# Introduction

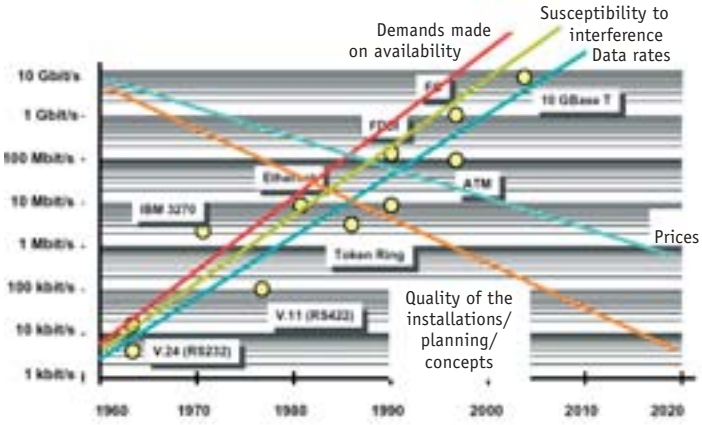
**In addition to numerous discoveries and achievement, the last thousend years have brought us the still young age of information.**
**Now we are experiencing a veritable information explosion.**
**Whereas humanity required about 40,000 years to double its knowledge, Robert Anton Wilson tells us that this is now happening every two years.**

Since the invention of the **Internet**, this knowledge has been available everywhere around the clock. **Worldwide networking** makes this possible.

Knowledge transfer thus no longer takes place in the form of analog voice transmission via the 100-year-old telephone network but preferably as digital data, image or voice transmission.
The information quantity is not measured in printed A4 pages now but in bits and bytes.

Did you know that a file size of up to 8 Mbytes is required for a PowerPoint presentation?
And that 24 digital photographs occupy memory space of 48 Mbytes?

In the course of 20 years, the transmission performance of networks designed to meet the demands of the future has increased by the incredible factor of 10,000 – and there is no end in sight.




Incredible but true: an uncompressed HDTV film with a length of two hours swallows up 1.35 Tbytes!

The demands made on network processors and the system periphery are rising considerably in step with the rapid increase in file size.

The prospective development of high-performance network technologies takes this fact into consideration.

As far back as 1990, the network industry allowed the transmission of 10 Mbit/s up to the user, thus replacing the techniques used in the first phase.
Five years later, performance at the workplace had been multiplied by 10 to reach 100 Mbit/s.
Since the year 2000, 1 Gigabit Ethernet has been on the increase.

A new era will be rung in with the introduction of 10 Gigabit Ethernet in 2006.

However, rising data rates, increased demands made on availability and growing susceptibility to interference on the one hand against price drops and the associated reduction in the quality of the planning and implementation of network installations on the other are now the cause of increasingly frequent network failure or reduced network performance.

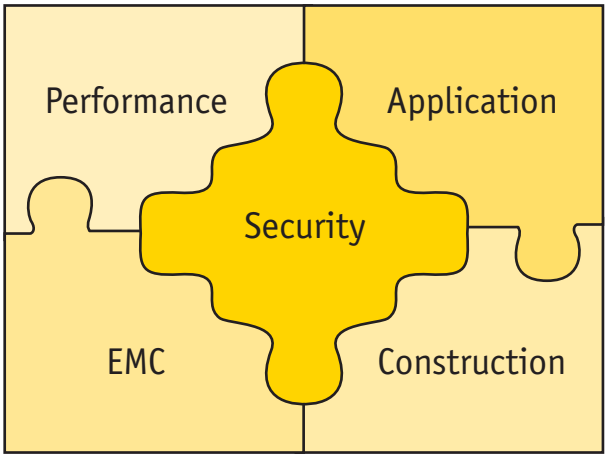
According to a survey carried out by well-known experts, 33 % of faults are due to unsuitable installations and 24 % are a result of insufficient planning. In 18 % of cases, faulty or insufficiently dimensioned cabling components were the cause of network problems.

If you consider that, measured against an expected service life of 10 to 15 years for the cabling required for information technology, the costs only make up 5 % of the total network costs, minimum budgets for the cabling often turn out to be bad investments. Sometimes the follow-up costs are several times the amount spent on the initial installation.

# The SPACE concept

With its new SPACE concept, KERPEN offers the market and its customers a decision-making matrix for finding the correct data cable in a pragmatic, structured way.

The SPACE concept is based on the classification of the 5 main selection criteria for determining the potential overall performance of a data cable.

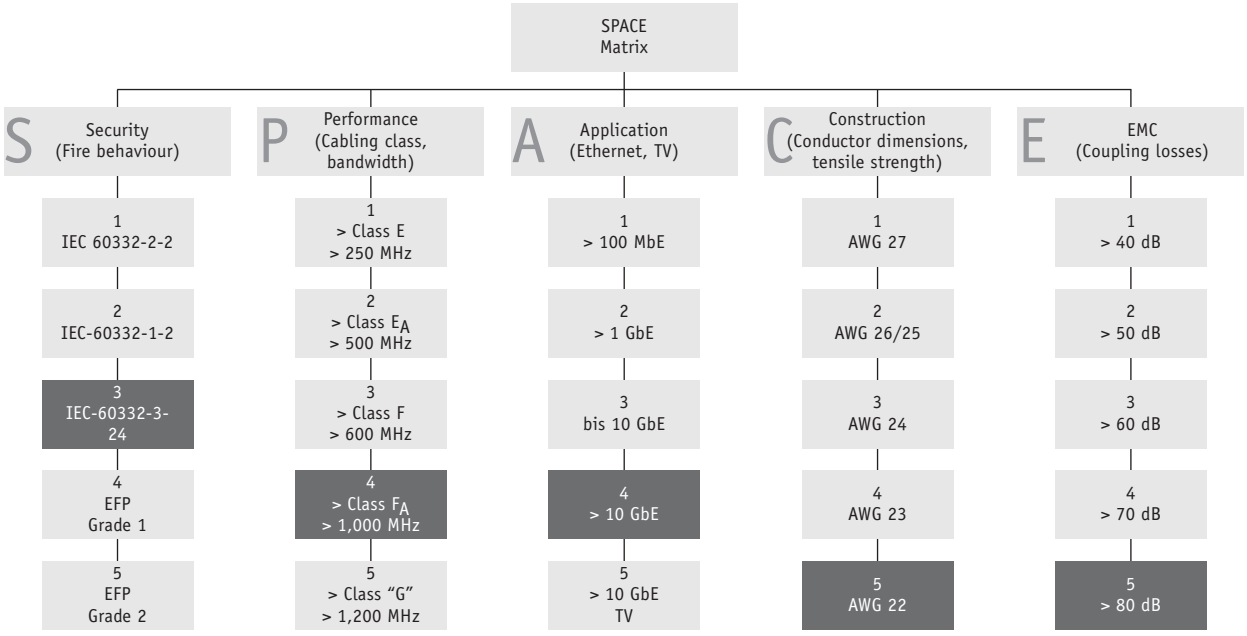



The SPACE concept also allows the value for money to be assessed and creates “space” for alternative technical and economical scenarios.

The demands made on the segment in question rise in step with the increase in the SPACE index.
For example, the cable marked in yellow is a data cable with the SPACE code 34455!
This means that the data cable in question passes the fire test according to IEC 60332-3-24 (Security Level 3), meets the minimum requirements of the new Class $F_A$ (Performance Level 4) and is dimensioned for applications with more than 10 GbE (Application Level 4). It consists of a conductor with AWG 22 (Construction Level 5) and thus has low attenuation values and an increased current-handling capacity. The noise suppression totals > 80 dB (EMC Level 5).

After SPACE classification, the appropriately structured MegaLine® specifications allow the elaboration of further unique technical features such as the safety reserves of the electrical characteristics in comparison to the minimum requirements of the standard and the freedom from heavy metals according to RoHS.

**With the VDE kitemark (an independent hallmark of quality including production monitoring), KERPEN documents that it guarantees the SPACE quality features at all times.**



# S:SECURITY

Fire behaviour

As a result of the constant increase in the installed basis and the installation density, the fire behaviour of data cables is an important safety criterion for avoiding fire damage to persons and material assets. In themselves, data cables are safe resources.
When manufactured according to the legal regulations and installed correctly, they cannot cause a fire. Like all objects made of plastic, however, if cables catch fire, they can ignite and spread the fire. The aim is to prevent or minimise the spreading of fire and the consequential damage it causes. This is achieved via flame-resistant, halogen-free cable designs.

**MegaLine® data cables have improved fire protection characteristics:**

- The extremely low smoke development according to IEC 61034 makes rescue and salvage operations easier
- The low toxicity (dioxins are not produced) means that the risk of poisoning is reduced
- As a result of the freedom from halogens according to IEC 60754-2, there is no consequential damage to material assets as a result of corrosion
- The low fire load values limit the exacerbating effects on the source of the fire
- The high oxygen index (OI up to 45) reduces the flammability

**The KERPEN SPACE concept offers five different security levels with regard to the fire propagation / flame retardance:**

**$S_1$: IEC 60332-2-2:**
Testing of the vertical flame propagation in a core or individual cable. Test method: incandescent flame.

**$S_2$: IEC 60332-1-2:**

Testing of the vertical flame propagation in a core or individual cable. Test procedure: 1 KW flame. A flame is applied to the lower end of a vertical sample of the cable with a length of approx. 60 cm for about 60 seconds using a type of Bunsen burner. After removal of the burner, the flames must go out by themselves. The parts of the cable damaged by the flames must not reach its upper end (distance: 50 mm).

**$S_3$: IEC 60332-3-24:**
Testing of the flame propagation in an arrangement of several cables, a so-called cable bundle, is carried out according to IEC 60332-3-24. In this cable bundle test, a flame is applied to the lower part of the test samples on a vertical ladder with a length of 360 cm using a high-performance burner. During and after intensive application of the flame for a test period of 20 minutes, the cables must not burn higher than 250 cm.

**$S_4$: EFP (Enhanced Fire Performance) Grade 1**

In this cable bundle test, a flame is applied to the lower part of the test samples on a vertical ladder with a length of 360 cm using a high-performance burner. During and after intensive application of the flame for a test period of 20 minutes, only about 1 m of the section to which the flame is applied must burn. Immediately after removal of the flame, the self-extinguishing process must start. Only specially designed data cables can stand up to this exacting fire test.

**$S_5$: EFP (Enhanced Fire Performance) Grade 2**
This stricter safety level is application-specific.

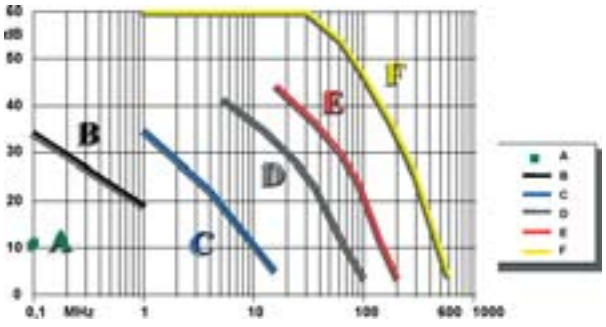
**Safety levels $S_3$ to $S_5$ are used in particular where high and very high safety measures are required for the protection of persons (in hospitals, schools, hotels, airports, stations, department stores etc.) or material assets (in power stations, computer centres, banks and insurance companies, alarm systems etc.).**

# P:PERFORMANCE

Cabling class/bandwidth

Indoor cablings are expected to have a service life of 10 to 15 years.
This requires far-sighted planning of the necessary performance of cabling systems and their components.

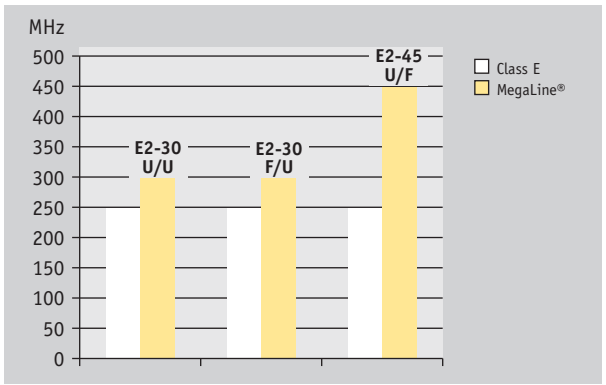
The international standards have often not gone far enough due to the compromises struggled for and in view of the swiftly increasing transmission rates. Since the development of 10 Gigabit Ethernet, none of the cabling classes below Class F can be said to meet the demands of the future.




Hard work is currently being done to standardise new classes in order to meet to the demands of the future.

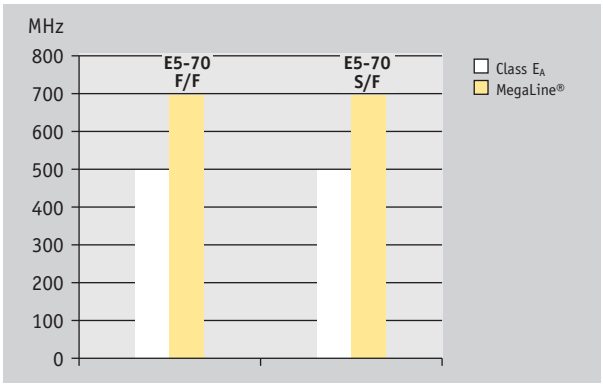
**With the MegaLine® SPACE concept, KERPEN provides five different performance classes to choose from. Each of them in itself has very high reserves with regard to the standard involved.**

### $P_1$: better than Class F (250 MHz)



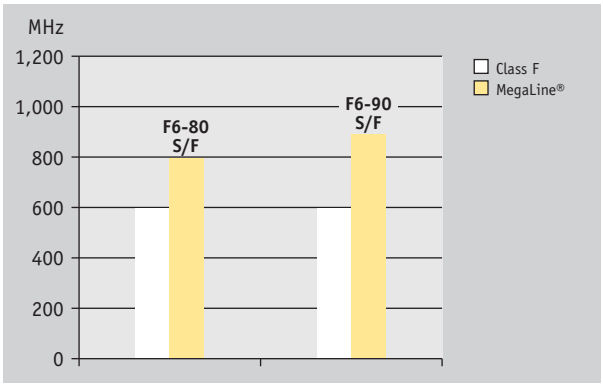

For example MegaLine® E2-45 U/F: better than Category 6 according to EN 50288 and IEC 61156 very good NEXT, low SKEW

### $P_2$: better than Class $E_A$ (500 MHz)



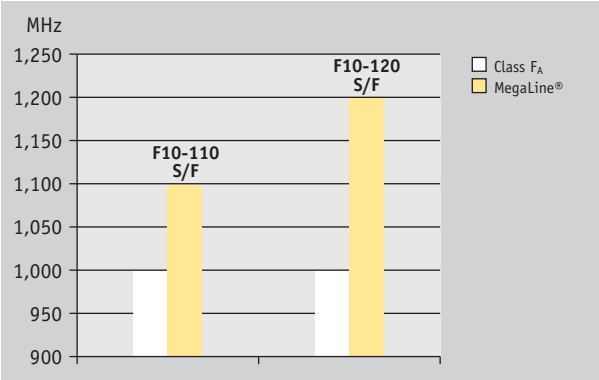

For example MegaLine® E5-70 S/F: better than Category 6 according to EN 50288 and IEC 61156 very good NEXT, very good shield characteristics (shielding of pairs and overall shielding), low SKEW

### $P_3$: better than Class F (600 MHz)



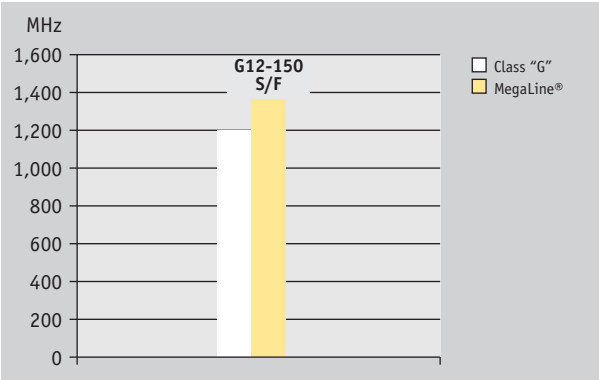

For example MegaLine® F6-90 S/F: better than Category 7 according to EN 50288 and IEC 61156 excellent NEXT, excellent shield characteristics (shielding of pairs and overall shielding), low SKEW

**$P_4$: better than Class $F_A$ (1,000 MHz)**




For example MegaLine® F10-120 S/F: better than Category 7 according to EN 50288 and IEC 61156 excellent NEXT, low attenuation, excellent shield characteristics (shielding of pairs and overall shielding), low SKEW

**$P_5$: better than Class "G" (1,200 MHz)**




MegaLine® G12-150 S/F is better than Category 7 ("8") according to EN 50288 and IEC 61156 excellent NEXT, excellent shield characteristics (shielding of pairs and overall shielding), low SKEW

**MegaLine® data cables have excellent transmission performance. They offer high safety reserves and are always one step ahead of the standard.**
**MegaLine®: an investment with a future!**

# A:APPLICATION

Ethernet/TV

**MegaLine® data cables are real all-rounders.**

Their excellent performance, their "total" universal capabilities and their convincing economic efficiency make them an unbeatable transmission medium for the last mile.
No other transmission medium has as many advantages when the aim is to network communication and information facilities in an economical way which meets the demands of the future.

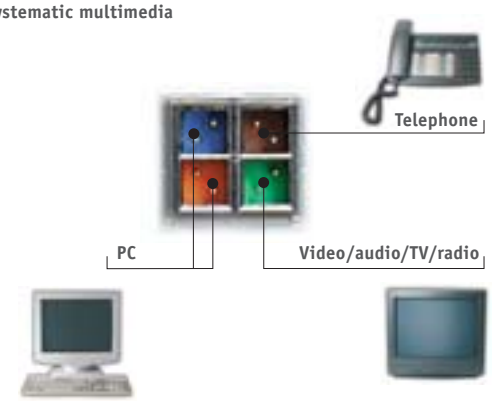
The large safety reserves mean that multimedia applications like TV or transmission protocols with high bandwidth requirements such as 10 Gigabit Ethernet and 8 Gigabit Fiberchannel can be transmitted over 100 m.

Experts have calculated that, as far as we know today, **MegaLine® Category 7 data cables allow transmission distances of as much as 56 Gbit/s.**

The use of low-loss broadband S/FTP cables with individual or overall shield in conjunction with multimedia cabling systems such as ELine 1200® EC7 allows so-called **cable or duty sharing.**
Cables and connectors form a perfect symbiosis: 4 pairs, 4 connecting clips: each with GHz performance.

This allows the parallel, simultaneous use of different applications via one cable and one connector: data, voice and images.

Systematic multimedia




Ultimately, this multimedia system does not need to cost more than conventional systems, in which an individual cable and an individual connector is usually required for each service.

This allows savings of up to 50 % of the necessary cables, connectors, outlets and patch panels.

Multiple use reduces the system costs by 15 – 30 % (depending on the services used).
The reduction of the cables and outlets actually required usually also allows reductions in the costs for cable channels, switching cabinets etc.

**But MegaLine® data cables are capable of more.**

The supply of current (up to 350 mA) and voltage (up to 48 V) can be provided via **PoE (according to IEEE 802.3af).**
The current is fed in centrally via the floor distributor or switch.
Devices such as IP telephones, Web cameras, WLAN access points etc. are supplied via the telecommunications outlet.
The voltage is tapped via a phantom circuit or two unassigned pairs.

**KERPEN provides five different application levels with the MegaLine® SPACE concept.**

**$A_1$: up to 100 Mbit/s (Fast Ethernet)**
IEEE 802.3 u
**$A_2$: up to 1,000 Mbit/s (Gigabit Ethernet)**
IEEE 802.3 ab
**$A_3$: up to 10,000 Mbit/s (10 Gigabit Ethernet)**
IEEE 802.3 an (draft)
**$A_4$: over 10,000 Mbit/s (10 Gigabit Ethernet)**
IEEE 802.3 an (draft)
**$A_5$: over 10,000 Mbit/s (10 Gigabit Ethernet) and TV**
IEEE 802.3 an (draft) and multimedia

**MegaLine® data cables have a convincingly wide range of applications and are unbeatable value for money.**

# C:CONSTRUCTION

Conductor dimensions

The demands made on data cables designed to meet the demands of the future are varied and at times contradictory. MegaLine® data cables of all categories and classes combine high-performance, universal capabilities and economic efficiency. This standard of quality can only be achieved via an integrated cable design.

KERPEN first put MegaLine® data cables in 4-pair S/FTP design (100 Ohm) on the market in the early 90s. This KERPEN innovation has been constantly optimised and adapted to the requirements of the market ever since.
High-precision conductor and core geometries, optimally matched lay lengths in the pairs and the use of very high-quality insulation and sheath materials are the characteristic features of MegaLine® data cables.

MegaLine® data cables are produced on ultra-modern equipment.
As a result of procedural innovations, the machinery used corresponds with the “state of the art” in the data cable industry. The use of physical foaming in the manufacture of high-frequency cores allows excellent, uniform electrical and geometrical characteristics to be achieved. Double skin layers ensure excellent mechanical stability. Patented stranding techniques show that, from a technical point of view, KERPEN takes the lead in the data cable industry.

MegaLine® data cables have low external diameters, thus allowing high packing densities and small bending radii. The weight savings and the robust cable structure are beneficial in assembly and installation, even under difficult conditions.

**With the MegaLine® SPACE concept, KERPEN divides the MegaLine® range into five different conductor classes.**
**The conductor classes describe the permitted tensile stress during installation and the conductor resistance. The current-handling capacity for a maximum environmental temperature of 60°C and the maximum installation lengths in the transmission channel can be derived from this on request.**

**$C_1$: AWG 27 (7x0.14 mm/0.112 mm²)**

Tensile stress: 40/20 N (4P/2P) maximum
Conductor resistance: 165 ohm/km maximum

**$C_2$: AWG 26 / AWG 25**

- **$C_{21}$: AWG 26 (7x0.16 mm/0.14 mm²)**
  Tensile stress: 60/30 N (4P/2P) maximum
  Conductor resistance: 132 ohm/km maximum

- **$C_{22}$: AWG 25 (7x0.18 mm/0.175 mm²)**
  Tensile stress: 70/35 N (4P/2P) maximum
  Conductor resistance: 105.6 ohm/km maximum

**$C_3$: AWG 24 (0.51 mm/0.205 mm²)**

Tensile stress: 90/45 N (4P/2P) maximum
Conductor resistance: 86.8 ohm/km maximum

**$C_4$: AWG 23 (0.57 mm/0.258 mm²)**

Tensile stress: 110/55 N (4P/2P) maximum
Conductor resistance: 68.9 ohm/km maximum

**$C_5$: AWG 22 (0.64 mm/0.325 mm²)**

Tensile stress: 130/65 N (4P/2P) maximum
Conductor resistance: 54.7 ohm/km maximum

**MegaLine® data cables can be recognized by their unmistakable “Ethernet” yellow. But there's only KERPEN inside if it says so on the outside!**

# E:EMC

Coupling attenuation

The electromagnetic compatibility (EMC) is the ability of devices, systems and plants to function satisfactorily in an electromagnetic environment without negative effects on other devices, systems or plants.
EMC legislation prescribes the electromagnetic compatibility of devices, systems and plants. The limits for the emission of interference and the immunity to interference which must be observed are regulated in EN 55022 (Class B) and EN 50082-1/2 / EN 55024.

The purpose of a data cable is to resist electromagnetic influences coming from the outside to the inside (immunity to interference) and from the inside to the outside (emission of interference).
The susceptibility of data cable systems to interference increases in step with the transmission frequency and the data rates (currently 10 Gigabit Ethernet).
**The main danger is increasingly a result of the Alien Crosstalk between adjacent data cables.**

Depending on their structure, data cables have different capabilities with regard to the prevention or reduction of interference.

- Unshielded data cables have very good symmetry characteristics but are not shielded against internal, external or adjacent sources of interference. They are endangered to a high degree by the environment of the installation.

- Data cables with individual or overall shield have very good symmetry characteristics and good or even very good shield characteristics. The EMC is very good or even excellent. Interference coming from the environment of the installation (adjacent data cables) can be ruled out completely.

**With the MegaLine® SPACE concept, KERPEN provides five different EMC levels to choose from.**

The evaluation criteria are the coupling attenuation (interference power suppression).
As the sum of the shield attenuation and the symmetry attenuation, the coupling attenuation are the “be-all and end-all” for the assessment and comparison of the overall EMC behaviour of data cables with various different structures.
**MegaLine® data cables with a dual shield reach values of > 80 dB up to 1,000 MHz, thus suppressing incoming or outgoing potential interference by a factor of > 10,000.**

**$E_1$: Coupling attenuation > 40 dB**
Interference suppression exceeding a factor of 100

**$E_2$: Coupling attenuation > 50 dB**
Interference suppression exceeding a factor of 300

**$E_3$: Coupling attenuation > 60 dB**
Interference suppression exceeding a factor of 1,000

**$E_4$: Coupling attenuation > 70 dB**
Interference suppression exceeding a factor of 3,000

**$E_5$: Coupling attenuation > 80 dB**
Interference suppression exceeding a factor of 10,000

**MegaLine® S/FTP data cables with overall shield and individually shielded S/FTP data cables have an excellent EMC, making them an obvious choice for the fail-safe transmission of high data rates such as those offered by 10 Gigabit Ethernet etc.**

**Electromagnetic compatibility**

| Structure | U/UTP | F/UTP | S/FTP |
|---|---|---|---|
| Symmetry characteristics | +++ | ++ | ++ |
| Shield characteristics | ./. | + | +++ |
| Influence of the installation environment | – | – | ./. |

# Nomenclature

There are a large number of different type designations. The standardisation defined in ISO/IEC 11801 2nd Edition determines the elements of the design in an unambiguous way:

**xx/xxx**

- 3rd x: Balanced element ___TP
- 2nd x: Individual shield___U = Unshielded; F = Foil shield
- 1st x: Overall shield___F = Foil shield; S = Copper braid shield; SF = Cooper braid and foil shield

**Examples:**

SF/UTP = Cable with overall copper braid and foil shield with unshielded individual elements.

S/FTP = Cable with overall copper braid shield and individual elements with foil shield.

## Cable types

S/FTP

F/FTP

U/FTP

| Letter for cabling class | Bandwidth acc. to standard (factor 100) | Bandwidth MegaLine® (factor 10) |
|---|---|---|
| "G" = Class "G"<br>F = Class F<br>E = Class E<br>D = Class D | 12 = 1,200 MHz<br>10 = 1,000 MHz<br>6 = 600 MHz<br>5 = 500 MHz<br>2 = 250 MHz<br>1 = 100 MHz | 150 = 1,500 MHz<br>120 = 1,200 MHz<br>110 = 1,100 MHz<br>90 = 900 MHz<br>8 = 800 MHz<br>70 = 700 MHz<br>45 = 450 MHz<br>30 = 300 MHz<br>20 = 200 MHz |

**SF/UTP**

**F/UTP**

**U/UTP**

With the SPACE concept, KERPEN has introduced a new nomenclature for Megaline®.
This makes it easier to assign cables to the old and new cabling classes and the corresponding categories.
The new nomenclature also includes the indication of the bandwidth of MegaLine® in comparison to the standard. This allows you to make the perfect choice "at a glance".
The new nomenclature is rounded off by information on design according to the international standard and the material used for the sheath.

**Example:**

**MegaLine® F10-120 S/F H: data cable according to new cabling class $F_A$ (1,000 MHz) with a bandwidth of 1,200 MHz in S/FTP design and with a halogen-free outer sheath.**

**Design**
**TP (Twisted Pair)**

S/F = Overall shield (copper braid)/individual shield (foil)
F/F = Overall shield (foil)/individual shield (foil)
U/F = Unshielded/individual shield (foil)
SF/U = Overall shield (copper braid & foil)/unshielded
F/U = Overall shield (foil)/unshielded
U/U = Unshielded/unshielded

**Sheath**

H = Halogen-free, flame-retardant
Y = PVC
2Y = PE
11Y = PUR