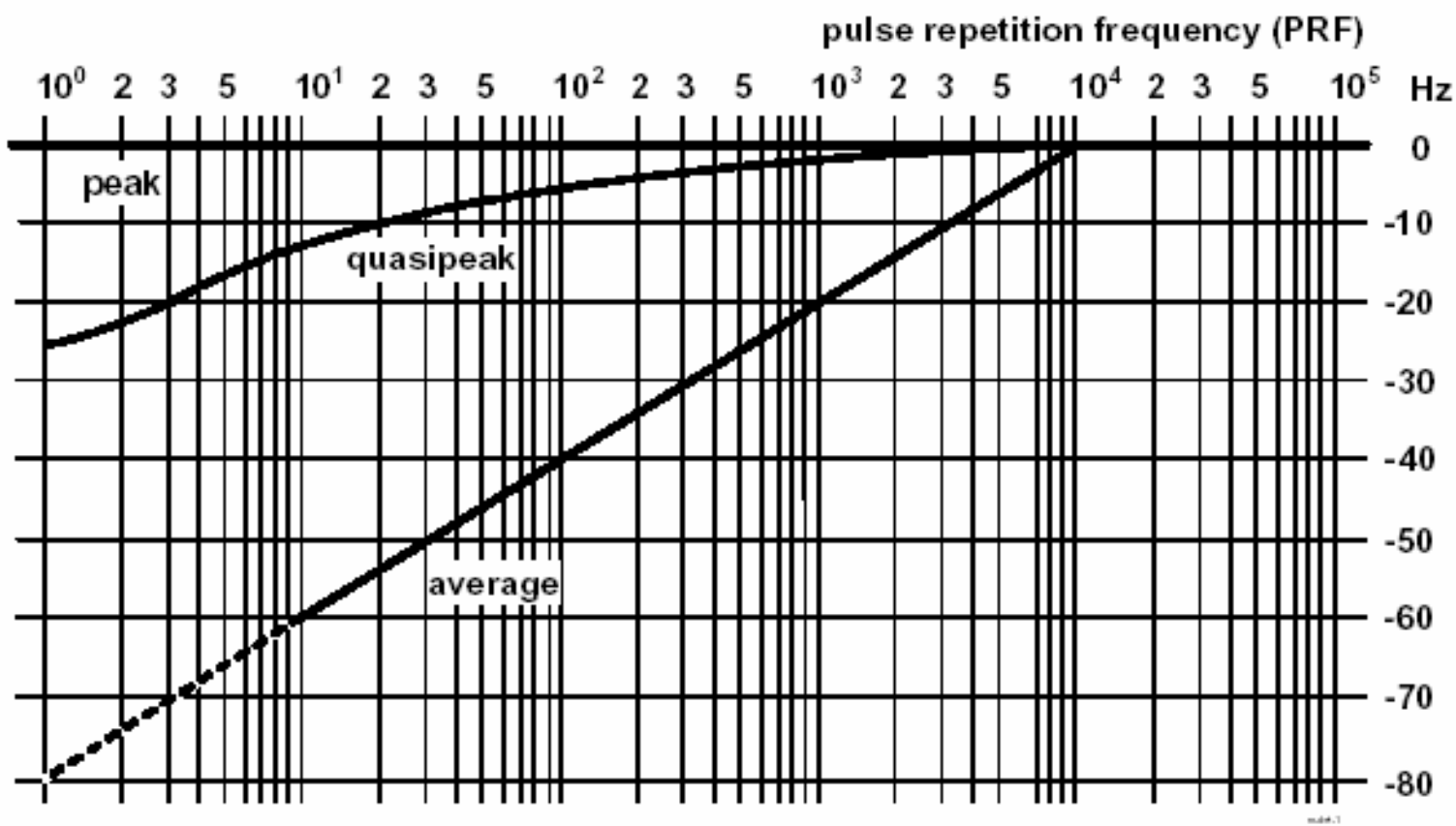
不同检波器对脉冲信号的响应特性



weighting characteristics of a test receiver for pulse signals

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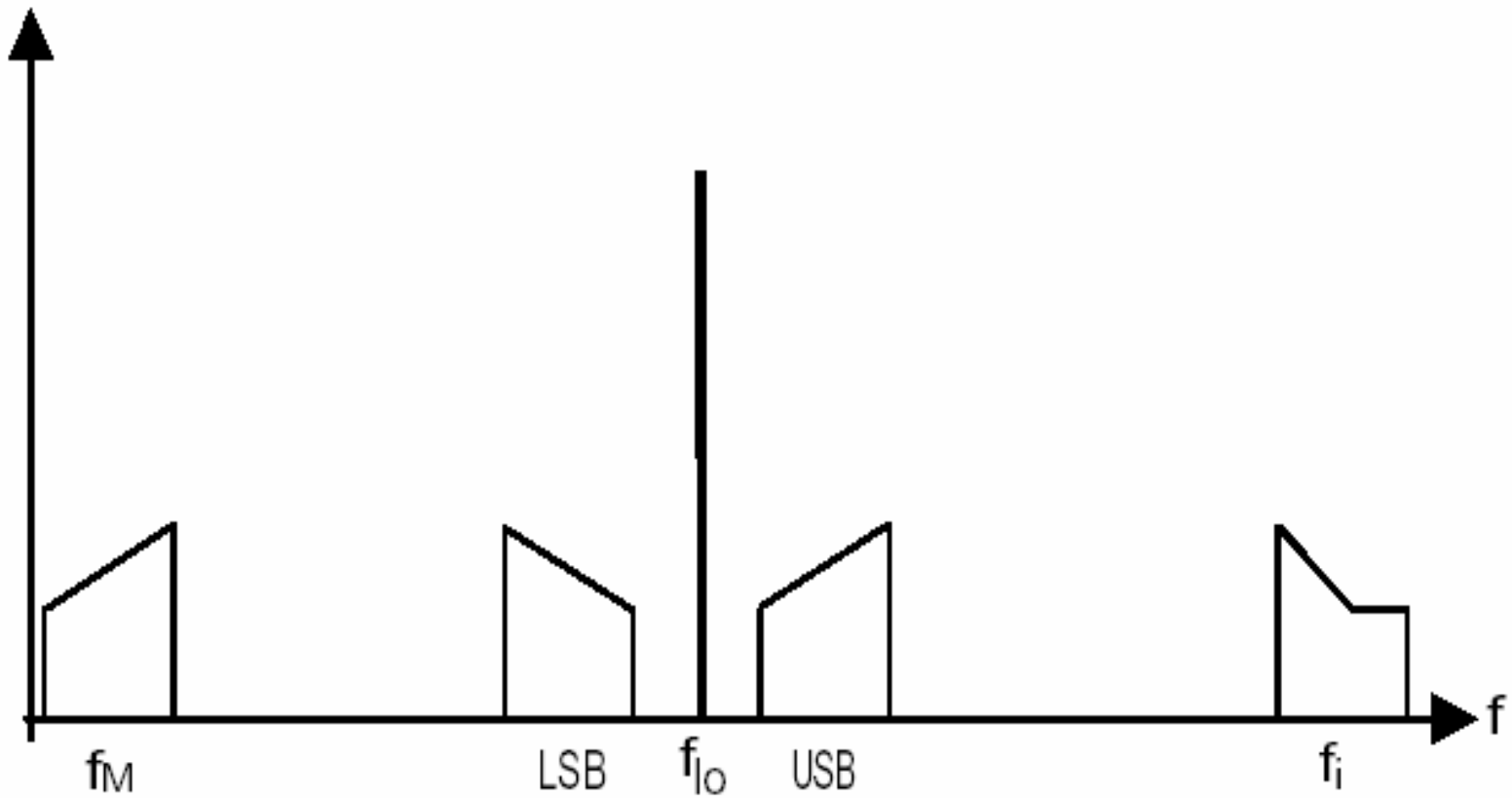
变频



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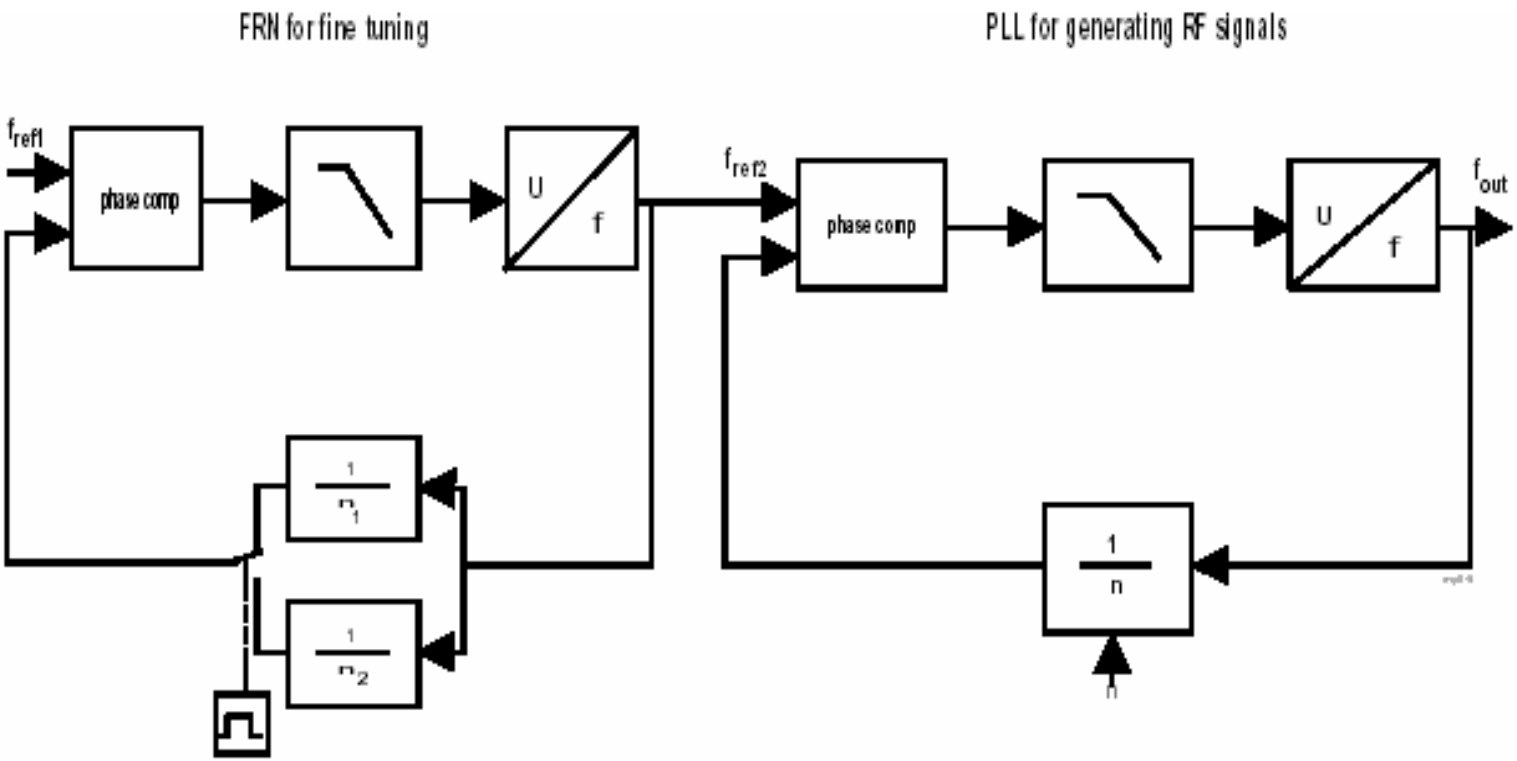
锁相环



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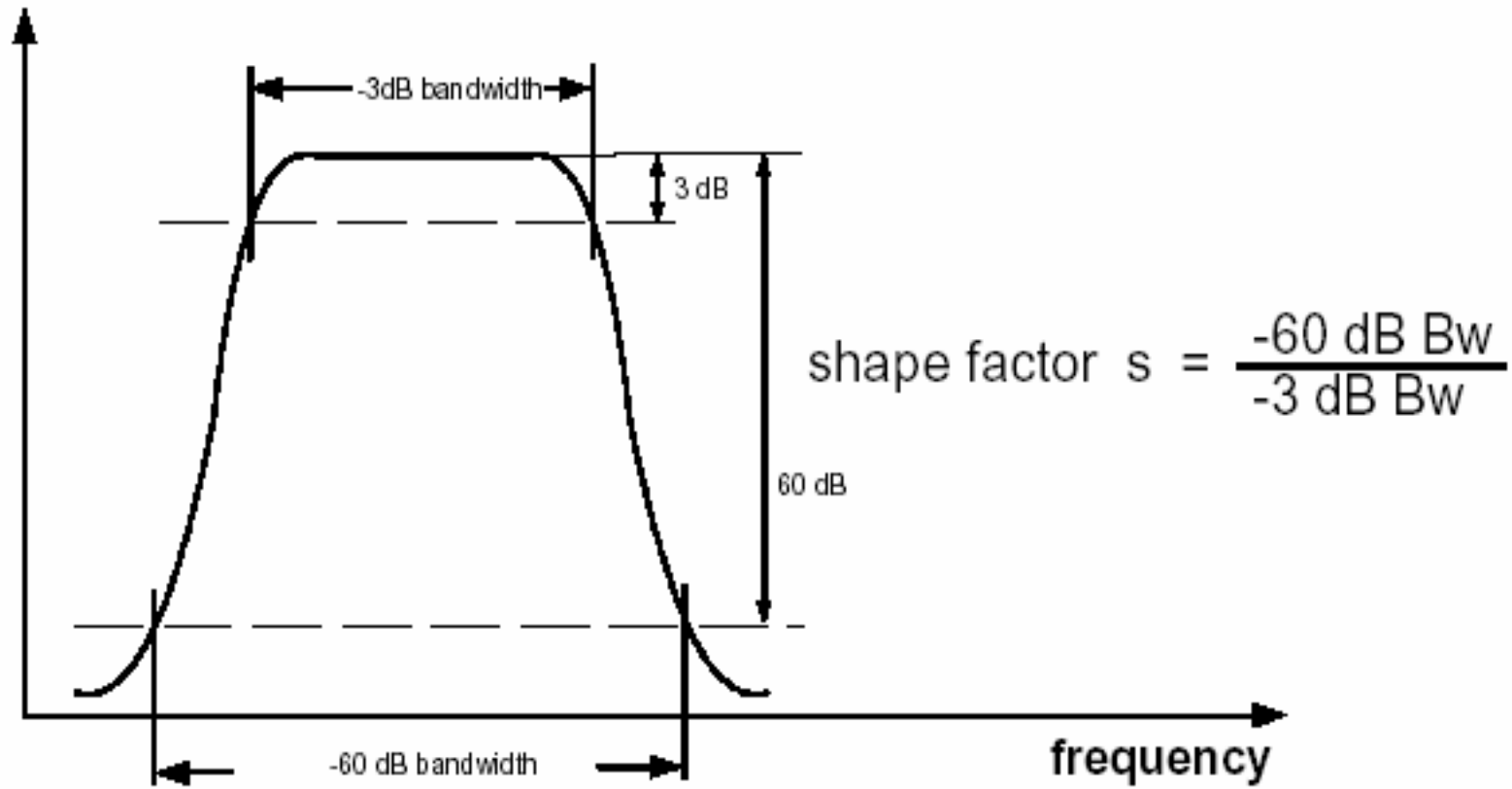
中频选择性



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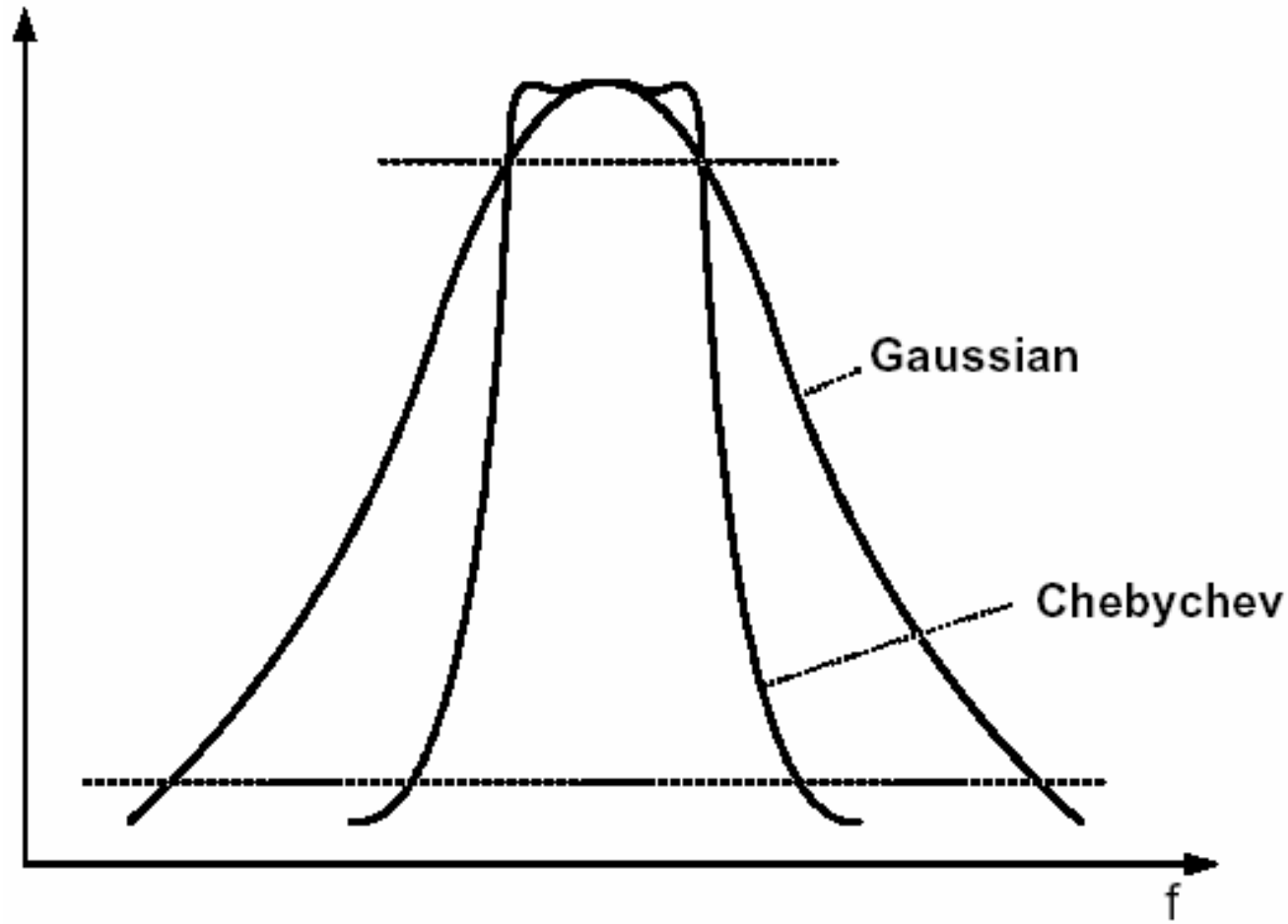
高斯滤波器与切比雪夫滤波器



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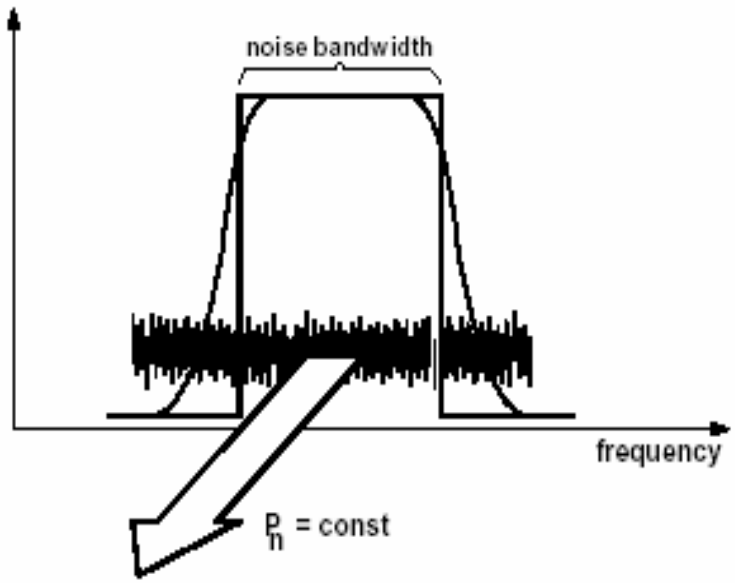
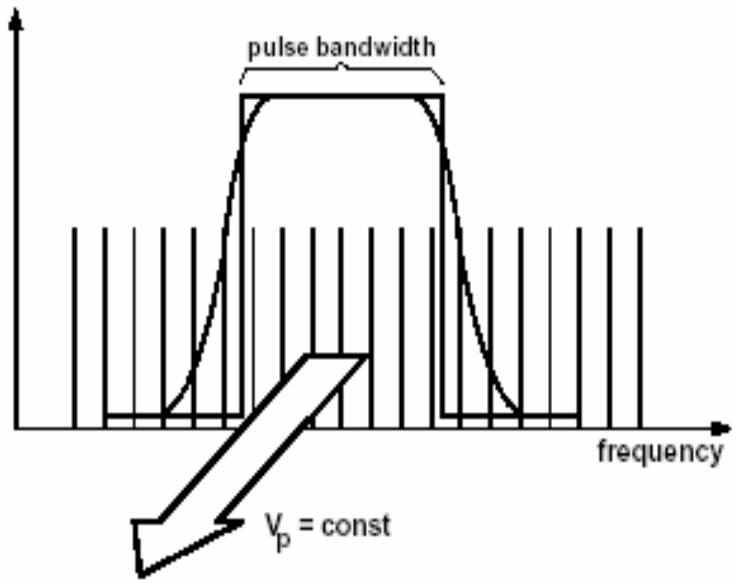
等效带宽





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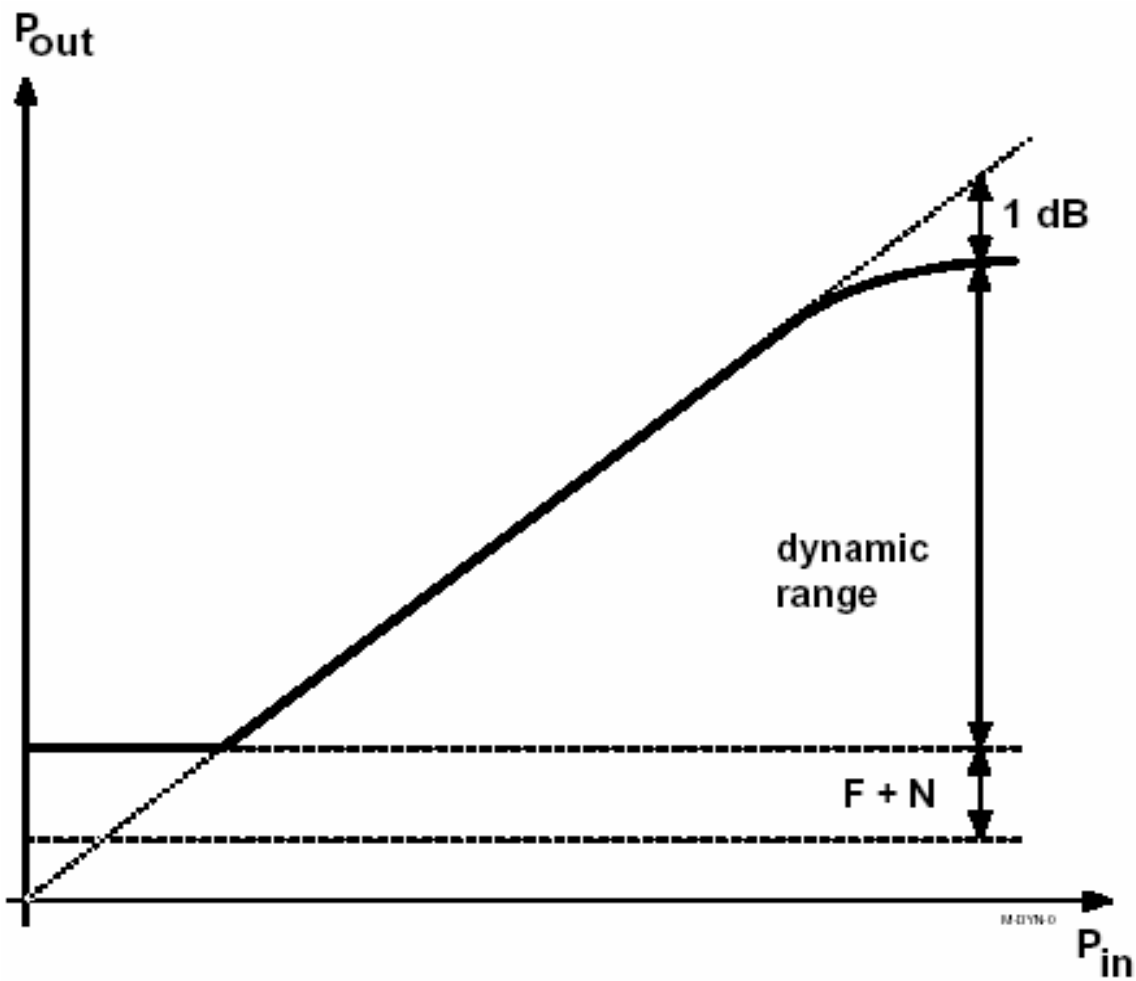
1dB压缩点



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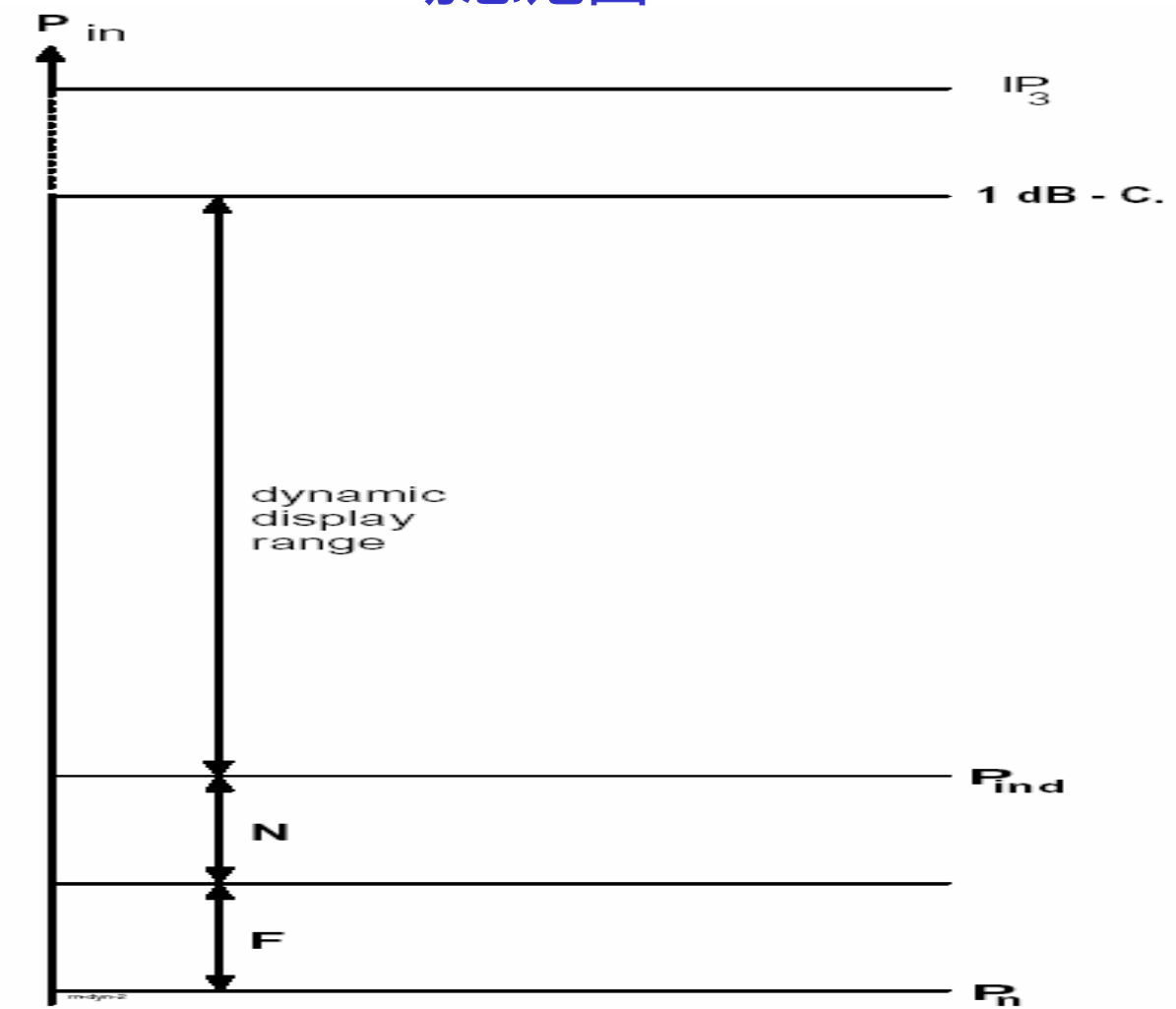
动态范围



测试接收机基础

第二章
性能指标

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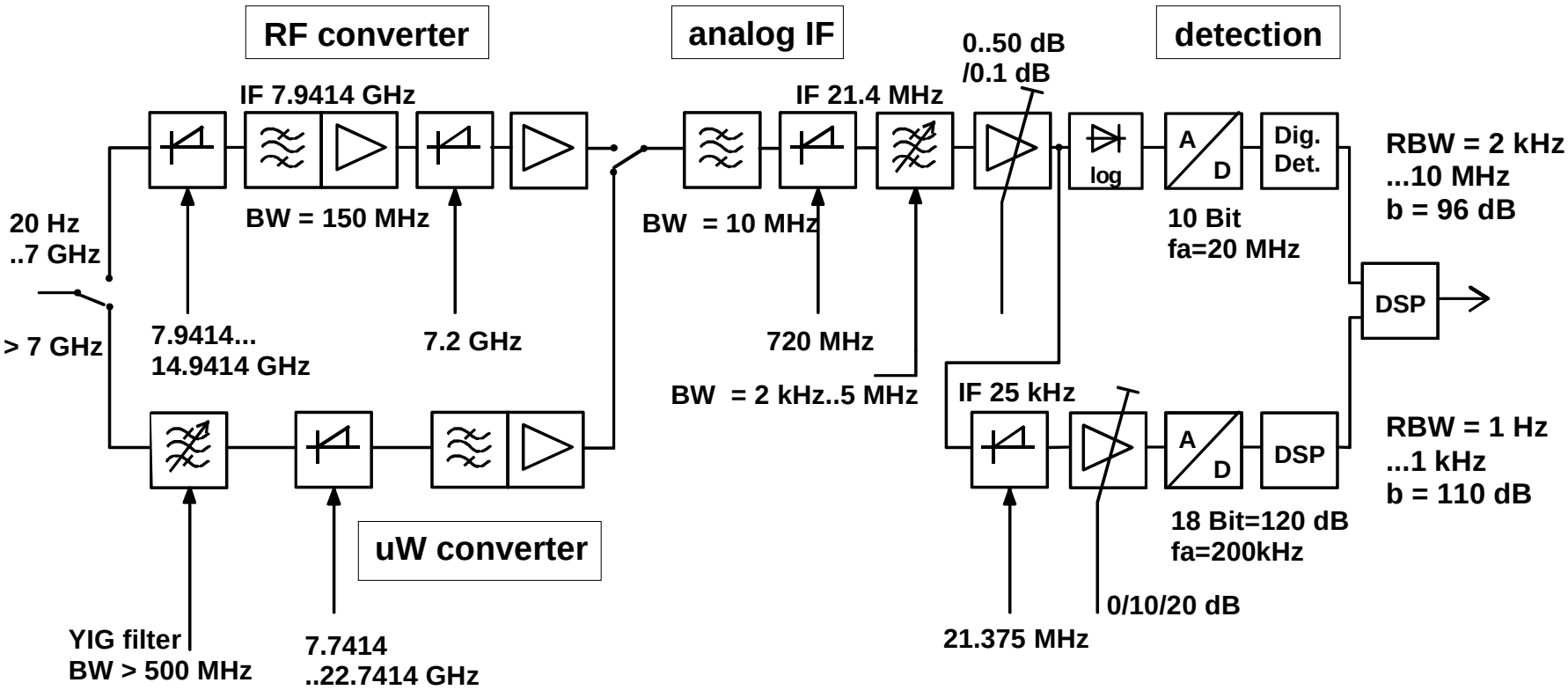
ESI Block Diagram



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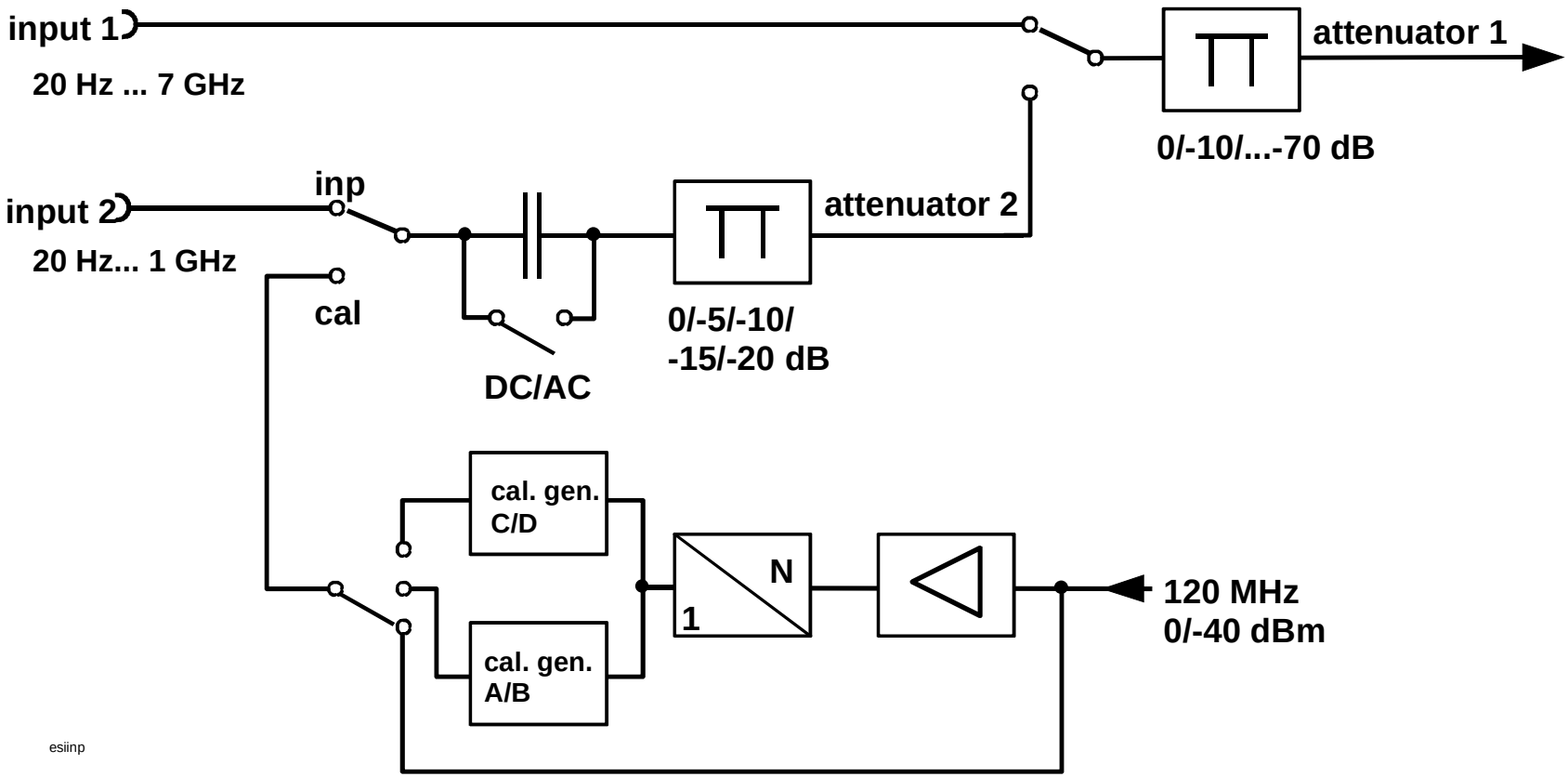
ESI attenuator and cal. generator



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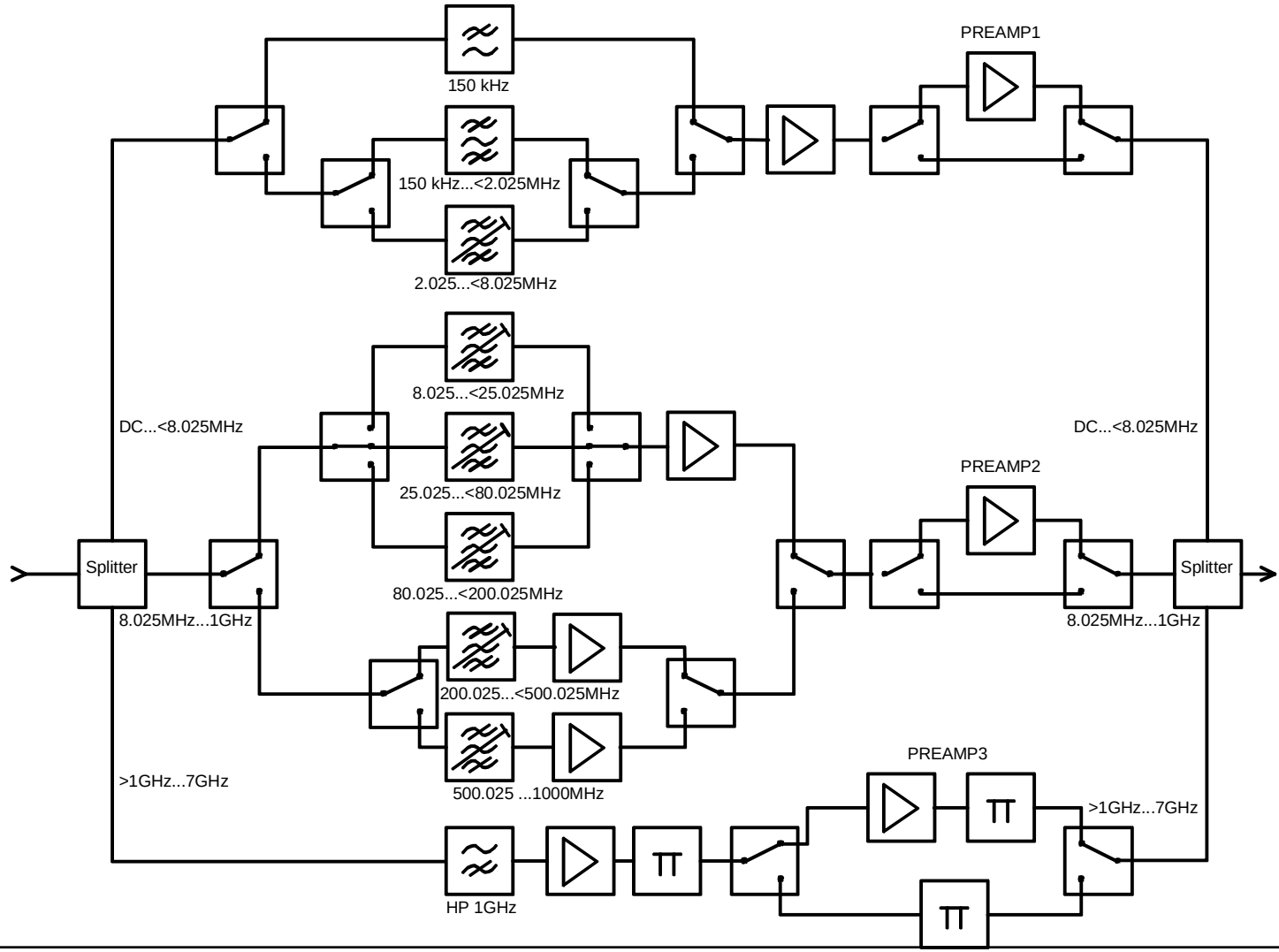
ESI preselection stage



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Minimal sweep times in analyzer mode with preselector (ESI)

filter	range	filter type	min. swp time / range	max. speed
1	20 Hz ... 150 kHz	LP	5 ms	30 kHz / ms
2	150 kHz...2,025 MHz	BP	5 ms	0.4 MHz / ms
3	2,025...8,025 MHz	BP, tuned	500 ms	0.12 MHz / ms
4	8,025...25,025 MHz	BP, tuned	50 ms	0.34 MHz / ms
5	25,025...80,025 MHz	BP, tuned	50 ms	1.1 MHz / ms
6	80,025...200,025 MHz	BP, tuned	50 ms	2.4 MHz / ms
7	200,025...500,025 MHz	BP, tuned	50 ms	6 MHz / ms
8	500,025 MHz...1000 MHz	BP, tuned	5 ms	100 MHz / ms

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Input capability of test receivers to CW signals

	ESH3	ESVP	ESHS	ESVS	ESS	ESPC	**ESCS**	**ESI**		**ESPI**
								Inp1 ("hi")	Inp2 ("lo")	
DC (V)										
Att = 0 dB	7	7	7	50	7	(7)	50	0	0/50	50
Att = 10 dB	7	7	7	50	7		7	(7)	("AC")	50
AC (dBµV)										
Att = 0 dB	130	130	130	130	130	130	130	127	127	127
Att = 10 dB	137	137	137	137	137	137	137	137	137	137
Pulse (dBµV/MHz)										
Att = 0 dB	96	96	96	96	97	97	97	97	97	97

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Input protection of test receivers (!! only with RF attenuator ≥ 10 dB !!)

		max voltage	max energy
ESAI, ESBI	hi input lo input	50 V 150 V	1 mWs 1 mWs
ESMI	hi input lo input	50 V 150 V	1 mWs 10 mWs
ESS	< 30 MHz > 30 MHz	700 V 150 V	100 mWs 100 mWs
ESS + ESVS-B1		1500 V	100 mWs
ESHS		700 V	100 mWs
ESPC		150 V	10 mWs
ESCS 30		150 V	10 mWs
ESI 7	hi input lo input	150 V 1500 V	1 mWs 30 mWs
ESI 26/40	hi input lo input	50 V 250 V	0.5 mWs 15 mWs
ESPI 3/7		150 V	1 mWs

Dynamic limitations

	analyzer mode	receiver mode
T.O.I.	≥ 12 dBm ≥ 15 dBm (<150 MHz)	≥ 2 dBm ≥ 5 dBm (<150 MHz)
1 dB cmp.	+ 10 dBm (nominal)	0 dBm (nominal)

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Calibration routines

	ESI
- frequency response + IF gains stored in EEPROMs	+
- IF bandwidth calibration (centre frequency, shape factor, gain)	+
- log amp calibration	+
- LO suppression calibration	+
- frequency response + gain calibration for preamp + preselection	+

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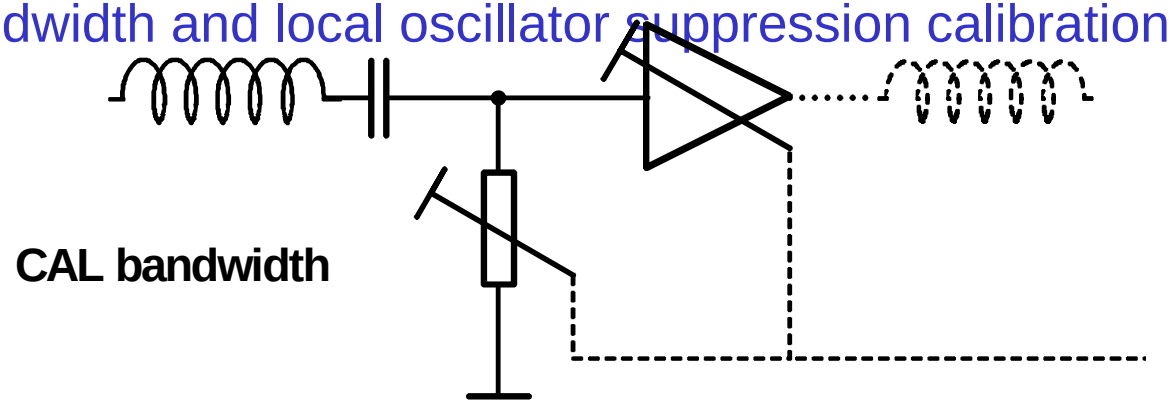
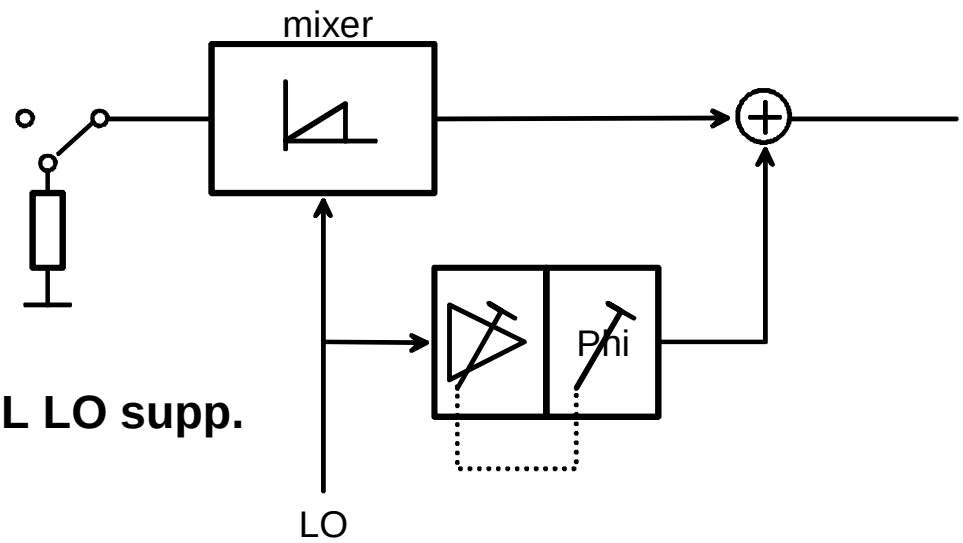
ESIB bandwidth and local oscillator suppression calibration





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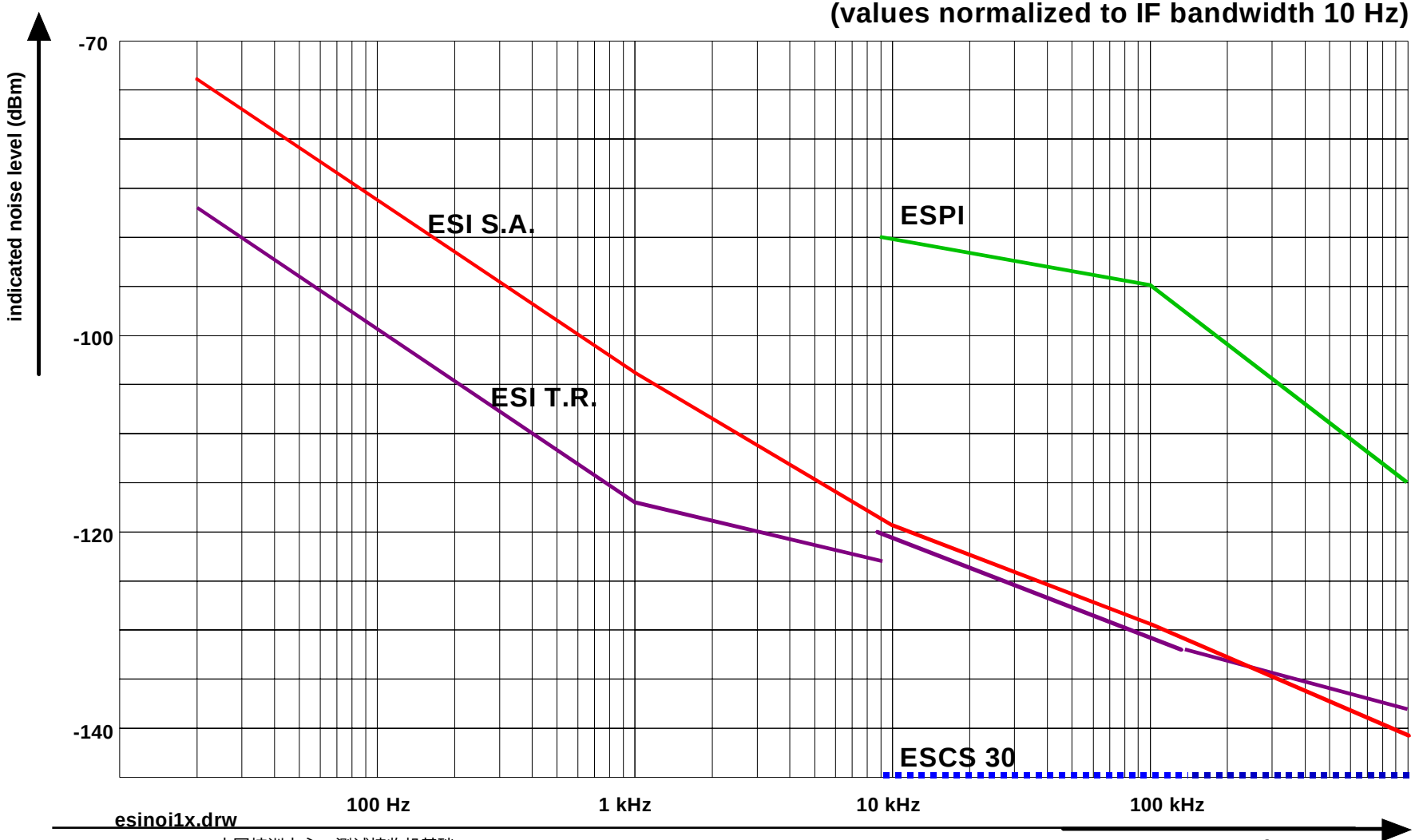
maximal noise indication (ESI, ESPI, ESCS 30)

(values normalized to IF bandwidth 10 Hz)



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maximal noise indication (ESI, ESPI, ESCS 30)

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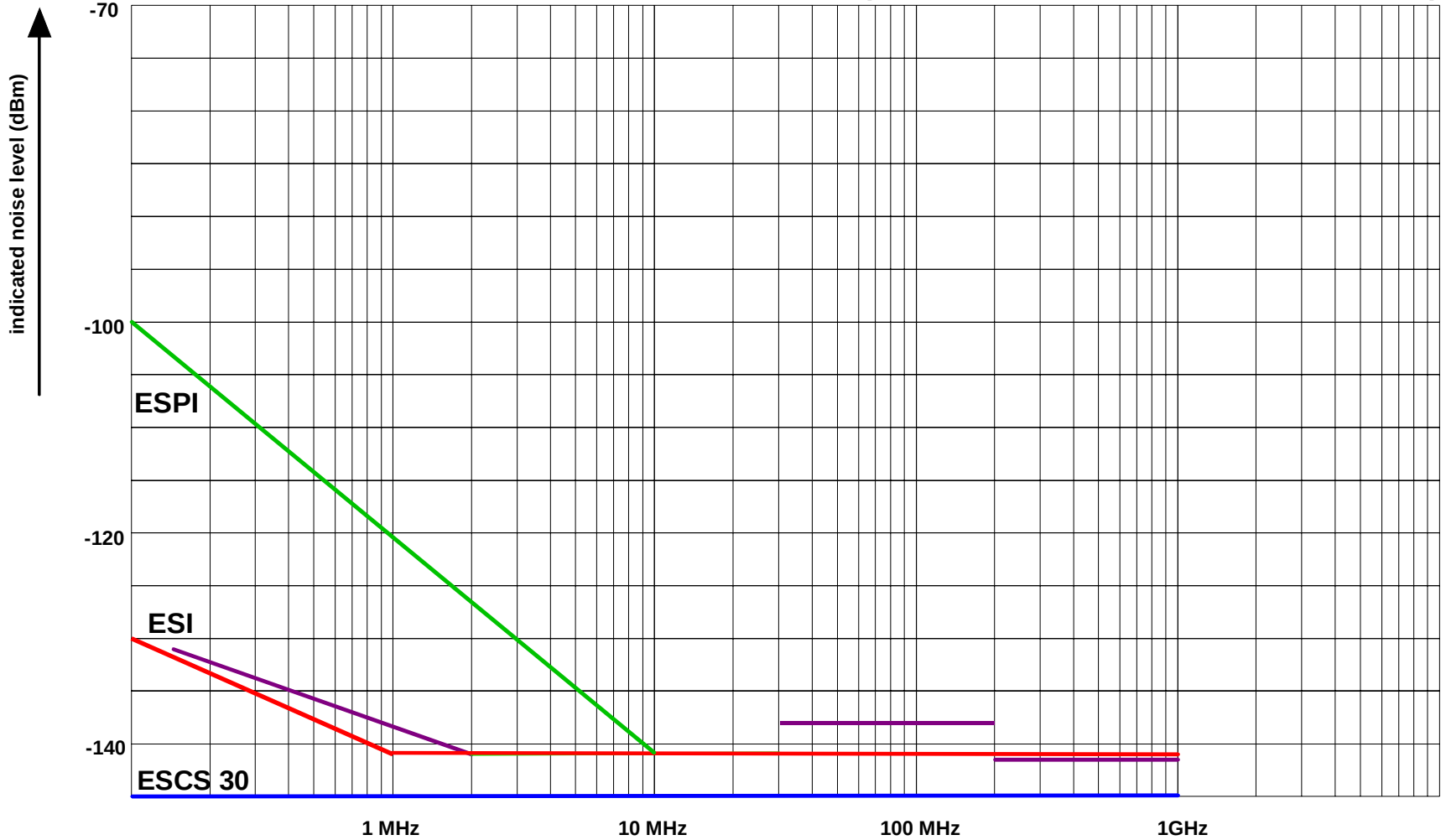

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IF bandwidth: requirements to CISPR

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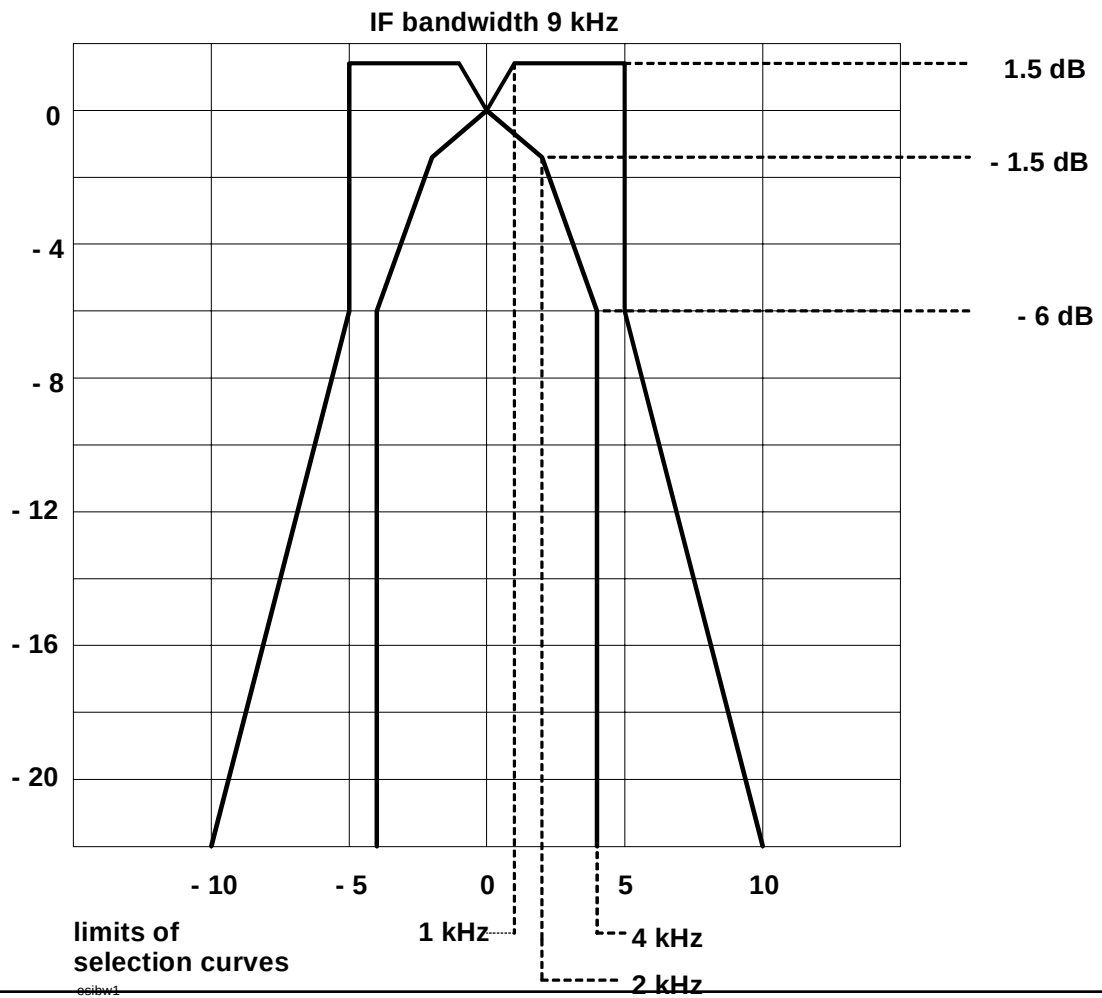

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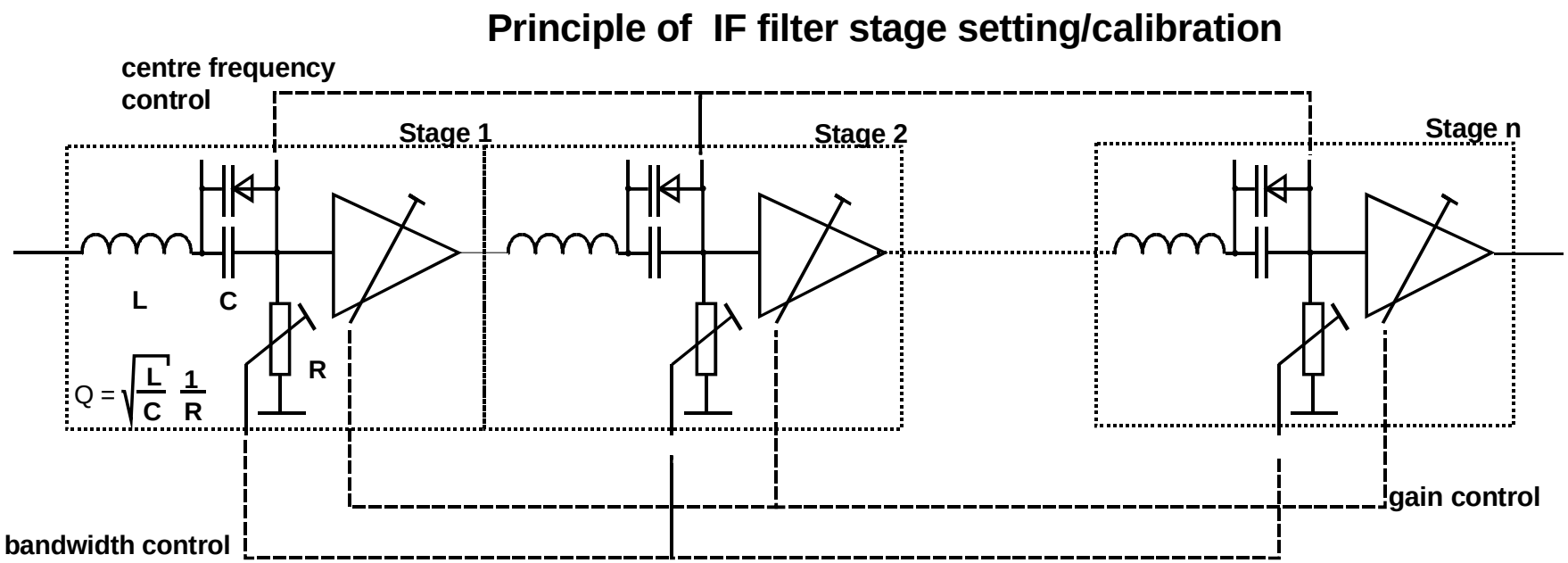
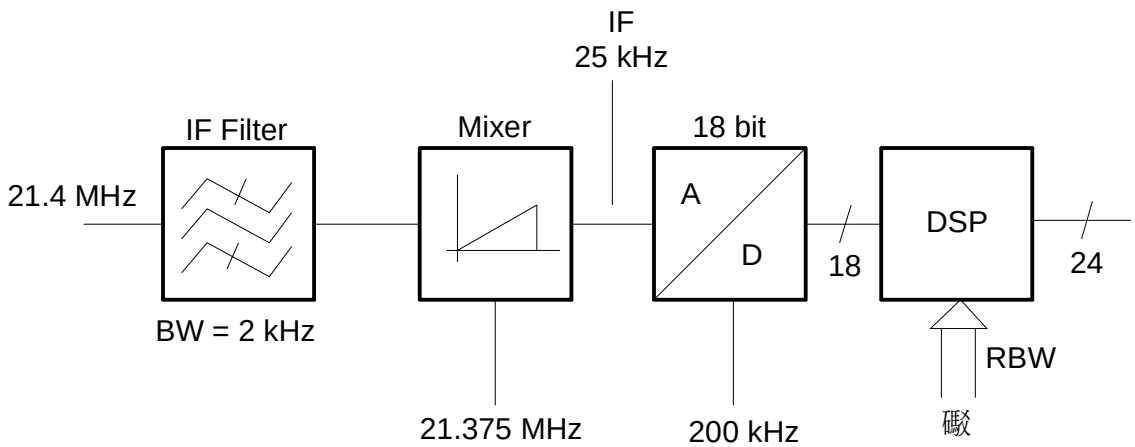
Analog IF filters



Digital IF Filter (ESIB)



- Bandwidths: 1 Hz to 1 kHz (ESIB) /
  10 Hz to 300 kHz (ESPI)
- Gaussian type filter
- Selectivity 60:3 dB = 4.6 (< 5.1)

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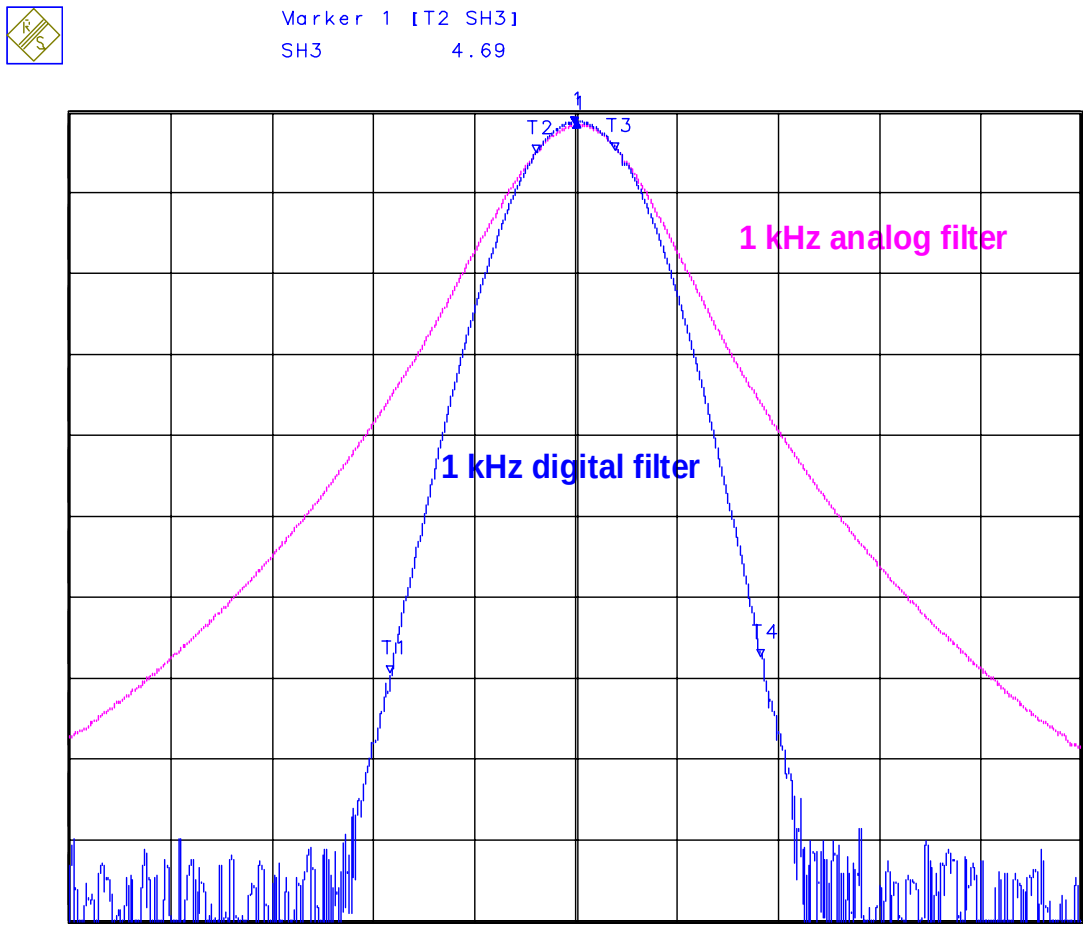
Analog vs digital Filter



Detectors

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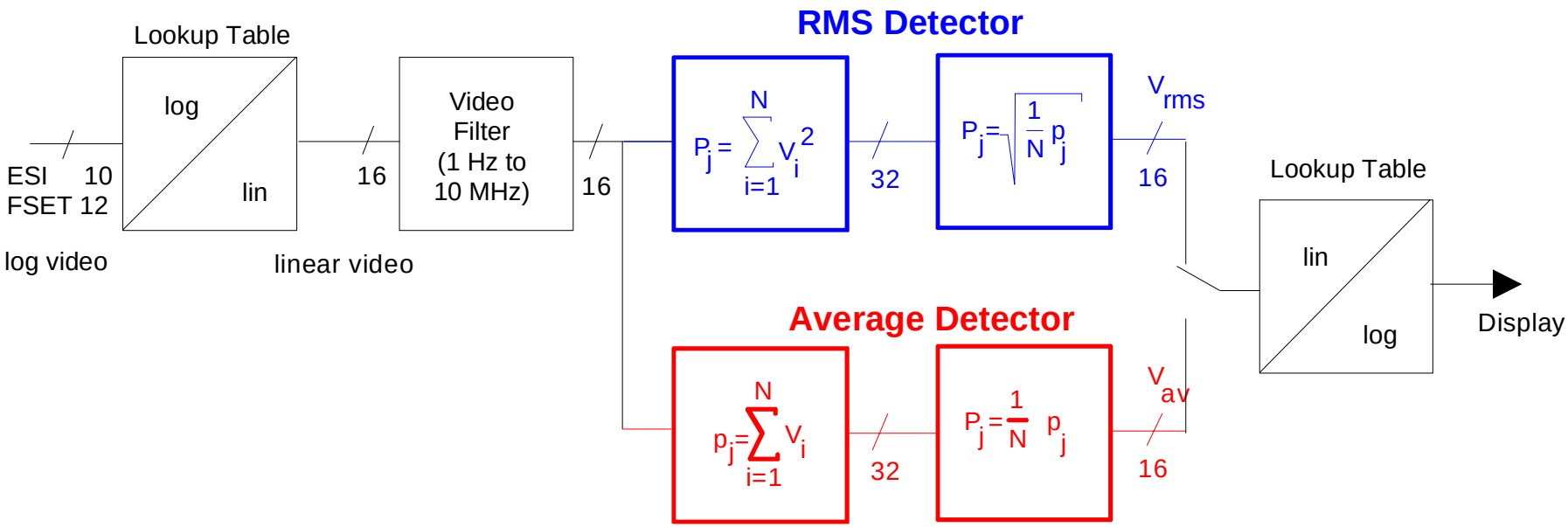
RMS and average detector



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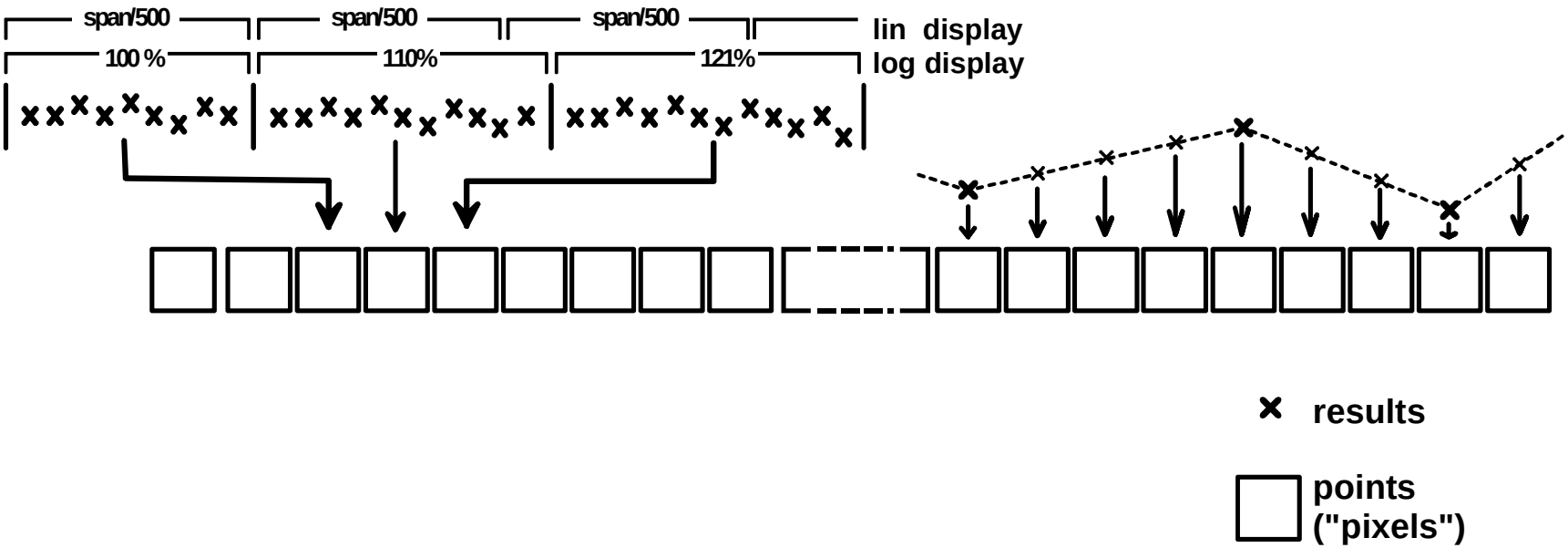
Receiver Mode: result to display assignment



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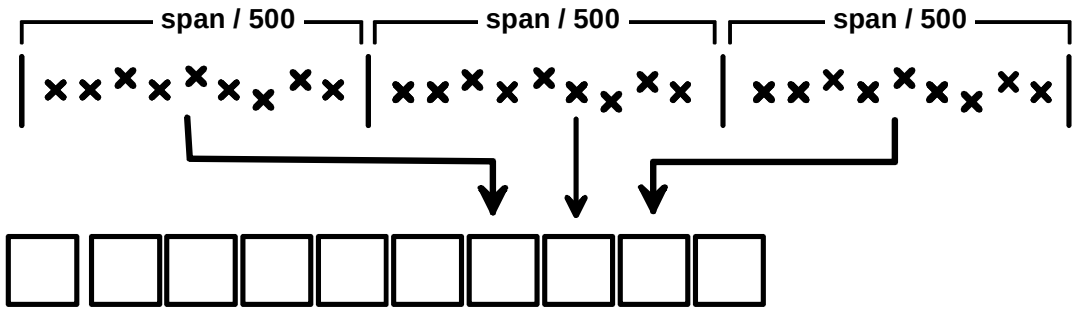
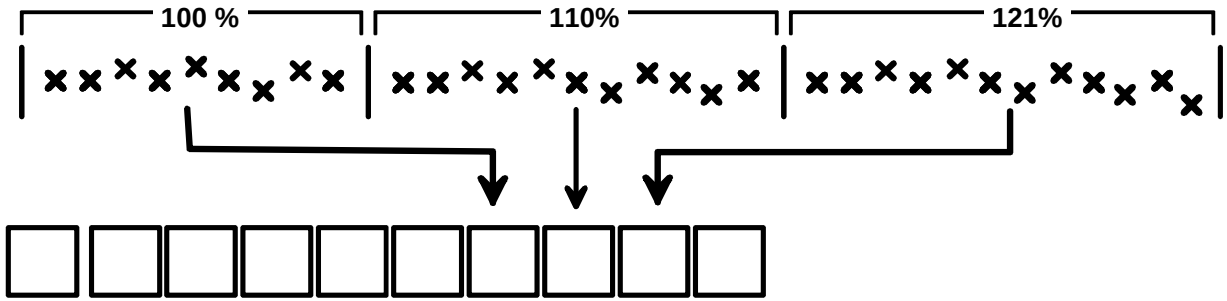
Analyzer Mode: samples to display assignment



analyzer LIN frequ mode



analyzer LOG frequ mode

× samples

points ("pixels")

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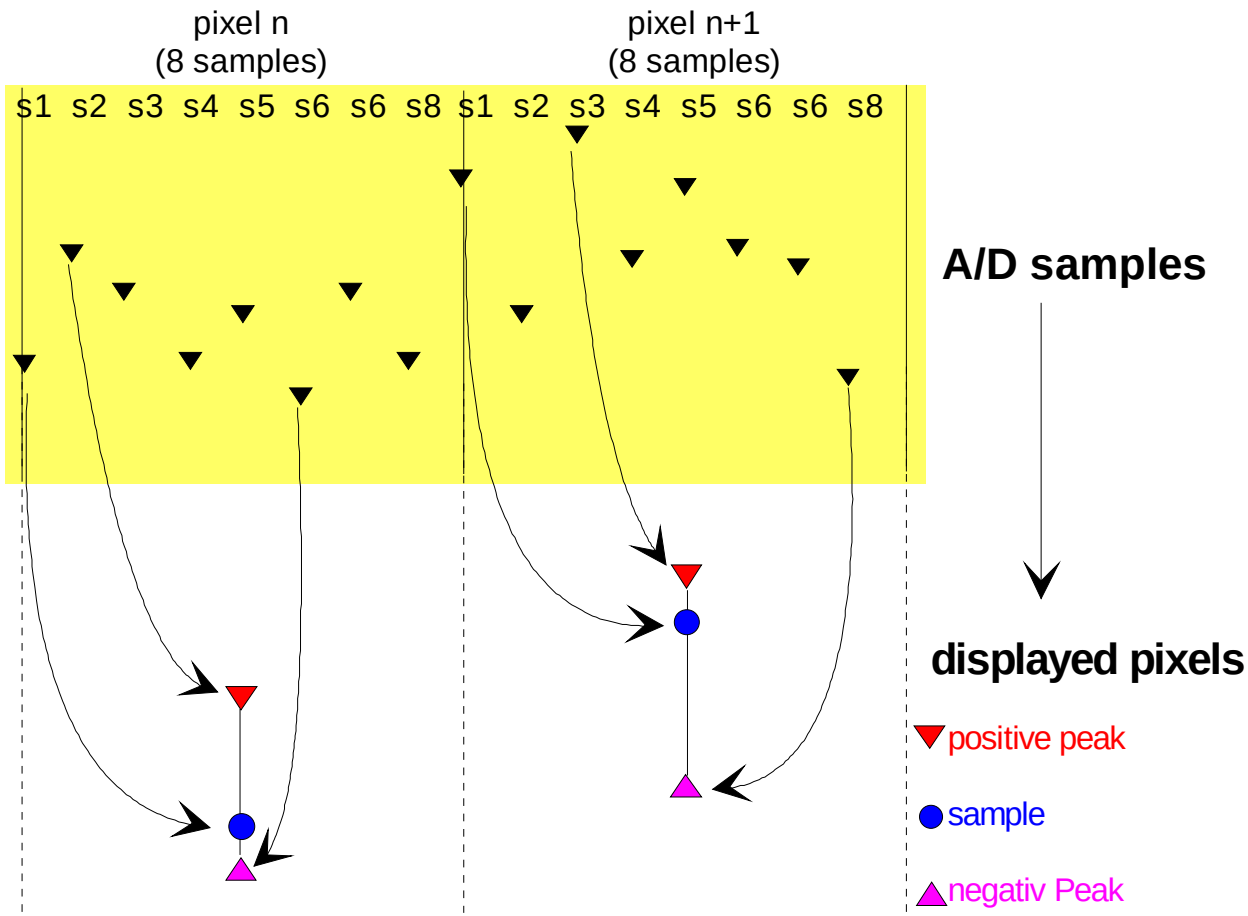
Data reduction for display



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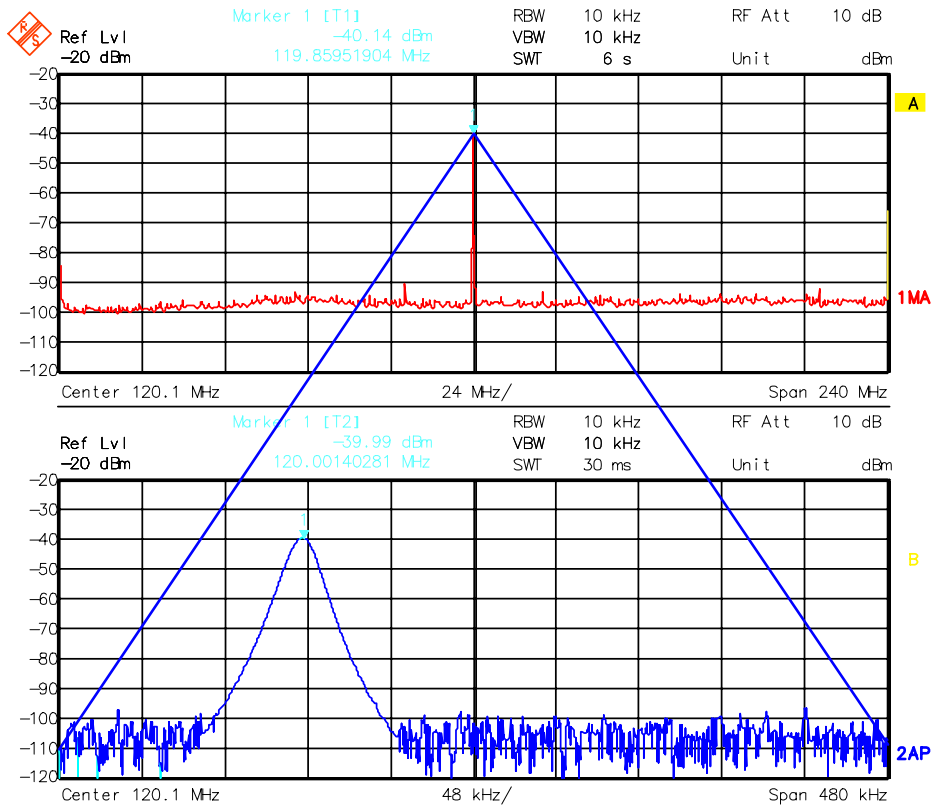
Data Reduction using the Peak Detector



Complete spectrum of lower display is compressed to one pixel in upper display

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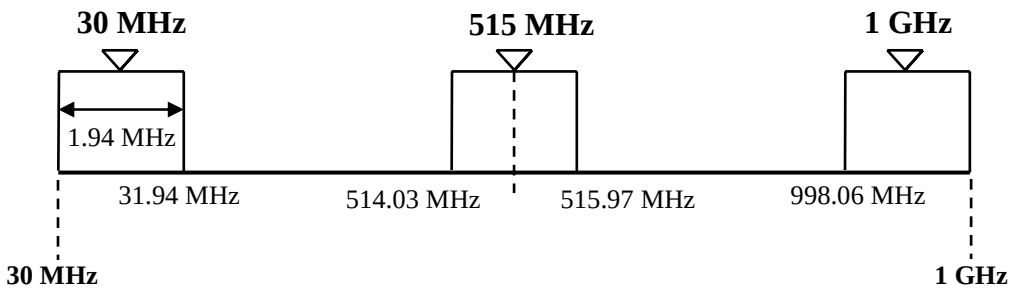
Display function principle

analyzer mode (sweep)	receiver mode (scan)
displayed level	
No. of results = 500:max result value in pixel	no. of results ≤ 500: result value, polygon No. of results = 500: result value in pixel no. of results > 500: max result value in pixel
displayed frequency	
nominal frequency of pixel	**real** frequency of max result



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Analyzer Mode:
Dynamic Range Considerations

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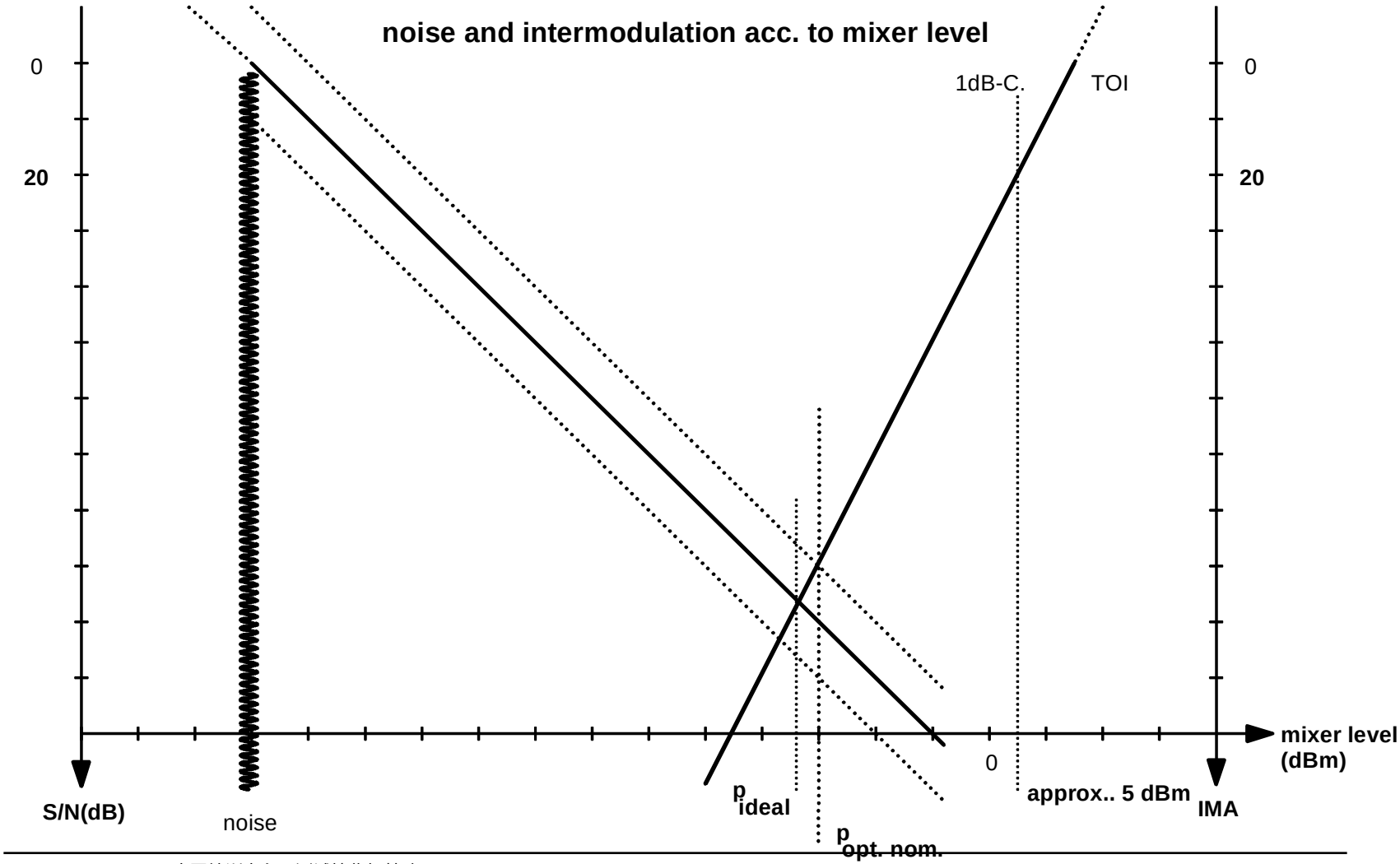
Dynamic adjustment consideration



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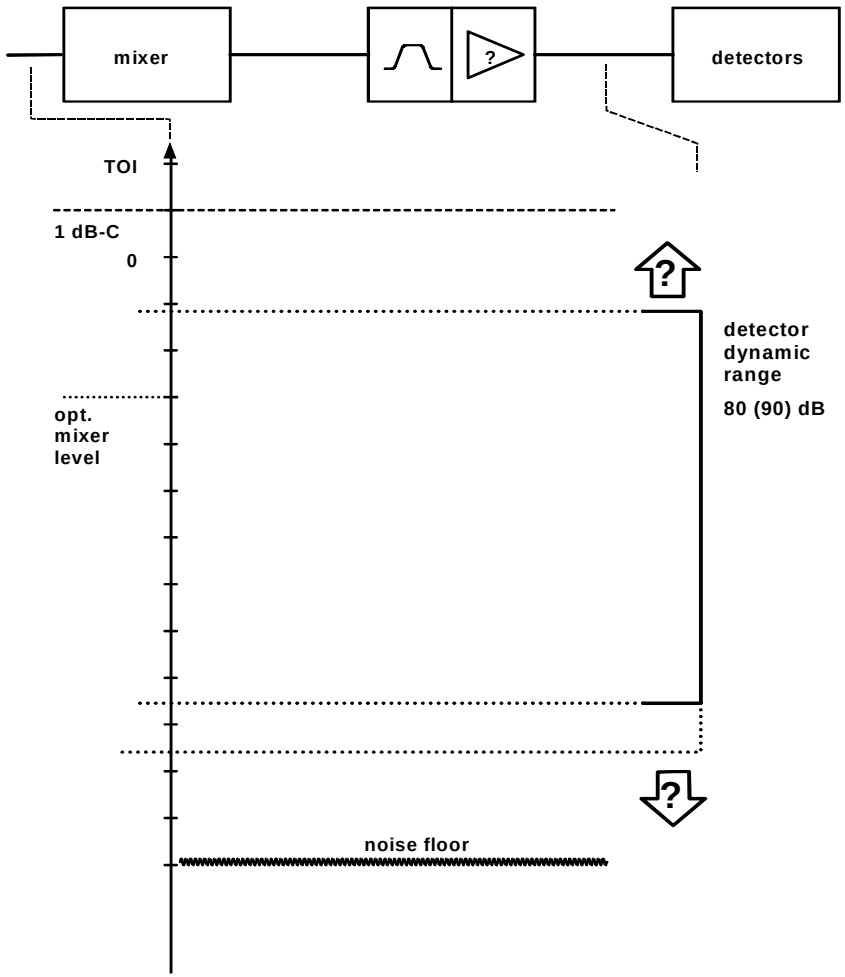
Dynamic adjustment consideration

general IF gain selection



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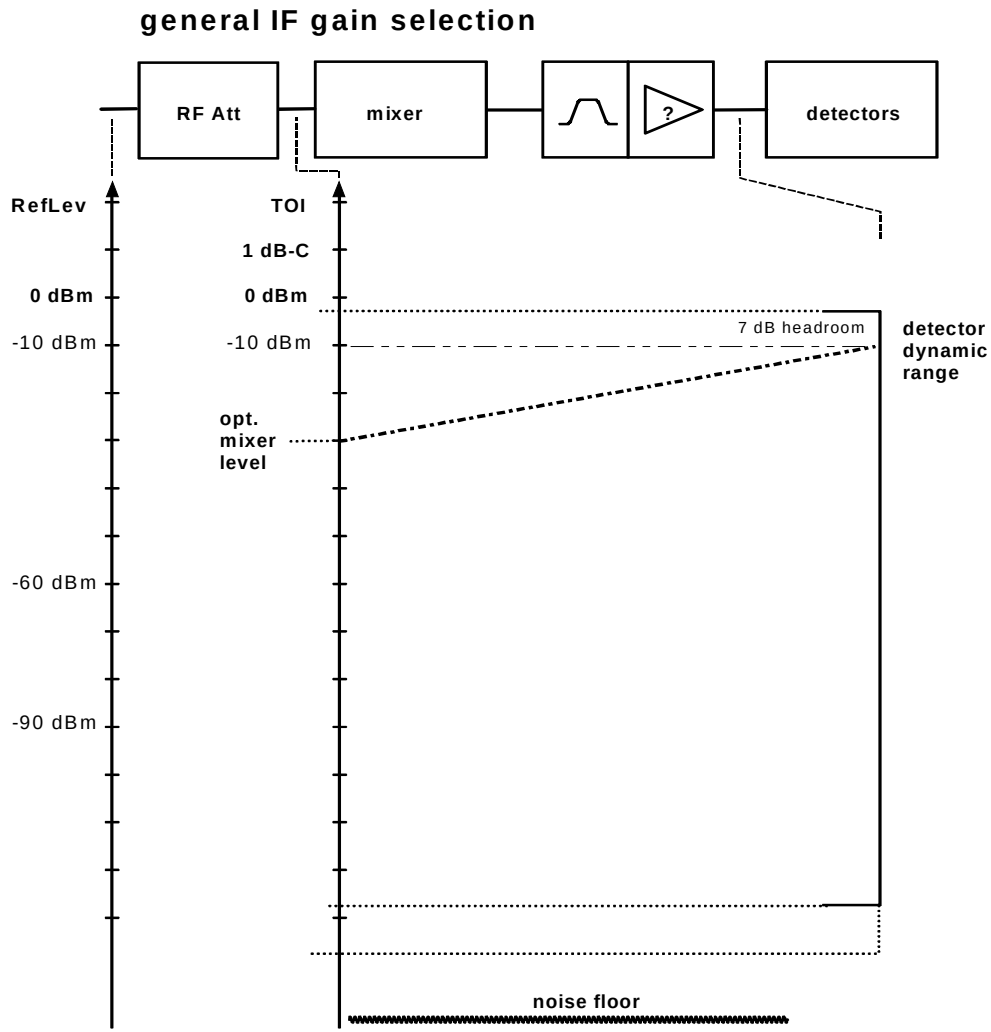
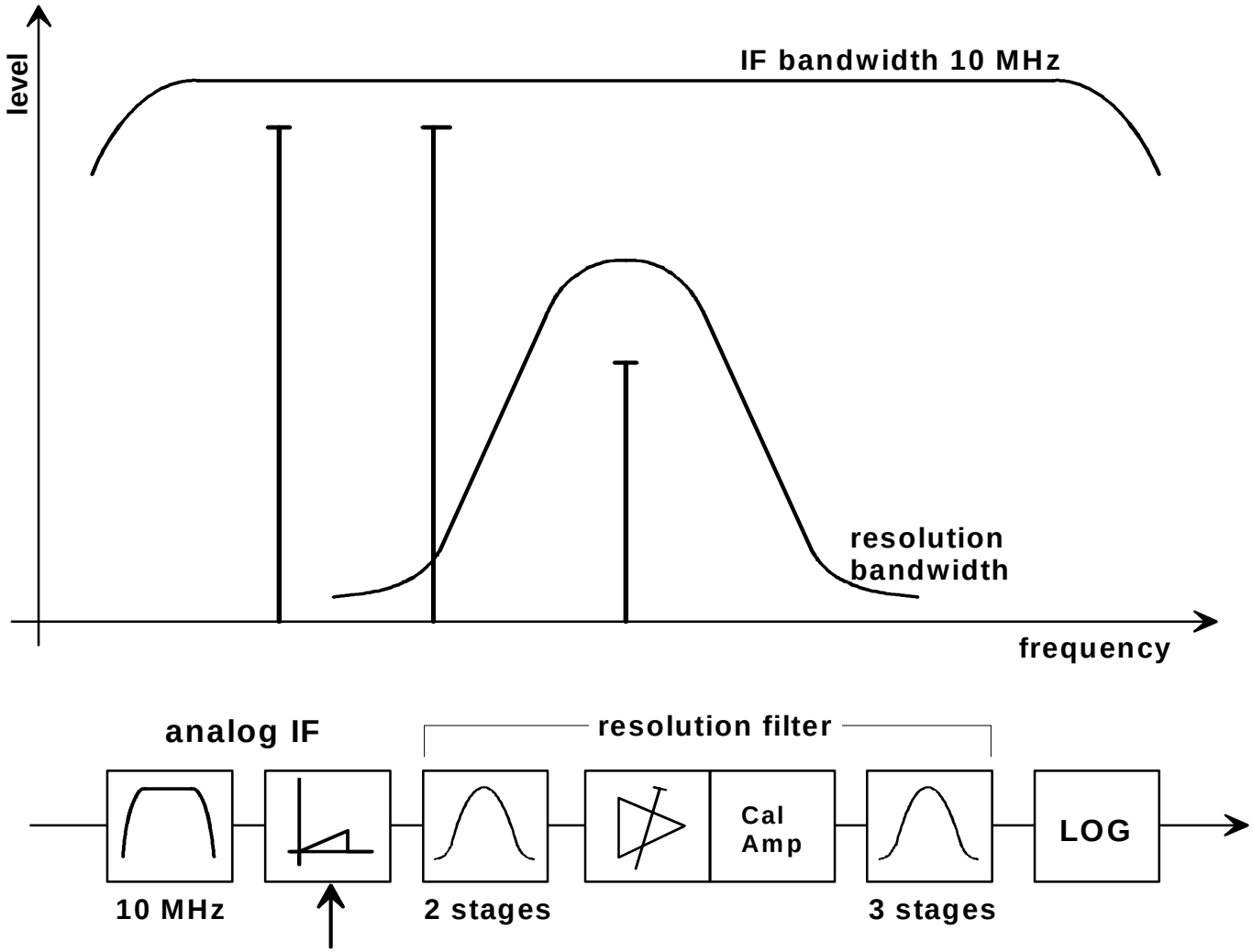
Dynamic adjustment consideration



IF overload 1



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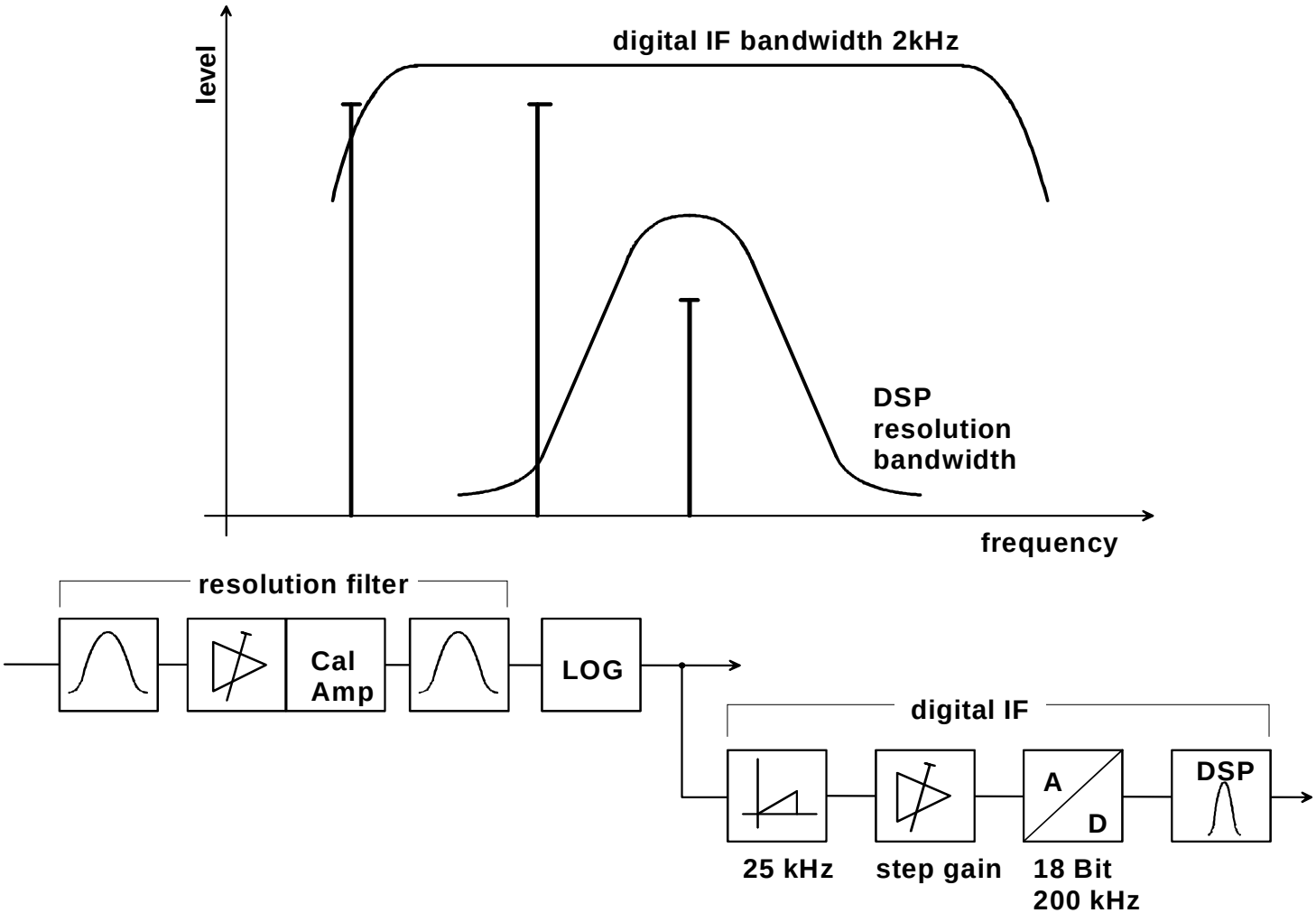
IF overload 2



接收机模式：
动态范围的考虑

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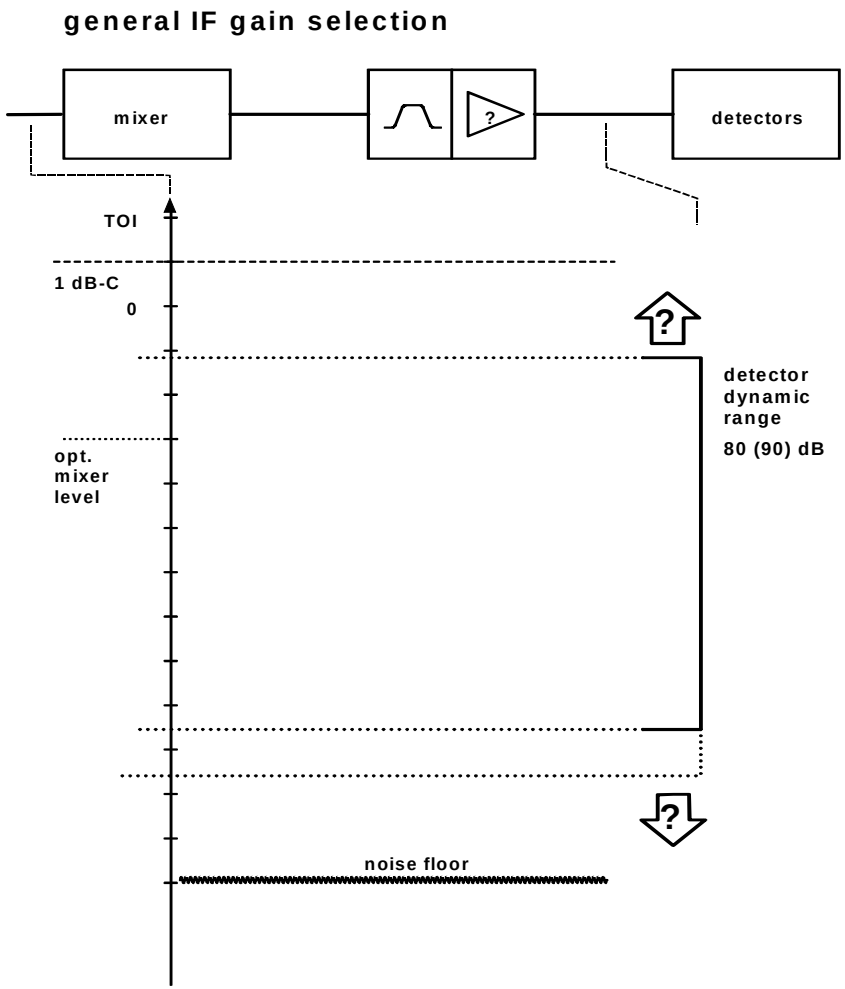
Dynamic adjustment consideration



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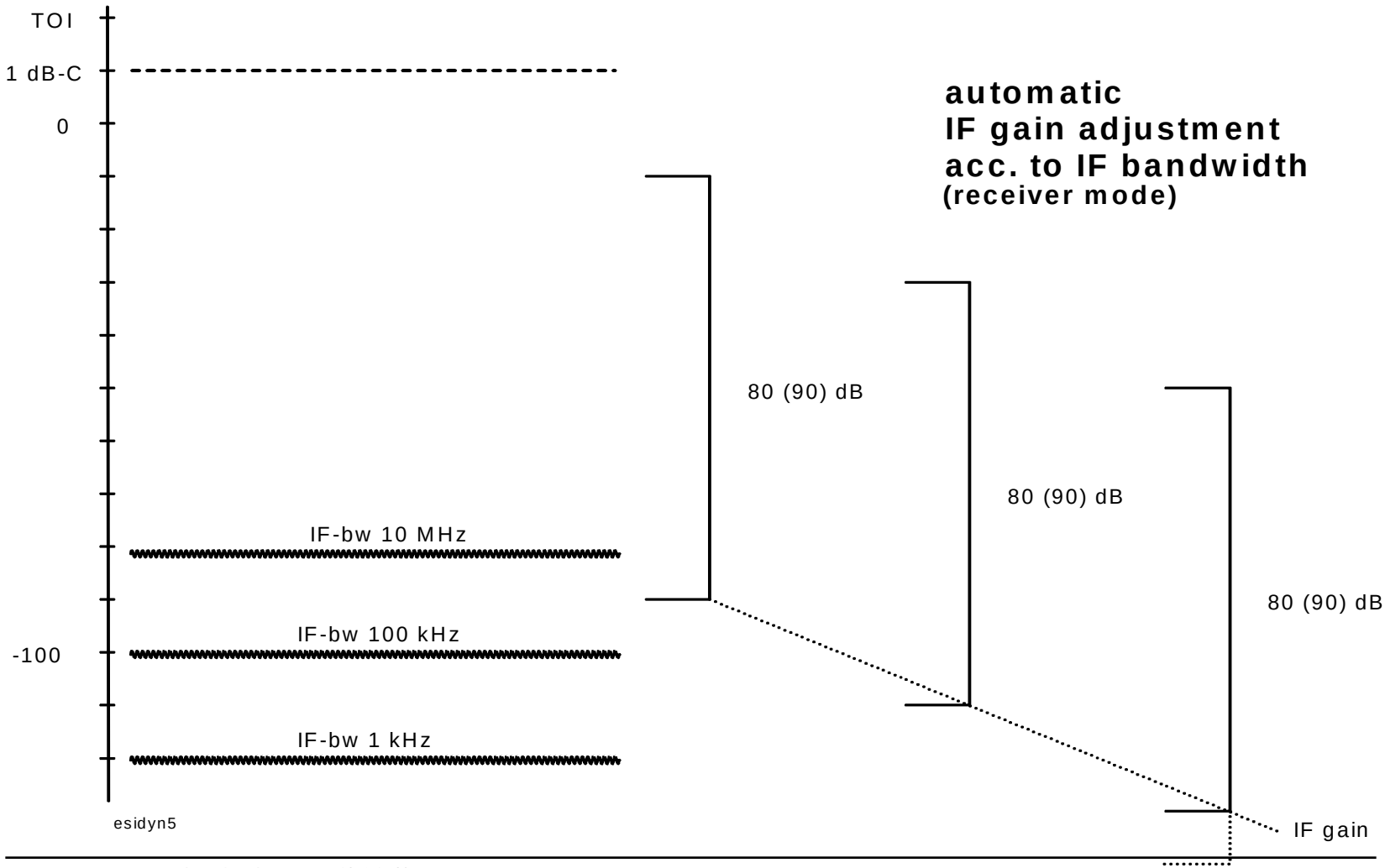
Dynamic adjustment consideration



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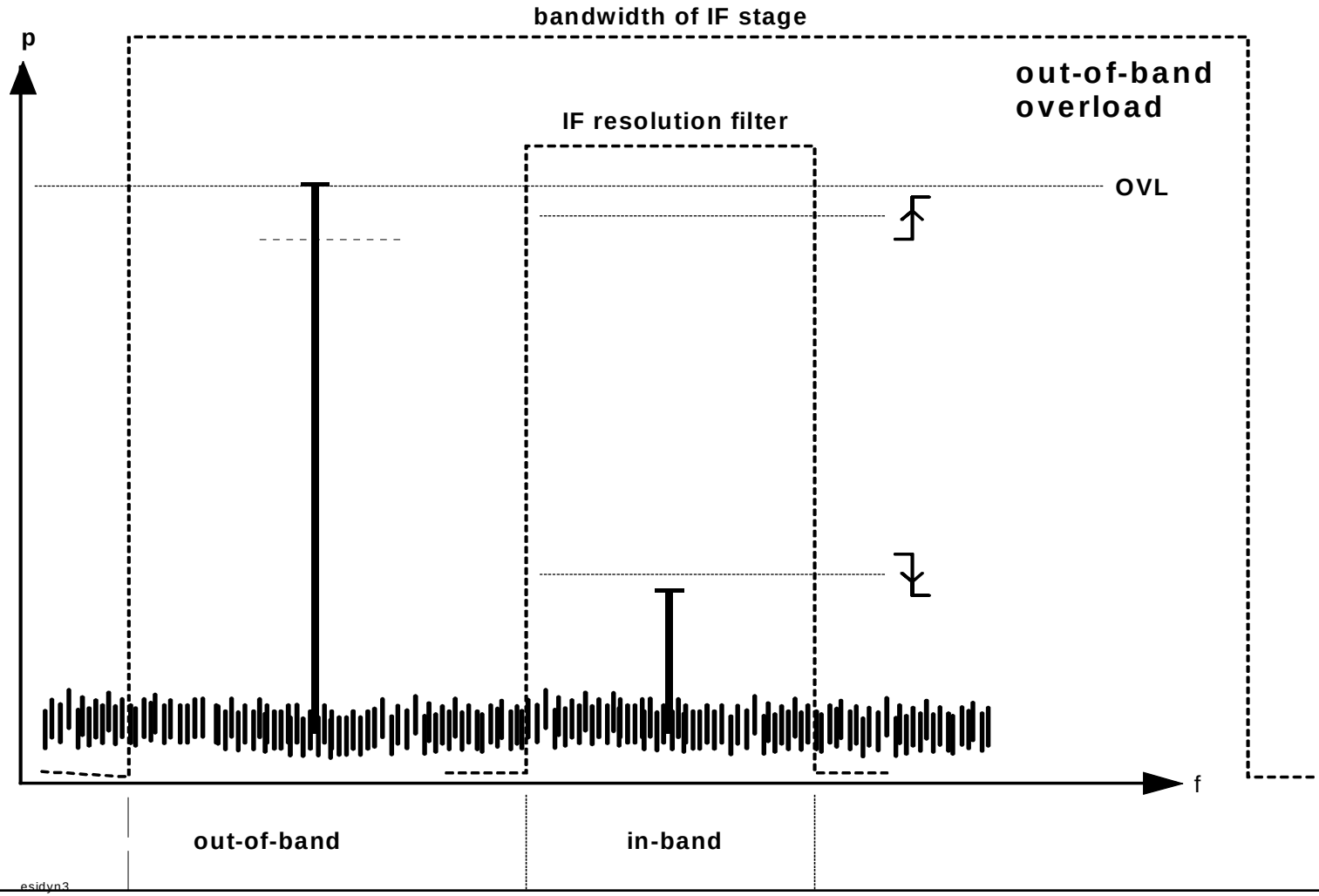
Dynamic adjustment consideration



测试接收机基础

第三章
仪器操作

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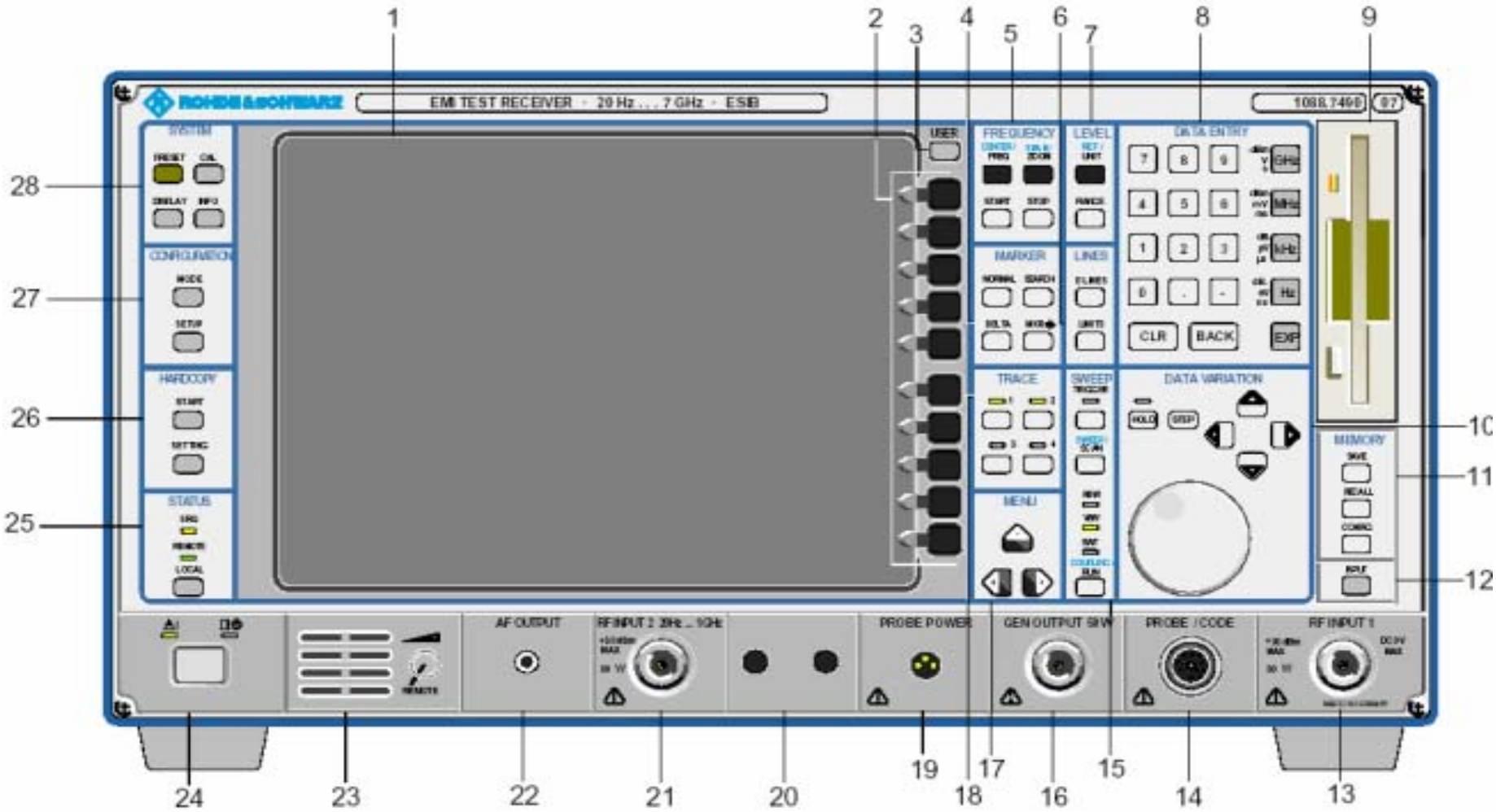
ESIB 前面板



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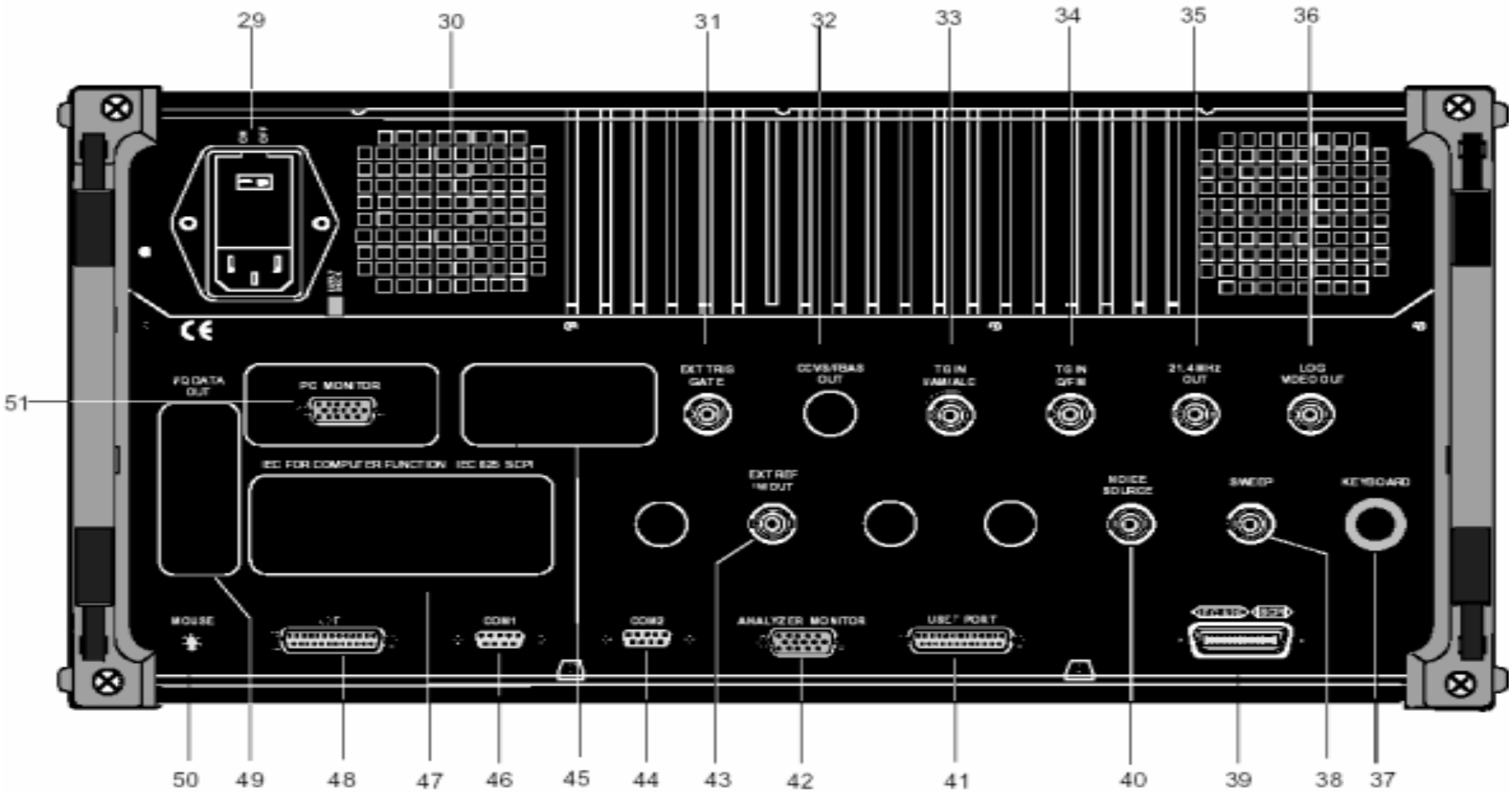
ESIB 后面板



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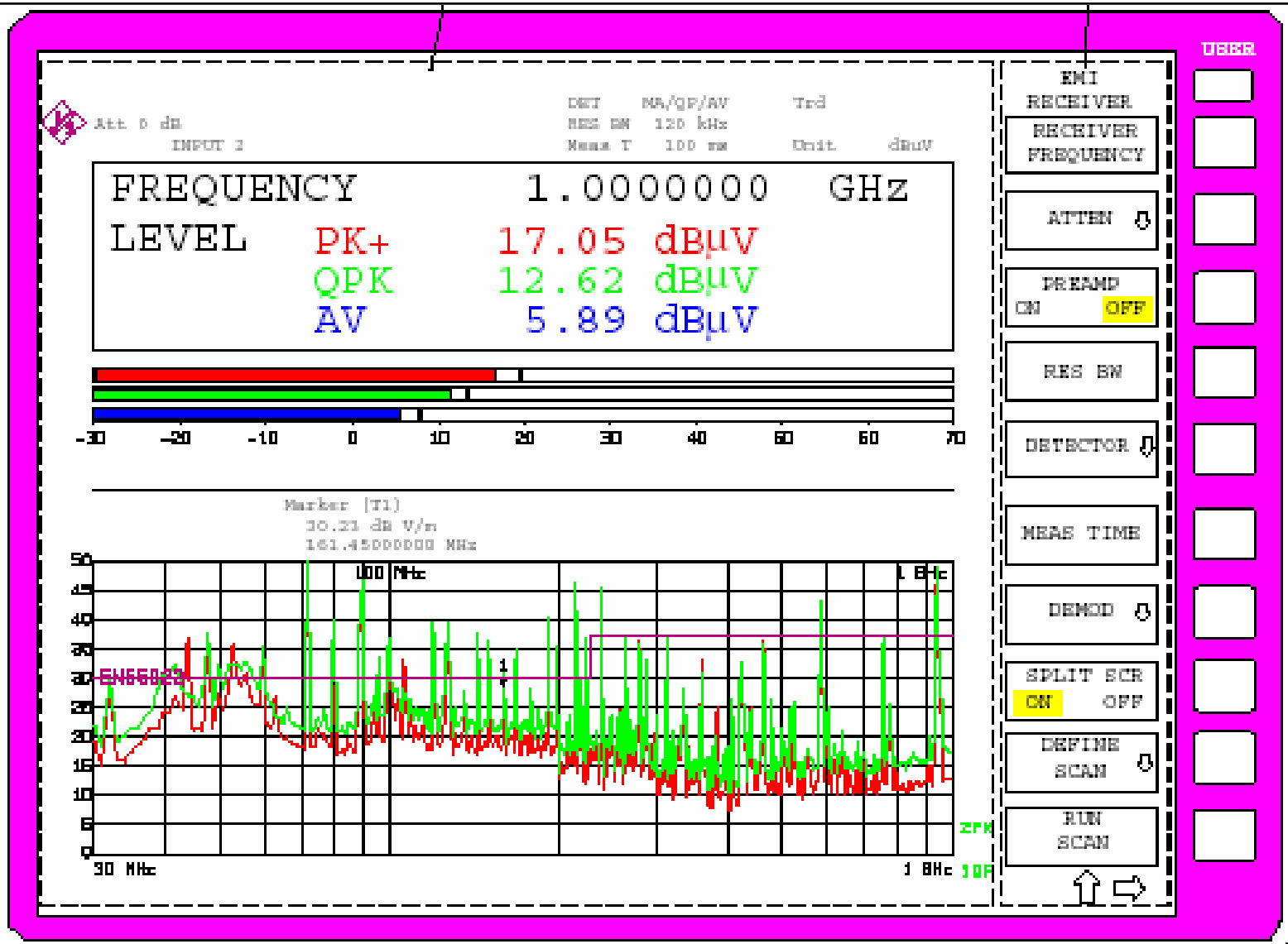

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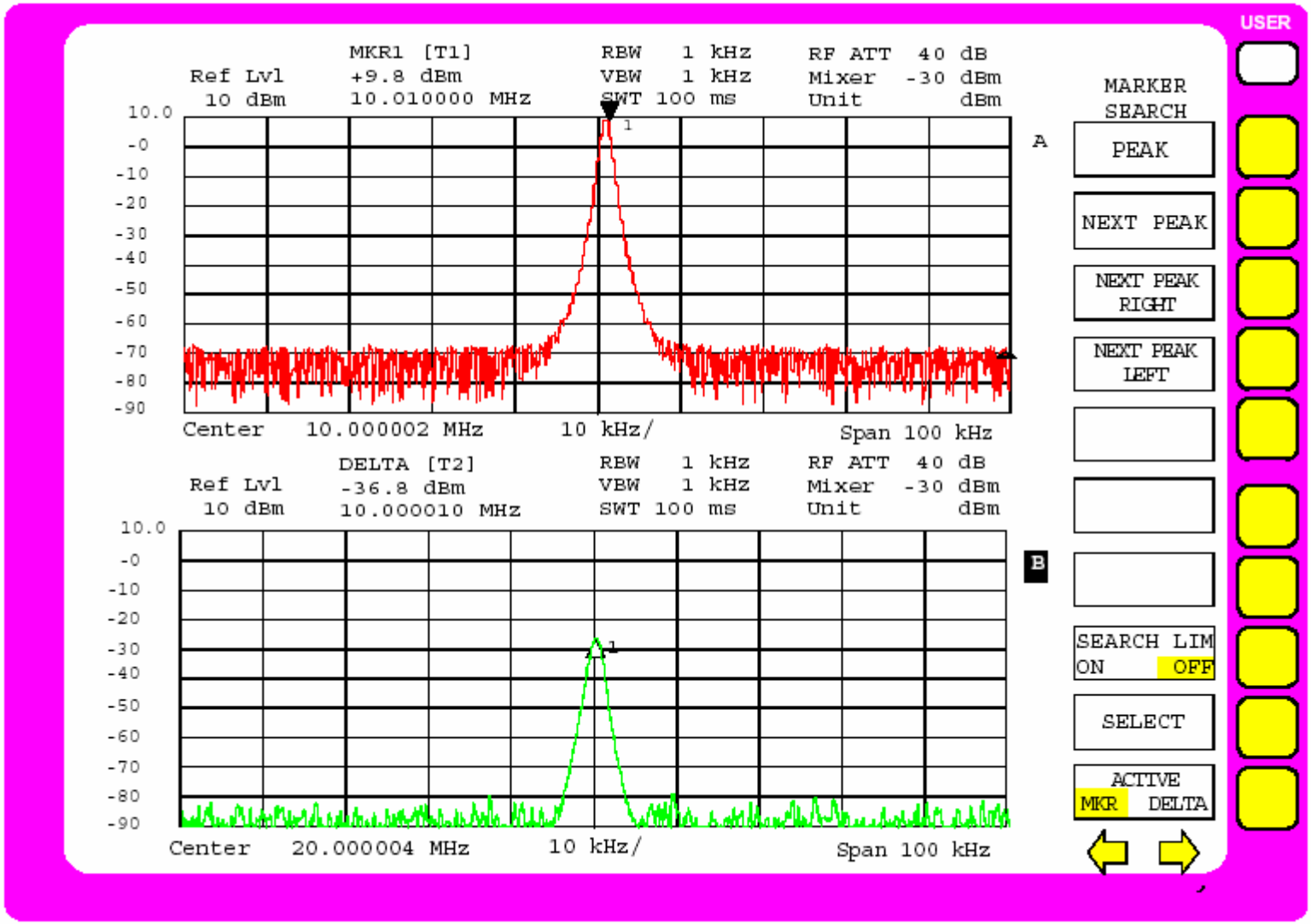
USER
MKR1 [T1]
Ref Lvl
10 dBm
+9.8 dBm
10.010000 MHz
RBW 1 kHz
VBW 1 kHz
SWT 100 ms
RF ATT 40 dB
Mixer -30 dBm
Unit dBm
10.0
-0
-10
-20
-30
-40
-50
-60
-70
-80
-90
Center 10.000002 MHz
10 kHz/
Span 100 kHz
A
DELTA [T2]
Ref Lvl
10 dBm
-36.8 dBm
10.000010 MHz
RBW 1 kHz
VBW 1 kHz
SWT 100 ms
RF ATT 40 dB
Mixer -30 dBm
Unit dBm
Center 20.000004 MHz
10 kHz/
Span 100 kHz
B
MARKER SEARCH
PEAK
NEXT PEAK
NEXT PEAK RIGHT
NEXT PEAK LEFT
SEARCH LIM
ON OFF
SELECT
ACTIVE
MKR DELTA

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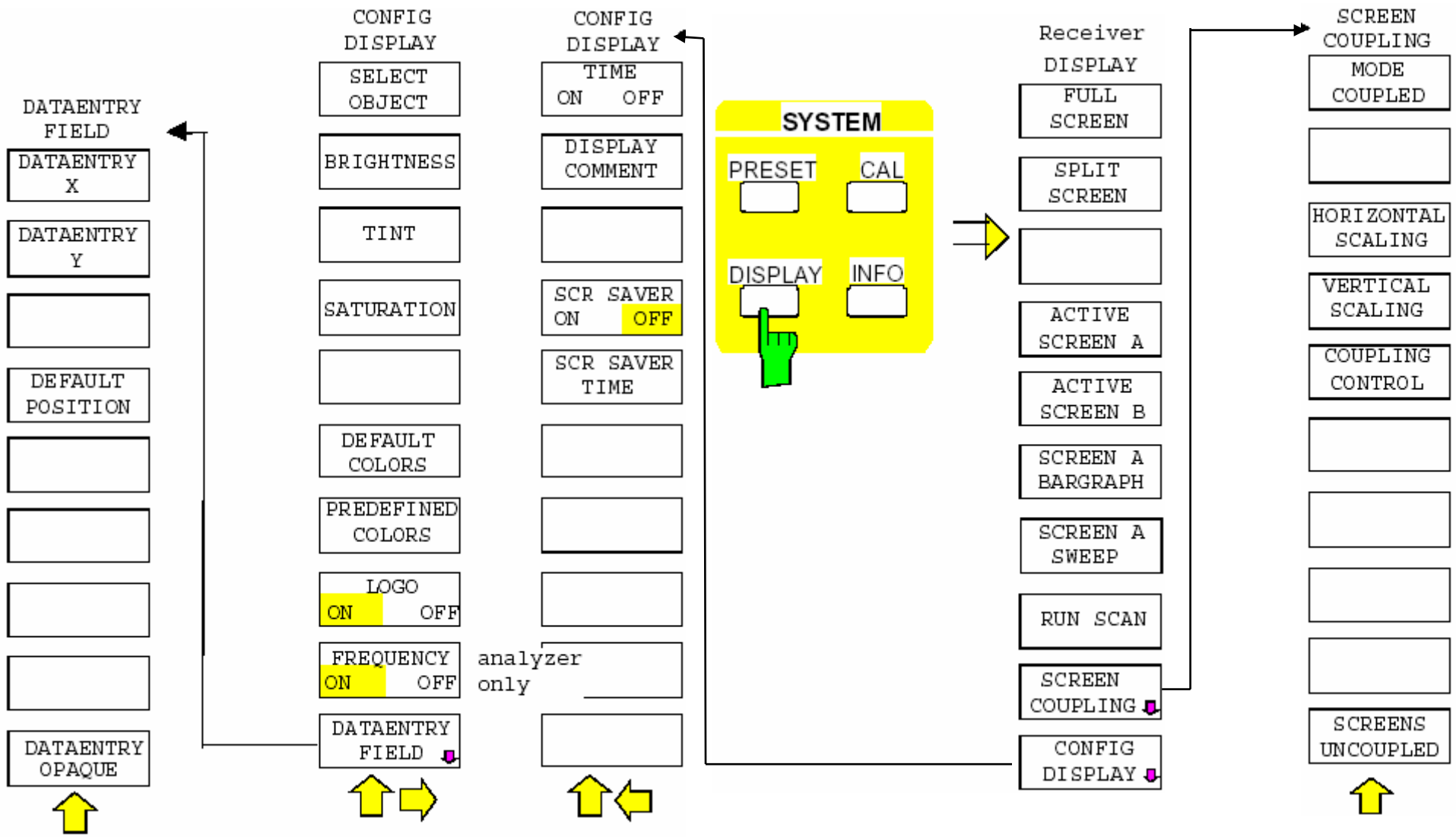
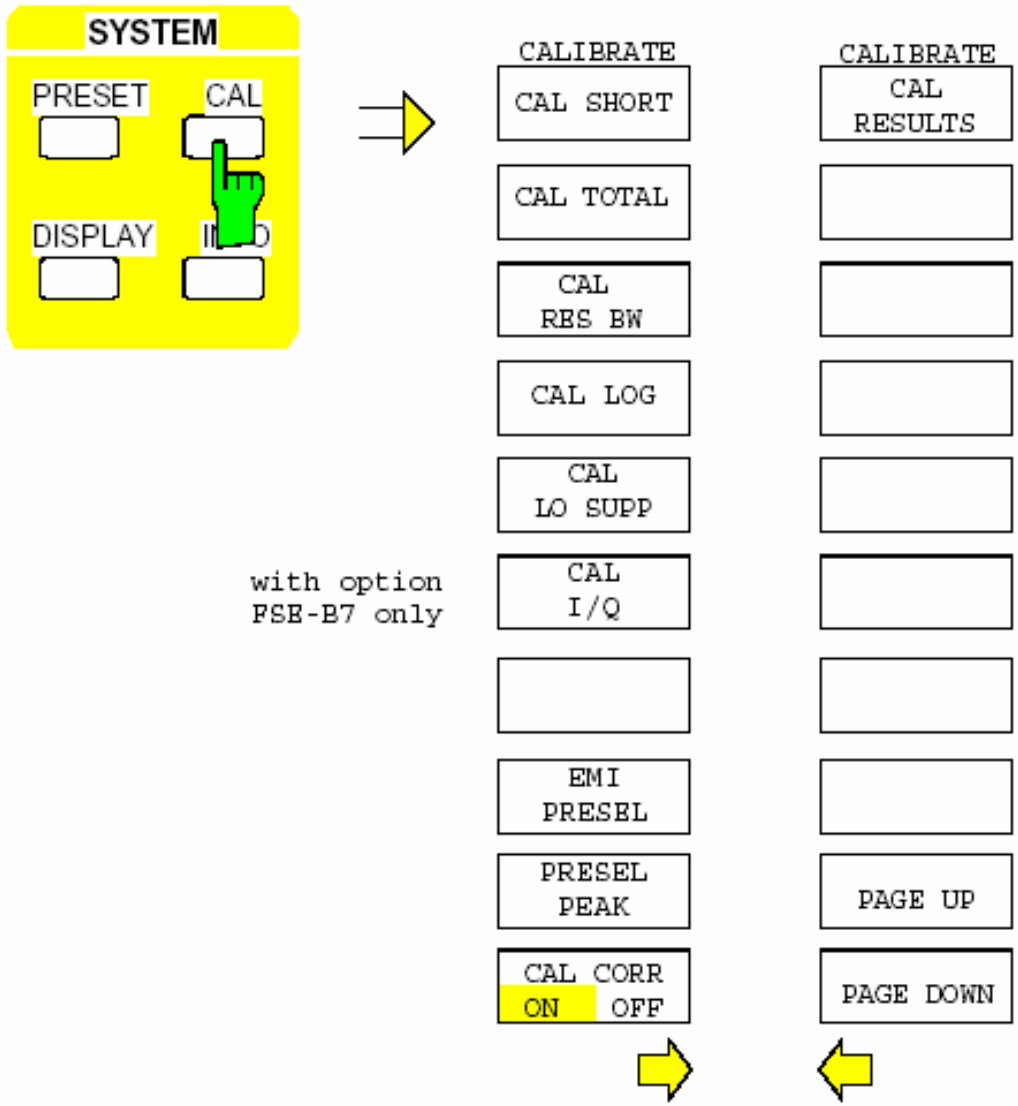
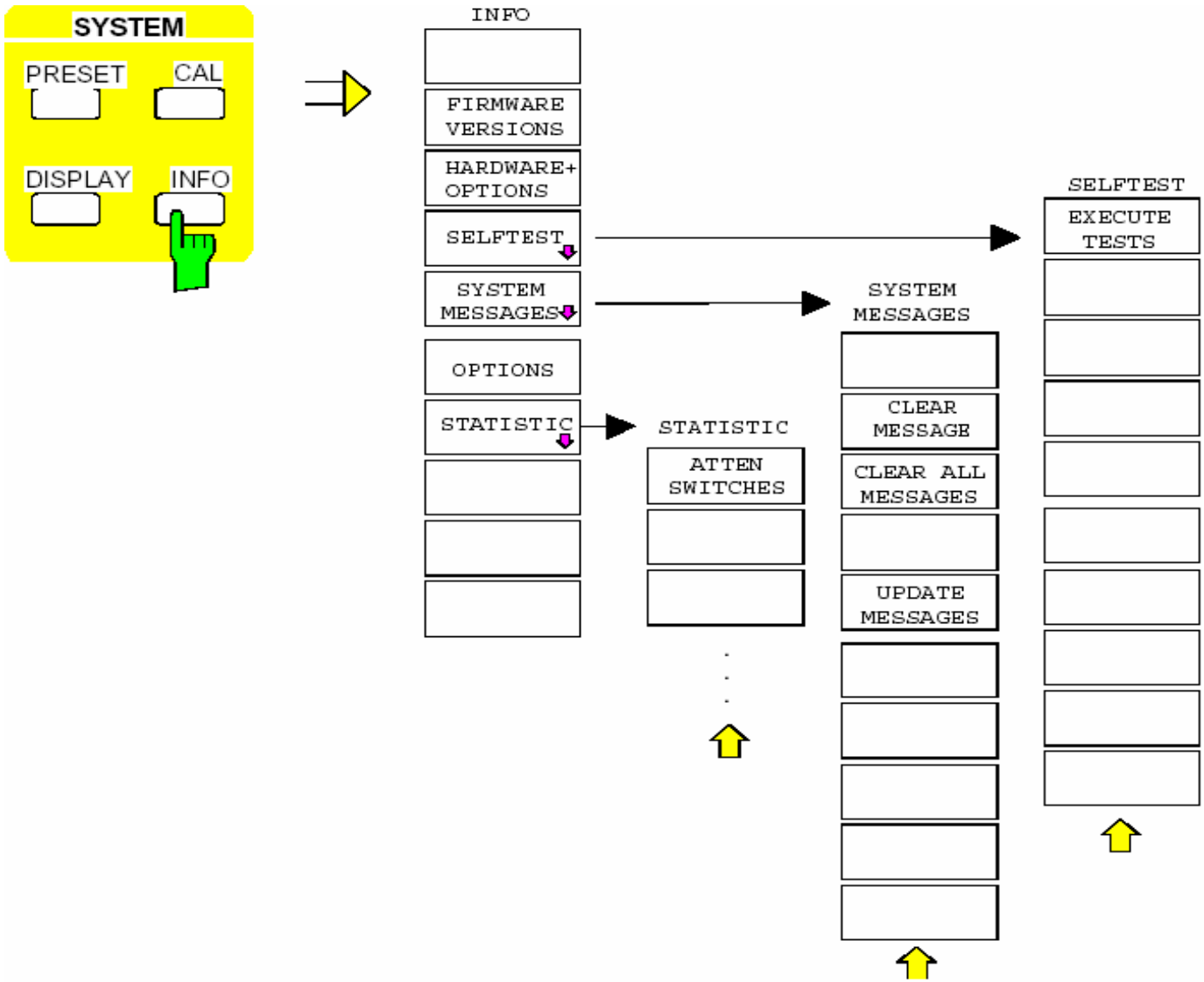
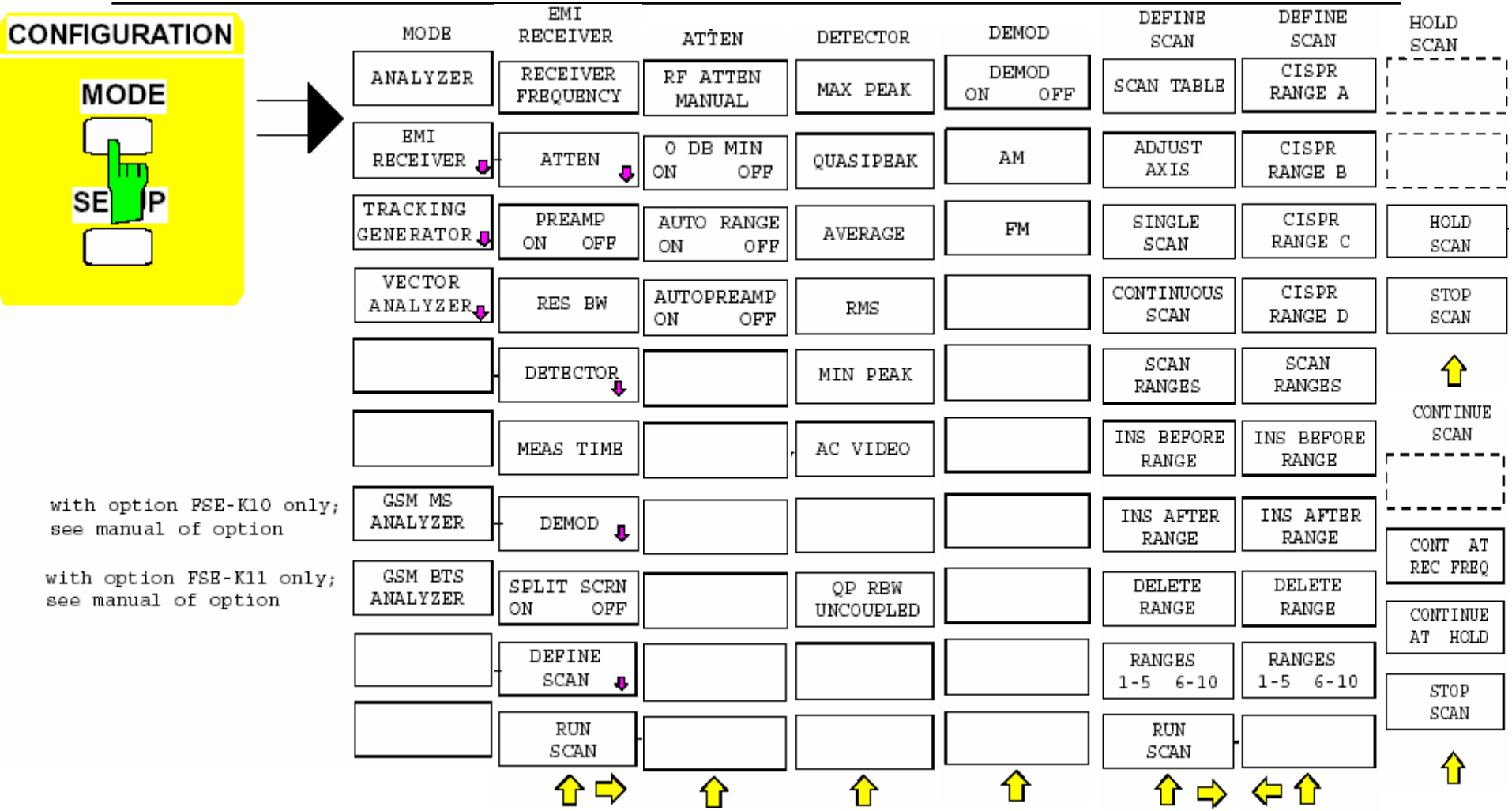


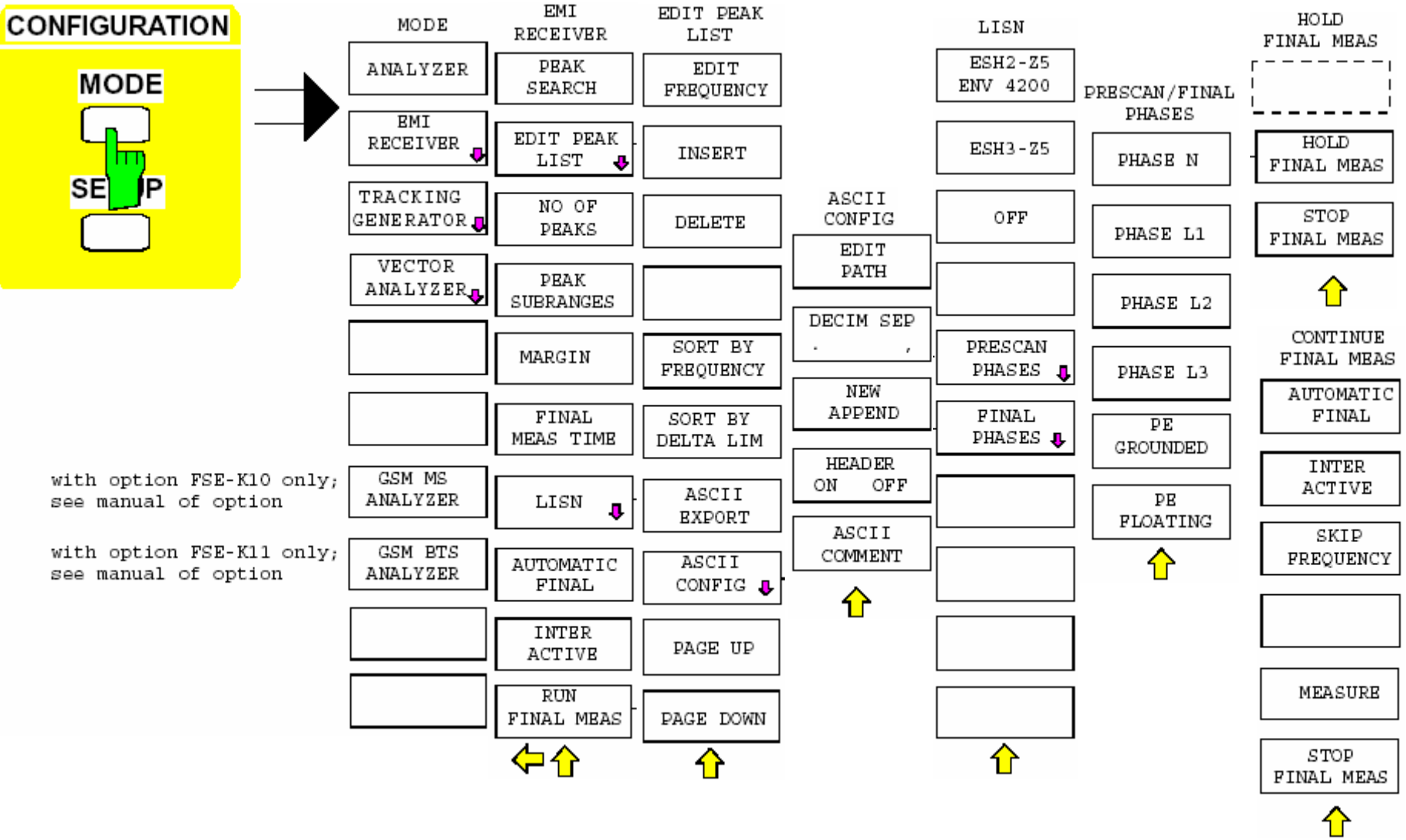

SYSTEM
PRESET
CAL
DISPLAY
CALIBRATE
CAL SHORT
CAL TOTAL
CAL RES BW
CAL LOG
CAL LO SUPP
CAL I/Q
EMI PRESEL
PRESEL PEAK
CAL CORR ON OFF
CALIBRATE
CAL RESULTS
PAGE UP
PAGE DOWN
with option FSE-B7 only


SYSTEM
PRESET
CAL
DISPLAY
INFO
INFO
FIRMWARE VERSIONS
HARDWARE+ OPTIONS
SELFTEST
SYSTEM MESSAGES
OPTIONS
STATISTIC
STATISTIC
ATTEN SWITCHES
SYSTEM MESSAGES
CLEAR MESSAGE
CLEAR ALL MESSAGES
UPDATE MESSAGES
SELFTEST
EXECUTE TESTS

ROHDE&SCHWARZ

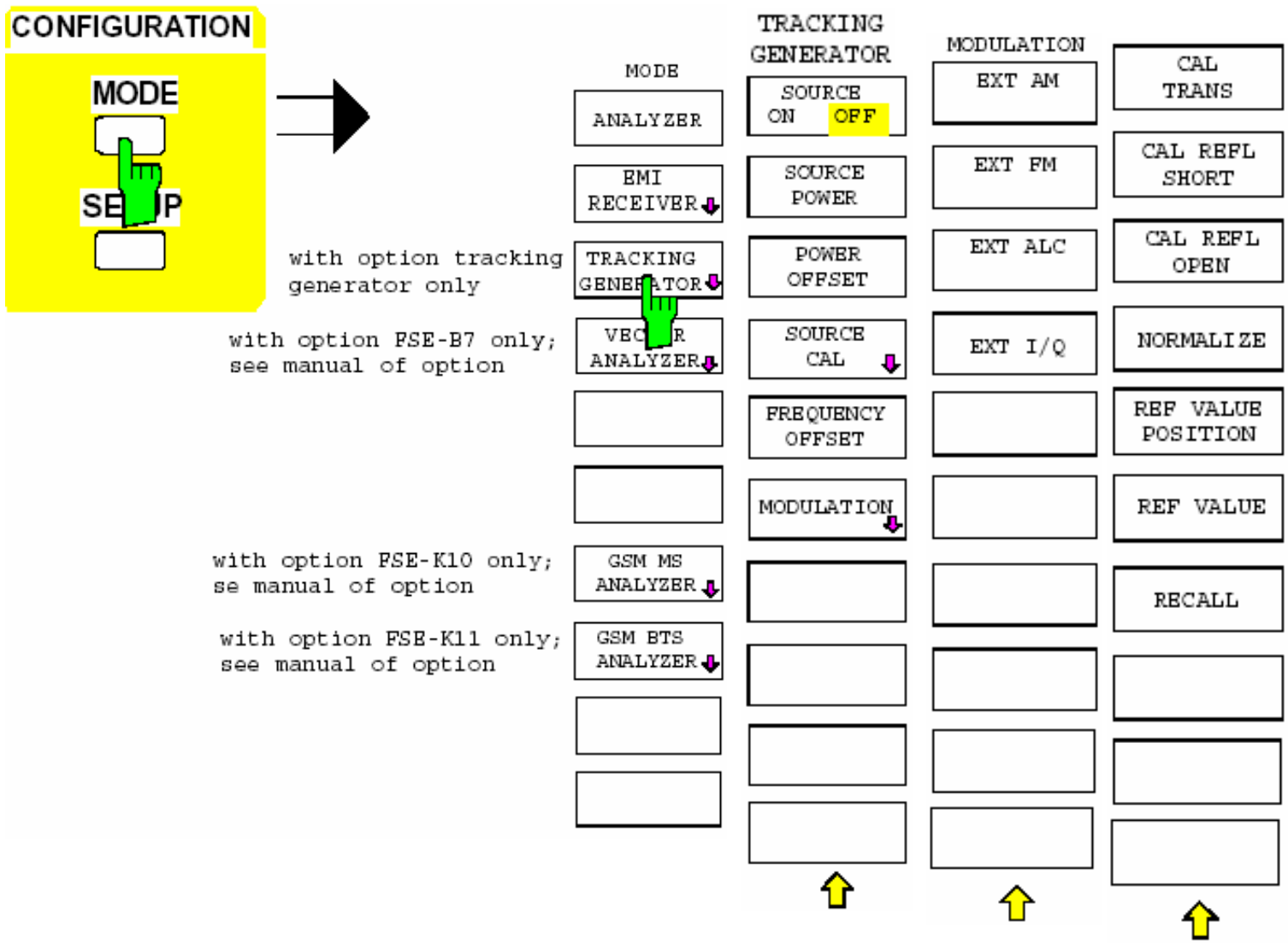


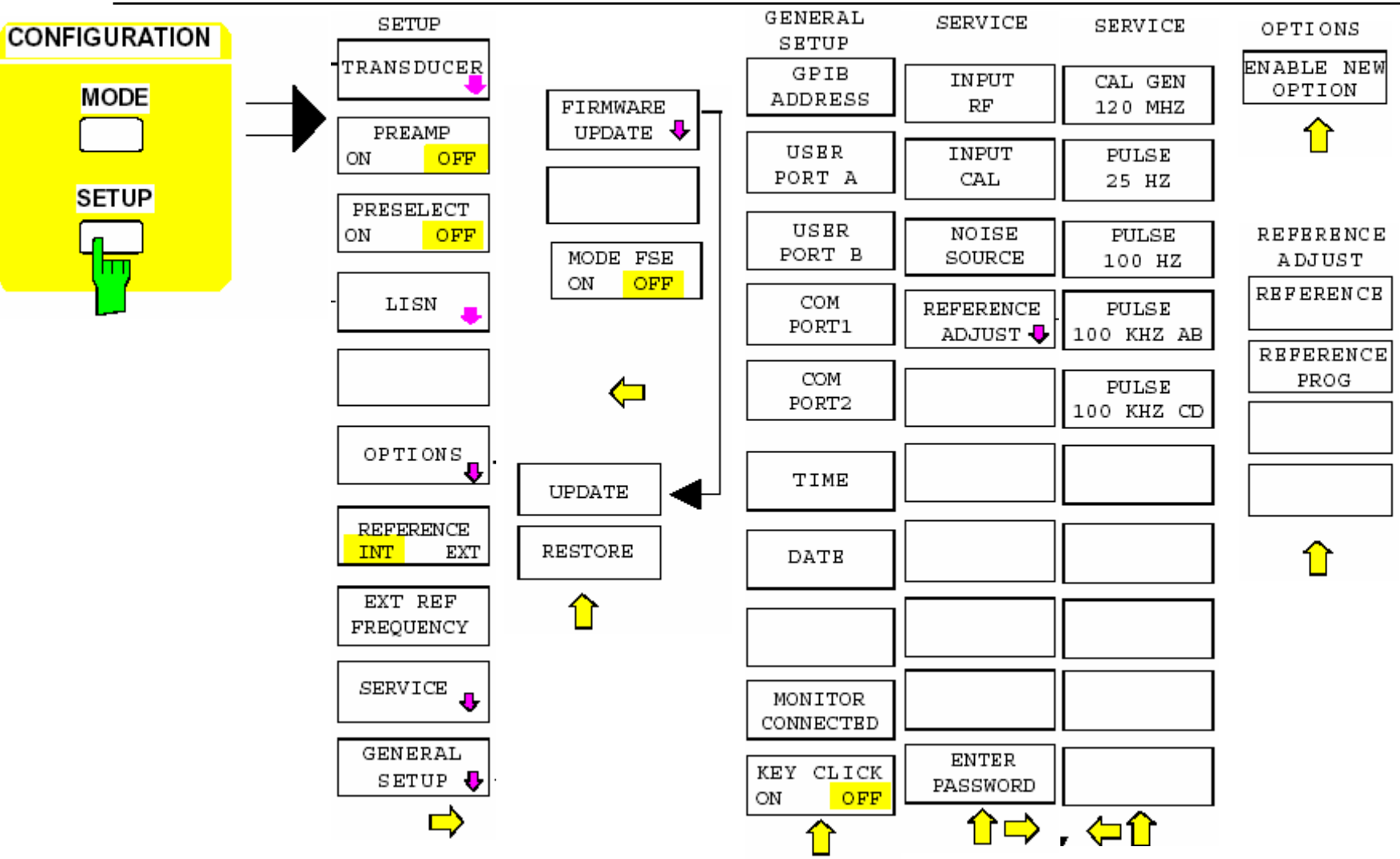
ROHDE & SCHWARZ

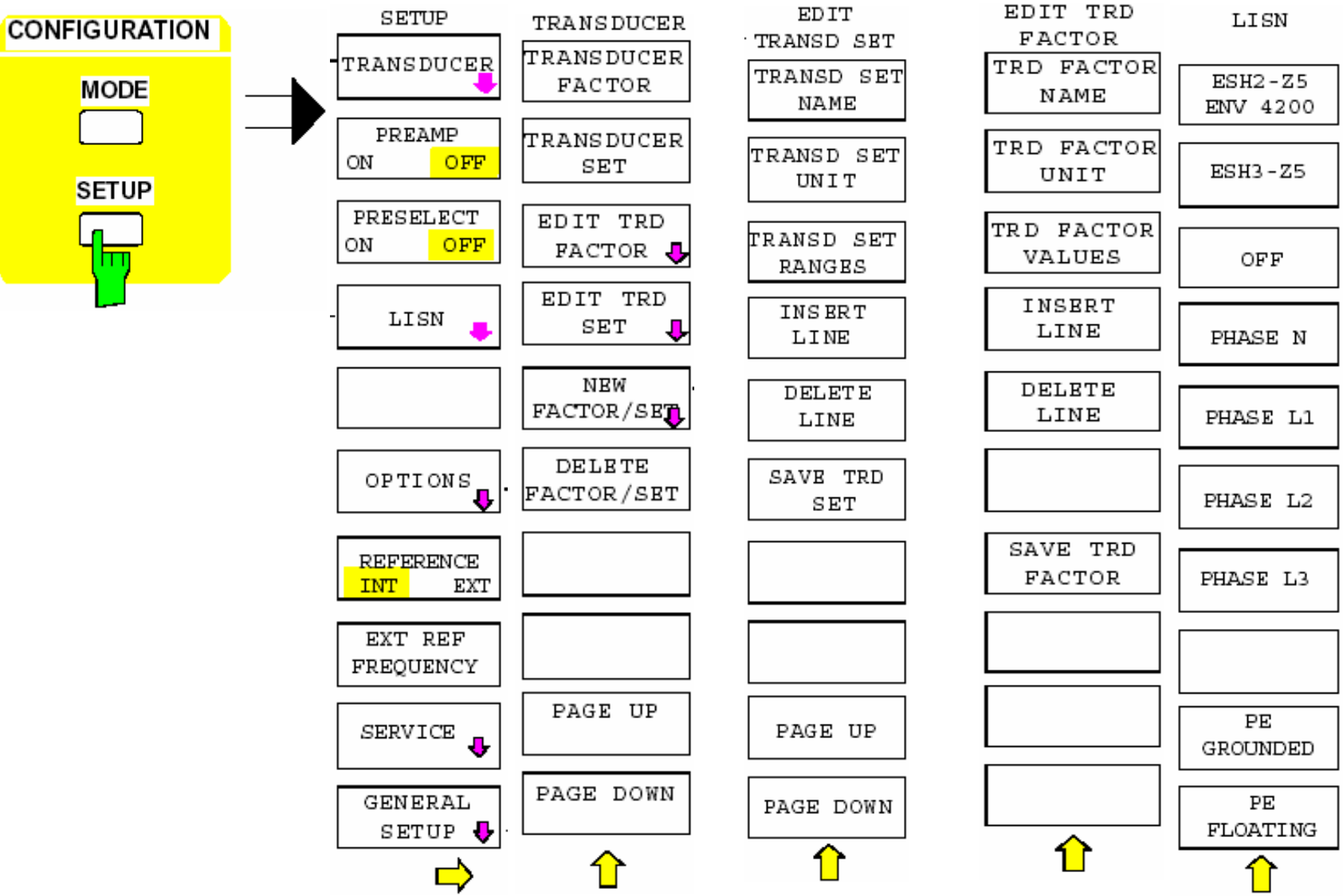


with option FSE-K10 only;
see manual of option

with option FSE-K11 only;
see manual of option


CONFIGURATION
MODE
SETUP
with option tracking generator only
with option FSE-B7 only; see manual of option
with option FSE-K10 only; se manual of option
with option FSE-K11 only; see manual of option
MODE
ANALYZER
EMI RECEIVER
TRACKING GENERATOR
VECTOR ANALYZER
GSM MS ANALYZER
GSM BTS ANALYZER
TRACKING GENERATOR
SOURCE ON OFF
SOURCE POWER
POWER OFFSET
SOURCE CAL
FREQUENCY OFFSET
MODULATION
MODULATION
EXT AM
EXT FM
EXT ALC
EXT I/Q
CAL TRANS
CAL REFL SHORT
CAL REFL OPEN
NORMALIZE
REF VALUE POSITION
REF VALUE
RECALL


CONFIGURATION
MODE
SETUP
SETUP
TRANSDUCER
PREAMP ON OFF
PRESELECT ON OFF
LISN
OPTIONS
REFERENCE INT EXT
EXT REF FREQUENCY
SERVICE
GENERAL SETUP
FIRMWARE UPDATE
MODE FSE ON OFF
UPDATE
RESTORE
GENERAL SETUP
GPIB ADDRESS
USER PORT A
USER PORT B
COM PORT1
COM PORT2
TIME
DATE
MONITOR CONNECTED
KEY CLICK ON OFF
SERVICE
INPUT RF
INPUT CAL
NOISE SOURCE
REFERENCE ADJUST
ENTER PASSWORD
SERVICE
CAL GEN 120 MHZ
PULSE 25 HZ
PULSE 100 HZ
PULSE 100 KHZ AB
PULSE 100 KHZ CD
OPTIONS
ENABLE NEW OPTION
REFERENCE ADJUST
REFERENCE
REFERENCE PROG


CONFIGURATION
MODE
SETUP
SETUP
TRANSDUCER
PREAMP ON OFF
PRESELECT ON OFF
LISN
OPTIONS
REFERENCE INT EXT
EXT REF FREQUENCY
SERVICE
GENERAL SETUP
TRANSDUCER
TRANSDUCER FACTOR
TRANSDUCER SET
EDIT TRD FACTOR
EDIT TRD SET
NEW FACTOR/SET
DELETE FACTOR/SET
PAGE UP
PAGE DOWN
EDIT TRANSD SET
TRANSD SET NAME
TRANSD SET UNIT
TRANSD SET RANGES
INSERT LINE
DELETE LINE
SAVE TRD SET
PAGE UP
PAGE DOWN
EDIT TRD FACTOR
TRD FACTOR NAME
TRD FACTOR UNIT
TRD FACTOR VALUES
INSERT LINE
DELETE LINE
SAVE TRD FACTOR
LISN
ESH2-Z5 ENV 4200
ESH3-Z5
OFF
PHASE N
PHASE L1
PHASE L2
PHASE L3
PE GROUNDED
PE FLOATING

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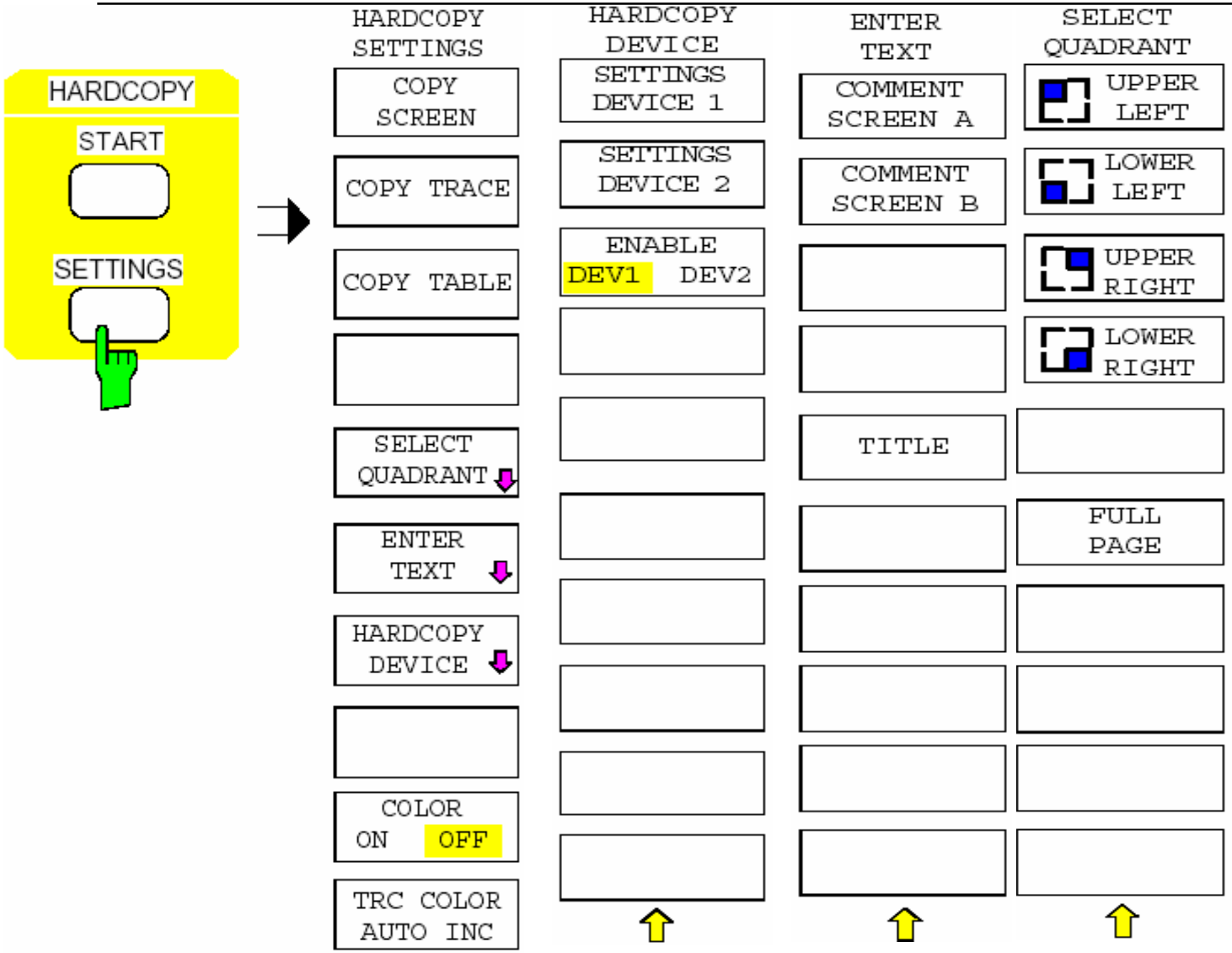
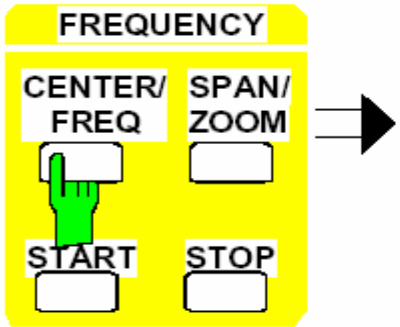
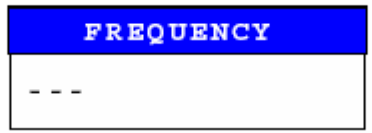
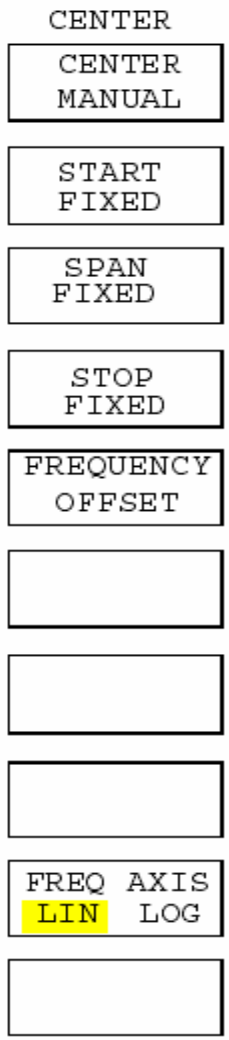


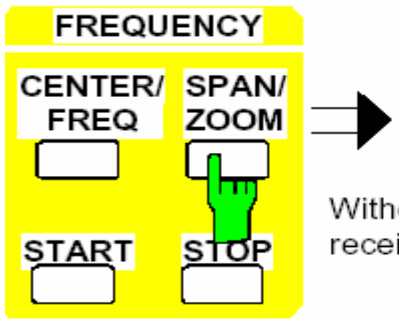


Receiver



Analyzer





Without function in receiver mode.

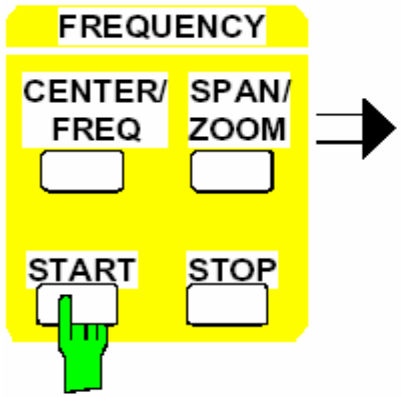
Analyzer

SPAN

- SPAN MANUAL
- START FIXED
- CENTER FIXED
- STOP FIXED
- ZERO SPAN
- FULL SPAN
- LAST SPAN
- ZOOM
- FREQ AXIS LIN LOG

FREQUENCY ZOOM

- MOVE ZOOM WINDOW
- MOVE ZOOM START
- MOVE ZOOM STOP
- ZOOM OFF



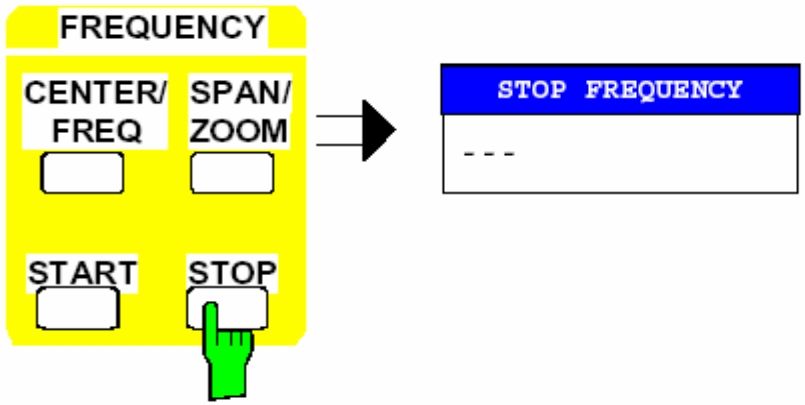
Receiver

START FREQUENCY

Analyzer

START FREQ

START MANUAL
CENTER FIXED
SPAN FIXED
STOP FIXED
FREQ AXIS LIN LOG



Analyzer

STOP FREQ

STOP MANUAL
START FIXED
CENTER FIXED
SPAN FIXED
FREQ AXIS LIN LOG

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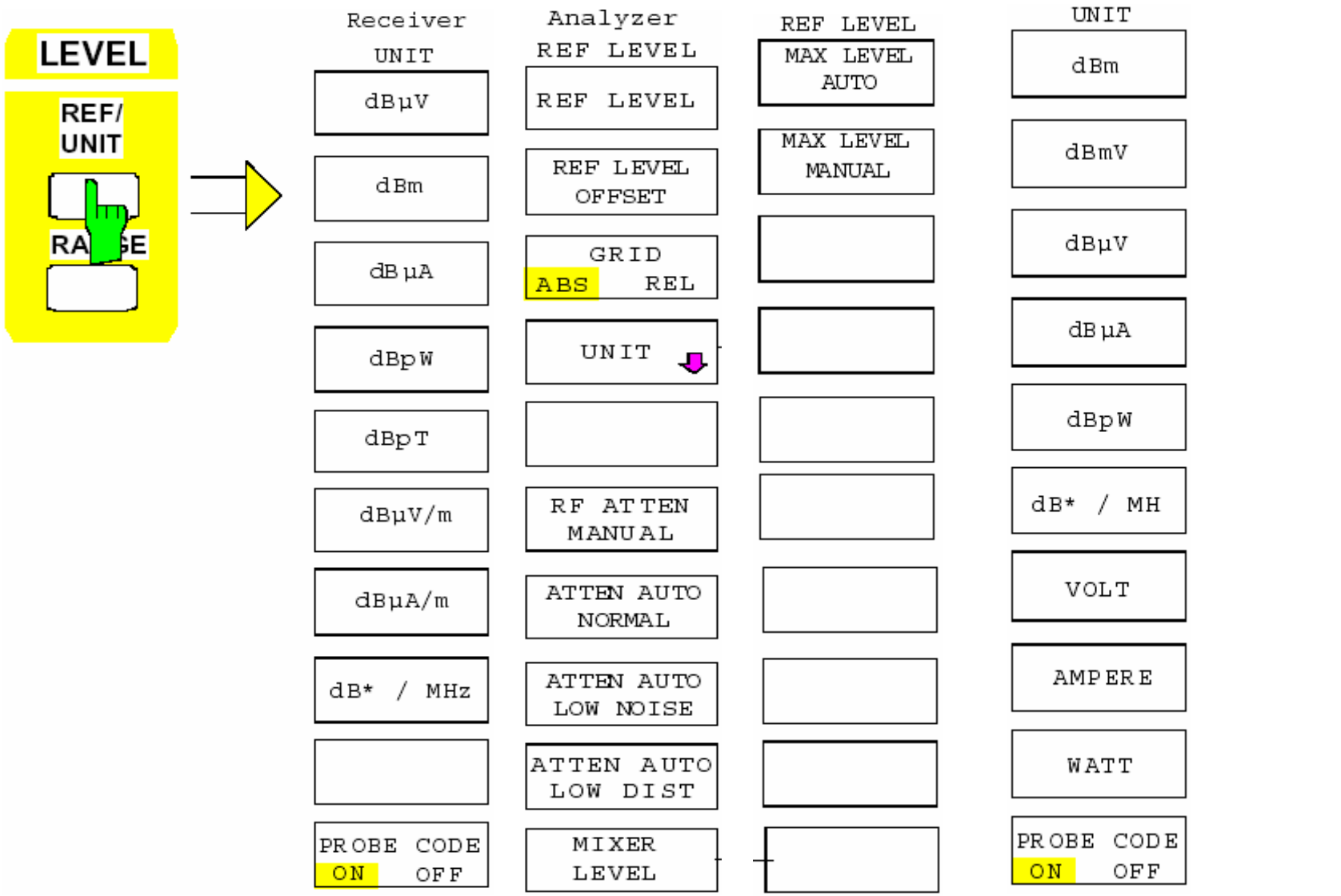
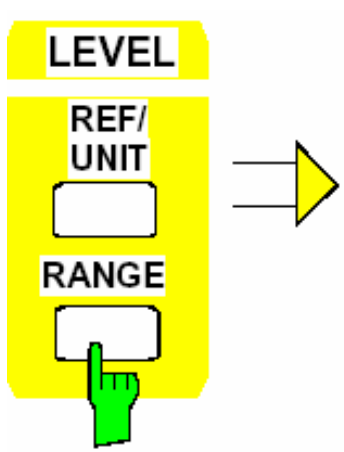
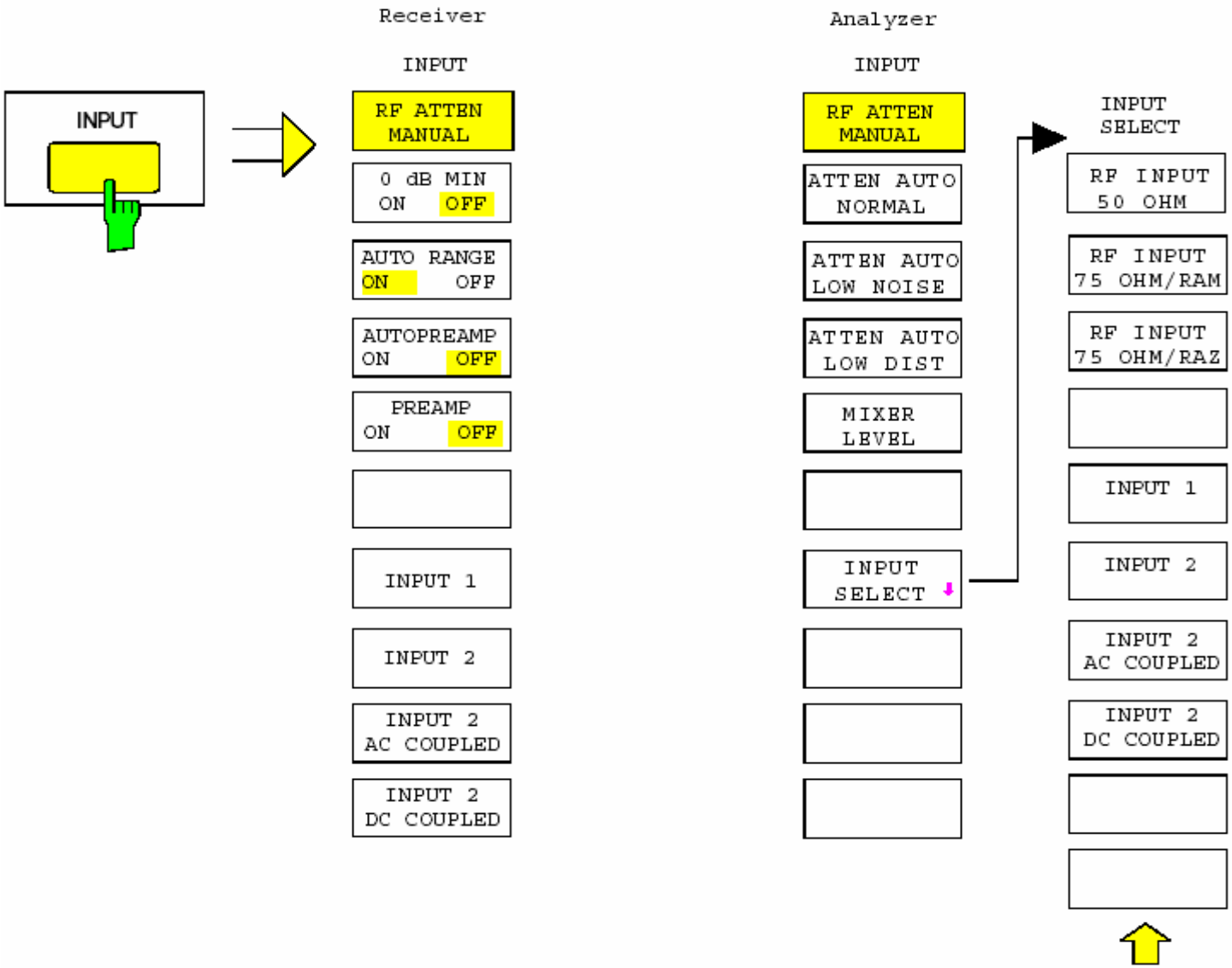
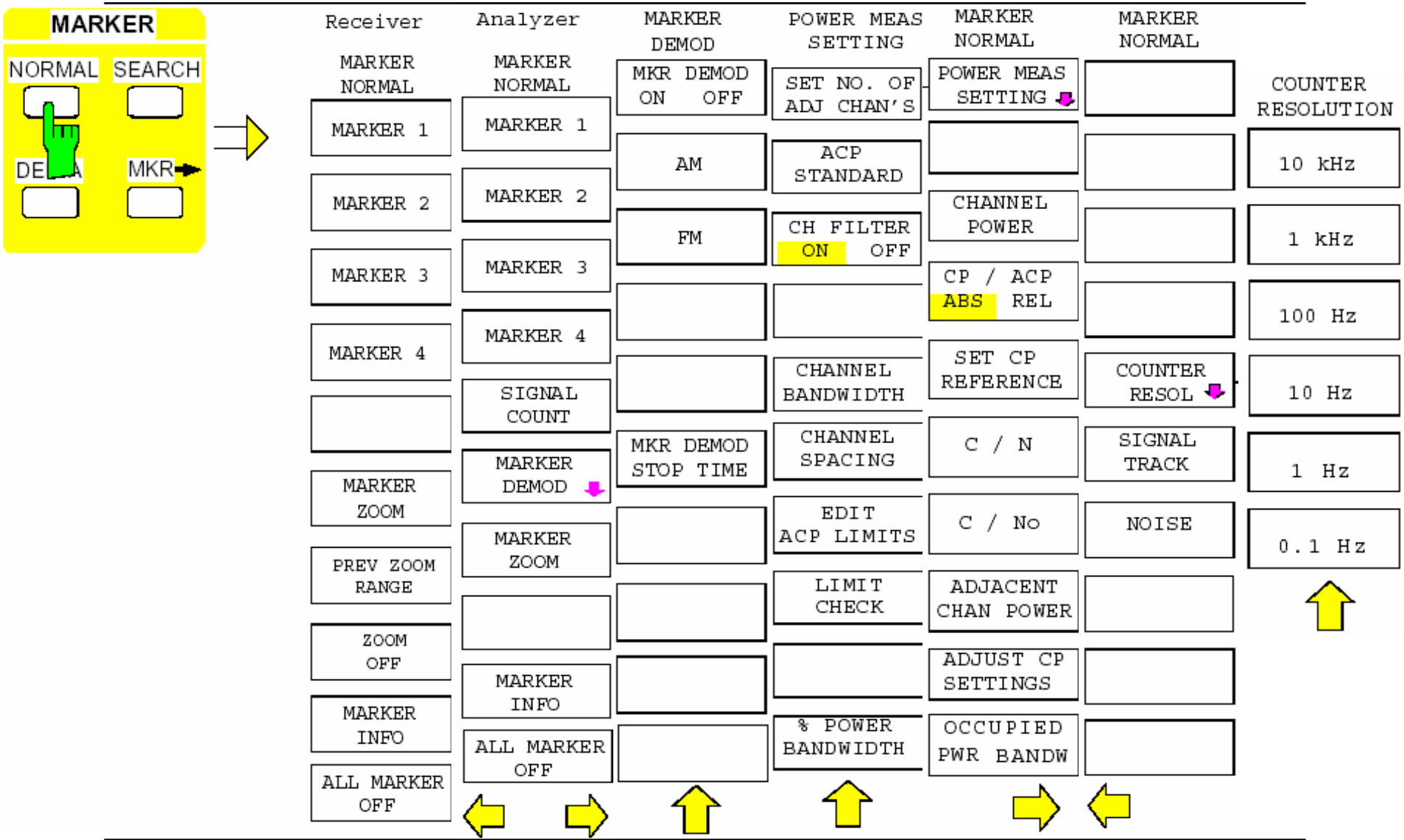


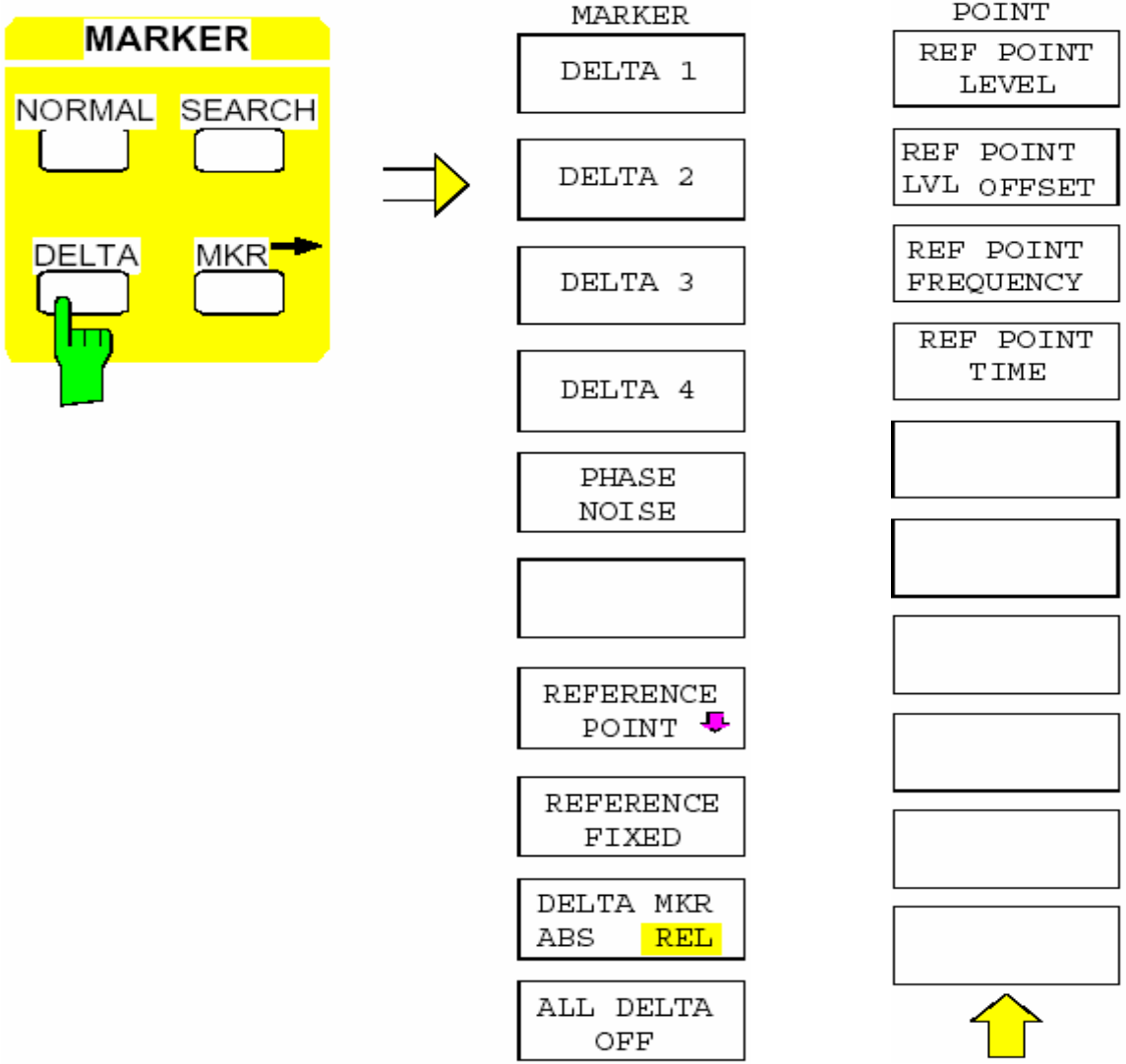


Receiver LEVEL RANGE	Analyzer LEVEL RANGE
LOG 120 dB	LOG 120 dB
LOG 100 dB	LOG 100 dB
LOG 50 dB	LOG 50 dB
LOG 20 dB	LOG 20 dB
LOG 10 dB	LOG 10 dB
LOG MANUAL	LOG MANUAL
	LINEAR/dB
GRID MAX LEVEL	LINEAR/%
GRID MIN LEVEL	GRID ABS REL

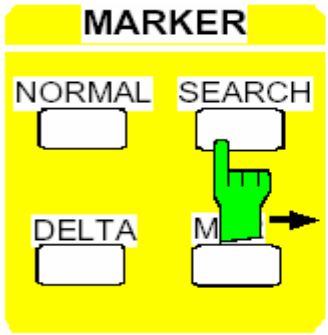

INPUT
Receiver
INPUT
RF ATTEN MANUAL
0 dB MIN ON OFF
AUTO RANGE ON OFF
AUTOPREAMP ON OFF
PREAMP ON OFF
INPUT 1
INPUT 2
INPUT 2 AC COUPLED
INPUT 2 DC COUPLED
Analyzer
INPUT
RF ATTEN MANUAL
ATTEN AUTO NORMAL
ATTEN AUTO LOW NOISE
ATTEN AUTO LOW DIST
MIXER LEVEL
INPUT SELECT
INPUT SELECT
RF INPUT 50 OHM
RF INPUT 75 OHM/RAM
RF INPUT 75 OHM/RAZ
INPUT 1
INPUT 2
INPUT 2 AC COUPLED
INPUT 2 DC COUPLED

ROHDE&SCHWARZ




MARKER
NORMAL
SEARCH
DELTA
MKR
DELTA MARKER
DELTA 1
DELTA 2
DELTA 3
DELTA 4
PHASE NOISE
REFERENCE POINT
REFERENCE FIXED
DELTA MKR ABS REL
ALL DELTA OFF
REFERENCE POINT
REF POINT LEVEL
REF POINT LVL OFFSET
REF POINT FREQUENCY
REF POINT TIME

ROHDE&SCHWARZ



Receiver	MARKER SEARCH	Analyzer	SUMMARY MARKER	MARKER SEARCH	MARKER SEARCH
MARKER SEARCH	PEAK	MARKER SEARCH		N DB DOWN	MIN
MIN	NEXT PEAK	PEAK		SHAPE FACT 60 /3 DB	NEXT MIN
NEXT MIN	NEXT PEAK RIGHT	NEXT PEAK		SHAPE FACT 60 /6 DB	NEXT MIN RIGHT
NEXT MIN RIGHT	NEXT MIN LEFT	NEXT PEAK RIGHT			NEXT MIN LEFT
NEXT MIN LEFT	TUNE TO MARKER	NEXT PEAK LEFT			
TUNE TO MARKER	MARKER TRACK	SUM MKR ON OFF	RMS		
MARKER TRACK	SETTINGS COUPLED	SUMMARY MARKER	MEAN		
SETTINGS COUPLED	SEARCH LIM ON OFF		PEAK HOLD ON OFF		EXCLUDE LO ON OFF
PEAK EXCURSION	SELECT MARKER	SEARCH LIM ON OFF	AVERAGE ON OFF		PEAK EXCURSION
SELECT MARKER	ACTIVE MKR DELTA	SELECT MARKER	SWEEP COUNT	SELECT MARKER	SELECT MARKER
ACTIVE MKR DELTA		ACTIVE MKR DELTA	ALL SUM MKR OFF	ACTIVE MKR DELTA	ACTIVE MKR DELTA

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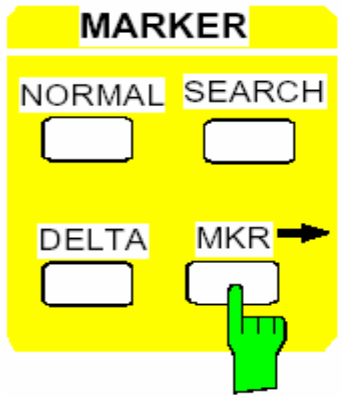
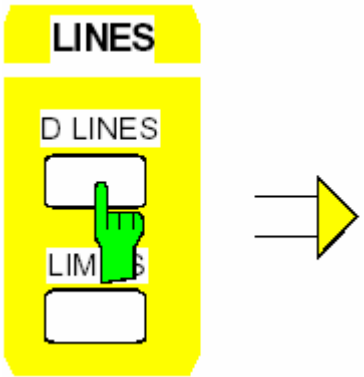
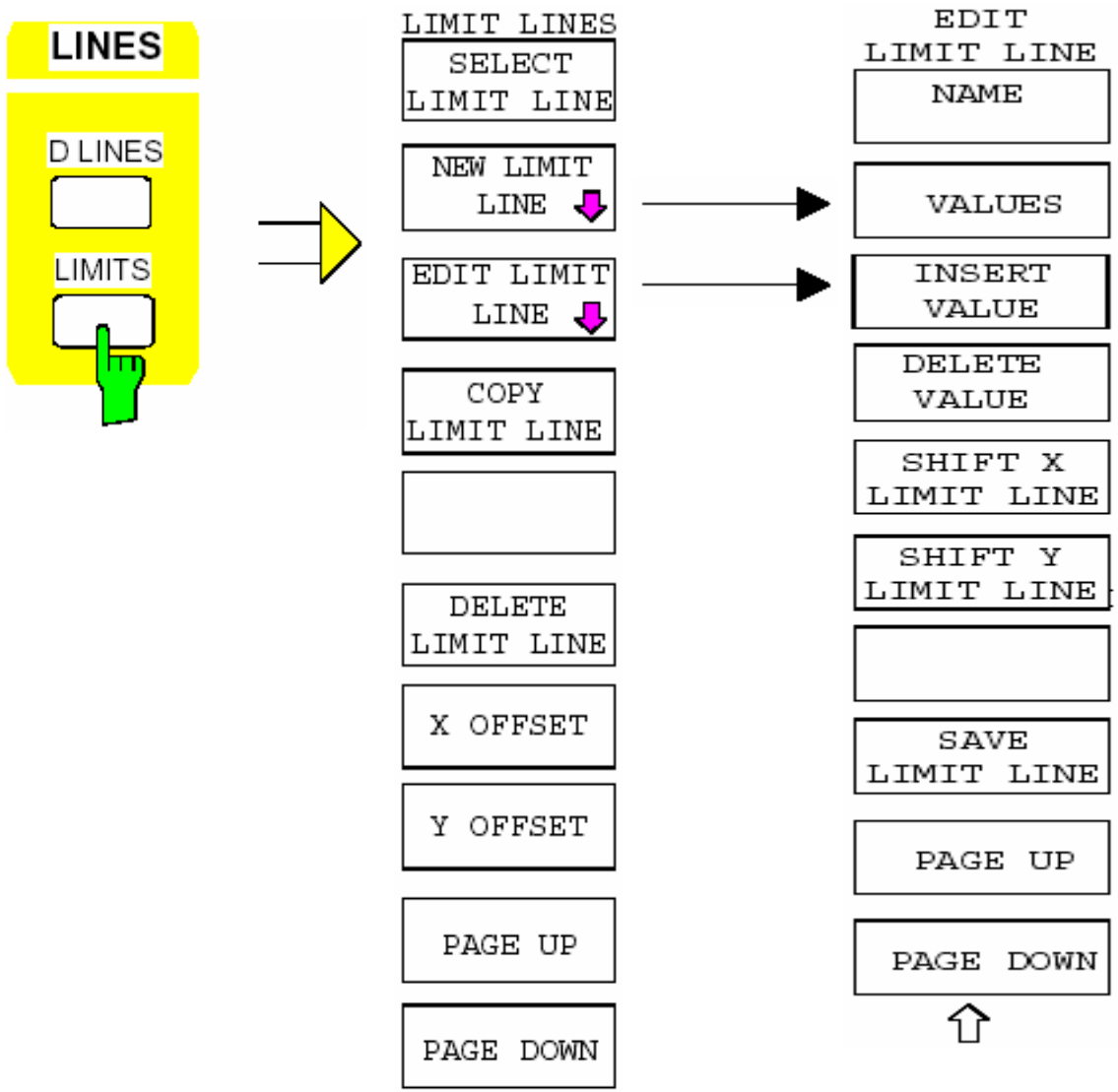


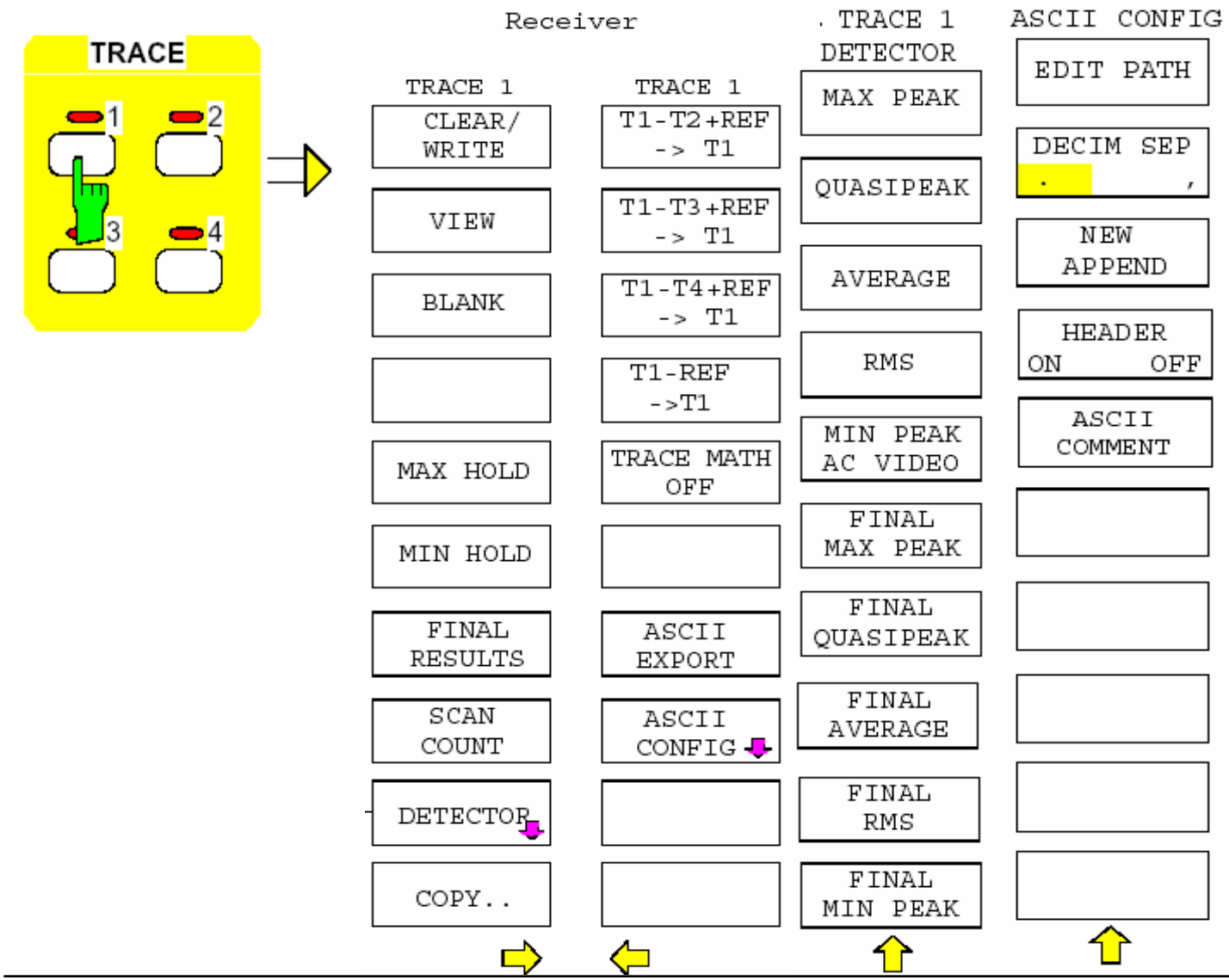
Receiver MARKER →	Analyzer MARKER →
PEAK	PEAK
NEXT PEAK	MKR→ CENTER
ADD TO PEAK LIST	MKR→ REF LEVEL
TUNE TO MARKER	
MKR->CF STEPSIZE	MKR->CF STEPSIZE
MARKER TRACK	MKR→ START
SETTINGS COUPLED	MKR→ STOP
MKR→ TRACE	MKR→ TRACE
SELECT MARKER	SELECT MARKER
ACTIVE MKR DELTA	ACTIVE MKR DELTA



Receiver		Analyzer	
	SPAN ≠ 0		SPAN = 0
DISPLAY LINES	DISPLAY LINES		DISPLAY LINES
DISPLAY LINE 1	DISPLAY LINE 1		DISPLAY LINE 1
DISPLAY LINE 2	DISPLAY LINE 2		DISPLAY LINE 2
THRESHOLD LINE	THRESHOLD LINE		THRESHOLD LINE
REFERENCE LINE	REFERENCE LINE		REFERENCE LINE
FREQUENCY LINE 1	FREQUENCY LINE 1	oder	TIME LINE 1
FREQUENCY LINE 2	FREQUENCY LINE 2		TIME LINE 2
	BASELINE CLIPPING		BASELINE CLIPPING


LINES
D LINES
LIMITS
LIMIT LINES
SELECT LIMIT LINE
NEW LIMIT LINE
EDIT LIMIT LINE
COPY LIMIT LINE
DELETE LIMIT LINE
X OFFSET
Y OFFSET
PAGE UP
PAGE DOWN
EDIT LIMIT LINE
NAME
VALUES
INSERT VALUE
DELETE VALUE
SHIFT X LIMIT LINE
SHIFT Y LIMIT LINE
SAVE LIMIT LINE
PAGE UP
PAGE DOWN

ROHDE&SCHWARZ



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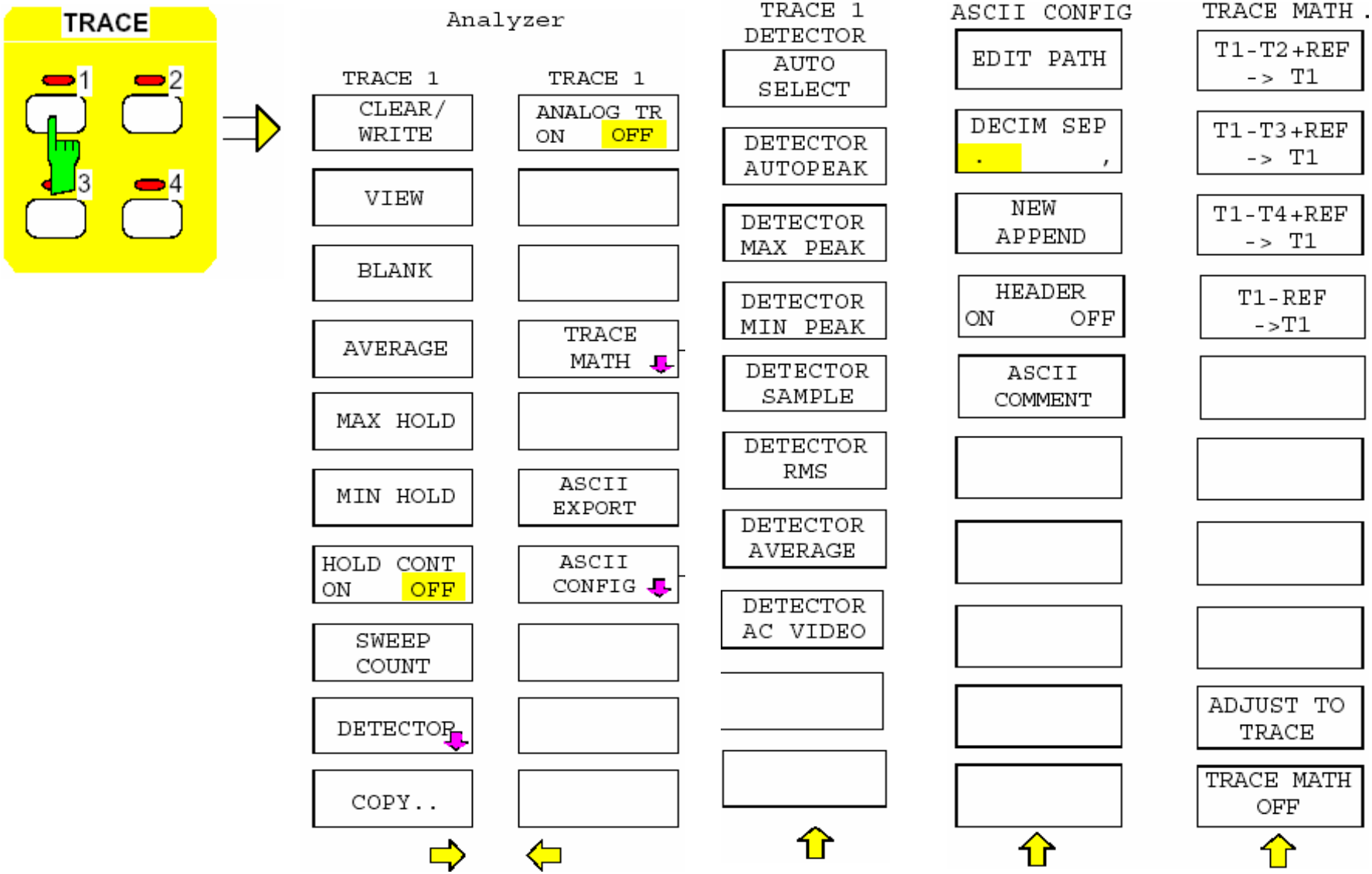

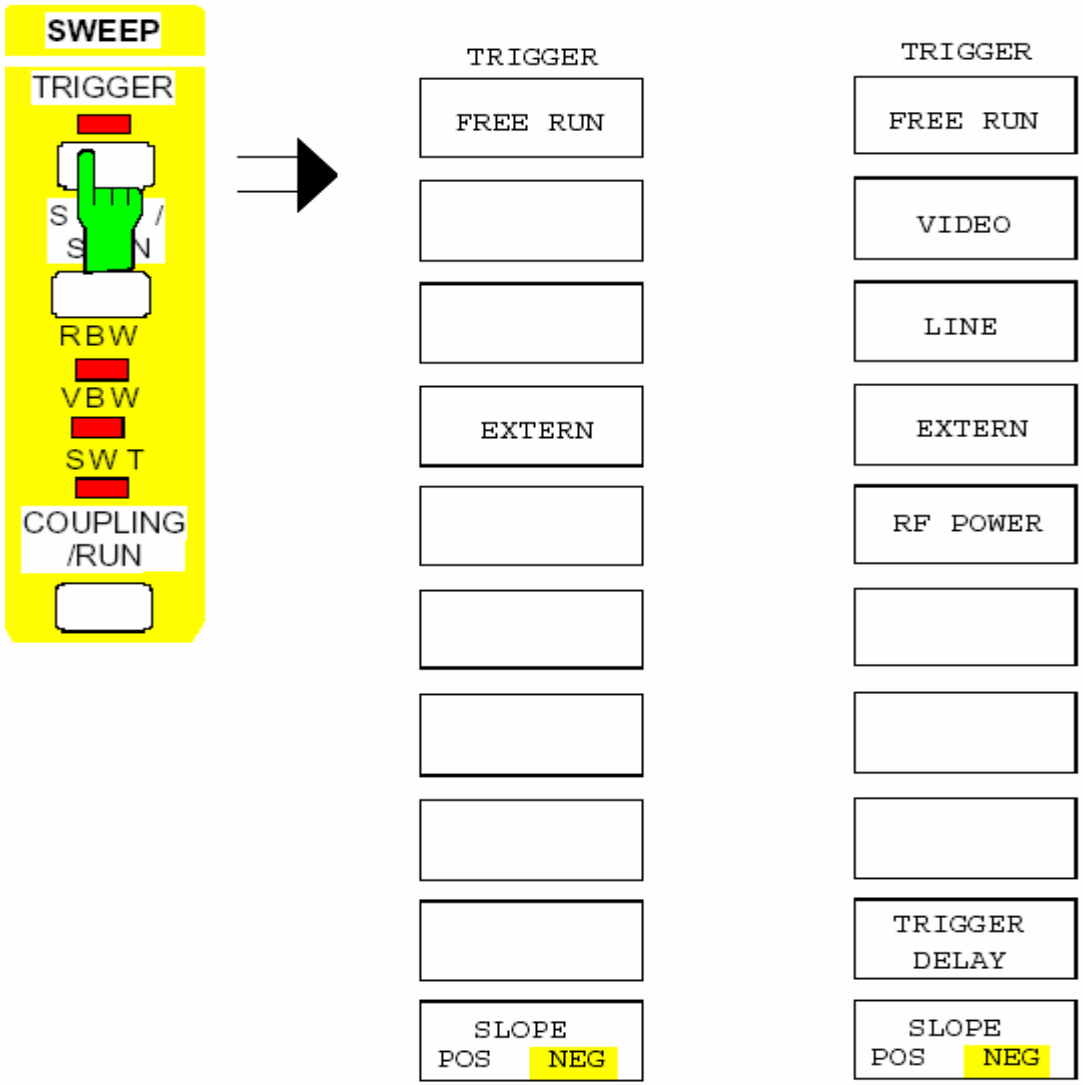
SWEEP
TRIGGER
RBW
VBW
SWT
COUPLING
/RUN
Receiver
TRIGGER
FREE RUN
EXTERN
SLOPE
POS NEG
Analyzer
TRIGGER
FREE RUN
VIDEO
LINE
EXTERN
RF POWER
TRIGGER
DELAY
SLOPE
POS NEG

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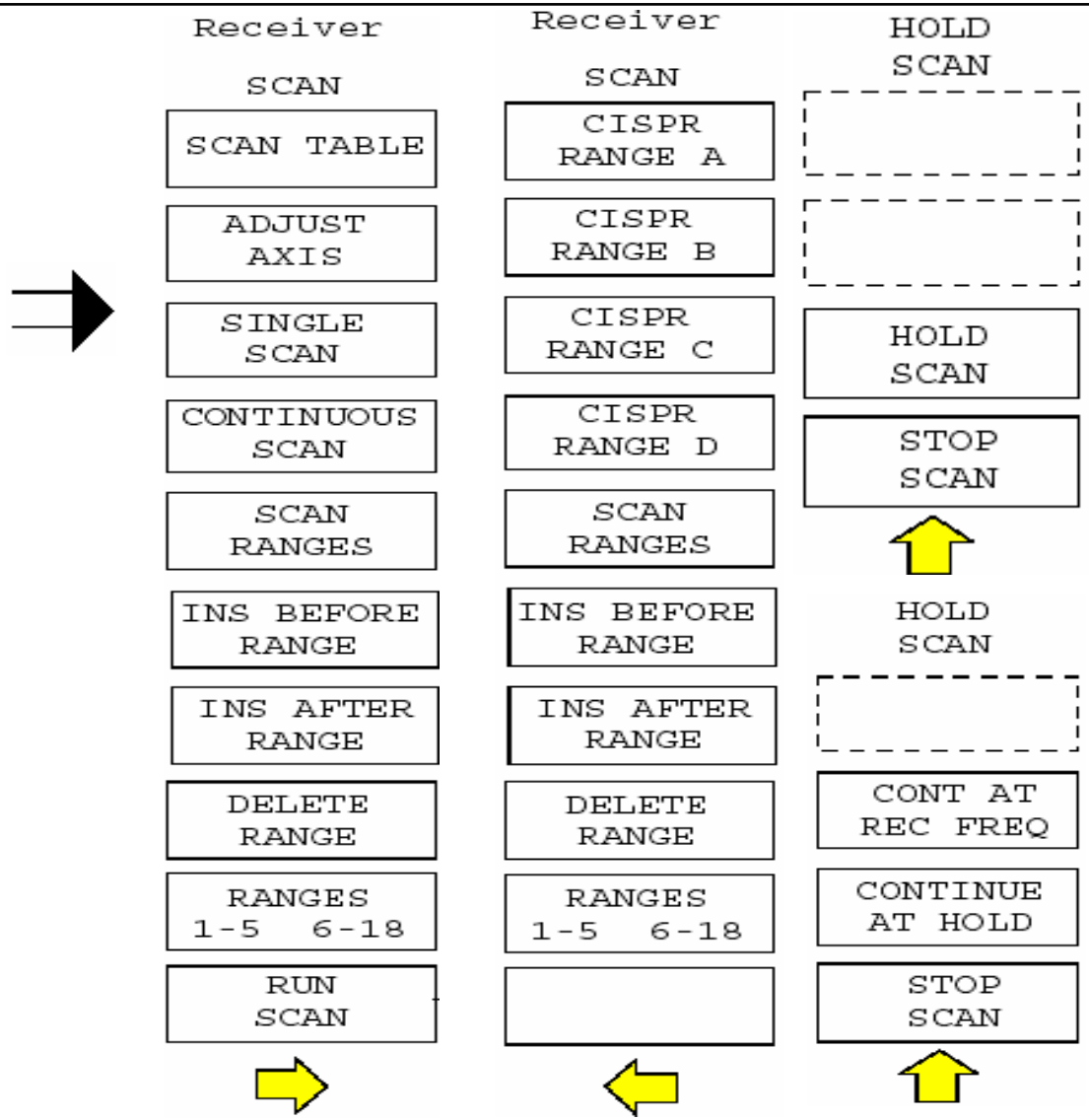
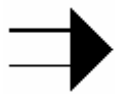
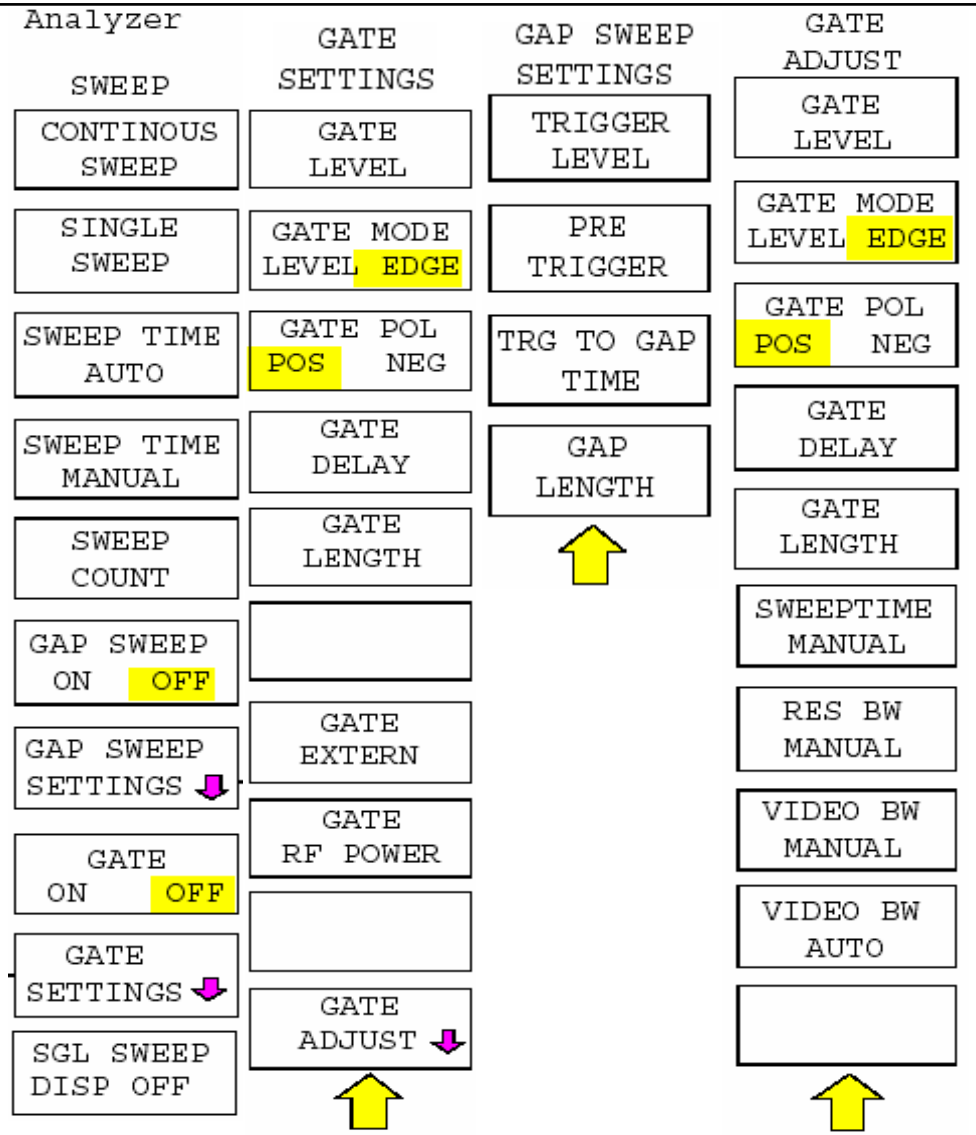
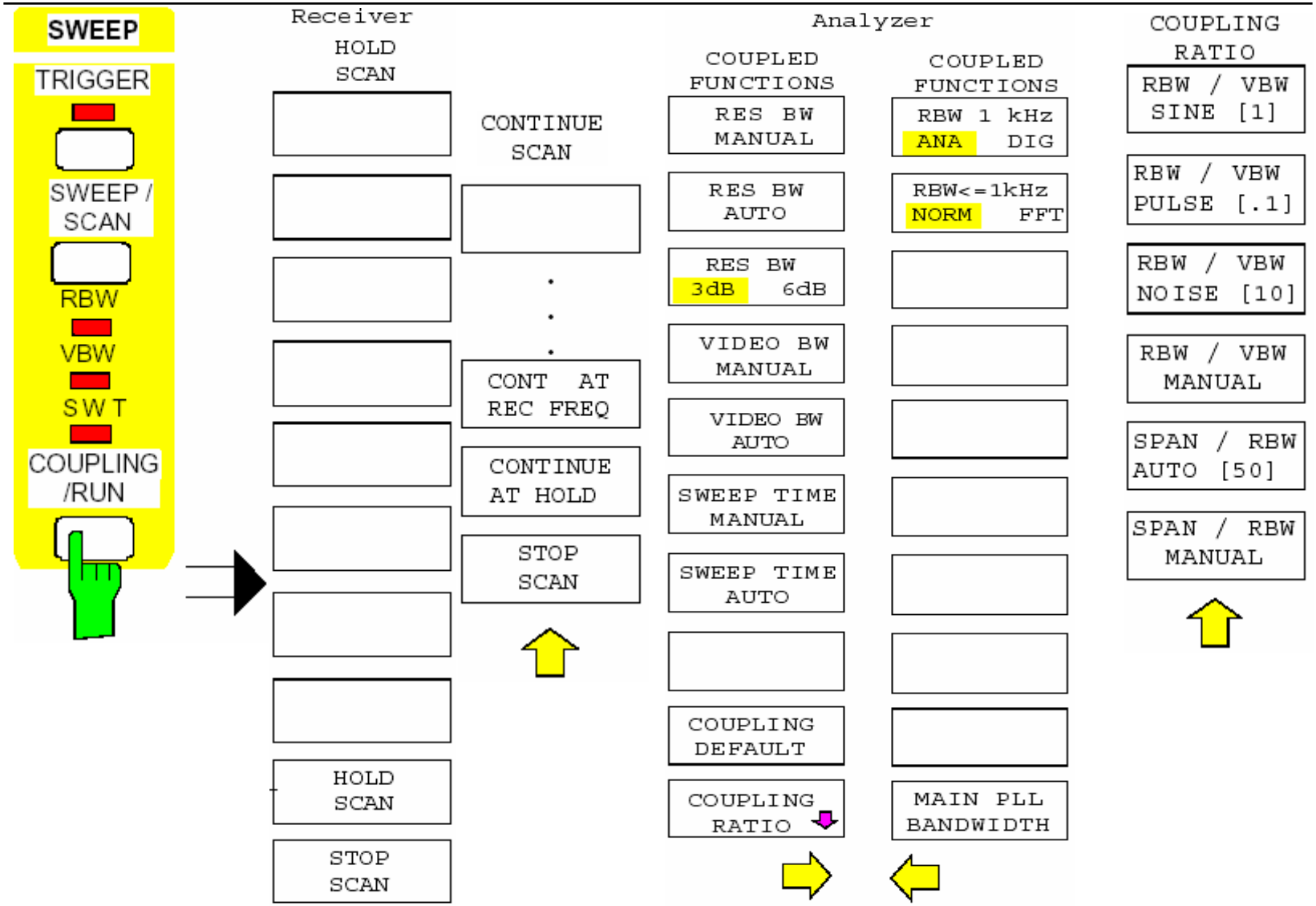


ROHDE&SCHWARZ

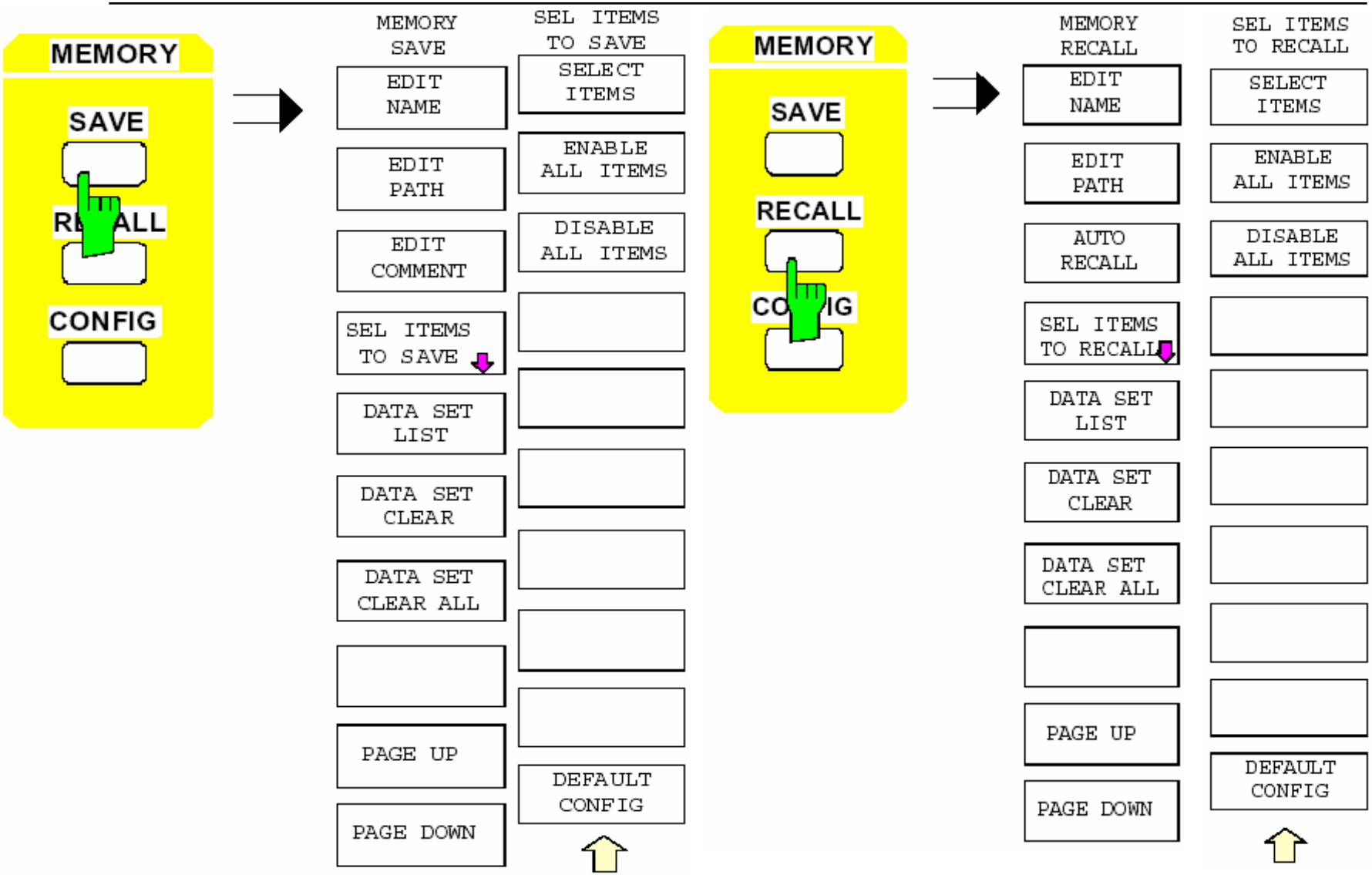


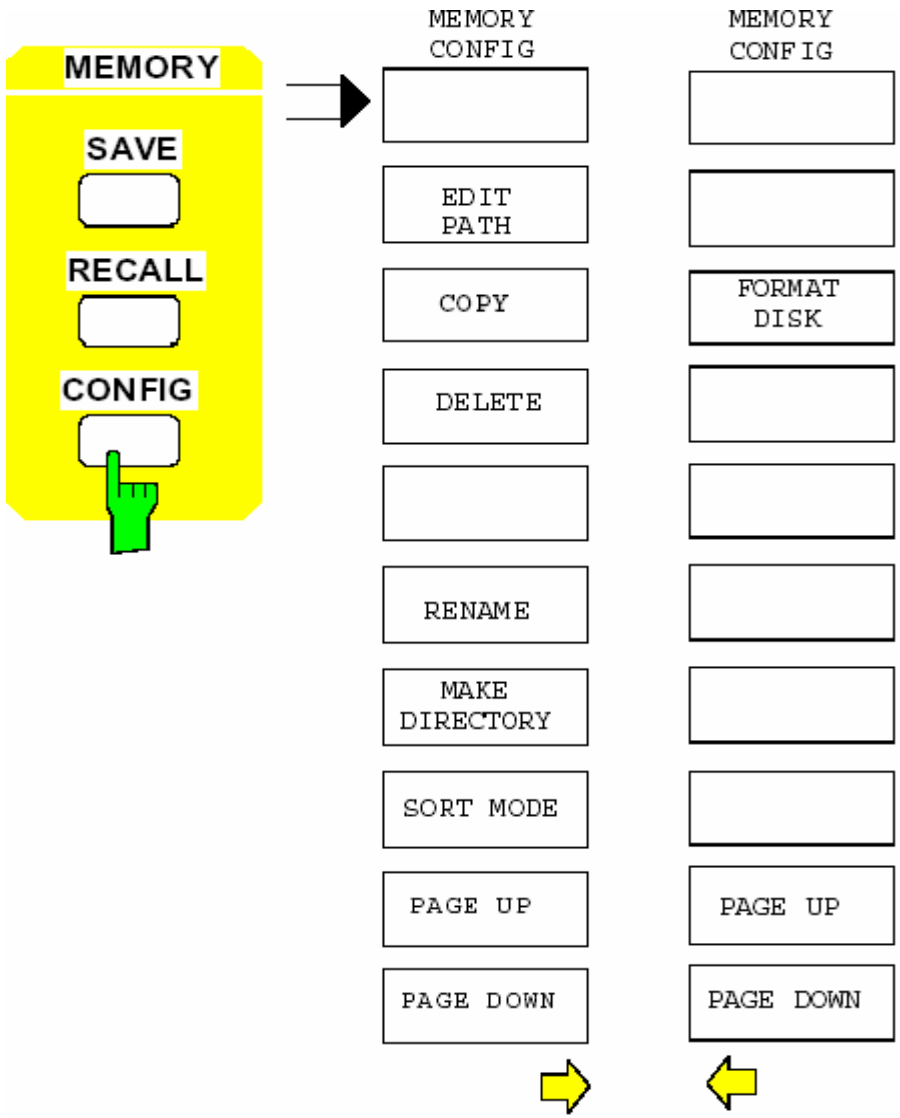


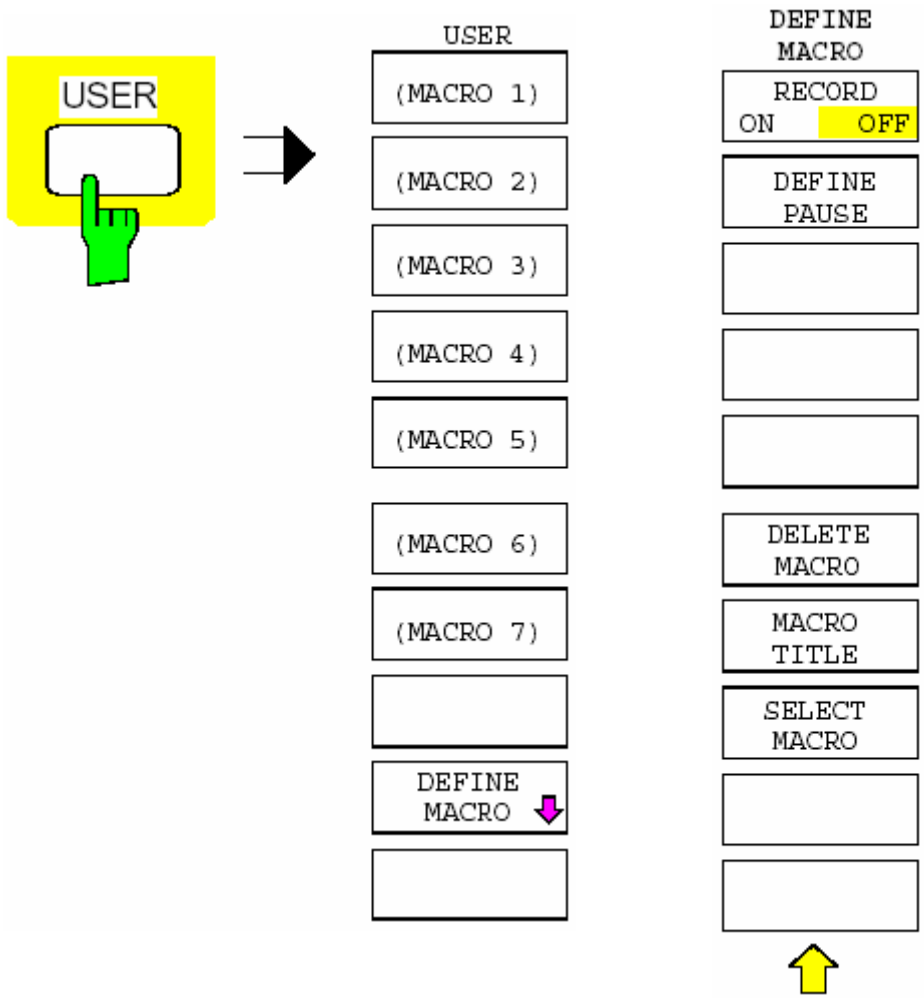
ROHDE & SCHWARZ



ROHDE & SCHWARZ




MEMORY
SAVE
RECALL
CONFIG
MEMORY CONFIG
EDIT PATH
COPY
DELETE
RENAME
MAKE DIRECTORY
SORT MODE
PAGE UP
PAGE DOWN
MEMORY CONFIG
FORMAT DISK
PAGE UP
PAGE DOWN

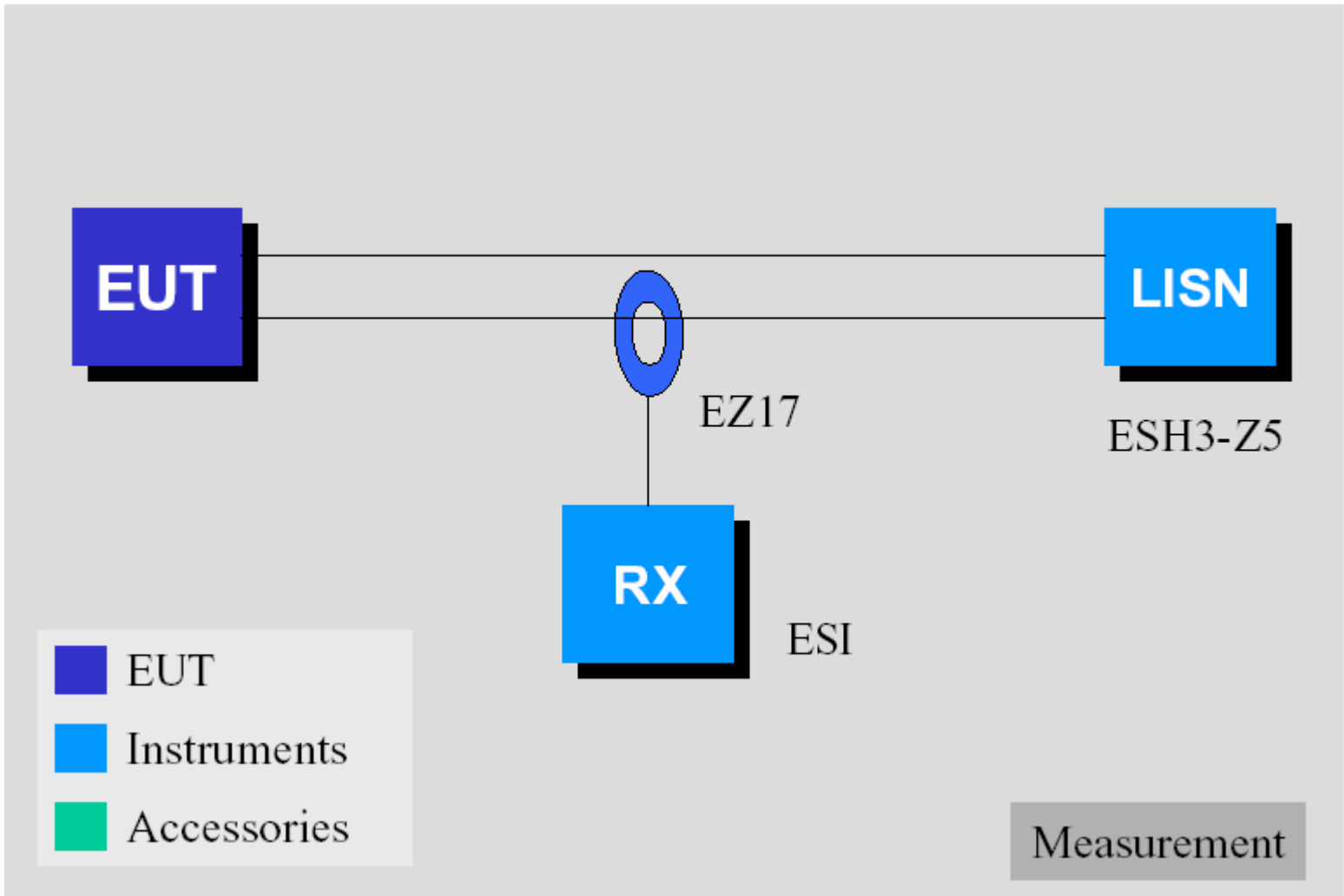

USER
USER
(MACRO 1)
(MACRO 2)
(MACRO 3)
(MACRO 4)
(MACRO 5)
(MACRO 6)
(MACRO 7)
DEFINE MACRO
DEFINE MACRO
RECORD
ON OFF
DEFINE PAUSE
DELETE MACRO
MACRO TITLE
SELECT MACRO

测试接收机基础

第四章
测试与应用

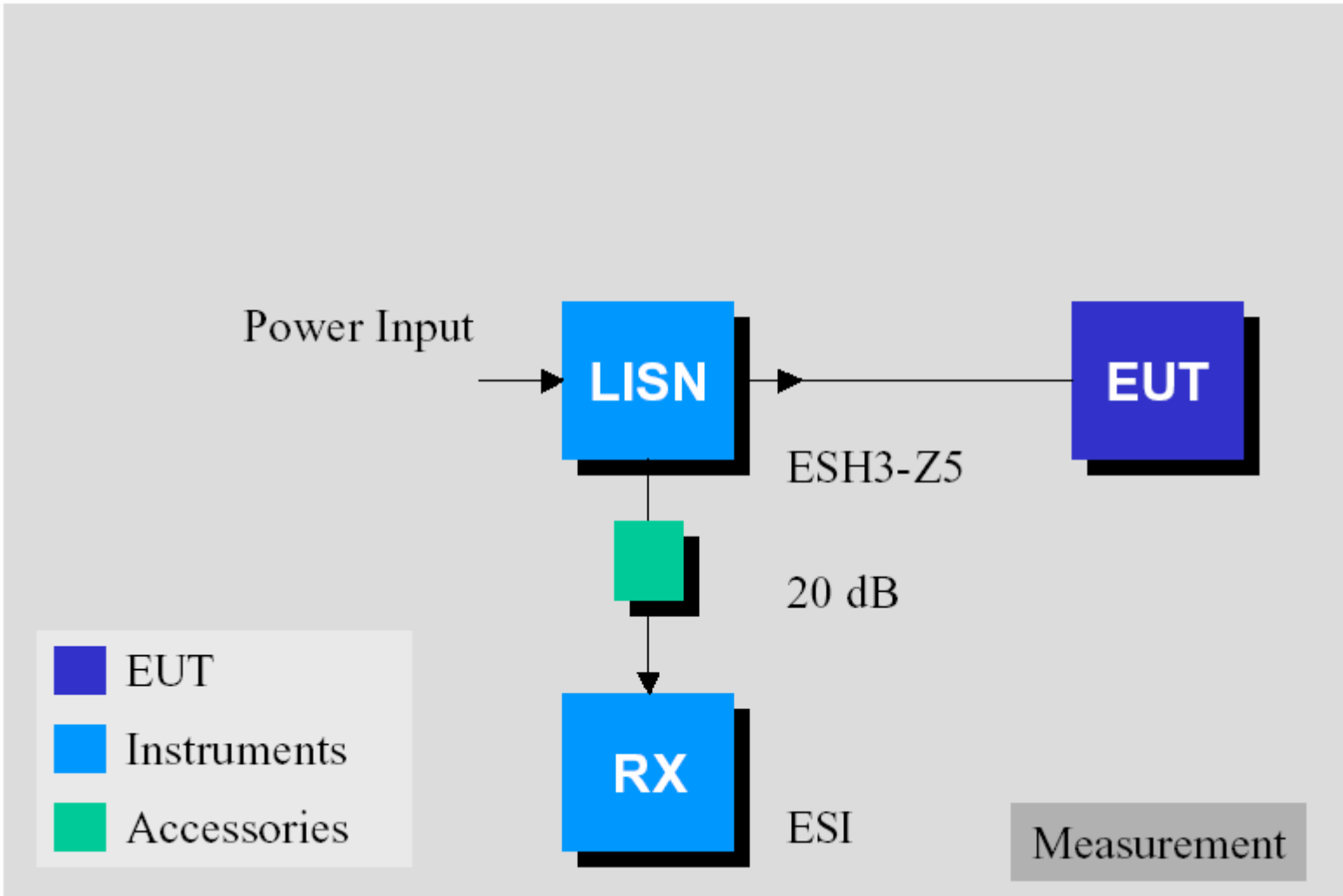
ROHDE&SCHWARZ

CE101 Power Leads 30 Hz to 10 kHz



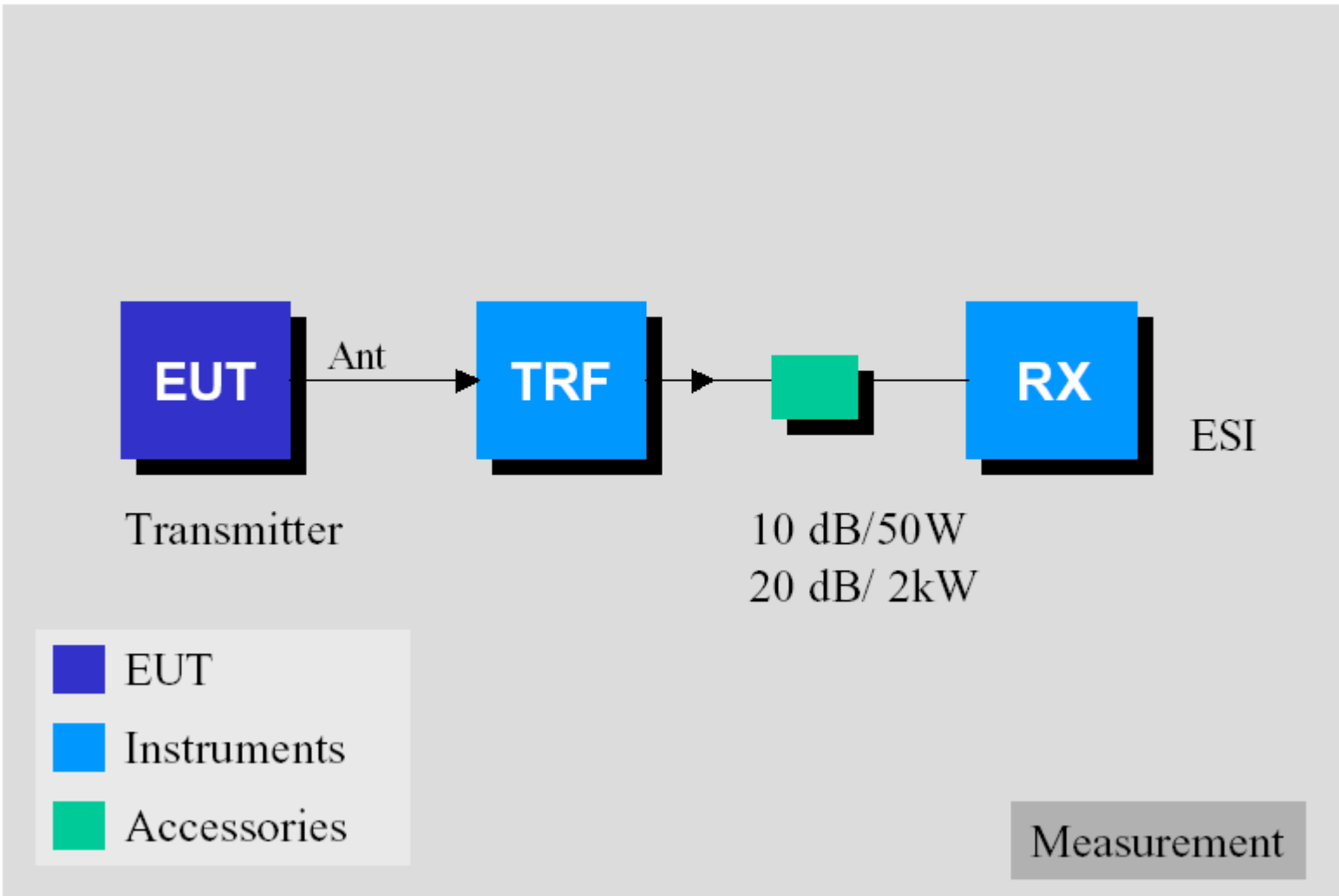
ROHDE&SCHWARZ

CE102 Power Leads 10 kHz to 10 MHz



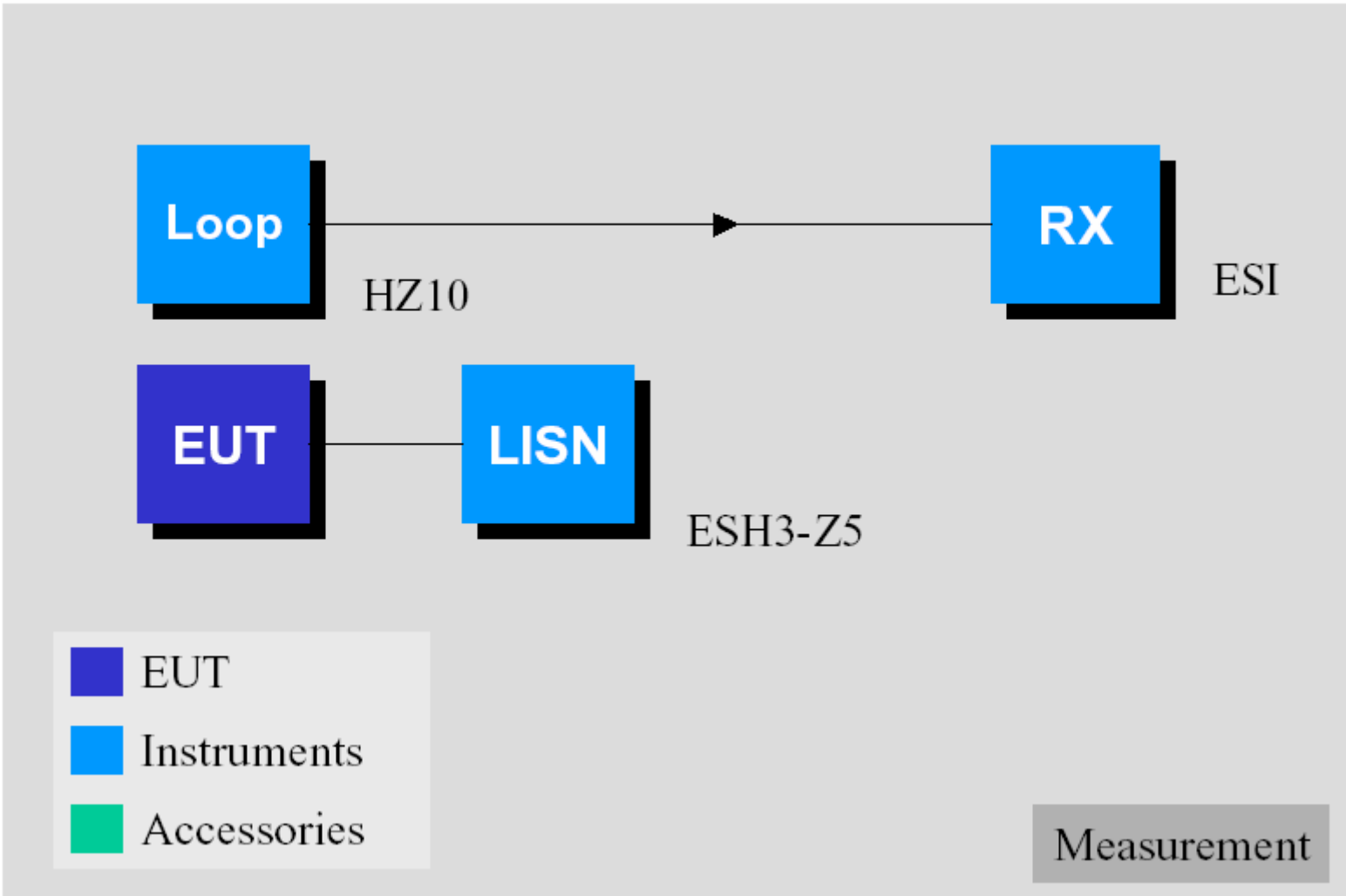
ROHDE & SCHWARZ

CE 106 Antenna Terminal 10 kHz to 40 GHz



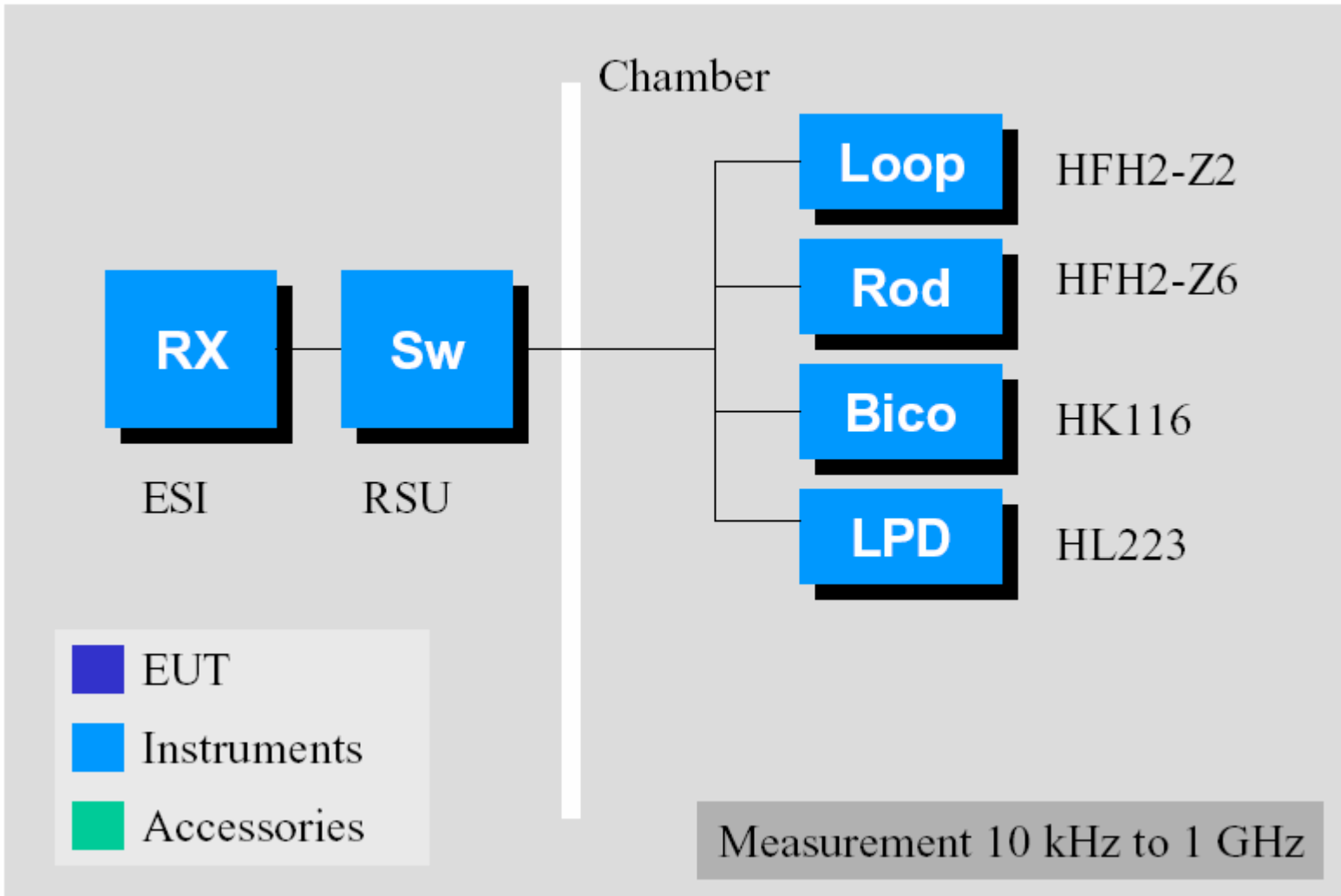
ROHDE&SCHWARZ

RE101 Magnetic Field 30 Hz to 100 kHz



ROHDE & SCHWARZ

RE102 Electric Field



ROHDE&SCHWARZ

EMI test system