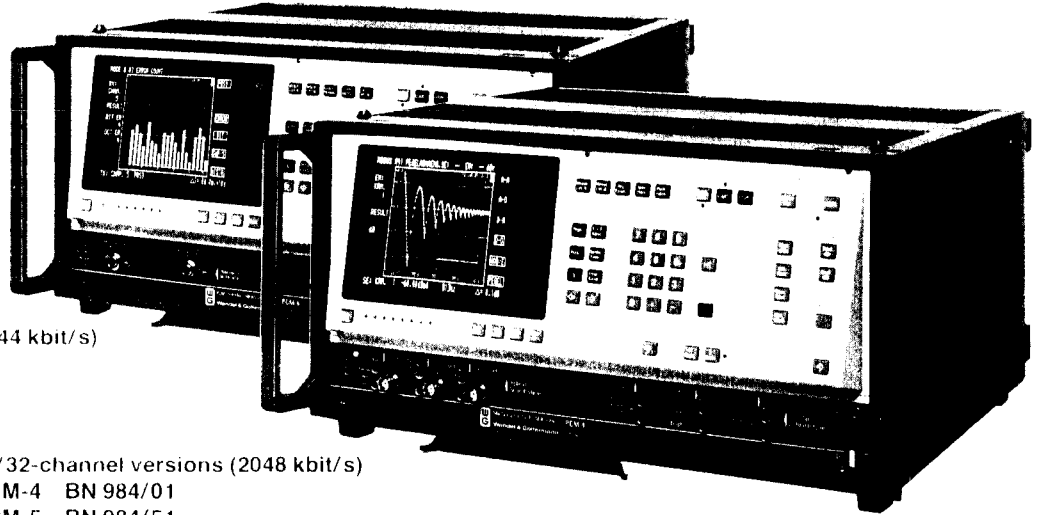




# PCM-4/PCM-5 PCM Channel Measuring Sets

for measurements on PCM coders/decoders between analog and digital interfaces

IEEE 488  
IEC 625



24-channel versions (1544 kbit/s)  
PCM-4 BN 984/02<sup>1)</sup>  
PCM-5 BN 984/52<sup>2)</sup>

30/32-channel versions (2048 kbit/s)  
PCM-4 BN 984/01  
PCM-5 BN 984/51

- Compact instruments for A-A, A-D, D-A and D-D measurements to CCITT Rec. O.133, G.700 Series and North American standards
- All versions with 64 kbit/s interface (option)
- 30/32-channel versions with CRC-4 extended frame to CCITT G.704
- 24-channel versions with normal/extended CRC-6 frame to CCITT Rec. G.704 and North American standards
- Linking of setups to form an automatic sequence of measurements
- Act as system controllers for MU-30 test point scanner, suitable ASCII printer or graphics plotter (HP-GL) connected via IEC 625/IEEE 488 bus.
- Digital signal processing for high accuracy and high measuring speed
- User definable tolerance mask graphics
- Conversion of PCM-10 frame to PCM-30 and vice versa with FC-10<sup>3)</sup> Frame Converter

All functions are remote controllable via the IEC 625/IEEE 488 interface. The user is therefore free to combine the PCM-4/PCM-5 with other instruments to create the measuring system of his choice.

The compact PCM-4/PCM-5 has complete ranges of functions for measurements between analog and digital interfaces. Besides the  $\mu$ P control and the interfaces, the PCM-4/PCM-5 has four main subassemblies for carrying out a variety of measurements. These subassemblies are: a digital signal generator, a digital signal receiver, an analog generator and an analog receiver. The PCM-4/PCM-5, which exploits digital signal processing and microprocessor control to the full, is so accurate that it can operate near the theoretical limits of the PCM technique. Great pains have been taken to ensure extremely high measuring speeds.

The integral screen has two advantages: firstly user-friendly operation and numerical display, secondly graphic output display. It only requires a few keystrokes to output graphs show-

The use of digital systems for transmission and switching is continuing to expand rapidly. As a result, PCM multiplexers between the digital and analog levels (half channel measurements) must now satisfy new requirements which place considerable demands on conventional measuring technology. The PCM-4/PCM-5 PCM Channel Measuring Sets can handle practically all PCM multiplexer measurements, and also measurements on the constituent subassemblies of digital exchanges. Transmultiplexer measurements are also possible because investigations between digital interfaces can be made. Single modules (e.g. CODECS) may also be checked as it is possible to carry out all measurements via 64 kbit/s interfaces.

Digital interfaces complying with CCITT Rec. G.703 . . . . . 2048 kbit/s versions and AT&T standards . . . . . 1544 kbit/s versions  
Analog interfaces . . . . . 600  $\Omega$ , 850  $\Omega$  (900  $\Omega$ ) and complex impedance

Options:  
64 kbit/s digital interfaces . . . . . serial or parallel;  
64 kbit/s V.11; co- or contradirectional (CCITT G.703) and 704 kbit/s with FC-10 Frame Converter (accessory)  
Return Loss and Longitudinal Conversion  
Transfer Loss Bridge to CCITT Rec. O.121 for PCM-4 only  
Accessories: D.C. Loop Holding Circuit, Test Point Scanner

1) PCM-4 with 1.214 APS connectors (Japan) BN 984/02  
2) PCM-5 with 1.214 APS connectors (Japan) BN 984/52  
3) Manufacturer AFSI (Italy)

ing gain vs frequency, gain vs input level, or total distortion. To adapt to a wide range of test items the PCM-4 has special keys for selecting the X and Y ranges. Other measurements such as idle channel noise, crosstalk or bit error count can be shown as histograms. The telephone channels are shown along the X-axis.

**Further characteristics and applications**

**Operating the PCM-4/PCM-5**

The PCM-4/PCM-5 itself gives information in the form of a menu and provides prompts to help the operator. The most important measurement modes are shown in MODE LIST A. It only requires a few key strokes to display results on the screen. Less common measurements are shown in MODE LIST B. Softkeys along the edge of the screen make it easy to switch rapidly between test setups and to quickly select other important parameters.

The user can also define his own measurement setups, and store them for future use. Up to 40 such setups can be linked together to form an automatic sequence of measurements which is user-specific.

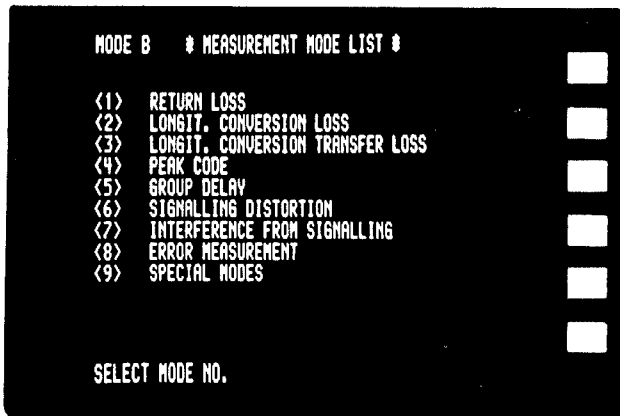
**Differences between PCM-4 and PCM-4**

The measurement modes printed on a grey background in the table are included in the PCM-4 but not in the PCM-5. Retrofitting of these items is not possible. Otherwise, both instrument types are identical as respects functions and characteristics.

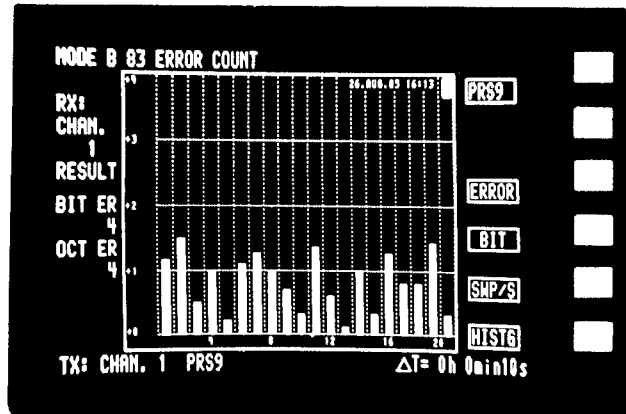
The modes available in the PCM-5 retain the same numbers as in the PCM-4, so that modes common to both PCM-4 and PCM-5 are programmed in exactly the same way when IEC bus control is used.

**System controller**

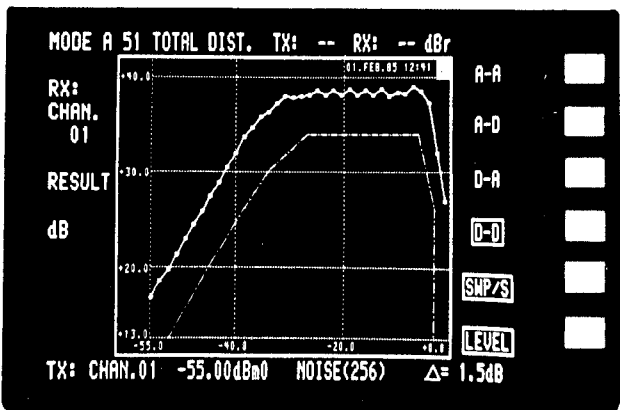
When used as system controller, the PCM-4/PCM-5 controls the MU-30 via the IEC 625/IEEE 488 bus, making rapid measurements in all channels possible. The results can be automatically printed out on a suitable ASCII printer during the measurement run. As well as the result, user defined tolerance thresholds can be printed out to help in evaluating the performance of the test object. If a graphics plotter (using HP-GL) is used, a press of a button is sufficient to plot out the complete screen contents. Several curves can be plotted on the same axes so that the scatter of various test items can easily be seen.



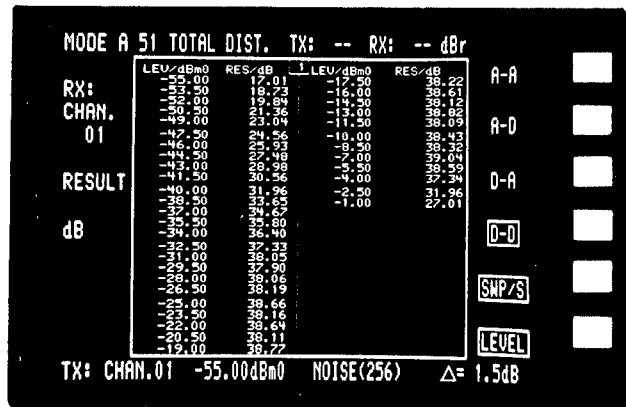
Overview of measurement modes called up via the "MODE LIST B" key on the PCM-4



Histogram of an error count in telephone channel 1 (PCM-4 and PCM-5)



Total distortion measurement with noise, selected with "MODE LIST A", "5" and "1" keys (PCM-4 and PCM-5)



Numerical result display after pressing "GRAPH/NUM" key (PCM-4 and PCM-5)

Measurement modes	Measurement conditions	A-A	A-D	D-A	D-D
Level measurement	With sinusoidal signal 20 Hz to 4 kHz (72 kHz). With noise signal to CCITT Rec. O. 131 and North American standards	•	•	•	•
Overall loss	With sinusoidal signal at 813 or 1014 Hz <sup>1)</sup> and a level of -10 or 0 dBm0	•	•	•	•
Echo return loss	With noise signal ERL and a level of -10 dBm0, to North American standards	•	•	•	•
Singing return loss	With noise signal SRL or SRL HI and a level of -10 dBm0, to North American standards	•	•	•	•
Transhybrid loss	2-wire termination with 910 Ω ± 39 nF <sup>2)</sup>	•			•
Variation of gain with frequency	With sinusoidal signal 20 Hz to 4 kHz and a level of -10 or 0 dBm0. Ref. frequency 813 or 1014 Hz <sup>1)</sup> (other reference frequencies available using VAR. MODE)	•	•	•	•
Variation of gain with input level	With sinusoidal signal at 813 or 1014 Hz <sup>1)</sup> . With noise signal to CCITT Rec. O. 131 and North American standards	•	•	•	•
Total distortion	With noise signal at 350 Hz ... 550 Hz or sinusoidal signal at 422 Hz, to CCITT Rec. O. 131 and North American standards. With sinusoidal signal at 813 or 1014 Hz <sup>1)</sup> , psoph. or C-message weighted to CCITT Rec. O. 132 and North American standards. With sinusoidal signal at 300 Hz ... 3350 Hz	•	•	•	•
Idle channel noise	At 300 Hz ... 3350 Hz or weighting with psoph. or C-message filter. Activating tone at 2 kHz possible	•	•	•	•
Crosstalk diff. channel	With sinusoidal signal at 301, 813, 1014 <sup>1)</sup> or 3343 Hz. With "Conventional Telephone Signal" to CCITT Rec. G. 227 and North American standards.	•	•	•	•
Crosstalk same channel	With sinusoidal signal at 301, 813, 1014 <sup>1)</sup> or 3343 Hz	•			•
Out-of-band measurement*	With sinusoidal signal in the range 4.6 ... 72 kHz; receive range 0.2 ... 4 kHz With sinusoidal signal in the range 0.2 ... 4 kHz; receive range 4.6 ... 128 kHz	•	•	•	
Harmonic distortion	2nd or 3rd order harmonic ratio with sinusoidal signal at 1014 Hz <sup>1)</sup>	•	•	•	•
4-tone intermodulation	2nd or 3rd order distortion with four equal-level tones at 857 Hz, 862 Hz, 1373 Hz and 1388 Hz	•	•	•	•
Return loss (option)*	Using BN 984/00.10 bridge: reference impedances 600 Ω, 900 Ω, CPLX <sup>3)</sup> Using BN 984/00.11 bridge: reference impedances 600 Ω, 850 Ω, CPLX <sup>3)</sup> BN 984/00.16 bridge impedance addition, upgrades possible, with 4 customer specific CPLX impedances, selectable by IEC/IEEE bus	Audio frequency ports			
Longitudinal conversion loss* (option)	Measured to CCITT Rec. O. 121 Using BN 984/00.10 bridge: reference impedances 600, 900 Ω Using BN 984/00.11 bridge: reference impedances 600, 850 Ω	Audio frequency ports			
Longitudinal conversion* transfer loss (option)	Measured to CCITT Rec. O. 121 Using BN 984/00.10 bridge: reference impedances 600, 900 Ω Using BN 984/00.11 bridge: reference impedances 600, 850 Ω	•	•	•	
Overload capacity	With pos. or neg. peak code, at 813 Hz or 1014 Hz <sup>1)</sup>		•		
Peak load			•		•
Coder offset			•		•
Absolute group delay* Group delay distortion	Loop measurements: AM-Signal with 8 fixed measuring frequencies similar to the signal described in CCITT Rec. O.81 and IEEE Standards	•	•	•	•
Signalling distortion*	Measures the duty cycle deviation of a rectangular signal of 10 or 20 Hz. Duty cycle settable in steps between 10 and 90 %	•	•	•	•
Interference from signalling*	Weighted measurement (to CCITT Rec. O.41 and North American standards) in voice channel. Duty cycle of rectangular signal adjustable	•	•	•	•
Error measurements	Framing errors (FAS and MFAS), CRC errors, Error ratio, error count and error free seconds with pseudorandom sequences or user programmable 8 bit word in one channel at 64 kbit/s or via 64 kbit/s interface				•
RX frame evaluation	Evaluation on screen of words and bits		•		•
MUX/DEMUX operation	One channel multiplexer: with 64 kbit/s input (option) only One channel demultiplexer: with 64 kbit/s output (option) only				•
					•

\* These modes are not included in the PCM-5 and cannot be retrofitted.  
1) BN 984/02, BN 984/52, BN 984/05 and BN 984/55: 1004 Hz  
2) 910 Ω ± 39 nF can be modified at factory  
3) 220 Ω in series with 820 Ω ± 115 nF, can be modified at factory  
**Note:** Measurement on digital transmit (TX) or receive (RX) interfaces can be carried out using the 2048 kbit/s, 1544 kbit/s, 704 kbit/s (with I.C. 10 not necessary) or 64 kbit/s interface (option). The following TX/RX combinations are possible: 2 M/2 Mbit/s, 64 k/64 kbit/s, 64 k/2 Mbit/s, 2 M/64 kbit/s, 1.5 M/1.5 Mbit/s, 64 k/64 kbit/s, 64 k/1.5 Mbit/s, 1.5 M/64 kbit/s, 704 k/704 kbit/s, 64 k/64 kbit/s, 64 k/704 kbit/s, 704 k/64 kbit/s.



## Specifications of the PCM Channel Measuring Sets

PCM-4/PCM-5

If nothing to the contrary is stated, the values given below are valid for all operating conditions and device settings within the rated ranges of use for a.c. line voltage, a.c. line frequency and ambient temperature.

### Analog generator

#### Generator output

BN 984/01, BN 984/51 . . . . . balanced, floating, 3-pin CF connector  
 BN 984/02, BN 984/52 . . . . . balanced,  
 fem. connector compatible with WECO 310  
 BN 984/05, BN 984/55 . . . . . balanced,  
 fem. connector compatible with I 214 APS

Output impedance,  
 switch-selectable . . . . . 600, 850, 900  $\Omega$  and complex<sup>1)</sup>  
 Permissible d.c. voltage to earth . . . . .  $\pm$  60 V

#### Send signals

Sinusoidal signals  
 Frequency range . . . . . 20 Hz to 72 kHz

#### Pseudorandom noise signals

Noise band	CCITT Recommendation	Spectral line spacing	Peak factor 20 log $V_p/V_{rms}$
350 to 550 Hz	O 131	3.906 Hz	10.5 $\pm$ 0.5 dB
350 to 550 Hz	O 131	7.813 Hz	10.5 $\pm$ 0.5 dB
Conventional telephone signal	G 227	7.813 Hz	10.5 $\pm$ 0.5 dB
560 to 1965 Hz (Echo Return Loss)	North American standards	7.813 Hz	10.5 $\pm$ 0.5 dB
260 to 500 Hz (Singing Return Loss)		7.813 Hz	10.5 $\pm$ 0.5 dB
2200 to 3400 Hz (Singing Return Loss High)		7.813 Hz	10.5 $\pm$ 0.5 dB

Group-delay measuring signal (PCM-4 only)  
 Similar to the measuring signal described in CCITT Rec. O.81 and IEEE Standards.

Measuring frequencies . . . . . 292, 500, 604, 1000,  
 1792, 2604, 2792 and 3396 Hz  
 Modulation frequency selectable . . . . . 41.66 or 83.33 Hz

4-tone signal  
 Four equal level tones at . . . . . 857, 862, 1373, and 1388 Hz

#### Send levels

Display of power levels (dBm0), can be switched over to voltage levels (dB0).

#### Relative level

Level entry in steps of 0.01 dB from . . . . . -19.9 to +9.9 dB  
 Displayed on screen in steps of 0.1 dB.

Levels relative to 1 mW at a point of 0 rel. level  
 Level entry in steps of 0.01 dB

Level range in the preferred range for relative level  
 -17 to +3 dB<sub>r</sub>, at 600  $\Omega$   
 for noise (350 to 550 Hz), at least . . . . . 60 to 2.0 dBm0  
 for sine signals ( $f < 200$  Hz), at least . . . . . 60.0 to +10.0 dBm0  
 for all other signals, at least . . . . . -30.0 to +2.0 dBm0

<sup>1)</sup> Complex impedance: 220  $\Omega$  in series with 820  $\Omega$   $\pm$  115 nF (modifiable ex works)

<sup>2)</sup> Complex impedance: 910  $\Omega$   $\pm$  39 nF (modifiable ex works)

<sup>3)</sup> BN 984/02, BN 984/52, BN 984/05 and BN 984/55: 1004 Hz

### Analog receiver

Receiver input . . . . . see "analog generator output"  
 Additional input impedance . . . . .  $\geq 30$  k $\Omega$

Two-wire input and output  
 The two-wire connector can be terminated with a complex impedance<sup>2)</sup> for transhybrid loss measurements.

#### Receive levels

Calibration, see "analog generator"

Relative levels, see "analog generator"

Levels relative to 1 mW at a point of 0 rel. level

Level range in the preferred range of the relative level  
 -9.9 to +9.9 dB<sub>r</sub> and at 600  $\Omega$ ,  
 signal level measurements, at least . . . . . 60.0 to +10.0 dBm0  
 noise and crosstalk measurements,  
 at least . . . . . 80 to +10 dBm0

#### Receive filters

Wideband filters passband range:	Narrow-band filters passband at:
200 Hz to 4 kHz	301 Hz
20 Hz to 4 kHz	813 Hz
330 Hz to 3100 Hz	1014 Hz <sup>3)</sup>
20 Hz to 72 kHz	3343 Hz
4.6 kHz to 128 kHz (PCM-4 only)	350 to 550 Hz

#### Filters for weighted noise measurements

Psophometer filter (CCITT Rec. P.53/O.41)  
 C-message weighting filter to North American standards  
 3 kHz flat filter to North American standards  
 Psophometer filter with 2 kHz notch-filter  
 C-message weighting filter with 2 kHz notch-filter  
 Bandpass 300 to 3350 Hz, with 2 kHz notch-filter

#### Filters for S/N measurements

Signal filter	Noise filter	Rec.
350 to 550 Hz	800 to 3350 Hz	CCITT O.131
800 to 855 Hz	Channel filter with notch at 813 Hz	---
	Psophometer filter with notch at 813 Hz	CCITT O.132
1000 to 1025 Hz	Channel filter with notch at 1014 Hz <sup>3)</sup>	---
	Psophometer filter with notch at 1014 Hz <sup>3)</sup>	---
	C-message weighting filter with notch at 1014 Hz <sup>3)</sup>	CCITT O.132

#### Filters for harm./interm. distortion measurements

	Passband range
2nd order harmonic distortion	2000 Hz to 2028 Hz
3rd order harmonic distortion	3000 Hz to 3042 Hz
2nd order intermodulation product	B-A 480 Hz to 560 Hz
	B+A 2229 Hz to 2251 Hz
3rd order intermodulation product	2B-A 1885 Hz to 1920 Hz
A 857 Hz $\pm$ 862 Hz	B 1373 Hz $\pm$ 1388 Hz
2	2

## Digital signal generator

### PCM frame structure BN 984/01 and BN 984/51

32 channel PCM frames containing:  
30 telephone channels . . . . . to CCITT Rec. G.704 Para. 3.3  
or 31 telephone channels . . . . . time slots 1 to 31  
or 32 telephone channels . . . . . all time slots

**BN 984/02, BN 984/52, BN 984/05 and BN 984/55**  
Selectable between . . . . . T1 "norm."  
12 FRM/MFRM to CCITT G.704 Para. 3.1  
and T1 "extd."  
24 FRM/MFRM to CCITT G.704 Para. 3.1  
Telephone channels per frame . . . . . 24  
Channel sequences . . . . . D3/D4, D2 or D1D  
Signalling  
µ-law . . . . . CCIS or CAS (7<sup>3/8</sup>)  
A-law . . . . . CCIS

### Generator outputs BN 984/01 and BN 984/51

Interface characteristics comply with CCITT Rec. G.703  
Line codes . . . . . NRZ, AMI and HDB3  
Coaxial output\* . . . . . Versacon® 9 Universal Connector  
System, adaptable to all common connectors  
Output impedance . . . . . 75 Ω  
Balanced output . . . . . 3 pole, CF connector  
Output impedance . . . . . 120 Ω

**BN 984/02, BN 984/52, BN 984/05 and BN 984/55**  
Interface characteristics comply with CCITT Rec. G.703  
and North American standards.  
Line codes . . . . . AMI and B8ZS  
Output pulse characteristic . . . . . to AT&T  
Technical Advisory No. 34  
W-bit insertion . . . . . ON or OFF  
Balanced output . . . . . fem. connector compatible with  
WECO 310 (BN 984/02 and 984/52);  
I 214 APS (BN 984/05 and 984/55)  
Output impedance . . . . . 100 Ω

### Operation and clock supply

Loop-through operation  
A test pattern is injected into one time slot of a PCM frame which  
has been looped through the PCM-4.

### BN 984/01 and BN 984/51

Generator operation  
from internal clock . . . . . 2048 kHz ± 25 × 10<sup>-6</sup>  
or external clock . . . . . 2048 kHz ± 100 × 10<sup>-6</sup>  
or external 8 kHz sync.-signal . . . . . 8 kHz ± 100 × 10<sup>-6</sup>  
or clock derived from receiver signal

Digital loops  
2 Mbit/s loop: all time slots are switched through.  
2 Mbit/s loop: selected time slots can be switched through  
(independent selection of the receive and send channel  
is possible)  
64 kbit/s loop: at relevant interfaces (Option).

### BN 984/02, BN 984/52, BN 984/05 and BN 984/55

Generator operation  
from internal clock . . . . . 1544 kHz ± 25 × 10<sup>-6</sup>  
or external clock . . . . . 1544 kHz ± 100 × 10<sup>-6</sup>  
or external 8 kHz sync. signal . . . . . 8 kHz ± 100 × 10<sup>-6</sup>  
or clock derived from receiver signal

Digital loops  
1.5 Mbit/s loop: all time slots are switched through.  
1.5 Mbit/s loop: selected time slots can be switched through  
(independent selection of the receive and send channel  
is possible).  
64 kbit/s loop: at relevant interfaces (Option).

**Digital words for telephone channels  
BN 984/01 and BN 984/51**  
Injection of a digital signal in one of the telephone channels  
1 to 30 (or 31, 32) or in all telephone channels, or in all telephone  
channels except the selected channel.  
Encoding law, selectable . . . . . A-law or µ-law

**BN 984/02, BN 984/52, BN 984/05 and BN 984/55**  
Injection of a digital signal in one of the telephone channels  
1 to 24, or in all telephone channels, or in all telephone channels  
except the selected channel.  
Encoding law, selectable . . . . . A-law or µ-law

### Send signals

Sine signals  
Frequency range . . . . . 20 Hz to 3.99 kHz  
Send level range (in steps of 0.1 dB) . . . . . -60.0 to +7.5 dBm0

Noise signals  
Pseudorandom noise signal . . . . . CCITT Rec. O.131  
350 Hz to 550 Hz complies with . . . . . -65.0 to +7.5 dBm0  
Send level range (0.1 dB steps) . . . . .  
Wideband noise signal for telephone channels  
Noise band . . . . . 300 to 3400 Hz  
Send level range . . . . . -65.0 to 0.0 dBm0  
Conventional telephone signal . . . . . complies with  
CCITT Rec. G.227

Send level range . . . . . -30.0 to 0.0 dBm0  
Echo return loss and singing return loss signals to North  
American standards  
Noise band of ERL-signal . . . . . 560 to 1965 Hz  
Noise band of SRL-signal . . . . . 260 to 500 Hz  
Noise band of SRLH-signal . . . . . 2200 to 3400 Hz  
Send level range . . . . . -30.0 to 0.0 dBm0

Group delay measuring signal  
See: "Analog generator signals"  
Send level range . . . . . -30.0 to 0.0 dBm0  
4-tone signal  
See: "Analog generator signals"  
Send level range . . . . . 30.0 to 0.0 dBm0

Idle channel signals  
Any fixed word can be selected. It is also possible to select  
words which vary randomly or periodically between two  
neighbouring values.

Bit patterns  
The following are available for bit error measurements:  
Pseudorandom sequence complying  
with CCITT Rec. V.52 . . . . . 2<sup>11</sup> - 1 bits long  
Pseudorandom sequence complying  
with CCITT Rec. O.152 . . . . . 2<sup>11</sup> - 1 bits long  
User-programmable 8 bit word

External analog signal (via VAR. MODE)  
An external analog signal can be input via an internal PCM  
coder and injected in one telephone channel or output via  
64 kbit/s interface.

**Test facilities and error insertion**

**BN 984/01 and BN 984/51**

- AIS transmission (continuous sequence of "1" s)
- Frame alignment bit error ratio . . . . .  $10^{-3}$  or  $10^{-4}$
- Frame alignment word errors . . . . . 2 or 3 in 4
- Multiframe alignment errors . . . . . 1 or 2 in 2
- CRC-4 error rate settable in steps of . . . . . 0.1 %  
in the range . . . . . 0.1 to 99.9 %  
based on 1 s (1000 CRC-4 words)

**BN 984/02, BN 984/52, BN 984/05 and BN 984/55**

- ALL ONES transmission
- Bit 2 alarm transmission
- Bit 2 is set to "0" in each channel
- S bit alarm (T1 "norm") transmission
- S-bit in frame 12 is set to "1"
- m bit alarm (T1 "extd") transmission
- Eight "0"-bits alternating with eight "1"-bits
- FAS errors . . . . . 1 in 6 bits or 2 in 4 bits
- S-bit/MFAS errors . . . . . 1 or 2 in 6 bits
- CRC-6 error rate settable in steps of . . . . . 0.3 %  
in the range . . . . . 0.3 to 99.7 %  
based on 999 ms (333 multiframe)

**Signalling facilities**

**BN 984/01 and BN 984/51**

- Static signalling bits
- Transmission of signalling bits a b c d in time slot 16 for selected and unoccupied telephone channels
- Signalling bit value settable via menu

**Dynamic signalling bits**

- Signalling bit value for selected telephone channel set externally via aux. parallel input

**BN 984/02, BN 984/52, BN 984/05 and BN 984/55**

- Static signalling bits
- Transmission of signalling bits A, B/A, B, C, D for selected and unoccupied telephone channels
- Signalling bit value settable via menu

**Dynamic signalling bits**

- Signalling bit value for selected telephone channel set externally via aux. parallel input for CAS (7<sup>2</sup>/6) only, or S/m bit value set externally via contradirectional 4 kbit/s input.

**Digital signal receiver**

**PCM frame structure**

see "digital signal generator"

**Receiver inputs**

**BN 984/01 and BN 984/51**

- Interface characteristics comply with CCITT Rec. G.703.
- Line codes . . . . . NRZ, AMI and HDB3
- Coaxial input \* . . . . . 75  $\Omega$  or  $>3$  k $\Omega$
- Balanced input . . . . . 120  $\Omega$  or  $>3$  k $\Omega$
- Input signal monitoring via LEDs:  
NO SIGNAL, AIS, NO FRAME, NO MULTIFRAME.

**BN 984/02, BN 984/52, BN 984/05 and BN 984/55**

- Interface characteristics comply with CCITT Rec. G.703 and North American standards.
- Line codes . . . . . AMI and B8ZS
- Balanced input . . . fem. connector compatible with WECO 310 (BN 984/02, 984/52); I 214 APS (BN 984/05, 984/55)

- Input impedance . . . . . 100  $\Omega$  or  $>3$  k $\Omega$
- Input signal monitoring via LEDs:  
NO SIGNAL, ALL ONES, NO SYNC, REMOTE ALARM.

**Evaluation of digital words in telephone channels**

**BN 984/01 and BN 984/51**

- Selecting a telephone channel
- A code word from one telephone channel 1 to 30 (or 31, 32) can be evaluated.

**Code word measurements**

- Encoding law, selectable . . . . . A-law or  $\mu$ -law
- Receive level range, at least . . . . . -80 to +6 dBm0

**BN 984/02, BN 984/52, BN 984/05 and BN 984/55**

- Selecting a telephone channel
- A code word from one telephone channel 1 to 24 can be evaluated.

**Code word measurements**

- Encoding law, selectable . . . . . A-law or  $\mu$ -law
- Receive level range, at least . . . . . -80 to +6 dBm0

**Receive filters**

see "Analog receiver"

**Bit error measurements**

- on telephone channels (64 kbit/s). Shown as a histogram with the X axis representing measuring periods or channels.
- Bit patterns: see "digital signal generator send signals"
- Error counts on FAS/MFAS and CRC-signals.

**Signalling distortion measurements (PCM-4 only)**

- Method:
- Measure the duty cycle deviation of a rectangular signal.

**Generator**

- Frequency setting . . . . . 10 Hz or 20 Hz
- Duty cycle settable in steps
- Analog output (back panel)
- Output impedance, mark . . . . .  $<30$   $\Omega$   
space . . . . .  $>20$  k $\Omega$
- Max. d.c. loading . . . . . 200 mA
- Max. switching voltage . . . . . 70 V

**Signalling receiver**

- Measuring range . . . . .  $\pm 10$  ms
- Resolution . . . . . 0.1 ms
- Analog input (back panel)
- Input impedance (connected internally to -15 V) . . . . . 750  $\Omega$
- Short-circuit current . . . . . 20 mA

**Evaluation and monitoring of words and bits**

**BN 984/01 and BN 984/51**

- Monitoring via 8 LEDs (bits 1 to 8)
- Codewords of selected channel, FAS, NOT FAS, MFAS, NOT MFAS, Signalling bits a b c d (TX and RX)

**Evaluation on screen (MODE B 91)**

- Codewords of selected channel, FAS, NOT FAS, MFAS, NOT MFAS, Signalling bits a b c d (RX)

**BN 984/02, BN 984/52, BN 984/05 and BN 984/55**

- Monitoring via 8 LEDs (bits 1 to 8)
- Codewords of selected channel, FAS or MFAS, S bits, Signalling bits A, B/A, B, C, D (TX and RX), m bits (1 ... 6 and 7 ... 12)

**Evaluation on screen (MODE B 91)**

- Codewords of selected channel, FAS or MFAS, S bits or m bits, Signalling bits A, B/A, B, C, D



**Auxiliary outputs (back panel)**

- Activation signal for crosstalk measurements
- Analog decoder output for decoded signal of selected telephone channel
- Signalling output
- Error and alarm outputs
- Video signal output

**General Specifications**

**Power supply**

Rated ranges of use for a.c. line voltage,  $\pm 12\%$  to  $+10\%$ , switch-selectable . . . . . 110/117/127/220/227/237 V  
BN 984/05 and BN 984/55 only . . . . . 100/110/117/200/210/217 V

Rated range of use of a.c. line frequency . . . . . 47.5 to 63 Hz  
Power consumption . . . . . approx. 150 VA  
Safety class to IEC 348 and VDE 0411 . . . . . Class I

**Ambient temperature**

Rated range of use . . . . .  $+5$  to  $+40^\circ\text{C}$   
Storage and transportation . . . . .  $-40$  to  $+70^\circ\text{C}$

**Dimensions**

Bench-top instrument (w x h x d in mm) . . . . . 477 x 244 x 425

Weight . . . . . approx. 25 kg

**Ordering information**

**PCM Channel Measuring Set PCM-4**

2048 kbit/s version, menu in English  
 1544 kbit/s version, menu in English,  
 WECO connectors  
 2048 kbit/s version, menu in German  
 1544 kbit/s version, menu in English,  
 I 214 APS connectors  
 2048 kbit/s version, menu in Spanish

<b>BN 984/01</b> ✓	Software retrofitted to the latest status for PCM-4 BN 984/01	BN 984/00.41
<b>BN 984/02</b>	PCM-4 BN 984/02	BN 984/00.42
<b>BN 984/03</b>	PCM-4 BN 984/03	BN 984/00.43

Specify actual software version and serial no. when ordering

<b>BN 984/05</b>	User specified modifications:	
<b>BN 984/06</b>	A detailed specification sheet is available for entering the values required.	
	Analog generator/receiver impedance modifications	BN 984/00.31

**PCM Channel Measuring Set PCM-5**

2048 kbit/s version, menu in English  
 1544 kbit/s version, menu in English,  
 WECO connectors  
 2048 kbit/s version, menu in German  
 1544 kbit/s version, menu in English,  
 I 214 APS connectors

<b>BN 984/51</b>	(replaces 850 Ω/900 Ω and CPLX <sup>2)</sup> )	
<b>BN 984/52</b>	Analog generator output impedance modified to $Z_{out} \approx 0 \Omega$ in place of complex impedance	BN 984/00.34
<b>BN 984/53</b>	Impedance modification (replaces 850 Ω or 900 Ω and CPLX <sup>2)</sup> )	BN 984/00.32

Options (charged extra)

Interfaces:

Codirectional 64 kbit/s input

Codirectional 64 kbit/s output

Electrical characteristics to CCITT G 703

Contradirectional 64 kbit/s input

Contradirectional 64 kbit/s output

Electrical characteristics to CCITT G 703

<b>BN 984/00.01</b> ✓	Tolerance masks programmed	BN 984/00.35
<b>BN 984/00.02</b> ✓	to user specifications	
	Instruments are equipped with CCITT tolerance masks as standard forms for entering tolerance mask changes are included in Appendix D of the operating manual.	

Serial 64 kbit/s TTL input

Serial 64 kbit/s TTL output

Co- or contradirectional, depending on mode

<b>BN 984/00.05</b>	Test Point Scanner MU-30	BN 823/ 11
<b>BN 984/00.06</b>	with IEC 625 - Interface Card	
	Balanced through-switching of 10, 24 or 30 VF channels in TX and RX directions	

Parallel 64 kbit/s TTL input

Parallel 64 kbit/s TTL output

Parallel 8 bit input/output with 8 kHz clock signal

64 kbit/s V.11 interface

input/output via 15 way plug to CCITT X.24

IEEE 488/IEC 625 Interface

with IEEE 488 connector and K 420 connecting cable

<b>BN 984/00.07</b>	Frame Converter FC- 10	BN 984/00.17
<b>BN 984/00.08</b>	Converts PCM- 10 frames at 704 kbit/s to PCM-30 frames at 2048 kbit/s and vice versa.	
	Bench-top instrument (w x h x d in mm): 477 x 100 x 425	
<b>BN 984/00.09</b>	Weight approx. 10 kg	

Bridges:

Return Loss and Longitudinal Conversion

Transfer Loss Bridge<sup>1)</sup>

600/900 Ω/CPLX<sup>2)</sup> (PCM-4 only)

600/850 Ω/CPLX<sup>2)</sup> (PCM-4 only)

Impedance modification

(replaces 850 Ω or 900 Ω and CPLX<sup>2)</sup>)

Bridge impedance addition

Up to 4 additional customer specific CPLX impedances can be added to the bridge, selection only via IEC/IEEE interface

IEC/IEEE interface

120 kHz low pass filter

for out-of-band noise suppression

<b>BN 958/24</b> ✓	Manufacturer AESSE (Milan, Italy)	
	D.C. Loop Holding Circuit GH-1	BN 984/00.12 ✓
	with capacitor-coupled output	
	1.5 m connecting cable	K 348
	CF (male) to WECO 310 (ADC jack)	
	1.0 m connecting cable	K 438
	CF (male) to I 214 APS (male)	
<b>BN 984/00.10</b> ✓	D.C. Decoupling for analog inputs and outputs, PCMZ-4	BN 984/00.13
<b>BN 984/00.11</b>	for use with BN 984/01, BN 984/51, BN 984/03 and BN 984/53 only. (Not required if GH-1 is used).	
<b>BN 984/00.32</b>	IEEE 488/ IEC 625 > Adaptor (m-m)	S 832
<b>BN 984/00.16</b>	for IEC 625 - interface card	
<b>BN 984/00.14</b>	Front and Back Panel Covers SD-5, (1 set)	BN 700/00.25
	19" conversion kit	BN 700/00.05

<sup>1)</sup> Equipped with the Versacon™ 9/75 Ω basic connector and BNC adaptor. For other adaptor types, see "Specification Sheet Versacon™ 9", and order chosen type when ordering instrument.

1) Only one bridge can be fitted at any one time.

2) CPLX is fitted as standard. CPLX<sup>2)</sup> = 220 Ω in series with 820 Ω ± 115 nF.

*Handwritten notes:*  
 checked against the manual  
 ...