



How Resonant Link Medical and Resonetics Are Powering the Next Generation of Bioelectronic Devices

Overview

This case study highlights the groundbreaking achievements of Resonant Link Medical and battery partner Resonetics in addressing the challenges of wireless charging for implantable medical devices. Resonant Link Medical's cutting-edge wireless power platform, Aurion WPT™, offers patients a faster, more efficient, and reliable charging solution, revolutionizing the field of medical implant power delivery and paving the way for 20-minute recharging for every patient.

The Benefits and Challenges of Titanium

Active implantable medical devices are medical devices inside the body that rely on electricity or external power to run, like neurostimulators and pacemakers. Clinicians and patients want to be able to recharge these devices; however, most active implantable medical devices are built inside a titanium case, called a can, which makes recharging difficult.

Titanium is known for its excellent strength, durability, and biocompatibility, making it a popular choice for encasing active implantable medical devices like neurostimulators, ICDs, pacemakers, and more. Despite these desirable properties, titanium presents challenges for wireless power transmission due to its relatively low electrical conductivity, limiting the devices that can be recharged and causing a frustrating patient experience when recharging is possible. These challenges include:

1. **Low Permeability to Electromagnetic Fields:** Titanium has low magnetic permeability, which means it resists the penetration of magnetic fields. This resistance makes it difficult for electromagnetic waves, such as those used for wireless power transmission, to pass through titanium encasings.
2. **Eddy Currents:** When electromagnetic fields encounter a conductive material like titanium, they can induce eddy currents within the metal. These eddy currents create resistance and energy loss, reducing the efficiency of power transmission.
3. **Reflection and Absorption:** Titanium can reflect and absorb electromagnetic waves rather than allowing them to pass through. This can result in further energy loss and reduced effectiveness of wireless power transmission.
4. **Heat Generation:** The interaction of electromagnetic fields with titanium can lead to localized heating of the metal, which creates unsafe conditions, especially in medical implant applications where excessive heat can harm patients.

5. **Limited Charging Efficiency:** Due to these factors, conventional wireless power transmission through a titanium can leads to hours-long charging sessions, requires precise alignment to work, and necessitates larger devices to accommodate bigger batteries and heat dissipation.

Since power and recharging is often a hurdle to overcome to ensure clinicians recommend, and patients want, implantable devices, medical device makers have long sought a better way to wirelessly power titanium-encased implantable medical devices.

Limitations of Conventional Wireless Power

Conventional wireless charging technologies to power implantable medical devices come with significant drawbacks, which are only exacerbated by the challenges of sending power through titanium.

Existing wireless power technologies suffer from low efficiency, high heating, and limited alignment flexibility. Patients experience charging frustration when they have to lie still for hours to recharge their devices, often multiple times per week for many devices. Oversized devices, shallow implant depths, and tight alignment constraints limit the body types in which devices can be used, excluding large groups of patients from using devices. This pushes device makers back to using primary cell batteries for their device's power source, necessitating recurring battery replacement surgeries which impose unnecessary burdens on patients and healthcare systems.

To overcome these challenges, advanced technologies and precise design considerations are employed. These innovations optimize wireless power transmission for titanium-encased medical devices, enhancing efficiency, reducing heat generation, enabling faster charging times, and freeing patients to move around while recharging, all while maintaining patient safety.



A Transformative Solution

Resonant Link Medical has introduced a transformative solution, the Vivigo™ 20-Minute Universal Charger, a wireless charging platform adapted from Resonant Link Medical's innovative Aurion WPT™ wireless technology platform. Vivigo™ combines innovations in coils, power electronics, magnetics and telemetry to deliver 10x faster charging over double the range, when compared to conventional wireless.

Key to this unprecedented performance is the multi-layer self-resonant structure (MSRS), a first-of-its-kind coil structure which reduces losses by 10x vs. conventional wireless charging. Vivigo™ enables wireless charging at 2.5 W of titanium-encased implantable pulse generators, offering patients charging times as short as 20 minutes, a dramatic improvement compared to existing solutions. The system also offers exceptional misalignment tolerance and implant depth, ensuring uninterrupted charging for patients, regardless of body shape or size. With real-time, dynamic controls, patients can charge on the go, at home, or in outpatient settings, giving them a higher quality of life and confidence in their charge, every time.

Resonant Link Medical has partnered with implantable medical battery technology leader Resonetics to incorporate the Contego® 440 lithium-ion battery into the Vivigo™ 20-Minute Universal Charger, maximizing total energy efficiency. This strategic collaboration delivers a complete solution for titanium-encased implantable medical devices, combining fast, flexible charging with high-efficiency energy storage and delivery within the implant.



Next-Generation Battery Technology

Resonetics' Contego® 440 battery has a capacity of 440 mAh and stands out for its distinct characteristics, including:

1. **Performance and Cycle Life:** The Contego® 440 battery has excellent performance and superior cycle life, ensuring it provides a reliable power source while maximizing the lifespan of implantable medical devices.
2. **Lithium-Ion Technology:** The Contego® 440 battery utilizes lithium-ion technology, known for its high energy density and long-lasting performance, making it well-suited for medical applications where extended battery life is crucial.
3. **Single-Cell Design:** The Contego® 440 battery features a single-cell configuration, simplifying the design and integration process within implantable medical devices.
4. **Advanced Engineering:** The Contego® 440 battery is ISO 13485 certified and engineered to meet the stringent requirements of medical device applications, ensuring safe and reliable operation within the human body.
5. **Enhanced Patient Experience:** The Contego® 440 battery's superior rate capability and cycle life contribute to a better patient experience by reducing the need for frequent battery replacement surgeries and associated inconveniences.
6. **Ideal Size and Form Factor:** The Contego® 440 battery is designed to fit the specific size and form factor requirements of implantable medical devices, optimizing its integration into various device types.

Overall, the Contego® 440 battery's high energy density, lithium-ion technology, single-cell design, and compatibility with medical device applications make it a standout choice for powering implantable medical devices.

Specifications and Results

Resonant Link Medical's Vivigo™ 20-Minute Universal Charger, is the first fast, reliable and patient-friendly wireless charging platform for implanted medical devices, including those encased in biocompatible titanium. The platform was designed in collaboration with leading medical device companies to accommodate the majority of current and desired use cases for implantable medical devices, and platform customization is available on request to adapt it to your device needs.

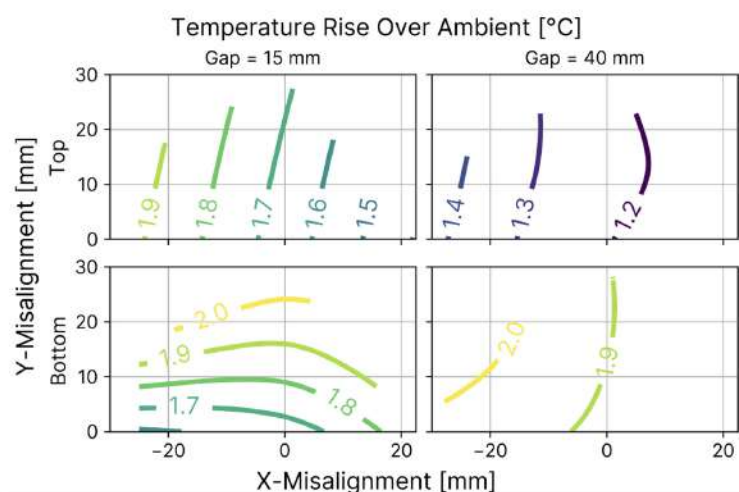
System Specifications:

Applications	Implantable pulse generators, ICDs, pacemakers, and more
Output Power	2.5 W over full charge range
Implant Depth	Up to 4-6 cm
Misalignment	+/- 3 cm misalignment
Angular Misalignment	Up to 30° tilt misalignment
Implant Battery	Contego® 440 single-cell lithium-ion battery
External Hub Size	220 grams, 109 mm diameter x 20 mm height
Implant PCB Space	100-150mm ²
Operating Frequency	6.78 MHz, within ISM band
External Hub -> Implant Data Speed	8 kb/s
Implant -> External Hub Data Speed	28 kb/s
MRI Compatible	Yes, 1.5T/3.0T for implant
Titanium Grade	Grade 2
Compliance	Pre-certified for IEC 60601, ISO 14708, and FCC Part 15 and 18

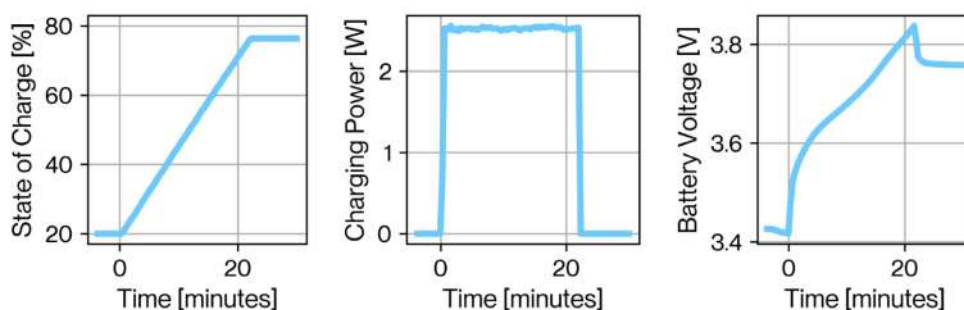
Results

Resonant Link Medical's Vivigo™ 20-Minute Universal Charger has been validated through extensive laboratory testing, including with phantom tissue models. Results demonstrated the system can charge a 440 mAh battery from 20% to 80% SOC in 21 minutes at 2.5 W continuous power. The system performance, including the thermal behavior of the implant, was tested through operation embedded in phantom tissue (glycerin gel). The gel was heated with a water bath at 37°C to approximate human body temperature and the surrounding ambient air temperature was 35°C. The gel consisted of two layers to approximate the thermal properties of muscle (lower layer) and fat (upper layer), and was then covered with a silicone sheet to approximate the skin layer.

The figure below shows the change in temperature while charging the implantable pulse generator battery at 2.5 W continuous power. Measurements are taken from thermistors positioned on the top and bottom of the titanium can. The 0, 0 misalignment position is the point at which the centers of the coils are perfectly aligned. Moving in - x direction means moving the external hub over the implantable pulse generator, + x is moving the hub away from the implantable pulse generator.



The figure below shows the charge speed and power.





Summary

Resonant Link Medical's innovative approach to wireless charging for titanium-encased implantable medical devices represents a monumental leap forward in medical device efficacy—improving patient compliance, satisfaction, and adoption. With the ability to recharge devices in 20 minutes and to move around while charging, Resonant Link Medical brings previously unheard of convenience to the implantable medical device industry. Patients can now benefit from faster, more convenient, and more reliable charging, enhancing their quality of life and reducing or eliminating the need for battery replacement surgeries. The impact of Resonant Link Medical's breakthrough technology extends to neurostimulators, implantable pulse generators, ICDs, pacemakers, and beyond, advancing healthcare innovation and patient well-being while giving medical device makers a faster and lower risk path to market for their next gen device.

For more details on Resonant Link Medical's Vivigo™ 20-Minute Universal Charger, contact info@rlmedical.com.

For more information on Resonetics' Contego® 440 battery, visit:
<https://resonetics.com/sensor-technology-medical-power/medical-batteries/>

