ITT Industries/X2Y Attenuators, LLC

Case Study of Filtered Connector Application in Blower Motor to Meet EMC Requirements
Prototype Test Goals

- Design and implement filtered connector with X2Y® Technology on a blower motor that can meet or exceed EMC requirements set forth by automobile manufacturers:
  - 2005 SAE World Congress paper:
    - Electromagnetic Compatibility of Direct Current Motors in an Automobile Environment
- Measure differences in modifications to connector.
- Verify X2Y performance vs. conventional EMI filtering.
Data was taken by X2Y Attenuators, LLC at the Detroit facility.

The measured radiated and conducted emissions data is used for A to B comparisons of filter effectiveness.

Although the data is not validated to specific test requirements at an approved test facility, products that meet performance benchmarks established in X2Y’s test chamber typically result in approvals at certified test facilities.
Radiated Emissions

Test Set-up
RE Test Set-up

- The DUT was placed in an ETS-Lindgren IC-GTEM 250 along with a 12 V power source connected by a 3 meter harness.
  - Note: the harness is wrapped between wooden pins on a wooden platform for repeatability of measurements.
  - Note: DUT is tested under load conditions.
An IFR AN920 spectrum analyzer was used to measure and record RE.

The spectrum analyzer settings are:

- Frequency spectrum = 100 kHz – 1000 MHz
- Bandwidth = 120 kHz
- Sampling = 3 Peak Hold
RE Test Set-up (continued)

- To baseline DUT measurements for A to B comparisons, an ambient, DUT non-filtered, & DUT production filter were taken.
  - Note: These measurement will appear on all data plots.

Note: Ambient Noise
Test Set-up

Conducted Emissions
Test Set-up
CE Test Set-up

- The DUT was placed in a shield box measuring approx 29 by 18 inches.
- Between the DUT and 12 V power source are (2) LISNs Type 6338-5-TS-50N. (manufactured by solar Electronics Co.)
- There is approx 8 inches of harness between power supply & LISN and LISN & DUT.
- Note: DUT is tested under load conditions.
CE Test Set-up (continued)

- Again, an IFR AN920 spectrum analyzer was used to measure and record CE.

- Measurements were taken in (2) different frequency spectrums.
  - Spectrum analyzer settings #1:
    - Frequency spectrum = 150 kHz – 30 MHz
    - Bandwidth = 9 kHz
    - Sampling = 3 Peak Hold
  - Spectrum analyzer settings #2:
    - Frequency spectrum = 30 MHz – 200 MHz
    - Bandwidth = 120 kHz
    - Sampling = 3 Peak Hold
To baseline DUT measurements for A to B comparisons, an ambient, DUT non-filtered, & DUT production filter measurement was taken.

- Note: These measurements will appear on all data plots.
Connector Prototype and Design Issues
Connector Design Issues

- Determining the ground layout of the connector face is critical. (Connector supplied by ITT Industries/Cannon.)
  - Bottom only GND
  - Top & Bottom GND
    - Note: solder connection preferred, press fit will lose RF performance.
  - Top & Bottom GND with (−) power lead attached to GND
    - Note: solder connection preferred, press fit will lose RF performance.

Bottom-only

Solder Connection

Top & Bottom

Top & Bottom w/ (−) power attachment

Solder connection
Connector Implementation Issues

Connector Prototype and Motor Implementation Issues
Connector Implementation Issues

- Determining the ground interface of the connector and motor housing is critical.
- A good RF GND would require multiple connector & motor housing contacts at several points.
  - Note: Conductive tape was used to make GND connection to top of connector during testing.
Connector Radiated Emissions

Test Results
RE Test Results

**RE - Bottom-only**

- Ambient
- No Filter
- (2) Ind & Cap Production
- 0.44μF X2Y with bottom-only plate

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July 3, 2006

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RE Test Results

RE - Top & Bottom

Ambient
No Filter
(2) Ind & Cap Production
0.44uF X2Y with bottom-only plate
0.44uF X2Y w/ top & bottom (soldered)
RE Test Results

RE - Top & Bottom w/ metal tape

- Ambient
- No Filter
- (2) Ind & Cap Production
- 0.44uF X2Y with bottom-only plate
- 0.44uF X2Y w/ top & bottom (soldered)
- 0.44 X2Y w/ top & bottom plate (soldered) - w/ metal tape
RE Test Results

RE - Top & Bottom w/ metal tape & (-) lead shorted

- Ambient
- No Filter
- (2) Ind & Cap Production
- 0.44uF X2Y with bottom-only plate
- 0.44uF X2Y w/ top & bottom (soldered)
- 0.44 X2Y w/ top & bottom plate (soldered) - w/ metal tape
- 0.44uF X2Y w/ top & bottom plate (soldered) - w/ metal tape & (-) lead shorted
Connector Conducted Emissions
Test Results
CE Test Results

**CE - Top & Bottom w/ metal tape & (-) lead shorted**

- Ambient
- No Filter
- (2) Ind & Cap Production
- 0.44uF X2Y w/ top & bottom plate (soldered) - w/ metal tape & (-) lead shorted
SUMMARY

- The technical feasibility of X2Y® Technology as EMI suppression for DC motors has been proven many times, and is in production with multiple motor manufacturers.

- The following technical and patent-related information is now available in the public domain, and can be downloaded from the internet.

- Technical Papers
  - 2005 SAE World Congress Motor Paper
  - 2004 IEEE EMC Motor Paper
  - Jan 2001 - Test & Measurement World Article
  - Nov 2001 - EMWC Paper
  - 2001 IEEE EMC Motor Paper
  - 1999 IEEE EMC Motor Paper

- Application Notes
  - Application Note #4001
  - Application Note #4002
  - Application Note #4003
  - Application Note #4004
  - Application Note #4005

- Technical Presentations
  - 2005 SAE World Congress Motor Presentation
  - X2Y® Technology in DC Motors Presentation
  - 2004 IEEE EMC Motor Presentation
SUMMARY (continued)

Delphi Technologies, Inc.

(12) United States Patent
(10) Patent No.: US 6,885,862 B1
(6) Date of Patent: May 3, 2006

(54) MOTOR ASSEMBLY HAVING IMPROVED ELECTROMAGNETIC NOISE FILTERING AND DISSIPATION

(56) References Cited
U.S. PATENT DOCUMENTS

FOREIGN PATENT DOCUMENTS

25 Claims, 7 Drawing Sheets

Hill-Rom Services, Inc.

(12) United States Patent
(10) Patent No.: US 6,381,153 B1
(6) Date of Patent: Apr. 30, 2002

(54) METHOD AND APPARATUS OF EMI FILTERING THAT ELIMINATES THE NEED FOR AN INDUCTOR

(56) References Cited
U.S. PATENT DOCUMENTS

FOREIGN PATENT DOCUMENTS

14 Claims, 6 Drawing Sheets

July 3, 2006
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SUMMARY (continued)

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Valeo

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Assistant Examiner—Julio Gonzalez
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ABSTRACT

An end cap assembly 20 for an electric motor has an insulating bush 22 and a conductive cover 24. The cover 24 supports a bearing 21 for a shaft of the motor. The body 22 supports brushes and motor terminals. An EMI device 84 is electrically connected across the motor terminals and is carried to the cover by way of conductive contacts.

13 Claims, 4 Drawing Sheets

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LISTE DES DOCUMENTS UTILISES DANS LE RECHERCHE PRELIMINAIRES : De recopier a la fin du present fascicule.

REFERENCES A D'AUTRES DOCUMENTS NATIONAUX APPAREILS :

NO A1

DISPOSITIF DE FILTRAGE ET D'ANTIPARASITAGE D'UN MOIETEUR ELECTRIQUE

L'inventeur propose un dispositif de filtrage et d'antiparasitage (90) d'un moteur electrique (30) comportant au moins un premier bateau (70) d'alimentation du collecteur d'induit du moteur electrique (34), du type qui comporte un condensateur (60) accroche a une borne debout electrique d'un cable conducteur de l'alimentation electrique du collecteur d'induit du moteur electrique (34), a l'aide d'un connecteur (62) operant par l'intermediaire d'une plaque coulissante (64) reliee au collecteur d'induit du moteur electrique (34) et d'un condensateur (60) a un bateau du dispositif de filtrage et d'antiparasitage (90) du type indique.
Please email inquiries and questions to x2y@x2y.com, or:

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