

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

Marvell Semiconductor, Inc.,

Petitioner,

v.

Credo Technology Group Ltd.,

Patent Owner.

IPR2025-01219

U.S. Patent No. 11,012,252

PETITION FOR *INTER PARTES* REVIEW

OF U.S. PATENT NO. 11,012,252

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EXHIBIT LIST

Exhibit No.	Description
1001	U.S. Patent No. 11,012,252 to Lam and Chen (“the ’252 patent”)
1002	Certified Prosecution File History for the ’252 Patent (“Prosecution History”)
1003	Declaration of Michael Shuo-wei Chen
1004	U.S. Patent No. 9,882,706 to Lugthart, et al. (“Lugthart”)
1005	U.S. Patent No. 7,445,389 to Aronson (“Aronson”)
1006	U.S. Patent No. 8,516,238 to Cornelius, et al. (“Cornelius”)
1007	Samaan, High-speed Serial Bus Repeater Primer (“Samaan”)
1008	Ars Technica, Why Thunderbolt cables will be expensive until 2013 (Library of Congress Capture)
1009	Intersil, ISL37231 [Datasheet]
1010	U.S. Patent Application Publication No. 2019/0028262 A1 to Kobayashi, et al. (“Kobayashi”)
1011	TE Connectivity, SFP+ High Speed Copper Cable Assemblies
1012	Cisco, Cisco 40GBASE QSFP Modules Data Sheet (Internet Archive Capture)
1013	AppleInsider, Intel details Thunderbolt, says Apple has full year head start (Internet Archive Capture)
1014	macstories, Intel: Apple Transferring Thunderbolt Trademark To Us (Internet Archive Capture)
1015	AnandTech, Intel’s Codename Light Peak Launches as Thunderbolt (Internet Archive Capture)
1016	Ars Technica, The technology inside Apple’s \$50 Thunderbolt cable (Internet Archive Capture)
1017	Gasca, et al., CMOS Continuous-Time Adaptive Equalizers for High-Speed Serial Links
1018	Declaration of June Munford re: Samaan
1019	Excerpts from 10G SFP+ Video
1020	Excerpts from Stauffer, High Speed Serdes Devices and Applications (“Stauffer”)
1021	U.S. Patent No. 7,233,617 to Gorecki (“Gorecki”)
1022	<i>Certain Active Electrical Cables and Components Thereof</i> , ITC Investigation 337-TA-1446, Exhibit 38 to Complaint, Credo’s Infringement Claim Chart Showing Molex’s Infringement of the ’252 Patent

Exhibit No.	Description
1023	<i>Certain Active Electrical Cables and Components Thereof</i> , ITC Investigation 337-TA-1446, Exhibit 41 to Complaint, Credo's Infringement Claim Chart Showing TE Connectivity's Infringement of the '252 Patent
1024	<i>Certain Active Electrical Cables and Components Thereof</i> , ITC Investigation 337-TA-1446, Exhibit 66 to Complaint, Credo's Domestic Industry Claim Chart for the '252 Patent
1025	SFF-8431 Rev 4.1 + Addendum
1026	Texas Instruments Technical Article, How to Reduce Jitter and Improve Signal Integrity in Source and Sink System Designs Supporting HDMI 2.0
1027	Intel, Thunderbolt™ Networking Bridging and Routing Instructional White Paper
1028	Intel, PCI Express Ethernet Networking White Paper
1029	U.S. Patent No. 9,231,846 to Sinha, et al. ("Sinha")
1030	Excerpts from Prosecution File History of CN2019101555359 to Thermo Scientific Co. Ltd. (Chinese counterpart application to the '252 Patent)
1031	U.S. Patent No. 8,787,430 to Rhagavan, et al. ("Raghavan")
1032	Internet Archive Declaration of Mina Ching re SFF-8636 Rev 1.7
1033	Intel, PCI Express Architecture
1034	Internet Archive Capture, The Wayback Machine, Wikipedia, "PCI Express"
1035	Intel Website Search Results

Active cables have been known and used for well over a decade. Apple and Intel collaborated on Thunderbolt cables, and Petitioner Marvell is a leading supplier of retimer chips for active cables. Prior art from these companies uses a common technique called “equalization” to offset channel loss. For communications between a host and the near end of a cable, numerous prior art references taught fixed, preset parameters for equalization of these host-side paths, which were separate and independent from the path over the connecting cable.

The '252 patent, filed years later, attempts to claim equalization for host-side paths, using fixed, cable-independent parameters. But the '252 patent is invalid because this was widely known and used.

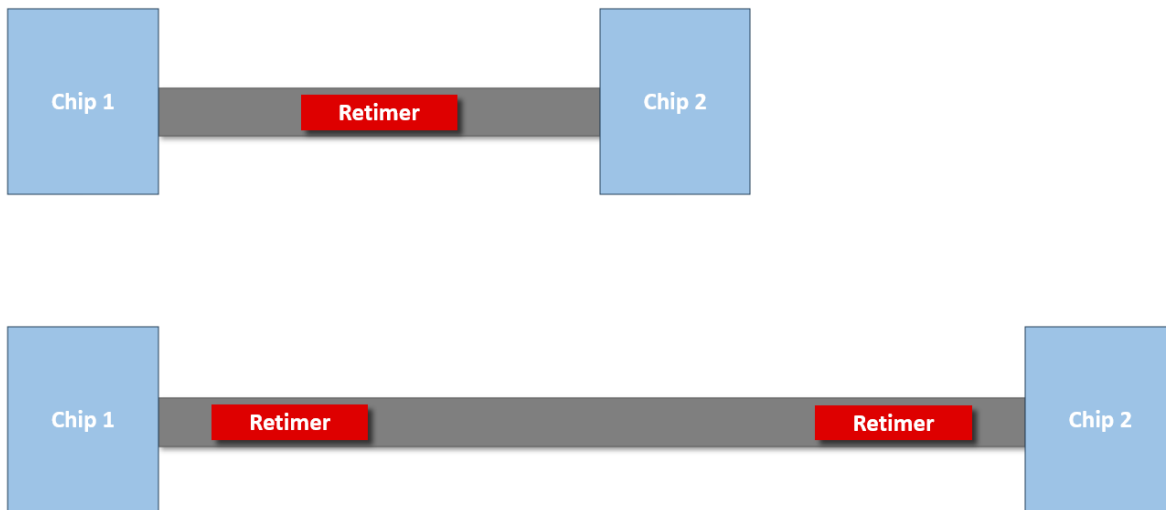
I. OVERVIEW OF THE TECHNOLOGY

High-speed serial communications became widespread in the 1990s. As transmission speeds increased, legacy parallel systems faced synchronization/routing challenges. Ex-1020, 000011-14. Serial communication addressed these limitations, simplifying synchronization and reducing pin count. Ex-1003, ¶4.

By the early 2000s, computer buses and networks largely shifted to serial connections that used serialization and de-serialization techniques (“SerDes”): Serial ATA (“SATA”), serial PCIe, and Universal Serial Bus (“USB”). Ethernet had long utilized serial connections. Ex-1020, 000058-61; Ex-1003, ¶5.

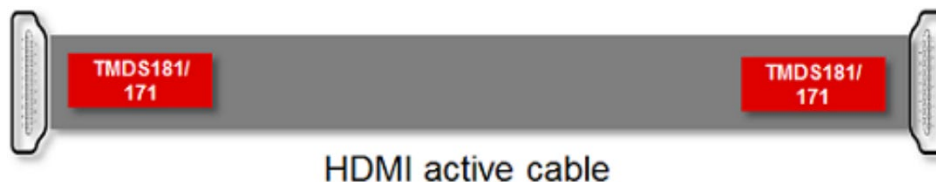
A. Active Cables

In serial communications, retimers were often used to extend link length and bandwidth by recovering digital data from the channel and re-modulating it. Ex-1007, ¶¶15-16. This removed noise and effectively renewed the signal for longer distances.

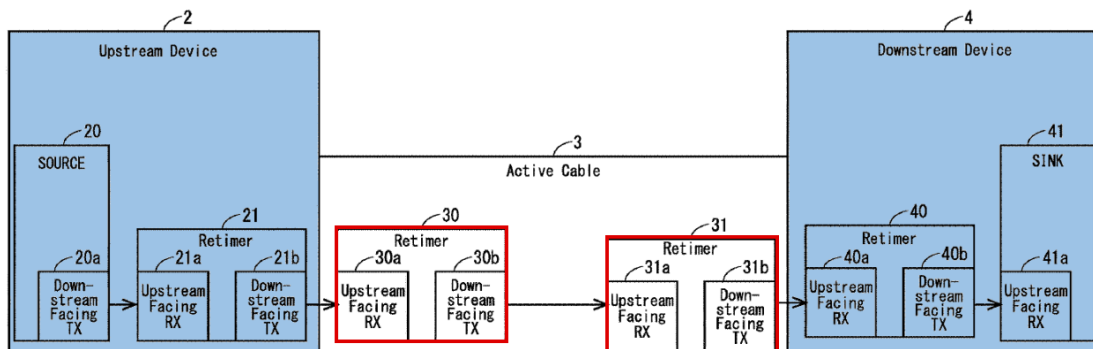


Ex-1003, ¶6.

Active electric cables extended the length of cables by incorporating retimers at each end of a cable. Ex-1010, ¶13. For example, Texas Instruments offered a retimer chip for active HDMI cables. Ex-1026, Fig.1:



This configuration was common for active electric cables. Ex-1010, Fig.1:¹



By 2015, active electric cables were used for a variety of protocols including DisplayPort, PCIe, USB, and Ethernet. Ex-1003, ¶7.

Ethernet has been a widely used networking standard since the 1990s. By the 2010s, Ethernet had become the primary high-speed serial communication standard for enterprise and data center networks, scaling from 1 Gigabit Ethernet (GbE) to widespread 10 GbE adoption. To support higher speeds and longer distances, manufacturers introduced active Ethernet cables with integrated retimers. By 2014, active Ethernet cables and components were available from various vendors. Ex-1011 (TE SFP+ cables); Ex-1012 (various Cisco products). Active Ethernet cables often used the SFP+ form factor for the modules at each end, connected by twinaxial cable. Ex-1019:

¹ All emphasis and annotations added unless stated otherwise.



```

{master:0}
root> show interfaces brief xe-0/0/40
Physical interface: xe-0/0/40, Enabled, Physical link is up
Link-level type: Ethernet, MTU: 1514, Speed: 10Gbps, Duplex: Full-Duplex,
Loopback: Disabled, Source filtering: Disabled, Flow control: Enabled
Device flags : Present Running
Interface flags: SNMP-Traps Internal: 0x0
Link flags   : None

Logical interface xe-0/0/40.0
Flags: SNMP-Traps 0x0 Encapsulation: Ethernet-Bridge
bridge

{master:0}
root>

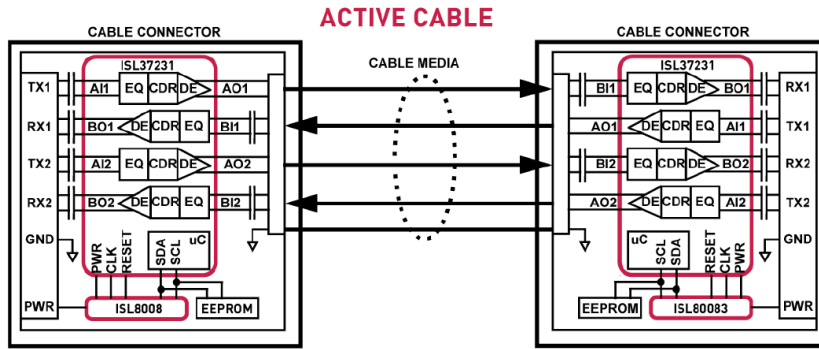
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The link is up

ethernet compatibility

Ex-1003, ¶¶8-9.

Thunderbolt, a high-profile active cable, was developed through a collaboration between Apple and Intel. Apple developed and marketed the cable (Ex-1014, 000002; Ex-1013, 000001-2), while Intel provided the port and retimer architectures. Ex-1016, 000001-2; Ex-1015, 000003. Macintosh computers featured Thunderbolt ports in 2011 (Ex-1013, 000001), with other vendors offering Thunderbolt solutions by 2013. Ex-1009, 000001; Ex-1008, 000002-3 (discussing Intersil retimers for Thunderbolt).



Intersil's active Thunderbolt cable solution reduces the number of necessary ICs from four to two. Credit: Intersil

Ex-1003, ¶10.

B. Equalization

As connection protocols transitioned to serial links, established serial communication techniques like equalization were adopted. Well before 2018, equalization was a standard topic in undergraduate courses on serial communications and routinely covered in relevant textbooks. Ex-1020, 000020-000024; Ex-1017, §§1.1.1-1.1.2 at 000025-29; Ex-1003, ¶¶11-12.

Equalization was performed at both the transmitter (“pre-equalization”) and receiver to compensate for signal loss caused by the channel. Ex-1007, Fig.34. Because channels attenuate different frequencies unevenly, equalization selectively boosted frequencies subject to greater loss. Channel losses and equalization canceled each other out, leaving the received signal closer to its original form. Ex-1020, 000020-24. Pre-equalization using “pre-emphasis” is illustrated below: the red boxes show the waveform without and with pre-equalization. Ex-1020, 000021:

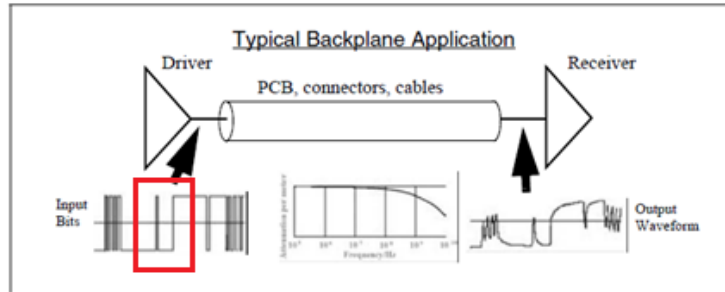


Fig. 1.9 Signal distortion for a typical channel application

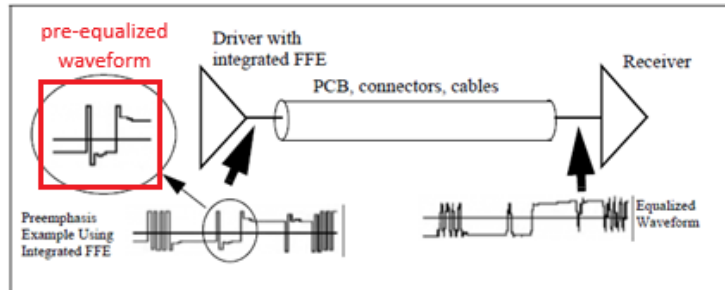


Fig. 1.10 Typical channel application with equalization at the transmitter

Ex-1003, ¶14. Equalization was used at the receiver to further adjust for channel loss, operating with the same principle. Having equalization at both ends counterbalanced the channel’s effects at two points instead of one, providing robust, high-speed transmission across noisy channels. Ex-1020, 000020-24; Ex-1003, ¶13, ¶19.

Equalization was often implemented using a finite impulse response (“FIR”) filter. An FIR filter performed a weighted sum by multiplying adjacent data “taps” with coefficients. These coefficients were selected to amplify frequencies that the channel diminished. Ex-1020, 000020-21; Ex-1017, 000025-27. These filter coefficients were parameters that controlled the behavior of the equalization filter. Ex-1003, ¶¶15-18.

Equalization parameters were often set as fixed values stored for later use.

Ex-1021, 7:18-33 (“coefficients of the tap(s)...may be pre-programmed or pre-set”), 1:65-67 (FIR filter “typically includes one or more taps having fixed or pre-programmed...coefficients.”); Ex-1020, 000020-21 (“tap weights are determined for many applications by design and coded as fixed values...”), Ex-1007, ¶227. Programming fixed values was the simplest approach to designing software or hardware. Ex-1003, ¶18.

Retimers generally included equalization on their receiver interfaces and pre-equalization on their transmitter interfaces. Receiver equalization improved separation between high and low values (called “opening the eye”), allowing improved clock and data recovery (“CDR”). Ex-1007, ¶217, Fig.34:

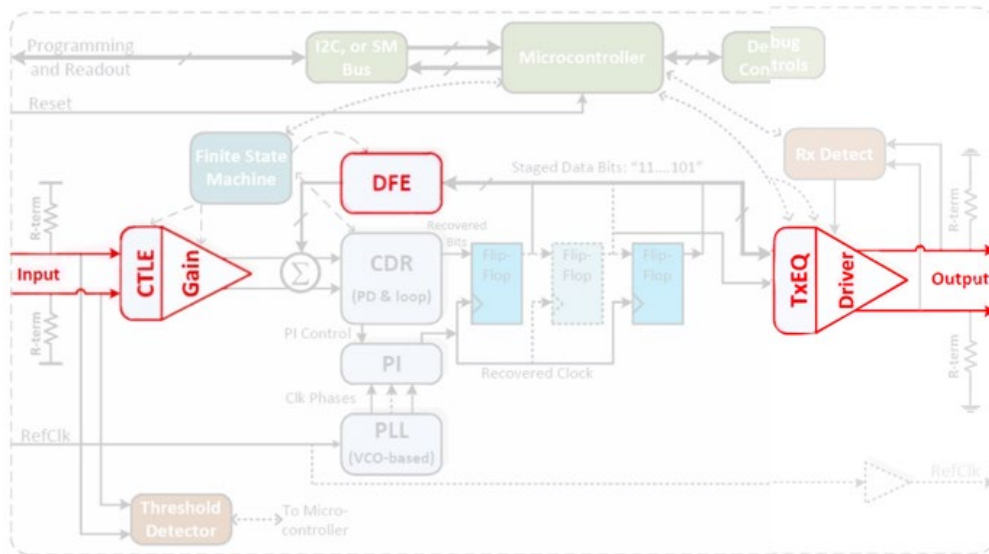
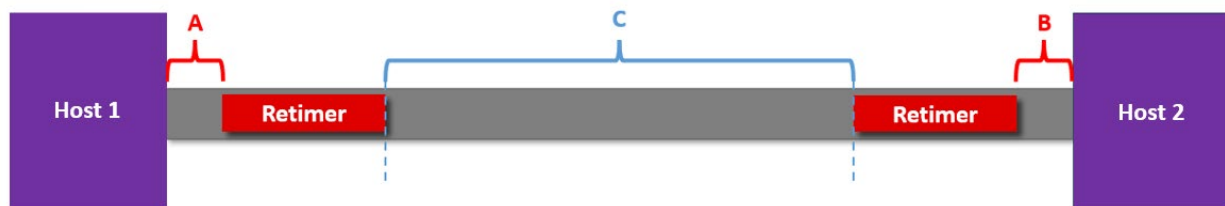


Figure 34 Conceptual micro-architecture of a “Bit Re-timer”, showing input CTLE, AGC, DFE, a CDR, and a data path connected directly to an output driver with TxEQ.

Ex-1003, ¶¶20.

Retimers extended link distance by dividing it into distinct sub-links that were independent from each other from a signal-integrity perspective. Ex-1007, ¶¶15-16. This effectively divided the link into a series of shorter distances and relaxed the burden of equalization for each link. Accordingly, pre-equalization and equalization coefficients for each sub-link were calibrated to the characteristics of that sub-link. *E.g.*, Ex-1007, ¶232; Ex-1003, ¶21.

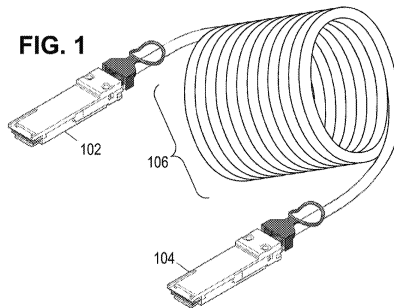
Active cables used retimers on both ends, dividing the link into three sub-links: (A) left-side host to left-side retimer; (B) right-side retimer to the right-side host; and (C) over the cable that connected the retimers.



The equalization on each path compensated for the channel characteristics of that path. Equalization parameters for path C compensated for the connecting cable and thus depended on the characteristics of the particular connecting cable. Equalization parameters for paths A and B compensated for host-side paths comprising circuit board traces; they did not depend on characteristics of the particular connecting cable because they dealt with other sub-links. Ex-1003, ¶22.

II. THE '252 PATENT

The '252 patent is directed to an active cable:



The patent recognizes challenges where “ever-higher data rates” cause “increased channel attenuation and dispersion.” Ex-1001, 1:14-21. The patent purports to address these challenges by adding transceivers in the cable connectors to retimer signals, which accomplished the patent’s stated goal: “mass-manufactured network hardware” with “consistently robust performance” at high communication speeds. Ex-1001, 1:26-42. The patent also lists 18 mundane details that follow from the use of retimers, including equalization. Ex-1001, 2:17-3:16. Ex-1003, ¶¶23-25.

A. Prosecution History

During prosecution, US9337993 (“Lugthart-993”) was used to reject the as-filed independent claims. Ex-1002, 000547-558. Applicant never disputed that Lugthart-993 taught the issued limitations [1pre]-[1d]. Instead, Applicant amended to import as-filed dependent claim 3, which became [1e]. Ex-1002, 000629, 000637; Ex-1003, ¶26.

However, the Examiner erred by failing to search for elements specific to [1e]: e.g., “equalization” or “parameters.” Ex-1002, 000443, 000449-450, 000455-458. The Examiner’s searches were limited to permutations of terms from

independent claims. Ex-1002, 000455-458 (e.g., “ethernet,” “cable,” “transceiv*”). Following amendment, the Examiner employed a similar search strategy that was not directed to the elements of [1e]. *Compare* Ex-1002, 000455-458, *with* 000514-520 (new searches only adding inventors as keywords). The Examiner concluded claim 3 was allowable without having searched for it in the prior art. Ex-1002, 000558; Ex-1003, ¶¶27-29.

Focusing on the independent claims, the Examiner failed to consider the clear teachings of the prior art regarding [1e], which added fixed equalization for host-side traces. For example, Aronson “provide[s] equalization...in the host board traces. Such equalization could be fixed....” Ex-1005, 13:49-14:5. Two related patents were disclosed in information disclosure statements (Ex-1002, 000002, 000451, 000640), which the Examiner initialed without any evidence that he analyzed the relevant portions. Ex-1002, 000650; Ex-1003, ¶¶31-33.

Had the Examiner searched for [1e], the Examiner would have found that prior art active cables included fixed equalization, including for host-side traces, because it was a textbook feature in retimers/transceivers (*supra* §I.B), and that [1e] was taught by Aronson and other references. Ex-1003, ¶¶30-33.

B. Priority Date

Petitioner demonstrates invalidity as of Mar. 1, 2019. Ex-1003, ¶34.

III. FIELD AND LEVEL OF ORDINARY SKILL

The field of the '252 patent is high-speed communications. The specification identifies a problem in this field: “ever-higher data rates” cause “increased channel attenuation and dispersion.” Ex-1001, 1:3-22 (discussing “50 Gbps” rates). The patent’s stated purpose is to provide “robust[]” performance at “26.5625 GBd and beyond.” Ex-1001, 1:26-42, 9:33-36. The embodiments include features to support high-speed communications. Ex-1001, 1:42, 1:62, 2:17-20, 2:38-39 (“bit rate of 50 Gbps or more”), 8:38-56 (“sending and receiving a 200 Gbps Ethernet data stream...sending and receiving 400 Gbps...”).

A person of ordinary skill in the art (“POSITA”) would have had a bachelor’s degree in electrical or computer engineering with at least three years of experience in the field. A person with less practical experience but more relevant education may also meet this standard. Ex-1003, ¶¶37-38.

A POSITA with the above-described skill would have been able to:

- Understand common high-speed serial components, e.g., equalization, CDR, modulation, filters;
- Design high-speed serial communication systems;
- Design active Ethernet cables;
- Design equalization filters, including filter coefficients;
- Program DSPs to perform common functions in transceivers; and

- Implement protocols for calibrating/setting equalization parameters.

Ex-1003, ¶39.

IV. CLAIM CONSTRUCTION

A. “inbound”/“outbound”

The ’252 patent defines these terms from the perspective of the cable:

“outbound data streams...exit the cable...[and] inbound data streams...enter the cable.” Ex-1001, 3:66-4:3, 2:27-32, 1:31-42, Figs.4-5; Ex-1003, ¶¶42-43.

B. “each...” (Claim 7)

The language “each employ fixed, cable-independent, equalization parameters” was absent during prosecution, but inserted at publication from a clerical error. *See* Ex-1002, 000052 (as-filed claim 11), 000631 (claim 11 not amended). It is therefore non-limiting. Ex-1003, ¶44.

V. INVALIDITY GROUNDS

Petitioner requests *inter partes* review and cancelation of the challenged claims on the following grounds:

Grounds	Claims	Statutory Basis	Prior Art ²
1	1-4, 6-9, 11-14	§ 103	Cornelius in view of Samaan
2	5, 10	§ 103	Ground 1 in view of Lugthart
3	1-14	§ 103	Lugthart in view of Aronson

² Post-AIA 35 U.S.C. §102 applies. MPEP §2159.02.

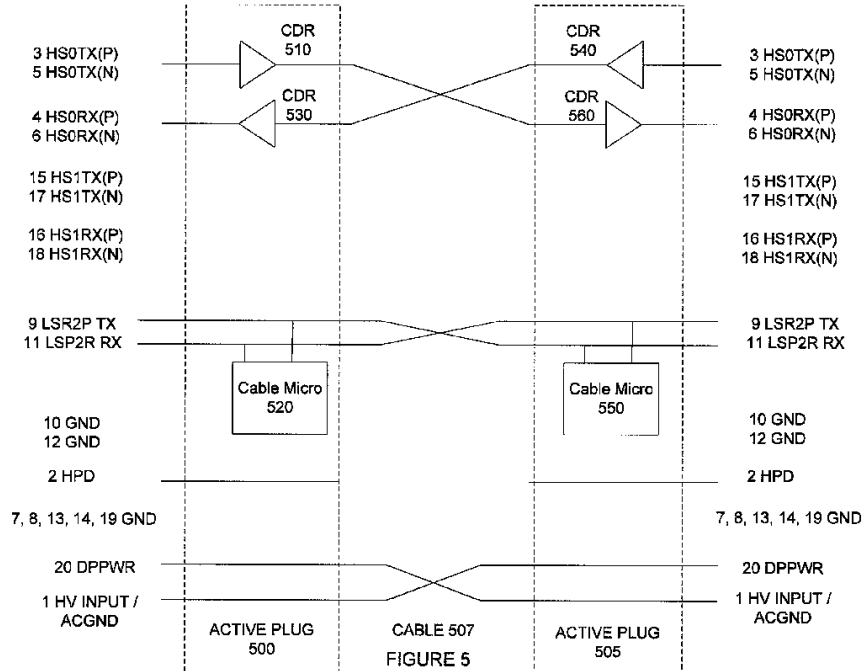
The Grounds render the challenged claims obvious because any differences between the claimed subject matter and the prior art are such that the subject matter, as a whole, would have been obvious at the time the invention was made to a POSITA to which the subject matter pertains. *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 406 (2007).

A. Ground 1

Cornelius is Apple prior art that teaches an active cable with CDR circuitry that “retime[s] data” and performs equalization. Ex-1006, 6:6-32. Samaan, an Intel paper, teaches retimer techniques and details, e.g., for performing CDR/equalization, remodulation, and support for Ethernet. Ex-1007, ¶¶208-209, ¶5, ¶238, ¶¶250-267. Ground 1 combines Cornelius’s active cable teachings with Samaan’s teachings about general retimer layout and operation. Ex-1003, ¶¶46-47.

1. U.S. Patent 8,516,238 (“Cornelius”) (Ex-1006)

Cornelius is post-AIA §102(a) prior art; it issued August 2013. Cornelius teaches “an active cable” with “dual clock and data recovery circuits” that perform equalization and “retime data at each of its ends[.]” Ex-1006, 6:6-32, 3:33-42. The equalization parameters may be calibrated “by the manufacture[r] and stored as presets for loading during operation” including for host-side paths. Ex-1006, 11:52-62.



Ex-1003, ¶¶47-50.

Cornelius is analogous art in the same field (*supra* §III). Cornelius teaches an active cable for “high-speed connection[s].” Ex-1006, 3:27-42, 3:54-64, 4:22-31, 4:45-54, 6:11-24, 8:57-9:6. Each active plug “provides” and “receives high-speed signals.” Ex-1006, 6:11-20, Fig.5. The ’252 patent recognized a problem where “ever-higher data rates” caused “increased channel attenuation and dispersion even as the equalizers are forced to operate at faster symbol rates” (Ex-1001, 1:14-22), which the claims address with equalization for transmit and receive paths (limitation [1e]). Cornelius is reasonably pertinent because it teaches

equalization solutions for high-speed active cables for both transmit and receive paths. Ex-1006, 6:30-32, 11:45-62, 12:12-13, claims 1, 6; Ex-1003, ¶51.

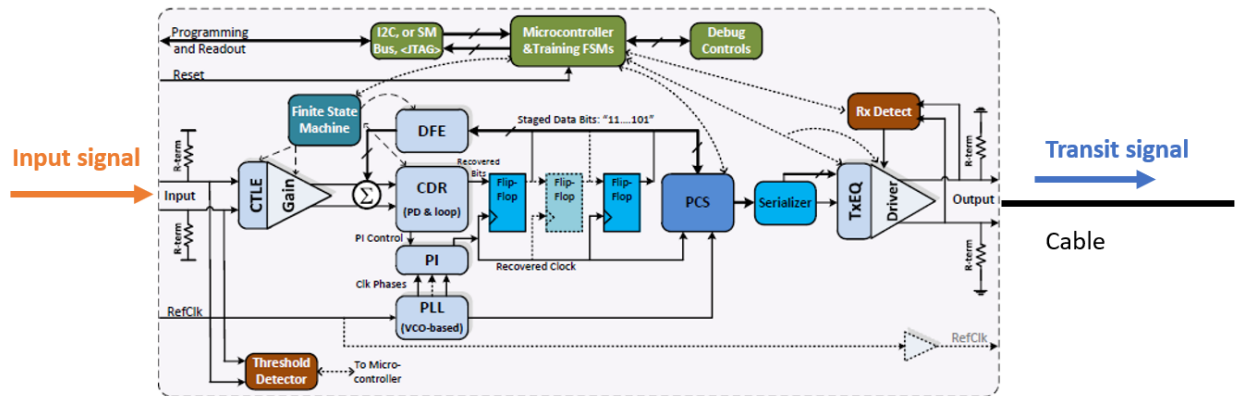
2. “High-Speed Serial Bus Repeater Primer” (“Samaan”) (Ex-1007)

Samaan is post-AIA §102(a) prior art. Ex-1003, ¶52.

Prior Art Publication. Samaan is an Intel whitepaper published in 2015 (Ex-1007, ¶1) and freely available for download on Intel’s public website by at least February 2016. Ex-1018, ¶7. Intel published whitepapers that were sought out by interested members of the public, including researchers at Texas Instruments that accessed and cited Samaan in their own work. Ex-1018, ¶18, ¶¶11-17. A POSITA could easily find white papers on Intel’s website with a few clicks and a search. For example, searching for Samaan’s title “High-Speed Serial Bus Repeater Primer” returns a single result “PCIe Architecture” (Ex-1035, 000001) that directly links to Samaan under “White Papers” (Ex-1033). Related search terms likewise return the PCIe Architecture page, with an accessible link to Samaan. Ex-1035, 000003, 000007-08, 000011, 000015. Snapshots from the Internet Archive confirm the PCIe Architecture webpage was available and provided access to Samaan before 2018. Ex-1018, 000105-106, 000029-30. This same page is cited in the PCIe Wikipedia entry. Ex-1034, 000028; Ex-1018, 000153, 000143-52. Notably, Cornelius also cites this Wikipedia page, and a

POSITA, like Cornelius’s inventors, would have followed such links for further information. Ex-1006, 000002 (“Other Publications”); Ex-1003, ¶¶53-56.

Samaan Overview. Samaan teaches re-timer architectures for high-speed copper channels. Ex-1007, ¶¶2-6. Samaan details how re-timers utilize equalization and CDR to extract bits from an input signal and then perform pre-equalization and modulation to transmit the signal on the other end. Ex-1007, Fig.35:



Samaan explains that redrivers and retimers share common components and architectural features, with many of its teachings regarding equalizations and I/O circuits applying to both. E.g., Ex-1007, ¶215, ¶¶225-229, Fig.3, Figs.34-35. Both are designed for bidirectional SerDes environments using differential signaling. *Id.*, ¶¶17-18, ¶28; Ex-1003, ¶¶57-58.

Samaan is analogous art in the same field (*supra* §III). This is stated in Samaan’s title. Samaan teaches re-timers for high-speed serial environments. Ex-1007, ¶1, ¶¶5-8, ¶¶12-15. Samaan is reasonably pertinent (*supra* §V.A.1)

because Samaan recognizes the problem of channel loss at high data rates (Ex-1007, ¶¶2-4) and teaches the use of equalization in retimers, which were transceivers, for both the transmit and receive paths. Ex-1007, ¶213, ¶1, ¶¶5-8, ¶¶207-220, Figs.34-35; Ex-1003, ¶59.

3. Claim 1

For the below limitations, the “first” and “second” designations can be swapped between elements at the ends of Cornelius’s active cable, which is symmetric. *E.g.*, Ex-1006, 6:14-23, Figs.5-6. Ex-1003, ¶60.

[1pre] An active Ethernet cable that comprises:
--

Cornelius teaches an “active cable.” Ex-1006, Title, 5:33-39, 6:6-20, 8:20-40, Figs.5-6, Claims 1-10. Cornelius provides “a few examples” of protocols (Ex-1006, 1:15-27, 4:1-9) and cites known standards including “Ethernet.” Ex-1006, 000002 (Other Publications). Therefore, Cornelius teaches or suggests using Ethernet with its active cable. Ex-1003, ¶¶61-62.

Ground 1 applies Samaan’s retimer teachings. *Supra* §V.A (explaining combination). Samaan teaches Ethernet support in retimers (Ex-1007, ¶¶250-251 (re-timer facilitating communication between “two ethernet ports”), ¶¶134-135), including support for Ethernet equalization training. Ex-1007, ¶208, ¶¶139-147. Therefore, the combination teaches or suggests Ethernet support for an active

cable, which further includes limitations [1a]-[1e]. See Ex-1007, ¶72, ¶238; Ex-1003, ¶63.

Motivation to Combine. In 2011, Apple and Intel co-developed active cable technologies later known as Thunderbolt. Ex-1013, 000001. Their collaboration drew significant attention, with Apple developing and marketing the cable (Ex-1014, 000001; Ex-1013, 000001-02), and Intel providing port and retimer architecture for the active plugs. Ex-1016, 000001-02; Ex-1015, 000003. Thunderbolt ports appeared in Mac computers beginning in 2011 (Ex-1013, 000001), and other vendors soon offered Thunderbolt solutions. Ex-1009, 000001; Ex-1008, 000003-05. Thunderbolt cables were commercially available by 2011. Ex-1016, 000001; Ex-1003, ¶¶64-65.

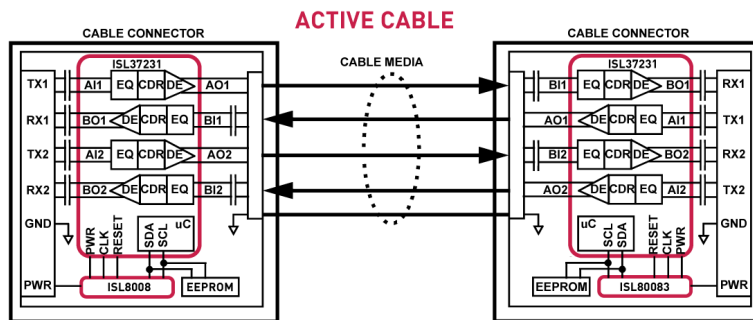
Therefore, by 2019, a POSITA developing active cables would have been motivated to consult Apple's cable art (e.g., Cornelius) and Intel's technical references on transceiver/retimer architecture (e.g., Samaan)—specifically, to apply Samaan's retimer teachings when implementing the "circuits for retiming data" in Cornelius's active plugs. Ex-1006, 6:11-32, 8:20-26, Figs.5-6. Because Cornelius does not provide implementation details—understandable given Apple's focus on the broader Thunderbolt assembly—a POSITA would have looked to known retimer architectures (Ex-1006, 12:21-34 (providing motivation to modify)) like Samaan. This combined prior art elements according to known methods to

yield predictable results (e.g., a retimer in an active cable, as Cornelius teaches).

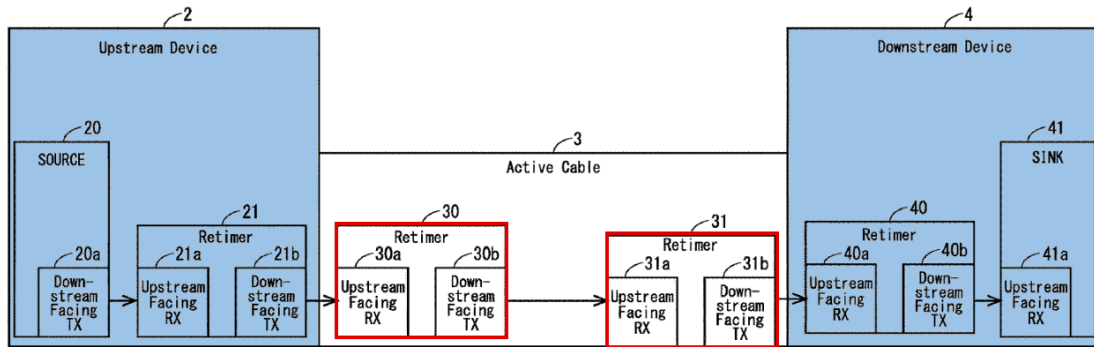
Ex-1003, ¶¶65-66.

Samaan applies its teachings to cables, explaining how re-timers are “usable in a reversible cable” (Ex-1007, ¶238) and with known cable/module standards, e.g., SFP+ (Ex-1007, 000072, ¶204, ¶72). See Ex-1011 (using SFP+ for Ethernet); Ex-1025, Tbl. 1; Ex-1012, 000001-09 (same); Ex-1019 (same). Samaan’s retimer teachings provide several benefits, e.g., jitter isolation, enhanced debug capabilities, and increased length. Ex-1007, ¶15, ¶202. Thus, the combination applies known retimer architectures to known active cables that were ready for improvement to yield predictable results: a retimer in an active cable. Ex-1003, ¶¶67-68.

The prior art provided express motivation to incorporate retimers in active cables and recognized numerous benefits. Ex-1026; Ex-1009, 000001 (explaining retimer benefits), Fig. 1:



Ex-1010, ¶2, Fig. 1:



Ex-1003, ¶¶69-70.

A POSITA would have been motivated to combine Samaan’s Ethernet teachings (explained above) with Cornelius for the benefits of supporting Ethernet. Cornelius teaches several protocols including Ethernet. Ex-1006, 000002. By March 2019, active Ethernet cables were commercially available. *Supra* §I.B; Ex-1011, 000001; Ex-1012, 000001-05, 000008-09; Ex-1019. Market demand would have further motivated applying Ethernet to Cornelius’ active cable teachings, resulting in an active Ethernet cable with Ethernet-capable ports. This applied a known technique (Ethernet) to a known device (Cornelius’ active cable) to achieve predictable results: an active Ethernet cable. Ex-1003, ¶71.

Ethernet had long been used across various physical channels, with common retimer architectures (with equalization, CDR, and remodulation) applied to backplanes and cables. Ex-1007, ¶5, ¶15 (discussing cables), ¶134 (Ethernet backplane), ¶238. Combining these teachings used a known technique (Ethernet) to improve similar devices (retimers in active cables or other devices) in the same

way with predictable results, given the range of physical channels/connectors used with Ethernet. *Infra* §V.A.3[1b]; Ex-1003, ¶72.

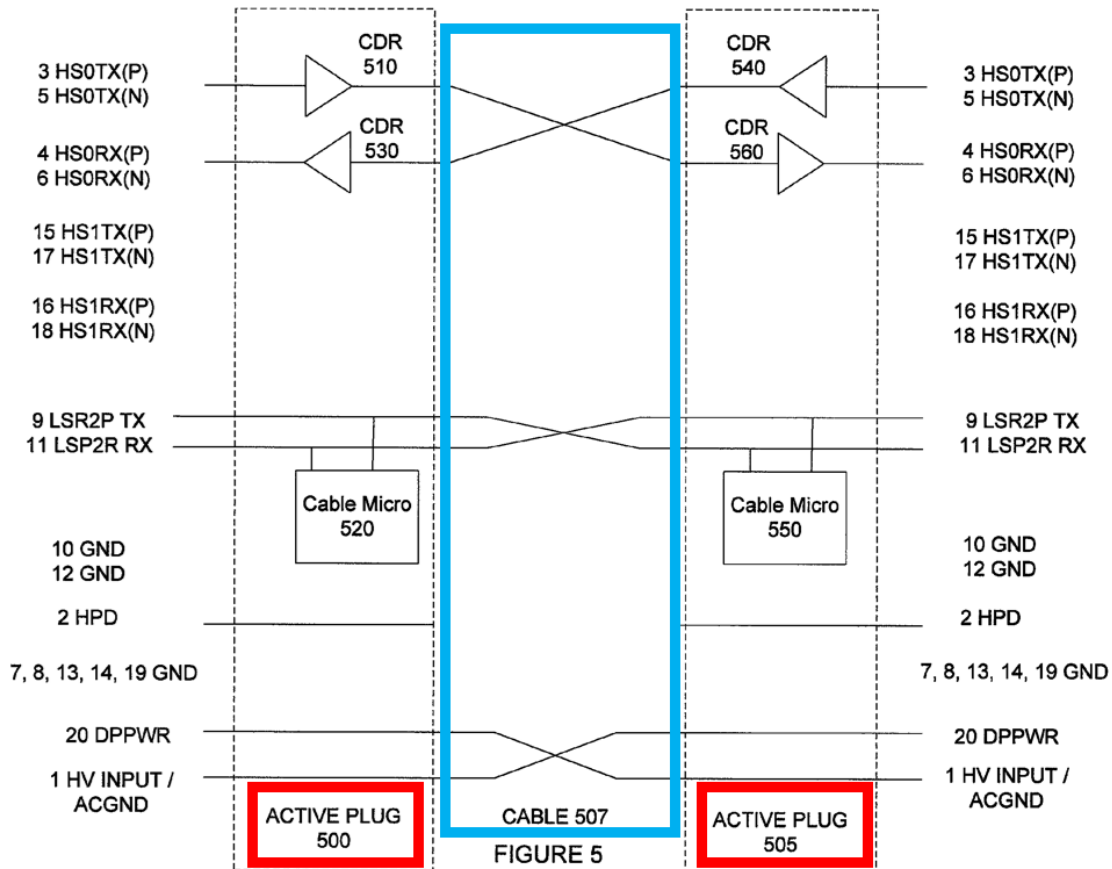
The combination would not have changed the principle of operation for either reference. Cornelius already teaches retimers in its active cable and suggests multiple protocols, including Ethernet. Ex-1006, 1:19-22, 4:4-9, 6:6-20, 000002. Both references teach retiming circuitry that performs CDR and equalization. Ex-1006, 6:6-32, claims 1, 6; Ex-1007, ¶¶202-231, ¶15. And Samaan’s broadly-applicable retimer architecture was already provided in a cable context; it would have operated in the same way for the same purpose in an active cable: to recover bits from one end and re-transmit them on the other. Ex-1003, ¶73.

Therefore, a POSITA would have had a reasonable expectation of success. Indeed, Samaan’s retimers reflect common retimer architectures long used for high-speed serial communications and taught in college courses. Active Ethernet cables with retimers were commercially available. A POSITA would have known how to use retimers with active Ethernet cables. *Supra* §III; Ex-1003, ¶74.

<p>[1a] electrical conductors connected between a first connector and a second connector,</p>
--

Cornelius teaches **electrical conductors connected between a first connector and a second connector**. Cornelius teaches an “active cable” that “includes two active plugs...one on each end[.]” Ex-1006, 6:11-20, 8:20-26,

Figs.5-6. Several pairs of electrical conductors (highlighted in blue below) are connected between the first/second connectors (e.g., first/second active plugs), comprising “copper or other conductor.” Ex-1006, 7:26-41.



Ex-1003, ¶¶76-77.

Cornelius also includes options for fiber optics (Ex-1006, 6:25-29), but a POSITA would have been motivated to apply Cornelius’ teachings for simply using copper for reduced costs and improved bend radius. See Ex-1013, 000001; Ex-1014, 000002. Indeed, Apple originally contemplated fiber optics but moved

to copper Thunderbolt to reduce cost. Ex-1013, 000001-02; Ex-1014, 000002; Ex-1003, ¶77-78.

[1b] each of the first and second connectors being adapted to fit into an Ethernet port of a corresponding host device to receive from that host device an electrical input signal conveying an inbound data stream to the cable and to provide to that host device an electrical output signal conveying an outbound data stream from the cable,

Ground 1 teaches **each of the first and second connectors** (e.g., first/second active plugs) **being adapted to fit into an Ethernet port of a corresponding host device**. Cornelius' active plugs connect to host devices, e.g., computers or other devices (Ex-1006, 3:28-64, 5:33-39, 6:6-10, Fig.2), which "provide ports where power and data signals can be shared[.]" Ex-1006, 1:15-17, 3:44-46, 4:55-65, Figs.2-3. Cornelius's active plugs are adapted to fit into corresponding host ports using an exemplary connector port interface, aligning corresponding pins on the plug and host:

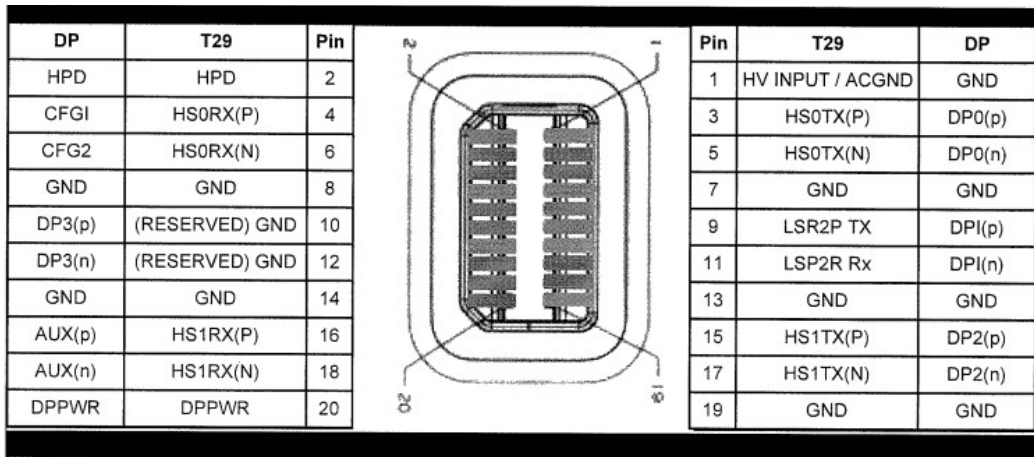


FIGURE 3

E.g., Ex-1006, 3:65-4:9, 4:22-44, 7:7-25, Figs.5-6; Ex-1003, ¶¶79-80.

Ground 1 teaches an active Ethernet cable. *Supra* §V.A (explaining combination), §V.A.3[1pre] (explaining combination/motivation). Therefore, the corresponding ports likewise support Ethernet; otherwise, the active cable would not function correctly. Cornelius’ active plug was compatible with Ethernet. For example, the port included pairs of transmit lines (pins 3, 5; 15, 17) and receive lines (pins 4, 6; 16, 18). Ex-1006, 4:22-31, Figs.3, 5-6. Ethernet used one pair of transmit and one pair of receive lines, which aligns with Cornelius’s teachings.³ Ethernet often used CAT-5, with transmit and receive pins connected to twisted pair cables—Cornelius’ Tx and Rx pins served the same purpose. Moreover,

³ Cornelius’ pins 9-12 would also have worked for this purpose.

Cornelius teaches or suggests Thunderbolt (Ex-1006, 1:19-22, 4:1-9), which supported Ethernet. Ex-1027, 000004; Ex-1003, ¶¶81-82.

Additionally, Samaan teaches an Ethernet port—its retimers facilitate connections between “two Ethernet ports[.]” Ex-1007, ¶251, ¶250, ¶¶252-267, ¶¶139-143, ¶208. Samaan teaches SFP connectors (Ex-1007, ¶204 (citing “[24]”)), which were known to support Ethernet; Ex-1003, ¶83.

Each plug **receives from that host device an electrical input signal conveying an inbound data stream to the cable and provides to that host device an electrical output signal conveying an outbound data stream from the cable.** Each plug “retime[s] signals received at an input of the [first/second] plug.” Ex-1006, claim 1. Each host transmits a signal conveying an inbound data stream to the plug over the TX pins (e.g., 3, 5) and receives a signal conveying an outbound data stream from the plug over the RX pins (e.g., 4, 6). Ex-1006, Fig.3, 4:23-54, 3:33-4:9.

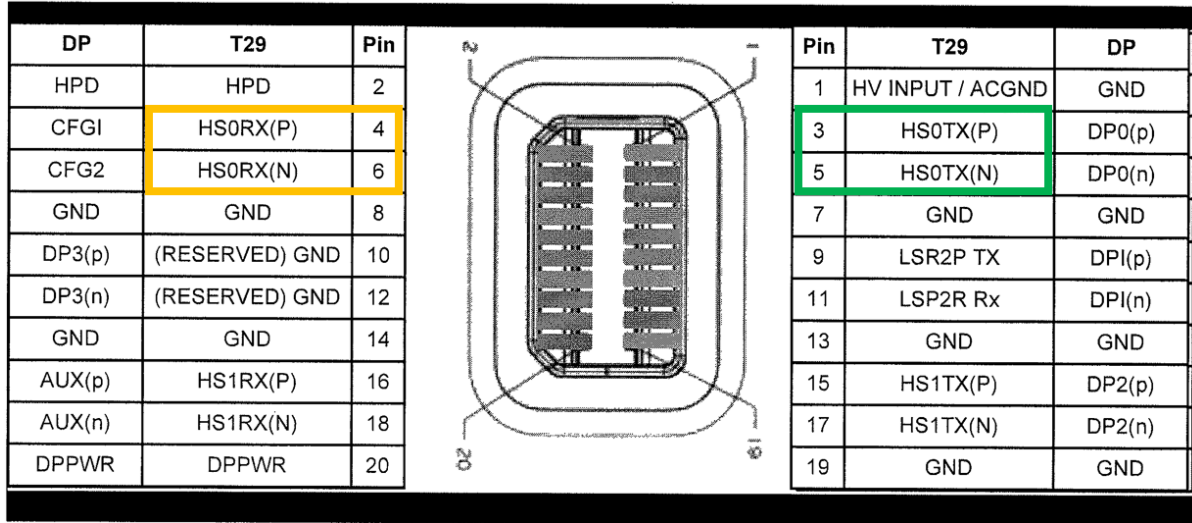
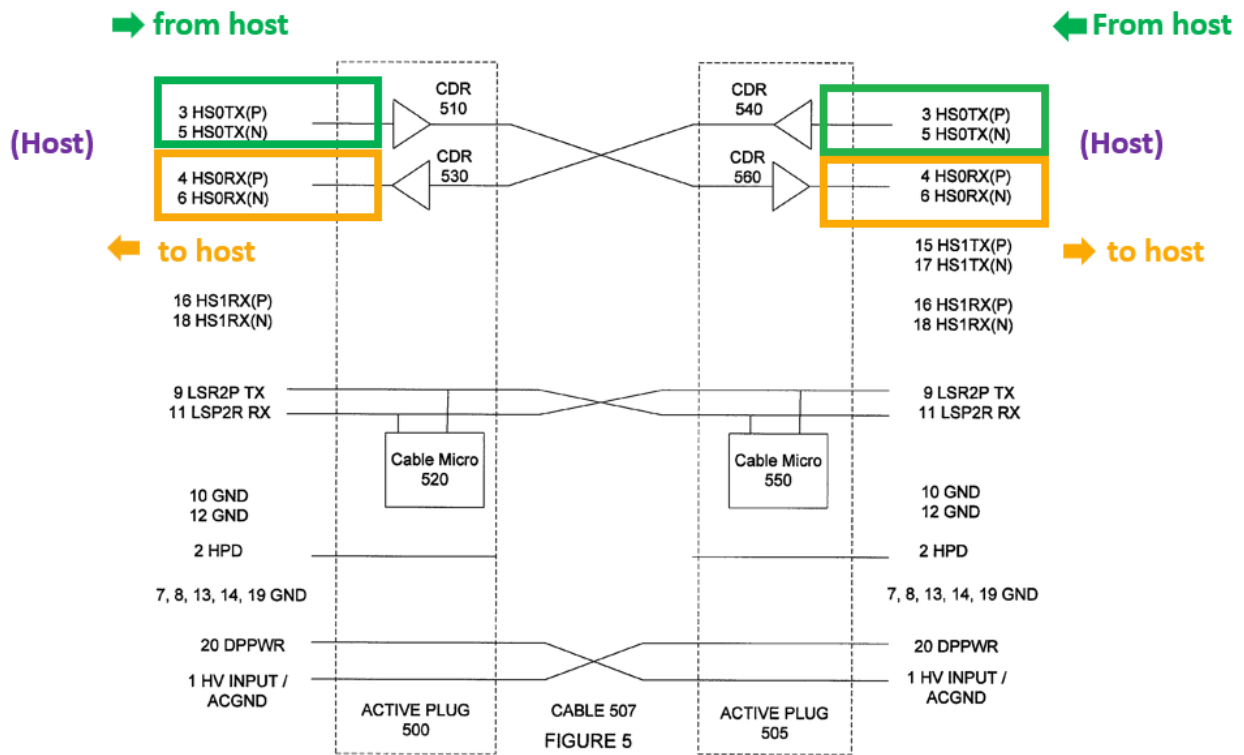


FIGURE 3

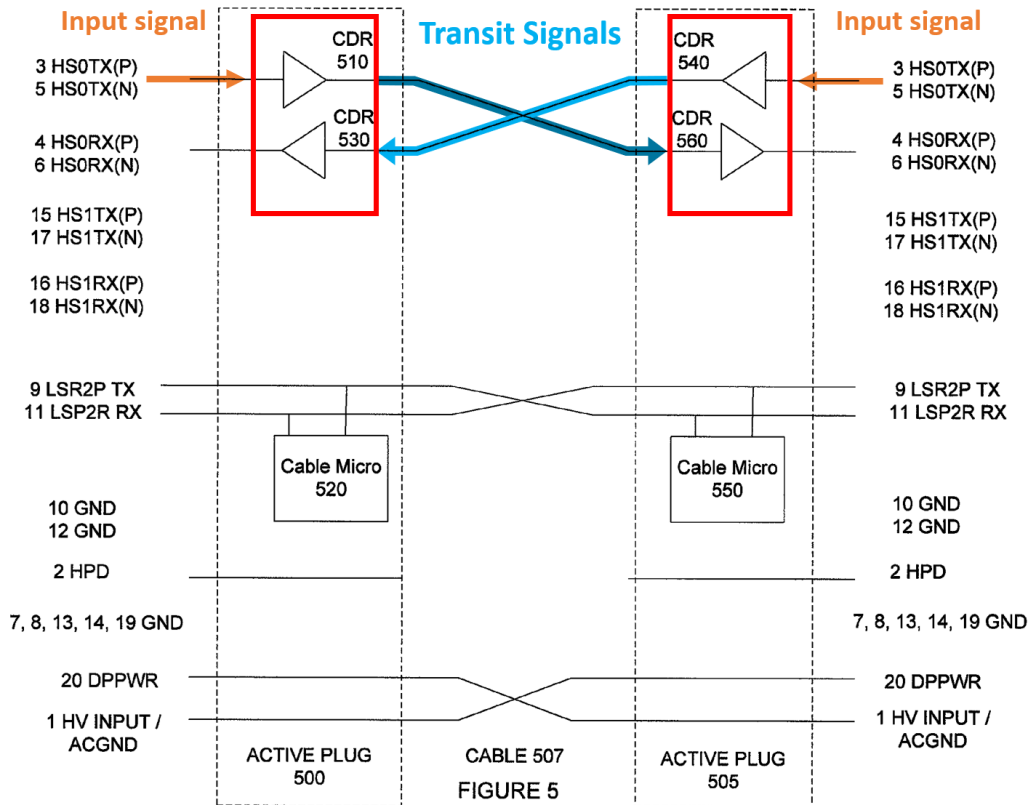


Ex-1003, ¶84.

Cornelius describes Tx and Rx from the host's perspective. The plug receives the signals transmitted by the host and provides the signals received by the host, through the connector interface. Ex-1006, 6:16-24, Figs.3, 5-6. Ex-1003, ¶¶84-86.

[1c] each of the first and second connectors including a respective transceiver that performs clock and data recovery on the electrical input signal to extract and re-modulate the inbound data stream for transit via the electrical conductors as a respective electrical transit signal conveying a transit data stream,

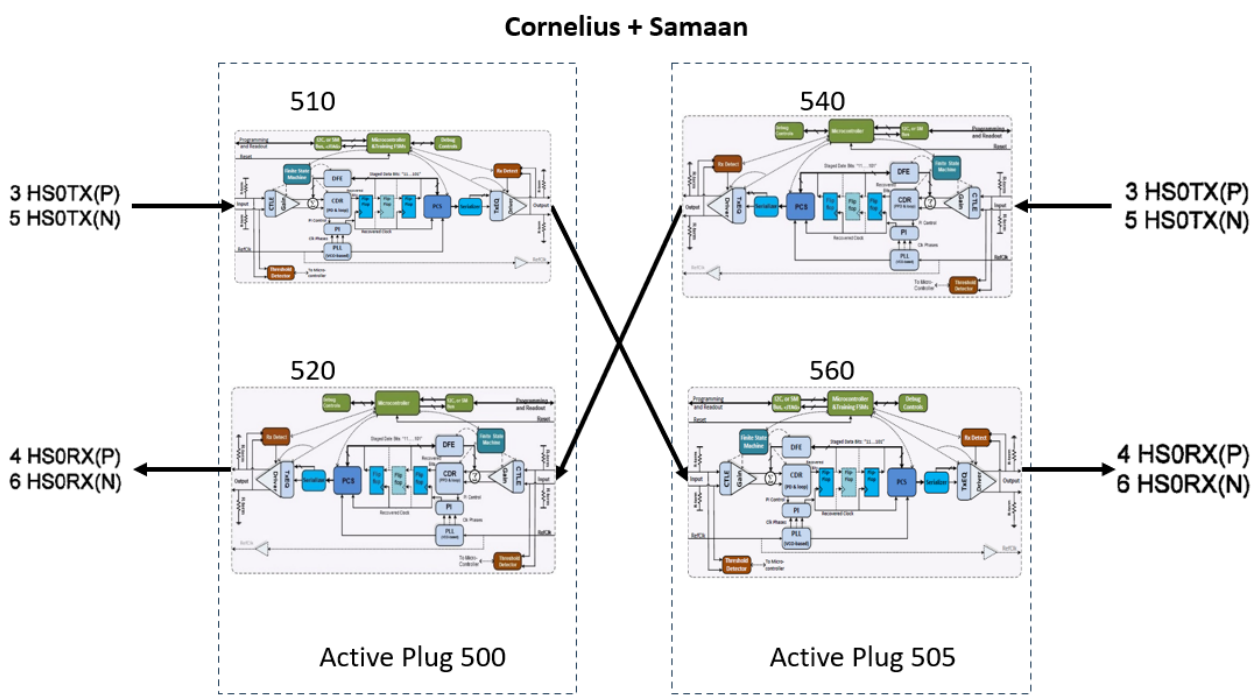
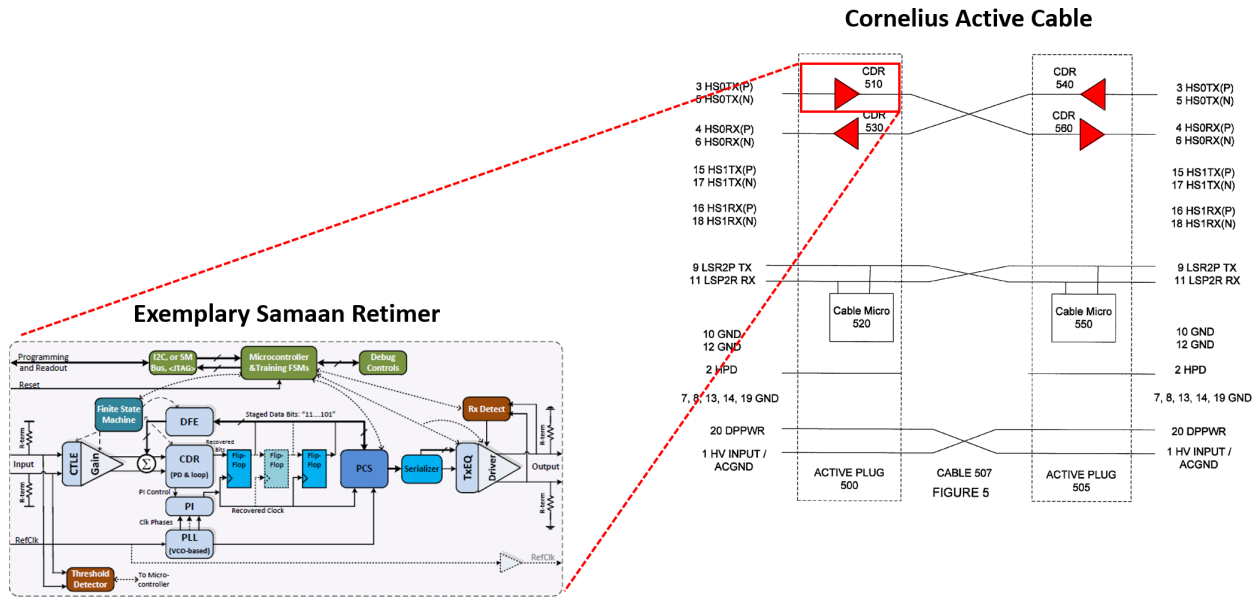
Ground 1 teaches **each of the first and second connectors** (e.g., first/second active plugs) **including a respective transceiver that performs clock and data recovery on the electrical input signal**. Cornelius teaches that “[e]ach active plug includes dual clock and data recovery circuits” that operate on the incoming electrical input signal. Ex-1006, 6:11-24, Figs.5-6. Cornelius’ “CDR” circuitry performs a broader function; it also retimes data. Ex-1006, 6:15-32. Therefore, the dual CDR circuitry in each plug is a transceiver that transmits and receives signals; this applies to individual CDR components, which receive on one side and transmit on the other, and also to the dual CDR circuitry as a whole, which transmits and receives on each side. Ex-1006, 6:6-33, 8:20-26, claim 1, Fig.5:



Ex-1003, ¶87.

Ground 1 applies Samaan’s teachings regarding general retimer layouts.

Supra §V.A (explaining combination), §V.A.3[1pre] (explaining combination/motivation). Samaan’s retimer architectures include the functionality Cornelius describes (Ex-1006, 6:6-32), e.g., CDR, equalization, buffers, and retiming. *E.g.*, Ex-1007, ¶225, ¶79, ¶91, ¶114, Figs.34-35. Thus, a POSITA would have applied Samaan’s retimer teachings to Cornelius’ active plugs (showing Samaan’s overall layout in Cornelius’s active cable):



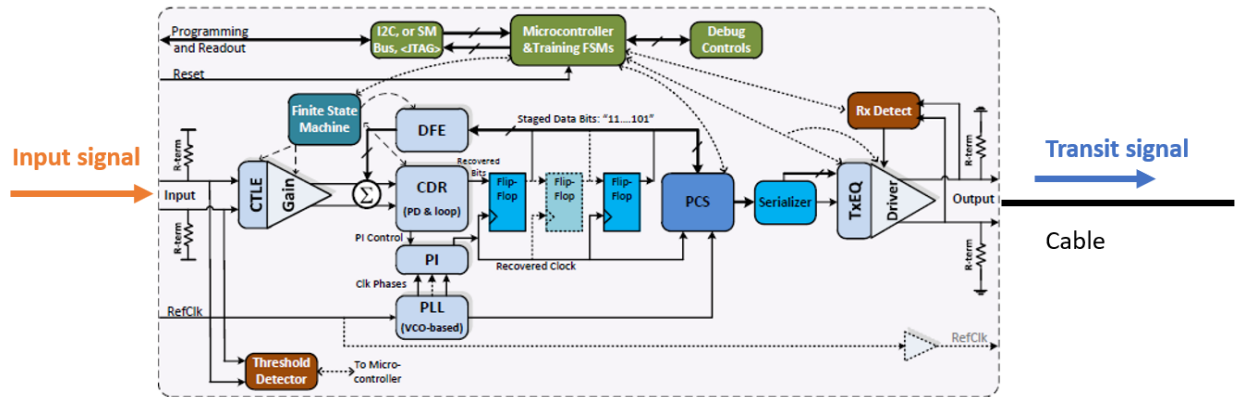
Ex-1006, Fig.5; Ex-1007, Figs.34-35; Ex-1003, ¶88.

Cornelius+Samaan teaches each active plug including a transceiver (Cornelius's dual CDR/retimer circuitry, combined with additional details from Samaan's retimer architectures) that performs CDR on the electrical input signal

(pins 3, 5). Ex-1007, ¶¶202 (“A Re-timer has a Clock Data Recovery circuit.”), ¶15, ¶¶216-217; Ex-1003, ¶89.

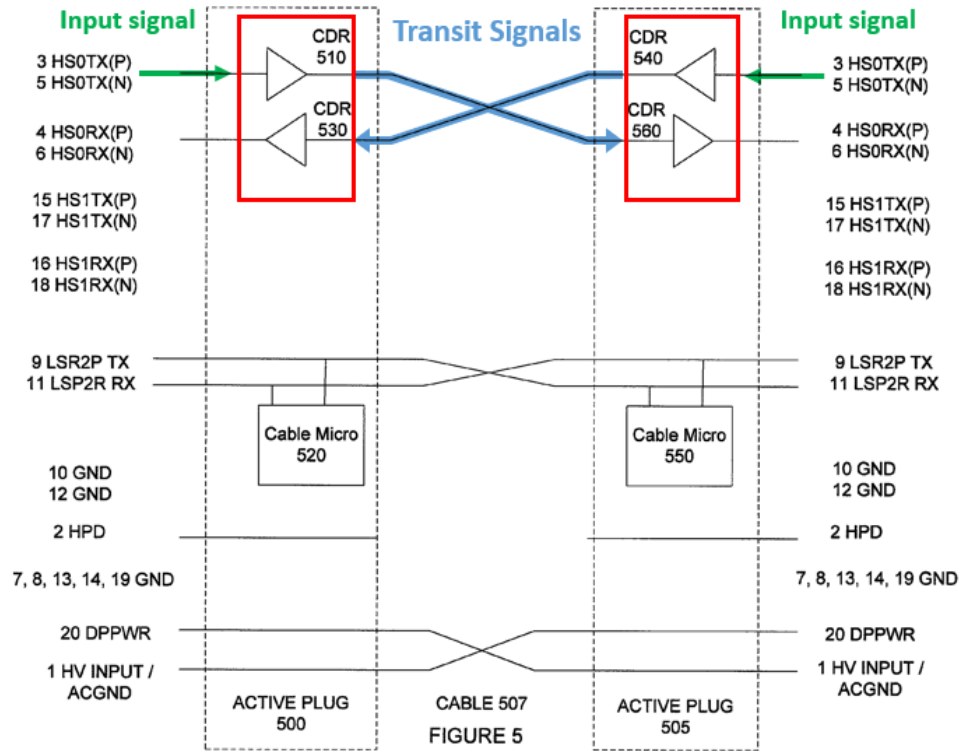
Each transceiver performs CDR to **extract and re-modulate the inbound data stream**. CDR extracts bits from the inbound data stream; Cornelius then “retime[s]^[4] signals received at an input.” Ex-1006, claim 1, 6:11-24, 8:20-26. Similarly, with Samaan’s additional retimer details, each retimer performs CDR to extract “data bits” (stored in flip-flops) from the inbound “data stream.” Ex-1007, ¶202, ¶¶203-212, ¶¶216-217. Next, the retimer re-modulates the digital bitstream and “re-transmits the digital data anew.” Ex-1007, ¶202, ¶15. For this re-modulation process, the data signal flows through the TxEQ and driver, plus the PCS and serializer blocks for protocol-aware retimers. Ex-1007, ¶¶216-231, Figs.34-35:

⁴ Patent Owner contends limitation [1c] is satisfied by the presence of retimers in an active cable. Ex-1024, 000004-05 (highlighting retimers/“retiming” capability); Ex-1022, 000004-09 (same); Ex-1023, 000004-09 (same).



Therefore, Cornelius and Samaan both re-modulate the inbound data stream by converting extracted bits into a signal for transmission over the communications channel (cable), which has independent jitter and timing characteristics from the inbound signal. Ex-1007, ¶¶15, ¶¶202; Ex-1003, ¶¶¶90-92.

The data stream is extracted/re-modulated **for transit via the electrical conductors as a respective electrical transit signal conveying a transit data stream**. The retimed CDR outputs are transmitted across cable 507, which comprises electrical conductors (*supra* §V.A.3[1a]); therefore, the outputs are electrical transit signals. Ex-1006, 6:21-29, 7:26-41, Fig.5:



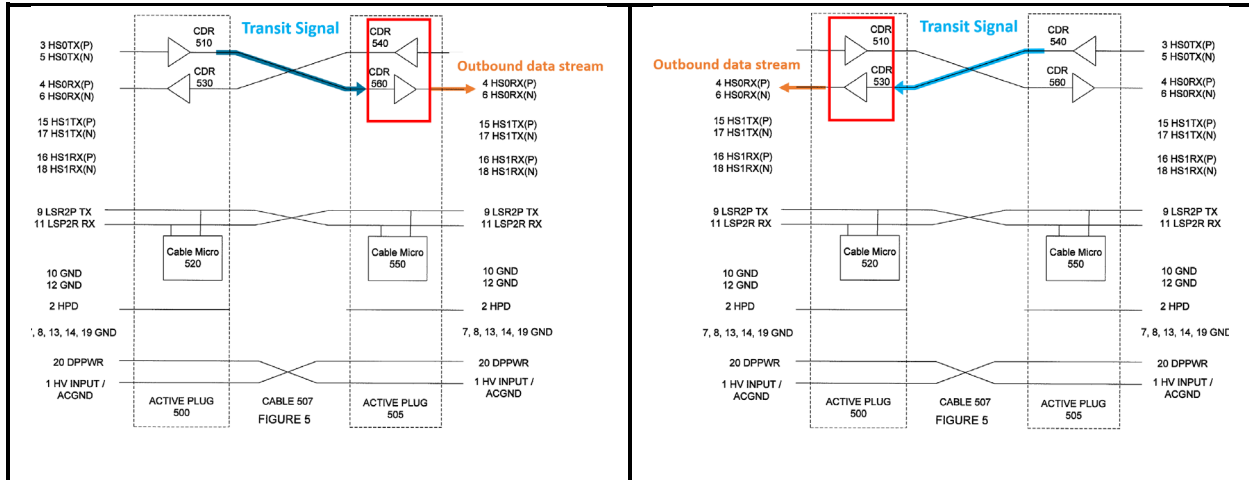
Each transit signal conveys a transit data stream comprising data from the host. Cornelius teaches “retim[ing] signals received at an input” and sending them over the cable. Ex-1006, Claim 1, 6:11-24, 8:20-26, Figs.5-6. Samaan likewise teaches that the retimer “re-transmits the digital data anew.” Ex-1007, ¶202. Ex-1003, ¶¶92-93.

[1d] the respective transceiver for each of the first and second connectors performing clock and data recovery on the respective electrical transit signal to extract and re-modulate the transit data stream as the outbound data stream from the cable, and

Ground 1 teaches **the respective transceiver for each of the first and second connectors (e.g., active plugs) performing clock and data recovery on the respective electrical transit signal.** Each transceiver (explained above, *supra*

§V.A.3[1c]) receives the electrical transit signal that was sent across the cable (Ex-1006, 6:11-32, claims 1, 6, Figs.5-6), performs CDR on that signal, and retimes it.

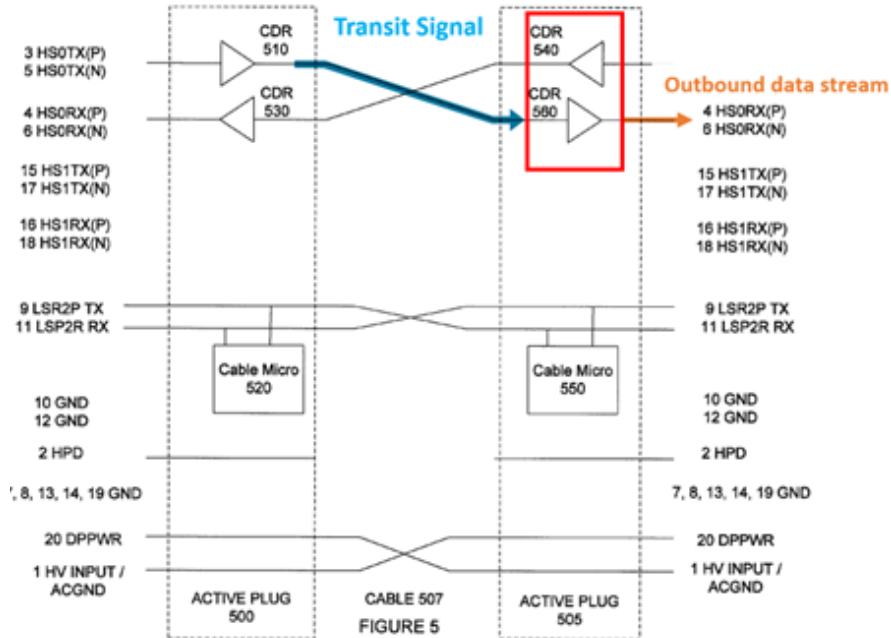
Ex-1006, 6:6-10, 14-16, claims 1, 6.



Ex-1003, ¶¶94-95.

The transceivers perform CDR to extract and re-modulate the transit data stream as the outbound data stream from the cable. CDR extracts bits from the transit data stream; Cornelius then “retime[s]^[5] signals received from the cable” which is the transit signal. Ex-1006, claim 1, 6:11-24, 8:20-26. Subsequently, the remodulated data stream is output as the outbound data stream from the active cable. Ex-1006, 6:11-24, Fig.5:

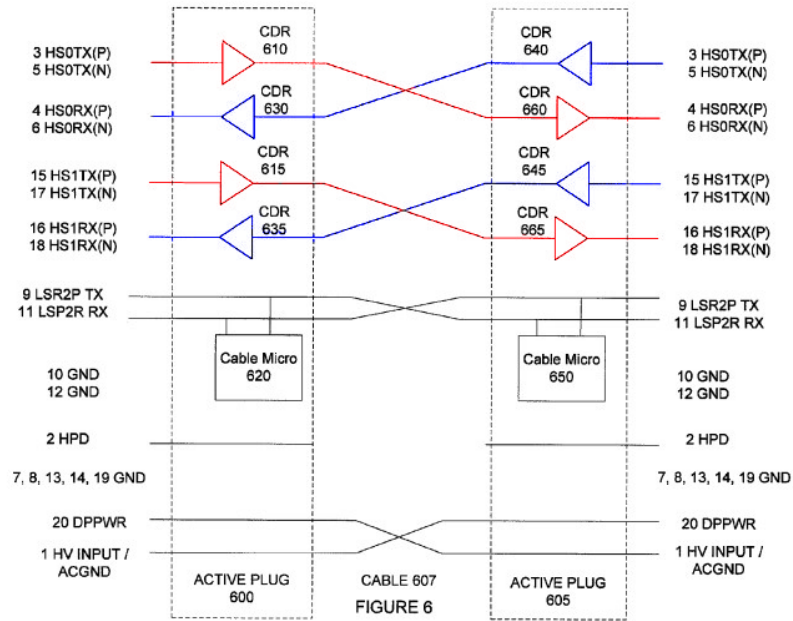
⁵ See *supra* n. 4.



Ex-1003, ¶¶96-97.

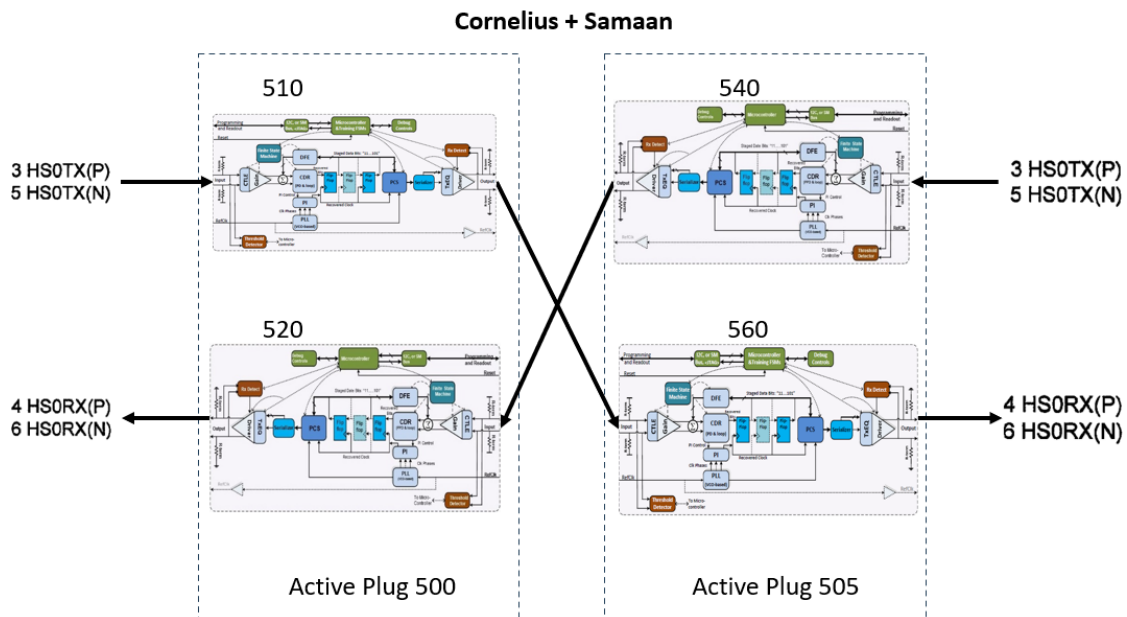
The same process is mirrored in the other direction for CDR 530. Ex-1006, 6:11-20, Fig.5; Ex-1003, ¶100. Data flows from CDR 510 to 560 (and CDR 540 to 530), following the direction of the arrows, which is the normal convention in the field. Ex-1003, ¶¶98-99.

Figure 6 teaches additional transceivers and signals that likewise satisfy [1c] and [1d]:



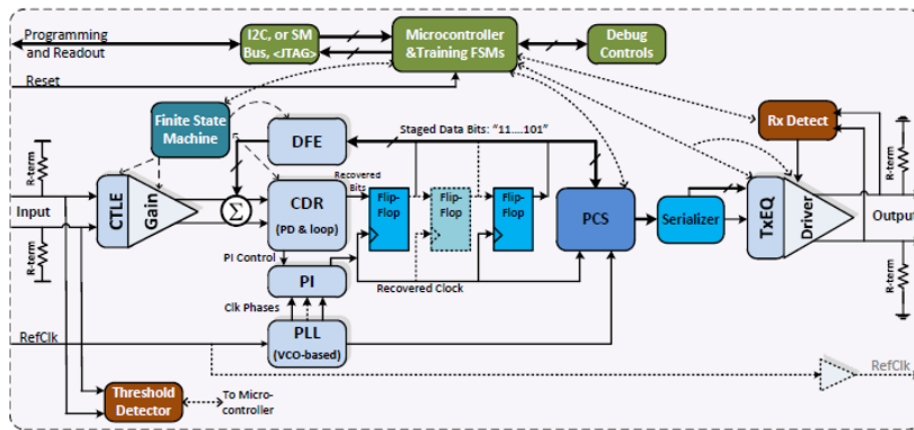
Ex-1003, ¶98.

Additionally, Ground 1 applies Samaan’s retimer teachings. *Supra* §V.A (explaining combination), §V.A.3[1pre] (explaining combination/motivation), §V.A.3[1c] (applying Samaan’s retimer teachings to Cornelius).



Ex-1003, ¶101.

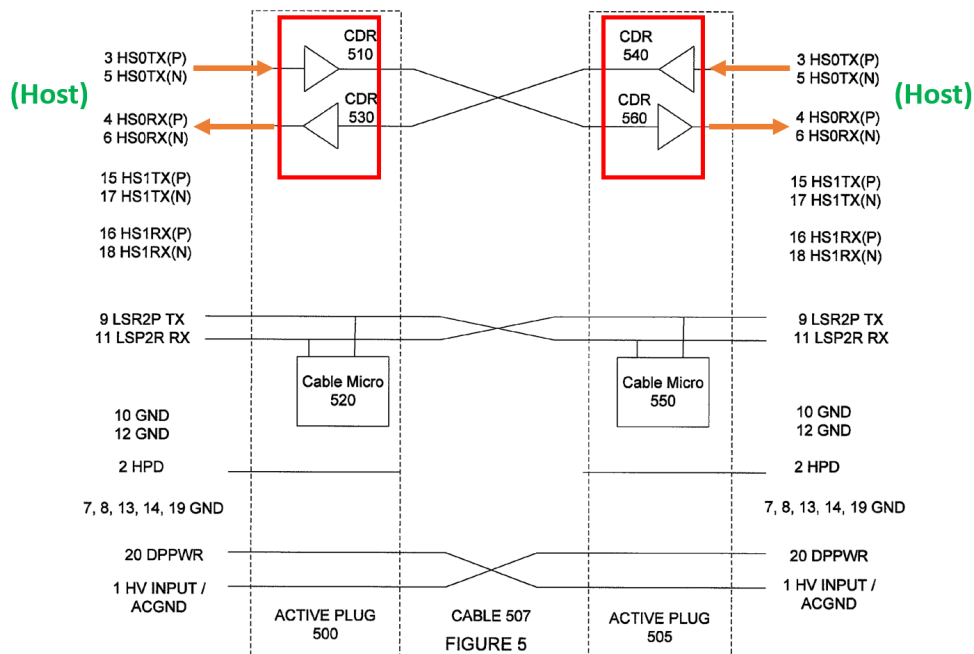
Each retimer performs “CDR” on the electrical transit signal received from the cable. This extracts data bits (stored in flip-flops) and re-modulates the transit data stream as the outbound data stream from the cable. Samaan’s CDR extraction and remodulation was previously explained; that analysis applies here. *Supra* §V.A.3[1c]; Ex-1007, ¶15, ¶202-212, ¶¶216-231, Figs.34-35.



Cornelius and Samaan both re-modulate the input transit stream by converting the extracted data bits from the stream into a signal for transmission over the communications channel to the host, which has independent jitter and timing characteristics from the input transit signal. Ex-1007, ¶¶15-16, ¶¶202-208; Ex-1003, ¶¶102-105, ¶96.

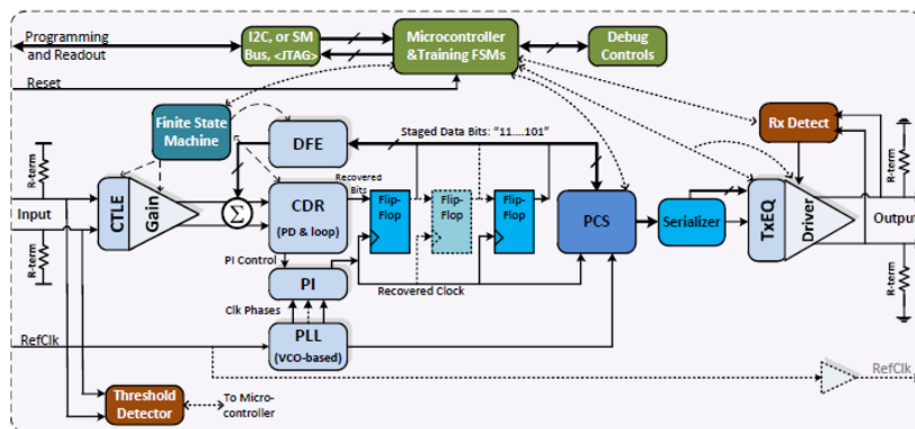
[1e] the respective transceivers each employing fixed, cable-independent, equalization parameters for each of: the remodulation of the transit data stream as the outbound data stream, and the clock and data recovery performed on the electrical input signal.

The respective transceivers each employing fixed, cable-independent, equalization parameters. Each transceiver (explained above, *supra* §§V.A.3[1c]-[1d]) employs equalization for signals exchanged with the host. Cornelius explains how its “CDR” component retimes data (Ex-1006, 6:15-16) and employs “equalizer circuits, buffers, emphasis, and de-emphasis circuits[.]” Ex-1006, 6:30-33; *supra* §V.A.3[1c]. Inbound and outbound signals are exchanged with the host on pins 3-6. *Supra* §V.A.3[1b].



Ex-1003, ¶106.

Ground 1 also applies Samaan’s retimer teachings. *Supra* §V.A (explaining combination), §V.A.3[1pre] (explaining combination/motivation), §V.A.3[1c] (applying retimer teachings). Each transceiver uses transmit linear equalization (TxEQ) on transmitted signals and other continuous time linear equalization (CTLE) and discrete feedback equalization (DFE) on received signals. Ex-1007, ¶4 (TxEQ), ¶204, ¶208, ¶20 (CTLE), ¶207, ¶8 (DFE), ¶¶215-221. Each equalization function employs parameters that control the equalization. *E.g.*, Ex-1007, ¶221 (“...manages...CTLE, DFE settings, and other parameters,”), ¶215, ¶¶20-21 (CTLE’s “programmed” “setting”), ¶220 (“amplitude of each DFE tap” and “number of DFE taps”), ¶225 (“TxEQ...settings have to be programmable”), ¶¶26-27, Figs.34-35.



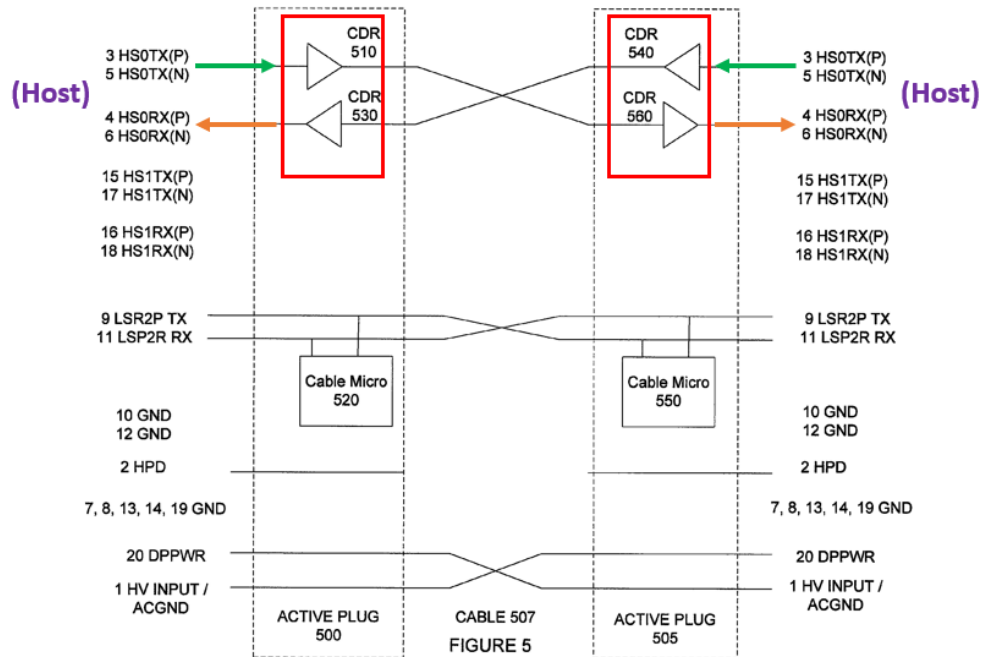
Ex-1003, ¶107.

Cornelius teaches **employing fixed, cable-independent equalization parameters**. Cornelius teaches calibrating equalization circuitry, which “may be adjusted using various parameters.” Ex-1006, 11:45-52. Next, Cornelius teaches

two distinct approaches. First, the “parameters for these circuits may be calibrated or otherwise determined by the manufacture[r] and stored as presets for loading during operation.” *Id.*, 11:52-55. Second, “[i]n other embodiments...these parameters may be determined while the system is connected” including “during power up, restart, or other periodical or event-based time.” *Id.*, 11:55-59.

Cornelius’s first approach employs parameters that are fixed at manufacturing and do not change during normal cable usage because Cornelius presents it as an alternative to parameters determined/trained when the cable is connected and operating. *Id.*, 11:52-59. Ex-1003, ¶108.

Cornelius teaches using routines—including the manufacturer presets—for host-side paths, “to calibrate the path from a host to a near end of the cable,” and, for the other plug, “the path from the cable to a device or other host.” Ex-1006, 11:59-62, Fig.5:



Ex-1003, ¶109.

These parameters are used to equalize signals exchanged on the host side⁶ of a transceiver, rather than the path through the cable (507). Ex-1006, Figs.5-6.

These parameters account for channel properties of host-side paths; they do not compensate for cable paths and do not depend on the properties of the particular connecting cable. It would not have made sense to customize these host-side parameters on a cable-by-cable basis, which would require testing of individual

⁶ PO contends parameters for host-side paths satisfy cable-independent parameters because they “are independent of communications through the cable[.]” Ex-1022, 000014-15; Ex-1023, 000017-19; Ex-1024, 000009-10.

assembled cables during operation to measure their channel characteristics.

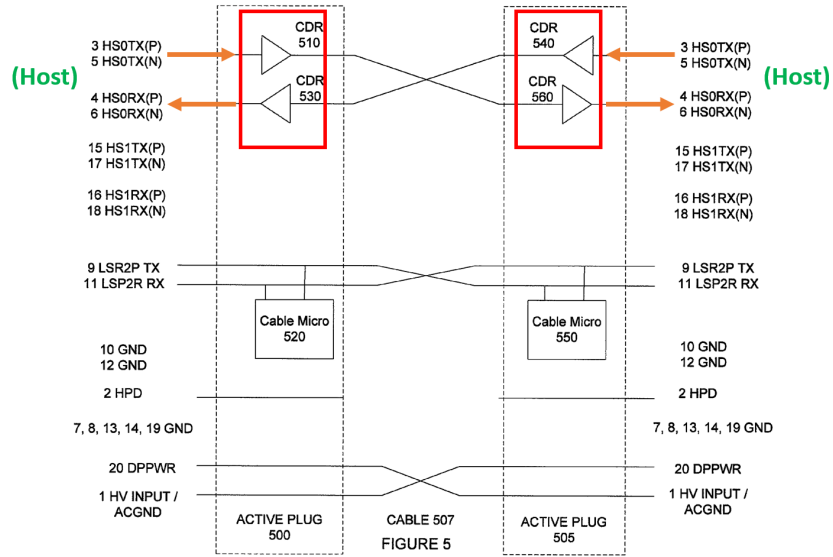
Cornelius describes this as an alternative approach to manufacturer-set preset parameters. Ex-1006, 11:51-59. Therefore, Cornelius teaches or suggests using fixed, cable-independent parameters. Ex-1003, ¶110.

Motivation to Combine. While Cornelius teaches alternative approaches, a POSITA would have been motivated to apply Cornelius's teachings of pre-set equalization parameters for host-side paths as explained above. Ex-1006, 11:45-62. Cornelius presents this as one of two options; a POSITA would have had ample reason to choose preset parameters, with a reasonable expectation of success, because the approach was simple, economical, and sensible for host-side parameters that were unaffected by cable differences, as explained above. The prior art provides express motivation to use this textbook approach. Ex-1020, 000020-21; Ex-1021, 7:18-33, 1:65-67. Therefore, a POSITA would have found it sufficient and obvious, as a matter of common sense, to calibrate the host-side equalization parameters once, during manufacturing, and then to use the same preset parameters for all cables of a given design. Ex-1006, 11:45-62; Ex-1003, ¶111.

Doing so would have been simpler and more cost-effective than customizing parameters for each cable because these host-side parameters operate on host-side traces and are not affected by differences in cable characteristics. Ex-1006, 11:45-

62. In more generic circumstances, retimer designs may incorporate more complex training/adaptation features to handle a range of unknown channels, e.g., when used in the middle of a long backplane or in-between two passive cables. For these multi-purpose retimer designs, the increased time, cost, and complexity of advanced training/adaptation algorithms can be justified. However, for Ground 1, Cornelius teaches a specific active cable application with retimers serving a defined role in each plug. In this context, Cornelius teaches that either of two approaches can be used (Ex-1006, 11:51-59), and as noted, preset parameters are well-suited for these particular host-side paths, which involve short paths to a nearby host chip rather than long cable distances. Ex-1003, ¶112.

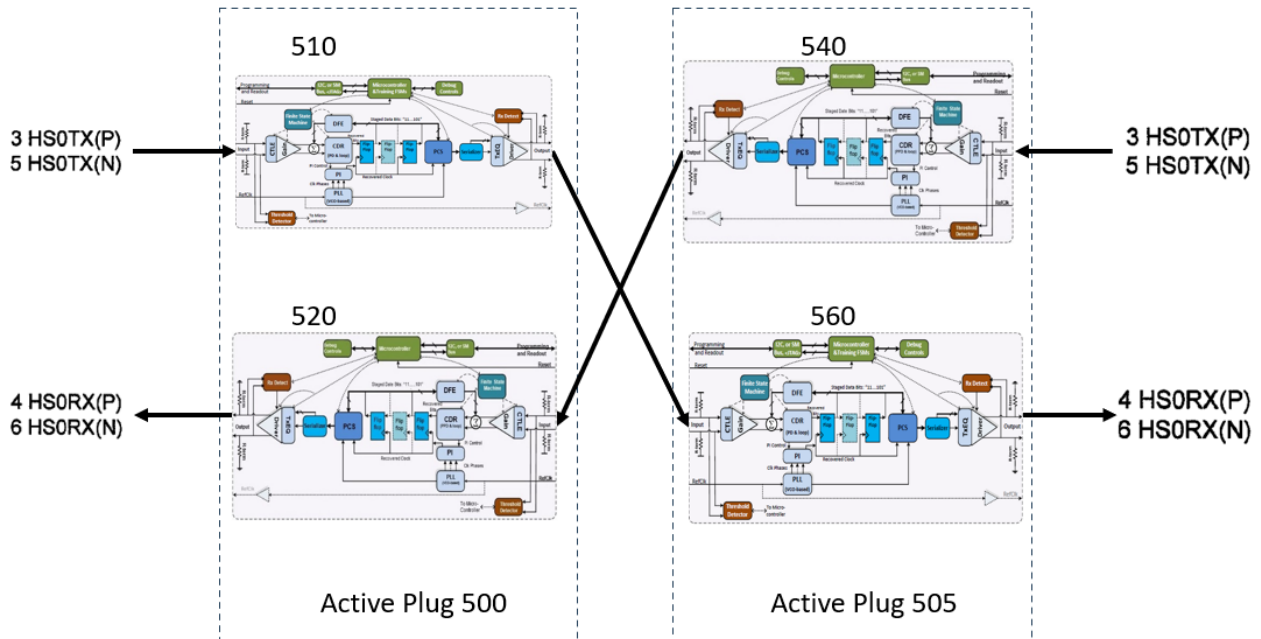
For each of the remodulation of the transit data stream as the outbound data stream, and the clock and data recovery performed on the electrical input signal. The equalization parameters in this section are used for host-side signals. Ex-1006, Figs.5-6.



Ex-1003, ¶113.

In the combination, Samaan’s retimer architecture applies equalization (e.g., TxEQ) to the remodulated outbound data stream to the host and equalization (e.g., CTLE and DFE) for the CDR performed on the electrical input signal from the host. Ex-1007, Figs.34-35; Ex-1006, Figs.5-6.

Cornelius + Samaan



Ex-1003, ¶114.

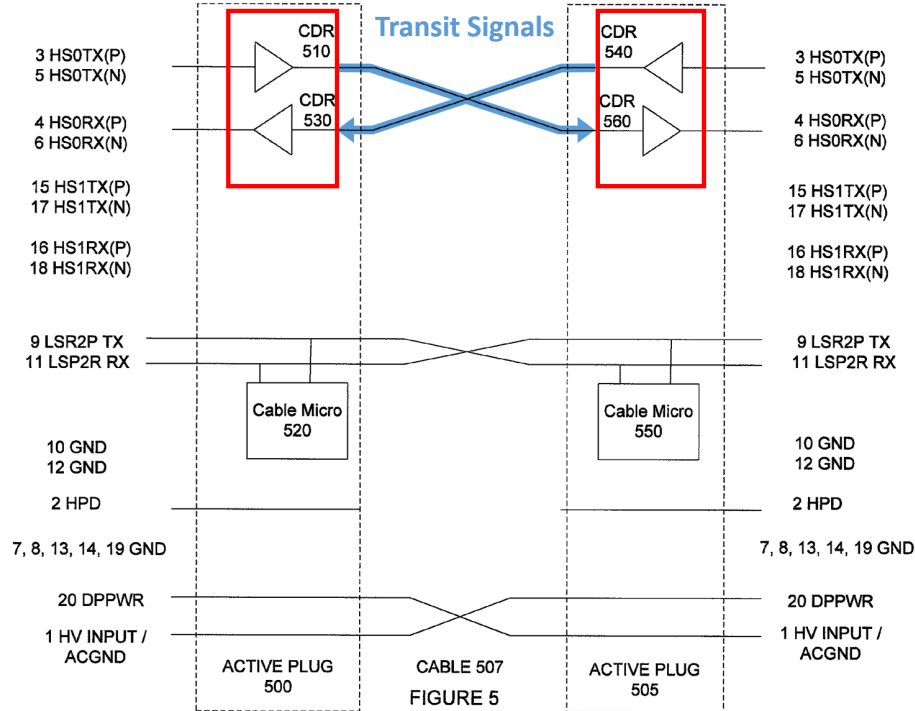
Remodulation and CDR were explained previously. *Supra* §§V.A.3[1c]-[1d]; Ex-1003, ¶¶115-116.

4. Claim 2

2. The active Ethernet cable of claim 1, wherein the respective transceivers each employ cable-dependent equalization parameters for at least one of: the remodulation of the inbound data stream for transit, and the clock and data recovery performed on the electrical transit signal.

Claim 2 recites overlapping limitations from [1c]-[1d] that are satisfied for the same reasons. *Supra* §V.A.3[1c] (explaining remodulation of inbound data stream), §V.A.3[1d] (explaining CDR of transit signal). Cornelius’ dual CDR/retimer circuitry employs “equalizer circuits, buffers, emphasis, and de-

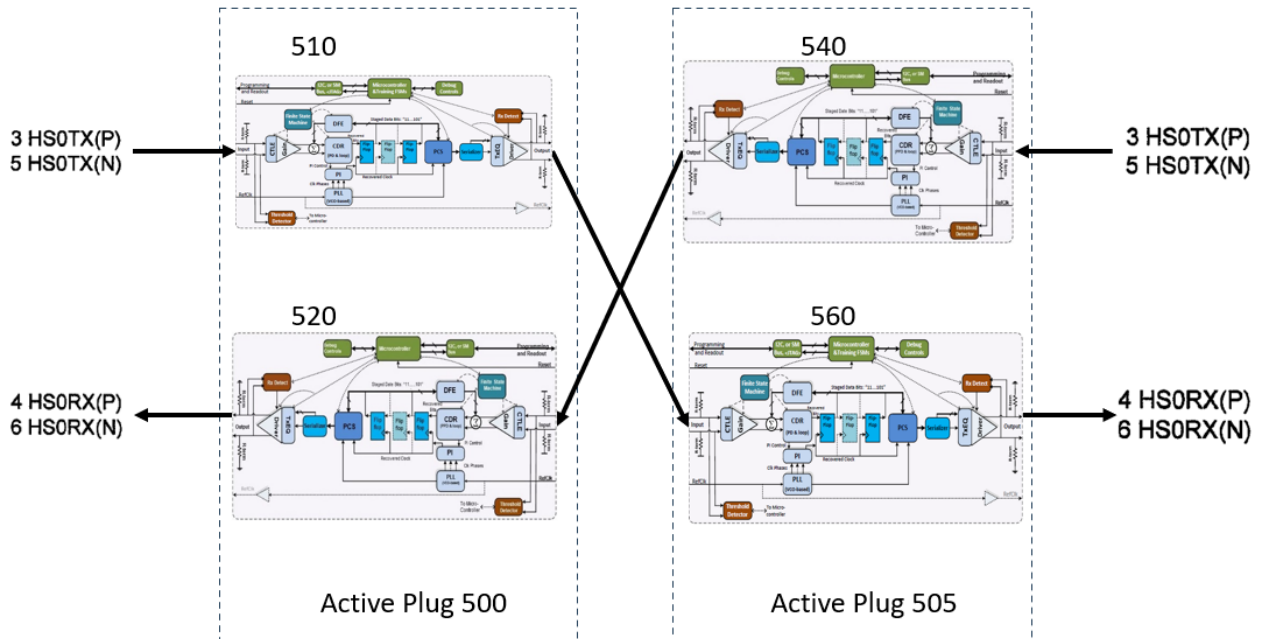
emphasis circuits” (Ex-1006, 6:30-33) which employ equalization for remodulation and CDR for the transit signals (Ex-1006, Figs.5-6).



Ex-1003, ¶118.

Ground 1 applies Samaan’s retimer details. *Supra* §V.A (explaining combination), §V.A.3[1pre] (explaining combination/motivation), §V.A.3[1c] (applying Samaan’s retimer teachings). For the remodulation of transit signals, Samaan teaches equalization (e.g., TxEQ); for CDR of transit signals, Samaan teaches equalization (e.g., CTLE and DFE). Ex-1007, ¶4 (TxEQ), ¶204, ¶208, ¶20 (CTLE), ¶207, ¶215, ¶¶216-217, ¶8 (DFE), ¶¶219-221. Each of these equalization functions employs parameters, explained previously. *Supra* §V.A.3[1e]; Ex-1007, ¶¶220-221, ¶215, ¶¶20-21, ¶225, ¶¶26-27.

Cornelius + Samaan



Ex-1003, ¶119.

Cornelius teaches employing **cable-dependent equalization parameters** for the remodulation and clock and data recovery operations. As an initial matter, Cornelius teaches training/calibration routines that adjust equalization parameters, calibrating them to “the path through the cable.” Ex-1006, 11:45-62. These equalization parameters compensate for the loss characteristics of individual cables and depend on the characteristics of that particular connecting cable. Ex-1003, ¶120.

Cornelius and Samaan both teach training parameters for individual cables. Ex-1006, 11:55-59 (training/determining parameters “while the system is connected,” which “may occur during power up, restart, or other periodical or event-based time”), 12:6-10; Ex-1007, ¶127 (changing starting parameters “in

search of better ones”), ¶78 (training “TxEQ” “for the specific channel and operating conditions at hand.”), ¶208. This training occurs when an individual cable is connected and in operation; therefore, the parameters are customized for each individual cable, and Ground 1 teaches employing cable-dependent equalization parameters. Ex-1003, ¶121.

Motivation to Combine. A POSITA would have combined these teachings from Cornelius and Samaan, as described above, because transmission characteristics (e.g., signal attenuation, noise susceptibility) vary from cable-to-cable, due to manufacturing variation and operating conditions. Unlike the host-side paths (normally inches long), cables were typically several feet or longer, exacerbating physical differences. Training, as Cornelius and Samaan teach, was the conventional approach to cable variation, as it tailored parameters to the particular cable at any particular moment, improving signal quality. This was beneficial for applications that demanded maximum performance, high data throughput, or extended cable lengths. Ex-1003, ¶¶122-123.

5. Claim 3

3. The active Ethernet cable of claim 2, wherein said cable-dependent equalization parameters adapt during usage of the Ethernet cable.

Ground 1 teaches cable-dependent equalization parameters that are trained (thus adapted) to the individual cable during operation/usage of the Ethernet cable; that analysis applies here. *Supra* §V.A.4 (claim 2). Cornelius teaches calibrating

equalization parameters “while the system is connected,” during operation/usage of the cable, including “during power up, restart, or other periodical or event-based time.” Ex-1006, 11:55-62. Samaan likewise teaches parameter training during usage. *E.g.*, Ex-1007, ¶¶208-211, ¶78, ¶¶234-236, ¶¶250-255; Ex-1003, ¶¶124-126.

6. Claim 4

4. The active Ethernet cable of claim 2, wherein said cable-dependent equalization parameters are fixed during normal usage of the Ethernet cable, and wherein said cable-dependent equalization parameters are determined during manufacturing-testing of the Ethernet cable.

Ground 1 teaches cable-dependent equalization parameters (*supra* §V.A.4) that are fixed during normal usage of the Ethernet cable and determined during manufacturing-testing of the Ethernet cable. As explained previously, Ground 1 teaches determining parameters while an assembled active cable is connected. Ex-1006, 11:55-59; *supra* §V.A.4. Samaan provides motivation to modify Cornelius’s teachings by simply saving those parameters as presets during manufacturing (*see* Ex-1006, 11:51-55); Samaan suggests it can be sufficient to simply use a link with preset equalization, without more advanced negotiation/live training features. *See* Ex-1007, ¶149 (suggesting to forego auto-negotiation/training, and “simply use an engineered link that is forced to 10G.”), ¶208 (discussing training support as optional and expensive), ¶88; Ex-1003, ¶127.

Motivation to Combine. The motivation to customize parameters to an individual cable was explained previously. *Supra* §V.A.4 (Motivation subsection). A POSITA would have found it obvious and been motivated to combine Cornelius and Samaan by further storing these calibrated values at manufacturing time. This approach benefited manufacturers who wished to avoid the time and expense of implementing adaptive training protocols and appealed to users seeking simple, reliable active cables without added complexity. Fixed parameters, tailored at the factory, were well-suited for environments with stable channel characteristics, e.g., with requirements/practices that limited noise/thermal issues. Ex-1003, ¶128.

Aronson’s teachings would have been readily incorporated into the quality assurance (“QA”) process. Compliance testing was a common practice as taught by Samaan. Ex-1007, ¶90. Therefore, a POSITA would reasonably expect such an approach to be successful. This was a combination of prior art elements (determining parameters and storing presets) according to known methods to yield predictable results. Ex-1003, ¶¶129-130.

7. Claim 6

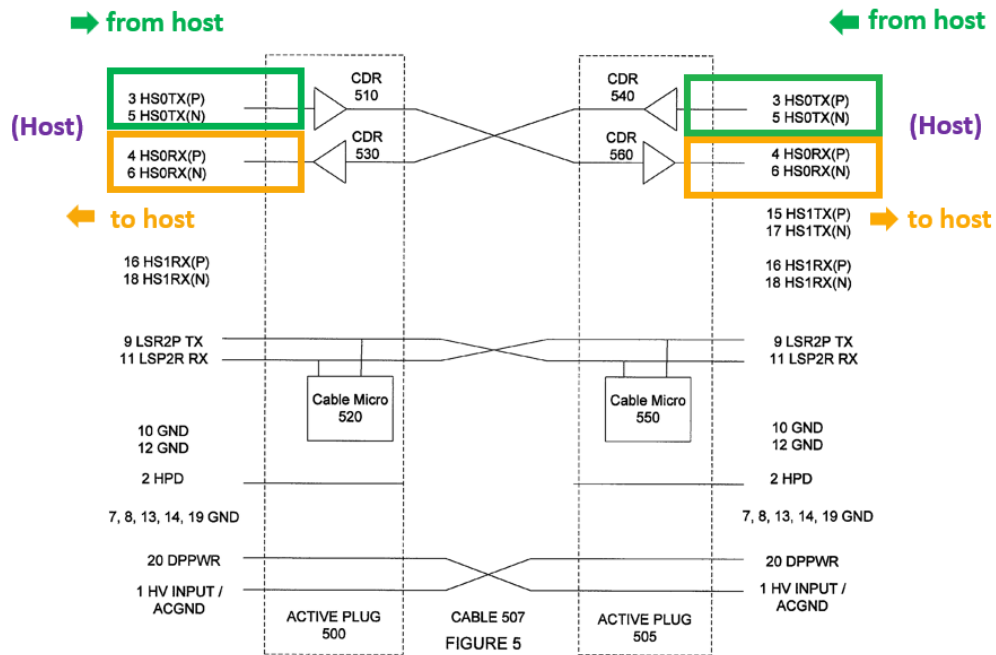
<p>[6pre] A communication method that comprises, in a network cable having conductor pairs electrically connecting a first connector to a second connector:</p>
--

Communication method. Cornelius teaches “methods” (Ex-1006, Abstract, 1:50-51, 1:55-58), including details and steps explained below ([6pre]-

[6k]). *E.g.*, Ex-1006, 3:28-64, 4:10-67, 11:45-12:20. Samaan teaches retiming steps and techniques. *E.g.*, Ex-1007, ¶¶255-259, ¶86; Ex-1003, ¶133.

A network cable. Ground 1’s active Ethernet cable is a network cable used for networking with the Ethernet protocol. *Supra* §V.A.3[1pre]; Ex-1003, ¶134.

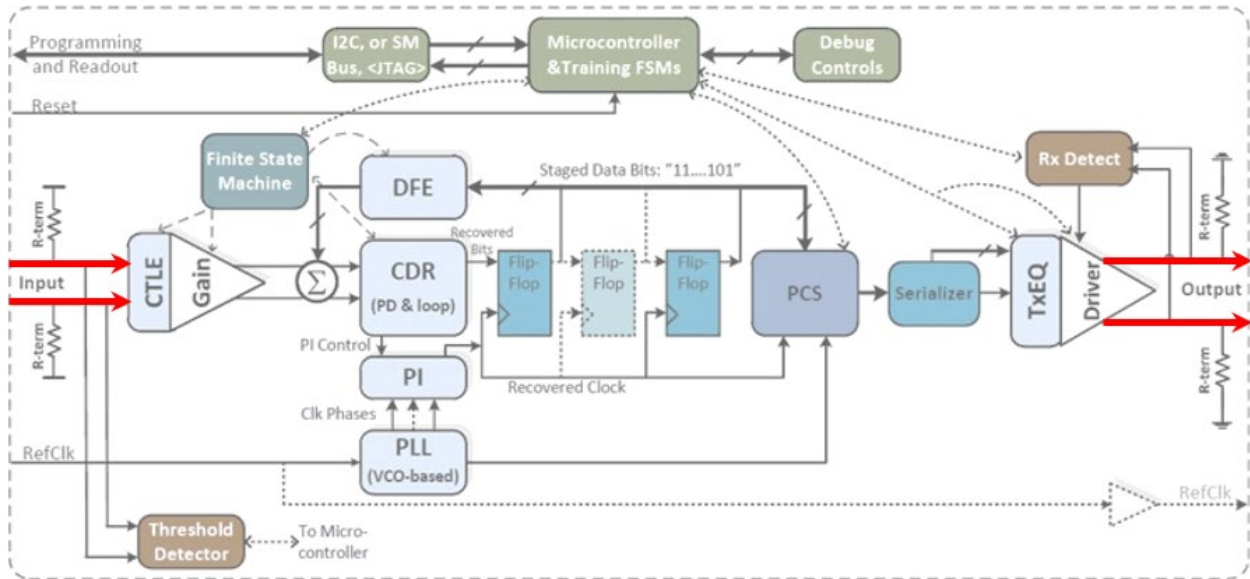
Conductor pairs electrically connecting a first connector to a second connector. Cornelius transmits signals over “high-speed differential signal paths,” consisting of pairs of electrical conductors that connect inbound TX pins on a (first) active plug to outbound RX on the opposite (second) active plug. Ex-1006, 1:67-2:2, 6:6-7:25, 8:10-15, Figs.3, 5-6. Cornelius denotes differential signal pairs with Positive (“P”) and Negative (“N”). *Id.*



Ex-1003, ¶135; *supra* §V.A.3[1a] (explaining conductors).

Samaan's retimers likewise use differential signal pairs (highlighted red).

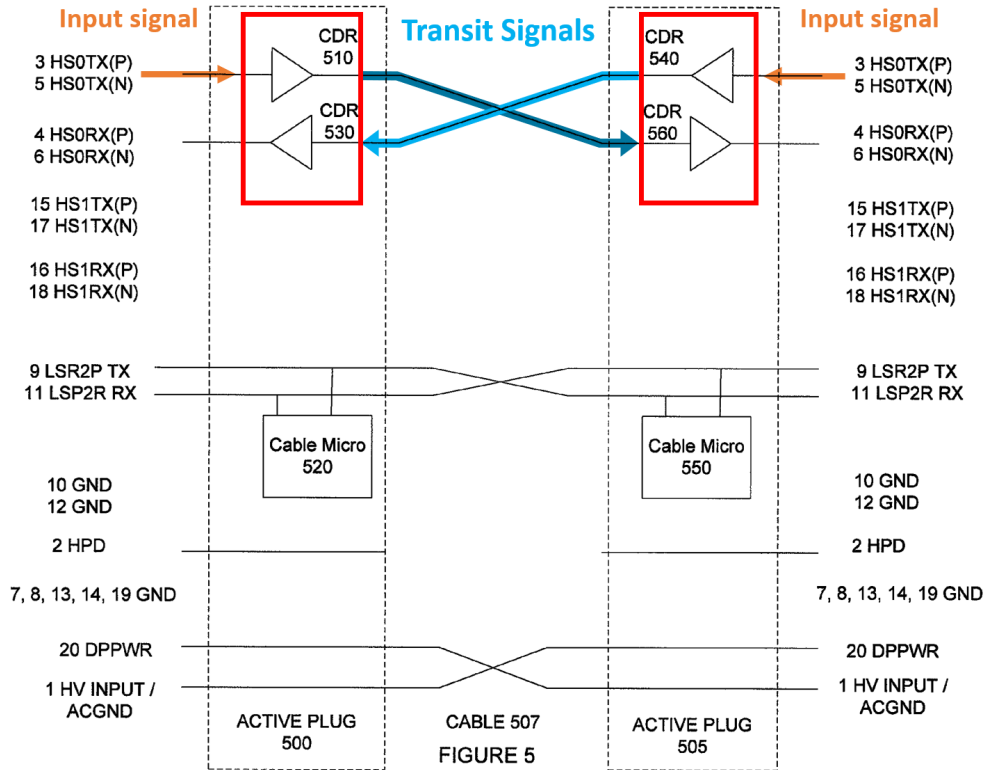
Ex-1007, ¶¶55-56, ¶134, ¶146, ¶224, Figs.3, 13, 34-35.



Ex-1003, ¶136.

- [6a] receiving with the first connector a first electrical input signal conveying a first inbound data stream from a first host device;
- [6b] performing clock and data recovery on the first electrical input signal with a first transceiver in the first connector to extract the first inbound data stream;
- [6c] re-modulating the first inbound data stream as a first transit data stream conveyed by a first electrical transit signal over a first of the conductor pairs;

The elements in [6a]-[6c] appear in [1b]-[1c] and are satisfied for the same reasons. *Supra* §§V.A.3[1b]-[1c]. Either of the active plugs is the *first* connector; the other is the *second*. The *first* input signal/inbound data stream is that received by the *first* connector from its corresponding host (the *first* host device). The *first* connector (e.g., active plug) includes a *first* transceiver inside. *Id.*



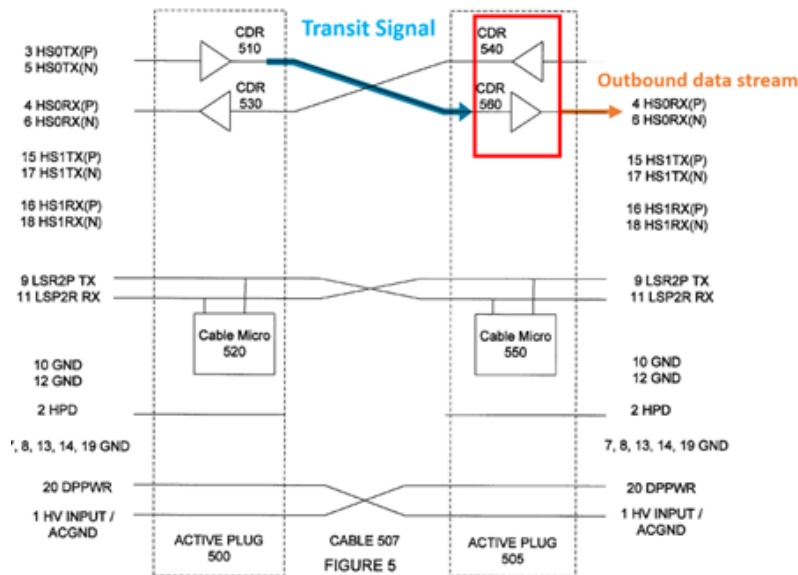
The *first* transit data stream is conveyed to the *second* connector (*supra* §V.A.3[1c]) over conductor pairs. *Supra* §V.A.7[6pre]; Ex-1003, ¶¶138-140.

[6d], [6e], [6f]

Limitations [6d]-[6f] mirror [6a]-[6c], respectively, but change “first” to “second.” The elements in [6d]-[6f] also appear in [1b]-[1c], and are satisfied for the same reasons, with the *second* signal/stream/host device being the ones corresponding to the second connector. *Supra* §§V.A.3[1b]-[1c]. The *second* transit signal is conveyed to the *first* connector (*supra* §V.A.3[1c]) over a *second* conductor pair. *Supra* §V.A.7[6pre]; Ex-1003, ¶¶141-143.

- [6g] performing clock and data recovery on the first electrical transit signal with the second transceiver to extract the first transit data stream;
- [6h] re-modulating the first transit data stream as a second outbound data stream conveyed by a second electrical output signal to the second host device;

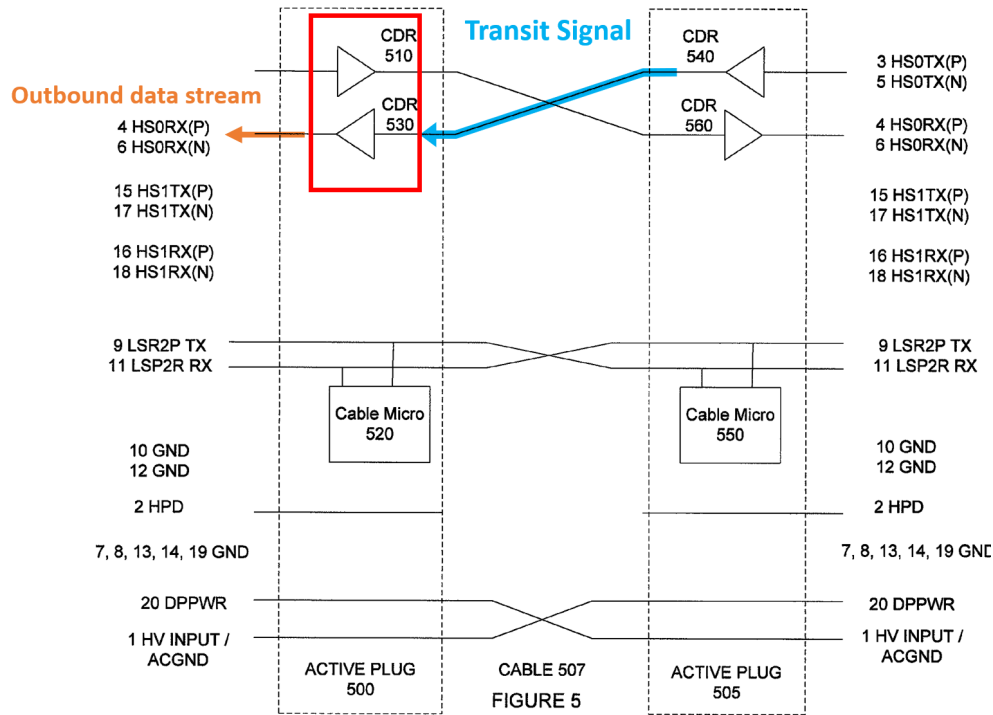
The elements in [6g]-[6h] appear in [1d] and are satisfied for the same reasons. *Supra* §V.A.3[1d]. The *first* electrical transit signal goes from the *first* transceiver/connector to the *second* and carries the *first* transit data stream.



The *second* outbound data stream is conveyed by an electrical output signal (*supra* §V.A.3[1b]) from the *second* transceiver to the *second* host through the second connector. Ex-1003, ¶¶144-145.

[6i]-[6j]

Limitations [6i]-[6j] mirror [6g]-[6h], respectively, but change “first” to “second.” The corresponding signals, data streams and components are likewise reversed in Cornelius’s symmetric cable:



The elements in [6i]-[6j] appear in [1d]/[1b], and are satisfied for the same reasons.

Supra §V.A.3[1d], §V.A.3[1b]; Ex-1003, ¶¶146-147.

[6k]

The elements in [6k] appear in [1e] and are satisfied for the same reasons.

Supra §V.A.3[1e]. The first and second transit data streams are the transit data streams received by the second and first transceivers, respectively, and the first and

second electrical input signals are the input signals received by the first and second transceivers, respectively. *Supra* §V.C.3[1e]. Ex-1003, ¶148.

8. Claim 7

Claim 7 overlaps with claim 2 and is satisfied for the same reasons. *Supra* §V.A.4. Because Ground 1's cables are bidirectional and symmetrical in operation (*supra* §V.A.3), Cornelius teaches employing cable dependent equalization parameters for remodulation of both the first and second inbound data streams and for CDR of both the first and second transit signals. Therefore, Ground 1 employs cable-dependent equalization parameters for at least one of the recited remodulation or CDR operations. Ex-1003, ¶¶149-152.

9. Claim 8

<p>8. The communication method of claim 7, wherein said cable-dependent equalization parameters are adaptively updated.</p>
--

Ground 1 teaches adapting the cable-dependent equalization parameters using calibration routines during use; claim 8 is taught for the same reasons. *Supra* §V.A.5 (claim 3), §V.A.4 (claim 2); Ex-1003, ¶¶153-154.

10. Claim 9

Claim 9 shares elements with claim 4 that are satisfied for the same reasons. *Supra* §V.A.6. Claim 9 also recites **manufacturer-testing**; this is satisfied by Cornelius' testing teachings, which are carried out "by the manufacture[r]." Ex-1006, 11:51-55; Ex-1003, ¶¶155-156.

11. Claim 11

[11pre] A cable manufacturing method that comprises:

Ground 1 teaches a **cable manufacturing method** comprising the steps of claim 11, which connect and package the elements of claim 1. Cornelius teaches claim 1 and that the “devices...may be manufactured,” including “the connections” in its embodiments. Ex-1006, 3:5-16. Cornelius teaches details for connecting circuits/packaging/materials for its active cable. Ex-1006, 6:6-67, 8:10-40, 3:65-4:65; Ex-1003, ¶¶158-159.

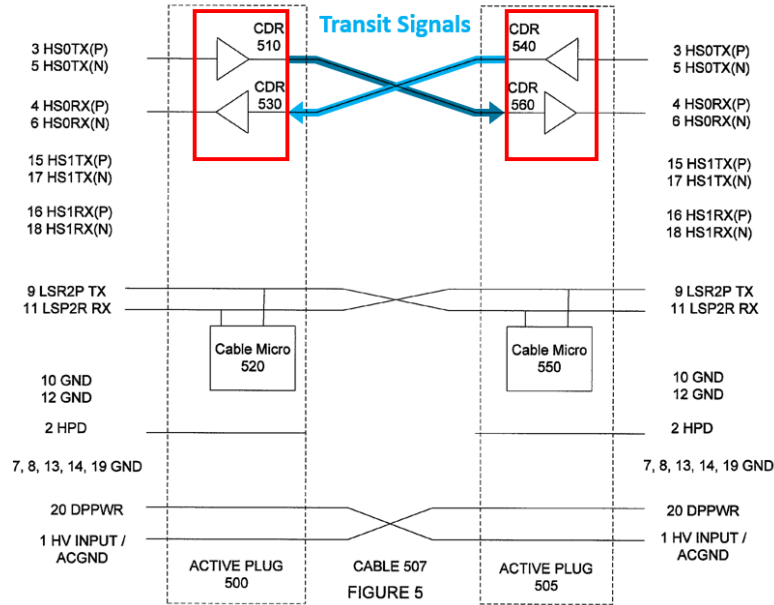
Cornelius also teaches steps carried out by the manufacturer, e.g., tuning/calibration (Ex-1006, 11:45-12:20) and cable functions that are “useful in test and manufacturing.” Ex-1006, 7:31-32, 7:7-17. The method further includes [11a]-[11d], discussed below. Ex-1003, ¶¶160-162.

[11a] connecting a first end and a second end of a set of conductor pairs to a first transceiver and a second transceiver, respectively, to transport a first electrical transit signal from the first transceiver to the second transceiver and a second electrical transit signal from the second transceiver to the first transceiver;

The elements in [11a] also appear in [1a], [1c], and [1d] and are satisfied for the same reasons. *Supra* §§V.A.3[1a], [1c]-[1d]; Ex-1003, ¶163.

Ground 1’s cable includes conductor pairs electrically **connecting** first/second connectors between TX and RX pins. *Supra* §V.A.7[6pre]. Each connector includes a transceiver (e.g., dual CDR/retimer circuitry) (Ex-1006, 6:11-

24, Figs.5-6) to “retime signals received from the cable” and “provide and receive signals.” Ex-1006, claims 1&6, 6:11-29. The dual CDR/retimer circuits are connected to ends of the conductor pairs:



Ex-1003, ¶164.

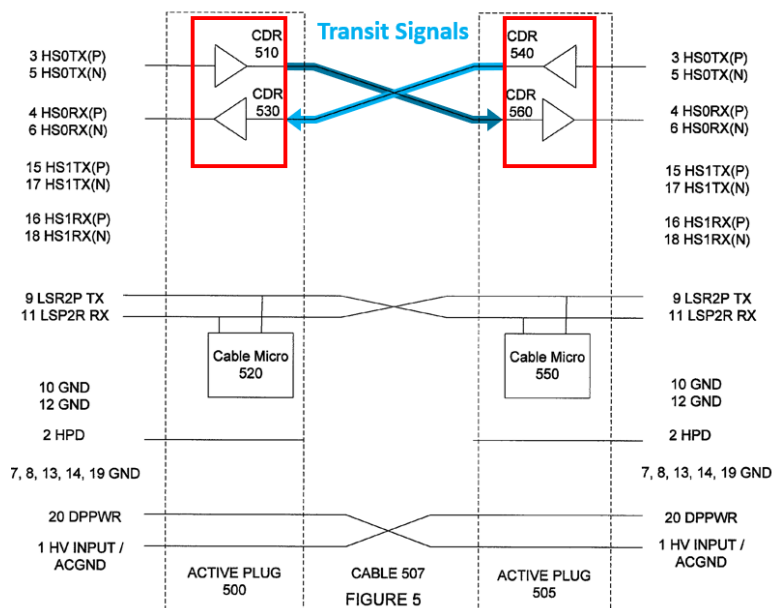
Cornelius teaches or suggests the step of connecting because the plugs and conductors are connected in an assembled cable; it was obvious to connect them in the manner taught by Cornelius. Ex-1006, Figs.5-6, 6:6-33, 8:20-26; Ex-1003, ¶¶165-166.

[11b]-[11c]

packaging the [first/second] transceiver into a [first/second] connector configured to couple a [first/second] electrical input signal from a network interface port of a [first/second] host device to the [first/second] transceiver and a [first/second] electrical output signal from the [first/second] transceiver to the network interface port of the [first/second] host device;

The elements in [11b]-[11c] appear in [1b]-[1c], and are satisfied for the same reasons. *Supra* §§V.A.3[1b]-[1c]; Ex-1003, ¶¶167.

Cornelius teaches or suggests **packaging** the transceivers into their connectors because the respective transceivers (e.g., dual CDR/retimer circuitry) are packaged inside their respective connectors (e.g., active plugs) in the assembled cable; it was obvious to package them in the manner taught by Cornelius. Ex-1006, 6:11-24, Figs.5-6.



Ex-1003, ¶¶168-169.

Ground 1 teaches an Ethernet port (*supra* §V.A.3[1b]), which is a network interface port because Ethernet is a networking protocol. Ex-1003, ¶¶170-171.

[11d]

The elements of [11d] appear in [1c]-[1d] and [1e], and are satisfied for the same reasons. *Supra* §V.A.3[1c]-[1d], [1e]. The respective transceivers, signals, and streams explained for claim 1 correspond to the first/second transceivers, signals, and streams in [11d]. Ex-1003, ¶172.

Limitation [11d] also recites “**generating**” the respective electrical output signals. Ground 1 teaches remodulating the transit data stream as the outbound data stream (*supra* §§V.A.3[1d]-[1e]), which generates electrical output signals conveying the remodulated data stream. Cornelius teaches transceivers (e.g., dual CDR/retimer circuitry) “re-transmit[] data anew, with new equalization” and “re-establishes signal shape” (Ex-1007, ¶15, ¶202), which generates electrical output signals. Ex-1003, ¶¶173-174.

12. Claim 12

12. The cable manufacturing method of claim 11, wherein the first and second transceivers are each configured to employ cable-dependent equalization parameters for generating the first and second electrical transit signals and for clock and data recovery on the second and first electrical transit signals.

Generating the electrical transit signals. Ground 1 teaches this by remodulating inbound data streams into electrical transit signals; that analysis

applies here. *Supra* §V.A.3[1c]; §V.A.11[11d] (explaining “generating”); Ex-1007, ¶15, ¶202; Ex-1003, ¶176.

Configured to employ cable-dependent equalization parameters. Ground 1 teaches the transceivers do so for generating the electrical transit signals and performing CDR on them (*supra* §V.A.4 (claim 2)); as Cornelius explains, the transceivers are “configured” to do this. Ex-1006, 6:50-57, 6:11-49, claims 1, 6; Ex-1007, ¶227; Ex-1003, ¶177.

The remainder of claim 12 overlaps with claim 2 and is satisfied for reasons explained previously. *Supra* §V.A.4; Ex-1003, ¶175.

13. Claim 13

13. The cable manufacturing method of claim 12, wherein the first and second transceivers are each configured to adapt the cable-dependent equalization parameters during operation.

Ground 1 teaches the transceivers are each **configured** to do so. Cornelius teaches this. Ex-1006, 6:50-57, 6:11-49, claims 1, 6; *supra* §V.A.5, §V.A.12; Ex-1003, ¶180.

Ground 1 teaches adapting during **operation**. Ground 1 teaches the adaptation occurs during use, which is when the cable is in operation. Ex-1006, 6:50-57 (“cables to adapt to new hosts and devices as the cable is used in various system applications”). Therefore the previous analysis applies here. *Supra* §V.A.5; Ex-1003, ¶180.

The remainder of claim 13 overlaps with claim 3 and is satisfied for reasons explained previously. *Supra* §V.A.5; Ex-1003, ¶179.

14. Claim 14

The first and second transceivers are each configured to employ cable-dependent equalization parameters. Ground 1 teaches this. *Supra* §V.A.12; §V.A.4.

Presets used during operation. Cornelius teaches equalization parameters that are “stored as presets for loading during operation.” Ex-1006, 11:51-55. The presets are loaded during operation, to be used during operation as the transceivers retime data transmitted over the cable. *Id.* Ground 1 teaches cable-dependent equalization parameters for that particular cable that are presets; the same analysis applies here. *Supra* §V.A.6 (explaining combination for fixed cable-dependent parameters); Ex-1003, ¶181.

Testing an assembled cable to determine the cable-dependent equalization parameters. Ground 1 teaches or suggests testing an assembled cable during manufacturing to determine the preset parameters for that particular cable using calibration routines. *Supra* §V.A.6; Ex-1003, ¶182.

B. Ground 2

Claim 5 recites a particular symbol rate, which is taught by Lugthart (introduced *infra* §V.C.1) for active cables. Ground 2 combines those teachings with Cornelius and Samaan. Ex-1003, ¶¶183-191.

1. Claim 5

5. The active Ethernet cable of claim 4, wherein the inbound data stream and the outbound data stream each have a per-lane symbol rate in excess of 50 GBd.

Ground 2 teaches the inbound/outbound data streams (*supra* §V.A.3[1pre] (explaining active Ethernet cable), [1b] (explaining streams)) **each have a per-lane symbol rate in excess of 50 GBd**. Lugthart teaches input signal IN up to 300 Gbit/s (Ex-1004, 35:29-38, Fig.2A) and other per-lane examples of 100, 400, 448 Gbit/s (Ex-1004, 13:13-14:6). As Lugthart explains, baud rate corresponds to the “number of symbols/second.” Ex-1004, 31:52-55. Each symbol represents two bits in PAM-4 or one bit in NRZ (*see* Ex-1004, 31:28-46), meaning that 100 Gbit/s corresponds to 50 GBd in PAM-4. 50 Gbit/s corresponds to 50 GBd in NRZ. Lugthart teaches those rates and higher, which are in excess of 50 GBd. Ex-1003, ¶¶185-186.

Lugthart applies its data rate teachings in both directions (inbound and outbound). Ex-1004, 13:49-57. Cornelius and Lugthart teach a symmetric cable (*supra* §V.A.3 (intro), *infra* §V.C.3 (intro)) where data input at one end of the

cable is output at the other using the same modulation scheme and rate (Ex-1004, 13:49-57, 8:50-60, 12:1-6, Figs.2A, 4A; Ex-1006, Fig.5). Therefore, Lugthart's teachings of inbound streams exceeding 50 GBd translate to outbound streams at the same rates. Ex-1003, ¶187.

Motivation to Combine. A POSITA would have been motivated to combine Lugthart's teachings with Ground 1 (*supra* §V.A.3[1pre] (explaining motivation/combination for Ground 1)) because Ground 1 teaches an active Ethernet cable, which a POSITA would have configured to known speeds. This used a known technique (running active cables at known speeds) to improve similar devices (active Ethernet cables) in the same way. Cornelius provides motivation to use high transmission rates (Ex-1006, 1:67-2:2, 4:10-31, 8:65-9:4), to increase data transfer rates in data centers and high-performance applications. A POSITA would have had a reasonable expectation of success because Lugthart applies its teachings to "a wide variety of systems" (Ex-1004, 35:24-28) and Cornelius teaches an active cable with CDRs/retimers, like Lugthart. Ex-1006, 5:33-39, 6:6-20, Figs.5-6; Ex-1003, ¶¶188-189.

2. Claim 10

The limitations of claim 10 appear in claim 5 and are satisfied for the same reasons. *Supra* §V.B.1; Ex-1003, ¶191.

C. Ground 3

Lugthart teaches an active Ethernet cable with limitations [1pre]-[1d], including equalization parameters for host-side inbound and outbound data streams. Ground 3 combines Lugthart with Aronson, which teaches parameter configuration details, including fixed, cable-independent host-side parameters for active cables, and cable-dependent parameters for the cable-side. Ex-1003, ¶¶192-193.

1. U.S. Patent 9,882,706 (“Lugthart”) (Ex-1004)

Lugthart is post-AIA §102(a) prior art; it issued January 2018. Lugthart is directed to an active cable with transceivers at each end. Ex-1004, Fig.2A, 6:65-7:3. Each transceiver performs CDR and remodulation, using equalization for host and line-side paths. *E.g.*, Ex-1004, 21:35-42, 7:66-8:7, 9:10-10:22, 15:64-16:10.

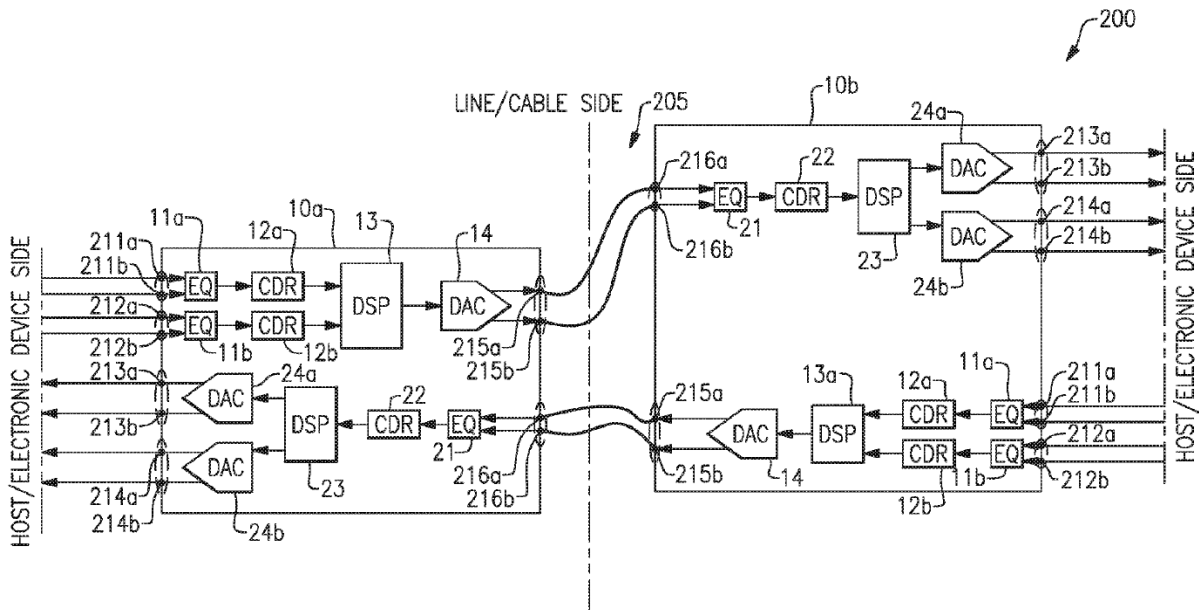


FIG. 4A

Ex-1003, ¶194-195.

Lugthart is analogous art in the same field (*supra* §III), directed to “methods for high speed communications” to “achieve reliable high-speed point-to-point communication[.]” Ex-1004, Abstract, 3:12-16, 4:10-12, 6:55-7:5, 14:29-31. Lugthart’s objective is to “establish high-speed point-to-point links[.]” Ex-1004, 47:24-27. Lugthart is reasonably pertinent because Lugthart teaches equalization in transmitters/receivers for serial communication architectures to account for signal degradation caused by channel loss. Ex-1004, 22:40-49, 21:35-42, Figs.1A, 4A; Ex-1003, ¶196.

2. U.S. Patent 7,445,389 (“Aronson”) (Ex-1005)

Aronson is post-AIA §102(a) prior art; it issued November 2008. Aronson teaches circuits and techniques for conditioning signals to maintain data integrity over transmission, including equalization circuits. Ex-1005, 13:51-54, 13:66-14:5, 14:24-25. Aronson teaches setting parameters to provide “fixed, adjustable or adaptive equalization.” Ex-1005, 14:34-41, 13:49-14:5, 14:50-57. Ex-1003, ¶¶197-198.

Aronson is analogous art in the same field (*supra* §III), directed to bi-directional high-speed communication over a cable. Ex-1005, Abstract, 2:22-31, 4:55-62, 6:46-48, 13:23-27. Aronson is reasonably pertinent because Aronson recognizes the issue of signal loss during transmission (Ex-1005, 11:32-48, 13:66-

14:5, 14:33-40) and addresses it by adjusting equalization circuits on transmit/receive paths to account for cable characteristics and reduce jitter. *E.g.*, Ex-1005, Figs.12A-B, 11:32-67, 13:49-14:9, 14:26-57; Ex-1003, ¶199.

3. Claim 1

For the below limitations, the “first” and “second” designations can be swapped between elements at the ends of Lugthart’s active cable, which is symmetric. *E.g.*, Ex-1004, 7:13-20, 13:49-57, Figs.2A, 4A; Ex-1005, 5:13-55, 13:3-27; Ex-1003, ¶200.

[1pre] An active Ethernet cable that comprises:

Lugthart teaches an active cable with “electrical conducting lines” and powered transceiver assemblies. Ex-1004, 16:11-15, 3:12-16, 4:10-12, 6:65-7:5, 10:4-22, 14:7-34, 17:26-59, Figs.2A, 3A-3B, 4A.

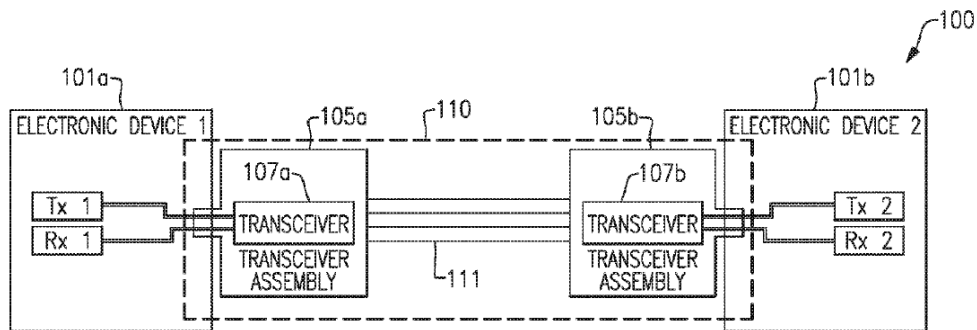
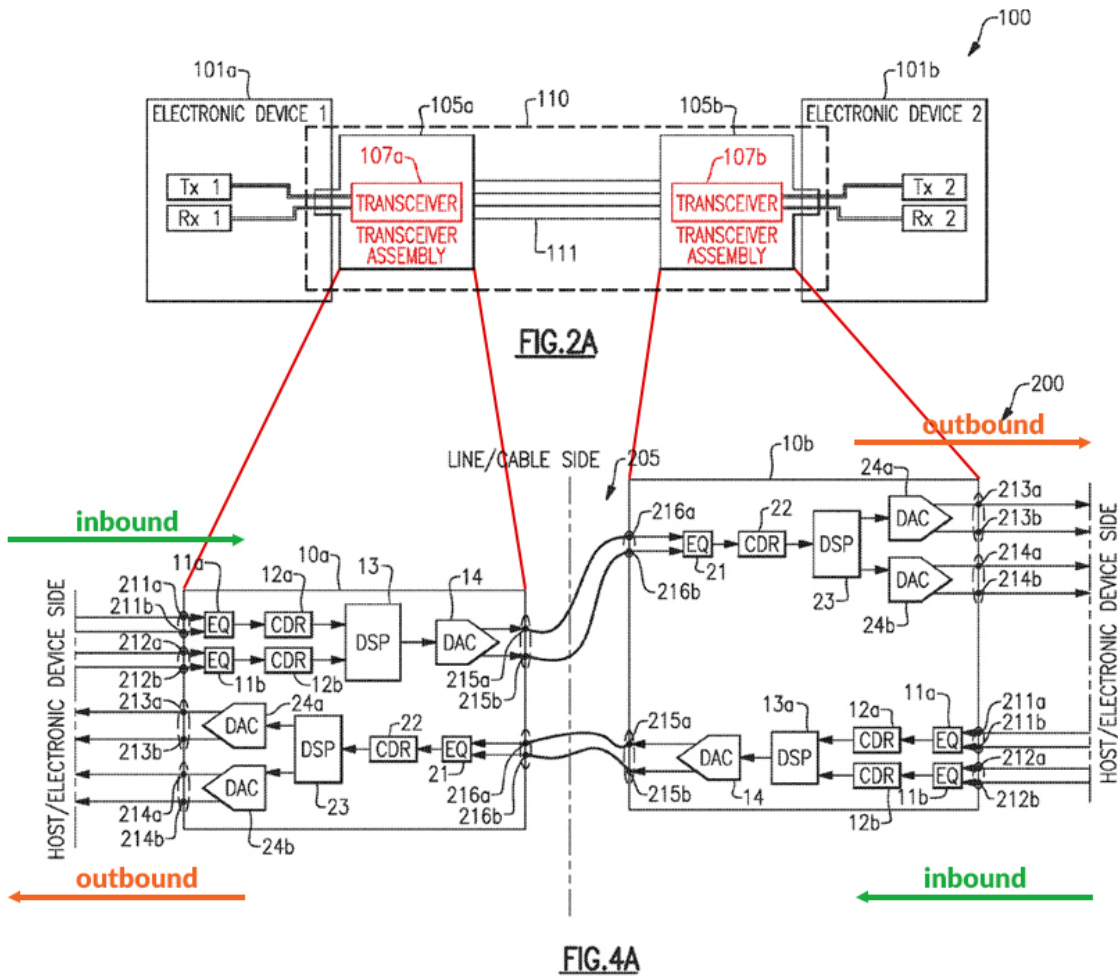


FIG.2A



Ex-1003, ¶202.

Lugthart further teaches the active cable supporting “gigabit Ethernet” (Ex-1004, 16:31-36, 53:36-39) and common Ethernet cabling Cat-5, Cat-5e, and Cat-6 (Ex-1004, 19:29-33), with Ethernet-compatible interfaces as end modules (e.g., Thunderbolt, SFP+, QSFP). Ex-1004, 29:6-20. Therefore, Lugthart teaches or suggests an active Ethernet cable. Ex-1003, ¶203.

Motivation to Combine. A POSITA would have found it obvious and been motivated to apply Lugthart’s Ethernet teachings because Lugthart teaches

cables/modules that support Ethernet. Ex-1004, 16:31-36, 19:29-33, 29:6-20.

Moreover, Lugthart targets data centers as the use environment for its cables (Ex-1004, 1:49-55, 53:36-39) where Ethernet is the predominant protocol and SFP+/QSFP were often used for active Ethernet cables. *Supra* §I.A. The prior art provides express motivation to apply Lugthart’s Ethernet teachings to its active cable. E.g., Ex-1019; Ex-1011; Ex-1012; *supra* §I.A; Ex-1003, ¶¶204-205.

[1a] electrical conductors connected between a first connector and a second connector,

Lugthart teaches first/second connectors: “first and second transceiver assemblies...positioned at either end of the conductive lines.” Ex-1004, 14:29-42, 10:4-8, 10:17-22, 4:10-16 (transceiver assembly is a “pluggable module” that “include[s] a...transceiver”), Fig.2A.

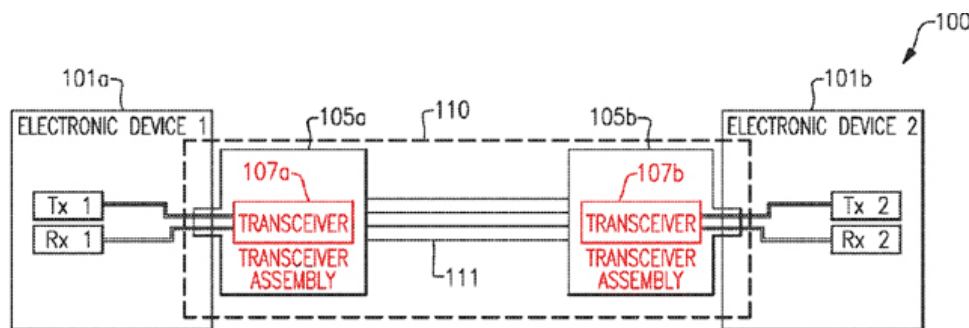


FIG.2A

The connecting lines are electrical conductors, including “metal (e.g., copper) conductors.” Ex-1004, 16:11-36, 14:43-46, 37:32-48; Ex-1003, ¶¶206-208.

[1b] each of the first and second connectors being adapted to fit into an Ethernet port of a corresponding host device to receive from that host device an electrical input signal conveying an inbound data stream to the cable and to provide to that host device an electrical output signal conveying an outbound data stream from the cable,

Each of the first and second connectors (e.g., transceiver assemblies) being adapted to fit into an Ethernet port of a corresponding host device. Each transceiver assembly is “a [] pluggable module” (Ex-1004, 4:10-14, 15:30-31) with “an input port that is configured to mechanically and electrically connect, e.g., in a releasable fashion, to a corresponding port or other interface on the respective electronic device[,]” referring to the host device. Ex-1004, 15:42-52, 14:14-15 (electronic devices 101a/101b are “host devices”), Fig.2A:

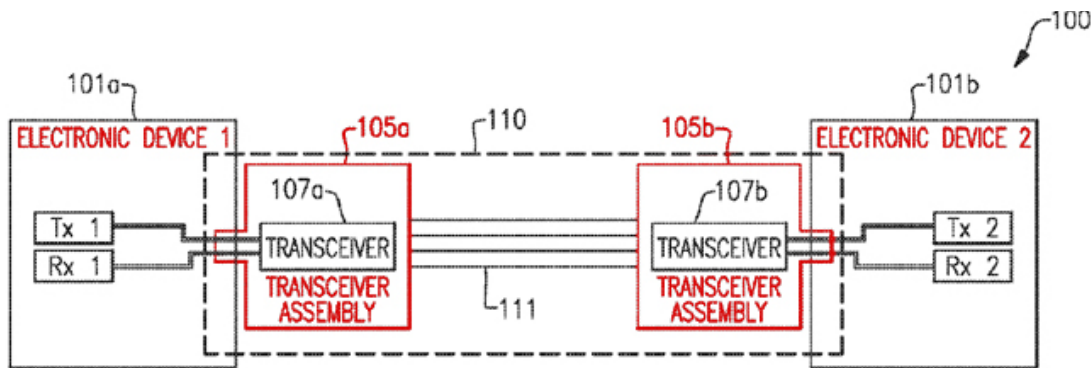


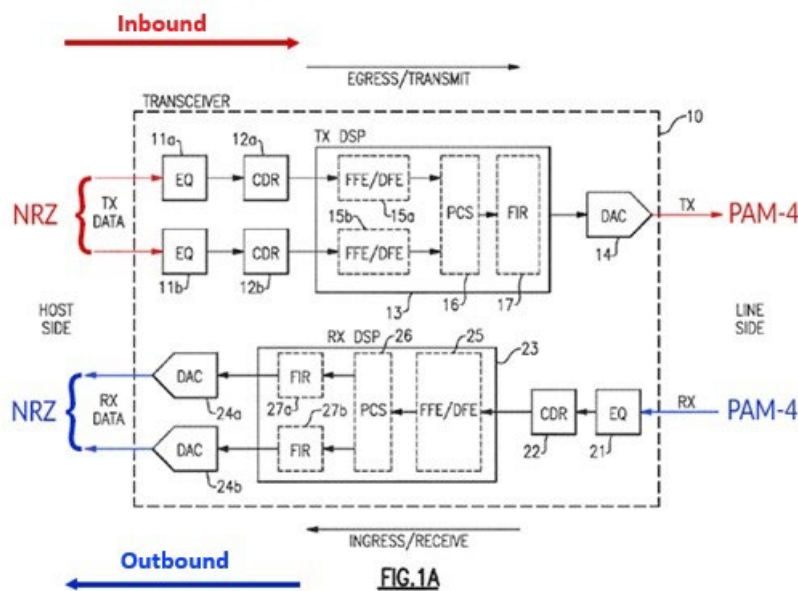
FIG.2A

Ex-1003, ¶209.

Lughart teaches or suggests host Ethernet ports because Lughart’s active Ethernet cable (*supra* §V.C.3[1pre]) connects to corresponding host ports (Ex-1004, Fig.2A, 15:42-52). Lughart’s active cable would not function otherwise.

Lugthart teaches form factors adapted to fit into Ethernet ports, including SFP/SFP+/QSFP. Ex-1004, 15:42-52; Ex-1003, ¶210.

Each connector receives from that host device an electrical input signal conveying an inbound data stream to the cable and to provide to that host device an electrical output signal conveying an outbound data stream from the cable. Each transceiver assembly “include[s] a [] transceiver” (Ex-1004, 4:10-14) that is “capable of receiving...signals on the host side and multiplexing these signals...for transmission to the line side over the cable” and, in the other direction, “receiving...on the line side and demultiplexing this signal...for communication to the host side.” Ex-1004, 8:48-60, 15:64-6:10, 19:56-60, Figs.1A, 4A. Each signal conveys a respective inbound (host-to-cable) or outbound (cable-to-host) data stream. *E.g.*, Ex-1004, 9:26-37, Fig.1A:



Ex-1003, ¶¶211-212.

[1c] each of the first and second connectors including a respective transceiver that performs clock and data recovery on the electrical input signal to extract and re-modulate the inbound data stream for transit via the electrical conductors as a respective electrical transit signal conveying a transit data stream,

Each of the first and second connectors (e.g., transceiver assemblies) including a respective transceiver that performs clock and data recovery on the electrical input signal. Lughart’s first/second transceiver assemblies include first/second transceivers. Ex-1004, 14:47-53, 15:25-27.

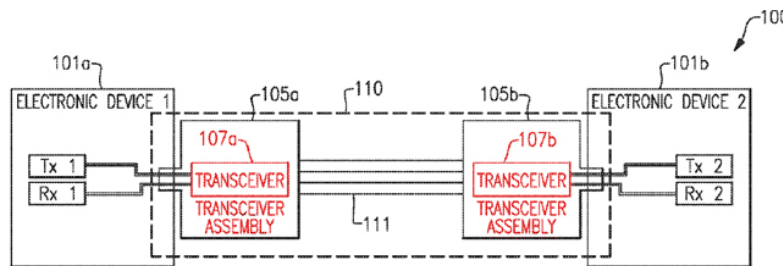
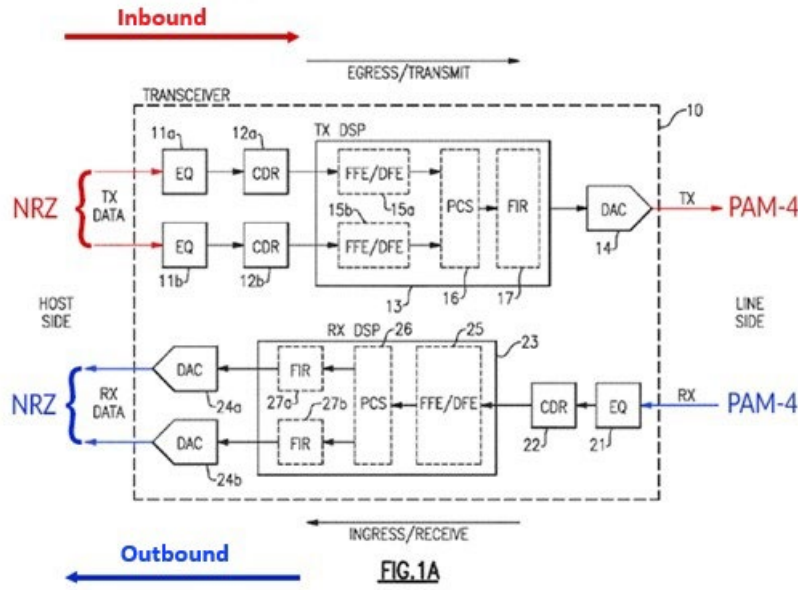


FIG. 2A

Each transceiver receives input signals through an “egress[/transmit] path from the electronic device side to the cable side” that includes, e.g., “a pair of equalizers...a pair of CDR circuits[.]” Ex-1004, 21:35-38, 7:66-8:22, 12:26-57. The equalizers “generate a clock and data recovery (CDR) input signal.” Ex-1004, 2:13-16. “The CDR circuits” extract the inbound data stream from the input signal by “recover[ing] the clock and data signals in the digital domain.” Ex-1004, 21:43-22:2.



Ex-1003, ¶213.

Lugthart’s transceivers perform CDR to extract and **re-modulate the inbound data stream for transit via the electrical conductors as a respective electrical transit signal conveying a transit data stream**. Each transceiver remodulates the extracted inbound data stream into a PAM-4 electrical transit signal that conveys a transit data stream over the cable. Ex-1004, 8:48-60.

Lugthart teaches a “multi-level modulation encoding” process, where each transceiver receives “NRZ” signals and multiplexes them into a single “PAM-4” signal “for transmission over the cable[.]” Ex-1004, 7:13-33, 8:40-60, 15:64-16:10, 23:44-24:23, Figs.1A, 4B. Therefore, the PAM-4 signal conveys a transit data stream comprising the multiplexed data from the inbound stream. *Id.*

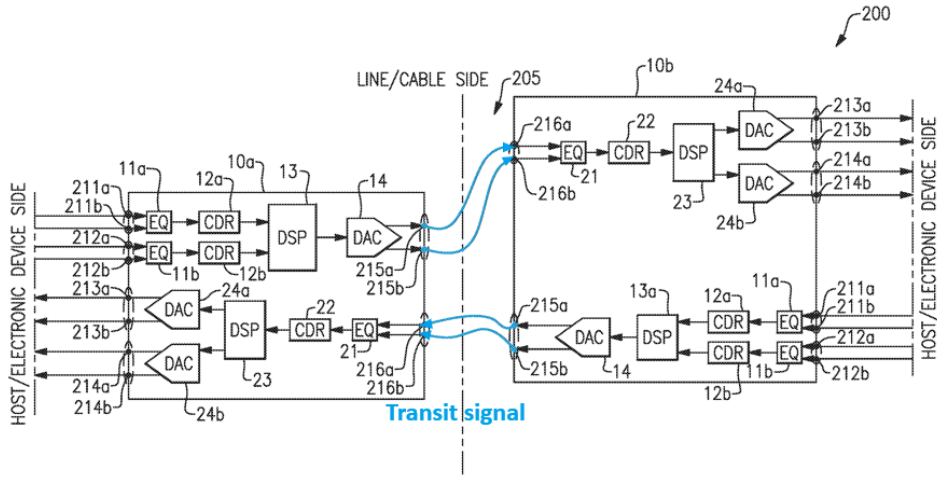


FIG.4A

Ex-1003, ¶214.

Lugthart further explains data recovery/remodulation. Ex-1004, 30:20-55,

Figs.6B, 6A:

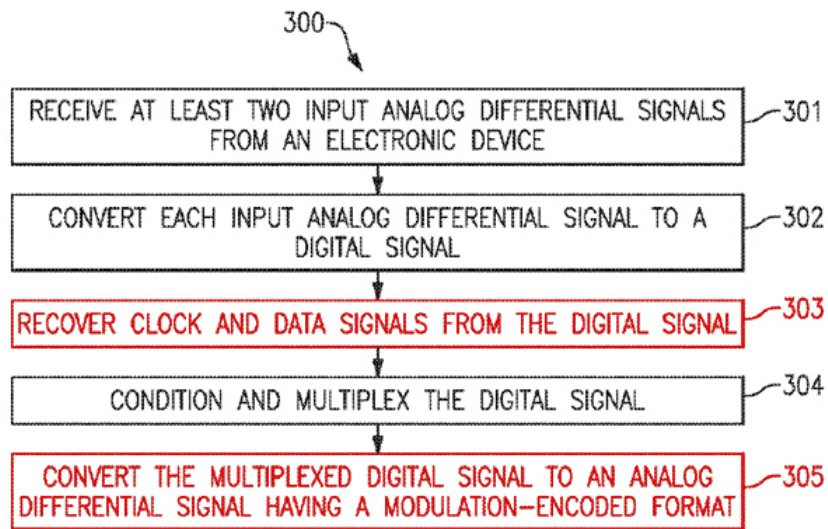


FIG.6A

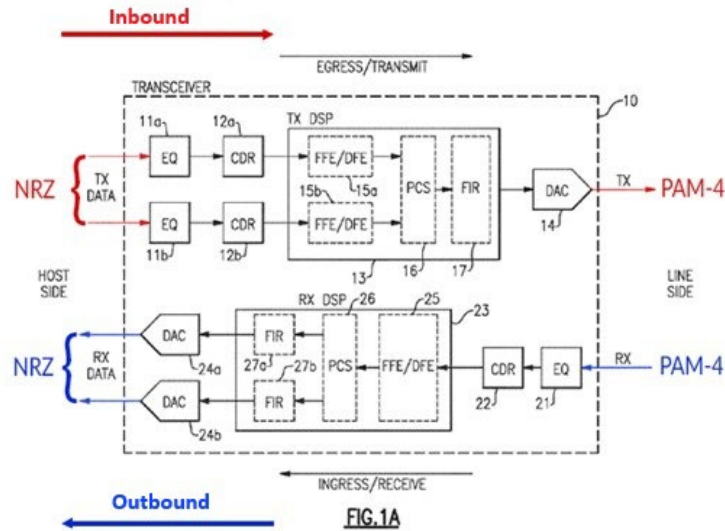
Ex-1003, ¶¶215-216.

[1d] the respective transceiver for each of the first and second connectors performing clock and data recovery on the respective electrical transit signal to extract and re-modulate the transit data stream as the outbound data stream from the cable, and

The respective transceiver for each of the first and second connectors (e.g., transceiver assemblies) **performing clock and data recovery on the respective electrical transit signal.** Lugthart teaches that each transceiver receives a transit signal through “the ingress path from the cable side to the electronic device side” that consists of, e.g., “an equalizer 21, a CDR circuit 22[.]” Ex-1004, 22:40-49, 7:66-8:32, 9:10-10:22, 12:42-57. The CDR circuit “is configured to digitize the incoming signals as well as to implement timing recovery to recover a clock and a data signal from the incoming differential signals” (Ex-1004, 22:50-55, 9:26-47), and thus extracts the transit data stream by “recover[ing] clock and data signals in the digital domain.” Ex-1004, 22:55-57, 9:26-37. Ex-1003, ¶217.

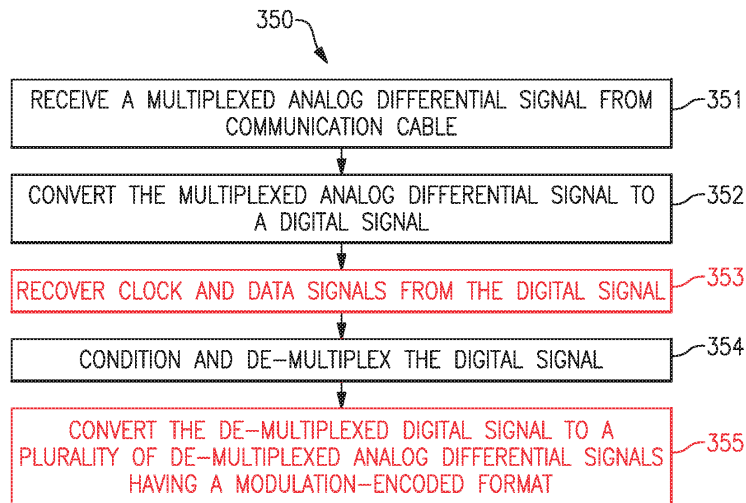
Lugthart’s transceivers perform CDR to extract and **re-modulate the transit data stream as the outbound data stream from the cable.** Each transceiver remodulates the extracted transit data stream into NRZ output conveying the outbound data stream for “communication to the host side.” Ex-1004, 8:56-60, 9:65-10:3. The “ingress/receive path” receives the PAM-4 signal and demultiplexes it into an output data stream comprising the data from the inbound

stream. Ex-1004, 8:56-60, 11:39-51, 24:20-23, 26:13-17, 30:56-59, Figs.1A, 4A-4B:



Ex-1003, ¶218.

Lugthart further explains data recovery/remodulation. Ex-1004, Fig.6B.



Ex-1003, ¶¶219-220.

[1e] the respective transceivers each employing fixed, cable-independent, equalization parameters for each of: the remodulation of the transit data stream as the outbound data stream, and the clock and data recovery performed on the electrical input signal.

The recited remodulation and CDR operations were previously explained.

Supra §§V.C.3[1c]-[1d]; Ex-1003, ¶221.

Ground 3 teaches **the respective transceivers each employing equalization parameters**. Lugthart teaches multiple equalization functions for the host-side paths. Ex-1004, 23:59-24:29, 15:64-16:3, 9:10-10:22, Figs.1A, 4A-B. For the outbound data stream from cable to host, pre-equalization (e.g., using FIR filters) is used for remodulating the stream before transmission. Ex-1004, 29:21-28, 23:59-24:2. For the input signal from host to cable, equalizers (e.g., EQ 11a/11b and FFE/DFE 15a/15b) are used for CDR to extract bits from the input signals. Ex-1004, 21:36-38, 7:66-8:32, 12:26-57, Fig.1A:

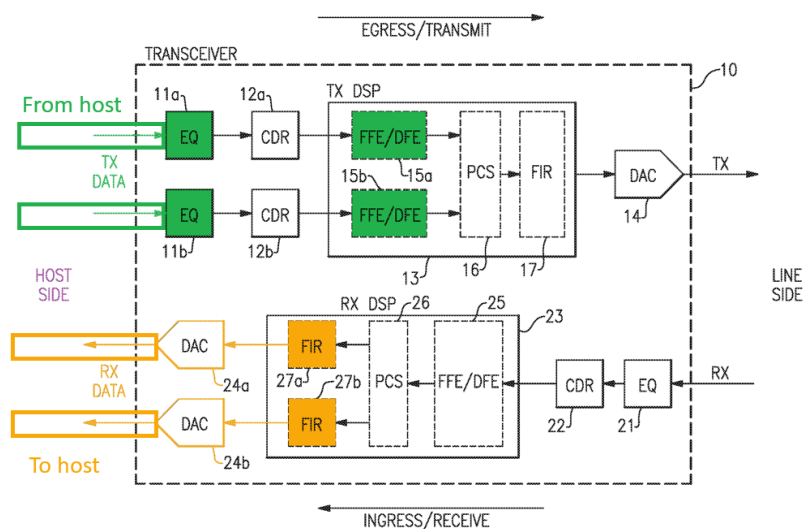


FIG. 1A

Ex-1003, ¶¶222-223.

Lugthart teaches that these equalization processes use “operating parameters.” Ex-1004, 49:8-34, 22:12-28. The FIR filters include coefficients (*id.*), and the FFE/DFE equalization filters were “configured to equalize the incoming signal”; therefore, they included parameters. Ex-1004, 23:39-40. A POSITA would have recognized Lugthart’s equalization blocks as textbook functions that included parameters such as filter coefficients. Likewise, Aronson teaches equalization parameters such as “degrees of equalization and/or preemphasis” that specify the gain or level of equalization. Ex-1005, 11:32-48, 13:66-14:5. Lugthart and Aronson both describe equalization parameters that control the effects of the equalization filters, including frequency response and the amount of equalization. Ex-1003, ¶224.

Ground 3 teaches that the equalization parameters are **fixed, cable-independent equalization parameters**. As an initial matter, Lugthart teaches “equalization to compensate for transmission line losses on the host side.” Ex-1004, 9:10-25. The parameters for Lugthart’s host-side equalization are used to account for channel losses in paths on the host side, rather than the cable, and therefore do not depend on the characteristics of any particular connecting cable. Moreover, Lugthart’s transceivers perform retiming functions that provide

separation between signals on the host-side versus cable-side. Ex-1004, 12: 58-67, Abstract; Ex-1003, ¶225.

Ground 3 combines Lugthart with Aronson. *Supra* §V.C (explaining combination). Aronson teaches using “fixed” equalization for host-side traces in both directions (Tx/Rx). Ex-1005, 13:52-56, 14:50-57. For the transmit direction (inbound to the cable), Aronson teaches “[t]he first block in this IC would provide equalization to compensation for high frequency loss in the host board traces.” Ex-1005, 13:49-54. “Such equalization could be fixed[.]” Ex-1005, 13:54-56. For the receive direction, “for driving the host PCB traces at this end of the cable, an output driver is provided with optional preemphasis. ...The preemphasis could be fixed...” Ex-1005, 14:50-57, Figs.12A-12B.⁷ Ex-1003, ¶226.

Aronson teaches parameters for host-side equalization that compensate for host-side board traces rather than the connecting cable: “[d]ifferent host systems may require different degrees of equalization and/or preemphasis because of the particular length or other nature of the electrical interconnect between the cable

⁷ Figures 12A-12B refer to adjustable equalization but the corresponding description teaches several options including fixed equalization. Ex-1005, 13:54-56. Aronson uses “adjustable” to refer to “adjustment at the factory,” which is fixed during normal usage. Ex-1005, 14:54-57, 14:37-41. Ex-1003, ¶227.

receptacle and the next IC elements.” Ex-1005, 11:32-48. These host-side parameters do not operate on cable signals and do not depend on characteristics of the particular connecting cable.⁸ Ex-1004, Fig.1 A; Ex-1005, Figs.12A, 12B. It would not have made sense to customize these host-side parameters on a cable-by-cable basis, based on the characteristics of individual connecting cables, given Aronson’s teaching and suggestion that it would not be beneficial. Therefore, the combination teaches or suggests fixed, cable-independent equalization parameters for host-side paths. Additionally, this was obvious for reasons explained below.

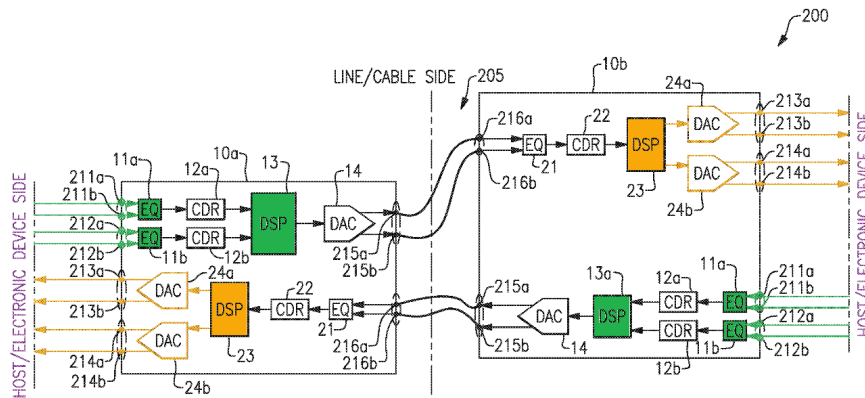


FIG. 4A

Ex-1003, ¶228.

Motivation to Combine. A POSITA would have been motivated, and found it obvious, to combine Lugthart with Aronson to use the same fixed parameters for host-side equalization across different cables. Aronson teaches

⁸ See *supra* n.**Error! Bookmark not defined.** (explaining PO’s contentions).

fixed equalization parameters (Ex-1005, 14:34-41, 13:49-14:5, 14:50-57), and ultimately, there are only two possibilities for setting those fixed parameters: (1) use the same parameters across different cables, or (2) customize the parameters on a cable-by-cable basis. Lugthart and Aronson provide motivation to use the same parameters for host-side equalization parameters by explaining that they do not vary between different connecting cables. Ex-1005, 11:32-48; Ex-1004, 9:10-25. Given these teachings, there was little justification for the extra complication or cost of customizing these parameters for properties of individual cables, when it would be equally effective to simply use the same host-side parameters for all active cables of a given design. This was a simple choice from a finite number of identified, predictable solutions for setting equalization parameters, with a reasonable expectation of success because it simply set the same fixed parameters that Aronson teaches. Ex-1005, 13:49-14:5, 14:33-57; Ex-1003, ¶229.

It would have been natural to consult references like Aronson, which provides implementation details for active cables. Aronson teaches common industry approaches, including using the same, preset parameters for the host-side and customized parameters for the cable side. Ex-1005, 13:49-14:5, 14:33-57. The prior art provides motivation to do so. Ex-1021, 7:18-33, 1:65-67; Ex-1020, 000020-21; Ex-1032, Tbls. 39-40; Ex-1007, ¶¶124-126. Therefore, Ground 3

combines prior art elements according to known methods to yield predictable results. It was also common sense given Aronson's teachings. Ex-1003, ¶¶230-231.

Other retimer scenarios might incorporate more complex training/adaptation features to handle a range of unknown channels. But Ground 3 addresses a specific active cable application with express teachings of using fixed equalization parameters for host-side paths (Ex-1005, 13:52-56, 14:50-57), which were well-suited for fixed, common equalization parameters because they involve short paths to a nearby host chip rather than long cable distances. Ex-1003, ¶229.

Additionally, Aronson's equalizer teachings were applicable to Lugthart's equalizers. They are similarly positioned and address channel losses in corresponding portions of active cables and hosts. Ex-1004, 15:64-16:3, 8:22-32, 9:10-45, 23:59-63, Fig.1A; Ex-1005, 13:49-14:57, Fig.12A-12B; Ex-1003, ¶¶232-235.

The combination would not have changed the principle of operation for either reference. Applying Aronson's calibration teachings to Lugthart simply fills in the implementation details about how/when parameters are set. And Aronson already provides its teachings for equalizing host-side paths in active cables. Ex-1005, 13:49-56, 14:50-57, Figs.12A-12B; Ex-1003, ¶236.

In addition to the above reasons, a POSITA would have had a reasonable expectation of success because the combination would not change the principle of operation (explained above), and using fixed, cable-independent parameters was a straightforward matter of storing values in nonvolatile memory—a basic programming task. *See* Ex-1021, 7:18-33, 1:65-67; Ex-1020, 000020-21; Ex-1032, Tbls. 39-40. Using hard-coded parameters was simple. Ex-1003, ¶¶237-238.

4. Claim 2

2. The active Ethernet cable of claim 1, wherein the respective transceivers each employ cable-dependent equalization parameters for at least one of: the remodulation of the inbound data stream for transit, and the clock and data recovery performed on the electrical transit signal.

Ground 3 teaches equalization parameters (*supra* §V.C.3[1e]) and remodulation/CDR for the transit signal. *Supra* §§V.C.3[1c]-[1d].

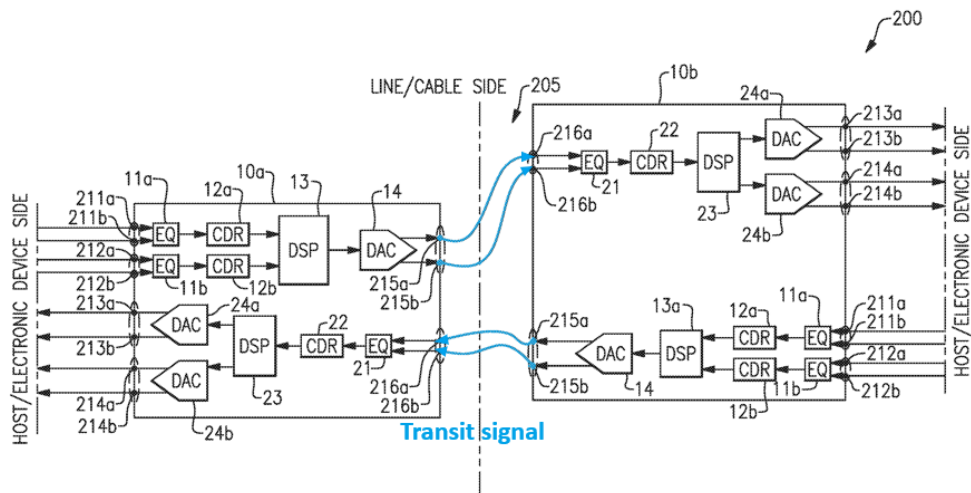


FIG. 4A

Ex-1003, ¶239.

Lugthart employs **equalization parameters** for the recited remodulation and CDR. Lugthart teaches equalization for the path over the cable. For host transmissions, Lugthart recovers the inbound data stream (*supra* §V.C.3[1c]) and performs equalization using FIR filter 17 which conditions the signal for re-transmission “over the cable” (Ex-1004, 15:64-16:3) “as a multi-level modulated signal[.]” Ex-1004, 23:59-63, 7:6-20, Figs.4A, 1A:

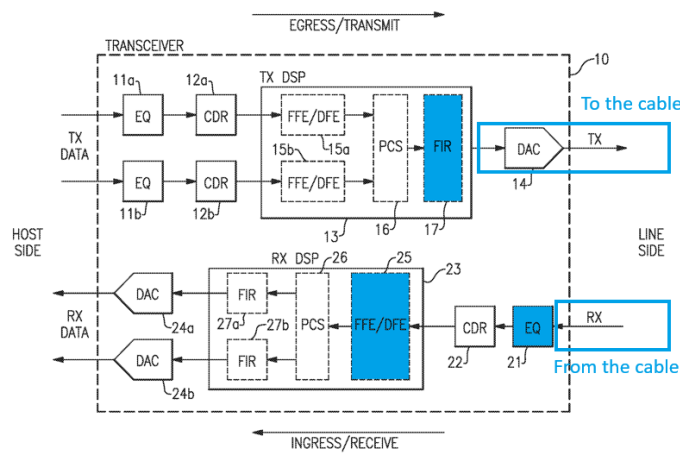


FIG. 1A

In the other direction, to recover bits from the data stream, Lugthart’s transceivers use equalizer 21 to “compensate for losses occurring during transmission over the cable,” while FFE/DFE in the DSP provides additional equalization. Ex-1004, 22:43-59, 8:19-32, Fig.1A, 4A:

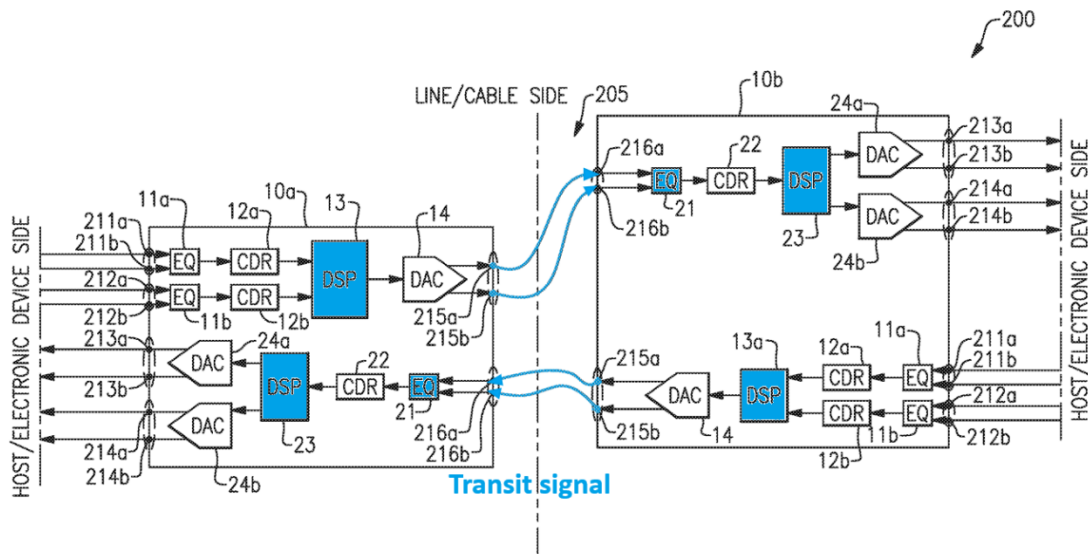


FIG. 4A

Ex-1003, ¶240.

Ground 3 teaches that these equalization functions (e.g., FIR pre-equalization, EQ, DFE/FFE) employ various parameters that control their operation, explained previously. Because the transceivers are used symmetrically, that analysis likewise applies here. *Supra* §V.C.3[1e]; Ex-1004, 22:12-16, 49:8-12, 49:30-34; Ex-1005, 11:32-48, 13:66-14:5. These equalization parameters configure equalization to compensate for losses from the connecting cable. Ex-1004, 22:43-45; Ex-1003, ¶241.

Ground 3 teaches or suggests **employing cable-dependent equalization parameters**. Lughart uses equalization to “compensate for losses occurring during transmission over the cable” (e.g., losses relate to the specific cable used for transmission). Ex-1004, 22:40-49; Ex-1003, ¶242.

Ground 3 combines Lugthart with Aronson. *Supra* §V.C (explaining combination). Aronson teaches setting pre-equalization “individually to match the particular length of the characteristics of the copper cabling.” Ex-1005, 13:66-14:5. On the receive side, Aronson teaches an “adjustable equalization” block “compensate[s] for the cable high frequency rolloff, rather than the host PCB traces” on the host-side. Ex-1005, 14:33-40. “Adjustable but factory set equalization is of particular interest because the cable length and characteristics will be established at the time of the cable manufacture.” Ex-1005, 14:22-41. Therefore, Ground 3 teaches cable-side equalization parameters that depend on the characteristics of the individual connecting cable. Aronson teaches adjusting those parameters on a cable-by-cable basis at the time of manufacturing. *Id.* Therefore, Ground 3 teaches or suggests employing cable-dependent equalization parameters. Ex-1003, ¶243.

Additionally, Ground 3 teaches particular implementations of cable-dependent equalization parameters, explained below. *Infra* §V.C.5 (claim 3), §V.C.6 (claim 4); Ex-1003, ¶243.

Motivation to Combine. A POSITA would have found it obvious and been motivated to combine these teachings from Lugthart and Aronson. The references provide express motivation to apply Aronson’s adjustments, which match equalization parameters to cable characteristics, by teaching that cable-side

equalization compensates for losses caused by the connecting cable. *E.g.*, Ex-1004, 22:40-49; Ex-1005, 13:66-14:5, 14:22-41. These physical cable characteristics vary for individual cables due to manufacturing variations. Aronson’s teachings improve signal quality, which was beneficial for, e.g., data centers requiring long cable lengths or high bitrates. Therefore, a POSITA would have tailored cable-side parameters on a cable-by-cable basis; this would have applied a known technique to improve similar devices in the same way because Aronson already applied its teachings to active cables. Ex-1003, ¶¶232-235 (explaining similarities), ¶¶244-245.

5. Claim 3

3. The active Ethernet cable of claim 2, wherein said cable-dependent equalization parameters adapt during usage of the Ethernet cable.

Ground 3 teaches transceivers that employ cable-dependent equalization parameters (*supra* §V.C.4). Lugthart teaches adjusting the “operating parameters for the equalizers” during training phases to account for channel characteristics and reduce errors. Ex-1004, 49:3-14, 49:30-34, 48:20-27. Training occurs after “Start-Up” while “establishing a high-speed communication link[.]” Ex-1004, 47:53-65, Fig.15. This occurs during usage because it happens when the cable is connected and is performed to communicate over the cable. Ex-1003, ¶247.

Likewise, Aronson teaches “adaptive equalization.” Ex-1005, 11:32-48, 14:33-40. A POSITA would have been motivated to apply Aronson’s teachings

because they reinforce Lugthart, which already teaches equalizer training and includes analogous equalizer functions. Ex-1003, ¶¶232-235. Aronson’s teachings automatically adapt equalization parameters to changing conditions, making the added complexity of training worthwhile for environments with unpredictable noise or thermal issues. Ex-1003, ¶¶248-249.

6. Claim 4

4. The active Ethernet cable of claim 2, wherein said cable-dependent equalization parameters are fixed during normal usage of the Ethernet cable, and wherein said cable-dependent equalization parameters are determined during manufacturing-testing of the Ethernet cable.

Ground 3 teaches cable-dependent equalization parameters (*supra* §V.C.4) that are fixed during normal usage and determined during manufacturing-testing of the cable. Aronson teaches “fixed...equalization” that is set by the factory during manufacturing: “[a]djustable but factory set equalization is of particular interest because the cable length and characteristics will be established at the time of the cable manufacture.” Ex-1005, 14:34-41. Likewise pre-equalization “can be adjusted at factory setup individually to match the particular length of the characteristics of the copper cabling.” Ex-1005, 13:65-14:5. Aronson teaches or suggests that these parameters are determined and fixed during “factory setup,” with manufacturing-testing to adjust parameters to match the particulars of individual cables. Ex-1005, 14:1-41; Ex-1003, ¶251.

A POSITA would have been motivated to apply Aronson's teachings, explained above, to determine and store fixed equalization parameters during manufacturing. This simply combined these known prior art elements with Lugthart's active cable according to known methods to yield predictable results, (e.g., fixed parameters). Moreover, this approach benefited manufacturers who wished to avoid the time and expense of implementing adaptive training protocols and appealed to users seeking simple, reliable active cables without added complexity. Fixed parameters, tailored at the factory, were well-suited for environments with stable channel characteristics, e.g., with requirements/practices that limited noise/thermal issues. This would have been readily incorporated into QA processes, which likewise combined existing QA processes with Aronson's prior art teachings according to known methods to yield predictable results (e.g., fixed parameters). Ex-1003, ¶252.

7. Claim 5

Lugthart teaches claim 5. While explained in the context of Ground 2, Lugthart's teachings likewise apply here. *Supra* §V.B.1, *Supra* §§V.C.3[1b]-[1c] (explaining inbound/outbound streams); Ex-1003, ¶¶253-255.

8. Claim 6

[6pre] A communication method that comprises, in a network cable having conductor pairs electrically connecting a first connector to a second connector:

A communication method that comprises a network cable. Lugthart teaches “methods for high speed communications” (Ex-1004, Abstract) for active Ethernet cables. *Supra* §V.C.3. Aronson likewise teaches methods for “the use of a communication cable.” Ex-1005, 4:36-54. Ground 3’s active Ethernet cable is a network cable because Ethernet is a networking protocol. *Supra* §V.C.3[1pre]. Ex-1003, ¶258.

Ground 3 teaches the network cable includes **conductor pairs electrically connecting a first connector to a second connector** (e.g., transceiver assemblies). Lugthart teaches “an electrical cable including one or more pairs of differential micro coaxial cables or conductors.” Ex-1004, 6:65-7:5, 17:35-19:33, Figs.3A-3C. The “electrical conducting lines...transport electrical signals” between the transceiver assemblies. Ex-1004, 16:11-36, Fig.4A. “Each of the pairs of conducting lines [] can be configured for differential signal transmission” for inbound data from a first transceiver assembly to a second assembly and vice versa.” Ex-1004, 17:43-45, 18:35-39, 14:7-28, Figs.2A-2B. Ground 3 teaches electrical conductors that connect the first and second connectors. *Supra* §V.C.3[1a].

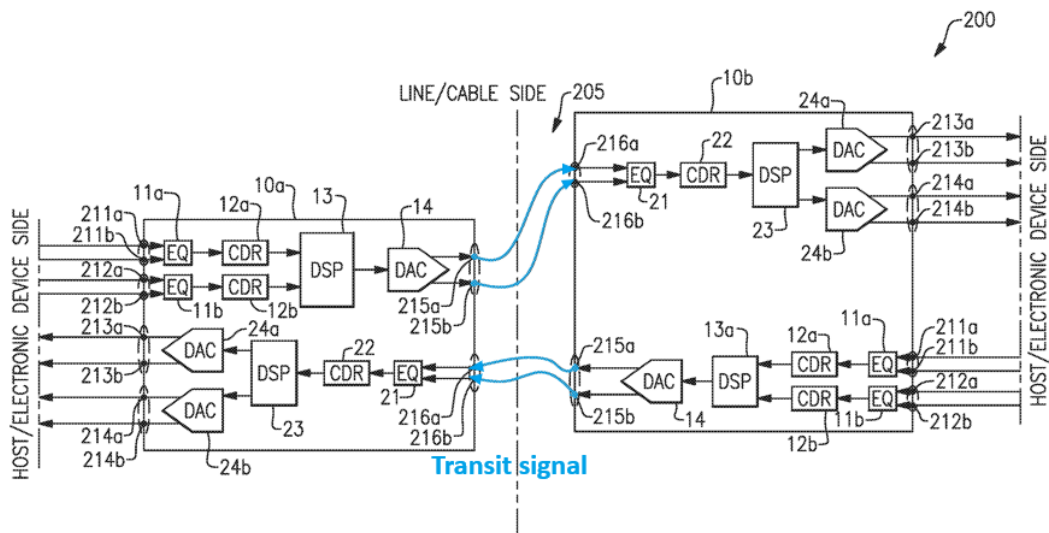


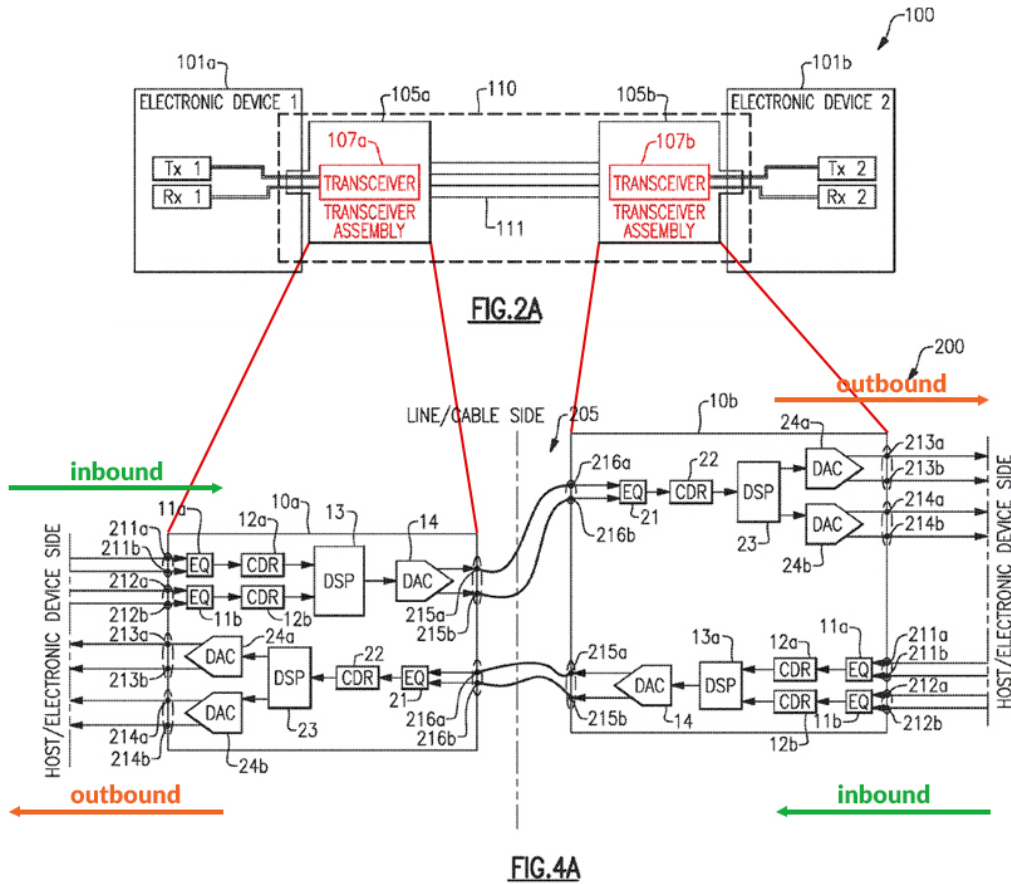
FIG.4A

Ex-1003, ¶¶259-260.

- [6a] receiving with the first connector a first electrical input signal conveying a first inbound data stream from a first host device;
- [6b] performing clock and data recovery on the first electrical input signal with a first transceiver in the first connector to extract the first inbound data stream;
- [6c] re-modulating the first inbound data stream as a first transit data stream conveyed by a first electrical transit signal over a first of the conductor pairs;

The elements in [6a]-[6c] appear in [1b]-[1c] and are satisfied for the same reasons. *Supra* §§V.C.3[1b]-[1c]. Either of the transceiver assemblies is the *first* connector; the other is the *second*. The *first* input signal/inbound data stream are those received by the *first* connector from its corresponding host (the *first* host device). The *first* connector (e.g., transceiver assembly) includes a *first* transceiver

inside. *Id.* The *first* transit data stream is conveyed to the *second* connector *supra* §V.C.3[1c]) over conductor pairs. *Supra* §V.C.8[6pre].



Ex-1003, ¶¶261-263.

[6d], [6e], [6f]

Limitations [6d]-[6f] mirror [6a]-[6c], respectively, but change “first” to “second.” The elements in [6d]-[6f] also appear in [1b]-[1c], and are satisfied for the same reasons, with the *second* input signal/data stream/host device being the ones corresponding to the second connector. *Supra* §§V.C.3[1b]-[1c]. The *second*

transit signal is conveyed to the *first* connector (§V.C.3[1c]), over a *second* conductor pair. *Supra* §V.C.8[6pre]; Ex-1003, ¶¶264-266.

- | |
|---|
| <p>[6g] performing clock and data recovery on the first electrical transit signal with the second transceiver to extract the first transit data stream;</p> <p>[6h] re-modulating the first transit data stream as a second outbound data stream conveyed by a second electrical output signal to the second host device;</p> |
|---|

The elements in [6g]-[6h] appear in [1d] and are satisfied for the same reasons. *Supra* §V.C.3[1d]. The *first* electrical transit signal goes from the *first* transceiver/connector to the *second* and carries the *first* transit data stream. As previously explained, the second outbound data stream is conveyed by an electrical output signal to the second host. *Supra* §V.C.3[1b]. Ex-1003, ¶¶267-268.

[6i]-[6j]

Limitations [6i]-[6j] mirror [6g]-[6h], respectively, but change “first” to “second.” The corresponding signals, data streams and components are likewise reversed in Ground 3’s symmetric cable. The elements in [6i]-[6j] appear in [1d]/[1b], and are satisfied for the same reasons. *Supra* §§V.C.3[1d], V.C.3[1b]; Ex-1003, ¶¶269-270.

[6k]

The elements in [6k] appear in [1e] and are satisfied for the same reasons., The first and second transit data streams are the transit data streams received by the

second and first transceivers, respectively, and the first and second electrical input signals are the input signals received by the first and second transceivers, respectively. *Supra* §V.C.3[1e]. Ex-1003, ¶271.

9. Claim 7

Ground 3 teaches claim 7. Ex-1003, ¶272-275. Claim 7 overlaps with claim 2 and is satisfied for the same reasons. *Supra* §V.C.4. Because the cables are bidirectional and symmetrical in operation (*supra* §V.C.3), Ground 3 teaches employing cable dependent equalization parameters for remodulation of both the first and second inbound data streams and for CDR of both the first and second transit signals. Ex-1003, ¶¶272-273.

Therefore, Ground 3 employs cable-dependent equalization parameters for at least one of the recited re-modulation or CDR operations. Ex-1003, ¶274.

For at least these reasons, Ground 3 teaches Claim 7. Ex-1003, ¶275.

10. Claim 8

Ground 3 teaches claim 8 by adapting the cable-dependent equalization parameters during usage of the Ethernet cable, e.g, with Lugthart's training routines, as previously explained; that analysis applies here. *Supra* §V.C.5 (claim 3), §V.C.4 (claim 2); Ex-1003, ¶¶276-277.

11. Claim 9

Claim 9 shares elements with claim 4 that are satisfied for the same reasons. *Supra* §V.C.6. Claim 9 also recites **manufacturer-testing**; this is satisfied by

Ground 3’s testing to determine the cable’s characteristics, carried out by the manufacturer at the factory. Ex-1005, 13:66-14:5 (“factory setup”), 14:33-40; Ex-1003, ¶278-279.

12. Claim 10

The limitations of claim 10 also appear in claim 5 and are satisfied for the same reasons. *Supra* §V.C.7 (claim 5), §V.B.1 (claim 5). Ex-1003, ¶280.

13. Claim 11

[11pre] A cable manufacturing method that comprises:

Ground 3 teaches a cable manufacturing method comprising the steps of claim 11, which connect and package the elements of claim 1. Ground 3 teaches the cable of claim 1 (*supra* §V.C.3), and the steps for manufacturing in [11a]-[11d] below. Lugthart teaches or suggests the manufacture of that cable by connecting its components together. Ex-1004, 6:65-67, 7:66-8:7, Figs.2A, 4A. Aronson similarly teaches manufacturing methods that involve, e.g., setting equalization parameters at factory setup. Ex-1005, 13:66-14:5, 14:50-57; Ex-1003, ¶¶281-283.

[11a]

The elements in [11a] also appear in [1a], [1c], and [1d] and are satisfied for the same reasons. *Supra* §§V.C.3[1a], [1c]-[1d]; Ex-1004, 14:29-42, 15:64-16:3, Fig.4A; Ex-1003, ¶284.

Ground 3's network cable includes conductor pairs electrically connecting first/second connectors (transceiver assemblies). *Supra* §V.C.8[6pre]. The transceiver assemblies include transceivers (Ex-1004, 15:25-27) that are “provided at respective ends of the cable” to send/receive signals. Ex-1004, 6:65-67, 7:21-33.

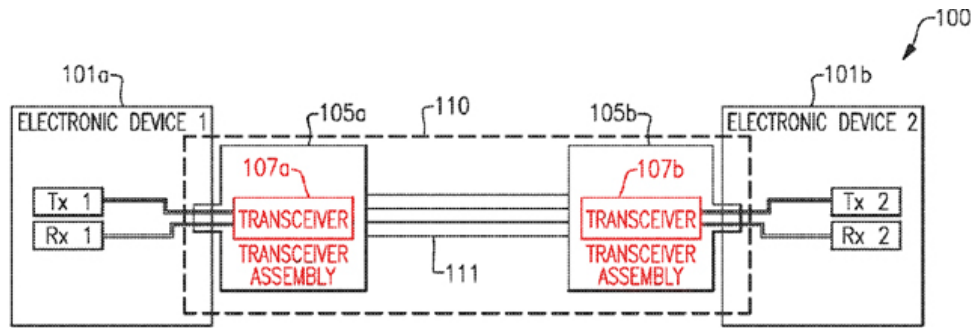


FIG.2A

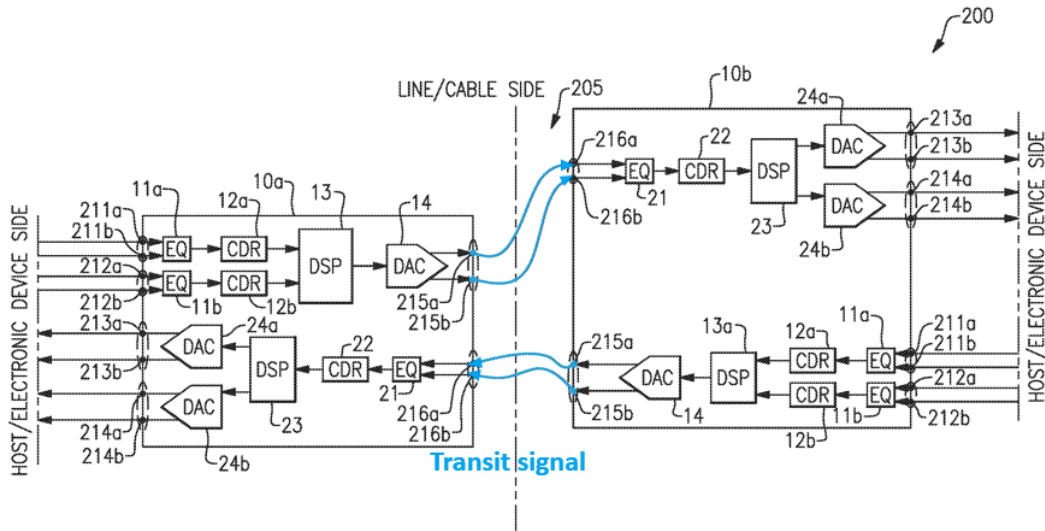


FIG.4A

Ex-1003, ¶285.

Ground 3 teaches or suggests the step of connecting because the transceivers and conductors are connected in an assembled cable; it was obvious to connect them in the manner taught by Ground 3. Cornelius teaches or suggests the step of connecting because the plugs and conductors are connected in an assembled cable; it was obvious to connect them in the manner taught by Cornelius. Ex-1004, Figs.2A, 4A; Ex-1003, ¶¶286-287.

[11b]-[11c]

The elements in [11b]-[11c] also appear in [1b]-[1c] and are satisfied for the same reasons. *Supra* §§V.C.3[1b]-[1c]; Ex-1003, ¶288.

Lughart teaches **packaging** the transceivers into their respective assemblies: each is “enclosed in a packaging[.]” Ex-1004, 15:25-31, 14:47-53, Fig.2A; *supra* §V.C.3[1c]. It was obvious to package and connect the transceivers and assemblies because Lughart teaches that they are packaged/connected that way.

Id.

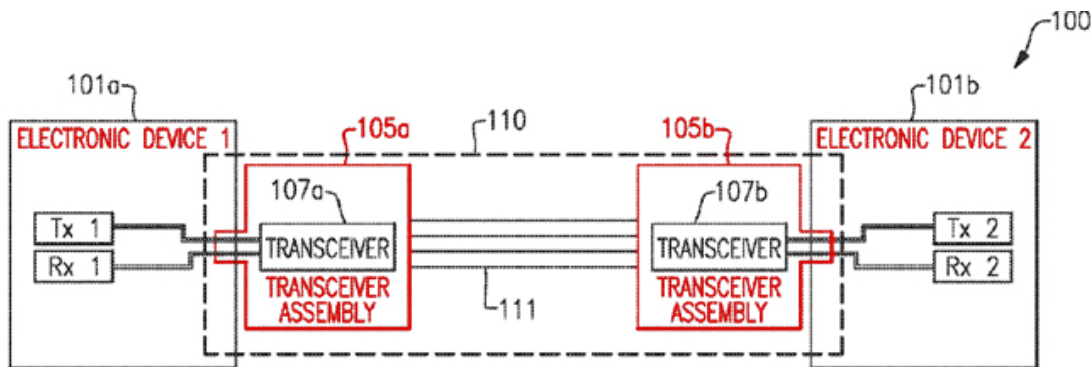


FIG. 2A

Ex-1003, ¶¶289-290.

Ground 3 teaches an Ethernet port (*supra* §V.C.3[1b]), which is a network interface port because Ethernet is a networking protocol. Ex-1003, ¶¶291-292.

[11d]

The elements of [11d] appear in [1c]-[1e], and are satisfied for the same reasons. *Supra* §§V.C.3[1c]-[1e]. The respective transceivers, signals, and streams explained for claim 1 correspond to the first/second transceivers, signals, and streams recited in limitation [11d]. Ex-1003, ¶293.

Limitation [11d] recites “**generating**” the respective electrical output signals. Ground 3 teaches the remodulation of the transit data stream as the outbound data stream (*supra* §§V.C.3[1d]-[1e]), which generates electrical output signals conveying the remodulated data stream. Lugthart teaches transceivers that “include outputs that generate host side receive data (RX DATA)[,]” which is “converted to an analog [output] signal by the DACs...before being transmitted to the electronic device.” Ex-1004, 23:10-12, 8:8-32; Ex-1003, ¶¶294-295.

14. Claim 12

Generating the electrical transit signals. Ground 3 generates electrical transit signals by remodulating the inbound data stream for transit. *Supra* §V.C.3[1c], §V.C.13[11d] (explaining “generating”); Ex-1004, 8:19-22; Ex-1004, 8:19-22, 10:4-13; Ex-1003, ¶297.

Configured to employ cable-dependent equalization parameters. Ground 3 teaches the transceivers do so for generating the electrical transit signals and performing CDR on them (*supra* §V.C.4 (claim 2)); Lugthart explains how the transceivers are “configured” to do this. Ex-1004, 22:40-49, 7:21-33, 21:35-42, 22:3-16, 22:50-57, claim 1; Ex-1003, ¶298.

The remainder of claim 12 overlaps with claim 2 and is satisfied for reasons explained previously. *Supra* §V.C.4; Ex-1003, ¶296.

15. Claim 13

Configured to adapt the cable-dependent equalization parameters. Ground 3 teaches the transceivers are each configured to do so during usage (*supra* §V.C.5 (claim 3); Ex-1004, 22:40-49 (teaching configuration), 7:21-33, 21:35-22:16, 22:50-57, claim 1; Ex-1003, ¶301.

Adaptation during operation. Ground 3 teaches that the recited parameter configuration occurs when the cable is in use, which is when the cable is in operation. *Supra* §V.C.5 (claim 3). Ground 3 teaches adaptation during operation. Ex-1004, 29:39-43; Ex-1003, ¶301.

The remainder of claim 13 overlaps with claim 3 and is satisfied for reasons explained previously. *Supra* §V.C.5; Ex-1003, ¶300.

16. Claim 14

The first and second transceivers are each configured to employ cable-dependent equalization parameters during operation. Ground 3 teaches this, as previously explained. *Supra* §V.C.12; §V.C.4 (claim 2). The parameters are employed during cable operation when signals are transmitted. *Supra* §§V.C.3[1b]-[1e]; Ex-1003, ¶303.

Preset parameters; testing an assembled cable to determine the cable-dependent equalization parameters. Aronson teaches “factory set equalization” parameters. Ex-1005, 14:38-40. Ground 3 teaches cable-dependent equalization parameters, including factory-preset parameters adjusted to match the characteristics of individual cables. *Supra* §V.C.3[1e], §V.C.4. Aronson teaches these presets are “adjusted at factory setup individually to match the particular length of the characteristics of the copper cabling” for each cable. Ex-1005, 13:49-14:5, 14:34-41. Therefore, Aronson tests assembled cables during manufacturing to adjust the equalization parameters to the precise characteristics of the assembled cable. *Id*; Ex-1003, ¶¶304-305.

VI. STANDING

Petitioner certifies that Petitioner is not barred or estopped from requesting this inter partes review, and the '252 patent is eligible for it.

VII. MANDATORY NOTICES AND FEES

1. **Real Party In Interest:** The real party-in-interest here is Marvell Semiconductor, Inc. No other parties directed, controlled, or funded this Inter Partes Review proceeding (IPR).

2. **Related Matters:**

- Certain Active Electrical Cables and Components Thereof, ITC Investigation 337-TA-1446
- *Credo Semiconductor Inc. and Credo Technology Group Ltd. v. Amphenol Corporation*, 2:25-cv-00296-JRG (EDTX)
- *Credo Semiconductor Inc. and Credo Technology Group Ltd. v. TE Connectivity PLC*, 2:25-cv-00297-JRG (EDTX)
- *Credo Semiconductor Inc. and Credo Technology Group Ltd. v. Volex PLC*, 2:25-cv-00298-JRG (EDTX)
- *Credo Semiconductor Inc. and Credo Technology Group Ltd. v. Molex LLC*, 1:25-cv-00316-JLH (Dist. Del.)
- *Amphenol Corporation v. Credo Technology Group Ltd.*, IPR2025-00834 (PTAB)

3. **Lead and Backup Counsel:** Pursuant to 37 C.F.R. §42.8(b)(3) and 42.10(a), Petitioner designates Harper Batts (Reg. No. 56,160) as lead counsel and Chris Ponder (Reg. No. 77,167) and Jeffrey Liang (Reg. No. 69,043) as back-up counsel, each of Sheppard, Mullin, Richter & Hampton LLP.

4. **Service Information:** Petitioner consents to service by electronic mail addressed to:

HBatts@sheppardmullin.com;

CPonder@sheppardmullin.com;
JLiang@sheppardmullin.com; and
LegalTM-Marvell-Credo-IPRs@sheppardmullin.com

Petitioner's counsel may also be served by mail or hand delivery at Sheppard, Mullin, Richter & Hampton LLP, 1540 El Camino Real Suite 120, Menlo Park, CA 94025. Petitioner's counsel may be reached by telephone at (650) 815-2673 and by facsimile at (650) 815-4668.

5. **Fees:** The Office is authorized to charge fees for this Petition to Deposit Account 50-4561, Ref. 20SW-408772.

Respectfully submitted,

SHEPPARD, MULLIN,
RICHTER & HAMPTON LLP

/Harper Batts/

Harper Batts (Reg. No. 56,160)
Attorneys for Petitioner

CLAIM APPENDIX

Claim 1	
[1pre]	An active Ethernet cable that comprises:
[1a]	electrical conductors connected between a first connector and a second connector,
[1b]	each of the first and second connectors being adapted to fit into an Ethernet port of a corresponding host device to receive from that host device an electrical input signal conveying an inbound data stream to the cable and to provide to that host device an electrical output signal conveying an outbound data stream from the cable,
[1c]	each of the first and second connectors including a respective transceiver that performs clock and data recovery on the electrical input signal to extract and re-modulate the inbound data stream for transit via the electrical conductors as a respective electrical transit signal conveying a transit data stream,
[1d]	the respective transceiver for each of the first and second connectors performing clock and data recovery on the respective electrical transit signal to extract and re-modulate the transit data stream as the outbound data stream from the cable, and
[1e]	the respective transceivers each employing fixed, cable-independent, equalization parameters for each of: the remodulation of the transit data stream as the outbound data stream, and the clock and data recovery performed on the electrical input signal.
Claim 2	
2	The active Ethernet cable of claim 1, wherein the respective transceivers each employ cable-dependent equalization parameters for at least one of: the remodulation of the inbound data stream for transit, and the clock and data recovery performed on the electrical transit signal.
Claim 3	

3	The active Ethernet cable of claim 2, wherein said cable-dependent equalization parameters adapt during usage of the Ethernet cable.
Claim 4	
4	The active Ethernet cable of claim 2, wherein said cable-dependent equalization parameters are fixed during normal usage of the Ethernet cable, and wherein said cable-dependent equalization parameters are determined during manufacturing-testing of the Ethernet cable.
Claim 5	
5	The active Ethernet cable of claim 4, wherein the inbound data stream and the outbound data stream each have a per-lane symbol rate in excess of 50 GBd.
Claim 6	
[6pre]	A communication method that comprises, in a network cable having conductor pairs electrically connecting a first connector to a second connector:
[6a]	receiving with the first connector a first electrical input signal conveying a first inbound data stream from a first host device;
[6b]	performing clock and data recovery on the first electrical input signal with a first transceiver in the first connector to extract the first inbound data stream;
[6c]	re-modulating the first inbound data stream as a first transit data stream conveyed by a first electrical transit signal over a first of the conductor pairs;
[6d]	receiving with the second connector a second electrical input signal conveying a second inbound data stream from a second host device;
[6e]	performing clock and data recovery on the second electrical input signal with a second transceiver in the second connector to extract the second inbound data stream;

[6f]	re-modulating the second inbound data stream as a second transit data stream conveyed by a second electrical transit signal over a second of the conductor pairs;
[6g]	performing clock and data recovery on the first electrical transit signal with the second transceiver to extract the first transit data stream;
[6h]	re-modulating the first transit data stream as a second outbound data stream conveyed by a second electrical output signal to the second host device;
[6i]	performing clock and data recovery on the second electrical transit signal with the first transceiver to extract the second transit data stream; and
[6j]	re-modulating the second transit data stream as a first outbound data stream conveyed by a first electrical output signal to the first host device,
[6k]	wherein said re-modulating the first transit data stream, said re-modulating the second transit data stream, said performing clock and data recovery on the first electrical input signal, and said performing clock and data recovery on the second electrical input signal, each employ fixed, cable-independent, equalization parameters.
Claim 7	
7	The communication method of claim 6, wherein cable-dependent equalization parameters are employed for at least one of: re-modulating the first inbound data stream, re-modulating the second inbound data stream, said performing clock and data recovery on the first electrical transit signal, and said performing clock and data recovery on the second electrical input signal, each employ fixed, cable-independent, equalization parameters.
Claim 8	
8	The communication method of claim 7, wherein said cable-dependent equalization parameters are adaptively updated.

Claim 9	
9	The communication method of claim 7, wherein said cable-dependent equalization parameters are fixed during normal usage, and wherein the method further comprises: determining said cable-dependent equalization parameters during manufacturer-testing of the network cable.
Claim 10	
10	The communication method of claim 9, wherein the first inbound data stream has a per-lane symbol rate in excess of 50 GBd.
Claim 11	
[11pre]	A cable manufacturing method that comprises:
[11a]	connecting a first end and a second end of a set of conductor pairs to a first transceiver and a second transceiver, respectively, to transport a first electrical transit signal from the first transceiver to the second transceiver and a second electrical transit signal from the second transceiver to the first transceiver;
[11b]	packaging the first transceiver into a first connector configured to couple a first electrical input signal from a network interface port of a first host device to the first transceiver and a first electrical output signal from the first transceiver to the network interface port of the first host device; and
[11c]	packaging the second transceiver into a second connector configured to couple a second electrical input signal from a network interface port of a second host device to the second transceiver and a second electrical output signal from the second transceiver to the network interface port of the second host device,
[11d]	the first and second transceivers being configured to perform clock and data recovery on the first and second electrical input signal to extract and re-modulate the first and second inbound data streams respectively

	as the first and second electrical transit signals conveying first and second transit data streams, configured to perform clock and data recovery on the second and first electrical transit signals to extract and re-modulate the second and first transit data streams as first and second outbound data streams conveyed by the first and second electrical output signals from the cable, and each configured to employ fixed, cable-independent, equalization parameters for clock and data recovery on the respective electrical input signals and for generating the respective electrical output signals.
Claim 12	
12	The cable manufacturing method of claim 11, wherein the first and second transceivers are each configured to employ cable-dependent equalization parameters for generating the first and second electrical transit signals and for clock and data recovery on the second and first electrical transit signals.
Claim 13	
13	The cable manufacturing method of claim 12, wherein the first and second transceivers are each configured to adapt the cable-dependent equalization parameters during operation.
Claim 14	
14	The cable manufacturing method of claim 12, wherein the first and second transceivers are each configured to use preset cable-dependent equalization parameters during operation, and wherein the method further comprises: testing an assembled cable to determine the cable-dependent equalization parameters.

CERTIFICATE OF SERVICE

The undersigned hereby certifies that on August 7, 2025, true and correct copies of the foregoing Petition for *Inter Partes* Review of U.S. Patent No. 11,012,252 and Exhibits 1001-1035 were served in entirety on the Patent Owner at the following addresses of record as listed on Patent Center, via Priority Mail Express®:

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**CERTIFICATE OF COMPLIANCE WITH
TYPE-VOLUME LIMITATION, TYPEFACE REQUIREMENTS,
AND TYPE STYLE REQUIREMENTS**

1. This Petition complies with the type-volume limitation of 14,000 words, comprising 13,376 words, as counted using the Microsoft Word software that was used to prepare this paper, excluding the parts exempted by 37 C.F.R. § 42.24(a).

2. This Petition complies with the general format requirements of 37 C.F.R. § 42.6(a) and has been prepared using Microsoft® Word in 14-point Times New Roman.

Respectfully submitted,

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