(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) **World Intellectual Property Organization**
International Bureau

(43) **International Publication Date**
21 March 2013 (21.03.2013)

WIPO | PCT

(10) **International Publication Number**
WO 2013/039655 A1

(51) **International Patent Classification**:
H04B 10/24 (2006.01) ***G02B 6/42*** (2006.01)

(21) **International Application Number**:
PCT/US2012/051778

(22) **International Filing Date**:
22 August 2012 (22.08.2012)

(25) **Filing Language**: English

(26) **Publication Language**: English

(30) **Priority Data**:
61/535,817 16 September 2011 (16.09.2011) US
13/406,629 28 February 2012 (28.02.2012) US

(71) **Applicant** *(for all designated States except US)*: **SMSC Holdings S.à.r.l** [LU/LU]; 6 rue Philippe II, L-2340 Luxembourg (LU).

(72) **Inventors; and**
(75) **Inventors/Applicants** *(for US only)*: **BECHT, Markus N.** [DE/DE]; Breitenacker 18, 76359 Marxzell (DE). **IVANOV, Galin I.** [DE/DE]; Tullastr 28, 76131 Karlsruhe (DE). **MARCHMAN, Evan L.** [US/US]; 6101 Harrogate Drive, Austin, Texas 78759 (US).

(74) **Agent**: **MEYERTONS, HOOD, KIVLIN, KOWERT & GOETZEL, P.C.**; HOOD, Jeffrey C, P.O. Box 398, Austin, Texas 78767-0398 (US).

(81) **Designated States** *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) **Designated States** *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

[Continued on next page]

(54) **Title**: ASSEMBLING AN OPTICAL TRANSCEIVER BASED ON LEAD FRAME FEATURES

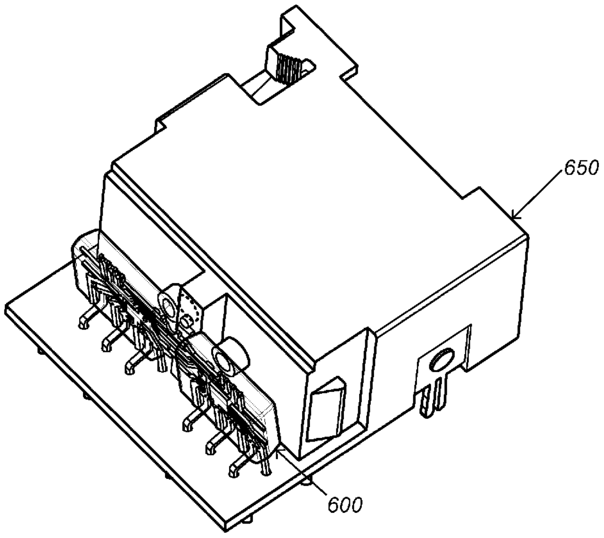

FIG. 9A

(57) **Abstract**: Assembling an optical transceiver. A connector housing for a semiconductor package may be received. The connector housing may include a first alignment feature for assembling the optical transceiver. Additionally, a semiconductor package may be received. The semiconductor package may include a leadframe that has a second alignment feature which is complementary to the first alignment feature. The semiconductor package may be attached to the connector housing to form the optical transceiver by aligning the second alignment feature of the leadframe of the semiconductor package with the first alignment feature of the connector housing. This alignment may operate to align an optical axis a fiber optic transmitter and/or a fiber optic receiver with a corresponding fiber optic connector.

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

ASSEMBLING AN OPTICAL TRANSCEIVER BASED ON LEAD FRAME FEATURES

Priority Information

[0001] This application claims benefit of priority of U.S. provisional application Serial No. 61/535,817 titled "Alignment of Optical Sensors" filed September 16, 2011, whose inventors were Tony Susanto, Zhonghong Shen, Tihsiang Hsu, Markus N. Becht, Galin I. Ivanov and Evan L. Marchman.

Field of the Invention

[0002] The present invention relates to the field of optical systems, and more particularly to assembling an optical transceiver based on alignment features.

Description of the Related Art

[0003] In recent years communication between devices has become both prevalent and necessary. In some systems, devices may communicate via optical means, e.g., using optical cables and optical transceivers. Accordingly, in manufacturing such devices, or, particularly, the chips which perform communication, alignment of the optical sensors is important. However, current solutions often align these sensors using imprecise methods. Accordingly, improvements in alignment of optical sensors are desired.

Summary of the Invention

[0004] Various embodiments of a system and method for alignment of optical sensors based on lead frame features are provided below.

[0005] Initially, a connector housing for a transceiver may be received. For example, the connector housing may have been previously manufactured or formed and may be provided to assemble an optical transceiver. The connector housing may include a first alignment feature comprised on the connector housing.

[0006] Additionally, a semiconductor package may be received. Similar to above, the semiconductor package may have been previously manufactured or formed and may be provided to combine with the connector housing to form the optical transceiver. The semiconductor package may include a leadframe, e.g., which physically connects or binds the transmitter and receiver together. Additionally, the leadframe may include a second alignment feature that is complementary to the first alignment feature. Note that the semiconductor package may generally be covered in a compound (e.g., plastic or molding) after manufacture. However, at least a portion of the leadframe, e.g., the portion which includes the second alignment feature, may remain exposed, without the compound, in order to perform the alignment discussed below.

[0007] In one embodiment, the first alignment feature comprises a first geometric shape, and the second alignment feature may include a second shape that is complementary to at least a first portion of the first geometric shape. In one embodiment, the first alignment feature may include a cylindrical protrusion. Accordingly, the second alignment feature may be a semicircular notch or divot that is complementary with the cylindrical protrusion (e.g., a half circle notch that is complementary to the circle formed by the cylindrical protrusion). Other shapes and pairings are envisioned. For example, the two may fit together in a two dimensional sense. In one particular embodiment, the shapes may fit together in a "puzzle piece" manner, e.g., where the two components cannot be combined in the same plane (e.g., horizontal plane) but are combined via approach from a different direction (e.g., along a vertical axis). Alternatively, the two shapes may fit together in a three dimensional sense, such as where one or more of the alignment features pair not only on a horizontal plane, but also in a vertical plane (e.g., where grooves or features fit into one or both of the semiconductor package or the connector housing).

[0008] In some embodiments, more than one set of alignment features may be used. For example, the connector housing may have a plurality of alignment features and the semiconductor package may have a corresponding plurality of alignment features. For example, the connector housing may have two similar alignment features (e.g., at the top and bottom of the connecting area) and the semiconductor package may have two similar, complementary alignment features for assembly. Alternatively, the alignment features may be inverted. For example, the connector housing may have a first alignment feature that protrudes and a second alignment feature that recesses. Accordingly, the semiconductor package may have corresponding complementary alignment features such that the two elements may "mate" with the proper orientation.

[0009] Accordingly, the semiconductor package and the connector housing may be combined (e.g., by attaching the semiconductor package to the connector housing) to form the optical transceiver. The attachment process may include aligning the second alignment feature of the leadframe of the semiconductor package with the first alignment feature of the connector housing. In some embodiments, the alignment of these features may result in alignment of an optical axis of at least one of a fiber optic transmitter or a fiber optic receiver with a corresponding fiber optic connector. For example, the connector housing may include a receiver port and a transmitter port which allow the receiver and the transmitter to receive and transmit optic signals through an optic connection (e.g., a fiber optic cable). More specifically, aligning the alignment features discussed above may precisely align the ports of the connector housing with the optic portions of the receiver and transmitter (e.g., which control a photodiode and LED respectively), thereby allowing the transceiver to properly perform optic communication. This procedure may be particularly more precise and less prone to alignment issues than aligning molded or plastic features (e.g., of the semiconductor package), which may not be as precisely manufactured as the lead frame.

Brief Description of the Drawings

[0010] A better understanding of the present invention can be obtained when the following detailed description of the preferred embodiment is considered in conjunction with the following drawings, in which:

[0011] Figure 1 illustrates an exemplary ring network for a set of devices, according to one embodiment;

[0012] Figure 2 illustrates an exemplary system block diagram of a portion of a device, according to one embodiment;

[0013] Figures 3 and 4 are block diagrams of exemplary transceivers, according to one embodiment;

[0014] Figures 5 is a flowchart diagram illustrating an embodiment of a method for aligning optical sensors based on lead frame features; and

[0015] Figures 6A-10B are exemplary Figures illustrating alignment of optical sensors according to the method of Figure 5, according to some embodiments.

[0016] While the invention is susceptible to various modifications and alternative forms, specific embodiments thereof are shown by way of example in the drawings and are herein described in detail. It should be understood, however, that the drawings and detailed description thereto are not intended to limit the invention to the particular form disclosed, but on the contrary, the intention is to cover all modifications, equivalents and alternatives falling within the spirit and scope of the present invention as defined by the appended claims.

Detailed Description of the Invention

Terms

[0017] The following is a glossary of terms used in the present application:

[0018] **Memory Medium** – Any of various types of memory devices or storage devices. The term "memory medium" is intended to include an installation medium, e.g., a CD-ROM, floppy disks 104, or tape device; a computer system memory or random access memory such as DRAM, DDR RAM, SRAM, EDO RAM, Rambus RAM, etc.; a non-volatile memory such as a Flash, magnetic media, e.g., a hard drive, or optical storage; registers, or other similar types of memory elements, etc. The memory medium may comprise other types of memory as well or combinations thereof. In addition, the memory medium may be located in a first computer in which the programs are executed, or may be located in a second different computer which connects to the first computer over a network, such as the Internet. In the latter instance, the second computer may provide program instructions to the first computer for execution. The term "memory medium" may include two or more memory mediums which may reside in different locations, e.g., in different computers that are connected over a network.

[0019] **Carrier Medium** – a memory medium as described above, as well as a physical transmission medium, such as a bus, network, and/or other physical transmission medium that conveys signals such as electrical, electromagnetic, or digital signals.

[0020] **Programmable Hardware Element** - includes various hardware devices comprising multiple programmable function blocks connected via a programmable interconnect. Examples include FPGAs (Field Programmable Gate Arrays), PLDs (Programmable Logic Devices), FPOAs (Field Programmable Object Arrays), and CPLDs (Complex PLDs). The programmable function blocks may range from fine grained (combinatorial logic or look up tables) to coarse grained (arithmetic logic units or processor cores). A programmable hardware element may also be referred to as "reconfigurable logic".

[0021] **Hardware Configuration Program** – a program, e.g., a netlist or bit file, that can be used to program or configure a programmable hardware element.

[0022] **Computer System** – any of various types of computing or processing systems, including a personal computer system (PC), mainframe computer system, workstation, network appliance, Internet appliance, personal digital assistant (PDA), television system, grid computing system, or other device or combinations of devices. In general, the term "computer system" can be broadly defined to encompass any device (or combination of devices) having at least one processor that executes instructions from a memory medium.

[0023] **Optical Device** – any of various devices which are capable of performing optical communication.

[0024] **Automatically** – refers to an action or operation performed by a computer system (e.g., software executed by the computer system) or device (e.g., circuitry, programmable hardware elements, ASICs, etc.), without user input directly specifying or performing the action or operation. Thus the term "automatically" is in contrast to an operation being manually performed or specified by the user, where the user provides input to directly perform the operation. An automatic procedure may be initiated by input provided by the user, but the subsequent actions that are performed "automatically" are not specified by the user, i.e., are not performed "manually", where the user specifies each action to perform. For example, a user filling out an electronic form by selecting each field and providing input specifying information (e.g., by typing information, selecting check boxes, radio selections, etc.) is filling out the form manually, even though the computer system must update the form in response to the user actions. The form may be automatically filled out by the computer system where the computer system (e.g., software executing on the computer system) analyzes the fields of the form and fills in the form without any user input specifying the answers to the fields. As indicated above, the user may invoke the automatic filling of the form, but is not involved in the actual filling of the form (e.g., the user is not manually specifying answers to fields but rather they are being automatically completed). The present specification provides various examples of operations being automatically performed in response to actions the user has taken.

Figure 1 – Exemplary Ring Network

[0025] Figure 1 illustrates an exemplary ring network 100 having a plurality of devices coupled together in a ring arrangement. More specifically, the network 100 of Figure 1 is an exemplary network involving a plurality of audio devices, e.g., within an automobile. As shown, the network 100 includes a receiver 102 coupled to right front speaker 104, which is in turn coupled to right rear speaker, which is in turn coupled to sub woofer 108, which is in turn coupled to left rear speaker 110, which is in turn coupled to left front speaker 112, which is also coupled to the receiver 102.

[0026] In the exemplary embodiment of Figure 1, the network 100 may be an optical network where each device communicates over the network 100 using optical communication. For example, each device may be coupled to its neighboring devices using an optical connection, such as optical fiber.

[0027] In one embodiment, the network 100 may be a MOST network that utilizes the MOST application framework. Generally, a MOST network may have a maximum of 64 nodes per ring, a maximum distance of 10 m between two nodes, and may be used in a point-to-point optical network, e.g., such as shown in Figure 1. The MOST application framework is a set of object oriented, reusable components to design multimedia systems in automotive environment, but also in similar other application areas. In a classically wired system, each device may be controlled by an individual cable, such that the wiring harness will grow with each new device that is added to the system. Accordingly, the devices each have proprietary connections and systems. These proprietary systems force a controlling device to handle many different interfaces and protocols.

[0028] In a networked system, such as in Figure 1, each device may be identified by a unique address and shares various data with a common connection. Devices can be controlled by a dedicated master (e.g., the receiver 102), but can also exchange information with each other. An advantage of a networked system is that the communication paths are defined. Therefore, developers can focus on the product functionality instead of continuously adapting their interfaces to the HMI.

[0029] The MOST application framework is independent from devices and network, allows use of functional modeling (e.g., fblocks, functions, etc.), provides hierarchical system management (e.g., masters, controllers, slaves, etc.), provides service discovery and plug and play mechanisms, provides modularity and reusability (e.g., of fblocks), and may provide free partitioning and easy repartioning (e.g., of fblocks), among other advantages.

[0030] In the exemplary network 100 of Figure 1, audio data may be provided from the receiver to the left front speaker 112 and/or the right front speaker 104. The audio data may include data for one or more (or each of) the right front speaker 104, the right rear speaker 106, the sub woofer 108, the left rear speaker 110, or the left front speaker 112. Accordingly, the right front speaker 104 may receive the audio data over the network, determine if any portion of the audio data is addressed or intended for the right front speaker 104 and pass the data on to right rear speaker 106, which may perform the same operations, continuing through the rest of the devices in the network 100. Alternatively, or additionally, the same procedures may be performed starting with the left front speaker 112 through the right front speaker 104 in the opposite direction. In various embodiments, the directionality of data may be clockwise, counter-clockwise, or both in the ring network 100.

[0031] While Figure 1 shows a typical ring network, note that in various other embodiments, different networks may be used. For example, the network 100 may be configured as a star network (e.g., having a centralized controller or hub) or may be a hybrid network, e.g., where a portion of the network uses a star configuration and another portion uses a ring configuration. Additionally, the particular devices and implementations of Figure 1 are exemplary only. Virtually any type of devices may be used in a ring network, instead of, or in addition to, the audio devices shown in Figure 1. For example, the devices in the network could include video devices, GPS devices, cell phones, tablets, computer systems, are any desired device. Thus, the network 100 and devices shown in Figure 1 are exemplary only and may be implemented according various different configurations and may include any of a variety of desired devices.

[0032] Thus, Figure 1 is an exemplary network which includes devices that may operate as described herein.

Figure 2 – Exemplary Block Diagram of a Device

[0033] Figure 2 illustrates an exemplary block diagram of a device 200, e.g., which may be included in the network 100. More specifically, the block diagram of Figure 2 may apply to any of the devices shown in Figure 1.

[0034] As shown, the device 200 may include a network interface chip 210 and a fiber optic transceiver 250. As also shown, the fiber optic transceiver 250 may include a transmitter 260 and a receiver 270, which are coupled to each other. As also shown, the fiber optic transceiver 202 may be coupled to the network interface chip 208 via one or more lines or pins. More specifically, there may be two LVDS lines from the network interface chip 208 and two LVDS lines from the fiber optic transceiver 202. Additionally, there may be a bidirectional line between the transmitter 204 of the fiber optic transceiver 202 and the network interface chip 208 which may provide STATUS information.

Figures 3 and 4 – Fiber Optic Transceiver 250

[0035] Figure 3 illustrates one embodiment of a more detailed block diagram of the fiber optic transceiver 250. As shown, the transceiver includes the receiver 270 (e.g., implemented as a first chip), which may be implemented as a sensitive optical receiver, and the transmitter 260 (e.g., an LED driver). In one embodiment, the receiver 270 and transmitter 260 may be comprised within the same optical assembly along with a photodiode and LED.

[0036] As shown, the receiver 270 and the transmitter 260 are coupled via a serial bus. More specifically, the receiver includes a serial peripheral interface (SPI) 272 which is coupled to the SPI 262 of the transmitter 260. In this particular embodiment, the SPIs 272 and 262 communicate using three lines from the SPI interface 262 to the SPI interface 272, one for SCLK (serial clock), one for MOSI (e.g., for data), and one for SS (slave select). As was shown in Figure 2, the transmitter may be directly coupled to the network interface chip 210, while the receiver 270 may not.

[0037] Thus, this system allows the two chips to transfer serial data between them across a SPI (e.g., a 3 pin SPI). The receiver 270 may be configured to receive important settings from the transmitter 260 that is also configured to serially communicate with the network interface chip 210. The network interface chip 210 may be configured to serially send and receive data to and from the transmitter 260 (e.g., via the serial_I/O pin), which can then serially shift important settings data to the receiver 270. Since the chip to chip transaction may be performed rarely, the receiver 270 can remain quiet of digital noise and optimize receive sensitivity while monitoring the photodiode. More specifically, in one embodiment, the receiver 270 may not perform analog to digital conversion and/or digital to analog conversion (e.g., it may not have circuitry that is able to perform such conversions or such circuits may not be utilized), may not receive clock signals (e.g., from the transmitter 260), may not generate clock signals (e.g., it may not be configured to generate clock signals), may not have state transitions (e.g., such as digital state transitions), may not have flip flop toggling, etc. during normal operation, such as while receiving optical data from devices on the network 100.

[0038] Figure 4 illustrates another embodiment of a more detailed block diagram of the fiber optic transceiver 250. In this embodiment, the receiver 270 may be configured to determine optical power being received by a photodiode. The analog interface 472 may be configured to provide this power reading, e.g., via voltage or current, to the transmitter 260, e.g., via serial I/O interface 462. In the embodiment of Figure 4, the transmitter 260 may be configured to perform analog to digital conversion of this information and communicate the resulting digital information to the network interface chip 210 through a serial I/O pin (e.g., the STATUS line shown in Figure 2). Accordingly, the noisy translation of the optical power signal to digital domain may be performed by the transmitter 260 rather than the receiver 270, thereby allowing the receiver 270 to remain quiet and be better able to translate sensitive optical inputs from the photodiode, e.g., without interference from digital oscillations.

[0039] Note that the embodiments of Figures 3 and 4 may be implemented separately, or may be combined, as desired. For example, the analog interface 472 of Figure 4 may utilize the SPI interfaces shown in Figure 3 to perform communication. Additionally, or alternatively, the analog interface 472 may be combined or included as a part of the SPI interface 272, as desired. Similarly, the serial I/O interface 462 may be implemented as (e.g., all or a portion of) the SPI interface 262. For example, the SPI interfaces 272 and 262 may be modified to include an additional line for providing the optical power information from the receiver 270 to the transmitter 260.

Figure 5 – Alignment of Optical Sensors Based on Lead Frame Features

[0040] Figure 5 illustrates a method for alignment of optical sensors based on lead frame features. The method shown in Figure 5 may be used in conjunction with any of the computer systems or devices shown in the above Figures, among other devices. More specifically, the method of Figure 5 may be used to manufacture and/or assemble the transceiver 250 discussed above. In various embodiments, some of the method elements shown may be performed concurrently, in a different order than shown, or may be omitted. Additional method elements may also be performed as desired. As shown, this method may operate as follows.

[0041] Initially, in 502, a connector housing for an optical transceiver may be received. For example, the connector housing may have been previously manufactured or formed and may be provided to assemble an optical transceiver. The connector housing may include a first alignment feature included on the connector housing. Generally, the connector housing may include elements which allows optical connections (e.g., fiber optic cable(s)) to interact or couple with the transmitter and receiver. In some embodiments, the connector housing may include a photodiode which detects incoming optical signals and an LED which is used to transmit optical signals. These may be electrically coupled to the receiver and transmitter, respectively, after assembly. However, the photodiode and LED may be included on the transmitter and receiver of a semiconductor package, discussed below.

[0042] In 504, the semiconductor package may be received. The semiconductor package may include the circuitry or logic implementing the receiver and transmitter described above. Similar to above, the semiconductor package may have been previously manufactured or formed and may be provided to combine with the connector housing to form the optical transceiver. According to various embodiments, the semiconductor package may have been manufactured by the same manufacturer as the connector housing, or a different manufacturer, as desired. The semiconductor package may include a leadframe, e.g., which physically connects or binds the transmitter and receiver together. Additionally, the leadframe may include a second alignment feature that is complementary to the first alignment feature of the connector housing. Note that the semiconductor package may generally be covered in a compound (e.g., plastic or molding) after manufacture. However, at least a portion of the leadframe, e.g., the portion which includes the second alignment feature, may remain exposed, without the compound, in order to perform the alignment discussed below.

[0043] In one embodiment, the first alignment feature may include a first geometric shape, and the second alignment feature may include a second shape that is complementary to at least a first portion of the first geometric shape. In one embodiment, the first alignment feature may include a cylindrical protrusion. Accordingly, the second alignment feature may be a semicircular notch or divot that is complementary with the cylindrical protrusion (e.g., a half circle notch that is complementary to the circle formed by the cylindrical protrusion).

[0044] Other shapes and pairings are envisioned. For example, the two may fit together in a two dimensional sense. In one particular embodiment, the shapes may fit together in a "puzzle piece" manner, e.g., where the two components cannot be combined within the same plane (e.g., horizontal plane) but are combined via approach from a different direction (e.g., along a vertical axis). Alternatively, the two shapes may fit together in a three dimensional sense, such as where one or more of the alignment features pair not only on a horizontal plane, but also in a vertical plane (e.g., where grooves or features fit into one or both of the semiconductor package or the connector housing). Further fittings between the two alignment features are envisioned.

[0045] In some embodiments, more than one set of alignment features may be used. For example, the connector housing may have a plurality of alignment features and the semiconductor package may have a corresponding plurality of alignment features. For example, the connector housing may have two similar alignment features (e.g., at the top and bottom of the connecting area) and the semiconductor package may have two similar, complementary alignment features for assembly. Alternatively, the alignment features may be inverted. For example, the connector housing may have a first alignment feature that protrudes and a second alignment feature that recedes. Accordingly, the semiconductor package may have corresponding complementary alignment features such that the two elements may "mate" with the proper orientation.

[0046] Accordingly, in 506, the semiconductor package and the connector housing may be combined, e.g., by attaching the semiconductor package to the connector housing, to form the optical transceiver. The attachment process may include aligning the second alignment feature of the leadframe of the semiconductor package with the first alignment feature of the connector housing. In some embodiments, the alignment of these features may result in alignment of an optical axis of at least one of a fiber optic transmitter or a fiber optic receiver with a corresponding fiber optic connector. For example, the connector housing may include a receiver port and a transmitter port which allow the receiver and the transmitter to receive and transmit optic signals through an optic connection (e.g., a fiber optic cable). More specifically, aligning the alignment features discussed above may precisely align the ports of the connector housing with the optic portions of the receiver and transmitter (e.g., which control a photodiode and LED respectively), thereby allowing the transceiver to properly perform optic communication. This procedure may be particularly more precise and less prone to alignment issues than aligning molded or plastic features (e.g., of the semiconductor package), which may not be as precisely manufactured as the lead frame.

Figures 6A-10B – Alignment of Optical Sensors

[0047] Figures 6A-6D are exemplary Figures illustrating alignment of optical sensors according to the method of Figure 5, according to some embodiments.

[0048] More specifically, Figure 6A illustrates proper alignment of the semiconductor package with the connector housing. More specifically, as shown, the lead frame 605 of the semiconductor package 600 connects the transmitter 602 and receiver 604. Additionally, as shown, the lead frame 605 includes two alignment features 610 and 620. These alignment features are complementary to the alignment features 660 and 670 of the connector housing 650. In the specific example shown in Figure 6A, the alignment features 610 and 620 are half circle notches which are complementary to the alignment features 660 and 670, which are cylindrical protrusions.

[0049] By aligning these alignment features, the optical sensors or elements 680A and 680B of the connector housing and the corresponding optical elements 630A and 630B semiconductor package are also properly aligned. Thus, proper alignment of the alignment features may result in proper alignment of the optical elements of the connector housing and the semiconductor package.

[0050] Figures 6B-6D illustrate various situations where the alignment features of the semiconductor package and the connector housing are not properly aligned, and correspondingly, the optical elements of the semiconductor package and the connector housing are also not properly aligned. These mis-alignments and corrections are shown with dotted circles and arrows in Figures 6B-6D. As shown, Figure 6B is slightly skewed in a counter clockwise direction and needs to be adjusted in a clockwise manner. Figures 6C and 6D have vertical mis-alignments and need to be aligned vertically. The alignment features of the package and housing allows this alignment to be performed quickly and accurately.

[0051] Figure 7A is a side view of the semiconductor package 600 and the connector housing 650 during assembly, but prior to completion. Figure 7B illustrates the same view with the semiconductor package 600 attached to the connector housing 650. As shown, there is physical contact for the optical elements of the semiconductor package 600 and the connector housing 650 as well as the exterior portion of the semiconductor package 600. Additionally, the optical elements are now properly aligned along the optical axis (shown as a dotted line). Finally, there is no contact of the transceiver circuitry with the semiconductor housing, as shown.

[0052] Figure 8A is a top down view of the semiconductor package 600 and the connector housing 650 during assembly, but prior to completion. Figure 8B illustrates the same view with the optical transceiver fully assembled.

[0053] Figure 9A is another top down view of the semiconductor package 600 and the connector housing 650 during assembly, but prior to completion. Figure 9B illustrates the same view with the optical transceiver fully assembled.

[0054] Figure 10A is a side bisected view of the semiconductor package 600 and the connector housing 650 during assembly, but prior to completion. As shown, the optical connector 650 is in the process of being aligned with the corresponding optical element of the semiconductor package 600. Figure 10B illustrates the same view with the optical transceiver fully assembled.

Additional Embodiments

[0055] While the above embodiments are described with respect to particular optical transceivers, the use of alignment features, particularly those present on leadframes, may be useful in other areas. Thus, the above described embodiments are not limited to the specific application discussed above, but may be applied to assembly of any type of circuit or device, as desired.

[0056] Additionally, the above embodiments are not limited to leadframes only. For example, in one embodiment, semiconductor packages may utilize additional types of sub-carrier, such as QFN, BGA, etc. Accordingly, instead of using leadframes (having the above-described alignment features), other materials may be used, such as FR4 (e.g., standard PCB material), BT (Bismaleimide-Traizine), polyimide, ceramic, or other custom materials. Such materials may be referred to as a "substrate" of the package, e.g., a "package substrate". In general, the substrate may be any material on which an IC is mounted. Thus, rather than using alignment feature(s) of the leadframe, alignment feature(s) of the substrate of the semiconductor package may be used.

[0057] Although the embodiments above have been described in considerable detail, numerous variations and modifications will become apparent to those skilled in the art once the above disclosure is fully appreciated. It is intended that the following claims be interpreted to embrace all such variations and modifications.

Claims

We Claim:

1. A method for assembling an optical transceiver, comprising:

receiving a connector housing for a semiconductor package, wherein the connector housing comprises a first alignment feature comprised on the connector housing;

receiving a semiconductor package comprising a leadframe, wherein the leadframe includes a second alignment feature, wherein the second alignment feature is complementary to the first alignment feature;

attaching the semiconductor package to the connector housing to form the optical transceiver, wherein said attaching comprises aligning the second alignment feature of the leadframe of the semiconductor package with the first alignment feature of the connector housing;

wherein said aligning operates to align an optical axis of at least one of a fiber optic transmitter or a fiber optic receiver with a corresponding fiber optic connector.

2. The method of claim 1, wherein the first alignment feature comprises a first geometric shape;

wherein the second alignment feature comprises a second shape that is complementary to at least a first portion of the first geometric shape.

3. The method of claim 2, wherein the first alignment feature comprises a cylindrical protrusion.

4. The method of claim 1, wherein the connector housing has a plurality of first alignment features, wherein the semiconductor package has a plurality of second alignment features, and wherein said aligning comprises aligning each of the plurality of first alignment features to a corresponding one of the plurality of second alignment features.

5. The method of claim 1, wherein at least a portion of the leadframe comprising the second alignment feature is exposed during said attaching.

6. The method of claim 1, wherein said aligning operates to align an optical axis of the fiber optic transmitter with a first fiber optic connector and to align an optical axis of the fiber optic receiver with a second fiber optic connector.

7. The method of claim 1, wherein the fiber optic transmitter and the fiber optic receiver are connected via the leadframe.

8. A semiconductor package for an optical transceiver, the semiconductor package comprising:

an optical transmitter;

an optical receiver; and

a leadframe, wherein the leadframe includes an alignment feature, wherein the alignment feature is complementary to a mating alignment feature on a connector housing of the optical transceiver;

wherein during assembly of the optical transceiver, the alignment feature of the leadframe is adapted to mate with the mating alignment feature on the connector housing;

wherein the alignment feature of the leadframe is configured to align an optical axis of the optical transmitter with a corresponding fiber optic connector and align an optical axis of the optical receiver with a corresponding fiber optic connector.

9. The semiconductor package of claim 8, wherein the alignment feature comprises a first geometric shape, wherein the mating alignment feature comprises a second shape that is complementary to at least a first portion of the first geometric shape.

10. The semiconductor package of claim 9, wherein the alignment feature comprises a semicircular indention, wherein the mating alignment feature comprises a cylindrical protrusion.

11. The semiconductor package of claim 8, wherein the leadframe physically connects the optical transmitter to the optical receiver.

12. The semiconductor package of claim 8, wherein the leadframe comprises a plurality of alignment features that are each complementary to a corresponding mating feature on the connector housing, wherein during assembly of the optical transceiver, the plurality of alignment features of the leadframe are each adapted to mate with the corresponding mating alignment feature on the connector housing.

13. The semiconductor package of claim 8, wherein at least a portion of the leadframe comprising the alignment feature is exposed for alignment during assembly.

14. An optical transceiver, comprising:

a connector housing for a semiconductor package, wherein the connector housing comprises a first alignment feature comprised on the connector housing;

a semiconductor package attached to the connector housing, wherein the semiconductor package comprises:

an optical transmitter;

an optical receiver; and

a leadframe, wherein the leadframe includes a second alignment feature, wherein the second alignment feature is complementary to the first alignment feature;

wherein the second alignment feature of the leadframe of the semiconductor package is aligned with the first alignment feature of the connector housing;

wherein the alignment of the second alignment feature of the leadframe with the first alignment feature of the connector housing operates to align an optical axis of the optical transmitter with a corresponding fiber optic connector and align an optical axis of the optical receiver with a corresponding fiber optic connector.

15. The optical transceiver of claim 14, wherein the first alignment feature comprises a first geometric shape, wherein the second alignment feature comprises a second shape that is complementary to at least a first portion of the first geometric shape.

16. The optical transceiver of claim 15, wherein the first alignment feature comprises a cylindrical protrusion, wherein the second alignment feature comprises a semicircular indention.

17. The optical transceiver of claim 14, wherein the leadframe physically connects the optical transmitter to the optical receiver.

18. The optical transceiver of claim 14, wherein the connector housing comprises a first plurality of alignment features including the first alignment feature, wherein the semiconductor package comprises a second plurality of alignment features including the second alignment

feature, wherein each alignment feature of the first plurality of alignment features is complementary to a respective one of the second plurality of alignment features.

19. The optical transceiver of claim 14, wherein at least a portion of the leadframe comprising the alignment feature is exposed for alignment during assembly.

20. A connector housing for an optical transceiver, the connector housing, comprising:

a first fiber optic connector for an optical transmitter;

a second fiber optic connector for an optical receiver; and

at least one alignment feature, wherein each of the at least one alignment feature is complementary to a corresponding alignment feature of a leadframe of a semiconductor package;

wherein during assembly of the optical transceiver, each of the at least one alignment feature is adapted to connect with the corresponding alignment feature of the leadframe, wherein alignment of connector housing and the semiconductor package operates to align an optical axis of an optical transmitter of the semiconductor package with the first fiber optic connector and align an optical axis of an optical receiver of the semiconductor package with the second fiber optic connector.

21. A method for assembling an optical transceiver, comprising:

receiving a connector housing for a semiconductor package, wherein the connector housing comprises a first alignment feature comprised on the connector housing;

receiving a semiconductor package comprising a substrate, wherein the substrate includes a second alignment feature, wherein the second alignment feature is complementary to the first alignment feature;

attaching the semiconductor package to the connector housing to form the optical transceiver, wherein said attaching comprises aligning the second alignment feature of the substrate of the semiconductor package with the first alignment feature of the connector housing;

wherein said aligning operates to align an optical axis of at least one of a fiber optic transmitter or a fiber optic receiver with a corresponding fiber optic connector.

22. The method of claim 21, wherein the first alignment feature comprises a first geometric shape;

wherein the second alignment feature comprises a second shape that is complementary to at least a first portion of the first geometric shape.

23. The method of claim 21, wherein the connector housing has a plurality of first alignment features, wherein the semiconductor package has a plurality of second alignment features, and wherein said aligning comprises aligning each of the plurality of first alignment features to a corresponding one of the plurality of second alignment features.

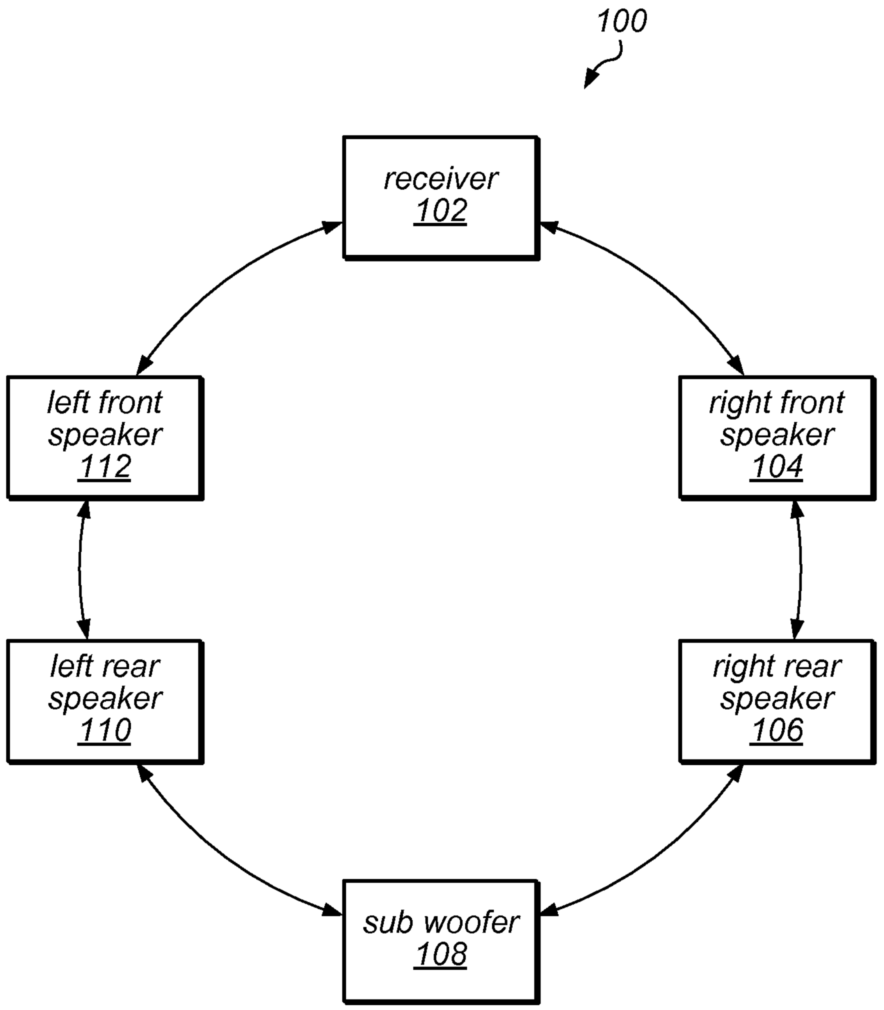
100
receiver
102
right front
speaker
104
right rear
speaker
106
sub woofer
108
left rear
speaker
110
left front
speaker
112

FIG. 1

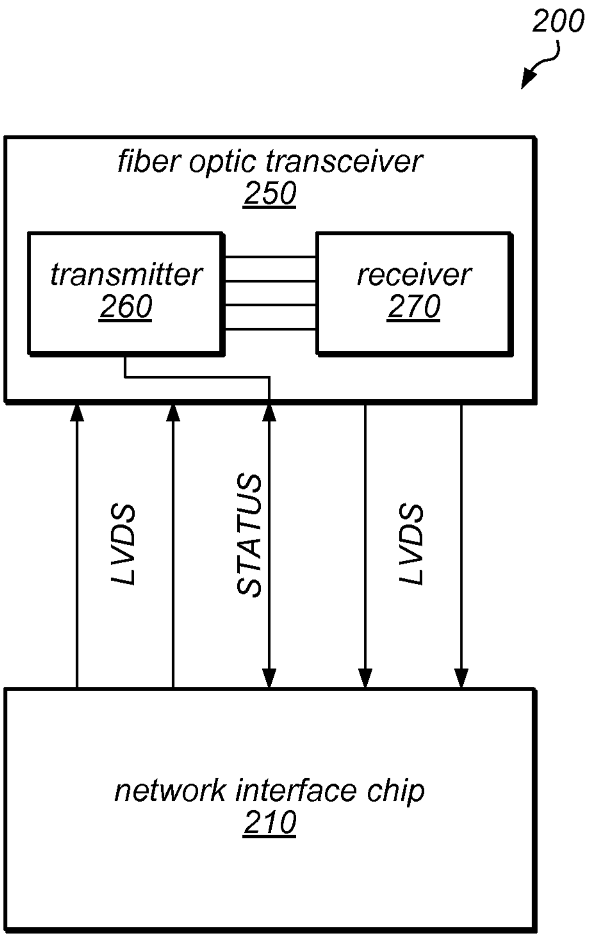
200
fiber optic transceiver
250
transmitter
260
receiver
270
LVDS
STATUS
LVDS
network interface chip
210

FIG. 2

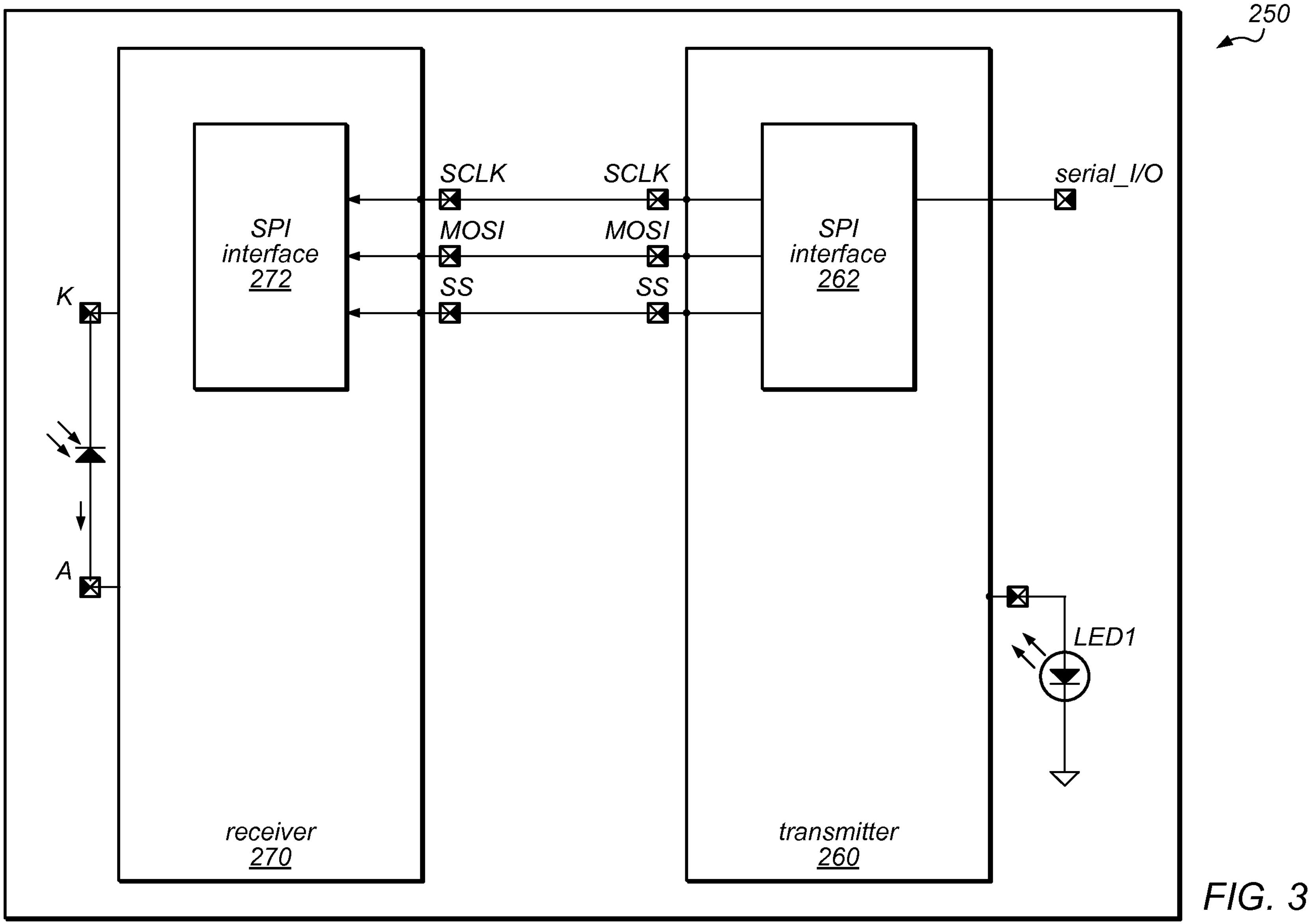
250
SPI
interface
272
SCLK
MOSI
SS
SCLK
MOSI
SS
SPI
interface
262
serial_I/O
K
A
LED1
receiver
270
transmitter
260

FIG. 3

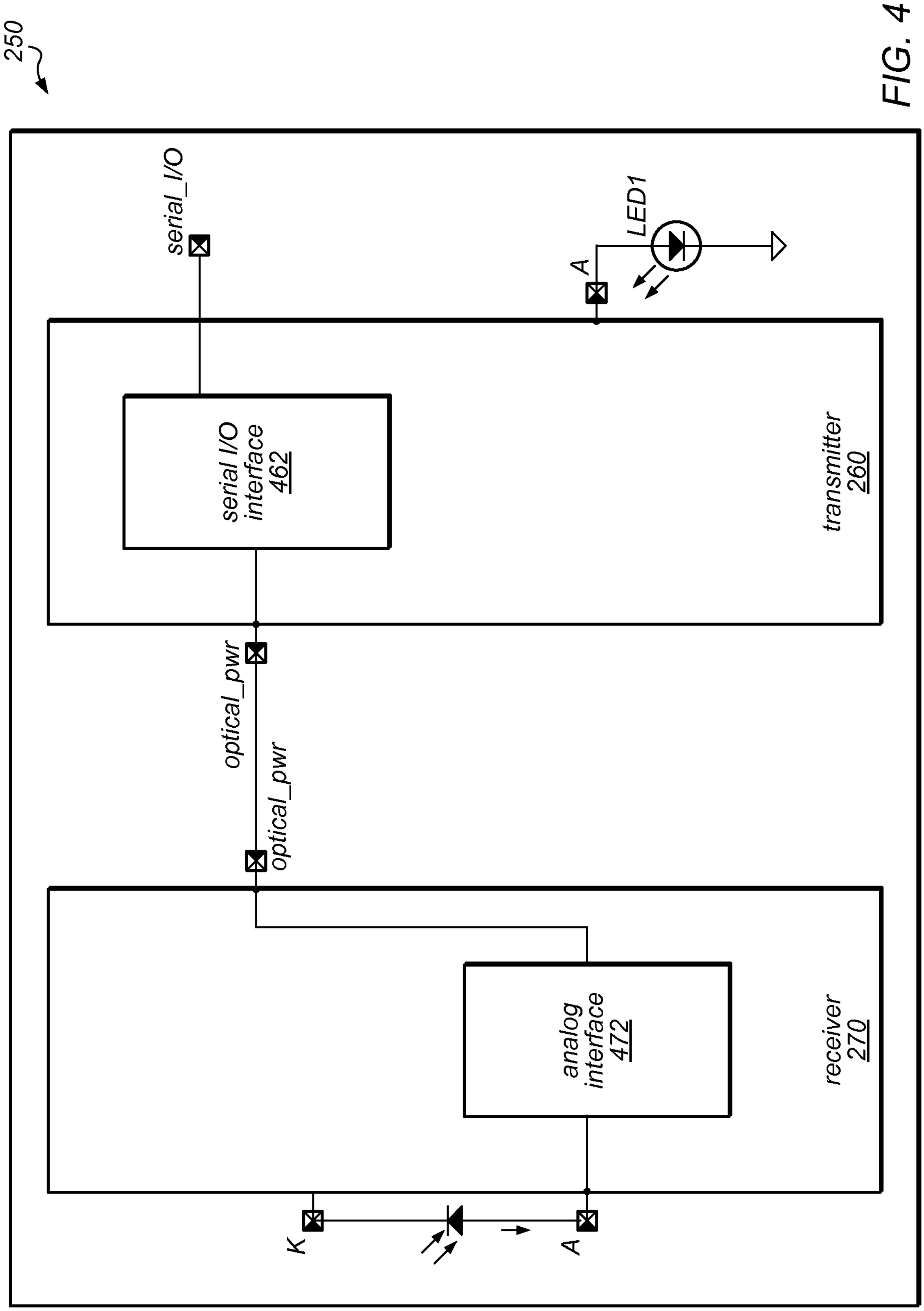
250
serial_I/O
A
LED1
serial I/O interface 462
transmitter 260
optical_pwr
optical_pwr
analog interface 472
receiver 270
K
A

FIG. 4

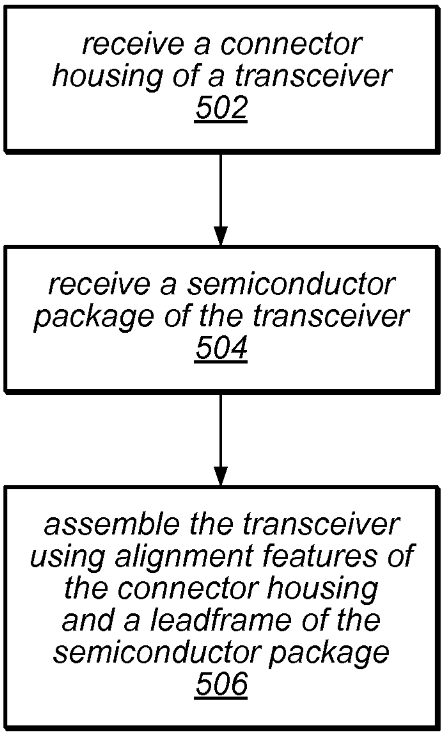
receive a connector housing of a transceiver
502
receive a semiconductor package of the transceiver
504
assemble the transceiver using alignment features of the connector housing and a leadframe of the semiconductor package
506

FIG. 5

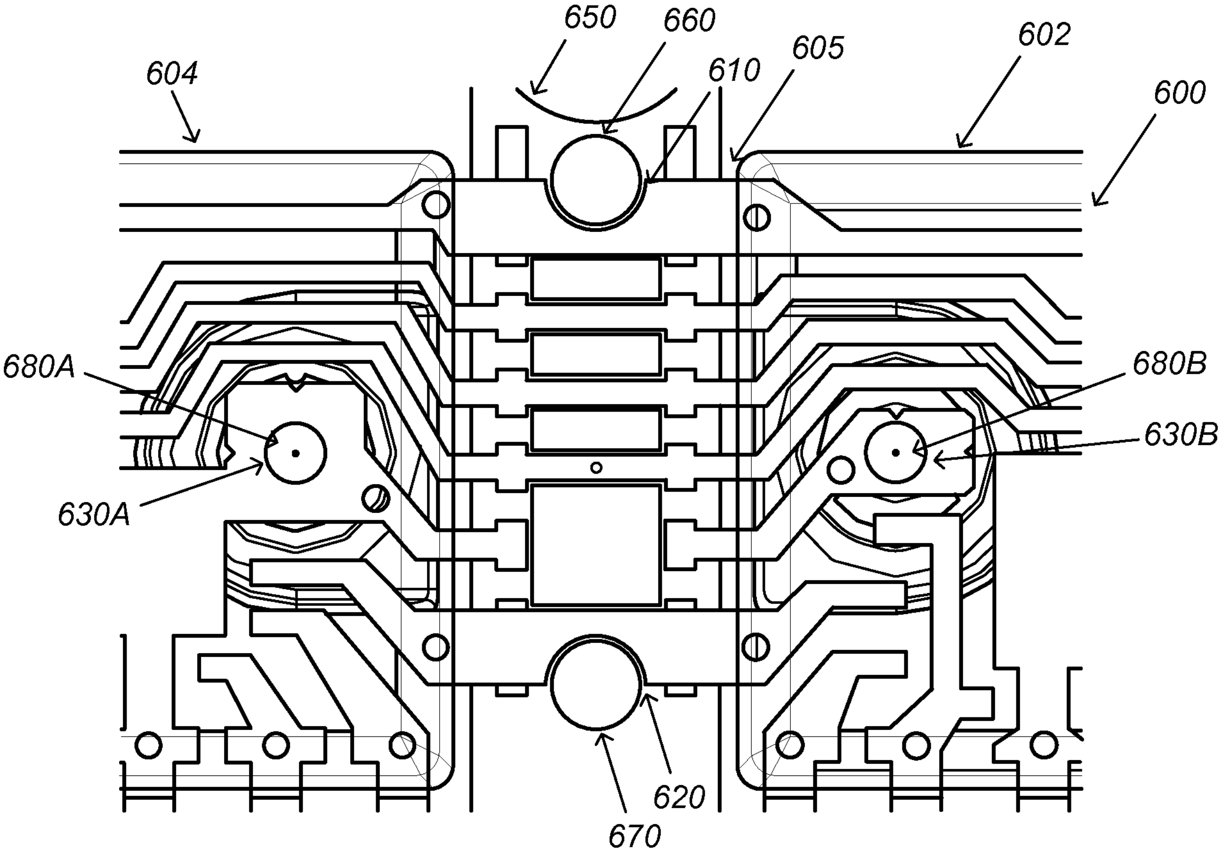
650
660
610
605
602
604
600
680A
680B
630B
630A
620
670

FIG. 6A

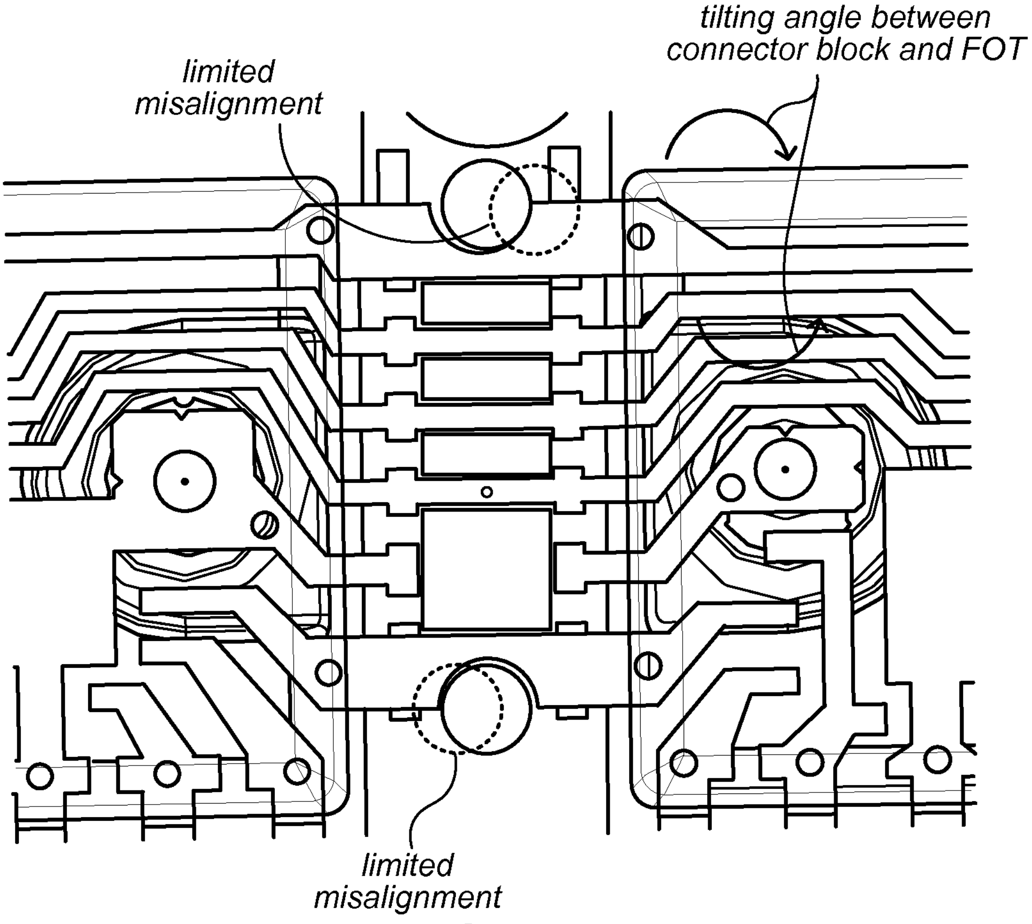
limited
misalignment
tilting angle between
connector block and FOT
limited
misalignment

FIG. 6B

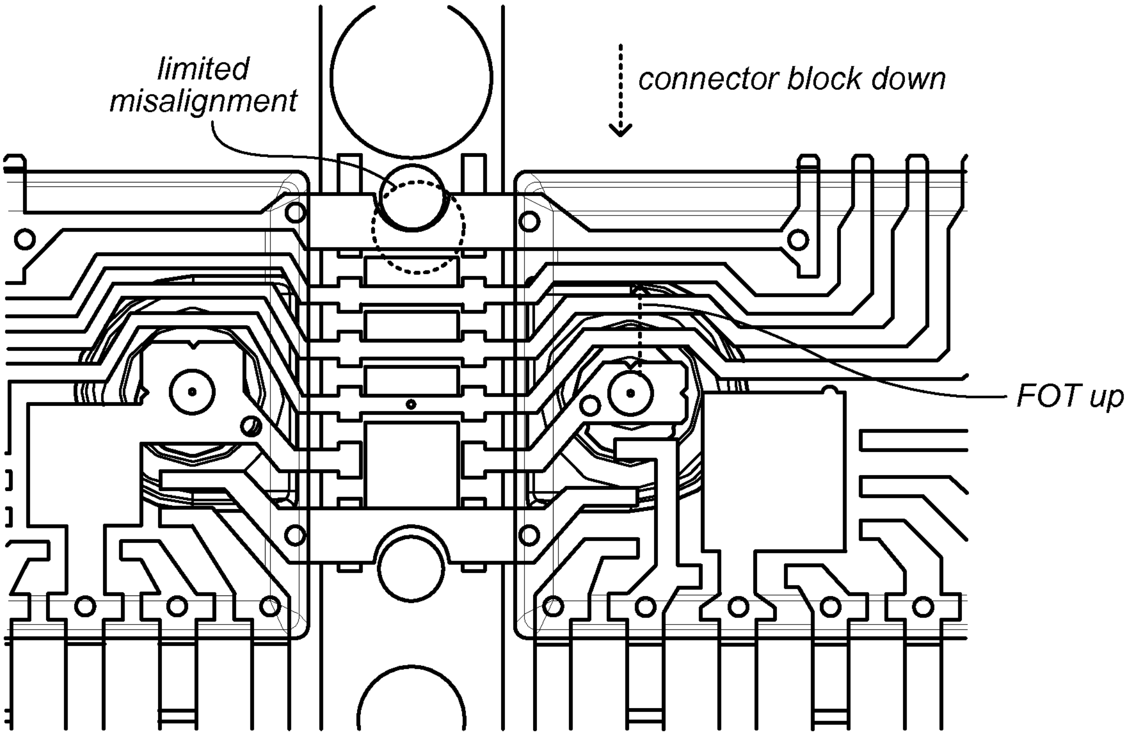
limited misalignment
connector block down
FOT up

FIG. 6C

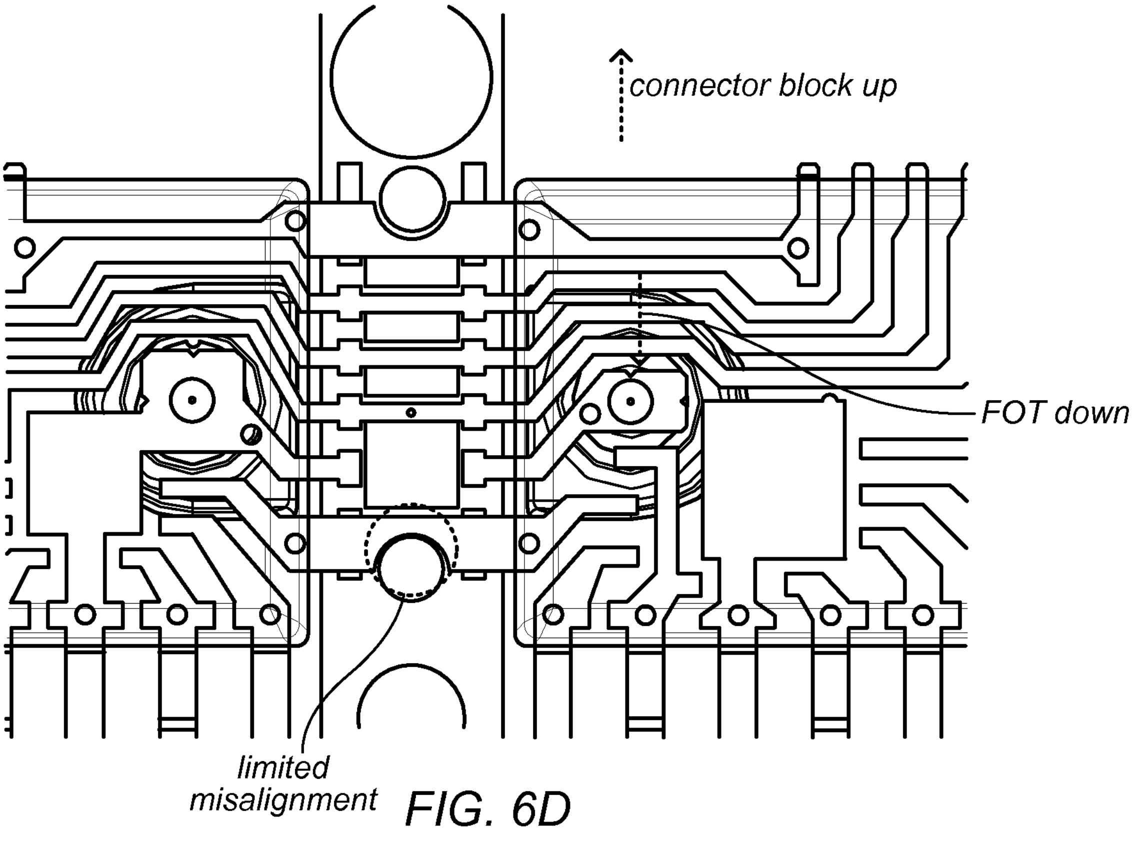
connector block up
FOT down
limited misalignment

FIG. 6D

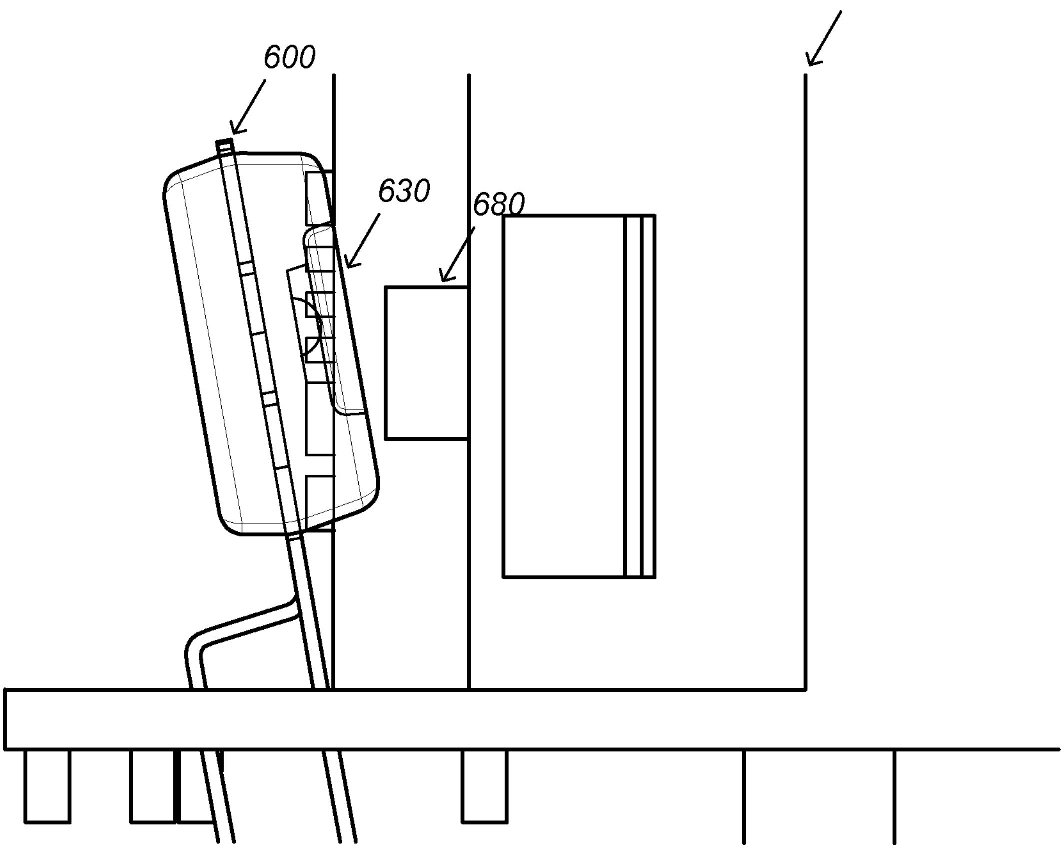

FIG. 7A

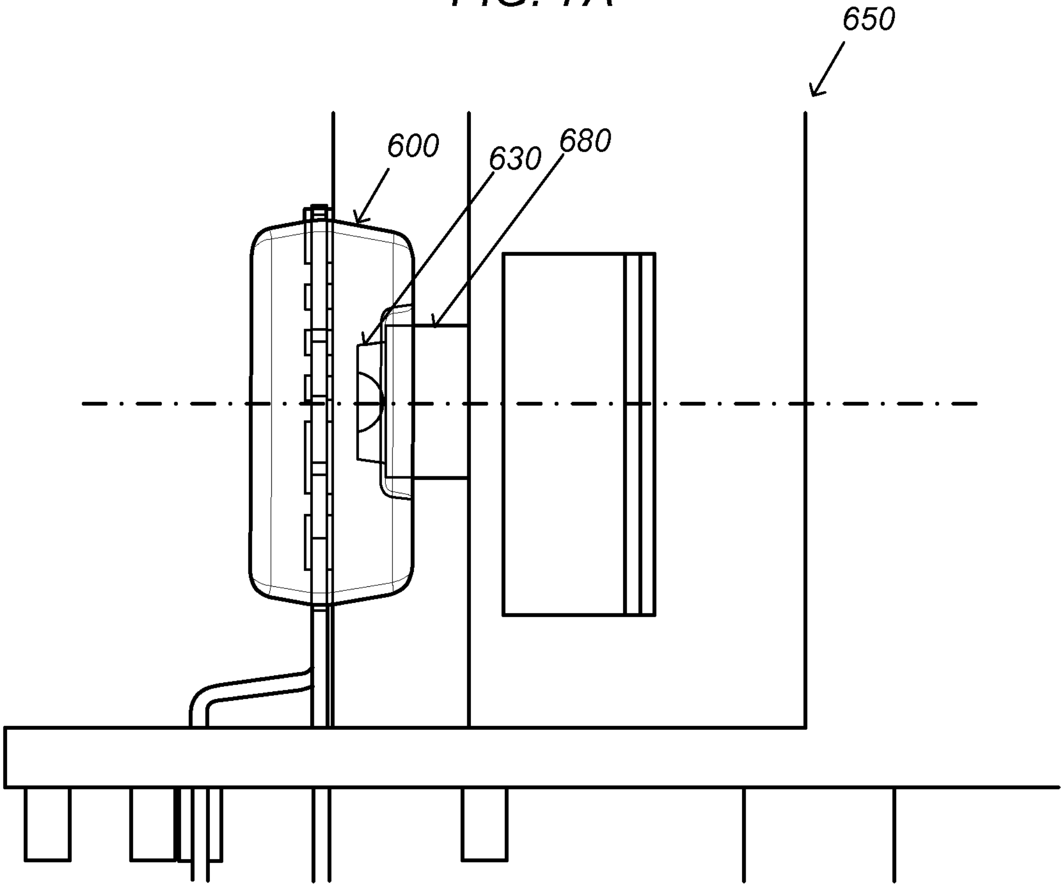

FIG. 7B

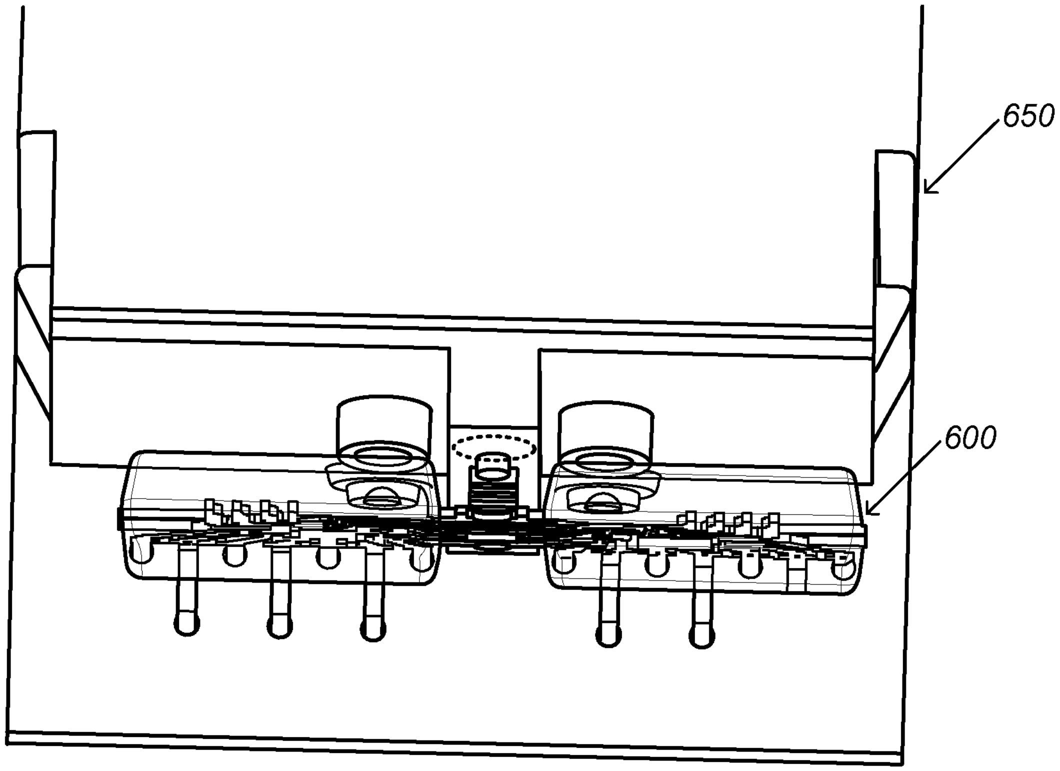

FIG. 8A

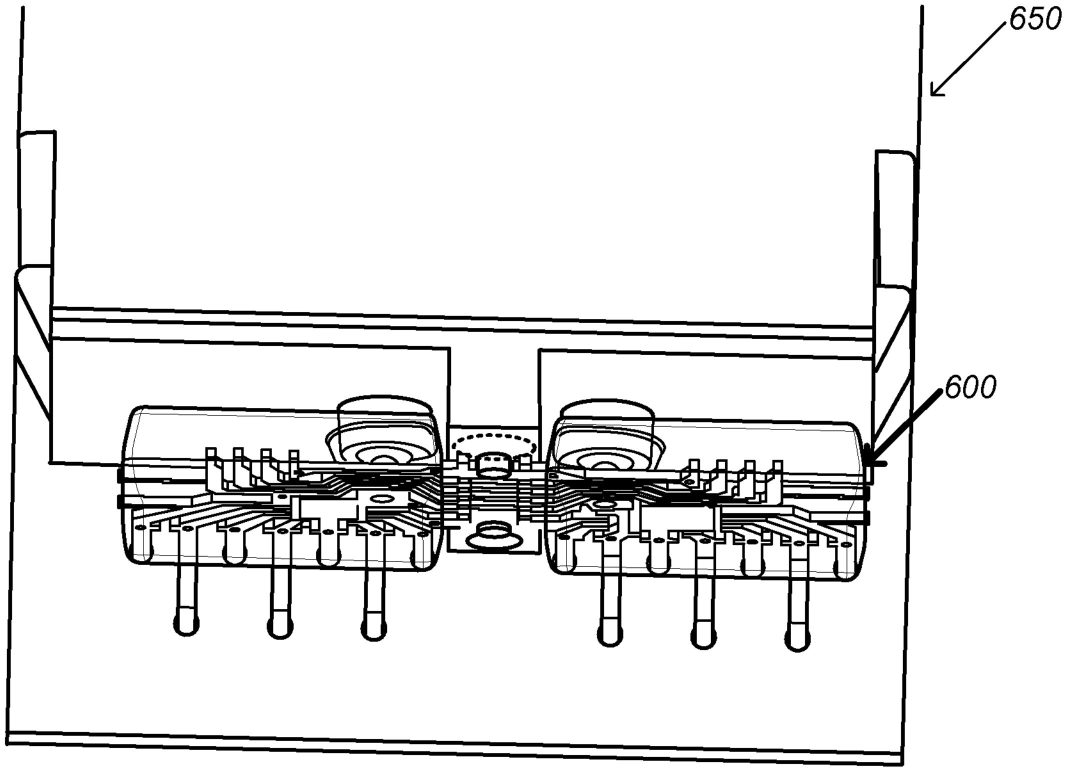

FIG. 8B

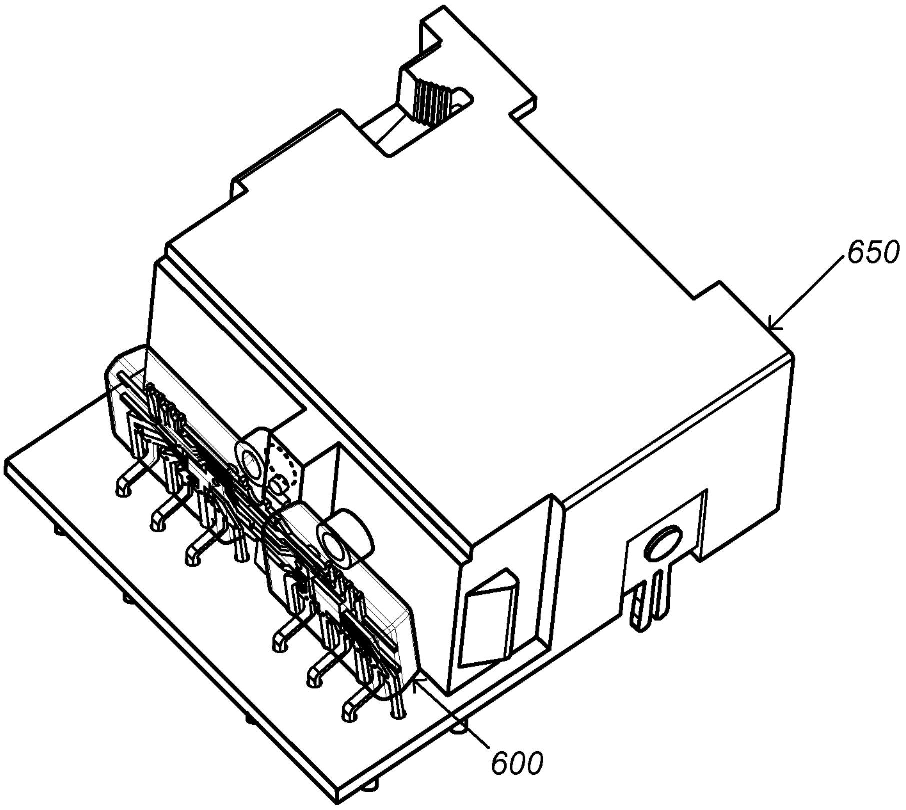

FIG. 9A

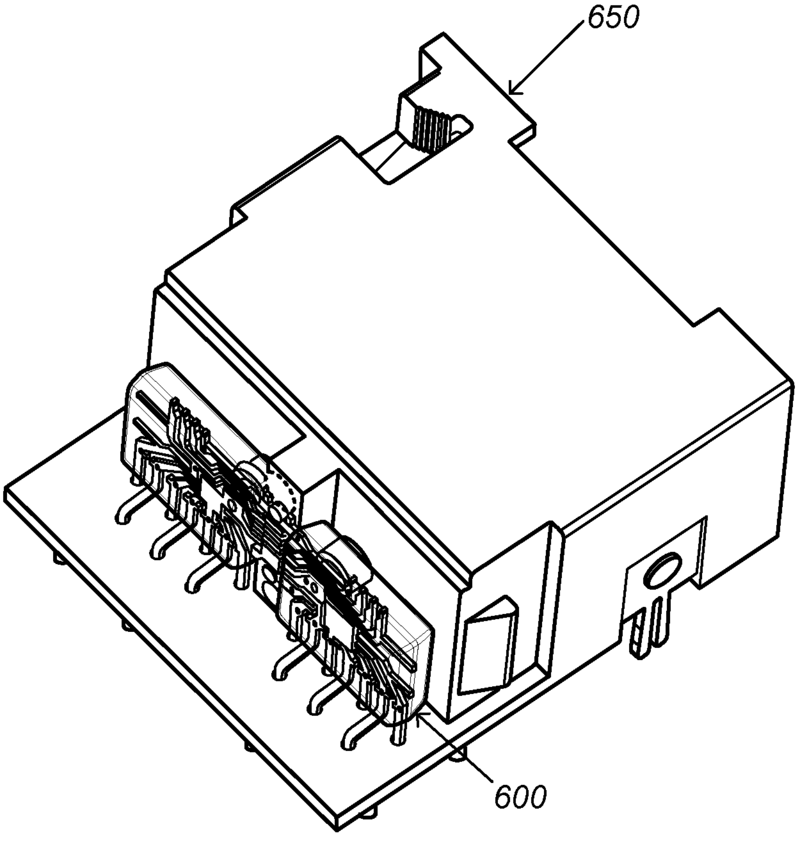

FIG. 9B

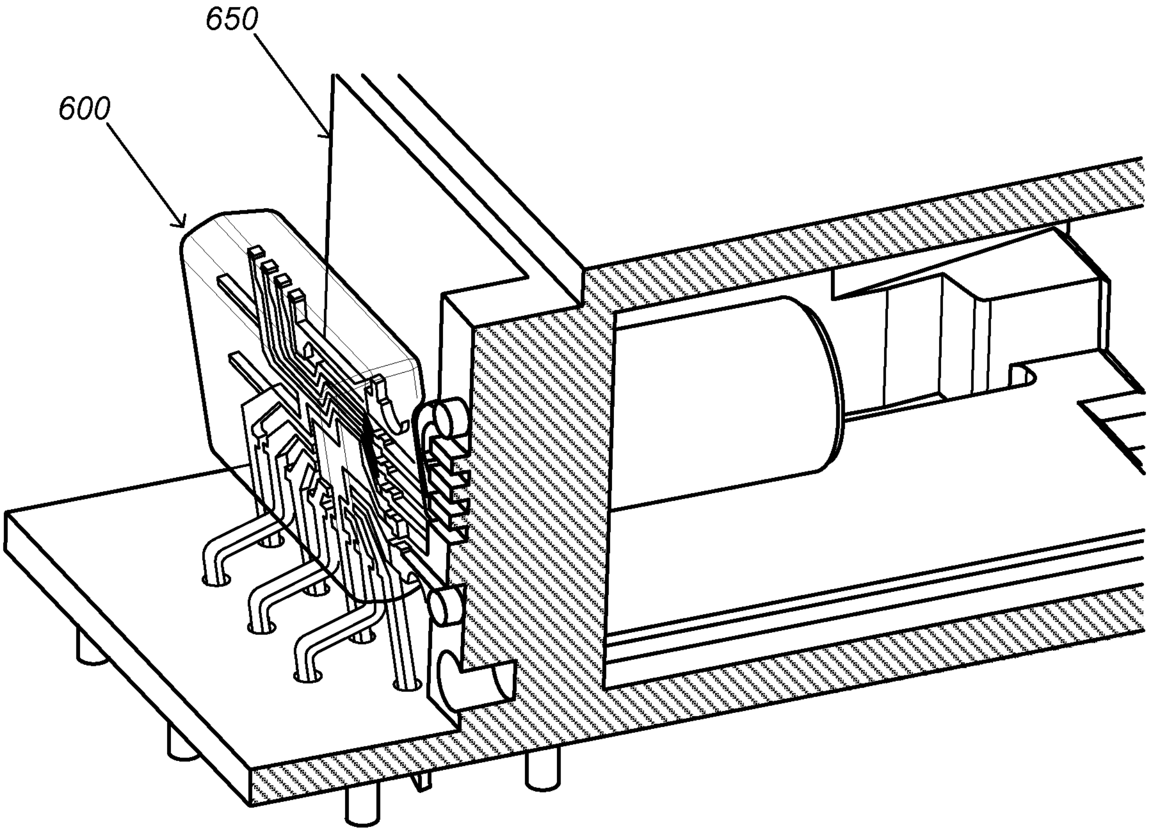

FIG. 10A

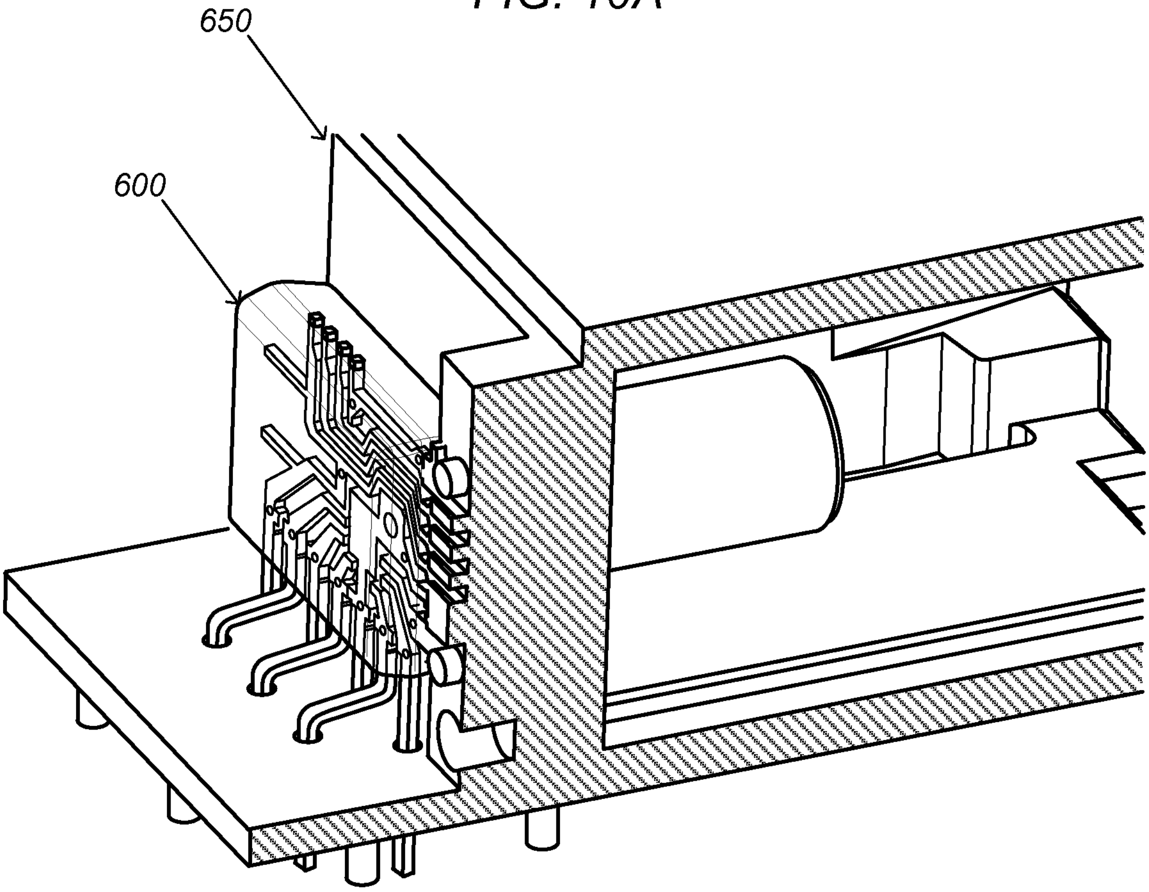

FIG. 10B

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2012/051778

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04B10/24 G02B6/42
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H04B G02B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 1 170 609 A2 (YAZAKI CORP [JP]) 9 January 2002 (2002-01-09) paragraph [0052]; figure 9 -----	1-23
X	US 2007/237461 A1 (SCHEMPP OTTO [DE]) 11 October 2007 (2007-10-11) paragraph [0072]; figures 3,4 -----	1,8,14
X	JP 2009 229613 A (MURATA MANUFACTURING CO) 8 October 2009 (2009-10-08) figures 6,7 -----	1,8,14
X	US 5 305 408 A (SCHAFFER RONALD R [US] ET AL) 19 April 1994 (1994-04-19) figure 4 ----- -/--	1,8,14

☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search 15 February 2013	Date of mailing of the international search report 26/02/2013
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer Plouzennec, Loïg

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 1 659 432 A1 (HOSIDEN CORP [JP]) 24 May 2006 (2006-05-24) figure 10A -----	1,8,14
X	GB 2 356 065 A (YAZAKI CORP [JP]) 9 May 2001 (2001-05-09) figures 4,5 -----	1,8,14
X	WO 99/54762 A1 (CIELO COMMUNICATIONS INC [US]) 28 October 1999 (1999-10-28) figure 13 -----	1,8,14
X	WO 2008/003031 A2 (OPTOGIG INC [US]; SALZBERG JOSE B [US]; MARGOLIN MARK [US]; BUNIN GREG) 3 January 2008 (2008-01-03) figures 7A,7B -----	1,8,14
X	US 7 013 088 B1 (JIANG WENBIN [US] ET AL) 14 March 2006 (2006-03-14) figure 3 -----	1,8,14
X	WO 2005/071458 A1 (MOLEX INC [US]; SCHEMPP OTTO [DE]; GERNER MATHIAS [DE]) 4 August 2005 (2005-08-04) figure 11 -----	1,8,14
X	US 2006/269195 A1 (MIYAO TAICHIRO [JP] ET AL) 30 November 2006 (2006-11-30) figure 1 -----	1,8,14

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2012/051778

Patent document cited in search report		Publication date	Patent family member(s)			Publication date
EP 1170609	A2	09-01-2002	DE	60124987	T2	20-09-2007
			EP	1170609	A2	09-01-2002
			JP	3735011	B2	11-01-2006
			JP	2002023021	A	23-01-2002
			US	2002001437	A1	03-01-2002
US 2007237461	A1	11-10-2007	CN	1961236	A	09-05-2007
			DE	102004027034	A1	29-12-2005
			EP	1751596	A1	14-02-2007
			US	2007237461	A1	11-10-2007
			WO	2005119320	A1	15-12-2005
JP 2009229613	A	08-10-2009	NONE			
US 5305408	A	19-04-1994	NONE			
EP 1659432	A1	24-05-2006	EP	1659432	A1	24-05-2006
			JP	4559952	B2	13-10-2010
			JP	2006154788	A	15-06-2006
			US	2006093288	A1	04-05-2006
			US	2008226233	A1	18-09-2008
GB 2356065	A	09-05-2001	DE	10015867	A1	12-07-2001
			GB	2356065	A	09-05-2001
			JP	4071407	B2	02-04-2008
			JP	2001133665	A	18-05-2001
			US	6491443	B1	10-12-2002
WO 9954762	A1	28-10-1999	AU	3863999	A	08-11-1999
			CA	2329370	A1	28-10-1999
			EP	1086392	A1	28-03-2001
			JP	2002512380	A	23-04-2002
			US	6015239	A	18-01-2000
			WO	9954762	A1	28-10-1999
WO 2008003031	A2	03-01-2008	US	2008013896	A1	17-01-2008
			WO	2008003031	A2	03-01-2008
US 7013088	B1	14-03-2006	NONE			
WO 2005071458	A1	04-08-2005	CN	1914534	A	14-02-2007
			DE	102004004240	A1	18-08-2005
			EP	1728112	A1	06-12-2006
			JP	4441540	B2	31-03-2010
			JP	2007519963	A	19-07-2007
			KR	20060131823	A	20-12-2006
			US	2007217746	A1	20-09-2007
			WO	2005071458	A1	04-08-2005
US 2006269195	A1	30-11-2006	AU	2003284618	A1	10-08-2004
			CN	1735827	A	15-02-2006
			TW	I286620	B	11-09-2007
			US	2006269195	A1	30-11-2006
			WO	2004063785	A1	29-07-2004