
SEVENTEENTH ANNUAL
BiTS
Burn-in & Test Strategies Workshop
March 6 - 9, 2016
Hilton Phoenix / Mesa Hotel
Mesa, Arizona
Archive- Session 6
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BiTS 2016 Burn-in & Test Strategies Workshop

Session 6

Jason Mroczkowski

Session Chair

BiTS Workshop 2016 Schedule

Performance Day

Tuesday March 8 - 1:30 pm

Cell-ebrating Test

"Vision Assist Method for Common Change Kit"

Brad Emberger, Zain Abadin – Advantest

"Test Cell Thermal Solution"

Gianluca Lombardi - Advantest

"Testing Magnetic Sensors"

Paul Ruo - Aries Electronics, Inc.

Larre Nelson - Kita USA

"Magnetically shielded test-cell for an integrated fluxgate sensor"

Gert Haensel - Texas Instruments

Loren Hillukka - Johnstech International Ltd.

BiTS 2016 Burn-in & Test Strategies Workshop

Testing Magnetic Sensors

Larre Nelson
Kita USA

Paul Ruo
Aries Electronics

2016 BiTS Workshop
March 6-9, 2016

Contents

- Magnetism 101
- Magnetic sensors through the ages
- MEMS magnetometer
- Test socket materials
- Contact materials
- Manual test sockets for magnetic sensors
- Automated system for testing magnetic sensors

Magnetism 101

Magnetism

Ferromagnetism & Domains

Magnetic Fields

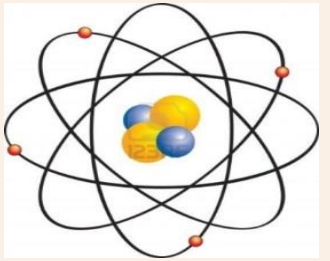
Magnetic Permeability

Soft magnets

Magnetism 101

What causes magnetism ?

Moving or spinning electrons
Unbalanced spins of electrons



Ferro-magnetism

Strongest type of magnetism
4 elements (Fe, Ni, Co, Gd)
Some naturally-occurring minerals (Fe_3O_4)
Some man-made compounds of rare-earth minerals

Domains

Ferromagnetic materials spontaneously self-align into small uniformly magnetic regions. But the magnetic orientation of each region is random. Under the influence of an external magnetic field, the domains become uniformly oriented and give the material a strong magnetic signature.

Magnetism 101

Magnetic Fields

Field strength (H)	ørsted		
Flux density (B)	gauss		
	tesla		
Examples:	MRI instrument	70,000	gauss
	Rare earth magnet	10,000	gauss
	Refrigerator magnet	50	gauss
	Earth's magnetic field	0.5	gauss

Magnetism 101

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Magnetism 101

Permeability (μ) Ability to create and maintain a magnetic field

Relative permeability (μ/μ_0) – compared to a vacuum

μ/μ_0 Examples:	
Air, Teflon, Cu, Al, Au, Pd	1
Austenitic stainless steel	1
Tungsten	7
Martensitic stainless steel	50 - 900
Tool steel	100
Nickel	600
Ferritic stainless steel	1,000 – 1,800
Iron	5,000

Magnetism 101

Soft Magnets The domains can quickly align, and quickly go back to an unaligned orientation in response to an external magnetic field.

Used in: Transformers
Recording heads
Magnetic shielding
Magnetometers

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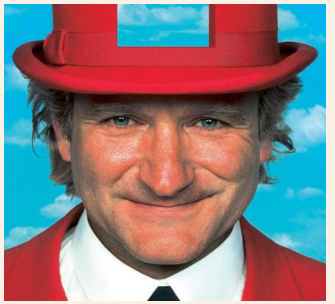
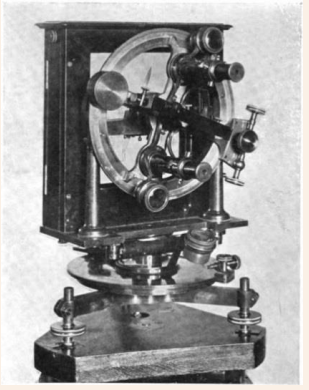
Just Like Robin Williams



Magnetic Sensors through the Ages

1000s	Loadstones (Fe_3O_4) used as a compass
1800s	First use of magnetometers for iron ore exploration
1900s	Hall-effect sensors used in computer keyboards
2000s	Cell phones and wearables



Magnetometer from 1890

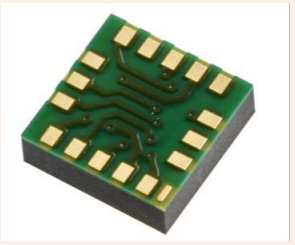
Hall Effect Sensor

Wearables

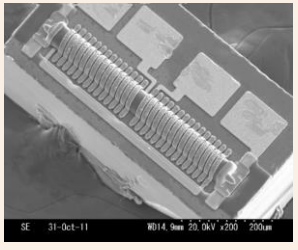
MEMS magnetometer

MEMS devices

Small and low cost
Very sensitive (0.1 gauss)
2 billion will be shipped in 2016



Kionix KMX62
3mm x 3mm, 16 pads, 0.5mm pitch
Combined magnetometer & accelerometer



A high frequency pulse is sent down a soft magnet core (Fe & Co alloy), inducing a voltage in surrounding sense coils. The measured voltage in the coils is conditioned by the presence of a nearby magnetic field.

Test Socket Materials

	Magnetic	Non-magnetic
Plungers	Steel	BeCu, Palladium alloys
Barrels	Nickel	Copper alloys (Brass, Bronze)
Springs	Music Wire (steel alloy)	BeCu
	Tungsten	Bronze
	Stainless Steel	Stainless Steel
Stampings	Stainless Steel	BeCu
Plating	Nickel	Nickel
		Gold, Pd, and PdCo
Elastomers	Using Ni or Fe particles	Using Ag particles
Socket bodies	Stainless Steel	Stainless Steel
	Music Wire (steel alloy)	Aluminum, Plastics, Air

Nickel and Stainless Steel

	Magnetic	Non-magnetic
Nickel	Pure nickel	Most nickel alloys
	Electroless Ni plating (low P)	Electroless Ni plating (high P)
	Electrolytic Ni plating	
Stainless Steel	Work-hardened Austenitic	Austenitic - not work-hardened
	Martensitic (400 series)	Special blends (NAS 604PH)
	Ferritic	

Nickel and Magnetism

Are nickels (and other coins) magnetic ?

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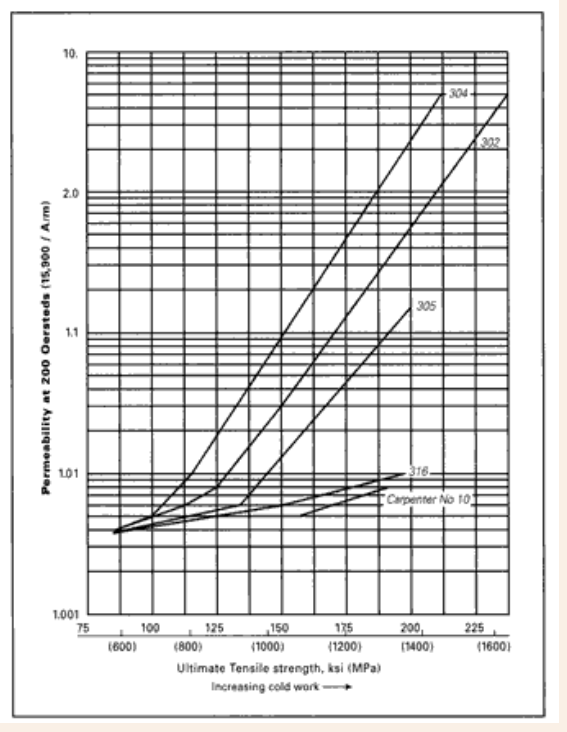
Stainless Steel and Magnetism

The magnetic permeability of austenitic stainless steels increases when cold worked. (Measured at 200 ørsted.)

The cold working scale on the horizontal axis can also be expressed in units of ultimate tensile strength.

Examples of cold working:

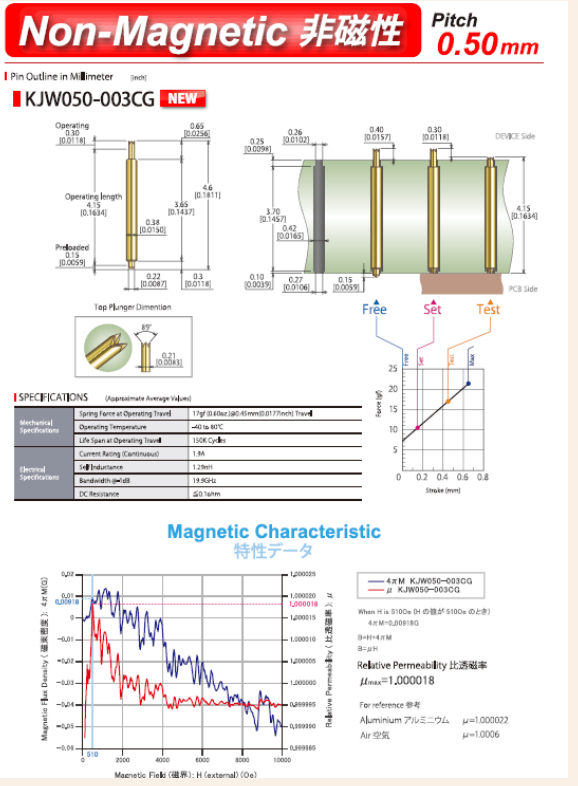
Fabrication to get a high tensile strength
Fabrication of a compression spring
Stamping and bending



Typical UTS (spring wire) ↑

Contact Materials (Spring Pins)

Plungers	BeCu Palladium Alloys
Barrels	Copper alloys 18K Au alloy
Springs	BeCu NAS 604PH
Plating	No nickel Au (hardened with Co) Palladium
Permeability	Target (μ/μ_0) = 1.0

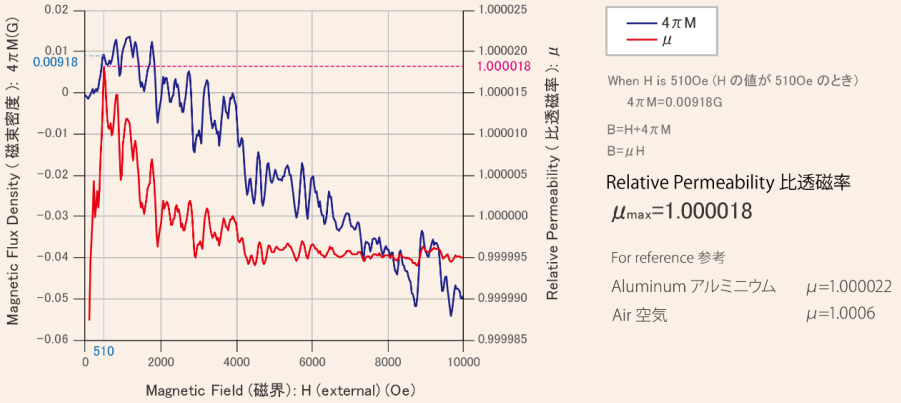


Contact Materials (Spring Pin)

Relative permeability and pin-related flux density of a non-magnetic spring pin in response to an external magnetic field:

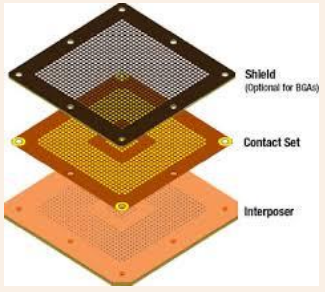
External Field:	0 – 10,000 ørsted
Flux density of pin:	+0.015 to -0.050 gauss
Relative permeability of pin:	1.000018 Max (at 510 ørsted)

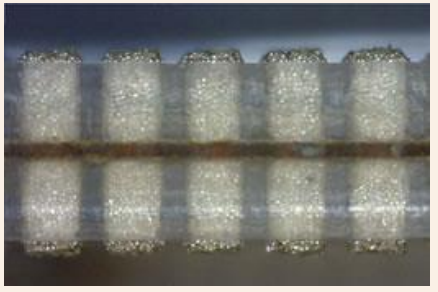
Magnetic Characteristic
特性データ

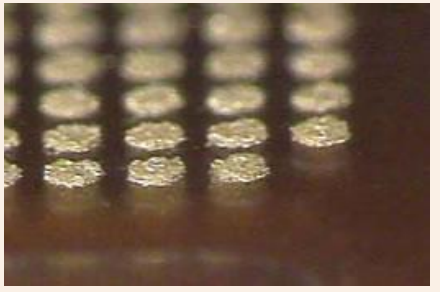


Contact Materials (Elastomers)

Some elastomers are constructed with non-magnetic materials. Elastomers use silicone or silicone/polyimide based materials as their primary media. The contacts are made from non-magnetic silver (Ag).

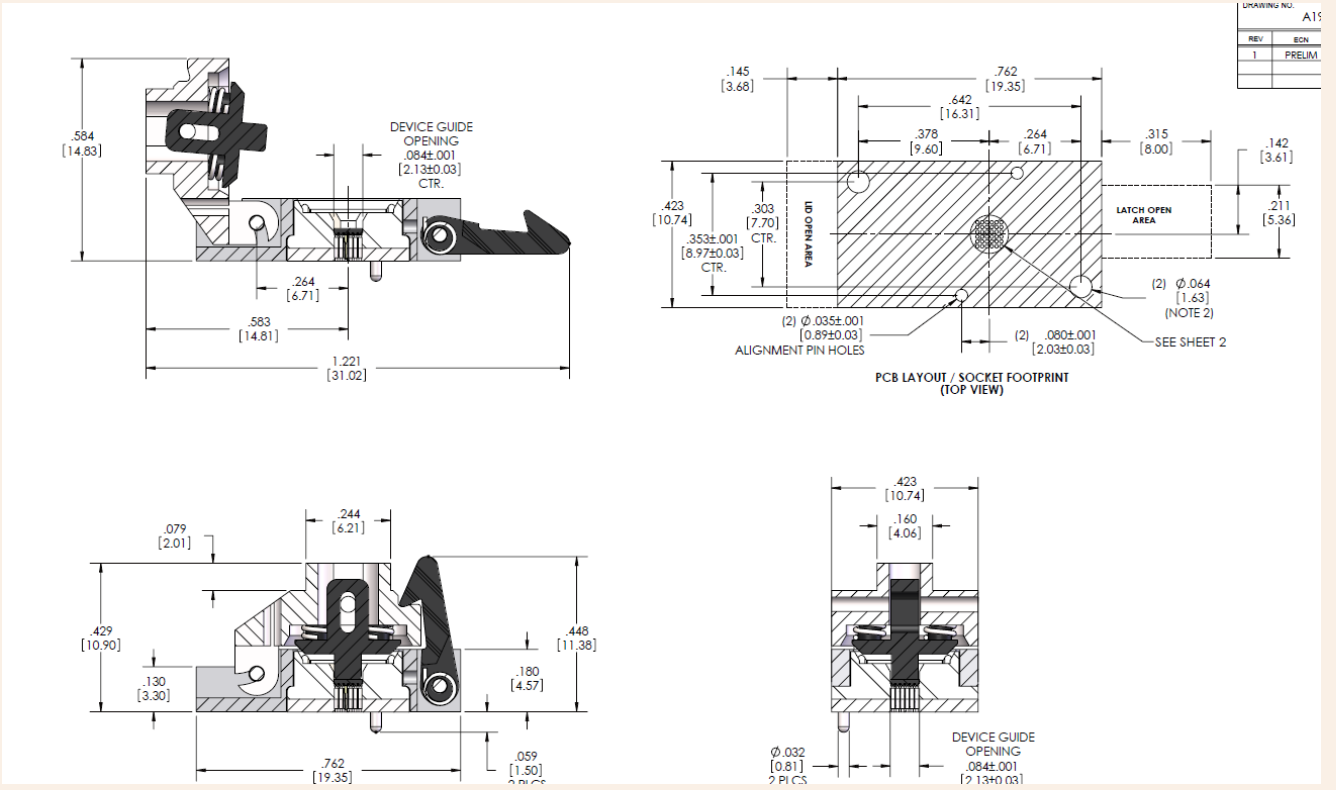






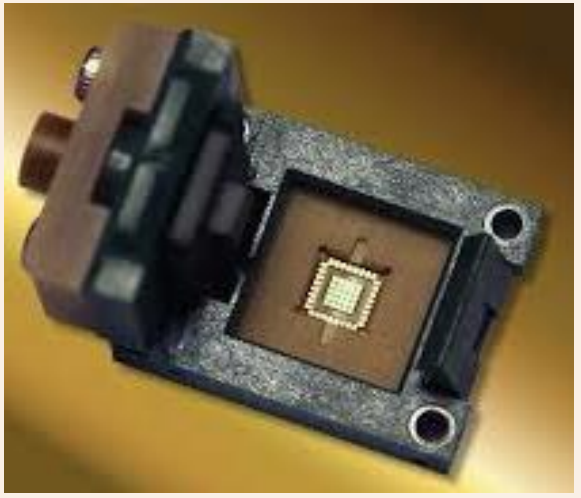
Elastomer Column Array

Manual Test Sockets

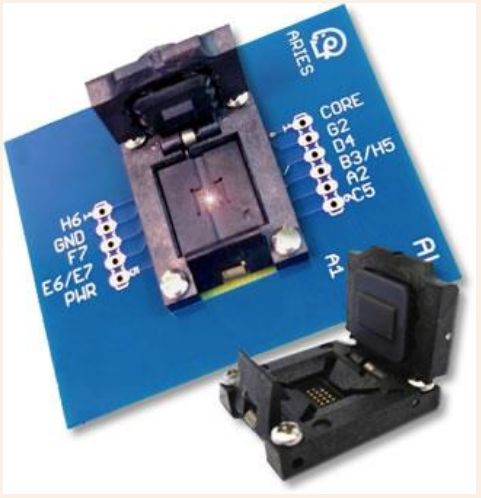


Manual Test Sockets

Non-Magnetic socket with silicone elastomer and Kapton hardware

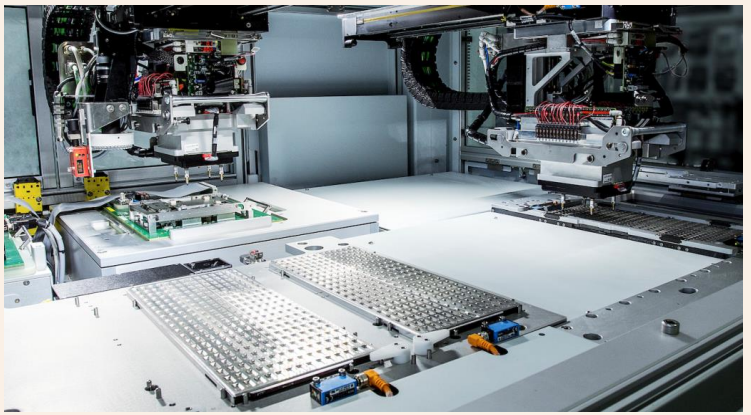


Non-magnetic socket with spring probes and standard hardware



Automated Test System

Tester and handler for magnetometer and accelerometer



Multi-cavity socket

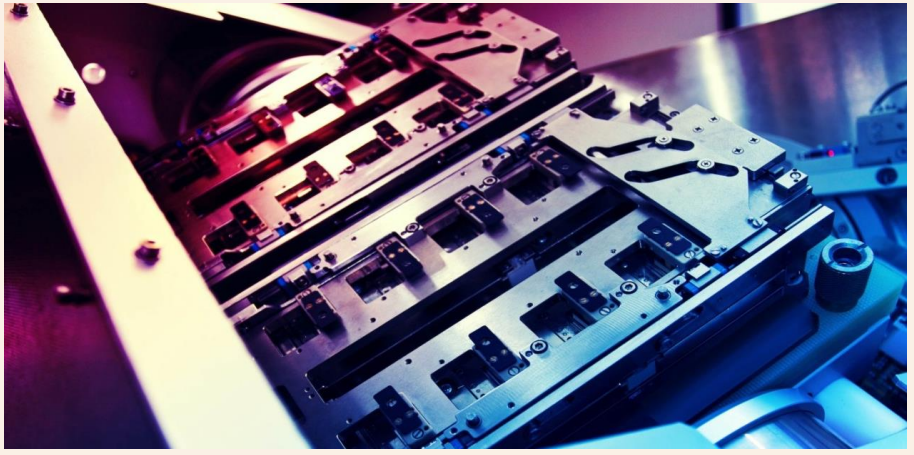
Multi-cavity

Handler-friendly

Capable of clamping in device when subjected to G forces

Relative permeability = 1.0

Magnetic coils included to introduce known magnetic fields



Summary

Testing magnetic sensors is a growth opportunity for test professionals and test equipment companies.

Testing any kind of sensor will challenge you to learn something new.

Magnetic sensors can be tested with conventional methods if you use the right materials.

BITS 2017: testing other kinds of sensors ?

Acknowledgements

Kita Japan Masanori Fujimoto

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