

# *Mag*IC

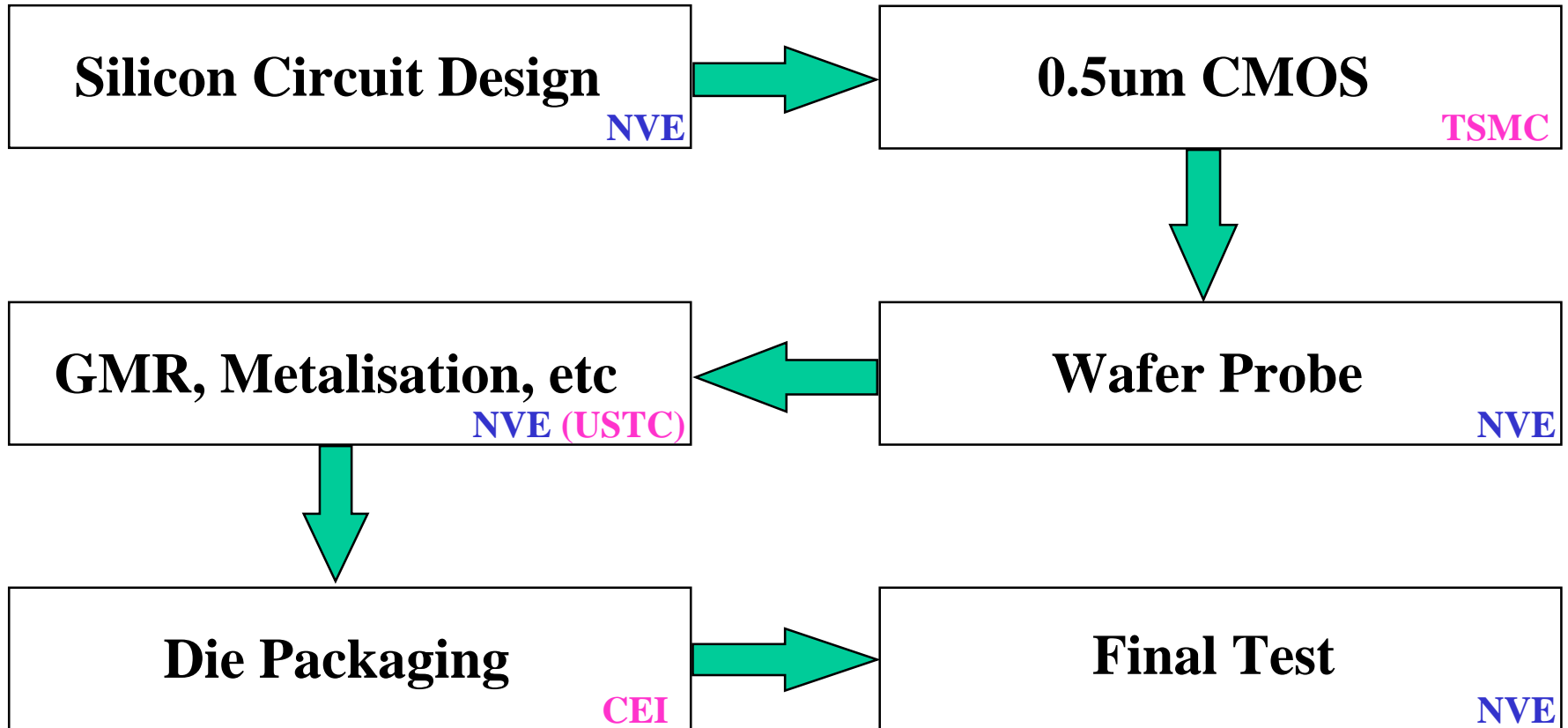
*Mag*netic And Silicon Materials  
On One *I*ntegrated *C*ircuit

# **NVE** is The World Leader In **MagIC™**

- **NVE Leads GMR** Technology/Applications
  - 11 years Experience (Since Founding in 1989)
  - Over \$30M Development
    - Competitive Government Contracts - \$20M
    - Commercial Customers - \$4.6M
    - Private Investment - \$4.5M
  - 32 Patents Issued, Pending, Or Licensed
- **World's First** GMR Products (1995)
- **World's First** GMR **MagIC™** Product (1997)
- ISO 9001 qualified

- **Sensors - NVE Established Products**
  - 20,000 units per month (1999)
  - Wheel Speed and Position (Platform qualified for ABS)
  - Electric Current
- **Isolators - NVE New Products**
  - Communications
  - Industrial Controls
- **Nonvolatile Memory - NVE Next Generation**
  - Data Security without Power
  - Magnetoresistive Random Access Memory (MRAM)

# Isolator: Design to Test

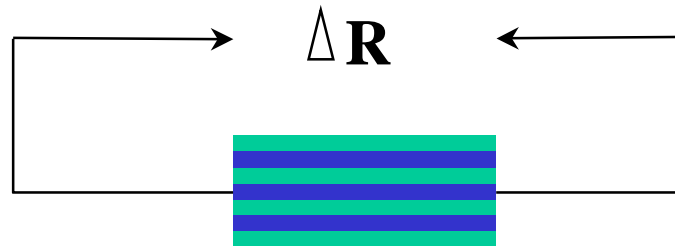


# GMR

$\sim 8 \times 10^{-9} \text{m}$

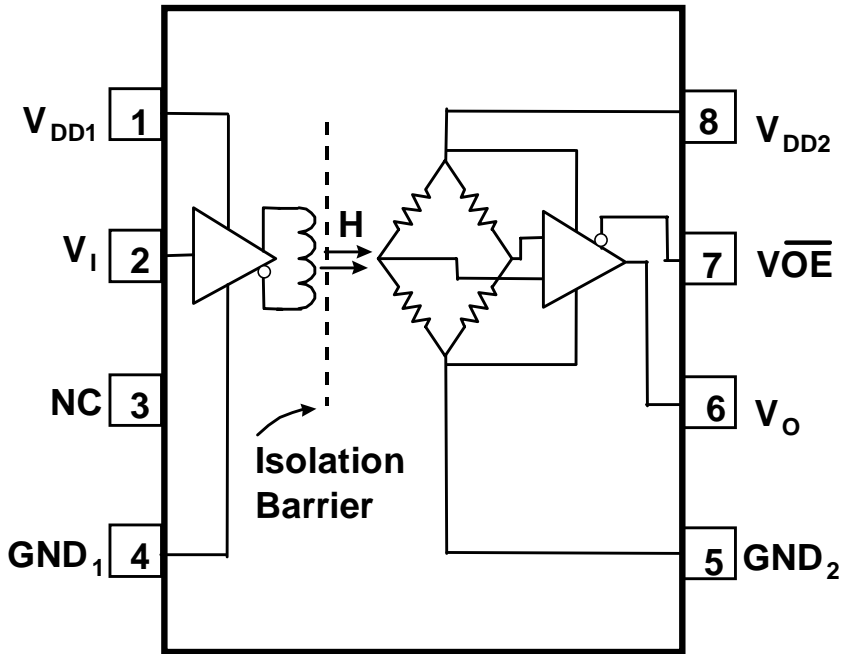


**Metallic Thin Films:  
Magnetic / Non-Magnetic**



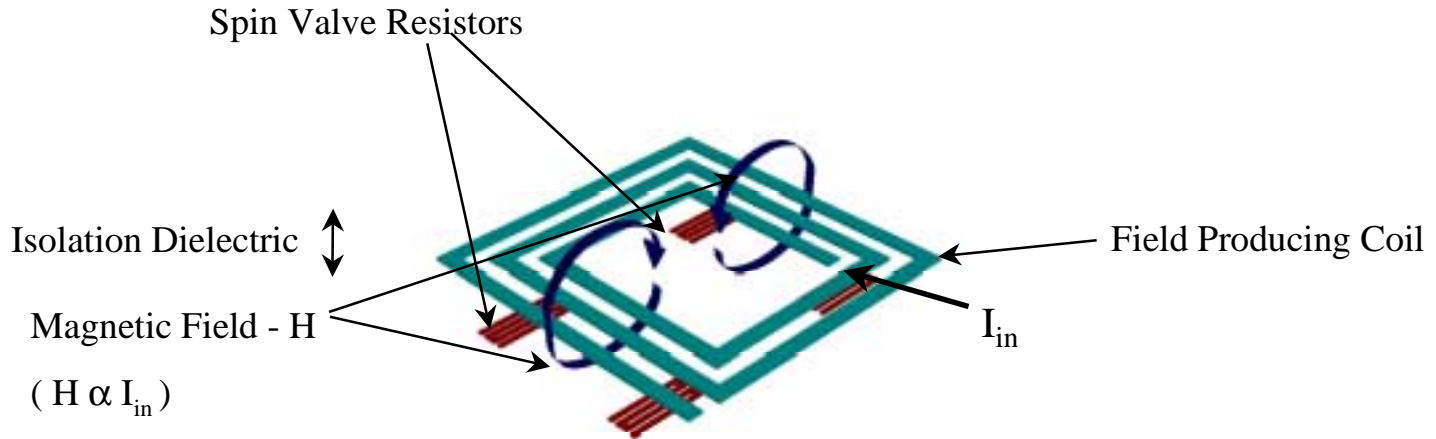
**IL710**

**HIGH SPEED DIGITAL ISOLATOR**

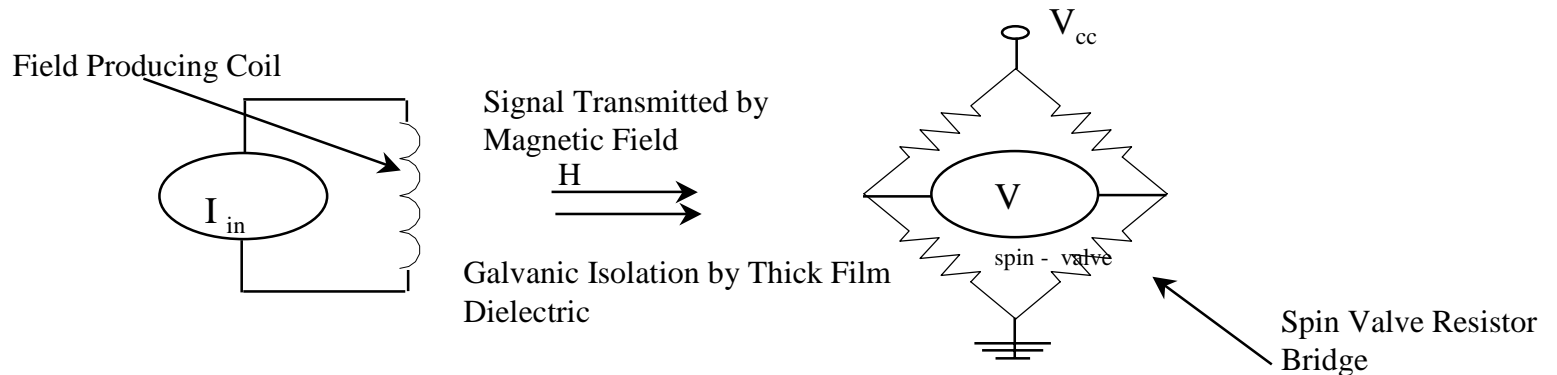


TRUTH TABLE		
$V_{IN}$	$\overline{OE}$	$V_O$
L	L	L
H	L	H
L	H	Z
H	H	Z

## Memory Mode Digital Spin Valve Isolator Structure

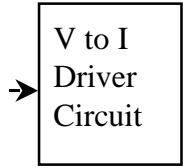
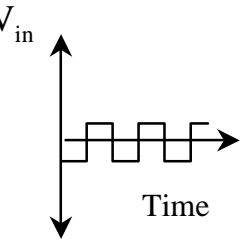


## Memory Mode Digital Spin Valve Isolator Schematic

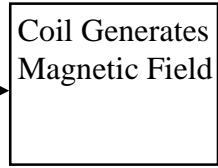
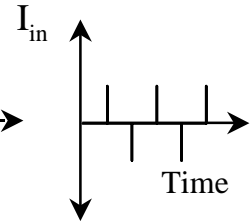


# GMR Isolator Transfer Function

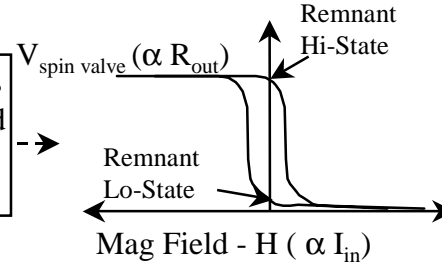
*Input Voltage Signal*



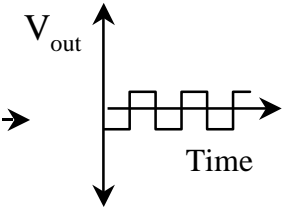
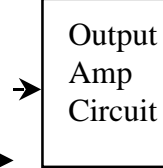
*Coil Current Signal*



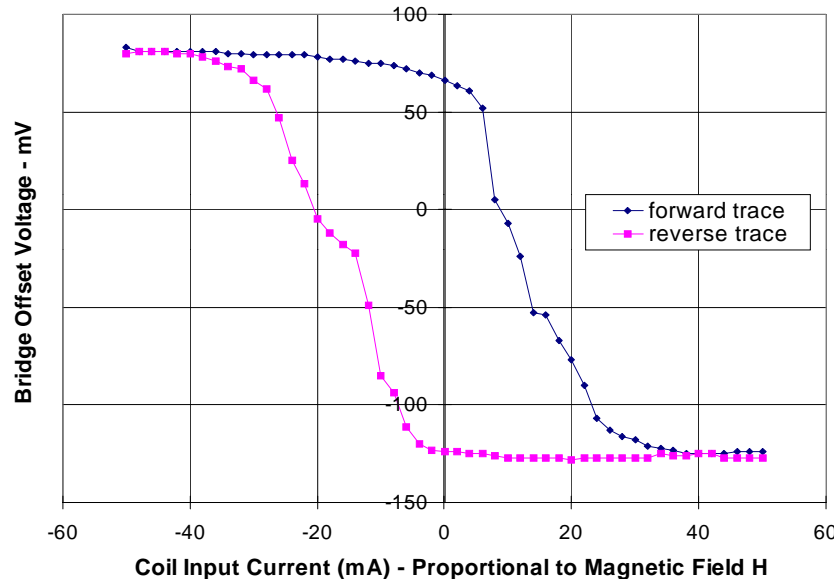
*Spin Valve Response*



*Isolated Output Voltage*



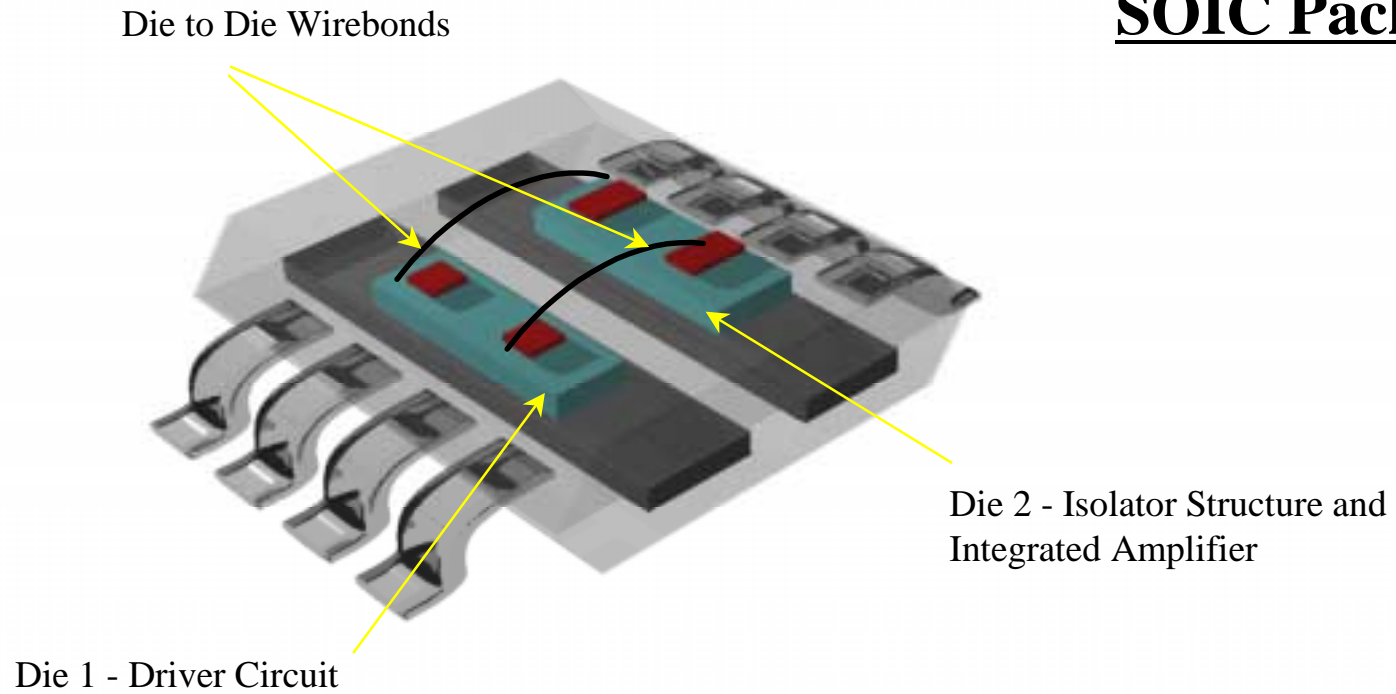
Schematic of Memory Mode Spin Valve Digital Signal Isolator



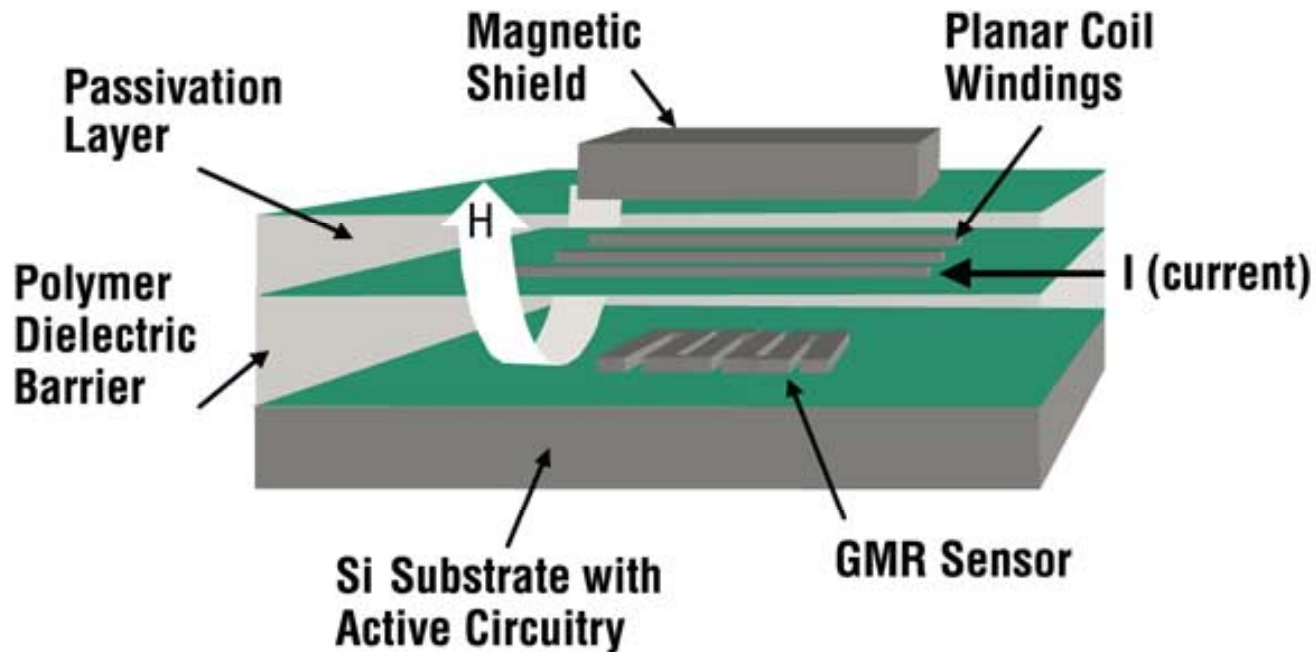
Magnetoresistance Response of Actual Patterned Spin Valve Isolator Structure

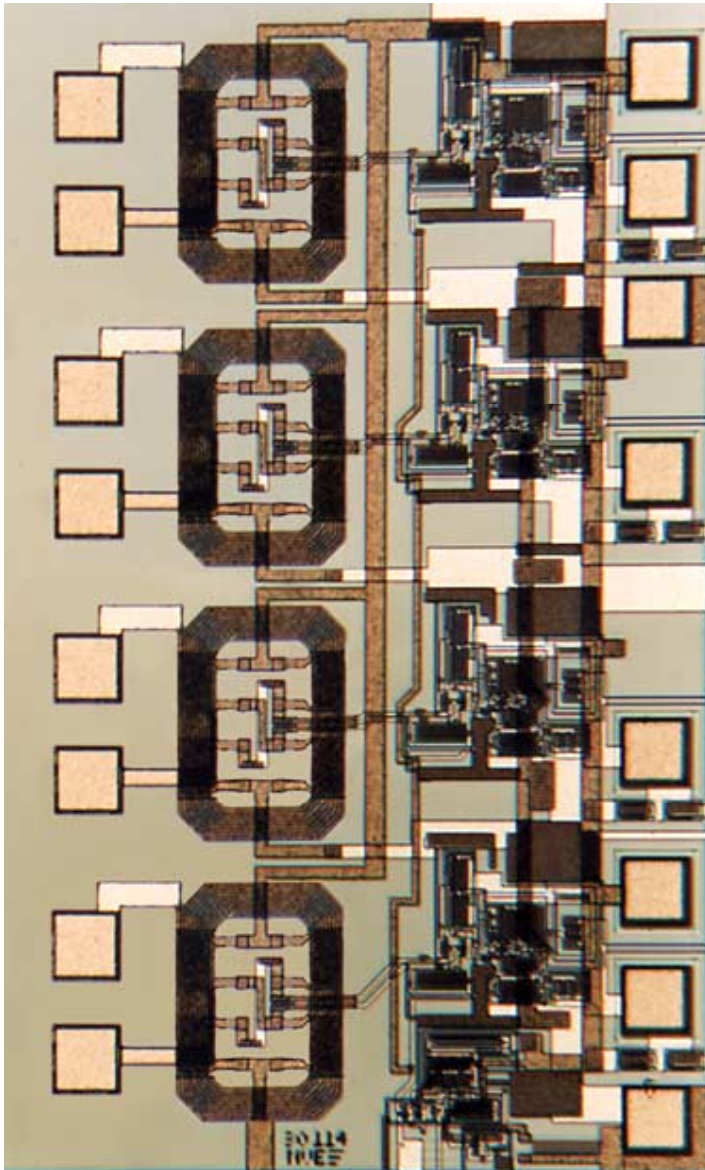


## SOIC Package



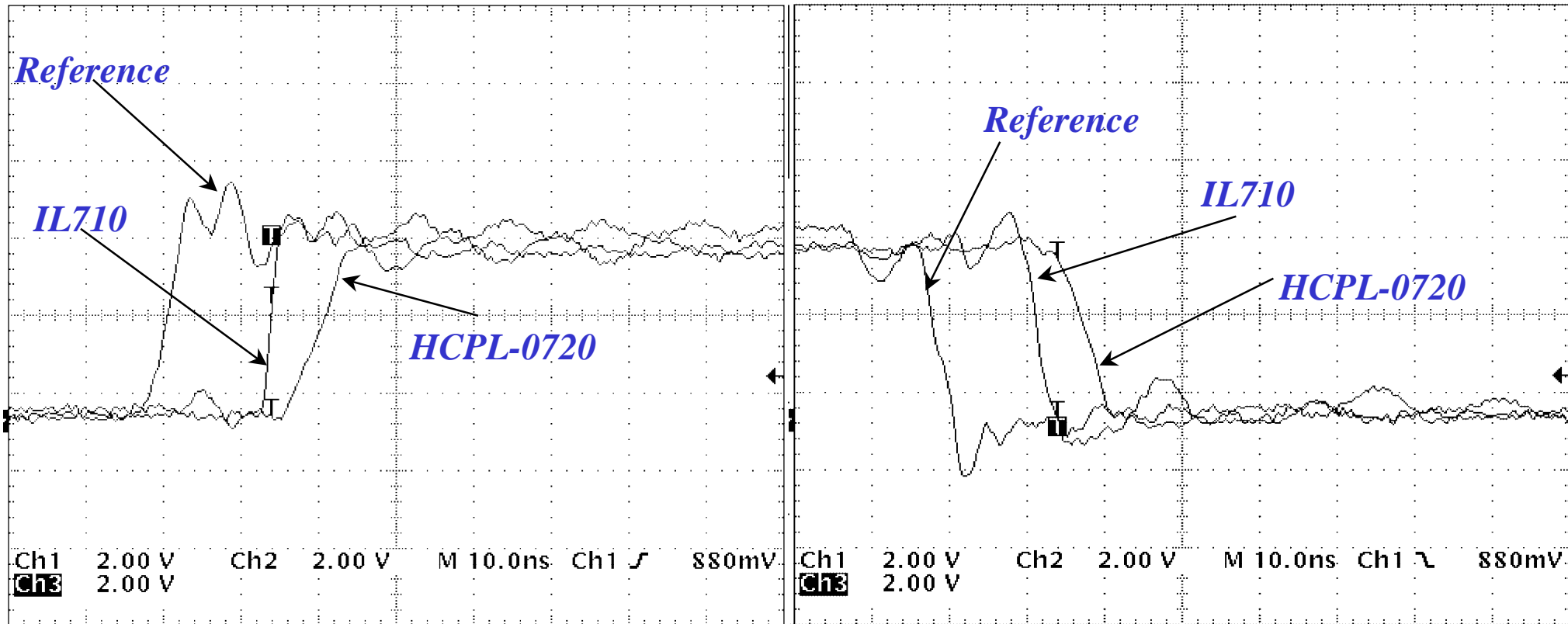
# Magnetic Isolator - Schematic



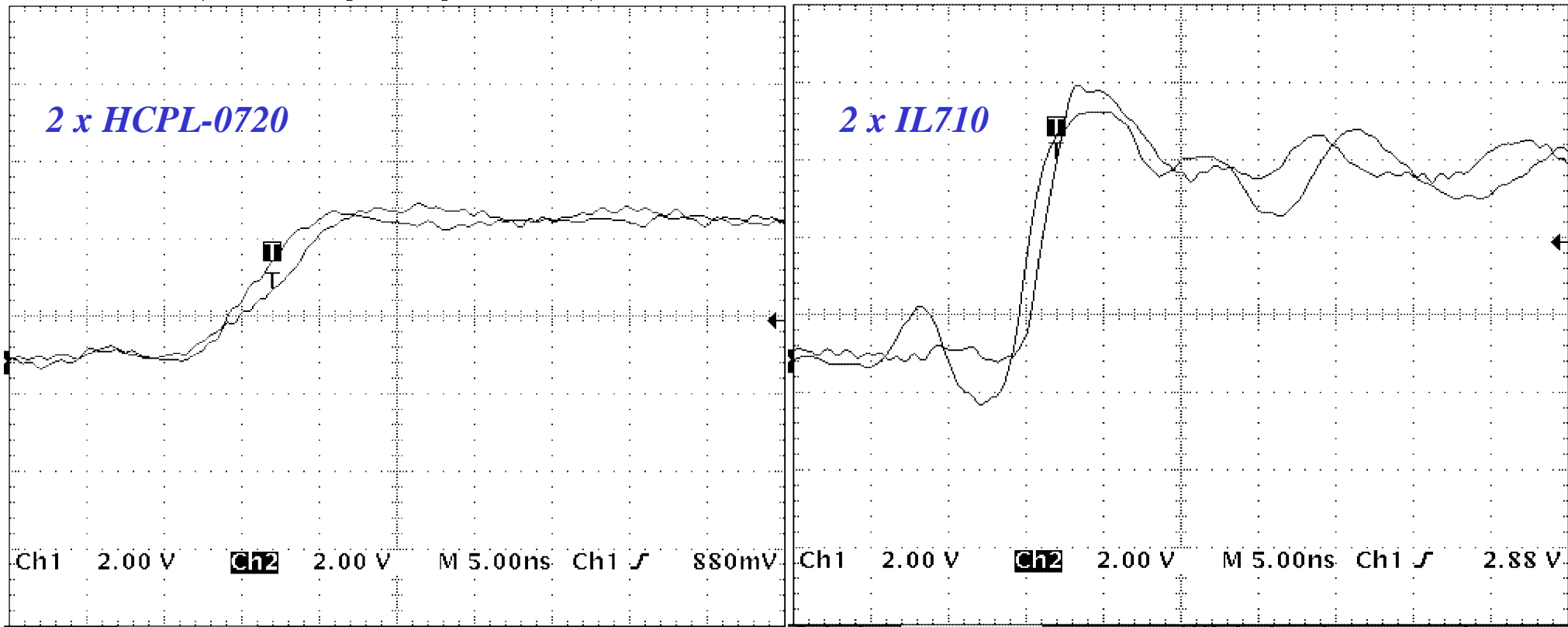


**Die Photograph**  
**4-channel Isolator**  
**Size: 1.1mm x 1.9mm**

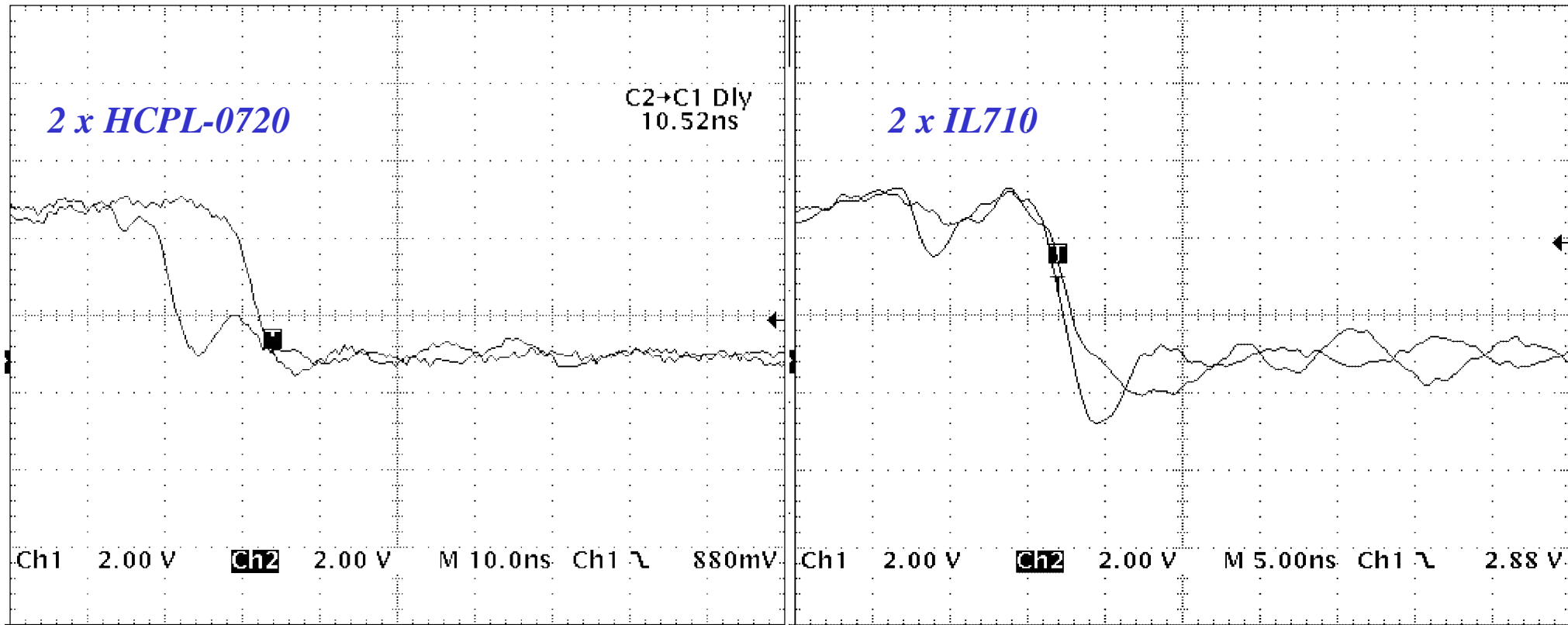
## Propagation Delay



## Positive Edge Skew



## Negative Edge Skew



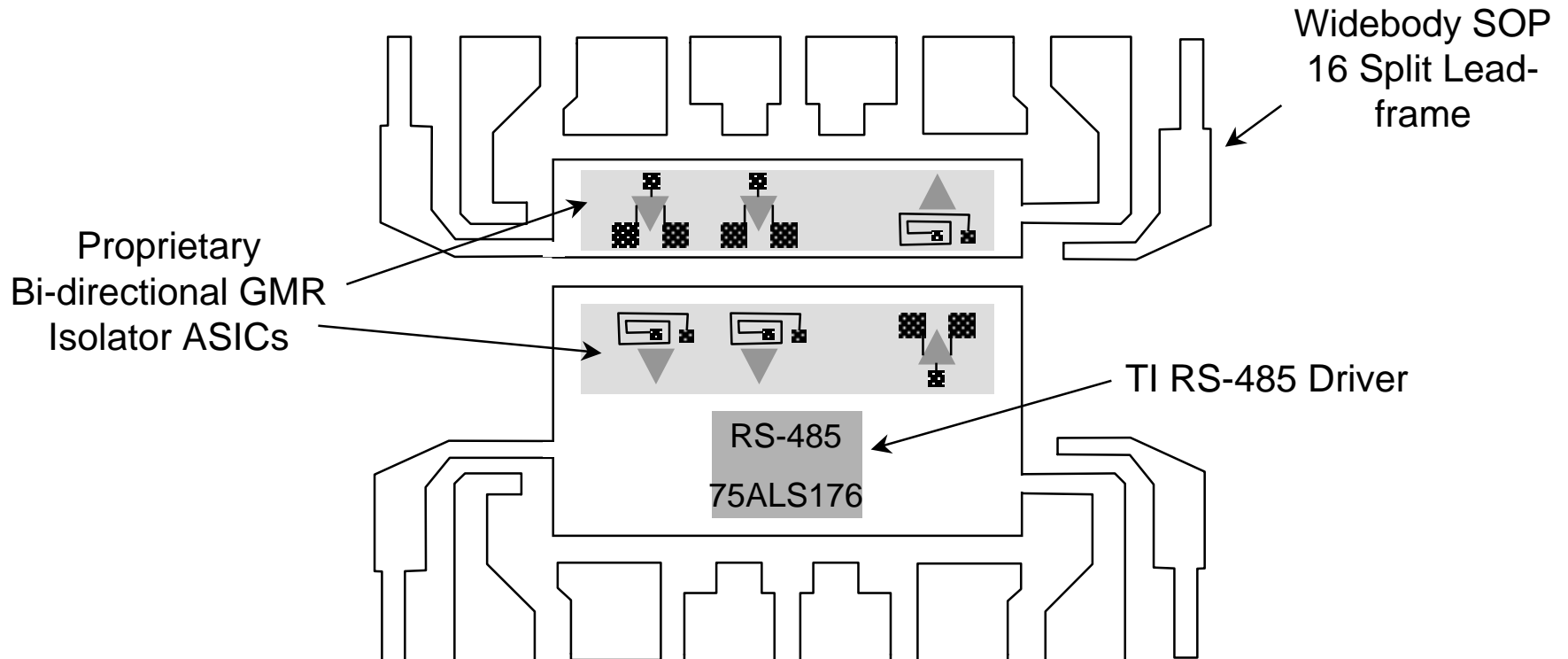
## No More *Speed* Problems



- *4 x Speed*
- *2 x Transient Immunity*
- *1/4 PWD*
- *1/4 Prop Delay*
- *1/5 Skew*

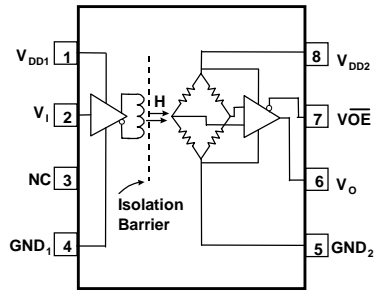
# GMR Isolated RS 485 Module

- 16 Pin SOP Wide Body Package
- Proprietary Bi-directional GMR Isolator ASIC
- TI 75ALS176 RS-485 Transceiver

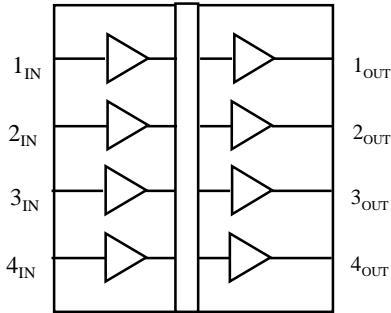




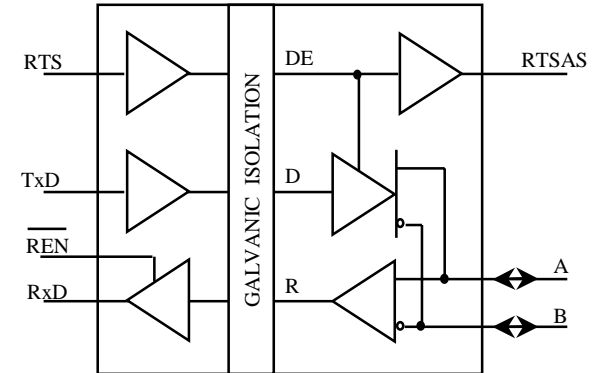
# First New Products



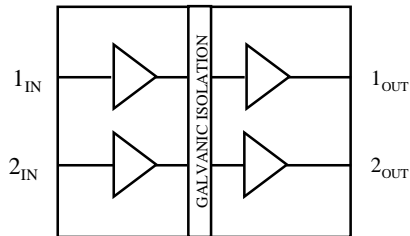
**IL710**



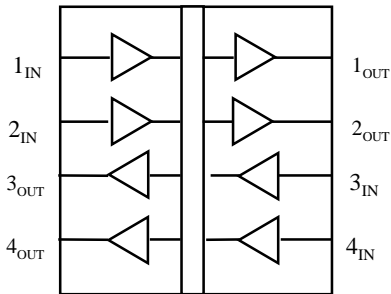
**IL715**



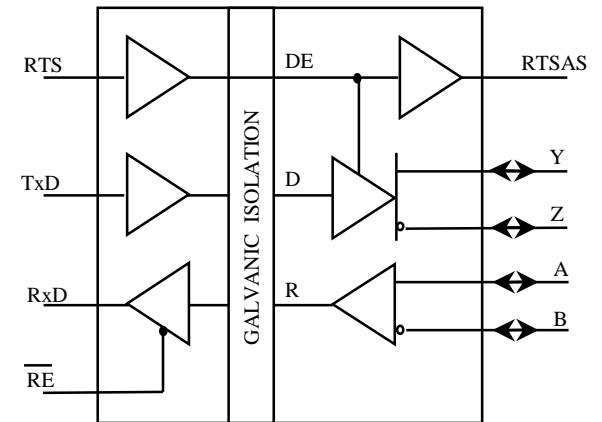
**IL485**



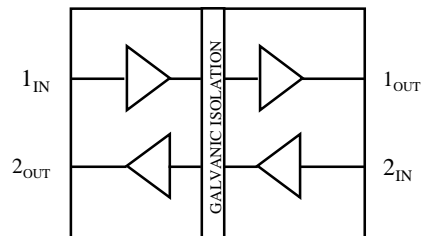
**IL711**



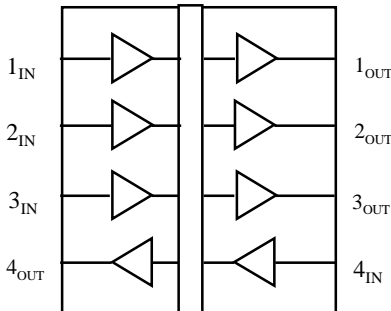
**IL716**



**IL422**



**IL712**

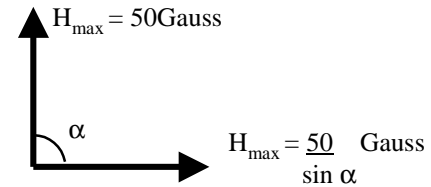
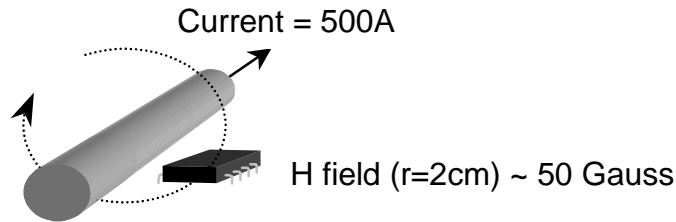


**IL717**

# External Magnetic Field Sensitivity

- Tolerant to 50 Gauss normal to plane of device
- Design improvements have increased it to ~ 100 Gauss
- Field produced by current is not be a problem
- Equation is as follow:

$$H \approx \frac{I \sin \alpha}{2\pi R * 0.8} \quad (\text{Where } I \text{ is amps, } R \text{ is cm \& } H \text{ is Gauss})$$



- Current Draw (amps)

500  
10

- Safe Separation Distance

2.0 cm.  
0.4 mm