

# SGH40N60UFD

## Ultra-Fast IGBT

### General Description

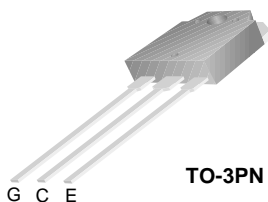
Fairchild's UFD series of Insulated Gate Bipolar Transistors (IGBTs) provides low conduction and switching losses. The UFD series is designed for applications such as motor control and general inverters where high speed switching is a required feature.

### Features

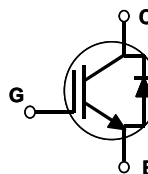
- High speed switching
- Low saturation voltage :  $V_{CE(sat)} = 2.1 \text{ V @ } I_C = 20\text{A}$
- High input impedance
- CO-PAK, IGBT with FRD :  $t_{rr} = 42\text{ns (typ.)}$

### Applications

AC & DC motor controls, general purpose inverters, robotics, and servo controls.



TO-3PN



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

Symbol	Description	SGH40N60UFD	Units
$V_{CES}$	Collector-Emitter Voltage	600	V
$V_{GES}$	Gate-Emitter Voltage	$\pm 20$	V
$I_C$	Collector Current @ $T_C = 25^\circ\text{C}$	40	A
	Collector Current @ $T_C = 100^\circ\text{C}$	20	A
$I_{CM(1)}$	Pulsed Collector Current	160	A
$I_F$	Diode Continuous Forward Current @ $T_C = 100^\circ\text{C}$	15	A
$I_{FM}$	Diode Maximum Forward Current	160	A
$P_D$	Maximum Power Dissipation @ $T_C = 25^\circ\text{C}$	160	W
	Maximum Power Dissipation @ $T_C = 100^\circ\text{C}$	64	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
$R_{\theta JC}$ (IGBT)	Thermal Resistance, Junction-to-Case	--	0.77	$^\circ\text{C/W}$
$R_{\theta JC}$ (DIODE)	Thermal Resistance, Junction-to-Case	--	1.7	$^\circ\text{C/W}$
$R_{\theta JA}$	Thermal Resistance, Junction-to-Ambient	--	40	$^\circ\text{C/W}$

**Electrical Characteristics of the 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 Coefficient 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	$I_C = 20mA, V_{CE} = V_{GE}$	3.5	4.5	6.5	V
$V_{CE(sat)}$	Collector to Emitter Saturation Voltage	$I_C = 20A, V_{GE} = 15V$	--	2.1	2.6	V
		$I_C = 40A, V_{GE} = 15V$	--	2.6	--	V

**Dynamic Characteristics**

$C_{ies}$	Input Capacitance	$V_{CE} = 30V, V_{GE} = 0V, f = 1MHz$	--	1430	--	pF
$C_{oes}$	Output Capacitance		--	170	--	pF
$C_{res}$	Reverse Transfer Capacitance		--	50	--	pF

**Switching Characteristics**

$t_{d(on)}$	Turn-On Delay Time	$V_{CC} = 300V, I_C = 20A, R_G = 10\Omega, V_{GE} = 15V, \text{Inductive Load}, T_C = 25^\circ C$	--	15	--	ns	
$t_r$	Rise Time		--	30	--	ns	
$t_{d(off)}$	Turn-Off Delay Time		--	65	130	ns	
$t_f$	Fall Time		--	50	150	ns	
$E_{on}$	Turn-On Switching Loss		--	160	--	$\mu J$	
$E_{off}$	Turn-Off Switching Loss		--	200	--	$\mu J$	
$E_{ts}$	Total Switching Loss		--	360	600	$\mu J$	
$t_{d(on)}$	Turn-On Delay Time		$V_{CC} = 300V, I_C = 20A, R_G = 10\Omega, V_{GE} = 15V, \text{Inductive Load}, T_C = 125^\circ C$	--	30	--	ns
$t_r$	Rise Time			--	37	--	ns
$t_{d(off)}$	Turn-Off Delay Time			--	110	200	ns
$t_f$	Fall Time	--		144	250	ns	
$E_{on}$	Turn-On Switching Loss	--		310	--	$\mu J$	
$E_{off}$	Turn-Off Switching Loss	--		430	--	$\mu J$	
$E_{ts}$	Total Switching Loss	--		740	1200	$\mu J$	
$Q_g$	Total Gate Charge	$V_{CE} = 300V, I_C = 20A, V_{GE} = 15V$		--	97	150	nC
$Q_{ge}$	Gate-Emitter Charge			--	20	30	nC
$Q_{gc}$	Gate-Collector Charge			--	25	40	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	$I_F = 15A$	$T_C = 25^\circ C$	--	1.4	1.7	V
			$T_C = 100^\circ C$	--	1.3	--	
$t_{rr}$	Diode Reverse Recovery Time	$I_F = 15A, di/dt = 200A/\mu s$	$T_C = 25^\circ C$	--	42	60	ns
			$T_C = 100^\circ C$	--	74	--	
$I_{rr}$	Diode Peak Reverse Recovery Current	$I_F = 15A, di/dt = 200A/\mu s$	$T_C = 25^\circ C$	--	4.5	6.0	A
			$T_C = 100^\circ C$	--	6.5	--	
$Q_{rr}$	Diode Reverse Recovery Charge	$I_F = 15A, di/dt = 200A/\mu s$	$T_C = 25^\circ C$	--	80	180	nC
			$T_C = 100^\circ C$	--	220	--	

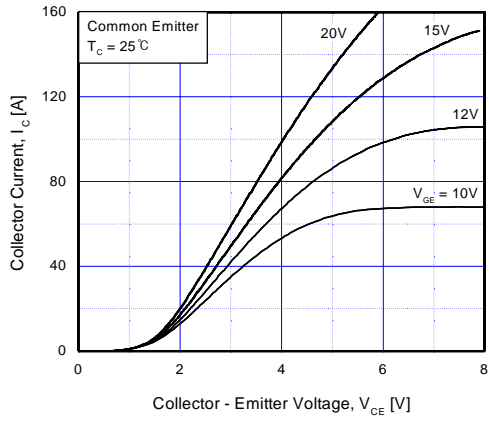


Fig 1. Typical Output Characteristics

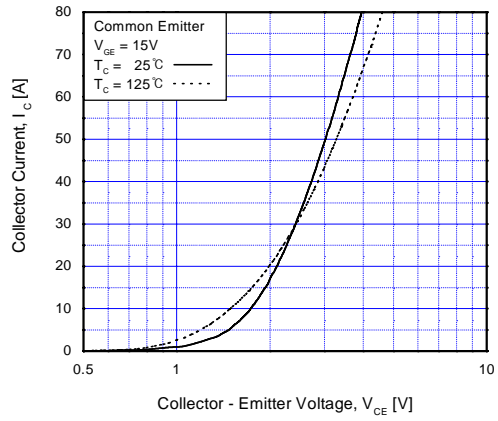


Fig 2. Typical Saturation Voltage Characteristics

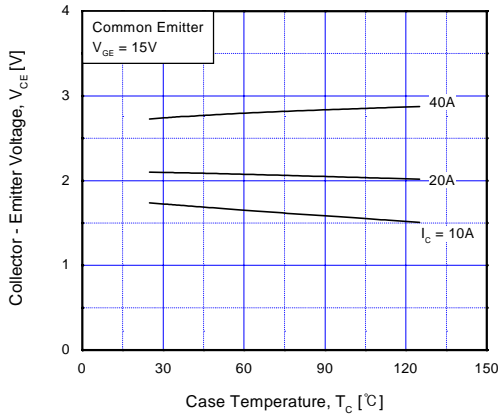


Fig 3. Saturation Voltage vs. Case Temperature at Variant Current Level

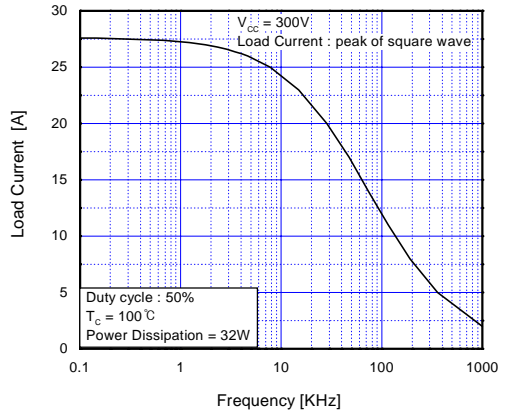


Fig 4. Load Current vs. Frequency

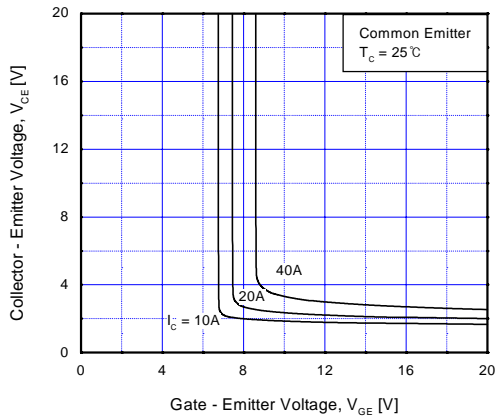


Fig 5. Saturation Voltage vs.  $V_{GE}$

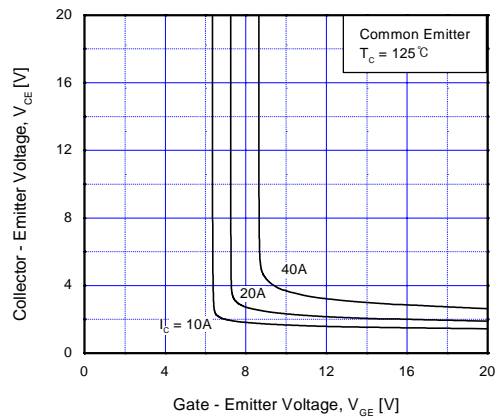
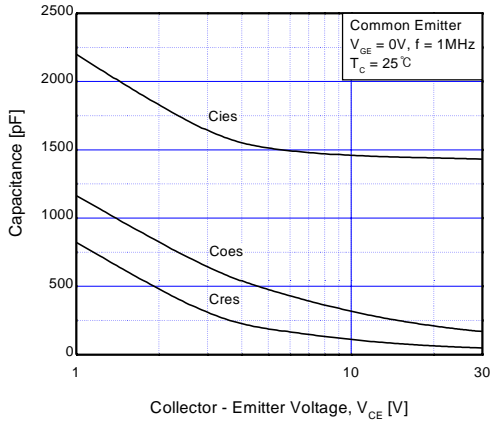
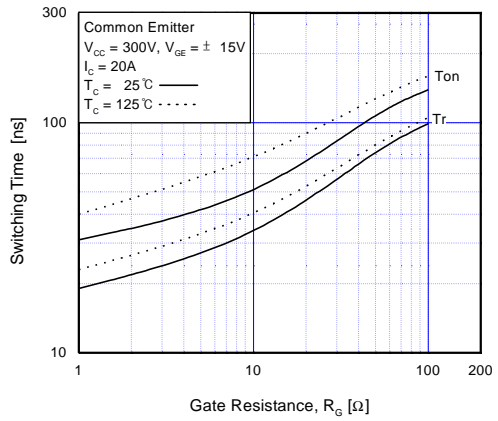


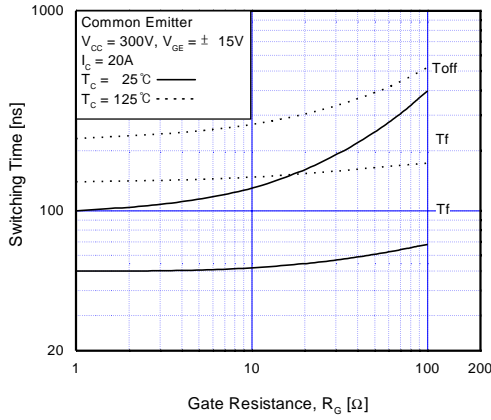
Fig 6. Saturation Voltage vs.  $V_{GE}$



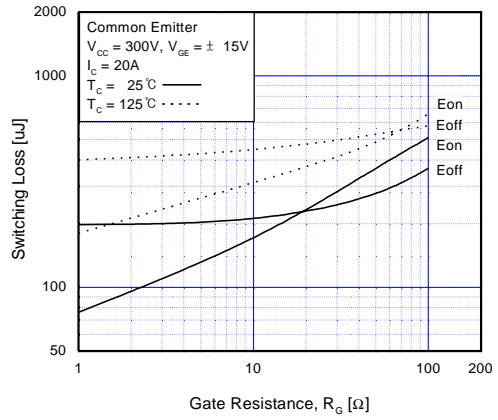
**Fig 7. Capacitance Characteristics**



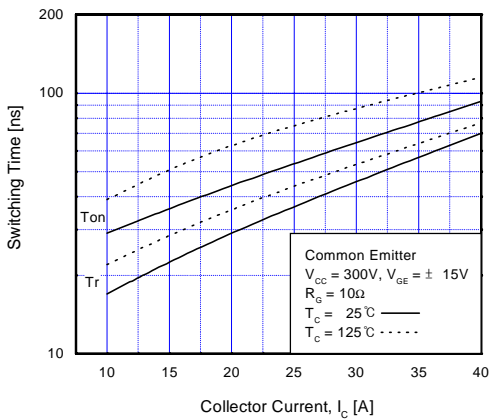
**Fig 8. Turn-On Characteristics vs. Gate Resistance**



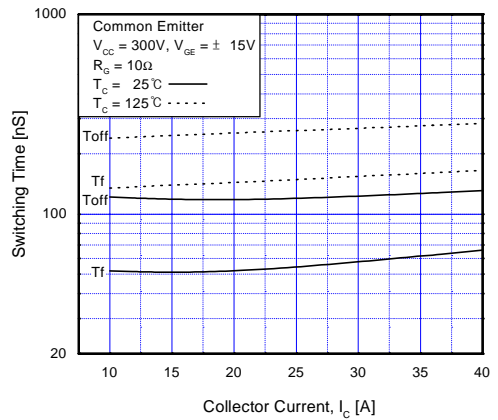
**Fig 9. Turn-Off Characteristics vs. Gate Resistance**



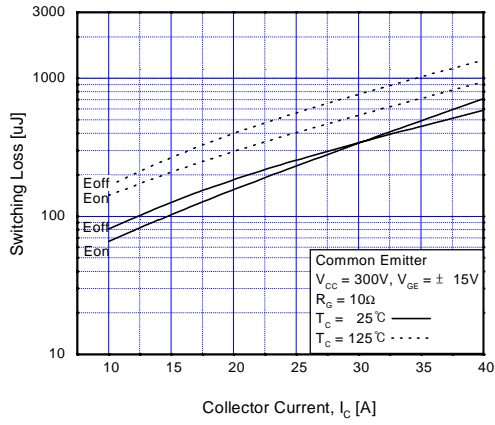
**Fig 10. Switching Loss vs. Gate Resistance**



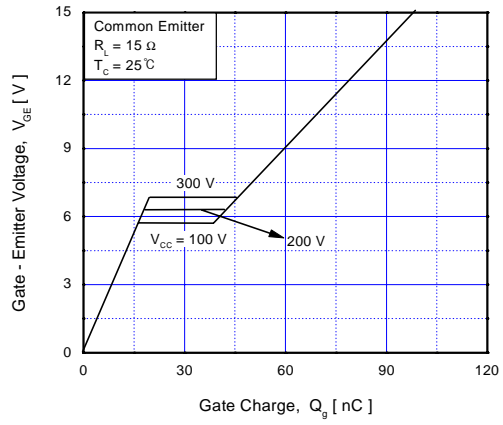
**Fig 11. Turn-On Characteristics vs. Collector Current**



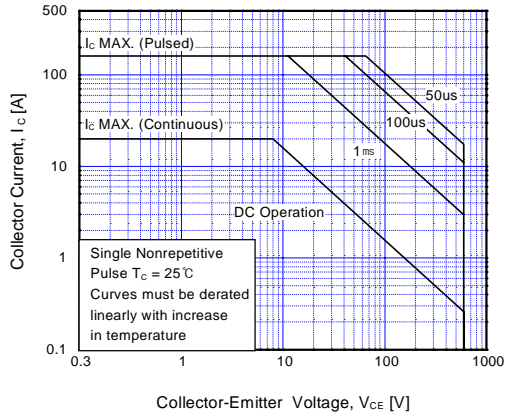
**Fig 12. Turn-Off Characteristics vs. Collector Current**



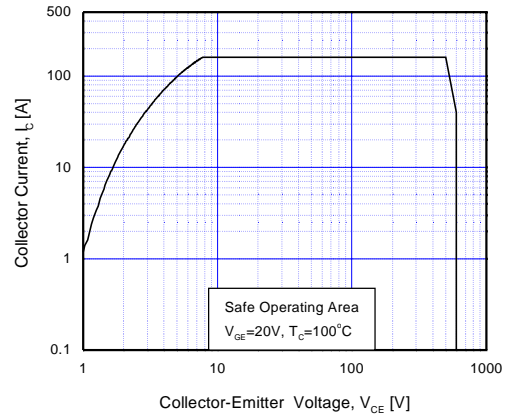
**Fig 13. Switching Loss vs. Collector Current**



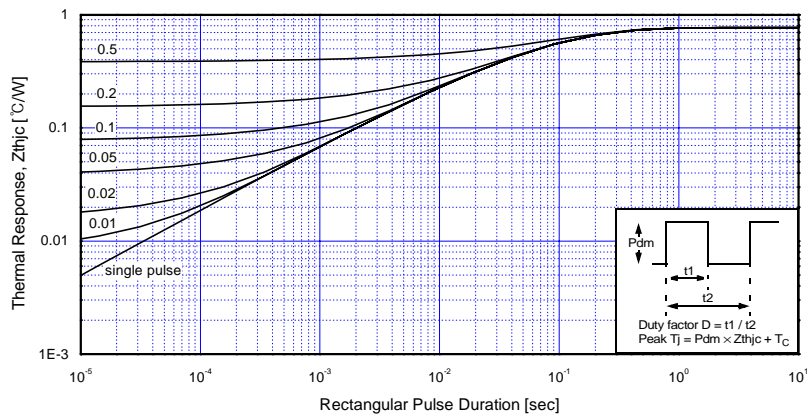
**Fig 14. Gate Charge Characteristics**



**Fig 15. SOA Characteristics**



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



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

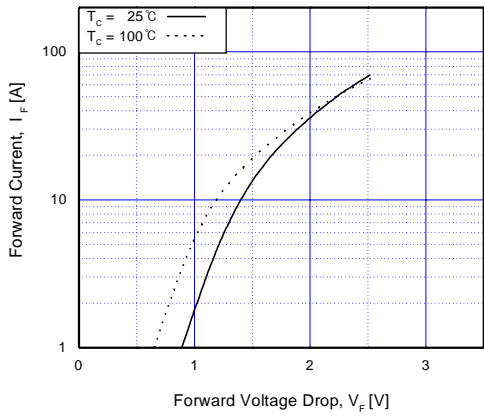


Fig 18. Forward Characteristics

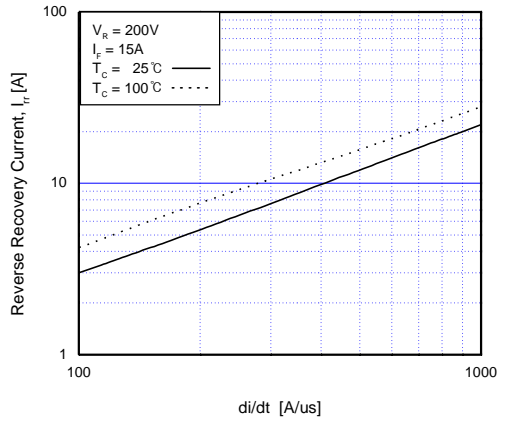


Fig 19. Reverse Recovery Current

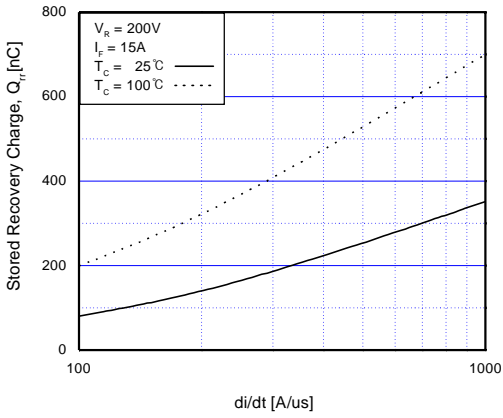


Fig 20. Stored Charge

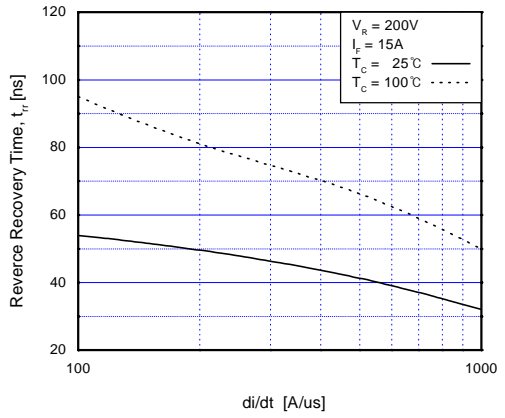


Fig 21. Reverse Recovery Time



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