

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

HUM INDUSTRIAL TECHNOLOGY, INC.
Petitioner

v.

AMSTED RAIL COMPANY, INC.
Patent Owner

Case IPR2023-00540
US Patent No. 10,137,915

Before JAMES P. CALVE, KEVIN W. CHERRY, and MICHAEL L. WOODS,
Administrative Patent Judges.

**DECLARATION OF STEVEN RICCA IN SUPPORT OF
PETITIONER'S REPLY TO PATENT OWNER RESPONSE**

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I. INTRODUCTION

1. I, Steven Ricca, hereby declare that the following is true and correct. I previously provided a declaration filed as EX1003 in support of Paper No. 1, Petition for *Inter Partes* Review (“Petition”), and my testimony from that first Declaration remains the same. I am competent to make this Declaration based upon my personal knowledge and technical expertise, which I addressed in my first Declaration. If called to testify, I could and would testify honestly, under oath, to the matters set forth herein.

2. In preparing this Declaration, I have considered all the materials filed through the date of this Declaration in this proceeding and any other materials cited in this Declaration.

3. I provided a declaration in support of the Petitioner’s proposed claim constructions in the related litigation pending in the Eastern District of Missouri (*Amsted Rail Co., Inc. v. Hum Industrial Tech., Inc. et al*, No. 4:22-cv-00445-AGF), including terms in claims of the ’915 Patent. *See* EX2007. It is my opinion that Petitioner’s proposed construction of “software filters” in the district court case is consistent with the plain and ordinary meaning of the term. I addressed my understanding of plain and ordinary meaning, and my opinion that all the claim terms for purposes of this *inter partes* review proceeding can be given their plain and ordinary meaning, in my first declaration. EX1003, ¶¶ 46-48.

II. GROUND 1, CLAIM 1

A. Armitage Discloses Filtering (Limitation 1(d))

4. As I stated in my first declaration (EX1003), there is nothing novel about collecting data with sensors located on a railcar, analyzing and filtering the data, and sending messages through a communication architecture (for example, through a wireless network) to detect operational anomalies and inform the railcar operator of operational conditions of a railcar. EX1003, ¶ 27. With respect to the filtering part of the data analysis, the '915 patent provides very little explanation of how its filters remove unwanted acceleration frequencies—disclosing very little guidance how one filters data in the '915 patent. EX1001, 5:23-27, 5:35-40; 13:13-24. 13:36-51, 13:57-14:9; 5:35-42. In my opinion, this is because filtering methodologies would have been well-known and a PHOSITA would have understood there are several ways remove unwanted frequencies.

5. The '915 patent teaches filtering data by ignoring or selecting certain categories of data through the use of a digital filter. *See* EX1001, 13:17-24; FIGS. 12. The '915 patent also discloses a particular embodiment of the system in Figure 12 in Figure 13, which shows the selection of data from each of the longitudinal, lateral, and vertical axes. EX1001, 13:36-51; FIGS. 13-14; *see also* EX1001 at 13:57-14:9 and FIG. 14 (describing another implementation of the analysis system of Figure 12 that selects data in the vertical direction to assess potential defaults).

6. In my opinion, a PHOSITA would understand that the '915 patent's "digital data filter" filters data by selection of data along certain axes or combinations of axes measured by the accelerometer and by the selection of certain acceleration frequencies in certain axes (x, y, and z) and ignoring data from unselected axes.

7. Armitage discloses a filter that takes output signals from a triaxial accelerometer and isolates accelerations for a single axis. At paragraph 45, Armitage (EX1006) says: "The accelerations monitored by the 3-D accelerometer are interpreted as vibrations. In some examples, axial vibration is monitored along a single axis, such as a z-axis aligned with the axle of a particular wheel or wheel assembly, and vibrations in other axes are ignored, such as radial axes including an x-axis aligned with the horizontal and a y-axis aligned with the vertical with respect to the railway car or wheel."

8. Armitage teaches the same filtering that is described in the '915 patent by selecting data corresponding to one axis and ignoring or discarding data corresponding to the other two axes outputted from the three-dimensional accelerometer of Armitage. At paragraph [0045], Armitage teaches the selection of acceleration data in certain axes, including the horizontal (x), vertical (y), and axial (z) axes, while it ignores data from unselected axes. EX1006, ¶ [0045]. Armitage goes further to explain why it is beneficial to consider accelerations only along a specific axis. For example, the '915 patent teaches accelerometer data from the

vertical direction is used to detect characteristic frequencies of derailment, wheel damage, and vertical impact. EX1001, 13:57-14:9. Armitage also explains why when detecting wheel damage you only consider accelerations along the z-axis (“axial” accelerations) and ignore accelerations along the x- and y-axes (“radial” accelerations). *Id.* So like the ’915 patent, Armitage teaches the filing of the output of a three-dimensional accelerometer to isolate data (i.e., vibrations) from a single axis in order to detect failure conditions such as wheel damage, associated with those vibrations along a singular axis.

9. In addition to these examples, there are a number of reasons why a PHOSITA would want to monitor accelerations along each axis to determine certain problem conditions of a railcar. As one example, a PHOSITA would have understood that accelerations along the transverse axis extending along the width of the railcar can be used to monitor conditions including truck hunting, which is a repetitive movement truck back and forth across the line of the rails (*see, e.g.*, EX1005, ¶ [0054]), wheel flat conditions (EX1006, ¶ [0045]), and bearing defects, among others. As another example, a PHOSITA would have understood that accelerations along the vertical axis can be used to monitor conditions including track defects, which generate large and sudden forces in the wheels and bearings (*see, e.g.*, EX1005, ¶¶ [0054], [0066]), wheel derailments (*see, e.g.*, EX1005, ¶ [0061]), and bearing defects, among others. And a PHOSITA would have understood that

accelerations along the longitudinal axis extending along the length of the railcar can be used to monitor conditions including truck hunting movements involving yaw displacements (*see, e.g.,* EX1005, ¶[0062]), changes in velocity (including collisions), and bearing defects, among others.

10. In conclusion, it is my opinion that a PHOSITA would have understood that Armitage discloses a three-dimensional accelerometer that teaches the same filtering of accelerations data performed by the digital data filter of the '915 patent.

B. Claim 1 does not include a temporal limitation for when accelerations are filtered

11. Nothing in independent claims 1, 30 and 36 requires filtering accelerations after they are collected by the sensors. The claims only requires “one or more filters configured to filter at least a portion of the accelerations.” EX1001, Claims, 1, 30, and 36. “[T]he accelerations” of limitation 1(d) refers to “accelerations of the railcar” of limitation 1(c). *Id.* “Accelerations of the railcar” does **not** refer to “measured” accelerations, but the accelerations of the railcar generally, whether measured or unmeasured. Claim 1 does not claim “measured ‘accelerations of the railcar.’ POR, 9; *compare* EX1001, limitation 1(c) (“one or more sensors configured to measure accelerations of the railcar”) *with* limitation 1(d) (“one or more filters configured to filter at least a portion of the accelerations”). So nothing in the claim language requires filtering of “measured” accelerations or filtering to occur before or after the acceleration data is collected.

12. I understand Amsted has argued that the Board erred in finding that dependent claim 26 is within the scope of claim 1 and that claim 1 does not encompass mechanical filtering. POR, 9. However, it is my opinion that the Board correctly determined mechanical filters are within the scope of claim 1, as the specification and plain language of the claims indicate the claimed filtering can occur before or after acceleration data is collected by the sensors. Paper 10, 26-27; claim 26 (“wherein the one or more filters [of claim 1] comprise one or more mechanical filters”). The ’915 patent explains “the analyzed signal (which is not filtered out by the mechanical filter 410 or potting material), originates with the accelerometer hardware 404 and is passed to one or more sensor sections 1202, 1208 or 1214,” which “select the data to be analyzed using a digital data filter 1204, 1210 or 1216.” EX1001, 13:13-18.

C. A PHOSITA Would Have Been Motivated to Combine Armitage and Barone

13. The advantages of filtering were well-known before the ’915 patent and a PHOSITA would have known that it is advantageous to get rid of unwanted data/noise in any data analysis, and in particular acceleration frequencies, through filtering which was well known decades before the ’915 Patent. EX1003, ¶¶ 67, 82, 138, 146, 158-159, 162; EX1006 at ¶¶ [0029] (recognizing noise affects sensor signals); EX1007 at ¶ [0175] (noting the advantage of filtering and processing data is to “enhance the quality of data”); EX1008 at 2:25-29 (“The structure is designed

and used as a filter to selectively transmit, attenuate, or amplify various frequencies of incident elastic waves that would otherwise propagate from the environment and into the sensor.”).

14. I understand that Amsted and Dr. Shamos argue that paragraphs 30 and 40-44 of Armitage refute the motivation to combine Armitage and Barone. However, these paragraphs teach the comparison of data from a sensor unit with data from other sensor units to determine whether *the entire sensor unit* is an “outlier.” EX1006 at ¶ [0042]. In reviewing the POR, it is my opinion that Amsted does not point to anything in Armitage that requires the identification of a single data point as an “outlier” to accomplish the objective of Armitage. POR, 10-14. Armitage illustrates this further by outlining several examples of *outlier sensors* and what type of condition they may indicate. EX1006, ¶ [0042]. In fact, a PHOSITA would understand that a filter is used to remove outlier data points *before* an assessment of the data set for the sensor unit and determination of whether an entire sensor unit is an outlier. The most extreme outliers from a data collection are data points you want to exclude from your fully processed data set, as they are frequently noise, like sporadic electrical or mechanical anomalies caused by measurement errors, AM/FM/CB radio transmissions, and even sun-spot activity. These negatively impact the data set. A PHOSITA would have known it is a very basic statistical concept that if you do not filter out extreme outliers in a data set your entire analysis

will be skewed. This concept has no bearing on the identification of entire outlier sensors as taught in Armitage.

15. I believe Amsted is also incorrect on this point because Amsted as well as its expert, Dr. Shamos, do not explain why every single sensor data point is required for the various statistical analyses described in Armitage. POR, 12-14. A PHOSITA would have understood that a single data outlier from an enormous population of data would not indicate a failure condition and would rather result in repeated false failure conditions. Armitage expressly teaches this at ¶ [0030]. EX1006 at ¶ [0030] (emphasis added). It is my opinion that Amsted's arguments regarding standard deviations and "dynamic normalizations" are also incorrect. EX1006 at ¶¶ [0041], [0043]. A PHOSITA would have understood, and Armitage teaches, that collection, transmission, analysis, and storage of every single data point collected by sensors would not be practical. A PHOSITA would have further understood that collecting, transmitting, analyzing, and storing that much data would require higher speed communication links, a higher processing power control node, and a more powerful energy source. All of these requirements would increase the cost of the system to an impractical amount and such a system would be undesirable to a PHOSITA.

16. Amsted's additional argument against modifying Armitage in view of Barone mischaracterizes statements I made in my first declaration. POR, 15-16. I referenced power savings to explain why a PHOSITA would have modified Armitage, where

filtering occurs at the CMU level (i.e., the control node), with the filtering of Barone, which occurs at the sensor level. To support this point, I stated that a PHOSITA would have understood that data filtering could occur at any point in the system and that power consumption is an important consideration in where filtering should occur in a real-time wireless system. EX1003, ¶¶ 80-81, 160. For example, filtering at the sensor level may require more power overall, while sending all the data to the CMU and filtering at the CMU level may require less power but require the transmission of more data.

III. GROUND 1, CLAIMS 25 AND 28

17. I agree with Amsted and Dr. Shamos that a software filter is a species of the digital filter genus, so to the extent Barone teaches a software filter, Barone also teaches a digital filter. POR, 26.

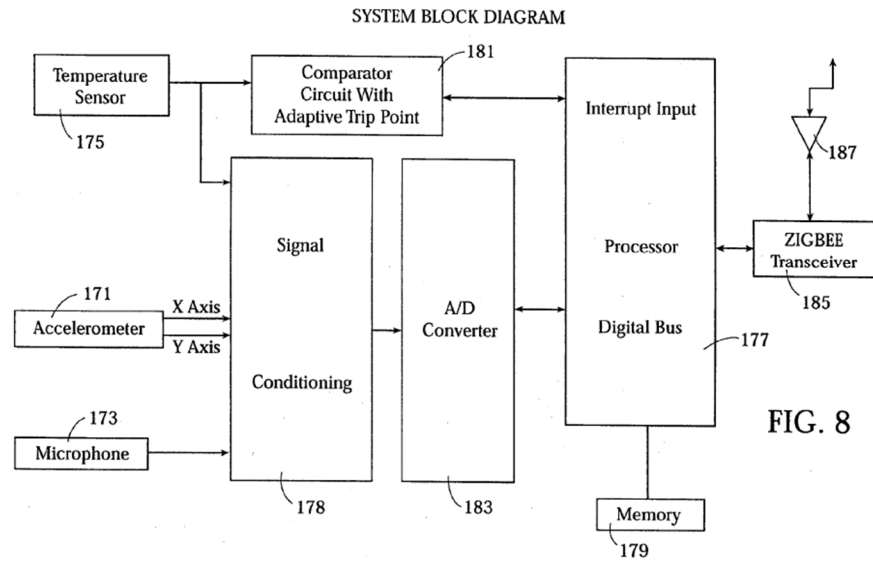
A. Barone's Filtering is Not Limited to Analog/Electronic Signals

18. Barone is not limited to analog/electronic signals; it acknowledges that the output signals from the accelerometer are *preferably analog* but does not limit to only analog. EX1007 at ¶ [0175]. Barone also discloses a digital and software filter as I will explain further below.

19. Barone at [0116] discloses a microcontroller programmed to receive sensor data, which *may* include an A/D (analog-to-digital) converter. EX1007 at ¶ [0016] (“a low-power micro-controller...to determine the health of the bearings through

vibration and acoustic trending and temperature monitoring received from the sensor array via...*and/or* analog/digital converter 183.”). The programmed microcontroller disclosed in Barone contemplates software used in the node to process data—therefore, a PHOSITA would understand that the signals processed by the software are digital signals. *Id.* Because the A/D converter in Barone is optional, that means the data received and processed by the software in the microprocessor can be digital in its original form, meaning that no conversion from analog to digital is necessary.

20. It is erroneous for both Amsted and Dr. Shamos to state that high, low, and band pass filters are exclusively electronic/analog. A PHOSITA would understand that high, low, and band pass filters (EX1007 at ¶¶ [0176], [0178]) are not exclusively electronic and would know Barone’s pass filters are not so limited. A PHOSITA would know that pass filters can filter digital data (i.e., digital filter) and can use software to execute the same type of pass filtering on digital data (i.e., software filter). For example, as shown in Figures 7 and 8 of Barone, “node 125 also includes a low-power micro-controller 177 such as the MSP430F1611 or MSP430FG4618 sold by Texas Instruments, *programmed with algorithms* to determine the health of bearings through via vibration and acoustic trending.” EX1007, ¶ [0116]; FIGS. 7-8. The micro-controller 177 receives digital data output from the A/D converter 183:



Id. The Texas Instrument micro-controllers incorporated by reference in Barone as “micro-controller 177” receive digital data from the A/D Converter 183 and include a “Low Pass Filter” that filters digital data and is controlled by software. EX1007, ¶ [0116]; EX1026, EX1027.

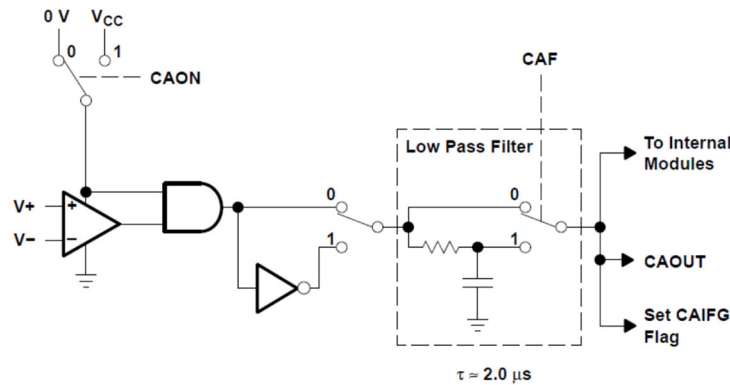


Figure 1. MSP430F1611 (EX1026 at Fig. 8)

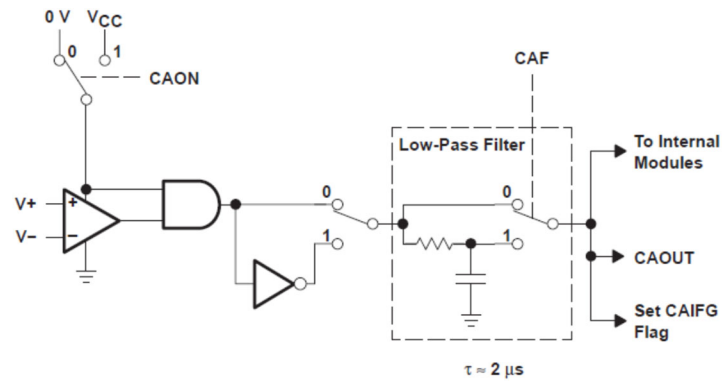
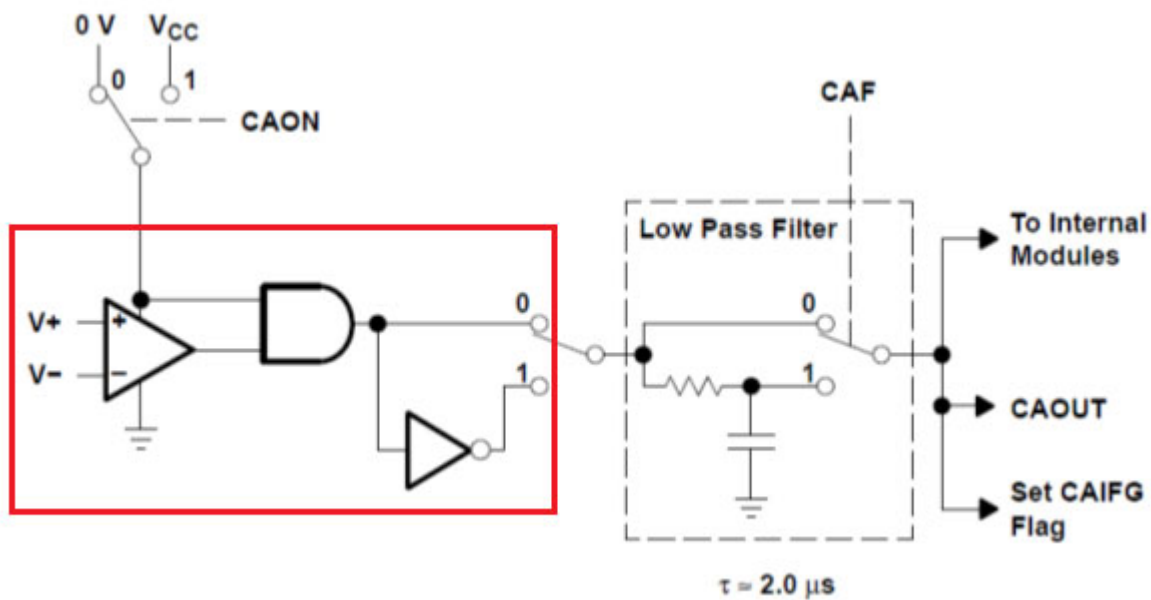


Figure 8. Block Diagram of Comparator_A Module

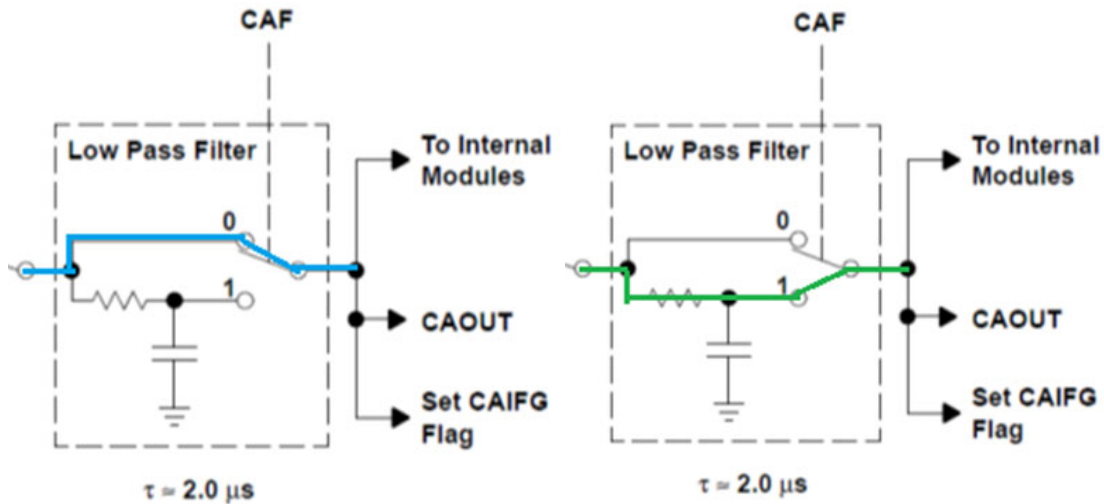
Figure 2. MSP430FG4618 (EX1027 at Fig. 8)

21. The Texas Instruments micro-controllers incorporated by reference in Barone are digital filters (i.e., they filter digital data). More specifically, they are software filters—as I will explain below, the low-pass filter is controlled by software.

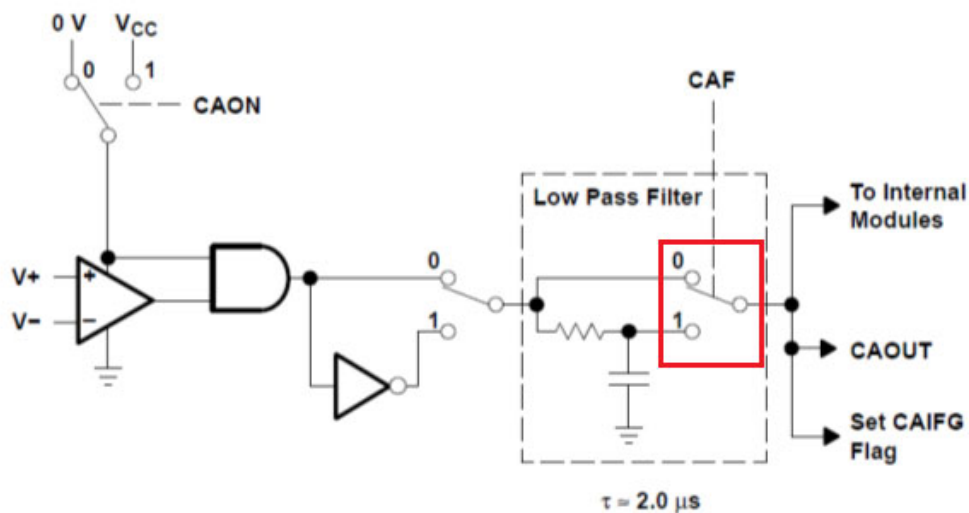
22. As shown in the block diagram below, an incoming signal (i.e., the output of Barone's A/D converter 183) is passed through a series of digital logic gates, and is presented to the low-pass filter as a stream of digital data.

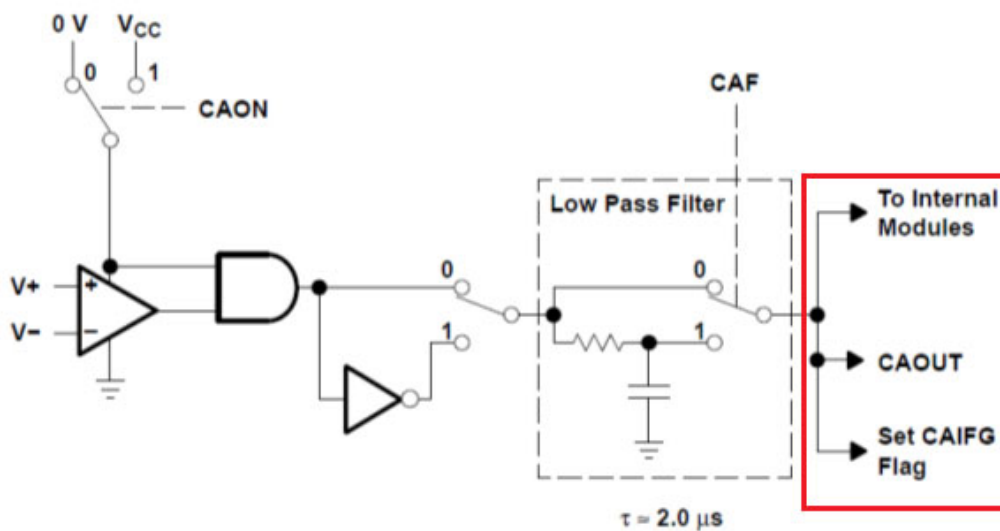
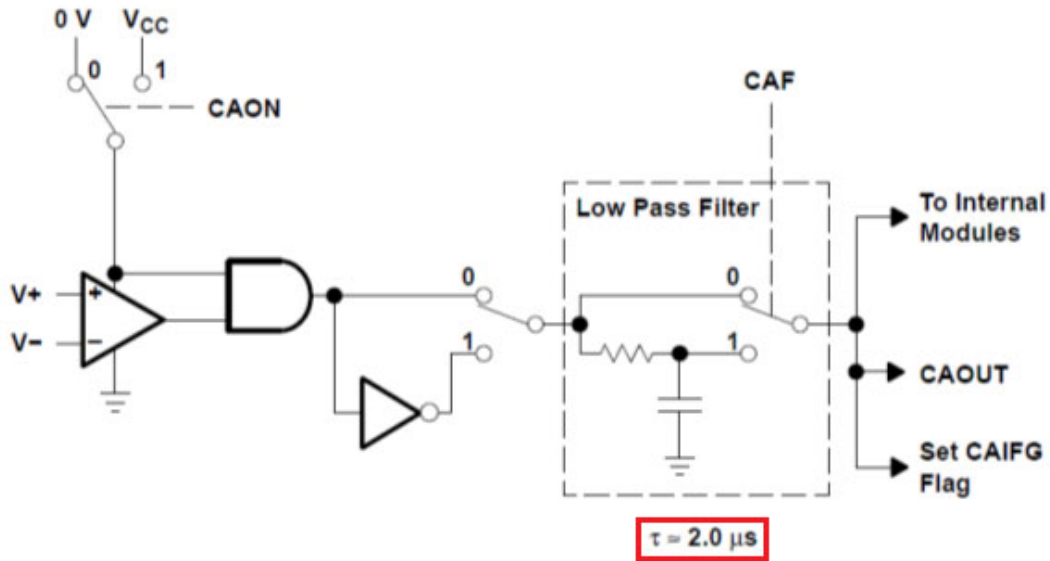


23. There are two potential paths that the digital data stream can take through the low-pass filter. I have annotated these below as Path A (marked in blue, left) and Path B (marked in green, right).



24. On Path A, the digital data is passed through the filter unchanged. On Path B, the digital data is filtered. Software running on the microcontroller determines which path is used at any given moment. This is indicated in the diagram by the switch (outlined in red below), where “0” enables Path A and “1” enables Path B.





26. Barone also discloses a digital band-pass filter. “[T]he discrete Fourier transform is further used to derive data values corresponding to the presence in the data samples of twenty (20) lines of frequencies in steps of 0.5 to 1 Hz *above and below the above-defined defect frequencies* and their harmonic overtones, i.e., ± 0.5 or 1 Hz to 10 to 20 Hz of the identified exemplary frequencies. EX1007 at ¶ [0221]. “It may be noted that the *range of frequencies* is preferably enough to allow analysis of the defect frequency *plus and minus* the wheel rotation frequency.” EX1007 at ¶ [0221]. This band-pass filter is executed by software (i.e., software filter). EX1007 at ¶ [0222].

27. Therefore, Barone teaches both software and digital filters, and as I noted in my first declaration in support of the Petition, it is my opinion that a PHOSITA would have been motivated to modify the system of Armitage to include the filtering of Barone to remove unwanted data and noise, amplify particularly relevant data, and ensure clean data is analyzed to accurately detect fault conditions.

B. Amsted Mischaracterizes Barone’s Disclosure

28. In my opinion, Amsted’s argument regarding aliasing as described in Barone is misinformed. Barone explains that *in one specific type of signal conditioning*, there is no aliasing problem and filtering may not be required. EX1007, ¶ [0234]. The same signal is filtered— “the output of the conditioning circuit *is filtered for frequencies below about 290 or 300 Hz.*” *Id.* This is a digital pass filter.

29. At the time of the invention it was common knowledge to a PHOSITA that various filtering methodologies, including software filtering and digital filtering, were advantageous to ensure the accuracy of data readings and correctly predict anomalous conditions of a railcar. EX1003, ¶¶ 81, 162.

IV. GROUND 4, CLAIM 1

A. LeFebvre Discloses Filtering (Limitation 1(d))

30. As I explained in my first declaration, LeFebvre teaches filtering as the term is used in the '915 patent. Pet. at 54-55; EX1005, ¶¶ [0034]-[0036], [0053]; EX1003, ¶¶ 156-157. Amsted references LeFebvre at [0053] in its POR to argue that LeFebvre does not disclose filtering; however, upon closer examination, this very paragraph discloses filtering: “[T]he *burden of transmitting all the data that might be sampled* in performing such monitoring is extremely large and, for the most part, *detailed data is not significant*. Preferably, only the observations which imply some fault or misbehavior are recognized. To *reduce the radio traffic* to manageable proportions, the system is designed to process the raw sensor data, looking for signs of trouble and then *send only essential indicative information*.” EX1005 at ¶ [0053]. Amsted’s own patent describes filtering by the selection of relevant data for analysis. EX1001 at 13:17-24 (“sensor sections select the data to be analyzed using digital data filter 1204, 1210 or 1216” and “[d]ata selection can be based on, for example, direction (e.g. vertical or longitudinal components), frequency (e.g. high-frequency clangs or

low frequency rocking), overall magnitude (combination of 2 or 3 directional components), or other variations of the collected data.”); *see also* EX1001 at 13:57-14:9 (describing the use of various filters to identify and extract specific types of data “characteristic” to certain fault conditions to streamline information that is sent to the CMU).

31. Another important consideration for a PHOSITA in the system would have been reduction of unnecessary data being sent for processing and analysis. LeFebvre confirms this, highlighting the importance of reducing the amount of data sent to the control node, citing cost and volume reasons, and noting the system is purposefully “designed to be tolerant of missing data.” EX1005 at ¶¶ [0010], [0095]-[0096]. A PHOSITA would have understood that this disclosure in LeFebvre emphasizes the advantages of filtering (i.e., “data selection”).

B. A PHOSITA Would Have Been Motivated to Combine LeFebvre with the Filtering of Barone

32. In my opinion, Amsted’s argument that modifying LeFebvre in view of Barone’s filtering would frustrate LeFebvre’s purpose of detecting alarm conditions is the same “outlier” argument it made regarding Armitage. But the ’915 patent, also directed to detection of fault conditions on railcars, does not explain how its filtering does not result in the same problem, as I already discussed above. *See* ¶¶ 14-15, *supra*.

33. EX1026 is a copy of the data sheet for Texas Instrument microcontroller MSP430F1611 (MSP430 family), dated October 2002 and revised in August 2006, and downloaded from <https://web.archive.org/web/20070212031700/http://focus.ti.com/lit/ds/symlink/msp430f1611.pdf>. A PHOSITA would understand that the revision dates on a data sheet from a microcontroller, especially Texas Instruments, are reliable and reflect when the original and revised data sheets were available to the public. This specific type of microcontroller is cited in Barone (EX1007) as an example of a low-power microcontroller for use in the wireless railcar monitoring system disclosed in Barone and uses digital data and software to operate algorithms that help monitor the health of railcar bearings through vibration and acoustic monitoring. In preparing my declaration in support of Petitioner's Reply, I located this manual, reviewed it, and discussed it in my Declaration in support of Petitioner's Reply.

34. EX1027 is a copy of the data sheet for Texas Instrument microcontroller MSP430FG4618 (MSP430 family), dated April 2006 and revised in December 2006, and downloaded from <https://web.archive.org/web/20070101063654/http://focus.ti.com/lit/ds/symlink/msp430fg4618.pdf>. A PHOSITA would understand that the revision dates on a data sheet from a microcontroller, especially Texas Instruments, are reliable and reflect when the original and revised data sheets were available to the public. This specific

type of microcontroller is cited in Barone (EX1007) as an example of a low-power microcontroller for use in the wireless railcar monitoring system disclosed in Barone and uses digital data and software to operate algorithms that help monitor the health of railcar bearings through vibration and acoustic monitoring. In preparing my declaration in support of Petitioner's Reply, I located this manual, reviewed it, and discussed it in my Declaration in support of Petitioner's Reply.

* * *

Pursuant to 28 U.S.C. § 1746, I declare under penalty of perjury under the laws of the United States of America that the foregoing is true and correct.

Executed on: January 26, 2024



STEVEN RICCA