

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

EOPTOLINK TECHNOLOGY USA INC.
Petitioner,

v.

APPLIED OPTOELECTRONICS, INC.
Patent Owner.

IPR2026-00123
U.S. Patent No. 11,177,887

**PETITION FOR *INTER PARTES* REVIEW
OF U.S. PATENT 11,177,887**

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Exhibit	Description
1001	U.S. Patent No. 11,177,887 to Lin et al. (“the ’887 patent”)
1002	Prosecution History of the ’887 patent
1003	Declaration of Dr. Michael Lebby
1004	U.S. Patent No. 7,366,367 to Kuhara et al., issued April 29, 2008
1005	U.S. Patent No. 10,509,184 to Ho et al., issued December 17, 2019
1006	U.S. Patent Publication No. 2014/0105612 to Wu et al., published April 17, 2014

I. INTRODUCTION

U.S. Patent No. 11,177,887 (“the ’887 patent”) discloses and claims a stepped-profile substrate that purportedly improves mounting and alignment of transmitter optical subassembly (TOSA) modules on the substrate. But as the examiner noted during prosecution, “positioning of a TOSA module, for example, edge mounting of TOSA module, such that a portion of TOSA module extends from the optical coupling end of a substrate, is merely a matter of design choice and a specific system requirement.” Ex. 1002, pp. 53-54. As Petitioner’s expert, Dr. Michael Lebby, further states in his Declaration: “mounting and alignment of optical components on a substrate, whether through edge-mounting or otherwise, is simply a matter of routine optimization that is well within the ordinary skills of one skilled in the art; it is not a matter of innovation.” Ex. 1003, ¶48.

Yet, the examiner allowed the claims, which were broadened during prosecution to overcome a written description rejection, without thoroughly examining them against the prior art of record or providing a stated reason for allowance. *See infra*, Section III.B. As Dr. Lebby explains, edge-mounting of TOSA modules on a substrate was well known and conventionally used in optoelectronic applications long before the effective filing date of the ’887 patent. Ex. 1003, ¶48. Indeed, it is evident from the anticipatory prior art reference (Kuhara) applied in this Petition that existing transceiver substrates not only included edge-mounted TOSA

modules, but also the other claimed elements, either in the exact configuration or in a manner that would have made the claimed transceiver arrangement obvious to those skilled in the art. The challenged claims of the '887 patent (claims 1-3 and 8-12) are therefore unpatentable and should not have been granted.

Despite the manifest lack of innovation in the '887 patent, Patent Owner pursued enforcement of the '887 patent against Petitioner in a district court action. In addition, Patent Owner has asserted five other patents, each covering different components or technologies related to optical transceivers, as part of a calculated licensing strategy aimed at capitalizing on technologies that have been standard practice in optical networking for more than a decade. The Board should therefore review the '887 patent claims based on the prior art and grounds presented in this Petition and find the challenged claims unpatentable.

II. PRIOR ART REFERENCES, GROUNDS, AND PETITIONER'S STIPULATION

A. Prior Art References and Grounds

Claims 1-3 and 8-12 are challenged based on the following prior art references. The prior art grounds are supported by the expert declaration of Dr. Michael Lebby (Ex. 1003).

Prior Art	
Ex. 1004	U.S. Patent No. 7,366,367 to Kuhara et al., filed May 17, 2004 and issued April 29, 2008 (“Kuhara”); prior art under 35 U.S.C. § 102(a)(1).
Ex. 1005	U.S. Patent No. 10,509,184 to Ho et al., filed March 29, 2017 and issued December 17, 2019 (“Ho”); prior art under 35 U.S.C. § 102(a)(1).

The presented prior art grounds are:

Ground	Claims	Basis Under 35 U.S.C. §§ 102, 103
1	1-3	Anticipated by Kuhara under § 102
2	8, 10, 12	Rendered obvious by Kuhara under § 103
3	8-12	Rendered obvious by Ho in view of Kuhara under § 103

B. Petitioner’s Stipulation for the Parallel District Court Action

In view of the United States Patent and Trademark Office’s (USPTO) Notice of Proposed Rulemaking, dated October 17, 2025, Petitioner hereby stipulates that if the Board institutes *inter partes* review (IPR) in this proceeding, IPR2026-00123, and neither the institution nor the final written decision resulting from this

proceeding is later vacated, withdrawn, or reversed by the Board, the Director, or the USPTO, then Petitioner will not pursue in the parallel district court litigation (Case No. 5:24-cv-08165-NW (N.D. Cal.)) any invalidity challenges under 35 U.S.C. §§ 102 or 103.

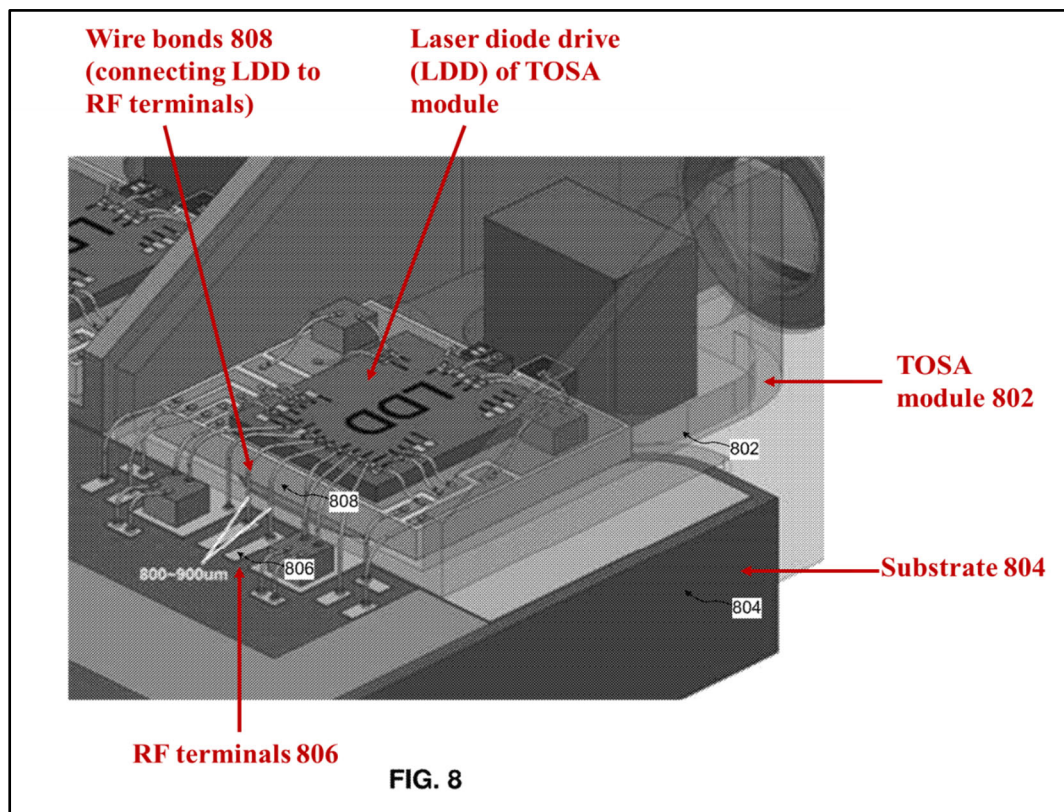
III. TECHNICAL BACKGROUND OF THE '887 PATENT

A. The '887 Patent

The '887 patent is directed to a stepped profile for substrates, e.g., printed circuit boards (PCBs), that support “‘on board’ optical subassembly arrangements,” particularly transmitter optical subassembly (TOSA) modules. Ex. 1001, Abstract; *see also id.*, Title, 1:19-26. The stepped profile facilitates mounting and alignment of TOSA modules, e.g., via edge mounting, and reduces the vertical offset between the TOSA module and the radiofrequency (RF) terminals of the substrate. *Id.*, Abstract, 1:19-26, 2:31-34. This in turn allows for shorter electrical interconnects, e.g., wire bonds, between the laser diode drive (LDD) of the TOSA module and the RF terminals. *Id.*

Figure 8 of the '887 patent illustrates the purported challenges of mounting optical subassemblies on transceiver substrates while maintaining increased transmission speed requirements. *Id.*, 2:29-50, 3:6-17. As shown in Figure 8, a plurality of TOSA modules 802 are coupled “on board” a transceiver substrate 804, e.g., a printed circuit board. *Id.* The LDD of each TOSA module is electrically

coupled with adjacent RF terminals 806 via wire bonds 808 to receive RF drive signals for modulating an associated laser diode of the TOSA. *Id.* However, wire bonds can introduce time of flight (ToF) and impedance mismatch issues for RF signals, which can degrade signal performance. *Id.*, 2:50-55. To mitigate the impact of these issues on signal performance, the lengths of the wire bonds may be shortened, but space constraints and challenges with component arrangement may make it difficult to shorten the wire-bond lengths. *Id.*, 2:56-3:5.



Ex. 1001, Fig. 8 (annotations added)

The '887 patent purports to simplify these mounting and alignment challenges and reduce the length of electrical interconnections by providing a substrate with a

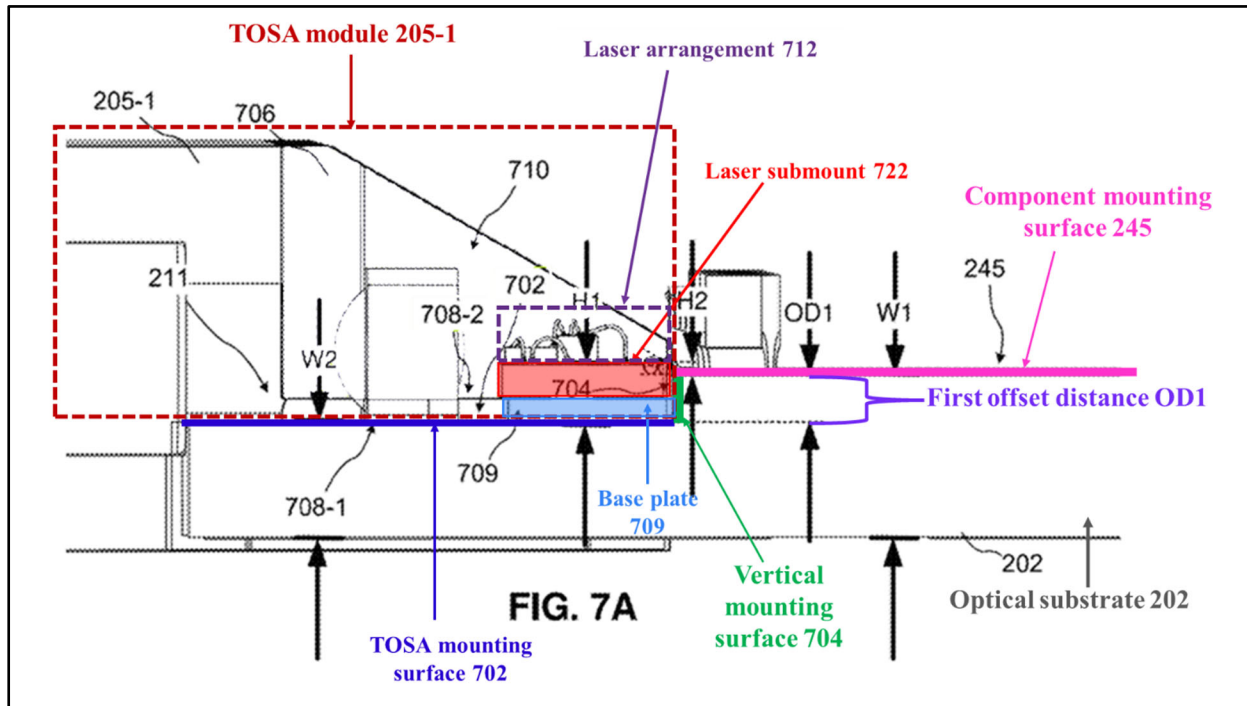
stepped profile, so that a TOSA module may be mounted “in a recessed orientation to reduce the overall distance between terminals of the substrate and associated components of the TOSA, e.g., RF terminals of the substrate and an LDD of the TOSA.” Ex. 1001, 3:18-24. Figures 7A and 7B show an exemplary stepped profile substrate for mounting TOSA modules.

As shown in Figure 7A, a stepped profile substrate 202 comprises a first component mounting surface 245 that extends from the electrical coupling end of the substrate to a second mounting region at the optical coupling end of the substrate. *Id.*, 10:55-61; *see also id.*, Fig. 2 (showing the electrical coupling end 207 and the optical coupling end 203 of a typical substrate 202). First component mounting surface 245 provides space for mounting components and provides traces for electrical interconnection with external circuitry. *Id.*

The second mounting region is defined at least in part by a step 211, which is formed by a recessed TOSA mounting surface 702 that is offset/recessed from first component mounting surface 245 by a first offset distance (OD1) and extends substantially parallel with component mounting surface 245. *Id.*, 10:62-11:13. Additionally, the recessed TOSA mounting surface 702 extends substantially transverse to a vertical surface 704 that adjoins surfaces 702 and 245. *Id.*

As shown in Figure 7A, annotated below, a TOSA module 205-1, which is coupled to the optical coupling end of substrate 202, “includes a body 706 (or

base) configured to securely mount, e.g., edge mount” to the recessed TOSA mounting surface 702. *Id.*, Fig. 7A, 11:28-39. Body 706 of TOSA module 205-1 includes at least one laser arrangement 712 mounted to a component mounting surface 708-2 of the TOSA body 706 “by way of a submount 722 and optional base plate 709.” *Id.*, 11:62-12:9. “The overall height H1 of the submount 722 (e.g., including the base plate 709) may therefore measure substantially equal to or greater than the first offset distance OD1.” *Id.*, 12:9-12. That is, “the submount 722 vertically displaces the components of the at least one laser arrangement 712 relative to the component mounting surface 708-2 of the body 706, e.g., by overall height H1, but the vertical displacement gets ‘offset’ based on [the] stepped profile of the substrate 202, and more particularly, the first offset distance (OD1) of the recessed TOSA mounting surface 702 relative to the first component mounting surface 245 of the substrate 202.” *Id.*, 12:17-25. This design allows “relatively short electrical interconnects, e.g., wire bonds 724, [to] electrically couple the LDD 714 to RF terminals/traces 726 disposed on the first component mounting surface 245.” *Id.*, 12:32-40.



Ex. 1001, Fig. 7A (annotations added)

According to the '887 patent, “[s]ubstrates having stepped profiles consistent with the present disclosure advantageously position components such as LDDs in close proximity with supporting terminals of the substrate 202.” *Id.*, 12:41-44. “[T]he stepped profile of the substrate 202 shown in FIGS. 7A and 7B allows for wire bonds 724 to be shortened/reduced in length by up to and exceeding 50% relative to wire bonds 808 of FIG. 8. Moreover, the wire bonds 724 extend at a relatively acute angle θ to provide a low-profile implementation.” *Id.*, 12:48-59. “[T]his reduction in wire bond length translates directly to improved signal quality, and in addition, enables maximum transmission speeds otherwise unachievable with longer electrical interconnections.” *Id.* But as Dr. Lebby explains, this was known

back in the 1970s when semiconductor lasers were first mounted on substrates/platforms and aligned to fiber optics (as per AT&T and other optical communication and networking companies at the time). Ex. 1003, ¶47.

B. Prosecution History of the '887 Patent

U.S. Patent Application No. 16/737,438, which issued at the '887 patent, was filed on January 8, 2020. Ex. 1001, cover page. The Patent Office issued a Non-Final Office Action on October 5, 2020, and a Final Office Action on February 19, 2021. Ex. 1002, pp. 48-60, 125-137. An examiner interview was conducted on May 11, 2021, following which Patent Owner submitted claim amendments and subsequently filed a Request for Continued Examination on June 21, 2021, with the same claim amendments. *Id.*, pp. 24, 35-45, 47. A Notice of Allowance issued on August 9, 2021, with no stated reasons for allowance. *Id.*, pp. 8-22.

In the Final Office Action, the examiner rejected claims 1-3, 5, and 10-15 under 35 U.S.C. § 103 as unpatentable over Wu (U.S. Patent Publication No. 2014/0105612) in view of Pezeshki (U.S. Patent Publication No. 2019/0278035). Ex. 1002, pp. 52-56. According to the examiner, Wu only differed from the claimed invention in that “Wu does not specifically disclose the second mounting region at the optical coupling end of the substrate is configured to edge mount to the at least one TOSA module such that a portion of the at least one TOSA module extends from the optical coupling end of the substrate when the at least one TOSA module is

coupled thereto.” *Id.*, p. 53. The examiner relied on Pezeshki as disclosing lasers mounted on a submount at a forward edge of a PCB. *Id.* The examiner found that it would have been obvious to one skilled in the art to position the TOSA module at an edge of a substrate. *Id.*, pp. 53-54 (“[P]ositioning of a TOSA module, for example, edge mounting of TOSA module, such that a portion of TOSA module extends from the optical coupling end of a substrate, is merely a matter of design choice and a specific system requirement.”).

In the Final Office Action, the examiner further rejected claims 1-3, 5-8, and 10-15 under 35 U.S.C. § 112(a) as failing to comply with the written description requirement. *Id.*, pp. 50-51. The examiner found that the specification did not teach “wherein the second mounting region at the optical coupling end of the substrate is configured to edge mount to the at least one TOSA module such that **a portion** of the at least one TOSA module **extends** from the optical coupling end of the substrate when the at least one TOSA module is coupled thereto,” as recited in pending claim 1. *Id.* (emphases in original). According to the examiner, the specification simply described a “recessed TOSA mounting surface 702 **extending** substantially parallel with the first component mounting surface 245 and substantially transverse relative to vertical surface 704.” *Id.*, p. 51 (emphasis in original).

In response to the Final Office Action, Patent Owner amended “the claims to remove the language ‘such that a portion of the at least one TOSA module extends

from the optical coupling end of the substrate when the at least one TOSA module is coupled thereto” to overcome the written description rejection. *Id.*, p. 38. Patent Owner also argued that the claimed invention was not obvious because the examiner’s proposed rearrangement of Wu would, among other things, “complicate optical alignment.” *Id.*, p. 39. Nevertheless, Patent Owner further amended independent claims 1 and 12 to recite, *inter alia*, “wherein the vertical surface provides a mechanical stop to engage a surface of the least one TOSA module and limit travel of the at least one TOSA module along one or more axis.” *Id.*, p. 40. This, Patent Owner alleged, “operate[s] as an alignment guide by providing mechanical stops/limits to limit travel along at least one axis. Alignment along the remaining axis, e.g., the Y axis, may therefore be performed by relatively simply lateral movement (e.g., along the X axis) of each TOSA module 205-1 to 205-4.” *Id.* (citation omitted).

Following the claim amendments, the examiner simply allowed the claims without any stated reason for allowance. *See, id.*, pp. 8-22. The ’887 patent issued on November 16, 2021. Ex. 1001, cover page.

Notably, the examiner had previously found Wu to be an invalidating prior art reference, except that “Wu does not specifically disclose the second mounting region at the optical coupling end of the substrate is configured to edge mount to the at least one TOSA module such that a portion of the at least one TOSA module extends from

the optical coupling end of the substrate when the at least one TOSA module is coupled thereto.” Ex. 1002, pp. 53-54. Wu indeed teaches edge-mounting of an optical engine assembly 1 (comprising bench 11, optoelectronic device 12, fixed member 13, and optical fibers 14) onto a substrate 23, which is applicable to the invention claimed in the ’887 patent. Ex. 1006, ¶[0036], Fig. 4B; Ex. 1003, ¶49. Wu further explains that substrate 23, which is a printed circuit board (PCB), “preferably includes a recess 231 configured to accommodate the optical engine assembly 1 so as to shorten a distance between the optoelectronic device 12 and the control chip 22 thereby shortening the wire bonding length.” Ex. 1005, ¶[0036]. But the examiner failed to apply Wu (or any other prior art reference) against the amended claims after Patent Owner removed the language “such that a portion of the at least one TOSA module extends from the optical coupling end of the substrate when the at least one TOSA module is coupled thereto” from the independent claims. Ex. 1003, ¶49.

The examiner also failed to realize that the added limitation—“the vertical surface provides a mechanical stop to engage a surface of the least one TOSA module and limit travel of the at least one TOSA module along one or more axis”—was not meaningful or material to patentability because, in any edge-mounting arrangement, the substrate would necessarily serve as a “mechanical stop” and limit travel along at least one axis. *Id.* That is, **although Patent Owner broadened the claims to avoid rejection under § 112(a), the examiner failed to properly**

reexamine the broadened claims under §§ 102 or 103 and allowed the claims without a stated reason for allowance.

In allowing the '887 patent, the examiner overlooked prior art references that teach edge mounting of TOSA modules to a substrate, even though the technique of edge mounting optical components to a substrate—for better alignment and utilization of substrate space and for reducing length of wire bonds—is routine and commonly used in the optoelectronics industry. *Id.*, ¶50.

IV. LEVEL OF ORDINARY SKILL

At the effective filing date of the '887 patent, a person of ordinary skill in the art (“POSITA”) would have had (1) a bachelor’s degree in electrical or electronic engineering or an equivalent degree, and (2) 2-4 years of work experience in optoelectronics, optical networking, optical communications, or a closely related field. Ex. 1003, ¶39.

V. CLAIM CONSTRUCTION

Claims must be construed only to the extent necessary to resolve a controversy. *Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co.*, 868 F.3d 1013, 1017 (Fed. Cir. 2017). No claim terms of the '887 patent require claim construction to resolve any disputes in this forum. Ex. 1003, ¶51.

VI. PRIOR ART REFERENCES

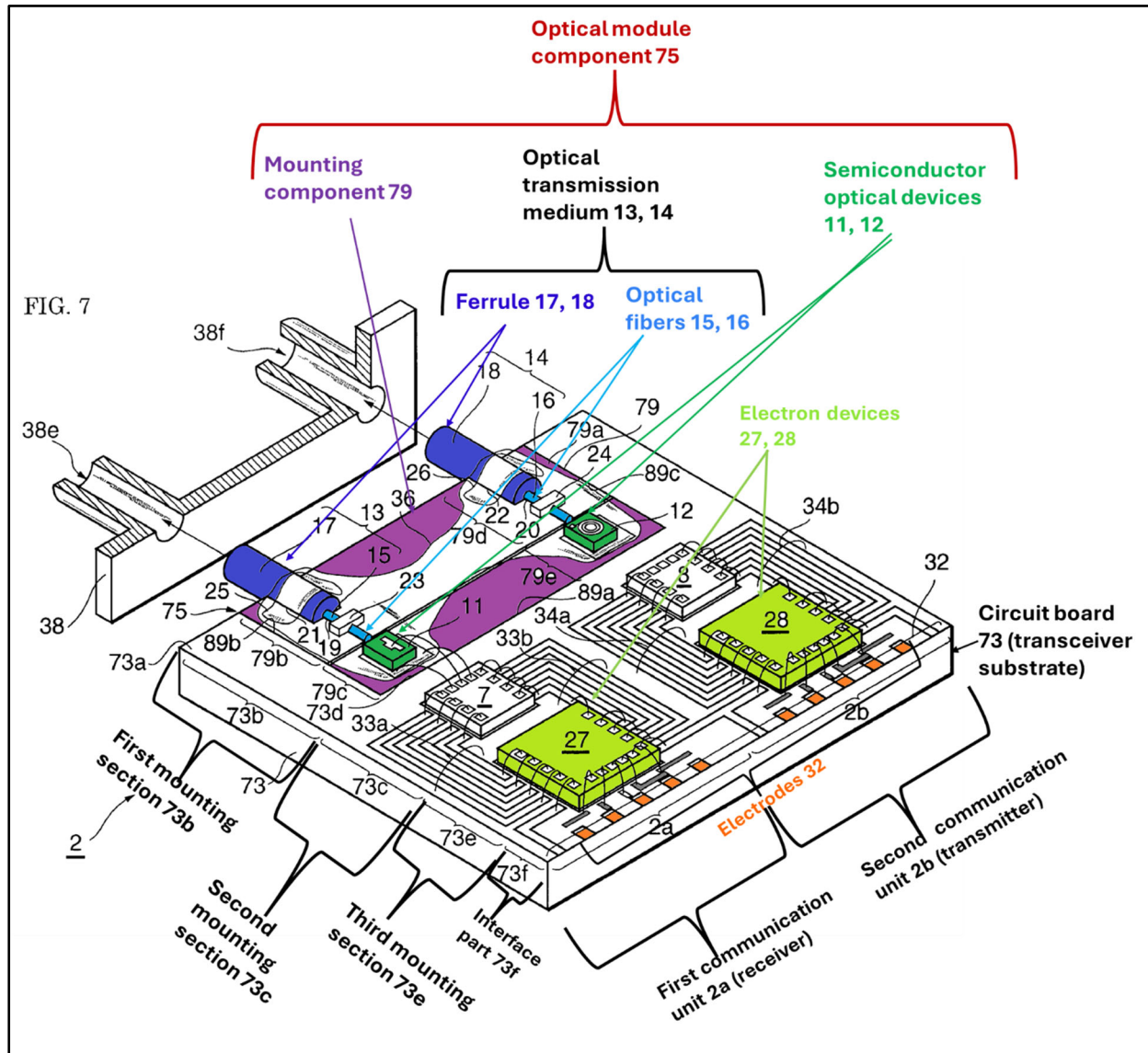
A. Kuhara (Ex. 1004)

Kuhara discloses an optical data link having a circuit board and an optical module component. Ex. 1004, Abstract, 2:13-20. The circuit board includes first and second mounting sections, with a step formed therebetween. *Id.* The first section mounts the optical module component, and the second section mounts an electron device. *Id.* According to Kuhara, the disclosed optical data link has “fewer component parts,” “reduces the electrical wiring length between the semiconductor optical device [of the optical module component] and the circuit board,” and facilitates mounting and alignment of components on the circuit board. *Id.*, 3:41-4:2.

More specifically, an exemplary optical data link 1, as shown in Figures 1A, 1B, and 2, includes “a circuit board 3 and an optical module component 5.” Ex. 1004, 5:1-3. “The optical module component 5 includes a mounting component 9, a semiconductor optical device 11, and an optical transmission medium 13.” *Id.*, 5:10-12. A POSITA would have understood optical data link 1 may be a transmitter, and optical module component 5 may be a TOSA (transmitter optical sub-assembly), if semiconductor optical device 11 is a laser to emit light based on driving signal received from electron device 7 (driving element) and the light is transmitted through optical transmission medium 13 (optical fiber 15 and ferrule 17). *Id.*, 5:27-28, 6:30-40; Ex. 1003, ¶53.

transmission mediums 13 and 14, each having a semiconductor optical device 11 and 12, respectively, and “the semiconductor optical device 11 may be a photodiode, and the semiconductor optical device 12 may be a semiconductor laser.” Ex. 1004, 10:28-33. A POSITA would have understood that an optical module component with a semiconductor laser is a TOSA for transmission of optical signals emitted by the laser, and an optical module component with a photodiode is a ROSA (receiver optical subassembly) for receiving optical signals and converting them to electrical signals. Ex. 1003, ¶55. A POSITA would also have understood that optical data link 2 comprising a TOSA and a ROSA is an optical transceiver capable of transmitting and receiving optical signals. *Id.*

As shown in Figure 7, annotated below, optical data link 2 includes a receiver defined by first communication unit 2a and a transmitter defined by second communication unit 2b. *Id.*, ¶56. First communication unit 2a includes a ROSA module having semiconductor optical device 11 (photodiode), optical transmission medium 13, and a portion of mounting component 79 (regions 79b, 79c) that is within communication unit 2a (receiver). *Id.*; Ex. 1004, Figs. 7, 8A, 8C, 9:54-61, 10:28-33. Second communication unit 2b includes a TOSA module comprising a semiconductor optical device 12 (laser), optical transmission medium 14, and a portion of mounting component 79 (regions 79d, 79e) that is within communication unit 2b. Ex. 1003, ¶56; Ex. 1004, 9:61-67, 10:28-33, Figs. 7, 8B.

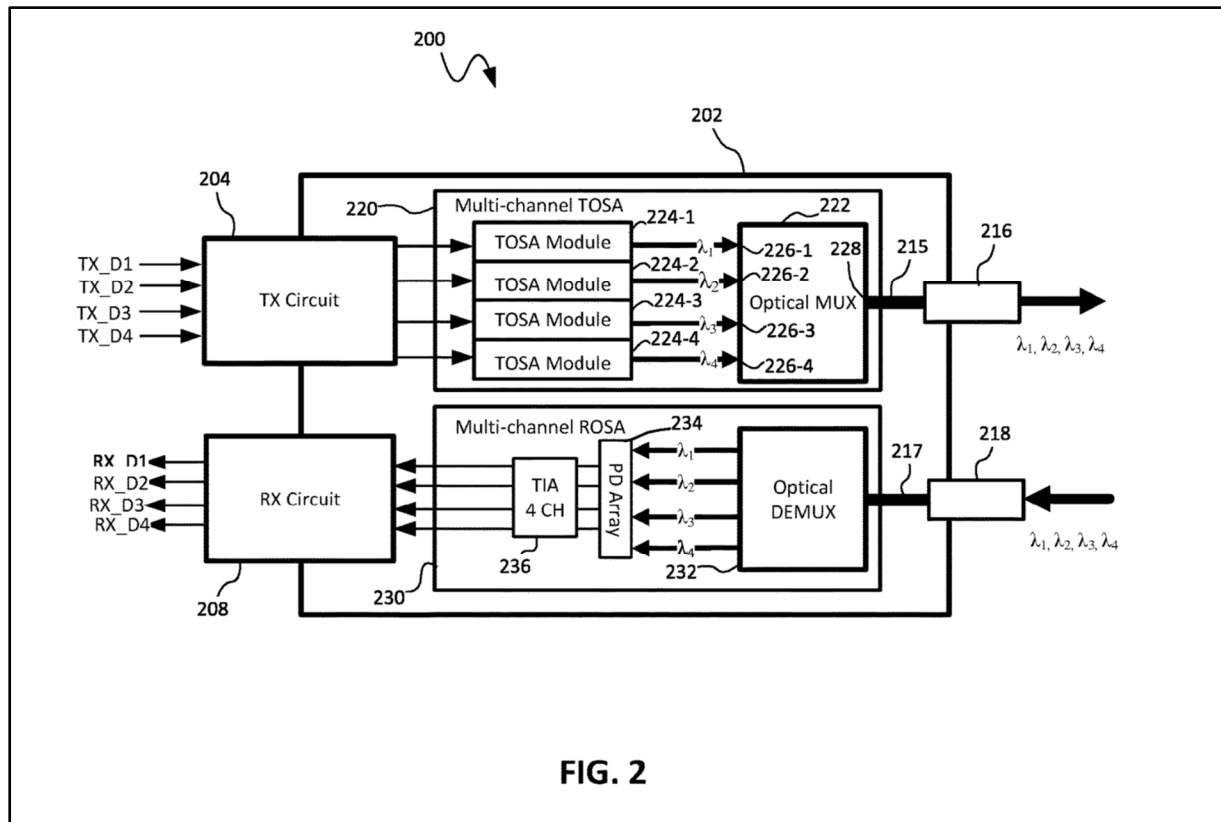


Ex. 1004, Fig. 7 (showing optical data link 2) (annotations added)

B. Ho (Ex. 1005)

Ho discloses an optical transceiver system 200 that “transmits and receives four (4) channels using four different channel wavelengths ($\lambda_1, \lambda_2, \lambda_3, \lambda_4$) and may be configured for coarse wavelength division multiplexing (CWDM)[.]” Ex. 1005, 4:18-25. “[O]ptical transceiver 200 includes a multi-channel transmitter optical

subassembly (TOSA) arrangement 220 for transmitting optical signals on the channel wavelengths (e.g., λ_1 , λ_2 , λ_3 , λ_4) and a multi-channel receiver optical subassembly (ROSA) 230 arrangement for receiving optical signals on the channel wavelengths (e.g., λ_1 , λ_2 , λ_3 , λ_4).” *Id.*, 4:44-49, Fig. 2 (reproduced below).

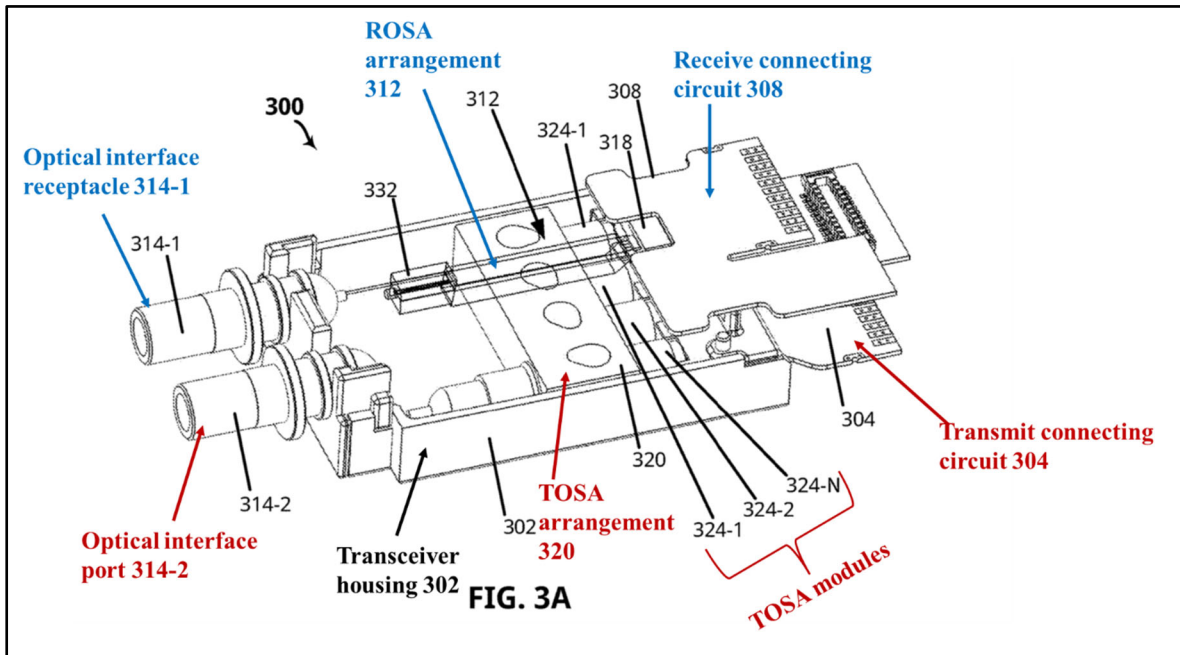


Ex. 1005, Fig. 2

Ho further discloses an optical transceiver 300 that “implements the optical transceiver system 200[.]” *Id.*, 6:4-20, Figs. 3A, 3B. “The optical transceiver 300 includes a transceiver housing 302 and a multi-channel TOSA arrangement 320 disposed within a region of the transceiver housing 302. The multi-channel TOSA arrangement 320 includes a plurality TOSA modules 324-1 to 324-N configured to

generate associated channel wavelengths and ... electrically couples to the transmit connecting circuit 304 and also couples to an optical interface port 314-2 of the transceiver housing 302 by way of a waveguide device such as an optical fiber (not shown). The transmit connecting circuit 304 may be implemented as a printed circuit board (PCB) or any other suitable substrate for supporting the transmit connecting circuit 304.” *Id.*

As shown in Figure 3A, annotated below, optical transceiver 300 further includes “a multichannel ROSA arrangement 312 disposed within a region of the transceiver housing 302. The multi-channel ROSA arrangement 312 may include an optical demultiplexing device 332. The optical demultiplexing device 332 may comprise an arrayed waveguide grating (AWG) device, for example. The ROSA arrangement 312 electrically is coupled to a receive connecting circuit 308, and optically coupled to an optical interface receptacle 314-1 at an end of the transceiver housing 302 by way of a waveguide device such as an optical fiber (not shown). The receive connecting circuit 308 may be configured as a PCB, for example, although other embodiments are within the scope of this disclosure. The multi-channel ROSA arrangement 312 may use the detectors and the associated circuitry 318 (e.g., a TIA) to detect, amplify and convert de-multiplexed channel wavelengths and may provide the same as electrical data signals, e.g., RX_D1 to RX_D4.” *Id.*, 6:43-60, Figs. 3A, 3B.



Ex. 1005, Fig. 3A (showing an optical transceiver 300 having a **transceiver housing 302**, a **TOSA arrangement 320**, and a **ROSA arrangement 312**)

VII. GROUND 1: CLAIMS 1-3 ARE ANTICIPATED BY KUHARA

A. Independent Claim 1

Kuhara discloses each and every limitation of claim 1. Ex. 1003, ¶60.

1. Claim 1[pre] (“An optical subassembly module, the optical subassembly module comprising:”)

Kuhara discloses an optical data link 1, which includes “a circuit board 3 and an optical module component 5,” and serves as an “optical subassembly module.” Ex. 1004, 5:1-3. “The optical module component 5 includes a mounting component 9, a semiconductor optical device 11, and an optical transmission medium 13.” Ex. 1004, 5:10-12. A POSITA would have understood optical module component 5 to be a TOSA when it includes a laser as semiconductor optical device 11 to emit light

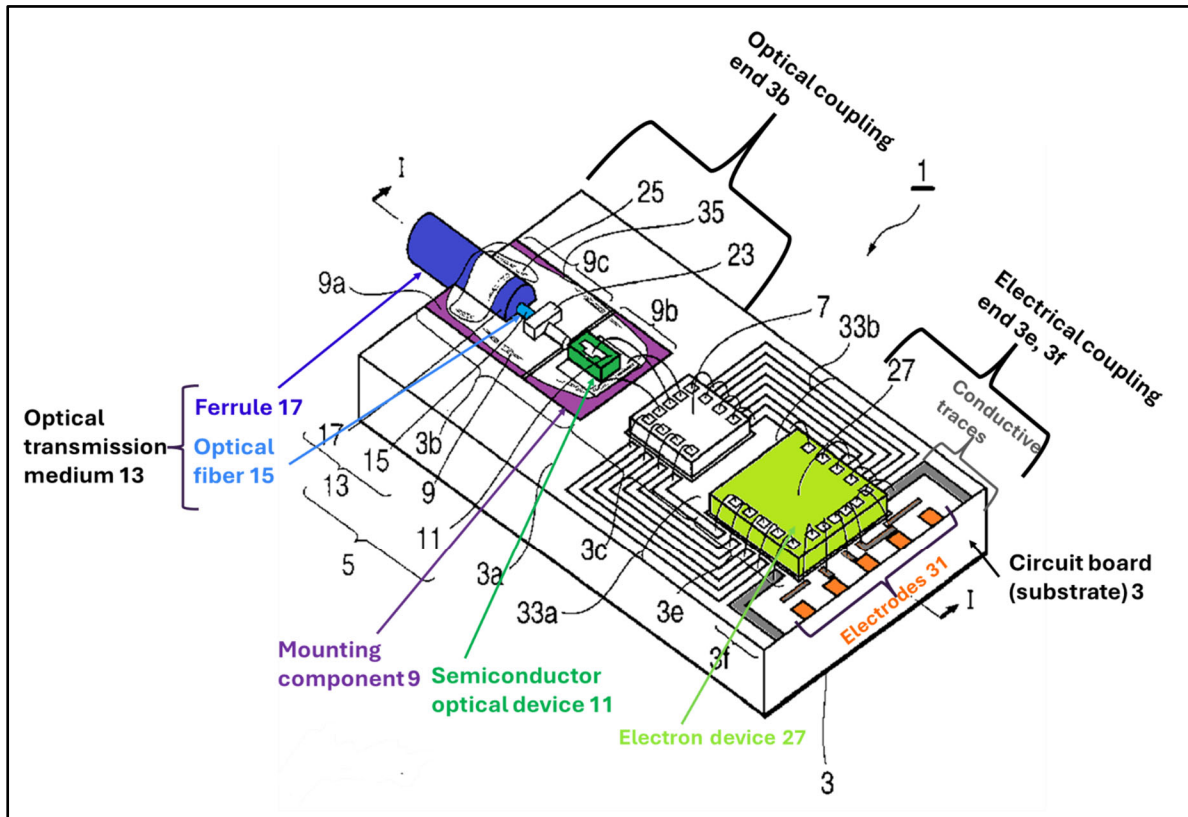
based on driving signal received from electron device 7 (driving element) and the light is transmitted through optical transmission medium 13 (optical fiber 15 and ferrule 17). *Id.*, 5:27-28, 6:30-40; Ex. 1003, ¶61.

2. Claim term 1[a] (“a substrate having an electrical coupling end for electrically coupling to external circuitry and an optical coupling end for launching at least one channel wavelength on a waveguide, the electrical coupling end disposed opposite the optical coupling end”)

Kuhara’s optical data link 1 (optical subassembly module) includes a circuit board 3 (substrate) that has “a principal plane 3*a*, and first and second mounting sections 3*b* and 3*c* disposed on the principal plane 3*a*.” Ex. 1004, 5:1-5. A POSITA would have understood first mounting section 3*b* to be an “optical coupling end” because it is disposed at an end portion of circuit board 3 and it mounts the optical module component 5. *Id.*, 5:8-9 (“The first mounting section 3*b* has the optical module component 5.”), Figs. 1A, 1B, 2; Ex. 1003, ¶62. Optical module component 5 includes a mounting component 9, a semiconductor optical device 11 (laser) and an optical transmission medium 13 (comprising an optical fiber 15 and a ferrule 17). Ex. 1004, 5:27-28, 6:30-40. Therefore, a POSITA would have understood that optical module component 5 is a TOSA and is configured to launch at least one channel wavelength (light) emitted by semiconductor optical device 11 (laser) onto optical fiber 15 based on driving signal received from electron device 7 (driving element). *Id.*; *see also id.*, 6:41-50 (discussing “the optical path from one to

the other of the semiconductor optical device 11 and the optical transmission medium 13.”); Ex. 1003, ¶62. A POSITA would have known and understood that an optical fiber is a specific type of waveguide. Ex. 1003, ¶62; *see also* Ex. 1005, 6:13-17, 6:49-53 (teaching that an optical fiber is a type of waveguide).

The circuit board 3 further includes an interface part 3*f* that has “one or a plurality of **electrodes 31** for connecting the circuit board 3 to an external device(s)” and a third mounting section 3*e* that mounts **electron device 27**. Ex. 1004, 5:58-67, Figs. 1A, 1B, 2. A POSITA would have understood third mounting section 3*e* and interface part 3*f* to be an “electrical coupling end for electrically coupling to external circuitry.” Ex. 1003, ¶63. The electrical coupling end (3*e* and 3*f*) is disposed opposite to the optical coupling end (3*b*) of circuit board 3 (substrate). Ex. 1004, Figs. 1A, 1B, 2.

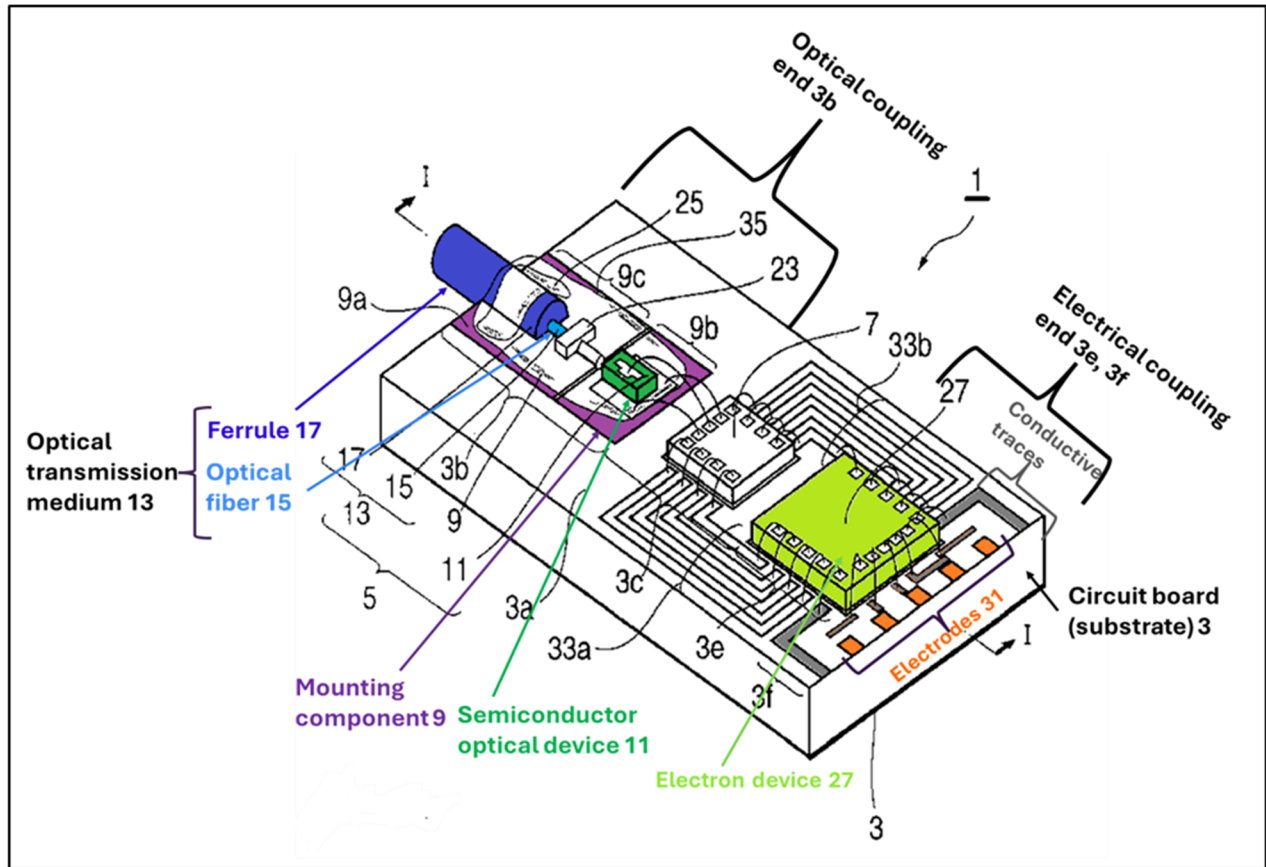


Ex. 1004, Fig. 1A (showing electrical coupling end 3e, 3f and optical coupling end 3b of substrate 3) (annotations added)

3. **Claim term 1[b]** (“a first mounting region at the electrical coupling end of the substrate to provide traces for electrical interconnection with the external circuitry, the first mounting region defined at least in part by a component mounting surface provided by a sidewall of the substrate”)

The electrical coupling end of the substrate (circuit board 3) includes a first mounting region defined by third mounting section 3e, which mounts **electron device 27**. Ex. 1004, 5:58-67, Figs. 1A, 1B, 2. The third mounting section 3e and interface part 3f include **conductive traces** (33d) and a plurality of **electrodes 31** for electrical interconnection with the external circuitry. *Id.*, 5:58-67, 6:19-29, Figs. 1A,

2. The first mounting region (third mounting section 3e) is part of the component mounting surface (3e and 3c), which is provided by a sidewall (principal plane 3a) of circuit board 3, and the component mounting surface mounts electron devices 7 and 27. *Id.*, Figs. 1A, 1B, 2. A POSITA would have understood the top surface/top wall defined by principal plane 3a to be a “sidewall” of circuit board 3 because components are typically always mounted on the top surface, and not along the sides of a circuit board/substrate. Ex. 1003, ¶64. Moreover, the ’887 patent itself shows that the first component mounting surface 245 is provided by a top surface of substrate 202, and thus the ’887 patent equates “sidewall” to the top surface or top wall of a substrate. *Id.*; *see* Ex. 1001, Figs. 1, 7A, 7B, 10:55-58.



Ex. 1004, Fig. 1A (showing the electrical coupling end (3e, 3f) of circuit board 3 having **conductive traces** and **electrodes 31** for electrical interconnection with external circuitry, and a component mounting surface for mounting **electron device 27**) (annotation added)

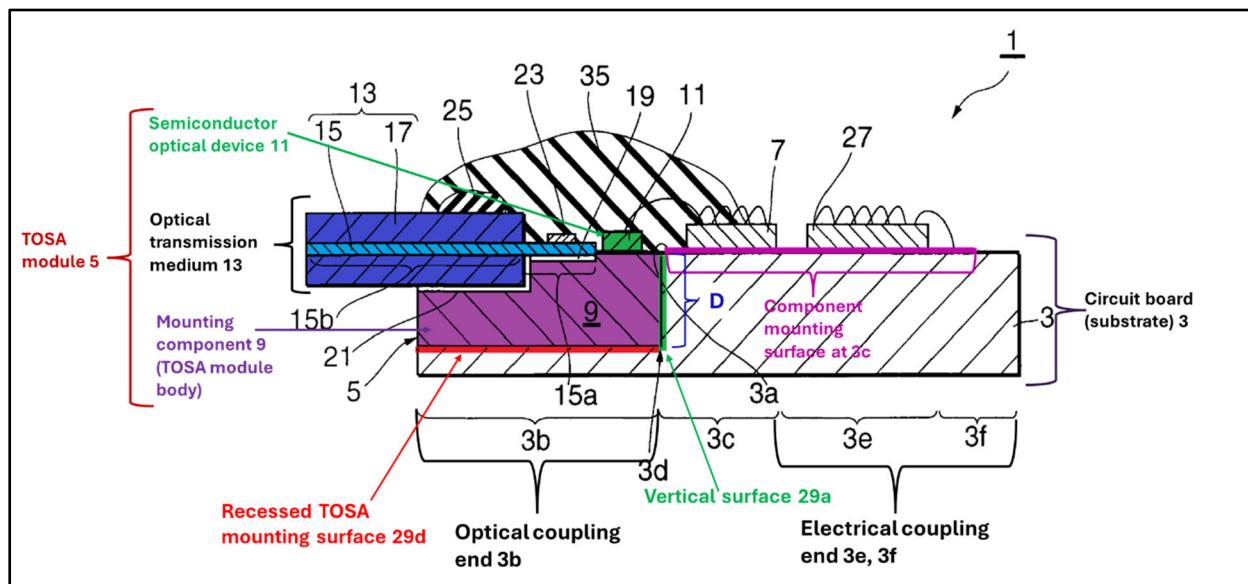
4. **Claim term 1[c]** (“a second mounting region at the optical coupling end of the substrate to couple to and support at least one transmitter optical subassembly (TOSA) module via a recessed TOSA mounting surface, the recessed TOSA mounting surface being disposed offset from the component mounting surface by first offset distance (OD1) based on a stepped profile, the stepped profile defined at least in part by the recessed TOSA mounting surface extending substantially parallel with the component mounting surface and substantially transverse relative to a vertical surface

adjoining the recessed TOSA mounting surface and the component mounting surface”)

The optical coupling end 3*b* of the substrate (circuit board 3) includes a second mounting region (concave portion 29), which couples to and supports optical module component 5, which is a TOSA as discussed above. Ex. 1004, 5:1-20, 6:1-18, Figs. 1A, 1B, 2. Specifically, a POSITA would have understood optical module component 5 to be a TOSA module when it includes a laser as semiconductor optical device 11 to emit light that is transmitted through optical transmission medium 13 (optical fiber 15 and ferrule 17). *Id.*, 5:27-28, 6:30-40; Ex. 1003, ¶65. The second mounting region includes a **recessed TOSA mounting surface (bottom face 29*d*)**, as shown in Figures 1B and 2, annotated below. Ex. 1004, 6:10-15 (“The first mounting section 3*b* has a bottom face 29*d* for supporting the mounting component 9. The bottom face 29*d* extends along a fourth reference plane, and the spacing between the first reference plane and the fourth reference plane is represented by symbol D in FIG. 2.”). The TOSA module 5 couples to and is supported by the recessed TOSA mounting surface (29*d*). Ex. 1003, ¶65.

principal plane 3a extends along a first reference plane. A step 3d is formed between the first mounting section 3b and the second mounting section 3c.”), Figs. 1A, 1B, 2 (showing that the second and the third mounting sections 3c and 3e are in the same principal plane 3a, and surface 29d is recessed therefrom); Ex. 1003, ¶66.

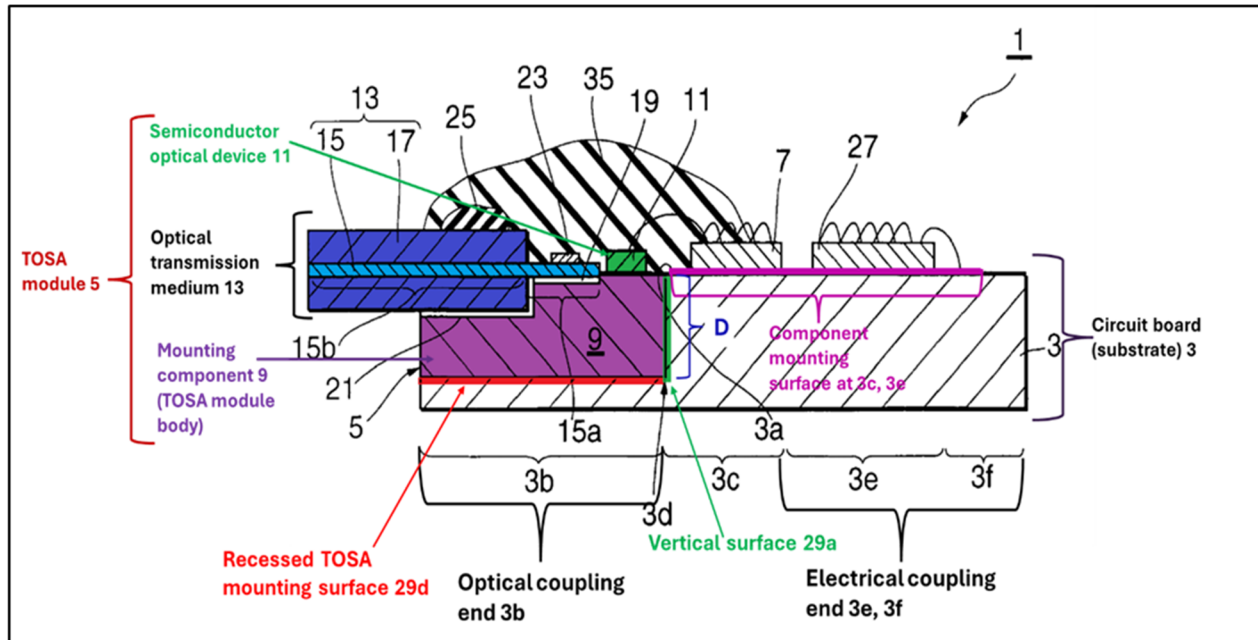
Figures 1B and 2 further show that the stepped profile (step 3d) is defined at least in part by the **recessed TOSA mounting surface (29d)**, which extends substantially parallel with the **component mounting surface (3c and 3e)**, and substantially transverse relative to a **vertical surface (positioning face 29a)** that adjoins the recessed TOSA mounting surface and the component mounting surface. Ex. 1003, ¶67.



Ex. 1004, Fig. 1B (showing stepped profile (step 3d) formed by **recessed TOSA mounting surface 29d** and **vertical surface 29a**) (annotations added)

5. **Claim term 1[d] (“wherein the vertical surface provides a mechanical stop to engage a surface of the least one TOSA module and limit travel of the at least one TOSA module along one or more axis, and wherein the second mounting region at the optical coupling end of the substrate is configured to edge mount to the at least one TOSA module.”)**

As shown in Figures 1A and 2, annotated above, the **vertical surface 29a** provides a mechanical stop to engage a side surface of the **mounting component 9** of the TOSA module (optical module component 5). Ex. 1004, Figs. 1A, 1B, 2 (Figure 1B annotated below). A POSITA would have readily understood that vertical surface 29a would limit travel of the TOSA module along a longitudinal axis that runs parallel to principal plane 3a of circuit board 3 (substrate). Ex. 1003, ¶68. As further shown in Figures 1A, 1B, and 2 of Kuhara, the TOSA module 5 is edge-mounted to the concave portion 29 (second mounting region) at the optical coupling end 3b of circuit board 3. *Id.*, Ex. 1004, Figs. 1A, 1B, 2.

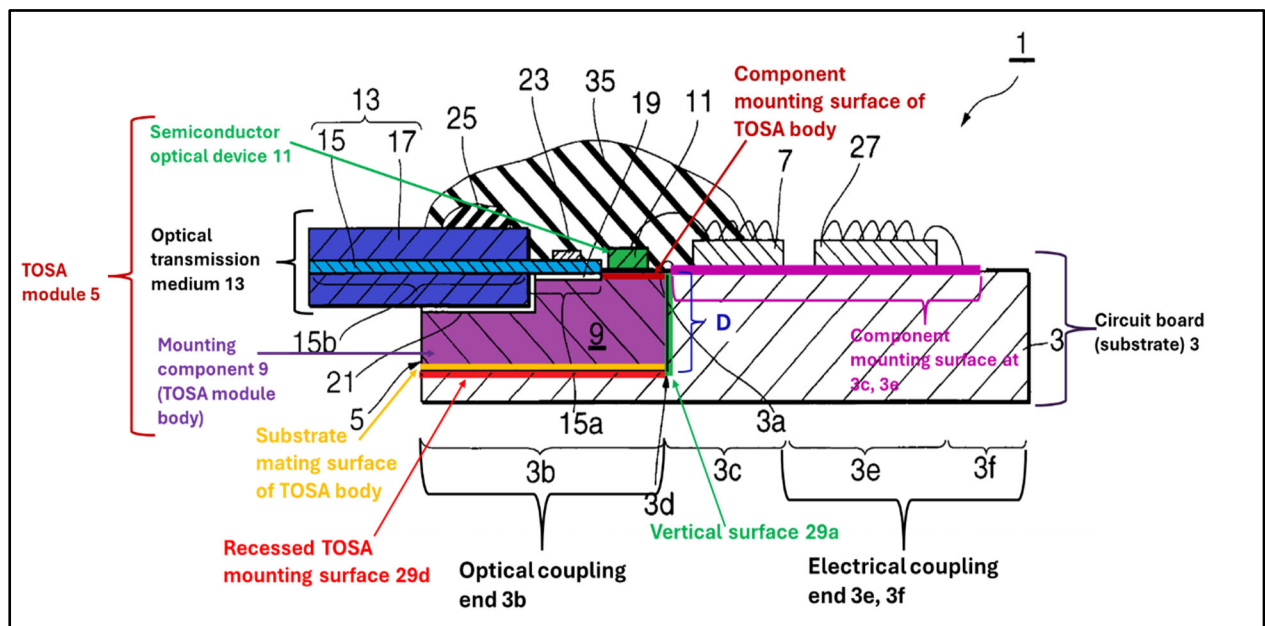


Ex. 1004, Fig. 1B (showing **vertical surface 29a** providing a mechanical stop for **mounting component 9** of the TOSA module) (annotations added)

- B. Claim 2 (“The optical subassembly module of claim 1, wherein the optical subassembly module further comprises the at least one TOSA module edge mounted to the second mounting region of the substrate, the at least one TOSA module having a body that includes a component mounting surface to couple to a laser arrangement and a substrate mating surface disposed opposite the component mounting surface of the body, the substrate mating surface of the body to couple to the recessed TOSA mounting surface of the optical coupling end of the substrate and extend from the substrate along an axis that is substantially parallel with a longitudinal axis of the substrate.”)**

As discussed regarding claim term 1[c], optical data link 1 (optical subassembly module) comprises a TOSA module (optical module component 5) edge-mounted to the concave portion 29 (second mounting region) of circuit board 3 (substrate). Ex. 1004, Figs. 1A, 1B, 2. The TOSA module comprises a body

(mounting component 9) that includes a **component mounting surface** to couple to a laser arrangement (semiconductor optical device 11) and a **substrate mating surface** disposed opposite the component mounting surface of the body. *Id.*, 5:12-17 (stating that the region 9b mounts semiconductor optical device 11), 6:30-40 (stating that the semiconductor optical device 11 may be a semiconductor laser.”), Figs. 1A, 1B, 2.



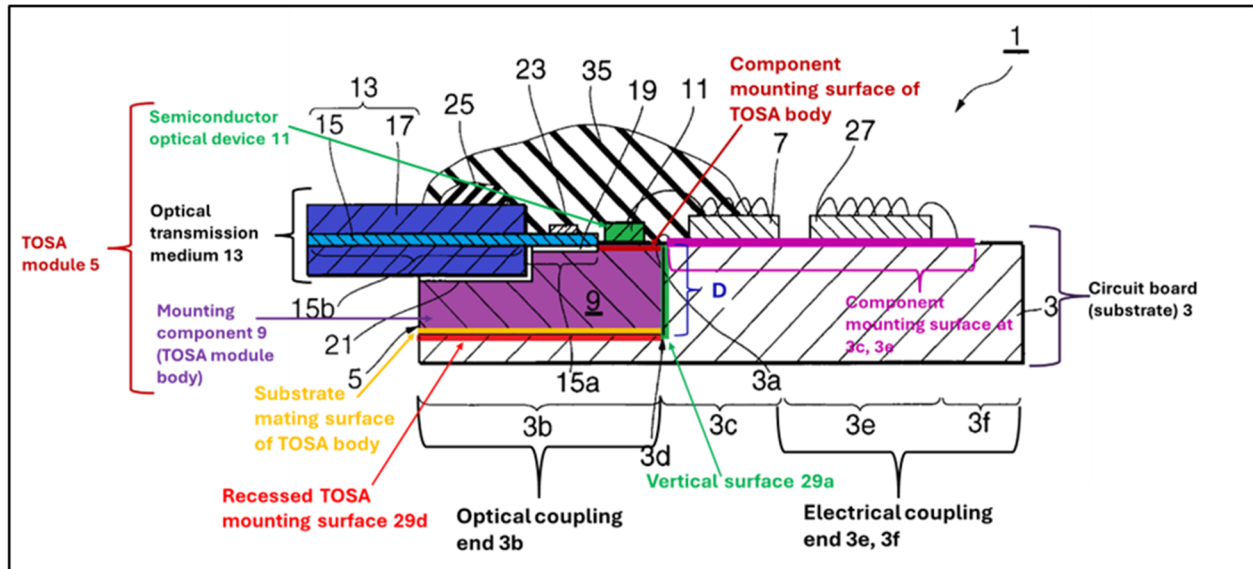
Ex. 1004, Fig. 1B (showing that the **TOSA module body** (mounting component 9) includes a **component mounting surface** to couple to a **laser arrangement** (semiconductor optical device 11) and a **substrate mating surface** that couples to the **recessed TOSA mounting surface**) (annotations added)

As shown in Figure 1B, annotated above, the **substrate mating surface** of the TOSA body couples to the **recessed TOSA mounting surface** (bottom face 29a)

of the optical coupling end 3*b* of the substrate (circuit board 3) and extends from the substrate along an axis that is substantially parallel with a longitudinal axis of the substrate that extends along principal plane 3*a*. *Id.*, Figs. 1B, 2; Ex. 1003, ¶70.

C. Claim 3 (“The optical subassembly module of claim 2, wherein the substrate mating surface of the body is vertically offset from the component mounting surface of the substrate by the first offset distance.”)

As shown in Figure 1B, annotated below, the substrate mating surface of the TOSA module body is vertically offset from the component mating surface of the circuit board 3 (substrate). Ex. 1004, Figures 1B, 2, 6:10-15 (“The first mounting section 3*b* has a bottom face 29*d* for supporting the mounting component 9. The bottom face 29*d* extends along a fourth reference plane, and the spacing between the first reference plane [defined by principal plane 3*a*] and the fourth reference plane is represented by symbol D in FIG. 2.”). A POSITA would have understood from Figures 1B and 2 that when the TOSA module body (mounting component 9) is mounted in concave portion 29 (second mounting region), the **substrate mating surface** of the TOSA module body would be vertically offset from the **component mating surface** of the substrate by the **first offset distance D** (i.e., the height of the vertical surface 29*d*). Ex. 1003, ¶71.



Ex. 1004, Fig. 1B (showing that the **substrate mating surface** of the TOSA module body is vertically offset from the **component mounting surface** of circuit board 3 (substrate) by the **first offset distance D**) (annotations added)

VIII. GROUND 2: CLAIMS 8, 10, AND 12 ARE RENDERED OBVIOUS BY KUHARA

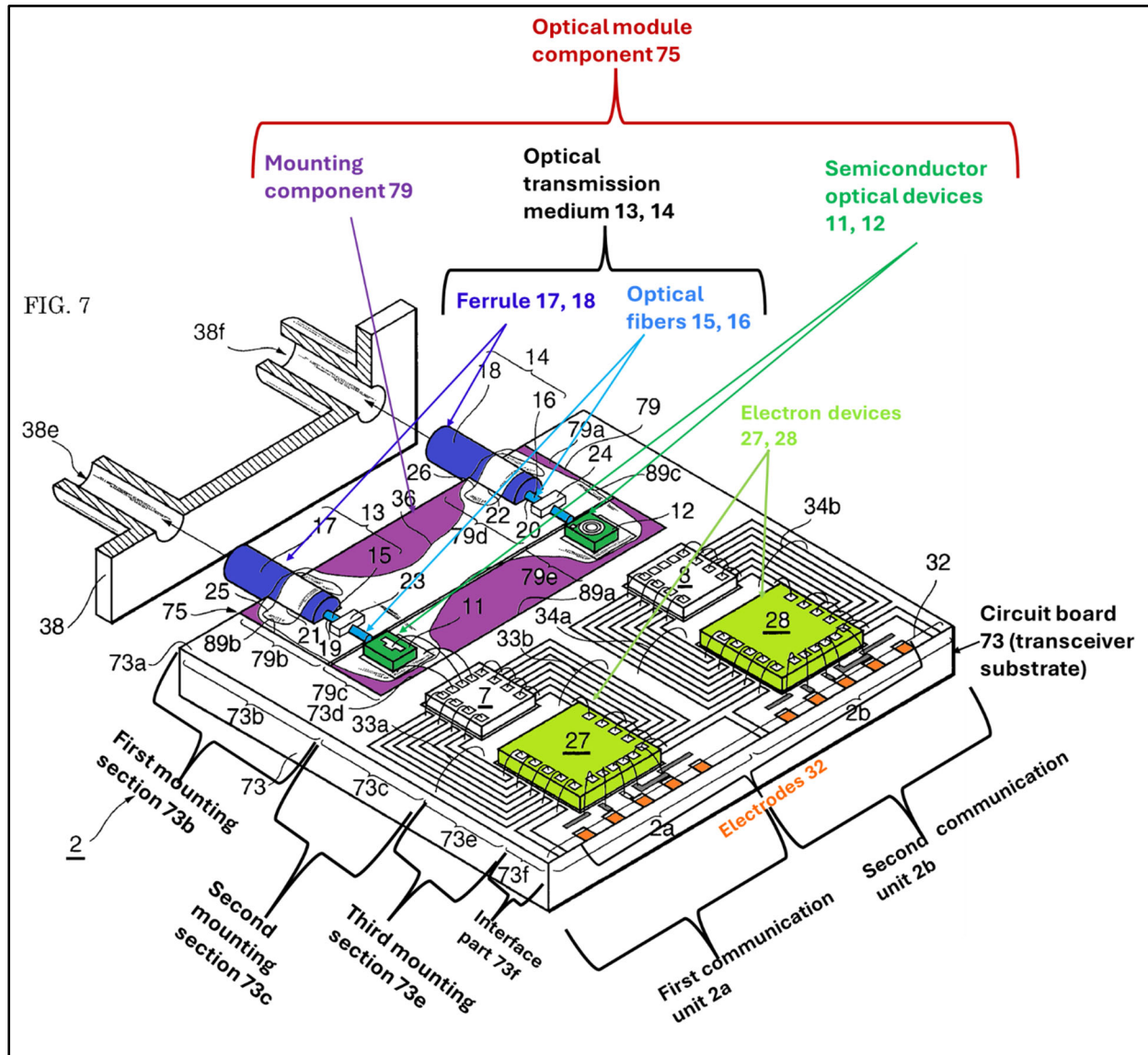
A. Claim 8 (“The optical subassembly of claim 1, wherein the second mounting region is configured to couple to and support a plurality of TOSA modules.”)

As discussed regarding claim term 1[c] (Section VII.A.4), Kuhara discloses an optical subassembly (optical data link 1), wherein the second mounting region (concave portion 29) is configured to couple to and support optical module component 5. Ex. 1004, 5:1-20, 6:1-18, Figs. 1A, 1B, 2. As discussed above, a POSITA would have understood optical module component 5 to be a TOSA module when it includes a laser as semiconductor optical device 11 to emit light based on

driving signal received from electron device (laser drive) 7 and the light is transmitted through optical transmission medium 13 (optical fiber 15 and ferrule 17).

Id., 5:27-28, 6:30-40; Ex. 1003, ¶72.

Kuhara also discloses an optical data link 2, as illustrated in Figures 7, 8A-8C, which includes two optical transmission mediums 13 and 14, each having a semiconductor optical device 11 and 12, respectively, and “both the semiconductor optical devices 11 and 12 may be semiconductor lasers.” Ex. 1004, 10:28-36. In such an arrangement, optical module component 75 of optical data link 2 would have been a TOSA arrangement having two TOSA modules: the first TOSA defined by optical transmission medium 13 and semiconductor laser 11 and the second TOSA defined by optical transmission medium 14 and semiconductor laser 12. *Id.*, 5:1-20, 10:28-36, Figs. 7, 8A-8C. Both TOSA modules would have the same mounting component 9, as shown in Figures 7 and 8A, and would have been driven by the same electron device 7 or by separate electron devices 7 and 8, as further shown in Figures 7 and 8A-8C. *Id.*, 9:54-10:7; Ex. 1003, ¶73.



Ex. 1004, Fig. 7 (showing optical module component 75 of optical data link 2 as a TOSA arrangement having two TOSA modules) (annotations added)

Based on Kuhara's disclosure of optical data link 2 shown in Figures 7 and 8A-8B, a POSITA would have been motivated to modify optical data link 1 (shown in Figures 1A, 1B, and 2) to have at least two TOSA modules having a common mounting component 9, with the first TOSA module defined by laser 11 and optical

transmission medium 13, and the second TOSA module defined by laser 12 and optical transmission medium 14. Ex. 1004, 5:1-20, 6:30-40, 10:28-36; Ex. 1003, ¶74. A POSITA would have been motivated to modify optical data link 1 to have a plurality of TOSA modules in view of optical data link 2 in order to have a multi-channel transmitter, where each TOSA transmits at a different wavelength and the wavelengths are multiplexed into a single, combined optical signal to be transmitted by a single optical fiber. Ex. 1003, ¶74. As a POSITA would have known, such multi-channel transmitters allow for higher data transmission rates and are often used in high-speed communication systems. *Id.*

Given Kuhara's detailed description of optical data link 2, a POSITA would have reasonably expected success in modifying optical data link 1 in view of optical data link 2 to have multiple TOSAs. *Id.*, ¶75. Indeed, the modification would have required nothing more than the routine and ordinary skills of a POSITA, and the modification would have yielded the predictable result of a multi-channel transmitter for application in high-speed communication systems. *Id.*

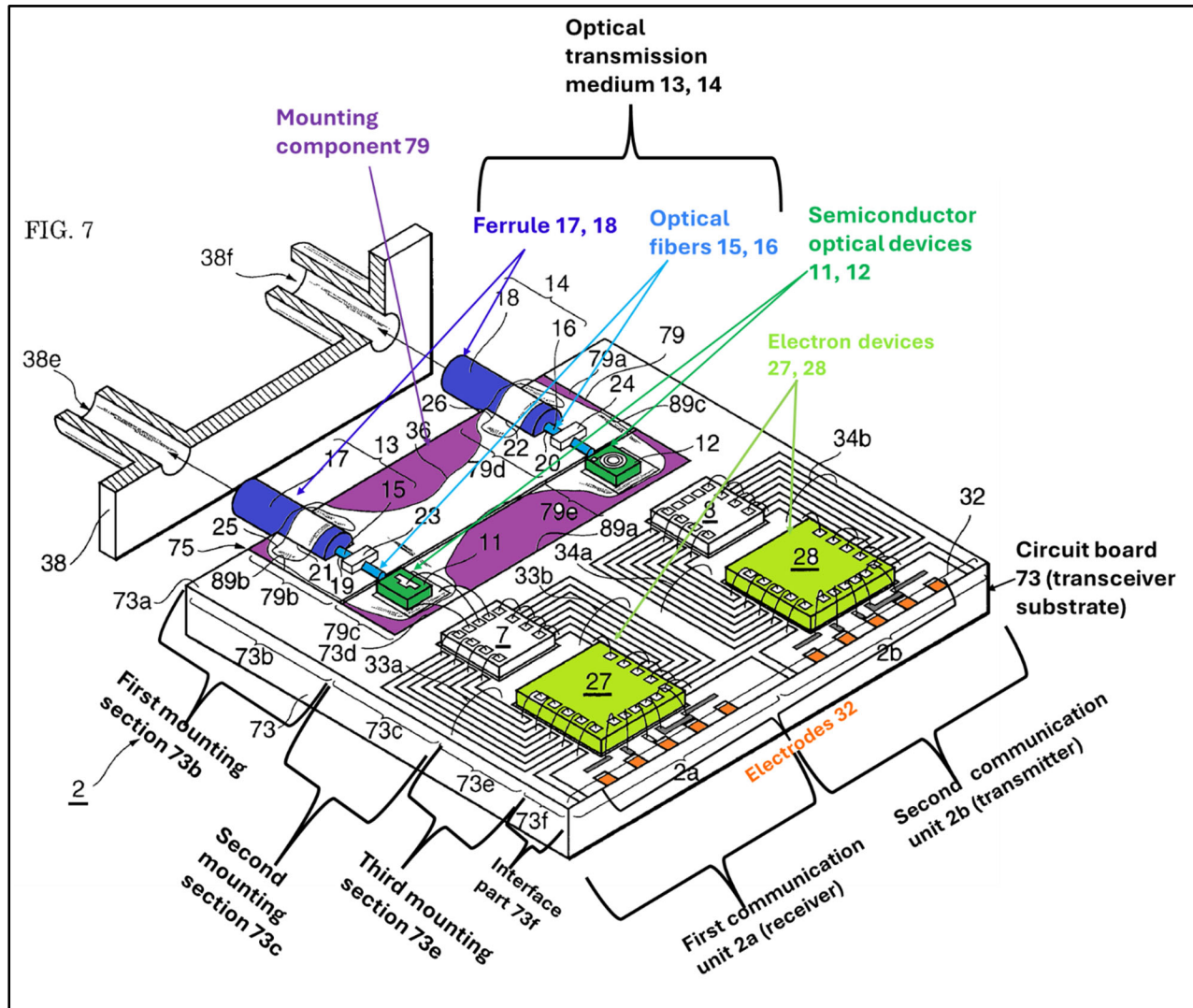
B. Independent Claim 10

1. Claim 10[pre] ("An optical transceiver, the optical transceiver comprising:")

Kuhara discloses an optical data link 2, as illustrated in Figures 7, 8A-8C. Optical module component 75 of optical data link 2 includes two optical transmission mediums 13 and 14, each having a semiconductor optical device 11

and 12, respectively, and “the semiconductor optical device 11 may be a photodiode, and the semiconductor optical device 12 may be a semiconductor laser.” Ex. 1004, 10:28-36. A POSITA would have known that an optical module component with a semiconductor laser is a TOSA for transmission of optical signals emitted by the laser, and an optical module component with a photodiode is a ROSA (receiver optical subassembly) for receiving optical signals and converting them to electrical signals. Ex. 1003, ¶76. A POSITA would also have known that optical data link 2 comprising a TOSA and a ROSA is a transceiver capable of transmitting and receiving optical signals. *Id.* In other words, it would have been obvious to a POSITA that optical data link 2 having a TOSA (with laser 12) and a ROSA (with photodiode 11) is a transceiver. *Id.*

Fig. 7, annotated below, shows optical data link 2 (optical transceiver) having a receiver defined by first communication unit 2a and a transmitter defined by second communication unit 2b.



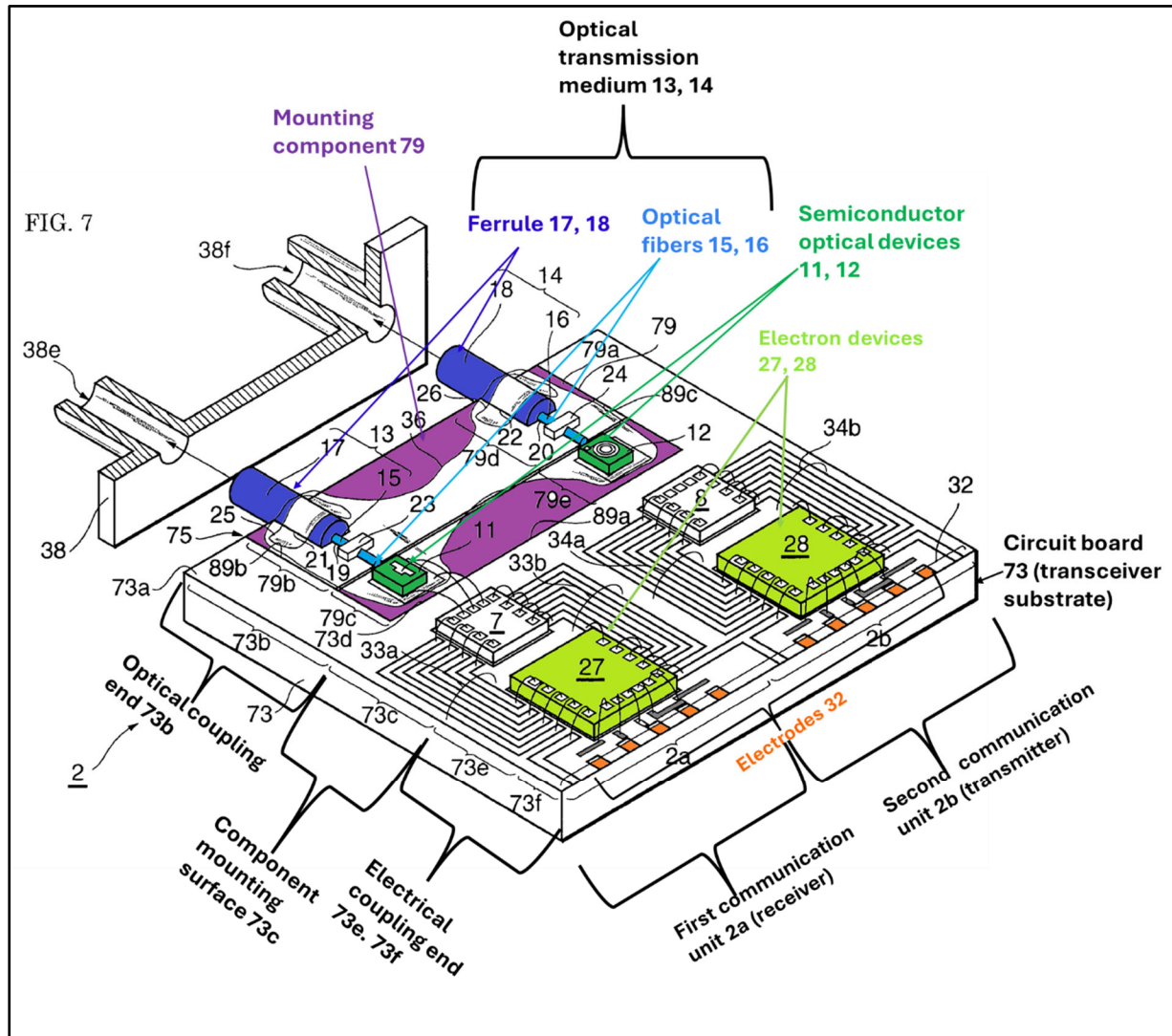
Ex. 1004, Fig. 7 (showing component of transceiver (optical data link 2))
(annotations added)

2. Claim term 10[a] (“a transceiver substrate having an optical coupling end disposed opposite an electrical coupling end”)

A POSITA would have understood that in optical data link 2 (optical transceiver), circuit board 73 is a transceiver substrate. Ex. 1004, 9:30-32; Ex. 1003, ¶78. Circuit board 73 has “a principal plane 73a, and first and second mounting

sections 73*b* and 73*c* disposed on the principal plane 37*a*.” Ex. 1004, 9:32-34. A POSITA would have understood first mounting section 73*b* to be an “optical coupling end” because it is disposed at an end portion of circuit board 73 and it mounts the optical module component 75. *Id.*, 9:37-38 (“The first mounting section 73*b* has the optical module component 75.”), Figs. 7, 8A; Ex. 1003, ¶78.

The circuit board 73 further includes an interface part 73*f* that has “an electrode or **electrodes 32** for connecting the circuit board 73 to an external device(s)” and a third mounting section 73*e* that mounts **electron devices 27 and 28**. Ex. 1004, 10:37-49, Figs. 7, 8A. A POSITA would have understood third mounting section 73*e* and interface part 73*f* to be an “electrical coupling end” for electrically coupling to external circuitry. Ex. 1003, ¶79. The electrical coupling end (73*e* and 73*f*) is disposed opposite to the optical coupling end (73*b*) of circuit board 73 (transceiver substrate). Ex. 1004, Figs. 7, 8A.

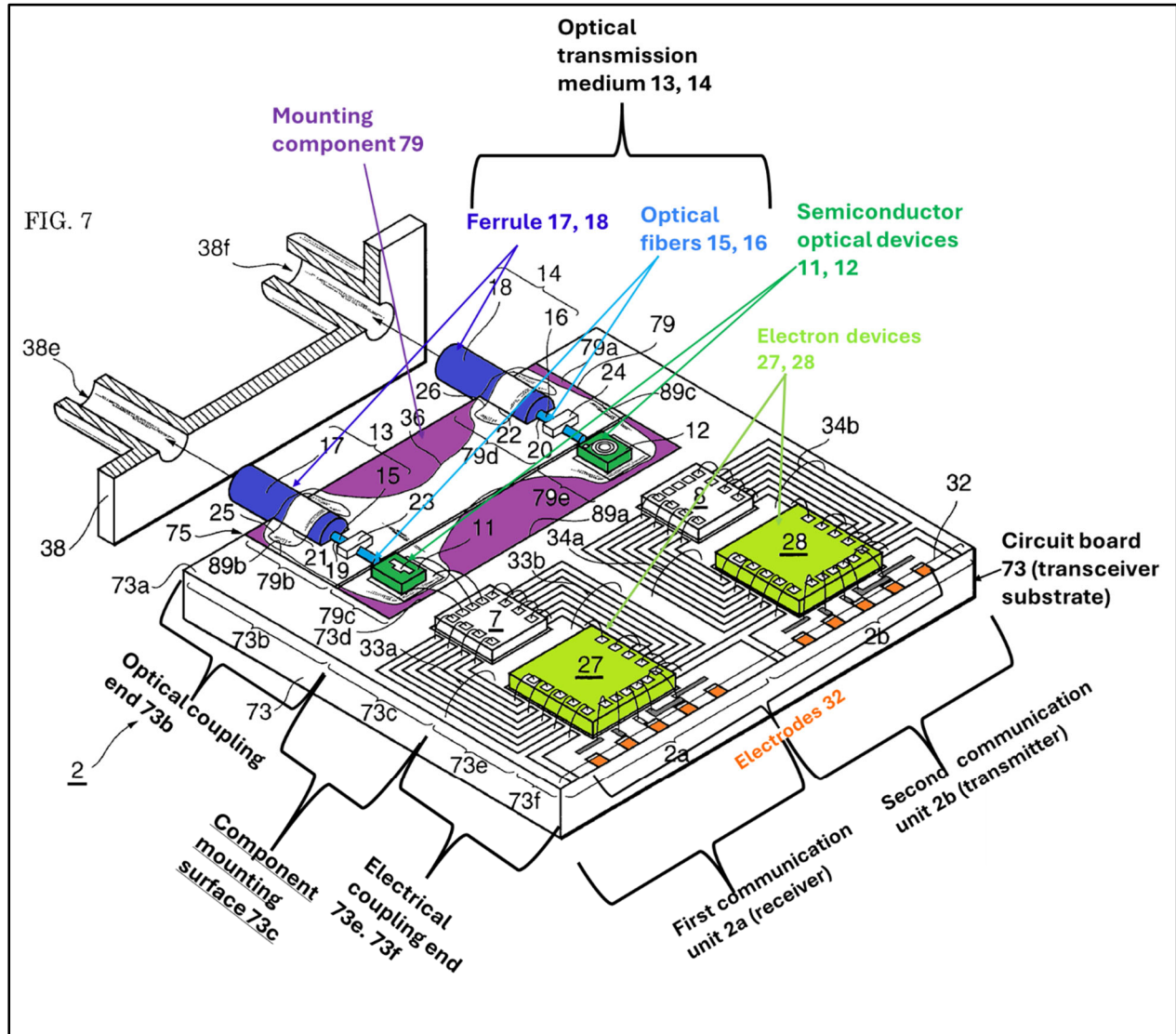


Ex. 1004, Fig. 7 (showing electrical coupling end 73e, 73f and optical coupling end 73b of substrate 73) (annotations added)

3. **Claim term 10[b]** (“at least one component mounting surface provided by the transceiver substrate extending between the optical coupling end and the electrical coupling end”)

As shown in Figure 8, annotated below, Kuhara’s circuit board 73 (transceiver substrate) provides at least one component mounting surface (second mounting

section 73c) extending between the optical coupling end (73b) and the electrical coupling end (73e, 73f). Ex. 1004, 9:30-53, 10:37-46.

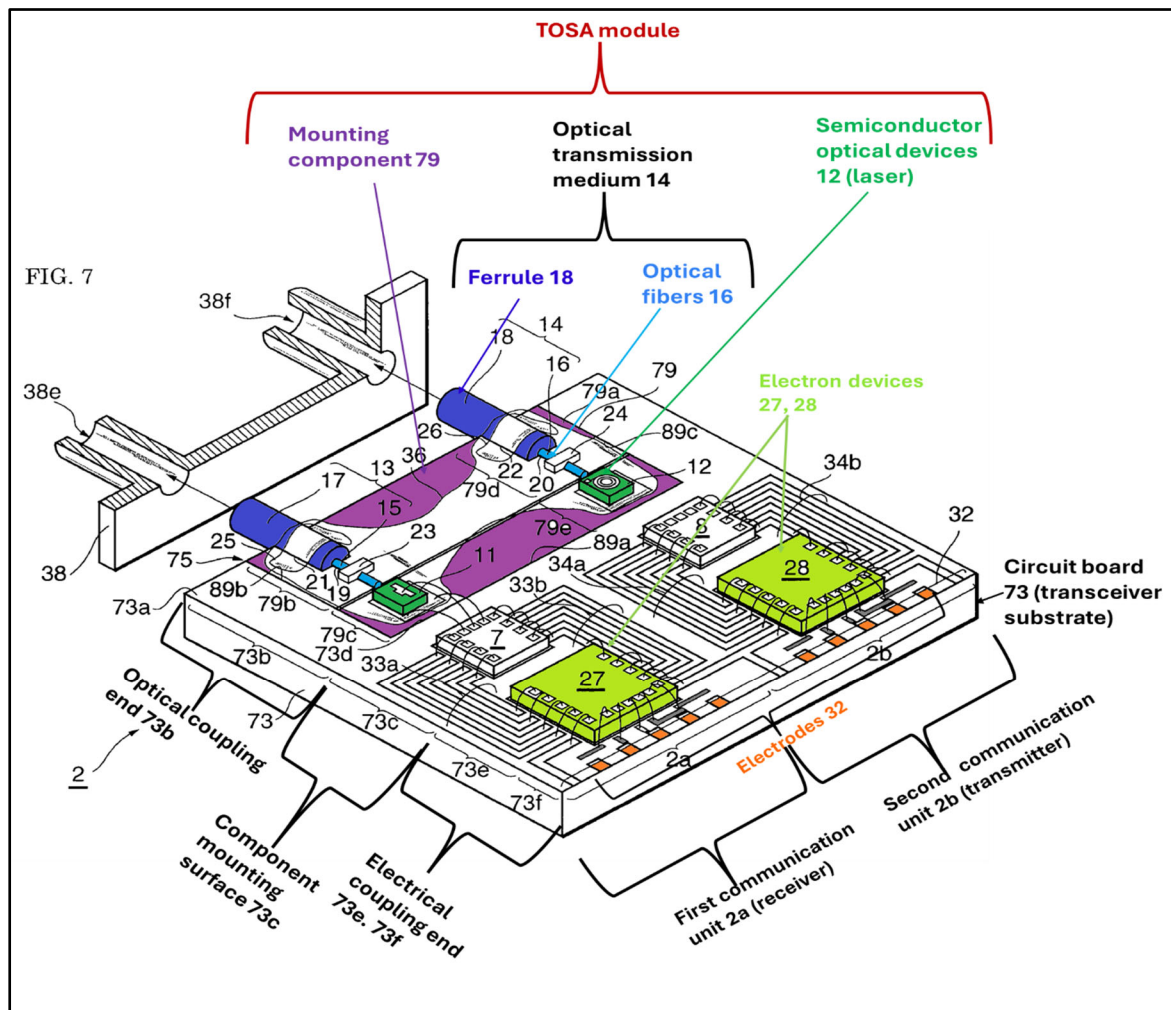


Ex. 1004, Fig. 7 (showing component mounting surface 73c) (annotations added)

4. **Claim term 10[c]** (“a recessed transmitter optical subassembly (TOSA) mounting surface at the optical coupling end of the substrate for coupling to and supporting at least one TOSA module, and wherein the recessed TOSA mounting surface extends substantially parallel with the at least one component mounting surface and substantially

transverse relative to a vertical surface adjoining the recessed TOSA mounting surface and the at least one component mounting surface”)

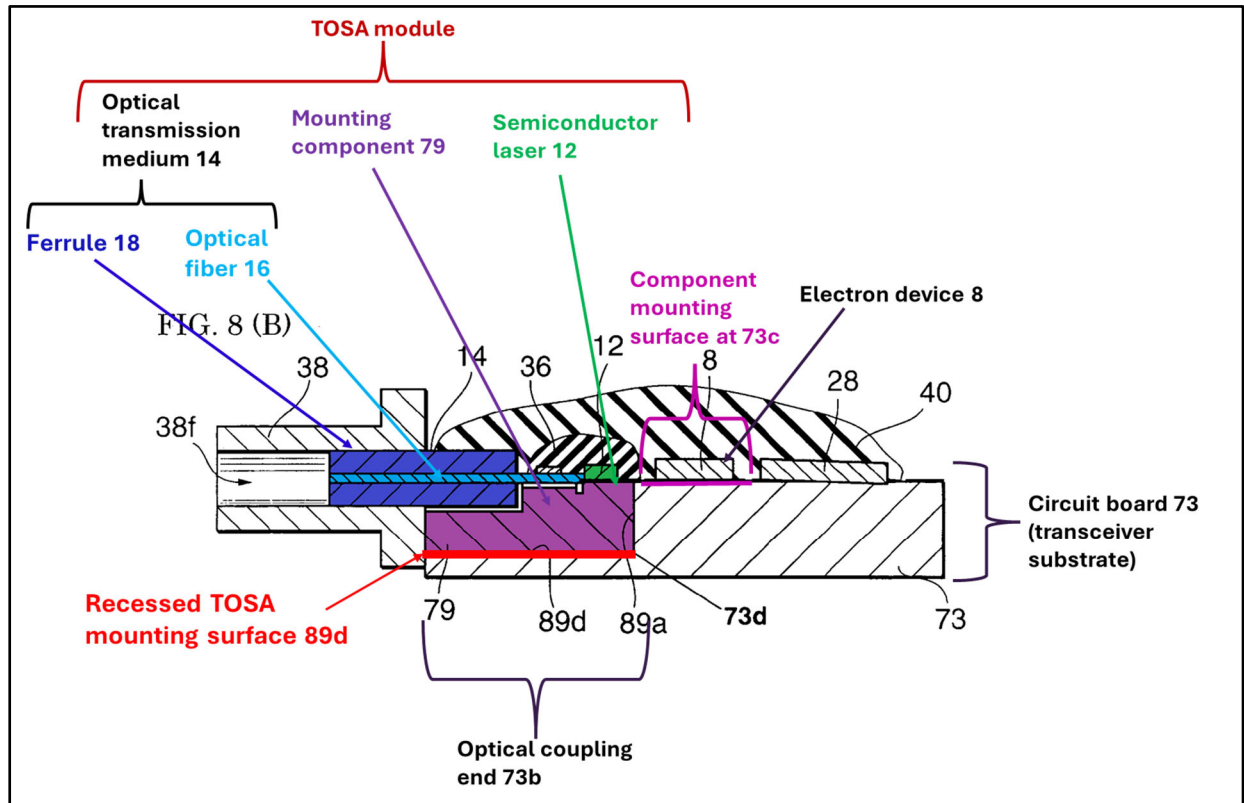
A POSITA would have understood Kuhara’s optical data link 2 (optical transceiver) to include a TOSA module having semiconductor optical device 12 (laser), optical transmission medium 14, and a portion of mounting component 79 (regions 79d, 79e) that is within communication unit 2b (transmitter). Ex. 1004, 9:54-67, 10:61-67, Figs. 7, 8B; Ex. 1003, ¶81.



Ex. 1004, Fig. 7 (showing TOSA module) (annotations added)

As shown in Figure 8B, the TOSA module is coupled to the concave portion (defined by 89a, 89b, 89c, 89d) at the optical coupling end 73b of circuit board 73 (transceiver substrate). Ex. 1004, Fig. 8B, 10:50-58. Specifically, optical coupling end 73b of the transceiver substrate (circuit board 73) has “a positioning face 89a for positioning the mounting component 79. The first mounting section 73b has guiding faces 89b and 89c for guiding the mounting component 79. As shown in FIGS. 8B and 8C, the first mounting section 73b has a bottom face 89d for supporting the mounting component 79.” *Id.*

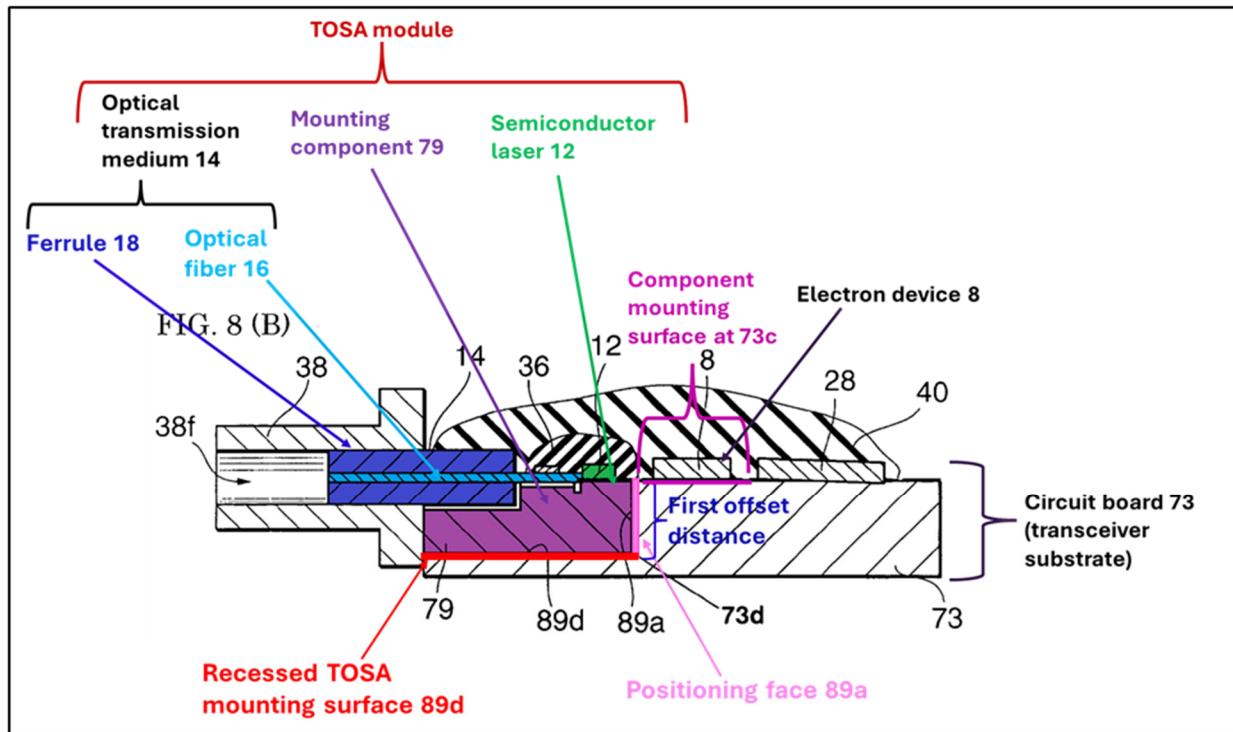
A POSITA would have understood bottom face 89d for coupling to and supporting the mounting component regions 79d , 79e of the TOSA module to be a **recessed TOSA mounting surface** at the optical coupling end 73b, as shown in Figure 8B, annotated below. *Id.*, 10:50-58; Ex. 1003, ¶83.



Ex. 1004, Fig. 8B (showing **recessed TOSA mounting surface** at the optical coupling end 73*b* of transceiver substrate 73) (annotations added)

As shown in Figure 8B, annotated below, the **recessed TOSA mounting surface 89d** extends substantially parallel with the **component mounting surface (73c)** and is disposed vertically offset from the component mounting surface (73c) by a **first offset distance** defined stepped profile 73d. Ex. 1004, 9:34-37 (“A step 73d is formed between the first mounting section 73b and the second mounting section 73c.”), 10:50-52 (“In the optical data link 2, the step 73d is formed between the first mounting section 73b and the second mounting section 73c on the circuit board 73.”), Fig. 8B. Figure 8B further shows that the stepped profile (step 73d) is

defined by a **positioning face 89a** that adjoins the **recessed TOSA mounting surface (89d)** and the **component mounting surface (73c)**, and the recessed TOSA mounting surface (89d) extends substantially transverse relative to vertical surface (89a). Ex. 1003, ¶84.

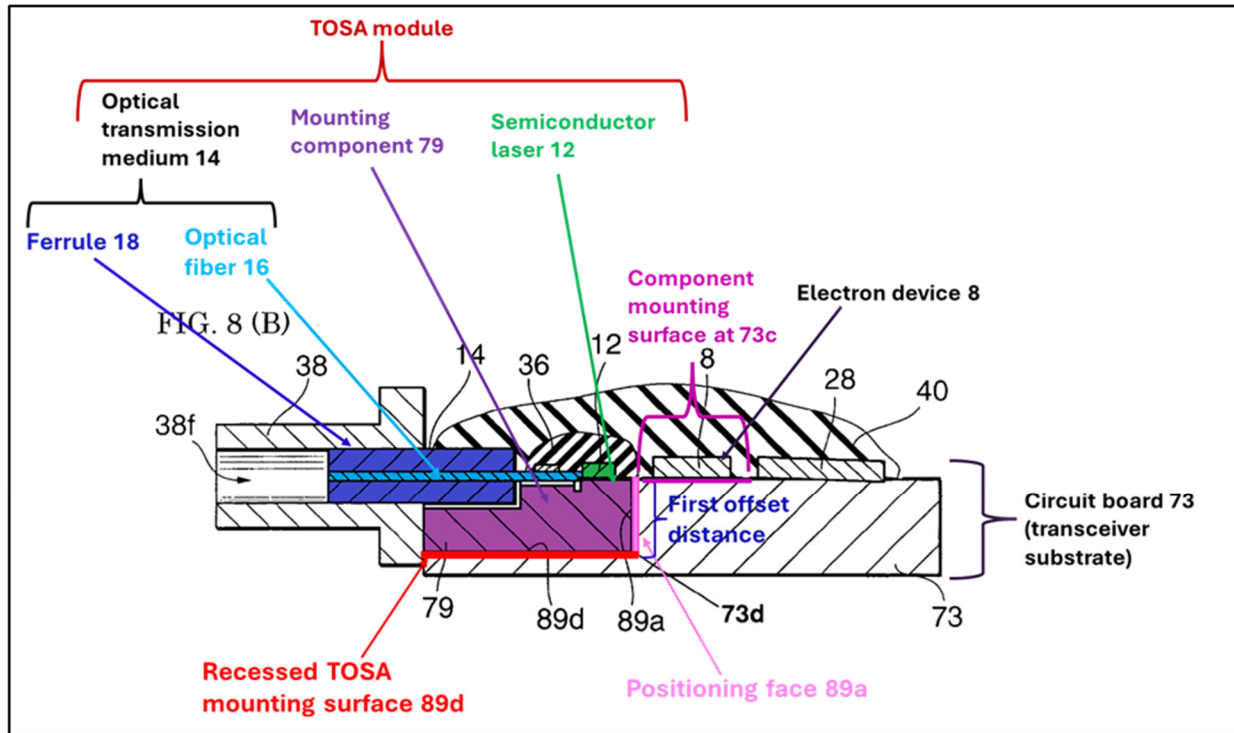


Ex. 1004, Fig. 8B (showing stepped profile (step 73d) formed by **recessed TOSA mounting surface 29d** and **positioning face 29a**) (annotations added)

5. **Claim term 10[d]** (“at least one TOSA module edge mounted to the optical coupling end of the transceiver substrate, wherein the vertical surface provides a mechanical stop to engage a surface of the least one TOSA module and limit travel of the at least one TOSA module along one or more axis”)

As shown in Figure 8B, annotated below, the TOSA module comprises semiconductor optical device 12 (laser), optical transmission medium 14, and a portion of mounting component 79 (regions 79*d*, 79*e*) that is within communication unit 2*b*. Ex. 1004, 9:54-67, 10:61-67, Fig. 8B. As further shown in Figure 8B, the TOSA module is edge-mounted to the concave portion (defined by 89*a*, 89*b*, 89*c*, 89*d*) at the optical coupling end 73*b* of circuit board 73 (transceiver substrate). Ex. 1004, Fig. 8B, 10:50-58; Ex. 1003, ¶85.

Additionally, the vertical surface (positioning face) 89*a* provides a mechanical stop to engage a side surface of the mounting component 79 of the TOSA module. Ex. 1004, Fig. 8B, 10:52-54 (“The first mounting section 73*b* has a positioning face 89*a* for positioning the mounting component 79.”); Ex. 1003, ¶86. A POSITA would have readily understood that positioning face 89*a* would limit travel of the TOSA module along a longitudinal axis that runs parallel to principal plane 73*a* of circuit board 73 (transceiver substrate). Ex. 1003, ¶86.

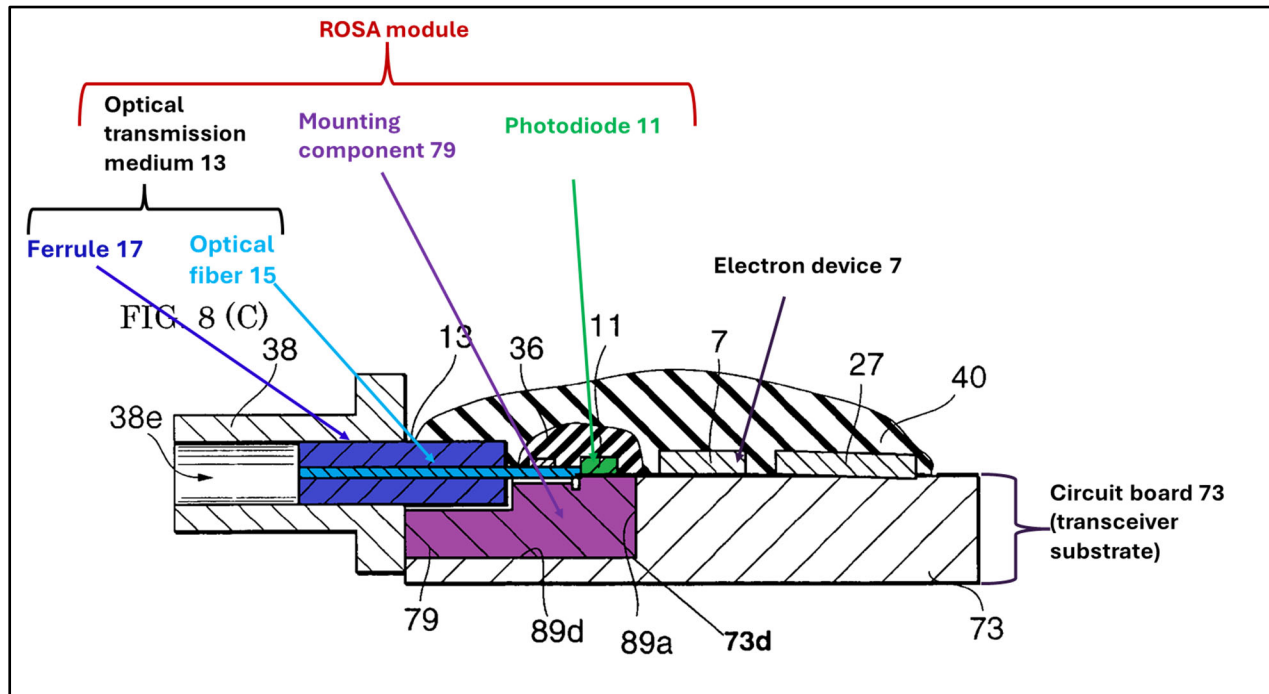


Ex. 1004, Fig. 8B (showing the TOSA module edge mounted to transceiver substrate 73) (annotations added)

6. Claim term 10[e] (“a receiver optical subassembly arrangement coupled to the transceiver substrate.”)

A POSITA would have understood Kuhara’s optical data link 2 (optical transceiver) to include a receiver optical subassembly (ROSA) module having semiconductor optical device 11 (photodiode), optical transmission medium 13, and a portion of mounting component 79 (regions 79b, 79c) that is within communication unit 2a (receiver). Ex. 1004, Figs. 7, 8A, 8C, 9:54-61, 10:28-33; Ex. 1003, ¶87. Specifically, a POSITA would have known and understood that an optical subassembly module having a photodiode and an amplifier that receives a signal

from the photodiode is a ROSA. Ex. 1004, 6:31-36; Ex. 1003, ¶87. The ROSA module is coupled to the optical coupling end 73b of the transceiver substrate (circuit board 73). Ex. 1004, Figs. 7, 8A, 8C; Ex. 1003, ¶87.

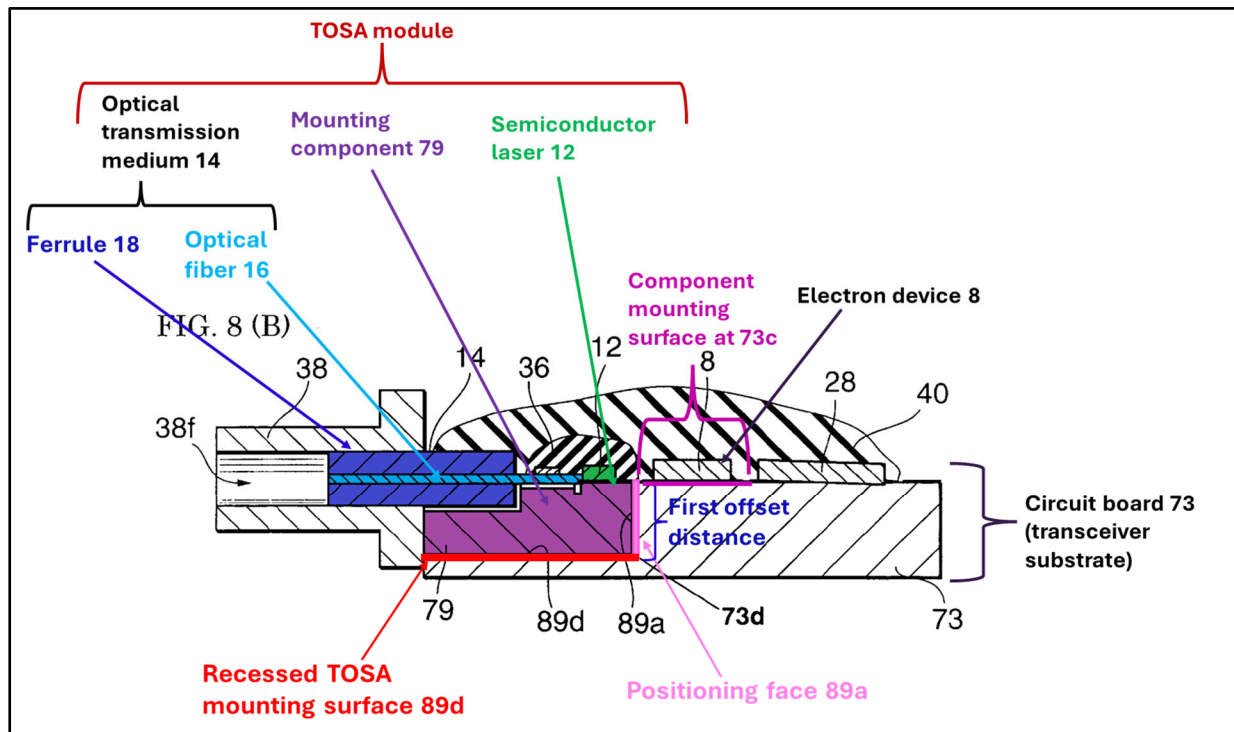


Ex. 1004, Fig. 8C (showing ROSA module formed by semiconductor optical device 11 (photodiode), optical transmission medium 13, and a portion of mounting component 79) (annotations added)

- C. **Claim 12 (“The optical transceiver of claim 10, wherein the recessed TOSA mounting surface is vertically offset relative to the at least one component mounting surface of the transceiver substrate by a first offset distance.”)**

As discussed with regard to claim term 10[c] (Section VIII.B.4), the **recessed TOSA mounting surface 89d** extends substantially parallel with the **component mounting surface (73c)** and is vertically offset from the component mounting

surface (73c) by a **first offset distance** based on stepped profile 73d that defines **positioning face 89a**. Ex. 1004, 9:34-37 (“A step 73d is formed between the first mounting section 73b and the second mounting section 73c.”), 10:50-52 (“In the optical data link 2, the step 73d is formed between the first mounting section 73b and the second mounting section 73c on the circuit board 73.”), Fig. 8B (showing that the first and second mounting sections 73b and 73c are offset by a **first offset distance** based on a stepped profile 73d).



Ex. 1004, Fig. 8B (showing **recessed TOSA mounting surface** is vertically offset relative to the **component mounting surface** of the transceiver substrate by a **first offset distance**) (annotations added)

IX. GROUND 3: CLAIMS 8-12 ARE RENDERED OBVIOUS BY HO IN VIEW OF KUHARA

A. A POSITA Would Have Been Motivated to Combine Ho and Kuhara, and Would Have Reasonably Expected Success in Doing So

Ho discloses a multi-channel optical transceiver for use in a wavelength division multiplexing (WDM) optical system. Ex. 1005, 4:18-25. Ho's optical transceiver further includes a multi-channel TOSA and a multi-channel ROSA. *Id.*, 4:44-49, Fig. 2. Kuhara discloses an optical data link that has "fewer component parts," "reduces the electrical wiring length between the semiconductor optical device [of a TOSA module] and the circuit board," and facilitates mounting and alignment of components on the circuit board. Ex. 1004, 3:41-4:2. Therefore, a POSITA would have been motivated to consider Ho and Kuhara together when designing or developing an improved transceiver that provides better alignment and spatial arrangement of optical components, reduces size and volume of the transceiver, and reduces wiring lengths between components and the transceiver substrate. Ex. 1003, ¶89. A POSITA would have known to combine Ho and Kuhara by modifying Ho's transceiver housing 302 and transmit connecting circuit 304 in view of Kuhara's circuit board 3. *Id.*

A POSITA would have reasonably expected success in combining the teachings of Ho and Kuhara because they each disclose similar and conventional transceiver components that could have been rearranged/reconfigured through

minimal and routine optimization and experimentation. *Id.*, ¶90. The combination of Ho and Kuhara would have only required the routine and ordinary skills of a POSITA. *Id.* Indeed, the combination of Ho and Kuhara would have been nothing more than the combination of known prior art elements according to their known functions, and a POSITA would have known that their combination would have yielded the predictable result of improved optical alignment, space reduction, and shortened wiring lengths in a transceiver. *Id.*

B. Claim 8 (“The optical subassembly of claim 1, wherein the second mounting region is configured to couple to and support a plurality of TOSA modules.”)

As discussed regarding claim term 1[c] (Section VII.A.4), Kuhara discloses an optical subassembly (optical data link 1), wherein the second mounting region (concave portion 29) is configured to couple to and support optical module component 5. Ex. 1004, 5:1-20, 6:1-18, Figs. 1A, 1B, 2. As discussed above, a POSITA would have understood optical module component 5 to be a TOSA module because it includes a semiconductor laser to emit light based on driving signal received from electron device 7 (driving element) and the light is transmitted through optical transmission medium 13 (optical fiber 15 and ferrule 17). *Id.*, 5:27-28, 6:30-40; Ex. 1003, ¶91.

It would have been obvious to a POSITA that when Ho’s transceiver housing 302 and transmit connecting circuit 304 are modified in view of Kuhara’s circuit

board 3, Ho's optical transceiver 300 would include a multi-channel TOSA arrangement 320 at the optical coupling end of Kuhara's circuit board 3. *See* Ex. 1004, Figs. 1A, 1B (showing TOSA module 5 at the optical coupling end 3*b* of circuit board 3); Ex. 1005, Figs. 3A, 3B (showing TOSA arrangement 320 coupled with transmit connecting circuit 304); Ex. 1003, ¶92. Ho further discloses that the "multi-channel TOSA arrangement 320 includes a plurality [of] TOSA modules 324-1 to 324-N configured to generate associated channel wavelengths and associated circuitry[.]" Ex. 1005, 6:7-20. Therefore, it would have been obvious to a POSITA that in Ho modified in view of Kuhara, the second mounting region at the optical coupling end 3*b* of circuit board 3 (transceiver substrate) would have been configured to couple to and support a plurality of TOSA modules 324-1 to 324-N. Ex. 1003, ¶92.

C. Claim 9 ("The optical subassembly of claim 1, wherein the substrate is a printed circuit board, and wherein the optical subassembly is a multi-channel optical transmitter or multi-channel optical transceiver capable of transmitting multiple channel wavelengths.")

Ho discloses an optical transceiver 300 (optical subassembly), which "implements the optical transceiver system 200" as shown in Ho's Figure 2. Ex. 1005, 5:58-6:6. With respect to optical transceiver system 200, Ho discloses that "optical transceiver 200 includes a multi-channel transmitter optical subassembly (TOSA) arrangement 220 for transmitting optical signals on the channel

wavelengths (e.g., $\lambda_1, \lambda_2, \lambda_3, \lambda_4$) and a multi-channel receiver optical subassembly (ROSA) 230 arrangement for receiving optical signals on the channel wavelengths (e.g., $\lambda_1, \lambda_2, \lambda_3, \lambda_4$).” *Id.*, 4:44-49. Thus, a POSITA would have understood that optical transceiver 300, which implements the optical transceiver system 200, is a multi-channel optical transceiver that is capable of transmitting multiple channel wavelengths (e.g., $\lambda_1, \lambda_2, \lambda_3, \lambda_4$). *See id.*; Ex. 1003, ¶93. It would have been obvious to a POSITA that Ho’s optical transceiver 300 modified in view of Kuhara’s optical data link 1 would be a multi-channel optical transceiver that would include Kuhara’s circuit board 3 as a transceiver substrate on which the TOSA modules and other components would be mounted. Ex. 1003, ¶93.

A POSITA would have readily understood Kuhara’s circuit board 3 to be a printed circuit board because it includes various conductive patterns/traces (33a, 33b, 33c, 33d) etched thereon to electronically connect components mounted on the circuit board. Ex. 1004, Figs. 1A, 1B, 2, 6:19-29; Ex. 1003, ¶94. Ho’s transmit connecting circuit 304 may also be a printed circuit board (PCB). Ex. 1005, 6:17-20.

D. Independent Claim 10

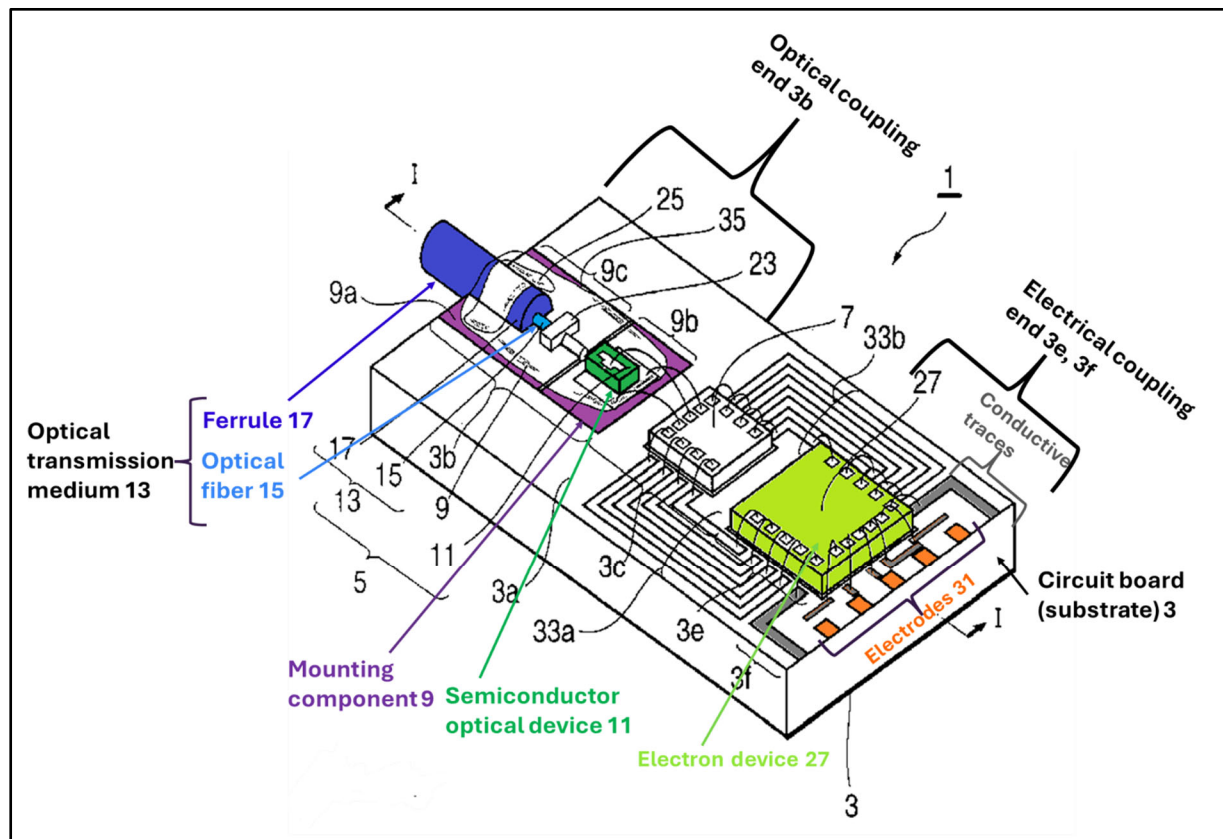
1. Claim 10[pre] (“An optical transceiver, the optical transceiver comprising:”)

Ho discloses an optical transceiver 300, which “implements the optical transceiver system 200” as shown in Ho’s Figure 2. Ex. 1005, 5:58-6:6.

2. Claim term 10[a] (“a transceiver substrate having an optical coupling end disposed opposite an electrical coupling end”)

It would have been obvious to a POSITA that in Ho in view of Kuhara, Ho’s transceiver housing 302 and transmit connecting circuit 304 would have been modified in view of Kuhara’s circuit board 3 to improve component mounting and alignment, reduce components, and shorten the length of electrical interconnects (wire bonds) between components. Ex. 1003, ¶96. Kuhara’s circuit board 3 (transceiver substrate) has “a principal plane 3*a*, and first and second mounting sections 3*b* and 3*c* disposed on the principal plane 3*a*.” Ex. 1004, 5:1-5. A POSITA would have understood first mounting section 3*b* to be an “optical coupling end” because it is disposed at an end portion of circuit board 3 and it mounts the optical module component 5. *Id.*, 5:8-9 (“The first mounting section 3*b* has the optical module component 5.”), Figs. 1A, 1B, 2; Ex. 1003, ¶96. Optical module component 5 includes a **mounting component 9**, a **semiconductor optical device 11** (laser) and an optical transmission medium 13 (comprising an **optical fiber 15** and a **ferrule 17**). Ex. 1004, 5:10-28, 6:30-40.

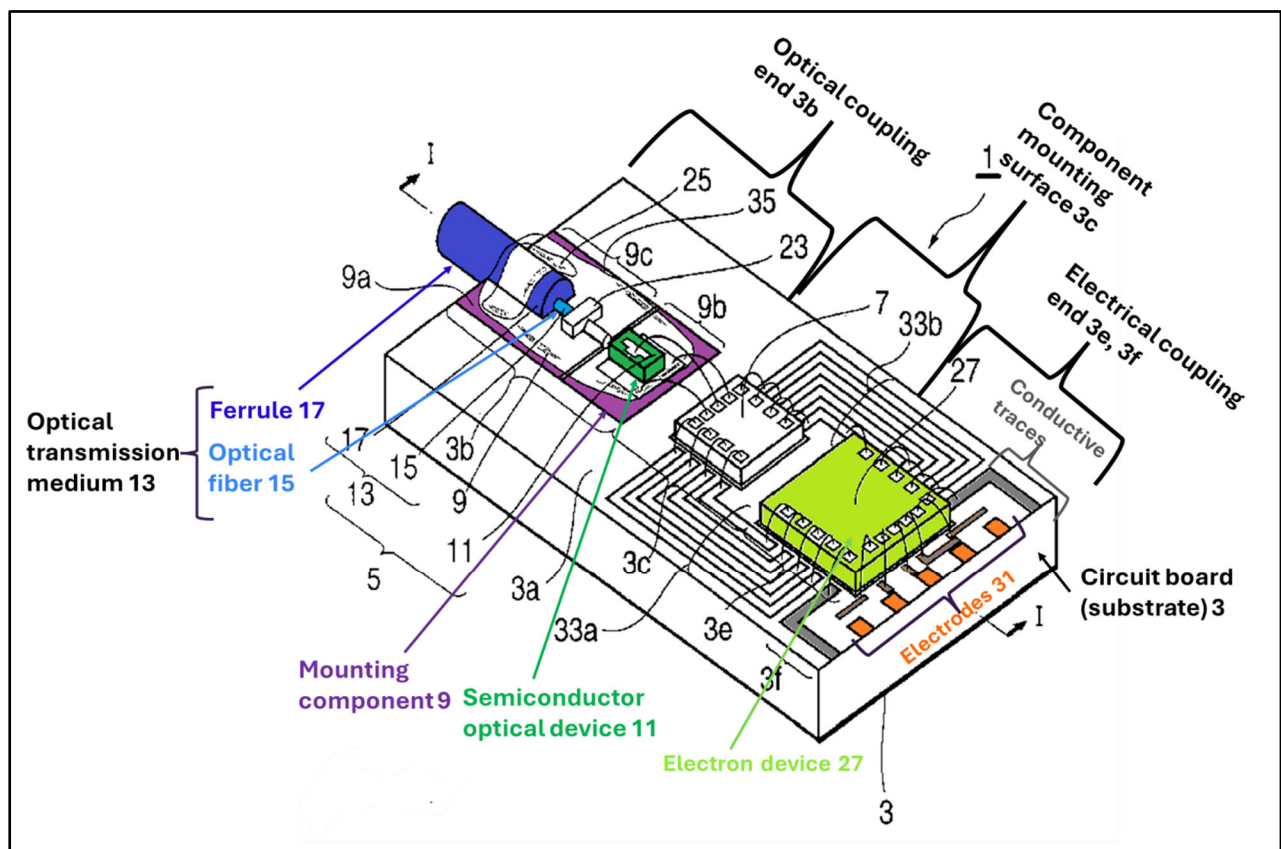
The circuit board 3 further includes an interface part 3f that has “one or a plurality of **electrodes 31** for connecting the circuit board 3 to an external device(s)” and a third mounting section 3e that mounts **electron device 27**. *Id.*, 5:58-67, Figs. 1A, 1B, 2. A POSITA would have understood third mounting section 3e and interface part 3f to be an “electrical coupling end for electrically coupling to external circuitry.” Ex. 1003, ¶97. The electrical coupling end (3e and 3f) is disposed opposite to the optical coupling end (3b) of circuit board 3 (substrate). Ex. 1004, Figs. 1A, 1B, 2.



Ex. 1004, Fig. 1A (showing electrical coupling end 3e, 3f and optical coupling end 3b of substrate 3) (annotations added)

3. **Claim term 10[b]** (“at least one component mounting surface provided by the transceiver substrate extending between the optical coupling end and the electrical coupling end”)

As shown in Figure 1A, annotated below, Kuhara’s circuit board 3 (transceiver substrate) provides at least one component mounting surface (second mounting section 3c) extending between the optical coupling end (3b) and the electrical coupling end (3e, 3f). Ex. 1004, 5:3-7.



Ex. 1004, Fig. 1A (showing component mounting surface 3c) (annotations added)

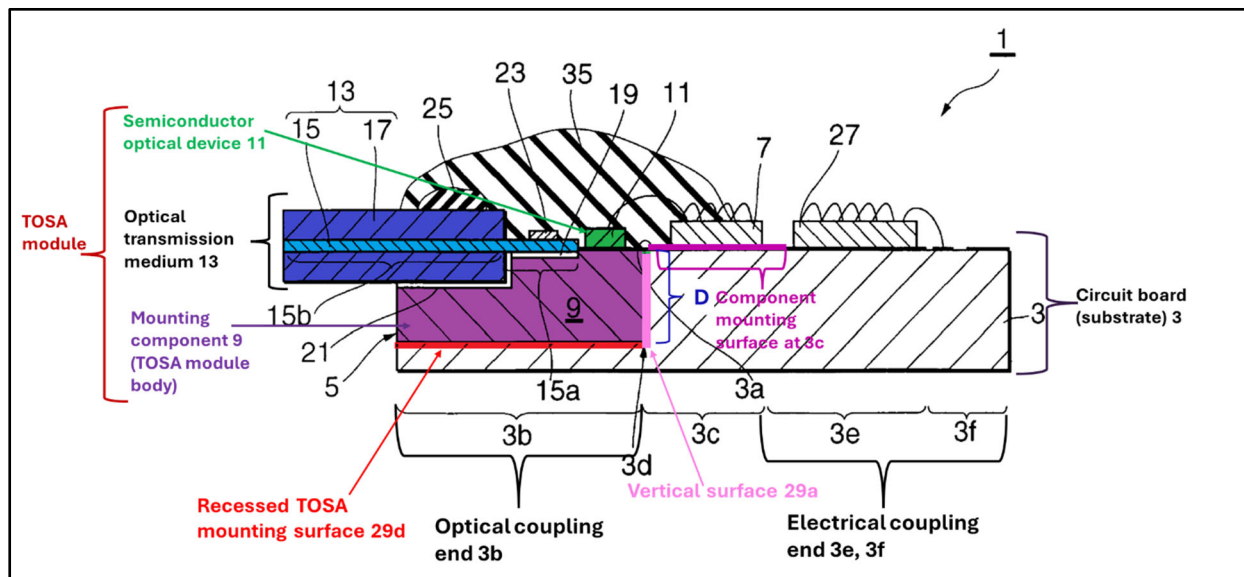
4. **Claim term 10[c]** (“a recessed transmitter optical subassembly (TOSA) mounting surface at the optical coupling end of the substrate for coupling to and supporting at least one TOSA module, and wherein the recessed TOSA

mounting surface extends substantially parallel with the at least one component mounting surface and substantially transverse relative to a vertical surface adjoining the recessed TOSA mounting surface and the at least one component mounting surface”)

The optical coupling end 3*b* of the transceiver substrate (circuit board 3) includes a concave portion 29, which couples to and supports optical module component 5. Ex. 1004, 5:1-20, 6:1-18, Figs. 1A, 1B, 2. A POSITA would have understood optical module component 5 to be a TOSA module when it includes a semiconductor optical device 11 (laser) to emit light based on driving signal received from electron device 7 (driving element) and the light is transmitted through optical transmission medium 13 (optical fiber 15 and ferrule 17). *Id.*, 5:27-28, 6:30-40; Ex. 1003, ¶99. The concave portion 29 includes a **recessed TOSA mounting surface** (bottom face 29*d*), as shown in Figures 1B and 2, annotated below. *Id.*, 6:10-15 (“The first mounting section 3*b* has a bottom face 29*d* for supporting the mounting component 9. The bottom face 29*d* extends along a fourth reference plane, and the spacing between the first reference plane and the fourth reference plane is represented by symbol D in FIG. 2.”)

3.”), 5:5-7 (“The principal plane 3*a* extends along a first reference plane. A step 3*d* is formed between the first mounting section 3*b* and the second mounting section 3*c*.”), Figs. 1A, 1B, 2.

Figures 1B and 2 further show that the stepped profile (step 3*d*) is defined by a **vertical surface (positioning face) 29*a*** that adjoins the **recessed TOSA mounting surface (29*d*)** and the **component mounting surface (3*c*)**, and the recessed TOSA mounting surface (29*d*) extends substantially transverse relative to vertical surface 29*a*. Ex. 1003, ¶101.



Ex. 1004, Fig. 1B (showing stepped profile (step 3*d*) formed by **recessed TOSA** **mounting surface 29*d*** and **vertical surface 29*a***) (annotations added)

- 5. Claim term 10[d] (“at least one TOSA module edge mounted to the optical coupling end of the transceiver substrate, wherein the vertical surface provides a mechanical stop to engage a surface of the least one TOSA**

**module and limit travel of the at least one TOSA module
along one or more axis”)**

As further shown in Figures 1A, 1B, and 2, the TOSA module (optical module component 5) is edge-mounted to the concave portion 29 at the optical coupling end 3*b* of circuit board 3 (transceiver substrate). Ex. 1003, ¶102.

As further shown in Figures 1A and 2, annotated above, the vertical surface 29*a* provides a mechanical stop to engage a side surface of the mounting component 9 of the TOSA module. Ex. 1004, Figs. 1A, 1B, 2; Ex. 1003, ¶103. A POSITA would have readily understood that vertical surface 29*a* would limit travel of the TOSA module along a longitudinal axis that runs parallel to principal plane 3*a* of circuit board 3 (substrate). Ex. 1003, ¶103.

**6. Claim term 10[e] (“a receiver optical subassembly
arrangement coupled to the transceiver substrate.”)**

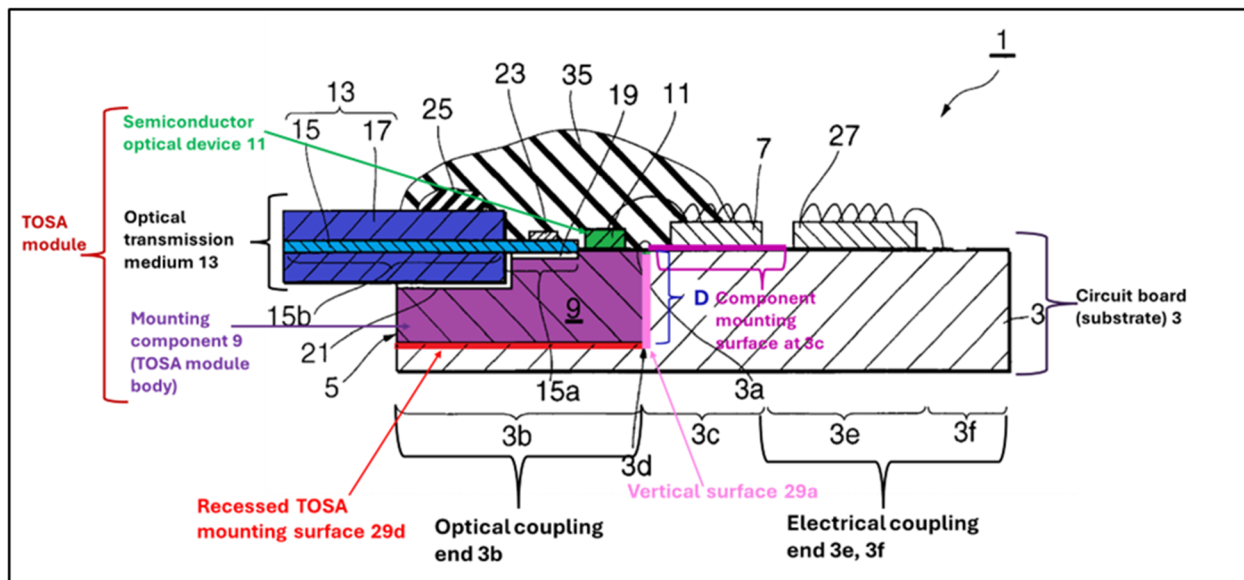
Ho’s optical transceiver 300 includes a multichannel ROSA arrangement 312 coupled to the transceiver housing 302. Ex. 1005, 6:43-45. As stated above, it would have been obvious to a POSITA that in Ho in view of Kuhara, Ho’s transceiver housing 302 and transmit connecting circuit 304 would have been modified in view of Kuhara’s circuit board 3. Ex. 1003, ¶104. For Ho’s transceiver 300 to function as a multi-channel transceiver, Kuhara’s circuit board 3 (transceiver substrate) would have been further modified to couple to Ho’s ROSA 312, just as Ho’s transceiver housing 302 includes ROSA 312, and a POSITA would have reasonably expected

success in doing so given Ho's detailed description of transceiver 300. *Id.* Indeed, coupling Ho's ROSA 312 to Kuhara's circuit board 3 (transceiver substrate) would have required nothing more than the routine and ordinary skills of a POSITA and the combination would have yielded the predictable result of a multi-channel transceiver. *Id.*

E. Claim 11 (“The optical transceiver of claim 10, further comprising radio frequency (RF) terminals disposed on the at least one component mounting surface proximate to the optical coupling end, wherein the at least one TOSA module electrically couples with the RF terminals via one or more wire bonds.”)

As shown in Figures 1A and 1B, component mounting surface 3c mounts electron device 7, which is electrically coupled with the semiconductor laser (semiconductor optical device 11) of the TOSA module (optical module component 5) through wire bonds to drive the laser. Ex. 1004, 6:19-40, Figs. 1A and 1B (showing wire bonds connecting electron device 7 to laser 11). Because lasers in high-speed transceivers have been typically driven by radio frequency (RF) signals since the 1980s, it would have been obvious to a POSITA that component mounting surface 3c (which mounts electron device 7) includes RF terminals proximate the optical coupling end that mounts TOSA module 5, and that electron device 7 provides RF drive signals to laser 11 through the RF terminals and the wire bonds. Ex. 1004, Figs. 1A, 1B; Ex. 1003, ¶105. Ho also discusses TOSA laser assemblies being driven by RF signals. Ex. 1005, 2:45-67 (discussing that the laser package

As discussed regarding claim term 10[c] (Section IX.D.4), the **recessed TOSA mounting surface 29d** extends substantially parallel with the component mounting surface (3c) and is vertically offset from the component mounting surface (3c) by a **first offset distance D** based on a stepped profile 3d. Ex. 1004, 6:1-12 (“In the optical data link 1, the step 3d is formed between the first mounting section 3b and the second mounting section 3c on the circuit board 3.”), 5:5-7 (“The principal plane 3a extends along a first reference plane. A step 3d is formed between the first mounting section 3b and the second mounting section 3c.”), Figs. 1A, 1B, 2 (showing that the first and second mounting sections 3b and 3c are offset by a first offset distance D based on a stepped profile 3d); Ex. 1003, ¶106.



Ex. 1004, Fig. 1A (showing **recessed TOSA mounting surface** is vertically offset relative to the **component mounting surface** of the transceiver substrate by a **first offset distance D**) (annotations added)

X. MANDATORY NOTICES

A. Real Parties-in-Interest

The real parties-in-interest for this Petition are Eoptolink Technology USA Inc. and Eoptolink Technology Inc., Ltd.

B. Related Matters

To Petitioner's knowledge, the '887 patent is involved in the following:

Name	Number	Court	Filed
<i>Applied Optoelectronics, Inc. v. Eoptolink Technology USA Inc.</i>	5:24-cv-08165	N.D. Cal.	Nov. 19, 2024

C. Lead and Back-Up Counsel

Lead Counsel	Back-Up Counsel
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D. Service Information

Please address correspondence to counsel at the email addresses above.

Petitioner consents to service by e-mail.

XI. STANDING

The '887 patent is eligible for IPR and Petitioner is not barred or estopped from requesting IPR challenging the patent claims on the grounds identified herein.

XII. CONCLUSION

For the foregoing reasons, claims 1-3 and 8-12 of the '887 patent should be canceled.

Dated: December 1, 2025

Respectfully submitted,

/Arpita Bhattacharyya/

Arpita Bhattacharyya, Reg. No. 63,681
Counsel for Petitioner

CERTIFICATION UNDER 37 C.F.R. § 42.24(d)

Pursuant to 37 C.F.R. § 42.24(a)(1)(i), the undersigned hereby certifies that the foregoing **Petition for *Inter Partes* Review** contains 10,663 words, excluding the parts of this Petition that are exempted under 37 C.F.R. § 42.24(a), as measured by the word-processing system used to prepare this paper.

/Arpita Bhattacharyya/

Arpita Bhattacharyya, Reg. No. 63,681
Counsel for Petitioners

CERTIFICATE OF SERVICE

Pursuant to 37 C.F.R. §§ 42.6(e) and 42.105(a), the undersigned certifies that on December 1, 2025, a copy of the foregoing Petition for *Inter Partes* Review, the associated power of attorney, and Exhibits 1001-1006 were served by FedEx Priority Overnight on the correspondence address of record indicated in the Patent Office's website for U.S. Patent No. 11,177,887:

APPLIED OPTOELECTRONICS, INC.
13115 Jess Pirtle Blvd.
Sugar Land, TX 77478

Courtesy copies were provided to Patent Owner's litigation counsel via email at the following addresses:

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Date: December 1, 2025

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