Alltest Instruments, Inc.

500 Central Ave.
Farmingdale, NJ 07727

P: (732) 919-3339
F: (732) 919-3332

alltest.net
sales@alltest.net

The test & measurement equipment you need at the price you want.

Alltest carries the world's largest selection of used/refurbished benchtop test & measurement equipment at 50% the price of new.

Our equipment is guaranteed working, warrantied, and available with certified calibration from our in-house staff of technicians and engineers.

- **10+ full time technicians with over 150 years of specialization**
- **90 day warranty & 5 day right of return on all equipment**
- **1-3 year warranties for new and premium-refurbished equipment**
- **Every unit tested to OEM specifications**
- **Satisfaction guaranteed**

You have plans, we will help you achieve them.
Any project. Any budget.

Get a quote today!

Call (732) 919-3339 or email sales@alltest.net.

ROHDE&SCHWARZ

Measuring Instruments
and Systems Division

Operating Manual

SIGNAL GENERATOR
SMX

826.4517.52

LA TRADUCTION FRANÇAISE SUIT LE TEXTE ANGLAIS

Printed in the Federal
Republic of Germany

Contents of SMX Manual

Operating Manual

1. Data Sheet

2. Preparation for Use and Operating Instructions

3. Maintenance

Service Manual

4. Service Manual for Complete Instrument

5. Service Instructions for the Individual PC Boards

	Order No.	Index
RF Oscillator	802.8835.04	1
Output Stage	802.7616.04	2
RF Attenuation Set	826.5065.02	3
Keyboard/Display	826.5265.02	4
Processor	826.5965.02	5
Power Pack	826.5665.02	6
Reference Oscillator, OCXO (Option SMX-B1)	826.9519.02	7
AF Synthesizer (Option SMX-B2)	826.9619.02	8

Table of Contents

		Page
1	**Data Sheet**	
2	**Preparation for Use and Operation**	
2.1	Legend to Front and Rear Views Figs. 2-1 and 2-2	2.1
2.2	Preparation for Use	2.5
2.2.1	Power Supply Fuse	2.5
2.2.2	AC Supply Voltage	2.5
2.2.3	Rack Mounting	2.5
2.3	Operation	2.6
2.3.1	Power-on Status	2.12
2.3.2	Internal/External Reference Frequency	2.13
2.3.3	Frequency (RF)	2.14
2.3.4	Frequency Offset (RF OFFSET)	2.15
2.3.5	Level	2.16
2.3.6	Non-interrupting Level Setting	2.17
2.3.7	Level EMF	2.17
2.3.8	Internal AF Modulation Frequency	2.18
2.3.9	Modulation, AM	2.19
2.3.10	Pulse Modulation	2.22
2.3.11	Modulation, FM	2.23
2.3.12	Modulation, External Source	2.25
2.3.13	Modulation, Two-tone	2.26
2.3.14	Variation, STEP	2.27
2.3.15	Store - Recall	2.29
2.3.16	Sequence	2.31
2.3.17	Special Functions	2.32
2.3.18	Self-test	2.34
2.3.19	Status	2.34
2.3.20	Instrument Preset	2.37
2.3.21	IEC-bus Address	2.38

2.4	Remote Control of Instrument via IEC Bus	2.39
2.4.1	Interface Description	2.39
2.4.2	Setting the Device Address	2.42
2.4.3	Local/Remote Switchover	2.42
2.4.4	Interface Messages	2.43
2.4.4.1	Universal Commands	2.43
2.4.4.2	Addressed Commands	2.44
2.4.5	Device Messages	2.46
2.4.5.1	Commands Received by the SMX in Listener Mode	2.46
2.4.5.2	Messages Transmitted by SMX in Talker Mode	2.50
2.4.5.3	Common Commands	2.53
2.4.5.4	Device-specific Commands	2.56
2.4.5.5	Alternatives for the Command Syntax	2.65
2.4.6	Service Request and Status Register	2.66
2.4.7	Timing of Command Processing and Synchronization	2.73
2.4.8	Error Handling	2.75
2.4.9	Resetting Device Functions	2.76
2.5	Options	2.77

Contents

		Page
3	**Maintenance**	
3.1	Required Measuring Equipment and Accessories	3.1
3.2	Testing the Performance Data	3.3
3.2.1	Display and Keyboard	3.3
3.2.2	Frequency Setting	3.3
3.2.3	Reference Frequency	3.3
3.2.4	Settling Time	3.4
3.2.5	Output Level	3.5
3.2.6	Attenuation Set	3.5
3.2.7	Non-interrupting Level Setting	3.6
3.2.8	Output Reflection Coefficient	3.6
3.2.9	Harmonics	3.7
3.2.10	Spurious	3.8
3.2.11	SSB Phase Noise	3.8
3.2.12	Broadband Noise	3.10
3.2.13	Residual FM	3.11
3.2.14	Modulation Generator	3.11
3.2.15	Function Test of the External Modulation Level Monitoring	3.12
3.2.16	AM Modulation Depth	3.12
3.2.17	AM Distortion	3.12
3.2.18	AM Frequency Response	3.13
3.2.19	AM DC	3.13
3.2.20	Residual AM	3.14
3.2.21	Incidental ΦM at AM	3.14
3.2.22	FM Deviation Setting	3.14
3.2.23	FM Distortion	3.14
3.2.24	FM Frequency Response	3.15
3.2.25	Incidental AM at FM	3.15
3.2.26	Overvoltage Protection	3.15
3.3	Performance Test Report	3.16

Supplement
to Operating Manual
SIGNAL GENERATOR SMX

SMX Model 59:

Unlike described in the manual, the Signal Generator SMX (order no. 826.4517.59) is equipped with the following internal modulation frequencies:

Internal modulation generator

Frequency: 40 Hz, 1 kHz, 3 kHz, 19 kHz

ROHDE&SCHWARZ

EC Certificate of Conformity

CE

Certificate No.: 960286

This is to certify that:

Equipment type	Order No.	Designation
SMX	0826.4517.52/.56	Synthesizer Signal Generator
SMX-B1	0826.9519.02	Reference Oscillator
SMX-B2	0826.9619.02	AF Synthesizer

complies with the provisions of the Directive of the Council of the European Union on the approximation of the laws of the Member States

- relating to electrical equipment for use within defined voltage limits (73/23/EEC revised by 93/68/EEC)
- relating to electromagnetic compatibility (89/336/EEC revised by 91/263/EEC, 92/31/EEC, 93/68/EEC)

Conformity is proven by compliance with the following standards:

EN61010-1 : 1991
EN50081-1 : 1992
EN50082-1 : 1992

Affixing the EC conformity mark as from 1993

ROHDE & SCHWARZ GmbH & Co. KG
Mühldorfstr. 15, D-81671 München

Munich, 11.11.96

Central Quality Management FS-QZ / Becker

2 Preparation for Use and Operation

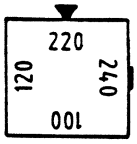
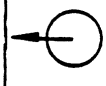
The values specified in this section are not guaranteed; only the specifications of the data sheet are binding.

All underlined numbers refer to the items of front and rear views Figs. 2-1 and 2-2 in the Appendix.

2.1 Legend to Front and Rear Views Figs. 2-1 and 2-2

No.	Labelling	Function
1	FREQUENCY	RF display. Further information in section 2.3, Operation.
2	AMPLITUDE	Level display. Further display functions in section 2.3, Operation.
3	MODULATION	Display of the modulation depth, deviation and AF. Further display functions in section 2.3, Operation.
4	MOD IN	BNC input for external modulation signals. Input impedance 100 kΩ (600 Ω). Further information in section "Modulation, external source."
5	POWER	Power switch
6	RF 50 Ω	RF output, N female 50 Ω.

No.	Labelling	Function
7	STEP	Keys for variation of parameter set in the PARAMETER keypad. Further information in section 2.3, Operation.
8	STATUS	Key for status check, LED display with special function being on or in case of error. Further information in section "Status".
9	INSTR PRESET	Key sets unit in a definite basic state (Instrument Preset). Further information in section "Instrument Preset".
10	DATA ENTER/UNITS	Numerical keypad for the parameter set in the PARAMETER keypad. Further information in section 2.3, Operation.
11	PARAMETER ON/OFF	The PARAMETER ON/OFF keypad is used to set the parameter to which numerical entries and variations shall apply. Parameters can be switched on or off using the ON/OFF keys. Further information in section 2.3, Operation.
12	MEMORY	Keypad to store instrument settings, to call stored settings and for the sequence function. Further information in sections "Store - Recall" and "Sequence".

No.	Labelling	Function
13	REMOTE	LED to indicate the remote state. LOCAL key to switch to manual operation. ADDR key for input and display of IEC-bus address. Further information in section "IEC-bus Address".
14	100/120 V T 2.0 D 220/240 V T 1.6 D	Fuse values for the different AC supply voltages.
15		Fuse holder and power supply selector.
16	 47...440 Hz	Power supply connection.
17	 AF INT	BNC output of the AF signal (10 Hz to 100 kHz, 1 V) equipped with the option SMX-B2 AF synthesizer. Further information in section "Internal AF Modulation Frequency".
18	 REF FREQ 10 MHz	Output of the internal reference frequency (level 0 dBm) with an internal reference. Input of the external reference frequency (level >100 mV sinewave or TTL) with an external reference. Further information in section "Internal/External Reference Frequency".

No.	Labelling	Function
19	IEC 625 IEEE 488	IEC-bus connector for remote control.
20	RF 50 Ω	Cut-out provided for fitting the front panel RF output to the rear panel of the unit.
21	MOD IN	Cut-out provided for fitting the front panel modulation input to the rear panel of the unit.

Special functions

Special functions extend the settings indicated by the labelling of the keys. Further information in section "Special Functions".

Status

Input errors are indicated in the modulation display by a brief appearance of the status code identifying the error and flashing of the STATUS LED.

Function errors are indicated by continuous flashing of the STATUS LED. The status code describing the error appears in the modulation display when the STATUS key is pressed.

Overrange/underrange settings are indicated by continuous lighting of the STATUS LED. The status code describing the setting appears in the modulation display when the STATUS key is pressed.

Continuous lighting of the STATUS LED also indicates that a special function is switched on. The status code describing the special function is output in the frequency display by pressing the STATUS key. Further information in section "Status".

IEC-bus address

The IEC-bus address can be output in the frequency display and set via the keyboard. Further information in section "IEC-bus Address".

Instrument preset

The generator is set to a defined basic status by the key INSTR PRESET. Further information in section "Instrument Preset".

2.3.1 Power-on Status

The generator has the same status when switched on as before switching off.

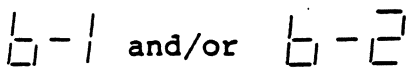
Exceptions:

- Local mode is always set.
- An RQS can be output on the IEC bus each time the instrument is switched on.
- For setting the registers of the service request function, see sections "Service Request and Status Registers" and "Resetting Device Function".

A function test is carried out following switch-on. The ROM and RAM contents are checked. The LED of the STATUS key flashes if an error is detected. The associated status display is output in the modulation display by pressing the STATUS key.

The preset status is set if the status prior to switch-off cannot be set again because of a memory error.

Display: The IEC-bus address is displayed in the frequency display and the information



is indicated in the amplitude/modulation display following power-on for a brief period if the unit is equipped with one of the options or with both (SMX-B1, SMX-B2).

2.3.2 Internal/External Reference Frequency

The internal standard reference source of the SMX is a 100-MHz crystal oscillator. Higher requirements with respect to frequency accuracy are satisfied by the option Reference Oscillator SMX-B1, OCXO. Subsequent fitting of this option is described in section "Options".

In internal reference mode, the internal reference signal with a frequency of 10 MHz is present at the female connector REF FREQ 10 MHz.

In external reference mode, an external signal with a frequency of 10 MHz must be fed into the female connector REF FREQ 10 MHz.

Frequency at the input/output REF FREQ 10 MHz: 10 MHz

Internal reference mode: Signal output (0.2 V into 50 Ω, V_{rms}), female connector REF FREQ 10 MHz on rear panel.

External reference mode: Signal input (0.1 to 2 V (V_{rms}), sinewave, squarewave or TTL), female connector REF FREQ 10 MHz on rear panel.

The internal or external reference is selected using the keyboard or via the IEC bus.

Examples	a) Setting for external reference b) Setting for internal reference	
	PARAMETER	**ON/OFF**
a)	RF	EXT
b)	RF	INT/ON
IEC-bus codes a)	REF:EXT	
b)	REF:INT	

Display: The note "REF EXT" appears in the frequency display if the external reference mode has been selected.

Note: The externally applied reference frequency of 10 MHz must not deviate by more than $\pm 5 \times 10^{-6}$ from 10 MHz.

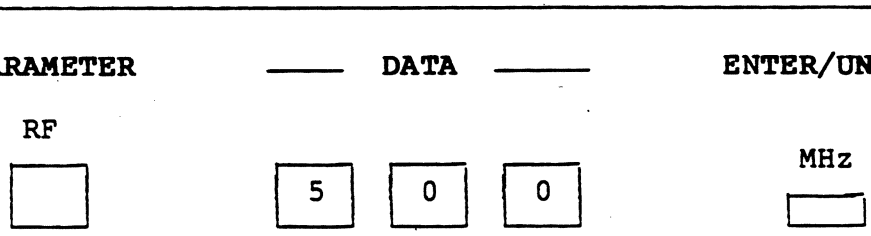
2.3.3 Frequency (RF)

Range: 100 kHz to 1000 MHz; adjustable as from 10 kHz without guarantee of rated specifications

Resolution of display:
10 Hz for f_{cr} <100 MHz
50 Hz for f_{cr} <500 MHz
100 Hz for f_{cr} >500 MHz

Units: MHz, kHz, Hz

Setting: RF —— Data —— Unit

Example	Setting of RF to 500 MHz
	
IEC-bus codes	RF 500MHZ

Display: The RF output frequency appears in the frequency display.

Associated instructions: Frequency offset (RF)
Internal/external reference frequency

2.3.4 Frequency Offset (RF OFFSET)

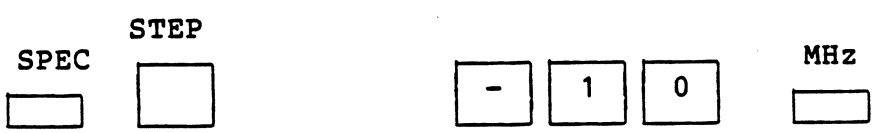
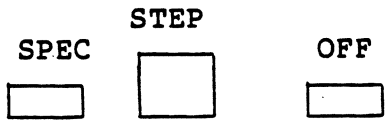
The magnitude and sign of the offset can be adjusted. The RF output frequency is lower than the displayed frequency by the negative offset or higher by the positive offset.

Setting: SPEC —— STEP —— Data —— Unit

(Data without sign for positive offset, with minus sign for negative offset; data input is mandatory for switching on the offset.)

Switching off the RF offset:

SPEC —— STEP —— OFF
or
SPEC —— STEP —— 0 (zero) —— Unit

Examples	a) Setting an offset of -10 MHz b) Switching off the offset
a)	
b)	
IEC-bus codes a)	RF:OFFS -10MHZ
b)	RF:OFFS:OFF

Display: The text "OFFSET" appears in the frequency display if an offset is set.

The offset value is output in the frequency display by pressing the key sequence SPEC —— STEP, as long as the key RF offset is pressed.

Note: The range limits of the output frequency must be taken into account when setting frequencies by using the offset method.

100 kHz < RF + offset < 1000 MHz
(RF = displayed frequency)

Associated instructions: Frequency (RF)

2.3.5 Level

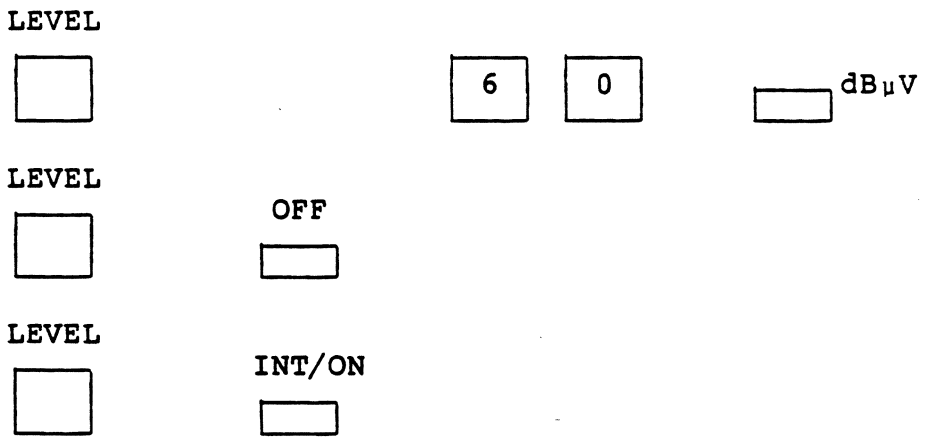
Range: -137 to 13 dBm (0.03 µV to 1 V, voltage into 50 Ω)

Resolution: 0.1 dB

Units: dBm, dBµV, mV, µV

Setting: LEVEL —— Data —— Unit

Examples	a) Setting a level of 60 dBµV b) Switching off the level c) Switching on the level to the stored value



IEC-bus codes	
a)	LEV 60DBUV
b)	LEV:OFF
c)	LEV:ON

Associated instructions: Non-interrupting level setting
Level EMF

2.3.6 Non-interrupting Level Setting

Independent of the set value, the special function "Non-interrupting level setting" permits to attenuate the level electronically by up to 10 dB without interruption, i.e. without using the interrupting mechanical attenuator. The value set when switching on the special function is used as reference level. Within the 10-dB range, the level can be set via the keyboard or the IEC bus.

Setting of a level outside the 10-dB range is made using the mechanical attenuator set. Starting at this new level, further level settings are made non-interruptive again in the range 0 to -10 dB.

If the special function is switched on again when already switched on, this has the same effect as if the special function were switched on for the first time, i.e. the full 10-dB range is then available referred to the set level.

Switching on of special function with code 1
Switching off of special function with code 2
} See special functions

Note: Specifications concerning level error, modulation depth error and distortion factor with AM do not apply with the special function "Non-interrupting level setting" switched on.

Associated instructions:
Level
Level EMF
Special functions

2.3.7 Level EMF

With the special function "Level EMF", the EMF value of the RF voltage is displayed and no longer the value of the RF voltage into 50 Ω. The EMF display appears if one of the units dBµV, mV or µV is selected.

Switching on of special function with code 3
Switching off of special function with code 4
} See special functions

Associated instructions:
Level
Non-interrupting level setting
Special functions

2.3.8 Internal AF Modulation Frequency

4 fixed frequencies: 400 Hz, 1 kHz, 3 kHz, 15 kHz

Frequency range with the option AF Synthesizer SMX-B2:

10 Hz to 100 kHz

Resolution: 1 Hz

Display: 3-digit

The AF signal for external use is taken out at the female connector AF INT (17) on the rear panel when equipped with the option SMX-B2. The AF signal at the female connector can also be switched on if no internal modulation is on. The output amplitude is 1 V (V_{rms}).

Setting the frequency: AF ___ Data ___ Unit

The frequency can be set for the AF synthesizer and the fixed frequency oscillator using the STEP ↑↓ keys. Entry of the step size is omitted for the fixed frequency oscillator.

Examples	a) Setting of AF (int. mod. frequency) to 400 Hz b) Switching on the AF signal to the stored value c) Switching off the AF signal			
	PARAMETER	**ON/OFF**	**DATA**	**ENTER/UNITS**
a)	AF		4 0 0	Hz
b)	AF	INT/ON	(only with option SMX-B2)	
c)	AF	OFF	(only with option SMX-B2) (no effect if internal modulation switched on)	
IEC-bus codes a)	AF 400HZ			
IEC-bus codes b)	AF:ON			
IEC-bus codes c)	AF:OFF			

Display: The modulation display indicates the modulation depth, the frequency deviation and the AF. The value of the parameter which is pressed last is displayed in the parameter keypad.

Associated instructions: Modulation (AM, FM)
Two-tone modulation

Comment to AM DC:

This mode enables external level control and external pulse modulation.

Modulation frequency ..... DC to 50 kHz
Modulation depth ..... 0 to 100%
Input voltage .....-1.41 V to +1.41 V

The level variation range is determined by the modulation depth input. A range from -1.41 V to +1.41 V corresponds to a change in level from $level_{0V}.(1-m)$ to $level_{0V}.(1+m)$.

$Level_{0V}$ is the RF level in V entered numerically.

The maximum range, e.g. for maximum carrier blanking in the case of pulse modulation, is at m = 100%.

Associated instructions:
Level
Internal AF modulation frequency
Modulation, external source
Two-tone modulation
Pulse modulation

2.3.10 Pulse Modulation

Rise/fall time of RF envelope: 2 µs

ON/OFF ratio: 40 dB

Special function "Pulse modulation" permits external pulse modulation for the SMX. It differs from the pulse modulation described under "Modulation, AM" with respect to modulation signal levels and the ON/OFF ratio, which is approximately 6 dB higher in the case of the special function.

When the special function is switched on, AM EXT with 100% modulation depth is set.

Modulation (not the special function) can be switched off by AM —— OFF and switched on by AM —— EXT.

AM INT and two-tone modulation are possible without guarantee of rated specifications.

The modulation depth is adjustable; maximum carrier blanking is obtained at m = 100%.

Level of external modulation signal:

0 V level on (corresponding to set level)

<-1.41 V level off
(min. -3.5 V)

Switch-on/switch-off code for special function "Pulse modulation"

	Code	IEC-bus code
Switching on	9	AM:PULSE
Switching off	10	AM:OFF

Display: AM EXT with modulation depth. The HIGH/LOW warning for the external modulation signal level is not effective.

Note: Shorting jumper AM DC/AM AC should be in position AM DC.

Associated instructions: Modulation, AM
Modulation, external source
Special functions

2.3.11 Modulation, FM

Deviation:	0 to 800 kHz (depending on the carrier frequency, see Data Sheet)
Resolution:	50 Hz to 1 kHz (depending on deviation range)
External modulation frequency range:	20 Hz to 500 kHz
With Low Rate FM (SCM-U1) modification kit:	3 Hz to 500 kHz
Internal modulation frequencies:	400 Hz, 1 kHz, 3 kHz, 15 kHz
With option AF Synthesizer SMX-B2:	10 Hz to 100 kHz

The internal modulation source and one external modulation source can be switched on simultaneously (see section "Two-tone modulation").

Setting:	FM — Data — Unit
Selection of the modulation source:	FM — INT/ON or FM — EXT
Selection of the internal modulation frequency:	See section "Internal AF Modulation Frequency".
Switching off the FM:	FM — OFF

Switching on the FM to the stored value (new value not entered):

FM — INT/ON or
FM — EXT

Special function code 11 activates the operationg mode "Low Rate FM". However this mode is available only if the Low Rate FM Modification Kit SCM-U1 is fitted in the instrument.

Special function "Low Rate FM":	Switch-on code 11 Switch-off code 12

Activating this special function does not automatically switch on the modulation. The modulation is switched on and the deviation set as with normal modulation, FM mode.

Notes on Low Rate FM Mode:

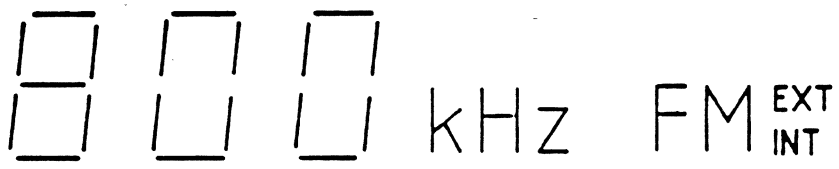
- In Low Rate FM operating mode, the RF setting time is 3 s (up to an offset from the end frequency of 2×10^{-6} or 250 Hz for RF < 31.25 MHz).
- For accurate transmission of low-frequency FM modulation signals, the FM signal path must be DC-coupled. For this purpose, a shorting jumper is inserted each to male connector X4 and X8 on the keyboard/display assembly (826.5265.02). As to positions and accessibility of the two male connectors, refer to section 2.3.9 "Modulation, AM".

Examples	a) Setting and switching on the FM with 40 kHz deviation b) Selection of modulation source EXT c) Switching off the FM

	PARAMETER	ON/OFF	— DATA —	ENTER/UNITS
a)	FM		4 0	kHz
b)	FM	EXT		
c)	FM	OFF		

IEC-bus codes	
a)	FM 40KHZ
b)	FM:EXT
c)	FM:OFF

Display:



If frequency modulation is switched on, this is indicated by

FM^{EXT}, FM_{INT}, or FM $\begin{matrix}EXT\\INT\end{matrix}$

depending on the modulation source selected.

The deviation is output with 3 digits in the modulation display. The display is common to the deviation with FM, the modulation depth with AM and the AF display. The value of the parameter AM, FM or AF is displayed which was pressed last in the parameter keypad.

Associated instructions:

Internal AF modulation frequency
Modulation, external source
Two-tone modulation
Special functions

2.3.15 Store - Recall

40 complete instrument settings can be stored. These comprise the complete instrument setting including all non-displayed settings and all special functions.

Storing the current instrument setting:

STO — Memory address — ENTER/UNITS

Recall of an instrument setting:

RCL — Memory address — ENTER/UNITS

Any one of the four ENTER/UNITS keys can be pressed following the data entry to activate store or recall.

Value of the memory address:

1 to 40 for STO
0 to 40 for RCL

Examples	a) Storing a complete instrument setting at memory location 7 b) Storing an instrument setting at memory location 25 c) Recalling the instrument setting from memory location 7		
	MEMORY	**— DATA —**	**ENTER/UNITS**
a)	STO	7	
b)	STO	2 5	
c)	RCL	7	
IEC-bus codes a)	STO 7		
b)	STO 25		
c)	REC 7		

Location 0 serves for a special function, i.e. the current instrument setting prior to the last memory or preset recall is stored at this location. This instrument setting can be set again using RCL 0.

Using the functions SEQ (sequence), the memory settings can be read out by repeated keying.

Display: The text "MEM" and the memory address are indicated in the modulation display during entry.

e.g.:



Associated instructions: Sequence

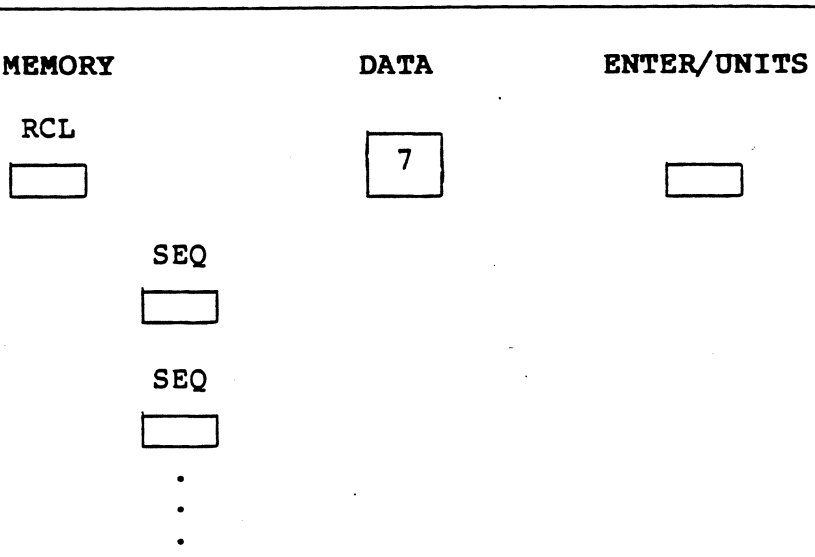
2.3.16 Sequence

It is possible to recall stored settings in continous sequence by repeated keying using the SEQ key in the memory keypad.

The first setting in a sequence of memory calls is fetched using the RCL key; the setting stored in the next higher memory location is activated by each subsequent keying of the SEQ key.

When the SEQ key is actuated in excess of the storage range of 40 settings, the setting produced by the last RCL call is activated again.

The sequence of the memory address starts with 1 if the INSTR PRESET key was previously actuated.

Examples	Recall of memory locations 7, 8, 9, ...
	
IEC-bus codes a)	REC 7
b)	SEQ
c)	SEQ

Display: The address of the memory location called last is indicated in the modulation display by the text "MEM" following each actuation of the SEQ key.

Associated instructions: Store - recall

2.3.17 Special Functions

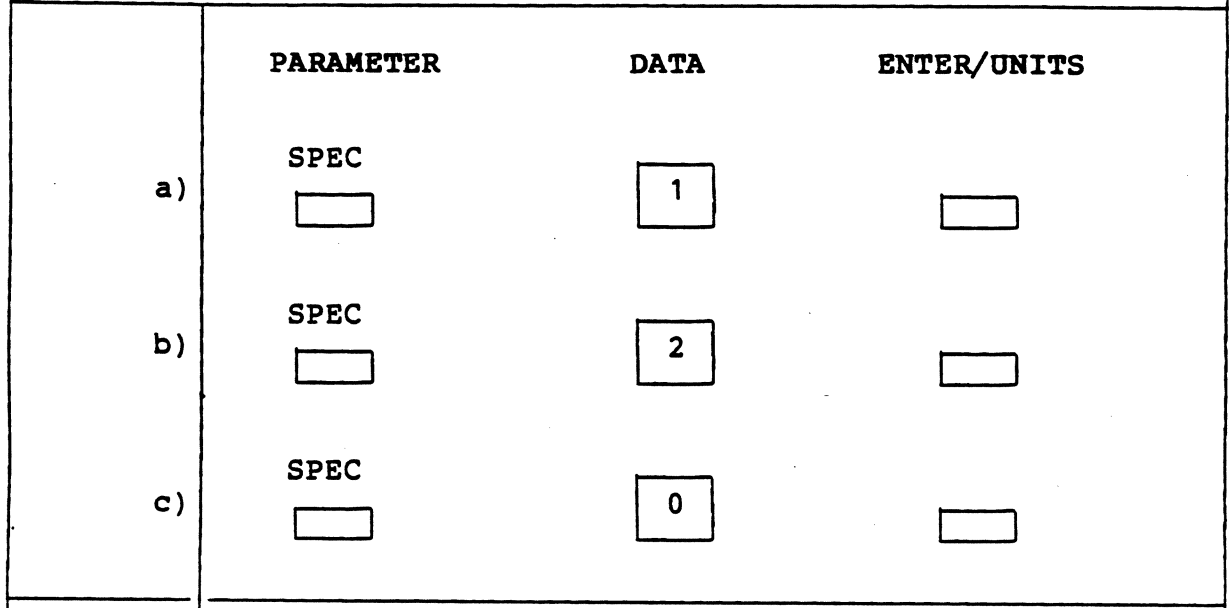
The special functions enable settings to be made other than those indicated by the keyboard labels.

The special functions are switched on and off using codes (data input) (see Table 2-1).

All special functions are switched off using code 0.

All special functions are also switched off by INSTRUMENT PRESET.

Examples	a) Switching on the special function "Non-interrupting level setting" b) Switching off the special function "Non-interrupting level setting" c) Switching off all special functions



IEC-bus codes a)	ATT:FIXED
b)	ATT:NORMAL

Display: The LED of the STATUS key lights up if a special function is switched on. By pressing the status key the code of the special function is output on the FREQUENCY display (see section "Status").

Table 2-1 Codes for switching the special functions on and off

Special functions	Code	
	Switch on	Switch off
Non-interrupting level setting	1	2
Level EMF	3	4
AM two-tone	5	6
FM two-tone	7	8
Pulse modulation	9	10
Low Rate FM	11	12
Set (Clear) Power On Clear Flag (see Table 2-11)	17	18
User Request	19	--
Switch off all special functions		0

Further special functions for test purposes are described in the Service Manual.

Remote-control commands

The special functions are serviced by separate remote-control commands.

Table 2-2

Special functions	Switch on	Switch off
Non-interrupting level setting	ATT:FIXED	ATT:NORMAL
Level EMF	LEVEL:EMF	LEVEL
AM two-tone	AM:DUAL	AM:OFF
FM two-tone	FM:DUAL	FM:OFF
Pulse modulation	AM:PULSE	AM:OFF
Low Rate FM	FM:EXT:LOW_RATE	FM:OFF

Explanation of the individual special functions:

Non-interrupting level setting — An interrupt-free level setting is possible within a range of 10 dB. See section "Non-interrupting Level Setting".

Level EMF — Display of EMF voltage. See section "Level EMF".

AM two-tone — AM with internal and external modulation signals. See section "Modulation, Two-tone".

FM two-tone — FM with internal and external modulation signals. See section "Modulation, Two-tone".

Pulse modulation — Pulse modulation with external modulation signal. See section "Pulse Modulation".

Low Rate FM — FM with modulation frequency range 3 Hz to 500 kHz. See section "Modulation, FM".

User request — When the switch-on code for this special function is entered, a service request via the IEC bus is triggered in the local mode. The user request function will not lead to a status display. See section "Service Request and Status Registers".

2.3.18 Self-test

The SMX carries out a self-test on power-up and permanently during operation.

The RAM and ROM contents are checked when the instrument is switched on. The most important instrument functions are automatically monitored during operation.

A faulty function determined during the self-test is indicated by flashing of the status LED and by a Service Request message. The status code to identify the error can be output in the modulation display by pressing the STATUS key 8 (see Table 2-4, status codes of operating and function errors in section "Status").

In addition, 17 internal test points can be scanned via the keyboard or the IEC bus and the results read out and displayed in the amplitude display. This more detailed test facility is described in the Service Manual.

2.3.19 Status

The generator produces numerical status messages to identify special functions and errors.

The status codes of special functions are output in the frequency display. The status codes of errors (input or function errors) are output in the modulation display by the text "Err." in the amplitude display.

They can also be scanned via the IEC bus (see section "Error Handling"). The meanings of the status codes are described in Tables 2-3 and 2-4.

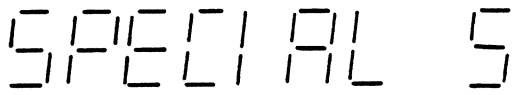
Operation: The status codes are output in the frequency and modulation displays as long as the STATUS key is pressed. If several status messages are applicable, the codes are automatically output repeatedly if the STATUS key is pressed continuously or are output one after the other every time the STATUS key is stroked.

Display: The STATUS LED **lights up continuously** if special functions are switched on or overrange/underrange settings are made.

The STATUS LED **flashes continuously** in the case of function errors.

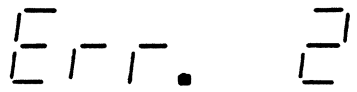
The STATUS LED **flashes briefly** in the case of input errors.

The status codes of the special functions are output in the frequency display in the following form:



The code is 0 if no special function is switched on.

The status codes of the function errors and of overrange/underrange settings are output in the amplitude/modulation display in the following form:



The code is 0 if no error is present.

In case of operator errors, the status codes of the input errors automatically appear briefly in the amplitude/modulation display in the following form:



IEC bus: A Service Request message (SRQ) may be output in the case of input and function errors and overrange/underrange settings. The type of error can be recognized from the event status register. An error code can be read out to permit exact error identification.

Table 2-3 Status codes of the special functions

Code	Meaning
0	No special function switched on
1	Non-interrupting level setting
3	Level EMF
5	AM two-tone
7	FM two-tone
9	Pulse modulation
11	Low Rate FM

The status codes of special functions for test purposes are described in the Service Manual.

Table 2-4 Status codes of errors and overrange/underrange settings

Code	Meaning
0	No error
	Function errors
1	Reference loop out of sync [1])
2	VCXO loop out of sync
3	Main oscillator loop out of sync
4	Level control inoperative
5	External overvoltage at RF output (see Service Manual, Section 4 "Adjustment of Overvoltage Protection")
6	ROM data error
7	RAM data error of the stored settings
8	RAM data error of the corrected FM deviation values [2]) (FM deviation correction, see Sect. 4 Service Manual)
	Input errors
50	Syntax errors
51	Numerical input outside permissible range
52	Illegal unit for the parameter selected
53	Illegal header (IEC bus)
54	AF synthesizer (option SMX-B2) cannot be switched off if internal modulation is on
55	Deviation input too great for set RF
56	Variation not possible if the parameter is not switched on (IEC bus)
	Overrange/underrange settings
70	AM not specified for set level
71	AM not specified for AF >50 kHz
72	RF <100 kHz
73	External modulation signal out of tolerance

[1]) When the instrument is operated with the Reference Oscillator option SMX-B1, display of the function error 1 in conjunction with the output of "Oven cold" in the frequency display is possible during the warming-up period of approx. 4 min.

[2]) If the FM correction data filed in the RAM are lost (function error code 8), the instrument remains ready for operation with decreased FM accuracy.

2.4 Remote Control of Instrument via IEC Bus

The SMX is fitted with an IEC-bus connection as standard. The interface corresponds to the IEC 625-1/IEEE 488 standard. In addition, a further standard recommended by the IEEE and also accepted by the IEC commission has also been taken into consideration. This includes a description of the data transmission formats and general commands.

2.4.1 Interface Description

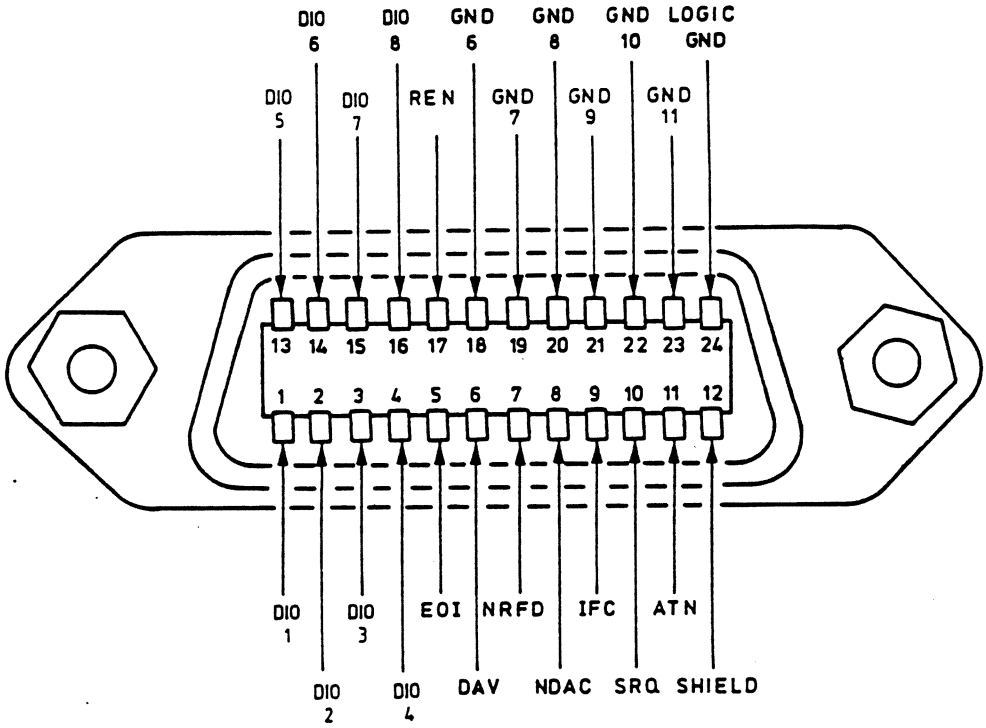


Fig. 2-8 Pin assignments

The bus connector 19 is located on the rear panel. The SMX is fitted with the 24-contact socket according to the IEEE 488 standard.

The standardized interface contains three groups of bus lines:

1. **Data bus** with 8 lines DIO 1 to DIO 8.

   Data transmission is bit-parallel and byte-serial and the characters can be transmitted in ISO 7-bit code (ASCII code).

   DIO 1 represents the least significant bit and DIO 8 the most significant bit.

2. **Control bus** with 5 lines.

This is used to transmit control functions:

ATN (Attention)	becomes active Low during transmission of addresses, universal commands or addressed commands to the connected devices.
REN (Remote Enable)	enables device to be switched to remote control.
SRQ (Service Request)	enables a connected device to send a Service Request to the controller by activating this line.
IFC (Interface Clear)	is activated by controller in order to set the IEC interfaces of the connected devices to a defined basic status.
EOI (End or Identify)	can be used to identify the end of data transmission and is used with a parallel poll.

3. **Handshake bus** with 3 lines.

This is used to control the data transmission sequence.

NRFD (Not Ready for Data)	an active Low on this line signals to the talker/controller that one of the connected devices is not ready to accept data.
DAV (Data Valid)	is activated by the talker/controller shortly after a new data byte has been applied to the data bus.
NDAC (Not Data Accepted)	is held at active Low by the connected device until the device has accepted the data present on the data bus.

More detailed information, such as the data transmission timing, can be obtained from the IEC 625-1 standard [1]).

[1]) Order designation "DIN IEC 625" Beuth Verlag, Berlin

According to the IEC 625-1 standard, devices with remote control via the IEC bus can be equipped with different interface functions. Table 2-6 lists the interface functions which apply to the SMX:

Table 2-6 Interface functions

SH1	Source Handshake, complete ability
AH1	Acceptor Handshake, complete ability
L4	Listener function, complete ability, unaddressing if MTA
T6	Talker function, complete ability, ability to reply to serial poll, unaddressing if MLA
SR1	Service Request, complete ability
PPØ	Parallel Poll function, not available
RL1	Remote/local switchover function, complete ability
DC1	Device Clear, complete ability
DTØ	Device Trigger, not available
CØ	Controller function, not available

2.4.2 Setting the Device Address

The ADDR key (in the REMOTE keypad 13) enables the address to be displayed and set under which the device is addressed via the IEC bus, as already described in the section "IEC-bus Address".

The address is the decimal equivalent of bits 1 to 5 of the talker or listener address. This form is also used with the IEC-bus commands of the controllers.

2.4.3 Local/Remote Switchover

The device is in local (manual operation) when switched on.

If the SMX is addressed by a controller as a listener (with R&S controllers by the BASIC commands IECOUT or IECLAD), it enters the remote status (remote control) in line with the standard and remains in this status when data transmission has been finished. This is indicated by the LED on the REMOTE keypad 13. All front panel controls except the LOCAL key (on the REMOTE keypad) are inhibited.

There are two possibilities to return to local:

- By the addressed command GTL (Go to Local) from the controller.
- By pressing the LOCAL key. Data output from the controller to the SMX should be stopped before pressing the LOCAL key or the SMX will immediately enter the remote status again. The function of the LOCAL key can be inhibited from the controller by sending the universal command LLO (Local Lockout).

The remaining device settings are not modified by a change in status from remote to local or vice versa.

2.4.4 Interface Messages

Interface messages (according to IEC 625-1/IEEE 488 standard) are transmitted to the SMX on the data lines with the attention line being active (Low).

2.4.4.1 Universal Commands

The universal commands are in the code range 10 to 1F hex. (see Table 2-9). They are effective, without previous addressing, on all devices connected to the bus.

Table 2-7

Command	BASIC command with R&S controllers	Effect on SMX
DCL (Device Clear)	IECDCL	Aborts processing of commands just received and sets the command processing software to a defined initial status. The device settings are not changed.
LLO (Local Lockout)	IECLLO	The LOCAL key is inhibited.
SPE (Serial Poll Enable)	IECSPE [1]	Ready for Serial Poll.
SPD (Serial Poll Disable	IECSPD [1]	End of Serial Poll.

[1] The BASIC command "IECSPL addr, status" contains the commands "IECSPE" and "IECSPD" and additionally reads the status of the device with address "addr" and stores it in the integer variable "status".

2.4.4.2 Addressed Commands

The addressed commands are in the code range 00 to 0F hex. (Table 2-9). They only act on devices addressed as Listeners (by the BASIC command "IECLAD addr").

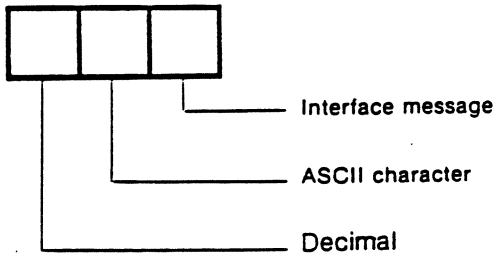
Table 2-8

Command	BASIC command with R&S controllers	Effect on SMX
SDC (Selected Device Clear)	IECSDC	Aborts processing of commands just received and sets the command processing software to a defined initial status. The device settings are not changed.
GTL (Go to Local)	IECGTL	Switchover to local status (manual operation).

Table 2-9 ASCII/ISO and IEC character set

CONTROL						NUMBERS SYMBOLS				UPPER CASE				LOWER CASE			
0	NUL		16	DLE		32	SP	48	0	64	@	80	P	96	`	112	p
1	SOH	GTL	17	DC1		33	!	49	1	65	A	81	Q	97	a	113	q
2	STX		18	DC2		34	"	50	2	66	B	82	R	98	b	114	r
3	ETX		19	DC3		35	#	51	3	67	C	83	S	99	c	115	s
4	EOT	SDC	20	DC4	DCL	36	$	52	4	68	D	84	T	100	d	116	t
5	ENQ	PPC	21	NAK	PPU	37	%	53	5	69	E	85	U	101	e	117	u
6	ACK		22	SYN		38	&	54	6	70	F	86	V	102	f	118	v
7	BEL		23	ETB		39	'	55	7	71	G	87	W	103	g	119	w
8	BS	GET	24	CAN	SPE	40	(	56	8	72	H	88	X	104	h	120	x
9	HT	TCT	25	EM	SPD	41	)	57	9	73	I	89	Y	105	i	121	y
10	LF		26	SUB		42	*	58	:	74	J	90	Z	106	j	122	z
11	VT		27	ESC		43	+	59	;	75	K	91	[	107	k	123	{
12	FF		28	FS		44	,	60	<	76	L	92	\	108	l	124	|
13	CR		29	GS		45	–	61	=	77	M	93	]	109	m	125	}
14	SO		30	RS		46	.	62	>	78	N	94	^	110	n	126	~
15	SI		31	US		47	/	63	? / UNL	79	O	95	_	111	o	127	DEL
ADRESSED COMMANDS			UNIVERSAL COMMANDS			LISTEN ADDRESSES				TALK ADDRESSES				SECONDARY ADDRESSES OR COMMANDS			

Key:



2.4.5 Device Messages

Device messages (to IEC 625-1) are transmitted on the data lines with the attention line being High, i.e. not active. The ASCII code (ISO 7-bit code) is used (see Table 2-9).

The device messages can be divided according to two different factors as shown in the following table.

Table 2-10

Transmission direction / Device dependence	Message received by SMX	Message transmitted by SMX
General, common commands (according to standard)	See Table 2-11	See Table 2-12
Device-specific commands (dependent on device functions)	See Table 2-13	See Table 2-14

Messages received by the SMX will be denoted as commands in the following.

2.4.5.1 Commands Received by the SMX in Listener Mode
(controller to device messages)

Fig. 2-9 shows the syntax of a command line (program message). Each command line must be terminated by an end character; permissible end characters are:

- New line (ASCII code 10 decimal)

- End (EOI line active) together with:

  - the last useful character of the command line or
  - the character "New line" or
  - the semicolon (;).

The combination "Carriage return + new line" is also permissible because the "Carriage return" character (ASCII code 13 decimal) is permissible as a filler before the end character without effect.

All IEC-bus controllers from Rohde & Schwarz transmit an end character which is accepted by the SMX.

A command line may require more than one line on the screen of the controller because it is only limited by the end character. Most IEC-bus controllers automatically hang the end character onto the useful text.

A command line may contain **several commands** (program message units) separated by **semicolons (;)**. For reasons of compatibility, the SMX also accepts a comma for this purpose (see Section "Alternatives for the Command Syntax").

A command can consist of the following parts:

- **Only a header**

  Example: PRESET

- **Header and question mark**

  Example: RF?

  This combination requests the SMX to provide the required data in an output buffer in order to transmit them via the IEC bus as soon as the SMX is addressed as a talker (see Section "Messages Transmitted by SMX in Talker Mode").

- **Header and number**

  Examples: RF 123.5E6; RF 123.5MHZ; RECALL 7

  According to the standard, the header and number(s) must be separated by at least one space (ASCII code 32 decimal). It is permissible with the SMX to omit this space to enable compatibility with other devices. In the case of the device-specific commands, the number can be supplemented by a unit.

The headers and their significance are described in Sections "Common Commands" and "Device-specific Commands".

Lower-case letters are permissible and are equivalent to the corresponding upper-case letters. Thus units can be used in the usual form (example: dBm) instead of the upper-case notation (example: DBM) which is also permissible.

Additional spaces may be entered at the following positions:

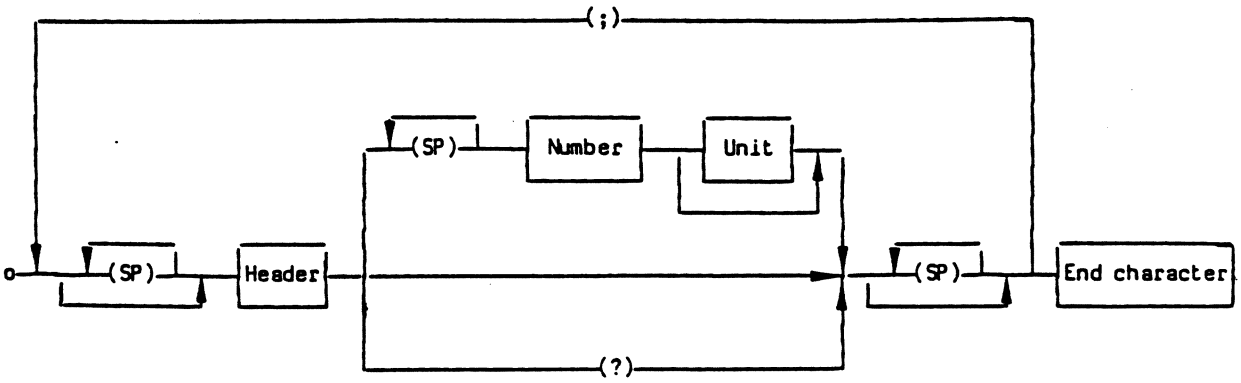
- before a header,
- between header and number,
- between number and unit,
- before and after a comma (,) and semicolon (;),
- before the end character.

Only **decimal numbers** are permissible with the following notations:

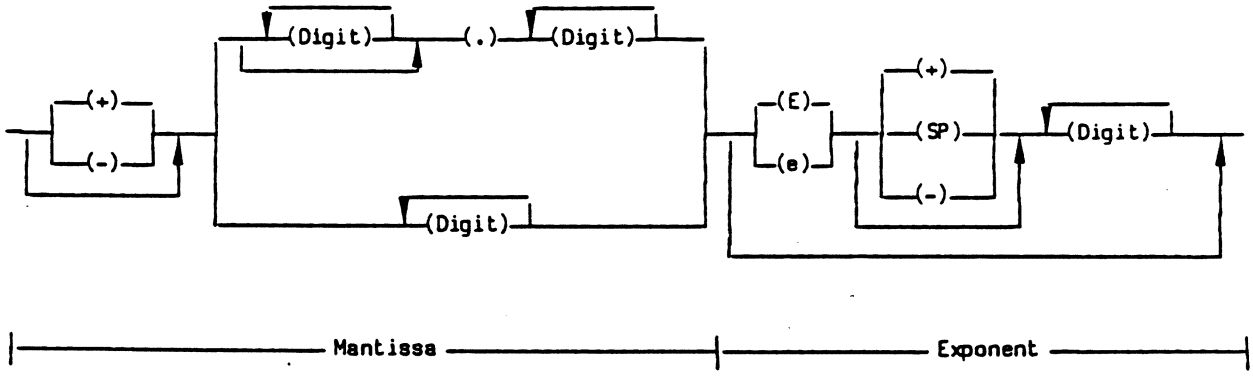
	Examples:
- With or without sign.	5, +5, -5
- With or without decimal point; the position of the decimal point is optional.	1.234, -100.5, .327,
- With or without exponent to base 10; "E" or "e" is used as the exponent character.	.451, 451E-3, +4.51e-2
- The exponent is permissible with or without a sign; a space is also permissible instead of the sign.	1.5E+3, 1.5E-3, 1.5E 3
- Leading zeros are permissible in the mantissa and exponent.	+0001.5, -01.5E-03
- The length of the number including the exponent may be up to 20 characters. The number of digits of the mantissa and exponent is only limited by this condition. Digits which exceed the resolution of the device are rounded up or down; they always contribute to the order of magnitude (power of ten).	150000000, 0.00000032

Note: An exponent alone (e.g.: E-3) is not permissible; 1E-3 is correct.

Command line



Number



SP: Any character of ASCII code 0 to 9 or 11 to 32 decimal, especially space.

Fig. 2-9 Syntax diagram of a command line

Examples:

```
*RST; RF 108.53MHZ; LEV -15DBM; FM 12.5E3; AF 3E+3 <CR><NL>
                                                    |   |
                                                    |   New Line
                                                    Carriage Return

*HDR Ø; RF?; FM? <NL>
                 |
                 New Line
```

2.4.5.2 Messages Transmitted by SMX in Talker Mode (device to controller messages)

The SMX transmits messages via the IEC bus if:

1. it is requested to provide data in its output buffer by one or more data requests (query messages) with a question mark (within one line) and

2. indicates by setting bit 4 in the status byte (MAV - message available) that the required data are now present in the output buffer (see also Section "Service Request and Status Register") and

3. has been addressed as a talker
   (BASIC command "IECIN addr, string variable").

It must be noted that the command line with the data requests must be transmitted immediately before the talker is addressed; the output buffer is cleared if a further command line is entered in between.

If the SMX is immediately addressed as a talker following the data request without observing point 2, the bus handshake is blocked until the requested data are available. This simple method of synchronization is meaningful with the SMX since only a few milliseconds are required to execute a data request.

The syntax of messages sent by the SMX is shown in Fig. 2-10. The syntax is similar to that for commands received by the SMX.

- "New line" (ASCII code 10 decimal) together with "End" (EOI line active) is used as the **end character.** It is also possible to set "Carriage return + new line + end" (using command TALK_TERMINATOR:CR_NL_END).

- The command "*HDR 0" or "*HDR 1" can be used to select whether **only the numbers** (*HDR 0) or **the header and numbers** (*HDR 1 are to be transmitted.

  The setting "Header and numbers" can also be selected by

  → the command "*RST" (reset) or
  → by switching on the operating voltage

  The setting "Header and numbers" enables the messages transmitted by the SMX to be returned to the SMX as unmodified commands. It is then possible to read a setting entered via the keyboard, store it in the controller and repeat it later via the IEC bus.

- If the SMX contains several data requests, it also returns **several messages** within one line which are separated by **semicolons (;)**.

- **Several numbers** can be transmitted as a reply to the queries SPECIAL_FUNCTION? and ERRORS? and are separated by **commas (,)**.

- Headers and numbers are always separated by a **space**.

- The **headers** only consists of upper-case letters and the characters ":", "_" and "*".

- The syntax of the **numbers** is shown in Fig. 2-10. Only decimal numbers are transmitted. The exact form of the numbers for each message can be obtained from Tables 2-12 and 2-14.

- Messages transmitted by the SMX do not contain **units**. In the case of physical variables, the numbers are referred to the basic unit specified in Table 2-14.

Program examples

(For the IEC-bus controller PCA; the IEC-bus address of the SMX has been assumed to be 27.)

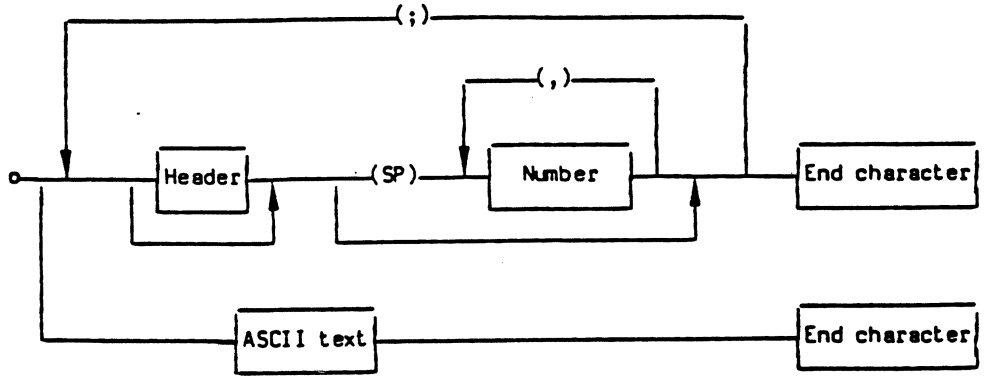
Example 1: Frequency scan; simple synchronization method

```
 5 IECTERM 10 ____________________________ Input terminator: LF
10 IECOUT27,"*HDR 0" ____________________ Setting: no header
20 IECOUT27,"RF?"_______________________ Data request: frequency
30 IECIN27,F$ ___________________________ Read talker address and
40 PRINT "Frequency of SMX:",F$          data
```

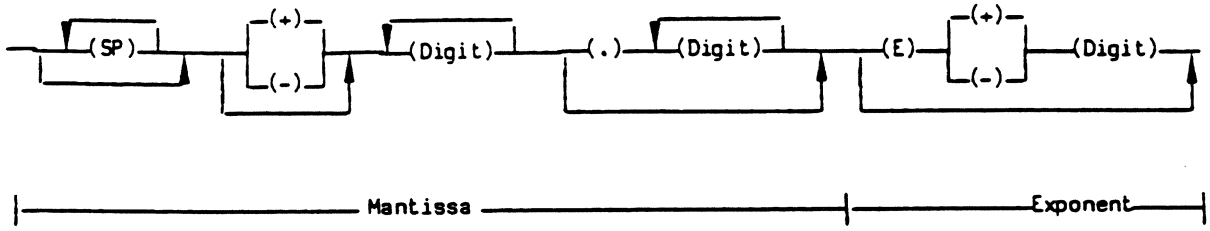
Example 2: Frequency scan; indication through Service Request that data are available.

```
                                          Input terminator: LF
 5 IECTERM 10 ____________________        Branch to line 100 with
10 ON SRQ GOSUB 100 ____________          Service Request.
20 IECOUT27,"*SRE 16, *HDR 0" ___________ SRQ by MAV bit
30 IECOUT27,"RF?" ______________          Setting: no header
.                                         Data request: frequency
.
.
100 REM ---SERVICE REQUEST ROUTINE ---
110 IECSPL27,S% _________________________ Serial Poll
120 IF S% <> (64+16) THEN GOTO 150_______ Service Request from SMX?
130 IECIN27,F$ __________________________ Yes, read talker address,
140 PRINT "Frequency of SMX:",F$         data.
150 ON SRQ GOSUB 100
160 RETURN
```

Output message line



Number



SP: Space (ASCII code 32 decimal)

ASCII text: Reply to commands "*IDN?" and "*OPT?"
(see Table 2-12)

Fig. 2-10 Syntax diagram of messages transmitted by SMX

Example with header:

RF 108.53000E+6;LEVEL -15.0;AM:OFF;FM:INT 12.50E+3<NL+END>
End character

Example without header:

108.53000E+6; -15.0;;12.50E+3<NL+END>
End character

2.4.5.3 Common Commands

These commands are listed in Tables 2-11 and 2-12.

They affect the following areas:

- Reset commands
- Commands which refer to the Service Request function with the associated status and mask registers
- Commands for device identification.

The commands have been taken from the standard. The standard ensures that these commands have the same effect in different devices.

The headers of these commands consist of a star (*) followed by 3 letters.

Table 2-11

Command	Number, range	Meaning
*RST	-	**Reset** Acts like the INSTR PRESET key (see Section "Instrument Preset") and → switches to message with header (like command *HDR 1), → sets the end character in talker mode to "New Line + End", Does not change the status of the IEC-bus interface, the set IEC-bus address, and the registers of the Service Request function.
*PSC	0 or 1	**Power On Clear Flag** If 1: The Service Request Enable mask register (SRE) and the Event Status Enable mask register (ESE) are also cleared when the instrument is switched on. If 0: The above-mentioned registers retain their contents even when the instrument is switched off and on. This enables a Service Request when the instrument is switched on. The Power On Clear Flag can be set with special function 17 and cleared with special function 18 (manual operation).
*HDR	0 or 1	**Header Flag** If 1: All messages from SMX to controller are transferred with a header. If 0: A header is not transferred with the above-mentioned messages. Is also set to 1 by switching on the operating voltage and by the command "*RST".
*OPC	-	**Operation Complete** Sets bit 0 (Operation Complete) in the Event Status register if all previous commands have been processed (see Section "Timing of Command Processing and Synchronization").
*CLS	-	**Clear Status** Sets the Event Status Register (ESR) to zero. The mask registers of the Service Request function (ESE and SRE) are not changed. A current Service Request message is only reset if not caused by a message in the output buffer or if *CLS is at the start of a command line. *)
*ESE	0 to 255	**Event Status Enable** The Event Status Enable mask register is set to the specified value interpreted as a decimal number *).
*SRE	0 to 255	**Service Request Enable** The Service Request Enable mask register is set to the specified value interpreted as a decimal number *).

*) See Section "Service Request and Status Register"

Table 2-12 Common commands which request the SMX to output messages on the IEC bus

Data request command	Output message			Meaning
		Data value		
	Header	No. of digits	Range	
*IDN?	-	23	(alpha-numeric)	**Identification Query** The following identification text is transmitted via the IEC bus (always without header) as a reply to the command "*IDN?". R O H D E & S C H W A R Z , S M X, 0, 1.0 Manufacturer — Model — Reserved for serial No., not used in SMX — Firmware release (example)
*OPT?	-	1 to 5	(alpha-numeric)	**Option Query** Transmits information on the fitted options via the IEC bus (always without header). B1: If Reference Oscillator Option SMX-B1 is fitted. B2: If AF Synthesizer Option SMX-B2 is fitted. B1,B2: If both options are fitted. 0: If no options are fitted.
*TST?	*TST	2	0 to 67	**Self-test Query** A ROM and RAM test is performed. The result can be obtained from the data value of the output message: 0: no error 6: ROM error 7: RAM error 67: ROM and RAM error
*PSC?	*PSC	1	0 or 1	**Power On Clear Query** To read the status of the Power On Clear Flag, see "*PSC" in Table 2-11.
*HDR?	*HDR	1	0 or 1	**Header Query** To read the status of the Header flag, see "*HDR" in Table 2-11.
*OPC?	*OPC	1	1	**Operation Complete Query** The message "*OPC 1" or only "1" (depending on the status of the Header flag) is entered into the output buffer and bit 4 (message available) in the status byte is set if all previous commands have been processed. In addition, bit 0 (operation complete) in the Event Status Register is set (see Section "Timing of Command Processing and Synchronization").

Data request command	Output message			Meaning
		Data value		
	Header	No. of digits	Range	
*ESR?	*ESR	3	0 to 255	**Event Status Register Query** The contents of the Event Status Register are output in decimal and the register is then set to zero.
*ESE?	*ESE	3	0 to 255	**Event Status Enable Query** The contents of the Event Status Enable mask register are output in decimal.
*STB?	*STB	3	0 to 255	**Status Byte Query** The contents of the status byte are output in decimal.
*SRE?	*SRE	3	0 to 255	**Service Request Enable Query** The contents of the Service Request Enable mask register are output in decimal.

2.4.5.4 Device-specific Commands

All SMX functions set using the keyboard can also be controlled via the IEC bus. The effect of the commands is the same as the corresponding entry via the keyboard.

The following commands have no equivalent key entry:

ATTENUATOR:FIXED and ATTENUATOR:NORMAL
LEVEL:EMF
AM:DUAL
FM:DUAL
AM:PULSE

This is a different notation for special functions which have been incorporated because of their usefulness for documentation.

According to the display, the values of all setting parameters, error informations (ERRORS?) and internal voltage values (TEST:VOLTAGE?) can be read in via the IEC bus.

Table 2-13 lists the setting commands and Table 2-14 the data request commands with the associated message read by the SMX.

The **headers** are the same as the respective key inscription or similar. This results in easily readable (self-documenting) programs.

The headers can be **shortened** as desired by omitting the last characters (e.g.: L or LEV instead of LEVEL). The shortest possible notation is shown by underlining in Tables 2-13 and 2-14.

Many headers consist of several parts separated from each other by colons (:) [1]) (e.g.: LEVEL:EMF). The abbreviations can be used for each part of the header separately (e.g.: LEV:E).

Certain headers contain the **underline** character (ASCII code 95 decimal) to facilitate reading. It must be written like the letters but is always located in the part which can be omitted by abbreviating [2]).

All setting commands which can be assigned a number are identified in Table 2-13 in column "Number".

With the setting commands the number can be followed by a unit [1]) (e.g. 125.3MHZ, also permissible is 125.3E3 KHZ). The permissible units are listed in Table 2-13. They can also be abbreviated and written with lower-case or upper-case letters. If no unit is entered, the respective default unit applies (Hz, dBm, dBµV, %, dB), see Table 2-13.

---

[1]) For reasons of compatibility the SMG also permits other ways of separating the header parts and positioning the units within the command (see Section "Alternatives for the Command Syntax").

[2]) The underline character is generated in the R&S Controllers PCA and PUC using the "←" key.

Table 2-13 Device-specific setting commands

The shortest possible notation is indicated by underlining.

Header	Number	Permissible units	Standard notation	Default unit	Explanation
AF	Value	HZ KHZ MHZ	Hz kHz MHz	Hz	Modulation frequency
AF:VAR_STEP [1]	Value	HZ KHZ MHZ	Hz kHz MHz	Hz	AF variation step width
AF:ON [1]	-	-	-	-	Switch on AF to stored value [2]
AF:OFF [1]	-	-	-	-	Switch off AF [2]
AM AM:INTERNAL AM:EXTERNAL	Value	% PCT	% per cent (same effect)	%	Switch on AF with modulation source selected and set modulation depth [3]
AM:INTERNAL AM:EXTERNAL	- -	- -	- -	- -	As above, but set stored value of modulation depth
AM:DUAL	Value	% PCT	% per cent (same effect)	%	Switch on two-tone AM with internal and external source and set modulation depth
AM:DUAL	-	-	-	-	As above, but set stored value of modulation depth
AM:PULSE	-	-	-	-	Corresponds to special function "Pulse modulation"

[1]) Only permissible with option SMX-B2.

[2]) These commands are only required if the AF output (connector AF INT (17)) is to be used.

[3]) If the modulation source (INTERNAL or EXTERNAL)is not specified,

- selection is internal if AM was not prior switched on,
- the previous source is retained unchanged if AM was switched on.

Header	Number	Permissible units	Standard notation	Default unit	Explanation
AM:OFF	-	-	-	-	Switch off AM. Switch off special function "Pulse modulation".
AM:VAR_STEP	Value	% PCT	% per cent (same effect)	%	Variation step width of modulation depth
ATTENUATOR:FIXED	-	-	-	-	Non-interrupting level setting (Switch on special function 1)
ATTENUATOR:NORMAL	-	-	-	-	Normal function of level setting (Switch off special function 1)
DECREMENT:AF DECREMENT:AM DECREMENT:FM DECREMENT:LEVEL DECREMENT:RF	-	-	-	-	Corresponds to key function STEP ↓. Entry of step width with VAR_STEP for each parameter.
FM FM:INTERNAL FM:EXTERNAL	Value	HZ KHZ MHZ	Hz kHz MHz	Hz	Switch on FM with modulation source selected and set FM deviation [4]
FM:INTERNAL FM:EXTERNAL	-	-	-	-	As above, but set stored value of deviation
FM:DUAL	Value	HZ KHZ MHZ	Hz kHz MHz	Hz	Switch on two-tone FM with external and internal source and adjust deviation
FM:DUAL	-	-	-	-	As above, but set stored value of deviation

[4]) If the modulation source (INTERNAL or EXTERNAL) is not specified,

- selection is internal if FM was not prior switch on,
- the previous source is retained unchanged if FM was switched on.

Header	Number	Permissible units	Standard notation	Default unit	Explanation
FM:INTERNAL:LOW_RATE FM:EXTERNAL:LOW_RATE FM:DUAL:LOW_RATE	Value	Hz kHz MHz	Hz kHz MHz	Hz	As above, but additionally special function 11 Low Rate FM is switched on (only with SCM-U1)
FM:INTERNAL:LOW_RATE FM:EXTERNAL:LOW_RATE FM:DUAL:LOW_RATE	-	-	-	-	
FM:OFF	-	-	-	-	Switch off FM

Header	Number	Permissible units	Standard notation	Default unit	Explanation
FM:VAR_STEP	Value	HZ KHZ MHZ	Hz kHz MHz	Hz	Variation step width of FM deviation
INCREMENT:AF INCREMENT:AM INCREMENT:FM INCREMENT:LEVEL INCREMENT:RF	-	-	-	-	Corresponds to key function STEP ↑. Entry of step width with VAR_STEP for each parameter.
LEVEL	Value	DBM DBUV V MV UV	dBm dBµV V mV µV	dBm	Level
LEVEL:EMF	Value	DBUV V MV UV	dBµV V mV µV	dBµV	Level EMF
LEVEL:VAR_STEP	Value	DB	dB	dB	Variation step width of the level
LEVEL:OFF	-	-	-	-	Switch off output signal
LEVEL:ON	-	-	-	-	Switch on output signal to stored value of level again
PRESET	-	-	-	-	Set device to basic status (see Section "Instrument Preset")
RECALL	Value	-	-	-	Call a stored device setting
REFERENCE_OSCILLATOR: INTERNAL	-	-	-	-	Internal reference frequency
REFERENCE_OSCILLATOR: EXTERNAL	-	-	-	-	External reference frequency

Header	Number	Permissible units	Standard notation	Default unit	Explanation
RF	Value	HZ KHZ MHZ	Hz kHz MHz	Hz	Frequency
RF:OFFSET	Value	HZ KHZ MHZ	Hz kHz MHz	Hz	Frequency offset
RF:OFFSET:OFF	-	-	-	-	Switch off frequency offset
RF:VAR_STEP	Value	HZ KHZ MHZ	Hz kHz MHz	Hz	Variation step width of the frequency
SEQUENCE	-	-	-	-	Sequence of stored device settings [5]
STORE	Value	-	-	-	Store device setting
TALK_TERMINATOR: NL_END [6]	-	-	-	-	End character in talk mode: New Line + End or
TALK_TERMINATOR: CR_NL_END	-	-	-	-	Carriage Return + New Line + End
TEST:POINT	Value	-	-	-	Selection of an internal test point (1 to 17) to measure the test voltage. Switches the special function "Test voltage" on (see Service Manual).
TEST:OFF	-	-	-	-	Switches the special function "Test voltage" off

[5]) The 1st memory location in the sequence is dfined by the RECALL command.
Example: Command sequence: RECALL 37 __ SEQ___ SEQ___ SEQ___ SEQ___ ...
Memory location: _____ 37 __ 38 ___ 39 ___ 40 ____37 ___ ...

[6]) Default setting following switch-on of operating voltage or command "*RST".

Examples:

(The IEC-bus address of the SMX has been assumed to be 27.)

1. Basic setting

```
IECOUT27,"PRESET"              or
IECOUT27,"*RST"
```

2. Set frequency (RF) to 123.45 MHz

```
IECOUT27,"RF 123.45MHZ"        or
IECOUT27,"RF 123.45E6"         or
IECOUT27,"RF 123450000"
```

3. Using an external reference oscillator

```
IECOUT27,"REF:EXT"
```

4. Amplitude modulation of 35% with the internal generator, modulation frequency 15 kHz

```
IECOUT27,"AF 15KHZ;AM:INT 35"
```

5. Frequeny modulation by an external modulation source with a deviation of 12.5 kHz

```
IECOUT27,"FM:EXT 12.5KHZ"
```

6. Two-tone frequency modulation, internal modulation frequency 3 kHz

```
IECOUT27,"AF 3KHZ; FM:DUAL 6.25KHZ"
```

7. Switch off modulation

```
IECOUT27,"AM:OFF; FM:OFF"
```

8. Set level to 120 µV

```
IECOUT27,"LEVEL 120uV"         or
IECOUT27,"LEV 120UV"           or
IECOUT27,"L 1.2E-4V"
```

9. Adjust level to an EMF of 2 V

```
IECOUT27,"LEV:EMF 2V"
```

10. Vary the level from -8 dBm to +2 dBm in steps of 0.2 dB without interruptions.

```
10 IECOUT27,"LEV 2; ATTEN:FIXED; LEV -8; LEV:VAR 0.2"
20 FOR I% = 1 TO 50
30 IECOUT27,"INCR:LEV"
40 NEXT I%
```

11. With special function "Non-interrupting level setting": read the level in dBm and the electronic attenuation in dB and output on the controller.

```
 5 IECTERM 10
10 IECOUT27,"*HDR 1; LEV?; ATTEN:CONT?"
20 IECIN27,L$
30 PRINT L$
```

12. Store various settings in memory location 38 to 40 and call in a continuous sequence. Line 40 defines the memory location (38) which is called in each case following memory 40.

```
10 IECOUT27,"PRESET; RF 28MHZ; LEV 10DBM; STO 38"
20 IECOUT27,"RF 30MHZ; STO 39"
30 IECOUT27,"AF 15KHZ; FM 40KHZ; STO 40"
40 IECOUT27,"RECALL 38"
50 IECOUT27,"SEQ"
60 HOLD 200
70 GOTO 50
```

2.4.5.5 Alternatives for the Command Syntax

In order to achieve as high a degree of compatibility with older R&S instruments, the SMX as a listener also accepts command notations which are not included in the described standard:

1. Instead of the semicolon (;), a comma (,) is also permissible as a delimiter between the commands.

   Example: *RST, LEVEL -10DBM, ATTEN:FIXED, *OPC?

2. Spaces or the brackets (), [] , {} are permissible instead of the colon (:) between the headers of the device-specific commands.

   Examples: AM INTERNAL 30;
   AM(INTERNAL) 30;
   RF(OFFSET OFF);

3. The space between the header and number can be omitted.

   Example: RECALL15;

4. An equal sign (=) can be inserted if required between the header and number.

   Example: AM=30%;

5. The unit may be located after the header (separated by a slash (/) and not only after the number.

   Examples: RE/MHZ 108.2;
   LEVEL/DBM -10.5;

6. Additional spaces are also permissible between the headers and between the sign and number.

   Examples: REFERENCE (EXTERNAL) ;
   LEVEL - 1.5DBM;
   LEVEL /V + 8.4E- 3;

   Spaces between number and subsequent unit are not permissible, however.

   Example: RF 25.3 MHZ; not permissible!

2.4.6 Service Request and Status Register

Fig. 2-11 shows the status registers and the links between them. In line with the standard, the status byte (STB) and its associated mask register (SRE), which are also present with older instruments, have been supplemented by the event status register (ESR) and its mask register, event status enable (ESE).

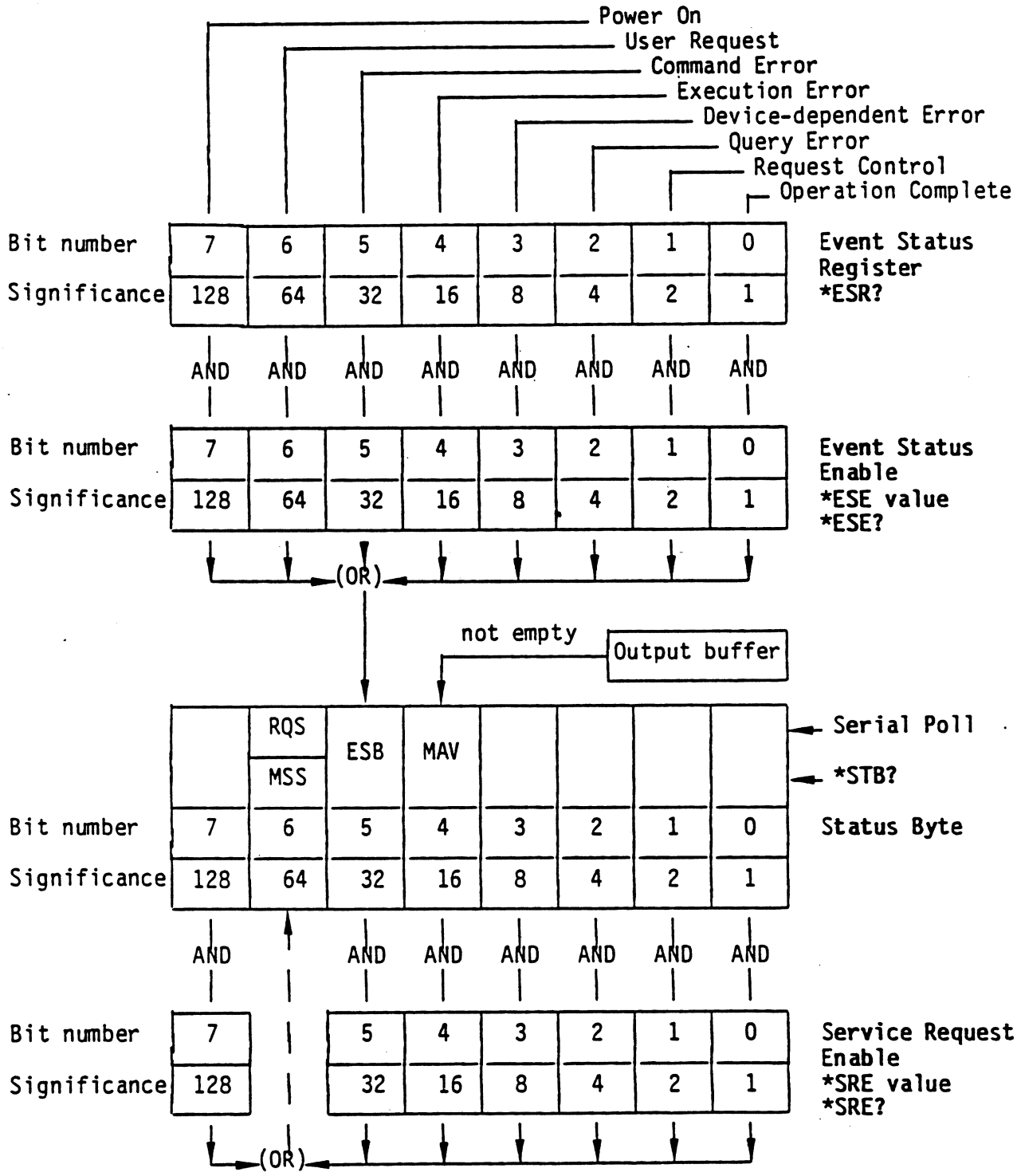


Fig. 2-11 Status registers

Table 2-15 Bit allocation of the event status register

Bit 7	**Power On** is set when the SMX is switched on or if the AC supply is restored after a failure.
Bit 6	**User Request** The operator can set this bit by activating special function 19 in the local status via the keyboard and thus initiate a Service Request with a corresponding setting of the mask register. This function is useful if test sequences require manual operation as well as control via the IEC bus.
Bit 5	**Command Error** This is set if one of the following errors is detected during analysis of the received commands: - Syntax error (error 50) - Illegal unit (error 52) - Illegal header (error 53) - A number has been combined with a header for which a number is not envisaged (error 50, e.g. INCREMENT:RF 10KHZ). In addition, the corresponding error code is displayed and stored internally just as when entering via the keyboard.

Bit 4	**Execution Error** is set if one of the following errors has been detected during execution of the received commands: - A number is outside the permissible range (for the respective parameter) (error 51) - The command AF:OFF has been sent although AM or FM was still switched on (error 54) - A parameter is to be varied although it is not switched on (error 56) - The FM deviation or the RF cannot be set because the FM deviation is too large for the selected RF (error 55) Attention must be paid to the correct sequence if both the FM deviation and the RF are changed. This error may briefly occur if the sequence is incorrect and if the deviation values are large and acceptance of a parameter value is then prevented. - Overrange/underrange settings (errors 70 to 72 in Table 2-4). The setting is nevertheless executed in these cases.
Bit 3	**Device-dependent Error** is set - if function errors occur (errors 1 to 9, see Table 2-4) or - if the external modulation signal is outside the tolerance range (Error 73).
Bit 2	**Query Error** This bit is set: - If the controller wishes to read data from the SMX but a data request has not been previously output. - If the data present in the output buffer of the SMX have not been read out and a new command line has been sent to the SMX instead. In this case the output buffer is cleared. - If the requested data exceed the capacity of the output buffer (approx. 200 characters).
Bit 1	**Request Control** Not used in SMX.
Bit 0	**Operation Complete** This bit is set by the commands "*OPC" and "*OPC?" if all previous commands have been executed.

A bit is set to "1" in the **event status register** (ESR) with certain events (e.g. fault, ready message); see Table 2-15.

The bits remain set until cleared by reading the event status register (by the command "*ESR?") or by the following conditions:

- The command "*CLS"
- The power supply is switched on (the Power On bit is set afterwards, however).

Using the **event status enable mask register (ESE)**, the user can select the bits in the event status register which also set the sum bit ESB (bit 5 in the status byte) through which a service request can be triggered. The sum bit is only set if at least one bit in the ESR and the corresponding bit in the ESE are set to "1". The sum bit is automatically cleared again if the above condition is no longer satisfied, e.g. if the bits in the ESR are cleared by reading the ESR or if the ESE is changed.

The event status enable mask register is written by the command "*ESE value" ("value" is the contents in decimal) and can be read again using the command "*ESE?". It is set to zero when the power supply is switched on if the Power On Clear flag is 1 (*PSC 1).

It is not changed by other commands or interface messages (DCL, SDC).

Only the following bits are used in the **status byte (STB)**:

Bit No.	Bus line	Designation	Meaning
4	DIO 5	MAV	Message available Indicates that a message is present in the output buffer which can be read. The bit is 0 if the output buffer is empty.
5	DIO 6	ESB	Sum bit of the event status register
6	DIO 7	RQS	Request Service (read by Serial Poll)
		MSS	Master Status Summary (read by *STB?)

It should be noted that the bits of the status registers are numbered 0 to 7 in accordance with the standard, but the bus data lines are designated DIO 1 to DIO 8.

Using the **service request enable mask register (SRE)**, the user can determine whether the RQS bit of the status byte is also to be set when the MAV or ESB bit switches from 0 to 1 and if a Service Request is to be sent to the controller by activating the SRQ line. The following possibilities exist since each bit in the service request enable mask register is assigned to the corresponding bit in the status byte:

Contents of the SRE (decimal)	Set bit No. in the SRE	Effect
0	-	No Service Request
16	4	Service Request when the MAV bit is set (message in output buffer)
32	5	Service Request when the ESB bit is set (at least 1 bit set in the event status register and not masked)
48	4+5	Service Request in both of the above cases

The service request enable mask register (SRE) is written with the command "*SRE value" ("value" is the contents in decimal) and can be read again using the command "*SRE?". It is set to zero when the power supply is switched on if the Power On Clear flag is 1, and the Service Request function of the SMX is thus inhibited. The SRE mask register is not changed by other commands or interface messages (DCL, SDC).

Several devices can trigger a Service Request simultaneously, the open collector drivers cause an OR function on the SRQ line. The controller must read the status bytes of the devices to identify which device has triggered the Service Request. A set RQS bit (bit 6/DIO 7) indicates that the device is transmitting a Service Request.

The status byte of the SMX can be read in the following manner:

1. By the command "*STB?".

   MSS (Master Status Summary) is transferred as bit 6. MSS is 1 if at least 1 bit in the status byte is set and the corresponding bit in the Service Request Enable mask register (SRE) is also set.

   The contents of the status byte (including MSS bit) are output in decimal. It is, however, not possible to detect a set MAV bit in this manner. The status byte is not modified by reading and a possibly present Service Request is not cleared.

2. By a Serial Poll

   (With R&S controllers: IECSPL adr, status)
   The contents are transferred in binary form as one byte. RQS is sent as bit 6 (Request Service). RQS is set if the addressed device has caused the Service Request. The RQS bit is subsequently set to zero and the Service Request becomes inactive, the other bits of the status byte are not changed.

   When MSS is cleared, RQS is also cleared, e.g. by setting the Service Request Enable mask register (SRE) to zero.

The status byte is cleared:

1. By "*CLS" at the start of a command line. At the start of a command line, the output buffer (and thus the MAV bit) is cleared. *CLS clears the event status register (and thus the ESB bit). This again clears the MSS or RQS bit and the Service Request.

2. By handling the entries in the status byte.

   With the MAV bit set: By reading the contents of the output buffer (IECIN adr, A$)

   With the ESB bit set: By reading the event status register (*ESR?)

   This also clears the MSS or RQS bit in the status byte and the Service Request.

Program example:

In the following program example, a Service Request is triggered when any error is detected, and the type of error is determined from the event status register. (The instruction set of the IEC-bus controller PCA has been used; the IEC-bus address for the SMX has been assumed to be 27.)

```
10 IECTERM 10 ------------------------------------------ Input termina-
20 ON SRQ GOSUB 100                                      tor: LF
30 IECOUT27, "*CLS; *HDR 0; *ESE 60; *SRE 32"
.                                  |   |   ------------- For Service
.                                                        Request in
.                                                        case of error
100 REM ------------------------------------
110 REM       SERVICE REQUEST ROUTINE
120 REM ------------------------------------
130 IECSPL 27, S%                                        SRQ not from
140 IF (S% AND 64) = 0 THEN GOTO 300 ------------------- SMX?
150 IECOUT27, "*ESR?"---------------------------------- Read event
160 IECIN27, E$                                          status register
170 E% = VAL(E$)
180 IF (E% AND 32) <> 0 THEN PRINT "COMMAND ERROR"
190 IF (E% AND 16) <> 0 THEN PRINT "EXECUTION  ERROR"
200 IF (E% AND  8) <> 0 THEN PRINT "DEVICE-DEPENDENT ERROR"
210 IF (E% AND  4) <> 0 THEN PRINT "QUERY ERROR"
220 ON SRQ GOSUB 100
230 RETURN
240 REM ------------------------------------
300 REM Service Request from other device
.
.
380 ON SRQ GOSUB 100
390 RETURN
```

2.4.7 Timing of Command Processing and Synchronization

The commands received by the SMX are first stored temporarily in an input buffer which is large enough for 81 to 121 characters. The commands are processed in the sequence in which they were transmitted once the end character has been received. The IEC bus can be used during this time for communication with other devices. Command lines which exceed the capacity of the input buffer are processed in several parts. The bus is occupied during this time.

The commands "*OPC" and "*OPC?" (Operation Complete) are used as feedbacks to indicate the time at which processing of the received commands has been finished and the new output signal of the SMX has completely settled at the new values.

"*OPC" sets bit 0 in the event status register and a Service Request can then be triggered if all previous commands have been executed.

The message "*OPC 1" or only "1" (with *HDR Ø) is also made available in the output buffer by **"*OPC?"** and bit 4 (MAV) in the status byte is set.

This synchronization procedure is recommended if another device which requires the settled signal of the SMX is to be requested to start a measurement via the IEC bus.

The following commands require additional time following processing before the output signal has settled:

- LEVEL if the mechanical attenuation set is switched
- RF, RF:OFFSET
- AF (when using the standard AF generator)
- INCREMENT, DECREMENT if the above parameters are to be changed
- Switching on of AM or FM (when using the standard AF generator)
- RECALL
- SEQUENCE
- PRESET

This additional time is automatically taken into consideration when using commands "*OPC" and "*OPC?".

Program examples:

(The command set of the IEC-bus controller PCA has been used; the IEC-bus address of the SMX has been assumed to be 27.)

The first program example shows a simple method of synchronization. The command *OPC? generates a message as soon as the preceding commands are executed and the output signal of the SMX is settled. Since this message is to be read in in line 30, the bus handshake is halted until the message is available and the SMX output signal settled.

```
10 IECTERM 10 ------------------------------------ Input terminator: LF
20 IECOUT27,"RF 108MHZ; LEV 25MV; FM 5KHZ; *OPC?"
30 IECIN27, A$ ----------------------------------- A$ is not used further
40 REM  The SMX has executed the commands
50 REM  in line 20. Its output signal is
60 REM  settled and can be used e.g. for
70 REM  measurements.
.          .
.          .
.          .
```

The command "*OPC?" is also used in the second program example. The message generated by it sets bit MAV in the status byte which triggers a Service Request. The generated message is not used further but is cleared again by "*CLS".

```
                                                  ,-- Reset, clear status
                                                  |   and Service Request
10 ON SRQ GOSUB 100                               |   by MAV bit
20 IECOUT27,"*RST; *CLS; *SRE 16" ----------------'
30 IECOUT27,"RF 108.25MHZ; LEV 250MV; FM 10KHZ; *OPC?"
40 REM The settling time can be used                  |
50 REM for other operations.                          Operation Complete?
.
.
.
100 REM ------ SERVICE REQUEST ROUTINE ------
110 IECSPL27, S% ------------------------------------ Serial Poll
120 IF (S% AND 64) = 0 THEN GOTO 190 ---------------- SRQ not from SMX?
130 IECOUT27,"*CLS"-------------------------------,
140 REM The SMX has executed the commands         '-- Clear status and
150 REM in line 30. Its output signal can             output buffer
160 REM be used e.g. for measurements.
.
.
.
190 ON SRQ GOSUB 100
200 RETURN
```

2.4.8 Error Handling

All errors detected by the SMX associated with operation from the IEC bus are displayed in the **event status register** (see Table 2-15) by setting a bit (bit 2, 4 or 5). Function errors are correspondingly signalled by setting bit 3. These bits remain set until the event status register is read or until they are cleared by command "*CLS". This is in accordance with the standard and enables a Service Request to be triggered and program-controlled evaluation of the type of error. (See the program example in the section "Service Request and Status Register".)

More detailed information is contained in the **error codes** which, just like with keyboard operations, are output in the amplitude and modulation display (see Table 2-4). The display may be overwritten by the next command, however, and is therefore not always visible with IEC-bus operation. It is therefore possible to read out these error codes via the IEC bus using command "ERRORS?". If several errors are present, the error codes are separated by commas. Code "0" indicates that no errors are present. Input errors (code numbers 50 to 55) are cleared if a new command line is sent to the SMX. The command "ERRORS?" must therefore be in the same line in which the error is assumed to be.

Error code 73 **with external modulation** indicates that the externally applied voltage does not have the required value. If information on the direction or the exact magnitude of the deviation is additionally required, the following command sequence must be used:

```
10 IECOUT27,"*HDR 0; TEST:POINT 17; TEST:VOLT?; TEST:OFF"
20 IECIN27,A$
```

The value contained in A$ is the peak value of the external modulation voltage in volts (with sinewave voltage) and can be compared with the correct value of 1.41 V.

2.4.9 Resetting Device Functions

The following table comprises the various commands and events which reset individual device functions.

Table 2-16

Event / Effect	Switch-on of operating voltage		DCL, SDC (Device Clear, Selected Device Clear)	Commands		
	Power On Clear flag 0	1		*RST	*CLS	PRESET
Basic instrument setting (see Section "Instrument Preset")	-	-	-	yes	-	yes
Set event status register ESR to zero	yes	yes	-	yes	yes	-
Set mask registers ESE and SRE to zero	-	yes	-	-	-	-
Clear output buffer	yes	yes	yes	-	3)	-
Clear Service Request	yes	1)	2)	-	3)	-
Message from SMX: setting "With header", talker end character new line + end	yes	yes	-	yes	-	-
Reset command processing and input buffer	yes	yes	yes	-	-	-

1) Yes, but "Service Request on Power On" is possible.
2) Yes, if only caused by message in output buffer.
3) Yes, if *CLS is at the start of a command line.

2.5 Options

The device can be fitted with the following options:

SMX-B1 Reference Oscillator, OCXO
SMX-B2 AF Synthesizer

The output "b-1 , b-2" indicates which options are fitted, if any, and appears briefly in the amplitude/modulation display when the device is switched on.

More details are contained in the Sections "Internal/external Reference Frequency", "Internal AF Modulation Frequency" and the Data Sheet.

Retrofitting of Option SMX-B1:

The Option SMX-B1 is fitted on the RF Oscillator module (802.7051.04). For this purpose, the bottom panel as well as the RF Oscillator (underneath the two transverse modules) must be removed. Unscrew the RF cover on the component side of the RF Oscillator and insert the option into the free slot. The switch-over to the option reference takes place automatically when inserted.

Retrofitting of Option SMX-B2:

The upper and lower panels and the plastic cover panel on the top transverse part of the front frame must be removed. Remove the processor board (the first board plugged in behind the front panel). The option can then be screwed to the 4 mounting brackets of the screen cover behind the amplitude/modulation display between the upper and lower transverse part of the front frame.

Feed the ribbon cable of the option to the right (viewed from the front) through the provided cut-out in the partition and connect to connector X2 on the keyboard/display module (directly behind the front panel). Connector X2 is labelled on the printed side.

Connect the Subminax socket on the coaxial cable supplied to the plug on the option. Route the cable to the rear panel and fit the BNC socket into the provided cut-out (labelled "AF INT").

3.1 Required Measuring Equipment and Accessories

Item	Instrument	Required specifications	Order No.	Use described in section
1	Frequency counter	Range 10 Hz to 1000 MHz Resolution 1 Hz		3.2.2 3.2.3 3.2.14
2	RF analyzer	Range 0.1 to 1500 MHz Crystal stabilized, dynamic range 90 dB		3.2.4 3.2.6 3.2.8 3.2.10 3.2.12 3.2.19
3	Power meter	Range 0.1 to 1000 MHz Power up to 20 mW, Z = 50 Ω, error <0.1 dB, resolution <0.02 dB		3.2.5 3.2.7
4	Precision attenuation set	Range >500 MHz Attenuation 0 to 120 dB, Z = 50 Ω	DPSP 334.6010.02	3.2.6
5	Controller	IEC 625-1 interface	PUC 344.8900..	3.2.4
6	Test generator	Range up to 1360 MHz Low noise	XPC 337.8014.52	3.2.8 3.2.11
7	SWR bridge	Range up to 1000 MHz Z = 50 Ω	ZRB2 373.9017.52	3.2.8
8	RF analyzer	Range up to 2.8 GHz Dynamic range >40 dB		3.2.9
9	Mixer	Range up to 1000 MHz Ring modulator, standard level		3.2.11
10	Lowpass filter 200 kHz	Z = 50 Ω for f >200 kHz		3.2.11
11	Instrument amplifier	Range 1 kHz to 20 kHz Gain 20 dB, inherent noise <5 nV/1 Hz test bandwidth		3.2.11

Item	Instrument	Required specifications	Order No.	Use described in section
12	AF analyzer	Range up to 20 kHz Sensitivity <3 µV, R_{in} >10 kΩ		3.2.11
13	Oscillo-scope	DC to 5 MHz, 0.1 V/div		3.2.11
14	Adjustable lowpass filter	Half octave intervals, 30 MHz to 1360 MHz		3.2.12
15	Deviation meter	Range up to 1000 MHz Residual FM at 250 MHz <1 Hz (CCITT) <2 Hz (30 Hz to 20 kHz)		3.2.13
16	Modulation analyzer	Frequency range up to 1000 MHz, AM, FM, ΦM, error <1%	FAM 334.2015.54 FAM-B2 334.4918.02 FAM-B8 334.5714.02	3.2.13 3.2.16 3.2.17 3.2.18 3.2.21 to 3.2.24
17	AF generator	Frequency range up to 100 kHz, frequency response <0.01 dB	SPN 336.3019.02	3.2.15 3.2.18 3.2.24
18	AF voltmeter	Frequency range up to 100 kHz, frequency response <0.01 dB	URE 342.1214.02	3.2.14 3.2.15 3.2.20 3.2.25
19	Distortion meter	Frequency range up to 100 kHz, Resolution <0.05%		3.2.14 3.2.17
20	Power signal generator	Level 30 dBm up to 1 GHz	SMLU 200.1009.03	3.2.26
21	RF peak-value rectifier	Frequency range 0.1 to 1000 MHz, 50 Ω frequency response <1 dB		3.2.20 3.2.25

3.2 Testing the Performance Data

3.2.1 Display and Keyboard

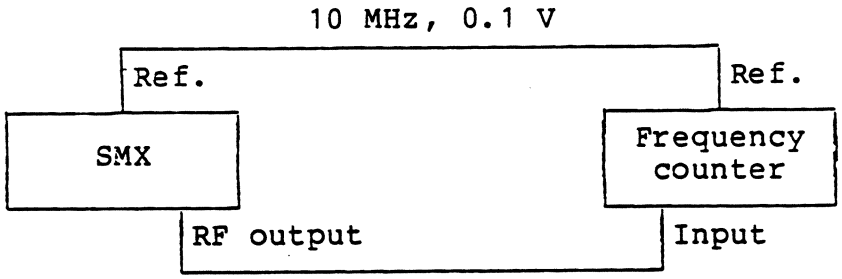
The special function "Display Test" (called up via SPECIAL 31) carries out a test of the displays. All displays are lit up.

The keys are tested by pressing them and their function checked against the display.

3.2.2 Frequency Setting

SMX setting: Unmodulated, level 0 dBm

Test setup:



Synchronize reference frequency from SMX and from frequency counter.

Test: Set the following frequencies on the SMX and check using the frequency counter.

10 MHz	150 MHz
30 MHz	450 MHz
50 MHz	1000 MHz
90 MHz	

The values on the counter must not deviate by more than ±1 Hz.

3.2.3 Reference Frequency

→ Allow at least one hour for the instrument to warm up.

→ Connect a calibrated frequency counter to output REF. FREQ. 18 (rear panel).

The relative frequency error must not exceed

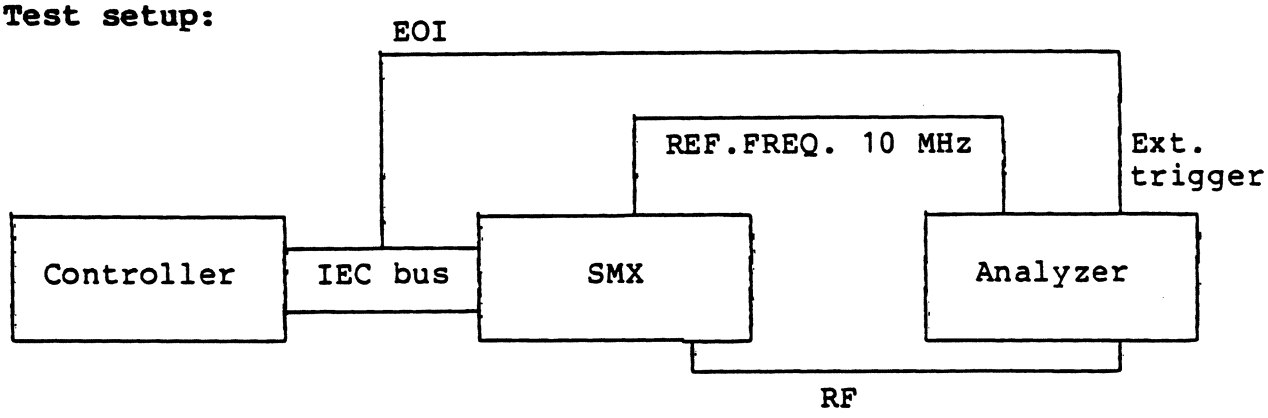
2×10^{-6}/year operation + 1×10^{-5} with the standard design
1×10^{-9}/day operation + 1×10^{-7} with the option SMX-B1 Reference Oscillator, OCXO

in the rated temperature range.

3.2.4 Settling Time

A crystal stabilized RF analyzer with a storage CRT which can be externally triggered by positive TTL edges is required to measure the settling time. The transient is made visible by edge demodulation with a 0-Hz span. Using a controller, two frequencies are set alternately on the SMX via the IEC bus. The controller should only activate the EOI line with the last data byte and must not otherwise send a terminator. The analyzer is adjusted such that one of the two frequencies lies on a filter edge. If the analyzer is triggered by the positive edge of the EOI signal, the transient appears on the CRT following the last character of the IEC-bus transmission.

Test setup:



Test: Synchronize reference frequency from the SMX and the RF analyzer. Connect the IEC bus and the RF line. Connect the EOI line (pin 5 on the IEC-bus connector) to the external trigger input of the analyzer. Set the SMX to 0 dBm and to the end value of the frequency jump to be measured. Set the reference level to -5 dBm on the analyzer, the amplitude scale to 1 dB/div, the resolution bandwidths to 1 kHz and the span to 3 kHz. Increase the centre frequency until the filter edge passes through the centre point of the CRT. The span can now be reduced to 0 Hz and the scale calibrated on the CRT using frequency steps of 100 Hz. The transient response appears on the CRT if the test program is now started and the analyzer switched to external triggering. The settling time (period up to final frequency 2 x 10^{-7}) must be <60 ms.

It is sufficient to only measure frequencies above 500 MHz since all frequencies below 500 MHz are derived by dividing and mixing the higher octaves.

Test program: Settling time

```
 10 IECTERM 1
 20 IECDCL : HOLD 500
 30 IECOUT27, "LEV 0DBM"
 40 INPUT "STARTFREQUENZ IN MHZ"; F1$
 50 INPUT "STOPPFREQUENZ IN MHZ"; F2$
 60 IECOUT27, "RF" + F1$ + "MHZ"
 70 HOLD 200
 80 IECOUT27, "RF" + F2$ + "MHZ"
 90 INPUT "REPEAT"; W$
100 IF W$ = "J" THEN 60
110 GOTO 40
```

3.2.5 Output Level

SMX setting: Unmodulated, level 0 dBm, frequencies 100 kHz to 1000 MHz

Test setup: Connect power meter to RF output.

Test: The frequency response must not fall below 1 dB.

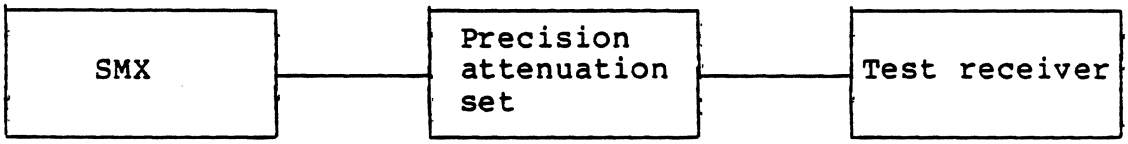
3.2.6 Attenuation Set

SMX setting: unmodulated, 100 MHz, 13 dBm

Precision attenuation set: 120 dB attenuation

Test receiver: 100 MHz, -10 dBµV, linear, mean value, bandwidth 7.5 kHz

Test setup:



Ensure that the cable connections are RF tight.

Test: The nominal attenuation values according to the performance test report must be taken into account.

- Note the level displayed on the test receiver as the reference value (approx. 0 dBµV).
- Repeat the measurement with the settings shown in Table 3-1.
- The difference from the reference value must not exceed 1 dB.

Table 3-1

SMX level dBm	Attenuation of the precision attenuation set dB
13	120
8	115
3	110
-7	100
-27	80
-47	60
-67	40
-87	20
-107	0

3.2.7 Non-interrupting Level Setting

SMX setting: Unmodulated, 100 MHz, 0,1 dBm
Level VAR STEP 2 dB,
special function "Non-interrupting level setting"

Test setup: Connect power meter to RF output.

Test: Calibrate the power meter to 0 dB (for relative level measurements) or note the absolute level. Reduce the level on the SMX in 2-dB steps using the STEP key and check the level jumps on the power meter.

The permissible deviation is ±0.2 dB for all settings.

3.2.8 Output Reflection Coefficient

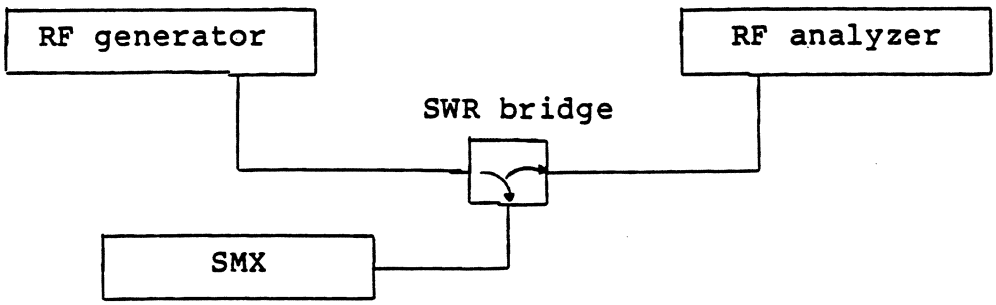
SMX setting: Frequency 5 to 1000 MHz, unmodulated
level 0 dBm,

RF generator setting: Frequency f[SMX]-100 Hz, unmodulated,
level 13 dBm

RF analyzer setting:

Center frequency	f[SMX]
Res BW = Video BW	10 kHz
Span	0 Hz
Sweep time	30 ms
Scale	linear

Test setup:



Test:

- Open the connection between the SMX and the SWR bridge; leave the input of the bridge open.
- Use the RF analyzer to measure the level of the RF generator signal reflected at the open input of the SWR bridge and note the result (reference level).
- Connect the SMX output with the SWR bridge and reduce the level of the RF generator to minimum. The 50-Ω output impedance of the RF generator must be maintained. If necessary, terminate the SWR bridge with 50 Ω.
- Set the SMX output level such that the reference level measured above is obtained on the RF analyzer. With output levels <0.1 dBm, use a bridge with a lower transmission loss.
- Set level of 13 dBm on the RF generator and determine V_{max} and V_{min} of the ripple indicated on the RF analyzer.

$$VSWR = \frac{V_{max}}{V_{min}}$$

The ripple must not exceed 1.5. For frequencies <8 MHz, an upper limit value of 1.8 is valid with level settings >0 dBm.

3.2.9 Harmonics

SMX setting: Unmodulated, level 13 dBm, frequency 100 kHz to 1000 MHz

Test setup: Connect RF analyzer to the RF output of the SMX.

Test: Sweep through the output frequency of 100 kHz to 1000 MHz and check the harmonics on the RF analyzer. The harmonic level must not exceed -30 dBc. Ensure that the RF analyzer is not overloaded.

3.2.10 Spurious

SMX setting: Unmodulated, level 0.1 dBm,
frequency 100 kHz to 1000 MHz

Test setup: Connect RF analyzer to the RF output.

Test: The spurious suppression is preferably tested at the following frequencies:

Table 3-2

SMX frequency	Search frequency	Spurious suppression
31 MHz	7 MHz 21 MHz 38 MHz 1048 MHz 1100 MHz	< -60 dBc
500 MHz	250 MHz	< -66 dBc
860 MHz 900 MHz 960 MHz	645 MHz 1000 MHz 720 MHz	< -60 dBc

3.2.11 SSB Phase Noise

In order to measure the SSB phase noise, the output signal of the SMX is down-converted with a signal of the same frequency from a reference signal generator. The carrier is then rejected and the noise spectrum converted to a low frequency. This low-frequency noise spectrum can be measured using an AF spectrum analyzer.

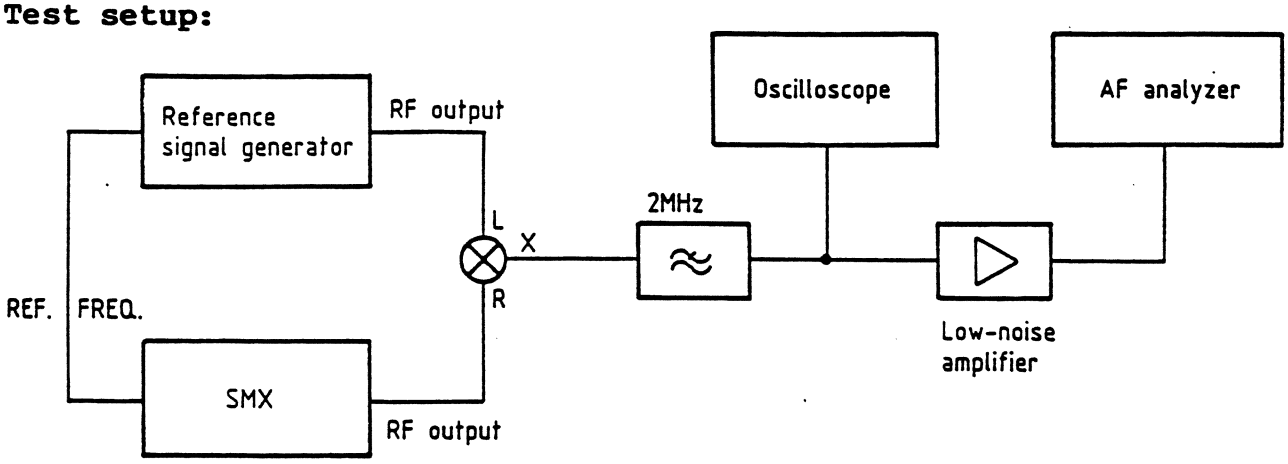
SMX setting: Unmodulated, level 0 dBm,
frequency 10 MHz (100/300/500/1000 MHz)

Reference generator: Unmodulated, level 7 dBm,
frequency 10 MHz
(100/300/500/1000 MHz)

Oscilloscope: DC, 0.1 V/div,
triggering AUTO

AF analyzer: Bandwidth 1 kHz, 5 kHz/div

Test setup:



Synchronize the reference frequencies from the SMX and the reference signal generator.

Test:

a) Set SMX to 10.02 MHz.
Read the reference value on the AF analyzer at 20 kHz.

b) Set SMX to 10 MHz.
Set a beat of 1 Hz using a step of 1 Hz upwards or downwards from the reference generator setting and stop the beat with a single step at the zero point on the oscilloscope (±50 mV). This sets the two input signals of the mixer in the phase quadrature.

c) Read the noise level on the analyzer at 20 kHz and convert to a 1-Hz bandwidth (if e.g. a bandwidth of 1 kHz is used for the measurement, 30 dB must be subtracted from the measured noise level). Take into account the form factor in the case of analyzers with mean-value rectification.

d) The SSB phase noise is calculated as follows:

	Example
Measured noise level (1-Hz bandwidth)	-118 dBm
Minus reference level	-(+12 dBm)
Minus 6 dB because 2 side bands are measured	-6 dB
	-136 dBc

e) Repeat the measurement at 100 MHz, 300 MHz, 500 MHz and 1000 MHz.

The following values of SSB phase noise must not be exceeded:

Table 3-3

Carrier frequency	SSB phase noise at 20 kHz from carier
10 MHz	-130 dBc
100 MHz	-130 dBc
300 MHz	-122 dBc
500 MHz	-122 dBc
1000 MHz	-116 dBc

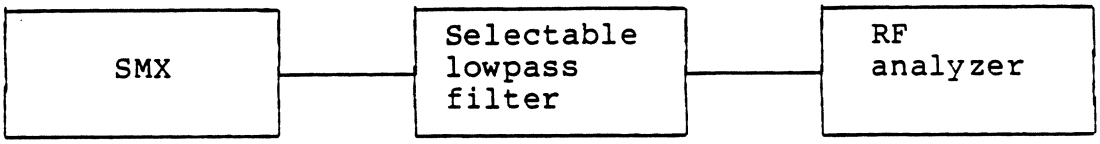
Note: This measurement takes into consideration the SSB phase noise of both generators. The reference signal generator must therefore be at least 10 dB better than the SMX in order to achieve an exact measurement.

3.2.12 Broadband Noise

The carrier of the SMX is attenuated using a filter in order to measure the broadband noise using an RF analyzer.

SMX setting: Unmodulated, level 0.1 dBm,
frequency 100 kHz to 1000 MHz

Test setup:



Test:

a) Set the lowpass filter such that the SMX carrier is attenuated by at least 20 dB.

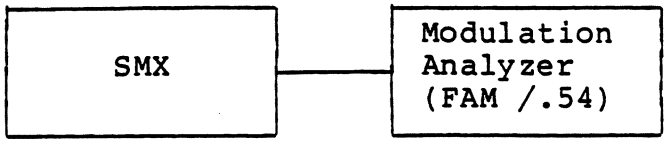
b) Set the analyzer as sensitive as possible (no pre-attenuation). Measure the noise level in the passband of the filter and convert to a 1-Hz bandwidth. This level, referred to 0.1 dBm, is the broadband noise level.

The broadband noise level must not exceed -140 dBc.

3.2.13 Residual FM

SMX setting: Unmodulated, level 0 dBm,
frequency 500 to 1000 MHz

Test setup:



Test: Measure the residual FM with a CCITT weighting filter or unweighted (30 Hz to 20 kHz) and an RMS rectifier.

In the given frequency range, the residual FM must not exceed 8 Hz with CCITT weighting filter or 20 Hz unweighted.

Possible test frequencies: 600, 800 and 1000 MHz.

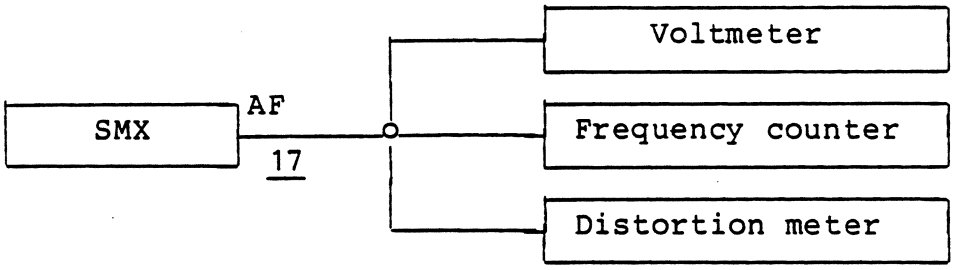
The inherent residual FM of the modulation analyzer must be taken into account by calibration.

3.2.14 Modulation Generator

Carry out the test only with the SMX-B2 AF Synthesizer option fitted.

SMX setting: AF 10 Hz to 100 kHz

Test setup:



Test: Vary the frequency of the modulation generator from 10 Hz to 100 kHz and measure the level, frequency and distortion.

The level at 1 kHz must be 1 V ±1%.

Frequency response:

< ±3 %

The frequency error must not exceed 4×10^{-5}.

The distortion at 1 kHz must not exceed 0.1%.

3.2.15 Function Test of the External Modulation Level Monitoring

SMX setting: Level 0 dBm, a) FM EXT 50 kHz
b) AM EXT 80 %

Test setup: Apply a modulation signal of 1 kHz to the modulation input 4.

Test: EXT LOW must light up in the modulation display with an input level of 0.97 V.

EXT HIGH must light up in the modulation display with an input level of 1.03 V.

Neither EXT LOW nor EXT HIGH is to light up with an input level of 0.99 to 1.01 V.

3.2.16 AM Modulation Depth

SMX setting: Level 0.1 dBm, frequency 0.1 to 1000 MHz, AM INT 0.5 to 80%, AF 1 kHz

Test setup: Connect modulation analyzer to RF output.

Test: The deviation of the modulation depth from a set value must not exceed 4% of the display +0.5 % (absolute).

3.2.17 AM Distortion

SMX setting: Level 0.1 dBm, frequency 0.1 to 1000 MHz, AM INT 30% (80%), AF 1 kHz

Test setup: Connect modulation analyzer with distortion meter to RF output.

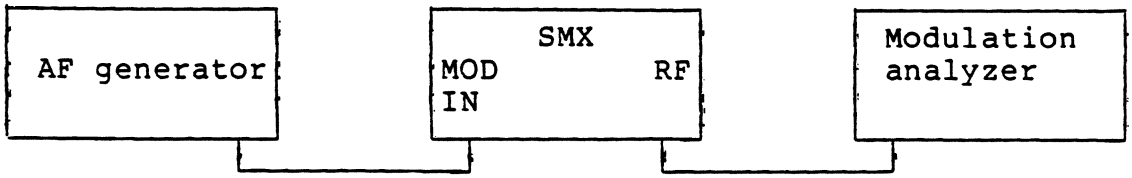
Test: The distortion must not exceed 1% with 30% AM.

The distortion must not exceed 2% with 80% AM.

3.2.18 AM Frequency Response

SMX setting: Level 0 dBm, frequency 0.1 to 1000 MHz, AM EXT 80%

Test setup:



Test: Set a level of 1 V on the AF generator and vary the frequency from 10 Hz to 50 kHz.

The modulation frequency response up to 15 kHz must not exceed 0.4 dB.

The modulation frequency response up to 50 kHz must not exceed 1 dB.

3.2.19 AM DC

Note: In the AM mode, the modulation input 4 is only DC-coupled with jumper X4 plugged in on the keyboard/display unit (826.5265.02).

SMX setting: Level 0 dBm, frequency 1000 MHz, AM EXT 100%

Test setup: Connect RF analyzer to RF output of SMX.

Test: A DC voltage of +1.41 V applied to the AM modulation input must increase the RF level by 5.5 to 6.5 dB.

A voltage of -1.41 V must result in an attenuation of at least 34 dB.

3.2.20 Residual AM

SMG setting: Unmodulated, level 13 dBm, frequency 0.1 to 1000 MHz

Test setup: Connect RF peak-value rectifier to SMX output. Connect RMS voltmeter with 20-kHz lowpass filter connected before to the output of the rectifier.

Test: The RMS value of the measured voltage must not exceed 200 µV.

3.2.21 Incidental ϕM at AM

SMG setting: Level 0 dBm, frequency 4 to 1000 MHz, AM INT 30%, AF 1 kHz

Test setup: Connect modulation analyzer to RF output.

Test: Measure the phase modulation produced at various carrier frequencies.

Permissible incidental ϕM <0.2 rad.

3.2.22 FM Deviation Setting

SMX setting: Level 0 dBm, frequency 100 MHz, FM INT 1 to 100 kHz, AF 1 kHz

Test setup: Connect modulation analyzer to RF output.

Test: Measure the FM deviation at the following deviation settings:

1 kHz, 3 kHz, 10 kHz, 30 kHz, 100 kHz

The deviation from the set value must not exceed 7%.

3.2.23 FM Distortion

SMX setting: Level 0 dBm, frequency 100 MHz, FM INT 50 kHz, AF 1 kHz

Test setup: Connect modulation analyzer with distortion meter to the RF output of the SMX.

Test: The FM distortion must not exceed 0.5%.

3.2.24 FM Frequency Response

SMX setting: Level 0 dBm, frequency 100 MHz, FM EXT 100 kHz

Test setup: Connect AF generator to modulation input. Connect calibrated modulation analyzer to RF output.

Test: Set a level of 1 V on the AF generator and vary the frequency from 100 Hz to 100 kHz. The modulation frequency response must not exceed 1 dB.

3.2.25 Incidental AM at FM

SMX setting: Level 0 dBm, frequency 0.1 to 1000 MHz, FM INT 40 kHz, AF 1 kHz

Test setup: Connect RF peak-value rectifier to SMX output. Connect RMS voltmeter with 20-kHz lowpass filter connected before to the output of the rectifier.

Test: The RMS value of the measured voltage must not exceed 224 µV.

3.2.26 Overvoltage Protection

SMX setting: Unmodulated, level -117 dBm, frequency 100 MHz

Test setup 1: Connect a regulated power supply unit to the RF output of the SMX via a 50-Ω resistor.

Test: Apply a DC voltage to the RF output. The overvoltage protection must trip at a voltage of 5 ±0.5 V.

Test setup 2: Connect a power signal generator with an RF power output of 0.5 to 2 W to the RF output of the SMX.

Test: Apply a frequency of 25 to 1000 MHz to the RF output. The overvoltage protection must trip at an RF power of 0.5 to 1 W.

3.3 Performance Test Report

ROHDE & SCHWARZ

SIGNAL GENERATOR SMX

Ord. No. 826.4517.52

SER. .....

Date: .....

Name: .....

Item	Characteristic	Measure as in Section	Min.	Actual	Max.	Unit
1	Function of keypads and displays	3.2.1	--		--	
2	Frequency setting	3.2.2	--		--	
3	Settling time	3.2.4	--		60	ms
4	Output level test level 0 dBm frequency response	3.2.5	 --		 1	 dB
5	Attenuation set error	3.2.6	--		1	dB
6	Non-interrupting level variation Error at -2 dB -4 dB -6 dB -8 dB -10 dB	3.2.7	 -- -- -- --		 0.2 0.2 0.2 0.2 0.2	 dB dB dB dB dB

Item	Characteristic	Measure as in Section	Min.	Actual	Max.	Unit
7	Output reflection coefficient	3.2.8				
	VSWR at 6 dBm, f >8 MHz		--		1.5	
	6 dBm, f <8 MHz		--		1.8	
8	Harmonics	3.2.9				
	at 10 dBm		--		-30	dBc
9	Spurious	3.2.10				
	at 31 MHz		--		-60	dBc
	500 MHz		--		-66	dBc
	960 MHz		--		-60	dBc
10	SSB phase noise at 20 kHz from carrier	3.2.11				
	at 10 MHz		--		-130	dBc
	100 MHz		--		-130	dBc
	300 MHz		--		-122	dBc
	500 MHz		--		-122	dBc
	1000 MHz		--		-116	dBc
11	Broadband noise	3.2.12	--		-140	dBc
12	Residual FM, CCITT, RMS 500 MHz <f ≤1000 MHz	3.2.13	--		8	Hz
	Residual FM (30 Hz to 20 kHz) 500 MHz <f ≤1000 MHz		--		20	Hz

Item	Characteristic	Measure as in Section	Min.	Actual	Max.	Unit
13	AF Synthesizer, SMX-B2	3.2.14				
	Level error at 1 kHz		--		3	%
	Frequency error		--		$4x10^{-5}$	
14	AF synthesizer distortion	3.2.14				
	at 1 kHz		--		0.1	%
15	Ext. modulation voltage window	3.2.15	0.97		1.03	V_{rms}
16	AM modulation depth	3.2.16				
	at 1 MHz m = 30%		27.8		32.2	%
	m = 80%		75.8		84.2	%
	10 MHz m = 30%		27.8		32.2	%
	m = 80%		75.8		84.2	%
	100 MHz m = 30%		27.8		32.2	%
	m = 80%		75.8		84.2	%
	1000 MHz m = 30%		27.8		32.2	%
	m = 80%		75.8		84.2	%
17	AM distortion f_{mod} = 1 kHz, m = 30%	3.2.17				
	at 1 MHz		--		1	%
	10 MHz		--		1	%
	100 MHz		--		1	%
	1000 MHz		--		1	%
	m = 80%					
	at 1 MHz		--		2	%
	10 MHz		--		2	%
	100 MHz		--		2	%
	1000 MHz		--		2	%

Item	Characteristic	Measure as in Section	Min.	Actual	Max.	Unit
18	AM frequency response	3.2.18				
	up to 15 kHz		--		0.4	dB
	up to 50 kHz		--		1	dB
19	Incidental ΦM at 30% AM	3.2.21	--		0.2	rad
20	FM deviation setting	3.2.22				
	at 1 kHz		0.93		1.07	kHz
	3 kHz		2.79		3.21	kHz
	10 kHz		9.3		10.7	kHz
	30 kHz		27.9		32.1	kHz
	100 kHz		93		107	kHz
21	FM distortion	3.2.23	--		0.5	%
22	FM frequency response	3.2.24				
	100 Hz to 100 kHz		--		1	dB
23	Response threshold of overvoltage protection	3.2.26				
	for RF		27		30	dBm
	for DC		4.5		5.5	V