DAVIDSON ®
INSTRUMENTS

# Combustion Dynamics Monitoring using High Temperature Fiber Optic Transducers

Davidson's patented temperature-tolerant fiber optic based pressure transducers have been proven in the field for monitoring combustion dynamics in GE 7E, 7F, 9E, 9F and Siemens 501 engines. The transducers can tolerate 1000° F continuously and are based on reliable interferometric Fabry-Pérot fiber optic displacement sensing technology.

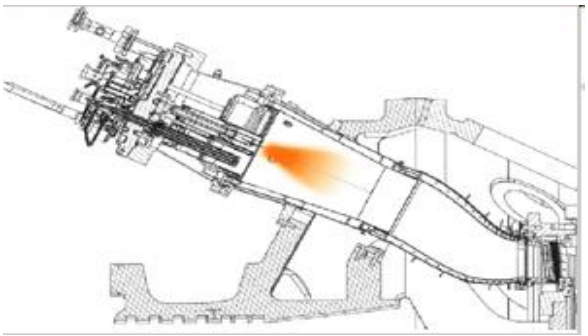
Davidson's CDMS transducers have been designed to be mounted directly on the turbine casing of GE engines and inside the J-tube of Siemens engines without the need for any modifications to the engines.

In the GE engines, the transducer projects through the casing and is positioned flush with the inner liner close to the combustion zone. The transducer has a flexible tip to prevent damage due to misalignment of the holes in the casing and the liner. The transducer is cooled by the 800° F air that circulates between the casing and the liner. In the Siemens engine, the transducer is installed in the J-Tube along side the combustion basket

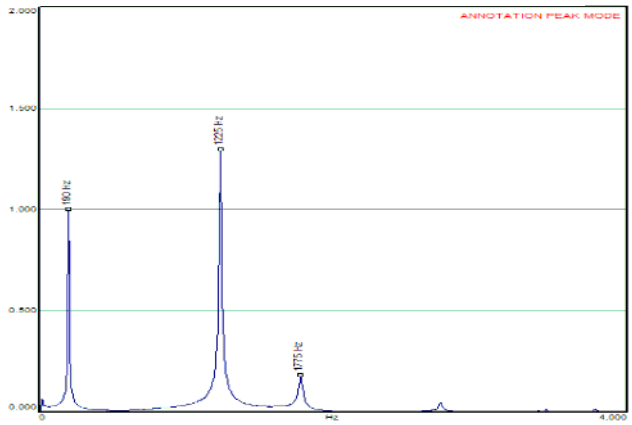
Davidson's fiber optic transducers eliminate the need for the acoustic tubes, purging systems, electronic transducers, and charge amplifiers. The signal conditioner can be configured to provide either an analog or digital output and is compatible with conventional spectrum analyzers and CDMS monitoring software.

# Combustion Dynamics Monitoring

Stable combustion in large frame gas turbines is necessary for long term engine reliability and availability. Abnormal combustion dynamics are caused by combustion instabilities and are exhibited as pressure fluctuations or oscillations in the combustion zone of a gas turbine. Combustion dynamics are measured as the amplitude, duration, and frequency of the pressure oscillations.



Cross-Section of Gas Turbine Combustor




Spectrum Analysis

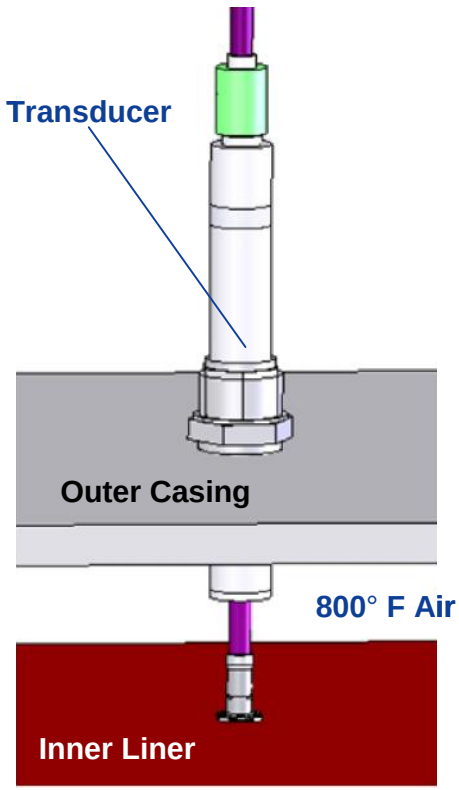
Fractured Transition Piece

Sudden changes in load, ambient temperature, humidity, and the Wobbe Index of natural gas can cause combustion instabilities and lead to a number of problems including: auto-ignition, flashback, combustor blowout, abnormal combustion dynamics, and non-compliant emissions. High amplitude pressure oscillations or combustion instabilities at the resonant frequencies of critical engine parts can degrade hot section components, i.e. liners, transition pieces, and crossfire tubes, etc. and ultimately destroy an engine.

Monitoring combustion dynamics continuously provides early detection of combustion instabilities.

Continuous combustion dynamics monitoring systems can be used to tune an engine, maintain stable combustion processes, minimize emissions, improve engine efficiency, and extend the life of an engine. A baseline of dynamic signatures can be used for the development of predictive maintenance and control algorithms. Ultimately, these predictive maintenance and control algorithms will be used together with the combustion dynamics monitoring system to develop fully integrated gas turbine control systems.

# Why Use Davidson Fiber Optic Transducers




Davidson Fiber Optic Transducer Configured for GE 7FA Engine

Davidson fiber optic transducers are the most reliable, sensitive, and stable transducers available for making measurements of the pressure fluctuations in gas turbines. Davidson transducers can be mounted very close to the combustion zone inside the engine because they can tolerate 1000° F continuously.

Because Davidson's fiber optic transducers are located so close to the combustion zone, they provide greater fidelity and are not subject to the resonance or attenuation caused by the acoustic waveguides or distortion caused by condensation.

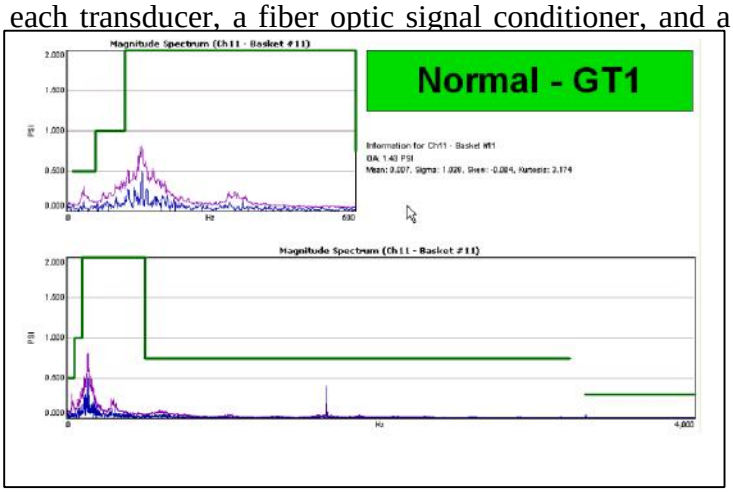
The pressure diaphragms inside the Davidson transducers are made of Inconel-718. Davidson transducers do not rely on piezoelectric crystals which degrade over time at elevated temperatures.

The installation of the fiber optic transducers is simple and eliminates the need for charge amplifiers, attenuation tubing, purging systems, and the installation cost and maintenance problems associated with such components.

Automated tuning and control systems can be integrated with the Davidson sensing system because it has an integral health monitoring system that stops reporting if the signal quality from a transducer ever falls below an acceptable threshold.

Davidson's transducers are not subject to the need for periodic calibration when operating below 1000° F because the properties of Inconel-718 are stable at these temperatures.

Davidson's system consists of a set of transducers, a junction box mounted on the turbine enclosure, a homerun cable that contains an optical fiber for each transducer, a fiber optic signal conditioner, and a spectrum analyzer.




The output of the combustion dynamics monitoring system can be displayed on a monitor showing separate alarm thresholds for cold tones, hot tones, and screech tones.

The combustion dynamics signals can be monitored remotely via the internet allowing experts to review and provide engine diagnostics using predictive maintenance and special diagnostic algorithms.

# Fiber Optic Measurement Instrumentation

Davidson is committed to manufacturing products of the highest quality and reliability for the most demanding industrial applications.

Fiber optic sensors offer the following benefits over conventional electronic sensors:

- Tolerant to High Temperatures and Corrosive Environments
- Safe in Class 1, Division I Explosion Hazardous Areas
- Immune to Electromagnetic Interference (EMI)

Additional benefits of Davidson's fiber optic sensing systems:

- Low installed cost and total life cycle cost
- Flat Frequency response from 0 to 10kHz
- High resolution and long term stability
- System diagnostics that eliminate false readings
- Seamless interface with analog and digital data acquisition systems

For more information about Davidson Instruments and our fiber optic sensing systems, visit our website at www.davidson-instruments.com

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