USER'S MANUAL

UV-J1002-REG

ENTRANCE OPTIC FOR GLOBAL IRRADIANCE MEASUREMENTS

Calibration • Measurement • Softwaresolution
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1 System Overview

This manual outlines the entrance optic ‘UV-J1002’ for measuring spectral UV irradiance with a spectrophotometer and a quartz light guide in between. The first system was installed in 1998. The system provides a considerably improved measurement accuracy in comparison to the traditional flat input optic. The direct cosine error of this system is typically less than 3% for incidence angles between 0° and 70°.The integral cosine error for isotropic radiation is less than 2.5%.

This system was extended in 2003 by the possibility of an external temperature regulation (UV-J1002-HEATING-REG).

Since 2004 the improved version ‘UV-J1002-REG’ of the global input optic ‘UV-J1002’ with internal temperature regulation is available. The mechanical dimensions are still the same.

The traditionally used flat entrance optic underestimates the true global solar irradiance by a factor of up to and exceeding 10%. This factor is not constant but depends on the time of day and the atmospheric conditions.

The entrance optic ‘UV-J1002-REG’ is flexible enough to be easily installed on every light guide and spectrophotometer. An initial adjustment to the light guide is required.

2 Technical Specification

2.1 Drawing UV-J1002

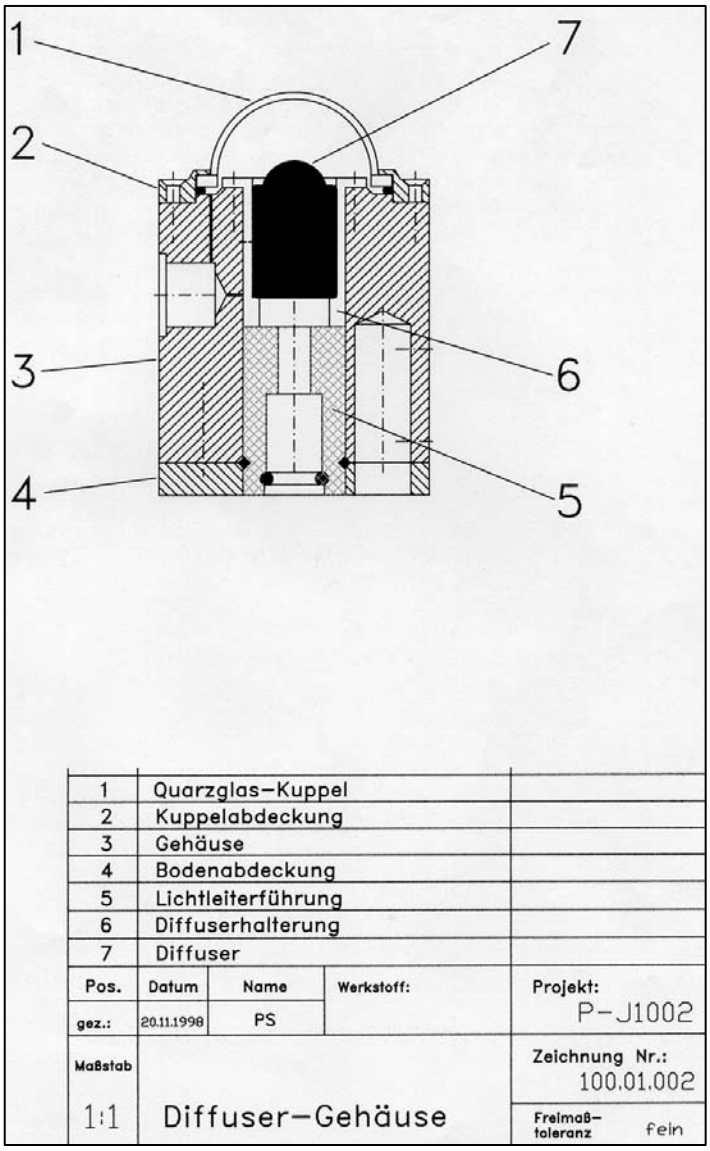

Figure 1 View UV-J1002

1 QUARTZ DOME

2 HOLDER QUARTZ DOME

3 HOUSING
diameter 58mm

4 GROUND COVERING

5 FLANGE for FIBRE
The fibre is fixed in a flange with 3 screws. The fibre is tilted in the flange to guarantee that the optical axis of the fibre is the same as its mechanical axis. If the optical axis deviates from the mechanical axis, an azimuthal error (of about 10%) may appear. By tilting the fibre the error in the azimuth disappears (< 1.5%).

6 FLANGE for DIFFUSER

7 DIFFUSER

SILICA
blue =< 8% relative humidity
slight red = silica is out of order, replace the cartridge

MONTAGE BAR
A standard opening for a standard bar allows an easy positioning of the housing with the spirit level. A bar with a diamater of 12mm has to be fixed in the hole of the housing with 2 screws.

In the entrance optic ‘UV-J1002-REG’ the Quartz dome (Part 1 in Figure 1) and the Holder Quartz dome (Part 2 in Figure 1) are replaced by one single Quartz dome ‘UV-J1002-DOM2’

2.2 Description Entrance Optic

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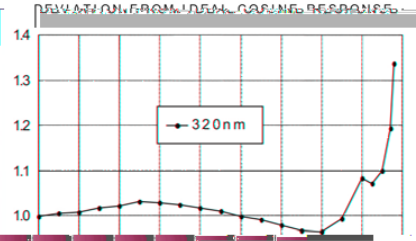

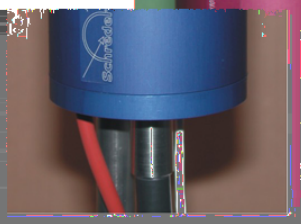

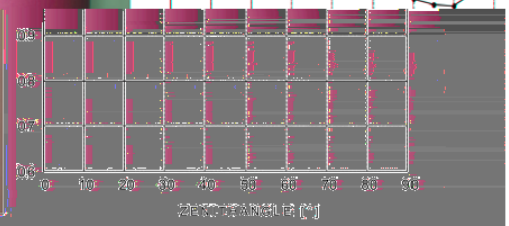

APPLICATION

The input optic provides a considerably improved measurement accuracy when compared to traditional optics. The diffuser has a weatherproof housing with an internal temperature regulation and is designed for use with a quartz fibre. The cosine error is less than 3 % for incidence angles between 0° an 70° and therefore the integral cosine error for isotropic radiation (DIN 5032) is less than 2.5%.
The fibre is especially adjusted with a flange to ensure that the optical axis is the same as its mechanical axis.
The detector proved its reliability perfectly under different climate conditions such as near the sea (Thessaloniki, GR) or on high mountains (Jungfraujoch, CH 3571 m / 11782 ft).

SPECIFICATION

Specified Wavelength	UV to VIS
Spirit level	yes
Drying agent	yes
Heating	signals to display on voltmeter. Set point and actual temperatures in °C
Integral cosine error	< 2.5% (DIN 5032)
Temperature regulation	

Physical data

Weight	0.5 kg
Size	58 mm (diameter) x 85 mm (length)
Material	anodised aluminium

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2.3 Description Quartz Dome

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UV-J1002-DOM UV-J1002-DOM2

APPLICATION

The polished quartz dome *UV-J1002-DOM* is sealed in a high-grade-steel flange. The used material HPFS (fused silica) is a high purity synthetic amorphous silicon dioxide.

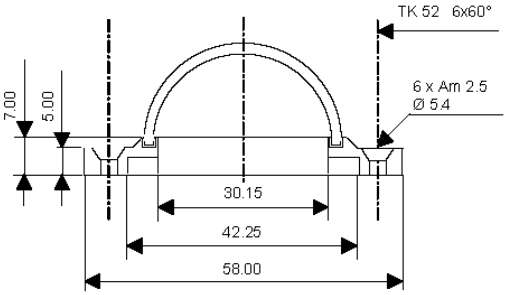
SPECIFICATION

Softing point	1585°C
Annealing point	1042°C
Density	2.2 g/cm³
Refractive index	1.44887 @ 1128.64 nm
	1.47455 @ 365.01 nm
	1.50860 @ 248.00 nm

Physical data

Weight	0.068 kg
Flange diameter out	58.0 mm
Flange thickness	5.0 mm
Flange material	high-grade-steel
Dome diameter	36.0 ± 0.1 mm
Dome wall thickness	1.7 ± 0.1 mm
Dome material	Corning HPFS Fused Silica

Drawing



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2.4 Description UV-J1002-Protec

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The protector *UV-J1002-PROTECT* should be used to protect the quartz dome of the global input optics *UV-J1002, UV-J1002-REG, and UV-J1003* during transport or other dangerous situations. It is made out o black synthetic material and is attached by two screws.

Physical data

Weight	0.14 kg
Size	70 mm (diameter) x 40 mm (length)
Material protector	synthetic material
Material screws	Nylon, M4

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2.5 Description additional Drying Agent

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UV-J1002-DRYING-K15

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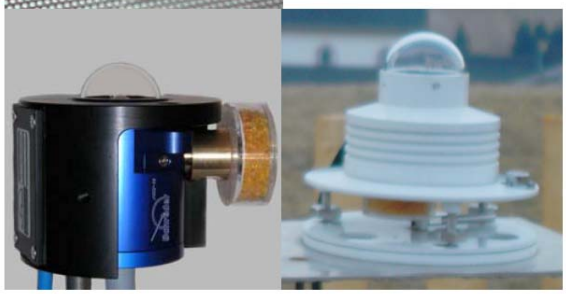

APPLICATION

The drying agent *UV-J1002-DRYING-K15* has a filling of about 12 g silica gel (orange).
It can be used in combination with the drying agent adaptor *UV-J1002-DRYING-K15-HOLDER* to fit into the entrance optics UV-J1002 and UV-J1002-REG. There it is placed instead of the original drying agent tablet *UV-J1002-DRYING*.
It can be directly used as drying agent for the Solar Light broadband meter.
This big amount of drying agent allows a longer servicing free period for all instruments.

Physical data

Weight	0.012 kg
Size	35 mm (diameter) x 20 mm (length)
Material	plastic
Thread	M18x1.5

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2.6 Description Drying Agent Holder

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UV-J1002-DRYING-K15-HOLDER

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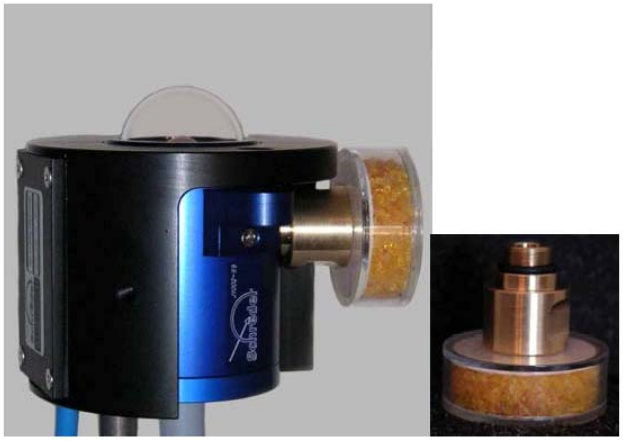

APPLICATION

The drying agent adaptor *UV-J1002-DRYING-ADA* can be placed instead of the original drying agent tablet *UV-J1002-DRYING* in the *UV-J1002* and UV-J1002-REG entrance optics. The suitable drying agent *UV-J1002-DRYING-K15* has a filling of about 12 g silica gel (orange). This amount of drying agent allows a longer servicing free period. The usage of the heating element *UV-J1002-HEATING* is further guarantied.

Physical data

Weight	0.05 kg
Size	20 mm (diameter) x 28 mm (length)
Material	brass
Thread	M14x1 / M18x1.5

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2.7 Description Rod

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UV-J1002-ROD

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The rod *UV-J1002-ROD* can be used for an easy installation of the entrance optics *UV-J1002* and *UV-J1002-REG*. It fits in the standard opening of the optics. Two grooves improve the fixing of the two standard fixing screws. A small marking groove simplifies the checking of the perfect positioning.

Physical data

Weight	0.22 kg
Size	217 mm (length) x 10.4 mm (diameter)
Material	High grade steel

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3 Technical Description:

The temperature stabilised version UV-J1002-REG of the entrance optic avoids possible temperature effects of the Teflon diffuser. A short description of the temperature sensitivity of the entrance optic is outlined in chapter 3.1. A detailed scientific description of the is published in ‘Optical Materials, in press Dec. 2004, "Lasse Ylianttila and Josef Schreder, Temperature effects on PTFE diffusers".

The temperature controller CT325PD2C5 (Minco) keeps the global input optic on a constant temperature. The temperature at which the global optic should be stabilised is adjustable. The regulation temperature is preset at 30°C. The signals of set point and actual temperature in °C can be displayed on a voltmeter. The sensor element is a standard PT100.
Power supply: 24V DC

The heating is not designed for winter measurement campaigns without servicing. To protect the input optic against ice-formation a manual cleaning of the dome is required.

Figure 2 View Global Optic UV-J1002-REG with Light Guide and Temperature Controller

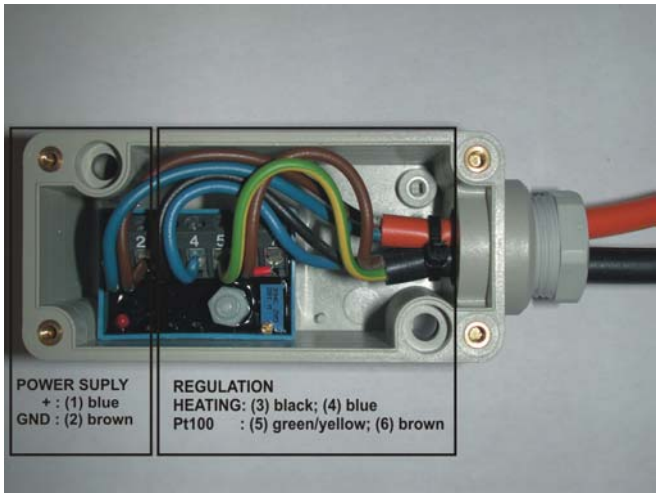


Figure 3 View Temperature Controller.

3.1 Report Temperature sensitivity

Temperature sensitivity of the global input optic UV-J1002

Blumthaler M., Inst. f. Medical Physics, Innsbruck
Schreder J., Calibration Measurement Softwaresolution, Kirchbichl

Date: 04/2004

In January 2003 the effect of temperature variations on the global input optic UV-J1002 were investigated between 22°C and to 44°C. The Optic was set up in the laboratory and radiation measurements were carried out at 320 nm. The optic showed a temperature sensitivity of about -1.1 % per 10 °C. The data are presented in Figure 1 (black line).

In April 2004 the effect of temperature variations on the global input optic UV-J1003 (special designed optic with shutter with the same diffuser material as the original UV-J1002) were investigated between 13 °C and 44 °C. The optic was set up in the laboratory and spectral radiation measurements were carried out from 280 nm up to 600 nm. The data are presented in Figure 1. A sharp change over the temperature range between 13 °C and 20 °C of about +2.5 % can be seen. Nearly no wavelength dependency in the temperature range from 13 °C up to 27 °C can be detected. When the temperature rises up from 27 °C to 44 C° a slight wavelength dependency occurs. At 44 °C there is a 1.5 % variation between 320 nm and 580 nm. A maximal change in the response of about -2 % occurs at 320 nm between 27 °C and 44 °C.

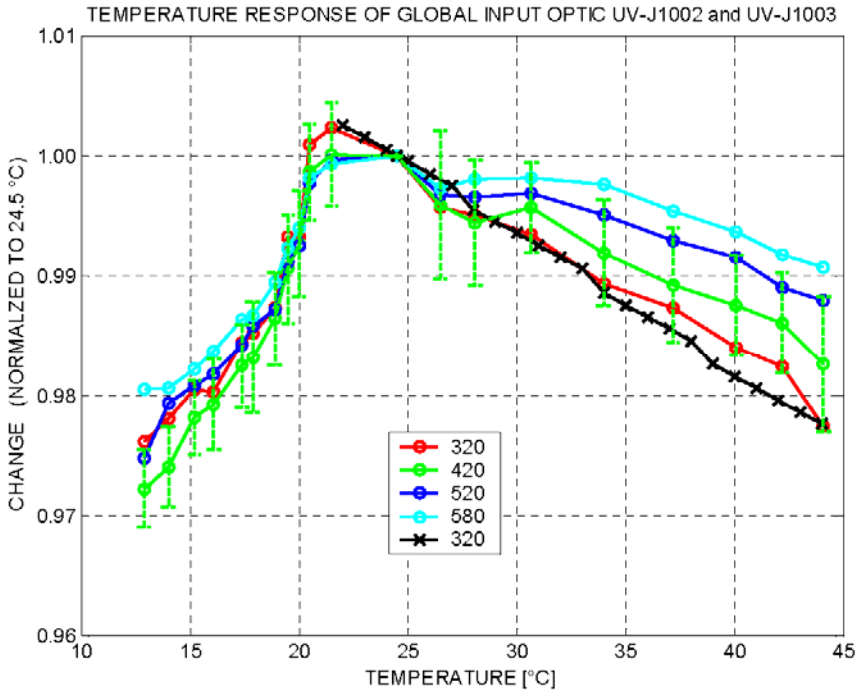


Figure 1 Normalized radiation measurements with the global input optic UV-J1002 at 320 nm (black line with cross). The measurements with input optic UV-J1003 were carried out at wavelengths between 280 nm and 600 nm (coloured lines with circle). The data points are averages over ±20 nm, the error bars (1 σ) are given for 420 nm. The measurements are normalized to the radiation measurement at 24.5 °C

Figure 4 Report Temperature sensitivity of the global input optic UV-J1002

3.2 General Measurement Data Entrance Optic

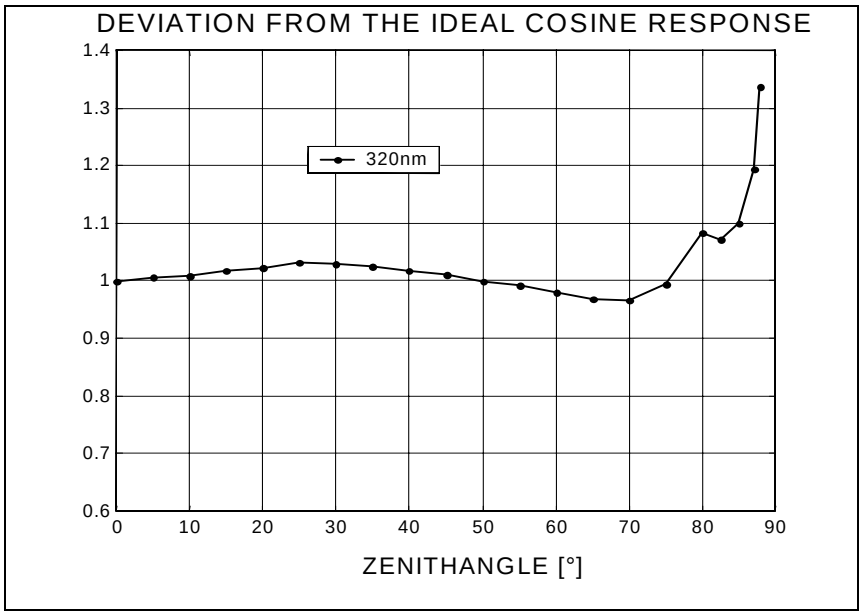


Figure 5 View general deviation from the cosine response.

3.3 Uncertainty Estimation COS - Justage

General Method: Gaußian – propagation of error

$$\overline{\Delta f(x_0, y_0)} = \sqrt{\left(\frac{\delta f(x,y)}{\delta x}\bigg|_{x_0,y_0}\right)^2 \bullet (\Delta x)^2 + \left(\frac{\delta f(x,y)}{\delta y}\bigg|_{x_0,y_0}\right)^2 \bullet (\Delta y)^2}$$

Application:

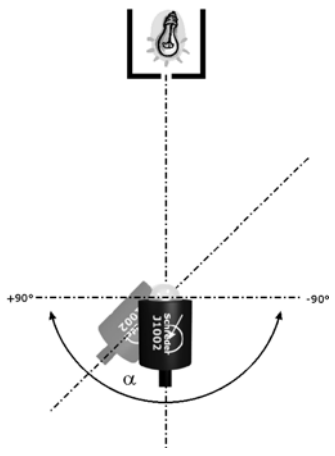


Figure 6 Setup for cosine response measurement

$$CF(I, I_0, \alpha) = \frac{\frac{I}{I_0}}{\cos(\alpha)}$$

ΔCF … cosine uncertainty
α … Zenith angle
I … Signal measured at zenith angle α
I_0 … Signal measured at vertical incidence (zenith angle α =0°)

$$(\Delta CF)^2 = \left(\frac{\delta CF}{\delta I}\right)^2 \bullet (\Delta I)^2 + \left(\frac{\delta CF}{\delta I_0}\right)^2 \bullet (\Delta I_0)^2 + \left(\frac{\delta CF}{\delta I}\right)^2 \bullet (\Delta\alpha)^2$$

$$\Delta CF = \sqrt{\left(\frac{1}{I_0 \cdot \cos(\alpha)}\right)^2 \bullet (\Delta I)^2 + \left(\frac{I_0}{I_0^2 \cdot \cos(\alpha)}\right)^2 \bullet (\Delta I_0)^2 + \left(\frac{I \cdot \sin(\alpha)}{I_0^2 \cdot \cos^2(\alpha)}\right)^2 \bullet (\Delta\alpha)^2}$$

Example:

Figure 8 and Figure 7 show the measured cosine response of a typical cosine diffuser J1002 with fixed ΔI, ΔI_0 and $\Delta \alpha$. Figure 7 clarifies the influence of a growing $\Delta \alpha$.

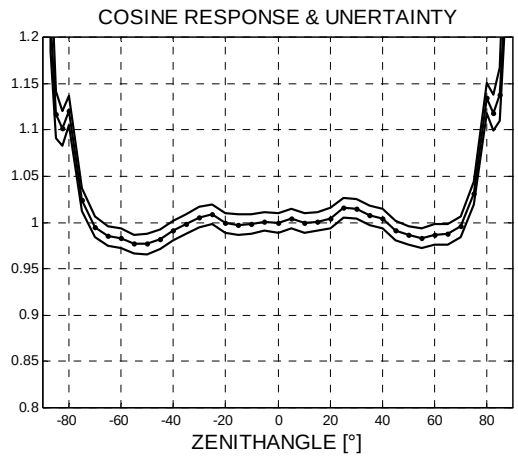


Figure 8 View typical cosine response ΔI=5%, ΔI_0=1.0%, $\Delta \alpha$ =0.1°

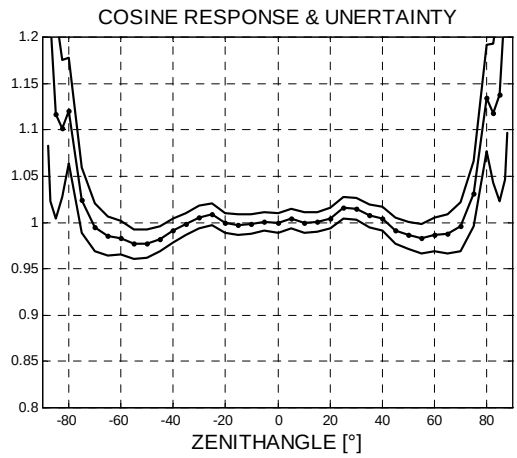


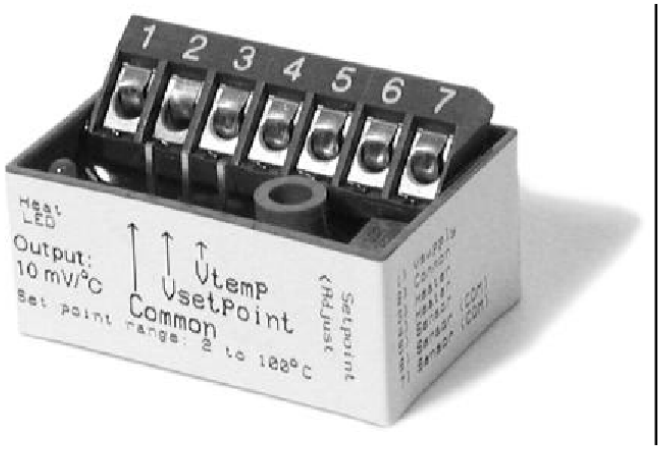
Figure 7 View typical cosine response ΔI=0.5%, ΔI_0=1.0%, $\Delta \alpha$ =0.5°

4 Parts

4.1 Minco temperature controller installation

MINCO

CT325 TEMPERATURE CONTROLLER
INSTALLATION AND OPERATING INSTRUCTIONS



- Heat items with up to 240 watts
- DC only – Up to 60 VDC
- Signals to display, on your voltmeter, the set point and actual temperatures in °C
- Heat an item to boiling temperature or just heat it to body temperature
- Quiet, solid-state reliability

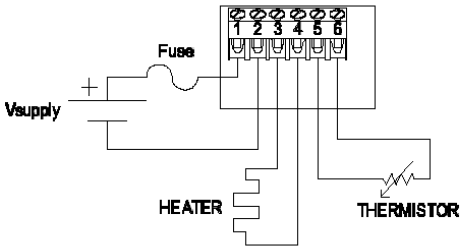
Why pay more for a controller with a digital display which is not used after installation?
The temperature which the sensor sees is turned into a voltage signal. Simply connect a voltmeter to the test pins to read the actual temperature and the set point temperature.

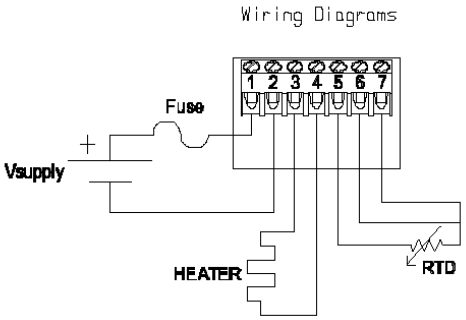
The CT325 is an ON/OFF temperature controller. The resistance of a temperature sensor is compared to the setting of the setpoint potentiometer. When the temperature is below setpoint, the solid-state output transistor switches the heat on. At temperatures above setpoint, the output transistor is turned off, and there is no heating. The “Heat LED” light is on when the heater is on.

Installation:

Locate the CT325 near the sensor and heater, in a location away from heavy dust and condensation. The ambient temperature range must be between -40 and 70 °C (-40 and 158 °F). Mount with a #6 machine or #8 self-tapping screw.

Power: Wire the CT325 as shown below, observing the +/- polarity of the power supply. Add a fuse that is sized to protect your heater load. A separate thermostat may be used for added protection. Maximum DC supply voltage is either 7.5 or 60 VDC depending on the CT325 being used.





Sensor:

Thermistor – Wire as at left.

3-wire RTD – Wire as at right. The controller will compensate for the resistance in the leadwires going to the RTD. For a 3-wire RTD, the two common wires are usually of the same color and they go to terminals 6 and 7. You can identify the common wires because their measured resistance will be only a few tenths of an ohm.

2-wire RTD - Connect the 2-wire RTD to terminals 5 & 6 and jumper terminal 6 to 7. To determine the amount of error due to lead resistance use the following formula: Error(°C) = (D x R_L x 2) / ΔR_{RTD}

Where D = Distance between RTD and CT325

R_L = Resistance of leadwire per foot

ΔR_{RTD} = Nominal change in resistance of RTD per °C (.385 Ω for PD, 3.85 Ω for PF)

Extension wires – To locate the RTD farther away, add 3 extension wires, using wire of the same gauge, from the same spool, and make the length of all wires identical. To extend wires for RTD's having only two wires, using the same guidelines, run three wires out to the two leadwires from the RTD.

Temperature sensor resistances:

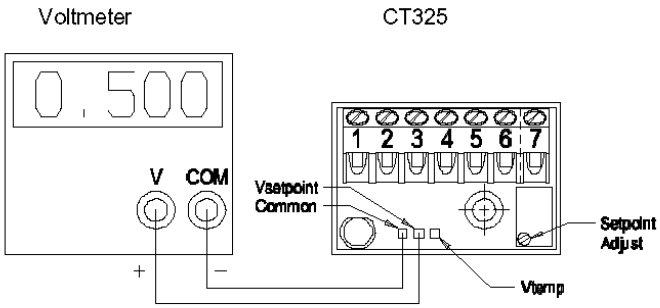
	0°C	*10°C*	*20°C*	*25°C*	*30°C*	*40°C*	*50°C*
	32°F	**50°F**	**68°F**	**77°F**	**86°F**	**104°F**	**122°F**
PD (Ω)	100.00	103.90	107.79	109.74	111.67	115.54	119.40
PF (Ω)	1000.0	1039.3	1077.9	1097.4	1116.7	1155.4	1194.0
TF (Ω)	155,600	97,490	62,240	50,000	40,350	26,640	17,940

	60°C	*65°C*	*70°C*	*75°C*	*80°C*	*90°C*	*100°C*
	140°F	**149°F**	**158°F**	**167°F**	**176°F**	**194°F**	**212°F**
PD (Ω)	123.24	125.16	127.08	128.99	130.90	134.71	138.51
PF (Ω)	1232.4	1251.6	1270.8	1289.9	1309.0	1347.1	1385.1
TF (Ω)	12,310	10,270	8,604	7,239	6,117	4,428	3,256

	110°C	*120°C*	*130°C*	*140°C*	*150°C*	*160°C*	*170°C*
	230°F	**248°F**	**266°F**	**284°F**	**302°F**	**320°F**	**338°F**
PD (Ω)	142.29	146.07	149.83	153.58	157.33	161.05	164.77
PF (Ω)	1422.93	1460.68	1498.32	1535.84	1573.25	1610.54	1647.72
TF (Ω)	2,429	1,836					

	180°C	*190°C*	*200°C*
	356°F	**374°F**	**392°F**
PD (Ω)	168.48	172.17	175.86
PF (Ω)	1684.78	1721.73	1758.56
TF (Ω)			

Operation:



50.0°C set point is shown.

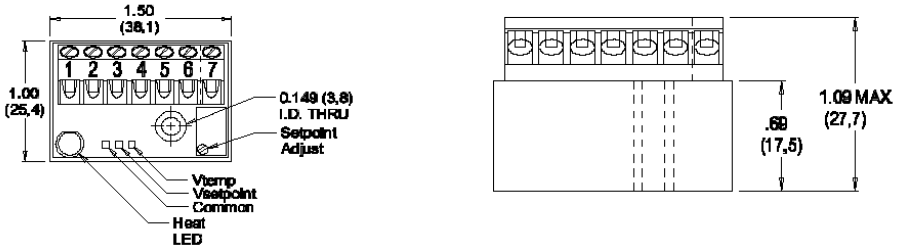
Adjust Setpoint:

1. Connect voltmeter as shown above.
2. Turn the Setpoint Adjust screw until the voltmeter displays the setpoint temperature you want, simply shifting the decimal point on your voltmeter reading. In the example drawn above, the voltmeter reading of 0.500 volts means 50.0°C. To raise the temperature turn the adjustment screw clockwise.

Reading temperature of sensor:

1. Connect voltmeter as shown above except move the positive voltmeter lead to the Vtemp pin of the CT325.
2. The Vtemp pin outputs 0.010 V/°C, exactly the same as the Vsetpoint pin does. For example, if the voltmeter is displaying 0.603 volts, this corresponds to a temperature of 60.3°C.

Dimensions:



Model code:

CT325	**Model number: CT325**
PD	**Sensor type:** PD = 100 Ω platinum RTD (2 to 100°C) PF = 1000 Ω platinum RTD (2 to 100°C) TF = 50 kΩ thermistor (25 to 75°C)
1	**Power supply:** 1 = 4.75 to 10 VDC 2 = 7.50 to 60 VDC
B	**Temperature range:** A = 25 to 75°C (Thermistor only) B = 2 to 100°C (RTD only) C = 2 to 200°C (RTD only)
5	**Deadband:** 5 = 0.5°C
CT325PD1B5 …	Sample part number

Specifications:

Input: 100 ohm or 1000 ohm platinum RTD, 0.00385 ohm/ohm/°C, 2- or 3-leads, or 50kΩ NTC thermistor, 2-lead.

Setpoint range:

2 to 100°C (36 to 212°F) or 2 to 200°C (36 to 392°F) for platinum RTD models.

25 to 75°C (77 to 167°F) for thermistor model.

Consult factory for other ranges.

Setpoint stability: +/- 0.02% of span/°C.

Vtemp signal: 0.010 V/°C over specified range.

	Platinum RTD Sensor		Thermistor Sensor	
	2°C	0.02V	25°C	0.25V
	50°C	0.50V	50°C	0.50V
	100°C	1.00V	75°C	0.75V
	200°C	2.00V		
Accuracy:	± 1°C	1% of span	± 2% of span	
Linearity:	± 0.1% of span		± 2% of span	

Deadband: 0.5°C.

Input power: 4.75 to 60 VDC.

Output: Open drain, 4 amps max. DC.

Leadwire compensation (3-wire RTD): ±0.06°C/ohm for 100 ohm or 1000 ohm platinum up to 25 ohms per leg.

Fault protection: Heater disabled on RTD short or thermistor open. No heater protection; external fuse recommended.

Operating ambient temperature range: -40 to 70°C (-40 to 158°F).

Relative humidity: 0 to 95% non-condensing.

Physical: Polycarbonate case, epoxy-sealed. 1 oz. (28g).

Connections: Terminal block for wires AWG 22 to AWG 14.

Mounting: Mounting hole for #6 screw through or #8 thread-forming screw.

MINCO
ISO 9001

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sales@minco.com
www.minco.com

4.2 Heating Element

The used heating element is a ‘Stego RCE 016’ heater. Power supply = 24V. The general description of this element is given in Figure 9

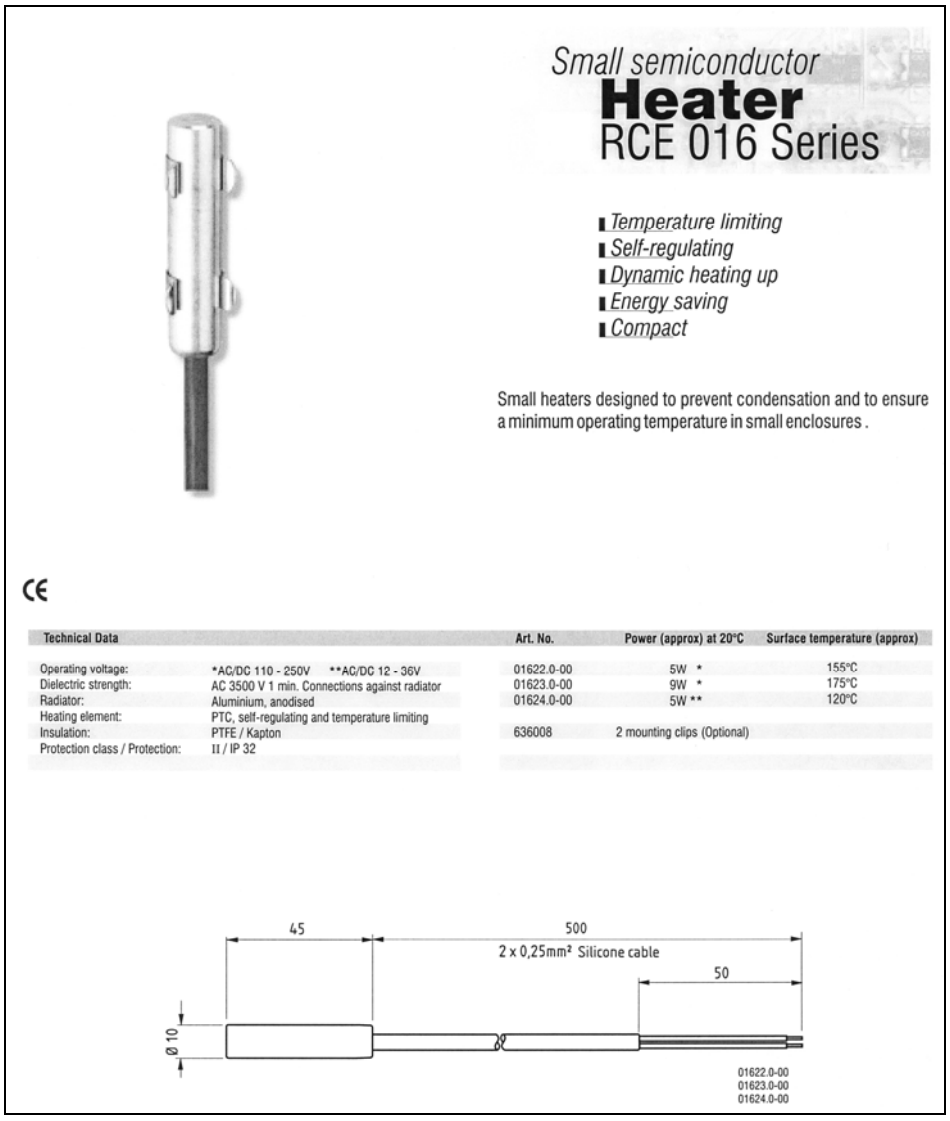


Figure 9 Heater RCE 016 Series, STEGO, DC 12-36V

4.3 PT100

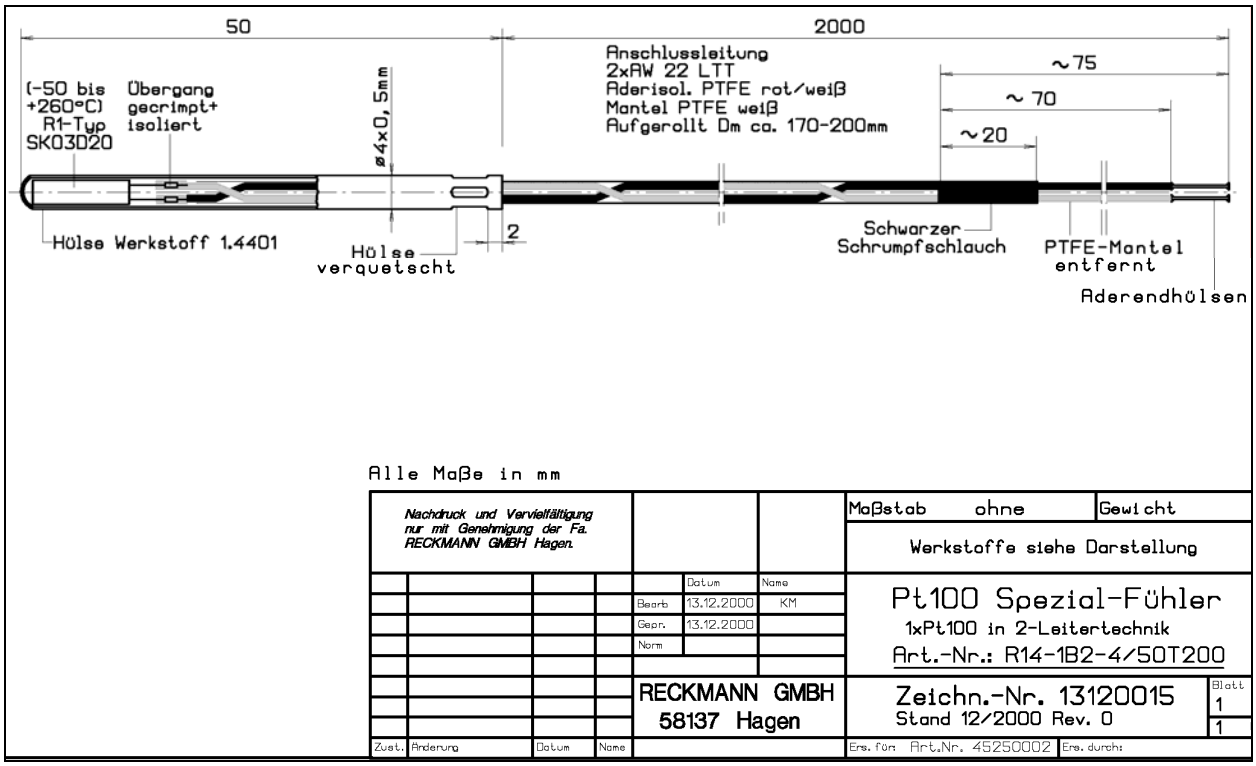


Figure 10 View PT100

4.4 Cable Power Supply

Name:	H05VV-F
Construction:	24x0.2 mm wires
Cross section:	2x0.75 mm²
conductor:	copper
isolation:	PVC
diameter:	6.2 mm
colour:	orange
standard length:	1.5 m

4.5 Cable Connection Temperature Controller to Entrance Optic

Name:	H05VV-F
Construction:	24x0.2 mm wires
Cross section:	4x0.75 mm²
conductor:	copper
isolation:	PVC
diameter:	7.2 mm
colour:	black
standard length:	4.5 m

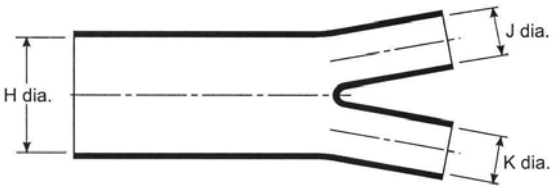
4.6 Thermofit

Article number: Raychem 382A012-25-CS-2065-0

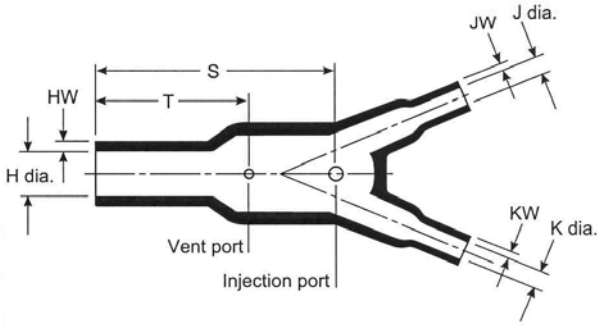
Thermofit® Molded Parts
382A012 to 046

Y Transition

As supplied (a)



After unrestricted recovery (b)



Applications

Provides strain relief and mechanical protection on cable harness assemblies.

Materials Available

Material	Material description	Precoating no.	Adhesive part no.
–3	Semirigid polyolefin	/42 or /86 or /180	S-1017 or S-1048 or S-1030
–4	Flexible polyolefin	/42 or /86 or /180	S-1017 or S-1048 or S-1030
–5	Flexible elastomer		
–6	Silicone		
–12	VITON®		
–25	Fluid-resistant elastomer	/42 or /86	S-1017 or S-1048

Product Dimensions (inches *(millimeters)*)

	H		J & K		S	T	HW	JW & KW
Part number	Min. a	Max. b	Min. a	Max. b	±10% b	±10% b	±20% b	±20% b
382A012	.52 *(13.2)*	.24 *(6.1)*	.26 *(6.6)*	.13 *(3.3)*	.94 *(23.9)*	.61 *(15.5)*	.06 *(1.52)*	.04 *(1.02)*
382A023	1.06 *(26.9)*	.49 *(12.4)*	.52 *(13.2)*	.24 *(6.1)*	2.10 *(53.3)*	1.30 *(33.0)*	.10 *(2.54)*	.06 *(1.52)*
382A034	1.52 *(38.6)*	.71 *(18.0)*	1.06 *(26.9)*	.49 *(12.4)*	3.10 *(78.7)*	2.20 *(55.9)*	.12 *(3.05)*	.10 *(2.54)*
382A046	2.19 *(55.6)*	1.02 *(25.9)*	1.06 *(26.9)*	.50 *(12.7)*	4.40 *(111.8)*	2.80 *(71.1)*	.18 *(4.57)*	.10 *(2.54)*