

TCB blackbodies

Precision differential area blackbodies



Fig.1. Photo of five TCB blackbodies:TCB-12D, TCB-8D, TCB-6D, TCB-4D, TCB-2D



Fig.2. Main window of TCB Control program

BASIC INFORMATION:

TCB series blackbodies are ultra precision, differential, area blackbodies designed to simulate cold and moderate warm targets. Radiator temperature is controlled using a thermoelectric element. Absolute temperature of blackbody radiator is typically regulated from 0 °C to 100°C but this range can be extended to -40°C to 180°C. Most popular are blackbodies with small emitters (area from 50×50 mm to 500x500mm) but models with bigger emitters up to 1000x1000mm) can be delivered, too.

The TCB series blackbodies are characterized by excellent temperature resolution, temporal stability, temperature uniformity, and temperature uncertainty. Better temperature uniformity comparing to performance of typical blackbodies should be particularly emphasized.

All these features makes TCB blackbodies an ideal choice as sources of infrared radiation in systems for testing thermal imagers or as temperature standards in national standard laboratories.

Next, TCB blackbodies are computerized blackbodies built with controller electronics integrated with blackbody head. TCB blackbodies are delivered as a single block. User is expected only to connect two standard cables (power supply, and RS232 cable) and can control blackbody from PC. This solution increases highly reliability of TCB blackbodies, its resistance to electro-magnetic disturbances, and simplify its operation. It can be said that it is difficult to damage this blackbody even by users having limited technical education.

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STANDARD VERSIONS

TCB blackbodies can be delivered in form of a series of versions. There are two main criterion: size of blackbody emitter and temperature range.

Emitter size is indicated by blackbody code: TCB- XD where X is approximate size of square of the emitter in inches. The following models are typically offered: TCB-2D, TCB-4D, TCB-6D, TCB-8D, TCB-12D, TCB-14D, TCB-20D. In standard version these blackbodies are optimized for temperature range from 0°C to 100°C.

TCB-2D blackbodies with small 50x50mm emitter for typical temperature range from 0 °C to 100 °C are used as blocks of DT/MS systems for testing thermal imagers. Blackbodies with bigger emitters and for any temperature range are offered as independent blocks for variety of applications.

Inframet can deliver TCB blackbodies with emitters as big as 500x500mm (model TCB-20D). However, it should be noticed that there are big differences between typical small blackbodies TCB-2D/TCB-4D blackbodies and large TCB-12D/TCB-20D. The latter blackbodies are much bigger, need more power, and are more expensive. Therefore it is recommended not to exaggerate with size of ordered blackbody.

Table 1. Parameters of standard TCB blackbodies

Model	TCB-2D	TCB-4D	TCB-6D/8D	TCB-10D/12D/14D	TCB-20D
Aperture	50× 50 mm	100×100mm m	150× 150 mm 200× 200 mm	250× 250 mm 300× 300 mm 350× 350 mm	500× 500 mm
Differential temperature range	-20°C ÷ + 80°C		-20°C ÷ + 80°C	-20°C ÷ + 80°C	-20°C ÷ + 80°C
Absolute temperature range	0°C ÷ +100°C at 20°C ambient temp.		0°C ÷ +100°C at 20°C	0°C ÷ +100°C at 20°C	0°C ÷ +100°C at 20°C
Emissivity	0.98±0.005		0.98±0.005	0.98±0.005	0.98±0.005
Temperature uniformity (temperature spatial uncertainty)	<0.01 °C or 0.4% T-Tamb		<0.01 °C or 0.5% T-Tamb	<0.015 °C or 0.6% T-Tamb	<0.02 °C or 0.6% T-Tamb
Set point and resolution	1 mK				
Regulation stability	±2 mK		±2 mK	±2 mK	±2 mK
Total temperature uncertainty [°C]	0.03°C		0.03°C	0.03°C	0.03°C
Heating rate ¹	0.8°C/s	0.2°C/s	0.15°C/sec	0.15°C/sec	0.15°C/sec
Cooling rate ¹	0.3°C/s	0.1°C/s	0.06°C/sec	0.06°C/sec	0.06°C/sec
Settling time ³	<30s	<40 s	< 60 sec	< 75 sec	< 80 sec
Computer control	USB 2.0				
Power supply	115-230VAC 50/60Hz				
Operating temperature	+5°C ÷ +45 °C (non condensing)				
Storage temperature	-10°C ÷ +60 °C				
Power consumption [W] (Max/ Average)	130W/60		250/90 750/300	1200/600 1700/900 1700/1200	2800/1700
Dimensions [mm]	160× 230×180		325x249x242 531x336x310	430x450x280 585x454x320 597x454x320	430x630x880
Mass [kg]	7.5	9	16.5/42	60/71/78	165

¹Measurement at temperature about 25°C

² Time needed to reduce temperature fluctuations from±0.1°C to below ±0.01°C level

Attention: Absolute temperature range is specified for +20°C ambient temperature. Real maximal absolute temperature equals to sum of ambient temperature and maximal differential temperature but cannot be over limits of the absolute temperature range specified in the table above. Real minimal absolute temperature equals to sum of ambient

TCB blackbodies

Precision differential area blackbodies

temperature and maximal negative differential temperature but cannot be over limits of the absolute temperature range.

The ranges of absolute temperature at different ambient temperatures are:

0°C to 90°C at 10°C ambient temperature

10°C to 100°C at 30°C ambient temperature.

It should be noted that these ranges can be extended on optional versions.

OPTIONAL VERSIONS

TCB series blackbodies can be also delivered in form of optional versions with modified temperature range or other parameters. The modified parameter is indicated by an additional code like below.

1. Extended temperature range (EX)
2. Ultra extended range (UEX)
3. High temperature range (HT)
4. Temperature chamber adapted (TC)
5. Low temperature range (LT)
6. Ultra low temperature range (ULT)
7. Ultra high emissivity (HE)
8. Long cables (CAB) -
9. Vacuum optimized (VAC)
10. Control using customer software API

EX option means extension of temperature range to from -10°C to +120°C at 20°C ambient temperature. It is achieved by modification of blackbody electronics (stronger Peltier element, additional low power heater).

HT option means extension of temperature range to range from -5°C to +180°C at 20°C ambient temperature. It is achieved by modification of blackbody electronics (stronger Peltier element, additional high power heater, two channel electronics).

TC option means that TCB blackbody can be used in extreme temperatures (-40°C ÷ +70°C) met in temperature chambers. This capability is achieved by design of electronics using special components capable to withstand extreme temperatures and humidity. Such blackbodies offers range extended to low temperatures: -40°C ÷ +100°C (option 150°C). However, it should be noted that low temperature -40 °C can be achieved only when temperature in chamber is also quite low (not higher than about -10°C because differential temperature range is no more than about -30 °C). Next, it is a warning that standard blackbodies should not be used in temperature chambers because electronics will be damaged by extreme temperatures.

LT option means that radiator of TCB blackbody can reach extreme low temperatures (as low as -40 °C) even when blackbody is working at typical ambient temperature about +20 °C. Such blackbodies are built using two temperature regulators. First, standard Peltier element enables precision temperature regulation in range from about 0°C to about 100°C. Second, liquid cooler is used to lower blackbody temperature to sub-zero region.

Due to significant design differences TCB-blackbodies in LT version are now marketed as independent BLIQ series blackbodies. It should be also noted that this option is significantly more expensive than other options.

HE option means that emissivity of blackbody emitter plate is increased up to 0.99±0.005 level using new special coatings. Two solutions are possible. The highest emissivity level can be achieved using Vantablack S-VIS coating. However it should be notices that this coating is soft, brittle and in generally of low durability. It is practically impossible to clean this coating. Slightly lower emissivity can be obtained using Inframet proprietary coating that is more durable

CAB option means that blackbody is optimized to be controlled and powered using long cables. The cables of length up to 50m (can be extended to 300m) are offered..

VAC option means that blackbody is optimized to work in vacuum chambers. Such modified TCB blackbodies are now marketed as independent blackbodies (VEB, VSB).

API option means Inframet delivers TCB driver API description, along with sample tutorials and documentation. The API allows End-user to control the blackbody temperature, target wheel position and access other features, like these available in TCB Control software. TCB driver is developed for .NET Framework platform, and can be used under multiple other programming languages (e.g. C++, Python with IronPython) and tools (like LabView, using Connectivity - .NET palette). It also can be used under many Linux distributions (Mono.NET is required).

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SPECIFICATION OF OPTIONAL VERSIONS

Model	TCB-2D/4D	TCB-5D//6D/12D/20D
<i>Extended temperature range (EX)</i>		
Absolute temperature range (at 20°C ambient temperature)	-10°C ÷ +120°C	-5°C ÷ +115°C
Differential temperature range	-30°C ÷ +100 °C	-30°C ÷ + 95 °C
<i>Ultra extended temperature range (UEX)</i>		
Absolute temperature range (at 20°C ambient temperature)	-15°C ÷ +150°C	-5°C ÷ +150°C
Differential temperature range	-35°C ÷ +130 °C	-25°C ÷ + 150 °C
Absolute temperature range (at 20°C ambient temperature)	-10°C ÷ +120°C	-5°C ÷ +115°C
Differential temperature range	-30°C ÷ +100 °C	-30°C ÷ + 95 °C
<i>High temperature range (HT)</i>		
Absolute temperature range	0°C ÷ +180°C	0°C ÷ +170°C
<i>Temperature chamber adapted (TC)</i>		
Chamber temperature range	-35°C ÷ +60°C (-40°C ÷ +70°C option)	-35°C ÷ +60°C (-40°C ÷ +70°C option)
Absolute temperature range	-40°C to 100°C but within specified differential range (option up to 150°C)	-40°C to 100°C but within specified differential range (option up to 150°C)
Differential temperature range	-25°C to +75°C (option: -30°C to +75°C)	-25°C to +75°C option: -30°C to +75°C)
Humidity (not condensing)	up to 90%	up to 90%
<i>Low temperature (LT) (offered as BLIQ blackbody)</i>	temperature as low as -40°C at ambient temperature 20°C	temperature as low as -40°C at ambient temperature 20°C
<i>Ultra high emissivity (HE)</i>		
Emissivity	0.99 ±0.005	0.99 ±0.005

Attention:

It is recommended to provide dry atmosphere around a blackbody when emitter temperature is approximately 20°C below ambient temperature.

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