

# SEMiX604GAR12E4s



SEMiX® 4s

## Trench IGBT Modules

### SEMiX604GAR12E4s

#### Features

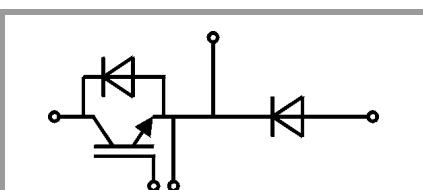
- Homogeneous Si
- Trench = Trenchgate technology
- $V_{CE(sat)}$  with positive temperature coefficient
- High short circuit capability
- UL recognized, file no. E63532

#### Typical Applications\*

- AC inverter drives
- UPS
- Electronic Welding

#### Remarks

- Case temperature limited to  $T_C=125^\circ\text{C}$  max.
- Product reliability results are valid for  $T_j=150^\circ\text{C}$
- Dynamic values apply to the following combination of resistors:  
 $R_{Gon,main} = 1,0 \Omega$   
 $R_{Goff,main} = 6,2 \Omega$   
 $R_{G,X} = 2,2 \Omega$   
 $R_{E,X} = 0,5 \Omega$



GAR

| Absolute Maximum Ratings  |  |                           |             |                  |
|---------------------------|--|---------------------------|-------------|------------------|
| Symbol                    | Conditions   |                           | Values      | Unit             |
| <b>IGBT</b>               |  |                           |             |                  |
| $V_{CES}$                 |  |                           | 1200        | V                |
| $I_C$                     | $T_j = 175^\circ\text{C}$                                    | $T_c = 25^\circ\text{C}$  | 916         | A                |
|                           |  | $T_c = 80^\circ\text{C}$  | 704         | A                |
| $I_{Cnom}$                |  |                           | 600         | A                |
| $I_{CRM}$                 | $I_{CRM} = 3 \times I_{Cnom}$                                |                           | 1800        | A                |
| $V_{GES}$                 |  |                           | -20 ... 20  | V                |
| $t_{psc}$                 | $V_{CC} = 800\text{ V}$                                      | $T_j = 150^\circ\text{C}$ | 10          | $\mu\text{s}$    |
|                           | $V_{GE} \leq 20\text{ V}$<br>$V_{CES} \leq 1200\text{ V}$    |                           |             |                  |
| $T_j$                     |  |                           | -40 ... 175 | $^\circ\text{C}$ |
| <b>Inverse diode</b>      |  |                           |             |                  |
| $I_F$                     | $T_j = 175^\circ\text{C}$                                    | $T_c = 25^\circ\text{C}$  | 707         | A                |
|                           |  | $T_c = 80^\circ\text{C}$  | 529         | A                |
| $I_{Fnom}$                |  |                           | 600         | A                |
| $I_{FRM}$                 | $I_{FRM} = 3 \times I_{Fnom}$                                |                           | 1800        | A                |
| $I_{FSM}$                 | $t_p = 10\text{ ms, sin } 180^\circ, T_j = 25^\circ\text{C}$ |                           | 3240        | A                |
| $T_j$                     |  |                           | -40 ... 175 | $^\circ\text{C}$ |
| <b>Freewheeling diode</b> |  |                           |             |                  |
| $I_F$                     | $T_j = 175^\circ\text{C}$                                    | $T_c = 25^\circ\text{C}$  | 707         | A                |
|                           |  | $T_c = 80^\circ\text{C}$  | 529         | A                |
| $I_{Fnom}$                |  |                           | 600         | A                |
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| $I_{FSM}$                 | $t_p = 10\text{ ms, sin } 180^\circ, T_j = 25^\circ\text{C}$ |                           | 3240        | A                |
| $T_j$                     |  |                           | -40 ... 175 | $^\circ\text{C}$ |
| <b>Module</b>             |  |                           |             |                  |
| $I_{t(RMS)}$              |  |                           | 600         | A                |
| $T_{stg}$                 |  |                           | -40 ... 125 | $^\circ\text{C}$ |
| $V_{isol}$                | AC sinus 50Hz, $t = 1\text{ min}$                            |                           | 4000        | V                |

| Characteristics |  |                           |      |      |      |                  |
|-----------------|--|---------------------------|------|------|------|------------------|
| Symbol          | Conditions   |                           | min. | typ. | max. | Unit             |
| <b>IGBT</b>     |  |                           |      |      |      |                  |
| $V_{CE(sat)}$   | $I_C = 600\text{ A}$<br>$V_{GE} = 15\text{ V}$<br>chipelevel | $T_j = 25^\circ\text{C}$  | 1.8  | 2.05 |      | V                |
|                 |  | $T_j = 150^\circ\text{C}$ | 2.2  | 2.4  |      | V                |
| $V_{CE0}$       |  | $T_j = 25^\circ\text{C}$  | 0.8  | 0.9  |      | V                |
|                 |  | $T_j = 150^\circ\text{C}$ | 0.7  | 0.8  |      | V                |
| $r_{CE}$        | $V_{GE} = 15\text{ V}$                                       | $T_j = 25^\circ\text{C}$  | 1.7  | 1.9  |      | $\text{m}\Omega$ |
|                 |  | $T_j = 150^\circ\text{C}$ | 2.5  | 2.7  |      | $\text{m}\Omega$ |
| $V_{GE(th)}$    | $V_{GE} = V_{CE}, I_C = 24\text{ mA}$                        |                           | 5    | 5.8  | 6.5  | V                |
| $I_{CES}$       | $V_{GE} = 0\text{ V}$<br>$V_{CE} = 1200\text{ V}$            | $T_j = 25^\circ\text{C}$  | 0.12 | 0.36 |      | $\text{mA}$      |
|                 |  | $T_j = 150^\circ\text{C}$ |      |      |      | $\text{mA}$      |
| $C_{ies}$       | $V_{CE} = 25\text{ V}$<br>$V_{GE} = 0\text{ V}$              | $f = 1\text{ MHz}$        |      | 37.2 |      | $\text{nF}$      |
| $C_{oes}$       |  | $f = 1\text{ MHz}$        |      | 2.32 |      | $\text{nF}$      |
| $C_{res}$       |  | $f = 1\text{ MHz}$        |      | 2.04 |      | $\text{nF}$      |
| $Q_G$           | $V_{GE} = -8\text{ V...} + 15\text{ V}$                      |                           |      | 3400 |      | $\text{nC}$      |
| $R_{Gint}$      | $T_j = 25^\circ\text{C}$                                     |                           |      | 1.25 |      | $\Omega$         |

# SEMiX604GAR12E4s



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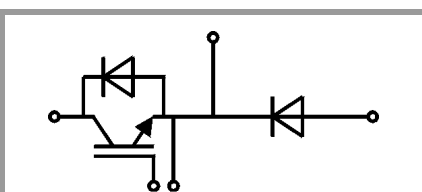
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| Characteristics    |  |                           |      |                |       |               |
|--------------------|--|---------------------------|------|----------------|-------|---------------|
| Symbol             | Conditions   |                           | min. | typ.           | max.  | Unit          |
| $t_{d(on)}$        | $V_{CC} = 600 \text{ V}$   | $T_J = 150^\circ\text{C}$ |      | 374            |       | ns            |
| $t_r$              | $I_C = 600 \text{ A}$  | $T_J = 150^\circ\text{C}$ |      | 85             |       | ns            |
| $E_{on}$           | $R_{G on} = 1.7 \Omega$  | $T_J = 150^\circ\text{C}$ |      | 35             |       | mJ            |
| $t_{d(off)}$       | $R_{G off} = 6.9 \Omega$   | $T_J = 150^\circ\text{C}$ |      | 1277           |       | ns            |
| $t_f$              | $di/dt_{on} = 7100 \text{ A}/\mu\text{s}$                        | $T_J = 150^\circ\text{C}$ |      | 114            |       | ns            |
| $E_{off}$          | $di/dt_{off} = 6350 \text{ A}/\mu\text{s}$                       | $T_J = 150^\circ\text{C}$ |      | 110.4          |       | mJ            |
| $R_{th(j-c)}$      | per IGBT   |                           |      |                | 0.049 | K/W           |
| Inverse diode      |  |                           |      |                |       |               |
| $V_F = V_{EC}$     | $I_F = 600 \text{ A}$  | $T_J = 25^\circ\text{C}$  |      | 2.1            | 2.46  | V             |
|                    | $V_{GE} = 0 \text{ V}$<br>chip                                   | $T_J = 150^\circ\text{C}$ |      | 2.1            | 2.4   | V             |
| $V_{F0}$           |  | $T_J = 25^\circ\text{C}$  | 1.1  | 1.3            | 1.5   | V             |
|                    |  | $T_J = 150^\circ\text{C}$ | 0.7  | 0.9            | 1.1   | V             |
| $r_F$              |  | $T_J = 25^\circ\text{C}$  | 1.1  | 1.4            | 1.6   | m $\Omega$    |
|                    |  | $T_J = 150^\circ\text{C}$ | 1.7  | 1.9            | 2.1   | m $\Omega$    |
| $I_{RRM}$          | $I_F = 600 \text{ A}$  | $T_J = 150^\circ\text{C}$ |      | 430            |       | A             |
| $Q_{rr}$           | $di/dt_{off} = 6000 \text{ A}/\mu\text{s}$                       | $T_J = 150^\circ\text{C}$ |      | 100            |       | $\mu\text{C}$ |
| $E_{rr}$           | $V_{GE} = -15 \text{ V}$   | $T_J = 150^\circ\text{C}$ |      | 44             |       | mJ            |
| $E_{rr}$           | $V_{CC} = 600 \text{ V}$   | $T_J = 150^\circ\text{C}$ |      | 44             |       | mJ            |
| $R_{th(j-c)}$      | per diode  |                           |      |                | 0.086 | K/W           |
| Freewheeling diode |  |                           |      |                |       |               |
| $V_F = V_{EC}$     | $I_F = 600 \text{ A}$  | $T_J = 25^\circ\text{C}$  |      | 2.1            | 2.46  | V             |
|                    | $V_{GE} = 0 \text{ V}$<br>chip                                   | $T_J = 150^\circ\text{C}$ |      | 2.1            | 2.4   | V             |
| $V_{F0}$           |  | $T_J = 25^\circ\text{C}$  | 1.1  | 1.3            | 1.5   | V             |
|                    |  | $T_J = 150^\circ\text{C}$ | 0.7  | 0.9            | 1.1   | V             |
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| $I_{RRM}$          | $I_F = 600 \text{ A}$  | $T_J = 150^\circ\text{C}$ |      | 430            |       | A             |
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| $E_{rr}$           | $V_{CC} = 600 \text{ V}$   | $T_J = 150^\circ\text{C}$ |      | 44             |       | mJ            |
| $R_{th(j-c)}$      | per diode  |                           |      |                | 0.086 | K/W           |
| Module             |  |                           |      |                |       |               |
| $L_{CE}$           |  |                           |      | 22             |       | nH            |
| $R_{CC+EE}$        | res., terminal-chip  | $T_C = 25^\circ\text{C}$  |      | 0.7            |       | m $\Omega$    |
|                    |  | $T_C = 125^\circ\text{C}$ |      | 1              |       | m $\Omega$    |
| $R_{th(c-s)}$      | per module   |                           |      | 0.03           |       | K/W           |
| $M_s$              | to heat sink (M5)  |                           | 3    |                | 5     | Nm            |
| $M_t$              |  | to terminals (M6)         | 2.5  |                | 5     | Nm            |
|                    |  |                           |      |                |       | Nm            |
| $w$                |  |                           |      |                | 400   | g             |
| Temperatur Sensor  |  |                           |      |                |       |               |
| $R_{100}$          | $T_C=100^\circ\text{C}$ ( $R_{25}=5 \text{ k}\Omega$ )           |                           |      | $493 \pm 5\%$  |       | $\Omega$      |
| $B_{100/125}$      | $R(T)=R_{100}\exp[B_{100/125}(1/T-1/T_{100})]$ ; $T[\text{K}]$ ; |                           |      | $3550 \pm 2\%$ |       | K             |

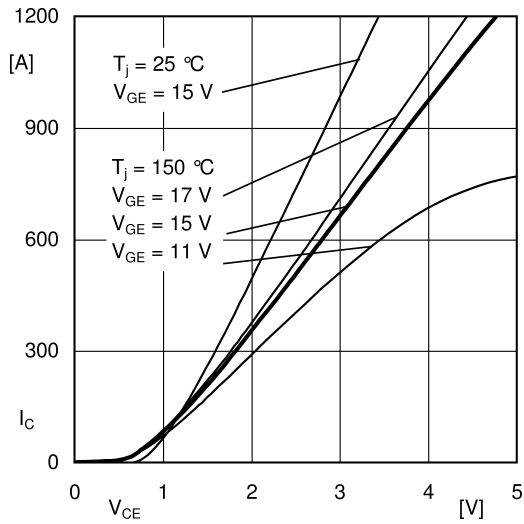


Fig. 1: Typ. output characteristic, inclusive  $R_{CC+EE}$

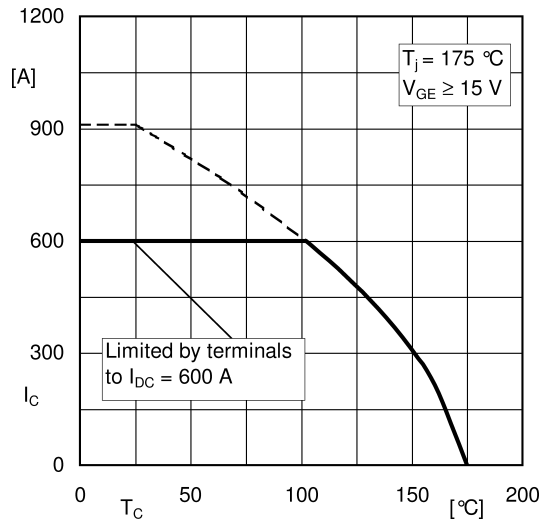


Fig. 2: Rated current vs. temperature  $I_C = f(T_C)$

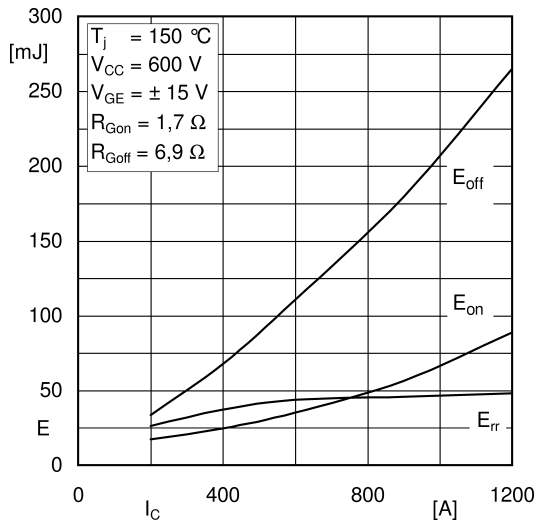


Fig. 3: Typ. turn-on /-off energy =  $f(I_C)$

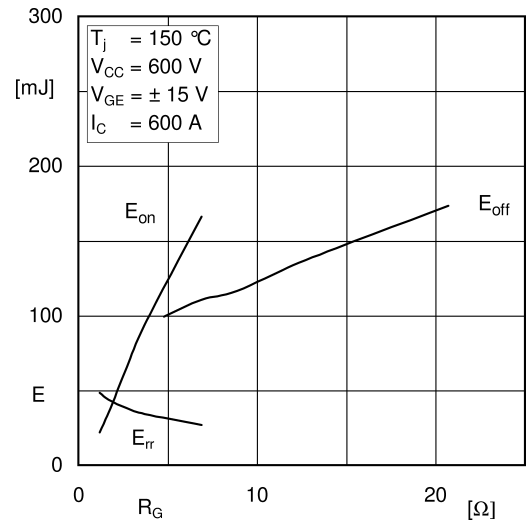


Fig. 4: Typ. turn-on /-off energy =  $f(R_G)$

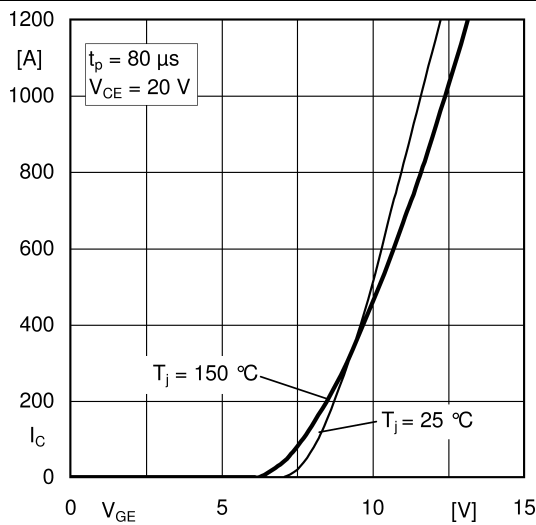


Fig. 5: Typ. transfer characteristic

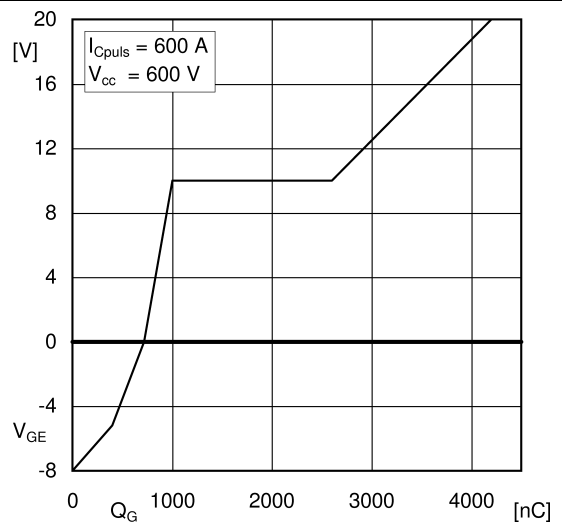


Fig. 6: Typ. gate charge characteristic

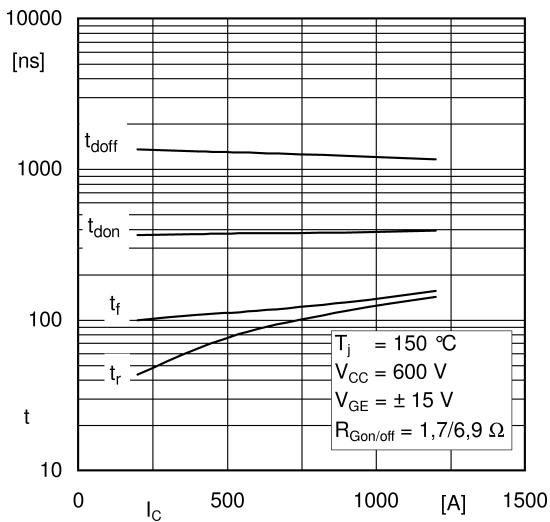


Fig. 7: Typ. switching times vs.  $I_C$

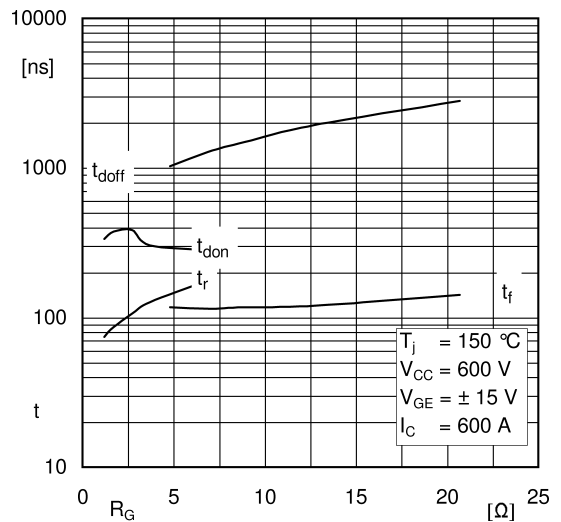


Fig. 8: Typ. switching times vs. gate resistor  $R_G$

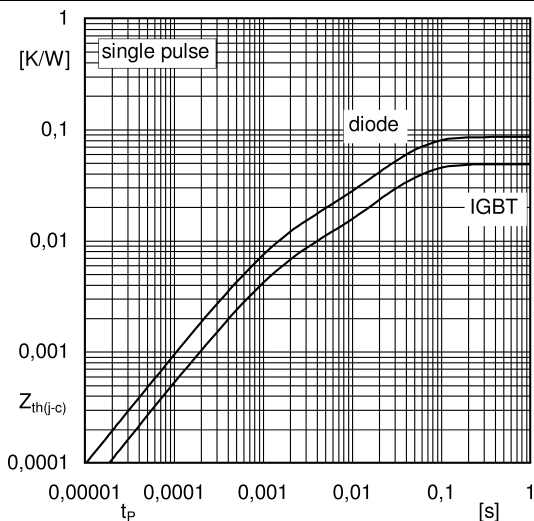


Fig. 9: Typ. transient thermal impedance

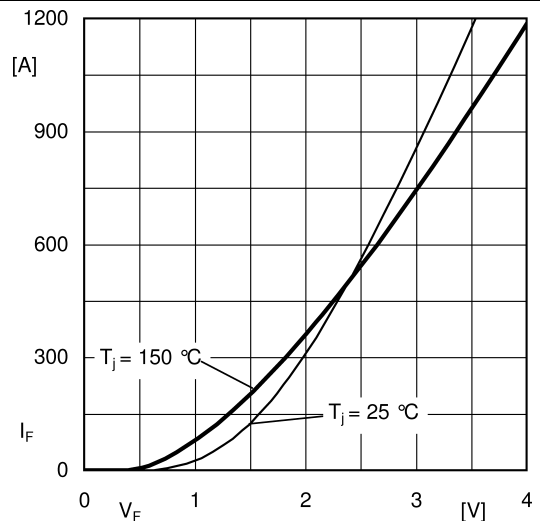


Fig. 10: Typ. CAL diode forward charact., incl.  $R_{CC+EE}$

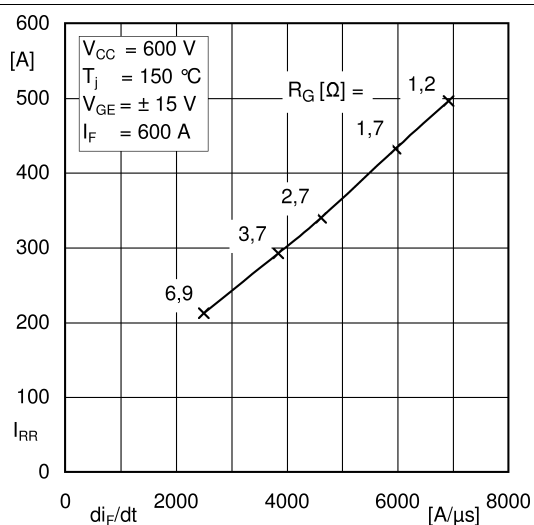


Fig. 11: Typ. CAL diode peak reverse recovery current

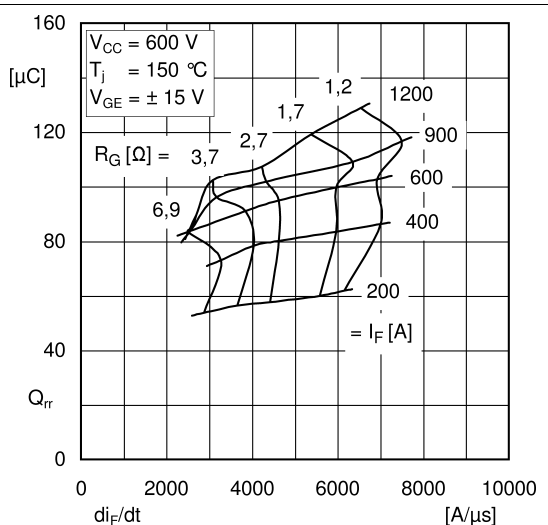
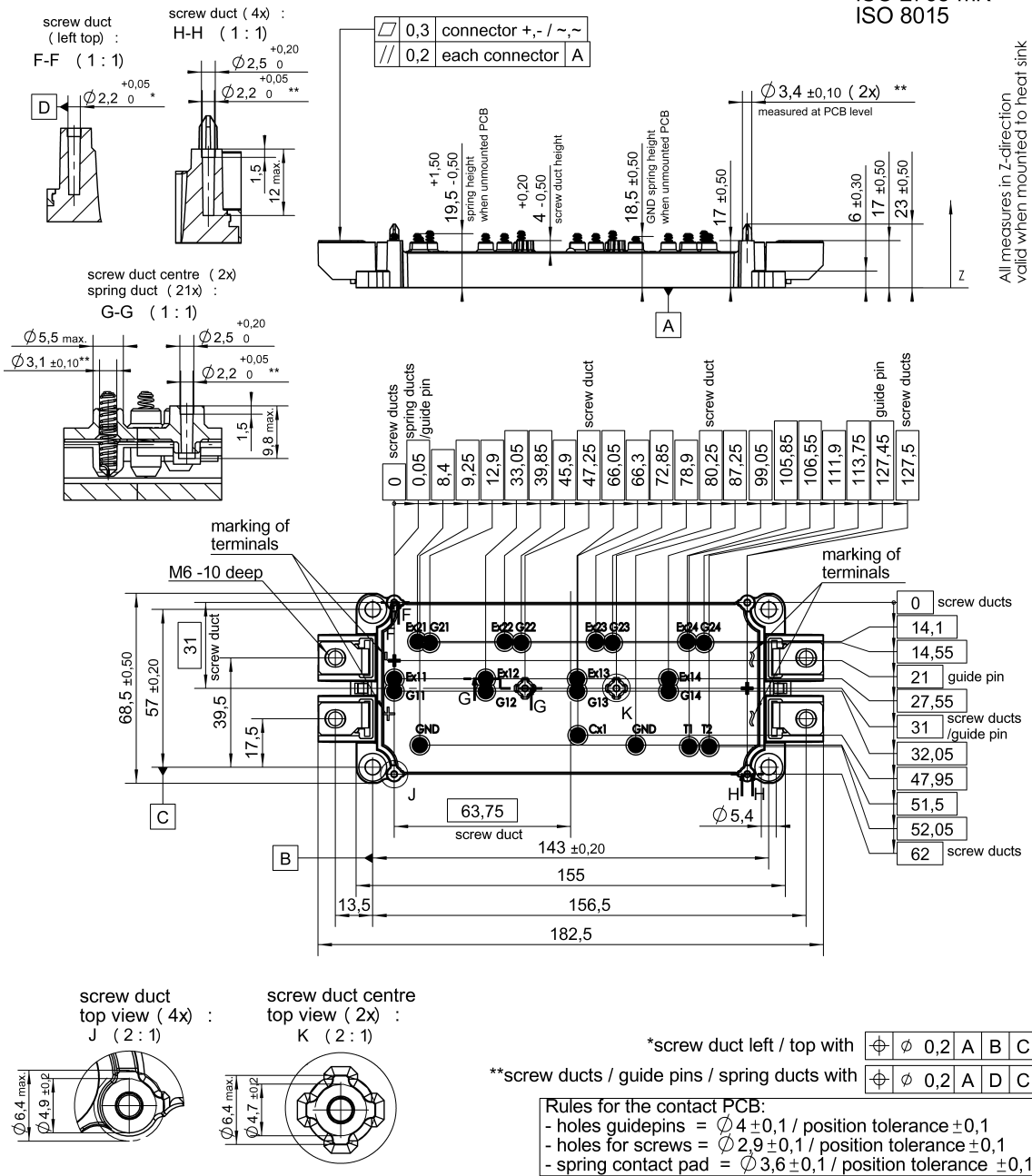


Fig. 12: Typ. CAL diode recovery charge

# SEMiX604GAR12E4s

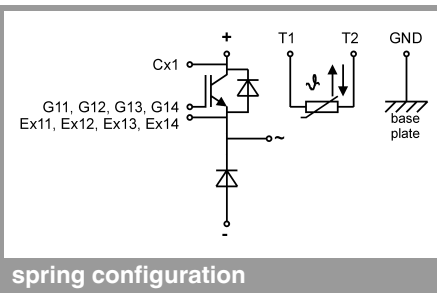
Case: SEMiX 4s

general tolerance:  
ISO 2768-mK  
ISO 8015



All measures in Z-direction valid when mounted to heat sink

## SEMiX 4s



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 personal.