

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

SAMSUNG ELECTRONICS CO., LTD. AND SAMSUNG ELECTRONICS
AMERICA, INC.,
Petitioner,

v.

GENGHISCOMM HOLDINGS LLC,
Patent Owner

Case: IPR2025-00780
U.S. Patent No. 9,768,842

**PETITION FOR *INTER PARTES* REVIEW OF CLAIMS 1-4, 7-9, 11, 17-
18, 22, 25-26, AND 28 OF U.S. PATENT NO. 9,768,842**

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LISTING OF CLAIMS

Claim 1. [1-PRE] An OFDM transmitter, comprising:

[1A] an OFDM spreader configured to spread a plurality of data symbols with Fourier coefficients to generate a discrete Fourier Transform (DFT)-spread data signal;

[1B] a mapper configured to map the DFT-spread data signal to a plurality of OFDM subcarriers; and

[1C] an OFDM modulator configured to modulate the DFT-spread data signal onto the plurality of OFDM subcarriers to produce an OFDM transmission signal comprising a superposition of the OFDM subcarriers,

[1D] wherein the OFDM spreader is configured to provide the superposition with a reduced peak-to-average power ratio.

Claim 2. The OFDM transmitter recited in claim 1, wherein the OFDM spreader comprises an N-point DFT and the OFDM modulator comprises an M-point inverse discrete Fourier Transform, wherein $M > N$.

Claim 3. The OFDM transmitter recited in claim 1, wherein the OFDM modulator comprises an inverse fast Fourier transform.

Claim 4. The OFDM transmitter recited in claim 1, wherein the data symbols comprise reference-signal symbols, which comprise at least one of known training

symbols and synchronization symbols.

Claim 7. The OFDM transmitter recited in claim 1, further comprising a cyclic prefix appender configured to append at least one of a cyclic prefix, a postfix, and a guard interval to the OFDM transmission signal.

Claim 8. The OFDM transmitter recited in claim 1, wherein the OFDM spreader is configured to provide channel precoding.

Claim 9. The OFDM transmitter recited in claim 1, wherein the plurality of data symbols are at least one of time-multiplexed with reference-signal symbols, frequency-multiplexed with reference-signal symbols, and code-multiplexed with reference-signal symbols.

Claim 11. [11Pre] A method, comprising:

[11A] multiplying a plurality of data symbols by a discrete Fourier Transform (DFT) spreading matrix to produce a plurality of DFT-spread symbols;

[11B] mapping the plurality of DFT-spread symbols to a plurality of OFDM subcarriers; and

[11C] modulating the plurality of DFT-spread symbols onto a plurality of OFDM subcarriers to produce a DFT-spread OFDM signal to be transmitted into a wireless channel, wherein the DFT-spread OFDM signal comprises a superposition of the OFDM subcarriers, and

[11D] wherein the DFT spreading matrix is configured to provide the

superposition with a reduced peak-to-average power ratio (PAPR).

Claim 17. The method recited in claim 11, further comprising appending at least one of a cyclic prefix, a postfix, and a guard interval onto the DFT-spread OFDM signal.

Claim 18. The method recited in claim 11, wherein the DFT spreading matrix comprises an N-point DFT, and the modulating comprises employing an M-point inverse-DFT, and wherein $N < M$.

Claim 22. [22Pre] An apparatus comprising:

[22A] a processor; and

[22B] a non-transitory memory coupled to the processor, the non-transitory memory including a set of instructions stored therein and executable by the processor to:

[22Bi] for a set of data symbols, perform an N-point discrete Fourier transform (DFT) spreading on the set of data symbols to generate a plurality N of DFT-spread data symbols;

[22Bii] map the N DFT-spread data symbols to at least N subcarriers of a plurality M of Orthogonal Frequency Division Multiplexing (OFDM) subcarriers to generate a set of complex subcarrier amplitudes; and

[22Biii] perform an M-point inverse discrete Fourier transform (IDFT) on the set of complex subcarrier amplitudes to generate a time-domain sequence to be transmitted into a wireless channel, the time-domain sequence comprising a

superposition of the OFDM subcarriers,

[22Biv] wherein the N-point DFT spreading is configured to provide the superposition with a reduced peak-to-average power ratio.

Claim 25. The apparatus recited in claim 22, wherein $M > N$.

Claim 26. The apparatus recited in claim 22, wherein the IDFT comprises an inverse fast Fourier transform.

Claim 28. The apparatus recited in claim 22, wherein the non-transitory memory further comprises instructions to append at least one of a cyclic prefix, a postfix, and a guard interval to the time-domain sequence.

PETITIONER’S EXHIBIT LIST

Exhibit No.	Description
1001	U.S. Patent No. 9,768,842 (“’842 Patent”)
1002	Declaration of Harry Bims, Ph.D.
1003	Angela Doufexi, et al., <i>Design Considerations and Initial Physical Layer Performance Results for a Space Time Coded OFDM 4G Cellular Network</i> , In The 13th IEEE International Symposium on Personal, Indoor and Mobile Radio Communications (Vol. 1, pp. 192-196). IEEE (Sept. 18, 2002) (“Doufexi”).
1004	Dirk Galda & Hermann Rohling, <i>A Low Complexity Transmitter Structure for OFDM-FDMA Uplink Systems</i> , Vehicular Technology Conference. IEEE 55 th Vehicular Technology Conference, vol. 4, pp.1737-1741 (May 6, 2002) (“Galda”).
1005	Stefan Kaiser, <i>Multi-Carrier CDMA Mobile Radio Systems – Analysis and Optimization of Detection, Decoding, and Channel Estimation</i> , VDI-Verlag, Dusseldorf, Germany (Jan. 1998) (ISBN 3-18-353110-0) (“Kaiser”)
1006	Lucent Technologies, <i>Proposed Baseline OFDM Systems for Study</i> , 3GPP TSG-RAN1 #28 bis, R1-02-01246 (Oct. 8-9, 2002) (“Lucent”).
1007	Andres Bury & Jurgen Linder, <i>Comparison of Amplitude Distributions for Hadamard Spreading and Fourier Spreading in Multi-Carrier Code Division Multiplexing</i> , Globecom ’00-IEEE. Global Telecommunications Conference, Vol. 2, pp.857-860 (Nov. 27, 2000) (“Bury”)
1008	Kwang-Cheng Chen, et al., <i>A Programmable Architecture for OFDM-CDMA</i> , IEEE Communications Magazine, pp.76-82 (Nov. 1999) (“Chen”)
1009	José Francia, <i>Proposal for an OFDM-based 802.16.3 Air Interface Physical Layer</i> , IEEE 802.16.3c-00/44 (Oct. 30, 2000)
1010	John Langley, <i>PHY Layer System Proposal for Sub 11 GHz BWA</i>

Exhibit No.	Description
	<i>Having SC-FDE and OFDM Modules</i> , IEEE802.16.3c-01/31r2 (Mar. 12, 2001).
1011	U.S. Patent Application Publication No. 2003/0081538 to Walton et al.
1012	Declaration of Sylvia Hall-Ellis, Ph.D.
1013	Hermann Rohling, et al., <i>Broad-Band OFDM Radio Transmission for Multimedia Applications</i> , Proceedings of the IEEE, Vol. 87, No. 10, Oct. 1999 (“Rohling”)
1014	Stephen B. Weinstein, <i>The History of Orthogonal Frequency-Division Multiplexing</i> , IEEE Communications Magazine, pp.26-35 (Nov. 2009).
1015	Richard van Nee & Ramjee Prasad, <i>OFDM for Wireless Multimedia Communications</i> (Artech House 2000).
1016	Karsten Bruninghaus & Herman Rohling, <i>Multi-carrier spread spectrum and its relationship to single-carrier transmission</i> , Vehicular Technology Conference. IEEE 48 th Vehicular Technology Conference, vol. 3, pp.2329-2332 (May 18-21, 1998) (“Brüninghaus”)
1017	RESERVED
1018	File History of U.S. Patent Application No. 15/283,881 as obtained from Patent Center (excerpts)
1019	File History of U.S. Patent Application No. 14/967,633 as obtained from Patent Center (excerpts)
1020	File History of U.S. Patent Application No. 14/168,466 as obtained from Patent Center.
1021	File History of U.S. Patent Application No. 11/187,107 as obtained from Patent Center (excerpts)
1022	File History of Provisional No. 60/589,187
1023	File History of U.S. Patent Application No. 10/145,854 as obtained from Patent Center (excerpts)

Exhibit No.	Description
1024	RESERVED
1025	RESERVED
1026	RESERVED
1027	RESERVED
1028	RESERVED
1029	RESERVED
1030	RESERVED
1031	RESERVED
1032	RESERVED
1033	RESERVED
1034	RESERVED
1035	3GPP TS 36.306 V8.0.0 (2007-12) (Release 8)
1036	RESERVED
1037	RESERVED
1038	3GPP TS 36.211 V8.8.0 (2009-09) 3 rd Generation Partnership Project; Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA); Physical Channels and Modulation (Release 8)
1039	Exhibit 1 to Plaintiff’s P.R. 3-1(c) Infringement Contentions (U.S. Pat. No. 9,768,842)
1040	Marco Breiling, et al., <i>Peak-Power Reduction in OFDM without Explicit Side Information</i> , 5 th Int’l OFDM-Workshop 2000 (Hamburg/Germany), Sept. 2000, pp.28-1 to 28-4.
1041	EP 0 734 132 A2 to Kabushiki Kaisha Toshiba (“Toshiba”)
1042	U.S. Patent No. 6,597,745 to Dowling
1043	Gerhard P. Fettweis, et al., <i>A Time Domain View to Multi-Carrier Spread Spectrum</i> , IEEE 6 th Int’l Symposium on Spread-

Exhibit No.	Description
	Spectrum & Applications (ISSSTA 2000), (Sept. 6-8, 2000) (pre-print)
1044	Armin Dekorsy & Volker Kuehn, <i>Exploiting Time and Frequency Diversity by Iterative Decoding in OFDM-CDMA Systems</i> , Seamless Interconnection for Universal Services, Global Telecommunications Conference. GLOBECOM'99, Vol. 5, pp.2576-2580 (Dec. 5, 1999)
1045	Volker Kuehn, et al., <i>Channel Coding Aspects in an OFDM-CDMA System</i> , ITG FACHBRICHT, pp.31-36 (Jan. 2000)
1046	Docket Control Order, <i>Genghiscomm Holdings, LLC v. Samsung Elecs., Am., Inc.</i> , No. 2:24-cv-0242-RWS-RSP, Dkt. 25 (Sept. 24, 2024)
1047	Complaint, <i>Genghiscomm Holdings, LLC v. Samsung Elecs., Am., Inc.</i> , No. 2:24-cv-0242-RWS-RSP, Dkt. 1 (Apr. 12, 2024).
1048	RESERVED
1049	RESERVED
1050	RESERVED
1051	RESERVED
1052	RESERVED
1053	RESERVED
1054	RESERVED
1055	RESERVED
1056	RESERVED
1057	RESERVED
1058	RESERVED
1059	Declaration of Gary Swatzell including Exhibits A-D
1060	Guidance on USPTO's rescission of "Interim Procedure for Discretionary Denials in AIA Post-Grant Proceedings with

Exhibit No.	Description
	Parallel District Court Litigation” (Mar. 24, 2025).
1061	Docket Control Order, <i>Slyde Analytics LLC v. Apple Inc.</i> , No. 2:24-cv-00331-RWS-RSP, Dkt. 46 (E.D. Tex. Sept. 23, 2024)
1062	Docket Control Order, <i>Innomemory, LLC v. Truis Financial Corp.</i> , No. 2:24-cv-00146-RWS-RSP, Dkt. 38 (E.D. Tex. Sept. 24, 2024)
1063	Docket Control Order, <i>Husky Injection Molding Systems Ltd. V. Ningbo Ao Sheng Mold Co., Ltd. D/B/A Aosimi</i> , No. 2:24-cv-00348-RWS-RSP, Dkt. 46 (E.D. Tex. Oct. 21, 2024)
1064	Docket Sheet for <i>Partec Ag, et al v. Microsoft Corporation</i> , No. 2:24-cv-00433 (downloaded Mar. 26, 2025)
1065	Combined asserted patents in <i>Genghiscomm Holdings, LLC v. Samsung Elecs., Am., Inc.</i> , No. 2:24-cv-0242-RWS-RSP, Dkt. 25 (Sept. 24, 2024)
1066	RESERVED
1067	RESERVED
1068	RESERVED
1069	RESERVED
1070	Results of Docket Navigator Search for '842 Patent
1071	The title page, page V, page 14, pages 32-24, pages 130-137, page 140, and page 150 of Kaiser, Stefan. <i>Multi-Carrier CDMA Mobile Radio Systems - Analysis and Optimization of Detection, Decoding, and Channel Estimation</i> . Doctoral Dissertation. Department of Computer Science and Engineering, Technische Universität München. Dusseldorf, Germany: Verein Deutscher Ingenieure (VDI) Verlag, ©1998. Obtained from the University of Mannheim Library in Mannheim Germany.

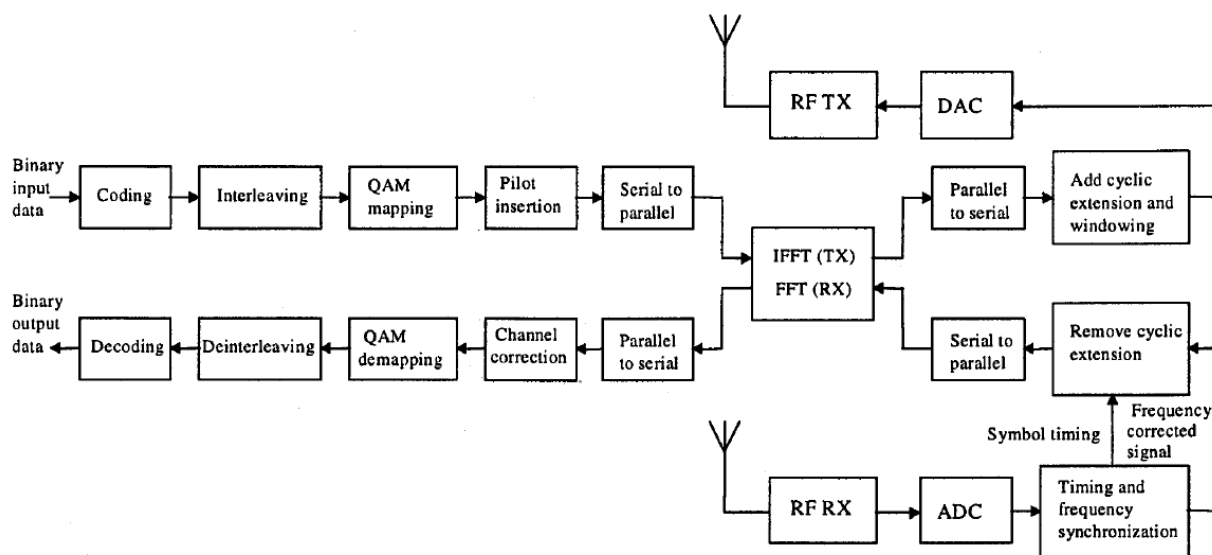
I. GROUNDS FOR STANDING

Petitioner has standing because neither it nor any privy or real party-in-interest was served with a Complaint more than one year before the filing of this Petition and it is not estopped from bringing this challenge.

II. TECHNICAL OVERVIEW

The Challenged Patent relates to processes for use in orthogonal frequency division multiplexing (“OFDM”) wireless communications. OFDM has been studied for more than 50 years. EX1014, pp.26-28; EX1015, pp.20-24.

A textbook OFDM transceiver is shown below.



EX1015, p.48. An OFDM signal is formed at the transmitter using an inverse Fourier transform, *e.g.*, an inverse fast Fourier transform (“IFFT”). *Id.*, pp.42, 47-48. A guard interval including a cyclic prefix is added to minimize interference. *Id.*, pp.39-

40; EX1002, ¶¶49.

OFDM systems can exhibit high peak-to-average power ratios (“PAPR” or “PAR”). EX1013, p.1780; EX1014, pp.31-32. The Challenged Patent purports to reduce PAPR in OFDM systems by spreading input data using complex-valued codes obtained from a discrete Fourier transform (“DFT”). EX1001, Abstract, 8:64-9:1.

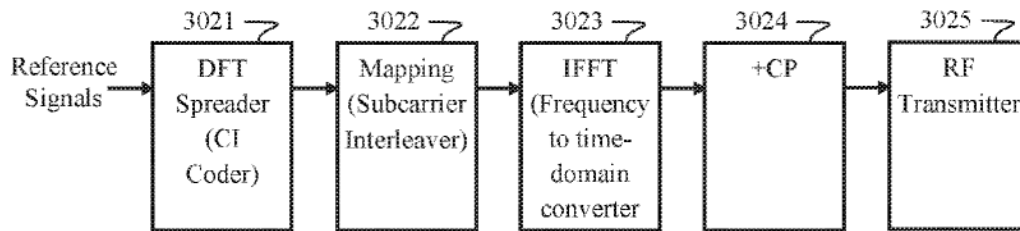
This technique for reducing PAPR in OFDM was not new. EX1002, ¶¶50-54. For example, Brüninghaus (1998) observes that when an “FFT matrix” is used “as a spreading matrix for OFDM-CDM” signals, this “leads to a single-carrier system with guard interval.” EX1016, p.2332. Bury (2000) explains that “Fourier spreading” can be “implemented by a discrete Fourier transform (DFT) operation” resulting in a “much lower” PAPR. EX1007, p.857. Galda (2002) “shows how an OFDM-FDMA uplink system can be combined with a user data spreading technique based on the DFT spreading matrix to reduce the PAR...” EX1004, p.1738.

III. THE '842 PATENT

A. Overview

The '842 Patent relates to an OFDM transmitter having (1) a “Discrete Fourier Transform (DFT) spreader” for spreading data symbols with Fourier coefficients, (2) a mapper that maps the DFT spread symbols to OFDM subcarriers, and (3) an OFDM modulator implemented using the typical IFFT to generate modulated

OFDM subcarriers including the DFT spread symbols. EX1001, Abstract, 8:57-9:1, 70:56-63, 77:7-18, FIG. 30A. A block diagram of such a transmitter is shown below.



EX1001, FIG. 30A.

B. Prosecution History

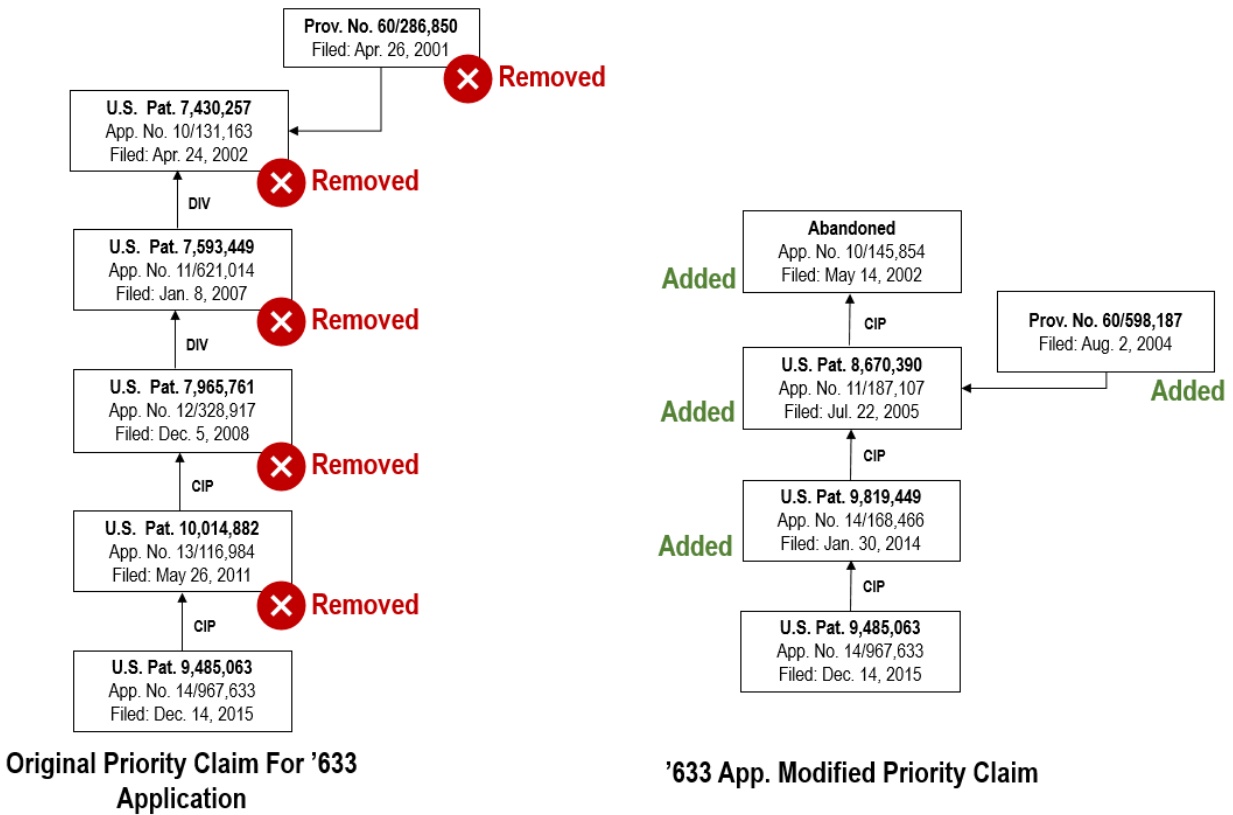
1. The '881 Application

The application for the '842 Patent was filed on October 17, 2016. EX1001, cover. The only rejection was based on obviousness-type double patenting over the parent and an application that would issue as U.S. Patent No. 10,200,227. EX1018, pp.23-26. No prior art was applied. The Examiner said “an OFDM modulator configured to modulate the DFT-spread data signal onto the plurality of OFDM subcarriers to produce an OFDM transmission signal comprising a superposition of the OFDM subcarriers, wherein the OFDM spreader is configured to provide the superposition with a reduced peak-to-average power ratio” rendered the claims patentable. EX1018, p.6 (emphasis original). None of the prior art raised in this Petition was of record.

2. The '633 Application

The '633 Application originally claimed priority to one set of applications.

Several months later, the priority claim was entirely changed:



EX1019, pp.31, 38-39, 202-203.

The original '633 Application claims had many of the same features as the '842 Patent claims including: a spreader, mapper, and OFDM modulator. *Id.*, p.196. Most claims were rejected over prior art but dependent claim 8 relating to a superposition signal with low PAPR was deemed allowable. EX1019, pp.19-26, 32-33 (claims 7-8). The independent claims were amended to incorporate claim 8 and the Examiner emphasized the added language in the Reasons for Allowance. *Id.*, pp.4-5. None of the references used as grounds in this Petition were even of record.

3. *The '466 and '107 Applications*

Neither of the '466 and '107 Applications relates to the subject matter of the '842 Patent. The '466 Application claims cooperative networking among a plurality of receiving nodes, EX1020, pp.281-284, and the '107 Application claims “cooperative beam-forming” in a “group of wireless terminals,” EX1021, p.76.

While the '466 Application incorporated earlier-filed applications in the priority chain by reference, the '107 Application did not. *Compare* EX1020, p.195 (incorporating by reference) *with* EX1021, p.7 (no incorporation by reference). None of the prior art applied in this Petition was cited against the '466 and '107 Applications.

4. *The '854 Application*

The '854 Application was filed on May 14, 2002. The Examiner initially rejected the claims based on (1) a patent application publication on which Mr. Shattil—the inventor of the '854 Application—was named and an article that Mr. Shattil co-authored. EX1023, pp.183-187, 213-223. Applicant argued that the references were not prior art. *Id.*, pp.178-180, 204-207. Additional rejections followed, and the prior art was distinguished via amendments and arguments. *Id.*, pp.93-117, 136-159. The issue fee was not paid after allowance. *Id.*, p.38. Applicant unsuccessfully sought to revive the application. *Id.*, p.30. Applicant petitioned again over ten years later, the petition was automatically granted, and a “patent like

document” published. *Id.*, p.3. Yet the Office revisited the petition and denied it because Applicant had not explained how the decade-plus gap in seeking revival was “unintentional.” *Id.*, pp.20-21. Applicant never refiled the petition, the “patent like document” was revoked, and the ’854 Application remains abandoned.

IV. EFFECTIVE FILING DATE; POST-AIA

The ’842 Patent is not entitled to an effective filing date before December 14, 2015.

Patent Owner was not required to prove entitlement to an earlier filing date during prosecution. *Supra* §III.B. “[C]laims in a patent or patent application are not entitled to priority under § 120 at least until the patent owner proves entitlement to the” Board. *Nat. Alts. Int’l, Inc. v. Iancu*, 904 F.3d 1375, 1380 (Fed. Cir. 2018); *Inari Agriculture, Inc. v. Corteva Agriscience LLC*, IPR2024-01014, Paper 15 (Dec. 16, 2024) (Petitioner must persuade the Board only after “a Patent Owner presents argument and evidence that the challenged claims are entitled to [an earlier] priority date.”).

A. The ’107 Application Is Materially Different From the ’854 Application.

While the ’854 Application describes “wireless transceivers that implement Carrier Interferometry (CI) and/or CI-based coding,” EX1023, p.227, the ’107 Application describes a different invention directed to “providing cooperative signal

processing between a plurality of wireless terminal devices ... to improve network access,” EX1021, p.99. These are different inventions. EX1002, ¶¶55-57.

To be entitled to the effective filing date of the ’854 Application, “each application in the chain leading back to” that application “must comply with the written description requirement.” *Zenon Envtl. Inc. v. U.S. Filter Corp.*, 506 F.3d 1370, 1378 (Fed. Cir. 2007) (cleaned up). “[I]f any application in the priority chain fails to make the requisite disclosure of subject matter, the later-filed application is not entitled to the benefit of the filing date of applications preceding the break in the priority chain.” *Holmer v. Harari*, 681 F.3d 1351, 1355 (Fed. Cir. 2012).

The ’107 Application fails to describe the subject matter claimed in the ’842 Patent. Claim 1 of the ’842 Patent claims a transmitter with a “spreader,” “a mapper,” and “an OFDM modulator” (or analogous steps), all of which perform specific functions. EX1001, 77:6-18, 77:52-65, 78:33-53. The “spreader” of claim 1 is “configured to spread a plurality of data symbols with Fourier coefficients” and the “mapper” is “configured to map the DFT-spread data signal to a plurality of OFDM subcarriers.” EX1001, 77:7-11. Method claim 11 requires distinct steps of “multiplying a plurality of data symbols by a discrete Fourier Transform (DFT) spreading matrix” and “mapping the plurality of DFT-spread symbols to a plurality of OFDM subcarriers” *Id.*, 77:53-57. Claim 22 requires computer-executable instructions that “perform an N-point discrete Fourier transform (DFT) spreading”

and “map the N DFT-spread data symbols to at least N subcarriers of a plurality of M of Orthogonal Frequency Division Multiplexing (OFDM) subcarriers” *Id.*, 78:35-45. These features are not described in the ’107 Application.

There are only two terse references to spreading using DFT codes in the ’107 Application. None refers to using a spreader, followed by a mapper (or spreading then mapping), as recited in the independent claims of the ’842 Patent. The ’107 Application refers to multicarrier spreading codes (e.g., orthogonal DFT, or CI, codes) and states:

Preferred embodiment of the invention may employ Spread-OFDM, which involves multiplying each data block $s(n)$ by a spreading matrix A:

$$U(n)=As(n)$$

In the case where CI spreading codes are employed, $A_{nm}=exp(-j2\pi nm/N)$. This maps the data symbols to pulse waveforms positioned orthogonally in time. This choice of spreading codes also gives the appearance of reducing the IFFT. However, the resulting set of pulse waveforms is a block, rather than a sequence, wherein each waveform represents a cyclic shift within the block duration T_s , such as described in U.S. Pat. Appl. Pubs. 20030147655 and 20040086027, which are both incorporated by reference.

EX1021, pp.34, 49. While this describes a matrix multiplication of spreading codes including the term $exp(-j2\pi nm/N)$, it does not describe the structure of a spreader or

a mapper. EX1002, ¶¶58-60. Instead, the '107 Application says that the multiplication performs the mapping (i.e., “[t]his [multiplying by spreading matrix] maps the data symbols to pulse waveforms”) and no structure is discussed at all. But the claims of the '842 require a distinct “spreader” and “mapper” (claim 1) and distinct “spreading” and “mapping” steps where the mapping step operates on the DFT-spread samples (claim 11). The '842 Patent apparatus claims are also not limited to using matrix multiplication, which is what the brief passage in the '107 Application describes. EX1002, ¶¶61-63.

B. The '854 Application Is Not Incorporated By Reference Into The '107 Application.

The '107 Application does not incorporate by reference the '854 Application. The priority claim to the '854 Application is not an incorporation by reference. *See In re de Seversky*, 474 F.2d 671, 674 (CCPA 1973). As such, any disclosure in the '854 Application that does not appear in the '107 Application cannot be used to show entitlement to the effective filing date of the '854 Application because that disclosure was removed, thus breaking continuity of disclosure.

C. Incorporation Of Publications From Other Patent Families Cannot Convert The '107 Application Into A Different Invention.

The '107 Application describes a different invention than the one claimed now. That application was titled “Cooperative Beam-Forming in Wireless Networks.” EX1021, p.7. Its field is “providing cooperative signal processing

between a plurality of wireless devices.” EX1021, p.7. The Abstract describes “a cooperative array of wireless terminals,” EX1021, p.82, and its claims recite “multiple wireless terminals,” *id.*, pp.76-77. The ’107 Application purports to address a problem that “power, cost, and size constraints typically make the implementation of antenna arrays on mobile wireless terminals ... impractical.” *Id.*, pp.9, 16-17. The invention coordinated among multiple wireless terminals to make them operate as if they were a single antenna array. *Id.*, p.16. The embodiments utilize multiple WTs operating together to transmit or receive signals. EX1002, ¶64. The claims of the ’842 Patent, however, are directed to a transmitter that does not depend on other transmitters. EX1002, ¶65. Therefore, the ’842 Patent claims are to different subject matter than the ’107 Application.

If Patent Owner relies on the patent application publications incorporated by reference into the disclosure, *see* EX1021, p.49, these applications describe different inventions and are found in a different patent family. Patent Owner’s reliance on incorporation by reference would have the Board improperly convert the invention of the ’107 Application into the invention disclosed in those other applications. *See, e.g., Modine Mfg. Co. v. U.S. Int’l Trade Comm’n*, 75 F.3d 1545, 1553 (Fed. Cir. 1996) (“[I]ncorporation by reference does not convert the invention of the incorporated patent into the invention of the host patent.”).

D. The '842 Patent Is A Post-AIA Patent For An Additional Reason.

The '842 Patent is a post-AIA patent for an independent reason. Claim 21 recites “[a] User Equipment configured to perform the method recited in claim 11.” EX1001, 78:31-32. The claim term “User Equipment” was first defined in the application for the immediate parent to the '842 Patent—i.e., the '633 Application filed on December 14, 2015. *Compare* EX1020, pp.195-285 (originally-filed '466 Application with no mention of “user equipment”) *with* EX1019, p.97 (defining “User Equipment (UE), as used herein”). The definition first appearing on December 14, 2015 incorporates technologies that did not exist at the time of the earlier effective filing dates. For example, the '842 Patent states:

User Equipment (UE), as used herein, may be fixed or mobile [A] UE is defined in ... 3GPP Long Term Evolution (LTE) as any device that connects to a base station NodeB or eNodeB as specified in ... 3GPP 25/36-series of specifications, UEs include equivalent devices.... Examples of UEs are provided in 3GPP technical specification (TS) 36.306, Release 8, the disclosure of which is incorporated herein by reference in its entirety.

EX1001, 13:12-51. The phrase “as used herein” indicates that these descriptions “are applicable to the ['842 Patent] as a whole” and “conveys an intent” for the description to be definitional. *ParkerVision, Inc. v. Vidal*, 88 F.4th 969, 976-77 (Fed. Cir. 2023). Therefore, the UE recited in claim 21 of the '842 Patent must be

interpreted to encompass UEs described in 3GPP TS 36.306, Release 8, *see* EX1035, because the patentee said that “UE” includes such devices.

UEs are claimed in the '842 Patent. The definition of UE was added after March 13, 2013. The UE claim of the '842 Patent cannot be entitled to an earlier filing date than the date the definition was added because the change to the specification should be deemed meaningful. *Cf. DDR Holdings, LLC v. Priceline.com LLC*, 122 F.4th 911, 916-17 (Fed. Cir. 2024) (difference between related applications “highly significant” in claim construction despite incorporation of earlier applications by reference). The '842 Patent should be evaluated under post-AIA law. *See* M.P.E.P. §2159.02; AIA §3(n)(1)-(2).

V. IDENTIFICATION OF THE CHALLENGE

Petitioner challenges the following claims on the following grounds:

Ground	Claims	Challenge	Statute
1	1-3, 7-8, 11, 17-18	Galda (anticipation)	Post-AIA §102(a)(1) or Pre-AIA §102(b)
2	1-3, 7-8, 11, 17-18	Galda (obviousness)	Post- or Pre-AIA §103
3	4, 9	Galda in view of Toshiba	
4	22, 25-26, 28	Galda in view of Dowling	
5	1-3, 7-8, 11, 17-18	Kaiser in view of Bury	
6	4, 9	Kaiser in view of Bury and Toshiba	
7	22, 25-26, 28	Kaiser in view of Bury and Dowling	

VI. THE PERSON OF ORDINARY SKILL IN THE ART (“POSITA”)

Based on the '842 Patent, the prior art and other documentation cited herein, and on Dr. Bims's testimony, a POSITA as of May 14, 2002 would have had “either a Master's degree in electrical engineering or a related field, or a Bachelor's degree in electrical engineering or a related field with three years of experience in wireless communication systems, signal processing, and related technologies.” EX1002, ¶67. A POSITA would have known that DFT spreading reduces PAPR, that reference-

signals are used in OFDM systems, and was familiar with hardware and software implementations of mobile transmitters. *Id.*, ¶¶67-69 This level of skill does not materially change regardless of the effective filing date. *Id.*, ¶70.

VII. CLAIM CONSTRUCTION

Except for the construction of “User Equipment,” *supra* §IV.D, Petitioner submits that no formal claim constructions are necessary because “claim terms need only be construed to the extent necessary to resolve the controversy.” *Wellman, Inc. v. Eastman Chem. Co.*, 642 F.3d 1355, 1361 (Fed. Cir. 2011). Petitioner reserves the right to respond to any constructions offered by Patent Owner or adopted by the Board.

VIII. PRIOR ART STATUS; ANALOGOUS ART

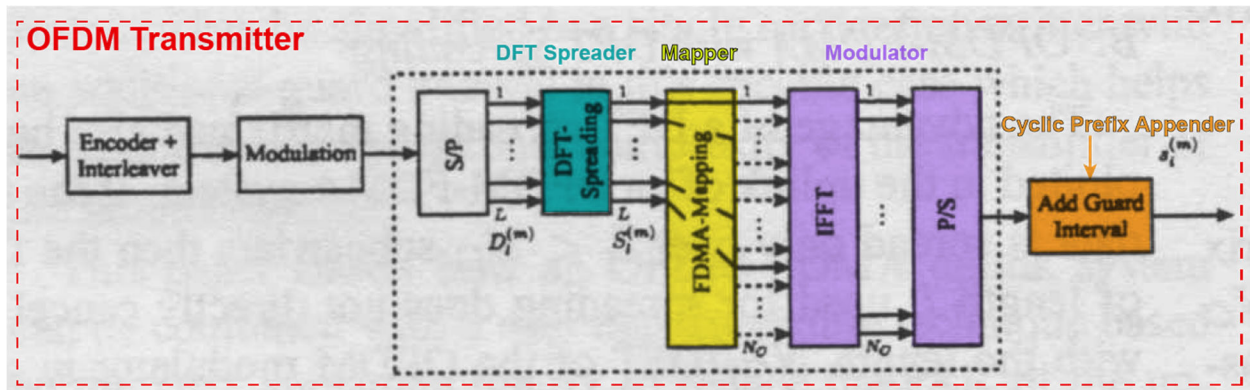
Each reference presented as grounds for the challenge is analogous prior to the '842 Patent. EX1002, ¶¶73-93.

A. Galda

Galda is a prior art printed publication because it was distributed and thus accessible to those skilled in the art between May 6th to 9th on CD ROM to as many as 400 attendees at IEEE's 55th Vehicular Technology Conference in Birmingham, Alabama. EX1059, ¶¶4-10. The “main focus” of the conference was “voice and data wireless mobile communications,” *Id.*, ¶6, and there were more than 100 presenters

skilled in the field at the conference. *Id.* CD ROMs were given to attendees when they checked in for the conference and included as part of the conference registration fee. *Id.*, ¶¶7-10, 11 (Exhibit D). The conference was open to the public and there were no confidentiality restrictions imposed on the conference proceedings, EX1059, ¶¶11-12, and it was expected that the proceedings would be shared widely as confirmed by the fact that the conference proceedings were cataloged into the Linda-Hall Library of Science, Engineering, and Technology less than two months later, then made available on the IEEE website by August 7, 2002. EX1012, ¶52; EX1002, ¶73. Galda is a prior art printed publication by at least May 6, 2002 and is prior art under pre-AIA §§ 102(a) or (b) (depending on the claim and effective filing date) or post-AIA § 102(a)(1). *E.g., GoPro, Inc. v. Contour Holding LLC*, 908 F.3d 690, 694-95 (Fed. Cir. 2018).

Galda teaches reducing PAPR (PAR) using “OFDM-FDMA multiple access ... combined with a data spreading technique based on a Discrete Fourier Transform spreading matrix using only the user specific subcarriers.” EX1004, p.1737. Galda’s transmitter is illustrated below.



Id., p.1740 (annotated).¹

Galda is analogous because it is in the same field because it describes applying complex-valued codes or “polyphase” codes that may be “derived from at least one invertible function, such as a Fourier transform” to OFDM signals to reduce PAPR. EX1001, 7:65-8:3, 72:42-43; EX1004, p.1737; EX1002, ¶¶73-75. Galda is also analogous art because one of the problems facing the inventor was reducing PAPR in OFDM communications, EX1001, 8:64-9:1 (OFDM modulator modulates DFT-spread symbols to produce OFDM signal “which can have low peak to average power ratio (PAPR)”); 70:9-11, 72:59-66, and Galda seeks to solve that problem by spreading symbols using complex-valued codes from a DFT—like the ’842 Patent, EX1004, p.1737. EX1002, ¶76.

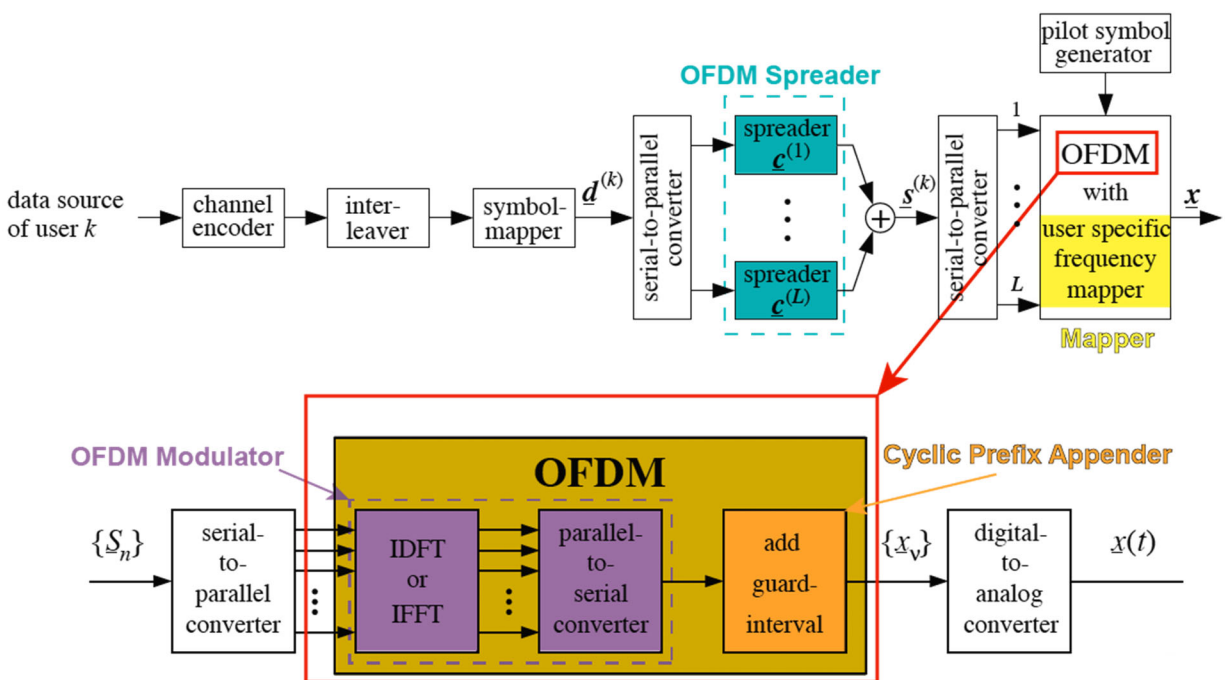
B. Kaiser

Kaiser is a thesis published by VDI-Verlag, Dusseldorf, Germany. EX1005.

¹ Coloring and/or colored text has been added to figures unless otherwise noted.

Kaiser bears January 1998 publication date. *Id.*, cover. Kaiser was cataloged by the Bavarian Library Network in its online catalog by April 15, 1998 and into the Bibliothèque Scientifique Nationale / National Research Council Library (Ottawa, Ontario, Canada) by July 6, 1998. EX1012, ¶48. Kaiser was cataloged by subject matter using terms that a POSITA would have reasonably used to locate Kaiser. EX1012, ¶49; EX1002, ¶78. Numerous articles predating May 2002 cite to Kaiser. EX1043, p.4 (reference [14]), EX1044, p.6 (reference [2]), EX1045, p.6 (reference [4]). Kaiser is thus prior art under pre-AIA §102(b) or post-AIA §102(a)(1).

Kaiser discloses an OFDM transmitter comprising an OFDM spreader, user-specific frequency mapper, an OFDM modulator, and a guard-interval appender:



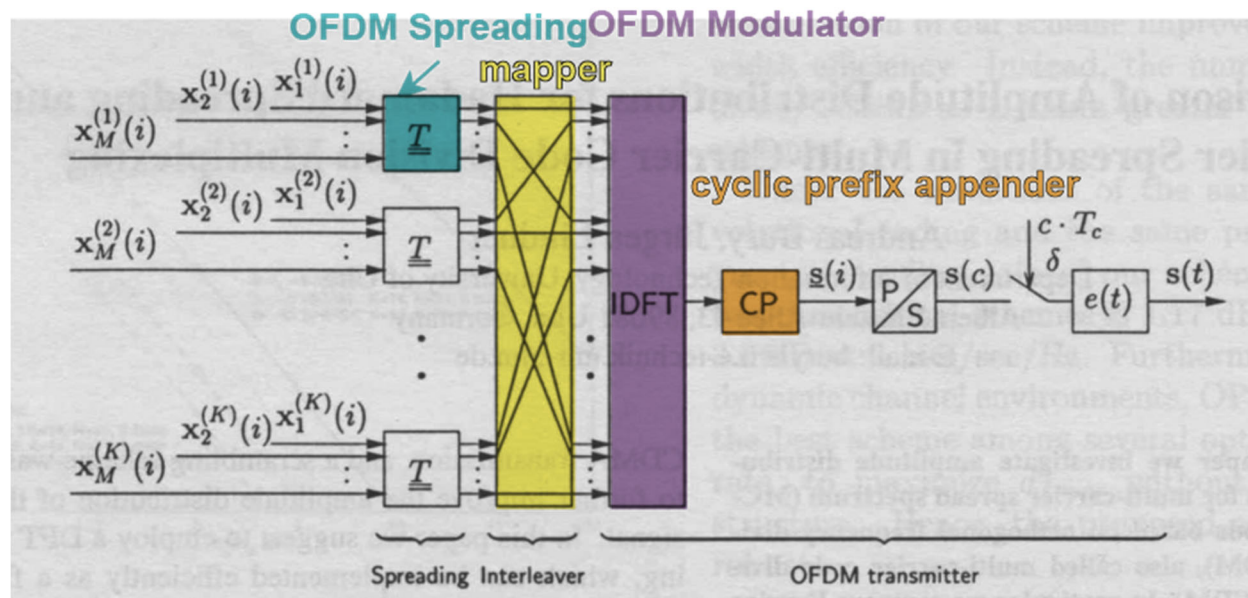
EX1005, pp.34, 132 (Figs. B.2 & 3.2).

Kaiser is analogous to the '842 Patent because they both relate to spread OFDM. EX1001, 1:27-29; EX1005, pp.130-37 (describing spread spectrum multiple access); EX1002, ¶¶79-80. Kaiser is also analogous because one of the problems facing the inventor was to achieve more efficient use of bandwidth in communication systems, EX1001, 2:58-3:3 (explaining how cellular networks are “experiencing declining data rates per user”). Kaiser is reasonably pertinent to this problem because it achieves “high bandwidth efficiency and great flexibility” using SS-MC-MA in the uplink. EX1005, p.137; EX1002, ¶81.

C. Bury

Bury is a conference paper. EX1007. Exhibit 1007 was obtained from the Linda Hall Library, which cataloged the proceedings into its collection on January 12, 2001. EX1012, ¶58, 60-61. Bury was cataloged by subject matter using terms that a POSITA would have reasonably used to locate it. EX1012, ¶¶37, 63-64; EX1002, ¶82. Bury is thus prior art under pre-AIA §102(b) or post-AIA §102(a)(1).

Bury discloses an OFDM transmitter including OFDM spreaders, a mapper, an IDFT/OFDM modulator, and a cyclic prefix appender:



EX1007, p.858 (Fig. 1(a)). Bury concludes that DFT-spreading codes/matrices should be used instead of Walsh-Hadamard codes to reduce PAPR. EX1007, pp.857, 860; EX1002, ¶¶83-84.

Bury is analogous because it relates to applying DFT spreading codes to OFDM signals to reduce PAPR. EX1001, 7:65-8:3, 72:42-43; EX1007, pp.857-860; EX1002, ¶85. Bury is also analogous because one problem facing the inventor was reducing PAPR in OFDM communications, EX1001, 8:64-9:1, 70:9-11, 72:59-66, and Bury solves that problem by spreading symbols using complex-valued codes from a DFT—like the '842 Patent, EX1007, pp.857, 860; EX1002, ¶85.

D. Toshiba

Toshiba published on September 25, 1996. EX1041, cover. Toshiba is thus prior art under pre-AIA § 102(b) or post-AIA § 102(a)(1).

Toshiba describes an OFDM transmission system in which high data rates are enabled using QAM modulation by transmitting a reduced number of reference symbols needed for QAM demodulation. EX1041, 1:38-2:13. Toshiba multiplexes four symbol types: QAM and QPSK information symbols, null symbols, and reference symbols before they are modulated, as shown below:

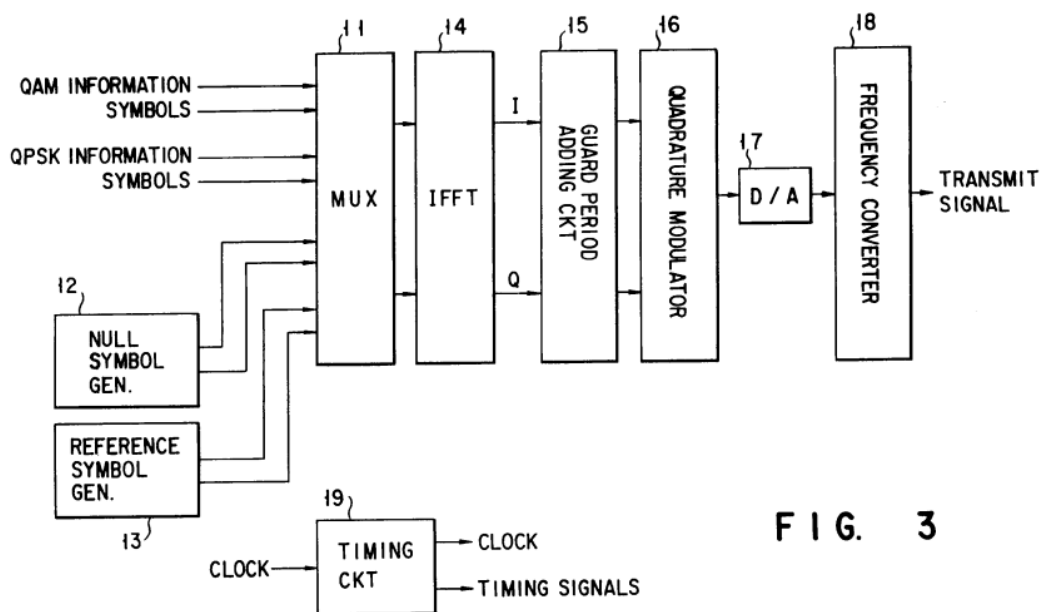


FIG. 3

EX1041, FIG. 3, 7:46-58, 8:25-38, 9:19-56. Null symbols are “used in the receiver as a reference symbol for timing synchronization.” *Id.*, 8:27-29. Reference symbols have known phase and amplitude and are used “as a synchronization reference symbol adapted to recognize the frame and as demodulation reference signals for demodulating the phase and amplitude of each carrier.” *Id.*, 8:29-36.

Toshiba is analogous art because it is in the same field of endeavor as the '842 Patent: OFDM wireless transmission systems. EX1001, 1:27-29; EX1041, 1:3-8

(invention relates to “radiocommunication system employing” OFDM); EX1002, ¶¶86-89. Toshiba is also reasonably pertinent to the problem to be solved because both the ’842 Patent and Toshiba address increasing data transmission efficiency. EX1001, 2:19-3:3 (describing issues with “spectral efficiency” and “declining data rates per user”); EX1041, 2:5-13 (explaining how invention increases “data transmission efficiency”); EX1002, ¶90.

E. Dowling

Dowling was filed on April 6, 1999 and issued July 22, 2003. EX1042, cover. Dowling is prior art under post-AIA §102(a)(1) or pre-AIA §102(e).

Dowling discloses multicarrier modulation and OFDM systems that may be implemented as software modules executing on programmable processors. Dowling’s transmitters, receivers, and precoders may be implemented in either hardware or software. EX1042, 3:46-50, 5:66-6:1.

Dowling is analogous to the ’842 Patent at least because it is in the same field of endeavor—namely wireless communications including OFDM communications. EX1001, 1:28-30 (“field” relates to “wireless communication networks ... more specifically” spread OFDM), EX1042, 1:6-12 (“field” relates to “data transmission,” more specifically to a “precoder” for multicarrier (e.g., OFDM) systems), 21:62-64 (invention “applied to other FFT based multicarrier modulation and OFDM systems.”); EX1002, ¶¶91-93.

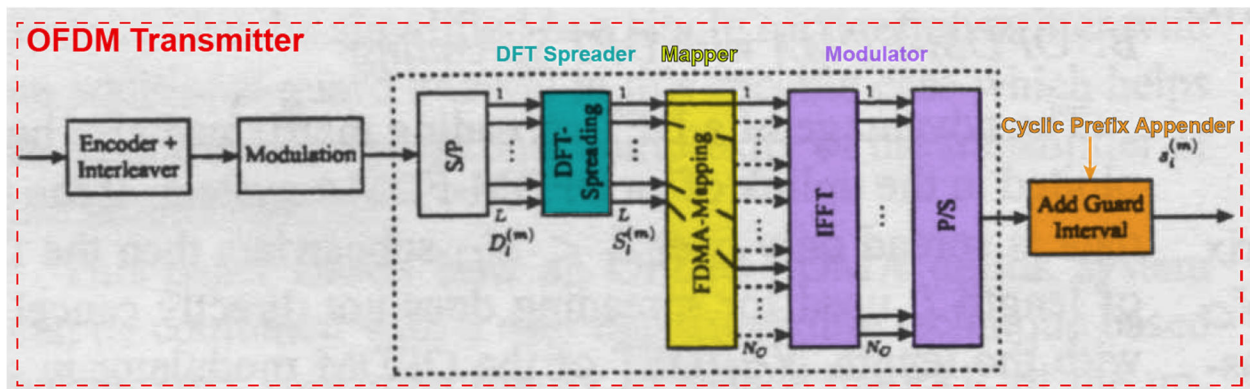
IX. DETAILED DISCUSSION

A. Grounds 1-2: Claims 1-3, 7-8, 11, and 17-18 are (Ground 1) anticipated by and (Ground 2) obvious over Galda.

1. Claim 1

a. [1Pre]: OFDM transmitter

Galda discloses “[a]n OFDM transmitter” [1Pre]:



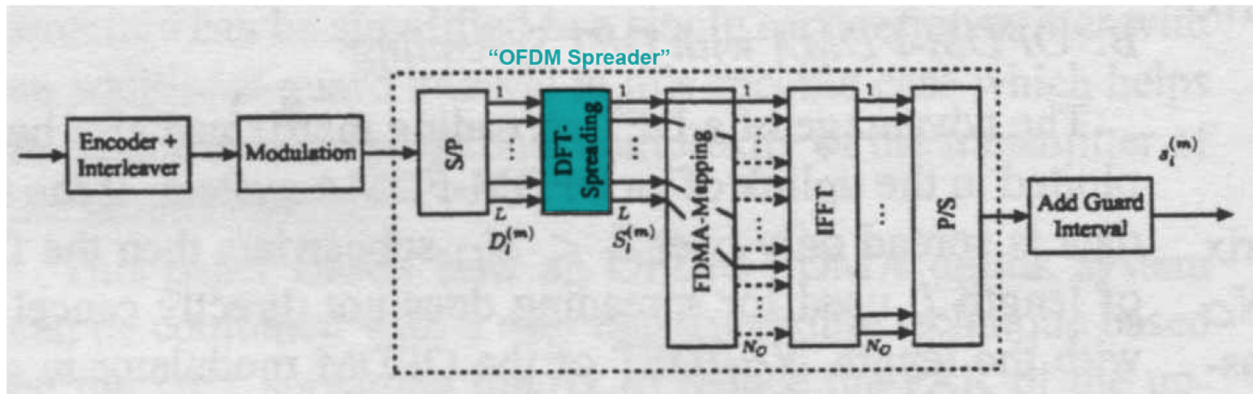
EX1004, Fig. 6(a) (“OFDM-FDMA transmitter”); *id.*, Abstract, pp.1737-38; EX1002, ¶¶94-95.

Petitioner relies on Galda’s disclosure in which channel spacings are not required to be equidistant for each user. EX1004, p.1738 (“[T]he set of subcarrier[s] assigned to each user can be composed of any L out of N_C subcarrier that have not been assigned to another user.” (emphasis added)); *see also id.*, p.1739 (“If the user data is spread over only $L < N_C$ subcarriers then the DFT of length L does not directly cancel out with the length N_C IDFT of the OFDM modulator....”). A POSITA would have understood that allowing flexible subcarrier allocation depending on channel conditions, deployment scenarios, and the payload to be transmitted on the uplink

would have improved system flexibility. EX1002, ¶¶96-98.

b. [1A] spreader

Galda also discloses and renders obvious *an OFDM spreader configured to spread a plurality of data symbols ($D_l^{(m)}$) with Fourier coefficients (DFT matrix coefficients) to generate a discrete Fourier Transform (DFT)-spread data signal (signal comprising symbols $S_l^{(m)}$)*. EX1002, ¶¶99-105. Galda discloses a DFT-spreading block:



EX1004, Fig. 6(a). Galda’s DFT-spreader is an OFDM spreader that spreads data symbols “ $D_l^{(m)}$,” with Fourier coefficients to generate a DFT-spread data signal comprising a plurality of spread data symbols “ $S_l^{(m)}$ ”:

The L modulation symbols $[D_l^{(m)}, l = 0, \dots, L - 1]$ are spread over the L user specifically allocated subcarrier with an unitary spreading matrix $[C]$ resulting in L complex transmit symbols $S_l^{(m)}$.

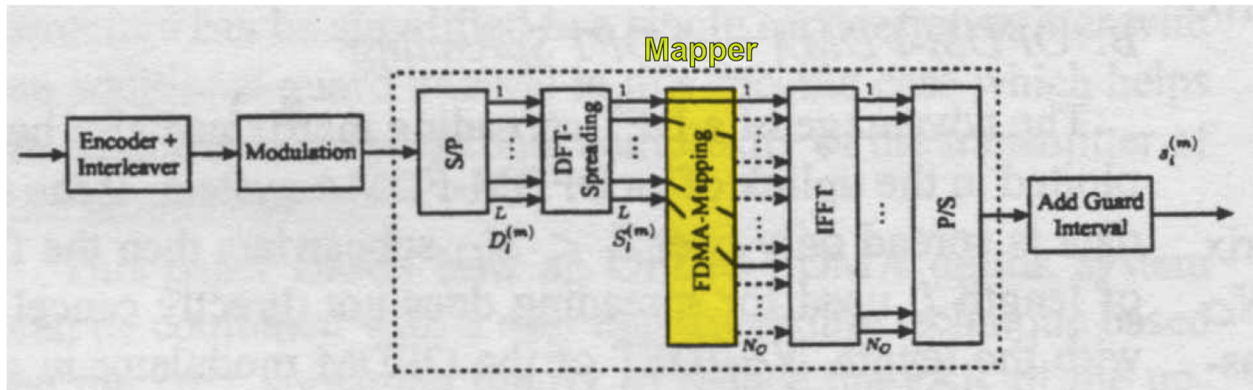
EX1004, p.1738. Galda’s “unitary spreading matrix $[C]$ ” includes *Fourier*

coefficients because Galda explains that “[t]he discrete Fourier matrix is” (1) unitary (thus invertible) and (2) reduces PAPR; and the individual elements of a DFT matrix are *Fourier coefficients*. EX1004, p.1739; EX1002, ¶¶101-04.

Thus, Galda discloses and renders obvious limitation [1A].

c. **[1B]: mapper**

Galda discloses and renders obvious *a mapper* (FDMA-Mapping block) configured to map the DFT-spread data signal (signal comprising symbols $S_l^{(m)}$) to a plurality of OFDM subcarriers (to L of N_C carriers). EX1002, ¶¶106-09. Figure 6(a) shows a mapper, i.e., FDMA-Mapping block:



EX1004, Fig. 6(a). The “FDMA-Mapping” block maps the DFT-spread data signal’s L transmit symbols $S_l^{(m)}$ onto a plurality L of the system’s available N_C subcarriers:

The transmit symbols $S_l^{(m)}$ are then mapped onto L of the available N_C subcarrier which are exclusively allocated to user m .

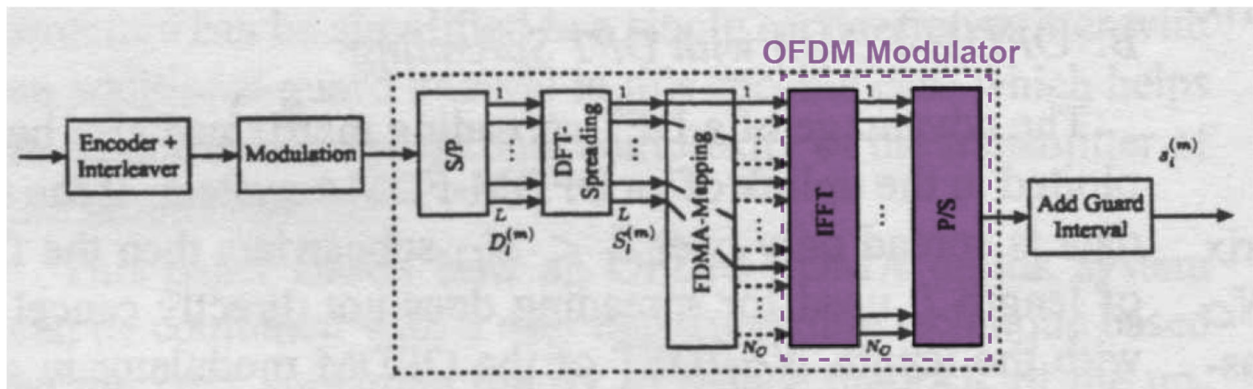
EX1004, p.1738.

Thus, Galda discloses and renders obvious limitation [1B].

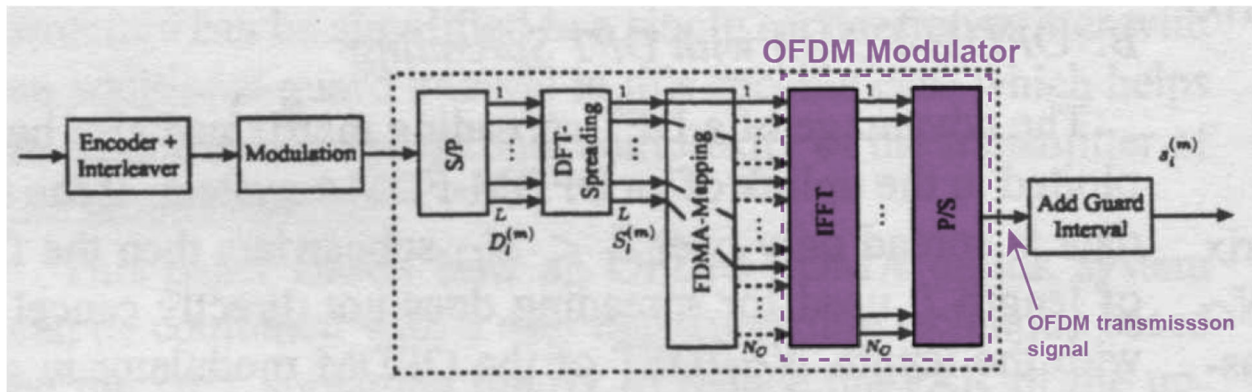
d. [1C]: OFDM modulator

Galda discloses and renders obvious an *OFDM modulator* (IFFT including P/S block) configured to modulate the DFT-spread data signal (signal comprising symbols $S_l^{(m)}$) onto the plurality of OFDM subcarriers (to L of N_C carriers) to produce an *OFDM transmission signal* comprising a superposition of the OFDM subcarriers (Galda's "OFDM transmit signal"). EX1002, ¶¶110-16.

Galda discloses an *OFDM modulator* ("IFFT" and "P/S" blocks):



EX1004, Fig. 6(a). This is consistent with claim 3, which says: "the OFDM modulator comprises an" IFFT. EX1001, 77:23-25. The '842 Patent further says "[t]he output of the IFFT is parallel-to-serial converted to produce a CI-OFDM signal having N frequency components." *Id.*, 69:43-45. Thus, Galda's teaching of the "IFFT" and "P/S" blocks generates the *OFDM transmission signal* just like the '842 Patent.



EX1004, Fig. 6(a).

To the extent the Board determines that Galda does not expressly disclose the claimed *superposition of the OFDM subcarriers*, it would have been obvious to a POSITA that Galda’s resulting *OFDM transmission signal* comprises a *superposition of the OFDM subcarriers* because, as Patent Owner admits that a POSITA “would understand that an OFDM signal is a superposition of subcarriers” and this is echoed in Galda. EX1038, p.10; *see also* EX1004, p.1737 (“[T]he OFDM transmit signal results from the superposition of a large number of independent symbols.”); EX1002, ¶¶114-16.

Thus, Galda discloses and renders obvious limitation [1C].

e. [1D]: reduced PAPR

Galda discloses and renders obvious *wherein the OFDM spreader is configured to provide the superposition with a reduced peak-to-average power ratio*. EX1002, ¶¶117-22.

Galda says: “using the Discrete Fourier Transform (DFT) matrix as an

orthogonal spreading technique will reduce the PAR significantly [sic].” EX1004, Abstract; *see also id.*, p.1739 (“[I]n case of a DFT spreading matrix the resulting PAR is significantly reduced.”).

Galda’s PAR refers to *peak-to-average power ratio* (PAPR). Galda defines PAR as:

$$PAR = 10 \log_{10} \left(\frac{\max(|s(t)|^2)}{\sigma_s^2} \right) [dB], \text{ where } \sigma_s^2 \text{ denotes the average transmit power.}$$

EX1004, p.1740. PAR is a peak-to-average power ratio because $\max(|s(t)|^2)$ represents the peak (“max”) transmit power of a signal and σ_s^2 is the average transmit power. EX1002, ¶¶118-19. Other references confirm that “PAR” refers to “peak-to-average power ratio.” *See* EX1040, p.28-1 (“We propose a novel method for reducing the ppeak-to-average power ratio (PAR) of the transmit signal....” (emphasis original)).

Thus, Galda anticipates and renders obvious limitation [1D] and claim 1.

2. Claim 11

Claim 11’s method steps correspond to the elements of apparatus claim 1. Thus, throughout the analysis below, reference is made back to the discussion of claim 1.

a. [11Pre] A method, comprising:

[11Pre] is a generic non-limiting preamble and Galda discloses and renders

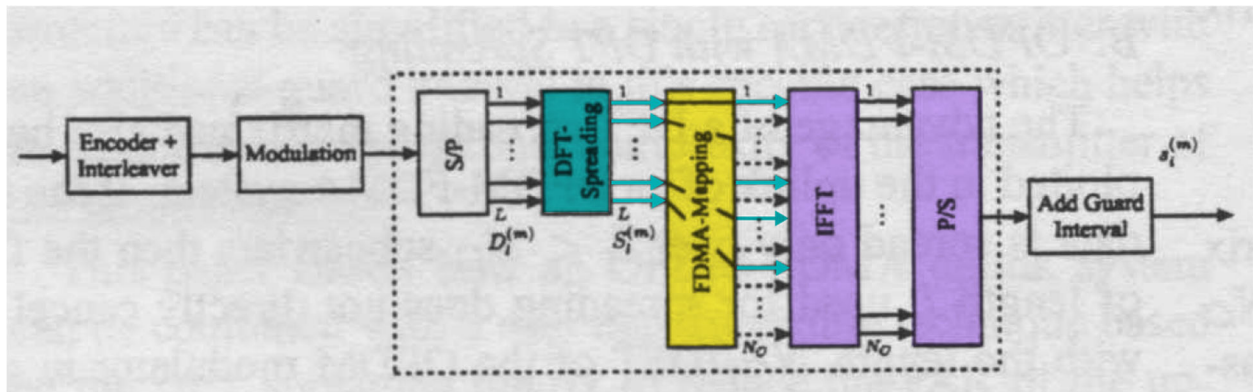
obvious the steps of claim 11 as explained below.

b. [11A] multiplying by a DFT spreading matrix

As explained in connection with Limitation [1A], Galda discloses and renders obvious *multiplying a plurality of data symbols* (symbols $D_l^{(m)}$ of vector $\vec{D}^{(m)}$) *by a discrete Fourier Transform (DFT) spreading matrix* (Galda's DFT spreading matrix [C]) *to produce a plurality of DFT-spread symbols* (symbols $S_l^{(m)}$ of vector $\vec{S}^{(m)}$). EX1002, ¶¶124-29; *supra* §IX.A.1.b. Galda describes the “spreading operation” as being “denoted mathematically by the following simple matrix multiplication $\vec{S}^{(m)} = [C]\vec{D}^{(m)}$,” thereby disclosing and rendering obvious *multiplying*. EX1004, p.1738.

c. [11B]: mapping

As explained in connection with Limitation [1B], Galda discloses and renders obvious *mapping the plurality of DFT-spread symbols* (symbols $S_l^{(m)}$ of vector $\vec{S}^{(m)}$) *to a plurality of OFDM subcarriers* (to L of N_C carriers) as shown below and described above. *Supra* §IX.A.1.c; EX1002, ¶¶130-33.



EX1004, p.1740.

d. [11C]: modulating

As explained in connection with Limitation [1C], Galda discloses and renders obvious *modulating* (Galda’s IFFT modulates) *the plurality of DFT-spread symbols* (symbols $S_l^{(m)}$ of vector $\vec{S}^{(m)}$) *onto a plurality of OFDM subcarriers* (L of N_C carriers) *to produce a DFT-spread OFDM signal* (Galda’s “OFDM transmit signal” spread with DFT matrix $[C]$) *to be transmitted into a wireless channel, wherein the DFT-spread OFDM signal comprises a superposition of the OFDM subcarriers* (Galda’s “OFDM transmit signal results from the superposition of a large number of independent symbols,” EX1004, p.1737. EX1002, ¶¶134-40; *Supra* §IX.A.1.d.

Galda’s DFT-spread OFDM transmission signal to be transmitted into a radio channel (i.e., a *wireless channel*) because Galda explains that OFDM “transmission technique” can “deal with ... multi-path propagation in the broadband radio channel.” EX1004, Abstract; *see also id.*, pp.1737 (describing OFDM in mobile

communications and broadband radio channels), 1738 (Fig. 1 showing radio transmission between “Mobile Terminal” and “Base Station”); EX1002, ¶¶137-39.

e. [11D]: reduced PAPR

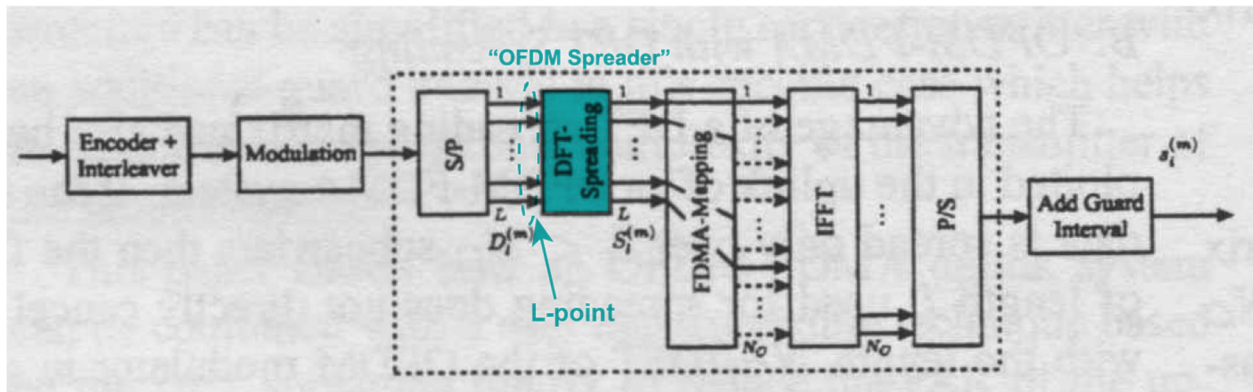
As explained in connection with Limitation [1D], Galda discloses and renders obvious *wherein the DFT spreading matrix* (“DFT spreading matrix” [C]) is *configured to provide the superposition with a reduced peak-to-average power ratio (PAPR)* as explained in connection with limitation [1D], above. EX1002, ¶¶141-44; *Supra* §IX.A.1.e.

Thus, Galda anticipates and renders obvious limitation [11D] and claim 11.

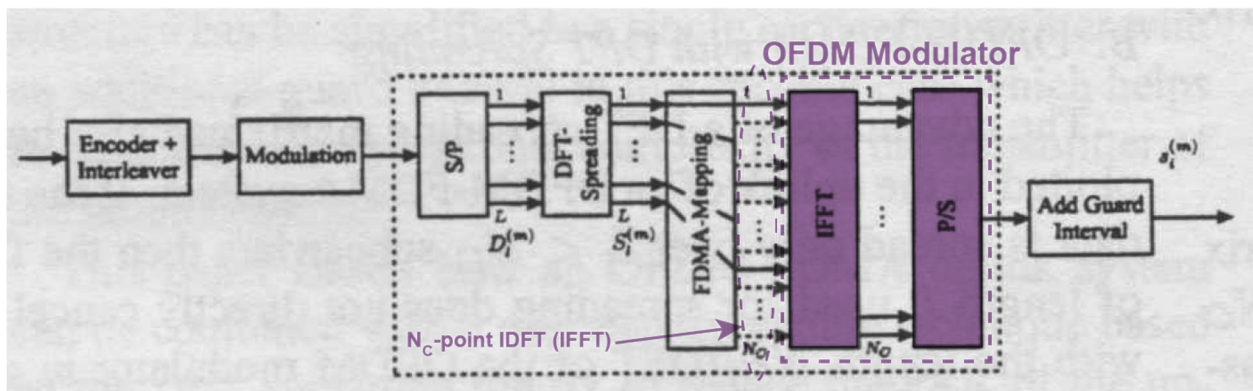
3. *Claims 2, 18*

[Claim 2] The OFDM transmitter recited in claim 1, wherein the OFDM spreader comprises an N-point DFT and the OFDM modulator comprises an M-point inverse discrete Fourier Transform, wherein $M > N$.	[Claim 18] The method recited in claim 11, wherein the DFT spreading matrix comprises an N-point DFT, and the modulating comprises employing an M-point inverse-DFT, and wherein $N < M$.
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Galda discloses and renders obvious claims 2 and 18. EX1002, ¶¶145-51. Specifically, the DFT-spreading element and corresponding spreading matrix (green) comprise an L -point DFT:



EX1004, Fig. 6(a); see §§IX.A.1.b, IX.A.2.b (limitations [1A], [11A]). Galda Fig. 6(a) shows using an N_C -point IFFT. See *supra* §§IX.A.1.d, IX.A.2.d (limitations [1C], [11C]). An IFFT is a type of inverse-Discrete Fourier Transform (IDFT). EX1001, FIG. 33 (item 3305), 72:48-52, 78:60-61 (“[T]he IDFT comprises an inverse fast Fourier transform.”). Galda’s N_C point DFT is shown below.



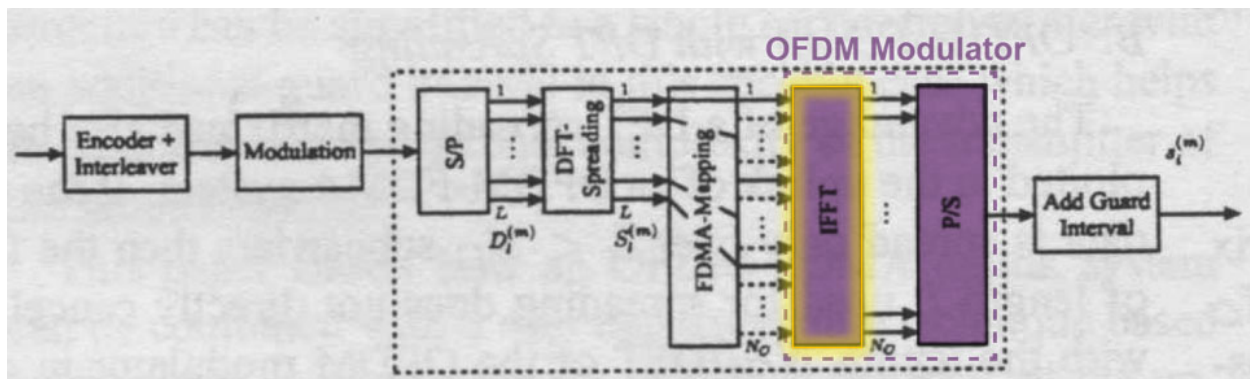
EX1004, Fig. 6(a). Galda’s L and N_C correspond to variables N and M because they describe the inputs into the DFT and IDFT, respectively. EX1002, ¶¶149-50. Because Galda’s DFT has fewer inputs than the IDFT (IFFT) (unused inputs shown as dashed lines in Fig. 6(a)), Galda discloses “ $M > N$ ” (Claim 2) and “ $N < M$ ” (Claim 18). EX1002, ¶150; EX1004, p.1739 (describing example where $L < N_C$ and user uses

some subset of system subcarriers).

Thus, Galda discloses and renders obvious claims 2 and 18.

4. Claim 3

Galda discloses and renders obvious “wherein the OFDM modulator comprises an inverse fast Fourier transform.” EX1002, ¶¶152-54. As discussed above (e.g., Limitations [1C], [11C]), Galda’s *OFDM modulator* includes an *IFFT* block. EX1004, p.1740 (Fig. 6(a) block labeled “IFFT” which stands for “inverse fast Fourier transform” (below)). See §§IX.A.1.d, IX.A.2.d; EX1002, ¶¶153; EX1004, p.1740 (Fig. 6(a)).



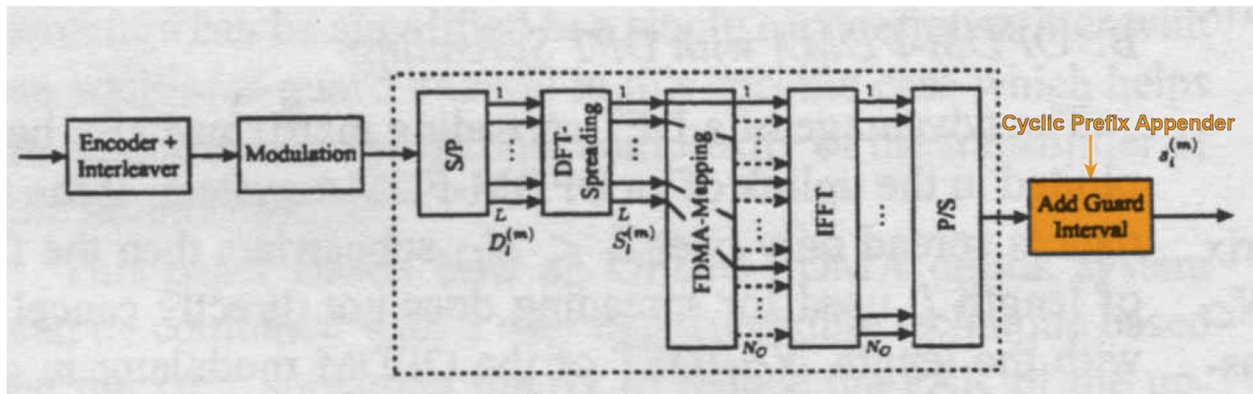
Thus, Galda discloses and renders obvious claim 3.

5. Claims 7, 17

[Claim 7] The OFDM transmitter recited in claim 1, further comprising a cyclic prefix appender configured to append at least one of a cyclic prefix, a postfix, and a guard interval to the OFDM transmission signal.	[Claim 17] The method recited in claim 11, further comprising appending at least one of a cyclic prefix, a postfix, and a guard interval onto the DFT-spread OFDM signal.
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Galda discloses and renders obvious claims 7 and 17. EX1002, ¶¶155-57.

Galda's Fig. 6(a) shows a *cyclic prefix appender* that append[s] "a guard interval as a *cyclic prefix*" onto the DFT-spread OFDM signal:



EX1004, Fig. 6(a), pp.1739-40; *see also id.*, p.1737 (interference can be avoided by “by introducing an additional guard interval into the OFDM symbol”); EX1002, ¶156.

Thus, Galda discloses and renders obvious claims 7 and 17.

6. Claim 8

Galda discloses and renders obvious *wherein the OFDM spreader is configured to provide channel precoding*. EX1002, ¶¶158-61. The '842 Patent says spreading with a CI matrix is an example of precoding: “CI-OFDM is distinctly different from prior-art OFDMA, for example, because of the DFT pre-coding (e.g., spreading) of the symbols in the transmitter....” EX1001, 72:55-58; *see also id.*, 65:1-5 (“CI spreading” can use “spreading matrix ... comprising DFT coefficients”), 65:59-61 (“CI spreading matrix can comprise channel precoding”), 70:32-34, FIG. 29A. Galda's DFT-spreader, which performs DFT spreading with DFT spreading

matrix $[C]$ coefficients before mapping and modulation, is configured to provide channel precoding consistent with the '842 Patent. EX1002, ¶160. Galda's channel precoding via DFT-spreading is discussed above regarding limitations [1A], [11A]. §§IX.A.1.b, IX.B.1.b.

Thus, Galda discloses and renders obvious claim 8.

B. Ground 3: Claims 4 and 9 are obvious over Galda in view of Toshiba

1. Overview of the combination; motivation to combine; expectation of success

Galda discloses and renders obvious each limitation of claim 1, from which claims 4 and 9 depend. *Supra* §IX.A.1. Galda does not describe “*data symbols*” that comprise “*reference-signal symbols*” (claim 4) or *data symbols are at least one of time-multiplexed with reference-signal symbols* (claim 9). These features were obvious over Galda in view of Toshiba.

A POSITA would have known that reference-signal symbols were commonly used in OFDM systems for performing functions like synchronization, timing, and demodulation. EX1002, ¶¶162-63. Toshiba's reference-signal symbols include “null symbol data” and “reference symbol data” in an OFDM system. EX1041, 8:13-42. The null symbols are “used in the receiver as a reference symbol for timing synchronization” and the “reference OFDM symbol[s]” “used in the receiver as a synchronization reference symbol adapted to recognize the frame and as

demodulation reference signals for demodulating the phase and amplitude of each carrier.” *Id.* Toshiba time-multiplexes reference-signal symbols with other information symbols as shown below.

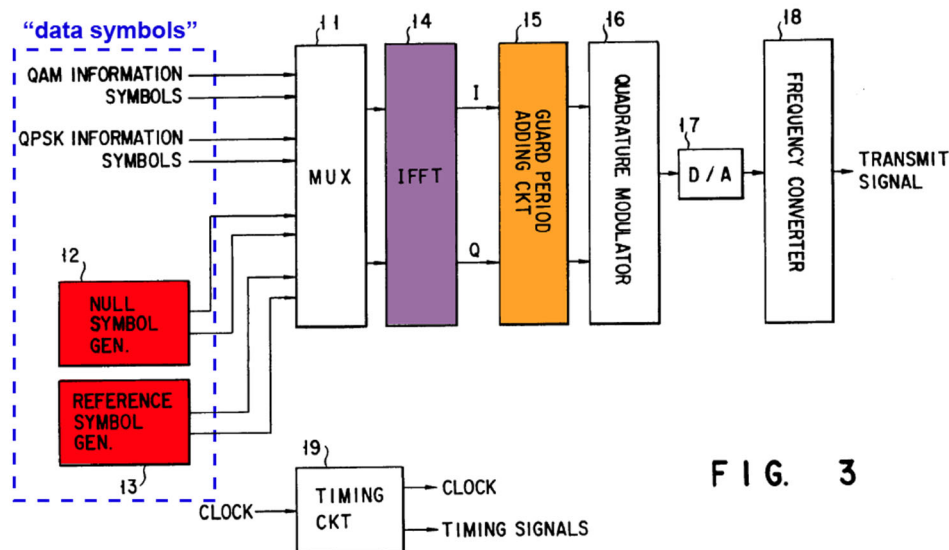
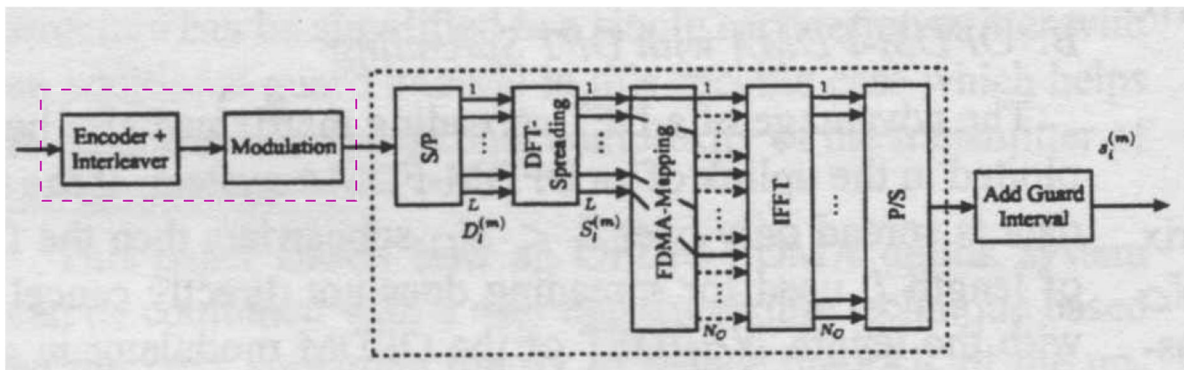


FIG. 3

EX1041, FIG. 3, 9:33-10:2; EX1002, ¶¶163-67.

Galda’s data symbols are encoded and modulated before spreading, but Galda does not describe the encoding or modulation.



EX1004, p.1740 (Fig. 6(a)). Thus, a POSITA would have sought out known modulation techniques for Galda’s data symbols. EX1002, ¶168.

A POSITA also would have appreciated that Galda's system needed to be time-synchronized. EX1004, p.1739 ("For a perfectly time and carrier synchronized system the received symbols are not influenced by ISI and ICI at all."); EX1002, ¶¶168-71. Galda does not describe how to achieve synchronization. *Id.* Thus, a POSITA would have sought out proper modulation schemes and time synchronization techniques for Galda's system. *Id.*

This would have led a POSITA to Toshiba, which teaches both techniques. EX1002, ¶¶169. First, Toshiba teaches using QAM modulation while minimizing the reference symbols needed, thus improving data efficiency. EX1041, 1:38-52 (explaining that digital television "needs a high transmission rate" and thus uses "multi-valued QAM" to modulate data for each carrier). Modifying Galda to perform QAM modulation would have allowed Galda to have high data rates. But, to employ QAM modulation, a POSITA would have known that demodulation of QAM modulated symbols requires amplitude and phase information. EX1041, 1:53-58. Toshiba provides reference symbols (i.e., *synchronization symbols*) for this purpose. EX1041, 8:25-38. Additionally, Toshiba describes time synchronization using reference-signal symbols called "null symbols" (i.e., *training symbols*). EX1041, 8:25-29.

Toshiba time-multiplexes reference-signal symbols with information symbols such that the reference signal symbols occupy the first two time slots in the OFDM

frame and the information signals come thereafter. EX1041, FIG. 2, 8:13-45; EX1002, ¶¶169-73. Placing reference signal symbols in the first timeslots across subcarriers allows for the receiver to obtain time synchronization and then frame synchronization to allow for the demodulation of the remainder of the modulated data in the frame. EX1002, ¶174; EX1041, 8:25-56.

Based on the combined teachings of Galda and Toshiba, a POSITA would have found it obvious to input data symbols that comprise *reference-signal symbols including at least one of known training symbols* (Toshiba's null symbols) *and synchronization symbols* (Toshiba's reference symbols) which are time-multiplexed into Galda's transmitter. EX1002, ¶175. A POSITA would have found it obvious to do so because (1) Galda explicitly contemplates using modulation and achieving time synchronization, EX1004, p.1739, but fails to explain how to do so, thus leading a POSITA to consider known methods. EX1002, ¶176.

A POSITA would have found it obvious to input time-multiplexed data symbols including reference-signal symbols (null and reference symbols as disclosed by Toshiba) into Galda's transmitter. EX1002, ¶177. Toshiba reflects a known use of null symbols multiplexed with other data symbols to achieve the timing synchronization needed by Galda. EX1004, p.1739; EX1002, ¶177. A POSITA would have applied Toshiba's known time-multiplexing of information and reference symbols to Galda's data signal input into the OFDM transmitter thus

combining prior art elements (various types of data symbols including reference-signal symbols) according to known methods (to time multiplex them before inputting them into Galda's transmitter) to achieve the predictable result of being able to use null symbols embedded in the OFDM signal to achieve QAM modulation and timing synchronization as taught by Toshiba. EX1002, ¶178. This not only would have reduced interference because of good time synchronization as taught by Galda, but it would have exhibited higher data rates using Toshiba's QAM modulation (which need Toshiba's reference symbols for synchronization and demodulation). EX1004, p.1739; EX1041, 8:25-38; EX1002, ¶179.

A POSITA also would have been motivated to apply Toshiba's known technique of multiplexing information and reference-signal symbols before OFDM modulation to Galda's known OFDM transmitter, which was ready for improvement in the form of increased data rates and timing synchronization techniques. EX1002, ¶180. The combination would have produced the predictable result of having reference signal symbols embedded in the OFDM signal received at a receiver, thereby allowing for timing synchronization and demodulation of QAM modulated information symbols. EX1002, ¶¶180-82.

At the very least, doing so was obvious to try because there are only two ways to implement reference-signal symbols in Galda (spread them or don't spread them). *Id.*, ¶180.

A POSITA also would have reasonably expected to succeed in implementing Toshiba's reference signal symbols in Galda's system because Toshiba teaches a conventional way to employ reference-signal symbols and use them to obtain time synchronization and allow for demodulation of QAM modulated data symbols, thereby improving data rates. EX1002, ¶¶182-83. A POSITA would have had no difficulty time-multiplexing various symbols together before inputting the symbols into Galda's transmitter because the symbol types vary only in the data that they contain and their resulting use by the system. *Id.* These symbols would all be operated on the same way mathematically as they are DFT spread, mapped to subcarriers, and processed by an IFFT to OFDM modulate the output signal. *Id.* These steps were understood by a POSITA and merely changing the data content and use of the symbols would have been viewed as a simple modification to Galda using either Toshiba. *Id.*

2. *Claim 4*

Galda in view of Toshiba renders obvious *wherein the data symbols comprise reference-signal symbols* (Toshiba's null and reference symbols), *which comprise at least one of known training symbols* (Toshiba's null symbols) *and synchronization symbols* (Toshiba's reference symbols). EX1002, ¶¶184-89.

Galda discloses data symbols, but does not describe the claimed *reference-signal symbols*. Toshiba describes the claimed symbols as shown below.

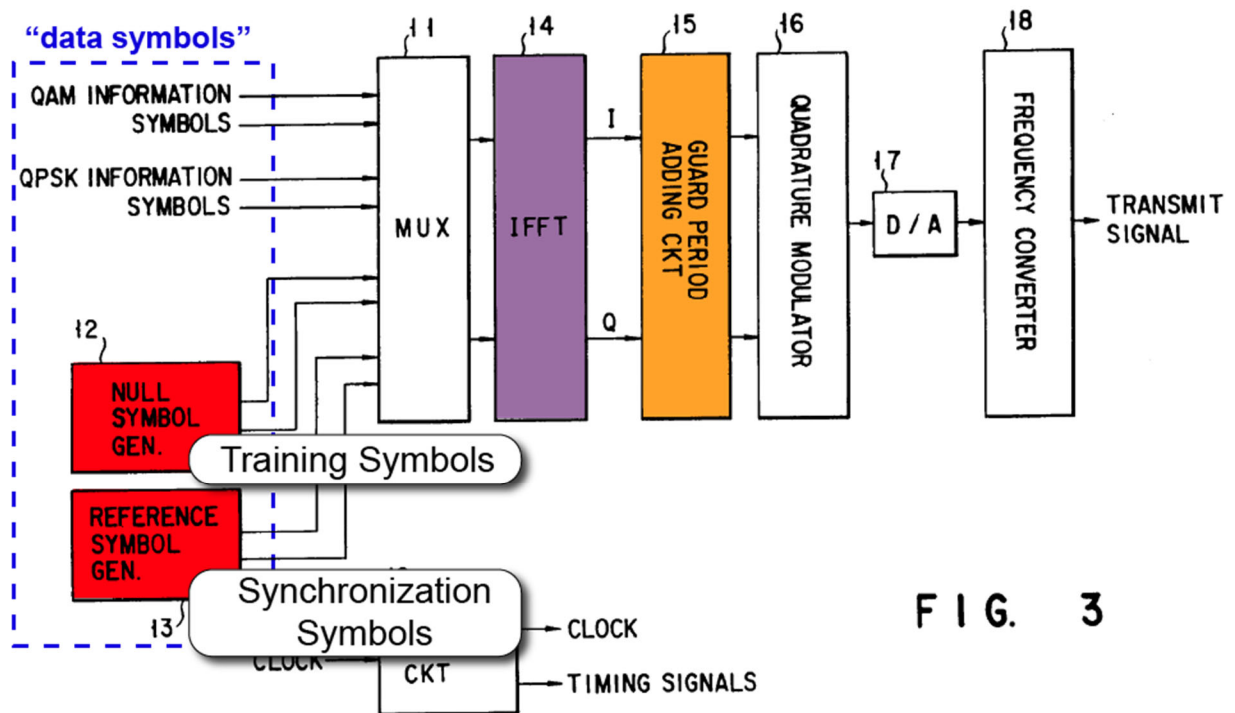


FIG. 3

EX1041, FIG. 3.

Toshiba's "null symbols" are *training symbols* consistent with the '842 Patent because the '842 Patent says training symbols "can be used for ... synchronization," EX1001, 41:22-25, and Toshiba's null symbols are used for synchronization, EX1041, 8:27-29 (null symbols is "used in the receiver as a reference symbol for timing synchronization"). Toshiba's reference symbols are *synchronization symbols* because they "are used in the receiver as a synchronization reference symbol adapted to recognize the frame and as demodulation reference signals for demodulating the phase and amplitude of each carrier." EX1041, 8:32-36. Therefore, Toshiba teaches the requirements of claim 4. It was obvious to combine Galda and Toshiba to arrive at claim 4 for the reasons explained above. *Supra* §IX.B.1.

3. *Claim 9*

Galda in view of Toshiba renders obvious *wherein the plurality of data symbols are at least one of time-multiplexed with reference-signal symbols, frequency-multiplexed with reference-signal symbols, and code-multiplexed with reference-signal symbols*. EX1002, ¶¶190-94. As explained above, Toshiba discloses time multiplexing data symbols (e.g., modulated “information symbols”) with reference-signal symbols (null symbols and “reference symbols”). *Supra* §IX.B.1. Toshiba FIG. 2 illustrates how the null symbols are first and reference symbols are second, followed by modulated information signals in subsequent time slots within each OFDM frame.

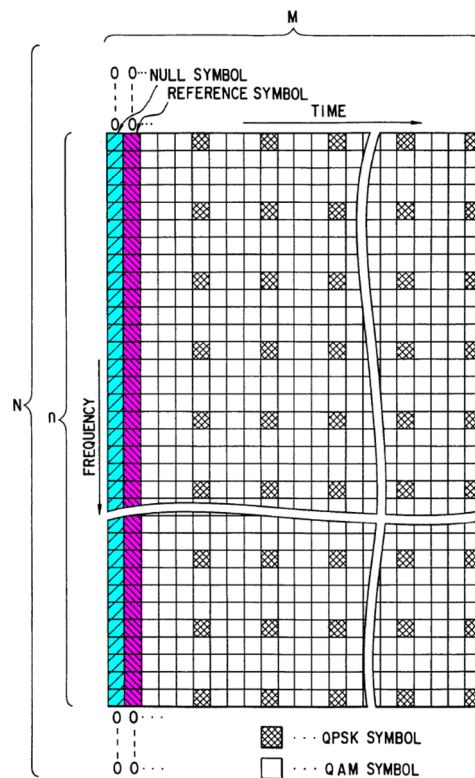


FIG. 2

EX1041, FIG. 2; EX1002, ¶¶192-93. Toshiba's multiplexer (11, FIG. 3) time-multiplexes the various data symbols (as shown by the time-axis of FIG. 2), thereby permitting timing synchronization using null symbols and frame synchronization and decoding of modulated data using the reference symbols. EX1041, FIG. 3 (item 11); EX1002, ¶¶193.

It was obvious to modify Galda such that data symbols are time multiplexed with reference signal symbols (e.g., Toshiba's null and reference symbols) based on Toshiba. Supra §IX.B.1.

C. Ground 4: Claims 22, 25-26, 28 are obvious over Galda in view of Dowling

1. Overview of the combination; motivation to combine; expectation of success

Claims 22, 25-26, and 28 require “a processor” [22A] and “a non-transitory memory coupled to the processor, the non-transitory memory including a set of instructions stored therein and executable by the processor” to perform subsequent steps [22B]. Otherwise, these claims correspond to claims 1-3, 7, 11, and 17-18.

Galda does not state whether the disclosed system is implemented in hardware or a combination of hardware and software. EX1002, ¶¶195-197. A POSITA would have found it obvious to implement Galda in software stored in memory coupled to a processor such that the software is executed by the processor. EX1002, ¶197.

A POSITA knew that transmitters may be implemented in hardware or software. Dowling explains that various aspects of an OFDM transmitter including its modulation techniques “may be implemented as software modules which execute on a programmable processor architecture.” EX1042, 3:46-50; *see id.* at 5:66-6:1 (disclosing that the transmitter, receiver, and precoder may be implemented in hardware or software”); 21:62-64 (disclosing that the “present invention” is applicable to FFT based multicarrier modulation and OFDM systems). In a software implementation, software is stored in some form of memory, and is provided to a processor for execution as was well known to a POSITA. EX1002, ¶¶198-99. A

POSITA knew of “software radios” that used code in memory and processors to execute that code to provide flexibility in design and updating, as opposed to hardware which was significantly more difficult to upgrade because it is fixed in silicon. EX1002, ¶¶199; EX1008 (describing OFDM-CDMA software radio); EX1011, ¶¶[0124]-[0125] (modulation “and other techniques” can be implemented in “hardware, software, or a combination thereof”). These references have similar disclosures to the ’842 Patent, which states that various aspects “may be implemented in hardware or special purpose circuits, software,” etc. EX1001, 76:37-43.

A POSITA would have been motivated to implement Galda’s spreading, mapping, modulation, and cyclic prefix appending functions (among others) in a software radio (including code in memory and a processor coupled to memory to execute the code) rather than in specialized hardware because doing so would have involved (a) the simple substitution of one known element (a software-based transmitter) for another (hardware implementation of same) to obtain predictable results (the same functionality performed in software rather than hardware), (b) the predictable use of prior art elements (software-based transmitter components) according to their established functions (i.e., performing the same functions taught by Galda), and (c) applying a known technique (software implementation) to a known device (Galda’s transmitter) ready for improvement—e.g., in need of

implementation details—to yield predictable results (a transmitter performing Galda’s operations in software). EX1002, ¶¶200-01.

A POSITA also would have expected to succeed in making this combination. Galda discloses an OFDM transmitter and defines the various mathematical operations for each of the components. *Supra* §§VIII.A, IX.A; EX1002, ¶202. Implementing these mathematical operations in software would have required only routine knowledge because software is especially well-suited for performing mathematical operations. EX1002, ¶202. Given the disclosures indicating that those in the field were aware that various transmitter functions were implemented in either hardware or software—two known alternatives—a POSITA would have reasonably expected success in achieving a software implementation using instructions stored on a memory for execution by a processor. EX1002, ¶202.

2. *Claim 22*

a. [22Pre]: An apparatus comprising:

Galda discloses and renders obvious “*an apparatus.*” EX1004, Abstract, pp.1737-38, Figs. 1, 4, 6; §§VIII.A, IX.A; EX1002, ¶¶203-05.

b. [22A] processor; [22B] memory

Galda in view of Dowling discloses and renders obvious *a processor [22A] and a non-transitory memory coupled to the processor, the non-transitory memory including a set of instructions stored therein and executable by the processor to*

[22B] perform claim 22's functions. EX1002, ¶¶206-09.

Dowling explains that OFDM modulation techniques “may be implemented as software modules which execute on a programmable processor architecture.” EX1042, 3:46-50; *see id.* at 5:66-6:1 (disclosing that the transmitter, receiver, and precoder may be implemented in hardware or software”); 21:62-64 (disclosing that the “present invention” is applicable to FFT based multicarrier modulation and OFDM systems). In a software implementation, software is stored in memory, and is provided from memory to a processor for execution. EX1002, ¶¶207-08. A POSITA knew about “software radios” with code in memory and processors to execute that code to provide flexibility in design and updating, as opposed to hardware which was significantly more difficult to upgrade because it is fixed in silicon. EX1002, ¶¶207-08; EX1008; EX1011, ¶¶[0124]-[0125] (modulation can be implemented in “hardware, software, or a combination thereof”). For the reasons explained above, a POSITA would have found it obvious to implement Galda in software stored on memory for execution by a processor coupled to the memory as recited in claim 22. *Supra* §IX.C.1.

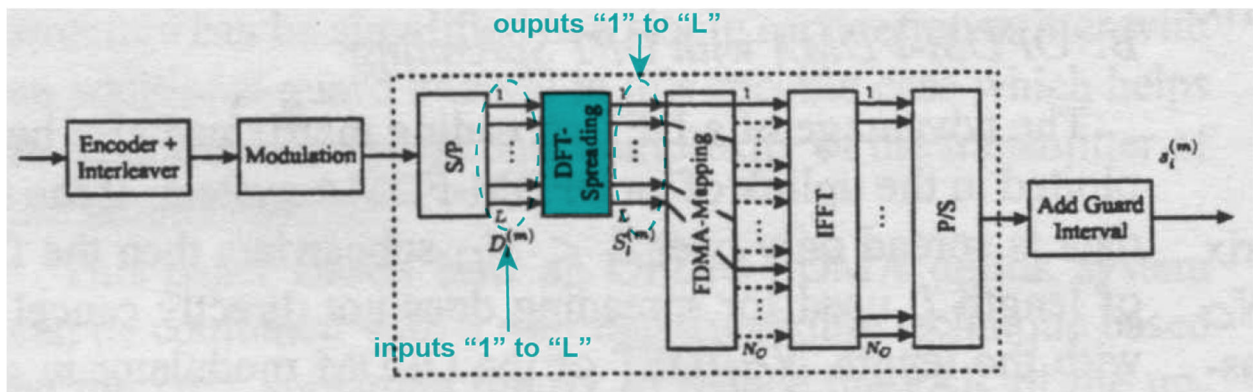
Thus, Galda in view of Dowling discloses and renders obvious limitations [22A]-[22B].

c. Limitations [22Bi]-[22Biv]

These limitations are substantively the same as limitations of claims that were

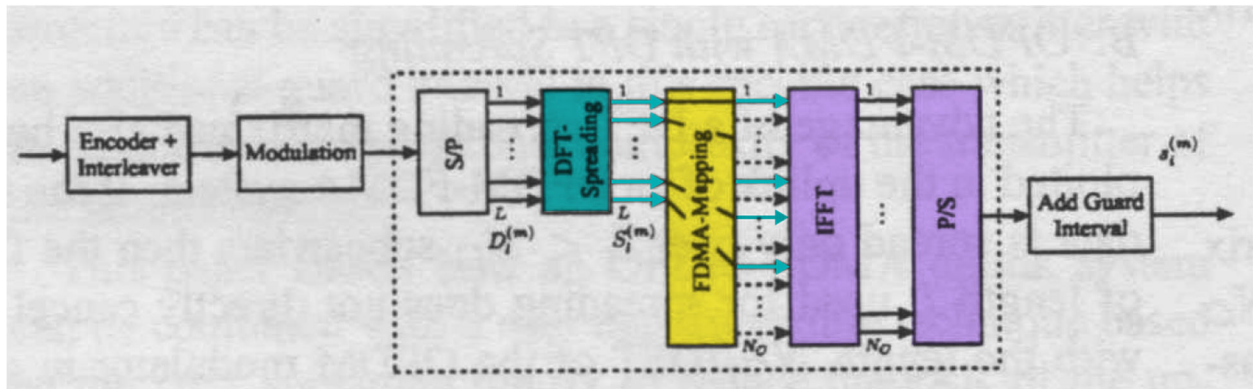
already addressed in connection with claims 1, 11, and their dependent claims. Differences are noted below.

Limitation [22Bi]: Galda discloses and renders obvious this claimed function because Galda discloses performing *N*-point DFT spreading on a set of data symbols ($D_l^{(m)}$) as explained for Limitations [1A], [11A], and claim 2. *Supra* §§IX.A.1.b, IX.A.2.b, IX.A.3. Galda's *N*-point DFT generates a plurality *N* of DFT-spread data symbols ($S_l^{(m)}$) because it has "L" inputs and "L" outputs. EX1004, p.1740 (Fig. 6(a) (below); EX1002, ¶¶210-11.



Limitation [22Bii]: Galda discloses and renders obvious the claimed function because Galda *map[s]* the *N* DFT-spread data symbols ($S_l^{(m)}$) to at least *N* subcarriers (*i.e.*, a subset of subcarriers 1 to N_C as shown by the solid and dashed lines in Galda's Fig. 6(a) below), of a plurality *M* of OFDM subcarriers (Galda's

system supports N_C subcarriers).² EX1004, p.1740; EX1002, ¶¶212-15. This is discussed further above. *Supra* §§IX.A.1.c, IX.A.2.c, IX.A.3 (Limitations [1B], [11B], claim 2).



Galda’s mapping generates *complex subcarrier amplitudes* because DFT-spread—i.e., “complex transmit symbols” ($S_l^{(m)}$)—are applied to N subcarriers such that N (L in Galda’s nomenclature) subcarriers have a complex non-zero amplitude. EX1002, ¶¶213-14.

Limitation [22Biii]: Galda discloses performing an M -point IDFT on the set of complex subcarrier amplitudes (as discussed with respect to Limitation [22Bii] and claim 2, *supra* §IX.A.3), to generate a time-domain sequence to be transmitted onto a wireless channel because an IFFT—a type of IDFT—converts complex

² In the annotated figure, one of the blue lines has been added to extend the line from mapper that is in the ellipses between the subcarriers partially shown in Galda Fig. 6(a). EX1002, ¶213.

subcarrier amplitudes from the frequency domain to the time domain. EX1002, ¶¶216-18, 48 (citing EX1015, 42, 4-48). In Galda the *time-domain sequence* comprises *a superposition of the OFDM subcarriers* as explained above. *Supra* §IX.A.d (Limitation [1C]).

Limitation [22Biv]: Galda discloses and renders obvious that the *N-point DFT spreading is configured to provide the superposition with a reduced peak-to-average power ratio* for the reasons explained in connection with Limitation [1D]. *Supra* §IX.A.e; EX1004, pp.1737, 1739-41; EX1002, ¶¶219-20.

Thus, Galda in view of Dowling renders obvious claim 22 for the reasons explained above.

3. *Claims 25-26 and 28*

a. Claim 25

Galda discloses that $M > N$ because $N_C > L$ as explained above. *Supra* §IX.A.3 (claim 2). EX1002, ¶¶221-22.

b. Claim 26

Galda's IDFT is *an inverse fast Fourier transform (IFFT)* as explained above. *Supra* §IX.A.4 (claim 3). EX1002, ¶¶223-24.

c. Claim 28

Galda discloses the function of appending *a cyclic prefix* and *a guard interval* to the time-domain sequence as explained above. *Supra* §IX.A.5 (claim 7). EX1002,

¶¶225-26.

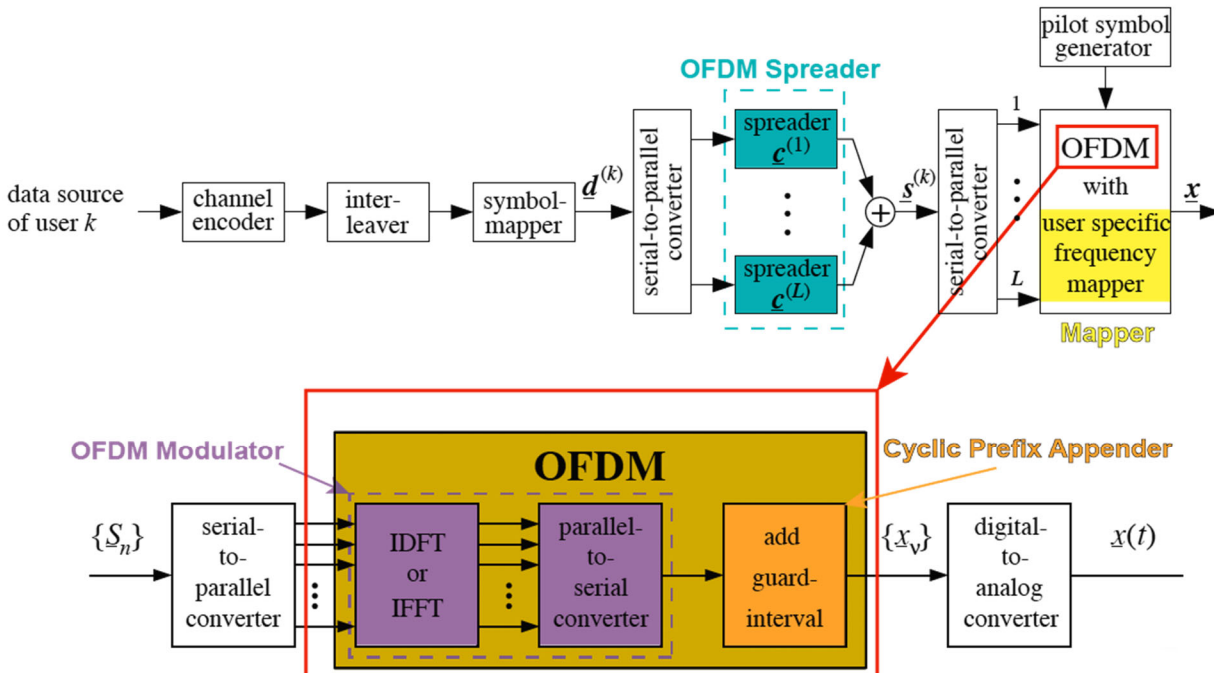
d. Obviousness of claims 25-26 and 28

It was obvious to implement the functionality recited in claims 25-26 and 28 in software stored in memory and executable by a processor coupled to the memory based on the combined teachings of Galda and Dowling for the same reasons explained for claim 22. *Supra* §IX.C.1.

D. Ground 5: Claims 1-3, 7-8, 11, 17-18 are obvious over Kaiser in view of Bury

1. Overview of the combination; motivation to combine; expectation of success

Kaiser discloses most limitations of the Challenged Claims. Kaiser shows: *OFDM transmitter* (“SS-MC-MA transmitter”), *OFDM spreader*, *mapper* (“user specific frequency mapper”), and *OFDM modulator* (IDFT or IFFT) to generate an OFDM transmission signal, and a *cyclic prefix appender*:

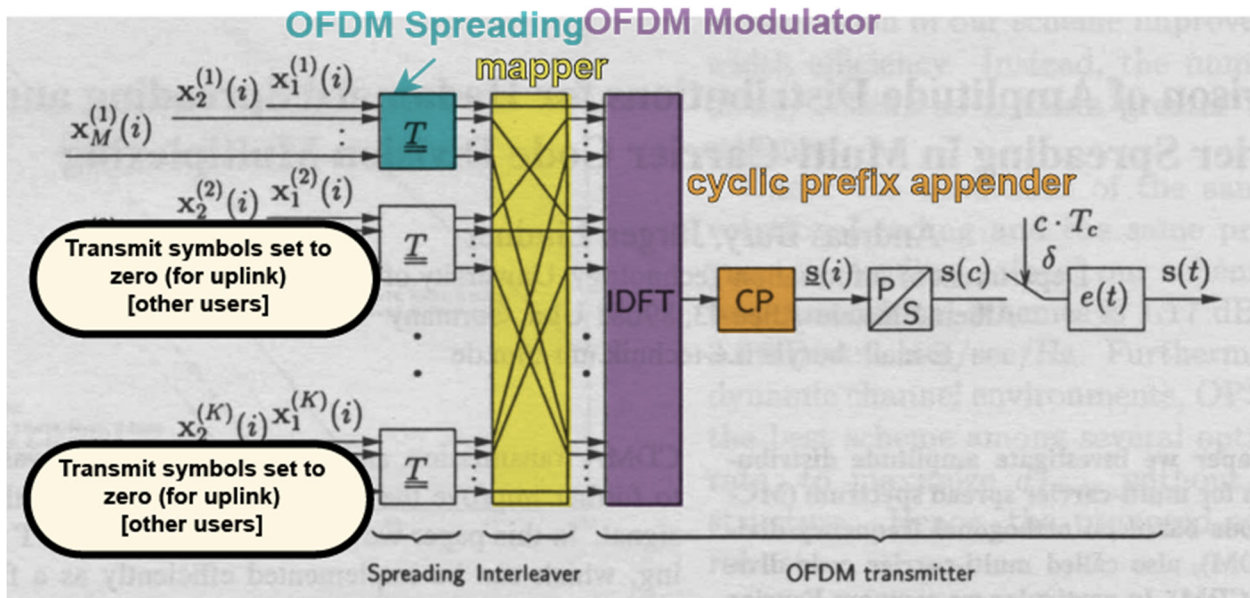


EX1005, pp.34, 132 (Figures B.2 & 3.2 (combined)); EX1002, ¶227. “OFDM with guard interval is applied in SS-MC-MA systems”—see Kaiser Figure B.2—“in the same way as in MC-CDMA systems, cf. Section 3.1.1.” EX1005, 133. Thus, a POSITA would have understood that Figure B.2’s “OFDM” has the functional blocks shown in §3.1.1, Figure 3.2. EX1002, ¶228.

Kaiser’s OFDM transmitter spreads data symbols with Walsh-Hadamard spreading and not the claimed DFT spreading. EX1005, p.135 (“[A] block of ... data symbols is ... spread with orthogonal Walsh Hadamard codes”); *id.*, p.134 (Table B.1, “spreading code”).

Bury describes a multi-carrier code division multiplexing (MC-CDM) transmitter that is “valid for both[] MC-CDMA and MC-FDMA” (called “MC-SS-

MA” by Kaiser). EX1007, pp.857, 858. Bury illustrates an uplink and downlink transmitter; one user “K” has non-zero symbol values and all other transmit symbols are set to zero “thereby omitting the corresponding signal paths” for the uplink as shown below.



EX1007, p.858 (Fig. 1(a)); EX1002, ¶¶229-31. Bury’s and Kaiser’s transmitters both have spreaders, mappers, OFDM modulators, and cyclic prefix appenders. EX1002, ¶232.

“Walsh-Hadamard spreading” is “commonly used” in MC-CDM systems. EX1007, p.857. This is true of Kaiser. Bury evaluated whether there were better spreading codes. Bury concluded that using “Fourier spreading” using a “discrete Fourier transform (DFT) operation” materially improved PAPR performance over Walsh-Hadamard codes. For instance, using Kaiser’s MC-SS-MA (i.e., Bury’s MC-

FDMA) technique, “the PAPR remains nearly constant at a low level for all spreading factors.” *Id.*, p.860. Thus, “in the uplink Fourier spreading outperforms Hadamard spreading in most cases.” *Id.* “For both up- and down-link Fourier spreading delivers a lower or equal PAPR. This superiority increases significantly for larger spreading factors. In the uplink, MC-FDMA (Kaiser’s MC-SS-MA) delivers lower PAPRs than MC-CDMA.” *Id.* Bury thus concludes Fourier spreading is “the best choice” combined with MC-FDMA in the uplink. *Id.*

Based on these teachings, a POSITA would have been motivated to use Bury’s DFT-spreading (Fourier spreading “implemented by” a DFT, EX1007, p.857) instead of Kaiser’s Walsh-Hadamard codes in Kaiser’s spreader for uplink OFDM transmissions. EX1002, ¶¶233-34. Not only are Kaiser and Bury discussing the same types of OFDM transmission systems (MC-FDMA (Bury) or MC-SS-MA (Kaiser), EX1007, p.857), but Bury concluded that DFT-spreading was “the best choice” for uplink communications. EX1002, ¶234. Bury thus provides an explicit motivation to use DFT spreading codes (DFT matrix) for spreading instead of Kaiser’s Walsh-Hadamard codes.

Combining Kaiser and Bury would have merely applied Bury’s known Fourier spreading techniques to improve Kaiser’s MC-SS-MA uplink transmitter with Bury’s Fourier spreading codes instead of Kaiser’s Walsh-Hadamard codes thereby improving Kaiser’s MC-SS-MA transmitter in the same way that it

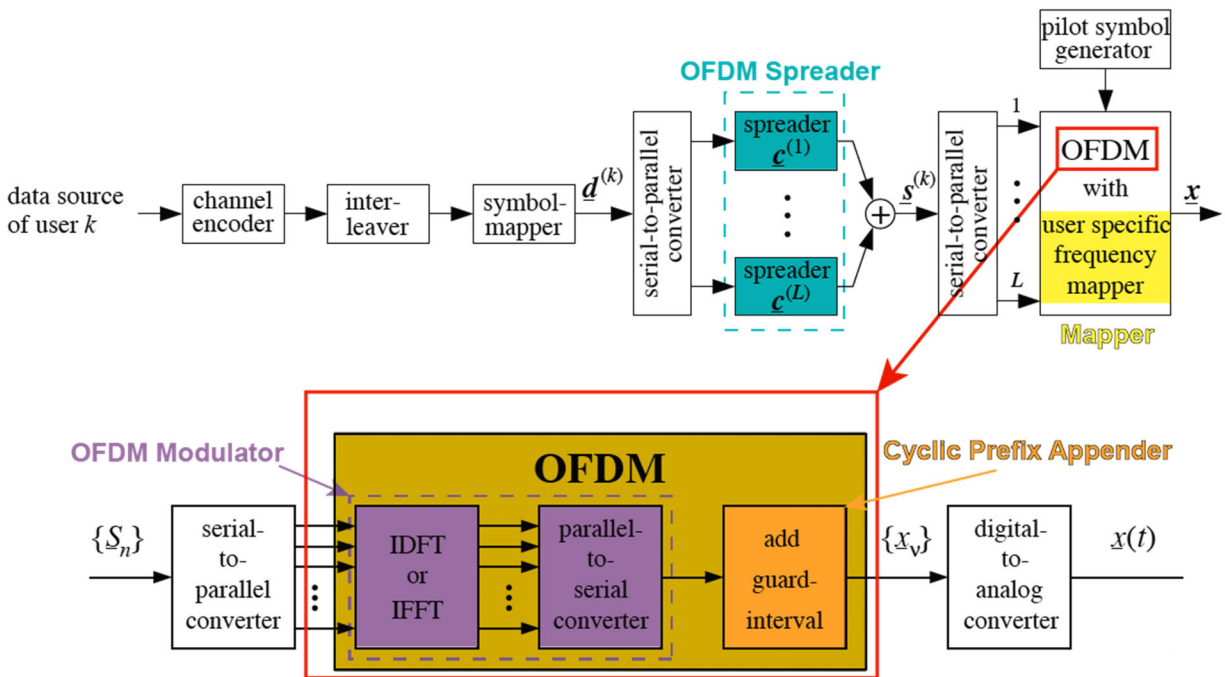
improved Bury's MC-FDMA transmitter.

A POSITA would have reasonably expected to succeed in using Bury's spreading codes in Kaiser's system because Bury describes using such spreading codes in the context of a system like Kaiser's and a POSITA would have understood that implementing DFT spreading codes would have merely required the undergraduate-level mathematical techniques (i.e., a DFT) to spread data symbols. EX1002, ¶¶235-38.

2. Claim 1

a. [1Pre]: OFDM transmitter

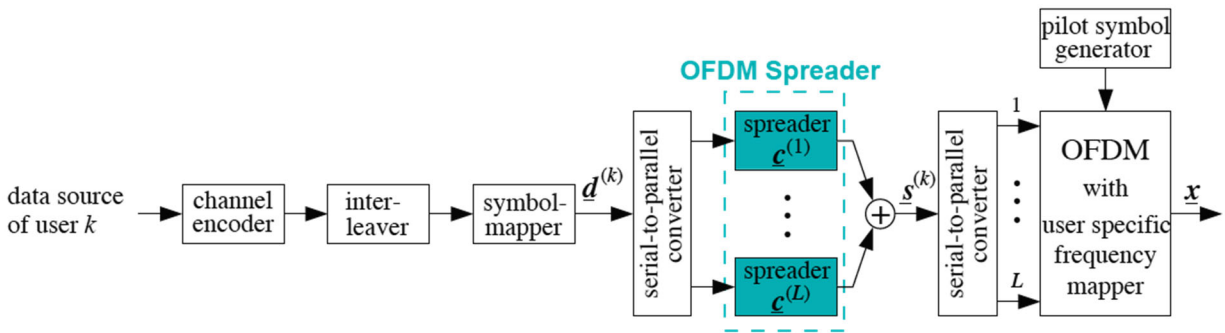
To the extent that the preamble is a limitation, Kaiser discloses “an OFDM transmitter” as shown below:



EX1005, Figs. B.2 & 3.2 (combined). Kaiser's Fig. B.2 shows an "SS-MC-MA transmitter of the k th user for the uplink." *Id.*, p.132. Kaiser thus discloses the preamble. EX1002, ¶¶239-41.

b. [1A]: Spreader

Kaiser discloses an *OFDM spreader configured to spread a plurality of data symbols* ($\underline{d}^{(k)}$):



EX1005, p.132. Kaiser's *OFDM spreader* is configured to spread data symbols ($\underline{d}^{(k)}$) using a spreading matrix to generate a spread signal ($\underline{s}^{(k)}$):

L subsequent complex-valued data symbols $\underline{d}_l^{(k)}, l = 1 \dots L$, of user k are serial-to-parallel converted. The vector

$$\underline{d}^{(k)} = \left(\underline{d}_1^{(k)}, \underline{d}_2^{(k)}, \dots, \underline{d}_L^{(k)} \right)^T \quad (B.1)$$

represents one block of L parallel converted data symbols of the k th user. Each of the L data symbols is multiplied with another orthogonal spreading code of length L . The $L \times L$ matrix

$$\underline{C} = (\underline{c}_1 \ \underline{c}_2 \ \dots \ \underline{c}_L) = \begin{pmatrix} \underline{C}_{1,1} & \underline{C}_{2,1} & \dots & \underline{C}_{L,1} \\ \underline{C}_{1,2} & \underline{C}_{2,2} & \dots & \underline{C}_{L,2} \\ \vdots & \vdots & \dots & \vdots \\ \underline{C}_{1,L} & \underline{C}_{2,L} & \dots & \underline{C}_{L,L} \end{pmatrix} \quad (B.2)$$

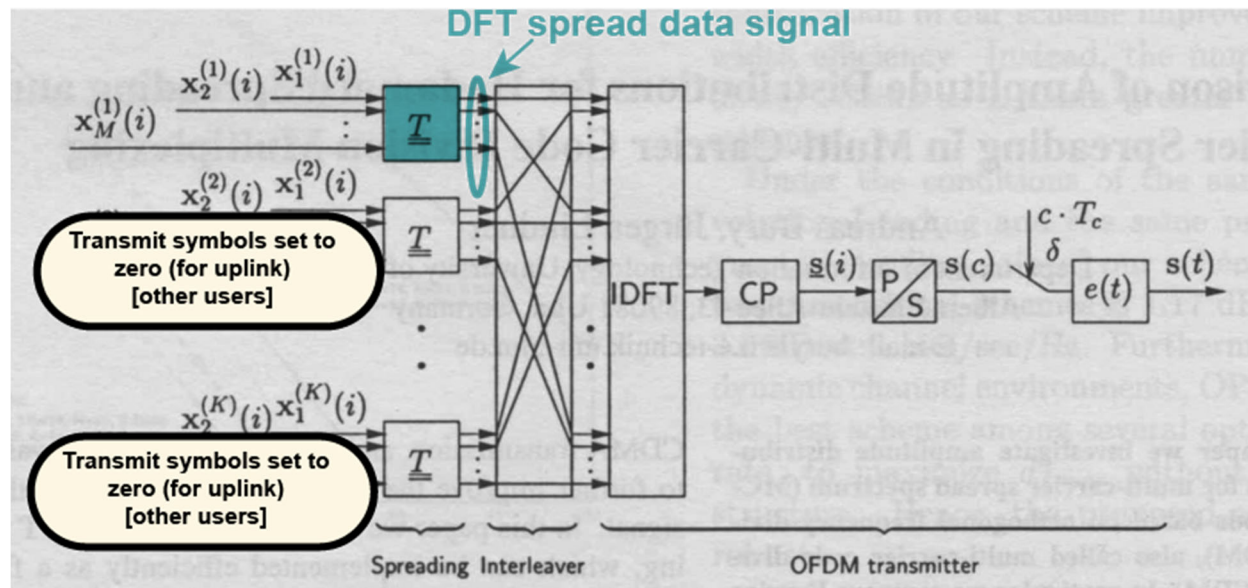
represents the L different spreading codes $\underline{c}_l, l = 1, \dots, L$, used by user k . The matrix $\underline{C}$ is the same for all users. The modulated spreading codes are data symbol and, thus, chip synchronously added, resulting in the transmission vector

$$\underline{s}^{(k)} = \underline{C} \underline{d}^{(k)} = \left(\underline{s}_1^{(k)}, \underline{s}_2^{(k)}, \dots, \underline{s}_L^{(k)} \right)^T \quad (B.3)$$

consisting of L components.

EX1005, pp.131-32; *see also id.*, pp.130-31, 133-35, Fig. B.2. Kaiser's spreading matrix includes Walsh-Hadamard codes. *Id.*, p.134. Kaiser does not describe spreading the data symbols *with Fourier coefficients to generate a discrete Fourier Transform (DFT)-spread data signal*.

Bury teaches spreading data symbols *with Fourier coefficients to generate a discrete Fourier Transform (DFT)-spread data signal*. EX1007, pp.857 (describing "Fourier spreading [3], which can be implemented by a discrete Fourier transform (DFT) operation"), 858 (explaining matrix $\underline{T}$ can be "a DFT"). This *generate[s] a DFT-spread data signal* at the output of the spreader as shown below:



EX1007, p.858; EX1002, ¶¶242-47. Bury explains: “[s]preading is done by transforming a vector of M symbols through a matrix $\underline{T}$,” where the matrix is orthogonal. EX1007, pp.857-58.

It was obvious to use Bury’s *Fourier coefficients* instead of Kaiser’s Walsh-Hadamard codes *to generate a discrete Fourier Transform (DFT)-spread data signal* because, among other reasons, Bury says this was “the best choice” for Kaiser’s uplink transmitter. *Supra* §IX.D.1; EX1007, p.860; EX1002, ¶249.³

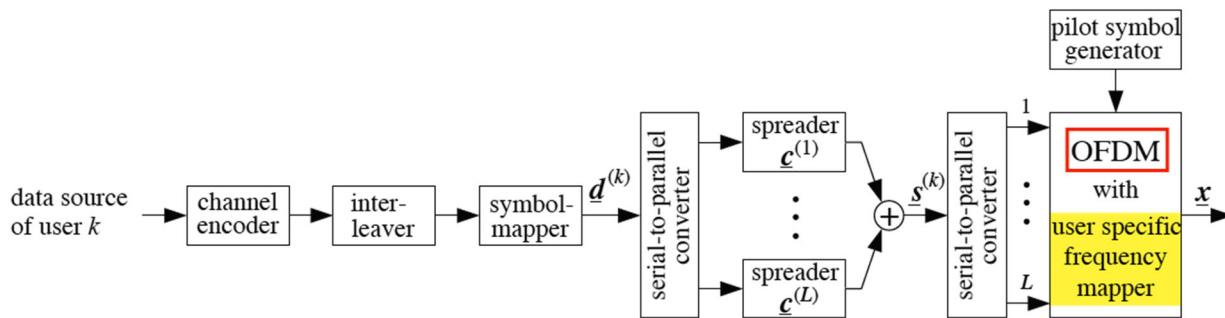
³ In the remainder of the discussion of the Kaiser-based Grounds, Petitioner refers to refers to DFT-spread symbols/signals in view of the Kaiser-Bury combination (i.e., replacing Kaiser’s Walsh-Hadamard coefficients with Bury’s DFT coefficients).

Thus, Kaiser in view of Bury renders limitation [1A] obvious.

c. [1B]: mapper

Kaiser in view of Bury renders obvious “a mapper configured to map the DFT-spread data signal to a plurality of OFDM subcarriers.” EX1002, ¶¶251-55.

Kaiser discloses a *mapper* as shown below:



EX1005, p.132 (Fig. B.2 & Figure 3.2). Kaiser further explains that the user-specific frequency mapping element $map[s]$ the DFT-spread data signal ($s^{(k)}$) to a plurality of OFDM subcarriers (L subcarriers). EX1005, p.132 (“mapping assigns each subsystem, and hence, each user exclusively to its L_i subcarriers”).

In one example, Kaiser’s mapper maps spread data symbols to $L=8$ subcarriers (of $N_C=256$ available subcarriers). *Id.*, pp.134-135. Figure B.4 shows “3 of the 8 subcarriers used by the k th user”:

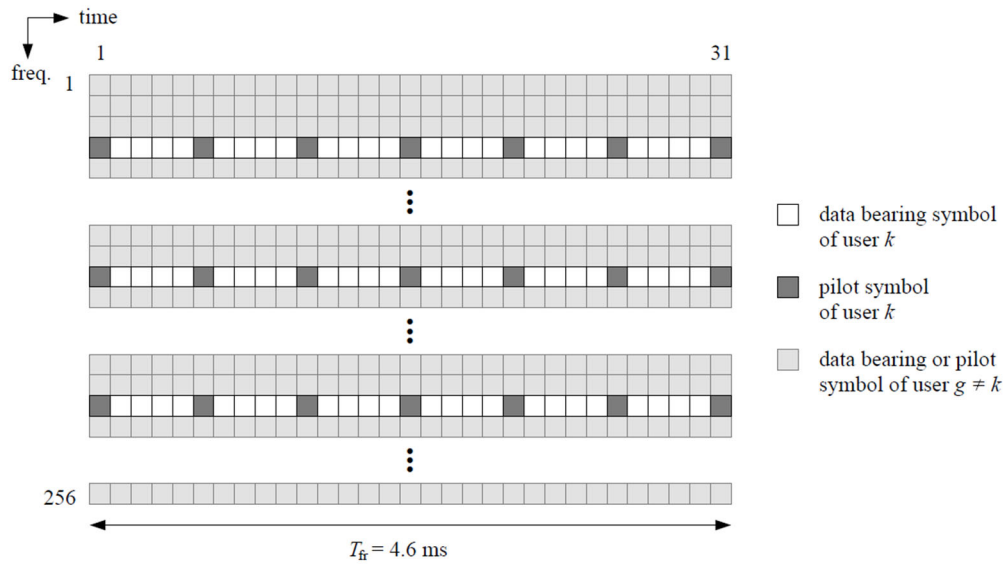


Figure B.4: OFDM frame of the proposed SS-MC-MA mobile radio system; $N_c = 256$; $N_s = 31$; $N_t = 5$; $N_{\text{grid}} = 1792$

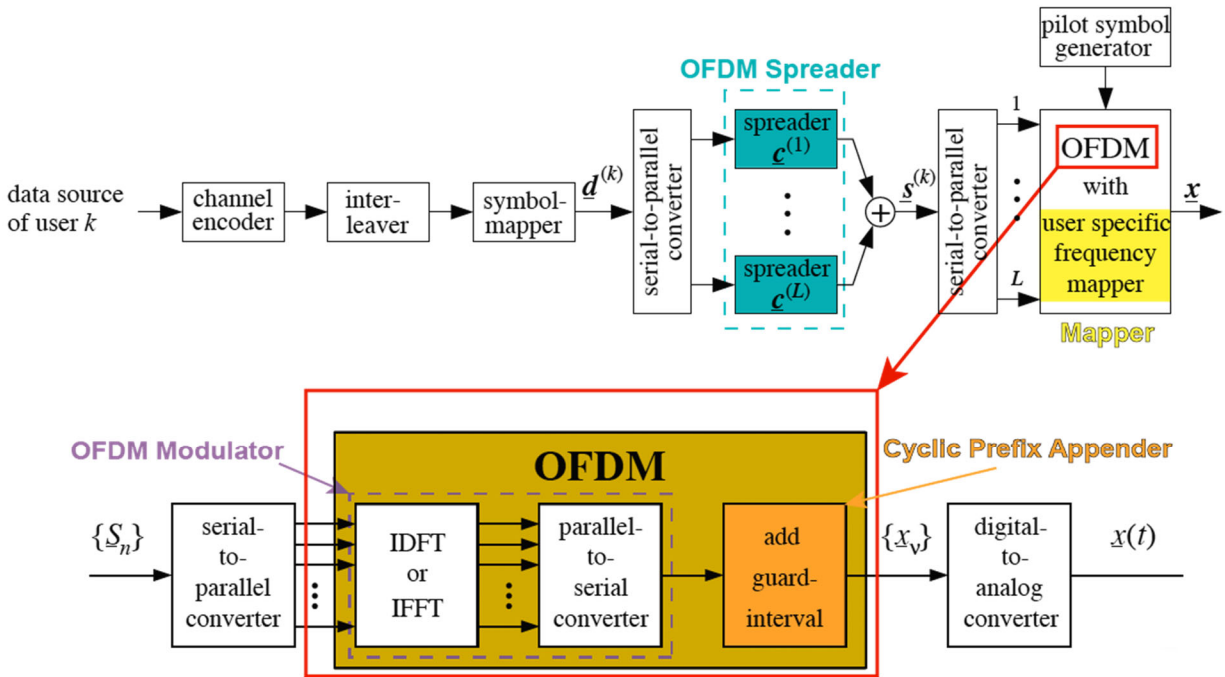
EX1005, p.135 (Figure B.4). Thus, Kaiser in view of Bury renders obvious mapping *the DFT-spread data signal to a plurality of OFDM subcarriers.*” EX1002, ¶¶251-55.

Thus, Kaiser in view of Bury renders obvious limitation [1B].

d. [1C]: OFDM Modulator

Kaiser in view of Bury renders obvious *an OFDM modulator configured to modulate the DFT-spread data signal onto the plurality of OFDM subcarriers to produce an OFDM transmission signal comprising a superposition of the OFDM subcarriers.* EX1002, ¶¶256-63.

Specifically, Kaiser discloses *an OFDM modulator* as shown below.



EX1005, pp.34, 132 (Figs. 3.2 & B.2 (combined)). Kaiser's OFDM modulator includes the IFFT/IDFT and parallel-to-serial converter. EX1002, ¶257. As explained above, Kaiser explains that the "OFDM" block in Fig. B.2 relies on the OFDM modulation techniques described in earlier section 3.1.1 (and thus illustrated in Fig. 3.2). EX1005, p.133; EX1002, ¶80.

Kaiser's *OFDM modulator* is configured to modulate a spread data signal (parallelized signal $\underline{s}^{(k)}$) onto the plurality of OFDM subcarriers (L subcarriers) to produce an OFDM transmission signal comprising a superposition of the OFDM subcarriers which is labeled " $\underline{x}$ " in Kaiser's Fig. B.2. EX1002, ¶¶257-59.

Kaiser's OFDM modulator produce[s] an OFDM transmission signal comprising a superposition of the OFDM subcarrier at the output of the parallel-to-

serial converter, for example. For example, Kaiser explains that

[a] key advantage of using OFDM is that the MC [(multi-carrier)] modulation can be implemented in the discrete domain using an IDFT, or a more computationally efficient IFFT. [] When sampling the complex envelope $x(t)$ of an OFDM symbol at time instances t equal to $(v=1, \dots, N_C)$, the samples are

$$\underline{x}_v = \frac{1}{\sqrt{N_C}} \sum_{n=1}^{N_C} \underline{s}_n e^{j2\pi(n-1)(v-1)/N_C}, v = 1, \dots, N_C$$

(3.6)

and the sampling rate is N_C/T_s . The important result is that the sampled sequence $\{\underline{x}_v\}$, $v = 1, \dots, N_C$, is the IDFT of the source symbol sequence $\{\underline{s}_n\}$, $n = 1, \dots, N_C$.

EX1005, p.32. Patent Owner has admitted that a POSITA “would understand that an OFDM signal is a superposition of subcarriers.” EX1039, p.10. And, “[i]f multiple symbols are input to the IFFT at the same time, the output discrete-time signal is a sum (i.e., a superposition) of the subcarriers modulated with their corresponding symbols.” *Id.* Thus, Kaiser’s disclosure of inputting multiple (spread) symbols $\{\underline{s}_n\}$ (or $\underline{s}^{(k)}$, depending on the figure) into an IFFT, *see, e.g.*, EX1005, p.34 (Fig. 3.2), the resulting discrete time signal $\{\underline{x}_v\}$ is a superposition of the subcarriers modulated with their corresponding symbols. EX1002, ¶¶260-63; EX1039, p.10; EX1005, pp.32, 34, 132-133.

Thus, Kaiser in view of Bury renders obvious limitation [1C].

e. [1D]: reduced PAPR

Kaiser in view of Bury renders obvious *wherein the OFDM spreader is configured to provide the superposition with a reduced peak-to-average power ratio.*” EX1002, ¶¶264-66.

As noted above, Bury’s DFT-spreading reduces PAPR in multi-carrier FDMA uplink transmissions as compared to Walsh-Hadamard spreading. *Supra* §§VIII.C, IX.D.1; EX1007, pp.860 (“For Fourier spreading ... the PAPR remains nearly constant at a low level for all spreading factors.... [I]n the uplink Fourier spreading outperforms Hadamard spreading in most cases.”); *see also id.* (“Fourier spreading delivers a lower or equal PAPR” with a “superiority” that “increases significantly for larger spreading factors.”); EX1002, ¶¶265; *Supra* §§IX.D.1, IX.D.2.e.

Thus, Kaiser in view of Bury renders obvious claim 1.

3. *Claim 11*

Claim 11 recites a method with steps that correspond to the elements of apparatus claim 1, as previously shown above relative to Grounds 1-2. *See* §§IX.A.

a. [11Pre] A method, comprising:

[11Pre] is a generic non-limiting preamble and Kaiser in view of Bury renders the method steps obvious.

b. [11A] multiplying by a DFT spreading matrix

As explained in connection with Limitation [1A], Kaiser in view of Bury

renders obvious *multiplying a plurality of data symbols* (Kaiser's "complex-valued data symbols $\underline{d}_l^{(k)}, l = 1 \dots L$ " are "multiplied with another orthogonal spreading code of length L " where the spreading codes are defined by a " $L \times L$ matrix" $\underline{C}$, EX1005, p.132) *by a discrete Fourier Transform (DFT) spreading matrix* (Bury's "orthogonal" and "square" matrix T , which is used for "Fourier spreading[], which can be implemented by a" DFT, EX1007, p.857) *to produce a plurality of DFT-spread symbols* (Kaiser's $\underline{s}^{(k)} = (\underline{s}_1^{(k)}, \underline{s}_2^{(k)} \dots \underline{s}_L^{(k)}) = \underline{C} \underline{d}^{(k)}$ with Bury's DFT matrix as $\underline{C}$, EX1005, p.132; EX1007, p.857). *Supra* §IX.D.2.b; EX1002, ¶¶268-70.

c. **[11B]: mapping**

As explained in connection with Limitation [1B], Kaiser in view of Bury renders obvious *mapping the plurality of DFT-spread symbols* $(\underline{s}^{(k)} = (\underline{s}_1^{(k)}, \underline{s}_2^{(k)} \dots \underline{s}_L^{(k)})$ *to a plurality of OFDM subcarriers* (L of N_C subcarriers). *Supra* §IX.D.2.c; EX1002, ¶¶271-72.

d. **[11C]: modulating**

As explained in connection with Limitation [1C], Kaiser in view of Bury renders obvious *modulating the plurality of DFT-spread symbols* $(\underline{s}^{(k)} = (\underline{s}_1^{(k)}, \underline{s}_2^{(k)} \dots \underline{s}_L^{(k)})$ *onto a plurality of OFDM subcarriers* (L of N_C subcarriers) *to produce a DFT-spread OFDM signal* (transmission signal labeled " $\underline{x}$ " in Kaiser's Fig. B.2 in the Kaiser-Bury modified method) *to be transmitted into a wireless*

channel, wherein the DFT-spread OFDM signal comprises a superposition of the OFDM subcarriers. Supra §IX.D.2.c; EX1002, ¶¶273-74. The Kaiser-Bury DFT-spread OFDM signal is to be transmitted into a wireless channel because Kaiser discusses “an SS-MC-MA mobile radio system,” EX1005, pp.130, 133, and a POSITA knew that mobile radio systems transmit over wireless channels, EX1002, ¶274.

Additionally, the combined Kaiser-Bury technique would produce a *DFT-spread OFDM signal comprising a superposition of the OFDM subcarriers. Supra §IX.D.2.d (Limitation [1C]).*

e. [11D]: reduced PAPR

As explained in connection with Limitation [1D], Kaiser in view of Bury renders obvious *the DFT spreading matrix is configured to provide the superposition with a reduced peak-to-average power ratio (PAPR). Supra §IX.D.2.e; EX1002, ¶¶276-77.*

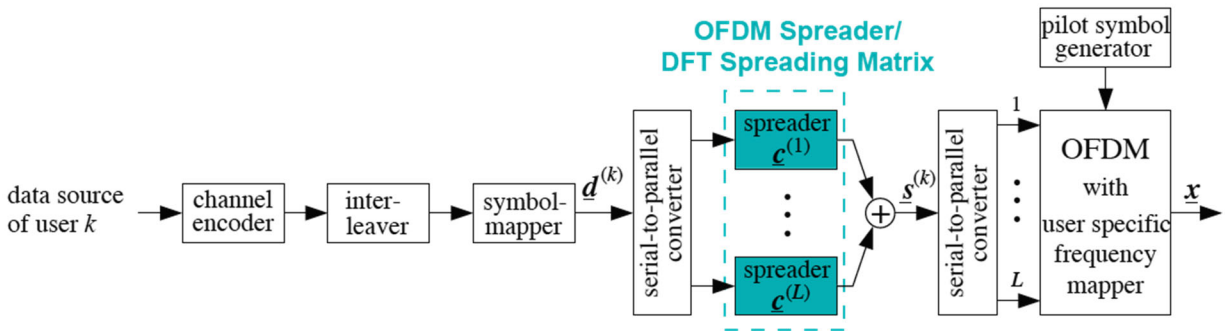
Thus, Kaiser in view of Bury renders obvious claim 11.

4. *Claims 2, 18*

Kaiser in view of Bury renders obvious *wherein the OFDM spreader comprises an N-point DFT and the OFDM modulator comprises an M-point inverse discrete Fourier Transform, wherein $M > N$ ” (Claim 2) and wherein the DFT spreading matrix comprises an N-point DFT, and the modulating comprises*

employing an M -point inverse-DFT, and wherein $N < M$ (Claim 18). EX1002, ¶¶278-83.

Specifically, Kaiser describes an L -point spreader. As shown below, Kaiser's spreader (a DFT matrix based on Bury) receives vector $\underline{d}^{(k)} = \underline{d}_1^{(k)}, \underline{d}_2^{(k)}, \dots, \underline{d}_L^{(k)}$, which "represents one block of L parallel converted data symbols of the k th user." EX1005, p.132.



Id., p.132 (Fig. B.2). Kaiser's spreading matrix is an $L \times L$ matrix. EX1005, p.132. Bury's DFT matrix has " M " inputs because "a vector of M symbols" is input into transform $\underline{T}$, and Bury illustrates inputs 1 to M . EX1007, pp.857-858 (Fig. 1). Thus, a POSITA would have understood that when using the combined Kaiser-Bury system and method, the *OFDM spreader/DFT spreading matrix* would have used an N -point DFT, where in Kaiser, the variable N (reflecting the total inputs into the spreader) is L and in Bury, the variable N is M .⁴ EX1002, ¶¶279-80.

⁴ In Bury N is specified as " M " because M defines the number of symbols in a

Kaiser's IFFT is an N_C -point IFFT.⁵ For example, Kaiser's Table B.1 & Fig. B.4 disclose a 256-point IFFT ($N_C=256=M$) and an 8-point spreading matrix ($L=8=N$), such that $M>N$. EX1005, p.134; EX1002, ¶282. Bury's IDFT is shown as having more inputs than the DFT matrix to accommodate the entire system bandwidth shared by all users. *Id.*, p.858 (Fig. 1); EX1002, ¶282. The letter defining the variable should have no patentable weight.

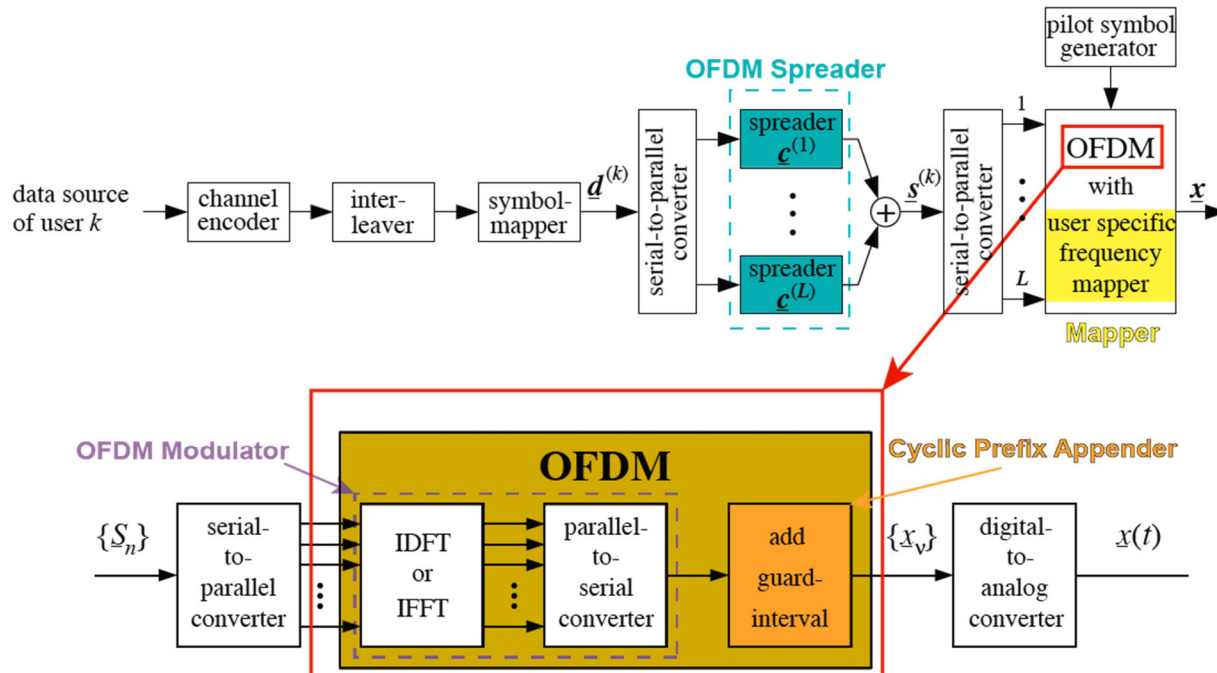
Thus, Kaiser in view of Bury renders obvious claims 2 and 18.

5. Claim 3

Kaiser in view of Bury renders obvious *wherein the OFDM modulator comprises an inverse fast Fourier transform* because Kaiser's OFDM modulator includes an IFFT:

spreading group. EX1007, p.858; EX1002, ¶281.

⁵ N_C refers to the "number of subcarriers." EX1005, p.140.



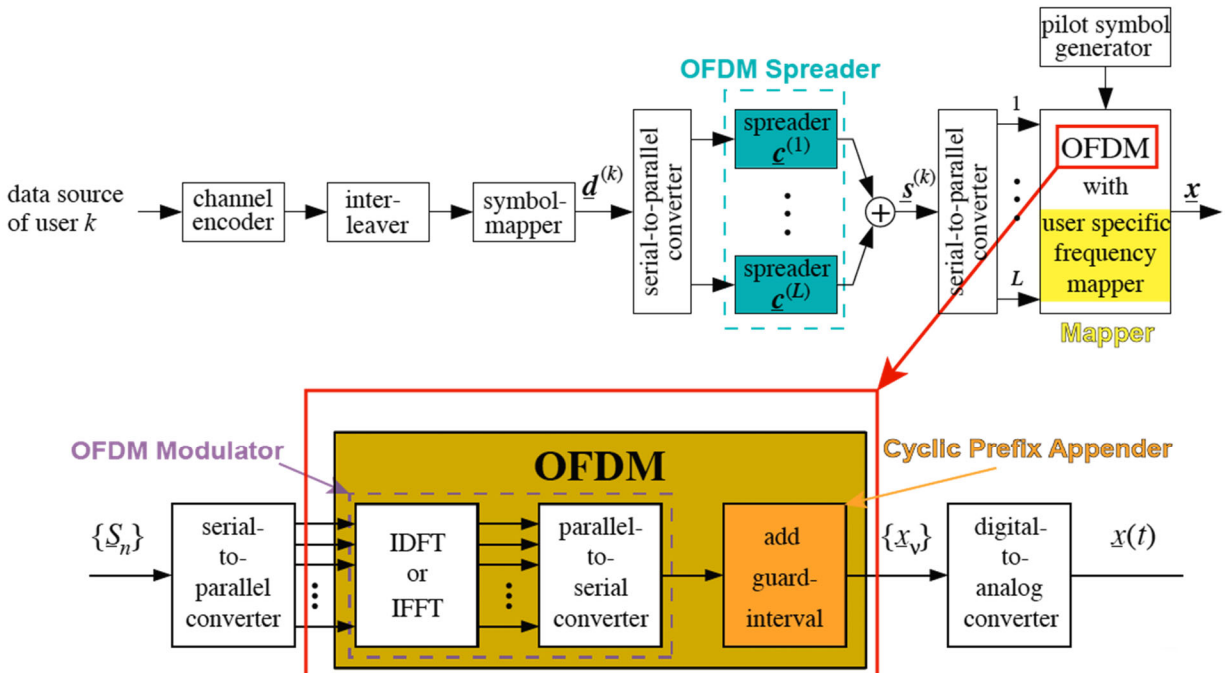
EX1005, pp.34, 132 (Figs. 3.2 & B.2 (combined)); *id.*, p.134 (Table B.1); EX1002, ¶¶284-87.

Thus, Kaiser in view of Bury renders obvious claim 3.

6. Claims 7, 17

Kaiser in view of Bury renders obvious *a cyclic prefix appender configured to append at least one of a cyclic prefix, a postfix, and a guard interval to the OFDM transmission signal* (claim 7) and *a method of appending at least one of a cyclic prefix, a postfix, and a guard interval onto the DFT-spread OFDM signal* (claim 17). EX1002, ¶¶288-90.

Kaiser discloses a cyclic prefix appender for adding a guard interval including a cyclic prefix onto a DFT-spread OFDM signal:



EX1005, pp.34, 132 (Figs. B.2 & 3.2 (combined)), 133 (“OFDM with guard interval is applied in SS-MC-MA systems in the same way as in MC-CDMA systems, cf. Section 3.1.1.”). Kaiser explains “[t]he guard interval is a cyclic prefix added to each OFDM symbol which is obtained by extending the duration of the OFDM symbol....” EX1005, p.33.

Thus, Kaiser in view of Bury renders obvious claims 7 and 17.

7. Claim 8

Kaiser in view of Bury renders obvious *wherein the OFDM spreader is configured to provide channel precoding.*” EX1002, ¶¶291-94. As previously explained, the ’842 Patent says that spreading with a CI matrix (e.g., including DFT spreading codes) provides precoding. *Supra* §IX.A.6 (discussing claim 8 and the

'842 Patent). EX1002, ¶¶159-60. As discussed above regarding limitations [1A] and [11A], Kaiser in view of Bury renders obvious a DFT spreader and DFT spreading data symbols before OFDM modulation, and thus discloses that the spreader is configured to provide channel precoding in the context of the '842 Patent. *Supra* §§IX.D.2.b, IX.D.3.b.

Thus, Kaiser in view of Bury renders obvious claim 8.

E. Ground 6: Claims 4 and 9 are obvious over Kaiser in view of Bury and further in view of Toshiba

1. Overview of the combination; motivation to combine; expectation of success

Neither Kaiser nor Bury describes “data symbols” comprising “reference-signal symbols” (claim 4) or “data symbols” multiplexed (e.g., time-multiplexed) with “reference-signal symbols” (claim 9). These features were obvious over Kaiser in view of Bury and Toshiba.

Even though Kaiser and Bury do not mention “data symbols” that include “reference-signal symbols,” a POSITA would have understood that reference-signal symbols were commonly used in OFDM systems for performing necessary functions like synchronization, timing, and properly demodulating received signals at a receiver. EX1002, ¶¶295-96. Toshiba’s teachings and how they apply to claims 4 and 9 are discussed in connection with Ground 3. *Supra* §§IX.B.1-3. EX1002, ¶¶297-98.

Kaiser's SS-MC-MA transmitter encodes data symbols using QPSK modulation. EX1005, p.134. A POSITA knew that higher order modulation schemes, such as QAM allowed higher data rates to be achieved. EX1002, ¶299; EX1041, 1:38-52. Additionally, Kaiser assumes that "[t]ime and frequency synchronization" are "perfect within this thesis" citing the literature for more information. EX1005, p.37. Thus, a POSITA would have investigated techniques for (1) increasing Kaiser's data rates and/or bandwidth efficiency, and (2) obtaining timing synchronization. EX1002, ¶300. A POSITA would have seen that Toshiba's OFDM transmission techniques accomplish both goals. EX1002, ¶301; EX1041, 2:5-13 (an "object of the invention" is reducing the amount of reference data needed to successfully demodulate "multi-valued modulated symbols" thus "increasing data transmission efficiency"); *id.*, 8:25-29 (using null symbols allows for achieving "time synchronization"); EX1005, p.137 (noting "high bandwidth efficiency" and "great flexibility" as being achieved).

In considering Toshiba's transmission technique, a POSITA would have understood that demodulation of QAM modulated symbols requires "reference symbols whose phase and amplitude are already known," EX1042, 1:53-56, 8:25-38, and that sending "null symbols" enable "timing synchronization," *id.*, 8:25-29. EX1002, ¶302. Toshiba's teachings about time-multiplexing various types of data symbols: information symbols, null symbols, and reference symbols before OFDM

modulation techniques are performed are summarized above. *Supra* §IX.B.

Based on the combined teachings of Kaiser, Bury, and Toshiba, a POSITA would have found it obvious to input data symbols that comprise *reference-signal symbols* including *at least one of known training symbols* (Toshiba's null symbols) and *synchronization symbols* (Toshiba's reference symbols) which are time multiplexed into the Kaiser-Bury DFT spreader, mapper, OFDM modulator, and guard interval appender. EX1002, ¶303. A POSITA would have found it obvious to do so because Kaiser assumes time synchronization, but refers to the literature about ways to achieve it, thus leading a POSITA to consider methods known in the art. EX1005, p.37; EX1002, ¶303.

A POSITA would have been motivated to time-multiplex Toshiba's reference-signals with the Kaiser data symbols before spreading and OFDM modulation because such a configuration is contemplated by Toshiba. EX1002, ¶304; EX1041, FIG. 3 (showing multiplexing before IFFT).

Moreover, a POSITA would have been motivated to apply Toshiba's time-multiplexing of information, null, and reference symbols such that Kaiser's complex-valued data symbols ($\underline{d}^{(k)}$) includes each type of symbol because it would have merely combined prior art elements (various types of data symbols including reference-signal symbols) according to known methods (time-multiplexing them into a data stream) to achieve the predictable result of being able to use null symbols

to achieve timing synchronization and reference symbols to be able to obtain phase and amplitude information and synchronization permitting demodulation of QAM encoded information symbols as taught by Toshiba. EX1002, ¶305. This modification would have provided the benefits of (1) providing a timing synchronization technique to Kaiser, which assumed perfect synchronization, and (2) allowed Kaiser to use QAM modulation, thus improving data rates. *Id.*, ¶306.

Furthermore, further modifying the Kaiser-Bury combination with Toshiba would have applied Toshiba's known technique of time-multiplexing information and reference-signal symbols before OFDM modulation to Kaiser's known OFDM transmitter, which was ready for improvement in the form of increased data rates and timing synchronization techniques. EX1002, ¶307. The combination would have produced the predictable result of having reference signal symbols embedded in the OFDM signal received at a receiver, thereby allowing for timing synchronization and demodulation of QAM modulated information symbols. *Id.*

A POSITA would have reasonably expected to succeed in implementing the proposed combination because Toshiba teaches a known way to employ reference-signal symbols and use them to obtain time synchronization and allow for demodulation of QAM modulated data symbols, thereby improving data rates. EX1002, ¶308. A POSITA would have had no difficulty time-multiplexing various types of symbols together because the symbols vary only in the data that they contain

and their ensuing use by the system. EX1002, ¶309. These symbols would all be operated on the same way mathematically as they are DFT spread, mapped to subcarriers, and processed by an IFFT to OFDM modulate the output signal. *Id.* These steps were understood by a POSITA and merely changing the data content and use of the symbols was a simple modification to the Kaiser-Bury system. *Id.*

2. *Claim 4*

Kaiser in view of Bury and further in view of Toshiba renders obvious *wherein the data symbols comprise reference-signal symbols, which comprise at least one of known training symbols and synchronization symbols.*” EX1002, ¶¶310-13.

Kaiser discloses “complex-valued data symbols $\underline{d}^{(k)}$,” EX1005, p.132, but does not describe “reference-signal symbols, which comprise at least one of known training symbols and synchronization symbols.” Toshiba describes this as indicated in the annotated version of Toshiba’s FIG. 3, below.

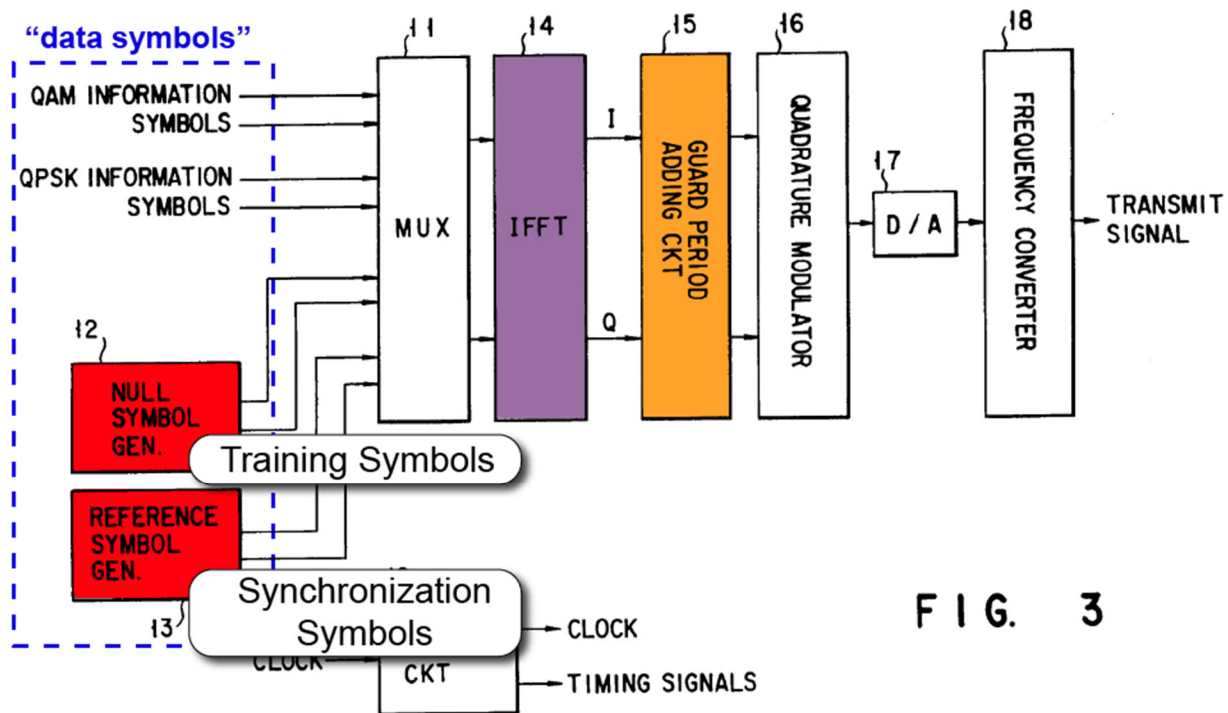


FIG. 3

EX1041, FIG. 3. An explanation of how Toshiba's "null symbols" are training symbols and how Toshiba's reference symbols are synchronization symbols in the context of the '842 Patent is provided above. *Supra* §IX.B. For the reasons already discussed, Toshiba discloses claim 4.

It was obvious to further modify Kaiser in view of Bury such that Kaiser's data symbols $d^{(k)}$ comprise Toshiba's reference-signal symbols (training symbols and synchronization symbols) for the reasons explained above. *Supra* §IX.E.1.

3. Claim 9

Kaiser in view of Bury and further in view of Toshiba renders obvious *wherein the plurality of data symbols are at least one of time-multiplexed with reference-signal symbols, frequency-multiplexed with reference-signal symbols, and*

code-multiplexed with reference-signal symbols.” EX1002, ¶¶314-17. As explained above, Toshiba discloses time-multiplexing data symbols (e.g., modulated “information symbols”) with reference-signal symbols (“null symbols” and “reference symbols”). *Supra* §§IX.E.1, IX.B. This is shown in more detail above, which shows that null symbols are first, reference symbols are second, and modulated information signals appear in subsequent time slots within an OFDM frame. Based on that discussion, Toshiba discloses the additional limitations of claim 9. *Supra* §§IX.B.1, IX.B.3.

For the reasons explained above, it was obvious to further modify Kaiser in view of Bury such that data symbols are time-multiplexed with reference-signal symbols (Toshiba’s null and reference symbols) based on Toshiba. *Supra* §IX.E.1.

F. Ground 7: Claims 22, 25-26, 28 are obvious over Kaiser in view of Bury and Dowling

1. Overview of the combination; motivation to combine; expectation of success

Claims 22, 25-26, and 28 require “a processor” [22A] and “a non-transitory memory coupled to the processor, the non-transitory memory including a set of instructions stored therein and executable by the processor” to perform subsequent steps [22B]. Otherwise, these claims correspond to claims 1-3, 7, 11, and 17-18.

Kaiser suggests that at least some of the transmitter structure is implemented in hardware. EX1005, p.137. Bury is silent on the matter. It was obvious to

implement the combined Kaiser-Bury OFDM transmitter (as discussed in connection with Ground 5, *supra* §IX.D) in computer instructions stored in memory (e.g., software) that are executed by a processor coupled to the memory based on Dowling.

Dowling explains that various aspects of an OFDM transmitter including its modulation techniques “may be implemented as software modules which execute on a programmable processor architecture.” EX1042, 3:46-50; *see id.* at 5:66-6:1; 21:62-64. A POSITA knew that software radios were available and had certain advantages over hardware implementations as discussed above. *Supra* §IX.C (Ground 4).

A POSITA would have been motivated to implement the Kaiser-Bury transmitter including functions of spreading, mapping, modulation, and cyclic prefix appending functions (among others) in a software radio for the same reasons a POSITA would have found implementing Galda’s analogous functions in software to be obvious. EX1002, ¶¶318-24, 195-02; *Supra* §IX.C.

A POSITA also would have expected to succeed in making this combination. Kaiser discloses an OFDM transmitter and defines the various mathematical operations for each of the components. EX1002, ¶324. Implementing the required mathematical operations in software would have needed only routine knowledge because software is especially well-suited for performing mathematical operations

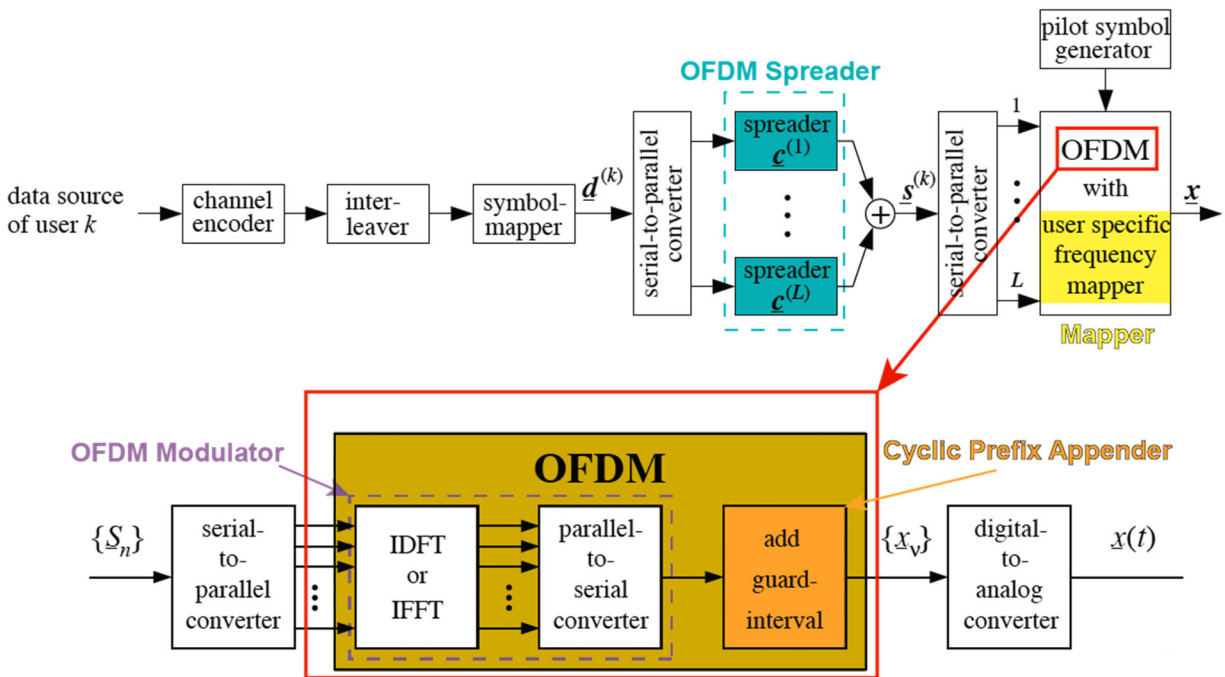
(e.g., DFT spreading, performing an IFFT, etc.). EX1002, ¶324. Given the number of disclosures indicating that those in the field knew that various transmitter functions were able to be implemented in either hardware or software—two known alternatives—a POSITA would have reasonably expected in achieving a software implementation using instructions stored on a memory for execution by a processor.

Id.

2. *Claim 22*

a. [22Pre]: An apparatus comprising:

This is not a limiting preamble. Nevertheless, Kaiser describes an apparatus shown below:



EX1005, pp.34, 132 (Figs. 3.2 & B.2 (combined)).

b. [22A] processor; [22B] memory

Kaiser and Bury do not explicitly describe the claimed processor or memory. Dowling discloses and renders obvious “a processor” [22A] and “a non-transitory memory coupled to the processor, the non-transitory memory including a set of instructions stored therein and executable by the processor to” [22B]. EX1002, ¶¶328-32.

Dowling discloses multi-carrier transmitters having modulators, precoders, among other things. EX1002, ¶329. Dowling explains that the disclosed transmitter and modulation techniques “may be implemented as software modules which execute on a programmable processor architecture.” EX1042, 3:46-50; *see id.* at 5:66-6:1 (disclosing that the transmitter, receiver, and precoder may be implemented in hardware or software”); 21:62-64 (disclosing that the “present invention” is applicable to FFT based multicarrier modulation and OFDM systems). Because software is computer instructions that must be executed to function, those instructions must be stored in some form of memory to allow the processor to access and execute the instructions. EX1002, ¶¶329-30. Dowling is merely exemplary of a well-known fact that transmitters were implemented in hardware or software. EX1002, ¶330 (citing EX1008, EX1011, ¶¶[0124]-[0125]).

For the reasons already explained, a POSITA would have found it obvious to implement the combined Kaiser-Bury system in software stored in memory for

execution by a processor coupled to the memory as recited in claim 22. *Supra* §IX.F.1. Thus, Kaiser in view of Bury and Dowling discloses and renders obvious limitations [22A]-[22B].

c. Limitations [22Bi]-[22Biv]

These limitations are substantively the same as limitations of claims that were already addressed in connection with claims 1, 11, and their dependent claims. Differences are noted below.

Limitation [22Bi]: Kaiser in view of Bury renders this limitation obvious as explained above regarding for Limitations [1A], [11A], and claim 2. The Kaiser-Bury N-point DFT generates *a plurality N of DFT-spread data symbols* ($\underline{s}^{(k)} = (\underline{s}_1^{(k)}, \underline{s}_2^{(k)}, \dots, \underline{s}_L^{(k)})$) because it would have had “L” inputs and “L” outputs. EX1005, 34, 132 (Figs. 3.2 & B.2 (annotated above)); EX1002, ¶¶333-35.

Limitation [22Bii]: The Kaiser-Bury combination renders obvious the function *map the N DFT-spread data symbols* ($\underline{s}_l^{(k)}$) *to at least N subcarriers (i.e., L subcarriers of Kaiser’s N_C subcarriers, EX1005, pp.132, 134; EX1002, ¶¶336-39), of a plurality M of OFDM subcarriers* (Kaiser supports N_C subcarriers, EX1005, p.134). This is discussed further above. *Supra* §§IX.D.2.c, IX.D.3.c, IX.D.4 (Limitations [1B], [11B], claim 2). Moreover, Kaiser’s mapping results in generating *complex subcarrier amplitudes* because DFT-spread complex-valued data symbols

in the combined Kaiser-Bury system are applied to N subcarriers such that N subcarriers (L in Kaiser) have a non-zero amplitude. EX1002, ¶338.

Limitation [22Biii]: The Kaiser-Bury combination discloses this limitation as explained above regarding claim 2 and because an IFFT—a type of IDFT—converts complex subcarrier amplitudes from the frequency domain to the time domain. EX1002, ¶¶340-342, 48 (citing EX1015, 42, 47-48); EX1005, p.32 (describing $\{x_v\}$ as representing the complex envelope of source symbols). In the Kaiser-Bury combination the *time-domain sequence* comprises *a superposition of the OFDM subcarriers* as explained above. *Supra* §IX.D.2.d (Limitation [1C]).

Limitation [22Biv]: Kaiser in view of Bury discloses this limitation for the reasons explained in connection with Limitation [1D]. *Supra* §IX.D.2.e. This is one of Bury’s chief benefits and a key reason a POSITA would have modified Kaiser. EX1007, 857, 860; EX1002, ¶¶33-45.

Thus, Kaiser in view of Bury (as discussed in Ground 5) and Dowling renders obvious claim 22 for the reasons explained above. *Supra* §IX.F.1.

3. *Claims 25-26 and 28*

a. Claim 25

Kaiser in view of Bury discloses this claim as explained with respect to claim 2. *Supra* §IX.D.4.

b. Claim 26

Kaiser discloses this claim as explained with respect to claim 3. *Supra* §IX.D.5.

c. Claim 28

Kaiser discloses this claim as explained with respect to claim 7. *Supra* §IX.D.6.

d. Obviousness of claims 25-26 and 28

It was obvious to implement the functionality recited in claims 25-26 and 28 in software stored in memory and executable by a processor coupled to the memory based on the combined teachings of Kaiser in view of Bury and Dowling for the same reasons explained in connection with claim 22, above. *Supra* §IX.F.1. See EX1002, ¶¶346-51.

X. DISCRETIONARY DENIAL UNWARRANTED⁶

A. *Fintiv* Factors Favor Institution

The *Fintiv* factors—as applied per the March 24, 2025 Guidance on the USPTO rescission of the Interim Procedure (EX1060, “Boalick Memo”) guides against discretionary denial. *Apple Inc. v. Fintiv, Inc.*, IPR2020-00019, Paper 11

⁶ Petitioner presents these arguments without waiving additional briefing under the USPTO’s March 26, 2025 “Interim Process for Workload Management.”

(precedential).

1. Petitioners Will Seek a Stay

Factor 1 favors institution. Petitioner will seek a stay of co-pending litigation pending the outcome of this and related IPRs and reexaminations. The Eastern District of Texas has granted stays before claim construction because such cases have “not reached such an advanced stage that it would weigh against a stay.” *Broadphone LLC v. Samsung Elecs. Co., Ltd.*, 2024 WL 3524022, at *2-3 (E.D. Tex. July 24, 2024) (granting stay where “significant amount of discovery remains, the claim construction hearing has not occurred, and trial is currently set for [over six months later]”).

2. Parallel Proceeding Trial Date

Factor 2 is at worst neutral. A jury trial is scheduled for April 20, 2026. EX1046, p.1. With this petition being filed in March 2025, a final written decision may be expected by September 2026, only five months after the scheduled trial date, assuming the trial date holds, which, at present is unlikely. Judge Schroeder has scheduled four patent jury trials scheduled for April 20, 2026. EX1061, p.1; EX1062, p.1; EX1063, p.1; EX1064, p.5 (resetting trial to 4/20/2024). “[T]he Board may consider any evidence that the parties make of record that bears on the proximity of the district court’s trial date.” EX1060, p.2. Because four patent cases cannot be tried simultaneously which (if any) trial will proceed is speculative. *Boe*

Tech. Grp. Co. v. Optronix Scis. LLC, No. IPR2024-01130, 2025 WL 305477, at *4 (P.T.A.B. Jan. 27, 2025) (Fintiv factor 2 “neutral or weigh[s] slightly in favor of not exercising discretion” where district court “set 10 cases for jury selection on the same day”).

Even when the Final Written Decision (“FWD”) may come after the trial date, the Board has instituted trial based on many of factors present here, such as diligence in filing the petition, a stipulation not to pursue the asserted grounds in litigation, minimal investment in litigation, and the merits of the challenge were strong. *Lego Sys., Inc. v. Mq Gaming LLC*, No. IPR2020-01445, 2021 WL 606917, at *8 (finding jury trial “five months before a final written decision” outweighed by “low” “investment by the court and parties in the [parallel case] on” common issues, Petitioner’s *Sotera* stipulation, and strong merits to the challenge); *Verizon Business Network Services, Inc. v. Huawei Techs. Co.*, IPR2020-01141, Paper 12 (Jan. 14, 2021). Petitioner diligently filed this petition particularly considering the complexity of the analysis undertaken across eight asserted patents that collectively have (1) 638 pages, (2) 243 claims, (3) a range of effective filing dates, and (4) are part of a patent family that was pending before the Office for about two decades. EX1047, ¶1; EX1065. The way Patent Owner structured its patent families, shifted patent disclosures from one application to the next, and, at times, incorporated dozens of patents and publications by reference, placed a significant burden on Petitioner to

assess its positions. EX1023, pp.233-236, 241; EX1031, pp.24, 26, 29, 32, 36, 44. The complexity presented by this, and the seven other IPR petitions Petitioner is filing, weigh strongly in favor of institution. *Apple, Inc. v. SEVEN Networks, LLC*, IPR2020-00156, Paper 10 at 21-22 (June 15, 2020) (“complexity of multiple patents and issues in the District Court Action” favored institution). Considering these procedural and technical complexities, the Board is uniquely situated to adjudicate patentability because of its expertise in patent law and technological questions.

3. *Investment in Parallel Proceeding*

Factor 3 weighs against discretionary denial. The district court case is in the early stages. Fact discovery is in its early stages: no depositions have occurred; expert discovery is many months away. Fact discovery will likely close December 1, 2025. EX1046, p.3. Expert discovery currently starts that same day. *Id.* A *Markman* hearing is scheduled for Oct. 21, 2025. *Id.* Where, as here, “the district court[s] ha[ve] not issued orders related to the patent at issue in the petition, this fact weighs against exercising discretion to deny institution.” *Fintiv* at 10.

4. *Stipulation Favors Institution*

Factor 4 weighs strongly against discretionary denial. Petitioner hereby stipulates that, if the IPR is instituted, Petitioner will not assert that any of the claims challenged in this proceeding are invalid on any ground that Petitioner raised or reasonably could have raised during this inter partes review. *Sotera Wireless, Inc. v.*

Masimo Corp., No. IPR2020-01019, at 19 (finding “stipulation here mitigates any concerns of duplicative efforts...as well as concerns of potentially conflicting decisions” and “ensures that an *inter partes* review is a ‘true alternative’ to the district court proceeding”); *Lego*, 2021 WL 606917, at *6 (“[F]actor weighs strongly against discretionary denial” where Petitioner makes *Sotera* stipulation); *Verizon Business Network Servs, Inc. v. Huawei Techs. Co.*, IPR2020-01141, Paper 12 (Jan. 14, 2021) (“[i]nstituting trial here serves overall system efficiency and integrity goals by not duplicating efforts and by resolving materially different patentability issues.”).

5. *Identity of the Parties*

Factor 5 is either neutral or weighs slightly against institution because Petitioner and Patent Owner are the same as in district court, but a “holistic view” favors institution. *Samsung Elecs. Co. Ltd. v. Dynamics Inc.*, IPR2020-00505, Paper 11 at 15 (Aug. 12, 2020).

6. *Merits Heavily Favor Institution*

Factor 6 favors institution. The compelling merits of the challenge presented herein further weigh heavily in favor of institution. As demonstrated by the Petition, the challenged claims are unpatentable the cited prior art, which was not previously considered despite numerous continuation filings. For example, a single undisclosed reference—Galda—anticipates and/or obviates most challenged claims. The

Board's views on the patentability of the challenged claims will also benefit the public, which is otherwise faced with a thicket of similar and related patents that Patent Owner contends are essential to 4G and 5G wireless standards and which have been asserted against various companies. EX1070. This is the first and only IPR on the '842 Patent, so a patentability determination by the Board on this Petition would conserve resources.

B. Denial Under §325(d) Unwarranted

The '842 Patent was not rejected on any prior art, and the prior art in Petitioner's Grounds was never cited, much less discussed, during prosecution. Therefore, denial under § 325(d) is unwarranted.

XI. MANDATORY NOTICES

A. Real Party-In-Interest

Samsung Electronics Co., Ltd. and Samsung Electronics America, Inc. are the real parties-in-interest.

B. Related Matters

The '842 Patent is asserted in the following litigation: *GenghisComm Holdings, LLC v. Samsung Electronics America, Inc. f/k/a Samsung Telecommunications America LLC*, No. 24-cv-00242.

Patents in the same or related patent families and which name the same inventor have been challenged in the following post-grant proceedings:

- **U.S. Patent No. 10,200,227:** U.S. Reexamination Control No. 90/019,411; *Samsung Electronics Co., Ltd. v. GenghisComm Holdings, LLC*, IPR2025-00781.
- **U.S. Patent No. 10,389,568:** *Samsung Electronics Co., Ltd. v. GenghisComm Holdings, LLC*, IPR2025-00788.
- **U.S. Patent No. 11,075,786:** *Samsung Electronics Co., Ltd. v. GenghisComm Holdings, LLC*, IPR2025-00789; Petitioner also anticipates filing a request for reexamination as to this patent to raise grounds that cannot be raised in this proceeding.
- **U.S. Patent No. 11,223,508:** *Samsung Electronics Co., Ltd. v. GenghisComm Holdings, LLC*, IPR2025-00790; Petitioner also anticipates filing a request for reexamination as to this patent to raise grounds that cannot be raised in this proceeding.
- **U.S. Patent No. 11,252,005:** U.S. Reexamination Control No. 90/019,847; *Samsung Electronics Co., Ltd. v. GenghisComm Holdings, LLC*, IPR2025-00791.
- **U.S. Patent No. 11,381,285:** *Samsung Electronics Co., Ltd. v. GenghisComm Holdings, LLC*, IPR2025-00792; Petitioner also anticipates filing a request for reexamination as to this patent to raise

grounds that cannot be raised in this proceeding.

- **U.S. Patent No. 11,424,792:** U.S. Reexamination Control No. 90/019,848; *Samsung Electronics Co., Ltd. v. GenghisComm Holdings, LLC*, IPR2025-00793.

A patent in the same family as the '842 Patent—i.e., U.S. Patent No. 11,431,386—is asserted in *GenghisComm Holdings, LLC v. Samsung Electronics America, Inc.*, No. 2:24-cv-901-RWS-RSP (E.D. Tex.).

C. Lead and Back-Up Counsel

Petitioner designates the following lead and back-up counsel:

Lead Counsel	Back-Up Counsel
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D. Service

Petitioner consents to service by email on the following email addresses: GT-Genghiscomm-IPR@gtlaw.com.

XII. FEES

The required fee is being paid electronically through P-TACTS.

Dated: March 28, 2025

Respectfully Submitted,

/Andrew R. Sommer/

Andrew R. Sommer
Reg. No. 53,932

CERTIFICATE OF COMPLIANCE

This petition complies with the word count limits set forth in 37 C.F.R. § 42.24(a)(i), effective May 2, 2016, because this Petition contains 13,872 words, excluding the parts of the petition exempted by 37 C.F.R. § 42.24(a), as determined using the word count provided by Microsoft Word, which was used to prepare this Petition.

Dated: March 28, 2025

Respectfully Submitted,

/Andrew R. Sommer/

Andrew R. Sommer
Reg. No. 53,932

CERTIFICATE OF SERVICE

Pursuant to 37 C.F.R. §§ 42.6(e) and 42.105(a), the undersigned certifies that on March 28, 2025, I caused a true and correct copy of **PETITION FOR *INTER PARTES* REVIEW OF CLAIMS 1-4, 7-9, 11, 17-18, 22, 25-26, AND 28 OF U.S. PATENT NO. 9,768,842, PETITIONER’S POWER OF ATTORNEY BY SAMSUNG ELECTRONICS CO., LTD., PETITIONER’S POWER OF ATTORNEY BY SAMSUNG ELECTRONICS AMERICA, INC., AND EXHIBIT NOS. 1010-1016, 1018-1023, 1035, 1038-1047, 1059-1065, 1070-1071** by EXPRESS MAIL on the Patent Owner at the correspondence address of record for U.S. Patent No. 9,768,842 as follows:

Mr. Steven J Shattil
P.O. Box 17355
Boulder, CO 80308-0355
UNITED STATES

I further certify that a courtesy copy of the above-identified materials were served on litigation counsel by electronic means upon the foregoing individuals:

Alison Richards, Esq. – aricahrds@giplg.com

/Andrew R. Sommer/

Andrew R. Sommer
Reg. No. 53,932