
Lake Shore
CRYOTRONICS
50
YEARS
1968 — 2018

Before Lake Shore

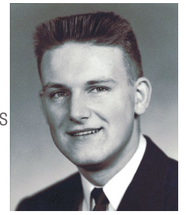
A chronology of what led John Swartz to found Lake Shore Cryotronics with his brother, David Swartz.

1954 1955 1956 1957 1958 1959 1960 1961 1962 1963 1964 1965 1966 1967

John and Helen Swartz on the day of John's graduation from Alfred University in 1958. The same day, he was commissioned as a 2nd Lieutenant in the U.S. Army Reserve.

1954

John Swartz enters Alfred University.



Upon graduation from Sherman Central High School in Chautauqua County, New York, John applied only to the Alfred University State College of Ceramics. His reason was the same as his brother David's: It was the only place that either of them could afford. The State College of Ceramics was the only engineering school in the state of New York that had no tuition. David, a 1947 Sherman graduate, earned a BS in 1951 and an MS in Ceramic Engineering in 1953 from Alfred University. He then went to work for the RCA Tube Department in Lancaster, PA.

Meanwhile, Helen, John's high school class valedictorian and soon-to-be wife, enrolled at Ohio State University (and later graduated early with a degree in Math Education). John, after graduating from Alfred University in 1958 with a BS in Ceramic Engineering, decided on Ohio State for graduate school and changed disciplines by enrolling in the Electrical Engineering Department.

“

In the Spring of 1959, I applied for a part-time technician job at Battelle in the Ceramic Engineering Department. A few months later, I switched to the Solid State Devices Division, and there, they had a project from the U.S. Army Signal Corps to develop a fast neutron dosimeter. They weren’t too far along on that project, and I was assigned the responsibility of not only doing some of the technician work but also understanding how this device worked—in other words, develop the theory for the current-voltage characteristic of the PIN diode and how it changes with fast neutron radiation. We were very successful with this project.

John Swartz

Co-founder, Lake Shore Cryotronics

1959

Begins work at Battelle.

While studying at Ohio State, John realized he needed a part-time job. Because of his ceramic engineering background, the nearby Battelle Memorial Institute seemed to be a good place to start.

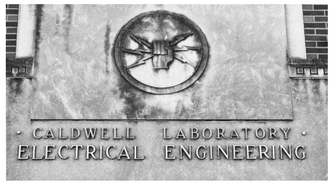
Discussions about the creation of Continental Electronics begin.

These discussions included Dr. Charles S. Peet, John’s Solid State Devices Division chief at Battelle, and Prof. Marlin Thurston, his academic advisor at Ohio State, who was also a consultant to Battelle and a veteran of the Signal Corps himself. Their objective: To build the fast neutron dosimeter for sale to the military. “And they had in mind me, myself and I being the Project Engineer, which I was from 1960 to 1965,” John says.

1960

Graduates in December.

For a portion of his master's thesis, John leaned on his experimental work in characterizing how a wide-based silicon diode responded to fast neutrons. As a result of his Battelle experiences, John's interests gravitated towards semiconductor physics.



1961

Uncle Sam comes calling.

"I had been applying for several six-month delays in fulfilling my six-month obligation for active duty while going to graduate school. In September of 1960, I received notice to report in June." With a newly pregnant wife, John was sent to Fort Bliss, TX, to attend Air Defense School. After completion of this three-month school, he decided to finish out his six-month duty closer to home at Fort Dix, N.J. On the way to New Jersey, the Berlin Wall crisis occurred on August 13, and within days, President Kennedy extended all six-month officers for another year.

Resumes dosimeter R&D.

Upon arriving at Fort Dix, John called Battelle, suggesting he might be more useful to the military by working on the neutron dosimeter for the Signal Corps. He also applied for a change of station to Fort Monmouth, N.J. Forty-three days later, he was at that post's Signal Corps Research & Development Laboratories working again on neutron dosimeter research.

1962

Witnesses H-bomb detonation.

"Because I was working on a project to measure fast neutron radiation from atomic bombs, I ended up at the Nevada Test Site to run some tests on some of the devices we were receiving from Battelle." He also saw the test detonation of a fission-fusion bomb meant for non-military use (e.g. mining and canal-building). "At 100 kilotons, it created an impressive cloud, even from my distance of over 10 miles away."

Photo Credit: Science Source

Enters PhD program.

Granted an early discharge to enter Ohio State's PhD program, John was busy that fall. While studying for his PhD, he worked at Battelle and as a half-time instructor in the Electrical Engineering Department. "I had to get out of my comfort zone by having to walk into a classroom and teach." This decision aided him also in his education. "I've always felt that I learned electrical engineering more from teaching than from taking the classes as a student. I'll always be glad that I had the opportunity to teach."

1963

An introduction to small business.

On top of his studies, teaching, and job at Battelle, John also became a part-time engineer for Continental Electronics. "It was the first of several companies that Marlin helped form over his lifetime. It was also my introduction to the world of small business as well." The company survived in those years on government contracts, with Edgewood Arsenal in Maryland continuing the funding for the neutron dosimeter.

Bell Labs publishes paper on an experimental cryogenic sensor.

The *Review of Scientific Instruments* paper detailed the use of a gallium arsenide diode for temperature measurement down to approximately 4 K. This paper would later prove influential in the start of Lake Shore Cryotronics.

1964

David Swartz joins the company.

Continental Electronics was renamed Phylatron and David Swartz, who had been with RCA, became its President, replacing Prof. Thurston, who would within a year become Chairman of the Electrical Engineering Department and simply didn't have time for Phylatron. With the dosimeter business winding down, David redirected the company to other areas.

David Swartz

1965

John receives his PhD.

In the Spring quarter, John passed his general PhD exams and submitted his dissertation for publication, but had to wait until December to graduate.

The same year, he became a full-time instructor and was asked to give a lecture on his dissertation to Ohio State faculty. "I went through it all and never realized that was probably the only job interview I ever had in my life, and I didn't even know it was an interview." Soon after, John was hired as an Assistant Professor.

Prof. Marlin Thurston (center) meeting with PhD candidates

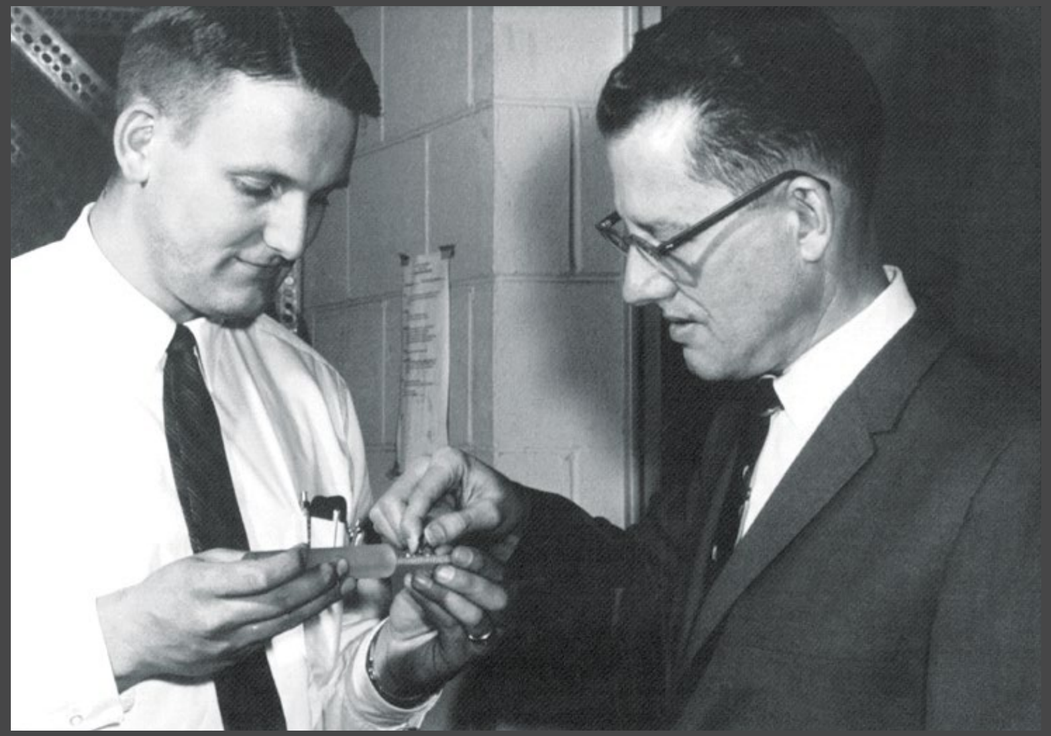
1966

The diodes are built.

In 1965, NASA, aware of Bell Labs' paper, sought someone to make the specialized diodes. Prof. Thurston suggested that Phylatron make them under contract. Two of his graduate students, Bill Closser and William Speers, both part-time employees of the company, completed the work, with the diodes delivered to NASA in February of 1966.

Phylatron was renamed Precision Systems when it was sold to Prof. Edward Funk, at which point David left the company.

John's dissertation, "Analysis of the Effect of Fast-Neutron Bombardment on the Current-Voltage Characteristic of a Conductivity-Modulated p-i-n Diode," was published in the *Journal of Applied Physics* in February, just two months after graduating. "Other than four pages which were tutorial-type graphs, the whole thing was published in the journal — and it was a dissertation!"



John Swartz & Dr. Marlin Thurston: The Story Behind This Photo

"Ohio State has a nuclear reactor, and so I was using this nuclear reactor for some of the measurements for my dissertation, and we wanted to measure exactly the number of fast neutrons. They started the reactor quickly, and then dropped the control rods, which stopped the reaction very quickly. Well, apparently in dropping them, something broke, and that reactor was out of business for almost a year as a result. So, for years, they had (this) picture of Marlin and myself hanging against the nuclear reactor — probably throwing darts at it! One day, I got a call from somebody down there, and they asked if wanted that picture, so that's how I ended up with it."

1967

A special request from Argonne.

Argonne National Laboratory had contacted Jerry Turk of Radiation Equipment, a dealer in Chicago who represented Precision Systems, with a request for a quote for 50 of the gallium arsenide temperature diodes. When Precision Systems passed on providing the sensors, Jerry contacted David Swartz in Buffalo, who then asked John to build the diodes. In the process of doing this, John turned to Prof. Thurston and Paul Fournier (an Ohio State graduate student, and previously, a technician who had worked at Bell Labs making these diodes) for advice, and he also experimented with the material. Although unfamiliar with the process of doping materials, he tried it, and instead of the gallium arsenide getting less sensitive at cryogenic temperatures, as earlier research suggested would occur, the material became *more* sensitive. This experimentation expanded the range of the diode from 4 K down to 1.5 K.

Based on this sale of 50 sensors priced at $35 apiece to Argonne, John and David decided to form a company.

MAGNETICS
BUSINESS & TECHNOLOGY

"Congratulations to all the team at Lake Shore Cryotronics on the 50th anniversary of the company! For 50 years, Lake Shore has been a hallmark of innovation and achievement in the field of magnetics, continually advancing the science and precision of measurement."

David Webster

Editor, Magnetics Business & Technology

IOP Publishing

"IOP Publishing would like to congratulate Lake Shore Cryotronics on this milestone anniversary. 50 years of innovative product development and helping to advance scientific research."

Jo Allen

Head of B2B & Marketing, IOP Publishing

Application

Thermometry and temperature control for a cryostat with five optical access ports used to take high-speed video of superfluid helium drop impacts.

"

I first ran into Lake Shore products while searching for a temperature controller. We liked that we could get both the controller and thermometers from the same supplier, both for purchasing and easy compatibility. Cernox® thermometers were a game-changer. Being decently accurate at room temperature and going down to 1 K saved us a lot of time and allowed us to use less total sensors. The casing provided on the thermometers was very well done, in a very small footprint, which was important to us. Also, the temperature controller itself worked like a dream. The LabVIEW drivers provided allowed us to quickly make a temperature logging and control program. Instructions on how to set up and operate the controller were incredibly clear. Overall, we were very satisfied and ended up buying another 336 temperature controller for another cryostat.

David Mallin

Graduate Student Researcher, Taborek Low-Temperature Materials Lab, University of California – Irvine

1968

Lake Shore Cryotronics is incorporated in the state of New York.

John and David come up with the name “Lake Shore” to pay homage to their early years living on the shores of Findley Lake in western New York. David coins “Cryotronics” to describe a branch of electronics that deals with the design, construction, and use of cryogenic devices.

Although officially founded in Buffalo, early on, the business is based in David’s Hamburg, NY home (and soon after, in a cottage behind his Eden, NY home). The sensors are built in John’s home in Minerva Park, Columbus, OH.

The TG-100 gallium arsenide cryogenic diode becomes the first product and sold for between $50 and $125. The company also begins selling a simple 10 µA current source designed and built by John Wereb of Cleveland-based Instrument Components. Lake Shore Cryotronics has $7,226 in sales that first year.

Where early sensor manufacturing occurred: John’s home, in Minerva Park, Columbus, OH

1969

Lake Shore Cryotronics receives its first I·R100 Award from *R&D Magazine* for the development of the TG-100 gallium arsenide (GaAs) cryogenic thermometer.
It is named one of the 100 most significant new technical products of 1969.

John is promoted to the tenured position of Associate Professor of Electrical Engineering at Ohio State.

The 1 to 100 K range GR-200 germanium resistance sensor is introduced. It was purchased uncalibrated then resold by Lake Shore calibrated, including calibration within a magnetic field.

Sales total $43,660 for the year.

1970

Lake Shore Cryotronics hires its first employees, working in the New York business office.

Lake Shore's business office, located in a cottage behind David's Eden, NY, home.

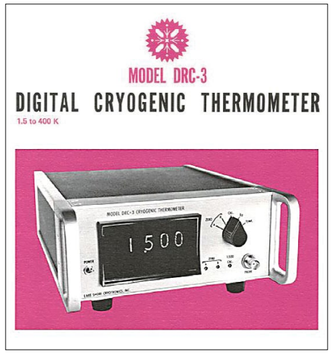
The company introduces the TGC-100 diode temperature controller, designed and built by engineer Yehuda Golahny (see page 19). He would go on to build many of the temperature instruments sold by Lake Shore in the 1970s.

1971

Business expands, with representatives in France, Germany, the U.K., and elsewhere in Europe, and nine regional representatives in the U.S.

Lake Shore secures the rights to market a capacitance and a carbon glass resistive sensor developed by Bill Lawless of Corning Glass Works (and later of Lake Shore), a key step in the company's growth. The sensors, named the CS-400 and the CGR sensors, allow cryogenic temperature measurement in the presence of large magnetic fields.

The CSC-400 capacitance controller and DRC-3 digital cryogenic thermometer appear on our mid-year price list.



1972

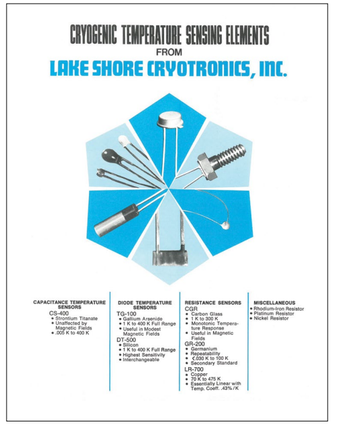
Lake Shore continues its contract with the Engineering Experiment Station of Ohio State (see page 19), but in addition to paying for some of John's computer time, it pays for a graduate student from Egypt, Hamoud Bayoumi, to calibrate temperature sensors.

Along with Corning Glass Works, Lake Shore receives its second I·R100 Award, for the capacitance sensor.

The DT-500 silicon diode debuts. This rugged sensor offers a 1 to 400 K temperature range. Ultra-miniature coaxial cable is also sold for sensor wiring.

The DTC-500 instrument is introduced. It was offered along with a kit to convert a TGC-100 to a DTC-500, which one needed for it to work with the new DT diode.

Lake Shore introduces the Model CSC-400 capacitance temperature indicator/ controller.



1973

Victor Wang, who had just received a MS in Physics at Ohio State, becomes the first direct employee of Lake Shore in Ohio. As John says, "I didn't want to make sensors anymore." He had a lab built under two bedrooms in his home, excavating to make space for it. "That's where I would make sensors for a while, and that was where Victor's first job was, in our house, in the basement."

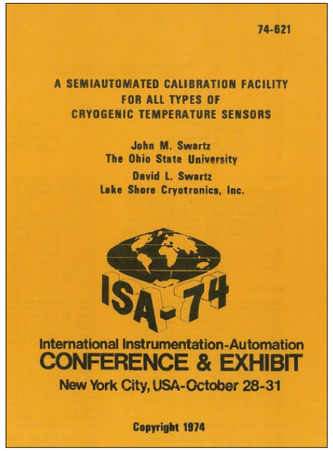
John and David Swartz in the early years of Lake Shore

1974

John sets up shop outside of his home, in a cramped space within a building on Freeway Drive in Columbus owned by F.W. Bell.

Larry Rubin of the National Magnet Lab at MIT (see page 19) designs and builds the first semiautomated calibration facility for Lake Shore.

To support the calibration system, Lake Shore purchases its first computer, a DEC PDP-10, to provide calibration reports to customers. Dr. Fred Clark is hired to run the calibration facility and the PDP-10.



Application
Research into growth of complex oxide thin films. To obtain a quick overview of the quality of the sample, measurements are performed in home-built cryostats that use Lake Shore sensors and instruments for thermometry and control.

“

Lake Shore temperature sensors and instruments gave me the possibility to build a small and convenient cryostat, so I get the first feedback about the sample without any delay. I am measuring 4-point resistance and I can apply a small magnetic field during the measurement. Lake Shore sensors are the best choice for these applications. The products have a really excellent quality. We have recently built two more cryostats in our department and in another department because the demand for a simple measuring device was so high that we ran out of measurement time.

Benjamin Stuhlhofer

Engineer, Scientific Facility Thin Film Technology
Max Planck Institute for Solid State Research

Important Early Contributors

The making and the calibration of a new temperature sensor requires a certain amount of equipment and certain skill sets. John and David Swartz pulled these together from a variety of different sources.

Diodes, even in the early days, required the use of a wafer and wire bonder. John had neither of these instruments. So, together with a graduate student friend, Ralph Hoffman, they made one. It consisted of a transformer, a variac, a strip heater, a 3-axis micromanipulator, and a microscope. It worked, but not too well. First calibrations were done in the Ohio State Physics Department by Prof. James R. Gaines, Sr.

Later calibrations were done by John using a helium Dewar with an adjustable probe containing a silver sample holder, either at various distances above or in the liquid helium bath. A vacuum pump allowed calibrations to below 1.5 K. For temperatures above 77 K, liquid nitrogen replaced the liquid helium. A 10 μA current source was used with voltage measurements taken with a K5 potentiometer. A resistive heater attached to the sample block allowed for variable temperature. The temperature standards were a germanium resistor and a platinum resistor.

To print out a table of standard temperatures versus the diode voltage, a computer program had to be written. For this, John turned to a young Assistant Professor friend of his from Ohio State, Frank Battocletti. The program was written for use on the departmental PDP-9 computer. A contract was negotiated with the Engineering Experiment station of Ohio State for use of this computer. John, very often, would sign up for a block of computer time—from 1 to 3 a.m.

Not only was the temperature dependence of the GaAs diodes of interest, but also the temperature error resulting from the presence of a large magnetic field. Larry Rubin ran the National Magnet Lab at MIT, which was available to scientists from all over the U.S. David arranged for John and Prof. Gaines to use this facility to characterize the GaAs diodes and later on the carbon glass resistors.

In addition, Larry had Yehuda Golahny, an engineer with the lab who also ran a company named IRICO, design a temperature controller for use by these visiting researchers to the laboratory. He then suggested that John and David meet Yehuda, and as a result of this meeting, this controller was added to the Lake Shore product line.

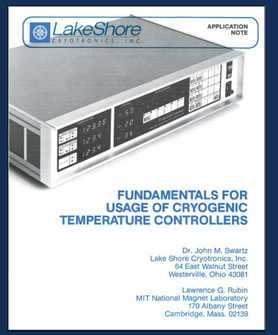
Larry Rubin, in the 1980s

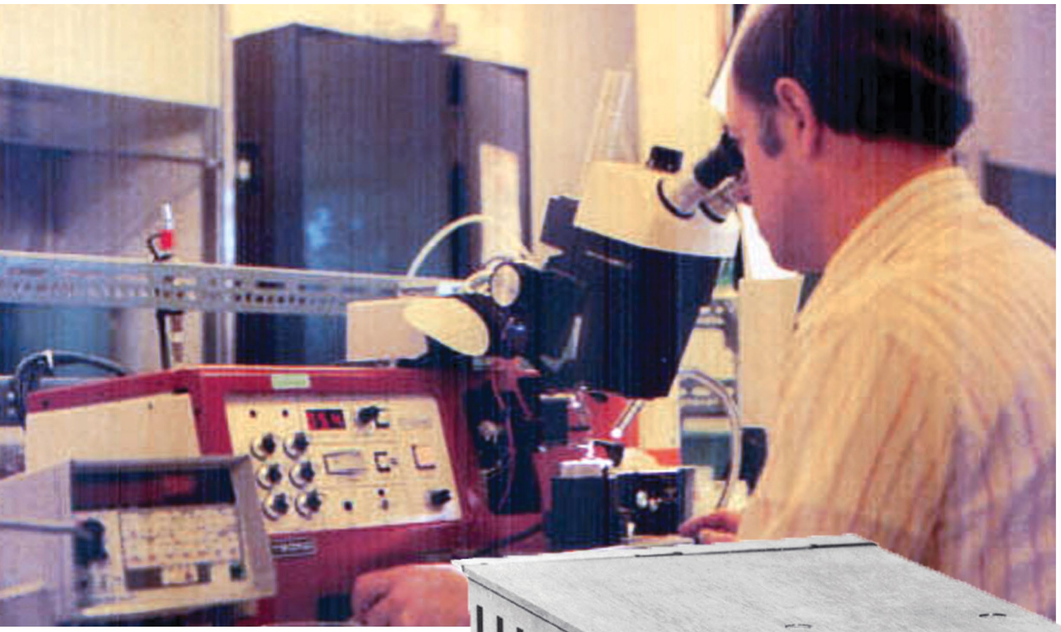
Yehuda Golahny in the early 1980s

James R Gaines, Sr., in the 1960s

Ralph Hoffman

Frank Battocletti in 1970





Above: Phil Swinehart at work in the 1970s
Right: DRC-5 cryogenic thermometer

1975

Dr. Phil Swinehart, while a post-doc, begins doing work on the Ohio State campus for John (and later is formally hired by the company in 1976). Phil would go on to invent and develop many of Lake Shore's key sensor products in the coming years, later serving as Vice President of Sensor R&D from 1984 until 2014, and Chief Scientist for the company thereafter.

The RF-800 rhodium iron resistor and PT-100 platinum resistor sensors are introduced.

The Cryogenic Dispensing Level Controller System is introduced, later providing the company with its third I·R100 Award.

Other new products this year: the DRC-5 (Chromel-gold/iron thermocouple) and DRC-6 (PT-100 platinum resistor) digital cryogenic thermometers; and the DRC-7 digital cryogenic thermometer and DRC-7C digital cryogenic thermometer/controller, the first to operate over the 1 to 400 K range using the DT-500 diode.

DRC-7C

The first person hired to build sensors was Victor Wang, a student who studied under Prof. James Gaines at Ohio State, shown here in early 1978 at the F.W. Bell office location. Looking on is John's younger daughter, Susan (Swartz) Ruhl, who would later join Lake Shore in 1997 after earning a degree in Electrical Engineering from Ohio State. All three of John and Helen's children would end up involved in the family business after working elsewhere. Susan's older sister, Karen (Swartz) Lint, joined in 1990 after earning her Electrical Engineering degree from Penn State, and Michael Swartz, in 1986, after receiving his Electrical Engineering degree from Ohio State.

1977

John takes a year sabbatical from Ohio State and never returns. He remains an Adjunct Associate Professor from 1977 to 1982, and later, joins the Industrial Advisory Board to the university's Electrical Engineering Department.

The company moves all of its business operations from Eden, N.Y., to Columbus, OH.

Lake Shore begins promoting its calibration capabilities and selling add-ons for CTI's refrigerator systems.

getting a good COLD can be very rewarding

And you can get a GOOD COLD (room temperature to 10 kelvin) in about half an hour, with an LTS-21 CRYOTRAN closed cycle refrigerator system. Depending on the system you choose, your cold can be stable to ~ 0.5 kelvin or to ~ 0.005 kelvin. You can even get two colds at the same time for a lot less money than ever before.

The new universal compressor supplied with all LTS-21 systems can power two cold heads simultaneously without sacrificing performance.

Features:

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- Smaller size
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(614) 891-2243 Telex: 24-0415 Cryotron WTVL

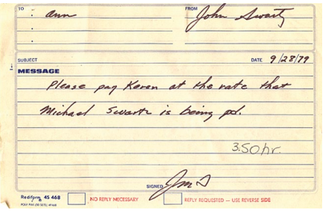
1978

Lake Shore moves again, this time to a 10,000-square-foot space formerly occupied by Kroger in Westerville, a suburb of Columbus. But, before moving in, it has to be refurbished.

"It was in bad shape. One night, we were putting down a new tile floor and there are three people putting down this tile: myself, Phil Swinehart, and Fred Clark, and all three of us had PhDs and we were laying tile," John remembers.

Lake Shore introduces the DRC-70 and -70C. The DRC-70 provided temperature readout only; the DR-70C, a thermometer/controller employed the same thyristor temperature control with the improved 0.1 degree resolution and 0.3 degree conformity error.

Lake Shore becomes a Union Carbide distributor in a multi-state region for liquid nitrogen and liquid helium.



TO: Ann
FROM: John Swartz
SUBJECT
DATE 9/27/79
MESSAGE
Please pay Karen at the rate that Michael Swartz is being pd.
3.50/hr.
SIGNED: JMS
No Reply Necessary
Reply Requested – Use Reverse Side

Memo instructing that John's daughter Karen be paid the same as his son, Michael, who are both part-time employees in 1979.

1979

John and Phil Swinehart are granted a patent for a "Sensitive Silicon PIN Diode Fast Neutron Dosimeter." Phil did the experimental manufacturing of the diode while John handled the theoretical explanation of how to enhance the sensitivity of the dosimeter, an extension of his PhD dissertation.

The patent is later assigned to the Harshaw Chemical Company of Cleveland (see next page).

Neutron Dosimeter Finds a Market

In 1980, the Harshaw Chemical Company became the authorized representative for marketing the dosimeter as a wrist-wearable device, containing a glass sensitive to gamma rays provided by Toshiba Corp. This was sold by Harshaw first to the U.S. Army and later to all the NATO forces in Europe.

Lake Shore received royalties on each dosimeter and also produced and sold the wafers for the dosimeters, with Lake Shore's Cordell Couch manufacturing wafers as fast as possible to fulfill customer demand. These products were a great source of profit for Lake Shore and continued to be as the arms races heated up through the 1980s and until the fall of the Berlin Wall in 1989.

"I started working on this dosimeter in 1959, and it finally became a successful product in the early 1980s, over 20 years later," John says.

Cordell Couch, assembly and test technician, with dosimeter test setup

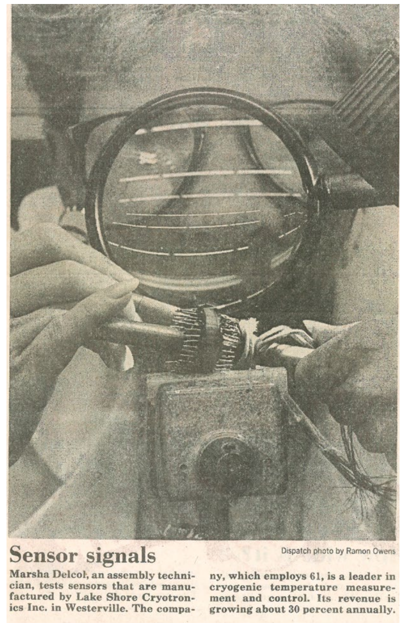
Early ad for dosimeter technology, before agreement with Harshaw Chemical is reached

Gen. Norman Schwarzkopf, Gulf War coalition forces commander, wearing a Lake Shore dosimeter

1980

The 5W-10A selector switch is introduced, enabling the multiplexing of sensor connections because the company lacked a controller with multiple inputs.

Lake Shore introduces the DRC-80, the first instrument to be designed and built by Lake Shore. Instruments before were normally built by outside contractors.


Sensor signals

Dispatch photo by Ramon Owens

Marsha Delcol, an assembly technician, tests sensors that are manufactured by Lake Shore Cryotronics Inc. in Westerville. The company, which employs 61, is a leader in cryogenic temperature measurement and control. Its revenue is growing about 30 percent annually.

Columbus Dispatch newspaper item about Lake Shore Cryotronics

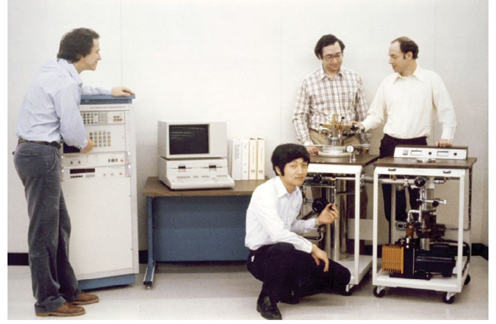
1981

John and David Swartz split the company, with David leaving to begin Cryosystems, Inc., and taking the refrigerating systems and the Union Carbide distributorship with him. Later that same year, he founds RMC, a manufacturer of high-tech products that served the scientific, engineering, and medical technology markets. John and all other shareholders of Lake Shore Cryotronics return the company to its core business of temperature sensors and instruments.

The DRC-80C temperature controller is introduced for use with Lake Shore's DT-500 series silicon diodes.

1982

Lake Shore builds and supplies a sensor calibration system to Rockwell. Work relating to this enabled Lake Shore to make vast improvements to its own calibration system and provided a basis for Lake Shore's current calibration system.



Calibration system team (left to right): Peter Panfil, Victor Wang, John Krause, and Phil Swinehart

The Model DRC-84C temperature controller is introduced.


Lake Shore Cryotronics, Inc.
64 E. Walnut St. Westerville, Ohio 43081
(614) 891-2243 • Telex 245415 • Cryotron WTVL

Technical Data
Model DRC-84C
Temperature Controller

Cryogenic Thermometer/Controller Combines Silicon-Diode Sensors and Platinum RTD's to cover 1.4 to 800K Range.

Features:

- **1.4 to 800K (525°C) Range**
- **Uses Silicon-Diode Sensors and 100-ohm Platinum RTD's**
- **Dual Sensor Input for Each Type**
- **0.1K Resolution**
- **Front-panel or Remote Control of Set-Point, Gain, and Reset**
- **Optional IEEE-488 or BCD Interfaces**
- **Optional Multi-Sensor Input**

Temperature measurement and control over a range of 1.4 to 800 Kelvin is now possible with a single controller — the DRC-84C from Lake Shore Cryotronics, Inc. The 84C is ideal for use with cryogenic systems (both closed-cycle and continuous flow), dewar systems, and other types of low-temperature refrigerators for applications such as deep-level transient spectroscopy, resistivity studies, and Hall-effect measurements. Because of its wide useful range, only a single controller is needed to cover temperatures as low as 1.4K and as high as 800K (525°C).

The Lake Shore DRC-84C utilizes two temperature sensor technologies to achieve its wide range: Silicon-diodes for the low range (1.4-330K), and platinum RTD's for higher temperatures (30-800K). Each sensor type has its own input section which contains appropriate sensor excitation sources, signal conditioning, and switching. A microprocessor in the 84C determines the temperature based on the input section activated, the sensor signal, and the sensor-response curve stored in internal memory. Additionally, the microprocessor generates a voltage equivalent to the control set-point temperature for the sensor in use. Comparison of that voltage with the actual sensor voltage produces the error signal which is the basis of the 84C's analog control.

Each input section of the DRC-84C features dual-sensor input which enables two sensors to be used concurrently. Either sensor can be selected to be the control sensor and/or the temperature display sensor (both sensors must be of the same type — silicon diodes or platinum RTD's). Thus control can be centered at one point in a system and temperature monitored elsewhere. This permits, for instance, maintenance of temperature at a particular cold stage and simultaneous measurement of sample temperature. Selection of input section as well as display and control sensor is made via front-panel pushbuttons.

A 4-digit display clearly and unambiguously shows the temperature directly in Kelvin or Celsius with 0.1 degree resolution. At low temperatures (under 30K) a SCALE EXPAND mode increases resolution to 0.01K for monitoring trends and other relative temperature measurements. Absolute accuracy at low temperatures is ±0.5K in either mode.

The silicon-diode input section of the DRC-84C is designed to use proven Lake Shore DT-500 Series DRC-curve silicon-diode Sensors, which provide measure-

Jane Dickenson, company receptionist who would later move to customer service

1983

Lake Shore introduces the Model 520 cryogenic temperature indicator/controller, designed to work with both resistance and diode temperature sensors.

1984

The Model 310 Self-Powered LN_2 level controller is introduced. This micro-fluidic instrument was powered by nitrogen boil-off.

Debut of the Model DRC-81C and DRC-82C temperature controllers.

Sensor calibration with technician Marilyn Wilson.

Kevin Hinkle, assembly and test technician

1985

The Model 805/855 temperature controller is introduced, representing Lake Shore's first instrument to incorporate some level of digital control in its circuitry.

Also new to the product lineup this year: The Model 817 and 818 cryopump monitors, Model 820 cryogenic thermometer, and Model 8085 sensor scanner.

1986

Lake Shore expands its office space to 25,000 square feet.

The Model CST-901 temperature transmitter is introduced.

Lake Shore employees moving equipment into newly expanded space within the company's building


Lake Shore Cryotronics, Inc.

Technical Data
DT-470 Series
Temperature Sensors

INTERCHANGEABILITY—the New Watch-Word in Cryogenic Temperature Sensors.

Another I-R 100 Award: *Lake Shore's John Krause (second from left) and Phil Swinehart (far right) receiving the award for the DT-470, a sensor that offered very good interchangeability and had a standard response curve and band tolerances. The sensor was "thermally superior to anything we were doing up to that point," remembers Brad Dodrill. Its introduction was commensurate with the introduction of the SD package, which was quite novel and served as the base package for every sensor thereafter. As Phil Swinehart says, "The SD package actually stopped companies from competing with us on diodes. They couldn't match it."*

1987

Alex Müller and Georg Bednorz win the Nobel Prize in Physics for discovering high-temperature superconductivity. Their research is, in part, performed using Lake Shore's sensors and instruments. This breakthrough sets off a mad race to develop superconductors with higher transition temperatures, with Lake Shore providing the equipment to scientists in this pursuit.

Lake Shore's Dr. John Krause and Brad Dodrill patent thermometry employing a gallium aluminum arsenide diode sensor. This became the TG-120 sensor, a replacement for the company's original TG-100 sensor. It had a small field-dependent offset at low fields (5 T and lower).

The Model DRC-91C temperature controller is introduced.

A new Systems Division is created, in part, comprising Brad Dodrill, Victor Wang, and John Krause, who had all previously been involved in sensor development. Working with NBS (known today as NIST) and Leiden University in the Netherlands, their focus is on developing the first commercial AC susceptometer for studying the magnetic properties of materials, including the recently discovered high-temperature superconductors.

NOBEL
Prize in Physics 1987

John's son, Michael, who joined the company full-time in 1987, with Lake Shore's Kathy Schwartz (no relation)

John Krause and Brad Dodrill using the first IBM PC purchased by Lake Shore

Application: IR sensor research and development, for which a Lake Shore temperature controller is used, both in the lab and in the field.

J.P. Curzan

Senior Engineer
Cyan Systems

My first employer in 1992 had Lake Shore temperature controllers and cryogenic test Dewars, and we have one 325 controller at Cyan Systems. I've always regarded Lake Shore as the 'gold standard' in their line of test equipment. And although we are not a volume user, if we ever need more capability, Lake Shore is the first place I'll turn to.

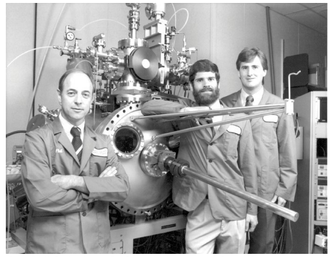
Application
Alternating gradient magnetometry and instrumentation for developing advanced magnetic measurement techniques for a wide range of magnetic materials but, in general, those associated with the technology underpinning hard disc drives.

"

In the course of my 30 years as an academic specializing in magnetic materials, I guess I have always worked with Lake Shore or companies that you have acquired during that time. Given that I am still routinely using two instruments that derive from your company indicates my level of satisfaction. My interactions with your representatives and service teams have always been excellent. In particular, the fact that you could rustle up support from the former PMC staff with a recent problem was most impressive. Furthermore, Brad Dodrill is a most knowledgeable and very pleasant person with whom to deal.

Kevin O'Grady

Professor of Experimental Physics
Department of Physics, University of York



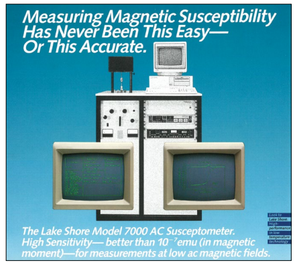
Drs. Phil Swinehart, D. Scott Holmes, and Scott Courts next to the new sputtering system

1988

A new sputtering system (above) is implemented. It would later aid in the development of the Cernox® sensor and is still in use today for sensor production and R&D.

Industrial Division is started to build an instantaneous rotational velocity sensor.

The debut of the 7000 Series AC susceptometer system for characterizing magnetic materials and high-temperature superconductors.

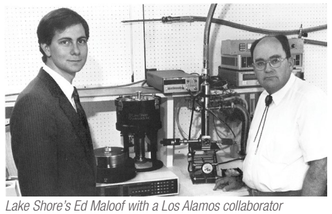


1989

Lake Shore wins the Ohio Governor's Exporting Award.

The company begins adding 5,000 square feet of office space.

The Model 7500 superconductor screening system is introduced. Developed with Los Alamos National Lab, it's designed to aid in the synthesis of materials with higher transition temperatures for superconductors, enabling measurements of eight samples simultaneously. Lake Shore and Los Alamos would later win an I•R 100 Award for the system.



Lake Shore's Ed Maloof with a Los Alamos collaborator

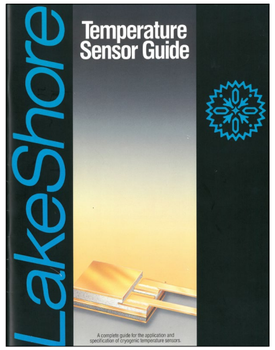
1990

A Department of Energy grant funds studies into the radiation tolerance of cryogenic sensors, confirming the radiation hardness of Lake Shore's Cernox® sensor.

Industrial Division introduces magneto-resistive digital tachometers designed primarily for the process control industry

Lake Shore introduces the world's first autotuning temperature controllers and Lake Shore's first fully digital controllers: the Model 320 and Model 330 instruments.

Debut of the Model DRC-91CA controller.



1991

Systems Division introduces a redesigned 7000 Series featuring the first commercially available AC susceptometer/DC magnetometer. Two Lake Shore patents result from this design.

The first of a new series of 4-quadrant magnet power supplies is introduced.

The Model DRC-93CA controller is introduced.

Working with John Henriksen, Lake Shore begins selling MTD-130 and MTD-150 modular test Dewars.

Karen (Swartz) Lint, center, with Ted Macafee and Jessica Brennan at an industry show in 1991

Michael Swartz with engineer Hartono Darmawaskita

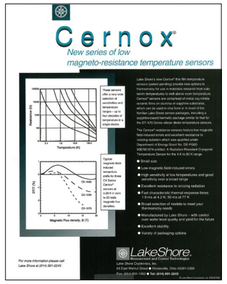
1992

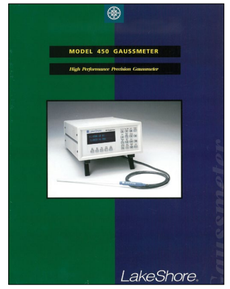
Lake Shore named Company of the Year by the American Production and Inventory Control Society.

The first Cernox® sensor is introduced, debuting at the APS March Meeting in Indianapolis.

Also debuting: a thin-film rhodium iron sensor, Model 200 temperature monitor, and Model 231 temperature transmitters.

Lake Shore enters magnetic instrumentation space with the Model 450 gaussmeter, a move made possible with the hire of F.W. Bell veteran Jeff Dierker.





Application
Vibrating sample magnetometry for measurement of high-resolution first order reversal curves (FORCs).

“

The 3900 and 8600 Series VSMs offer unique measurement capabilities for special measurement protocols. Lake Shore is quite open in taking special needs of our small research community into account. I had excellent experience with your sales manager, Shane Hritz, and with the technician that installed the VSM, Cosmin Radu. They have been always very helpful. Shane helped me a lot with some unfortunate circumstances (the instrument was damaged during the transport) and was patient with the very complicated procedure we needed to follow in order to buy the instrument.

Ramon Egli

Research Director, Geodynamics Group
Central Institution for Meteorology and Geodynamics (ZAMG)

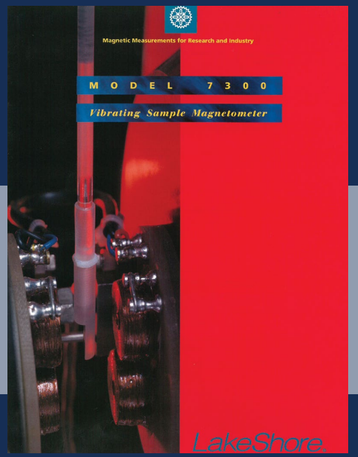
Lake Shore Enters the VSM Business

Jeff Lindemuth: the nicest bonus we ever got with a purchase.

Lake Shore entered the VSM business in a rush. The company’s early VSM technology and product line was acquired from EG&G with an agreement reached in late 1992. John informed the Systems Division to be ready because the VSM was coming soon — and he meant soon, which meant the holiday season that year was extra busy for Lake Shore employees. Then, during the first week of January of 1993, not only did the production inventory start arriving at the door, but the company also received Dr. Jeffrey Lindemuth, who managed R&D for EG&G’s Princeton, NJ, location, as part of the VSM deal.

As John Krause recounts, “We were immediately faced with existing orders to fill, outstanding service issues to address, installations to be done, and what we had were boxes of parts that we had no idea of what to do with. But all the issues were worked through, orders started to be taken by Lake Shore Sales, and production began during that first hectic year.”

The addition of the VSM line proved to be a good move for the company. It allowed Lake Shore to seek business opportunities not only with researchers studying the magnetic properties of materials, but it also expanded its markets into commercial manufacturing, where the VSM was used for in-line process control of permanent magnet materials, and magnetic recording media and read heads.



The VSM was invented by Simon Foner of MIT’s Lincoln lab in 1959. Simon was a former Lake Shore Board member and the original VSMs (called Foner Magnetometers) had a sensitivity of 10^{-4} emu. Lake Shore has continually advanced and improved the VSM technology since acquiring it from EG&G, and our current 8600 Series VSM has a sensitivity of 10^{-8} emu, ten thousand times more sensitive than Foner’s original.

1993

A First Class 1000 Cleanroom is purchased from Tosoh America in Columbus. As Scott Courts recounts, “We loaded it into a truck and brought it back to our building one Saturday morning.” It was set up in space formerly used by Kroger as a loading dock by Scott, Phil Swinehart, and others.

Lake Shore introduces Model 102, 110CS, and 120CS current sources, which gave users an inexpensive way to get a Lake Shore sensor up and running; Model 231 and 234 temperature transmitters; and the Model 321 controller, a lower-priced replacement for the Model 320.

Debut of Model 410 handheld and Model 460 3-channel gaussmeters.

Ad from the early 1990s

1994

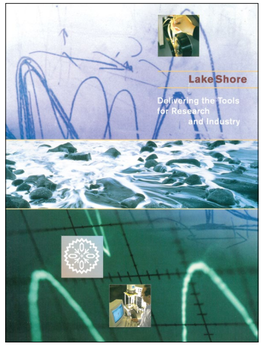
Agreement is signed for Lake Shore and Argonne National Lab to co-develop advanced techniques and instrumentation for characterizing magnetic materials.

Phil Swinehart and Lake Shore scientists Scott Courts and D. Scott Holmes patent “metal oxy-nitride resistance films and methods” relating to the Cernox® sensor. Phil also patents “film resistors having trimmable electrodes” relating to finger-style electrode patterning for Cernox®.

Introduction of: Model 100/101 battery-powered current source, Model 241 LHe level monitor, and Model 412 electromagnetic field meter.

1995

The Model 622, Model 623, and Model 647 magnet power supplies are introduced. A huge endeavor, these were Lake Shore’s first switching power supplies and resulted in a number of sales in the hospital MRI market.



1996

John, Dr. Thurston, Dr. Edward Martin, and Emilio Barbera form BioCrystal, Ltd., to continue Thurston and Martin’s work on cancer detection and to develop and sell semiconductor nanocrystals for medical applications.

The first website is posted to the internet.

Debut of the Model 340 temperature controller, Lake Shore’s first high-end instrument. It featured a 16-bit 386 processor, the same microcontroller used in modern PCs, allowing users to write firmware for the controller. Later, capabilities of the Model 340 would be split between two instruments: the Model 336 and Model 350.

Model 340 development team: Rob Welsh, Ed Maloof, Scott Kirkpatrick, with John Orrell, service manager

The launch of the 7500 Series Hall effect measurement system, which was developed in collaboration with Wright Patterson AFB and Keithley Instruments. It was the industry’s first fully integrated Hall measurement system with electronics, electromagnets, and data acquisition/analysis software. Also unique: the Quantitative Mobility Spectrum Analysis (QMSA) software developed as part of an SBIR-funded project to improve methods for extracting mobility spectrum for semiconductors containing multiple carriers from resistivity and Hall measurements in the presence of magnetic field. Later, a patent was obtained for “quantitative mobility spectrum analysis of magnetic-field dependent Hall and resistivity data.”

1997

Lake Shore moves into its current building on McCorkle Boulevard in Westerville, a 55,000-square-foot space that could accommodate its rapid growth.

BioCrystal also moves into Lake Shore’s new building.

Application
SputterTek designs custom magnetics for sputter sources. Lake Shore magnetic instruments are used to measure fields on new products as well as to test older products for possible damage.

"At SputterTek, we have been using Lake Shore gaussmeters for over 20 years. We are a small company. Lake Shore gaussmeters are priced so that a small company can afford the tools they need. We recently purchased a 410 single-axis meter to go along with our older 3-axis 460 gaussmeter that is still going strong. When I called to order our new 410 gaussmeter, the service was excellent, and the meter arrived in less than a week."

Liz Wescott
Owner, SputterTek, LLC

Application
The Vilesov Research Group specializes in the spectroscopy of molecules and molecular clusters isolated in superfluid He droplets and the study of quantum fluids on an atomic scale. Lake Shore temperature instruments and sensors aid in the group's research.

"Our lab has been using Lake Shore products for more than 15 years. We use the diode sensors to measure the temperature of our cryocoolers. The products give us the range we need for our temperature measurements and are convenient to use."

Rico Mayro Tanyag
Graduate Student, Vilesov Research Group, University of Southern California

Application
Temperature sensors and instruments to control and measure temperatures in cryostats used to test detectors, mainly CCDs and IR detectors.

"Lake Shore equipment has always been used in our labs, and about 10 years ago, I started to be involved in temperature measurements and naturally delved into your manuals and application notes. Your manuals are excellent: clear and accurate. One does not need to be an expert to properly use your hardware. Your application notes on temperature measurements have been of great help to improve our temperature measurement methods, and the support received has always been of good help. Our laboratories achieved expertise in CCDs characterization, partly because of the excellent performance and reliability of your products. Keep up the good work."

Thierry Beaufort
Engineer, ESA-European Space Research and Technology Centre

Lake Shore is ISO9001:1994 certified

1998

The Model 218 temperature monitor is introduced, enabling monitoring of multiple independent sensor channels. It also supported data logging and serial printer connections, broadening its appeal to the process control industry.

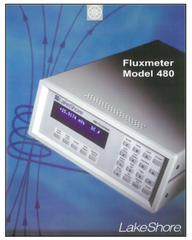
Lake Shore is granted exclusive license to sell the QMSA software. It was developed as part of SBIR-funded work relating to the 7500 Series system in collaboration with the U.S. Naval Research Laboratory and University of Western Australia.

1999

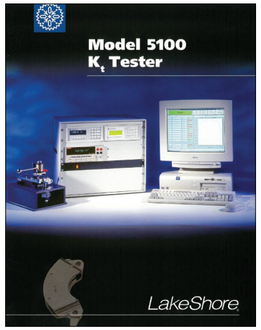
The Industrial Division is split off as a separate company and named NorthStar Technologies.

Debut of the Model RX 102 ruthenium oxide sensor, trademarked as the Rox™, an interchangeable sensor for 20 to 50 mK operation.

Lake Shore introduces the Model 421 gaussmeter and the Model 480 fluxmeter, offering a new level of stability of magnetic measurement, with software that automatically monitored and minimized drift in the measurement so the user didn't have to compensate manually.



The company begins a project to markedly improve its VSM, primarily to increase system sensitivity, later achieved with a completely new VSM head drive design, new magnet configurations, and new control electronics.



2000

Introduction of the Model 5100 Kt tester to measure the torque constant v. angular position of hard disk VCM assemblies.

The DT-600 silicon diode debuts following testing at beta sites, improving on fabrication processes used for the DT-400 to yield higher tolerance bands and better stability in the 4 to 15 K range.

A Model 7800 hysteresisgraph, used to measure DC properties of "hard" permanent magnet materials, is introduced.

Model 331 controller is launched, *quickly displacing the Model 330, which had dominated the mid-range controller market for a decade. The Model 331 introduced a new autotuning algorithm and offered better temperature measurements, leaning on technology used in the Model 340.*

New Innovations for a New Century

At the dawn of a new millennium, Lake Shore introduced two important technologies:

Model 370 AC resistance bridge

Providing instrumentation for sensors operating 50 mK and below, it is the result of a project started several years earlier when Lake Shore sought to surpass the capabilities of the Linear Research 400, at that time, the industry standard for resistance bridges. This goal is achieved by incorporating unique technology into the instrument: a balanced current source with active common mode reduction, developed and later patented by Lake Shore engineer Geoff Pomeroy, for significantly reducing environmental noise in the measurement. Many of the world's leading cryogenic refrigerator manufacturers would begin to include this bridge with their systems, and Lake Shore ended up purchasing Linear Research several years later.

7400 Series VSM

Its introduction is the culmination of a development project begun two years earlier. Magnetic materials that used to be difficult to measure in the 7300 Series VSM are now being done routinely in the 7400 Series system, mainly because of it being 50× more sensitive than its predecessor. Its introduction expanded Lake Shore's VSM market because it could measure materials with weak magnetic signatures, such as ultra-thin films, measurements not easily accomplished with the 7300 Series VSM. It also opened up new industrial markets in magnetic recording. When the recording industry transitioned from magneto-resistive (MR) to giant magneto-resistive (GMR) recording heads, the 7400 Series was used for GMR sensor process control applications by IBM, Seagate Technology, and other disk drive companies.

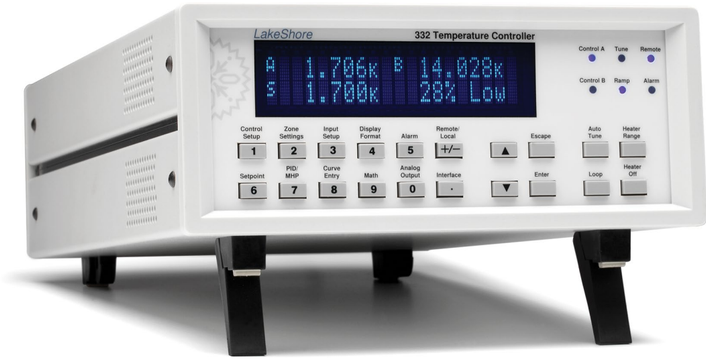
Lake Shore's Geoff Pomeroy, in the instrument lab

2001

NorthStar Technologies is acquired by Danaher Corporation.

The Sensors R&D group successfully builds the first complete microfluxgate using MEMS technology to miniaturize the sensor. It included a magnetic field sensor superior to a Hall generator in sensitivity and better than magnetoresistors in long-term stability.

Production begins for the Model 332 controller, which based on customer requests, contains an extra 10 W of heater power to Loop 2 of the circuitry used in the Model 331.



2002

BioCrystal sells the Bio-Pixel (semiconductor nanocrystals) and Opticell product lines.

The first major redesign of the Lake Shore website occurs.

Lake Shore introduces the Model 211, a low-cost temperature monitor that ended up being used in some unexpected applications: by technicians troubleshooting MRI machines and even in mining machinery.

The Model 7600 Hall effect measurement system, the successor of the 7500 Series, debuts. It features a lower resistance range and a lower price to broaden its appeal to a wider range of users.


inside Westerville

Changing of the GUARD

John Swartz passes leadership of the highly successful hi-tech Westerville business Lake Shore Cryotronics to his daughter and son

2003

Michael Swartz becomes President and CEO of Lake Shore and Karen (Swartz) Lint is appointed Chief Operating Officer. John remains Chairman of the Board.

The company receives ISO9001:2000 certification.

Lake Shore offers its first instrument featuring digital signal processing technology: the Model 475 DSP gaussmeter.

The Cernox® 1010 sensor, the first sensor for use in the 0.1 to 420 K range, is introduced.

Lake Shore begins offering the Model 625 superconducting magnet power supply, marking its return to the power supply market. It utilizes a linear power supply for lower-noise measurements.

2004

A new dilution refrigerator is installed at Lake Shore, primarily for secondary-standard calibrations for germanium sensors but also for calibrations down to 20 mK for new Rox™ sensors in development.

DESERT CRYOGENICS

Lake Shore acquires Desert Cryogenics, an Arizona-based manufacturer of cryogenic probe stations used to test the electronic and magnetotransport properties of chips, wafers, and packaged devices under vacuum and at variable temperatures. This move is a significant one, enabling Lake Shore to better engage with researchers involved in nanoscale material R&D. (For more about this, see page 49.)

GRAVITY PROBE B
testing einstein's universe

NASA Gravity Probe B is launched with Lake Shore germanium sensors aboard.

Brad Dodrill with a visitor to Lake Shore's booth at the MMM conference

2005

NASA's Deep Impact probe is launched, with Lake Shore temperature sensors and Hall generators aboard.

Lake Shore introduces the Model 455 gaussmeter as a part of their family of DSP gaussmeters.

2006

NASA New Horizons launches with Lake Shore DT-670C-SD sensors aboard.

Lake Shore wins the 2006 Top CAT Award presented by TechColumbus, a central Ohio technology organization, in part, because of the use of Lake Shore's probe stations in the ever-growing area of nanotechnology research.

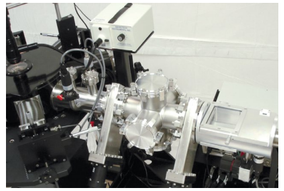
Lake Shore introduces a new line of silicon infrared long-pass filters, developed with the support of NASA grants.

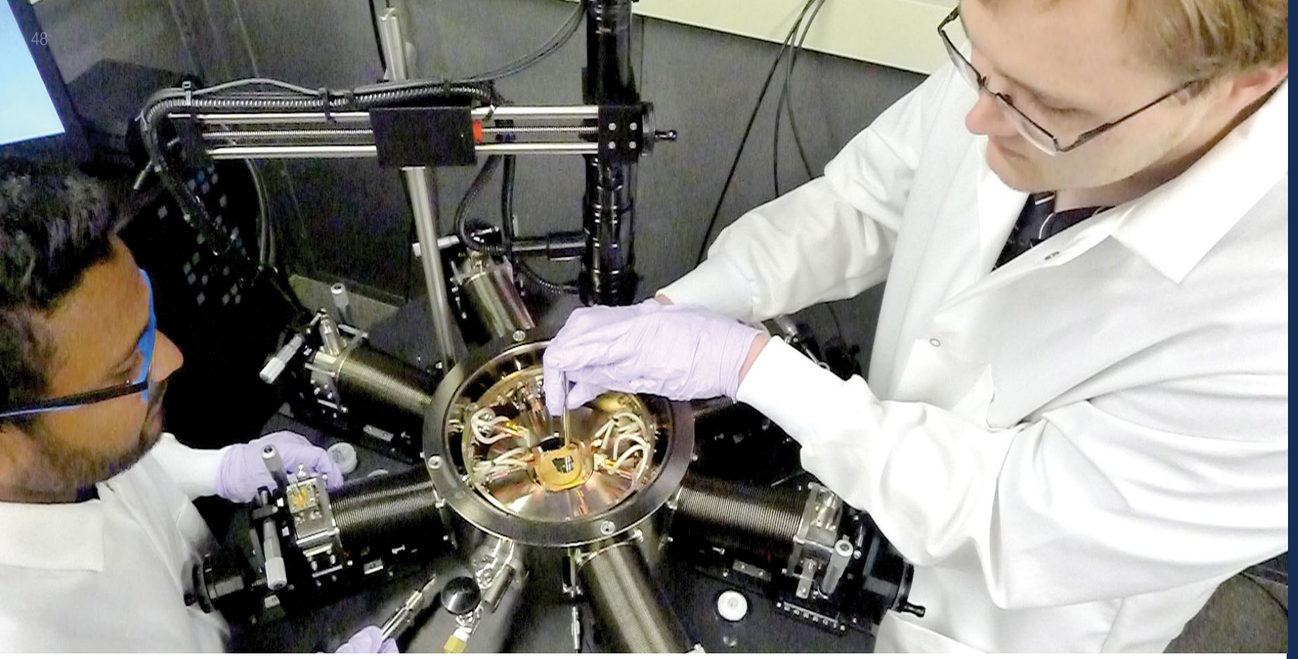
Lake Shore introduces the Model 325 temperature controller, replacing the Model 320 and utilizing improvements implemented on the Model 331.

2007

The first commercially available cryogenic sensor calibrated from 20 mK to 40 K, the Model RX 102B-CB ruthenium oxide (Rox™) sensor, is offered.

Lake Shore introduces Model HVTTP6 high vacuum and LLTTP6 load-lock probe stations for researchers seeking more environmental control when handling sensitive material samples.





Application: A customized cryogenic probe station for investigations of microwave power sensors based on graphene and carbon nanotube thin films as well as investigations of nonlinear properties of complex oxide thin films.

Dr. Ryan Toonen

Assistant Professor,
Department of Electrical
& Computer Engineering,
University of Akron

As a graduate student at the University of Wisconsin-Madison, I did some work with a Desert Cryogenics TT-Prober. Later, while employed as a research engineer at the U.S. Army Research Laboratory, I worked with a CPX-VF. Upon receiving a faculty position at the University of Akron, I purchased a highly-customized CPX-VF, and I have not regretted the decision. My CPX-VF allows me to conduct experiments involving on-wafer probing at base temperatures ranging from 1.7 to 400 K in the presence of an externally applied vertical magnetic field ranging from 0 to ±3.0 T with test signals ranging from DC to 67 GHz in an ultra-high vacuum chamber that is suitable for characterizing devices made from organic and inorganic materials. Essentially, my system provides me with a means to control all of the major extrinsic variables with which one might have concern when investigating experimental solid state devices… Additionally, as an Ohio state public servant, I like the fact that the Lake Shore Cryotronics provides manufacturing jobs in the state. I am always happy to support local businesses when possible.

Desert Cryogenics Added to the Fold

Eric Swartz

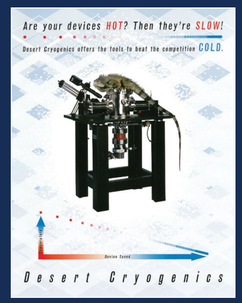
In 2004, Lake Shore acquired Desert Cryogenics, a company whose roots were intertwined with those of Lake Shore's. The company itself was founded in 1995 by David Swartz's son Eric, whose technical brilliance was demonstrated earlier when, at the age of 17, he designed his first cryostat, a 4.5 K refrigerator, while working a summer job at Lake Shore. Later, while a grad student at Cornell, he developed an improved helium-3 cryostat that could be inserted into a standard helium-4 Dewar, enabling routine measurements to be conducted at temperatures from 0.28 K to more than 400 K. This design and similar cryostat designs were published in the *Review of Scientific Instruments*.

Eric ended up earning a PhD in Physics from Cornell in 1986, and his dissertation on thermal boundary resistance at cryogenic temperatures was later published in the *Review of Modern Physics*. This research extended the mathematical understanding of Kapitza resistance, and since its publishing, has been cited numerous times in the technical literature.

Eric was regarded as one of the top cryogenic system designers of his time. As an entrepreneur, his Arizona-based Desert Cryogenics soon became a leading provider of cryogenic probe stations in the world, supplying cryogenic systems for TRW Inc., IBM, Hughes Technologies, and others.

Sadly, Eric Swartz passed away in September of 2001 following a long battle with leukemia.

Because the Desert Cryogenics product line complimented the Lake Shore product line so well — our sensors and instruments were already being used in Desert stations — Lake Shore purchased the company from the family several years later.



This acquisition proved to be a significant one for Lake Shore. It enabled better engagement with researchers involved in studying nanoscale electronic and magneto-transport materials, a field that continues to grow. Researchers have used such stations to test on-wafer nanoscale devices under vacuum and at variable temperatures at the earliest stages of the device development process. In addition to benefiting nanoscale device R&D, cryogenic probing has also aided in the study of transition metal dichalcogenide (TMD) and 2D material transistors as well as GaN and other wide-bandgap devices.

Lake Shore also continues to expand on the technology obtained from Desert Cryogenics. In 2008, Lake Shore revamped the product portfolio to include tabletop and closed-cycle refrigerator-based, cryogen-free probe station models, which eliminated the operating expense of liquid helium. Then, in 2013, Lake Shore introduced a new continuously variable temperature (CVT) probe, developed in collaboration with TOYO Corporation, which allowed for true, continuous unattended wafer probing of a material sample across a range of temperatures.

DESERT CRYOGENICS
a division of Lake Shore Cryotronics

2008

"Cryotronics" is added to the *McGraw-Hill Dictionary of Scientific and Technical Terms*.

The Model 3708 8-channel preamp/scanner for the Model 370 bridge is introduced, enabling one to measure very low resistances for material characterization.

Lake Shore begins offering tabletop, superconducting magnet/electromagnet-based, and cryogen-free versions of cryogenic probe stations.

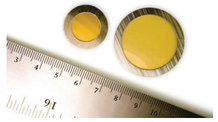
An entirely new platform for temperature control, the Model 336 debuts, the first and only controller on the market with four standard inputs, four control outputs, and 150 W of low-noise heater power.

John with daughters Karen (Swartz) Lint and Susan (Swartz) Ruhl, Christmas 2008

2009

Lake Shore's far-infrared, metal-mesh band pass filters are used on NASA's FORCAST instrument, part of the SOFIA science center.

Photo Credit: nasaimages.org



2011

Lake Shore is ISO 9001:2008 certified.

Michael Swartz is appointed to the President's Export Council Subcommittee on Export Administration.

The Model 425 gaussmeter debuts, replacing the Model 421 with a lower-cost instrument featuring a universal switching power supply.

The Model 335 controller is introduced, replacing the Model 331 and 332. It is our most popular controller to date.

Developed in collaboration with TOYO Corporation of Japan, the 8400 Series AC/DC Hall effect measurement system is introduced. It supports lower mobility measurements, benefiting solar cell R&D.

2012

The Model 350 ultra-low cryogenic controller makes its debut and is quickly adopted for use in pumped He-3 and ADR applications.

Lake Shore introduces a new 3-year standard warranty.

Model CRX-VF and Model CRX-EM-HF cryogen-free probe stations are launched.

2013

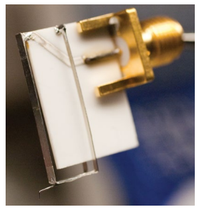
VSM/AGM manufacturer Princeton Measurements Corporation (PMC) is acquired, a move that leads to more interactions with users performing first-order-reversal curve (FORC) measurements.

PMC's Harry Reichard and Anthony Cumbo at the 2013 MMM/ Intermag conference

Visits by two dignitaries: U.S. Senator Rob Portman, to discuss energy advancements, and U.S. Commerce Secretary Penny Pritzker, to highlight Lake Shore's role as an exporter.

Model 336 controller is seen on TV, in the NOVA episode "Making Stuff Colder."

Continuously variable temperature (CVT) probes, developed with TOYO Corporation, are offered for the first time, which allowed for continuous unattended wafer probing of materials over a wide range of temperatures.



Lake Shore introduces a THz materials characterization system

Model 121 programmable DC current source debuts.

Introduction of the Model 224 monitor with 12 independently configurable inputs, which reduces the price per sensor channel while offering Model 336 controller circuitry in a monitor-only instrument.

A ready-to-ship version of the Model TTPX probe station is added to the product line.

2014

Lake Shore adopts the “Advancing Science” tagline as well as new logo.

A Lake Shore probe station is used by Georgia Tech researchers to achieve the world’s fastest silicon-based chip speed.

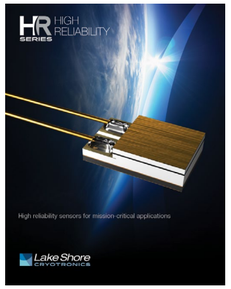
Michael Swartz is named Westerville Chamber of Commerce Business Person of the Year.

Lake Shore partners with SWISSto12 for the company to supply THz waveguides to Lake Shore.

The Model 372 AC resistance bridge and temperature controller is introduced, featuring a unique control input and quadrature measurements. It would later become the instrument of choice for dilution refrigerator suppliers supporting quantum computing research.

Lake Shore introduces the Model 8425 Hall system, combining the DC Hall measurement capabilities of the 8400 Series system with the convenience of a cryogenic probe station.

New “off-the-shelf” HR Series sensors are introduced, drastically reducing order lead times for aerospace customers.



2015

Cascade Microtech and Lake Shore become collaboration partners, sharing exhibit space at SEMICON China.

Lake Shore is named SBA Small Business Exporter of the Year for the Columbus district and a Top Workplace by *Columbus CEO* magazine.

For VSMs, Lake Shore begins offering magneto-caloric effect analysis software developed by Dr. Victorino Franco of Seville University in Spain.

Lake Shore sponsors the first-ever FORC Workshop, held at the University of Minnesota.

Lake Shore partners with Keysight Technologies to promote the interoperability of Lake Shore probe stations with Keysight analyzers.

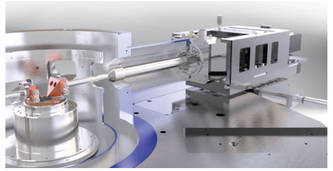
The Wendelstein 7-X (W7-X) experimental reactor in Germany makes headlines by producing the first helium plasma in the reactor, aided by Lake Shore Cernox® sensors used to monitor the reactor’s superconducting rings.

2016

Lake Shore releases 7400-S Series VSM featuring higher electromagnet field strengths and other system enhancements.

Lake Shore offers a specialized suitcase for load-lock assemblies used in probe stations.

As the result of a collaboration with Dominion MicroProbes, SWISSto12, Virginia Diodes, Cascade Microtech, and the University of Virginia, Lake Shore introduces the industry’s first THz-frequency on-wafer cryogenic probe arm.



Nanjing University is featured on Chinese TV, highlighting the use of a Lake Shore probe station used for 2D material R&D.

Lake Shore sponsors Virginia Tech students building a prototype pod for the SpaceX HyperLoop competition, supplying a gaussmeter for their testing of permanent magnets. They end up placing 4th among 27 teams competing.

2nd Annual FORC Workshop is held in New Orleans with Lake Shore sponsoring.

8600 Series VSM is introduced, featuring an entirely new design for simpler operation and much higher measurement sensitivity than previous VSMs.

New 240 Series input modules debut, offering a convenient solution for precision monitoring of sensors in large-scale, PLC-based applications. Later, the modules would be used in Fermilab’s Muon g-2 experiment for monitoring of sensors of the large superconducting electromagnet ring.

David Swartz passes away at the age of 87. After leaving Lake Shore and founding RMC, he moved the company to Arizona in 1985 and sold it in 1998. David continued as a consultant to various companies for many years.

Lake Shore’s Scott Courts is elected to the Board of Technical Directors for the Cryogenic Society of America (CSA)

Norma and David Swartz

Application
A Lake Shore VSM for research into materials used in the development of magnetic refrigeration technology.

"In my days before running the exhibit, I encountered Jeffrey Bergen who tapped me on the shoulder and said, 'How can Lake Shore become a Corporate Affiliate?' That had to be in late 80s and Lake Shore has been an advertiser, an exhibitor, a sponsor and now a Corporate Partner. Lake Shore is in the top 1% for number of years exhibiting with MRS. You have been a great partner with MRS through the years. Thank you."

Mary E. Kaufold

Manager, Advertising & Exhibits,
Materials Research Society

"The Lake Shore VSM has been both a standard workhorse instrument and used as a specialized instrument for very accurate measurements of the hysteresis in some magnetic phase transitions, leading to high-profile publications. In addition, I have been very happy with the customer service."

Christian Bahl

Senior Researcher, Department of
Energy Conversion & Storage
Technical University of Denmark,
Risø Campus

Application
Synchrotron radiation XRD and XAS experiments of lithium ion batteries employing a variable temperature sample mount. Lake Shore sensors and controllers were used to measure and control the sample temperatures when studying in-situ behavior of lithium Ion battery cathode materials.

"

I first heard about Lake Shore Cryotronics during my graduate studies at the University of Guelph. I saw we used some Lake Shore equipment in our lab and knew where to go for all my temperature sensing needs. The team at Lake Shore was helpful in making sure I had the right product. Without Lake Shore sensors, especially the DT-670 with its small size, I would not have been able to succeed in expanding the research capabilities of my research group's lab. I wouldn't have been able to investigate the structural behavior of lithium ion battery cathode materials under elevated temperatures. Precise temperature control was necessary for the experiment and made possible by Lake Shore.

Vincent Emond

Research Assistant, Physics Department
University of Guelph

Dave Ghioldi, David Plaga, and Adam Porsch with the 155 MeasureReady™ precision I/V source, the first product to use the company's entirely-new XIP instrument platform

Lead engineer Thomas Bapu with Scott Yano, VP of Product Development, receive the R&D 100 Award for 8600 Series VSM.

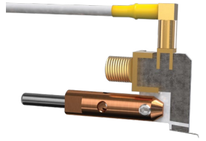
2017

With many efforts underway worldwide to develop quantum computers, Lake Shore sees an increase in sales to companies and institutions seeking thermometry and instrumentation for dilution refrigerators operating at approximately 15 mK.

Scientists begin testing cryomodules for the Linac Coherent Light Source-II in California using a prototype that includes radiation-hard Lake Shore Cernox® sensors for superconducting temperature monitoring.

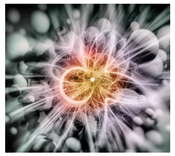
Superconducting microwave device characterization is performed by the U.S. Army Research Labs and the University of Virginia using a Lake Shore Model CPX probe station.

New parametric probe options are introduced for Lake Shore probe stations, enabling higher-quality, wafer-lever C-V measurements in a cryogenic probing environment.



NASA's Cassini completes its Saturn mission, one that began 19 years earlier with Lake Shore sensors on-board.

A paper published by the IRFU CEA-Saclay lab recommends the use of Lake Shore Cernox® and platinum sensors for a new superconducting magnet-based accelerator.



The 155 MeasureReady™ precision I/V source is released, the first product using Lake Shore's new XIP instrument design and featuring a smartphone-like touchscreen interface.

8600 Series VSM wins an R&D 100 Award in the Analytical/Test category.

Lake Shore is awarded a patent for a new "Fast Hall Effect Measurement System," technology that will be seen in a new product to be introduced in 2018. It is expected to significantly expand the range of Hall measurement solutions offered by Lake Shore.

Lake Shore CRYOTRONICS

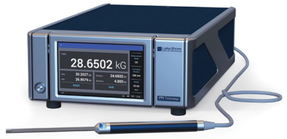
50 YEARS

1968 — 2018

2018

For the third consecutive year, Lake Shore is named a Top Workplace by *Columbus CEO Magazine*.

The next XIP platform-based instruments debut: our F71 & F41 teslameters. Featuring new TruZero™ technology, they enable users to measure with confidence without the need to re-zero Hall probes.



Lake Shore begins developing a probe station for testing of quantum technology components at <2 K temperatures as research into quantum computing increases worldwide.

Lake Shore's Brad Dodrill publishes a plot book, detailing results of measurements run in the 8600 Series VSM.

The company offers a first look at its new MeasureReady™ MCS Series system. This flexible, expandable electromagnet-based system is designed so users can quickly adapt to a wide range of material characterization applications, now and into the future.

Application
In an ultra-high vacuum, all-metal line built to separate and purify noble gases (NGs) for isotopic analysis, separation of NGs is done by cryogenic methods. Lake Shore sensors and controllers are used for very fine temperature control.

"In the Noble Gas Laboratory of Manchester University (U.K.), where I went to discuss technical aspects of noble gas isotopic analysis with Prof. Ray Burgess, they used Lake Shore equipment and warmly recommended it. Lake Shore products we purchased were adequate for our application. I was able to read temperatures from very close to absolute zero to well above ambient and had fine control over the heaters to create multiple temperature programs at specific values, required to separate NGs. More importantly, perhaps, I had excellent support from your agent in Switzerland, from whom I learnt a lot."

Clemente Ricio
Profesor Titular
formerly of Stable Isotope Laboratory
Universidad de Salamanca

Application
The use of Lake Shore thermometry and an electromagnetic power supply, enabling researchers to measure and record millikelvin temperatures easily without adding additional noise to other parts of the experiment.

"Serious people, good products. Everything is on the web. It's simply serious and easy, still being high quality in terms of noise. It's not very fancy looking, but the power supply is doing well and is less noisy than similar equipment we run. Lake Shore was founded the same year as our university. We are also celebrating 50 years."

Hermann Suderow
Director
Nicolas Cabrera Institute
Universidad Autonoma de Madrid

Looking Forward

As the pace of technology advancements accelerate and the demands of the worldwide research community change, Lake Shore continues to evolve, expediting the development of innovative products to meet the expectations of our users.

With every new product we develop, we're focused on enabling more science in less time, so researchers achieve results faster and are able to devote their time to studying materials rather than assembling measurement equipment and writing custom software. To advance science going forward, we realize our products will need to provide even more capability while still being easy to use.

To preserve the investment that our customers have made in their instruments and systems, we are working to equip our users with future-proof solutions that can be easily upgraded, adapted, and expanded to meet future needs at the pace that their evolving research focus and funding dictate.

As an example, the new MeasureReady™ MCS Series introduced in 2018 will provide a more cost-sensitive approach to configuring flexible characterization systems utilizing common base platforms and modular options for temperature, measurement, and other capabilities. These integration-friendly platforms will readily accommodate new experimental setups while also enabling work in the lab to progress naturally — without the high initial cost and constraints often associated with bundled systems.

We are paying close attention to developments in emerging technological fields, such as quantum computing, mobile platforms and wearables, internet of things, virtual instruments, artificial intelligence, privacy/security, and cloud-based services, to ensure that our next-generation products either support the relevant research or are aligned with customer expectations derived from these technologies.

Is a wireless cryogenic sensor feasible and beneficial? Would augmented reality make operation of complex cryogenic systems simpler? What will the first commercial quantum computer look like? While it is impossible to accurately predict what the future will bring, we know it will present exciting opportunities for Lake Shore to continue to play an important role in the research that benefits people's lives.

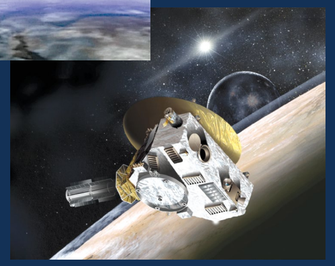
In addition, Lake Shore is intently looking at ways to tighten the feedback loop between us and our users. We constantly strive for more interactions in the field, during customer site visits, and at industry events, as well as via our online user forum. Using this feedback, we will aim to develop leading-edge tools for where research is heading and fulfill our vision:

To advance science by providing easy to use, high value, and high-performance products.

50 Years of Advancing Aerospace

Lake Shore offers a rich history of working with scientists and engineers at a number of aerospace companies and agencies, including NASA, supplying thermometry and other technology that offer long-term stability and performance over the duration of a mission.

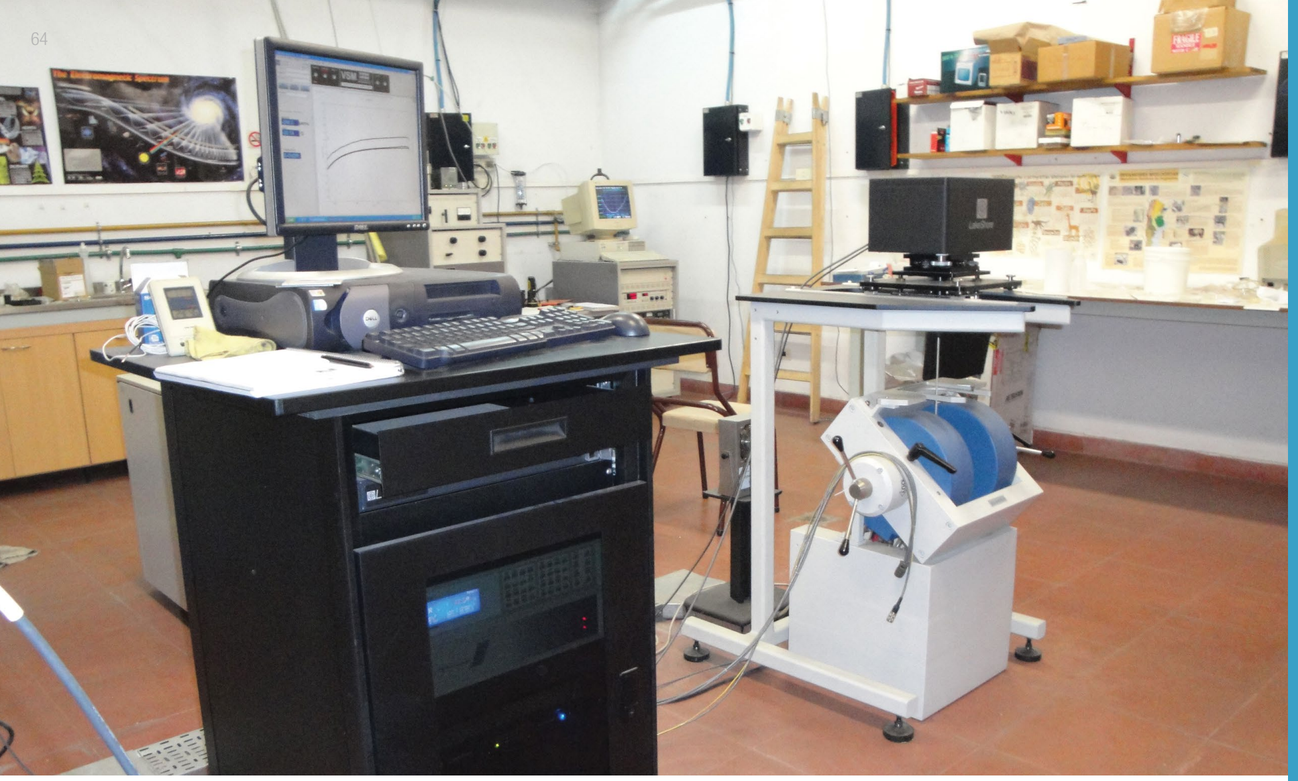
Companies around the world have depended on Lake Shore to supply high reliability and flight-qualified temperature sensors for their major programs, including those in which discrete components must be able to operate in extreme cold, in vacuum, and under intense radiation—not to mention survive the shock, vibration, and acceleration of launch.



Space telescope applications in particular have benefited from Lake Shore thermometers. To detect and capture distant light in the cosmos, focal plane arrays of infrared detectors must be cooled to temperatures of approximately 7 K, and our sensors have played a critical role in all of this, uniformly monitoring of cooling of on-board cryocooler systems to a temperature low enough to prevent distortion and remove thermal noise from the telescope instrumentation.

The many space projects supported by Lake Shore, mostly with radiation-hard Cernox® sensors, include:

- NASA's Mars Curiosity Rover project, launched into space in 2011
- NASA's James Webb Space Telescope, currently scheduled for launch in 2020
- Sapphire, a Canadian space surveillance satellite launched in 2013
- NASA's New Horizons, a robotic interplanetary space probe launched in 2006
- The Hubble Space Telescope, launched in 1990, which has Lake Shore diode sensors on-board
- Gravity Probe B, co-developed by NASA and Stanford University and launched in 2004, which uses Lake Shore germanium sensors
- NASA's Deep Impact space probe, launched in 2005
- Sentinel-3, an European Space Agency observation satellite constellation, launched in 2016
- NASA's Kepler Space Telescope, launched in 2009
- Planck spacecraft, operated by the European Space Agency and launched in 2009 along with ESA's Herschel spacecraft, concluding its scientific mission in 2013



Application: A VSM and AC susceptometer used in a laboratory of magnetism for solid state magnetism, nanoparticle magnetic property, materials science, catalysis, paleomagnetic, and soil magnetism research.

Roberto Mercader

Professor of Physics
Department of Physics,
University of La Plata
and Institute of Physics,
CONICET

My overall experience with Lake Shore has been outstanding. Over many years, we have worked shoulder to shoulder with the people up in Westerville to overcome countless infrastructure and bureaucratic setbacks to install our instruments down here in La Plata. They fully understood the circumstances in which research is carried out down here and enthusiastically helped us out to set up the Laboratory of Magnetism at the Institute of Physics, which has been instrumental to change the way in which solid state and materials science research is performed at the Institute. Currently, there is a 7130 AC susceptometer and a 7404 VSM that has exceeded the expectations since its installation on August 31, 2009.

“

Happy 50th anniversary, Lake Shore Cryotronics!

The Cryogenic Society of America salutes Lake Shore Cryotronics for this achievement and for the company’s contributions to the cryogenics and superconductivity industries. Its steady growth and strong involvement in the betterment of science have been exemplary.

CSA is extremely grateful to Lake Shore co-founder Dr. John Swartz, who was one of our very first Corporate Sustaining Members, giving us his support in 1985, shortly after the society’s reorganization in Illinois. I personally always look back to Dr. Swartz with great appreciation for his faith in our mission and his generous support of our efforts. It meant a lot to me and inspired me in the early days when we were getting started.

Since that time Lake Shore has been a steady and strong supporter of our work. Lake Shore employees have provided help whenever we asked, teaching short courses for us, and today serving on our board in the person of Dr. Scott Courts.

A company does not survive in the marketplace unless it is well-managed, hires excellent people and has outstanding products. The founders of Lake Shore laid the foundation for the excellent organization of today. We at CSA wish you happy anniversary and many more years of success.

Laurie Huget

Executive Director
Cryogenic Society of America, Inc.

Cryogenic Society of America, Inc.
The Go-To Place for Cryogenics

50 Years of Advancing Physics

Research demands precise, reliable measurement data. Increasingly over the past 50 years, scientists have turned to Lake Shore Cryotronics for the products and expertise to obtain that data. In fact, more than 1,800 colleges and universities worldwide use our technology. We interact daily with physicists, engineers, and others involved in scientific research. As a result of this dialogue, we have introduced — and strive to consistently develop — leading-edge measurement technology for where research is heading.

Our thermometry technology can also be found at various large, and often multinational, projects for high-energy physics and plasma physics research around the world. Lake Shore sensors and instrumentation have aided the study of condensed matter at both low temperature and under high magnetic field in large particle accelerators and fusion reactors, and scientists conducting experiments at government and multinational research facilities have benefited from Lake Shore thermometry sensing, control, and monitoring technology.

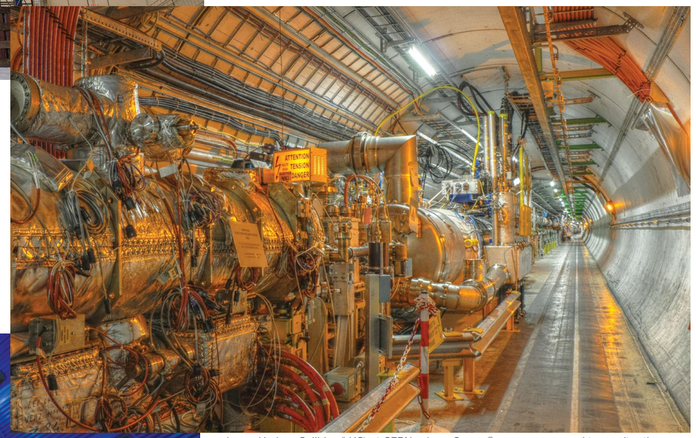
A number of Cernox® sensors have been used in support of the LCLS-II project at the SLAC National Accelerator Laboratory in California

In addition to the CERN Large Hadron Collider (France-Switzerland), where more than 10,000 of our sensors are used to monitor the temperature of the particle accelerator superconducting magnets, sensors of ours are used at the:

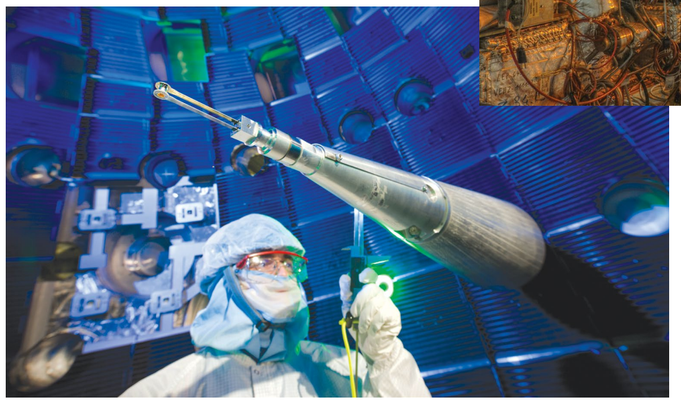
- Spallation Neutron Source (SNS) at Oak Ridge National Lab (U.S.)
- Light Coherent Light Source (LCLS) at the SLAC National Accelerator Laboratory at Stanford University (U.S.)
- Muon g-2 experiment at Fermilab (U.S.)
- Advanced Photon Source at Argonne National Lab (U.S.)
- Facility for Antiproton and Ion Research (Germany)
- SRF Linac at IFMIF (multiple countries)
- Superconducting Test Facility (STF) at KEK (Japan)
- CEBAF Linac at the Thomas Jefferson National Lab (U.S.)
- Superconducting Ring Cyclotron at Riken (Japan)
- ITER Tokamak fusion reactor under construction (France)
- National Ignition Facility (NIF) at Lawrence Livermore National Lab (U.S.)
- Korea Superconducting Tokamak Advanced Research (KSTAR) fusion facility (Korea)
- Wendelstein 7-X (W7-X) fusion reactor of the Max Planck Institute for Plasma Physics (Germany)

As well as various other smaller physics facilities at national labs and universities worldwide.

Lake Shore diodes, transmitters, and 240 Series input modules are used to monitor temperatures of superconducting coils of the Muon g-2 particle storage ring at Fermilab



Large Hadron Collider (LHC) at CERN, where Cernox® sensors are used to monitor the temperature of the superconducting magnets used to steer and focus the particle beam
Image credit: Laszlo Daroczy



The National Ignition Facility (NIF) at Lawrence Livermore National Lab, where Lake Shore temperature sensors have been used.

Lake Shore Patents

3/14/1972, "Capacitive Cryogenic Thermometer," William Lawless, Corning Glass Works, NY (Licensed to Lake Shore Cryotronics)

9/18/1972, "Resistive Device," Ray Forker, Jr., and William Lawless, Corning Glass Works, NY (Licensed to Lake Shore Cryotronics)

7/31/1979, "Sensitive Silicon PIN Diode Fast Neutron Dosimeter," Phillip R. Swinehart and John M. Swartz

2/17/1987, "Thermometry Employing Gallium Aluminum Arsenide Diode Sensor," John K. Krause and Bradley C. Dodrill

3/8/1994, "Self-Aligning Tachometer with Interchangeable Elements for Different Resolution Outputs," Neil C. Griffen, Richard S. Stokes, and Joseph F. Bioty

5/10/1994, "Magnetic Property Characterization System Employing a Single Sensing Coil Arrangement to Measure AC Susceptibility and DC Moment of a Sample," John K. Krause, Victor Wang, and Bradley C. Dodrill

8/9/1994, "Magneto-Resistive Tachometer Assembly with Reversible Cover and Related Method," Neil C. Griffen and Mark Ayzenberg

11/8/1994, "Film Resistors Having Trimmable Electrodes," Philip R. Swinehart

11/22/1994, "Metal Oxy-Nitride Resistance Films and Methods of Making the Same," Philip R. Swinehart, S. Scott Courts, and D. Scott Holmes

3/5/1996, "Tachometer Assembly with Integral Internal Wrench," Neil Griffen and Mark Azyenberg

4/9/1996, "U.S. Magnetic Property Characterization System Employing a Single Sensing Coil Arrangement to Measure Both AC Susceptibility and DC Magnetization," John K. Krause, Victor Wang, and Bradley C. Dodrill

5/7/1996, "Slim Profile Digital Tachometer Including Planar Block and Rotor Having Spokes and Clamp," Neil Griffen, Mark Ayzenberg, and Kenneth Dickinson

8/5/1997, "Magneto-Resistive Sensor Module with Different Resolution Outputs for the Same Magnetic Drum," Neil C. Griffen, Richard S. Stokes, and Joseph F. Bioty

10/21/1997, "Magneto-Resistive Sensor with Reduced Output Signal Jitter," Neil C. Griffen and Richard S. Stokes

8/4/1998, "Quantitative Mobility Spectrum Analysis of Magnetic-Field Dependent Hall and Resistivity Data," Jerry R. Meyer, Craig A. Hoffman, Filbert J. Bartoli, Jaroslav Antoszewski, and Lorenzo Faraon (Licensed to Lake Shore Cryotronics)

5/4/1999, "Magneto-Resistive Tachometer Kit Including Two Sensor Modules Providing Different Resolution Quadrature Outputs from the Same Rotor," Neil C. Griffen, Richard S. Stokes, and Joseph F. Bioty

5/11/1999," Taper Shaft Lock," Neil C. Griffen and Kenneth L. Dickinson

8/8/2000, "Quantitative Mobility Spectrum Analysis of Magnetic-Field Dependent Hall and Resistivity Data, " Jerry R. Meyer, Igor Vurgaftman, David Redfern, Jaroslav Antoszewski, Lorenzo Faraone, and Jeffrey R. Lindemuth (Licensed to Lake Shore Cryotronics)

6/12/2001, "Magneto-Resistive Sensor with Reduced Output Signal Jitter and Temperature Compensation," Neil C. Griffen and Richard S. Stokes

12/31/2002, "Differential Current Source with Active Common Mode Reduction," Geoffrey S. Pomeroy

4/15/2003, "System and Method for Measuring Physical, Chemical and Biological Stimuli Using Vertical Cavity Surface Emitting Lasers with Integrated Tuner," Vladimir Kochergin and Philip Swinehart

10/7/2003, "Eletromechanical Drive for Magnetometers," John Krause, Jefferey Lindemuth, Edward Maloof, and David Plaga

11/16/2004, "System and Method for Measuring Physical, Chemical and Biological Stimuli Using Vertical Cavity Surface Emitting Lasers with Integrated Tuner," Vladimir Kochergin and Philip Swinehart (Follow on to 4/15/2003 patent with additional claims)

12/28/2004, "System and Method for Measuring Physical Stimuli Using Vertical Cavity Surface Emitting Lasers with Integrated Tuning Means," Vladimir Kochergin and Philip Swinehart (Follow on to 11/16/2004 and 4/15/2003 patents with additional claims)

8/23/2005, "Magnetic Field and Electrical Current Visualization System," Vladimir Kochergin

4/18/2006, "Spectral Filter for Green and Shorter Wavelengths," Vladimir Kochergin and Philip Swinehart

5/16/2006, "Method for Manufacturing A Spectral Filter for Green and Longer Wavelengths," Vladimir Kochergin and Philip Swinehart

9/12/2006, "Magneto-Optical Sensing Employing Phase-Shifted Transmission Bragg Gratings," Vladimir Kochergin and Philip Swinehart

11/14/2006, "Method for Manufacturing A Spectral Filter for Green and Shorter Wavelengths," Vladimir Kochergin and Philip Swinehart

11/21/2006, "Spectral Filter for Green and Longer Wavelengths," Vladimir Kochergin and Philip Swinehart
8/7/2007, "Magneto-Optical Resonant Waveguide Sensors," Vladimir Kochergin, Philip Swinehart, and Makhtar Maklad

9/4/2007, "Surface Corrugation Enhanced Magneto-Optical Indicator Film," Vladimir Kochergin

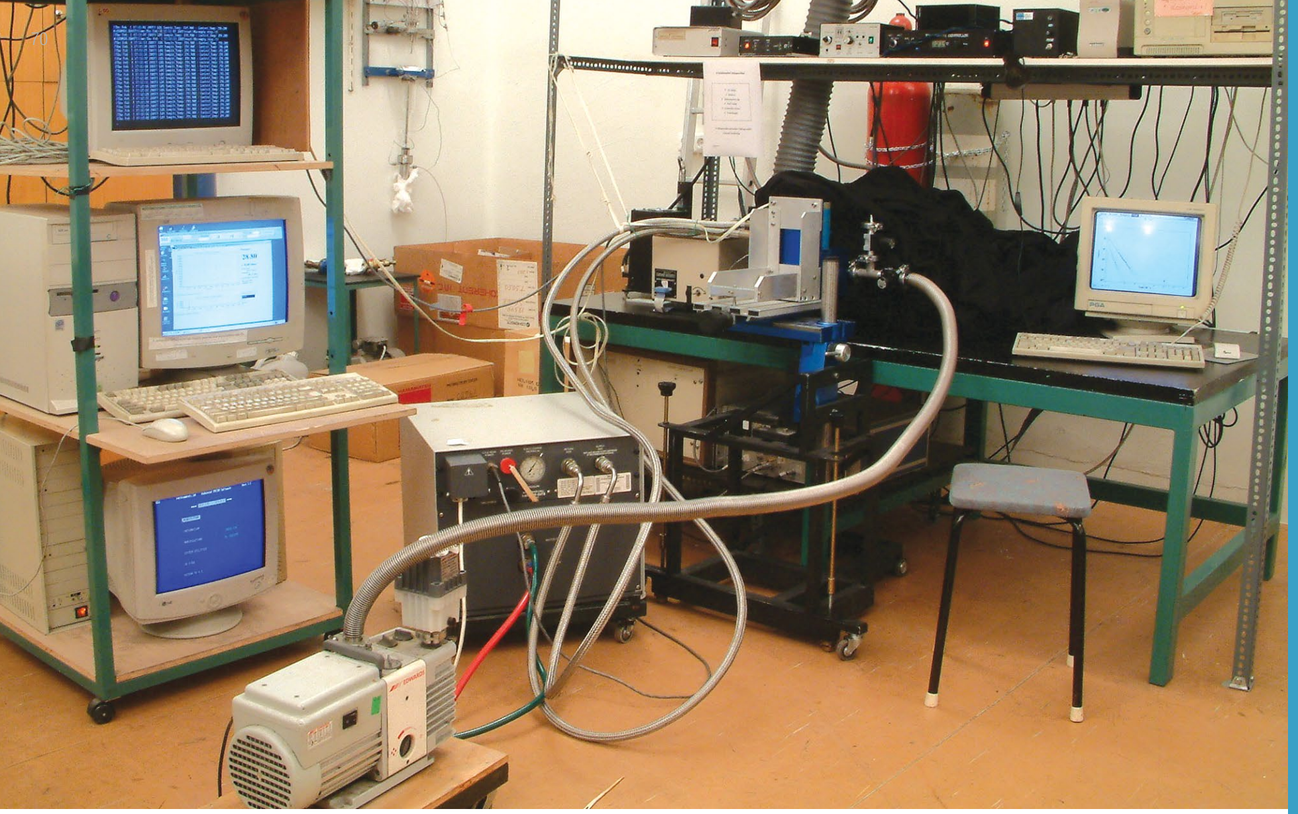
12/8/2009, "Method for Manufacturing a Spectral Filter for Green and Longer Wavelengths," Vladimir Kochergin and Philip Swinehart

7/20/2010, "Negative Refractive Index and Opto-Magnetic Materials and Methods of Fabricating Same," Vladimir Kochergin

9/7/2010, "Fiber Optic Gas Sensor," Peng Chen, Michael P. Buric, Philip Swinehart, Mokhtar S. Maklad, (Assignee: University of Pittsburgh)

12/11/2012, "Probe Tip," Jason S. Caudill, Edward C. Maloof, Masaki Yamaguchi, and Shin Mizuta

10/24/2017, "Fast Hall Effect Measurement System," Jeffrey R. Lindemuth



Application: Lake Shore temperature instrumentation used for fluorescence line narrowing spectroscopy.

Gusztav Schay

Researcher, Biophysics & Radiation Biology Department, Semmelweis University

We had bought a cryostat from Helix Corp., and it came with a Lake Shore Model 330 autotuning temperature controller. We designed a special temperature-programmed cryogenic protocol to measure the activation of protein dynamics with the temperature controller. We had a great experience. The controller was running for more than 20 years, for very long periods day and night without ever a problem. We almost always used remote control mode, with RS-232. We just named the device our 'workhorse' :).

Application
Research focusing on magnetic materials for energy applications, with special emphasis on magnetocaloric materials for magnetic refrigeration and ultra-soft amorphous and nanocrystalline magnetic alloys.

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The arrival of the Lake Shore VSM to our lab was a real game-changer. It allowed us to enter into more varied research topics, in particular into the field of magnetocaloric research. That transition started from the very moment that the system was installed and allowed us to increase the visibility of the magnetic research carried out at Sevilla University. Despite the long geographic distance, over all these years, Lake Shore support has just been one email or one phone call away. They really go the extra mile to help the users whenever they need support. I met several staff from the company and they all show a great passion for the work they do, feeling proud about doing it well. This behavior as a team makes a difference when it permeates into the interactions with the users. Also, over the years, I had the privilege to collaborate with Lake Shore scientists to improve the user friendliness of the VSM for people doing magnetocaloric research, and three years ago, Lake Shore released software for the design of appropriate measurement protocols for magnetocaloric research as well as for the seamless analysis of the data. To the best of my knowledge, Lake Shore is the only company that provides this kind of magnetocaloric software for their users.

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Lake Shore
CRYOTRONICS
50
YEARS
1968 — 2018