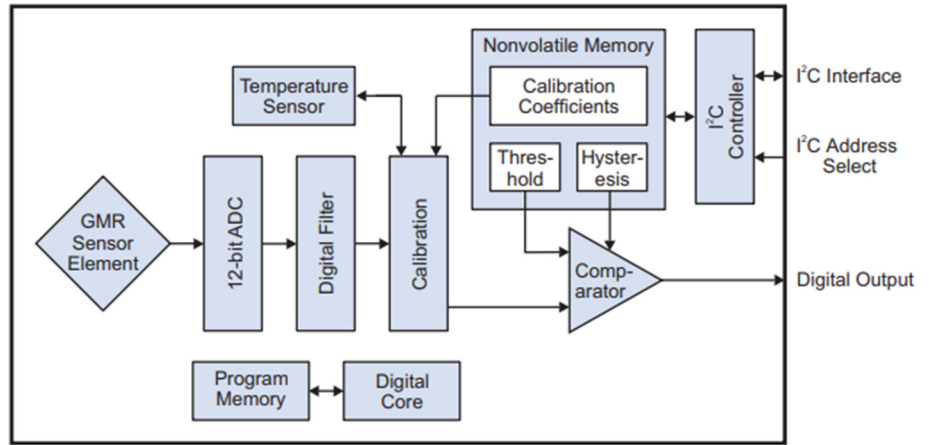# Application Bulletin
Ultraminiature, ultraprecise TMR switch for IO-link nodes

SM-series smart, programmable GMR and TMR magnetic switch sensors

NVE's groundbreaking family of programmable GMR and TMR switches combine high sensitivity, high resolution, and high speed in an ultraminiature DFN package. The switches support position sensing, speed sensing, noncontact current sensing, and other magnetic field-based sensing applications. SM-series sensors are factory calibrated for superior temperature stability over the extended –40 – 125°C temperature range.

SM12x Block Diagram

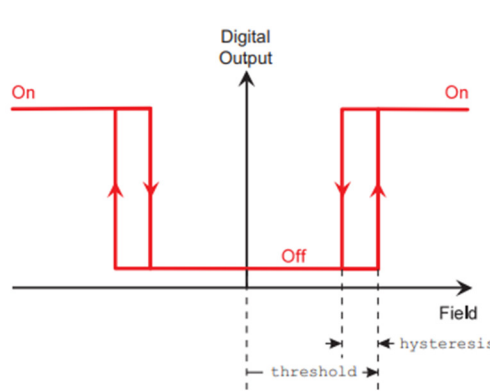| Sensor	Technology	Field range	Resolution	Switching speed	Package size
SM124	Omnipolar GMR	0 to 1 mT	0.01 mT	**10 kHz**	**2.5 x 2.5 x 0.8 mm DFN6**
SM125	Omnipolar GMR	0 to 4 mT	0.04 mT	**10 kHz**	**2.5 x 2.5 x 0.8 mm DFN6**
SM223	Bipolar TMR	– 1.5 to 1.5 mT	0.001 mT	**15 kHz**	**2.5 x 2.5 x 0.8 mm DFN6**
SM228	Bipolar TMR	– 15 to 15 mT	0.01 mT	**15 kHz**	**2.5 x 2.5 x 0.8 mm DFN6**

Switching modes

The switching behavior of SM-series sensors can be programmed over a simple I²C interface and stored in nonvolatile memory. In addition to *threshold*, *hysteresis*, and *mode*, the digital output can be *inverted* for LOW = ON compatibility.
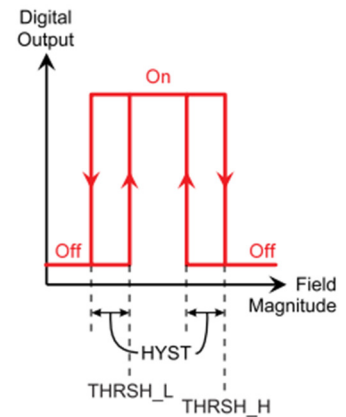
SM12x sensors are omnipolar, meaning they do not distinguish magnetic field polarity, only magnitude. In *default mode*, they have a single switching point with programmable threshold and hsyteresis.

A second switching point can be programmed for *window comparator mode*, which is useful in certain mechatronics applications.
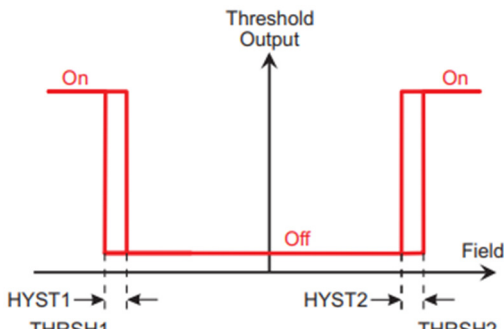
SM22x sensors are bipolar, meaning they detect field magnitude and polarity. SM22x sensors can be used in *default mode*, *bipolar mode*, or *unipolar mode*.
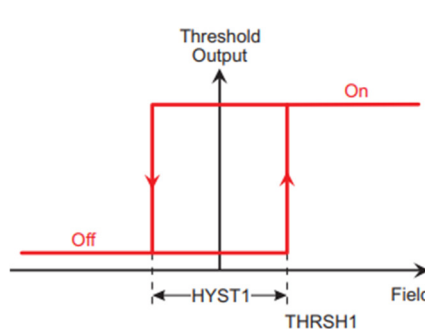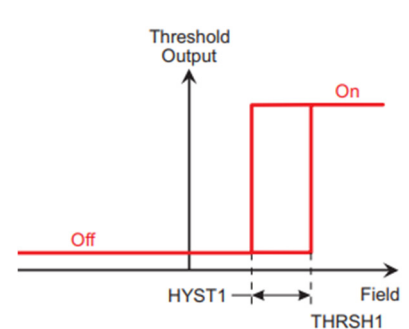

SM12x default mode
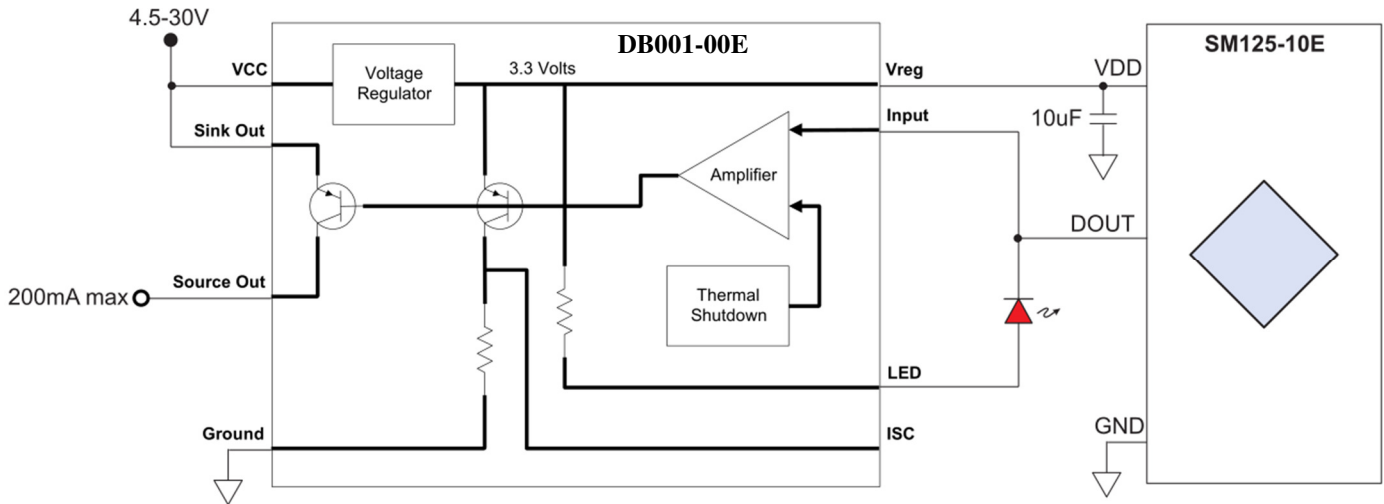

SM12x window comparator mode

SM22x default mode

SM22x bipolar mode

SM22x unipolar mode

1

Robust, ultracompact IO-link compatible solution

The SM12x can be combined with NVE's DB00x switching ICs for a robust, IO-link compatible solution requiring only three components. NVE's DB00x switching ICs are a complete front-end for NVE's GMR switches, with integrated protection against short circuits, high-voltage switching transients, thermal shutdown, and reverse battery. An integrated voltage regulator provides power for the NVE switch sensor, and a 4.5-30V, 200mA max PNP output is compatible with IO-link masters. An optional LED can be connected to visually indicate switching.
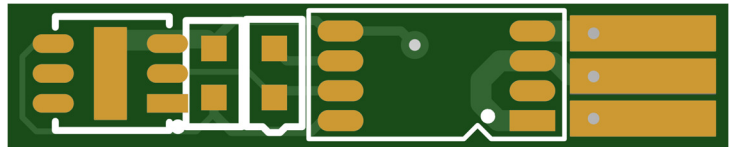

Combining an SM-series sensor with DB001 for a robust, IO-link compatible, proximity sensing solution.
The SM-series sensor should be used with DOUT_INVERT set HIGH for compatibility with the inverting input. The 10uF capacitor should be placed as close as possible to the SM-series sensor. The LED is optional to indicate switching.

The compact sensor solution can easily fit on a 1/8-inch by 5/8-inch (3 mm by 15 mm) circuit board.

The compatibility chart for DB00x switching ICs is shown below. DB002 has additional compatibility with SM-series, ADL-series, and ADT92x when paired with an external voltage regulation scheme to generate a 3.3V rail.

Example layout of SM125-10E and DB001-00E solution

Part number	Compatibility	Input voltage	Output current	Vreg output	Package size
DB001-00E	AD9xx, SM-series, ADL-series, ADT92x	4.5 – 30 V	200 mA	3.3 V	MSOP8
DB001-01E	AD9xx, SM-series, ADL-series, ADT92x	4.5 – 30 V	200 mA	3.3 V	1.5 x 2.2 mm bare die
DB002-02E	AD0xx	6.2 – 30 V	300 mA	5 V	SOIC8
DB002-01E	AD0xx	6.2 – 30 V	300 mA	5 V	1.9 x 2.9 mm bare die

Design support for applications large or small

We have free Web-based calculators to help designers with magnet and sensor selection:
nve.com/spec/calculators#tabs-Digital-Sensor-Distance

For live demonstrations of sensors and sensor applications, check out our YouTube channel: https://www.youtube.com/@NveCorporation

Additional applications information can be found at https://www.nve.com/SensorApps

Please contact sensor-apps@nve.com for help with your switch application.

SB-00-160 Rev. A   April 2023