FAIRCHILD

SEMICONDUCTOR®

FDZ391P
P-Channel 1.5 V PowerTrench® Thin WL-CSP MOSFET
-20 V, -3 A, 85 mΩ

Features

- Max $r_{DS(on)}$ = 85 mΩ at V_{GS} = -4.5 V, I_D = -1 A

- Max $r_{DS(on)}$ = 123 mΩ at V_{GS} = -2.5 V, I_D = -1 A

- Max $r_{DS(on)}$ = 200 mΩ at V_{GS} = -1.5 V, I_D = -1 A

- Occupies only 1.5 mm² of PCB area

- **Ultra-thin package**: less than 0.4 mm height when mounted to PCB

- RoHS Compliant

General Description

Designed on Fairchild's advanced 1.5 V PowerTrench process with state of the art "low pitch" **Thin** WLCSP packaging process, the FDZ391P minimizes both PCB space and $r_{DS(on)}$. This advanced WLCSP MOSFET embodies a breakthrough in packaging technology which enables the device to combine excellent thermal transfer characteristics, ultra-low profile packaging, low gate charge, and low $r_{DS(on)}$.
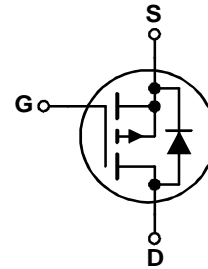
Applications

- Battery management
- Load switch
- Battery protection
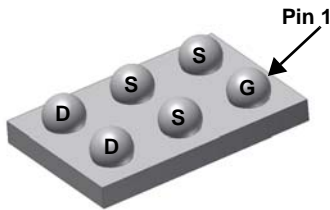
BOTTOM   **TOP**

MOSFET Maximum Ratings T_A = 25 °C unless otherwise noted

Symbol	Parameter			Ratings	Units
V_{DS}	Drain to Source Voltage			-20	V
V_{GS}	Gate to Source Voltage			±8	V
I_D	Drain Current -Continuous	T_A = 25 °C	(Note 1a)	-3	A
	-Pulsed			-15	
P_D	Power Dissipation	T_A = 25 °C	(Note 1a)	1.9	W
	Power Dissipation	T_A = 25 °C	(Note 1b)	0.9	
T_J, T_{STG}	Operating and Storage Junction Temperature Range			-55 to +150	°C

Thermal Characteristics

$R_{\theta JA}$	Thermal Resistance, Junction to Ambient		(Note 1a)	65	°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient		(Note 1b)	133	

Package Marking and Ordering Information

Device Marking	Device	Package	Reel Size	Tape Width	Quantity
6	FDZ391P	WL-CSP **Thin**	7 "	8 mm	5000 units

Electrical Characteristics T_J = 25 °C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Typ	Max	Units
Off Characteristics						
BV_{DSS}	Drain to Source Breakdown Voltage	I_D = -250 μA, V_{GS} = 0 V	-20			V
$\frac{\Delta BV_{DSS}}{\Delta T_J}$	Breakdown Voltage Temperature Coefficient	I_D = -250 μA, referenced to 25 °C		-12		mV/°C
I_{DSS}	Zero Gate Voltage Drain Current	V_{DS} = -16 V, V_{GS} = 0 V			-1	μA
I_{GSS}	Gate to Source Leakage Current	V_{GS} = ±8 V, V_{DS} = 0 V			±100	nA
On Characteristics						
$V_{GS(th)}$	Gate to Source Threshold Voltage	V_{GS} = V_{DS}, I_D = -250 μA	-0.4	-0.6	-1.5	V
$\frac{\Delta V_{GS(th)}}{\Delta T_J}$	Gate to Source Threshold Voltage Temperature Coefficient	I_D = -250 μA, referenced to 25 °C		2		mV/°C
$r_{DS(on)}$	Drain to Source On Resistance	V_{GS} = -4.5 V, I_D = -1 A		74	85	mΩ
		V_{GS} = -2.5 V, I_D = -1 A		90	123	
		V_{GS} = -1.5 V, I_D = -1 A		140	200	
		V_{GS} = -4.5 V, I_D = -1 A T_J = 125 °C		100	123	
$I_{D(on)}$	On to State Drain Current	V_{GS} = -4.5 V, V_{DS} = - 5 V	-10			A
g_{FS}	Forward Transconductance	V_{DS} = -5 V, I_D = -1 A		7		S
Dynamic Characteristics						
C_{iss}	Input Capacitance	V_{DS} = -10 V, V_{GS} = 0 V, f = 1 MHz		800	1065	pF
C_{oss}	Output Capacitance			155	205	pF
C_{rss}	Reverse Transfer Capacitance			90	135	pF
R_g	Gate Resistance	f = 1 MHz		9		Ω
Switching Characteristics						
$t_{d(on)}$	Turn-On Delay Time	V_{DD} = -10 V, I_D = -1 A V_{GS} = -4.5 V, R_{GEN} = 6 Ω		11	20	ns
t_r	Rise Time			10	20	ns
$t_{d(off)}$	Turn-Off Delay Time			50	80	ns
t_f	Fall Time			30	48	ns
Q_g	Total Gate Charge	V_{GS} = -4.5 V V_{DD} = -10 V I_D = -1 A		9	13	nC
Q_{gs}	Gate to Source Gate Charge			1		nC
Q_{gd}	Gate to Drain "Miller" Charge			2		nC
Drain-Source Diode Characteristics						
I_S	Maximum continuous Drain-Source Diode Forward Current				-1.1	A
V_{SD}	Source to Drain Diode Forward Voltage	V_{GS} = 0 V, I_S = -1.1 A (Note 2)		-0.7	-1.2	V
t_{rr}	Reverse Recovery Time	I_F = -1 A, di/dt = 100 A/μs		21		ns
Q_{rr}	Reverse Recovery Charge			5		nC

Notes:

1. $R_{θJA}$ is determined with the device mounted on a 1 in^2 pad 2 oz copper pad on a 1.5 x 1.5 in. board of FR-4 material. $R_{θJC}$ is guaranteed by design while $R_{θCA}$ is determined by the user's board design.
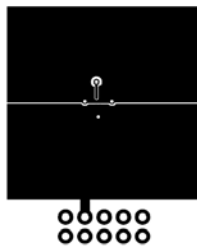
a. 65 °C/W when mounted   on a 1 in^2 pad of 2 oz copper.

b. 133 °C/W when mounted on a minimum pad of 2 oz copper.

2. Pulse Test: Pulse Width < 300μs, Duty cycle < 2.0%.

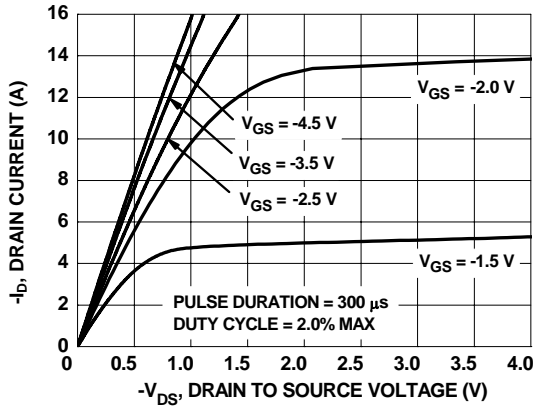**Typical Characteristics** T_J = 25 °C unless otherwise noted

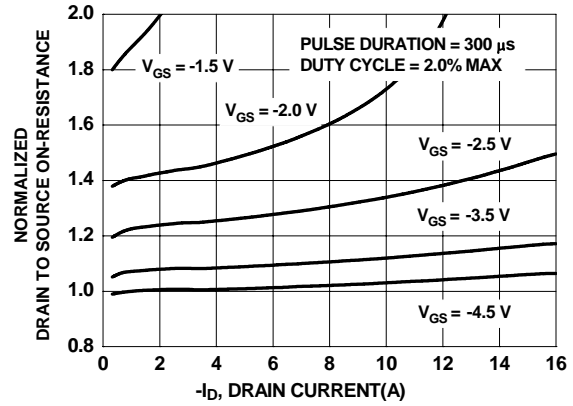**Figure 1. On Region Characteristics**

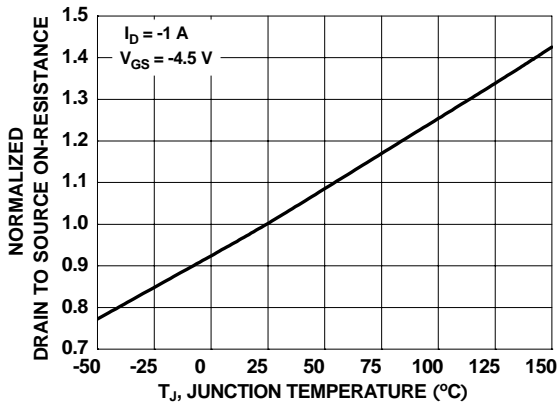**Figure 2. Normalized On-Resistance vs Drain Current and Gate Voltage**

Figure 3. Normalized On Resistance vs Junction Temperature
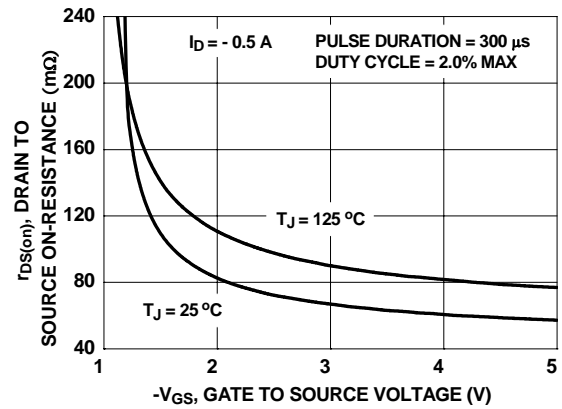

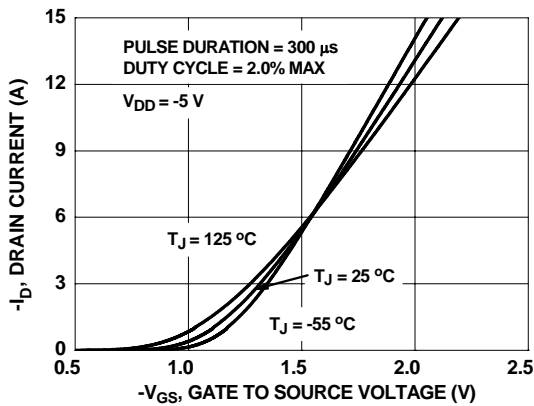**Figure 4. On-Resistance vs Gate to Source Voltage**
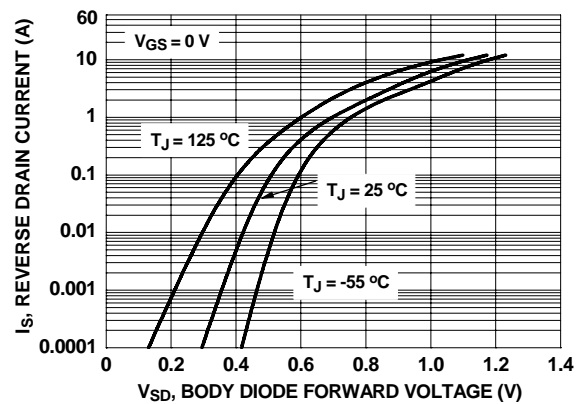

Figure 5. Transfer Characteristics

Figure 6. Source to Drain Diode Forward Voltage vs Source Current

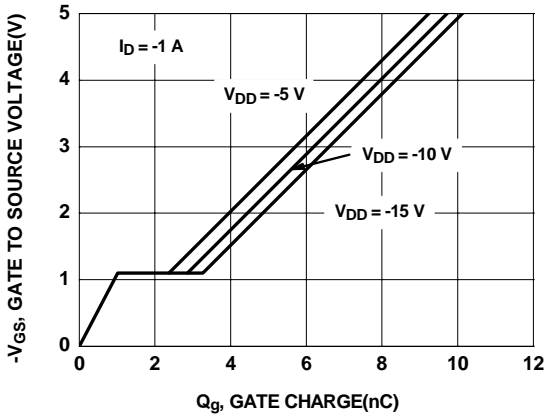## Typical Characteristics T_J = 25 °C unless otherwise noted

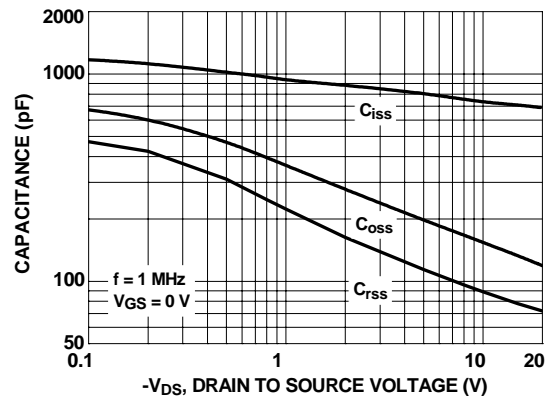**Figure 7. Gate Charge Characteristics**

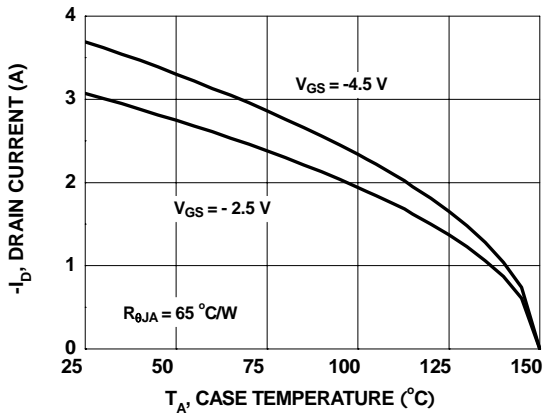**Figure 8. Capacitance vs Drain to Source Voltage**
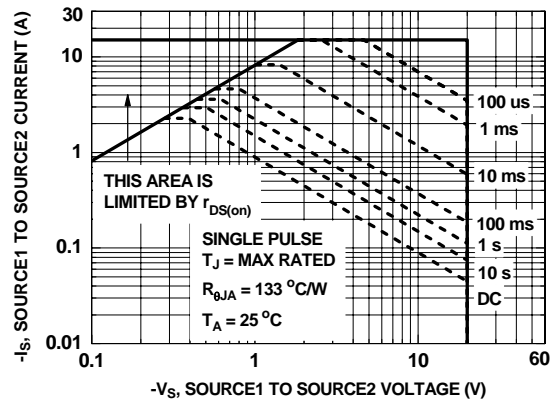
Figure 9. Maximum Continuous Drain Current vs Ambient Temperature

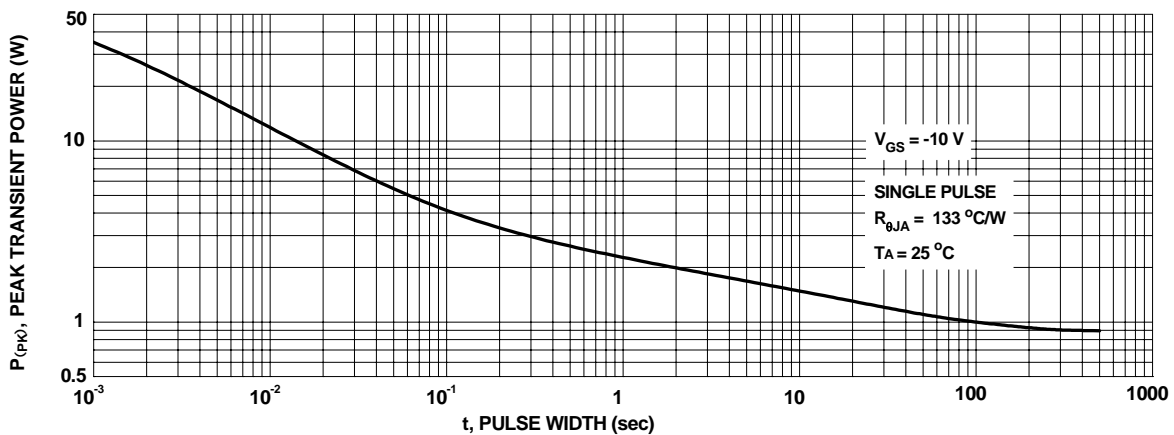**Figure 10. Forward Bias Safe Operating Area**

Figure 11. Single Pulse Maximum Power Dissipation
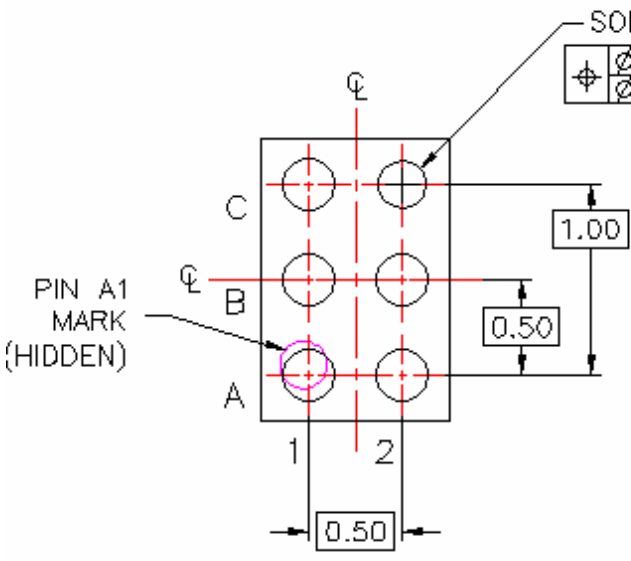
Typical Characteristics T_J = 25 °C unless otherwise noted

NORMALIZED THERMAL IMPEDANCE, $Z_{\theta JA}$

DUTY CYCLE-DESCENDING ORDER

D = 0.5
0.2
0.1
0.05
0.02
0.01

SINGLE PULSE

$R_{\theta JA}$ = 133 °C/W

t, RECTANGULAR PULSE DURATION (sec)

NOTES:
DUTY FACTOR: D = t_1/t_2
PEAK T_J = P_{DM} x $Z_{\theta JA}$ x $R_{\theta JA}$ + T_A

Figure 12. Transient Thermal Response Curve
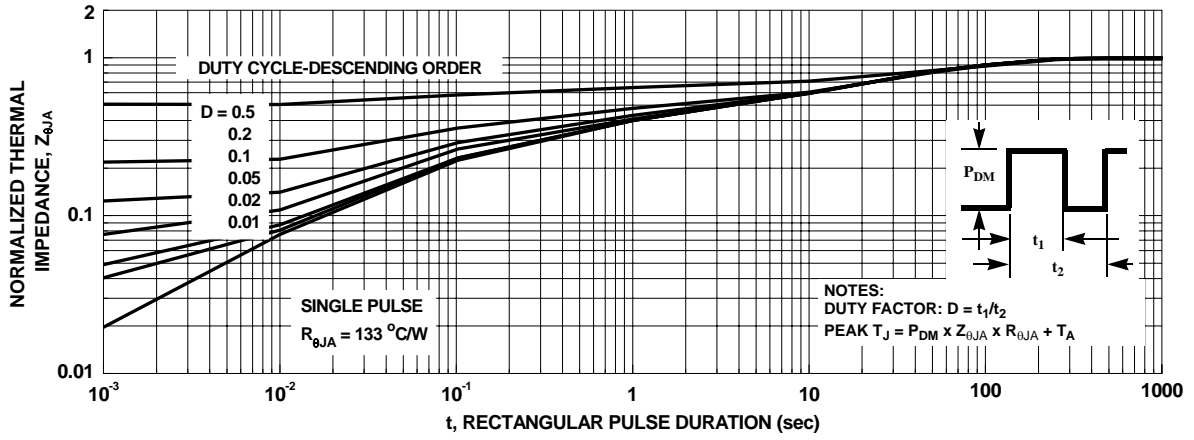
Dimensional Outline and Pad Layout

LAND PATTERN
RECOMMENDATION
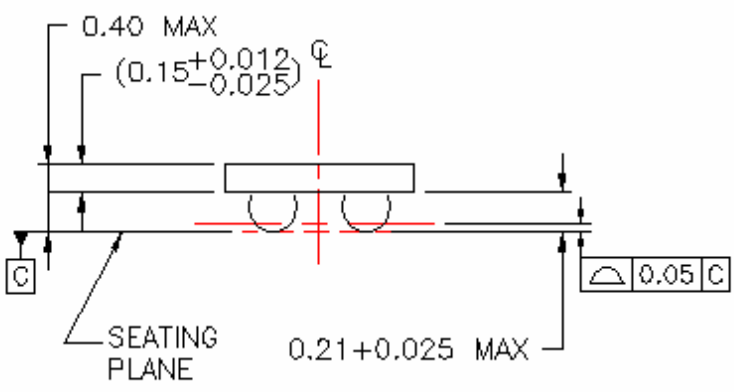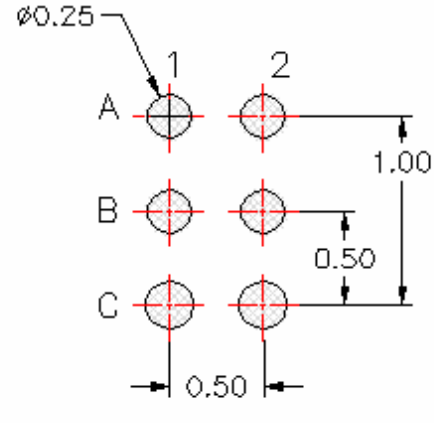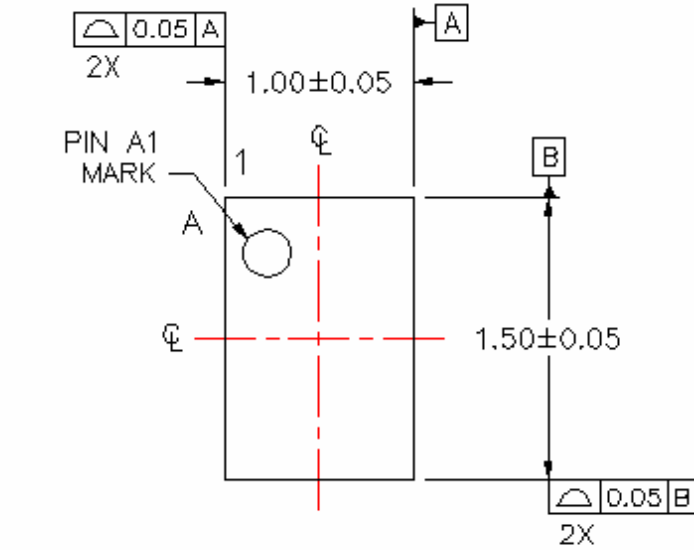
NOTES: UNLESS OTHERWISE SPECIFIED

A) THIS PACKAGE IS NOT PRESENTLY
   REGISTERED WITH ANY STANDARDS
   COMMITTEE.
B) DIMENSIONS ARE IN MILLIMETERS.
C) DRAWING CONFORMS TO ASME
   Y14.5M-1994
D) TERMINAL CONFIGURATION TABLE:

GATE	SOURCE	DRAIN
A1	A2, B1, B2	C1, C2

E) DRAWING FILENAME: MKT-UC006AEREV2

FAIRCHILD
SEMICONDUCTOR®

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.

Build it Now™	FRFET®	Programmable Active Droop™	**the power** franchise
CorePLUS™	Global Power Resource℠	QFET®	TinyBoost™
CorePOWER™	Green FPS™	QS™	TinyBuck™
CROSSVOLT™	Green FPS™ e-Series™	Quiet Series™	TinyLogic®
CTL™	GTO™	RapidConfigure™	TINYOPTO™
Current Transfer Logic™	IntelliMAX™		TinyPower™
EcoSPARK®	ISOPLANAR™	Saving our world, 1mW /W /kW at a time™	TinyPWM™
EfficentMax™	MegaBuck™	SmartMax™	TinyWire™
EZSWITCH™ *	MICROCOUPLER™	SMART START™	μSerDes™
EZ™	MicroFET™	SPM®	
F®	MicroPak™	STEALTH™	μSerDes™
Fairchild®	MillerDrive™	SuperFET™	UHC®
Fairchild Semiconductor®	MotionMax™	SuperSOT™-3	Ultra FRFET™
FACT Quiet Series™	Motion-SPM™	SuperSOT™-6	UniFET™
FACT®	OPTOLOGIC®	SuperSOT™-8	VCX™
FAST®	OPTOPLANAR®	SupreMOS™	VisualMax™
FastvCore™		SyncFET™	XS™
FlashWriter® *	PDP SPM™		
FPS™	Power-SPM™	SYSTEM GENERAL®	
F-PFS™	PowerTrench®	The Power Franchise®	
	PowerXS™		

* EZSWITCH™ and FlashWriter® are 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 herein:

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 Farichild'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. Farichild 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. I37