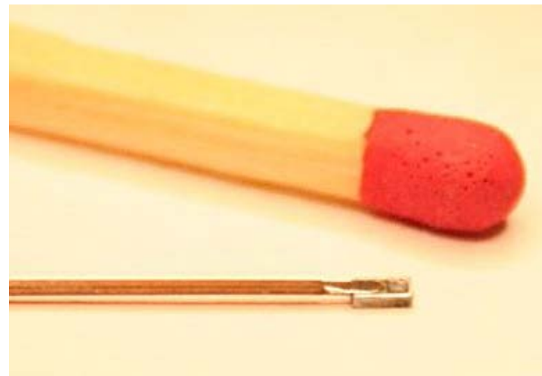
Model SMA-2RTV, SMA-2PS
Fast Response Pressure Sensor

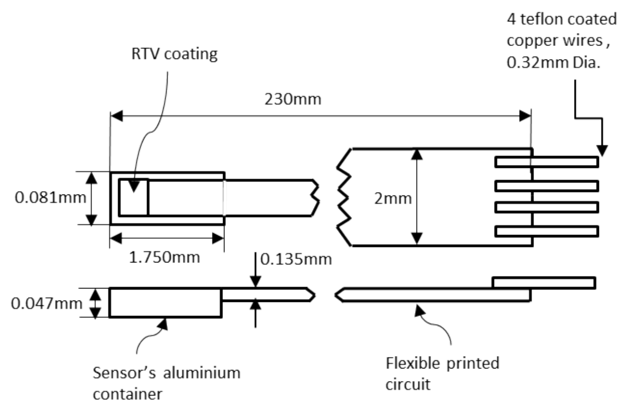
- Encapsulated absolute pressure die
- Miniature packaging size
  0.81 X 1.75 X 0.47mm
- High measurement bandwidth
- Slim flexible printed circuit
- Air, Water & Steam compatible



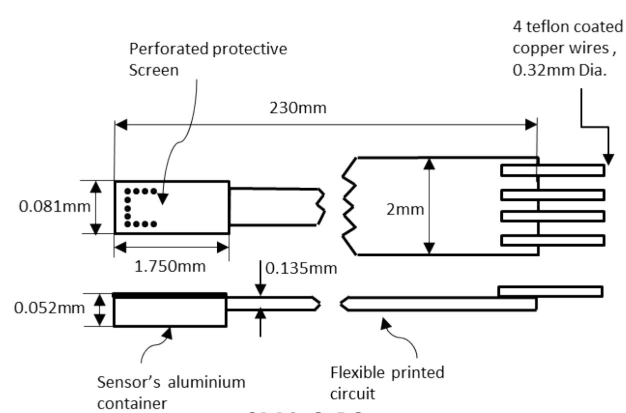
The SMA-2 sensor assemblies offer the smallest packaged sensor assembly yet achieved in the market, opening new fields of application for blade surface dynamic pressure measurements. Thanks to its miniature size the sensor assembly is typically prone for high density packaging applications under high rotational speed.

The sensor assemblies consist of an absolute pressure die mounted onto an stainless steel housing. The housing can be easily mounted onto the blade surface with standard epoxy glue. The sensor is RTV coated and can be applied in air, water or steam flows (model: SMA-2-RTV). For harsh environments , the assembly can be equipped with a perforated screen (model: SMA-2-PS).

The pressure transducers can be either operated in a constant current or constant voltage mode. They are delivered fully calibrated with integrated temperature compensation, if requested. LSc also provide electronics for signal conditioning and current supply, please refer to the wireless multi-sensor measurement system product. The sensors will be delivered calibrated with the on-board electronics, and a set of polynomial calibration coefficient will be provided to be used with LSc's monitoring software.



SMA-2-RTV



SMA-2-PS

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Model SMA-2-RTV, SMA-2-PS
Fast Response Pressure Sensor

Specifications

All specifications assume a 1mA excitation voltage unless otherwise stated. The following parameters are 100% tested.

Characteristics	Units	SMA-2-RTV	SMA-2-PS
Pressure range	bar	0 - 2	0 - 2
Temperature range: Operation / Calibration	°C	-50 to 120°C / 5°C to 120°C	-50 to 120°C / 5°C to 120°C
Measurement bandwidth	kHz	210	51
Sensitivity @ 25°C	mV/bar	3.2	3.2
Proof / Burst pressure (diaphragm)	bar	2.7 / 4.5	2.7 / 4.5
Temperature coefficient of offset @ $p_{,abs}$ = 300mbar	%FSO	0.27	0.27
Temperature coefficient of sensitivity from 15°C to 95°C	%	0.074	0.074
Non-Linearity	%FSO	0.2	0.2
Bridge resitance	Ω	3200	3200
Electrical supply constant voltage or current mode	V /mA	5 / 1	5 / 1
Steady acceleration	g	90’000	90’000
Media compatibility		Air, steam, water	Air
Case material		Stainless steel	Stainless steel

An On-Board Wireless Multi-Sensor Measurement System for Rotating Turbomachinery Application

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ABSTRACT

A novel multi-sensor wireless measurement system for measurements in the rotating frame of reference is presented and demonstrated in this paper. The system is comprised of newly developed in-house surface mount pressure sensors and wireless signal conditioning and acquisition boards. The surface mount pressure sensor assemblies are packaged a miniature aluminum casing of 1.75mm x 0.81 x 0.47mm. The RTV-coated assembly offers the highest measurement bandwidth of 210 kHz which provides a measurement bandwidth at least 40 times above the maximum intended blade passing period. The uncertainty analysis performed shows that the pressure sensors offer a measurement accuracy of ±87Pa and ±77Pa in absolute and fluctuating pressure measurements, respectively. The sensors and the wireless data acquisition boards provide a high signal-to-noise ratio with a pressure resolution of 6Pa on the raw signal. The measurement system is successfully deployed in an axial one-and-1/2-stage-turbine facility, and preliminary measurements are presented and discussed.

NOMENCLATURE

A	area	[m^2]
L	length	[m]
P,p	pressure	[Pa]
S	sensitivity	[mV/mbar]
T	temperature	[^oC]
U	pressure signal	[V]
U_e	Temperature signal	[V]
f	frequency	[Hz]
k	stiffness	[Nm/rad]
m	mass	[kg]

Greek

σ	standard deviation

Abbreviations

FRAP	fast-response aerodynamic probe
TCO	temperature coefficient of offset
TCS	Temperature coefficient of span
SMA-RTV	surface mount pressure sensor assemblies coated with RTV
SMA-PS	surface mount pressure sensor assemblies with perforated screen

Subscripts

abs	absolute
e	excitation
fluct	fluctuating
avg	average value
min	minimum
max	maximum
rel	relative

INTRODUCTION

In turbomachinery, blades suffer from flutter or forced response depending on the type of application and operating conditions. In the early stage of new turbine or compressor development, the design focuses on satisfying the mechanical integrity of the rotating parts to meet the requirements in terms of expected effective operating hours. For now many years the design of new aero-engines is focusing in minimizing the weight. This is achieved by reducing the number of stages and therefore increasing the blades loading. As reported in [1-3], it is vitally important to study the sources of inter-blade row interactions on the aerodynamic blade excitation to mitigate the risk of early failure. Similarly, centrifugal compressors have gone through considerable developments over the past 10 years, evolving towards high speed, high efficiency and high pressure ratio compressors. The current design trends tend to increase the risks of failure. Several research groups have worked in identifying the sources of excitations related to wake potential field interaction with the impeller as well as with the primary and secondary flow paths [4-6].

This process relies on the capability to predict the cause and magnitude of blade excitation and to assess damping mechanisms. To enable this kind of quantification, the measurement of the unsteady pressure acting of the blades has to be coupled to the blade mechanical deformation over the entire range of intended operating conditions. It requires conducting measurement in the rotating frame of reference, which is more challenging to construct and instrument at the same degree than stationary experiments. This becomes especially true if the blades have to be equipped with a high