“Passive Micro Sensors: When Power is Not an Option”

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HT Micro, Inc.

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Outline

Reliable Passive Microsensors

- Why?
- Issues
- Examples
- Manufacturing / Test
- Applications

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Why?

Applications where No Power is available

or desired

Why?

Force Sensing

flexure thickness	area	force sensitivity	power	technology
25 μm	~ 0.5 cm^2	10 mN	5 mW	bulk Si piezoresistive
1 μm	~ 1 mm^2	1 μN	1 mW	SMM polySi piezoresistive
1 μm	~ 0.05 mm^2	0.1 nN	0.1 nW	SMM resonator optical
0.05 μm	< 0.01 mm^2	3 aN	0.1 mW	MRFM (NEMS)

"Ideal sensor does not perturb its environment"

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How?

A Micro Sensor which is also inherently an

Energy Harvester

(and will perturb its environment!)

How?

Microfabricated

Ohmic

Physical Sensor

Switch

Issues

- Size
- Cost
- Reliability
- Manufacturability
- Testability

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Issues

Prismatic Planar Processed

Micro Electromechanical Transducers

Energy → Volume

Cost → Area

Reliability → Force, Ambient

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Issues

$$FOM \sim \frac{F\eta}{\$A}$$

Issues / Examples

Integrated Magnetic Switch

$$FOM \sim \frac{B^2 h \eta}{\$}$$

Integrated Inertia Switch

$$FOM \sim \frac{\rho h \eta}{\$}$$

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Issues / Examples

Integrated Magnetic Switch		Integrated Inertia Switch
high μ_R, σ_Y, σ-n	material	high ρ, σ_Y, σ-n
high A.R.	geometry	high A.R.
hermetic, w.s.	package	hermetic, w.s.

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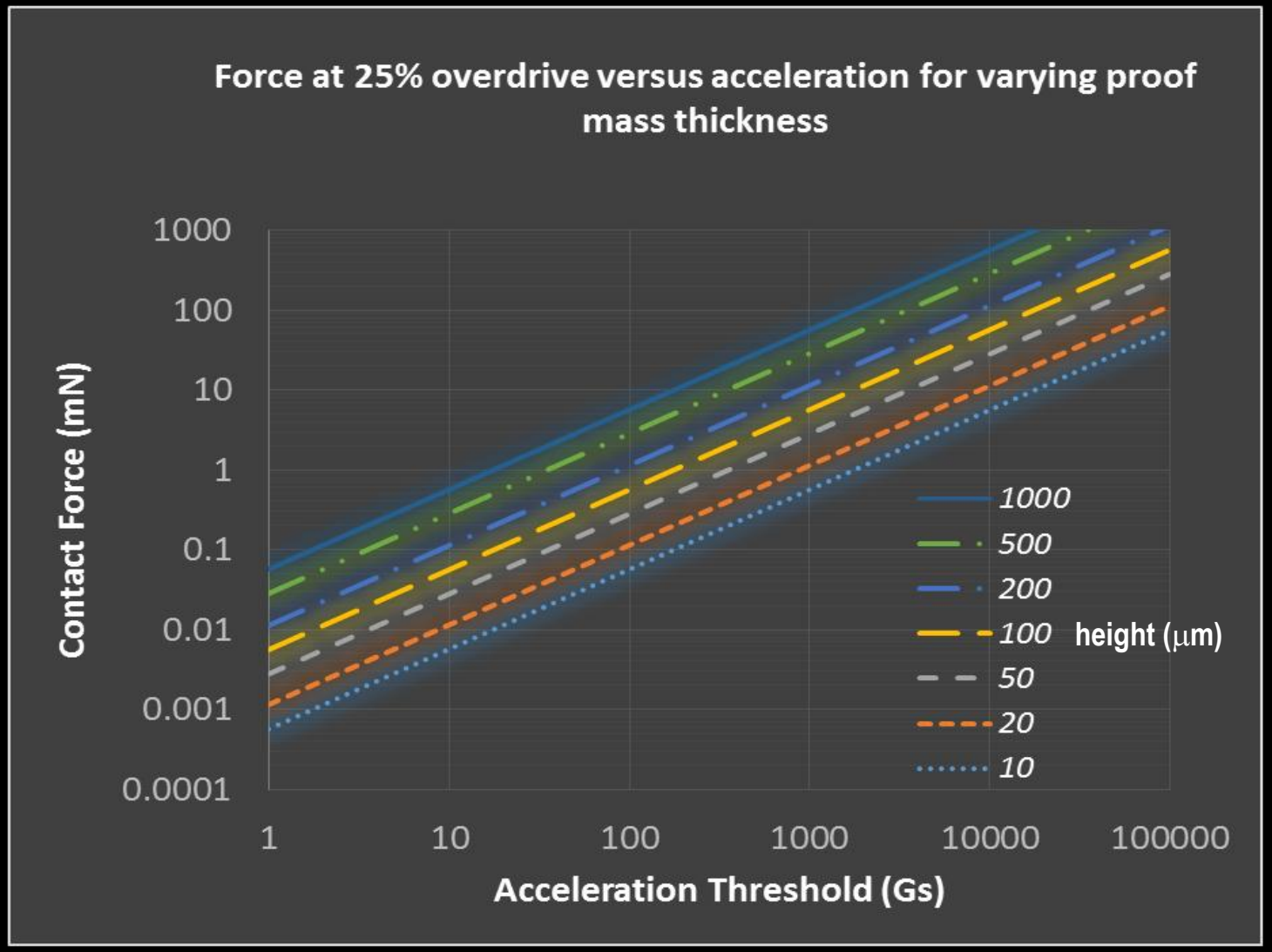
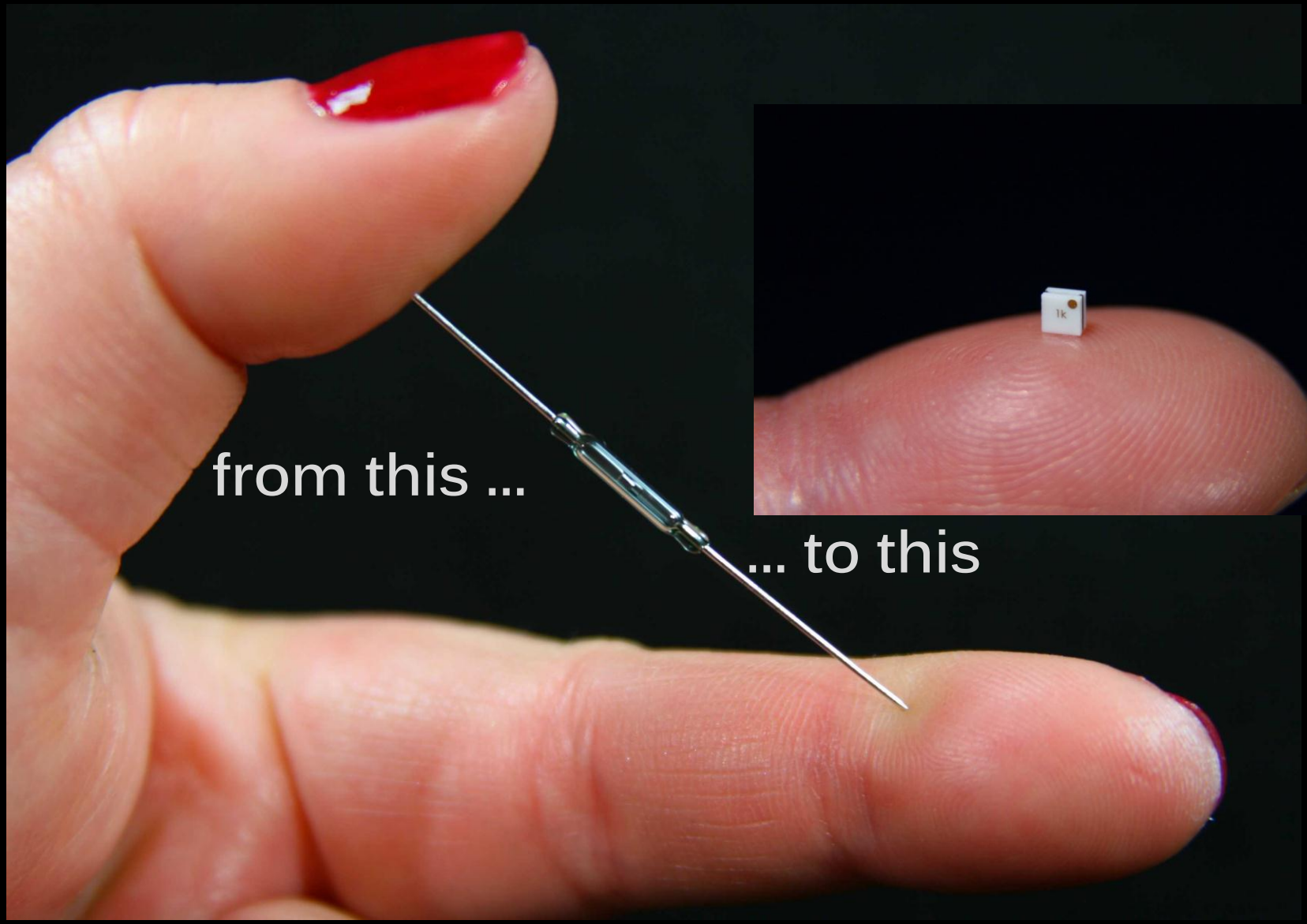
Issues


Force at 25% overdrive versus acceleration for varying proof mass thickness
Contact Force (mN)
1000
100
10
1
0.1
0.01
0.001
0.0001
1
10
100
1000
10000
100000
Acceleration Threshold (Gs)
1000
500
200
100
50
20
10
height (μm)

Examples



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Examples

Integrated Magnetic Switch

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Examples

Integrated magnetic switch:

- surface mount
- 1x2 mm area die
- >10M cycles
- hot switches 5V, 100mA

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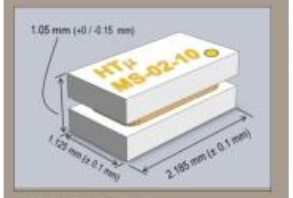
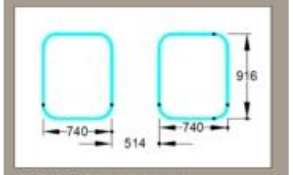
Micro Reed Switch
Form A
Model MS-02-10

FEATURES:
- World's Smallest Reed Switch – 2mm²
- Hot Switchable
- Surface Mount – Au over Ni pads
- Tape and Reel Packaging
- Hermetic Seal
- Zero Power Operation

APPLICATIONS:
- Proximity / Position Sensing
- Relays
- Pulse Counters
- More



MS-02-10 Device Dimensions



MS-02-10 Pad Dimensions (microns)

Preliminary Specifications

OPERATING CHARACTERISTICS:

Operate Range	15	mT
Release Range	7.5	mT
Operate Time (including bounce)	< 500	μs
Bounce Time	< 100	μs
Release Time	< 200	μs

ELECTRICAL CHARACTERISTICS

Switched Power	0.3	W
Switched Voltage DC	100	V
Switched Voltage AC, RMS	70	V
Switched Current DC	50	mA
Switched Current AC, RMS	35	mA
Carry Current DC; AC, RMS	100	mA
- Rise in temperature (mounted on 25 mm x 12mm x 1.5mm bare FR4)	15	°C
Breakdown Voltage	200	VDC
Contact Resistance (typ.@ 40 mT)	1.5	Ω
Contact Resistance (max.@ 40 mT)	< 7	Ω
Contact Capacitance	< 2	pF
Insulation Resistance (min.)	10^{12}	Ω

LIFE EXPECTANCY:

No Load	10^8	Operations

ENVIRONMENTAL RATINGS:

Operate Temperature Range	-40 to +90	°C
Storage Temperature Range	-55 to +125	°C
Shock (any direction)	1000	g
Vibration (10 to 5000 Hz)	50	g
PCB/Pad Shear Force	> 5	N

PHYSICAL CHARACTERISTICS:

Dimensions (LxWxH)	2.185 x 1.125 x 0.94	mm
Volume	~ 2.5	mm^3
Mass	12	milligrams
ROHS Compliant ?	Yes	

Note that the information on this data sheet is for reference only. Please verify the specifications by consulting our engineering department.

Rev 130918

HT MicroAnalytical, Inc. • 4301 Masthead NE Albuquerque, NM 87109 • 505.341.0466 • www.htmicro.com

Examples

NEW!

1mm^2

magnetic reed switch

yet smaller!

(less than half the footprint of the MS-02 switch)

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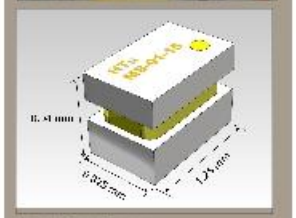
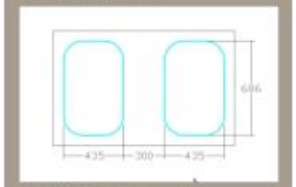
Micro Reed Switch
Form A
Model MS-01-15

FEATURES:
- World's Smallest Reed Switch Series
- Hot Switchable
- Surface Mount – Au over Ni pads
- Tape and Reel Packaging
- Hermetic Seal
- Zero Power Operation

APPLICATIONS:
- Proximity / Position Sensing
- Relays
- Pulse Counters
- More



MS-01-15 Device Dimensions



MS-01-15 Pad Dimensions (microns)

Preliminary Specifications

OPERATING CHARACTERISTICS:

Operate Range	10-20	mT
Release Range	5-10	mT
Operate Time (including bounce)	< 500	µs
Bounce Time	< 100	µs
Release Time	< 200	µs

Rev 130918

ELECTRICAL CHARACTERISTICS

Switched Power	0.1	W
Switched Voltage DC	12	V
Switched Voltage AC, RMS	8	V
Switched Current DC	10	mA
Switched Current AC, RMS	7	mA
Carry Current DC; AC, RMS	30	mA
- Rise in temperature	< 10	°C
(mounted on 25 mm x 12mm x 1.5mm bare FR4)		
Breakdown Voltage	>150	VDC
Contact Resistance (typ.@ 40 mT)	< 7	Ω
Contact Resistance (max.@ 40 mT)	< 7	Ω
Contact Capacitance	< 2	pF
Insulation Resistance (min.)	10^{12}	Ω

LIFE EXPECTANCY:

No Load	10^8	Operations

ENVIRONMENTAL RATINGS:

Operate Temperature Range	-40 to +90	°C
Storage Temperature Range	-55 to +125	°C
Shock (any direction)	1000	g
Vibration (10 to 5000 Hz)	50	g
PCB/Pad Shear Force	> 2.5	N

PHYSICAL CHARACTERISTICS:

Dimensions (LxWxH)	1.25 x 0.825 x 0.94	mm
Volume	~ 1	mm^3
Mass	5	milligrams
ROHS Compliant ?	Yes	

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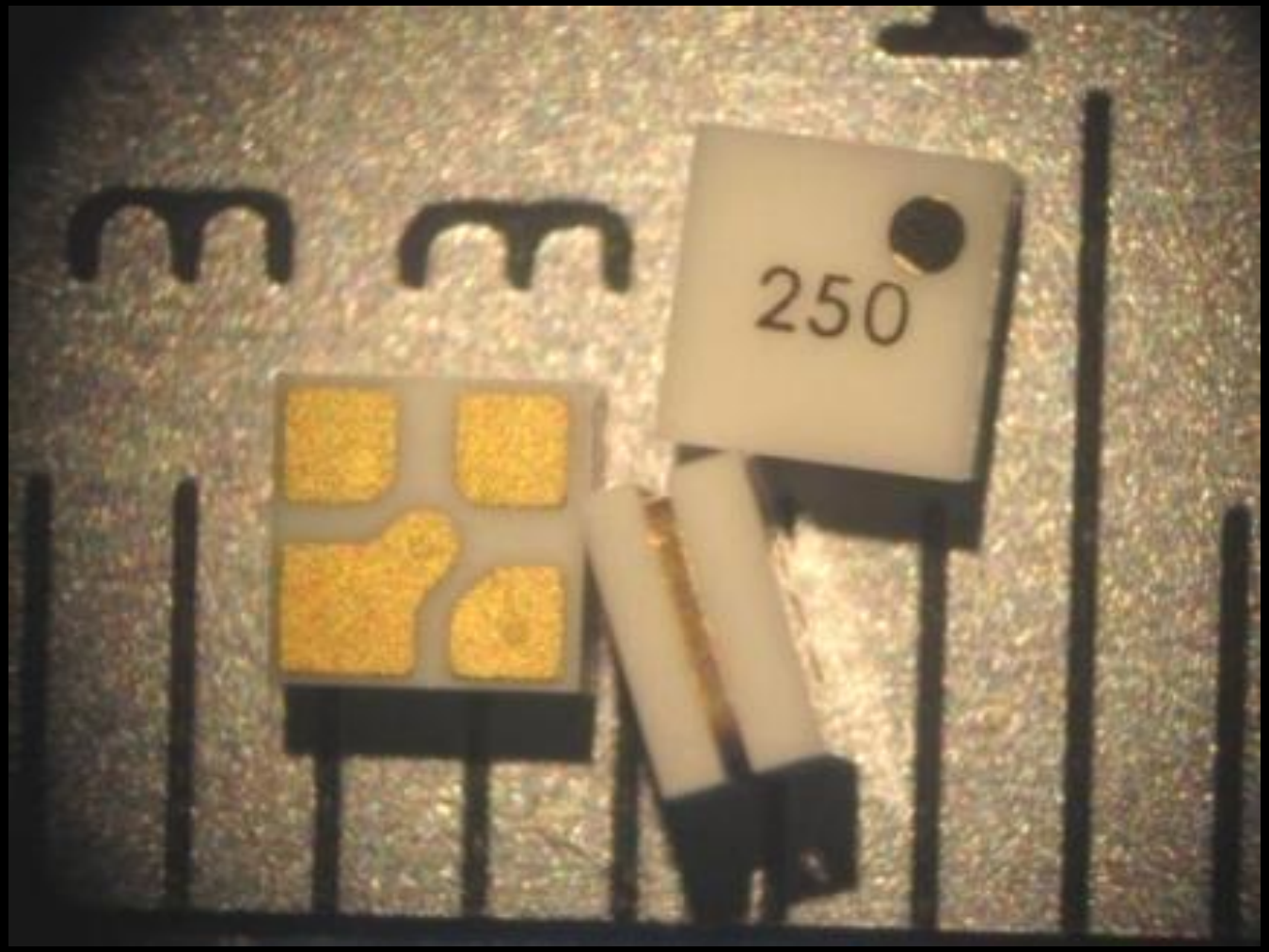
Examples

Integrated Inertia Switch



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Examples

Integrated Inertia Switch:

1.8 x 1.8 x 1.0 mm

withstands >100kG shock

Rosenberger North America

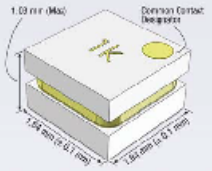
Micro G Switch
Single Axis
Model AT-1000SF

Features

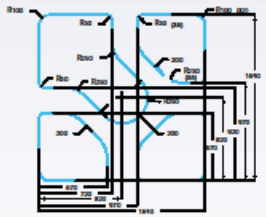
- Small and Lightweight - 3.4 mm³
- Extremely Fast Response Times
- High Shock Survivability – 65,000+ g
- Surface Mount – Au over Ni Pads
- Tape and Reel Packaging
- Hermetic Seal

Applications

- Impact Detection
- Arming / Fuzing
- Artillery, Launch
- More



AT-1000SF Device Dimensions



AT-1000SF Pad Dimensions
Viewed From Pad Side

Specifications

Operating Characteristics

Sensitivity	+Z (normal to PCB)	
Contact Acceleration Threshold	1350	g
Contact Type	Normally Open, Non-Latching	
Response Time (2)	< 50	µs
Reset	Automatic with g decay	

Electrical Characteristics

Contact Resistance (1)	< 10	ohms
Insulation Resistance (min.)	1000	Mohm
Breakdown Voltage	> 230	VDC

Environmental Ratings

Operate Temperature Range	-55 to +125	°C
Storage Temperature Range	-55 to +125	°C
PCB/Pad Shear Force	> 20	N

Physical Characteristics

Dimensions (LxWxH)	1.84 x 1.84 x 1.08	mm
Volume	3.7	mm^3
Mass	20	milligrams
ROHS Compliant?	Yes	

Note 1: Contact resistance is dependent on input pulse acceleration level.
Note 2: Response time depends upon input pulse profile.

Note that the information on this data sheet is for reference only. Please verify the specifications by consulting our engineering department.

For more information contact:

Rosenberger North America

1100 Professional Drive
Suite 100
Plano, Texas 75074
Telephone: +1-972-423-8991
Fax: +1-972-424-7521
Web: www.rosenbergerna.com
Email: salesinfo@rosenbergerna.com

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Examples

Low profile
pin connector:

< 0.7mm profile

< 30mΩ contact resistance

2A current carry

Rosenberger North America

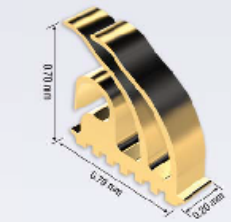
Low Profile Pin
Model LPP-DA-1

Features

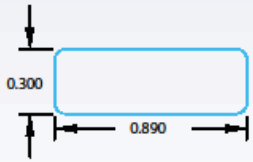
- Minimize Component Height Above Board
- Surface Mount
- Contact Material: Hard Gold
- Low Contact Resistance
- High Contact Force

Applications

- Micro Sockets
- Micro Connectors
- More



LPP-DA-1 Pin Dimensions



LPP-DA-1 Pin Dimensions mm

For more information contact:
Rosenberger North America
1100 Professional Drive
Suite 100
Plano, Texas 75074
Telephone: +1-972-423-8991
Fax: +1-972-424-7521
Web: www.rosenbergerna.com
Email: salesinfo@rosenbergerna.com

Provisional Specifications

Mechanical Characteristics

Contact Travel Length	> 0.125	mm
Contact Scrub Length (with contact travel of 0.125mm)	> 0.075	mm
Contact Force (with contact travel of 0.125mm)	> 35	gram-force
Cycle Lifetime (1)	> 10000	cycles
Solderability – Rework (1,2)	> 3	reflow cycles

Electrical Characteristics

Contact Resistance (with contact force of 10 gram-force)	< 30	mΩ
Current (Maximum)	2	A
Voltage (Nominal)	5	V
Characteristic Impendence (Differential) Ground/Signal/Ground Configuration with 0.74mm spacing	71	ohms
RFR Response (Rise Time Degradation) (3)	< 10	%

Environmental

Operate Temperature	-55 to 175	°C
Humidity (non-condensing)	5 to 95	% RH

Materials

Body	NiFe (80/20)
Contact	Hard Gold

Physical Characteristics

Dimensions (LxWxH)	0.79 x 0.2 x 0.7	mm
Mass	~0.3	mg
ROHS Compliant?	Yes	

Note 1: Further investigation required.
Note 2: SMIC solder M705-GRN360-MZ.
Note 3: Reference signal rise time: 60 psec – 20%-80%.

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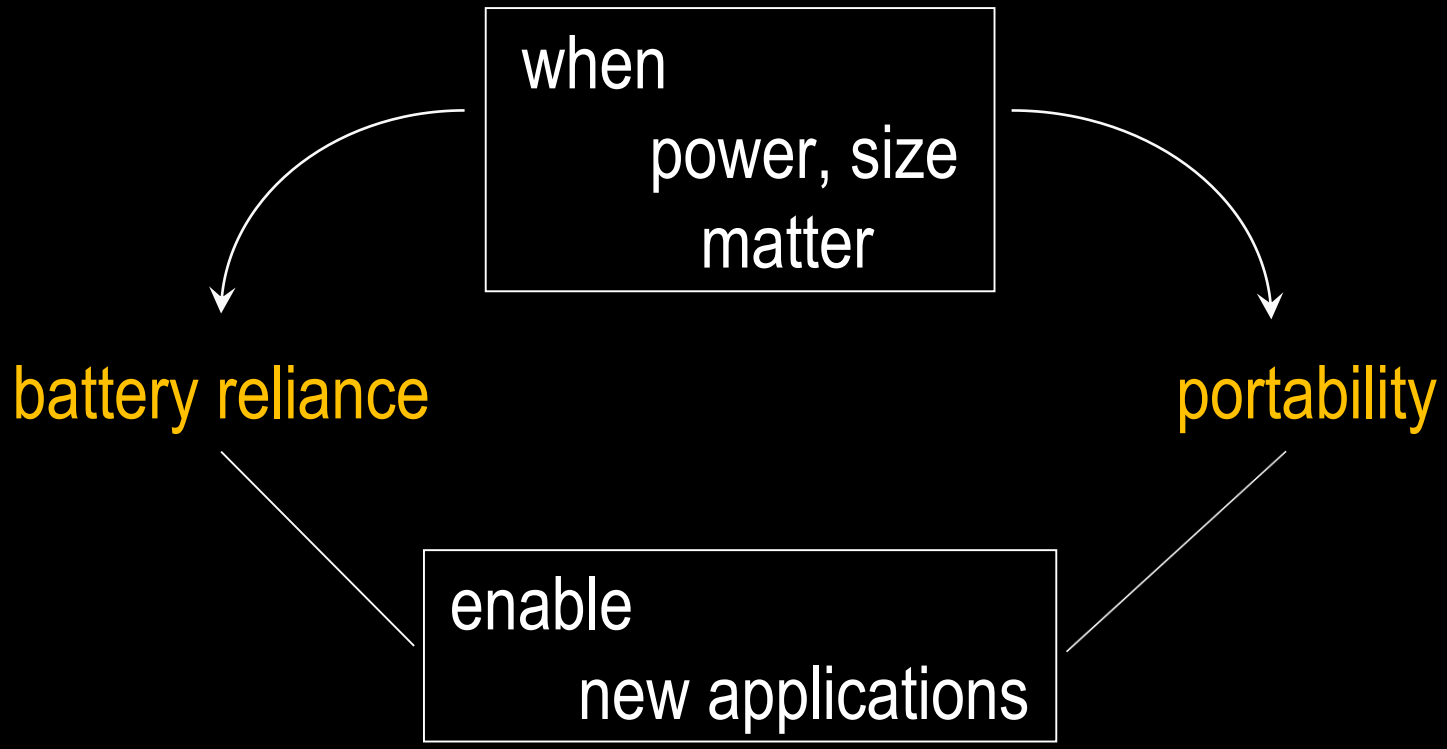
Applications for: PassiveMicro™

"Breaking Constraints"



- wearable tech
- medical devices
- distributed sensing

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Applications for: PassiveMicro™

magnetic switch		inertia switch
intermittent	battery reliance	wake-up
in-situ	safety and care	awareness
form-factor independence	portable and remote	isolated location

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Test

- 100% test
- highly customized
- automated wafer scale testing

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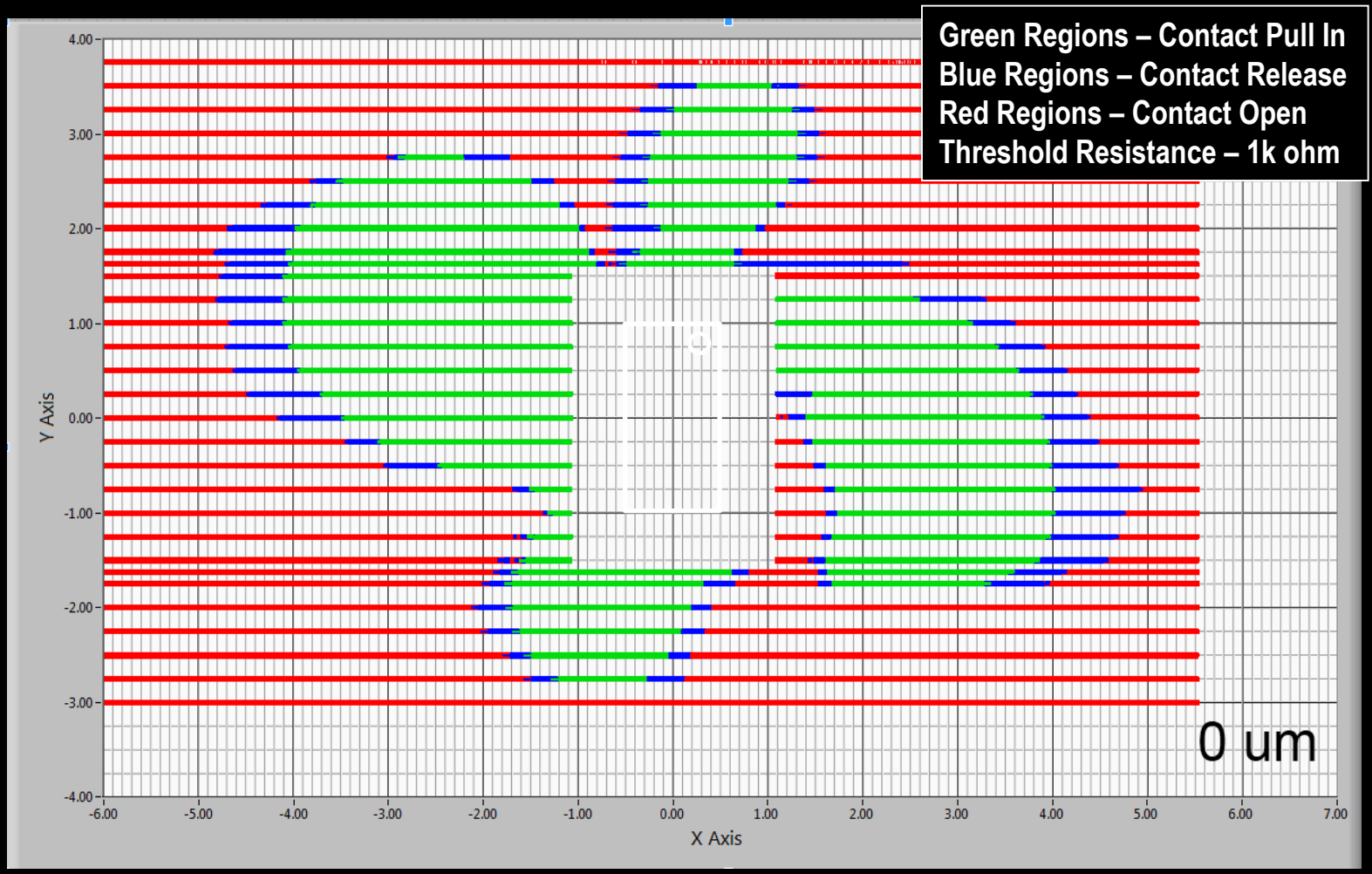
Switch Magnetic Response – Pull-In and Release

Magnet Angle 0 degrees



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Angled Magnet Response

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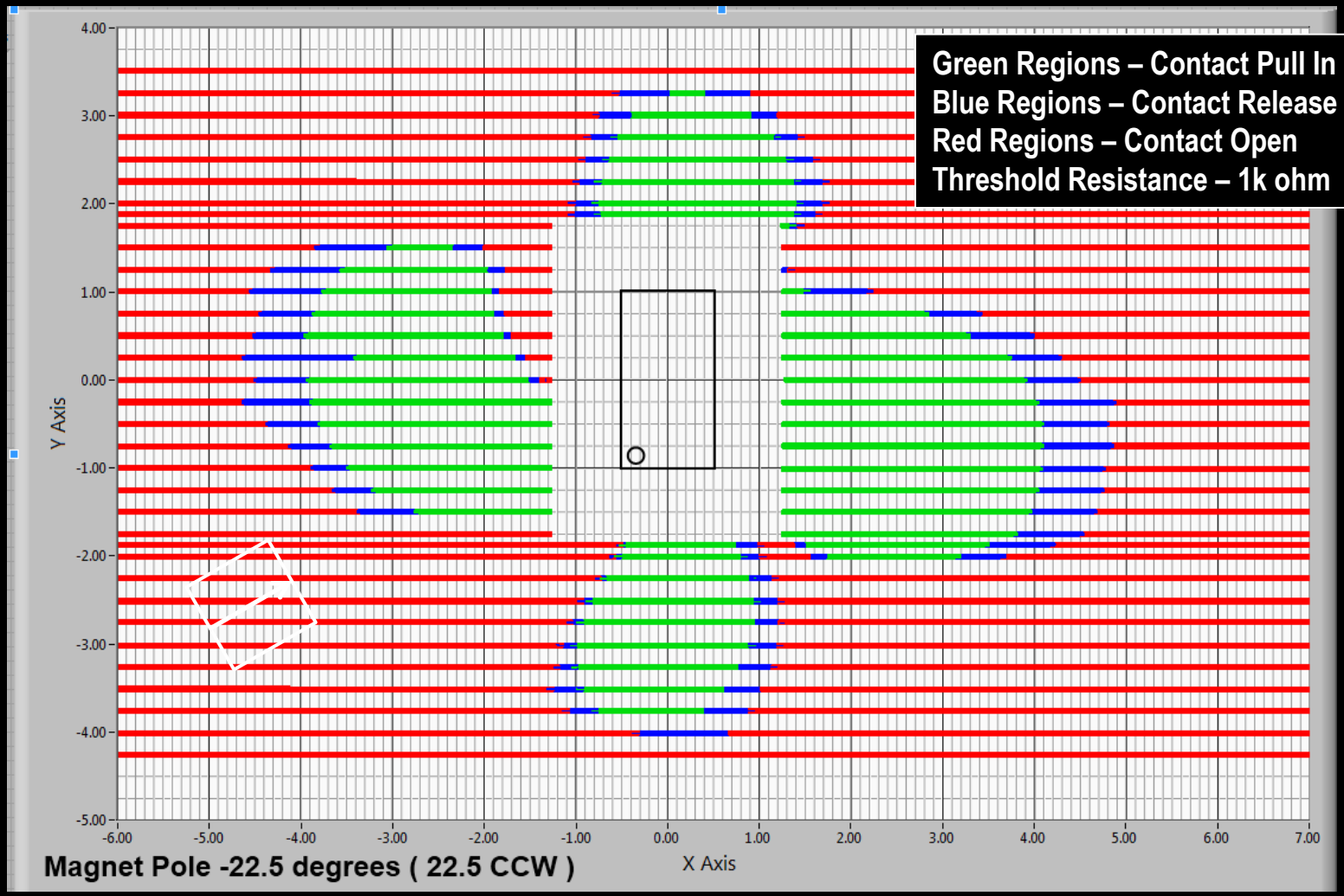
Switch Magnetic Response – Pull-In and Release

Angled Magnet – Z=0 microns



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Test

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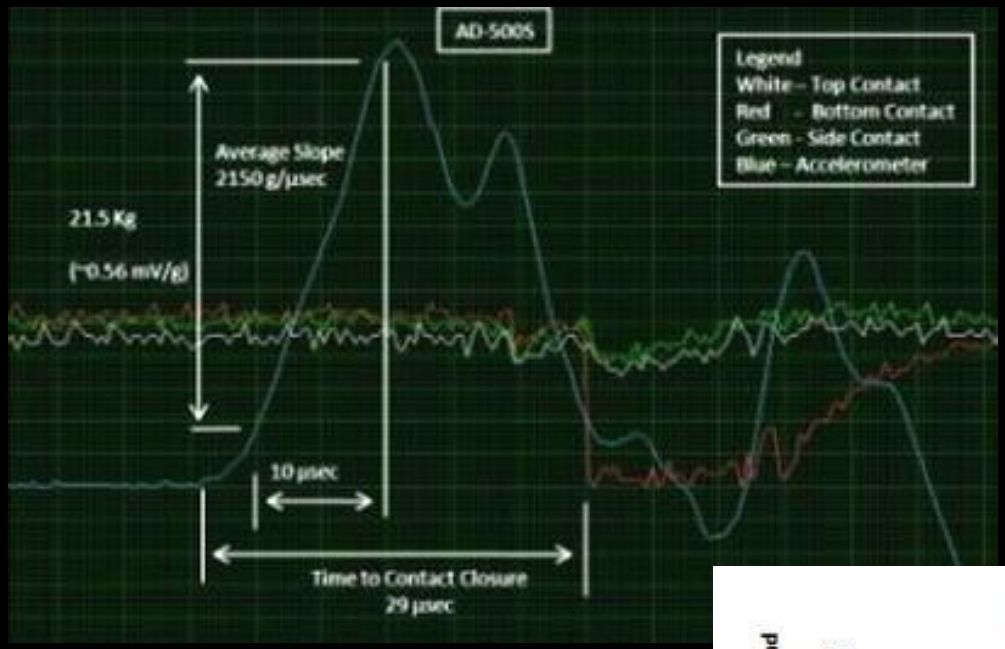
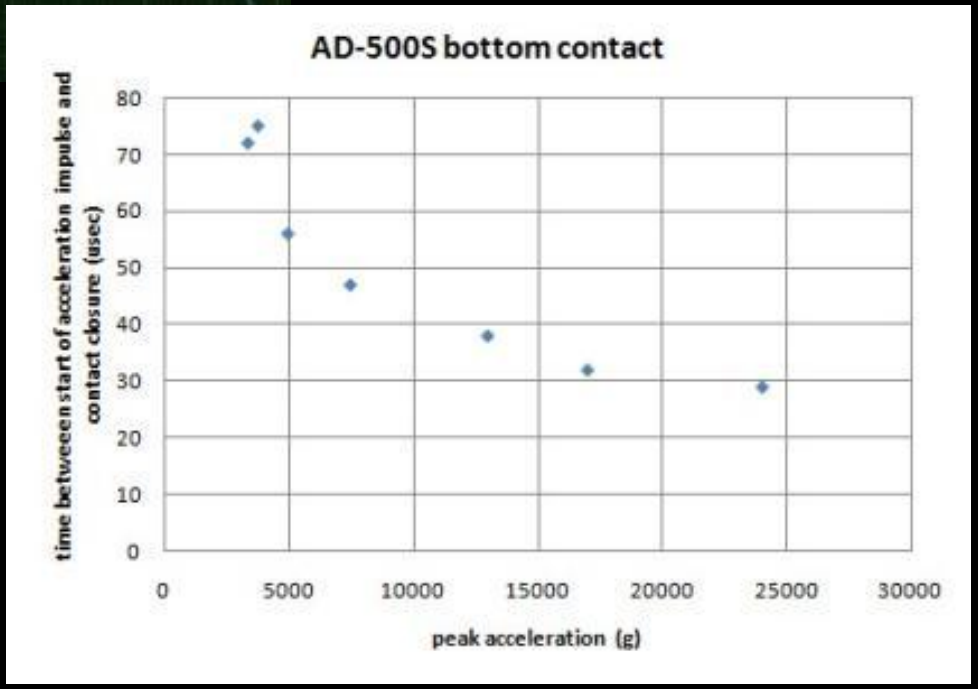
Test


AD-500S
Legend
White – Top Contact
Red – Bottom Contact
Green – Side Contact
Blue – Accelerometer
Average Slope
2150 g/µsec
21.5 Kg
(~0.56 mV/g)
10 µsec
Time to Contact Closure
29 µsec


AD-500S bottom contact
time betweeen start of acceleration impulse and contact closure (usec)
0
10
20
30
40
50
60
70
80
0
5000
10000
15000
20000
25000
30000
peak acceleration (g)

Examples

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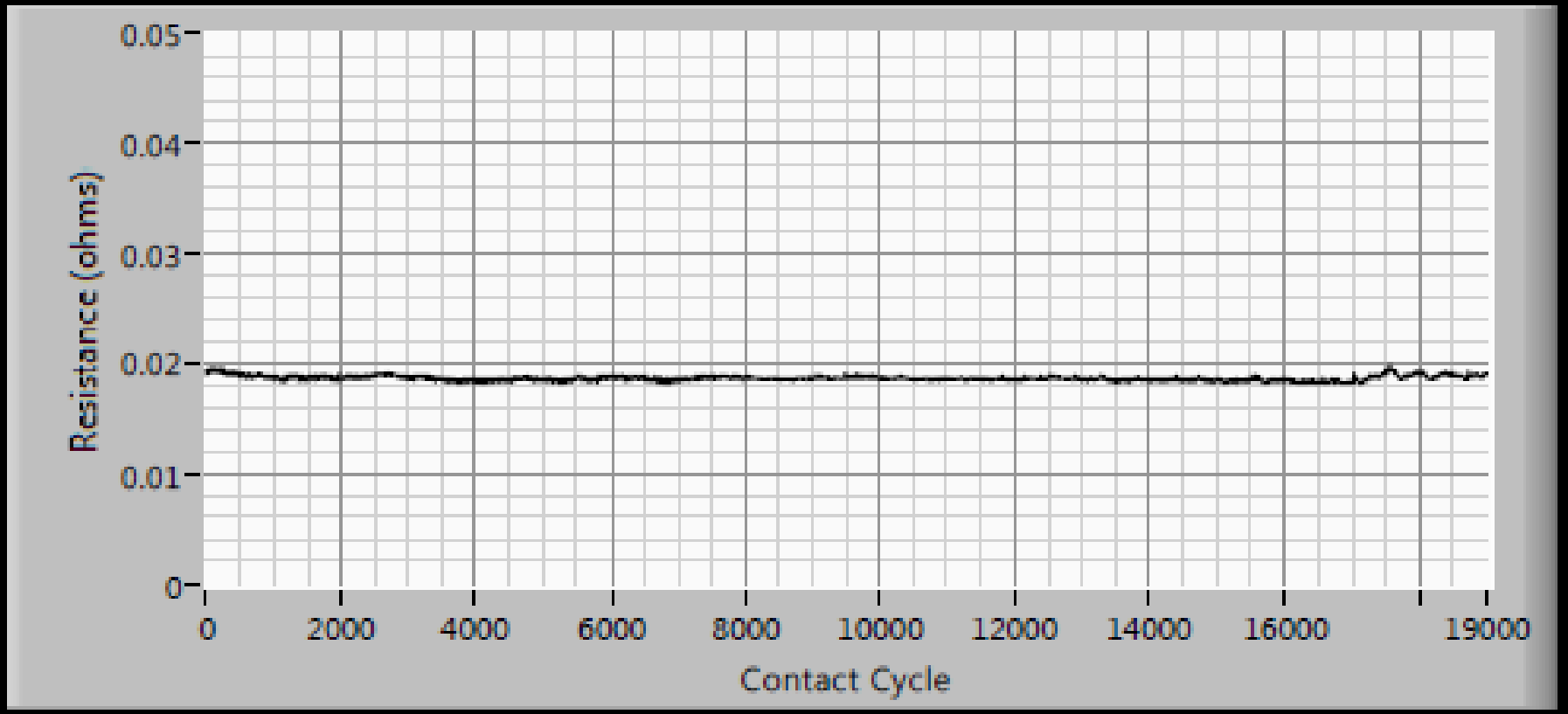
Connector pin performance:



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Conclusions

large variety of high volume sensing applications

desire and are enabled by

- zero power consumption
- ultra miniaturization
- ultra high reliability

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