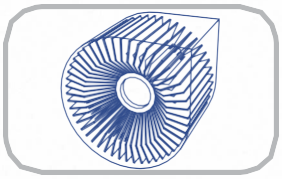
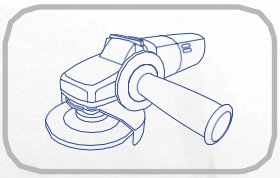
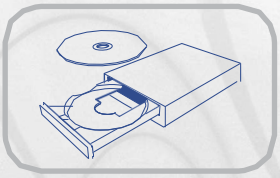
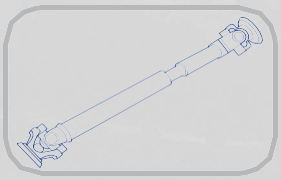
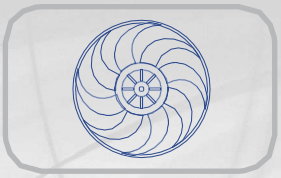
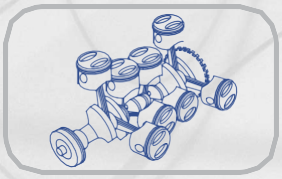
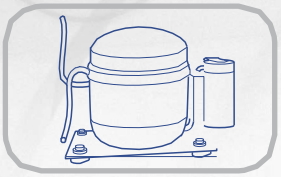
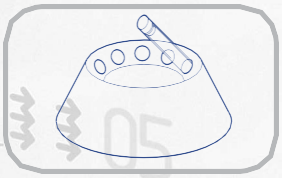
PERPETUAL INDUSTRIES INC.

Please direct all inquiries to:

5634 Opportunity Blvd, Unit F
Auburn, Indiana 46706
P: 702-707-9811
E: info@perpetualindustries.com
www.perpetualindustries.com

XYO PROTOTYPE BALANCER AS APPLIED TO A GE WASHING MACHINE

Testing Report Summary

CURRENT STATE AND OPPORTUNITY

The XYO technology shows significant improvements in washing machine performance during independent studies. Perpetual Industries wants to work with innovative washing machine manufacturers to optimize and implement the XYO balancer in their product.

Contact us to see how your product can beat the competition using XYO

RESULT HIGHLIGHTS

The XYO balancer reduces vibration by compensating for variable mass imbalance during the spin cycle of washing machines. The benefits of reduced vibrations include:

- higher spin speeds
- reduced energy consumption
- lower noise emissions
- less mechanical wear

Tests show that the XYO system has a significant impact on performance of the washing machine. Vibrations measured at various locations on the washer tub and body showed a dramatic improvement with an **XYO prototype balancer**. Energy consumption, spin speeds and noise emissions were also improved with the XYO balancer technology.

Washing Machine
Vibration Decreased by 89%

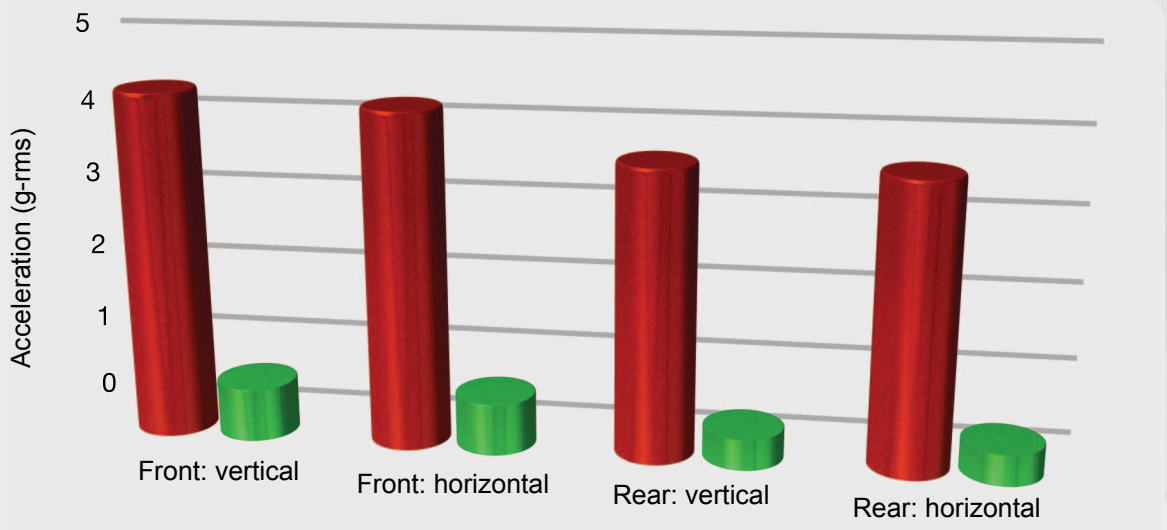


Figure 1. Vibration levels on GE's GCVH6800JWW washing machine, in the vertical and horizontal directions at the front and rear of the tub with1kg of mass imbalance

Note:

- **The results in this report are based on a prototype XYO balancer for a GE front-loading washing machine, model GCV46800JWW. A separate report is available for two other front and top-loading washing machines, showing similar improvements using XYO.**
- **A 1kg mass imbalance load was chosen as a good representation on an unbalanced load. However, the XYO balancer can compensate for much a larger unbalanced mass if desired.**
- **While the results are positive, it is possible to further improve the washing machine's performance and realize further benefits with refinements to the system.**

RESULT HIGHLIGHTS (Continued)

Spin Speed Increased by 29 RPM

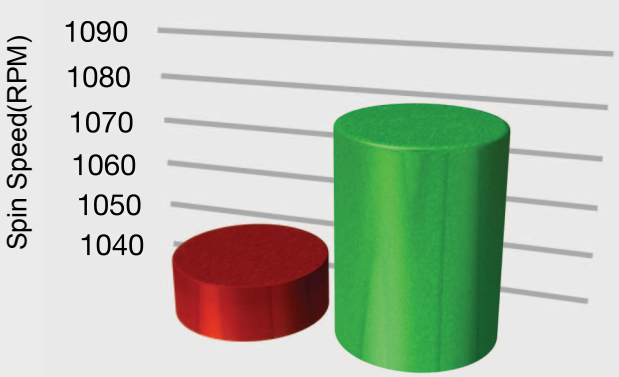


Figure 2. Impact of XYO on spin speed of washing machine

- Figure 2 demonstrates the higher spin speeds achievable using the XYO balancer.
- The spin basket speed increased from 1051 RPM to 1080 RPM.
- Higher spin speeds will enable greater water extraction with shorter spin cycles.
- This will not only improve the energy efficiency of the washing machine, but will contribute significantly to shorter drying times.

Energy Consumption Decreased by 43%

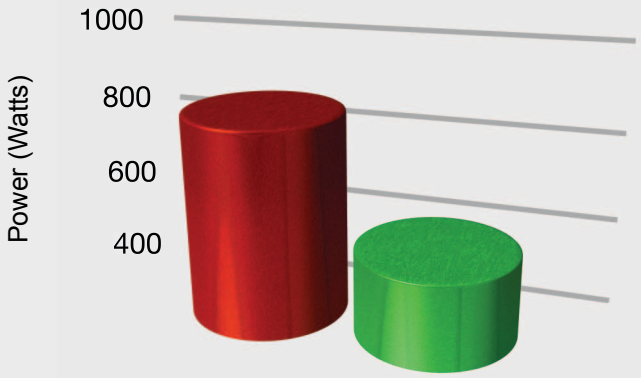


Figure 3. Impact of XYO on energy consumption of washing machine

- Figure 3 compares the steady-state power usage during the spin cycle.
- The XYO balancer reduced the power usage from 857 Watts to 489 Watts.
- There is a 43% reduction in energy consumption that will improve the washing machine's energy rating.
- It also means the XYO balancer enables greater water extraction at a lower cost.

RESULT HIGHLIGHTS (Continued)

Noise Emission Decreased by 11.3 dB

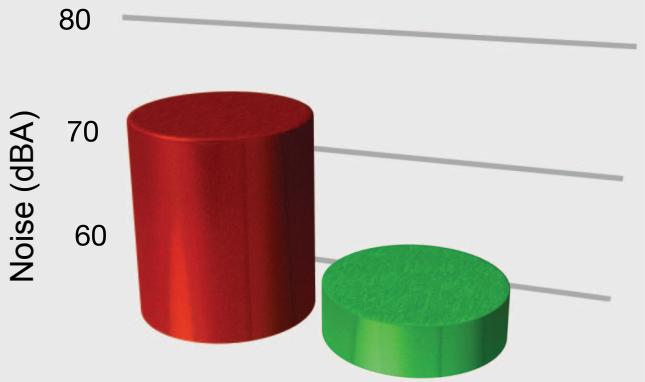


Figure 4. Impact of XYO on noise emission of washing machine

- Figure 4 shows the noise reduction with the XYO balancer installed
- Noise emissions decreased by 15%, from 75.2 dB to 63.9 dB
- This corresponds to better perceived quality for the consumer and a better noise rating for the washing machine.

WITHOUT XYO **WITH XYO**

ADDITIONAL BENEFITS INCLUDE:

- **Lower shipping costs** by eliminating the use of heavy counterweights used to the stabilize the tub during operation.
- **Reduced manufacturing costs** because mechanical items such as hydraulic dampers and springs can be removed, or replaced with smaller, lighter and cheaper components.
- **Fewer warranty claims** will result from the increased product life of the washing machine; excessive vibration will be avoided using the XYO balancer to reduce mechanical wear
- **Longer warranty periods** can be offered to customers for a competitive advantage in the market

INTRODUCTION

During the spin cycle of all washing machines and extractors the mass imbalance caused by wet clothes can lead to violent vibration. Since excessive vibration can have negative impacts (e.g., increased energy consumption, increased noise emission and increased mechanical wear). Manufacturers have tried several techniques to reduce or eliminate vibration. Some examples of these techniques include: adding counterweights to reduce movement, implementing fuzzy logic systems to redistribute the load, employing elaborate suspension systems. None of these techniques solve the vibration problem at its source. In fact, they increase the manufacturing and shipping costs of the product.

TEST OBJECTIVE

XYO is a patented technology that can automatically compensate for mass imbalance in rotating systems. Although XYO can be applied to all rotating machines it is particularly well suited to washing machines. In order to demonstrate the value of implementing the patented XYO balancing technology for washing machines, we fabricated a prototype XYO balancer and installed it (Figure 8) into a GE 4.0 cubic foot front loading washing machine, shown in Figure 5. This particular model was chosen because of the large capacity, suspension system, and the counter weight improvement opportunities.

TEST OVERVIEW

The main vibration concern in washing machines is the motion of the spin basket. Reducing the displacement of the spin basket leads to many beneficial qualities of the system. The measurements presented here concentrate on quantifying the vibration of the spin basket and real world concerns such as noise and energy consumption. Values such as acceleration, spin speed, energy consumption and noise emissions were quantified on a stock machine and compared to a machine with the XYO balancer installed.

Figure 5. GE's domestic front loading washing machine, model GCVH6800JWW

Mass Imbalance: A 1kg mass imbalance was applied to both types of machines by a securing rubber weight inside the spin basket (Figure 6).

Acceleration: Vibration levels for both machines were measured using 50g (100mV/g) accelerometers placed at multiple locations around the washing machine (Figure 7).

Noise: Sound levels were measured in a sound chamber using an Extech HD600 sound level meter was placed in a sound chamber in front of the washing machine.

Energy consumption: Power usage was obtained with a current measurement transformer and a WattNode Pulse voltage reader.

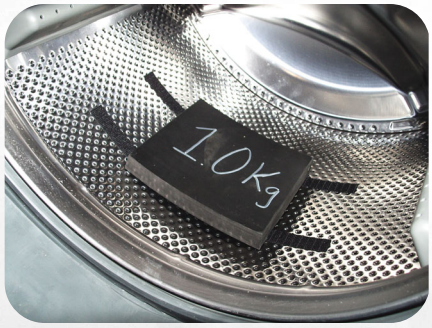


Figure 6. 1.0 kg mass imbalance placed in tub

Figure 7. Accelerometer locations on washing machine tub

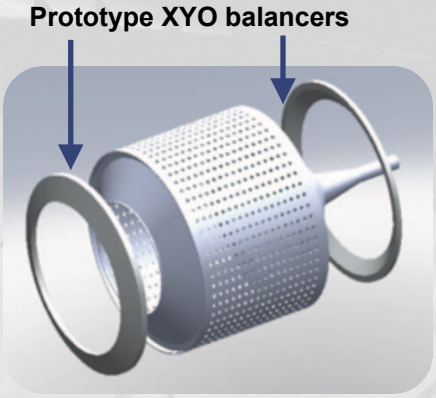


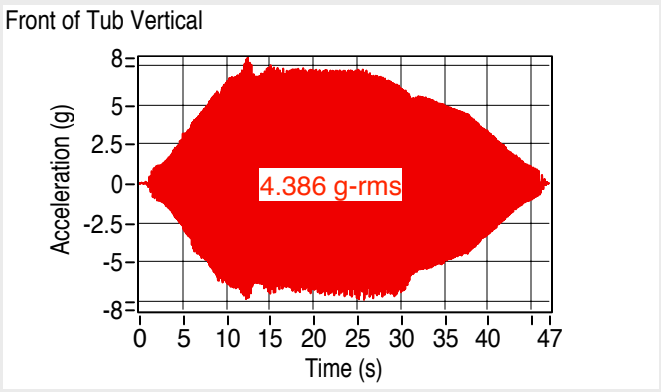
Figure 8. Prototype XYO balancers installed on front & rear of the washing machine basket

Spin Speed: To measure rotational speed, a piece of reflective tape was placed on the spin basket wheel and rotation was detected by an optical pickup.

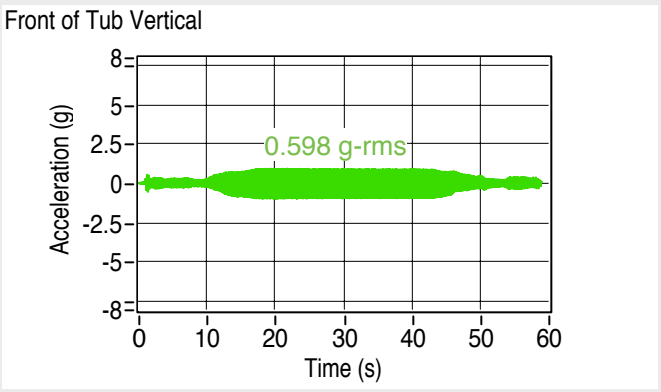
TEST RESULTS

The following results show data for a single set of tests on the washing machine, with and without the XYO balancer. Figures 9 and 10 compare horizontal and vertical vibration levels of the front and back of the washing machine tub, respectively. Figure 11 compares vibrations at the right side, top and front of the washing machine cabinet. Figure 12, 13 and 14 show the difference in speed profiles, power consumption and sound levels, respectively. Table 1 provides a summary of the average measurements during 10s of steady state operation based on three test runs. In all cases, the XYO balancer showed performance improvements over the baseline washing machine running without a balancer.

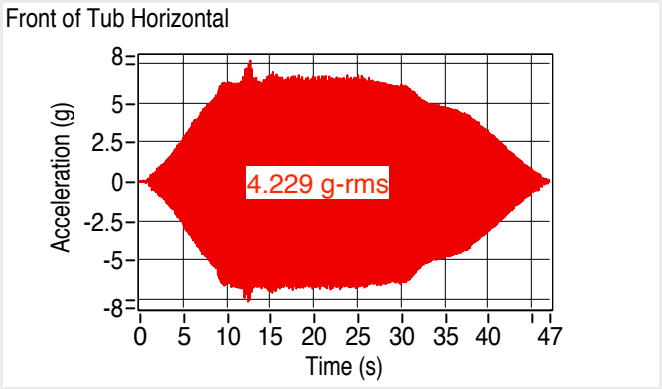
Vibration of the Front of Spin Basket With and Without XYO



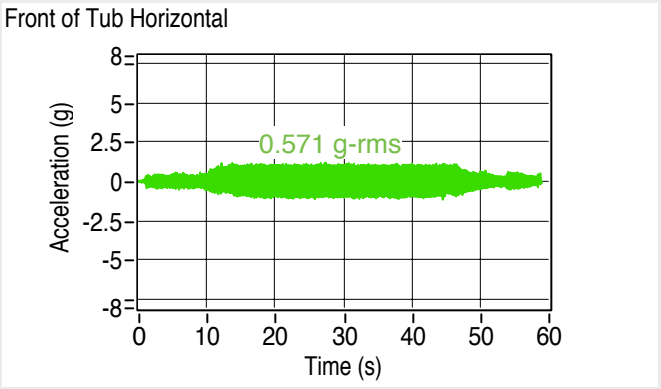
a) Vertical vibration without XYO



b) Vertical vibration with XYO



c) Horizontal vibration without XYO



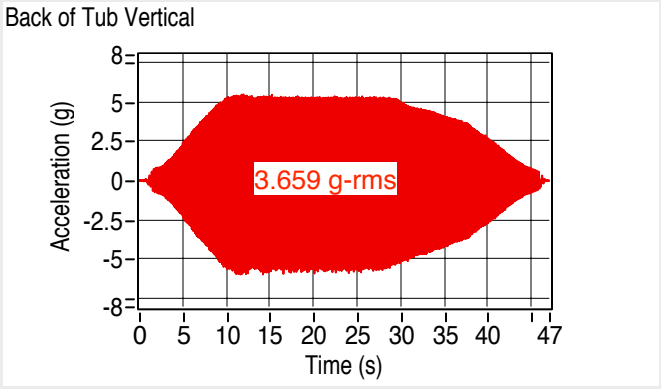
d) Horizontal vibration with XYO

Figure 9. Vibration results at the front of the washing machine tub

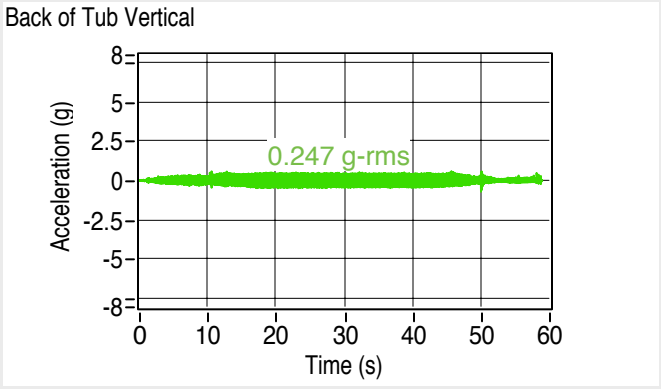
WITHOUT XYO **WITH XYO**

TEST RESULTS (Continued)

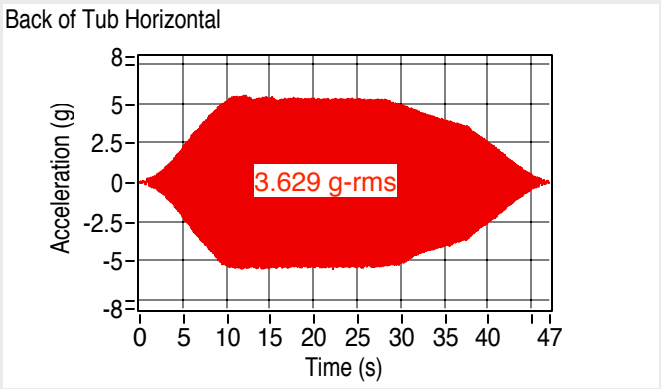
Vibration of the Back of Spin Basket With and Without XYO



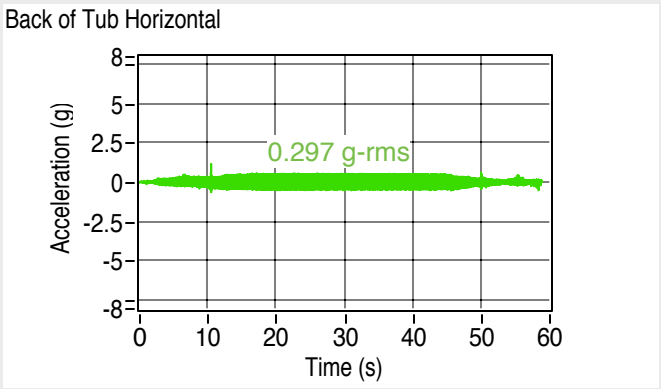
a) Vertical vibration without XYO



b) Vertical vibration with XYO



c) Horizontal vibration without XYO



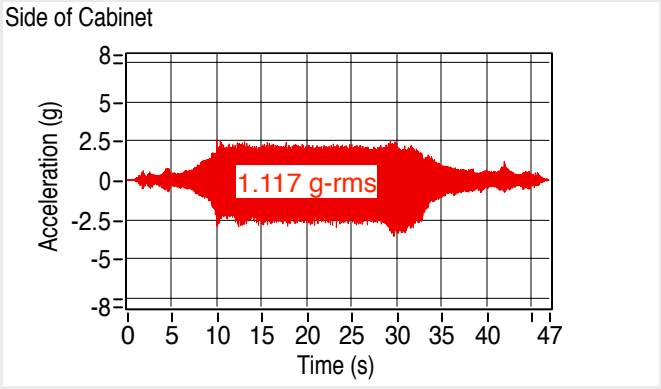
d) Horizontal vibration with XYO

Figure 10. Vibration results at the back of the washing machine tub

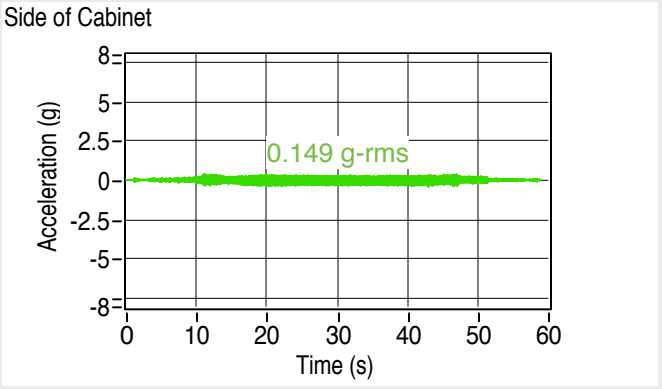
WITHOUT XYO **WITH XYO**

TEST RESULTS (Continued)

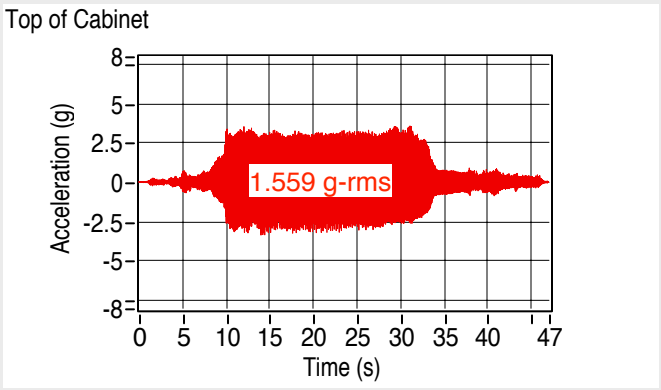
Vibration Around the Cabinet With and Without XYO



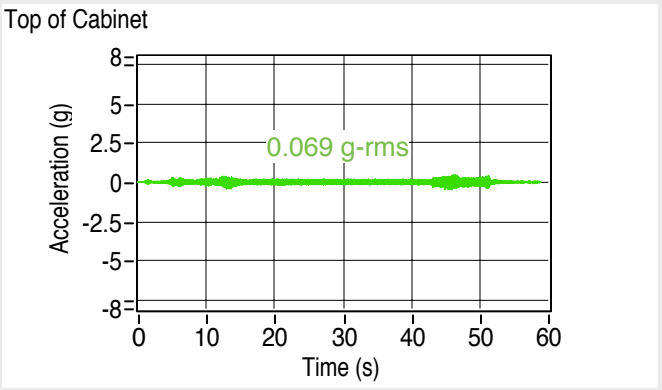
a) Right side vibration of the cabinet without XYO



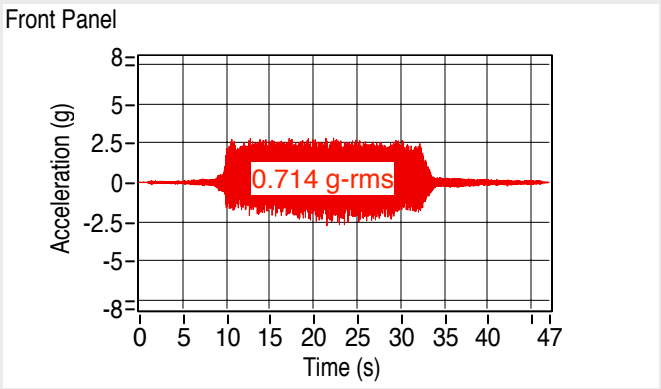
b) Right side vibration of the cabinet with XYO



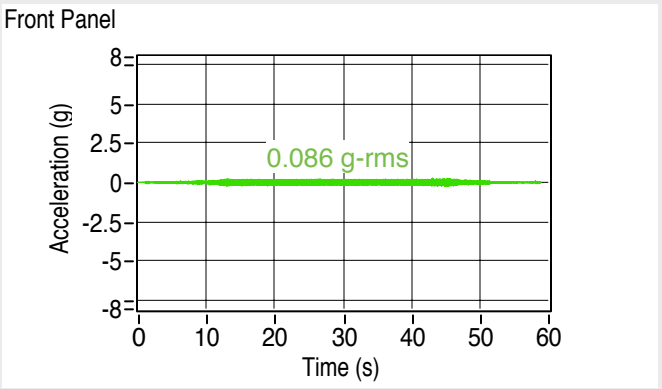
c) Top of the cabinet vibration without XYO



d) Top of the cabinet vibration with XYO



e) Vibration of the front cabinet panel without XYO



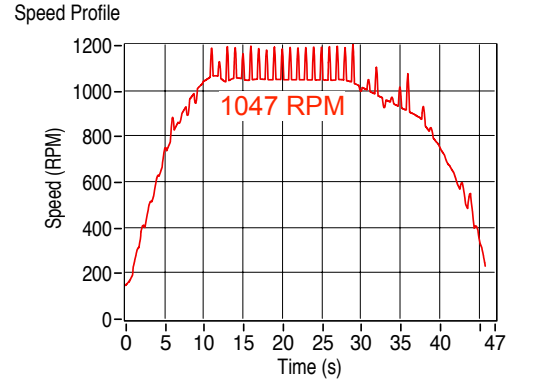
f) Vibration of the front cabinet panel with XYO

Figure 11. Vibration results around the cabinet of the washing machine

WITHOUT XYO **WITH XYO**

TEST RESULTS (Continued)

Speed, Energy Usage and Noise Emissions With and Without XYO



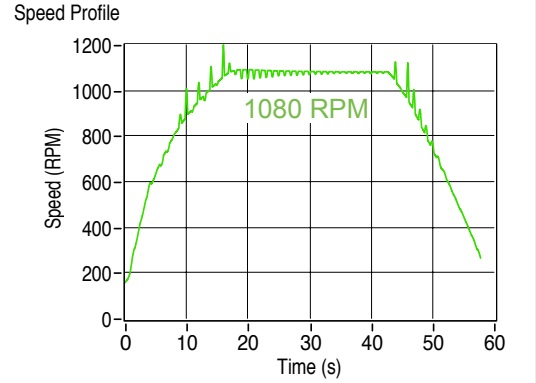
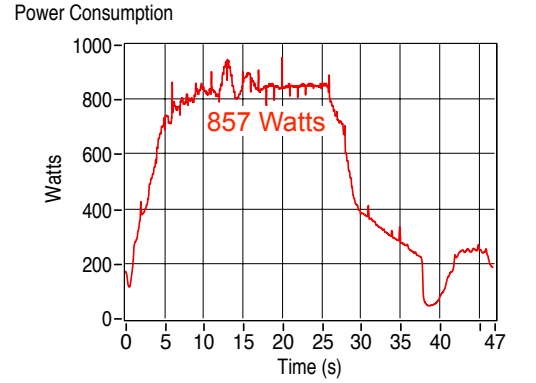


Figure 12. Speed profiles of the washing machine with and without XYO



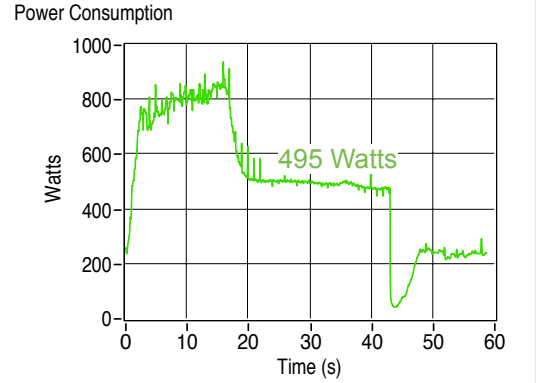
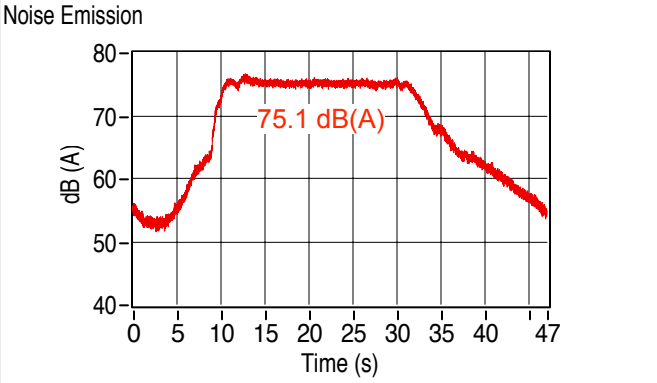


Figure 13. Energy usage of the washing machine with and without XYO



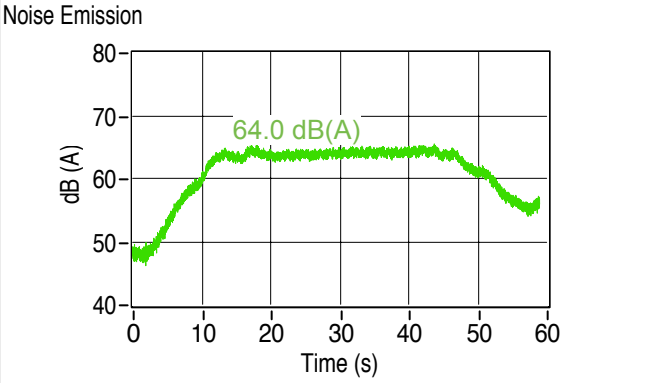


Figure 14. Noise emissions of the washing machine with and without XYO

WITHOUT XYO **WITH XYO**

TEST RESULTS (Continued)

Table 1. Comparison of steady state measurements on the washing machine

	WITHOUT XYO	WITH XYO	IMPROVEMENT
Vertical vibration - front of tub	4.385 g-rms	0.679 g-rms	85% Reduction
Horizontal vibration - front of tub	4.253 g-rms	0.660 g-rms	85% Reduction
Vertical vibration - back of tub	3.677 g-rms	0.396 g-rms	89% Reduction
Horizontal vibration - back of tub	3.647 g-rms	0.398 g-rms	89% Reduction
Vibration - side of cabinet	1.123 g-rms	0.181 g-rms	84% Reduction
Vibration - top of cabinet	1.493 g-rms	0.089 g-rms	94% Reduction
Vibration - front of cabinet	0.688 g-rms	0.096 g-rms	86% Reduction
Spin Speed	1051 RPM	1080 RPM	29 RPM Increase
Energy consumption	857 Watts	489 Watts	43% Reduction
Noise Emission	75.2 dB(A)	63.9 dB(A)	11.3 dB(A) Reduction

Based on the results, the front of the tub experience the greatest vibration levels, up to 4.385 g-rms in the vertical direction; the XYO balancer reduced it down to 0.679 g-rms, an 85% improvement. Similarly, the horizontal vibration declined from 4.253 g-rms to 0.660 g-rms, an 85% improvement.

The rear of the washing machine tub vibrates at 3.677 g-rms in the vertical axis; this number was reduced by 89% to 0.396 g-rms with the XYO balancer installed. Vibrations dropped 89% from 3.647 g-rms to 0.398 g-rms in the horizontal direction as well.

Vibrations around the outside cabinet of the washing machine were dampened significantly by the XYO balancer. Vibrations improved by 84% along the side of the cabinet, going from 1.123 g-rms to 0.181 g-rms. Along the top of the cabinet levels decreased by 94% from 1.493 g-rms to 0.089 g-rms. An 86% improvement was recorded at the front panel, with readings going from 0.688 g-rms to 0.096 g-rms.

The spin speed of the basket increased from 1051 RPM to 1080 RPM with the XYO balancer. It allows increased water extraction and reduced washing cycles. An added benefit was the reduced power consumption, which dropped from 857 Watts to 489 Watts during steady state operation--a 43% reduction in power consumption. Noise emissions also decreased from 75.2 dB(A) to 63.9 dB(A), a 15% reduction. The performance enhancements using XYO make the washing machine more efficient and provide a significant competitive advantage for any washing machine manufacturer.

FINDINGS AND CONCLUSIONS

Comparing washing machines with and without the XYO balancer, we have observed **84% to 94% reduction in vibration** at various locations. Further improvements can be achieved if cooperation with a capable washing machine manufacturer is established. Some of the advantages of using XYO technology include:

- Vibration reduction by implementing XYO will reduce premature part failures; therefore less warranty claims should be experienced.
- The washer will spin faster because of reduced vibration. This will result in increased water extraction and reduced spin cycle time. This will also result in further energy savings due to less drying time.
- By using XYO the manufacturer solves the vibration problem at the source. Thus, the manufacturer should be able to use less expensive components and avoid costly methods that were previously used to deal with problems arising from vibration caused by imbalanced loads. There will also be substantially less design changes due to unforeseen vibration problems.
- The reduction in spin cycle time and direct reduction of energy consumed by the motor will translate into a substantial improvement in energy rating. This will result in a significant competitive advantage.
- The reduced noise emission of a washer equipped with XYO will increase the quality of the machine and also provide a competitive advantage in the marketplace.
- The manufacturing costs of the machine can be reduced by removing the heavy counterweights (25kg), which also has an impact on the hidden cost of shipping the units.
- Complicated and expensive electronic imbalance detection is no longer required. By implementing XYO, expensive sensors and programming can be eliminated. This will translate into cost savings per unit.

There are many technical and competitive advantages for any washing machine manufacturer to integrate XYO into their line of washing machines. The reduction in vibration created by XYO leads to numerous benefits to both the manufacturer and the consumer. XYO works on all rotating machines and is extremely effective with washing machine applications.

Impact of XYO:

- **Vibration reduced by 94%**
- **Spin speed increased 29 RPM**
- **Power consumption decreased 43%**
- **Noise emissions decreased 11.3 dB**