Fuji IGBT Module V series
Technical notes

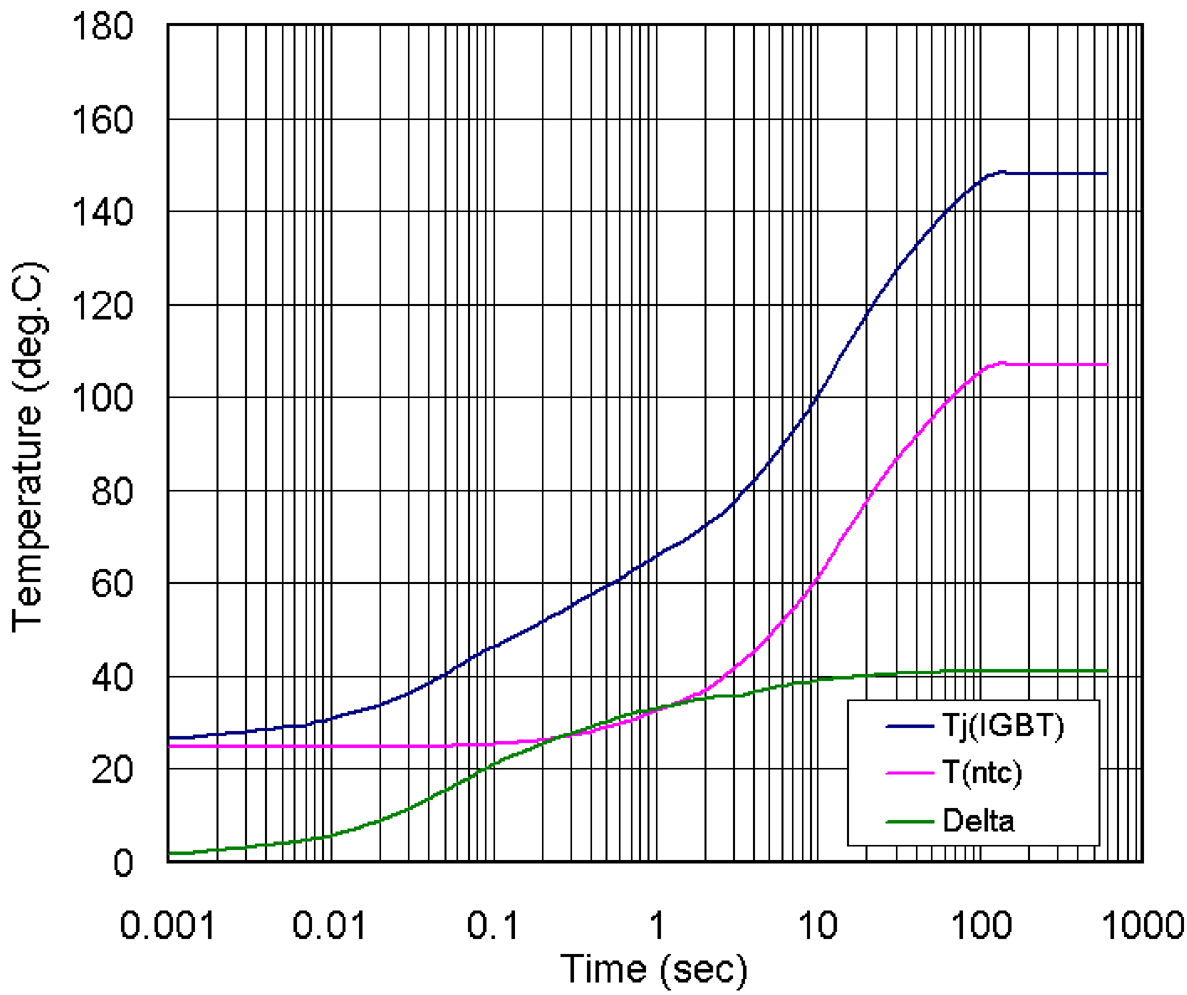
e-Front runners

Fuji Electric Co.,Ltd.

− Fuji IGBT Module −

Junction temperature Tj and time response of thermistor temperature T_ntc

Typename: 2MBI300VJ-120-50



Transient thermal behavior of NTC thermister and IGBT Junction Temperature

In many of Fuji IGBT module, an integrated NTC thermistor is provided mainly to report value to detect rough IGBT case temperature in thermally equilibrium operation, such as steady-state.

The above figure shows an example of the IGBT junction temperature and the time response of the thermistor temperature in 2MBI300VJ-120-50. However, the time response changes depending on the usage environment (thermal design, driving conditions of IGBT module, etc.).

As shown, there is a difference in starting time of temperature rise between the IGBT chip and the thermistor time response. In the time domain 100msec or less, only the chip temperature rises while the thermistor keeps stable. Therefore, as shown by the fact that the temperature difference becomes big between the IGBT chip temperature and the thermistor temperature, it is hard to know the junction temperature from the thermistor response in such a short period.

In addition, , in a short-circuit mode, in which high current flows while voltage is applied, the guaranteed time is about 10micro seconds (the guaranteed short-circuit time differs depending on product generation, voltage classes and operating conditions), and so the thermistor temperature does not rise in this short-circuit period. Namely, the temperature detection by thermistor cannot be used for short-circuit protection. Therefore, other protection functions such as over current detection with current sensors and/or monitoring the saturation voltage of IGBT Vce (sat).

Technical data: MT5F19496

− Fuji IGBT Module −

Calculation of power cycle life when there are multiple different temperature rise peaks

The power cycle lifeof the IGBT module depends on the temperature swing (and maximum temperature) during power cycle. Therefore, when there is only one temperature swing of the IGBT module in one particular operation cycle of the inverters/converters, the number of times calculated from the power cycle life curve is the life cycle of the IGBT module.

However, when there are multiple temperature rise peaks in one operation cycle of the inverter, the life cycle becomes shorter because the module is influenced by the multiple temperature rises. The calculation method of power cycle life when there are multiple different temperature rise peaks is shown below.

When there are n times of temperature rises for one operation cycle of inverter, the combined power cycle life can be expressed in the following formula, where PC(k) is the power cycle life for the k-th (k=1, 2, 3, …., n) temperature rise.

$$PC = 1/\left(\sum_{k=1}^{n}\frac{1}{PC(k)}\right)$$

For example, when n=4 and the power cycle numbers for the respective power rise peaks are 3.8×10^6, 1.2×10^6, 7.6×10^5 and 4.6×10^5, calculation is made as follows:

$$PC = 1/\left(\frac{1}{3.8\,\mathrm{x}10^6}+\frac{1}{1.2\,\mathrm{x}10^6}+\frac{1}{7.6\,\mathrm{x}10^5}+\frac{1}{4.6\,\mathrm{x}10^5}\right) = 2.2\,\mathrm{x}10^5$$

Therefore, the power cycle lifetime can be obtained from the product of the power cycle life calculated in this way and one cycle (time) of operation mode.

For example, when one cycle of the above operation mode is 1800sec (30min), the lifetime is calculated as follows:

$2.2 \times 10^5 \times 1800 / (60 \times 60 \times 24 \times 365) = 12.55 \approx$ 12 years and 6 months.

Technical data: MT5F20514

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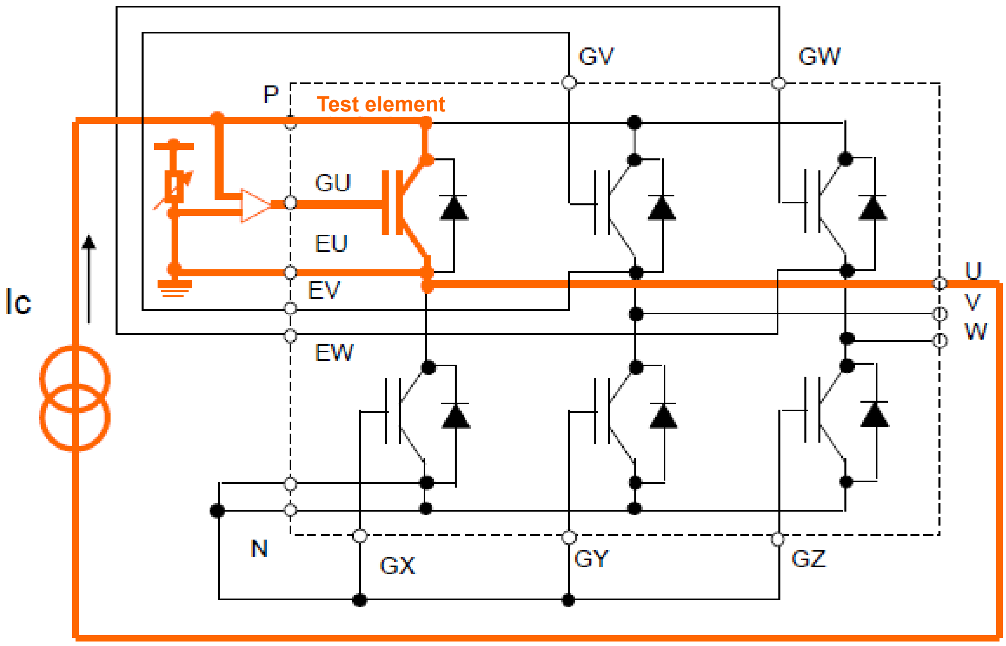
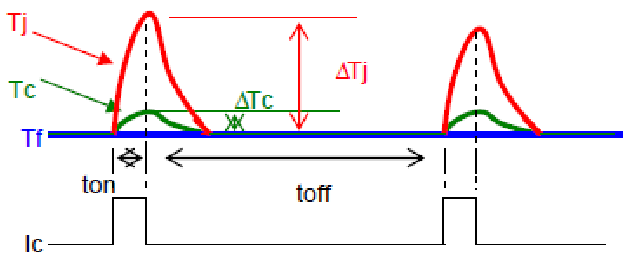
− Fuji IGBT Module U and V Series −

ΔTj power cycle test method and lifetime curve (technical reference material)

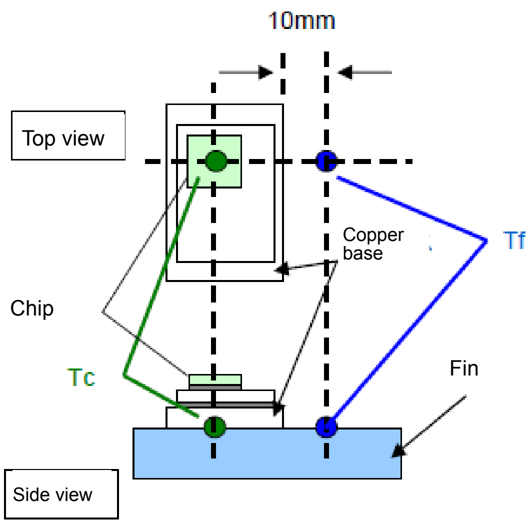


Test equivalent circuit

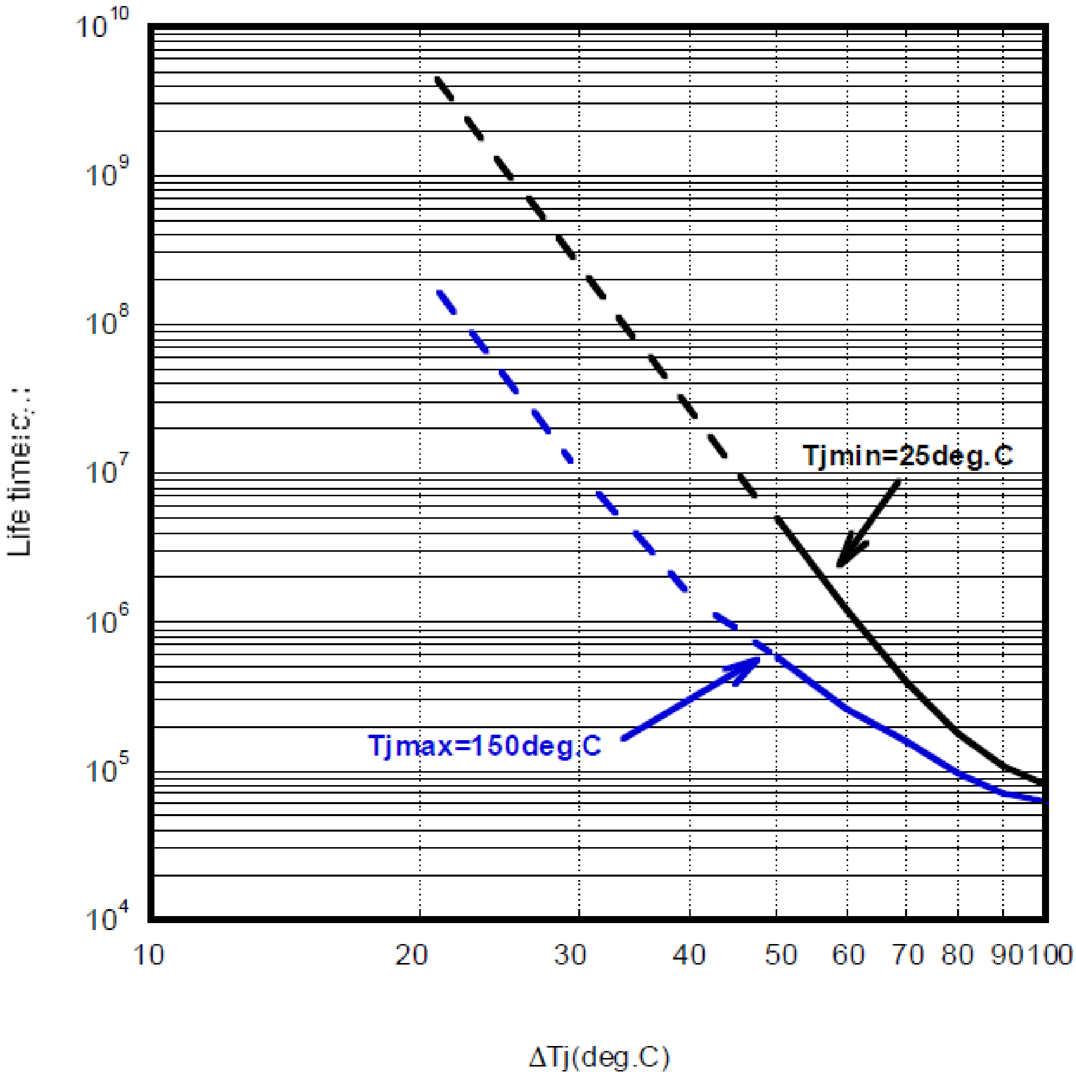


ton = 2sec.
toff = 18sec.

Current flow pattern of ΔTj power cycle and temperature change



Tc and Tf measurement positions



ΔTj Power cycling life time curve

∗1) The judgment criterion for failure is the point when the test element becomes open or short.

∗2) The radiation fin and module are mounted according to our test standards.

∗3) The capacity data in the lifetime curve is the one when the failure rate is 1% in the Weibull analysis.

∗4) The capacity data in the lifetime curve shows the result of multiple models.

∗5) The dotted lines show the estimated lifetime, not the guaranteed value.

∗6) The IGBT (FWD) chips connected in parallel are not included.

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