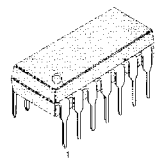
## QUAD OPERATIONAL AMPLIFIERS

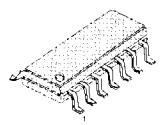
The KA224 series consists of four independent, high gain, internally frequency compensated operational amplifiers which were designed specifically to operate from a single power supply over a wide voltage range.
Operation from split power supplies is also possible so long as the difference between the two supplies is 3 volts to 32 volts.

Application areas include transducer amplifier, DC gain blocks and all the conventional OP amp circuits which now can be easily implemented in single power supply systems.

14 DIP



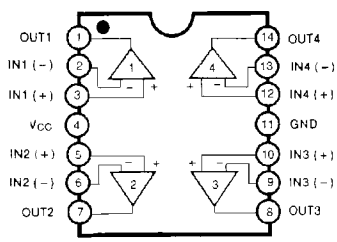
14 SOP



## FEATURES

- Internally frequency compensated for unity gain
- Large DC voltage gain: 100dB
- Wide power supply range: KA224/A, KA324/A: 3V 32V (or± 1.5 ~ 15V)
  KA2902: 3V~26V (or ± 1.5V ~ 13V)
- Input common-mode voltage range includes ground
- Large output voltage swing: 0V DC to $V_{CC}$ -1.5V DC
- Power drain suitable for battery operation.

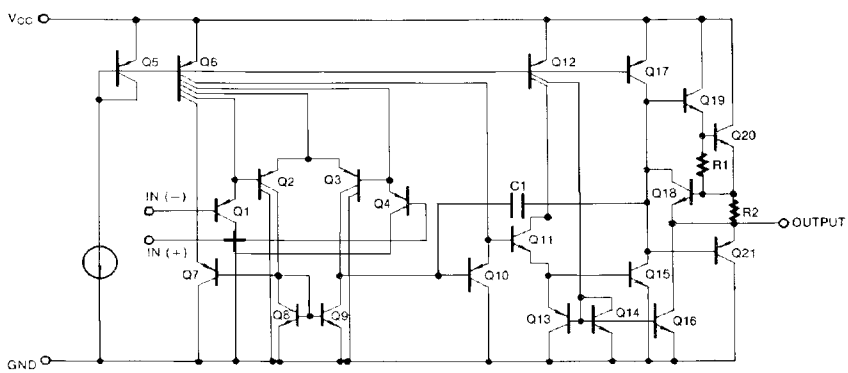
## BLOCK DIAGRAM




## ORDERING INFORMATION

| Device | Package | Operating Temperature |
|---|---|---|
| KA324<br>KA324A | 14 DIP | 0 ~ + 70℃ |
| KA324D<br>KA324AD | 14 SOP | |
| KA224<br>KA224A | 14 DIP | -25 ~ +85℃ |
| KA224D<br>KA224AD | 14 SOP | |
| KA2902 | 14 DIP | -40 ~ + 85℃ |
| KA2902D | 14 SOP | |

## SCHEMATIC DIAGRAM (One Section Only)




Rev. B

FAIRCHILD
SEMICONDUCTOR™

## ABSOLUTE MAXIMUM RATINGS

| Characteristic | Symbol | KA224/KA224A | KA324/KA324A | KA2902 | Unit |
|---|---|---|---|---|---|
| Power Supply Voltage | $V_{CC}$ | ± 18 or 32 | ± 18 or 32 | ± 13 or 26 | V |
| Differential Input Voltage | $V_{I(DIFF)}$ | 32 | 32 | 26 | V |
| Input Voltage | $V_I$ | -0.3 to + 32 | -0.3 to +32 | -0.3 to +26 | V |
| Output Short Circuit to GND $V_{CC}$≤ 15V $T_A$=25℃(One Amp) | | Continuous | Continuous | Continuous | |
| Power Dissipation | $P_D$ | 570 | 570 | 570 | mW |
| Operating Temperature Range | $T_{OPR}$ | -25 ~ +85 | 0 ~ + 70 | -40 ~ + 85 | ℃ |
| Storage Temperature Range | $T_{STG}$ | -65 ~ + 150 | -65 ~ + 150 | -65 ~ + 150 | ℃ |

## ELECTRICAL CHARACTERISTICS

($V_{CC}$=5.0V, $V_{EE}$=GND, $T_A$=25℃, unless otherwise specified)

| Characteristic | Symbol | Test Conditions | | KA224 | | | KA324 | | | KA2902 | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Min | Typ | Max | Min | Typ | Max | Min | Typ | Max | |
| Input Offset Voltage | $V_{IO}$ | $V_{CM}$ = 0V to $V_{CC}$ = 1.5V<br>$V_{O(P)}$ = 1.4V, $R_S$ = 0Ω | | | 1.5 | 5.0 | | 1.5 | 7.0 | | 1.5 | 7.0 | mV |
| Input Offset Current | $I_{IO}$ | | | | 2.0 | 30 | | 3.0 | 50 | | 3.0 | 50 | nA |
| Input Bias Current | $I_{BIAS}$ | | | | 40 | 150 | | 40 | 250 | | 40 | 250 | nA |
| Input Common-Mode Voltage Range | $V_{I(R)}$ | $V_{CC}$ = 30V<br>($V_{CC}$ = 26V for KA2902) | | 0 | | $V_{CC}$ -1.5 | 0 | $V_{CC}$ -1.5 | | 0 | | $V_{CC}$ -1.5 | V |
| Supply Current | $I_{CC}$ | $R_L$ = ∞, $V_{CC}$ = 30V (all Amps) | | | 1.0 | 3 | | 1.0 | 3 | | 1.0 | 3 | mA |
| | | $R_L$ = ∞, $V_{CC}$ = 5V (all Amps)<br>($V_{CC}$ = 26V for KA2902) | | | 0.7 | 1.2 | | 0.7 | 1.2 | | 0.7 | 1.2 | mA |
| Large Signal Voltage Gain | $G_V$ | $V_{CC}$ = 15V, $R_L$≥ 2KΩ<br>$V_{O(P)}$ = 1V to 11V | | 50 | 100 | | 25 | 100 | | | 100 | | V/mV |
| Output Voltage Swing | $V_{O(H)}$ | $V_{CC}$ = 30V | $R_L$ = 2KΩ | 26 | | | 26 | | | 22 | | | V |
| | | $V_{CC}$=26V for 2902 | $R_L$ = 10KΩ | 27 | 28 | | 27 | 28 | | 23 | 24 | | V |
| | $V_{O(L)}$ | $V_{CC}$ = 5V, $R_L$≥ 10KΩ | | | 5 | 20 | | 5 | 20 | | 5 | 100 | mV |
| Common-Mode Rejection Ratio | CMRR | | | 70 | 85 | | 65 | 75 | | 50 | 75 | | dB |
| Power Supply Rejection Ratio | PSRR | | | 65 | 100 | | 65 | 100 | | 50 | 100 | | dB |
| Channel Separation | CS | f = 1KHz to 20KHz | | | 120 | | | 120 | | | 120 | | dB |
| Short Circuit to GND | $I_{SC}$ | | | | 40 | 60 | | 40 | 60 | | 40 | 60 | mA |
| Output Current | $I_{SOURCE}$ | $V_{I(+)}$ = 1V, $V_{I(-)}$ = 0V<br>$V_{CC}$ = 15V, $V_{O(P)}$ = 2V | | 20 | 40 | | 20 | 40 | | 20 | 40 | | mA |
| | $I_{SINK}$ | $V_{I(+)}$ = 0V, $V_{I(-)}$ = 1V<br>$V_{CC}$ = 15V, $V_{O(P)}$ = 2V | | 10 | 13 | | 10 | 13 | | 10 | 13 | | mA |
| | | $V_{I(+)}$ = 0V, $V_{I(-)}$ = 1V<br>$V_{CC}$ = 15V,$V_{O(R)}$ = 200mV | | 12 | 45 | | 12 | 45 | | | | | μA |
| Differential Input Voltage | $V_{I(DIFF)}$ | | | | | $V_{CC}$ | | | $V_{CC}$ | | | $V_{CC}$ | V |

FAIRCHILD
SEMICONDUCTOR™

## ELECTRICAL CHARACTERISTICS

($V_{CC}$ = 5.0V, $V_{EE}$ = GND, unless otherwise specified)
The following specification apply over the range of -25℃≤ $T_A$≤ + 85℃ for the KA224; and the 0℃≤ $T_A$≤ +70℃ for the KA324 ; and the - 40℃≤ $T_A$≤ +85℃ for the KA2902

| Characteristic | Symbol | Test Conditions | KA224 | | | KA324 | | | KA2902 | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Min | Typ | Max | Min | Typ | Max | Min | Typ | Max | |
| Input Offset Voltage | $V_{IO}$ | $V_{ICM}$ = 0V to $V_{CC}$ = 1.5V<br>$V_{O(P)}$ = 1.4V, $R_S$ = 0Ω | | | 7.0 | | | 9.0 | | | 10.0 | mV |
| Input Offset Voltage Drift | Δ $V_{IO}$/Δ T | | | 7.0 | | | 7.0 | | | 7.0 | | μ V/℃ |
| Input Offset Current | $I_{IO}$ | | | | 100 | | | 150 | | | 200 | nA |
| Input Offset Current Drift | Δ $I_{IO}$/Δ T | | | 10 | | | 10 | | | 10 | | pA/℃ |
| Input Bias Current | $I_{BIAS}$ | | | | 300 | | | 500 | | | 500 | nA |
| Input Common-Mode Voltage Range | $V_{IC(R)}$ | $V_{CC}$ = 30V<br>($V_{CC}$ = 26V for KA2902) | 0 | | $V_{CC}$ -2.0 | 0 | | $V_{CC}$ -2.0 | 0 | | $V_{CC}$ -2.0 | V |
| Large Signal Voltage Gain | $G_V$ | $V_{CC}$ = 15V, $R_L$≥ 2.0KΩ<br>$V_{O(P)}$ = 1V to 11V | 25 | | | 15 | | | 15 | | | V/mV |
| Output Voltage Swing | $V_{O(H)}$ | $V_{CC}$ = 30V, $R_L$ = 2KΩ | 26 | | | 26 | | | 22 | | | V |
| | | $V_{CC}$ =26V for 2902, $R_L$ = 10KΩ | 27 | 28 | | 27 | 28 | | 23 | 24 | | V |
| | $V_{O(L)}$ | $V_{CC}$ = 5V, $R_L$≥ 10KΩ | | 5 | 20 | | 5 | 20 | | 5 | 100 | mV |
| Output Current | $I_{SOURCE}$ | $V_{I(+)}$ = 1V, $V_{I(-)}$ = 0V<br>$V_{CC}$ = 15V, $V_{O(P)}$ = 2V | 10 | 20 | | 10 | 20 | | 10 | 20 | | mA |
| | $I_{SINK}$ | $V_{I(+)}$ = 0V, $V_{I(-)}$ = 1V<br>$V_{CC}$ = 15V, $V_{O(P)}$ = 2V | 10 | 13 | | 5 | 8 | | 5 | 8 | | mA |
| Differential Input Voltage | $V_{I(DIFS)}$ | | | | $V_{CC}$ | | | $V_{CC}$ | | | $V_{CC}$ | V |

FAIRCHILD
SEMICONDUCTOR™

## ELECTRICAL CHARACTERISTICS

($V_{CC}$=50V, $V_{EE}$ = GND, $T_A$=25℃, unless otherwise specified)

| Characteristic | Symbol | Test Conditions | | KA224A | | | KA324A | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Min | Typ | Max | Min | Typ | Max | |
| Input Offset Voltage | $V_{IO}$ | $V_{CM}$ = 0V to $V_{CC}$ = 1.5V<br>$V_{O(P)}$ = 1.4V, $R_S$ = 0 | | | 1.0 | 3.0 | | 1.5 | 3.0 | mV |
| Input Offset Current | $I_{IO}$ | | | | 2 | 15 | | 3.0 | 30 | nA |
| Input Bias Current | $I_{BIAS}$ | | | | 40 | 80 | | 40 | 100 | nA |
| Input Common-Mode Voltage Range | $V_{I(R)}$ | $V_{CC}$ = 30V | | 0 | | $V_{CC}$ -1.5 | 0 | | $V_{CC}$ -1.5 | V |
| Supply Current (All Amps) | $I_{CC}$ | $V_{CC}$ = 30V | | | 1.5 | 3 | | 1.5 | 3 | mA |
| | | $V_{CC}$ = 5V | | | 0.7 | 1.2 | | 0.7 | 1.2 | mA |
| Large Signal Voltage Gain | $G_V$ | $V_{CC}$ = 15V, $R_L \geq$ 2KΩ<br>$V_{O(P)}$ = 1V to 11V | | 50 | 100 | | 25 | 100 | | V/mV |
| Output Voltage Swing | $V_{O(H)}$ | $V_{CC}$ = 30V | $R_L$ = 2KΩ | 26 | | | 26 | | | V |
| | | $V_{CC}$ = 26V for 2902 | $R_L$ = 10KΩ | 27 | 28 | | 27 | 28 | | V |
| | $V_{O(L)}$ | $V_{CC}$ = 5V, $R_L \geq$ 10KΩ | | | 5 | 20 | | 5 | 20 | mV |
| Common-Mode Rejection Ratio | CMRR | | | 70 | 85 | | 65 | 85 | | dB |
| Power Supply Rejection Ratio | PSRR | | | 65 | 100 | | 65 | 100 | | dB |
| Channel Separation | CS | f = 1KHz to 20KHz | | | 120 | | | 120 | | dB |
| Short Circuit to GND | $I_{SC}$ | | | | 40 | 60 | | 40 | 60 | mA |
| Output Current | $I_{SOURCE}$ | $V_{I(+)}$ = 1V, $V_{I(-)}$ = 0V<br>$V_{CC}$ = 15V | | 20 | 40 | | 20 | 40 | | mA |
| | $I_{SINK}$ | $V_{I(+)}$ = 0V, $V_{I(-)}$ = 1V<br>$V_{CC}$ = 15V, $V_{O(P)}$ = 2V | | 10 | 20 | | 10 | 20 | | mA |
| | | $V_{I(+)}$ = 0v, $V_{I(-)}$ = 1V<br>$V_{CC}$ = 15V, $V_{O(P)}$ = 200mV | | 12 | 50 | | 12 | 50 | | μA |
| Differential Input Voltage | $V_{I(DIFF)}$ | | | | | $V_{CC}$ | | | $V_{CC}$ | V |

FAIRCHILD
SEMICONDUCTOR™

## ELECTRICAL CHARACTERISTICS

($V_{CC}$ = 5.0V, $V_{EE}$ = GND, unless otherwise specified)
The following specification apply over the range of -25℃≤ $T_A$≤ +85℃ for the KA224A; and the 0℃≤ $T_A$≤ +70℃ for the KA324A

| Characteristic | Symbol | Test Conditions | KA224A | | | KA324A | | | Unit |
|---|---|---|---|---|---|---|---|---|---|
| | | | Min | Typ | Max | Min | Typ | Max | |
| Input Offset Voltage | $V_{IO}$ | $V_{CM}$ = 0V to $V_{CC}$ = 1.5V, $V_{O(P)}$ = 1.4V, $R_S$ = 0Ω | | | 4.0 | | | 5.0 | mV |
| Input Offset Voltage Drift | Δ $V_{IO}$/Δ T | | | 7.0 | 20 | | 7.0 | 30 | μ V/℃ |
| Input Offset Current | $I_{IO}$ | | | | 30 | | | 75 | nA |
| Input Offset Current Drift | Δ $I_{IO}$/Δ T | | | 10 | 200 | | 10 | 300 | pA/℃ |
| Input Bias Current | $I_{BIAS}$ | | | 40 | 100 | | 40 | 200 | nA |
| Input Common-Mode Voltage Range | $V_{I(R)}$ | $V_{CC}$ = 30V | 0 | | $V_{CC}$ -2.0 | 0 | | $V_{CC}$ -2.0 | V |
| Large Signal Voltage Gain | $G_V$ | $V_{CC}$ = 15V, $R_L$≥ 2.0KΩ | 25 | | | 15 | | | V/mV |
| Output Voltage Swing | $V_{O(P-P)}$ | $V_{CC}$ = 30V, $R_L$ = 2KΩ | 26 | | | 26 | | | V |
| | | $V_{CC}$ = 30V, $R_L$ = 10KΩ | 27 | 28 | | 27 | 28 | | V |
| | | $V_{CC}$ = 5V, $R_L$≤ 10KΩ | | 5 | 20 | | 5 | 20 | mA |
| Output Current | $I_{SOURCE}$ | $V_{I(+)}$ = 1V, $V_{I(-)}$ = 0V, $V_{CC}$ = 15V | 10 | 20 | | 10 | 20 | | mA |
| | $I_{SINK}$ | $V_{I(+)}$ = 0V, $V_{I(-)}$ = 1V, $V_{CC}$ = 15V | 5 | 8 | | 5 | 8 | | mA |
| Differential Input Voltage | $V_{I(DIFF)}$ | | | | $V_{CC}$ | | | $V_{CC}$ | V |

FAIRCHILD
SEMICONDUCTOR™

## TYPICAL PERFORMANCE CHARACTERISTICS

Fig. 1 INPUT VOLTAGE RANGE

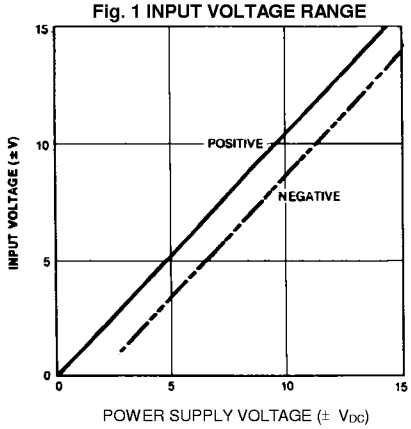



Fig. 2 INPUT CURRENT

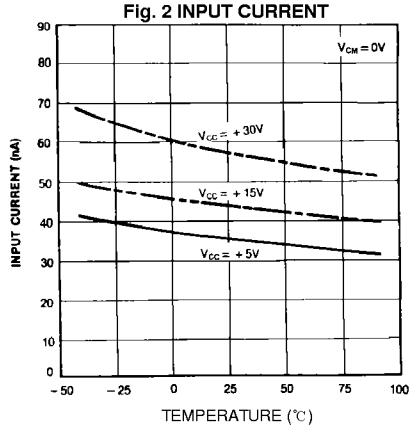



Fig. 3 SUPPLY CURRENT

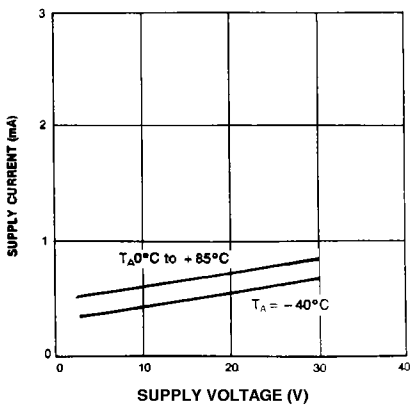



Fig. 4 VOLTAGE GAIN

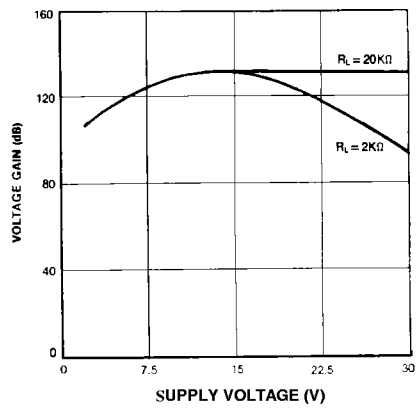



Fig. 5 OPEN LOOP FREQUENCY RESPONSE

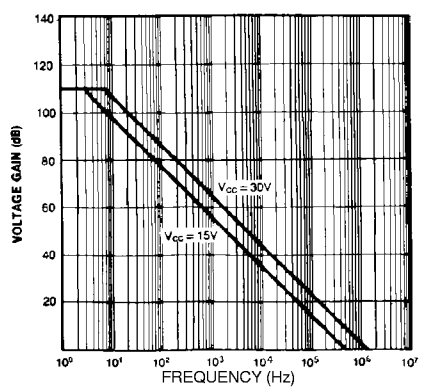
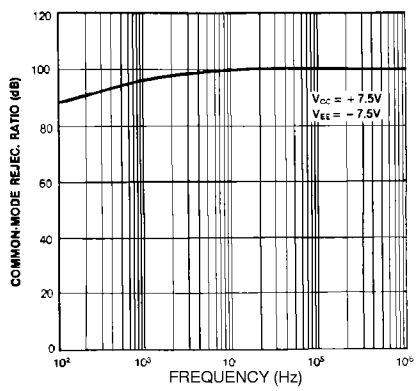



Fig. 6 COMMON.MOOE REJECTION RATIO




FAIRCHILD
SEMICONDUCTOR™

Fig.7 SLEW RATE

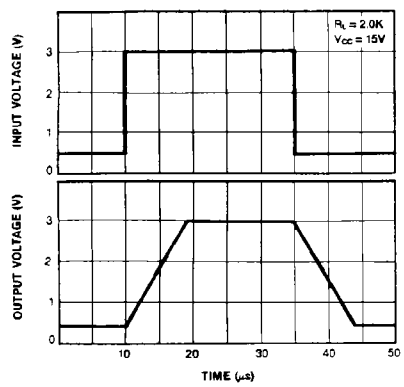



Fig. 8 VOLTAGE FOLLOWER PULSE RESPONSE (SMALL SIGNAL)

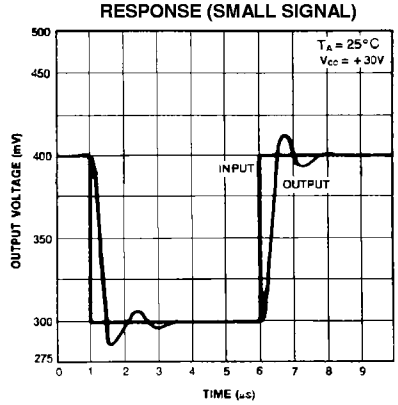



Fig. 9 LARGE SIGNAL FREQUECY RESPONSE

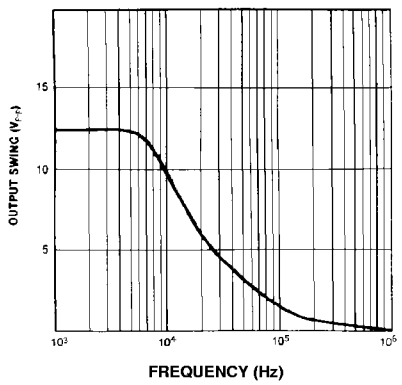



Fig. 10 OUTPUT CHARACTERISTICS CURRENT SOURCING

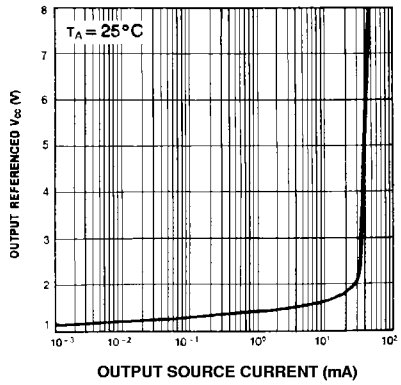



Fig. 11 OUTPUT CHARACTERISTICS CURRENT SINKING

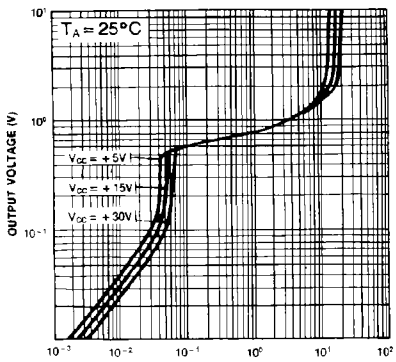
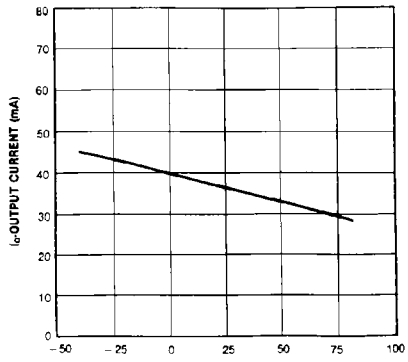



Fig. 12 CURRENT LIMITING




FAIRCHILD SEMICONDUCTOR™

## TRADEMARKS

The following are registered and unregistered trademarks Fairchild Semiconductor owns or is authorized to use and is not intended to be an exhaustive list of all such trademarks.

ACEx™
CoolFET™
CROSSVOLT™
E²CMOS™
FACT™
FACT Quiet Series™
FAST®
FASTr™
GTO™
HiSeC™
ISOPLANAR™
MICROWIRE™
POP™
PowerTrench™
QS™
Quiet Series™
SuperSOT™-3
SuperSOT™-6
SuperSOT™-8
TinyLogic™
UHC™
VCX™

## 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.

## 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, or (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 significant injury to the user.

2. A critical component is 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.

## PRODUCT STATUS DEFINITIONS

### Definition of Terms

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