product data

WM-10 and WM-11

Wandermeters for SDH, PDH and SONET synchronization testing

Find sync problems faster and easier

- Wander measurements on transmission rates from 4 kHz to 52 Mbits/s
- MTIE and TDEV masks
- Portable 2.048/1.544 MHz clock generator
- Stability check of 27 MHz video/10 MHz frequency reference signal
- Easy-to-use e.g. auto-calibration of internal Rubidium
- -48V DC supply and Ethernet interface (WM-11)

Incorrect synchronization in digital communication networks can cause severe transmission problems. Voice calls (fixed or cellular) will be lost, Fax machines will misprint, data will be lost or frequently re-transmitted. In any case, network performance is degraded, the operators service costs are increased and revenues are down.

The main cause for synchronization problems in transport networks is *wander* of the synchronization clock. Quality control of the synchronization clock requires monitoring of wander over a longer period (hours or days) using an ultra-stable clock as reference.

So far measurement of Wander has involved bulky, complex and very expensive instrumentation. To be able to view the wander parameters MTIE and TDEV specified in international standards, external Rubidium standards and/or external computers were often needed.

Pendulum Instruments offer two Wandermeter models;

- WM-10, a very accurate and easy-to-use portable Wandermeter, designed for wander measurements on E1 clock and data signals (2.048 MHz/Mbits/s).
- WM-11, a multi-application synchronization testing tool for a multitude of data rates in SDH, PDH, SONET, Video and frequency reference distribution networks.

And last but not least, both models come with an affordable price. No need anymore to refrain from preventive maintenance of wander, due to budget restrictions.

Quick guide to WM-10 and WM-11

Model:	WM-10	WM-11
SDH/PDH/SONET Frequencies		
2.048 kHz / kbit/s	x	x
4 / 8 kHz		x
64 kbit/s		x
34 / 45 / 52 Mbit/s		x
1.544 MHz / Mbit/s		x
Video Frequencies		
27 MHz		x
15.750 / 15.625 kHz		x
Reference frequencies		
10 MHz		x
Graphical display	x	x
Rubidium reference	x	x
Ethernet interface		x
2.048 MHz clock output	Opt.	x
1.544 MHz clock output		x
-48 V DC supply		x

Applications

WM-10 and WM-11 could be used for several purposes:

- As an *accurate certification tool*, to document conformance to standards (ANSI T1.10x (only WM-11), ITU G811-813, ETS 300 462) for telephone network operators, network leasers, and buyers and sellers of synchronization services.
- As a *preventive (diagnostic) maintenance tool* in transport nodes using SONET (only WM-11), SDH, or PDH.
- As a *quick trouble-shooting tool* in SONET (only WM-11), SDH or PDH networks when a node is suspected not to operate correctly.

Both models can be used both by the transport network owners and all users of the network, e.g. GSM network operators and radio link services.

- As a *design tool* for manufacturers of equipment for SONET (only WM-11), SDH and PDH and network elements, PBX'es, GSM access equipment, Radio links etc.
- As a *signal quality measurement tool* (only WM-11) for video distribution systems and frequency reference distribution systems.
- As a *remote monitoring station* (only WM-11) with remote control and network wander data retrieval over Internet.

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Measures to standard

The WM-10/WM-11 Wandermeter models are designed to measure wander according to ITU- and ANSI-standards (only WM-11) of various signals in SONET (only WM-11), SDH- or PDH-network nodes, with graphical presentation of TIE, MTIE and TDEV and comparison to standard masks e.g. PRC, SSU, SEC. It is possible to create user-defined masks, for new or changed standards, for easy recall of the operator during measurements. New or updated masks can be downloaded from Pendulums website www.pendulum.se at any time

WM-10/WM-11 can measure both "absolute" and "relative" wander. In the first case the measured signal (clock or data) is compared to the ultimate stability of the internal Rubidium "atomic" clock or an external 10 MHz reference. In the second case, the relative wander between two signals, e.g. in- and outgoing E1-signal from a network element, is measured. This makes it possible to verify wander tolerance and the amount of "extra wander" created by the device under test.

Complete unit

The instruments are compact, lightweight and fully self-contained with a build-in Rubidium reference clock and a graphical display. There is no need to carry around an external frequency standard or a separate PC to make and view the measurement. A PC-cable and 120Ω -to-75Ω transformers are included as standard, to enable measurement on any kind of cable system, whether 75Ω unbalanced or 120Ω balanced.

In WM-11, also an Ethernet interface, a 1.544/2.048 MHz clock and a -48V DC voltage supply are included as standard.

Easy to operate and calibrate

The units are very easy to use and can even be operated by unskilled personnel. For standard measurements only a few keystrokes are required. Once the measurement is started, the WM-10/WM-11 can be left unattended for automatic measurements. It stops automatically after set measuring time and can even delay its measurement start when required.

A fully automatic signal check informs the user whether he/she has connected the right signal from the rack.

On-line context-sensitive help is available, making the operator's manual obsolete.

Also the calibration and adjustment of the internal Rubidium clock is fully automatic and very easy. Just connect a known reference signal from a Cesium or a GPS-controlled Rubidium clock, enter the calibration mode of WM-10/WM-11 and leave the unit overnight. Next morning, the WM-10/WM-11 is perfectly adjusted, without any manual trimming involved.

The WM-10/WM-11 is also easy to carry and transport, and includes e.g. side handles and a flight-proof transport case (extra accessory).

Remote control via Internet (WM-11)

Once you have installed the WM-11 at one network node location to perform measurements, you do not need to travel back to get the result from individual wander measurements. Via the Ethernet-port you can connect the WM-11 to the Internet, and from a central PC running WanderView™. You can also control the downloading of measurement data and the set-up of new measurements.

Working principle

The Pendulum WM-10/WM-11 Wandermeter is built in an EMI-proof metal cabinet and contains a Rubidium Reference and a special in-house developed Time Interval Error (TIE) measuring circuitry, that phase compares the connected signal with the Rubidium reference. The WM-10/WM-11 communicates its results to the user via a graphical display, and to a PC via an RS232-port or an Ethernet-port (only WM-11). See figure 1.

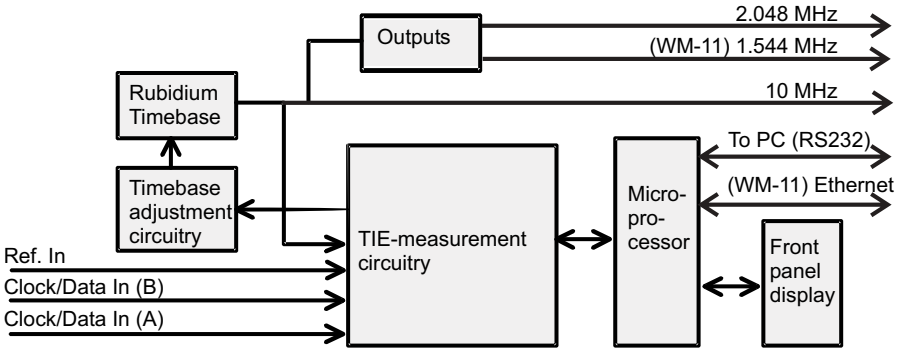

Figure 1. Block diagram of WM-10/WM-11

WM-10/WM-11 operates in two different modes:

Local mode operation:

The WM-10/WM-11 Wandermeter can be operated stand-alone. During the measurement, the TIE-curve on the display is continuously updated, showing the performance of the sync-clock "so far". This mode is intended for fully automated diagnostics and/or fault-finding measurement "on-site", with direct visual feedback at any time. The sampling rate is approx. 1 Sa/s. The WM-10 Wandermeter calculates and presents the MTIE or TDEV curves after completed TIE measurement, and compares to stored masks.

Remote (PC-controlled) operation:

The WM-10/WM-11 Wandermeter can be operated controlled from the RS232 port of a PC, running the *WanderView™* PC-SW. See figure 2. In this mode the Wandermeter acts as a sampling front-end and transfer the TIE-values one-by-one to the PC. The local display of the Wandermeter is not updated. In the WM-11 model, there is also an Ethernet port available for the same purpose.

Sample speed is >30 TIE-values/s and the storage is only limited by the PC, which means that the fast sample rate can be maintained during a 24h period (or longer if required). The PC-SW calculates and presents MTIE and TDEV curves after completed measurement period, and compares to the defined masks. This mode is intended for verification of conformance to ETSI- or ANSI-standards.

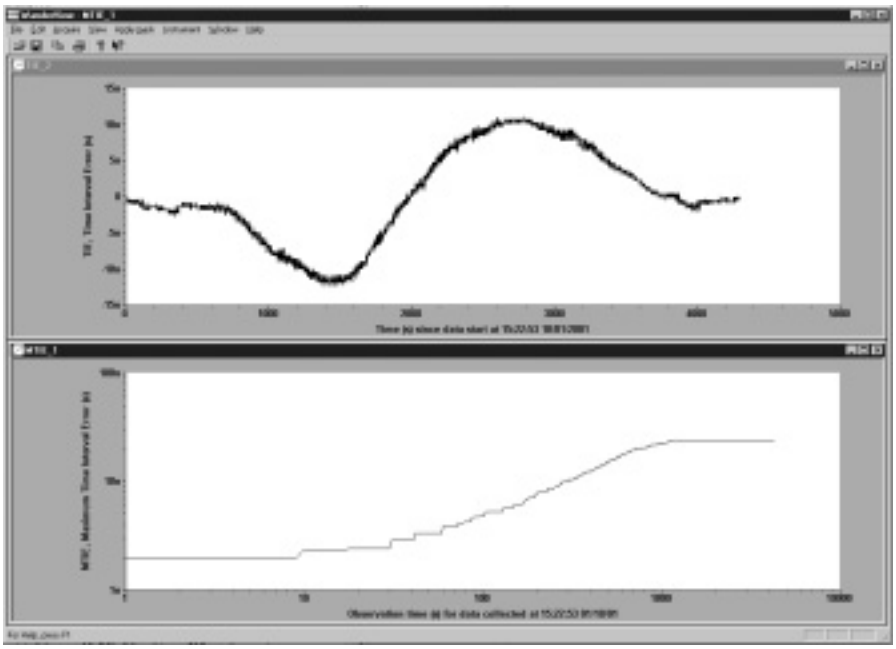

Figure 2. WanderView screen, showing a TIE-curve (top) and a MTIE curve (bottom)

WM-10/WM-11 Specifications

Note: Specifications apply after 30 minutes warm-up time

Operation Modes

Local: The WM-10/WM-11 Wandermeter operates stand-alone and measures the wander of a connected clock or data signal (WM-10 only 2.048 MHz/Mbits/s). Alternatively the differential phase (Time Interval) between two connected clocks or data signals is measured. During the measurement, the TIE curve is continuously updated on the display. This mode has limitation in sampling rate and number of stored samples.
Remote: The WM-10/WM-11 Wandermeter is controlled from a PC running the WanderView PC-software and measures the wander of a connected clock or data signal (WM-10 only E1). During the measurement, the WM-10/WM-11 Wandermeter acts as a sampling front-end and the display is not updated. A quick look at the performance so far can be made from WanderView.

Presentation Modes

TIE:	Time Interval Error is displayed and continuously updated in Local Mode operation.
MTIE:	MTIE is calculated from the measured and stored TIE-values and displayed after completed measurement in Local Mode operation.
TDEV:	TDEV is calculated from the measured and stored TIE-values and displayed after completed measurement in Local Mode operation.

Test modes (MTIE and TDEV masks)

The internal Rubidium clock is used as reference in all modes except "Differential". Mask applies for MTIE and TDEV graphs.

Draft:	No masks
PRC:	Masks for G811-clock (ETS 300 462-3)
SSU:	Masks for G812-clock (ETS 300 462-3)
SEC:	Masks for G813-clock (ETS 300 462-3)
SSU (locked mode):	Masks for G812-clock (ETS 300 462-4)
SEC (locked mode):	Masks for G813-clock (ETS 300 462-5)
ANSI-standards:	To be defined
Video:	To be defined
Differential:	Relative wander (TIE, MTIE and TDEV) between two clocks or data signals.

Signal types WM-10

2.048 MHz
2.048 Mbit/s

Signal types WM-11

4 kHz
8 kHz
64 Kbit/s
1.544 MHz
1.544 Mbit/s
2.048 MHz
2.048 Mbit/s
10 MHz
27 MHz
34 Mbit/s
45 Mbit/s
52 Mbit/s
15.750 KHz
15.625 kHz

Input signal characteristics

Frequency WM-10:	2.048 MHz
Frequency WM-11:	4 kHz, 8 kHz, 64 kbit/s, 1.544 MHz, 1.544 Mbit/s, 2.048 MHz, 2.048 Mbit/s, 10 Mhz, 27 MHz, 34 Mbit/s, 45 Mbit/s, 52 Mbit/s, 15.750 kHz (NTSC), 15.625 kHz (PAL)
Amplitude:	inside -5V…+5V
Signal type WM-10:	Symmetrical pulse (Clock signal) HDB3-coded data (Data signal)
Signal type WM-11:	Symmetrical pulse (Clock signal) Unsymmetrical repetitive pulse (Clock signal) HDB3-coded data (Data signal) AMI B8ZS, B3ZS (Data signal)

Time Interval Error (TIE)

Reference clock:	Built-in Rubidium clock or an external 10 MHz clock signal connected to Ext. Reference input
Measure time WM-10:	2h, 24h or continuously (local mode)
Measure time WM-11:	30 min, 2h, 4h, 24h or continuously (local mode)
Local Mode update Rate:	
30 min, 2h, 4h:	approx. 1 Sa/s
24h:	approx. 0.2 Sa/s (1Sa/6s)
Continuously:	16000/time Sa/s; max. approx. 1 Sa/s. Data compression after approx. 4h
Remote Mode update rate:	
Any measure time:	up to 30 Sa/s

Internal data storage

Size:	16000 stored TIE-values
Type:	Non-volatile storage

Measuring Time

Time WM-10:	Short (2h), Long (24h) and continuous
Time WM-11:	Short (30 min, 2h, 4h), Long (24h) and continuous
Start/Stop:	Via START/STOP key
Warm-up time:	Selectable delay before measurement starts, to allow the instrument to warm-up properly 0, 30 min, 4h or 24h

Signal Check

Measures and displays the following parameters:
Signal type (Clock, Data or Unknown)
Frequency (for clock signals)
Pulse width (for data signals)
Voltage peak-peak (min. 120 mVp-p)

Self Test

Power-up:	Test of critical digital functions
On demand (user opt.):	Test of most digital functions

INFO

A built in context sensitive help function gives guidance for all manual settings

SAVE / RECALL

No. of instrument set-ups:	5
No. of screen images:	3 (TIE, MTIE or TDEV)
Stored TIE-value array:	16k values (1 set)
Write protection:	Saved set-up, screen image or TIE-value array can be protected against accidental over-writing

Graph display

Display Modes:	TIE, MTIE or TDEV
Vertical scale:	Displayed TIE, MTIE or TDEV value in ns or ms AUTO scaled
Horizontal scale:	Real-time axis (TIE) or "τ"- axis (MTIE/TDEV) AUTO scaled (continuous measurement and differential test mode) or fixed scale (2h/24h full scale)
No of divisions:	8x10 (vert. x horiz.)
Masks WM-10:	MTIE and TDEV masks according to selected test mode: PRC, SSU, SEC
Masks WM-11:	MTIE and TDEV masks according to selected test mode

Clock/Data Inputs A and B

Connector:	BNC
Coupling:	DC Coupled
Voltage Range:	± 5.00V
Sensitivity:	60 mVpp
Impedance:	75Ω , VSWR <2:1
Maximum Input Voltage Without Damage:	12 Vrms up to 2 MHz, decreasing to 6 Vrms at 10 MHz
Trigger Level:	Automatically set via Signal Check. Can be manually adjusted
Range:	± 5.00V
Resolution:	10 mV

Ext. Reference Input

Connector:	BNC
Input frequency:	10 MHz
Voltage Range:	0.5 Vrms to 12 Vrms
Impedance:	approx. 500Ω
Coupling:	AC coupled
Max. Input Voltage Without Damage:	30 Vrms up to 1 kHz, decreasing to 6 Vrms at 10 MHz

Reference Frequency output

Connector:	BNC
Ref. Frequency:	10 MHz square-wave
Frequency stability:	See Internal Timebase Stability spec.
Output levels:	Fixed TTL: low <0.4V, high >1.8V into 50Ω

2.048 MHz Clock output (WM-10 option 35)

Connector:	BNC
Ref. Frequency:	2.048 MHz square-wave
Freq. Stability:	See timebase oscillator spec.
Jitter:	<0.01 UI
Wander:	MTIE < 15 ns + τ x (freq.offset)$^{-1}$
Output level:	Acc. to G703:10; ±1.2V ±10% in 75Ω

WM-10/WM-11 Specifications

1.544/2.048 MHz Clock output (WM-11)

Connector:	BNC
Ref. Frequency:	1.544/2.048 MHz square-wave
Freq. Stability:	See Internal Timebase Stability spec.
Jitter:	<0.01 UI
Wander:	MTIE < 15 ns + (freq.offset)$^{-1}$
Output level:	Acc. to G703:10; ±1.2V ±10% in 75Ω

RS232 Data in/output

Connector:	9-pin male D-Sub connector
Baud rate:	9600 bps
Data format:	8 databits, 1 stopbit, no parity

Ethernet (WM-11)

Communication port:	
Connector:	RJ45
Protocol:	10Base-T
Configuration port:	
Connector:	Dsub9, RS232

WanderView SW

Operating system:	Windows 95/98/NT
Data transfer from WM-10/WM-11:	
	TIE-values (real-time or stored values)
	Stored graphs
	Instrument id
	Setup information (only WM-11)
Calculate functions:	MTIE, TDEV
Instrument control functions to WM-10/WM-11:	
	Local or Remote mode
	Auto-adjust of Rubidium osc.
	Instrument setup (only WM-11)
Custom mask editor WM-10:	4+4 user defined MTIE+TDEV mask
Custom mask editor WM-11:	Unlimited user defined MTIE+TDEV mask
File functions:	Document printout, File save/retrieve

Calibration

Principle:	Closed Case Calibration with automatic adjustment of the Rubidium timebase
Calibration reference:	Cs-oscillator or GPS-controlled Rubidium
Calibration ref. frequency WM-10:	1, 2.048, 5 or 10 MHz
Calibration ref. frequency WM-11:	100 kHz, 1, 1.544, 2.048, 5 or 10 MHz
Calibration uncertainty:	<2x10^{-12}+ Cal. ref. freq. uncertainty

Internal Time Base Stability

Stability versus:		
Temperature	20° to 26° 0° to 50°	<2x10^{-11} <3x10^{-10}
Aging Rate per:	24h Month	<2x10^{-12} (typ.) <5x10^{-11}
Short term stability per:	1s 10s	<3x10^{-11} <1x10^{-11}
Warm up stability:	10 min	<4x10^{-10}
Factory adjustment uncertainty (+23°C)	<10 MHz ± 0.0005 Hz	

Display

Type:	Super Twisted Liquid Crystal
Size:	84x84 mm, 4.7" diagonal
Resolution:	240x240 pixels
Backlight:	Cold Cathode Fluorescent (CCFL) tube Brightness approx. 50 cd/m^2
Contrast ratio:	User adjustable, max. 1:15 (typical at 20°C)

Environmental Data

Temperature:	
Operating:	0°C to 50°C
Storage:	-20°C to 70°C
Humidity:	
Operating:	20°C to 30°C, 90% RH non-condensing 30°C to 50°C, 70% RH non-condensing
Storage:	95% RH
Altitude:	
Operating:	3000m (10 000 ft)
Storage:	12000m (40 000 ft)
Safety:	EN 61010-1:1997, CAT II, Pollution degree 2, CE
EMC:	EN 55022B, EN 61000-6-2, CE

Power Supply

Line voltage:	100 to 240 Vrms ±10% 47 Hz to 63 Hz, <60W
-48V DC voltage:	38V to 72V DC, <60W (only WM-11)

Mechanical Data

WxHxD:	342x177x305 mm
Weight:	Net 5 kg (11 lb) Shipping 7 kg (15 lb)

Ordering Information

WM-10 Wandermeter:	Wandermeter for E1 clock or data signals
WM-11 Wandermeter:	Wandermeter for general clock or data signals
Included with Instrument:	
	Line power cord
	Two 120Ω-to-75Ω transformers (BNC mounted)
	PC connection cable
	Operators Manual
	Certificate of calibration
Options (factory built in) WM-10:	
Option 35:	2.048 MHz clock output
Optional accessories:	
Option 27W:	Heavy Duty Hard Transport Case

Specifications subject to change without notice

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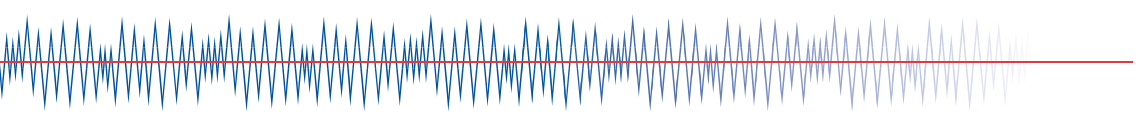
Pendulum Instruments AB
www.pendulum.se

– experts in Time & Frequency Calibration, Measurement and Analysis



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