

# SGF23N60UFD

## Ultra-Fast IGBT

### General Description

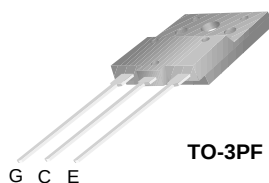
Fairchild's Insulated Gate Bipolar Transistor(IGBT) UFD series provides low conduction and switching losses. UFD series is designed for the applications such as motor control and general inverters where High Speed Switching is required.

### Features

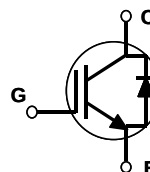
- High Speed Switching
- Low Saturation Voltage :  $V_{CE(sat)} = 2.1\text{ V @ } I_C = 12\text{ A}$
- High Input Impedance
- CO-PAK, IGBT with FRD :  $t_{rr} = 42\text{ ns (typ.)}$

### Application

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



TO-3PF



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

| Symbol      | Description                                                             | SGF23N60UFD | 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 @ $T_C = 25^\circ\text{C}$                    | 75          | W                |
|             | Maximum Power Dissipation @ $T_C = 100^\circ\text{C}$                   | 30          | 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 Purposes, 1/8" from Case for 5 Seconds | 300         | $^\circ\text{C}$ |

**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    | --   | 1.6  | $^\circ\text{C/W}$ |
| $R_{\theta JC}(\text{DIODE})$ | Thermal Resistance, Junction-to-Case    | --   | 3.0  | $^\circ\text{C/W}$ |
| $R_{\theta JA}$               | 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            |
| $\Delta BV_{CES}/\Delta T_J$ | 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            | $V_{CE} = 30V, V_{GE} = 0V, f = 1MHz$ | -- | 720 | -- | pF |
| $C_{oes}$ | Output Capacitance           |                                       | -- | 100 | -- | pF |
| $C_{res}$ | Reverse Transfer Capacitance |                                       | -- | 25  | -- | pF |

**Switching Characteristics**

|              |                             |                                                                                                    |    |     |     |         |
|--------------|-----------------------------|----------------------------------------------------------------------------------------------------|----|-----|-----|---------|
| $t_{d(on)}$  | Turn-On Delay Time          | $V_{CC} = 300V, I_C = 12A, R_G = 23\Omega, V_{GE} = 15V, \text{Inductive Load}, T_C = 25^\circ C$  | -- | 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     | $V_{CC} = 300V, I_C = 12A, R_G = 23\Omega, V_{GE} = 15V, \text{Inductive Load}, T_C = 125^\circ C$ | -- | 135 | --  | $\mu J$ |
| $E_{ts}$     | Total Switching Loss        |                                                                                                    | -- | 250 | 400 | $\mu J$ |
| $t_{d(on)}$  | Turn-On Delay Time          |                                                                                                    | -- | 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      | $V_{CE} = 300V, I_C = 12A, V_{GE} = 15V$                                                           | -- | 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           |                                                                                                    | -- | 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 <sub>FM</sub> | Diode Forward Voltage               | I <sub>F</sub> = 12A                     | T <sub>C</sub> = 25°C  | --   | 1.4  | 1.7  | V     |
|                 |                                     |                                          | T <sub>C</sub> = 100°C | --   | 1.3  | --   |       |
| t <sub>rr</sub> | Diode Reverse Recovery Time         | I <sub>F</sub> = 12A,<br>di/dt = 200A/us | T <sub>C</sub> = 25°C  | --   | 42   | 60   | ns    |
|                 |                                     |                                          | T <sub>C</sub> = 100°C | --   | 80   | --   |       |
| I <sub>rr</sub> | Diode Peak Reverse Recovery Current |                                          | T <sub>C</sub> = 25°C  | --   | 3.5  | 6.0  | A     |
|                 |                                     |                                          | T <sub>C</sub> = 100°C | --   | 5.6  | --   |       |
| Q <sub>rr</sub> | Diode Reverse Recovery Charge       |                                          | T <sub>C</sub> = 25°C  | --   | 80   | 180  | nC    |
|                 |                                     |                                          | T <sub>C</sub> = 100°C | --   | 220  | --   |       |

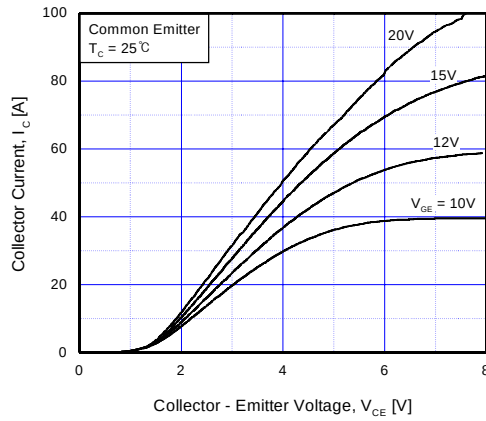


Fig 1. Typical Output Characteristics

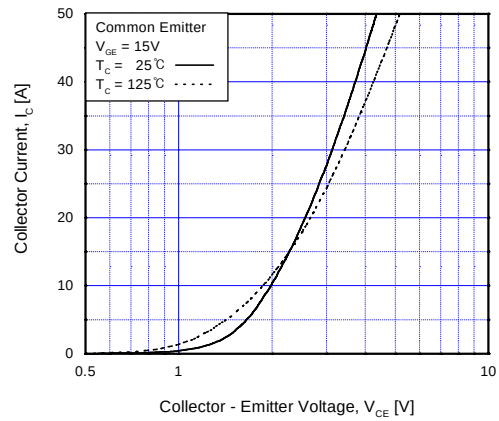


Fig 2. Typical Saturation Voltage Characteristics

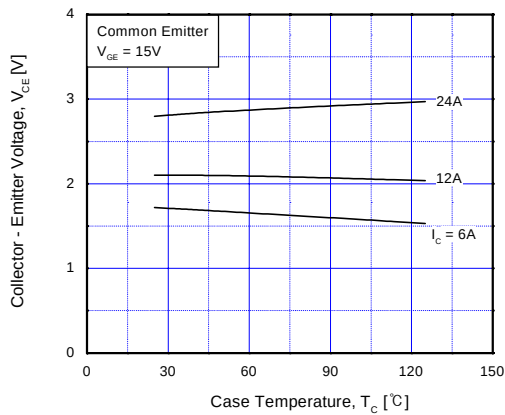


Fig 3. Saturation Voltage vs. Case Temperature at Variant Current Level

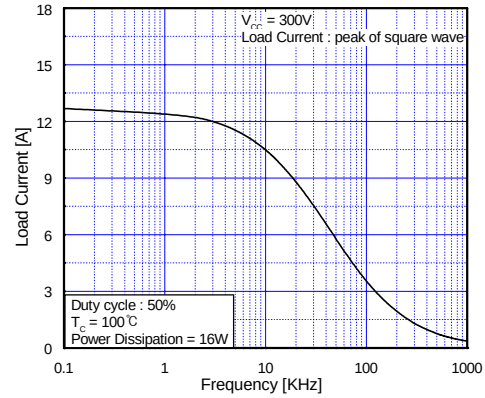
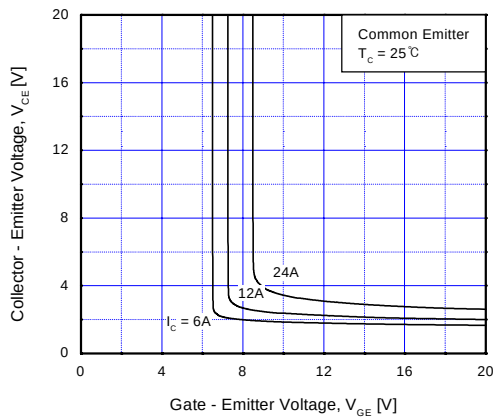
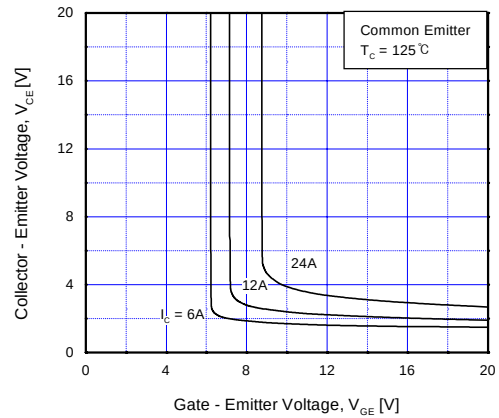


Fig 4. Load Current vs. Frequency

Fig 5. Saturation Voltage vs.  $V_{GE}$ Fig 6. Saturation Voltage vs.  $V_{GE}$

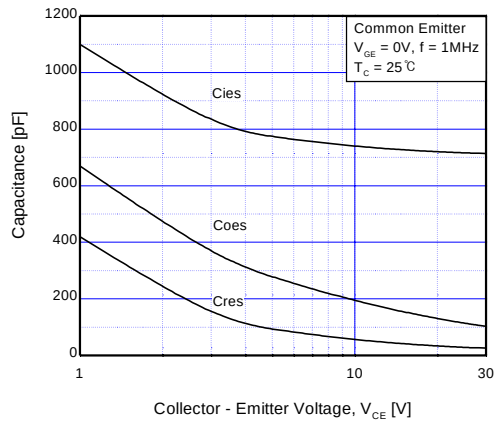


Fig 7. Capacitance Characteristics

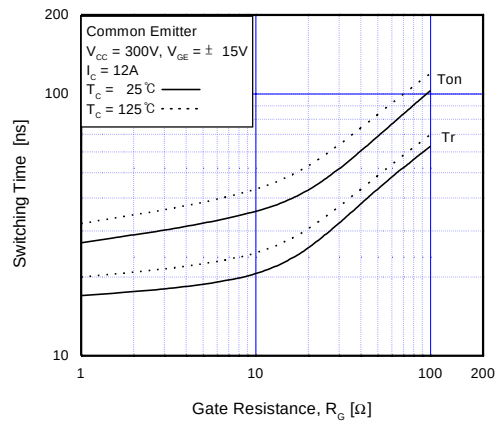


Fig 8. Turn-On Characteristics vs. Gate Resistance

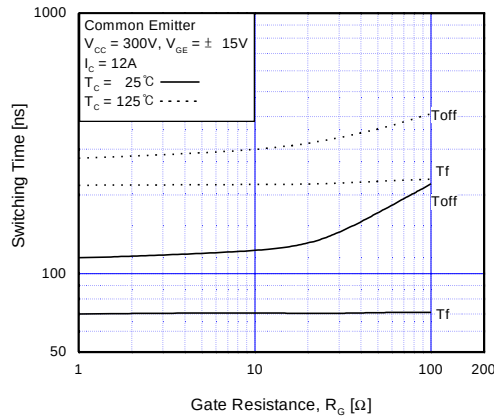


Fig 9. Turn-Off Characteristics vs. Gate Resistance

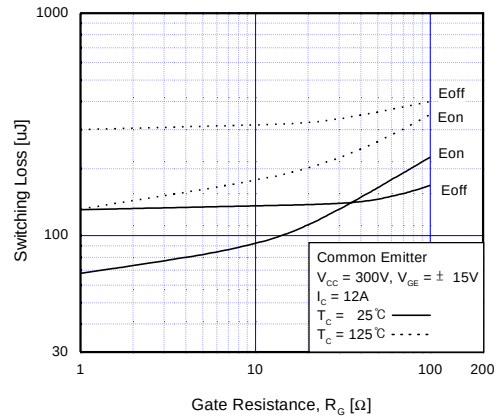


Fig 10. Switching Loss vs. Gate Resistance

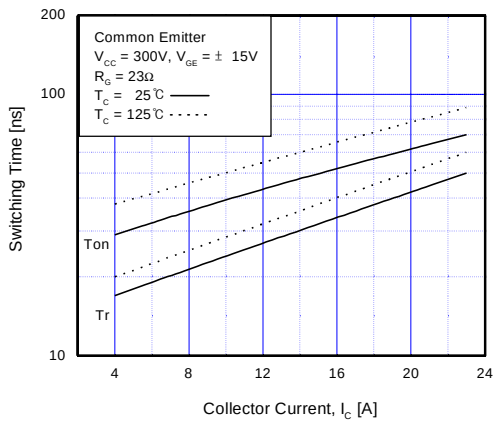


Fig 11. Turn-On Characteristics vs. Collector Current

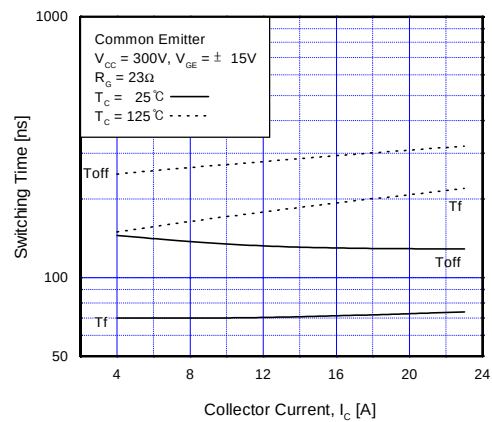


Fig 12. Turn-Off Characteristics vs. Collector Current

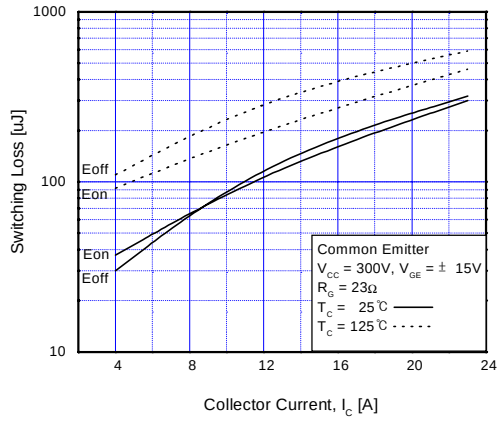


Fig 13. Switching Loss vs. Collector Current

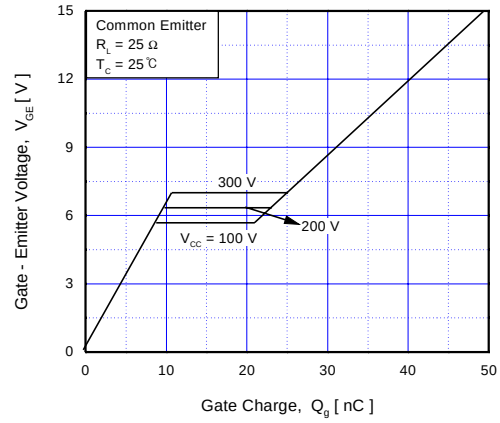


Fig 14. Gate Charge Characteristics

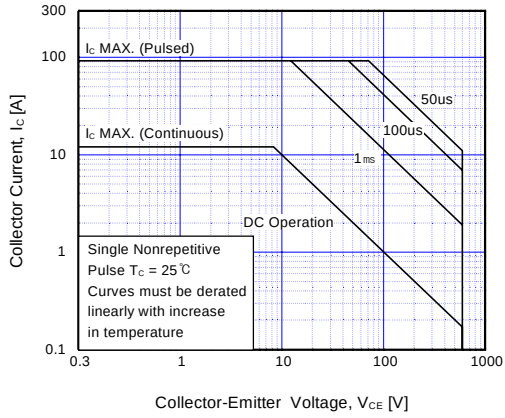


Fig 15. SOA Characteristics

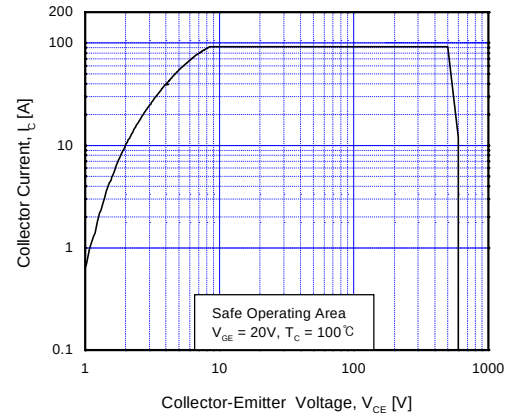


Fig 16. Turn-Off SOA Characteristics

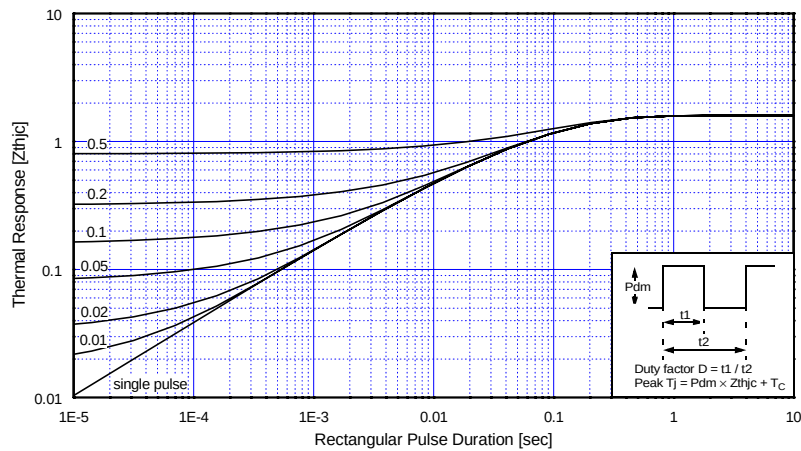


Fig 17. Transient Thermal Impedance of IGBT

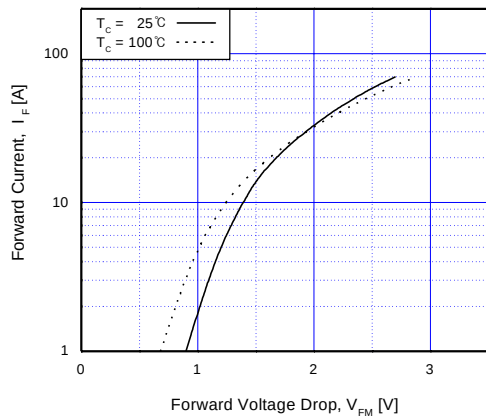


Fig 18. Forward Characteristics

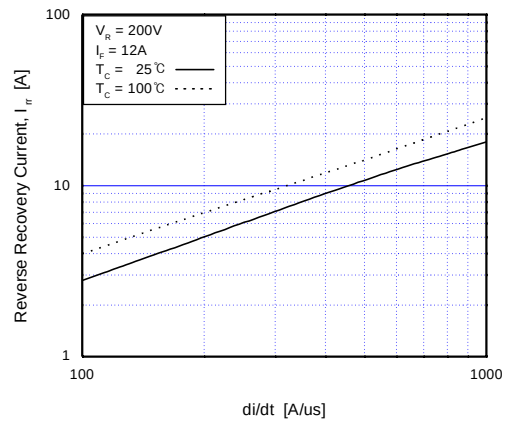


Fig 19. Reverse Recovery Current

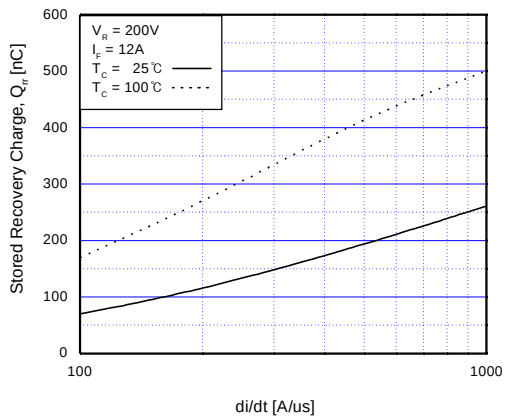


Fig 20. Stored Charge

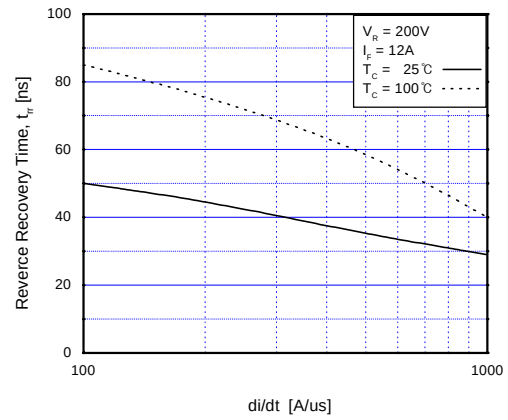


Fig 21. Reverse Recovery Time

Technical drawing of a mechanical part, showing three views: front, side, and top. The drawing includes dimensions and tolerances.

**Front View Dimensions:**

- Overall width:  $15.50 \pm 0.20$
- Overall height:  $26.50 \pm 0.20$
- Top section height:  $4.50 \pm 0.20$
- Section height:  $16.50 \pm 0.20$
- Section height:  $14.50 \pm 0.20$
- Section height:  $2.00 \pm 0.20$
- Section height:  $2.50 \pm 0.20$
- Section height:  $14.80 \pm 0.20$
- Section height:  $2.00 \pm 0.20$
- Section height:  $2.00 \pm 0.20$
- Section height:  $4.00 \pm 0.20$
- Section height:  $0.75^{+0.20}_{-0.10}$
- Section height:  $2.00 \pm 0.20$
- Section height:  $2.00 \pm 0.20$
- Section height:  $5.45 \text{ TYP}$  [ $5.45 \pm 0.30$ ]
- Section height:  $5.45 \text{ TYP}$  [ $5.45 \pm 0.30$ ]

**Side View Dimensions:**

- Overall width:  $5.50 \pm 0.20$
- Overall height:  $23.00 \pm 0.20$
- Section height:  $10.00 \pm 0.20$
- Section height:  $16.50 \pm 0.20$
- Section height:  $1.50 \pm 0.20$
- Section height:  $2.00 \pm 0.20$
- Section height:  $3.30 \pm 0.20$
- Section height:  $0.90^{+0.20}_{-0.10}$

**Top View Dimensions:**

- Overall width:  $15.50 \pm 0.20$
- Overall height:  $5.50 \pm 0.20$
- Section height:  $3.30 \pm 0.20$
- Section height:  $2.00 \pm 0.20$

**Other Dimensions:**

- Section height:  $0.85 \pm 0.03$
- Section height:  $1.00$
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- Section height:  $80$

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| CoolFET <sup>™</sup>             | FRFET <sup>™</sup>              | POP <sup>™</sup>                | SuperSOT <sup>™</sup> -3    |
| CROSSVOLT <sup>™</sup>           | GlobalOptoisolator <sup>™</sup> | Power247 <sup>™</sup>           | SuperSOT <sup>™</sup> -6    |
| DenseTrench <sup>™</sup>         | GTO <sup>™</sup>                | PowerTrench <sup>®</sup>        | SuperSOT <sup>™</sup> -8    |
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| E <sup>2</sup> CMOS <sup>™</sup> | LittleFET <sup>™</sup>          | QT Optoelectronics <sup>™</sup> | TinyLogic <sup>™</sup>      |
| EnSigna <sup>™</sup>             | MicroFET <sup>™</sup>           | Quiet Series <sup>™</sup>       | UHC <sup>™</sup>            |
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FAIRCHILD'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF FAIRCHILD SEMICONDUCTOR INTERNATIONAL.

As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, or (c) whose failure to perform when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in significant injury to the user.
2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

## PRODUCT STATUS DEFINITIONS

### Definition of Terms

| Datasheet Identification | Product Status         | Definition                                                                                                                                                                                                            |
|--------------------------|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Advance Information      | Formative or In Design | This datasheet contains the design specifications for product development. Specifications may change in any manner without notice.                                                                                    |
| Preliminary              | First Production       | This datasheet contains preliminary data, and supplementary data will be published at a later date. Fairchild Semiconductor reserves the right to make changes at any time without notice in order to improve design. |
| No Identification Needed | Full Production        | This datasheet contains final specifications. Fairchild Semiconductor reserves the right to make changes at any time without notice in order to improve design.                                                       |
| Obsolete                 | Not In Production      | This datasheet contains specifications on a product that has been discontinued by Fairchild semiconductor. The datasheet is printed for reference information only.                                                   |