

# High speed camera imaging system

## optical combustion analysis system with camera

High speed camera imaging system especially designed for optical investigations in internal combustion engines. The system comprehends optical adapters with customized dimension, endoscope, objective, high-speed camera, and the control system for synchronization and data acquisition.

- Optical combustion analysis system with high speed camera
- Adaption to any engine by means of endoscope and optical probe
- 1-megapixel image at frame rates up to 12 800 fps  
Minimum exposure duration of 1  $\mu$ s
- Combination with illumination system LED
- Combination with cylinder pressure sensor and amplifier for piezoelectric signal in SCP

### Description

The high-speed camera is controlled by the combustion analyzer Combi which allows the synchronous recording of images and combustion analysis data. The combination with the high-intensity illumination system Type LED-P40/ LED-P80/ LED-P160 allows the acquisition of high resolution images of non-light-emitting processes, as for example injection process.

### Applications

Applicable to multi-cylinder production engines, single-cylinder research engines, constant volume chambers.

The combustion analyzer and control system Combi perfectly synchronizes the information acquired via high-speed camera and the combustion analysis results from cylinder pressure. Images and combustion parameters are displayed on the user interface of the Combi SW simultaneously allowing the user to deeply investigate and optimize physical processes. Additionally, all pressure relevant data and statistical values are available in post processing.



Fig. 1. Basic layout of high speed camera imaging system applied to single cylinder

### Type HIS



Fig. 2. Components of high speed camera imaging system

### Components

#### Optical windows

Endoscope and All-In-One probe
Endoscope with air cooling
Endoscope diameter: 4 mm, 6.5 mm, 8.5 mm
All-In-One probe with optical fiber ring illumination
Separate light path
Min. probe diameter 6.5 mm
Diameter All-In-One probe 8.5 mm

### LED light source system

The high intensity fiber optic light source provides illumination for light critical high speed imaging with camera.

LED-P40
Output max. 18000 lm (for green LED)
Pulsed, continuous, or single shot modes
Pulse length 10 $\mu$ s - 1000 $\mu$ s



Fig. 3. LED-P40 light source system connected to AIO probe with endoscope

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This information corresponds to the current state of knowledge. Kistler reserves the right to make technical changes. Liability for consequential damage resulting from the use of Kistler products is excluded.

**High-speed camera**

Frame rate	Resolution
up to 12 800 fps	1024x1024
up to 40 000 fps	512x512
up to 115200 fps	256x256
Monochrome	Up to ISO 64000
Color	Up to ISO 16000



Fig. 4. High-speed cameras and sooting combustion of GDI engine

**Control system Combi**

Synchronization of the high-speed camera and LED light source system with the combustion cycle, data storage and combustion analysis calculation.

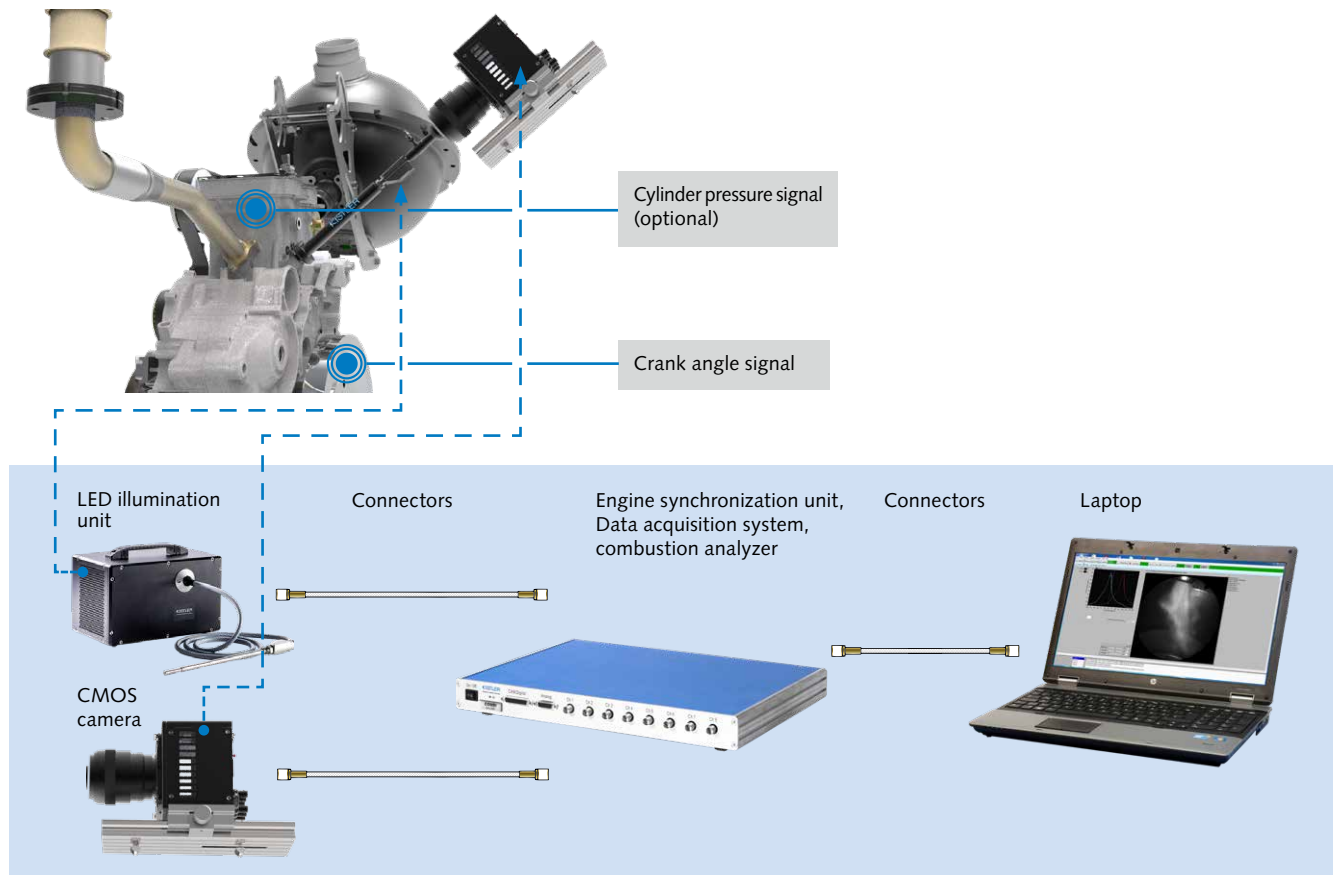
Analog input channels	8
Digital input channels	8
Analog output channels	8
Digital output channels	8
Sampling rate (per channel)	1 MHz
Resolution	14 Bit
Interface	GigaBit
Power supply	12V/ 230V



Fig. 5. Engine synchronization unit, data acquisition and combustion analyzer

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### Measuring chain



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