

## Functional Safety Information

# SN74AHC1G00-Q1

## Functional Safety FIT Rate, FMD and Pin FMA



TEXAS INSTRUMENTS

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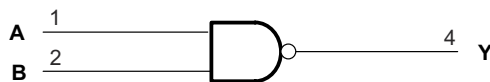
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## 1 Overview

This document contains information for SN74AHC1G00-Q1 (SC-70 package) to aid in a functional safety system design. Information provided are:

- Functional Safety Failure In Time (FIT) rates of the semiconductor component estimated by the application of industry reliability standards
- Component failure modes and their distribution (FMD) based on the primary function of the device
- Pin failure mode analysis (Pin FMA)

Figure 1-1 shows the device functional block diagram for reference.



**Figure 1-1. Functional Block Diagram**

SN74AHC1G00-Q1 were developed using a quality-managed development process, but were not developed in accordance with the IEC 61508 or ISO 26262 standards.

## 2 Functional Safety Failure In Time (FIT) Rates

This section provides Functional Safety Failure In Time (FIT) rates for SN74AHC1G00-Q1 based on two different industry-wide used reliability standards:

- [Table 2-1](#) provides FIT rates based on IEC TR 62380 / ISO 26262 part 11
- [Table 2-2](#) provides FIT rates based on the Siemens Norm SN 29500-2

**Table 2-1. Component Failure Rates per IEC TR 62380 / ISO 26262 Part 11**

FIT IEC TR 62380 / ISO 26262	FIT (Failures Per 10 <sup>9</sup> Hours)
Total Component FIT Rate	3
Die FIT Rate	2
Package FIT Rate	1

The failure rate and mission profile information in [Table 2-1](#) comes from the Reliability data handbook IEC TR 62380 / ISO 26262 part 11:

- Mission Profile: Motor Control from Table 11
- Power dissipation: 15 mW
- Climate type: World-wide Table 8
- Package factor (lambda 3): Table 17b
- Substrate Material: FR4
- EOS FIT rate assumed: 0 FIT

**Table 2-2. Component Failure Rates per Siemens Norm SN 29500-2**

Table	Category	Reference FIT Rate	Reference Virtual T <sub>J</sub>
3	CMOS Logic FCT, HC, LV, LVC, ALVC, VHC, and so forth	3 FIT	45°C

The Reference FIT Rate and Reference Virtual T<sub>J</sub> (junction temperature) in [Table 2-2](#) come from the Siemens Norm SN 29500-2 tables 1 through 5. Failure rates under operating conditions are calculated from the reference failure rate and virtual junction temperature using conversion information in SN 29500-2 section 4.

### 3 Failure Mode Distribution (FMD)

The failure mode distribution estimation for SN74AHC1G00-Q1 in [Table 3-1](#) comes from the combination of common failure modes listed in standards such as IEC 61508 and ISO 26262, the ratio of sub-circuit function size and complexity and from best engineering judgment.

The failure modes listed in this section reflect random failure events and do not include failures due to misuse or overstress.

**Table 3-1. Die Failure Modes and Distribution**

Die Failure Modes	Failure Mode Distribution (%)
Output Stuck-at fault	20%
Output open (HIZ)	20%
Output functional – out of specification timing or voltage	40%
Short circuit any two pins	20%

## 4 Pin Failure Mode Analysis (Pin FMA)

This section provides a Failure Mode Analysis (FMA) for the pins of the SN74AHC1G00-Q1. The failure modes covered in this document include the typical pin-by-pin failure scenarios:

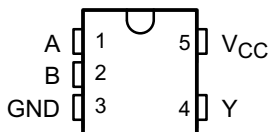
- Pin short-circuited to Ground (see [Table 4-2](#))
- Pin open-circuited (see [Table 4-3](#))
- Pin short-circuited to an adjacent pin (see [Table 4-4](#))
- Pin short-circuited to VCC (see [Table 4-5](#))

[Table 4-2](#) through [Table 4-5](#) also indicate how these pin conditions can affect the device as per the failure effects classification in [Table 4-1](#).

**Table 4-1. TI Classification of Failure Effects**

Class	Failure Effects
A	Potential device damage that affects functionality
B	No device damage, but loss of functionality
C	No device damage, but performance degradation
D	No device damage, no impact to functionality or performance

[Figure 4-1](#) shows the SN74AHC1G00-Q1 pin diagram. For a detailed description of the device pins please refer to the *Pin Configuration and Functions* section in the SN74AHC1G00-Q1 data sheet.



**Figure 4-1. Pin Diagram**

**Table 4-2. Pin FMA for Device Pins Short-Circuited to Ground**

Pin Name	Pin No.	Description of Potential Failure Effect(s)	Failure Effect Class
A, B	1, 2	The input pin functionality is defined as low input (for example, if the buffer input is GND, then the output will always be driven low).	B
Y	4	If the buffer output is shorted to ground and is attempting to drive to V <sub>CC</sub> , then it can cause excessive output current, and the output will not switch.	A
V <sub>CC</sub>	5	The device is not powered, because short is external to the device. System level damage may occur in this scenario.	B
GND	3	Normal operation.	D

**Table 4-3. Pin FMA for Device Pins Open-Circuited**

Pin Name	Pin No.	Description of Potential Failure Effect(s)	Failure Effect Class
A, B	1, 2	The pin is floating, and it can change the output state and cause excessive current to flow from V <sub>CC</sub> to GND. Refer to the <a href="#">Implications of Slow or Floating CMOS Inputs</a> .	A
Y	4	Normal operation.	D
V <sub>CC</sub>	5	The device is not powered.	B
GND	3	The device is not powered.	B

**Table 4-4. Pin FMA for Device Pins Short-Circuited to Adjacent Pin**

Pin Name	Pin No.	Shorted to	Description of Potential Failure Effect(s)	Failure Effect Class
A, B	1, 2	B, A	Two inputs shorted together will not cause damage unless there is an external bus contention that drives the input (such that $V_{IL} < \text{Input Voltage} < V_{IH}$ ), in which case excessive supply current to GND may cause damage. System level damage may occur in this scenario.	A
A, B	1, 2	Y	Can cause excessive output current, output will not switch (for example, if inverter input is shorted to output).	A
A, B	1, 2	GND	The input pin functionality is defined as low input (for example, if the buffer input is GND, then the output will always be driven low).	B
A, B	1, 2	$V_{CC}$	The input pin functionality is defined as high input. For example, if the buffer input is $V_{CC}$ , then the output will always be driven high.	B
Y	4	GND	If the buffer output is shorted to ground and is attempting to drive to $V_{CC}$ , then it can cause excessive output current, and the output will not switch.	A
Y	4	$V_{CC}$	Can cause excessive output current, and the output will not switch (for example, if the buffer output is shorted to $V_{CC}$ and is attempting to drive to GND).	A

**Table 4-5. Pin FMA for Device Pins Short-Circuited to  $V_{CC}$** 

Pin Name	Pin No.	Description of Potential Failure Effect(s)	Failure Effect Class
A, B	1, 2	The input pin functionality is defined as high input. For example, if the buffer input is $V_{CC}$ , then the output will always be driven high.	B
Y	4	Can cause excessive output current, and the output will not switch (for example, if the buffer output is shorted to $V_{CC}$ and is attempting to drive to GND).	A
$V_{CC}$	5	Normal operation.	D
GND	3	The device is not powered, because short is external to the device. System level damage may occur in this scenario.	B

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