



## Haptic Technologies Consume Minimal Power in Smart Phones

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## 1 Abstract

Mobile application developers should not be concerned that haptic effects will impact a handset's battery life. New research conducted by Immersion Corp. found that haptic technology power consumption is not significant in mobile devices, even when haptic effects are employed under very aggressive usage scenarios. Researchers assessed the impact on battery capacity for six popular applications that use a range of haptic technologies from Immersion Corp. as well as the generic Vibe technology included in Android devices. They also evaluated the power consumption of three smart phone applications used on an Android phone with and without haptics engaged; the haptics used in this second study were supplied by Immersion.

## 2 Research Overview

Minimizing the power consumption associated with mobile device applications is a constant concern in the mobile industry and Immersion has encountered this concern frequently in its work with mobile developers and in its research with consumers. In fact, the first question developers and consumers often ask, when considering the use of haptic effects in mobile applications, is "Will haptic effects impact the battery life of the device?"

The purpose of this research was to provide a quantifiable answer to that question. Two studies were performed. The first study evaluated power consumption for three Immersion technologies as well as a generic Android technology that provide touch sensations when consumers use their mobile devices to make phone calls, send text messages, correspond by email, or play games. The second study compared the power consumption of three popular applications when operated on a device for long periods of time, with and without Immersion haptics technologies engaged.

Both studies found that the impact of haptics on a handset's battery life is minimal. Even when employed under worst-case usage scenarios for a 24-hour period, the Immersion haptic technologies consumed from .95 to 4.11 percent of the device battery capacity, depending on the use case. The findings should reassure developers and consumers that haptics sensations can be enjoyed on Android smart phones without fear of depleting battery capacity.

### 3 Impact of Haptics on Battery Capacity for Six Use-Case Scenarios

In this study, researchers assessed the impact of haptics on battery capacity for six popular applications that use a variety of haptic technologies.

The devices employed in the study included three of Immersion's TouchSense technologies: the TouchSense 5000 solution, which is employed with a Piezo actuator to provide high-definition haptic effects; the TouchSense 3000 solution, which is employed with a Linear Resonant Actuator (LRA) that provides standard-definition haptic effects; and the TouchSense 3000 solution employed with a standard-definition Eccentric Rotating Mass (ERM) actuator. The study also evaluated the power consumption of the generic Vibe technology available in Android devices, which uses a conventional ERM.

The researchers assessed the power consumption of the selected haptics technologies for six use-case scenarios. The use cases were very aggressive and represented worst-case operating conditions for a single device during a single 24-hour period. The use-case scenarios included the following:

- **Phone calls:** This scenario represented 25 phone calls, each lasting 4 minutes. Each phone call required launching the dialer application, entering 10 digits plus the "call" or "send" button, as well as the "end" button. This scenario represented 12 haptics effects per phone call.
- **Text messages:** This scenario included 50 text messages, each 140-characters in length. Haptic effects were used when launching the application, selecting a contact, and using a haptic keyboard. The scenario required 160 haptic effects per text message.
- **E-mail correspondence:** This scenario represented 4 hours of e-mail correspondence with continuous text entry at 40 words per minute on a haptic keyboard. The scenario required 2,400 haptic effects per hour.
- **Game play:** Three game play scenarios were represented in the study.
  - 60 minutes of a crossword game, which required entering a 10-character word every minute
  - 30 minutes of a jumping game requiring a haptic effect every second
  - 30 minutes of a shooting game that required a "re-load" associated with a long and short haptic effect every 30 seconds and shooting effects every 10 seconds.

The researchers first determined the actual power consumption required to produce and maintain each haptic effect associated with these applications, such as bump, click, double-click, weapons and shooting sensations. They used a current probe to measure the power consumption for the Immersion technologies and calculated the power consumption for the generic Vibe technology based on equivalent haptic use cases.

They used the measurements of those effects to calculate the power consumption required for each use-case, for each haptics technology employed. They then aggregated the power consumption calculations

to determine the overall impact, for each use case and haptic technology, on device battery capacity. The study assumed that each device would use a 1200 mAh battery, which is the capacity of a typical battery used in high-end smart phones.

### 3.1 Study Findings

The study found that overall demands on the battery for a device that powered 25 haptics-enabled phone calls, 50 text messages, 4 hours of e-mail and two hours of gaming in a single, 24-hour session, were minor. The percentage of battery capacity required to power all of these use-cases ranged from .95% to 7.1%.

The TouchSense 3000 solution with an LRA actuator had the least impact on battery capacity, consuming just .95% of the battery. The TouchSense 5000 with the Piezo actuator consumed 1.21%, the TouchSense 3000 with an ERM actuator consumed 4.11%, and the generic Vibe used with an ERM actuator consumed 7.10 % of the battery. The generic Vibe technology consumed more power because it does not have efficient control circuitry or overdrive and braking capabilities and therefore needs to run significantly longer than the other options to produce the intended effects.

In general, text messaging and e-mail were the most power-hungry haptic-enabled applications, followed by the jumping game, which was more power-hungry than each of the crossword, shooting game and phone call applications.

Figure 1 – Power Consumption and Percentage of Battery Capacity Consumed for Each Haptics Technology

<b>Power Consumption and Percentage of Battery Capacity Consumed for Each Haptics Technology</b>				
<b>Aggregated Use Cases*</b>	<b>TS5000 Piezo</b>	<b>TS3000 LRA</b>	<b>TS3000 ERM</b>	<b>Generic Vibe</b>
25 phone calls 50 text messages 4 hours of e-mail 60 minutes of Crossword 30 minutes of Jumping Game 30 minutes of Shooting Game	14.54 mAh** 1.21%	11.37 mAh 0.95%	49.29 mAh 4.11%	85.25 mAh 7.10%
*All six use cases are employed during a 24-hour period on a single high-end mobile phone **Based on a 1200 mAh battery				

## 4 Impact of Haptics on Battery Capacity for Three Popular Applications

Researchers performed additional evaluations to determine how much power is consumed when popular haptic-enabled applications are used on a high-end device. The studies were performed on a Nexus One handset that employed haptics solutions supplied by Immersion. A battery management application was used to track battery consumption. The applications included the game “Angry Birds,” the standard Android stopwatch, and the “Need for Speed” game. The applications were tested with and without haptic effects employed.

### **Angry Birds**

Angry Birds was evaluated on a Nexus One device equipped with an ERM actuator used in conjunction with Immersion’s TouchSense 3000 solution and its Reverb Module that uses audio to trigger haptic effects. The game was played twice for 55 minutes each time: It was played once with haptics set at the maximum (high) setting and once again without haptics.

The difference in power consumption was minimal. When played without haptics, Angry Bird consumed 15% of battery capacity. When played with haptics engaged, it consumed 17% of battery capacity.

### **Android Stopwatch**

The stopwatch application was evaluated on a Nexus One device equipped with an ERM actuator and Immersion’s TouchSense 3000 haptic solution, which created an animation effect every second as the counter “rolled over” to the next number. The application was run twice for 60 minutes each time: It was operated once with haptics enabled and once without haptics.

The difference in power consumption was minimal. When operated on the Nexus One without haptics, the stopwatch consumed 10% of the battery capacity. When operated with haptics, it consumed 11%.

### **Need for Speed**

Need for Speed was tested because it is an aggressive user of Reverb haptics. The application has an engine sound effect that runs continuously throughout the game.

The game was evaluated on Nexus-S device equipped with an LRA actuator and Immersion’s TouchSense 3000 solution and its Reverb Module. The Reverb was operated at the moderate setting. As before, the game was played twice, for 60 minutes each time: Once with haptics enabled, and once without haptics.

The difference in power consumption was minimal. When played without haptics, Need for Speed consumed 30% of the device battery capacity. When played with haptics engaged, it consumed 31% of the battery capacity.

## 4.1 Study Findings

The three applications were tested under very aggressive use cases. When haptics were engaged, they were set at strong levels and employed throughout the use of the application. Despite this usage, the impact on battery capacity was minimal, from 1 to 2%, which is within the margin of error for the battery management application used to track consumption.

Figure 2 – Power Impact of Haptics on Battery Consumption for Three Popular Apps

<b>Impact of Haptics on Battery Consumption for Three Popular Applications (Percent of Battery Capacity Consumed)</b>				
<b>Application</b>	<b>Duration of Test</b>	<b>Without Haptic Effects</b>	<b>With Haptic Effects</b>	<b>Net Impact on Battery Capacity</b>
Angry Birds	55 minutes	15%	17%	+2%
Android Stopwatch	60 minutes	10%	11%	+1%
Need for Speed	60 minutes	30%	31%	+1%

## 5 Conclusion

The power consumption of haptics technologies is not a serious concern in mobile devices. Developers should feel comfortable incorporating haptics into their applications and consumers should not be concerned about the impact of these features on battery life.

As the first study showed, the percentage of battery capacity needed to power all 25-haptics-enabled phone calls, 50 text messages, 4 hours of e-mail and two hours of gaming in a single, 24-hour session, is minimal. The percentage of battery capacity needed to power all of these use-cases ranged from .95% to 7.1%, depending on the haptics technology used. In general, the three TouchSense solutions performed better than the Generic Vibe, which does not have the control circuitry, overdrive and braking capabilities offered by the other technologies and therefore must run significantly longer than the other options to produce the intended effects.

The second study showed that Immersion TouchSense haptics technologies have negligible impact on power consumption when used for long periods of time for three popular applications that make demanding use of the technology. Impact on battery capacity in each of these cases was less than 2%.



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