Jitter Generation, Measurement, and Pulse Mask Compliance

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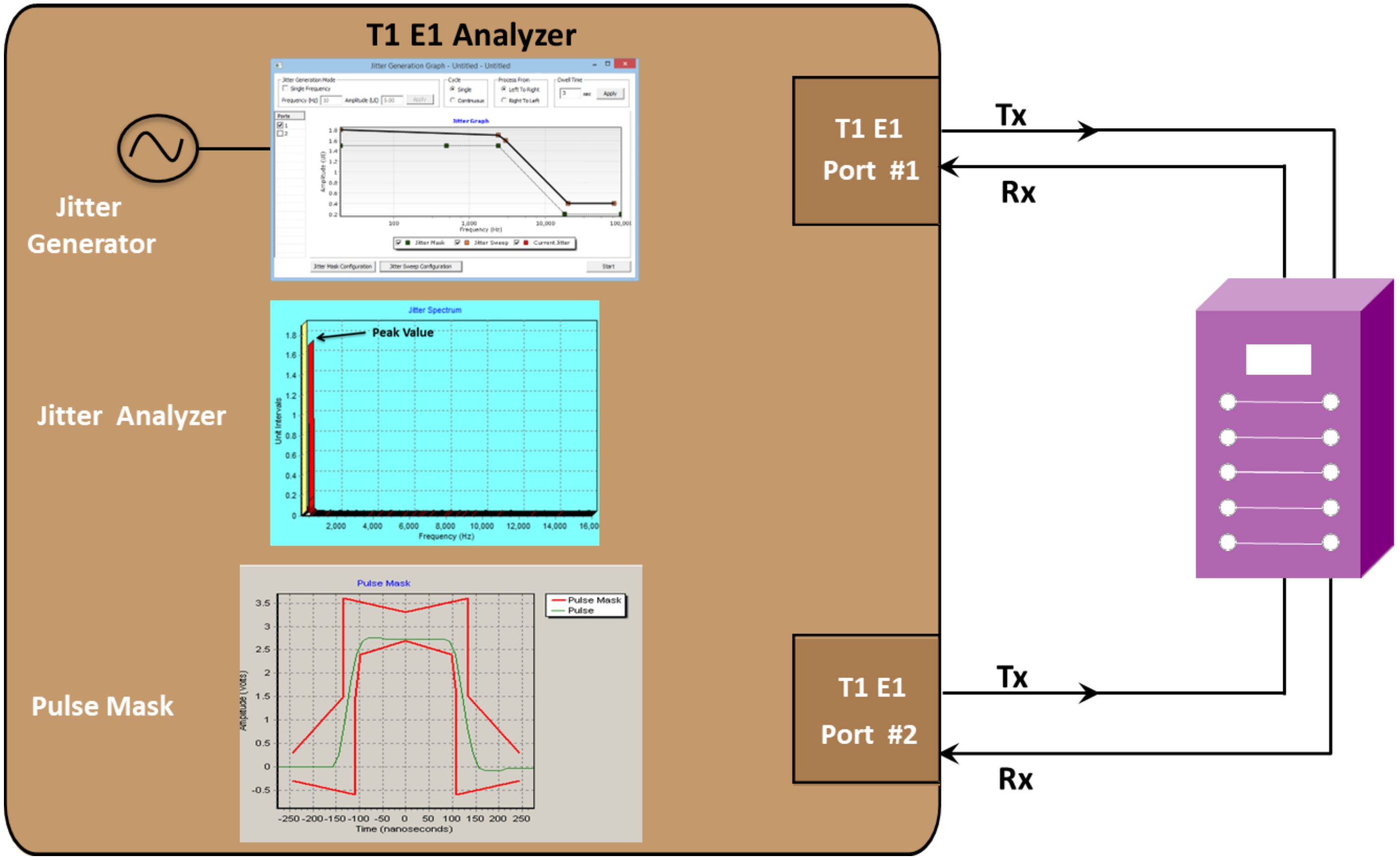
Overview



T1 E1 Analyzer
Jitter Generator
Jitter Analyzer
Pulse Mask
Jitter Generation Graph - Untitled - Untitled
Jitter Graph
Jitter Spectrum
Peak Value
Unit Intervals
Frequency (Hz)
Pulse Mask
Pulse
Time (nanoseconds)
T1 E1
Port #1
Tx
Rx
T1 E1
Port #2
Tx
Rx

Introduction

- Jitter Generation software generates jittered output T1 E1 signal with the user-selected frequency and amplitude
- Jitter Measurement allows one to accurately measure jitter associated with an incoming T1 E1 signals
- Pulse Mask Compliance developed to determine if the pulse shape fits within a “pulse mask” as specified by standards ITU G.703 and ANSI T1.102-1993
- Jitter Measurement, Pulse Mask Compliance (XX012) is available as a part of T1 E1 analyzer basic applications

What is Jitter?

Jitter Measurement

- Jitter is the difference between the actual time of arrival of a clock pulse and its theoretical arrival time

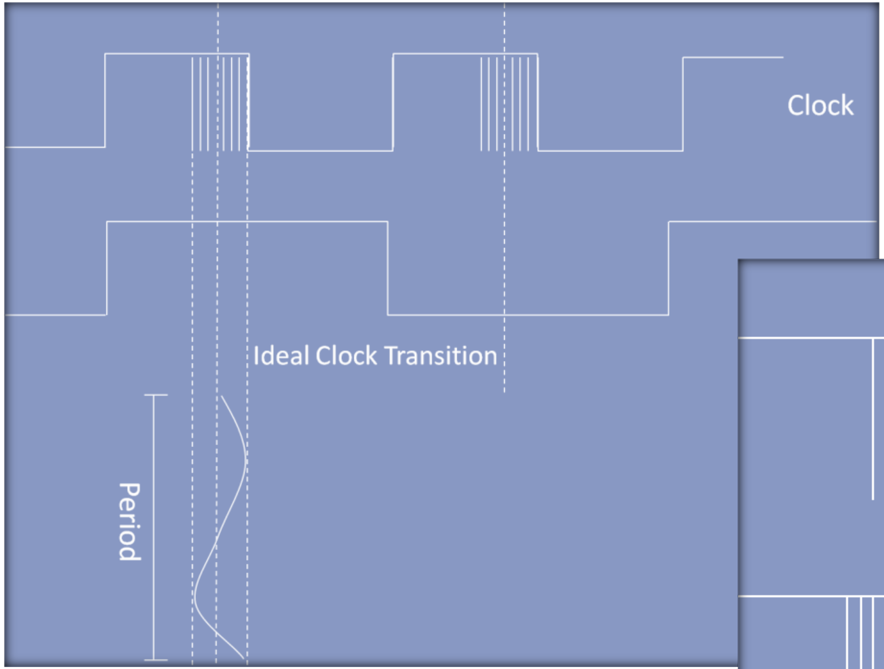
Sources of Jitter

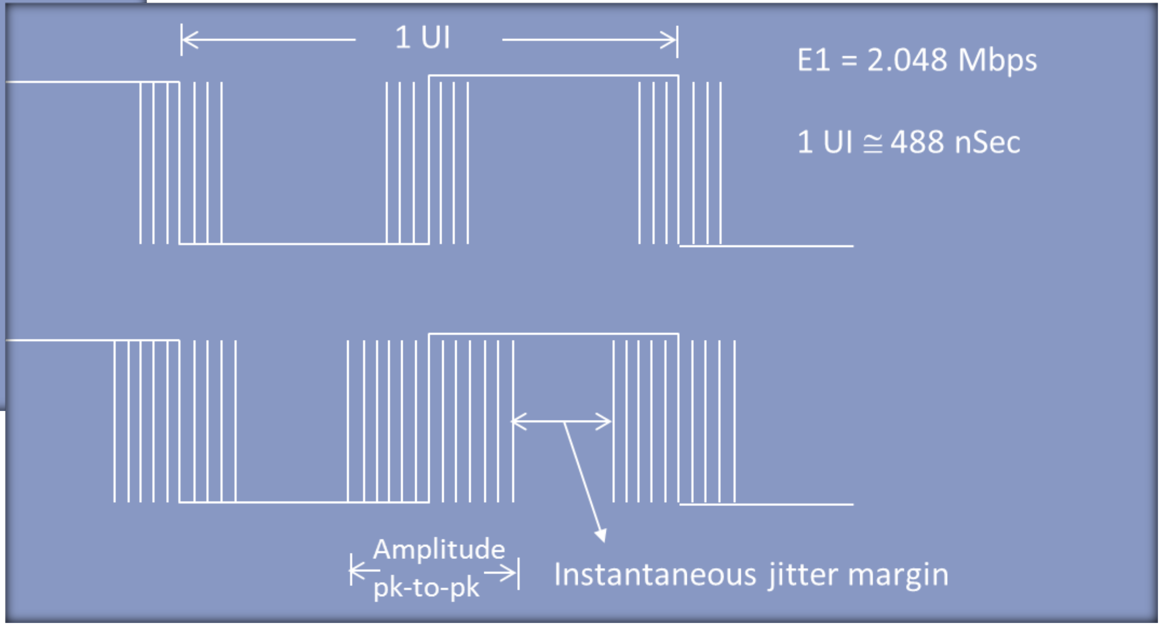
- Aging of clock and data recovery circuits
- Thermal and loading effects
- Doppler shifts
- Multiplexing / De-multiplexing from higher bit rate data streams

Jitter Measurement

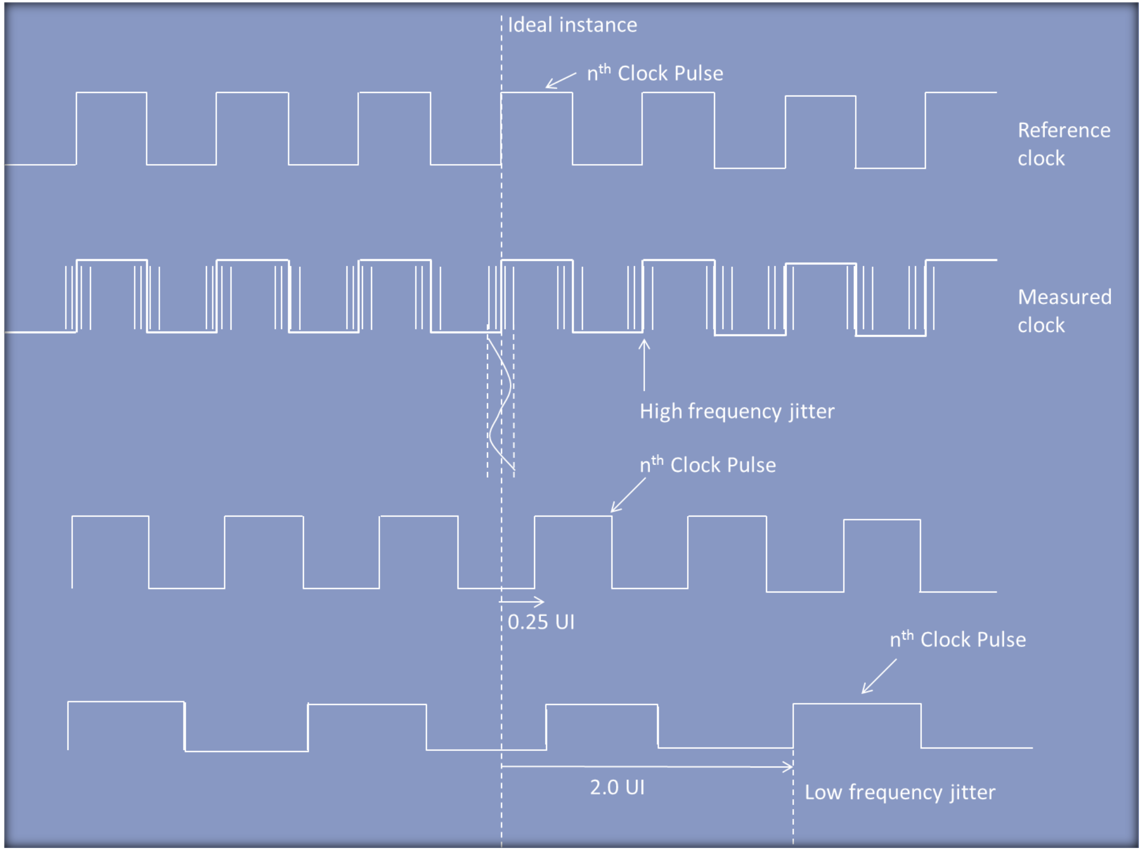
- **Jitter**: Small amplitude and fast variations in time instants of clock pulses with frequency of variations above 10 Hz
- **Wander**: Larger amplitude and slow variations in time instants of clock pulses with frequency of variations below 10 Hz
- **Drift**: Very slow variations in a clock signal (below 1 Hz)
- **Frequency Offset or Deviation**: A permanent or steady-state difference in clock rates. It will eventually result in either frame slips (bit insertions or deletions) or in loss of synchronization of network elements

Jitter Concept

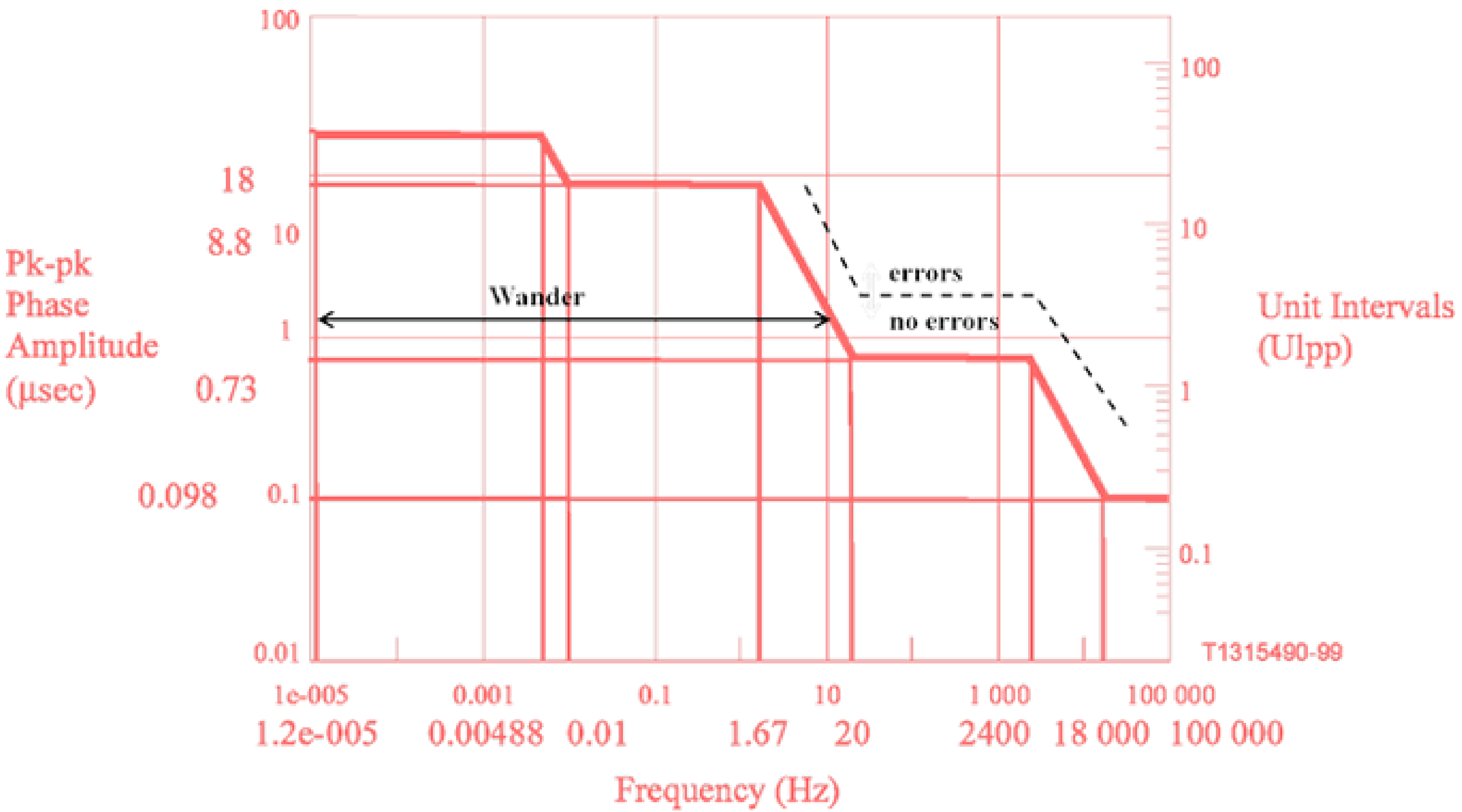




Jitter Concept (Contd.)



Input Jitter and Wander Tolerance (2048Kbit/s)



Input Jitter and Wander Tolerance (2048kbit/s) Specification

Frequency F(Hz)	Requirements (pk-to-pk phase amplitude)
12 μ < f ≤ 4.88 m	18 μs
4.88 m < f ≤ 10 m	0.088 f^{-1} μs
10 m < f ≤ 1.67	8.8μs
1.67 < f ≤ 20	15 f^{-1} μs
20 < f ≤ 2.4 k (Note1)	1.5 UI
2.4 k < f ≤ 18 k (Note1)	3.6 x 10^3 f^{-1} UI
18 k < f ≤ 100 k (Note1)	0.2 UI
Note1: For 2048 kbit/s interface the frequency specified as 93 Hz and 70 Hz Note2: 1 UI = 488 ns	

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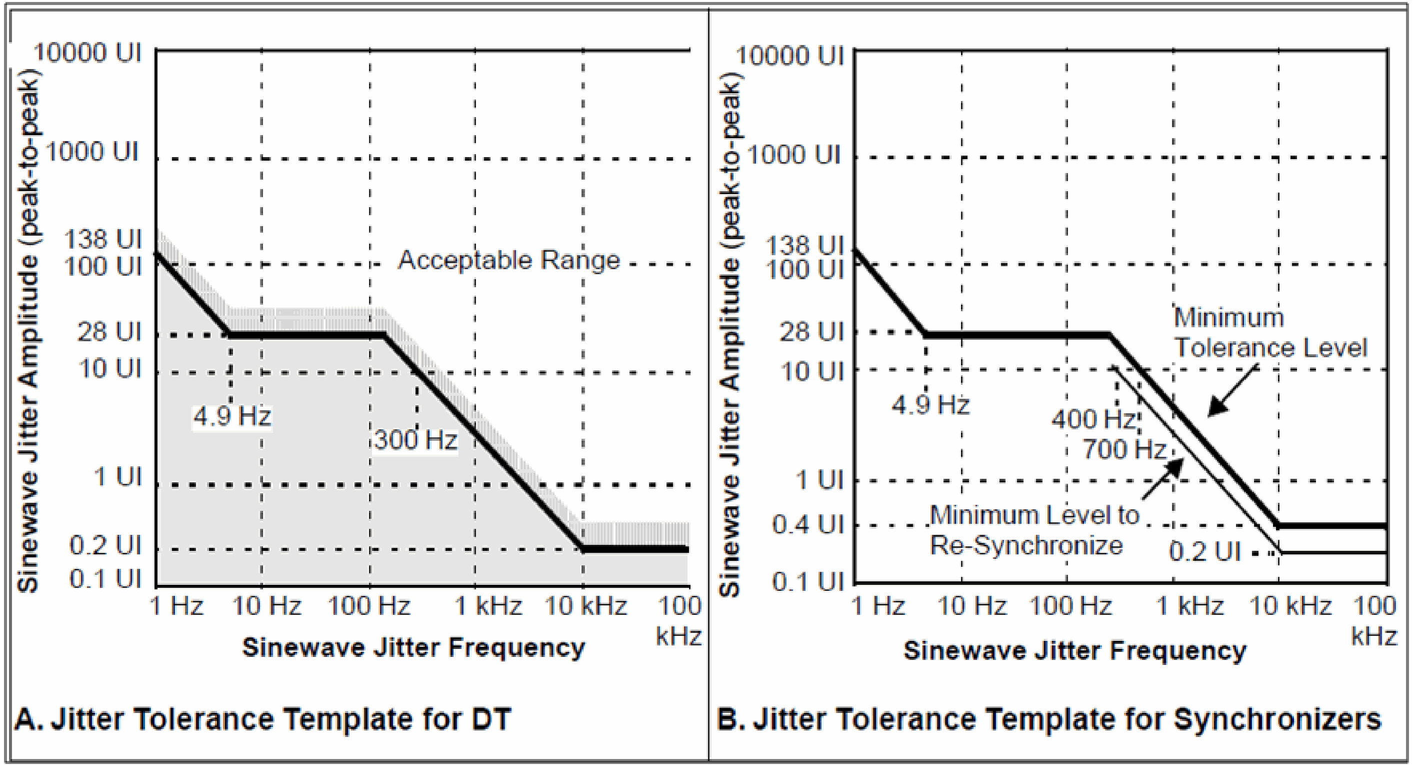
Input Jitter Tolerance



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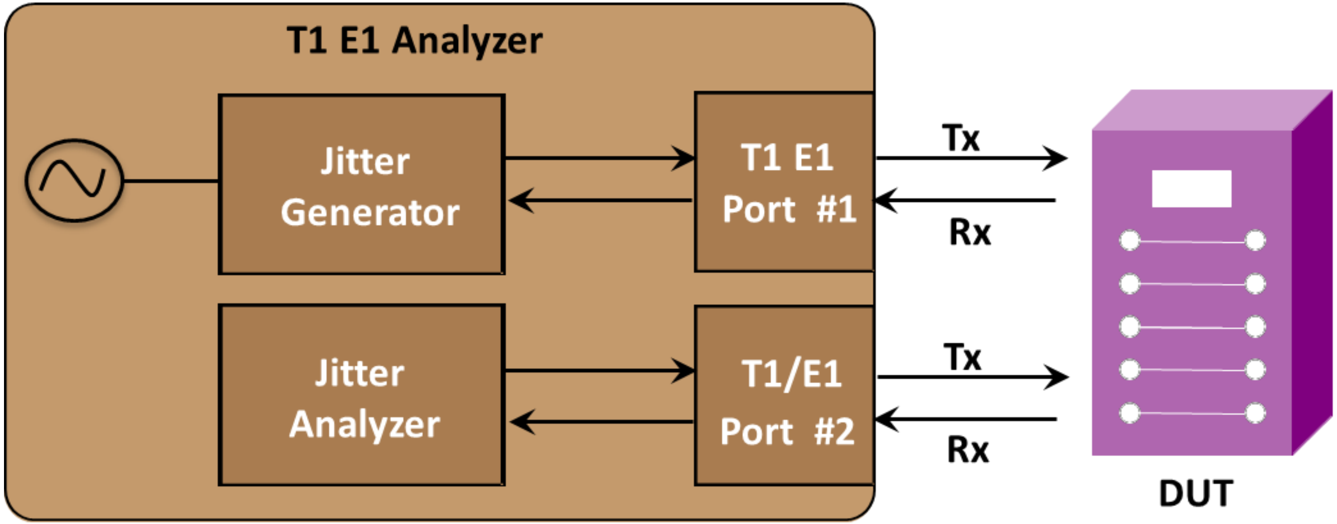
Jitter Generation

Introduction

- When the signal traverses a network, the jitter generated by the DUT becomes the input jitter to the next part of the network
- If this jitter is amplified, it can exceed the jitter tolerance of the subsequent DUT
- Generate jittered output T1 E1 signal with the user-selected frequency and amplitude in compliance with standards such as G.823



Main Features

- Generates intrinsic jitter without any error as per G.823 standards
- Generates user-defined jitter value against an input jitter tolerance mask to test DUTs capability to tolerate large amounts of generated jitter
- In conjunction with ‘Jitter Measurement’ application, allows jitter analysis at the system output by displaying the peak-to-peak jitter value for a given frequency
- Evaluate the jitter in real-time on either a tick-by-tick or a cumulative basis

Specification of Jitter Tolerance Mask for T1

GR-499 Cat 1	**10Hz – 5 UI**
	500Hz – 5 UI
	8KHz – 0.1 UI
	40KHz – 0.1 UI
GR-499 Cat 2	10Hz – 10 UI
	193Hz – 10 UI
	6.43KHz – 0.3 UI
	40KHz – 0.3 UI
AT&T Pub 62411 (Dec. 90)	1Hz – 138 UI
	4.9HZ – 28 UI
	300Hz – 28 UI
	10KHz – 0.4 UI
	100KHz – 0.4 UI

Specification of Jitter Tolerance Mask for E1

ITU-T G.823	**20Hz – 1.5UI**
	2.4KHz – 1.5UI
	18KHz – 0.2UI
	100KHz – 0.2UI

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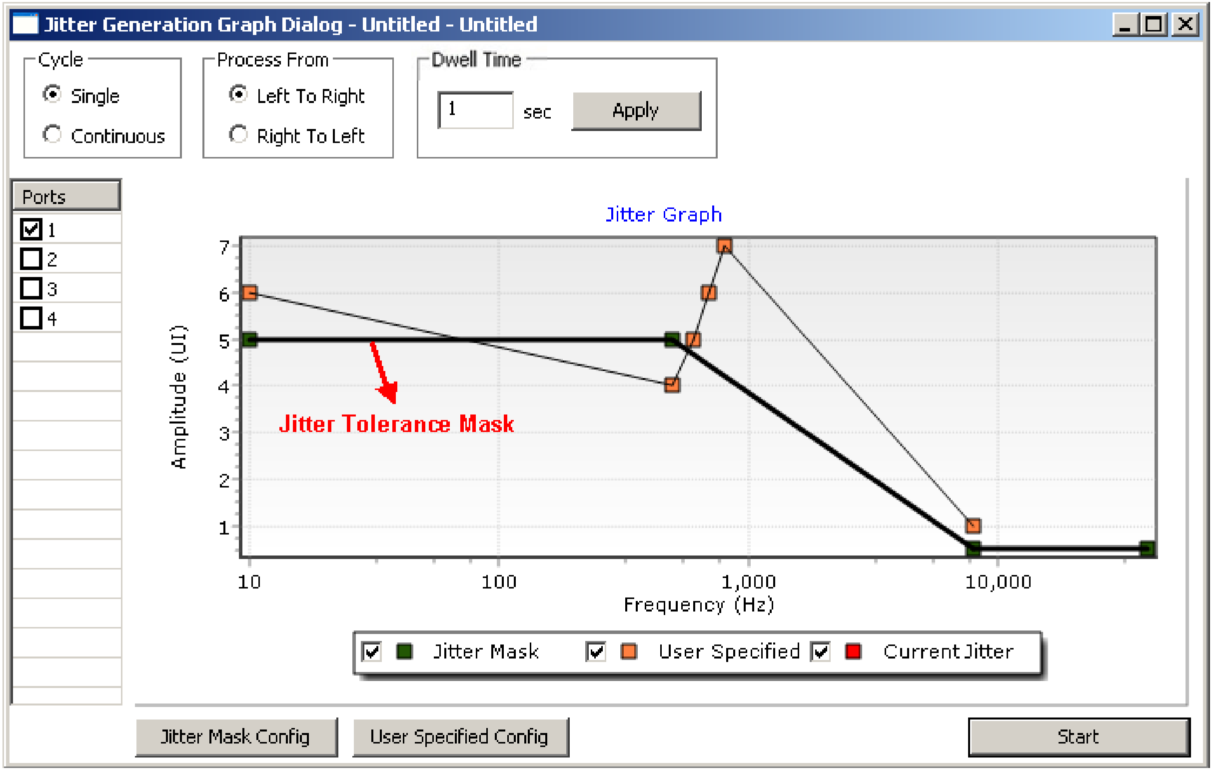
Jitter Tolerance Mask

- Jitter tolerance mask is defined as per the standard to create a benchmark for the generated jitter

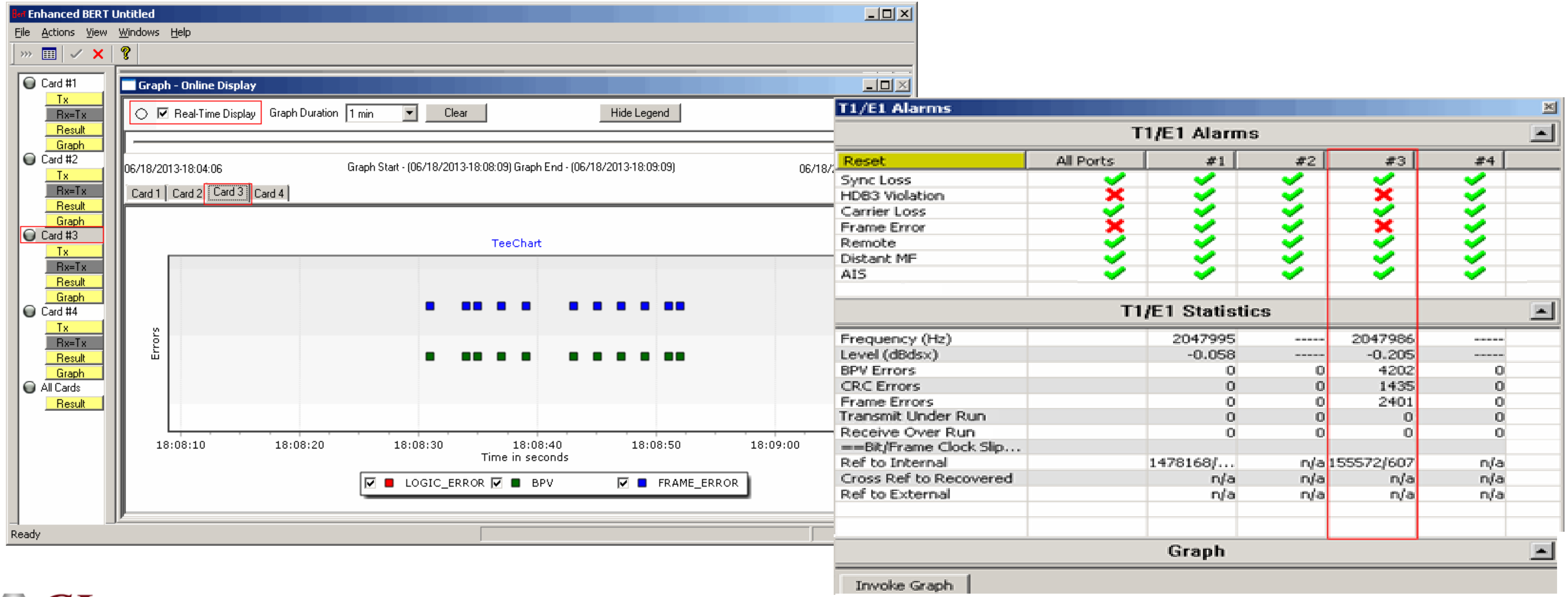


Jitter Generated Value

- Jitter is generated based on user defined frequency and amplitudes

Verifying Jitter through BER Tester

- Generates frame errors and bipolar violation alarms due to the applied data transition jitter
- This can be verified using **Monitor T1 E1 Line Status** and **Bit Error Rate (BER) Tester** applications



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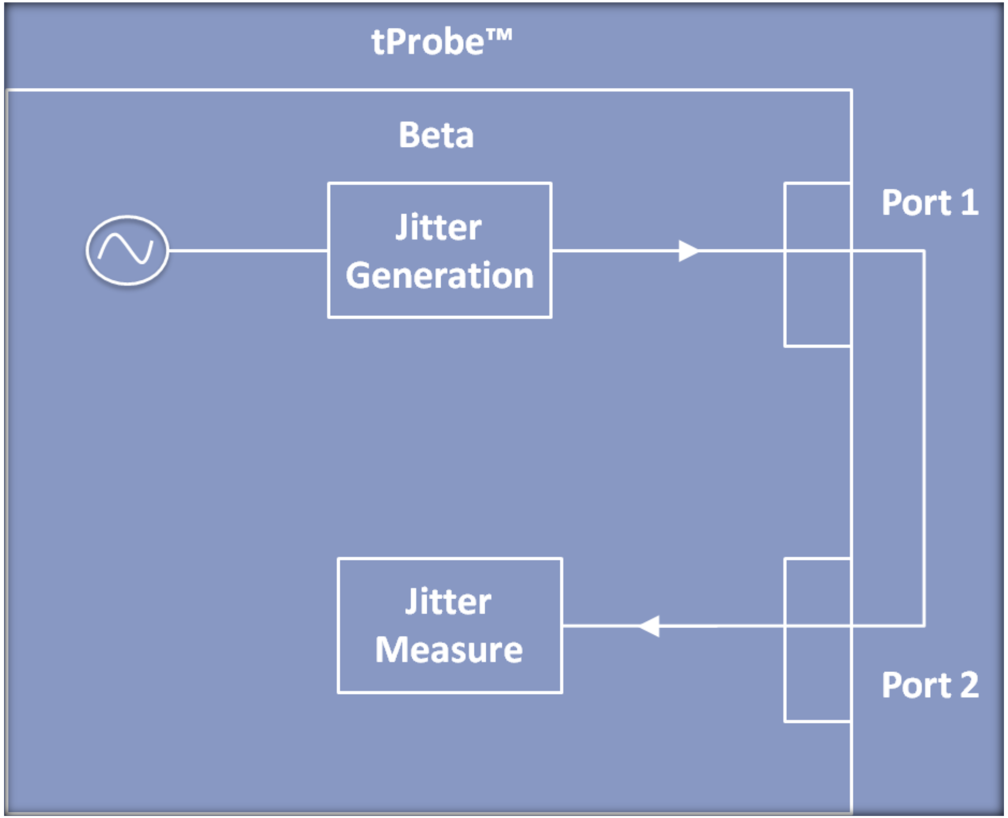
Jitter Measurement

Main Features

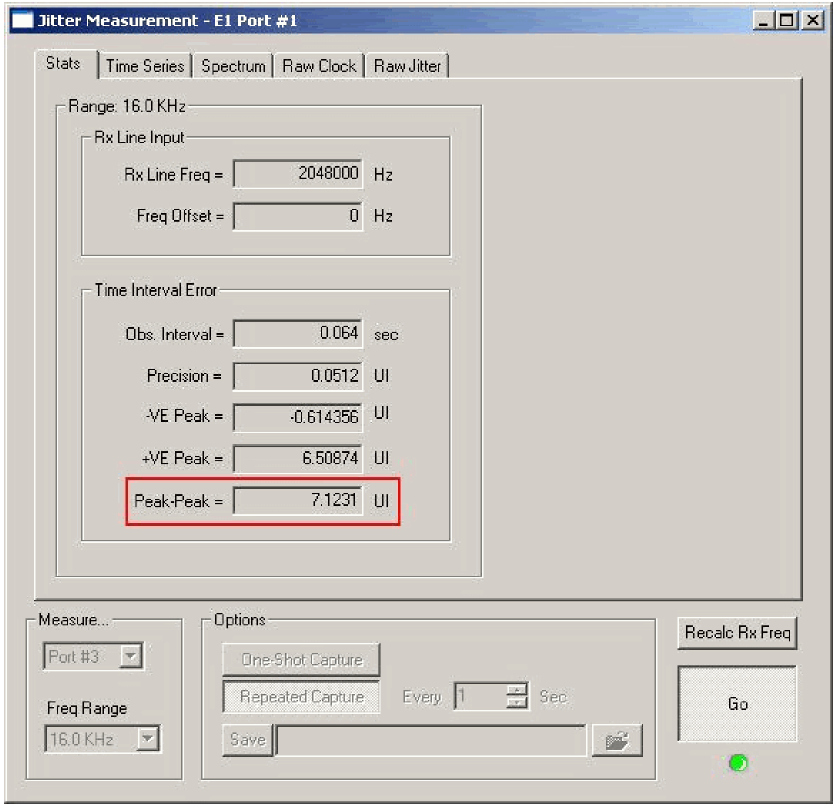
- Easy, accurate, visual pulse shape and jitter measurement for T1 E1 signals
- Provides an option to select T1 or E1 port for monitoring and the frequency range of interest
- Supports ‘One-Shot Capture’ and ‘Repeated Capture’ options for jitter measurement
- CSV files are generated for further analysis using spreadsheet – one containing the raw clock counts, and raw jitter counts, the other file containing the FFT data which can be used within a data analysis tool to plot the jitter frequency spectrum
- Graphs generated can be saved to a file, zoomed-in/zoomed-out, printed, and more

Jitter Measurement Demonstration



Peak-to-Peak Jitter Value in Stats Tab

- Peak-to-peak jitter amplitude value is computed as the highest cumulative jitter value minus the lowest cumulative jitter value



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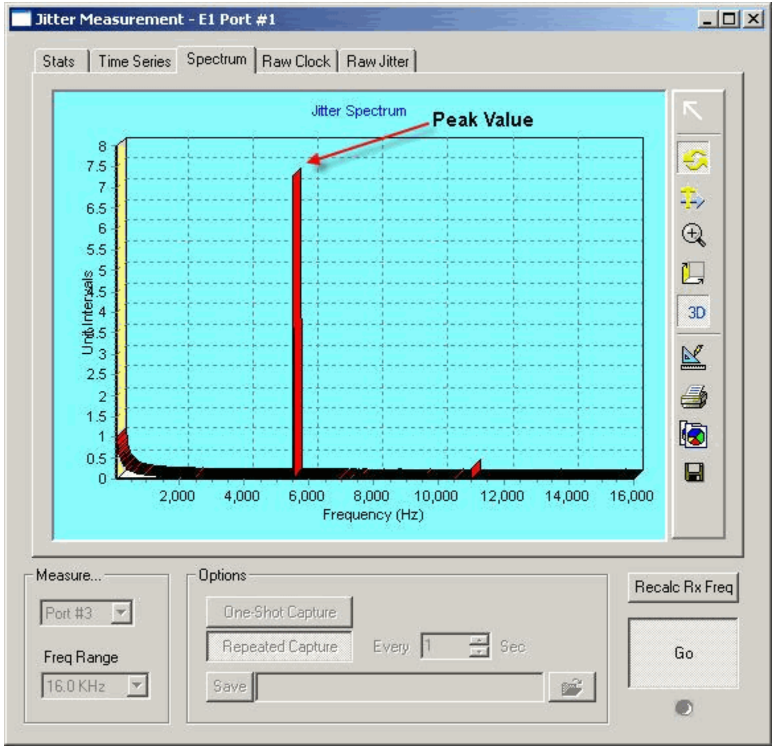
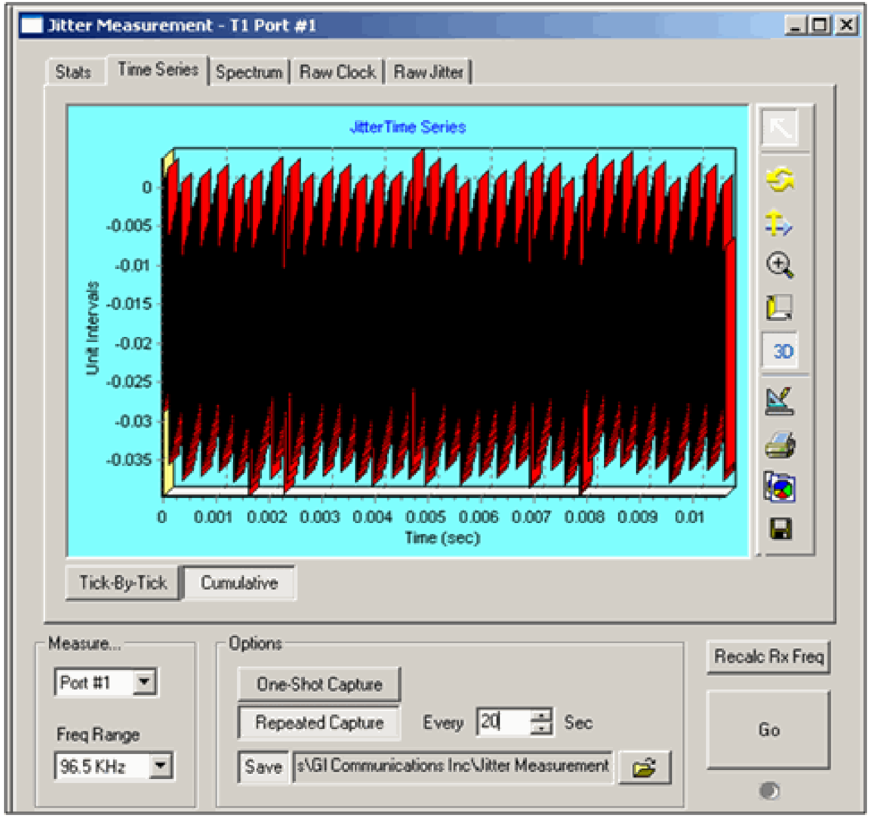
Peak-to-Peak Jitter Value in Spectrum Tab

- Peak-to-peak jitter amplitude value is displayed for the corresponding frequency
- The peak-to-peak jitter is displayed as a function of jitter frequency



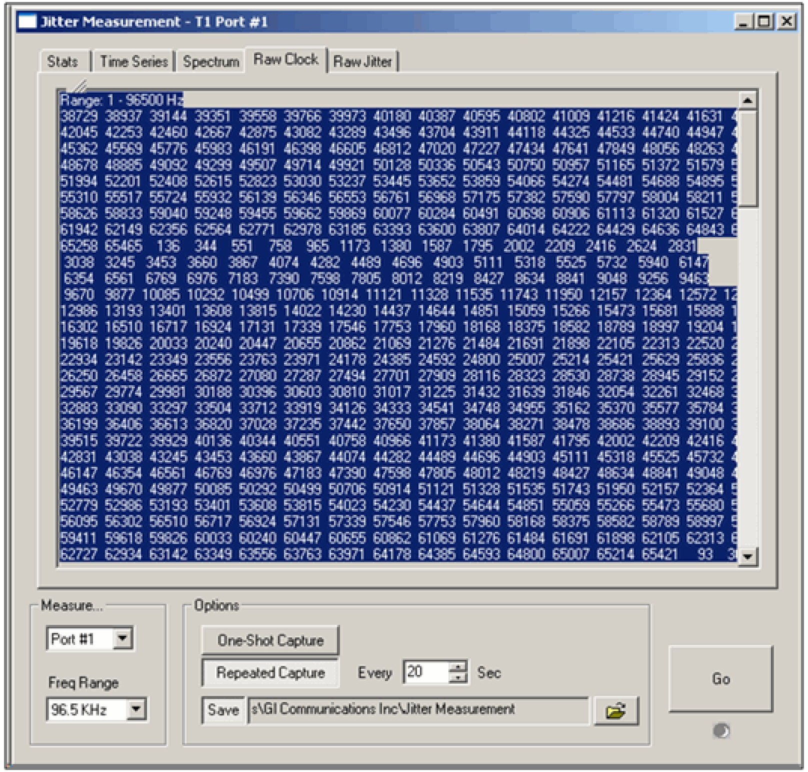
Time Series

- Displays the captured jitter values on either a cumulative or tick-by-tick basis



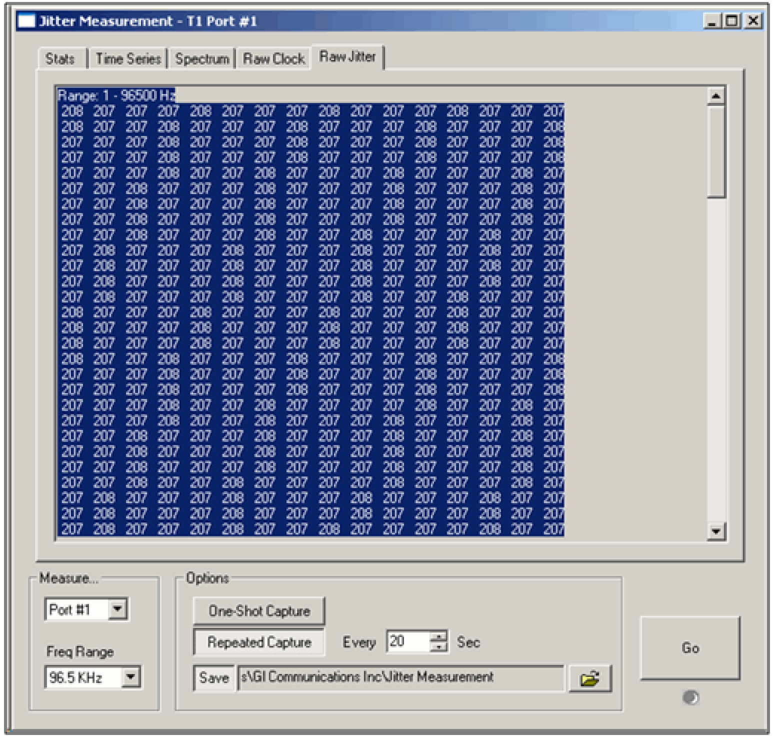
Raw Clock Page

- It displays raw reference clock values in integer format
- The reference clock value for each nominal clock tick is read and recorded



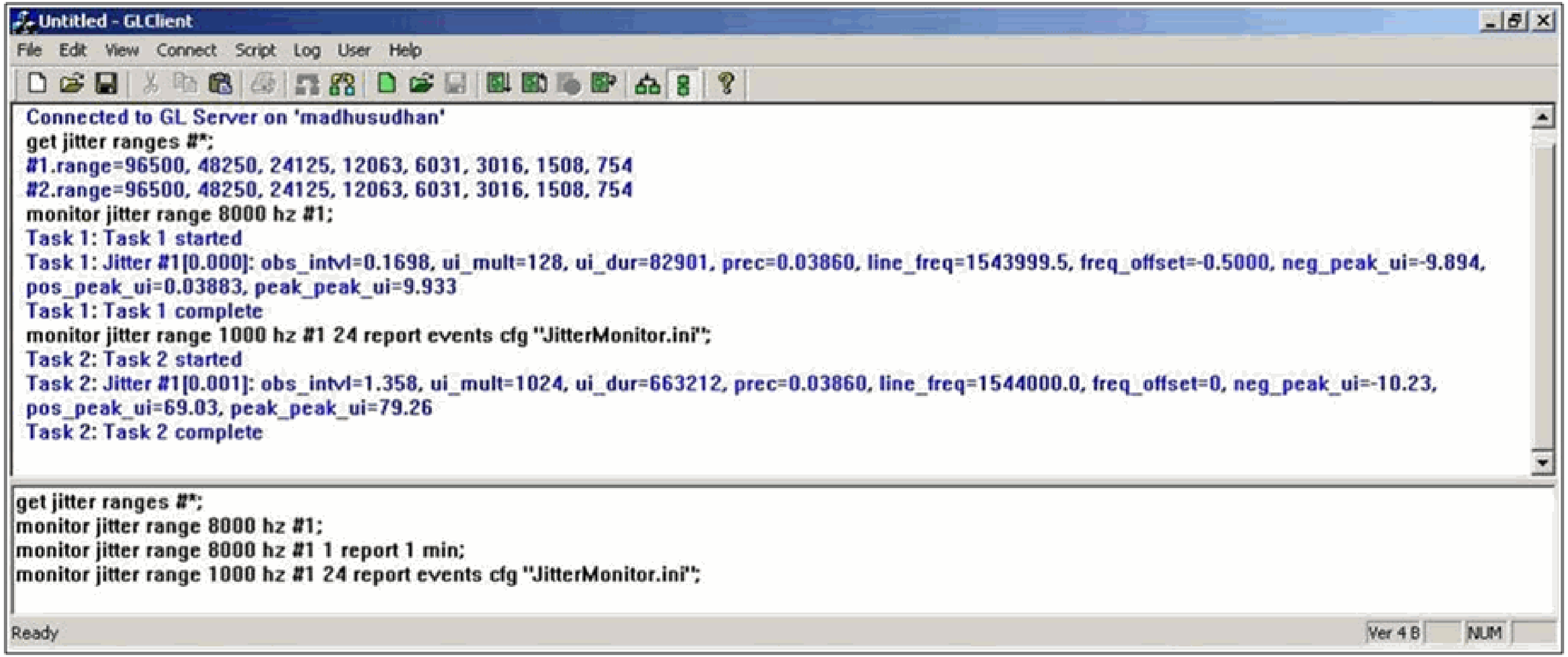
Raw Jitter Page

- It displays the number of reference clock ticks for each successive tick of the clock under test (the nominal clock)
- The tick values are displayed in decimal format. Read the values from left to right



WCS Jitter Measurement

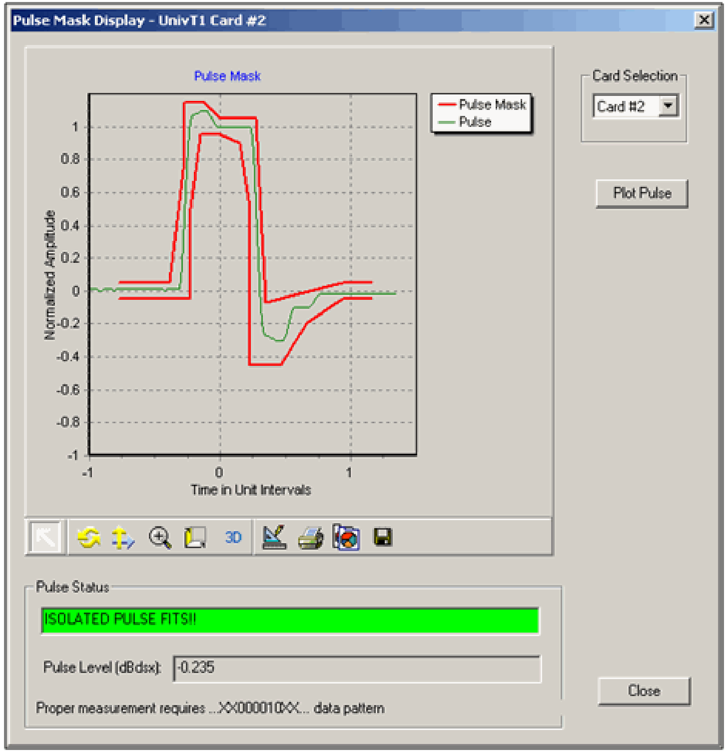
- Monitor Jitter ranges and perform Jitter measurement through simple commands with Windows Client-Server application



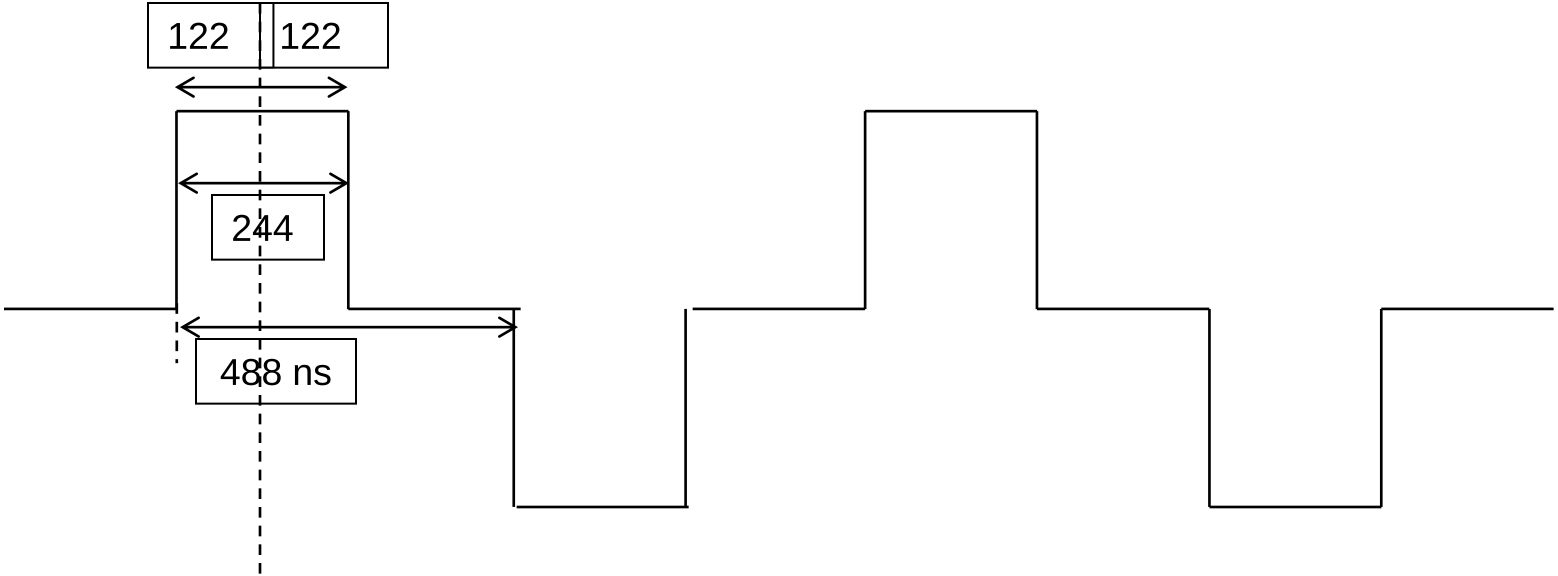
Pulse Mask

T1 Pulse Mask

- Compares the incoming T1 E1 pulses against the pulse mask display
- For T1 pulses, the x-axis measures time in unit intervals (UI) and the y-axis measures the normalized amplitude in volts



E1 Pulse

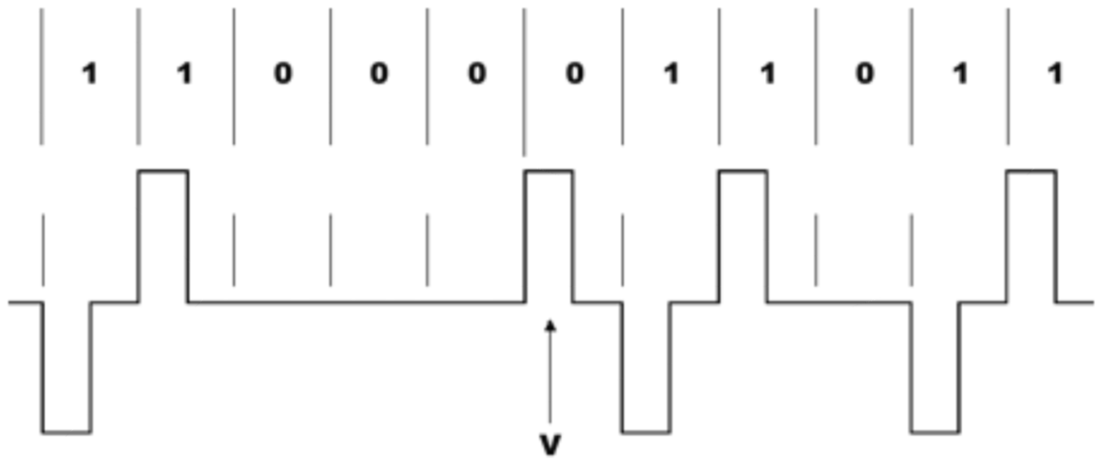


Pulse Level dBdsx

0.115 dBdsx = 20 log $\frac{3.15}{3.0}$

High Density Bipolar 3 Zero (HDB3) Coding

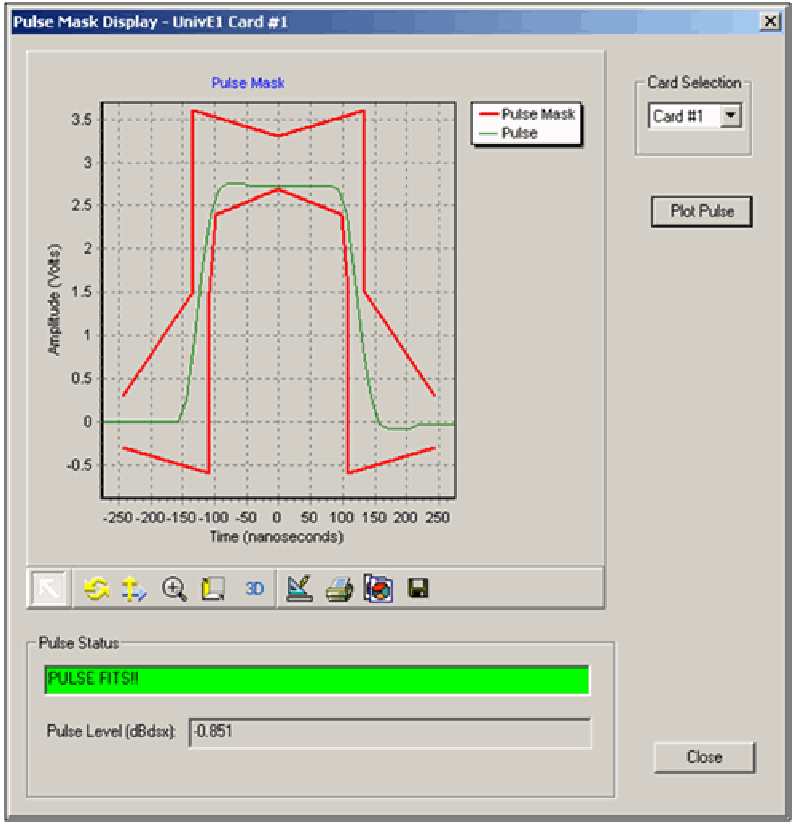
- HDB3 code is the encoding technique used over G.703 E1 networks
- Here, a line code in which a logical 0 is represented by zero volts and a logical 1 is represented by pulses of alternating polarity. HDB3 prevents more than four “0” bits from being sent consecutively



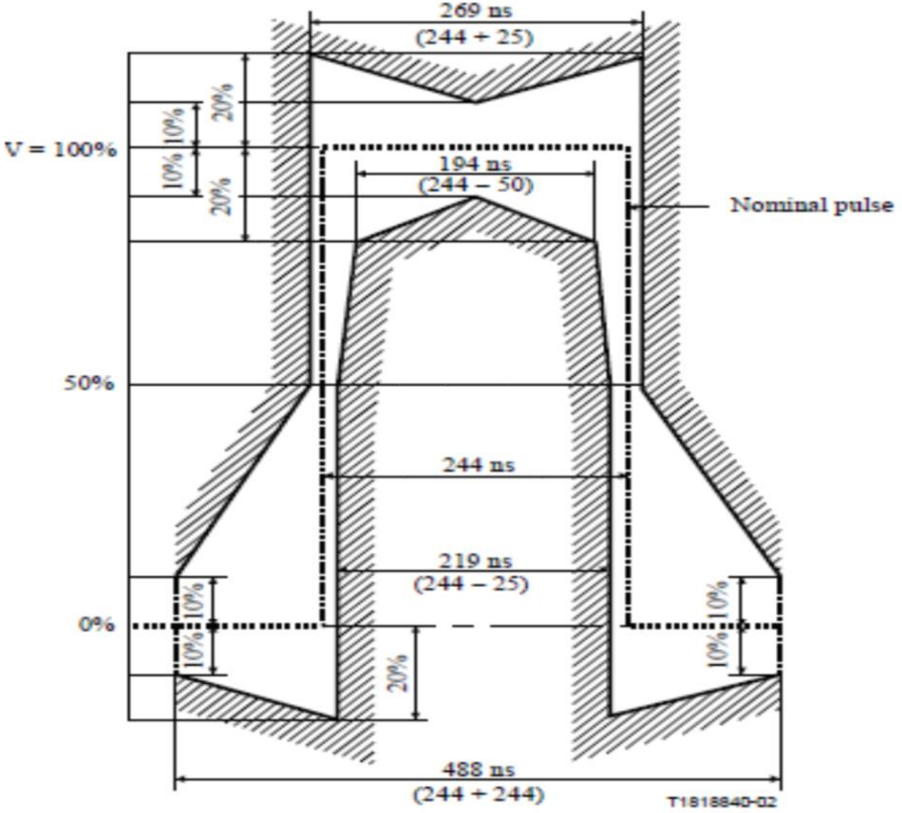
Picture 2 HDB3 Coding

E1 Pulse Mask

- For E1 pulse, the x-axis measures time in nanoseconds (ns), and the y-axis measures the normalized amplitude in volts



E1 Pulse Mask



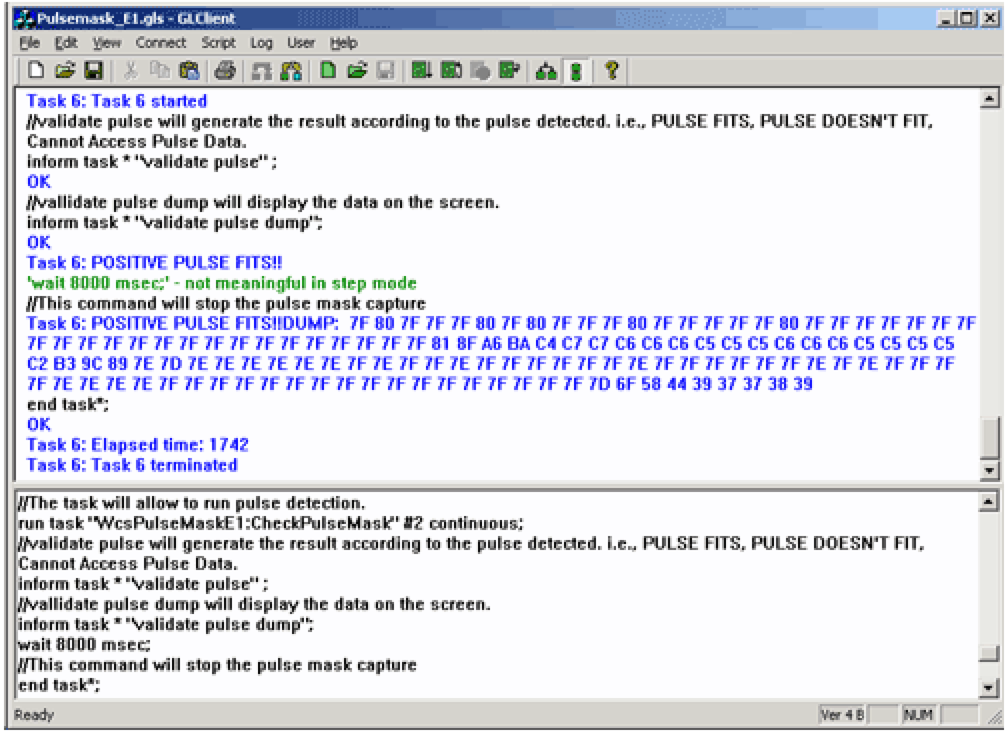
NOTE – V corresponds to the nominal peak value.

Digital Interface in 2048 kbits/s

Pulse Shape (nominally rectangular)	**All marks of a valid signal must conform with the mask irrespective of the sign. The value ‘V’ corresponds to the nominal peak value**	
Pairs in each direction	One coaxial pair	One symmetrical pair
Test load impedance	75 ohms resistive	120 ohms resistive
Nominal peak voltage of a mark (pulse)	2.37 V	3 V
Peak voltage of a space (pulse)	0 ± 0.237 V	0 ± 0.3 V
Nominal pulse width	244 ns	
Ratio of the amplitudes of positive and negative pulses at the center of the pulse interval	0.95 to 1.05	
Ratio of the widths of positive and negative pulses at the nominal half amplitude	0.95 to 1.05	

WCS Pulse Mask

- Perform Pulse mask compliance testing through Windows Client-Server commands
- Commands supported are Check Pulse mask, Validate pulse, Stop pulse mask validation, etc.



Thank you