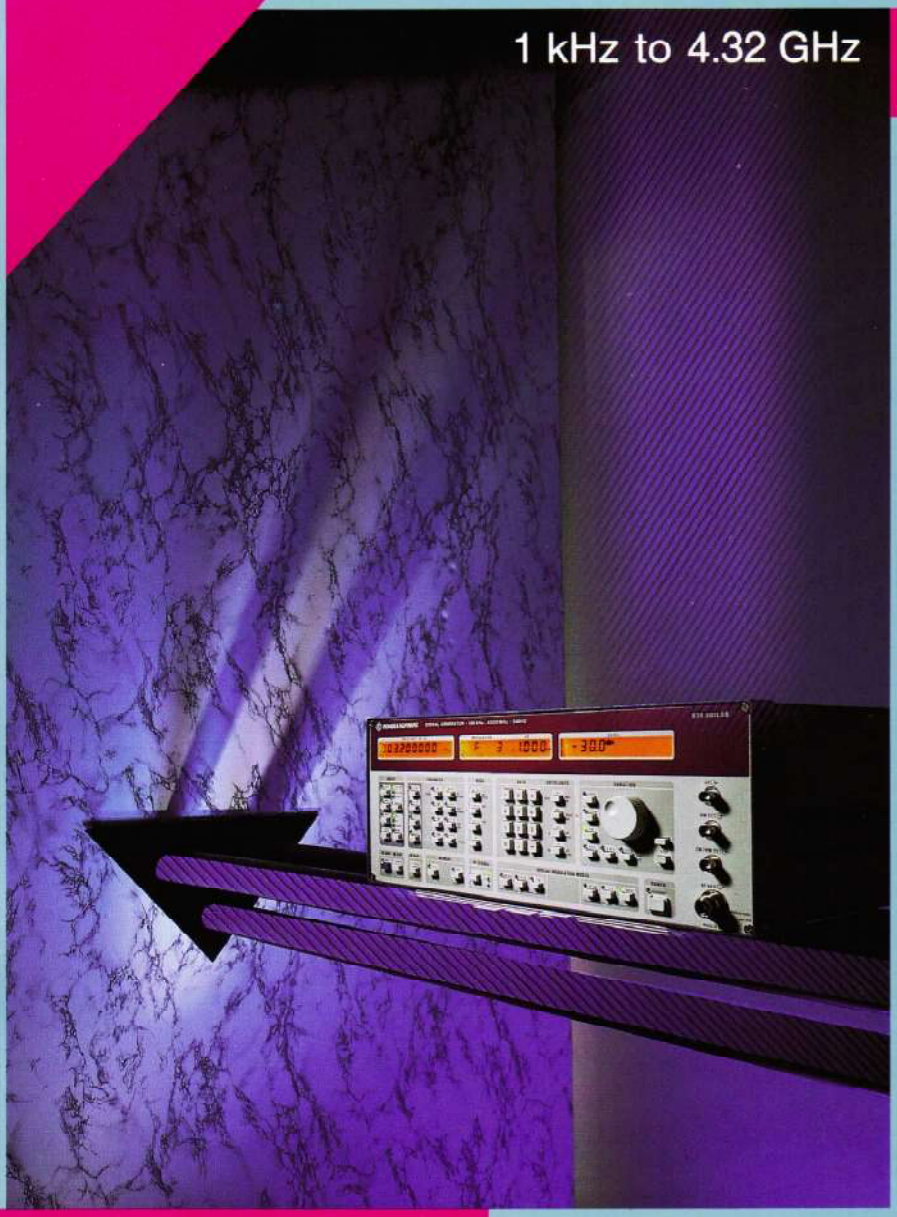
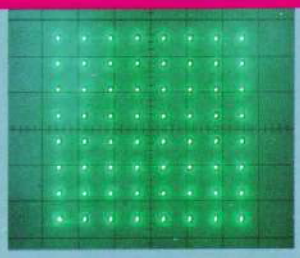
ROHDE & SCHWARZ

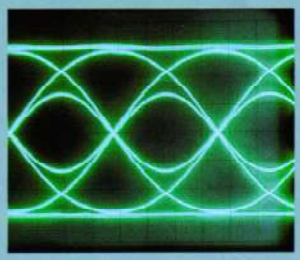
Signal Generator

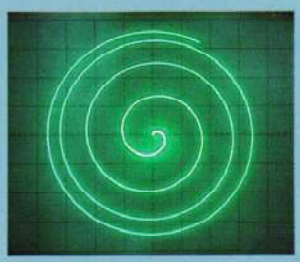
1 kHz to 4.32 GHz

SMHU 58

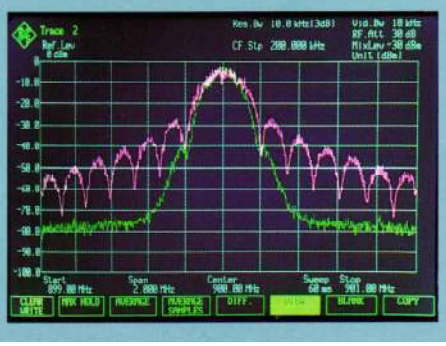








- Digital and analog broadband modulation
- GMSK for GSM mobile radio
- Frequency agility for frequency hopping applications



with I/Q modulator

5 MHz to 1.95 GHz

Signal Generator SMHU 58

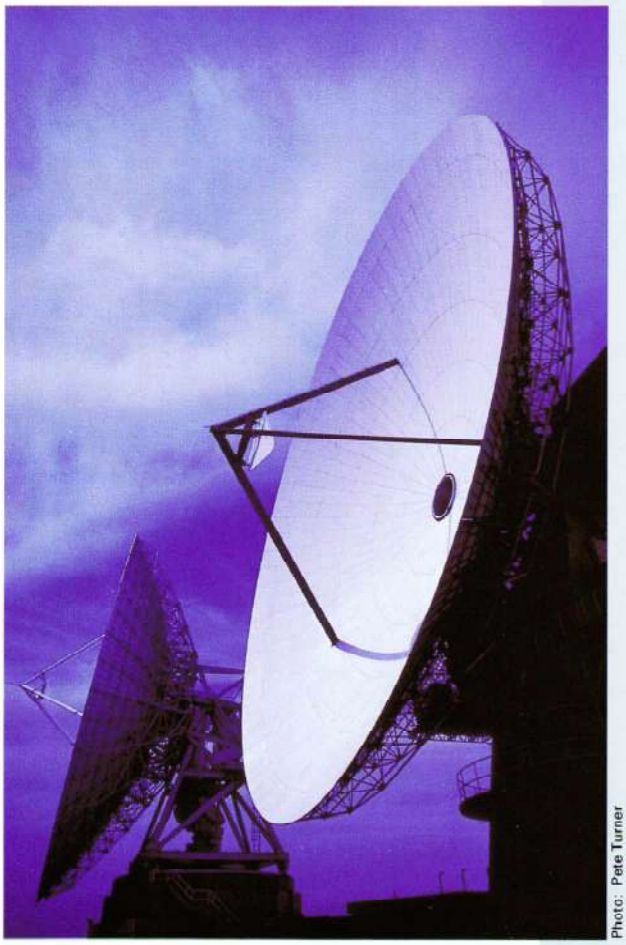


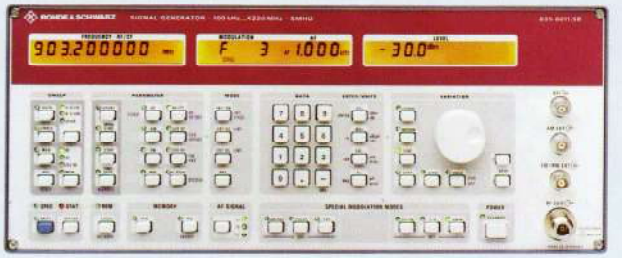
Photo: Pete Turner

- I/Q modulator for any phase and amplitude modulation modes
- GMSK[1]) for GSM[2]) mobile radio
- Broadband FM, bandwidth 20 MHz
- Broadband AM, bandwidth 50 MHz
- Second, coherent carrier for simple I/Q demodulation
- Setting time < 1 ms — for frequency-agile systems
- Parallel bus interface for addressing 4800 stored settings in frequency hopping mode
- High spectral purity for out-of-channel measurements and LO applications
- High carrier frequency accuracy and drift-free FMDC for FSK and VCO modes
- Fast AMDC for generating level bursts
- RF, AF, level and memory sweeps for automatic test runs

The Signal Generator SMHU 58 is used for generating complex test signals for modern communications and radar systems. Its high versatility is based on the great variety of modulation capabilities in conjunction with high spectral purity and frequency hopping.

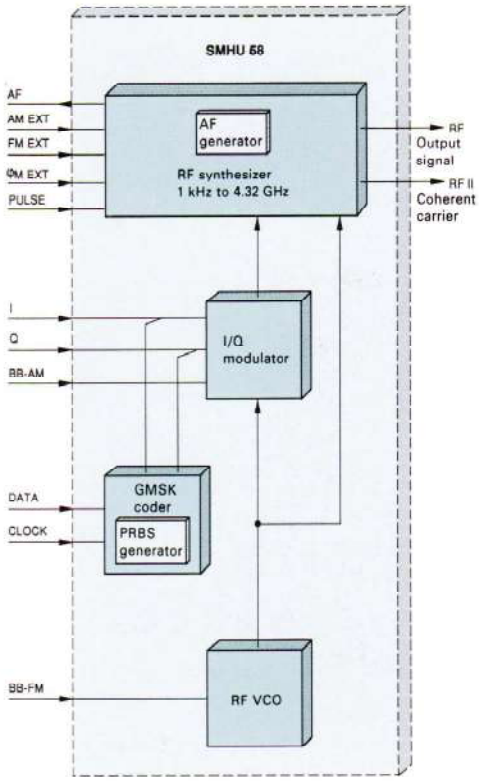
The I/Q and the broadband FM modulators of the SMHU 58 make all digital and analog modulation modes for directional radio and satellite communications possible. Modern radio networks, like the GSM mobile radio network and also DECT[3]), PCN[4]) and ADC[5]), use digital modulation methods, for which the SMHU 58 is ideally suited due to the high accuracy of its I/Q modulator. For modulation using serial data signals, coders can be integrated for the necessary signal processing and filtering to relevant standards. The **optional GMSK coder** produces from a serial data stream filtered analog signals for driving the I/Q modulator. The accuracy of the resulting phase modulation meets all requirements placed on a reference signal for GSM receiver testing.

Broadband FM can be used for fast FSK, analog sweeping, video modulation and for generating chirp signals.



[1]) GMSK = Gaussian Minimum Shift Keying
[2]) GSM = Groupe Spécial Mobile
[3]) DECT = Digital European Cordless Telephone
[4]) PCN = Personal Communication Network
[5]) ADC = American Digital Cellular

All modulation modes at a glance



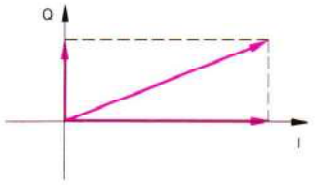
The simplified block diagram shows the inputs with all the possible modulation modes of the SMHU 58.

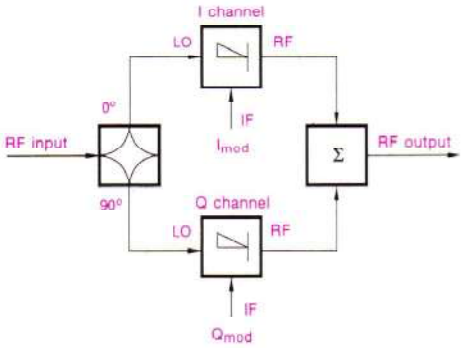
The modulation facilities of the SMHU 58 include the usual modes of top-class generators, ie **AM, FM, φM and pulse modulation,** which can be utilized over the entire frequency range from 1 kHz to 4.32 GHz, plus the additional facilities for **I/Q modulation** and its special applications GMSK and broadband AM (BB-AM) as well as for **broadband FM** (BB-FM). These modulation modes can be used between 5 MHz and 1.95 GHz, ie within the TV satellite IF band and the transmission bands of present and future radio networks.

Simultaneous modulation is required for simulating the complex signals of modern communications and radar systems. Simultaneous use of GMSK and AMDC, for instance, allows power ramping in the generated bursts like in time division multiplex operation of GSM mobile radio. I/Q or GMSK modulation with simultaneous FMDC makes Doppler shifting possible. The combination of pulse modulation and I/Q modulation or BB-FM enables the generation of complex radar signals, the pulsed signal being additionally phase-coded or frequency-modulated. The table below shows which types of modulation can be combined.

Modulation	AM	FM (φM)	Pulse	I/Q	BB-AM	GMSK	BB-FM
AM		●				●	●
FM (φM)	●		●	●	●	●	
Pulse		●		●	●	●	●
I/Q		●	●				●
BB-AM		●	●				●
GMSK	●	●	●				
BB-FM	●		●	●	●		

I/Q modulation

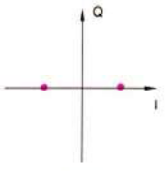




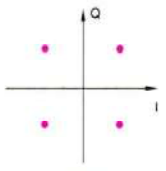
I/Q modulation is performed by a **quadrature modulator** as shown in the block diagram on the left.

At the input, the RF signal is split up into the two orthogonal I and Q components (in-phase and quadrature phase). The mixer connected in each of the two branches acts as a multiplier. Amplitude and phase of the RF signal are controlled by the amplitude and polarity of the I and Q modulation signal. A polarity reversal of the modulation signal causes a 180° phase shift of the RF signal. By adding the two components, an RF output signal is obtained whose amplitude and phase can be varied as desired.

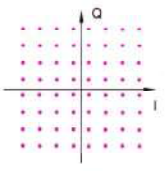
Digital modulation, an application of the I/Q modulator



BPSK



QPSK



64-QAM

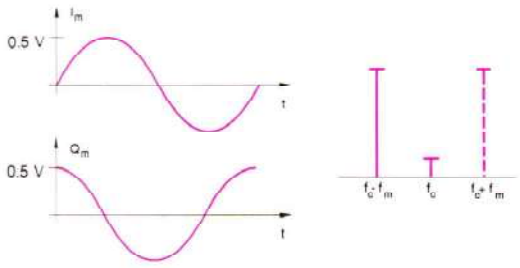
Digital modulation methods are based on phase, amplitude and combined phase/amplitude shift keying. To enable these types of modulation, bipolar signals with stepped amplitude are applied to the I/Q modulator of the SMHU 58.

The diagrams on the left show three common modes of carrier keying. The end points of the carrier vectors represent the possible phase and amplitude states of the RF output signal.

Further applications of I/Q modulation

Frequency shifting and FSK

When applying sinusoidal, 90° phase-shifted I and Q modulation signals to the I/Q modulator, its input frequency is shifted by the frequency of the modulation signals. Varying the phase offset of the two modulation signals by 180° causes a polarity reversal of the frequency offset. Using this method, the SMHU 58 allows very fast frequency shift keying with shifts of up to 400 MHz. A further advantage of this method is the shift accuracy which only depends on the frequency accuracy of the modulation source.



Level control and ASK*)

For level control or level keying, the control signal must be applied to the I input and the Q input terminated with 50 Ω. In the input voltage range from 0 to 0.5 V, there is a linear level control over 60 dB from the minimum value to the set nominal output level. The input frequency range is from DC to 200 MHz.

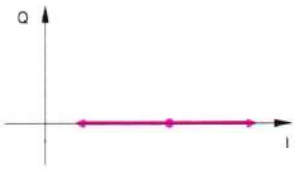
*) ASK = Amplitude Shift Keying

Broadband AM

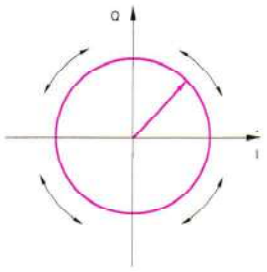
The I/Q modulator is also used for broadband amplitude modulation within a modulation bandwidth of 50 MHz. There are no limiting effects up to a level of +7 dBm; between +7 and +13 dBm, the characteristics depend on the magnitude of the modulation.

The modulation depth is a linear function of the modulation signal amplitude; an input voltage of 1 V_p causes 100% modulation.

Modulation range, linearity and bandwidth make the SMHU 58 an ideal instrument for high-quality video AM.



GMSK for testing GSM receivers



MSK and GMSK are phase-continuous modulation methods, with the I/Q vector continuously moving on a circle of constant amplitude.

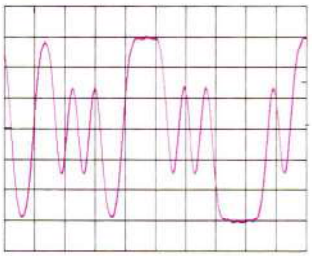
When equipped with the optional GMSK coder, the SMHU 58 provides a 0.3 GMSK modulation in line with the GSM specifications. When external signal sources are used, a data signal and a clock of 270.833 kHz must be applied. An internal PRBS*) data generator with sequences of 2^9-1 and 2^{15}-1 as well as crystal-accurate clock makes the SMHU 58 independent of external signal sources.

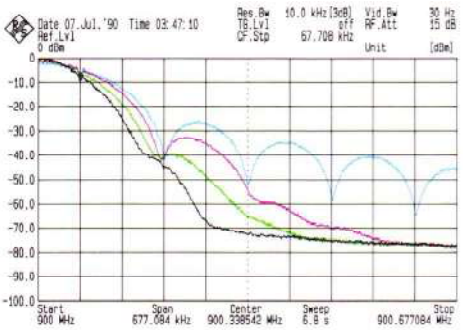
The GMSK coder filters the data signal according to the specified Gaussian function and generates precise I and Q modulation signals for phase modulation in the I/Q modulator. The rms error of the phase response produced referred to the nominal response is less than 1°.

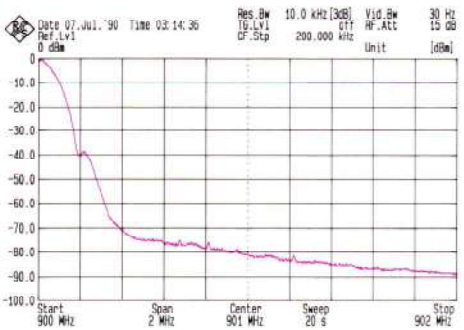
The I/Q signals generated in the GMSK coder can be picked up at the I and Q sockets. They can be used, for instance, as reference signals for comparison with the I/Q signals that are available after demodulation in the receiver.

For varying the modulation spectrum, other standard filter bandwidth values can be selected in addition to the 0.3 value; the diagrams on the left show modulation spectra for B × T = 0.2/0.3/0.5 and ∞ (MSK).

*) PRBS = Pseudo Random Binary Sequence





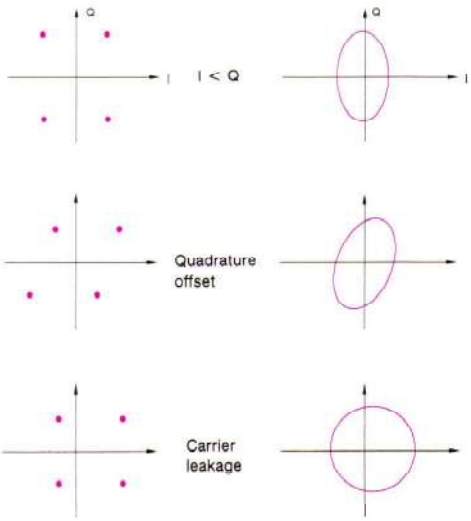


GMSK frequency response (→ 10 µs or ↑ 22.5 kHz/div) [top]; GMSK modulation spectra for B × T = 0.2 (black), 0.3 (green), 0.5 (red) and ∞ (blue) [center] as well as for B × T = 0.3, measured with a carrier offset of up to 2 MHz [bottom]

Autocalibration and error simulation

The I/Q modulator is adjusted for minimum amplitude and phase error in an automatic calibration routine. As a result, equal gain is adjusted in the I and the Q branch (I/Q balance), the phase offset set to exactly 90° (quadrature) and the carrier leakage minimized to typically –60 dBc.

These three settings can also be varied to simulate a non-ideal behaviour of the modulator. In all cases, this will result in phase and amplitude errors of the modulated signal (see diagrams); with phase-continuous modulation, there is an additional spurious deviation. With the aid of selectable defined modulation distortion, effects on bit error rates can be determined and demodulator maladjustments corrected.



Broadband FM

Broadband FM allows modulation frequencies up to 20 MHz. The lower 3-dB cutoff frequency can be set to 20 Hz or 100 kHz; switching to 100 kHz reduces the residual φM.

The frequency deviation can be adjusted in fine steps in the range from 1 kHz up to the carrier-frequency-independent maximum value of 50 MHz.

Through the simultaneous use of pulse modulation and BB-FM, the SMHU 58 can generate radar chirps with a frequency variation up to 100 MHz in less than 100 ns.

Further applications of the top-class frequency modulator are in the field of video measurements and also in satellite reception, where the first IF band (950 to 1750 MHz) and the low intermediate frequencies are within the frequency span of the SMHU 58 for BB-FM.

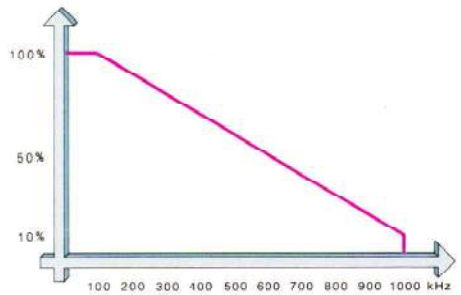
Normal FM

The modulation frequency range for FM extends from DC to 1 MHz. The maximum deviation that can be set for modulation frequencies above 100 kHz decreases linearly down to 10 % at 1 MHz.

The FM applications range from high-quality stereo modulation to fast FSK.

The maximum deviation usually decreases with the carrier frequency. This is different when FM is simultaneously used with I/Q, GMSK or BB-AM. The maximum deviation then has a constant value of 3.2 MHz in the range between 5 MHz and 1.95 GHz.

In FMDC mode, high carrier frequency accuracy is ensured by a novel frequency control circuit. When FMDC is selected, the frequency offset remains smaller than $10^{-7} \times f_c$ (f_c = carrier frequency) and smaller than 400 Hz for I/Q modulation, BB-AM and GMSK. There is practically no drift. This is particularly useful for receivers with digital signalling.

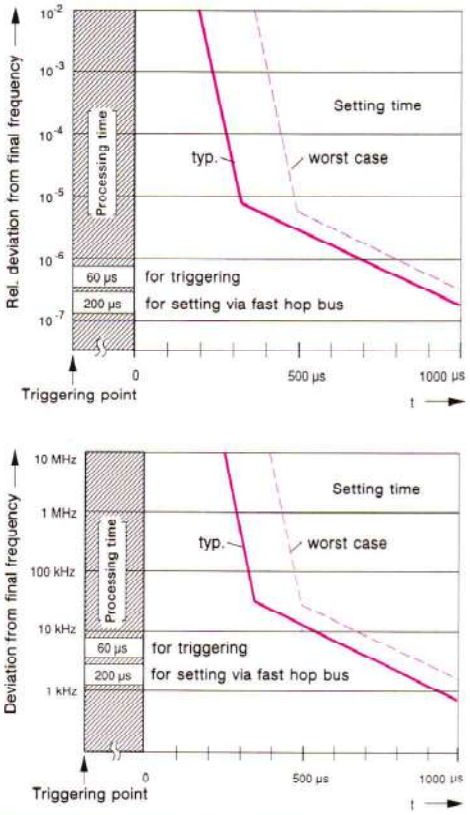


Characteristic of maximum deviation adjustable for FM

Signal Generator SMHU 58


SIGNAL GENERATOR · 100 kHz...4320 MHz · SMHU
835.8011.58
MODULATION
AF
F 3 AF 1.000 kHz
GMSK
LEVEL
-30.0 dBm
PARAMETER
MODE
DATA
ENTER/UNITS
VARIATION
AF
RF/CF
RF OFFSET
AM
LEV RF
LEV OFFSET
FM
LEV AF
FM PRE
ΦM
V-STEP
SPECIAL
INT/ON
INT FIXED
EXT AC +INT
EXT DC +INT
OFF
7 8 9
4 5 6
1 2 3
0 . -
ENTER
GHz
MHz
kHz
Hz
COARSE
MEDIUM
FINE
STEP
Δ REF
HOLD
AF
AM EXT
FM/ΦM EXT
RF 50Ω
MEMORY
STO
RCL
PRESET
AF SIGNAL
SPECIAL MODULATION MODES
AM SQU
PULSE
FSK
BB-FM
I/Q
GMSK
POWER
STANDBY

Frequency hopping



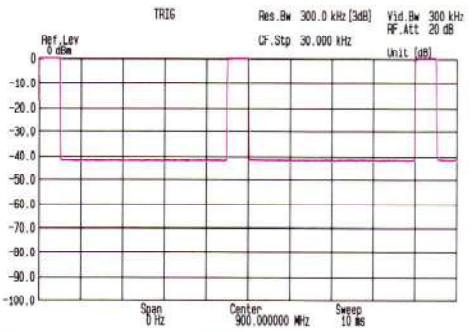
Setting time in frequency hopping mode
with AM, FM, φM and pulse modulation (top)
with I/Q modulation, GMSK, BB-AM and BB-FM (bottom)

With IEEE-bus control, the frequency setting time is below 10 ms. The setting time is actually less than 1 ms, since the processor takes 9 ms to execute the setting.

In the fast mode, which means access to already stored settings, the setting time is less than 1 ms. 4800 frequencies can be stored together with modulation and level settings in a range of 20 dB. There are two setting modes: in the first mode, the stored frequencies including modulation and level can be recalled in ascending address sequence by means of internal or external trigger pulses (time for each setup internally adjustable from 1 ms to 60 s); the second mode uses the parallel interface of the SMHU 58 for addressing the memories via a process controller. This method is mainly intended for applications, in which the hop pattern is generated according to a random algorithm.

To avoid co-location problems, the signal level is normally reduced during frequency changes. For this purpose, a synchronous 470-µs signal is available at the Z-axis output, which must be applied to the AM input (adjustable up to 40 dB) or to the pulse modulation input (80 dB) for level blanking.

Power reserve and dynamic range



Power ramping in AM EXT mode

Level range from −140 to +13 dBm
Overrange up to +19 dBm

With GMSK, the output level can be controlled over a range of 40 dB using AMDC. Level bursts can thus be produced such as used in modern communication networks.

The rise/fall times are 2 µs. Extremely short rise/fall times and an on/off ratio of greater than 80 dB can be achieved by pulse modulation. Use of the I/Q modulator provides another possibility of very fast level control.

Spectral purity

The SMHU 58 phase noise and spurious characteristics are influenced by the operating mode. Highest spectral purity is ensured in CW and AM mode, where up to 1 GHz non-harmonic spuriae are below –100 dBc. The SSB phase noise 20 kHz from a 1 GHz carrier is –134 dBc, the noise floor far from the carrier is below –145 dBc.

In the I/Q modulation, GMSK, BB-AM and BB-FM modes, the signal quality exceeds the standard required even for the most demanding measurements like for instance determination of the intermodulation rejection in line with the GSM specifications.

Useful extra facilities

Phase offset
The phase of the RF output signal can be set in 1° steps using keyboard entry or the rotary knob. This makes it easier to adjust for phase quadrature during noise measurements and to investigate phase-critical components.

Trigger facilities
The SMHU 58 can be triggered by external signals. Various trigger functions are available. For instance, using the trigger pulse, frequency, level and other parameters can be varied in defined increments in a way similar to the step key function; moreover, stored setups can be recalled. In the automatic mode, it is possible to stop or start a sweep as a function of an event.

Self-diagnostics

For maintenance and calibration, precise data on the instrument status are required. Using built-in test equipment, the SMHU 58 provides these data without any extra equipment.

Self-test enhances reliability
The signal generator status is continuously monitored. The SMHU 58 signals malfunctions and deviations from nominal values by a status indication with error code on the display and by a service request via the IEC/IEEE bus.

Built-in test equipment
The signal generator can be fully checked without any extra test equipment and without opening it up. 85 test points cover all important areas in the signal generation section like RF signal level and tuning/check voltage in the control circuits. When a test point is called up via the keyboard or the IEC/IEEE bus, its number and value are displayed. The source of a fault can thus easily be identified if there is a problem.

A diagnostic and adjustment program for process controllers compatible with the industry standard (included in Service Kit SMGU-Z2) enables automatic evaluation and logging of the device status. Adjustments can easily and rapidly be made without any extra test equipment. During the several days of burn-in following production, the SMHU 58 is continuously checked with the aid of this program. This ensures that an extremely reliable instrument tested over a wide temperature range will be delivered to the customer.

Specifications, Part I

valid for CW, AM, FM, φM and pulse modulation

Frequency

Range ..... 100 kHz to 4320 MHz
Underrange
(specs not guaranteed) ..... down to 1 kHz

Frequency bands
Switchover of the frequency bands in small steps is with hysteresis.

Frequency range (nominal) (MHz)		Frequency range (end points with hysteresis) (MHz)	
2160	to 4320	2159.000001	to 4320
1000	to 2160	1000	to 2160
500	to 1000	500	to 1000.249999
250	to 500	250	to 500.124999
125	to 250	125	to 250.062499
62.5	to 125	62.5	to 125.031249
31.25	to 62.5	31.25	to 62.515624
15.625	to 31.25	15.625	to 31.257812
0.1	to 15.625	0.1	to 15.749999
0.1	to 125*)	0.1	to 125.499999

*) With special function "heterodyne band 125 MHz"

Resolution ..... 0.1 Hz
Stability ..... same as reference frequency
Setting time ..... < 10 ms, < 1 ms in fast mode
(to within < 1 × 10⁻⁶ for f > 15.625 MHz,
< 150 Hz for f < 15.625 MHz,
with special function "heterodyne band 125 MHz"
to within < 650 Hz for f < 125 MHz)
Phase offset ..... adjustable in 1° steps
Reference frequency
Aging ..... < 1 × 10⁻⁹/day after 30 days of operation
Temperature effect ..... < 2 × 10⁻⁹/°C
Output ..... 0.5 V_{rms} into 50 Ω
Frequency ..... 5 or 10 MHz, selectable via special function
Input ..... 0.1 to 2 V_{rms}
Frequency ..... 5 or 10 MHz ±3 × 10⁻⁶

Spectral purity

Spurious signals
Harmonics ..... < −30 dBc
Subharmonics
f < 2160 MHz ..... none
f > 2160 MHz ..... < −60 dBc[1])
Nonharmonics
> 10 kHz from carrier[1])
f ≤ 1000 MHz ..... < −100 dBc[2])
f > 1000 MHz ..... < − 94 dBc
f > 2160 MHz ..... < − 88 dBc
Broadband noise for CW[1])
(at > 2 MHz from carrier;
> 5 MHz for f > 2.16 GHz,
1-Hz bandwidth) ..... typ. < −145 dBc

Single-sideband phase noise 20 kHz from carrier at 1-Hz bandwidth (FM/φM deviation < 2% of maximum deviation)[2])

15.6	125	250	500	1000	2000	4000 MHz
< −141	< −144	< −142	< −136	< −130	< −124	< −118 dBc

Typical single-sideband phase noise at 1000 MHz

Residual FM, rms (FM/φM deviation < 2% of maximum deviation)

Frequency range (MHz)	Weighting bandwidth 0.3 to 3 kHz (CCITT) (Hz)	0.03 to 20 kHz (Hz)
0.1 to 500	< 0.5	< 1
500 to 1000	< 1	< 2
1000 to 2160	< 2	< 4
2160 to 4320	< 4	< 8

Residual AM, rms
(0.3 to 3 kHz) ..... < 0.01%

Level

Range ..... −140 to +13 dBm
Overrange (specs not guaranteed) . up to 19 dBm
Resolution ..... 0.1 dB
Total error for levels > −127 dBm[1])[3])
f ≤ 2160 MHz ..... < ±1.5 dB
f > 2160 MHz ..... < ±2.5 dB
Frequency response flatness at 0 dBm[1])[3])
f ≤ 2160 MHz ..... < 1 dB (typ. 0.1 dB)
f > 2160 MHz ..... < 1.5 dB (typ. 0.2 dB)
Output impedance ..... 50 Ω
VSWR ..... < 1.8 for f ≤ 3000 MHz
< 2.5 for f > 3000 MHz
Setting time ..... < 25 ms (< 10 ms for non-interrupting level setting)
Non-interrupting level setting ..... 0 to −20 dB, from any level

Overvoltage protection

(protects the set from externally applied RF power (50-Ω source) and DC voltages)
Max. RF power ..... 30 W
Max. DC voltage ..... 35 V

Modulation generator

AF synthesizer
Frequency range
Sinewave ..... 1 Hz to 100 kHz
Sawtooth, squarewave ..... 1 Hz to 2 kHz
Resolution ..... 1 Hz
Display ..... 4 digits, floating point
Frequency error ..... < 4 × 10⁻⁵
Output level (V_p)
AF INT connector ..... 0.2 mV to 2 V
Resolution up to 200 mV ..... 0.2 mV
Resolution above 200 mV ..... 2 mV
Level error at 1 kHz ..... < 1% + 0.5 mV
Frequency response flatness
up to 20 kHz ..... < ±2.5%
up to 100 kHz ..... < ±3.5%
Distortion (level > 0.5 V) ..... < 0.1%
Setting time ..... < 5 ms
AF fixed-frequency generator ..... 409.6 Hz, 1024 Hz

Amplitude modulation

Operating modes ..... INT, EXT AC, EXT DC, two tone
Modulation depth ..... 0 to 100%
(Modulation depths meeting the AM specifications decrease linearly from 7 to 13 dBm; a status message is output if the modulation depth is too great.)
Resolution 0.1%
Setting error at 1 kHz
and m < 80%[1])
f < 2160 MHz ..... < (4% of reading + 1%)
f > 2160 MHz ..... < (6% of reading + 1%)
AM distortion at 1 kHz[1])
and m = 60% ..... < 2%
Modulation frequency (3-dB bandwidth)
AM EXT AC (DC) ..... 10 Hz (DC) to 50 kHz
AM INT ..... 1 Hz to 50 kHz
Modulation frequency response[1])
10 Hz (DC) to 20 kHz ..... < 1 dB
Incidental φM at 30% AM, f_{mod} = 1 kHz
f < 2000 MHz ..... < 0.2 rad
f > 2000 MHz ..... < 0.4 rad
Modulation input AM EXT
Input impedance ..... 100 kΩ, link-selectable to 600 Ω
Input voltage for selected modulation depth (V_p) ..... 1 V (high/low display at ±3%)

AM square (AM-SQU)

Dynamic range[1]) ..... typ. 30 dB
Rise/fall time ..... typ. 2 µs
Modulation signal (AM EXT) ..... logic signal (low < 1 V, high > 3.5 V), polarity selectable via special function

Frequency modulation

Operating modes ..... INT, EXT AC, EXT DC, two tone, preemphasis

Carrier (MHz)	Max. deviation (kHz)	Max. deviation (kHz) with preemphasis
2160 to 4320	3200	800
1000 to 2160	1600	400
500 to 1000	800	200
250 to 500	400	100
125 to 250	200	50
62.5 to 125	100	25
31.25 to 62.5	50	12.5
15.625 to 31.25	25	6.25
0.1 to 15.625	200	50
0.1 to 125*)	800	200

*) With special function "heterodyne band 125 MHz"

Resolution ..... <1%, min. 10 Hz
Setting error at
f_{mod} = 1 kHz ..... <3% of reading + 20 Hz
with preemphasis ..... <5% of reading + 20 Hz
FM distortion at 1 kHz and
half max. deviation ..... <0.2% (<1% with preemphasis)
Modulation frequency
FM INT ..... 10 Hz to 100 kHz
FM EXT AC (DC) ..... 10 Hz (DC) to 100 kHz, 10 Hz (DC) to 1 MHz (with deviation <10% of max. dev.)
Modulation frequency response
20 Hz to 100 kHz ..... <0.5 dB
Preemphasis ..... 50 µs, 75 µs
Incidental AM at f_{mod} = 1 kHz, deviation = 40 kHz (f >1 MHz) ..... <0.1%
Carrier frequency deviation at FM
f >15.625 MHz ..... $<1 \times 10^{-7} \times f_c$ +1% of deviation
f <15.625 MHz ..... <15 Hz +1% of deviation
With special function "heterodyne band 125 MHz" for
f <125 MHz ..... <65 Hz +1% of deviation
Modulation input FM/φM EXT
Input impedance ..... 100 kΩ, link-selectable to 600 Ω
Input voltage for selected deviation (V_p) ..... 1 V (high/low display at ±3%)

FSK modulation

The deviation is the same as for FM.
Frequency accuracy ..... same as for FM AC + 4% of deviation
Rise/fall time ..... 10 µs
Modulation signal (FM/φM EXT) .... logic signal (low <1 V, high >3.5 V), polarity selectable via special function

Phase modulation

Operating modes ..... INT, EXT AC, two tone

φM deviation

Carrier (MHz)	Max. deviation (rad)
2160 to 4320	320
1000 to 2160	160
500 to 1000	80
250 to 500	40
125 to 250	20
62.5 to 125	10
31.25 to 62.5	5
15.625 to 31.25	2.5
0.1 to 15.625	20
0.1 to 125*)	80

*) With special function "heterodyne band 125 MHz"

Resolution ..... <1%, min. 0.001 rad
Setting error at f_{mod} = 1 kHz ..... <5% of reading + 0.01 rad
φM distorsion at f = 1 kHz
and half max. deviation ..... <0.5%
Modulation frequency ..... 10 Hz to 10 kHz
Modulation frequency response
10 Hz to 10 kHz ..... <1 dB
Carrier frequency deviation ..... same as for FM (FM dev. = φM dev. x 10 kHz)
Modulation input FM/φM EXT
Input impedance ..... 100 kΩ, link-selectable to 600 Ω
Input voltage for selected deviation (V_p) ..... 1 V (high/low display at ±3%)

Pulse modulation

Operating mode ..... external
On/off ratio ..... >80 dB
Rise/fall time ..... <20 ns (f >125 MHz)
Modulation signal ..... HCT signal, polarity selectable via special function

Sweep

Operating modes ..... automatic, single-shot or manual

	RF sweep	AF sweep	RF level sweep	Memory sweep
Sweep range	user-selectable	user-selectable	0.1 to 20 dB	user-selectable
Step width (lin)	user-selectable	user-selectable	—	1
Step width (log)	0.01 to 50%	0.01 to 50%	0.1 to 20 dB	—
Step time	10 ms to 1 s	10 ms to 1 s	10 ms to 1 s	50 ms to 60 s 1 ms to 60 s*)
Marker	user-selectable	user-selectable	user-selectable	—

*) in fast mode

X output ..... 0 to 10 V
Z output ..... 0/5 V logic signal, polarity selectable via special function

Remote control

System ..... IEC 625-1 (IEEE 488)
Connector ..... 24-contact Amphenol
Remote-controllable functions ..... all, except those of spinwheel and power switch
IEC-bus address ..... selectable via keypad (0 to 30)
Interface functions SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT1, C0

General data

Rated temperature range ..... 0 to 50 °C
Storage temperature range ..... −40 to +75 °C
RF leakage ..... meets VDE 0871 and MIL-STD-461B (Methods CE 03 and RE 02), radiated and conducted interference; also meets VDE 0875 (RFI suppression grade K)
Mechanical stress ..... shock-tested to DIN 40046, part 7 (30 g, 11 ms) and vibration-tested to DIN 40046, part 8 (5 to 55 Hz, 2 g); corresponds to IEC Publications 68-2-27 and 68-2-6
Power supply ..... 100/120/220/240 V ±10% 47 to 63 Hz (max. 270 VA) safety class I to VDE 0411 (IEC 348)
Dimensions (W x H x D) ..... 435 mm x 192 mm x 460 mm
Weight ..... 26 kg

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[1]) Does not apply to special function "non-interrupting level setting".
[2]) Does not apply to special function "heterodyne band 125 MHz".
[3]) Does not apply to special function "level control off" and to pulse modulation.

Specifications, Part 2

valid for I/Q modulation, GMSK, BB-FM and BB-AM, supplementary data to Part 1

Frequency

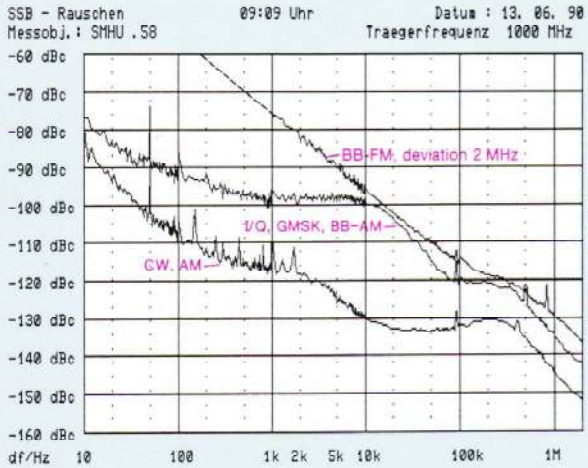
Range ..... 10 to 1900 MHz
Overrange
(specs not guaranteed) ..... 1 to 2000 MHz
Setting time for frequency change
(phase drift < 4° within one
577-µs time slot) ..... < 4 ms in fast mode

Spectral purity

Spurious signals
Harmonics ..... < −30 dBc
Nonharmonics at
> 10 kHz from carrier[1]) in
frequency range 10 to 250 MHz .. < −74 dBc
845 to 1005 MHz . < −74 dBc
1650 to 1900 MHz . < −74 dBc
10 to 1900 MHz . −45 dBc

Broadband noise with
I/Q modulation, GMSK and BB-FM
(deviation < 2 MHz),
carrier offset > 2 MHz,
1-Hz bandwidth ..... typ. < −135 dBc[1])

Single-sideband phase noise with
I/Q modulation, GMSK and BB-AM,
1-Hz bandwidth,
carrier offset 1 kHz ..... < −94 dBc
20 kHz ..... < −98 dBc
100 kHz ..... < −112 dBc



Typical single-sideband phase noise at 1000 MHz

Residual FM, rms at 1000 MHz

Operating mode	Weighting bandwidth 0.3 to 3 kHz (CCITT) (Hz)	0.03 to 20 kHz (Hz)
I/Q, GMSK, BB-AM	< 8	< 40
BB-FM, deviation < 0.4 MHz	< 20	< 50
BB-FM, deviation 0.4 to 2 MHz	< 40	< 100
BB-FM, deviation 2 to 10 MHz	< 100	< 500
BB-FM, deviation > 10 MHz	< 400	< 2000

2nd RF output (RF II)

Unmodulated coherent carrier if I/Q, GMSK or BB-AM is selected.
The output level is unregulated.
Frequency range ..... 10 to 1900 MHz
Output level ..... typ. −3 to +3 dBm
Output impedance ..... 50 Ω

Broadband AM

Operating mode ..... EXT DC
Level range ..... up to +7 dBm
(overrange up to +13 dBm)

Modulation frequency response at
140 MHz and m = 60 %
DC to 50 MHz ..... < 3 dB
AM distortion at
f_{mod} = 1 kHz and m = 60 % ..... < 0.5 %
Incidental φM at 30 % AM,
f_{mod} = 1 kHz ..... typ. 0.003 rad

Modulation input BB-AM

Input impedance ..... 50 Ω
Input voltage V_p for
100 % modulation ..... 1 V ±4 %

Frequency modulation

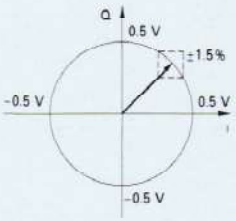
Normal FM with I/Q,
GMSK and BB-AM
Maximum deviation ..... 3200 kHz

Broadband FM (BB-FM)

Operating modes ..... INT, EXT AC
Deviation range ..... 50 kHz to 50 MHz,
adjustable from 1 kHz
Resolution ..... < 1 %, min. 1 kHz
Setting error at f_{mod} = 1 kHz,
deviation ≤ 25 MHz ..... < 5 % of reading
FM distortion at f_{mod} = 1 kHz,
deviation = 25 MHz, carrier
frequency 100 to 1800 MHz ..... < 0.5 %
Modulation frequency
BB-FM, INT ..... 20 Hz to 100 kHz
BB-FM, EXT AC ..... 20 Hz to 20 MHz
Modulation frequency response at
a carrier frequency of 100 to 1800 MHz,
deviation < 25 MHz,
20 Hz to 20 MHz ..... < 3 dB
50 Hz to 10 MHz ..... typ. < 1 dB
Modulation input BB-FM
Input impedance ..... 50 Ω, link-selectable to 75 Ω
Input voltage for
selected deviation (V_p) ..... 1 V

I/Q modulation

Vector DC accuracy, referred
to full-scale I input,
fed from 50-Ω source,
input voltage range $\sqrt{I^2+Q^2} \leq 0{,}5$ V
carrier 140 MHz ..... < 1.5 %[2])
10 to 1900 MHz ..... typ. < 1.5 %[2])



Magnitude worst-case error ..... $\leq 20 \log \left(\frac{\sqrt{I^2+Q^2} \pm 10.6\ mV}{\sqrt{I^2+Q^2}}\right)$ dB[2])

Phase worst-case error ..... $\leq \pm \arctan \left(\frac{10.6\ mV}{\sqrt{I^2+Q^2}}\right)$ degree[2])

Modulation frequency response
f_{mod} = DC to 200 MHz
carrier 1000 MHz ..... < 3 dB
250 to 1500 MHz ..... typ. < 3 dB

Residual carrier at 0 V input voltage,
fed from 50-Ω source (I and Q),
ref. to full-scale input
carrier 140 MHz ..... < 0.3 %[2])
10 to 1900 MHz ..... typ. < 0.3 %[2])

I/Q impairment
Carrier leakage
Setting range ..... 0 to 50 %
Resolution ..... 1 %
I ≠ Q
Setting range ..... −12 to +12 %
Resolution up to 10 % ..... 0.1 %
above 10 % ..... 1 %
Quadrature offset
Setting range ..... −9.9 to +9.9°
Resolution ..... 0.1°

Modulation inputs I and Q
Input impedance ..... 50 Ω
VSWR (DC to 200 MHz) ..... < 1.4
Input voltage for
full-scale magnitude ..... ±0.5 V (±1 V EMF, 50-Ω source)

GMSK modulation (option SMHU-B2)

Operating mode ..... internal with pseudo-random binary sequence, external

PRBS (pseudo-random binary sequence) ..... 2^9-1 sequence length to CCITT Rec. V52 or $2^{15}-1$ to CCITT Rec. 0.151, selectable via special function

Differential coding ..... to GSM Rec. 05.04, selectable via special function

Selectable filters

Filter No.	Modulation, filter
1	GMSK, B x T = 0.2
2	GMSK, B x T = 0.25
3	GMSK, B x T = 0.3
4	GMSK, B x T = 0.4
5	GMSK, B x T = 0.5
6	GMSK, B x T = 0.7
7	GMSK, B x T = 1
9	MSK, 0.7 MHz (3 dB)
10	TFM

Data rate ..... 270.833 kHz ±13.5 Hz

Modulation phase error[2])

rms ..... <1°

peak ..... <3°

Modulation inputs DATA, CLOCK

Input levels ..... TTL

Input impedance ..... 1 kΩ

The polarity of the active clock edge and of the modulation deviation can be selected via special functions

Ordering information

Order designation ..... ▶ Signal Generator SMHU 58 835.8011.58

Accessories supplied ..... power cable, manual

Option

GMSK Coder ..... SMHU-B2 ..... 820.4350.02

Recommended extras

Rear-panel connectors for RF and AF ..... SMGU-Z9 ..... 820.4415.02

19" Rack Adapter ..... ZZA-94 ..... 396.4905.00

Service Kit ..... SMGU-Z2 ..... 820.4515.02

Service Manual 836.3771.24

Transport Case ..... ZZK-944 ..... 1013.9366.00

Trolley ..... ZZK-1 ..... 1014.0510.00

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[1]) Does not apply to special function "non-interrupting level setting".

[2]) Applies after 1 hour warmup and recalibration using special function "calibration routine for I/Q modulation" for 4 hours operation and temperature variations of less than 5 degrees.

Rear view of SMHU 58