Blackbody Calibration Source ME20

For Calibration of Radiation Thermometers and Thermal Imaging Systems
Temperature Range -20 °C ... 350 °C

- Portable; weight < 20 kg (44 lbs)
- Cavity source immersed in a liquid bath
- Aperture: ∅ 60 mm (2.4"); cavity length: 300 mm (12")
- Emissivity: 0.9994 ± 0.0002
- Uncertainty: 0.12 ... 0.60 °C
- Liquid volume: < 1.5 liters (0.4 gallons)
- Excellent temperature uniformity by a novel pumping system
- 6 tubes for control with temperature probes
- Precision controller, including a basic-8-segment-programmer
- High stability; low controller-oscillations
- Fast heat-up: max. 1 h for stabilization
- Built-in cooling coils for an external cooler
- Nitrogen rinsing to suppress dewpoint
- Traceable by RTD + 4 digit thermometer
- Calibration of RTD's and thermocouples

ME20.01	40 ... 350 °C *)
ME20.11	40 ... 250 °C *)
ME20.02 (built-in cooling coils):	–20 ... 350 °C (ext.cooler)
ME20.12 (built-in cooling coils):	–20 ... 250 °C (ext.cooler)
ME 20.03 (built-in Peltier-cooling):	20 ... 102 °C *)

*) ambient temperature: 20...25 °C

According to the latest development in technology a **Blackbody Calibration Source** has to be used to calibrate infrared radiation thermometers and thermal imaging systems with temperature ranges within -20 to 350°C.

An ideal **Blackbody** sends out radiation - in a defined wavelength region - which only depends on its temperature. Its emissivity is 1 (Planck's law of radiation). A surface which comes very close to this perfect radiator is achieved by the aperture of a cavity whose inner surface is blackened and at a uniform temperature. When the opening is small with regard to the dimensions of the cavity, Blackbody behavior is approximated. The emissivity towards 1. This condition is achieved by a cylinder (tube with a bottom) when the ratio length to diameter is high. Therefore the opening of the cylinder excellently suits as a source of calibration for (infrared) radiation thermometers and thermal imaging systems..

During calibration the radiation thermometer, respectively the thermal imaging system, is being placed at a certain distance in front of the radiator's aperture and the output signal is being compared to the radiation temperature of the Blackbody Calibration Source. Its radiation temperature t_S can be measured with a precise high-resolution radiation thermometer which must possess the same optical design and spectral response as the radiation thermometer or the thermal imaging system to be tested (traceable to a higher standard). At a lower price and even more precise according to the latest development of technology - is the method applied here: The radiation temperature t_S only slightly deviates from the wall temperature t_W of a cavity with a high degree of emissivity: $t_S = t_W - t_K$. The deviation t_K is identical with a correction value. This value is dependent on the emissivity ε_S, on the ambient temperature t_U (wall temperature of the laboratory) and on the spectral response λ_e of the radiation thermometer or of the thermal imaging system to be calibrated. The wall temperature of the cavity t_W can be measured with a calibrated temperature measurement set consisting of a RTD probe and an electronic thermometer.

As the wall temperature t_W can only be measured at one point, a good temperature uniformity is extremely important to keep the uncertainty of the measured wall temperature t_W low.

The cavity of of the calibration source ME20 is a cylinder consisting of a copper tube with an inner diameter of 60 mm (2.4") and a length of 300 mm (12"). The cylinder is closed with a bottom panel, inclined against the axis by 30°. The inner walls are covered with a heat-resistant black varnish, showing an emissivity of $\varepsilon_W = 0.93 \pm 0.02$ in the spectral range of 2 to 15 µm.

With these values the emissivity ε_S for the radiating opening can be determined. It amounts to $\varepsilon_S = 0.9994 \pm 0.0002$. This results

MESTER
Radiation Thermometry

Engineering consultancy • Dipl.-Ing. Ulrich Mester • Arndtstr. 44 • D-65232 Taunusstein • +49 - 6128 - 21717 • +49 - 6128 - 21776 DB20EA13
Available through **Wintronics, Inc**. • 50 Division Ave • Millington, NJ 07946 • (800) 247-7976 • Fax: (908) 647-8379 • E-mail: win@wintron.com

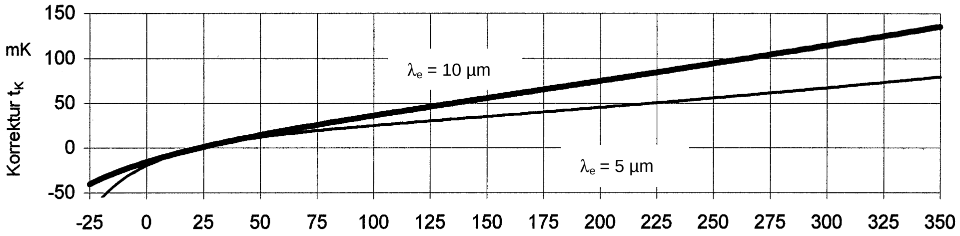
in temperature correction values t_K with uncertainties, that can be read from Fig. 1 (see also specifications).

The cavity is placed in a tube with a somewhat bigger diameter. A liquid of silicone oil or a water/glycol mixture respectively is circulated in the gap between the tubes. The circulation is done completely within a few seconds by means of a powerful pump. By this construction an excellent temperature uniformity on the cavity walls is achieved. The bath capacity is only 0.34 gallons. A low weight and a short heat-up time of only 1 h results from this. The bath is connected with a balancing vessel by a thin pipe, so the bath fluid can evade to the vessel at the moment of expansion. The balancing vessel is cooled by a ventilator, to ensure that the hot bath fluid does not get into direct contact with the air oxygen. By means of a precision-controller in conjunction with a RTD probe the bath temperature is kept exactly at the adjusted temperature.

The determination of the wall temperature and the control of the temperature uniformity are possible in a very simple way. 6 thin tubes (inner diameter = 6 mm (0.24")) are fitted to the cavity surface with a very good heat contact. Thus by help of a Pt100-RTD all relevant places of the cavity wall can be measured, for example those parts of the wall, which are predominantly registered by the optic of the radiation thermometer during the calibration procedure. In one of the tubes RTDs or thermocouples can be calibrated as well.

Measurement of wall temperatures t_W takes place with the built-in RTD for controlling and the readout of the controller. Accuracy can essentially be increased, if an external Pt100-RTD-probe is placed into one of the tubes connected to an electronic thermometer (see order information).

Three different bath fluids are recommended. For temperatures -20 °C to 102 °C use a mixture of water/glycol (1:1), for 40 °C to 250 °C use silicone oil Si250 and for 90 °C to 350 °C use silicone oil Si350. The oil Si250 has a lower viscosity than the oil Si350. Therefore you should prefer Si250 below 250 °C to get a better temperature uniformity. Model ME20.01 (ME20.11)is the standard design for temperatures from 15 °C above ambient-temperature up to 350 °C (250 °C). Model ME20.02 (ME20.12) is equipped with cooling coils and a device for nitrogen rinsing to avoid ice building below the dewpoint. By use of an external circulation cooler the total range from -20 °C to 350 °C (250 °C) can be covered. Model ME20.03 is equipped with Peltier-cooling. The lowest value of temperature can be adjusted to 5 °C below ambient-temperature and the highest value amounts to 102 °C. One of the possible applications of this model is the calibration of medical radiation thermometers.



Cavity wall temperature in °C

Fig. 1 Temperature corrections t_k for ε_S = 0.9994 dependent on cavity wall temperature t_W ambient (wall)temperature: t_U = 23 °C; spectral response: λ_e = 5 µm and λ_e = 10 µm

Specifications

Aperture dimensions: 60 mm (2.4") diam. **Cavity length:** 300 mm (12") **Emissivity:** 0.9994 ± 0.0002 **Radiation temperature:** $t_S = t_W - t_K$ (see text) **Accuracy:** $t_S \pm u_S$ see below **Bathvolume:** 1.3 liters (0.34 gallons) **Bathfluid:** Water/Glycol: -20 ... 102 °C Silicone oil Si250: 40 ... 250 °C Silicone oil Si350: 90 ... 350 °C	**Power requirements**: 230 VAC ± 10%, 50 Hz, 5 Amps (115 VAC, 60 Hz, 10 Amps optional) **Controller:** Eurotherm 2404; 4 Digit-PID included a basic-8-segment-programmer; Configuration by RS-232 interface **Controller settability:** 0.1 °C **Controller oscillations:** 0.03 ... 0.1 °C **Ambient operating Range:** 15 ... 35 °C **Heat-up time for stabilisation:** max. 1 h **Weigth:** 18 kg (40 lbs)

Temperature-corrections t_K with uncertainties u_k for ε_S = 0.9994 ± 0.0002 (see Fig. 1).

Cavity-wall temperature t_W in °C		-20	23	100	150	200	250	350
$t_K \pm u_k$ (λ_e = 5 µm)	in mK	-56±19	0±0	25±8	35±12	45±15	56±19	80±27
$t_K \pm u_k$ (λ_e = 10 µm)	in mK	-34±11	0±0	36±12	56±18	75±24	95±31	136±45

Uncertainty u_w of cavity wall temperature t_w .

Cavity wall temperature t_W	-20 to 200 °C	200 to 350 °C
u_w of the controller read out	250 mK	500 mK
u_w calibrated set TM30; RTD PZ30 + 4 digit thermom.	50 mK	---
u_w calibrated set; RTD + 6.5 digit DMM	50 mK	60 mK

Temperature non-uniformity u_h (temp.differences of cavity walls from 30 to 300 mm)

t_W Cavity wall temperature in °C	-20	23	100	150	200	250	350
u_h water/glycol or . silicone oil in mK	100	50	100	200	300	500	800

Standard uncertainty u_s of radiation temperature t_S : considered are the uncertainties: u_k , u_w, u_h, in addition influences of heat treatment, losses, short time stability, oscillations etc..

Radiation temperature t_S	in °C	-20	0	23	50	100	150	200	250	350
Bath fluid		water/glycol : 1/1					Si250		Si350	
u_s (with calibrated set)	in mK	150	130	120	130	150	250	350	600	900

Order information

(Price and accessory list on request)

Blackbody Calibration source ME20.01
with built-in precision-controller including 8 segment-programmer and a RS-232-interface: (ambient-temp.+15) °C ... 350 °C.

Blackbody Calibration source ME20.02
as ME20.01; additional built-in cooling coils and nitrogen rinsing;
range: (ambient temp. +15) °C ... 350 °C;
–20 °C ... 350 °C (with ext. cooler).

Blackbody Calibration source ME20.11
with built-in precision-controller including 8 segment-programmer and a RS-232-interface: (ambient-temp.+15) °C ... 250 °C.

Blackbody Calibration source ME20.12
as ME20.01; additional built-in cooling coils and nitrogen rinsing;
range: (ambient temp. +15) °C ... 250 °C;
–20 °C ... 250 °C (with ext. cooler).

Blackbody Calibration source ME20.03
as ME20.11 additional built-in Peltier cooling range: (ambient temp. – 5) °C ... 102 °C

Silicone oil Si350
for 90 ... 350 °C; 1.5 liters (0.4 gallons).

Silicone oil Si250
for 40 ... 250 °C; 1.5 liters (0.4 gallons).

Glycol you can buy at gas stations.

Precision resistance thermometer PZ30
EN 60 751; Pt100 RTD probe;
with DKD calibration certificate;
4-wire circuit; for temperatures from -200 to +450 °C; lenght=400 mm (15.7"); diameter= 3 mm (0.12"); stainless steel protection tube; Lemosa connector; DKD calibrated at 0, 100, 200 and. 300 °C; supplied with coefficients R_o , A and B together with a table of resistance values in 1 °C steps; drift not exceeding 0.05 °C per year; see price and accessory list for detailed specifications.

Temperature measurement set TM30
with DKD calibration certificate
RTD probe PZ30 and precision microprocessor thermometer P555 with 4 digit LCD display and bargraph; temperature range: -20 to 200 °C; input for 2 Pt100 RTD; temperature difference indication; RS-232 interface; temperature resolution: 10 mK; uncertainty < 50 mK; see price and accessory list for detailed specifications.

Cooling device DK30
see price and accessory list for detailed specifications.

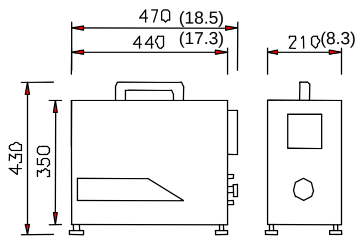


Fig. 2 Dimensions in mm (inch)

MESTER
Radiation Thermometry

Engineering consultancy • Dipl.-Ing. Ulrich Mester • Arndtstr. 44 • D-65232 Taunusstein • +49 - 6128 - 21717 • +49 - 6128 - 21776 DB20EA13
Available through **Wintronics, Inc**. • 50 Division Ave • Millington, NJ 07946 • (800) 247-7976 • Fax: (908) 647-8379 • E-mail: win@wintron.com