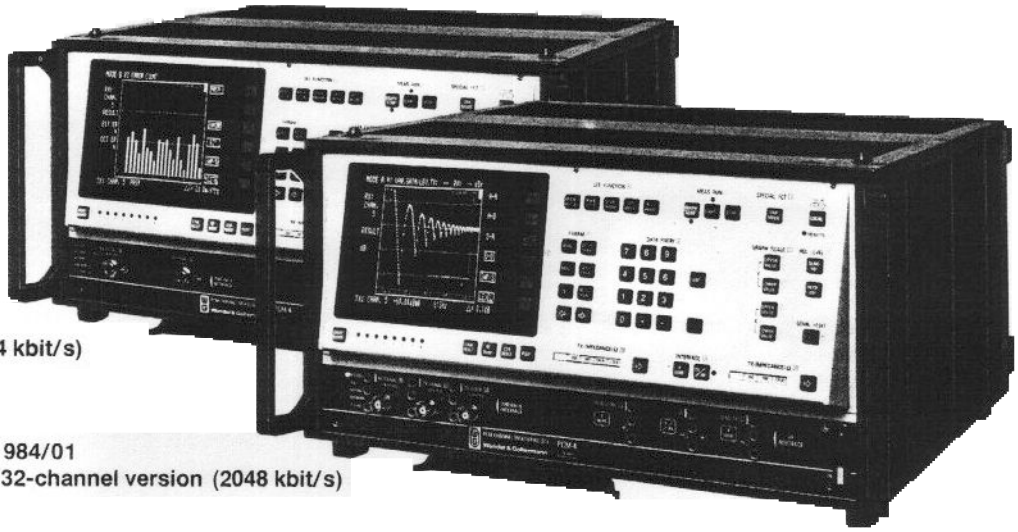
# PCM-4
# PCM Channel Measuring Set

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

IEEE 488
IEC 625



BN 984/02
24-channel version (1544 kbit/s)

BN 984/01
30/32-channel version (2048 kbit/s)

- **Compact instrument for A-A, A-D, D-A and D-D measurements to CCITT Rec. O.133, G.700 Series and North American standards (BN 984/02)**
- **Both versions with 64 kbit/s interface (option) complying with CCITT Rec. G.703**
- **30/32-channel version (BN 984/01) with CRC-4 extended frame to CCITT G.704**
- **24-channel version (BN 984/02) with normal/extended (CRC-6) PCM frame structure to CCITT Rec. G.704 and North American standards**
- **Linking of setups to form an automatic sequence of measurements**
- **Acts as system controller for MU-30 test point scanner, suitable ASCII printer or graphics plotter (hp-GL) connected via IEC 625/IEEE 488 bus.**
- **A-law and μ-law (included in both versions)**
- **Digital signal processing for high accuracy and high measuring speed**

## Applications

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

## Characteristics

The compact PCM-4 has a complete range of functions for measurements between analog and digital interfaces. Besides the μP control and the interfaces, the PCM-4 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, 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 showing 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.

Digital interfaces complying
with CCITT Rec. G.703 . . . . . 2048 kbit/s (BN 984/01)
and AT&T standards . . . . . 1544 kbit/s
(BN 984/02 and BN 984/05)
Analog interfaces . . . . . 600 Ω, 800 Ω, 900 Ω
and complex impedance

Options
64 kbit/s digital interfaces . . codirectional, serial or parallel
Return Loss and Longitudinal Conversion
Transfer Loss Bridge complies with CCITT Rec. O.121
Accessories: D.C. Loop Holding Circuit, Test Point Scanner

## Further characteristics and applications

### Operating the PCM-4

The PCM-4 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 PCM-4 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.

### Multi-processor system

Only because the PCM-4 is controlled by a number of microprocessors is it possible to combine digital signal processing, an enormous range of measurements, and ease of operation in one instrument. There are three microprocessors, one handles the screen, one is responsible for the general control functions of the PCM-4 and remote control via the < IEC 625 >/IEEE 488 interface. The last processor evaluates the results.

The multiprocessor system means that measuring speed can be optimised; for example, new setting commands can be sent over the remote-control interface at the same time as the results are being processed.

### Special measurements

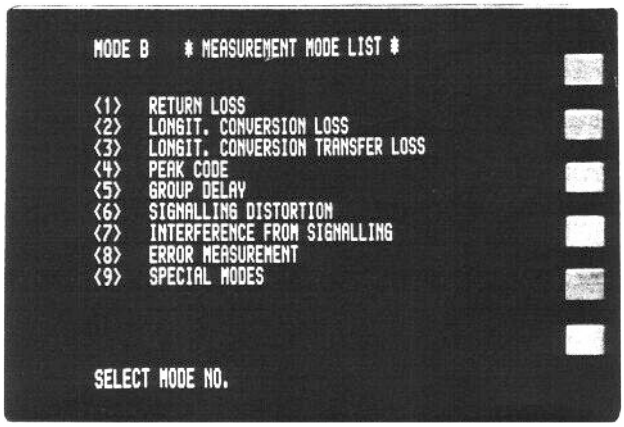
Another special feature of the PCM-4 is the facility for signalling investigation; the usual telephone channel measurements and out-of-band measurements up to 128 kHz can, of course, also be made.

Moreover, it is also possible to check the bit error ratio of a 64 kbit/s channel or the group delay of a "half-channel".

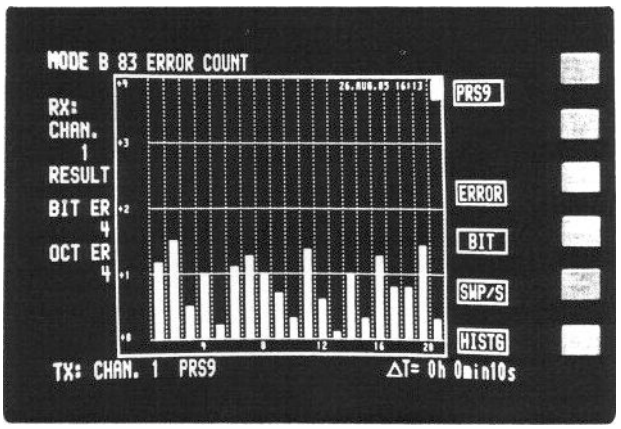
Measurements on two-wire test items are particularly straightforward and easy. While measurements are being carried out on the analog side of the test item, 2 Mbit/s (BN 984/01)/ 1.5 Mbit/s (BN 984/02) or 64 kbit/s loops can be set up on the digital side. The information and signalling bits in any receive channel can be transferred to any other send channel of the 2 Mbit/s/ 1.5 Mbit/s loop.

### System controller

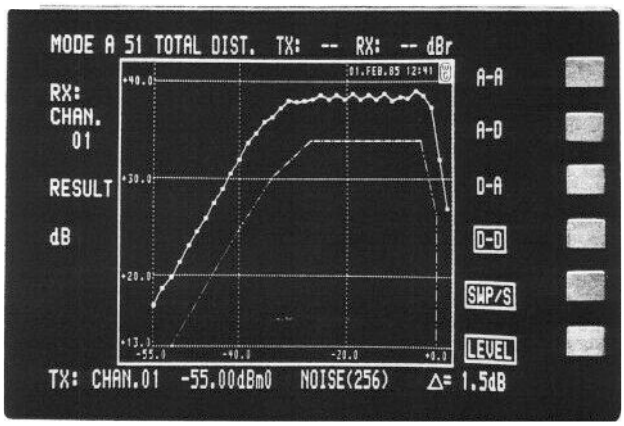
When used as system controller, the PCM-4 controls the MU-30 via the IEC 625/IEEE 488 bus, making rapid measurements in all channels possible. The results can be automatically printed out on a suitable ASCII printer during the measurement run. As well as the result, tolerance thresholds can be printed 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.



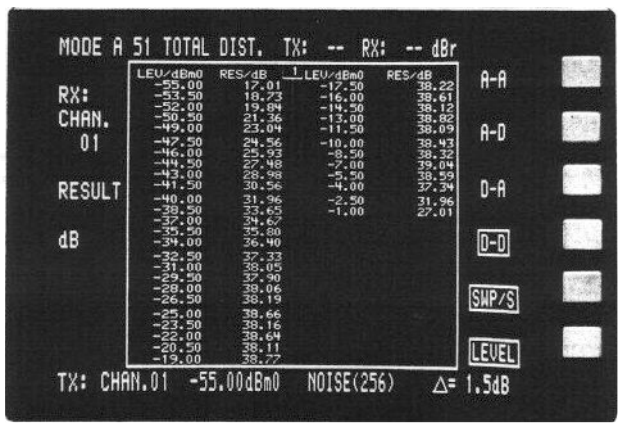

**Overview of measurement modes called up via the "MODE LIST B" key**




**Histogram of an error count in telephone channel 1**




**Total distortion measurement with noise, selected with "MODE LIST A", "5" and "1" keys**




**Numerical result display after pressing "GRAPH/NUM" key**

| Measurement mode | Measurement conditions | A-A | A-D | D-A | D-D |
|---|---|---|---|---|---|
| Level measurement | With sinusoidal signal 20 Hz to 4 kHz (72 kHz).<br>With noise signal to CCITT Rec. O.131 and North American standards | ● | ● | ● | ● |
| Overall loss<br>Echo return loss<br>Singing return loss<br><br>Transhybrid loss | With sinusoidal signal at 813 or 1014 Hz [1] and a level of −10 or 0 dBm0<br>With noise signal ERL and a level of −10 dBm0, to North American standards<br>With noise signal SRL or SRL HI and a level of −10 dBm0, to North American standards<br>2-wire termination with 910 Ω ‖ 39 nF [2] | ●<br>●<br>●<br>● | ●<br>●<br>● | ●<br>●<br>● | ●<br>●<br>●<br>● |
| Variation of gain with frequency | With sinusoidal signal 20 Hz to 4 kHz and a level of −10 or 0 dBm0.<br>Ref. frequency 813 or 1014 Hz [1] (other reference frequencies available using VAR. MODE) | ● | ● | ● | ● |
| Variation of gain with input level | With sinusoidal signal at 813 or 1014 Hz [1]. 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.<br>With sinusoidal signal at 813 or 1014 Hz [1], psoph. or C-message weighted to CCITT Rec. O.132 and North American standards.<br>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<br><br><br>Crosstalk same channel | With sinusoidal signal at 301, 813, 1014 [1] or 3343 Hz.<br>With "Conventional Telephone Signal" to CCITT Rec. G.227 and North American standards, (BN 984/01 psoph. wtd/BN 984/02 C-message weighted).<br>With sinusoidal signal at 301, 813, 1014 [1] or 3343 Hz | ●<br><br>● | ● | ● | ●<br><br>● |
| Out-of-band measurement | With sinusoidal signal in the range 4.6 ... 72 kHz; receive range 0.2 ... 4 kHz<br>With sinusoidal signal in the range 0.2 ... 4 kHz; receive range 4.6 ... 128 kHz | ●<br>● | ● | <br>● | |
| Harmonic distortion<br>4-tone intermodulation | 2nd or 3rd order harmonic ratio with sinusoidal signal at 1014 Hz [1]<br>2nd or 3rd order distortion with four equal-level tones at 857 Hz, 862 Hz, 1373 Hz and 1388 Hz | ●<br>● | ●<br>● | ●<br>● | ●<br>● |
| Return loss (option) | Using BN 984/00.10 bridge: reference impedances 600, 900 Ω and complex [3]<br>Using BN 984/00.11 bridge: reference impedances 600/850 Ω and complex [3] | Audio frequency ports | | | |
| Longitudinal conversion loss (option) | Measured to CCITT Rec. O.121<br>Using BN 984/00.10 bridge: reference impedances 600, 900 Ω<br>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<br>Using BN 984/00.10 bridge: reference impedances 600, 900 Ω<br>Using BN 984/00.11 bridge: reference impedances 600, 850 Ω | ● | ● | ● | |
| Overload capacity<br>Peak load<br>Coder offset | With pos. or neg. peak code, at 813 Hz or 1014 Hz [1] | | ●<br>●<br>● | | ●<br>● |
| Absolute group delay<br>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 | ●<br>● | ●<br>● | ●<br>● | ●<br>● |
| Signalling distortion | Measures the duty cycle deviation of a rectangular signal of 10 or 20 Hz.<br>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 programable 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<br>One channel demultiplexer: with 64 kbit/s output (option) only | | | | ●<br>● |

1) BN 984/02 and BN 984/05: 1004 Hz
2) Complex impedance can be modified at factory
3) 220 Ω in series with 820 Ω ‖ 115 nF, can be modified at factory
**Note:** Measurements on digital Transmit (TX) or Receive (RX) interfaces can be carried out using the 2048 kbit/s (BN 984/01), 1544 kbit/s (BN 984/02) 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.

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 . . . . balanced, floating, 3-pin CF connector
BN 984/02 . . . . . balanced, fem. connector compatible with WECO 310
BN 984/05 . . . . . balanced, fem. connector compatible with I 214 APS
Output impedance, switch-selectable . . . . . 600, 850, 900 Ω and complex[1]
Permissible d.c. voltage to earth . . . . . ≦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 $V_p/V_{r.m.s.}$ |
|---|---|---|---|
| 350 to 550 Hz | O.131 | 3.906 Hz | 10.5 ±0.5 dB |
| 350 to 550 Hz | O.131 | 7.813 Hz | 10.5 ±0.5 dB |
| Conventional telephone signal | G.227 | 7.813 Hz | 10.5 ±0.5 dB |
| 560 to 1965 Hz (Echo Return Loss) | North American standards | 7.813 Hz | 10.5 ±0.5 dB |
| 260 to 500 Hz (Singing Return Loss) | North American standards | 7.813 Hz | 10.5 ±0.5 dB |
| 2200 to 3400 Hz (Singing Return Loss High) | North American standards | 7.813 Hz | 10.5 ±0.5 dB |

Group-delay measuring signal
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 dBr
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 dBr, at 600 Ω
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

1) Complex impedance: 220 Ω in series with 820 Ω ‖ 115 nF (modifiable ex-works)
2) Complex impedance: 910 Ω ‖ 39 nF (modifiable ex-works)
3) BN 984/02 and BN 984/05 with 1004 Hz

## Analog receiver

**Receiver input** . . . . . see "analog generator output"
Additional input impedance . . . . . ≧30 kΩ

Two-wire input and output
The two-wire connector can be terminated with a complex impedance[2] 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 dBr and at 600 Ω,
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[3] |
| 20 Hz to 72 kHz | 3343 Hz |
| 4.6 kHz to 128 kHz | 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[3] | — |
| | Psophometer filter with notch at 1014 Hz[3] | — |
| | C-message weighting filter with notch at 1014 Hz[3] | 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 |
| $A = \frac{857\text{ Hz} + 862\text{ Hz}}{2}$ $B = \frac{1373\text{ Hz} + 1388\text{ Hz}}{2}$ | | |

## Digital signal generator

**PCM frame structure**
**BN 984/01**

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 and 984/05**
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 (7⅝)
A-law . . . . . CCIS

**Generator outputs**
**BN 984/01**
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 and BN 984/05**
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); I 214 APS (BN 984/05)
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**

Generator operation
from internal clock . . . . . 2048 kHz $\pm 25 \times 10^{-6}$
or external clock . . . . . 2048 kHz $\pm 100 \times 10^{-6}$
or external 8 kHz sync.-signal . . . 8 kHz $\pm 100 \times 10^{-6}$
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 and BN 984/05**

Generator operation
from internal clock . . . . . 1544 kHz $\pm 25 \times 10^{-6}$
or external clock . . 1544 kHz $\pm 100 \times 10^{-6}$
or external 8 kHz sync. signal . . . 8 kHz $\pm 100 \times 10^{-6}$
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**
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 and BN 984/05**
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
350 Hz to 550 Hz complies with . . . . . CCITT Rec. O.131
Send level range (0.1 dB steps) . . . . . −65.0 to +7.5 dBm0
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 . . . . . $2^9 - 1$ bits long
Pseudorandom sequence complying with CCITT Rec. O.152 . . . . . $2^{11} - 1$ 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**
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 and BN 984/05**
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 multiframes)

**Signalling facilities**
**BN 984/01**

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 and BN 984/05**

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 (7⅝) only, or S/m bit value set externally via contradirectional 4 kbit/s input.

## Digital signal receiver

**PCM frame structure**
see "digital signal generator"

**Digital signal inputs**
**BN 984/01**
Interface characteristics comply with CCITT Rec. G.703.
Line codes . . . . . NRZ, AMI and HDB3
Coaxial input* . . . . . 75 Ω or >3 kΩ
Balanced input . . . . . 120 Ω or >3 kΩ
Input signal monitoring via LEDs:
NO SIGNAL, AIS, NO FRAME, NO MULTIFRAME.

**BN 984/02 and BN 984/05**
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); I 214 APS (BN 984/05)
Input impedance . . . . . 100 Ω or >3 kΩ
Input signal monitoring via LEDs:
NO SIGNAL, ALL ONES, NO SYNC, REMOTE ALARM.

**Evaluation of digital words in telephone channels**
**BN 984/01**

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

Code word measurements
Signalling bits . . . . . a, b, c, d
Encoding law, selectable . . . . . A-law or μ-law
Receive level range, at least . . . . . −80 to +6 dBm0

**BN 984/02 and BN 984/05**

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

Code word measurements
Signalling bits . . . . . A, B/A, B, C, D
Encoding law, selectable . . . . . A-law or μ-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**
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 Ω
space . . . . . >20 kΩ
Max. d.c. loading . . . . . 200 mA
Max. switching voltage . . . . . 70 V

Signalling receiver
Measuring range . . . . . ±10 ms
Resolution . . . . . 0.1 ms
Analog input (back panel)
Input impedance (connected internally to −15 V) . . . 750 Ω
Short-circuit current . . . . . 20 mA

**Evaluation and monitoring of words and bits**
**BN 984/01**

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 and BN 984/05**

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, switch-selectable . . . . . 110/117/127/220/227/237 V, in each case −12 % to +10 %
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 °C
Storage and transportation . . . . . −40 to +70 °C

Dimensions
Bench-top instrument (w × h × d in mm) 477 × 244 × 425

Weight . . . . . approx. 25 kg

## Options

**Codirectional 64 kbit/s input,** BN 984/00.01
**Codirectional 64 kbit/s output,** BN 984/00.02
Electrical characteristics comply with CCITT Rec. G.703.

**Serial, 64 kbit/s TTL input,** BN 984/00.05
**Serial, 64 kbit/s TTL output,** BN 984/00.06
Depending on operating mode, co- or contradirectional.

**Parallel, 64 kbit/s TTL input,** BN 984/00.07
**Parallel, 64 kbit/s TTL output,** BN 984/00.08
Parallel, 8 bit input/output with 8 kHz timing signal.

**Return Loss and Longitudinal Conversion Transfer Loss Bridge**
Reference impedances (BN 984/00.10) . . . . . 600, 900 Ω [1]
(BN 984/00.11) . . . . . 600, 850 Ω [1]

**<IEC 625> Interface Card,** BN 958/21
Remote control of all device functions and interrogation of measured values. Connected to the IEC bus with adaptor S 832.

## Accessories

**Test Point Scanner MU-30,** BN 823/11
Balanced connection of 30 (BN 984/01) or 24 (BN 984/02) low-frequency channels in the send and receive direction
Frequency range . . . . . 0 to 128 kHz
Can be remote controlled by the PCM-4 PCM Channel Measuring Set.

**D.C. Loop Holding Circuit GH-1,** BN 984/00.12
Two d.c. loop holding circuits in one casing.

**PCMZ-4,** BN 984/00.13
Attachment for removing the d.c. signal component at the audio input and output of the PCM-4 (not for BN 984/02 or BN 984/05 and not necessary if GH-1 [BN 984/00.12] is used)

1) For return loss measurements: additional complex impedance 220 Ω in series with 820 Ω | 115 nF; can be modified at factory.

**Ordering Information**

| | |
|---|---|
| **PCM Channel Measuring Set PCM-4** | |
| 2048 kbit/s version, menu in English | **BN 984/01** |
| 1544 kbit/s version, menu in English, WECO connectors | **BN 984/02** |
| 2048 kbit/s version, menu in German | **BN 984/03** |
| 1544 kbit/s version, menu in English, I 214 APS connectors | **BN 984/05** |
| Options (charged extra) | |
| Codirectional 64 kbit/s input [1] | BN 984/00.01 |
| Codirectional 64 kbit/s output [2] | BN 984/00.02 |
| Serial 64 kbit/s TTL input [1] | BN 984/00.05 |
| Serial 64 kbit/s TTL output [2] | BN 984/00.06 |
| Parallel 64 kbit/s TTL input [1] | BN 984/00.07 |
| Parallel 64 kbit/s TTL output [2] | BN 984/00.08 |
| Return Loss and Longitudinal Conversion Transfer Loss Bridge 600/900 Ω [3] | BN 984/00.10 |
| 600/850 Ω [3] | BN 984/00.11 |
| Analog generator output impedance modified to $Z_{out} \approx 0$ Ω in place of complex impedance | BN 984/00.34 |
| Software retrofitted to the latest status | BN 984/00.41 |
| <IEC 625> Interface Card with IEEE 488 connector and connecting cable K 420 | BN 958/21 |
| Accessories (charged extra) | |
| Test Point Scanner MU-30 with <IEC 625> Interface Card | BN 823/11 |
| D.C. Loop Holding Circuit GH-1 with capacitor-coupled output | BN 984/00.12 |
| D.C. Decoupling for PCM-4, PCMZ-4 (not for BN 984/02 or BN 984/05) | BN 984/00.13 |
| IEEE 488/<IEC 625> Adaptor (m-m) for <IEC 625> interface card | S 832 |
| Front and Back Panel Covers SD-5, (1 set) | BN 700/00.25 |

* 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 input can be used at any one time.
2) Only one output can be used at any one time.
3) Only one bridge can be fitted at any one time.

A Specification Sheet with more details and a Colour Brochure are available on request