

Using 3D linear Hall-effect sensors for detecting magnetic tampering

TI Precision Labs – Magnetic sensors
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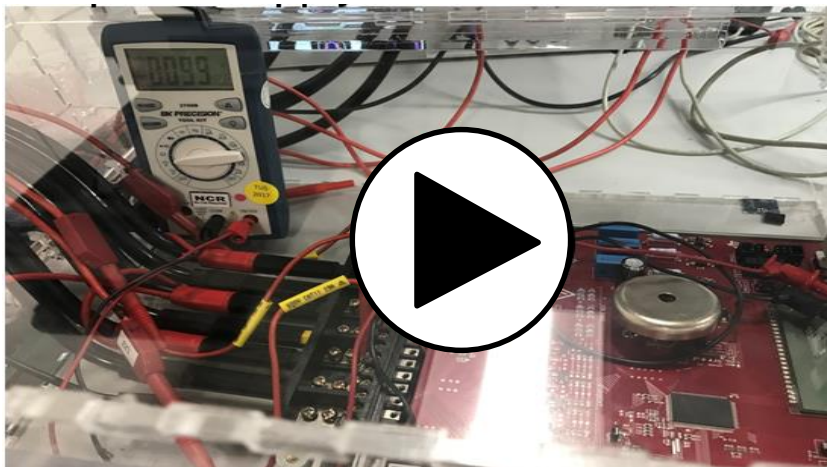
Electricity meter tampering is a problem

- Electricity meter tampering is a type of non-technical loss where individuals hack meters to slow or stop the accumulation of energy usage statistics.
 - Increased requirements for enhancing the protection designed into new smart meters.
- Non-technical losses - “theft” - account for billions of dollars of revenue loss for utility providers.
 - In 2017, globally, \$96 billion were lost due to non-technical losses.
 - Impacts utility providers and their customers.
- Electricity meter tampering has led to increased requirements in enhancing the protection designed into new smart meters.

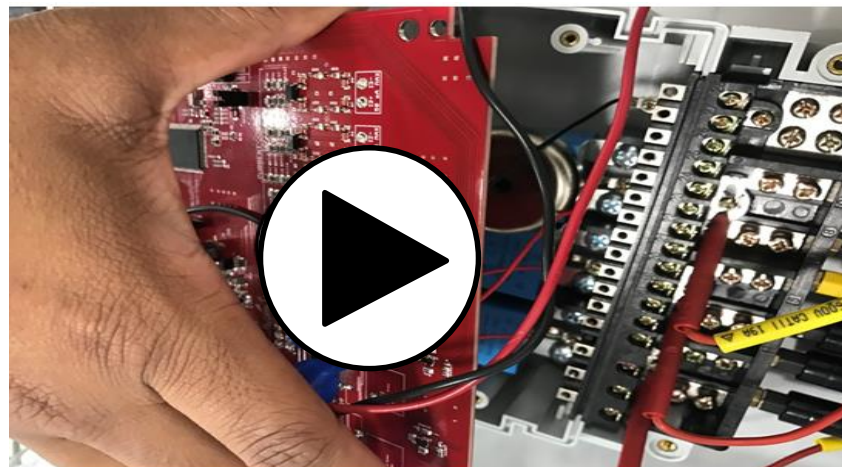
Source: Northwest Group LLC, [Electricity Theft and Non-Technical Losses: Global Markets, Solutions, and Vendors](#)

The effect of magnetic tampering on electricity meters

Power supply transformers

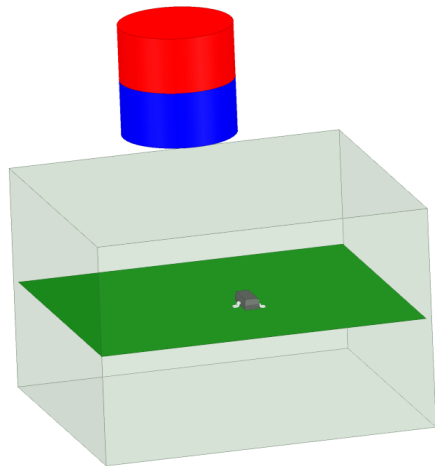


Current transformers

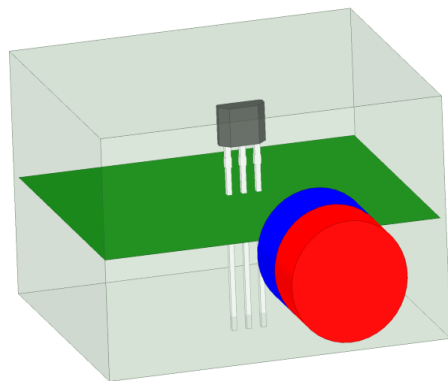


Out-of-plane 1D Hall sensor orientation

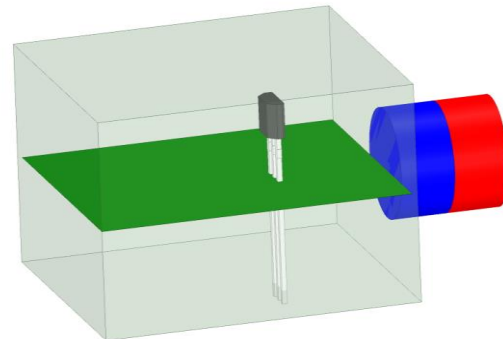
Magnet on top of the case and Printed Circuit Board (PCB)



Magnet in front of the case and PCB

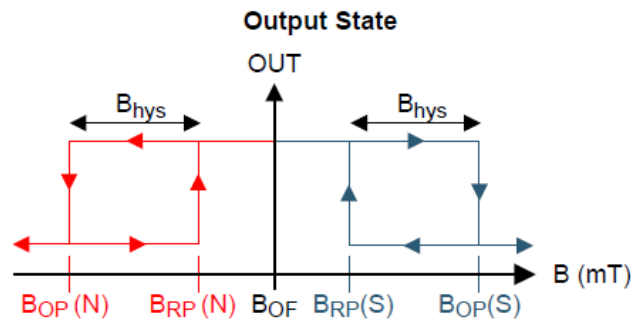
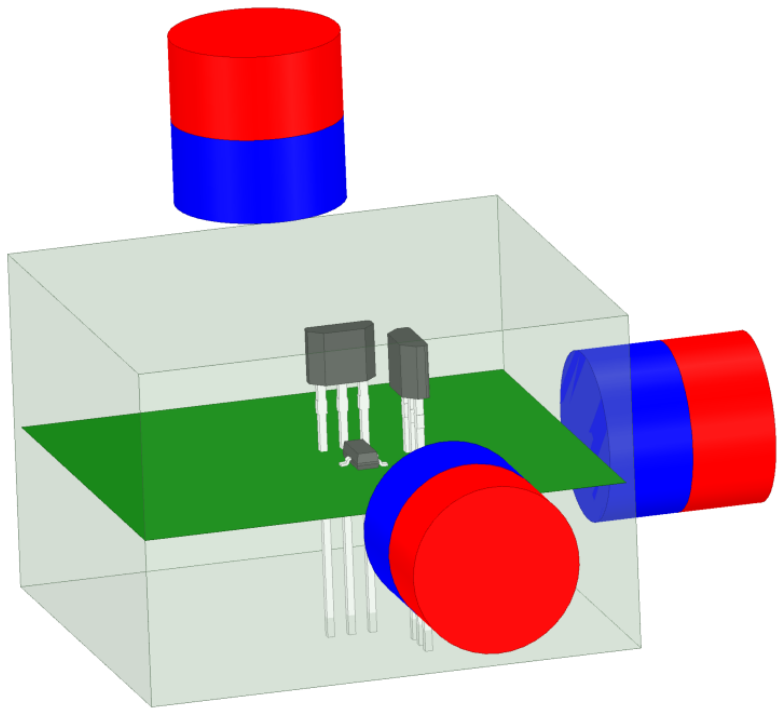


Magnet to the right of case and PCB

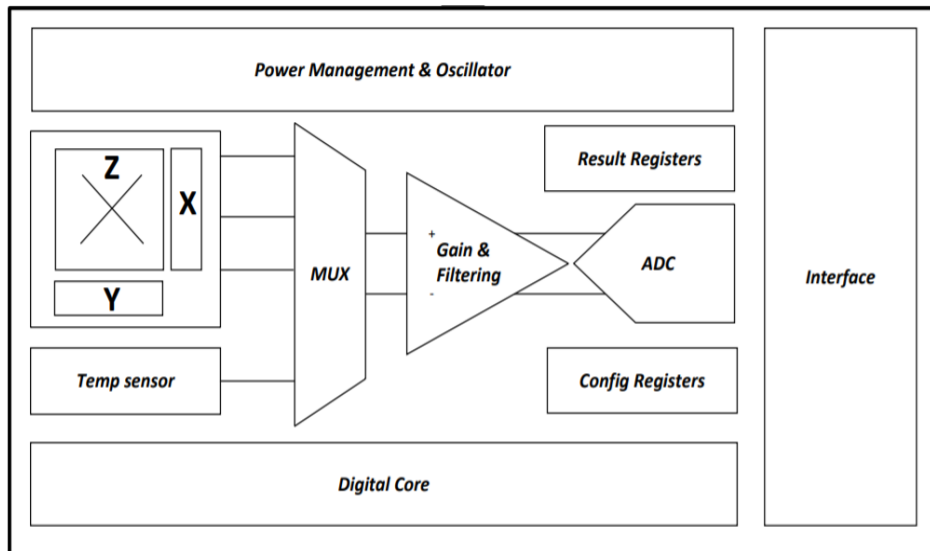
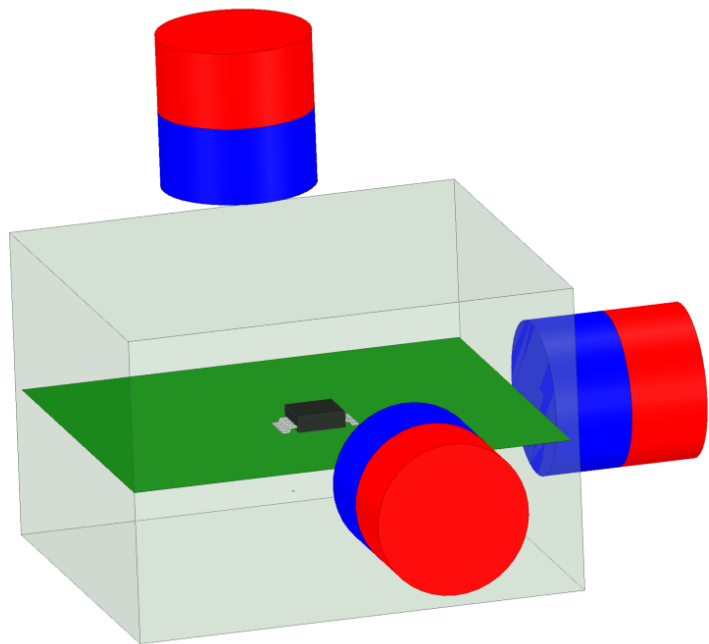


Hall sensors are not as fragile as reed switches, making them easier to assemble.

3D tamper detection using out-of-plane 1D sensors



3D tamper detection using one 3D Hall sensor



Only one surface mount IC is needed to sense across all three dimensions when using a 3D Hall sensor.

Tamper detection demo with 3D linear Hall sensors



Selecting the magnetic tampering threshold



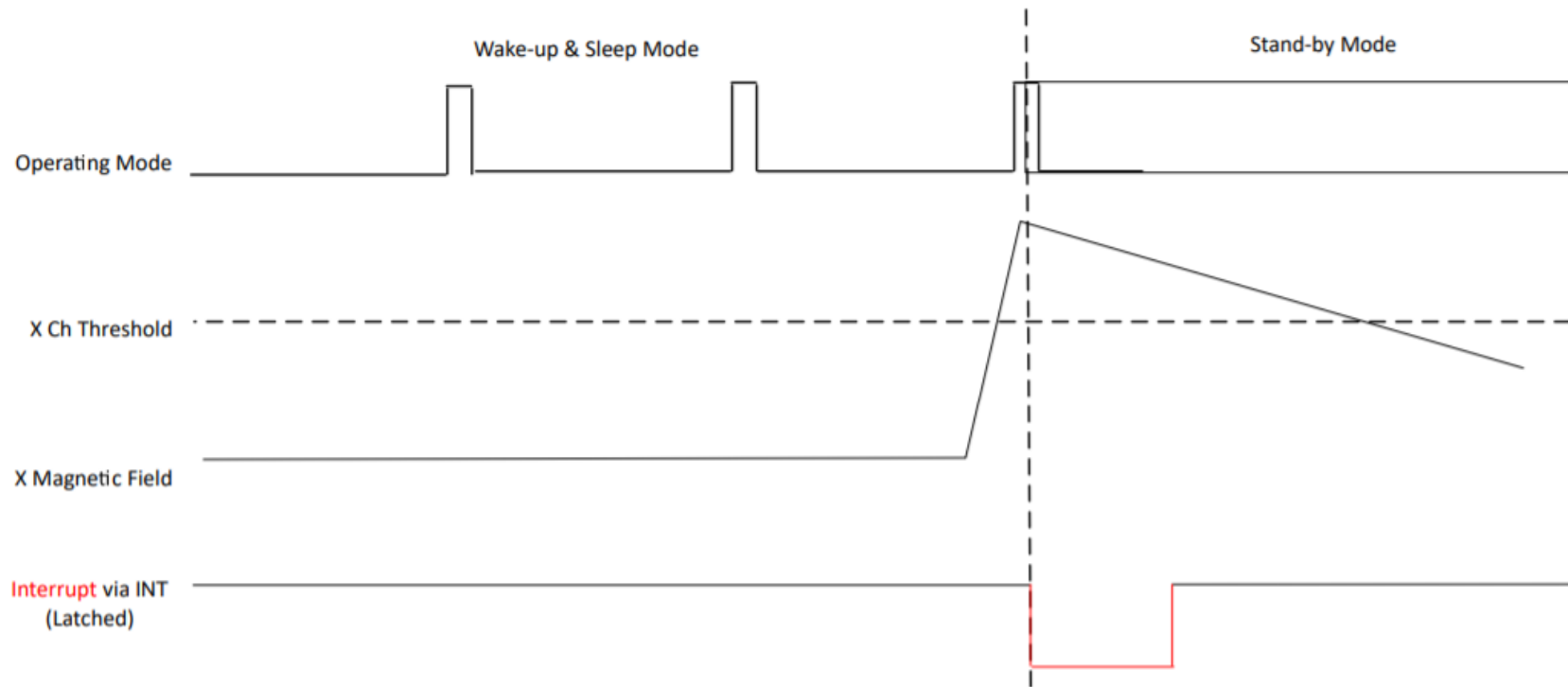
3D linear Hall sensors allow for the customization of the magnetic tampering threshold based on the desired magnet and dimensions of the meter case.

3D linear Hall sensor power modes

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
I_{ACTIVE}	Active mode current	X, Y, Z, or thermal sensor active conversion, LP_LN =0b		2.3		mA
$I_{STANDBY}$	Stand-by mode current	Device in trigger mode, no conversion started		0.45		mA
I_{SLEEP}	Sleep mode current			5		nA
AVERAGE POWER DURING DUTY-CYCLE MODE						
$I_{CC_DCM_1000_4}$	Duty-cycle mode current consumption	Wake-up interval 1-ms, 4-ch conversion, LP_LN =0b, V_{CC} =3.3V		227		μ A
$I_{CC_DCM_0p2_4}$	Duty-cycle mode current consumption	Wake-up interval 1000-ms, 4-ch conversion, LP_LN =0b, V_{CC} =3.3V		1.25		μ A

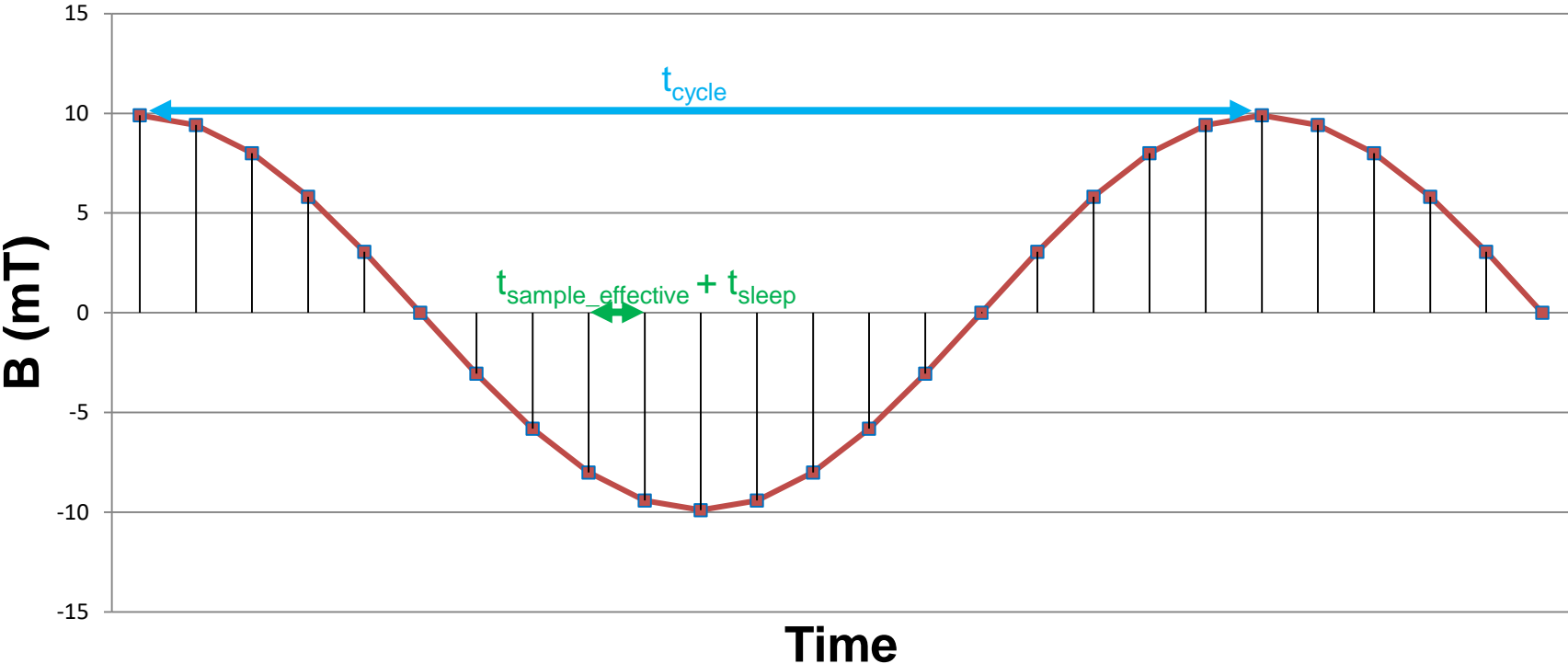
3D Linear Hall sensors support changing between multiple power modes, as needed

Interrupts on dedicated interrupt pin



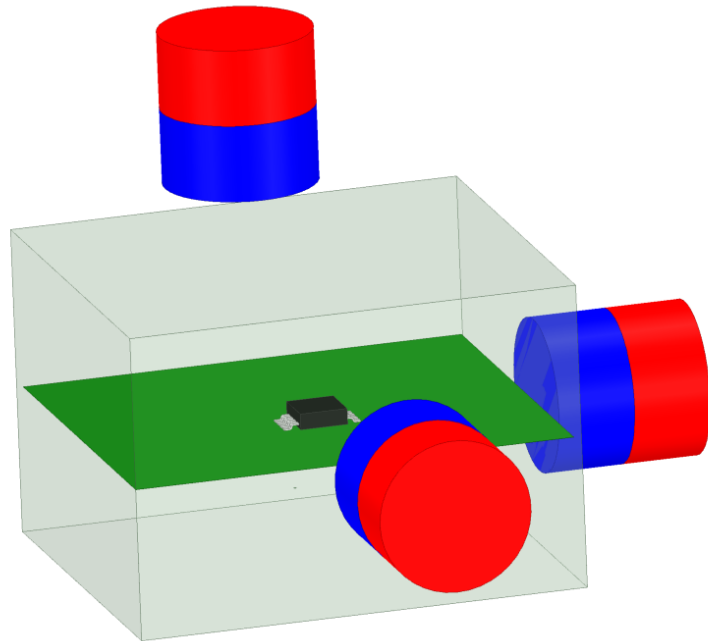
3D Hall sensors with magnetic interrupt capabilities enable the microcontroller to go to sleep mode

Detection of alternating-current (AC) magnets



3D linear Hall-effect sensors advantages

- Ease of assembly
- Only one surface mount IC needed
- Flexibility for defining magnetic tampering threshold
- Ability to change between multiple device power modes
- Interrupts when magnetic tampering is detected (depending on the device)
- Detection of AC magnets



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