SHIELD02

Off-Axis Angle Sensor Demonstration and Development Board
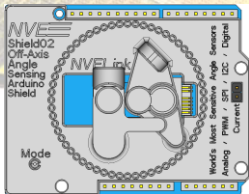
Overview

SHIELD02 is a printed circuit board assembly that allows you to evaluate NVE's unique tunneling magnetoresistance (TMR) angle sensors. Key NVE angle sensors features include:

- Analog / Digital Quadrant / I^{2}C / SPI / ABZ interfaces
- < 1 μA supply current – ideal for battery power
- Ultraminiature 2.5 x 2.5 x 0.8 mm package size
- Detect 0.1 μT$_{PP}$ rotating magnetic field (ALT521-10E)
- Minimum operate points as low as 3 mT$_{PP}$
- –40 to +125 °C temperature range

NVE
NVE CORPORATION

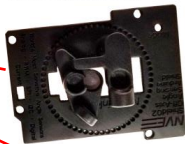**NVELink**

Common NVE Angle Sensor Applications

Many applications can use NVE angle sensors at wide airgaps in off-axis configurations:

- Flowmeter / water meter sensor
- Potentiometer
- BLDC motor encoder
- Joystick
- Battery backup servo encoder
- Robot arm / prosthetic arm
- Cylinder position sensor
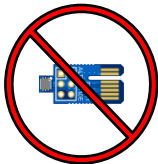
SHIELD02 includes the following:

- 60-RGB-LED PCBA with edge connector, male pins, and female pins

- 3D-printed magnet pocket fixture

- Ring magnet 1/4 x 1/4 x 1/8" NdFeB

- 1/8 x 3" magnet turning rod

SHIELD02 <u>does not</u> includes the following:

- Microcontroller board (such as Arduino Uno)
- USB cable or power supply
- *NVELink*🖰 EVB01 sensor PCBs


These items need to be purchased separately

Recommended Compatible Products

SHIELD02 can be used to demonstrate:

Eval Board	Sensor IC	Part Family
AAT001-10E-EVB01	AAT001-10E	Saturation Analog
AAT003-10E-EVB01	AAT003-10E	Saturation Analog
AAT006-10E-EVB01	AAT006-10E	Saturation Analog
AAT009-10E-EVB01	AAT009-10E	Saturation Analog
AAT101-10E-EVB01	AAT101-10E	Saturation Analog
ADT001-10E-EVB01	ADT001-10E	Digital Quadrant
ADT002-10E-EVB01	ADT002-10E	Digital Quadrant
ADT005-10E-EVB01	ADT005-10E	Digital Quadrant
ASR002-10E-EVB01	ASR002-10E	Programmable SPI
ASR012-10E-EVB01	ASR012-10E	Programmable I²C
ASR022-10E-EVB01	ASR022-10E	ABZ Encoder
ALT521-10E-EVB01	ALT521-10E	Ultrasensitive Linear Analog
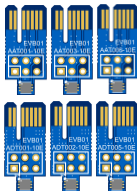
NVELink
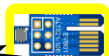
New!

Quick Start

- ➢ Connect SHIELD02 to a compatible single-board computer, such as Arduino Uno
- ➢ Connect a compatible EVB01 board from NVE
- ➢ Download and program demonstration or evaluation firmware: github.com/NveCorporation
- ➢ Attach the magnetic fixturing unit and place the magnet in one of the pockets
- ➢ Observe the LEDs tracking the angle of the magnet
- ➢ Use the "LED Mode" button for additional features (documented in the firmware)
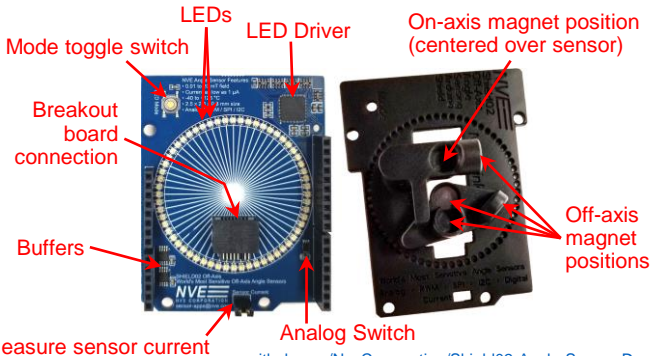
Circuit Description

SHIELD02 is a 2.1 x 2.7" PCBA in the form factor of an Arduino Shield. The board has male header pins pre-soldered, so it can easily connect to boards such as Arduino Uno. Other features include:
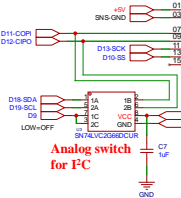
- 60 programmable RGB LEDs
- I^{2}C LED driver IC
- Unity-gain buffer for high-impedance outputs
- Removable jumper to measure sensor current
- "LED Mode" pushbutton

SHIELD02 PCB and Magnet Holder
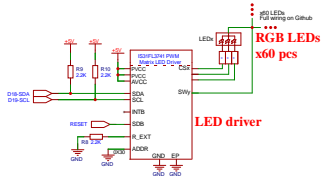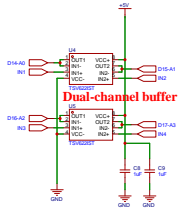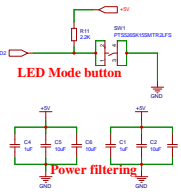

LEDs

LED Driver

On-axis magnet position (centered over sensor)

Mode toggle switch

Breakout board connection

Buffers

Off-axis magnet positions

Measure sensor current

Analog Switch

github.com/NveCorporation/Shield02-Angle-Sensor-Demo

Schematic

Card edge for EVB01

U1
MEC1-108-02-F-D-RA1-SL

D11-COPI
D12-CIPO

SNS-GND

VDD0
GND

+5V

+3.3V
SNS-GND

GPIO1 (MOSI) (SDA)
GPIO2 (MISO) (SCL)
GPIO3 (SCLK)
GPIO4 (CAN L)
GPIO5 (CAN H)

D13-SCK
D10-SS

ADC1+ (CurrMon1+)
ADC1- (ADC3+)
ADC2+ (ADC3-)
ADC2- (ADC4+)

IN1
IN2
IN3
IN4

SNS-GND
GND

GPIO6(CurrMonComm)

2.54×1×2

Jumper to measure sensor current

D18-SDA
D19-SCL

1A
1B

2A
2B

1C
2C

VCC
GND

+5V

LOW=OFF

GND

C7
1uF

SN74LVC2G66DCUR

GND

Analog switch for I²C

H6
IOREF
RESET
+3.3V
+5V
GND
GND
VIN

D19-SCL
D18-SDA
AREF
GND
D12-CIPO
D11-COPI
D10-SS
D8

H7

H4
01
02
03
04
05
06

D14-A0
D15-A1
D16-A2
D17-A3
D18-A4
D19-A5

Also
I2C

D7
D6
D5
D4
D3
D2
D1-TX
D0-RX

H3

Male header pins (bottom)
Female header pins (top)

R11
2.2K

SW1
PTS526SK15SMTR2LFS

LED Mode button

GND

D16-A0
IN1

IN1-
IN1+
VCC-

OUT1+
VCC+
OUT1-

D15-A1

D16-A2
IN2

IN2-
IN2+
VCC-

OUT2+
VCC+
OUT2-

D17-A3
IN3

TSV862IPT

Dual-channel buffer

GND

+5V

C4
1uF

C5
10uF

C6
10uF

C1
1uF

C2
10uF

C3
10uF

Power filtering

GND

+5V

R9
2.2K

IS31FL3741W.FVM
AVDD
GCC
AVSS
CSX
SDA
SDB
INTB
GND
R_EXT
ADDR

LEDs

RESET

GND

GND

GND EP

LED driver

LEDs

∎∎∎∎

RGB LEDs x60 pcs

x60 LEDs
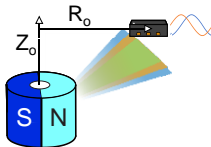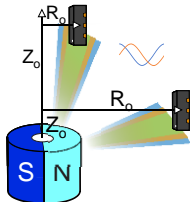Full wiring on Github

SWy

Angle Sensing Principles

Unlike competitive angle sensors, NVE's TMR angle sensors can be used in both *on-axis* and *off-axis* angle sensing configurations
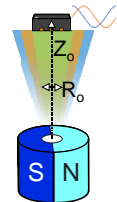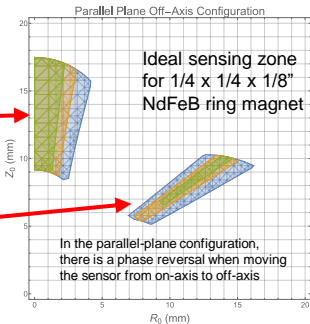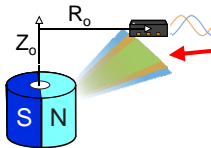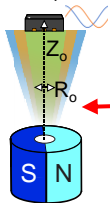

On-axis /
end of shaft

Off-axis /
parallel-plane
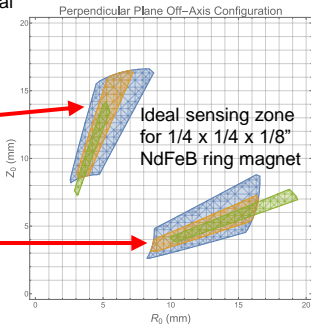
Off-axis /
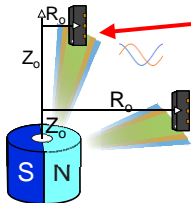perpendicular-plane

Parallel-Plane Orientation

For best performance, sensors should be placed within the ideal sensing zone. The ideal zone depends on the magnet size and shape.

Parallel Plane Off−Axis Configuration

Ideal sensing zone for 1/4 x 1/4 x 1/8" NdFeB ring magnet

In the parallel-plane configuration, there is a phase reversal when moving the sensor from on-axis to off-axis
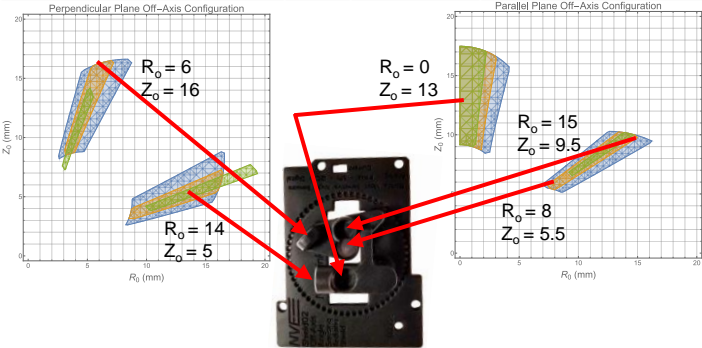
Perpendicular-Plane Orientation

Ideal locations are equilibrium points where the magnetic field rotates in a perfectly non-elliptical Lissajous circle. These can be determined by calculation or magnetics simulation

Ideal sensing zone for 1/4 x 1/4 x 1/8" NdFeB ring magnet

Magnet Holder Sensing Locations

Perpendicular Plane Off-Axis Configuration

$R_o = 6$
$Z_o = 16$

$R_o = 14$
$Z_o = 5$

Parallel Plane Off-Axis Configuration

$R_o = 0$
$Z_o = 13$

$R_o = 15$
$Z_o = 9.5$

$R_o = 8$
$Z_o = 5.5$
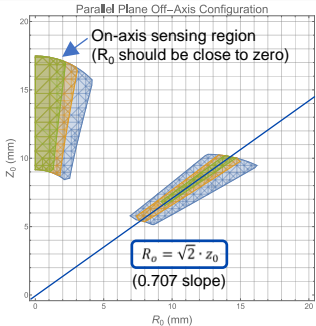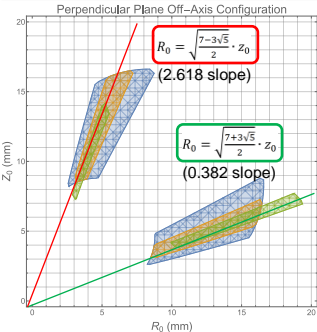
R_o and Z_o distance is measured center-to-center between magnet and angle sensor IC

Ideal Sensing Zones – Approximate Rule of Thumb

Perpendicular Plane Off–Axis Configuration

$$R_0 = \sqrt{\frac{7-3\sqrt{5}}{2} \cdot z_0}$$
(2.618 slope)

$$R_0 = \sqrt{\frac{7+3\sqrt{5}}{2}} \, z_0$$
(0.382 slope)

Parallel Plane Off–Axis Configuration

On-axis sensing region
(R_0 should be close to zero)

$$R_o = \sqrt{2} \cdot z_0$$
(0.707 slope)

Z_0 (mm)

R_0 (mm)

The linear slopes are approximations obtained from theoretical calculation

Off-Axis Angle Sensing Advice

- If the sensor cannot be placed within the ideal sensing zone, use NVE's Smart TMR Angle Sensors with calibration feature **New**
- Magnets are typically chosen for convenience within the existing mechanical constraints. Magnets as small as 1 mm or as large as 3" can be used – only the ideal sensing zone changes
- NVE engineers can generate an ideal sensing zone simulation for your magnet:
  - sensor-apps@nve.com
- Free web-calculator: nve.com/spec/calculators
- Application note: nve.com/SensorApps

Off-Axis Angle Sensing

NVE angle sensors are typically used for off-axis angle sensing and rotation sensing because they have:

- *High sensitivity* to detect weaker, off-axis magnetic fields
- *Robust misalignment tolerance* for easier mounting placement
- *Absolute position* encoding – one full magnet rotation produces one full sine/cosine cycle
- *Small package size* – sensors easily fit inside tight spaces

Off-Axis Angle Sensor Demo and Dev Board
NVE's **Shield02** includes:
• LED angle indicator and interface board
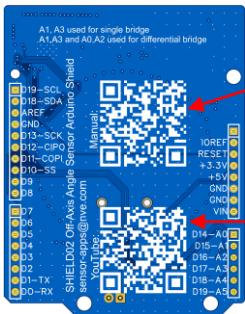• 1/4" NdFeB magnet and 3D printed guide fixture
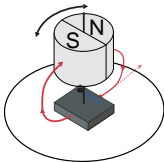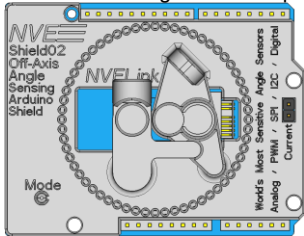
GitHub:

Buy it again:

Back   Front

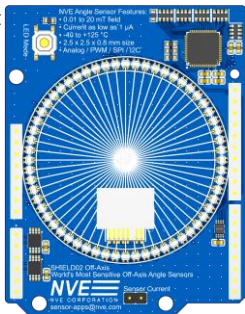Download the *manual* for quick-start info.

Follow *NVE Corporation's YouTube* Channel for demos

Manual:

YouTube:

A1, A3 used for single bridge
A1,A3 and A0,A2 used for differential bridge

D19—SCL
D18—SDA
AREF
GND
D13—SCK
D12—CIPO
D11—COPI
D10—SS
D9
D8

D7
D6
D5
D4
D3
D2
D1—TX
D0—RX

SHIELD02 Off-Axis Angle Sensor Arduino Shield
sensor-apps@nve.com

IOREF
RESET
+3.3V
+5V
GND
GND
VIN

D14—A0
D15—A1
D16—A2
D17—A3
D18—A4
D19—A5

NVE Angle Sensor Features:
• 0.01 to 20 mT field
• Current as low as 1 µA
• −40 to +125 °C
• 2.5 x 2.5 x 0.8 mm size
• Analog / PWM / SPI / I2C

SHIELD02 Off-Axis
World's Most Sensitive Off-Axis Angle Sensors

NVE
N V E   C O R P O R A T I O N
sensor-apps@nve.com   Sensor Current

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