

BOARD CONNECTOR

FIELD OF THE DISCLOSURE

The invention relates to a board connector for connecting a complementary second connector, such as an optical cable connector, to a substrate, such as a printed circuit board.

- 5 The connector comprises one or more elements mounted on the printed circuit board, such as an optical coupling device for receiving light signals to be guided to a transducer on the substrate.

10 BACKGROUND OF THE DISCLOSURE

- When the complementary second connector is brought into engagement with the board connector, the internals of the board connector can be dislocated. Small changes of the position of internal elements involved in signal transfer, can
15 result in substantial loss of signal integrity. These internals can for instances be mounted to the board by means of an adhesive. This results in shear stresses in the adhesive.

- This problem particularly occurs with optical cable
20 connectors, which must be pressed against a light receiving element in order to achieve accurate positioning and reliable fixation.

- It is an object of the present invention to provide a more
25 reliable way of fixating the positions of board connector elements in a reliable and stable manner.

SUMMARY OF THE DISCLOSURE

An opto-electric on-board connector is disclosed comprising:

- opto-electronic elements, such as VCEL's and/or pin-diodes and associated drivers and circuitry;

- an optical coupling device for guiding optical signals between the opto-electronic elements on a substrate, such as a transceiver board, and a complementary optical cable connector

- wherein the optical coupling device comprises a prism with a contact face and a lower face;
- wherein the optical coupling device further comprises two or more supports spacing each the lower face from the oppositely arranged opto-electronic elements;
- wherein each support comprises one or more feet attached to the substrate.

The supports accurately space the lower face at a desired distance of the opto-electronic elements. The feet enable a firm and reliable attachment to the substrate, also during mating or unmating of a complementary connector.

In use, each lens of the first array faces a terminal end of an associated optical fiber of the complementary optical cable connector.

The opto-electronic elements can for instance be positioned on a bottom surface of the transceiver, such as an inner connector board or substrate.

Each support can for example comprise two oppositely extending feet to define an H-shape of the optical coupling device in plan view. Such feet can be used to balance forces exerted by pushing a complementary connector against the optical coupling device.

The connector will typically comprise a housing encasing the optical coupling device and the opto-electronic elements. To improve heat dissipation, the housing may be made of an thermoconductive material.

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The opto-electronic elements can for example include VCEL's VCEL's (Vertical-cavity surface-emitting lasers), which can receive and emit light signals, and/or PIN photo-diodes, which can only receive light signals from the oppositely arranged
10 array of lenses of the optical coupling device. VCEL's and PIN diodes are controlled by drivers, which generate heat. If the drivers are positioned between the feet of the optical coupling device supports, the drivers are at short distance of the associated opto-electronic elements while the generated
15 heat can be dissipated effectively.

Heat dissipation can be further optimized if the housing comprises an interior surface profiled to provide a tight contact with the upper surfaces of the drivers, in such a way
20 that there are no substantial air gaps left. Air gaps substantially reduce heat dissipation. In order to avoid the presence of air gaps, thermally conductive gap filling material can be applied between the drivers and the interior housing surface. Suitable gap filling materials are for
25 example Tpli® and Tflex® of Laird Technologies.

The support and the feet of the optical coupling device can for example be bonded to the substrate by an adhesive, such as UV-curable or thermally curable adhesives, e.g., a UV-curable
30 or thermally curable epoxy adhesive or mixtures thereof.

In a specific embodiment, the prism of the optical coupling device may comprise a light-reflective back face under an angle to guide optical signals from each lens of the first

array of the contact face to an associated lens of the second array at the prisms' lower surface.

To align the optical coupling device and a complementary cable
5 connector, the optical coupling device can for example
comprise alignment features, such as alignment pin, flanking
the first array of lenses, the alignment features matching
with corresponding alignment features of a complementary cable
connector. The alignment features of the optical coupling
10 device may for instance include parallel alignment pins
extending in a direction under right angles with the contact
face.

Optionally, the supports have side faces profiled to cooperate
15 with latches of a complementary cable connector.

In an specific embodiment, the supports of the optical
coupling device can be provided with flat top faces to enable
using vacuum nozzle pick and place systems for positioning the
20 optical coupling device during the assembling process.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be further explained under reference to the
accompanying drawings.

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Figure 1A: shows an exemplary embodiment of a connector
with a complementary second connector;

Figure 1B: shows the two connectors of Figure 1A in an
assembled state;

30 Figure 2A: shows the second connector of Figure 1 in
exploded view;

Figure 2B: shows in perspective cross section a cable
connection of the connector of Figure 2A;

- Figure 3A: shows in perspective view the internal configuration with an optical coupling device member of the connector of Figure 1;
- 5 Figure 3B: shows the configuration of Figure 3A in exploded view;
- Figure 3C: shows in detail a mounting section of the optical coupling device member of Figure 3A;
- Figure 4A: shows a detail of the optical coupling device member of Figure 3A;
- 10 Figure 4B: shows in perspective rear view the optical coupling device member of Figure 3A;
- Figure 4C: shows the optical coupling device member of Figure 3A in top view;
- Figure 4D: shows the optical coupling device member of Figure 3A in bottom view;
- 15 Figure 5A: shows the second connector in front view;
- Figure 5B: shows the second connector in front view during connection with the first connector;
- Figure 6A: shows in cross section the connector and the complementary connector of Figure 1 just before being mated;
- 20 Figure 6B: shows the connector and the complementary connector of Figure 1 just after being mated in cross section along a vertical plane;
- 25 Figure 7A: shows the two connectors in a cross section along a horizontal plane during mating;
- Figure 7B: shows the two connectors in a cross section along a horizontal plane after being mated;
- Figure 8A: shows the two connectors in a cross section along a horizontal plane during disconnection;
- 30 Figure 8B: shows the two connectors in a cross section along a horizontal plane after being disconnected;

Figure 9A: shows an alternative embodiment of an optical coupling device;

Figure 9B: shows an alternative embodiment of an optical coupling device;

5 Figure 9C: shows an alternative embodiment of an optical coupling device.

DETAILED DESCRIPTION OF EMBODIMENTS

10 Figures 1A and 1B show an exemplary embodiment of a connector assembly 1 of a board connector 2 and a complementary optical cable connector 3. In Figure 1A, the optical cable connector 3 is moved in a mating direction A to be connected to the board connector 2, as shown in Figure 1B.

15 The optical connector 3 comprises a plug 4 at the end of an optical cable (not shown). The plug 4 is shown in exploded view in Figure 2A and comprises a rectangular cable bent relief 7 of a rubber-like material holding the end of the optical cable to protect the fibers from overstressing by
20 bending. The cable holder 7 is partly inserted into a matching rectangular opening 8 in a ferrule 9. The rectangular opening 8 is flanked by two cylindrical openings 11, each holding one end of a compression spring 12. Openings 13 of a smaller diameter extend coaxially from the cylindrical openings 11 to
25 the opposite end 14 of the ferrule 9. This end exposes the terminal ends of the optical fibers 15 (see Figure 5B). A shoulder 16 is formed between the larger openings 11 and the smaller openings 13. The compression springs 12 abut the shoulder 16.

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The ferrule 9 has a central opening 17 filled with a cured adhesive fixating the fiber ends within the ferrule 9.

The ferrule 9 is capped by release member 20. The release member 20 is a single piece, e.g., of a resilient elastomeric material, and comprises a shutter 21 hiding the end 14 of the ferrule 9. As shown in Figures 5a and 5E, the shutter 21 is formed by an upper blade 22 and a lower blade 23 which can be separated to expose the optical fibers 15 when the cable connector 3 is connected to the board connector 2. The upper and lower blades 22, 23 face each other with edges provided with spacers 24 creating a split 25.

The release member 20 further comprises a U-shaped resilient bridge 26 at lateral both sides of the ferrule 9. The U-shaped bridges 26 bias the blades 22, 23 towards each other. In this position the shutter 21 closes off the terminal ends of the optical fibers 15, protecting the fiber ends against moisture, dirt and mechanical impact.

An upper web 27 of the release member 20 covers the top side of the ferrule 9. Similarly, a lower web 28 is provided below the lower side of the ferrule 9. One end of the upper web 27 is resiliently connected to the upper ends of the two U-shaped bridges 26 and the upper blade 22 by means of two mirrored C-shaped resilient members 29 symmetrically arranged back-to-back in a mirrored manner. Similarly, one end of the lower web 28 is resiliently connected to the lower ends of the two U-shaped bridges 26 and the lower blade 23 by means of two similarly mirrored C-shaped resilient members 31.

At the cable side of the plug 4 the upper web 27 of the release member 20 is connected to a pull tab 32, which can be pulled by a user to disconnect the cable connector 3, as will be explained hereinafter.

The cable connector 3 further comprises a locking device 36 (see Figure 1A) with a box-shaped main body 37 having an open side 38 receiving the ferrule 9 and a closed side 39 with a cable passage 41. An upper face 42 of the main body 37 covers the upper web 27 of the release member 20, while a lower face 43 of the main body 37 covers the lower web 28 of the release member 20.

The locking device 36 has two symmetrically arranged mirrored latches 44 extending from the main body 37 pointing into the mating direction A. The latches 44 cover the side faces of the ferrule 9 and the U-shaped bridges 26 of the release member 20.

The front end 19 of the ferrule 9 is somewhat broader. The open side 38 of the main body 37 is bordered with a collar 45 for enclosing the broadened front end 19 of the ferrule 9 to limit the sliding movement of the ferrule relative to the release member (see Figure 8A).

The latches 44 have a free end provided with a cam 46. The two cams 46 point to each other and project in mating direction A over a distance from the shutter 21. The upper and lower webs 27, 28 of the release member 20 are provided with ridges 40 creating a labyrinth between the shutter and the locking device 36 to protect the internals, in particular the optical coupling device 71 from dust. Internally, the compression springs 12 are compressed between the shoulder 16 and the inner surface of the main body 37 of the locking device 36.

The upper and lower webs 27, 28 of the release member 20 are both provided with a central projection 47 moveable in the mating direction A in a slit 48 at the topside and bottom side of the main body 37, respectively (see Figures 8A and 8B).

The locking device 36 is formed by two identical angled parts 51, both having a short side 52 forming the lateral sides of the locking device 36, and a long side 53, forming the top and bottom sides of the locking device 36. The short and long
5 sides 52, 53 of the parts 51 are under right angles. The latches 44 extend from the short sides. The short side 52 has one side edge connected to an end of longer side 53, while the opposite side edge comprises two parallel studs 54, which can be snapped into matching openings 56 in the longer side 53 of
10 the other angled part 51 to form the assembled locking device 36. The two parts 51 are held together by an elastic band 57.

The exemplary embodiment of the board connector 2 as shown in the drawings is a transceiver with a top cover 61 with four
15 corners bolted onto a rectangular lower housing section 62 holding an internal transceiver board 63 carrying the optoelectronic elements 91 and the feet 72 of the optical coupling device 71 (see Figure 3A). The board connector 2 is mounted into a socket 65 mounted on a substrate 70, such as a printed
20 circuit board (see Figure 1A). The top cover 61 comprises a casing 64 with one side having a receiving opening 66 for receiving the cable connector 3. The top side 67 of the casing 64 slants downwardly from the side with the receiving opening 66 to the opposite side of the casing 64. A locking ring 68
25 with two opposite pinching grips 69 is put over the casing 64 to lock the board connector 2 in the socket 65.

The internals of the board connector 2 are shown in Figures 3a and 3B. An optical coupling device or optical coupling device
30 71 is positioned on the substrate 63 to face the optical fibers 15 of the optical connector 3 when it is received in the board connector 2. The optical coupling device 71 comprises two feet 72. Both feet 72 have two openings 73 filled with a cured adhesive 74 embedding an anchoring element

76 mounted on an internal connector substrate 63 (see Figure 3C). Forces exerted to the optical coupling device 71 when the connectors 2, 3 are connected or disconnected, are absorbed as compression stresses and bending stresses by the anchoring elements besides internal shear stresses in the adhesive and peel stresses between the adhesive and the substrate. This way, the anchoring elements 76 contribute to a more reliable fixation of the optical coupling device member 71. In the embodiment shown in Figure 3C, the anchoring element 76 is a capacitor 77 mounted on the board by two capacitor feet 78.

Between the feet 72 the optical coupling device member 71 carries two rectangular columns 79 sandwiching a prism 81. The prism 81 has a flat front face 82 with an array of lenses 83 facing the respective optical fiber ends 16 of the cable connector 3 when the connectors 2, 3 are connected. The array of lenses 83 is flanked by two symmetrically arranged parallel pegs 84 extending from the columns 79. The pegs 84 serve to open the shutter 21 of the optical cable connector 3 when the optical cable connector 3 is connected to the board connector 2.

The back side of the prism 81 (see Figure 4B) has a vertical lower part 86 and a light reflective upper part 87 which slants under an angle to deflect light entering the prism 81 via the lenses 83 downwardly to the bottom 88, where the light leaves the optical coupling device 71 via a second array of lenses 89 (see Figure 4D). Each lens 83 of the first array transfers light signals to a single lens 89 of the second array. The light is then received by an opto-electronic element 91, such as a VCEL or a PIN photo diode, located on the substrate 63 below the bottom side of the prism 81 (see Figure 3A). The opto-electronic element 91 translates the light signals into electronic signals to be transferred via circuitry (not shown) printed on the substrate 63.

The tops 80 of the columns are configured as flat, substantially horizontal surfaces and are suitable for use with automated vacuum nozzles pick and place systems.

5 At the side of the feet 72 both columns 79 have a vertical ridge 94 (see Figures 4C and 7A) for cooperation with the latches 44 of the locking device 36 when the optical connector 3 is connected to the board connector 2, as will be explained hereinafter.

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Figure 6A shows in cross section the cable connector 3 approaching the board connector 2 just before being connected. The receiving opening 66 of the top cover 61 is closed by a flap 100 connected to the lower edge of the receiving opening
15 66 by means of a hinge 101, allowing movement of the flap 100 between a first position closing off the receiving opening 66, as shown in Figure 6A, and a second position, where the flap 100 is folded backwards towards the optical coupling device 71. A torsion spring 110 biases the flap 100 to the closing
20 position, where it abuts a stop 102 at the edge of the receiving opening 66.

The VCEL's or photo PIN diodes 91 comprise drivers 105 generating heat. The interior of the top cover 61 is profiled
25 to tightly contact the top surfaces of the drivers 105 in such a way that no air gap remains between the top cover 61 and these respective surfaces. This enables effective dissipation via the top cover 61. The top cover 61 comprises an inwardly protruding vertical brim 111 fitting against the back face of
30 the optical coupling device and covering the drivers 105. Air gaps and inclusions can be avoided by applying an air gap filler material between the drivers and the inner surface of the top cover.

When the cable connector 3 is inserted into the receiving opening 66 of the board connector 2, the flap 100 is folded down and the plug 4 is pushed towards the optical coupling device 71 until the shutter 21 hits the pegs 84. The pegs 84
5 are cylindrical with flattened upper and lower sides (see Figure 4A) dimensioned to wedge the split 25 between the upper and lower blades 22, 23 of the shutter. As a result the upper and lower blades 22, 23 are forced apart against the action of the resilient U-shaped bridges 26 of the release member 20. In
10 this position, the fiber ends 15 are exposed (see Figure 5B). Pushing the plug 4 further into the board connector 3 will insert the pegs 84 into the smaller diameter opening 13 in the ferrule 9 (see also Figure 7A). The pegs 84 are dimensioned to snugly fit within the openings 13 to enable very accurate
15 positioning of the fiber ends 15 relative to the lenses 83 of the optical coupling device 71 (see Figure 7A).

The mating process is shown from above in Figures 7a and 7B. During positioning respective contact faces 103 of the cams 46
20 of the latches 44 encounter parallel contact faces 114 the vertical lateral ridges 94 of the optical coupling device 71. Meanwhile, the outer end of the ferrule 9 encounters spacers 106 of the optical coupling device 71 right next to the pegs 84. The spacers 106 are dimensioned to space the fiber ends 15
25 very accurately at a desired distance from the lenses 83 of the optical coupling device 71, forming a gap 107 of uniform width. Although the ferrule 9 is stopped by the spacers 106, the locking device 36 can be pushed further inwardly against the action of the compression springs 12 until the cams 46 of
30 the latches 44 hook behind the ridges 94, preventing unintentional disconnection of the connectors 2, 3. In this position, the compression springs 12 exert a continuous pressure pressing the plug 4 against the optical coupling device 71, fixating the fibers ends 15 relative to the lenses

83, which contributes to the overall reliability of the connector system.

The connectors 2, 3 can be disconnected by pulling the pull
5 tab 32. In the locked position the contact end of the
connector 2 is fit between the inner surfaces of the board
connector 3 in such way hat the shutter blades cannot be moved
apart by pulling the pull tab 32. The mirrored pair of C-
shaped resilient members 29, 31 is stretched, while the
10 locking device 36 and the ferrule 9 stay in place. The latches
44 have a slanting base 108 forming a contact face of a
pushing section 109 of the release member 20. The pushing
section 109 is positioned at a point where the C-shaped
resilient member 29, 31 is linked to the upper web 27, or to
15 the lower web 28 respectively. The pushing section 109
projects over a lateral distance from the upper and lower webs
27, 28. The pushing section 109 presses against the contact
face 108 of the latches 44. As a result, the latches 44 are
pushed aside and eventually unhooked from the ridges 94. The
20 compression springs 12 and the C-shaped resilient members 29,
31 are now allowed to relax. The locking device 36 is pushed
backwardly by the springs 12. This contributes to easier
removal of the cable connector 3.

25 Alternative embodiments of the optical coupling device are
shown in Figures 9A-C. These embodiments have feet extending
at only one side of the respective support. In Figure 9A the
coupling device 120 comprises oppositely extending feet. In
Figures 9B and 9C the feet extend in the direction of the
30 contact face (Figure 9C) and in the opposite direction (Figure
9B), respectively.

CLAIMS

1. Opto-electric on-board connector (2) comprising opto-electronic elements (91) on a substrate (63) and an optical coupling device (71) for transferring optical signals between the opto-electronic elements and a complementary optical cable connector

- wherein the optical coupling device comprises a prism (81) with a contact face (82) and a lower face (88);
- wherein the optical coupling device further comprises two or more supports (79) spacing each the lower face from the oppositely arranged opto-electronic elements;
- wherein each support comprises one or more feet (72) attached to the substrate.

2. A connector according to claim 1 comprising a connector board carrying the opto-electronic elements and the supports of the optical coupling device (71).

3. A connector according to claim 1 or 2 wherein the feet (72) of the two or more supports (79) are parallel.

4. A connector according to claim 3 wherein each support (79) comprises two oppositely extending feet (72) to define an H-shape of the optical coupling device (71) in plan view.

5. A connector according to any one of the preceding claims wherein the opto-electronic elements (91) on the substrate include VCEL's and/or PIN photo-diodes with drivers (105) arranged between the feet (72) of the optical coupling device supports.

6. A connector according to claim 5 comprising a housing with an interior surface profiled to provide a tight contact with the upper surfaces of the drivers (105).

5 7. A connector according to claim 6 wherein a thermally conductive air gap filler material is applied between the surface of the drivers and the inner housing surface.

8. A connector according to any one of the preceding claims
10 wherein the prism (81) comprises a light-reflective back face (87) under an angle to guide optical signals from each lens of the first array of the contact face to an associated lens of the second array at the prisms' lower surface (88).

15 9. A connector according to any one of the preceding claims wherein the optical coupling device (71) comprises alignment features flanking the first array of lenses, the alignment features (83) matching with corresponding alignment features of a complementary cable connector.

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10. A connector according to claim 9 wherein the alignment features of the optical coupling device (71) include parallel alignment pins (83) extending in a direction under right angles with the contact face.

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11. A connector according to any one of the preceding claims wherein the supports (79) have side faces profiled to cooperate with latches (44) of a complementary cable connector.

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12. A connector according to any one of the preceding claims wherein the supports (79) are provided with flat top faces (80).

13. A connector according to any one of the preceding claims wherein the contact face comprises a first array of lenses (83) each lens being configured to face an individual optical fiber end of a complementary cable connector.

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14. A connector according to any one of the preceding claims wherein the lower face of the optical coupling device is provided with a second array of lenses (89), wherein each lens of the second array is spaced from an oppositely arranged
10 associated opto-electronic element.