PS-19
Level Generator
Send Section PSS-19

BN 870, series K onwards
BN 871, series E onwards

Operating Manual

Wandel & Goltermann
Electronic Measurement Technology

1 SPECIFICATIONS

1.1 FREQUENCY

1.1.1 FREQUENCY RANGE

Coaxial output 75 Ω ..... 80 Hz to 25 MHz
Balanced output 124 Ω/150 Ω ..... 60 kHz to 14 MHz
Balanced output 0 Ω/150 Ω/600 Ω ..... 80 Hz to 620 kHz

1.1.2 FREQUENCY DISPLAY (PS-19) ..... 9 digits

Resolution ..... 0.1 Hz[1)]

1.1.3 FREQUENCY TUNING

PS-19:
- digital with keypad;
- in frequency steps with direction pushbuttons (input of increment with keypad);
- pseudo-continuous with knob over complete frequency range, switchable between coarse and fine tuning;
- recall of stored fixed frequencies (see Section 1.5);
- in position "remote tuning", the output frequency depends on the frequency to which the receiver SPM-18 and SPM-19 is set. The internal synthesizer is switched off.

Smallest tuning step, digital ..... 0.1 Hz
pseudo-continuous, fine ..... 1 Hz
coarse ..... 100 Hz

PSS-19:
- Frequency is set on the receiver SPM-18 or SPM-19

1.1.4 AUTOMATIC FREQUENCY SEQUENCES

1.1.4.1 Auto-step

Automatic stepping of the output frequency in fixed steps between adjustable limit frequencies.
Frequency increment and limit frequencies entered on keypad.
Stepping time (with automatic generator blanking switched off) adjustable ..... 0.03, 0.1, 0.3, ... 300 s

When the automatic generator blanking circuit is switched on, the selected step time is increased
in the frequency range 80 Hz to < 10 kHz ..... ≤ 270 ms
in the frequency range 10 kHz to 25 MHz ..... ≤ 120 ms

1) digital frequency adjustment

1.1.4.2 Auto-step with frequency offset between generator and receiver

The frequency limits and increment steps are set as described in 1.1.4.1 on the generator PS-19 and on the receiver SPM-19 (Series C ...). Frequency stepping in the same or opposite directions is possible by setting suitable frequency limits on the PS-19.

Step synchronization, and start and stop of the frequency sequence are determined from the receiver SPM-19; the step time is set only on the receiver.

If automatic generator blanking is selected on the PS-19, the step time set on the receiver SPM-19 is increased as described in 1.1.4.1.

1.1.4.3 Sweeping the generator frequency (Version 870/02 only)

The sweep limits are set by entering the start and stop frequency or the center frequency and sweep deviation on the keypad.

Sweep: Periodic (triangular) or single sweep

Sequence duration ($f_{START} \longrightarrow f_{STOP}$) adjustable ..... 0.03, 0.1, 0.3, ... , 300 s

Minimum permissible sweep duration (max. sweep frequency)

for $f_{START} \geq$ 50 kHz ..... 0.03 s ($\cong$ 16 Hz)

$\geq$ 10 kHz ..... 0.1 s ($\cong$ 5 Hz)

$\geq$ 200 Hz ..... 1 s ($\cong$ 0.5 Hz)

Additional adjustment facility ..... manual sweep with knob

Frequency resolution for manual sweep

sweep width $\Delta f \leq$ 3 kHz ..... 0.1 Hz

sweep width 3 kHz < $\Delta f \leq$ 10 kHz ..... 0.3 Hz

sweep width Δf > 10 kHz ..... 1 Hz

1.1.4.4 Sweep frequency operation with frequency offset between generator and receiver

The sweep limits are set separately on the PS-19 and SPM-19 (Series C ...) with the same frequency deviation and the same sweep sequence duration.

Sweeping in the same or in opposite directions is possible by selecting suitable start and stop frequencies on the PS-19. Start-stop and synchronization of the sweep sequence controlled by the SPM-19.

1.1.5 ERROR LIMITS OF THE TUNED FREQUENCY ..... $\pm 3 \times 10^{-7}$

with additional option BN 865/00.03 ..... $\pm 1 \times 10^{-7}$

The error limits specified here are valid for the rated range of use of the influence quantities specified in Section 1.8, including aging over a period of one year.

1.2 OUTPUT LEVEL

1.2.1 SIGNAL SHAPE ..... sinusoidal

1.2.2 LEVEL DISPLAY

- rms, 3-digit FILED display with sign, resolution ..... 0.1 dB
- as power level (dBm) referred to ..... 1 mW
- as voltage level (dB) referred to ..... 0.7746 V
- as dBm0, dB0 referred to a "relative" level (dBr) which can be selected anywhere within the overall level range (as specified in Section 1.2.4).
  The upper and lower limits of the algebraic sum of the levels in dBm0 (dB0) and dBr correspond to the limits P_{min} and P_{max} of the level range (as specified in Section 1.2.4).

1.2.3 LEVEL SETTING

on keypad, resolution ..... 0.1 dB

the level can be changed step-by-step with increment keys for each decade position, witch carry.

1.2.4 LEVEL RANGE

at $Z_{in} = Z_{out} = Z_0$ or $Z_{in} = 0$, $Z_{out} = Z_0$

Output	Z_0	Z_{in}	Power level P_{min} P_{max}	Voltage level P_{min} P_{max}
Coaxial	75 Ω	Z_0	-74.9 to +10.0 dBm	-83.9 to + 1.0 dB
Balanced I	124 Ω	Z_0	-75.3 to + 9.6 dBm	-82.2 to + 2.7 dB
	150 Ω	Z^0	-76.2 to + 8.7 dBm	
Balanced II [1]	150 Ω	Z^0	-77.9 to +17 dBm	-83.9 to +11 dB
		0	-72 to +22.9 dBm	-78 to +16.9 dB
	600 Ω	Z^0	-83.9 to +11 dBm	-83.9 to +11 dB
		0	-77.9 to +17 dBm	-77.9 to +17 dB

1.2.5 ERROR LIMITS OF THE OUTPUT LEVEL

1.2.5.1 Error limit at f = 20 kHz and 200 kHz and $Z_{in} = Z_{out} = Z_0$ or $Z_{in} = 0$ and $Z_{out} = Z_0$

Output	P_{min}	-29.9	-19.9	P_{max}	dBm dB
75 Ω, coaxial	20 kHz	±0.15	±0.1	±0.1	
124 Ω, 150 Ω, balanced	200 kHz	±0.18		±0.15	
150 Ω, 600 Ω, balanced	20 kHz	±0.18	±0.15		

(Table values in dB)

1) output level for all Z values at f < 200 Hz: ≤ 0 dB/dBm

1.2.5.2 Variation of output level with frequency

at $Z_{in} = Z_{out}$ or $Z_{in} = 0$, $Z_{out} = Z_0$

Output	80 Hz Reference	200 Hz	1 kHz	60 kHz	100 kHz	620 kHz	5 MHz	14 MHz	25 MHz
75 Ω, coaxial	20 kHz	±0.25	±0.1	±0.08			±0.1		
124 Ω, 150 Ω balanced	200 kHz	—		±0.15			±0.25	—	
150 Ω, 600 Ω balanced	20 kHz	±0.25[1]	±0.15	±0.13	±0.25	—			

(Table values in dB)

1.2.5.3 Overall Error

at $Z_{in} = Z_{out} = Z_0$ or $Z_{in} = 0$, $Z_{out} = Z_0$

(the partial errors 1.2.5.1 and 1.2.5.2 are included)

Output	Level	80 Hz	200 Hz	1 kHz	60 kHz	100 kHz	620 kHz	5 MHz	14 MHz	25 MHz
75 Ω coax.	≥ -19.9 dBm dB	±0.4	±0.2							
	≤ -20.0 dBm dB		±0.25							
124 Ω, 150 Ω bal.	≥ -19.9 dBm dB	—			±0.3				—	
	≤ -20.0 dBm dB				±0.35					
150 Ω, 600 Ω balanced		±0.45[1]	±0.35			±0.45	—			

1.3 M E A S U R I N G O U T P U T S

1.3.1 COAXIAL OUTPUT

unbalanced, tied to ground, convertible to
all common socket types ..... Versacon® System
Output impedance ..... 75 Ω
Return loss at f = 5 MHz, send levels ≤ -5 dBm (≤ -15 dB) ..... ≥ 34 dB
Frequency range ..... 80 Hz to 25 MHz

Balanced output 124 Ω/150 Ω

Balanced, floating ..... 3-pin CF socket
Output impedance, switchable ..... 124 Ω, 150 Ω
Return loss at f = 1 MHz, send levels ≤ -5 dBm (≤ -15 dB) ..... ≥ 34 dB
Frequency range ..... 60 kHz to 14 MHz
Signal balance ratio in accordance with CCITT 0.121 at f = 60 kHz to 14 MHz..... ≥ 40 dB

1) for output levels ≤ 0 dB/dBm

Balanced output, 150 Ω/600 Ω

Balanced, floating ..... 3-pin CF socket
Output impedance, switchable ..... approximately 0 Ω, 150 Ω, 600 Ω
Return loss at f = 20 kHz ..... ≥ 34 dB
Frequency range ..... 80 Hz to 620 kHz
Signal balance ratio in accordance with CCITT 0.121
at f = 80 Hz to 620 kHz ..... ≥ 40 dB

1.4 SPECTRAL PURITY OF THE OUTPUT VOLTAGE

at $Z_{in} = Z_{out} = Z_0$ or $Z_{in} = 0$, $Z_{out} = Z_0$

1.4.1 HARMONIC RATIO

Output	Fundamental frequency	Output level	a_{k2} and a_{k3}
75 Ω, coaxial	800 Hz to 25 MHz	P_{min} to P_{max} 1)	≥ 50 dB
	200 Hz to 25 MHz		≥ 48 dB
124 Ω, 150 Ω, balanced	60 kHz to 14 MHz	P_{min} to P_{max} 1)	≥ 50 dB
150 Ω, 600 Ω, balanced	800 Hz to 100 kHz	P_{min} to P_{max} 1)	≥ 50 dB
	200 Hz to 620 kHz		≥ 44 dB

1.4.2 NON-HARMONIC NOISE VOLTAGE

Discrete, non-harmonic noise voltage in the range 200 Hz to 25 MHz, ≥ 60 dB below wanted signal or interference level ≤ -120 dB (-110 dBm)

1.4.3 NOISE

1.4.3.1 Coaxial output and 124/150 Ω balanced output

Signal-to-noise ratio referred to a 1 Hz bandwidth for output frequency ≥ 10 kHz (200 Hz to 10 kHz) at the frequency offset from the wanted signal of

≥ 200 Hz ..... ≥ 95 dB
≥ 15 kHz ..... ≥ 110 dB
≥ 200 kHz ..... ≥ 128 dB (≥ 110 dB)

1.4.3.2 Balanced output 150/600 Ω

Signal-to-noise ratio referred to 1 Hz bandwidth for output frequency ≥ 10 kHz (200 Hz to 10 kHz) at a frequency offset from the wanted signal of

≥ 200 Hz ..... ≥ 95 dB (≥ 85 dB)
≥ 15 kHz ..... ≥ 105 dB (≥ 85 dB)

1) See Section 1.2.4 for level ranges

1.8 POWER SUPPLIES AND AMBIENT CONDITIONS

All error limits specified in the above specifications are valid for the rated ranges of use of the influence quantities specified here, unless otherwise specified, and after a warm-up period of 15 minutes.

1.8.1 POWER SUPPLIES

Level generator PS-19

Mains voltage range without switching,
Rated range of use ..... 96 V to 261 V
Mains frequency, rated range of use ..... 47.5 Hz to 63 Hz
Current consumption I_{rms} ..... $\leq$ 2 A
Power consumption .....approx. 50 W
Safety class in accordance with IEC 348 and VDE 0411 I

Send section PSS-19

Mains voltage nominal operating ranges ..... 96.5 V to 121 V
103 V to 129 V
111.5 V to 140 V
193 V to 242 V
199 V to 250 V
208 V to 261 V
Mains frequency, rated range of use ..... 47.5 Hz to 63 Hz
Power consumption ..... approx. 45 VA
Safety class in accordance with IEC 348 and VDE 0411 I

1.8.2 OPERATING CONDITIONS

Ambient temperature
Rated range of use ..... +5°C to +40°C
Storage and transport range ..... -40°C to +70°C
Radio frequency interference suppression in accordance with Vfg. 526/1979 issued by the Federal German Post Office

1.9 DIMENSIONS, WEIGHT

Level generator PS-19
Dimensions in mm

Bench unit		19" chassis (DIN 41 494)	
Width with handles	477	Chassis width	443
Overall height	199	Chassis height (4 U)	175
Depth with handles	434	Depth	379

19" conversion kit ..... BN 700/00.04
Weight ..... approx. 18 kg

Send section PSS-19
Dimensions in mm

Bench top unit		19" chassis (DIN 41 494)	
Width with handles	477	Chassis width	443
Overall height	155	Chassis height (3 U)	131
Depth with handles	434	Depth	379

19" conversion kit ..... BN 700/00.03
Weight ..... approx. 14 kg

1.10 O P T I O N S

1.10.1 STANDARD-FREQUENCY OSCILLATOR FOR PS-19, BN 856/00.03

with increased accuracy ..... $\pm$ 1 x 10^{-7}

1.10.2 EPROM FOR PS-19, BN 870/00.01

Memory for 100 fixed frequencies and 40 setups in accordance with customer's specification (please request order form No. 5/785a, b)

1.10.3 EPROM FOR PSS-19, BN 871/00.01

Memory for 40 setups in accordance with customer's specifications (please request order form No. 5/785a)

1.10.4 INTERFACE BUS <IEC 625> BOARD, BN 853/05

For PS-19, for remote control of all equipment functions. (Remote control of PSS-19 is carried out via SPM-19)

Connection to the IEEE bus via connector S 834.
Interface functions SH1, AH1, T6, L4, SR1, RL1, PP2, DC1, DT1, C0, E1

1.11 ORDERING INFORMATION

Level generator PS-19*	BN 870/01
Level generator PS-19*, with sweep section	BN 870/02
Level generator PS-19*, with fixed frequency programs (for German PTT)	BN 870/05
Send section PSS-19* (for SPM-19 and SPM-18)	BN 871/01
Options (at extra cost)	
Increased frequency accuracy for PS-19	BN 865/00.03
Interface bus <IEC 625> board for PS-19	BN 853/05
with adapter plug <IEC 625>/IEEE 488 (S 834)	
EPROM for PS-19[1)]	BN 870/00.01
EPROM for PSS-19[1)]	BN 871/00.01
Accessories (at extra cost)	
Milliwatt power meter EPM-1[2)]; 0; 10 Hz to 300 MHz	BN 564/00
Cable for connecting the PS-19 to the SPM-19, 24-pin, 50 cm	K 366
Connection cable for interface bus <IEC 625>	
120 cm	K 343
200 cm	K 344
Front and rear covers SD-4 for PS-19 (1 set)	BN 700/00.24
SD-3 for PSS-19 (1 set)	BN 700/00.23
19" conversion kit for PS-19	BN 700/00.04
for PSS-19	BN 700/00.03
Transport containers TPK-4 for PS-19	BN 626/10
TPK-3 for PSS-19	BN 626/09
Transport case TPG-4 for PS-19	BN 621/04
TPG-43 for PSS-19	BN 621/43

* Equipped with the 75 Ω basic socket Versacon®9 and fitted with BNC insert. Other inserts - see Versacon®9 specification sheet - must be specified when ordering.

1) Specify the required fixed frequencies (PS-19) and setups with order form No. 5/785a, b

2) See EPM-1 specification sheet

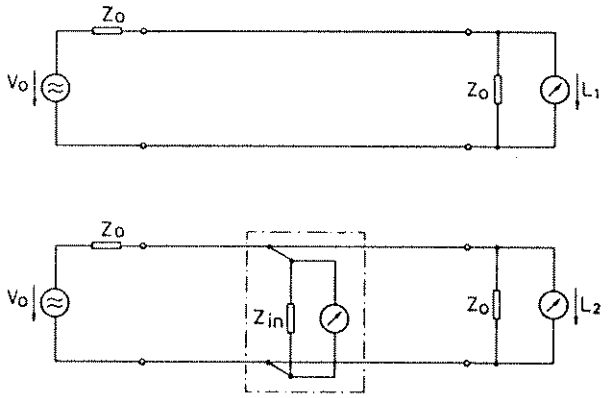
Return Loss

The effect introduced by the return loss of the receiver input or the generator output is included in the error specified for the level reading of a receiver or the output level of a generator.

Moreover, the specified error takes into account that a level meter is operated as "terminated" (input impedance = source impedance = Z_o). This is also valid for a level generator (output impedance = load impedance = Z_o).

Bridging Loss

A receiver operated in the "high impedance" (bridging) mode introduces a level error due to the finite input impedance. The error's maximum value when measured at a testpoint of source impedance Z/2 is expressed as a_B, the bridging loss.



The bridging loss is defined as follows:
Bridging loss $a_B = L_2 - L_1$

$$a_B = 20 \text{ lg} \left| 1 + \frac{1}{2} \frac{Z_o}{Z_{in}} \right|$$

Therefore, the bridging loss is the level difference caused by the high impedance level meter input bridging a system terminated with Z_o.

In every case, $Z_{in} \gg Z_o$, which results in:

$$a_B \leqq 4.3 \frac{Z_o}{Z_{in}} \quad [dB]$$

For that reason, the specified value of $a_{B,1}$ related to the value Z_1 (e.g. 600 Ohms) can be easily recalculated to yield the value of $a_{B,2}$ for the value Z_2 (e.g. 900 Ohms):

$$a_{B,2} = a_{B,1} \cdot \frac{Z_2}{Z_1}$$

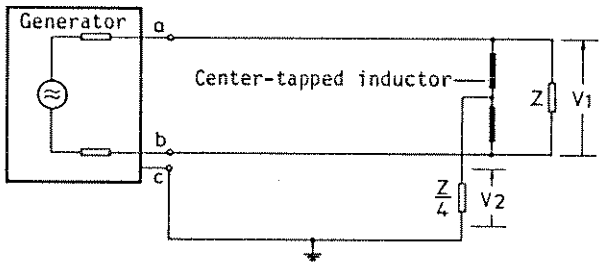
Impedance balance ratio

The specifications given for the input or output balance are provided by the methods defined in CCITT Recommendation O. 121.

This same Recommendation states that:
"The signal balance ratio is an overall measurement of the symmetry of a device and includes the influence of the impedance balance ratio as well as the influence of unwanted longitudinal voltages produced by a generator or the influence of the common-mode rejection ratio of a receiver."

To describe the degree of balance of a device (generator or receiver) under operational conditions in most cases it is sufficient to measure and specify the signal balance ratio only. Thus, the specifications in this Operating Mannual are provided by measurement of signal balance ratio. This is done through emploment of an accurately center-tapped inductor with both of the tightly-coupled half windings being completely symmetrical. Each half represents Z/2.

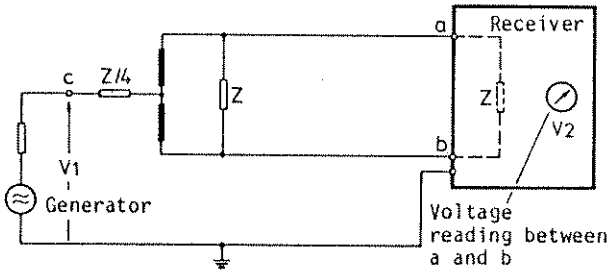
Measurement of Generator Signal Balance Ratio



Generator signal balance ratio is defined as:

$$a_B = 20 \log \left| \frac{V_1}{V_2} \right| \quad [dB]$$

Measurement of Receiver Signal Balance Ratio



Receiver signal balance ratio is defined as:

$$a_B = 20 \log \left| \frac{V_1}{V_2} \right| \quad [dB]$$

The dotted impedance, Z, is the input impedance of the device under test. If the input impedance is a high value, then this impedance must be externally connected in the parallel.

2 TECHNICAL DETAILS

The level meter PS-19 consists of the module synthesizer, output section, and control section, which includes the microcomputer with the control and indicator panel and some other assemblies.

The send section PSS-19 does not include the synthesizer module. In the following text, generation of the output frequency and level and the various modules are described in more detail using Figure 2-1.

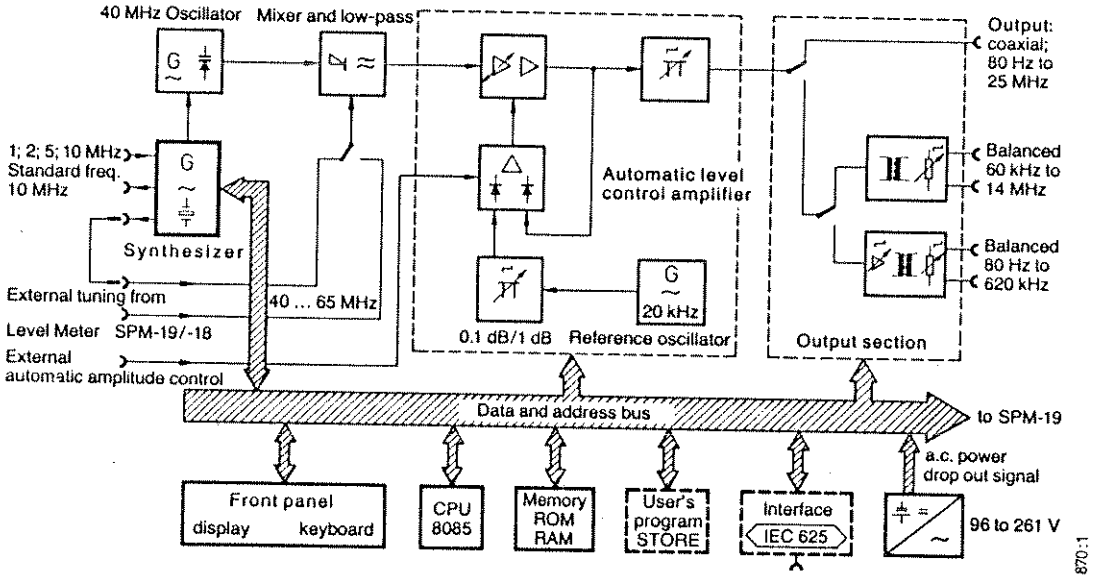


Figure 2-1 Simplified block diagram of level generator PS-19

2.1 SEND SECTION

2.1.1 OUTPUT FREQUENCY GENERATION

The level generator operates on the heterodyne principle, the output frequency resulting from the difference between the fixed frequency of 40 MHz and a variable carrier frequency of 40 to 65 MHz. The fixed frequency is generated in a phase-controlled LC oscillator, which is locked to a standard frequency generated by the synthesizer or, in case of the PSS-19, an external standard frequency. As the fixed frequency corresponds to the first intermediate frequency of the level meter SPM-19 or SPM-18, the generator and receiver can thus be tuned by means of a single variable oscillator.

The fixed frequency is passed via a low-pass filter to the mixer and is converted, with the aid of the carrier frequency, from the synthesizer or from an external source (in the PSS-19, only from the external source), to the output frequency range of 80 Hz to 25 MHz. The following low-pass filter suppresses the upper sideband, harmonics, and residual components of the fixed and variable frequency.

The synthesizer in the PS-19 is described in Section 2.2.

2.1.2 LEVEL GENERATION (AGC AMPLIFIER)

The signal coming from the mixer is amplified in the AGC amplifier, where it is also adjusted to a constant value by means of an AGC circuit. The control voltage is obtained by comparing the signal voltage with a 20 kHz reference voltage. Fine adjustment of the output level is also carried out in this reference path, while the coarse level steps are adjusted by means of a variable attenuator in the output path of the AGC amplifier.

An external AGC circuit can be established via the control voltage input of the AGC amplifier for external level regulation, e.g. with the aid of the milliwatt power meter EPM-1.

2.1.3 OUTPUT PANEL

The signal is connected directly to the coaxial output, and via balancing transformers to the other two outputs for balanced measurements. The transformer in the low frequency output path is preceded by an amplifier which provides both a lower output impedance and an increase of approximately 10 dB in the output level.

2.1.4 OUTPUT LEVEL BLANKING

The output level can be switched on and off, with a smooth transition in the AGC amplifier. In order to achieve better blanking attenuation, the 40 MHz oscillator is also switched off.

The blanking time is approximately 20 ms; switching on the output signal takes approximately 150 ms (approximately 400 ms for frequencies below 10 kHz).

2.1.5 POWER SUPPLY UNIT

The level generator PS-19 is equipped with a switching power supply unit which accepts mains voltages between 96 and 261 V. It is characterized by a high efficiency, which means that the heating effects are relatively low in spite of the compact construction. This also increases the reliability of the level generator.

The send section PSS-19, in contrast, is equipped with a conventional power supply unit which can be set to all common mains voltage values.

A built-in, rechargeable battery buffers the complete data memory in the case of mains interruption of if the unit is switched off in order to retain the stored data and setups.

2.1.6 FREQUENCY TUNING

Frequency tuning is carried out digitally in BCD code in all operating modes. For pseudo-continuous frequency tuning over a continuous range, a small DC generator (tacho-generator) driven by a knob provides setting pulses to the internal counters via a following voltage-frequency converter. The frequency information is passed to the frequency display and to the synthesizer via display buffers.

2.2 THE SYNTHESIZER IN THE PS-19

The control frequency of 40 to 65 MHz required to tune of the level generator PS-19 and the fixed frequency required for synchronization are generated in a synthesizer (BN 865), which has the following properties:

- High frequency accuracy and stability
- High spectral purity (extremely harmonic and noise values)
- Phase continuity when the frequency is changed
- High setting rate
- Compact construction

The principle and most important modules are shown in the extremely simplified block diagram of the synthesizer (Figure 2-2).

The control frequency f_T (40 to 65 MHz) is generated in a voltage-controlled oscillator which is regulated such that the control frequency is always precisely the sum of the frequency f_R from the locking oscillator and the frequency f_I from the interpolation oscillator.

The locking oscillator operates in the frequency range 39.8 to 64.7 MHz. It can be set in 100 kHz steps via a further control loop. For this purpose, the oscillator frequency is divided down to 100 kHz in a programmable locking divider and compared with the standard frequency in a zero phase regulator.

Interpolation between the 100 kHz locking steps is carried out in a single interpolation loop. This operates with a non-integral division ratio, thus permitting the frequency to be set in increments of less than 1 Hz. [1]

This arrangement results in short setting times, even for small increments.

The interpolation oscillator runs at a relatively high frequency between 40 and 60 MHz in order to permit reduction, in the following 200:1 divider, of phase errors caused by the control loop.

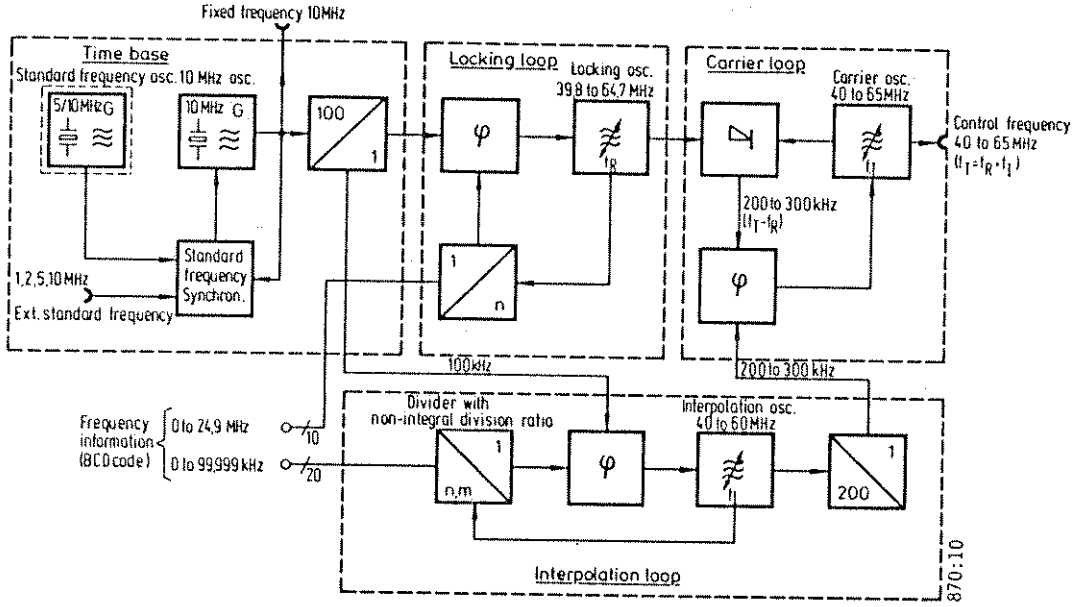


Figure 2-2 Simplified block diagram of the synthesizer BN 865

[1] P. Harzer: Frequenzsynthese in modernen Pegelmeßplätzen. NTZ, Vol. 33 (1980), Issue 2, Pages 90-94

As it is desired to adjust the interpolation frequency in 0.1 Hz steps, the 200:1 divider makes it necessary to change the interpolation divider in steps of 200 Hz. For rapid reprogramming, the output frequency of the interpolation divider is 100 kHz. This is compared in the phase meter with the divided standard frequency. Frequency settings in the 1 Hz to 1 kHz decades would result in phase errors due to the non-integral division rato. For this reason, the output signal of the phase meter is combined with a compensation voltage in the form of the interference voltage.

Further measures, such as synchronous transfer of the frequency setting information into the locking and interpolation dividers, or blocking of the carrier loop in the case of a so-called interpolation exchange, permit a high spurious frequency rejection of the control signal.

The 100 kHz reference frequency and further synchronization frequencies are generated in the time base. This consists mainly of the standard frequency oscillator and a 10 MHz crystal oscillator with low harmonic values, which is locked rigidly to the reference frequency via the standard frequency standardization. The standard frequency oscillator, which can be replaced by external frequency standards of 1, 2, 5, of 10 MHz, is thermostatically controlled in order to achieve the required accuracy of 3×10^{-7} or 1×10^{-7}.

2.3 CONTROL SECTION WITH MICROCOMPUTER

The microcomputer consists of the central processing unit (CPU) - a type 8085 microprocessor - the program memory (ROM), the main memory (RAM), and the input and output gates. The displays and controls in the front panel are connected to the microcomputer via data and control lines. The keypad of the control panel can be used, amongst other things, for inputting fixed frequencies and complete equipment setups into the main memory. A buffer battery is provided for the RAM power supply in order to retain the stored data if the mains supply fails.

If required, an additional, customer-specific EPROM for fixed frequencies and equipment setups can be installed. For remote control of the level generator PS-19 by an external computer, an optional interface board for the <IEC 625> bus can be fitted. Remote control of the send section PSS-19, which does not have the synthesizer, is executed via an additional data connection from the level meter.

When the unit is switched on, an automatic RAM/ROM test is executed. If a fault is detected, the test sequence is stopped and the fault number is displayed.

3 COMMISSIONING

3.1 UNPACKING THE UNIT

The unit is delivered in special packing materials, which were thoroughly tested by Wandel & Goltermann before being released for general use.

These packing materials guarantee that the unit arrives undamaged, even if it was subject to rough handling during transport. The unit should be removed carefully from the appropriate side of the packing material. We recommend that the original packing material be saved if the equipment is to be shipped at a latter date. If the packing materials have been lost, please observe the following instructions.

3.1.1 INSTRUCTIONS FOR SHIPPING

Shipping without damage can be achieved only by using suitably designed packing materials. If the original packing materials have been lost, we recommend that the unit be packed as shown in Figure 3-1.

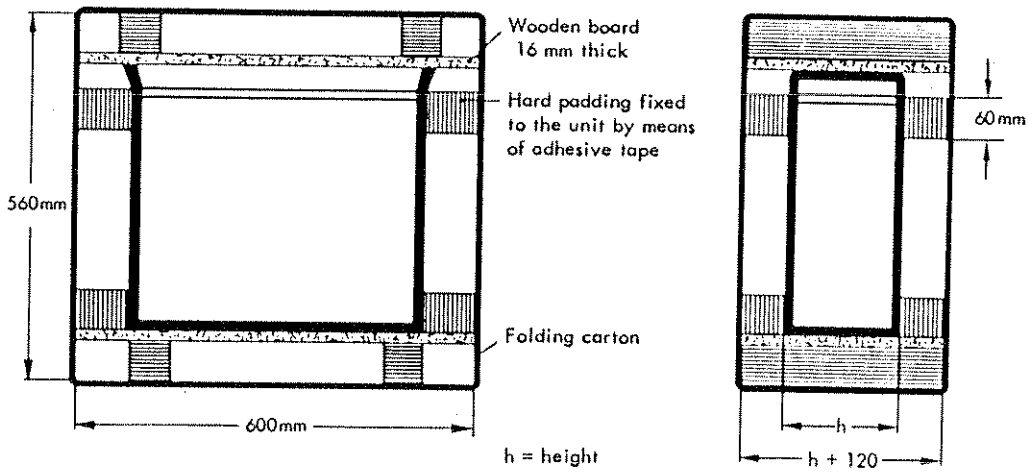


Figure 3-1 Packing instructions

3.1.2 TRANSPORT IN THE TRANSPORT CONTAINER OR TRANSPORT CASE

The transport containers TPK-4 for the PS-19 or TPK-3 for the PSS-19 protects the unit against dust and mechanical damage during low stress transportation (e.g. in a motor vehicle). It also provides suitable splash protection. Additional protection of the inclined control panel can be provided by fitting the rear cover SD-4 (SD-3) on the front of the PS-19 (PSS-19) before packing it in the transport container. In the case of increased climatic or mechanical stresses (e.g. rail or air transport), we recommend the use of the transport case TPG-4 (TPG-3), which protects the units against extreme environmental effects.

3.1.3 USE IN 19" RACKS

The case dimensions comply with DIN Standard 41 494 and the American Standard ASA C 83.9 "Racks and front panels". The unit is thus suitable for installation in 19" racks, the only necessary modification being extending the front panel dimensions by fitting two mounting brackets as shown in Figure 3-2. The complete 19" conversion kit, including mounting screws, is available under order No. BN 700/00.04 for the PS-19 of BN 700/00.03 for the PSS-19. The feed on the lower side of the unit and the guide pins on the upper side of the unit should be removed before installation (see also Figure 3-2).

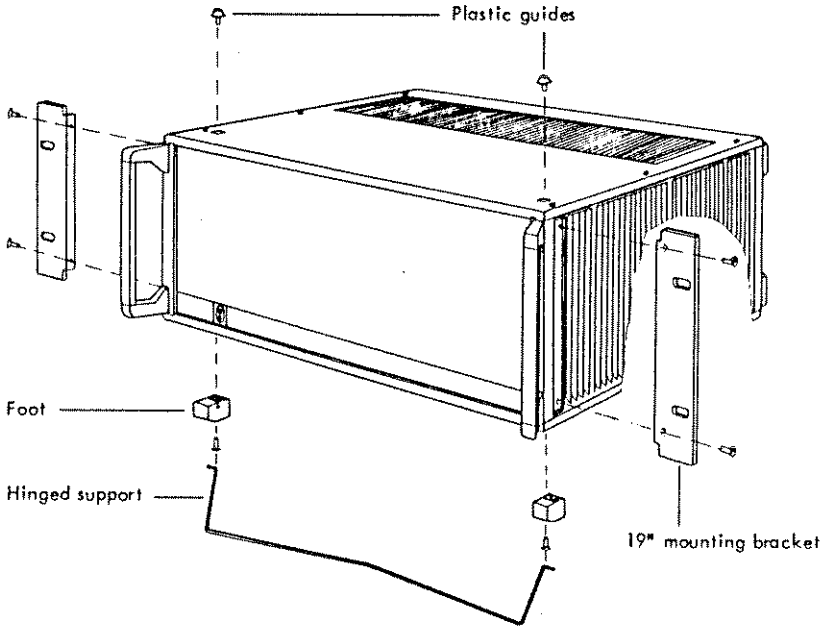


Figure 3-2 Converting the bench top unit for rack installation

Caution: When installing in equipment cabinet, ensure that the upper limit is not exceeded (see Section 3.2). Generally, the following measures are necessary:

A gap of one height unit (44.4 mm) must be maintained between the units.

If necessary, ventilators must be fitted to extract the heat generated in the cabinet. Suitable filters should be provided to prevent excessive deposits of dust on the units.

3.2 SETTING UP THE UNIT

The level generator PS-19 (PSS-19) can be operated at ambient temperatures between +5 and +40°C. If used within larger systems, or if installed in racks, care must be taken that this temperature range is not exceeded (e.g. by means of spacing between the various units, see Section 3.1.3).

For operation with mains voltages of 110/117/127 V, the slow blow fuse G must be replaced (see Section 3.4.1).

Use the enclosed mains cable for connecting the unit to the mains supply. The level generator belongs to safety class I as defined in VDE 0411, i.e. the chassis and ground socket are connected to the protective conductor. If a different mains cable is used, ensure that it contains a protective conductor.

After inserting the mains cable in the mains connector on the rear of the unit, connect the other end of the cable to the mains outlet socket and switch on the unit with the mains switch on the front (by depressing the pushbutton). The specified error limits are valid after a warming up period of 15 minutes.

3.4.1 CHANGING THE FUSE

a) Level generator PS-19

If the level and frequency displays remain blank and no LEDs light when the unit is switched on, unscrew the fuse holder on the rear of the unit and check the fuse.

Fuses of type T 3.15 A (3.15 A, slow-blow) should always be used; two of these fuses are enclosed with the unit in the accessory box K (rear of unit).

b) Send section PSS-19

The following fuse values are specified:

Mains voltage range 110 to 127 V:	1.25 A, slow-blow
Mains voltage range 220 to 237 V:	0.63 A, slow-blow

If the level display remains blank and no LEDs light, unscrew fuse holder G on the rear of the unit and check the fuse.

Defective fuses can be replaced by the spare fuses in the accessory box F (rear of unit).

3.5 S E L F T E S T

As soon as the level generator PS-19 is switched on, an automatic RAM/ROM test is executed in order to check the functional readiness of the random access memory and the operational software (ROM). If the test is successful, the symbols 0----- appear for a short period in the frequency display, before the unit sets itself to the parameters, frequencies and levels which were last stored.

If there is a fault in the control section, a fault number is displayed in the frequency display. These numbers have the following meaning:

0--100	RAM fault
0--200	ROM fault

See the notes in the servicing instructions on repairing such faults.

In the case of the send section PSS-19, a functional fault in the main or program memory causes display of a fault number on the level display.

These numbers have the following meanings:

0--1	RAM fault
0--2	ROM fault

If the test is successful, the symbols 0--- are momentarily displayed at the end of the test.

3.6 STANDARD SETUP

All setups are stored in a semiconductor memory, which is powered by a rechargeable battery if the unit is switched off. For this reason, the last setup which was entered before switching off the unit will appear again when the unit is switched on. In the PS-19, stored fixed frequencies are also retained in the same manner.

However, if the unit has been switched off for a long period, the built-in battery may go flat, which means that the stored information is lost. In this case, the following standard setup is automatically generated when the unit is switched on:

f = 0 kHz (PS-19)
f_{STEP} = 1.000 kHz (PS-19)
Output: Z = 75 Ω
Output level: -70 dBm/dB
Display "SWEEP OR STEP TIME" = 1s (PS-19)

During repairs, it may be necessary to disconnect the battery, which again means that the stored data are lost. For a defined initial status, carry out the procedure specified in Section 6.3.4.

Note: If a standard setup is transferred to the memory by means of a so-called "bootstrap initialization" (see Section 6.3.4), the stored fixed frequencies in the PS-19 (address range 0 to 99) are deleted and the stored setups are replaced by a standard setup as described in Section 3.6.

Important Safety Instructions

A.C. power line voltage

The operating voltage of the instrument should be the same as the a.c. line voltage, so check whether or not the two voltages are equal.

Safety Class

This instrument is categorized as Safety Class I according to VDE 0411 or IEC Publ. 348. The power cord delivered with the equipment has a protective ground conductor. The a.c. power plug must be plugged into an a.c. power receptacle that has a third wire to ground, except in rooms that are particularly certified otherwise. Any disconnection of the protective ground conductor either inside or outside of the instrument is not permitted.

Connection to measuring circuits presenting hazards to personnel

Before the connection is made to a hazardous circuit, a protective ground connection, for protection against the measurement circuit, ought to be connected to the enclosure. In case the protective ground conductor of the a.c. power line can also assume this protective function, the a.c. power connection should be established first of all. If the measuring circuit has an inherent protective ground conductor, then this conductor must be connected to the enclosure before a connection is made to the measuring circuit.

Defects and Exceptional Conditions

When it can be assumed that safe operation is no longer possible, the equipment should be taken out of service and inadvertent operation should be prevented.
This occurs when

- the equipment shows external signs of damage
- the equipment no longer operates
- after being overstressed in any way (e.g. storage, transport) so that the tolerable limits are exceeded.

Fuses

Only specified fuses are permitted for use.

Opening the Instrument

After the covers have been removed or when components are removed with tools, certain components that operate with applied voltage could be exposed. And also connection points might be carrying a voltage.
Therefore, before the instrument is opened for inspection, all voltage sources should be disconnected.
But sometimes calibration, maintenance or repairs require that the instrument be open and operating with applied voltage. So only experienced craftspersons who understand the dangers associated with working on instruments that have exposed voltage points should undertake the job.
Capacitors can retain a voltage charge even after the instrument has been disconnected from voltage sources. Thus, the circuit diagrams should be observed.

Repairs, Replacement of Components

Repairs must be done according to correct technical practice. With that, particular attention must be paid to the characteristics of construction. None of the safety precautions should be changed, especially for leakage paths and air gaps, and separation by insulation must not be reduced.
Only original replacement parts ought to be used. Other replacement parts are only permitted if the safety and protection against human injury are not degraded through the use of non-original components.

Safety Testing after Repair and Maintenance

Testing of the protective ground conductor in the power cord for the instrument:

The resistance of the protective ground conductor shall be measured. It should be $<0.5\ \Omega$. The power cord should be bent and kinked during the measurement so as to reveal any intermittent connection. This gives evidence of a defective power cord.

Testing the insulation of the a.c. power circuit:

The insulation resistance is measured at 500 V between the a.c. power connection and the protective ground conductor connection. For this measurement, the instrument's power switch should be ON.
The insulation resistance ought to be $>2\ M\Omega$.

4 OPERATION

4.1 CONTROLS ON THE FRONT AND REAR PANELS

The front of the level generator PS-19 or of the send section PSS-19 is divided into three functional areas: connection panel, operating panel, and display panel. Selection of all parameters necessary for measurements is carried out mainly by means of the pushbuttons on the inclined front panel, which simplifies operation and provides a pleasing design for the unit.

On the left side of the operating panel there are pushbuttons for selecting the output level and the appropriate output, together with the level display. The right side of the PS-19 front panel has pushbuttons for frequency selection. The frequency display is on this side of the front panel.

Each pushbutton has a LED which is on when the function is active. Some of the pushbuttons have double or triple functions, these being clearly defined by lettering or by a second LED.

The rear of the unit, on which the layout of the level generator - control section, analog section, synthesizer in the PS-19 - can be seen, mainly contains connection sockets for analog and digital control signals, the insertion position for the remote control board in the PS-19, and the mains power supply components.

The abbreviations for the controls and sockets used in the operating instructions are shown in Figures 4-1 to 4-4, which are on fold-out pages for easy reference.

The relationships between the abbreviations (normally digits enclosed in square brackets) and the circuit diagrams in the Appendix are described in Tables 4-1 to 4-4.

An example of the abbreviations used in the circuit diagram is 16 Bu 1 (PS-19); this means that the coaxial output socket can be found in circuit diagram 16 and is designated there as Bu 1.

The numbers enclosed in square brackets in the Tables and in the text are the same as the numbers within boxes printed on the front and rear of the unit. Pushbuttons are referred to in the form "XXX".
Examples:

"MAN" corresponds to the pushbutton [MAN]

"20 dB" corresponds to the pushbutton [20 dB]

The Table also provides a summary of the functions of the various pushbuttons and sockets. All coaxial sockets are universal sockets which can easily be converted to the common types of sockets used in telecom work (see Section 6.3.5).

4.1.1 ABRIDGED OPERATING INSTRUCTIONS

A thin drawer is located at the bottom of the PS-19. This contains the abridged operating instructions. The information sheets are arranged like a stack of cards after the drawer has been pulled out. The cards that are not of current interest can be pushed backwards until the card you want is exposed. The AOI are written in two languages (German/English): A different language on each side. The cards can be turned over and a cut-out in the bottom of the drawer simplifies the turn-over. An index helps you to find the side you want.

The AOI contains, besides the frequency and level settings, information about storage functions and error numbers, as well as information on the PS-19 self-test. When the PS-19 is used for the first time, or if you want to do complex measurements, the detailed Description and Operating Manual should be consulted.

4.2 SETUP AFTER SWITCHING ON

After being set up and switched on as described in Chapter 3, the unit automatically sets itself to the parameters which existed before it was switched off. A different setup (standard setup as described in Section 3.6) appears if the built-in buffer battery for supplying the CMOS memory was insufficiently charged, or if it was disconnected from the memories during repair work. A fully charged battery will retain the memory data for approximately 30 days with the unit switched off.

4.3 OUTPUTS, INTERNAL IMPEDANCES, FREQUENCY RANGES

The level generator PS-19/PSS-19 is equipped with one coaxial output [19]/[11] for the complete frequency range 80 Hz to 25 MHz.
The other two output sockets are for balanced measurements.

The frequency ranges and impedances of these two outputs are:

	PS-19	PSS-19	Z_0	Frequency range
BAL I	[20]	[12]	124, 150 Ω	60 kHz to 14 MHz
BAL II	[21]	[13]	≈ 0, 150, 600 Ω	80 Hz to 620 kHz

The output and its impedance are selected with the impedance selection switch [15] on the PS-19 or [7] on the PSS-19. The unit switches automatically between the outputs and impedances as long as the toggle switch is depressed. The output is only connected when the switch is released.

The selected output and impedance are displayed in the illuminated window.

4.4 SELECTION OF THE LEVEL UNIT

The level generator can be set to both absolute levels and referred levels.

The level which is to be generated and displayed is selected with the following pushbuttons:

"dBm" (dB)	absolute level
"dBm0" (dB0)	level referred to OTLP
"dBr"	relative level

When one of the pushbuttons is depressed, a corresponding LED lights, and the appropriate units are displayed in the level display A.

The following relationship exists between the above-mentioned levels:

(a) dBm0 + (b) dBr = (a + b) dBm

4.5 SETTING THE OUTPUT LEVEL

The output level is set either by means of direction pushbuttons below the level display or by means of the digital keypad.

4.5.1 LEVEL INPUT WITH DIRECTION PUSHBUTTONS (PSS-19)

The level displayed in the level display is increased or decreased, depending on the pushbutton depressed, by

10 dB with pushbutton [3]
1 dB with pushbutton [4]
0.1 dB with pushbutton [5]

if the pushbutton is held down, the level is stepped automatically, with a carry to the next decade when required.

4.5.2 LEVEL INPUT ON THE DIGITAL KEYPAD (PSS-19)

Before entering the level value, select the appropriate level unit with one of the pushbuttons "dBm", "dBmO", or "dBr".

After this, enter the numerical value via the digital keypad, entering the negative sign (pushbutton "-") before or after the digits for negative values.

The digits are shifted from right to left into the level display. If an incorrect digit is entered, the display can be cleared with the aid of the clear key "CLR" and the required level value re-entered. The existing output level is not affected by this operation.

The generator is switched to the new level only when the pushbutton "dBm/dBmO" is depressed.

Input of a new level is always carried out by overwriting the old level.

4.5.3 LEVEL INPUT BY MEANS OF DIRECTION PUSHBUTTONS (PS-19)

The level displayed in the level display is increased or decreased by

10 dB with pushbutton [2]
1 dB with pushbutton [3]
0.1 dB with pushbutton [4]

If the pushbutton is held down, the level is stepped automatically, with a carry into the next decade when necessary.

4.5.4 LEVEL INPUT VIA DIGITAL KEYPAD (PS-19)

The keypad can be used for entering levels, frequencies, and memory addresses.

For level input, the function ENTRY SELECT [6] LEVEL must be activated with pushbutton "LEVEL". The LED above this pushbutton must light.

After this, the appropriate level unit is selected with one of the pushbuttons "dBm", "dBmO", or "dBr".

The numerical value is now entered via the digital keypad, the negative sign (pushbutton "-") being entered before or after the digits for negative level values.

The digits are shifted from right to left into the level display. If an incorrect value is entered, the display can be cleared with the aid of the clear key "CLR" and the required level

value re-entered. The existing output level is not affected by this operation. The generator is switched to the new level only when the pushbutton "dBm/dBm0" (enter function) is depressed. The absolute level appearing at the output (dB or dBm) remains unchanged even if pushbuttons "dBm0" or "dBr" are depressed.

A new level is entered by overwriting the old level.

4.5.5 REACTION TO INPUT OF LEVELS OUTSIDE THE PERMISSIBLE RANGES

4.5.5.1 Absolute level

On the basis of the relationship described in Section 4.4 between the various level units, input of a new absolute level (dBm, dB) causes corresponding variation in the level in dBm0, dB0.

If the absolute level is too large or too small, the unit sets itself to the maximum or minimum possible value, respectively. This value depends on the selected output, output impedance, and calibration (see Specifications).

4.5.5.2 Relative level and levels in dBm0

When a relative level or a level in dBm0 is entered, limiting of the level occurs only at extreme values.

If the microcomputer determines, after level input, that the possible absolute level range has been exceeded, the corresponding minimum or maximum absolute level appears in the display and at the output.

In order to indicate that the relationship for the absolute level described in Section 4.4 no longer applies, a warning arrow lights up on the level display.

These arrows have the following meaning:

↑ The sum of the values for the level in dBm0 and the relative level results in an absolute level which exceeds the maximum possible value. The maximum possible value appears at the generator output.

↓ Addition of the values for the level in dBm0 and the relative level results in an absolute level which is smaller than permissible. The smallest possible output level appears at the generator output.

This arrow appears for both of the levels, as they are regarded as a single item.

The warning arrows disappear, and the display of the level in dBm0 is simultaneously corrected, if the pushbutton "dBm" is depressed.

4.6 GENERATOR BLANKING

For many measuring tasks, it is necessary to temporarily switch off the output signal. For this purpose, the unit has two pushbuttons which permit either static or dynamic blanking. In both cases, the output signal is switched on and off "gradually", i.e. the level does not change instantaneously. This measure is particularly useful in avoiding interference in carrier frequency systems resulting from the frequency spectra caused by rapid switching operations. The selected output impedance is unchanged by the blanking operation.

4.6.1 STATIC BLANKING "BLANK"

Pressing the pushbutton "BLANK" causes the selected output level to be reduced gradually by more than 80 dB (reduction time approximately 20 ms). Blanking is shown on the level display by the symbols ----.

If one of the three pushbuttons for the level unit is pressed, the selected level value is displayed. Similarly, it is possible to enter a different output level as described above (Section 4.5). When the enter pushbutton "dBm/dBmO" is depressed, the blanking symbol again appears. In both cases, the level remains blanked.

Gradual unblanking of the signals is carried out after a further depression of the "BLANK" pushbutton.

The settling time to 1 mB is approximately 400 ms.

4.6.2 DYNAMIC BLANKING "AUTO BLANK"

Note: If the PSS-19 is operated with the level meter SPM-19, socket [30] of the PSS-19 (rear-side) must be connected to socket [40] or [41] of the SPM-19 (rear side) with the cable K 350.

Depression of the pushbutton "AUTO BLANK" activates the function (green LED lights); subsequent depression of the pushbutton deactivates the function.

When the function is active, the level is gradually reduced by more than 70 dB before each digital frequency change (see Section 4.8).

Automatic level blanking is not active for pseudo-continuous frequency tuning or sweep frequency operation.

During blanking, the level value in the level display is replaced for a few moments by the blanking symbol ----.

The blanking duration depends on the output frequency. The time between the start of blanking and the time at which the output level has settled to within 1 mB of its final value is 250 ms or 500 ms ($f \leq 10$ kHz). These times must be taken into account for automatic frequency stepping (see Sections 4.8.3.2 and 4.12.3).

4.7 SWITCHING BETWEEN POWER LEVEL AND VOLTAGE LEVEL

The required calibration - voltage level (dB) or power level (dBm) - must be selected with the slider switch [21] on the rear of the PSS-19, or [31] on the rear of the PSS-19, or [31] on the rear of the PS-19 before switching on the level generator. It is also possible to switch the calibration from the front panel by pressing the following pushbuttons in the specified sequence:

dB calibration	"MEM"	9900	"RCL"	"MEM"
dBm calibration	"MEM"	9901	"RCL"	"MEM"

If the unit is switched off and on again, it automatically sets itself to the calibration mode selected by the slide switch at the rear.

4.8 SETTING THE OUTPUT FREQUENCY

Tuning of the output frequency for the send section PSS-19 is carried out on the level meter SPM-18 or SPM-19 (see Figure 3-3b).

Tuning facilities are descried in detail in the description and operating instructions of the appropriate level meter.

In the level meter PS-19, the output frequency can be selected digitally by the keypad, continuously, or automatically (AUTO STEP).

The uses of a synthesizer which is characterized by high harmonic and signal-to-noise ratios and by phase continuity during frequency changes provides high accuracy and good stability of the selected frequency in all operating modes. The frequency uncertainty of the PS-19 is, depending on the version, $\pm$ 3 x 10^{-7} or $\pm$ 1 x 10^{-7} of the displayed frequency value. This error limit includes the temperature response within the rated range of use and the aging of the internal crystal within a period of 1 year.

4.8.1 DIGITAL FREQUENCY SETTING [13]

The send frequency is entered in MHz or kHz with the aid of the keypad [13]. For input of the frequency, the function ENTRY SELECT [6] "FREQ." must be selected. The lamp above the LED must light; otherwise depress the pushbutton again. Example for a frequency input of 987.6 Hz:

Entry: "." "9876" "kHz" Display: 987.6 Hz
or "." "0009876" "MHz"

The synthesizer will not be tuned to the new value, unless "kHz" or "MHz" (ENTER function) has been pressed. The display is always in Hz. The display has dots to show MHz, kHz, Hz and 0.1 Hz. This makes it easier to read the display.

If an incorrect digit is entered during frequency input, the display can be cleared with the aid of the clear pushbutton "CLR" and the required frequency re-entered. The current tuning of the synthesizer is not affected by this operation. The digits are shifted from right to left into the display. The maximum possible frequency which can be entered is 26.5 MHz.

A new frequency is input by overwriting the old value.

4.8.2 CONTINUOUS FREQUENCY TUNING "MAN"

Frequency tuning is carried out in a pseudo-continuous mode, i.e. in steps of 1 Hz or 100 Hz,

with a resolution of 1 Hz (FINE) if pushbutton "MAN" is pressed once
with a resolution of 100 Hz (COARSE) if pushbutton "MAN" is pressed twice.

Due to the phase continuity of the synthesizer, there are no interfering phase shifts during continuous tuning, which means that no additional sideband spectrum is generated.

After previous selection of the tuning mode "coarse or fine", the output frequency can be tuned continuously over the whole frequency range with the knob [17]. The frequency variaton per revolution of the knob also increases as the speed of rotation of the knob increases. This makes it possible to tune rapidly over the whole frequency range.

When tuning with the resolution of 100 Hz, the last two digits of the frequency display are set to zero. Although the upper frequency limit of the level generator is 25 MHz, frequencies up to 26.5 MHz can be set.

To switch back to digital frequency tuning (4.8.1), simply enter the required output frequency via the keypad [13].

Addresses	Contents	PS-19	PSS-19
0 ... 99	Fixed frequencies in RAM	X	
100 ... 109 (110)	Setups in RAM	X	(X)
200 ... 299	Fixed frequencies in ROM	X	
300 ... 339	Setups in ROM		X
500 ... 539	Setups in ROM	X	

Table 4-5 Organization of measuring parameter memory

Address	Function
9 900	Voltage level calibration (dB)
9 901	Power level calibration (dBm)

Table 4-6 Calling up special programs via memory addresses (see Section 4.10.2, when SPM-19 and PSS-19 are used together call up for PSS-19 via SPM-19)

4.10.2 THE STORE AND RECALL FUNCTIONS

With the aid of the two pushbuttons "STO" and "RCL" on control panel [13] of the PS-19, it is possible to store and recall data and measuring parameters. After the parameters have been entered, the following pushbuttons must be depressed:

Store: "MEM" Address number "STO"

The LED above the "MEM" pushbutton flashes until the function pushbutton "STO" is depressed. An error number is displayed if an invalid address number is selected (see Section 4.10.1).

Recall: "MEM" Address number "STO"

The LED above the "MEM" pushbutton flashes until the function pushbutton "RCL" is depressed. An error number is displayed if an invalid address number is selected (see Section 4.10.1). After a successful recall, the MEM function remains active. The contents of further addresses can be recalled directly by entering the address on the keypad or sequentially by depressing the two direction pushbuttons ⇧ and ⇩ . Automatic stepping is possible in the address ranges 0 to 99, and 200 to 299 (see Section 4.10.5b).

With the MEM function active, the selected address number is shown in the frequency display as long as the "RCL" pushbutton is depressed.

4.10.3 STORING FIXED FREQUENCIES

* PS-19 ONLY *

Number: up to 100 fixed frequencies
Address range: 0 ... 99 (see Table 4-5)

- Input of the required frequency on the keypad (see 4.8.1)
- Depress "MEM" (LED must light)
- Select required memory location (address) on the keypad [13]
- Depress "STO"
- Enter the next frequency

When storing a large number of fixed frequencies at sequential addresses, the operator can avoid the necessity of noting each address as it is used by using a different input procedure shown below:

Input of first frequency - "MEM" on - enter start address - "STO" - "MEM" on - step ⇧ "MEM" off

- Input of 2nd frequency -
"MEM" on - "STO" - "MEM" on - step ⇧ etc.

4.10.4 RECALLING SINGLE FIXED FREQUENCIES IN ANY ORDER

* PS-19 ONLY *

From the address ranges 0 ... 99 and 200 ... 299 (only with optional feature "PROM", BN 870/00.01)

- Depress "MEM"
- Enter required address on keypad [13]
- Depress "RCL". The desired fixed frequency appears in the frequency display.

As the MEM function remains active, further fixed frequencies can be recalled immediately by simply entering the addresses.

4.10.5 CALLING UP A SEQUENCE OF FIXED FREQUENCIES

* PS-19 ONLY *

If measurements are to be carried out at several frequencies which are stored at sequential addresses in the memory (RAM), tuning can be simplified considerably by manual or automatic recall.

a) Manual recall

- Recall the contents of the starting address as described in 4.10.4
- The following fixed frequencies are then recalled with the two pushbuttons ⇧ ⇩ The MEM function remains active. The corresponding address number can be displayed by depressing the "RCL" pushbutton.

b) Automatic recall

In this operating mode, the start and stop address (frequency) are specified. Measurements are then carried out within the selected limits. This operating mode can be used, for example, for selective end-to-end measurements (see Operating Manual SPM-19, Section 4.11).

- Set up the required stepping time in the display window "SWEEP OR STEP TIME/S" with toggle switch [18].
- Depress "MEM"
- Depress "f_{START}" and enter the start address on the keypad
- Depress "RCL": the frequency of the start address is generated
- Depress "f_{STOP}" and enter the stop address on the keypad
- Depress "RCL": the frequency of the stop address is generated
- Depress "AUTO STEP": the frequency of the stop address is generated until the step time has elapsed; the frequency of the start address then follows.

The frequency is stepped cyclically between the start and stop address frequencies. After one complete cycle, the unit starts again at the start address frequency.

If the frequency cycle is to begin at the start address frequency, then the pushbuttons "f_{START}" and "RCL" must be depressed before depressing the pushbutton "AUTO STEP".

Switching off automatic frequency stepping

- depress "f" (deactivates the auto step function)
- depress "MEM" (to switch off the memory function)

Notes:

- Checking the processing stages:
  Depress "RCL". As long as this pushbutton is depressed, the current address appears in the frequency display.
- Dynamic address modification during an AUTO STEP run:
  Enter the required address and depress "RCL".
- Interrupting autostep cycle and resuming later at the interruption point:
  Depress "f" (stops autostep function)
  Depress "AUTO STEP" (restarts the function)
- Interrogating the start or stop address:
  Depress "f_{START}" or "f_{STOP}" and then depress "RCL". As long as this pushbutton is depressed, the address number appears in the frequency display.
- If the AUTO BLANK function is active, the settling behavior of the level described in Section 4.8.3.2 also applies; this means that the two shortest step times of 0.03 second and 0.1 second can be used only if the increased error limits of the output level are acceptable.

  The behavior of the unit when the 10 kHz mark is passed described in Section 4.8.3.2 also applies here: Switching of the regulation time constant in the amplitude regulation circuit results in brief level variations. These can be transferred to the blanking period by activating the auto blank function.

4.10.6 STORING SETUPS*

Number: up to 10 complete front panel setups
Address range: 100 ... 109 (see Table 4-5)

With the exception of the AUTO STEP function, all functions and parameters which can be set on the front panel can be stored. Storage and recall are carried out as described in Section 4.10.2:

- Input of the required parameters and data
- Depress "MEM" (LED must light)
- Enter the required memory location (address) on the keypad [13]
- Depress "STO"
- Enter the next setup

4.10.7 RECALLING SETUPS*

From the address ranges 100 ... 109 and 500 ... 539 (only with optional feature "PROM" BN 870/00.01) is carried out as described in Section 4.10.2:

- Depress "MEM"
- Enter the required address (setup) on keypad [13]
- Depress "RCL"

*) The setups described here are for the PS-19.
See the note in Section 4.10 for the PSS-19.

As the MEM function remains active, further setups can be recalled directly by entering the address or sequentially by using the two direction pushbuttons " ⇧ " and " ⇩ " (see 4.10.5a).

4.10.8 AN APPLICATION EXAMPLE

Assume, for example, that 100 frequencies are stored as follows in a customer-specific PROM (BN 870/00.01):

Measuring task 1: Fixed frequencies in the address range 200 to 219
Measuring task 2: Fixed frequencies in the address range 220 to 236
etc.

The frequency groups are to be processed with automatic frequency stepping.

The various measuring tasks are stored in the memory as setups:

Measuring task 1 at address number 101,
Measuring task 2 at address number 102,
etc

- Depress "MEM"	Enter measuring parameters
- Depress "f_{START}"	
- Enter start address 200	
- Depress "RCL"	
- Depress "f_{STOP}"	
- Enter end address 219	
- Depress "RCL"	
- Select step time	
- Enter setup address 101	Store measuring parameters
- Depress "STO"	

The measuring parameters for further measuring tasks are entered in the same manner and stored at the following setup addresses 102, 103, etc.

Measuring task 1 is then recalled as follows:

- The memory function must be active; if not, depress "MEM"
- Enter setup address 101
- Depress "RCL"
- Depress "AUTO STEP"

4.11 REMOTE CONTROL OF THE PS-19

The level generator PS-19 can be supplemented with the level meter SPM-19 (or SPM-18) to form a complete level measuring setup.

If the generator and meter are installed at the same location, their frequencies can be tuned synchronously with the controls on the level meter.

The level measuring set consisting of the PS-19 and SPM-19 offers a comprehensive range of synchronous tuning facilities:

1. Synchronous (carrier frequency) tuning of the generator by the level meter SPM-19 (SPM-18) Measurements with frequency offset
2. Synchronous, manual frequency stepping (single step)
3. Synchronous, automatic frequency stepping (auto step)
4. Synchronous sweep frequency operation

Necessary cable connections:

The generator and the meter are connected together as shown in Figures 4-6a and 4-6b. The two coaxial cables should be as short as possible.

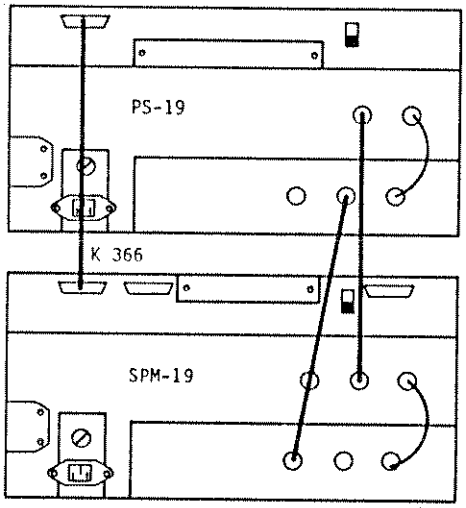


Figure 4-6a Remote control PS-19/SPM-19

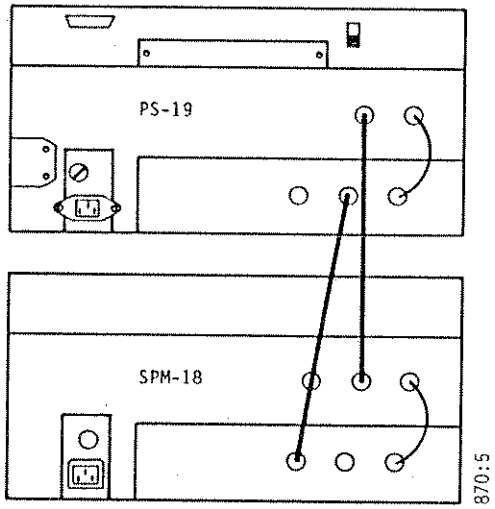


Figure 4-6b Remote control PS-19/SPM-18

Only operating mode 4.11.1 can be selected with the PS-19/SPM-18 combination.

Caution:
The cable K 366 (24-core cable) must be plugged in as shown in Figure 4-6a, as the synchronization signals in the operating modes 4.11.2 to 4.11.4 and the signal for switching of the regulation time constant of the generator are carried in this cable.

4.11.1 SYNCHRONOUS (CARRIER FREQUENCY) TUNING OF THE GENERATOR PS-19 BY THE LEVEL METER SPM-19

- Depress the pushbutton "EXT"

The frequency is switched off. If the data connection cable K 366 is not fitted, the output level cannot be blanked automatically with the AUTO BLANK function if a digital frequency change is carried out in the meter and the regulation time constant of the amplitude regulation circuit in the generator remains set to slow operation. This may result in small ripples in the output signal when carrying out sweep measurements at high sweep rates.

4.11.2 SYNCHRONOUS, MANUAL FREQUENCY STEPPING (SINGLE STEP) WITH DIFFERENT OUTPUT AND RECEIVE FREQUENCIES

4.11.2.1 Frequency stepping with constant step value

The function is initiated with the two "STEP" direction pushbuttons " ⇧ " and " ⇩ " on the meter.

The generator receives the information for stepping the frequency (8-bit word) from the meter via cable K 366 which connects the PS-19 and SPM-19.

The generator then synchronously changes its curent frequency by a step value f_{STEP}. The incoming stepping signals ⇧ or ⇩ can be inverted, or left as they are with the aid of the pushbuttons f_{START} and f_{STOP} on the generator, thus permitting the generator to be stepped in the opposite direction or the same direction as the level meter (inverted or normal sideband).

The following rules apply:

$f_{START} < f_{STOP}$	Normal sideband, i.e. the generator is stepped in the same direction as the level meter.
$f_{START} > f_{STOP}$	Inverted sideband, i.e. the generator is stepped in the opposite direction to the level meter.

The pushbuttons f_{START} and f_{STOP} are used only to select the appropriate sideband. The absolute value has no meaning.

Operation:

- Specify the inverted or normal sideband by depressing f_{START} or f_{STOP} (see above).
- Depress "f_{STEP}" and enter the required frequency step on the keypad.
- Depress "f" and enter the required starting frequency.
- Depress "EXT".
- Depress "AUTO STEP". The generator is now ready for use and waits for stepping signals from the receiver, initiated by depressing the "STEP" direction pushbutton.
  No further frequency parameters can be entered. For selection of other frequencies, the frequency step function must be switched off.

Switching off the function

- Depress pushbutton "EXT"

4.11.2.2 Frequency stepping by means of memory addresses

For this operating mode, the memory function "MEM" must be active in the PS-19 and the SPM-19.

Stepping of stored fixed frequencies is carried out on the level meter SPM-19 with the two direction pushbuttons ⇧ and ⇩ , the connection cable K 366 must be fitted as shown in Figure 4-6a, as the generator receives the stepping information via this cable. When a pushbutton on the SPM-19 is depressed, the PS-19 increments or decrements its memory address by one step.

In this operating mode, it is not necessary to select the inverted or normal sideband.

Operation:

- Depress "MEM" and enter the required start address
- Depress "RCL"
- Depress "EXT"
- Depress "AUTO STEP". The unit is now ready and waits for stepping signals from the SPM-19.

To check the address number which is currently selected, depress the "RCL" pushbutton; the address appears in the frequency display.

Switching off the function:

- Depress pushbuttons "EXT", "MEM"

4.11.3 SYNCHRONOUS, AUTOMATIC FREQUENCY STEPPING (AUTO STEP) WITH DIFFERENT OUTPUT AND RECEIVE FREQUENCIES

In contrast to manual frequency stepping (Section 4.11.2), the frequency is automatically stepped in this mode by a clock signal which is determined by the STEP TIME set up on the SPM-19 and which is transmitted from the level meter [40] or [41] to the generator [30] via the data connection cable K 366. The STEP TIME switch on the PS-19 is disabled and the display window is not illuminated.
The sequences described in Sections 4.8.3.2 and 4.10.5 can also be executed in this operating mode:

- automatic frequency stepping
- automatic memory address stepping

The parameters which determine the sequence, such as f_{START}, f_{STOP}, f_{STEP} or start and end address, must be selected correctly in the PS-19 and SPM-19 in order to maintain synchronization of the stepping functions.

In other words, the number of frequency or address steps and the frequency or address limits must be identical in the generator and level meter.

As the sequence is always executed in the level meter and generator from the start frequency to the stop frequency in the case of automatic frequency stepping (4.11.3.1), the measuring set can be operated in the inverted or normal sideband position by suitable selection of the two frequencies.

Caution: If the "AUTO BLANK" function is active, it is recommended that the stepping time of the level meter is not set to a value less than 1 s, in order to ensure that the generator has sufficient time for settling (see Section 4.6.2).

4.11.3.1 Automatic frequency stepping (see abridged operating instructions in Section 5.3.2)

Settings on the PS-19

- Depress "f_{STEP}" and enter the step frequency
- Depress "f_{STOP}" and enter the stop frequency; the stop frequency is now transmitted.
- Depress "f_{START}" and enter the start frequency; the start frequency is now transmitted.
- Depress "EXT"; the frequency determined by the receiver is now transmitted.
- Depress "AUTO STEP"; the start frequency is transmitted.

The unit is now ready and waits for stepping signals from the level meter SPM-19, on which f_{START}, f_{STOP} and f_{STEP} must also have been entered.
the frequency stepping function must be reset to permit modification of frequency parameters on the PS-19.

Switching off the function: Depress "EXT"

Notes:
The level meter always executes a cycle which starts at f_{START} and ends at f_{STOP}.
For a new cycle, the receiver must again be stepped to the starting point by depressing the pushbutton "f_{START}". This also tunes the generator to its starting frequency.

In order to maintain synchronization between the level meter and generator, no pushbuttons must be depressed on the generator during the cycle.

The user must always ensure that the frequency parameters in the generator and level meter result in the same number of steps. If the generator reaches its stop frequency before the level meter, then it starts again at the start frequency.

4.11.3.2 Automatic frequency stepping by means of memory addresses

- Depress "MEM"
- Depress "f_{STOP}"; the stop frequency of the AUTO STEP function is transmitted.
- Enter the stop address via the keypad.
- Depress "RCL"; the frequency if the stop address is transmitted.
- Depress "f_{START}"; the start frequency of the AUTO STEP function is transmitted.
- Enter the start address via the keypad.
- Depress "RCL"; the frequency of the start address is transmitted.
- Depress "EXT"; the frequency determined by the level meter is transmitted.
- Depress "AUTO STEP"; the frequency of the start address is transmitted.

The unit is now ready in the operating mode "synchronous, automatic memory stepping" and waits for stepping signals from the level meter, which must be set accordingly with respect to start and stop addresses. The number of address steps in the PS-19 and SPM-19 must in all cases be equal.

In order to avoid disturbing synchronization, no further pushbuttons must be pressed on the generator!

Switching off the function: Depress pushbuttons "EXT", "MEM"

4.11.4 SYNCHRONOUS SWEEP FREQUENCY OPERATION WITH FREQUENCY OFFSET (see abridged operating instructions in Section 5.3.1)

This sweep frequency measuring method is a special operating mode of the PS-19/SPM-19 combination which permits sweep measurements on frequency converters.

Figure 4-7 shows the test configuration and the necessary connections.

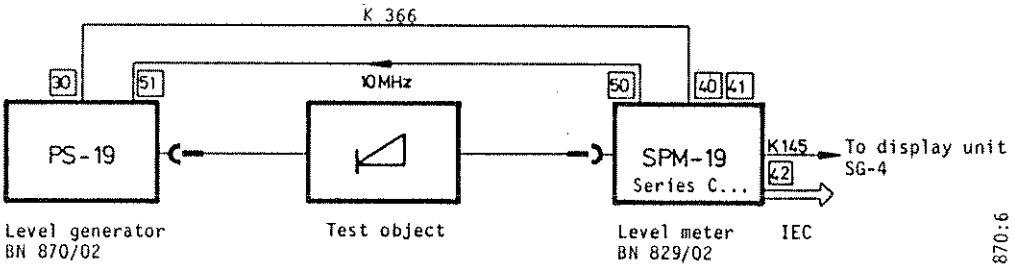


Figure 4-7 Sweep frequency measuring set for frequency converters

Synchronization of the PS-19 is carried out via the cable K 366[1].

Settings:

- Set up the required start and stop frequencies on the PS-19 and SPM-19.
- Set the PS-19 and the SPM-19 to the same sweep time. (Do not exceed the maximum sweep rates specified below!)
- Set both units to the start frequency.
- Prepare the PS-19 for "synchronous sweep"; this is done by depressing "EXT" followed by "SWEEP" ⩘ .
  (The PS-19 now waits at the preselected position and its starting frequency is displayed).
- Start the sweep by depressing "SWEEP" ⩘ on the SPM-19.

1) K 366 must be purchased separately.

Parameters can be modified only if the operating mode "synchronous sweep frequency operation is switched on!

- The operating mode EXT - SWEEP ⩘ on the PS-19 can be switched off by depressing push-button "EXT" or "FREQ".

The following prerequisites must be fulfilled for correct operation:

> No operator controls of the PS-19 or SPM-19 may be operated during this sweep sequence; the IEC bus must also not address these two units!

The maximum sweep rate must not be exceeded! This depends on the smallest existing bandwidth of the receive path (text object and level meter) and is

for bandwidth 25 Hz : $\frac{\Delta f}{\Delta t} \leq 20 \frac{kHz}{s}$

for bandwidth 400 Hz : $\frac{\Delta f}{\Delta t} \leq 200 \frac{kHz}{s}$

for bandwidth 1.74 kHz : $\frac{\Delta f}{\Delta t} \leq 1 \frac{MHz}{s}$

for bandwidth 3.1 kHz : $\frac{\Delta f}{\Delta t} \leq 10 \frac{MHz}{s}$

4.12 STANDARD FREQUENCY INPUT [51]

If the specified frequency accuracy of the PS-19 in not sufficient for specific measuring tasks, the accuracy of the output frequency can be improved by connecting an external, more accurate standard frequency of 1, 2, 5, or 10 MHz to socket [51]. The necessary level for a sinusoidal input signal lies between -20 and 0 dB; for a square-wave signal, the voltage V_{pp} may lie between 200 mV and 2 V (input impedance 75 Ω).

4.13 EXTERNAL LEVEL REGULATION

The output level can be varied by approximately ±1 dB if a positive DC voltage of approximately 1.3 V is connected to socket [22] of the PS-19 or socket [14] of the PSS-10 "external level regulation"; the necessary voltage variation for the above level variation is approximately ± 700 mV.

If the EPM-1 is used as an AGC amplifier, an external control loop can be constructed. In this case, the output level from the generator is measured as close as possible to the test object with the test probe of the EPM-1. The control voltage output of the EPM-1 provides a DC voltage which is proportional to the deviation from the specified value, and this voltage is connected back to the input socket [22] or [14] of the level generator. This regulation loop makes it possible to compensate for cable losses in long cables, for errors due to the generator output impedance or errors caused by the test cable. See Section 5.2 for further details.

4.14 COMPUTER CONTROL

All functions of the level generator PS-19 or send section PSS-19 can be controlled by an external computer. The unit can thus be integrated in automatic measuring systems and can carry out comprehensive measuring tasks not only precisely and reliably, but also with major savings in time and costs. Figure 4-8 shows the configuration of a simple automatic level measuring set, which can be expanded as required. The transmit side uses the send section PSS-19, whose functions can be controlled via the digital interface [20]. The actual computer control is executed via the IEC interface of the level meter SPM-19. Data traffic is exchanged over the cable K 350 between the generator [20] and level meter [40] [41].

To control the level generator PS-19, the optional interface board BN 853/05 must be inserted in the rear of the unit. Connection to systems with IEEE 488 interfaces is carried out via the additional adapter plug S 834. The interface board can be fitted later to existing units as described in Section 6. The external control of the PS-19 is indicated by the red LED above the pushbutton "LOCAL" being on. As long as this LED is on, manual operation of the unit by keypad input is inhibited.

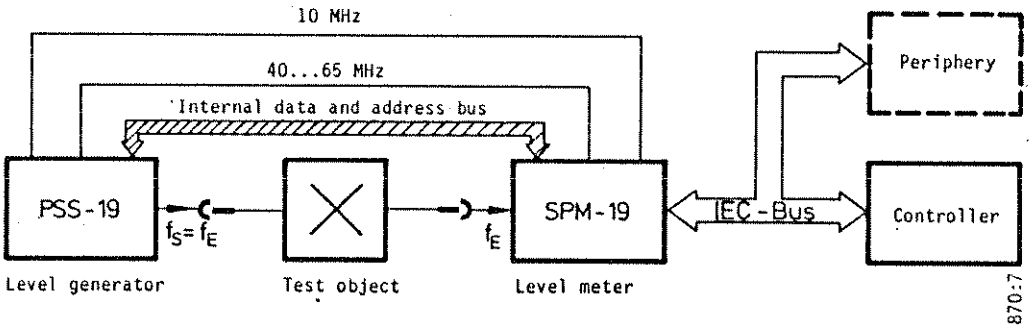


Figure 4-8 Block diagram of a simple level measuring set

Switching to manual control with the computer connected by depressing the pushbutton "LOCAL" is possible in accordance with the conditions described in the IEC bus standard (remote-local function RL1). Details of programming of the level generator can be found in the separate manual "Remote control and programming of the SPM-19".

4.14.1 INTERFACE-BUS <IEC 625>

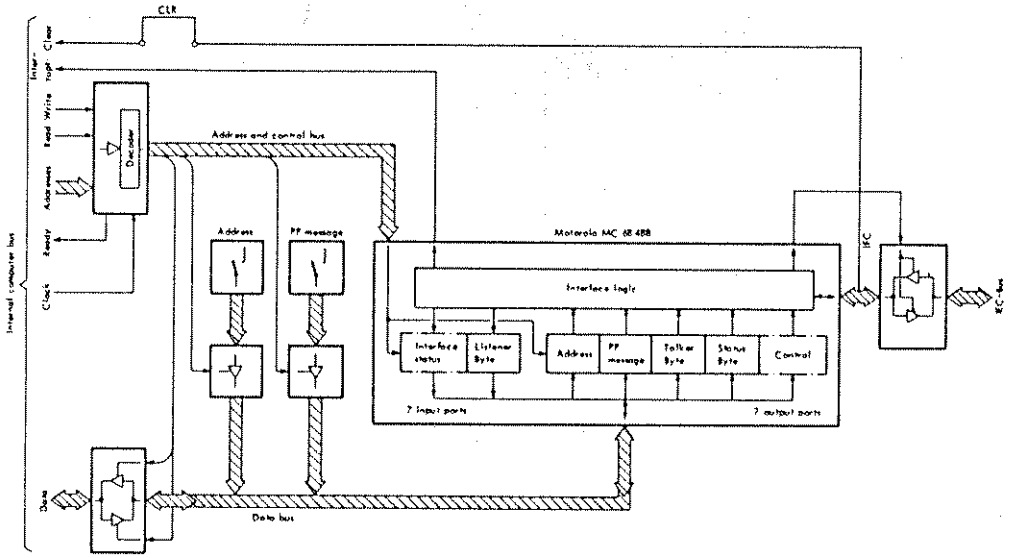


Figure 4-9 Block diagram of the IEC bus interface

Figure 4-9 shows a simplified block diagram of the interface bus <IEC 625> board. For better comprehension of the following description of the interface board, it is recommended that the user first read the brochure "Interface bus <IEC 625>".

For the microprocessor, the IEC bus interface is nothing more than a collection of input and output ports. Exchange of data between the IEC bus and the unit is executed via these ports and is controlled by the IEC bus program. The PROMs in which this program is stored are located inside the unit, not on the IEC bus interface board.

The actual interface logic is in an IEC bus interface module. This is connected, on the one side, via the necessary drive and receiver circuits with the interface of the IEC bus, and on the other side with the plug connected to the input/output bus of the microprocessor within the level generator. This interface logic handles the major part of the interface tasks automatically, i.e. without using the microprocessor within the generator. It automatically carries out, for example, the IEC bus handshake cycle and decodes all messages which are transmitted on the IEC bus. The interface states assumed as the result of these messages are written into the appropriate input ports.

A further input port acts as a transfer register for listener data, i.e. those data which are to be transmitted from the IEC bus to the generator as long as the generator is addressed as a listener (e.g. during transmission of setting parameters for the generator).

The output ports are used

- To receive control instructions with which the microprocessor can influence the behaviour of the interface logic. It can, for example, in addition to a large number of other possibilities, stop the handshake cycle or transmit a service request signal (SRQ) via the IEC bus.

- as a transfer register for data which are to be transmitted from the generator to the IEC bus, for example talker data and status information.

  Talker data are data which are transmitted from the generator to the IEC bus as long as the generator is operating as the talker, e.g. when the result of a measurement is being transmitted.

  The status byte is the response of the generator to a serial poll and contains the current generator status.

The generator address can be set up on the address switch (see Figure 6-1).

With the aid of the "PP switch" (see Figure 6-1), it is possible to specify the data line of the IEC bus on which the generator is to transmit its request service signal (RQS) if the controller executes a status interrogation by means of a parallel poll.

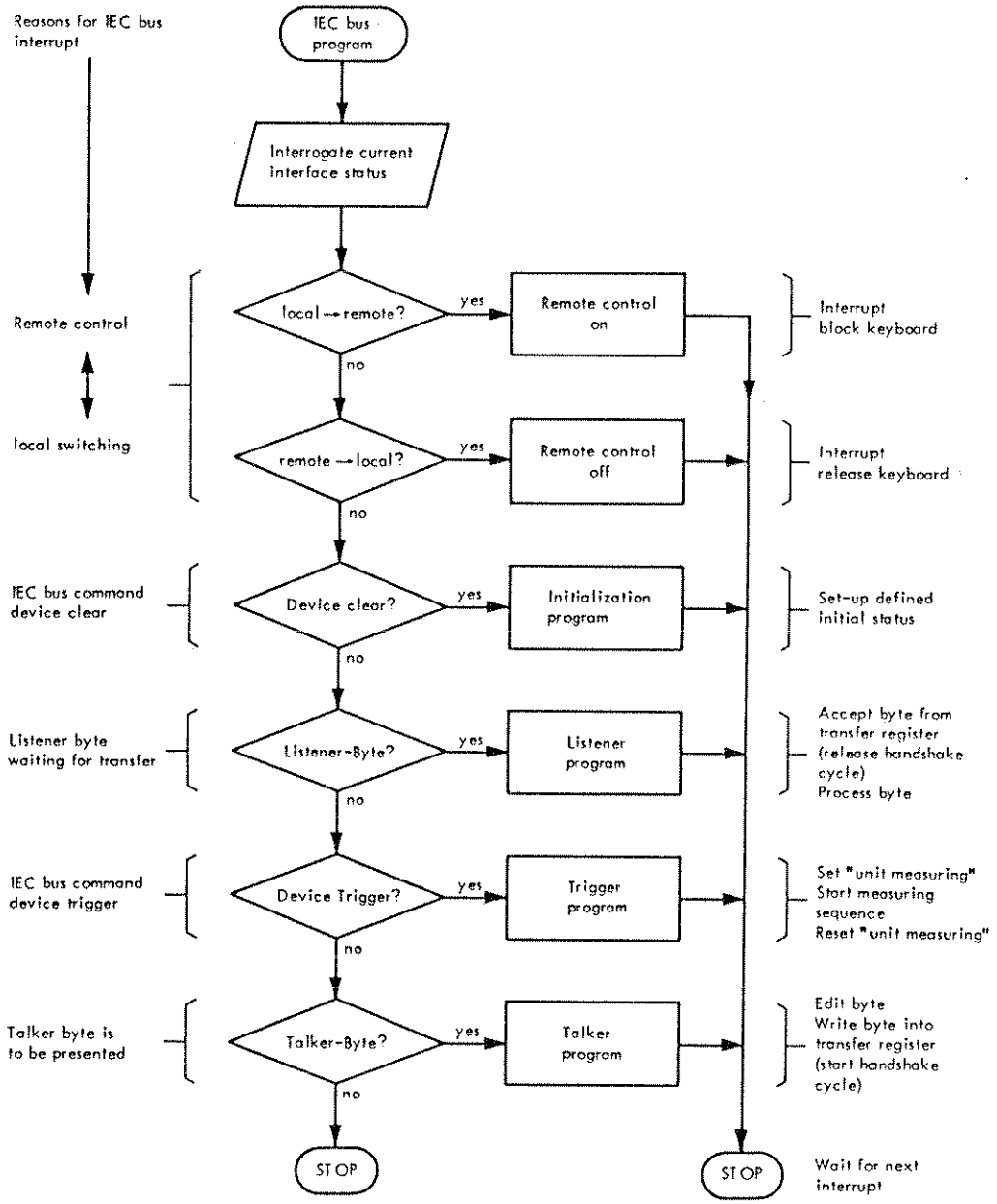
4.14.1.1 Interactions between the instrument and IEC bus interface

When the IEC bus has reached a status in which operation by the microprocessor within the generator is necessary, the IEC bus interface generates an interrupt signal to the generator. As a result of this interrupt, the microprocessor executes the IEC bus program. This is the case whenever:

- The unit is to be switched from local to remote or from remote to local.
- A listener byte was transmitted over the IEC bus. The interface logic has in this case written the byte into the transfer register for listener data and stopped the handshake cycle. The handshake cycle remains stopped until the microprocessor has read this byte (NDAC then becomes not true, i.e. the data have been received). After processing and storage of the listener data, NRFD becomes not true, indicating that the unit is ready to receive data.
- The unit must provide a new talker byte. When the new talker byte is written into the appropriate output port, the handshake cycle is started (DAV = true, i.e. data are valid).
- Execution of a measurement by the unit is to be initiated by the IEC Execute Trigger)" . The interface logic has in this case stopped the handshake cycle. The cycle remains interrupted until the microprocessor has initialized the unit and enabled the handshake cycle again (NDAC = not true and NRFD = not true).
- The unit is to be set to a designed initial status by the IEC bus instruction "device clear (DCL or SDC = selected device clear)". Again, the interface logic stops the handshake cycle and the cycle remains interrupted until the microprocessor has initialized the unit and enabled the handshake cycle again (NDAC = not true and NRFD = not true).

If the strap CLR is fitted on the IEC bus interface board, the IEC bus signal IFC (interface clear) causes the generator to be initialized. This makes it possible to initialize the generator via the IEC bus, for example in the case of a hangup. (This is important for units in unmanned stations, where a hangup resulting from external interference cannot be cleared by switching the mains voltage off and on again).

4.14.1.2 Structure of the IEC-Bus program



4.14.2 BUS SPECIFICATION AND BUS PLUG

In an automatic measuring system which is compatible with the IEC bus, up to 15 devices can be connected in parallel via this standard interface.

Each single device is connected via a cable with a maximum length of 2 m to the bus. The total bus length of the system must not exceed 20 m. Lengths greater than this can be achieved by intermediate interface couplers (via 2 wire and 4 wire connections), or modems.

The ISO 7-bit code or ASCII code is used for encoding of characters. The data are transmitted parallel by bit and serial by byte.

The pin assignments of the bus plug on the device are shown in Figure 4-10. The most important differences between the <IEC 625> and the IEEE 488 interfaces is in the version of the plug (IEC: 25-pin Cannon plug; IEEE: 24-pin Amphenol plug) and in the pin assignments. The measuring devices with IEC interfaces can, however, easily be modified to match controllers with IEEE interfaces by the use of adapter plug S 834, which is delivered together with the interface board.

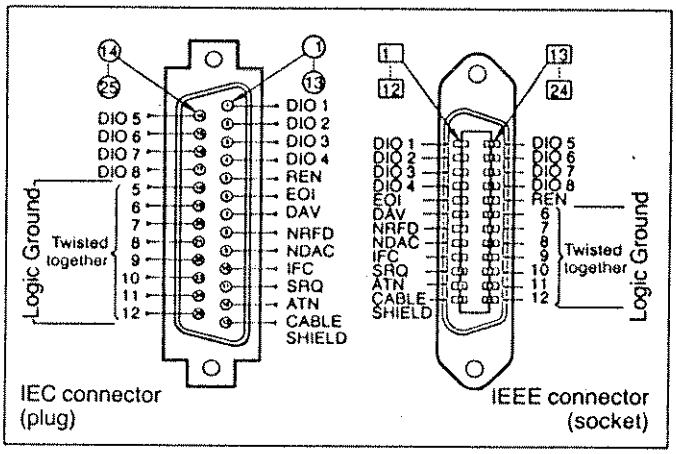


Figure 4-10 Pin assignments of the bus interface on the device

4.15 EPROM OPTION

Up to 100 fixed frequencies (PS-19 only) and 40 complete equipment setups can be stored in a customer-specific EPROM and then be recalled with the address numbers shown in Table 4-5 (see Sections 4.10.4 and 4.10.7). If the PROM is not fitted in the unit, an error number appears in the frequency display of the PS-19, or in the frequency display of SPM-19 if operated together with the PSS-19, (e.g. 2--001 = invalid address number) if one of the addresses is selected. Interpretation of the error numbers is shown in Section 6.

When ordering the EPROM, which can be installed later in existing generators if the installation instructions (see Section 6.3.3) are observed, the forms 5/785a for setups (Part I) and/or 5/785b for fixed frequencies in the PS-19 (Part II) must be filled out completely. Examples of these ordering forms are shown in Figures 4-11 and 4-12. An example for a setup is shown in Column 1 of the forms.

If more than six setups are required, further forms 5/785a should be used, numbering each page. Always enter all level and frequency values, even if they are only infrequently required.

4.16 LEVEL GENERATOR PS-19, BN 870/05 WITH FIXED FREQUENCY PROGRAMS

This version has eight fixed frequency programs (see Table 4-7). Each program can be called up by means of a program number between 501 and 508. When "AUTO STEP" is pressed each fixed frequency is selected cyclically at a selected time interval [18]. These time intervals are different from those stated in Section 1.1.4.1:

0.2, 0.3, 0.4, 0.5, 0.6, 0.8, 1, 1.5, 2 and 3 sec.

Program call-up (example)

You want to transmit the frequency sequence in program No. 6.
Key sequence: "MEM" (on) "506" "RCL" "AUTO STEP"
Stop the frequency sequence by pressing "f".
Calling up a fixed frequency in this program, e.g. 227.92 kHz:
Key sequence: "MEM" (on) "370" "RCL" (see Section 4.10.5b also)

"AUTO BLANK" function [10]

This function is always on. When the frequency is changed the send level is blanked and keyed in "softly" (see Section 4.6).

The function can only be switched off by means of a bootstrap initialization (e.g. Section 6.3.4.2). The function can be switched on again by pressing "AUTO BLANK" [10].

Program / Step	1		2		3		4		5		6		7		8	
	Setup 501		Setup 502		Setup 503		Setup 504		Setup 505		Setup 506		Setup 507		Setup 508	
	MEM	f/kHz	MEM	f/kHz	MEM	f/kHz	MEM	f/kHz	MEM	f/kHz	MEM	f/kHz	MEM	f/kHz	MEM	f/kHz
1	200	22,08	242	63,92	250	22,08	312	75,92	326	23,92	366	95,92	378	23,92	428	156,92
2	201	26,08	243	83,92	251	30,08	313	99,92	327	35,92	367	131,92	379	59,92	429	282,00
3	202	30,08	244	95,92	252	38,08	314	124,08	328	47,92	368	167,92	380	83,92	430	396,08
4	203	34,08	245	107,92	253	46,08	315	148,08	329	59,92	369	203,92	381	107,92	431	504,08
5	204	38,08	246	95,92	254	57,00	316	181,92	330	71,92	370	227,92	382	131,92	432	528,08
6	205	42,08	247	83,92	255	67,92	317	201,92	331	83,92	371	254,00	383	156,92	433	552,08
7	206	46,08	248	63,92	256	75,92	318	221,92	332	95,92	372	227,92	384	179,92	434	528,08
8	207	50,08			257	83,92	319	201,92	333	107,92	373	203,92	385	203,92	435	504,08
9	208	57,00			258	91,92	320	181,92	334	119,92	374	167,92	386	227,92	436	396,08
10	209	63,92			259	99,92	321	148,08	335	131,92	375	131,92	387	254,00	437	282,00
11	210	67,92			260	107,92	322	124,08	336	143,92	376	95,92	388	282,00	438	156,92
12	211	71,92			261	114,00	323	99,92	337	156,92			389	324,08		
13	212	75,92			262	124,08	324	75,92	338	167,92			390	348,08		
14	213	79,92			263	132,08			339	179,92			391	372,08		
15	214	83,92			264	140,08			340	191,92			392	396,08		
16	215	87,92			265	148,08			341	203,92			393	420,08		
17	216	91,92			266	156,08			342	215,92			394	444,08		
18	217	95,92			267	164,08			343	227,92			395	468,08		
19	218	99,92			268	171,00			344	239,92			396	480,08		
20	219	103,92			269	177,92			345	254,00			397	492,08		
21	220	107,92			270	181,92			346	239,92			398	504,08		
22	221	103,92			271	185,92			347	227,92			399	516,08		
23	222	99,92			272	189,92			348	215,92			400	528,08		
24	223	95,92			273	193,92			349	203,92			401	540,08		
25	224	91,92			274	197,92			350	191,92			402	552,08		
26	225	87,92			275	201,92			351	179,92			403	540,08		
27	226	83,92			276	205,92			352	167,92			404	528,08		
28	227	79,92			277	209,92			353	156,92			405	516,08		
29	228	75,92			278	213,92			354	143,92			406	504,08		
30	229	71,92			279	217,92			355	131,92			407	492,08		
31	230	67,92			280	221,92			356	119,92			408	480,08		
32	231	63,92			281	217,92			357	107,92			409	468,08		
33	232	57,00			282	213,92			358	95,92			410	444,08		
34	233	50,08			283	209,92			359	83,92			411	420,08		
35	234	46,08			284	205,92			360	71,92			412	396,08		
36	235	42,08			285	201,92			361	59,92			413	372,08		
37	236	38,08			286	197,92			362	47,92			414	348,08		
38	237	34,08			287	193,92			363	35,92			415	324,08		
39	238	30,08			288	189,92			364	23,92			416	282,00		
40	239	26,08			289	185,92							417	254,00		
41	240	22,08			290	181,92							418	227,92		
42					291	177,92							419	203,92		
43					292	171,00							420	179,92		
44					293	164,08							421	156,92		
45					294	156,08							422	131,92		
46					295	148,08							423	107,92		
47					296	140,08							424	83,92		
48					297	132,08							425	59,92		
49					298	124,08							426	23,92		
50					299	114,00										
51					300	107,92										
52					301	99,92										
53					302	91,92										
54					303	83,92										
55					304	75,92										
56					305	67,92										
57					306	57,00										
58					307	46,08										
59					308	38,08										
60					309	30,08										
61					310	22,08										

Table 4-7 Fixed-frequency programs for the PS-19, BN 870/05

Aussteller bitte nur die stark umrandeten Felder **vollständig** ausfüllen

Please fill out **completely**, but only in those areas bordered by bold black lines

☐ **PS-19** Option BN 870/00.01

☐ **PSS-19** Option BN 871/00.01

Bestellvorschrift
Ordering Instructions

Nr. ☐☐☐☐

Blatt / Sheet

Teil I / Part I: Geräteeinstellungen / Instrument settings *)		Kunde / Customer	Bestell-Nr. / Order No.
PS-19/PSS-19, Nr.:	**AB:**		
geprüft: / erstellt (Datum):	**T:**	Festfrequenzen / Fixed Frequencies (Teil II / Part II) ja / yes ◯ nein / no ◯	

Gewünschte Einstellungen ☐ und Zahlenwerte ● **vollständig** eintragen. Bei > 6 Setups weitere Vordrucke verwenden.
Settings ☐ and values ● must be **completely** entered. For more than 6 Setups, use additional printed form(s).
Adreßnummern / addresses PS-19: 500 ... 539 / PSS-19: 300 ... 339 (≙ SPM-19). Lückenlos durchnumerieren / Numbered consecutively.

Adresse / Address No. eintragen / Enter	Beispiel / Example						
Blank: On [4] ; Off [0] Autoblank: On [1]	[0]	☐	☐	☐	☐	☐	☐
Output: Unbal. 75 Ω [0] Bal. I 124 Ω [1] 150 Ω [2] Bal. II 150 Ω Z, 0 [3], [4] 600 Ω Z, 0 [5], [6]	[0]	☐	☐	☐	☐	☐	☐
Level Calibration: dBm(0) [1], dB(0) [0]	[1]	☐	☐	☐	☐	☐	☐
Level Mode: dB(m) [2] dB(m)0 [1] dBr [0]	[2]	☐	☐	☐	☐	☐	☐
Entry Select: Level [2] Mem.[7] [1] Freq. [0]	[0]	☐	☐	☐	☐	☐	☐
Nur PS-19 / Only PS-19 External Freq. Tuning: On [1] Off [0]	[0]	☐	☐	☐	☐	☐	☐
Contin.[8]: Man Fine [0] Coarse [1] Sweep ⩘ [1] [5] ⩗ [1] [6] Auto Step[2] [4] Off (dig. setting) [9]	[5]	☐	☐	☐	☐	☐	☐
Sweep or Step Time/s ●	0,3	.....	.....	.....	.....	.....	.....
Man[3] [0]	[0]	☐	☐	☐	☐	☐	☐
dB(m)-Wert / Value ●	+/− 0 3 0 0	+/−	+/−	+/−	+/−	+/−	+/−
dB(m)0-Wert / Value ● [4]	+/− 0 1 0 0						
dBr-Wert / Value ●	+/− 0 2 0 0						
Nur PS-19 / Only PS-19	MHz kHz Hz	MHz kHz Hz	MHz kHz Hz	MHz kHz Hz	MHz kHz Hz	MHz kHz Hz	MHz kHz Hz
Frequenz / Frequency f[5] ●	0 0 1 2 3 4 5 6						
f_{START} ● [6]	0 0 1 2 3 4 5 6						
f_{STOP} ● [6]	2 3 4 5 6 7 8 9						
f_{STEP} ● [6]	0 0 0 0 1 0 0 0						
Memory Start-Adresse / Address ● [7]	200	.....	.....	.....	.....	.....	.....
Memory Stop-Adresse / Address ● [7]	230	.....	.....	.....	.....	.....	.....

1) Für Offset Sweep ⩘ oder ⩗ mit SPM-19 zusätzlich bei Ext. Freq. Tuning 1 eintragen.
2) Nur in Verbindung mit Ext. Freq. Tuning als Synchr. Single- und Auto-Step möglich.
3) Zusätzlich bei „Sweep" 5 eintragen.
4) Alle 3 Werte eintragen. Es gilt: a dBm0 + b dBr = (a + b) dBm
5) Bei Frequenzablaufen Anfangsfrequenz eintragen.
6) Hier stets einen Zahlenwert eintragen, auch wenn Set-Up ohne Wobbel- oder f_{STEP}-Funktion.
7) Für die Betriebsart Memory – Auto – Step Start- und Stop-Adresse angeben.
8) Gewünschte Einstellung auch bei Ext. Freq. Tuning „ein" [1] angeben.

1) For Offset Sweep ⩘ or ⩗ with SPM-19, enter additionally with Ext. Freq. Tuning 1
2) Possible only in conjunction with Ext. Freq. Tuning as Sync. Single and Auto-Step
3) Also enter 5 under "sweep".
4) Enter all three values. Expressed as: a dBm0 + b dBr = (a + b) dBm
5) Enter initial frequency with frequency runs
6) Always enter a numerical value here, also if Set-up has no Sweep or f_{STEP} function
7) Give Start and Stop addresses for the operating mode Memory – Auto – Step
8) If Ext. Freq. Tun. ("on [1]"), select one of headings below.

5/785.a

*) Setups und Festfrequenzen in 1 EPROM gespeichert / Setups and fixed frequencies stored in one EPROM

Aussteller bitte nur die stark umrandeten Felder vollständig ausfüllen

Please fill out completely, but only in those areas bordered by bold black lines

PS-19

Option BN 870/00.01

Bestellvorschrift
Ordering Instructions

Nr.

Teil II / Part II: Festfrequenzen / Fixed Frequencies *)

PS-19 Nr.:	AB:
geprüft: / erstellt (Datum):	T:

Kunde / Customer	Bestell-Nr. / Order No.

Geräteeinstellungen / Set-ups (Teil I / Part I) ja / yes ◯ nein / no ◯

Gewünschte Festfrequenzen in Hz lückenlos eintragen. Adressbereich 200–299 / Enter wanted fixed frequencies in Hz and in consecutive order (no gaps). Address area 200–299. Freie Adressen werden mit f = 0 Hz belegt / Free addresses are allocated with f = 0 Hz.

MEM z. B. / e. g.	MHz 1	MHz 2	kHz 3	kHz 4	kHz 5	Hz 6	Hz 7	Hz 8
200								
201								
202								
203								
204								
205								
206								
207								
208								
209								
210								
211								
212								
213								
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5 MEASURING NOTES

5.1 MEASURING HIGH ATTENUATION VALUES

For level measurements on four-pole networks with high attenuation values, a high return impedance Z_S between the generator and receiver of the measuring set is necessary (see Figure 5-1). If the return impedance is not infinitely large, the voltage drops in the ground lead resistances r_1 and r_2 of the test cables, generate additional measuring errors. In order to keep these errors small in practical applications, Z_S must be large in comparison with r_1 and r_2. This high return impedance is achieved in the SPM-19 by decoupling the ground of the measuring circuit from the chassis ground (floating input).

The effects of the above-mentioned impedances and resistances on the measureable attenuation are described in the following section.

The object to be measured is a four-pole network with an infinitely large attenuation. Z_S is the return impedance, r_1 and r_2 are the unavoidable ground lead resistances[1)], which may in fact be impedances just like Z_S. Due to the voltage drop across r_1 resulting from the generator current, a voltage exists between the chassis of the generator and receiver.

If the return impedance Z_S is finite, a signal current flows through r_2 and generates a signal voltage at the receiver input, thus simulating a finite attenuation if the object being measured.

It is assumed that r_1 and r_2 are small with respect to R_i, R_e, Z and Z_s, a simple calculation shows

$$\frac{U_2}{U_o} = \frac{r_1}{R_i + Z} \times \frac{r_2}{Z_s} \times \frac{R_e}{R_e + Z}$$

In the case where $R_i = R_e = Z$, the effective attenuation is

$$a = 20\ \text{dB} \times \log \frac{U_0}{2 \times U_2}$$

$$= 20\ \text{dB} \times \log \frac{2 \times Z \times Z_s}{r_1 \times r_2}$$

This attenuation must, for example for a maximum measuring error of 0.01 dB, be approximately 60 dB greater (approximately 40 dB for 0.1 dB error) than the attenuation to be measured if the most unfavorable phase angle between the measured voltage and error voltage is assumed.

The magnitude of the return impedance Z_s is approximately 40 Ω over a wide frequency range.

---

1) In literature, r_1 and r_2 are called "coupling resistances" in the case of coaxial cables, plugs, etc. and are definied as follows:

Coupling resistance =

$$\frac{\text{Voltage drop on the outside of the outer conductor}}{\text{Current on the inside of the outer conductor}}$$

Coupling resistance =

$$\frac{\text{Voltage drop on the inside of the outer conductor}}{\text{Current on the outside of the outer conductor}}$$

If it is assumed that r_1 and r_2 are each 10 mΩ - this is the value for the coupling resistance of a good, double-screen coaxial cable with a length of 50 cm - then the effective attenuation with Z = 75 Ω and Z_S = 40 Ω for the configuration shown in Figure 5-1 can be calculated to be 156 dB.

As the maximum attenuation which can be measured with the measuring set PS-19/SPM-19 is, for example, 96 dB calculated with the above assumptions leads to an additional inaccuracy of more than 0.01 dB.

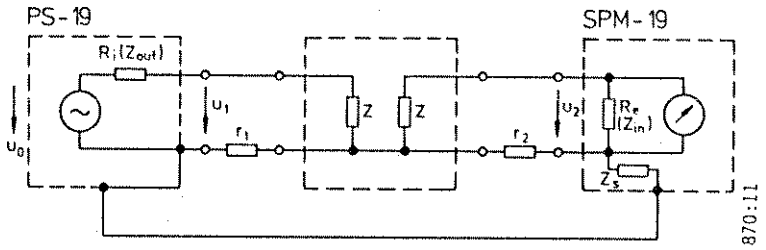


Figure 5-1 Measuring high attenuation values

5.2 EXTERNAL REGULATION OF THE GENERATOR OUTPUT LEVEL

The output level of the PSS-19 or PS-19 can be kept virtually constant over the whole frequency range with the aid of the milliwatt power meter EPM-1. In this case, the EPM-1 is used as an AGC amplifier and forms, together with the generator, a closed control loop.

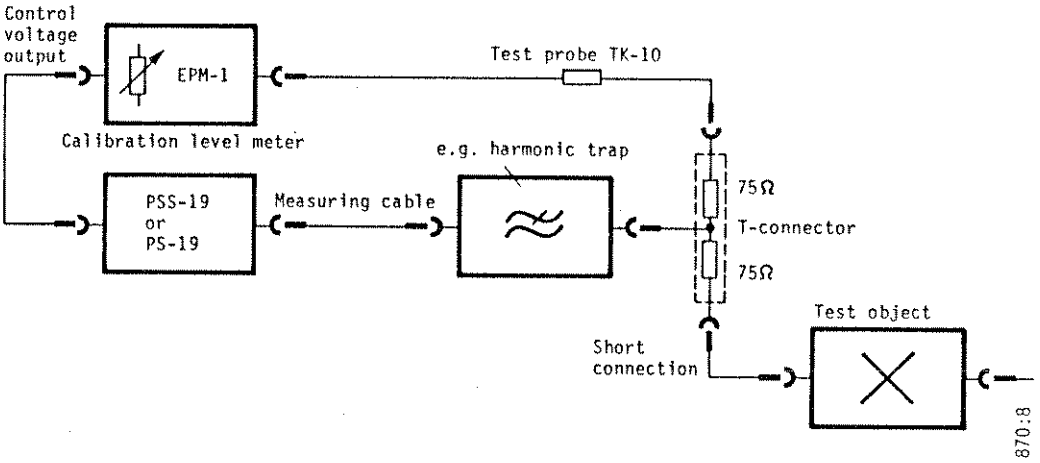


Figure 5-2 Test configuration for external level regulation

In the measuring example in Figure 5-2, the generator signal is connected via a low-pass filter, which acts as a harmonic block, to the test object. A T connector feeds the generator level of approximately 6 dBm equally to the unit to be tested and to the test probe TK-10 of the milliwatt power meter. A DC voltage which is proportional to the deviation from the required value available at the control voltage output of the EPM-1 is connected to the input "external level regulation" of the generator to control its output level. This system provides an extremely accurate level at the input to the test object, the level being independent of the frequency.

The system also compensates for errors due to the insertion loss and non-linearity of the low-pass filter, due to the measuring cables, and due to reflection at connection points. The residual error is determined only by the frequency response of the test probe, the regulation error of the EPM-1, and the unbalance of the T connector.

The magnitude of the test signal at the input to the test object can be adjusted precisely and continously by varying the reference voltage at the EPM-1 (potentiometer P 304).

In order to obtain constant output voltages of 0 dB or +10 dB, a suitable attenuator must be connected to the measuring probe in order to match the level. If only levels considerably below 0 dBm are permissible for the unit under test, a 75 Ω variable attenuator set to a suitable value can be connected to the test object. This configuration is advisable only if the variable attenuator is extremely precise, as its intrinsic errors are not compensated by the above circuit.

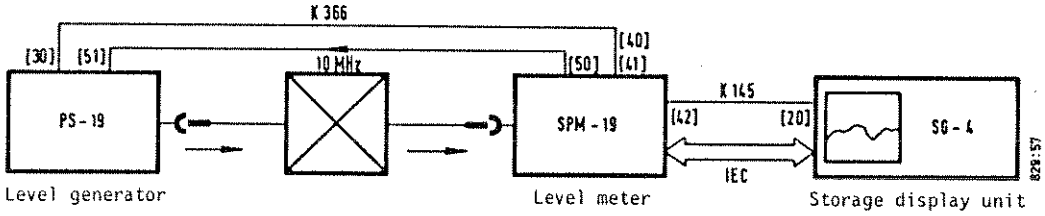
Note: When the PS-19 is remote-controlled by the SPM-19 (cf. Section 4.11) with the data cable in, the level generator is blanked for a short time while the receiver is being blanked. If the EPM-1 is used to externally regulate the send level, then, under these circumstances, the function will only operate correctly when the automatic calibration facility of the level meter is switched off, or the connection to the digital interface is removed (flashing error message 2--005).

5.3 ABRIDGED OPERATING INSTRUCTIONS FOR THE PS-19/SPM-19/SG-4 FOR MEASUREMENTS WITH FREQUENCY OFFSET

The following sections only describe those settings which are required in addition to the basic setup. The basic setup (send level, Z_0, bandwidth etc.) is fully described in the operating instructions. The best result-display is obtained on the SG-4 Storage Display Unit.

5.3.1 SWEEP WITH FREQUENCY OFFSET

5.3.1.1 Measurement setup

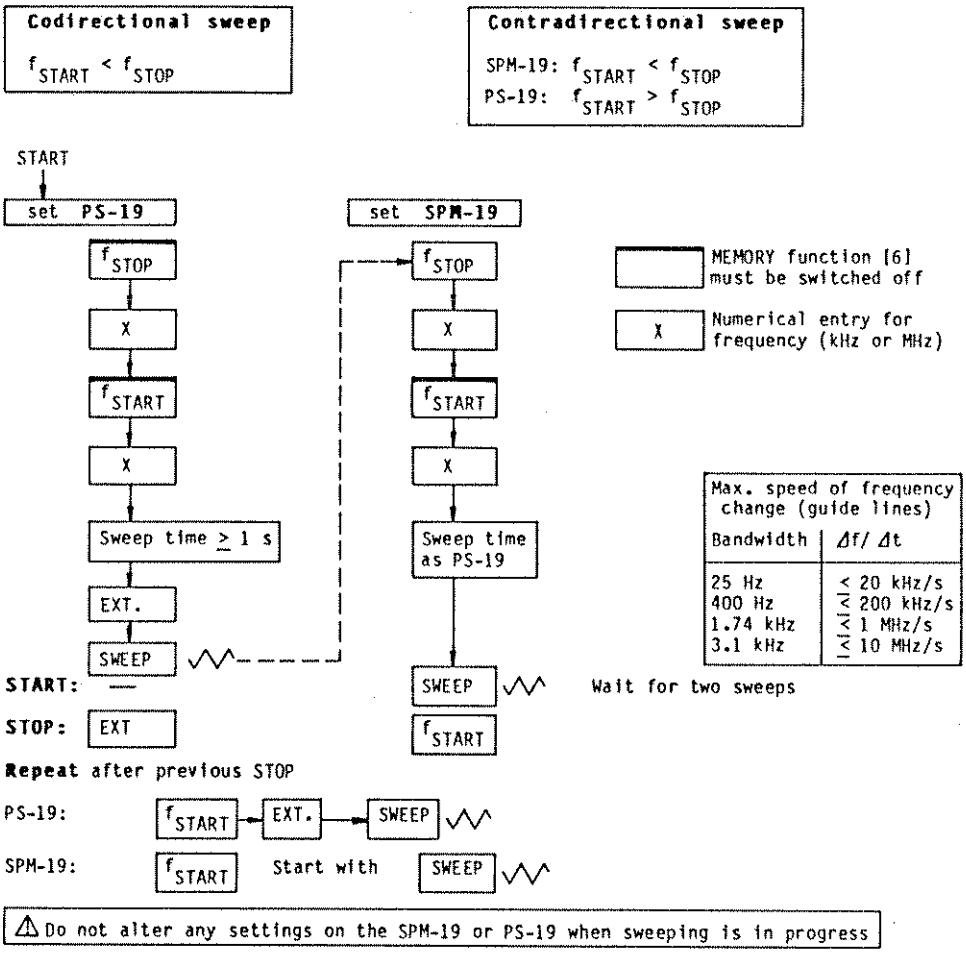


5.3.1.2 Settings

SG-4

- SCALE MENU [2] off
- Current trace "A" on
- "MODE" [7] [8] [9] off

On the level generator PS-19 and the level meter SPM-19



5.3.2 AUTOMATIC STEP MEASUREMENTS WITH FREQUENCY OFFSET

5.3.2.1 Measurement setup

as 5.3.1.1 (coax cable -10 MHz- not required)

5.3.2.2 Settings

SG-4

- SCALE MENU [2] off
- Current trace "A" on
- MODE [7] [8] [9] off

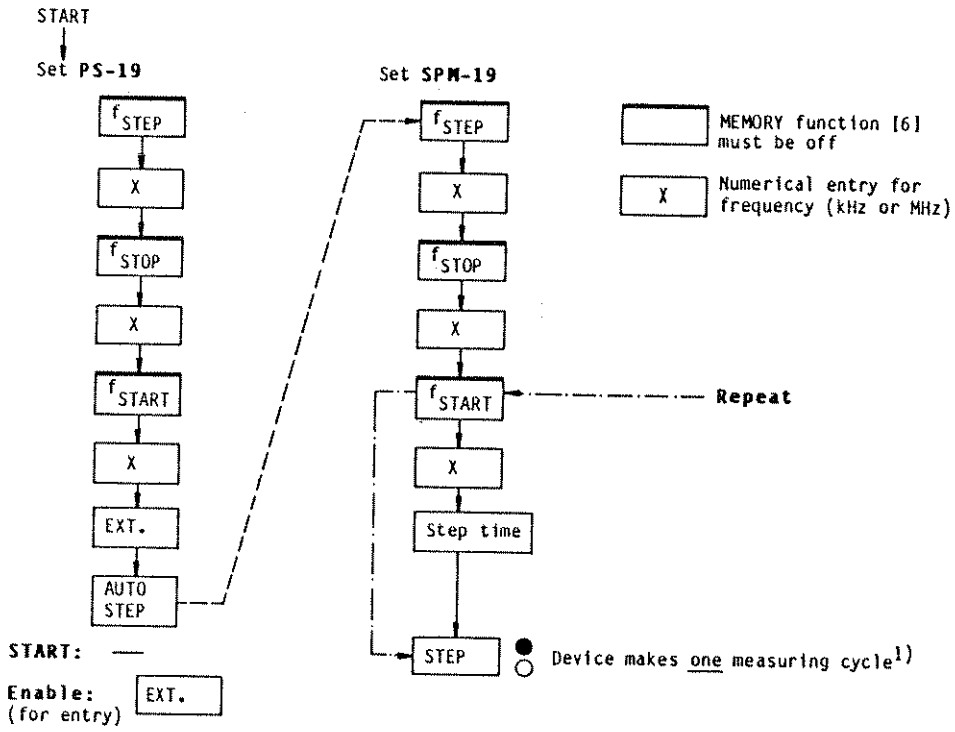
Level generator PS-19 and level meter SPM-19

Codirectional stepping

$f_{START} < f_{STOP}$

Contradirectional stepping

SPM-19: $f_{START} < f_{STOP}$
PS-19: $f_{START} > f_{STOP}$



1) A periodic measurement cycle

can be carried out if the following key sequence is entered on the SPM-19 before the start of the run:

MEM 6000 RCL MEM

STOP via f_{START} key

or "f" key (in this case repeat is erased)

⚠ Do not alter any settings on the SPM-19 or PS-19!