# RBN40H65T1FPQ-A0

650V - 40A - IGBT
Power Switching

R07DS1379EJ0121
Rev.1.21
Oct.14.2021

## Features

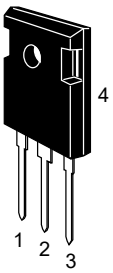
- Trench gate and thin wafer technology (G8H series)
- Built in fast recovery diode in one package
- Low collector to emitter saturation voltage
  $V_{CE(sat)}$ = 1.5 V typ. (at $I_C$ = 40 A, $V_{GE}$ = 15 V, Ta = 25°C)
- Quality grade: Standard
- High speed switching
- Non-specification for short circuit
- Applications: UPS, Welding, photovoltaic inverters, Power converter system

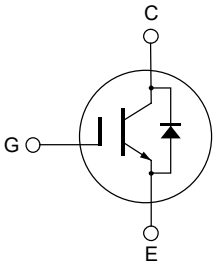
## Key Performance

| Type | $V_{CES}$ | $I_C$ | $V_{CE(sat)}$, $T_C$=25°C | $I_F$ | $T_j$ |
|---|---|---|---|---|---|
| RBN40H65T1FPQ-A0 | 650 V | 40 A | 1.5 V | 30 A | 175 °C |

## Outline

RENESAS Package code: PRSS0003ZH-A
(Package name: TO-247A)




1. Gate
2. Collector
3. Emitter
4. Collector

## Absolute Maximum Ratings

(Tc = 25°C)

| Item | | Symbol | Ratings | Unit |
|---|---|---|---|---|
| Collector to emitter voltage | | $V_{CES}$ | 650 | V |
| Gate to emitter voltage | | $V_{GES}$ | ±30 | V |
| Collector current | Tc = 25 °C | $I_C$ | 80 | A |
| | Tc = 100 °C | $I_C$ | 40 | A |
| Collector peak current | | $I_{C(peak)}$ Notes1 | 160 | A |
| Diode forward current | Tc = 25 °C | $I_F$ | 60 | A |
| | Tc = 100 °C | $I_F$ | 30 | A |
| Diode forward peak current | | $I_{F(peak)}$ Notes1 | 160 | A |
| Collector power dissipation | | $P_C$ Notes 2 | 185 | W |
| Junction temperature | | $T_j$ Notes2 | 175 | °C |
| Storage temperature | | $T_{stg}$ | –55 to +150 | °C |

Note: Continuous heavy condition (e.g. high temperature/voltage/current or high variation of temperature) may affect a reliability even if it is within the absolute maximum ratings. Please consider derating condition for appropriate reliability in reference Renesas Semiconductor Reliability Handbook (Recommendation for Handling and Usage of Semiconductor Devices) and individual reliability data.

Notes: 1. PW ≤ 10 μs, duty cycle ≤ 1%
2. Please use this device in the thermal conditions which the junction temperature does not exceed 175 °C. Renesas IGBT Application Note is disclosed about reliability test and application condition up to 175 °C.

## Thermal Resistance Characteristics

(Tc = 25°C)

| Item | Symbol | Max. Value Notes3 | Unit |
|---|---|---|---|
| Junction to case thermal resistance (IGBT) | $R_{th(j-c)}$ | 0.81 | °C/W |
| Junction to case thermal resistance (Diode) | $R_{th(j-c)}$ | 0.97 | °C/W |

Notes: 3. Designed target value on Renesas measurement condition. (Not tested)

## Electrical Characteristics

(Tc = 25°C)

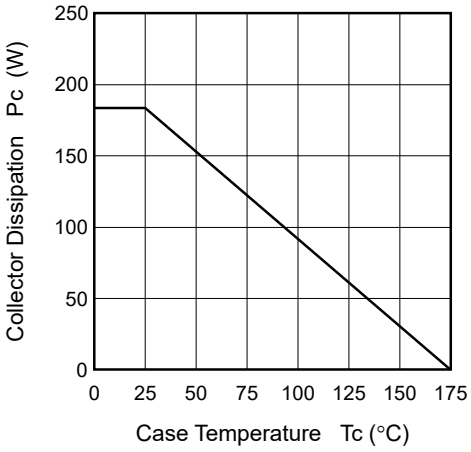
| Item | Symbol | Min | Typ | Max | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| Collector to emitter leakage current | $I_{CES}$ | — | — | 200 | μA | $V_{CE}$ = 650 V, $V_{GE}$ = 0 V |
| Gate to emitter leakage current | $I_{GES}$ | — | — | ±1 | μA | $V_{GE}$ = ±30 V, $V_{CE}$ = 0 V |
| Gate to emitter threshold voltage | $V_{GE(th)}$ | 4.1 | — | 5.9 | V | $V_{CE}$ = 10 V, $I_C$ = 0.8 mA |
| Collector to emitter saturation voltage | $V_{CE(sat)}$ | — | 1.5 | 2.0 | V | $I_C$ = 40 A, $V_{GE}$ = 15 V Notes4 |
| Input capacitance | $C_{ies}$ | — | 775 | — | pF | $V_{CE}$ = 25 V |
| Output capacitance | $C_{oes}$ | — | 105 | — | pF | $V_{GE}$ = 0 V |
| Reverse transfer capacitance | $C_{res}$ | — | 10 | — | pF | f = 1 MHz |
| Total gate charge | $Q_g$ | — | 28 | — | nC | $V_{GE}$ = 15 V |
| Gate to emitter charge | $Q_{ge}$ | — | 7 | — | nC | $V_{CE}$ = 400 V |
| Gate to collector charge | $Q_{gc}$ | — | 13 | — | nC | $I_C$ = 40 A |
| Turn-on delay time | $t_{d(on)}$ | — | 22 | — | Ns | $V_{CC}$ = 400 V |
| Rise time | $t_r$ | — | 19 | — | ns | $V_{GE}$ = +15 V/–5 V |
| Turn-off delay time | $t_{d(off)}$ | — | 96 | — | ns | $I_C$ = 40 A |
| Fall time | $t_f$ | — | 45 | — | ns | $R_g$ = 16 Ω |
| Turn-on loss energy | $E_{on}$ | — | 0.62 | — | mJ | $T_C$ = 25 °C |
| Turn-off loss energy | $E_{off}$ | — | 0.52 | — | mJ | Inductive load Notes5 |
| Total switching energy | $E_{total}$ | — | 1.14 | — | mJ | |
| Turn-on delay time | $t_{d(on)}$ | — | 21 | — | Ns | $V_{CC}$ = 400 V |
| Rise time | $t_r$ | — | 20 | — | ns | $V_{GE}$ = +15 V/–5V |
| Turn-off delay time | $t_{d(off)}$ | — | 120 | — | ns | $I_C$ = 40 A |
| Fall time | $t_f$ | — | 60 | — | ns | $R_g$ = 16 Ω |
| Turn-on loss energy | $E_{on}$ | — | 0.98 | — | mJ | $T_C$ = 150 °C |
| Turn-off loss energy | $E_{off}$ | — | 0.88 | — | mJ | Inductive load Notes5 |
| Total switching energy | $E_{total}$ | — | 1.86 | — | mJ | |
| Diode forward voltage | $V_F$ | — | 1.7 | 2.2 | V | $I_F$ = 30 A Notes4 |
| Diode reverse recovery time | $t_{rr}$ | — | 55 | — | ns | $I_F$ = 30 A, $d_{iF}/d_t$ = 300 A/μs |
| Diode reverse recovery charge | $Q_{rr}$ | — | 0.21 | — | μC | |
| Diode peak reverse recovery current | $I_{rr}$ | — | 7 | — | A | |

Notes: 4. Pulse test

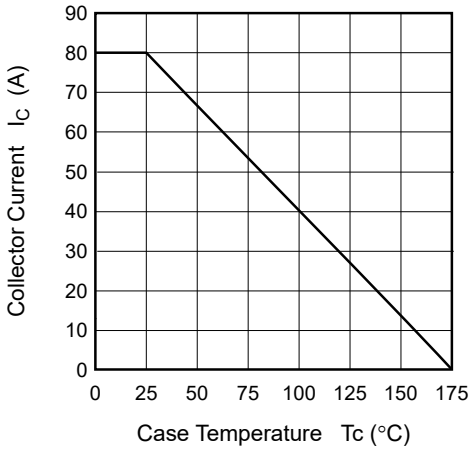
5. Switching time test circuit and waveform are shown below.

## Main Characteristics

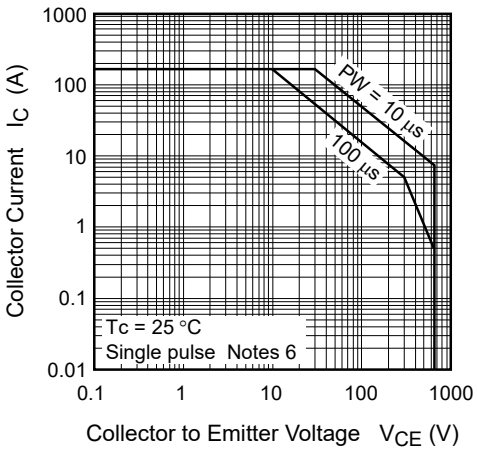
Collector Dissipation vs. Case Temperature



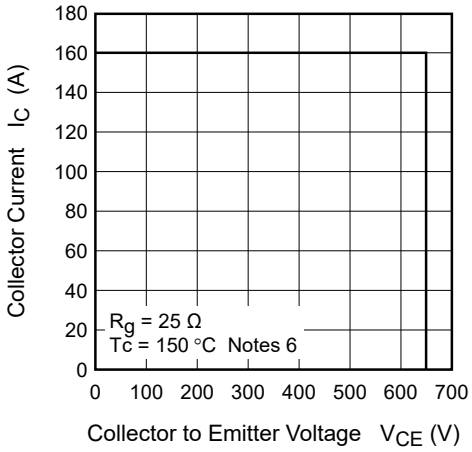

Maximum DC Collector Current vs. Case Temperature



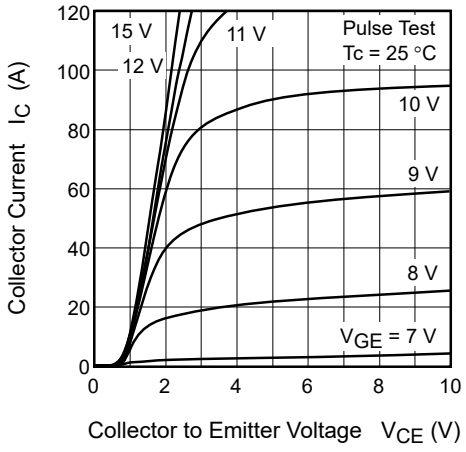

Forward Bias Safe Operating Area



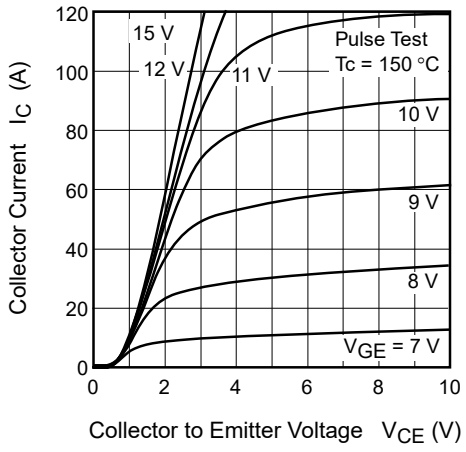

Reverse Bias Safe Operating Area




Typical Output Characteristics

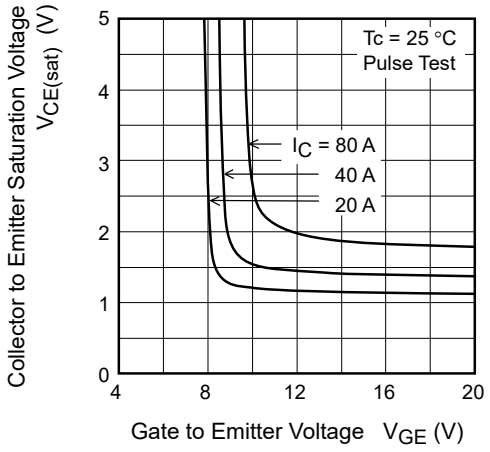



Typical Output Characteristics

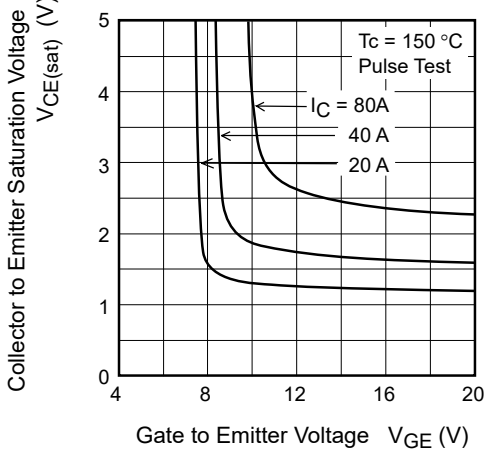



Notes: 6. Designed target value on Renesas measurement condition. (Not tested)
Renesas recommends that operating conditions are designed according to a document “Power MOS FET・IGBT Attention of Handling Semiconductor Devices”.

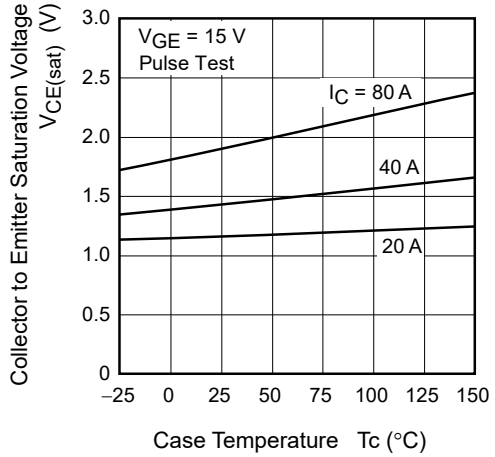
Collector to Emitter Saturation Voltage vs. Gate to Emitter Voltage (Typical)



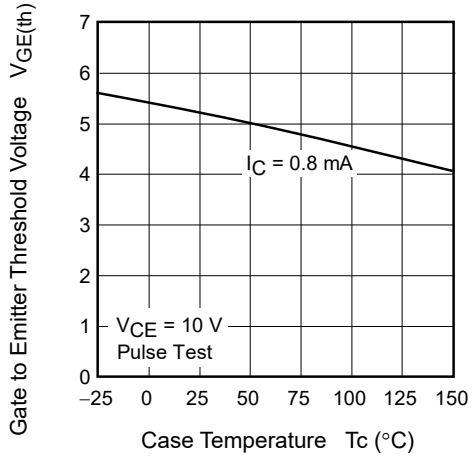

Collector to Emitter Saturation Voltage vs. Gate to Emitter Voltage (Typical)



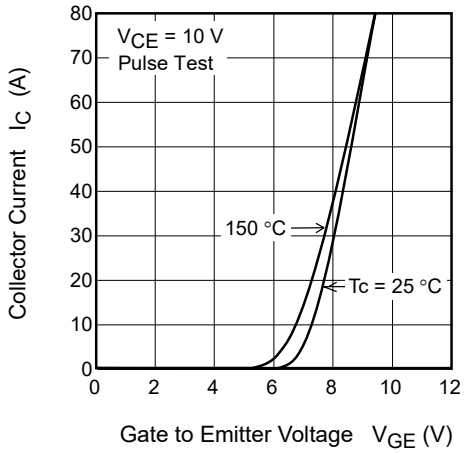

Collector to Emitter Saturation Voltage vs. Case Temperature (Typical)



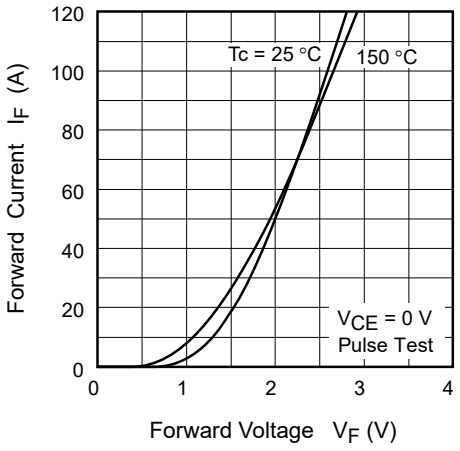

Gate to Emitter Threshold Voltage vs. Case Temperature (Typical)



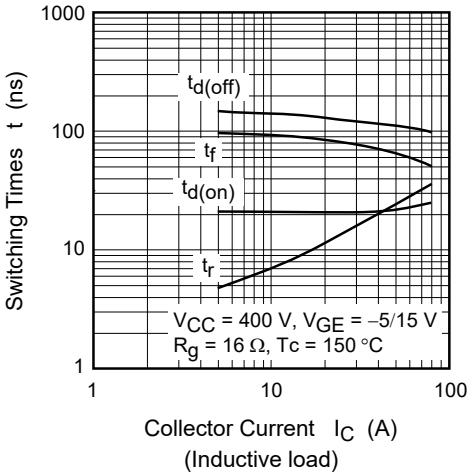

Typical Transfer Characteristics



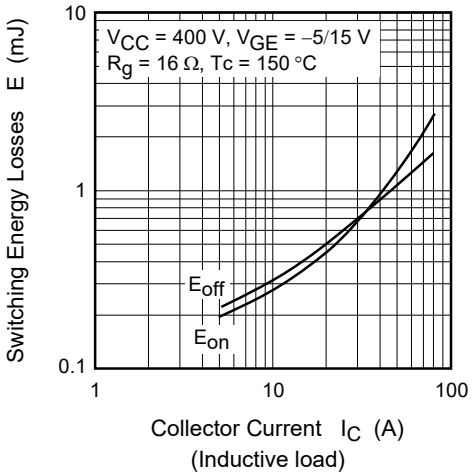

Diode Forward Current vs. Diode Forward Voltage (Typical)



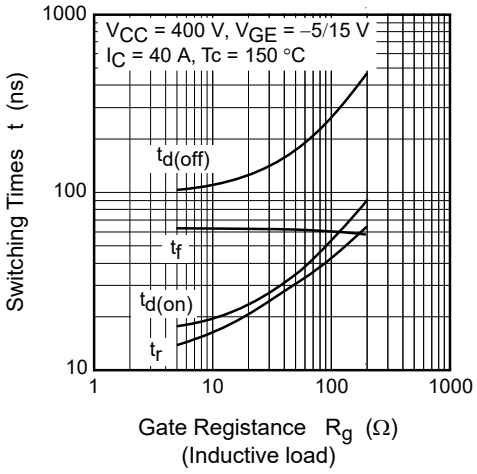
Switching Characteristics (Typical) (1)



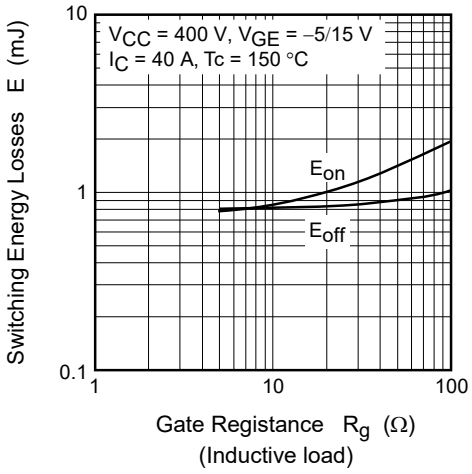

Switching Characteristics (Typical) (2)



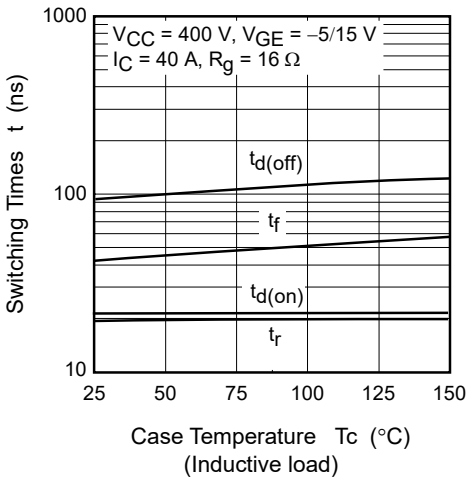

Switching Characteristics (Typical) (3)



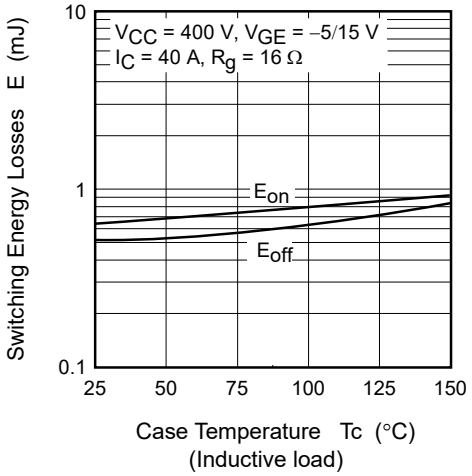

Switching Characteristics (Typical) (4)



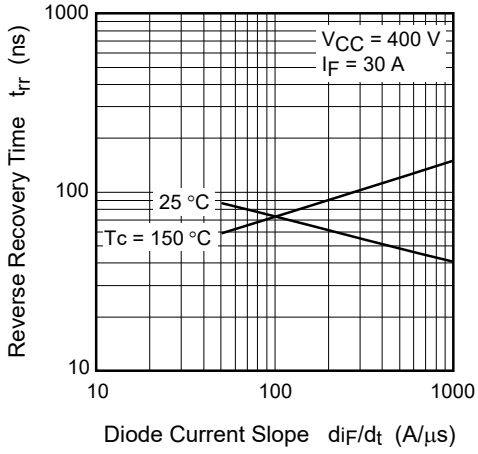

Switching Characteristics (Typical) (5)



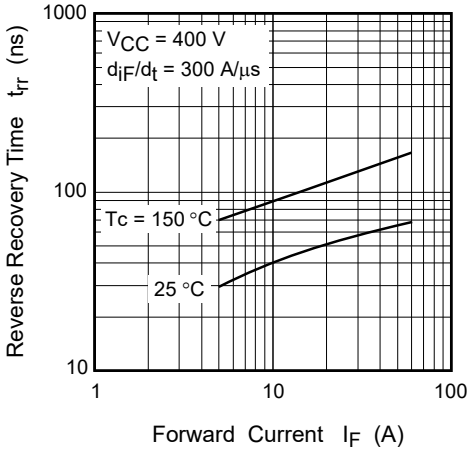

Switching Characteristics (Typical) (6)



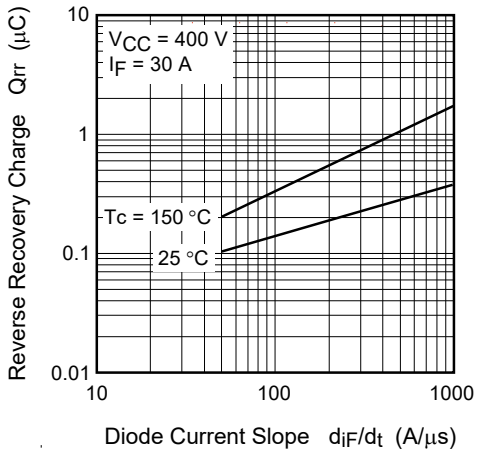
Reverse Recovery Time vs.
Diode Current Slope (Typical)



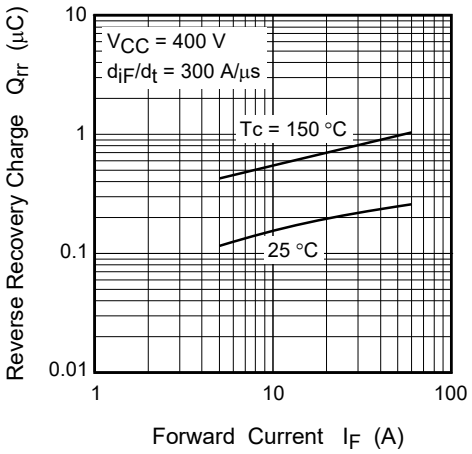

Reverse Recovery Time vs.
Forward Current (Typical)



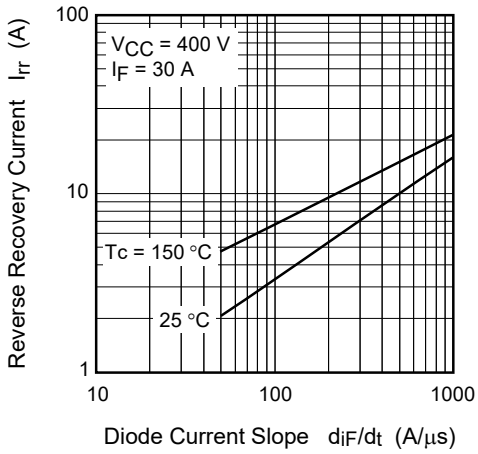

Reverse Recovery Charge vs.
Diode Current Slope (Typical)



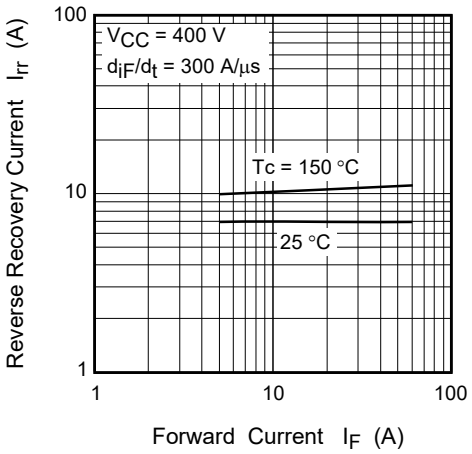

Reverse Recovery Charge vs.
Forward Current (Typical)



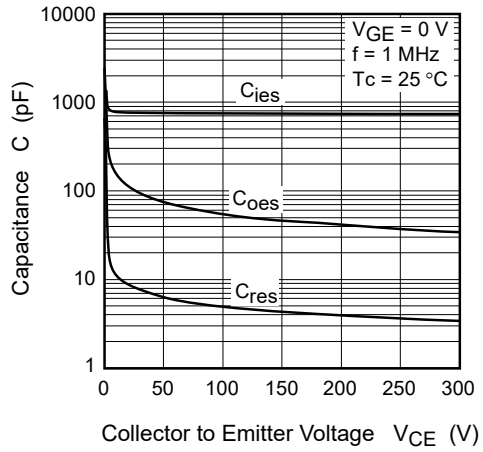

Reverse Recovery Current vs.
Diode Current Slope (Typical)



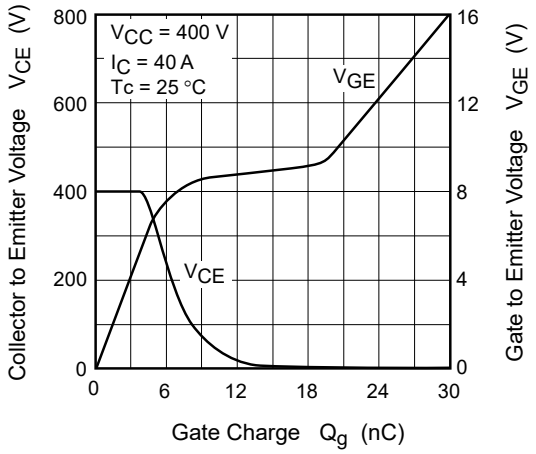

Reverse Recovery Current vs.
Forward Current (Typical)

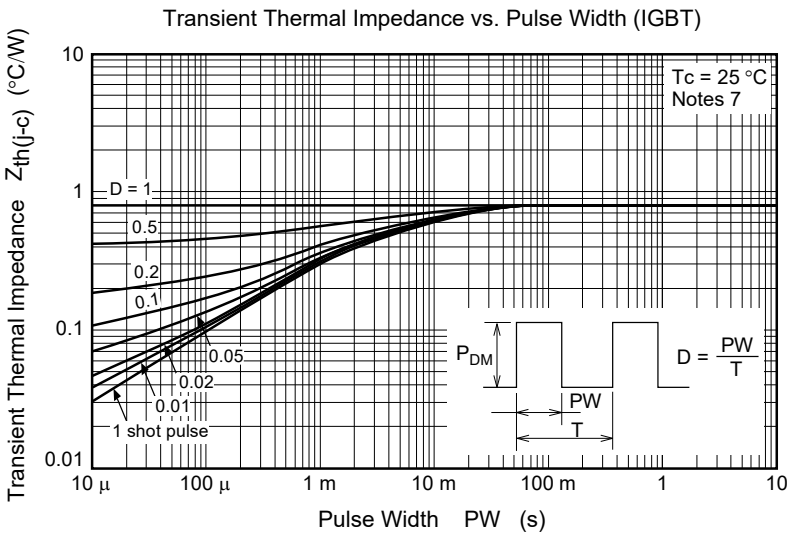


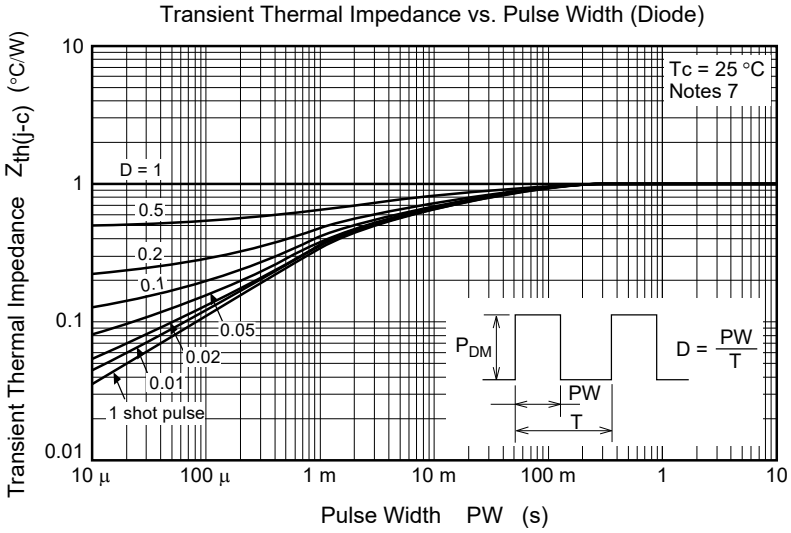
Typical Capacitance vs.
Collector to Emitter Voltage




Dynamic Input Characteristics (Typical)

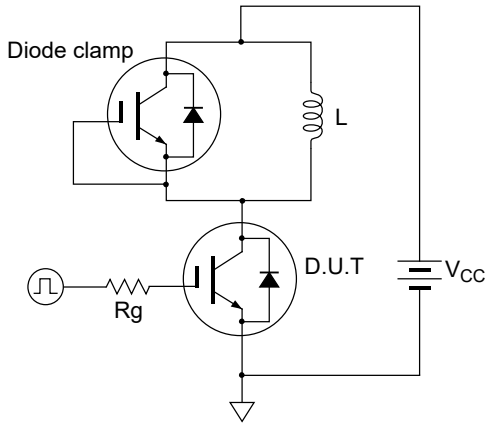




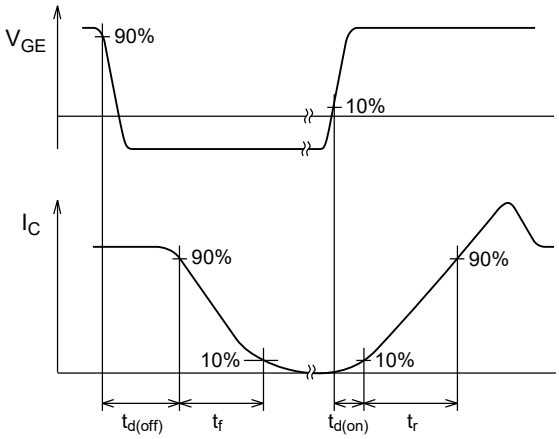




Notes: 7. Designed target value on Renesas measurement condition. (Not tested)

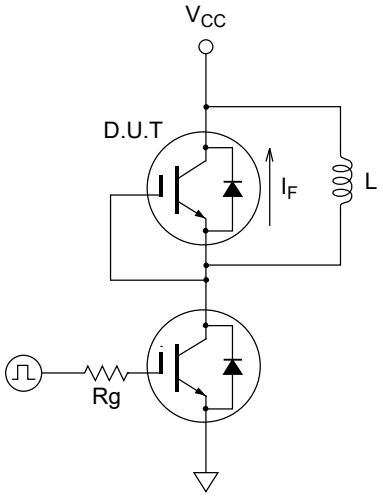
Switching Time Test Circuit



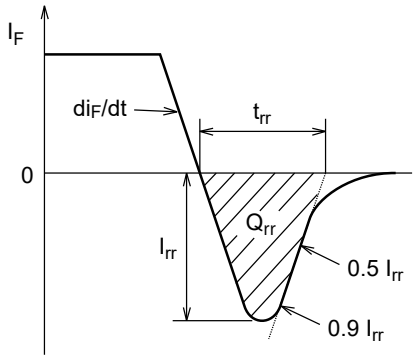

Waveform




Diode Reverse Recovery Time Test Circuit



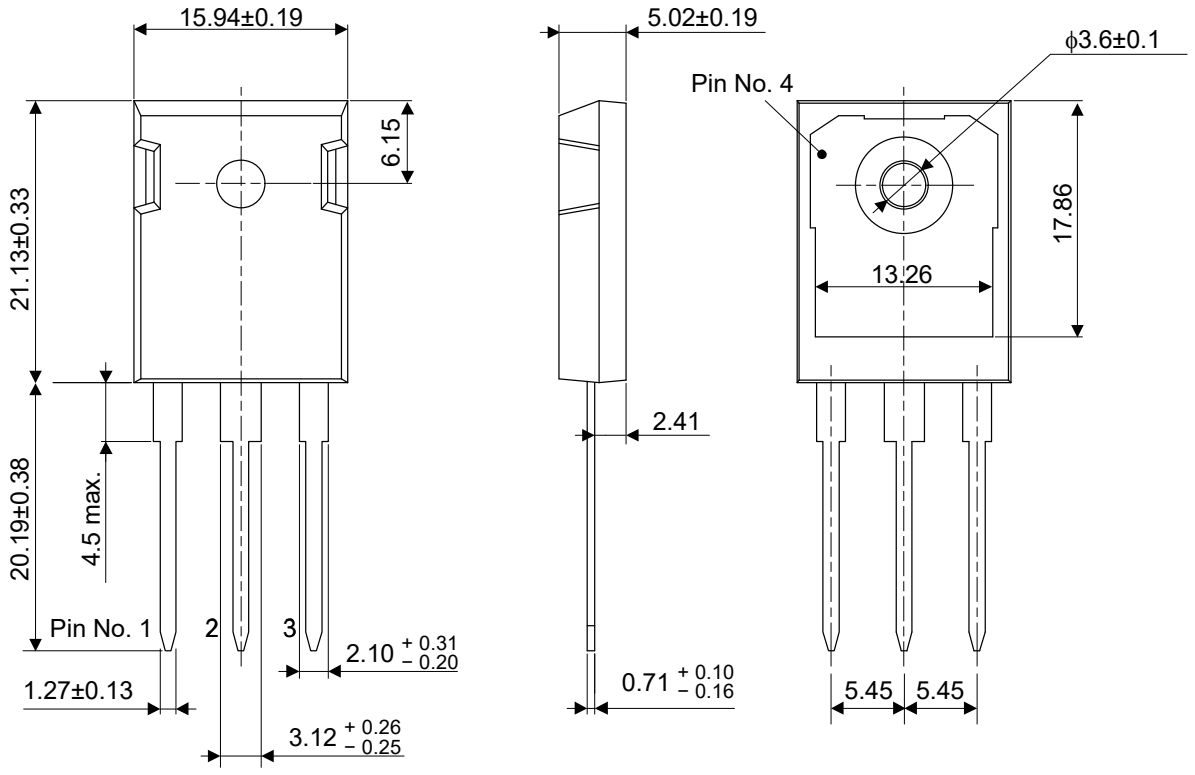

Waveform



## Package Dimensions

| JEDEC Package Code | RENESAS Code | Previous Code | MASS (Typ) [g] |
|---|---|---|---|
| TO-247AD | PRSS0003ZH-A | — | 6.14 |

Unit: mm




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## Ordering Information

| Orderable Part Number | Quantity | Shipping Container |
|---|---|---|
| RBN40H65T1FPQ-A0#CB0 | 240 pcs | Box (Tube) |

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