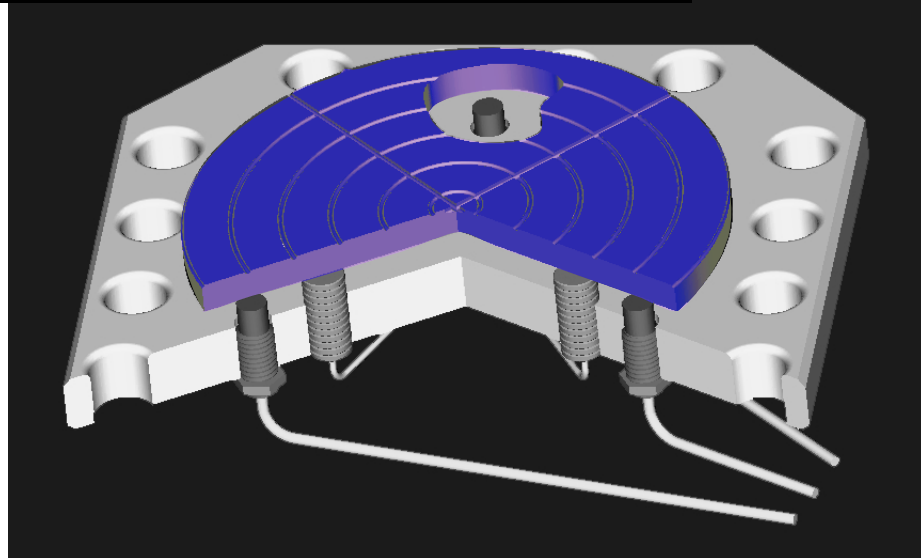


# **SMU** 9000/9200™

## Flexible systems for OEM applications



### FEATURES

- Extremely high resolution, to 1Å.
- Signal-to-noise ratio: 1 PPM.
- Precision of 0.1% of full scale, using computer correction.
- Small size for efficient system integration: 2 channels in less than 5.5 cubic inches (91 cc).
- Flexible packaging and performance.
- Multiple configurations available: 9000 single channel, 9200 dual or balanced differential operation, and three and four channel models.
- Wide range of sensor options.
- Low power consumption: less than 40 mW per channel.



## PRODUCT OVERVIEW

Kaman’s SMU-9000/9200 systems use proven inductive (eddy current) technology to measure position without contacting the target. They are ideal for applications requiring high resolution, including precision machining and grinding, spindle axial runout, mirror alignment, optical stage positioning, metrology measurements, and others.

The SMU-9000/9200 systems are based on Kaman’s proprietary Pulse Width Modulated electronics, incorporating the latest surface-mount components with printed circuit board designs. Combined with our proven eddy current sensors recognized worldwide for high reliability and outstanding quality, we provide a simple, small, stable, and highly-reliable measurement tool with extraordinarily low noise for your most demanding application.

### Meeting the price and performance requirements of OEMs

The SMU-9000/9200 are versatile enough to meet the most demanding of OEM performance and packaging requirements. Chances are, Kaman has already designed a system to measure in places

worse than what you have in mind. The SMU systems bring the right combination of position sensing performance and packaging elements together at the right price for the OEM.

Choose from a wide range of sensors with integral cable and signal conditioning electronics. Six standard sensors and their dimensions and ranges are presented on the following pages. Other sensors are available upon request. For best performance, the system should be calibrated with the actual target material.

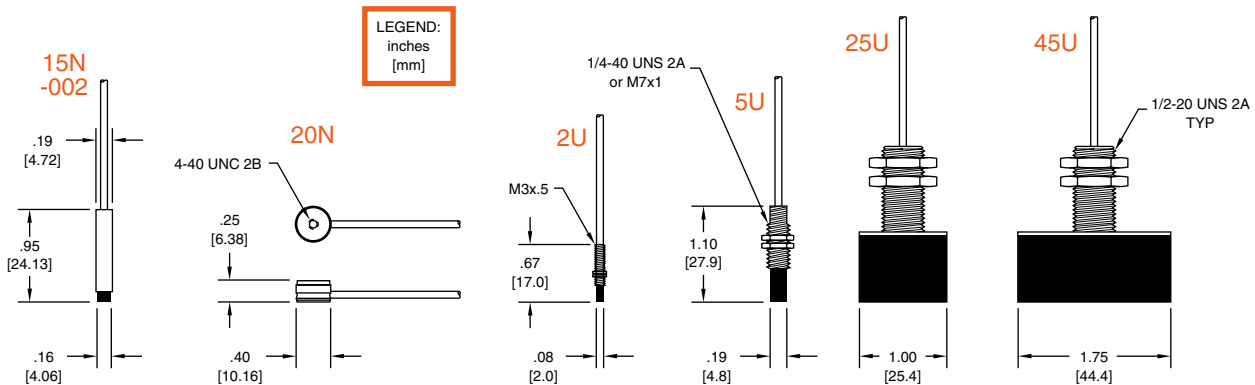
Measuring ranges in excess of 50% of sensor diameter are feasible, with trade-offs in linearity and resolution. Kaman designed these systems to offer flexibility in making these trade-offs while optimizing resolution, repeatability, thermal stability, linearity, packaging, and price for your application.

### Linearity and temperature trade-offs

In general, systems with the best linearity will not yield the best thermal stability; systems set up for the best thermal stability will be less linear.

As a rule, a sensor set up for a measuring range equal to about 10% of its diameter against a non-magnetic target will be linear to 1% with thermal

## SMU SENSORS



SENSOR TYPE		15N**	20N**	2U**	5U**	25U	45U
Offset*	in. (mm)	.01 (.25)	.04 (1.00)	.002 (.05)	.004 (.10)	.040 (1.00)	.140 (3.50)
Range (FSR)*	in. (mm)	.03 (.88)	.07 (1.27)	.02 (.50)	.05 (1.25)	.20 (5.00)	.48 (12.00)

\* Typical parameters for an aluminum target. \*\* For use with nonmagnetic targets only.

Operating temperature: Electronics: 0°F to +150°F (-20°C to +65°C). Sensors: -67°F to +220°F (-55°C to +105°C).

Storage temperature: -55°C to +105°C (-67°F to +220°F).

stability of 0.05% full scale output (FSO)/°C. At this range, if optimal linearity is needed, the system can be adjusted to provide nonlinearity of less than 1% while the temperature stability decreases (temperature coefficient = 0.05% FSO/°C). Likewise, if temperature is the more critical parameter, at this range the temperature coefficient can be as low as 0.01% FSO/°C with nonlinearity increasing to ±3% typically. Fifth order polynomial curve fit linearity coefficients can be provided for use in customer processors to achieve linearity performance of ~0.01% FS.

Often, when considered early in the design cycle, these trade-offs are easily managed through the proper choice of measuring range, sensor size, and target material. With computer modeling, we can provide you with a specification unique to your application. At the same time, we provide preliminary drawings of the sensor and electronics, as well as mounting provisions, operating and storage temperatures, and other parameters.

## Custom and standard packaging/sensors

Custom packaging and sensor designs are also available. These include signal conditioning electronics integral to the sensor for three-wire operation (+6 to +30 Vdc, common, and signal out). The minimum package size for integral sensors is 15 mm x 45 mm. Smaller sensors will require signal conditioning electronics separate from the sensor itself. Multiple channels, synchronized and on a single PC board, are also available.

While the SMU-9000/9200 were designed to be customized, Kaman does offer standard sensors and packaging. Many applications do not require customizing, while others benefit from a proof of concept measurement study. In either case, an off-the-shelf part will help to speed delivery time. Standard sensors and specifications are shown on *page 5*.

## EXAMPLES OF CURRENT APPLICATIONS

### AIRCRAFT MANUFACTURING: DYNAMIC RIVET HEIGHT INSPECTION

*The small 2U sensor provides the needed range and fits the limited space available in this dynamic inspection system that measures rivet height and uniformity. Nonlinearity is not important in this application due to computer correction.*

**Part number:** Custom system.

**Sensor:** 2U, 3 channels.

**Target material:** Aluminum.

**Offset:** 0.5 mm.

**Range:** 0.5 mm.

**Nonlinearity:** ±10% FSO.

**Resolution:**

*Static:* <math>50 \times 10^{-9}</math> meter.

*Dynamic:* <math>5.0 \times 10^{-9}</math> meter/root Hz.

**Sensitivity:** 10 V/mm.

**Power supply requirements:**

*Input voltage:* +7.5 to +30 Vdc.

*Input current:* 15 mA per channel.

**Frequency response:** Static to 10 kHz (-3 dB).

**Cable length:** 2 meters, RG-178.



**Output, full range:**

*Analogue:* 0 to 5 Vdc.

*Impedance:* 100 Ω.

**Temperature coefficient:**

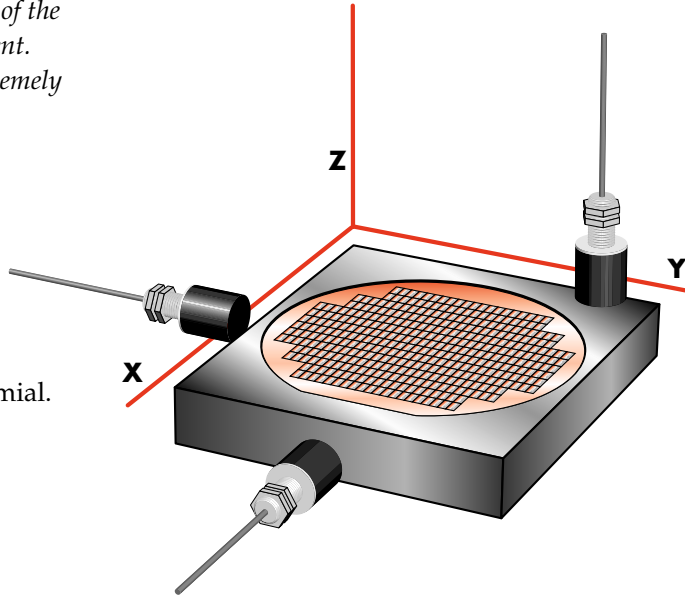
<math>< 0.5 \mu\text{m}/^\circ\text{C}</math> (10.0 μinch/°F).

**EXAMPLES OF CURRENT APPLICATIONS**

**HIGH-PRECISION 3-CHANNEL PHOTOLITHOGRAPHY STAGE POSITION**

*This system is designed to be an integral part of the latest generation of photolithography equipment. Feedback from Kaman's sensors allow for extremely precise 3-axis positioning of the stage.*

- Part number:** 854562-001.
- Sensor:** 16U, 3 channel system.
- Target material:** Aluminum.
- Offset:** 0.5 mm.
- Range:** 1.6 mm.
- Nonlinearity:**  
 $\pm 7.0\%$ ;  $\pm 0.1\%$  using 5th order polynomial.
- Resolution:** *Static:*  $< 25 \times 10^{-9}$  meter.  
*Dynamic:*  $< 2.5 \times 10^{-9}$  meter / root Hz.
- Sensitivity:** 12.5 V/mm.
- Power supply requirements:**  
*Input voltage:*  $\pm 15$  Vdc.  
*Input current:* 15 mA per channel.
- Frequency response:** Static to 10 kHz (-3 dB).
- Cable length:** 1.0 meter.
- Output, full range:** *Analog:*  $\pm 10.0$  Vdc.
- Temperature coefficient:**  
 $< 2 \mu\text{m}/^\circ\text{C}$  ( $40 \mu\text{inch}/^\circ\text{F}$ ).



- Enclosure:** Die cast metal.  
 3.2 in x 2.8 in x 2.3 in, gray enamel paint.

**HIGH-PRECISION 1-CHANNEL PHOTOLITHOGRAPHY STAGE POSITION**

*Kaman's system provides feedback for positioning the optical head in a photolithography process. High resolution and extremely good repeatability are critical.*

- Part number:** 853834-001.
- Sensor:** 15N, 1 channel.
- Target material:** Aluminum.
- Offset:** 0.25 mm.
- Range:** 25  $\mu\text{m}$ .
- Nonlinearity:**  $\pm 1\%$  FSO.
- Resolution:** *Static:*  $< 25 \times 10^{-11}$  meter.  
*Dynamic:*  $< 2.5 \times 10^{-11}$  meter / root Hz.

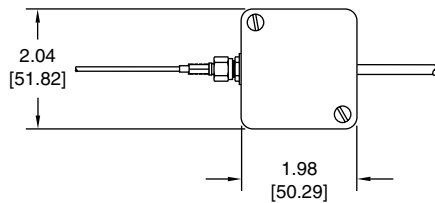
- Sensitivity:** 0.4 V/ $\mu\text{m}$ .
- Power supply requirements:**  
*Input voltage:* +12 to +30 Vdc.  
*Input current:* 15 mA per channel.
- Frequency response:** Static to 10 kHz (-3 dB).
- Cable length:** 0.5 meter, RG-178.
- Output, full range:** *Analog:* 0 to 10 Vdc.  
*Impedance:* 100  $\Omega$ .
- Temperature coefficient:**  
 $< 0.5 \mu\text{m}/^\circ\text{C}$  ( $10.0 \mu\text{inch}/^\circ\text{F}$ ).

### TYPICAL APPLICATIONS

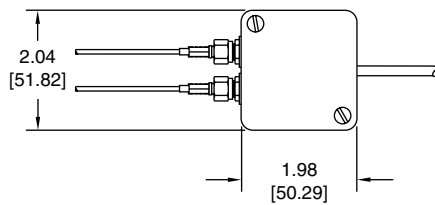
- Optical stage position measurement
- Semiconductor and optics polishing and grinding
- Semiconductor mask alignment stepper systems
- Vapor deposition systems
- Scanning electron microscope - vertical axis positioning
- Atomic force microscopy - vertical axis positioning
- Magnetic bearing suspension control
- Fine positioning for parts grinding and precision machining
- Aircraft rivet height inspection
- Mirror steering
- Material compression testing measurement
- Mechanical structure creep detection and testing

### ELECTRONICS CONFIGURATIONS

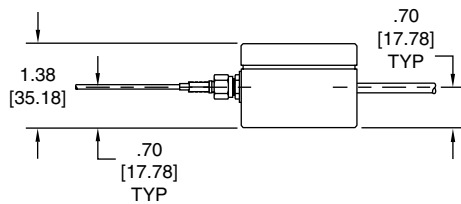
*Die cast aluminum enclosure*



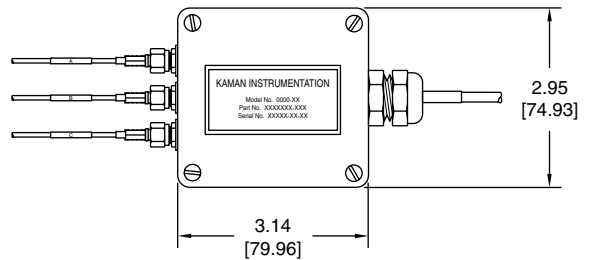
*Single-channel system. Top view.*



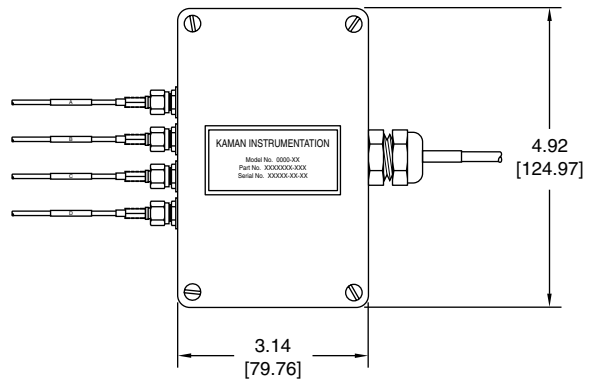
*Dual-channel system. Top view.*



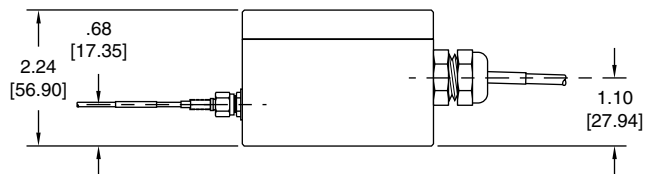
*Single- and dual-channel systems. Side view.*



*Three-channel system. Top view.*



*Four-channel system. Top view.*



*Three- and four-channel systems. Side view.*

