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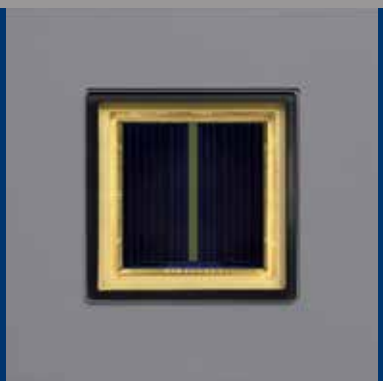

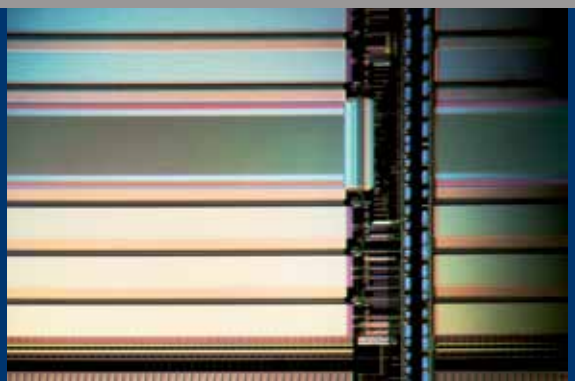

1 *xposure CMOS line scan sensor.*
2 *Photomicrograph of xposure.*

xposure

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AIT AUSTRIAN INSTITUTE OF TECHNOLOGY

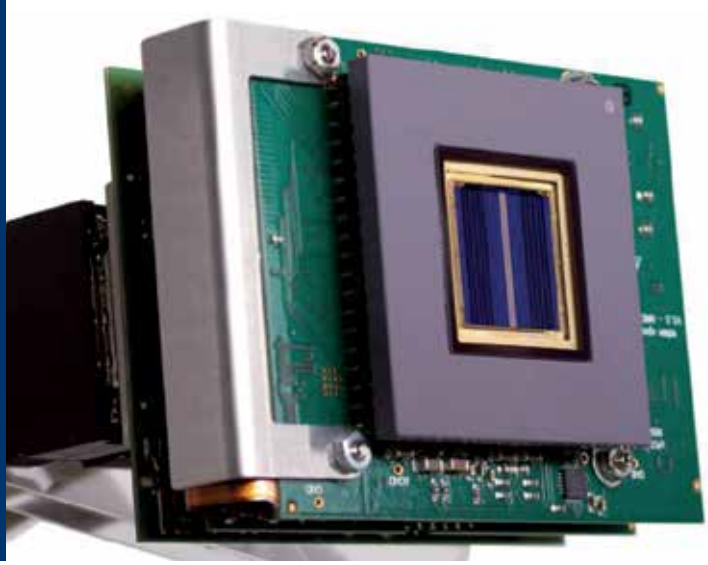
600/200 kHz High Speed RGB Line-Scan Sensor

The AIT Austrian Institute of Technology GmbH and the Fraunhofer Institute for Microelectronic Circuits and Systems (Fraunhofer IMS) developed a novel CMOS line-scan sensor xposure for applications in the field of fast optical inspection systems such as printed text checking, material analysis, surface analysis, systems used in earth-surface scanning and aerial imaging. The xposure sensor represents an important technological step towards high-speed & high quality imaging. Fraunhofer IMS fabricates the sensor in its own 0.35 µm CMOS process. The process used is certified for automotive applications.

The sensor comprises 60 lines which can be uncoated for b/w applications or coated with alternating filters (R, G, B). Every line of the sensor consists of 2K pixels. The pixel pitch is 9 µm. The horizontal fill factor is almost 100%. A patented anti Moiré effect technology is applied to the sensor. The processing of the color filters used by the xposure high-speed color line-scan sensors takes place at the Fraunhofer IMS. It is a user specific processing with multiple full RGB lines. The advantage compared to Bayer patterns lies in the dense RGB information. No interpolation (demosaicing) is needed and color artifacts at image edges are avoided.

The outstanding sensitivity of the sensor in combination with its very dense line spacing allows for using standard optics and illumination. An additional advantage of the sensor is the free adjustability of the exposure time and the line-scan frequency. Thereby, the line images can be adapted to the available amount of light and can be synchronized with the speed of the object defined by the specific application.

The pixel readout uses a correlated double sampling technique to increase signal-to-noise ratio. The sensor uses on-chip column-parallel analog-to-digital conversion, thus



eliminating the need of external high-speed ADC's. The integrated column-parallel architecture enables line readout frequencies of up to 600 kHz for the monochrome sensor version and up to 200 kHz for the color sensor version. xposure is thus the fastest line-scan sensor world-wide. Readout of a certain region of interest (ROI) or the complete 60 light sensitive lines of the chip in area-scan mode permits easy adjustment of the sensor to position it in the correct way. This reduces the costs for integrating the sensor into the inspection system.

The xposure sensor, a joint development of AIT and Fraunhofer IMS, stretches the limits of high-speed line-scan imaging and thus enables new applications with demanding speed requirements.

Parameter	Specification
Technology	Fraunhofer IMS 0.35 µm standard CMOS certified for automotive applications
High speed line-scan	600 kHz monochrome 200 kHz color
Pixel count	2K x 60
Color	multiple full RGB lines
ADC	on-chip column-parallel ADCs, 10 bit
Output format	digital, 16 channels (16 × 10 bit)
Dynamic range	53 dB
Pixel size	9 × 9 µm²
Horizontal fill factor	almost 100 %
Master clock	80 MHz
Bandwidth	1.6 Gbytes/s

Application Examples

- **Color-print inspection:** High quality color with 50 µm resolution at 10 m/s speed
- **High-speed railway inspection:** Photometric stereo with 300 kHz RB enable 0.3 mm resolution and 3D-profiling at 300 km/h train speed
- **Industrial quality inspection:** 600 kHz monochrome provide 2 µm resolution at 4.3 km/h speed
- **Inline 3D-recognition:** by photometric stereo in RGB mode
- **Plastic material recycling:** in multispectral mode using multiple filter lines
- **Security print inspection:** Lightfield camera operation enables inspection of advanced security features

3 *xposure camera system.*

4 *Silicon wafer with xposure sensor.*