



Abb. 1: C-Leg® Anwender © 2011 Otto Bock

Trusting the next step.

Ottobock and maxon DC motors give people new quality of life. Enjoy life to the full – Take carefree strolls, cycle with friends or going on a mountain hike. With the correct prosthesis, being active can be part of day-to-day life again.

People living with an amputation have to overcome many obstacles on a daily basis – from stairs to an uneven bush track. Using the correct prosthesis, these hurdles are easily overcome. The C-Leg® is an intelligent leg prosthesis system making the life of trans femoral amputation patients much easier. Globally, over 40,000 fittings with the C-Leg prosthesis system confirms the advantages of this unique technology. Medical technology specialist Ottobock developed the C-Leg prosthesis. Ottobock has shown stable growth for many years and as global leader in the field of prosthetics, it sets the benchmarks for the industry. The company builds on the mature C-Leg® technology, which has proven itself time and time again since 1997. To date, C-Leg has been constantly updated. The current model was released in July 2011 many new technologies have been implemented and the prosthesis is now certified for a maximum body weight of 136 kg.

The intelligent knee joint permanently detects the current phase of the gait cycle and adjusts it accordingly in real-time. A knee angle sensor supplies information required for dynamic control of the swing phase, depending on the respective step length and frequency of the prosthesis wearer. The joint hydraulically limits the maximum bending angle during the swing when the leg prosthesis is in the air during the gait cycle. On the new C-Leg®, various mechanical and electronic adjustments allow improved swing phase control. As a result, the prosthesis user has a more natural gait and improved ease-of-movement in the knee joint. Whether the wearer is taking the stairs or manoeuvring through a packed shopping mall, taking a leisurely Sunday stroll or rushing to work – the C-Leg® system automatically adjusts to all situations. Uneven ground, darkness or a crowded environment is also no longer an insurmountable problem, as the high resistance secures the C-Leg® during the stance phase and the knee joint only switches to the swing phase when it is necessary.

This significantly reduces the risk of falling when wearing a leg prosthesis. The C-Leg® also offers a special mode that allows it to be configured for various activities such as cross-country skiing or cycling. In this additional activity mode, the amount of hydraulic dampening depends on the knee angle. The initial dampening and the progression can be configured individually. Thus the behaviour of the leg prosthesis can be programmed for diverse activities beyond normal walking. To enable the prosthesis to withstand the forces to which it is subjected daily, the high activity frame of the prosthesis is made of carbon, an extremely stable, high quality and light material. The frame covers the electronics, the hydraulics and the battery.

What is behind it?

How exactly does the C-Leg® technology work? The intelligent controller of the prosthetic system adapts to the gait of each individual. The control operations are performed via a microprocessor controlled hydraulic unit that dynamically adjusts the system to all gait speeds. Simultaneously the controller ensures that the prosthesis is reliably secured during the stance phase. This tried-and-tested control mechanism is achieved by means of a complex sensor system. The sensors record the load every 0.02 seconds, or, to be more precise, the sensors measure the ankle moments above the foot fitting component, as well as the angle and angle speed of the knee joint. Thus the knee joint permanently detects the current gait phase of the prosthesis wearer. A lithium ion battery powers the C-Leg® and lasts approx. 48 hours.



Figure 2: The C-Leg® is an intelligent leg prosthesis that adapts to the gait of the wearer. © 2011 Ottobock

Small efficient DC motor.

The characteristics of the hydraulics are adapted by means of two valves. These valves are adjusted by maxon RE10 DC motors. Two motors are used in each C-Leg®. Here one of the main strengths of the RE10 motor is its compact size. With a diameter of just 10 mm, the DC motor is the second smallest brushed DC motor in the maxon motor range. This, combined with the Capacitor Long Life (CLL) system for an extended service life, played an important part in Ottobock's decision to use these high-precision motors. The motors also have ironless windings and neodymium magnets that allow top performance at a minimum size.

Precious metal brushes are used for mechanical commutation of the motors. This ensures detent-free (zero cogging) running of the DC servo motors, even at low speeds. During commutation using brushes, contacts are constantly opened and closed via the inductive load of individual segments of the motor winding. The sparks generated when the contacts open typically attack the metal brushes and commutator of the PMDC motor by melting the surface. This "brush fire" reduces the life span of the commutation system of the DC motor. By means of the capacitors integrated in the motors, the life span is significantly increased. The CLL principle means that an additional element is inserted between two adjacent commutator segments parallel to the opening contact. Through the use of the CLL concept, the brush fire is largely suppressed. Furthermore the spark reduction also has a positive influence on the electromagnetic radiation. In the C-Leg®, the maxon DC motors have to operate in pulse mode or intermittent mode, i.e. the motor is only activated for a short period for adjustments and is not constantly in use. Ottobock estimates that 9 million such adjustments are made during the life span of the C-Leg®. On average, the motor performs 10 rotations for these adjustments.

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Taking a stand in life - on both legs

For many leg amputees, using the C-Leg® is a completely new experience. With other prostheses the user has concentrate on every step. "It is not exhausting at all, it is impressively simple and I was really surprised. Now walking is fun again - almost like it used to be," says Ed from America, who lost his leg in a car accident but has nevertheless been standing in a bakery for many years.

The success story of the C-Leg® continues as more and more people are switching to this intelligent leg prosthesis and are achieving amazing things with it. In 2011, 74-year old Roland Zahn crossed Germany

on foot, from Leipzig to Tübingen – with his C-Leg® as trustworthy companion. And a 60-year old woman climbed in the Himalayas at altitudes up to 4000 m with her prosthesis.

Contact maxon motor in Sydney for further information or assistance selecting DC motors for your application. Ph:+61 2 9476 4777



Figure 3: C-Leg® puts the joy back in walking.© Ottobock



Figure 4: On the new C-Leg®, diverse mechanical and electronic adjustments allow improved swing phase control. © Ottobock



Figure 5: RE 10 DC-Motor © 2011 maxon motor

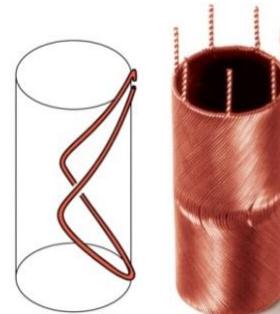


Figure 6: Self-supporting ironless winding, designed by maxon.© 2011 maxon motor



Ed's C-Leg story.

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3/3