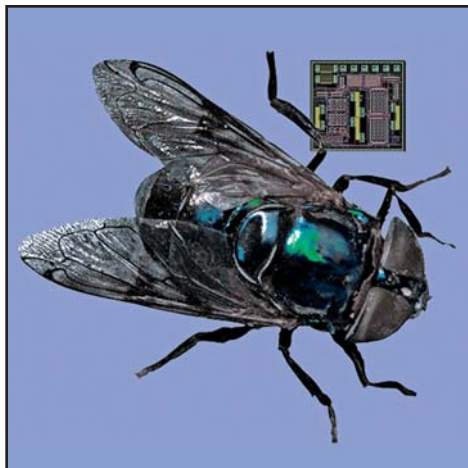


Changing Times

1990-1999



Chips for Hearts, Ears, and Satellites

NVE Corp.'s investigation into magnetic computer memory has led to sensors enabling the next generation of pacemakers and hearing aids.

Missile Defense Needs. The radiation in space is not kind to electronics, therefore in 1992 SDIO began funding NVE Corporation (Eden Prairie, MN), to investigate a new kind of computer memory, called magnetoresistive random access memory (MRAM), that might withstand radiation. Although MRAM would combine the advantages of existing types of memory, it is still being developed. However, devices needed for MRAM are being used to improve medical products.

Technology Solutions. MRAM uses magnetic fields to record information, but unlike tape recorders and VCRs in which a short section of tape holds magnetic information, these fields are

held in extremely small spaces—basically by one electron. With information stored in this way, extremely sensitive sensors are required to read the information. That role is played by giant magnetoresistive (GMR) sensors.

When conventional magnetic sensors pass over a magnetic surface, like a tape, an electrical current is induced in the sensor and is measured. In magnetoresistance, the magnetic field causes a change in resistance, or the flow of current, instead of inducing a current. In 1988 French scientists discovered the GMR phenomenon by using a unique arrangement of new materials to make an extremely sensitive sensor. Most

hard drives use this to read data and NVE has developed several GMR technologies in its push toward MRAM.

Cashing In. Some of the most useful applications of GMR sensors have been in medicine. New hearing aids being manufactured by Starkey Laboratories use NVE's GMR-based components to automatically detect whether a telephone headset or headphones are being used. Conventional hearing aids must be manually switched or incorporate a bulky mechanical coil sensor, so that they can amplify the sounds being produced by the telephone or speaker correctly. Now, Starkey produces very small hearing aids that can automatically

1992

SDIO funds
NVE Corporation



1980

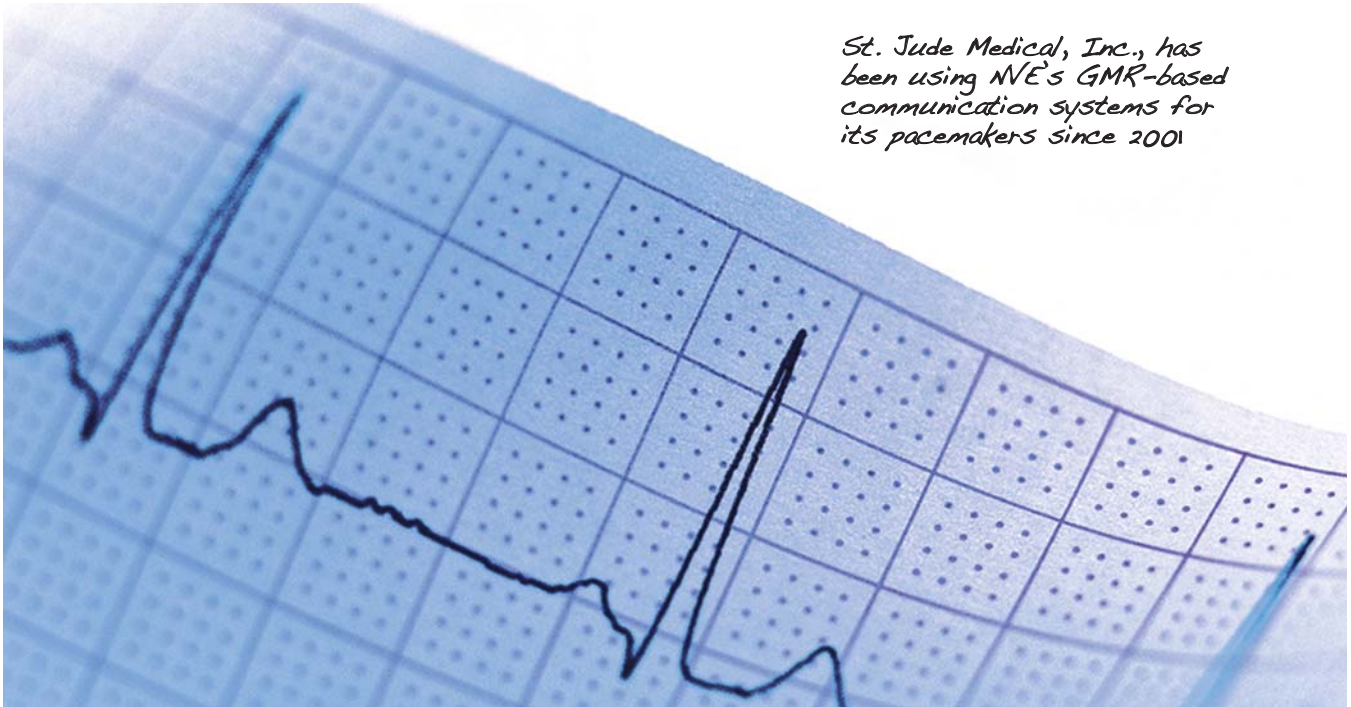
1985

1990

1995

2000

2005



St. Jude Medical, Inc., has been using NVE's GMR-based communication systems for its pacemakers since 2001

adjust—something that could not be done without a GMR sensor.

GMR sensors are used in hard drives to sense magnetic fields and read information, but NVE has developed a series of components for short distance wireless magnetic communication. The components use small coils as transmitters and GMR sensors as receivers, and they are being used in an important medical device: the pacemaker.

The Cardiac Rhythm Management Division of St. Jude Medical, Inc., has been using NVE's GMR-based communication systems for its pacemakers since 2001 when it placed an order for

more than \$200,000 of these systems—an order that grew to \$1.2 million in 2003. The GMR components allow the pacemaker to communicate information about heart function and receive new instructions faster and more reliably while still in the chest of the patient.

NVE is now developing on a nanoscale biological sensor that uses GMR sensors to detect and track molecules, such as DNA and proteins, that have been attached to nanosized magnetic beads.

One company is using NVE GMR sensors for a more pedestrian use, vehicle traffic sensors. Nu-Metrics, Inc. makes a line of compact automobile traffic sensors that

can be embedded in roadways to detect cars, trigger traffic lights, and record traffic volume. Conventional wire loops (rectangles cut into pavement at intersections) work well but are labor-intensive, interrupt traffic, and difficult to repair.

For more information visit:
www.nve.com



The World in 1992 ... Iraq refuses to abide by UN resolutions after the Gulf War. William Jefferson Clinton is elected president.

At SDIO in 1992 ... Ambassador Henry Cooper completes a memorandum of understanding with the branches of the armed services describing how the services would work with SDIO on missile defense systems.