

**FAIRCHILD**  
SEMICONDUCTOR®

October 2001

**IGBT**

## FMC7G50US60

### Compact & Complex Module

#### General Description

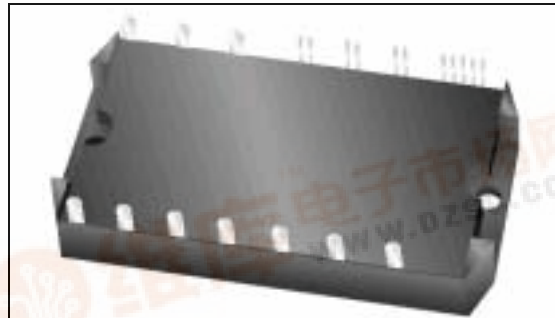
Fairchild's Insulated Gate Bipolar Transistor (IGBT) power modules provide low conduction and switching losses as well as short circuit ruggedness. They are designed for applications such as motor control, uninterrupted power supplies (UPS) and general inverters where short circuit ruggedness is a required feature.

#### Features

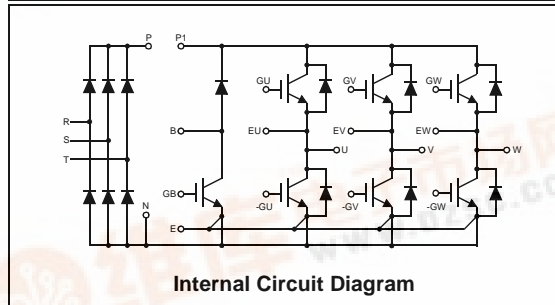
- UL Certified No. E209204
- Short circuit rated 10us @  $T_C = 100^\circ\text{C}$ ,  $V_{GE} = 15\text{V}$
- High speed switching
- Low saturation voltage :  $V_{CE(sat)} = 2.2\text{ V @ } I_C = 50\text{A}$
- High input impedance
- Built in brake and 3 phase rectifier circuit
- Fast & soft anti-parallel FWD

#### Applications

- AC & DC motor controls
- General purpose inverters
- Robotics
- Servo controls



Package Code : 21PM-BA



Internal Circuit Diagram

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

	Symbol	Description	FMC7G50US60	Units
Inverter & Brake	$V_{CES}$	Collector-Emitter Voltage	600	V
	$V_{GES}$	Gate-Emitter Voltage	$\pm 20$	V
	$I_C$	Collector Current @ $T_C = 25^\circ\text{C}$	50	A
	$I_{CM(1)}$	Pulsed Collector Current	100	A
	$I_F$	Diode Continuous Forward Current @ $T_C = 100^\circ\text{C}$	50	A
	$I_{FM}$	Diode Maximum Forward Current	100	A
	$P_D$	Maximum Power Dissipation @ $T_C = 25^\circ\text{C}$	200	W
Converter	$T_{SC}$	Short Circuit Withstand Time @ $T_C = 100^\circ\text{C}$	10	us
	$V_{RRM}$	Repetitive Peak Reverse Voltage	1200	V
	$I_O$	Average Output Rectified Current	50	A
	$I_{FSM}$	Surge Forward Current @ 1 Cycle at 60Hz, Peak value Non-Repetitive	500	A
Common	$I^2t$	1 Cycle Surge Current	1025	$\text{A}^2\text{s}$
	$T_J$	Operating Junction Temperature	-40 to +150	$^\circ\text{C}$
	$T_{STG}$	Storage Temperature Range	-40 to +125	$^\circ\text{C}$
Mounting Torque	$V_{ISO}$	Isolation Voltage @ AC 1minute	2500	V
		Mounting part Screw @ M4	1.25	N.m

**Notes :**

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



**Electrical Characteristics of the IGBT @ Inverter & Brake**  $T_C = 25^\circ\text{C}$  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/ $^\circ\text{C}$
$I_{CES}$	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

<b>On Characteristics</b>						
$V_{GE(th)}$	G-E Threshold Voltage	$I_C = 500mA, V_{CE} = V_{GE}$	5.0	6.0	8.5	V
$V_{CE(sat)}$	Collector to Emitter Saturation Voltage	$I_C = 50A, V_{GE} = 15V$	--	2.2	2.8	V

<b>Dynamic Characteristics</b>						
$C_{ies}$	Input Capacitance	$V_{CE} = 30V, V_{GE} = 0V, f = 1MHz$	--	3460	--	pF
$C_{oes}$	Output Capacitance		--	480	--	pF
$C_{res}$	Reverse Transfer Capacitance		--	140	--	pF

<b>Switching Characteristics</b>						
$t_{d(on)}$	Turn-On Delay Time	$V_{CC} = 300V, I_C = 50A, R_G = 5.9\Omega, V_{GE} = 15V$ Inductive Load, $T_C = 25^\circ\text{C}$	--	32	--	ns
$t_r$	Rise Time		--	67	--	ns
$t_{d(off)}$	Turn-Off Delay Time		--	66	100	ns
$t_f$	Fall Time		--	118	200	ns
$E_{on}$	Turn-On Switching Loss		--	1.8	--	mJ
$E_{off}$	Turn-Off Switching Loss		--	1.0	--	mJ
$E_{ts}$	Total Switching Loss	--	2.8	3.8	mJ	
$t_{d(on)}$	Turn-On Delay Time	$V_{CC} = 300V, I_C = 50A, R_G = 5.9\Omega, V_{GE} = 15V$ Inductive Load, $T_C = 125^\circ\text{C}$	--	33	--	ns
$t_r$	Rise Time		--	68	--	ns
$t_{d(off)}$	Turn-Off Delay Time		--	68	110	ns
$t_f$	Fall Time		--	261	400	ns
$E_{on}$	Turn-On Switching Loss		--	2.41	--	mJ
$E_{off}$	Turn-Off Switching Loss		--	2.31	--	mJ
$E_{ts}$	Total Switching Loss	--	4.72	6.65	mJ	
$T_{sc}$	Short Circuit Withstand Time	$V_{CC} = 300V, V_{GE} = 15V$ @ $T_C = 100^\circ\text{C}$	10	--	--	us
$Q_g$	Total Gate Charge	$V_{CE} = 300V, I_C = 50A, V_{GE} = 15V$	--	145	210	nC
$Q_{ge}$	Gate-Emitter Charge		--	28	40	nC
$Q_{gc}$	Gate-Collector Charge		--	65	95	nC

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

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Units	
$V_{FM}$	Diode Forward Voltage	$I_F = 50\text{A}$	$T_C = 25^\circ\text{C}$	--	1.9	2.8	V
			$T_C = 100^\circ\text{C}$	--	1.8	--	
$t_{rr}$	Diode Reverse Recovery Time		$T_C = 25^\circ\text{C}$	--	90	130	ns
			$T_C = 100^\circ\text{C}$	--	130	--	
$I_{rr}$	Diode Peak Reverse Recovery Current	$I_F = 50\text{A}$ $di / dt = 100 \text{ A/us}$	$T_C = 25^\circ\text{C}$	--	5	6.5	A
			$T_C = 100^\circ\text{C}$	--	7	--	
$Q_{rr}$	Diode Reverse Recovery Charge		$T_C = 25^\circ\text{C}$	--	225	422	nC
			$T_C = 100^\circ\text{C}$	--	455	--	

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

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Units	
$V_{FM}$	Diode Forward Voltage	$I_F = 50\text{A}$	$T_C = 25^\circ\text{C}$	--	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)	--	0.625	$^\circ\text{C/W}$
	$R_{\theta JC}$	Junction-to-Case (DIODE Part, per 1/6 Module)	--	1.6	$^\circ\text{C/W}$
Brake	$R_{\theta JC}$	Junction-to-Case (IGBT Part)	--	0.625	$^\circ\text{C/W}$
	$R_{\theta JC}$	Junction-to-Case (DIODE Part)	--	1.6	$^\circ\text{C/W}$
Converter	$R_{\theta JC}$	Junction-to-Case (DIODE Part, per 1/6 Module)	--	1.5	$^\circ\text{C/W}$
Weight		Weight of Module	270	--	g

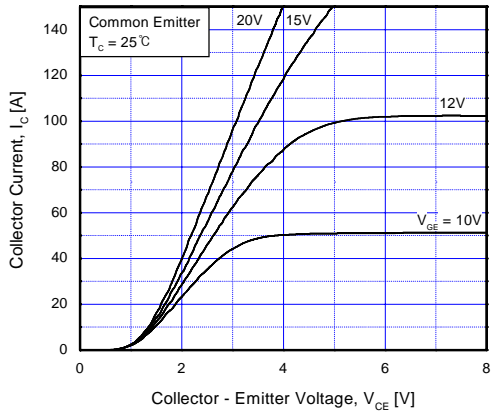


Fig 1. Typical Output Characteristics

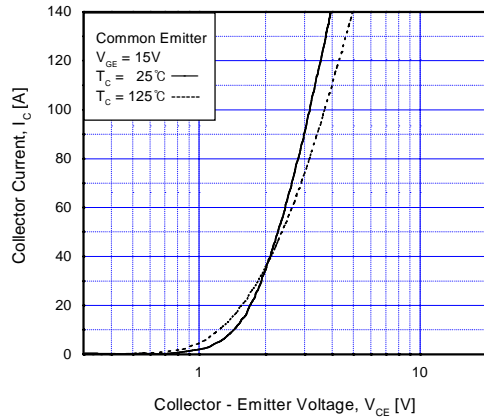


Fig 2. Typical Saturation Voltage Characteristics

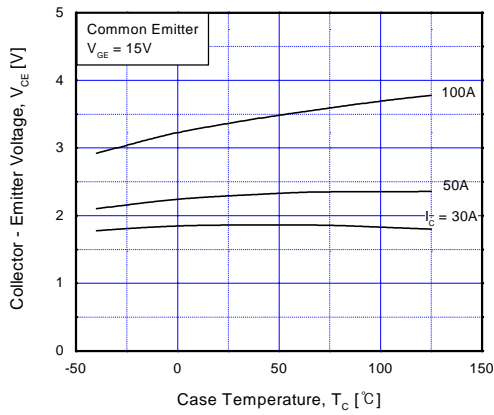


Fig 3. Saturation Voltage vs. Case Temperature at Variant Current Level

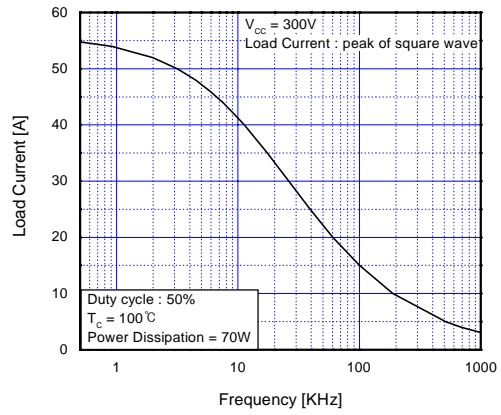


Fig 4. Load Current vs. Frequency

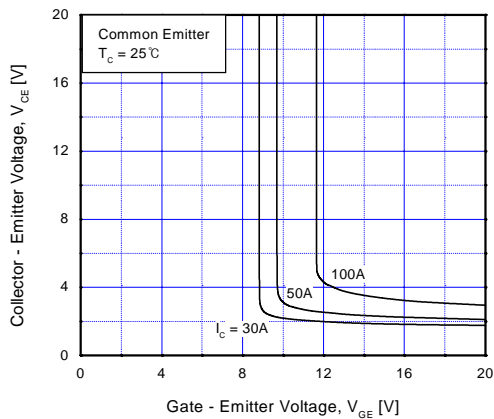


Fig 5. Saturation Voltage vs.  $V_{GE}$

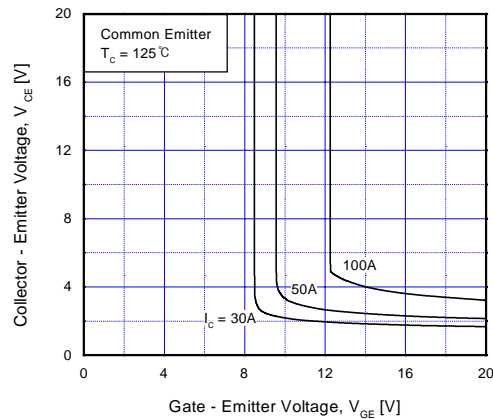


Fig 6. Saturation Voltage vs.  $V_{GE}$

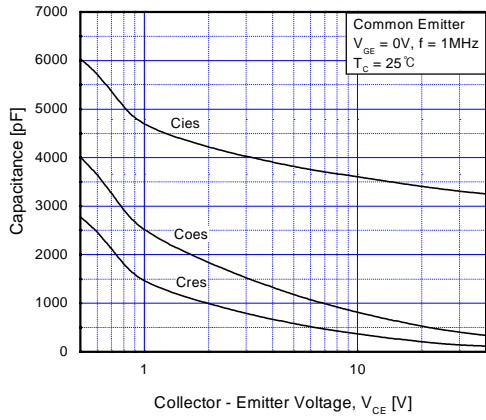


Fig 7. Capacitance Characteristics

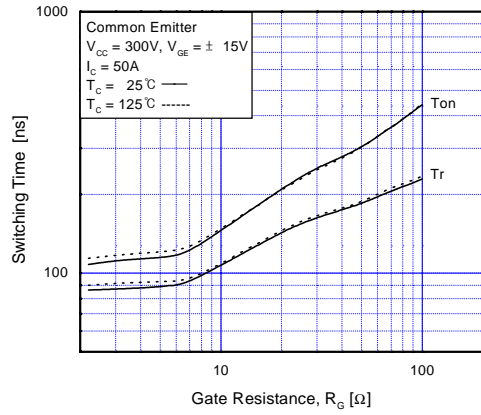


Fig 8. Turn-On Characteristics vs. Gate Resistance

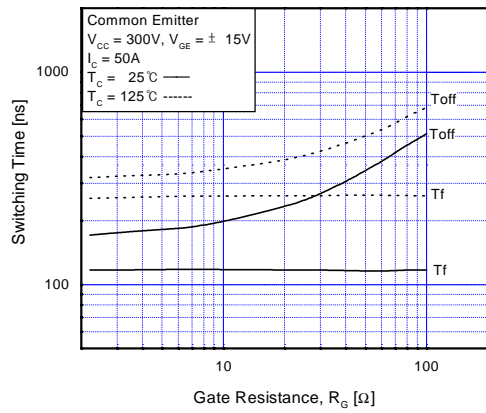


Fig 9. Turn-Off Characteristics vs. Gate Resistance

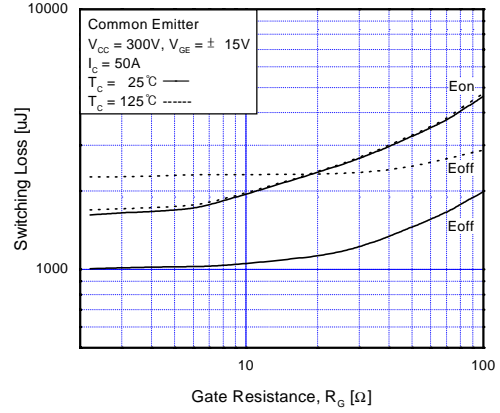


Fig 10. Switching Loss vs. Gate Resistance

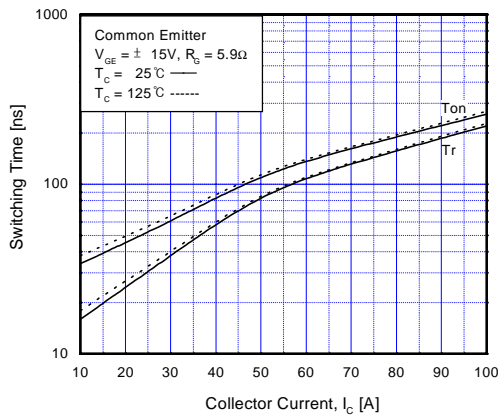


Fig 11. Turn-On Characteristics vs. Collector Current

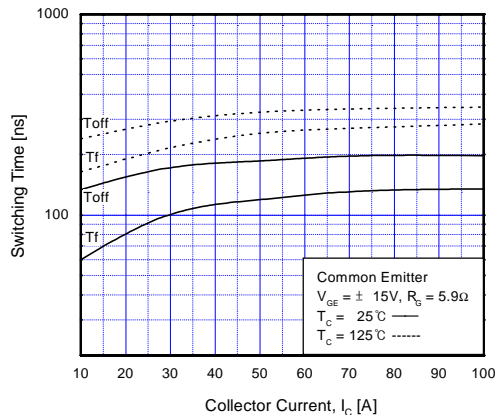
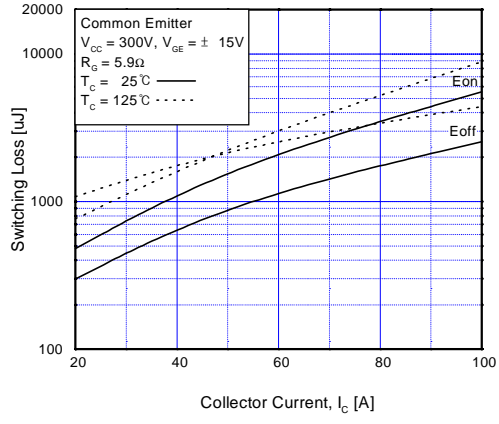
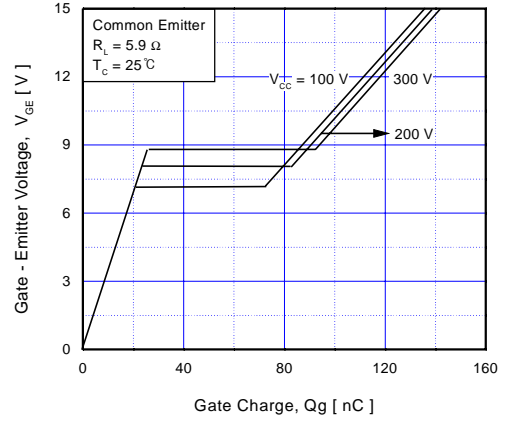


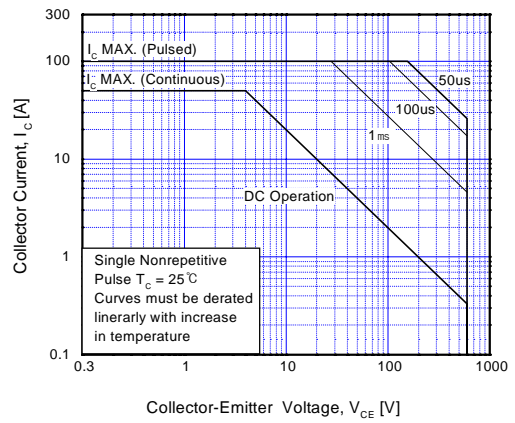
Fig 12. Turn-Off Characteristics vs. Collector Current



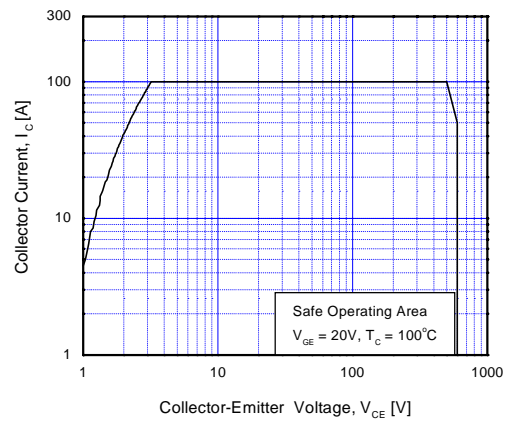
**Fig 13. Switching Loss vs. Collector Current**



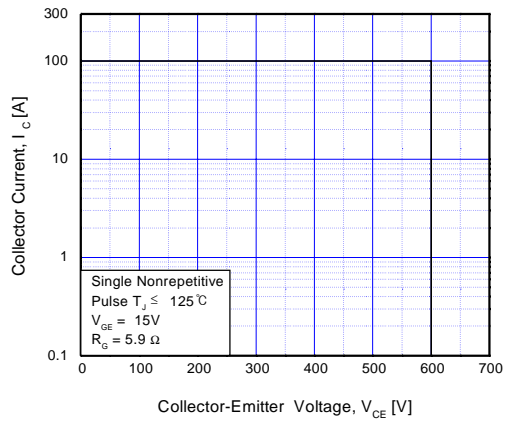
**Fig 14. Gate Charge Characteristics**



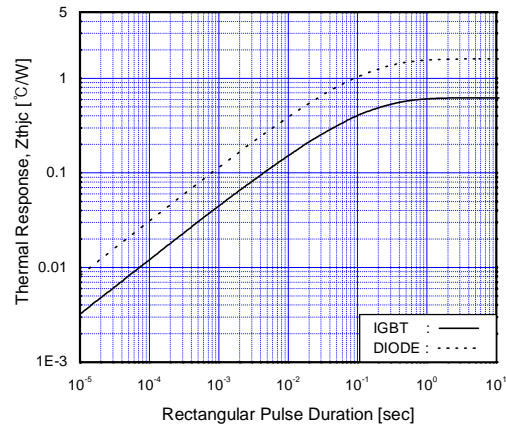
**Fig 15. SOA Characteristics**



**Fig 16. Turn-Off SOA Characteristics**



**Fig 17. RBSOA Characteristics**



**Fig 18. Transient Thermal Impedance**

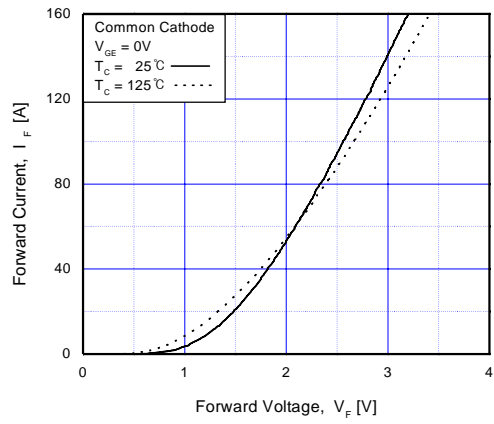


Fig 19. Forward Characteristics

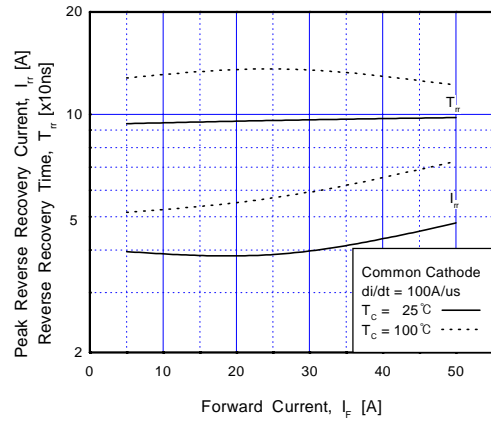
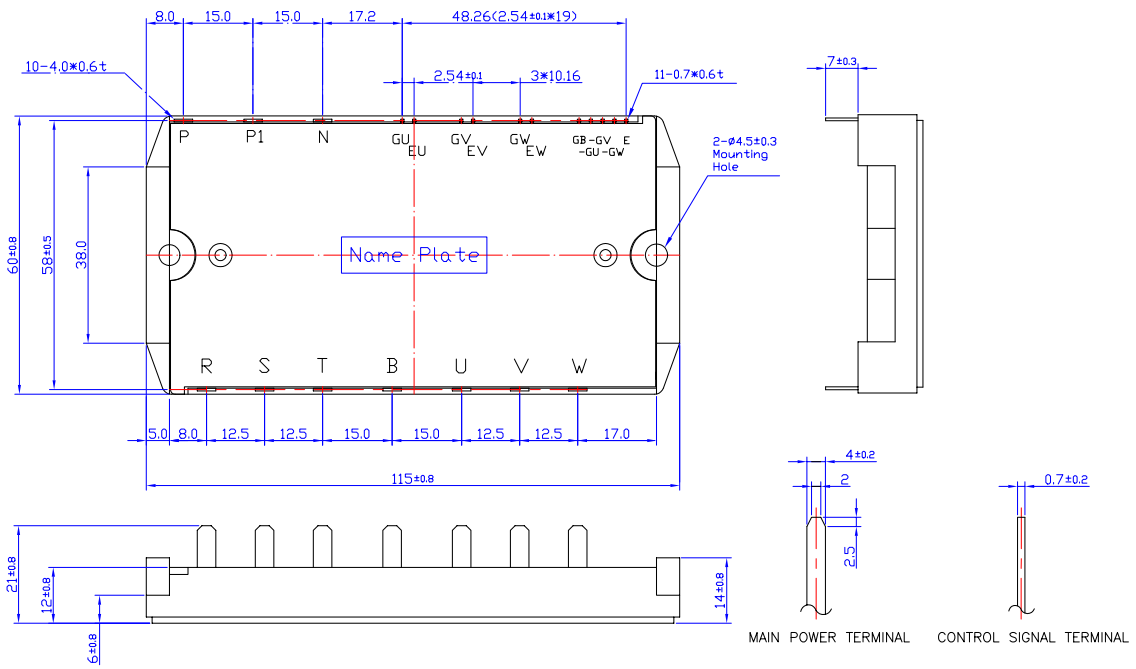


Fig 20. Reverse Recovery Characteristics

Package Dimension

21PM-BA (FS PKG CODE BK)



Dimensions in Millimeters



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