FAIRCHILD
SEMICONDUCTOR®

November 2013

FGA60N60UFD
600 V, 60 A Field Stop IGBT

Features

- High Current Capability
- Low Saturation Voltage: $V_{CE(sat)}$ = 1.9 V @ I_C = 60 A
- High Input Impedance
- Fast Switching
- RoHS Compliant

Applications

- Solar Inverter, UPS, Welder, PFC

General Description

Using novel field stop IGBT technology, Fairchild's field stop IGBTs offer the optimum performance for solar inverter, UPS, welder and PFC applications where low conduction and switching losses are essential.

TO-3P

G C E

C

G

E
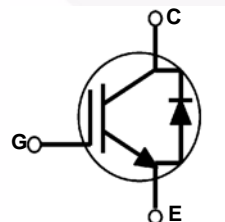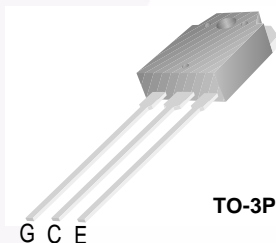
Absolute Maximum Ratings

Symbol	Description		Ratings	Unit
V_{CES}	Collector to Emitter Voltage		600	V
V_{GES}	Gate to Emitter Voltage		± 20	V
I_C	Collector Current	@ T_C = 25°C	120	A
	Collector Current	@ T_C = 100°C	60	A
$I_{CM (1)}$	Pulsed Collector Current	@ T_C = 25°C	180	A
P_D	Maximum Power Dissipation	@ T_C = 25°C	298	W
	Maximum Power Dissipation	@ T_C = 100°C	119	W
T_J	Operating Junction Temperature		-55 to +150	°C
T_{stg}	Storage Temperature Range		-55 to +150	°C
T_L	Maximum Lead Temp. for soldering Purposes, 1/8" from case for 5 seconds		300	°C

Notes:
1: Repetitive test , Pulse width limited by max. junction temperature

Thermal Characteristics

Symbol	Parameter	Typ.	Max.	Unit
$R_{\theta JC}$(IGBT)	Thermal Resistance, Junction to Case	-	0.33	°C/W
$R_{\theta JC}$(Diode)	Thermal Resistance, Junction to Case	-	1.1	°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	-	40	°C/W

Package Marking and Ordering Information

Part Number	Top Mark	Package	Packing Method	Reel Size	Tape Width	Quantity
FGA60N60UFDTU	FGA60N60UFD	TO-3P	Tube	N/A	N/A	30

Electrical Characteristics of the IGBT $T_C = 25°C$ unless otherwise noted

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
Off Characteristics						
BV_{CES}	Collector to Emitter Breakdown Voltage	$V_{GE} = 0$ V, $I_C = 250$ μA	600	-	-	V
ΔBV_{CES} ΔT_J	Temperature Coefficient of Breakdown Voltage	$V_{GE} = 0$ V, $I_C = 250$ μA	-	0.67	-	V/°C
I_{CES}	Collector Cut-Off Current	$V_{CE} = V_{CES}$, $V_{GE} = 0$ V	-	-	250	μA
I_{GES}	G-E Leakage Current	$V_{GE} = V_{GES}$, $V_{CE} = 0$ V	-	-	±400	nA
On Characteristics						
$V_{GE(th)}$	G-E Threshold Voltage	$I_C = 250$ μA, $V_{CE} = V_{GE}$	4.0	5.0	6.5	V
$V_{CE(sat)}$	Collector to Emitter Saturation Voltage	$I_C = 60$ A, $V_{GE} = 15$ V	-	1.9	2.4	V
		$I_C = 60$ A, $V_{GE} = 15$ V, $T_C = 125°C$	-	2.1	-	V
Dynamic Characteristics						
C_{ies}	Input Capacitance	$V_{CE} = 30$ V, $V_{GE} = 0$ V, f = 1 MHz	-	2855	-	pF
C_{oes}	Output Capacitance		-	325	-	pF
C_{res}	Reverse Transfer Capacitance		-	110	-	pF
Switching Characteristics						
$t_{d(on)}$	Turn-On Delay Time	$V_{CC} = 400$ V, $I_C = 60$ A, $R_G = 5$ Ω, $V_{GE} = 15$ V, Inductive Load, $T_C = 25°C$	-	23	-	ns
t_r	Rise Time		-	58	-	ns
$t_{d(off)}$	Turn-Off Delay Time		-	130	-	ns
t_f	Fall Time		-	40	80	ns
E_{on}	Turn-On Switching Loss		-	1.81	-	mJ
E_{off}	Turn-Off Switching Loss		-	0.81	-	mJ
E_{ts}	Total Switching Loss		-	2.62	-	mJ
$t_{d(on)}$	Turn-On Delay Time	$V_{CC} = 400$ V, $I_C = 60$ A, $R_G = 5$ Ω, $V_{GE} = 15$ V, Inductive Load, $T_C = 125°C$	-	22	-	ns
t_r	Rise Time		-	61	-	ns
$t_{d(off)}$	Turn-Off Delay Time		-	141	-	ns
t_f	Fall Time		-	63	-	ns
E_{on}	Turn-On Switching Loss		-	1.92	-	mJ
E_{off}	Turn-Off Switching Loss		-	1.23	-	mJ
E_{ts}	Total Switching Loss		-	3.15	-	mJ
Q_g	Total Gate Charge	$V_{CE} = 400$ V, $I_C = 60$ A, $V_{GE} = 15$ V	-	188	-	nC
Q_{ge}	Gate to Emitter Charge		-	21	-	nC
Q_{gc}	Gate to Collector Charge		-	97	-	nC

Electrical Characteristics of the Diode $T_C = 25°C$ unless otherwise noted

Symbol	Parameter	Test Conditions		Min.	Typ.	Max	Unit
V_{FM}	Diode Forward Voltage	$I_F = 30$ A	$T_C = 25°C$	-	2.0	2.6	V
			$T_C = 125°C$	-	1.8	-	
t_{rr}	Diode Reverse Recovery Time	$I_F = 30$ A, $di_F/dt = 200$ A/µs	$T_C = 25°C$	-	47	-	ns
			$T_C = 125°C$	-	179	-	
Q_{rr}	Diode Reverse Recovery Charge		$T_C = 25°C$	-	83	-	nC
			$T_C = 125°C$	-	567	-	

FGA60N60UFD — 600 V, 60 A Field Stop IGBT

Typical Performance Characteristics

Figure 1. Typical Output Characteristics
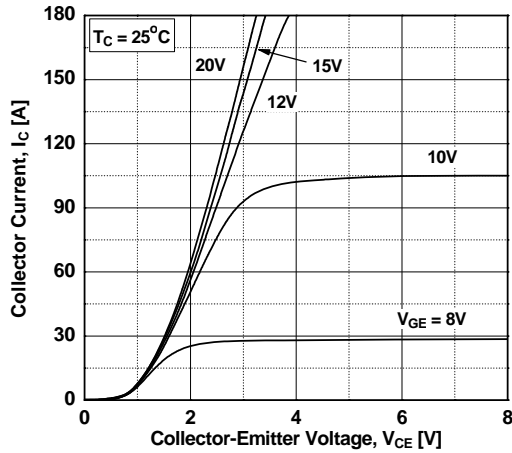
Figure 2. Typical Output Characteristics
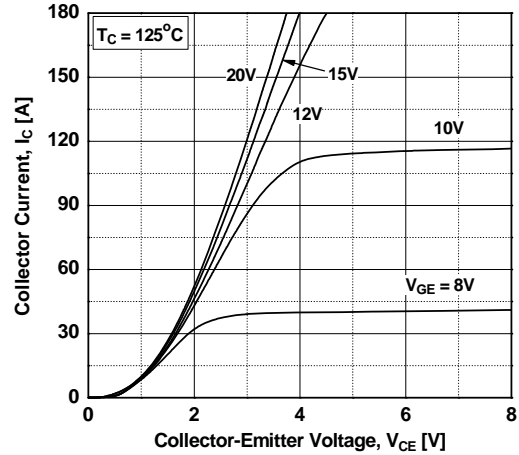
Figure 3. Typical Saturation Voltage Characteristics
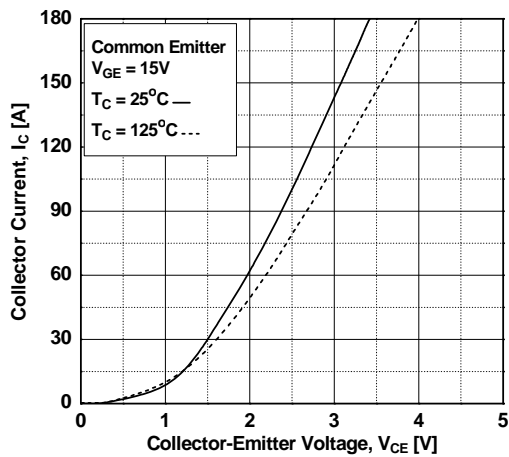

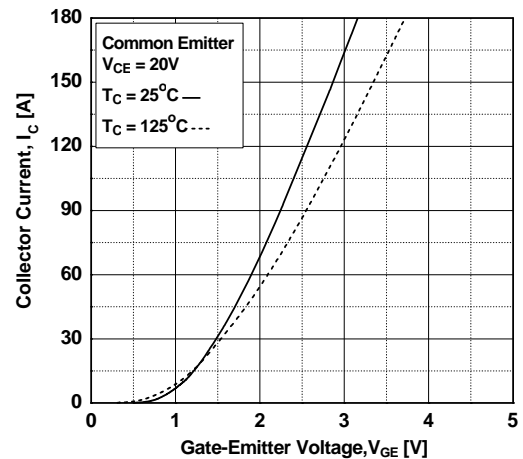### Figure 4. Transfer Characteristics

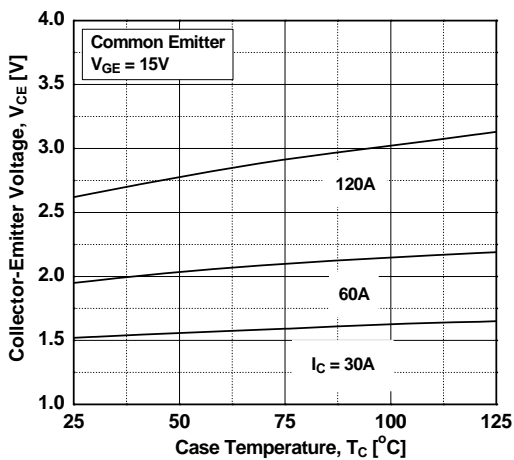### Figure 5. Saturation Voltage vs. Case Temperature at Variant Current Level
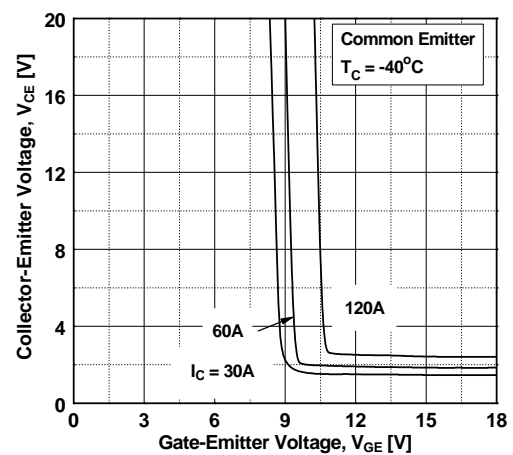

Figure 6. Saturation Voltage vs. V_{GE}

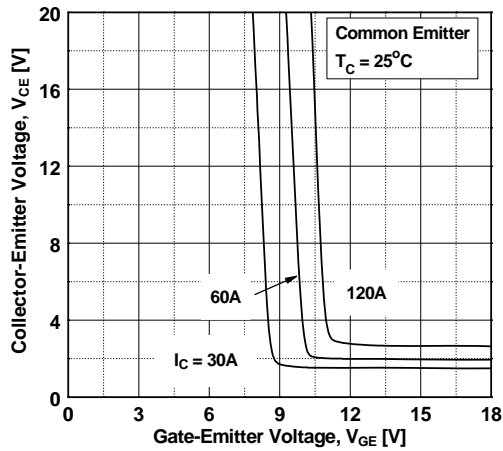# Typical Performance Characteristics

Figure 7. Saturation Voltage vs. V_{GE}

Common Emitter
$T_C = 25^oC$

60A   120A
$I_C = 30A$

Collector-Emitter Voltage, V_{CE} [V]
Gate-Emitter Voltage, V_{GE} [V]

Figure 8. Saturation Voltage vs. V_{GE}

Common Emitter
$T_C = 125^oC$

60A   120A
$I_C = 30A$

Collector-Emitter Voltage, V_{CE} [V]
Gate-Emitter Voltage, V_{GE} [V]
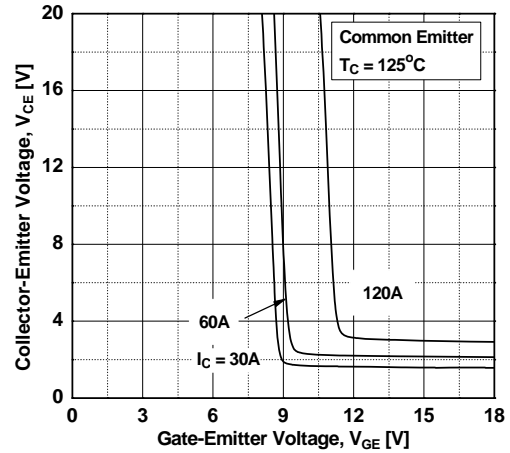
Figure 9. Capacitance Characteristics

Common Emitter
$V_{GE} = 0V$, $f = 1MHz$
$T_C = 25^oC$

C_{ies}
C_{oes}
C_{res}

Capacitance [pF]
Collector-Emitter Voltage, V_{CE} [V]
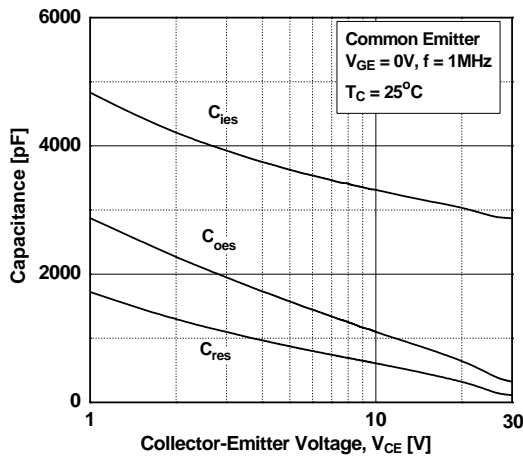
Figure 10. Gate charge Characteristics

Common Emitter
$T_C = 25^oC$

$V_{CC} = 100V$ 300V
200V

Gate-Emitter Voltage, V_{GE} [V]
Gate Charge, Q_g [nC]
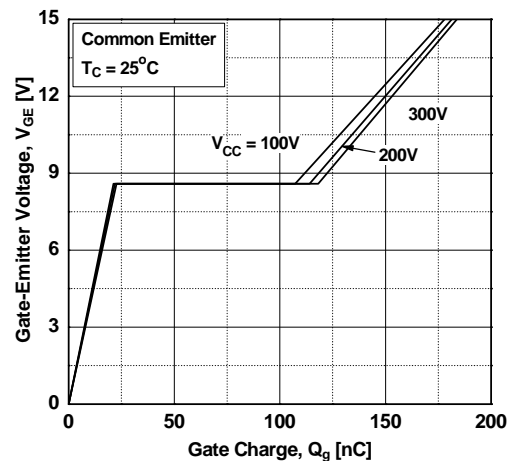
Figure 11. SOA Characteristics

10µs
100µs
1ms
10 ms
DC

Single Nonrepetitive
Pulse $T_C = 25^oC$
Curves must be derated
linearly with increase
in temperature

Collector Current, I_C [A]
Collector-Emitter Voltage, V_{CE} [V]
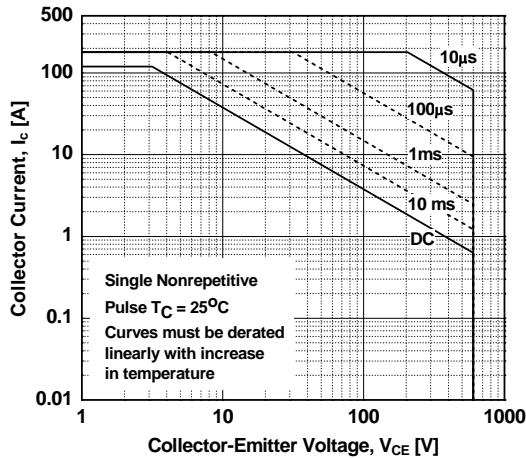
Figure 12. Turn off Switching SOA Characteristics

Safe Operating Area
$V_{GE} = 15V$, $T_C = 125^oC$

Collector Current, I_C [A]
Collector-Emitter Voltage, V_{CE} [V]
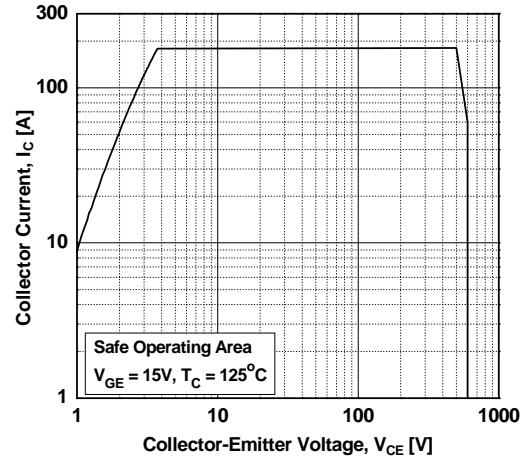
Typical Performance Characteristics

Figure 13. Turn-on Characteristics vs. Gate Resistance
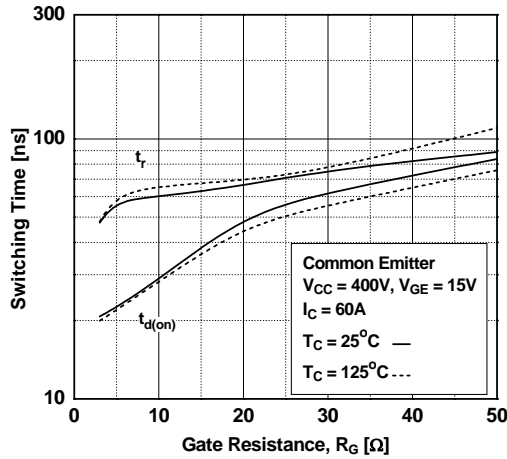

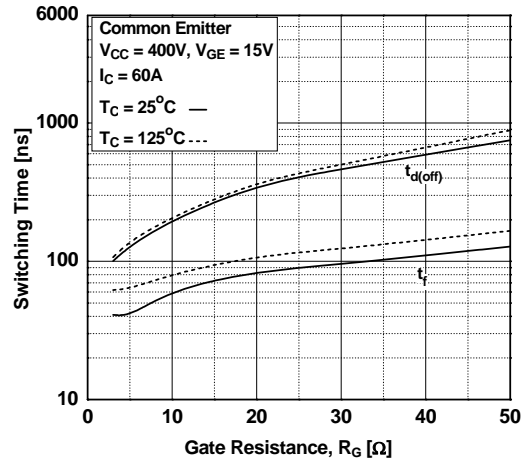### Figure 14. Turn-off Characteristics vs. Gate Resistance

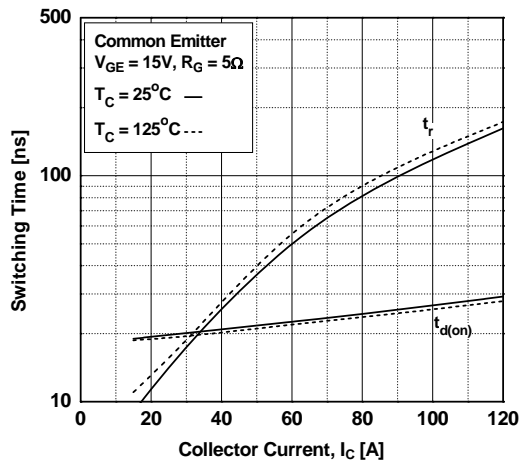### Figure 15. Turn-on Characteristics vs. Collector Current

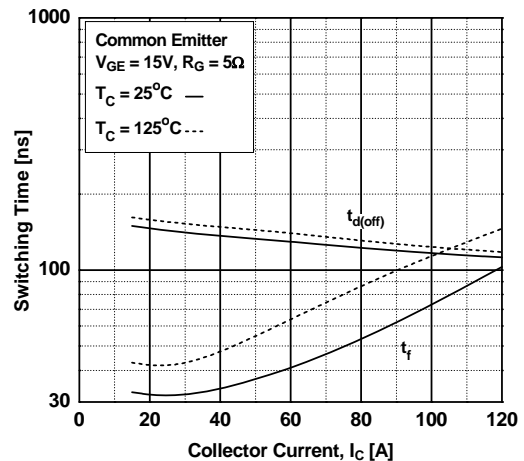### Figure 16. Turn-off Characteristics vs. Collector Current

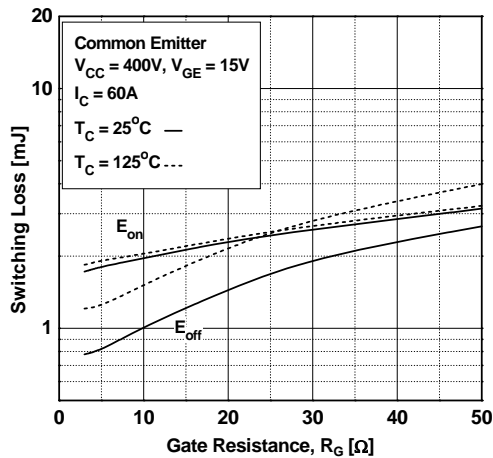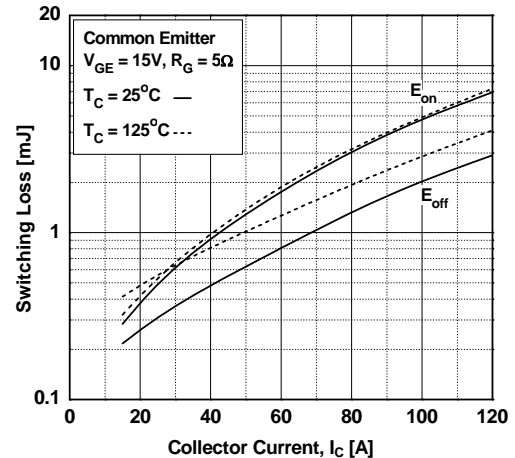### Figure 17. Switching Loss vs. Gate Resistance

Figure 18. Switching Loss vs. Collector Current

Typical Performance Characteristics
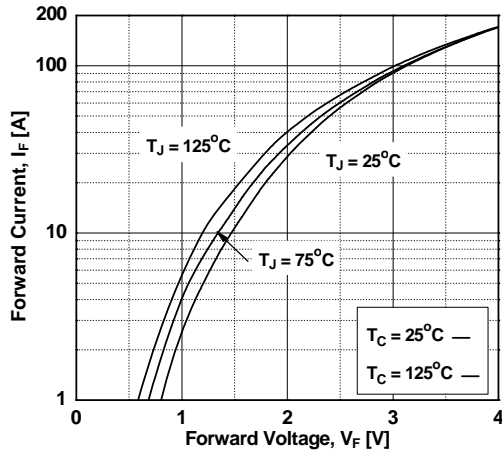
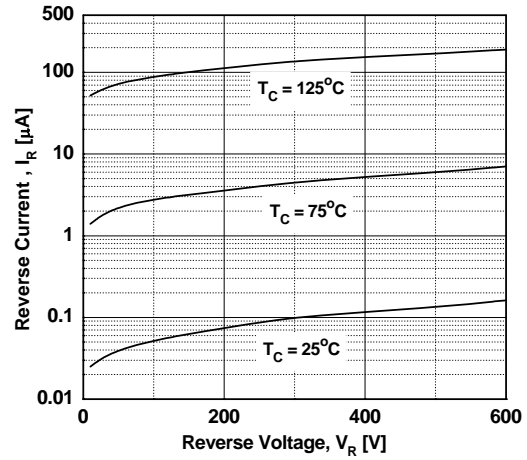### Figure 19. Forward Characteristics

Figure 20. Reverse Current
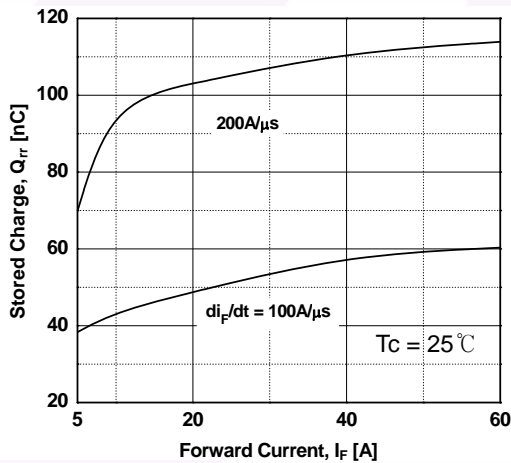

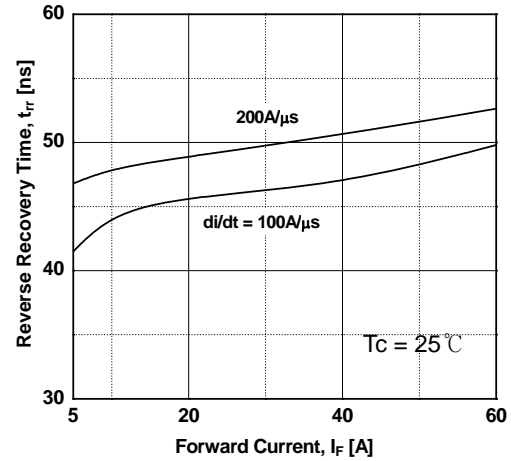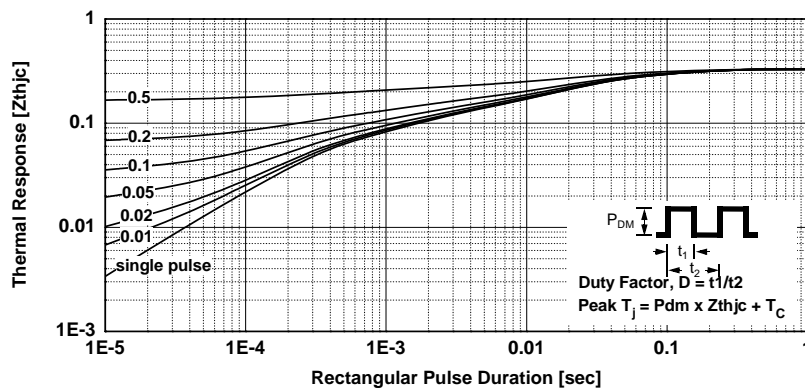### Figure 21. Stored Charge

Figure 22. Reverse Recovery Time

Figure 23. Transient Thermal Impedance of IGBT

Mechanical Dimensions

15.80
15.40

5.20
4.80

20.10
19.70

18.90
18.50

(1.85)

2.20
1.80

1.20
0.80

⌖ ∅ 0.55 (M)

5.45

5.45

3.70
3.30

3.20
2.80

(R0.50)

5.00
4.60

1.65
1.45

(R0.50)

3°

4°

3°

2.90
1.90

0.75
0.55

13.80
13.40

∅ 3.30
3.10

∅ 7.20
6.80

16.96
16.56

20.30
19.70

NOTES: UNLESS OTHERWISE SPECIFIED

A) THIS PACKAGE CONFORMS TO EIAJ
   SC-65 PACKAGING STANDARD.
B) ALL DIMENSIONS ARE IN MILLIMETERS.
C) DIMENSION AND TOLERANCING PER
   ASME14.5
D) DIMENSIONS ARE EXCLUSSIVE OF BURRS,
   MOLD FLASH, AND TIE BAR EXTRUSSIONS.
E) THIS PACKAGE IS INTENDED ONLY FOR TO3PN.
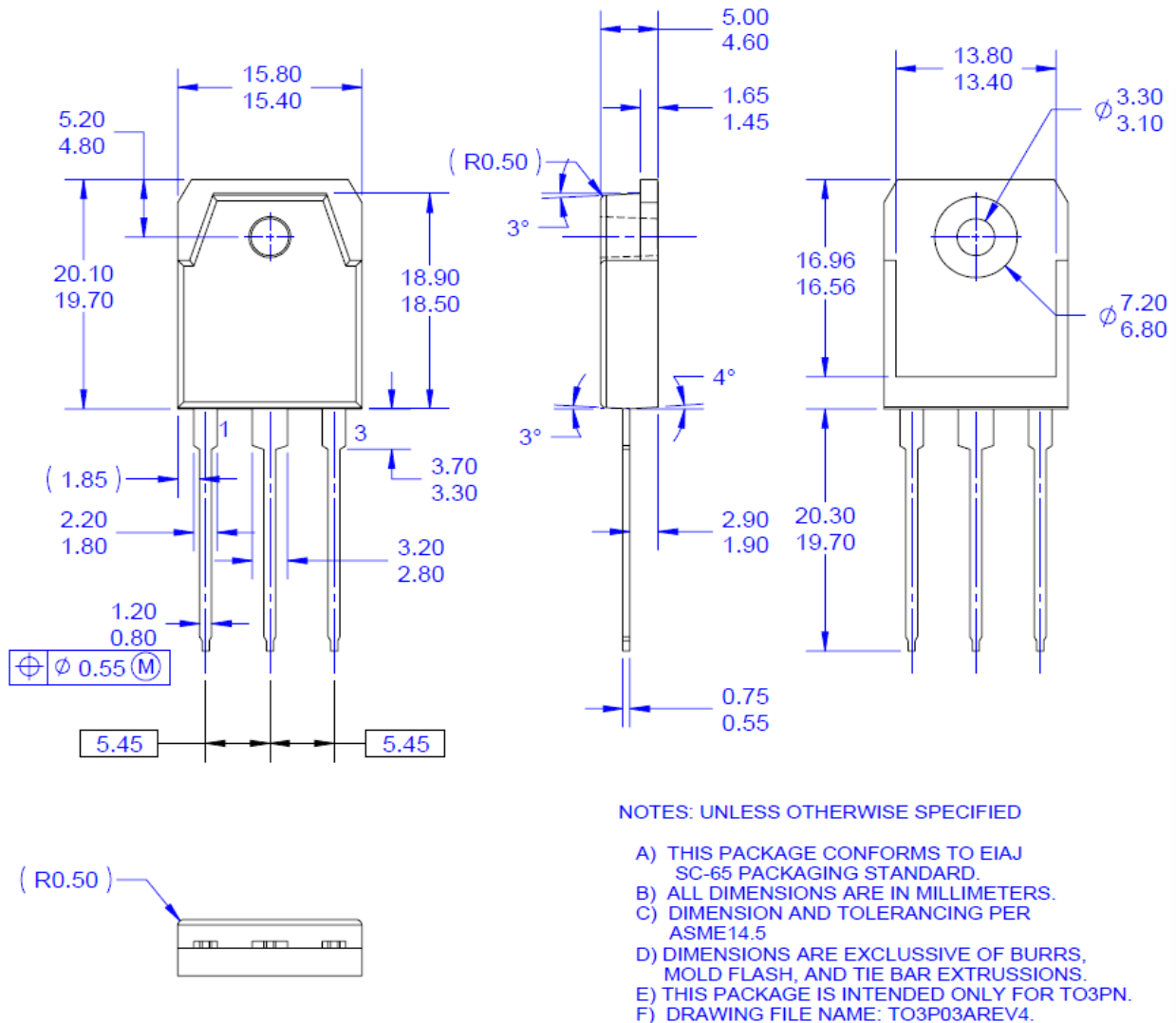F) DRAWING FILE NAME: TO3P03AREV4.

Figure 24. TO-3P 3L - 3LD, T03, PLASTIC, EIAJ SC-65

Package drawings are provided as a service to customers considering Fairchild components. Drawings may change in any manner without notice. Please note the revision and/or date on the drawing and contact a Fairchild Semiconductor representative to verify or obtain the most recent revision. Package specifications do not expand the terms of Fairchild's worldwide terms and conditions, specifically the warranty therein, which covers Fairchild products.

Always visit Fairchild Semiconductor's online packaging area for the most recent package drawings:

http://www.fairchildsemi.com/package/packageDetails.html?id=PN_TT3P0-003

Dimensions in Millimeters

TRADEMARKS

The following includes registered and unregistered trademarks and service marks, owned by Fairchild Semiconductor and/or its global subsidiaries, and is not intended to be an exhaustive list of all such trademarks.

AccuPower™
AX-CAP®*
BitSiC™
Build it Now™
CorePLUS™
CorePOWER™
CROSSVOLT™
CTL™
Current Transfer Logic™
DEUXPEED®
Dual Cool™
EcoSPARK®
EfficentMax™
ESBC™

F®

Fairchild®
Fairchild Semiconductor®
FACT Quiet Series™
FACT®
FAST®
FastvCore™
FETBench™
FPS™

F-PFS™
FRFET®
Global Power Resource℠
GreenBridge™
Green FPS™
Green FPS™ e-Series™
G*max*™
GTO™
IntelliMAX™
ISOPLANAR™
Marking Small Speakers Sound Louder and Better™
MegaBuck™
MICROCOUPLER™
MicroFET™
MicroPak™
MicroPak2™
MillerDrive™
MotionMax™
mWSaver®
OptoHiT™
OPTOLOGIC®
OPTOPLANAR®

®

PowerTrench®
PowerXS™
Programmable Active Droop™
QFET®
QS™
Quiet Series™
RapidConfigure™

™

Saving our world, 1mW/W/kW at a time™
SignalWise™
SmartMax™
SMART START™
Solutions for Your Success™
SPM®
STEALTH™
SuperFET®
SuperSOT™-3
SuperSOT™-6
SuperSOT™-8
SupreMOS®
SyncFET™

Sync-Lock™

SYSTEM ®*
GENERAL

TinyBoost®
TinyBuck®
TinyCalc™
TinyLogic®
TINYOPTO™
TinyPower™
TinyPWM™
TinyWire™
TranSiC™
TriFault Detect™
TRUECURRENT®*
µSerDes™

SerDes™

UHC®
Ultra FRFET™
UniFET™
VCX™
VisualMax™
VoltagePlus™
XS™

*Trademarks of System General Corporation, used under license by Fairchild Semiconductor.

DISCLAIMER
FAIRCHILD SEMICONDUCTOR RESERVES THE RIGHT TO MAKE CHANGES WITHOUT FURTHER NOTICE TO ANY PRODUCTS HEREIN TO IMPROVE RELIABILITY, FUNCTION, OR DESIGN. FAIRCHILD DOES NOT ASSUME ANY LIABILITY ARISING OUT OF THE APPLICATION OR USE OF ANY PRODUCT OR CIRCUIT DESCRIBED HEREIN; NEITHER DOES IT CONVEY ANY LICENSE UNDER ITS PATENT RIGHTS, NOR THE RIGHTS OF OTHERS. THESE SPECIFICATIONS DO NOT EXPAND THE TERMS OF FAIRCHILD'S WORLDWIDE TERMS AND CONDITIONS, SPECIFICALLY THE WARRANTY THEREIN, WHICH COVERS THESE PRODUCTS.

LIFE SUPPORT POLICY
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 CORPORATION.

As used here in:

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, and (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 a significant injury of the user.

2. A critical component in 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.

ANTI-COUNTERFEITING POLICY
Fairchild Semiconductor Corporation's Anti-Counterfeiting Policy. Fairchild's Anti-Counterfeiting Policy is also stated on our external website, www.Fairchildsemi.com, under Sales Support.

Counterfeiting of semiconductor parts is a growing problem in the industry. All manufactures of semiconductor products are experiencing counterfeiting of their parts. Customers who inadvertently purchase counterfeit parts experience many problems such as loss of brand reputation, substandard performance, failed application, and increased cost of production and manufacturing delays. Fairchild is taking strong measures to protect ourselves and our customers from the proliferation of counterfeit parts. Fairchild strongly encourages customers to purchase Fairchild parts either directly from Fairchild or from Authorized Fairchild Distributors who are listed by country on our web page cited above. Products customers buy either from Fairchild directly or from Authorized Fairchild Distributors are genuine parts, have full traceability, meet Fairchild's quality standards for handing and storage and provide access to Fairchild's full range of up-to-date technical and product information. Fairchild and our Authorized Distributors will stand behind all warranties and will appropriately address and warranty issues that may arise. Fairchild will not provide any warranty coverage or other assistance for parts bought from Unauthorized Sources. Fairchild is committed to combat this global problem and encourage our customers to do their part in stopping this practice by buying direct or from authorized distributors.

PRODUCT STATUS DEFINITIONS
Definition of Terms

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

Rev. I66