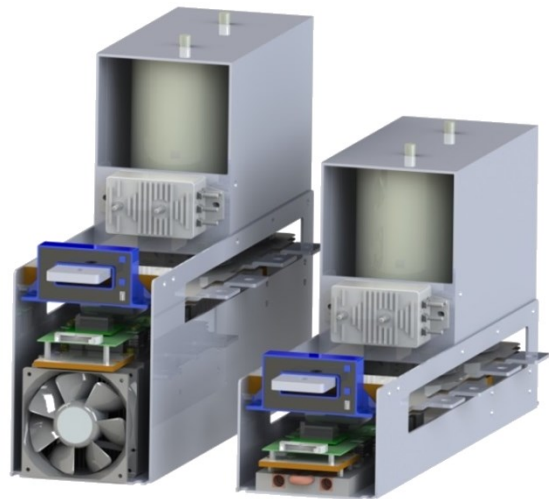
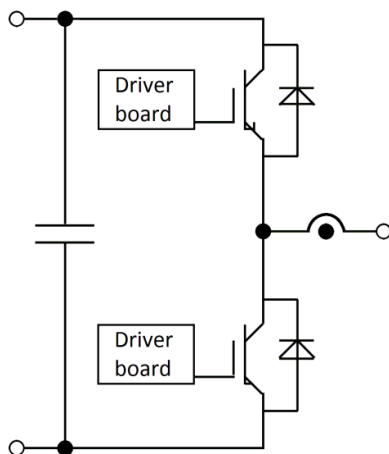


Datasheet

Modular Inverter System VARIS™-06-12

- Individual circuit arrangement
- Water or forced air cooled
- 3360µF 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:

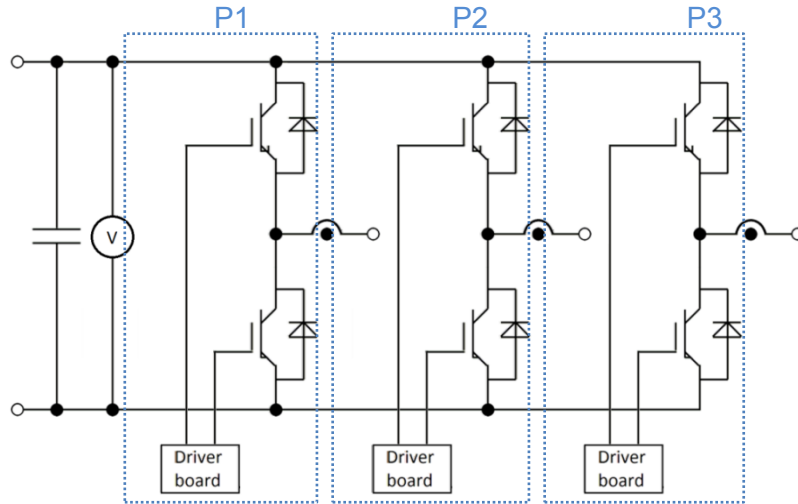


Figure 1: 3-phase inverter

Single-phase inverter with break chopper:

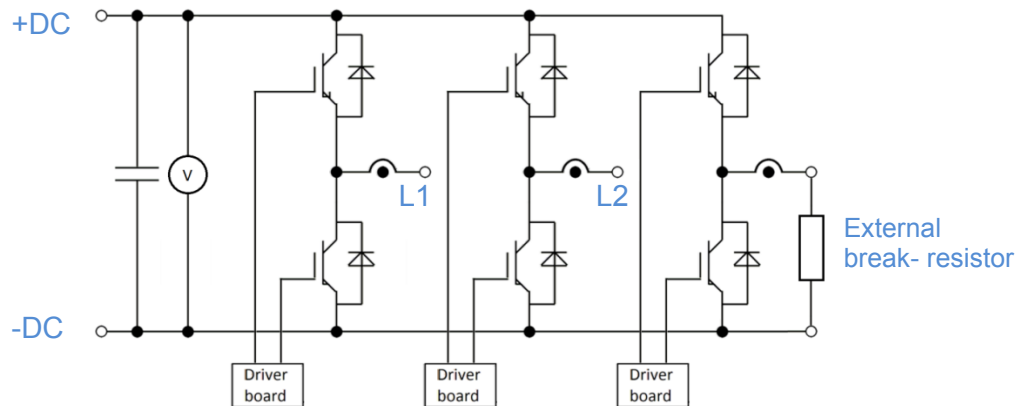


Figure 2: Single-phase inverter with break chopper

AFE with interleaved Chopper:

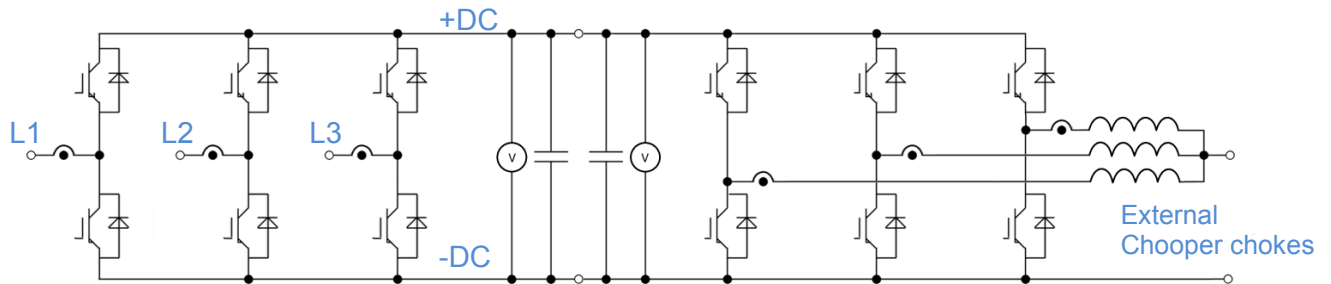


Figure 3: 3-phase AFE with triple interleaved Chopper

2. Technical Data Phase Leg:

Absolute maximum rated values			Symbol	Min.	Typ.	Max.	Unit
Collector emitter voltage	IGBT, $T_{vj}=25^{\circ}\text{C}$		V_{ces}			1200	V
Peak reverse voltage	Diode, $T_{vj}=25^{\circ}\text{C}$		V_{rrm}			1200	V
DC-link voltage			V_{dc}			800	V
Maximum line voltage	$\pm 10\%$ tolerance		V_{line}			400	V_{RMS}
Insulation test voltage according EN 61800-5-1	$f=50\text{Hz}$, $t=1\text{min}$		V_{iso}			3000	V_{RMS}
Repetitive peak collector current, IGBT	$t_p \leq 1\text{ms}$		I_{crm}			1200	A
Repetitive peak forward current, Diode	$t_p \leq 1\text{ms}$		I_{frm}			1200	A
Continuous output current	$V_{dc}=600\text{V}$, $V_{ac}=400\text{Vrms}$, $\cos(\phi)=0.95$, $f_{ac_sine}=50\text{Hz}$, $f_{sw}=2\text{kHz}$, $m=1.0$, $T_{inlet}/T_{amb} \leq 25^{\circ}\text{C}$, $T_{vjsw} \leq 125^{\circ}\text{C}$	Water	I_{ac}			827	A_{RMS}
		Air				440	A_{RMS}
Junction temperature under switching conditions	At continuous current I_{ac}		T_{vjsw}			125	$^{\circ}\text{C}$
Junction temperature under overload conditions	At $I_{ac_over1/2}$		T_{vjsw}			150	$^{\circ}\text{C}$

Characteristic values			Symbol	Min.	Typ.	Max.	Unit
Rated voltage	DC-link		V_{dc}		600	800	V
Total capacitance	Capacitor rated tolerance $\pm 10\%$		C_{dc}		3360		μF
DC-link current ripple	$T_{amb} \leq 55^{\circ}\text{C}$		I_{ripple_Cdc}			200	A_{RMS}
Capacitor type	IEC61071 Standard, 50 FIT (100000h, $\theta_{Hotspot} \leq 70^{\circ}\text{C}$)				PP-Foil		
Balance or discharge resistor per DC link unit	Optional, refers to customers desired discharge time				TBD		$\text{k}\Omega$

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/s ²
Mech. shock	According DIN IEC 60721				TBD		m/s ²
Protection degree					IP00		
Pollution degree					2		
Dimensions	Width x Depth x Height		water	220	651.5	322.52	mm
			air	220	651.5	425.52	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 $f_{SW} = 2$ kHz, optical	I_{driver}		304		mA
	at $f_{SW} = 2$ kHz, electrical			100		mA
	at $f_{SW} = 6$ kHz, optical			379		mA
	at $f_{SW} = 6$ kHz, electrical			151		mA
Maximum switching frequency	$T_{amb} \leq 85^{\circ}\text{C}$	f_{SW_max}			15	kHz
	$T_{amb} \leq 70^{\circ}\text{C}$				25	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)

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

Formula 1.0

The following constants are valid for the used NTC:

Constants of formula 1.0	Symbol	Min.	Typ.	Max.	Unit
Resistance	R _s		220		Ω
Resistance	R _p		1800		Ω
B value	B		3433		K
Resistance	R ₂₅		5000		Ω
Factor	X		11		

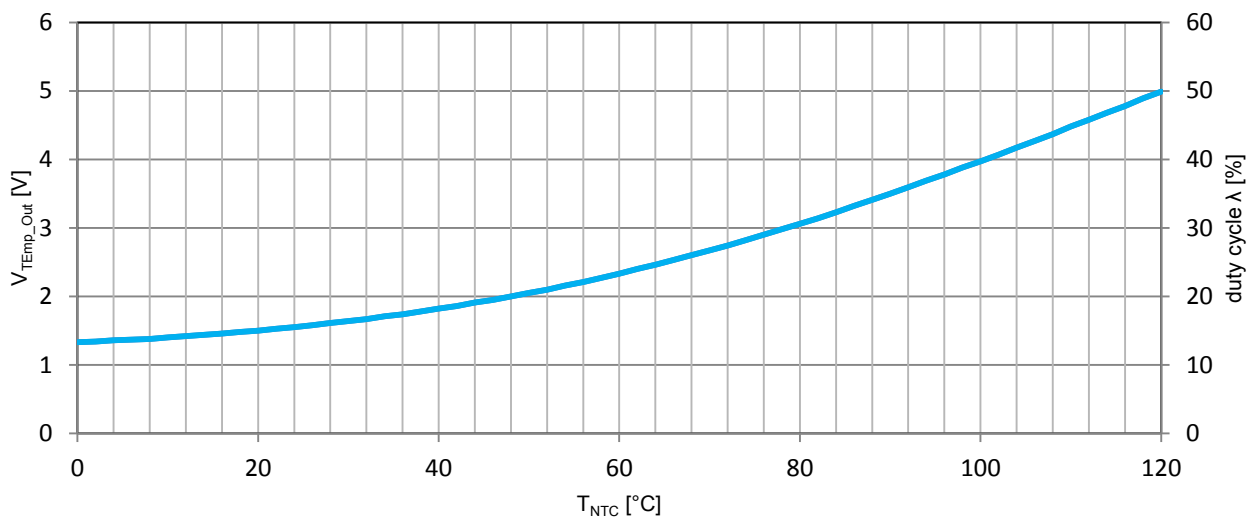


Figure 4: Characteristic curve of the analog temperature sense output V_{Temp_Out} and the duty cycle λ over the IGBT NTC temperature T_{NTC}

4. Technical Data Sensoring:

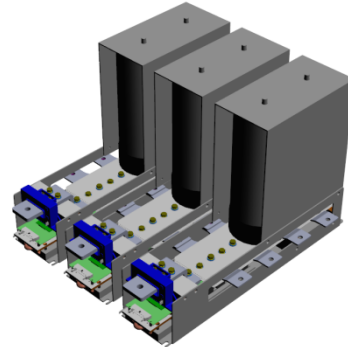
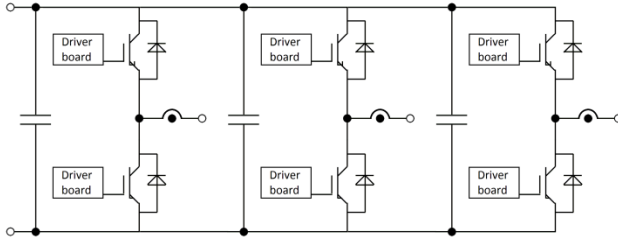
Each VARIS module includes a current sensor for measuring the output current. The power circuit is already prewired. The control circuit must be wired according to the following connector interface:

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 $T_{amb} = 25^\circ\text{C}$, excluding elec- trical offset voltage		-1.0		+1.0	%
Electrical offset voltage	at $T_{amb} = 25^\circ\text{C}$		-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 voltage V_{pn} to secondary current I_{out}				20000		V/A
Current consumption		I_{pn}		<20		mA
Accuracy at V_{pn}	at $T_{amb} = 25^\circ\text{C}$		-0.9		+0.9	%
Electrical offset current	at $T_{amb} = 25^\circ\text{C}$		-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	$V_{dc}=600V, V_{ac}=400V_{rms}, \cos(\varphi)=0.95, f_{ac_sine}=50Hz, f_{sw}=2kHz, m=1.0, T_{inlet}/T_{amb} \leq 25^{\circ}C, T_{vjsw} \leq 125^{\circ}C$	Water	I_{ac}			827	A_{RMS}
		Air				440	A_{RMS}
Rated continuous output power 3 phase inverter	$V_{dc}=600V, V_{ac}=400V_{rms}, \cos(\varphi)=0.95, f_{ac_sine}=50Hz, f_{sw}=2kHz, m=1.0, T_{inlet}/T_{amb} \leq 25^{\circ}C, T_{vjsw} \leq 125^{\circ}C$	Water	P_{out}			545	kW
		Air				289	kW
Rated continuous over- current $t_{on} \leq 60s$	$V_{dc}=600V, V_{ac}=400V_{rms}, \cos(\varphi)=0.95, f_{ac_sine}=50Hz, f_{sw}=2kHz, m=1.0, T_{inlet}/T_{amb} \leq 25^{\circ}C, t_{on} \leq 60s, T_{j} \leq 150^{\circ}C$	Water	I_{ac_over1}			848*	A_{RMS}
		Air				530	A_{RMS}
Rated continuous over- current $t_{on} \leq 3s$	$V_{dc}=600V, V_{ac}=400V_{rms}, \cos(\varphi)=0.95, f_{ac_sine}=50Hz, f_{sw}=2kHz, m=1.0, T_{inlet}/T_{amb} \leq 25^{\circ}C, t_{on} \leq 3s, T_{j} \leq 150^{\circ}C$	Water	I_{ac_over2}			848*	A_{RMS}
		Air				540	A_{RMS}
Power losses per phase leg	$V_{dc}=600V, V_{ac}=400V_{rms}, \cos(\varphi)=0.95, f_{ac_sine}=50Hz, f_{sw}=2kHz, m=1.0, \text{at } I_{ac}, T_{vjsw} \leq 125^{\circ}C$	Water	P_{loss_leg}			2314	W
		Air				956	W
Power losses 3 phase inverter	$V_{dc}=600V, V_{ac}=400V_{rms}, \cos(\varphi)=0.95, f_{ac_sine}=50Hz, f_{sw}=2kHz, m=1.0, \text{at } I_{ac}, T_{vjsw} \leq 125^{\circ}C$	Water	P_{loss_tot}			6942	W
		Air				2868	W
Switching frequency		Water/Air	f_{sw}		2000		Hz
Power factor			$\cos(\varphi)$	-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™-06-12-A):

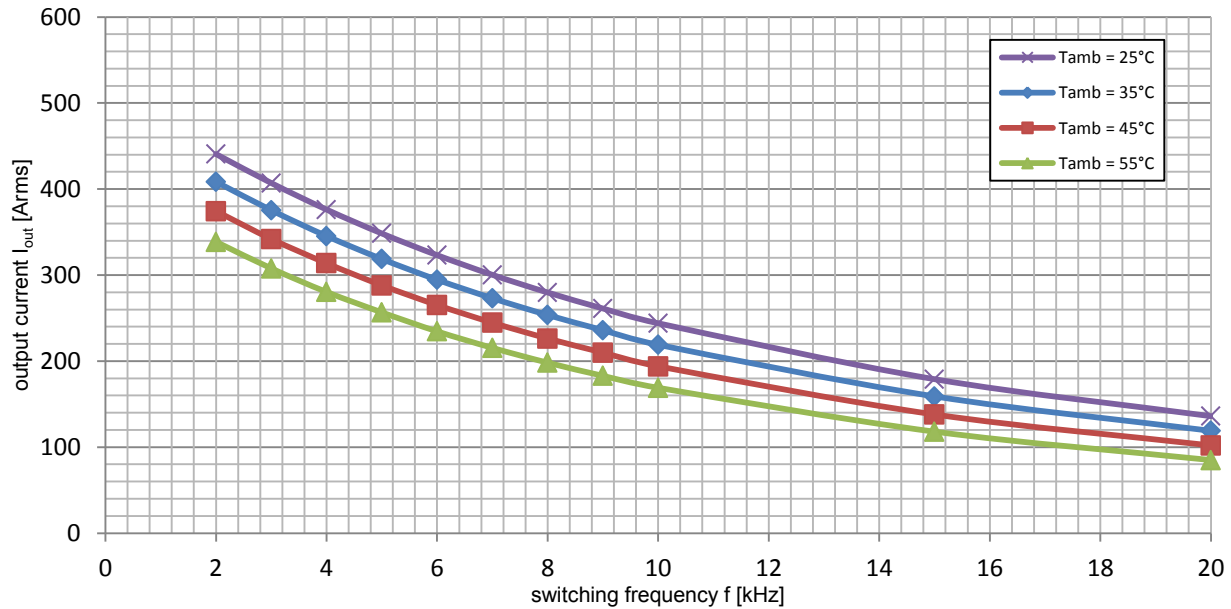


Figure 5: Current rating VARIS™-06-12-A (3-phase),
Measurement at $V_{dc}=600\text{V}$, $v_{air} = 6\text{m/s}$, $V_{ac}=400\text{Vrms}$, $\cos(\varphi)=0.95$, $m=1.0$, $f_{ac_sine}=50\text{Hz}$, $T_{vjsw}\leq 125^\circ\text{C}$

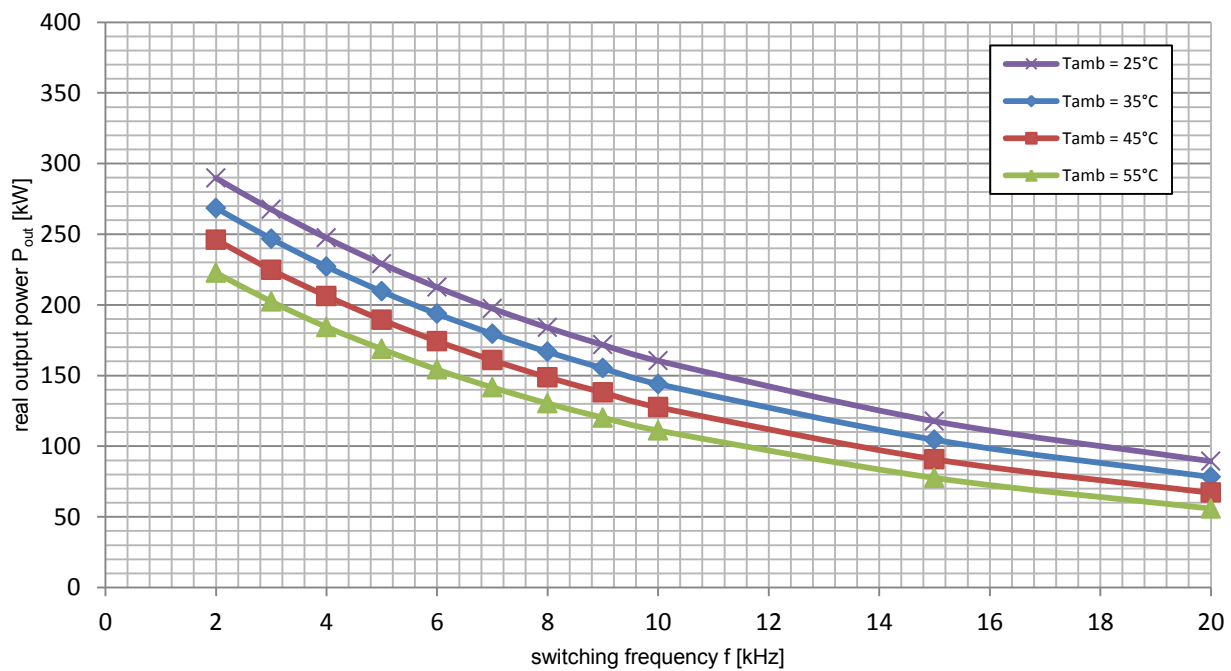


Figure 6: Power rating VARIS™-06-12-A (3-phase)
Measurement at $V_{dc}=600\text{V}$, $v_{air} = 6\text{m/s}$, $V_{ac}=400\text{Vrms}$, $\cos(\varphi)=0.95$, $m=1.0$, $f_{ac_sine}=50\text{Hz}$, $T_{vjsw}\leq 125^\circ\text{C}$

Current and Power ratings water cooled 3-phase configuration (3x VARIS™-06-12-TT-W):

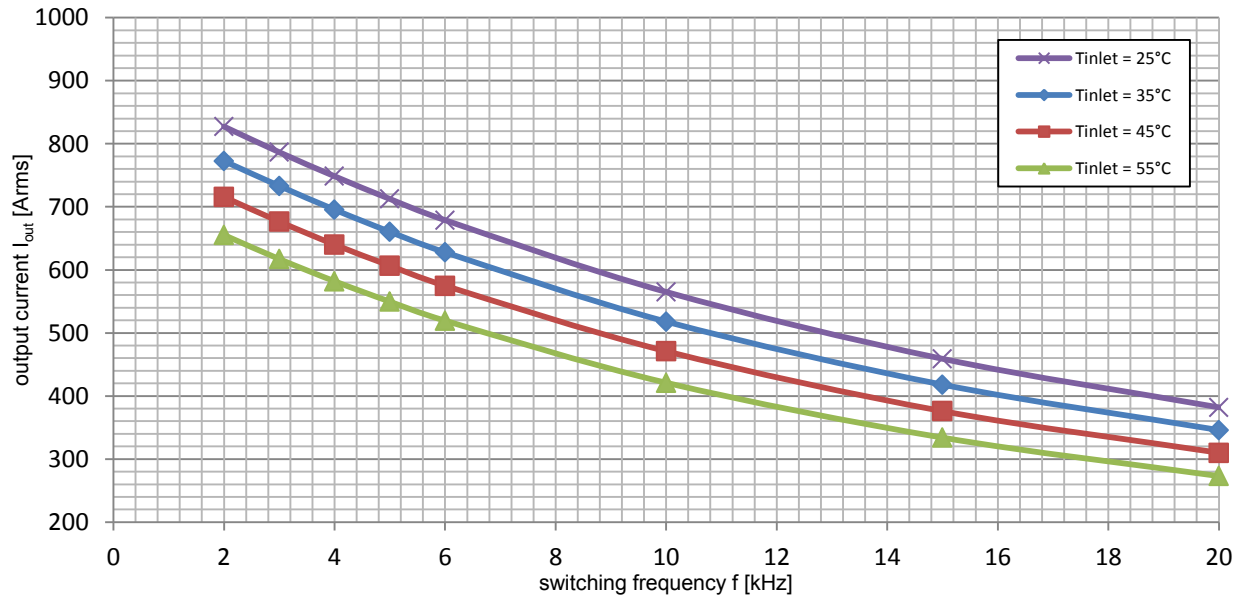


Figure 7: Current rating VARIS™-06-12-W (3-phase, water cooled)
Measurement at $V_{dc}=600\text{V}$, $Q = 4,3 \text{ L/min}$, $V_{ac}=400\text{Vrms}$, $\cos(\varphi)=0.95$, $m=1.0$, $f_{ac_sine}=50\text{Hz}$, $T_{vjsw}\leq 125^{\circ}\text{C}$

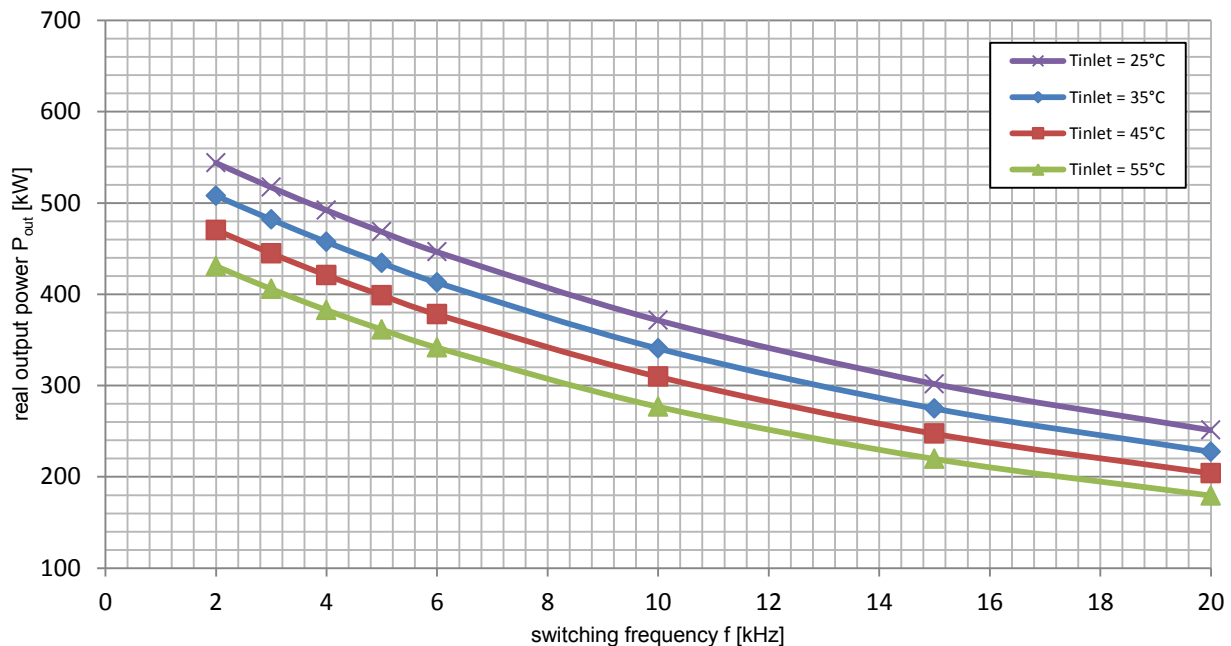
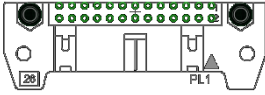


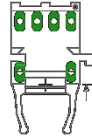
Figure 8: Power rating VARIS™-06-12-W (3-phase, water cooled)
Measurement at $V_{dc}=600\text{V}$, $Q = 4,3 \text{ L/min}$, $V_{ac}=400\text{Vrms}$, $\cos(\varphi)=0.95$, $m=1.0$, $f_{ac_sine}=50\text{Hz}$, $T_{vjsw}\leq 125^{\circ}\text{C}$

6. Signal Interfaces:

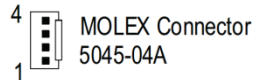
Driverboard electrical:



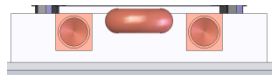
Driverboard optical (HFBR-15xx, supply voltage MSTBA4 5.08mm):



Current sensor:



Water cooler (¼ inch):



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



7. Mechanical drawings:

- All dimensions in millimeter (mm)

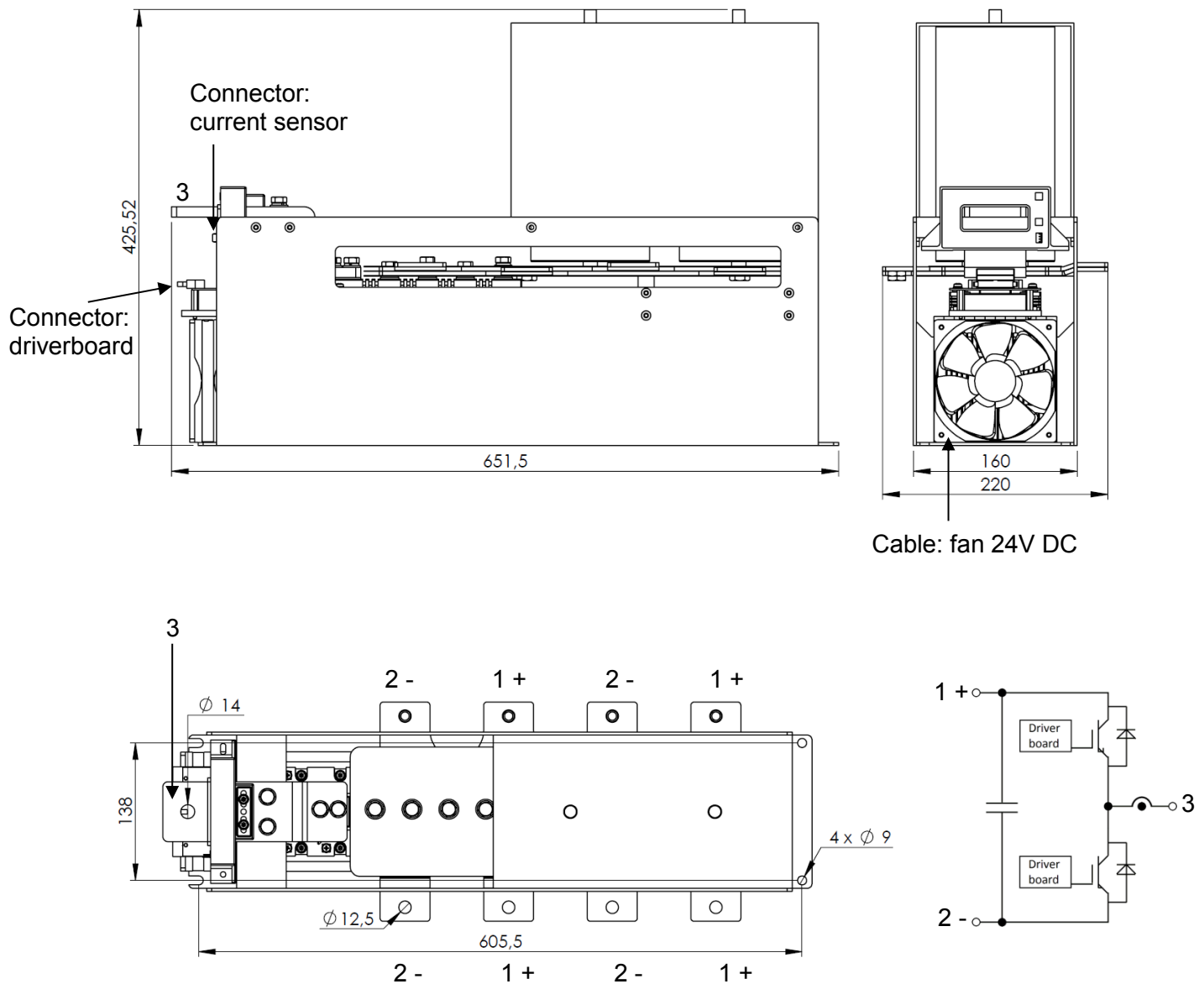


Figure 9: Mechanical drawing of the VARIS™-06-12-A (air cooled)

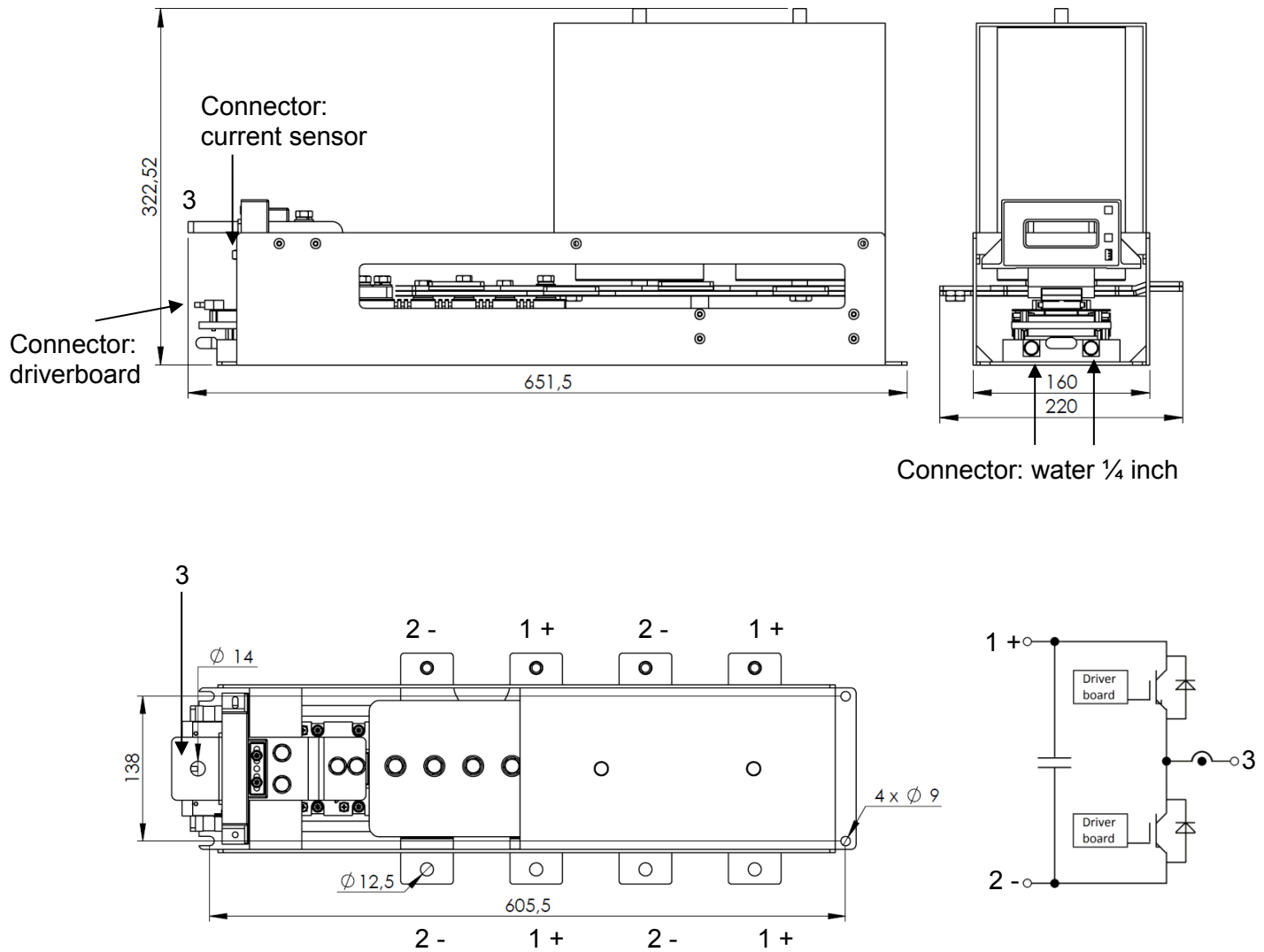


Figure 10: Mechanical drawing of the VARIS™-06-12-W (water cooled)

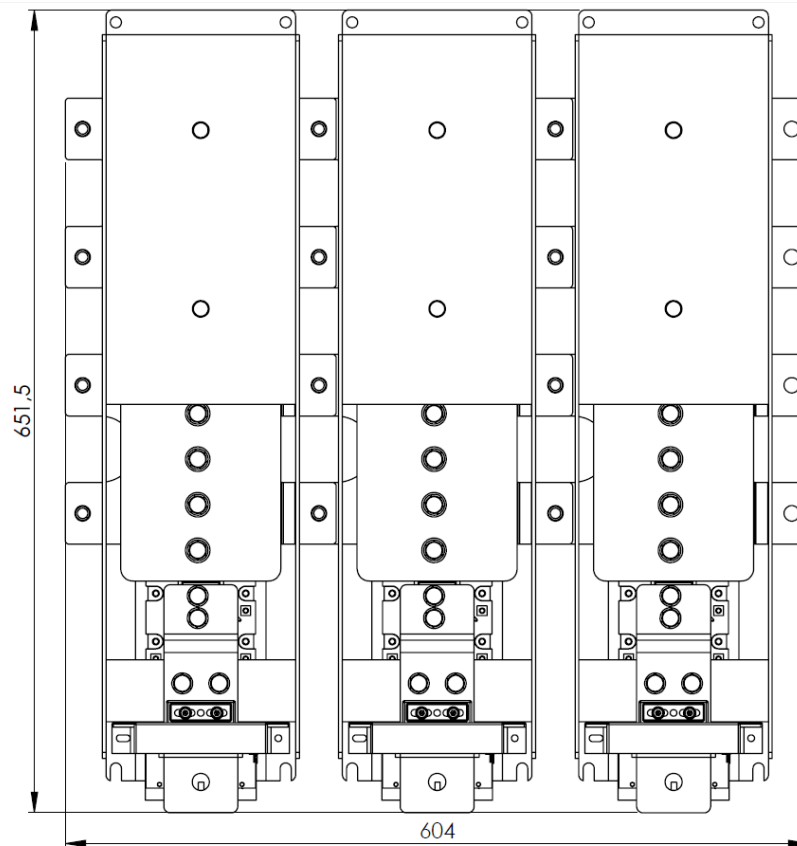


Figure 11: Mechanical drawing of 3x VARIS™-06-12 three phase configuration

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

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