International Telecommunication Union

# ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

# G.8251
## Amendment 2
(01/2010)

SERIES G: TRANSMISSION SYSTEMS AND MEDIA,
DIGITAL SYSTEMS AND NETWORKS

Packet over Transport aspects – Quality and availability targets

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# The control of jitter and wander within the optical transport network (OTN)

## Amendment 2: Enhancements to support transport of 1 gigabit Ethernet

Recommendation ITU-T G.8251 (2001) – Amendment 2

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# Recommendation ITU-T G.8251

## The control of jitter and wander within the optical transport network (OTN)

## Amendment 2

## Enhancements to support transport of 1 gigabit Ethernet


**Summary**

Recommendation ITU-T G.8251 specifies the maximum network limits of jitter and wander that shall not be exceeded and the minimum equipment tolerance to jitter and wander that shall be provided at any relevant interfaces which are based on the Optical Transport Network (OTN).

The requirements for the jitter and wander characteristics that are specified in this Recommendation must be adhered to in order to ensure interoperability of equipment produced by different manufacturers and a satisfactory network performance.

Amendment 1 contains extensions to the first version of the Recommendation related to the addition of ODUk multiplexing.

Corrigendum 2 contains material to correct Recommendation ITU-T G.8251 in terms of 40 Gbit/s rate signals.

Amendment 2 contains the addition of support of transport of Gigabit Ethernet (GE) signals over ODU0.



**History**

| Edition | Recommendation | Approval | Study Group |
|---|---|---|---|
| 1.0 | ITU-T G.8251 | 2001-11-29 | 15 |
| 1.1 | ITU-T G.8251 (2001) Cor. 1 | 2002-06-13 | 15 |
| 1.2 | ITU-T G.8251 (2001) Amend. 1 | 2002-06-13 | 15 |
| 1.3 | ITU-T G.8251 (2001) Cor. 2 | 2008-05-22 | 15 |
| 1.4 | ITU-T G.8251 (2001) Amend.2 | 2010-01-13 | 15 |

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## Recommendation ITU-T G.8251

# The control of jitter and wander within the optical transport network (OTN)

## Amendment 2

## Enhancements to support transport of 1 gigabit Ethernet

*Modifications introduced by this amendment are shown in revision marks. Unchanged text is replaced by ellipsis (…). Some parts of unchanged texts (clause numbers, etc.) may be kept to indicate the correct insertion points.*

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### 2 References

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[15] ITU-T Recommendation G.693 (2006), *Optical interfaces for intra-office systems*.

[16] Recommendation ITU-T G.709/Y.1331 (2003), *Interfaces for the Optical Transport Network (OTN)*, plus Amd.3 (2009), 100 Gbit/s support, one-stage multiplexing and other improvements.

[17] IEEE Std. 802.3-2008, *Information Technology – Local and Metropolitan Area Networks – Specific Requirements Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications*.

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### 6.2 Jitter and wander tolerance of CBR1G25, CBR2G5, CBR10G, and CBR40G client interfaces

Jitter and wander tolerance requirements and network limits for CBR2G5, CBR10G, and CBR40G are derived from the corresponding requirements for STM-16, STM-64 and STM-256 signals, respectively, given in ITU-T Rec. G.825.

STM input ports, i.e. the input to the ODUkP/CBRx-a_A_So and ODUkP/CBRx-b_A_So atomic functions, ~~for the case where the STM client is STM-16, STM-64, or STM-256,~~ must tolerate jitter and wander levels specified in ITU-T Rec. G.825. Guidelines for measuring the input jitter and wander tolerance of equipment input interfaces are given in Appendix III/G.823.

For input ports to the ODU0P-to-Client adaptation function (ODU0P/CBRx_A, 0≤x≤1.25G), the specification of the particular clients applies. Jitter and wander tolerance requirements and network limits for CBR1G25 are derived from the corresponding requirements for (transcoded) 1GE signals, given in IEEE 802.3. For SDH rates, the ITU-T Rec. G.825 specifications apply; for native Ethernet, IEEE 802.3 specifications (clock tolerance of 100 ppm) apply.

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# Annex A

## Specification of the ODUk clock (ODC)

### A.1 Scope

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**Table A.1 – Summary of ODUk Clock (ODC) types**

| | ODCa | ODCb | ODCr | ODCp |
|---|---|---|---|---|
| … | | | | |
| Frequency accuracy | ±20 ppm | ±20 ppm for ODUk (k = 0, 1, 2, 3) ±20 ppm for CBRx (x = 2G5, 10G, 40G) ±100 ppm for 1GE ±20 ppm | ±20 ppm | ±20 ppm for ODUk (k = 0, 1, 2, 3) ±20 ppm for CBRx (x = 2G5, 10G, 40G) ±100 ppm for CBRx (x = 1G25)±20 ppm |
| … | | | | |
| Pull-in range | NA | ±20 ppm/±100 ppm | ±20 ppm | ±20 ppm/±100 ppm |
| Pull-out range | NA | ±20 ppm/±100 ppm | ±20 ppm | ±20 ppm/±100 ppm |
| … | | | | |

**Table A.1 – Summary of ODUk Clock (ODC) types**

| | ODCa | ODCb | ODCr | ODCp |
|---|---|---|---|---|
| Jitter tolerance | NA | ITU-T Rec. G.825<br>IEEE 802.3 for Ethernet clients | Table 2, Figure 1 (OTU1)<br>Table 3, Figure 2 (OTU2)<br>Table 4, Figure 3 (OTU3) | Table 2, Figure 1 (OTU1)<br>Table 3, Figure 2 (OTU2)<br>Table 4, Figure 3 (OTU3)<br>IEEE 802.3 for Ethernet clients |
| Wander tolerance | NA | ITU-T Rec. G.825 | Clause 6.1 | Clause 6.1 |
| Jitter transfer | NA | Maximum Bandwidth:<br>ODU0: 0.5 kHz<br>ODU1: 1 kHz<br>ODU2: 4 kHz<br>ODU3: 16 kHz<br>Maximum Gain Peaking:<br>0.1 dB for ODU0, 1, 2, and 3<br>(see Table A.4 and Figure A.1) | Maximum Bandwidth:<br>OTU1: 250 kHz<br>OTU2: 1000 kHz<br>OTU3: 4000 kHz<br>Maximum Gain Peaking:<br>0.1 dB for OTU1, 2, and 3<br>(see Table A.5 and Figure A.1) | Maximum Bandwidth:<br>300 Hz for ODUk (k = 0, 1, 2, 3) for CBRx (x = 2G5, 10G, 40G)<br>TBD Hz for CBRx (x = 1G25)<br>~~300 Hz~~<br>Maximum Gain Peaking:<br>0.1 dB<br>(see A.7.3) |
| Output when input signal is lost | AIS (CBRx client)<br>OTUk: no frame hit<br>OTUk frequency unchanged | AIS (CBRx client)<br>OTUk: no frame hit<br>OTUk initial frequency change ≤ 9 ppm | AIS (OTUk)<br>OTUk: frame hit allowed<br>Temporary OTUk frequency offset > 20 ppm allowed | AIS (CBRx client), AIS (ODUj[/i] client)<br>Frequency offset ≤ 20 ppm<br>Local Fault (1GE client Frequency offset ≤ 100 ppm) |
| … | | | | |

…

## A.3 Frequency accuracy

Under free-running conditions, the output frequency accuracy of ODCa and~~, ODCb,~~ ODCr~~, and ODCp~~ shall not be worse than 20 ppm with respect to a reference traceable to a G.811 clock. Under free-running conditions, the output frequency accuracy of ODCb shall not be worse than 100 ppm for 1GE clients, and shall not be worse than 20 ppm for all other respective clients and ODUs (see Table A.1). Under free-running conditions, the output frequency accuracy of ODCp shall not be worse than 100 ppm for CBR1G25 and shall not be worse than 20 ppm for all other respective clients and ODUs (see Table A.1).

## A.4 Pull-in and pull-out ranges

### A.4.1 Pull-in range

The minimum pull-in range of ODCb, ODCr, and ODCp shall be ±~~20 ppm,~~100 ppm for 1GE and CBR1G25 clients, and ±20 ppm for all other clients and ODUs (see Table A.1), whatever the internal oscillator frequency offset may be. There is no requirement for the pull-in range of ODCa because it is free~~-~~-running.

### A.4.2 Pull-out range

The minimum pull-out range of ODCb, ODCr, and ODCp shall be ±100 ppm for 1GE and CBR1G25 clients, and ±20 ppm~~,~~ for all other clients and ODUs (see Table A.1), whatever the internal oscillator frequency offset may be. There is no requirement for the pull-out range of ODCa because it is free-running.

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#### A.5.1.1 ODCa, ODCb, and ODCr jitter generation

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**Table A.2 – ODCa, ODCb, and ODCr jitter generation requirements**

| Interface | Measurement bandwidth, –3 dB frequencies (Hz) | Peak-to-peak amplitude (UIpp) (Note 2) |
|---|---|---|
| ODU0 | 2.5 k to 10 M | 0.3 |
| | 0.5 M to 10 M | 0.1 |
| ODU1, OTU1 | 5 k to 20 M | 0.3 |
| | 1 M to 20 M | 0.1 |
| ODU2, OTU2 | 20 k to 80 M | 0.3 |
| | 4 M to 80 M | 0.1 |
| ODU3, OTU3 | 20 k to 320 M | 1.2 (Note 1) |
| | 16 M to 320 M | 0.14 |

NOTE 1 – See IV.4 for additional information.

NOTE 2 – ODU0 $1\text{ UI} = \frac{1}{1.24416}[\text{ns}] = 803.8\text{ ps}$

ODU1 $1\text{ UI} = \frac{238}{(239)(2.48832)}[\text{ns}] = 400.2\text{ ps}$

ODU2 $1\text{ UI} = \frac{237}{(239)(9.95328)}[\text{ns}] = 99.63\text{ ps}$

ODU3 $1\text{ UI} = \frac{236}{(239)(39.81312)}[\text{ns}] = 24.80\text{ ps}$

OTU1 $1\text{ UI} = \frac{238}{(255)(2.48832)}[\text{ns}] = 375.1\text{ ps}$

OTU2 $1\text{ UI} = \frac{237}{(255)(9.95328)}[\text{ns}] = 93.38\text{ ps}$

OTU3 $1\text{ UI} = \frac{236}{(255)(39.81312)}[\text{ns}] = 23.25\text{ ps}$

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### A.5.1.2 ODCp jitter generation

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**Table A.3 – ODCp jitter generation requirements**

| Interface | Measurement bandwidth, –3 dB frequencies (Hz) | Peak-to-peak amplitude (UIpp) (Note 2) |
|---|---|---|
| CBR1G25 | 2.52 k to 10 M | 1.0 |
| | 0.673 M to $f_4$ (Note 1) | As specified for TP2, according to subclause 38.5, Table 38-10, of IEEE 802.3 |
| ODU0 | 2.5 k to 10 M | 1.0 |
| | 0.673 M to 10 M | 0.1 |
| CBR2G5<br>ODU1 | 5 k to 20 M | 1.0 |
| | 1 M to 20 M | 0.1 |
| CBR10G<br>ODU2 | 20 k to 80 M | 1.0 |
| | 4 M to 80 M | 0.1 |
| CBR40G<br>ODU3 | 80 k to 320 M (Note) | 1.0 |
| | 16 M to 320 M | 0.14 |

NOTE 1 – $f_4$ = bandwidth of fourth-order Bessel-Thomson filter defined in subclause 38.6.5 of IEEE 802.3

NOTE 2 – CBR1G25 $1\ \text{UI} = \frac{1}{1.25}\ [\text{ns}] = 800\ \text{ps}$

CBR2G5 $1\ \text{UI} = \frac{1}{2.48832}\ [\text{ns}] = 401.9\ \text{ps}$

CBR10G $1\ \text{UI} = \frac{1}{9.95328}\ [\text{ns}] = 100.5\ \text{ps}$

CBR40G $1\ \text{UI} = \frac{1}{39.81312}\ [\text{ns}] = 25.12\ \text{ps}$

ODU0 $1\ \text{UI} = \frac{1}{1.24416}\ [\text{ns}] = 803.8\ \text{ps}$

ODU1 $1\ \text{UI} = \frac{238}{(239)(2.48832)}\ [\text{ns}] = 400.2\ \text{ps}$

ODU2 $1\ \text{UI} = \frac{237}{(239)(9.95328)}\ [\text{ns}] = 99.63\ \text{ps}$

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## A.6 Noise tolerance

This clause specifies the jitter and wander tolerance of ODCb, ODCr, and ODCp. There are no jitter and wander tolerance requirements for ODCa because ODCa is free-running.

ODCb must satisfy the same jitter and wander tolerance requirements as CBR1G25, CBR2G5, CBR10G and CBR40G client interfaces (the input to the ODUkP/CBRx-b_A_So atomic function). These requirements are given in 6.2, which references ITU-T Rec. G.825. Note that and the ODCb is containedEthernet specifications in the ODUkP/CBRx-b_A_So atomic function.IEEE 802.3 [17].

ODCr and ODCp must satisfy the same jitter and wander tolerance requirements as OTUk input ports (the input to the OCh/OTUk_A_Sk atomic function). These requirements are given in 6.1 and its subclauses. Note that the ODCr is contained in the OTUk/ODUk_A_So and OTUk/ODUk_A_Sk atomic functions, and the ODCp is contained in the ODUkP/CBRx_A_Sk atomic function.

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### A.7.1 Jitter transfer for ODCb

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**Table A.4 – ODCb jitter transfer requirement**

| ODUk level | $f_L$ (Hz) | $f_C$ (kHz) | $f_H$ (kHz) | *P* (dB) | Input mask |
|---|---|---|---|---|---|
| ODU0 | 10 | 0.5 | 50 | 0.1 | Clause A.6 |
| ODU1 | 10 | 1 | 100 | 0.1 | Clause A.6 |
| ODU2 | 40 | 4 | 400 | 0.1 | Clause A.6 |
| ODU3 | 160 | 16 | 1600 | 0.1 | Clause A.6 |

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## A.8 Transient response

When a CBR client signal is lost and AIS is inserted, or when the CBR client is restored and AIS is removed, the ODUk and OTUk timing must be maintained. This requirement is met automatically for asynchronous mappings because the ODCa is free-running and therefore independent of the client signal clock. However for bit-synchronous mapping, the ODCb takes its timing from the client. Specifically, the client signal timing is recovered by the clock recovery circuit that resides in the OS/CBR_A_Sk atomic function; the output of this clock recovery circuit is input to the ODCb (see Appendix VI for a summary of the atomic functions). Loss of the client signal results in the ODCb either entering free-run or switching to a free-running AIS clock or Ethernet local fault clock; restoration of the client signal results in the ODCb switching from free-run condition or from a free-running AIS clock to an independent client-signal clock. In addition, there may be a short period between the instant the client input to the clock recovery circuit is lost and the detection of this loss; during this period, the clock recovery circuit output may be off frequency and still be input to the ODCb. In all these cases, ITU-T Rec. G.798 requires that the ODUk clock shall stay within its limits and no frame phase discontinuity shall be introduced.

The maximum possible frequency difference between a ±20 ppm CBRx (e.g., SDH) client and free-running ODCb or free-running AIS clock is 40 ppm (because the largest possible offset for each signal is ±20 ppm). The maximum possible frequency difference between a ±100 ppm 1GE client and free-running ODCb or free-running AIS clock is 120 ppm.

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Printed in Switzerland
Geneva, 2010