

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

ACCELIGHT TECHNOLOGIES, INC.,
Petitioner,

v.

APPLIED OPTOELECTRONICS, INC.
Patent Owner.

IPR2025-01567
U.S. Patent No. 10,379,301

**PETITION FOR *INTER PARTES* REVIEW
OF U.S. PATENT 10,379,301**

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TABLE OF EXHIBITS

Exhibit	Description
1001	U.S. Patent No. 10,379,301 to Ho et al. (“the ’301 patent”)
1002	Prosecution History of the ’301 patent
1003	Declaration of Dr. Michael Lebby
1004	U.S. Patent Publication No. 2014/0169389 to Kim et al., published June 19, 2014
1005	U.S. Patent Publication No. 2014/0341578 to Ho et al., published Nov. 20, 2014
1006	U.S. Patent Publication No. 2014/0183344 to Lee et al., published July 3, 2014
1007	U.S. Patent No. 10,042,116 to Ho et al., issued August 7, 2018

I. INTRODUCTION

Petitioner Accelight Technologies, Inc. (“Accelight” or “Petitioner”) requests *inter partes* review of U.S. Patent No. 10,379,301 (“the ’301 patent”) based on prior art that was not considered by the patent examiner during prosecution of the ’301 patent. Nor was the prior art reviewed by the Patent Trial and Appeal Board (PTAB) for an *inter partes* review petition filed by an unrelated petitioner, Cambridge Industries USA Inc., in IPR2025-00434. The prior art and grounds presented here clearly show that the challenged claims of the ’301 patent (claims 1-4) are unpatentable and should not have been granted. Yet, Patent Owner Applied Optoelectronics, Inc. (“AOI” or “Patent Owner”) has asserted the ’301 patent against multiple defendants in district court to monetize the patent—years after it was issued—by alleging infringement by defendants’ products that have been in the U.S. market for almost as long as the life of the patent, and pressing for quick settlements before the cases reach any significant milestone in district court and before *inter partes* review petition(s) are filed.¹

¹ The undersigned counsel is representing Petitioner against Patent Owner’s claims in district court in case no. 4:24-cv-09041-HSG (N.D. Cal.). Same counsel is also

More specifically, the challenged claims of the '301 patent recite devices and techniques that were well known and standard practices in the field of optical transceivers before the effective filing date of the '301 patent. For example, the challenged claims recite an optical receiving device, such as a receiver optical sub-assembly (ROSA), having an arrayed waveguide grating (AWG) demultiplexer, which was well known and routinely used in optoelectronic devices long before the effective filing date of the '301 patent. Ex. 1003, ¶45. Indeed, Patent Owner's own prior filing, U.S. 2014/0341578 (Ex. 1005), discloses all these elements. *Id.*, ¶58. The only claimed technique that may be considered comparatively newer is the use of an angled surface of the AWG to directly couple demultiplexed output signals with respective photodiodes through reflection instead of using waveguides or fibers. *See* Ex. 1001, 5:7-19 (claim 1). But even this direct coupling technique was known before the effective filing date of the '301 patent, as demonstrated by analogous prior art references Kim (Ex. 1004) and Lee (Ex. 1005) that are in the

representing another defendant Eoptolink Technology USA Inc. against Patent Owner in case no. 5:24-cv-08165-NW (N.D. Cal.), and previously represented Molex, LLC against Patent Owner in case no. 4:23-cv-04787-JST (N.D. Cal.), which has now been dismissed.

same field of optical transceivers, and each discloses the claimed direct coupling technique. Ex. 1003, ¶¶45, 54, 61-62.

Importantly, Patent Owner AOI has claimed the **direct coupling technique** between AWG demultiplexers and photodetectors in multiple different patents, such as the '301 patent, U.S. 10,042,116, and U.S. 9,509,433. *Id.*, ¶¶46, 59; Ex. 1001, Abstract, 3:34-4:20; Ex. 1007, Title, Abstract. 7:60-66. In fact, U.S. Patent Publication No. 2014/0341578 (“Ho,” Ex. 1005), which issued as Patent Owner’s ’433 patent, is a §102(a) prior art against both the '301 patent challenged here and Patent Owner’s ’116 patent. Ex. 1005, ¶¶[0042], [0043], claim 1 (7:10-13). By filing for and obtaining multiple patents on substantially the same invention—without claiming priority or properly disclosing the relationship between the subject matters of the patents to the Patent Office—Patent Owner has improperly extended the patent term for its alleged “direct coupling” invention. Patent Owner’s attempts to game the patent system through unjustified extension of its patent term should not be allowed. The challenged claims should be found unpatentable.

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

A. Prior Art References and Grounds

Claims 1-4 are challenged based on the following prior art references. Some other references are discussed throughout the Petition to demonstrate the relevant state of the art and established techniques in the field of optical transceivers.

Prior Art	
Ex. 1004	U.S. Patent Publication No. 2014/0169389 to Kim et al., filed July 12, 2013 and published June 19, 2014 (“Kim”); prior art under 35 U.S.C. § 102(a)(1).
Ex. 1005	U.S. Patent Publication No. 2014/0341578 to Ho et al., filed November 25, 2013 and published November 20, 2014 (“Ho”); prior art under 35 U.S.C. § 102(a)(1).
Ex. 1006	U.S. Patent Publication No. 2014/0183344 to Lee et al., filed Aug. 22, 2013 and published July 3, 2014 (“Lee”); prior art under 35 U.S.C. § 102(a)(1).

The presented prior art grounds are:

Ground	Claims	Basis Under 35 U.S.C. § 103
1	1-4	Rendered obvious by Kim
2	1-4	Rendered obvious by Ho in view of Lee

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

If the Board institutes an IPR based on this Petition (and does not subsequently vacate or withdraw institution), Petitioner will not pursue in the parallel district court litigation (case no. 4:24-cv-09041-HSG (N.D. Cal.)), (i) the specific grounds raised in this Petition, (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

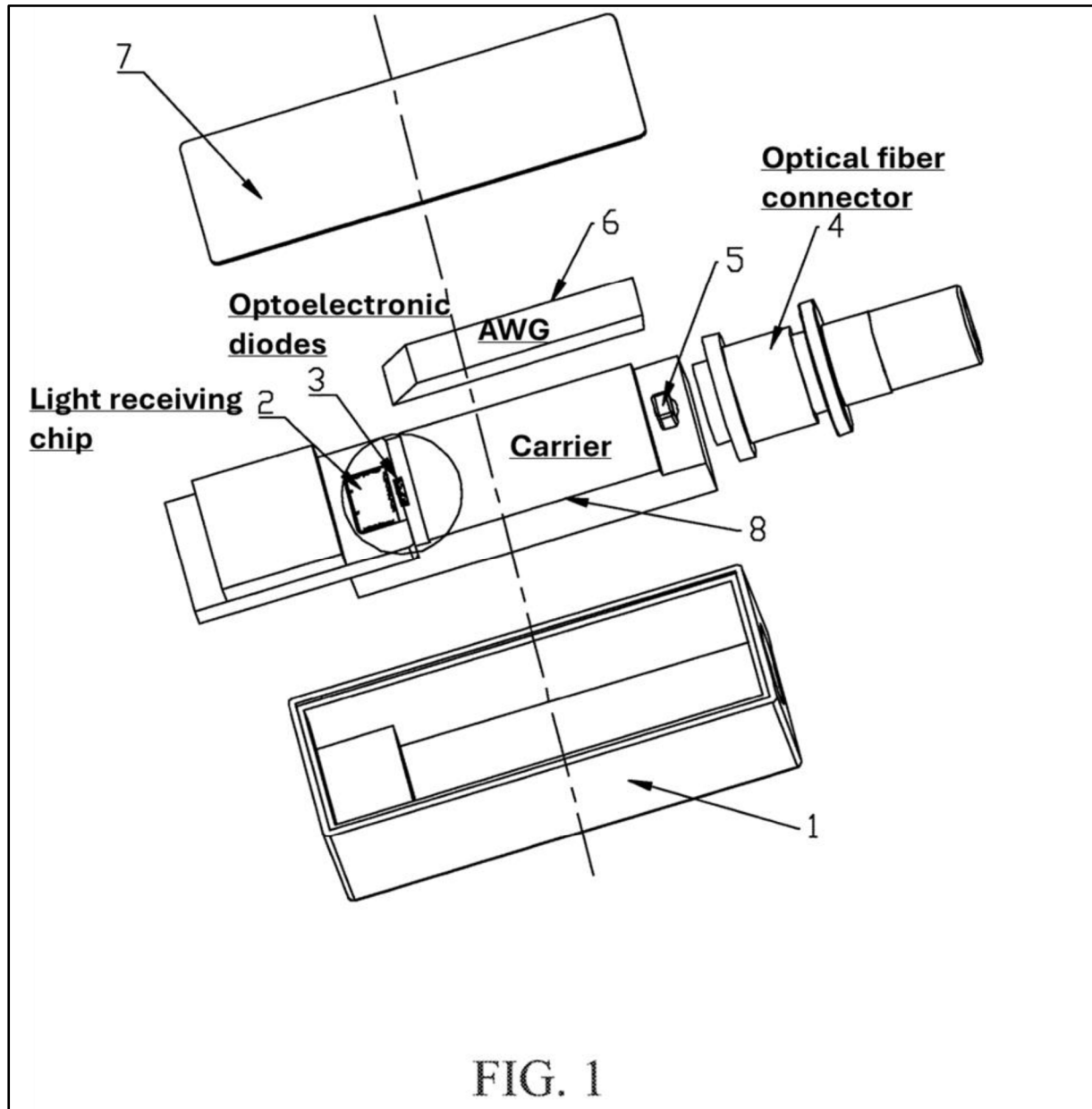
ground based on a combination of system prior art and the prior art references asserted in this Petition (identified in Section II.A, above).

III. TECHNICAL BACKGROUND OF THE '301 PATENT

A. The '301 Patent

The '301 patent describes a multi-channel parallel optical receiving device (e.g., a ROSA) having an AWG (arrayed waveguide grating) demultiplexer structure. Ex. 1001, Title, Abstract, 1:6-8, 1:37-54, 3:12-17. The optical receiving device of the '301 patent comprises, among other things, a carrier, a light receiving chip, an AWG disposed on the top surface of the carrier, and a plurality of optoelectronic diodes. *Id.*, Abstract, 1:37-54.

Specifically, the disclosed optical receiving device includes a carrier 8 disposed in the bottom shell 1 of the optical receiving device, as shown in Figure 1 (below). A plurality of optoelectronic diodes 3 and a light receiving chip 2 (such as a transimpedance amplifier (TIA) chip) are disposed on one end of carrier 8, and the diodes 3 are electrically connected to light receiving chip 2 through bonding wires. *Id.*, 2:66-3:17. An AWG 6 is also disposed on carrier 8 and an input end 61 of AWG 6 is connected to optical fiber connector 4 to receive optical signals. *Id.* The AWG divides (demultiplexes) the received optical signal into multiple signals in parallel based on wavelength. *Id.*

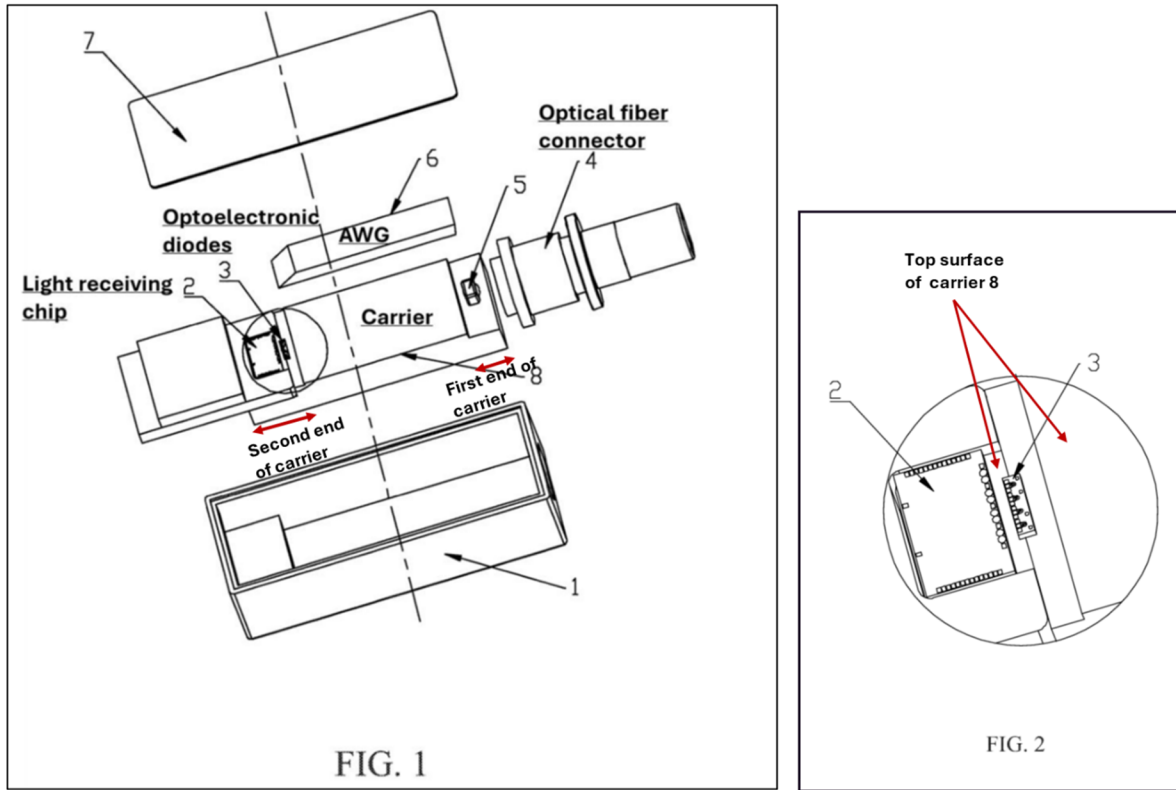


Ex. 1001, Fig. 1 (annotations added); Ex. 1003, ¶42

Regarding placement of components on carrier 8, the '301 patent states that “[a] plurality of **optoelectronic diodes 3** may be disposed on a top surface of an **end of the carrier 8**, and the plurality of optoelectronic diodes 3 may be electrically connected to the light receiving chip 2. ... An **optical fiber connector 4** may be

disposed at another end of the carrier 8, and an arrayed waveguide grating 6 may be further disposed on the top surface of the carrier 8.” *Id.*, 3:1-12 (emphases added). Based on this disclosure, a POSITA would have understood that the positioning of light receiving chip 2, optoelectronic diodes 3, and AWG 6 on carrier 8 is as shown in annotated Figures 1 and 2, below. Ex. 1003, ¶43.

As further discussed below in Section III.B, below, during prosecution of the '301 patent, the patent examiner stated, and Patent Owner acquiesced, that the top surface of carrier 8 has “three distinct surfaces, to include (1) a top surface of an end of the carrier (e.g. left side [of] Fig. 1, where Chip 2 and O/E 3 are located), (2) a top surface in the middle of the carrier (central, middle where AWG [is] located), and (3) a top surface of the another end of the carrier (e.g., right side of Fig. 1, where Lens 5 [is] located).” Ex. 1002, 253-54 (emphases and quotation marks omitted). Thus, the patent examiner found that one end of the carrier is the “left side [of] Fig. 1,” where light receiving chip 2 and optoelectronic diodes 3 are located, and the other end of the carrier is the “right side of Fig. 1,” where lens 5 is located. *Id.* This is exactly how the first end and the second end of carrier 8 are annotated in Figure 1, below.



Ex. 1001, Fig. 1 (showing optical fiber connector 4 disposed at a first end of carrier 8, light receiving chip 2 and optoelectronic diodes 3 disposed on a second end of carrier 8, and AWG 6 disposed on the mid-section of carrier 8); Fig. 2 (showing the top surface of carrier 8 on which light receiving chip 2, optoelectronic diodes 3, and AWG 6 are mounted); Ex. 1003, ¶43

The '301 patent further discloses that the top surface 63 of the output end 62 of AWG 6 is at a predetermined angle, so that demultiplexed optical signals may be reflected by top surface 63 to the array of optoelectronic diodes 3. *Id.*, 3:12-17, 3:55-60. This design allows direct optical coupling between the AWG and the diodes without requiring optical fibers or waveguides and simplifies the manufacturing

process of the disclosed optical receiving device. *Id.*, 3:60-4:11. The '301 patent identifies the predetermined angle as 41 to 46 degrees, but does not specify the reference sides/surfaces of the AWG that define the predetermined angle. *Id.*, 4:15-17. For the purposes of this Petition, Petitioner and its expert (Dr. Michael Lebby) are assuming, based on Patent Owner's infringement contentions in the parallel district court litigation, that the "predetermined angle" is the interior angle between the top surface 63 and the base of AWG 6 facing carrier 8. Ex. 1003, ¶44.

But as discussed below, optical transceivers with ROSAs, AWG demultiplexers, and direct optical coupling of demultiplexed outputs to photodiodes using an angled/inclined surface, were each well known before the effective filing date of the '301 patent. Ex. 1003, ¶45.

B. Prosecution History of the '301 Patent

U.S. Patent Application No. 15/432,242, which issued as the '301 patent, was filed on February 14, 2017 and claims priority to Chinese patent application CN 1 03460078, filed May 23, 2016. Ex. 1001, cover page. The Patent Office issued a Non-Final Office Action dated August 29, 2017, rejecting claims 1-4 and 6 as anticipated by U.S. Patent Application Publication No. 2017/0168252 to Pezeshki et al. ("Pezeshki") and as obvious over U.S. Patent Application Publication No. 2016/0349451 to Shen et al. ("Shen") in view of Pezeshki. Ex. 1002, pp. 64-77. Claims 5 and 7 were rejected as obvious over Pezeshki and in view of U.S. Patent

Application Publication No. 2003/0174964 to Gao et al. (“Gao”). *Id.* In a Reply filed February 28, 2018, Patent Owner amended claim 1 to recite that the optoelectronic diodes, light receiving chip, and a substantial portion of the arrayed waveguide grating (AWG) are disposed on the top surface of the carrier, and that a predetermined angle of a top surface defined by the output end of the arrayed waveguide grating is in a range of 41 to 46 degrees. *Id.*, p. 87. The Patent Office then issued a Final Office Action dated April 13, 2018, rejecting the claims as indefinite as to what constituted a “substantial portion” of the AWG. *Id.*, pp. 136-159. Application claims 1-3, 5 and 8 were also rejected as anticipated by U.S. Patent Application Publication No. 2017/0307819 to Ho et al. *Id.* In addition, claims 1-3 and 6 were rejected as anticipated by U.S. Patent No. 9,341,786 to Gamache et al. (“Gamache”), claims 5 and 8 were rejected as obvious over Gamache in view of U.S. Patent No. 7,162,124 to Gunn, III et al. (“Gunn”), and claim 7 was rejected as obvious over Gamache in view of Gao. *Id.* The Final Office Action also repeated the rejection of claims 1-3 and 6 as obvious over Shen in view of Pezeshki; claims 5 and 8 as obvious over Shen in view of Pezeshki and further in view of Gunn; and claim 7 as obvious over Shen in view of Pezeshki and further in view of Gao. *Id.*

Patent Owner then filed a Reply on July 13, 2018, further amending the claims to recite, among other things, that the AWG has “a first end, a middle, and a second end disposed opposite the first end” and that “the top surface of the carrier underlies

the middle of” the AWG. *Id.*, 173-176. But the amendments were not entered until a Request for Continued Examination was filed on August 13, 2018. *Id.*, 188-192. On September 13, 2018, the Patent Office issued another Non-Final Office Action, repeating the obviousness rejections set forth in the prior Final Office Action based on Shen, Pezeshki, Gunn, Gamache, and Gao, and rejecting Patent Owner’s arguments as not persuasive. *Id.*, 199-217. Patent Owner filed a Reply on December 13, 2018, arguing that the claim amendments filed on August 13, 2018, adequately distinguished over the prior art. *Id.*, 227-242. In particular, Patent Owner argued that in amended claim 1, the optoelectronic diodes and the light receiving chip are disposed “directly” on the “same surface,” whereas in Shen those components are located on different surfaces. *Id.* Patent Owner disagreed with the Examiner’s contention that a POSITA would have been motivated to place both components of Shen on the “same surface,” arguing that the alleged invention simplified manufacture by reducing the length of wire bonds connecting the diodes to the light receiving chip. *Id.* The Patent Office then issue a Non-Final Office Action on January 28, 2019, again rejecting all pending claims under Section 112. *Id.*, 251-258. The Examiner noted that “a/the ‘top surface of the carrier’” needed more specificity because “this top surface is in three distinct surfaces, to include (1) a top surface of an end of the carrier (e.g. left side Fig. 1, where Chip 2 and O/E 3 are located), (2) a top surface in the middle of the carrier (central, middle where AWG

located), and (3) a top surface of the another end of the carrier (e.g., right side Fig. 1, where Lens 5 located).” *Id.*, 253-54 (emphases and quotation marks omitted). Patent Owner then filed another amendment on April 29, 2019, further amending the claims to clarify on which portions/sections of the “top surface” the various components are disposed. *Id.*, pp. 318-320. A Notice of Allowance issued on May 13, 2019, including a Notice of Allowability stating that “Applicant has made the specific corrections to clearly identify the three distinct ‘top surface’ portions of the carrier element (reference #8 in Fig. 1)[.]” *Id.*, 325-329. The Notice of Allowability further stated: “The Examiner is unable to make a *prima facie* case for obviousness for such combination, most particularly in which the ‘light receiving chip’ (2) and the ‘optoelectronic diodes’ (3) are disposed *directly* on the same surface of the end of the carrier (left end/side in Fig. 1 *same* surface).” *Id.* (emphases in original). The ’301 patent issued on August 13, 2019. Ex. 1001, cover page.

But as discussed below, several prior art references disclosed the amended claim limitations that resulted in the issuance of the ’301 patent, but the Examiner did not find or apply those prior art. For example, both Kim (Ex. 1004) and Ho (Ex. 1005) show a light receiving chip and optoelectronic diodes positioned on the same top surface of one end of the carrier.

IV. LEVEL OF ORDINARY SKILL

At the effective filing date of the '301 patent, a person of ordinary skill in the art ("POSITA") would have had (1) a bachelor's degree in electrical or electronics 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). Only the term "carrier" recited in claims 1 and 2 would benefit from claim construction to resolve the controversy in this forum.

A. "carrier"

The term "carrier" in claims 1 and 2 of the '301 patent should be construed to mean "the supporting structure that is contained within the multichannel parallel optical receiving device." Ex. 1003, ¶48.

In the parallel district court litigation, Patent Owner has argued that "carrier" should be given its plain and ordinary meaning, or in the alternative as "supporting structure." But "carrier" has a plain English meaning as a transporter, mover, or shipper, which is not applicable to the subject matter of the '301 patent. *Id.*, ¶49. In the context of the '301 patent, the claim term "carrier" has a specialized technical

meaning that is different from its plain and ordinary meaning, and therefore the term should be construed based on the disclosure and claims of the '301 patent. *Id.*

Patent Owner's alternative construction of "carrier" as simply a "supporting structure" is also incorrect. Patent Owner is seeking this construction in order to present the circuit board on which the optical receiving device is mounted as the claimed "carrier" for alleged infringement mapping on Petitioner's products. But a POSITA would understand this to be incorrect based on the disclosure of the '301 patent. *Id.*, ¶¶50, 51. As shown in Figure 1 of the '301 patent, the optical receiving device disclosed in the '301 patent includes a bottom shell 1 and a top cap 7, which together define a space within which carrier 8 and other components of the optical receiving device are placed. Ex. 1001, 3:23-26. Carrier 8 serves as a supporting structure on which a plurality of optoelectronics diodes 3, a light receiving chip 2, and an arrayed waveguide grating (AWG) 6 are mounted. *Id.*, 2:66-3:14, 4:2-5. Accordingly, a POSITA would understand "carrier" to mean a supporting structure that is contained within the optical receiving device and on which various components are mounted. Ex. 1002, ¶50. Simply put, a POSITA would understand "carrier" to be a structure that is part of the optical receiving device, and not as a base or support on which the optical receiving device itself is mounted. *Id.*

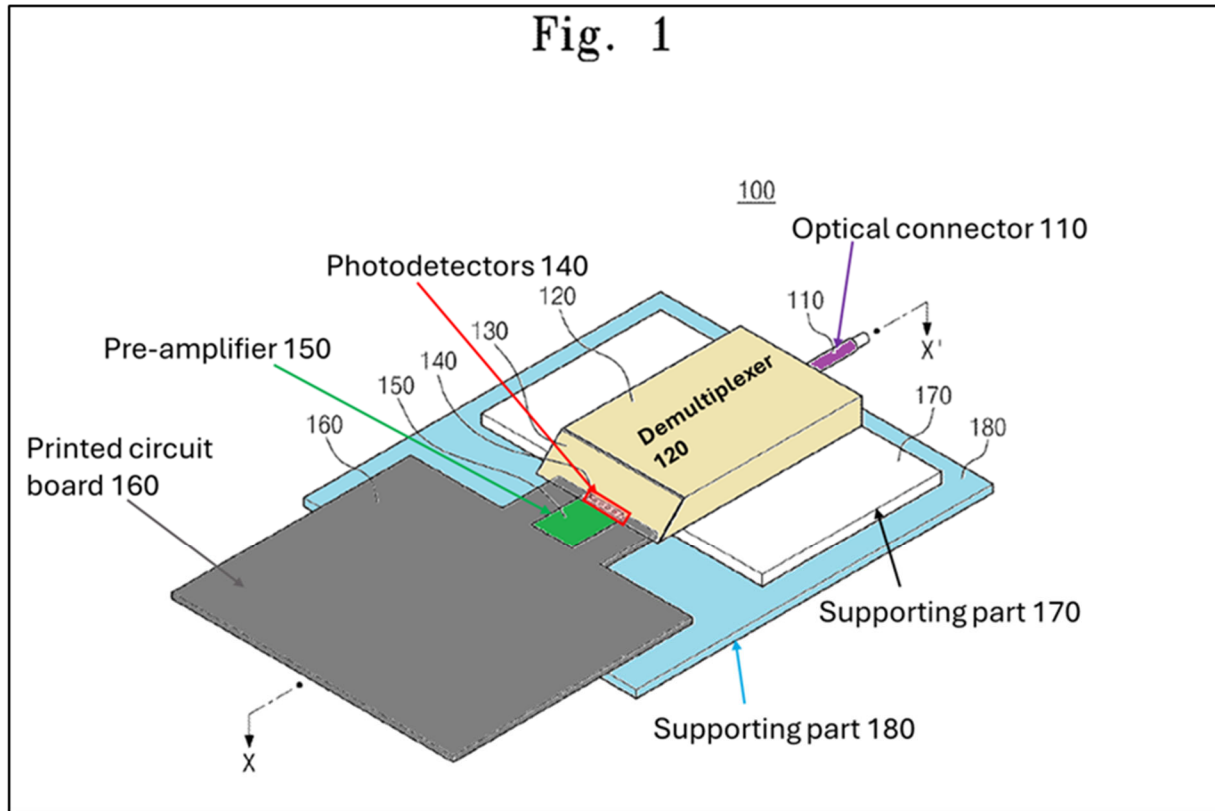
The claims of the '301 patent fully support this meaning of "carrier" in the context of the '301 patent. Claim 1 explicitly recites that the multi-channel parallel

optical receiving device comprises a “carrier,” which indicates to a POSITA that the “carrier” is contained within the optical receiving device. *Id.*, ¶51. The term “carrier” should be construed accordingly to mean “the supporting structure that is contained within the multi-channel parallel optical receiving device.” *Id.*

VI. [GROUND 1] CLAIMS 1-4 ARE RENDERED OBVIOUS BY KIM

A. Kim (Ex. 1004)

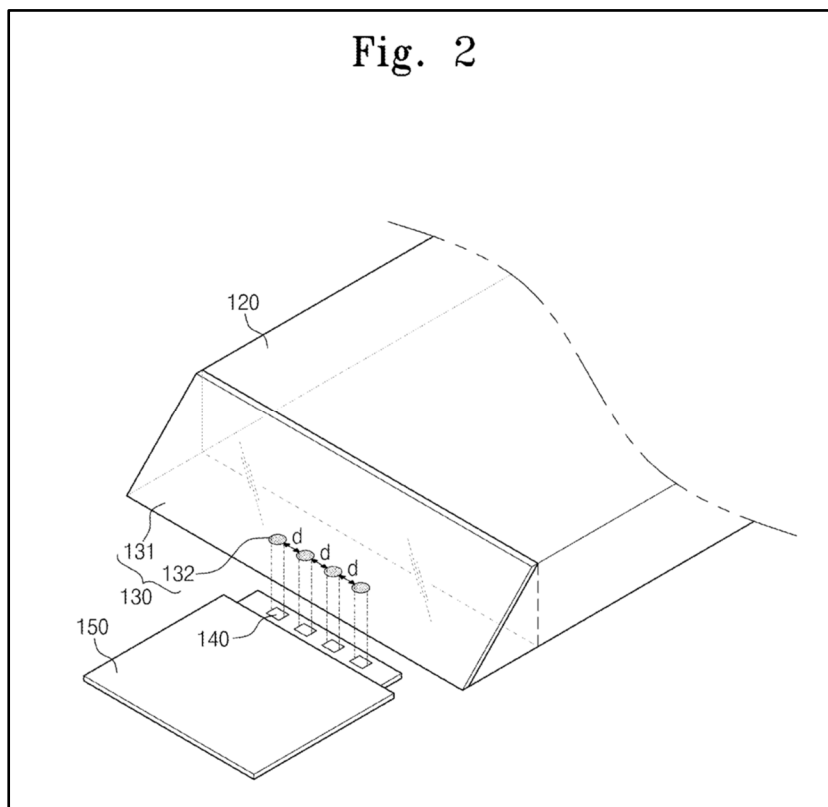
Kim discloses an optical receiver module 100 comprising, among other things, an **optical connector 110**, a **demultiplexer 120** having an integrated optical device 130, a **photodetector array 140**, a **pre-amplifier 150**, supporting part 170, and **supporting part 180**, as shown in Figure 1 (below). Ex. 1004, ¶[0022], Fig. 1; *see also id.*, Abstract, ¶¶[0009], [0025] (discussing that optical device 130 and demultiplexer 120 may have a “united structure”).



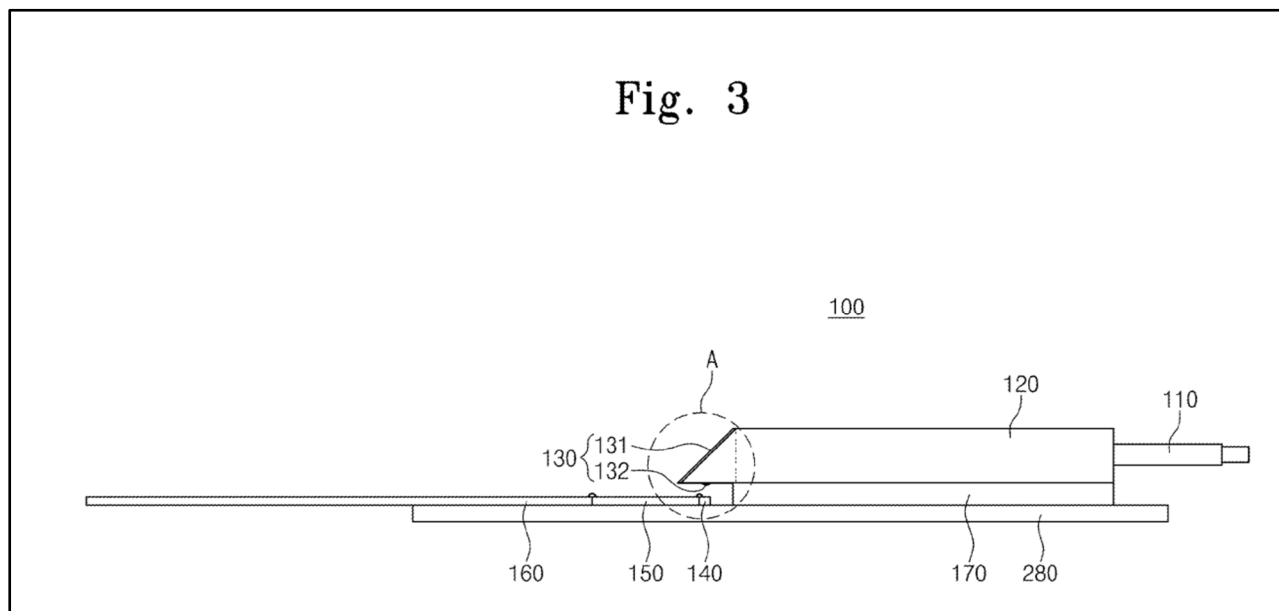
Ex. 1004, Fig. 1 (annotations added)

Optical receiver module 100 “uses a wavelength division multiplexing (WDM) technique which employs multiple light wavelengths to transmit signals of various channels through a single optical fiber.” *Id.*, ¶[0022]. Optical connector 110 receives a multi-channel optical signal through a single optical fiber and transmits the input signal to demultiplexer 120. *Id.*, ¶[0023]. Demultiplexer 120, which may have an AWG structure, divides the multi-channel input optical signal into separate optical signals corresponding to each channel, and transmits each channel to optical device 130. *Id.*, ¶¶[0024], [0040]. As shown in Figure 1 above, optical device 130 and demultiplexer 120 may be combined with each other to constitute a unitary

structure. *Id.*, ¶¶[0025], [0042]. Optical device 130 includes a single mirror 131 and N lenses 132 (where N represents that number of input channels). *Id.*, ¶¶[0032], [0033]. An end portion of optical device 130 may be cut at an angle of 45 degrees and the cut surface may then be polished. *Id.*, ¶[0034]. A silica-based material may be coated on the outer side of the cut surface to form mirror 131. *Id.* “The mirror 131 reflects the optical signal transmitted in a horizontal direction through the demultiplexer 120, and the reflected optical signal is transmitted in a vertical direction to the lenses 132.” *Id.*, ¶¶[0034], [0041], Fig. 4. Each optical signal (corresponding to a channel wavelength) passes through one of the lenses 132 and is optically coupled with a corresponding photodetector 140, which converts the received optical signal into an electrical signal and transmits the electrical signal to a pre-amplifier 150, which then transmits the amplified signal to a printed circuit board 160 for external transmission. *Id.*, ¶¶[0029], [0030], [0041], [0042], Figs. 2 and 3 (reproduced below).



Ex. 1004, Fig. 2



Id., Fig. 3

B. Kim Renders Claims 1-4 Obvious

1. Independent claim 1

Kim discloses, teaches, or suggests each and every limitation of claim 1.

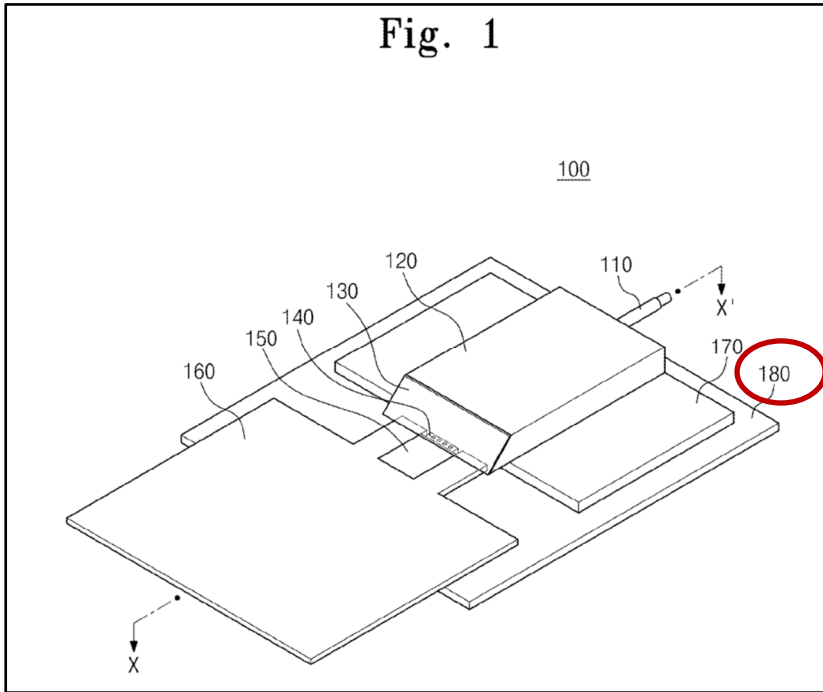
a. 1[preamble] (“A multi-channel parallel optical receiving device”)

Kim discloses “an optical receiver module 100 [which] includes an optical connector 110, a demultiplexer 120, an optical device 130, a photodetector 140, a pre-amplifier 150, a printed circuit board 160, a first supporting part 170, and a second supporting part 180.” Ex. 1004, ¶[0022]. Kim also discloses that demultiplexer 120 may be an AWG demultiplexer. *Id.*, ¶¶[0022]-[0024]. Kim additionally discloses that optical receiver module 100 receives an optical signal that may be “4-channel input optical signals which have four wavelengths different from each other, respectively.” *Id.* “The demultiplexer 120 **divides the 4-channel optical signal into optical signals corresponding to channels**, respectively.” *Id.* (emphasis added). Each optical signal (corresponding to a channel wavelength) is optically coupled with a corresponding photodetector 140, which converts the received optical signal into an electrical signal and transmits the electrical signal to a pre-amplifier 150. *Id.*, ¶¶[0028], [0029], [0030], [0041], Figs. 1, 2, and 3. “Additionally, **4 photodetectors 140 are provided for the 4-channel input optical signals**. The 4 photodetectors 140 may be fabricated in an array form.” *Id.*, ¶[0028] (emphasis added), Fig. 3. Based on Kim’s disclosures of 4-channel input optical signals that

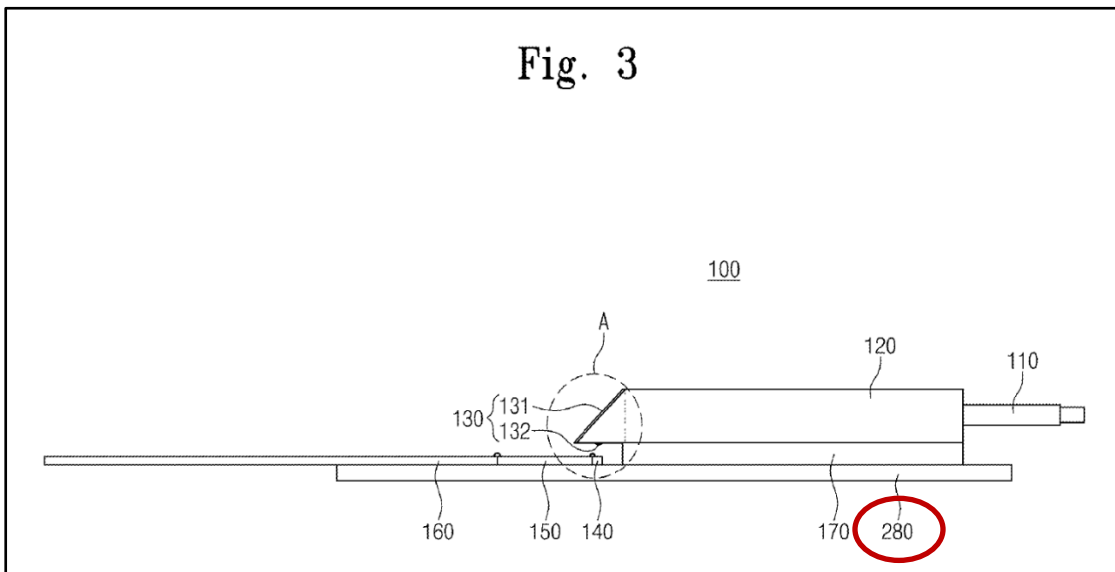
are demultiplexed by AWG 120 into optical signals corresponding to each channel, and four photodetectors 140 corresponding to the four demultiplexed channels, a POSITA would have understood Kim's optical receiver module 100 to be a multi-channel parallel optical receiving device. Ex. 1003, ¶65.

b. Claim term 1[a] (“a carrier”)

The optical receiver module 100 of Kim includes a supporting part 180/280, i.e., a “carrier,” on which AWG demultiplexer 120, photodetectors 140, pre-amplifier 150, and printed circuit board 160 are mounted. Ex. 1004, Figs. 1 and 3, ¶[0031] (“The second supporting part 180 may be disposed at the lowermost part of the optical receiver module 100 to entirely support the optical receiver module 100.”), ¶[0045] (referring to the second supporting part as 280). Carrier 180/280 is a supporting structure that is contained within and is part of optical receiver module 100. Ex. 1003, ¶66.



Ex. 1004, Fig. 1 (showing supporting part (carrier) 180)



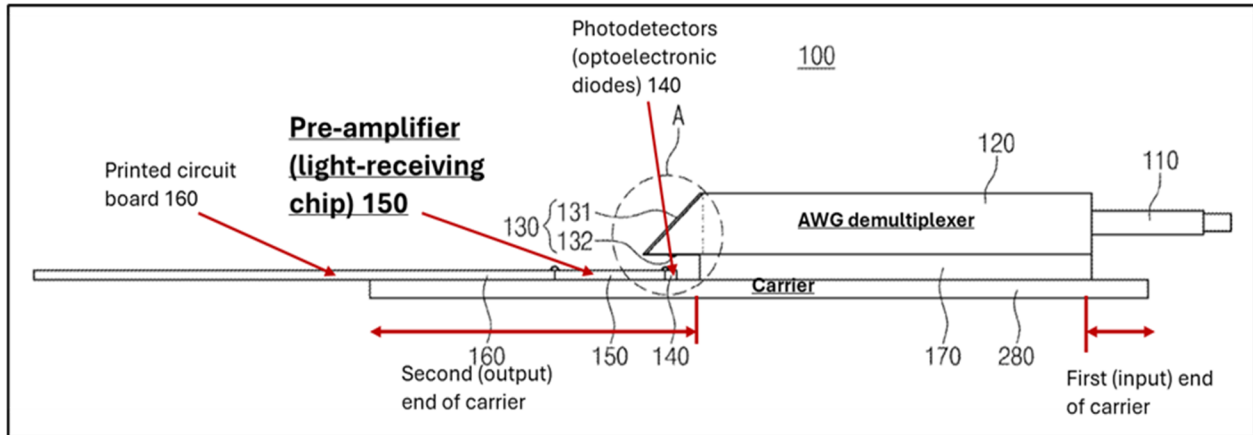
Id., Fig. 1 (showing supporting part (carrier) 280)

c. Claim term 1[b] (“a light receiving chip disposed on a top surface of an end of the carrier”)

The optical receiver module 100 of Kim includes a light receiving chip (pre-amplifier 150) disposed on a top surface of an end of carrier 180/280. Ex. 1004, Fig. 3. A POSITA would have understood Kim’s pre-amplifier 150 to be a “light receiving chip”; indeed, the ’301 patent similarly describes its “trans-impedance amplifier (TIA) chip” as a light receiving chip. Ex. 1001, 3:1-9; Ex. 1003, ¶67.

As discussed in Section III.A, above, in the context of the ’301 patent, the second (output) end of carrier 8 is the portion having optoelectronic diodes 3 and light receiving chip 2. Similarly, in the context of Kim’s disclosure, it would have been obvious to the POSITA that the portion of carrier 180/280 that is outside supporting part 170 (on which AWG 120 is mounted) and that supports pre-amplifier 150 and photodetectors 140 is the second (output) end of carrier 180/280. Ex. 1003, ¶68. Moreover, adjusting the size and shape of the carrier and positioning of components thereon are well within the routine and ordinary skills of a POSITA. *Id.* As such, it would have been obvious to a POSITA based on Kim’s disclosure that pre-amplifier 150 and photodetectors 140, which receive the demultiplexed (output) signals from AWG 120, would have been positioned towards an end region of carrier 180/280, so that the electrical signals from the photodetectors and the pre-amplifier

are easily transmitted (with minimal losses) to the transmission circuitry at the periphery of the optical receiver module. *Id.*

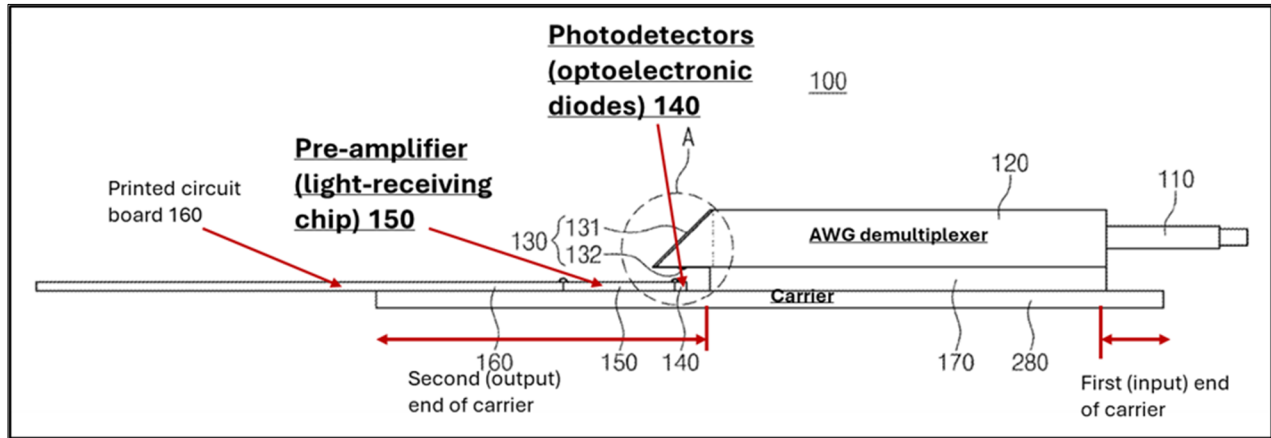


Ex. 1004, Fig. 3 (showing light receiving chip 150 on one end of carrier 280) (annotations added)

- d. **Claim term 1[c] (“a plurality of optoelectronic diodes disposed on the top surface of the end of the carrier, and the plurality of optoelectronic diodes electrically connected to the light receiving chip via bonding wire, wherein the optoelectronic diodes and the light receiving chip are disposed directly on the same top surface of the end of the carrier”)**

The optical receiver module 100 of Kim includes a plurality of photodetectors 140 on the top surface of the second (output) end of carrier 180/280, with the plurality of photodetectors 140 electrically connected to the pre-amplifier (light receiving chip) 150 via bonding wires. Ex. 1004, Figs. 1-4; Ex. 1003, ¶70. Moreover, as shown in Figure 3, photodetectors (optoelectronic diodes) 140 and pre-amplifier

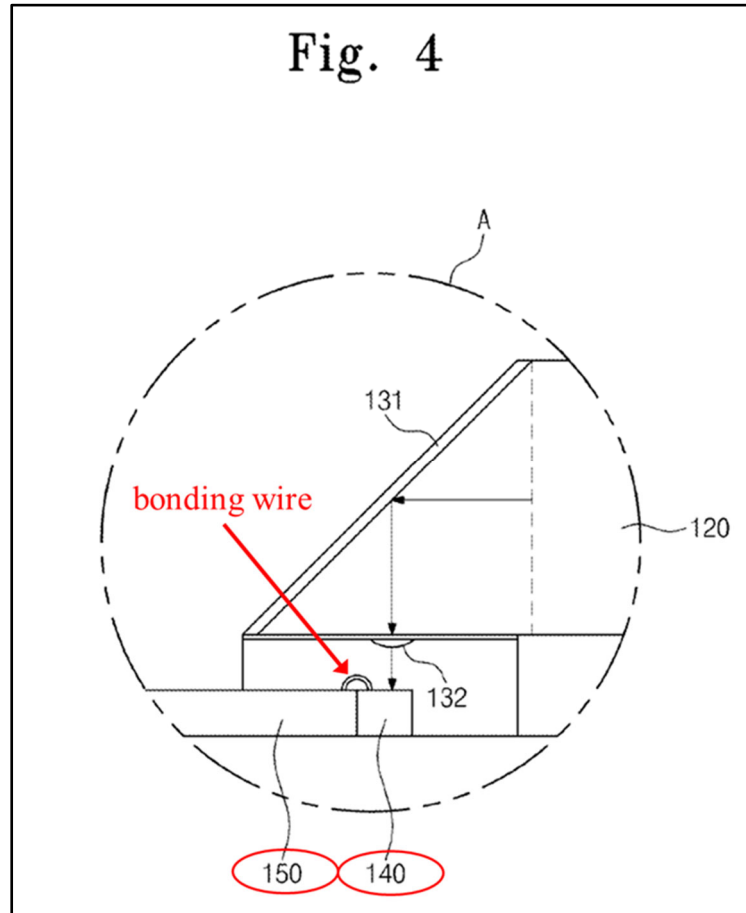
(light receiving chip) 150 are disposed **directly** on the same top surface of the end of carrier 180/280. Ex. 1003, ¶70.



Ex. 1004, Fig. 3 (showing optoelectronic diodes 140 and light receiving chip 150 are disposed directly on the top surface of an end of carrier 280) (annotations added)

While Kim does not explicitly disclose that the photodetectors 140 are optoelectronic diodes, it does disclose that photodetectors 140 “may be a surface-illuminated type” and that there is a photodetector for each optical signal channel received from the optical device 130. *Id.*, ¶[0028]. A POSITA would have known that a “surface-illuminated” photodetector is an optoelectronic diode, i.e., a photodiode. Ex. 1003, ¶71.

disclosure that photodetectors (optoelectronic diodes) 140 and pre-amplifier (light receiving chip) 150 of Kim are electrically interconnected through wire-bonding. *Id.*

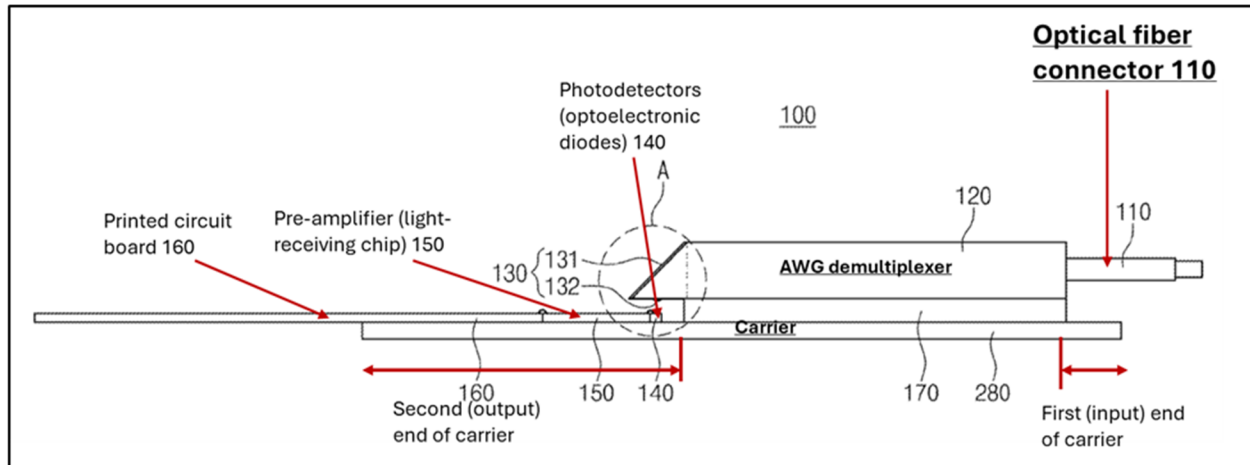


Ex. 1004, Fig. 4 (showing an optoelectronic diode 140 wire-bonded to light receiving chip 150)

e. Claim term 1[d] (“an optical fiber connector disposed in an end of the carrier”)

Kim discloses that optical receiver module 100 includes an optical fiber connector (optical connector 110), which “receives an optical signal inputted through a single optical fiber and then transmits the optical signal to the

demultiplexer 120.” Ex. 1004, ¶[0023]. Optical connector 110 of Kim has “a pigtail-shape or a receptacle-shape.” *Id.*, ¶[0023], Fig. 3. As shown in Figure 3, below, optical connector 110 is coupled to the input end of AWG demultiplexer 120, with optical connector 110 being disposed at the first (input) end of carrier 180/280. *Id.*; Ex. 1003, ¶73. A POSITA would have understood that the claim element “an optical fiber connector disposed in an end of the carrier” does not mean that the connector is coupled directly to the end of the carrier; rather, it means that the connector is disposed at an end region of the carrier. Ex. 1003, ¶73. This is fully supported by the specification of the ’301 patent, which explicitly states that the “[a]n optical fiber connector 4 may be disposed at another end of the carrier 8 ... **An input end 61 of the arrayed waveguide grating 6 may be connected to the optical fiber connector 4 for receiving an optical signal from the optical fiber.**” Ex. 1001, 3:9-14 (emphasis added). This is also supported by claim 1, which recites that “an input end of the arrayed waveguide grating [is] connected to the optical fiber connector for receiving an optical signal from the optical fiber.” *Id.*, 5:2-4.



Ex. 1004, Fig. 3 (showing optical connector 110 coupled with an input end of AWG demultiplexer 120 at an end of carrier 180/280)

- f. **Claim term 1[e] (“an arrayed waveguide grating further disposed on a top surface of the carrier that defines a midpoint of the carrier, the arrayed waveguide grating having a first end, a middle, and a second end disposed opposite the first end, and an input end of the arrayed waveguide grating connected to the optical fiber connector for receiving an optical signal from the optical fiber, wherein the top surface of the carrier underlies the middle of the arrayed waveguide grating”)**

Kim discloses an arrayed waveguide grating (AWG) demultiplexer 120 mounted on a supporting part 170, which is disposed on a top surface of carrier 180/280 that defines a midpoint of the carrier. Ex. 1004, Figs. 1 and 3; Ex. 1003, ¶74. It would have been obvious to a POSITA that because AWG demultiplexer 120 is mounted on supporting part 170, which is then mounted on carrier 180/280, AWG demultiplexer 120 is disposed on a top surface of carrier 180/280. Ex. 1003, ¶74. As

Kim's AWG demultiplexer 120 has a first (input) end, a middle, and a second (output) end disposed opposite the first end, and the first (input) end of the AWG is connected to optical fiber connector 110 for receiving an optical signal from the optical fiber. Ex. 1004, Fig. 3, ¶¶[0023]-[0024]; Ex. 1003, ¶75.

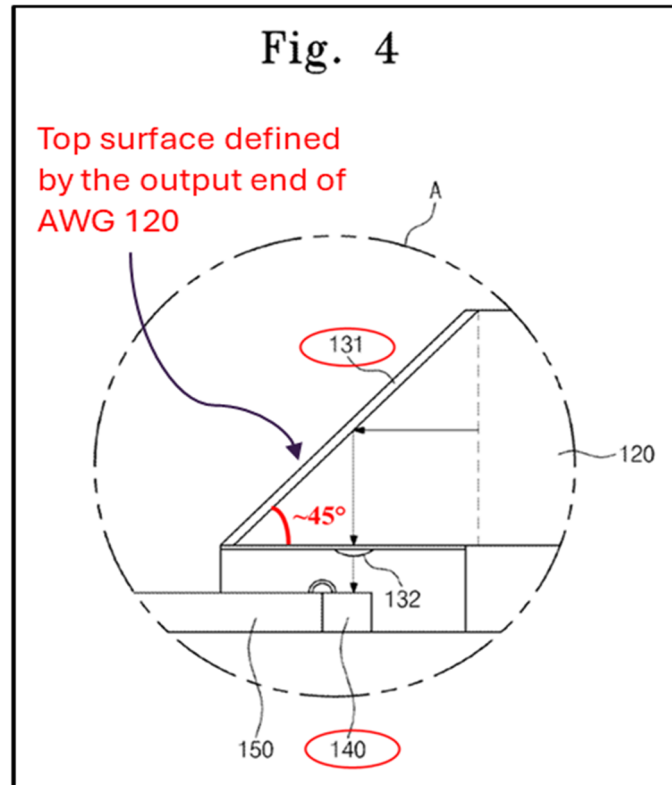
- g. **Claim term 1[f] (“wherein the optical signal is divided into multi-channel optical signals in parallel by the arrayed waveguide grating based on their wavelengths, a top surface defined by an output end of the arrayed waveguide grating is at a predetermined angle, causing the multi-channel optical signals reflected by the top surface defined by the output end of the arrayed waveguide grating to be reflected to a photosensitive surface of the plurality of optoelectronic diodes arranged in parallel, wherein the predetermined angle of the top surface defined by the output end of the arrayed waveguide grating is in a range of 41 to 46 degrees such that the top surface provides the reflection.”)**

Kim discloses that AWG demultiplexer 120 divides (demultiplexes) the received optical signal into multiple optical channels based on their wavelengths. Ex. 1004, ¶¶[0023]-[0024] (“The demultiplexer 120 **divides the 4-channel optical signal into optical signals corresponding to channels**, respectively.”) (emphasis added); Ex. 1003, ¶76. “Additionally, **4 photodetectors 140 are provided for the 4-channel input optical signals**. The 4 photodetectors 140 may be fabricated in an array form.” Ex. 1004, ¶[0028] (emphasis added); *see also id.*, ¶[0040] (“[T]he demultiplexer 120 divides the 4-channel input optical signals transmitted through

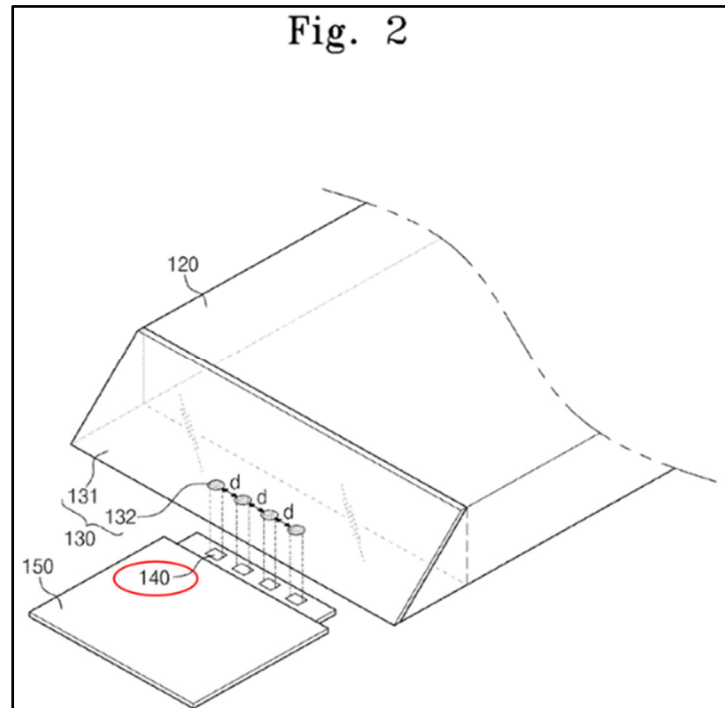
the optical connector 110 into four optical signals respectively corresponding to 4 channels. The optical signal divided suitably for each channel may travel along the arrayed wavelength grating (AWG) of the demultiplexer 120.”). It would have been obvious to a POSITA, based on Kim’s disclosures of AWG demultiplexing and four photodetectors corresponding to the 4-channel input optical signal, that AWG 120 demultiplexes the 4-channel input optical signal into individual channels in parallel based on their wavelengths. Ex. 1003, ¶76. Indeed, a POSITA would have known that an AWG demultiplexer, like the one disclosed in Kim, necessarily divides (demultiplexes) the received multiplexed input signal into corresponding channels in parallel. *Id.*

The output end of AWG demultiplexer 120 is defined by optical device 30, which is combined with AWG 120 to “constitute a unitary structure,” and which includes an inclined surface with mirror 131 formed thereon that defines a top surface of AWG demultiplexer 120. Ex. 1004, ¶¶[0034], [0042], Figs. 2 and 3. The inclined (top) surface of optical device 130 “may be cut at an angle of 45 degrees and then the cut surface of the optical device 130 may be polished.” *Id.*, ¶[0034]. Thus, Kim teaches that demultiplexed light is provided to the output end of AWG demultiplexer 120, which is defined by an inclined surface that is cut at a predetermined angle of 45 degrees (to the horizontal). *Id.*, ¶¶[0033], [0034], Figs. 2 and 3; Ex. 1003, ¶77. Mirror 131 provided on the inclined surface vertically reflects

the demultiplexed light through lenses 132 to the photosensitive surfaces of photodetectors (optoelectronic diodes) 140 that are arranged in parallel. Ex. 1004, ¶¶[0033]-[0034], [0041]-[0042], Figs. 2, 3, 4; Ex. 1003, ¶¶77, 78.



Ex. 1004, Fig. 4 (showing that the inclined surface (having mirror 131), which is provided at the output end of AWG 120, is at an angle of about 45 degrees to the horizontal base of the AWG and reflects the demultiplexed optical signals orthogonally onto photodetectors 140) (annotations added); Ex. 1003, ¶¶77, 78



Ex. 1004, Fig. 2 (showing four **photodetectors 140** arranged in parallel to receive demultiplexed light reflected by mirror 131 via four lenses 132)

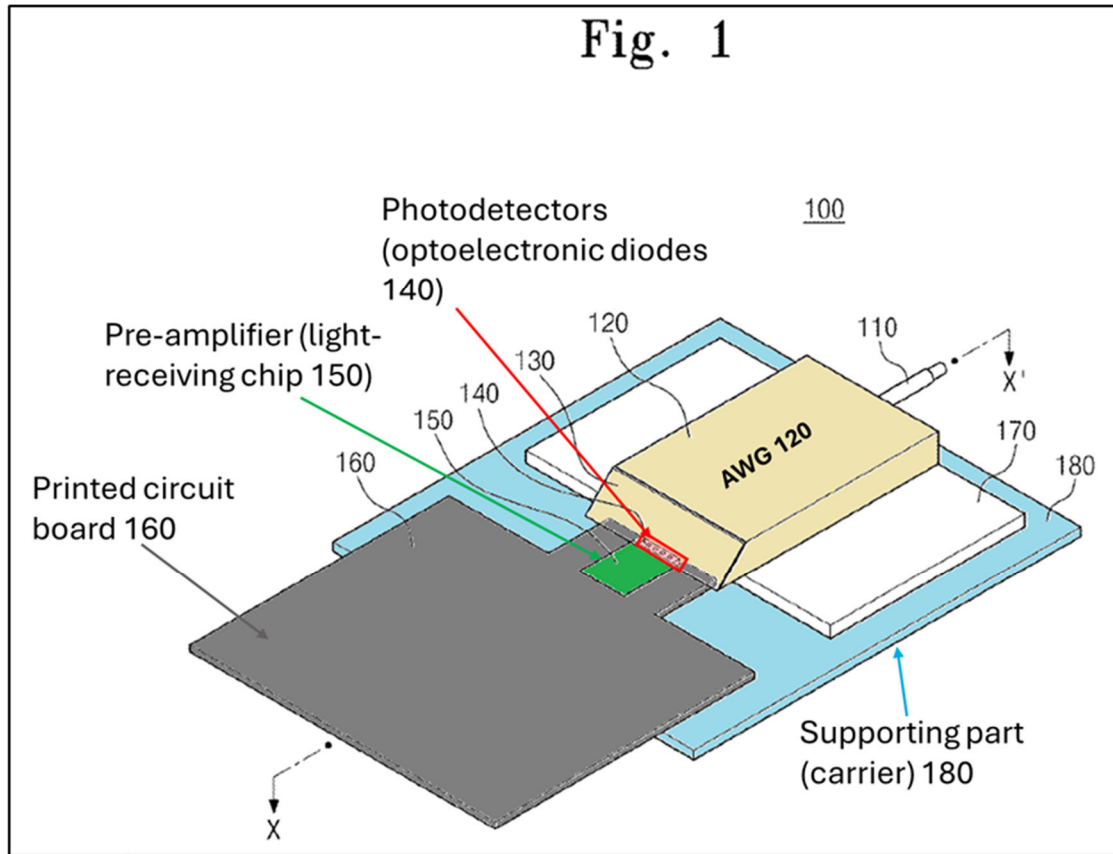
Kim’s disclosure that an interior angle of the top surface defined by the output end of AWG 120 is about 45 degrees, which falls within the recited range of about 41 to 46 degrees, renders the claimed range obvious. *See UCB, Inc. v. Actavis Labs. UT, Inc.*, 65 F.4th 679, 687 (Fed. Cir. 2023) (“If the prior art discloses a point within the claimed range, the prior art anticipates the claim.”); *see also Titanium Metals Corp. v. Banner*, 778 F.2d 775, 776-77, 782-83 (Fed. Cir. 1985) (Claims to titanium (Ti) alloy with 0.6-0.9% nickel (Ni) and 0.2-0.4% molybdenum (Mo) were held anticipated and rendered obvious by a graph in a Russian article on Ti-Mo-Ni alloys because the graph contained an actual data point corresponding to a Ti alloy

containing 0.25% Mo and 0.75% Ni and this composition was within the claimed range of compositions). Moreover, a POSITA would also have been able to determine the range of suitable angles based on the teachings of Lee, through routine experimentation and optimization, to obtain desired coupling efficiency. *See, e.g.*, Ex. 1003, ¶¶83-87.

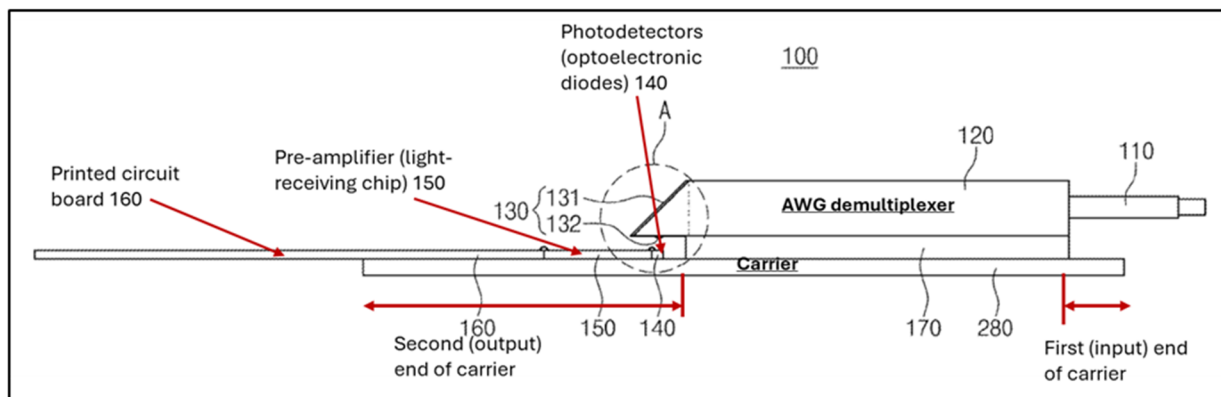
2. Claim 2 (“The multi-channel parallel optical receiving device according to claim 1, wherein the top surface of the end of the carrier is defined at least in part by a circuit board, and wherein the plurality of optoelectronic diodes and the light receiving chip are directly disposed on the circuit board.”)

Kim’s optical receiver module 100 includes a printed circuit board 160, which is disposed in part on the top surface of the end of carrier 180/280 and defines at least in part the top surface of the end of the carrier. Ex. 1004, ¶¶[0022], [0030], Figs. 1 and 3; ¶Ex. 1003, ¶80. The plurality of photodetectors (optoelectronic diodes) 140 and pre-amplifier (light-receiving chip) 150 are disposed on carrier 180/280, which is adjacent to and contiguous with printed circuit board carrier 160, as shown in Figures 1 and 3, below. Ex. 1003, ¶80. It would have been obvious to a POSITA that instead of positioning photodetectors 140 and pre-amplifier 150 directly on the top surface of carrier 180/280, they could have been positioned directly on printed circuit board 160 to save space on carrier 180/280. *Id.* A POSITA would have been motivated to position photodetectors 140 and pre-amplifier 150 on the printed circuit

board 160 to reduce the overall size of the carrier and the optical receiver module 100, and thereby adapt to the trend in electronics and optoelectronics technology where devices and their components are continually becoming smaller and more compact while maintaining or increasing their functionality and performance. *Id.*, ¶81. This trend towards compactness and smaller form factors of optoelectronic devices was prevalent and well known at the time of the claimed effective filing date (May 2016) of the '301 patent. *Id.* A POSITA would have reasonably expected success in positioning photodetectors 140 and pre-amplifier 150 on the printed circuit board 160 because locating and aligning electronic components within a device is well within the routine and ordinary skills of a POSITA. *Id.* Indeed, a POSITA would reasonably have been able to reposition photodetectors 140 and pre-amplifier 150 on the printed circuit board 160 through minimal trial-and-error, routine experimentation, and the exercise of ordinary skill, and would have been motivated to do so to make the module more compact. *Id.*



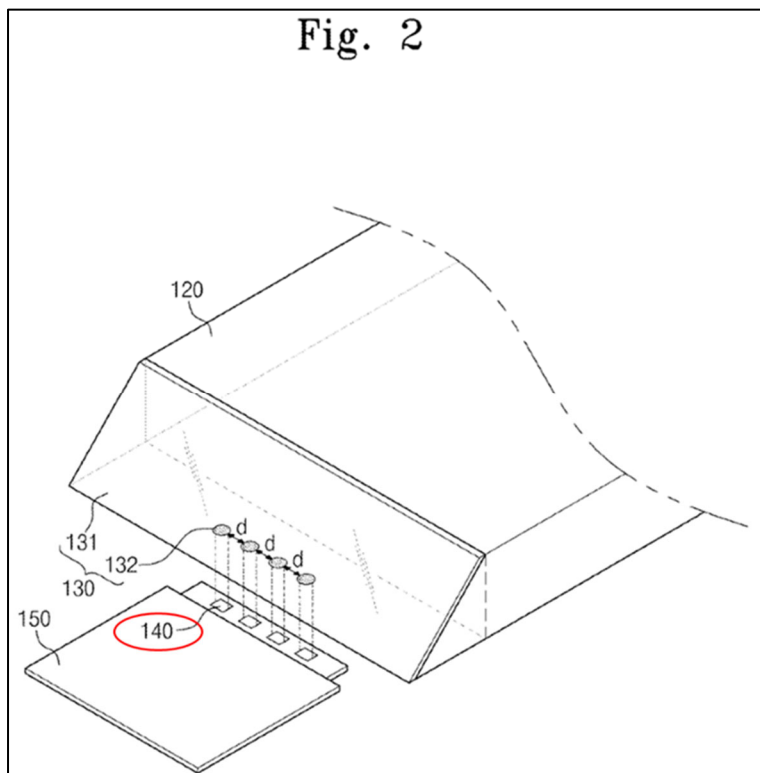
Ex. 1004, Fig. 2 (showing printed circuit board 160 disposed on the top surface of carrier 180/280, and photodetectors 140 and pre-amplifier 150 positioned on the same top surface of carrier 180/280 contiguous with printed circuit board 160)



Id., Fig. 3 (same)

3. Claim 3 (“The multi-channel parallel optical receiving device according to claim 1, wherein the amount of the optoelectronic diodes is equal to the amount of optical paths divided by the arrayed waveguide grating.”)

Kim discloses that the number of photodetectors (optoelectronic diodes) 140 is equal to the number of optical paths divided by AWG demultiplexer 120. Ex. 1004, ¶[0028] (“The photodetector 140 receives the optical signal of each channel from the optical device 130. ... Additionally, 4 photodetectors 140 are provided for the 4-channel input optical signals. The 4 photodetectors 140 may be fabricated in an array form.”); *see also id.*, Fig. 2.



Ex. 1004, Fig. 2 (showing four photodetectors 140 corresponding to the four optical paths divided by AWG demultiplexer 120)

4. Claim 4 (“The multi-channel parallel optical receiving device according to claim 1, wherein the predetermined angle of the top surface of the output end of the arrayed waveguide grating is 42 degrees.”)

Kim discloses that the top surface of the output end of AWG demultiplexer 120 is inclined and is cut at a predetermined angle of 45 degrees (to the horizontal) to directly optically couple the demultiplexed light reflected by the inclined surface with corresponding photodetectors 140. Ex. 1004, ¶¶[0033]-[0034], Fig. 3; Ex. 1003, ¶83. While Kim does not explicitly disclose that the predetermined angle of the top surface is 42 degrees, Kim’s disclosure of 45 degrees renders this claim limitation obvious, especially because the ’301 patent does not disclose that a 42-degree angle is critical, or generates new or unexpected results. Ex. 1003, ¶83; *In re Brandt*, 886 F.3d 1171, 1177 (Fed. Cir. 2018) (the court found a *prima facie* case of obviousness had been made in a predictable art wherein the claimed range of “less than 6 pounds per cubic feet” and the prior art range of “between 6 lbs./ft³ and 25 lbs./ft³” were so mathematically close that the difference between the claimed range and prior art range was virtually negligible absent any showing of unexpected results or criticality.); *In re Dreyfus*, 73 F.2d 931, 934 (C.C.P.A. 1934) (the prior art, which taught about 0.7:1 of alkali to water, renders obvious a claim that increased the proportion to at least 1:1 because there was no showing that the claimed proportions were critical).

Indeed, it is well established that a *prima facie* case of obviousness exists where the claimed amount or value does not overlap with the prior art but is close. *See* M.P.E.P. § 2144.05 (citing *Titanium Metals*, 778 F.2d at 783 (the court held as proper a rejection of a claim directed to an alloy “having 0.8% nickel, 0.3% molybdenum, up to 0.1% iron, balance titanium” as obvious over a reference disclosing alloys of 0.75% nickel, 0.25% molybdenum, balance titanium and 0.94% nickel, 0.31% molybdenum, balance titanium, and explaining that “[t]he proportions are so close that prima facie one skilled in the art would have expected them to have the same properties.”); *In re Aller*, 220 F.2d 454, 456 (C.C.P.A. 1955) (claimed process which was performed at a temperature between 40°C and 80°C and an acid concentration between 25% and 70% was held to be obvious over a reference process performed at a temperature of 100°C and an acid concentration of 10%); *In re Scherl*, 156 F.2d 72, 74-75 (C.C.P.A. 1946) (claimed angle of no less than 120° was found obvious based on prior art reference showing an angle in a groove of up to 90°)).

Moreover, a POSITA would have known that a 42-degree interior angle of the inclined top surface of the output end of the AWG is an obvious design choice and obvious-to-try based on multiple considerations, as discussed below. Ex. 1003, ¶84. Specifically, a POSITA would have known that the ability of the AWG chip to effectively reflect light onto the photodetectors would be affected by the interior

angle of the inclined surface of the AWG. *Id.*, ¶85. Therefore, the interior angle of the inclined top surface is a result-effective variable that affects the reflection of light onto the photodetectors. *Id.* And it is well established that the determination of the optimum value or range of a result-effective variable is within the grasp of one skilled in the art. *In re Boesch*, 617 F.2d 272, 276 (C.C.P.A. 1980) (“[D]iscovery of an optimum value of a result effective variable . . . is ordinarily within the skill of the art.”). Moreover, the ’301 patent does not show that “the claimed ranges [or values] are ‘critical’ or ‘produce a new and unexpected result which is different in kind and not merely in degree from the results of the prior art.’” *In re Applied Materials, Inc.*, 692 F.3d 1289, 1295, 1297 (Fed. Cir. 2012) (quoting *In re Aller*, 220 F.2d 454, 456 (C.C.P.A. 1955)); *Iron Grip Barbell Co. v. USA Sports, Inc.*, 392 F.3d 1317, 1322 (Fed. Cir. 2004). Therefore, optimization of the interior angle (i.e., the predetermined angle) of the inclined top surface of the AWG was nothing other than the exercise of ordinary skill in the art. *In re Huang*, 100 F.3d 135, 139 (Fed. Cir. 1996); *Iron Grip*, 392 F.3d at 1322.

Indeed, a POSITA would have known to design an AWG with an inclined top surface having a suitable interior angle, e.g., an angle of about 42 degrees, based on the teachings of Kim and through routine optimization and design considerations, to optimize the direct coupling of demultiplexed light with respective photodetectors. Ex. 1003, ¶86. For example, an AWG demultiplexer chip having an inclined surface

with an interior angle of 45 degrees was already taught by Kim. *See* Ex. 1004, ¶¶[0033]-[0034], Figs. 2, 3, 4. Based on the teachings of Kim, a POSITA would have known how to adjust the interior angle for other AWG demultiplexer chips using routine experimentation and design considerations to effectively reflect light onto photodetectors and have minimal signal losses. Ex. 1003, ¶86. Thus, the recited angle of 42 degrees would have been obvious to a POSITA. *Id.*

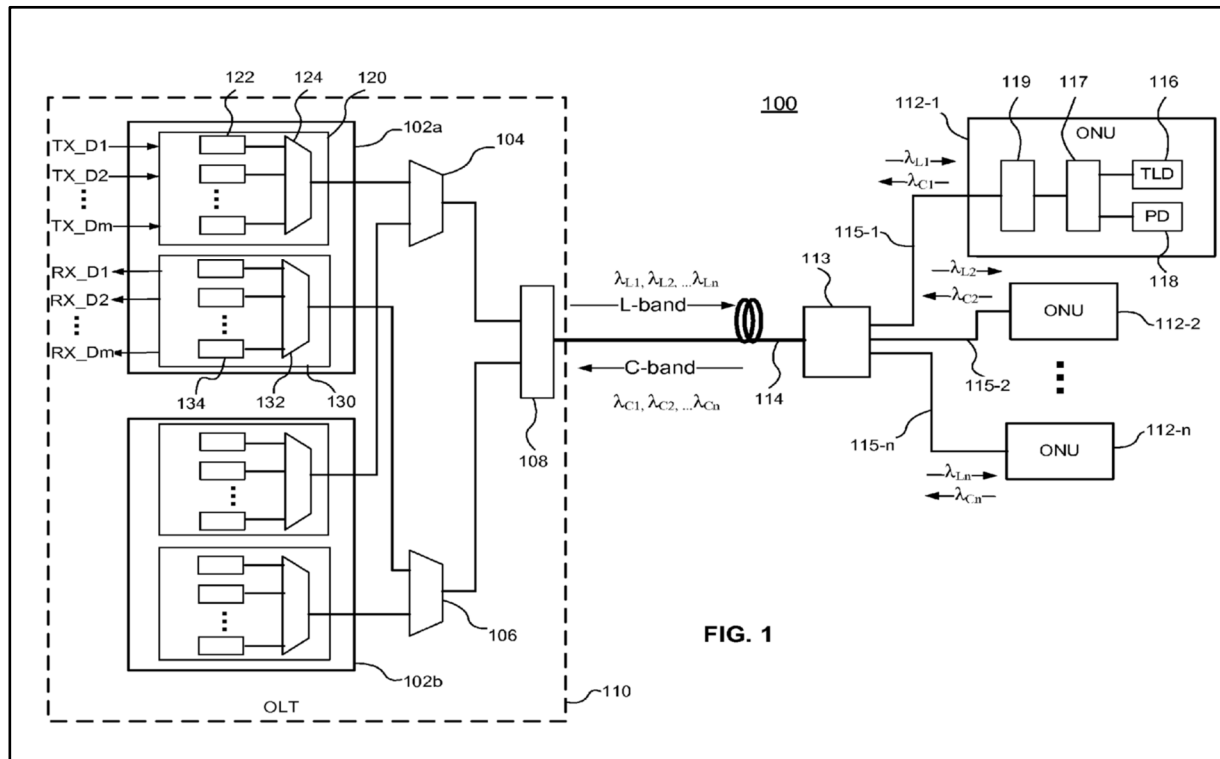
In short, Kim’s disclosure that “[a]n end portion of the optical device 130 may be cut at an angle of 45 degrees,” which is close to the claimed value of 42 degrees, renders claim 4 obvious. Ex. 1004, ¶[0034]; Ex. 1003, ¶87.

VII. [GROUND 2] CLAIMS 1-4 ARE RENDERED OBVIOUS BY HO IN VIEW OF LEE

A. Ho (Ex. 1005)

Ho discloses an 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. 1005, ¶[0018]. 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.*, ¶[0020]. The 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 locations or

premises. *Id.*, ¶[0021]. The WDM-PON 100 may use different wavelength bands for transmission of downstream and upstream optical signals relative to the OLT 110 to avoid interference between the received signal and the back-reflected transmission signal on the same fiber. *Id.*, ¶[0023]. The ONUs 112-1 to 112-n may thus be configured to receive an optical signal on an assigned downstream channel wavelength (λ_L) within the L-band, and they may be configured to transmit at an assigned upstream channel wavelength (λ_C) in the C-band. *Id.*, ¶[0023], [0024].

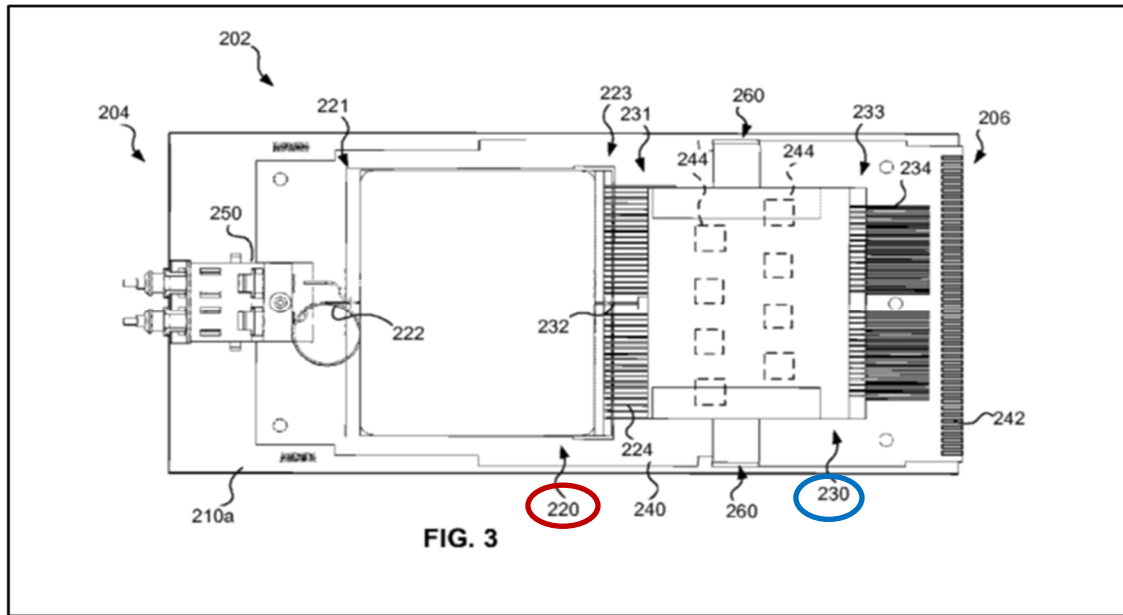


Ex. 1005, Fig. 1.

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

into the downstream WDM signal. *Id.*, ¶[0027]. 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 102a, 102b, 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 separating and receiving the optical signals at the multiple channel wavelengths. *Id.*

Ho further discloses an exemplary optical transceiver module 202, as shown in Figure 3 (reproduced below), for use in OLT 110. *See also id.*, Fig. 2, ¶[0033]. Optical transceiver module 202 includes a transceiver housing 210a, 210b 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.*, ¶[0033]. TOSA 220 includes an array of lasers that are coupled to a multiplexer (such as an AWG) 225. *Id.*, ¶¶[0037]. Each laser generates light at a different channel wavelength and the AWG multiplexer combines the different channel wavelengths into a single WDM optical signal. *Id.*, ¶¶[0028], [0029], [0037], [0058].

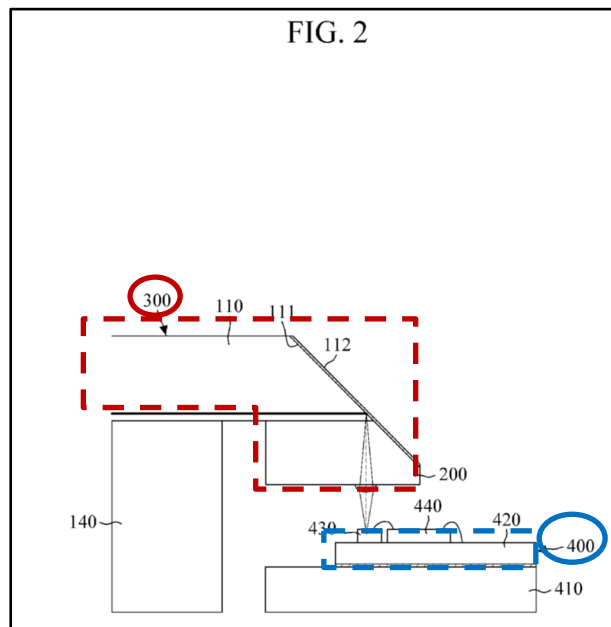


Ex. 1005, Fig. 3 (showing an optical transceiver 202 having a housing portion 210a and including a **TOSA 220** and a **ROSA 230**)

Likewise, ROSA 230 of optical transceiver module 202 includes an AWG demultiplexer 235. *Id.*, ¶[0042]. The ROSA is configured to receive a WDM optical signal on multiple channel wavelengths and to demultiplex (divide) the WDM signal into individual channel wavelengths. *Id.*, ¶[0057]. Optical outputs 237 of the demultiplexer 235 are “directly optically coupled” to an array of photodetector 236, having photodiodes 270, without any intermediate fibers. *Id.*, ¶¶[0042], [0043]. The outputs of photodetectors 236 are electrically connected to the ROSA pins 234 at the electrical connection end 233 via TIAs (transimpedance amplifiers) 274. *Id.*, ¶¶[0042]-[0045], Fig. 3.

B. Lee (Ex. 1006)

Lee discloses a hybrid optical coupling module comprising an optical unit for transmitting light and an electrical unit for converting an optical signal into an electrical signal. Ex. 1006, Abstract, ¶[0003]. More specifically, Lee discloses an optical module comprising 1) an optical unit 300 that includes an optical transmission means in the form of a planar lightwave circuit (PLC) 110 and array lens 200, and 2) an electrical unit 400 that includes a photodiode (PD) 430, transimpedance amplifier (TIA) 440, and substrate 420. *Id.*, ¶¶[0033], [0036], [0038], [0043]-[0045], Figs. 2 and 8.



Ex. 1006, Fig. 2 (showing direct optical coupling between **optical unit 300** and **electrical unit 400**); *see also id.*, Fig. 8.

Lee discloses that one application of the optical coupling module is an optical transceiver, wherein the PLC is used as a demultiplexer comprising an arrayed waveguide grating (AWG). *Id.*, ¶¶[0008]-[0009]. Lee further discloses that the optical coupling between optical unit 300 and electrical unit 400 is achieved by having an inclined surface 111 formed at an angle of 45 degrees on one side of PLC 110 and by providing a reflection layer 112 on inclined surface 111, for vertically reflecting an optical signal from optical unit 300 to photodiode 430 of electrical unit 400. *Id.*, ¶¶[0049]-[0054], [0073]-[0074], Fig. 2 (depicted above).

Lee additionally discloses that in another embodiment, as shown in Figure 8, instead of polishing the entire second end of PLC 110 and array lens 200 at the angle of 45 degrees, a concave space 115 may be formed in a part of PLC 110 where light exits and a 45-degree inclined surface may be formed at the end of the concave space 115. *See id.*, Fig. 8, ¶[0053].

C. A POSITA Would Have Been Motivated to Combine Ho With the Teachings of Lee, and Would Have Reasonably Expected Success in Doing So

Ho discloses a multi-channel optical transceiver module 202 comprising a multi-channel TOSA 220, a multi-channel ROSA 230 (which is an optical receiver module) and a dual fiber type direct link adapter 250 directly linked to the multi-channel TOSA and the multi-channel ROSA for providing optical inputs and outputs. Ex. 1005, ¶[0033]. Similarly, Lee discloses an optical component of a

transceiver module that “performs optical transmission and reception functions in an optical communication device such as an optical transmission system, a large-capacity router, a switch, or the like which uses an optical fiber as a medium.” Ex. 1006, ¶[0008]. Therefore, a POSITA would have considered the teachings of Ho and Lee together when designing or developing an optical receiver module (ROSA), such as the one disclosed in the ’301 patent, to perform optical reception functions. Ex. 1003, ¶92.

Specifically, Lee discloses “an optical component for performing optical-electric conversion and electric-optical conversion functions [wherein] ... a plurality of optical signals can be simultaneously connected so as to receive signals of a large is [*sic*] capacity[.]” Ex. 1006, ¶[0009]. Lee’s optical component is in the form of a planar lightwave circuit (PLC), such as PLC 110. *Id.*; *see also id.*, ¶¶[0034], [0035], [0043]-[0046]. Lee further discloses that one application of the PLC is a demultiplexer comprising an arrayed waveguide grating (AWG), but Lee does not provide many details about the AWG demultiplexing process, except that it uses direct coupling (without fibers or waveguides) to transmit optical signals from the PLC to respective photodetectors. *Id.*, ¶[0009]. Given Lee’s disclosures that one application of the PLC-based optical component is an optical receiver module (ROSA) and that the PLC may be used as an AWG demultiplexer, it would have

been obvious to a POSITA that Lee's teachings may be applied to a ROSA having an AWG demultiplexer. *Id.*, ¶¶[0008], [0009], [0034]-[0035]; Ex. 1003, ¶92.

Ho explicitly discloses that ROSA 130/230 includes an AWG demultiplexer and provides details of the AWG demultiplexing process. Ex. 1005, ¶¶[0018], [0039], [0042], [0043]. Moreover, a POSITA would have known that it is common to have an AWG demultiplexer in a ROSA to divide a received signal into individual channel wavelengths. Ex. 1003, ¶90. Thus, a POSITA would have been motivated to consider the teachings of Lee and Ho together to build an efficient and effective ROSA with an AWG demultiplexer and a direct coupling mechanism for transmitting the demultiplexed output signal from the AWG to an electrical unit comprising photodetectors. *Id.*, ¶¶92, 93.

A POSITA would have been motivated to use the direct coupling mechanism of Lee with the AWG demultiplexer of Ho (instead of Ho's direct coupling technique), because of the simpler, more reliable, and more efficient method of direct coupling demultiplexed signals with respective photodetectors, as discussed in Lee. *Id.*, ¶94. Indeed, a POSITA would have recognized that the direct coupling technique disclosed in Lee provides more effective and reliable coupling between the AWG and the photodetectors, and minimizes manufacturing issues and concerns associated with the low tolerance of the passive alignment process outlined in Ho. *Id.*; *see also* Ex. 1005, ¶¶[0047]-[0055] (describing passive alignment between Ho's photodiodes

270 and respective demultiplexer outputs 237). At a minimum, the direct coupling technique described in Lee is a good alternative to the passive alignment technique described in Ho, and a POSITA would have been motivated to try the mechanism of Lee to achieve desired coupling efficiency. Ex. 1003, ¶94.

Furthermore, a POSITA would have readily recognized the design compatibility between Lee and Ho, and would thus have been motivated to and reasonably expected success in using them together. *Id.*, ¶95. This is because the optical communication techniques of Lee and Ho are similar—they both use single mode optics and single mode fibers—and therefore a POSITA would have been able to combine them with little experimentation and testing and with a reasonable expectation of success. *Id.*

AWG demultiplexers and direct coupling of demultiplexed optical signals with photodetectors (without fibers or waveguides) were routinely used in optoelectronics at the time of the effective filing date of the '301 patent. *Id.*, ¶96. Therefore, combining Ho's AWG demultiplexer with the direct coupling technique of Lee would have required nothing more than the application of ordinary skill and basic knowledge of optical components. *Id.* Indeed, combining Ho with Lee would have been a combination of known prior art elements according to their established functions, and the combination would have yielded the predictable result of an

optical receiver module with an AWG demultiplexer that provides direct optical coupling of the demultiplexed outputs with corresponding photodetectors. *Id.*

D. Ho in View of Lee Renders Claims 1-4 Obvious

1. Independent claim 1

Ho in view of Lee discloses, teaches, or suggests each and every limitation of claim 1.

a. 1[preamble] (“A multi-channel parallel optical receiving device”)

Ho discloses “[a] multi-channel receiver optical subassembly (ROSA),” which “includes an optical demultiplexer, such as an arrayed waveguide grating (AWG), with outputs directly optically coupled to respective photodetectors such as photodiodes.” Ex. 1005, ¶[0018]; *see also id.*, ¶[0002], Title, Abstract. Ho describes two multi-channel ROSAs, 130 and 230. *Id.*, ¶¶[0027], [0033]. Based on the disclosure of Ho, a POSITA would have understood that ROSA 130 and ROSA 230 are analogous embodiments with similar structure, functions, and operation. *See id.*, ¶¶[0027], [0033]; Ex. 1003, ¶89.

Ho additionally discloses that ROSA 130, 230 separates the input optical signal into multiple channels based on wavelength. Ex. 1005, ¶¶[0027], [0057]; Ex.1003, ¶90. Ho also explicitly discloses that its ROSA includes an AWG demultiplexer. *Id.*, ¶¶[0018], [0039], [0042], [0043]. Moreover, a POSITA would

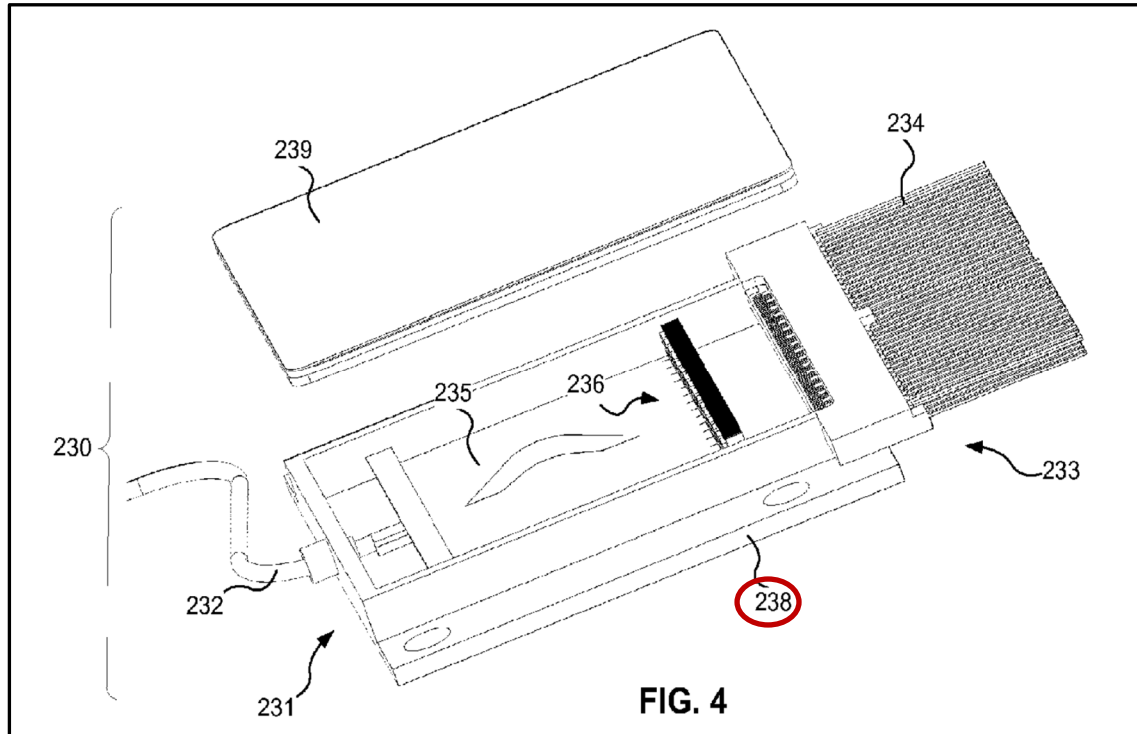
have known that it is common to have an AWG demultiplexer in a ROSA to separate a received signal into individual channel wavelengths. Ex. 1003, ¶90.

A POSITA would have further understood from Ho, particularly Ho's disclosures of AWG demultiplexing and direct optical coupling of demultiplexed outputs with respective photodetectors, that the separation of the optical signals into different channel wavelengths is done in parallel by the AWG. Ex. 1005, ¶¶[0018], [0027], [0057]; Ex. 1003, ¶91. Thus, Ho's multi-channel receiver optical subassembly (ROSA), such as ROSA 130/230, is a multi-channel parallel optical receiving device. Ex. 1003, ¶91.

b. Claim term 1[a] (“a carrier”)

Ho discloses that ROSA 230 includes “a demultiplexer 235, such as an AWG, mounted on a ROSA base portion 238. Optical outputs 237 of the demultiplexer 235 are optically coupled to an array of photodetectors 236, such as photodiodes. An input of the demultiplexer 235 is optically coupled to the input optical fiber 232 at the optical connection end 231 and the output of the photodetectors 236 are electrically connected to the ROSA pins 234 at the electrical connection end 233. A ROSA cover 239 covers the ROSA base portion 238 and encloses the demultiplexer 235 and array of photodetectors 236.” Ex. 1005, ¶[0042], Figs. 4 and 5. A POSITA would have understood base portion 238 to be a supporting structure contained

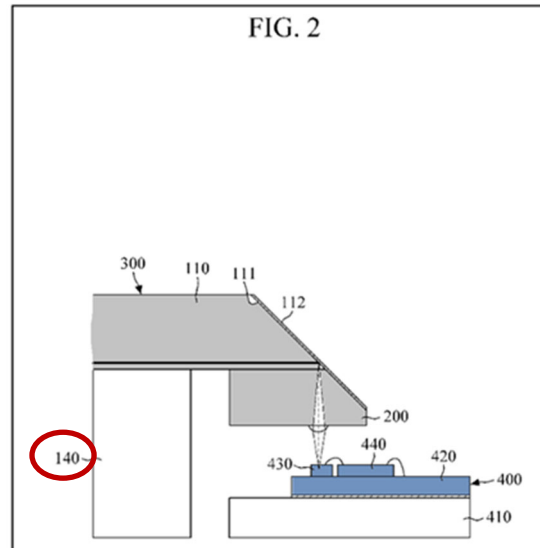
within ROSA 230 and on which AWG 235 is mounted. Ex. 1003, ¶97. Base portion 238 is thus a “carrier.” *Id.*



Ex. 1005, Fig. 4 (showing **base portion (carrier) 238**).

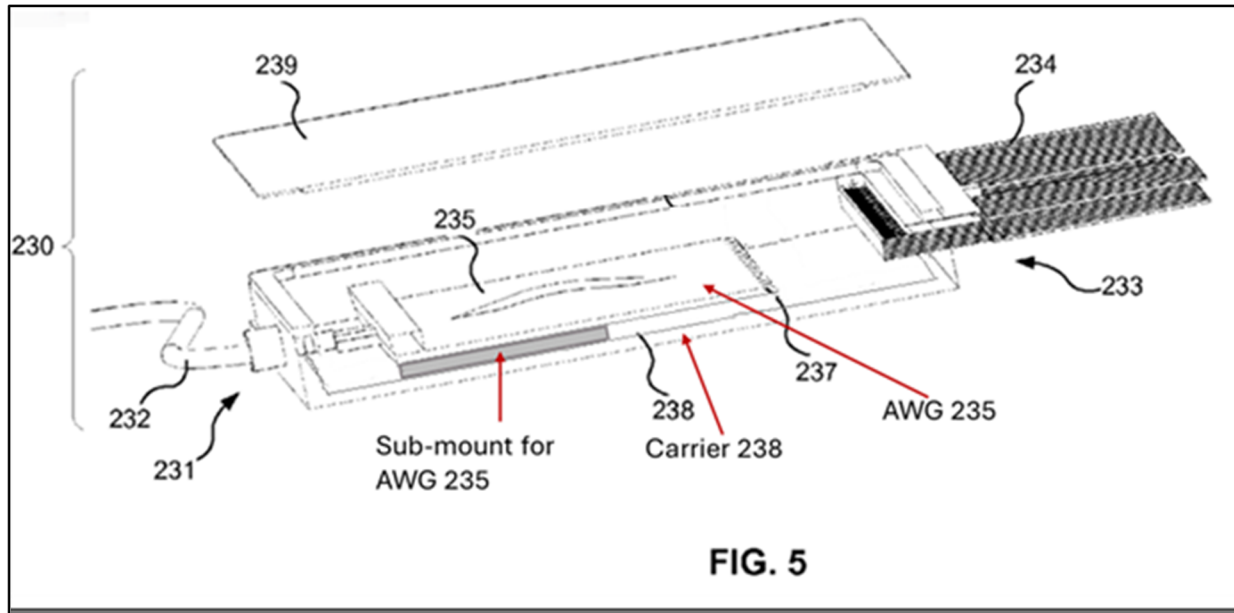
To use the more efficient and reliable direct optical coupling method disclosed in Lee, it would have been obvious to a POSITA to modify Ho by elevating AWG demultiplexer 235 off carrier 238 using mounts, such as sub-mount 140 of Lee shown in Figure 2, below. *See* Ex. 1006, Figs. 2 and 8; Ex. 1003, ¶98. This is because Ho’s photodetectors 236 must be placed underneath the angled/inclined surface at the output end of Ho’s AWG 235 (modified in view of Lee) to receive the demultiplexed output signals via reflection from the inclined surface, as shown in Lee’s Figure 2. Ex. 1003, ¶98. As such, AWG 235 would have to be elevated off

carrier 238 to make space for photodetectors 236 underneath the output end of AWG 235. *Id.*



Ex. 1006, Fig. 2 (showing Lee's **optical unit 300** being mounted on a sub-mount 140, so that photodiode 430 can be placed directly underneath the inclined surface of PLC 110 to achieve direct optical coupling between **optical unit 300** and **electrical unit 400**)

As shown below, Ho modified in view of Lee would have AWG 235 mounted on a sub-mount, which is disposed on carrier 238. Ex. 1003, ¶99.



Ex. 1005, Fig. 5 (annotated and modified in view of Lee to show that AWG 235 is positioned on a sub-mount disposed on a top surface of carrier 238 and deleting photodetector mounting bar 272)

Lee further shows that photodiode 430 and TIA 440 are mounted on a substrate 420. Ex. 1006, Fig. 2. It would have been obvious to a POSITA that in Ho modified in view of Lee, Ho's photodetectors 236 and TIAs 274 would have been mounted directly on carrier 238, which is similar to substrate 420 of Lee, such that photodetectors 236 are placed directly underneath the angled/inclined surface of Ho's AWG 235 (modified in view of Lee). Ex. 1003, ¶100. This arrangement would reduce the number of sub-mounts or substrates on Ho's carrier 238 and thus reduce manufacturing complexities and costs. *Id.* As such, a POSITA would have been

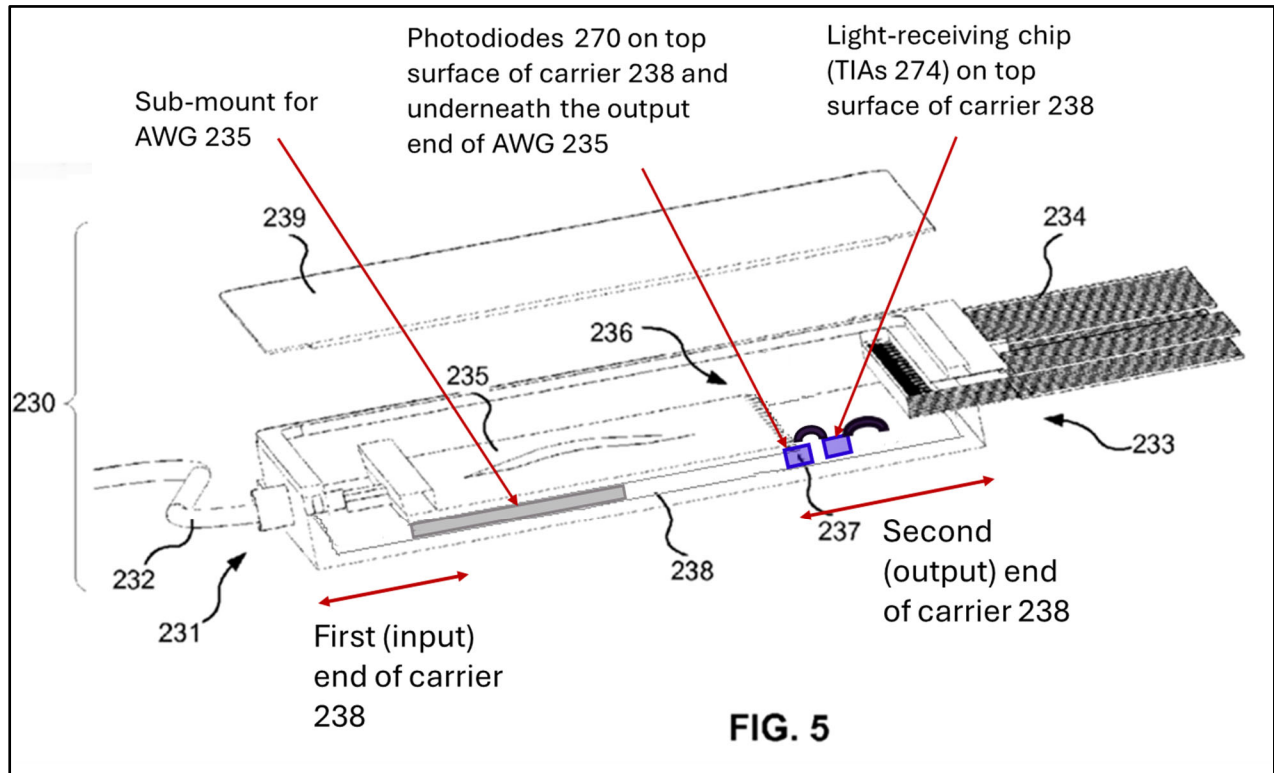
motivated to do so and would have reasonably expected success for all the reasons discussed above in Section VII.C. *See also id.*

c. Claim term 1[b] (“a light receiving chip disposed on a top surface of an end of the carrier”)

The ROSA 230 of Ho includes an “array of photodetectors 236 includ[ing] PIN type photodiodes 270 mounted on a photodetector mounting bar 272 together with associated transimpedance amplifiers (TIAs) 274.” Ex. 1005, ¶[0044]. “[E]ach of the photodiodes 270 is electrically connected to each of the TIAs 274 using wire bonding. Wires 271 extend from wire bonding points on the photodiodes 270 to wire bonding points on the associated TIAs 274. Wires 271 also extend between the photodiodes 270 and/or TIAs 274 and conductive paths or pads on the mounting bar 272, for example, to ground paths 273.” *Id.*, ¶[0045]. A POSITA would have understood Ho’s TIAs 274 to be a “light receiving chip”; indeed, the ’301 patent similarly discloses/describes its “trans-impedance amplifier (TIA) chip” as a light receiving chip. Ex. 1001, 3:1-9; Ex. 1003, ¶101.

photodetector mounting bar 272 would not have been required, and instead Ho's photodetectors 236 (having photodiodes 270) and TIAs 274 would have been mounted directly on a top surface of carrier 238, which is similar to Lee's substrate 420, in such a way that photodiodes 270 would have been placed directly underneath the output end of Ho's AWG 235 (modified in view of Lee to have an inclined/angled surface). *Id.*, ¶103.

Furthermore, Lee teaches mounting photodiode 430 and TIA 440 adjacent each other and directly on the top surface of substrate 420, and wire-bonding the photodiode, the TIA, and the substrate. Ex. 1006, Figs. 2 and 8. Accordingly, it would have been obvious to a POSITA that Ho's TIAs 274 (i.e., the light receiving chip) would also have been disposed on a top surface at the end of carrier 238 in close proximity to photodiodes 270, as shown below, to facilitate wire bonding between the photodiodes, the TIAs, and carrier 238. Ex. 1004, ¶104.



Ex. 1005, Fig. 5 (annotated and modified in view of Lee to show the locations of photodiodes 270 and TIAs 274 on the top surface of an end of carrier 238 (instead of locating the photodiodes and the TIAs on photodetector mounting bar 272))

- d. **Claim term 1[c] (“a plurality of optoelectronic diodes disposed on the top surface of the end of the carrier, and the plurality of optoelectronic diodes electrically connected to the light receiving chip via bonding wire, wherein the optoelectronic diodes and the light receiving chip are disposed directly on the same top surface of the end of the carrier”)**

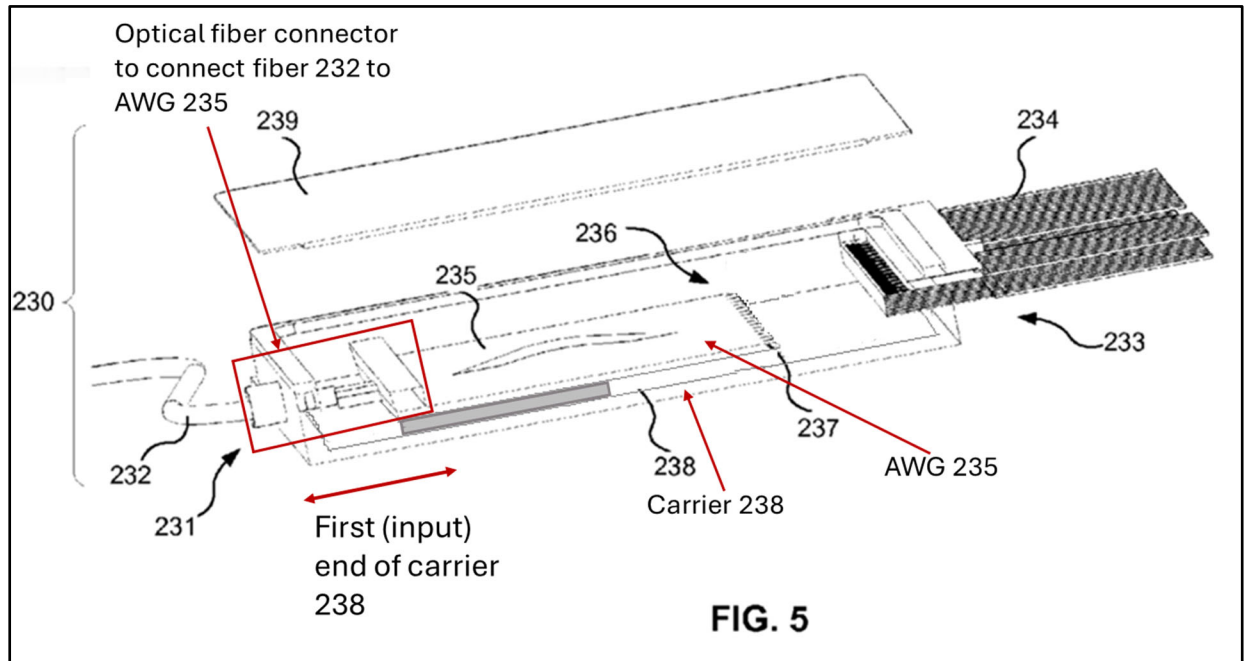
As discussed above with regard to claim terms 1[a] and 1[b], Ho modified in view of Lee includes a plurality of photodiodes 270 (included in Ho’s photodetectors 236) that are disposed on the top surface of the end of carrier 238 in close proximity

Ex. 1005, Fig. 5 (annotated and modified in view of Lee to show locations of photodiodes 270 and TIAs 274 on the top surface of carrier 238)

Lee also teaches wire-bonding between its photodiode 430 and TIA 440. Ex. 1006, Fig. 7, ¶¶[0038]-[0039].

e. Claim term 1[d] (“an optical fiber connector disposed in an end of the carrier”)

Ho discloses that ROSA 230 includes an optical fiber connector (shown below) that connects optical fiber 232 to AWG 235. Ex. 1005, ¶[0035], Figs. 4 and 5. As shown in Figure 5, below, the optical connector is disposed at the first (input) end of carrier 238. A POSITA would have understood that the claim element “an optical fiber connector disposed in an end of the carrier” does not mean that the connector is coupled directly to the end of the carrier; rather, it means that the connector is disposed at an end region of the carrier. Ex. 1003, ¶108. As discussed above in Ground 1, the specification of the '301 patent and claim 1 supports the understanding of a POSITA that the claim element “an optical fiber connector disposed in an end of the carrier” means that the connector is disposed at an end region of the carrier. *See, e.g.*, Ex. 1001, 3:9-14, 5:2-4 (claim 1).



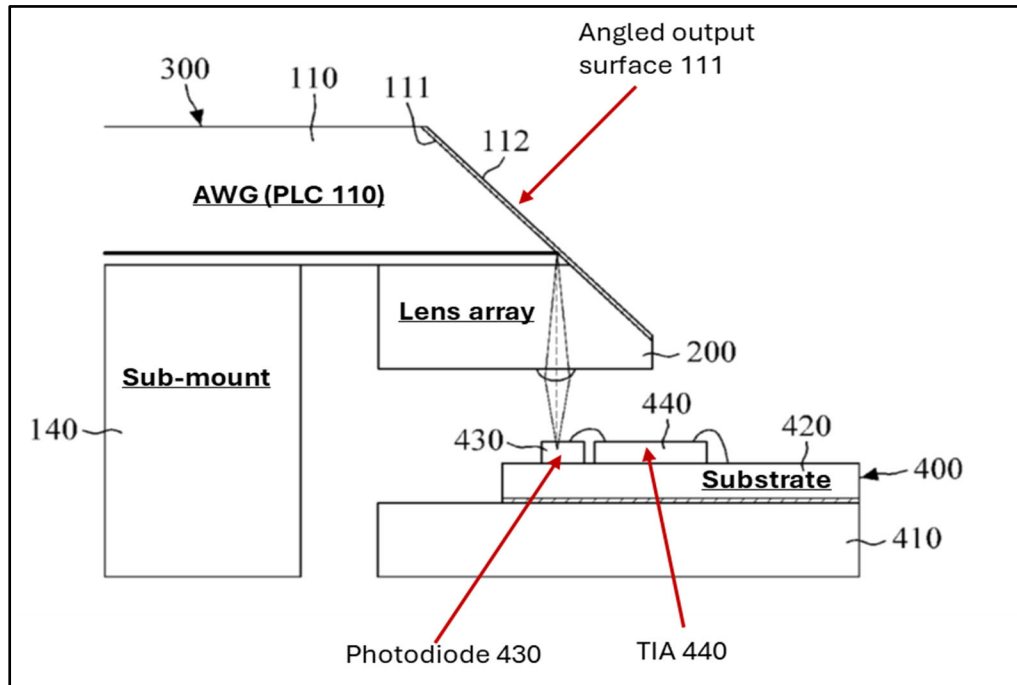
Ex. 1004, Fig. 5 (showing optical fiber connector coupled with AWG 235 at the input end of carrier 238)

- f. **Claim term 1[e] (“an arrayed waveguide grating further disposed on a top surface of the carrier that defines a midpoint of the carrier, the arrayed waveguide grating having a first end, a middle, and a second end disposed opposite the first end, and an input end of the arrayed waveguide grating connected to the optical fiber connector for receiving an optical signal from the optical fiber, wherein the top surface of the carrier underlies the middle of the arrayed waveguide grating”)**

Ho discloses an AWG demultiplexer 235 in ROSA 230. Ex. 1004, ¶¶[0039], [0042], [0043]. In Ho modified in view of Lee, AWG 235 would have been mounted on a sub-mount disposed on a top surface of carrier 238 that defines a midpoint of the carrier. Ex. 1004, Fig. 5 (shown below); *see also id.*, Fig. 4; Ex. 1003, ¶109. It

wavelengths and to demultiplex (divide) the WDM signal into individual channel wavelengths. *Id.*, ¶¶[0057], [0027]. Optical outputs 237 of the demultiplexer 235 are directly optically coupled to an array of photodetector 236, having photodiodes 270, without any intermediate fibers. *Id.*, ¶¶[0042], [0043]. It would have been obvious to a POSITA, based on Ho's disclosure of an array of photodetectors 236 corresponding to the number of optical outputs 237 and Ho's disclosure of AWG demultiplexing, that the demultiplexing of the optical signals is done in parallel by the AWG. *Id.*, ¶¶[0018], [0027], [0057]; Ex. 1003, ¶111. Indeed, a POSITA would have known that an AWG demultiplexer, like the one disclosed in Ho, necessarily divides the received signal into multi-channel optical signals in parallel based on their wavelengths. Ex. 1003, ¶111.

Lee discloses a PLC (planar lightwave circuit) 110, which may be used as an AWG demultiplexer. Ex. 1006, ¶[0009]. PLC 110 includes an inclined/angled surface 111 disposed at the second (output) end of PLC 110, as shown in Lee's Figure 2, below. Lee further discloses that inclined surface 111 may be formed at an angle of 45 degrees, and a reflection layer 112 is formed on inclined surface 111 for vertically reflecting an optical signal from PLC 110 to photodiode 430. *Id.*, ¶¶[0049]-[0051], [0053], [0058], Figs. 2, 8.



Ex. 1004, Fig. 2 (showing that light from PLC 110 is reflected down by the inclined surface 111 to photodiode 430) (annotations added)

As discussed above, a POSITA would have been motivated to modify Ho in view of Lee to use the more efficient and reliable direct coupling technique disclosed in Lee. *See* Section VII.C, above. Accordingly, in Ho modified in view of Lee, the output end of Ho's AWG 235 would have been modified to have an inclined surface cut at a 45-degree angle, such as surface 111 of Lee, to vertically reflect the demultiplexed outputs 237 to the photosensitive surfaces of photodiodes 270 provided below the angled surface. Ex. 1003, ¶113.

Lee's disclosure that an angle of the inclined surface 111 is about 45 degrees, which falls within the recited range of about 41 to 46 degrees, renders the claimed

range obvious. *See UCB*, 65 F.4th at 687; *Titanium*, 778 F.2d at 776-77. Moreover, a POSITA would also have been able to determine the range of suitable angles based on the teachings of Lee, through routine experimentation and optimization, to obtain desired coupling efficiency. *See, e.g.*, Ex. 1003, ¶¶118-122.

2. Claim 2 (“The multi-channel parallel optical receiving device according to claim 1, wherein the top surface of the end of the carrier is defined at least in part by a circuit board, and wherein the plurality of optoelectronic diodes and the light receiving chip are directly disposed on the circuit board.”)

Ho teaches mounting the “array of photodetectors 236 includ[ing] PIN type photodiodes 270 [] on a photodetector mounting bar 272 together with associated transimpedance amplifiers (TIAs) 274.” Ex. 1005, ¶[0044]. A POSITA would have understood photodetector mounting bar 272 to be a circuit board. *See id.*, ¶¶[0045], [0046] (discussing conducting paths, pads, and components on mounting bar 272); Ex. 1003, ¶115. Similarly, Lee teaches that the photodiodes may be mounted on a PLC (planar lightwave circuit) or a mounting board put on the PLC. Ex. 1006, ¶[0013], Fig. 1. Therefore, it would have been obvious to a POSITA that Ho’s photodiodes (optoelectronic diodes) 270 and TIAs (light receiving circuit) 274 may be mounted on a circuit board, such as a PLC or a mounting bar, instead of mounting them directly on carrier 238, as discussed above with reference to claim terms 1[b] and 1[c]. Ex. 1003, ¶115. The circuit board would have been mounted at least in part

on the top surface of the end of carrier 238, so that photodiodes 270 are positioned below the output edge of AWG 235. *Id.* When Ho in view of Lee is modified to mount photodiodes 270 and TIAs 277 on a circuit board and then position the circuit board at least partially on carrier 238, the top surface of the end of the carrier 238 would have been defined at least in part by the circuit board, and wherein the plurality of optoelectronic diodes and the light receiving chip are directly disposed on the circuit board. *Id.*

Although mounting Ho's photodiodes 270 and TIAs 274 directly on carrier 238 may reduce the number of components on the carrier, as discussed above, a POSITA alternatively would have been motivated to mount photodiodes 270 and TIAs 274 on a circuit board instead of directly on the carrier to make the alignment process (between the AWG outputs and the photodiodes) easier and efficient. Ex. 1003, ¶116. That is, a POSITA would have understood that if photodiodes 270 and TIAs 274 are pre-mounted on a circuit board, it would have been easier to align photodiodes 270 with the demultiplexed output 237 during manufacturing assembly. *Id.* Moreover, a POSITA would have known that if any defect arises in any of the photodiodes 270, TIAs 274 or the wire-bonding between the photodiodes and the TIAs, only the circuit board would have to be replaced instead of the entire ROSA 230 or the entire carrier 238. *Id.* A POSITA would have reasonably expected success in positioning photodiodes 270 and TIAs 274 on a circuit board, which is then

mounted on carrier 238, because locating and aligning electronic components within a device is well within the routine and ordinary skills of POSITA. *Id.* Indeed, a POSITA would reasonably have been able to position photodiodes 270 and TIAs 277 on a printed circuit board and then position the circuit board on carrier 238 through minimal trial-and-error and routine experimentation/optimization and the exercise of ordinary skill. *Id.*

3. Claim 3 (“The multi-channel parallel optical receiving device according to claim 1, wherein the amount of the optoelectronic diodes is equal to the amount of optical paths divided by the arrayed waveguide grating.”)

Ho discloses that the number of photodiodes (optoelectronic diodes) 270 is equal to the number of optical paths divided by AWG demultiplexer 235. Ex. 1004, ¶[0044] (“In the illustrated embodiment of a 16 channel ROSA, for example, 16 photodiodes 270 are aligned with 16 optical outputs 237 and electrically connected to 16 associated TIAs 274, respectively.”); *see also id.*, ¶¶[0042], [0043].

4. Claim 4 (“The multi-channel parallel optical receiving device according to claim 1, wherein the predetermined angle of the top surface of the output end of the arrayed waveguide grating is 42 degrees.”)

Lee discloses an AWG demultiplexer having an inclined surface 111 (i.e., the top surface of the output end of the AWG) that is cut at a predetermined angle of 45 degrees to directly couple the light reflected orthogonally by inclined surface 111 with corresponding photodiodes 430. Ex. 1006, ¶[0012] (Lee discussing that a

“method of coupling light by reflecting a path of light at an angle of 90 using a mirror surface 1 with an angle of 45 as shown in FIG. 1 is widely used.”), ¶[0051] (“The angle of the inclined surface 111 is most desirably 45 degrees, but not limited to 45 degrees because it is difficult to accurately polish the inclined surface 111 in the actual implementation.”).

While Lee does not explicitly disclose that the predetermined angle of the top surface is 42 degrees, Lee’s disclosure of 45 degrees renders this claim limitation obvious, especially because the ’301 patent does not disclose that a 42-degree angle is critical, or generates new or unexpected results. *Brandt*, 886 F.3d at 1177; *Dreyfus*, 73 F.2d at 934.

Indeed, it is well established that a *prima facie* case of obviousness exists where the claimed range or value does not overlap with the prior art but is close. *See* M.P.E.P. § 2144.05 (citing *Titanium Metals*, 778 F.2d at 783; *Aller*, 220 F.2d at 456; *Scherl*, 156 F.2d at 74-75).

Moreover, a POSITA would have known that a 42-degree interior angle of the inclined top surface of the AWG is an obvious design choice and obvious-to-try based on multiple considerations, as discussed below. Ex. 1003, ¶119.

Specifically, a POSITA would have known that the ability of the AWG chip to effectively reflect light onto the photodetectors would be affected by the interior angle of the inclined surface of the AWG. Ex. 1003, ¶120. Therefore, the interior

angle of the inclined top surface is a result-effective variable that affects the reflection of light onto the photodetectors. *Id.* And it is well established that the determination of the optimum range of a result-effective variable is within the grasp of one skilled in the art. *Boesch*, 617 F.2d at 276; *Applied Materials*, 692 F.3d at 1295, 1297 (quoting *Aller*, 220 F.2d at 456). Therefore, optimization of the interior angle of the inclined top surface of the AWG was nothing other than the exercise of ordinary skill in the art. *Huang*, 100 F.3d at 139; *Iron Grip*, 392 F.3d at 1322.

Indeed, a POSITA would have known to design an AWG with an inclined top surface having a suitable interior angle, e.g., an angle of about 42 degrees, based on the teachings of Lee and through routine experimentation and design considerations, to optimize the direct coupling of demultiplexed light with respective photodetectors. Ex. 1003, ¶121. For example, an AWG chip having an inclined surface with an interior angle of 45 degrees was already taught by Lee. *See* Ex. 1006, ¶¶[0012], [0050], [0051]. Based on the teachings of Lee, a POSITA would have known how to adjust interior angle for other AWG demultiplexer chips using routine optimization and design considerations to effectively reflect light onto photodiodes. Ex. 1003, ¶121. Thus, the recited angle of 42 degrees would have been obvious to a POSITA. *Id.*

In short, Lee's disclosure that "[t]he angle of the inclined surface 111 is most desirably 45 degrees," which is close to the claimed value of 42 degrees, renders

claim 4 obvious. Ex. 1006, ¶[0051]; Ex. 1003, ¶122.

VIII. MANDATORY NOTICES

A. Real Parties-in-Interest

The real parties-in-interest for this Petition are Accelight Technologies, Inc. and Accelight Technologies (Wuhan) Inc.

B. Related Matters

To Petitioner's knowledge, the '301 patent is involved in the following:

Name	Number	Court	Filed
<i>Applied Optoelectronics, Inc. v. Accelight Technologies, Inc.</i>	4:24-cv-09041	N.D. Cal.	Dec. 13, 2024
<i>Applied Optoelectronics, Inc. v. Cambridge Industries USA, Inc.,</i>	5:24-cv-01010	N.D. Cal.	Feb. 20, 2024

C. Lead and 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.

IX. STANDING

The '301 patent is eligible for IPR and Petitioner is not barred or estopped from requesting IPR challenging the patent claims on the grounds identified herein.

X. CONCLUSION

For the foregoing reasons, Petitioner submits that the challenged claims of the '301 patent should be cancelled.

Dated: September 26, 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 12,718 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 September 26, 2025, a copy of the foregoing Petition for *Inter Partes* Review, the associated power of attorney, and Exhibits 1001-1007 were served by FedEx Priority Overnight on the correspondence address of record indicated in the Patent Office's website for U.S. Patent No. 10,379,301:

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: September 26, 2025

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