

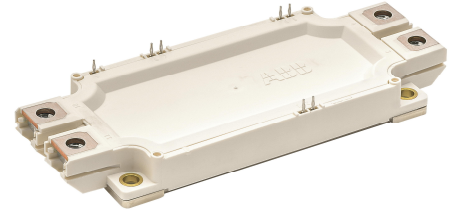
# 5SNG 0450R170390

## LoPak1 phase leg IGBT Module

$$V_{CE} = 1700 \text{ V}$$

$$I_C = 2 \times 450 \text{ A}$$

Press-fit pins for reliable auxiliary contacts  
 Ultra low-loss, rugged SPT++ chip-set  
 NTC thermistor for temperature sensing  
 Cu base-plate for low thermal resistance  
 Pre-Applied Thermal Interface Material (TIM) to improve thermal conductivity between module and heat sink  
 Industry standard package



### Maximum rated values <sup>1)</sup>

| Parameter                      | Symbol       | Conditions  | min | max                     | Unit             |
|--------------------------------|--------------|---|-----|-------------------------|------------------|
| Collector-emitter voltage      | $V_{CES}$    | $V_{GE} = 0 \text{ V}$ , $T_{vj} \geq 25 \text{ }^\circ\text{C}$  |     | 1700                    | V                |
| DC collector current           | $I_C$        | $T_C = 115 \text{ }^\circ\text{C}$ , $T_{vj} = 175 \text{ }^\circ\text{C}$  |     | 450                     | A                |
| Peak collector current         | $I_{CM}$     | $t_p = 1 \text{ ms}$  |     | 900                     | A                |
| Gate-emitter voltage           | $V_{GES}$    |   | -20 | 20                      | V                |
| DC forward current             | $I_F$        |   |     | 450                     | A                |
| Peak forward current           | $I_{FRM}$    | $t_p = 1 \text{ ms}$  |     | 900                     | A                |
| Surge current                  | $I_{FSM}$    | $V_R = 0 \text{ V}$ , $T_{vj} = 175 \text{ }^\circ\text{C}$ ,<br>$t_p = 10 \text{ ms}$ , half-sinewave  |     | 2250                    | A                |
| IGBT short circuit SOA         | $t_{psc}$    | $V_{CC} = 1300 \text{ V}$ , $V_{CEM \text{ CHIP}} \leq 1700 \text{ V}$<br>$V_{GE} \leq 15 \text{ V}$ , $T_{vj} \leq 150 \text{ }^\circ\text{C}$ |     | 10                      | $\mu\text{s}$    |
| Isolation voltage              | $V_{ISOL}$   | 1 min, $f = 50 \text{ Hz}$  |     | 4000                    | V                |
| Junction temperature           | $T_{vj}$     |   | -40 | 175                     | $^\circ\text{C}$ |
| Junction operating temperature | $T_{vj(op)}$ |   | -40 | 175                     | $^\circ\text{C}$ |
| Case temperature               | $T_C$        |   | -40 | 125 <sup>2)</sup> / 150 | $^\circ\text{C}$ |
| Storage temperature            | $T_{stg}$    |   | -40 | 125                     | $^\circ\text{C}$ |
| Mounting torques <sup>3)</sup> | $M_s$        | Base-heatsink, M5 screws  | 3   | 6                       | Nm               |
|                                | $M_{t1}$     | Main terminals, M6 screws   | 3   | 6                       |                  |

<sup>1)</sup> Maximum rated values indicate limits beyond which damage to the device may occur per IEC 60747

<sup>2)</sup> For UL1557 compliance  $T_{Cmax}$  must be limited to 125 $^\circ\text{C}$

<sup>3)</sup> For detailed mounting instructions refer to ABB Document No. 5SYA 2113

**IGBT characteristic values <sup>4)</sup>**

| Parameter  | Symbol              | Conditions   | min                      | typ  | max  | Unit          |
|--|---------------------|--|--------------------------|------|------|---------------|
| Collector (-emitter) breakdown voltage             | $V_{(BR)CES}$       | $V_{GE} = 0\text{ V}$ , $I_C = 10\text{ mA}$ , $T_{vj} = 25\text{ °C}$   | 1700                     |      |      | V             |
| Collector-emitter <sup>5)</sup> saturation voltage | $V_{CE\text{ sat}}$ | $I_C = 450\text{ A}$ , $V_{GE} = 15\text{ V}$  | $T_{vj} = 25\text{ °C}$  | 2.25 | 2.6  | V             |
|  |                     |  | $T_{vj} = 125\text{ °C}$ |      | 2.55 | V             |
|  |                     |  | $T_{vj} = 175\text{ °C}$ |      | 2.75 | V             |
| Collector cut-off current                          | $I_{CES}$           | $V_{CE} = 1700\text{ V}$ , $V_{GE} = 0\text{ V}$   | $T_{vj} = 25\text{ °C}$  |      | 0.1  | mA            |
|  |                     |  | $T_{vj} = 125\text{ °C}$ |      | 1.2  | mA            |
|  |                     |  | $T_{vj} = 175\text{ °C}$ |      | 20   | mA            |
| Gate leakage current                               | $I_{GES}$           | $V_{CE} = 0\text{ V}$ , $V_{GE} = \pm 20\text{ V}$ , $T_{vj} = 175\text{ °C}$  | -500                     |      | 500  | nA            |
| Gate-emitter threshold voltage                     | $V_{GE(th)}$        | $I_C = 12\text{ mA}$ , $V_{CE} = V_{GE}$ , $T_{vj} = 25\text{ °C}$   | 4.5                      |      | 6.5  | V             |
| Gate charge  | $Q_G$               | $I_C = 450\text{ A}$ , $V_{CE} = 900\text{ V}$ , $V_{GE} = -15\text{ V} \dots 15\text{ V}$   |                          | 3.2  |      | $\mu\text{C}$ |
| Input capacitance                                  | $C_{ies}$           | $V_{CE} = 25\text{ V}$ , $V_{GE} = 0\text{ V}$ , $f = 1\text{ MHz}$ , $T_{vj} = 25\text{ °C}$  |                          | 28.8 |      | nF            |
| Internal gate resistance                           | $R_{Gint}$          | per switch   |                          | 1    |      | $\Omega$      |
| Turn-on delay time                                 | $t_{d(on)}$         | $V_{CC} = 900\text{ V}$ , $I_C = 450\text{ A}$ ,<br>$R_G = 0.47\ \Omega$ ,<br>$V_{GE} = \pm 15\text{ V}$ ,<br>$L_\sigma = 40\text{ nH}$ , inductive load | $T_{vj} = 25\text{ °C}$  | 245  |      | ns            |
|  |                     |  | $T_{vj} = 125\text{ °C}$ | 260  |      | ns            |
|  |                     |  | $T_{vj} = 175\text{ °C}$ | 270  |      | ns            |
| Rise time  | $t_r$               | $V_{CC} = 900\text{ V}$ , $I_C = 450\text{ A}$ ,<br>$R_G = 0.47\ \Omega$ ,<br>$V_{GE} = \pm 15\text{ V}$ ,<br>$L_\sigma = 40\text{ nH}$ , inductive load | $T_{vj} = 25\text{ °C}$  | 70   |      | ns            |
|  |                     |  | $T_{vj} = 125\text{ °C}$ | 90   |      | ns            |
|  |                     |  | $T_{vj} = 175\text{ °C}$ | 95   |      | ns            |
| Turn-off delay time                                | $t_{d(off)}$        | $V_{CC} = 900\text{ V}$ , $I_C = 450\text{ A}$ ,<br>$R_G = 0.47\ \Omega$ ,<br>$V_{GE} = \pm 15\text{ V}$ ,<br>$L_\sigma = 40\text{ nH}$ , inductive load | $T_{vj} = 25\text{ °C}$  | 440  |      | ns            |
|  |                     |  | $T_{vj} = 125\text{ °C}$ | 540  |      | ns            |
|  |                     |  | $T_{vj} = 175\text{ °C}$ | 600  |      | ns            |
| Fall time  | $t_f$               | $V_{CC} = 900\text{ V}$ , $I_C = 450\text{ A}$ ,<br>$R_G = 0.47\ \Omega$ ,<br>$V_{GE} = \pm 15\text{ V}$ ,<br>$L_\sigma = 40\text{ nH}$ , inductive load | $T_{vj} = 25\text{ °C}$  | 110  |      | ns            |
|  |                     |  | $T_{vj} = 125\text{ °C}$ | 160  |      | ns            |
|  |                     |  | $T_{vj} = 175\text{ °C}$ | 165  |      | ns            |
| Turn-on switching energy                           | $E_{on}$            | $V_{CC} = 900\text{ V}$ , $I_C = 450\text{ A}$ ,<br>$R_G = 0.47\ \Omega$ ,<br>$V_{GE} = \pm 15\text{ V}$ ,<br>$L_\sigma = 40\text{ nH}$ , inductive load | $T_{vj} = 25\text{ °C}$  | 95   |      | mJ            |
|  |                     |  | $T_{vj} = 125\text{ °C}$ | 145  |      | mJ            |
|  |                     |  | $T_{vj} = 175\text{ °C}$ | 185  |      | mJ            |
| Turn-off switching energy                          | $E_{off}$           | $V_{CC} = 900\text{ V}$ , $I_C = 450\text{ A}$ ,<br>$R_G = 0.47\ \Omega$ ,<br>$V_{GE} = \pm 15\text{ V}$ ,<br>$L_\sigma = 40\text{ nH}$ , inductive load | $T_{vj} = 25\text{ °C}$  | 90   |      | mJ            |
|  |                     |  | $T_{vj} = 125\text{ °C}$ | 135  |      | mJ            |
|  |                     |  | $T_{vj} = 175\text{ °C}$ | 165  |      | mJ            |
| Short circuit current                              | $I_{SC}$            | $t_{psc} \leq 10\ \mu\text{s}$ , $V_{GE} = 15\text{ V}$ ,<br>$V_{CC} = 1300\text{ V}$ ,<br>$V_{CEM\text{ CHIP}} \leq 1700\text{ V}$                      | $T_{vj} = 150\text{ °C}$ | 1500 |      | A             |

<sup>4)</sup> Characteristic values according to IEC 60747 - 9

<sup>5)</sup> Collector-emitter saturation voltage is given at chip level

## Diode characteristic values <sup>6)</sup>

| Parameter                     | Symbol           | Conditions   | min                      | typ | max  | Unit |
|-------------------------------|------------------|--|--------------------------|-----|------|------|
| Forward voltage <sup>7)</sup> | V <sub>F</sub>   | I <sub>F</sub> = 450 A   | T <sub>vj</sub> = 25 °C  | 1.6 | 2.2  | V    |
|                               |                  |  | T <sub>vj</sub> = 125 °C |     | 1.75 | V    |
|                               |                  |  | T <sub>vj</sub> = 175 °C |     | 1.7  | V    |
| Peak reverse recovery current | I <sub>RM</sub>  |  | T <sub>vj</sub> = 25 °C  | 480 |      | A    |
|                               |                  |  | T <sub>vj</sub> = 125 °C |     | 490  | A    |
|                               |                  |  | T <sub>vj</sub> = 175 °C |     | 530  | A    |
| Recovered charge              | Q <sub>r</sub>   | V <sub>CC</sub> = 900 V,<br>I <sub>F</sub> = 450 A,<br>V <sub>GE</sub> = ±15 V,<br>R <sub>G</sub> = 0.47 Ω,<br>di/dt = 5.3 kA/μs<br>L <sub>σ</sub> = 40 nH, inductive load | T <sub>vj</sub> = 25 °C  | 120 |      | μC   |
|                               |                  |  | T <sub>vj</sub> = 125 °C |     | 190  | μC   |
|                               |                  |  | T <sub>vj</sub> = 175 °C |     | 260  | μC   |
| Reverse recovery time         | t <sub>rr</sub>  |  | T <sub>vj</sub> = 25 °C  | 490 |      | ns   |
|                               |                  |  | T <sub>vj</sub> = 125 °C |     | 790  | ns   |
|                               |                  |  | T <sub>vj</sub> = 175 °C |     | 930  | ns   |
| Reverse recovery energy       | E <sub>rec</sub> |  | T <sub>vj</sub> = 25 °C  | 75  |      | mJ   |
|                               |                  |  | T <sub>vj</sub> = 125 °C |     | 115  | mJ   |
|                               |                  |  | T <sub>vj</sub> = 175 °C |     | 155  | mJ   |

<sup>6)</sup> Characteristic values according to IEC 60747 - 2

<sup>7)</sup> Forward voltage is given at chip level

## NTC Thermistor

| Parameter        | Symbol              | Conditions   | min | typ  | max | Unit |
|------------------|---------------------|--|-----|------|-----|------|
| Rated resistance | R <sub>25</sub>     | T <sub>C</sub> = 25 °C   |     | 5    |     | kΩ   |
| R100             | R <sub>100</sub>    | T <sub>C</sub> = 100 °C  | 468 |      | 517 | Ω    |
| B-value          | B <sub>25/50</sub>  | R <sub>25</sub> = R <sub>25</sub> exp [B <sub>25/50</sub> (1/T <sub>2</sub> - 1/(298.15K))]  |     | 3375 |     | K    |
| B-value          | B <sub>25/100</sub> | R <sub>25</sub> = R <sub>25</sub> exp [B <sub>25/100</sub> (1/T <sub>2</sub> - 1/(298.15K))] |     | 3433 |     | K    |

## Package properties <sup>8)</sup>

| Parameter   | Symbol                    | Conditions                              | min                     | typ   | max   | Unit |
|---|---------------------------|---|-------------------------|-------|-------|------|
| IGBT thermal resistance junction to case                | R <sub>th(j-c)IGBT</sub>  | per switch                              |                         |       | 0.048 | K/W  |
| Diode thermal resistance junction to case               | R <sub>th(j-c)DIODE</sub> |   |                         |       | 0.087 | K/W  |
| IGBT thermal resistance <sup>3)</sup> case to heatsink  | R <sub>th(c-s)IGBT</sub>  | IGBT per switch, λ grease = 5.2W/m x K  |                         | 0.025 |       | K/W  |
| Diode thermal resistance <sup>3)</sup> case to heatsink | R <sub>th(c-s)DIODE</sub> | Diode per switch, λ grease = 5.2W/m x K |                         | 0.041 |       | K/W  |
| Comparative tracking index                              | CTI                       |   | 200                     |       |       |      |
| Module stray inductance                                 | L <sub>σ CE</sub>         | per switch                              |                         | 25    |       | nH   |
| Resistance, terminal-chip                               | R <sub>CC'+EE'</sub>      | per switch                              | T <sub>C</sub> = 25 °C  | 0.95  |       | mΩ   |
|   |                           |   | T <sub>C</sub> = 125 °C | 1.35  |       |      |
|   |                           |   | T <sub>C</sub> = 175 °C | 1.55  |       |      |

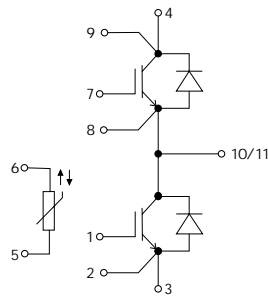
<sup>3)</sup> For detailed mounting instructions refer to ABB Document No. 5SYA 2113

## Mechanical properties <sup>8)</sup>

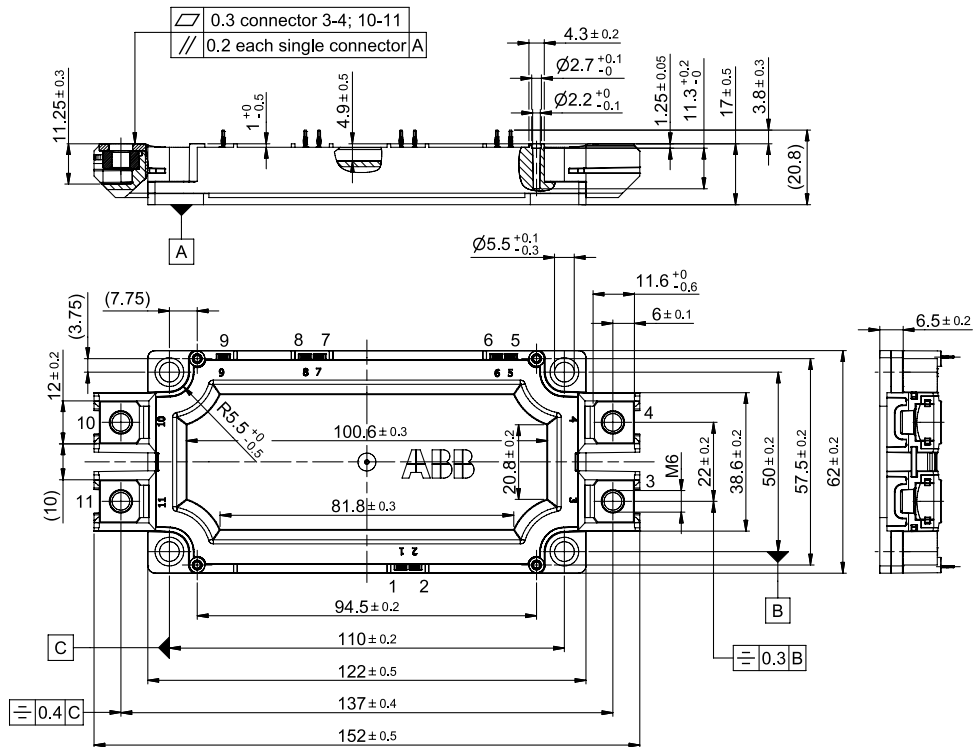
| Parameter                 | Symbol         | Conditions                              | min            | typ           | max | Unit |
|---------------------------|----------------|---|----------------|---------------|-----|------|
| Dimensions                | L x W x H      | Typical                                 |                | 152 x 62 x 17 |     | mm   |
| Clearance distance in air | d <sub>a</sub> | according to IEC 60664-1 and EN 50124-1 | Term. to base: | 12.5          |     | mm   |
|                           |                |   | Term. to term: | 10            |     |      |
| Surface creepage distance | d <sub>s</sub> | according to IEC 60664-1 and EN 50124-1 | Term. to base: | 14.5          |     | mm   |
|                           |                |   | Term. to term: | 13            |     |      |
| Mass                      | m              |   |                | 350           |     | g    |

<sup>8)</sup> Package and mechanical properties according to IEC 60747 - 15

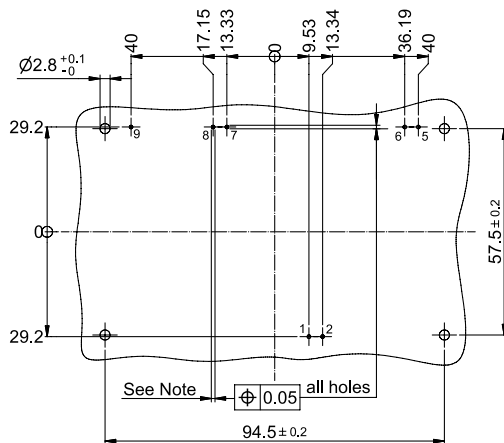
## Electrical configuration



## Outline drawing <sup>3)</sup>



### PCB drill hole pattern for press-fit



#### Note:

- Ø1<sup>+0.09</sup><sub>-0.06</sub> Diameter of finished plated through-hole
- Ø1.15 Diameter of drilled hole

Note: all dimensions are shown in millimeters

<sup>3)</sup> For detailed mounting instructions refer to ABB Document No. 5SYA 2113

This is an electrostatic sensitive device, please observe the international standard IEC 60747-1, chap. VIII. This product has been designed and qualified for Industrial Level.

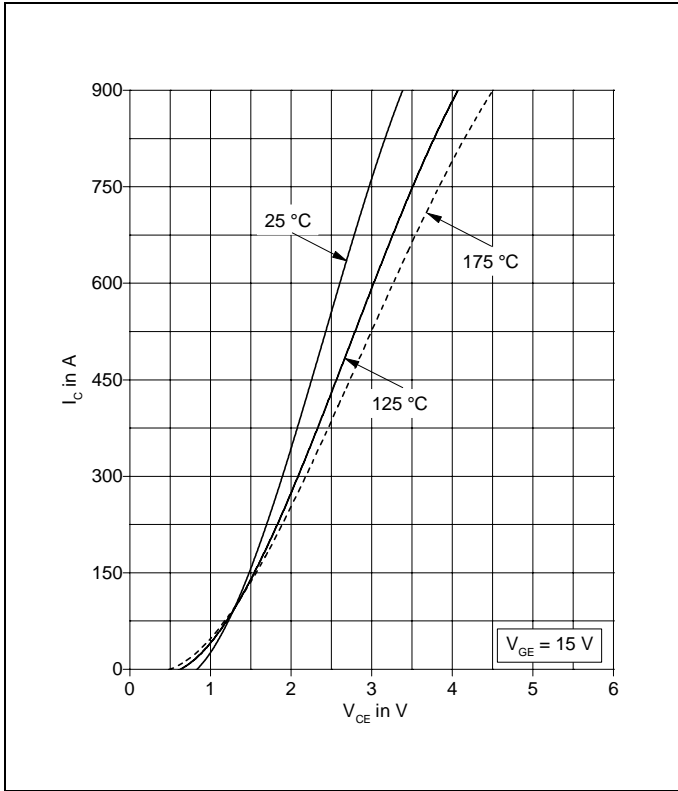


Fig. 1 Typical on-state characteristics, chip level

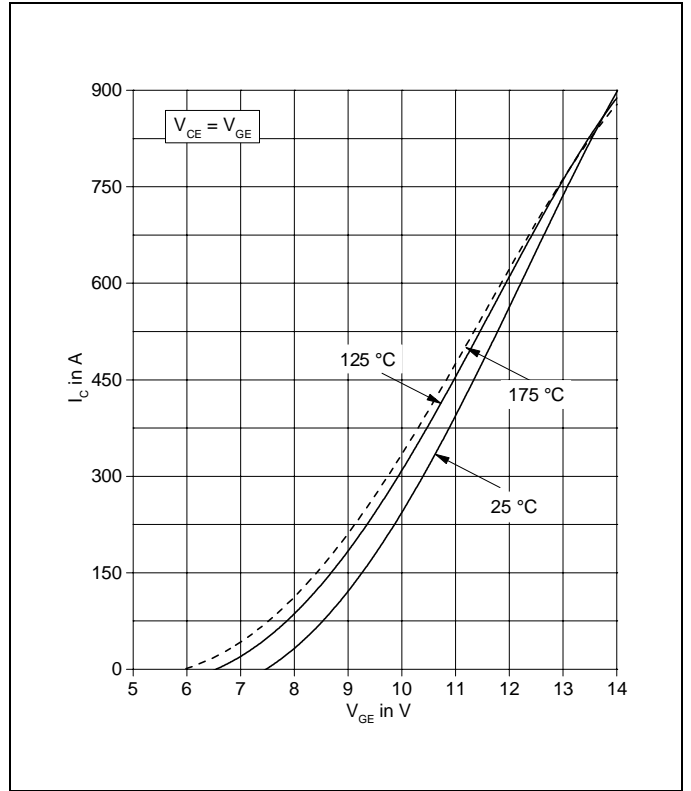


Fig. 2 Typical transfer characteristics, chip level

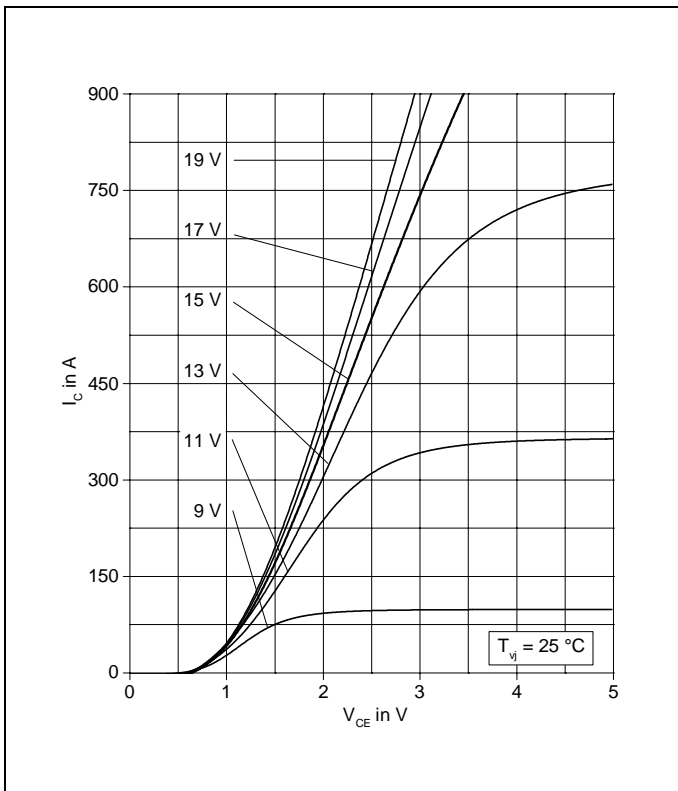


Fig. 3 Typical output characteristics, chip level

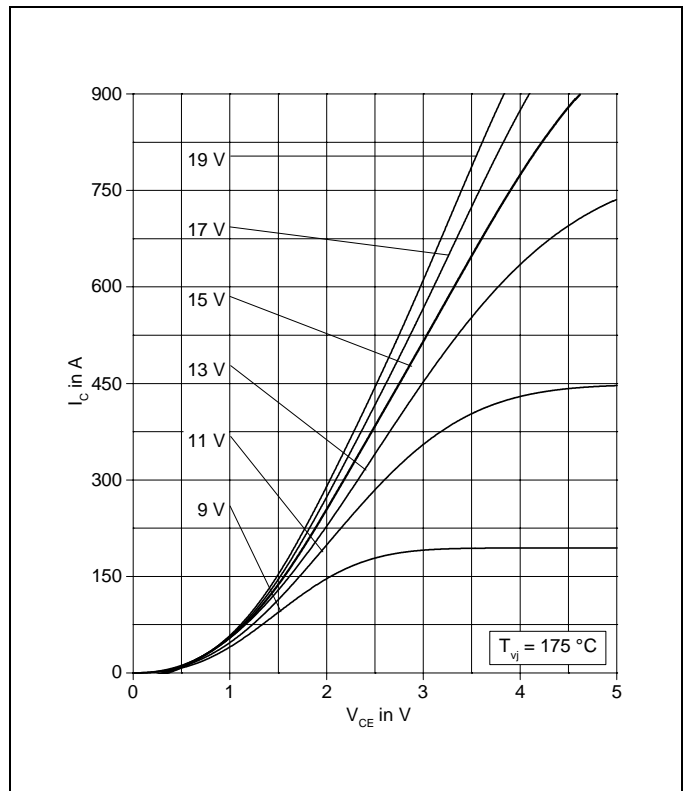


Fig. 4 Typical output characteristics, chip level

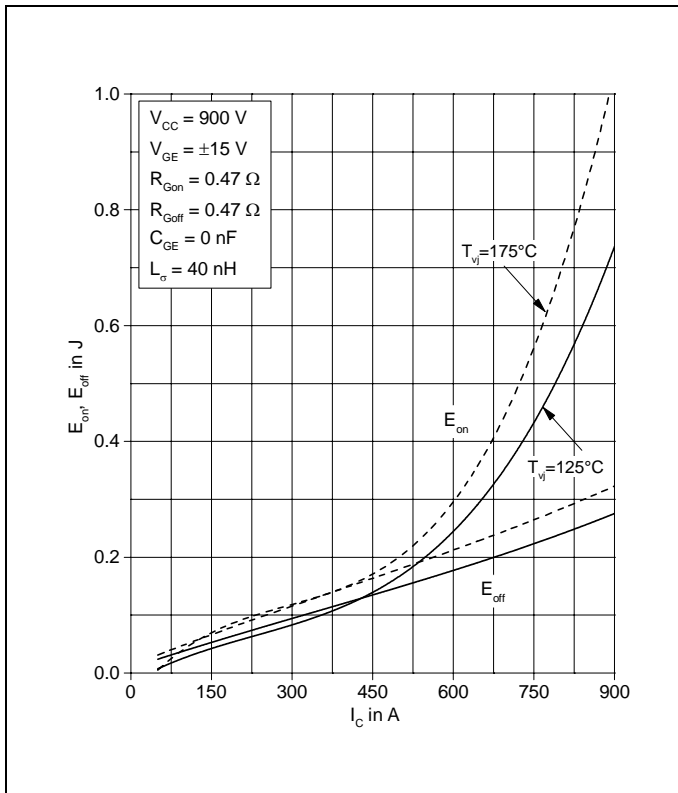


Fig. 5 Typical switching energies per pulse vs. collector current

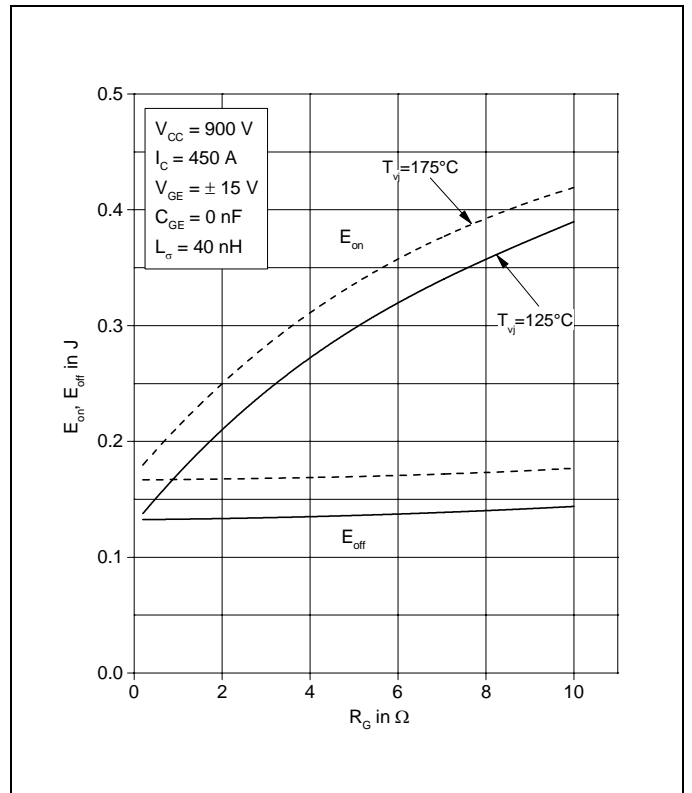


Fig. 6 Typical switching energies per pulse vs. gate resistor

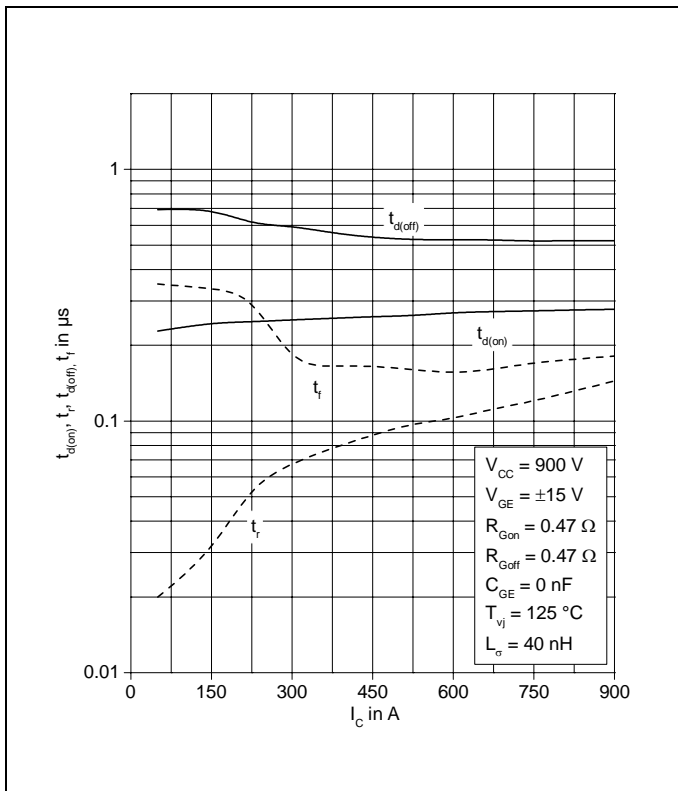


Fig. 7 Typical switching times vs. collector current

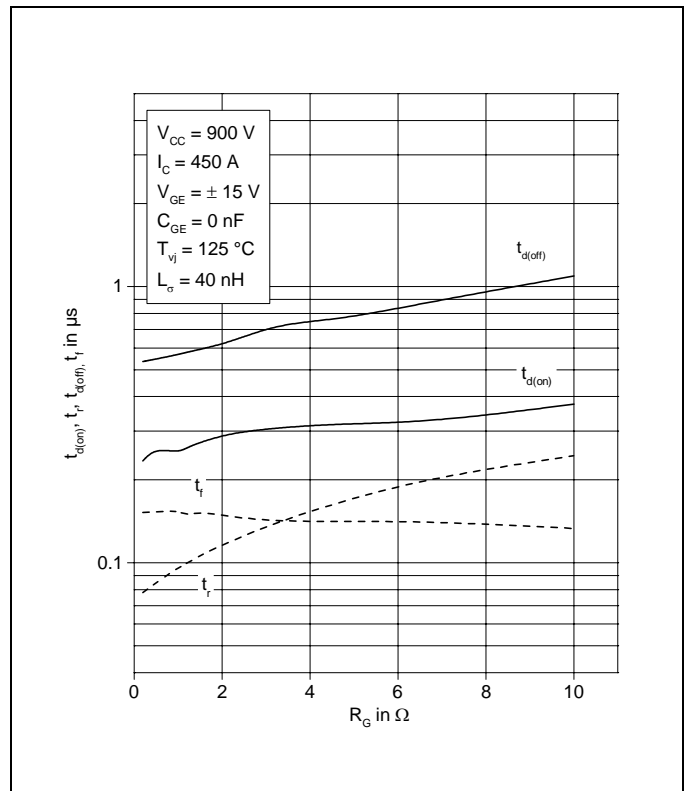


Fig. 8 Typical switching times vs. gate resistor

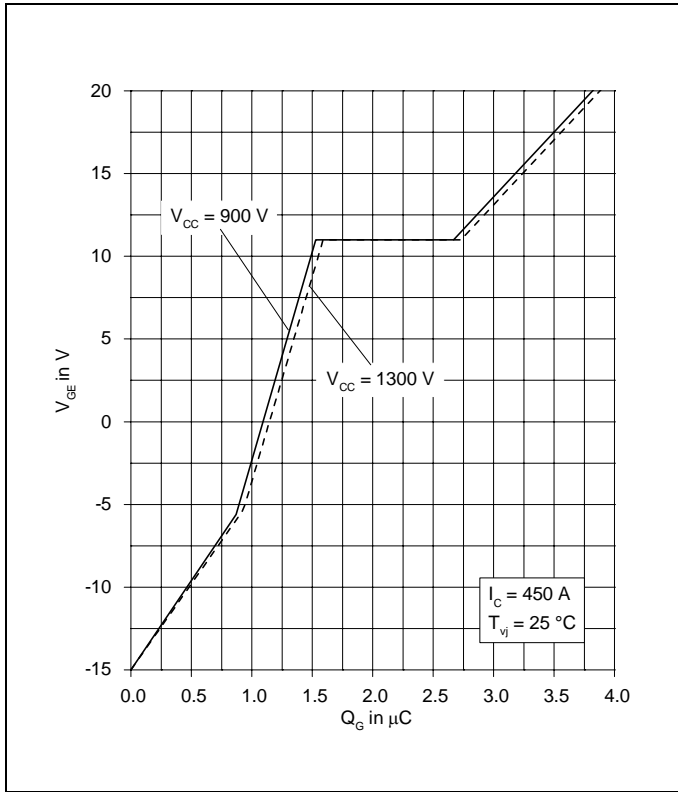


Fig. 9 Typical gate charge characteristics

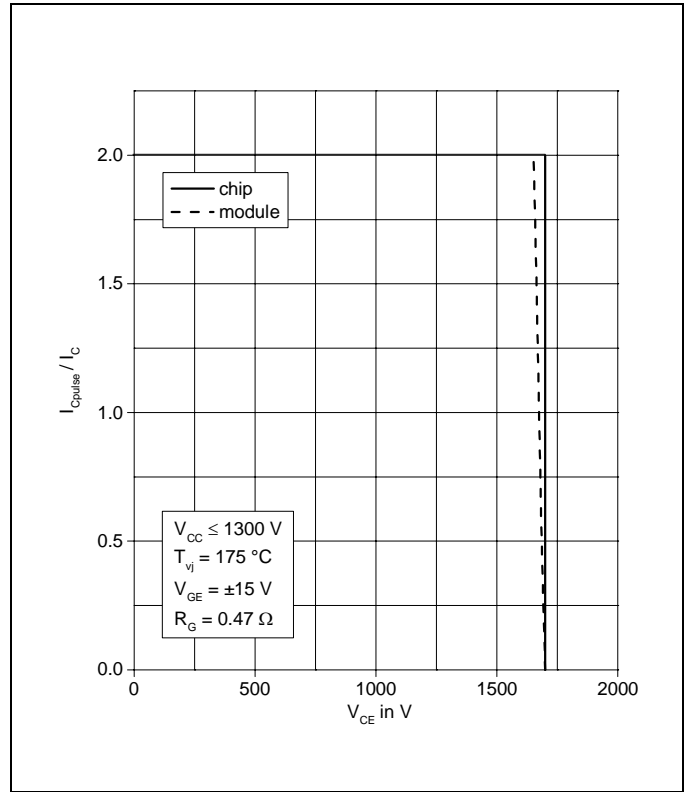


Fig. 10 Turn-off safe operating area (RBSOA)

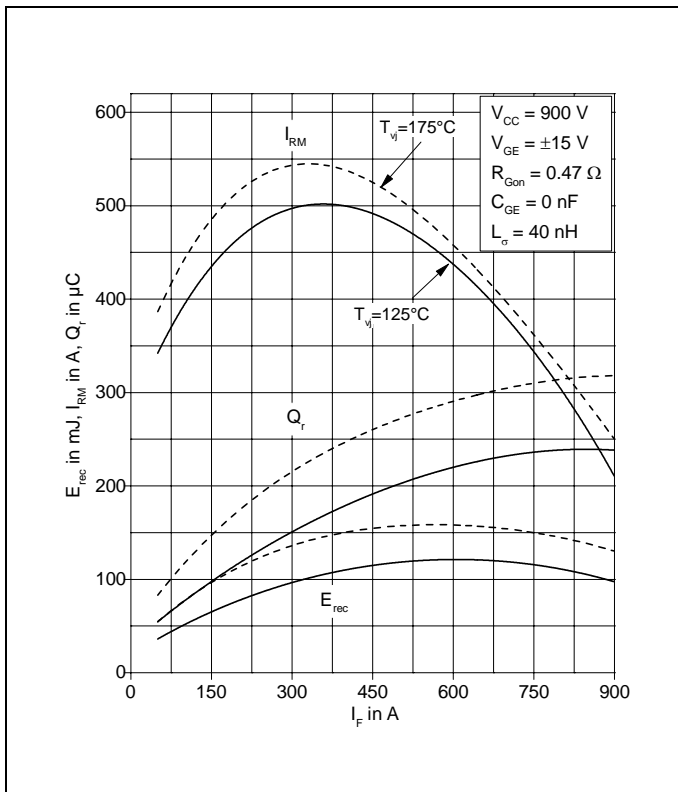


Fig. 11 Typical reverse recovery characteristics vs. forward current

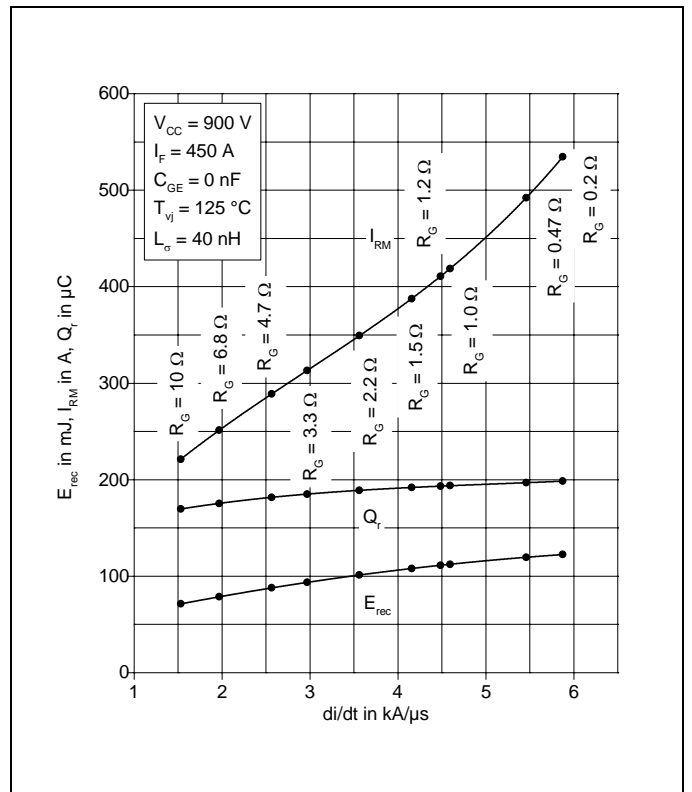


Fig. 12 Typical reverse recovery characteristics vs.  $di/dt$

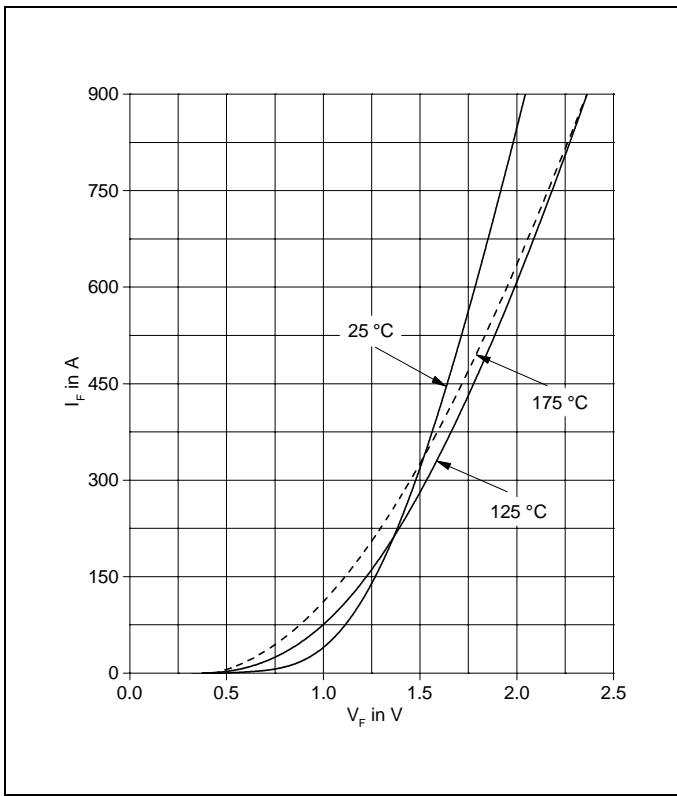


Fig. 13 Typical diode forward characteristics chip level

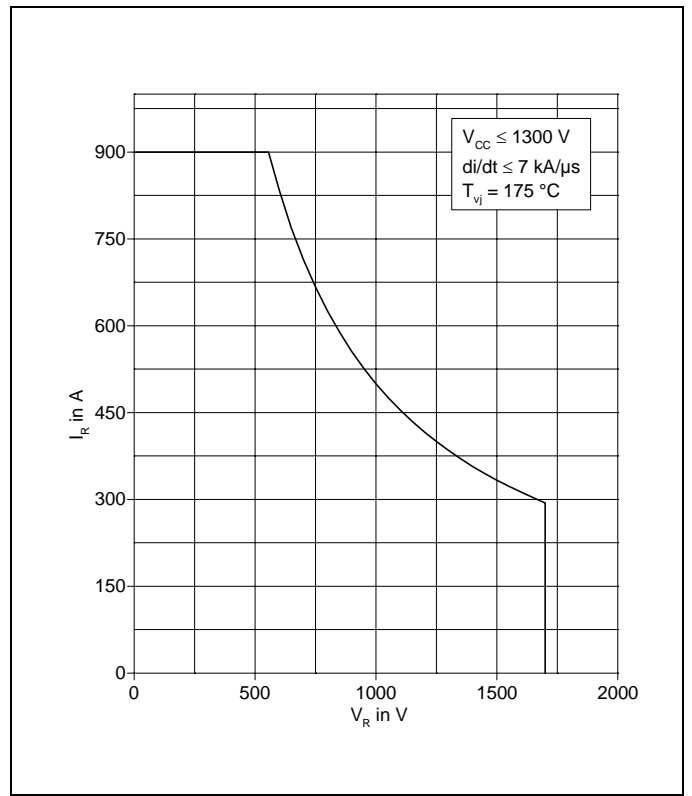


Fig. 14 Safe operating area diode (SOA)

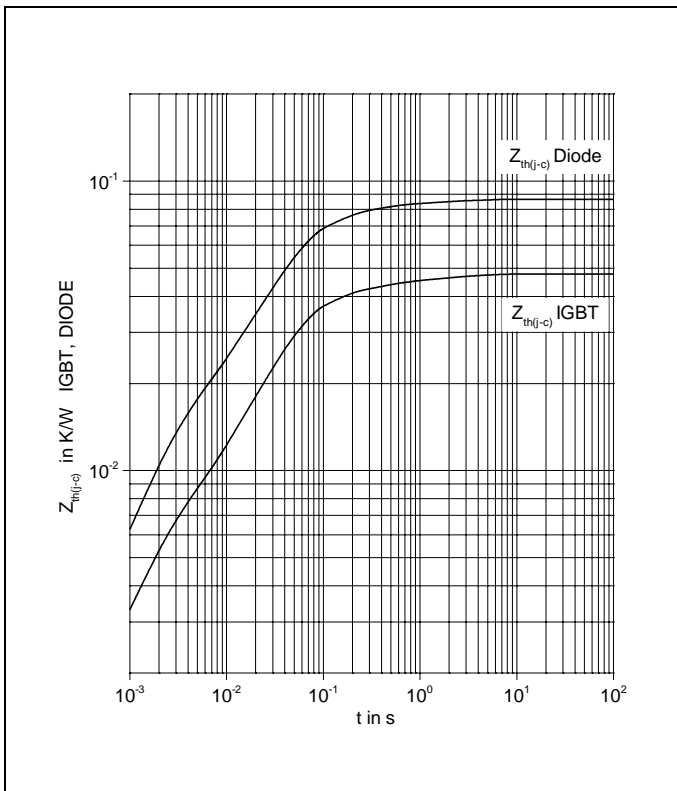


Fig. 15 Thermal impedance vs. time

Analytical function for transient thermal impedance:

$$Z_{th(j-c)}(t) = \sum_{i=1}^n R_i (1 - e^{-t/\tau_i})$$

|       |                       |      |      |      |      |   |
|-------|-----------------------|------|------|------|------|---|
|       | i                     | 1    | 2    | 3    | 4    | 5 |
| IGBT  | R <sub>i</sub> (K/kW) | 4.97 | 33.5 | 6.07 | 3.29 |   |
|       | τ <sub>i</sub> (ms)   | 1.43 | 42   | 318  | 2400 |   |
| DIODE | R <sub>i</sub> (K/kW) | 11.7 | 58.9 | 11.9 | 3.99 |   |
|       | τ <sub>i</sub> (ms)   | 1.87 | 42.8 | 262  | 2290 |   |



**Related documents:**

5SYA 2045 Thermal runaway during blocking  
5SYA 2053 Applying IGBT  
5SYA 2058 Surge currents for IGBT diodes  
5SYA 2093 Thermal design and temperature ratings of IGBT modules  
5SYA 2098 Paralleling of IGBT modules  
5SYA 2113 Mounting instructions for LoPak1 modules

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