

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
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In re Patent of: Dennis Fink
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EXPERT DECLARATION OF BOB CORDELL

CREST 2001

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I, Bob Cordell, declare as follows:

I. BACKGROUND AND QUALIFICATIONS

1. I retired from the telecommunications industry in 2013. My electrical engineering career spanned 44 years, during 22 of which I supervised numerous groups of engineers. I have worked at Bell Laboratories, Bellcore, David Sarnoff Research Center and Tyco Telecommunications. My CV is attached at the end of this declaration.

2. My fields of experience include audio engineering, linear integrated circuit design, WDM fiber optic communications, DSP and microprocessor systems, CMOS VLSI design and CAD research, high-speed optoelectronic integrated circuit design and development of VLSI integrated circuits for digital television.

3. I currently am proprietor of Cordell Audio, where I am an author and consultant in the field of audio engineering (cordellaudio.com). My personal involvement in audio has run parallel to my professional career since 1970. I authored the book “Designing Audio Power Amplifiers”, published by McGraw-Hill in 2010. The 600-page book covers all aspects of audio power amplifier design.

4. I graduated from Stanford University with an MSEE. I graduated from RPI with a BSEE. I am a Member of the Audio Engineering Society and a Senior Member of the IEEE. I have presented 13 papers at industry technical conferences and have held leadership positions for several of those industry conferences. I am a member of the Review Board for the Journal of the Audio Engineering Society.

5. I have been granted 16 patents in various fields.

6. I have been retained by Crest Audio to advise on issues related to the validity of certain claims in U.S. Patent No. 5,652,544 (“the ‘544 patent) and the state of the art

and the knowledge of a person of ordinary skill in the art to which the '544 patent pertains at the time of its invention. I am being paid at a consulting rate of \$250 per hour. My compensation is not contingent on the results of this or any other proceeding relating to the '544 patent.

7. I have reviewed the '544 patent and its claims. I have also reviewed the prior art references cited with the Petition for *inter partes* Review and the references cited by the inventor and Examiner in the '544 patent.

8. I have also reviewed the following:

- prosecution history for the '544 patent
- Petitioner's petition for *inter parte* review
- Prior art cited by Petitioner in *inter parte* review
- Patent and Trial Appeal Board decision instituting *inter partes* review
- transcript of deposition of petitioner's expert

II. OVERVIEW OF THE '544 PATENT

9. My overview of the '544 patent here is limited to those aspects that pertain to the claims at issue, namely independent claim 1 and dependent claims 7, 8, 11, 13, and 21.

10. The '544 patent describes a portable removable programmer arrangement for entering programs and parameters into an audio power amplifier that includes a programmable digital signal processor in its signal path. The '544 patent refers to programs and parameters as functions and function parameters.

11. The '544 patent pertains to audio power amplifiers, particularly those used in professional sound reinforcement, theaters, stadiums and other venues.¹ An audio signal can be a voltage or a current or a delivered power. It is usually a representation of a music or speech signal. Audio signals usually lie in or somewhat beyond the frequency range of 20Hz to 20kHz. Audio power amplifier input signals often have maximum values that lie in the range of 0.1 to 5 volts. Maximum power amplifier output signals often lie in the range of 10 to 100V. The maximum audio signal power delivered to a load by an audio power amplifier usually lies in the range of 10 watts to 2000 watts.

12. The '544 patent describes an audio power amplifier incorporating a programmable digital signal processor that enables it to be particularly suitable for the professional sound part of the audio power amplifier industry.

13. DSP, microcontroller and ADC/DAC integrated circuits (chips) were beginning to enter consumer electronics applications during the late 1980s, but those applications involved virtually no programmability of the digital signal processing function (program) or the coefficients used by the digital signal processing function after assembly of the product. Sets of such data were usually stored in read only memory (ROM) in these consumer applications. The data was typically programmed at the factory and was not reprogrammed thereafter. Digital signal processing functions and function parameters stored in ROM cannot be modified.

14. The '544 patent describes an audio power amplifier with a digital signal processor in the signal path, likely including an ADC before the DSP and a DAC between the output of the DSP and the power amplifier proper. In cases where the audio input signal is already in a digital format, the ADC is not required.

¹ See '544 patent 1:43-48 and 6:18-26.

15. The digital signal processor can be an integrated circuit, or a subsystem including a group of integrated circuits, that performs signal processing by means of arithmetic operations on a digital signal. The term “DSP” is often used to describe the integrated circuit where most of the processing takes place. A digital signal processor that comprises a subsystem might include a DSP chip connected with a ROM memory IC and perhaps a RAM memory IC. DSP chips of the early 1990s often had limited on-chip memory resources, and so were sometimes connected with external ROM or RAM chips for memory expansion. The use of an external ROM for storage of programs and/or coefficients was often convenient because different signal processing functions could then be implemented in different products or situations without resort to changing the internal ROM of the DSP chip. In some cases, the external ROM was even placed in a socket to allow such flexibility. In some cases the digital signal processing subsystem would include a microprocessor or microcontroller.

16. The DSP receives and stores one or more digital signal processing functions (i.e., programs) and parameters (i.e., coefficients) that control the signal processing functions. A parameter that sets the cut-off frequency for a DSP filter program would be an example. An example of different DSP functions would be crossover filters of different order, such as second order or fourth order. Another example of different functions would be equalizers and compressors. It is often desirable to employ numerous such functions at the same time in the signal processing chain. This capability to receive and store functions and parameters requires the inclusion of an electronically re-writable nonvolatile memory. The amplifier of the ‘544 patent includes a programming input port

to receive functions and parameters from an external source, such as a network or portable programmer.

17. The very flexible programming of the digital signal processor in the '544 patent allows the amplifier to perform a host of different functions that were previously implemented by other pieces of associated equipment, such as electronic crossovers, room and loudspeaker equalizers and adjustable signal delays for time alignment of the acoustic signals from the loudspeakers.

18. The '544 patent also allows a user to make changes in processing functions and their parameters in real time, while the amplifier is operating and delivering a signal to its loudspeaker(s). This enables a setup technician to listen to the effects of the changes being made, even at a location that is remote from the amplifier, such as at a mixing desk.

III. LEVEL OF ORDINARY SKILL IN THE ART

19. In my opinion, the '544 patent pertains to the field of audio power amplifiers.

20. I have supervised many persons having ordinary skill in the art as well as persons with a very high level of skill in the art for 22 years of my 44-year career, including 6 years as a supervisor at Bell Laboratories, Holmdel. I believe that I am very familiar with the capabilities of persons having ordinary skill in the art from several disciplines within electrical engineering, including audio engineering, analog and digital design, integrated circuit design, microcomputers, DSPs and fiber optic transmission systems.

21. I understand that the date of invention for the purposes of this *inter partes* review is November 9, 1994, which is the filing date of the parent of the ‘544 patent. It is my opinion that the field of invention for the ‘544 patent is audio amplifiers.²

22. In my opinion, a person having ordinary skill in the art (PHOSITA) for purposes of the ‘544 patent subject matter would have a Master’s degree in electrical engineering and at least 1 year of practical experience in the design and test of audio power amplifiers, or a Bachelor’s degree in electrical engineering with at least 3 years of experience in the design and test of audio power amplifiers. I believe that I am an expert in the field of the ‘544 patent and that I have a level of skill that exceeds the level of skill for a PHOSITA. I have been designing and building audio power amplifiers since the late 1960’s.

23. I believe that it is necessary that actual designing and testing of audio power amplifiers is necessary to be considered a PHOSITA in this field. This enables the PHOSITA to understand the intricacies of such designs, such as the operation of protection circuits and thermal considerations. This also enables the PHOSITA to understand whether a given design approach is workable or desirable.

IV. STATE OF THE ART

24. A proper review of the references provided with the Petition for *Inter Partes* Review requires a deep and careful reading of those references to ascertain the state of the art that they represented, and what they taught, at a time of the invention of the ‘544 patent. In some cases, the reference may not explicitly discuss a matter relevant to the

² See ‘544 patent 1:8-45.

‘544 patent review, and so some inference in the context of the reference may be necessary.

25. At the time of invention of the ‘544 patent, the use of digital signal processing had been made economical by the availability of general-purpose digital signal processor integrated circuits (DSP) and inexpensive high-quality analog-to-digital converters (ADC) and digital-to-analog converters (DAC).³

26. DSPs, microcontrollers and ADC/DAC components were beginning to enter consumer electronics applications during this time, but those applications involved virtually no programmability of the DSP function (program) or parameters (coefficients) used by the DSP function. After the product was manufactured, sets of such data were usually stored in read only memory (ROM) in these consumer applications.⁴

27. The ‘544 patent pertains to audio power amplifiers, particularly those used in professional sound reinforcement, theaters, stadiums and other venues.⁵ An audio power amplifier amplifies an audio input signal to a level where it can provide adequate output power to a load, such as a loudspeaker, for its intended use. Sound systems in large venues often employ numerous amplifiers, many of which may not be easily accessible. This makes the setup and adjustment of conventional power amplifiers labor-intensive and subject to trial and error.

A. Sudo – Efficient Data Processing Method for Coefficient Data in a DSP

³ See TMS320 datasheet, Ex. 1012.

⁴ See U.S. Patent No. 5,822,775 to Sudo et al, 3:53-66.

⁵ See ‘542 patent: 1:43-48 and 6:18-26.

28. Sudo describes an audio digital signal processing technique for use in applications such as consumer audio processing. Such digital signal processing might take place in a car radio or a consumer audio/video (A/V) receiver. See Ex. 1005 1:14-23). Sudo does not show or suggest its system being used as a research and development environment. Sudo specifically discusses the implementation of audio sound effects.⁶ An example audio sound effect would be to control the sound field of a reproduced sound in order to produce an acoustic space similar to that of a concert hall. A different sound field to be chosen might be that of a theater. Many A/V receivers offer such options with the push of a button.

29. Sudo describes such signal processing as being done with a DSP. A central objective of Sudo is to be able to select a different sound field or the like by pressing a different selection key and making the change without disrupting the audio signal. As explained in Sudo, “A program for an arithmetic operating process which is used in the DSP is stored in a rewritable program RAM in the DSP. Each time the sound field mode or the like is switched, the corresponding processing program and coefficient data are transferred from a microcomputer and are written to the rewritable program RAM, so that the desired acoustic space sound can be produced.”⁷ This is an example of a digital signal processing subsystem that includes a microcontroller,⁸ since the DSP chip cannot function without the microcontroller supplying its instruction information.

30. The focus of Sudo is to accomplish the necessary change in processing coefficients quickly enough in real time to avoid disrupting the audio processing while mitigating the need to use a very high-speed DSP to do so. This is reflected in the title of

⁶ See Sudo, Ex. 1005 1:15-23.

⁷ See Sudo, Ex. 1005 1:35-42.

⁸ See Paragraph 15 herein.

the patent: “Efficient data processing method for coefficient data in a digital [signal] processor”.

31. “It is an object of the invention to provide a coefficient data change processing method for a DSP which can provide a surplus time in execution of a rewriting process of coefficient data in the read cycle steal and doesn’t need a high speed operation.”⁹

32. More specifically, Sudo discloses an audio signal processing DSP architecture wherein the processing program and coefficient data are transferred and supplied from a microcomputer to a DSP. Fixed sets of coefficients are stored in ROM associated with the microcomputer. “The microcomputer 20 includes a CPU, an [sic] RAM and an [sic] ROM (all of them are not shown). In addition to the control program for the microcomputer itself, various processing program groups which are used in the DSP 2, a plurality of coefficient data groups which are used in the processing programs, and the like, have been stored in the ROM of the microcomputer 20.”¹⁰ Examples of members of such groups would be functions and function parameters needed to implement “Hall” or “Theater” sound fields.

33. The keypad is used to select which of these parameter combinations is to be transferred from the microcomputer to the DSP’s RAM in order to obtain the sound field that has been chosen by the push of a button on the keypad. “The microcomputer 20 reads out the processing program corresponding to the operated sound field control key, the coefficient data group used in a particular program, and the like, from the ROM, and

⁹ See Sudo, Ex. 1005 2:24-28 and 6:38-43.

¹⁰ See Sudo, Ex. 1005 3:54-60.

transfers this data to the DSP 2 through the interface 19.”¹¹ In my opinion, this would be like the plurality of pushbuttons that are often found on a typical consumer A/V receiver, each of which is labeled as providing a different sound field, such as “Theater” and “Hall”.

34. In my opinion, Sudo does not teach or disclose the modification of DSP programs and parameters. Instead, he merely describes the transfer of preconfigured programs and coefficients that had already been stored in the microcomputer’s ROM into the DSP. In other words, after the product is manufactured, a user cannot enter an entirely new sound field.

35. In Sudo’s Figure 1, the DSP device identified as DSP 2, is enclosed by a dashed box. In my opinion a PHOSITA would immediately conclude that the DSP 2 is an integrated circuit. He or she would also see that interface 19 clearly is enclosed within DSP 2 and resides on the DSP integrated circuit chip. Interface 19 connects to the internal main bus 17 in the DSP, which is commonly understood by a PHOSITA to be typically operating at a high speed and to be a “wide” bus comprising numerous communication lines.¹² Such a bus usually connects to other integrated circuits, like memories or microcomputers with metal traces on a printed wiring board.

36. In my opinion, the DSP 2 in Sudo’s Figure 1 is an integrated circuit and the small circles on the perimeter of the dashed box denote the pins of the IC (or pads or solder balls in the case of surface-mount devices). Accordingly, in my opinion, the connections to these small circles on the perimeter of the dashed box 2 are made with metal traces on a printed wiring board. Such connections are not removable.

¹¹ See Sudo, Ex. 1005 3:61-67.

¹² See Sudo, Ex. 1005 3:47-52.

37. In my opinion, Interface 19 is plainly not that of a connector, nor is the interface 19 removable. I believe that a PHOSITA would recognize that this is a hard-wired printed wiring board interface, just as are the A/D and D/A interfaces to I/O Interface 3. A PHOSITA understands that the A/D and D/A would be connected to the I/O interface 3 using a hardwired connection. The box enclosing the DSP and its inner detail in Figure 1 is, in my opinion, meant to highlight the DSP integrated circuit device being discussed. Interface 19 is inside the dotted box, suggesting that it is internal to the DSP integrated circuit. In my opinion, a PHOSITA would interpret the small circles on the perimeter of DSP 2 as being pins or groups of pins on the integrated circuit package.

38. In my opinion, a PHOSITA would recognize that the microcomputer is interfaced to the internal DSP system bus 17 in a way that involves numerous interconnections, and which would be very challenging to externalize, even if it were desirable to do so. “The microcomputer 20 is connected to the main bus 17 through an interface 19.”¹³ Sudo does not teach how to externalize interface 19, nor does he contemplate externalizing Interface 19. Moreover, externalizing Interface 19 would certainly not be obvious to a PHOSITA. In my experience, interfaces like that of 19 often involve high-speed busses with numerous wires and tight timing constraints that can be difficult to maintain through connectors and over distances.

39. Dr. Ellis repeatedly cites the use of a PC as the programmer.¹⁴ However, in my opinion, the use of a personal computer as the programmer would also not be possible if interface 19 was externalized because a PC has no means of interfacing to this type of wide, high-speed bus.

¹³ See Sudo, Ex. 1005 3:50-52.

¹⁴ See Ellis’ Declaration, Ex. 1003, paragraphs 35, 61, 63, 68, 77.

40. I disagree with Dr. Ellis' statement, "The fact that the microcomputer 20 is shown connected to the DSP through the interface 19 suggests that the microprocessor 20 is not hardwired to the DSP but is connected via some sort of removable connection."¹⁵ In my opinion, Sudo's Figure 1 makes it clear that Interface 19 resides within the DSP integrated circuit, just as does the A/D and D/A interface 3.¹⁶ In my opinion, and based on my experience, this suggests that the interface 19 is a desirably hardwired connection. I do not believe that it would be desirable to modify the connection between the DSP chip and microprocessor 20 of Sudo so as to comprise a connector and be removable. Moreover, I can think of no reason why someone would want to do this. The technical challenges of making the interface 19 removable would deter one from doing it this way. Those challenges include the likely required bus width (number of wires) and stringent timing constraints for the transfer of data across such an interface. An example of such stringent interface timing can be found in the TMS320 data sheet.¹⁷

B. Porambo – Method and Apparatus for Diagnosing Amp to Speaker Connections

41. Porambo describes a car radio system that includes a factory test diagnostic mode that can identify short circuits and open circuits in the wiring connecting the car radio to the loudspeakers. This diagnostic capability is made possible by the existence of a digital signal processor in the car radio that is in the signal path ahead of the power amplifier(s).

42. Porambo's system includes two microprocessors and a digital signal processor subsystem DSP 28 (actually comprising 2 DSP devices). The DSP 28 is in the signal

¹⁵ See Ellis' Declaration, Ex. 1003, paragraph 13.

¹⁶ See Sudo, Ex. 1005, Figure 1. See dashed box labeled DSP enclosing interface 19.

¹⁷ See TMS320 datasheet, Ex. 1008, pp. 24,42 and 43.

path, preceded by an ADC and followed by a DAC that feeds the power amplifiers.¹⁸ The DSP 28 is able to provide functions like volume, balance, fader and tone controls. Microprocessor 29 is located in the dashboard module 12 where the controls and a display are located.¹⁹ Microprocessor 27 is in the control box 14 mounted in the trunk. The control box also contains the DSP 28, an AM/FM tuner, the ADC, the DAC and the amplifiers. The two microprocessors 27 and 29 communicate over a simple serial interface that is compatible with both processors.²⁰ Control panel functions are thus conveniently communicated to the control box where all signal processing actually takes place.

43. In its central focus, Porambo describes a diagnosis technique. Porambo's diagnostic function pertains to the connection between the power amplifiers and the loudspeakers. It is not a technique intended for use when the car radio is in use performing its normal function. Its primary purpose is for factory test and diagnosis of the wiring between a car radio and its speakers. Porambo generates an inaudible tone in the diagnostic mode that is sent from the amplifier to the loudspeaker. This tone facilitates the automated diagnosis procedure. If there is something wrong with the wiring harness or the connectors at either end, Porambo's diagnostic system will detect it and indicate whether it is a short circuit or an open circuit.

44. Porambo's DSPs do not have memories that allow the DSP to receive and store signal processing functions and function parameters. These DSPs include ROM or EPROM for storage of programs. It is well understood that ROM cannot receive information after its one-time programming at the factory. As explained below in the

¹⁸ See Porambo, Ex. 1006 Fig. 1.

¹⁹ See Porambo, Ex. 1006 Fig. 2.

²⁰ See Porambo, Ex. 1006 4:27-32.

section describing the TMS320 state of the art, EPROM is also not suitable for receiving signal processing functions and parameters in the application disclosed by Porambo and other similar applications because it cannot be electronically be re-written. It must be first erased in a programming fixture by the exposure to ultraviolet light. Moreover, Porambo is intended for mass production manufacture, and the TMS320 datasheet states that ROM should be used in high-volume applications.²¹

45. In my opinion, Porambo is a typical conventional audio system that includes a DSP with preconfigured ROM for storage of functions and parameters. For this reason, Porambo's DSP cannot receive and store programs and parameters. After installation the ROM and all that it stores is incapable of being modified.

46. Porambo discloses that the TMS320C25 DSP should be used.²² The TMS320 series of DSPs is available in versions with ROM or EPROM for program storage. The TMS320C25 specified by Porambo is the ROM version. The TMS320E25 is the EPROM version.²³ For this reason it is my opinion that programs are stored in ROM by Porambo. It follows that Porambo's DSP cannot receive and store functions and parameters.

47. Porambo states that the diagnostic function can be added to a known DSP radio system via programming without additional hardware.²⁴ "Only software need be incorporated in the programmable memory of the DSP of a previously known radio assembly in order to implement the control and display of the status of each speaker connection to the DSP radio." This should not be mistaken for programmability.

Although Porambo suggests that the diagnostic function can be implemented in existing

²¹ See TMS320 datasheet, Ex. 1008, 58:1-5.

²² See Porambo, Ex. 1006, 4:15-19.

²³ See TMS320 datasheet, Ex. 1008 page 1, third and fourth bullets.

²⁴ See Porambo, Ex. 1006 6:14-22.

digital radios without a hardware change, in my opinion he is only suggesting that new radios of the same kind can be manufactured with merely a change to the preconfigured ROM used in the assembly of the radio.

48. In my opinion, this does not anticipate or teach the modification of the software in the field or a software upgrade in the field. Any such software change would more than likely be made to a ROM in the DSP or a ROM associated with the DSP or a ROM on or associated with microprocessor 27. In my opinion, Porambo does not teach the receiving and storing of programs and parameters, since, in my opinion, those are stored in preconfigured ROM at the factory.

49. In my opinion, Porambo brings nothing to the table here beyond the placement of a DSP in the signal path to an amplifier. Porambo:

- makes no mention of uploading functions or parameters to the DSP
- does not describe or teach upgrading of software in the field
- does not teach the use of non-volatile memory
- is silent on in-service functionality
- makes no mention of the use of TMS320 EPROM

C. Krokstad – Hearing Aid

50. Krokstad discloses a programmable hearing aid that incorporates a DSP in the hearing aid. “A number of response functions are stored in a memory (RAM2) in a control unit and is [sic] freely chosen by the user in regard of adaption [sic] to hearing function and acoustic environment.”²⁵ The user is offered a menu of several response

²⁵ See Krokstad, Ex. 1007 page 1, Abstract.

functions with a corresponding number of stored parameter sets. A touch keypad on the hearing aid initiates a change of program parameters. This touch switch is connected to a control unit in the hearing aid, which is then connected to a DSP.²⁶

51. Importantly, in my opinion, a close reading of Krokstad indicates that coefficients (parameters) that establish the filter functions (i.e., frequency response transfer functions) are uploaded to the hearing aid (RAM2), but not programs or algorithms that are to be executed by the DSP in the hearing aid. “A sixth object is to provide a hearing aid in which the stored response functions can be reprogrammed in that the hearing aid is connected to a computer via an interface for input of new response functions.”²⁷ Here, in my opinion, the semantic meaning for “functions” corresponds to transfer functions as created by sets of parameters. “The transfer functions of the individual filters can now be altered in that these are provided with different sets of filter coefficients, a set of filter coefficients being provided for each individual filter.”²⁸ “Each individual set of filter coefficients thus represents a specific response function for the hearing aid...”²⁹

52. In describing the storage of parameters, “All the parameters, including the filter coefficients, which are required in order to generate a specific response function, are stored in the memory RAM2 in the control unit CU and also in the external random-access memory RAM8 [probably should read RAM1, see Figure 4a] which is provided in the hearing aid’s secondary section 2 or in a case and constitutes a spare memory.”³⁰ “The hearing aid can easily be reprogrammed to suit altered user conditions and changes

²⁶ See Krokstad, Ex. 1007 Fig 4a.

²⁷ See Krokstad, Ex. 1007 page 7, 6th paragraph.

²⁸ See Krokstad, Ex. 1007 page 22: 9-12.

²⁹ See Krokstad, Ex. 1007, page 22: 16-18.

³⁰ See Krokstad, Ex. 1007 page 22: 21-27.

in the hearing of the user or the hearing of another user.”³¹ In my opinion, here “reprogrammed” refers to uploading new filter coefficients. Krokstad makes no mention of uploading DSP programs or algorithms, and in my opinion he does not do that or teach that.³²

53. The hearing aid is programmed by placing the hearing aid into its storage case and then connecting the programmer to the storage case. Programming information created by the programmer is transmitted to the storage case, and then transmitted by the storage case to the hearing aid that is placed in the storage case. The hearing aid is also placed in the storage case to have its batteries recharged in the course of normal use.

54. The programmer, identified by Krokstad as a personal computer (PC), is connected to the hearing aid’s storage case via a serial RS232 interface.³³ An RS232 interface is a serial interface that is very slow. The case is connected to the hearing aid by placing the hearing aid into the case when it is to be programmed. The interface between RAM1 and RAM2 in Figure 4a is not described.

55. The coefficients (parameters) are stored in RAM2, which is located in the portion of the hearing aid that is inserted into in the ear. Those parameters are communicated to RAM2 by RAM1 via an unspecified type of removable interface (see Figure 4a). RAM1 is located in the storage case. The parameters determined by the programmer (PC) are communicated to RAM1 in the case by an RS232 connection. RAM1 in the case also acts as a backup of the information for RAM2. Thus, there is no specified RS232 interface to the hearing aid in the ear, or to its DSP.

³¹ See Krokstad, Ex. 1007, page 23: 18-20.

³² See Krokstad, Ex. 1007, claim 21.

³³ See Krokstad, Ex. 1007, page 23:20-23.

56. In my opinion, the programming of the hearing aid does not transfer anything that can be construed as a function (i.e., a program to be executed by the DSP).

57. Krokstad states that the control unit microcontroller and DSP reside on the same CMOS integrated circuit chip.³⁴ Given the die size of general purpose DSPs of the time, it is unlikely that Krokstad's DSP was of a general purpose nature, given the extreme size constraints for placement in the ear. The die size for a general purpose DSP of the era, like the Texas Instruments TMS320, was about 10mm square. Krokstad states that the sound generator SG should have a diameter less than about 4.5mm. From this I infer that the combined DSP/microcontroller chip in Krokstad should certainly be smaller than 4.5mm, thus having less than ¼ the available silicon area of a general purpose DSP. Thus, in my opinion, a general purpose programmable DSP would be unsuitable for reasons of size, given the available circuit density that was achievable with the technology at the time of invention of the '544 patent. Nowhere does Krokstad mention or suggest the use of a general-purpose DSP.

D. Texas Instruments TMS320 Data Sheet

58. The Texas Instruments TMS320 digital signal processor chip, whose referenced data sheet was published in 1991 (Ex. 1008), typifies the general purpose digital signal processor integrated circuits that were available at the time in the early 1990s.

59. The TMS320 includes 512 words of data RAM and 4k words of either ROM or EPROM. The ROM version is designated as the TMS320C, while the EPROM version

³⁴ See Krokstad, Ex. 1007, page 25:1-5.

is designated the TMS320E.³⁵ The TMS320 has a 16-bit data bus and a 16-bit address bus, both made available at package pins. These busses can be used to implement memory expansion with external ROM or RAM, or they can be used to interface the DSP with an external microcontroller.³⁶

60. Nonvolatile (NV) memory is memory that retains its stored data even when power is removed from the system. While it was well known to include nonvolatile (NV) memory (ROM/EPROM) in a DSP at the time of invention of the '544 patent, electronically re-writable nonvolatile memory was not commercially available as on-chip memory in DSPs at this time. EPROM is not electronically re-writable. The EPROM must first be erased in a programming fixture before it can be written with new data. The EPROM is erased in the fixture by shining Ultraviolet light through a transparent glass window in the package.³⁷ The Ultraviolet light discharges the floating gates of the transistors that are used to store information. The entire content is erased. The need for erasure by Ultraviolet light means that the EPROM is not electronically rewritable. Clearly, the need for Ultraviolet erasure in a commercial application would be burdensome. The EPROM is thus unsuitable for use as the NV memory in commercial applications where new information must be written in-situ into an NV memory.

61. Moreover, the TMS320 on-board NV memory is intended to be in the form of ROM for mass-produced products. EPROM is primarily intended for development purposes. The TMS320 datasheet indicates that EPROM is primarily for development purposes and that the masked ROM version should be used in production or during

³⁵ See TMS320 datasheet, Ex 1008 page 1, third and fourth bullets.

³⁶ See First Generation TMS320 User's Guide, pp. 6-1 to 6-15.

³⁷ See TMS320 datasheet, Ex. 1008, pages 57-60. Window shown on page 57 and described in footnote 1.

manufacture, never to be programmed again.³⁸ In my opinion, it is extremely unlikely, for example, that Porambo would have used the EPROM version of the TMS320 in his car radio.

62. Dr. Ellis asserts that the EPROM in the TMS320 would be suitable to meet the nonvolatile memory needs of the ‘544 patent.³⁹ I disagree. As explained above, EPROM is not electronically re-writable, which capability is required by ‘544 patent arrangement.⁴⁰ Indeed, a PHOSITA at the time of invention of the ‘544 patent would have recognized that using EPROM to meet the objectives of the ‘544 patent was unworkable and too costly.

63. Porambo discloses that the TMS320C25 DSP should be used.⁴¹ The TMS320 series of DSPs is available in versions with ROM or EPROM for program storage. The TMS320C25 specified by Porambo is the ROM version. The TMS320E25 is the EPROM version.⁴² This underscores my opinion that programs are stored in ROM by Porambo.

64. In car radios or other mass-produced devices that employ ROM, the ROM memory is usually programmed in a one-time programming step at the factory (usually the factory where the ROM was manufactured). The ROM is programmed before the radio or other device is assembled. A ROM is not capable of receiving information after it is manufactured. A digital signal processor employing ROM for storage of functions and parameters is not capable of receiving an algorithm and parameters after it is assembled into the product in which it is used.

³⁸ See TMS320 datasheet, Ex. 1008, 58:1-5.

³⁹ See Ellis’ Declaration, Ex. 1003 paragraph 24.

⁴⁰ See ‘544 patent 3:21-24, 5:13-17 and claim 8.

⁴¹ See Porambo, Ex. 1006, 4:15-19.

⁴² See TMS320 datasheet, Ex. 1008 page 1, third and fourth bullets.

65. ROM is considered to be nonvolatile memory, but it cannot be reprogrammed. The TMS320 also includes 512 words of on-chip data RAM. It is re-writable but it is volatile; its contents will disappear when power is removed.

E. Statements Alleged by Petitioner as Patent Owner's Admitted Prior Art

66. The Background of the Art section of the '544 patent discusses signal processing circuits in conventional prior art amplifiers. Nowhere in this section is the term "digital signal processor" or DSP used. It is important to distinguish signal processing circuits from digital signal processors. The former can be implemented with conventional analog components. In my opinion, the '544 patent makes no mention or admission of others employing a DSP in the signal path of an amplifier in its "Background of the Art" section.

67. The '544 patent describes as prior art the inclusion of a signal processing circuit within an amplifier. It further describes as prior art the implementation of numerous sound processing functions, like a crossover function, in a conventional audio power amplifier. The '544 patent also describes as prior art the inclusion of a controller for receiving input command signals for modifying the signal processing parameters.⁴³

68. The '544 patent makes no mention of programming or uploading of programs or coefficients in its Background of the Art section.

69. I have reviewed all of the other references cited in the '544 patent and none of them refer to the use of digital signal processing or programming.

⁴³ See '544 patent 2:22-25.

V. MY UNDERSTANDING OF OBVIOUSNESS

70. I have been retained to review the prior art and the claims in the '544 patent, and to provide an opinion and explanation as to whether the claimed subject matter would have been obvious to a person having ordinary skill in the art (PHOSITA) at the time of invention of the '544 patent.

71. I understand that an individual cannot obtain a patent if the differences between the subject matter claimed and the prior art are such that the subject matter as a whole would have been obvious to a PHOSITA in the art to which the subject matter pertains.

72. I understand that a prior art reference must be considered in its entirety, i.e., as a whole, including portions that would lead away from the claimed invention.

73. I understand that the scope of the claimed invention must be clearly determined by giving the claims the broadest reasonable interpretation consistent with the specification, as they would be read from the point of view of a PHOSITA.

74. I understand that it is important to consider how a person of ordinary skill would have understood prior art teachings, or what a person of ordinary skill would have known or could have done.

75. I understand that the focus when making a determination of obviousness should be on what a person of ordinary skill in the pertinent art would have known at the time of the invention and on what such a person would have reasonably expected to have been able to do in view of that knowledge.

VI. CLAIM CONSTRUCTION

76. I have been asked to give my opinion of what is the broadest reasonable interpretation of the claim terms below based on my reading the claims of the ‘544 patent and the ‘544 patent specification.

77. The term ***“digital signal processor capable of receiving”*** describes a digital signal processor that is able to receive digital signal information to be processed, or information that determines how signal information is to be processed. In the context of claim 1 of the ‘544 patent, the latter information is being referred to. More specifically, the receipt of program information and parameter information is being referred to. Implicit to the execution of the program with its parameters is the storage of the received information. This term excludes digital signal processors wherein the information is stored in ROM.

78. The term ***“at least one signal processing function and signal processing function parameter”*** means BOTH a signal processing function (e.g., a DSP program) AND a parameter used by that function (e.g., a coefficient), at minimum.

79. The term ***“programming information from at least one of the input device and a control circuit of the amplifier”*** means that the receiving device, in this case the microcontroller in an external programmer, must be able to receive programming information from both its input device and from the amplifier to which it may be connected. This means that the microcontroller can read back programming information, such as functions and function parameters, that were previously stored in the amplifier.

80. The term ***“power amplifier”*** describes an electronic device that takes a small signal and renders at its output a replica of the input signal with significantly greater

amplitude, and which can deliver significant power to a load. In the context of the ‘544 patent, a power amplifier is a circuit for taking low power audio signals to a higher level that is suitable for driving loudspeakers. In the context of the ‘544 patent, an audio signal can be a voltage or a current or a delivered power. It can also be a digital signal. It is usually a representation of a music or speech program signal. Audio signals usually lie in or somewhat beyond the frequency range of 20Hz to 20kHz. Audio power amplifier input signals often have maximum values that lie in the range of 0.1 to 5 volts. Maximum audio power amplifier output signals often lie in the range of 10V to 100V. The maximum audio signal power delivered to a load by an audio power amplifier usually lies in the range of 10 watts to 2000 watts.

81. The term “*control panel*” describes a physical interface including controls to control an amplifier.

82. The term “*performance characteristics*” means any variable data relating to the behavior of the signal processing circuits, including signal processing functions and/or signal processing function parameters.⁴⁴ Two examples of performance characteristics that might be modified are the slope and cutoff frequency of a filter. Such modifications change the behavior of the system.

VII. CHALLENGED INDEPENDENT CLAIM 1

A. The subject matter of Claim 1 would not have been obvious in view of Sudo and Porambo

83. Below is challenged independent claim 1, with its individual constituent elements labeled for reference.

⁴⁴ See ‘544 patent 3:42-48.

An amplifier comprising:

- A. an input port for receiving an input signal;
- B. a signal processing circuit comprising a digital signal processor capable of receiving at least one of a signal processing function and signal processing function parameter, wherein the signal processing circuit receives the input signal from the input port and modifies the input signal;
- C. a power amplifier for amplifying the modified input signal received from the signal processing circuit and outputting an amplified signal to an output device;
- D. an external programmer; and
- E. a programming signal input port for receiving at least one programming signal from the external programmer, the external programmer being removably connectable to the programming signal input port for modifying at least one of a signal processing function and a signal processing function parameter defined in said signal processing circuit.

84. In my opinion, the cited references do not show or suggest the restriction in (E) that the amplifier includes a removable external programmer.

85. For the reasons discussed above, the interface between DSP 2 and the microcomputer 20 is hardwired and not removable. The interface 19 is not a connector, nor does it allow the microcomputer 20 to be removable. Transfer of the programming information from microcomputer 20 to DSP 2 requires a wide bus operating at high speed to satisfy tight timing constraints. The connections between the DSP 2 and the microcomputer 20 are made with metal traces on a printed wiring board. Such connections are permanent. Good engineering practice dictates that microprocessor chip 20 and DSP chip 2 be physically close together and interconnected with short printed wiring board traces.

86. Dr. Ellis agreed in his deposition that the interface between microcomputer 20 and DSP 2 must involve high speed and many connections.⁴⁵

87. As described above, DSP 2 is depicted as an integrated circuit (IC) in Sudo's Figure 1. The pins of the IC correspond to the small circles drawn on the dashed perimeter of DSP 2. Those IC package pins must be soldered to the printed wiring board and connected to microprocessor 20 with metal traces on the printed wiring board. To implement the interface between microcomputer 20 and DSP 2 with a removable connector would be technically difficult and require an expensive connector. There is no engineering motivation to make this interconnection removable and to incur these disadvantages. In fact, a PHOSITA would regard such an approach as poor engineering practice.

88. Petitioner alleges that the interface 19 in Sudo is a programming input port. It would not have been obvious to modify the proposed combination of Sudo and Porambo so that the interface 19 would be located on a control panel. In Sudo, a user controls the system by selecting keys on the keyboard 21. As such, if anything in Sudo were considered to be a control panel, it would be the keyboard 21. Nonetheless, it would not be obvious to modify Sudo to put the interface 19 on the keyboard 21, as the system would not be able to function if modified in this way. Additionally, there is no valid reason to put a control panel between the microcomputer 20 and the interface 19 in Sudo. Thus, it would not have been obvious to modify Sudo to provide a programming signal input port on a control panel.

⁴⁵ See Ellis Deposition, 6/27/2014, pages 176-180.

89. In my opinion, and for those reasons cited above, a PHOSITA would not conclude that the subject matter of claim 1 would have been obvious in view of any combination of the cited references.

**B The subject matter of Claim 1 would not have been obvious
in view of Sudo and Krokstad**

90. Below is challenged independent claim 1, with its individual constituent elements labeled for reference.

An amplifier comprising:

- A. an input port for receiving an input signal;
- B. a signal processing circuit comprising a digital signal processor capable of receiving at least one of a signal processing function and signal processing function parameter, wherein the signal processing circuit receives the input signal from the input port and modifies the input signal;
- C. a power amplifier for amplifying the modified input signal received from the signal processing circuit and outputting an amplified signal to an output device;
- D. an external programmer; and
- E. a programming signal input port for receiving at least one programming signal from the external programmer, the external programmer being removably connectable to the programming signal input port for modifying at least one of a signal processing function and a signal processing function parameter defined in said signal processing circuit.

91. In my opinion, it would not have been obvious to modify Sudo to include the RS232 connection between the microcomputer 20 and the DSP 2 to disclose the restriction in (E) that the amplifier includes a removable external programmer.

92. An RS232 connection between DSP 2 and microcomputer 20 would not work because it would not be fast enough to satisfy the needs for transfer of the programming

information from microcomputer 20 to DSP 2. The interconnection between the DSP 2 and microcomputer 20 requires a wide bus operating at high speed and having to satisfy tight timing constraints. As described above, DSP 2 is depicted as an integrated circuit (IC) in Sudo's Figure 1. The pins of the IC correspond to the small circles drawn on the dashed perimeter of DSP 2. Those IC package pins must be soldered to the printed wiring board and connected to microprocessor 20 with metal traces on the printed wiring board. To implement the interface between microcomputer 20 and DSP 2 with a removable connector would be technically difficult and require an expensive connector. There is no engineering motivation to make this interconnection removable and to incur these disadvantages. In fact, a PHOSITA would regard such an approach as poor engineering practice.

93. I know of no DSP chip that has ever been implemented with an RS232 interface. When an RS232 interface is needed to provide information to a DSP, the RS232 connection is usually made to a microcomputer that is connected to the DSP as a subsystem. Indeed, the combination of microcomputer 20 and DSP 2 is such a subsystem. This means that microcomputer 20 cannot be the removably connectable programmer, as asserted by Petitioner.

94. In my opinion, and for those reasons cited above, a PHOSITA would not conclude that the subject matter of claim 1 would have been obvious in view of any combination of the cited references.

VIII. CHALLENGED DEPENDENT CLAIM 7

A. is not obvious over Sudo in view of Porambo

95. Dependent claim 7 states:

The amplifier of claim 1, further comprising a control panel, wherein said programming signal input port is provided on the control panel.

96. The control panel of the amplifier can be seen in Figure 1 of the '544 patent, where the programming signal input port is labeled 120. None of the cited references or prior art describes a programming signal input port on the control panel or elsewhere.

97. Petitioner argues that in Sudo, microcomputer 20, together with its “keyboard” is the programmer. If anything in Sudo could be considered a control panel, it would be the keyboard because that is where the user controls the system. However, because Petitioner argues that the programming signal input port is between the microcomputer 20 and the DSP 2, then the keyboard would have to reside at the interface between microcomputer 20 and DSP 2 in order to meet this claim limitation. The keyboard is not between the microcomputer 20 and DSP 2. Additionally, because the keyboard is a control panel, there would be no motivation to include yet another control panel between the microcomputer 20 and the DSP 2.

98. In my opinion, the subject matter of claim 7 would not have been obvious to a PHOSITA in view of the cited references at the time of invention of the '544 patent.

B. is not obvious over Sudo in view of Krokstad

99. Dependent claim 7 states:

The amplifier of claim 1, further comprising a control panel, wherein said programming signal input port is provided on the control panel.

100. The control panel of the amplifier can be seen in Figure 1 of the ‘544 patent, where the programming signal input port is labeled 120. None of the cited references or prior art describes a programming signal input port on the control panel or elsewhere.

101. Petitioner here makes the same faulty allegations as in A above.

102. In my opinion, the subject matter of claim 7 would not have been obvious to a PHOSITA in view of the cited references at the time of invention of the ‘544 patent.

**IX. CHALLENGED DEPENDENT CLAIM 8
is not obvious over Sudo in view of either Porambo or Krokstad
in further view of the TMS320 Data Sheet**

103. Dependent claim 8 states:

The amplifier of claim 1, wherein the signal processing circuit further comprises a plurality of electronic components and a nonvolatile storage means for storing a set of performance characteristics.

104. In my opinion, the cited references do not show or suggest the restriction in claim 8 that the signal processing circuit includes a nonvolatile memory for storing a set of functions and function parameters.

105. As explained in the ‘544 patent specification, the use of nonvolatile memory allows the amplifier to retain its programmed information after power has been removed from the amplifier.⁴⁶ “Further, non-volatility is achieved without battery backup, RAM or ROM so that when the control signals for the signal processing circuit elements in the amplifier are input from the programmer, the circuit elements remain programmed whether the power to the amplifier is on or off.”⁴⁷ In my opinion, it would have been clear to a PHOSITA that the nonvolatility requirement of claim 8 would require the use

⁴⁶ See ‘544 patent, 3:21-24.

⁴⁷ See ‘544 patent at 5:13-17.

of NV memory that can be electronically re-written while installed in the amplifier in order to store variable data as the data changes throughout the use of the amplifier.

106. Dr. Ellis asserts that the EPROM in the TMS320 DSP can meet this limitation.⁴⁸ However, as explained earlier,⁴⁹ EPROM is not electronically re-writable, as required to meet the restriction of claim 8 that requires nonvolatile storage means:

The TMS320, whose referenced data sheet was published in 1991 (Ex. 1008), typifies the general-purpose digital signal processor integrated circuits that were available in the early 1990s.

While it was well known to include nonvolatile (NV) memory (ROM/EPROM) in a DSP at the time of invention of the '544 patent, electronically re-writable nonvolatile memory was not commercially available as on-chip memory in DSPs at this time. EPROM is not electronically re-writable. The EPROM must first be erased in a programming fixture before it can be written with new data. The EPROM is erased in the fixture by shining Ultraviolet light through a transparent glass window in the package. The Ultraviolet light discharges the floating gates of the transistors that are used to store information. The entire content is erased. The need for erasure by Ultraviolet light means that the EPROM is not electronically re-writable. Clearly, the need for Ultraviolet erasure in a commercial application would be burdensome. The EPROM is thus unsuitable for use as the NV memory in commercial applications where new information must be written in-situ into an NV memory.

Moreover, the TMS320 on-board NV memory is intended to be in the form of ROM for mass-produced products. EPROM is primarily intended for development purposes. The TMS320 datasheet indicates that EPROM is primarily for development purposes and that the masked ROM version should be used in production or during manufacture, never to be programmed again.⁵⁰ In my opinion, it is extremely unlikely, for example, that Porambo would have used the EPROM version of the TMS320 in his car radio.

107. Dr. Ellis asserts that Sudo could be modified to include EPROM in order to meet the restriction that the signal processing circuit must include nonvolatile storage means for storing a set of performance characteristics. He cites the TMS320 datasheet as

⁴⁸ See Ellis' Declaration, Ex. 1003, paragraph 58.

⁴⁹ See TMS320 – State of the Art, Section IV-D, Paragraphs 58, 60 and 61 herein.

⁵⁰ See TMS320 datasheet, Ex. 1008, 58:1-5.

providing nonvolatile memory in the form of EPROM.⁵¹ I disagree with Dr. Ellis' assertion.

108. The TMS320 family DSPs include ROM or EPROM for nonvolatile storage.⁵² It is well understood that ROM cannot receive information after its one-time programming at the factory. EPROM is also not suitable for nonvolatile storage of performance characteristics in the application disclosed by the '544 patent because it cannot be electronically be re-written. It must be first erased in a programming fixture by the exposure to Ultraviolet light.⁵³ Moreover, Sudo is intended for mass production manufacture, and the TMS320 datasheet states that ROM should be used in high-volume applications.⁵⁴

109. Dr. Ellis made a similar argument suggesting the use of EPROM in Porambo order to meet the restriction that the digital signal processor be capable of receiving a signal processing function and parameter.⁵⁵ However, Porambo discloses that the TMS320C25 DSP should be used.⁵⁶ The TMS320 series of DSPs is available in versions with ROM or EPROM for program storage. The TMS320C25 specified by Porambo is the ROM version. The TMS320E25 is the EPROM version.⁵⁷ For this reason it is my opinion that programs are stored in ROM by Porambo. This undermines Dr. Ellis' assertion here and further supports my opinion that EPROM would not be a workable modification to Sudo in order to meet the restriction that the signal processing circuit include nonvolatile storage means for storing a set of performance characteristics. In my

⁵¹ See Ellis' Declaration, Ex. 1003, paragraphs 58 and 59.

⁵² See TMS320 datasheet, Ex. 1008, pages 1 and 58.

⁵³ See TMS320 datasheet, Ex. 1008, 58:1-5.

⁵⁴ See TMS320 datasheet, Ex. 1008, 58:1-5.

⁵⁵ See Ellis' Declaration for the '542 patent, paragraphs 23 and 43.

⁵⁶ See Porambo, Ex. 1006, 4:15-19.

⁵⁷ See TMS320 datasheet, Ex. 1008 page 1, third and fourth bullets.

opinion, it follows that Sudo's disclosure does not meet the limitation that the signal processing circuit include nonvolatile storage means for storing a set of performance characteristics.

110. In my opinion, the subject matter of claim 8 would not have been obvious to a PHOSITA in view of the cited references at the time of invention of the '544 patent. None of the references cited by Petitioner describe the use of NV memory that is electronically re-writable, nor suitable to meet the restriction for nonvolatility in claim 8.

**X. CHALLENGED DEPENDENT CLAIM 11
is not obvious over Sudo in view of either Porambo or Krokstad**

111. Dependent claim 11 states:

The amplifier of claim 9, wherein the external programmer further comprises a storage device for storing the input programming information and previously selected control signals.

112. In my opinion, the cited references do not show or suggest the restriction in claim 11 that the external programmer includes a memory for storing input programming information and previously selected functions and function parameters.

113. This restriction refers to storage (memory) in the programmer itself. "The microprocessor 252 receives information from the keypad 230 and may store the input information in the memory 254."⁵⁸ This memory is the unlabeled box 254 in the programmer depiction in Figure 2. This allows the selection of previously-programmed functions and parameters, as might have previously been entered in the programming of an amplifier.⁵⁹ This can be especially useful for programming multiple amplifiers one

⁵⁸ See '544 patent, 7:9-11.

⁵⁹ See '544 patent, 8:3-15.

after the other. In some cases, this means that programming information only needs to be manually entered once. “The memory may also store previously set parameter values, a menu and plurality of groups of parameter values, signal processing function programs and program data and other suitable control information.”⁶⁰ When the programmer is connected to program an amplifier, it can already have program and parameter information stored in it, possibly more than one set of such information.

114. This programming information can be accessed from a menu. This memory could also facilitate the programmer receiving the information from a source like a PC where libraries of program information may be stored. The programmer could also read the programmed information from one amplifier and store it,⁶¹ and then be used to upload that information to other amplifiers, as in a cloning process.⁶² This capability can be valuable in setting up many amplifiers in a large venue. It can also help assure that multiple amplifiers have exactly the same programming, if desired. Manual programming of each amplifier with the programmer would be more labor-intensive and less reliable in terms of programming consistency and operator error.

115. Petitioner relies on Sudo for the alleged disclosure of a storage device in an external programmer to satisfy the limitation of claim 11.⁶³ However, Sudo stores only pre-configured functions and parameters in microcomputer 20, which Petitioner alleges to be the programmer, and no entry of functions and parameters is possible. “In addition to the control program for the microcomputer itself, various processing program groups which are used in the DSP 2, a plurality of coefficient data groups which are used in the

⁶⁰ See ‘544 patent 7:11-14.

⁶¹ See ‘544 patent, 4:13-21.

⁶² See ‘544 patent, 5:23-27.

⁶³ See Ellis’ Declaration, paragraph 65.

processing programs, and the like, have been stored in the ROM of the microcomputer 20.”⁶⁴ “The microcomputer 20 reads out the processing program corresponding to the operated sound field control key, the coefficient data group used in a particular program, and the like, from the ROM, and transfers this data to the DSP 2 through the interface 19.”⁶⁵

116. Sudo makes no mention of microcomputer 20 receiving information (especially programming information) from the DSP 2. The system in Sudo performs read cycle steal operations where the microcomputer 20 provides the DSP 2 with data. The DSP 2 does not provide the microcomputer 20 with data. Modifying Sudo to make the DSP 2 able to send data to the microcomputer 20 would increase bandwidth on the main bus 17 and interface 19, which could interfere with the strict timing requirement of the read cycle steal operation. Additionally, Sudo does not disclose storing the current and previous selections.

117. In my opinion, the subject matter of claim 11 would not have been obvious to a PHOSITA in view of the cited references at the time of invention of the ‘544 patent.

**XI. CHALLENGED DEPENDENT CLAIM 13
is not obvious over Sudo in view of either Porambo or Krokstad**

118. Dependent claim 13 states:

The amplifier of claim 9, wherein the controller comprises a microprocessor for receiving programming information from at least one of the input device and a control circuit of the amplifier.

⁶⁴ See Sudo, Ex. 1005 3:54-60.

⁶⁵ See Sudo, Ex. 1005 3:61-67.

119. In my opinion, the cited references do not show or suggest the restriction in claim 13 that the microprocessor in the external programmer is able to receive functions and function parameters from both the input device and the amplifier.

120. The controller referred to in claim 9 is the controller that resides in the programmer, and is described as:

a controller for receiving the input programming information, generating programming signals from the input programming information and transmitting the programming signals through the input/output port to the amplifier for modifying at least one of a signal processing function and a signal processing function parameter of the amplifier.

Note the phrase “receiving programming information from at least one of the input device and a control circuit of the amplifier”. This implies bi-directional information flow to and from the amplifier, since it has already been made clear that the programmer transmits programming information to the amplifier. Moreover, it means that programming information that was previously stored in the amplifier can be read back by the microprocessor in the programmer, specifically including previously stored program and coefficient data.⁶⁶

121. Petitioner relies on Sudo for the alleged disclosure of a microprocessor in an external programmer to receive programming information from a control circuit in the amplifier in order to satisfy the limitation of claim 13.⁶⁷ Sudo makes no mention of microcomputer 20 receiving information (especially programming information) from the DSP. In Sudo, the microcomputer merely transfers (transmits) programming information to the DSP.⁶⁸

⁶⁶ See ‘544 patent, 7:29-38.

⁶⁷ See Ellis’ Declaration, paragraph 71.

⁶⁸ See Sudo, Ex. 1005 3:61-67.

122. In my opinion, Sudo does not disclose an external programmer with a microprocessor for receiving programming information from a control circuit of an amplifier. In my opinion, the subject matter of claim 13 would not have been obvious to a PHOSITA in view of the cited references at the time of invention of the ‘544 patent.

**XII. CHALLENGED DEPENDENT CLAIM 21
is not obvious over Sudo in view of Porambo or Krokstad**

123. Dependent claim 21 states:

The amplifier of claim 1, wherein said digital signal processor receives and stores a combination of at least two signal processing functions.

124. In my opinion, the cited references do not show or suggest the restriction in claim 21 that the digital signal processor receives and stores a combination of at least two signal processing functions.

125. This restriction refers to the requirement that multiple different signal processing functions can be combined to create a new signal processing function and function parameters. For example, a crossover and an equalizing function can be made into a single signal processing function called “subwoofer 1” that is intended to be in the signal chain of a subwoofer.⁶⁹ A desirable advantage of the restriction of claim 21 is the enablement of the amplifier to take over and provide signal processing functions that previously required separate boxes or equipment external to the amplifier.

126. Petitioner relies on the disclosure of Krokstad to meet this limitation, claiming that Krokstad discloses a DSP that performs more than one signal processing

⁶⁹ See ‘544 patent, 4:1-5.

function in an amplifier (e.g., compression, equalization, pre-compensation, etc).⁷⁰

However, Krokstad does not meet the limitation of claim 1 requiring that the digital signal processor be able to be programmed in such a way as to modify at least one of a signal processing function and a signal processing function parameter.⁷¹ Krokstad does not disclose the programming of functions into the DSP. Krokstad only discloses the programming of coefficients into the DSP.⁷² Additionally, Krokstad only mentions different preconfigured functions (precompensator 37, compressor 33, equalizer 34).⁷³ There is no mention or suggestion of these functions being combined to create a new and different combination of functions.

127. Petitioner also relies on statements alleged as Patent Owner's Admitted Prior Art. These statements are made in the context of a conventional signal processing circuit, not in the context of programming a digital signal processor. Moreover, these statements do not address combining multiple signal processing functions to create a new and different combination of functions.

128. In my opinion, Petitioner has failed to provide a disclosure of a signal processor that receives and stores a combination of at least 2 signal processing functions. In my opinion, therefore, the subject matter of claim 21 would not have been seen as obvious by a PHOSITA.

⁷⁰ See Ellis' Disclosure, Ex. 1003, paragraph 96.

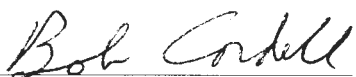
⁷¹ See '544 patent, 8:38-41.

⁷² See Krokstad – State of the Art, Section IV-C, Paragraphs 51, 52 and 56 herein.

⁷³ See Krokstad, Ex. 1007, 20:1-9.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further, that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the results of these proceedings.

Respectfully Submitted.


Bob Cordell


Date

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Education

Bachelor of Electrical Engineering
Rensselaer Polytechnic Institute (RPI), 1970

Master of Electrical Engineering
Stanford, 1971

Professional Experience

Bell Laboratories – Holmdel, NJ
Member of Technical Staff, Transmission Systems Division, 1970 - 1977

Bell Laboratories – Holmdel, NJ
Supervisor – Digital Systems Group, 1977 - 1983

Bell Communications Research (Bellcore) – Red Bank, NJ
Director, VLSI Systems Research Group, 1983 – 1993

Bell Communications Research (Bellcore) – Red Bank, NJ
Director, Optical Network Systems Technology Research, 1993 – 1997

David Sarnoff Research Center – Princeton, NJ
Head, Integrated Systems Design, 1997 - 2000

Tyco Telecommunications - Eatontown, NJ
Distinguished MTS, Optical Terminal Systems, 2000 – 2013

Cordell Audio – Holmdel, NJ
Proprietor, author and consultant, 2013 - Present

Patents

Granted sixteen patents in the areas of:

- ATM switching
- digital compression coding
- clock and data recovery
- integrated circuit phase-locked loops
- variable equalizers
- optical communications
- loudspeaker design

Conference Presentations

Presented 13 papers at industry technical conferences

- ISSCC (3)
- CICC (3)
- ICC (1)
- NTC (1)
- NFOEC (1)
- AES (4).

Professional Organizations and Industry Participation

- Technical Program Committee, IEEE GaAs IC Symposium
- Steering Committee, Custom Integrated Circuits Conference (CICC), 1996-2001
- Technical Program Chairman, 1996 CICC, Conference Chairman 1997
- Review Board, Journal of the Audio Engineering Society
- Senior Member, IEEE
- Member Audio Engineering Society (AES)

1. I began my career in 1970, working as an electrical engineer at Bell Laboratories in Holmdel, NJ, after having graduated with a Bachelor of Electrical Engineering degree from RPI.

2. As an employee with Bell Labs, I attended Stanford in 1970 – 1971, graduating with a Master of Electrical Engineering. This sponsorship was called the One Year on Campus (OYOC) program.

3. My responsibilities at Bell Labs during this time included analog and high speed digital transmission system design, the latter including both digital coaxial and fiber optic systems.

4. During this period I designed 1) linear integrated circuit phase-locked loops, including a phase-frequency locked loop for timing recovery in a 45 Mbit/s lightwave regenerator; 2) a fault locating system (for a coaxial digital transmission system) that employed FSK telemetry and microprocessors; 3) Intel 8008- and 8080-based microprocessor systems; 4) precision fixed and adaptive equalizers for the Picturephone repeater.

5. In 1977 I was promoted to Supervisor of the Digital Systems Group at Bell Labs, Holmdel.

6. During this period I managed the design of hardware/firmware development tools for the first and later Bell Labs VLSI programmable digital signal processors (DSP).

7. In 1983 I left Bell Labs and joined Bell Communications Research (Bellcore) as part of the Divestiture of the Bell System. There I formed the VLSI Systems Research Group, and was its Director.

8. During this period I managed research on CMOS VLSI design and Computer Aided Design (CAD) tools. The CAD effort concentrated on symbolic layout systems. Results included the first Symbolic Standard Cell system. The VLSI design effort focused on high-speed CMOS

circuits for SONET, ATM, HDTV, and low-power wireless applications. Results included work on a 622 Mb/s CMOS clock and data recovery circuit and the design and implementation of a research prototype low-power TDMA PCS wireless modem chip in 0.6-micron CMOS and operating at 3 Volts.

9. In 1993 while at Bellcore I became Director of the Optical Network Systems Technology Research group.

10. During this period I managed research on multiwavelength all-optical networks, including Bellcore's role as principle member of the Optical Networks Technology Consortium (ONTC), an ARPA-supported optical networking project involving transmission at 2.5 Gbits/s on each of four wavelengths on a single optical fiber. Areas of research included high-speed transmission technology and system integration, network architecture and network operations. Results included joint development of a multiwavelength Network Access Module (NAM), which won a 1996 R&D 100 Award. The NAM ultimately evolved into the flagship product of Tellium, Inc., after Tellium was spun out of Bellcore.

11. During this period I also managed research and development of high-speed optoelectronic integrated circuits and fabrication processes based on Indium Phosphide (InP) Heterojunction Bipolar Transistor (HBT) technology. Results of this effort included a practical carbon-doped InP HBT IC process and an 8-channel, 2.5 Gbit/channel Optoelectronic Integrated Circuit (OEIC) receiver array IC built in this process.

12. In 1997 I joined the David Sarnoff Research Center in Princeton, NJ to manage the development of VLSI integrated circuits for digital television systems. There I was Head of Integrated Systems Design.

13. During this period I managed IC MPEG-2 audio/video decoder development, and sale of Digital TV chip design IP to other corporations. Versions of the decoder design included DVD program parsing or DVB transport parsing. Audio decoding included both Dolby AC-3 and

MPEG-2. The 200,000-gate design was licensed to several companies. This job also involved extensive contact with industry customers for both technical interchange and marketing of this and similar IP.

14. In 2000 I joined Tyco Telecommunications (now TE SubCom) as a Distinguished MTS. TE SubCom, a descendant of AT&T Long Lines, is the premier provider of undersea fiber optic transmission systems. These systems employ dense wavelength division multiplexed optical technology to provide transport at rates of 10, 40 and 100Gb/s on each of as many as 128 different optical wavelengths.

15. During this period I was responsible for optical terminal design that included highly complex high-speed 20-layer circuit boards. These boards included high-speed forward error correction integrated circuits operating at clock speeds in excess of 10GHz and packaged in ball grid arrays with more than 1500 pins. These boards also included very large high-speed FPGA devices. I was a key developer of the first DPSK lightwave transmission system deployed for ultra long haul undersea systems. Subsequently, I was a key developer for TE SubCom's coherent optical communications systems operating at 40 and 100Gb/s per wavelength.

16. I retired from TE SubCom in 2013 to pursue full-time my personal career in audio engineering with Cordell Audio, where I am an author and consultant. My personal involvement in audio has run parallel to my professional career since 1970. In 2010 I authored the book "Designing Audio Power Amplifiers", published by McGraw-Hill. The 600-page book covers all aspects of audio power amplifier design. In 2014 I wrote the chapter "Amplifier Design" for the sixth edition of "The Handbook for Sound Engineers", edited by Glen Ballou and to be published late in 2014 by Focal Press.

17. Since 2012 I have been consulting for Linear Integrated Systems, Fremont CA. They are a semiconductor company whose products include single and dual monolithic JFETs, for which I provide application engineering. I also provide technical assistance with the introduction of new products. In the course of that work I wrote an application note titled “LSK489 Ultra Low Noise JFET” (www.linearsystems.com). This note discusses JFET noise sources and numerous applications of the LSK489 dual monolithic JFET.

18. During the course of my career I was granted 16 patents. I participated extensively in the writing of the specifications and claims for all of these patents, working closely with the patent attorneys. One of those patents is for an Equalized Quasi Sealed System (EQSS) loudspeaker arrangement. I wrote and prosecuted that patent myself, without a patent attorney, and interacted directly with the patent examiner.