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# SGH23N60UFD

## Ultra-Fast IGBT

### General Description

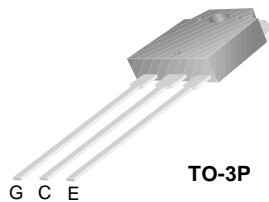
Fairchild's Insulated Gate Bipolar Transistor(IGBT) UFD series provides low conduction and switching losses. UFD series is designed for the applications such as motor control and general inverters where High Speed Switching is required.

### Features

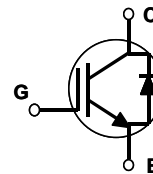
- High Speed Switching
- Low Saturation Voltage :  $V_{CE(sat)} = 2.1\text{ V @ } I_C = 12\text{ A}$
- High Input Impedance
- CO-PAK, IGBT with FRD :  $t_{rr} = 42\text{ ns (typ.)}$

### Application

AC & DC Motor controls, General Purpose Inverters, Robotics, Servo Controls



TO-3P



### Absolute Maximum Ratings $T_C = 25^\circ\text{C}$ unless otherwise noted

| Symbol      | Description  | SGH23N60UFD | Units            |
|-------------|--|-------------|------------------|
| $V_{CES}$   | Collector-Emitter Voltage                                    | 600         | V                |
| $V_{GES}$   | Gate-Emitter Voltage   | $\pm 20$    | V                |
| $I_C$       | Collector Current @ $T_C = 25^\circ\text{C}$                 | 23          | A                |
|             | Collector Current @ $T_C = 100^\circ\text{C}$                | 12          | A                |
| $I_{CM(1)}$ | Pulsed Collector Current                                     | 92          | A                |
| $I_F$       | Diode Continuous Forward Current @ $T_C = 100^\circ\text{C}$ | 12          | A                |
| $I_{FM}$    | Diode Maximum Forward Current                                | 92          | A                |
| $P_D$       | Maximum Power Dissipation @ $T_C = 25^\circ\text{C}$         | 100         | W                |
|             | Maximum Power Dissipation @ $T_C = 100^\circ\text{C}$        | 40          | W                |
| $T_J$       | Operating Junction Temperature                               | -55 to +150 | $^\circ\text{C}$ |
| $T_{stg}$   | Storage Temperature Range                                    | -55 to +150 | $^\circ\text{C}$ |
| $T_L$       | Maximum Lead Temp. for Soldering                             | 300         | $^\circ\text{C}$ |
|             | Purposes, 1/8" from Case for 5 Seconds                       |             |                  |

**Notes :**

(1) Repetitive rating : Pulse width limited by max. junction temperature

### Thermal Characteristics

| Symbol                        | Parameter                               | Typ. | Max. | Units              |
|-------------------------------|---|------|------|--------------------|
| $R_{\theta JC}(\text{IGBT})$  | Thermal Resistance, Junction-to-Case    | --   | 1.2  | $^\circ\text{C/W}$ |
| $R_{\theta JC}(\text{DIODE})$ | Thermal Resistance, Junction-to-Case    | --   | 2.5  | $^\circ\text{C/W}$ |
| $R_{\theta JA}$               | Thermal Resistance, Junction-to-Ambient | --   | 40   | $^\circ\text{C/W}$ |

**Electrical Characteristics of IGBT**  $T_C = 25^\circ\text{C}$  unless otherwise noted

| Symbol                               | Parameter                               | Test Conditions                 | Min. | Typ. | Max.      | Units        |
|--------------------------------------|---|---------------------------------|------|------|-----------|--------------|
| <b>Off Characteristics</b>           |   |                                 |      |      |           |              |
| $BV_{CES}$                           | Collector-Emitter Breakdown Voltage     | $V_{GE} = 0V, I_C = 250\mu A$   | 600  | --   | --        | V            |
| $\frac{\Delta BV_{CES}}{\Delta T_J}$ | Temperature Coeff. of Breakdown Voltage | $V_{GE} = 0V, I_C = 1mA$        | --   | 0.6  | --        | $V/^\circ C$ |
| $I_{CES}$                            | Collector Cut-Off Current               | $V_{CE} = V_{CES}, V_{GE} = 0V$ | --   | --   | 250       | $\mu A$      |
| $I_{GES}$                            | G-E Leakage Current                     | $V_{GE} = V_{GES}, V_{CE} = 0V$ | --   | --   | $\pm 100$ | nA           |

**On Characteristics**

|               |   |                               |     |     |     |   |
|---------------|---|-------------------------------|-----|-----|-----|---|
| $V_{GE(th)}$  | G-E Threshold Voltage                   | $I_C = 12mA, V_{CE} = V_{GE}$ | 3.5 | 4.5 | 6.5 | V |
| $V_{CE(sat)}$ | Collector to Emitter Saturation Voltage | $I_C = 12A, V_{GE} = 15V$     | --  | 2.1 | 2.6 | V |
|               |   | $I_C = 23A, V_{GE} = 15V$     | --  | 2.6 | --  | V |

**Dynamic Characteristics**

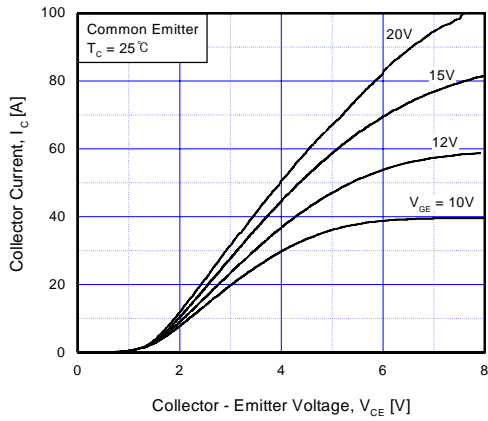
|           |                              |  |    |     |    |    |
|-----------|------------------------------|--|----|-----|----|----|
| $C_{ies}$ | Input Capacitance            | $V_{CE} = 30V, V_{GE} = 0V,$<br>$f = 1MHz$ | -- | 720 | -- | pF |
| $C_{oes}$ | Output Capacitance           |  | -- | 100 | -- | pF |
| $C_{res}$ | Reverse Transfer Capacitance |  | -- | 25  | -- | pF |

**Switching Characteristics**

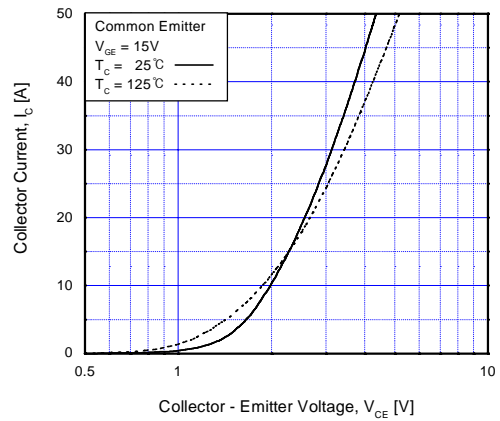
|              |                             |   |     |     |         |         |
|--------------|-----------------------------|---|-----|-----|---------|---------|
| $t_{d(on)}$  | Turn-On Delay Time          | $V_{CC} = 300V, I_C = 12A,$<br>$R_G = 23\Omega, V_{GE} = 15V,$<br>Inductive Load, $T_C = 25^\circ C$  | --  | 17  | --      | ns      |
| $t_r$        | Rise Time                   |   | --  | 27  | --      | ns      |
| $t_{d(off)}$ | Turn-Off Delay Time         |   | --  | 60  | 130     | ns      |
| $t_f$        | Fall Time                   |   | --  | 70  | 150     | ns      |
| $E_{on}$     | Turn-On Switching Loss      |   | --  | 115 | --      | $\mu J$ |
| $E_{off}$    | Turn-Off Switching Loss     |   | --  | 135 | --      | $\mu J$ |
| $E_{ts}$     | Total Switching Loss        | --  | 250 | 400 | $\mu J$ |         |
| $t_{d(on)}$  | Turn-On Delay Time          | $V_{CC} = 300V, I_C = 12A,$<br>$R_G = 23\Omega, V_{GE} = 15V,$<br>Inductive Load, $T_C = 125^\circ C$ | --  | 23  | --      | ns      |
| $t_r$        | Rise Time                   |   | --  | 32  | --      | ns      |
| $t_{d(off)}$ | Turn-Off Delay Time         |   | --  | 100 | 200     | ns      |
| $t_f$        | Fall Time                   |   | --  | 220 | 250     | ns      |
| $E_{on}$     | Turn- On Switching Loss     |   | --  | 205 | --      | $\mu J$ |
| $E_{off}$    | Turn- Off Switching Loss    |   | --  | 320 | --      | $\mu J$ |
| $E_{ts}$     | Total Switching Loss        | --  | 525 | 800 | $\mu J$ |         |
| $Q_g$        | Total Gate Charge           | $V_{CE} = 300V, I_C = 12A,$<br>$V_{GE} = 15V$   | --  | 49  | 80      | nC      |
| $Q_{ge}$     | Gate-Emitter Charge         |   | --  | 11  | 17      | nC      |
| $Q_{gc}$     | Gate-Collector Charge       |   | --  | 14  | 22      | nC      |
| $L_e$        | Internal Emitter Inductance | Measured 5mm from PKG   | --  | 14  | --      | nH      |

**Electrical Characteristics of DIODE**  $T_C = 25^\circ\text{C}$  unless otherwise noted

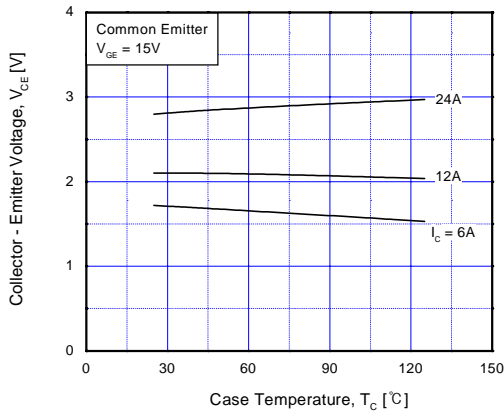
| Symbol   | Parameter                           | Test Conditions                      | Min.                | Typ. | Max. | Units |    |
|----------|-------------------------------------|--------------------------------------|---------------------|------|------|-------|----|
| $V_{FM}$ | Diode Forward Voltage               | $I_F = 12A$                          | $T_C = 25^\circ C$  | --   | 1.4  | 1.7   | V  |
|          |                                     |                                      | $T_C = 100^\circ C$ | --   | 1.3  | --    |    |
| $t_{rr}$ | Diode Reverse Recovery Time         | $I_F = 12A,$<br>$di/dt = 200A/\mu s$ | $T_C = 25^\circ C$  | --   | 42   | 60    | ns |
|          |                                     |                                      | $T_C = 100^\circ C$ | --   | 80   | --    |    |
| $I_{rr}$ | Diode Peak Reverse Recovery Current | $I_F = 12A,$<br>$di/dt = 200A/\mu s$ | $T_C = 25^\circ C$  | --   | 3.5  | 6.0   | A  |
|          |                                     |                                      | $T_C = 100^\circ C$ | --   | 5.6  | --    |    |
| $Q_{rr}$ | Diode Reverse Recovery Charge       | $I_F = 12A,$<br>$di/dt = 200A/\mu s$ | $T_C = 25^\circ C$  | --   | 80   | 180   | nC |
|          |                                     |                                      | $T_C = 100^\circ C$ | --   | 220  | --    |    |



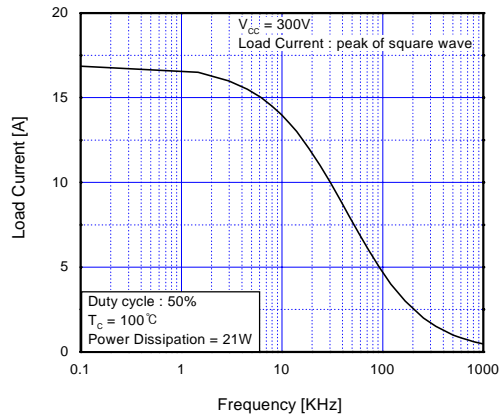
**Fig 1. Typical Output Characteristics**



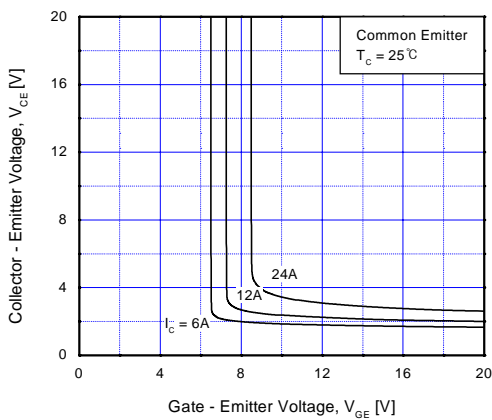
**Fig 2. Typical Saturation Voltage Characteristics**



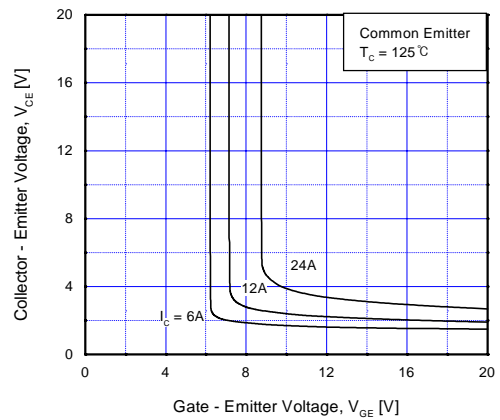
**Fig 3. Saturation Voltage vs. Case Temperature at Variant Current Level**



**Fig 4. Load Current vs. Frequency**



**Fig 5. Saturation Voltage vs.  $V_{GE}$**



**Fig 6. Saturation Voltage vs.  $V_{GE}$**

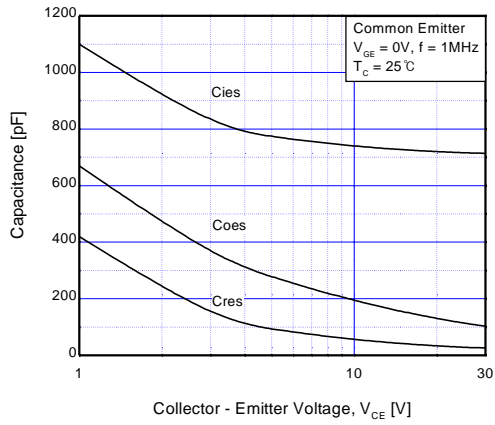


Fig 7. Capacitance Characteristics

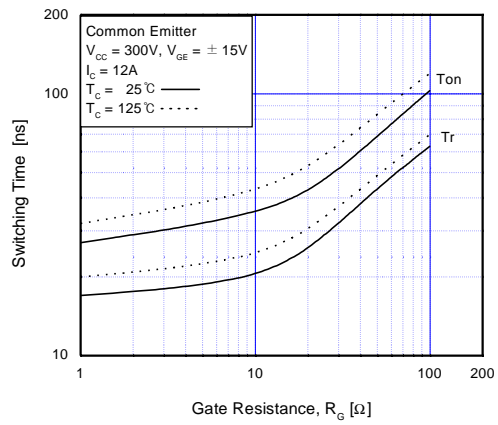


Fig 8. Turn-On Characteristics vs. Gate Resistance

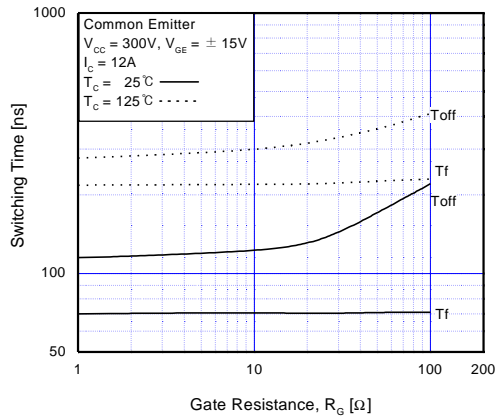


Fig 9. Turn-Off Characteristics vs. Gate Resistance

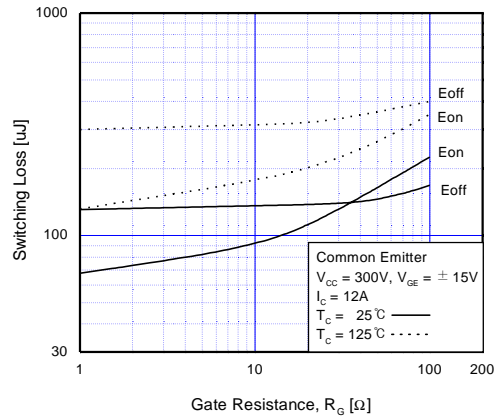


Fig 10. Switching Loss vs. Gate Resistance

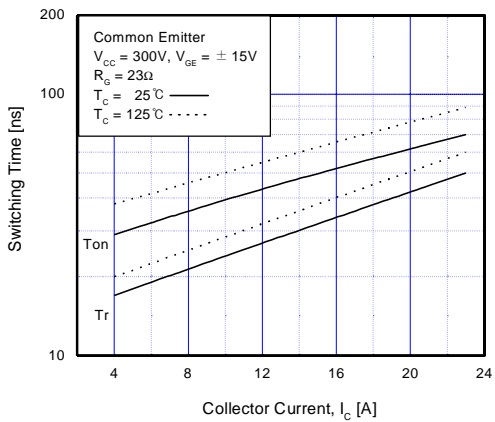


Fig 11. Turn-On Characteristics vs. Collector Current

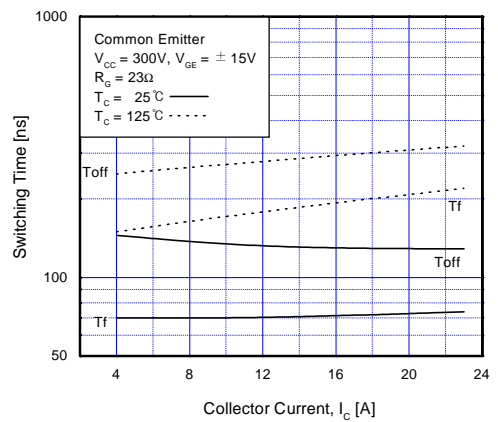


Fig 12. Turn-Off Characteristics vs. Collector Current

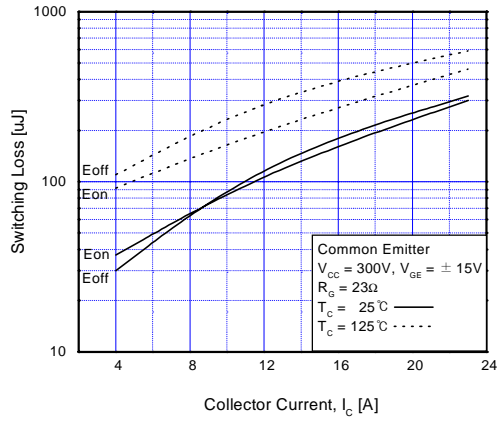


Fig 13. Switching Loss vs. Collector Current

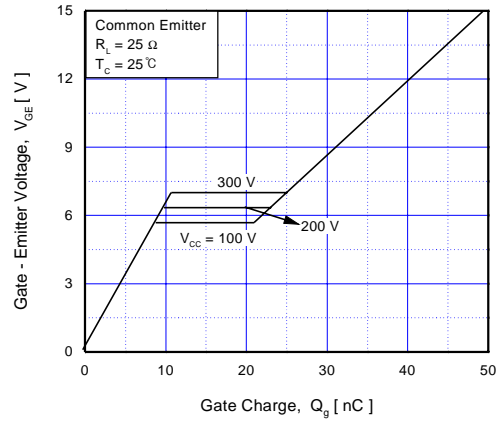


Fig 14. Gate Charge Characteristics

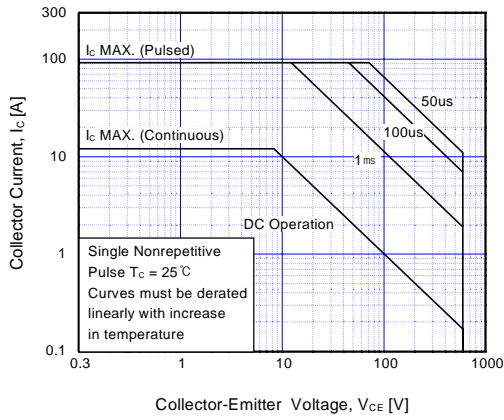


Fig 15. SOA Characteristics

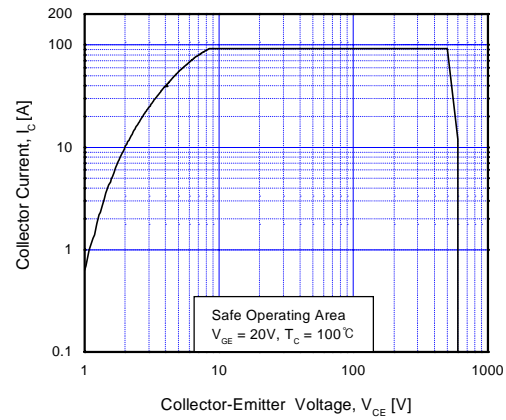


Fig 16. Turn-Off SOA Characteristics

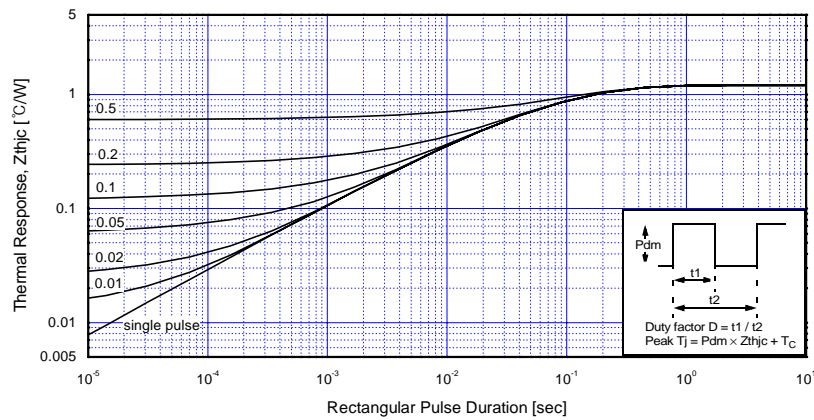


Fig 17. Transient Thermal Impedance of IGBT

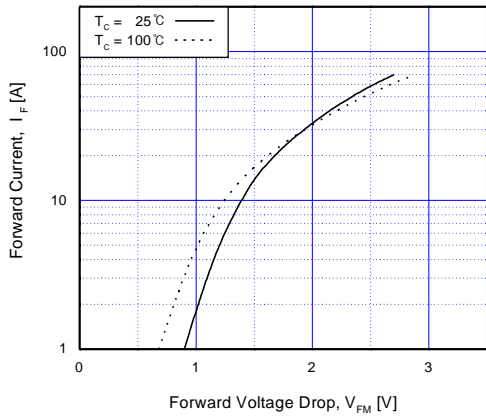


Fig 18. Forward Characteristics

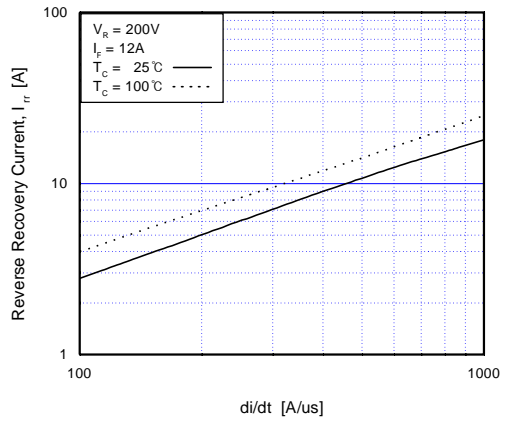


Fig 19. Reverse Recovery Current

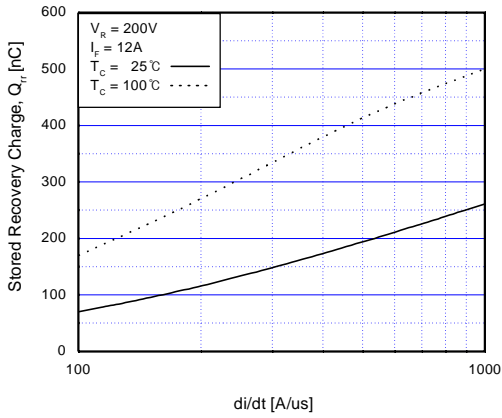


Fig 20. Stored Charge

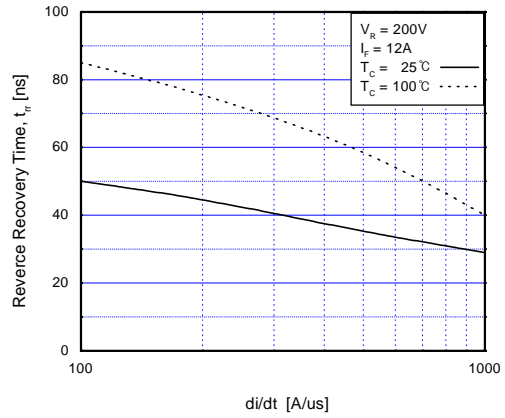


Fig 21. Reverse Recovery Time

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