

**ANT-20, ANT-20E
Advanced Network Tester**

MTIE / TDEV Analysis

BN 3035/95.21

Software Version 3.03

Operating Manual

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© 2000

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Order no.: BN 3035/98.33

Edition: 02/00.04 (V 3.03)

Previous edition:

01/99.08 (V 3.00)

Subject to change without notice.

Our normal guarantee and delivery terms apply.

Printed in Germany



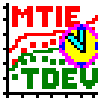
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Introduction

1 New features (compared with Release 2.10)

- TIE data zoom in and zoom out
- Calculation of frequency offset
- Calculation of drift rate
- TIE data with a resolution of up to 300 samples per second are now supported (available with ANT-20 Software Release 7.0 and higher)
- Improved printing of TIE and MTIE/TDEV graphs
- MTIE/TDEV calculation for definable analysis ranges
- Improved handling (switching between graphics, mask display, etc.)
- Masks for higher TIE data resolution (pre-defined for ETSI, ANSI and ITU-T)

2 Preface

Quick guide for installation and operation of the WWG ANT-20 "MTIE/TDEV Analysis" software, BN 3035/95.21 V.3.03, April 2000.

The "MTIE/TDEV Analysis" software calculates and evaluates the values of MTIE (**M**aximum **T**ime **I**nterval **E**rror) and TDEV (**T**ime **D**eviation) as recommended in ETSI 300 462, ITU-T G.811, 812 and 813, ANSI T1.101/GR-253 and compares them against the defined masks.

Calculation results are based on wander data gathered using a standard ANT-20 with jitter and wander options. This short-form manual only describes the operation of the off-line evaluation software. For details on how to perform a wander measurement with the ANT-20, please refer to the appropriate section of the ANT-20 Operating Manual.

3 Requirements

The wander data (TIE/Time Interval Error) must be gathered using an ANT-20 with software version 7.0 or higher. The ANT-20 or ANT-20E must be equipped with the jitter and wander options to be able to perform the relevant measurements.

MTIE/TDEV evaluation will run on the built-in ANT-20 PC or on any Windows PC with minimum 16 MB RAM and 50 MB free hard disk space (preferably more if long term wander data are to be evaluated) on drive C:\. The operating system should be Windows 95/98 or Windows NT.



4 Installation

1. Insert Disk 1/2 "MTIE/TDEV Analysis" software into the floppy drive "A:" of the ANT-20 or of a Windows PC.
2. Run "A:\SETUP.EXE" from the "Start" menu.
3. Follow the instructions displayed on the screen.

After successful installation, you can run the analysis software by clicking on the "TIE & MTIE_TDEV analysis" item in the "Start" menu ("TIE & MTIE_TDEV analysis" group).

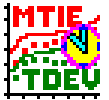
– or –

If the "MTIE/TDEV Analysis" software has been installed on the ANT-20, you can also start it from the "Jitter Generator/Analyzer" VI of the ANT-20 with the "TIE Analysis" command in the "View" menu or with the "TDEV" icon in the toolbar.

5 De-installation

1. Click on the "Uninstall TIE & MTIE_TDEV analysis" item in the "Start" menu ("TIE & MTIE_TDEV analysis" group).
2. Follow the instructions displayed on the screen.

If de-installation is successful, the analysis software is deleted from the hard disk.



Operation with an ANT-20

1 Starting the MTIE/TDEV Analysis software

The software can be started in various ways.

The “MTIE/TDEV Analysis” software is installed on the ANT-20

- ✓ Windows is running.
- ⇒ Click on the following icon on the desktop.



The “TIE analysis” window opens (see Fig. O-2).

– or –

- ✓ Windows is running.
 - ✓ The ANT-20 “Jitter Generator/Analyzer” VI is running.
 - ✓ The appropriate interfaces are connected to the device under test.
1. Click on “TIE” in the “Mode” menu of the “Jitter Generator/Analyzer” VI or click on the “TIE” icon in the toolbar.
 2. Start a TIE measurement by pressing function key “F5”.
The data are recorded in the file named “WANDMSEC.BIN”.

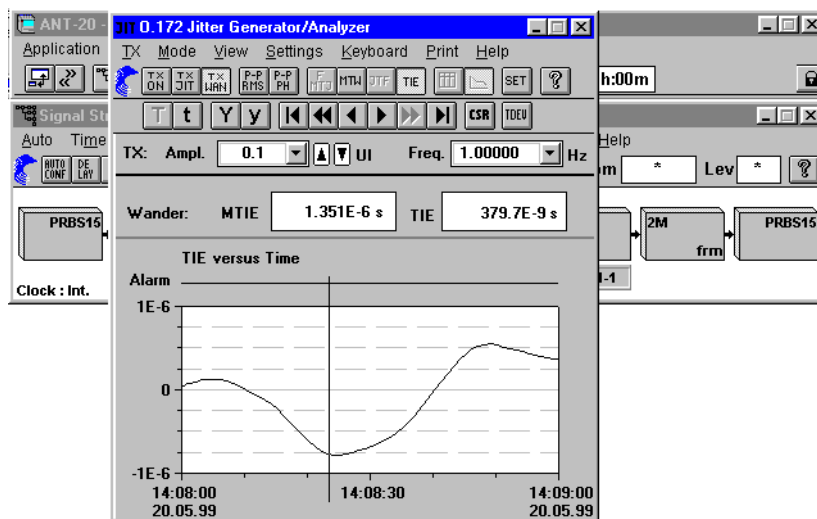


Fig. O-1 ANT-20 “Jitter Generator/Analyzer” VI

3. When the recording is finished, click on “MTIE/TDEV Offline Analyzer” in the “View” menu of the “Jitter Generator/Analyzer” VI or click on the “TDEV” icon in the toolbar.
The “TIE analysis” window opens.
The data from the last version of “WANDMSEC.BIN” to be saved will be loaded automatically (see Fig. O-3).

The “MTIE/TDEV Analysis” software is installed on an external PC

✓ Windows is running.

⇒ Click on the “TIE & MTIE_TDEV analysis” item in the “Start” menu (“TIE & MTIE_TDEV analysis” group).

The “TIE analysis” window opens.

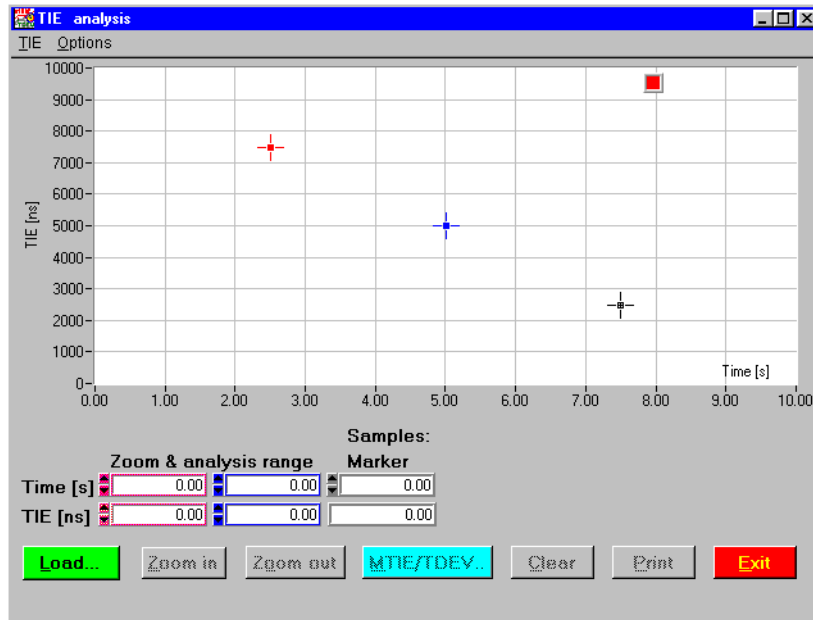


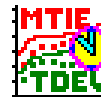
Fig. O-2 Empty “TIE analysis” window

The “MTIE/TDEV Analysis” application consists of two main windows:

- “TIE analysis” window: Display of loaded TIE data and marker positions.
- “MTIE analysis” window: Display of calculated values for MTIE and TDEV (MADEV, ADEV) and the tolerance masks.

Proceed as follows:

1. First load a file containing TIE data. see Sec. 1.1, Page O-3 and Sec. 2.1.1, Page O-6
 (The last version of “WANDMSEC.BIN” is loaded automatically if the software is started from the “Jitter Generator/Analyzer” VI.)
 – or –
 Simulate TIE data. see Sec. 1.2, Page O-3 and Sec. 2.1.1, Page O-6
2. Use the cursors to select a range of values if required. see Sec. 2.1, Page O-4
3. Change to MTIE/TDEV Analysis. see Sec. 2.1.1, Page O-6
4. Select a tolerance mask. see Sec. 2.2, Page O-8
5. Calculate the values. see Sec. 2.2.1, Page O-11
6. Print out the graph if required. see Sec. 2.2.1, Page O-11
7. Export the data in “CSV” format if required. see Sec. 2.2.2, Page O-12



1.1 Loading TIE data

To load TIE wander data gathered with the ANT-20, click on the “Load” action button and select the binary file containing the data you want to evaluate.

See also Sec. 2.1.1, Page O-6.

After an ANT-20 measurement is completed, a file named “WANDMSEC.BIN” is always available automatically in the “C:\ANT20\RESULTS” folder. It contains the raw data for sample rates of 1, 30, 60 or 300 per second. If you renamed this file beforehand, you should load the renamed binary file.

It is also possible to load “*.CSV” ANT-20 data. Simply enter the appropriate file name, e.g. “WANDMSEC.CSV”.

After the raw data have been loaded, a graph showing TIE versus time is displayed in the “TIE analysis” window.

Data are organized in blocks. A block runs from the start of the measurement to the next occurrence of an alarm condition or “Stop”, or from the end of an alarm condition to the start of the next alarm condition or “Stop”. If the measurement is uninterrupted (i.e. no alarm condition occurs during the gate time), there will be only one block of measurement data. The evaluation applies to one block only. It is not possible to extend an evaluation over more than one block.

You can load up to four binary files and display them in the “TIE analysis” window at the same time. The graphs are displayed in different colors. However, only the last file loaded is used to calculate the MTIE/TDEV values.

1.2 Simulating TIE data

Extensive simulation facilities are provided for demonstration purposes and to help you become familiar with some of the characteristics of MTIE/TDEV evaluation. Also refer to Sec. 2.1.1, Page O-6. The “Simulation - TIE data generation” window opens. In this window you can select up to three different phase deviation characteristics that may be superimposed. The selections available are “white noise”, “linear and square with selectable amplitude”, and “sinewave with selectable amplitude and frequency”.

2 Functions

2.1 TIE analysis window

The TIE data are displayed in the “TIE analysis” window when you have loaded a data file.

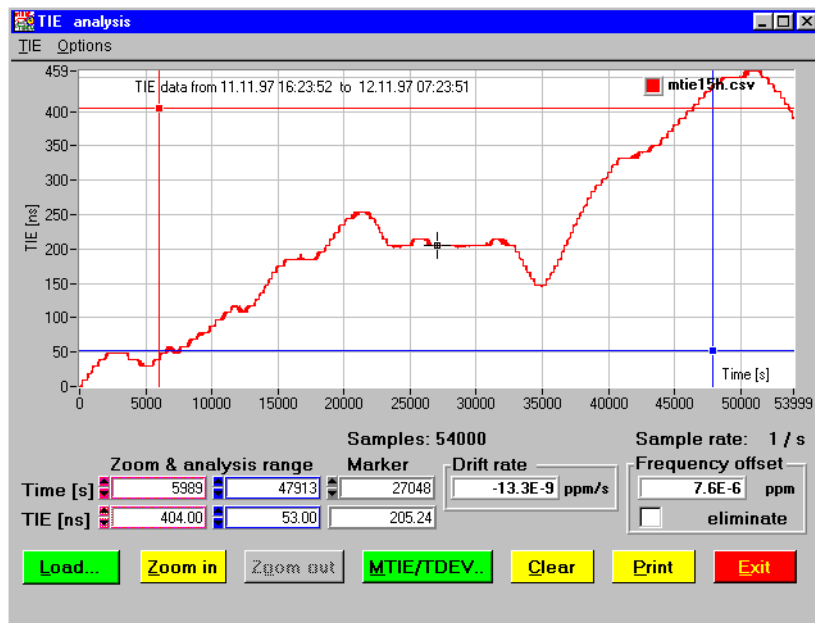


Fig. O-3 “TIE analysis” window with TIE data

Marker functions

The red and blue markers are used to select a section of the graph. The black marker can only be moved along the graph itself. Markers are moved using the mouse or the trackball. The three marker positions are indicated in text boxes at the bottom of the window. You can also enter values in these boxes using the keyboard.

Zoom in/Zoom out

The “Zoom in” button enlarges the section of the graph that you have marked with the red and blue markers. The “Drift rate” and “Frequency offset” are recalculated and refer to the section of the graph that is displayed.

The “Zoom out” button reduces the size of the selected part of the graph.

Additional displays

The “Drift rate” and “Frequency offset” are displayed on the right next to the marker position values.

If you activate the “eliminate” check box, a second graph is displayed for which the frequency offset has been compensated out.

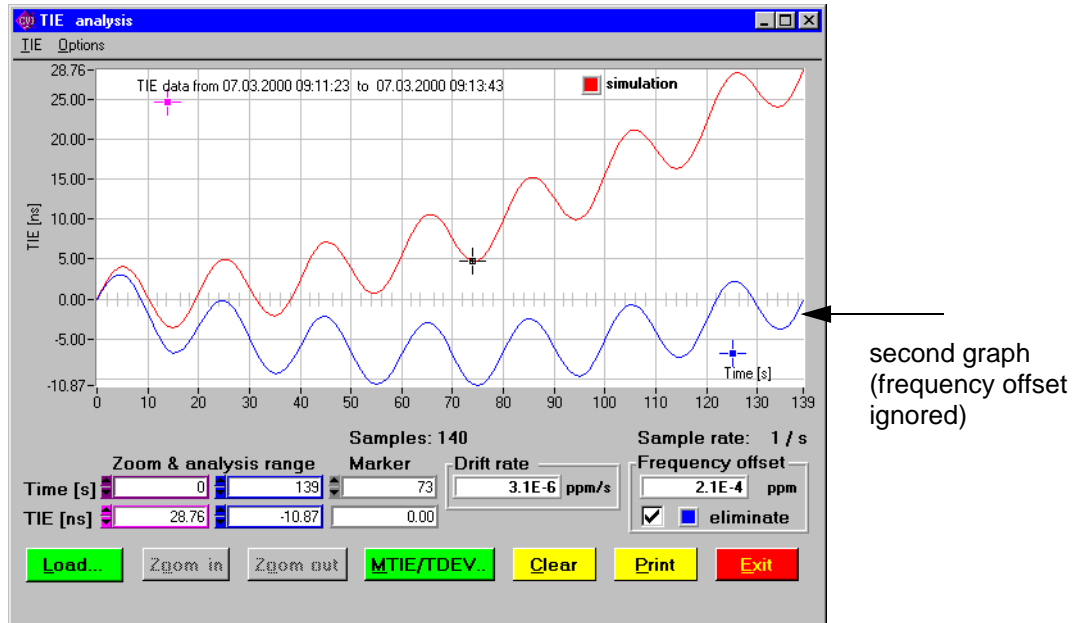


Fig. O-4 “TIE analysis” window with TIE data (“eliminate” check box activated)

The “Frequency offset” and “Drift rate” are refreshed for the area that is set by the cursors. The values of “Frequency offset” and “Drift rate” are frozen if the “eliminate” check box is activated. “Zoom in” is activated automatically. “Zoom out” is no longer possible. If the “eliminate” check box is deactivated, the last TIE data displayed will be reloaded and displayed over the full time range.

Changing the graph color

A color palette opens when you click on the color mark in the upper right corner of the “TIE analysis” window. You can select a different color for the graph here. The “More” button opens the “Select Color” window where you can define and select further colors.

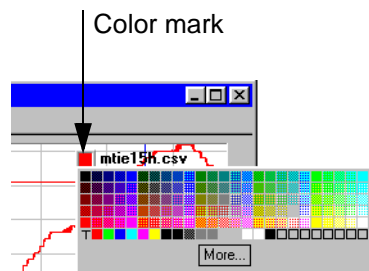


Fig. O-5 Changing the graph color

2.1.1 TIE menu

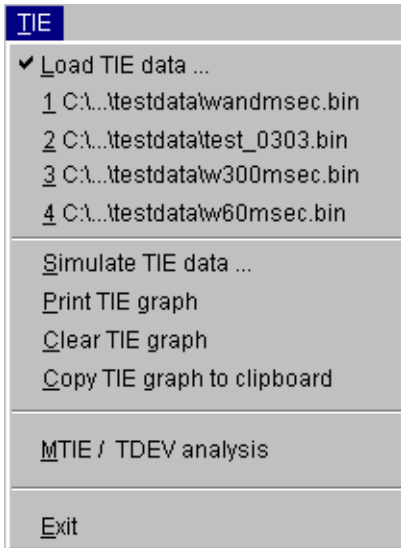




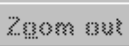




Fig. O-6 “TIE” menu

Menu item	Meaning
Load TIE data ...	Opens the “Load data file” window. You can select a file containing TIE data captured using an ANT-20 (file name extension “*.BIN” or “*.CSV”) from this window. Up to four TIE graphs can be displayed at the same time.
1 C:\...\testdata\wandmsec.bin 2 ...	List of the last files loaded (up to four).
Simulate TIE data ...	Opens the “Simulation - TIE data generation” window. You can simulate TIE data from this window.
Print TIE graph	Opens the “Comment” and “Print” windows for printing the graph.
Clear TIE graph	Clears the TIE graph display.
Copy TIE graph to clipboard	Copies the TIE graph onto the Windows clipboard.
MTIE / TDEV analysis	Switches to the “MTIE/TDEV analysis” window.
Exit	Closes the “TIE analysis” window.

Table O-1 “TIE” menu commands

2.1.1.1 Action buttons

The action buttons correspond to the following commands in the “TIE” menu:

						
Load TIE data ...	-	-	MTIE / TDEV analysis	Clear TIE graph	Print TIE graph	Exit



2.1.2 Options menu

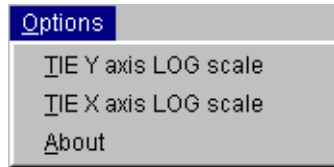


Fig. O-7 "Options" menu

Menu item	Meaning
TIE Y axis LOG scale	Switches to logarithmic display for the Y axis.
TIE X axis LOG scale	Switches to logarithmic display for the X axis.
About	Opens the "About MTIE / TDEV Analysis" window with information about the software.

Table O-2 "Options" menu commands

Note: The logarithm is undefined at the zero point.
Therefore, select a valid range with the aid of the zoom function before you switch to the logarithmic display.

2.2 MTIE analysis window

When you click on the “Analysis” button, the MTIE/TDEV values are first calculated from the TIE data that have been loaded and then displayed in the “MTIE analysis” window.

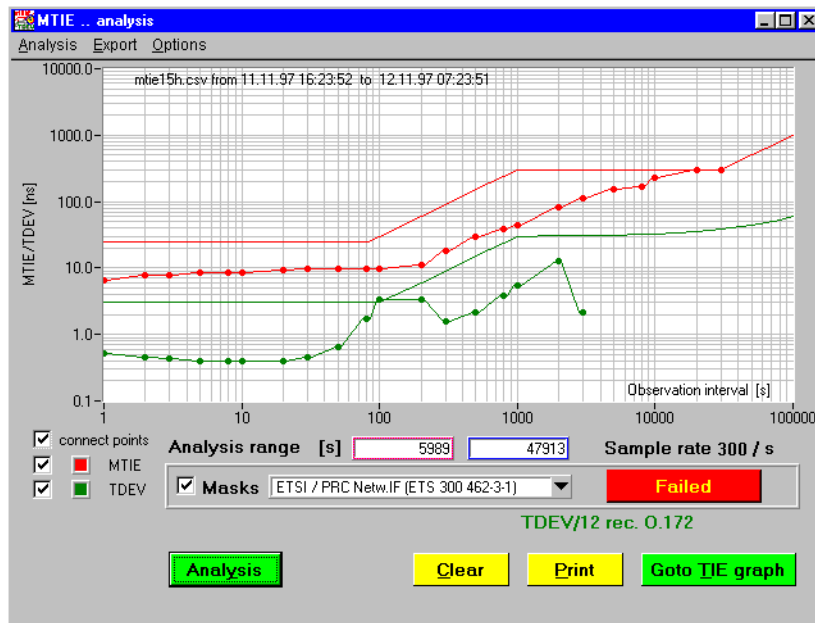


Fig. O-8 “MTIE analysis” window with MTIE and TDEV data and ETSI tolerance masks

Displaying the graphs

The check boxes in front of “MTIE” and “TDEV” are used to select the values that are calculated and displayed. If the “Analysis with MADEV & ADEV” command is activated in the “Options” menu, the values for “MADEV” and “ADEV” will also be calculated and displayed.

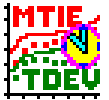
The points at which the values are calculated are defined in the file “standard.txt”. You can edit this file if required. The number of fixed points affects the calculation time.

Joining up the MTIE, TDEV, MADEV and ADEV values with straight lines

The calculated values for MTIE, TDEV, MADEV and ADEV will be joined up by straight lines when you activate the check box in front of “connect points”. Intermediate values are not calculated.

Graphics documentation

Use the “Copy analysis graph to clipboard” command in the “Analysis” menu to document the graph in other Windows applications such as WinWord, or use the “Print analysis graph” command to obtain a printout.



Displaying the pre-defined or user-defined tolerance masks

If the "Masks" check box is activated, you can activate pre-defined tolerance masks or ones that you define yourself and superimpose them on the display. Pre-defined tolerance masks to ANSI, ETSI and ITU-T standards are provided.

	Interface	Standard
ANSI	DS1	T1.101
	OC-N	T1.101
	PRS	T1.101
ETSI	140 M Netw. IF	EN 302 084
	2 M Netw. IF	EN 302 084
	34 M Netw. IF	EN 302 084
	PDH Distr. IF	ETS 300 462-3-1
	PRC	ETS 300 462-6-1
	PRC Netw. IF	ETS 300 462-3-1
	SEC	ETS 300 462-5-1
	PRC Netw. IF	ETS 300 462-3-1
	SSU	ETS 300 462-4-1
	SSU Netw. IF	ETS 300 462-3-1
ITU-T	PDH Sync. IF	G.823
	PRC	G.811
	PRC Netw. IF	G.823, G.825
	SEC Netw. IF	G.823, G.825
	SEC Opt. 1	G.813
	SEC Opt. 2	G.813
	SSU Netw. IF	G.823, G.825
	SSU Type I	G.812
	SSU Type II, III	G.812

Table O-3 Pre-defined tolerance masks to ANSI, ETSI and ITU-T standards

To generate your own mask, you must first create a "TXT" format file with the same format as one of the mask files supplied by Wavetek Wandel Goltermann. The format is simple: x-MTIE, y-MTIE, x-TDEV, y-TDEV.

```

template.txt - Editor
Datei Bearbeiten Suchen ?
# User Mask: (...)
# comment
# comment
# MTIE 0 = no Ua1. TDEV 0 = no Ua1.
# x[s] y[ns] x[s] y[ns]
0.1, 200, 0.1, 3
0.2, 400, 0.2, 3
1, 2000, 1, 5
2, 4000, 2, 5
3, 6000, 3, 5
5, 8000, 5, 20
8, 7000, 8, 20
50000000, 290, 50000000, 0
80000000, 0, 80000000, 0
    
```

Fig. O-9 Example of a mask file ("template.txt")

Pass / Fail assessment

The calculated MTIE/TDEV values are compared with the tolerance mask values (Pass / Fail assessment). If there is no tolerance mask value corresponding to a particular MTIE/TDEV value, a tolerance value will be interpolated from the mask.

The following applies to the tolerance comparison:

- Tolerance mask: The specified points as well as the interpolated values will be used for the comparison.
- Analysis curve: Only the individual result points from the analysis are used for the comparison. The points on the interpolated lines are **not** compared. They merely improve the optical display (see Fig. O-8).

Example:

- Case 1: The MTIE/TDEV value is compared with the tolerance mask value and assessed.
- Case 2: The intersection between the line and the tolerance mask is **not** compared or assessed.
- Case 3: The MTIE/TDEV value is compared with the interpolated value of the tolerance mask and assessed.

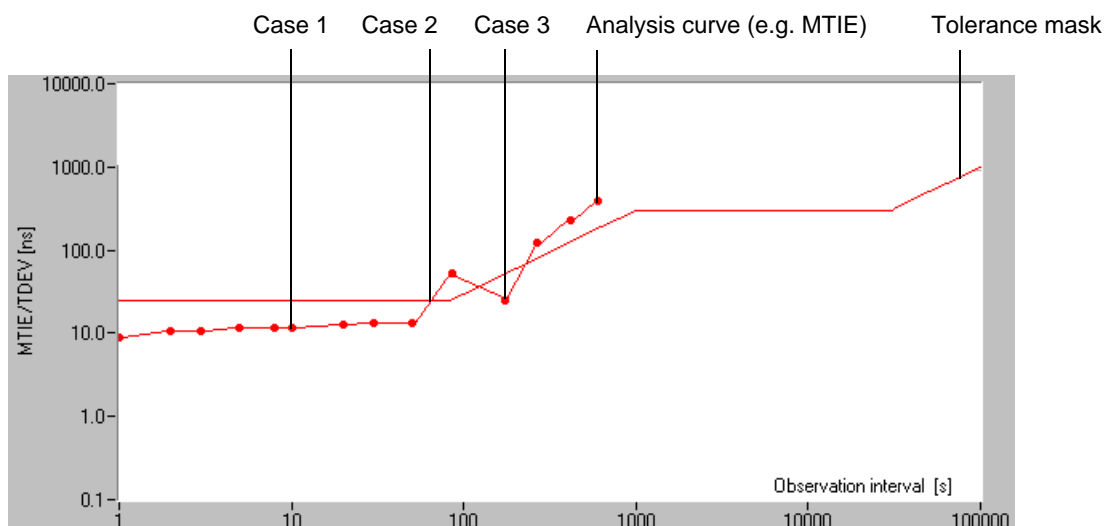
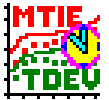


Fig. O-10 Special features of the Pass / Fail assessment



Changing the color of the graph and the corresponding tolerance mask

A color palette opens if you click on one of the check boxes with a color mark in the lower left corner of the “MTIE analysis” window. You can select a different color for the graph and the corresponding tolerance mask (when displayed) here. The “More” button opens the “Select Color” window where you can define and select further colors.

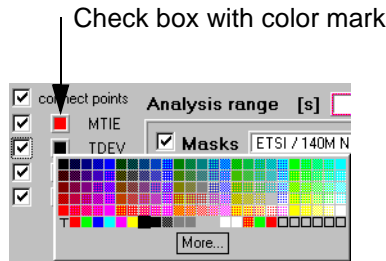


Fig. O-11 Changing the color of the graph and the corresponding tolerance mask

2.2.1 Analysis menu

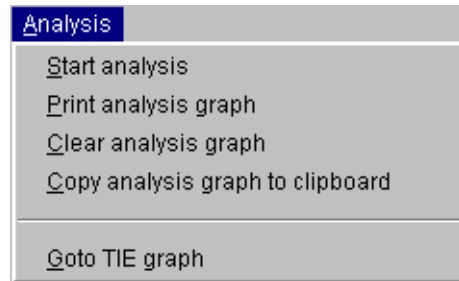


Fig. O-12 “Analysis” menu

Menu item	Meaning
Start analysis	Starts calculation of MTIE/TDEV values for the section of the graph in “TIE analysis” that is defined by the markers.
Print analysis graph	Opens the “Comment” and “Print” windows for printing out the graph using the printer connected. It is possible to insert a user-defined comment for this graph which may be helpful for future reference.
Clear analysis graph	Clears the MTIE/TDEV graph display.
Copy analysis graph to clipboard	Copies the MTIE/TDEV graph to the Windows clipboard.
Goto TIE graph	Switches to the “TIE analysis” window.

Table O-4 “Analysis” menu commands

2.2.1.1 Action buttons

The action buttons correspond to the following commands in the “Analysis” menu:

Analysis	Clear	Print	Goto TIE graph
Start analysis	Clear analysis graph	Print analysis graph	Goto TIE graph

2.2.2 Export menu

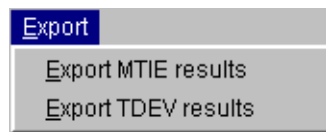


Fig. O-13 “Export” menu

Menu item	Meaning
Export MTIE results	Opens the “Save MTIE/TDEV results” window. You can specify a name for the export file in this window. The MTIE results are saved as “CSV” data in this file. This “CSV” file can then be loaded into standard Windows applications such as Microsoft Excel for further data processing and printing purposes.
Export TDEV results	Opens the “Save MTIE/TDEV results” window. You can specify a name for the export file in this window. The TDEV results are saved as “CSV” data in this file. This “CSV” file can then be loaded into standard Windows applications such as Microsoft Excel for further data processing and printing purposes.

Table O-5 “Export” menu commands



2.2.3 Options menu

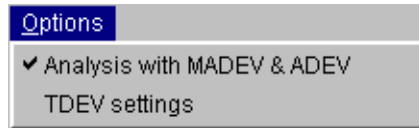


Fig. O-14 "Options" menu

Menu item	Meaning
Analysis with MADEV & ADEV	Adds the "MADEV" (Modified Allan Deviation) and "ADEV" (Allan Deviation) check boxes to the "MTIE analysis" window. If these check boxes are activated, the graphs for MADEV and ADEV will also be displayed when you click on the "Analysis" action button.
TDEV settings	Opens the "Settings for TDEV" window. You can select a value for the observation time for the TDEV calculation from a list box here. The selected observation time is shown in the graph, e.g.: TDEV: N/12 - rec. O.172, TDEV: N/6 - not rec. or TDEV: N/3 - not rec.

Table O-6 "Options" menu commands

3 Example

3.1 Loading and comparing two recorded TIE curves

You can load and display up to four TIE curves at the same time.

- ✓ The “MTIE/TDEV Analysis” software is running.
 - ✓ The data were recorded using the same sample rate.
1. Load the first file, e.g. “TDEV_10_99new.csv”.
The TIE data are displayed in the “TIE analysis” window.
 2. Click on the “MTIE/TDEV ...” button.
The “MTIE analysis” window opens.
 3. Click on the “Analysis” button.
The MTIE values will be calculated and displayed.
 4. Click on the “Goto TIE graph” button.
The “TIE analysis” window is placed on top.
 5. Load the next file, e.g. “TDEV_test1.bin”.
The data from the second file are displayed in addition to those from the first file. The data can be compared visually (see Fig. O-15).
 6. Click on the “Analysis” button.
The MTIE values for the last file loaded will be calculated and displayed (see Fig. O-16).
 7. Change the color of the second set of calculated values to distinguish them from the first.
The MTIE values can now be compared visually.

Note: The TIE data must have the same sample rate. The tolerance mask assessment always applies to the last TIE curve selected.

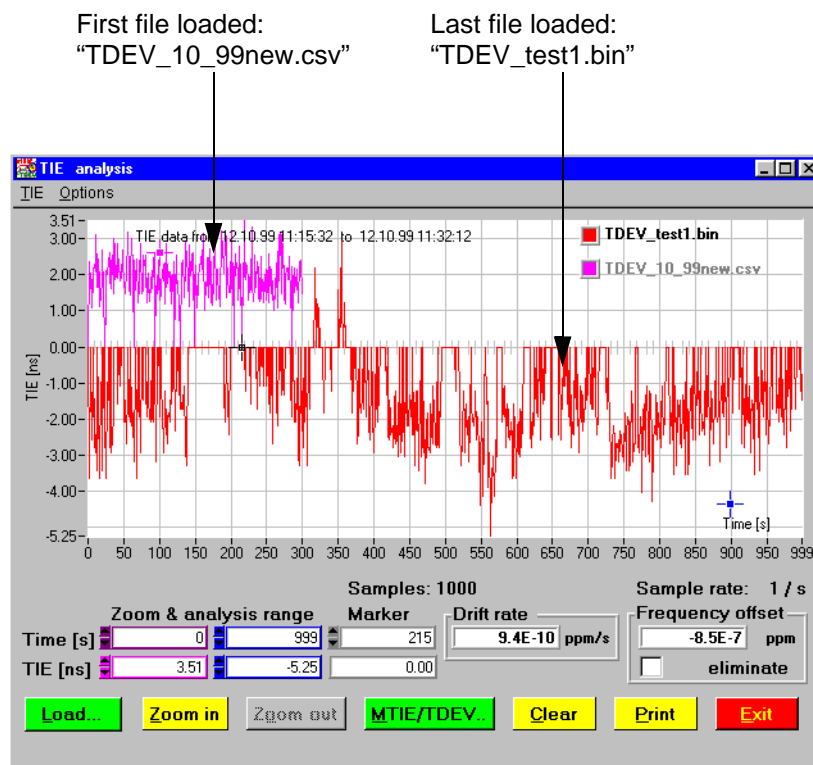


Fig. O-15 “TIE analysis” window with TIE data loaded from two files

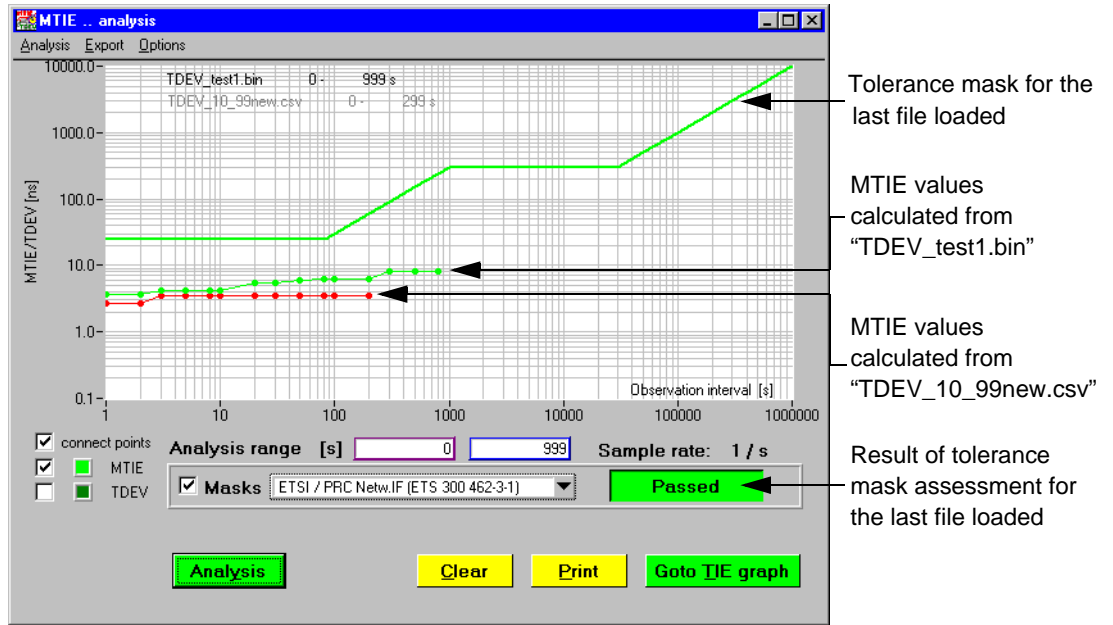


Fig. O-16 MTIE values calculated from data loaded from two files.

4 Calculation formulae

Key to all formulae:

Expression	Meaning
x_i	time error sample
N	total number of samples
τ_0	time error sampling interval
τ	integration time, the independent variable of TDEV
n	number of sampling intervals within the integration time τ

Table O-7 Key to all formulae

4.1 TIE analysis

4.1.1 Frequency offset

Frequency offset is calculated using the following formula (as per ANSI T1.101-199X / T1X1.3/98-002):

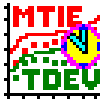
$$y = \frac{0.006}{N\tau_0} \sum_{i=1}^N x_i \left[\frac{2i}{N^2 - 1} - \frac{1}{N - 1} \right]$$

The analysis yields a single numerical value that can also be determined for a selected TIE segment.

4.1.2 Drift rate

Drift rate is calculated using the following formula (as per ANSI T1.101-199X / T1X1.3/98-002):

$$D = \frac{0.06}{N\tau_0^2} \sum_{i=1}^N x_i \left[\frac{6i^2}{N^4 - 5N^2 + 4} - \frac{6i}{N^3 - N^2 - 4N + 4} + \frac{1}{N^2 - 3N + 2} \right]$$



4.2 MTIE/TDEV analysis

4.2.1 MTIE (Maximum Time Interval Error)

MTIE can be estimated from:

$$\text{MTIE}(n\tau_0) \cong \max_{1 \leq k \leq N-n} \left(\max_{k \leq i \leq k+n} x(i) - \min_{k \leq i \leq k+n} x(i) \right)$$

$$n = 1, 2, \dots, N-1$$

The above is a point estimate and is obtained for measurements over a single measurement period.

4.2.2 TDEV (Time Deviation)

TDEV: A measure of the expected time variation of a signal as a function of integration time. TDEV can also provide information about the spectral content of the phase (or time) noise of a signal. TDEV is in units of time and is based on the sequence of time error samples.

TDEV can be estimated from:

$$\text{TDEV}(n\tau_0) \cong \sqrt{\frac{1}{6n^2(N-3n+1)} \sum_{j=1}^{N-3n+1} \left[\sum_{i=j}^{n+j-1} (x_{i+2n} - 2x_{i+n} + x_i) \right]^2}$$

$$n = 1, 2, \dots, \text{integer part} \left(\frac{N}{12}, \frac{N}{6} \text{ or } \frac{N}{3} \right)$$

4.2.3 MADEV (Modified Allan Deviation)

MADEV can be estimated from:

$$\text{MADEV}(n\tau_0) \cong \sqrt{\frac{1}{2n^4\tau_0^2(N-3n+1)} \sum_{j=1}^{N-3n+1} \left[\sum_{i=j}^{n+j-1} (x_{i+2n} - 2x_{i+n} + x_i) \right]^2}$$

$$n = 1, 2, \dots, \text{integer part} \left(\frac{N}{12}, \frac{N}{6} \text{ or } \frac{N}{3} \right)$$

4.2.4 ADEV (Allan Deviation)

ADEV can be estimated from:

$$\text{ADEV}(n\tau_0) \cong \sqrt{\frac{1}{2n^2\tau_0^2(N-2n)} \sum_{i=j}^{N-2n} (x_{i+2n} - 2x_{i+n} + x_i)^2}$$

$n = 1, 2, \dots, \text{integer part}\left(\frac{N-1}{2}\right)$

4.3 Independent clock measurement configuration

Any situation where there is no common master clock controlling the timing signals between which the time error is measured is referred to as an independent clock configuration. The time error measured in independent clock configuration, besides being dependent on internal clock noises, is affected by any frequency offset or frequency drift of the clocks involved in the measurement. The “Frequency offset eliminate” check box in the “TIE analysis” window is used to compensate for this situation.