Vector Signal Generator R&S SMV03

Vector modulation in the analog class

- Frequency range 9 kHz to 3.3 GHz
- I/Q modulator (100 MHz RF bandwidth) with excellent vector accuracy (f >500 MHz to 3 GHz)
- SSB phase noise –128 dBc (1 Hz)
- Setting times <10 ms
- High level accuracy <0.5 dB
- High reliability through electronic attenuator
- Digital frequency and level sweep
- AM/FM/φM
- Optional pulse modulator with integrated pulse generator
- 3-year calibration cycle

ROHDE&SCHWARZ

The allrounder

The Vector Signal Generator R&S SMV03 is based on the successful analog Signal Generator R&S SML03 and so features the same excellent technical characteristics. It comprises an additional broadband I/Q modulator which is able to generate any digital signal in conjunction with an external I/Q source. The R&S SMV03 is, therefore, a way of entering the wide field of automatic test systems as well as gaining access to applications like R&D and service. When used together with the R&S AMIQ and R&S WinIQSIM™, the R&S SMV03 can generate digital signals that meet any requirement.

RF characteristics

- Frequency range from 9 kHz to 3.3 GHz with 0.1 Hz resolution
- High output level of +13 dBm with a deviation <0.5 dB
- Interruption-free level setting by electronic attenuator
- High spectral purity (<–122 dBc (1 Hz) at f = 1 GHz and 20 kHz carrier offset)
- Frequency and level setting time <10 ms

Vector modulation

- Wide I/Q bandwidth of >50 MHz (3 dB), 100 MHz RF bandwidth for f >500 MHz to 3 GHz
- High vector accuracy

Analog modulation

- AM/FM/φM as standard
- Simultaneous AM, FM/φM, pulse and vector modulation
- Optional pulse modulator with integrated pulse generator (R&S SML-B3)

Dimensions

- Compact size 427 mm x 88 mm x 450 mm
- Low weight <9.5 kg

Low cost of ownership

- 3-year calibration cycle
- Electronic attenuator for wear-free operation
- Service-friendly (continuous selftest, access to internal test points)

Applications

Production: fast, accurate, reliable

Versatility
The R&S SMV03 generates all kinds of I/Q-modulated signals using the integrated vector modulator. Thanks to its wide I/Q bandwidth of 50 MHz, the R&S SMV03 is also optimally suited for applications using high data rates such as WLAN standards. Signals to digital stan-dards can be easily generated in conjunction with an external I/Q source like the Modulation Generator R&S AMIQ (PD 0757.3970) and the associated R&S WinIQSIM™ simulation software (PD 0757.6940).

The R&S SMV03 therefore optimally meets production environment requirements.

Dimensions
The compact size (only 2 HU) makes the R&S SMV03 ideal for use in production where space is often limited.

Speed
Speed is essential – especially in production. And this is exactly where the R&S SMV03 shows what it can do with a frequency and level setting time of <10 ms.

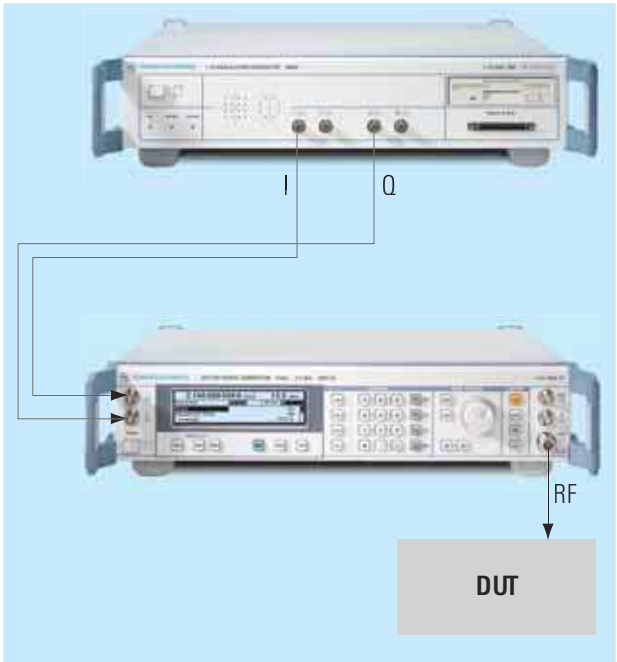
Accuracy
Any measurement uncertainty has two components: the uncertainty due to the measuring instrument and that due to the rest of the test setup. The lower the level uncertainty of the vector signal generator, the greater the test setup tolerance that may be allowed. If greater tolerances can be allowed for the DUT because of the small level error of the R&S SMV03, production rejects can be markedly reduced – an advantage that pays off immediately.

Reliability
A signal generator used in production must feature high reliability. The R&S SMV03 meets this requirement, for example, through the use of a completely wear-free electronic attenuator.

Output level
In production test systems, the signal is routed to the DUT via switches and cables which introduce losses. This can be compensated for by the high output power of the R&S SMV03.

Example: component test

- Tests using digital signals are becoming increasingly important for checking the functions of individual components – especially at the component production stage. In this environment, the R&S SMV03's I/Q modulator shows what it can do. Thanks to its wide signal bandwidth of 50 MHz, it can generate a great variety of digital signals when an external I/Q source is used.
- To obtain reliable information on component quality, high level accuracy and high output level repeatability are essential. The R&S SMV03 fully meets these requirements thanks to a maximum level uncertainty of <0.5 dB (at levels >–120 dBm) and high reproducibility.
- Extremely short frequency and level setting times (<10 ms) allow fast measurements and make the R&S SMV03 the ideal generator for production testing.
- Overshoots that occur when the level is changed may damage or even destroy the DUT. This cannot happen with the R&S SMV03 as no overshoots are produced.



Applications

Lab and R&D: versatile

Versatile modulation modes
Particularly in research, a great variety of digital signals are used in the development of new systems, which are not always covered by a standard. Thanks to its very wideband I/Q modulator, the R&S SMV03 can handle universal tasks of this kind.

In conjunction with the optional Pulse Modulator R&S SML-B3, the vector signal generator can also handle all types of analog modulation. AM, FM/φM and pulse modulation can be used simultaneously as can vector modulation, FM/φM and pulse modulation.

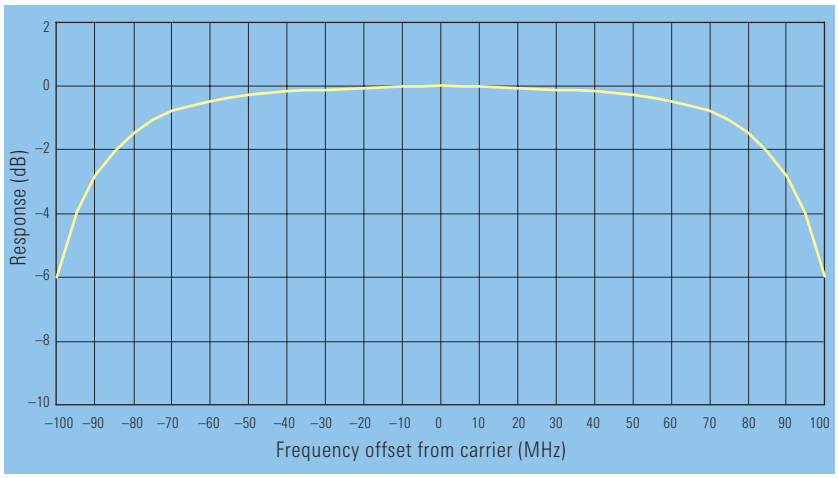
High spectral purity
Thanks to its low phase noise, the R&S SMV03 is ideally suited to replace LOs.

High and accurate output level
The high level accuracy of the Vector Signal Generator R&S SMV03 is a prerequisite for highly accurate measurements on sensitive analog and digital receivers. Its high output level makes the R&S SMV03 an ideal source for driving high-level mixers.

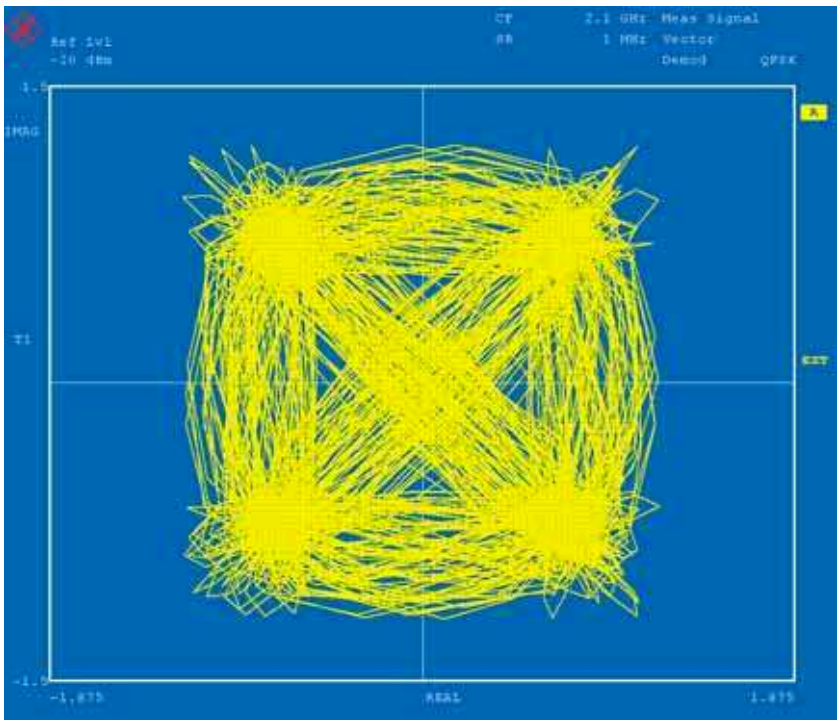
Excellent modulation characteristics
As the R&S SMV03 provides high-linearity FM, it can be used as a precise VCO.

Example: receiver measurements

- Sensitivity measurements require a signal generator with high level accuracy. High accuracy is even more critical at low output levels. Thanks to its sophisticated calibration methods, the R&S SMV03 features high level accuracy (uncertainty <0.5 dB at levels >–120 dBm).
- Minimal spurious, minimal broadband noise and, above all, excellent SSB phase noise are prerequisites for using the R&S SMV03 as an interference source.
  With an SSB phase noise of typ. –128 dBc/Hz (at f = 1 GHz, Δf = 20 kHz), spurious suppression of typ. –76 dBc and broadband noise of typ. –150 dBc (1 Hz), the R&S SMV03 meets even the most exacting requirements.
- The mechanical design of the R&S SMV03 ensures excellent RF shielding of its casing. This is particularly important for measurements on highly sensitive receivers with built-in antenna.



Frequency response of I/Q modulator (carrier frequency 1 GHz)



Vector diagram of QPSK signals

Servicing: robust, compact, lightweight

Mobility
The R&S SMV03 is lightweight (<9.5 kg) and compact and therefore very easy to transport.

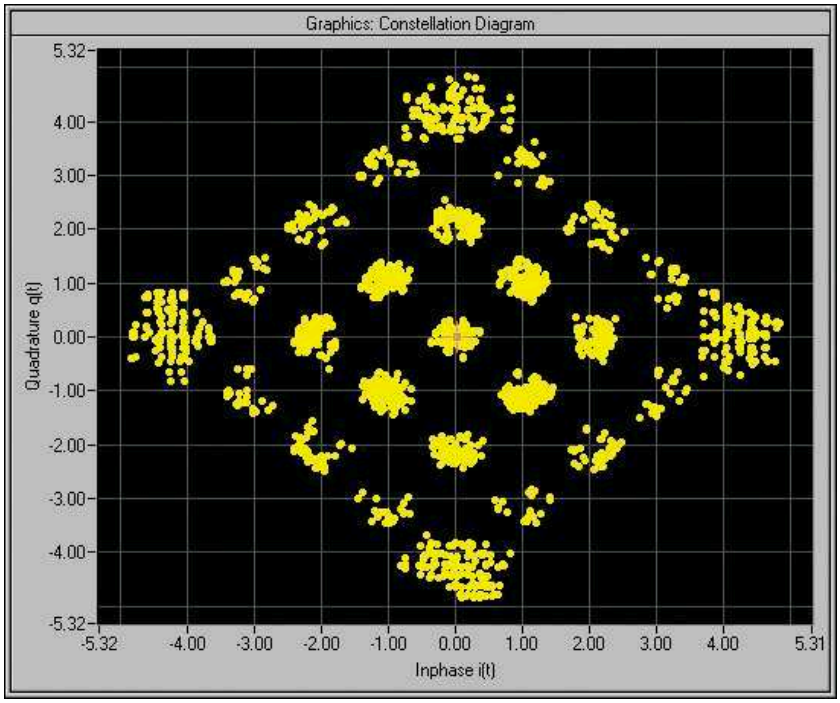
Flexible control
In service environments, an IEC/IEEE bus interface is not always available to control the generator. This is not a problem as the R&S SMV03 can also be controlled via a standard RS-232-C interface.

Protection against overvoltage
The integrated overvoltage protection of the RF output protects the R&S SMV03 against very high external voltages such as may occur during transceiver measurements.

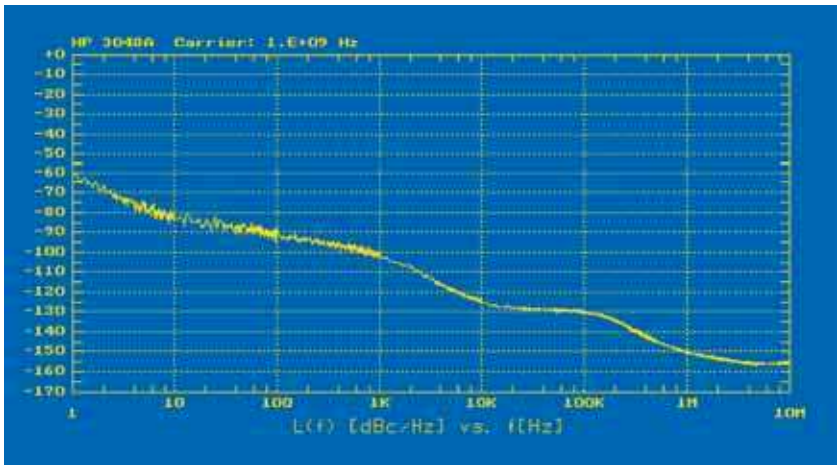
EMS measurements

Interruption-free level setting without overshoots
EMS measurements require interruption-free level setting which should also be overshoot-free. The R&S SMV03 does not produce any overshoots – even at setting times <10 ms. Furthermore, it has a wide dynamic range of typ. 30 dB over which level adjustment is interruption-free.

Wide frequency range
The R&S SMV03 features a lower frequency limit of 9 kHz as standard and so fully covers the frequency range required for EMC measurements.



Constellation diagram of WCDMA signal in 3GPP TDD mode



Typical SSB phase noise at 1 GHz (with OCXO option R&S SML-B1)

Module test with R&S SMV03, R&S AMIQ and Spectrum Analyzer R&S FSP

Reference source

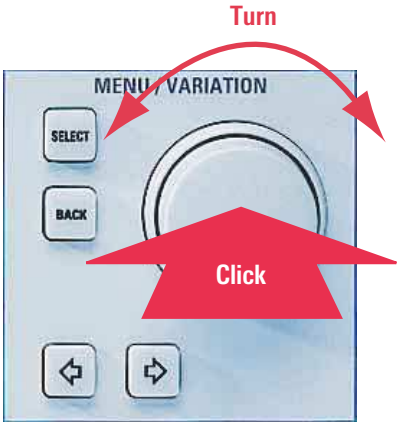
The R&S SMV03 allows selection of the mode of frequency generation. In the extended divider range mode, the RF signal is generated by frequency division. The excellent values obtained in this mode for SSB phase noise are comparable to those from the high-grade crystal oscillators normally used as reference sources from 10 MHz to 30 MHz.

Compared to crystal oscillators, the R&S SMV03 has the following benefits:

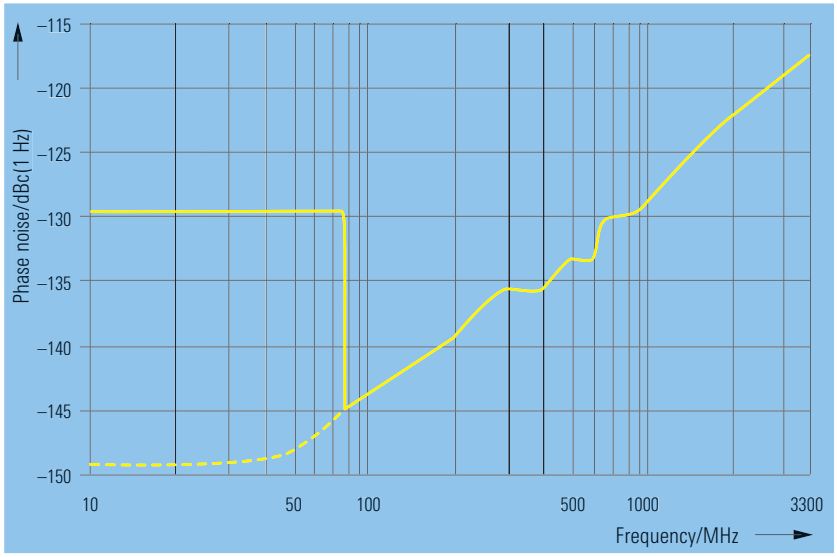
- Frequency can be set in 0.1 Hz steps and synchronized to an external reference
- All functions can be remotely controlled via the IEC/IEEE bus or serial interface

EasyWheel

- One-hand operation with EasyWheel
- All settings simple and self-explanatory
- High-contrast LCD
- User-assignable menu keys
- Online help including IEC/IEEE bus commands



Simply select the desired menu with the spinwheel and click the button to open the submenu



Typical SSB phase noise versus carrier frequency (carrier offset 20 kHz); dashed line: extended divider range mode

Offset from carrier	SSB phase noise, typical values
1 Hz	–95 dB
10 Hz	–120 dB
100 Hz	–130 dB
1 kHz	–138 dB
10 kHz	–148 dB

SSB phase noise at 9.5 MHz output frequency, extended divider range activated, 1 Hz measurement bandwidth

Certified Quality System
ISO 9001
DQS REG. NO 1954

Certified Environmental System
ISO 14001
REG. NO 1954

Specifications

Specifications apply under the following conditions:
30 minutes warmup time at ambient temperature, specified environmental conditions met, calibration cycle adhered to, and total calibration performed.
Data designated "nominal" are design parameters and are not tested.
Data designated "overrange" are not warranted.
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Frequency

R&S SMV03	
I/Q modulation off	9 kHz to 3.3 GHz
I/Q modulation on	5 MHz to 3.3 GHz
Resolution	0.1 Hz
Setting time (for an offset of $<1x10^{-7}$ or <90 Hz for f ≤76 MHz) after IEC/IEEE bus delimiter	
I/Q modulation off	<10 ms
I/Q modulation on	<12 ms

Reference frequency

	Standard	Option R&S SML-B1
Aging (after 30 days of operation)	$<1 \times 10^{-6}$/year	$<1 \times 10^{-7}$/year $<5 \times 10^{-10}$/day
Temperature effect (0 °C to 55 °C)	$<1 \times 10^{-6}$	$<2 \times 10^{-8}$
Output for internal reference		
Frequency	10 MHz	
Output voltage, V rms, sinewave	>0.5 V into 50 Ω	
Source impedance	50 Ω	
Input for external reference		
Frequency	10 MHz	
Permissible frequency drift	5×10^{-6}	
Input voltage, V rms, sinewave	0.5 V to 2 V into 50 Ω	
Input impedance	50 Ω	

Spectral purity

Spurious signals	
Harmonics[1] (for f >100 kHz)	<–30 dBc at levels ≤+8 dBm
Subharmonics	
f ≤1.1 GHz	–
f >1.1 GHz	<–50 dBc
Nonharmonics	
(carrier offset >10 kHz)	
f ≤1.1 GHz	<–70 dBc
f >1.1 GHz to 2.2 GHz	<–64 dBc
f >2.2 GHz to 3.3 GHz	<–58 dBc
Broadband noise[2] [3] (f = 1 GHz, carrier offset >2 MHz, 1 Hz bandwidth)	<–135 dBc, –140 dBc typ.
SSB phase noise (f = 1 GHz, 20 kHz carrier offset, 1 Hz bandwidth)	<–122 dBc, –128 dBc typ.
Spurious FM, rms (f = 1 GHz)	
0.3 kHz to 3 kHz	<4 Hz, 1 Hz typ.
0.03 kHz to 20 kHz	<10 Hz, 3 Hz typ.
Spurious AM, rms	
0.03 kHz to 20 kHz	<0.02%

Level

Range	–140 dBm to +13 dBm [2] [4] (overrange +19 dBm)
Resolution	0.1 dB
Level accuracy [2] [3] (level >–120 dBm)	
100 kHz to ≤2 GHz	<0.5 dB
f >2 GHz	<0.9 dB
Frequency response at 0 dBm[2] [3]	
100 kHz to ≤2 GHz	<0.7 dB
f >2 GHz	<1.0 dB
Characteristic impedance	50 Ω
SWR	
100 kHz to 1.5 GHz	1.6
f >1.5 GHz	2.3
Setting time (IEC/IEEE bus), f >100 kHz	<10 ms, 5 ms typ.
Interruption-free level setting[5] (for f >100 kHz)	
I/Q modulation off	20 dB, overrange 30 dB
I/Q modulation on	15 dB, overrange 20 dB
Overvoltage protection	safeguards unit against externally applied RF power and DC voltage (50 Ω source)
Max. permissible RF power	
f ≤2.2 GHz	50 W
f >2.2 GHz	25 W
Max. permissible DC voltage	35 V

Vector modulation

Additional level inaccuracy in case of vector modulation (ALC OFF), referred to CW mode	<0.3 dB
Operating mode	external DC
I and Q modulation inputs	
Input impedance	50 Ω
SWR (DC to 30 MHz)	<1.2
Input voltage for full-scale level	$\sqrt{I^2 + Q^2} = 0.5V$ (1 V EMF with 50 Ω source)
Static error vector[6], Level <+8 dBm	
Rms value	
f <2.6 GHz	<0.5%
f >2.6 GHz to f=3 GHz	<0.7%
Peak value	
f <2.6 GHz	<1%
f >2.6 GHz to f=3 GHz	<1.4%
Modulation frequency response	
f >500 MHz to 3 GHz	
DC to 5 MHz	<0.4 dB
DC to 50 MHz	<3 dB
f <500 MHz and f >3 GHz[7]	
DC to 5 MHz	<0.4 dB
DC to 30 MHz	<3 dB
Residual carrier at 0 V input voltage referred to max. input voltage	<–45 dBc (at f=5 MHz to 3 GHz)
I/Q imbalance	
Carrier leakage	
Setting range	0% to 50%
Resolution	0.5%
I≠Q	
Setting range	–12% to +12%
Resolution	0.1%
Quadrature offset	
Setting range	–10° to +10°
Resolution	0.1°
Adjacent-channel leakage ratio (ACLR) WCDMA 3GPP FDD (f = 2.14 GHz) Test model 1 (64 DPCHs)	
Offset 5 MHz	nom. >60 dB, 62 dB typ.
Offset 10 MHz	nom. >64 dB, 66 dB typ.

Internal modulation generator

Frequency range	0.1 Hz to 1 MHz
Resolution	0.1 Hz
Frequency accuracy	as for reference frequency + 2.4×10^{-3} Hz

Frequency response (up to 500 kHz, level >100 mV)	<0.5 dB
THD (up to 100 kHz, level 4 V, R_L = 600 Ω)	<0.1%
Open-circuit voltage V_p (LF connector) Resolution Setting accuracy (at 1 kHz)	1 mV to 4 V 1 mV 1% of V_p + 1 mV
Output impedance	approx. 10 Ω
Frequency setting time (after reception of last IEC/IEEE bus character)	<10 ms
Simultaneous modulation	AM, FM/φM and pulse modulation or vector modulation, FM/φM and pulse modulation

Amplitude modulation[8)]

Operating modes	internal, external AC/DC, internal/external two-tone
Modulation depth	0% to 100% settable modulation depth continuously decreasing between +7 dBm and +13 dBm[9)] while adhering to AM specifications; a status message is output when the modulation depth is too high
Resolution	0.1%
Setting accuracy at 1 kHz (m <80%)[10)]	<4% of reading +1%
AM distortion at 1 kHz m = 30% m = 80%	<1% <2%
Modulation frequency range (<3 dB)	DC/10 Hz to 50 kHz
Incidental φM at AM (30%), AF = 1 kHz	<0.2 rad
Modulation input EXT Input impedance Input voltage V_p for set modulation depth	>100 kΩ 1 V

Frequency modulation

Operating modes	internal, external AC/DC, internal/external two-tone
Frequency deviation 9 kHz to 76 MHz >76 MHz to 151.3125 MHz >151.3125 MHz to 302.625 MHz >302.625 MHz to 605.25 MHz >605.25 MHz to 1.2105 GHz >1.2105 GHz to 1.818 GHz >1.818 GHz to 2.655 GHz >2.655 GHz to 3.300 GHz	 0 Hz to 1 MHz 0 Hz to 125 kHz 0 Hz to 250 kHz 0 Hz to 500 kHz 0 Hz to 1 MHz 0 Hz to 2 MHz 0 Hz to 3 MHz 0 Hz to 4 MHz
Resolution	<1% of set deviation, minimum 10 Hz
Setting accuracy (at AF = 1 kHz)	<4% of reading + 20 Hz
FM distortion (at AF = 1 kHz and 50% of max. deviation)	<0.2%, 0.1% typ.
Modulation frequency range (<3 dB) Standard Wide	 DC to 100 kHz 10 Hz to 500 kHz
Incidental AM (at AF = 1 kHz, f >10 MHz, 40 kHz deviation)	<0.1%
Stereo modulation at 40 kHz useful deviation, AF = 1 kHz, RF = 87 MHz to 108 MHz Crosstalk S/N ratio unweighted, rms S/N ratio weighted, rms Distortion	 >50 dB >70 dB >70 dB <0.2%, 0.1% typ.
Carrier frequency offset at FM DC	0.1% typ. of set deviation
Modulation input EXT Input impedance Input voltage V_p for set deviation (nominal value)	 >100 kΩ 1 V

Phase modulation

Operating modes	internal, external AC/DC, internal/external two-tone
Phase deviation[11)] 9 kHz to 76 MHz >76 MHz to 151.3125 MHz >151.3125 MHz to 302.625 MHz >302.625 MHz to 605.25 MHz >605.25 MHz to 1.2105 GHz >1.2105 GHz to 1.818 GHz >1.818 GHz to 2.655 GHz >2.655 GHz to 3.300 GHz	 0 rad to 10 (2) rad 0 rad to 1.25 (0.25) rad 0 rad to 2.5 (0.5) rad 0 rad to 5 (1) rad 0 rad to 10 (2) rad 0 rad to 20 (4) rad 0 rad to 30 (6) rad 0 rad to 40 (8) rad
Resolution	<1%, min. 0.001 rad
Setting accuracy at AF = 1 kHz	<4% of reading + 0.02 rad
Phase distortion (at AF = 1 kHz and 50% of maximum deviation)	<0.2%, 0.1% typ.
Modulation frequency range (–3 dB) Standard Wide	 DC to 100 kHz 10 Hz to 500 kHz
Modulation inputs EXT Input impedance Input voltage V_p for set deviation (nominal value)	 >100 kΩ 1 V

Pulse modulation (with option R&S SML-B3)

Operating modes	internal, external
On/off ratio	>80 dB
Rise/fall time (10%/90%)	<20 ns, 10 ns typ.
Pulse repetition frequency	0 Hz to 2.5 MHz
Pulse delay	50 ns typ.
Video crosstalk (V_p)	<30 mV
Modulation input PULSE Input level Input impedance	 TTL level (HCT) 10 kΩ or 50 Ω, selectable with internal link

Pulse generator (with option R&S SML-B3)

Operating modes	automatic, externally triggered, external gate mode, single pulse, double pulse, delayed pulse (externally triggered)
Active trigger edge	positive or negative
Pulse period Resolution Accuracy	100 ns to 85 s 5 digits, min. 20 ns <1 x 10^{-4}
Pulse width Resolution Accuracy	20 ns to 1 s 4 digits, min. 20 ns <1 x 10^{-4} + 3 ns
Pulse delay Resolution Accuracy	20 ns to 1 s 4 digits, min. 20 ns <1 x 10^{-4} + 3 ns
Double-pulse spacing Resolution Accuracy	20 ns to 1 s 4 digits, min. 20 ns <1 x 10^{-4} + 3 ns
Trigger delay	50 ns typ.
Jitter	<10 ns
PULSE/VIDEO output	TTL signal (R_L ≥50 Ω)

Sweep	digital in discrete steps
RF sweep, AF sweep	
Operating modes	automatic, single-shot, manually or externally triggered, linear or logarithmic
Sweep range	user-selectable
Step width (lin)	user-selectable
Step width (log)	0.01% to 100%
Level sweep	
Operating modes	automatic, single-shot, manually or externally triggered, logarithmic
Sweep range	user-selectable
Step width (log)	user-selectable
Step time	10 ms to 1 s
Resolution	0.1 ms
Trigger input	
Input level	TTL (HCT)
Input impedance	10 kΩ (pull-up)

Memory for device settings

Number of storable settings	100

Remote control

System	IEC 60625 (IEEE 488) and RS-232-C
Command set	SCPI 1995.0
Connector	Amphenol, 24-pin and 9-pin
IEC/IEEE bus address	0 to 30
Interface functions	SH1, AH1, T6, L4, SR1, RL1, PP1, DC1, DT1, C0

General data

Rated temperature range	0°C to 55°C; meets IEC 68-2-1 and IEC 68-2-2
Storage temperature range	–40°C to +70°C
Climatic resistance	
Damp heat	95% relative humidity at +25°C/ +40°C cyclically; meets IEC 60068
Mechanical resistance	
Vibration, sinusoidal	5 Hz to 150 Hz, max. 2 g at 55 Hz, max. 0.5 g between 55 Hz and 150 Hz, meets IEC 60068, IEC 61010 and MIL-T-28800D, class 5
Vibration, random	10 Hz to 300 Hz, acceleration 1.2 g (rms)
Shock	40 g shock spectrum, meets MIL-STD-810D and MIL-T-28800D, class 3/5
Electromagnetic compatibility	meets EN 55011 and EN 61326-1 (EMC directive of EU)
Immunity to radiated interference	10 V/m
Power supply	100 V to 120 V (AC), 50 Hz to 400 Hz, 200 V to 240 V (AC), 50 Hz to 60 Hz, autoranging, max. 250 VA
Safety	meets DIN EN 61010-1, IEC 1010-1, UL 3111-1, CSA 22.2 No. 1010-1
Dimensions (W x H x D)	427 mm x 88 mm x 450 mm
Weight	9.5 kg when fully equipped

1) With option R&S SML-B3 only for f > 20 MHz.
2) With attenuator mode auto.
3) Temperature range 20°C to 30°C.
4) –140 dBm to 11 dBm at f ≤5 MHz, f >3 GHz.
5) With attenuator mode fixed.
6) After 1 hour warmup and recalibration within 4 hours of operation after temperature variations <5°C.
7) The modulation bandwidth continuously decreases upon approaching 5 MHz or. 3.3 GHz.
8) With attenuator mode auto, f ≥100 kHz.
9) +5 dBm to +11 dBm at f ≤5 MHz, f >3 GHz.
10) With option R&S SML-B3 only for f >10 MHz.
11) Values in brackets apply to wide modulation bandwidth.

Ordering information

Vector Signal Generator	R&S SMV03	1147.7509.13
Accessories supplied		power cable, user manual
Options		
Reference Oscillator OCXO	R&S SML-B1	1090.5790.02
Pulse Modulator	R&S SML-B3	1090.5403.02[1]
Stereo /RDS Coder	R&S SML-B5	1147.8805.02
Rear Connectors for AF, RF	R&S SML-B19	1090.5303.02[1]
Recommended extras		
Service Kit	R&S SML-Z2	1090.5203.02
19" Rack Adapter	R&S ZZA-211	1096.3260.00
Transport Bag	R&S ZZT-214	1109.5119.00
Service Manual, Modules		1090.3123.24

1) Factory-fitted only.

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