FM20

Ultra-Low-Power Analog Temperature Sensor

Features

- Analog Output, -11.77mV/°C
- Range, -55 to 130°C
- Accuracy, ±1°C at 25°C
- Supply Current, 9µA typical
- Output Drive, 1µA
- Self-heating < 0.021°C
- Operating Voltage: +2.4V to +6V

Applications

- Mobile Phones
- Computers
- Battery Management
- Office Equipment
- HVAC
- Power Supply Modules
- Disk Drives
- Automotive

Description

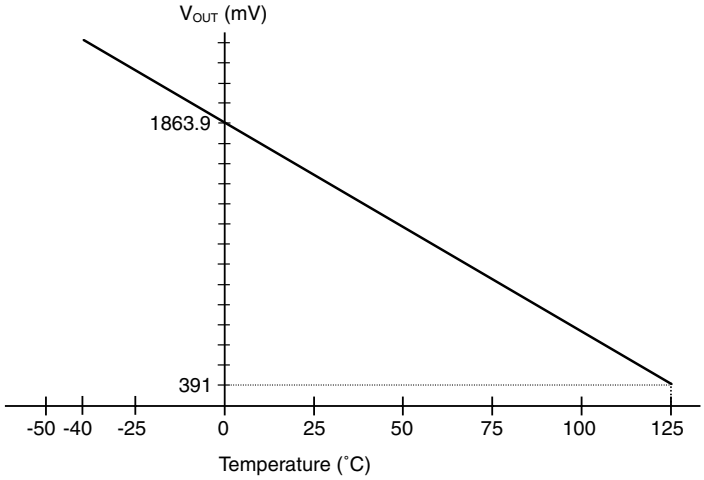
As a precision CMOS temperature sensor, the FM20 is cost-effective for accurate low-power temperature monitoring applications. Output voltage versus temperature is extremely linear. With no load, the supply current is typically 1µA. For normal operation, the load on V_{OUT} should be 5MΩ or less.

In a typical application, a remotely mounted FM20 is monitored by a microcontroller with an analog A/D converter input. Alternatively, the FM20 can drive a comparator with a high impedance input.

Accuracy is typically ±1°C at room temperature; and better than ±2.5°C from 0 to 50°C.

Available packages are surface mount 5-pin SC70 and 3-pin SOT-23.

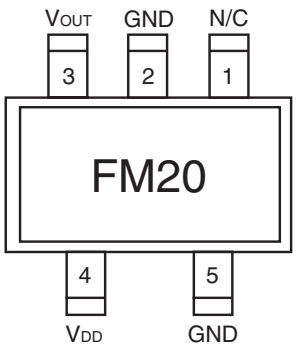
Thermal Response

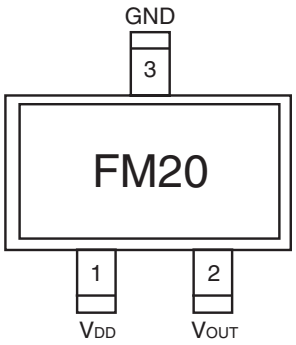


$$\text{Temperature (˚C)} = \frac{V_{OUT} - 1863.9\text{mV}}{-11.77\text{mV/˚C}}$$

FM20 Output Voltage vs. Temperature

Pin Assignments





Pin Descriptions

Pin Name	Pin No. SC-70	Pin No. SOT-23	Type	Function
V_{OUT}	3	2	Analog Output	**Temperature Sense.** Analog output voltage indicating temperature. V_{OUT} = 1863.9 – 11.77 T(°C) mV
V_{DD}	4	1	Power	**Supply Voltage.** 2.4 to 6.0V
GND	2, 5	3	Power	**Ground.**

Absolute Maximum Ratings[1]

Parameter	Min.	Typ.	Max.	Units
Supply Voltage			+7	V
Output Voltage			V_{DD} + 0.5	V
Output Current			-20/+1	µA
Storage Temperature Range	-60		+150	°C
Lead Soldering Temperature			220	°C
ESD[2] Human Body Model Machine Model			 2000 250	 V V

Notes:

1. Absolute maximum ratings are limits beyond which operation may cause permanent damage to the device. These are stress ratings only; functional operation at or above these limits is not implied.
2. Human Body Model: 100pF capacitor discharged through a 1.5kΩ resistor into each pin. Machine Model: 200pF capacitor discharged directly into each pin.

Electrical Characteristics[3]

Limits apply for -55°C ≤ T_A ≤ +130°C and V_{DD} = +5.0V unless otherwise noted.

Parameter	Symbol	Conditions	Min	Typ	Max	Units
Transfer Characteristic						
Sensitivity				-11.77		mV/°C
Output at 0°C				1863.9		mV
Accuracy[4]		T_A = +25°C T_A = -55°C (T_{MIN}) T_A = +130°C (T_{MAX})	-2 -3 -5	±1 ±2 ±2	+2 +3 +5	°C °C °C
Temperature Range			-55		+130	°C
Non-Linearity[5]			-0.5		+0.2	°C
Output						
Output Voltage Range		V_{OUT} < V_{DD}	300		2550	mV
Output Current Source[6]	I_{ONSN}	Sensing		1		µA
	I_{ONSG}	Surge				mA
Output Current Sink[6]	I_{OL}			20		µA
Output resistance		T_A = 25°C				kΩ
Load regulation						mV/mA
Capacitive Load[7]	C_L		100		1000	pF
Power						
Supply Voltage	V_{DD}		2.4		6.0	V
Quiescent Supply Current Output Floating	I_{DD}	T_A = +25°C -55°C ≤ T_A ≤ +130°C		9 9	11.5 14	µA µA
Package						
Self Heating		SOT-23 SC70			0.02016 0.02082	°C °C

Notes:

3. These specifications are guaranteed only for the test conditions listed.
4. Accuracy (expressed in °C) = Difference between calculated output voltage and measured output voltage. Calculated output voltage = -11.77mV/°C multiplied by device's case temperature at specified conditions of temperature, voltage and power supply plus an offset of 1863.9 mV at 0°C.
5. Non-linearity is defined as the deviation of the output-voltage-versus-temperature curve from the best-fit straight line, over the device's rated temperature range.
6. Lowest output current should be targeted; higher currents result in more self-heating of the device.
7. High capacitive loads may be driven by the output in a static mode, but it may require a delay time before initial read at power up to allow for the RC time constant of the charging capacitor.

Typical Performance Characteristics

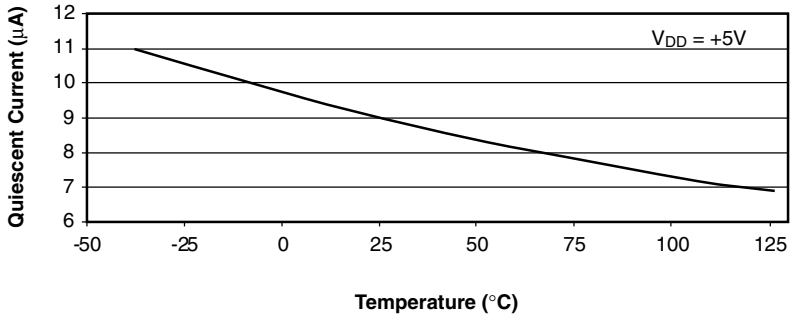


Figure 1. Quiescent Current vs. Temperature

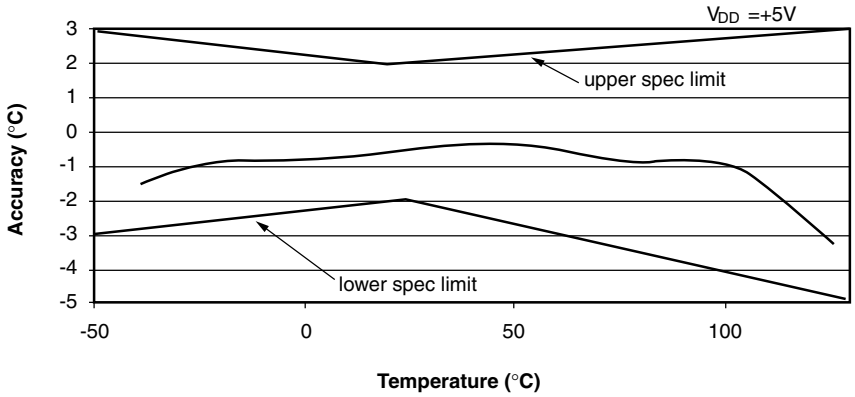


Figure 2. Accuracy vs. Temperature

Applications Information

Mounting

The FM20 can be easily mounted by gluing or cementing it to a surface. In this case, its temperature will be within about 0.2°C of the temperature of the surface it is attached to if the ambient air temperature is almost the same as the surface temperature. If the air temperature is much higher or lower than the surface temperature, the actual temperature of the FM20 die will be at an intermediate temperature between the surface temperature and the air temperature.

To ensure good thermal conductivity, the backside of the FM20 die is directly attached to the GND pin. The lands and traces to the FM20 will, of course, be part of the printed circuit board, which is the object whose temperature is being measured. These printed circuit board lands and traces will not cause the FM20's temperature to deviate from the desired temperature.

Alternatively, the FM20 can be mounted inside a sealed-end metal tube, and can then be dipped into a bath or screwed into a threaded hole in a tank. As with any IC, the FM20 and accompanying wiring and circuits must be kept insulated and dry to avoid leakage and corrosion. This is especially true if the circuit may operate at cold temperatures where condensation can occur. Printed-circuit coatings and varnishes such as Humiseal and epoxy paint or dips can be used to ensure that moisture cannot corrode the FM20 or its connections.

Loading

The FM20 will handle sizable capacitive loads up to 300pF without any special considerations. In an extremely noisy environment it may be advisable to add some filtering to minimize noise in the output voltage. It is also recommended that a 0.1µF bypass capacitor be added between the supply voltage and ground. This is due to the instant current demand caused by switching CMOS transistors. Normally it is unadvisable to put a sufficiently large supply (particularly in portable electronics) to be able to handle the dynamic currents of CMOS transistors. It is a much simpler solution to use a bypass capacitor to sustain the supply voltage during this short demand period.

In environments that are particularly noisy it may be necessary to add a low-pass filter network to the output of the device. As shown below, a 1µF capacitor in addition to the output impedance of the device and a 200Ω series resistor for a low-pass filter that will pass the slow thermal time constant of the FM20, while filtering the higher frequency noise. The response time of the FM20 can be affected by this filter network, therefore values for C_{FILTER} < 1500pF are recommended.

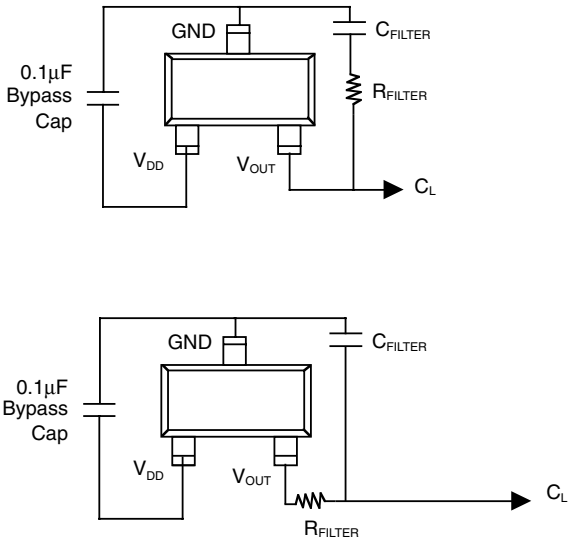


Figure 3. FM20 with Filter Network for Noisy Environments or for Capacitive Loads Greater than 300pF

Table 1. Resistor/Capacitor Combinations for Filter Network

R_{FILTER}	C_{FILTER}
200Ω	1µF
470Ω	0.1µF
680Ω	0.01µF
1000Ω	1000pF
10kΩ	100pF
100kΩ	10pF

Example Applications Circuits

Typical Applications

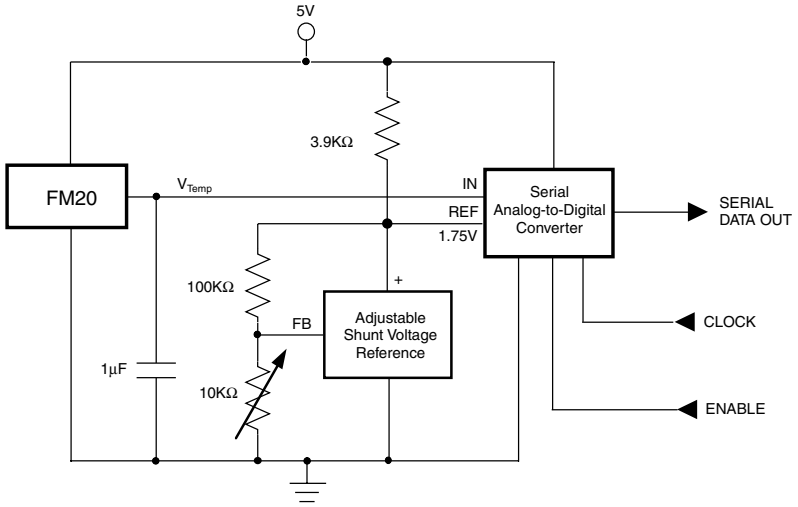


Figure 4. Serial Output Temperature to Digital Converter
(The full scale of the A-to-D Converter will typically be limited to +125°C simply by the number of bits available in the conversion. The FM20 would still be capable of its full output swing.)

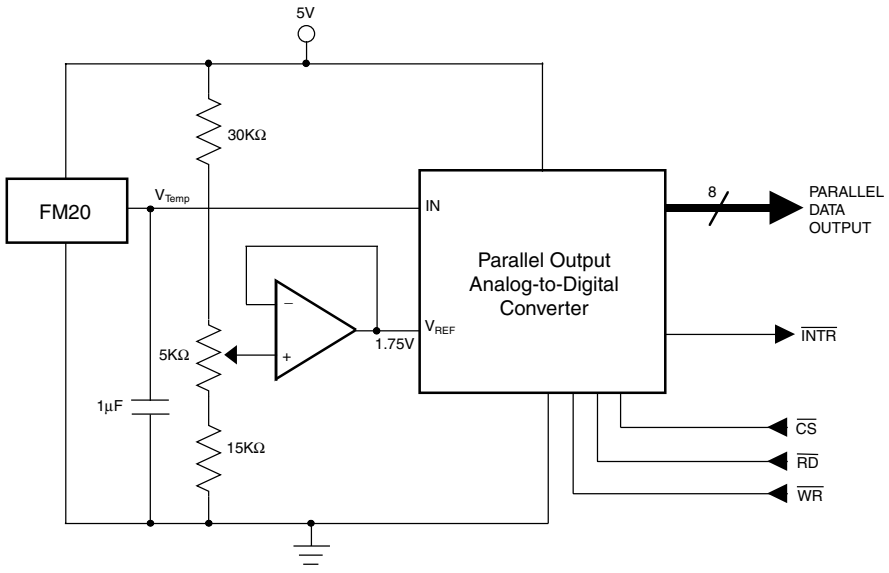
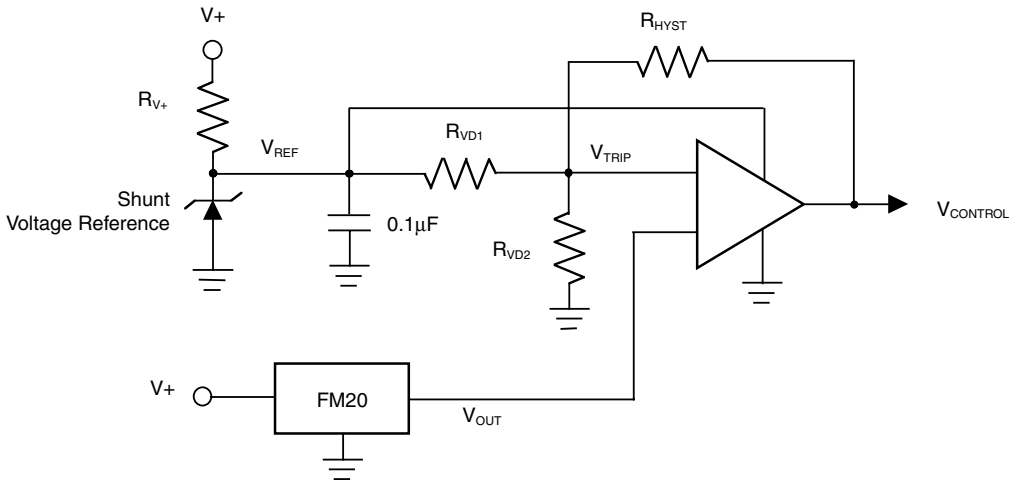
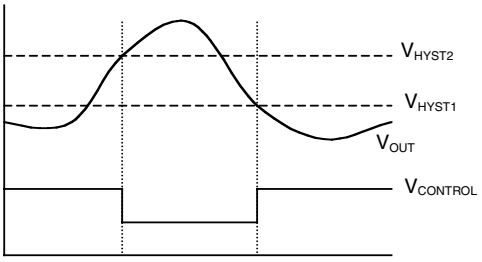


Figure 5. Parallel Output Temperature to Digital Converter (Full Scale = +125°C)

Typical Applications (continued)





$$V_{HYST2} = \frac{(V_{REF}) \cdot (R_{VD2})}{R_{VD1} + \frac{(R_{VD2}) \cdot (R_{HYST})}{R_{HYST} + R_{VD2}}}$$

$$V_{HYST1} = \frac{(V_{REF}) \cdot (R_{VD2})}{R_{VD2} + \frac{(R_{VD1}) \cdot (R_{HYST})}{R_{HYST} + R_{VD1}}}$$

V_{REF} is set by the Shunt Voltage Reference. $V_{CONTROL}$ high is an alarm state or control for activating cooling/fan.

Figure 6. Thermostat/Fan Controller

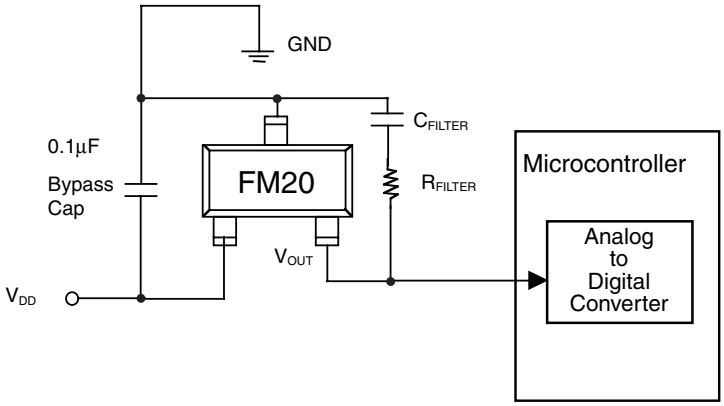
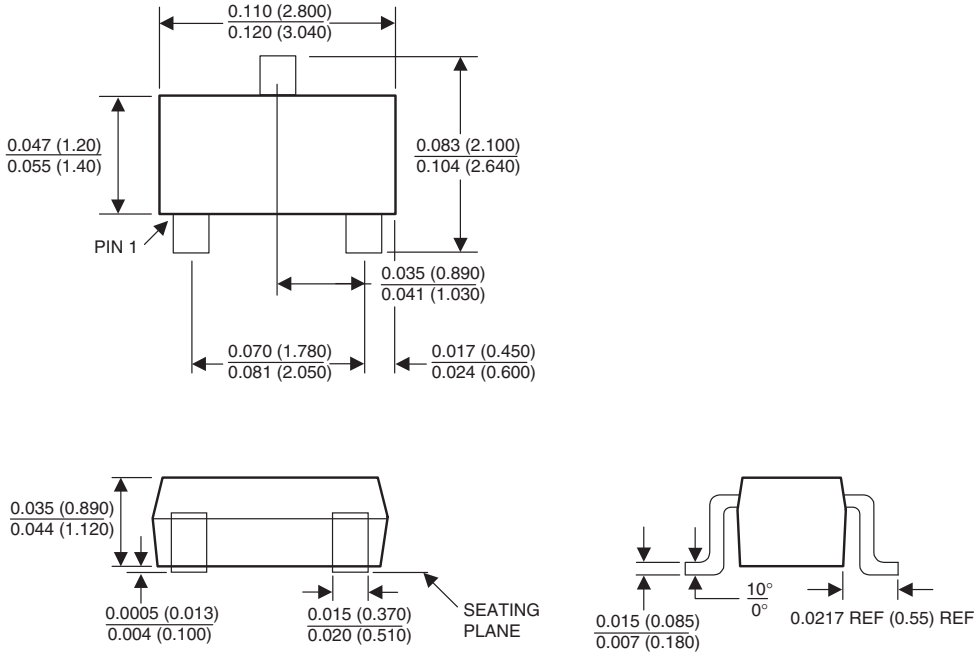


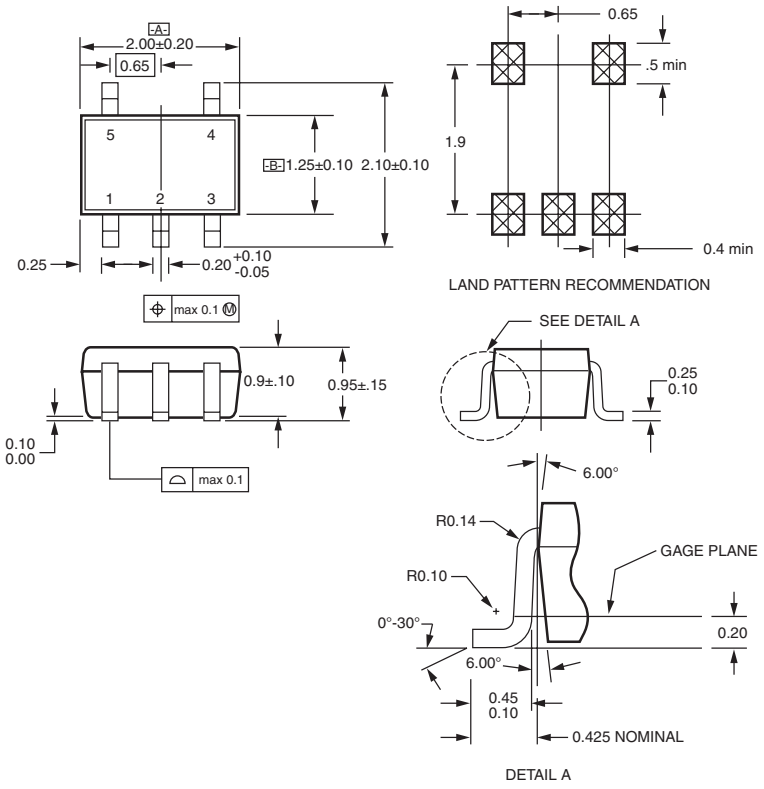
Figure 7. Digital Temperature Output Through a Microcontroller

Mechanical Dimensions inches (millimeters) unless otherwise noted

SOT-23 FS Package Code MA03A



SC70 5-pin FS Package Code MAA05A



NOTES:

A. CONFORMS TO EIAJ REGISTERED OUTLINE DRAWING SC88A.
B. DIMENSIONS DO NOT INCLUDE BURRS OR MOLD FLASH.
C. DIMENSIONS ARE IN MILLIMETERS.

Ordering Information

Part Number	Package	Temperature Range	Shipping
FM20P5X	5-Pin SC70	-55°C to +130°C	Tape and Reel, 3000 units/reel
FM20S3X	3-Pin SOT-23	-55°C to +130°C	Tape and Reel, 3000 units/reel

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 THE PRESIDENT 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.

1/9/03 0.0m 003
Stock#DS30000020
©2002 Fairchild Semiconductor Corporation