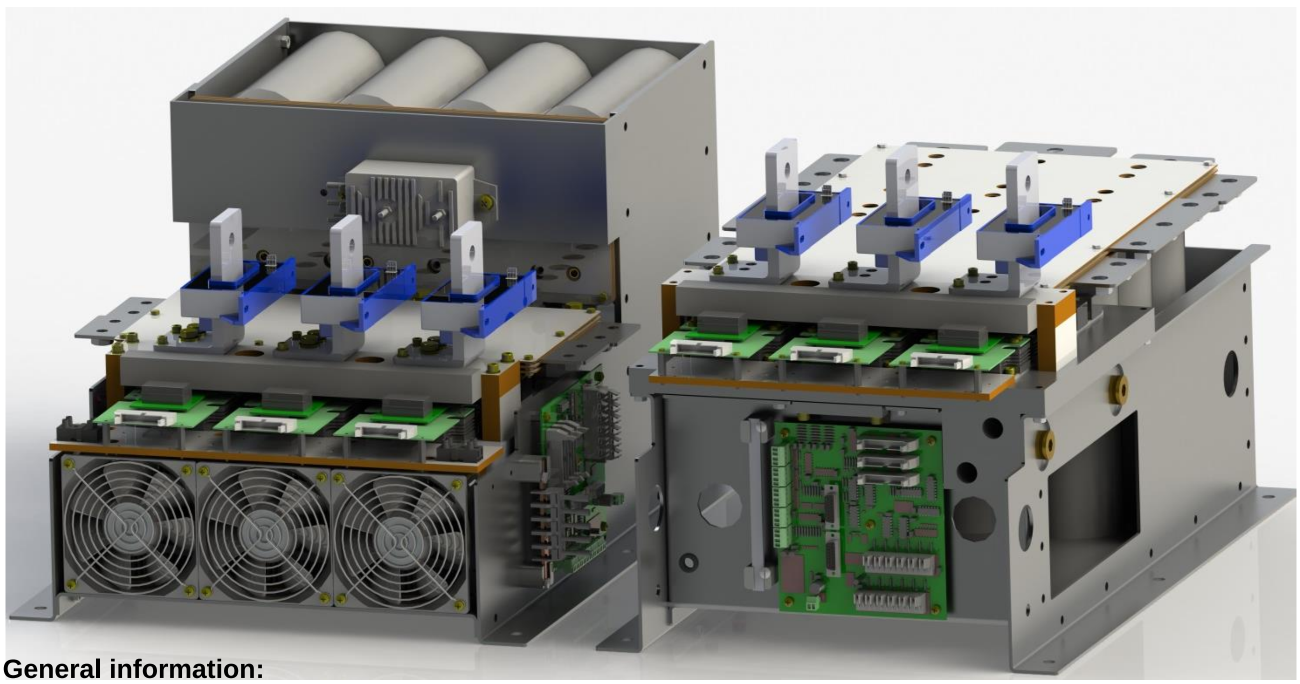
Datasheet

Modular Inverter System VARIS™ XT Compact-14-12

- **Individual circuit arrangement**
- **Hard- and soft paralleling possible**
- **Water or forced air cooled**
- **Up to 10350µF capacitance per module**
- **Current, voltage and temperature measurement**
- **Interfaceboard with signal processing**



General information:

VARIS™ XT Compact is the little brother of the VARIS™ XT and consists of three half bridge IGBT modules with 8 or 9 dc-link capacitors. All semiconductors are placed on one cooling plate for a perfect homogenous cooling. Its modular design allows paralleling of the AC-output/input as well as paralleling of the dc-link with other VARIS™ XT Compacts. Possible circuit arrangements are single three phase inverters, active front end topologies, and chopper circuits.

An interfaceboard located on the front of the VARIS™ XT Compact summarizes all IGBT signals as well as voltage, current and temperature measurements.

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Table of Content

1. General Circuit Arrangements:

The following figure shows the general circuit arrangement. VARIS™ XT Compact can be divided into three half bridge modules (P1-P3) that are all connected to one DC-link.

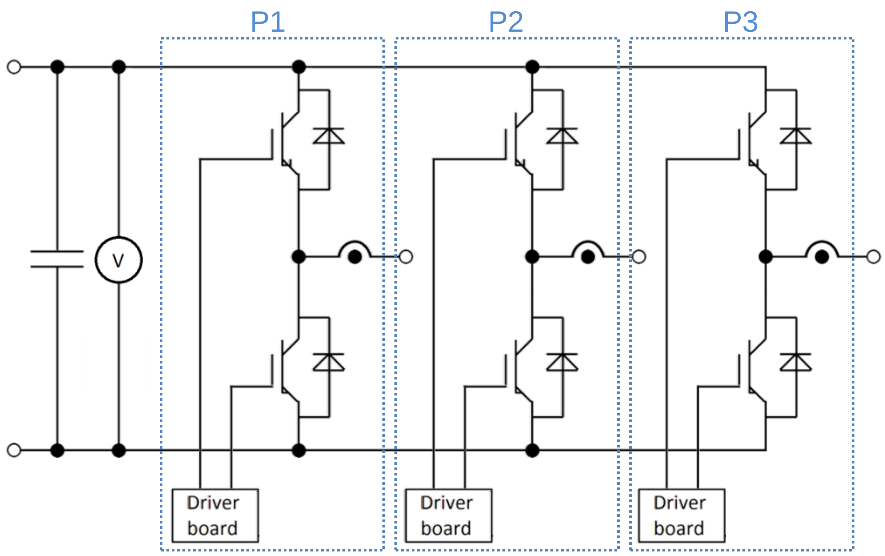


Figure 1: Standard hardware setup

Depending on the application different circuit arrangements are possible. For higher power, all circuits shown below can be expanded with additional VARIS™ XT Compact modules.

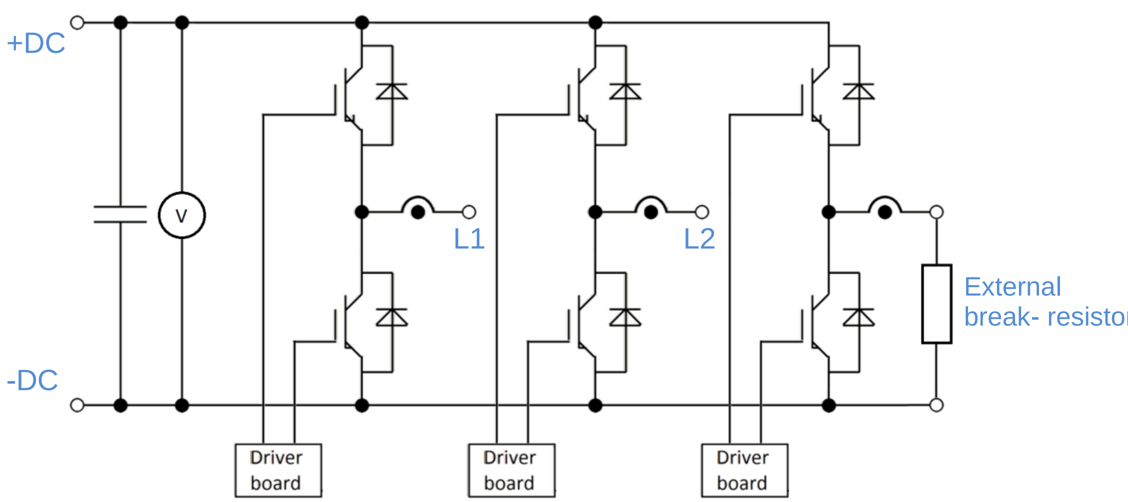


Figure 2: Single-phase inverter with break chopper

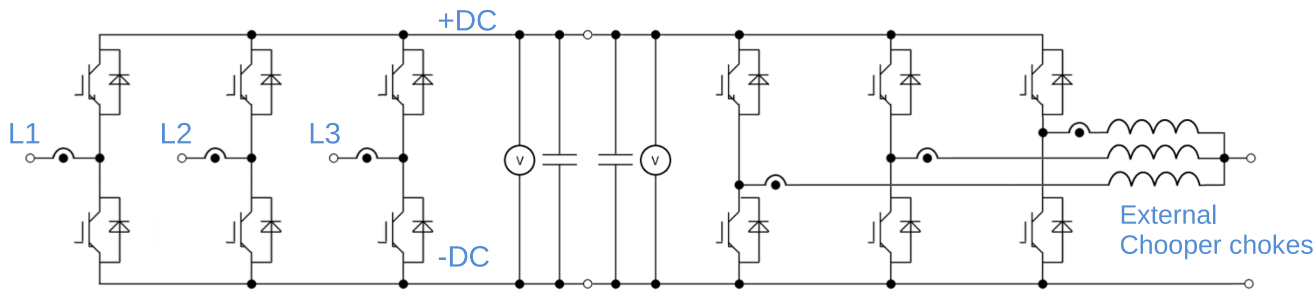
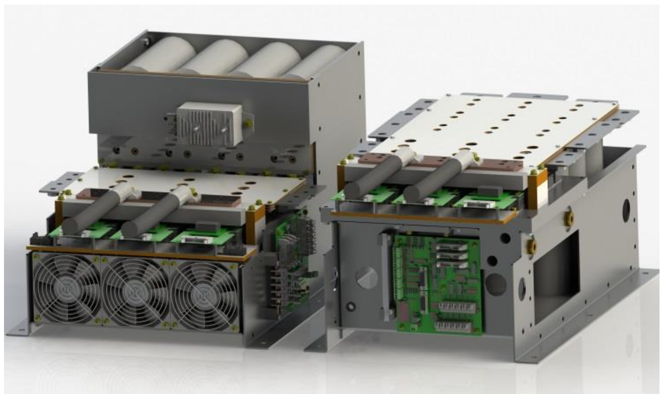


Figure 3: 3 phase AFE with triple interleaved Chopper

Our IGBT modules are optimized for direct paralleling, which means they have the same $V_{ce(sat)}$ forward voltage among themselves.
However, when using direct paralleling the current measurement has to be external. Optional current sensors for direct paralleling are available on request.



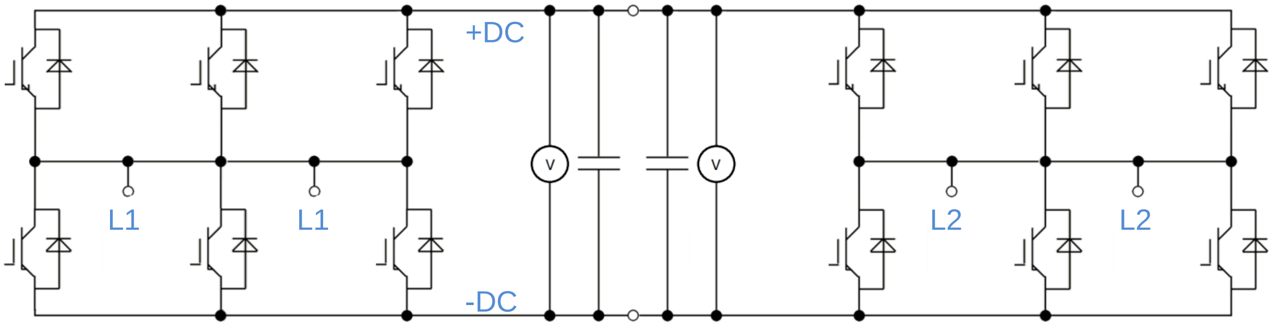


Figure 4: Two VARIS XT Compact in parallel, AC- output/input of each VARIS paralleled

2. *Technical Data Module:*

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, $T_{inlet}/T_{amb} \leq$ 25°C, $T_{vjsw} \leq$125°C	Water	I_{ac}			1619	A_{RMS}
		Air				690	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	Water cooled, Capacitor rated tolerance ±10%	C_{dc}		10350		µF
	Air cooled, Capacitor rated tolerance ±10%			9200		
DC-link current ripple	Water cooled, T_{amb} <=55°C	I_{ripple_Cdc}			540	A_{RMS}
	Air cooled, T_{amb} <=55°C				480	
Capacitor type	IEC61071 Standard, 50 FIT (100000h, $\theta_{Hotspot} \leq$ 70°C)			PP-Foil		
Balance or discharge resistor per DC link unit	Optional, refers to customers desired discharge time			TBD		kΩ

System data general			**Symb.**	**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			412	668	414.5	mm
	Air			461	665	367.5	
Water flow			Q		12	30	L/min
Water pressure drop	at Q		Δp		400	2700	mbar
Test pressure	heatsink		p		7		bar
Coolant inlet temperature			T_{inlet}	-25		55	°C
Coolant composition	Recommended mix ratio: Water (W) – antifreeze (AF)			48 (W)		52 (AF)	%
Cooling channel material	Aluminum						
Water connection	Standard terminal at the front, inner thread				½		inch
Weight	Water		m		40.9		kg
	Air				46.5		

3. Technical Data Interfaceboard:

The Interfaceboard is located right next to the Driverboards and summarizes the IGBT signals as well as the AC-output current measurements, DC-link voltage measurement, and PT100 temperature measurement.

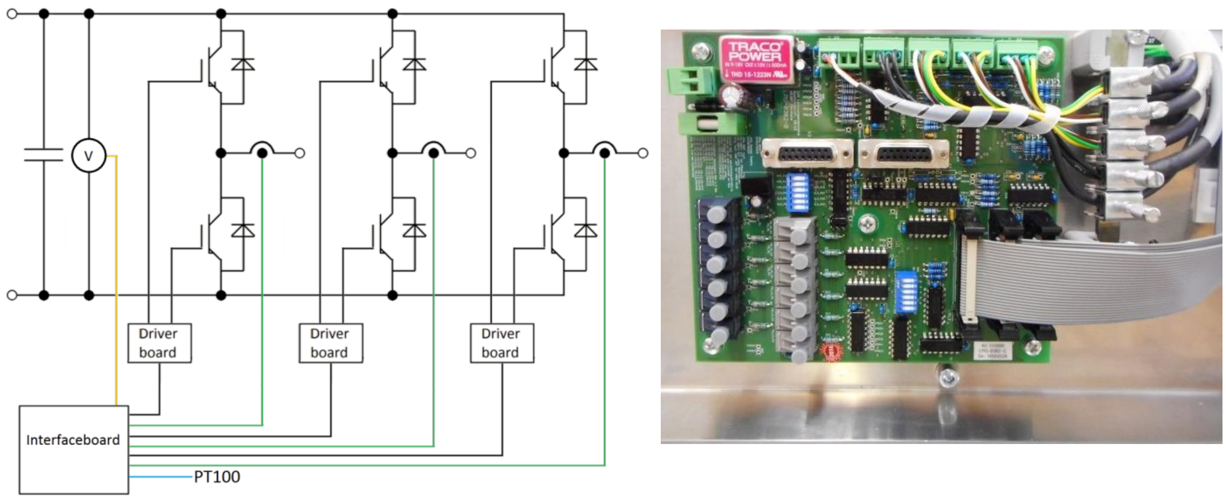


Figure 5: VARIS™ XT Compact circuit arrangement with Interfaceboard

The interfaceboard can be controlled optical via HFBR connectors, or electrical via SUB-D connectors. It contains switches for paralleling of the IGBT phase legs, where the IGBT signals are automatically split and directed to the corresponding paralleled modules.

The board can give out the feedback from each IGBT modules high- and lowside, or can combine the modules high- and lowside status to one feedback signal. The combined feedback minimizes the wiring effort, and still guaranties a feedback from each module.

A hardware interlock of the PWM signals automatically shuts down the system when a short circuit or under voltage of one driverboard is detected. When the error disappears the system either can go back to normal operation, or can store the error until the interfaceboard gets an external reset.

For thermal monitoring the NTC of each IGBT module is evaluated. If an over temperature of an IGBT arises a status signal is send to the operator controller. The temperature error can be reset automatically or erased externally. Moreover, VARIS XT Compact features a PT100 heatsink measurement, which can be evaluated by the costumer controller.

The current and voltage measurements are collected, filtered, amplified and given to a SUB-D connector for further evaluation. The system voltage of the interfaceboard is 15V.

Interfaceboard: General system data		Symbol	Min.	Typ.	Max.	Unit
Supply voltage	Phoenix MSTBA2 connector Pin 1	V_{DD}	14.5	15	15.5	V_{DC}
Driverboard ground	Phoenix MSTBA2 connector Pin 2	GND		0		V_{DC}
Supply current inter-face-board during stand-by	Stand-by, $f_{SW} = 0$	I_{driver}		970		mA
Supply current interfa-ceboard during opera-tion	at $f_{SW} = 2kHz$	I_{driver}		1720		mA
	at $f_{SW} = 6kHz$			2840		mA
	Max.				5000	mA

Interfaceboard: Optical interface	Versatile link HFBR-connectors	Symbol		Signal	
Gate signal highside P1	Fiber optic receiver HFBR-2531	XR1		HS_P1*	
Gate signal highside P2	Fiber optic receiver HFBR-2531	XR2		HS_P2*	
Gate signal highside P3	Fiber optic receiver HFBR-2531	XR3		HS_P3*	
Gate signal lowside P1	Fiber optic receiver HFBR-2531	XR4		LS_P1*	
Gate signal lowside P2	Fiber optic receiver HFBR-2531	XR5		LS_P2*	
Gate signal lowside P3	Fiber optic receiver HFBR-2531	XR6		LS_P3*	
Status signal P1/ P1_HS	Fiber optic transmitter HFBR-1531	XT1		FB_P1/ FB_HS_P1	
Status signal P2/ P2_HS	Fiber optic transmitter HFBR-1531	XT2		FB_P2/ FB_HS_P2	
Status signal P3/ P3_HS	Fiber optic transmitter HFBR-1531	XT3		FB_P3/ FB_HS_P3	
Status signal P4_LS	Fiber optic transmitter HFBR-1531	XT4		FB_LS_P1	
Status signal P5_LS	Fiber optic transmitter HFBR-1531	XT5		FB_LS_P2	
Status signal P3_LS	Fiber optic transmitter HFBR-1531	XT6		FB_LS_P3	

*Optical: Light On=IGBT On, Light Off=IGBT Off

Interfaceboard: Electrical interface X2	**15 SUB-D Connector (FCI D15S24A4GV00LF Female)**	**Symbol**	**Min.**	**Typ.**	**Max.**	**Unit**
Pin 1	Sensor ground	GND_{SENSE}		0		V
Pin 2	Positive supply voltage	$+V_{CC}$		+15		V_{DC}
Pin 3	Sensor ground	GND_{SENSE}		0		V
Pin 4	Current sensor signal P1 at I_{pn} =2000A converted into voltage	C_{P1} at I_{pn}		±10		V
Pin 5	Sensor ground	GND_{SENSE}		0		V
Pin 6	Current sensor signal P2 at I_{pn} =2000A converted into voltage	C_{P2} at I_{pn}		±10		V
Pin 7	Sensor ground	GND_{SENSE}		0		V
Pin 8	Current sensor signal P3 at I_{pn} =2000A converted into voltage	C_{P3} at I_{pn}		±10		V
Pin 9	Sensor ground	GND_{SENSE}		0		V
Pin 10	Negative supply voltage	$-V_{CC}$		-15		V_{DC}
Pin 11	Sensor ground	GND_{SENSE}		0		V
Pin 12	temperature sensor (PT100) signal T1	V_{T1}	0(0°C)		+11,5 (150°C)	V
Pin 13	Sensor ground	GND_{SENSE}		0		V
Pin 14	DC-link voltage sensor signal at V_{pn} =1500V	V_{DC} at V_{pn}		+10		V
Pin 15	Sensor ground	GND_{SENSE}		0		V

Interfaceboard: Electrical interface X3	**15 SUB-D Connector (FCI D15S24A4GV00LF Female)**	**Symbol**	**Min.**	**Typ.**	**Max.**	**Unit**
Pin 1	Driver fault	FAULT	Ok: 0		Fault: 15	V
Pin 2	Reset overtemp. or driver fault	RESET		+15		V
Pin 3	Driver temperature status	TEMP_OK	Fault: 0		Ok: 15	V
Pin 4	Driver ground	GND		0		V
Pin 5	Clock signal HS P1*	#HS_P1	0		+15	V
Pin 6	Driver ground	GND		0		V
Pin 7	Clock signal HS P2*	#HS_P2	0		+15	V
Pin 8	Driver ground	GND		0		V
Pin 9	Clock signal HS P3*	#HS_P3	0		+15	V
Pin 10	Driver ground	GND		0		V
Pin 11	Clock signal LS P1*	#LS_P1	0		+15	V
Pin 12	Driver ground	GND		0		V
Pin 13	Clock signal LS P2*	#LS_P2	0		+15	V
Pin 14	Driver ground	GND		0		V
Pin 15	Clock signal LS P3*	#LS_P3	0		+15	V

*Electrical: 0V=IGBT Off, 15V=IGBT On

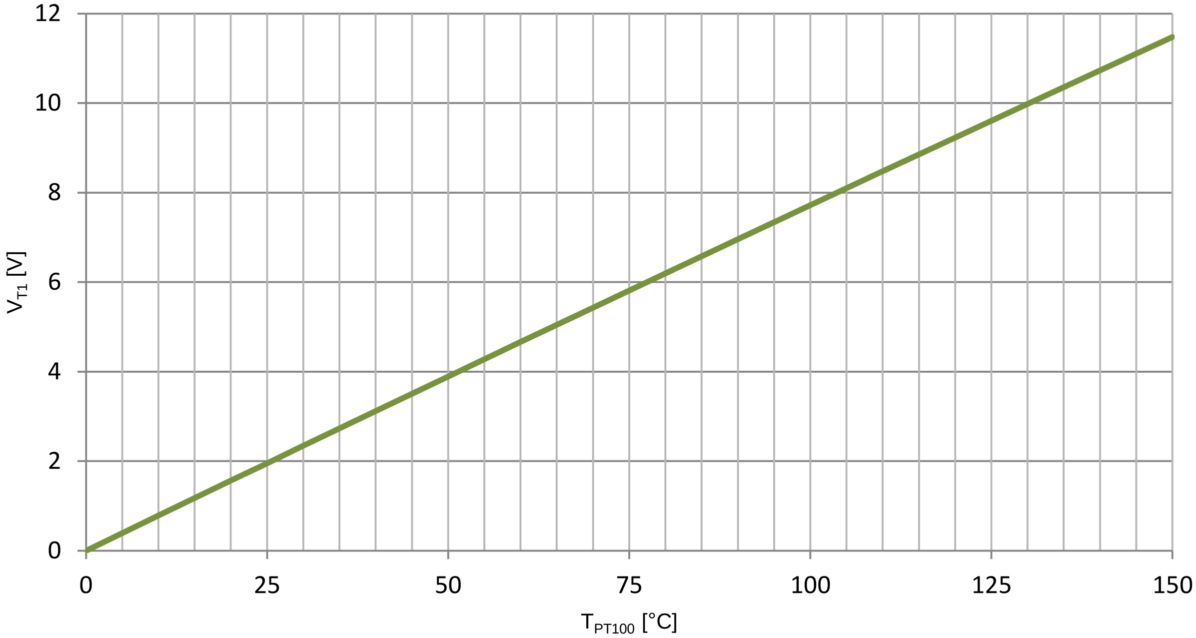


Figure 6: Characteristic curve of the analog heatsink temperature V_{T1} over the PT100 temperature sensor

4. Technical Data Driverboard:

Each IGBT module has its own driverboard, and all driverboard signals are brought together at the interfaceboard. The signal transfer from driverboard to interfaceboard is electrical, and from interfaceboard to customer control optical or electrical.
However, VARIS™ XT Compact is also available without interfaceboard. In this case the operator also can choose between an optical and an electrical driverboard signal transmission.

Driverboard interface		**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				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)

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

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		

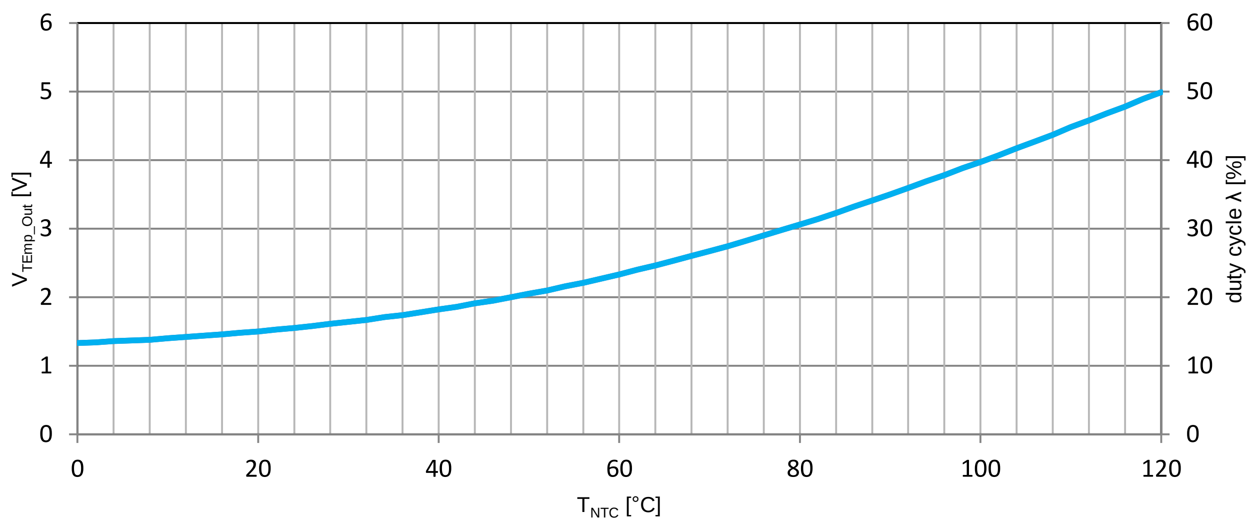


Figure 7: Characteristic curve of the analog temperature sense output V_{Temp_Out} and the duty cycle λ over the IGBT NTC temperature T_{NTC}

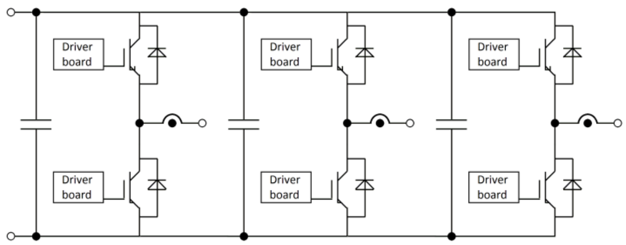
5. Technical Data Sensoring:

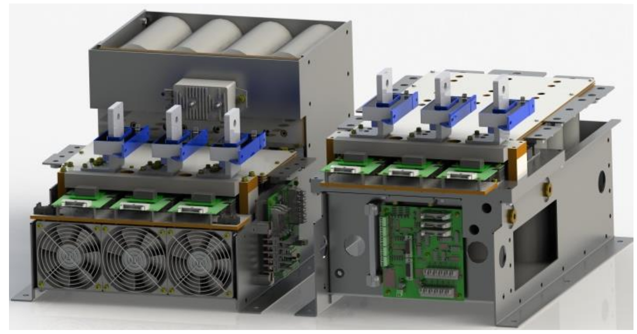
The supply voltage of all sensors is provided by the interfaceboard. The actual values of current, voltage and temperature are amplified, filtered, and directed to two SUB-D connectors (details see interfaceboard section). However this section gives a quick overview of the sensors used and their accuracy.

Current sensor interface		**Symbol**	**Min.**	**Typ.**	**Max.**	**Unit**
Positive supply voltage		$+V_a$			+15	V
Negative supply voltage		$-V_a$	-15			V
Nominal primary current		I_{pn}		$\pm$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 connector (e.g. Molex 5045-04A)**	**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	Ground	GND		0		V

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}		$\underline{+}$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

6. Technical Data 3-Phase Inverter:





The following values are for a three phase inverter configuration:

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, $T_{inlet}/T_{amb} \leq 25°C$, $T_{vjsw} \leq 125°C$	Water	I_{ac}			1619	A_{RMS}
		Air				690	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, $T_{inlet}/T_{amb} \leq 25°C$, $T_{vjsw} \leq 125°C$	Water	P_{out}			1065	kW
		Air				454	kW
Rated continuous over- current $t_{on} \leq 60s$	V_{dc}=600V, V_{ac}=400Vrms, cos(φ)=0.95, f_{ac_sine}=50Hz, f_{sw}=2kHz, m=1.0, $T_{inlet}/T_{amb} \leq 25°C$, $t_{on} \leq 60s$ $T_j \leq 150°C$	Water	I_{ac_over1}			1800*	A_{RMS}
		Air				1021	A_{RMS}
Rated continuous over- current $t_{on} \leq 3s$	V_{dc}=600V, V_{ac}=400Vrms, cos(φ)=0.95, f_{ac_sine}=50Hz, f_{sw}=2kHz, m=1.0 $T_{inlet}/T_{amb} \leq 25°C$, $t_{on} \leq 3s$ $T_j \leq 150°C$	Water	I_{ac_over2}			1800*	A_{RMS}
		Air				1233	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} $T_{vjsw} \leq 125°C$	Water	P_{loss_leg}			2090	W
		Air				1798	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} $T_{vjsw} \leq 125°C$	Water	P_{loss_tot}			6270	W
		Air				5394	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 (VARIS™ XT Compact-14-12-A):

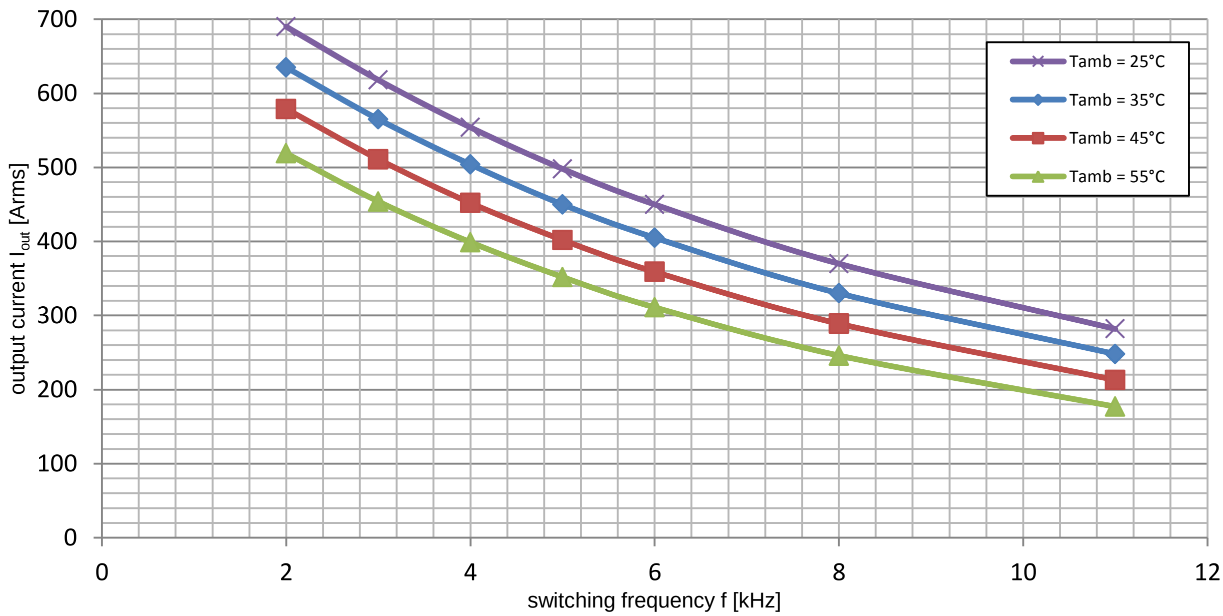


Figure 8: Current rating VARIS™ XT Compact-14-12-A (3-phase),
Measurement at V_{dc}=600V, v_{air} = 6m/s, V_{ac}=400Vrms, cos(φ)=0.95, m=1.0, f_{ac_sine}=50Hz, T_{vjsw}≤125°C

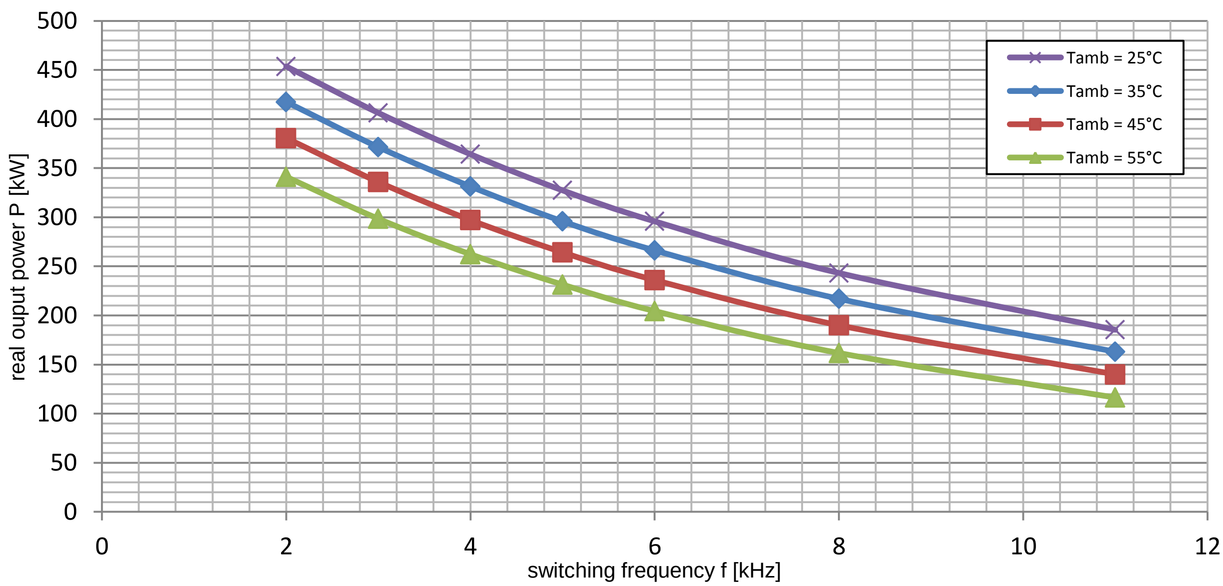


Figure 9: Power rating VARIS™ XT Compact-14-12-A (3-phase)
Measurement at V_{dc}=600V, v_{air} = 6m/s, V_{ac}=400Vrms, cos(φ)=0.95, m=1.0, f_{ac_sine}=50Hz, T_{vjsw}≤125°C

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

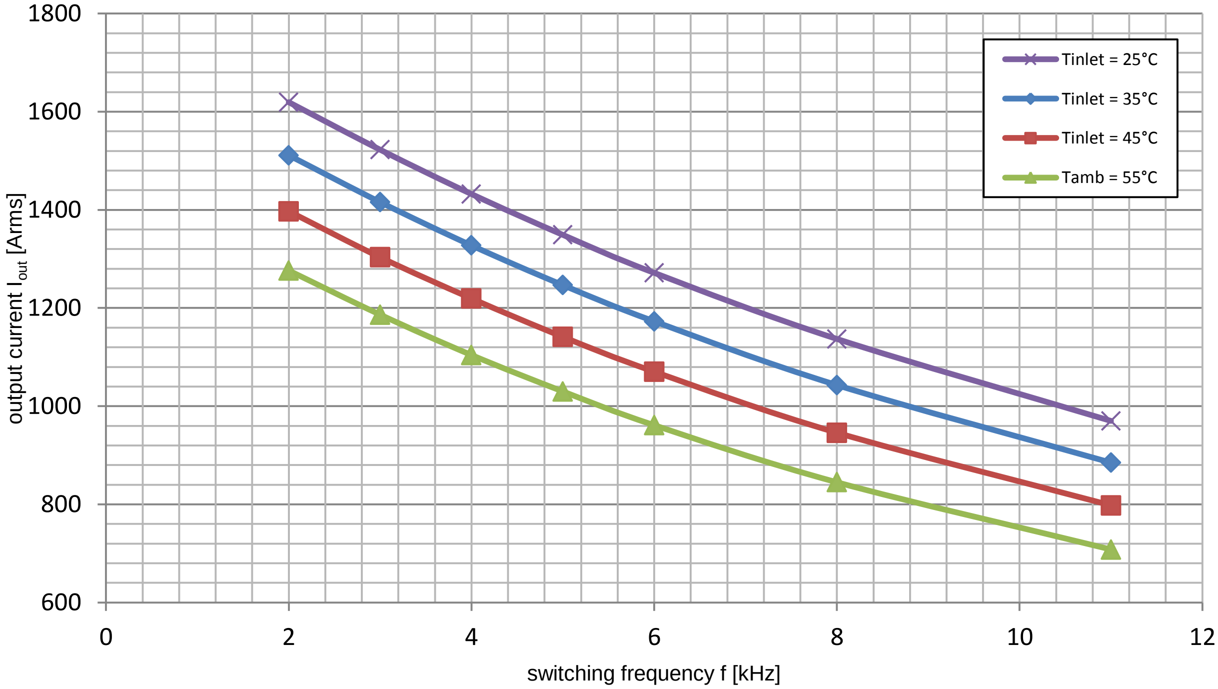


Figure 10: Current rating VARIS™ XT Compact-14-12-W (3-phase, water cooled)
Measurement at V_{dc}=600V, Q = 4,3 L/min, V_{ac}=400V_{RMS}, cos(φ)=0.95, m=1.0, f_{ac_sine}=50Hz, T_{vjsw}≤125°C

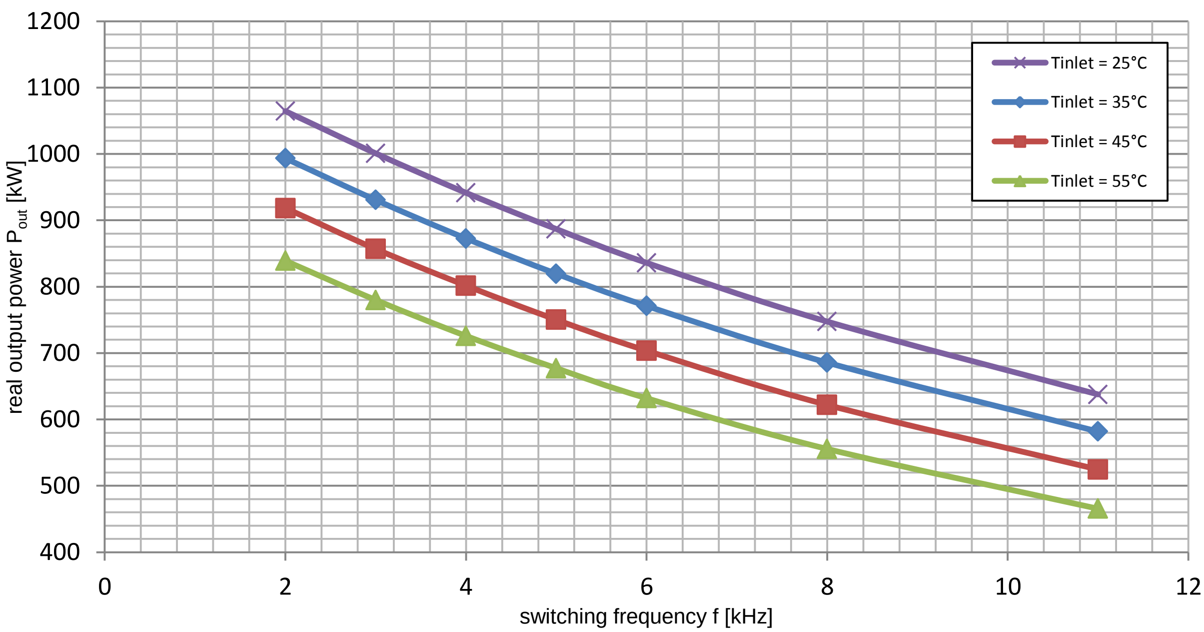
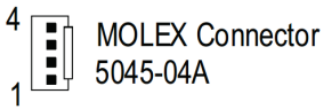
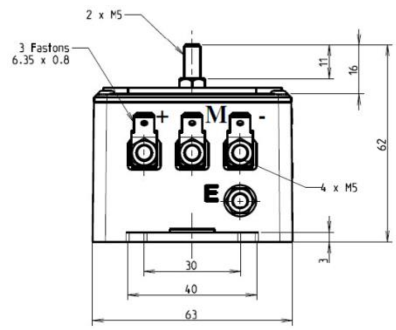
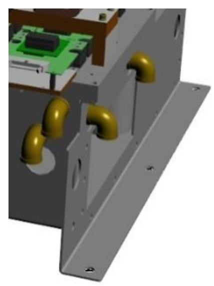
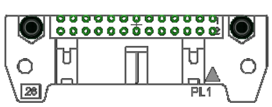
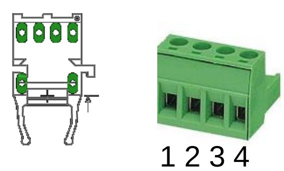
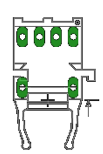
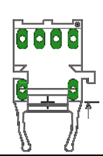


Figure 11: Power rating VARIS™ XT Compact-14-12-W (3-phase, water cooled)
Measurement at V_{dc}=600V, Q = 4,3 L/min, V_{ac}=400V_{RMS}, cos(φ)=0.95, m=1.0, f_{ac_sine}=50Hz, T_{vjsw}≤125°C

7. Interfaces and Connections:

Current- and Voltage- Sensor Interface:	
Current sensor:	Voltage sensor:
	
Water Connection (1/2 inch) two possibilities to connect:	
	
Signal Interfaces Driverboard:	
Driverboard electrical 26 Pin Latch/Ejector, 2.54mm grid (e.g. 3M 34296002):	Driverboard optical (HFBR-15xx, supply voltage MSTBA4 5.08mm):
	
Signal Interfaces Interfaceboard:	
2x 15 Pin female SUB-D for electrical sensor signals (female on PCB):	12x HFBR-2531 for IGBT control signals:
	
MSTBA2 for power supply:	6x HFBR-1531 for IGBT feedback signals:
	

8. Mechanical Drawings:

- All dimensions in millimeter (mm)

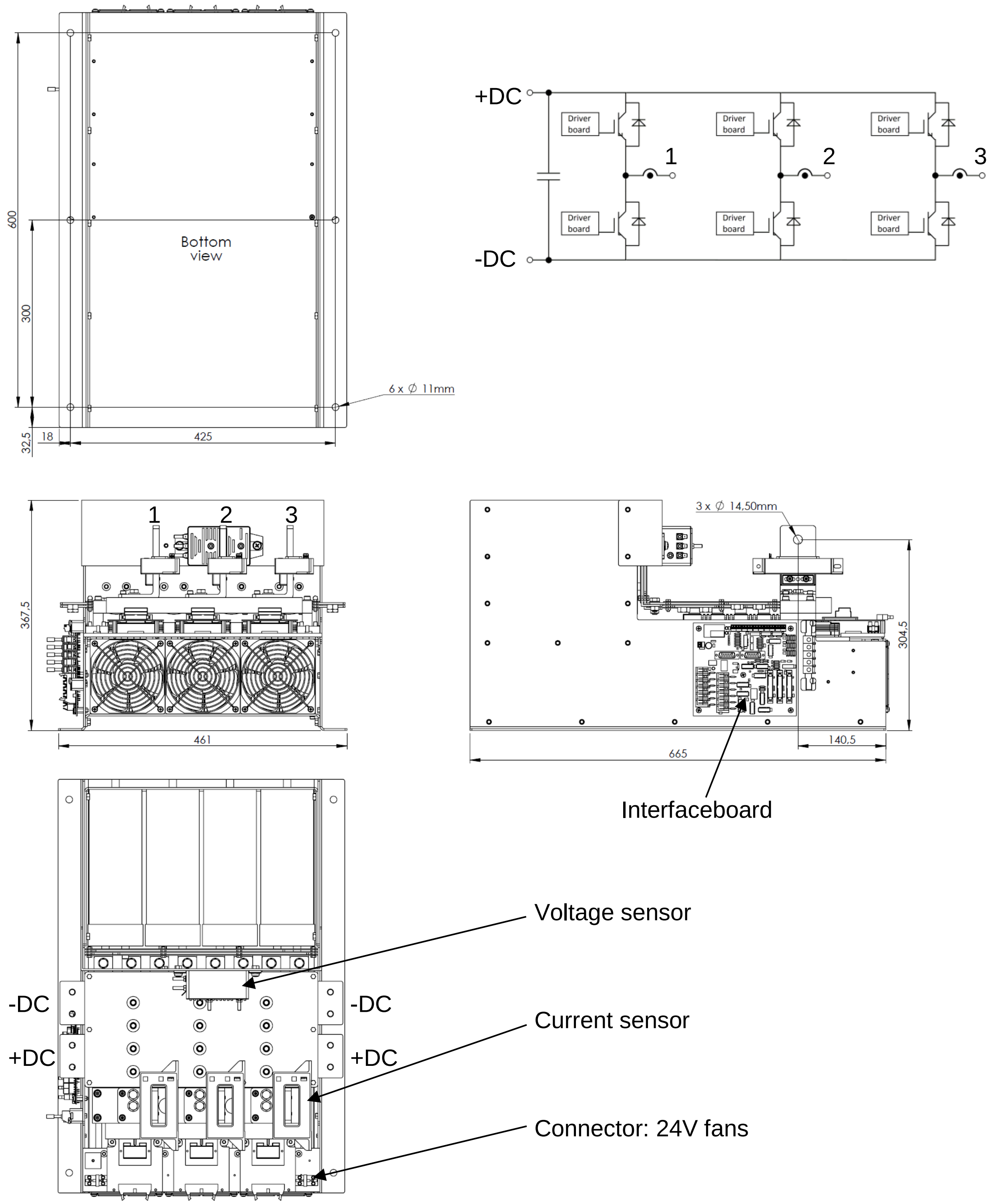
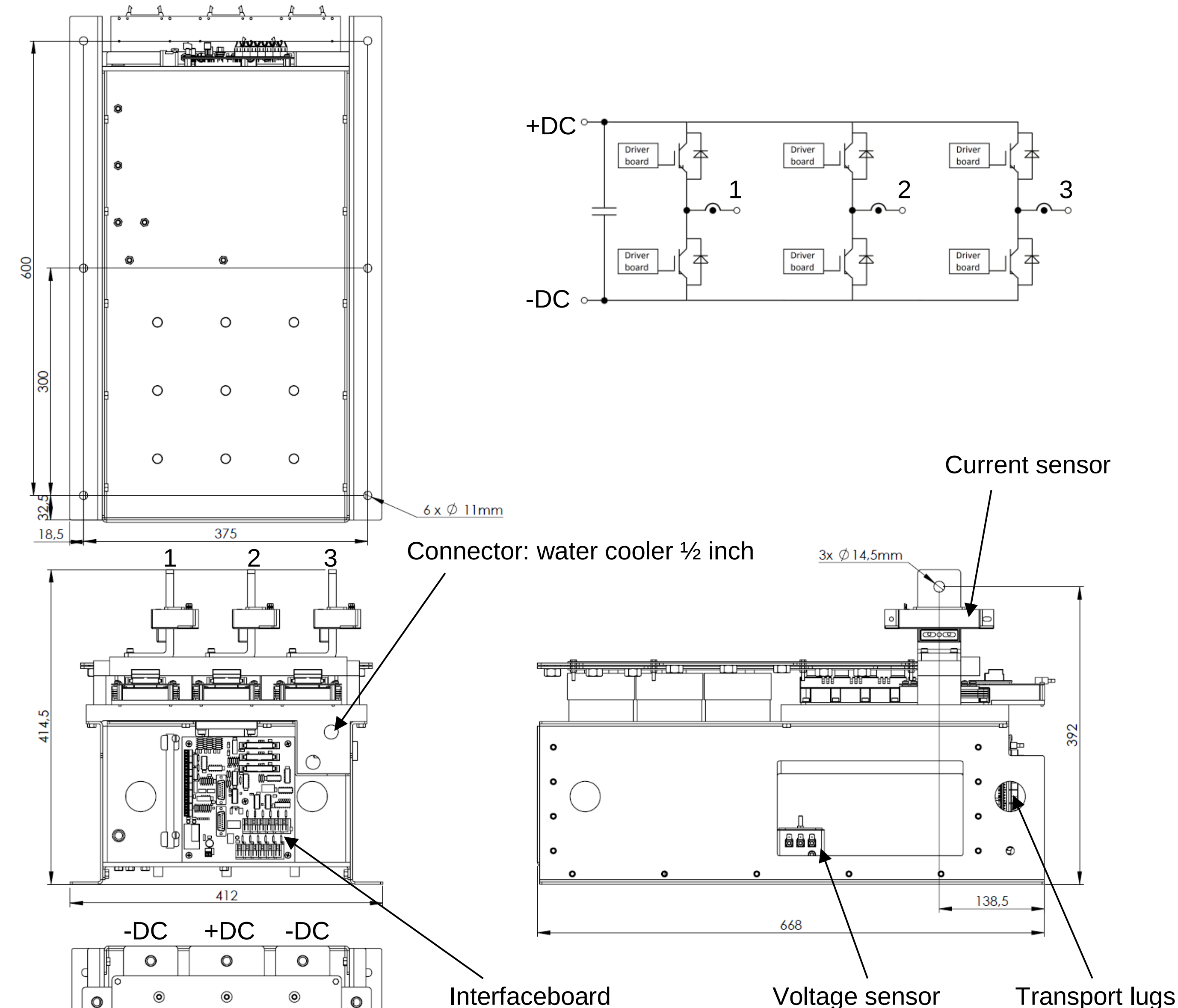


Figure 12: Mechanical drawing of the VARIS™ XT Compact-14-17-A (air cooled)



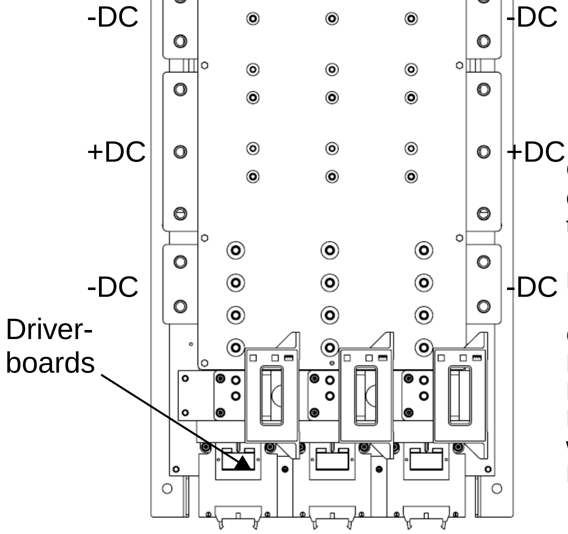


Figure 13: Mechanical drawing of the VARIS™ XT Compact-14-17-W (water cooled)

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:

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