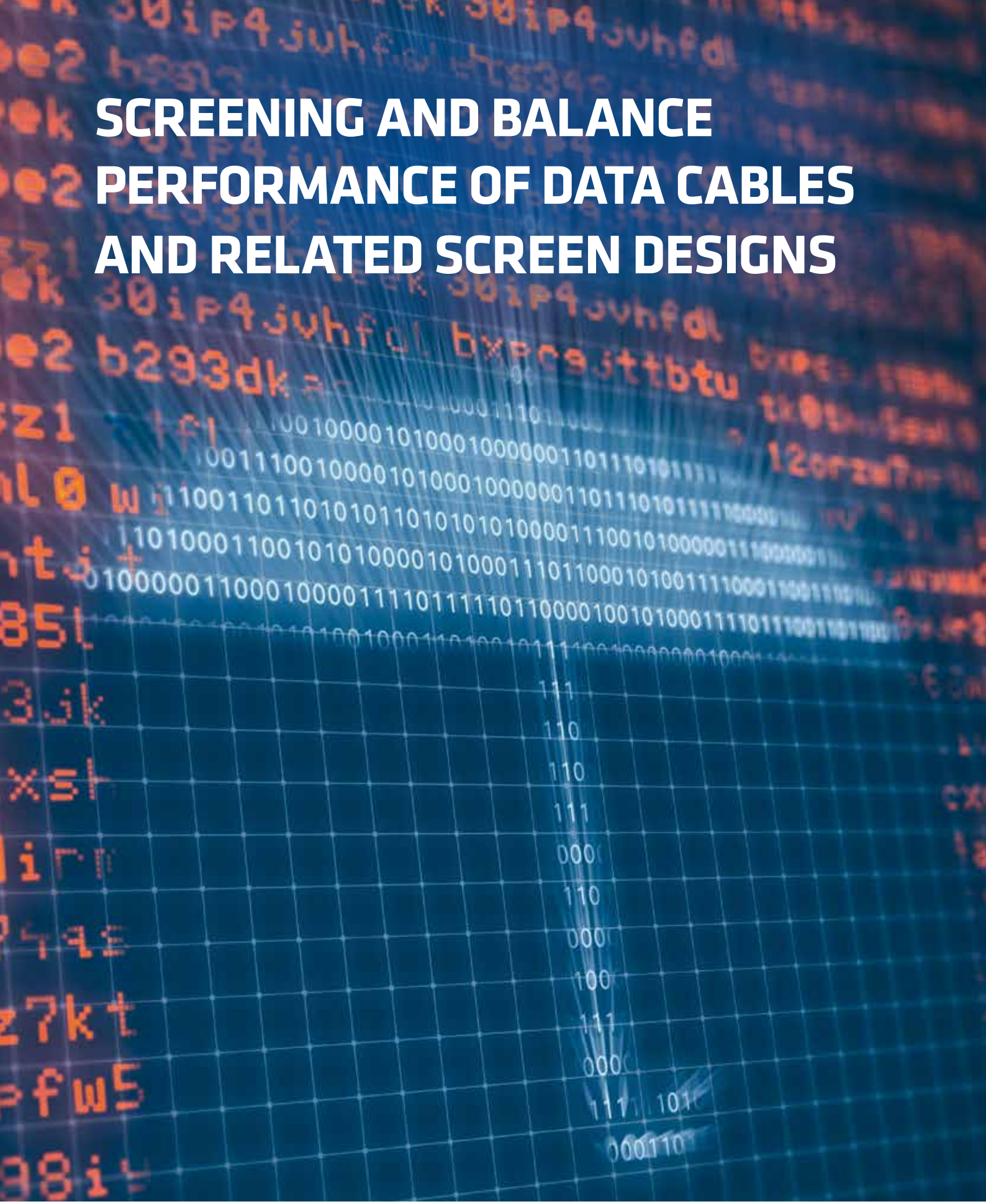
SCREENING AND BALANCE PERFORMANCE OF DATA CABLES AND RELATED SCREEN DESIGNS



Draka

A Brand of Prysmian Group

Dr. Christian Pfeiler
R&D Manager

SCREENING AND BALANCE PERFORMANCE OF DATA CABLES AND RELATED SCREEN DESIGNS

Balanced high frequency cables are the basis of the horizontal cabling of today's data communications infrastructure. Due to the balanced mode signal propagation these cables provide an inherent immunity against electromagnetic ingress even when un-screened. By adding a screen, the proctection can further be increased. International standards provide various parameters for quantifying this degree of proctection. Different designs of screening can be related to the specified levels of these parameters. This white paper summarises the specifications and provides an overview of the differences between requirements for pure cables and for cabling systems.

THE NOMENCLATURE OF SCREENING DESIGNS

According to the ISO/IEC 11801 and the IEC 61156 standards series, different cable types are identified by an abbreviation like "oo/iii"

- "oo" denotes an overall screen of the cable
- "iii" denotes a shielding of the individual balanced element.

Balanced cables can be based on pairs or quads and these pairs or quads can be individually shielded, typically by a foil. This results in:

- "iii" equals FTP (Foil shielded Twisted Pair) or FTQ (Foil shielded Twisted Quad).
- UTP or UTQ (U – Unshielded) if there is no individual shield.

For an overall screen there are two options:

1. A foil again would be denoted with an "F",
2. A braid would be denoted "S".
3. A "U" would mean no screen and for
4. UTP cable cores the "SF" screening option is common (foil with additional braid).

As all cables of Category 7 and higher require individually shielded pairs and for Category 5e cables individually shielded pairs are not common due to their degree of complexity, the shielding and screening design options can be related to the different categories as shown in table 1.

	Unscreened and overall screened	Pair-screened
Category 5e	U/UTP F/UTP SF/UTP	**unusual**
Category 6		U/FTP F/FTP S/FTP
Category 6_A		
Category 7	**not applicable**	
Category 7_A		
Category 8	Category 8.1: F/UTP, SF/UTP	Category 8.2: U/FTP, F/FTP, S/FTP

Table 1: Cable Categories and Related Basic Designs

PARAMETERS OF SCREENING PERFORMANCE

Cables that are subject to ISO/IEC 11801 are specified in the IEC 61156 series of standards, whereas IEC 61156-5 describes installation cables. Flexible "work area" cables are described in IEC 61156-6. The latest editions of these standards offer two parameters quantifying screening performance: transfer impedance and coupling attenuation.

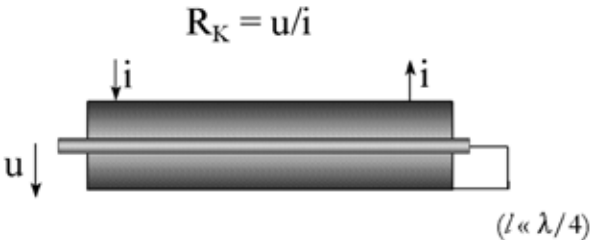
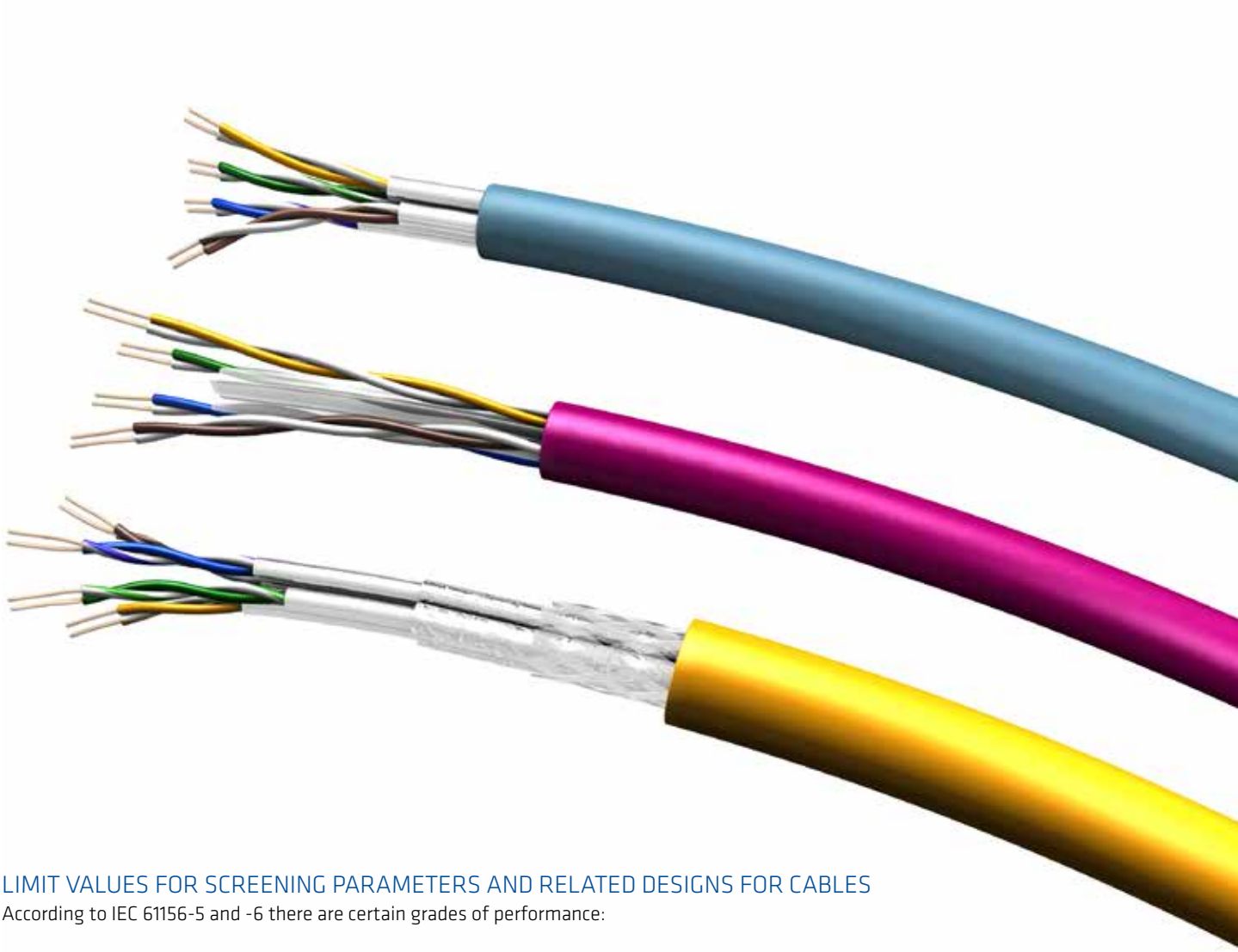


Figure 1: Definition of transfer impedance

Transfer impedance is defined as shown in figure 1. An interference current (i) in the screen causes a voltage drop (u). The better the screening performance the lower is the voltage. As the ratio of the interference voltage and current has the dimension of an impedance this parameter is called transfer impedance (R_K). Of course, this parameter is only applicable to screened cable. Measurement of this parameter is detailed in IEC 62153-4-3.

Coupling attenuation is a parameter that can be measured for screened and unscreened cables. Measurement is typically performed by high frequency current transformers. They detect the leaky current on the outer surface of the cable which is being fed with a balanced continuous wave signal over a certain frequency range. These current transformers are typically combined with ferrite absorbers – so called absorbing clamps. They assure the defined conditions on a specific length of cable and avoid standing waves. The measurement is described in IEC 62153-4-5.

Coupling attenuation of unscreened cables is very closely related to the balance of the cable under test. Balance is typically specified by TCL (Transverse Conversion Loss) and EL TCTL (Equivalent Level Transverse Conversion Transfer Loss). The definition and background of these parameters is described in IEC TR 61156-1-2.



LIMIT VALUES FOR SCREENING PARAMETERS AND RELATED DESIGNS FOR CABLES

According to IEC 61156-5 and -6 there are certain grades of performance:

Transfer Impedance	Coupling Attenuation	TCL	EL TCTL
Grade 1: f/MHz RK/mΩ/m 1 10 10 10 30 30 100 60	Anchor value a for 30 – 100 MHz: Type I: 85 dB Type Ib: 70 dB Type II: 55 dB Type III: 40 dB Frequency dependence: 100 MHz – 1 GHz: *a – 20 log (f/100 MHz)*	Anchor value a: Level 1: 40 dB Level 2: 50 dB Level 3: 60 dB Level 4: 70 dB Frequency dependence: 1 MHz – 250 MHz (100 MHz for Category 5e): *a – 10 log (f/MHz)* Maximum requirement: 50 dB	Anchor value a: Level 1: 35 dB Level 2: 35 dB Level 3: 45 dB Level 4: 55 dB Frequency dependence: 1 MHz – 30 MHz: *a – 20 log (f/MHz)* Maximum requirement: 40 dB
Grade 2: f/MHz RK/mΩ/m 1 50 10 100 30 200 100 1000			

Table 2: Limit Values for Screening and Balance Parameters according to IEC 61156-5 and -6

Even though the different types and grades seem to be independent there are typical designs that are used to achieve a certain performance. To fulfil the Grade 1 transfer impedance requirements a braid/foil screen is typically used.

To fulfil Grade 2 requirements a foil screen with certain characteristics is sufficient. Type I and Type II coupling attenuation are therefore related to Grade 1 and Grade 2 respectively.

A braided screen not only provides best screening performance, it also significantly improves the electrical contact between cables and connecting hardware. Type Ib coupling attenuation has been introduced by using braided cables with a lower performing and cost-saving braid in environments where a maximum screening performance is not required. The transfer impedance of these designs usually has significant margin above Grade 2. For U/UTP cables only coupling attenuation measurement is applicable. U/UTP cables typically achieve Type II or Type III performance.

SCREENING AND BALANCE PERFORMANCE REQUIREMENTS OF CABLES COMPARED TO CABLING SYSTEMS

For unscreened cabling system according to ISO/IEC 11801 only the balance parameters TCL and EL TCTL are specified covering the EMC performance of the system. Whereas ISO/IEC 11801 only specifies coupling attenuation as an EMC related parameter for screened cabling system. It does not specify balance parameters for screened cabling system except for those of Class I and Class II ("Category 8"), see 6.3.3.12.1 of ISO/IEC 11801-1 Ed1 (2017). If the balance parameters are included in a field test of screened cabling, these parameters are for information only. They can offer insights for a deeper analysis of the transmission performance.

Table 3 below summarises the balance parameter requirements for unscreened Class EA and screened Class EA channels as these are the most common. The environmental classification E1 to E3 reflects the respective MICE levels.

Coupling Attenuation of Screened Channel Class E_A	**TCL of Unscreened Channel Class E_A**		**EL TCTL of Unscreened Channel Class E_A**
Anchor value a for 30 – 100 MHz: E1: 40 dB E2: 50 dB E3: 60 dB Frequency dependence: 100 MHz – 500 MHz: *a – 20 log (f/100 MHz)*	Anchor value a for 1 – 30 MHz: E1: 53 dB E2: 63 dB E3: 73 dB Frequency dependence: 1 MHz – 30 MHz: *a – 15 log (f/MHz)* Maximum requirement: 40 dB	Anchor value a for 30 – 250 MHz: E1: 60.3 dB E2: 70.3 dB E3: 80.3 dB Frequency dependence: 30 MHz – 250 MHz: *a – 20 log (f/MHz)* Maximum requirement: 40 dB	Anchor value a: E1: 30 dB E2: 40 dB E3: 50 dB Frequency dependence: 1 MHz – 30 MHz: *a – 20 log (f/MHz)* Maximum requirement: 40 dB

Table 3: Limit Values for Screening and Balance Parameters according to ISO/IEC 11801-1, excerpt

SCREENING PERFORMANCE COVERED BY DRAKA UC-CABLE RANGE

The various cable designs within the Draka UC portfolio cover most of the different requirements for screening performance and market demands. An overview of installation cables and typical coupling attenuation is given in table 4.

Coupling Attenuation/Transfer Impedance (anchor value at 100 MHz/limit value at 10 MHz)				
Category	Type 1/Grade1 (85 dB/10 mΩ/m)	Type 1b/Grade1b (75 dB/30 mΩ/m)	Type 2/Grade2 (55 dB/100 mΩ/m)	Type3 (40 dB/–)
5		SF/UTP: UC300 HS24	F/UTP: UC300 S24	U/UTP: UC300 24
6		S/FTP: UC400 HS23 (patented 2foil-design)	U/FTP: UC400 S23 (patented 2foil-design)	U/UTP: UC400 HD
6_A			U/FTP: UC500 S23 (patented 2foil-design) F/FTP: UC500 AS23 (3foil-design)	
7	S/FTP: UC900 SS23	S/FTP: UC900 HS23		
7_A	S/FTP: UC1500 SS23 S/FTP: UC1500 SS22	S/FTP: UC1200 HS23 S/FTP: UC1200 HS22		
8.2	UC^{FUTURE} COMPACT22 Cat8.2			

Table 4: Overview of the Nominal Performance of Designs of the UC-Cable Portfolio

Draka

A Brand of Prysmian Group

Draka Comteq Germany GmbH & Co. KG

Piccoloministr. 2
51063 Cologne | Germany

www.draka-cable.com
multimedia@prysmiangroup.com