

## Shielding and Armoring

### Overview

#### Innovative Leadership

The evolution of technology maintains steady demand for sophisticated cable shielding. Belden meets that demand with innovative shielding and shield effectiveness testing methods to supply you with high quality, dependable cable.

With the creation of trademarked shield designs and patented test methods, Belden has earned a reputation for innovation and leadership that is unequalled in the wire and cable industry. In addition, Belden offers the broadest line of shielded multi-conductor, coaxial and flat cable in the industry.

Several unique Belden innovations are utilized across a wide range of shielding applications:

- **Beldfoil®** — The first aluminum/polyester foil developed for use as a cable shield. Provides 100% shield coverage for optimum protection.
- **Duofoil®** — Consists of an aluminum-poly-aluminum laminate wrapped around the cable's dielectric core. Provides 100% physical coverage, and improves shield reliability and flex life.

Belden also utilizes a number of innovative techniques to apply shielding to multi-conductor and paired cables:

- **“French Braid” Shields** — Belden's patented “French Braid” shield is a double spiral (double serve shield) with the two spirals tied together by one weave.



Belden's patented “French Braid” shield.

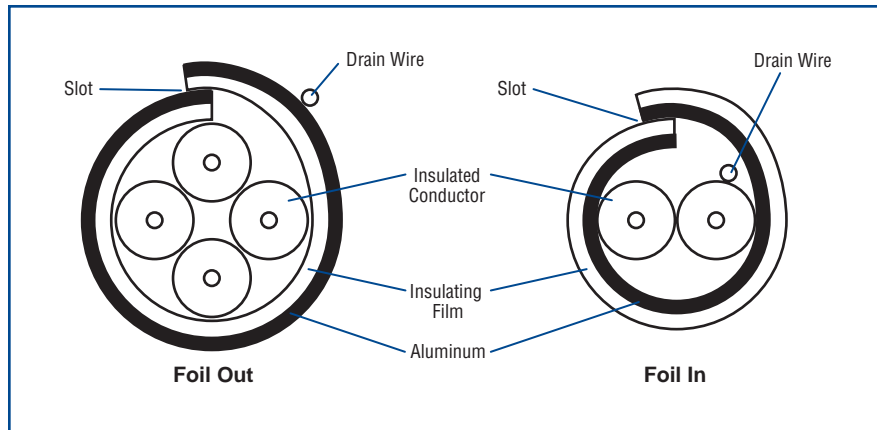


Figure 1: Foil shield configurations without shorting folds.

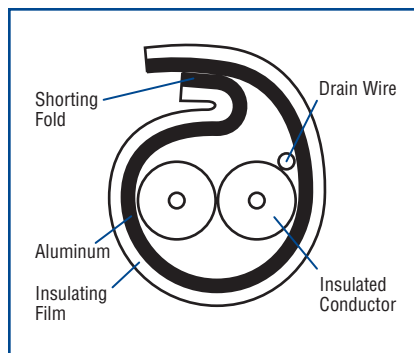


Figure 2: Foil shield configuration with shorting fold.

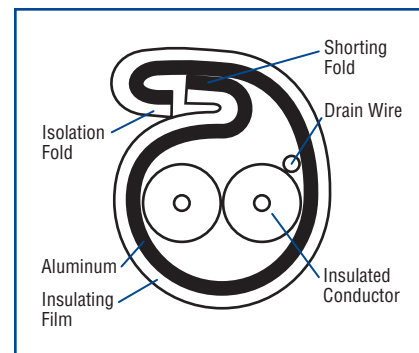


Figure 3: Foil shield with Z-Fold reduces crosstalk in multi-pair applications.

- **Shorting Fold** — Belden uses a shorting fold technique to maintain metal-to-metal contact for improved high frequency performance. Without the shorting fold, a slot is created through which signals can leak and cause interference. (See Figures 1 and 2 above.)

- **Z-Fold®** — Belden improves on the traditional shorting fold by employing a Z-Fold designed for use in multi-pair applications to reduce crosstalk. The Z-Fold (see Figure 3) combines an isolation and a shorting fold. The shorting fold provides metal-to-metal contact while the isolation fold keeps shields from shorting to one another in multi-pair, individually shielded cables.

The use of either a shorting fold or a Z-Fold increases the foil shield's range of effectiveness to higher frequencies.

## Shielding and Armoring

### Characteristics of Belden® Shield Types and Armor Styles

#### Foil Shields

Foil shields consist of aluminum foil laminated to a polyester or polypropylene film. The film gives the shield mechanical strength and bonus insulation. Foil shields provide 100% cable coverage, necessary for electrostatic shield protection. Because of their small size, foil shields are commonly used to shield individual pairs of multi-pair data cables to reduce crosstalk. They have less weight, bulk and cost less than spiral or braid shields and are generally more effective than braid shields in RF ranges. Foil shields are more flexible than braid but have a shorter flex life than spiral or braid.

Drain wires are used with foil shields to make termination easier and to ground electrostatic discharges. The shortcomings in using the foil shield include higher DC resistance and lower mechanical strength than braid or spiral shields.

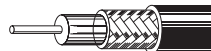


#### Braid Shields

A braid shield consists of groups of tinned or bare copper or aluminum strands, one set woven in a clockwise direction and interwoven with another set in a counter-clockwise direction.

Braid shields provide superior structural integrity, while maintaining good flexibility and flex life. These shields are ideal for minimizing low frequency interference and have lower DC resistance than foil. Braid shields are effective at audio, as well as RF ranges. Generally, the higher the braid coverage, the more effective the shield. However, the trade-off between cost and braid coverage must be considered. Typical braid coverages are between 80% and 95%. Coverage of 100% is unattainable with a braid shield. Other features to consider when choosing a braid shield are the weave angle, strand diameter, number of carriers (strand groups) and the number of ends (strands).

Braid shields are generally bulkier and heavier than other shields and, in some cases, harder to terminate because the braid may be combed out and pigtailed.



#### Spiral/Serve Shields

A spiral/serve shield consists of wire (usually copper) wrapped in a spiral around the inner cable core.

Superior flexibility and flex life, ease of termination and up to 97% coverage are the advantages of spiral shields. They are best suited for audio applications. As a rule, spiral shields are not effective above the audio frequency range due to the coil effect produced by the inductance of served wire strands.



#### “French Braid” Shields

Belden's patented “French Braid” shield is a double spiral (double serve shield) with the two spirals tied together by one weave. This construction provides improved flex life over standard spiral shields, improved flexibility over conventional braid shields, and lower levels of microphonic or triboelectric noise than either spiral or conventional braid shields.



#### Combination Shields

Combination shields consist of more than one layer of shielding. They provide maximum shield efficiency across the frequency spectrum. The combination foil/braid shield combines the advantages of 100% foil coverage, plus the strength and low DC resistance of the braid.

Belden has also developed a number of shielding configurations for use with broadband coaxial cables.

- **Duobond®**  
Duobond is essentially the same construction as Duofoil® (a laminated tape of foil/film/foil), but with an extra layer of adhesive bonding the foil shield to the dielectric core. This foil shield provides 100% coverage and insures maximum shield protection.

- **Duobond II (Foil/Braid)**

Combines Duobond with an outer braid, applied for greater protection against interference and to increase the overall tensile strength.

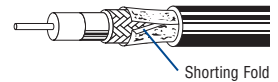


- **Duobond III (Tri-Shield)**

Utilizes the Duobond II design (foil/braid) plus a surrounding layer of Duofoil. The extra foil layer improves shield reliability and provides an additional interference barrier.



- **Duobond Plus®** — Features foil/braid/foil construction with a shorting fold in the outermost foil. This fold prevents a slot opening from being created in the shield, thereby preventing signal egress or ingress.



- **Duobond IV (Quad Shield)**

Offers an extra layer of braid shield (foil/braid/foil/braid) for improved strength and durability.



Other combination shields are available such as the foil/braid/foil/braid used on the Ethernet cables, braid/braid or foil/spiral.

#### Armoring

Belden's innovative technology delivers maximum effectiveness to meet the performance requirements of a wide range of applications.

Belden also has the capability to protect electronic, instrumentation, and control cables with interlocking steel or aluminum armor.

# Shielding and Armoring

Shield Types Application Guide, Table 8: Relative Cost Comparison of Shield Types

Table 9: Shield Performance Ratings

## Shield Types Application Guide

### Choose a Foil Shield...

- For protection against capacitive (electric field) coupling where shield coverage is more important than low DC resistance.
- When possible sources of interference include TV signals, crosstalk from other circuits, radio transmitters, fluorescent lights or computing equipment.
- For MATV, CATV, video, networking, computer I/O cables in office, industrial or commercial environments where ambient EMI levels are low.

### Choose a Braid Shield...

- For superior performance against diffusion coupling, where low DC resistance is important, and to a lesser extent, capacitive and inductive coupling.
- When possible sources of interference exhibit low impedance characteristics, such as motor control circuits and switches which operate inductive loads.
- For computer to terminal interconnect for process, instrumentation or control applications.

### Choose a Spiral Shield...

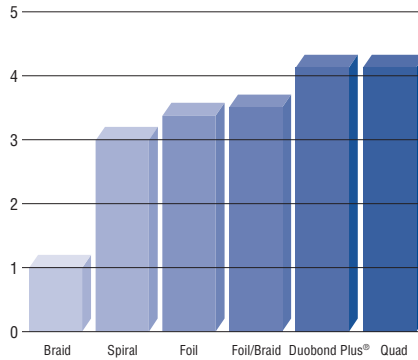
- For functional shielding against diffusion and capacitive coupling at audio frequencies only.
- When possible sources of interference are power lines and fluorescent lights.
- For applications when flexibility and flex life are major concerns, such as microphone and audio cables and retractile cords.

### Choose a Combination Shield...

- For shielding against high frequency radiated emissions coupling and ESD. Combines the low resistance of braid and 100% coverage of foil shields.
- When possible sources of interference include radio transmitters, TV stations, printed circuit boards, back planes, motor control circuits and computing equipment.
- For Video, CATV, MATV, networking, computer I/O cables and computer-aided manufacturing applications.

### Table 8: Relative Cost Comparison

Relative cost comparisons are based on coaxial cable. Chart shows relative shield cost as one component of the total cost of the cable. *These cost ratings may change depending on the physical construction of the cable.*



### Table 9: Shield Performance Comparison Chart

Frequency Range and Types of Interference Anticipated	Cable Shield Ratings*				
	Braid (95% Coverage)	Spiral	Foil	Foil/Braid	Foil/Braid/Foil Duobond Plus®
<b>Frequency: DC</b>					
Capacitive	A	AA	AAA	AAA	AAA
Diffusion	AAA	A	C	AAA	AAA
Diffusion/Inductive	—	—	—	—	—
Diffusion/Inductive/Capacitive	—	—	—	—	—
<b>Frequency: 15 kHz</b>					
Capacitive	A	AA	AAA	AAA	AAA
Diffusion	AAA	B	C	AAA	AAA
Diffusion/Inductive	AA	C	A	AA	AAA
Diffusion/Inductive/Capacitive	—	—	—	—	—
<b>Frequency: 10 MHz to 1000 MHz</b>					
Capacitive	A	AA	AAA	AAA	AAA
Diffusion	—	—	—	—	—
Diffusion/Inductive	B	C	A	AA	AAA
Diffusion/Inductive/Capacitive	B	C	A	AA	AAA

\*Although ratings shown in Table 9 are based on shielded coaxial cable test results, these ratings also pertain to shielded multi-conductor and flat cable where shield types are available.

Note: Shield effectiveness decreases as frequency increases. Therefore, ratings in one frequency category do not imply equal shield effectiveness in other frequency categories.

Shield Rating Key	
AAA	Best
AA	Better
A	Good
B	Functional
C	Unsatisfactory
—	Not Applicable