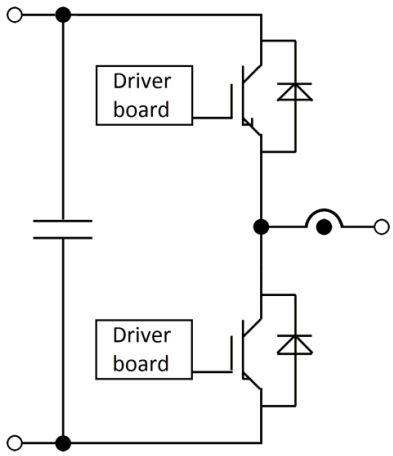
Datasheet

Modular Inverter System VARIS™-14-12

- **Individual circuit arrangement**
- **Water cooled**
- **8000µF 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.

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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:

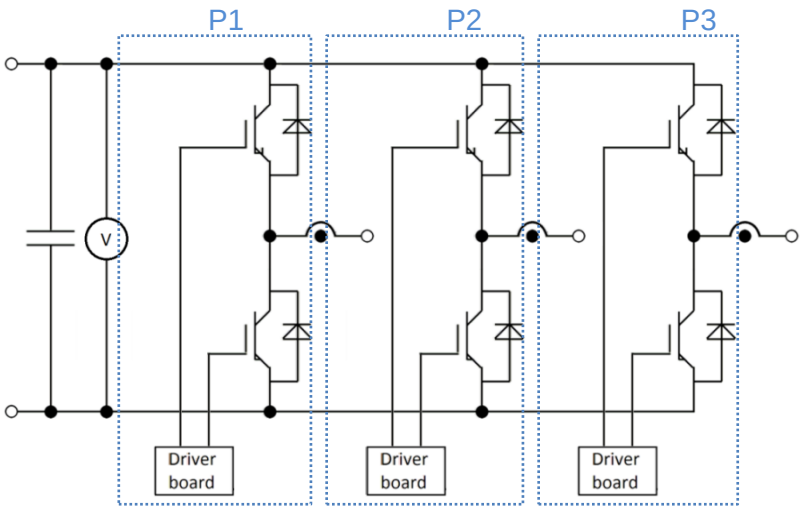


Figure 1: 3-phase inverter

Single-phase inverter with break chopper:

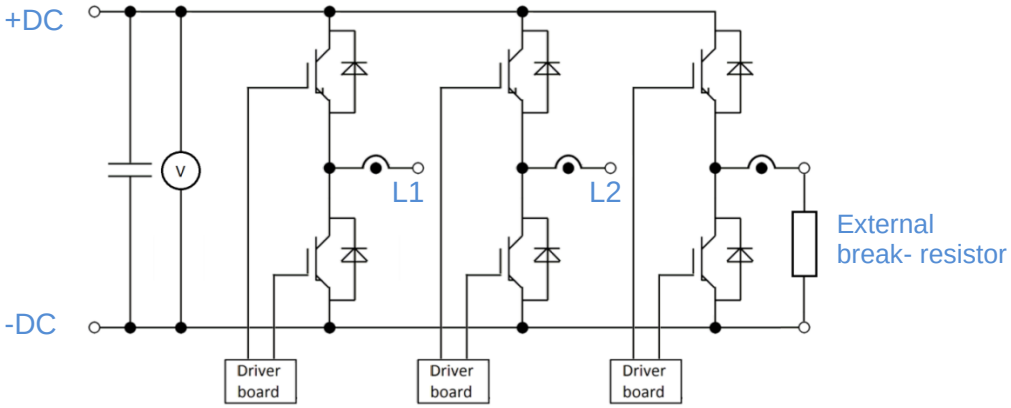


Figure 2: Single-phase inverter with break chopper

3-phase AFE with triple interleaved Chopper:

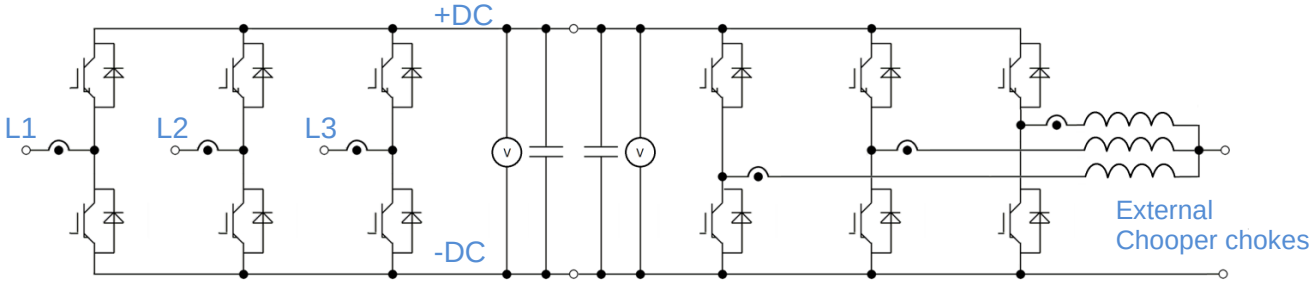


Figure 3: 3-phase AFE with triple interleaved Chopper

2. Technical Data Phase Leg:

Absolute maximum rated values			**Symbol**	**Min.**	**Typ.**	**Max.**	**Unit**
Collector emitter voltage	IGBT, T_{vj}=25°C		V_{ces}			1200	V
Peak reverse voltage	Diode, T_{vj}=25°C		V_{rrm}			1200	V
DC-link voltage			V_{dc}			800	V
Maximum line voltage	±10% tolerance		V_{line}			400	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}=600V, V_{ac}=400Vrms, 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}			1619	A_{RMS}
		Air				747	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}		600	800	V
Total capacitance	Capacitor rated tolerance ±10%	C_{dc}		8000		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
			air	220	651.5	540.52	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			15.1		kg

System data air cooled		**Symbol**	**Min.**	**Typ.**	**Max.**	**Unit**
Input voltage fan	Supply voltage	V_{fan}	16	24	30	V_{DC}
Cooling air velocity	at $24V_{DC}$	V_{air}		6		m/s
Power consumption fan	at $24V_{DC}$	P_{fan}		19.5		W
Ambient temperature	Standard atmosphere	t_{amb}	-25		55	°C
Heatsink material	Aluminum					
Weight	System air cooled			18.4		kg
Electrical interface	**two-wire cable**					
Pin 1	Supply voltage	V_{fan}		24		V_{DC}
Pin 2	Ground	GND		0		V_{DC}

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}		353		mA
	at f_{SW} = 2kHz, electrical			134		mA
	at f_{SW} = 6kHz, optical			527		mA
	at f_{SW} = 6kHz, electrical			254		mA
Maximum switching frequency	T_{amb} <=85°C	f_{SW_max}			7	kHz
	T_{amb} <=70°C				11	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		

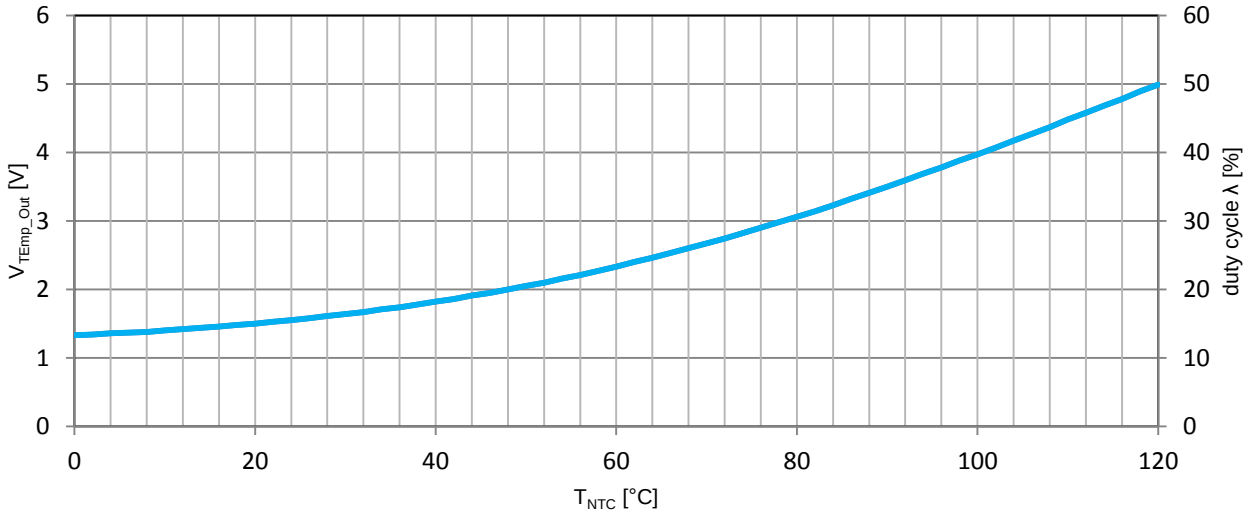


Figure 4: Characteristic curve of the analog temperature sense output V_{Temp_Out} and the duty cycle λ over the IGBT NTC temperature T_{NTC}

4. Technical Data Sensoring:

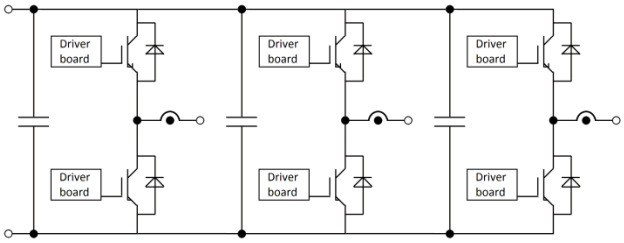
Each VARIS module includes a current sensor for measuring the output current. The power circuit is already prewired. The control circuit must be wired according to the following connector interface:

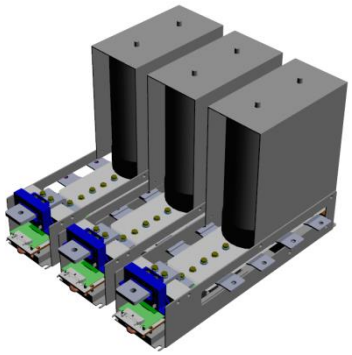
Current sensor interface			**Min.**	**Typ.**	**Max.**	
Positive supply voltage		$+V_a$			+15	V
Negative supply voltage		$-V_a$	-15			V
Nominal primary current		I_{pn}		±1000		A
Measuring range		I_{p_max}	-3000		3000	A
Output voltage		V_{out} at I_{pn}		±4		V
Ratio primary current I_{pn} to secondary 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}=600V, V_{ac}=400Vrms, 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}			1619	A_{RMS}
		Air				747	A_{RMS}
Rated continuous output power 3 phase inverter	V_{dc}=600V, V_{ac}=400Vrms, 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}			1065	kW
		Air				491	kW
Rated continuous over- current t_{on} ≤ 60s	V_{dc}=600V, V_{ac}=400Vrms, 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}			1800*	A_{RMS}
		Air				1110	A_{RMS}
Rated continuous over- current t_{on} ≤ 3s	V_{dc}=600V, V_{ac}=400Vrms, 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}			1800*	A_{RMS}
		Air				1340	A_{RMS}
Power losses per phase leg	V_{dc}=600V, V_{ac}=400Vrms, 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}			2090	W
		Air				2472	W
Power losses 3 phase inverter	V_{dc}=600V, V_{ac}=400Vrms, 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}			6270	W
		Air				7416	W
Switching frequency		Water/Air	f_{sw}		2000		Hz
Power factor			cos(φ)	-1.00		1.00	

*over current I_{ac_over1} and I_{ac_over2} are limited due to semiconductor restrictions

Current and Power ratings air cooled 3-phase configuration (3x VARIS™-14-12-A):

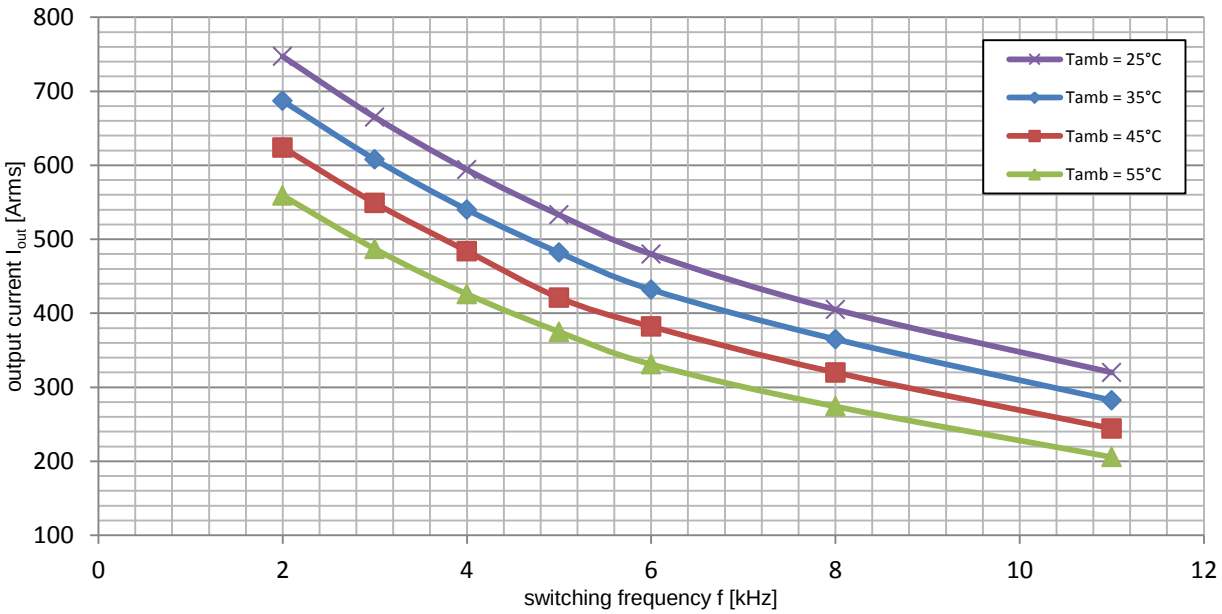


Figure 5: Current rating VARIS™-14-12-A (3-phase),
Measurement at V_{dc}=600V, v_{air} = 6m/s, V_{ac}=400Vrms, cos(φ)=0.95, m=1.0, f_{ac_sine}=50Hz, T_{vjsw}≤125°C

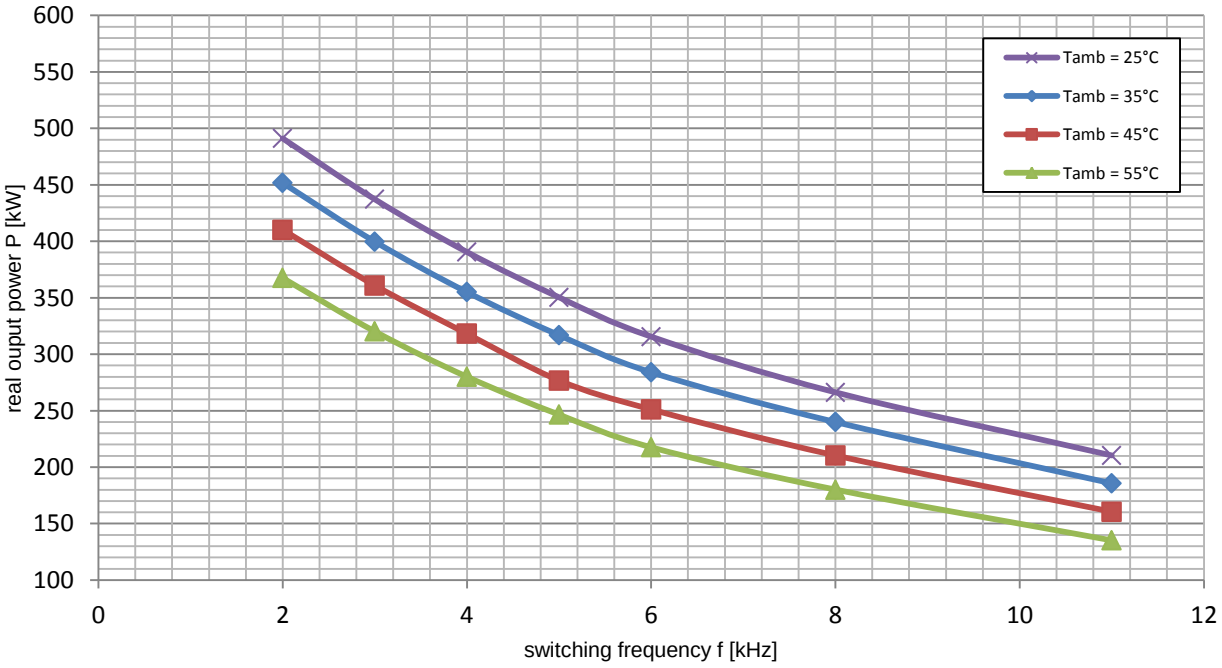


Figure 6: Power rating VARIS™-14-12-A (3-phase)
Measurement at V_{dc}=600V, v_{air} = 6m/s, V_{ac}=400Vrms, cos(φ)=0.95, m=1.0, f_{ac_sine}=50Hz, T_{vjsw}≤125°C

Current and Power ratings water cooled 3-phase configuration (3x VARIS™-14-12-W):

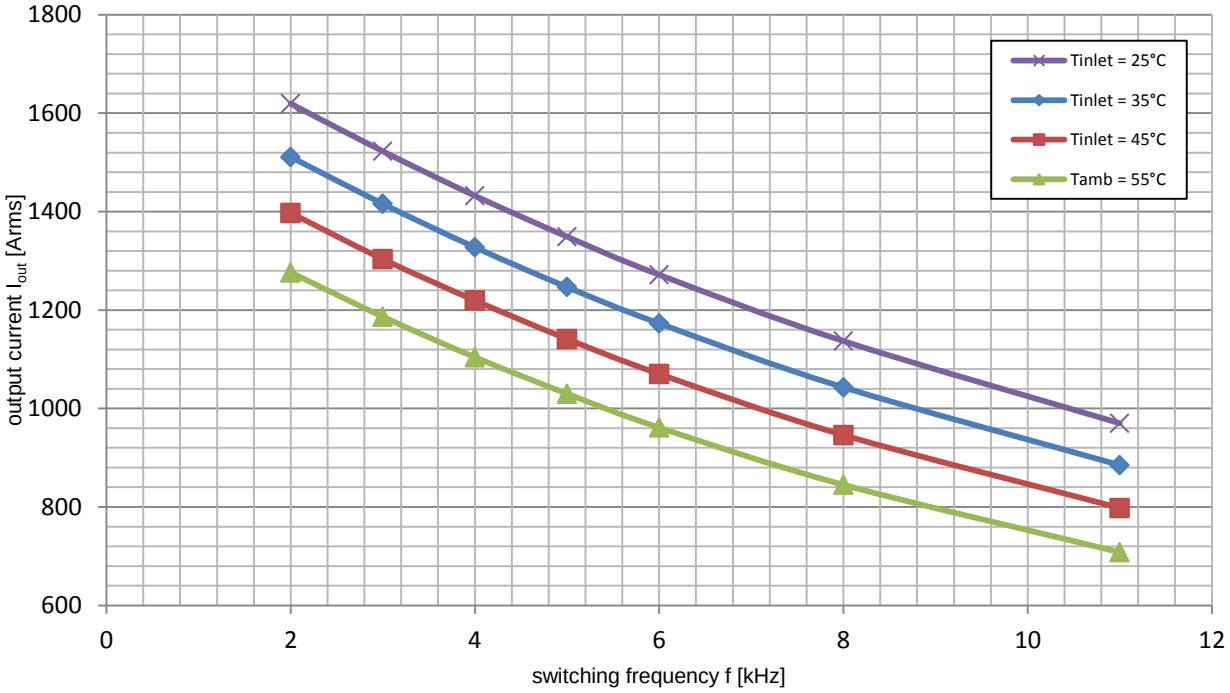


Figure 7: Current rating VARIS™-14-12-W (3-phase, water cooled)
Measurement at V_{dc}=600V, Q = 4,3 L/min, V_{ac}=400V_{RMS}, cos(φ)=0.95, m=1.0, f_{ac_sine}=50Hz, T_{vjsw}≤125°C

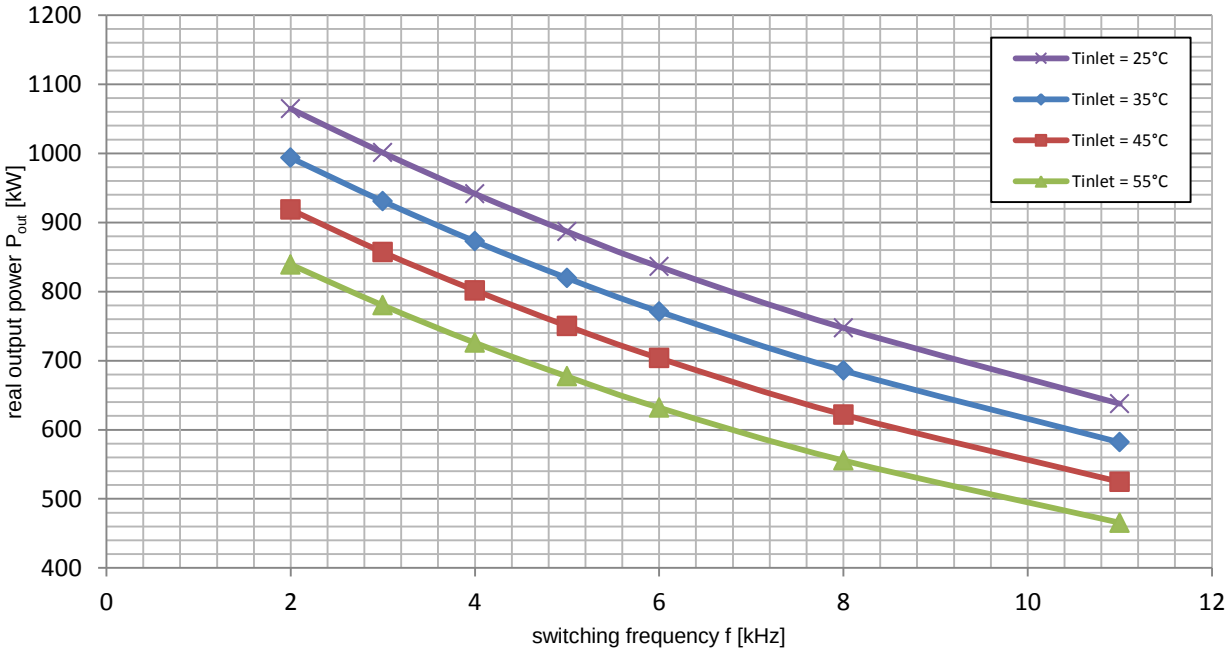
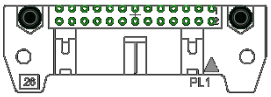


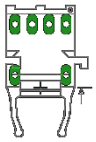
Figure 8: Power rating VARIS™-14-12-W (3-phase, water cooled)
Measurement at V_{dc}=600V, Q = 4,3 L/min, V_{ac}=400V_{RMS}, cos(φ)=0.95, m=1.0, f_{ac_sine}=50Hz, T_{vjsw}≤125°C

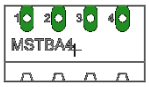
6. Signal Interfaces:

Driverboard electrical:

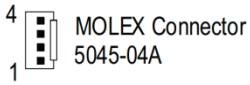


Driverboard optical (HFBR-15xx, supply voltage MSTBA4 5.08mm):





Current sensor:



Water cooler (¼ inch):

Fan (red: 24V, black: GND):

7. Mechanical drawings:

- All dimensions in millimeter (mm)

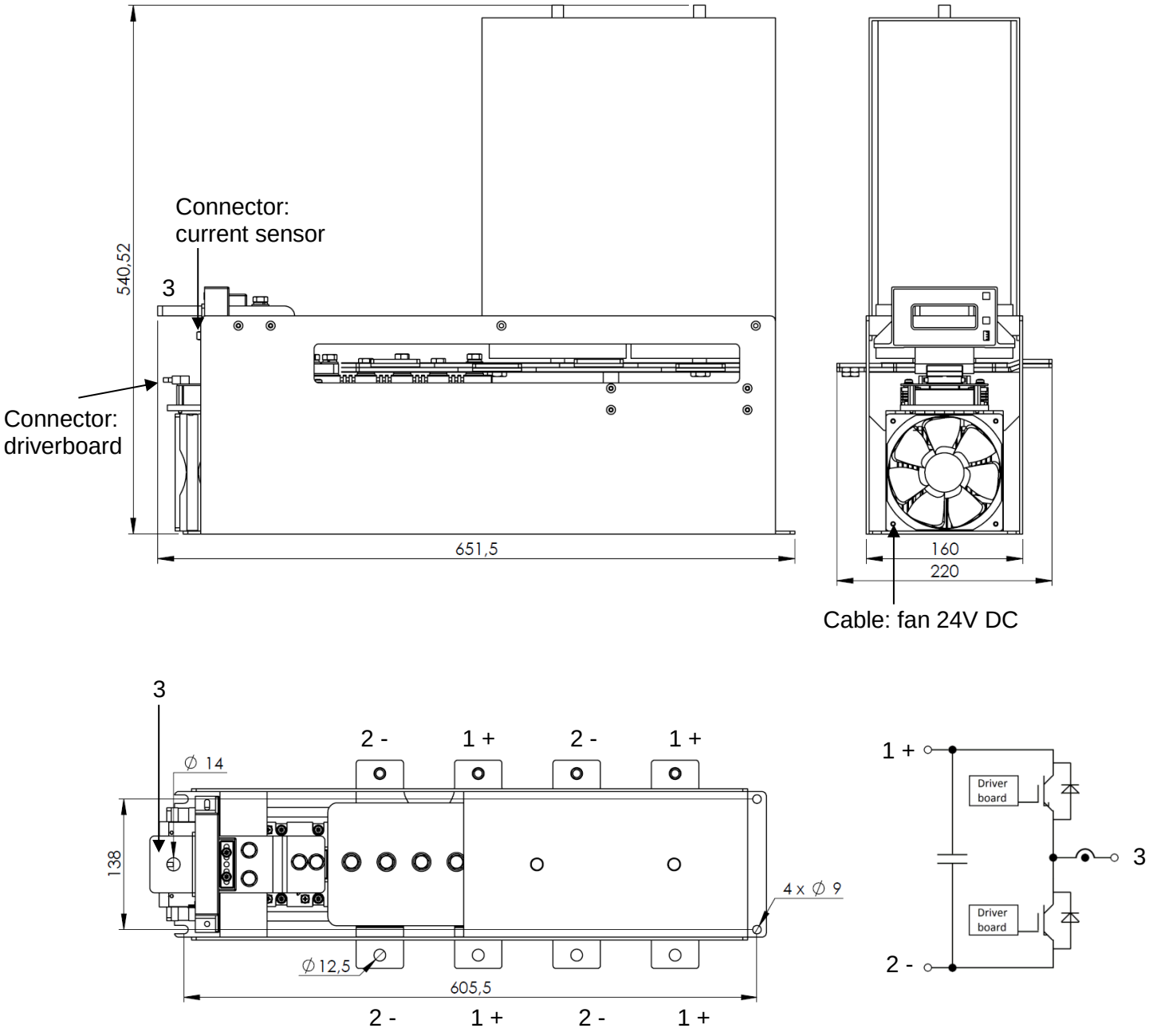
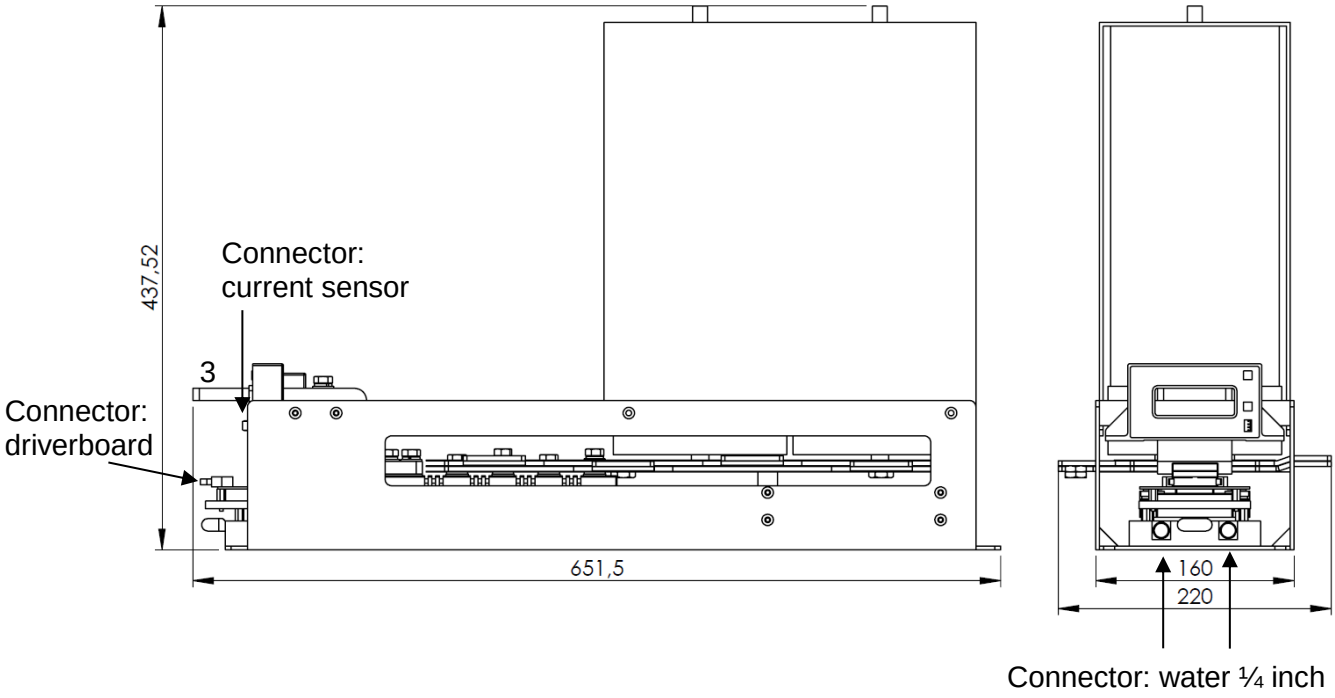


Figure 9: Mechanical drawing of the VARIS™-10-17-A (air cooled)



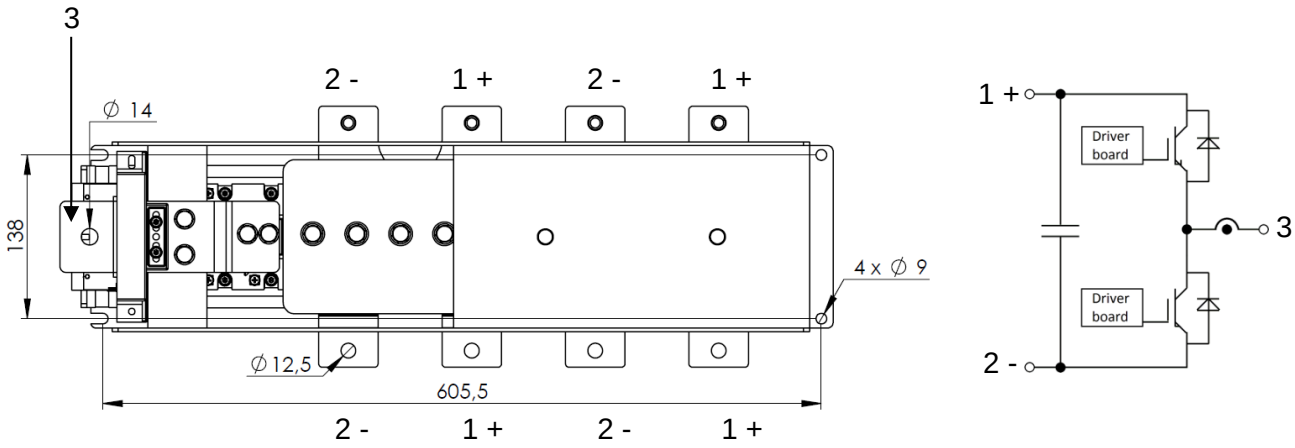


Figure 10: Mechanical drawing of the VARIS™-10-17-W (water cooled)

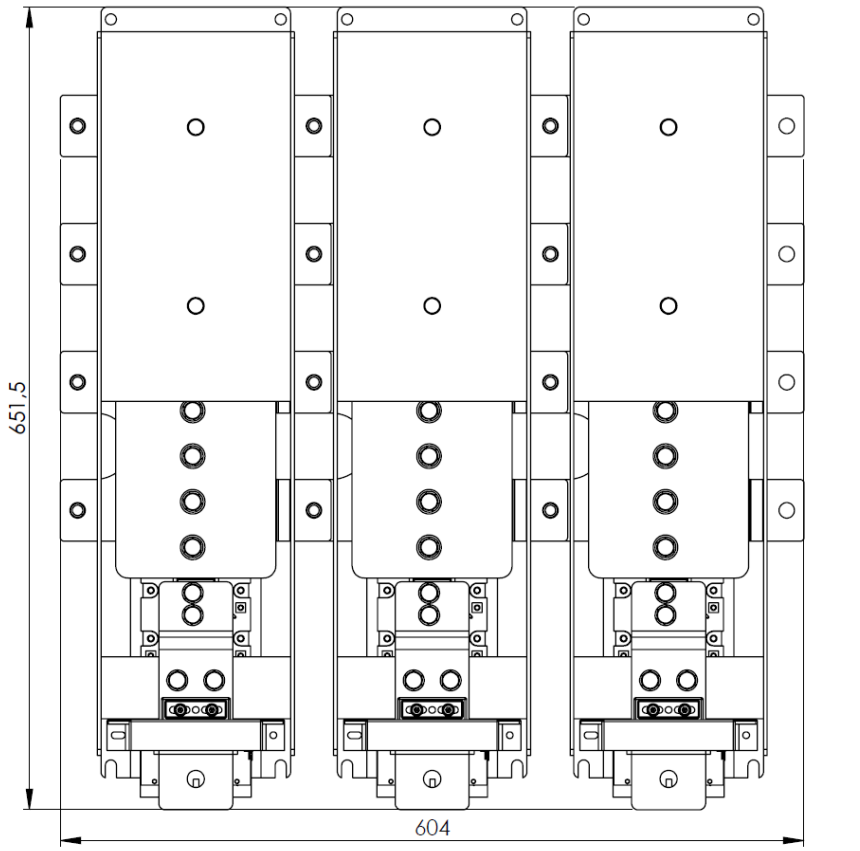


Figure 11: Mechanical drawing of 3x VARIS™-10-17 three phase configuration

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