

# Fiber optic spark plug

## Spark plug with integrated optical fibers

Type FOSP

Spark plug with integrated fiber-optic system for optical combustion analysis in spark-ignition engines.

- Up to 12 optical windows to the combustion chamber (more possible, depending on the spark plug dimensions)
- Radial and/or axial direction of observation
- Adaptation of optical probes to almost any serial production spark plug
- Thread sizes M8, M10, M12, M14

### Description

The optical probes of the spark plug acquire combustion radiation in discrete areas of the combustion chamber. The acquired light intensity is conducted through optical fibers to highly sensitive optical amplifiers and converted to a voltage signal.

The addition of optical windows to the serial production spark plug doesn't affect its heat range, spark position or ignition characteristics.

### Application

Reliable combustion data are readily available thanks to the easy adaptability of the fiber-optic spark plug. In addition to the ignition process, abnormal combustion phenomena such as knocking, pre-ignition and soot formation can be made clearly apparent both over time and in space. The extreme sensitivity of the system allows for combustion analysis even during idle operation and cold start.

The reconstruction of the early flame propagation provides a global understanding of the charge motion and allows the analysis of the ignition under different operating conditions. The signals from the optical probes can also be used for misfire detection.

### Procedure

The realization of the fiber optic spark plug requires the availability of at least three samples of the serial spark plug. Kistler has the capability of including the optical windows and optical fibers to almost any type of serial production spark plug. The customized modification with optical probes is engineered for each project specifically and a dedicated project drawing will be created.



### Technical data

#### Optical windows

Max. number		12
Viewing angle arrangement with respect to longitudinal axis	Degree	70
Observation angle		
- Optical window in radial direction	Degree	25
- Optical window in axial direction	Degree	7
Operating temperature range	°C	-20 ... 500

#### Optical sensors

Transmission	nm	190 – 1 200
Fiber length, flexible routing	mm	1 200
Connector	-	Type ST

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Fig. 1: Components used to capture local light intensity in the combustion chamber: fiber optic spark plug, PMD optical amplifier, Combi data acquisition system

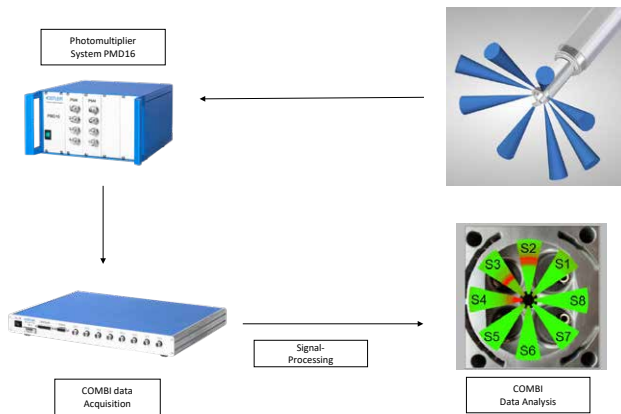


Fig. 2: Measuring setup with fiber optic spark plug, PMD optical amplifier and Combi data acquisition system

The fiber optic spark plug detects from the cylinder several patterns of light intensity signals. Represented in Figure 4 is the light intensity of one single viewing sector in radial direction, in four distinct applications. In the case of normal combustion, at partial load, the signal peak at the timing of ignition is significant. After start of combustion the signal shape is similar to that of the indicated cylinder pressure with a maximum between 200 and 210 °CA. This is the luminosity of the flame emission mainly generated by hydrocarbon radicals.

In case of knocking high frequent oscillations are superimposed to the main signal. With pre-ignition light intensity is already detected before the spark timing event.

A peak of light intensity during the expansion stroke is typical for sooting combustion.

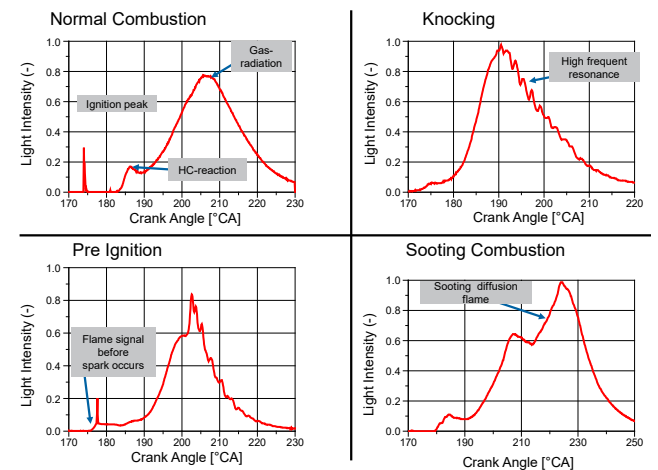


Fig. 4: Several patterns of light intensity signals acquired from one viewing sector with the fiber optics spark plug.

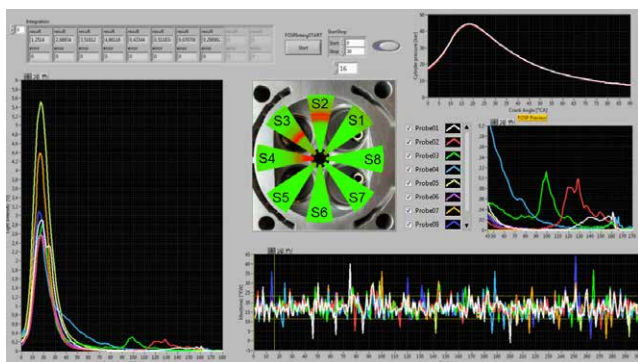


Fig. 3: Use of fiber optic spark plug in a gasoline engine with direct injection in transient operation: detection of soot formation in the combustion chamber

Skilled technical specialists are able to support users and even carry out measuring service on-site, please contact Kistler for more information.

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