

# IGBT Modules

## H-Bridge

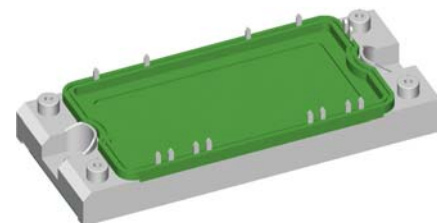
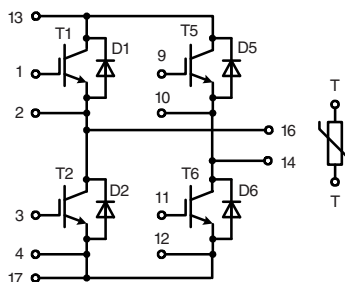
Short Circuit SOA Capability  
Square RBSOA

$$I_{C25} = 72 \text{ A}$$

$$V_{CES} = 600 \text{ V}$$

$$V_{CE(sat) \text{ typ.}} = 1.9 \text{ V}$$

|               |              |
|---------------|--------------|
| Type          | NTC - Option |
| MKI 50-06 A7  | without NTC  |
| MKI 50-06 A7T | with NTC     |



| IGBTs               |                                                                                                                             |                                          |               |  |
|---------------------|-----------------------------------------------------------------------------------------------------------------------------|------------------------------------------|---------------|--|
| Symbol              | Conditions                                                                                                                  | Maximum Ratings                          |               |  |
| $V_{CES}$           | $T_{VJ} = 25^{\circ}\text{C to } 150^{\circ}\text{C}$                                                                       | 600                                      | V             |  |
| $V_{GES}$           |                                                                                                                             | $\pm 20$                                 | V             |  |
| $I_{C25}$           | $T_C = 25^{\circ}\text{C}$                                                                                                  | 72                                       | A             |  |
| $I_{C80}$           | $T_C = 80^{\circ}\text{C}$                                                                                                  | 50                                       | A             |  |
| RBSOA               | $V_{GE} = \pm 15 \text{ V}; R_G = 22 \Omega; T_{VJ} = 125^{\circ}\text{C}$<br>Clamped inductive load; $L = 100 \mu\text{H}$ | $I_{CM} = 100$<br>$V_{CEK} \leq V_{CES}$ | A             |  |
| $t_{SC}$<br>(SCSOA) | $V_{CE} = V_{CES}; V_{GE} = \pm 15 \text{ V}; R_G = 22 \Omega; T_{VJ} = 125^{\circ}\text{C}$<br>non-repetitive              | 10                                       | $\mu\text{s}$ |  |
| $P_{tot}$           | $T_C = 25^{\circ}\text{C}$                                                                                                  | 225                                      | W             |  |

### Features

- NPT IGBT technology
- low saturation voltage
- low switching losses
- square RBSOA, no latch up
- high short circuit capability
- positive temperature coefficient for easy paralleling
- MOS input, voltage controlled
- ultra fast free wheeling diodes
- solderable pins for PCB mounting
- package with copper base plate

### Advantages

- space savings
- reduced protection circuits
- package designed for wave soldering

### Typical Applications

- motor control
  - DC motor armature winding
  - DC motor excitation winding
  - synchronous motor excitation winding
- supply of transformer primary winding
  - power supplies
  - welding
  - X-ray
  - UPS
  - battery charger

| Symbol                                                                 | Conditions                                                                                                                                     | Characteristic Values<br>( $T_{VJ} = 25^{\circ}\text{C}$ , unless otherwise specified) |      |          |
|------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|------|----------|
|                                                                        |                                                                                                                                                | min.                                                                                   | typ. | max.     |
| $V_{CE(sat)}$                                                          | $I_C = 50 \text{ A}; V_{GE} = 15 \text{ V}; T_{VJ} = 25^{\circ}\text{C}$<br>$T_{VJ} = 125^{\circ}\text{C}$                                     | 1.9                                                                                    | 2.2  | 2.4 V    |
| $V_{GE(th)}$                                                           | $I_C = 1 \text{ mA}; V_{GE} = V_{CE}$                                                                                                          | 4.5                                                                                    |      | 6.5 V    |
| $I_{CES}$                                                              | $V_{CE} = V_{CES}; V_{GE} = 0 \text{ V}; T_{VJ} = 25^{\circ}\text{C}$<br>$T_{VJ} = 125^{\circ}\text{C}$                                        | 0.7                                                                                    |      | 0.6 mA   |
| $I_{GES}$                                                              | $V_{CE} = 0 \text{ V}; V_{GE} = \pm 20 \text{ V}$                                                                                              |                                                                                        |      | 200 nA   |
| $t_{d(on)}$<br>$t_r$<br>$t_{d(off)}$<br>$t_f$<br>$E_{on}$<br>$E_{off}$ | Inductive load, $T_{VJ} = 125^{\circ}\text{C}$<br>$V_{CE} = 300 \text{ V}; I_C = 50 \text{ A}$<br>$V_{GE} = \pm 15 \text{ V}; R_G = 22 \Omega$ | 50                                                                                     |      | ns       |
|                                                                        |                                                                                                                                                | 60                                                                                     |      | ns       |
|                                                                        |                                                                                                                                                | 300                                                                                    |      | ns       |
|                                                                        |                                                                                                                                                | 30                                                                                     |      | ns       |
|                                                                        |                                                                                                                                                | 2.3                                                                                    |      | mJ       |
|                                                                        |                                                                                                                                                | 1.7                                                                                    |      | mJ       |
| $C_{ies}$                                                              | $V_{CE} = 25 \text{ V}; V_{GE} = 0 \text{ V}; f = 1 \text{ MHz}$                                                                               | 2800                                                                                   |      | pF       |
| $Q_{Gon}$                                                              | $V_{CE} = 300 \text{ V}; V_{GE} = 15 \text{ V}; I_C = 50 \text{ A}$                                                                            | 120                                                                                    |      | nC       |
| $R_{thJC}$                                                             | (per IGBT)                                                                                                                                     |                                                                                        |      | 0.55 K/W |

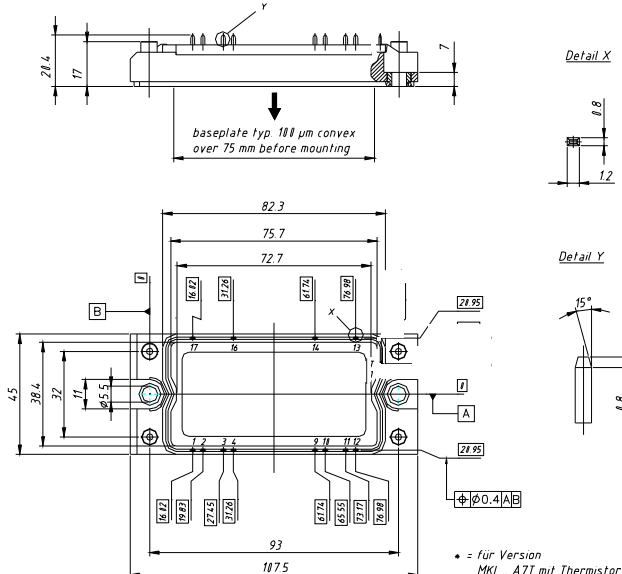
| Diodes    |                          |                 |   |
|-----------|--------------------------|-----------------|---|
| Symbol    | Conditions               | Maximum Ratings |   |
| $I_{F25}$ | $T_C = 25^\circ\text{C}$ | 72              | A |
| $I_{F80}$ | $T_C = 80^\circ\text{C}$ | 45              | A |

|            |                                                                                      | Characteristic Values |      |          |
|------------|--------------------------------------------------------------------------------------|-----------------------|------|----------|
|            |                                                                                      | min.                  | typ. | max.     |
| $V_F$      | $I_F = 50\text{ A}; V_{GE} = 0\text{ V}; T_{VJ} = 25^\circ\text{C}$                  |                       | 1.6  | 1.8      |
|            |                                                                                      |                       | 1.3  | V        |
| $I_{RM}$   | $I_F = 30\text{ A}; di_F/dt = -500\text{ A}/\mu\text{s}; T_{VJ} = 125^\circ\text{C}$ |                       | 25   | A        |
| $t_{rr}$   |                                                                                      |                       | 90   | ns       |
| $R_{thJC}$ | (per diode)                                                                          |                       |      | 1.19 K/W |

| Module     |                                              |                 |                  |
|------------|----------------------------------------------|-----------------|------------------|
| Symbol     | Conditions                                   | Maximum Ratings |                  |
| $T_{VJ}$   |                                              | -40...+150      | $^\circ\text{C}$ |
| $T_{stg}$  |                                              | -40...+125      | $^\circ\text{C}$ |
| $V_{ISOL}$ | $I_{ISOL} \leq 1\text{ mA}; 50/60\text{ Hz}$ | 2500            | V~               |
| $M_d$      | Mounting torque (M5)                         | 2.7 - 3.3       | Nm               |

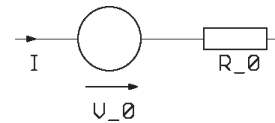
|                |                              | Characteristic Values |      |            |
|----------------|------------------------------|-----------------------|------|------------|
|                |                              | min.                  | typ. | max.       |
| $R_{pin-chip}$ |                              |                       | 5    | m $\Omega$ |
| $d_s$          | Creepage distance on surface | 6                     |      | mm         |
| $d_A$          | Strike distance in air       | 6                     |      | mm         |
| $R_{thCH}$     | with heatsink compound       |                       | 0.02 | K/W        |
| Weight         |                              |                       | 180  | g          |

| Temperature Sensor NTC (MKI ... A7T version only) |            |                       |      |         |
|---------------------------------------------------|------------|-----------------------|------|---------|
| Symbol                                            | Conditions | Characteristic Values |      |         |
|                                                   |            | min.                  | typ. | max.    |
| R <sub>25</sub>                                   | T = 25°C   | 4.75                  | 5.0  | 5.25 kΩ |
| B <sub>25/50</sub>                                |            |                       | 3375 | K       |



## Equivalent Circuits for Simulation

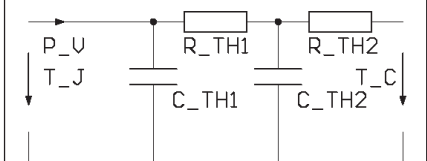
### Conduction



IGBT (typ. at  $V_{GE} = 15\text{ V}; T_J = 125^\circ\text{C}$ )  
 $V_o = 0.82\text{ V}; R_o = 28\text{ m}\Omega$

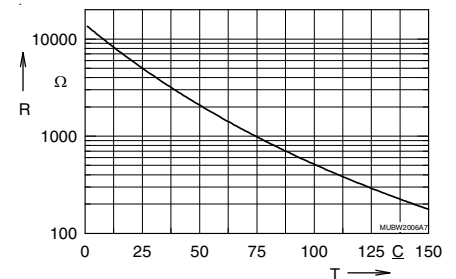
Free Wheeling Diode (typ. at  $T_J = 125^\circ\text{C}$ )  
 $V_o = 0.89\text{ V}; R_o = 8\text{ m}\Omega$

### Thermal Response



IGBT (typ.)  
 $C_{th1} = 0.201\text{ J/K}; R_{th1} = 0.42\text{ K/W}$   
 $C_{th2} = 1.252\text{ J/K}; R_{th2} = 0.131\text{ K/W}$

Free Wheeling Diode (typ.)  
 $C_{th1} = 0.116\text{ J/K}; R_{th1} = 0.973\text{ K/W}$   
 $C_{th2} = 0.88\text{ J/K}; R_{th2} = 0.277\text{ K/W}$



Typ. thermistor resistance versus temperature

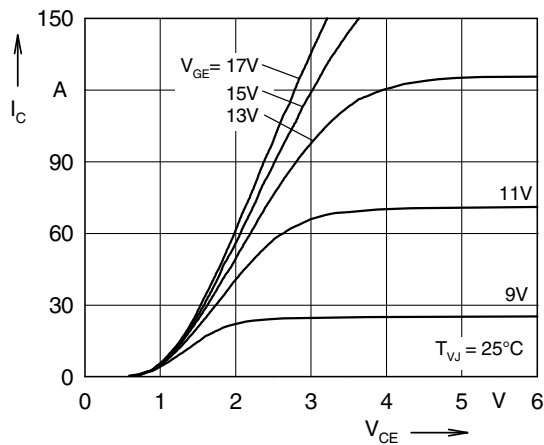


Fig. 1 Typ. output characteristics

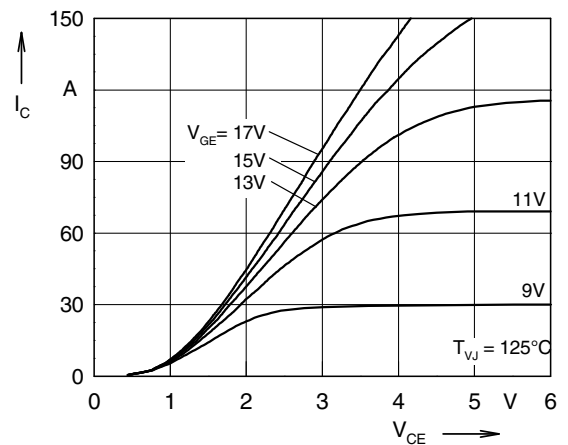


Fig. 2 Typ. output characteristics

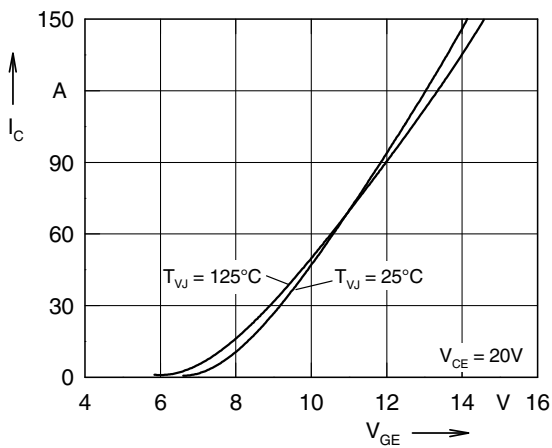


Fig. 3 Typ. transfer characteristics

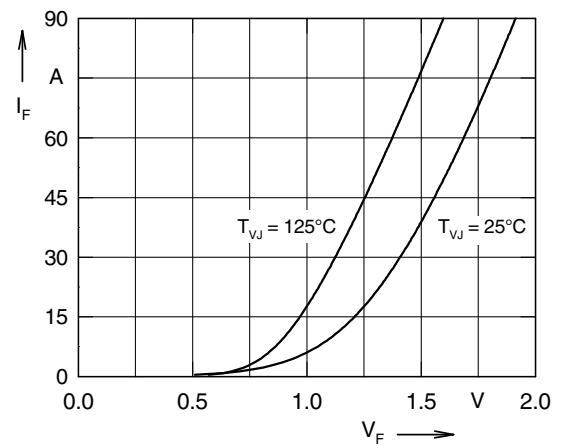


Fig. 4 Typ. forward characteristics of free wheeling diode

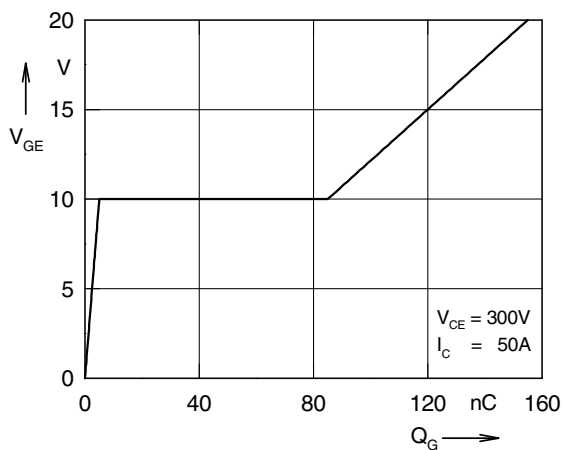


Fig. 5 Typ. turn on gate charge

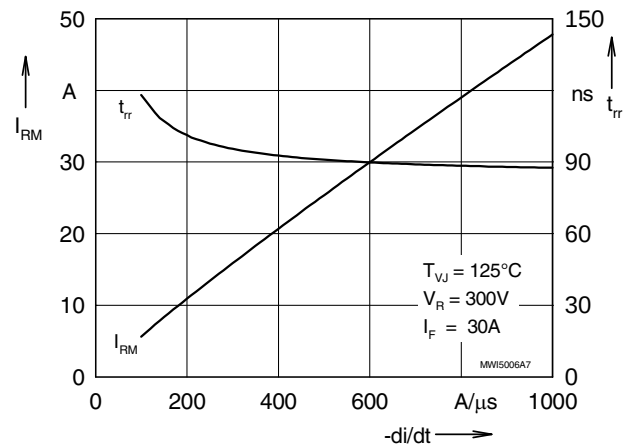


Fig. 6 Typ. turn off characteristics of free wheeling diode

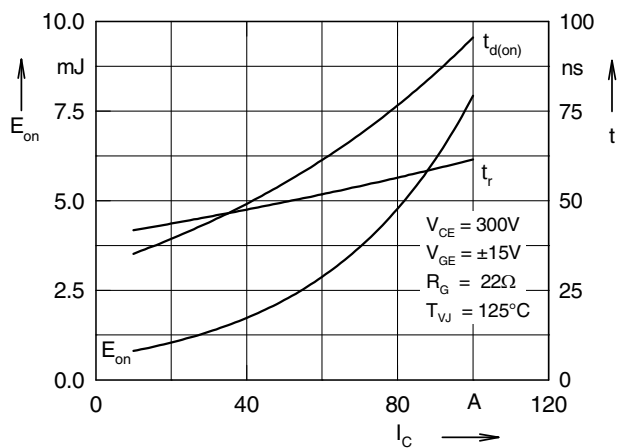


Fig. 7 Typ. turn on energy and switching times versus collector current

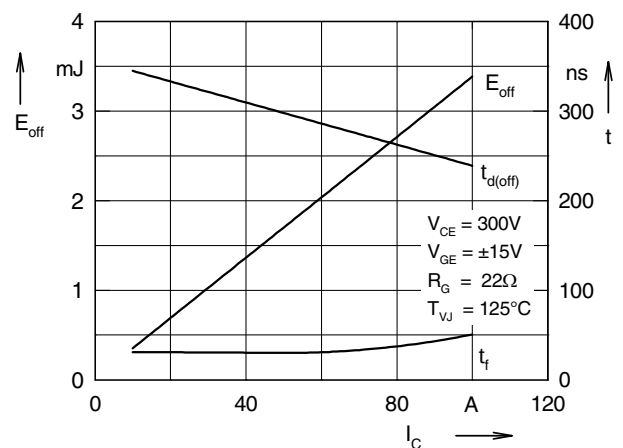


Fig. 8 Typ. turn off energy and switching times versus collector current

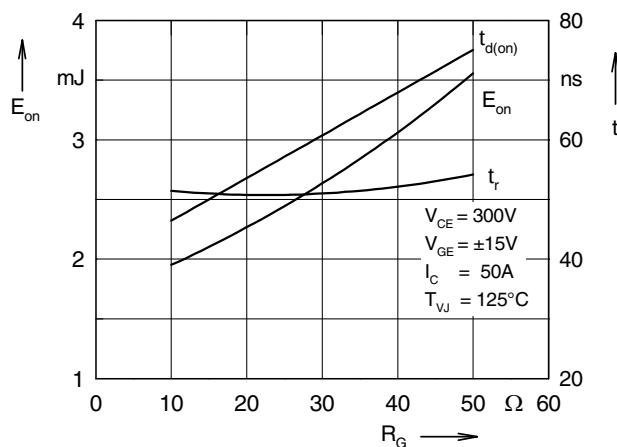


Fig. 9 Typ. turn on energy and switching times versus gate resistor

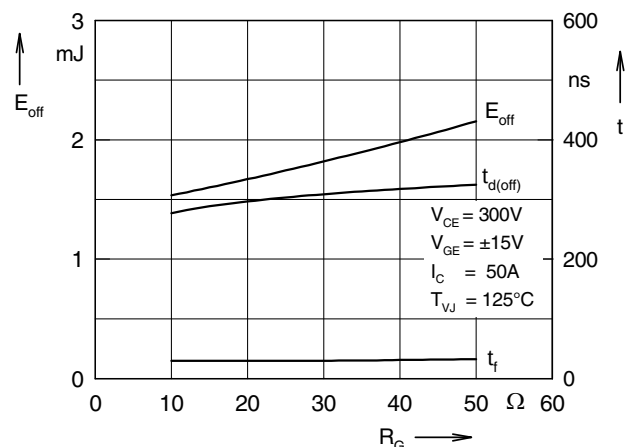


Fig. 10 Typ. turn off energy and switching times versus gate resistor

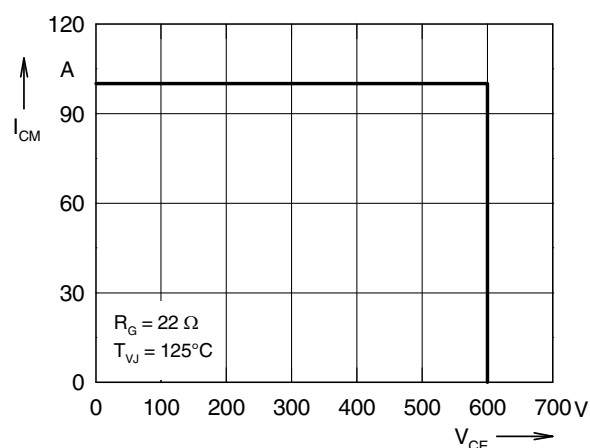


Fig. 11 Reverse biased safe operating area RBSOA

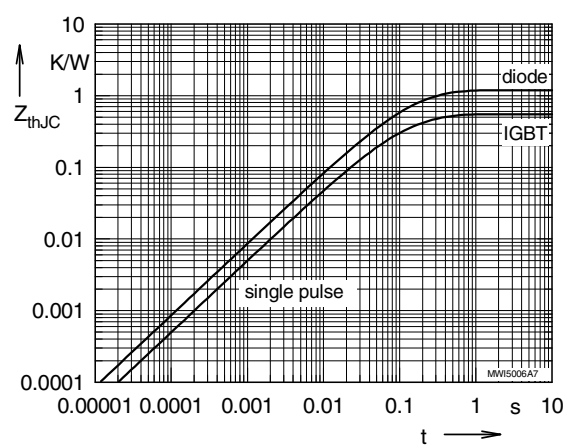


Fig. 12 Typ. transient thermal impedance