

United States Court of Appeals for the Federal Circuit

99-1558,-1559, 00-1006

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CRYSTAL SEMICONDUCTOR CORPORATION,

APR 05 2001

Plaintiff-Appellant,

CLERK, U.S. DISTRICT COURT
WESTERN DISTRICT OF TEXAS
[Signature]
DEPUTY CLERK

v.

TRITECH MICROELECTRONICS INTERNATIONAL, INC.
and TRITECH MICROELECTRONICS INTERNATIONAL PTE LTD.,

Defendants-Cross Appellants,

and

OPTI, INC.,

Defendant.

JUDGMENT

ON APPEAL from the United States District Court for the Western
District of Texas

in CASE NO(S) 1: 97-CV-26 SS

This CAUSE having been heard and considered, it is

ORDERED and ADJUDGED:

AFFIRMED-IN-PART, REVERSED-IN-PART, VACATED-IN-PART, and REMANDED

ENTERED BY ORDER OF THE COURT.

DATED MAR - 7 2001

[Signature: Jan Horbaly]
Jan Horbaly, Clerk

A True Copy.

Attach: March 28, 2001
[Signature: Linda P. Gude]
Deputy Clerk

ISSUED AS A MANDATE: MARCH 28, 2001

687

United States Court of Appeals for the Federal Circuit

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Plaintiff-Appellant,

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TRITECH MICROELECTRONICS INTERNATIONAL, INC.
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Defendants-Cross Appellants,

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OPTi, INC.,

Defendant.

Wayne M. Harding, Brobeck, Phleger & Harrison LLP, of Austin, Texas, argued for plaintiff-appellant. With him on the brief were Kevin S. Kudlac, and Steven J. Pollinger. Of counsel on the brief was J.P. Violette, Crystal Semiconductor Corporation, of Austin, Texas.

Daniel Joseph, Akin, Gump, Strauss, Hauer & Feld, L.L.P., of Washington, DC, argued for defendants-cross appellants. With him on the brief were C. Fairley Spillman; and Michael Rocco Cannatti, of Austin, Texas. Of counsel was Gary W. Hamilton, Akin, Gump, Strauss Hauer & Feld, L.L.P., of Austin, Texas. Also of counsel was Michael A. Piazza, Akin, Gump, Strauss, Hauer & Feld, L.L.P., of Dallas, Texas.

Appealed from: United States District Court for the Western District of Texas

Judge Sam Sparks

United States Court of Appeals for the Federal Circuit

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TRITECH MICROELECTRONICS INTERNATIONAL, INC.
and TRITECH MICROELECTRONICS INTERNATIONAL PTE LTD.,

Defendants-Cross Appellants,

and

OPTi, INC.,

Defendant.

DECIDED: March 7, 2001

Before MAYER, Chief Judge, CLEVINGER, and RADER, Circuit Judge.

RADER, Circuit Judge.

On a motion for partial summary judgment, the United States District Court for the Western District of Texas determined that OPTi Inc.'s (OPTi's) and TriTech Microelectronics International, Inc.'s (TriTech's) accused devices literally infringe Crystal Semiconductor Corporation's (Crystal's) U.S. Patent Nos. 4,746,899 ('899 patent) and 5,220,483 ('483 patent). See Crystal Semiconductor Corp. v. OPTi, Inc., No. A 97-CA-026 SS (W.D. Tex. Apr. 20, 1999). After the close of evidence but before the case went to the jury, the district court granted judgment as a matter of law (JMOL) that Crystal's U.S. Patent No. 4,851,841 (the '841 patent) was not invalid due to an on-

sale bar. See Crystal Semiconductor Corp. v. OPTi, Inc., No. A 97-CA-026 SS (W.D. Tex. May 12, 1999).

At trial, the jury found that TriTech and OPTi willfully infringed all three patents and awarded damages in excess of \$48 million. The district court granted TriTech's JMOL motion that Crystal was not entitled to lost profit or price erosion damages, and remitted Crystal's damages to a reasonable royalty of \$10 million. See Crystal Semiconductor Corp. v. OPTi, Inc., No. A 97-CA-026 SS, slip op. at 8 (W.D. Tex. July 23, 1999) (Crystal). The district court then doubled Crystal's damages to \$20 million due to TriTech's willful infringement. See id. at 19. The district court also awarded Crystal attorney fees but denied prejudgment interest. See id. at 21.

Because the district court properly granted partial summary judgment of infringement, this court affirms that portion of the judgment. However, because the district court improperly entertained Crystal's JMOL motion on the on-sale bar, this court vacates and remands. Further, because the district court properly granted TriTech's JMOL motion to deny price erosion damages, properly denied TriTech's JMOL motion to void the finding of willfulness, and acted within its discretion in denying prejudgment interest, this court affirms those parts of the judgment. However, because the record shows entitlement to lost profit damages and because the district court erred in its damages calculation, this court reverses and remands to the district court to enter an award as determined by this court.

I.

Crystal, a subsidiary of Cirrus Logic, Inc., is the assignee of the '483, '841, and '899 patents. All three patents involve analog-to-digital (A/D) converter technology. A/D converters convert sound (or analog input voltage information) into digital information and are commonly used in the compact disc burners or sound cards of personal computer (PC) systems.

Sound may be recorded using either analog or digital signals. In an analog recording, sound is converted into an electrical signal by a device such as a microphone. The microphone generates an electrical signal that varies in proportion to changes in pitch, tone, and volume. The voltage signal is an analogous replica of the sound source, thus the name "analog" sound.

A digital recording converts the same sound source into a series of binary numbers, 1s and 0s. This digital signal represents the sound source. A digital signal is not continuous. Rather, it represents a "sampling" of the sound source at regular, closely spaced intervals. Each sample is analogous to a digital snapshot of the sound at a particular point in time. If the sampling is done frequently enough, the digital signal can accurately represent the sound source. Common A/D converters operate at approximately 44.1 kHz, meaning they sample sound approximately 44,100 times per second. In sum, an A/D converter transforms audio waveforms into series of bits. These bits can be processed and stored by a digital recording medium.

Earlier A/D converters were typically made of two or more separate converter circuit devices and several external components. These multiple bulky components

operated on two or three power supply voltages. In the late 1970's, the semiconductor industry integrated A/D converters onto a single chip. These integrated-circuit A/D converters are smaller, more reliable, less costly, and consume less power. However, because the single chip design places many components in close proximity, electrical noise is an inherent problem. In particular, components for processing analog inputs generate high frequency bursts that interfere with components for digitizing the input voltage. This electrical noise causes digitization errors that distort the recording.

In general, Crystal's three patents-in-suit relate to techniques for reducing or eliminating the effects of electrical noise in integrated-circuit A/D converter chips. The '899 patent, issued on May 24, 1988, discloses a method for using clock technology to control electrical noise. Under the claimed method, a first clock signal samples the analog input voltage while a separate, delayed clock signal activates operation of the digital circuit. Because activation of the digital circuit is thus offset in time from the analog sampling, the activation signal does not interfere with the analog sampling, or vice versa.

The '841 patent, issued on July 25, 1989, claims an A/D converter with a sampling component called a delta-sigma modulator and a signal digitizing component called a digital decimation filter. These components reduce the effects of noise in the integrated chip. The patent also claims methods for reducing noise. The delta-sigma modulator has a feedback reference voltage input and the digital decimation filter uses impulse-response coefficients. The patent claims recite the reduction of noise through gain scaling – setting the effective feedback reference voltage on the delta-sigma

modulator to a value that is greater than the maximum analog input voltage and correspondingly adjusting the gain of the digital decimation filter.

The '483 patent, issued on June 15, 1993, claims a capacitor structure with a sub-circuit and a tri-layered, insulated capacitor. This capacitor has a guarding structure around the second layer (the sensitive node) to shield extraneous noise.

By 1994, Apple and Intel/Windows PCs included audio systems with stereo sound. These audio systems used a CODEC -- a combination A/D converter and digital-to-analog converter on a single chip. The CODEC transforms analog sound signals into digital form for processing on a PC, and also decodes the digital form back into analog sound so the user can hear it. Crystal incorporated its A/D converter technology, covered by the three patents-in-suit, into CODEC audio chips, and began selling the chips in the audio PC market in 1991. Early audio chips were of relatively low quality, with only eight bits of digitization per sample. Crystal's audio chips are sixteen-bit CODECs and provide higher quality sound than the eight-bit CODECs.

TriTech, a company with facilities in Singapore and California, designs, manufactures, and sells audio chips. In 1994, TriTech began manufacturing sixteen-bit audio CODECs in Singapore and selling the chips worldwide. TriTech sold some of these chips to OPTi, which in turn sold these audio chips under the name "Model 931" to the U.S. PC market.

By March 1995, Crystal reverse engineered several of OPTi's and TriTech's audio chips to determine whether the technology in these chips fell within the scope of Crystal's patents. On January 10, 1997, Crystal filed suit in the United States District

Court for the Western District of Texas accusing both TriTech and OPTi of infringing Crystal's '899, '841, and '483 patents.

Following a hearing in January 1998, a special master construed the claims of these patents. J. App. 95-144.1. The district court adopted the Special Master's claim interpretation. Crystal then filed summary judgment motions alleging that the OPTi Model 931 audio chip literally infringed the '483 and '899 patents. The district court entered summary judgment that the Model 931 chips contain every element of claims 1, 6, 9, 10, 15, and 18 of the '483 patent and claims 1, 3, and 4 of the '899 patent. The court left to the jury to decide whether TriTech and OPTi had committed acts of infringement in the United States.

The district court conducted a jury trial on infringement, validity, enforceability, and damages. At the close of evidence, but before jury deliberation, the district court granted Crystal's motion for JMOL that the '841 patent was not invalid under an on-sale bar. The district court further granted Crystal's JMOL motion that the '899 and '841 patents were not unenforceable due to inequitable conduct and were not invalid for violating the best-mode requirement.

Before trial, OPTi conceded infringement of claims 1, 10, and 15 of the '483 patent. The jury returned with a verdict that both TriTech and OPTi literally infringed claim 4 of the '899 patent and claims 2-4 of the '841 patent, and that TriTech literally infringed claims 1, 10, and 15 of the '483 patent. The jury further found both TriTech and OPTi to have infringed claims 2-4 of the '841 patent under the doctrine of equivalents. The jury next found all asserted claims of all three patents nonobvious.

On the question of damages, the jury awarded Crystal \$11,830,862 in lost profits, \$26,649,766 in price erosion damages, and \$10,000,000 in reasonable royalties. The jury split the damages, finding TriTech liable for 60% and OPTi liable for 40%. Finally, the jury found TriTech willfully infringed the claims of the asserted patents.

After the jury verdict, TriTech and OPTi requested the trial court on JMOL to reject the jury's lost profits and price erosion verdicts. Crystal opposed the motions and filed its own motion for prejudgment interest. The district court entered JMOL denying Crystal lost profits and price erosion due to lack of supporting evidence. The court further denied Crystal any prejudgment interest.

TriTech also challenged the jury's willfulness finding by a JMOL motion. The court rejected the challenge. Based on this willfulness finding, the court doubled Crystal's reasonable royalty award and entered a total enhanced damage award of \$20,000,000.

Crystal appeals the district court's denial of the jury's lost profits and price erosion verdicts and the court's denial of Crystal's request for prejudgment interest. TriTech cross-appeals the court's grant of JMOL that Crystal's '841 patent is not barred by premature sale, the court's construction of the '483 patent's claims, the court's grant of summary judgment of literal infringement of the '483 and '899 patents, the jury's finding that TriTech infringed the '899 patent, the jury's verdict of willful infringement of the '483 and '841 patents, and the court's enhanced damages calculation. Before appeal, OPTi settled its case with Crystal. This court has jurisdiction to hear Crystal's appeal and TriTech's cross-appeal under 28 U.S.C. § 1295(a)(1) (1994).

II.

This court reviews without deference a district court's grant of summary judgment and draws all reasonable factual inferences in favor of the non-movant. Anderson v. Liberty Lobby, Inc., 477 U.S. 242, 255 (1986); Cortland Line Co. v. Orvis Co., 203 F.3d 1351, 1355, 53 USPQ2d 1734, 1746 (Fed. Cir. 2000).

Patent infringement involves both claim construction and application of the claim to the accused product. Markman v. Westview Instruments, Inc., 52 F.3d 967, 976, 34 USPQ2d 1321, 1326 (Fed. Cir. 1996) (en banc), aff'd, 517 U.S. 370 (1996). Claim construction is a matter of law that this court reviews without deference. Cybor Corp. v. FAS Techs., Inc., 138 F.3d 1448, 1454, 46 USPQ2d 1169, 1172 (Fed. Cir. 1998) (en banc). Application of the claim to the accused device is a question of fact, findings of which are accorded substantial deference on review. Embrex, Inc. v. Serv. Eng'g Corp., 216 F.3d 1343, 1348-49, 55 USPQ2d 1161, 1164 (Fed. Cir. 2000). The infringement inquiry remains focused at all times on the claim language, as illuminated by the written description and the prosecution history. Pitney Bowes, Inc. v. Hewlett-Packard Co., 182 F.3d 1298, 1309, 51 USPQ2d 1161, 1169 (Fed. Cir. 1999).

This court reviews without deference a district court's grant of JMOL under Federal Rule of Civil Procedure 50. Burroughs Wellcome Co. v. Barr Lab. Inc., 40 F.3d 1223, 1227, 32 USPQ2d 1915, 1919 (Fed. Cir. 1994). On appeal, this court applies the same standard as the district court. Id. This court affirms a grant of JMOL if substantial evidence does not support the jury's factual findings or if those factual findings do not support the jury's legal conclusions. Id.

The measurement of patent damages is a question of fact. Brooktree Corp. v. Advanced Micro Devices, Inc., 977 F.2d 1555, 1578, 24 USPQ2d 1401, 1417 (Fed. Cir. 1992). This court, therefore, reviews a jury's damage award for substantial evidence. SmithKline Diagnostics, Inc. v. Helena Lab. Corp., 926 F.2d 1161, 1164 n.2, 17 USPQ2d 1922, 1925 n.2 (Fed. Cir. 1991).

A jury verdict of willful infringement is a question of fact and is reviewed by this court for substantial evidence. Hoechst Celanese Corp. v. BP Chems. Ltd., 78 F.3d 1575, 1582, 38 USPQ2d 1126, 1132 (Fed. Cir. 1996). To establish willful infringement, a plaintiff must prove by clear and convincing evidence that the defendant acted without a reasonable belief that its action avoided infringement. E.I. DuPont de Nemours & Co. v. Phillips Petroleum Co., 849 F.2d 1430, 1440, 7 USPQ2d 1129, 1137 (Fed. Cir. 1988).

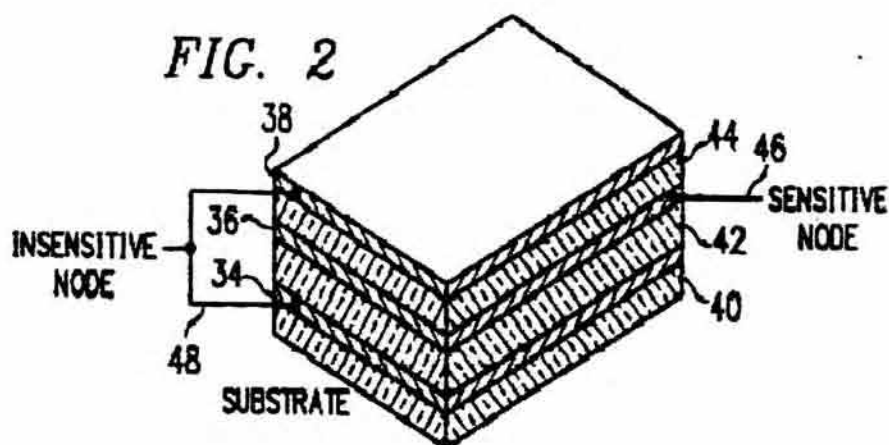
This court reviews a district court's denial of prejudgment interest for an abuse of discretion. Lummus Indus., Inc. v. D.M. & E. Corp., 862 F.2d 267, 275, 8 USPQ2d 1983, 1989 (Fed. Cir. 1988). However, the discretion of the district court in denying prejudgment interest is limited to specific circumstances. Gen. Motors Corp. v. Devex Corp., 461 U.S. 648, 657 (1983) ("[P]rejudgment interest should be awarded under § 284 absent some justification for withholding such an award."); Lummus at 275.

Infringement

The '483 Patent

Claim 1 of the '483 patent recites three main elements: (1) a substrate, (2) a sub-circuit, and (3) a capacitor with three sandwiched layers -- each "disposed over a

portion" of the underlying layer. The tri-layered structure has a first conductive layer of a material such as polysilicon. This layer lies over the semiconductor substrate. A second conductive layer of a material, such as a metal, lies over the first layer surrounded by a guarding capacitor structure. A third layer of a material, such as a metal, lies over the second layer. An insulating layer separates each of these three layers from one another. Thus the invention describes a sandwiched structure as depicted in Figure 2 of the '483 patent (the first, second, and third layers labeled as 34, 36, and 38 respectively).



The disputed portion of claim 1 recites:

a capacitor having first and second plates formed on the first face of said semiconductor substrate, said capacitor having:

a first conductive layer disposed over a portion of the first face of said semiconductor substrate and separated therefrom by a first insulating layer,

a second and shielded conductive layer disposed over a portion of said first conductive layer and separated therefrom by a second insulating layer,

a third conductive layer disposed over a portion of said second and conductive layer and separated therefrom by a third insulating layer,

....

a fourth conductive layer disposed in substantially the same plane as said second shielded conductive layer and disposed a predetermined distance therefrom and a third connecting device for connecting said fourth conductive layer to a predetermined voltage.

(emphasis added). The trial court construed "disposed over a portion" to require an "area of coincidence between the two layers greater than zero." Thus, the court interpreted claim 1 to encompass capacitor structures with layers covering anywhere from a small area to the entire area of the underlying surface.

Claim language itself sets the claim scope. Vitronics Corp v. Conceptronic, Inc., 90 F.3d 1576, 1582, 39 USPQ2d 1573, 1577 (Fed. Cir. 1996). This court has consistently emphasized that the indefinite articles "a" or "an," when used in a patent claim, mean "one or more" in claims containing open-ended transitional phrases such as "comprising." KCJ Corp. v. Kinetic Concepts, Inc., 223 F.3d 1351, 1356, 55 USPQ2d 1835, 1839 (Fed. Cir. 2000); see Elkay Mfg. Co. v. Ebco Mfg. Co., 192 F.3d 973, 977, 52 USPQ2d 1109, 1112 (Fed. Cir. 1999); AbTox, Inc. v. Exitron Corp., 122 F.3d 1019, 1023, 43 USPQ2d 1545, 1548 (Fed. Cir. 1997). "Under this conventional rule, the claim limitation 'a,' without more, requires at least one." KCJ at 1356 (emphasis added).

Based on this conventional rule, because claim 1 is open-ended, the limitation "disposed over a portion" means "disposed over at least one portion." This claim construction comports completely with the district court's claim construction. Thus, claim 1's proper construction does not limit "disposed over a portion" to only a portion of the layer beneath. In other words, claim 1 includes within its scope a capacitor structure with layers disposed over the entirety of the underlying surface. Claim 1 does

not require a capacitor structure shaped like a three-tiered wedding cake, with the first layer being largest in surface area and the third layer being smallest, or stacked like staggered, partly overlapping layers.

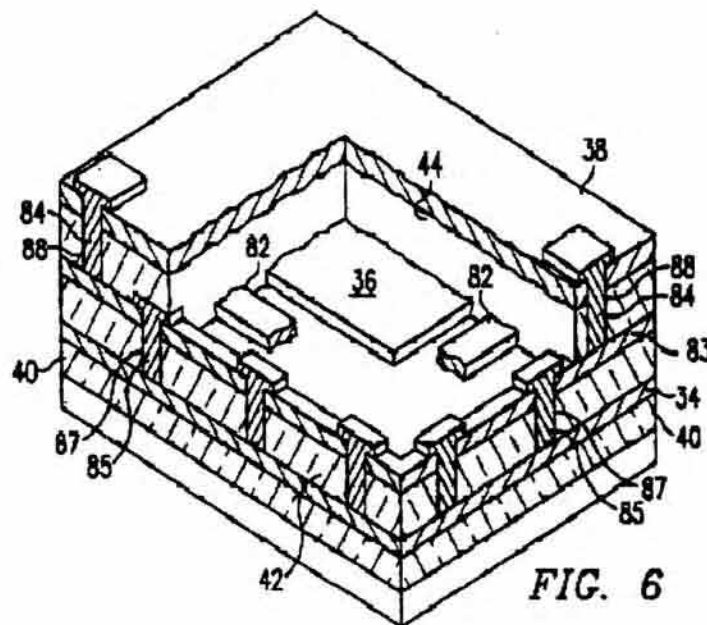
When a patent claim uses the word "comprising" as its transitional phrase, the use of "comprising" creates a presumption that the body of the claim is open. In the parlance of patent law, the transition "comprising" creates a presumption that the recited elements are only a part of the device, that the claim does not exclude additional, unrecited elements. See KCJ, 223 F.3d at 1356.

The transition "having" can also make a claim open. Regents of the Univ. of Cal. v. Eli Lilly & Co., 119 F.3d 1559, 1573, 43 USPQ2d 1398, 1410 (Fed. Cir. 1997). However, the term "having" does not convey the open-ended meaning as strongly as "comprising." "Having," for instance, does not create a presumption that the body of the claim is open. Therefore, this court examines the claim in its full context to determine whether Crystal's use of "having" limits claim 1 to its recited elements.

The language of claim 1 itself does not limit the term "having" to a closed meaning. The '483 patent discloses a capacitor structure that shields the sensitive plate of the capacitor from stray noise. The "Background of the Invention" describes typical prior art capacitors with a two-plate structure. Col. 1, ll. 58-68. The top plate served as a "sensitive 'virtual ground' capacitor plate" while the bottom "shield[ed] the sensitive node from substrate noise." Id. These two-plate capacitors were "still susceptible to noise coupling onto the sensitive top plate through passivation and packaging dielectrics." Id. at 66-68. The claimed tri-layered structure improves noise

shielding. The first and third layers are connected together and operate "to shield . . . the second conductive layer, from noise resulting from external sources or from the semiconductor substrate." Col. 2, ll. 19-24; col. 4, ll. 8-11 ("[T]he upper metal plate 38 is operable to shield the shielded plate 36 from noise resulting from signals that are disposed above the plate 38.").

Figure 6 illustrates that the preferred embodiment of the claimed '483 invention shields against noise by entirely covering the middle layer (36):



According to the written description, the fourth conductive layer (also called the conductive ring 82) "is disposed between the contacts 84 and 85, and the shielded plate 36 to substantially eliminate stray capacitance between plate 34 and sensitive plate 36." Col. 5, ll. 10-15. Contacts 84 connect the upper conductive layer to the intermediate interconnection strip 83 as depicted in Figure 6. Col. 5, ll. 42-50. Contacts 85 connect the lower conductive layer to the same interconnection strip to link the upper and lower layers. Because the conductive ring "is disposed between plate 34

and contacts 84 and 85," a capacitor structure with such a conductive ring must have a middle layer that is smaller in surface area than the upper and lower layers. In other words, because claim 1 recites this fourth conductive layer, the written description requires claim 1 to encompass a capacitor structure wherein the third layer covers the entirety of the second layer.

The written description thus shows the intent to make claim 1 at least partially open to permit the limitation "disposed over a portion" to mean "disposed over at least one portion." Any assertion that "disposed over a portion" means "disposed over only one portion" would contradict the clear purpose of the invention as described in the written description, depicted in Figure 6, and recited in claim 1. Such an assertion would also impermissibly read the preferred embodiment out of claim 1. Vitronics, 90 F.3d at 1583.

The accused Model 931 device has first and third layers of approximately equal size and a smaller second, or middle, layer. Because each layer overlies a portion of the underlying layer, the Model 931 literally infringes claim 1 of the '483 patent. Therefore, this court detects no error in the district court's reading of the "over a portion" limitation and its application of that claim language to the accused device.

Claim 1 also requires that the conductive ring in the devices is "disposed a predetermined distance" from the second layer. The district court construed the term "predetermined distance" in claim 1 to mean "[a] distance that is determined before the fourth conductive layer is disposed on the substrate and that is sufficiently close to the second shielded conductive layer to provide acceptable shielding." The parties do not

dispute this claim construction. This court must address, however, whether this language reads on the accused Model 931.

TriTech alleges that the conductive guard ring structure in the Model 931 is "noisy" because it is "positioned so that it is not as close as possible to the second conductive layer . . . but is instead spaced at almost twice the minimum distance possible." Thus, the Model 931 guard ring structure allegedly does not provide "acceptable shielding" against noise. This court must determine whether these factual allegations raise genuine issues that preclude summary judgment.

In summarily finding literal infringement, the district court stated: "[T]he crucial issue is whether the guard ring is located close enough to the second conductive layer so that it could provide acceptable shielding, not whether the guard ring actually provides acceptable shielding in practice." This court discerns no error in the district court's interpretation of claim 1 or its application of the claim to the Model 931. The parties do not dispute that the Model 931 guard ring structure is disposed a uniform distance (1.3 microns) from the second conductive layer. Thus, the district court correctly entered summary judgment of literal infringement.

The '899 Patent

The '899 patent claims a method for reducing the effect of noise on the analog sampling process by switching digital section logic gates in an A/D converter. The patent discloses two sets of clocks: one to control timing of the analog sampling in the analog section; the other to control timing of the logic gate output switching in the digital section. By offsetting the two clocks, digital logic gate switching occurs during gaps in

the analog sampling. Clock offsetting prevents digital logic gate noise from affecting analog signal sampling.

The disputed portion of claim 4, which is dependent on claim 1, recites:

a method for reducing deleterious effects of said electrical noise on the analog-to-digital conversion process, said method comprising:

a. providing a first clock signal to said analog circuitry for controlling the sampling of an analog input voltage;

....

c. generating a second clock signal having its leading edge delayed with respect to the trailing edge of said first clock signal

(emphasis added). In construing the claims, the district court explained: "[T]he integrated circuit must have at least one common reference clock (either digital or analog . . .)." The district court further stated: "[The phrase] 'first clock signal' . . . indicates the analog circuit clock signal comes prior to the 'second' digital circuit clock signal. Again, this language does not limit the claims construction to one clock."

As the district court correctly noted, "a first clock signal" does not require a single clock signal to control sampling. As previously discussed, the word "comprising" in the transitional phrase of a patent claim creates a presumption that the body of the claim is open. Because claim 4 uses "comprising," it encompasses more than one clock unless the written description or the prosecution history clearly limits claim 4 to its recited elements. Similarly, the article "a" in "a first clock signal" generally suggests one or more clocks. The written description and figures of the '899 patent actually disclose two analog clocks, ACLK1 and ACLK2, in the preferred embodiment. See, e.g., col. 2, ll. 52-56; col. 4, ll. 16-26; Fig. 3. According to the preferred embodiment, analog clock

ACLK1 accepts the analog input voltage (the charge), analog clock ACLK2 transfers the charge to or from the feedback capacitor.

Although ACLK1 provides the first clock signal for controlling the sampling of an analog input voltage, neither the written description nor the prosecution history precludes more than one clock or clock signal. In sum, the '899 patent does not limit "a first clock signal" to only one clock. The district court, therefore, did not err in granting summary judgment that claim 4 reads on the accused Model 931 chip, which uses four clocks.

TriTech did not practice the claimed '899 method in the United States. TriTech, therefore, cannot be liable for direct infringement under 35 U.S.C. § 271(a) (1994). TriTech's acts in connection with selling its chip to OPTi, however, constitute active inducement under 35 U.S.C. § 271(b).

Inducement only occurs if the party being induced directly infringes the patent. E.g., Micro Chem., Inc. v. Great Plains Chem. Co., 103 F.3d 1538, 1549, 41 USPQ2d 1238, 1247 (Fed. Cir. 1997). The verdict form and jury instructions in the present case required the jury to make findings on literal infringement, not direct infringement. The jury found that both OPTi and TriTech infringed claim 4 of the '899 patent. The parties do not dispute that any infringement by OPTi was direct because OPTi practiced the claim method of the '899 patent in the United States. The trial court properly instructed the jury to assess whether TriTech literally infringed by actively inducing OPTi's direct infringement. Thus, because the jury found infringement by OPTi, this court discerns no error in the jury's verdict of literal infringement by TriTech.

Willfulness

The district court instructed the jury on willful infringement. TriTech did not object to these instructions. TriTech seeks to vacate the jury's verdict of willful infringement for the '483 and '841 patents because its defenses of invalidity and non-infringement to the present suit were not frivolous.

When an infringer has actual notice of a patentee's rights, the infringer has an affirmative duty of due care to avoid infringement. Avia Group Int'l Inc. v. L.A. Gear Cal., Inc., 853 F.2d 1557, 1566, 7 USPQ2d 1548, 1555 (Fed. Cir. 1988). Contrary to TriTech's assertions, Gustafson, Inc. v. Intersystems Industrial Products, Inc., 897 F.2d 508, 13 USPQ2d 1972 (Fed. Cir. 1990), did not change this requirement of due care on the part of the potential infringer. Rather, Gustafson stated: "Exercising due care, a party may continue to manufacture and may present what in good faith it believes to be a legitimate defense without risk of being found on that basis alone a willful infringer." Id. at 511 (emphasis added). Gustafson did not hold, as a matter of law, that a party that continues its accused infringing activity after a patentee files suit cannot be guilty of willful infringement as long as that party presents a non-frivolous defense to infringement.

TriTech did not obtain any competent legal opinion of non-infringement or invalidity after Crystal notified TriTech of its potential infringement by filing suit. Although TriTech obtained counsel to defend this action, defenses prepared for a trial are not equivalent to the competent legal opinion of non-infringement or invalidity which qualify as "due care" before undertaking any potentially infringing activity. Also, the

record shows that TriTech copied Crystal's patented parts to develop the infringing devices. See, e.g., Advanced Display Sys., Inc. v. Kent State Univ., 212 F.3d 1272, 1285, 54 USPQ2d 1673, 1681 (Fed. Cir. 2000) (stating that evidence of copying is relevant to a determination of willfulness). Furthermore, TriTech had known of Crystal's '899 patent since 1994 and had even altered its chip design in an unsuccessful attempt to design around the '899 patent. TriTech, however, never sought advice of counsel as to whether it was infringing Crystal's patents. Because the jury's verdict that TriTech willfully infringed Crystal's '483 and '841 patents is not clearly erroneous, this court affirms.

On-sale bar

Under 35 U.S.C. § 102(b), an invention on sale more than one year before patent application filing date cannot receive a patent. Pfaff v. Wells Elec., Inc., 525 U.S. 55, 48 USPQ2d 1641 (1998). In Pfaff, the Supreme Court applied this on-sale bar when, more than one year before the filing of a patent application: (1) a product embodying the patented invention was offered for commercial sale; and (2) the invention was ready for patenting. Id. at 67.

The record in this case contains allegations that Crystal sold or offered to sell its CS5316 chip, undisputedly an embodiment of the '841 invention, before the critical date October 2, 1986. Before jury deliberation, Crystal filed a JMOL motion to preclude TriTech's on-sale bar defense alleging insufficient evidence to show a commercial offer for sale of the CS5316. The district court granted Crystal's JMOL motion.

The record, however, contains evidence on which a reasonable jury could have found an on-sale bar. For example, the record shows that on September 11, 1986, Crystal received a purchase order confirmation from E.S.P. Microscope for five CS5316 parts. This purchase order, listing part numbers and price information, called for shipment to Canada. Crystal's accountants counted E.S.P.'s \$214.25 order as revenue for the month of September but did not ship the CS5316 parts until October 9, 1986, after the critical date. Crystal asserts that it placed this purchase order on hold and did not accept it until after the critical date.

The record also shows that Crystal shipped two CS5316 parts to its distributor on September 22, 1986, for delivery to Lions Systems. In an informational letter to a professor, Crystal classified this shipment as the first commercial exploitation of the CS5316. Crystal also characterized this shipment as the first "commercial exploitation" of its CS5316 in a Mask Work Registration filed with the United States Copyright Office in October of 1986. Crystal asserts that the shipment does not qualify as a sale because it was an engineering sample of no value that it shipped to a customer site at no charge for confidential testing. Although this alleged experimental use, if proven, would negate an on-sale bar, it does not negate the record evidence of an alleged commercial exploitation. Construing this evidence, as it must, in a light favorable to TriTech, this court concludes that a reasonable jury deserved to weigh the facts and determine whether Crystal's '841 patent is subject to an on-sale bar. This court, therefore, vacates the district court's grant of JMOL of no on-sale bar and remands for a trial on this issue.

This court recognizes that this remand on the '841 patent does not affect the damages calculation in this case. The parties do not dispute the reasonable royalty award and neither party has asked for any reasonable royalty recalculation based on the validity of any of the patents. The lost profits calculation in this case may rest on the infringement of the '899 patent alone.

Damages

Section 284 of title 35 of the United States Code provides: "Upon finding for the claimant the court shall award the claimant damages adequate to compensate for the infringement but in no event less than a reasonable royalty for the use made of the invention by the infringer, together with interest and costs as fixed by the court." Thus, a reasonable royalty for each infringing device sold by TriTech and OPTi is the minimum measure of damages in this case. Crystal, the patentee, bears the burden of proving its damages. SmithKline Diagnostics, 926 F.2d at 1163.

Section 287(a) of title 35 further provides that, without adequate marking, "no damages shall be recovered by the patentee in any action for infringement, except on proof that the infringer was notified of the infringement and continued to infringe thereafter." 35 U.S.C. § 287(a). If the infringer continues to infringe after receiving notice, the patentee may recover damages. Id. Filing an infringement action constitutes notice. Id.

Crystal filed an action against TriTech for infringement of the '483 and '841 patents on January 10, 1997. The parties agree that this is the date that Crystal first notified TriTech and OPTi of its claim of patent infringement. Because the '899 patent

only claims methods, the notice provisions of § 287(a) do not apply to it. Am. Med. Sys., Inc. v. Med. Eng'g Corp., 6 F.3d 1523, 1538, 28 USPQ2d 1321, 1332 (Fed. Cir. 1993) ("The law is clear that the notice provisions of section 287 do not apply where the patent is directed to a process or method"). Furthermore, TriTech does not dispute that it had notice of the '899 patent in 1994. Thus, the district court correctly instructed the jury that if the jury found infringement of the '899 patent by OPTi, to calculate damages from the date that infringing activity began in 1994. The jury's damage award of lost profits demonstrates that the jury calculated damages back to 1994.

Lost Profits

Beyond reasonable royalties, a patentee may seek lost profit damages for infringement. To recover lost profits, "a patent owner must prove a causal relation between the infringement and its loss of profits." BIC Leisure Prods., Inc. v. Windsurfing Int'l, Inc., 1 F.3d 1214, 1218, 27 USPQ2d 1671, 1674 (Fed. Cir. 1993). In other words, the burden rests on the patentee to show a reasonable probability that "but for" the infringing activity, the patentee would have made the infringer's sales. Water Tech. Corp. v. Calco Ltd., 850 F.2d 660, 671, 7 USPQ2d 1097, 1106 (Fed. Cir.).

A patentee receives a reasonable royalty for any of the infringer's sales not included in the lost profit calculation. Minco, Inc. v. Combustion Eng'g, Inc., 95 F.3d 1109, 1119, 40 USPQ2d 1001, 1008 (Fed. Cir. 1996); State Indus., Inc. v. Mor-Flo Indus., Inc., 883 F.2d 1573, 1577, 12 USPQ2d 1026, 1028 (Fed. Cir. 1989). Thus, a patentee may obtain lost profit damages for that portion of the infringer's sales for which the patentee can demonstrate "but for" causation and reasonable royalties for any

remaining infringing. King Instruments Corp. v. Perego, 65 F.3d 941, 952-53, 36 USPQ2d 1129, 1137 (Fed. Cir. 1995).

Crystal sought lost profits for about 42% of TriTech's infringing sales and reasonable royalties for the remainder. Crystal sought lost profits based on its market share. Specifically, Crystal's witnesses divided the overall audio chip market into two segments: the low quality segment for chips below specific industry audio standards; and the high quality segment for chips within those standards. In the "high quality" chip market, Crystal had an estimated 42% market share and sought lost profits on that portion of TriTech's sales. Crystal sought reasonable royalties for the rest of TriTech's infringing chip sales.

To establish its market share in the high-quality market, Crystal presented the expert testimony of Mr. Henry Davis, an audio industry consultant with more than 15 years of experience. During trial TriTech moved to preclude Mr. Davis' testimony based on Daubert factors, but then expressly withdrew its motion before the court heard argument on it. See Daubert v. Merrell Dow Pharm., 509 U.S. 579 (1993). The district court judge admitted Mr. Davis' expert testimony. Although TriTech made several objections during Mr. Davis' testimony, it had admitted Mr. Davis' expert reports in advance. The jury received these reports as part of the record.

Mr. Davis differentiated between "high quality" and "low quality" segments in the PC audio market. To show this difference, Mr. Davis explained differences in PC audio quality and purchasing criteria for PC audio CODECs. Mr. Ensley, Crystal's marketing executive, also testified about "high quality" and "low quality" market segments based

on sound performance. Mr. Ensley explained that Crystal, with its delta-sigma design, sold more CODECs than its competitors in the "high quality" segment, while ESS Technology, another audio chip manufacturer, sold the most in the "low quality" segment.

Based on this market segmentation analysis, Mr. Davis calculated Crystal's market share for each year of infringement from 1994 to 1998. Mr. Davis began with overall audio-chip market shares reported by the Mercury Research annual reports. Crystal's and OPTi's experts agreed that the Mercury Research reports were reliable standard market sources. Mr. Davis next removed the sales of the accused infringers, TriTech and OPTi, from the market to derive Crystal's market share without infringement. Mr. Davis also removed the sales of ESS from his market share calculation because ESS sold chips in the low quality market segment.

Mr. Davis' analysis yielded market shares for Crystal ranging from 35% to 67% over the 5 years of infringement, and an average market share of 41.9%. Based on this average, Crystal requested the jury to award lost profits of approximately \$14.3 million. TriTech's expert, Mr. Carlile, used the same market share data but did not remove ESS from his calculation. Mr. Carlile's calculations resulted in a market share range of 19% to 44% for Crystal. OPTi's expert, Ms. Scott, also segmented the market, but under a different theory than that of Crystal's experts. Before adjusting Crystal's market shares for market segmentation, Ms. Scott assigned Crystal market shares ranging from 24% to 56% over the 5 years of infringement. Factoring in market segmentation, Ms. Scott assigned Crystal market shares ranging from 12% to 78%. After hearing this testimony,

the jury returned a verdict of \$11,830,862 in lost profit damages, equating to a market share of about 35% for Crystal.

After the jury verdict, the district court granted TriTech's JMOL motion to remit Crystal's damages. The district court first found Mr. Davis' testimony "so unreliable that [it] did not constitute substantial evidence on which a reasonable jury could base such a large award of . . . lost profits." Crystal, slip op. at 10. Specifically, the district court noted Mr. Davis' "minimal specialized academic qualifications" and minimal prior experience with patent damages. Id. at 9-10. In addition, the trial court found Mr. Davis' testimony incompetent because he "merely used the published market share information published in the Mercury Research Reports" along with "simple mathematical calculations to estimate Crystal's market share." Id. The court added that if TriTech had not pre-admitted Mr. Davis' expert reports before trial, the court would have exercised its discretion under Daubert and Kumho Tire Co. v. Carmichael, 526 U.S. 137 (1999), to exclude Mr. Davis' testimony as incompetent. Crystal, slip. op. at 10.

The district court next explained that OPTi conceded that the evidence supported a jury award of \$7.4 million in lost profits: "Mr. Davis's ESS-included market share (21.8%) is 0.52 of his ESS-excluded market share (41.9%). Multiplying Crystal's proposed lost profits number by 0.52 gives a maximum potential lost profit[] of \$7,416,189." Crystal, slip op. at 14. However, the district court did not remit the jury's \$11.8 million lost profit award to \$7.4. Instead, the district court found Crystal was not

entitled to any lost profits because Crystal "failed to prove that it is entitled to both lost profits and reasonable royalties." Crystal, slip op. at 16.

The district court eliminated the jury's lost profits award and declined to increase the reasonable royalty award. In other words, the district court's actions left Crystal with no recovery for approximately 42% of the infringing sales. As previously discussed, the Patent Act mandates no less "than a reasonable royalty" for every infringing sale. 35 U.S.C. § 284. By overlooking this statutory requirement, the trial court erred. In effect, the district court erred by giving Crystal no credit for any of its market share in the audio chip market.

To show "but for" causation and entitlement to lost profits, a patentee must reconstruct the market to show, hypothetically, "likely outcomes with infringement factored out of the economic picture." Grain Processing Corp. v. Am. Maize-Prods., 185 F.3d 1341, 1350, 51 USPQ2d 1556, 1562 (1999). Such market reconstruction, though hypothetical, requires "sound economic proof of the nature of the market." Id. This court has affirmed lost profit awards based on a wide variety of reconstruction theories where the patentee has presented reliable economic evidence of "but for" causation.

In State Industries, for example, this court affirmed an award of lost profits for 40%, and a reasonable royalty for the remaining 60%, of the infringer's sales. 883 F.2d at 1573. The patentee showed credible evidence of a 40% national market share. Id. at 1579. This court therefore affirmed that 40% of infringing sales was the minimum lost profit damage. Id. at 1578. Accordingly, Crystal was entitled, as OPTi conceded,

to at least a 21.8% market share, or \$7.4 million. For this reason, the district court erred in denying Crystal all lost profits.

Moreover, both TriTech's and OPTi's experts testified that Crystal deserved a lost profit award, albeit less than Crystal's requested 42% market share. The jury itself reduced Crystal's award to 35%. Between Crystal's unadjusted market share, the testimony of TriTech's and OPTi's experts, and the testimonies of Crystal's other fact witnesses, the record supplied sufficient evidence to support the jury's 35% lost profit award.

Furthermore, the record also supports a market segmentation theory, even without Mr. Davis' testimony. In BIC Leisure, this court required proper identification of the actual market affected by the infringement. This court explained: "[T]he patent owner and the infringer [must] sell products sufficiently similar to compete against each other in the same market segment." 1 F.3d at 1218. In other words, for lost profits based on the infringer's sales, a patentee must show that the infringing units do "not have a disparately higher price than or possess characteristics significantly different from the patented product." Id. at 1219 (quoting Kaufman Co. v. Lantech, Inc., 926 F.2d 1136, 1142, 17 USPQ2d 1828, 1832 (Fed. Cir. 1991)). Similarly, to determine a patentee's market share, the record must accurately identify the market. This requires an analysis which excludes alternatives to the patented product with disparately different prices or significantly different characteristics.

Here, Crystal's fact witness, Mr. Ensley, opined that ESS sold its audio chips -- though for approximately the same price as Crystal and OPTi -- to a different segment

of the market. Mr. Ensley explained that ESS chips had a low signal-to-noise ratio and did not meet industry standards for high sound quality. However, ESS chips were better integrated than those of Crystal and TriTech/OPTi. Thus, ESS sold its chips to a segment of the market that put a higher premium on integration and less on sound quality. Crystal and TriTech/OPTi sold their chips to a segment of the market that put a higher premium on sound quality and less on integration. While OPTi's witness, Mr. Edelson, did not agree with Crystal's segmentation theory, he verified that ESS did indeed manufacture a low sound quality product and that sound quality is an important factor to companies that purchase PC audio CODECs.

Ms. Scott, OPTi's expert witness, also testified about differences in the audio chip market. She divided the market between mother board and add-in uses of audio chips instead of between high and low quality. Although based on a different theory of market differences than Mr. Ensley's, Ms. Scott's testimony verified that the audio-chip market was not a uniform, completely elastic market.

Thus, the record contains sufficient evidence to support the jury's lost profit award for Crystal's market share based on market segmentation, even discounting Mr. Davis' expert opinion. This court, therefore, need not reach the reliability of Mr. Davis' testimony or the propriety of the district court striking Mr. Davis' testimony on JMOL.

Furthermore, this court need not remand to the district court to recalculate lost profit damages based on any further validity determination of the '841 patent. Lost profit damages do not depend on the number of patents infringed by one single product in the present case. The lost profit calculation depends only on market variables.

Price Erosion

Crystal alleged additional loss of profits on a theory of price erosion. The Supreme Court opened the door for price erosion damages in 1886: "Reduction of prices, and consequent loss of profits, enforced by infringing competition, is a proper ground for awarding of damages. The only question is as to the character and sufficiency of the evidence in the particular case." Yale Lock Mfg. Co. v. Sargent, 117 U.S. 536, 551 (1886). This court has since explained that "the question as to the character and sufficiency of the evidence" places the burden on the patentee to show that "but for" infringement, it would have sold its product at higher prices. See BIC Leisure, 1 F.3d at 1220. Moreover, in a credible economic analysis, the patentee cannot show entitlement to a higher price divorced from the effect of that higher price on demand for the product. In other words, the patentee must also present evidence of the (presumably reduced) amount of product the patentee would have sold at the higher price. Thus, in harmony with the Supreme Court's requirement in Yale Lock, the patentee's price erosion theory must account for the nature, or definition, of the market, similarities between any benchmark market and the market in which price erosion is alleged, and the effect of the hypothetically increased price on the likely number of sales at that price in that market.

To make out its theory of price erosion, Crystal used the expert testimony of Mr. Stephen Knowlton. Mr. Knowlton used a "benchmark methodology" to assess price erosion. Under this method, Mr. Knowlton selected a product similar to the patented product and compared the performance of that benchmark in a market free of

infringement with the performance of the patented product in the market affected by infringement.

Mr. Knowlton selected as his benchmark Crystal's audio CODEC sales to the separate Apple Computer market. These CODECs featured technology similar to the chips Crystal sold in the IBM and IBM compatible (PC) market. However, neither TriTech nor OPTi sold any product to the Apple Market. In fact, the only manufacturers of CODECs for the Apple market were Crystal and National Semiconductor (National). These two companies worked jointly to develop CODECs for the Apple market and had an agreement with Apple to sell their CODECs on a pro rata basis. Specifically, Crystal supplied 70% of Apple's CODECs, and National 30%.

Mr. Knowlton next compared the performance of chips in the Apple market to nine of Crystal's products in the PC market between the years 1994 and 1998. Mr. Knowlton determined that CODECs sold in the benchmark market had an approximate 49.8% gross margin and decreased about 10% in price over the 17 quarters between 1994 and 1998. Mr. Knowlton then calculated a hypothetical selling price based on the Apple market gross margin for Crystal's products sold in the PC market, and, taking the 10% decrease in price to the Apple market into account, determined the average decrease in Crystal's PC audio CODEC selling prices from the hypothetical price. Mr. Knowlton attributed the entire decrease in Crystal's CODEC selling prices to TriTech/OPTi's infringement.

Mr. Knowlton's calculation resulted in an upper price erosion amount of \$1.94 per unit and a lower amount of 89¢ per unit. Multiplying the lower price erosion figure

of 89¢ per unit by the total CODEC units sold by Crystal between 1994 and 1998 would yield price erosion damages of \$34,700,000. After deliberating, the jury returned with a verdict of \$26,649,766 in price erosion damages.

In granting TriTech's JMOL motion to remit Crystal's damages, the district court found Mr. Knowlton's expert testimony, and particularly Mr. Knowlton's "benchmark methodology," unreliable. The court also held that even if Mr. Knowlton's expert opinion could be found reliable, the testimony did not provide "substantial evidence to support Crystal's claims for any price erosion at all." Crystal, slip op. at 11.

Upon review, this court affirms the trial court's judgment that Mr. Knowlton's methodology used an inappropriate benchmark, resulting in an inadequate foundation for Crystal's entire price erosion theory. The Apple market differed from the PC CODEC market in several important ways. Most importantly, the Apple CODEC market had characteristics of an oligopoly while the PC CODEC market was competitive.

The Apple CODEC market had only two suppliers – Crystal and National. These two suppliers cooperated with one another as demonstrated by their joint development of audio CODECs for the Apple market and their pro rata supply agreements with Apple. Their amicable relationship and desire to maintain profits, together with the fact that they sold nearly identical products, may well have created a less than competitive market for Crystal and National. The pro rata agreements also may have formed a barrier to expansion for National and made demand static, thereby further decreasing competition in the market. Additionally, as Mr. Knowlton pointed out, competitors such as Yamaha and ADI attempted to enter this market and failed. This evidence suggests

the presence of barriers to entry into the Apple market. In sum, the Apple market hardly resembles a market with the same demand characteristics as the PC CODEC market in this case.

The PC market was much larger and more competitive than the Apple market. Crystal faced great price competition from many other CODEC manufacturers besides the alleged infringers. Indeed, the record shows that some of Crystal's competitors beat Crystal to the market with better integrated products. Additionally, the evidence shows that CODEC manufacturers felt great pressure from PC manufacturers to lower chip prices as the price for PCs themselves dropped. In other words, the record amply underscores the district court's determination that the Apple CODEC market did not resemble the PC market in demand characteristics. To repeat the colloquial phrase of the district court, Mr. Knowlton's use of the Apple CODEC market as a benchmark was like comparing apples and oranges. Crystal, slip op. at 13.

Crystal argues that TriTech's and OPTi's experts were unable to identify a better benchmark for comparison with the PC CODEC market. However, just because the marketplace does not supply another market for comparison, a poor benchmark cannot supply sufficient evidence to show the likely reaction of this PC market "but for" infringement. Economists can define hypothetical markets, derive a demand curve, and make price erosion approximations without relying on inapposite benchmarks. See, e.g., Brooktree, 977 F.2d at 1579-80 (price erosion calculated based on the selling price of the same product before the infringer entered the market); Minnesota Mining & Mfg. Co., v. Johnson & Johnson Orthopaedics, 976 F.2d 1559, 1579, 24 USPQ2d

1321, 1337 (Fed. Cir. 1992) (price erosion was calculated based on pre-infringement prices because the patentee and infringer occupied almost the entire market).

Even if Mr. Knowlton's testimony and benchmark analysis were correct, the record does not contain sufficient evidence to show the reaction of the market if, "but for" infringement, Crystal would have tried to charge at least 89¢ more per CODEC. All markets must respect the law of demand. See Paul A. Samuelson, Economics 53-55 (11th ed. 1980). According to the law of demand, consumers will almost always purchase fewer units of a product at a higher price than at a lower price, possibly substituting other products. Id. at 55. For example, if substitution of a product were impossible and the product were a necessity, elasticity of demand would be zero -- meaning consumers would purchase the product at identical rates even when the price increases. This very rare type of market is called inelastic. Id. at 360. On the other side of the spectrum, if any price increase would eradicate demand, elasticity of demand would be infinite -- meaning consumers would decline to purchase another single product if the price increases by any amount. This very rare type of market is called perfectly elastic. Id. Markets typically have an elasticity greater than zero and less than infinity.

Thus, in a competitive market, sales quantity reacts to price changes. The record shows that the PC CODEC market was competitive. Therefore, according to basic tenets of economics, because Crystal is in a competitive market, if Crystal raised prices, Crystal's sales would have fallen.

In BIC, this court held that the infringer's product and the patentee's product had to compete in the same market in order to establish "but for" causation for lost profits due to lost sales. 1 F.3d at 1220. Price erosion requires an analogous showing. To show causation with reliable evidence, a patentee must produce credible economic evidence to show the decrease in sales, if any, that would have occurred at the higher hypothetical price.

Most of the CODECs Crystal sold were priced at under \$10 per unit. A minimum 89¢ price increase would have translated to an approximate 10% increase in selling price. Because Crystal was competing in a competitive market, a 10% price increase would have likely caused customers to substitute the CODECs of other manufacturers for Crystal's CODECs. Crystal, however, presented no evidence of the elasticity of demand of the PC sound card CODEC market. Nor did Crystal make any estimates as to the number of sales it would have lost or kept had it increased its prices by 89¢ per unit. Thus, Crystal did not make a showing of "but for" causation of price erosion.

At oral argument, Crystal's counsel asserted that because CODECs are relatively cheap parts in an overall expensive machine, an increase in price of the CODECs would not affect the number of units sold. This argument is unavailing. Although the proportion of consumer income spent on a good, or in this case the proportion of total PC cost attributed to a sound card CODEC, affects the price elasticity of demand, a low proportion does not nullify elasticity. See Ernest Gellhorn, An Introduction to Antitrust Economics, 1 Duke L.J. 19-22 (1975).

Crystal also argues that the fact that audio chips were included in nearly all personal computers indicates that the "astounding" demand for these chips would not have waned with a "small" price increase. Crystal's assertion does not overcome its failure to supply reliable evidence of price erosion. This market featured both a large demand for the chips and competition. Without adequate record support for Crystal's theories, this court cannot discern whether, if Crystal had increased its prices, the competitors might have expanded their production to meet market demand at a lower price. Likewise, new competitors might have entered the market to supply demand at a lower price. Crystal cannot assert that demand for its CODECs would not have waned with an increase in price without evidence of barriers to entry and expansion that would have prevented competitors from taking over Crystal's supply.

Furthermore, Crystal did not present any evidence of how a hypothetical increase in price would have affected Crystal's profits due to lost sales. Lost sales and price erosion damages are inextricably linked. Panduit Corp. v. Stahl Bros. Fibre Works, 575 F.2d 1152, 1157 (6th Cir. 1978) ("The right to damages caused by price reduction stands on the same ground as that to damages caused by lost sales."). To prevent inconsistent results, this court will not venture to evaluate price erosion and lost profits damages separately. See Christopher S. Marchese, Patent Infringement and Future Lost Profits Damages, 26 Ariz. St. L.J. 885, 747-752 (1994).

As this court explained in BIC, lost profits due to lost sales depend on how the patentee and infringer interact in the market. 1 F.3d at 1218. If the patentee and infringer do not sell their products in the same market segment, "but for" causation

cannot be demonstrated. Id. at 1218-19. In BIC, the patentee's sailboards were priced at the upper end of the sailboard price spectrum while the infringer's sailboards were priced at the lower end. Id. at 1216-17. This court, therefore, held that even without the infringer in the market, the infringer's customers would have likely sought boards in the same price range and would not have purchased more of Windsurfing's boards. Id. at 1218.

In the present case, Crystal did not present any evidence of whether any of its suggested hypothetical price increases, in a world without TriTech and OPTi, would have left Crystal's CODECs in the same market. Crystal presented evidence that the market was already segmented into high quality and low quality market segments according to sound quality instead of price. However, Crystal presented no evidence about whether the market would have been further segmented with greater price differences between the different CODECs. Crystal seeks lost profits because TriTech/OPTi sold CODECs in the same market segment as Crystal. Yet, Crystal also seeks price erosion damages without showing that a higher CODEC price would have allowed Crystal to sell its CODECs in that same market segment. Without economic evidence of the resulting market for higher priced CODECs, Crystal cannot have both lost profits and price erosion damages on each of those lost sales. The district court correctly denied Crystal's price erosion damages for lack of adequate record support.

Damages Calculation

After eliminating the jury's lost profit and price erosion verdicts, the district court doubled the remaining \$10,000,000 in reasonable royalties due to the jury's finding that

TriTech willfully infringed Crystal's patents. TriTech argues that it was improper for the district court to double the entire damages award because OPTi was not found to willfully infringe. Thus, asserts TriTech, the trial court should have multiplied the damage award by 0.6 for TriTech's 60% liability as assigned by the jury, and then doubled for TriTech's willfulness.

A party that induces or contributes to infringement is jointly and severally liable with the direct infringer for all general damages. See Hewlett-Packard Co. v. Bausch & Lomb Inc., 909 F.2d 1464, 1469, 15 USPQ2d 1525, 1528 (Fed. Cir. 1990). Because TriTech induced all of the infringing sales made by OPTi, TriTech is jointly and severally liable for all the infringing sales.

Damages for willfulness are punitive and are thus levied against parties found to willfully infringe. Sensonic, Inc. v. Aerosonic Corp., 81 F.3d 1566, 1574, 38 USPQ2d 1551, 1557 (Fed. Cir. 1996). Parties not found to willfully infringe, therefore, cannot be held jointly and severally liable for willfulness damages. Therefore damages owed by OPTi cannot be multiplied due to TriTech's willfulness. However, because TriTech induced all of the infringing sales, TriTech is liable for willful inducement of all of the infringing sales.

The jury apportioned 60% of the damages to TriTech. TriTech is, therefore, liable for \$21,830,862 (the combined amount of reasonable royalty and lost profit damages) in punitive damages for its willfulness plus 60% of that same amount for its share of liability. In sum, aside from attorney fees not at issue in the present appeal, TriTech's share of damages owed Crystal is \$34,929,379.

Prejudgment Interest

Crystal also requested an assessment of prejudgment interest on its damage award. The district court declined, naming two reasons: "(1) Crystal delayed several years in filing suit, and (2) Crystal engaged in litigation tactics that delayed the disposition of this lawsuit." Crystal, slip op. at 21.

An award of prejudgment interest serves to make the patentee whole because the patentee also lost the use of its money due to infringement. Gen. Motors, 461 U.S. at 655-656. In General Motors, the Supreme Court made prejudgment interest the rule, not the exception. Any justification for withholding the award, according to the Supreme Court, must have some relationship to the award of prejudgment interest itself. Id. at 655. The Supreme Court specifically noted that a patentee's undue delay in prosecution could justify denial of prejudgment interest. Id. at 657. This court added: "[A]bsent prejudice to the defendants, any delay by [the patentee] does not support the denial of prejudgment interest." Lummus, 862 F.2d at 275; see Radio Steel & Mfg. Co. v. MTD Prods., Inc., 788 F.2d 1554, 1558, 229 USPQ 431, 434 (Fed. Cir. 1986).

Crystal first asserted its '841 and '899 patents in litigation against Analog Devices, Inc., resulting in a 1994 consent judgment of validity and infringement of those patents. Crystal next turned its attention to TriTech and OPTi, the new entrants into the audio chip marketplace. Crystal reverse engineered several of OPTi's chips and by March 1995, determined that TriTech/OPTi infringed Crystal's patents. Crystal claims it spent the next two years building its case, including investigating and testing the alleged infringing products before filing suit.

TriTech, on the other hand, presented evidence that Crystal's delay was a litigation tactic. According to the testimony of Jim Clardy, Crystal's former president, Crystal sent letters to 30 or 40 companies in 1994-95 informing the companies of Crystal's patents. However, Crystal did not send any such letter to TriTech or OPTi, even though Crystal had already determined that TriTech and OPTi were infringing Crystal's patents. Mr. Clardy explained that Crystal did not inform TriTech and OPTi of its patents or intent to enforce its patent rights for two reasons: (1) Crystal decided that TriTech and OPTi must have already been aware of its patents because TriTech and OPTi were attempting to upgrade the quality of their products in infringing ways; and (2) Crystal was trying to establish a business relationship with Creative Technologies, a company that had a relationship with TriTech and OPTi, to supply Creative with audio CODECs.

Crystal's two year delay in initiating the present suit caused the damages owed by TriTech and OPTi to escalate. The record contains sufficient evidence for the district court to determine that Crystal's delay was self-serving and resulted in prejudice to the defendants. Thus, the district court acted within its discretion in denying Crystal prejudgment interest.

CONCLUSION

This court affirms the district court's claim interpretation and judgments holding the '899, '841, and '483 patents willfully infringed by TriTech. This court also affirms the district court's judgment that Crystal is not entitled to price erosion damages or prejudgment interest. Further, this court vacates the district court's judgment that the

'841 patent is not invalid due to an on-sale bar and remands for trial. This court also reverses the district court's judgment that Crystal is not entitled to lost profit damages, vacates the district court's damages order, and remands to the district court to enter damages totaling \$34,929,379 for Crystal to be paid by TriTech.

COSTS

Each party shall bear its own costs.

AFFIRMED-IN-PART, REVERSED-IN-PART, VACATED-IN-PART, and REMANDED

A True Copy.

Attest: *MARCH 28, 2001*

Linda R. Purdie
Deputy Clerk