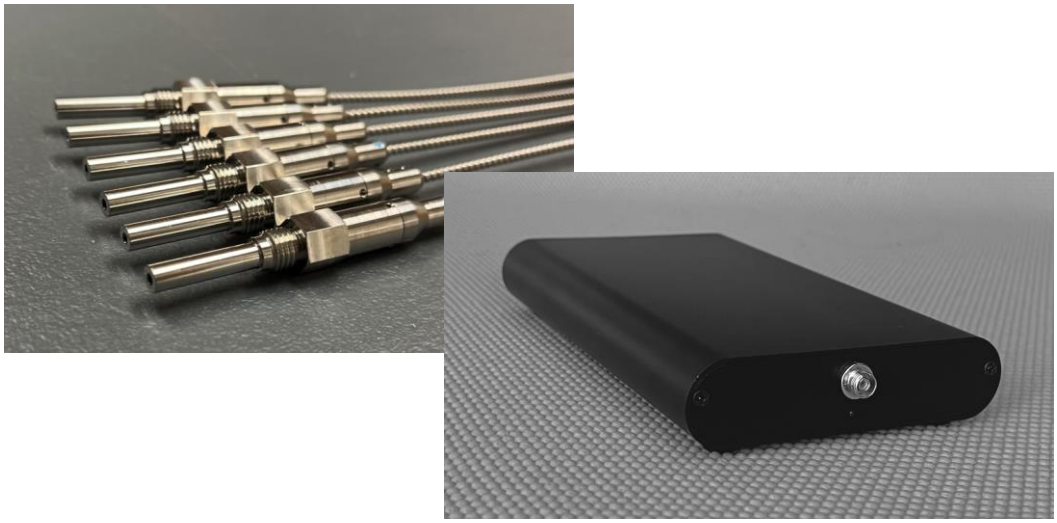
SENTEK INSTRUMENT LLC

Pressure Sensor

for Extremely High Temperatures

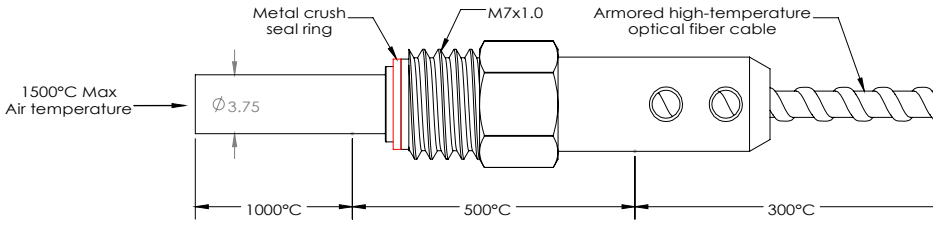


NovaPT™-E is a patented optical pressure sensor that can reliably operate at temperatures up to 1500°C. This unprecedented capability is further enhanced by a range of interrogation instrument options. The eye-safe Class 1 light from an interrogator propagates via a robust fiber optic cable to the sensor. Given the exceptionally low fiber optic transmission loss, the fiber cable length can be many meters without compromising the measurement accuracy. The light reflected off the sensor travels back along the same fiber cable to the interrogator where pressure is determined using a patented signal processing scheme. Besides its ultrahigh temperature capability, the NovaPT™-E sensor is able to operate reliably in other harsh environments such as electromagnetic interference, chemical corrosion and neutron radiation. The sensor also exhibits excellent measurement linearity, repeatability and resistance against thermal shock and fatigue. NovaPT™-E is an unparalleled choice for monitoring of all conventional and unconventional gas turbine engines and many other industrial systems without the need for sensor cooling or a standoff tube.

SENSOR PROBE

The NovaPT™-E sensor is packaged in a metal housing that is oxidation- and corrosion-resistant, and has a 3.75mm tip diameter as shown in the drawing below. The standard M7x1.0mm mounting thread with a metal crush seal ring as shown in the schematic drawing below makes the sensor installation simple, easy and reliable. The maximum service temperature of the sensor is rated for 1000°C for continuous use and for 1500°C for pulse

temperature or limited time use. Higher service temperatures can be available by custom order. Smaller form factors can also be customized to accommodate special application needs.



SENSOR SPECIFICATIONS		
Model	**NovaPT™-E600**	**NovaPT™-E4000**
Maximum Static Pressure	40bars (580psi)	250bars (3,626psi)
Diaphragm Resonance Frequency	400kHz	1MHz
Sensor Tip Diameter	3.75mm	
Combined Non-linearity, Hysteresis and Repeatability	<1% F.S.	
Maximum Sensor Tip Temperature	1000°C (1832°F) for continuous use, 1500°C (2732°F) for pulse temperature	
Installation Thread	M7x1.0	
Fiber Cable Length	0.5m 150°C rated fiber cable; 3, 15 or 50m extension cable option available	

SENSOR INTERROGATORS AND SOFTWARE

The NovaPT™-E sensor intrinsically offers multiple measurement functions including dynamic pressure, static pressure, temperature and even multiple temperatures at different sensor axial positions. These functions can be unlocked by the use of different sensor interrogator options without any need for sensor modifications or fiber cable changes.

Interrogator rear panel view

Graphical user interface

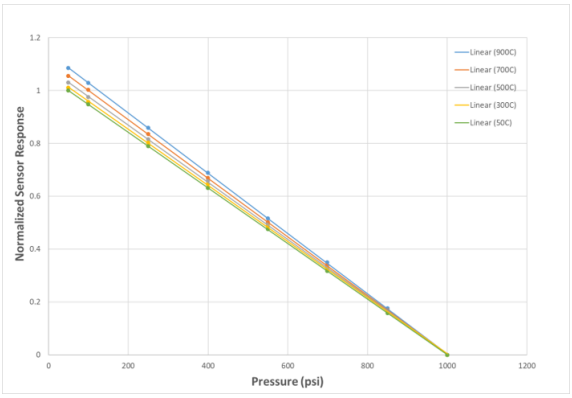
The Fasedyne is an interrogator for dynamic pressure measurement. This compact interrogator along with the NovaPT™-E is designed to meet the increasing market demand for dynamic pressure measurement directly at ultrahigh temperatures without the need for a standoff tube or water cooling. The miniature sensor probe permits measurement in space-constrained areas without distortions to the dynamic pressure signals. The interrogator provides both 0-5V analog and digital outputs. This compact size, light weight, and low power consumption interrogator can also be upgraded to work in 125°C environment and offers a great potential for its integration into full authority engine control (FADEC) units of flight engines. The Fasedyne interrogator comes with a graphical user interface (GUI) that allows the user to display and analyze the pressure signals from the interrogator in real time on an external PC. Besides the temporal pressure traces, the user can choose to display the Discrete Fourier Transform (DFT) for any single screenshot or as a function of time, as displayed in either waterfall or 3-D graphics.

INTERROGATOR SPECIFICATIONS			
Model	**Fasedyne-1000**	**Fasedyne-2000**	**Fasedyne-3000**
Measurement	Dynamic Pressure		
Frequency Response	20-4,000Hz	20-25,000Hz	20-60,000Hz
Resolution (1σ) **Maximum Static Pressure Rating**	<0.01%	<0.02%	<0.02%
Sampling Rate	27kHz	50kHz	120kHz
Sensor Channels	1, 2 or custom	1, 2 or custom	1 only
Dimensions	26x108x180mm, 1 or 2 channels 310x220x120mm, 4, 8 and 16 channels		
Power Supply and Consumption	12VDC, 4W		
Digital Output	USB Micro-B		
Analog Output (Optional)	SMA, Hi-Z, 0-5V		
Trigger Input	SMA, 50Ω, 10V (Max)		
Environmental Conditions	-10 to 45°C, 5-90% humidity		
Software	Flexible data display, storage control or spectrum analysis (Fasedyne only)		

Sentek can also offer additional specially designed interrogators to further unlock the other intrinsic measurement functionalities offered by the NovaPT™-E sensor. These interrogators need to be custom ordered for measurement of static pressure, temperature, and multiple temperatures for deduction of other quantities such as heat flux.

RELEVANT DATA

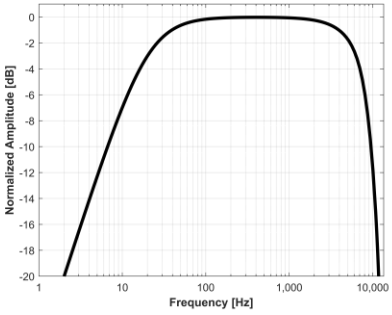
SENSORS



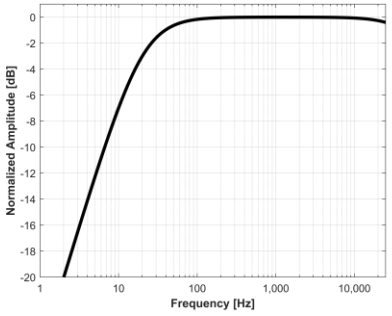
NovaPT™-E sensing transduction is realized by the optical measurement of the deflection of a single-crystal sapphire pressure diaphragm. The diaphragm deflection is temperature dependent due to the thermal dependence of sapphire mechanical characteristics - mainly the Young's modulus. This dependence is evaluated by measurement of the sensor response to pressure under different temperatures. The temperature coefficient of pressure measurement is measured to be 0.010% reading point/°C for measured temperatures up to 900°C. Sapphire's Young's modulus has been measured for greater temperatures up to 1400°C [J. B. Wachtman Jr. et al. J. American Ceramic Society, 42, p254] and the data show continued modulus linear dependence for the extended temperature range.

INTERROGATORS

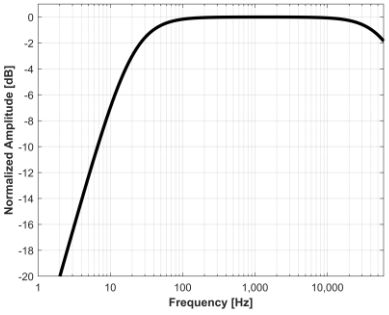
The Fasedyne sensor interrogation instruments are designed to provide flat response over a wide frequency range for high-fidelity broadband dynamic pressure measurement. The frequency responses of each interrogator model are plotted in the figures below.



Fasedyne-1000



Fasedyne-2000



Fasedyne-3000

The flat frequency response over the wide frequency range with sharp transitions around the lower and higher cutoffs for each model is achieved by integrated design of analog electronics, digital filters and signal processing algorithms. These frequency responses remain stable across a large dynamic range.