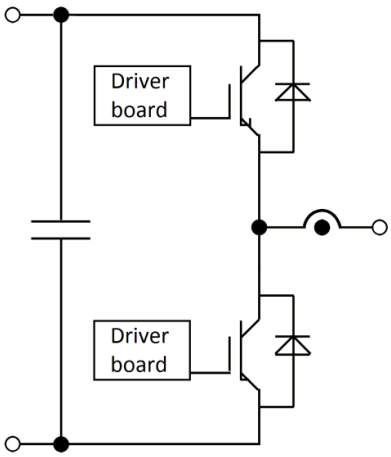
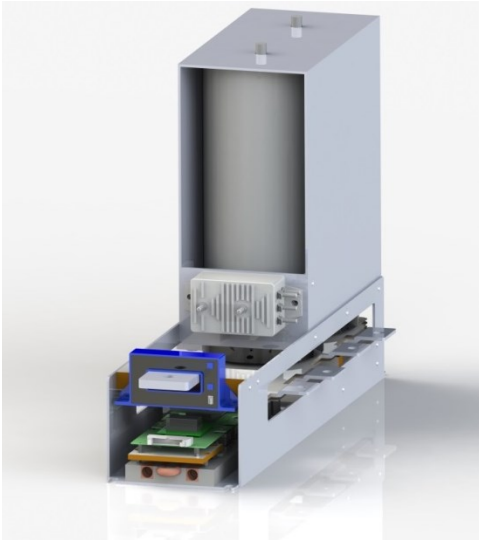
Datasheet

# Modular Inverter System VARIS™-14-17-W

- **Individual circuit arrangement**
- **Water cooled**
- **3900µF capacitance per module**
- **Optical or electrical signal transmission**
- **Current and temperature measurement**



1. ***Technical Data Phase Leg***
2. ***Technical Data 3-Phase Inverter***

**General information:**

VARIS™ consists of a half bridge IGBT module with dc-link capacitors. One VARIS™ can be used as a phase-leg for AC inverters as well as a boost- or buck converter for DC operation. Three VARIS™ connected together result in a 3-phase inverter. For higher power, parallel configurations of the boost converter, buck converter or 3-phase inverter are possible.

VARIS™ is available with water or forced air cooling, and an optical or electrical signal transmission. Each module has its own heatsink, driverboard and current sensor. For the technical data of the 3-phase inverter please see section 2.

CE

GvA Leistungselektronik
Boehringerstraße 10-12
68307 Mannheim

Telefon: +49 (0) 621/7 89 92-0
Fax: +49 (0) 621/7 89 92-99
E-Mail: info@gva-leistungselektronik.de
Web: gva-leistungselektronik.de

## *1. General Circuit Arrangements:*

Depending on the application different circuit arrangements are possible. The following figures will show some examples for combining several VARIS™ modules together:

3-phase inverter:

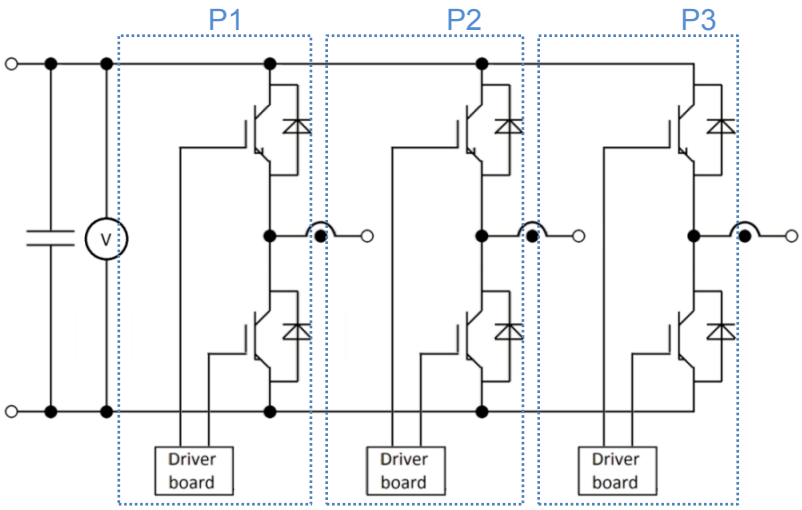



**Figure 1:** 3-phase inverter

Single-phase inverter with break chopper:

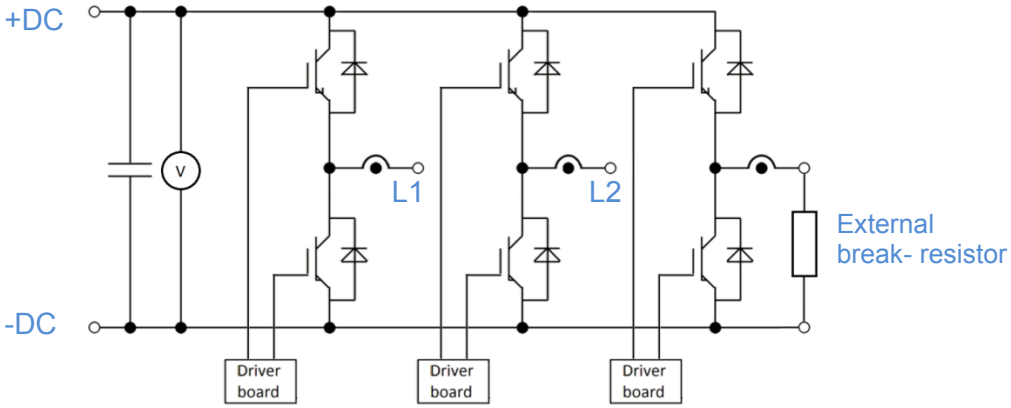



**Figure 2:** Single-phase inverter with break chopper

3-phase AFE with triple interleaved Chopper:

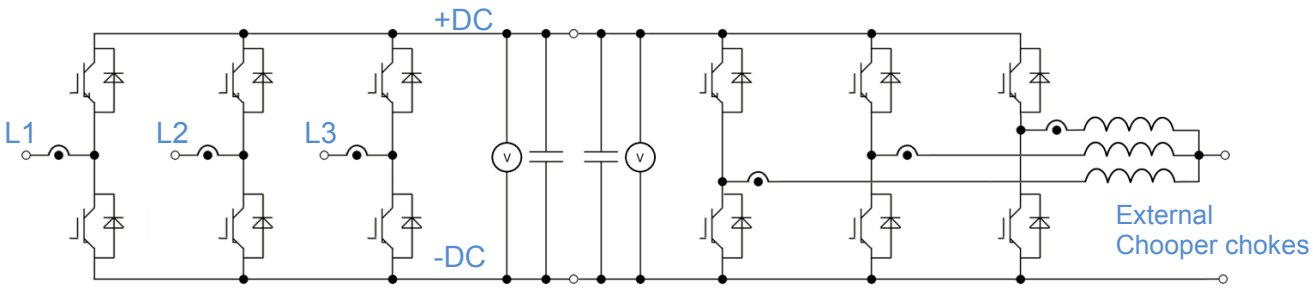



**Figure 3:** 3-phase AFE with triple interleaved Chopper

## 2. Technical Data Phase Leg:

| **Absolute maximum rated values** | | | **Symbol** | **Min.** | **Typ.** | **Max.** | **Unit** |
|---|---|---|---|---|---|---|---|
| Collector emitter voltage | IGBT, $T_{vj}$=25°C | | $V_{ces}$ | | | 1700 | V |
| Peak reverse voltage | Diode, $T_{vj}$=25°C | | $V_{rrm}$ | | | 1700 | V |
| DC-link voltage | | | $V_{dc}$ | | | 1200 | V |
| Maximum line voltage | ±10% tolerance | | $V_{line}$ | | | 690 | $V_{RMS}$ |
| Insulation test voltage according EN 61800-5-1 | f=50Hz, t=1min | | $V_{iso}$ | | | 3000 | $V_{RMS}$ |
| Repetitive peak collector current, IGBT | $t_p$ <=1ms | | $I_{crm}$ | | | 2800 | A |
| Repetitive peak forward current, Diode | $t_p$ <=1ms | | $I_{frm}$ | | | 2800 | A |
| Continuous output current | $V_{dc}$=1000V, $V_{ac}$=690$V_{RMS}$, cos(φ)=0.95, $f_{ac\_sine}$=50Hz, $f_{sw}$=2kHz, m=1.0, $T_{inlet}/T_{amb}$ ≤ 25°C, $T_{vjsw}$≤125°C | Water | $I_{ac}$ | | | 1242 | $A_{RMS}$ |
| Junction temperature under switching conditions | At continuous current $I_{ac}$ | | $T_{vjsw}$ | | | 125 | °C |
| Junction temperature under overload conditions | At $I_{ac\_over1/2}$ | | $T_{vjsw}$ | | | 150 | °C |

| **Characteristic values** | | **Symbol** | **Min.** | **Typ.** | **Max.** | **Unit** |
|---|---|---|---|---|---|---|
| Rated voltage | DC-link | $V_{dc}$ | | 1000 | 1200 | V |
| Total capacitance | Capacitor rated tolerance ±10% | $C_{dc}$ | | 3900 | | µF |
| DC-link current ripple | $T_{amb}$ <=55°C | $I_{ripple\_Cdc}$ | | | 240 | $A_{RMS}$ |
| Capacitor type | IEC61071 Standard, 50 FIT (100000h, $\theta_{Hotspot}$ ≤ 70°C) | | | PP-Foil | | |
| Balance or discharge resistor per DC link unit | Optional, refers to customers desired discharge time | | | TBD | | kΩ |

| System data general | | | Symbol | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|---|
| EMC robustness | According to EN 61800-3 | Power | $V_{burst}$ | | TBD | | kV |
| | | Control | $V_{burst}$ | | TBD | | kV |
| | | Aux | $V_{surge}$ | | TBD | | kV |
| Storage temperature | Without remains of coolant | | $T_{storage}$ | -40 | | 80 | °C |
| Operational ambient temp. | | | $T_{op\_amb}$ | -20 | | 55 | °C |
| Humidity No condensation | max. relative humidity | | Rel. H | | 75 | | % |
| | occasional | | Occ. H | | 85 | | |
| | 30 days/year | | 30 day. H | | 95 | | |
| Cabinet cooling air velocity | PCB, DC link capacitor, bus bar | | $V_{air}$ | 2 | | | m/s |
| Vibration | According DIN IEC 60721 | | | | TBD | | m/s² |
| Mech. shock | According DIN IEC 60721 | | | | TBD | | m/s² |
| Protection degree | | | | | IP00 | | |
| Pollution degree | | | | | 2 | | |
| Dimensions | Width x Depth x Height | | water | 220 | 651.5 | 437.52 | mm |

| System data water cooled | | Symbol | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| Water flow | | Q | 4 | | | L/min |
| Water pressure drop | at Q | Δp | | 200 | | mbar |
| Coolant inlet temperature | | $T_{inlet}$ | -25 | | 55 | °C |
| Coolant composition | Recommended mix ratio: Water (W) – antifreeze (AF) | | 48 (W) | | 52 (AF) | % |
| Cooling channel material | Copper | | | | | |
| Water connection | Standard terminal at the front, inner thread | | | ¼ | | inch |
| Weight | System water cooled | | | 21.0 | | kg |

## 3. Technical Data Driverboard:

Each VARIS module has its own driverboard. It is available with an optical or an electrical signal transmission.

| **Driverboard: general system data** | | **Symbol** | **Min.** | **Typ.** | **Max.** | **Unit** |
|---|---|---|---|---|---|---|
| Supply voltage Pin 1 GND, Pin 2 Vaux | | $V_{aux}$ | 14.5 | 15 | 15.5 | $V_{DC}$ |
| Supply current driver-board during stand-by | Stand-by, $f_{SW}$ = 0, optical | $I_{driver}$ | | 266 | | mA |
| | Stand-by, $f_{SW}$ = 0, electrical | $I_{driver}$ | | 74 | | mA |
| Supply current driver-board during operation | at $f_{SW}$ = 2kHz, optical | $I_{driver}$ | | 343 | | mA |
| | at $f_{SW}$ = 2kHz, electrical | | | 127 | | mA |
| | at $f_{SW}$ = 6kHz, optical | | | 497 | | mA |
| | at $f_{SW}$ = 6kHz, electrical | | | 234 | | mA |
| Maximum switching frequency | $T_{amb}$ <=85°C | $f_{SW\_max}$ | | | 7 | kHz |
| | $T_{amb}$ <=70°C | | | | 12 | kHz |
| IGBT NTC temperature measurement range** | Electrical: analog voltage signal | $T_{NTC}$ | -25 | | 150 | °C |

| **Driverboard: Electrical interface** | **26 Pin Latch/Ejector, 2.54mm grid (e.g. 3M 34296002)** | **Symbol** | **Min.** | **Typ.** | **Max.** | **Unit** |
|---|---|---|---|---|---|---|
| Pin 1,3 | Supply voltage | $V_{DC}$ | | 15 | | $V_{DC}$ |
| Pin 5,7 | Supply voltage | $V_{CC}$ | | 15 | | $V_{DC}$ |
| Pin 9 | Status lowside, 15V CMOS out | SO2_OUT | | 15 | | V |
| Pin 11 | Signal input lowside | SI_INB | | 15 | | V |
| Pin 13 | Status highside, 15V CMOS out | SO1_OUT | | 15 | | V |
| Pin 15 | Signal input highside | SI_INA | | 15 | | V |
| Pin 17 | Do not connect | | | | | |
| Pin 19 | Do not connect | | | | | |
| Pin 21 | Status lowside with acknowledgment pulse | Status2 | | 15 | | V |
| Pin 23 | Status highside with acknowledgment pulse | Status1 | | 15 | | V |
| Pin 25 | Analog output of NTC** | $V_{Temp\_Out}$ | 0 | | 5 | V |
| Pin 2,4,6,8,10,12,14, 16,18,20,22,24,26 | Ground | GND | | | | |

| Driverboard: Optical interface | Versatile link HFBR-connectors | Symbol | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| Gate signal highside | Fiber optic receiver HFBR-2521 | XR1 | | | | |
| Status signal highside | Fiber optic transmitter HFBR-1521 | XT1 | | | | |
| Gate signal lowside | Fiber optic receiver HFBR-2521 | XR2 | | | | |
| Status signal lowside | Fiber optic transmitter HFBR-1521 | XT2 | | | | |

| Electrical interface X1 | Driver supply when using optical interface MSTBA4-5.08mm | Symbol | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| Pin 1 | Ground | GND | | | | |
| Pin 2 | Supply voltage | $V_{CC}$ | | 15 | | $V_{DC}$ |
| Pin 3 | Supply voltage | $V_{DC}$ | | 15 | | $V_{DC}$ |
| Pin 4 | Analog output of NTC** | $V_{Temp\_Out}$ | 0 | | 5 | V |

**The temperature of the IGBT-module NTC is converted into a voltage. The following formula gives the conversion from voltage to temperature and vice versa. (Unit of $T_{NTC}$ in absolute Kelvin)

$$T_{NTC} = \frac{B}{\ln\left(\frac{\left(X*R_S*R_P-R_S*V_{Temp\_Out}*R_P\right)}{R_{25}*\left(V_{Temp\_Out}*R_P-R_S*X+R_S*V_{Temp\_Out}\right)}\right)+\frac{B}{298{,}15}}$$

Formula 1.0

The following constants are valid for the used NTC:

| Constants of formula 1.0 | Symbol | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| Resistance | Rs | | 220 | | Ω |
| Resistance | Rp | | 1800 | | Ω |
| B value | B | | 3433 | | K |
| Resistance | R25 | | 5000 | | Ω |
| Factor | X | | 11 | | |

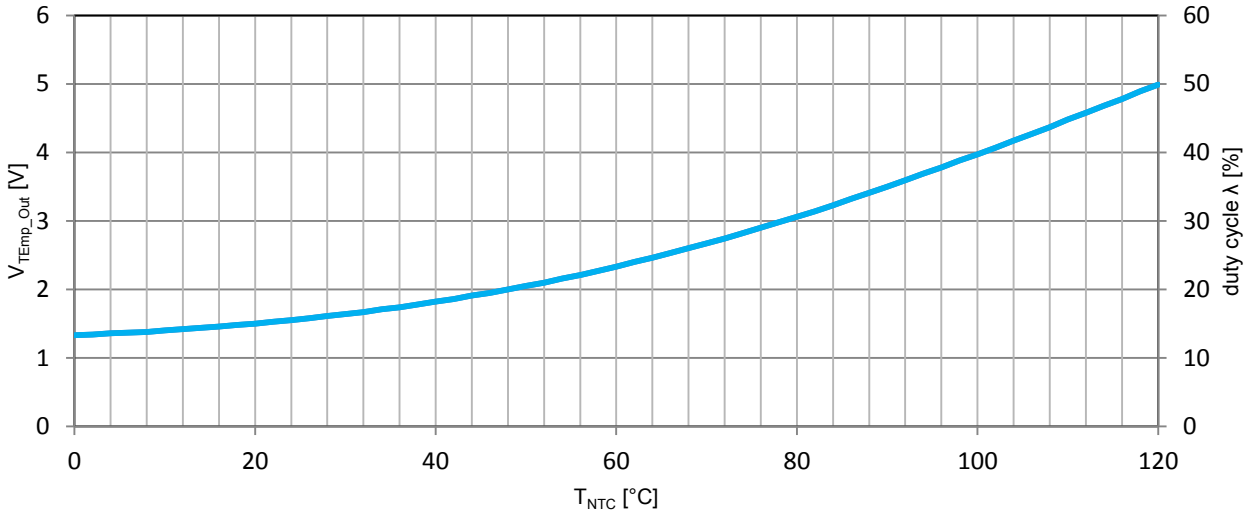



**Figure 4:** Characteristic curve of the analog temperature sense output $V_{Temp\_Out}$ and the duty cycle λ over the IGBT NTC temperature $T_{NTC}$

## *4. Technical Data Sensoring:*

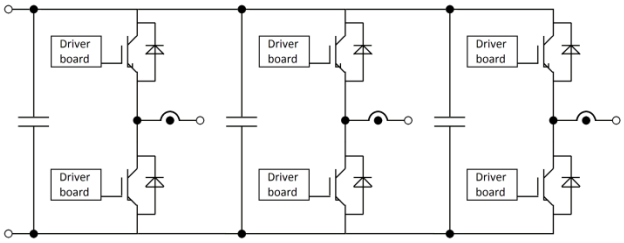
Each VARIS module includes a current sensor for measuring the output current. The power circuit is already prewired. The control circuit must be wired according to the following connector interface:

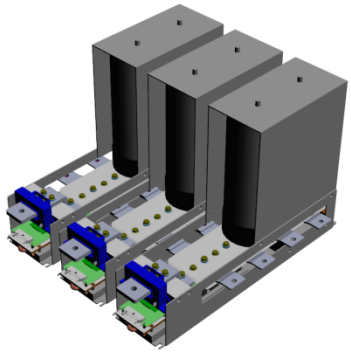
| **Current sensor interface** | | | **Min.** | **Typ.** | **Max.** | |
|---|---|---|---|---|---|---|
| Positive supply voltage | | $+V_a$ | | | +15 | V |
| Negative supply voltage | | $-V_a$ | -15 | | | V |
| Nominal primary current | | $I_{pn}$ | | ±1000 | | A |
| Measuring range | | $I_{p\_max}$ | -3000 | | 3000 | A |
| Output voltage | | $V_{out}$ at $I_{pn}$ | | ±4 | | V |
| Ratio primary current $I_{pn}$ to secondary voltage $V_{out}$ | | | | 250 | | A/V |
| Current consumption | | $I_{pn}$ | | <20 | | mA |
| Accuracy at $I_{pn}$ | at $T_{amb}$ = 25°C, excluding electrical offset voltage | | -1.0 | | +1.0 | % |
| Electrical offset voltage | at $T_{amb}$ = 25°C | | -20 | | +20 | mV |
| Frequency Bandwidth | | BW | DC | | 25 | kHz |
| **Electrical interface** | **4 Pin Molex connector** | **5045-04A** | | | | |
| Pin 1 | Positive supply voltage | $+V_a$ | | +15 | | V |
| Pin 2 | Negative supply voltage | $-V_a$ | | -15 | | V |
| Pin 3 | Output | M | | | | V |
| Pin 4 | Ground | GND | | 0 | | V |

A measurement of the DC-Link voltage is optional available. The power circuit is already prewired. The control circuit must be wired according to the following connector interface:

| **Voltage sensor interface** | | **Symbol** | **Min.** | **Typ.** | **Max.** | **Unit** |
|---|---|---|---|---|---|---|
| Positive supply voltage | | $+V_a$ | | | +15 | V |
| Negative supply voltage | | $-V_a$ | -15 | | | V |
| Nominal primary voltage | | $V_{pn}$ | | ±1000 | | V |
| Measuring range | | $V_{p\_max}$ | -1500 | | 1500 | V |
| Output current | | $I_{out}$ at $V_{pn}$ | | ±50 | | mA |
| Ratio primary votalge $V_{pn}$ to secondary current $I_{out}$ | | | | 20000 | | V/A |
| Current consumption | | $I_{pn}$ | | <20 | | mA |
| Accuracy at $V_{pn}$ | at $T_{amb}$ = 25°C | | -0.9 | | +0.9 | % |
| Electrical offset current | at $T_{amb}$ = 25°C | | -0.15 | | +0.15 | mA |
| Frequency Bandwidth | | BW | DC | | 25 | kHz |
| **Electrical interface** | **M4 screw terminal** | **Symbol** | **Min.** | **Typ.** | **Max.** | **Unit** |
| Pin 1 | Positive supply voltage | $+V_a$ | | +15 | | V |
| Pin 2 | Negative supply voltage | $-V_a$ | | -15 | | V |
| Pin 3 | Output | M | | | | V |
| Pin 4 | Earth | E | | | | V |
| Pin 5 | Positive high voltage | HV+ | | | | V |
| Pin 6 | Negative high voltage | HV- | | | | V |

## *5. Technical data 3-phase inverter:*



| **Characteristic values** | | **Cooling type** | **Symbol** | **Min.** | **Typ.** | **Max.** | **Unit** |
|---|---|---|---|---|---|---|---|
| Rated continuous current per leg | $V_{dc}$=1000V, $V_{ac}$=690$V_{RMS}$, cos(φ)=0.95, $f_{ac\_sine}$=50Hz, $f_{sw}$=2kHz, m=1.0, $T_{inlet}/T_{amb}$ ≤ 25°C, $T_{vjsw}$≤125°C | Water | $I_{ac}$ | | | 1242 | $A_{RMS}$ |
| Rated continuous output power 3 phase inverter | $V_{dc}$=1000V, $V_{ac}$=690$V_{RMS}$, cos(φ)=0.95, $f_{ac\_sine}$=50Hz, $f_{sw}$=2kHz, m=1.0, $T_{inlet}/T_{amb}$ ≤ 25°C, $T_{vjsw}$≤125°C | Water | $P_{out}$ | | | 1410 | kW |
| Rated continuous over- current $t_{on}$ ≤ 60s | $V_{dc}$=1000V, $V_{ac}$=690$V_{RMS}$, cos(φ)=0.95, $f_{ac\_sine}$=50Hz, $f_{sw}$=2kHz, m=1.0, $T_{inlet}/T_{amb}$ ≤ 25°C, $t_{on}$ ≤ 60s $T_j$≤150°C | Water | $I_{ac\_over1}$ | | | 1550 | $A_{RMS}$ |
| Rated continuous over- current $t_{on}$ ≤ 3s | $V_{dc}$=1000V, $V_{ac}$=690$V_{RMS}$, cos(φ)=0.95, $f_{ac\_sine}$=50Hz, $f_{sw}$=2kHz, m=1.0 $T_{inlet}/T_{amb}$ ≤ 25°C, $t_{on}$ ≤ 3s $T_j$≤150°C | Water | $I_{ac\_over2}$ | | | 1620 | $A_{RMS}$ |
| Power losses per phase leg | $V_{dc}$=1000V, $V_{ac}$=690$V_{RMS}$, cos(φ)=0.95, $f_{ac\_sine}$=50Hz, $f_{sw}$=2kHz, m=1.0, at $I_{ac}$ $T_{vjsw}$≤125°C | Water | $P_{loss\_leg}$ | | | 4844 | W |
| Power losses 3 phase inverter | $V_{dc}$=1000V, $V_{ac}$=690$V_{RMS}$, cos(φ)=0.95, $f_{ac\_sine}$=50Hz, $f_{sw}$=2kHz, m=1.0, at $I_{ac}$ $T_{vjsw}$≤125°C | Water | $P_{loss\_tot}$ | | | 14532 | W |
| Switching frequency | | Water | $f_{sw}$ | | 2000 | | Hz |
| Power factor | | | cos(φ) | -1.00 | | 1.00 | |

**Current and Power ratings water cooled 3-phase configuration (3x VARIS™-14-17-W):**

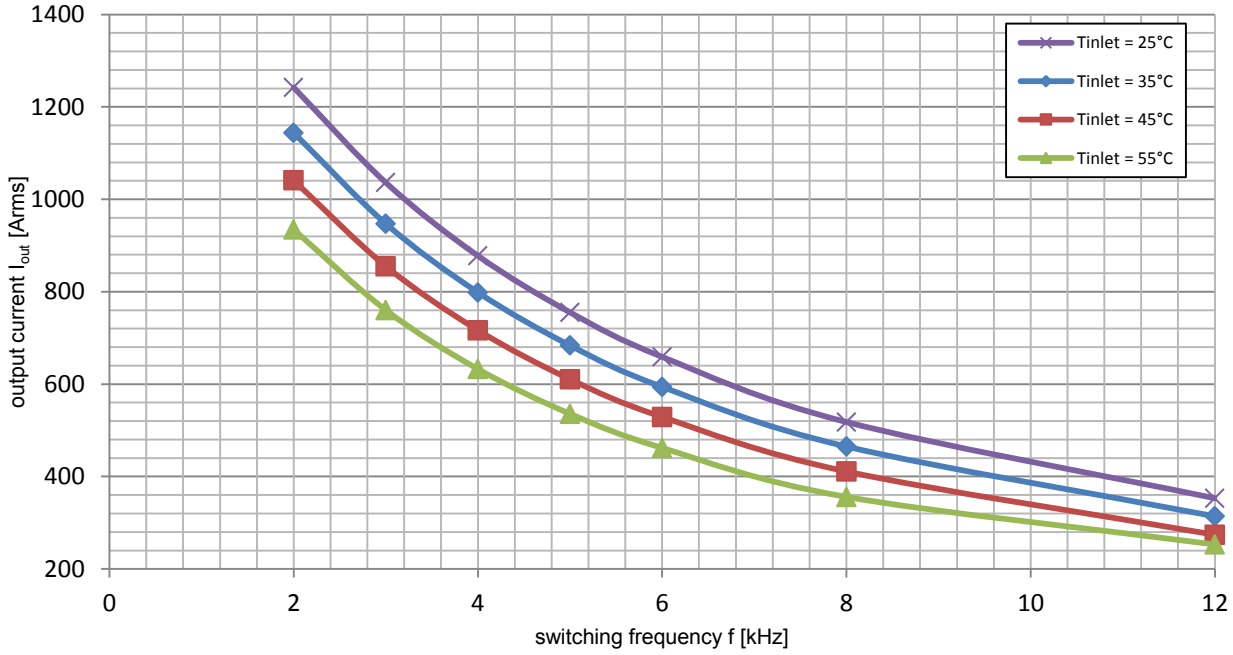



**Figure 5:** Current rating VARIS™-14-17-W (3-phase, water cooled)
Measurement at $V_{dc}$=1000V, Q = 4,3 L/min, $V_{ac}$=690$V_{RMS}$, cos(φ)=0.95, m=1.0, $f_{ac\_sine}$=50Hz, $T_{vjsw}$≤125°C

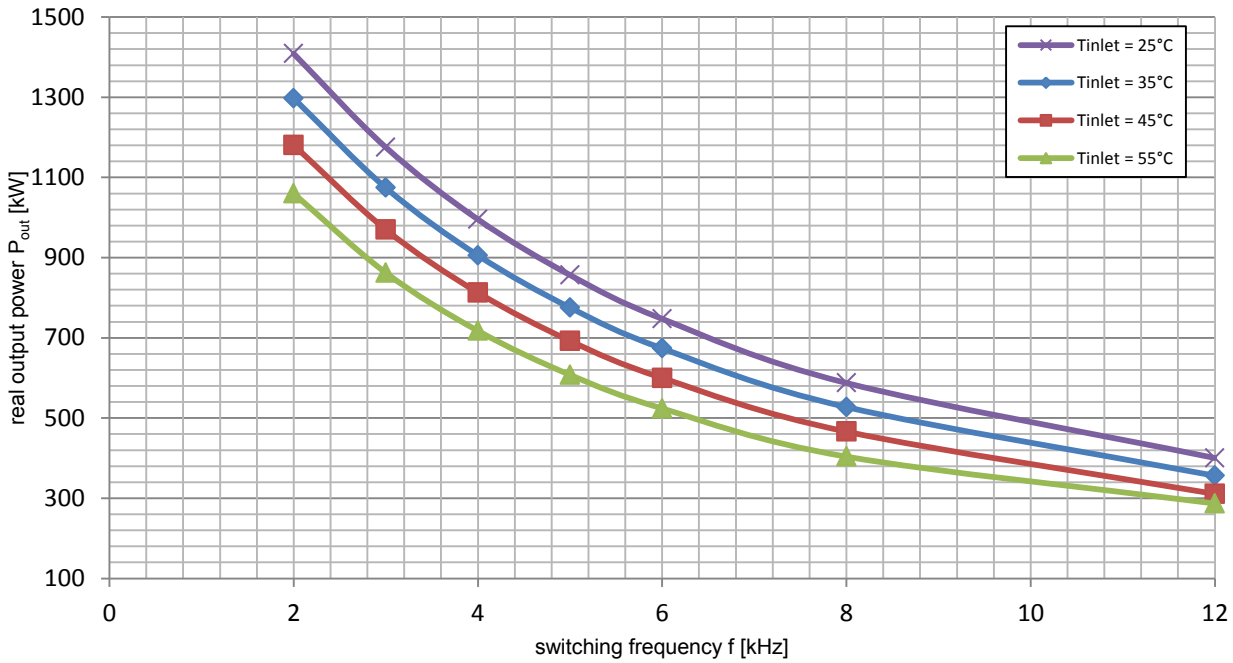
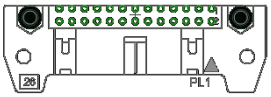


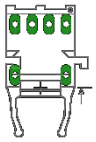

**Figure 6:** Power rating VARIS™-14-17-W (3-phase, water cooled)
Measurement at $V_{dc}$=1000V, Q = 4,3 L/min, $V_{ac}$=690$V_{RMS}$, cos(φ)=0.95, m=1.0, $f_{ac\_sine}$=50Hz, $T_{vjsw}$≤125°C

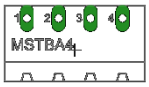
## *6. Signal Interfaces:*

Driverboard electrical:

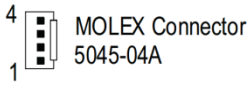



Driverboard optical (HFBR-15xx, supply voltage MSTBA4 5.08mm):





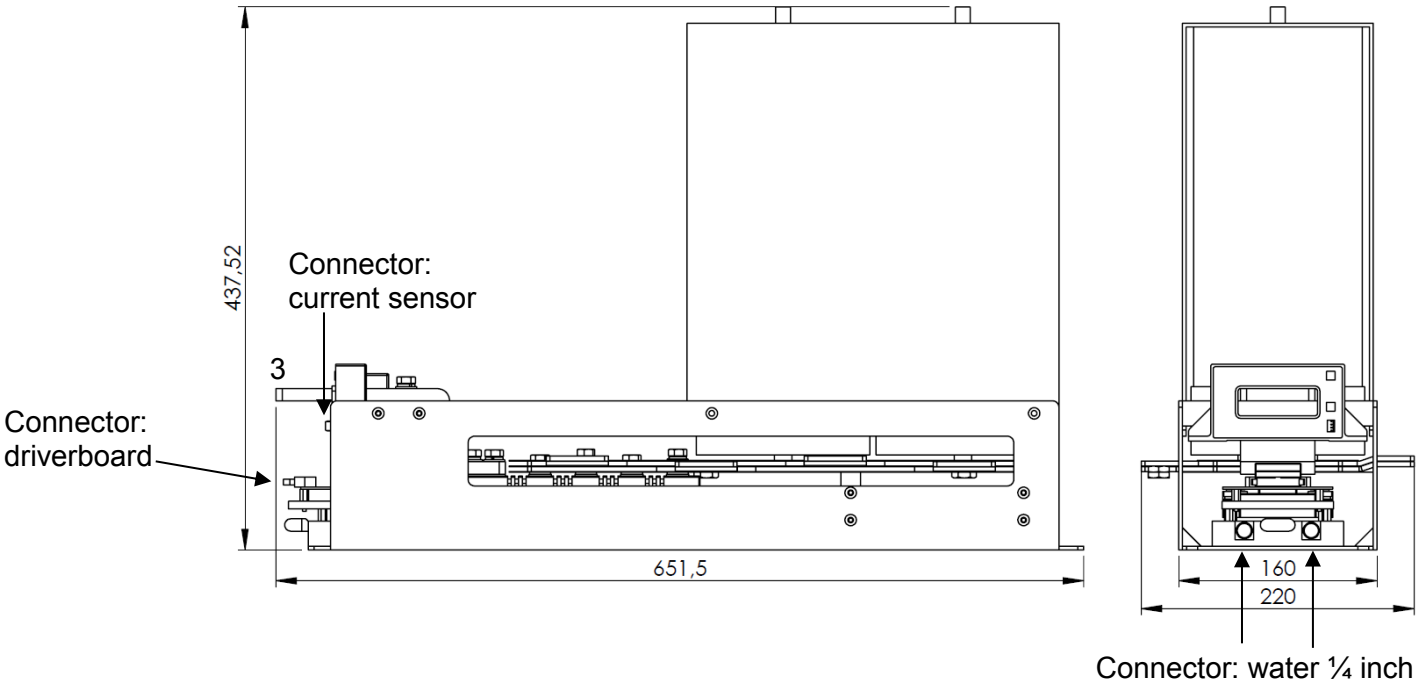

Current sensor:




Water cooler (¼ inch):

## *7. Mechanical drawings:*

- All dimensions in millimeter (mm)



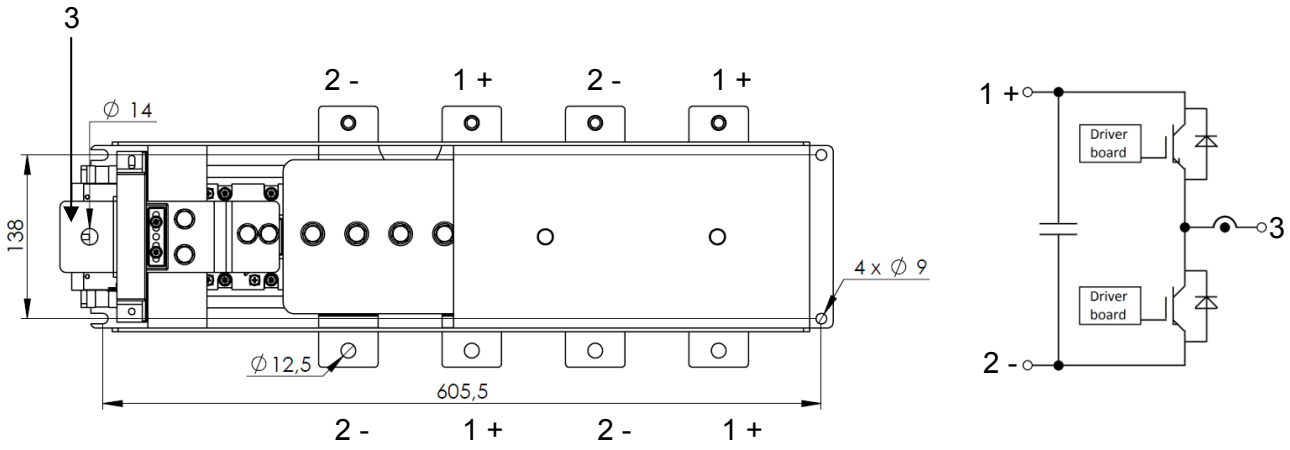




**Figure 7:** Mechanical drawing of the VARIS™-14-17-W (water cooled)

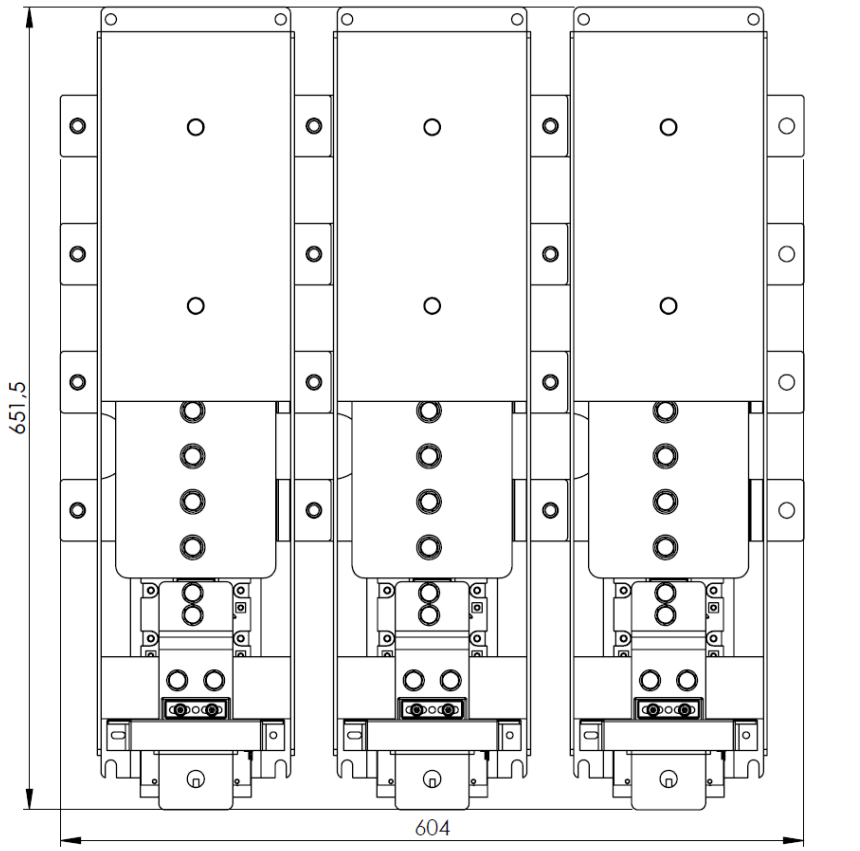



**Figure 8:** Mechanical drawing of 3 x VARIS™-14-17 three phase configuration

GvA Leistungselektronik GmbH reserves the right to adapt or amend the content of this technical information at any time and without prior notification.

For further information feel free to contact us:

GvA Leistungselektronik GmbH
Boehringer Str. 10-12
D-68307 Mannheim
Phone: +49 (0)621 78992-0
www.gva-leistungselektronik.de
Email: info@gva-leistungselektronik.de