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NOTE 1 Facteur nominal de division en tension = 9,5 dB.

NOTE 2 Z_{cat} représente le réseau asymétrique exigé pour régler l'affaiblissement de conversion longitudinale (ACL) applicable.

NOTE 3 AVERTISSEMENT - En raison de la possibilité de résultats de mesurage erronés, ce réseau fictif asymétrique (AAN) ne peut pas être utilisé pour mesurer les émissions de mode commun sur des câbles à paires non blindées connectés à des accès de télécommunication utilisant moins de quatre paires symétriques non blindées.

Figure I.7 – Exemple de réseau fictif asymétrique (AAN) destiné à être utilisé avec quatre paires symétriques non blindées



NOTE Facteur nominal de division en tension = 9,5 dB.

Figure I.8 – Exemple de réseau fictif (AN) destiné à être utilisé avec des câbles coaxiaux, utilisant une bobine d'arrêt de mode commun interne créée par un enroulement bifilaire d'un conducteur central isolé et d'un conducteur de blindage isolé sur un noyau magnétique commun (par exemple, un tore en ferrite)



NOTE 1 Facteur nominal de division en tension = 9,5 dB.

NOTE 2 Un plus grand nombre de tores peut être nécessaire pour satisfaire entièrement aux exigences pour les réseaux fictifs (AN).

Figure I.9 – Exemple de réseau fictif (AN) destiné à être utilisé avec des câbles coaxiaux, utilisant une bobine d'arrêt de mode commun interne créée par un câble coaxial miniature (câble coaxial à blindage de cuivre plein semi-rigide ou à blindage miniature à double tresse) enroulé sur des tores en ferrite



NOTE Facteur nominal de division en tension = 9,5 dB.

Figure I.10 – Exemple de réseau fictif (AN) destiné à être utilisé avec des câbles blindés multiconducteur, utilisant une bobine d'arrêt de mode commun interne créée par un enroulement bifilaire de plusieurs conducteurs de signaux isolés et un conducteur de blindage isolé sur un noyau magnétique commun (par exemple, un tore en ferrite)



NOTE 1 Facteur nominal de division en tension = 9,5 dB.

NOTE 2 Un plus grand nombre de tores peut être nécessaire pour satisfaire entièrement aux exigences pour les réseaux fictifs (AN).

Figure I.11 – Exemple de réseau fictif (AN) destiné à être utilisé avec des câbles blindés multiconducteur, utilisant une bobine d'arrêt de mode commun interne créée par un enroulement d'un câble blindé multiconducteur sur des tores en ferrite

Bibliographie

- [1] CISPR 11:2003, Appareils industriels, scientifiques et médicaux (ISM) à fréquence radioélectrique – Caractéristiques de perturbations électromagnétiques – Limites et méthodes de mesure
- [2] CISPR 16-1-4:2010, Spécifications des méthodes et des appareils de mesure des perturbations radioélectriques et de l'immunité aux perturbations radioélectriques – Partie 14: Appareils de mesure des perturbations radioélectriques et de l'immunité aux perturbations radioélectriques – Antennes et emplacements d'essai pour les mesures des perturbations rayonnées
- [3] CISPR 16-2-3:2010, Spécifications des méthodes et des appareils de mesure des perturbations radioélectriques et de l'immunité aux perturbations radioélectriques Partie 2-3: Méthodes de mesure des perturbations et de l'immunité Mesures des perturbations rayonnées
- [4] CISPR/TR 16-3, Specification for radio disturbance and immunity measuring apparatus and methods – Part 3: CISPR technical reports (disponible en anglais seulement)
- [5] CISPR 16-4-1, Specification for radio disturbance and immunity measuring apparatus and methods – Part 4-1: Uncertainties, statistics and limit modelling – Uncertainties in standardized EMC tests (disponible en anglais seulement)
- [6] CISPR/TR 16-4-3:2004, Specification for radio disturbance and immunity measuring apparatus and methods – Part 4-3: Uncertainties, statistics and limit modelling – Statistical considerations in the determination of EMC compliance of mass-produced products (disponible en anglais seulement)
- [7] IEC/TR 60083:2006, Prises de courant pour usages domestiques et analogues normalisées par les pays membres de l'IEC
- [8] IEC 60364-4 (toutes les sous-parties), *Low-voltage electrical installations Part 4: Protection for safety* (disponible en anglais seulement)
- [9] IEC 61000-4-6:2008, Compatibilité électromagnétique (CEM) Partie 4-6: Techniques d'essai et de mesure – Immunité aux perturbations conduites, induites par les champs radioélectriques
- [10] IEC 61010-1:2001, Règles de sécurité pour appareils électriques de mesurage, de régulation et de laboratoire Partie 1: Prescriptions générales
- [11] UIT-R Recommandation BS.468-4: *Mesure du niveau de tension des bruits audiofréquence en radiodiffusion sonore*
- [12] JCGM 200:2012, Vocabulaire international de métrologie Concepts fondamentaux et généraux et termes associés (VIM)





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Spécifications des méthodes et des appareils de mesure des perturbations radioélectriques et de l'immunité aux perturbations radioélectriques – Partie 2-1: Méthodes de mesure des perturbations et de l'immunité – Mesures des perturbations conduites

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