

# FMS7G20US60

## Compact & Complex Module

### Features

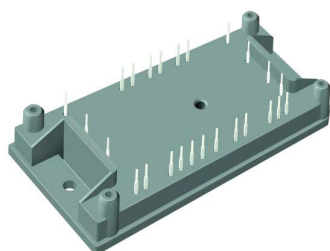
- Short Circuit rated  $10\mu\text{s}$  @  $T_C = 100^\circ\text{C}$ ,  $V_{GE} = 15\text{V}$
- High Speed Switching
- Low Saturation Voltage :  $V_{CE(sat)} = 2.1\text{ V @ } I_C = 20\text{A}$
- High Input Impedance
- Built in Brake & 3 Phase Rectifier Circuit
- Fast & Soft Anti-Parallel FWD
- Built-in NTC Thermistor

### Applications

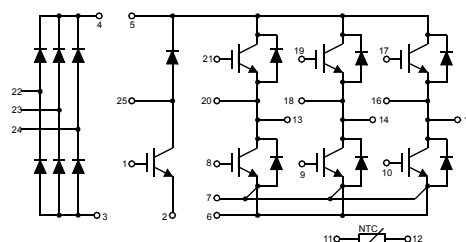
- AC & DC Motor Controls
- General Purpose Inverters
- Robotics
- Servo Controls

### Description

Fairchild IGBT Power Module provides low conduction and switching losses as well as short circuit ruggedness. It's designed for the applications such as motor control and general inverters where short-circuit ruggedness is required.



Package Code : 25PM-AA



Internal Circuit Diagram

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

|                  | Symbol      | Description                                                          | FMS7G20US60 | Units                |
|------------------|-------------|----------------------------------------------------------------------|-------------|----------------------|
| Inverter & Brake | $V_{CES}$   | Collector-Emitter Voltage                                            | 600         | V                    |
|                  | $V_{GES}$   | Gate-Emitter Voltage                                                 | $\pm 20$    | V                    |
|                  | $I_C$       | Collector Current @ $T_C = 80^\circ\text{C}$                         | 20          | A                    |
|                  | $I_{CM(1)}$ | Pulsed Collector Current                                             | 40          | A                    |
|                  | $I_F$       | Diode Continuous Forward Current @ $T_C = 80^\circ\text{C}$          | 20          | A                    |
|                  | $I_{FM}$    | Diode Maximum Forward Current                                        | 40          | A                    |
|                  | $P_D$       | Maximum Power Dissipation @ $T_C = 25^\circ\text{C}$                 | 89          | W                    |
|                  | $T_{SC}$    | Short Circuit Withstand Time @ $T_C = 100^\circ\text{C}$             | 10          | $\mu\text{s}$        |
| Converter        | $V_{RRM}$   | Repetitive Peak Reverse Voltage                                      | 1600        | V                    |
|                  | $I_O$       | Average Output Rectified Current                                     | 20          | A                    |
|                  | $I_{FSM}$   | Surge Forward Current<br>@ 1Cycle at 60Hz, Peak value Non-Repetitive | 200         | A                    |
|                  | $i^2t$      | Energy pulse @ 1Cycle at 60Hz                                        | 164         | $\text{A}^2\text{s}$ |
| Common           | $T_J$       | Operating Junction Temperature                                       | -40 to +150 | $^\circ\text{C}$     |
|                  | $T_{STG}$   | Storage Temperature Range                                            | -40 to +125 | $^\circ\text{C}$     |
|                  | $V_{ISO}$   | Isolation Voltage @ AC 1minute                                       | 2500        | V                    |
| Mounting Torque  |             | Mounting part Screw @ M4                                             | 2.0         | N·m                  |

### Notes :

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

## Package Marking and Ordering Information

| Device Marking | Device      | Package | Reel Size | Tape Width | Quantity |
|----------------|-------------|---------|-----------|------------|----------|
| FMS7G20US60    | FMS7G20US60 | 25PM-AA | --        | --         | --       |

(2) TMC2 Reliability test was done under  $-45^\circ\text{C} \sim 125^\circ\text{C}$

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

| Symbol                                         | Parameter                               | Test Conditions                                                                                                                    | Min.                                                                    | Typ. | Max.  | Units |
|------------------------------------------------|-----------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------|------|-------|-------|
| Off Characteristics                            |                                         |                                                                                                                                    |                                                                         |      |       |       |
| BV <sub>CES</sub>                              | Collector-Emitter Breakdown Voltage     | V <sub>GE</sub> = 0V, I <sub>C</sub> = 250μA                                                                                       | 600                                                                     | --   | --    | V     |
| ΔB <sub>V<sub>CES</sub></sub> /ΔT <sub>J</sub> | Temperature Coeff. of Breakdown Voltage | V <sub>GE</sub> = 0V, I <sub>C</sub> = 1mA                                                                                         | --                                                                      | 0.6  | --    | V/°C  |
| I <sub>CES</sub>                               | Collector Cut-Off Current               | V <sub>CE</sub> = V <sub>CES</sub> , V <sub>GE</sub> = 0V                                                                          | --                                                                      | --   | 250   | μA    |
| I <sub>GES</sub>                               | Gate - Emitter Leakage Current          | V <sub>GE</sub> = V <sub>GES</sub> , V <sub>CE</sub> = 0V                                                                          | --                                                                      | --   | ± 100 | nA    |
| On Characteristics                             |                                         |                                                                                                                                    |                                                                         |      |       |       |
| V <sub>GE(th)</sub>                            | Gate - Emitter Threshold Voltage        | I <sub>C</sub> = 20mA, V <sub>CE</sub> = V <sub>GE</sub>                                                                           | 5.0                                                                     | 6.5  | 8.5   | V     |
| V <sub>CE(sat)</sub>                           | Collector to Emitter Saturation Voltage | I <sub>C</sub> = 20A, V <sub>GE</sub> = 15V                                                                                        | --                                                                      | 2.1  | 2.7   | V     |
| Dynamic Characteristics                        |                                         |                                                                                                                                    |                                                                         |      |       |       |
| C <sub>ies</sub>                               | Input Capacitance                       | V <sub>CE</sub> = 30V, V <sub>GE</sub> = 0V, f = 1MHz                                                                              | --                                                                      | 1277 | --    | pF    |
| C <sub>oes</sub>                               | Output Capacitance                      |                                                                                                                                    | --                                                                      | 98   | --    | pF    |
| C <sub>res</sub>                               | Reverse Transfer Capacitance            |                                                                                                                                    | --                                                                      | 21   | --    | pF    |
| Switching Characteristics                      |                                         |                                                                                                                                    |                                                                         |      |       |       |
| t <sub>d(on)</sub>                             | Turn-On Delay Time                      | V <sub>CC</sub> = 300 V, I <sub>C</sub> = 20A, R <sub>G</sub> = 10Ω, V <sub>GE</sub> = 15V, Inductive Load, T <sub>C</sub> = 25°C  | --                                                                      | 65   | 130   | ns    |
| t <sub>r</sub>                                 | Rise Time                               |                                                                                                                                    | --                                                                      | 100  | 200   | ns    |
| t <sub>d(off)</sub>                            | Turn-Off Delay Time                     |                                                                                                                                    | --                                                                      | 80   | 160   | ns    |
| t <sub>f</sub>                                 | Fall Time                               |                                                                                                                                    | --                                                                      | 100  | 200   | ns    |
| E <sub>on</sub>                                | Turn-On Switching Loss                  |                                                                                                                                    | --                                                                      | 0.45 | --    | mJ    |
| E <sub>off</sub>                               | Turn-Off Switching Loss                 | V <sub>CC</sub> = 300 V, I <sub>C</sub> = 20A, R <sub>G</sub> = 10Ω, V <sub>GE</sub> = 15V, Inductive Load, T <sub>C</sub> = 125°C | --                                                                      | 0.42 | --    | mJ    |
| t <sub>d(on)</sub>                             | Turn-On Delay Time                      |                                                                                                                                    | --                                                                      | 70   | 140   | ns    |
| t <sub>r</sub>                                 | Rise Time                               |                                                                                                                                    | --                                                                      | 100  | 200   | ns    |
| t <sub>d(off)</sub>                            | Turn-Off Delay Time                     |                                                                                                                                    | --                                                                      | 110  | 220   | ns    |
| t <sub>f</sub>                                 | Fall Time                               |                                                                                                                                    | --                                                                      | 210  | 350   | ns    |
| E <sub>on</sub>                                | Turn-On Switching Loss                  |                                                                                                                                    | --                                                                      | 0.5  | --    | mJ    |
| E <sub>off</sub>                               | Turn-Off Switching Loss                 |                                                                                                                                    | --                                                                      | 0.72 | --    | mJ    |
| T <sub>sc</sub>                                | Short Circuit Withstand Time            |                                                                                                                                    | V <sub>CC</sub> = 300 V, V <sub>GE</sub> = 15V @ T <sub>C</sub> = 100°C | 10   | --    | --    |
| Q <sub>g</sub>                                 | Total Gate Charge                       | V <sub>CE</sub> = 300 V, I <sub>C</sub> = 20A, V <sub>GE</sub> = 15V                                                               | --                                                                      | 55   | 65    | nC    |
| Q <sub>ge</sub>                                | Gate-Emitter Charge                     |                                                                                                                                    | --                                                                      | 10   | 15    | nC    |
| Q <sub>gc</sub>                                | Gate-Collector Charge                   |                                                                                                                                    | --                                                                      | 20   | 30    | nC    |

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

| Symbol          | Parameter                           | Test Conditions                           |                        | Min. | Typ. | Max. | Units |
|-----------------|-------------------------------------|-------------------------------------------|------------------------|------|------|------|-------|
| V <sub>FM</sub> | Diode Forward Voltage               | I <sub>F</sub> = 20A                      | T <sub>C</sub> = 25°C  | --   | 1.9  | 2.8  | V     |
|                 |                                     |                                           | T <sub>C</sub> = 100°C | --   | 2.0  | --   |       |
| t <sub>rr</sub> | Diode Reverse Recovery Time         | I <sub>F</sub> = 20A<br>di / dt = 40 A/μs | T <sub>C</sub> = 25°C  | --   | 75   | 150  | ns    |
|                 |                                     |                                           | T <sub>C</sub> = 100°C | --   | 110  | --   |       |
| I <sub>rr</sub> | Diode Peak Reverse Recovery Current |                                           | T <sub>C</sub> = 25°C  | --   | 1.3  | 2.6  | A     |
|                 |                                     |                                           | T <sub>C</sub> = 100°C | --   | 1.8  | --   |       |
| Q <sub>rr</sub> | Diode Reverse Recovery Charge       |                                           | T <sub>C</sub> = 25°C  | --   | 50   | 195  | nC    |
|                 |                                     |                                           | T <sub>C</sub> = 100°C | --   | 100  | --   |       |

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

| Symbol    | Parameter                  | Test Conditions    |                           | Min. | Typ. | Max. | Units |
|-----------|----------------------------|--------------------|---------------------------|------|------|------|-------|
| $V_{FM}$  | Diode Forward Voltage      | $I_F = 20\text{A}$ | $T_C = 25^\circ\text{C}$  | --   | 1.1  | 1.5  | V     |
|           |                            |                    | $T_C = 100^\circ\text{C}$ | --   | 1.0  | --   |       |
| $I_{RRM}$ | Repetitive Reverse Current | $V_R = V_{RRM}$    | $T_C = 25^\circ\text{C}$  | --   | --   | 8    | mA    |
|           |                            |                    | $T_C = 100^\circ\text{C}$ | --   | 5    | --   |       |

**Thermal Characteristics**

|           | Symbol          | Parameter                                     | Typ. | Max. | Units                     |
|-----------|-----------------|-----------------------------------------------|------|------|---------------------------|
| Inverter  | $R_{\theta JC}$ | Junction-to-Case (IGBT Part, per 1/6 Module)  | --   | 1.4  | $^\circ\text{C}/\text{W}$ |
|           | $R_{\theta JC}$ | Junction-to-Case (DIODE Part, per 1/6 Module) | --   | 2.3  | $^\circ\text{C}/\text{W}$ |
| Brake     | $R_{\theta JC}$ | Junction-to-Case (IGBT Part)                  | --   | 1.4  | $^\circ\text{C}/\text{W}$ |
|           | $R_{\theta JC}$ | Junction-to-Case (DIODE Part)                 | --   | 2.3  | $^\circ\text{C}/\text{W}$ |
| Converter | $R_{\theta JC}$ | Junction-to-Case (DIODE Part, per 1/6 Module) | --   | 1.5  | $^\circ\text{C}/\text{W}$ |
| Weight    |                 | Weight of Module                              | 60   | --   | g                         |

**NTC Thermistor Characteristics**

|            | Symbol    | Parameter                                   | Tol.    | Typ. | Units            |
|------------|-----------|---------------------------------------------|---------|------|------------------|
| Thermistor | R25       | Rated Resistance @ $T_c = 25^\circ\text{C}$ | +/- 5 % | 4.7  | $\text{K}\Omega$ |
|            | B(25/100) | B - Value                                   | +/- 3 % | 3530 |                  |

## Typical Performance Characteristics

Figure 1. Typical Output Characteristics

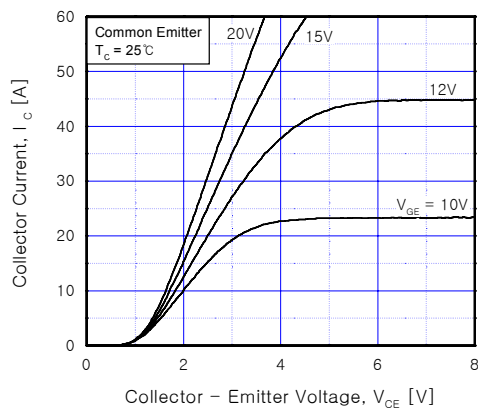


Figure 2. Typical Saturation Voltage Characteristics

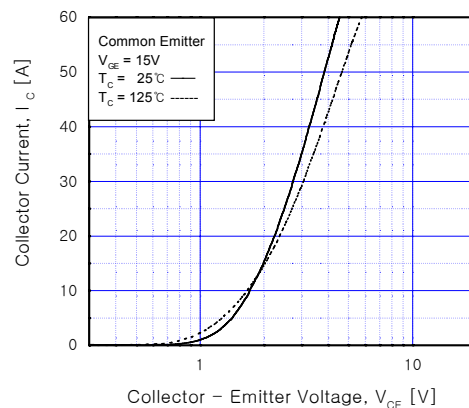


Figure 3. Saturation Voltage vs. Case Temperature at Variant Current Level

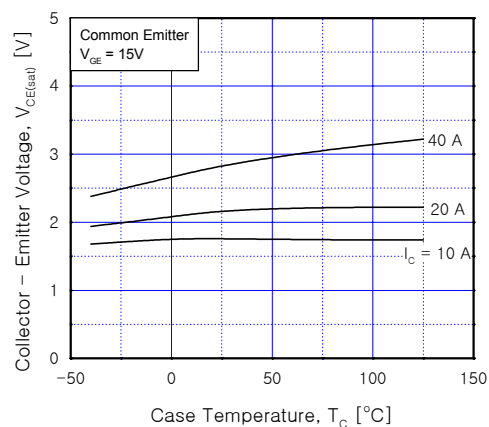


Figure 4. Transient Thermal Impedance

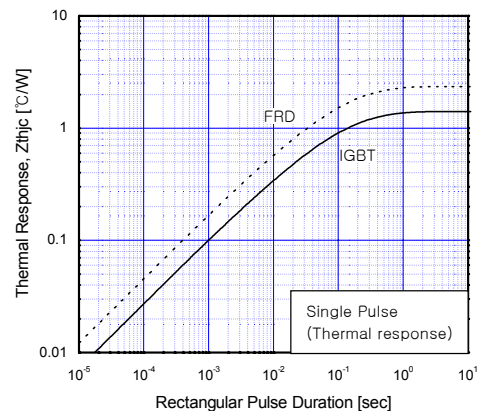


Figure 5. Saturation Voltage vs.  $V_{GE}$

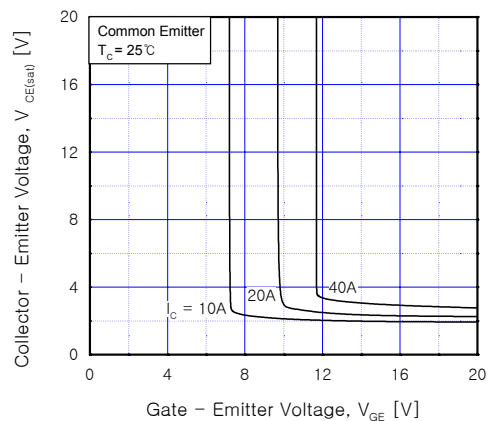
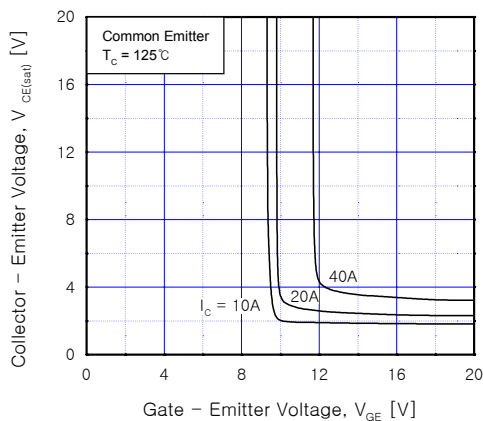


Figure 6. Saturation Voltage vs.  $V_{GE}$



## Typical Performance Characteristics (Continued)

Figure 7. Capacitance Characteristics

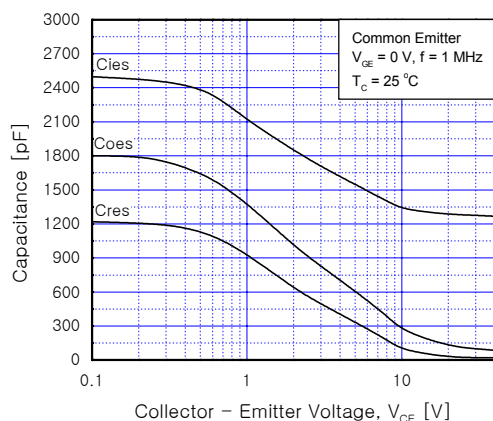


Figure 8. Turn-On Characteristics vs. Gate Resistance

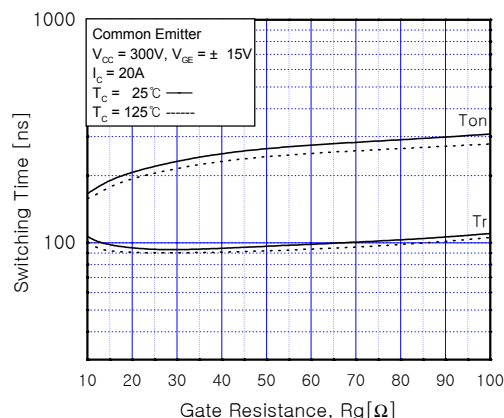


Figure 9. Turn-Off Characteristics vs. Gate Resistance

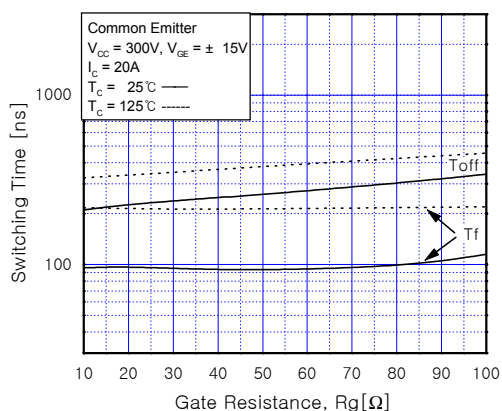


Figure 10. Switching Loss vs. Gate Resistance

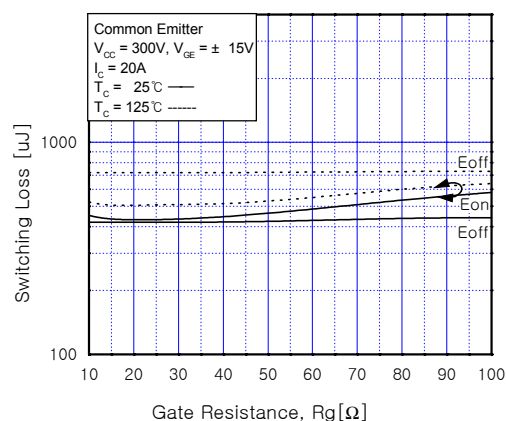


Figure 11. Turn-On Characteristics vs. Collector Current

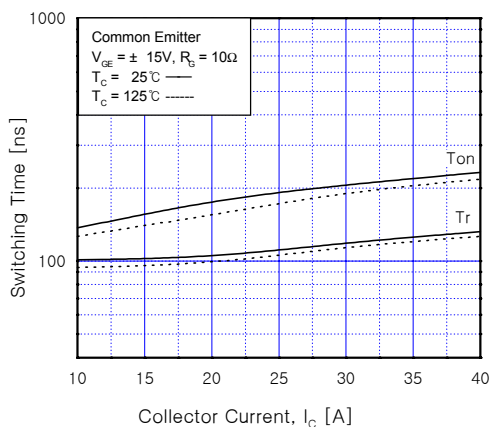
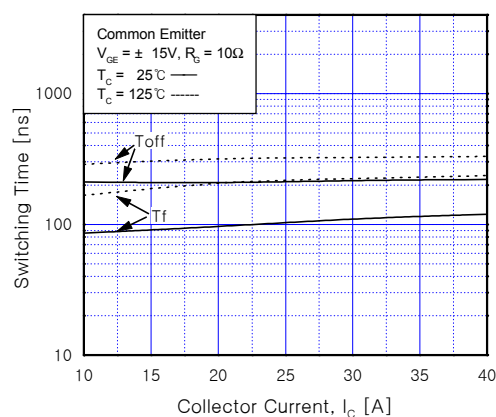


Figure 12. Turn-Off Characteristics vs. Collector Current



## Typical Performance Characteristics (Continued)

Figure 13. Switching Loss vs. Collector Current

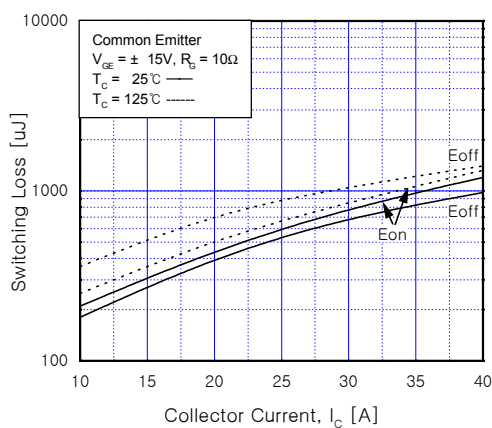


Figure 14. Gate Charge Characteristics

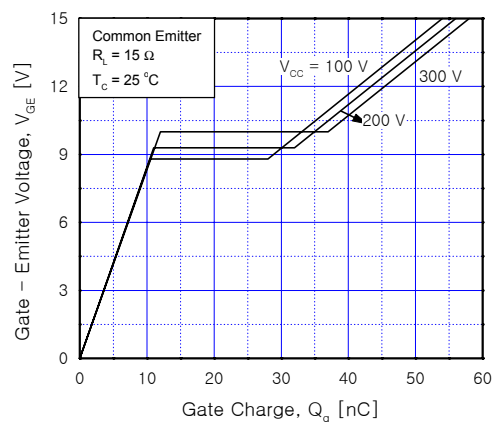


Figure 15. SOA Characteristics

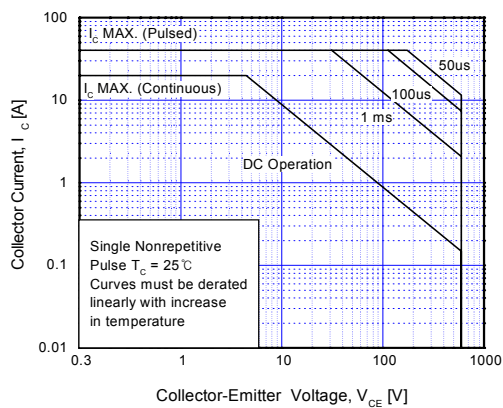


Figure 16. RBSOA Characteristics

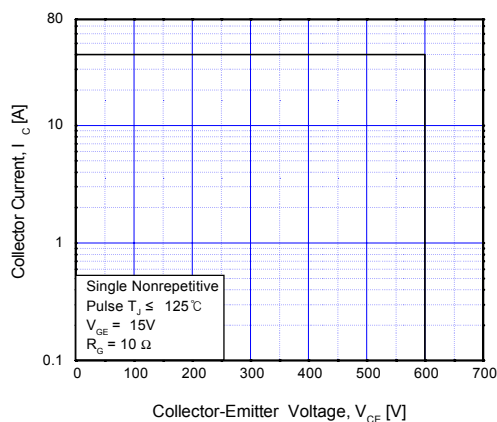


Figure 17. Forward Characteristics

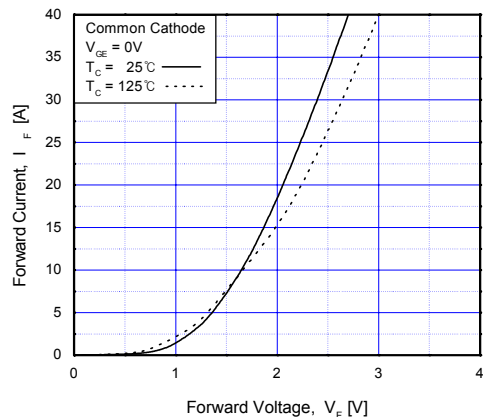
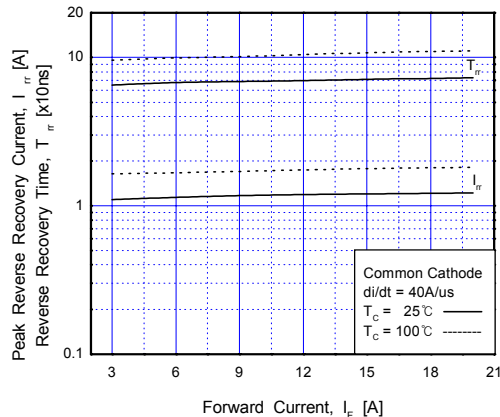
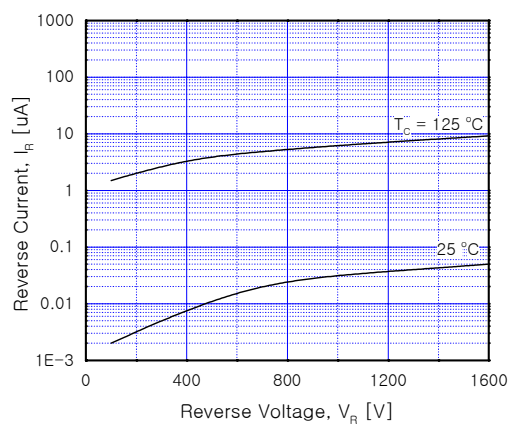
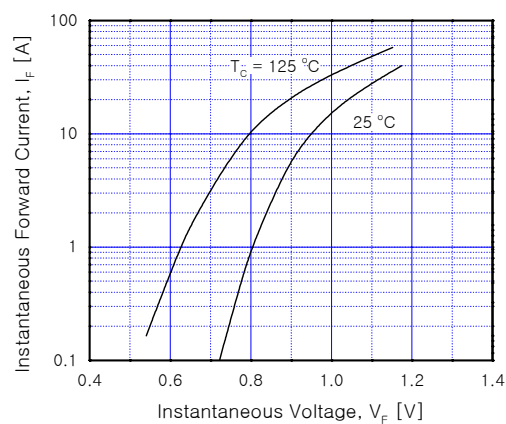
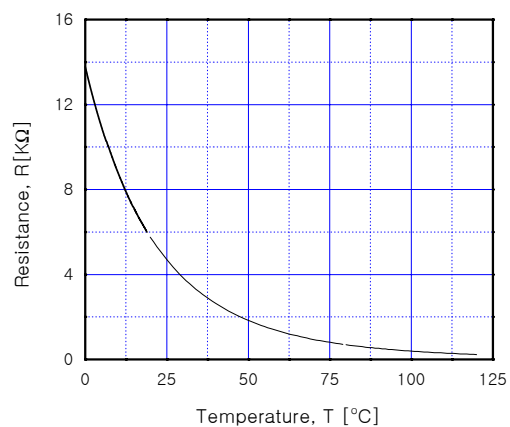


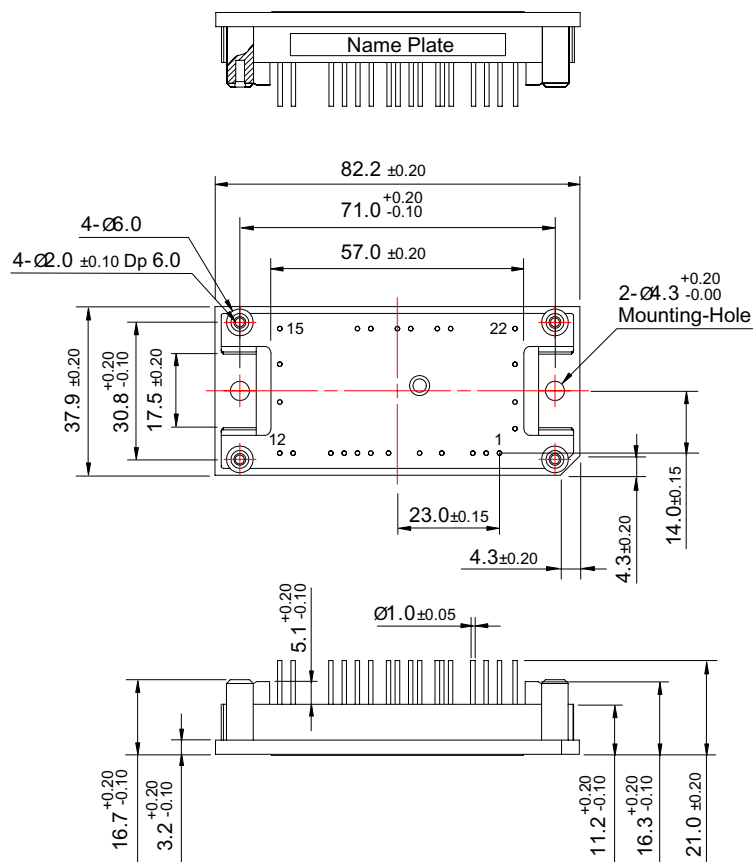
Figure 18. Reverse Recovery Characteristics



**Typical Performance Characteristics** (Continued)**Figure 19. Rectifier (Converter) Characteristics****Figure 20. Rectifier (Converter) Characteristics****Figure 21. NTC Characteristics**

Mechanical Dimensions

25PM-AA



-. Pin Coordinate

| Pin #No | Coordinate |      |
|---------|------------|------|
|         | x          | y    |
| 1       | 0.0        | 0.0  |
| 2       | -3.0       | 0.0  |
| 3       | -6.0       | 0.0  |
| 4       | -13.0      | 0.0  |
| 5       | -18.0      | 0.0  |
| 6       | -25.0      | 0.0  |
| 7       | -29.0      | 0.0  |
| 8       | -32.0      | 0.0  |
| 9       | -35.0      | 0.0  |
| 10      | -38.0      | 0.0  |
| 11      | -46.5      | 0.0  |
| 12      | -49.5      | 0.0  |
| 13      | -49.5      | 11.5 |
| 14      | -49.5      | 20.0 |
| 15      | -49.5      | 28.0 |
| 16      | -32.0      | 28.0 |
| 17      | -29.0      | 28.0 |
| 18      | -23.0      | 28.0 |
| 19      | -20.0      | 28.0 |
| 20      | -14.0      | 28.0 |
| 21      | -11.0      | 28.0 |
| 22      | 3.5        | 28.0 |
| 23      | 3.5        | 20.0 |
| 24      | 3.5        | 11.5 |
| 25      | 3.5        | 5.5  |

\* datum pin : #1

\* Pin Tilt : ±0.15

Dimensions in Millimeters

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| ActiveArray <sup>™</sup>                         | FAST <sup>™</sup>               | LittleFET <sup>™</sup>    | PowerTrench <sup>®</sup>        | SyncFET <sup>™</sup>        |
| Bottomless <sup>™</sup>                          | FPS <sup>™</sup>                | MICROCOUPLER <sup>™</sup> | QFET <sup>®</sup>               | TinyLogic <sup>®</sup>      |
| Build it Now <sup>™</sup>                        | FRFET <sup>™</sup>              | MicroFET <sup>™</sup>     | QS <sup>™</sup>                 | TINYOPTO <sup>™</sup>       |
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| CROSSVOLT <sup>™</sup>                           | GTO <sup>™</sup>                | MICROWIRE <sup>™</sup>    | Quiet Series <sup>™</sup>       | UHC <sup>™</sup>            |
| DOVE <sup>™</sup>                                | HiSeC <sup>™</sup>              | MSX <sup>™</sup>          | RapidConfigure <sup>™</sup>     | UltraFET <sup>®</sup>       |
| EcoSPARK <sup>™</sup>                            | I <sup>2</sup> C <sup>™</sup>   | MSXPro <sup>™</sup>       | RapidConnect <sup>™</sup>       | UniFET <sup>™</sup>         |
| E <sup>2</sup> C <sup>™</sup>                    | i-Lo <sup>™</sup>               | OCX <sup>™</sup>          | μSerDes <sup>™</sup>            | VCX <sup>™</sup>            |
| EnSigna <sup>™</sup>                             | ImpliedDisconnect <sup>™</sup>  | OCXPro <sup>™</sup>       | SILENT SWITCHER <sup>®</sup>    | Wire <sup>™</sup>           |
| FACT <sup>™</sup>                                | IntelliMAX <sup>™</sup>         | OPTOLOGIC <sup>®</sup>    | SMART START <sup>™</sup>        |                             |
| FACT Quiet Series <sup>™</sup>                   |                                 | OPTOPLANAR <sup>™</sup>   | SPM <sup>™</sup>                |                             |
|                                                  |                                 | PACMAN <sup>™</sup>       | Stealth <sup>™</sup>            |                             |
| Across the board. Around the world. <sup>™</sup> |                                 | POP <sup>™</sup>          | SuperFET <sup>™</sup>           |                             |
| The Power Franchise <sup>®</sup>                 |                                 | Power247 <sup>™</sup>     | SuperSOT <sup>™</sup> -3        |                             |
| Programmable Active Droop <sup>™</sup>           |                                 | PowerEdge <sup>™</sup>    | SuperSOT <sup>™</sup> -6        |                             |

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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.                                                       |
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Rev. 116