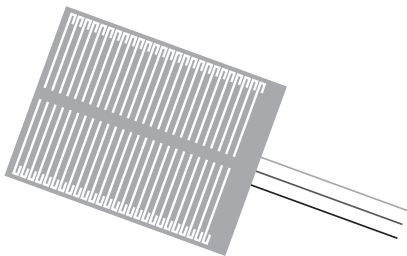


**1 YEAR**  
WARRANTY

MADE IN  
**USA**



# User's Guide



**Shop online at**

**omega.com<sup>®</sup>**

Ω OMEGA<sup>®</sup>

**omega.com**

**e-mail: [info@omega.com](mailto:info@omega.com)**

**For latest product manuals:  
[omegamanual.info](http://omegamanual.info)**

**ISO 9001**  
CERTIFIED  
CORPORATE QUALITY

STAMFORD, CT

**ISO 9002**  
CERTIFIED  
CORPORATE QUALITY

MANCHESTER, UK

# HFS-3, HFS-4

## Thin Film Flux Sensors

**omega.com**<sup>®</sup>

ΩOMEGA

OMEGAnet<sup>®</sup> On-Line Service  
omega.com

Internet e-mail  
info@omega.com

### Servicing North America:

U.S.A.: ISO 9001 Certified  
One Omega Drive, Box 4047  
Stamford, CT 06907-0047  
Tel: (203) 359-1660  
FAX: (203) 359-7700  
e-mail: info@omega.com

Canada:  
976 Bergar  
Laval (Quebec) H7L 5A1, Canada  
Tel: (514) 856-6928  
FAX: (514) 856-6886  
e-mail: info@omega.ca

### For immediate technical or application assistance:

U.S.A. and Canada:  
Sales Service: 1-800-826-6342/1-800-TC-OMEGA<sup>®</sup>  
Customer Service: 1-800-622-2378/1-800-622-BEST<sup>®</sup>  
Engineering Service: 1-800-872-9436/1-800-USA-WHEN<sup>®</sup>

Mexico:  
En Español: (001) 203-359-7803  
FAX: (001) 203-359-7807  
e-mail: espanol@omega.com  
info@omega.com.mx

### Servicing Europe:

**Czech Republic:**  
Frystatska 184, 733 01 Karviná, Czech Republic  
Tel: +420 (0)59 6311899  
FAX: +420 (0)59 6311114  
Toll Free: 0800-1-66342  
e-mail: info@omegashop.cz

**Germany/Austria:**  
Daimlerstrasse 26, D-75392  
Deckenpfronn, Germany  
Tel: +49 (0)7056 9398-0  
FAX: +49 (0)7056 9398-29  
Toll Free in Germany: 0800 639 7678  
e-mail: info@omega.de

**United Kingdom:**  
ISO 9002 Certified  
One Omega Drive  
River Bend Technology Centre  
Northbank, Irlam  
Manchester M44 5BD United Kingdom  
Tel: +44 (0)161 777 6611 FAX: +44 (0)161 777 6622  
Toll Free in United Kingdom: 0800-488-488  
e-mail: sales@omega.co.uk

---

It is the policy of OMEGA Engineering, Inc. to comply with all worldwide safety and EMC/EMI regulations that apply. OMEGA is constantly pursuing certification of its products to the European New Approach Directives. OMEGA will add the CE mark to every appropriate device upon certification.

The information contained in this document is believed to be correct, but OMEGA accepts no liability for any errors it contains, and reserves the right to alter specifications without notice.

**WARNING:** These products are not designed for use in, and should not be used for, human applications.

	<b>Page</b>
<b>Chapter 1 General Information .....</b>	<b>1-1</b>
<b>Chapter 2 Installing the Sensor .....</b>	<b>2-1</b>
<b>Chapter 3 Principle of Operation .....</b>	<b>3-1</b>
<b>Chapter 4 Typical Applications .....</b>	<b>4-1</b>
<b>Chapter 5 Specifications .....</b>	<b>5-1</b>



**HFS-3, HFS-4**  
**Thin Film Heat Flux Sensors**

---

**NOTES:**

### UNPACKING

Remove the Packing List and verify that you have received all equipment. If you have any questions about the shipment, please call the OMEGA Customer Service Department at **1-800-622-2378** or **(203) 359-1660**. We can also be reached on the Internet at **omega.com**  
**e-mail: cservive@omega.com**

When you receive the shipment, inspect the container and equipment for any signs of damage. Note any evidence of rough handling in transit. Immediately report any damage to the shipping agent.

---

**NOTE**

---

The carrier will not honor any claims unless all shipping material is saved for their examination. After examining and removing contents, save packing material and carton in the event reshipment is necessary.

---

The OMEGA® HFS Series Sensors are designed for precise measurement of heat transfer through any material. They can be mounted on flat or curved surfaces, and have very low thermal profiles for efficient readings. The sensors are available with or without an integral thermocouple for discrete temperature measurement, and are available in two different sensitivity ranges. Refer to Table 1-1.

**Table 1-1. Available Models**

---

HFS-3	4-wire Sensor with Thermocouple (sensitivity of 3.0*)
-------	---

---

HFS-4	4-wire Sensor with Thermocouple (sensitivity of 6.5*)
-------	---

---

(\*  $\mu\text{V}/\text{BTU}/\text{ft}^2\text{Hr}$ )

The heart of the HFS Series Sensors is a differential thermocouple sensor. A thin foil, 50 plus junction thermopile is bonded to either side of a Kapton barrier, which has known thermal characteristics. Since the heat transfer rate is directly proportional to the temperature difference across the thermal barrier, the exact rate of transfer can be calculated by measuring this difference.

Copper/constantan junctions are formed and wired in series on alternating sides of the Kapton core. Copper output leads are then attached, one to the first junction on the upper surface, and one from the last junction of the lower surface. Refer to Figure 1-1. As a result, the sensor can be directly interfaced to a standard microvolt meter with no cold-junction compensation required.

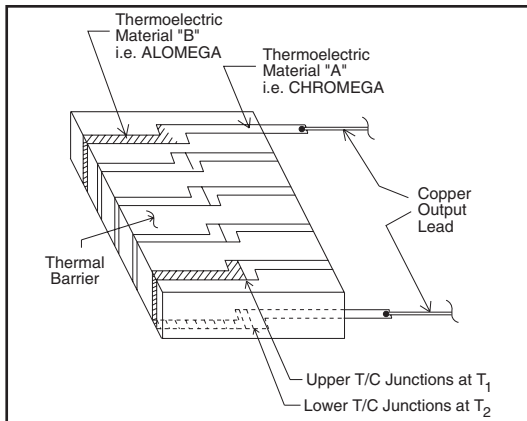


Figure 1-1. Construction of the Sensors



## 2

## Installing the Sensor

---

Because of their thin profile and overall flexibility, you can install the HFS Series Sensors on nearly any flat or curved surface and bonded in place using conventional epoxies or adhesives. You can also use double adhesive-backed Mylar tape, OMEGA's OB-200 epoxy, and thin polyester tape on the sensors.

### **Instrumentation to Use**

The HFS heat flow sensors are self-generating devices requiring no external voltage or current stimulation. The voltage output from the device is readable with any commercially available voltmeter which has microvolt resolution. Alternatively, a process meter with engineering units scalability can be used to directly display in BTU/ft<sup>2</sup> Hr.

For example:

An HFS Sensor is installed which has a sensitivity of 6.37 microvolts per BTU/ft<sup>2</sup> Hr. An OMEGA CN3000 controller is available to provide display and control ability. The CN3000 will take a 0 to 100mV input, and has a span of 31,565 engineering counts. When producing a voltage level of 100mV, the sensor is measuring:

$$\frac{100 \times 10^{-3}}{6.37 \times 10^{-6}} = 15,699 \text{ BTU / ft}^2\text{Hr}$$

Since 15,699 is well within the maximum display reading of 31,565 available on the CN3000, the controller can then be programmed to display zero at 0mV and 15,699 at 100mV.

In addition, HFS sensors are often connected to chart recorders, data loggers, or totalizers in order to record a running tally of total heat transfer through a given surface. Refer to Figure 2-1.

## Wiring

### HFS-3 and HFS-4

White	=	-	] connections for heat flux measurement
Red	=	+	
Yellow	=	+	] connections for Type K thermocouple hookup
Red	=	-	

## 2

## Installing the Sensor

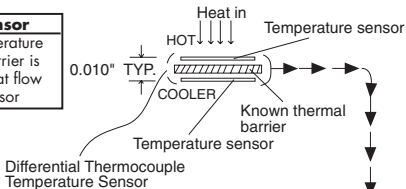
## HEAT FLOW MEASUREMENT INSTALLATION AND HOW IT WORKS

**Heat Flow Sensor**

Difference in temperature across thermal barrier is proportional to heat flow through the sensor

Digital display of heat flow through the heat flow sensor  
Positive (+) for heat going into surface sensor is mounted on; negative (-) for heat flowing out of surface. Either BTU/FT<sup>2</sup>HR or WATT/M<sup>2</sup> by switch selection.

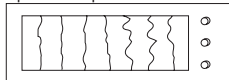
Note: 1 BTU/FT<sup>2</sup> HR = 3.15 W/M<sup>2</sup>, approx.



Heat flow meter



Optional Strip Chart Recorder



Records Rate in BTU/FT<sup>2</sup> HR  
or WATTS/METER<sup>2</sup>

Figure 2-1. Hooking Up Sensor with Instruments



### 3

## Principle of Operation

---

Only one pair of junctions is actually needed for a working sensor; however, the output signal and sensitivity are directly proportional to the number of junctions placed in series. As a result, we use multiple junctions to provide an easily readable, amplified output.

The sensor output signal is generated as follows: The sensor is placed in intimate contact with the surface for which the heat transfer rate is to be calculated. The same energy must flow through the HFS sensor as through the surface to which it is attached. When this happens, a temperature gradient,  $\Delta T$ , is formed across the thermal barrier. This gradient is directly proportional to the heat transfer rate. The dual thermopiles measure the magnitude of this gradient and provide a calibrated voltage output easily readable on any micro-voltmeter.

<b>Notes</b>
--------------

---

---

---

---

---

---

---

---

---

---



## 4

# Typical Applications

---

OMEGA's HFS Series heat flux sensors have found applications in a wide variety of research, industrial and commercial fields. Some of the most popular applications include

- measurement of insulating material heat transfer rates, particularly in the construction industry
- heat loss measurement in process mixing vessels and steam piping
- process control in rolling mills and glass production
- aerodynamic wind tunnel studies.

In all applications, the primary function of the heat flow sensor is to provide a measurement of the thermal energy transfer per unit of time per unit area. This is generally expressed in BTU/ft<sup>2</sup>Hr or watts/m<sup>2</sup>.

<b>Notes</b>
--------------

---

---

---

---

---

---

---

---

---

---



## 5

# Specifications

## General

Upper Temperature Limit:	300°F
Number of Junctions:	50+
Carrier:	Polyimide film (Kapton)
Sensor Resistance:	160 approximately
Lead Wires:	#30 AWG Solid, Teflon insulated color coded, 10 feet long
Dimensions:	See Figure 5-1

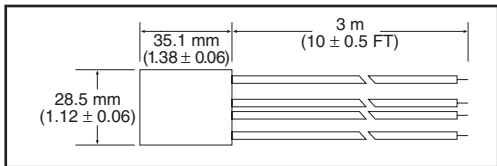


Figure 5-1. Dimensions

---

**Nominal Sensitivity ( $\mu\text{V}/\text{BTU}/\text{ft}^2\text{Hr}$ )**

---

HFS-3:	3.0
HFS-4:	6.5

---

**\*Max recommended heat flux ( $\text{BTU}/\text{ft}^2\text{Hr}$ )**

---

HFS-3:	30,000
HFS-4:	30,000

---

\*exceeding the maximum recommended heat flux can result in a large enough temperature rise to cause delamination of the Kapton bonding material. The given maximum values assume a 100°F ambient temperature.

---

**Integral Thermocouple (Type K)**

---

HFS-3:	Yes
HFS-4:	Yes

---

**Response Time (seconds)**

---

HFS-3:	0.20
--------	------

HFS-4:	0.20
--------	------

---

**Thermal Capacitance (BTU/ft<sup>2</sup>°F)**

---

HFS-3:	0.01
--------	------

HFS-4:	0.01
--------	------

---

**Thermal Resistance (°F/BTU/ft<sup>2</sup>Hr)**

---

HFS-3:	0.01
--------	------

HFS-4:	0.01
--------	------

---

**Nominal Thickness (inches)**

---

HFS-3:	0.007
--------	-------

HFS-4:	0.007
--------	-------

---

**Notes**



## WARRANTY/DISCLAIMER

OMEGA ENGINEERING, INC. warrants this unit to be free of defects in materials and workmanship for a period of **13 months** from date of purchase. OMEGA's WARRANTY adds an additional one (1) month grace period to the normal **one (1) year product warranty** to cover handling and shipping time. This ensures that OMEGA's customers receive maximum coverage on each product.

If the unit malfunctions, it must be returned to the factory for evaluation. OMEGA's Customer Service Department will issue an Authorized Return (AR) number immediately upon phone or written request. Upon examination by OMEGA, if the unit is found to be defective, it will be repaired or replaced at no charge. OMEGA's WARRANTY does not apply to defects resulting from any action of the purchaser, including but not limited to mishandling, improper interfacing, operation outside of design limits, improper repair, or unauthorized modification. This WARRANTY is VOID if the unit shows evidence of having been tampered with or shows evidence of having been damaged as a result of excessive corrosion; or current, heat, moisture or vibration; improper specification; misapplication; misuse or other operating conditions outside of OMEGA's control. Components in which wear is not warranted, include but are not limited to contact points, fuses, and triacs.

**OMEGA is pleased to offer suggestions on the use of its various products. However, OMEGA neither assumes responsibility for any omissions or errors nor assumes liability for any damages that result from the use of its products in accordance with information provided by OMEGA, either verbal or written. OMEGA warrants only that the parts manufactured by the company will be as specified and free of defects. OMEGA MAKES NO OTHER WARRANTIES OR REPRESENTATIONS OF ANY KIND WHATSOEVER, EXPRESSED OR IMPLIED, EXCEPT THAT OF TITLE, AND ALL IMPLIED WARRANTIES INCLUDING ANY WARRANTY OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE HEREBY DISCLAIMED. LIMITATION OF LIABILITY: The remedies of purchaser set forth herein are exclusive, and the total liability of OMEGA with respect to this order, whether based on contract, warranty, negligence, indemnification, strict liability or otherwise, shall not exceed the purchase price of the component upon which liability is based. In no event shall OMEGA be liable for consequential, incidental or special damages.**

CONDITIONS: Equipment sold by OMEGA is not intended to be used, nor shall it be used: (1) as a "Basic Component" under 10 CFR 21 (NRC), used in or with any nuclear installation or activity; or (2) in medical applications or used on humans. Should any Product(s) be used in or with any nuclear installation or activity, medical application, used on humans, or misused in any way, OMEGA assumes no responsibility as set forth in our basic WARRANTY/DISCLAIMER language, and, additionally, purchaser will indemnify OMEGA and hold OMEGA harmless from any liability or damage whatsoever arising out of the use of the Product(s) in such a manner.

## RETURN REQUESTS/INQUIRIES

Direct all warranty and repair requests/inquiries to the OMEGA Customer Service Department. BEFORE RETURNING ANY PRODUCT(S) TO OMEGA, PURCHASER MUST OBTAIN AN AUTHORIZED RETURN (AR) NUMBER FROM OMEGA'S CUSTOMER SERVICE DEPARTMENT (IN ORDER TO AVOID PROCESSING DELAYS). The assigned AR number should then be marked on the outside of the return package and on any correspondence. The purchaser is responsible for shipping charges, freight, insurance and proper packaging to prevent breakage in transit.

FOR **WARRANTY** RETURNS, please have the following information available BEFORE contacting OMEGA:

1. Purchase Order number under which the product was PURCHASED,
2. Model and serial number of the product under warranty, and
3. Repair instructions and/or specific problems relative to the product.

FOR **NON-WARRANTY** REPAIRS, consult OMEGA for current repair charges. Have the following information available BEFORE contacting OMEGA:

1. Purchase Order number to cover the COST of the repair,
2. Model and serial number of the product, and
3. Repair instructions and/or specific problems relative to the product.

OMEGA's policy is to make running changes, not model changes, whenever an improvement is possible. This affords our customers the latest in technology and engineering. OMEGA is a registered trademark of OMEGA ENGINEERING, INC. © Copyright 2007 OMEGA ENGINEERING, INC. All rights reserved. This document may not be copied, photocopied, reproduced, translated, or reduced to any electronic medium or machine-readable form, in whole or in part, without the prior written consent of OMEGA ENGINEERING, INC.

# Where Do I Find Everything I Need for Process Measurement and Control?

## OMEGA...Of Course!

*Shop online at [omega.com](http://omega.com)*

### TEMPERATURE

- ☑ Thermocouple, RTD & Thermistor Probes, Connectors, Panels & Assemblies
- ☑ Wire: Thermocouple, RTD & Thermistor
- ☑ Calibrators & Ice Point References
- ☑ Recorders, Controllers & Process Monitors
- ☑ Infrared Pyrometers

### PRESSURE, STRAIN AND FORCE

- ☑ Transducers & Strain Gages
- ☑ Load Cells & Pressure Gages
- ☑ Displacement Transducers
- ☑ Instrumentation & Accessories

### FLOW/LEVEL

- ☑ Rotameters, Gas Mass Flowmeters & Flow Computers
- ☑ Air Velocity Indicators
- ☑ Turbine/Paddlewheel Systems
- ☑ Totalizers & Batch Controllers

### pH/CONDUCTIVITY

- ☑ pH Electrodes, Testers & Accessories
- ☑ Benchtop/Laboratory Meters
- ☑ Controllers, Calibrators, Simulators & Pumps
- ☑ Industrial pH & Conductivity Equipment

### DATA ACQUISITION

- ☑ Data Acquisition & Engineering Software
- ☑ Communications-Based Acquisition Systems
- ☑ Plug-in Cards for Apple, IBM & Compatibles
- ☑ Datalogging Systems
- ☑ Recorders, Printers & Plotters

### HEATERS

- ☑ Heating Cable
- ☑ Cartridge & Strip Heaters
- ☑ Immersion & Band Heaters
- ☑ Flexible Heaters
- ☑ Laboratory Heaters

### ENVIRONMENTAL MONITORING AND CONTROL

- ☑ Metering & Control Instrumentation
- ☑ Refractometers
- ☑ Pumps & Tubing
- ☑ Air, Soil & Water Monitors
- ☑ Industrial Water & Wastewater Treatment
- ☑ pH, Conductivity & Dissolved Oxygen Instruments