Designing an Analog Proximity Sensor with the DRV5056

TI Precision Labs – Magnetic Position Sensing

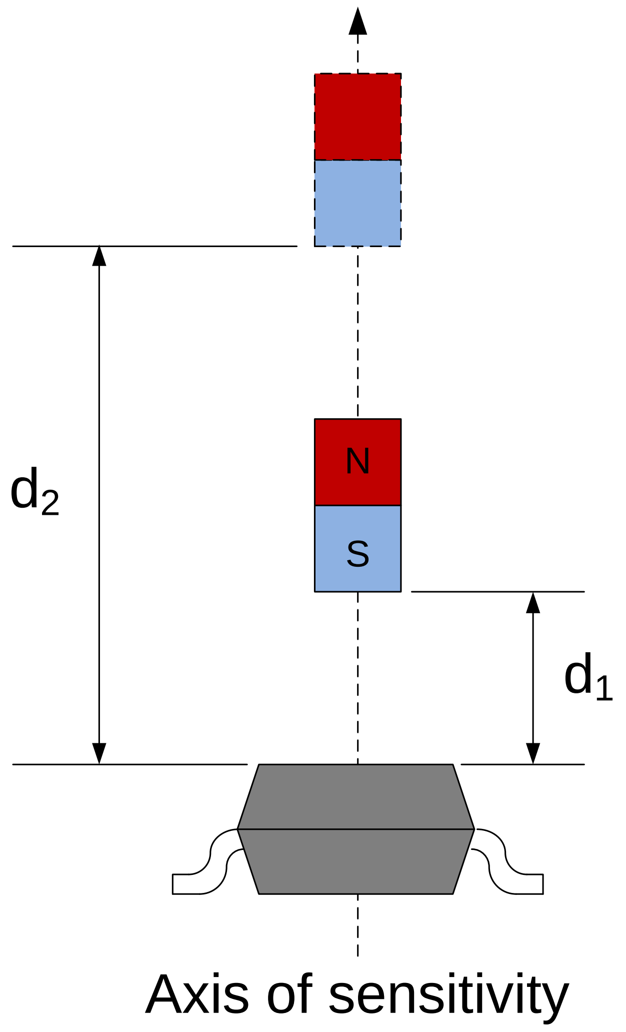
Presented by Ian Williams

Prepared by Harsha Munikoti and Ian Williams

Typical application

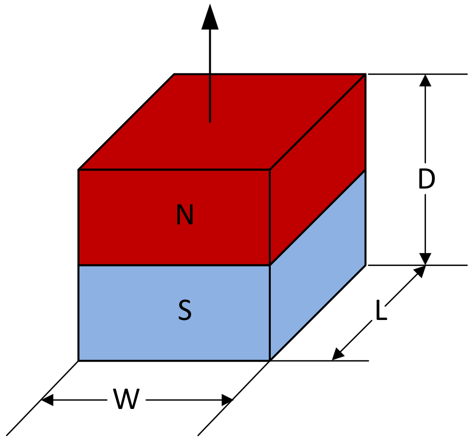
- Linear Hall-effect sensor to measure proximity of magnet moving along axis of sensitivity
  - Min and Max distances between sensor and magnet (d_1 and d_2) specified
  - Select sensor and magnet to accurately measure distances between d_1 and d_2

- Design goals:
  1) Maximize measurement accuracy
  2) Maximize SNR over distance range for resolution
  3) Minimize magnet size to meet mechanical design constraints and cost targets



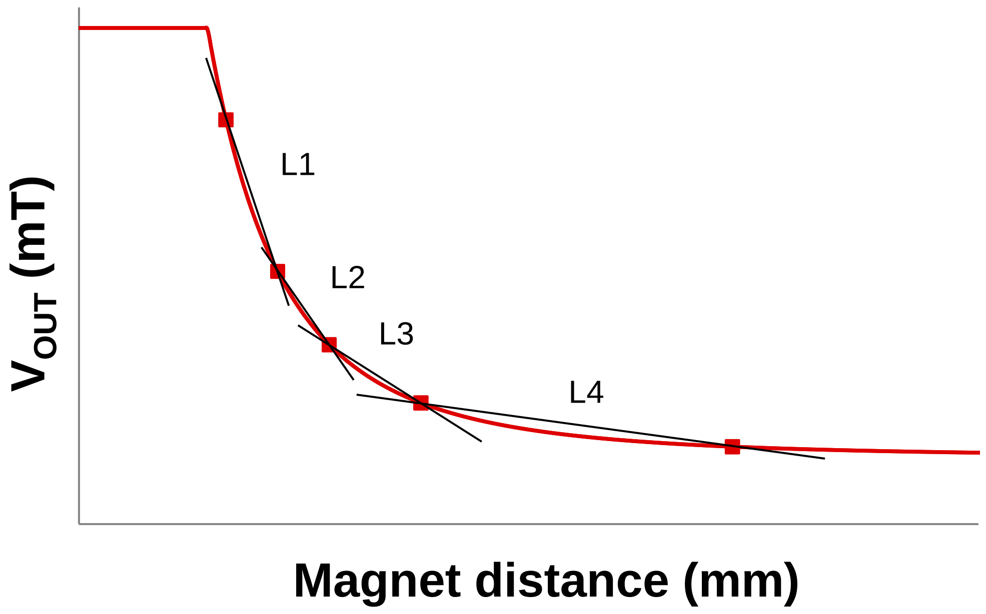
Improving accuracy

$$|\vec{B}| = \frac{B_r}{\pi}\left[\arctan\left(\frac{LW}{2z\sqrt{4z^2+L^2+W^2}}\right) - \arctan\left(\frac{LW}{2(D+z)\sqrt{4(D+z)^2+L^2+W^2}}\right)\right]$$

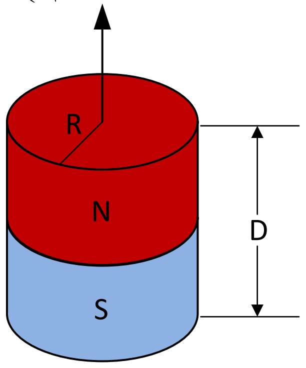


- Ensure sensor output does not saturate over distance range
  - Pick a magnet with the right strength for the sensitivity used

- Calibrate nonlinear V_{OUT} vs. distance transfer function
  - For example, fit transfer curve to N-segment piece-wise linear model
  - Estimate distance for a V_{OUT} value using equation of nearest segment

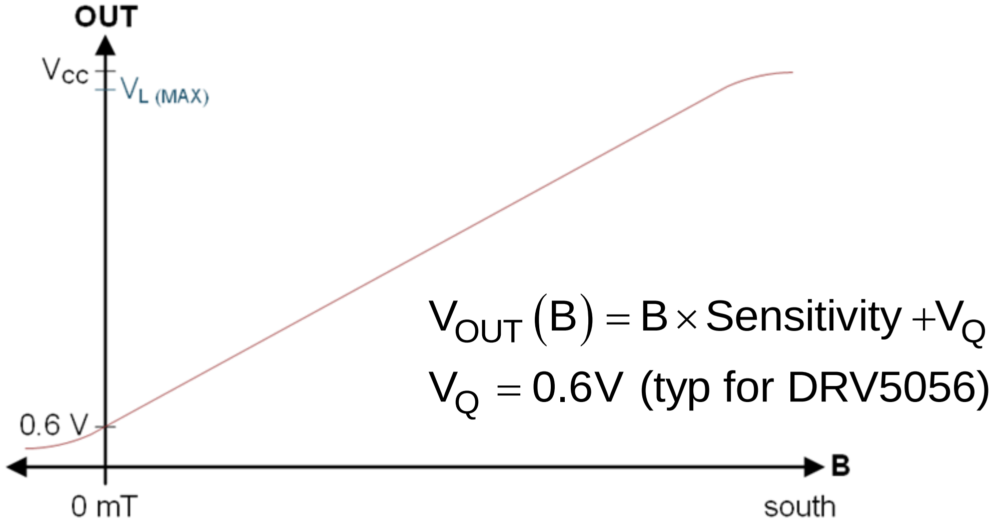


$$|\vec{B}| = \frac{B_r}{2}\left(\frac{D+z}{\sqrt{R^2+(D+z)^2}} - \frac{z}{\sqrt{R^2+z^2}}\right)$$



Improving SNR

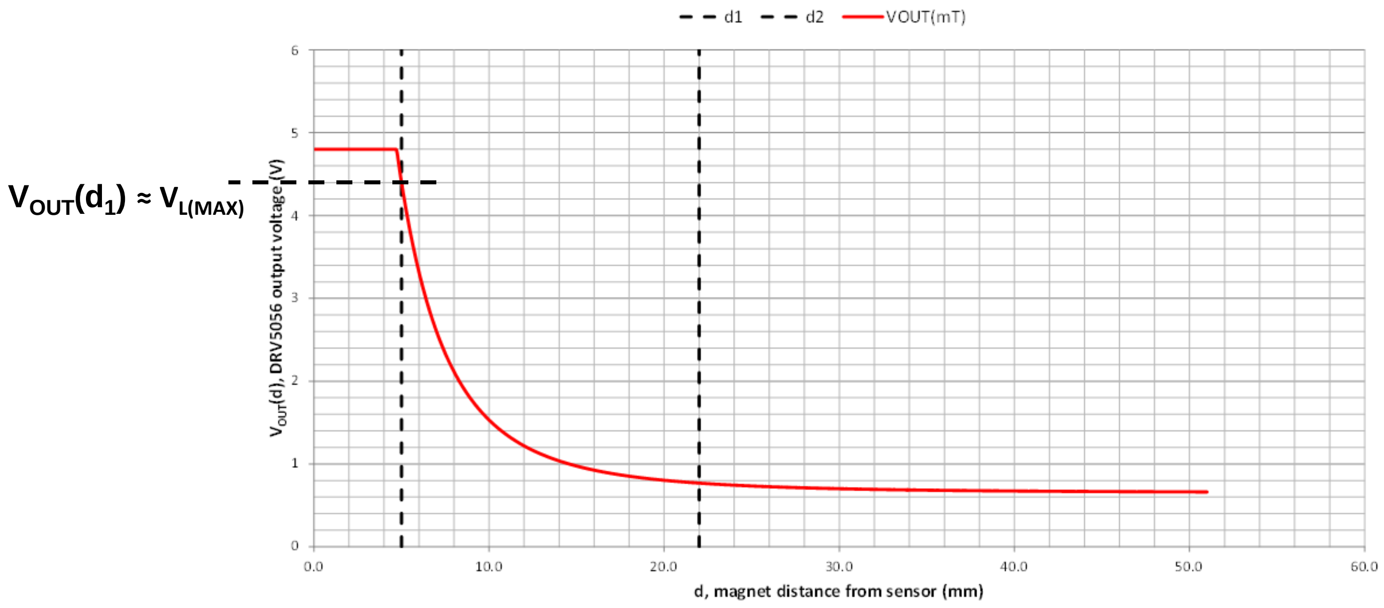
- Maximize sensor output swing over distance range
  - Use a ratiometric sensor and higher V_{CC}
  - Use sensor with unipolar input range (e.g. DRV5056)
  - Map d_1 to $V_{L(MAX)}$



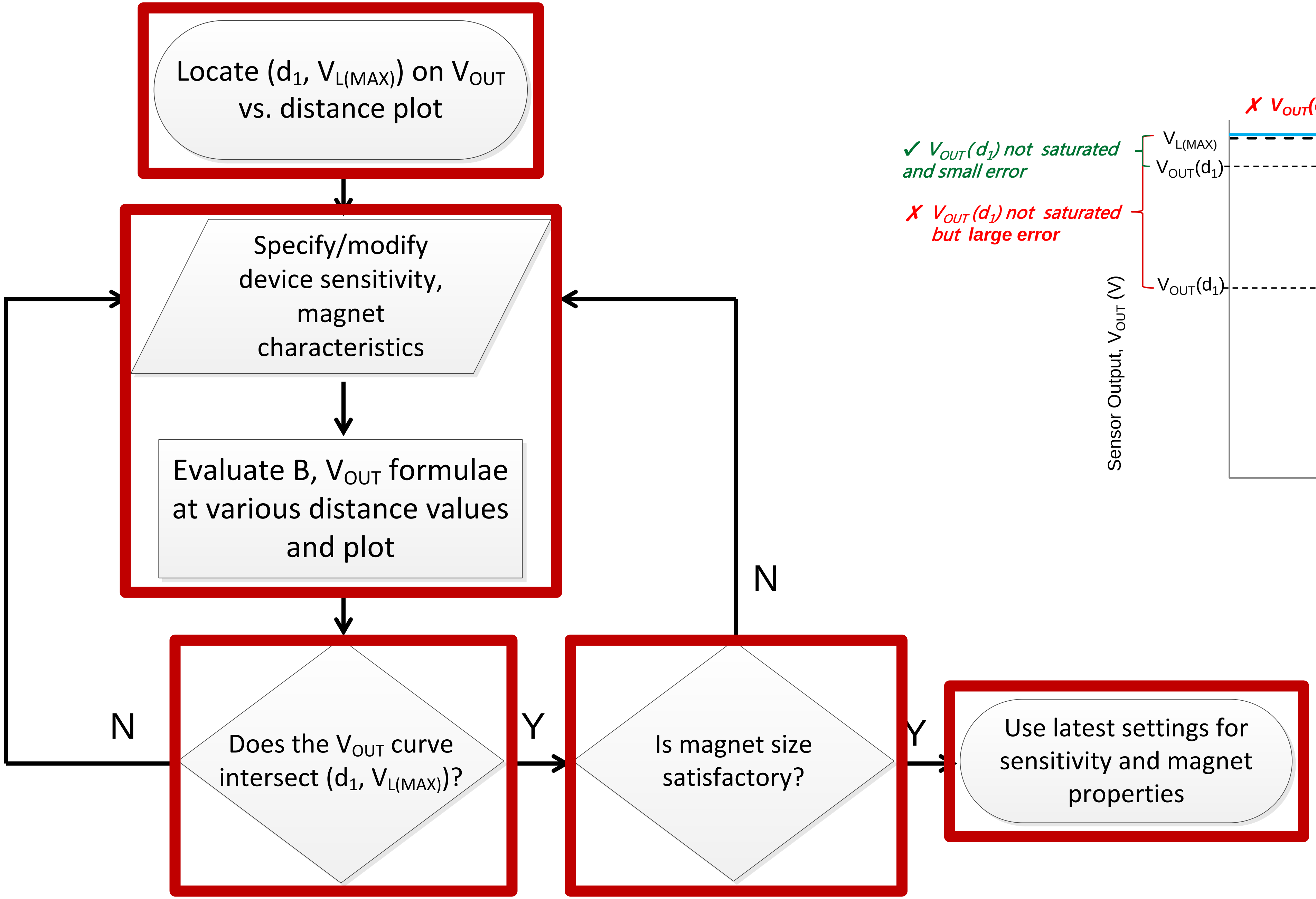
- Minimize output noise
  - Low-pass filtering, averaging
  - Tradeoff: Lower bandwidth ➔ longer output settling time
  - Use device with lower sensitivity

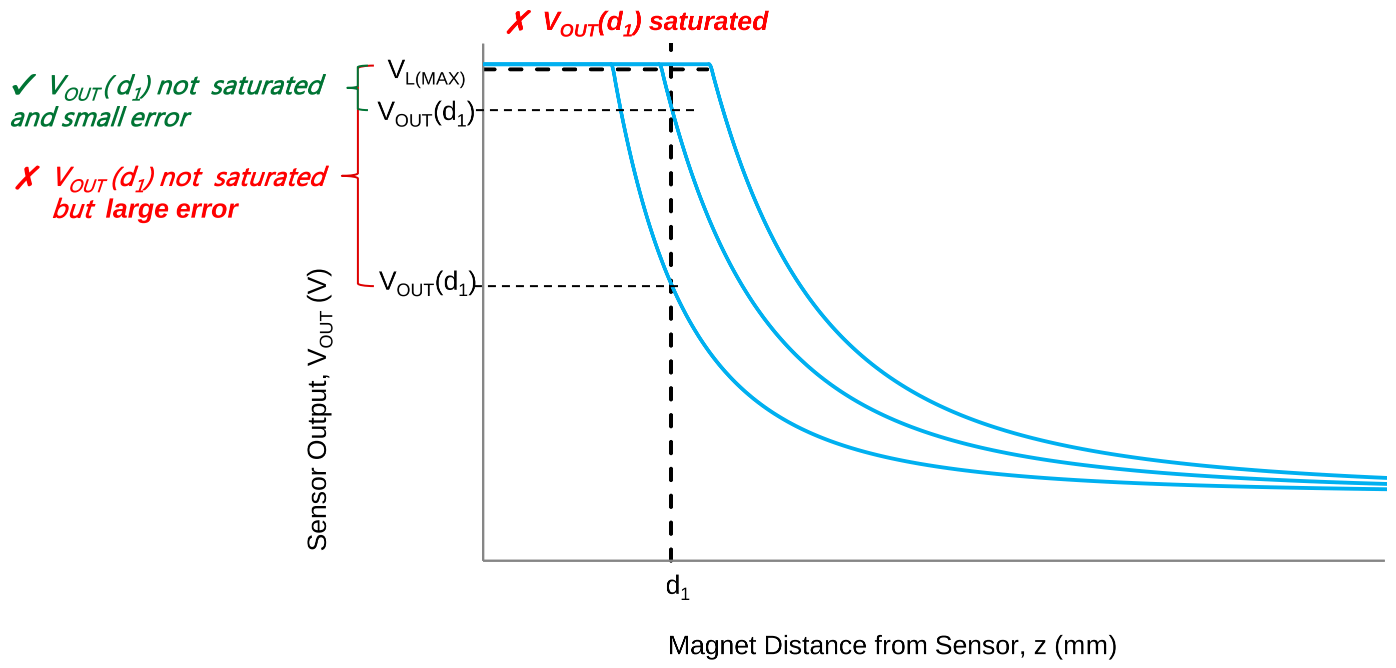
$$V_{N,OUTPUT,RMS} = B_{N,INPUT,RMS} \times Sensitivity$$

  - Tradeoff: Lower sensitivity ➔ need bigger B for max output swing ➔ Bigger, more expensive magnet!

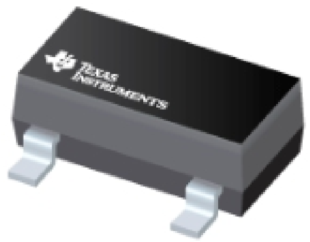


Iterative design procedure





DRV5056 distance measurement tool



DATASHEET

DRV5056 unipolar ratiometric linear hall effect sensor datasheet (Rev. A)

View now | Download

Description & parametrics | Technical documents | **Tools & software** | Order now | Quality & packaging | Support & training

Models | Design kits & evaluation modules | TI Designs & reference designs | Software | Development tools | TI design network

Design kits & evaluation modules (2)

Name	Part#	Type
Breakout Adapter for SOT-23 and TO-92 Hall Sensor Evaluation	HALL-ADAPTER-EVM	Evaluation Modules & Boards
DRV5055, DRV5056 and DRV5057 linear Hall effect sensor evaluation module	DRV5055-5057EVM	Evaluation Modules & Boards

Software (3)

DRV5056 Distance Measurement Tool (ZIP 1110 KB) 09 Jan 2019

DRV5055-ANGLE-EVM MSP Flasher Batch File (Rev. A) (ZIP 7233 KB) 20 Dec 2018

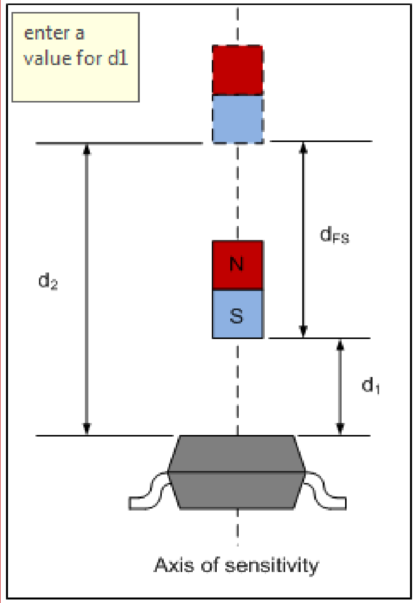
DRV5055-ANGLE-EVM Source Code (Rev. A) (ZIP 1183 KB) 20 Dec 2018

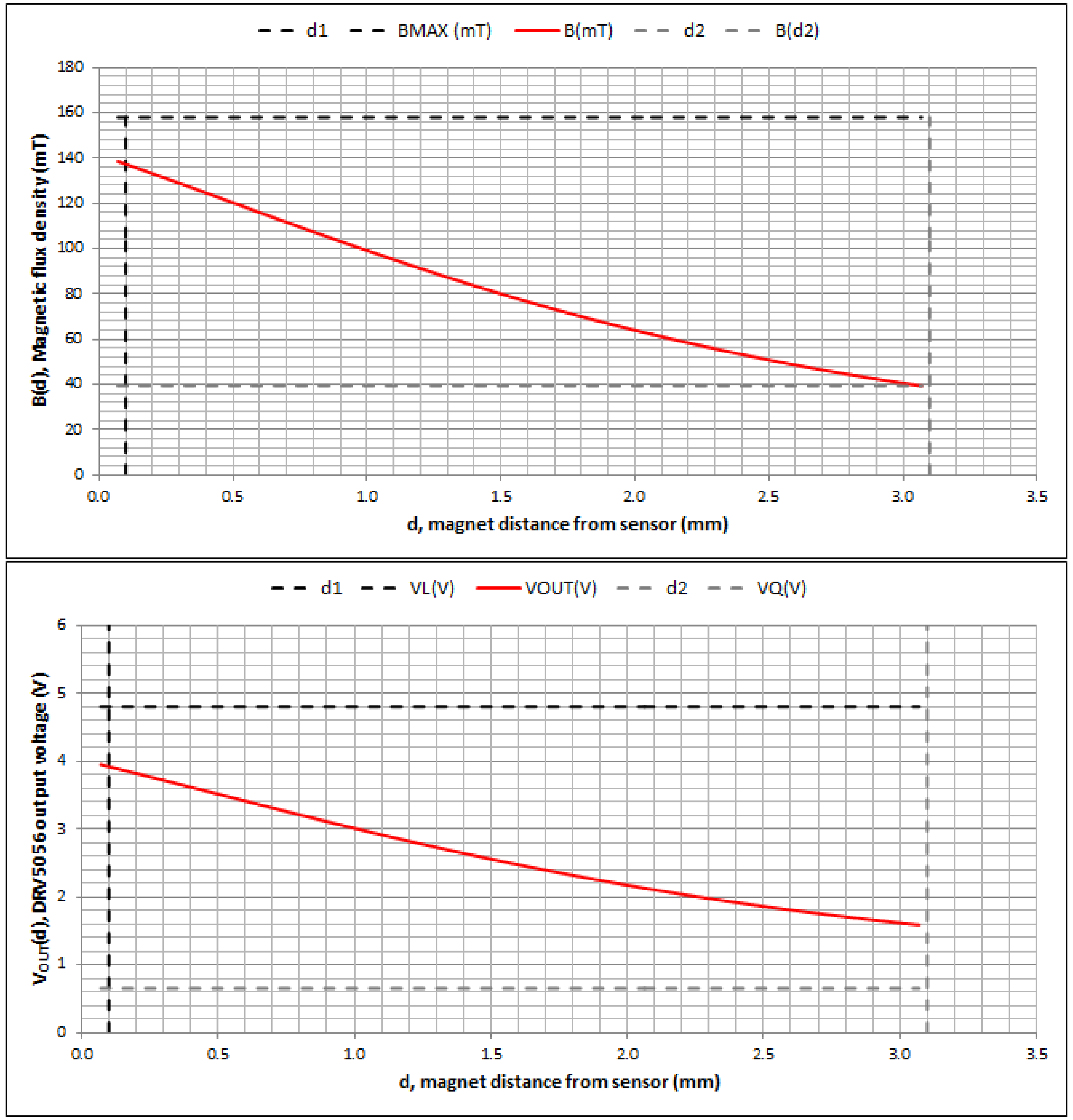
DRV5056 distance measurement tool

TEXAS INSTRUMENTS

DRV5056 - Contactless Distance Measurement

d_1 (closest point)	0.1	mm
d_2 (farthest point)	3.1	mm
d_{FS} (full-scale)	3	mm
V_{SUPPLY} (nominal)	5V	
Part#	DRV5056A4	
$B_{IN,MAX}$	158	mT
$B_{IN,MIN}$	0.06	mT
Sensitivity (min)	23.8	mV/mT
V_Q (max)	0.65	V
$V_{L(MAX)}$	4.8	V
Magnet Shape	CYLINDER	
Magnet Material	Ferrite	
Br (Remanence)	4000	G
R (see Help)	3.175	mm
D (see Help)	3.175	mm
B(0.097mm)	137.43	mT
B(3.07mm)	39.26	mT
VOUT(0.097mm)	3.92	V
VOUT(3.07mm)	1.58	V





LEGEND:

- Input Field
- Output Field
- [ERROR] Invalid Value or Sensor Input Saturated

To find more magnetic position sensing technical resources and search products, visit ti.com/halleffect