PJM-4
Jitter Meter

for jitter measurements on clock and data signals to 168 Mbit/s

IEEE 488
IEC 625

- **Fulfils all CCITT Rec. O.171 requirements for jitter meters and in some respects meets more stringent requirements**
- **Bit rates of 2048, 8448, 25 776, 34 368 and 139 264 kbit/s; a further four bit rates as option, values specified by customer**
- **External clocks, 8 to 168 MHz, can be used, automatic phase adjustment**
- **CMI, AMI and HDB3 code violation evaluation; 4B3T and 5B6B or B6ZS and B8ZS as options**
- **Adjustable threshold and gate time for analysing phase hits (absolute and relative)**
- **Integrable into automated test systems: excellent synchronisation characteristics and extremely rapid jitter measurement sequences**
- **User-friendly softkey operation; user-selectable bit rates, codes and weighting filters**
- **All device functions can be remote-controlled via an <IEC 625>/IEEE 488 interface bus. Connector for printer**

Applications

Digital communications systems are continuing to gain in popularity all over the world. If they are to run smoothly, the signal processing systems and transmission systems they contain must be optimally dimensioned. The more complex these systems become, the more difficult it is to ensure that they will meet the conditions required for reliable interworking. An essential proviso that smooth signal transfer takes place at the digital interfaces is that the permissible jitter tolerances are maintained.
Error ratio measurements tell one a great deal about the quality of digital communications systems. Code violations, which can be counted and assessed while the system is in operation, are an excellent measure of overall transmission quality.

A test set in this field has to be able to handle the wide variety of bit rates and codes that are currently in use. Economics and system optimisation are the reasons why there are so many types of code. The different system interfaces used for cable, radio-link and satellite communications and the electrical interfaces of optical systems mean that test sets of this kind have to be highly adaptable.

Characteristics

The PJM-4 Jitter Meter can measure all the parameters mentioned above at the interfaces of the latest 30 channel PCM system hierarchies. The wide range of bit rates that the PJM-4 can handle, and the wide selection of weighting filters which have been incorporated in the instrument mean that there is hardly a type of jitter measurement that the PJM-4 cannot make. CMI, AMI, HDB3, B3ZS, B6ZS, B8ZS, 4B3T, 5B6B, NRZ and RZ codes can all be set on the PJM-4 – the bit rate does not affect code selection.
If the range of bit rates provided is not sufficient, external clocks can be used. The PJM-4 accepts any external clock signal having a frequency between 8 and 168 MHz – frequency offset and phase drift are taken care of automatically.

Analysis of jitter, bit rates . . . . . 700 kbit/s to 168 Mbit/s

Evaluates phase threshold transgressions and code errors over intervals from 1 s to 100 days

Event-free seconds

Receiver input to CCITT Rec. G.703

Demodulator output for selective jitter measurements

Other characteristics and applications

Jitter measurements
The clock recovery circuits, the phase demodulator and the weighting filters were designed to reduce intrinsic jitter to a minimum and give a very wide demodulator bandwidth. High measurement rates, which are essential for automated test systems, are also provided by the PJM-4.

The bit rate option considerably enchances the flexibility of the PJM-4. The user can select a number of bit rates to solve any specialised measurement problems that arise. Another of the PJM-4's useful features is that it can process practically any input waveform, e.g. sinusoidal signals, rectangular signals and ternary signals, provided not more than 15 edges are missing.

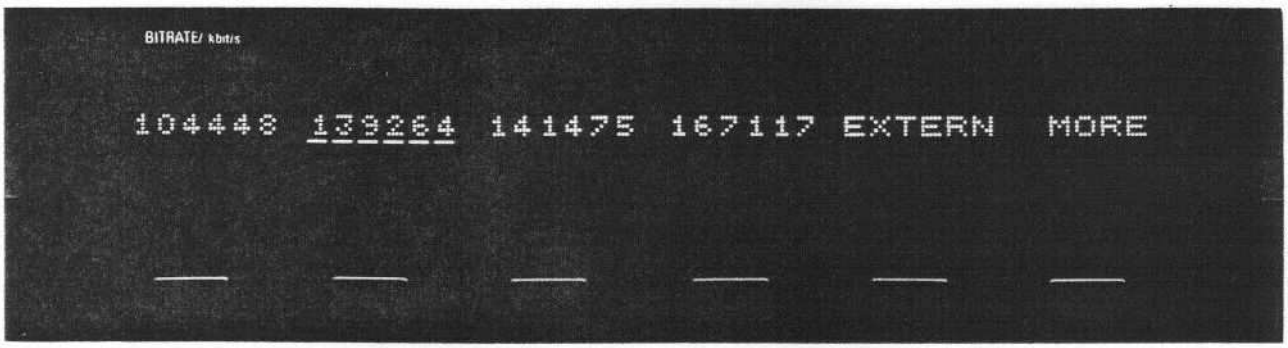
Event recording
At the same time as certain phase thresholds are exceeded there are, in general, an increased number of code violations on the transmission path. So that the effect of jitter on the whole transmission path can be analysed, the PJM-4 Jitter Meter is provided with two event counters. The PJM-4 can determine when adjustable phase thresholds have been exceeded by means of a continuous measurement and at the same time detect errors in signal coding.

The PJM-4 has error recognition facilities for CMI, AMI and all HDB codes. When the Code Violation Evaluation option is fitted, the PJM-4 can also handle 4B3T (MS43, MMS43, MMS43-BP, FOMOT) and 5B6B or B6ZS and B8ZS. This means, that the PJM-4 deals with a large number of commonly used codes.

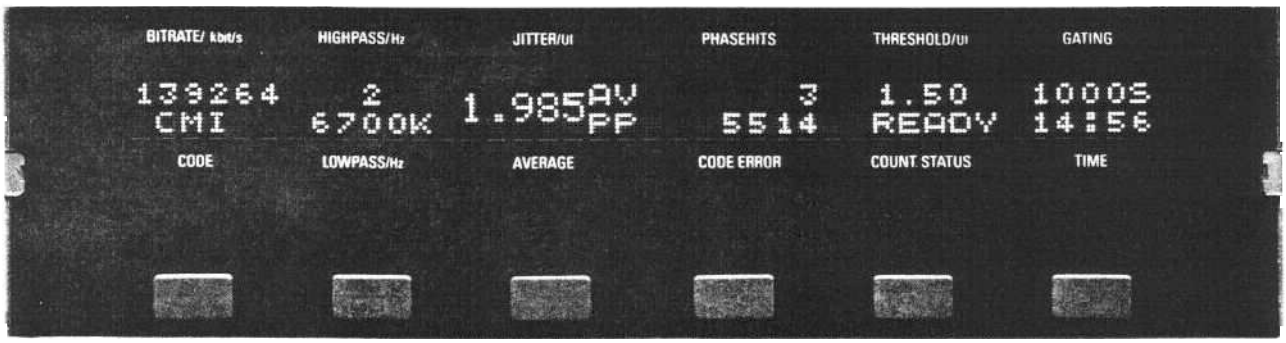
The events can be counted over a settable gate time, a selectable number of clock periods or expressed in terms of the ratio (in %) of error-free seconds to the total measurement time. These types of measurement are based on CCITT Rec. G.821. The maximum measurement interval is 100 days.

Remote control
When the <IEC 625> interface board is fitted, the PJM-4 can be remote-controlled by means of an external computer which can interrogate all measured values, alarm statuses and the time. Rapid synchronisation to the test signal and a high measurement rate are extremely useful features when the PJM-4 is integrated into an automated test system.
In this way, investigations which provide valuable information on long-haul transmission paths and statistics on critical signal connections can be made.

Printer listings
When the <IEC 625> bus option is fitted, the PJM-4 can be used to perform automated long-term monitoring. All results, the date, time, and the PJM-4's settings can be printed out on any printer compatible with the <IEC 625>/IEEE 488 interface bus. The printout can be started manually or can be printed out at regular intervals set on the PJM-4.
The timer allows single measurements, or a sequence of measurements, to be carried out a certain time each day. The time when an alarm starts and finishes is also printed out with the results. This saves paper as the presence of the alarm over a number of measurement intervals is not recorded.



Dialog mode to help the operator select the bit rate he requires



The digital results are easy to read

Unless otherwise stated, the data is valid for the nominal range of mains voltage, mains frequency and ambient temperature.

Bit rates

Internal reference clock generation
Bit rates, selectable . . . . . 2048, 8448, 25776, 34368 and 139264 kbit/s
A maximum of four bit rates can be specified by the customer (option), 700 to 168000 kbit/s.

External clock input (back panel)
Frequency range . . . . . 8 to 168 MHz
Input impedance . . . . . 75 Ω
Required input voltage . . . . . 0.5 to 4 V_{p-p}

Pull-in range limits . . . . . $\pm 75 \times 10^{-6}$

Signal input

Input impedance . . . . . 75 Ω
Return loss, 25 kHz to 210 MHz . . . . . ≧20 dB
Reference voltage for the input impedance
for NRZ/ECL and RZ/ECL . . . . . −2 V
all other codes . . . . . 0 V

Input voltages
Max. amplitude . . . . . 7 V
Pulse amplitude or sinusoidal amplitude . ±50 mV to ±3 V

Input equaliser
Automatic equalisation of frequency-dependent cable attenuation
Pulse amplitude, adjustable . . . . . ±100 mV to ±3 V
Max. equalisation at 70 MHz . . . . . 12 dB

Jitter measurements

Jitter measurements on clock signals
Sinusoidal signals or square waves
with a duty cycle of . . . . 50 %
Periodic bit patterns, code
RZ (TTL/ECL) . . . .1111...
NRZ (TTL/ECL) . . . .1010...
CMI . ...0000... or ...1111...

Jitter measurements on data signals
B3ZS, HDB3, B6ZS, B8ZS, CMI, 4B3T, 5B6B and 7B8B codes . . . . . any pattern

AMI, NRZ (TTL/ECL) and RZ (TTL/ECL) codes
Periodic bit sequence . . . . up to 15 missing edges
Pseudorandom sequence . . . . max. length $2^{23}-1$ bits

Jitter display . . . . 4 digits
Max. resolution . . . . 0.001 UI
Display averaging, selectable, averaging time . . . . . 5 s
Evaluation, selectable . . . . . positive peaks only, negative peaks only, peak-to-peak

Jitter frequency range
Weighting filters
Manual selection, or filter combinations to CCITT Rec. O.171 can be called up.

Low passes

3 dB cutoff	Attenuation <0.1 dB at
74 kHz	40 kHz
185 kHz	100 kHz
300 kHz	160 kHz
600 kHz	400 kHz
1200 kHz	800 kHz
6700 kHz	4500 kHz

Attenuation in stopband . ≧60 dB/decade
Connector for external filter.

Highpasses
3 dB cutoff frequencies . . . 2, 10, 20, 60, 100, 200, 700 Hz, 3, 8, 10, 18, 24, 32, 80, 160, 900 kHz
Attenuation in stopband . . . . . ≧20 dB/decade

Weighting filter combinations to CCITT Rec. O.171 (3 dB cutoff)

Bit rate	Lowpass	Highpass 1	Highpass 2
1544 kbit/s	74 kHz	10 Hz	8 kHz
2048 kbit/s	185 kHz	20 Hz	700 Hz
6312 kbit/s	300 kHz	10 Hz	24 kHz
8448 kbit/s	600 kHz	20 Hz	3 kHz
32064 kbit/s	1.2 MHz	60 Hz	160 kHz
34368 kbit/s	1.2 MHz	100 Hz	10 kHz
44736 kbit/s	6.7 MHz	10 Hz	900 kHz
139264 kbit/s	6.7 MHz	200 Hz	10 kHz

Maximum measurable jitter amplitude as a function of jitter frequency

Bit rate	Data signals		Clock signals	
Mbit/s	f_2 kHz	f_3 kHz	f_2 kHz	f_3 kHz
0.7 to 2	0.063	2	0.63	20
>2 to 8	0.25	8	1.50	50
>8 to 32	1.0	33	7.8	250
>32 to 128	1.5	50		
>128 to 168	4.7	150		

Clock signals: $A_1 = 16$, $A_2 = 0.5$ UI_{p-p}, f_4 corresponds to 1/10 of bit rate
Data signals: depends on edge density if f_4 lies beween 1/10th and 1/100 of the bit rate.

Specified jitter measurement ranges
when the guaranteed error limits are kept.
Clock-signal measurements

Bit rate	Jitter (UI_{p-p})		Frequencies defining jitter function			
kbit/s	A_1	A_2	f_1 Hz	f_2 Hz	f_3 kHz	f_4 kHz
1544	10	0.3	10	200	7	40
2048	10	0.5	20	2400	45	100
6312	10	0.5	10	1600	32	160
8448	10	0.5	20	400	8.5	400
8448	10	0.5	20	10700	200	400
32064	10	0.5	60	1600	32	800
34368	10	0.5	100	1000	20	800
44736	16	0.5	10	3200	100	4500
139264	10	0.5	10	500	10	3500

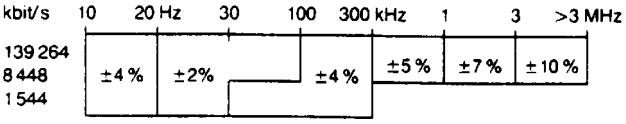
Error limits of displayed jitter
at a jitter frequency of 1 kHz, using clock signal or ... 1000 ... (to CCITT Rec. O.171 when the reference clock is generated internally)

Bit rate	Error limits (display averaging on)
<30 Mbit/s	<5 % of measured value ±5 mUI_{pp}
>30 Mbit/s	<5 % of measured value ± 10 mUI_{pp}

at a jitter frequency of 1 kHz with pseudorandom sequences having a length up to 2^{23}-1 bits

Bit rate range	Error limits (referred to the displayed value, display averaging on)
≦8.448 Mbit/s	<5 % +18 mUI_{pp} − 9 mUI_{pp}
>8.448 Mbit/s	<5 % +28 mUI_{pp} −12 mUI_{pp}

Max. frequency response error referred to 1 kHz, measured using clock signal, 0.5 UI_{p-p}



Phase threshold transgressions
The demodulated jitter function can be further investigated using adjustable thresholds.
Entry range . . . . . 0.05 to 7.99 UI_p

ABSOLUTE COUNT
Counts the number of phase threshold transgressions during a certain gate time (selectable). Six-digit display (999 999), also display with 3-digit mantissa and max. exponent of 1.99×10^9.

EVENT-FREE SECONDS
Ratio (in %) of the number of second intervals during which jitter was below threshold to the total observation time.

RATIO
Number of phase threshold transgressions per second measured over a selectable interval.
Digital display, 3 digit mantissa and exponent.

Code violation recognition
Error evaluation for . . . . . CMI, AMI and all HDB codes
See options for more codes.
Same display format as for phase threshold transgressions.
Common format selection.
RATIO: code violations to clock periods.

Observation interval
Simultaneous evaluation of phase threshold transgressions and code violations
Measurement intervals . . . . . 1, 10, 100 or 1000 s
or hours/minutes . . . . . to 99 h 60 min
or days/hours . . . . . to 99 d 24 h
Clock period multiples . . . . . 10^6, 10^7 to 10^{12} UI

Other inputs and outputs

Phase-demodulator output* (75 Ω)
Return loss to 5 MHz . . . . . ≧30 dB
Output voltage corresponding to a jitter amplitude of 1 UI . . . . . 0.1096 V

Low-frequency demodulator output

Connector for external filter (75 Ω)
Nominal filter insertion loss . . . . . 6 dB
Insertion loss compensation, adjustable . . . . . ±1 dB

Output for recovered clock (75 Ω)
Output voltage . . . . . 0.8 V_{p-p}

Output for equalised input signal (75 Ω)

Code-violation output (75 Ω)
Positive pulse width . . . . . 0.5 UI
Open circuit output level . . . . . ECL levels

Input for error counter
Logic levels and input impedance, selectable
75 Ω to −2 V . . . . . ECL levels
10 kΩ to 0 V . . . . . low = 0 to 0.3 V, high = 1 to 5.0 V
10 kΩ to 0 V . . . . . TTL levels
Maximum counting frequency . . . . . 170 MHz

Options

Additional Bit Rates, BN 2019/00.10
A maximum of four bit rates between 700 kbit/s and 168000 kbit/s.

Code Violation Evaluation for 4B3T and 5B6B, BN 2019/00.01
When the option is fitted the PJM-4 can also handle 4B3T (MS43, MMS43, MMS43-BP, FOMOT) and 5B6B codes.

<IEC 625> Interface Board, BN 958/21
Remote control of all functions and result interrogation.
Controls an external IEC bus printer.

Accessories

Test Probe TKD-1, BN 882/01
High impedance tapping at balanced interfaces.

Active Test Probe TK-11, BN 573/00
Power supplied by PJM-4.

General specifications

Power supply
Nominal ranges of use of a.c. line voltage, selectable . . . . 110 V, −18 to +28 %/220 V, −12 to +18 %
Nominal range of use of a.c. line frequency . . . . 47.5 to 63 Hz
Power consumption . . . . . approx. 115 VA
Safety class to VDE 0411 and IEC 348 . . . . . class 1
EMI/RFI suppression to . . . . . Bundespost 1046/1984

Ambient temperature
Nominal range of use . . . . . +5 to +40°C
Storage and transportation . . . . . −40 to +70°C

Dimensions in mm
Bench model (w×h×d) . . . . . 477×155×434

Weight . . . . . approx. 16 kg

Ordering information

Jitter Meter PJM-4	**BN 2019/01**
Options (charged extra)	
Code Violation Evaluation for 4B3T and 5B6B	BN 2019/00.01
Code Violation Evaluation for B6ZS and B8ZS	BN 2019/00.02
Additional Bit Rate [1]	BN 2019/00.10
<IEC 625> Interface Board with IEEE 488 connector and K 420 cable	BN 958/21
Accessories (charged extra)	
IEEE 488/IEC 625 adaptor (m-m)	S 832
Transportation Case TPK-3	BN 626/09
Front and back panel covers SD-3, (1 set)	BN 700/00.23
19" conversion kit	BN 700/00.03

1) State required bit rates when ordering instrument.
*) Equipped with the Versacon® 9 basic connector and BNC insert. For other inserts see the Versacon® 9 specification sheet, state inserts you require when you place your order for the PJM-4.