

UNITED STATES PATENT AND TRADEMARK OFFICE

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BEFORE THE PATENT TRIAL AND APPEAL BOARD

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EOPTOLINK TECHNOLOGY USA INC.  
Petitioner,

v.

APPLIED OPTOELECTRONICS, INC.  
Patent Owner.

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IPR2026-00122  
U.S. Patent No. 10,714,890

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**PETITION FOR *INTER PARTES* REVIEW  
OF U.S. PATENT 10,714,890**

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### STATUTES

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**TABLE OF EXHIBITS**

| <b>Exhibit</b> | <b>Description</b>                                                                                                                    |
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| 1001           | U.S. Patent No. 10,714,890 to Lin et al. (“the ’890 patent”)                                                                          |
| 1002           | Prosecution History of the ’890 patent                                                                                                |
| 1003           | Declaration of Dr. Michael Lebby                                                                                                      |
| 1004           | Certified English translation of Japanese Patent Publication No. JP 2010-161146 to Takashi Kounosu, published September July 22, 2010 |
| 1005           | U.S. Patent No. 9,385,830 to Sato, issued July 5, 2016                                                                                |
| 1006           | U.S. Patent No. 9,306,671 to Ho et al., issued April 5, 2016                                                                          |
| 1007           | U.S. Patent Publication No. 2018/0138657 to Miura et al., published May 17, 2018                                                      |
| 1008           | U.S. Patent Publication No. 2004/0163836 to Kumar et al., published August 26, 2004                                                   |
| 1009           | Japanese Patent Publication No. JP 2010-161146 to Takashi Kounosu, published September July 22, 2010                                  |

## **I. INTRODUCTION**

U.S. Patent No. 10,714,890 (“the ’890 patent”) discloses and claims a simple and customary component of an optical transceiver—a transmitter optical sub-assembly (TOSA)—for transmitting optical signals. The ’890 patent makes it clear that the purported novelty or inventiveness of the claimed TOSA arrangement is “vertically-mounted monitor photodiodes” (MPDs) that supposedly reduce the TOSA housing dimensions and improve the radio frequency (RF) driving signal. Ex. 1001, Title, Abstract, 1:8-12, 3:1-16. But as the prior art described in this Petition shows, such TOSA arrangements with “vertically-mounted monitor photodiodes” were known and conventionally used in optoelectronic applications long before the effective filing date of the ’890 patent. As Petitioner’s expert, Dr. Lebby, has testified: “nothing in the ’890 patent is novel or inventive because arrangement of MPDs to receive optimal feedback from laser diodes while reducing TOSA housing dimension is just routine optimization that is well within the ordinary skills of a POSITA; it is not a matter of innovation.” Ex. 1003, ¶47. Indeed, it is evident from the anticipatory prior art reference (Takashi) applied in this Petition that existing TOSA modules not only included “vertically-mounted monitor photodiodes,” but also the other claimed elements, either in the exact configuration or in a manner that would have made the claimed TOSA arrangement obvious to those skilled in the art.

The challenged claims of the '890 patent (claims 1-9 and 15-19) are therefore unpatentable and should not have been granted.

During prosecution, however, the examiner failed to conduct a thorough search and evaluation of the prior art, and allowed the claims after a single office action. Relatedly, Patent Owner Applied Optoelectronics, Inc. ("Patent Owner") did not submit a single Information Disclosure Statement (IDS) identifying prior art to the Patent Office, even though one skilled in the art would have known that the TOSA claimed in the '890 patent is conventional and there would have been relevant invalidating prior art against it.

Despite the manifest lack of innovation in the '890 patent, Patent Owner pursued enforcement of the '890 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 '890 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 1-9 and 15-19 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  | Japanese Patent Publication No. JP 2010-161146 to Takashi Kounosu, filed January 7, 2009 and published July 22, 2010 ("Takashi"); prior art under 35 U.S.C. § 102(a)(1). |
| Ex. 1005  | U.S. Patent No. 9,385,830 to Sato, filed November 6, 2014 and issued July 5, 2016 ("Sato"); prior art under 35 U.S.C. § 102(a)(1).                                       |
| Ex. 1006  | U.S. Patent No. 9,306,671 to Ho et al., filed December 7, 2012 and issued April 5, 2016 ("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      | Anticipated by Takashi under § 102                      |
| 2      | 2-9    | Rendered obvious by Takashi in view of Sato under § 103 |

| Ground | Claims | Basis Under 35 U.S.C. §§ 102, 103                                                 |
|--------|--------|-----------------------------------------------------------------------------------|
| 3      | 15-19  | Rendered obvious by Ho in view of Takashi and further in view of Sato under § 103 |

**B. Petitioner’s *Sotera*-Plus Stipulation for the Parallel District Court Action**

If the Board institutes IPR based on this Petition (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.)), (i) the specific grounds raised in this Petition, or (ii) any other grounds that reasonably could have been raised under §§ 102 or 103 on the basis of prior art patents or printed publications, or (iii) any ground based on a combination of system prior art and the prior art references asserted in this Petition (identified in Section II.A, above). *See Sotera Wireless, Inc. v. Masimo Corp.*, IPR2020- 01019, Paper 12, at 18-19 (P.T.A.B. Dec. 1, 2020) (“*Sotera*”) (describing the standard, unbroadened *Sotera* stipulation).

Notwithstanding the above and for the avoidance of doubt, this stipulation does not limit Petitioner’s ability to rely on its own products and systems as anticipatory prior art in the litigation, including to demonstrate that the challenged claims are invalid based on Petitioner’s own products and systems being in public

use, on sale, or otherwise available to the public before the effective filing date of the claimed invention. In the IPR, Petitioner could not raise any grounds based on its own products or systems being in public use, on sale, or otherwise available to the public. *Ingenico Inc. v. IOENGINE, LLC*, 136 F.4th 1354, 1367 (Fed. Cir. 2025) (recognizing that assertions “that a claimed invention was known or used by others, on sale, or in public use...could not be raised during an IPR.”). Therefore, there will be no overlap between the issues raised in the Petition and in the district court, and the IPR will serve as a “true alternative” to the district court proceeding.

### **III. TECHNICAL BACKGROUND OF THE '890 PATENT**

#### **A. The '890 Patent**

The '890 patent discloses and claims a transmitter optical subassembly (TOSA)<sup>1</sup> module “with vertically-mounted MPDs [monitor photodiodes] to reduce TOSA housing dimensions and improve RF [radio frequency] driving signal

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<sup>1</sup> A TOSA is an optical transceiver component that converts electrical signal to optical signal for transmission through an optical fiber. It generally consists of a light source (e.g., a laser diode), a monitor photodiode for power regulation, circuitry for driving the light source, and an optical interface to guide the light from the source to the optical fiber. Ex. 1001, 1:27-39; Ex. 1003, ¶41.

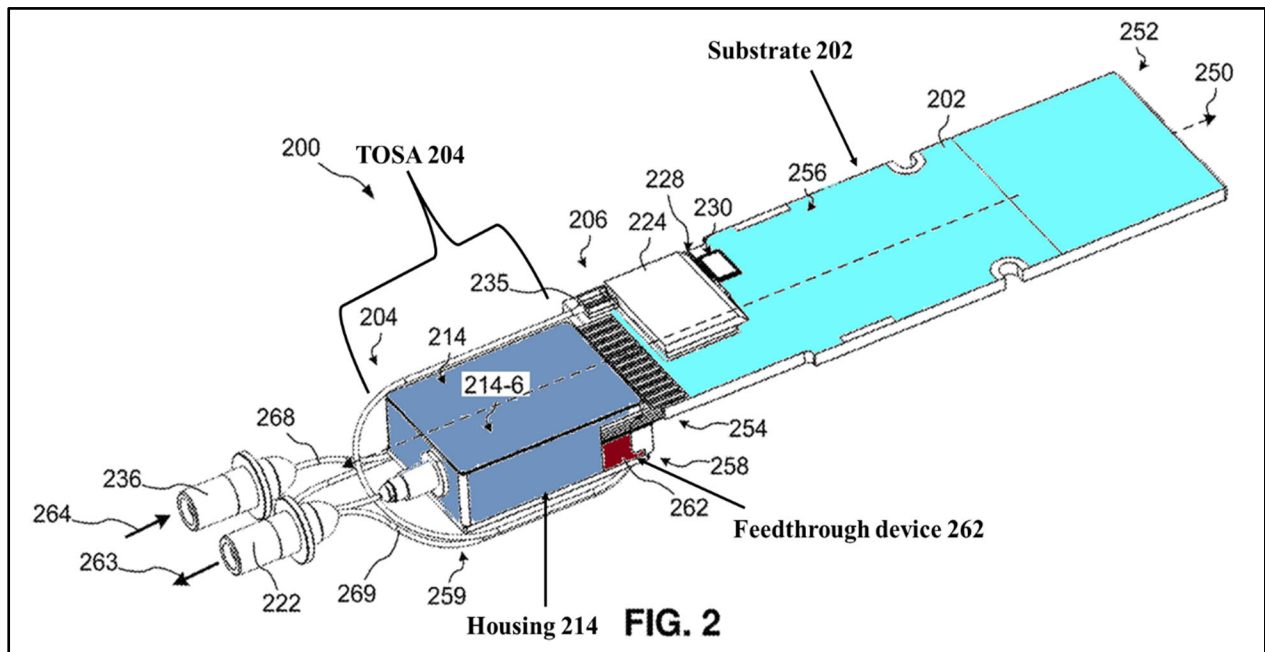
quality.” Ex. 1001, Abstract; *see also id.*, Title, 1:8-12, 3:1-4. Specifically, a TOSA according to the ’890 patent includes “at least one vertical MPD mounting surface that extends substantially transverse relative to a LD [laser diode] mounting surface” such that the vertically-mounted MPDs make “regions adjacent an LD that would otherwise be utilized to mount an MPD available for patterning of conductive RF traces to provide an RF driving signal to the LD.” *Id.*, Abstract; *see also id.*, 3:4-16. In exemplary embodiments of the ’890 patent, “the vertical MPD mounting surface may be provided at least in part by a feedthrough device<sup>2</sup> of the TOSA housing. The feedthrough device can be configured to be at least partially disposed in a hermetically-sealed cavity of the TOSA housing to provide electrical connectivity to optical components therein.” Ex. 1001, 3:19-22.

As shown in Figures 2 and 4 of the ’890 patent, an exemplary **TOSA 204** of optical transceiver module 200 comprises a **housing 214** having a plurality of sidewalls 214-1 to 214-6 forming a hermetically sealed cavity 220. *Id.*, 6:34-42,

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<sup>2</sup> A “feedthrough device” is a commonly used component of an optoelectronic device that uses conductive traces to enable passage of signals into or out of a sealed compartment while preserving specific environmental or electrical conditions of the sealed compartment, e.g., hermeticity. Ex. 1003, ¶42.

6:51-7:3, 7:19-27, Figs. 2, 4. TOSA 204 further comprises a **feedthrough device 262** partially disposed in cavity 220 of housing 214. *Id.* The feedthrough device 262 “at least partially defines the first end 452 of the TOSA housing 214 and includes a plurality of electrical interconnects 464, e.g., bus bars, external to the cavity 220 for mounting to and electrically coupling with the **substrate 202**. The plurality of electrical interconnects 464 can provide power and radio frequency (RF) driving signals to the plurality of laser arrangements 210.” *Id.*, 7:28-35, Fig. 6.

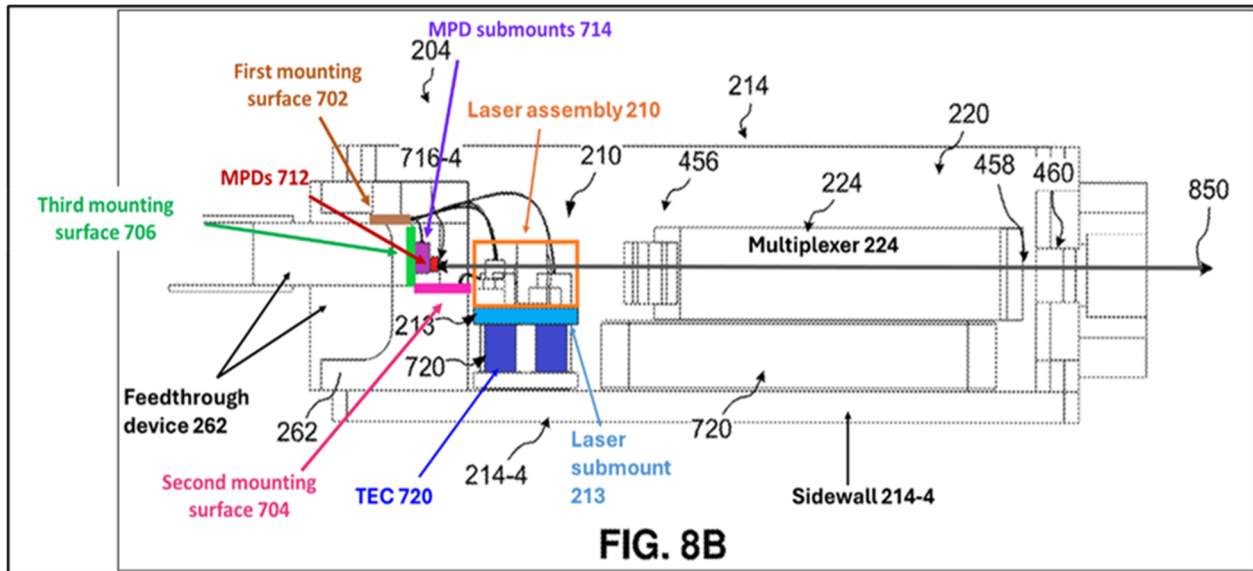


Ex. 1001, Fig. 2 (annotations added)

TOSA 204 includes “a plurality of laser arrangements 210 [that] are disposed on and are supported by a mounting surface provided at least in part by the sidewall 214-4. A multiplexing device 224 is also disposed on and supported by the mounting surface provided at least by the sidewall 214-4.” *Id.*, 7:40-44. Multiplexing device



substantially transverse to each of the same. Thus, the first, second and third mounting surfaces 702, 704 and 706 provide a multi-tiered or multi-step mounting structure for coupling to optical components.” *Id.*, 7:65-8:7. **First mounting surface 702** includes “a first plurality of conductive traces/paths 708 patterned thereon ... to provide power from the substrate 202 and to pass data signals from a plurality of MPDs 712 that are mounted to and supported by the third mounting surface [706].” *Id.*, 8:9-14, Figs. 7, 8B. “The **second mounting surface 704** includes a second plurality of conductive traces/paths 711 disposed thereon ... to provide power and data signals from the substrate 202 to each of the plurality of lasers arrangements 210.” *Id.*, 8:14-21, Figs. 7, 8B. The **third mounting surface 706** (vertical MPD mounting surface 706) mounts one or more **MPDs 712**. *Id.*, 8:24-29, Figs. 7, 8B. “Each MPD of the plurality of MPDs 712 may be supported by a **MPD submount 714**[.]” *Id.*, 8:29-31, Figs. 7, 8B.



Ex. 1001, Fig. 8B (showing feedthrough device 262 having a **first mounting surface 702** and a **second mounting surface 704** extending parallel to each other, and a **third mounting surface 706** that extends substantially transverse to the first and second mounting surfaces; the third mounting surface provides **MPD submounts 714** which support **MPDs 712**) (annotations added)

As shown in Figure 8B, annotated above, TOSA 204 further comprises a laser diode (LD) mounting surface (**laser submount 213**) in the cavity 220 and has a plurality of laser diodes 211 (of **laser assembly/arrangement 210**) disposed thereon. *Id.*, 8:66-9:16. “During operation, channel wavelengths emitted by each of the plurality of laser assemblies 210 is launched on to a corresponding path of the plurality of optical paths 850, with each of the plurality of optical paths 850 extending substantially parallel relative to each other.” *Id.*, 9:34-38. “[A] portion of the optical power gets emitted from a surface opposite of the emission surface of

each laser diode, which may be referred to as a back-side emission surface, thus launching a portion of optical power towards the MPDs 712. Each light receiving region of the MPDs, e.g., light receiving region 716-4, then registers this portion of optical power for purposes of providing a feedback loop, e.g., by converting optical power to a proportional electrical current.” *Id.*, 9:38-46. As further shown in Figure 8B, annotated above, the vertical MPD mounting surface 706 extends substantially transverse to the LD mounting surface 213 such that first optical paths 850 intersect with the corresponding light receiving regions 716-4 of the MPDs 712 and the MPDs thereby receive the back-side emission from the corresponding laser diodes 211. *Id.*, Figs. 7 and 8B, 10:16-27.

#### **B. Prosecution History of the '890 Patent**

U.S. Patent Application No. 16/268,765, which issued as the '890 patent, was filed on February 6, 2019. Ex. 1001, cover page. The Patent Office issued a Non-Final Office Action dated January 24, 2020, rejecting pending claims 1 and 11 as anticipated by U.S. Patent Publication No. 2018/0138657 to Miura et al. (“Miura,” Ex. 1007) and rejected claim 16 as obvious over Miura in view of U.S. Patent Publication No. 2004/0163836 to Kumar et al. (“Kumar,” Ex. 1008). Ex. 1002, pp. 44-47. The Office Action further indicated that claims 12-15 and 20 were allowed, and objected to claims 2-10 as dependent upon a rejected base claim but would be

allowable if rewritten in independent form including all the limitations of the base claim and any intervening claims. *Id.*, pp. 42, 47-50.

Patent Owner responded on April 14, 2020, amending claims 1-2, 16-17, and 20. *Id.*, pp. 28-37. Claim 1 was amended to include the limitation “a base portion comprising a feedthrough device, the feedthrough device providing a vertical MPD mounting surface.” *Id.*, p. 29. Patent Owner asserted that Miura “discloses that the photodiode 160 mounts to a base 110 by way of photodiode holder 161. ... In Mura [*sic*], the base 110 is configured to be disposed within housing 200, see e.g., Mura [*sic*]; FIGs. 1 and 6, but nothing in Mura [*sic*] teaches that base 110 is a feedthrough device. The Office Action appears to agree with Applicant’s understanding that Mura [*sic*] fails to teach or make obvious such a feature based on allowed independent claim 12 being generally directed to a method that includes ‘mounting at least one MPD to a vertical MPD mounting surface provided by a feedthrough device.’” *Id.*, p. 36 (emphases omitted).

A Notice of Allowance issued on May 7, 2020, allowing claims 1-10 and 12-20 and stating that “[i]ndependent claim 1 is allowed based on applicant’s amendment and arguments filed on April 24, 2020, where the claim now includes the limitation ‘a base portion comprising a feedthrough device, **the feedthrough device providing a vertical MPD mounting surface.**’” *Id.*, pp. 9-13 (emphasis added).

In allowing the '890 patent, the examiner overlooked prior art references that teach a “feedthrough device providing a vertical MPD mounting surface.” *See, e.g.*, Ex. 1004, ¶[0019], Fig 1 (Takashi disclosing feedthrough device with a vertical MPD mounting surface). In fact, the examiner never once searched for the term “feedthrough” or “feedthrough device,” nor did the examiner search for a MPD vertically mounted on a feedthrough, even after indicating allowability based on that feature. Ex. 1002, pp. 21-26, 53-56. As a POSITA would have known, feedthrough devices are routinely used in optoelectronic systems to propagate electrical signals (e.g., RF signals, DC (power) signals, etc.) into a hermetically sealed package while maintaining the hermetic seal. Ex. 1003, ¶47. In fact, vertically-mounted MPDs on feedthrough devices were well known in the optoelectronics industry since the 1990s. *Id.* But despite the clear relevance of feedthrough devices and the conventional application of feedthroughs in optoelectronics, Patent Owner did not submit any prior art reference teaching feedthrough devices in optoelectronic applications. In fact, **Patent Owner did not submit a single Information Disclosure Statement (IDS) during prosecution.** The examiner likewise overlooked this critical feature, failing to search for “feedthrough,” MPD on feedthrough, or related terms, and allowed the application without a thorough examination. *Id.*

#### IV. LEVEL OF ORDINARY SKILL

At the effective filing date of the '890 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 '890 patent require claim construction to resolve any disputes in this forum. Ex. 1003, ¶48.

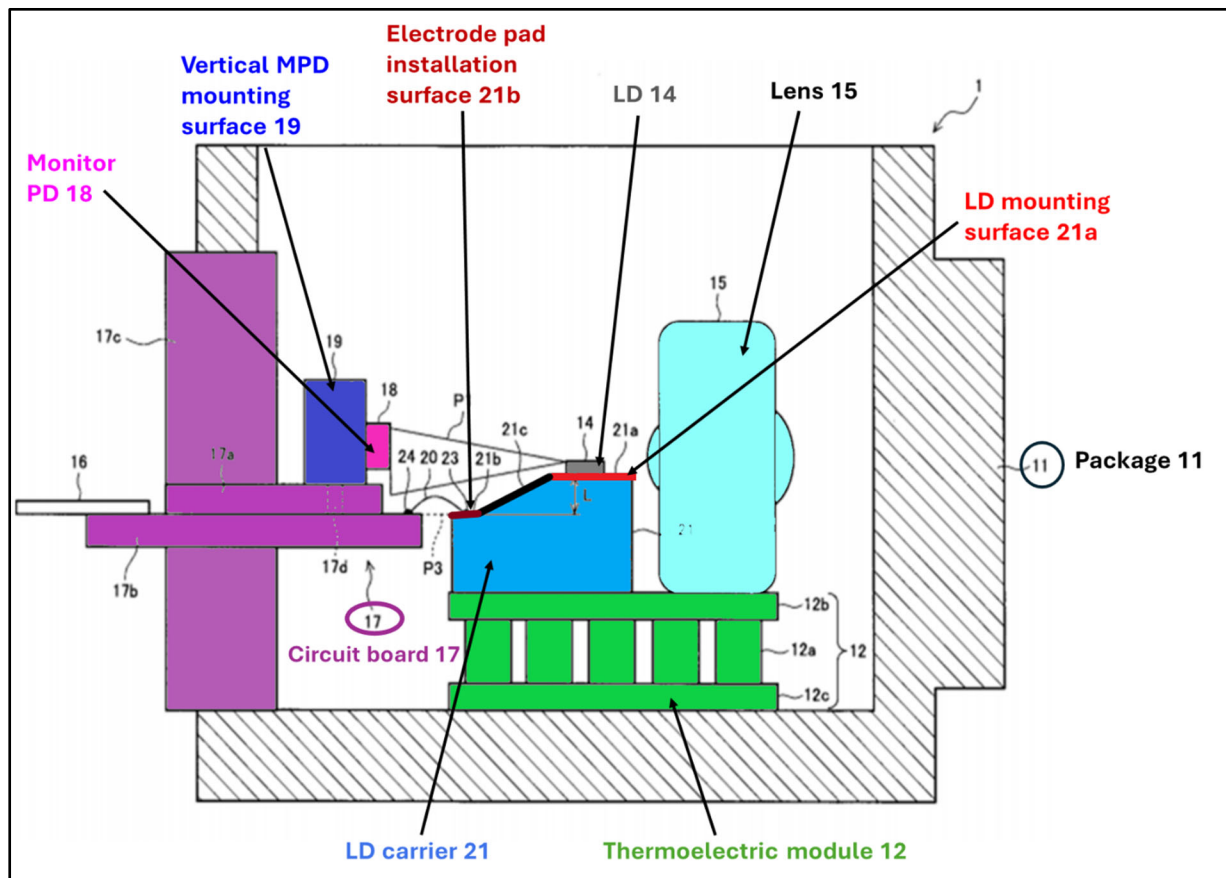
#### VI. PRIOR ART REFERENCES

##### A. Takashi (Ex. 1004)

Takashi discloses an optical transmission module having a monitor photodiode ("monitor PD" or "MPD") that is positioned such that "rearward-emitted light from an LD [laser diode] can be efficiently received, and a wire connecting an LD carrier electrode pad to a circuit board electrode pad can be shortened in length." Ex. 1004, [Abstract].

Specifically, Takashi discloses an optical transmission module (TOSA) 1 having a package 11 and a **thermoelectric module 12** that is installed within the

package. *Id.*, ¶[0018]. An **LD carrier 21** is mounted on thermoelectric module 12 and an **LD 14** is mounted on LD carrier member 21. *Id.* LD carrier 21 includes an “**LD mounting surface 21a** for mounting LD 14 and an **installation surface 21b** for holding LD 14 electrode pads 23[.]” *Id.*, ¶[0020], Fig. 1. LD mounting surface 21a and electrode pad installation surface 21b have a “level difference L” formed by a **sloped surface 21c**. *Id.* Signal light emitted by LD 14 passes through a lens 15 (which is also mounted on thermoelectric module 12) and is incident on an optical fiber at the front of package 11. *Id.*, ¶[0019].



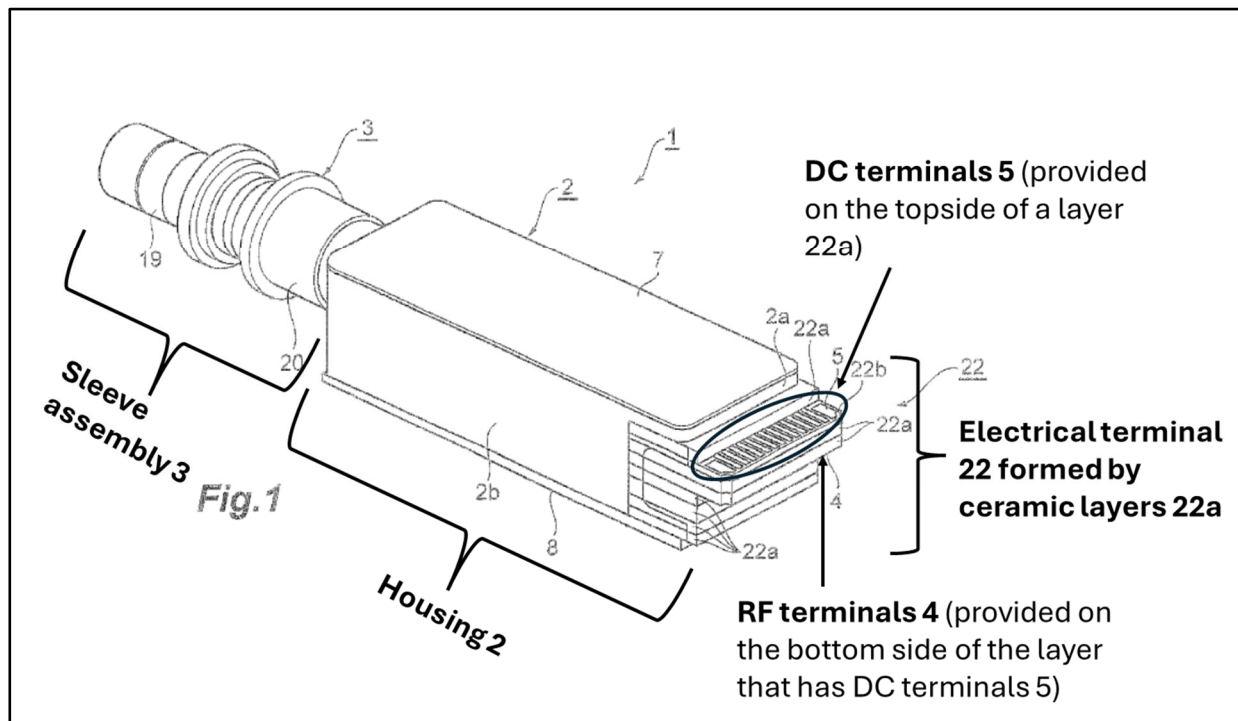
Ex. 1004, Fig. 1 (annotations added)

As shown in Figure 1, annotated above, optical transmission module 1 further includes a multi-layer **circuit board 17**, which connects to external lead terminals 16, and is mounted at the rear of package 11 (opposite the side where lens 15 is disposed). Ex. 1004, ¶[0019]. A **monitor PD 18** is mounted on a vertical **PD carrier 19** provided on circuit board 17. *Id.* A POSITA would have understood PD carrier 19 to be the “vertical MPD mounting surface” claimed in the ’890 patent. Ex. 1003, ¶51. The height of the LD mounting surface 21a is set so that “the LD14 rearward-emitted light P1 can be made directly incident on monitor PD 18 without refraction, reflection, or focusing” and the rearward-emitted light P1 is “efficiently received” by monitor PD 18. Ex. 1004, ¶¶[0009], [0020]. Additionally, the height position of electrode pad installation surface 21b is set to be coplanar with the electrode pad installation surface 24 on the circuit board 17, as shown by line P3 in Figure 1, so that the length of LD drive interconnect wire 20 is shortened “to maximally reduce the effect of parasitic inductance in the LD drive interconnect wire 20 on the optical output waveform, and to prevent deterioration of high-frequency characteristics.” *Id.*, ¶¶[0010], [0020].

**B. Sato (Ex. 1005)**

Sato discloses a transmitter optical module comprising a plurality of laser diodes (LDs) as optical signal sources, with each LD emitting an optical signal of a specific wavelength different from the other LDs. Ex. 1005, Abstract, 1:43-46. As

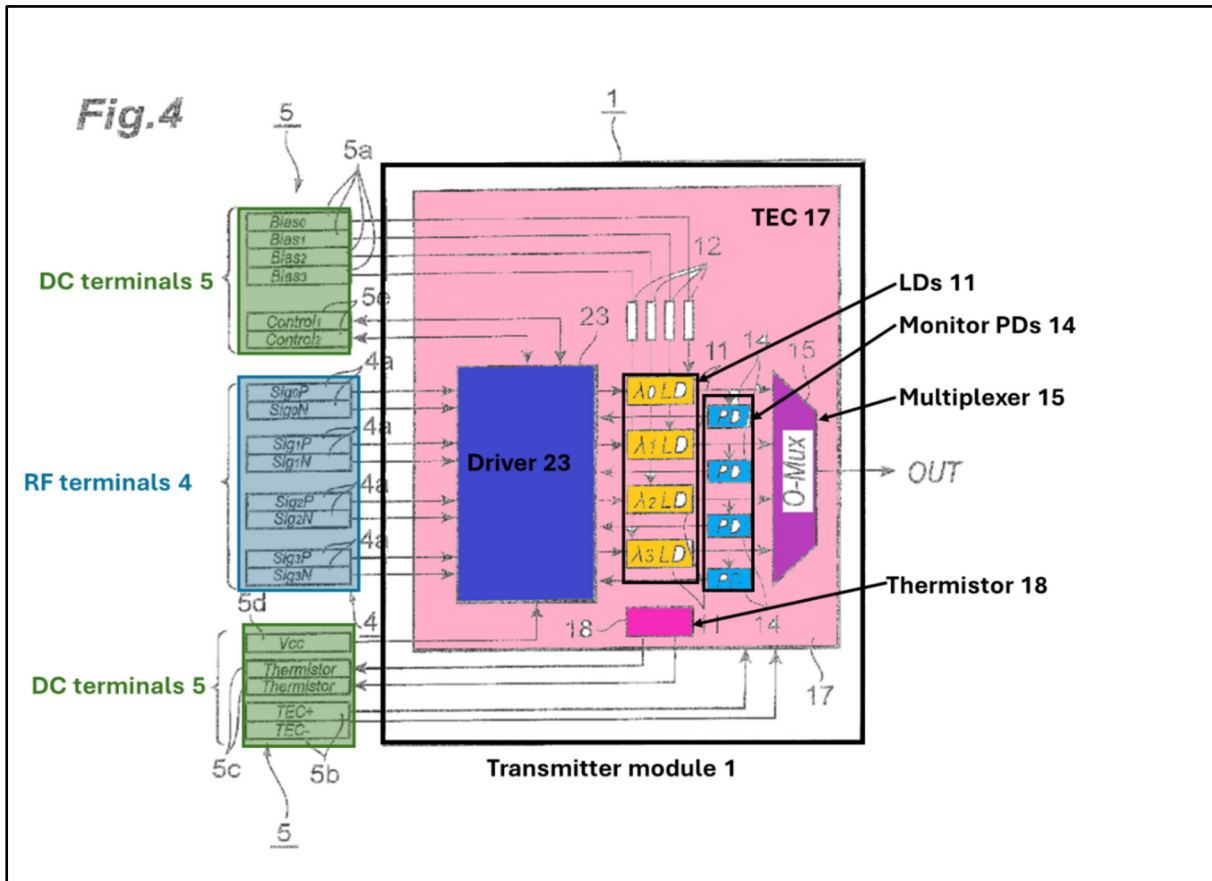
shown in Figure 1, annotated below, an exemplary transmitter module 1 comprises a “box-shaped housing 2 and a cylindrical sleeve assembly 3 provided in the front wall 2c of the housing 2. The housing 2 also provides the electrical terminal 22 in the rear wall 2a. The electrical terminal 22 includes RF terminals 4 for high frequency signals and DC terminals 5 for DC biases.” *Id.*, 3:29-34, Figs. 1, 2, 3A, 3B. Electrical terminal 22 includes a plurality of ceramic layers 22a that provide electrical interconnection to external RF and power sources, with DC terminals 5 provided on the topmost surface 22b of a particular layer and RF terminals 4 provided on the bottommost surface 22c of that layer. *Id.*, 4:4-13, Figs. 1, 2, 3A, 3B.



Ex. 1005, Fig. 1 (showing transmitter module 1) (annotations added)

Transmitter module 1 includes, among other components, a plurality of laser diodes (LDs) 11, a driver 23 to drive the LDs, a plurality of monitor photodiodes (PDs) 14 corresponding to the number of LDs 11, and an optical multiplexer 15 to multiplex the beams emitted from the LDs 11. *Id.*, 3:45-60. The multiplexed light from the LDs is optically coupled with a coupling fiber secured in the sleeve assembly 3. *Id.*

Transmitter module 1 further includes a thermoelectric cooler (TEC) 17 for “mounting primary components of the transmitter module 1.” *Id.*, 4:31-40. In an exemplary embodiment shown in Figure 4, “TEC 17 mounts a driver 23, four LDs 11, four monitor PDs 14, the optical multiplexer 15, and [a] thermistor 18 thereon.” *Id.*

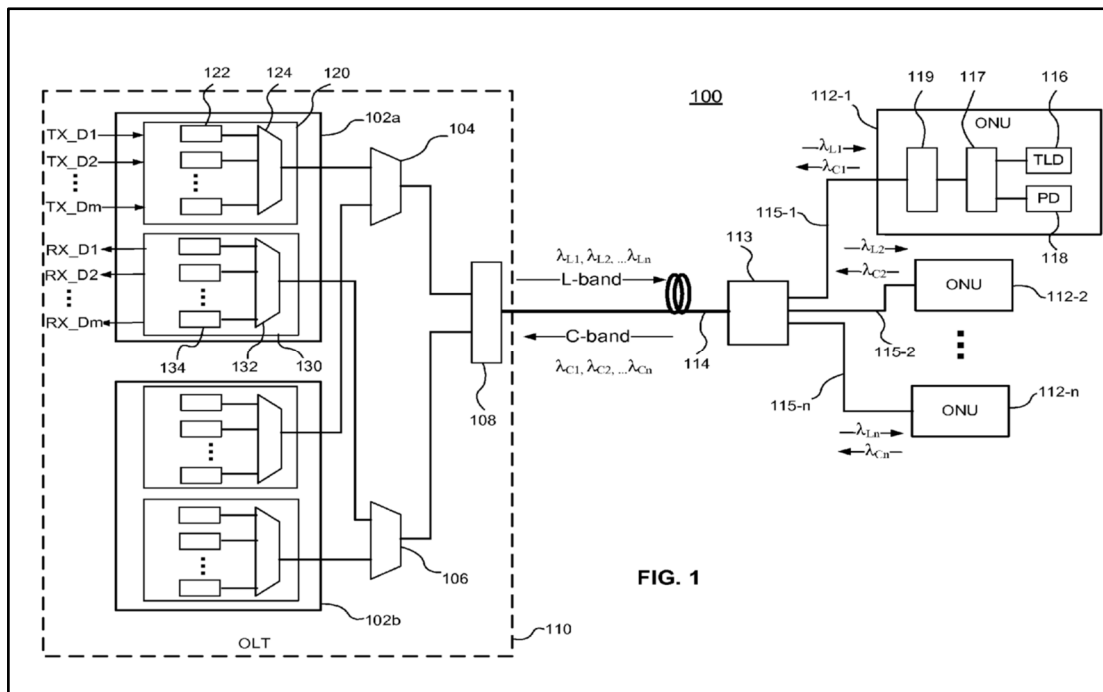


Ex. 1005, Fig. 4 (showing **transmitter module 1** having a **TEC 17** that mounts a **driver 23**, four **LDs 11**, four **monitor PDs 14**, an **optical multiplexer 15**, and a **thermistor 18** thereon) (annotation added)

### C. Ho (Ex. 1006)

Ho discloses a multi-channel optical transceiver module for use in a wavelength division multiplexed (WDM) optical system, for example, in an optical line terminal (OLT) in a WDM passive optical network (PON). Ex. 1006, 2:38-41. Specifically, Ho discloses a WDM-PON 100, which includes at least one OLT 110 coupled to a plurality of optical networking terminals (ONTs) or optical networking

units (ONUs) 112-1 to 112- $n$  via optical fibers, waveguides, and/or paths 114 and 115-1 to 115- $n$ , as shown in Figure 1 (reproduced below). *Id.*, 2:63-3:12. “One application of the WDM-PON 100 is to provide fiber-to-the-home (FTTH) or fiber-to-the-premises (FTTP) capable of delivering voice, data, and/or video services across a common platform.” *Id.*, 3:24-27. In such an application, “OLT 110 may be located at a central office of the WDM-PON 100, and the ONUs 112-1 to 112- $n$  may be located in homes, businesses or other types of subscriber location or premises.” *Id.*, 3:9-12.



Ex. 1006, Fig. 1.

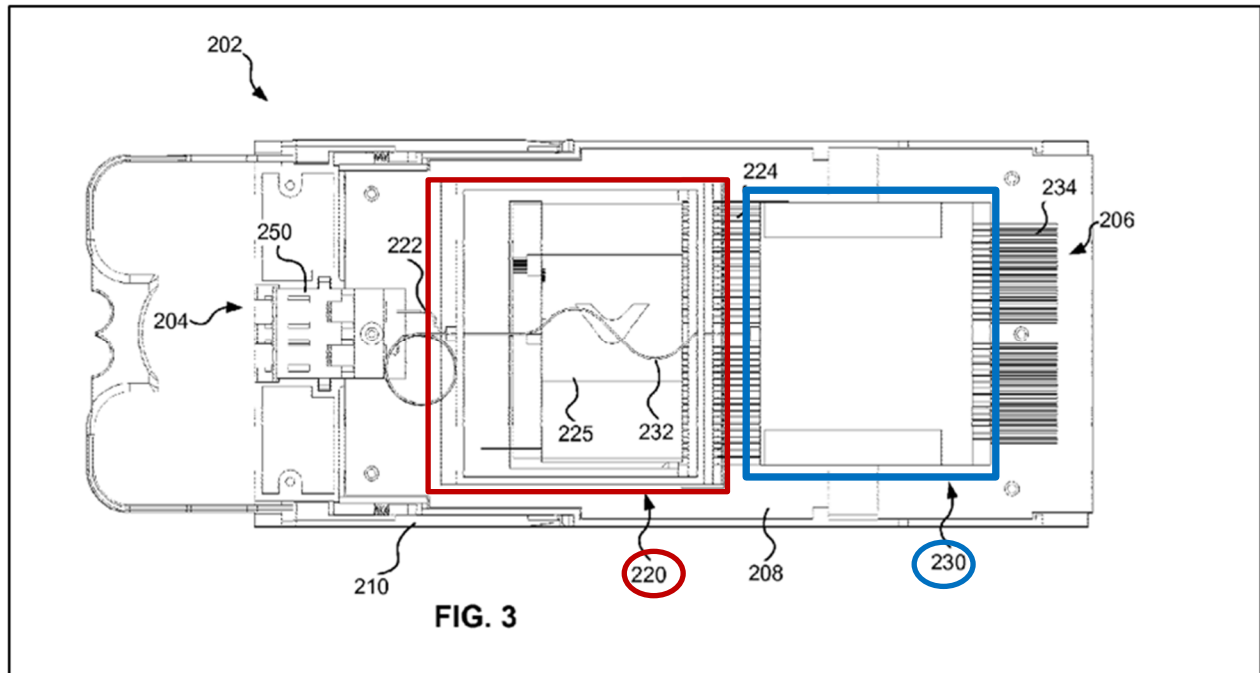
The OLT 110 may be configured to generate multiple optical signals at different channel wavelengths ( $\lambda_{L1}$ ,  $\lambda_{L2}$ , . . .  $\lambda_{Ln}$ ) and to combine the optical signals

into the downstream WDM signal. *Id.*, 4:18-33. Similarly, the OLT 110 may be configured to receive and separate optical signals at different channel wavelengths ( $\lambda_{C1}, \lambda_{C2}, \dots \lambda_{Cn}$ ) from an upstream WDM signal. *Id.* The OLT 110 may thus include multi-channel optical transceivers 102*a*, 102*b*, and each transceiver may include a multi-channel TOSA 120 for generating and combining the optical signals at the multiple channel wavelengths and a multi-channel ROSA 130 for receiving and separating the optical signals at the multiple channel wavelengths. *Id.*

Ho further discloses an exemplary optical transceiver module 202, as shown in Figures 2 and 3, for use in OLT 110. *Id.*, Figs. 2 and 3, 5:51-67. Optical transceiver module 202 includes a transceiver housing 210 containing a multi-channel TOSA 220, a multi-channel ROSA 230, and a dual fiber type direct link adapter 250 directly linked to the TOSA 220 and the ROSA 230 for providing the optical input and output. *Id.* Transceiver module 202 may also include one or more printed circuit boards 208 coupled to TOSA 220 and/or ROSA 230 via conductive leads 224 and 234, respectively. *Id.*, 6:24-33.

TOSA 220 includes an array of lasers 226-1 to 226-*n* that are coupled to a multiplexer (such as an AWG) 225. *Id.*, 6:14-16, 6:45-58. Each laser generates light at a different channel wavelength and the AWG combines the different channel wavelengths into a multiplexed optical signal. *Id.*, 8:57-66. TOSA 220 also includes a temperature control device 260 “for cooling the array of lasers 226-1 to 226-*n* and

the AWG 225.” *Id.*, 6:62-7:10. By using the same temperature control device, “the desired temperature range can be maintained with relatively low power consumption and within a relatively small space.” *Id.*



Ex. 1006, Fig. 3 (showing an optical transceiver 202 having a housing 210 and including a **TOSA 220** and a **ROSA 230**)

## VII. GROUND 1: CLAIM 1 IS ANTICIPATED BY TAKASHI

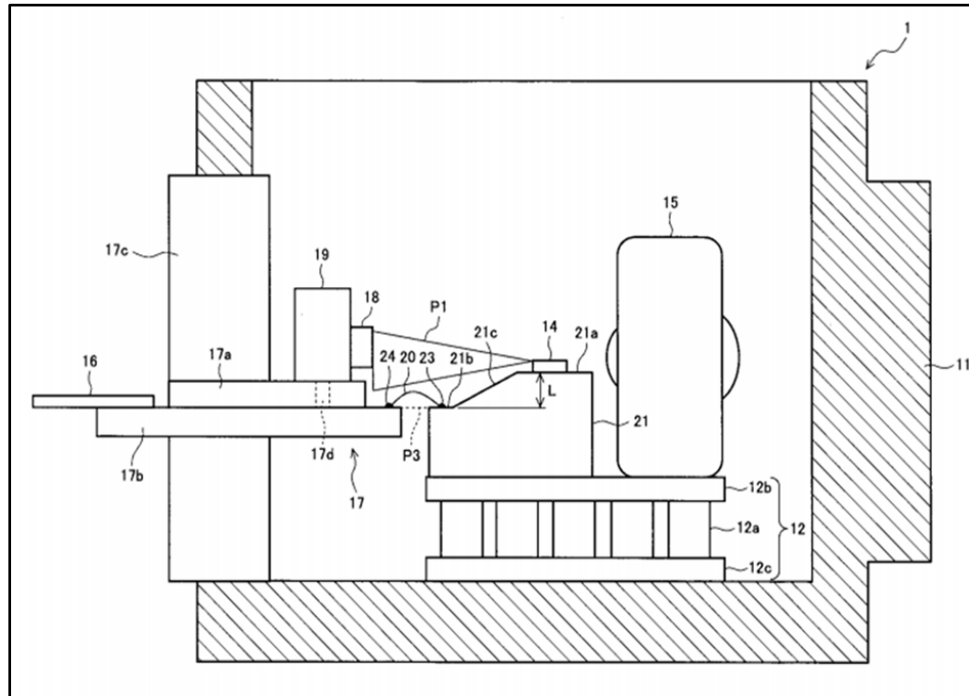
### A. Independent Claim 1

Takashi discloses each and every limitation of claim 1.

#### 1. Claim 1[pre] (“A transmitter optical subassembly (TOSA) module, the TOSA module comprising:”)

Takashi discloses an optical transmission module 1. Ex. 1004, ¶[0018], Fig. 1 (reproduced below). A POSITA would have understood optical transmission module 1 as a transmitter optical subassembly (TOSA) module. *See, e.g., id.*, ¶[0002]

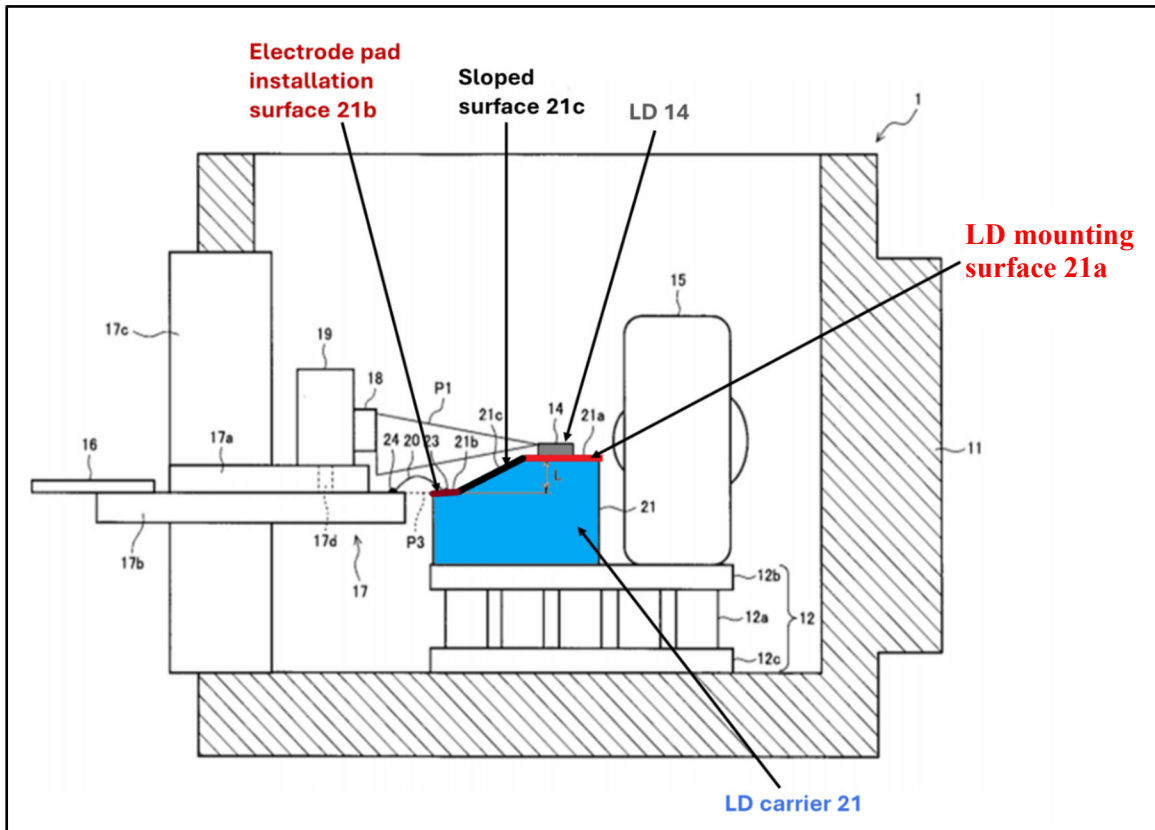
(referring to an optical transmitting module as a “TOSA: Transmitting Optical Sub-Assembly”); Ex. 1003, ¶60.



Ex. 1004, Fig. 1 (showing TOSA module 1)

## 2. Claim term 1[a] (“a laser diode (LD) mounting surface”)

Takashi discloses that TOSA module 1 includes an **LD carrier member 21** on which **LD 14** is mounted. Ex. 1004, ¶¶[0018], [0020], Fig. 1. Specifically, LD carrier member 21 includes an “LD mounting surface 21a for mounting LD 14 and an installation surface 21b for holding LD 14 electrode pads 23[.]” *Id.*, ¶[0020]. LD mounting surface 21a and electrode pad installation surface 21b have a “level difference L” formed by a sloped surface 21c. *Id.*, ¶[0020], Fig. 1.

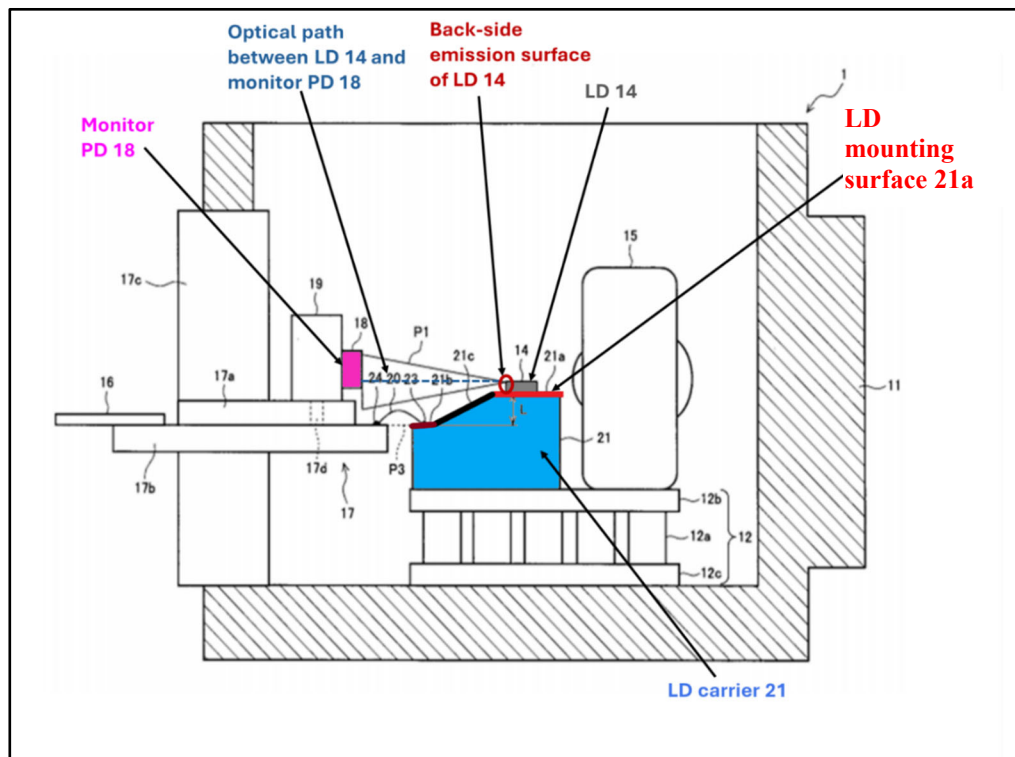


Ex. 1004, Fig. 1 (showing **LD mounting surface 21a** on which **LD 14** is mounted)  
(annotation added)

3. **Claim term 1[b] (“at least a first LD disposed on the LD mounting surface, the first LD having a back-side emission surface for emitting a portion of optical power along a first optical path”)**

Takashi discloses an LD 14 disposed on the LD mounting surface 21a of LD carrier 21. Ex. 1004, ¶¶[0018], [0020], Fig. 1. As shown in Figure 1, LD 14 has a back-side emission surface for emitting a portion of optical power, i.e., “rear-emitting light P1,” along a first optical path that intersects with monitor PD 18. *Id.*, ¶[0019] (discussing that “the light-emitting portion of the LD14 rear-emitting light

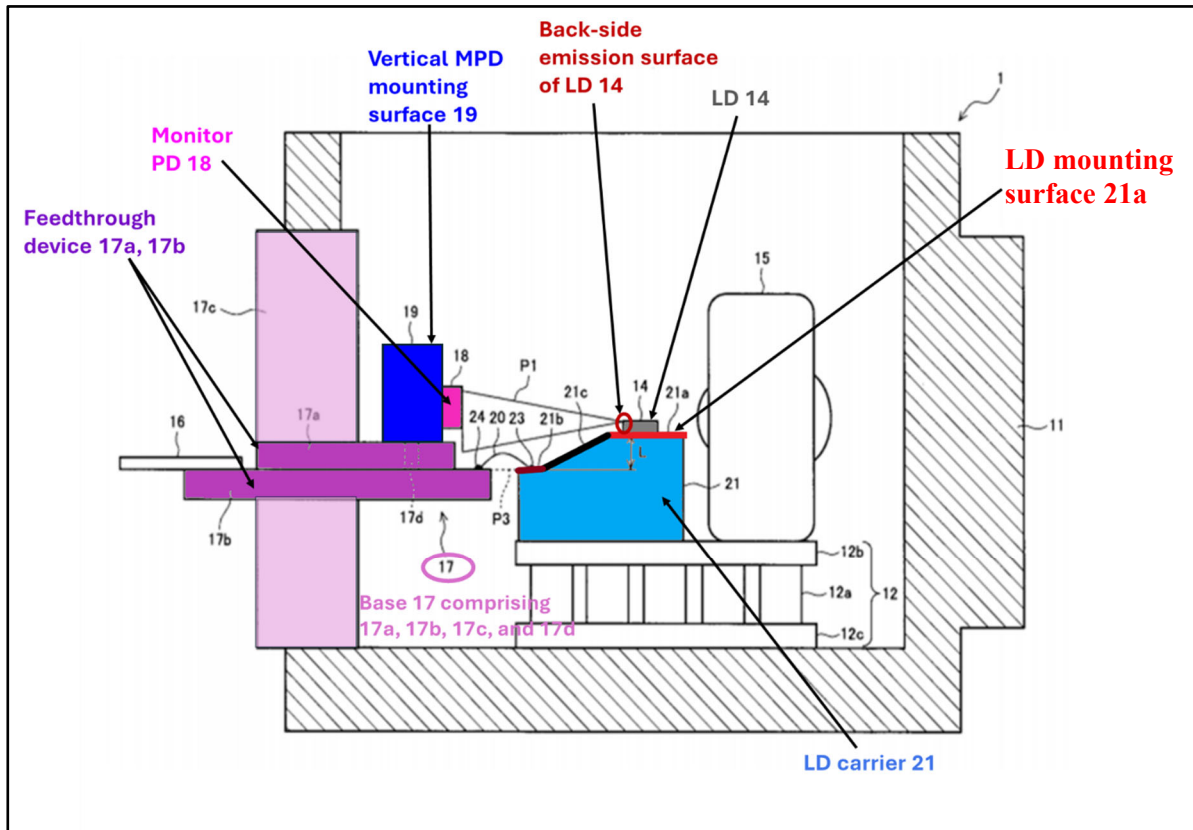
P1 and the monitor PD18 light-receiving surface are opposed one another.”), ¶[0020] (discussing that monitor PD 18 receives “rearward-emitted light P1 from LD 14.”), ¶[0015] (“In present the invention, **the monitor PD can be positioned along the optical path of the LD rearward-emitted light**, allowing it to receive this light with high efficiency[.]”) (emphasis added), Fig. 1; *see also id.*, ¶¶[0013]-[0014] (discussing generally that the LD in Takashi’s disclosure has a surface for backside/rearward emission of a portion of the optical power that is received by a monitor PD).



Ex. 1004, Fig. 1 (showing LD 14 disposed on **LD mounting surface 21a**, and LD 14 having a back-side emission surface that emits light P1 received by **monitor PD 18**) (annotation added)

**4. Claim term 1[c] (“a base portion comprising a feedthrough device, the feedthrough device providing a vertical MPD mounting surface”)**

Takashi’s TOSA module 1 comprises a circuit board 17 (base portion) comprising, among other parts, a **feedthrough device** formed by ceramic blocks 17a and 17b. Ex. 1004, ¶[0019], Fig. 1. “Electrode pads and interconnect conductors (see Figure 2) are formed on each ceramic substrate 17a, 17b, and utilized to electrically connect the thermoelectric module 12, LD 14, monitor PD 18, and external equipment.” *Id.*, ¶[0019]. A POSITA would have readily understood ceramic substrates 17a, 17b as a “feedthrough device” because they comprise electrode pads and interconnect conductors that enable passage of signals into or out of package 11 of TOSA 1. Ex. 1003, ¶63. In addition to feedthrough device 17a, 17b, base portion 17 includes an insulating block 17c and via hole 17d. Ex. 1004, ¶[0019]. Additionally, feedthrough device 17a, 17b provides a vertical **PD carrier 19 (“vertical MPD mounting surface”)** for mounting monitor PD (MPD)18. *Id.*, ¶[0019], Fig 1.

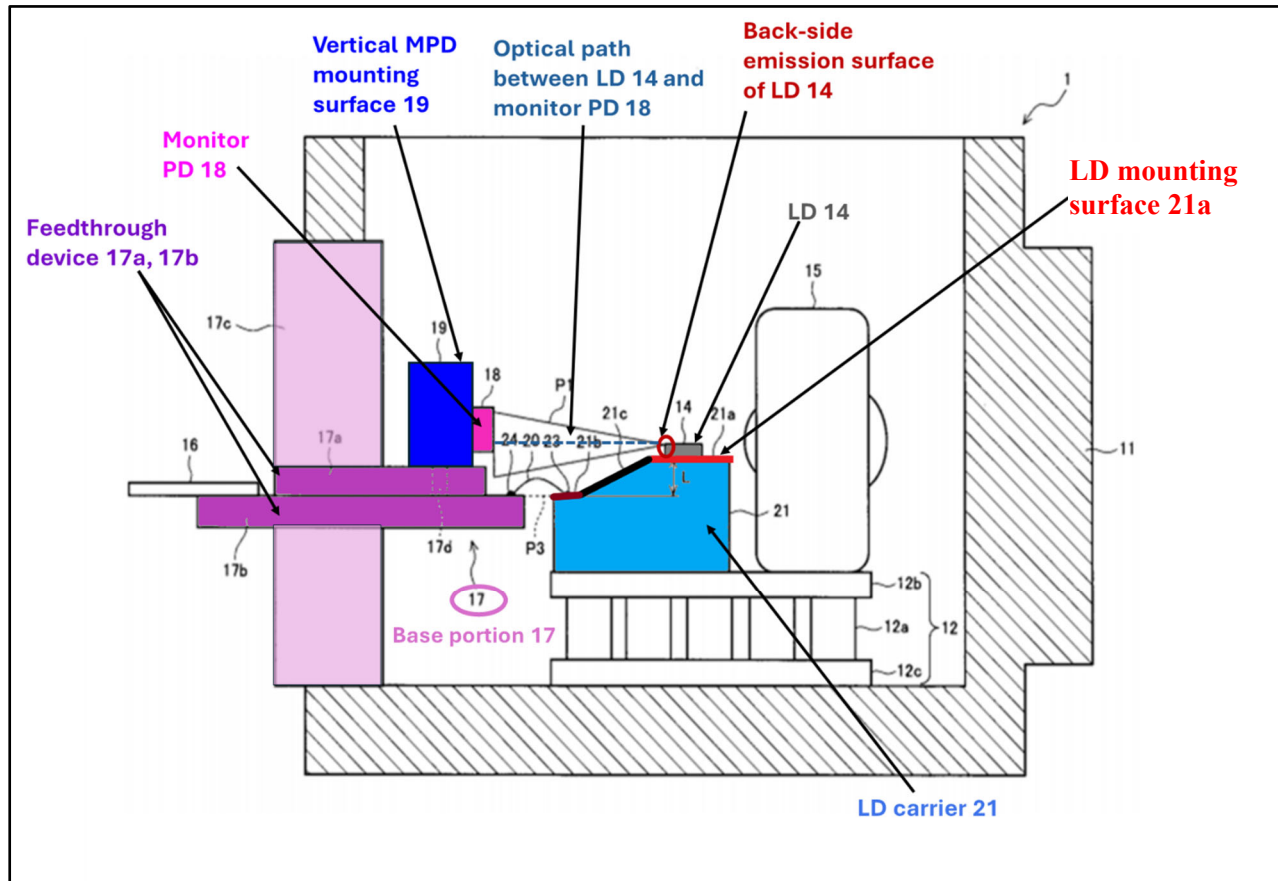


Ex. 1004, Fig. 1 (showing a **feedthrough device 17a, 17b** providing a **vertical MPD mounting surface 19**) (annotations added)

- 5. Claim term 1[d] (“a first MPD disposed on the vertical MPD mounting surface, the first MPD having a light receiving region optically aligned with the first LD via the first optical path based at least in part on the vertical MPD mounting surface extending substantially transverse relative to the LD mounting surface such that the first optical path intersects with the light receiving region of the first MPD.”)**

Takashi discloses that a monitor PD (MPD) 18 is disposed on the vertical MPD mounting surface 19. Ex. 1004, ¶[0019], Fig 1. MPD 18 has a light receiving region that is optically aligned with LD 14, so that the back-side emission from LD

14, i.e., “rear-emitting light P1,” is received by MPD 18 along a first optical path that intersects with monitor PD 18. *Id.*, ¶[0019] (“[T]he light-emitting portion of the LD14 rear-emitting light P1 and the monitor PD18 light-receiving surface are opposed one another.”), ¶[0020] (discussing that monitor PD 18 receives “rearward-emitted light P1 from LD 14.”), ¶[0015] (“In present the invention, **the monitor PD can be positioned along the optical path of the LD rearward-emitted light**, allowing it to receive this light with high efficiency[.]”) (emphasis added), Fig. 1. As shown in Figure 1, the vertical MPD mounting surface 19 extends substantially transverse relative to the LD mounting surface 21a so that the first optical path intersects with the light receiving region of MPD 18. *Id.*, Fig. 1.



Ex. 1004, Fig. 1 (showing **MPD 18** disposed on **vertical MPD mounting surface 19**, which extends transverse to **LD mounting surface 21a**, such that MPD 18 is optically aligned with **LD 14** to receive back-side emission from LD 14 along an **optical path** between LD 14 and MPD 18) (annotations added)

#### VIII. GROUND II: CLAIMS 2-9 ARE RENDERED OBVIOUS BY TAKASHI IN VIEW OF SATO

##### A. A POSITA Would Have Been Motivated to Combine Takashi and Sato and Would Have Reasonably Expected Success in Doing So

Takashi and Sato are in the same field of optical transmitter modules. Ex. 1004, Title (“Optical Transmission Module”); Ex. 1005, Title (“Transmitter Module

Outputting Wavelength Multiplexed Light”). Therefore, a POSITA would have been motivated to consider them together when designing or developing an improved transmitter module (TOSA) for use in a transceiver. Ex. 1003, ¶65.

Specifically, Sato discloses a transmitter module having a plurality of laser diodes (LDs) as optical sources for emitting light at different wavelengths. Ex. 1005, Abstract, 1:7-9. Takashi discloses a TOSA module that improves “optical coupling efficiency” by providing a monitor PD 18 that is “disposed on the rearward-emitted light optical path so that the LD 14 rearward-emitted light P1 can be made directly incident on monitor PD 18 without refraction, reflection, or focusing, and also so that this rearward-emitted light can be efficiently received.” Ex. 1004, ¶[0009], ¶[0013]. Takashi also discloses that its TOSA arrangement not only allows the rearward-emitted light from LD 14 to be “efficiently received” by monitor PD 18, but it also “shorten[s] the length of wire connecting an LD carrier electrode pad to a circuit board electrode pad” to “maximally reduce the effect of parasitic inductance in the LD drive interconnect wire 20 on the optical output waveform, and to prevent deterioration of high-frequency characteristics.” *Id.*, ¶¶[0009]-[0010].

A POSITA would have been motivated to consider Sato’s design and use of multiple laser diodes and multiple monitor photodiodes within a transmitter when modifying Takashi’s TOSA for use in a transceiver that transmits multiple wavelengths of light multiplexed together, e.g., in a Wavelength Division

Multiplexing (WDM) system. Ex. 1003, ¶67. As a POSITA would have known, WDM systems increase the capacity of a single optical fiber by transmitting multiple data streams simultaneously on different wavelengths of light. *Id.* This leads to benefits like reduced costs (as fewer fiber optic cables are needed), simplified network management, improved scalability, and support for high-bandwidth applications. *Id.* Because of these well-known benefits of WDM systems, a POSITA would have been motivated to modify Takashi to have two or more laser diodes, as taught by Sato, to transmit multiple data streams simultaneously on different wavelengths of light for application in a WDM system. *Id.*

A POSITA would have reasonably expected success in combining the teachings of Takashi and Sato because they each disclose similar and conventional transmitter components that could have been rearranged/reconfigured through minimal and routine optimization and experimentation. *Id.*, ¶68. For example, a POSITA would have known and understood that Takashi could have been easily modified in view of Sato for application in a WDM system, and would have been motivated to do so, by adding one or more lasers and corresponding MPDs and a multiplexer to Takashi's TOSA. *Id.* The combination of Takashi and Sato would have only required the routine and ordinary skills of a POSITA. *Id.* Indeed, the combination of Takashi and Sato would have been nothing more than the combination of known prior art elements according to their known functions, and a

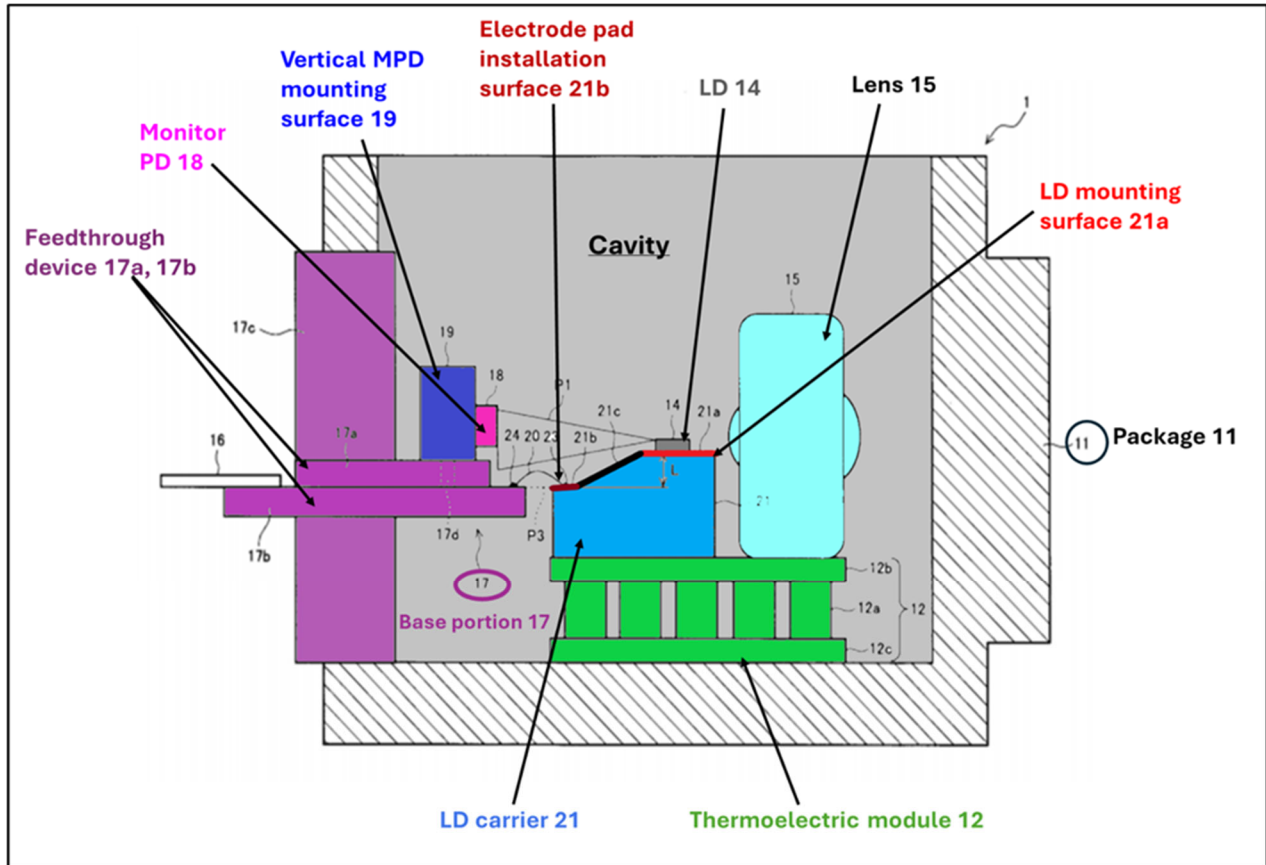
POSITA would have known that their combination would have yielded the predictable results of 1) improved optical coupling efficiency (between LDs and MPDs) in a transmitter module, and 2) increased bandwidth capacity and cost-efficiency of a fiber optic network by transmitting multiple data streams over a single fiber. *Id.*

**B. Claim 2 (“The TOSA module of claim 1, further comprising:”)**

As discussed above, Takashi discloses each and every limitation of claim 1. Takashi in view of Sato discloses the additional limitations of claim 2, and thus renders claim 2 obvious. Ex. 1003, ¶69.

**1. Claim term 2[a] (“a housing having a plurality of sidewalls that define a cavity, the LD mounting surface being disposed in the cavity”)**

Takashi’s TOSA module 1 comprises a package 11 (housing) having a plurality of sidewalls, as shown in Figure 1, below. Ex. 1004, ¶¶[0018], [0019], Fig. 1. The sidewalls (shown by crosshatching in Figure 1) define a cavity within package 11 and the **LD mounting surface 21a** is disposed in the cavity. *Id.*, Fig. 1.

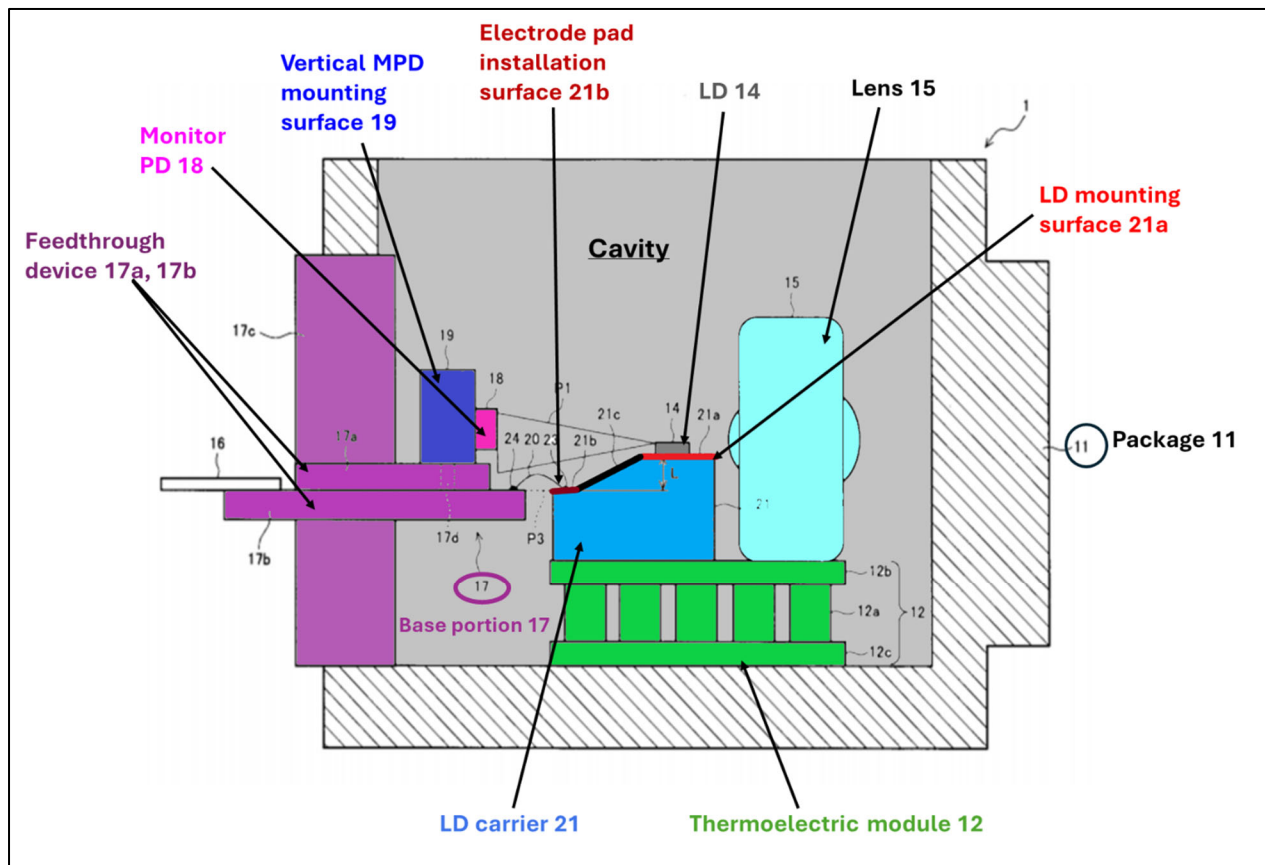


Ex. 1004, Fig. 1 (showing a cavity within package (housing) 11) (annotations added)

2. **Claim term 2[b] (“wherein the feedthrough device is configured to at least partially be disposed in the cavity of the housing, and wherein a first end of the feedthrough device provides an electrical coupling region to electrically couple to an optical module substrate to receive a radio frequency (RF) driving signal to drive the first LD, and a second end of the feedthrough device defines the vertical MPD mounting surface, the vertical MPD mounting surface being disposed in the cavity.”)**

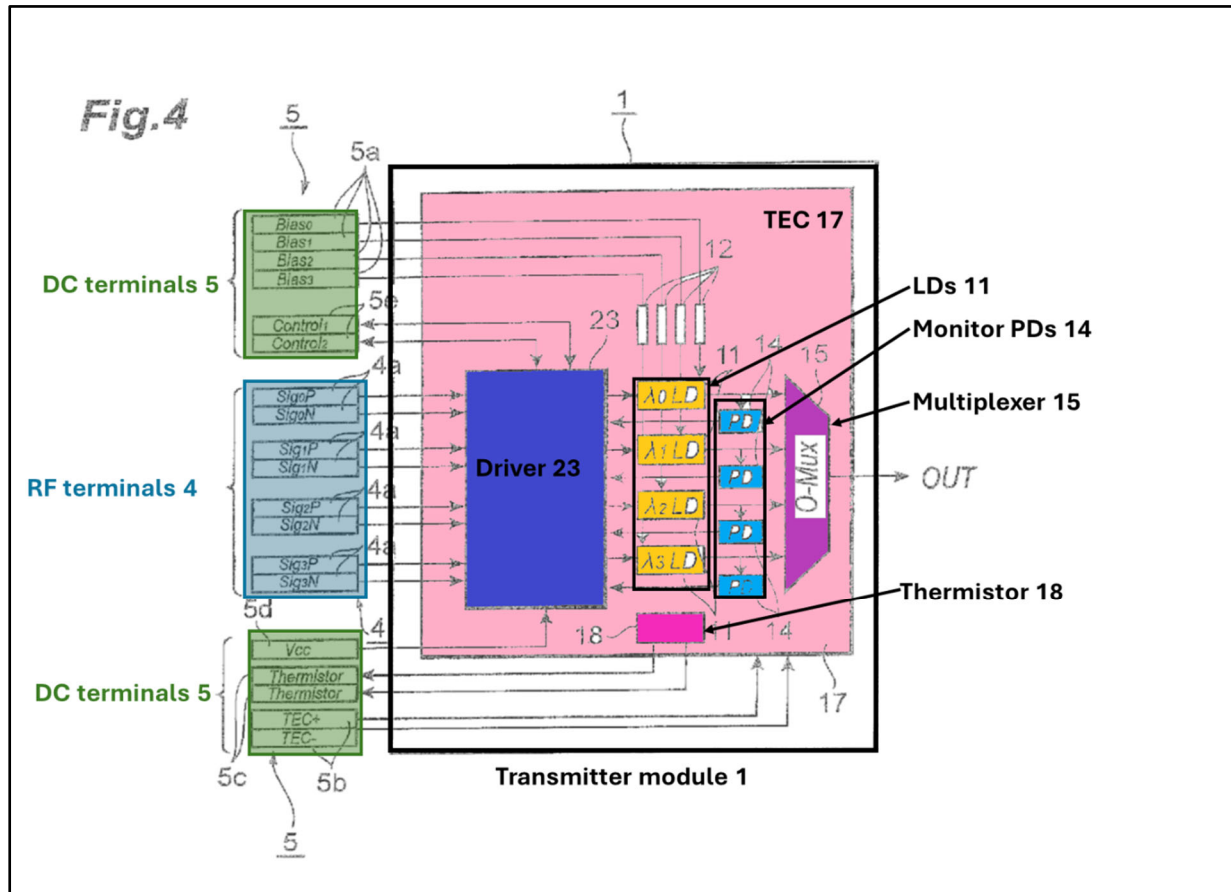
As shown in Figure 1, annotated below, the feedthrough device 17a, 17b is disposed at least partially within the cavity of package 11 (housing). Ex. 1004, ¶[0019], Figs. 1 and 2. A first end of the feedthrough device includes an electrical

coupling region to couple with lead terminals 16. *Id.* Specifically, the first end of the feedthrough device 17a, 17b includes an electrical coupling region that connects lead terminals 16a-16f to the ends of interconnect conductors 28a-28f formed on ceramic substrate 17b of the feedthrough device. *Id.*, ¶[0028], Figs. 1 and 2. Additionally, a second end of feedthrough device 17a, 17b defines the vertical MPD mounting surface 19, which is also disposed in the cavity of package 11. *Id.*, Figs. 1 and 2.



Ex. 1004, Fig. 1 (showing **feedthrough device 17a, 17b** disposed at least partially within the cavity of package 11) (annotation added)

Takashi discloses that LD lead terminals 16a and 16b are connected to LD 14 through interconnect conductors 28a, 28b. Ex. 1004, ¶[0029], Fig. 2. A POSITA would have understood that LD lead terminals 16a and 16b electrically connect to an optical module substrate, such as a circuit board of the transceiver module, to receive a radio frequency (RF) driving signal and to provide the RF signal via interconnect conductors 28a, 28b to LD 14 to drive the LD. Ex. 1003, ¶72. Indeed, it would have been obvious to a POSITA that LD lead terminals 16a, 16b and interconnect conductors 28a, 28b would provide RF transmit signals because laser diodes in high-speed communication transceivers typically use RF signals for driving the lasers. *Id.* Nevertheless, Sato explicitly discloses that its transmitter module 1 comprises a box-shaped housing 2 that has an electrical terminal 22 in the rear wall 2a, and electrical terminal 22 includes RF lead terminals 4 that provide high frequency (RF) signal to driver 23 to drive the LDs 11. Ex. 1005, 3:29-37, 5:29-33, 6:57-58, 7:4-14.



Ex. 1005, Fig. 4 (showing **transmitter module 1** having **RF terminals 4** that connect with **driver 23** to provide RF signals for driving **LDs 11**) (annotation added)

Sato further discloses that transmitter module 1 is installed within a transceiver, which would have indicated to a POSITA that electrical terminal 22 of transmitter module 1 would electrically connect with an optical module substrate, such as a circuit board, of the transceiver. *Id.*, 3:38-43, 4:16-20; Ex. 1003, ¶73. Indeed, other prior art references (for example, Ho) disclose that a transceiver module comprises a printed circuit board and that a transmitter module (TOSA) of the transceiver electrically connects with the board through conductive leads. Ex.

1006, 6:24-33 (discussing that transceiver module 202 includes one or more printed circuit boards 208 coupled to TOSA 220 and/or ROSA 230 via conductive leads 224 and 234, respectively), Fig. 3; Ex. 1003, ¶73.

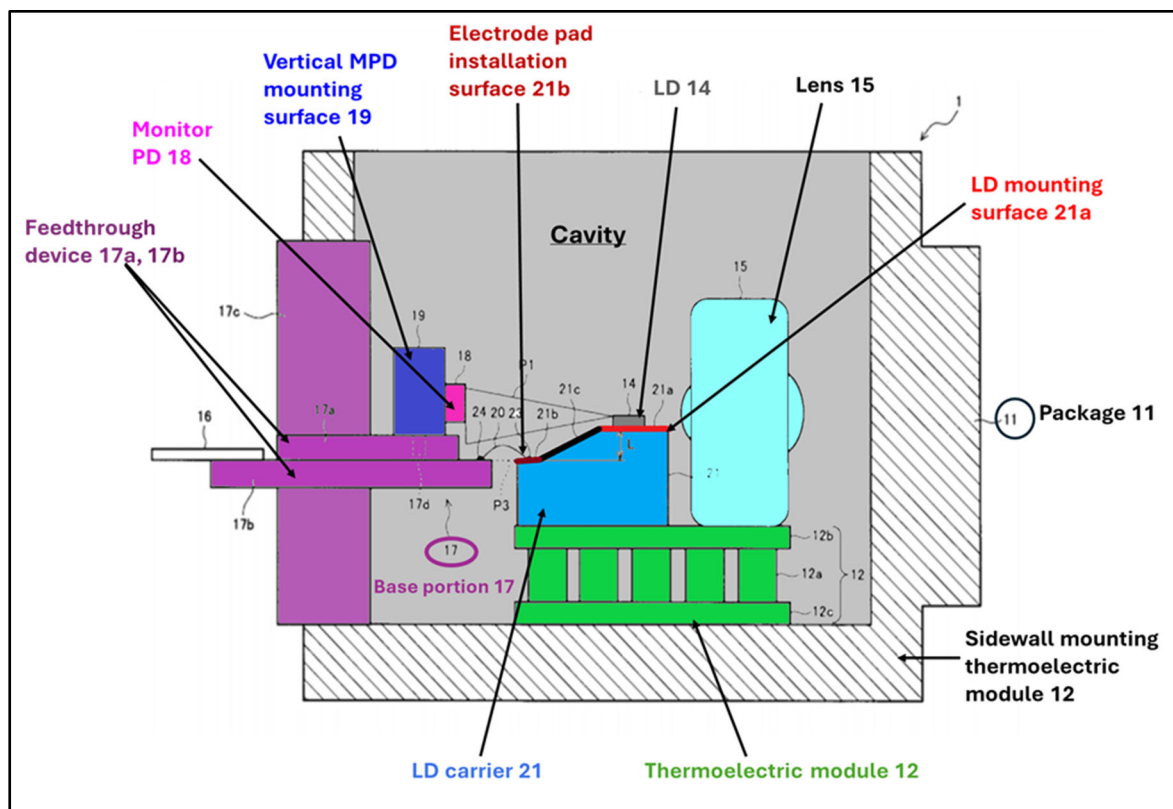
Accordingly, it would have been obvious to a POSITA that in Takashi in view of Sato, the LD lead terminals 16a and 16b connect to an optical module substrate, such as a circuit board of the transceiver, to receive high frequency (RF) drive signal to drive Takashi's LD 14. Ex. 1003, ¶74.

**C. Claim 3 (“The TOSA module of claim 2, wherein the cavity of the housing is hermetically sealed to prevent ingress of contaminants.”)**

Although Takashi does not explicitly disclose that the cavity within package 11 (housing) of TOSA module 1 is hermetically sealed to prevent ingress of contaminants, Sato discloses that housing 2 of its transmitter module 1 is “air-tightly or hermetically sealed by welding the ceiling 7 as substituting inner atmosphere, namely air, with dry nitrogen after those optical and electrical components are installed therein.” Ex. 1005, 3:53-56. It would have been obvious to a POSITA to hermetically seal package 11 of Takashi's TOSA module 1, as taught by Sato, to protect the sensitive laser components inside the TOSA from moisture, dust, and other environmental contaminants, thereby ensuring long-term performance, stability, and reliability. Ex. 1003, ¶75.

**D. Claim 4 (“The TOSA module of claim 2, wherein at least one sidewall of the plurality of sidewalls of the housing provides a thermoelectric cooler (TEC) mounting section, and wherein the TOSA provides:”)**

Takashi's TOSA module 1 comprises a package 11 (housing) having a plurality of sidewalls. Ex. 1004, Fig. 1. One of the sidewalls of package 11 provides a mounting section for mounting thermoelectric module 12 thereon. *Id.* A POSITA would have readily understood thermoelectric module 12 to be a thermoelectric cooler (TEC) because Takashi explicitly refers to the thermoelectric module as a "Thermo-Electric Cooler: TEC." *Id.*, ¶[0005]; *see also id.*, ¶[0030]; Ex. 1003, ¶76.



Ex. 1004, Fig. 1 (showing **thermoelectric module 12 (TEC)** mounted on a section of a sidewall of package 11) (annotation added)

**1. Claim term 4[a] (“a thermoelectric cooler (TEC) arrangement mounted to the TEC mounting section”)**

As discussed above, a thermoelectric module 12 (TEC) arrangement is mounted on the TEC mounting section of a sidewall of package 11. Ex. 1004, Fig. 1 (annotated above).

**2. Claim term 4[b] (“a LD submount disposed on the TEC arrangement, the LD submount being in thermal communication with the TEC arrangement, and wherein the LD submount provides the LD mounting surface.”)**

As shown in Figure 1, annotated above, an LD carrier 21 (LD submount) is disposed on thermoelectric module 12 (TEC) arrangement. Ex. 1004, ¶[0018] (“In thermoelectric module 12, a first flat body 12b is disposed on the heat-absorbing side of thermoelectric conversion element 12a and a second flat body 12c is disposed on the heat-emitting side [thereof]; and an LD carrier 21 is mounted on first flat body 12b on the heat-absorbing side.”), Fig. 1. LD carrier 21 (LD submount) is in thermal communication with thermoelectric module 12 (TEC) to exhaust the heat generated by LD14 through thermoelectric module 12 and package 11. *Id.*, ¶[0018].

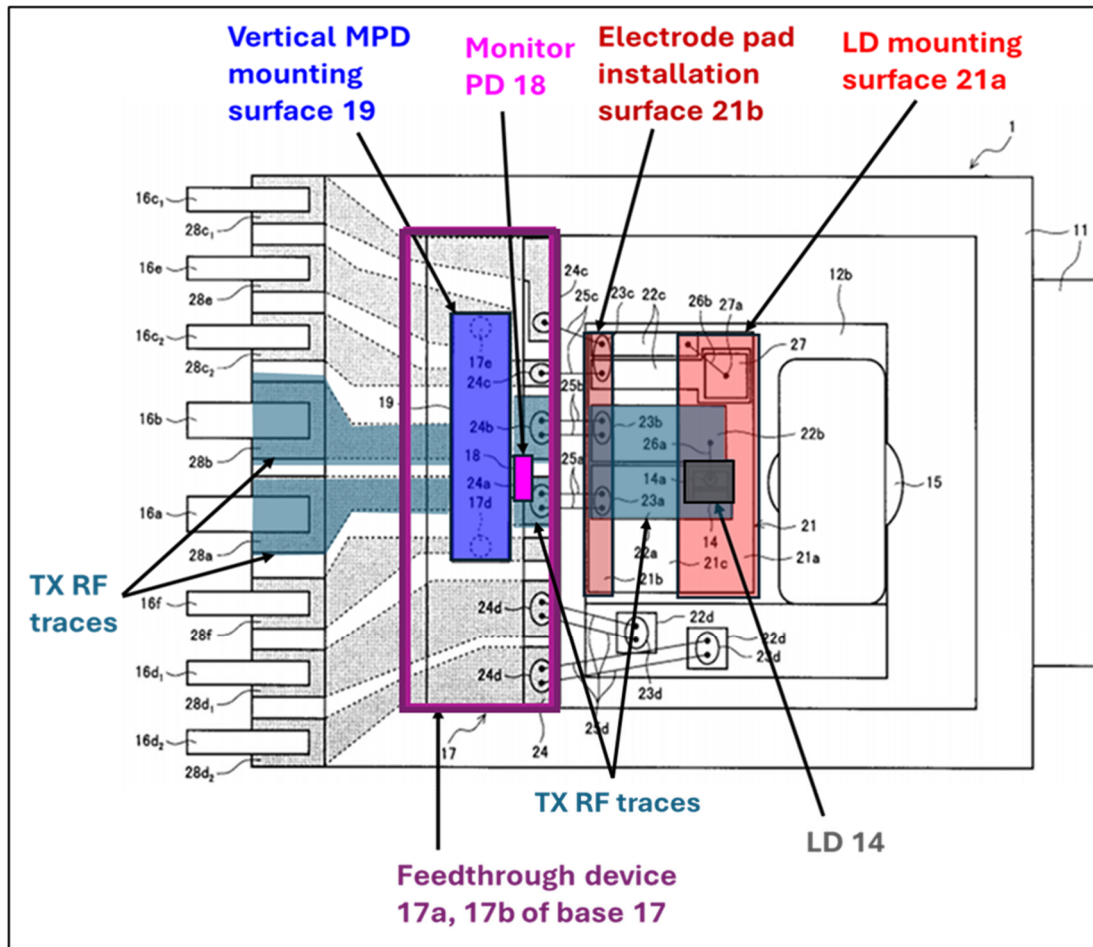
LD carrier 21 (LD submount) provides LD mounting surface 21a for mounting LD 14 thereon. *Id.*, Fig. 1, ¶[0018] (“LD14 is mounted on the LD carrier 21 mounting surface 21a”).

- E. Claim 5 (“The TOSA module of claim 1, further comprising a plurality of transmit (TX) radio frequency (RF) traces, the TX RF traces being disposed on a surface of the base that extends away from the vertical mounting surface along a direction that is substantially parallel with the LD mounting surface.”)**

Takashi discloses interconnect conductors 28a, 28b (which a POSITA would have understood to be conductive traces) as well as a plurality of other conductive traces that connect LD lead terminals 16a, 16b to the LD cathode electrode pad 24a and LD anode electrode pad 24b provided at the end of feedthrough device 17a, 17b. Ex. 1004, ¶¶[0021], [0022], [0029], Figs. 1 and 2; Ex. 1003, ¶80. The LD electrode pads 24a, 24b are then connected to electrode pads 23a, 23b provided on the mounting surface 21b of LD carrier 21 through interconnect wires 25a, 25b, and the electrode pads 23a, 23b connect through interconnect conductors (conductive traces) 22a, 22b with LD 14. Ex. 1004, ¶¶[0021], [0022], [0029], Figs. 1 and 2; Ex. 1003, ¶80.

As discussed above with regard to claim term 2[b] (Section VIII.B.2), it would have been obvious to a POSITA based on the teachings of Sato that Takashi’s LD lead terminals 16a, 16b electrically connect to an optical module substrate, such as a circuit board of the transceiver module, to receive a radio frequency (RF) transmit signal (RF TX) and to provide the RF TX signal via a plurality of conductive traces to LD 14 to drive the LD. Ex. 1003, ¶81; *see also* Ex. 1005, 3:29-37, 5:29-33, 6:57-58, 7:4-14. It would thus have been obvious to a POSITA that the traces that

electrically connect LD lead terminals 16a, 16b to the LD electrode pads 24a, 24b and the interconnect conductors 22a, 22b (conductive traces) that connect electrode pads 23a, 23b to LD 14 are radio frequency (RF) traces that deliver transmit signal (TX RF) to LD 14. Ex. 1003, ¶81.



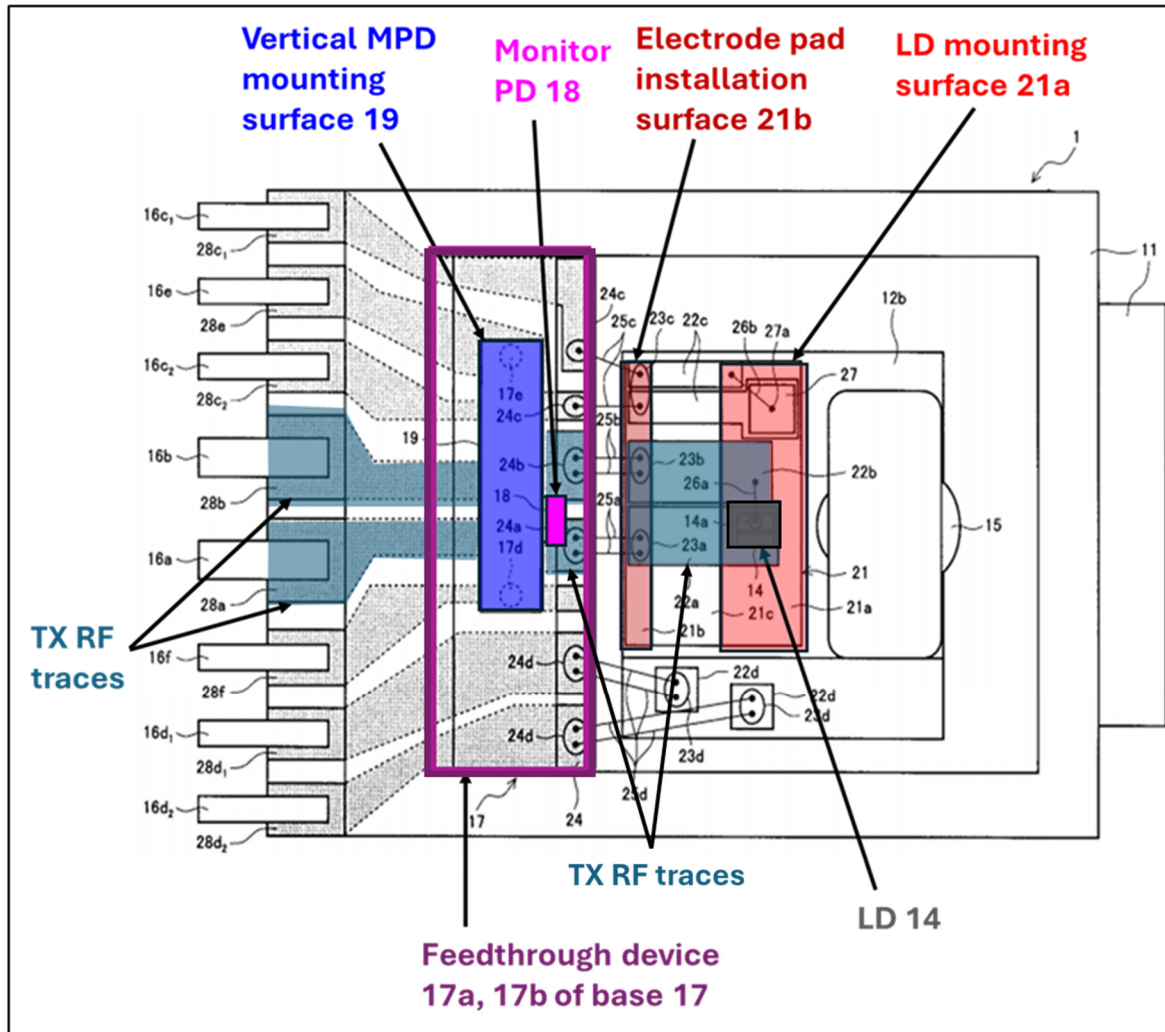
Ex. 1004, Fig. 2 (showing **TX RF traces** being disposed on a surface of the feedthrough device of **base 17** that extends away from the **vertical MPD mounting surface 19** along a direction that is substantially parallel with the **LD mounting surface 21a**) (annotations added)

As shown in Figure 2 of Takashi, annotated above, the TX RF traces are disposed on a surface of base 17, specifically on the surface of feedthrough device 17a, 17b of the base. Ex. 1004, Fig. 2. As further shown in annotated Figure 2, above, the TX RF traces extend away from the vertical MPD mounting surface 19 along a direction that is substantially parallel with LD mounting surface 21a. Ex. 1003, ¶82; *see also* Ex. 1004, Fig. 1 (showing that feedthrough device 17a, 17b extends substantially parallel to LD mounting surface 21a).

**F. Claim 6 (“The TOSA module of claim 5, wherein the plurality of TX RF traces are disposed below the MPD when mounted to the vertical MPD mounting surface to allow the plurality of TX RF traces to extend towards the LD mounting surface, and wherein a portion of the plurality of TX RF traces are disposed adjacent the LD mounting surface.”)**

As shown in Figure 2 of Takashi, annotated above, the plurality of the TX RF traces are disposed below the monitor PD (MPD) 18 when mounted to the vertical MPD mounting surface 19 to allow the plurality of TX RF traces to extend towards the LD mounting surface 21a. Ex. 1004, Figs. 1 and 2; Ex. 1003, ¶83. Annotated Figure 2 of Takashi also shows that the TX RF traces are disposed adjacent to and on the LD mounting surface 21a. Ex. 1004, Figs. 1 and 2; Ex. 1003, ¶83. A POSITA would also have found it obvious to position the TX RF traces adjacent to the LD mounting surface to avoid long interconnect wires between the traces and the LD

because long wires tend to attenuate high frequency (e.g., RF) signals, cause noise ingress, or result in impedance mismatch that degrades the signal. Ex. 1003, ¶83.



Ex. 1004, Fig. 2 (showing TX RF traces disposed below MPD 18 when mounted to the vertical MPD mounting surface 19 and adjacent LD mounting surface 21a) (annotations added)

- G. Claim 7 (“The TOSA module of claim 1, further comprising a second LD disposed on the LD mounting surface and a second MPD disposed on the vertical MPD mounting surface, the second LD being configured to emit an associated channel wavelength

**different from that of the first LD, and wherein the second LD and second MPD are optically aligned via a second optical path such that the second optical path extends from a back-side emission surface of the second LD and intersects with a light receiving region of the second MPD.”)**

Takashi discloses a first LD 14 mounted on LD mounting surface 21a and a first monitor PD (MPD) 18 disposed on the vertical MPD mounting surface 19. Ex. 1004, ¶¶[0019], [0020], Fig. 1. Takashi also discloses that LD 14 has a back-side emission surface for emitting a portion of optical power, i.e., “rear-emitting light P1,” along a first optical path that extends from the back-side emission surface of LD 14 and intersects with a light receiving region of monitor PD 18. *Id.*, ¶¶[0015], [0019], [0020], Fig. 1; *see* Sections VII.A.3 and VII.A.5, above.

It would have been obvious to a POSITA that when Takashi’s TOSA 1 is modified in view of Sato for use in a WDM (Wavelength Division Multiplexing) system to transmit multiple optical signals, each at a different wavelength, over a single optical fiber, TOSA 1 would have included two or more LDs 14 to generate specific and distinct channel wavelengths (and the channel wavelengths would have been multiplexed into a single output signal). *See, e.g.*, Ex. 1005, Title (“Transmitter Module Outputting Wavelength Multiplexed Light”), 1:11-14 (“An optical transmitter module that installs four laser diodes (herein after denoted as LDS) each emitting an optical beam with a specific wavelength different from others has been known in the field.”); Ex. 1003, ¶85. At the time of the effective filing date of the

'890 patent, WDM systems were well known and common in modern data center and telecommunication applications. Ex. 1003, ¶85. A TOSA for such WDM applications was conventionally designed to have an array of laser diodes within a single compact module. *Id.* Each laser was manufactured to emit light at a distinct wavelength, following the International Telecommunication Union (ITU-T) recommendations for Wavelength Division Multiplexing (WDM) systems, and an optical multiplexer was used to combine the different wavelengths into a single optical fiber for transmission. *Id.*

Indeed, Sato explicitly discloses that “transmitter module 1 includes four (4) LDs 11, where each emits an optical beam with a wavelength specific thereto and different from others, and the optical multiplexer 15 to multiplex[] respective optical beams.” Ex. 1005, 4:22-30. Sato further explains that although four LDs are shown, “transmitter module 1 is not restricted to this arrangement, and the transmitter module 1 may install two or more LDs or channels.” *Id.* Sato further teaches two LD submounts 31 and two LDs 11 are mounted on each LD submount 31. *Id.*, Fig. 7, 6:8-12 (“[E]xactly two LD sub-mounts 31 are arranged on the carrier 32 in side-by-side along the lateral direction of the housing 2. Each of the LD sub-mounts 31 mounts two LDS 11 also arranged in side-by-side.”). Sato additionally teaches four monitor PDs 14 corresponding to the four LDs 11. *Id.*, 3:45-52, 4:33-37.

It would have been obvious to a POSITA that Takashi modified in view of Sato would have a second LD 14 disposed on the LD mounting surface 21a, with the second LD 14 being configured to emit an associated channel wavelength different from that of the first LD 14. Ex. 1005, 4:21-30, 6:8-12 (Sato disclosing two LDs 11 on a single LD submount 31); Ex. 1003, ¶87. It would also have been obvious to a POSITA that Takashi modified in view of Sato would have a second monitor PD 18 corresponding to the second LD 14 and that second MPD 18 would have been optically aligned with second LD 14 via a second optical path that extends from a back-side emission surface of the second LD and intersects with a light receiving region of the second MPD. Ex. 1005, 3:45-52, 4:33-37 (Sato disclosing a second MPD corresponding to a second LD); Section VII.A.5, above (discussing that Takashi's MPD 18 is optically aligned with its LD 14 along an optical path that extends from the back-side emission surface of LD 14 and intersects with a light receiving region of MPD 18); Ex. 1003, ¶87.

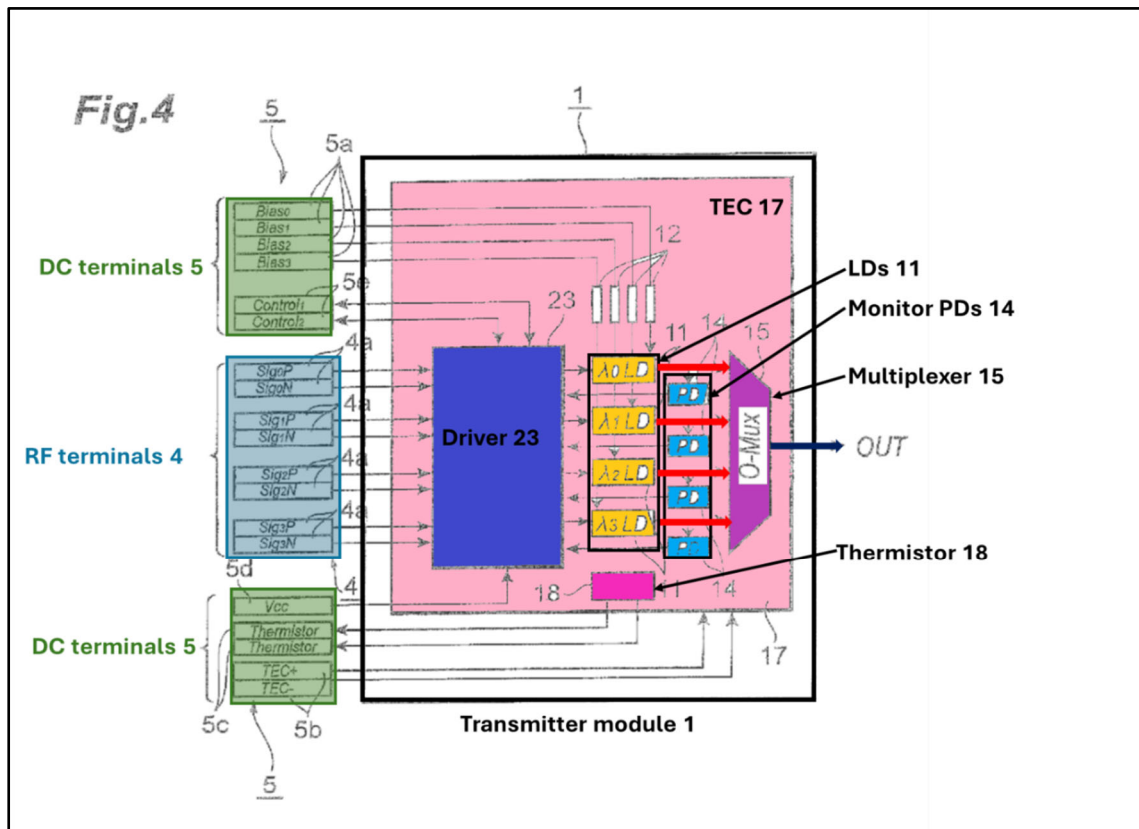
It would further have been obvious to a POSITA that the second MPD 18 would have been disposed on Takashi's vertical MPD mounting surface 19 so that "the LD14 rearward-emitted light P1 can be made directly incident on monitor PD 18 without refraction, reflection, or focusing" and the rearward-emitted light P1 is "efficiently received" by monitor PD 18. Ex. 1004, ¶¶[0009], [0020]; Ex. 1003, ¶88. Placement of the second MPD on the vertical MPD mounting surface 19 would also

have been a matter of routine optimization and design choice by a POSITA to use space within the TOSA housing more efficiently, have fewer parts/components, and reduce the size/volume of the TOSA housing. Ex. 1003, ¶88.

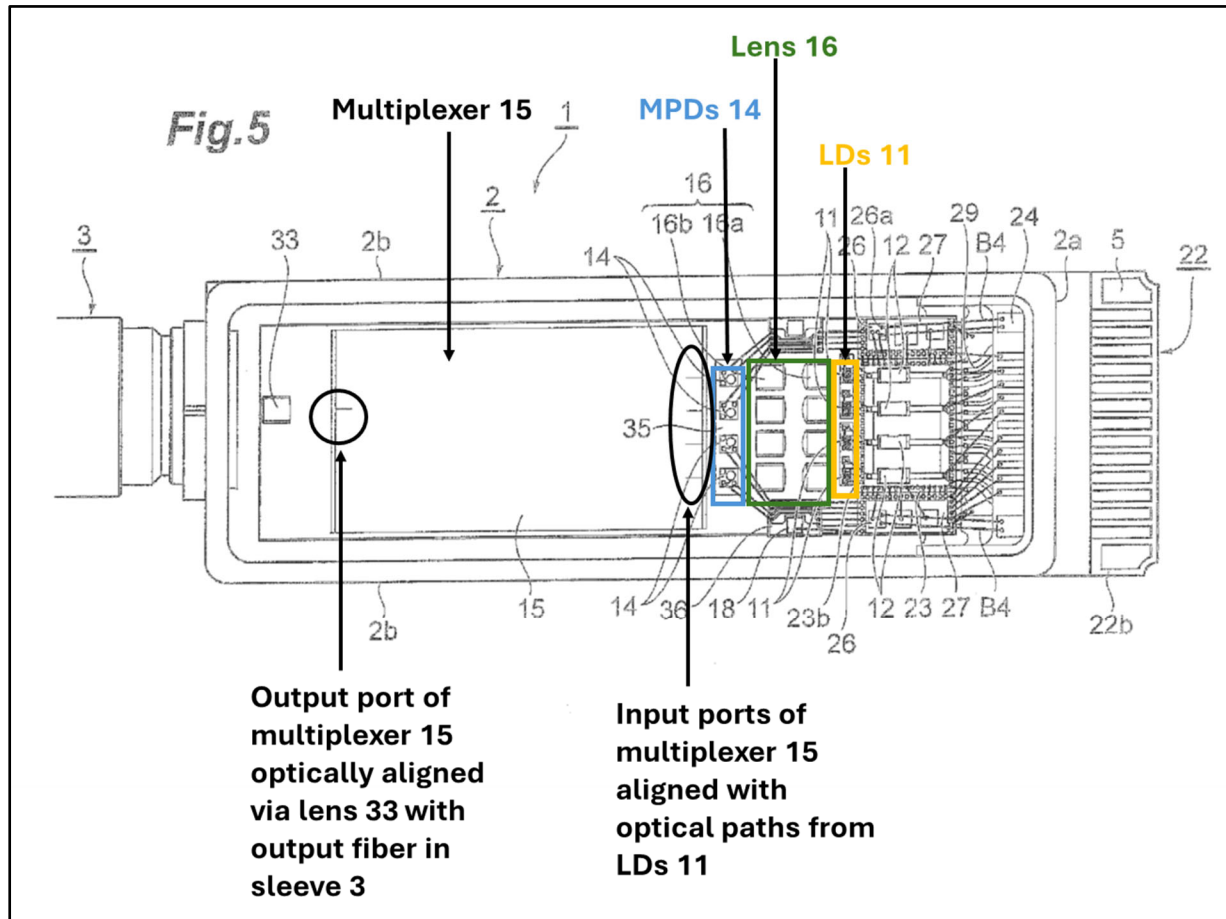
**H. Claim 8 (“The TOSA module of claim 7, further comprising a multiplexing arrangement, the multiplexing arrangement having at least first and second input ports optically aligned with the first and second optical paths, respectively, to receive and combine channel wavelengths emitted by the first and second LDs into a multiplexed optical signal for output via an output port.”)**

Sato’s transmitter module 1 comprises a multiplexer 15 (multiplexing arrangement) to multiplex the beams emitted by LDs 11. Ex. 1005, 3:45-52. Specifically, transmitter module 1 includes “four (4) LDs 11, where each emits an optical beam with a wavelength specific thereto and different from others, and the optical multiplexer 15 to multiplexes respective optical beams.” *Id.*, 4:22-25. As shown in Figures 4 and 5 of Sato, and as a POSITA would have readily understood, multiplexer 15 has at least two input ports that are optically aligned with the respective optical paths from the at least two LDs 11 to receive the light emitted by the LDs, and to combine channel wavelengths emitted by the at least two LDs 11 into a multiplexed optical signal for output via an output port that is optically coupled to a coupling fiber secured in the sleeve assembly 3. *Id.*, 6:44-54 (“The optical beams each emitted from the LDs 11 enter the optical multiplexer 15 as passing through respective lenses 16. The PDs 14 are put in the upstream of the multiplexer 15 to

monitor the magnitude of respective optical beams output from the LDs 11. The multiplexer 15 multiplexes the optical beams to output the multiplexed light. The multiplexed light is concentrated on the coupling fiber secured in the sleeve assembly 3 [by] passing through one or more lenses 33 also provided in the sleeve assembly 3. Mating an external optical connector with the sleeve assembly 3, the transmitter module 1 may optically couple with the external fiber.”), Figs. 4 and 5; Ex. 1003, ¶89.



Ex. 1005, Fig. 4 (showing **optical paths** from LDs 11 aligned with **multiplexer 15** to receive and combine the light emitted by the LDs into a **multiplexed optical signal** for output via an output port) (annotations added)



Ex. 1005, Fig. 5 (showing input ports of **multiplexer 15** that are aligned with optical paths from **LDs 11** and output port of multiplexer 15 optically aligned with output fiber in sleeve 3) (annotations added)

It would have been obvious to a POSITA that in Takashi in view of Sato, TOSA module 1 of Takashi would have a multiplexer, such as multiplexer 15 of Sato, comprising first and second input ports optically aligned with the first and second optical paths from Takashi's LDs 14 to receive and combine the channel wavelengths emitted by the LDs into a multiplexed optical signal for output via an output port of the multiplexer. Ex. 1003, ¶90.

- I. Claim 9 (“The TOSA module of claim 8, wherein the multiplexing arrangement includes an arrayed waveguide grating AWG to multiplex the received channel wavelengths, and wherein AWG provides the output port and passes the multiplexed optical signal on to a transmit waveguide coupled to the output port.”)**

Sato discloses that multiplexer 15 may be an arrayed waveguide grating (AWG) to multiplex the channel wavelengths emitted by LDs 11. Ex. 1005, 9:9-12. It would have been obvious to a POSITA that in Takashi in view of Sato, Takashi’s TOSA module 1 may have an AWG multiplexer, and the AWG would pass the multiplexed optical signal on to a transmit waveguide, i.e., the “coupling fiber secured in the sleeve assembly 3,” that is optically coupled to the output port of the AWG. *Id.*, 6:44-54 (“The optical beams each emitted from the LDs 11 enter the optical multiplexer 15 [by] passing through respective lenses 16. ... **The multiplexer 15 multiplexes the optical beams to output the multiplexed light. The multiplexed light is concentrated on the coupling fiber secured in the sleeve assembly 3** [by] passing through one or more lenses 33 also provided in the sleeve assembly 3. Mating an external optical connector with the sleeve assembly 3, the transmitter module 1 may optically couple with the external fiber.”) (emphasis added), Figs. 4 and 5; Ex. 1003, ¶91.

**IX. GROUND 3: CLAIMS 15-19 ARE RENDERED OBVIOUS BY HO IN VIEW OF TAKASHI AND FURTHER IN VIEW OF SATO**

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

Ho discloses a multi-channel optical transceiver module for use in a wavelength division multiplexing (WDM) optical system. Ex. 1006, 2:38-41, 2:63-3:12. Ho further discloses that the transceiver for the WDM application may include a multi-channel TOSA for generating and combining optical signals at multiple channel wavelengths *Id.*, 4:18-33, 5:51-67. As discussed above, Takashi also discloses an improved transmitter module (TOSA). Ex. 1004, Title (“Optical Transmission Module”). Therefore, a POSITA would have been motivated to consider Ho and Takashi together when designing or developing an improved transmitter module (TOSA) for use in an optical transceiver. Ex. 1003, ¶92.

Specifically, Takashi discloses a TOSA module that improves “optical coupling efficiency” by providing a monitor PD 18 that is “disposed on the rearward-emitted light optical path so that the LD 14 rearward-emitted light P1 can be made directly incident on monitor PD 18 without refraction, reflection, or focusing, and also so that this rearward-emitted light can be efficiently received.” Ex. 1004, ¶¶[0009], [0013]. Takashi also discloses that its TOSA arrangement not only allows the rearward-emitted light from LD 14 to be “efficiently received” by monitor PD 18, but it also “shorten[s] the length of wire connecting an LD carrier electrode pad

to a circuit board electrode pad” to “maximally reduce the effect of parasitic inductance in the LD drive interconnect wire 20 on the optical output waveform, and to prevent deterioration of high-frequency characteristics.” *Id.*, ¶¶[0009]-[0013]. A POSITA would also have known that Takashi’s arrangement reduces volume and space within the TOSA housing. Ex. 1003, ¶93.

Because of these improvements described in Takashi, a POSITA would have been motivated to consider Takashi when developing an improved transmitter module for application in Ho’s transceiver. Ex. 1003, ¶94. More specifically, a POSITA would have been motivated to incorporate the TOSA arrangement taught by Takashi into Ho’s transceiver to 1) improve the coupling efficiency between the back-emitted light from the laser diodes and the respective monitor photodiodes, and 2) shorten the length of electrical interconnection between the laser diodes and the conductive traces/leads providing driving signals to the laser diodes. *Id.*

A POSITA would also have been motivated to consider Sato’s design and use of multiple laser diodes and multiple monitor photodiodes within a transmitter when modifying Takashi’s TOSA for use in Ho’s transceiver, which transmits multiple wavelengths of light multiplexed together in a WDM system. *Id.*, ¶95. As a POSITA would have known, WDM systems increase the capacity of a single optical fiber by transmitting multiple data streams simultaneously on different wavelengths of light. *Id.* This leads to benefits like reduced costs (as fewer fiber optic cables are needed),

simplified network management, improved scalability, and support for high-bandwidth applications. *Id.* Because of these well-known benefits of WDM systems, a POSITA would have been motivated to modify Takashi to have two or more laser diodes, as taught by Sato, to transmit multiple data streams simultaneously on different wavelengths of light for application in a WDM system, as described in Ho. *Id.*

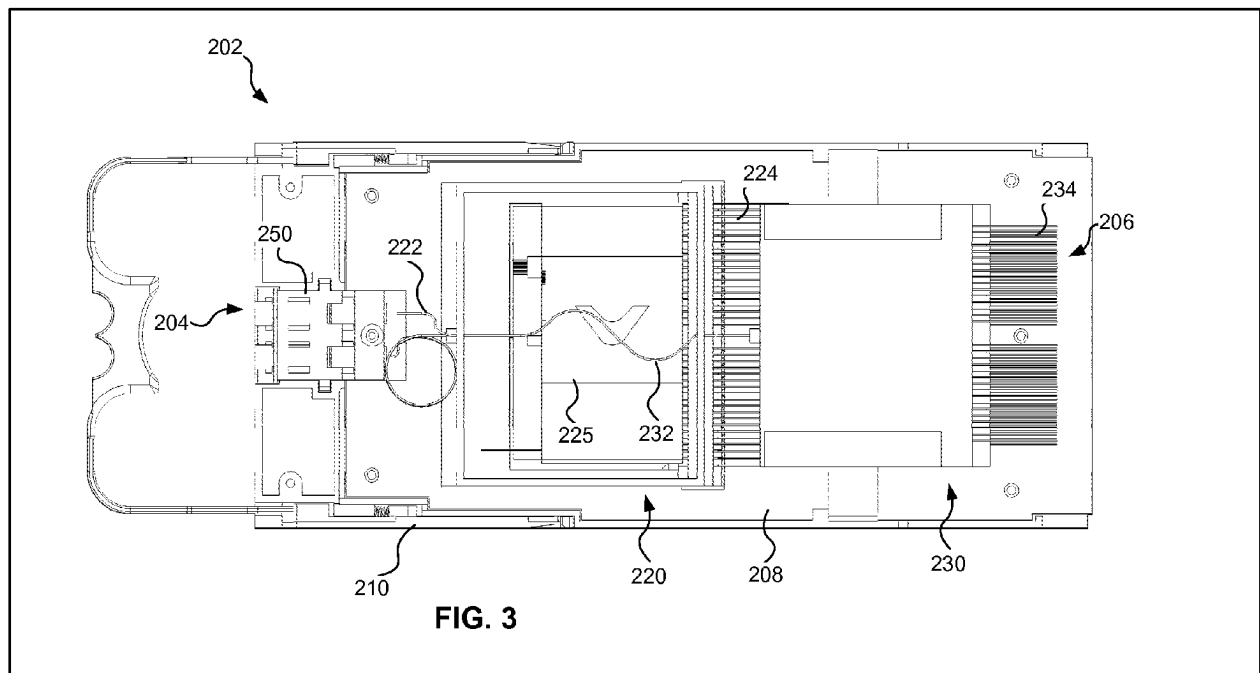
A POSITA would have reasonably expected success in combining the teachings of Ho, Takashi, and Sato because they each disclose similar and conventional transmitter components that could have been rearranged/reconfigured through minimal and routine optimization and experimentation. *Id.*, ¶96. The combination of Ho, Takashi, and Sato would have only required the routine and ordinary skills of a POSITA. *Id.* Indeed, the combination of Ho, Takashi, and Sato 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 1) improved optical coupling efficiency (between LDs and MPDs) in a transmitter module, and 2) increased bandwidth capacity and cost-efficiency of a fiber optic network by transmitting multiple data streams over a single fiber. *Id.*

**B. Independent Claim 15**

Ho in view of Takashi and Sato discloses, teaches, or suggests each and every limitation of claim 15. Ex. 1003, ¶97.

**1. Claim 15[pre] (“A multi-channel optical transceiver module comprising:”)**

Ho discloses a multi-channel optical transceiver module 202. Ex. 1006, 5:51-67, Figs. 2 and 3. “The transceiver module 202 includes a transceiver housing 210 containing the thermally isolated multi-channel TOSA 220, a multi-channel ROSA 230, and a dual fiber type direct link adapter 250 directly linked to the TOSA 220 and the ROSA 230 for providing the optical input and output.” *Id.*



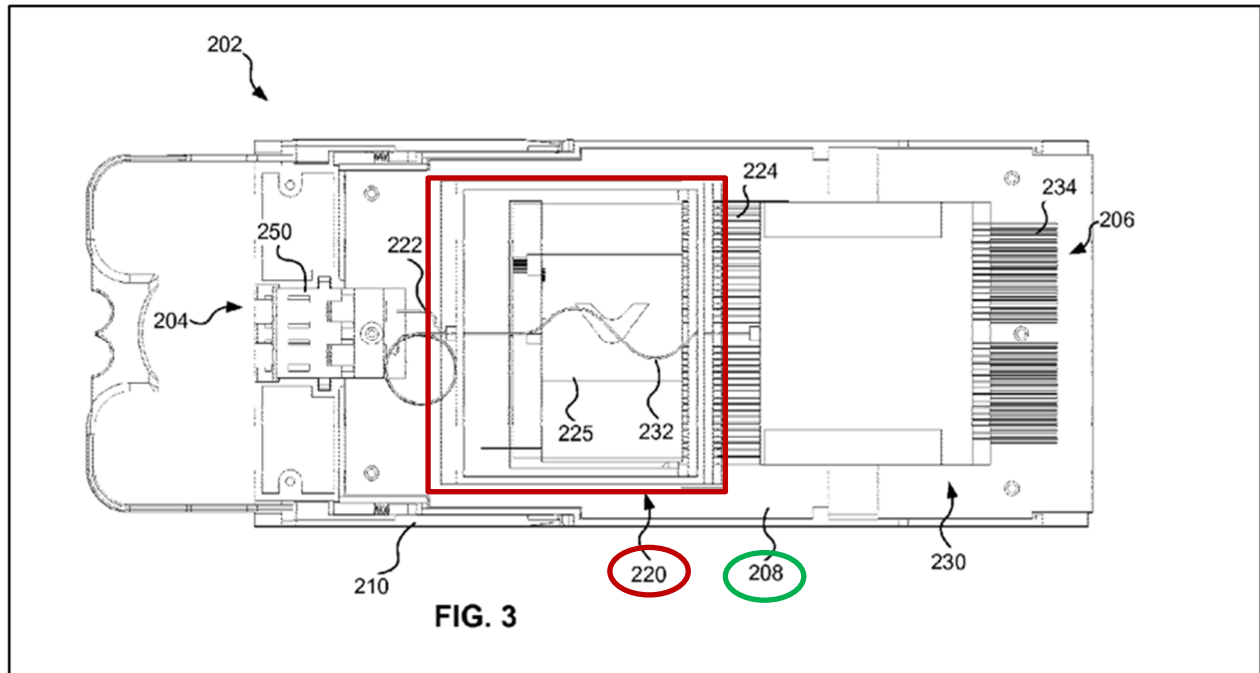
Ex. 1006, Fig. 3 (showing multi-channel optical transceiver module 202)

**2. Claim term 15[a] (“a printed circuit board assembly (PCBA)”)**

Ho’s optical transceiver module 202 includes “one or more printed circuit boards 208 coupled to the TOSA 220 and/or ROSA 230. The printed circuit board(s) 208 may include circuitry and electronic components such as laser drivers, transimpedance amplifiers (TIAS), and control interfaces.” Ex. 1006, 6:24-33, Figs. 2 and 3. A POSITA would have understood Ho’s printed circuit board(s) 208 that are coupled to TOSA 220 and/or ROSA 230 as a “printed circuit board assembly” (PCBA). *Id.*; Ex. 1003, ¶99.

**3. Claim term 15[b] (“a multi-channel transmitter optical subassembly (TOSA) arrangement coupled to the PCBA, the TOSA arrangement comprising:”)**

Ho’s PCBA 208 is coupled to a multi-channel TOSA 220. Ex. 1006, 6:24-33, Fig. 3. TOSA 220 is coupled to conductive leads 224 of PCBA 208 for “carrying the electronic signals including the data to be transmitted by the TOSA 220.” *Id.*



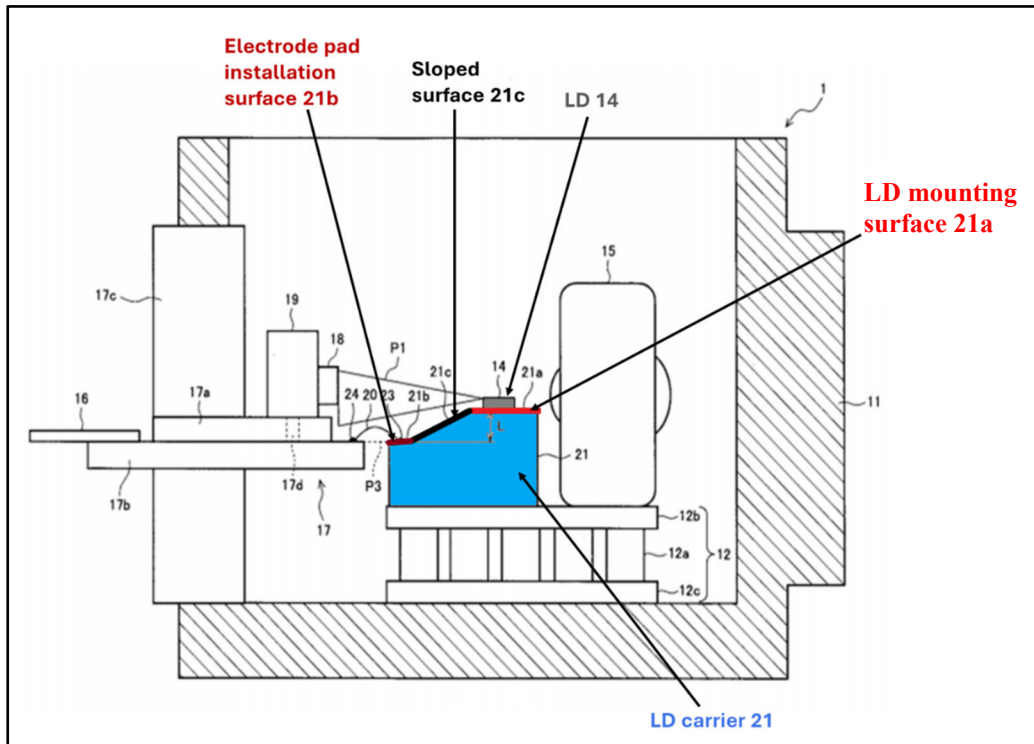
Ex. 1006, Fig. 3 (showing **TOSA 220** coupled to **PCBA 208**)

The multi-channel TOSA 220 includes “an array of lasers 226-1 to 226-n ... optically coupled to the AWG [multiplexer] 225. The lasers 226-1 to 226-n may be optically coupled to the AWG 225, for example, using low bending loss optical fibers (not shown). Each laser 226-1 may be provided as a laser package including, but not limited to, a laser diode chip mounted on a laser mounting structure. The laser package may also include optical components, such as a lens for optically coupling the laser light into a respective one of the optical fibers, and/or optoelectronic components, such as a monitor photodiode.” Ex. 1006, 6:45-58; *see also id.*, 2:28-31, 8:57-66 (discussing that the AWG is “configured to combine the laser light at different channel wavelengths”).

As discussed in Section IX.A, above, a POSITA would have been motivated to modify Ho's transceiver module 202 in view of Takashi's TOSA 1 to have a TOSA arrangement with a vertically-mounted MPD to improve optical coupling efficiency and shorten the length of the interconnect wire between the laser diodes and the conductive traces/leads providing driving signals to the laser diodes. Ex. 1003, ¶102. A POSITA would also have been motivated to have two or more laser diodes (and corresponding MPDs) and a multiplexer in Takashi's TOSA 1, as taught by Sato, for application in the WDM system taught by Ho. *Id.*

**4. Claim term 15[b1] (“a laser diode (LD) mounting surface”)**

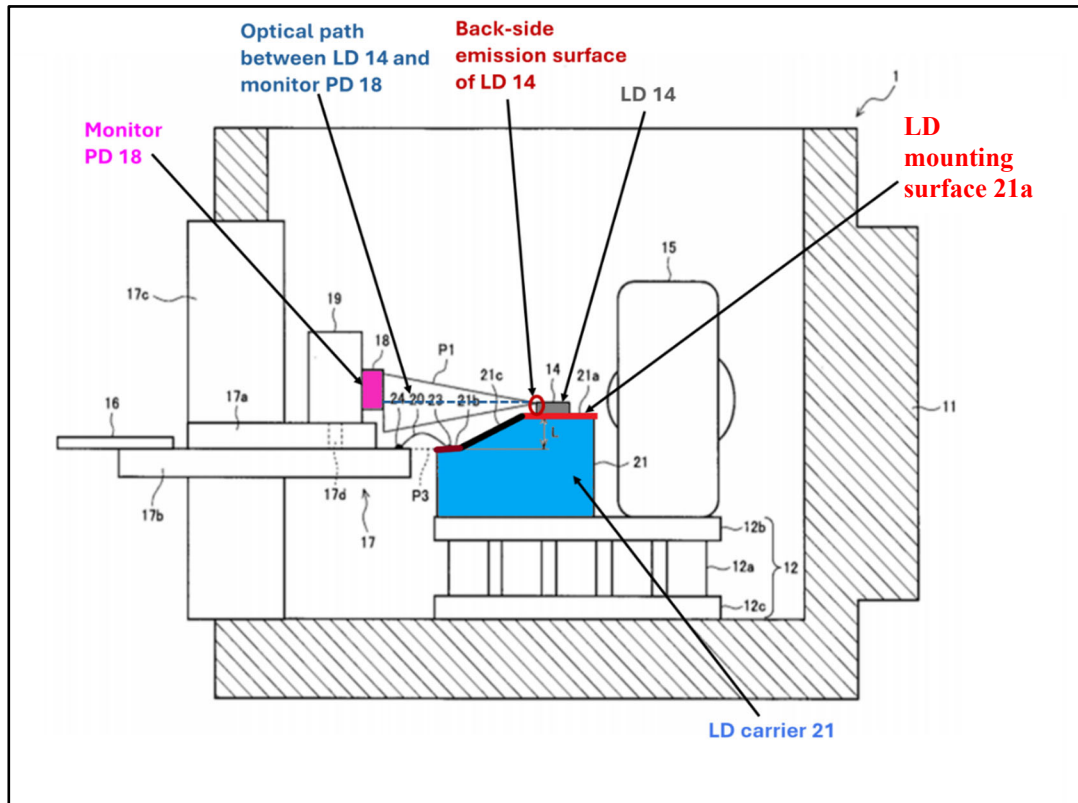
As discussed in Section VII.A.2, above, Takashi's TOSA module 1 includes an LD carrier member 21 having an LD mounting surface 21a on which LD 14 is mounted. Ex. 1004, ¶¶[0018], [0020], Fig. 1.



Ex. 1004, Fig. 1 (showing **LD mounting surface 21a** on which **LD 14** is mounted)  
(annotation added)

5. **Claim term 15[b2]** (“at least a first LD disposed on the LD mounting surface, the first LD having a back-side emission surface for emitting a portion of optical power along a first optical path”)

As discussed in Section VII.A.3, above, Takashi discloses an LD 14 disposed on the LD mounting surface 21a of LD carrier 21. Ex. 1004, ¶¶[0018], [0020], Fig. 1. LD 14 has a back-side emission surface for emitting a portion of optical power, i.e., “rear-emitting light P1,” along a first optical path that intersects with monitor PD 18. *Id.*, ¶¶[0015], [0019], [0020].



Ex. 1004, Fig. 1 (showing LD 14 disposed on **LD mounting surface 21a**, and LD 14 having a back-side emission surface that emits light P1 received by **monitor PD 18**) (annotation added)

As discussed with regard to claim 7 (Section VIII.G, above), it would have been obvious to a POSITA that when Takashi's TOSA 1 is used in a WDM system to transmit multiple optical signals (each at a different wavelength) over a single optical fiber, TOSA 1 would have included two or more LDs 14 to generate specific and distinct channel wavelengths and the channel wavelengths would have been multiplexed into a single output signal. Ex. 1003, ¶105. At the time of the effective filing date of the '890 patent, WDM systems were well known and common in

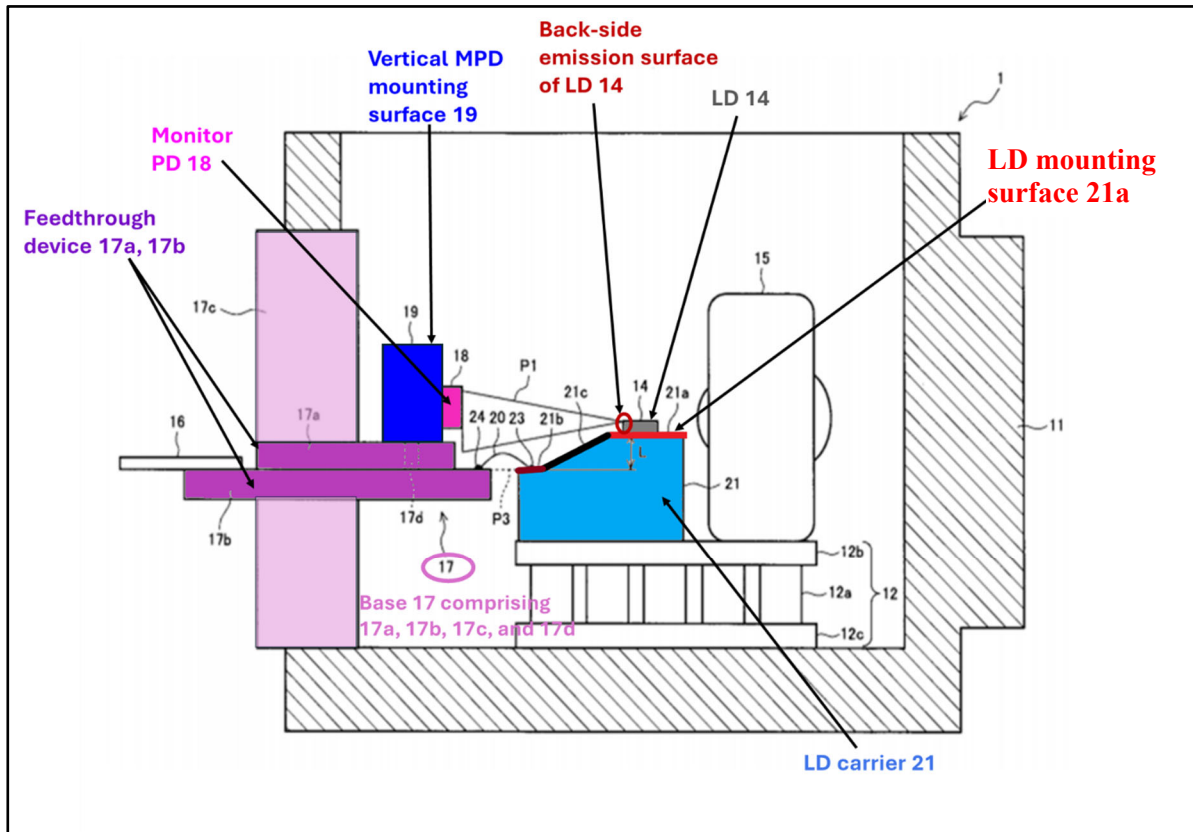
modern data center and telecommunication applications. *Id.* A TOSA for such WDM applications was conventionally designed with an array of laser diodes (and corresponding monitor PDs) and an optical multiplexer to combine the different wavelengths into a single optical fiber for transmission. *Id.* Sato, for example, explicitly discloses that its “transmitter module 1 includes four (4) LDs 11, where each emits an optical beam with a wavelength specific thereto and different from others, and the optical multiplexer 15 to multiplex[] respective optical beams.” Ex. 1005, 4:22-30. Sato additionally teaches four monitor PDs 14 corresponding to the four LDs 11. *Id.*, 3:45-52, 4:33-37.

It would have been obvious to a POSITA that Ho modified in view of Takashi and further in view of Sato would have included two or more LDs 14 disposed on the LD mounting surface 21a of Takashi, with each LD 14 being configured to emit a specific and distinct channel wavelength. Ex. 1005, 4:21-30, 6:8-12 (Sato disclosing two LDs 11 on a single LD submount 31); Ex. 1003, ¶106. It would also have been obvious to a POSITA that Ho modified in view of Takashi and further in view of Sato would have two or more monitor PDs (MPDs) 18 corresponding to the two or more LDs and that each MPD 18 would have been optically aligned with a LD 14 to receive back-side emission. *See* Section VII.A.5, above (discussing that Takashi’s MPD 18 is optically aligned with its LD 14 along an optical path that

extends from back-side emission surface of LD 14 and intersects with a light receiving region of MPD 18); Ex. 1003, ¶106.

**6. Claim term 15[b3] (“a base portion comprising a feedthrough device, the feedthrough device providing a vertical MPD mounting surface”)**

As discussed in Section VII.A.4, above, Takashi’s TOSA module 1 comprises a circuit board 17 (base portion) comprising, among other parts, a **feedthrough device** formed by ceramic blocks 17a and 17b. Ex. 1004, ¶[0019], Fig. 1. A POSITA would have readily understood ceramic substrates 17a, 17b as a “feedthrough device” because they comprise electrode pads and interconnect conductors that enable passage of signals into or out of package 11 of TOSA 1. Ex. 1003, ¶107. Additionally, feedthrough device 17a, 17b provides a vertical **PD carrier 19 (“vertical MPD mounting surface”)** for mounting monitor PD 18. Ex. 1004, ¶[0019], Fig 1.

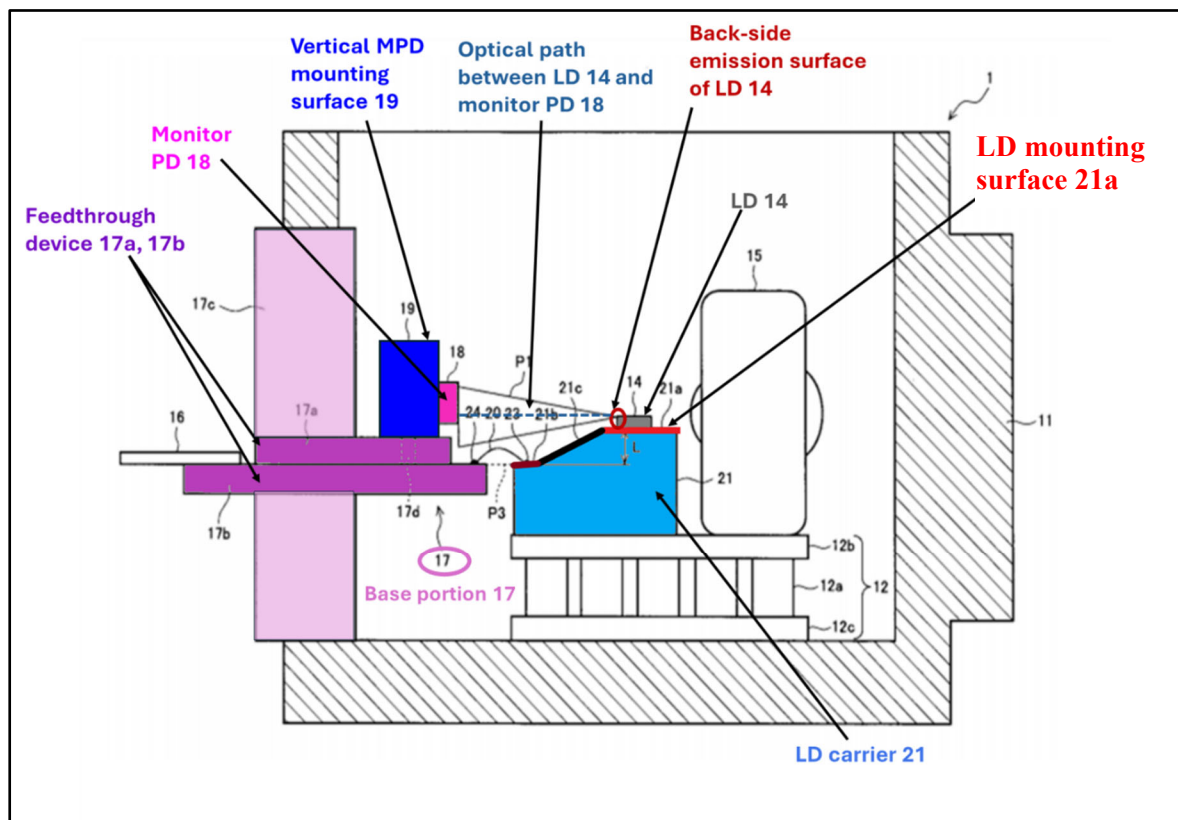


Ex. 1004, Fig. 1 (showing a **feedthrough device 17a, 17b** providing a **vertical MPD mounting surface 19**) (annotations added)

7. **Claim term 15[b4] (“a first MPD disposed on the vertical MPD mounting surface, the first MPD having a light receiving region optically aligned with the first LD via the first optical path based at least in part on the vertical MPD mounting surface extending substantially transverse relative to the LD mounting surface such that the first optical path intersects with the light receiving region of the first MPD”)**

As discussed in Section VII.A.5, above, Takashi discloses that a monitor PD (MPD) 18 is disposed on the vertical MPD mounting surface 19. Ex. 1004, ¶[0019], Fig 1. MPD 18 has a light receiving region that is optically aligned with LD 14, so

that the back-side emission from LD 14, i.e., the “rear-emitting light P1,” is received by MPD 18 along a first optical path that intersects with monitor PD 18. *Id.*, ¶¶[0015], [0019], [0020], Fig. 1. As shown in Figure 1, the vertical MPD mounting surface 19 extends substantially transverse relative to the LD mounting surface 21a so that the first optical path intersects with the light receiving region of MPD 18. *Id.*, Fig. 1

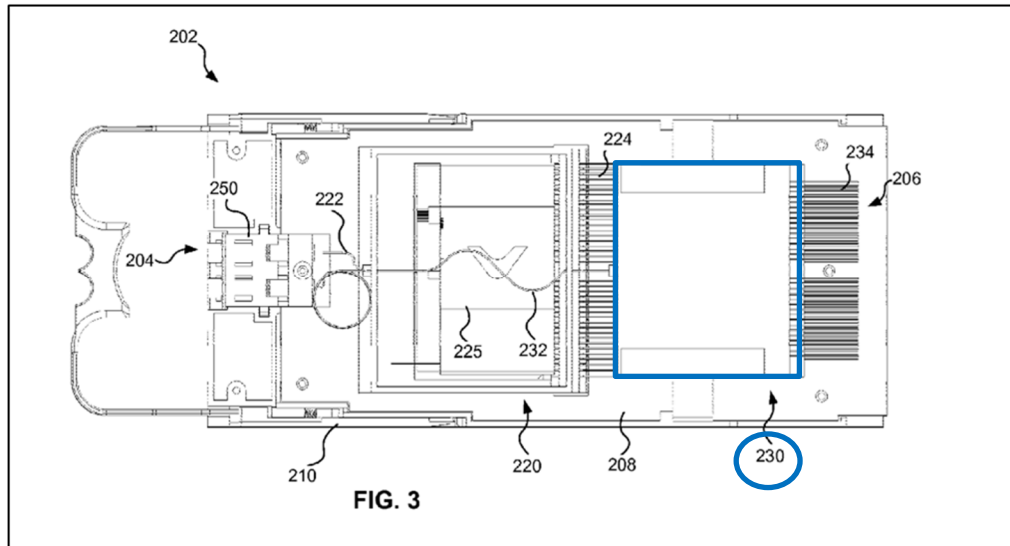


Ex. 1004, Fig. 1 (showing **MPD 18** disposed on **vertical MPD mounting surface 19**, which extends transverse to **LD mounting surface 21a**, such that MPD 18 is optically aligned with **LD 14** to receive back-side emission from LD 14 along an **optical path** between LD 14 and MPD 18) (annotations added)

It would further have been obvious to a POSITA that in Ho in view of Takashi and further in view of Sato, the two or more MPDs 18 would have been disposed on Takashi's vertical MPD mounting surface 19 so that each "LD14 rearward-emitted light P1 can be made directly incident on [the corresponding] monitor PD 18 without refraction, reflection, or focusing" and the rearward-emitted light P1 is "efficiently received" by the respective monitor PD 18. *Id.*, ¶¶[0009], [0020]; Ex. 1003, ¶109. Placement of the second MPD on the vertical MPD mounting surface 19 would also have been a matter of routine optimization and design choice by a POSITA to use space within the TOSA housing more efficiently, have fewer parts/components, and reduce the size/volume of the TOSA housing. *See* Ex. 1003, ¶88.

**8. Claim term 15[c] ("a multi-channel receiver optical subassembly arrangement.")**

Ho's optical transceiver module 202 includes a multi-channel ROSA 230. Ex. 1006, 5:62-67, Fig. 3; *see also id.*, 8:51-56 ("The multi-channel transceiver module further includes a multi-channel receiver optical subassembly (ROSA) located in the transceiver housing. The ROSA is configured to receive a wavelength division multiplexed (WDM) optical signal on multiple channel wavelengths.").



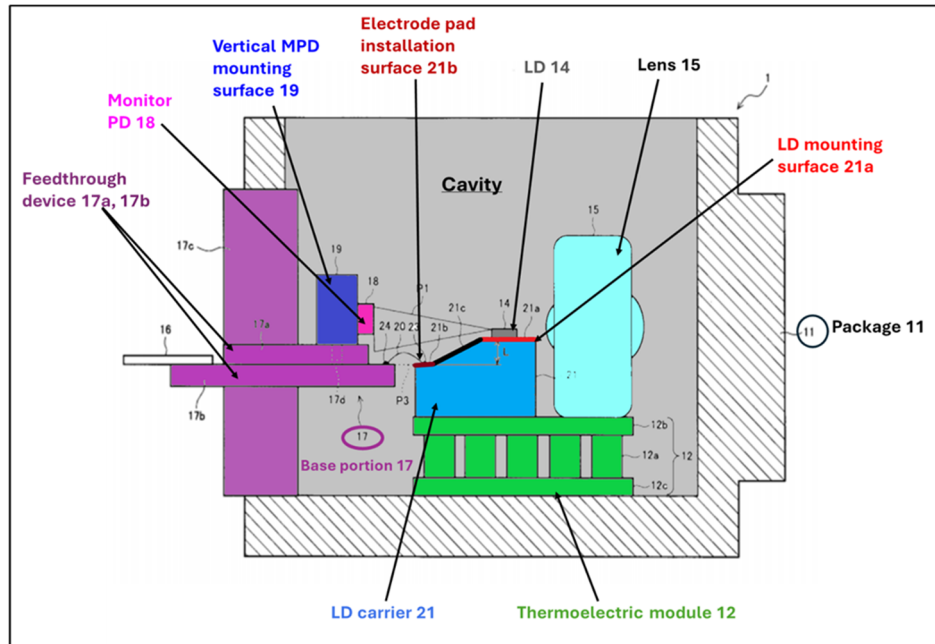
Ex. 1006, Fig. 3 (showing **ROSA 230** of optical transceiver module 202)

**C. Claim 16 (“The multi-channel optical transceiver of claim 15, wherein the TOSA arrangement further comprises:”)**

As discussed above, Ho in view of Takashi and further in view of Sato discloses each and every limitation of claim 15. Ho in view of Takashi and further in view of Sato also discloses the additional limitations of claim 16. Ex. 1003, ¶111.

**1. Claim term 16[a] (“a TOSA housing having a plurality of sidewalls that define a cavity, the LD mounting surface being disposed in the cavity”)**

Takashi's TOSA module 1 comprises a package 11 (TOSA housing) having a plurality of sidewalls, as shown in Figure 1, below. Ex. 1004, ¶¶[0018], [0019], Fig. 1. The sidewalls (shown by crosshatching in Figure 1) define a cavity within package 11 and the **LD mounting surface 21a** is disposed in the cavity. *Id.*, Fig. 1.

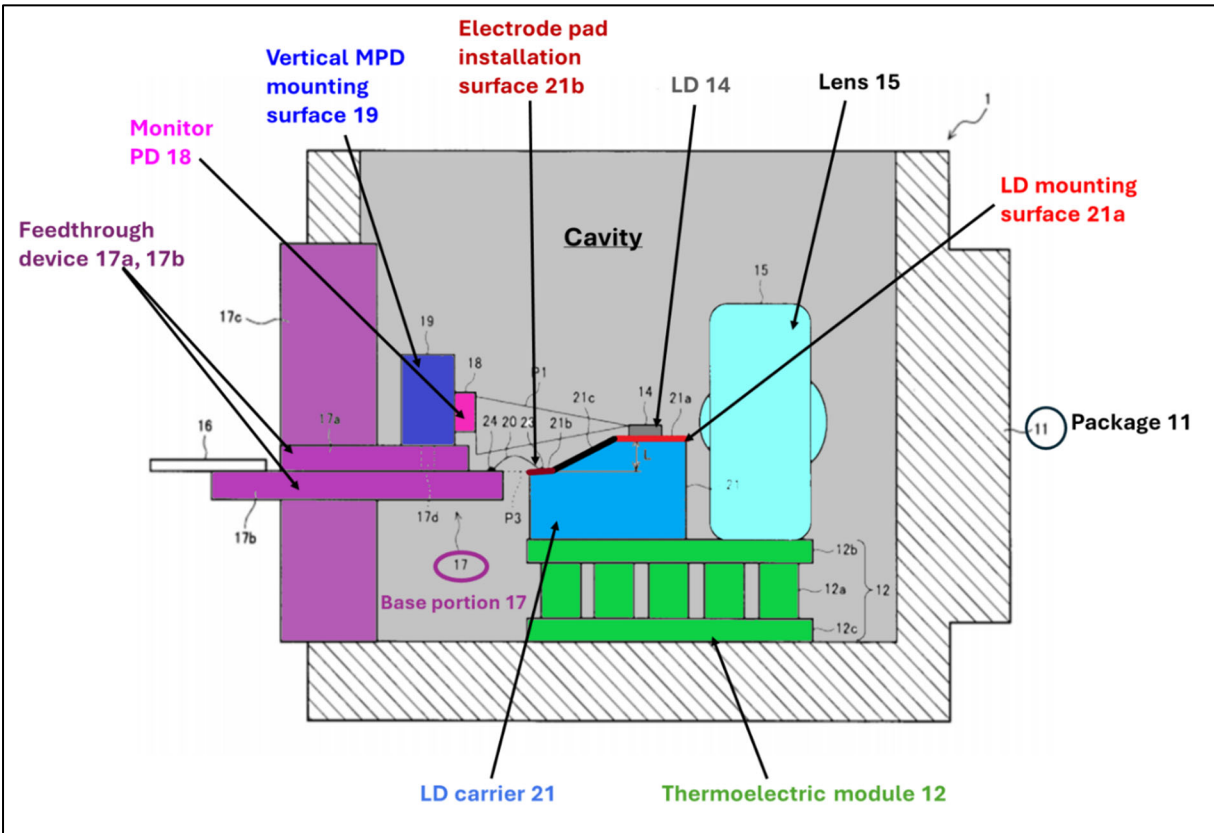


Ex. 1004, Fig. 1 (showing a cavity within package (TOSA housing) 11) (annotations added)

2. **Claim term 16[b]** (“wherein the feedthrough device is configured to at least partially be disposed in the cavity of the TOSA housing, and wherein a first end of the feedthrough device provides an electrical coupling region to electrically couple to an optical module substrate to receive a radio frequency (RF) driving signal to drive the first LD, and a second end of the feedthrough device defines the vertical MPD mounting surface, the vertical MPD mounting surface being disposed in the cavity of the TOSA housing.”)

As shown in Figure 1, annotated below, the feedthrough device 17a, 17b is disposed at least partially within the cavity of package 11 (TOSA housing). Ex. 1004, Figs. 1 and 2. A first end of the feedthrough device 17a, 17b includes an electrical coupling region that connects lead terminals 16a-16f to the ends of interconnect conductors 28a-28f formed on ceramic substrate 17b of the feedthrough

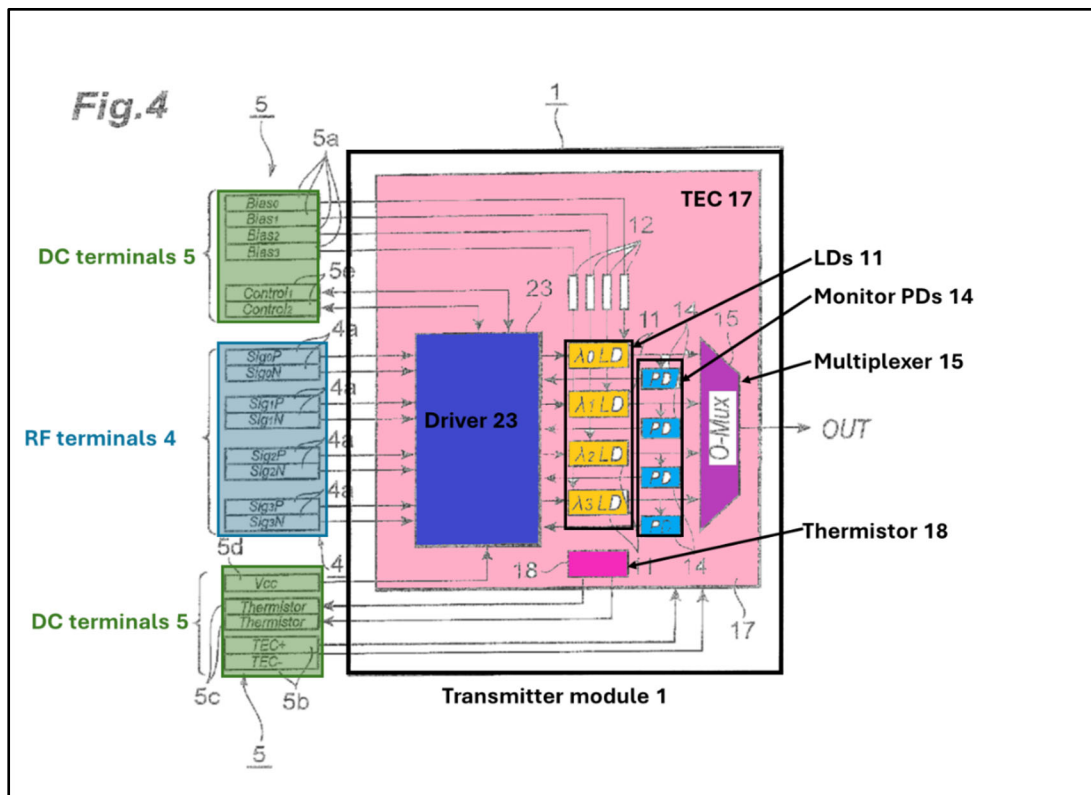
device. *Id.*, ¶¶[0019], [0028], Figs. 1 and 2. Additionally, a second end of feedthrough device 17a, 17b defines the vertical MPD mounting surface 19, which is also disposed in the cavity of package 11. *Id.*, Figs. 1 and 2.



Ex. 1004, Fig. 1 (showing **feedthrough device 17a, 17b** disposed at least partially within the cavity of package 11) (annotation added)

As discussed with regard to claim term 2[b] (Section VIII.B.2), a POSITA would have understood that LD lead terminals 16a and 16b electrically connect to an optical module substrate, such as a circuit board of the transceiver module, to receive a radio frequency (RF) driving signal and to provide the RF signal via interconnect conductors 28a, 28b to LD 14 to drive the LD. Ex. 1003, ¶114. Indeed,

it would have been obvious to a POSITA that LD lead terminals 16a, 16b and interconnect conductors 28a, 28b would provide RF transmit signals because laser diodes in high-speed communication transceivers typically use RF signals for driving the lasers. *Id.* Nevertheless, Sato explicitly discloses that its transmitter module 1 comprises a box-shaped housing 2 that has an electrical terminal 22 in the rear wall 2a, and electrical terminal 22 includes RF lead terminals 4 that provide high frequency (RF) signal to driver 23 to drive the LDs 11. Ex. 1005, 3:29-37, 5:29-33, 6:57-58, 7:4-14.



Ex. 1005, Fig. 4 (showing **transmitter module 1** having **RF terminals 4** that connect with **driver 23** to provide RF signals for driving **LDs 11**) (annotation added)

Sato further discloses that transmitter module 1 is installed within a transceiver, which would indicate to a POSITA that electrical terminal 22 of transmitter module 1 would electrically connect with an optical module substrate, such as a circuit board, of the transceiver to receive the RF transmit signal. *Id.*, 3:38-43, 4:16-20; Ex. 1003, ¶115. Indeed, Ho explicitly discloses that a transceiver module comprises a printed circuit board and that a transmitter module (TOSA) of the transceiver electrically connects with the board through conductive leads. Ex. 1006, 6:24-33 (discussing that transceiver module 202 includes one or more printed circuit boards 208 coupled to TOSA 220 and/or ROSA 230 via conductive leads 224 and 234, respectively), Fig. 3.

Accordingly, it would have been obvious to a POSITA that in Ho modified in view of Takashi and further in view of Sato, the LD lead terminals 16a,16b of Takashi connect to an optical module substrate, such as a circuit board 208 of Ho's transceiver, to receive high frequency (RF) drive signal to drive Takashi's LD 14. Ex. 1003, ¶116.

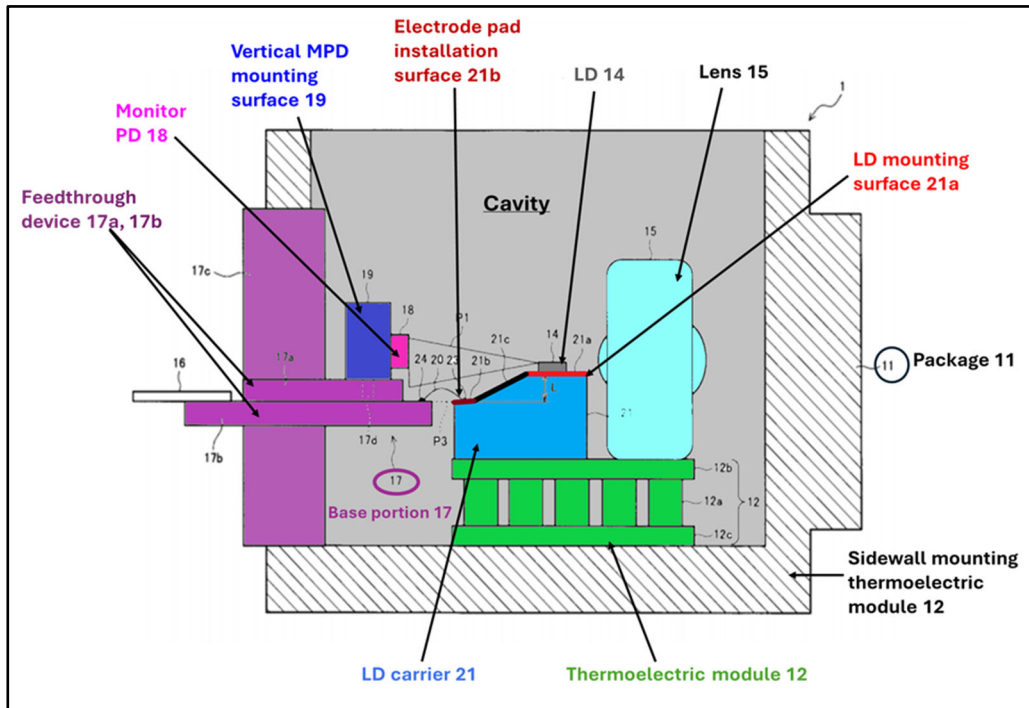
**D. Claim 17 (“The multi-channel optical transceiver of claim 16, wherein the cavity of the TOSA housing is hermetically sealed to prevent ingress of contaminants.”)**

As discussed with reference to claim 3 (Section VIII.C), Sato discloses that housing 2 of its transmitter module 1 is “air-tightly or hermetically sealed by welding the ceiling 7 as substituting inner atmosphere, namely air, with dry nitrogen after

those optical and electrical components are installed therein.” Ex. 1005, 3:53-56. It would have been obvious to a POSITA to hermetically seal package 11 (TOSA housing) of Takashi’s TOSA module 1, as taught by Sato, to protect the sensitive laser components inside the TOSA from moisture, dust, and other environmental contaminants, thereby ensuring long-term performance, stability, and reliability. Ex. 1003, ¶117.

**E. Claim 18 (“The multi-channel optical transceiver of claim 16, wherein at least one sidewall of the plurality of sidewalls of the housing provides a thermoelectric cooler (TEC) mounting section, and wherein the TOSA provides:”)**

As discussed with regard to claim 4 (Section VIII.D), Takashi’s TOSA module 1 comprises a package 11 (housing) having a plurality of sidewalls. Ex. 1004, Fig. 1. One of the sidewalls of package 11 provides a mounting section for mounting thermoelectric cooler (TEC) 12 thereon. *Id.*; *see also id.*, ¶¶[0005], [0030].



Ex. 1004, Fig. 1 (showing **thermoelectric module 12 (TEC)** mounted on a section of a sidewall of package 11) (annotation added)

**1. Claim term 18[a] (“a thermoelectric cooler (TEC) arrangement mounted to the TEC mounting section”)**

As discussed above, a thermoelectric cooler (TEC) 12 is mounted on the TEC mounting section of a sidewall of package 11. Ex. 1004, Fig. 1 (annotated above).

**2. Claim term 18[b] (“a LD submount disposed on the TEC arrangement, the LD submount being in thermal communication with the TEC arrangement, and wherein the LD submount provides the LD mounting surface.”)**

As shown in Figure 1, annotated above, LD carrier 21 (LD submount) is disposed on the TEC 12 arrangement. Ex. 1004, ¶[0018], Fig. 1. LD carrier 21 is in

thermal communication with TEC 12 to exhaust the heat generated by LD 14 through the TEC and package 11. *Id.*, ¶[0018].

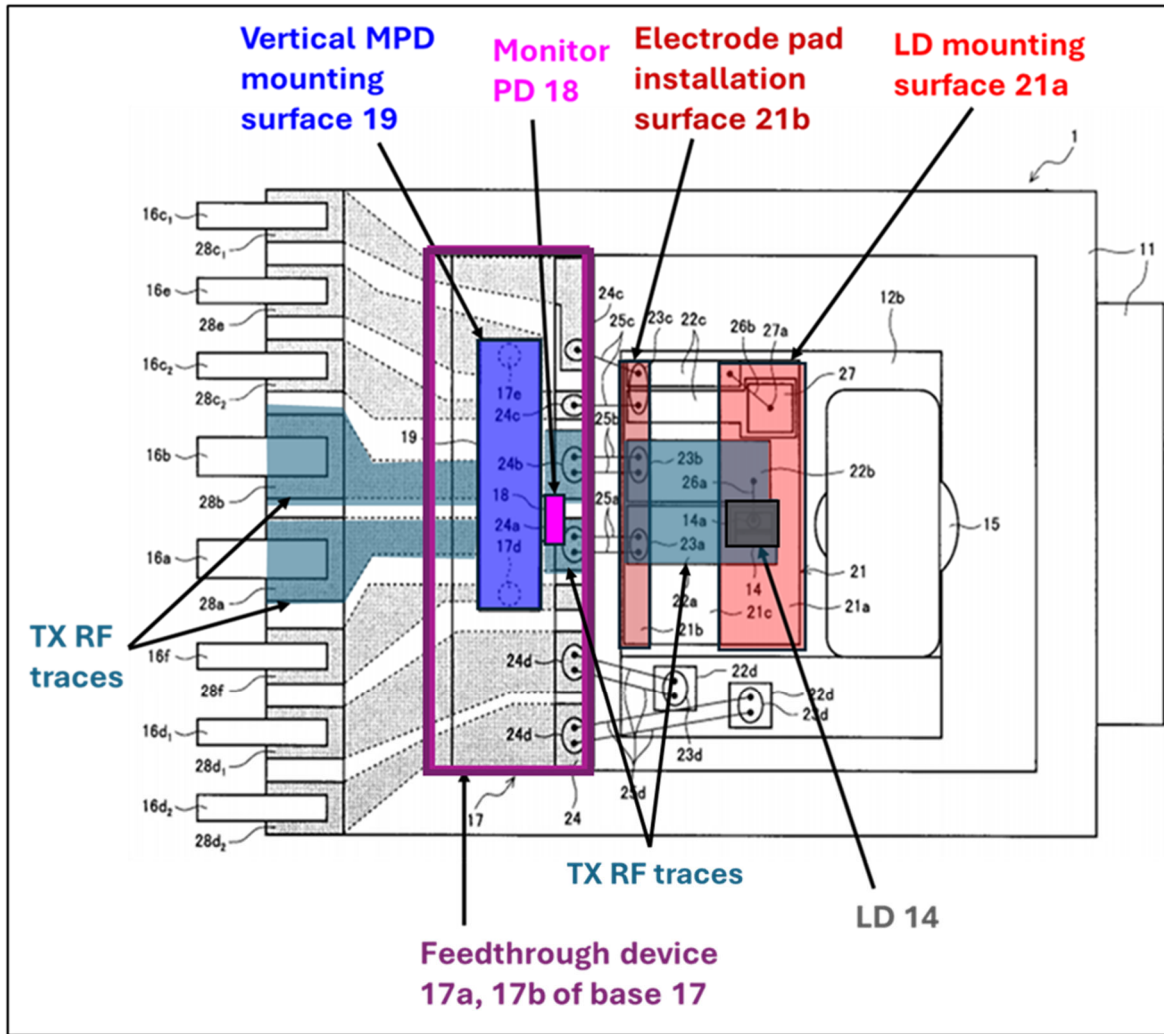
LD carrier 21 (LD submount) provides LD mounting surface 21a for mounting LD 14 thereon. *Id.*, Fig. 1, ¶[0018] (“LD14 is mounted on the LD carrier 21 mounting surface 21a”).

**F. Claim 19 (“The multi-channel optical transceiver of claim 15, further comprising a plurality of transmit (TX) radio frequency (RF) traces, the TX RF traces being disposed on a surface of the base portion that extends away from the vertical mounting surface along a direction that is substantially parallel with the LD mounting surface, and wherein the TX RF traces are disposed below the MPD when mounted to the vertical MPD mounting surface to allow the TX RF traces to extend towards the LD mounting surface.”)**

As disclosed with regard to claim 5 (Section VIII.E), Takashi discloses a plurality of conductive traces that electrically connect LD lead terminals 16a, 16b to LD electrode pads 24a, 24b provided at the end of feedthrough device 17a, 17b. Ex. 1004, ¶¶[0021], [0022], [0029], Figs. 1 and 2; Ex. 1003, ¶122. The LD electrode pads 24a, 24b are connected to electrode pads 23a, 23b provided on the mounting surface 21b of LD carrier 21 through interconnect wires 25a, 25b, and the electrode pads 23a, 23b then connect through interconnect conductors (conductive traces) 22a, 22b with LD 14. Ex. 1004, ¶¶[0021], [0022], [0029], Figs. 1 and 2; Ex. 1003, ¶122.

As discussed above with regard to claim term 16[b] (Section X.C.2), it would have been obvious to a POSITA based on Sato that Takashi’s LD lead terminals 16a,

16b electrically connect to an optical module substrate, such as a circuit board of the transceiver module, to receive a radio frequency (RF) transmit signal (TX RF) and to provide the TX RF signal via conductive traces and interconnect wires 25a, 25b, to LD 14. *See* Ex. 1006, 6:24-33; Ex. 1003, ¶123. That is, it would have been obvious to a POSITA that the conductive traces that electrically connect LD lead terminals 16a, 16b to the LD electrode pads 24a, 24b as well as the interconnect conductors (traces) 22a, 22b that connect electrode pads 23a, 23b to LD 14 are radio frequency (RF) traces that deliver transmit signal (TX RF) to LD 14. Ex. 1003, ¶123.



Ex. 1004, Fig. 2 (showing **TX RF traces** being disposed on a surface of the feedthrough device of **base 17** that extends away from the **vertical MPD mounting surface 19** along a direction that is substantially parallel with the **LD mounting surface 21a**) (annotations added)

As shown in Figure 2 of Takashi, annotated above, the TX RF traces are disposed on a surface of base 17, specifically on the surface of feedthrough device 17a, 17b of the base. As further shown in annotated Figure 2, above, the TX RF

traces extend away from the vertical MPD mounting surface 19 along a direction that is substantially parallel with LD mounting surface 21a. Ex. 1003, ¶124; *see also* Ex. 1004, Fig. 1 (showing that feedthrough device 17a, 17b extends substantially parallel to LD mounting surface 21a). Figure 2 of Takashi also shows that the TX RF traces are disposed below the monitor PD 18 (MPD 18) when mounted to the vertical MPD mounting surface 19 to allow the TX RF traces to extend towards the LD mounting surface 21a. Ex. 1004, Figs. 1 and 2; Ex. 1003, ¶124.

## **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 '890 patent is involved in the following:

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

### **C. Lead and Back-Up Counsel**

| <b>Lead Counsel</b>                                                                                                   | <b>Back-Up Counsel</b>                                                                                    |
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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 '890 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 1-9 and 15-19 of the '890 patent should be canceled.

Dated: November 25, 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 12,863 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 Petitioner

**CERTIFICATE OF SERVICE**

Pursuant to 37 C.F.R. §§ 42.6(e) and 42.105(a), the undersigned certifies that on November 25, 2025, a copy of the foregoing Petition for *Inter Partes* Review, the associated power of attorney, and Exhibits 1001-1009 were served by FedEx Priority Overnight on the correspondence address of record indicated in the Patent Office's website for U.S. Patent No. 10,714,890:

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: November 25, 2025

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