*159159*

# CABLE ASSEMBLY

*G00002*

## TECHNICAL FIELD

The present invention relates generally to cable assemblies, and more particularly to extensible cable assemblies.

## BACKGROUND

It is a common practice to use a cable assembly to electrically connect two electronic devices. One example is to connect a data storage device to a computer system by having one end of a cable assembly configured with a plug connector interconnected to a socket connector on a printed circuit board (PCB) which is coupled to the data storage device and another end of the cable assembly having a second plug connector interconnected to a second socket connector on a backplane of the computer system.

The management of the cable assembly becomes difficult when the cable has a large number of conductors and when interconnecting relatively moveable electronic devices. In the example given above, a large number of conductors are required to interconnect the electronic circuitry on the printed circuit board of the data storage device to the backplane of the computer system. The data storage device is often disposed on a sliding drawer. An excess length of the conductors is needed in order to facilitate the movement of the drawer towards and away from the backplane of the computer system. It is undesirable to leave the conductors loose during the movement of the drawer as the conductors may be entangled and therefore, be damaged.

Solutions have been devised to store lengths of cables for selective extension of the cables when a component connected to one end of the cable assembly is moved towards and away from a component mounted to the other end of the cable assembly. One such solution is described in United States Patent

Number 3,647,936. Some of the earlier solutions are adapted for use with relatively heavy gauge cables comprising no more than a few conductors. Other solutions involve bulky hinged frames which may be expensive to manufacture and/or are unsuitable for compact electronic equipment due to the space constraints.

## SUMMARY

It would be desirable to provide cable assemblies, and more particularly to extensible cable assemblies whereby cables in the cable assemblies reproducibly folds and unfolds when in use.

In accordance with one embodiment of the present invention, there is provided a cable assembly having a folded planar cable housed within a cable tidy. The cable tidy includes a header section comprising a first end of the cable tidy and a body section comprising an opposite second end of the cable tidy whereby the body section being extensible from the header section of the cable tidy. The cable has a first cable end disposed at the first end of the cable tidy configured to be connected to a first substrate and a second cable end disposed at the second end of the cable tidy configured to be connected to a second substrate. The cable tidy organises the cable in such a manner that the cable reproducibly folds and unfolds as the body section of the cable tidy moves in and out of the header section of the cable tidy.

In accordance with another embodiment of the present invention, there is provided a cable assembly including a cable tidy and a planar cable housed within the cable tidy. The cable tidy includes a header section comprising a first end of the cable tidy and a body section comprising an opposite second end of the cable tidy, and the body section being extensible from the header section of the cable tidy. The planar cable includes a plurality of conductor sets, each having one or more insulated conductors, extending along a length of the cable

and being spaced apart from each other along a width of the cable. The planar cable further includes a first shielding film disposed on one side of the cable bonded to a second shielding film disposed on an opposite side of the cable. The first and second films have cover portions and pinched portions arranged such that, in transverse cross section, the cover portions of the first and second films in combination substantially surround each conductor set, and the pinched portions of the first and second films in combination form pinched portions of the cable on each side of each conductor set, the pinched portions being thinner than the conductor sets. A first cable end disposed at the first end of the cable tidy is configured to be connected to a first electronic device. An opposite second cable end disposed at the second end of the cable tidy is configured to be connected to a second electronic device. When the body section of the cable tidy moves in and out of the header section of the cable tidy, the cable reproducibly folds and unfolds.

The invention further includes any alternative combination of parts or features mentioned herein or shown in the accompanying drawings. Known equivalents of these parts or features which are not expressly set out are nevertheless deemed to be included.

## BRIEF DESCRIPTION OF THE DRAWINGS

An exemplary form of the present invention will now be described with reference to the accompanying drawings in which:

**Figure 1** is a perspective cross-sectional view of an exemplary embodiment of a cable assembly in an extended position in accordance with the present invention;

**Figure 2** is a perspective view of the cable tidy in Figure 1;

**Figure 3A** is a perspective cross-sectional partial view of the cable tidy in Figure 2;

**Figure 3B** is a perspective cross-sectional detail view of a header section of the cable tidy in Figure 3A in a locked position with a telescoping part of the cable tidy in Figure 3A;

**Figure 3C** is a perspective cross-sectional detail view of the telescoping part of the cable tidy in Figure 3A in a locked position with a neighbouring telescoping part of the cable tidy in Figure 3A;

**Figure 4** is a perspective view of an exemplary embodiment of a cable to be disposed in the cable assembly of the present invention;

**Figure 5A** is a perspective view of an exemplary embodiment of a cable to be disposed in the cable assembly of the present invention wherein each conductor in the cable is encompassed by a first dielectric;

**Figure 5B** is a cross-sectional view of the conductor in Figure 5A about to be bonded to a film;

**Figure 5C** is a cross-sectional view of another configuration of a cable to be disposed in the cable assembly of the present invention wherein each conductor in the cable is encompassed by a first dielectric;

**Figure 5D** is a cross-sectional view of another configuration of a cable to be disposed in the cable assembly of the present invention wherein each conductor set includes a concentric portion, a pinched portion and a transition portion;

**Figure 6** is a perspective view of an exemplary embodiment of a cable to be disposed in the cable assembly of the present invention wherein the cable may be bent while maintaining good electrical properties;

**Figure 7** is a perspective view of a cable fabricated with a first substrate wherein conductive traces on the first substrate are in electrical contact with conductor sets of the cable;

**Figure 8** is a perspective cross-sectional view of another exemplary embodiment of a cable assembly in an extended position in accordance with the present invention;

**Figure 9** is another perspective cross-sectional view of the cable assembly of Figure 8; and

**Figure 10** is a partial perspective view of a cable included in the cable assembly of Figure 8 with a first and second set of cable pegs.

While the above identified drawing figures set forth several embodiments of the invention, other embodiments are also contemplated, as noted in the discussion. In all cases, this disclosure presents the invention by way of representation and not limitation. It should be understood that numerous other modifications and embodiments can be devised by those skilled in the art, which fall within the scope and spirit of the principles of the invention. The figures may not be drawn to scale. Like reference numbers have been used throughout the figures to denote like parts.

## DETAILED DESCRIPTION

Figure 1 illustrates a perspective cross-sectional view of an exemplary embodiment of a cable assembly **100** in an extended position in accordance with the present invention. The cable assembly **100** comprises a cable **1000** housed within a cable tidy **200**. The cable tidy **200** includes a header section **210** comprising a first end **201** of the cable tidy **200** and a body section **230** comprising an opposite second end **202** of the cable tidy **200**. The body section **230** is extensible from the header section **210** of the cable tidy **200** and the cable tidy **200** organises the cable **1000** in such a manner that the cable **1000** reproducibly folds and unfolds as the body section **230** of the cable tidy **200** moves in and out of the header section **210** of the cable tidy **200**.

In one embodiment, the body section **230** further comprises a first end **231**, a second end **232** and a plurality of telescoping parts **220**. The body section **230** slidably extends from the header section **210** of the cable tidy **200** when the telescoping parts **220** of the body section **230** slide out of the header section **210**. With reference to Figure 2 which shows a perspective view of the cable tidy **200** in Figure 1, the header section **210** has a first end **211**, a second end **212**, a first side section **213** extending from the first end **211** to the second end **212**, a second side section **214** extending from the first end **211** to the second end **212** and a bridging section **215** connecting the first side section **213** to the second side section **214**. Similarly, each telescoping part **220** has a first end **221**, a second end **222**, a first side section **223** extending from the first end **221** to the second end **222**, a second side section **224** extending from the first end **221** to the second end **222** and a bridging section **225** connecting the first side **223** section to the second side section **224**. A groove **240** may be present and configured on the first side sections **213**, **223** and the second side sections **214**, **224** of both the header section **210** and the body section **230** for the purpose of guiding and keeping the telescoping parts **220** in alignment as they slide along the lateral axis Z.

Perspective cross-sectional views of the cable tidy **200** in Figure 2 are illustrated in Figures 3A, 3B and 3C wherein the cable tidy **200** further comprises a plurality of interlocking devices **250A**, **250B** and a plurality of complementary interlocking devices **260A**, **260B** configured on the header section **210** and the telescoping parts **220**. For the purposes of explaining the operation of the interlocking devices with the complementary interlocking devices during use, the telescoping parts **220** are further differentiated as telescoping part **220A** and neighbouring telescoping part **220B**.

During use, the cable tidy **200** may be extended and retracted as needed. When the cable tidy **200** is extended, the body section **230** comprising telescoping part **220A** and neighbouring telescoping part **220B**, slides out of the header section **210** along the lateral axis Z in the direction indicated by arrow A in Figure 3A. The telescoping part **220A** will continue to slide until the interlocking device **250A** configured on the telescoping part **220A** is engaged with the complementary interlocking device **260A** configured on the header section **210** as illustrated by Figure 3B. Once the interlocking device **250A** is fully engaged with the complementary interlocking device **260A**, the telescoping part **220A** is locked in its position relative to the header section **210** and the telescoping part **220A** will not slide further away from the header section **210**.

At this point, the neighbouring telescoping part **220B** will start to slide out of the telescoping part **220A**. Similarly, when the interlocking device **250B** on a neighbouring telescoping part **220B** is fully engaged with the complementary interlocking device **260B** configured on the telescoping part **220A** as illustrated by Figure 3C, the neighbouring telescoping part **220B** is locked in its position relative to the telescoping part **220A** and the neighbouring telescoping part **220B** will not slide further away from the telescoping part **220A**. The cooperation of the interlocking devices **250A**, **250B** with the complementary interlocking devices **260A**, **260B** ensures that the header section **210** and the body section **230**

stay connected as the body section **230** slidably extends from the header section **210** when the cable tidy **200** is extended.

Reversely, as the cable tidy **200** retracts, the interlocking device **250B** on the neighbouring telescoping part **220B** disengages from the complementary interlocking device **260B** configured on the telescoping part **220A** before the neighbouring telescoping part **220B** starts to slide along the lateral axis Z towards the header section **210** in the direction indicated by arrow B in Figure 3A. When the neighbouring telescoping part **220B** fully slides into the telescoping part **220A**, the interlocking device **250A** on the telescoping part will disengage from the complementary interlocking device **260A** configured on the header section **210** before the body section **230** slides along the lateral axis Z into the header section **210**. While the drawings and explanation above make reference to two telescoping parts, it is important to note that the scope of this invention is not limited to two telescoping parts as more telescoping parts may be added in similar fashion as and where needed.

With reference to Figure 2, in another exemplary embodiment of the present invention, the cable assembly **100** further comprises a plurality of securing devices configured on the cable tidy **200**. In one configuration, the header section **210** of the cable tidy **200** is configured with a securing device such as a cable clip **270** on the bridging section **215** for securing a first end **1010** of the cable **1000** (not shown) housed within the cable tidy **200** to the header section **210**. In another configuration, the header section **210** of the cable tidy **200** is further configured with a plurality of attachment braces **280A** on the bridging section **215** for securing the header section **210** of the cable tidy **200** to an external casing (not shown) which may further be connected to a fixed module (not shown) of an electronic system. In any of the configurations, the cable tidy **200** may further comprise a plurality of attachment braces **280B** extending from at least one side section **223**, **224** of one telescoping part **220** wherein the attachment braces **280B** secure the telescoping part **220** to a printed circuit board

(not shown) which may further be connected to a moveable module (not shown) of an electronic system.

A cable disposed in the cable tidy **200** of the cable assembly **100** may be, but not limited to, a shielded electrical cable suitable for high speed data transmission with unique and beneficial properties and characteristics. The cable is typically in a generally planar or ribbon format, with one or more conductor sets each including one or more conductors (which may or may not be insulated) extending along a length dimension of the cable and spaced apart from each other along a width dimension of the cable. The insulated conductors may have a wire diameter of no more than 24 American Wire Gauge (AWG). The cable may provide high packing density in a limited cable width, preferably while maintaining adequate high frequency electrical isolation and/or low crosstalk between the different conductor sets of the cable. The cable may have one or more drain wires to provide on-demand or localised drain wire feature by attaching the drain wires differently to different termination components on opposite ends of the cable. The cable may provide mixed conductor sets, e.g., one or more conductor sets adapted for high speed data transmission, and one or more conductor sets adapted for lower speed data transmission or power transmission. A configuration of the cable may provide only one of these beneficial design features, while another configuration of the cable may provide combinations of some or all of these features. The cable may be a shielded electrical cable similar to that described in United States Provisional Patent Application Numbers 61/218739, 61/260881, 61/348800 and 61/352473. These applications are hereby incorporated in the present application by reference.

Figure 4 shows a perspective view of an exemplary embodiment of a shielded planar electrical cable **1000A** which may be disposed in the cable assembly **100** of the present invention. The cable **1000A** which may be used to connect a high speed data storage device to a backplane of a computer system comprises a plurality of first conductor sets **1100A** and second conductor sets

**1100B**, each conductor set having a plurality of conductors **1150** with an insulator **1160**. The first conductor set **1100A** may be used for data transmission while the second conductor set **1100B** may be used for command instruction exchange between the data storage device (not shown) and the backplane of the computer system (not shown). The cable **1000A** further comprises a plurality of drain wires **1170** disposed between the first conductor set **1100A** and the second conductor set **1100B**.

In another embodiment of the present invention, a cable **2000** which may be disposed in the cable tidy **200** of the cable assembly **100** is a shielded electrical ribbon cable with dielectric spacing similar to that described in United States Provisional Patent Application Number 61/378868, of which the application is hereby incorporated in the present application by reference.

The cable **2000** as shown in Figure 5A comprises at least one conductor set **2100** having at least two elongated conductors **2150** extending from end-to-end of the cable **2000**, wherein each of the conductors **2150** are encompassed along a length of the cable **2000** by respective first dielectrics **2210**. The cable **2000** further comprises a first and second film **2310**, **2320** extending from end-to-end of the cable **2000** and disposed on opposite sides of the cable **2000**, wherein the conductors **2150** are fixably coupled to the first and second films **2310**, **2320** such that a consistent spacing **2330** is maintained between the first dielectrics **2210** of the conductors **2150** of each conductor set **2100** along the length of the cable **2000**. The cable **2000** further comprises second dielectrics **2220**, which may include but not limited to air gaps, disposed within the spacings between the first dielectrics **2210** of the conductors **2150** of each conductor set **2100**.

In more particular configurations, at least one of the first and second films **2310**, **2320** may be conformably shaped to, in transverse cross section of the cable **2000**, partially surround each conductor set **2100**. For example, both the

first and second films **2310**, **2320** may be in combination conformably shaped to, in transverse cross section of the cable **2000**, substantially surround each conductor set **2100**. In such case, flattened portions **2410** of the first and second films **2310**, **2320** may be coupled together to form a flattened cable portion on each side of at least one conductor set **2100**.

In any of these configurations, the first dielectrics **2210** of the conductors **2150** may be bonded to the first and/or second films **2310**, **2320**. In an example illustrated in Figure 5B, the second film **2320** comprising a rigid dielectric layer **2322**, a shielding film **2324** fixably coupled to the rigid dielectric layer **2322** and a deformable dielectric adhesive layer **2326**, may be bonded to the first dielectric **2210** of the conductor **2150** when the conductor **2150** moves towards the second film **2320** in the direction as shown by the arrow D and comes into contact with the deformable dielectric adhesive layer **2326**.

In any of these configurations, a dielectric constant of the first dielectric **2210** may be higher than a dielectric constant of the second dielectric **2220**. Also in any of these configurations, at least one conductor set **2100** may be adapted for maximum data transmission rates of at least 1 Giga bits per second (Gb/s).

In a configuration illustrated in Figure 5C, the first and second films comprise first and second shielding films **2311**, **2312** disposed on opposite sides of the cable **2000A** and the conductors **2150** in the conductor set **2100A** are separated by a dielectric gap **2221**. In some cases, one or both shielding films may include a conductive layer disposed on a dielectric substrate. In some cases, the first and second shielding films **2311**, **2312** include cover portions **2420** and pinched portions **2430** arranged such that, in traverse cross section, the cover portions **2420** of the first and second shielding films **2311**, **2312** in combination substantially surround each conductor set **2100A**, the pinched portions **2430** of the first and second shielding films **2311**, **2312** in combination form pinched portions **2430** of the cable **2000A** on each side of each conductor set **2100A**, and

the pinched portions **2430** being thinner than the conductor sets **2100A**. In some cases, a first adhesive layer **2331** bonds the first shielding film **2311** to the second shielding film **2312** in the pinched portions **2430** of the cable **2000A**.

In another configuration as illustrated by Figure 5D, the first and second shielding films **2311, 2312** may include concentric portions **2425**, pinched portions **2430**, and transition portions **2440** arranged such that, in transverse cross section, the concentric portions **2425** are substantially concentric with one or more end conductors **2150** of each conductor set **2100B**, the pinched portions **2430** of the first and second shielding films **2311, 2312** in combination form pinched portions **2430** of the cable **2000B** on two sides of the conductor set **2100B**, and the transition portions **2440** provide gradual transitions between the concentric portions **2425** and the pinched portions **2430**. In any of these configurations, the cable **2000B** may further comprise a drain wire **2170** disposed along the length of the cable **2000B** and in electrical communication with at least one of the first and second shielding films **2311, 2312**.

Figure 6 shows a perspective view of an exemplary embodiment of another cable **3000** which may be disposed in the cable tidy **200** of the cable assembly **100**. The cable **3000** is a high speed shielded electrical cable that has a plurality of conductor sets **3100**, each conductor set **3100** having a plurality of insulated conductors **3150** extending along a length of the cable **3000** and being spaced apart from each other along a width of the cable **3000**. The cable **3000** has unique electrical and bending characteristics as well as the conductor sets **3100** within may be arranged in many ways including those taught in United States Provisional Patent Application Numbers 61/378902, 61/378872, 61/378640 and 61/378856. These applications are hereby incorporated in the present application by reference.

As shown in Figure 6, the cable **3000** has eight conductor sets **3100** and two drain wires **3170**, each of which is disposed at or near a respective edge of

the cable **3000**. Each conductor set **3100** is substantially a twinax pair, i.e., each includes only two insulated conductors **3150**, each conductor set **3100** preferably being tailored to transmit and/or receive high speed data signals. The generally flat or planar design of the cable **3000** allows it to be readily bent or otherwise manipulated as shown while maintaining good high frequency shielding of the conductor sets **3100** and acceptable losses.

Adhesive material may be used in the cable construction to bond the shielding films including, bonding one or two shielding films to one, some, or all of the conductor sets at cover regions of the cable, and/or bonding two shielding films together at pinched regions of the cable (as discussed earlier and illustrated by Figures 5C and 5D). A layer of adhesive material may be disposed on at least one shielding film, and in cases where two shielding films are used on opposite sides of the cable, a layer of adhesive material may be disposed on both shielding films. A given adhesive layer may include an electrically insulative adhesive, and may provide an insulative bond between two shielding films, an insulative bond between at least one of shielding films and insulated conductors of one, some, or all of the conductor sets, and/or an insulative bond between at least one of shielding films and one, some, or all of the drain wires (if any). Alternatively, a given adhesive layer may include an electrically conductive adhesive, and may provide a conductive bond between two shielding films and/or a conductive bond between at least one of shielding films and one, some, or all of the drain wires (if any). Suitable conductive adhesives include conductive particles to provide the flow of electrical current.

When used in a given cable construction, an adhesive layer is preferably substantially conformable in shape relative to other elements of the cable, and conformable with regard to bending motions of the cable. In some cases, a given adhesive layer may be substantially continuous, e.g., extending along substantially the entire length and width of a given major surface of a given shielding film. In other cases, the adhesive layer may be substantially

discontinuous, e.g., the adhesive layer may be present only in some portions along the length or width of a given shielding film. A discontinuous adhesive layer may for example include a plurality of longitudinal adhesive stripes that are disposed, e.g., between the pinched portions of the shielding films on both sides of each conductor set and between the shielding films beside the drain wires (if any). A given adhesive material may be or include at least one of a pressure sensitive adhesive, a hot melt adhesive, a thermo-set adhesive, and a curable adhesive.

An adhesive layer may be configured to provide a bond between shielding films that is substantially stronger than a bond between one or more insulated conductor and the shielding films. This may be achieved, e.g., by appropriate selection of the adhesive formulation. An advantage of this adhesive configuration is to allow the shielding films to be readily strippable from the insulation of insulated conductors. In other cases, an adhesive layer may be configured to provide a bond between shielding films and a bond between one or more insulated conductor and the shielding films that are substantially equally strong. An advantage of this adhesive configuration is that the insulated conductors are anchored between the shielding films. When a cable having this construction is bent, this allows for little relative movement and therefore reduces the likelihood of buckling of the shielding films. Suitable bond strengths may be chosen based on the intended application.

A given adhesive layer may conform to achieve desired mechanical and electrical performance characteristics of the cable. For example, the adhesive layer may conform to be thinner between the shielding films in areas between conductor sets, which increases at least the lateral flexibility of the cable. This may allow the cable to be placed more easily into a curvilinear outer jacket. In some cases, an adhesive layer may conform to be thicker in areas immediately adjacent the conductor sets and substantially conform to the conductor sets. This may increase the mechanical strength and enable forming a curvilinear shape of

shielding films in these areas, which may increase the durability of the cable, for example, during flexing of the cable. In addition, this may help to maintain the position and spacing of the insulated conductors relative to the shielding films along the length of the cable, which may result in more uniform impedance and superior signal integrity of the cable. In some cases, a conformable adhesive layer may be chosen to cooperate with a first and second dielectrics of a cable in such a manner that when the cable is folded and disposed within the cable tidy, the cable will reproducibly fold and unfolds as the cable tidy moves along the lateral axis Z.

Any of the cable configurations discussed above may be used in combination with a substrate such as a paddle card, an electronic device or the like, having conductive traces disposed thereon. Figure 7 shows a partial perspective view of the cable **3000** having a first end **3010** of the cable **3000** connected to a first substrate **300** such as a paddle card having a plurality of conductive traces **320**, each trace extending from a first end **301** to a second end **302** of the first substrate **300**. While it is not shown in Figure 7, the cable **3000** may also have a second end connected to a second substrate that may or may not be similar to the first substrate **300**.

The conductive traces **320** on the first substrate **300** electrically connect a plurality of connection sites **310** on the first substrate **300**. The conductors **3150** of the cable **3000** are electrically connected to the first substrate **300** at the connection sites **310**. Similarly, the first substrate may be configured to have a plurality of drain wire connection sites (not shown) for electrically connecting drain wires of the cable. Individual conductor of the cable may attach to corresponding conductive trace via the corresponding connection site at the first end of the substrate. In some cases, all of the corresponding conductive traces may be disposed on one major surface of the substrate. In some cases, at least one of the corresponding conductive traces may be disposed on one major surface of the substrate, and at least another of the corresponding conductive

traces may be disposed on an opposed major surface of the substrate. In some cases, at least one of the conductive traces may have a first portion on a first major surface of the substrate at the first end, and a second portion on an opposed second major surface of the substrate at the second end. In some cases, alternating ones of the conductor sets may attach to conductive traces on opposite major surfaces of the substrate.

Figures 8 and 9 are two perspective cross-sectional views of another exemplary embodiment of a cable assembly **110** in an extended position in accordance with the present invention. The cable assembly **110** comprises a planar cable **5000** housed within the cable tidy **200**. A first end **5010** of the cable **5000** disposed at the first end **201** of the cable tidy **210** is configured to be connected to a first electronic device such as a first cable assembly connector **401** which is configured to mate with a first board mount connector **403** attached to a first printed circuit board **405** (see Figure 9) on which a fixed module **610** (see Figure 9) may be connected. An opposite second end **5020** of the cable **5000** disposed at the second end **202** of the cable tidy **210** is configured to be connected to a second electronic device such as a second cable assembly connector **402** which is configured to mate with a second board mount connector **404** attached to a second printed circuit board **406** on which a moveable module **620** (see Figure 9) may be attached. The board mounts **403**, **404** may be attached to their respective printed circuit boards by a variety of ways, including but not limited to, soldering the board mounts to the printed circuit boards or using screws and press-fits.

The cable **5000** may be any one of the cable configurations as taught in the earlier sections of this application. Preferably, the cable **5000** is folded before it is disposed in the cable tidy **200**. Also preferably, the cable **5000** has a configuration that allows it to remain folded when it is disposed within the cable tidy **200** and the cable **5000** reproducibly folds and unfolds when the body

section **230** of the cable tidy **200** moves in and out of the header section **210** of the cable tidy **200**.

Preferably, the first end **5010** of the cable **5000** is secured to the bridging section **215** of the header section **210** of the cable tidy **200** by the cable clip **270** as shown in Figure 2. Preferably, the cable tidy **200** is secured to the second printed circuit board **406** by the attachment braces **280B** configured on the body section **230** near the second end **202** of the cable tidy **210**.

In one embodiment of the present invention, the cable assembly **110** further comprises a first set **510** and a second set **520** of cable pegs **500** disposed at each top fold line **X-X** and bottom fold line **Y-Y** of the folded cable **5000**. Figure 10 gives a partial perspective view of the cable **5000** with the first set **510** and the second set **520** of cable pegs **500**. Cable pegs **500** of the first set **510** are aligned in a reverse vertical orientation from the cable pegs **500** of the second set **520**. The cable pegs **500** primarily serve to prevent the cable **5000** from over-extending to the extent that the cable **5000** is unable to return to its folded state when the cable tidy **200** is retracted.

One configuration of the cable peg **500** includes a first arm **531** coupled to a second arm **532** via a hinge joint **533** configured at an intersection between a first end **531A** of the first arm **531** and a first end **532A** of the second arm **532**, and a lock device **555** disposed at a second end **531B** of the first arm **531** configured to receive a second end **532B** of the second arm **532**. To install the cable peg **500** at the fold line of the cable **5000**, first release the second arm **532** from the lock device **555** configured at the second end **531B** of the first arm **531**, then swing the second arm **532** away from the first arm **531** around the hinge joint **533**, then place the cable **5000** between the first and second arms **531**, **532** and then lock the second arm **532** to the first arm **531** by swinging the second arm **532** around the hinge joint **533** towards the first arm **531** until the second end

**532B** of the second arm **532** engages with the lock device **555** configured at the second end **531B** of the first arm **531**.

The foregoing description of the preferred embodiment of the invention has been presented for purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise forms disclosed, since many modifications or variations thereof are possible in light of the above teaching. All such modifications and variations are within the scope of the invention. The embodiments described herein were chosen and described in order to best explain the principles of the invention and its practical application, thereby to enable others skilled in the art to utilise the invention in various embodiments and with various modifications as are suited to the particular use contemplated thereof. It is intended that the scope of the invention be defined by the claims appended hereto, when interpreted in accordance with the full breadth to which they are legally and equitably suited.

## CLAIMS

1. A cable assembly comprising:

a folded planar cable housed within a cable tidy;

the cable tidy comprising a header section comprising a first end of the cable tidy, a body section comprising an opposite second end of the cable tidy, and wherein the body section is extensible from the header section of the cable tidy;

the cable comprising a first cable end disposed at the first end of the cable tidy and configured to be connected to a first substrate, and a second cable end disposed at the second end of the cable tidy and configured to be connected to a second substrate; and

wherein the cable tidy organises the cable in such a manner that the cable reproducibly folds and unfolds as the body section of the cable tidy moves in and out of the header section of the cable tidy.

2. The cable assembly as claimed in claim 1 wherein the body section of the cable tidy further comprises a plurality of telescoping parts.

3. The cable assembly as claimed in claim 2 further comprising a plurality of interlocking devices and complementary interlocking devices configured on the header section and the telescoping parts of the cable tidy.

4. The cable assembly as claimed in claim 1 wherein a plurality of conductive traces are disposed on the first substrate and/or the second substrate.

5. The cable assembly as claimed in claim 4 wherein the first substrate with conductive traces is housed within a first electronic device and/or the second substrate with conductive traces is housed within a second electronic device.

6. The cable assembly as claimed in any of claims 1 to 5 wherein the cable further comprises a plurality of conductor sets, each set having one or more conductors extending along a length of the cable while being spaced apart from

each other along a width of the cable; and a first shielding film disposed on one side of the cable bonded to a second shielding film disposed on an opposite side of the cable.

7. The cable assembly as claimed in claim 6 wherein each conductor in the conductor sets is encompassed by a first dielectric along the length of the cable.

8. The cable assembly as claimed in claim 6 wherein the first and second shielding films include cover portions and pinched portions arranged such that, in transverse cross section, the cover portions of the first and second shielding films in combination substantially surround each conductor set, and the pinched portions of the first and second shielding films in combination form pinched portions of the cable on each side of each conductor set, the pinched portions being thinner than the conductor sets.

9. The cable assembly as claimed in claim 6 wherein the first and second shielding films include concentric portions, pinched portions, and transition portions arranged such that, in transverse cross section, the concentric portions are substantially concentric with one or more end conductors of each conductor set, the pinched portions of the first and second shielding films in combination form pinched portions of the cable on two sides of the conductor set, and the transition portions provide gradual transitions between the concentric portions and the pinched portions.

10. The cable assembly as claimed in any of claims 6 to 9 further comprising at least one drain wire.

11. The cable assembly as claimed in any of claims 6 to 10 wherein the electrical properties of the cable are maintained even when the cable is bent or manipulated.

12. The cable assembly as claimed in claim 11 further comprising a cable peg disposed at each fold line of the cable.

13. A cable assembly comprising:

a cable tidy comprising:

a header section comprising a first end of the cable tidy; and

a body section comprising an opposite second end of the cable tidy and being extensible from the header section of the cable tidy; and

a planar cable housed within the cable tidy comprising:

a plurality of conductor sets extending along a length of the cable and being spaced apart from each other along a width of the cable, each conductor set including one or more insulated conductors;

first and second shielding films disposed on opposite sides of the cable, the first and second films including cover portions and pinched portions arranged such that, in transverse cross section, the cover portions of the first and second films in combination substantially surround each conductor set, and the pinched portions of the first and second films in combination form pinched portions of the cable on each side of each conductor set, the pinched portions being thinner than the conductor sets;

a first cable end disposed at the first end of the cable tidy and configured to be connected to a first electronic device; and

an opposite second cable end disposed at the second end of the cable tidy and configured to be connected to a second electronic device, such that when the body section of the cable tidy moves in and out of the header section of the cable tidy, the cable reproducibly folds and unfolds.

14. The cable assembly as claimed in claim 13 wherein the body section of the cable tidy further comprises a plurality of telescoping parts.

15. The cable assembly as claimed in claim 14 further comprising a plurality of interlocking devices and complementary interlocking devices configured on the header section and the telescoping parts of the cable tidy.

16. The cable assembly as claimed in any of claims 13 to 15 further comprising at least one drain wire.

17. The cable assembly as claimed in any of claims 13 to 16 wherein the electrical properties of the cable is maintained even when the cable is bent or manipulated.

18. The cable assembly as claimed in claim 17 further comprising a cable peg disposed at each fold line of the cable.

19. An electronic system comprising the cable assembly as claimed in claim 13 wherein the first electronic device disposed at the first cable end mates with a first board mount connector electrically connected to a first printed circuit board which is attached to a fixed module of the electronic system and the second electronic device disposed at the second cable end mates with a second board mount connector electrically connected to a second printed circuit board which is attached to a moveable module of the electronic system and the cable reproducibly folds and unfolds as the moveable module moves away from and towards the fixed module.