

Prepared for

Microsoft Corporation

Mouse Battery Life Comparison Test Report - Executive Summary -

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1 Introduction

1.1 Executive Summary

Introduction

Independent test results obtained by Percept Technology Labs, Inc. show that the Microsoft® Wireless IntelliMouse® Explorer and Microsoft Wireless Optical Mouse have an estimated battery life three times greater than a major competitor's wireless mouse products.

From October through November 2003, Percept Technology Labs, Inc. conducted an independent battery life comparison assessment between the Microsoft Wireless IntelliMouse Explorer and Wireless Optical Mouse, and the Logitech® Cordless Click!® Plus and Cordless Click! ®. The purpose of the test was to determine a mouse battery life comparison under actual, controlled operating conditions.

Test details, including equipment, fixtures, actual motion profile, current consumption data, mouse performance characterization, and battery life calculations are discussed in the full report.

Reasons for Controlled Environment Testing

Microsoft Corporation engaged Percept Technology Labs to undertake an independent battery life comparison test to verify the competitive performance of Microsoft's newly developed optical and power consumption technology optimized for wireless mouse products. According to Microsoft, this new technology will provide most users significantly increased battery life over competitors' models.

For wireless optical mouse products, battery life is dependent on multiple factors, including:

- Frequency and amount of usage
- Desktop surface type and color
- The type and current capacity of batteries used

Percept developed a controlled test environment and testing process taking into account the above factors to accurately compare the relative performance of different mouse products.

User Profile

Because power conservation in the idle and sleep modes is significant in the battery life comparison, it is important that the motion/user profile used for testing be representative of a typical start and stop motion profile experienced during mouse usage. A good battery life comparison cannot be made by continuously running the mouse and observing which one lasts

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longer. The motion/user profile must have a representative number of on and off times similar to how a mouse is used.

Percept reviewed several mouse usability studies for detailed motion profiles of a sample of users to determine an appropriate mouse motion profile to be used in testing. Percept's review included studies from Lawrence Livermore National Laboratory, Cornell University, American Industrial Hygiene Foundation, and the mouse usage data from the Microsoft Real People Real Data user study (RPRD). These studies indicated that actual mouse usage (mouse motion) can range from between 4 hours and 27 hours per week.

The Real People Real Data (RPRD) study provided the most detailed data of start-stop (motion, no motion) events, and the study results showed a range of mouse usage consistent with the other studies mentioned above. Percept concluded that the Microsoft RPRD study was generally representative of actual mouse usage, and used the RPRD data to construct an usability (motion/no motion, start/stop) profile for battery life testing. This user profile is not used for actual battery life prediction, only as a method to compare the power consumption of different products to each other.

Test and Data Analysis Method

Percept tested a sample of over 30 total mice from of the four different mouse product lines to:

- Observe performance characteristics and the various sleep states for the different products tested.
- Provide statistical mouse power consumption data for the motion profile testing.

Sleep State Current Test

The mouse products observed in this study are designed to extend battery life for as long as possible by conserving power when the mouse is not in motion. When a mouse is in motion, power consumption is highest so that tracking and performance are acceptable to the user. Conversely, when mouse motion stops, the mouse powers down into various "idle" or "sleep" modes where less battery power is consumed. Battery life is significantly affected by how much power is saved when the mouse is not in motion. Table 1 shows these "sleep" modes for Microsoft and Logitech products tested. Also shown is the current consumption measured in each mode. As the table shows, the conclusion from the sleep state current measurements is that the Microsoft mouse products use less battery current in sleep modes, which contributes to longer battery life. The current values are totals for the mouse, not for each battery.

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**Table 1, Mouse Power Modes and Average Current Consumption Measurements
(Measured at the power input connections to the mouse)**

Power Mode	Microsoft		Logitech	
	Wireless Intellimouse Explorer	Wireless Optical Mouse	Cordless Click Plus	Cordless Click
	(33) samples	(34) samples	(36) samples	(30) samples
Integrated Average, Current, IActive This is the current measured during the motion / no motion, start/stop test.	11.7 mA	13.0 mA	23.0 mA	22.4 mA
Intermediate sleep state ("idle mode"). This is the power state between active and the deepest sleep state.	0.942 mA	0.913 mA	1.320 mA	1.313 mA
Current consumption in the deepest sleep state (this was observed by Percept to occur for both products after about 10 minutes of no motion)* * no deeper sleep state was observed for any products after 12 hours of no motion	0.157 mA	0.146 mA	0.296 mA	0.293 mA
<i>Conclusion from the Motion, Idle mode, and Sleep State Current Measurements: Microsoft mouse products use less battery current in all modes, which contributes to longer battery life.</i>				

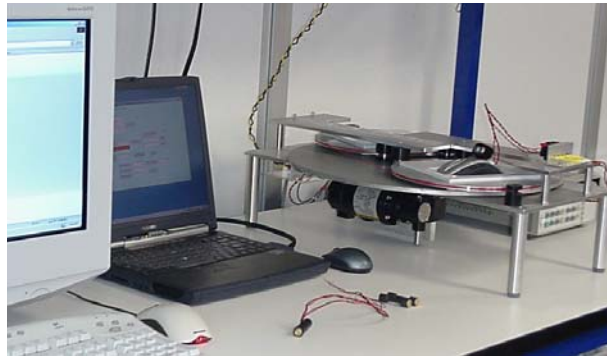
Motion Profile Test

For the motion testing, a custom-automated servo-controlled mouse testing fixture (Figure 1) was designed and used to test all mouse products using the motion profile developed from the RPRD study.

Figure 1, Motion Profile Test Fixture



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Battery configuration and capacity

Configuration of the batteries (series or parallel) and total battery capacity were also noted to correctly estimate battery life. It is noted that alkaline battery capacity estimates are used for comparison purposes only; they are based on Energizer (and Duracell where applicable) capacity specification of 2850 mAh per battery at operation down to a cutoff voltage of 0.8 Vdc and a constant current of 25mA. Usually specifications are conservative. The parallel configuration of two AA cell alkaline batteries yields a current capacity of 5,700 mAh. The series configuration of two AA cell alkaline batteries yields a current capacity of 2850 mAh.

The Microsoft mouse products were tested fully functional down to 0.6 Vdc. Under most conditions, the Logitech mouse products stopped functioning properly as the batteries reached 0.8 Vdc per cell. For the purposes of this report, all mouse products were assumed not to work below 0.8 volts per cell.

To determine a battery life comparison between the products tested, the current measurements and total battery capacity described above were used as follows:

- The user profile developed from the Real People Real Data study and used here indicated that the mouse is in the deepest sleep state approximately 74% of the time (e.g., 124 hours per week).
- The remaining 26 % of time (e.g., 44 hours per week) the mouse is in use as simulated by the motion profile.

Using this data, a comparison factor for battery life can be estimated as follows:

$$\begin{aligned} & \text{Microsoft Mouse Battery Life Compared to Logitech Mouse battery Life} = \\ & \frac{\text{[Total Capacity / (0.26 * } I_{\text{active}} + 0.74 * } I_{\text{sleep}} \text{)] for Microsoft mouse products}}{\text{[Total Capacity / (0.26 * } I_{\text{active}} + 0.74 * } I_{\text{sleep}} \text{)] for Logitech mouse products}} \end{aligned}$$

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Conclusions

Based on the above testing methods and resulting calculations of battery life, the test data indicates the following:

- The battery life of the Microsoft IntelliMouse Explorer will be an estimated 3.9 times longer than the Logitech Cordless Click Plus.
- The battery life of the Microsoft Optical Mouse will be an estimated 3.5 times longer than the Logitech Cordless Click Mouse.

Test details, including equipment, fixtures, motion profile, current consumption data, mouse performance characterization, and battery life calculations are provided in the full report.