F DLC - Direct Liquid Cooling with non-conductive coolants

● Best cooling efficiency of all known cooling methods ● Allows an extremely compact high voltage switch design in connection with excellent Pd(max) specifications ● The absence of grounded heatsinks minimizes the stray capacitance with the result of faster electrical rise time and lower power losses at high operating frequencies ● The DLC principle allows a very homogenous cooling of the entire electronics of the switching module and reduces significantly the thermal stress at cyclic load change.

Please click here for an hi-res image of the BEHLKE DLC demonstration display with the new intelligent pump unit PU-2

Note: Behlke DLC cooling systems can be operated with GALDEN® or any other similar PFPE / PFC / HFE heat transfer fluid. A cost efficient alternative to the PFPE / PFC / HFE coolants is the low viscose sillicone oil WACKER AK 10 (chemically compatible to all materials of BEHLKE DLC switches including BEHLKE PU-2 pump unit). Mineral transformer oils are partly not compatible to BEHLKE DLC systems. Please consult BEHLKE for more information regarding transformer oil restrictions.

Please click here for further information about PFPE / PFC / HFE coolants:
Solvay Solexis: Perfluorinated Polyether PFPE Heat Transfer Fluids
Solvay Solexis: Data Sheet Heat Transfer Fluid GALDEN HT-135
3M: Thermal Management Fluids
3M: Fluorinert Electronic Liquids
3M: Novec 7500 Engineered Fluid
3M: Reducing Emissions of PFC Heat Transfer Fluids
3M: Dielectric Heat Transfer Fluid Solutions for Military and Aerospace Applications

● Preferred stock type ○ Stock may be limited x Product no longer available. Spare parts on request.

Pump Units

PU-2 ●

"Intelligent" pump unit with coolant reservoir and built-in control electronics for the pump motor and possible external radiator fans. Highly reliable design for professional purposes. The pump housing / reservoir is milled from a billet aluminum block and allows an absolute leakage free operation also at high temperature and high pressure. The front side of the unit, which is usually mounted behind the front panel of a system housing (e.g. a 19 inch housing unit), has an o-ring sealed viewing window for the built-in flow turbine wheel. The flow turbine wheel serves as a visual flow indicator and as digital flow sensor in the same time. Double ball bearing in connection with optical scanning guarantees a MTBF of several hundred thousand hours for this safety relevant part component.

The built-in electronics is monitoring the coolant flow, the tank fill level (also by optical sensors), the coolant temperature, the motor function and the supply voltage. The speed of the pump motor and the speed of the externally connected radiator fans is regulated proportionally to the coolant temperature. The automatic speed control can be turned-off by a logic signal for full cooling power or external speed control over the supply voltage, if demanded.

In case of any fault condition (over temperature, flow disturbance, empty reservoir, missing or incorrect supply voltage etc.) a relay contact is immediately released to protect the connected power electronics in the cooling circle. For Behlke HTS high voltage switches, the alarm contact (normaly closed contact) will simply be connected between the "Inhibit" and the "GND" input of the switch control. Any false or critical operating condition will also be indicated by different color illuminations of the coolant, which is visible through the viewing window. During normal cooling operation the color of illumination is blue. Other colors are available, to meet individual front panel design requirements.

If ordered with option "IHE" (internal heat exchanger), the pump block with its plain milled surfaces can also be utilized as a highly efficient heat exchanger / heat sink. With the help of the option "IHE", the coolant heat can be easily transferred via the housing block to an existing heatsink. This can be a classical heatsink or any large massive metal housing (e.g. a 19 inch housing with thick front panel) or a large metal chassis of a machine. A cooling solution with option "IHE" allows a power dissipation of at least 500 Watt without active radiators.

The maximum cooling capacity with sufficient active radiators is approx. 3000 Watt for the standard pump unit and approx. 5000 Watt in connection with the power option "30W".

The option "EFSI" (extra features for system integration) includes an additional optocoupler output (open collector), a digital flow signal output and an integrated coolant temperature sensor according to customers specifications (PT100, KTY, NTC etc.)

PU-2 Features:

- Non-blocking, highly reliable pump motor for industrial purposes with coolant lubricated and self-adjusting ceramic bearing
- Guarranteed motor life expectancy >50,000 hours (typical 100,000 hours) at maximum temperature / maximum load
- Temperature depending speed control (can be switched off) for low power consumption and maximum motor life expectancy
- Maximum flow rate > 3l / min with Galden HT-135 @ 25°C and < 30 cm height difference. Useful up to 3000 Watt power dissipation
- Pump power 8 - 20 Watt (12 - 30 Watt with option "30W"), 12 VDC, current consumption max. 1.8 A (2.5A with option "30W")
- Fan output for active radiators. With temperature depending speed control, 6 - 12 VDC, max. 3A. Noiseless analog control - no PWM
- Monitoring of coolant flow, coolant temperature, coolant fill level and supply voltage. Safety shutdown / alarm at T>65°C (149°F)
- Alarm output by a passively closed relay contact (max. 0.5 A) and optionally by an additional opto coupler with open collector (option EFSI)
- Fill port and overpressure valve (0.5 bar / 7 psi) on top lid. Alternatively on front side over the viewing window, if installed in 19" housings.
- Useful reservoir volume approx. 400 ml (13.5 oz), air buffer volume (volume change compensation) approx. 100 ml (3.4 oz)
- Threated inserts, metric, d = 5 mm (M5) on bottom, right side, rear side and front side for heatsink attachment (8 threaded inserts on each side). Alternative attachment by a flange plate. Flange and sufficient M5 screws are included in supply. The plastic spacer on front side can be removed, if the viewing window shall be in line with a front panel plate. Please ask for a modified window thickness, if your front plate has an unusual thickness.
- Housing billet aluminum, black anodized, block dimension (without spacer and removable flange) 120 x 100 x 100 mm³ (HxWxD), net weight without coolant 1.95 kg (4.3 lb)
- Operating Temperature Range -25 to 65°C (-13 to 149 °F) with Galden HT-135

For further information please click here:
Data Sheet and Instructions of the PU-2 pump unit
Large image of the PU-2 pump unit

		Large image of the PU-2 pump motor Large image of its internal control electronics
Option 30W		Increased pump power (12-30 W). Recommended for systems with > 2000 Watt power dissipation. Maximum flow rate > 5l / min with Galden HT-135 @ 25°C. For 12 VDC. Please note the higher current consumption of approx. 2.5 A. Dimensions and weight as above.
Option IHE		Internal heat exchanger for the heat transfer via the plain milled pump block surfaces. The reservoir volume is reduced by approx. 10%.
Option H-CF		Housing block with cooling fins for secondary air cooling. Recommended In connection with option IHE. Cooling fins can be attached on the rear side and / or the right side of the housing block. Heat resistance down to 0.2 K/W per side (forced air convection, air velocity >4 m/s).
Option EFSI		Extra features for system integration: Alarm optocoupler output, digital flow signal output, custom specific temperature sensor (12 pole plug).
Option H-DIM		Housing dimension adapted to customers requirements. Any housing shape and size is possible, but height must be > 60 mm.
Option IIO		Inclination independent operation. Recommended if the angle of inclination exceeds permanently 45° or if the unit will be rotated over his axis.
Option TPL		Transparent plastic lid as temporary or permanent replacement of the metal lid. Allows a vertical view into the reservoir. Incl. o-ring.
PU-1	X	Pump Unit complete with ESD protected reservoir, decoupled base plate and temperature sensor for speed control purposes, speed / power adjustable by voltage (7-12 V / 4-20 W), maximum flow rate 3l / min with Galden HT 135 @ 25°C, 120 x 88 x 94 mm³

DLC Cooling Boxes

Pressure proof cooling boxes for the integration of non-DLC components, such as classical power electronic components and peripheral circuit boards, into a DLC cooling system. 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 maximum available length (inner dimension 944 mm, outher dimension 974 mm, see data sheet for detailed information). Customized DLC cooling boxes in any dimension up to 1000 x 750 x 120 mm³ with any kind of electrical feedthrus in any position are available. Please contact us for further information. The cooling boxes 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 feedthrus. Two hose connectors and screw caps are included in the supply. Electrical feedthrus must be ordered separately. The standard housings are made from Delrin and Makrolon. PEEK, PVC and Aluminum are optionally available.

Box A	•	DLC Cooling Box, inner dimension 64 x 64 x 25 mm³, outer dimension 94 x 94 x 41 mm³
Box A1	•	DLC Cooling Box, inner dimension 104 x 64 x 25 mm³, outer dimension 134 x 94 x 41 mm³
Box A2	•	DLC Cooling Box, inner dimension 144 x 64 x 25 mm³, outer dimension 174 x 94 x 41 mm³
Box A3	•	DLC Cooling Box, inner dimension 184 x 64 x 25 mm³, outer dimension 214 x 94 x 41 mm³
Box A4	•	DLC Cooling Box, inner dimension 224 x 64 x 25 mm³, outer dimension 254 x 94 x 41 mm³
Box A5	•	DLC Cooling Box, inner dimension 264 x 64 x 25 mm³, outer dimension 294 x 94 x 41 mm³
Box B	•	DLC Cooling Box, inner dimension 104 x 104 x 25 mm³, outer dimension 134 x 134 x 41 mm³
Box B1	•	DLC Cooling Box, inner dimension 144 x 104 x 25 mm³, outer dimension 174 x 134 x 41 mm³
Box B2	•	DLC Cooling Box, inner dimension 184 x 104 x 25 mm³, outer dimension 214 x 134 x 41 mm³
Box B3	•	DLC Cooling Box, inner dimension 224 x 104 x 25 mm³, outer dimension 254 x 134 x 41 mm³
Box B4	•	DLC Cooling Box, inner dimension 264 x 104 x 25 mm³, outer dimension 294 x 134 x 41 mm³
Box C	•	DLC Cooling Box, inner dimension 144 x 144 x 25 mm³, outer dimension 174 x 174 x 41 mm³
Box C1	•	DLC Cooling Box, inner dimension 184 x 144 x 25 mm³, outer dimension 214 x 174 x 41 mm³
Box C2	•	DLC Cooling Box, inner dimension 224 x 144 x 25 mm³, outer dimension 254 x 174 x 41 mm³
Box C3	•	DLC Cooling Box, inner dimension 264 x 144 x 25 mm³, outer dimension 294 x 174 x 41 mm³
Box D	•	DLC Cooling Box, inner dimension 184 x 184 x 25 mm³, outer dimension 214 x 214 x 41 mm³
Box D1	•	DLC Cooling Box, inner dimension 224 x 184 x 25 mm³, outer dimension 254 x 214 x 41 mm³
Box D2	•	DLC Cooling Box, inner dimension 264 x 184 x 25 mm³, outer dimension 294 x 214 x 41 mm³
Box E	•	DLC Cooling Box, inner dimension 224 x 224 x 25 mm³, outer dimension 254 x 254 x 41 mm³
Box E1	•	DLC Cooling Box, inner dimension 264 x 224 x 25 mm³, outer dimension 294 x 254 x 41 mm³
Box F	•	DLC Cooling Box, inner dimension 264 x 264 x 25 mm³, outer dimension 294 x 294 x 41 mm³

Options for DLC Cooling Boxes

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

Electrical Feedthrus for DLC Cooling Boxes
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.

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 with TYCO-AMPMODU connector and open wires

FT-BNC-50	•	BNC Feedthru with 50 ohms coaxial pigtail
FT-LEMO-4P	•	4 pole LEMO connector with open wires

Active Radiators

AR-500W	•	Active Radiator, useable up to 500W, 155 x 120 x 60 mm³
AR-800W	•	Active Radiator, useable up to 800W, 155 x 120 x 87 mm³
AR-2000W	•	Active Radiator, useable up to 2000W, 275 x 120 x 87 mm³
AR-3000W	•	Active Radiator, useable up to 3000W, 395 x 120 x 87 mm³
AR-4000W	○	Active Radiator, useable up to 4000W, 515 x 120 x 87 mm³
AR-9000W	○	Active Radiator, useable up to 9000W, 411 x 370 x 80 mm³

Liquid Coolers

LC-200W	•	Liquid Cooler, useable up to 200W, for attachment on existing heat sinks or large metal housings, 90 x 60 x 42 mm³
LC-1500W	•	Liquid Cooler, useable up to 1500W, for attachment on existing heat sinks or large metal housings, 250 x 144 x 50 mm³

Passive Radiators

PR1-1	•	High efficiency cooling profile complete with two 90° fittings, 420 x 50 x 50 mm³
PR1-4	•	Set of four PR1-1 cooling profiles incl. connecting pieces, 420 x 200 x 50 mm³

Heat Exchangers

HE-10	•	Heat Exchanger complete with fittings for primary and secondary circuit, useable up to 10kW, 224 x 89 x 55 mm³

Thermometers and Sensors

TM-1	•	Thermometer with LCD display and blue background illumination, snap-in assembly
TS-1	•	In-Line Thermo-Sensor with ESD protection, both sides for tubing connection
TS-2	•	In-Line Thermo-Sensor with ESD protection, 1x tubing connection, 1x thread G1/4"
TS-3	•	Thermo-Sensor with ESD protection, for thread G1/4"

Flow Sensors and Indicators

FI-1	•	Flow Indicator, for tubing connection
FI-2	•	Flow Indicator with particle filter, 2x G1/4" fittings required
FS-1	•	Flow turbine with digital tacho signal and background light, both sides for tubing connection
FS-2	•	Flow turbine with diamond bearing and digital tacho signal, both sides for thread G1/4"

Fitting Kits

FK-8x1.0	•	Metal fittings for tubing 8 x 1.00 mm, threads G1/4" with O-ring. Fitting caps inner diameter 10 mm.
FK-8x1.5	•	Metal fittings for tubing 8 x 1.50 mm, threads G1/4" with O-ring. Fitting caps inner diameter 11 mm.

Tubing

PVC 8 x 1.5	•	PVC tubing, ring of 5 m, highly flexible, ideal for laboratory use. Note: PVC plasticizers may migrate over the time. For d=11mm fitting caps.
PUR 8 x 1.0	•	PUR tubing, ring of 5 m, recommended for professional purposes and higher temperature. For use with d=10mm fitting caps (8x1.0 fittings).
PE 8 x 1.0	•	PE tubing, ring of 5 m, recommended for professional purposes and higher temperature. For use with d=10mm fitting caps (8x1.0 fittings).
PTFE 8 x 1.0	•	PTFE tubing, ring of 5 m, recommended for professional purposes and higher temperature. For use with d=10mm fitting caps (8x1.0 fittings).

Coolant

HT-135 5.0kg	•	Galden HT135 (PFPE), high performance dielectric coolant, non-flammable, non-toxic, residue-free evaporation. 5 kg can.
HT-135 1.7kg	•	Galden HT135 (PFPE), high performance dielectric coolant, non-flammable, non-toxic, residue-free evaporation. 1.7 kg bottle.
AK 10	•	Wacker Silicone Oil AK-10, colorless, 5 liter can
AK 10	•	Wacker Silicone Oil AK-10, colorless, 1 liter bottle

Further information, data sheets and drawings are available on request. All data and specifications subject to change without notice. **REV 19-APRIL-2016**