



From his pioneering work on photoelectric cells and selenium rectifiers, to his leadership in commercializing power MOSFETs and other technologies, International Rectifier's founder and chairman has made significant and lasting contributions to the power semiconductor industry. More than half a century after he established it, Lidow's company is still striving to improve the way the world uses energy, developing semiconductor components and systems for more-efficient power supplies, motion controls and lighting systems.

By David Morrison, Editor, *Power Electronics Technology*

To list the highlights of Eric Lidow's career in power electronics is to chronicle many of this industry's milestones dating back to the introduction of power semiconductors. In a career spanning more than six decades, the founder and chairman of International Rectifier (IR) has played a leading role in the development and commercialization of several cornerstone technologies. Most notable are his efforts relating to photovoltaic cells, selenium photocells and rectifiers, silicon controlled rectifiers (SCRs), power germanium rectifiers, and power MOSFETs.

Power MOSFETs in particular revolutionized the power electronics field, fueling a shift from bipolar transistors to more-efficient MOSFET devices based on IR's hexagonal cell structure, known under its trade name "HEXFET." Today, the power MOSFETs pioneered by IR under their founder's leadership represent a \$4 billion industry.

However, the HEXFET[®] provides only one example of Lidow's impact on the business of power electronics. Lidow's career has included a host of business-related firsts that helped grow the power electronics industry. Lidow founded two of the earliest power semiconductor manufacturers, starting in 1940 with Selenium Corp., the first U.S. producer of photovoltaic cells. In 1947, Lidow began his second new venture, International Rectifier, which would become the first company to mass-produce selenium photocells and rectifiers.

Among the first to realize the potential of power semiconductors as an international enterprise, Lidow expanded IR's production capabilities by establishing semiconductor fabs in other countries. IR was among the first companies to manufacture semiconductors in England (1956), Italy (1957), Japan (1958) and India (early 1960s).

In recent years, the company Lidow founded has expanded its development of power components to include application-oriented power ICs and systems, while continuing to develop discrete component technology through innovations in semiconductor and packaging design. All of these developments have been fostered with the idea of adding value to the company's products, a fundamental concept that Lidow grasped accidentally as a young engineering student.

Unlikely Beginnings

Eric Lidow was born 91 years ago in the Lithuanian city of Vilnius, which was then part of Russia. Soon after his birth, his father, Leon, joined the Russian army and moved his wife and young son to Russia. When Lidow was nine, the family moved back to Vilnius, which had come under Polish control.

It was there in Vilnius that Lidow attended middle and high school (gymnasium). At first glance, his early education would seem to offer little encouragement for a budding engineer. Lidow encountered no mentor in science or technology. Moreover, neither the Catholic priests who instructed him nor his peers were technically inclined. As Lidow recounted in a recent interview, "Most of my friends wanted to be prosperous attorneys or doctors or businessmen."

However, Lidow, born in a place where borders and governments were continually shifting, wanted to pursue a career that would not be limited by geography or politics. This tended to point him away from opportunities in banking or the law, and medicine was not something that appealed to him. Seeking something with an "international flavor" and with an inclination toward applied physics and mathematics, Lidow gravitated toward a technical career.

Following graduation from gymnasium in 1931, Lidow moved to Germany and enrolled in the Berlin Technical University, where his engineering studies focused on heavy electric power. Although his parents had only a vague conception of electrical engineering, they trusted their son's judgment. Still, Lidow recalls that his father offered him two memorable admonitions when he left home.

"He said, 'Remember that your life will depend on your contribution to society.' And 'Don't marry a rich woman.'" Despite the humor of the latter advice, Lidow understood the serious message underlying both of his father's instructions. In the second instance, the father wanted to warn his son that a wealthy mate would expect a lavish lifestyle. However, notes Lidow, his father also wanted him to understand that "wealth is so transient, while knowledge is not."

The value of knowledge would be made real to Lidow by a fortuitous mishap he experienced as an engineering student. Lidow recalls, "I decided to go into semiconductors because of a very strange incident. In our school, if you ruined a piece of equipment, you had to pay for it. So, when I ruined a light meter—a very fancy exposure meter—I had to pay my monthly allowance for it, which was equivalent to \$1300 now.

"Then a professor gave me the piece that I had ruined. It was a photocell made of copper oxide, the size of a dollar and about one-eighth of an inch thick. Not too heavy, only about 40 cents worth of copper, mostly know how. And I had to pay \$1300! I looked at it and realized that this was value added. This is what I should be producing."

That experience prompted Lidow to focus his studies on all things relating to photoelectric cells. Later, Lidow's extensive knowledge of these devices would provide his entry into the semiconductor field.



Eric Lidow cofounded International Rectifier with his father, Leon, who is shown here in the background.

Though he completed his electrical engineering studies in 1937, his opportunities for further education in Germany were limited by the country's buildup to war. As time went by, one technical lecture after another was being closed off to foreign students because of "military implications." With his opportunities in Germany dwindling, Lidow immigrated to the United States soon after graduation.

Although he spoke four languages, Lidow arrived in New York penniless with no knowledge of English. To make matters worse, he soon discovered that his master's degree in electrical engineering would be of no help in landing one of the available jobs as a busboy or dishwasher.

However, the young immigrant's first break came when he learned of an opening for a foreman at Automatic Winding (which later became part of General Instruments) in Newark, N.J. While waiting for an interview at the company, a secretary ran into the office where Lidow sat and inquired frantically whether anyone there spoke German. As the secretary explained, the chairman of the company was meeting with important German-speaking visitors and desperately needed a translator to facilitate the meeting.

Lidow, who by then had learned English, informed the secretary that he spoke German. He was promptly hired on a temporary basis as an interpreter. But Lidow so impressed his bosses that they offered him a manager's position. Initially put in charge of nine workers, Lidow had 120 people reporting to him after just one year. Given that increase in responsibilities, Lidow was fully expecting a raise when his boss asked to meet with him.

Unfortunately, his boss had other expectations. "You know, I've had very good reports on you," said the boss, "and you have just about my build." His boss then opened a closet, removed a dirty white suit and said, "There's nothing wrong with this suit that the cleaner can't fix."

Unimpressed with his reward, Lidow left the meeting at Automatic Winding and discarded the suit. But he came away from this encounter feeling that his talents would be put to better use elsewhere. To that end, Lidow withdrew \$34 from his savings account—his complete savings—and placed an advertisement in the *New York Times* announcing his availability for work as a "photoelectric expert." This led Lidow to his first promising position in Los Angeles, where he was hired by Carl Laemmle of Universal Studios to develop photoelectric control for printing film.

That opportunity fell through, however, because Laemmle died before Lidow arrived on the job. Nevertheless, the trip to



Under Lidow's guidance, IR has developed and commercialized numerous power semiconductor technologies.

California was not in vain as one of Laemmle's employees suggested to Lidow that they start their own venture to develop photoelectric cells. He approached Lidow with \$2000, providing the seed money for Selenium Corp. of America, which Lidow founded in 1940.

From Photoelectric Cells to Rectifiers

Initially, Selenium Corp. developed its business by supplying photoelectric cells to the U.S. government. These photoelectric cells found use in exposure meters. But when World War II broke out, demand for those meters dried up. Nevertheless, the government needed a related type of device, selenium rectifiers. After a meeting in Washington, where Noble laureate Enrico Fermi interviewed him, Lidow obtained the government's orders for the high-voltage selenium rectifiers that would be needed for the war effort.

At the time Selenium Corp. produced the new rectifiers, Lidow did not know how they ultimately would be used. Years later, he learned that the rectifiers served as proximity fuses in munitions, causing them to explode before impact.

By the war's end, Selenium Corp. had grown to approximately 200 employees. However, Lidow learned that launching his first new business was not without obstacles.

The pioneering nature of Lidow's work on photoelectric cells and later selenium rectifiers meant that all manufacturing processes needed to be developed from scratch. Lidow explains, "Nothing was fixed. You had to develop every single step, including how to apply selenium, how to oxidize it and how to apply the barrier layer."

Selenium Corp. was actually co-owned by Lidow with two other individuals. In 1944, Lidow's partners sold their shares in the company to Sperry Corp. But Lidow, for his part, retained his shares and went to work for Sperry Corp. Vickers Division, where he became a vice president of engineering. Lidow remained in that position until 1947 when he sold his stock in the company.

Another Journey Begins

In August of that same year, Lidow combined the proceeds of the sale with matching funds from another investor to start International Rectifier (IR), which he cofounded with his father. The senior Lidow was an intelligent, experienced businessman whose guidance was valued greatly by his son. As with other seminal events in his career, there was an element of fortune here for Lidow. Only recently had his father had made his way to America, having survived the Holocaust in Europe.

After a brief start in Inglewood, Calif., IR soon moved to El

Segundo, Calif., where it has been headquartered ever since. When IR began, Lidow was careful to develop products that would be different from those he produced at Sperry. "We established ourselves as making much bigger rectifiers than they had at Vickers," says Lidow. "The new business was oriented toward heavy industry and higher power."

Some of the first applications for these high-power selenium rectifiers were in plating plants and mining units. Another application was in battery chargers for cars, making IR one of the first companies to manufacture trickle chargers.

The same year that IR was born, Bell Labs invented the first transistor. However, Lidow was then unaware of the discovery. "Frankly, I didn't even know about it at the time, because transistors were so far from our basic power management; they were out of our area," says Lidow. The first contact Lidow made with Bell Laboratories was in 1953. Bell Labs had developed a diffusion system in silicon, which IR needed and licensed. That technology was used to produce germanium rectifiers, the successors to IR's selenium rectifiers. In making the switch, IR became one of the first vendors to commercialize power germanium rectifiers. Later, the company would switch from germanium to silicon when it introduced silicon rectifiers in 1956.

Another technological shift came when IR added transistors to its product line. "It was becoming obvious that transistors could do many functions that we attributed to thyristors," says Lidow, referring to the SCR technology that IR helped to commercialize in the 1950s. "Transistors could do everything that thyristors could do and better, in a much smaller package."

But after just a few years of manufacturing bipolars, the company was preparing for another technological leap. Lidow's son, Alex, who was then a recent graduate of Stanford and is now IR's CEO, felt that the future belonged to field effect transistors (FETs, also known as MOSFETs).

While one other company was building MOSFETs at the time, their "V-groove" structure made it impossible to build a big transistor. IR's new HEXFET design, developed by Alex and a team of IR engineers, enabled the company to build the largest FETs available. As its name implies, the HEXFET employed a six-sided structure that would be more space efficient than existing designs.

IR also built what was then the largest facility for transistors anywhere—a 230,000-sq. ft. factory that cost nearly \$100 million. At the time the facility was completed, the total world demand for MOSFETs was no more than 20% of the factory's capacity. Acknowledging the boldness of building such a big facility for a product with so little market, one visitor commented on the fab, "It was an engineer's dream and an accountant's nightmare."

In 1979, when IR debuted its HEXFETs, a name that became synonymous with MOSFETs in the early years, the company faced a difficult task in converting engineers from the familiar bipolars. "We had to fight for almost every application," says Lidow. However, for most designs, the performance advantages of the MOSFETs would prove convincing to customers. Still, to win engineers over to

the HEXFET, IR had to develop a series of applications. Facing even greater resistance internally from a sales force schooled in rectifiers, IR was forced to sell the MOSFETs through outside sales reps.

When asked a quarter of a century after the HEXFET's introduction whether it might be time for another radically new transistor design, Lidow responds in the affirmative. "We stuck with the old concept long enough," says Lidow. "If you talk to our engineers, they feel that the basic field effect transistor is a mature process and a mature product. But I don't see anything new outside of better geometries, more transistors per square inch and possibly thinner silicon."

"I do feel there's a lot of possibility in packaging," he continues. "When you take a small piece of silicon and put a big bulk of plastic over it, that is not an effective way to package. So, there will be some changes in packaging. That will necessitate better passivation of surfaces."

Because of IR's success with MOSFETs, the devices became commodities, affecting an evolution in the company's mission. "With our success in field effect transistors, we pushed the world forward in technology and made this particular technology available to everybody. And that makes things possible that were not possible before. Everything is smaller, more efficient and requires less power."

As Lidow explains, the next step would be to pursue these same goals with systems, particularly in motion control and in lighting where the potential energy savings are great and where IR has traditionally sought to improve efficiency. Automotive, an area related to motion control, also presents opportunities for energy savings. For its initial foray into system-level designs, the company leveraged its experience in high voltage to develop high-voltage ICs, but from there went on to develop low-voltage components.

Despite his many years in the power semiconductor industry, Lidow is still excited about his work. "I like to be in the forefront," he explains. "It means that our company is not a 'me-too' company. It affected our profitability in the past because we always wanted to be first. But then, we created an industry that didn't exist. We're doing this now again with the DirectFET™. And we're working on alternative substrate materials, which is exciting. Also, I'm very interested in getting more electricity in the automobile. To me, this is almost a passion." Lidow, who currently drives a leased Toyota electric car, notes that his motivation for improving automobile efficiency is the desire to diminish our dependence on foreign oil.

In addition to his passion for technology, Lidow finds continued motivation in supporting the people who are responsible for IR's success.

"We recognize one thing. This is why I'm sticking around, because I want to see that this is preserved: The people are the most important ingredient of the company—not the equipment, not the real estate, not the technology. You have to realize that people are motivated differently. Don't introduce bureaucratic things—be able to make exceptions, if necessary. To me, this is terribly important."

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For more information contact:
Steve Harrison, Investor Relations (310) 252-7731
Graham Robertson, Media Relations (310) 726-8512