DLC COOLING BOXES - Standard Program

The cooling of high voltage and high frequency power electronics is a very special challenge. The pursuit of good electrical insulation and low thermal resistance is difficult because the two are diametrically opposite. This is especially true at higher operating frequencies where classical cooling methods quickly reach their limits. Capacitive coupling between grounded heatsinks and the part components to be cooled can cause significant noise currents, which make EMC design of the whole application very difficult or even impossible, not to mention the significant capacitive power losses. To solve this challenge, BEHLKE developed already in 1993 a special method of liquid cooling for their high voltage solid-state switches. This **"Direct Liquid Cooling" (DLC)** uses a dielectric liquid to combine excellent cooling efficiency with extremely good insulation even at the high operating frequencies. The DLC principle utilizes highly insulating and chemically inert liquids for the heat transfer from the high voltage / high frequency circuit to grounded heat exchangers or active radiators. These liquids can be Per-fluorinated Polyethers (**PFPE**), Perfluorocarbons (**PFC**) or Hydro-fluorethers (**HFE**), or, as a cost efficient but relatively "dirty" alternative, low viscosity silicone oil.

Compared to classical cooling methods using grounded heatsinks or ceramic watercoolers, the **DLC** cooling avoids any stray capacitance between power circuit and ground. In the same time, the cooling performance is increased dramatically, since there is no heat resistance from insulating material between power part components and the coolant media. Another advantage of the **DLC** cooling is, that complete power circuit boards can be immersed in the coolant, which means less temperature stress for the entire circuit board and all part components on it. All part components in direct contact with the coolant can be operated at a significantly increased power dissipation (by the factor 2 to 20 higher) compared to an operation in air.

Besides a sufficient pump unit (e.g. BEHLKE PU-2) and some kind of thermal sink (a radiator, a cooling plate or a PFPE to water heat exchanger), a DLC cooling system also needs a pressure proof container where the power electronics to be cooled can be immersed in the coolant, if the coolant does not flow thru existing DLC cooling channels as it is the case with BEHLKE high voltage switches with option DLC.

To facilitate the integration of non-DLC components, such as classical power electronic components and periphal circuit boards into a DLC cooling system, BEHLKE has developed an extensive standard program of pressure proof cooling boxes for universal DLC cooling purposes.

The cooling boxes described here have an inner height of 25 mm (1") and are ideal for printed circuit boards. The inner height can optionally be increased or reduced. The housings have at least 3 threaded holes G1/4 on each side (only 2 on the front / rear side for size A...). The G1/4 threads are used for the hose connectors and for the electrical standard feedtrughs, which are shown in Fig. 2. Two hose connectors and screw caps are included in the supply. Electrical feedthrus must be ordered separately.

The standard feedthru program includes various standard sockets (BNC, BNC-HT, SHV-NIM, LEMO etc.) as well as multiple single ended wires (up to 13 wires per feedthru). Any other customized feedthru can be realized. Board connectors with several hundred pins are possible.

The standard housings are made from Delrin and Makrolon. PEEK, PVC and Aluminum are optionally available.

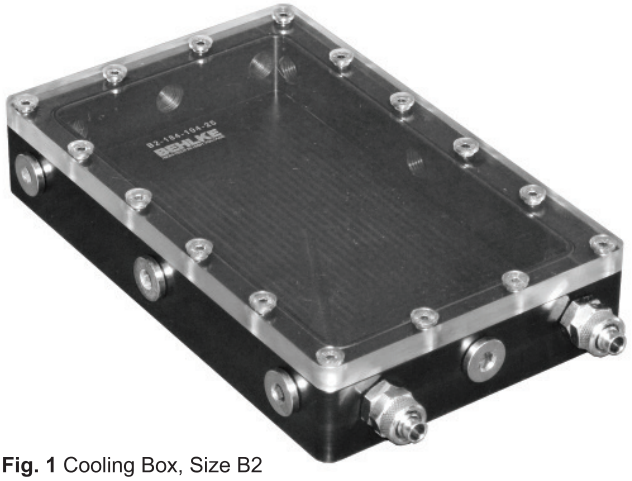
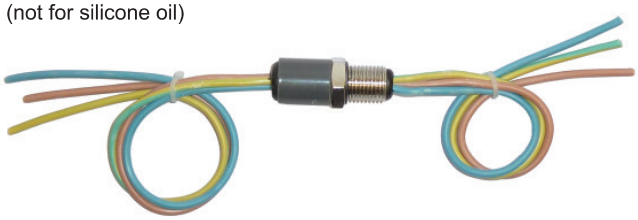


Fig. 1 Cooling Box, Size B2

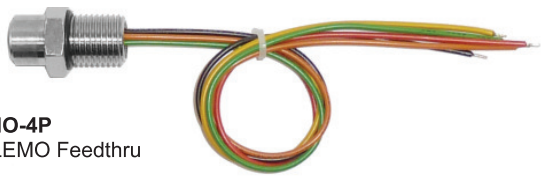
FT-SIL-80 HV Feedthru, single wire, silicone, max. 80 kVDC (not for silicone oil)



FT-3-WIRE-240VAC 240 VAC Feedthru with open wires

FT-TYCO-12P 12 Pole Wire Feedthru

FT-BNC-50
BNC Feedthru with
50 Ohm coax pigtail



FT-LEMO-4P
4 Pole LEMO Feedthru

Fig. 2 Electrical Feedthrus (extraction from the standard program)

Technical Data (plastic standard boxes):

Max. Operating Pressure ..... 1 bar (14 psi)
Max. Operating Temperature ..... 70°C (158°F)
Housing Insulation Voltage ..... > 60 kVDC
Chemical Compatibility..... PFPE, PFC, HFE, Silicon Oil

Please refer to page 2 for dimensions. Technical drawings are available on request.

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Inner dimension (LxWxH) and outer dimension (LxWxH) including lid in mm. Plase note the inner corner radius of r = 4mm

A	A1	A2	A3	A4	A5	A maximum
64 x 64 x 25 94 x 94 x 41	104 x 64 x 25 134 x 94 x 41	144 x 64 x 25 174 x 94 x 41	184 x 64 x 25 214 x 94 x 41	224 x 64 x 25 254 x 94 x 41	264 x 64 x 25 294 x 94 x 41	< 944 x 64 x 25 < 974 x 94 x 41

B	B1	B2	B3	B4	B maximum
104 x 104 x 25 134 x 134 x 41	144 x 104 x 25 174 x 134 x 41	184 x 104 x 25 214 x 134 x 41	224 x 104 x 25 254 x 134 x 41	264 x 104 x 25 294 x 134 x 41	< 944 x 104 x 25 < 974 x 144 x 41

C	C1	C2	C3	C maximum
144 x 144 x 25 174 x 174 x 41	184 x 144 x 25 214 x 174 x 41	224 x 144 x 25 254 x 174 x 41	264 x 144 x 25 294 x 174 x 41	< 944 x 144 x 25 < 974 x 174 x 41

D	D1	D2	D maximum
184 x 184 x 25 214 x 214 x 46	224 x 184 x 25 254 x 214 x 46	264 x 184 x 25 294 x 214 x 46	< 944 x 184 x 25 < 974 x 214 x 46

E	E1	E maximum
224 x 224 x 25 254 x 254 x 41	264 x 224 x 25 294 x 254 x 41	< 944 x 224 x 25 < 974 x 224 x 55

F	F maximum
264 x 264 x 25 294 x 294 x 61	< 944 x 264 x 25 < 974 x 294 x 55

Note:
The standard cooling box program is based on a 40 mm grid. Any x-y enlargement can be realized in steps of 40 mm up to the limits.

When ordering, please always indicate the box code and the inner dimensions, e.g. **"DLC Cooling Box A1, 104-64-25"**

Note:
All standard cooling boxes have at least three G 1/4 threated holes on each side for hose connectors and electrical feedthrus (except box size A, which has only two on each side). Additional holes in different positions and with different types of threats are available on request. Please ask us for detailed technical drawings.

Option BOTT+05	Enforced bottom, box height +5 mm
Option BOTT+10	Enforced bottom, box height +10 mm
Option LID+05	Enforced lid, lid / box height +5mm
Option LID+10	Enforced lid, lid / box height +10mm
Option WALL-10	Inner height reduced by 10 mm
Option WALL-05	Inner height reduced by 5 mm
Option WALL+05	Inner / box height increased by 5 mm
Option WALL+10	Inner / box height increased by 10 mm
Option WALL+20	Inner / box height increased by 20 mm
Option WALL+30	Inner / box height increased by 30 mm
Option LID-BLACK	Intransparent black plastic lid
Option BOX-PVC	Box made of PVC (UL94 V0)
Option BOX-PEEK	Box made of PEEK (higher pressure)
Option BOX-ALU	Box made of black anodized aluminum

We also manufacture customized DLC cooling boxes in any dimension up to 1000 x 750 x 120 mm^3 with any kind of electrical feedthrus in any position! Please contact us for further information.