

# GT40QR21

## 1. Applications

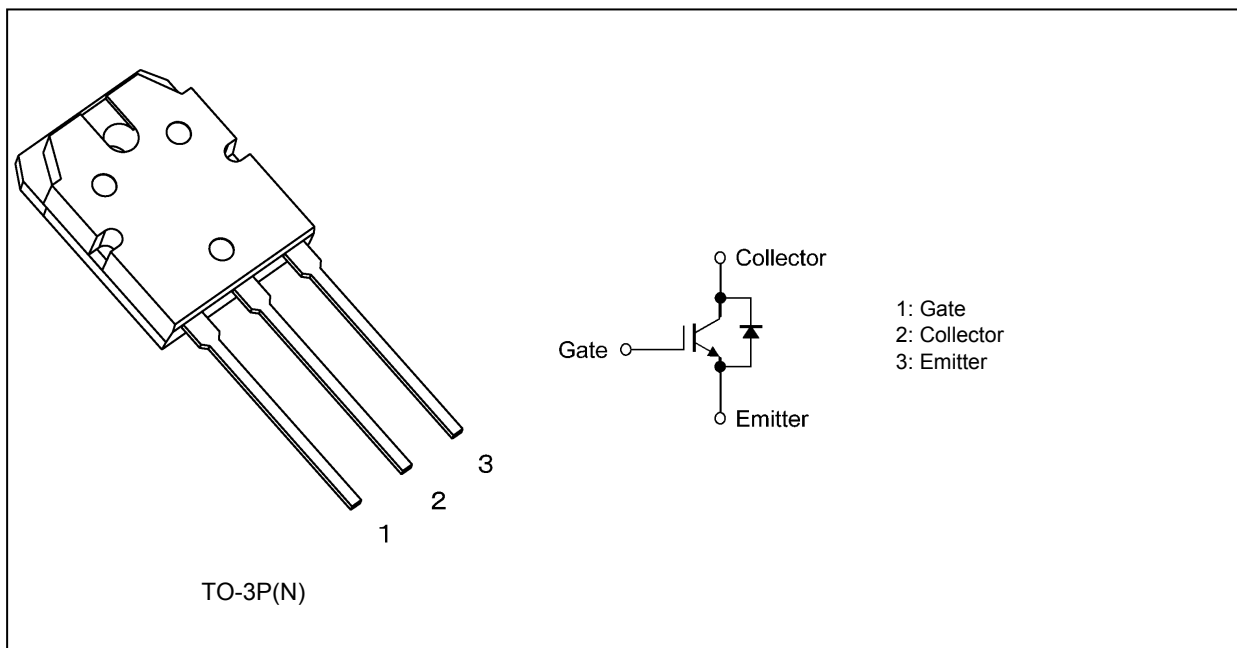
- Dedicated to Voltage-Resonant Inverter Switching Applications

Note: The product(s) described herein should not be used for any other application.

## 2. Features

- (1) 6.5th generation
- (2) The RC-IGBT consists of a freewheeling diode monolithically integrated in an IGBT chip.
- (3) Enhancement mode
- (4) High-speed switching  
 IGBT :  $t_f = 0.20 \mu s$  (typ.) ( $I_C = 40 A$ )  
 FWD :  $t_{rr} = 0.60 \mu s$  (typ.) ( $I_F = 15 A$ )
- (5) Low saturation voltage :  $V_{CE(sat)} = 1.9 V$  (typ.) ( $I_C = 40 A$ )
- (6) High junction temperature :  $T_j = 175^\circ C$  (max)

## 3. Packaging and Internal Circuit



Start of commercial production

2010-12

**4. Absolute Maximum Ratings (Note) ( $T_a = 25^\circ\text{C}$ , unless otherwise specified)**

Characteristics	Symbol	Rating	Unit
Collector-emitter voltage	$V_{CES}$	1200	V
Gate-emitter voltage	$V_{GES}$	$\pm 25$	
Collector current (DC) ( $T_c = 25^\circ\text{C}$ )	$I_C$	40	A
Collector current (DC) ( $T_c = 100^\circ\text{C}$ )		35	
Collector current (1 ms)	$I_{CP}$	80	
Diode forward current (DC)	$I_F$	20	
Diode forward current (100 $\mu\text{s}$ )	$I_{FP}$	80	
Collector power dissipation ( $T_c = 25^\circ\text{C}$ )	$P_C$	230	
Junction temperature (Note 1)	$T_j$	175	$^\circ\text{C}$
Storage temperature	$T_{stg}$	-55 to 175	
Mounting torque	TOR	0.8	N · m

Note: Using continuously under heavy loads (e.g. the application of high temperature/current/voltage and the significant change in temperature, etc.) may cause this product to decrease in the reliability significantly even if the operating conditions (i.e. operating temperature/current/voltage, etc.) are within the absolute maximum ratings.

Please design the appropriate reliability upon reviewing the Toshiba Semiconductor Reliability Handbook ("Handling Precautions"/"Derating Concept and Methods") and individual reliability data (i.e. reliability test report and estimated failure rate, etc).

In general, loss of IGBT increases more when it has positive temperature coefficient and gets higher temperature.

In case that the temperature rise due to loss of IGBT exceeds the heat release capacity of a device, it leads to thermorunaway and results in destruction.

Therefore, please design heat release of a device with due consideration to the temperature rise of IGBT.

Note 1: Ensure that the junction temperature does not exceed  $175^\circ\text{C}$ .

**5. Thermal Characteristics**

Characteristics	Symbol	Max	Unit
Junction-to-case thermal resistance	$R_{th(j-c)}$	0.65	$^\circ\text{C/W}$

**6. Electrical Characteristics**

**6.1. Static Characteristics ( $T_a = 25^\circ\text{C}$ , unless otherwise specified)**

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Gate leakage current	$I_{GES}$	$V_{GE} = \pm 25\text{ V}, V_{CE} = 0\text{ V}$	—	—	$\pm 100$	nA
Collector cut-off current	$I_{CES}$	$V_{CE} = 1200\text{ V}, V_{GE} = 0\text{ V}$	—	—	1	mA
Gate-emitter cut-off voltage	$V_{GE(OFF)}$	$I_C = 40\text{ mA}, V_{CE} = 5\text{ V}$	4.5	—	7.5	V
Collector-emitter saturation voltage	$V_{CE(sat)(1)}$	$I_C = 20\text{ A}, V_{GE} = 15\text{ V}$	—	1.50	—	
Collector-emitter saturation voltage	$V_{CE(sat)(2)}$	$I_C = 20\text{ A}, V_{GE} = 15\text{ V}, T_j = 125^\circ\text{C}$	—	1.75	—	
Collector-emitter saturation voltage	$V_{CE(sat)(3)}$	$I_C = 20\text{ A}, V_{GE} = 15\text{ V}, T_j = 175^\circ\text{C}$	—	1.89	—	
Collector-emitter saturation voltage	$V_{CE(sat)(4)}$	$I_C = 40\text{ A}, V_{GE} = 15\text{ V}$	—	1.90	2.70	
Collector-emitter saturation voltage	$V_{CE(sat)(5)}$	$I_C = 40\text{ A}, V_{GE} = 15\text{ V}, T_j = 125^\circ\text{C}$	—	2.29	—	
Collector-emitter saturation voltage	$V_{CE(sat)(6)}$	$I_C = 40\text{ A}, V_{GE} = 15\text{ V}, T_j = 175^\circ\text{C}$	—	2.50	—	
Diode forward voltage	$V_F$	$I_F = 15\text{ A}, V_{GE} = 0\text{ V}$	—	—	2.6	

**6.2. Dynamic Characteristics ( $T_a = 25^\circ\text{C}$ , unless otherwise specified)**

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Input capacitance	$C_{ies}$	$V_{CE} = 10\text{ V}, V_{GE} = 0\text{ V}, f = 1\text{ MHz}$	—	1500	—	pF
Switching time (rise time)	$t_r$	Resistive load $V_{CC} = 600\text{ V}, I_C = 40\text{ A}, V_{GG} = \pm 15\text{ V}, R_G = 39\ \Omega$ See Fig. 6.2.1, 6.2.2.	—	0.12	—	$\mu\text{s}$
Switching time (turn-on time)	$t_{on}$		—	0.18	—	
Switching time (fall time)	$t_f$		—	0.20	0.40	
Switching time (turn-off time)	$t_{off}$		—	0.40	—	
Switching loss (turn-off switching loss)	$E_{off(1)}$	Inductive Load $V_{CC} = 280\text{ V}, I_C = 40\text{ A}, L = 30\ \mu\text{H}, C = 0.33\ \mu\text{F}, V_{GG} = 20\text{ V}, R_G = 10\ \Omega$ See Fig. 6.2.3, 6.2.4.	—	0.16	—	mJ
Switching loss (turn-off switching loss)	$E_{off(2)}$	Inductive Load $V_{CC} = 280\text{ V}, I_C = 40\text{ A}, L = 30\ \mu\text{H}, C = 0.33\ \mu\text{H}, V_{GG} = 20\text{ V}, R_G = 10\ \Omega, T_c = 125^\circ\text{C}$ See Fig. 6.2.3, 6.2.4.	—	0.29	—	
Reverse recovery time	$t_{rr}$	$I_F = 15\text{ A}, V_{GE} = 0\text{ V}, di/dt = -20\text{ A}/\mu\text{s}$	—	0.60	—	$\mu\text{s}$

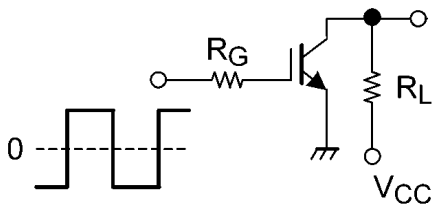


Fig. 6.2.1 Test Circuit of Switching Time

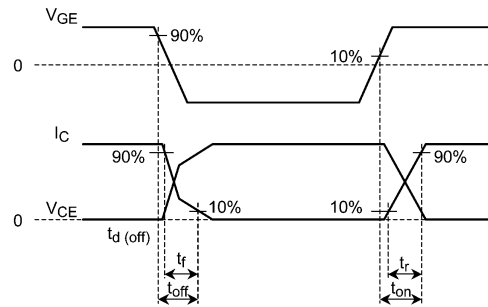


Fig. 6.2.2 Timing Chart of Switching Time

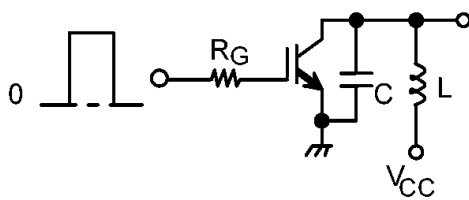


Fig. 6.2.3 Test Circuit of Switching Loss

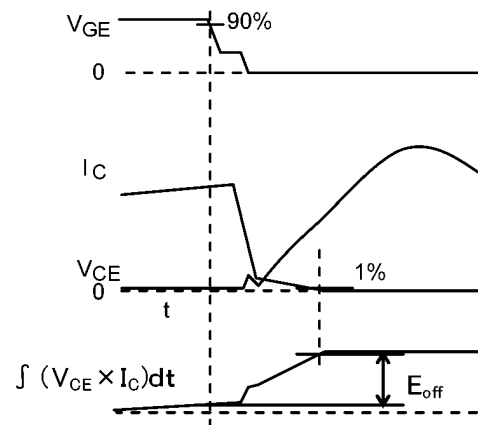
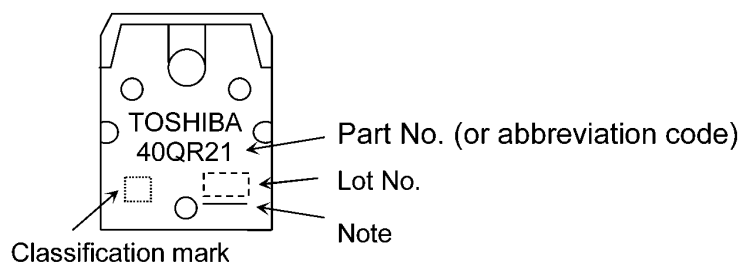


Fig. 6.2.4 Timing Chart of Switching Loss

**7. Marking (Note)****Fig. 7.1 Marking**

Note: A line under a Lot No. identifies the indication of product Labels.

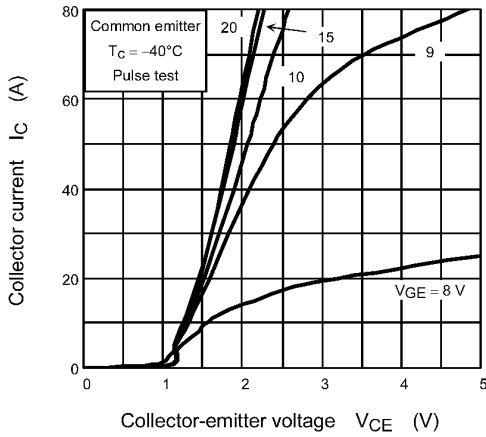
[[G]]/RoHS COMPATIBLE or [[G]]/RoHS [[Pb]]

Please contact your TOSHIBA sales representative for details as to environmental matters such as the RoHS compatibility of Product.

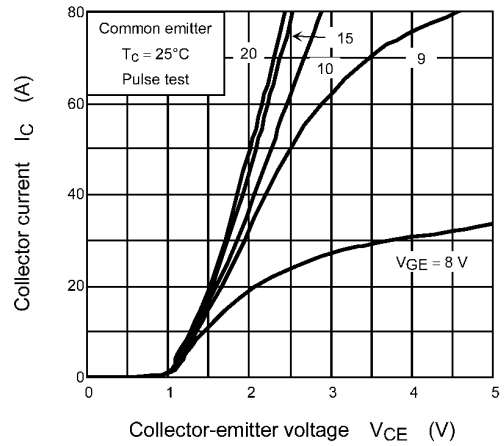
The RoHS is the Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

Note: This transistor is sensitive to electrostatic discharge and should be handled with care.

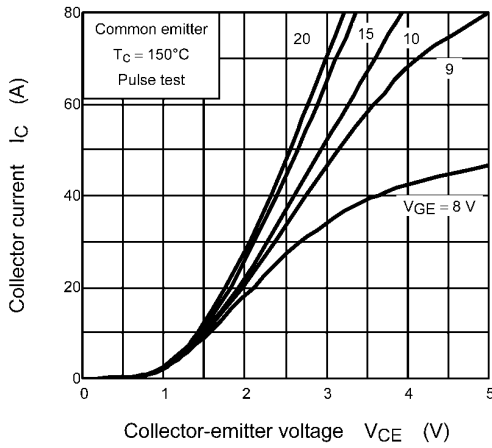
**8. Characteristics Curves (Note)**



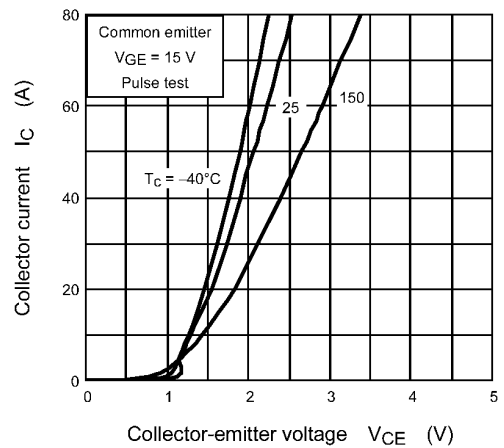
**Fig. 8.1  $I_c - V_{CE}$**



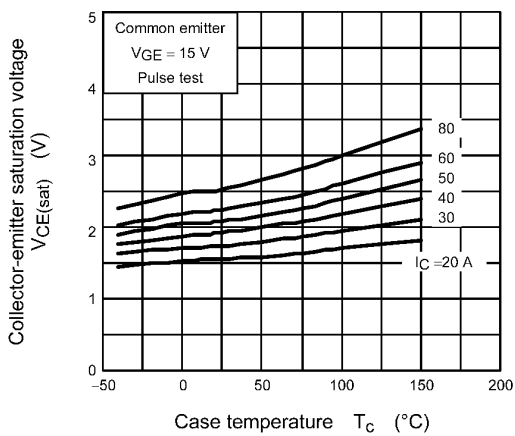
**Fig. 8.2  $I_c - V_{CE}$**



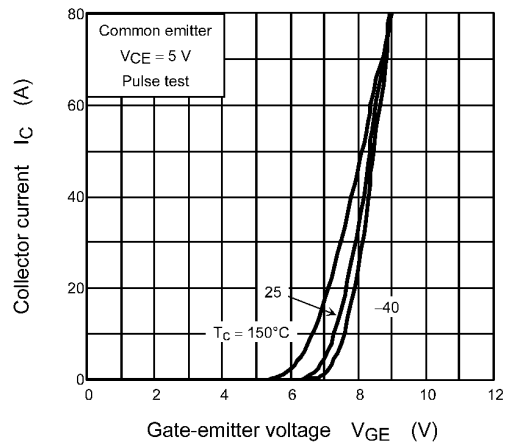
**Fig. 8.3  $I_c - V_{CE}$**



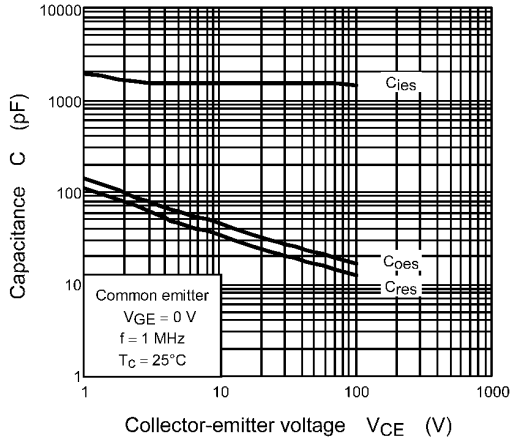
**Fig. 8.4  $I_c - V_{CE}$**



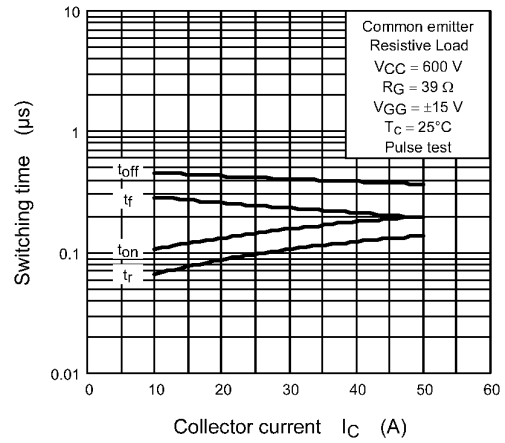
**Fig. 8.5  $V_{CE(sat)} - T_c$**



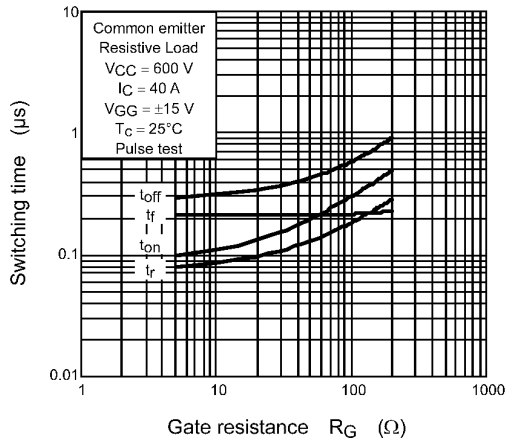
**Fig. 8.6  $I_c - V_{GE}$**



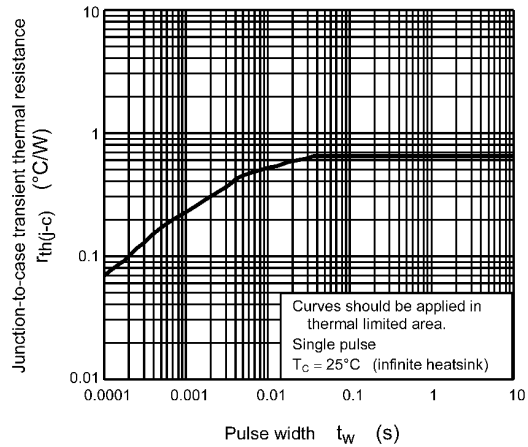
**Fig. 8.7 C -  $V_{CE}$**



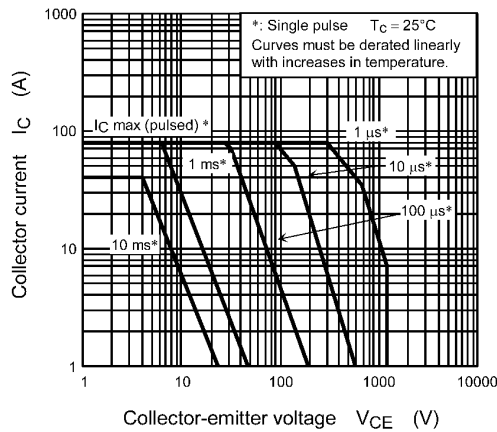
**Fig. 8.8 Switching Time -  $I_C$**



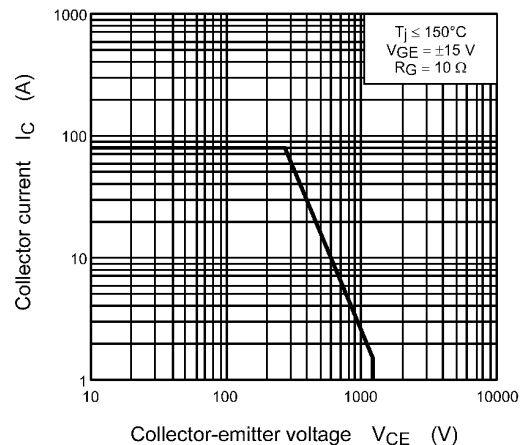
**Fig. 8.9 Switching Time -  $R_G$**



**Fig. 8.10  $r_{th(j-c)}$  -  $t_w$   
(Guaranteed Maximum)**



**Fig. 8.11 Safe Operating Area  
(Guaranteed Maximum)**



**Fig. 8.12 Reverse Bias SOA  
(Guaranteed Maximum)**

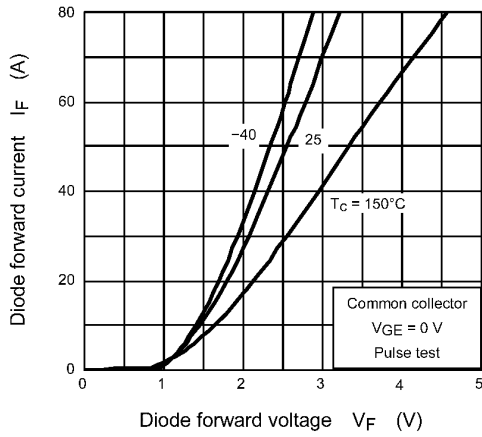


Fig. 8.13  $I_F - V_F$

Note: The above characteristics curves are presented for reference only and not guaranteed by production test, unless otherwise noted.





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