SKAI 45 A2 GD12-W12CI

HV SKAI 2

Three-phase IGBT inverter

SKAI 45 A2 GD12-W12CI

Target Data

Features

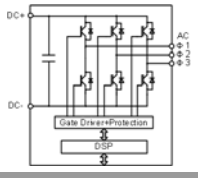
- Optimized for HEV and EV
- high power density
- high overload capability
- Compact integration in IP67 Enclosure:
  V, I, T sensors
  Integrated Controller
  Gate driver with protection features
  IGBT's + CAL Diodes
  Fully programmable digital signalprocessor
  EMI filters
  Liquid cooling
  DC link capacitor

Typical Applications*

- commercial application vehicle
- hybrid vehicle
- battery driven vehicle

No. 14282007

Characteristics					
Symbol	**Conditions**	**min.**	**typ.**	**max.**	**Unit**
Electrical Data					
V_{isol}	DC, t = 1 s		4000		V
V_{CC}	DC supply voltage		750	800	V
I_{nom}	rms @ rated conditions: dV/dt = 10l/min, 50% Glykol/ 50% H_20, f_{sw} = 4kHz, V_{CC} = 750V, V_{out} = 400V, f_{out} = 50Hz, cos(phi) = 0.85, M = 0.87, $T_{coolant}$ = 65 °C, T_{air} = 65 °C		300		A
f_{sw}	Switching frequency	1		20	kHz
C_{DC}	DC Bus Capacitance	0.9		1.25	mF
C_y	EMI Capacitor; DC to enclosure		0.66		µF
R_F	DC+ to enclosure, DC- to enclosure		1.13		MΩ
R_{BL}	DC+ to DC-		1		MΩ
Mechanical Data					
Weight			15		kg
Height			109		mm
Width			244		mm
Length			475		mm
M_t	AC / DC terminals (M8 screw)	13	14	15	Nm
M_c	Cover of terminal box (M5x16 flat-head-screw)	3.5	4	4.5	Nm
M_{cg}	AC / DC cable glands (recommended)		10		Nm
M_e	Assembly of enclosure; thread (l): > 15mm — M8 screw			20	Nm
	Assembly of enclosure; thread (l): > 15mm — M6 screw			14	Nm
M_{gnd}	Ground connection	13	14	15	Nm
Hydraulical Data					
dp	Pressure drop@ 10l/min, $T_{coolant}$ = 25°C		100		mbar
p	Operating pressure			2	bar
P	Power dissipation to coolant; rated conditions		2.4		kW
Environmental Data					
T_{stg}	storage temperature	-40		85	°C
T_{no}	Non operating temperature range	-40		105	°C
T_{air}	Operating range, derating for T_{air} > 85°C	-40		105	°C
$T_{coolant}$	Operating range, derating for $T_{coolant}$ > 65°C	-40		75	°C
IP	Enclosure protection level		IP67		
	With external connector protection		IP6K9K		
Altitude	V_{cc} = 800 V			2000	m



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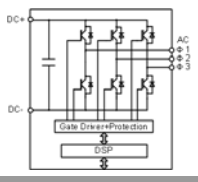


HV SKAI 2

Characteristics					
Symbol	**Conditions**	**min.**	**typ.**	**max.**	**Unit**
Interface parameters					
V_s		8	12	16	V
I_{SO}	Auxiliary supply current primary side if power converter is not activated (ELX X1:02 lower than threshold voltage or not connected (n.c.))			0.5	mA
I_S	Auxiliary supply current primary side at 12V (without additional power consumption at Pins MP_DO_Cx; PS_PWRx, depending on f_sw), power converter activated (ELX higher than threshold voltage)		1500	1900	mA
t_{POR}	Power-on reset completed		0.1	0.9	s
Controller switching parameters					
$t_{d(on)IO}$	Input-output turn-on propagation time		0.5	0.6	µs
$t_{d(off)IO}$	Input-output turn-off propagation time		0.5	0.6	µs
t_{jitter}	Signal transfer prim - sec (total jitter)			50	ns
t_{SIS}	Short pulse suppression time	0.026		0.052	µs
t_{et}	Input impulse extension time	0.9	1	1.1	µs
$t_{d(err)DSCP}$	Error input-output propagation time for DSCP error	0.2		1	µs
$t_{d(err)OCP}$	Error input-output propagation time for OCP error		4	10	µs
$t_{d(err)TMP}$	Error input-output propagation time for temperature error			50	ms
t_{TD}	Top-Bot interlock dead time		4	4.1	µs
t_{bl}	VCE monitoring blanking time		5	5.1	µs
Protection functions					
$T_{PCBtrip}$	Over temperature protection trip level (PCB)	100			°C
T_{CStrip}	Over temperature protection trip level on ceramic-substrate	120			°C
BW_{TBsens}	Bandwidth of temperature sensing on driver board	100			Hz
V_{DCtrip}	DC-Link voltage trip level	800			V
V_{VStrip}	Under voltage protection trip level of board primary side			8.8	V
V_{VSrst}	Threshold voltage level for driver reset after failure event	8.8			V
I_{TRIPSC}	Overcurrent trip level	567			A_{PEAK}
$I_{outsens}$	AC sensing range	-616		616	A
$m_{Ioutsens}$	Gradient of output current sensing		3.324		digits/A
$OS_{Ioutsens}$	Offset of AC current sensing		2048		digits
$BW_{Ioutsens}$	Bandwidth (3 dB) of AC current sensing		16		kHz
V_{DCsens}	Measurable DC-link-voltage	0		1000	V
$m_{VDCsens}$	Gradient of DC-link voltage sensing		4.095		digits/V
$BW_{VDCsens}$	Bandwidth (3 dB) of DC-link voltage sensing		8		kHz
Miscellaneous functions					
V_{pre_charge}	Pre-charge voltage		200		V

Signal Connector

PIN	Signal	Function	Specifications
X1:01	PWR_VP	INPUT Auxiliary power supply / battery "+"	Supply voltage Vs
X1:02	ELX	INPUT Turn on / turn off signal of power converter	Input voltage range = 0V … +18V; Trip level for boot loader configuration change = +16V; Threshold voltage = 6.0V (±2V); Input impedance ≥ 2kΩ;
X1:03	PS_PWR1_GND	GND	Ground of speed/position sensor power supply 1
X1:04	PS_PWR1	OUTPUT	Speed/position sensor power supply 1; Output voltage range = +11.0V … 13.0V; Output current limit Iout,limit = 100mA (no over current protection);
X1:05	PS_PWR2_GND	GND	Ground of speed/position sensor power supply 2
X1:06	PS_PWR2	OUTPUT	Speed/position sensor power supply 2; Output voltage range = +4.75V … +5.25V; Output current limit Iout,limit = 250mA (no over current protection)
X1:07	PS_DI_AP	INPUT/OUTPUT Digital position/speed sensor Track A Complementary signal to PS_DI_AN (pin 19)	Input voltage range = 0V … +5.25V; Input voltage in case of open line = 2.0V(±0.25V); Input impedance (signal to GND) = 2.3kΩ (±15%); Input filter time constant = 200ns; Threshold voltage HIGH = PS_DI_AP - PS_DI_AN ! +200mV; Threshold voltage LOW = PS_DI_AP - PS_DI_AN " -200mV;
X1:08	PS_DI_BP	INPUT/OUTPUT Digital position/speed sensor Track B Complementary signal to PS_DI_BN (pin 20)	Input voltage range = 0V … +5.25V; Input voltage in case of open line = 2.0V (±0.25); Input impedance (signal to GND) = 2.3kΩ (±15%); Input filter time constant = 200ns; Threshold voltage HIGH = PS_DI_BP - PS_DI_BN ≥+200mV; Threshold voltage LOW = PS_DI_BP - PS_DI_BN ≤-200mV;

PIN	Signal	Function	Specifications
X1:09	PS_DI_NP	INPUT/OUTPUT Digital Position/Speed sensor index Track N Complementary signal to PS_DI_NN (pin 21)	Input voltage range = 0V … +5.25V; Input voltage in case of open line = 2.0V (±0.25); Input impedance (signal to GND) = 2.3kΩ (±15%); Input filter time constant = 200ns; Threshold voltage HIGH = PS_DI_NP - PS_DI_NN ≥ +200mV; Threshold voltage LOW = PS_DI_NP - PS_DI_NN ≤ -200mV;
X1:10	MP_AI_C1P	INPUT Configurable multipurpose analog input channel 1 Complementary signal MP_AI_C1N (pin 22)	Input voltage range = 0V … +10V; Input impedance = 20kΩ (±10%); Accuracy of analog signal = ±2.5%; Bandwidth = 10kHz;
X1:11	PS_AI_C1	INPUT Analog position/speed sensor input channel 1	Input voltage range = 0V … +10V; Input impedance = 5.5kΩ (±10%); Accuracy of analog signal = ±2.5%; Bandwidth = 10kHz;
X1:12	PS_AI_C2	INPUT Analog position/speed sensor input channel 2	Input voltage range = 0V … +5V; Input impedance = 5.5kΩ (±10%); Accuracy of analog signal = ±2.5%; Bandwidth = 10kHz;
X1:13	PWR_GND	Auxiliary power supply ground	Ground of auxiliary power supply
X1:14	CANA_H	INPUT/OUTPUT CAN interface channel A HIGH line	No termination resistors populated; Specification: ISO 11783 (2.5V, 250kbit/sec minimum, quad twisted cable) or J1939/11 (250kbit/sec minimum, twisted shielded pair);
X1:15	CANA_L	INPUT/OUTPUT CAN interface channel A LOW line	No termination resistors populated; Specification: ISO 11783 (2.5V, 250kbit/sec minimum, quad twisted cable) or J1939/11 (250kbit/sec minimum, twisted shielded pair);
X1:16	CANB_H	INPUT/OUTPUT CAN interface channel B HIGH line	No termination resistors populated; Specification: ISO 11783 (2.5V, 250kbit/sec minimum, quad twisted cable) or J1939/11 (250kbit/sec minimum, twisted shielded pair);
X1:17	CANB_L	INPUT/OUTPUT CAN interface channel B LOW line	No termination resistors populated; Specification: ISO 11783 (2.5V, 250kbit/sec minimum, quad twisted cable) or J1939/11 (250kbit/sec minimum, twisted shielded pair);

PIN	Signal	Function	Specifications
X1:18	MP_DO_C1	OUTPUT Multipurpose digital port output channel 1	The unit provides multipurpose digital output with overcurrent protection. The output is switched to PWR_VP voltage by a high side switch. Output voltage range MP_DO_Cx = 0V … PWR_VP, the ground for the digital output is PWR_GND (X1:13). Average output current per output IAverage,out = 1.0A; Output current limit Iout,limit = 5A … 14A (overtemperature range); On-state recistance ≤ 300mΩ;
X1.19	PS_DI_AN	INPUT/OUTPUT Digital position/speed sensor Track A Complementary signal to PS_DI_AP (pin 7)	See pin 7 specifications; Input impedance = 3.4 kΩ (±15%); Input voltage (open line) = 3.0V (±0.25V); Input filter time constant = 200ns;
X1:20	PS_DI_BN	INPUT/OUTPUT Digital position/speed sensor Track B Complementary signal to PS_DI_BP (pin 8)	See pin 8 specifications; Input impedance = 3.4 kΩ (±15%); Input voltage (open line) = 3.0V (±0.25V); Input filter time constant = 200ns;
X1:21	PS_DI_NN	INPUT/OUTPUT Digital Position/Speed sensor index Track N Complementary signal to PS_DI_NP (pin 9)	See pin 9 specifications; Input impedance = 3.4 kΩ (±15%); Input voltage (open line) = 3.0V (±0.25V); Input filter time constant = 200ns;
X1:22	MP_AI_C1N	INPUT Configurable multipurpose analog input channel 1 Complementary signal to MP_AI_C1P (pin 10)	See pin 10 specifications
X1:23	TS_AI_MOT	INPUT Motor temperature sensor analog input channel 1	Temperature sensor range = 50Ω … 210kΩ;
X1:24	AI_GND	Analog ground	Ground of TS_AI_MOT
X1:25	CANA_PWR	RESERVED / NOT CONNECTED	CAN bus power supply channel A
X1:26	CANA_GND	OUTPUT	Return of CAN bus power supply channel A connected to PWR_GND
X1:27	CANB_PWR	RESERVED / NOT CONNECTED	CAN bus power supply channel B
X1:28	CANB_GND	OUTPUT	Return of CAN bus power supply channel B connected to PWR_GND
X1:29	MP_AI_C2P	INPUT Configurable multipurpose analog input channel 2 Complementary signal to MP_AI_C2N (pin 30)	Input voltage range = 0V … +10V; Input impedance = 20kΩ (±10%); Accuracy of analog signal = ±2.5%; Bandwidth = 10kHz;
X1:30	MP_AI_C2N	INPUT Configurable multipurpose analog input channel 2 Complementary signal to MP_AI_C2P (pin 29)	See pin 29 specifications

PIN	Signal	Function	Specifications
X1:31	MP_DI_C1	INPUT Isolated multipurpose digital port input channel 1	Input voltage range = 0V … +10V; Threshold voltage = 5V (±1.0); Input impedance = 820Ω (±20%); Input filter time constant = 200ns; Isolation between input and logic ground = 100 VDC;
X1:32	MP_DI_C2	INPUT Isolated multipurpose digital port input channel 2	Input voltage range = 0V … +10V; Threshold voltage = 5V (±1.0); Input impedance = 820Ω (±20%); Input filter time constant = 200ns; Isolation between input and logic ground = 100 VDC;
X1:33	MP_DI_GND	Digital ground	Ground of multipurpose digital port input channels
X1:34	MP_DO_C2	OUTPUT Multipurpose digital port output channel 2	The unit provides multipurpose digital output with overcurrent protection. The output is switched to PWR_VP voltage by a high side switch. Output voltage range MP_DO_Cx = 0V … PWR_VP, the ground for the digital output is PWR_GND (X1:13). Average output current per output $I_{Average,out}$ = 1.0A; Output current limit Iout,limit = 5A … 14A (overtemperature range); On-state recistance ≤ 300mΩ;
X1:35	ENCLOSURE	INPUT/OUTPUT	Connected to the inverter enclosure by gore EMI pads

Power Connectors

Terminal	Function	cable harness cross section Cu / mm²
DC+	HVDC Bus "+"	≤ 70
DC-	HVDC Bus "-"	≤ 70
L1	Phase L1	≤ 70
L2	Phase L2	≤ 70
L3	Phase L3	≤ 70

Coolant fittings

Terminal	Function
IN	Coolant Inlet
OUT	Coolant Outlet

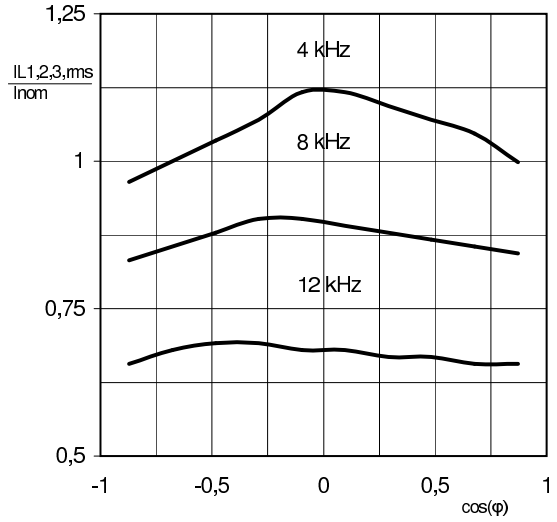


Fig. 1: Normalized output current vs. cos(phi)

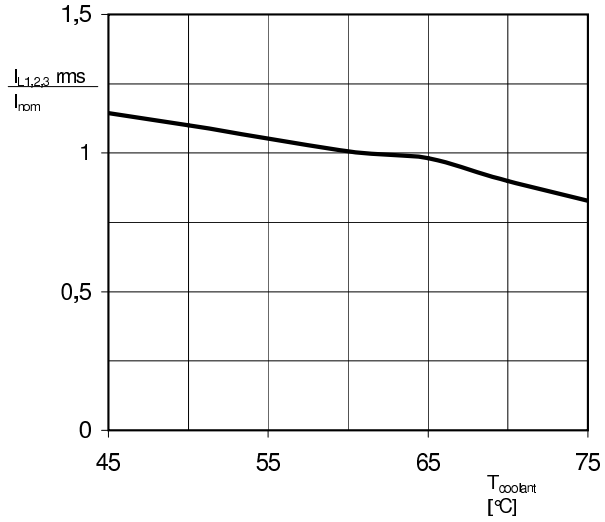


Fig. 2: Normalized output current vs. coolant temperature

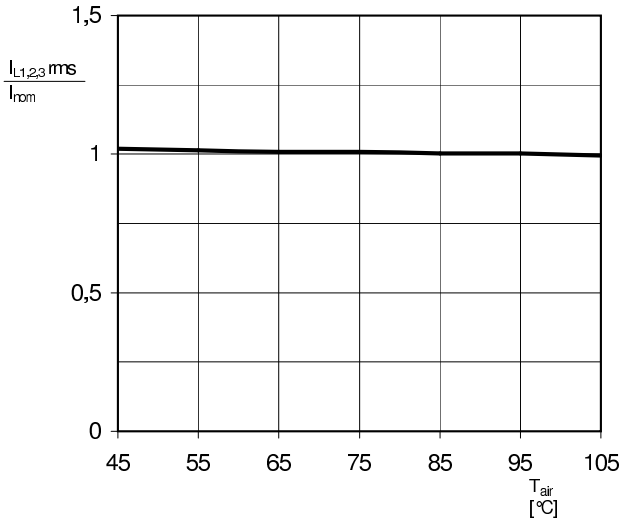


Fig. 3: Normalized output current vs. ambient temperature

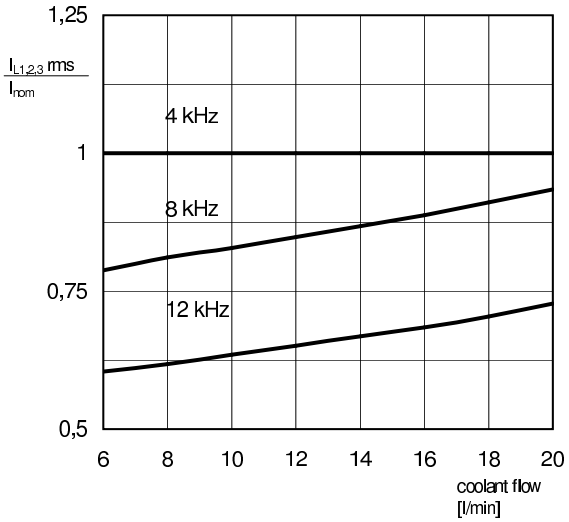


Fig. 4: Normalized output current vs. coolant flow

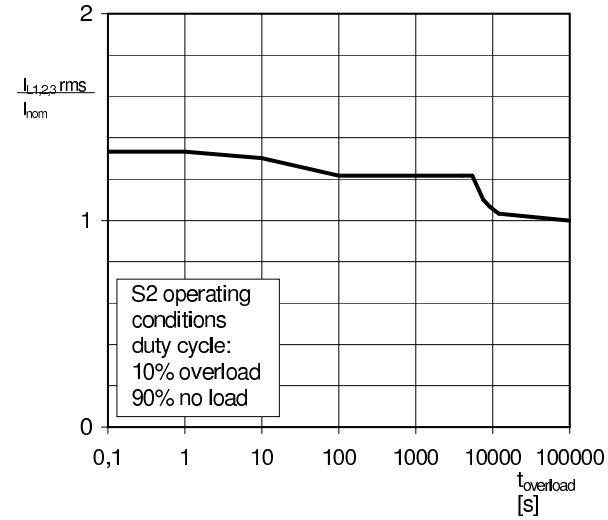


Fig. 5: Overload capability

Operating point:
if not specified otherwise

$T_{coolant}$		65	°C
T_{air}		65	°C
dV/dt	coolant flow	10	l/min
f_{sw}	switching frequency	4	kHz
V_{CC}	DC supply voltage	750	V
V_{out}	output voltage	400	V
f_{out}	output frequency	50	Hz
cos(φ)		0,85	
I_{nom}	normalized current	300	A
M	modulation factor	0,87	

Fig. 6: Legend

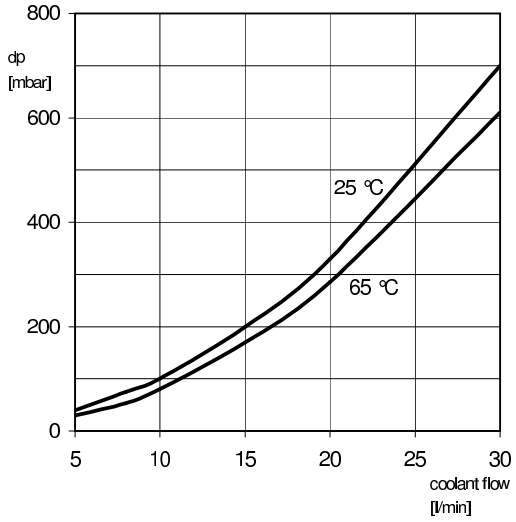


Fig. 7: Pressure drop characteristic

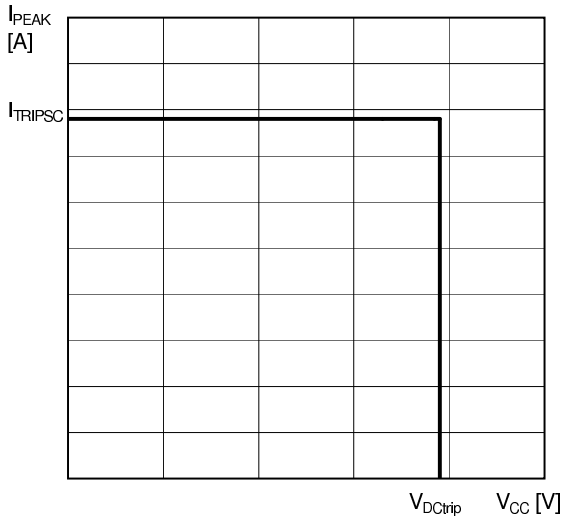


Fig. 8: Transient thermal impedance Zth(s-a)

DCB Temperature [°C]	ADC_{OUT} [digit]		
	min.	typ.	max
-40	3959	4084	4208
-30	3948	4072	4197
-20	3927	4053	4179
-10	3895	4022	4148
0	3844	3972	4099
10	3767	3896	4024
20	3657	3786	3915
30	3504	3635	3766
40	3300	3437	3572
50	3047	3191	3332
60	2753	2903	3050
70	2433	2586	2736
80	2105	2258	2407
90	1788	1935	2080
100	1494	1634	1772
110	1241	1363	1490
120	1018	1131	1241
130	835	934	1030
140	683	768	850
150	561	631	702

Fig. 9: DCB temperature measurement scaling

PCB Temperature [°C]	ADC_{OUT} [digit]		
	min.	typ.	max.
-40	3893	4026	4156
-30	3835	3972	4106
-20	3745	3887	4025
-10	3613	3759	3901
0	3431	3578	3722
5	3319	3465	3609
10	3193	3337	3480
15	3054	3195	3335
20	2904	3040	3175
25	2744	2873	3002
30	2564	2698	2830
35	2380	2516	2652
40	2193	2332	2470
45	2009	2149	2288
50	1828	1969	2108
55	1655	1794	1932
60	1491	1628	1764
65	1338	1472	1604
70	1198	1326	1454
75	1069	1192	1315
80	952	1069	1186
85	847	957	1068
90	752	856	961
95	668	766	864
100	594	685	777
105	528	612	698

Fig. 10: PCB temperature measurement scaling

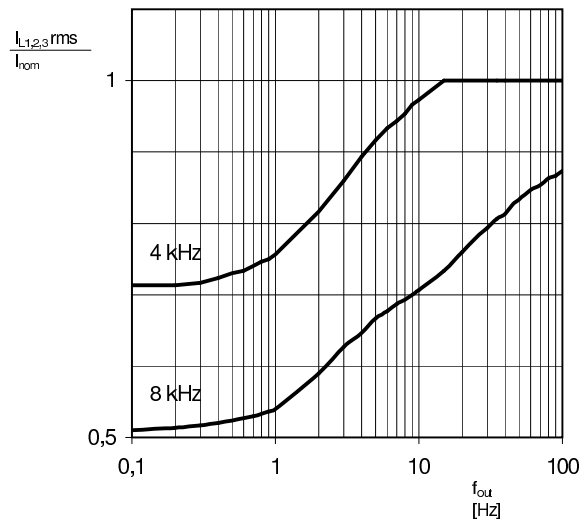
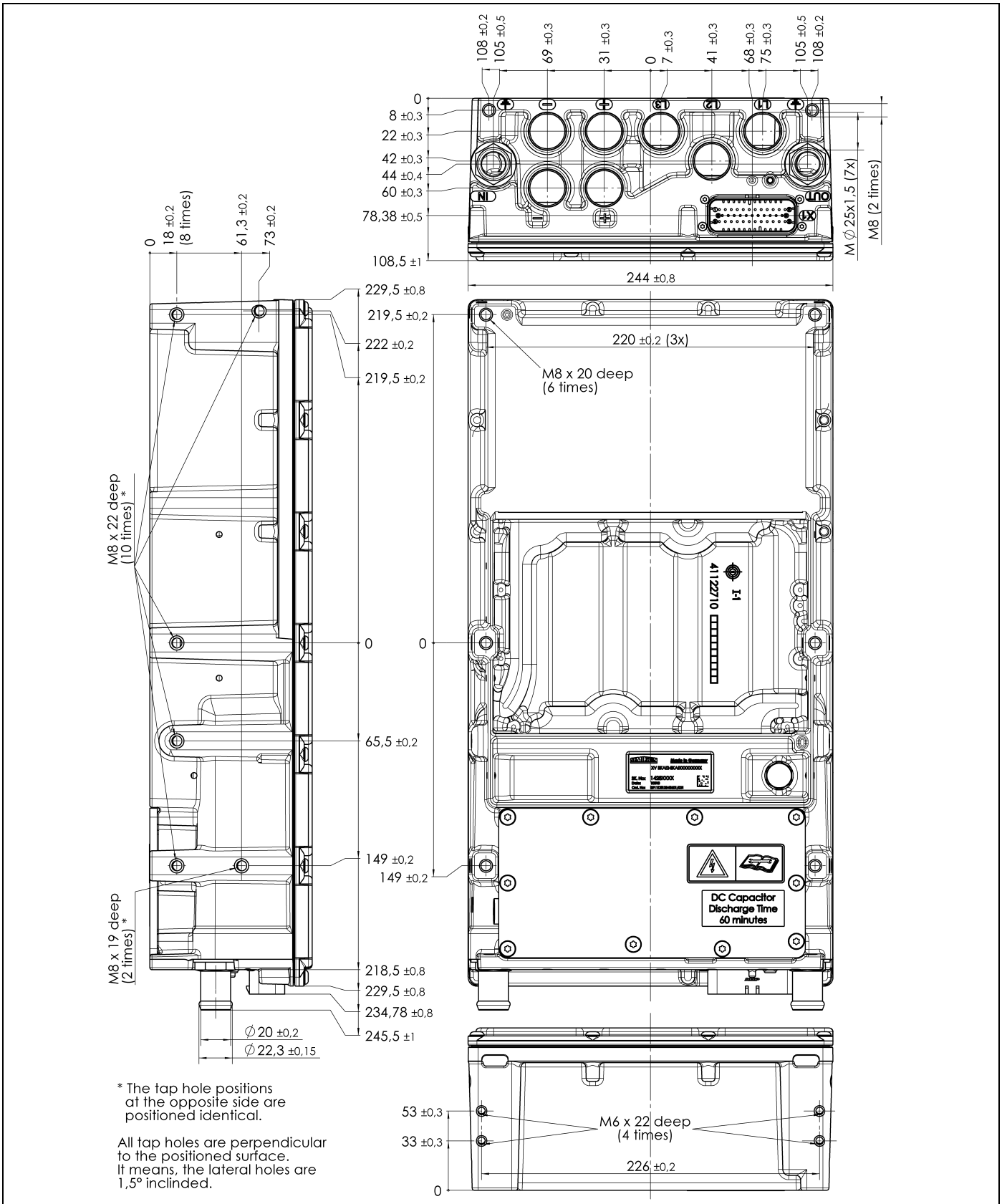


Fig. 11: Normalized output current vs. output frequency



This is an electrostatic discharge sensitive device (ESDS), international standard IEC 60747-1, Chapter IX

* The specifications of our components may not be considered as an assurance of component characteristics. Components have to be tested for the respective application. Adjustments may be necessary. The use of SEMIKRON products in life support appliances and systems is subject to prior specification and written approval by SEMIKRON. We therefore strongly recommend prior consultation of our staff.