1 YEAR WARRANTY

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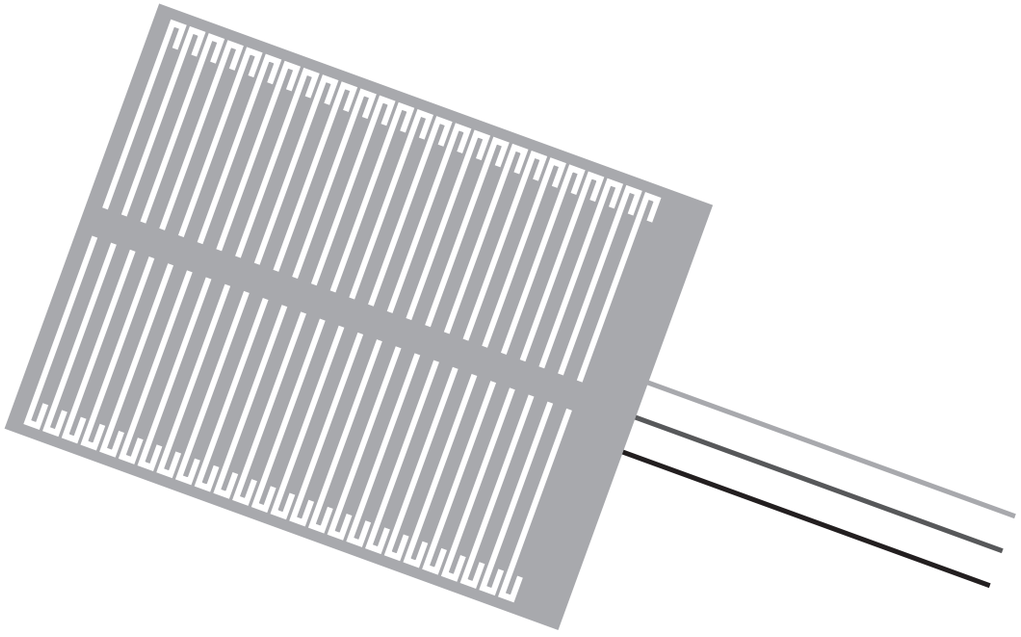
User's Guide



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HFS-3, HFS-4
Thin Film Flux Sensors

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Toll-Free: 1-800-826-6342 TEL: (203) 359-1660
FAX: (203) 359-7700 e-mail: info@omega.com

Canada:
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Toll-Free: 0800 6397678 TEL: +49 (0) 7056 9398-0
FAX: +49 (0) 7056 9398-29 e-mail: info@omega.de

United Kingdom:
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OMEGA Engineering Ltd., One Omega Drive
River Bend Technology Centre
Northbank, Irlam,
Manchester M44 5BD United Kingdom
Toll-Free: 0800-488-488
TEL: +44 (0) 161 777-6611
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HFS-3, HFS-4
Thin Film Heat Flux Sensors

NOTES:

1 General Information

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.

1 General Information

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*)

(* μV/BTU/ft^{2}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/constanton 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.

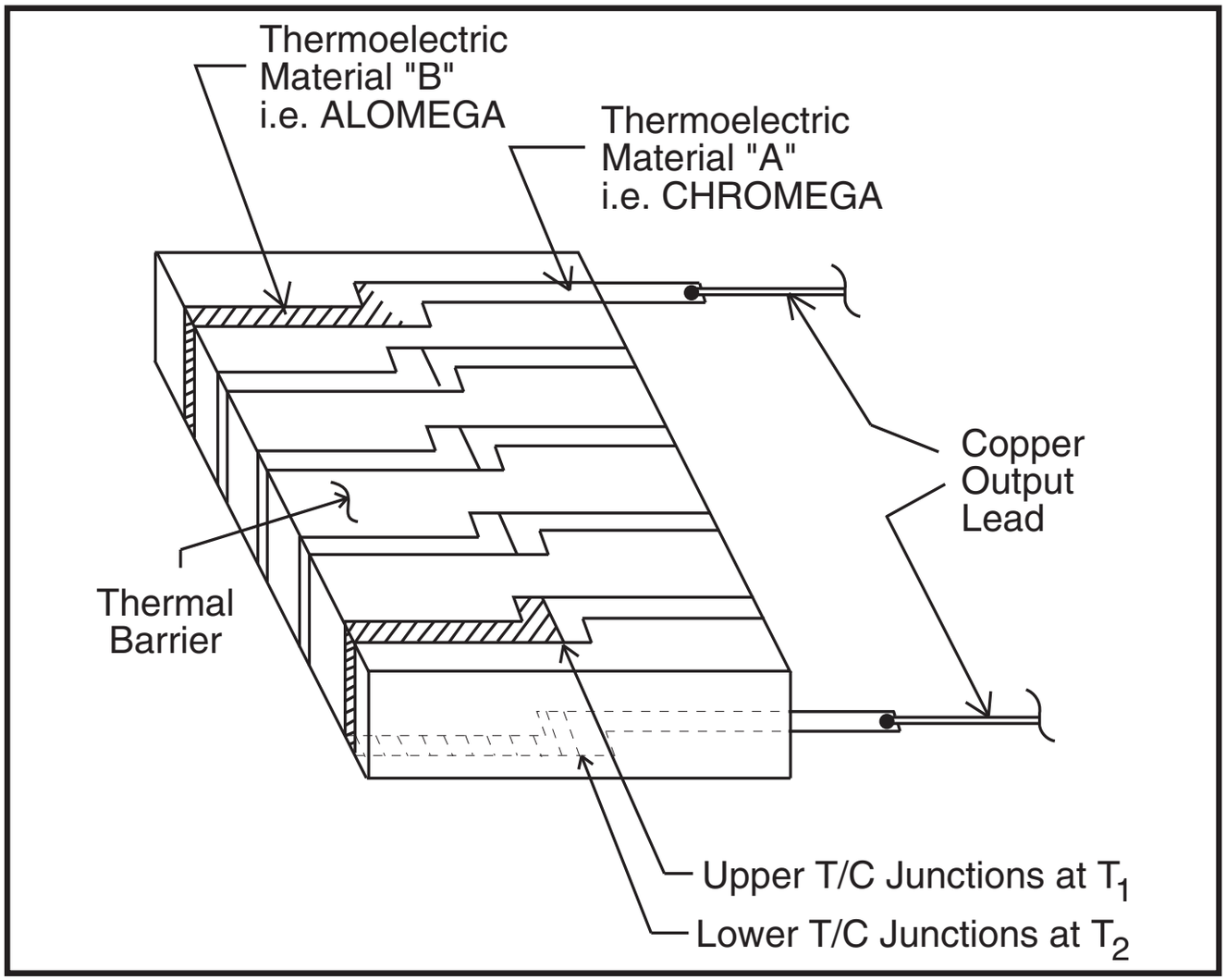

Figure 1-1. Construction of the Sensors

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^2 Hr.

For example:

An HFS Sensor is installed which has a sensitivity of 6.37 microvolts per BTU/ft2 Hr. An OMEGA DP41-E meter is available to provide a display. The DP41-E meter will take a 0 to 100mV input, and has a span of 500,000 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 500,000 available on the DP41-E, the meter 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	=	–	

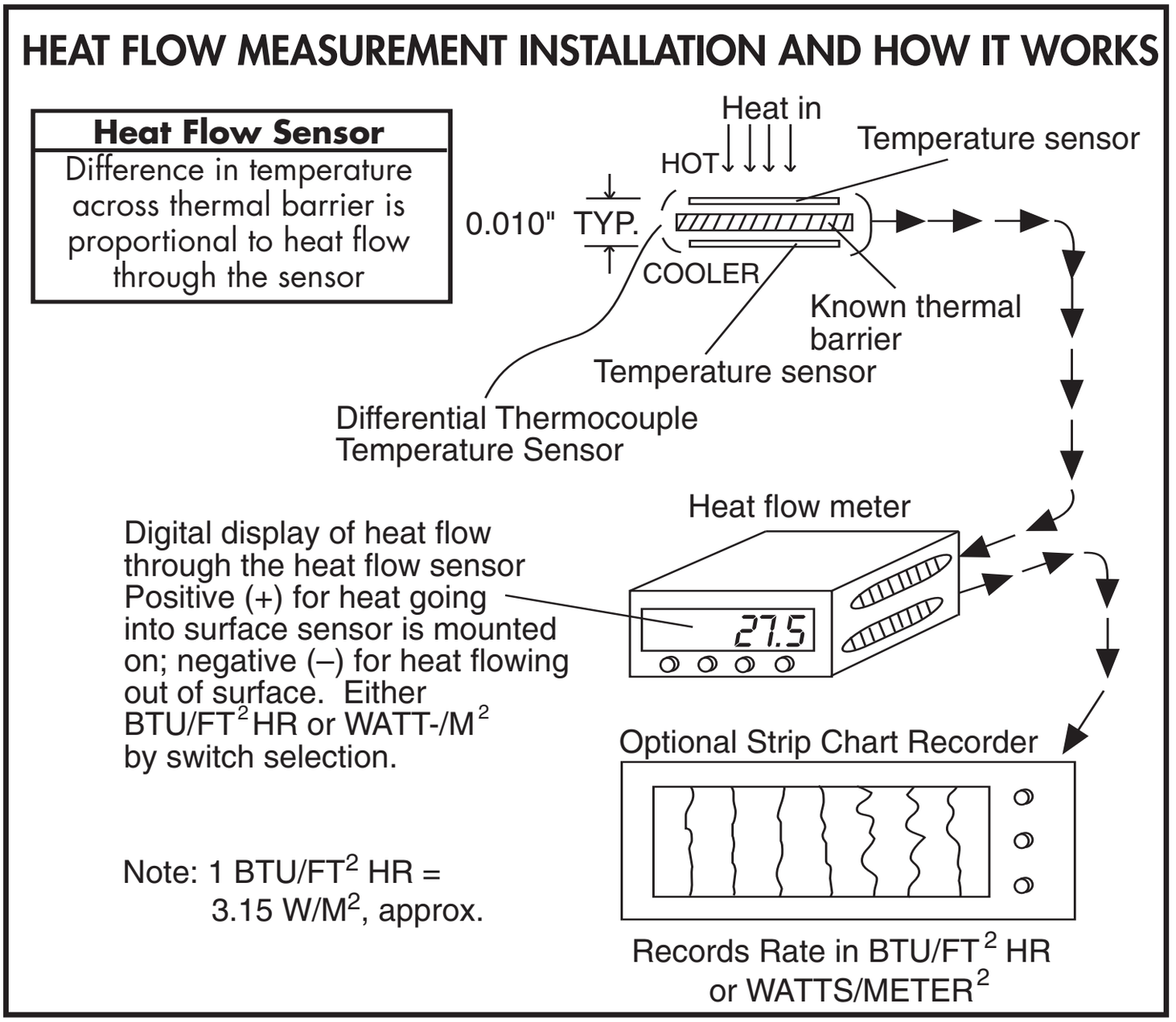

Figure 2-1. Hooking Up Sensor with Instruments

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, ΔT, 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.

Notes

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 expresses in BTU/ft^2Hr or $watts/m^2$.

Notes

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

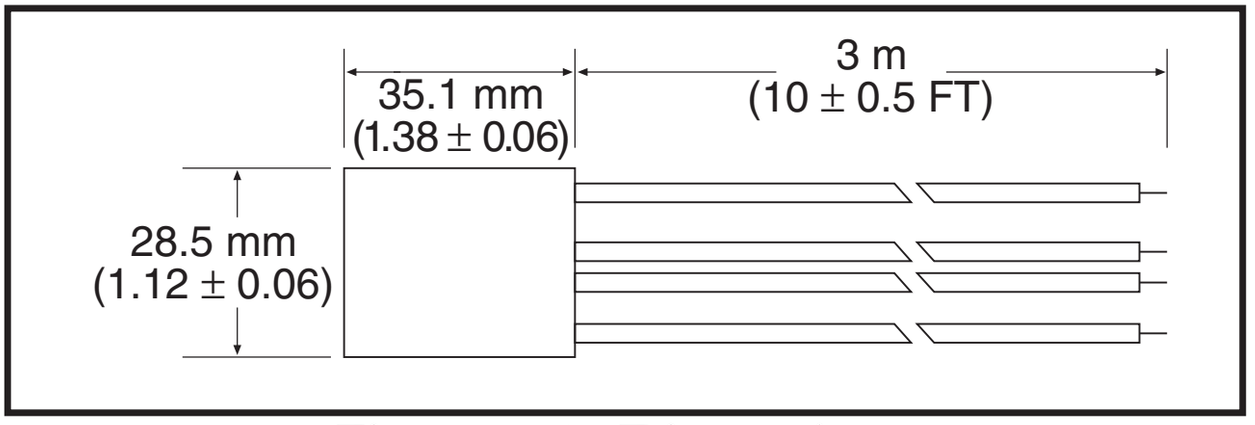

Figure 5-1. Dimensions

Nominal Sensitivity (μV/BTU/ft²Hr)

HFS-3:	3.0
HFS-4:	6.5

*Max recommended heat flux (BTU/ft²Hr)

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/ft²°F)	
HFS-3:	0.01
HFS-4:	0.01
Thermal Resistance (°F/BTU/ft²Hr)	
HFS-3:	0.01
HFS-4:	0.01
Nominal Thickness (inches)	
HFS-3:	0.007
HFS-4:	0.007

Notes

Notes

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.

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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.

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