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Technical Information

IGBT Modules

Definition and use of junction temperature values

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Definition and use of the junction temperature values (T_{vj}; T_{vjmax}, T_{vjop})

The International Standard IEC 60747-9 gives product specific standards for terminology, letter symbols, essential ratings and characteristics, verification of ratings and methods of measurement for insulated-gate bipolar transistors (IGBTs).

Essential ratings and characteristics in the IEC Standards

In chapter 5.1 the ratings and limiting values are defined for:
ambient or case or virtual junction temperature (T_a or T_c or T_{vj}),
Storage temperature (T_{stg}),
Collector-emitter voltage with gate-emitter short-circuited (V_{CES}),
Gate-emitter voltages (V_{GES}),
Continuous collector current (I_C),
Repetitive peak collector current (I_{CRM}),
Non-repetitive peak collector current (I_{CSM}),
Total power dissipation (P_{tot}),
Maximum safe operating area,
Maximum reverse biased safe operating area (RBSOA) and
Maxmum short circuit safe operating area (SCSOA).

Definition of T_{vj}

The Junction temperature T_{vj} is the temperature in the junction region of a semiconductor chip. This junction temperature is to determine the thermal resistance junction to case R_{thJC} used for further calculations. Because it does not precisely match the exact junction temperature of one of the chips in a module it is more correctly termed “Virtual junction temperature”.

Definition of $T_{vj\ max}$

The rated maximum operating junction temperature T_{vjmax} is used to determine the maximum allowable power dissipation of a continuously turned on IGBT (i.e. static operation).
For switching operation (also for the short period of time during turn-off of the IGBT) it has to be ensured that the device safely operates under high dynamic stress, short dynamic temperature transients and operational chip- and module temperature inhomogenities.
Hence, the maximum calculated virtual junction temperature under dynamic operation is limited to a value lower than T_{vjmax}.
The RBSOA diagram (Reverse Biased Safe Operating Area) in the respective data sheets is showing the area of collector current I_C and collector-emitter voltage V_{CE} which the IGBTs will sustain simultaneously for a short period of time during turn-off without being damaged under the specified conditions.

Definition of $T_{vj\ op}$ (most practical value)
The operating temperature T_{vjop} specifies the limits (minimum and maximum value) of the junction temperature between which the device may be operated. This includes the switching operation and shows identical maximum values as specified in the RBSOA diagram.
For applications with switching operation the relevant design limit is therefore the specified operation temperature T_{vjop}. Calculations of current carrying capability at normal load and overload (also for short time duration) should be done using the average on state, turn-on (E_{on}) and turn-off (E_{off}) losses in regard to stay within the allowed operation temperature range. (Note: One can ignore the peak power losses and the generated transient temperature rise during “turn on” or “turn off”. They are not specified in detail and already considered in the specified temperature T_{vjop})

The specified maximum operation temperature T_{vjop} of Infineon (eupec) IGBT modules is:

$T_{vjop\ max}$ =125°C

- 600V IGBT2 DLC, KL4 series
- 1200V IGBT2 DN2, DLC, KF4, KL4C and KS4 series
- 1200V IGBT3 KE3 and KT3 series
- 1600/1700V IGBT1 DN2 and KF4 series
- 1700V IGBT2 DLC and KF6 series
- 1700V IGBT3 KE3 series
- 3300V IGBT2 KF2C series
- 6500V IGBT2 KF2 series

$T_{vjop\ max}$ =150°C

- 600V IGBT3 E3 series
- 1200V IGBT4 P4, E4, T4 series
- 1700V IGBT4 P4, E4 series
- 3300V IGBT3 L3, E3 series

Important note:
Exceeding the specified limiting values means operation out of the specification. This can lead to a failure and will reduce the life time of the device!