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

Digital sections and digital line system – Metallic access networks

Enhanced common mode limits and measurement methods for customer premises equipment operating on copper pairs

Recommendation ITU-T G.995.2

International Telecommunication Union

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Recommendation ITU-T G.995.2

Enhanced common mode limits and measurement methods for customer premises equipment operating on copper pairs

Summary

To achieve optimal performance for VDSL2 lines making use of vectoring, Recommendation ITU-T G.995.2 specifies common mode (CM) voltage limits up to 30 MHz on the digital subscriber line (DSL) that provide additional radio protection relative to what is currently specified in CISPR22.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T G.995.2	2015-08-29	15	11.1002/1000/12565

* To access the Recommendation, type the URL http://handle.itu.int/ in the address field of your web browser, followed by the Recommendation's unique ID. For example, http://handle.itu.int/11.1002/1000/11830-en.

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications, information and communication technologies (ICTs). The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

Compliance with this Recommendation is voluntary. However, the Recommendation may contain certain mandatory provisions (to ensure, e.g., interoperability or applicability) and compliance with the Recommendation is achieved when all of these mandatory provisions are met. The words "shall" or some other obligatory language such as "must" and the negative equivalents are used to express requirements. The use of such words does not suggest that compliance with the Recommendation is required of any party.

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As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementers are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database at http://www.itu.int/ITU-T/ipr/.

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Enhanced common mode limits and measurement methods for customer premises equipment operating on copper pairs

1 Scope

To achieve optimal performance for VDSL2 lines making use of vectoring, this Recommendation specifies common mode (CM) voltage limits up to 30 MHz on the DSL line that provide additional radio protection relative to what is currently specified in [IEC CISPR 22].

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

[ITU-T G.993.2] Recommendation ITU-T G.993.2 (2015), *Very high speed digital subscriber line transceivers 2 (VDSL2).*

[IEC CISPR 22] IEC CISPR 22 (2008), *Information Technology Equipment – Radio Disturbance Characteristics – Limits and Methods of Measurement.*

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following term defined elsewhere:

3.1.1 vectoring [b-ITU-T G.993.5]: The coordinated transmission and/or coordinated reception of signals of multiple DSL transceivers using techniques to mitigate the adverse effects of crosstalk to improve performance.

3.2 Terms defined in this Recommendation

This Recommendation defines the following term:

3.2.1 customer premises equipment (CPE): Equipment located at the customer premises, including the network termination (NT) equipment, as shown in Figure 5-4 of [ITU-T G.993.2].

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

ADSL Asymmetric Digital Subscriber Line

CM Common Mode

CPE Customer Premises Equipment

ISN Impedance Stabilization Network

DSL Digital Subscriber Line

LCL Longitudinal Conversion Loss

SHDSL Single-pair High-speed Digital Subscriber Line

VDSL Very high speed Digital Subscriber Line

5 CPE common mode voltage limits

The common mode voltage limits for VDSL2 CPE are defined in Annex A, clauses A.1 and A.2.

6 Common mode voltage measurement method

The common mode voltage measurement method for VDSL2 CPE is defined in Annex A, clause A.3.

Annex A

ITU-T G.993.2 CPE common mode voltage limits and measurement method

(This annex forms an integral part of this Recommendation.)

To achieve optimal performance for VDSL2 lines making use of vectoring, this annex specifies common mode (CM) voltage limits up to 30 MHz on the DSL line that provide additional radio protection relative to what is currently specified in [IEC CISPR 22].

A.1 CM voltage limits in frequency band 2.208 MHz to 30 MHz

At the U-R2 reference point (see Figure 5-4 of [ITU-T G.993.2]), and for frequencies in the frequency band from 2.208 MHz to 30 MHz, the CM voltage (U_{CM}) shall comply with the CM voltage limit and the CM power in a 1 MHz sliding window (P_{CM}) shall comply with the CM power limit, as listed in Table A.1.

Table A.1 – CM voltage and power limits

Frequency (MHz)	CM voltage limit Average detector (dBµV)	CM power limit in a 1 MHz sliding window (dBm)
2.208-30	40	−60

NOTE 1 – For an efficient operation of vectored VDSL2, a low quiet line noise of approximately −140 dBm/Hz in this frequency band is required. A general U_{CM} voltage limit of 40 dBµV together with P_{CM} power limit in a 1 MHz sliding window of −60 dBm seems to be appropriate to ensure such a low noise level even in environments with a concentrated deployment of DSL equipment. On customer side, the combination of a power supply unit with low CM emissions and a CM choke (nominal value between 0.5 and 2 mH) in the line interface should enable CPEs to fulfil the limits.

NOTE 2 – With U_{CM} measured with 9 kHz bandwidth into a 150 Ohms impedance, and P_{CM} measured with 1 MHz bandwidth, a P_{CM} level of −60 dBm corresponds with a U_{CM} level of −60−10×log(1000000)+10×log(9000)+(90+10×log(150)) = 31.3 dBµV.

A.2 CM voltage limits in the frequency band 138 kHz to 2.208 MHz

For frequencies in the frequency band from 138 kHz to 2.208 MHz, the common mode voltage (U_{CM}) at the U-R2 reference point shall satisfy:

$$U_{CM} \le 63 - 23 \times \frac{\log(f / f_0)}{\log(f_1 / f_0)} \text{ dBµV,}$$

with:

f_0 = 138 kHz and

f_1 = 2.208 MHz.

NOTE 1 – The limit for U_{CM} decreases linearly with the logarithm of the frequency from 63 dBµV at 138 kHz to 40 dBµV at 2.208 MHz. The slope of the limit curve in this frequency interval has been chosen identical to CISPR22 limit slope between 150 kHz and 500 kHz.

NOTE 2 – This frequency range is often not exclusively used for vectored VDSL2 but also for (non-vectored) SHDSL [b-ITU-T G.991.2] or ADSL2plus [b-ITU-T G.992.5] in the same cable. Due to the crosstalk noise, the acceptable common mode voltage from external sources is higher. Furthermore, the longitudinal conversion loss (LCL) of cables is usually higher in this frequency range, resulting in a lower conversed differential mode signal.

A.3 CM measurement method

The measurement method for the CM voltage on the line shall be as defined in [IEC CISPR 22], however with following deviations:

– The common mode voltage measurement shall be carried out at the U-R2 reference point in the average detector mode (AV detector) with a measurement bandwidth of 9 kHz.

– Only the power supply of the equipment shall be connected during the measurement.

– Instead of the impedance stabilization network (ISN) for category 3 cables, an ISN with a high longitudinal conversion loss (LCL) shall be used in order to reduce the influence of the transmit signal (differential mode) on the measurement result.

– In this regard, this test should be conducted with restricted VDSL2 spectrum usage (e.g., ≤ 2.2 MHz) or with an additional attenuation in the VDSL2 signal path.

The CM voltage limits defined in clauses A.1 and A.2 are shown in Figure A.1, in overlay with a measurement example of a compliant VDSL2 CPE.

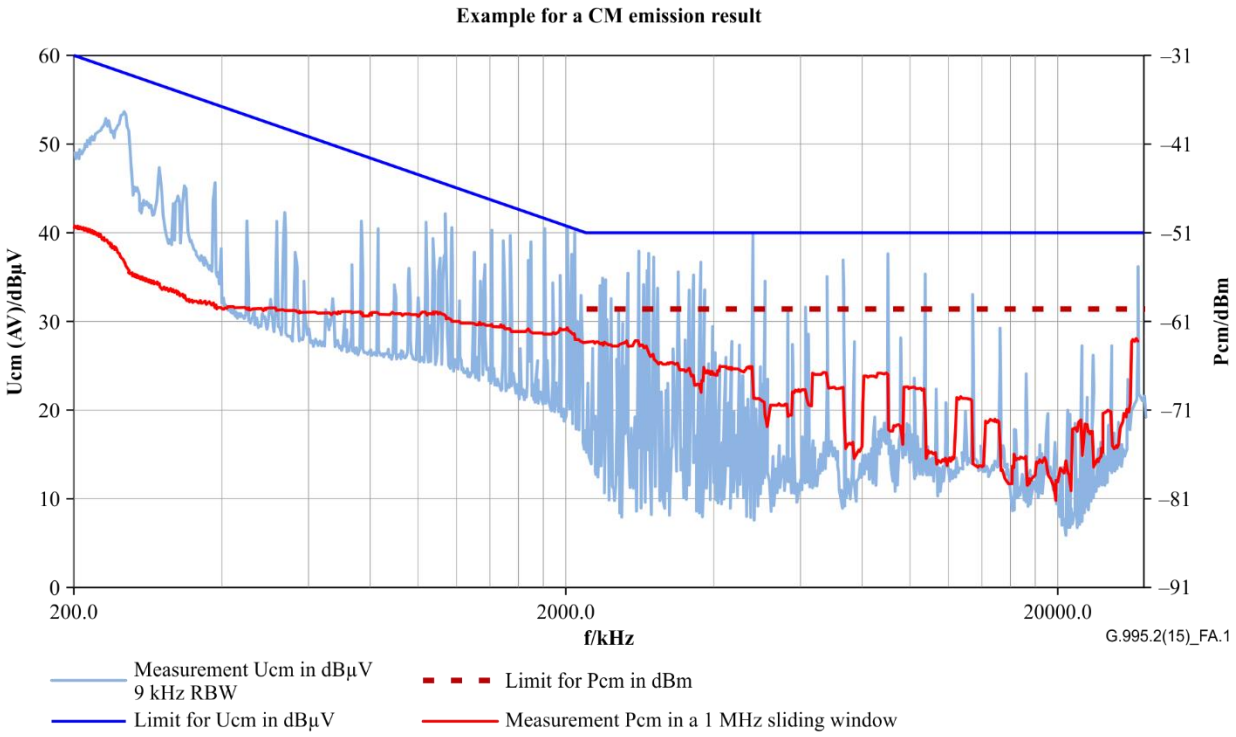

Figure A.1 – CM voltage limits and measurement example of a compliant VDSL2 CPE

Bibliography

[b-ITU-T G.991.2] Recommendation ITU-T G.991.2 (2003), *Single-pair high-speed digital subscriber line (SHDSL) transceivers.*

[b-ITU-T G.992.5] Recommendation ITU-T G.992.5 (2009), *Asymmetric digital subscriber line 2 transceivers (ADSL2) – Extended bandwidth ADSL2 (ADSL2plus).*

[b-ITU-T G.993.5] Recommendation ITU-T G.993.5 (2015), *Self-FEXT cancellation (vectoring) for use with VDSL2 transceivers.*

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