# SKAI 90 A2 GD06-W12DI

HV SKAI 2

Three-phase IGBT inverter

**SKAI 90 A2 GD06-W12DI**

Target Data

### Features

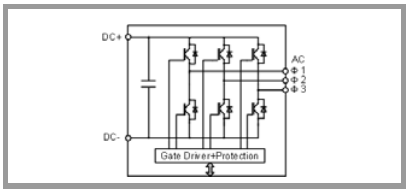
- Optimized for HEV and EV
- high power density
- high overload capability
- Compact integration in IP67 Enclosure:
  V, I, T sensors
  Gate driver with protection features
  EMI filters
  Liquid cooling
  DC link capacitor

### Typical Applications*

- commercial application vehicle
- hybrid vehicle
- battery driven vehicle

No. 14282013

| Characteristics | | | | | |
|---|---|---|---|---|---|
| **Symbol** | **Conditions** | **min.** | **typ.** | **max.** | **Unit** |
| **Electrical Data** | | | | | |
| $V_{isol}$ | DC, t = 1 s | | 3000 | | V |
| $V_{CC}$ | DC supply voltage | | 350 | 450 | V |
| $I_{nom}$ | rms @ rated conditions: dV/dt = 10l/min, 50% Glykol/ 50% $H_20$, $f_{sw}$ = 4kHz, $V_{CC}$ = 350V, $V_{out}$ = 200V, $f_{out}$ = 50 Hz, cos(phi) = 0.85, M = 0.93, $T_{coolant}$ = 65 °C, $T_{air}$ = 65 °C | | 300 | | A |
| $f_{sw}$ | Switching frequency | 1 | | 15 | 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 | | 7.5 | | 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 | | 1.9 | | 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 | $V_{CC}$ =450 V | | | 5000 | m |

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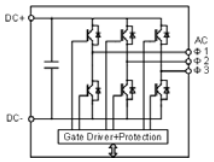



HV SKAI 2

| Characteristics | | | | | |
|---|---|---|---|---|---|
| **Symbol** | **Conditions** | **min.** | **typ.** | **max.** | **Unit** |
| **Interface parameters** | | | | | |
| $V_s$ | | 8 | 12 | 16 | V |
| $I_{SO}$ | Auxiliary supply current primary side without driving a gate ($V_s$ = 12 V) | | | 900 | mA |
| $I_S$ | Auxiliary supply current primary side, driving the gates ($V_s$ = 12 V) | | | 3000 | mA |
| $V_{iH}$ | Input signal voltage (HIGH) | 0.7 * Vs | | Vs + 0.3 | V |
| $V_{iL}$ | Input signal voltage (LOW) | GND - 0.3 | | 0.3 * Vs | V |
| $t_{POR}$ | Power-on reset completed | | 0.1 | 0.9 | s |
| $t_{pRESET}$ | Error reset time | | | 3 | 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 | 0.2 | 0.25 | 0.3 | 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 |
| $T_{RelPCBtrip}$ | Release temperature for PCB overtemperature trip level | 90 | | | °C |
| $T_{RelCStrip}$ | Release temperature for ceramic substrate overtemperature trip level | 85 | | | °C |
| $V_{DCtrip}$ | Trip level of DC-link voltage monitoring | 450 | | | V |
| $V_{VStrip}$ | Under voltage protection trip level of board primary side | | | 7 | V |
| $V_{VSrst}$ | Threshold voltage level for driver reset after failure event | 8 | | | V |
| $I_{TRIPSC}$ | Overcurrent trip level | 850 | | | $A_{PEAK}$ |
| $I_{outsens}$ | AC sensing range | -924 | | 924 | A |
| $m_{Ioutsens}$ | Gradient of output current sensing | 10.8 | 11.13 | 11.47 | mV/A |
| $BW_{Ioutsens}$ | Bandwidth (3 dB) of AC current sensing | | 17 | | kHz |
| $V_{DCsens}$ | Measurable DC-link voltage | 0 | | 600 | V |
| $m_{VDCsens}$ | Gradient of DC-link voltage sensing | 19.669 | 20.067 | 20.472 | mV/V |
| $BW_{VDCsens}$ | Bandwidth (3 dB) of DC-link voltage sensing | | 0.25 | | kHz |
| $T_{CSsens}$ | Temperature sensing range on ceramic substrate | 30 | | 150 | °C |
| $m_{TCSsens}$ | Gradient of temperature sensing on ceramic-substrate | | 83.3 | | mV/°C |
| $BW_{TCSsens}$ | Bandwidth of temperature sensing on ceramic-substrate | | 100 | | Hz |

**Signal Connector**

| PIN | Signal | Function | Specifications |
|---|---|---|---|
| X1:01 | PWR_VP | INPUT<br>Auxiliary power supply / battery "+" | Supply voltage $V_s$ |
| X1:02 | PWR_GND | Auxiliary power supply ground | Ground of auxiliary power supply |
| X1:03 | DC_LINK_DISCHARGE | INPUT | HIGH, NOT CONNECTED (n.c.) or module not supplied with Auxiliary power = DC Link discharge active<br>LOW = DC Link discharge disabled<br>(internal pull-up resistor, external pull-up resistor required as well) |
| X1:04 | CMN_HALT | INPUT/OUTPUT | All connected units have to change the signal mode to „dominant" if following happens:<br>The unit is not ready to operate<br>Error happened<br><br>All connected units must be able to process (read) the signal. In case of recognised dominant signal, following steps need to be performed:<br>The unit must be switched to a defined safe operation mode<br>The unit must interrupt the main process unitl a recessive signal has been recognised<br><br>LOW (dominant) = not ready to operate<br>HIGH (recessive) = ready to operate |
| X1:05 | CMN_TEMP_GND | Ground for temperature sensor signal CMN_TEMP | Internally connected to PWR_GND |
| X1:06 | HB1_TOP | INPUT<br>Switching PWM signal [push/pull] | Digital PWR_VP logic<br>LOW = IGBT off<br>HIGH = IGBT on |
| X1:07 | HB1_BOT | INPUT<br>Switching PWM signal [push/pull] | Digital PWR_VP logic<br>LOW = IGBT off<br>HIGH = IGBT on |
| X1:08 | HB2_TOP | INPUT<br>Switching PWM signal [push/pull] | Digital PWR_VP logic<br>LOW = IGBT off<br>HIGH = IGBT on |
| X1:09 | HB2_BOT | INPUT<br>Switching PWM signal [push/pull] | Digital PWR_VP logic<br>LOW = IGBT off<br>HIGH = IGBT on |
| X1:10 | HB3_TOP | INPUT<br>Switching PWM signal [push/pull] | Digital PWR_VP logic<br>LOW = IGBT off<br>HIGH = IGBT on |
| X1:11 | HB3_BOT | INPUT<br>Switching PWM signal [push/pull] | Digital PWR_VP logic<br>LOW = IGBT off<br>HIGH = IGBT on |
| X1:12 | CAN_GND | GND | Ground of CAN bus |

| PIN | Signal | Function | Specifications |
|---|---|---|---|
| X1:13 | PWR_VP | INPUT<br>Auxiliary power supply / battery "+" | Supply voltage $V_s$ |
| X1:14 | PWR_GND | Auxiliary power supply ground | Ground of auxiliary power supply |
| X1:15 | CMN_GND | Ground for CMN_DIAG, CMN_HALT, CMN_GPIO | Internally connected to PWR_GND |
| X1:16 | CMN_TEMP | OUTPUT<br>Temperature sensor signal CMN_TEMP | This pin is used to transmit the temperature sensor analog signal.<br>Max. output current: 5 mA<br>Nominal voltage range: 0…10 V |
| X1:17 | Reserved | | |
| X1:18 | HB1_GND | Ground for HB1_TOP, HB1_BOT | Internally connected to PWR_GND |
| X1.19 | Reserved | | |
| X1:20 | HB2_GND | Ground for HB2_TOP, HB2_BOT | Internally connected to PWR_GND |
| X1:21 | Reserved | | |
| X1:22 | HB3_GND | Ground for HB3_TOP, HB3_BOT | Internally connected to PWR_GND |
| X1:23 | CAN_L | INPUT/OUTPUT<br>CAN interface LOW line | Input impedance = 121 Ω<br>Specification:<br>ISO 11783 (2.5V, 250 kbit/sec minimum, quad twisted cable) or J1939/11 (250 kbit/sec minimum, twisted shielded pair). |
| X1:24 | PWR_VP | INPUT<br>Auxiliary power supply / battery "+" | Supply voltage $V_s$ |
| X1:25 | PWR_GND | Auxiliary power supply ground | Ground of auxiliary power supply |
| X1:26 | CMN_DIAG | INPUT/OUTPUT<br>Single line CAN communication [dominant/recessive] | Dominant/Recessive diagnose input/output signal. All connected units can communicate using this serial signal for setting/getting parameters of the unit and reading error information from unit registers. |
| X1:27 | CMN_DCL | OUTPUT<br>DC-Link voltage signal [analog] | This pin is used to transmit the DC-Link voltage level.<br>Max. output current: 5 mA<br>Nominal voltage range: 0….+10 V |
| X1:28 | CMN_DCL_GND | Ground for DC-Link voltage signal CMN_DCL | Internally connected to PWR_GND |
| X1:29 | HB1_I | OUTPUT<br>Current sensor out for HB1 [analog] | Max. output current: 5 mA<br>Nominal voltage range: -10 … +10 V |
| X1:30 | HB1_I_GND | Ground for HB1_I | Internally connected to PWR_GND |
| X1:31 | HB2_I | OUTPUT<br>Current sensor out for HB2 [analog] | Max. output current: 5 mA<br>Nominal voltage range: -10 … +10 V |
| X1:32 | HB2_I_GND | Ground for HB2_I | Internally connected to PWR_GND |
| X1:33 | HB3_I | OUTPUT<br>Current sensor out for HB3 [analog] | Max. output current: 5 mA<br>Nominal voltage range: -10 … +10 V |
| X1:34 | HB3_I_GND | Ground for HB3_I | Internally connected to PWR_GND |
| X1:35 | CAN_H | INPUT/OUTPUT<br>CAN interface HIGH line | Input impedance = 121 Ω<br>Specification:<br>ISO 11783 (2.5V, 250 kbit/sec minimum, quad twisted cable) or J1939/11 (250 kbit/sec minimum, twisted shielded pair). |

**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 |

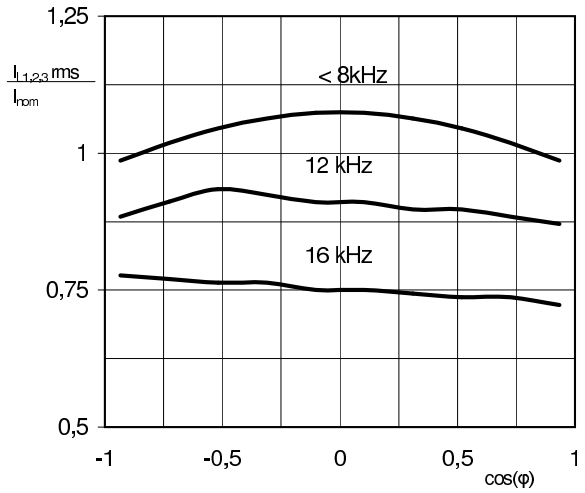



Fig. 1: Normalized output current vs. cos(phi)

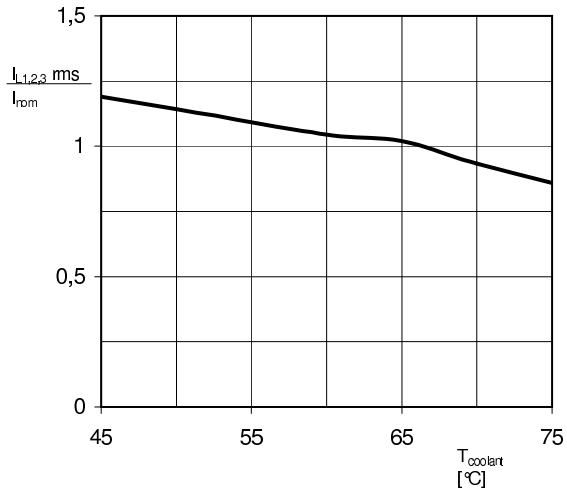



Fig. 2: Normalized output current vs. coolant temperature

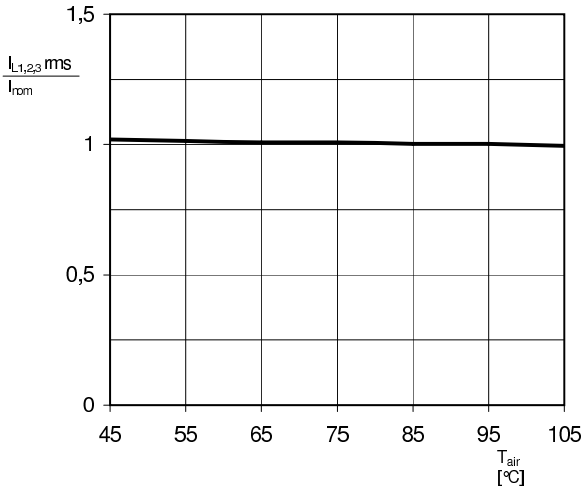



Fig. 3: Normalized output current vs. ambient temperature

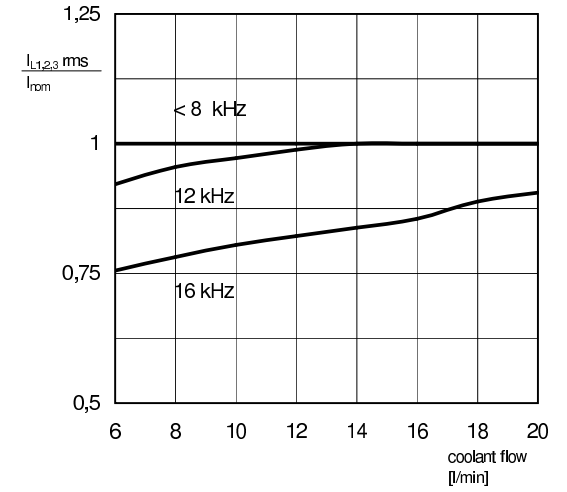



Fig. 4: Normalized output current vs. coolant flow

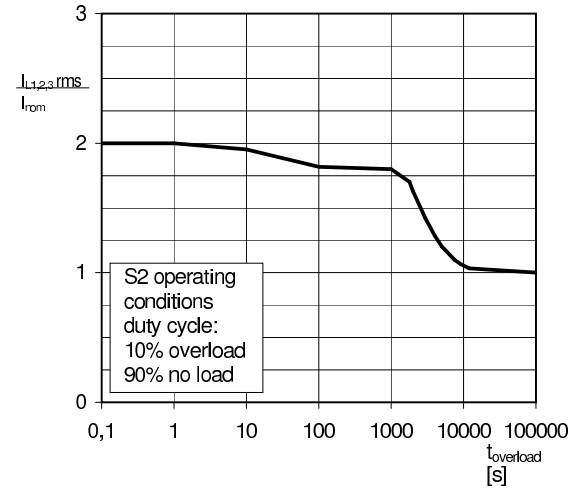



Fig. 5: Overload capability

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 | 350 | V |
| $V_{OUT}$ | output voltage | 200 | V |
| $f_{out}$ | output frequency | 50 | Hz |
| cos(φ) | | 0,85 | |
| $I_{norm}$ | normalized current | 300 | A |
| M | modulation factor | 0,93 | |

Fig. 6: Legend

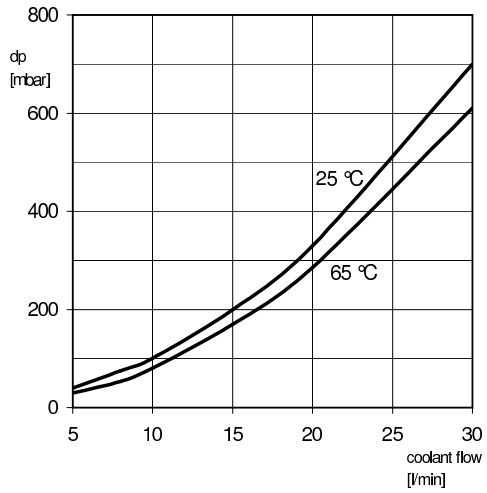



Fig. 7: Pressure drop characteristic

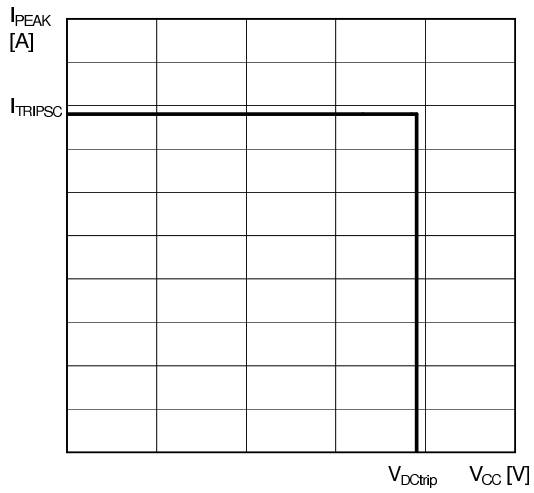



Fig. 8: Safe operating area

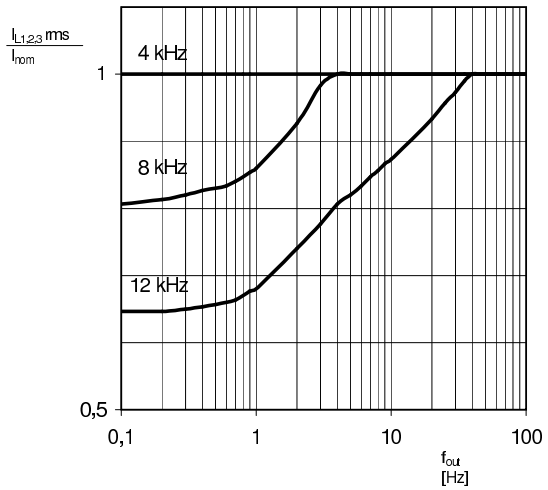
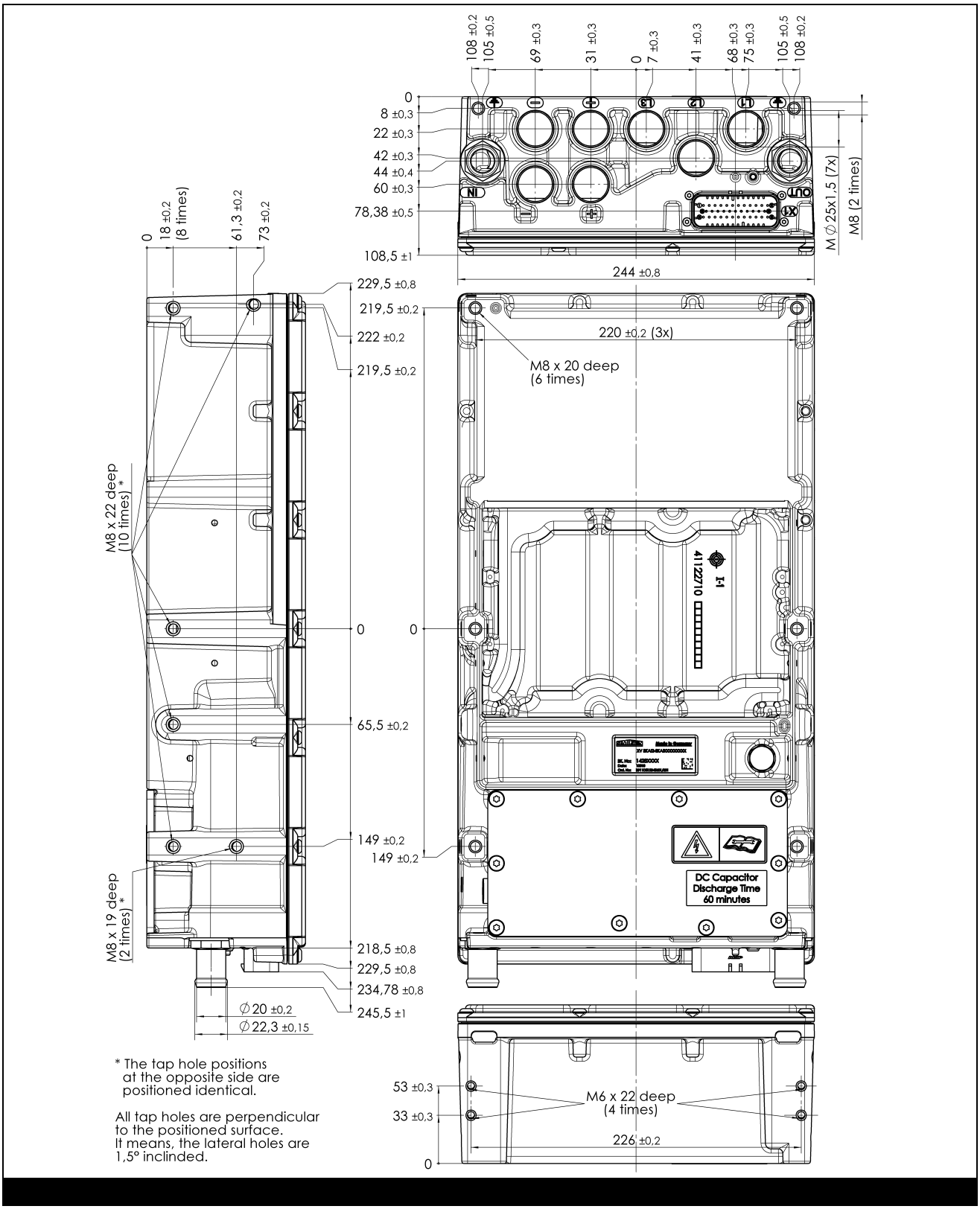



Fig. 9: Normilized output current vs. output frequency




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.