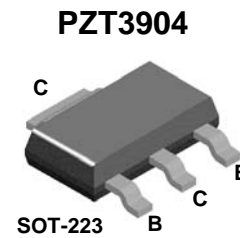
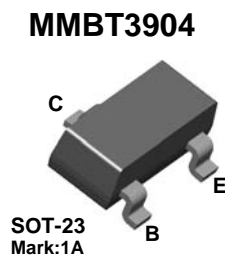


2N3904 / MMBT3904 / PZT3904 NPN General Purpose Amplifier

Features

- This device is designed as a general purpose amplifier and switch.
- The useful dynamic range extends to 100 mA as a switch and to 100 MHz as an amplifier.



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

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	40	V
V_{CBO}	Collector-Base Voltage	60	V
V_{EBO}	Emitter-Base Voltage	6.0	V
I_C	Collector Current - Continuous	200	mA
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	$^\circ\text{C}$

* These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:

- 1) These ratings are based on a maximum junction temperature of 150 degrees C.
- 2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics $T_a = 25^\circ\text{C}$ unless otherwise noted

Symbol	Parameter	Max.			Units
		2N3904	*MMBT3904	**PZT3904	
P_D	Total Device Dissipation	625	350	1,000	mW
	Derate above 25°C	5.0	2.8	8.0	mW/ $^\circ\text{C}$
$R_{\theta JC}$	Thermal Resistance, Junction to Case	83.3			$^\circ\text{C}/\text{W}$
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	200	357	125	$^\circ\text{C}/\text{W}$

* Device mounted on FR-4 PCB 1.6" X 1.6" X 0.06".

** Device mounted on FR-4 PCB 36 mm X 18 mm X 1.5 mm; mounting pad for the collector lead min. 6 cm².

Electrical Characteristics $T_a = 25^\circ\text{C}$ unless otherwise noted

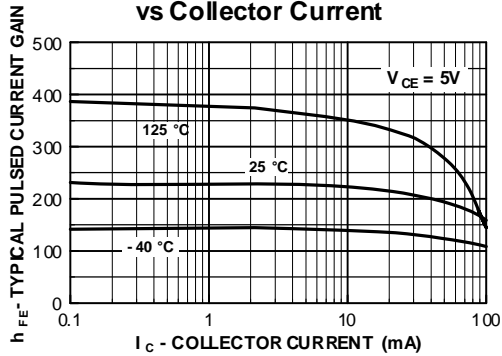
Symbol	Parameter	Test Condition	Min.	Max.	Units
OFF CHARACTERISTICS					
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage	$I_C = 1.0\text{mA}, I_B = 0$	40		V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	$I_C = 10\mu\text{A}, I_E = 0$	60		V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	$I_E = 10\mu\text{A}, I_C = 0$	6.0		V
I_{BL}	Base Cutoff Current	$V_{CE} = 30\text{V}, V_{EB} = 3\text{V}$		50	nA
I_{CEX}	Collector Cutoff Current	$V_{CE} = 30\text{V}, V_{EB} = 3\text{V}$		50	nA
ON CHARACTERISTICS*					
h_{FE}	DC Current Gain	$I_C = 0.1\text{mA}, V_{CE} = 1.0\text{V}$ $I_C = 1.0\text{mA}, V_{CE} = 1.0\text{V}$ $I_C = 10\text{mA}, V_{CE} = 1.0\text{V}$ $I_C = 50\text{mA}, V_{CE} = 1.0\text{V}$ $I_C = 100\text{mA}, V_{CE} = 1.0\text{V}$	40 70 100 60 30	300	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	$I_C = 10\text{mA}, I_B = 1.0\text{mA}$ $I_C = 50\text{mA}, I_B = 5.0\text{mA}$		0.2 0.3	V V
$V_{BE(sat)}$	Base-Emitter Saturation Voltage	$I_C = 10\text{mA}, I_B = 1.0\text{mA}$ $I_C = 50\text{mA}, I_B = 5.0\text{mA}$	0.65	0.85 0.95	V V
SMALL SIGNAL CHARACTERISTICS					
f_T	Current Gain - Bandwidth Product	$I_C = 10\text{mA}, V_{CE} = 20\text{V},$ $f = 100\text{MHz}$	300		MHz
C_{obo}	Output Capacitance	$V_{CB} = 5.0\text{V}, I_E = 0,$ $f = 1.0\text{MHz}$		4.0	pF
C_{ibo}	Input Capacitance	$V_{EB} = 0.5\text{V}, I_C = 0,$ $f = 1.0\text{MHz}$		8.0	pF
NF	Noise Figure	$I_C = 100\mu\text{A}, V_{CE} = 5.0\text{V},$ $R_S = 1.0\text{k}\Omega,$ $f = 10\text{Hz to } 15.7\text{kHz}$		5.0	dB
SWITCHING CHARACTERISTICS					
t_d	Delay Time	$V_{CC} = 3.0\text{V}, V_{BE} = 0.5\text{V}$		35	ns
t_r	Rise Time	$I_C = 10\text{mA}, I_{B1} = 1.0\text{mA}$		35	ns
t_s	Storage Time	$V_{CC} = 3.0\text{V}, I_C = 10\text{mA},$		200	ns
t_f	Fall Time	$I_{B1} = I_{B2} = 1.0\text{mA}$		50	ns

* Pulse Test: Pulse Width $\leq 300\mu\text{s}$, Duty Cycle $\leq 2.0\%$ **Ordering Information**

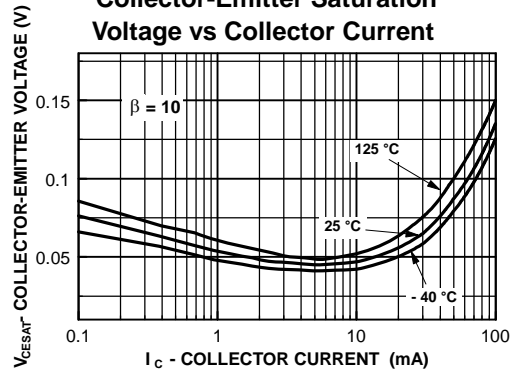
Part Number	Marking	Package	Packing Method	Pack Qty
2N3904BU	2N3904	TO-92	BULK	10000
2N3904TA	2N3904	TO-92	AMMO	2000
2N3904TAR	2N3904	TO-92	AMMO	2000
2N3904TF	2N3904	TO-92	TAPE REEL	2000
2N3904TFR	2N3904	TO-92	TAPE REEL	2000
MMBT3904	1A	SOT-23	TAPE REEL	3000
MMBT3904_D87Z	1A	SOT-23	TAPE REEL	10000
PZT3904	3904	SOT-223	TAPE REEL	2500

Typical Performance Characteristics

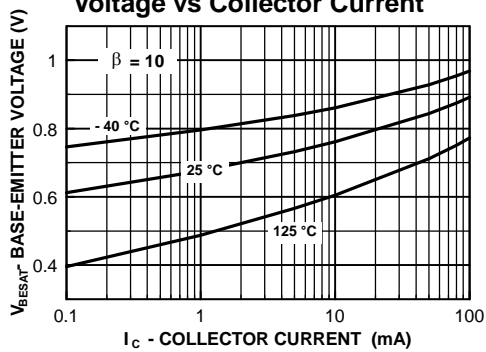
Typical Pulsed Current Gain vs Collector Current



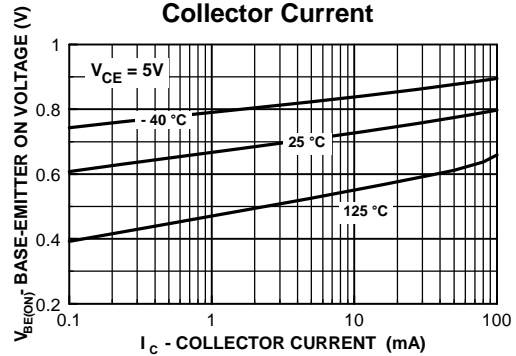
Collector-Emitter Saturation Voltage vs Collector Current



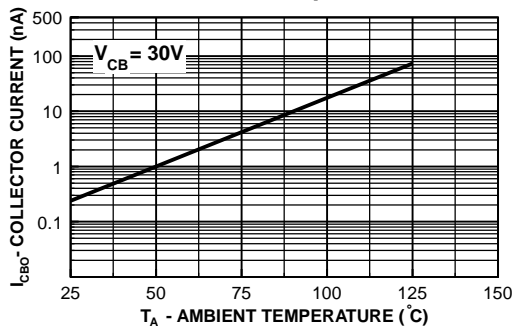
Base-Emitter Saturation Voltage vs Collector Current



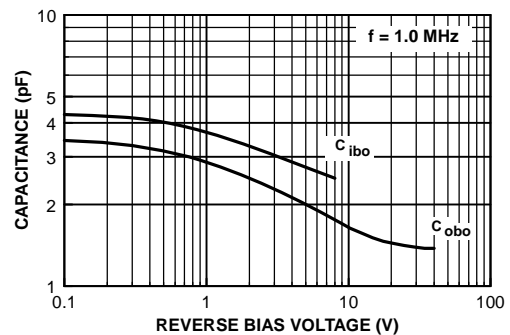
Base-Emitter ON Voltage vs Collector Current



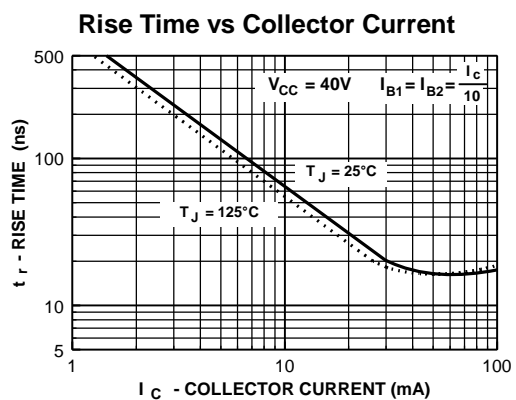
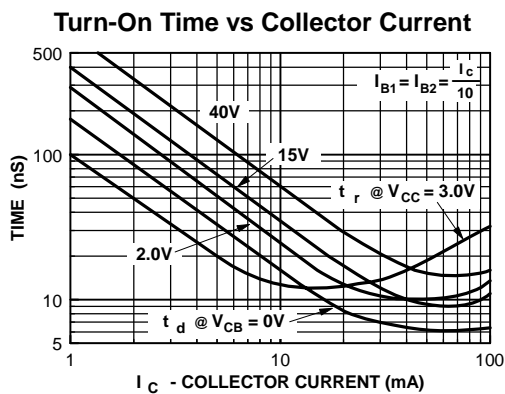
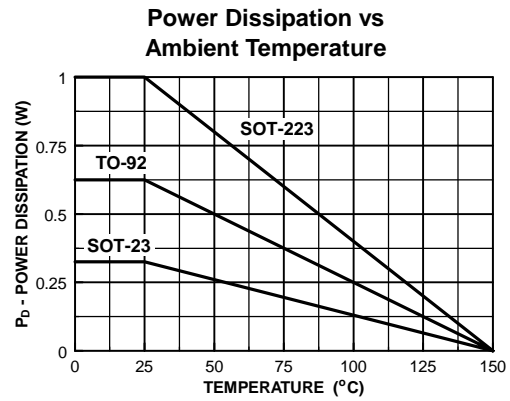
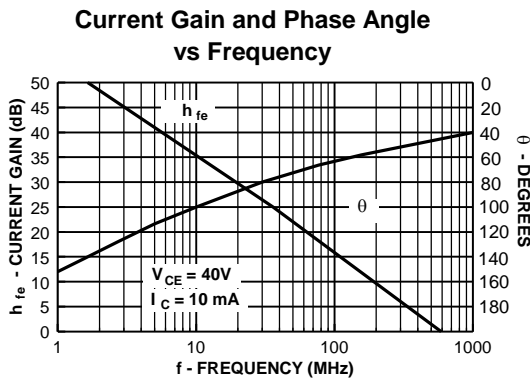
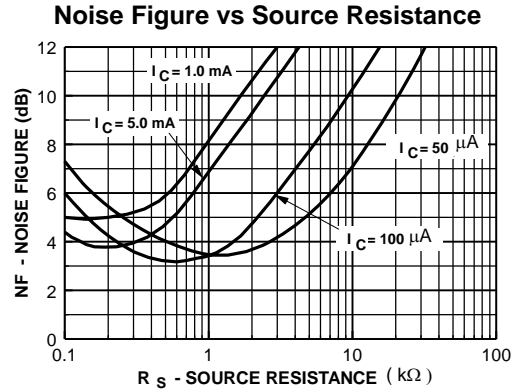
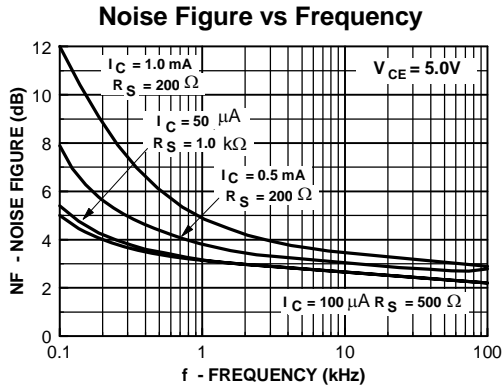
Collector-Cutoff Current vs Ambient Temperature



Capacitance vs Reverse Bias Voltage

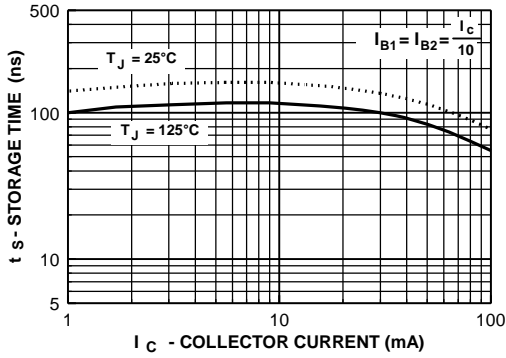


Typical Performance Characteristics (continued)

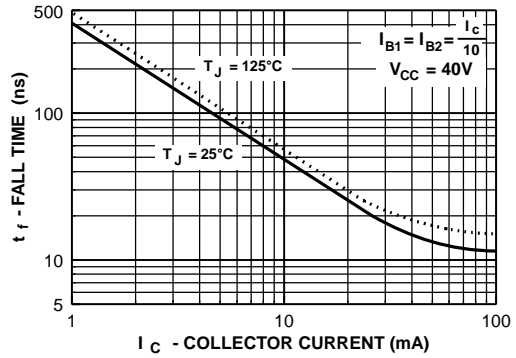


Typical Performance Characteristics (continued)

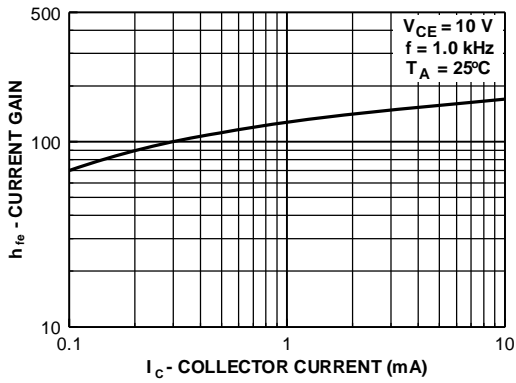
Storage Time vs Collector Current



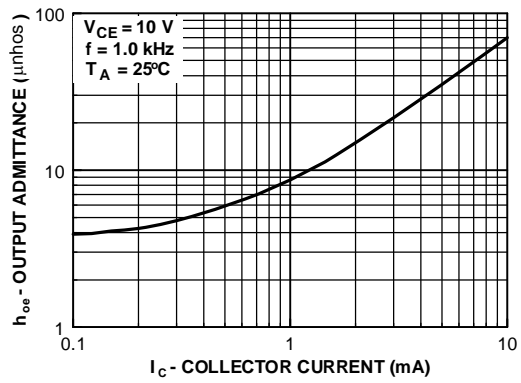
Fall Time vs Collector Current



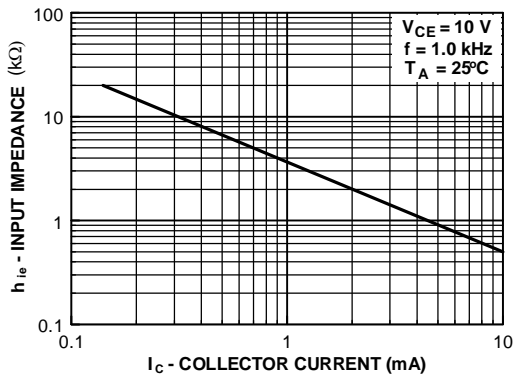
Current Gain



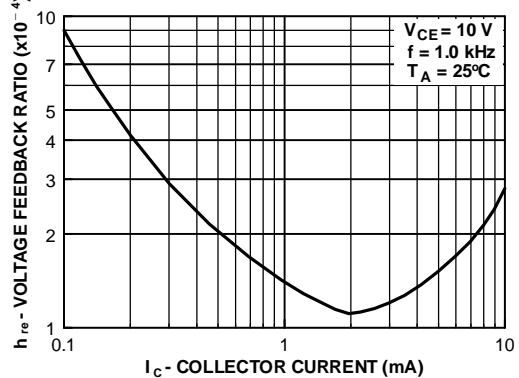
Output Admittance



Input Impedance



Voltage Feedback Ratio



Test Circuits

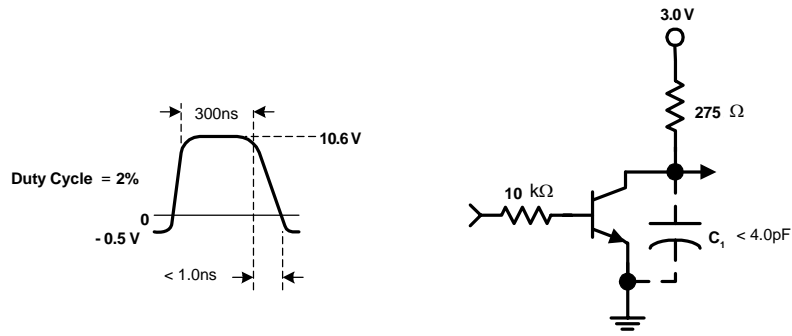


FIGURE 1: Delay and Rise Time Equivalent Test Circuit

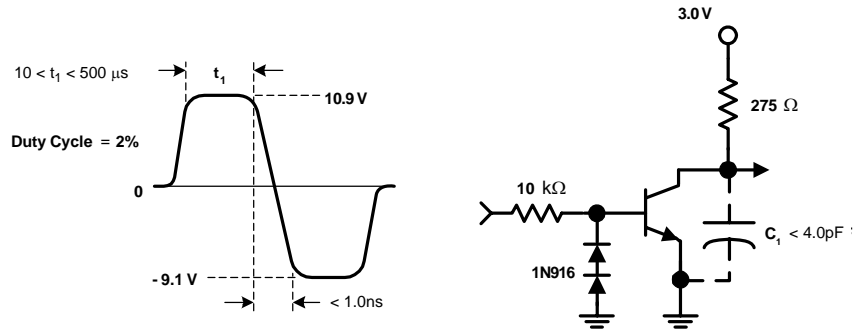






FIGURE 2: Storage and Fall Time Equivalent Test Circuit



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.

- | | | | |
|---|--|---|---|
| 2Cool™ | FPS™ | PDP SPM™ | The Power Franchise® |
| AccuPower™ | F-PFS™ | Power-SPM™ | the power® |
| Auto-SPM™ | FRFET® | PowerTrench® | franchise |
| AX-CAP™* | Global Power Resource SM | PowerXS™ | TinyBoost™ |
| BitSiC® | Green FPS™ | Programmable Active Droop™ | TinyBuck™ |
| Build it Now™ | Green FPS™ e-Series™ | QFET® | TinyCalc™ |
| CorePLUS™ | Gmax™ | QS™ | TinyLogic® |
| CorePOWER™ | GTO™ | Quiet Series™ | TINYOPTO™ |
| CROSSVOLT™ | IntelliMAX™ | RapidConfigure™ | TinyPower™ |
| CTL™ | ISOPLANAR™ |  ™ | TinyPWM™ |
| Current Transfer Logic™ | Making Small Speakers Sound Louder and Better™ | Saving our world, 1mW/W/kW at a time™ | TinyWire™ |
| DEUXPEED® | MegaBuck™ | SignalWise™ | TranSiC® |
| Dual Cool™ | MICROCOUPLER™ | SmartMax™ | TriFault Detect™ |
| EcoSPARK® | MicroFET™ | SMART START™ | TRUECURRENT®* |
| EfficientMax™ | MicroPak™ | SPM® | μSerDes™ |
| ESBC™ | MicroPak2™ | STEALTH™ |  ™ |
|  ™ | MillerDrive™ | SuperFET® | UHC® |
| Fairchild® | MotionMax™ | SuperSOT™-3 | Ultra FRFET™ |
| Fairchild Semiconductor® | Motion-SPM™ | SuperSOT™-6 | UniFET™ |
| FACT Quiet Series™ | mWSaver™ | SuperSOT™-8 | VCX™ |
| FACT® | OptoHiT™ | SupreMOS® | VisualMax™ |
| FAST® | OPTOLOGIC® | SyncFET™ | VoltagePlus™ |
| FastvCore™ | OPTOPLANAR® | Sync-Lock™ | XS™ |
| FETBench™ | |  ™ | |
| FlashWriter®* | | | |

* 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 manufacturers 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 applications, 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 handling 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 any 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.