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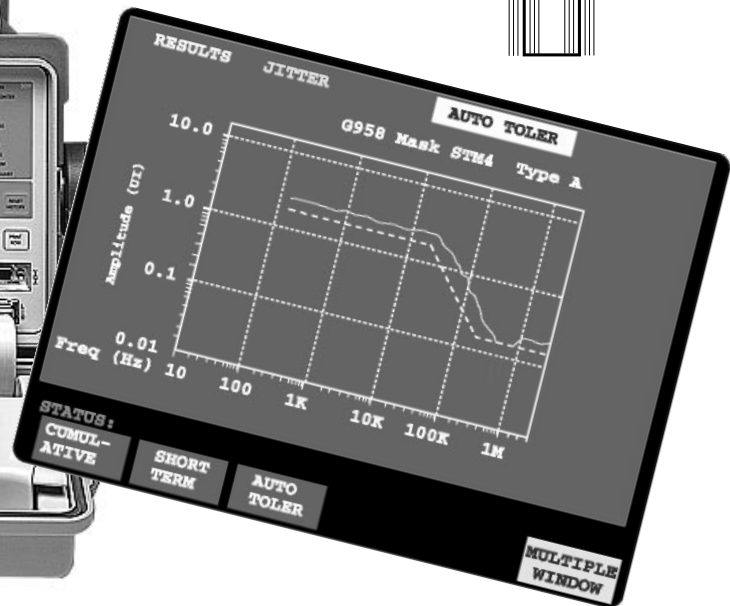
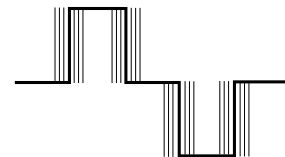
Automatic verification of network equipment to ITU-T jitter tolerance recommendations

Product note

HP 37717B/C communications performance analyzer



HP 37717C communications performance analyzer



If jitter at the input port of a network element (NE) exceeds a threshold value, errors or loss of data will occur in the digital signal. As jitter is present in all telecommunications networks to some degree, NEs must be designed to tolerate a sufficient level of jitter to ensure they don't lose lock or introduce errors when certain values of jitter are present.

The ITU-T specifies the lower limit of maximum tolerable input jitter (MTIJ) in the form of an ITU-T jitter tolerance mask. All NEs must be rigorously tested against this minimum standard to ensure their measured input jitter tolerance is greater than the ITU-T mask.

This product note describes how the HP 37717B/C communications performance analyzer provides an automatic measurement solution to quickly and accurately test NEs to ITU-T jitter tolerance standards.

The automatic MTIJ measurement solution

Introduction

Verifying NEs to ITU-T recommendations manually is a slow and laborious process.

It involves setting up a PDH/SDH analyzer—with a signal generator connected to the external jitter modulation input—to perform an out-of-service BER test using a defined PRBS. The signal generator's frequency and amplitude need to be manually set too, with the amplitude increased until errors are recorded on the PDH/SDH analyzer's receiver. The jitter amplitude and jitter frequency must also be manually recorded and plotted on a graph for comparison with the ITU-T limits.

Automatic verification

Speeding up the measurement process means automatic testing, and Hewlett-Packard's answer is the HP 37717B/C communications performance analyzer fitted with a jitter/wander generator module.

This dedicated jitter analyzer provides internal jitter and wander generation without the need for an external signal generator. The analyzer automatically applies varying amplitudes of jitter at the defined jitter modulation frequencies until the NE starts to introduce errors. These are detected by the analyzer's receiver.

The analyzer performs the jitter tolerance test using two measurement techniques.

The first is the 1 dB power penalty technique. This technique is used to evaluate the ability of an NE's clock recovery input circuitry to accurately recover the clock from a jittered data signal. It is the recommended test method (supplement No 3.8 of the ITU-T O series or ITU-T O.171 appendix A). It involves setting up a BER test under no-jitter conditions, then reducing the optical power level at the NE's optical input, using an external optical attenuator, until a BER of 10^{-10} is measured by the analyzer. (Note: An optical receiver's sensitivity is specified as the input power which results in an error rate of 10^{-10} .)

Figure 1
ITU-T G.823
PDH jitter
tolerance
specifications

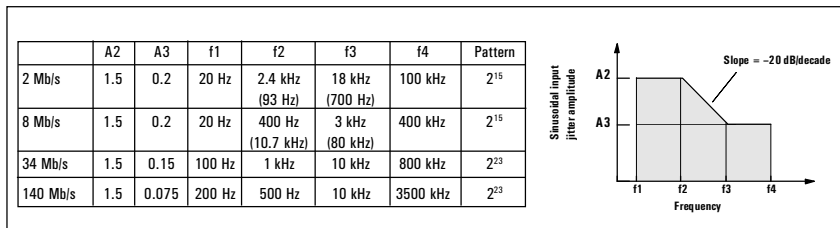
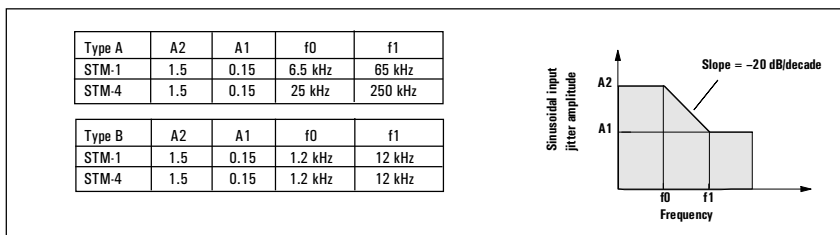


Figure 2
ITU-T G.958
SDH optical
line systems
jitter tolerance
specifications



ITU-T standards

The ITU-T defines the lower limit of MTIJ in terms of the amplitude and frequency of sinusoidal jitter which, when modulating a test pattern, should not cause any significant degradation in the operation of the NE.

ITU-T G.823 (figure 1) defines the MTIJ for PDH interfaces based on 2 Mb/s systems (2, 8, 34, 140 Mb/s).

ITU-T G.958 (figure 2) defines the MTIJ for SDH line systems (STM-1, STM-4 and STM-16).

ITU-T G.825 (figure 3) provides specifications for the MTIJ of SDH NEs.

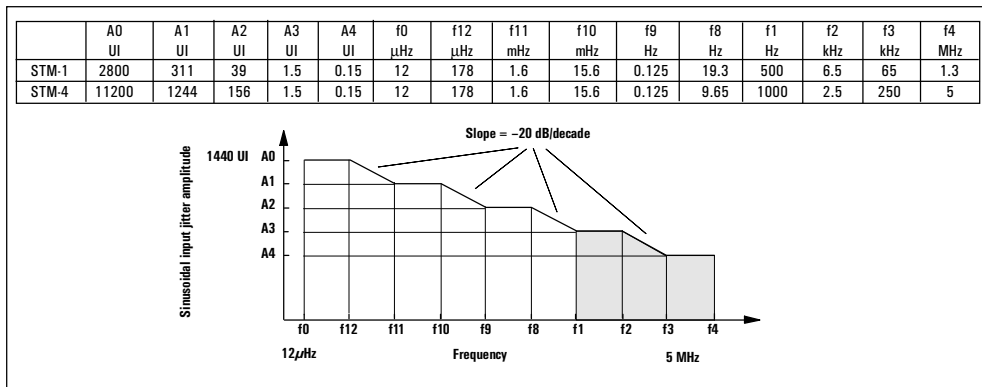
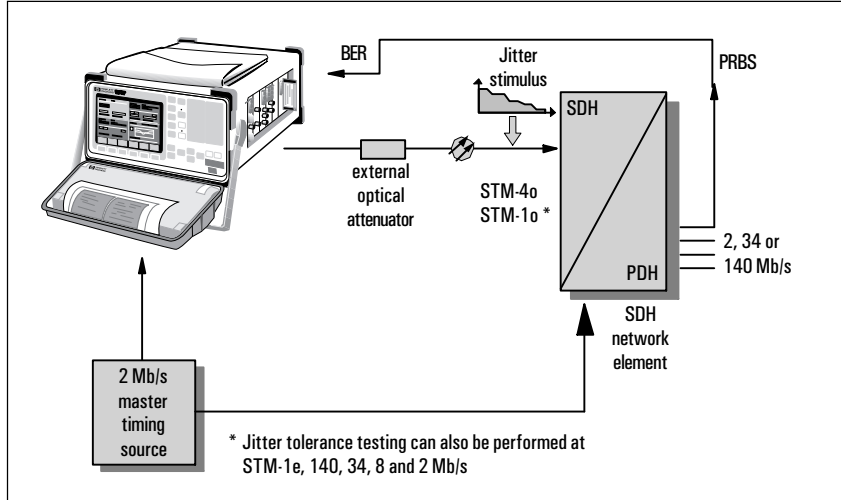


Figure 3. ITU-T G.825 SDH network equipment jitter tolerance specification

Figure 4. Set-up for automatic jitter tolerance test (1 dB power penalty technique)



Using the optical attenuator, the optical power is then increased by 1 dB. Jitter is also applied and increased until the specified 10^{-10} BER is detected. Although a 10^{-10} BER is specified by the ITU-T, this results in very long test times. In practice a BER in the range 10^{-7} to 10^{-10} is used to provide valid results.

The second measurement method is the onset of errors technique. This technique is used to evaluate electrical interfaces and the ability of circuits, such as synchronizers and desynchronizers in SDH network equipment, to accommodate dynamically varying input data rates. It involves increasing the applied jitter until *any* errors or alarms of any type are detected by the analyzer's receiver.

Performing the MTIJ measurement using the 1 dB power penalty method

With the HP 37717B/C communications performance analyzer connected to the NE as shown in figure 4, jitter is added to the analyzer's transmitter at the selected interface rate.

The analyzer automatically selects the relevant ITU-T mask for the chosen interface rate.

One key press carries out the MTIJ measurement automatically, and plots the results against the relevant ITU-T mask. User-defined parameters are available for delay/dwell time, number of frequency points and error threshold control.

When configuring the analyzer, the amount of settling time after each frequency/amplitude step must be set to allow the NE time to recover from the jitter stimulus. This is referred to as the *delay time*.

Dwell time refers to the amount of time the analyzer spends measuring or gating at each jitter frequency/amplitude point waiting for error events before moving to the next point.

Error threshold allows you to select the 1 dB power penalty method by specifying a bit error threshold (that is, BER), or the onset of errors method by specifying "any errors" in the error threshold field.

Printing your results

Connecting an external printer or using the HP 37717C analyzer's graphics printer allows you to log the jitter automatic tolerance plot. This is easily accomplished by

enabling logging and viewing the jitter tolerance plot in the results screen, then pressing the print key.

Notes on the ITU-T masks

ITU-T G.823 (see figure 1)

This defines the MTIJ for 2 Mb/s based PDH interfaces covering both high Q and low Q systems.

Note: *High Q* refers to NEs with a narrow jitter transfer function but poor jitter tolerance. These are typically regenerators that control jitter accumulation along the link. Typical Q is 40 to 50. *Low Q* refers to NEs with excellent jitter tolerance but wide jitter transfer function. Accumulated jitter is generally removed in an elastic store at the end of the transmission path. Typical Q is 6 to 7.

ITU-T G.958 (see figure 2)

This defines the MTIJ for SDH rates with different masks—one for type A systems and one for type B systems. Type A/type B is the SDH term analogous to high Q/low Q in PDH terminology. Type A refers to wide bandwidth, ie, low Q systems optimized for jitter tolerance. Type B refers to narrow bandwidth, ie, high Q systems with a reduced jitter tolerance specification.

ITU-T G.825 (see figure 3)

This defines the specifications for the MTIJ for SDH NEs (ADMs, DXCs and so on) and covers very low modulating frequencies down to 12 μ Hz at high jitter amplitudes (ie, 11200 UI at STM-4). As an installation test, jitter tolerance is normally evaluated against the ITU-T G.958 mask. Testing to the full ITU-T G.825 mask is more appropriate during design verification.

HP 37717B/C communications performance analyzer

Offers a modular, upgradeable one-box solution for installation, commissioning, and field maintenance. This rugged, portable tester allows comprehensive functional testing of SDH, PDH and ATM equipment including jitter generation and test. The HP 37717C analyzer has a color display and graphics printer, with the monochrome HP 37717B analyzer providing a budget solution, and a 20-column printer. Both instruments include a 3.5-inch disk drive to ease results retrieval and analysis, and perform firmware upgrades.



HP 37717B communications performance analyzer

Related literature

- HP 37717B/C generic brochure, 5964-0106E.
- HP 37717B/C jitter brochure, 5965-5618E.
- HP 37717B/C ATM brochure, 5965-4968E.
- HP 37717B/C technical specifications, 5964-2255E.
- HP 37717B configuration guide, 5965-5764E.
- HP 37717C configuration guide, 5965-5621E.
- HP 37717B/C product note, Tributary jitter testing of SDH network equipment using ITU-T G.783 pointer sequences, 5965-4862E

References

ITU-T G.823 control of jitter and wander within PDH networks (2 Mb/s based)

ITU-T G.825 control of jitter and wander within SDH networks.

ITU-T G.958 digital line systems based on SDH for use on optical fibre

ITU-T O.171 timing jitter and wander measuring equipment for digital systems.

Supplement No. 3.8 O series recommendations

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