



Smart Wavefront Sensor

500 Frames/Second



High speed wavefront metrology has never been easier than with the AMO WaveFront Sciences Smart Sensor. The Smart Sensor is a Shack-Hartmann wavefront sensor that incorporates an on-board dedicated processor capable of executing the complex, numerically intensive operations required to measure a rapidly changing wavefront, generate control signals for an AO element, or record wavefront data for high speed metrology. By processing the mega pixel raw image data on the sensor, the wavefront data at up to 500 frames per second are ported via conventional USB2.0 connection. By pre-processing the data, the host computer is freed to deal with other system components such as controlling AO or motion control, managing data storage or displaying data. The system interconnections are particularly simple when smart AO elements are used, e.g., USB driven AO elements (Iris AO, Berkley, CA, USA).

Hardware

The smart sensor incorporates a 10-bit, CMOS imager chip comprising 1280 X 1024 12 mm square pixels (Micron MI-MV13). The data may be read out 10 columns at a time, and the full-frame data may be read at **500 frames/s** (for integration times less than 2 ms); higher frame rates can be achieved for sub aperture readout. Provision has been made for temperature stabilization of the imager chip for high precision applications. A custom-designed array of 3038 lenslets on a 62 by 49 rectangular grid each 0.24 mm square and 24.46 mm focal length provide diffraction-limited focal spots for the slope measurements. A Field Programmable Gate Array (FPGA) controls the basic chip functions and performs various diagnostic, setup and user-definable calculations.

Software/Firmware

The software uploads the firmware onto the Smart Sensor FPGA and reads the output. A user definable vector of reference spot locations and a user-definable transfer matrix may be stored in the FPGA. The firmware provides on-board calculation of the spot displacements relative to the reference locations and is also designed to carry out a matrix multiplication suitable for a modal wavefront reconstruction or to generate control signals for AO elements, all without burdening the host computer with these arduous calculations.

The user may elect to either simply download the **6076-element spot displacement vector** or to internally multiply this vector by the user definable 6076 X 78-element transfer matrix that yields a downloadable output vector as long as 78 elements. This vector length is sufficient to produce a **real-time** polynomial wavefront fit with 78 coefficients (e.g., a **Taylor or Zernike decomposition complete to 10th order**) or to directly drive an AO element. The firmware has extensive features and diagnostic capabilities that facilitate sensor setup and enable firmware validation. These include the ability to electronically shift the portion of the image analyzed and to simultaneously download the raw image and the corresponding processed data information.

Smart Sensor Specifications

| Parameter | Specification |
|--|--------------------------------|
| Maximum Frame Rate | 500 Frames/Second ¹ |
| Zernike or Influence Function Output Terms | 78 terms ² |
| Sensitivity ³ | $\lambda/100$ |
| Dynamic Range | +/- 4 mR |
| Lenslet Size | 240 μm Square |
| Focal Length | 24.46 mm |
| Number of Lenslets | 3038 |
| Lenslet Array | 62 (h) by 49 (v) |
| Exposure Range | 2 μS to >1 S |
| Aperture Size | 14.88 by 11.76 mm |
| CMOS Pixel Size | 12 μm Square |
| Digitization Depth | 10 Bits |
| Interface | USB2.0 |
| Size | 5"(h)x4"(w)x4"(l) |
| Weight | <1.5 lbs |
| Electrical | 2.4A @ 5V DC (<12W) |

Specifications are subject to change without notice. CLAS-2D, COAS, ClearWave, and CrystalWave are trademarks of AMO WaveFront Sciences, LLC.