

# SGH23N60UFD

## Ultra-Fast IGBT

### General Description

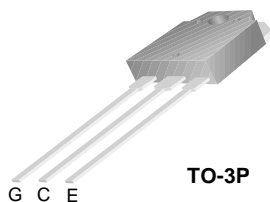
Fairchild's Insulated Gate Bipolar Transistor(IGBT) UFD series provides low conduction and switching losses. UFD series is designed for the applications such as motor control and general inverters where High Speed Switching is required.

### Features

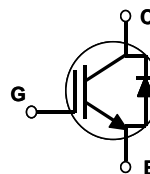
- High Speed Switching
- Low Saturation Voltage :  $V_{CE(sat)} = 2.1\text{ V @ } I_C = 12\text{A}$
- High Input Impedance
- CO-PAK, IGBT with FRD :  $t_{rr} = 42\text{ns (typ.)}$

### 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 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	--	1.2	$^\circ\text{C/W}$
$R_{\theta JC}(\text{DIODE})$	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	$V_{GE} = 0V, I_C = 250\mu\text{A}$	600	--	--	V
$\frac{\Delta BV_{CES}}{\Delta T_J}$	Temperature Coeff. of Breakdown Voltage	$V_{GE} = 0V, I_C = 1\text{mA}$	--	0.6	--	$V/^\circ\text{C}$
$I_{CES}$	Collector Cut-Off Current	$V_{CE} = V_{CES}, V_{GE} = 0V$	--	--	250	$\mu\text{A}$
$I_{GES}$	G-E Leakage Current	$V_{GE} = V_{GES}, V_{CE} = 0V$	--	--	$\pm 100$	nA

**On Characteristics**

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

**Dynamic Characteristics**

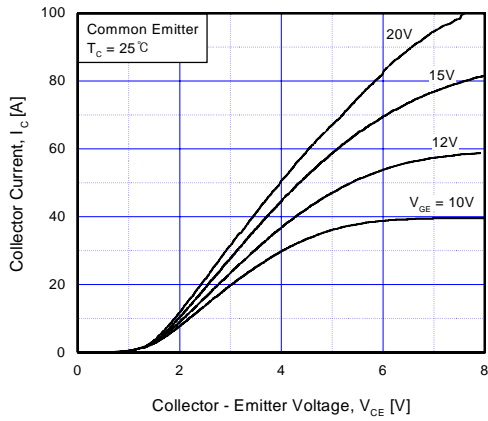
$C_{ies}$	Input Capacitance	$V_{CE} = 30V, V_{GE} = 0V,$ $f = 1\text{MHz}$	--	720	--	pF
$C_{oes}$	Output Capacitance		--	100	--	pF
$C_{res}$	Reverse Transfer Capacitance		--	25	--	pF

**Switching Characteristics**

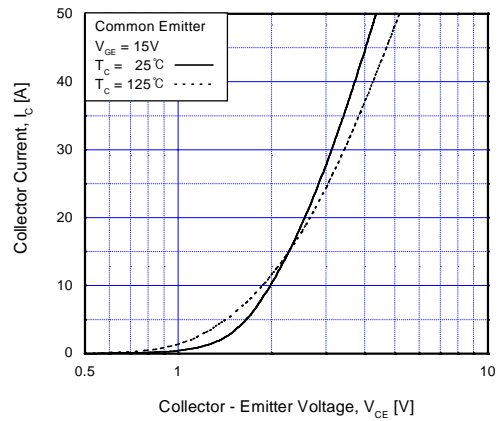
$t_{d(on)}$	Turn-On Delay Time	$V_{CC} = 300V, I_C = 12\text{A},$ $R_G = 23\Omega, V_{GE} = 15V,$ Inductive Load, $T_C = 25^\circ\text{C}$	--	17	--	ns
$t_r$	Rise Time		--	27	--	ns
$t_{d(off)}$	Turn-Off Delay Time		--	60	130	ns
$t_f$	Fall Time		--	70	150	ns
$E_{on}$	Turn-On Switching Loss		--	115	--	$\mu\text{J}$
$E_{off}$	Turn-Off Switching Loss		--	135	--	$\mu\text{J}$
$E_{ts}$	Total Switching Loss	--	250	400	$\mu\text{J}$	
$t_{d(on)}$	Turn-On Delay Time	$V_{CC} = 300V, I_C = 12\text{A},$ $R_G = 23\Omega, V_{GE} = 15V,$ Inductive Load, $T_C = 125^\circ\text{C}$	--	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	--	$\mu\text{J}$
$E_{off}$	Turn- Off Switching Loss		--	320	--	$\mu\text{J}$
$E_{ts}$	Total Switching Loss	--	525	800	$\mu\text{J}$	
$Q_g$	Total Gate Charge	$V_{CE} = 300V, I_C = 12\text{A},$ $V_{GE} = 15V$	--	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

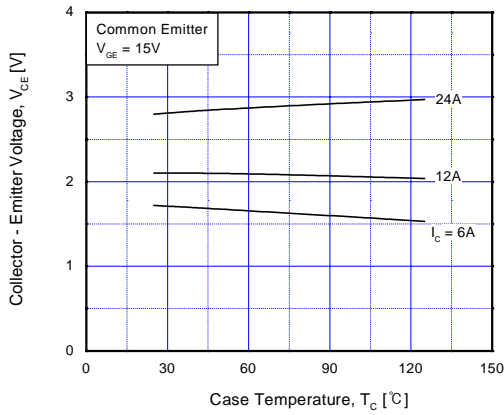
Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Units	
$V_{FM}$	Diode Forward Voltage	$I_F = 12\text{A}$	$T_C = 25^\circ\text{C}$	--	1.4	1.7	V
			$T_C = 100^\circ\text{C}$	--	1.3	--	
$t_{rr}$	Diode Reverse Recovery Time	$I_F = 12\text{A},$ $di/dt = 200\text{A}/\mu\text{s}$	$T_C = 25^\circ\text{C}$	--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



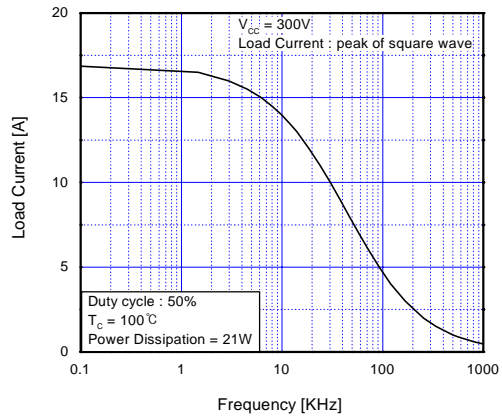
**Fig 1. Typical Output Characteristics**



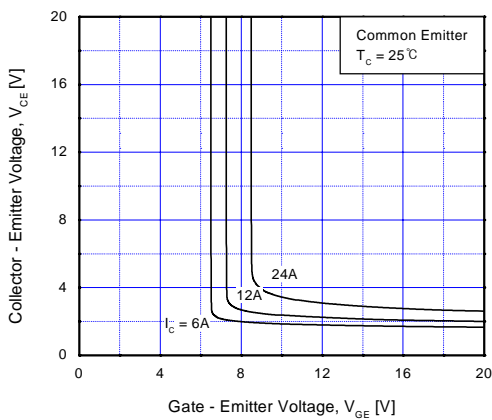
**Fig 2. Typical Saturation Voltage Characteristics**



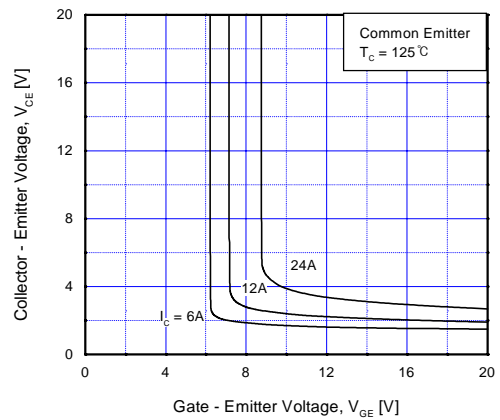
**Fig 3. Saturation Voltage vs. Case Temperature at Variant Current Level**



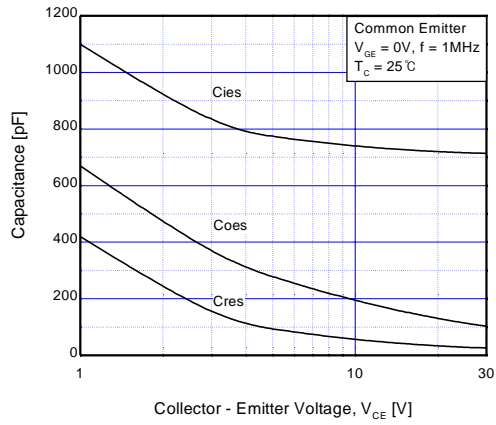
**Fig 4. Load Current vs. Frequency**



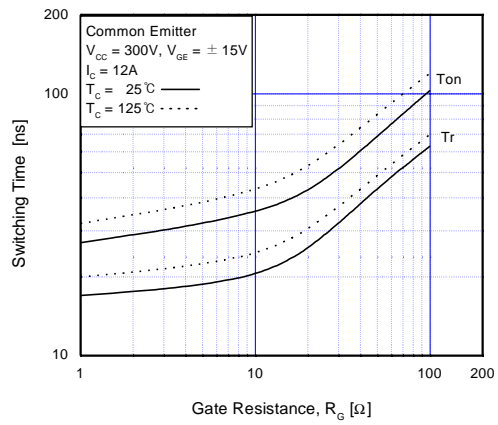
**Fig 5. Saturation Voltage vs.  $V_{GE}$**



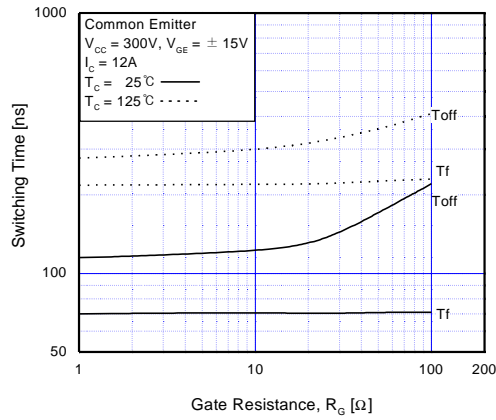
**Fig 6. Saturation Voltage vs.  $V_{GE}$**



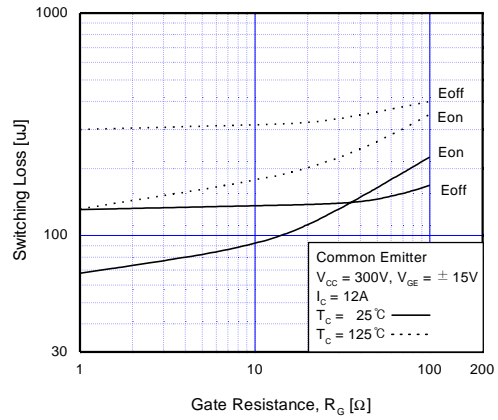
**Fig 7. Capacitance Characteristics**



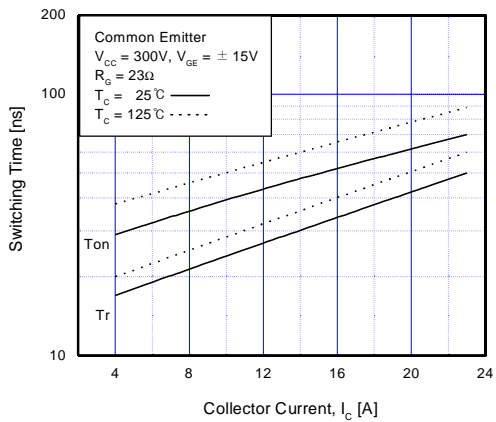
**Fig 8. Turn-On Characteristics vs. Gate Resistance**



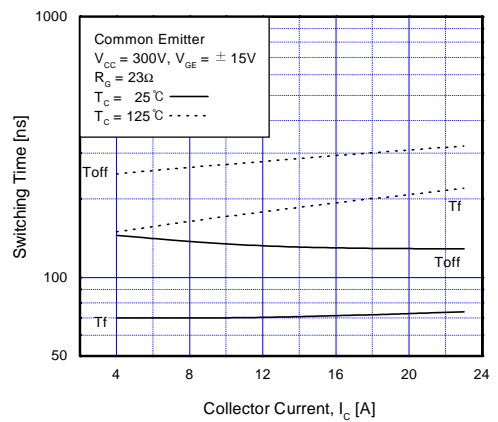
**Fig 9. Turn-Off Characteristics vs. Gate Resistance**



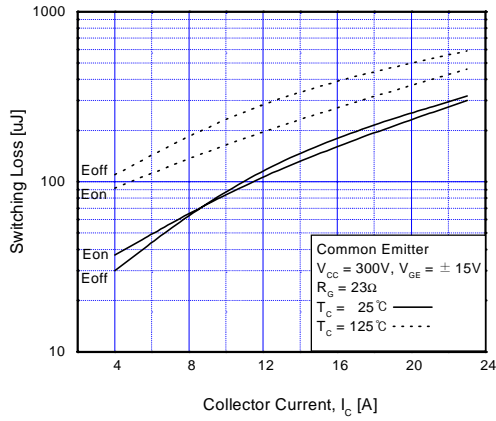
**Fig 10. Switching Loss vs. Gate Resistance**



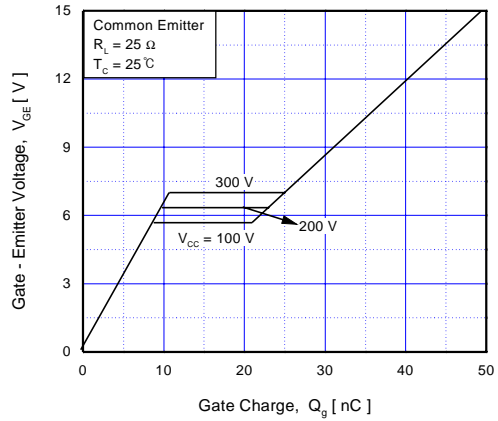
**Fig 11. Turn-On Characteristics vs. Collector Current**



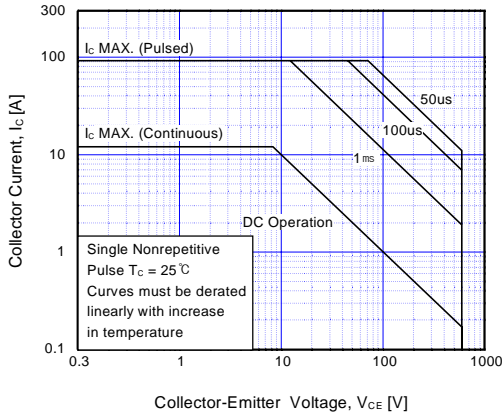
**Fig 12. Turn-Off Characteristics vs. Collector Current**



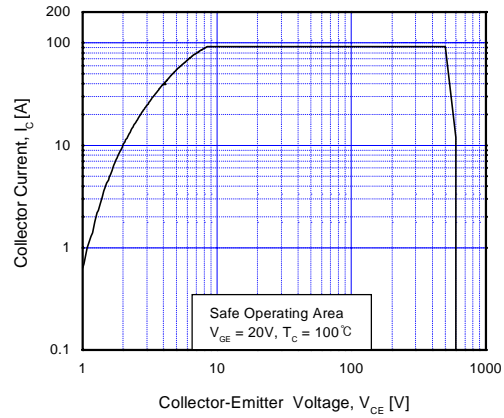
**Fig 13. Switching Loss vs. Collector Current**



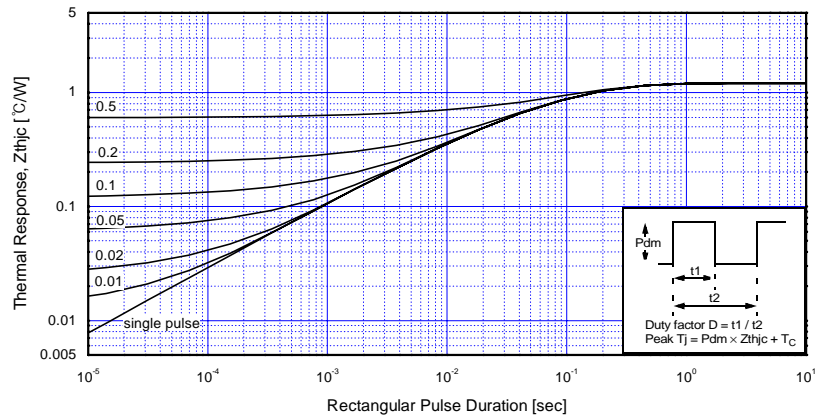
**Fig 14. Gate Charge Characteristics**



**Fig 15. SOA Characteristics**



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



**Fig 17. Transient Thermal Impedance of IGBT**

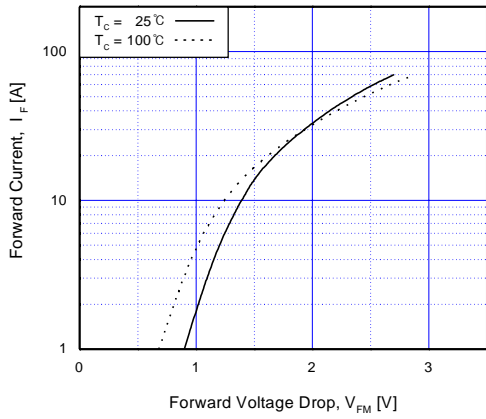


Fig 18. Forward Characteristics

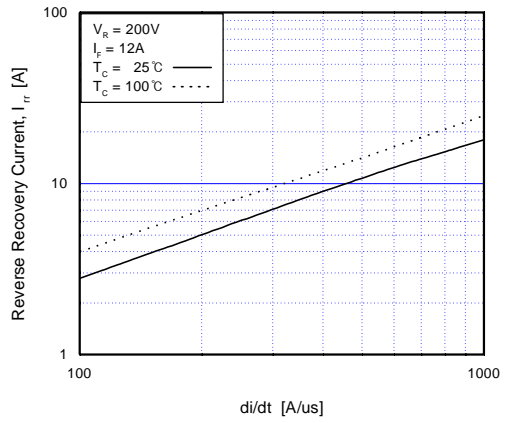


Fig 19. Reverse Recovery Current

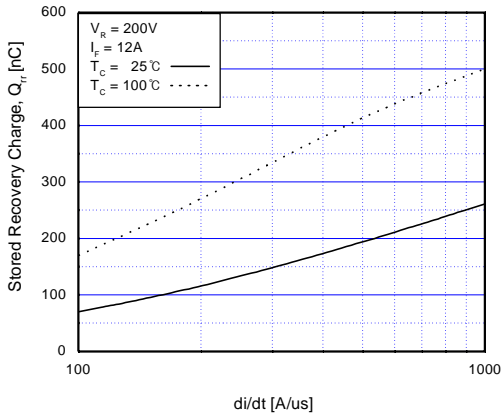


Fig 20. Stored Charge

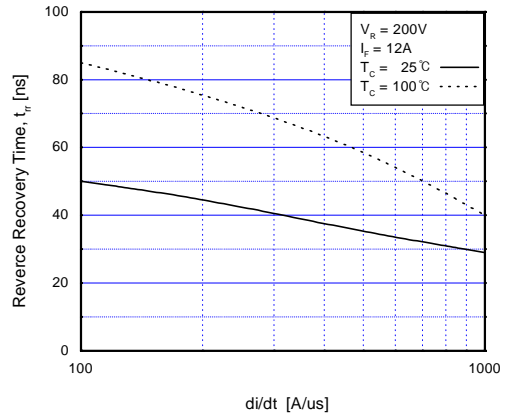


Fig 21. Reverse Recovery Time

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