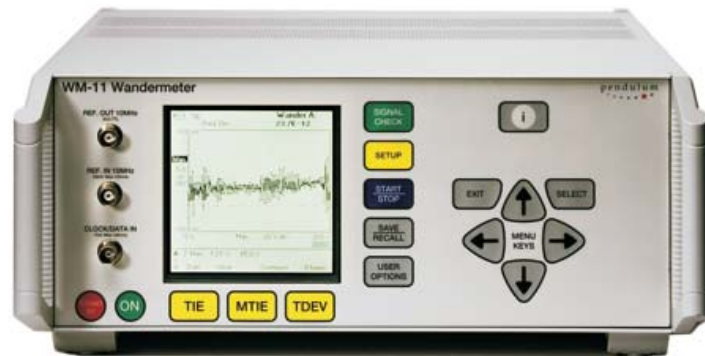


## Wandermeter for SDH, PDH and SONET synchronization testing

### 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 any frequency reference clock signal to 65 MHz
- Easy-to-use e.g. auto-calibration of internal Rubidium
- - 48V DC supply and Ethernet interface



Incorrect synchronization in digital communication networks can cause severe transmission problems. Voice calls (fixed or cellular) will be lost, fax machines will misprint, and 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 offers the WM-11, a multi-application synchronization testing tool for a multitude of data rates in SDH, PDH, SONET, Video and frequency reference distribution networks.

### Quick Guide to the WM-11

Model:	WM-11
<b>SDH/PDH/SONET Frequencies</b>	
2048 kHz / kbit/s	X
4 / 8 kHz	X
64 kbit/s	X
34 / 45 / 52 Mbit/s	X
1.544 MHz / Mbit/s	X
<b>Video Frequencies</b>	
27 MHz	X
15.750 / 15.625 kHz	X
<b>Reference Frequencies</b>	
10 MHz / 5 MHz	X
<b>Any clock frequency:</b>	
50 Hz...65535 Hz in 1 Hz steps	X
1 kHz...65535 kHz in 1 kHz steps	X
<b>Graphical Display</b>	X
<b>Rubidium Reference</b>	X
<b>Ethernet Interface</b>	X
<b>2.048 MHz Clock Output</b>	X
<b>1.544 MHz Clock Output</b>	X
<b>-48V DC Supply</b>	X

### Applications

WM-11 can be used both by the transport network owners and all users of the network, e.g. GSM network operators and radio link services. Applications are several:

- As an accurate certification tool, to document conformance to standards (ANSI T1.10x, ITU G811-813, ETS 300 462) for telephone network operators, network leasers, and buyers/sellers of synchronization services.
- As a preventive (diagnostic) maintenance tool in transport nodes using SONET, SDH or PDH.

- As a quick trouble-shooting tool in SONET, SDH or PDH networks when a node is suspected not to operate correctly.

- As a design tool for manufacturers of equipment for SONET, SDH and PDH and network elements, PBX'es, GSM access equipment, Radio links etc.

- As a signal quality measurement tool for video distribution systems and frequency reference distribution systems.

- As a remote monitoring station with remote control and network wander data retrieval over Internet.

## Measures to Standard

The WM-11 Wandermeter is designed to measure wander according to ITU- and ANSI-standards of various signals in SONET, 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.

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 instrument is 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.

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

## Easy to Operate and Calibrate

The unit is 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-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.

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

The 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

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 control the downloading of measurement data and the set-up of new measurements.

## Working Principle

The Pendulum Wandermeter is built in an EMI-proof metal cabinet and contain 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-11 communicate its results to the user via a graphical display, and to a PC via an RS232-port or an Ethernet-port. See figure 1.

WM-11 operates in two different modes; local and remote.

## Local Mode Operation

The Wandermeter can be operated stand-alone. During the measurement, the TIE-curve on the display is continuously up-

dated, showing the performance of the sync-clock “so far”. This mode is intended for fully automated diagnostics and/or faultfinding measurement “on-site”, with direct visual feedback at any time. The sampling rate is approx. 1 Sa/s. The Wandermeters calculate and present the MTIE or TDEV curves, and compare them to stored masks.

## Remote (PC-controlled) Operation

The 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 a sampling front-end and transfers the TIE-values one by one to the PC. The WM-11 model also offers 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, and compares to the defined masks. This mode is intended for verification of conformance to ETSI- or ANSI- standards. Multiple graphs can be displayed on-screen, and multiple masks can be applied.

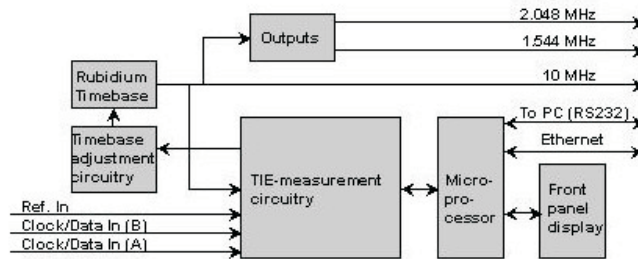


Figure 1: Block diagram of WM-11

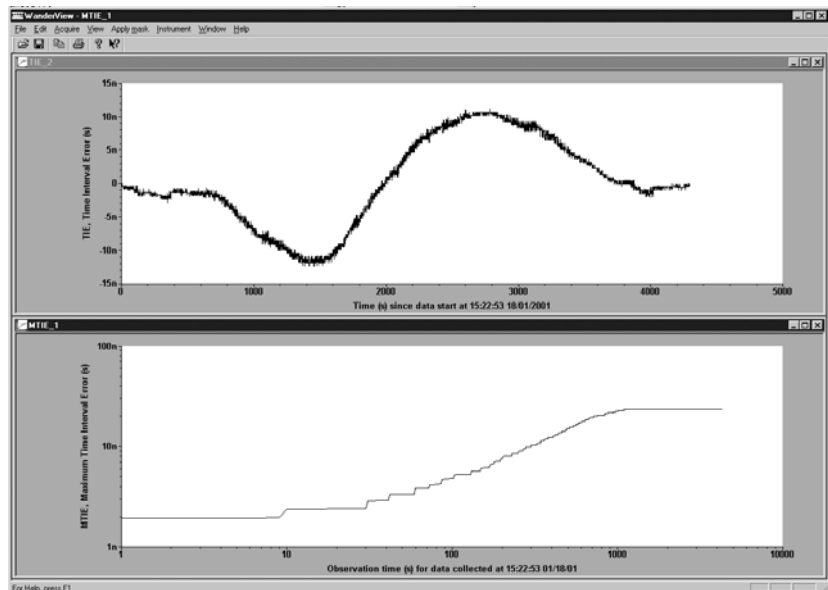


Figure 2: WanderView screen, showing a TIE-curve (top) and a MTIE curve (bottom).

# WM-11 Specifications

Note: Specifications apply after 30 minutes of warm-up time

## Operation Modes

**Local:** The WM-11 Wandermeter operates stand-alone and measures the wander of a connected clock or data signal. 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.

**Remote:** The WM-11 Wandermeter is controlled from a PC running the WanderView PC-software and measures the wander of a connected clock or data signal. During the measurement, the WM-11 Wandermeter acts as a sampling front-end. This mode has no limitation in sampling rate (<30 Sa/s) and number of stored samples. TIE is presented graphically on screen, in real-time, and current MTIE and TIE values are continuously displayed numerically.

## 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 complete measurements 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.

<b>Draft:</b>	No mask
PRC/SSU/SEC:	Masks for G811/G812/G813-clocks (ETS 300 462-3)
ANSI-standard:	DS1 and OC-N masks
Video:	NTSC and PAL masks
User-defined:	Any
<b>Differential:</b>	Relative Wander (TIE, MTIE and TDEV) between two clocks or data signals.

## Signal Types – predefined

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

## Clock Signal Types – user settable

50 Hz to 65535 Hz in 1 Hz steps  
1 kHz to 65535 kHz in 1 kHz steps  
Note: The signal under test must be a symmetrical clock-type signal

## Input Signal Characteristics

<b>Frequency:</b>	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 (PAL)
<b>Amplitude:</b>	Inside -5V...+5V
<b>Signal Type:</b>	Symmetrical pulse (Clock signal) Unsymmetrical repetitive pulse (Clock signal) HDB3-coded data (Data signal) AMI B8ZS, B3ZS (Data signal)

## Time Interval Error (TIE)

<b>Reference Clock:</b>	Built-in Rubidium clock or an external 10 MHz clock signal connected to Ext. Reference input
<b>Measure Time:</b>	30 min, 2h, 4h, 24h or continuously (local mode)
<b>Local Mode Update Rate:</b>	
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
<b>Remote Mode Update Rate:</b>	
Any Measure Time:	up to 30 Sa/s

## Internal data storage

<b>Size:</b>	16000 stored TIE values
<b>Type:</b>	Non-volatile storage

## Measuring Time

<b>Time:</b>	Short (30 min, 2h, 4h), long (24h) and continuous
<b>Start/Stop:</b>	via START/STOP key.
<b>Warm-up Time:</b>	Selectable delay before measurement starts, to allow the instrument to warm-up properly; 0, 30 min, 4h or 24h.

## Signal Check

<b>Measures and Displays the Following Parameters:</b>	
	Signal type (Clock, Data or Unknown)
	Frequency (for clock signals)
	Pulse width (for data signals)
	Voltage peak-peak (min. 120 mVp-p)

## Self Test

<b>Power-up:</b>	Test of critical digital functions
<b>On Demand (user opt.):</b>	Test of the most digital function

## Info

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

## SAVE / RECALL

<b>No. of Instrument Set-ups:</b>	5
<b>No. of Screen Images:</b>	3 (TIE, MTIE or TDEV)
<b>Stored TIE-value Array:</b>	16k values (1 set)
<b>Write Protection:</b>	Saved set-up, screen image or TIE-value array can be protected against accidental over-writing.

## Graph Display

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

## Clock / Data input A and B

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

## External Reference Input

<b>Connector:</b>	BNC
<b>Input Frequency:</b>	10 MHz
<b>Voltage Range:</b>	0.5 Vrms to 12 Vrms
<b>Impedance:</b>	approx. 500Ω

# WM-11 Specifications

**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

## 1.544 / 2.048 MHz Clock Output

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

## RS232 Data in/output

**Connector:** 9-pin male D-Sub connector  
**Baud Rate:** 4800 to 19200 bps  
**Data Format:** 8 databits, 1 stopbit, no parity

## Ethernet

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

## WanderView SW

**Operating System:** Windows 2000/XP/Vista  
**Data Transfer from WM-11:** TIE-values (real-time or stored values)  
Stored graphs  
Instrument id  
Setup information  
**Calculate Functions:** MTIE, RTIE, MRTIE, TDEV, ADEV, MADEV, FDEV  
**Instrument Control Functions to WM-11:** Local or Remote mode  
Auto-adjust of Rubidium osc.  
Instrument setup  
**Self Test:** Start/Stop TIE measurement  
Install new/updated Signal Types  
Install new/updated Masks  
**Custom Mask Editor WM-11:** Unlimited user defined MTIE+TDEV mask  
**File Functions:** Document printout, File save/retrieve  
**Window Types:** Graph windows of TIE and calculated parameters (unlimited)  
Graph data window  
Measurement set-up window  
Event log window (logs e.g. transmission interrupts)

## Calibration

**Principle:** Closed Case Calibration with automatic adjustment of the Rubidium timebase.  
**Calibration Reference:** Cs-oscillator or GPS-controlled Rubidium  
**Calibration Ref. Frequency:** 100 kHz, 1, 1.544, 2.048, 5 or 10 MHz  
**Calibration Uncertainty:**  $< 2 \times 10^{-12} + \text{Cal. Ref. Freq. Uncertainty}$

## Internal Time Base Stability

<i>Stability Versus</i>		
Temperature:	20° to 26° 0° to 50°	$< 2 \times 10^{-11}$ $< 3 \times 10^{-10}$
Aging Rate per:	24h Month	$< 2 \times 10^{-12}$ (typ.) $< 5 \times 10^{-11}$
Short Term Stability per:	1s 10s	$< 3 \times 10^{-11}$ $< 1 \times 10^{-11}$

Factory Adjustment Uncertainty (+23°C): <10 MHz  $\pm 0.0005$  Hz

## Display

**Type:** Super Twisted Liquid Crystal  
**Size:** 84 x 84 mm, 4.7" diagonal  
**Resolution:** 240x240 pixels  
**Backlight:** Cold Cathode Fluorescent (CCFL) tube.  
Brightness approx. 50 cd/m<sup>2</sup>  
**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:** 3 000m (10 000 ft)  
**Storage:** 12 000m (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  $\pm 10\%$   
47 Hz to 63 Hz, <60 W  
**-48V DC Voltage:** 38V to 60V DC, <60W

## Mechanical Data

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

## Ordering Information

**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  
**Optional Accessories:**  
Option 27W: Heavy Duty Hard Transport Case

Specifications subject to change without notice

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- Experts in time & frequency calibration, measurement and analysis

Pendulum Instruments is a company of the Orolia Group