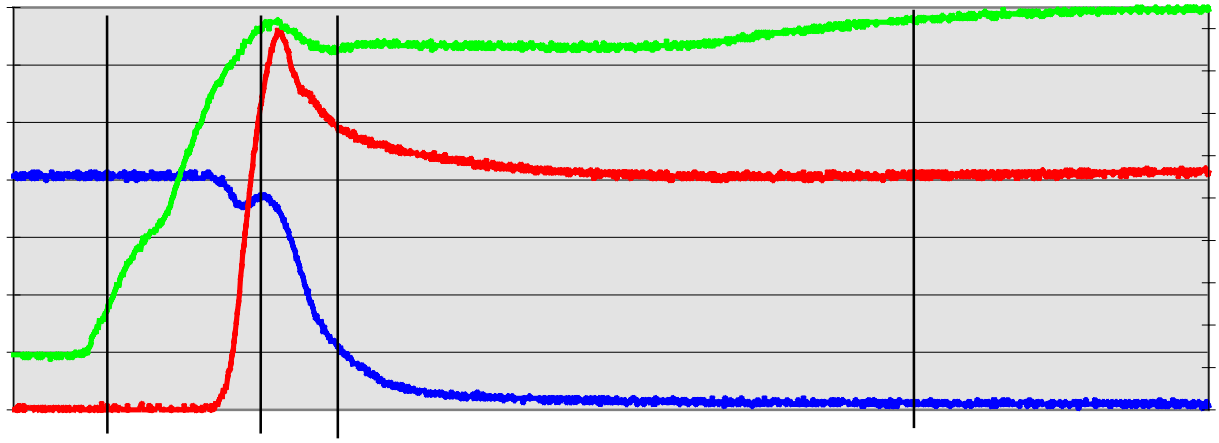
Effect of Gate-Emitter Capacitor C_{GE}

Attached you find some informations, which should give explanations about the advantages of using an additional gate capacitor C_G.

The main idea behind this is to control dI_C/dt and dV_{CE}/dt **independently** at **turn-on**. The need for this is given by the wish for lowest IGBT turn-on losses and a not unlimited di/dt-capability of the free wheeling diode.

By just raising the R_G (until the dI_C/dt_{max} is ok) would increase the turn-on losses E_{on}. With the additional component C_G the dI_C/dt can be controlled by the time constant given by R_G and $C_{GE}//C_G$. For the turn-on dV_{CE}/dt only R_G and $C_G//C_{GC}$ (C_{GC}: Miller-capacity) are effective. Because $C_{GC} >> C_G$, finally only R_G (and not C_G) is responsible for the resulting dV_{CE}/dt value !

By this measure the R_G and therefore the switching losses can remain on a low value.



range	determined by	condition	influenced by	influence on
1	$\mathbf{V_{GE}} < V_{GEth}$	C_{iss} = const.	C'_{GE}	t_{don}
2	$V_{GEth} < \mathbf{V_{GE}} < V_{GEM}$	C_{iss}= const.	C'_{GE}	dI_C / dt
3	$\mathbf{V_{GE}} = V_{GEM}$	V_{GE} = const.	R_G, C_{GC}	dV_{CE} / dt
4	$\mathbf{V_{GE}} > V_{GEM}$	C_{iss} = const.	C'_{GE} // C_{GC}	dV_{CEsat} / dt

$C'_{GE} = C_{GE} // C_G$

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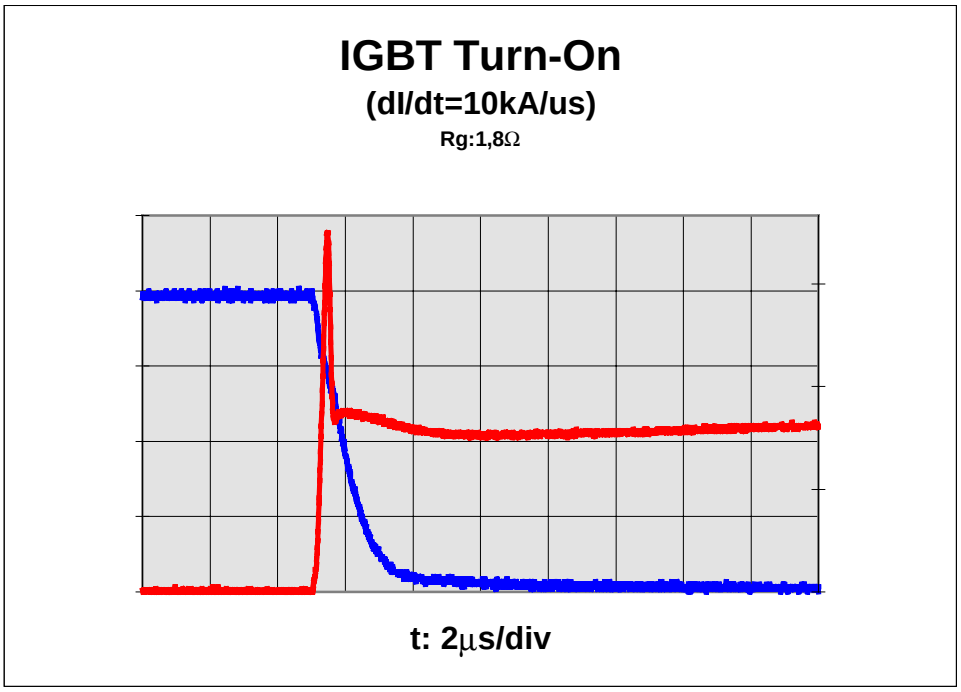
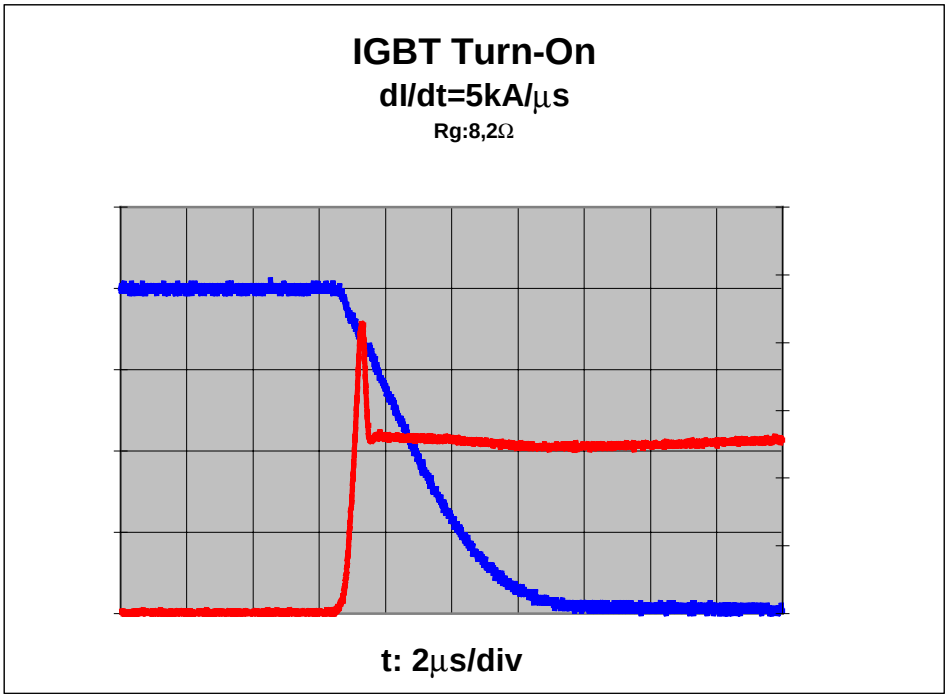
Example : FZ1200R33KF1, turn-on without C_G

V_{CE}: 500V / div, I_C: 600A / div



high dI_C/dt due to low gate resistor R_G



low dV_{CE}/dt and high turn-on losses due to high gate resistor R_G

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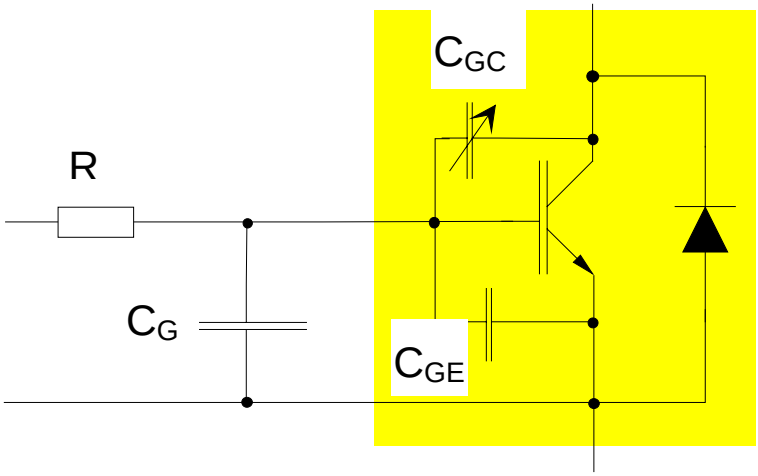
Solution:

An additional Capacitance between Gate & Emitter allows independent control of dI_C/dt and dV_{CE}/dt



- dV_{CE}/dt is controlled via R_G and C_{GC}
- dIc/dt is controlled via R_G and $C_{GE}//C_G$

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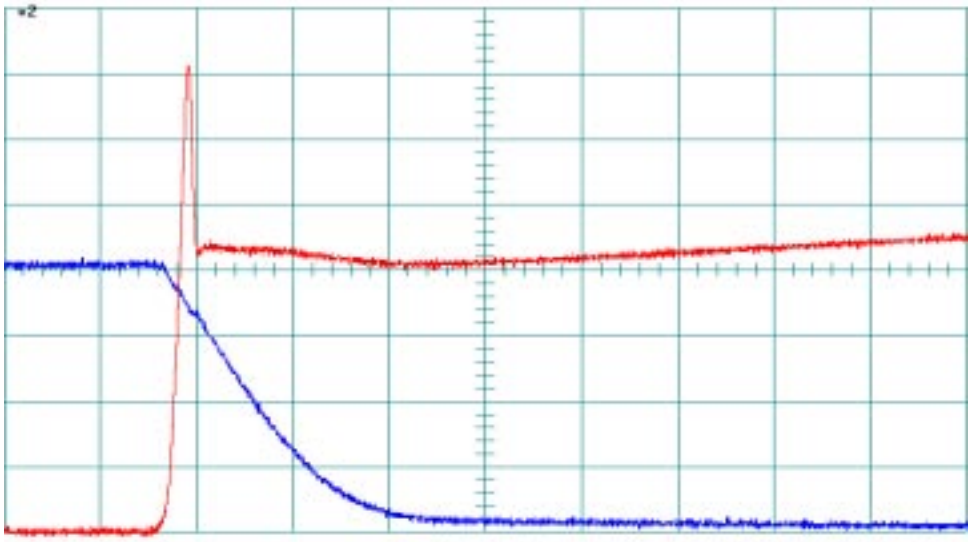
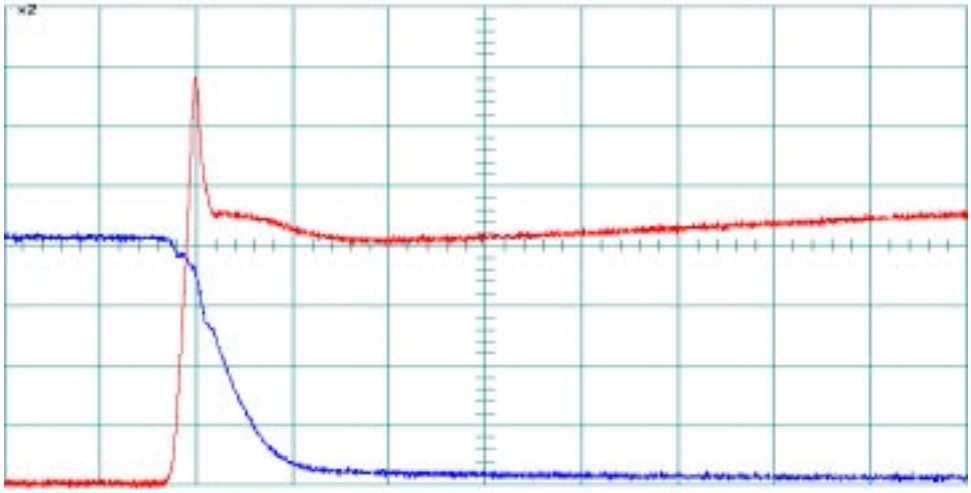


Example:

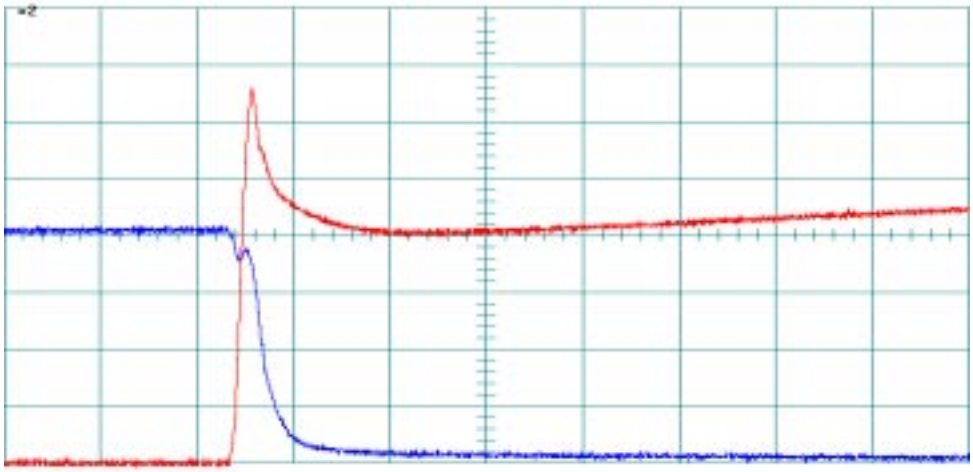
FZ1200R33KF1

Variation of R_G and C_G

R_G=8,2Ω, C_G=0, I_C/dt= 5kA/µs, dV_{CE}/dt=0,6kV/µs, E_{on}=6,4J



R_G=3,3Ω, C_G=100nF, I_C/dt= 4,5kA/µs, dV_{CE}/dt=1kV/µs, E_{on}=4,1J



R_G=1,0Ω, C_G=330nF, I_C/dt= 5,1kA/µs, dV_{CE}/dt=2,8kV/µs, E_{on}=2,8J

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