

**General information**

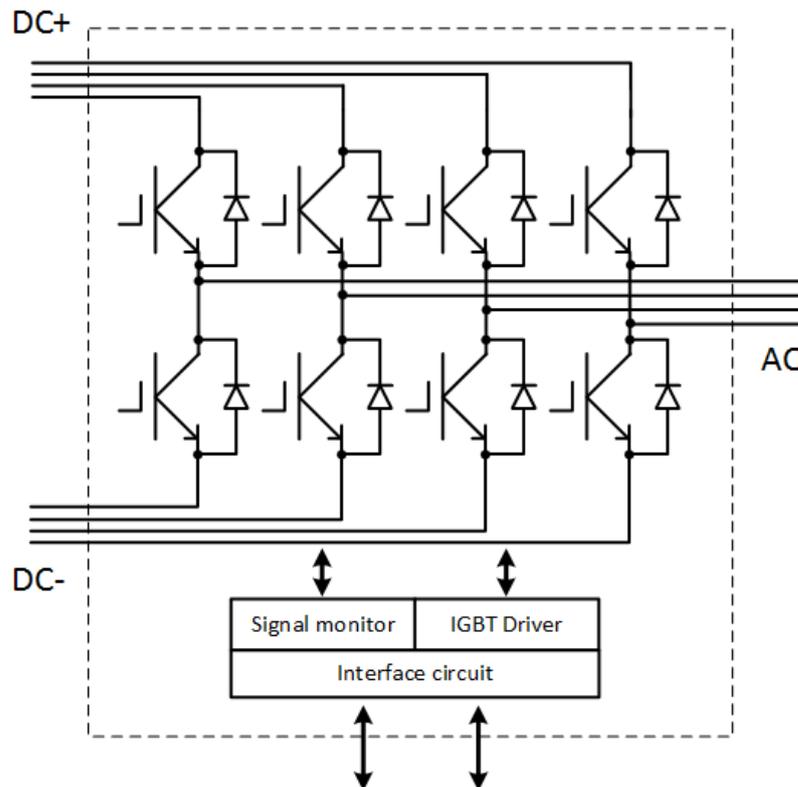
**IPM for typical voltages up to 690 V<sub>RMS</sub>**  
**Rated output current 650 A<sub>RMS</sub>**

Features

- Integrated current, voltage and temperature measurement
- Tvjop max=150°C
- Real time Tvj simulation
- IGBT4 technology
- Smart protection
- TIM and pressfit technology
- Modbus interface
- 100% tested IPM
- ROHS compliant
- Integrated chip current : 2400A
- Integrated chip voltage: 1700V



|                     |   |
|---------------------|---|
| Topology            | half bridge                                     |
| Application         | Energy Storage, Smart Grid, Wind, Drives, Solar |
| Heatsink            | air cooled                                      |
| Implemented sensors | voltage, current, temperature                   |
| Driver signals IGBT | +15V  |
| Approvals           | UL61800-5-1                                     |
| Sales - name        | IFF2400P17AE440989                              |



|                 |                                 |
|-----------------|---------------------------------|
| prepared by: OW | date of publication: 2018-06-22 |
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Preliminary data

Characteristic values

IGBT characteristic value

|  |  |                               | min. | typ.   | max. |     |
|--|--|-------------------------------|------|--------|------|-----|
| Collector-emitter voltage  | $I_C = 2400\text{ A}, T_{vj} = 25^\circ\text{C}$   | $V_{ce\text{ sat}}$           |      | 1.95   | 2.30 | V   |
|  | $I_C = 2400\text{ A}, T_{vj} = 150^\circ\text{C}$  |                               |      | 2.45   |      | V   |
| Turn on energy loss  | $I_C = 2400\text{ A}, V_{DC} = 900\text{ V}, L_S = 17\text{ nH}, T_{vj} = 25^\circ\text{C}$  | $E_{on}$                      |      | 730    |      | mJ  |
|  | $I_C = 2400\text{ A}, V_{DC} = 900\text{ V}, L_S = 17\text{ nH}, T_{vj} = 150^\circ\text{C}$ |                               |      | 1170   |      | mJ  |
| Turn off energy loss   | $I_C = 2400\text{ A}, V_{DC} = 900\text{ V}, L_S = 17\text{ nH}, T_{vj} = 25^\circ\text{C}$  | $E_{off}$                     |      | 460    |      | mJ  |
|  | $I_C = 2400\text{ A}, V_{DC} = 900\text{ V}, L_S = 17\text{ nH}, T_{vj} = 150^\circ\text{C}$ |                               |      | 810    |      | mJ  |
| Thermal resistance junction to ambient for diode due diode housing | per IPM switch, Air flow rate= 550m <sup>3</sup> /h  | $R_{thja\text{ IGBT->IGBT}}$  |      | 0.0619 |      | K/W |
| Thermal resistance junction to ambient for IGBT due IGBT housing   | per IPM switch, Air flow rate= 550m <sup>3</sup> /h  | $R_{thja\text{ IGBT->diode}}$ |      | 0.0492 |      | K/W |

Notes

Tinlet = 25°C

For further details about the thermal resistance please refer to the handbook.

Diode characteristic value

|  |  |                                | min. | typ.   | max. |     |
|--|--|--------------------------------|------|--------|------|-----|
| Forward voltage  | $I_C = 2400\text{ A}, T_{vj} = 25^\circ\text{C}$   | $V_F$                          |      | 1.80   | 2.20 | V   |
|  | $I_C = 2400\text{ A}, T_{vj} = 150^\circ\text{C}$  |                                |      | 1.95   |      | V   |
| Reverse recovery energy  | $I_C = 2400\text{ A}, V_{DC} = 900\text{ V}, L_S = 17\text{ nH}, T_{vj} = 25^\circ\text{C}$  | $E_{rec}$                      |      | 250    |      | mJ  |
|  | $I_C = 2400\text{ A}, V_{DC} = 900\text{ V}, L_S = 17\text{ nH}, T_{vj} = 150^\circ\text{C}$ |                                |      | 530    |      | mJ  |
| Thermal resistance junction to ambient for diode due diode housing | per IPM switch, Air flow rate= 550m <sup>3</sup> /h  | $R_{thja\text{ diode->diode}}$ |      | 0.0721 |      | K/W |
| Thermal resistance junction to ambient for IGBT due IGBT housing   | per IPM switch, Air flow rate= 550m <sup>3</sup> /h  | $R_{thja\text{ diode->IGBT}}$  |      | 0.0485 |      | K/W |

Notes

Tinlet = 25°C

For further details about the thermal resistance please refer to the handbook.

Absolute maximum rated values

|                                      |                                     |            |  |      |  |                   |
|--------------------------------------|-------------------------------------|------------|--|------|--|-------------------|
| Collector-emitter voltage            | IGBT; $T_{vj} = 25^\circ\text{C}$   | $V_{CES}$  |  | 1700 |  | V                 |
| Repetitive peak reverse voltage      | Diode; $T_{vj} = 25^\circ\text{C}$  | $V_{RRM}$  |  | 1700 |  | V                 |
| DC link voltage                      |                                     | $V_{DC}$   |  | 1450 |  | V                 |
| Peak switching current               |                                     | $I_{peak}$ |  | 4000 |  | A                 |
| Insulation test voltage              | $f = 50\text{ Hz}, t = 60\text{ s}$ | $V_{ISOL}$ |  | 3.4  |  | kV <sub>RMS</sub> |
| Junction temperature                 | under switching conditions          | $T_{vjop}$ |  | 150  |  | °C                |
| Operational ambient temperature min. |                                     | $T_{amb}$  |  | -40  |  | °C                |
| Switching frequency operation values |                                     | $f_{sw2}$  |  | 10   |  | kHz               |

Notes

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Preliminary data

Operation values

|                          |   |            | min. | typ. | max. |           |
|--------------------------|---|------------|------|------|------|-----------|
| Rated continuous current | $V_{DC} = 1100\text{ V}$ , $V_{AC} = 690\text{ V}_{RMS}$ , $\cos(\varphi) = 0.85$ ,<br>$f_{AC\ sine} = 50\text{ Hz}$ , $f_{sw} = 3000\text{ Hz}$ , $T_{inlet} = 25^\circ\text{C}$ , $T_j \leq 150^\circ\text{C}$                              | $I_{AC}$   |      | 650  |      | $A_{RMS}$ |
| Power losses             | $I_{AC} = 650\text{ A}$ , $V_{DC} = 1100\text{ V}$ , $V_{AC} = 690\text{ V}_{RMS}$ ,<br>$\cos(\varphi) = 0.85$ , $f_{AC\ sine} = 50\text{ Hz}$ , $f_{sw} = 3000\text{ Hz}$ ,<br>$T_{inlet} = 25^\circ\text{C}$ , $T_j \leq 150^\circ\text{C}$ | $P_{loss}$ |      | 4000 |      | W         |

Controller interface

|  |   |                 | min. | typ.  | max. |                  |
|--|---|-----------------|------|-------|------|------------------|
| Auxiliary voltage                      |   | $V_{aux}$       | 19.2 | 24    | 28.3 | V                |
| Auxiliary power requirement            | $V_{aux} = 24\text{ V}$                         | $P_{aux}$       |      |       | 48   | W                |
| Digital input level                    |   | $V_{in\ low}$   |      |       | 2    | V                |
|  |   | $V_{in\ high}$  | 8.5  |       | 16   | V                |
| Digital output level                   | max. 1 mA                                       | $V_{out\ low}$  |      |       | 2    | V                |
|  |   | $V_{out\ high}$ | 13.5 | 15    | 16.5 | V                |
| Interlock time                         | default value                                   | $t_{interlock}$ |      | 4     |      | $\mu\text{s}$    |
| Propagation delay for PWM              | default value                                   | $t_{prop}$      |      | 4     |      | $\mu\text{s}$    |
| Analog output for phase current        | for 650 A                                       | $V_{Iac\ ana}$  |      | 1.54  |      | V                |
| Over current shut down                 | default value, response time 15 $\mu\text{s}$   | $I_{ac\ trip}$  |      | 4200  |      | A                |
| Analog DC link voltage sensor output   | load max 5 mA, @ 1100 V                         | $V_{DC\ ana}$   |      | 7.86  |      | V                |
| Over voltage shut down                 | default value, response time 500 $\mu\text{s}$  | $V_{dc\ trip}$  |      | 1340  |      | V                |
| Chip over temperature shut down        | default value, response time 1000 $\mu\text{s}$ | $T_{vj\ trip}$  |      | 150   |      | $^\circ\text{C}$ |
| Analog output for junction temperature | for 150 $^\circ\text{C}$                        | $V_{Tvj\ ana}$  |      | 10    |      | V                |
| PCB ambient over temperature shut down | default value, response time 1 s                | $T_{pcb\ err}$  |      | 85    |      | $^\circ\text{C}$ |
| Serial BUS                             | Modbus, RS485                                   |                 |      | 19200 |      | Bit/s            |

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**Preliminary data**

**System data**

|                                 |   |                     | min.               | typ. | max. |    |
|---------------------------------|---|---------------------|--------------------|------|------|----|
| EMC robustness                  | according to IEC61800 at named interfaces | power               | V <sub>Burst</sub> |      | 2    | kV |
|                                 |   | control             | V <sub>Burst</sub> |      | 2    | kV |
| Storage temperature             |   | T <sub>stor</sub>   | -40                |      | 85   | °C |
| Operational ambient temperature |   | T <sub>op amb</sub> | -40                |      | 65   | °C |
| Stray inductance                |   | L <sub>s</sub>      |                    | 8.5  |      | nH |
| Lead resistance                 |   | R <sub>CC EE</sub>  |                    | 1.2  |      | mΩ |
| Impuls test voltage             | Power to logic side, acc .IEC 61800-5-1   |                     |                    | 12   |      | kV |
| Isolation test voltage          | RMS, f = 50 Hz, t = 60 s                  | V <sub>ISOL</sub>   |                    | 3.4  |      | kV |
| Creepage distance               | Power side to heatsink across housing     |                     |                    | 13   |      | mm |
| Clearance                       | Power side to heatsink                    |                     |                    | 8    |      | mm |
| Protection degree               |   |                     | IP00               |      |      |    |
| Pollution degree                |   |                     | 2                  |      |      |    |
| Dimensions                      | width x depth x height                    |                     | 215                | 338  | 166  | mm |
| Weight                          |   |                     |                    | 11.5 |      | kg |

**Notes**

Partical discharge test, power side to logic side, according to IEC 61800-5-1, TE > 1920V

Housing CTI > 175

For further details about the system data please refer to the handbook.

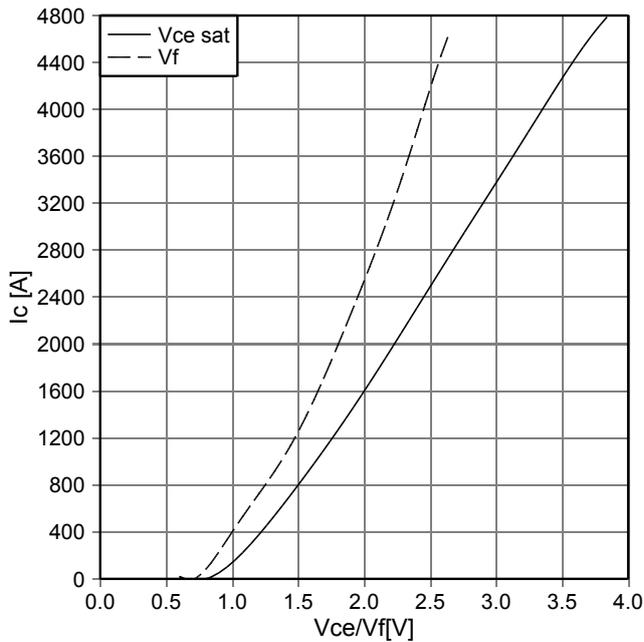
**Heatsink air cooled**

|                       |  |                    | min. | typ. | max. |      |
|-----------------------|--|--------------------|------|------|------|------|
| Air flow              | T <sub>air</sub> = 25 °C, P <sub>air</sub> = 5.5 hPa, dry and dust free, measured at the side of the heat sink | ΔV/Δt              |      | 550  |      | m³/h |
| Air inlet temperature |  | T <sub>inlet</sub> |      | 40   |      | °C   |

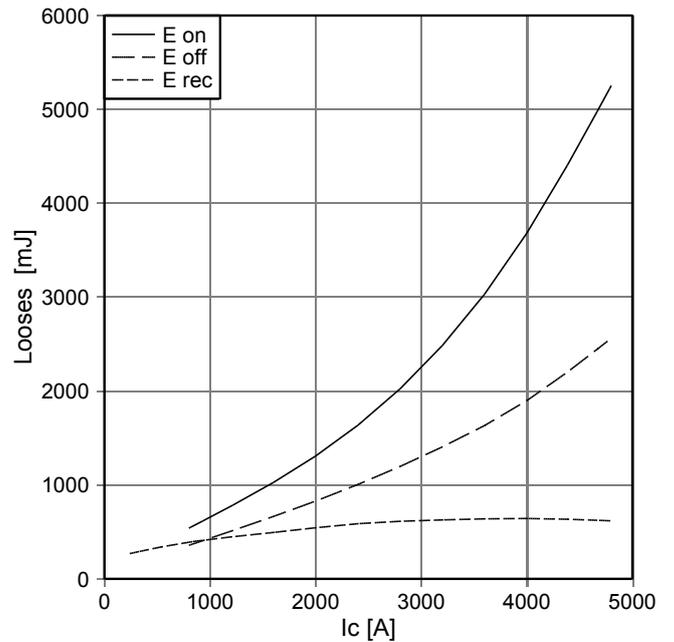
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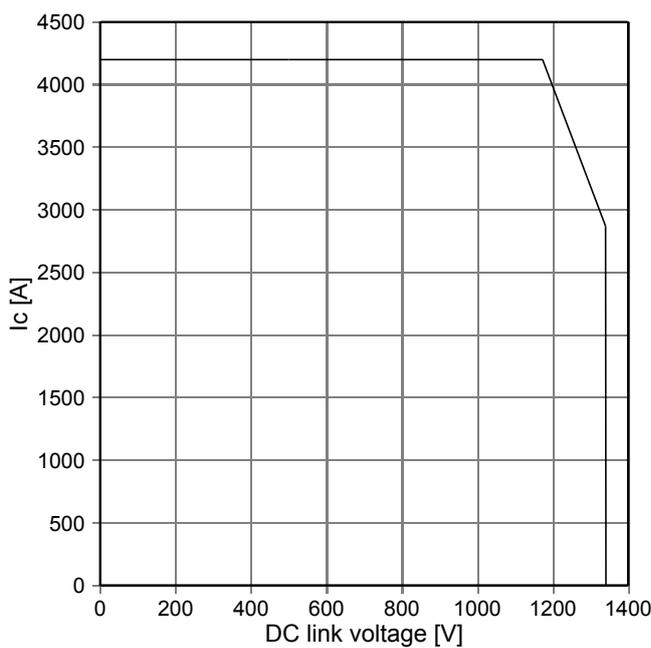
output characteristic IGBT/Diode  
 $T_{vj} = 150^{\circ}\text{C}$



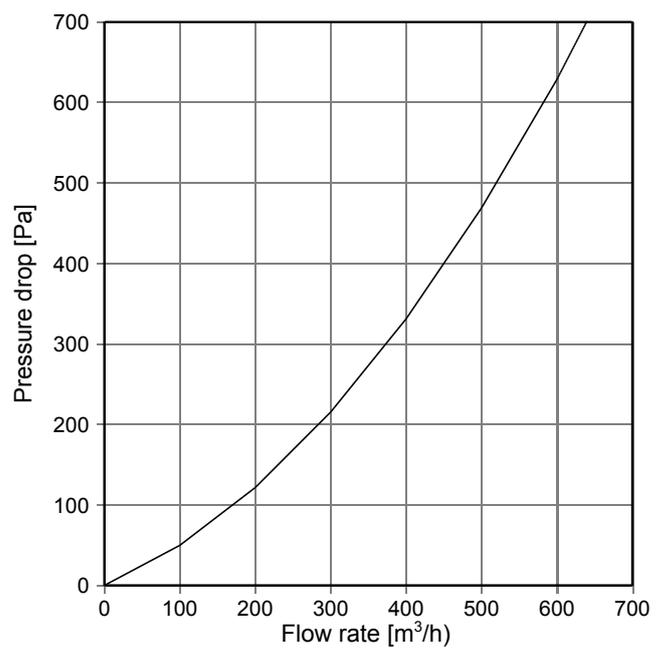
switching losses, Eon, Eoff, Erec  
 $V_{dc} 1100\text{V}, T_{vj} = 150^{\circ}\text{C}$



safe operating area



Pressure drop vs. flow rate  
 $T_{inlet} = 25^{\circ}\text{C}$

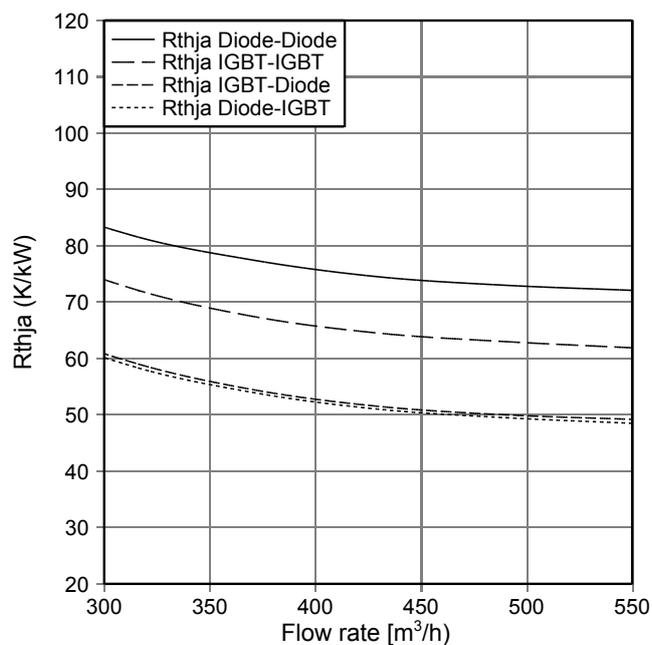


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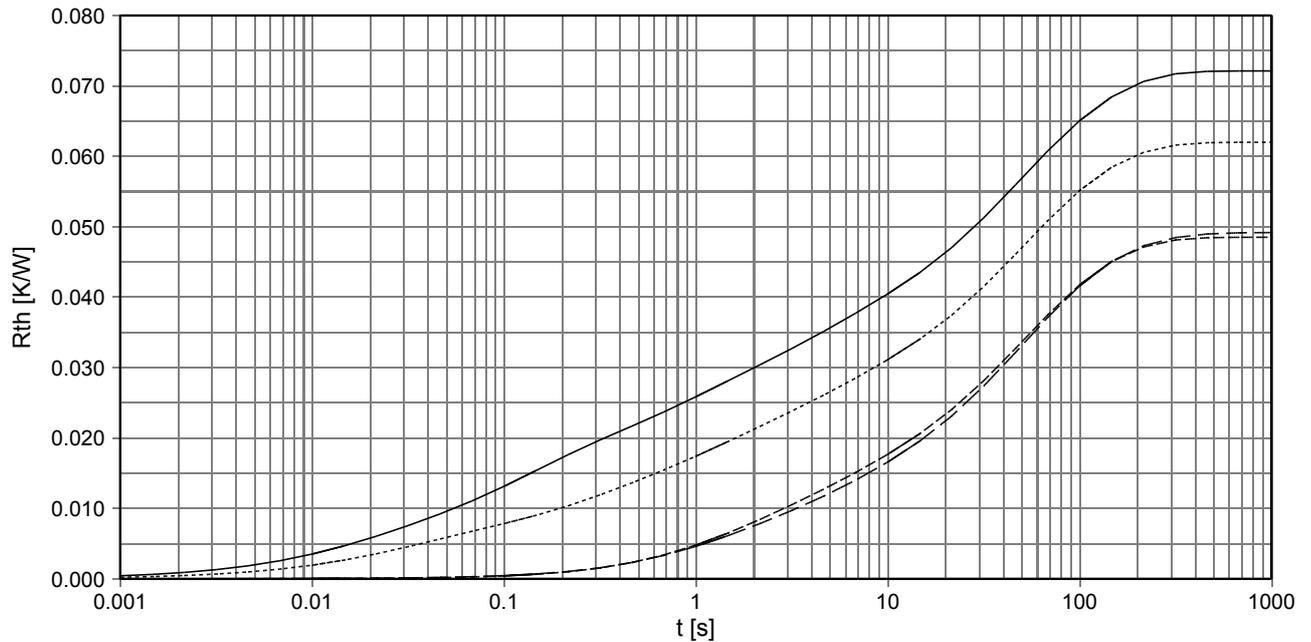
Preliminary data

Thermal resistance vs. Flow rate  
T inlet=25°C



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thermal impedance  
 Tinlet =25°C, Air flow rate= 550m3/h



—— Rthja Diode - Diode

| i:      | 1      | 2       | 3      | 4       | 5       | 6      |
|---------|--------|---------|--------|---------|---------|--------|
| r[K/W]: | 0.0045 | 0.01125 | 0.0084 | 0.00975 | 0.01473 | 0.0235 |
| τ[s]:   | 0.014  | 0.102   | 0.638  | 3.11    | 30.44   | 78     |

--- Rthja IGBT - Diode

| i:      | 1        | 2       | 3       | 4       | 5      | 6       |
|---------|----------|---------|---------|---------|--------|---------|
| r[K/W]: | -0.00052 | 0.00429 | 0.00628 | 0.00458 | 0.0263 | 0.00825 |
| τ[s]:   | 0.172    | 0.942   | 3.525   | 22.34   | 51.9   | 125     |

--- Rthja Diode-IGBT

| i:      | 1        | 2       | 3       | 4       | 5       | 6       |
|---------|----------|---------|---------|---------|---------|---------|
| r[K/W]: | -0.00059 | 0.00523 | 0.00694 | 0.00185 | 0.01666 | 0.01842 |
| τ[s]:   | 0.164    | 1.165   | 3.71    | 19.85   | 39.7    | 81.6    |

..... Rthja IGBT-IGBT

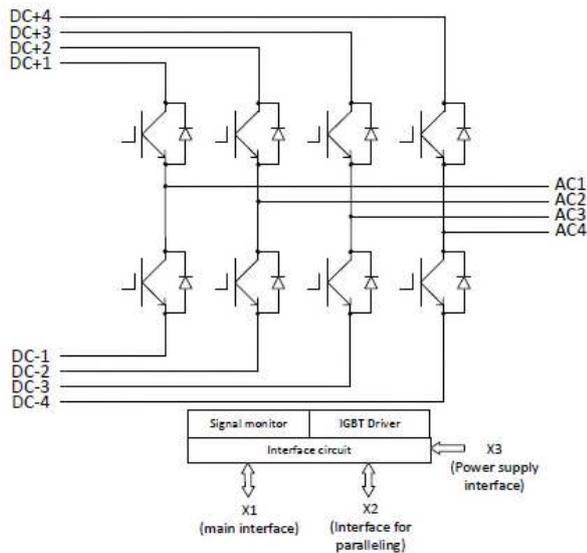
| i:      | 1     | 2      | 3      | 4      | 5      | 6      |
|---------|-------|--------|--------|--------|--------|--------|
| r[K/W]: | 0.005 | 0.0047 | 0.0072 | 0.0083 | 0.0164 | 0.0204 |
| τ[s]:   | 0.026 | 0.2    | 0.848  | 3.525  | 35.58  | 80.37  |

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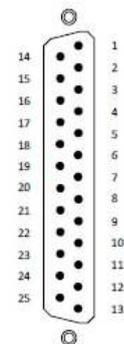
Circuit diagram



Pin configuration for X1 (main control interface)

| Pin | Signal     | I/O     | Pin | Signal            | I/O    |
|-----|------------|---------|-----|-------------------|--------|
| 1   | 24V_supply | PWR     | 14  | GND_supply        | PWR    |
| 2   | 24V_supply | PWR     | 15  | GND_supply        | PWR    |
| 3   | +15_DC     | PWR     | 16  | GND_DC            | PWR    |
| 4   | Alert      | OUT     | 17  | Enable            | IN     |
| 5   | Fault      | IN/OUT  | 18  | Warn_OV           | IN/OUT |
| 6   | ANA_Tj     | ANA OUT | 19  | ID_det            | IN/OUT |
| 7   | ANA_Vdc    | ANA OUT | 20  | GND_ana           | PWR    |
| 8   | PWM_top    | IN      | 21  | PWM_bot           | IN     |
| 9   | Warn_OC    | IN/OUT  | 22  | GND_dig           | PWR    |
| 10  | ANA_lc     | ANA OUT | 23  | Warn_OT           | IN/OUT |
| 11  | TX/RX_IN+  | IN/OUT  | 24  | TX/RX_IN-         | IN/OUT |
| 12  | TX/RX_Out+ | IN/OUT  | 25  | TX/RX_Out-        | IN/OUT |
| 13  | Shield     |         |     | Housing is shield |        |

Detail information for X1, X2 and X3 refer to handbook



Sub-D 25, male with UNC thread

|                 |                                 |
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**Safety Instructions**

Prior to installation and operation, all safety notices and warnings and all warning signs attached to the equipment have to be carefully read. Make sure that all warning signs remain in a legible condition and that missing or damaged signs are replaced. To installation and operation, all safety notices and warnings and all warning signs attached to the equipment have to be carefully read. Make sure that all warning signs remain in a legible condition and that missing or damaged signs are replaced.

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