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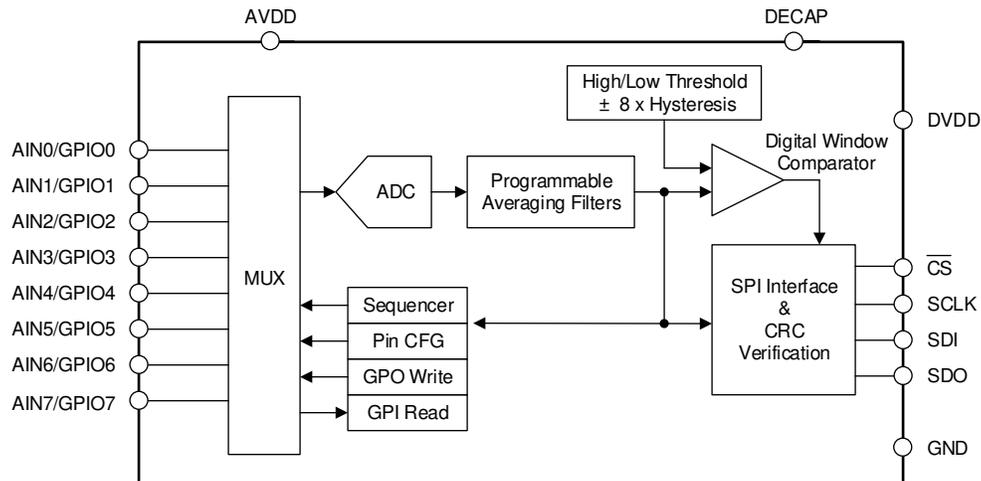
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## 1 Overview

This document contains information for the ADS7038-Q1 (WQFN 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**

The ADS7038-Q1 was developed using a quality-managed development process, but was 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 the ADS7038-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	8
Die FIT rate	2
Package FIT rate	6

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: 3.3 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>
5	CMOS, BICMOS Digital, analog, or mixed	60 FIT	70°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 the ADS7038-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 resulting from misuse or overstress.

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

<b>Die Failure Modes</b>	<b>Failure Mode Distribution (%)</b>
Incorrect channel selected	20
Channel-channel short	15
ADC output code bit error	10
ADC gain error out of specification	10
ADC offset error out of specification	10
Communication error	10
Digital window comparator output fails to trip or false trip	10
Incorrect GPIOx pin configuration	5
Incorrect AINx/GPIOx pin operation (input/output stuck-at, floating, or incorrect logic level)	5
Incorrect programmable averaging filter output	5

## 4 Pin Failure Mode Analysis (Pin FMA)

This section provides a failure mode analysis (FMA) for the pins of the ADS7038-Q1. The failure modes covered in this document include the typical pin-by-pin failure scenarios:

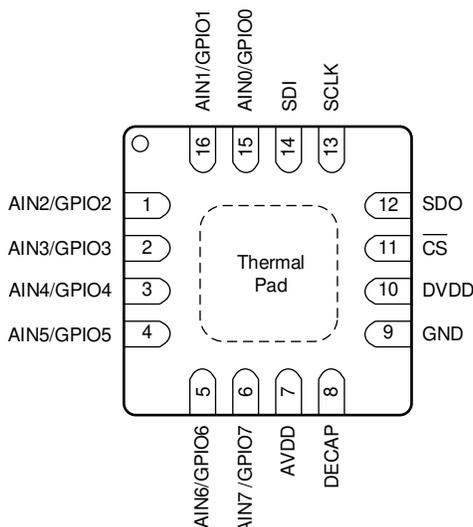
- Pin short-circuited to Ground (see [Table 4-2](#))
- Pin open-circuited (see [Table 4-3](#))
- Pin short-circuited to an adjacent pin (see [Table 4-4](#))
- Pin short-circuited to supply (see [Table 4-5](#))

[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 ADS7038-Q1 pin diagram. For a detailed description of the device pins, see the *Pin Configuration and Functions* section in the ADS7038-Q1 data sheet.



**Figure 4-1. Pin Diagram**

Following are the assumptions of use and the device configuration assumed for the pin FMA in this section:

- AVDD and DVDD use the same supply voltage.
- *Short-circuit to power* means short to AVDD = DVDD.
- RC filters are on every analog input, AINx. Series resistors are sized to limit the input currents into the analog inputs to <10 mA in all circumstances (for example, if the device is unpowered and an input signal is applied).
- The device is the only peripheral on the SPI bus.

**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
AIN2/GPIO2	1	AIN2/GPIO2 is configured as an analog input. The conversion result for this channel is close to 0x000.	B
		AIN2/GPIO2 is configured as a digital input: GPIO2 is stuck low. The readback value of GPI_VALUE[2] is 0b.	B
		AIN2/GPIO2 is configured as a digital output: GPIO2 is stuck low. Increase in supply current when GPIO2 tries to drive high. Device damage may be plausible.	A
AIN3/GPIO3	2	AIN3/GPIO3 is configured as an analog input. The conversion result for this channel is close to 0x000.	B
		AIN3/GPIO3 is configured as a digital input: GPIO3 is stuck low. The readback value of GPI_VALUE[3] is 0b.	B
		AIN3/GPIO3 is configured as a digital output: GPIO3 is stuck low. Increase in supply current when GPIO3 tries to drive high. Device damage may be plausible.	A
AIN4/GPIO4	3	AIN4/GPIO4 is configured as an analog input. The conversion result for this channel is close to 0x000.	B
		AIN4/GPIO4 is configured as a digital input: GPIO4 is stuck low. The readback value of GPI_VALUE[4] is 0b.	B
		AIN4/GPIO4 is configured as a digital output: GPIO4 is stuck low. Increase in supply current when GPIO4 tries to drive high. Device damage may be plausible.	A
AIN5/GPIO5	4	AIN5/GPIO5 is configured as an analog input. The conversion result for this channel is close to 0x000.	B
		AIN5/GPIO5 is configured as a digital input: GPIO5 is stuck low. The readback value of GPI_VALUE[5] is 0b.	B
		AIN5/GPIO5 is configured as a digital output: GPIO5 is stuck low. Increase in supply current when GPIO5 tries to drive high. Device damage may be plausible.	A
AIN6/GPIO6	5	AIN6/GPIO6 is configured as an analog input. The conversion result for this channel is close to 0x000.	B
		AIN6/GPIO6 is configured as a digital input: GPIO6 is stuck low. The readback value of GPI_VALUE[6] is 0b.	B
		AIN6/GPIO6 is configured as a digital output: GPIO6 is stuck low. Increase in supply current when GPIO6 tries to drive high. Device damage may be plausible.	A
AIN7/GPIO7	6	AIN7/GPIO7 is configured as an analog input. The conversion result for this channel is close to 0x000.	B
		AIN7/GPIO7 is configured as a digital input: GPIO7 is stuck low. The readback value of GPI_VALUE[7] is 0b.	B
		AIN7/GPIO7 is configured as a digital output: GPIO7 is stuck low. Increase in supply current when GPIO7 tries to drive high. Device damage may be plausible.	A
AVDD	7	Device unpowered and not functional. Observe that the absolute maximum ratings for all pins of the device are met, otherwise device damage may be plausible.	A
DECAP	8	Device not functional. Increase in supply current. Device damage may be plausible.	A
GND	9	No effect. Normal operation.	D
DVDD	10	Device unpowered and not functional. Observe that the absolute maximum ratings for all pins of the device are met, otherwise device damage may be plausible.	A
$\overline{CS}$	11	$\overline{CS}$ stuck low. No SPI communication with the device is possible.	B
SDO	12	SDO stuck low. No data readback possible from the device. Increase in supply current when device tries to drive SDO high. Device damage may be plausible.	A
SCLK	13	SCLK stuck low. No SPI communication with the device possible.	B
SDI	14	SDI stuck low. Device configuration cannot be modified. Device remains in previously configured state until the reset condition occurs. Device remains in default configuration after power-up.	B

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

Pin Name	Pin No.	Description of Potential Failure Effect(s)	Failure Effect Class
AIN0/GPIO0	15	AIN0/GPIO0 is configured as an analog input. The conversion result for this channel is close to 0x000.	B
		AIN0/GPIO0 is configured as a digital input: GPIO0 is stuck low. The readback value of GPI_VALUE[0] is 0b.	B
		AIN0/GPIO0 is configured as a digital output: GPIO0 is stuck low. Increase in supply current when GPIO0 tries to drive high. Device damage may be plausible.	A
AIN1/GPIO1	16	AIN1/GPIO1 is configured as an analog input. The conversion result for this channel is close to 0x000.	B
		AIN1/GPIO1 is configured as a digital input: GPIO1 is stuck low. The readback value of GPI_VALUE[1] is 0b.	B
		AIN1/GPIO1 is configured as a digital output: GPIO1 is stuck low. Increase in supply current when GPIO1 tries to drive high. Device damage may be plausible.	A
Thermal Pad	—	No effect. 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
AIN2/GPIO2	1	AIN2/GPIO2 is configured as an analog input. The conversion result for this channel is undetermined.	B
		AIN2/GPIO2 is configured as a digital input. The readback value of GPI_VALUE[2] is undetermined.	B
		AIN2/GPIO2 is configured as a digital output. No logic signaling between GPIO2 and the external circuit is possible. Otherwise, normal operation.	D
AIN3/GPIO3	2	AIN3/GPIO3 is configured as an analog input. The conversion result for this channel is undetermined.	B
		AIN3/GPIO3 is configured as a digital input: GPIO3 is stuck low. The readback value of GPI_VALUE[3] is undetermined.	B
		AIN3/GPIO3 is configured as a digital output. No logic signaling between GPIO3 and the external circuit is possible. Otherwise, normal operation.	D
AIN4/GPIO4	3	AIN4/GPIO4 is configured as an analog input. The conversion result for this channel is undetermined.	B
		AIN4/GPIO4 is configured as a digital input: GPIO4 is stuck low. The readback value of GPI_VALUE[4] is undetermined.	B
		AIN4/GPIO4 is configured as a digital output. No logic signaling between GPIO4 and the external circuit is possible. Otherwise, normal operation.	D
AIN5/GPIO5	4	AIN5/GPIO5 is configured as an analog input. The conversion result for this channel is undetermined.	B
		AIN5/GPIO5 is configured as a digital input: GPIO5 is stuck low. The readback value of GPI_VALUE[5] is undetermined.	B
		AIN5/GPIO5 is configured as a digital output. No logic signaling between GPIO5 and the external circuit is possible. Otherwise, normal operation.	D
AIN6/GPIO6	5	AIN6/GPIO6 is configured as an analog input. The conversion result for this channel is undetermined.	B
		AIN6/GPIO6 is configured as a digital input: GPIO6 is stuck low. The readback value of GPI_VALUE[6] is undetermined.	B
		AIN6/GPIO6 is configured as a digital output. No logic signaling between GPIO6 and the external circuit is possible. Otherwise, normal operation.	D
AIN7/GPIO7	6	AIN7/GPIO7 is configured as an analog input. The conversion result for this channel is undetermined.	B
		AIN7/GPIO7 is configured as a digital input: GPIO7 is stuck low. The readback value of GPI_VALUE[7] is undetermined.	B
		AIN7/GPIO7 is configured as a digital output. No logic signaling between GPIO7 and the external circuit is possible. Otherwise, normal operation.	D

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

Pin Name	Pin No.	Description of Potential Failure Effect(s)	Failure Effect Class
AVDD	7	Device functionality is undetermined. The device is unpowered and not functional if all external analog pins are held low. Observe that the absolute maximum ratings for all analog pins of the device are met, otherwise device damage may be plausible. The device may power up through internal ESD diodes to AVDD if voltages above the device power-on reset threshold are present on any of the analog pins.	A
DECAP	8	Device not functional. Increase in supply current. Device damage may be plausible.	A
GND	9	Device functionality is undetermined. The device may be unpowered or connected to ground internally through an alternate pin ESD diode and power up.	B
DVDD	10	Digital interface is not powered up if all external digital pins are held low. No SPI communication with the device is possible. Observe that the absolute maximum ratings for all pins of the device are met, otherwise device damage may be plausible. Digital interface may power up through internal ESD diodes to DVDD if voltages above the device power-on reset threshold are present on any of the digital pins.	A
$\overline{CS}$	11	State of $\overline{CS}$ is undetermined. No SPI communication with the device is possible.	B
SDO	12	No data readback is possible from the device.	B
SCLK	13	State of SCLK is undetermined. No SPI communication with the device is possible.	B
SDI	14	State of SDI is undetermined. Device configuration cannot be modified. The device remains in the previously configured state until a reset condition occurs. The device remains in default configuration after power-up.	B
AIN0/GPIO0	15	AIN0/GPIO0 is configured as an analog input. The conversion result for this channel is undetermined.	B
		AIN0/GPIO0 is configured as a digital input: GPIO0 is stuck low. The readback value of GPI_VALUE[0] is undetermined.	B
		AIN0/GPIO0 is configured as a digital output. No logic signaling between GPIO0 and the external circuit is possible. Otherwise, normal operation.	D
AIN1/GPIO1	16	AIN1/GPIO1 is configured as an analog input. The conversion result for this channel is undetermined.	B
		AIN1/GPIO1 is configured as a digital input: GPIO1 is stuck low. The readback value of GPI_VALUE[1] is undetermined.	B
		AIN1/GPIO1 is configured as a digital output. No logic signaling between GPIO1 and the external circuit is possible. Otherwise, normal operation.	D
Thermal Pad	—	No effect. Normal operation.	D

**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
AIN2/GPIO2	1	AIN3/GPIO3	AIN2/GPIO2 and AIN3/GPIO3 are configured as analog inputs. The conversion results for AIN2 and AIN3 are the same. Depending on the external circuits driving AIN2 and AIN3, the conversion results may be incorrect.	B
			AIN2/GPIO2 is configured as an analog input and AIN3/GPIO3 is configured as a digital input. The conversion result for AIN2 may be incorrect depending on the external circuit driving GPIO3. The readback value of GPI_VALUE[3] may be incorrect.	B
			AIN2/GPIO2 is configured as an analog input and AIN3/GPIO3 is configured as a digital output. The conversion result for AIN2 may be incorrect. There may be an increase in supply current when GPIO3 tries to drive high when the AIN2 voltage is low and vice versa. Device damage may be plausible.	A
			AIN2/GPIO2 is configured as a digital input and AIN3/GPIO3 is configured as an analog input. The conversion result for AIN3 may be incorrect depending on the external circuit driving GPIO2. The readback value of GPI_VALUE[2] may be incorrect.	B
			AIN2/GPIO2 and AIN3/GPIO3 are configured as digital inputs. The readback values of GPI_VALUE[2] and GPI_VALUE[3] are the same. The readback values may be incorrect depending on the external circuits driving these pins.	B
			AIN2/GPIO2 is configured as a digital input and AIN3/GPIO3 is configured as a digital output. The readback value of GPI_VALUE[2] depends on the output drive on GPIO3.	B
			AIN2/GPIO2 is configured as a digital output and AIN3/GPIO3 is configured as an analog input. The conversion result for AIN3 may be incorrect. There may be an increase in supply current when GPIO2 tries to drive high when the AIN3 voltage is low and vice versa. Device damage may be plausible.	A
			AIN2/GPIO2 is configured as a digital output and AIN3/GPIO3 is configured as a digital input. The readback value of GPI_VALUE[3] depends on the output drive on GPIO2.	B
			AIN2/GPIO2 and AIN3/GPIO3 are configured as digital outputs. Increase in supply current when GPIO2 tries to drive low and GPIO3 tries to drive high and vice versa. Device damage may be plausible.	A

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

Pin Name	Pin No.	Shorted to	Description of Potential Failure Effect(s)	Failure Effect Class
AIN3/GPIO3	2	AIN4/GPIO4	AIN3/GPIO3 and AIN4/GPIO4 are configured as analog inputs. The conversion results for AIN3 and AIN4 are the same. Depending on the external circuits driving AIN3 and AIN4, the conversion results may be incorrect.	B
			AIN3/GPIO3 is configured as an analog input and AIN4/GPIO4 is configured as a digital input. The conversion result for AIN3 may be incorrect depending on the external circuit driving GPIO4. The readback value of GPI_VALUE[4] may be incorrect.	B
			AIN3/GPIO3 is configured as an analog input and AIN4/GPIO4 is configured as a digital output. The conversion result for AIN3 may be incorrect. There may be an increase in supply current when GPIO4 tries to drive high when the AIN3 voltage is low and vice versa. Device damage may be plausible.	A
			AIN3/GPIO3 is configured as a digital input and AIN4/GPIO4 is configured as an analog input. The conversion result for AIN4 may be incorrect depending on the external circuit driving GPIO3. The readback value of GPI_VALUE[3] may be incorrect.	B
			AIN3/GPIO3 and AIN4/GPIO4 are configured as digital inputs. The readback values of GPI_VALUE[3] and GPI_VALUE[4] are the same. The readback values may be incorrect depending on the external circuits driving these pins.	B
			AIN3/GPIO3 is configured as a digital input and AIN4/GPIO4 is configured as a digital output. The readback value of GPI_VALUE[3] depends on the output drive on GPIO4.	B
			AIN3/GPIO3 is configured as a digital output and AIN4/GPIO4 is configured as an analog input. The conversion result for AIN4 may be incorrect. There may be an increase in supply current when GPIO3 tries to drive high when the AIN4 voltage is low and vice versa. Device damage may be plausible.	A
			AIN3/GPIO3 is configured as a digital output and AIN4/GPIO4 is configured as a digital input. The readback value of GPI_VALUE[4] depends on the output drive on GPIO3.	B
AIN3/GPIO3 and AIN4/GPIO4 are configured as digital outputs. Increase in supply current when GPIO3 tries to drive low and GPIO4 tries to drive high and vice versa. Device damage may be plausible.	A			

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

Pin Name	Pin No.	Shorted to	Description of Potential Failure Effect(s)	Failure Effect Class
AIN4/GPIO4	3	AIN5/GPIO5	AIN4/GPIO4 and AIN5/GPIO5 are configured as analog inputs. The conversion result for AIN4 and AIN5 are the same. Depending on the external circuits driving AIN4 and AIN5, the conversion results may be incorrect.	B
			AIN4/GPIO4 is configured as an analog input and AIN5/GPIO5 is configured as a digital input. The conversion result for AIN4 may be incorrect depending on the external circuit driving GPIO5. The readback value of GPI_VALUE[5] may be incorrect.	B
			AIN4/GPIO4 is configured as an analog input and AIN5/GPIO5 is configured as a digital output. The conversion result for AIN4 may be incorrect. There may be an increase in supply current when GPIO5 tries to drive high when the AIN4 voltage is low and vice versa. Device damage may be plausible.	A
			AIN4/GPIO4 is configured as a digital input and AIN5/GPIO5 is configured as an analog input. The conversion result for AIN5 may be incorrect depending on the external circuit driving GPIO4. The readback value of GPI_VALUE[4] may be incorrect.	B
			AIN4/GPIO4 and AIN5/GPIO5 are configured as digital inputs. The readback values of GPI_VALUE[4] and GPI_VALUE[5] are the same. The readback values may be incorrect depending on the external circuits driving these pins.	B
			AIN4/GPIO4 is configured as a digital input and AIN5/GPIO5 is configured as a digital output. The readback value of GPI_VALUE[4] depends on the output drive on GPIO5.	B
			AIN4/GPIO4 is configured as a digital output and AIN5/GPIO5 is configured as an analog input. The conversion result for AIN5 may be incorrect. There may be an increase in supply current when GPIO4 tries to drive high when the AIN5 voltage is low and vice versa. Device damage may be plausible.	A
			AIN4/GPIO4 is configured as a digital output and AIN5/GPIO5 is configured as a digital input. The readback value of GPI_VALUE[5] depends on the output drive on GPIO4.	B
			AIN4/GPIO4 and AIN5/GPIO5 are configured as digital outputs. Increase in supply current when GPIO4 tries to drive low and GPIO5 tries to drive high and vice versa. Device damage may be plausible.	A
AIN5/GPIO5	4	—	Not considered. Corner pin.	-

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

Pin Name	Pin No.	Shorted to	Description of Potential Failure Effect(s)	Failure Effect Class
AIN6/GPIO6	5	AIN7/GPIO7	AIN6/GPIO6 and AIN7/GPIO7 are configured as analog inputs. The conversion results for AIN6 and AIN7 are the same. Depending on the external circuits driving AIN6 and AIN7, the conversion results may be incorrect.	B
			AIN6/GPIO6 is configured as an analog input and AIN7/GPIO7 is configured as a digital input. The conversion result for AIN6 may be incorrect depending on the external circuit driving GPIO7. The readback value of GPI_VALUE[7] may be incorrect.	B
			AIN6/GPIO6 is configured as an analog input and AIN7/GPIO7 is configured as a digital output. The conversion result for AIN6 may be incorrect. There may be an increase in supply current when GPIO7 tries to drive high when the AIN6 voltage is low and vice versa. Device damage may be plausible.	A
			AIN6/GPIO6 is configured as a digital input and AIN7/GPIO7 is configured as an analog input. The conversion result for AIN7 may be incorrect depending on the external circuit driving GPIO6. The readback value of GPI_VALUE[6] may be incorrect.	B
			AIN6/GPIO6 and AIN7/GPIO7 are configured as digital inputs. The readback values of GPI_VALUE[6] and GPI_VALUE[7] are the same. The readback values may be incorrect depending on the external circuits driving these pins.	B
			AIN6/GPIO6 is configured as a digital input and AIN7/GPIO7 is configured as a digital output. The readback value of GPI_VALUE[6] depends on the output drive on GPIO7.	B
			AIN6/GPIO6 is configured as a digital output and AIN7/GPIO7 is configured as an analog input. The conversion result for AIN7 may be incorrect. There may be an increase in supply current when GPIO6 tries to drive high when the AIN7 voltage is low and vice versa. Device damage may be plausible.	A
			AIN6/GPIO6 is configured as a digital output and AIN7/GPIO7 is configured as a digital input. The readback value of GPI_VALUE[7] depends on the output drive on GPIO6.	B
AIN7/GPIO7	6	AVDD	AIN6/GPIO6 and AIN7/GPIO7 are configured as digital outputs. Increase in supply current when GPIO6 tries to drive low and GPIO7 tries to drive high and vice versa. Device damage may be plausible.	A
			AIN7/GPIO7 is configured as an analog input. The conversion result for AIN7 is close to 0xFFFF.	B
			AIN7/GPIO7 is configured as a digital input: GPIO7 is stuck high. The readback value of GPI_VALUE[7] is 1b.	B
AVDD	7	DECAP	AIN7/GPIO7 is configured as a digital output: GPIO7 is stuck high. Increase in supply current when GPIO7 tries to drive low. Device damage may be plausible.	A
			A voltage higher than the absolute maximum rating is applied to the pin because minimum supply voltage is higher than the absolute maximum voltage rating of the DECAP pin. Device damage may be plausible.	A
			Not considered. Corner pin.	-
DECAP	8	-	Not considered. Corner pin.	-
GND	9	DVDD	The device is unpowered and not functional. Observe that the absolute maximum ratings for all pins of the device are met, otherwise device damage may be plausible.	A
DVDD	10	$\overline{CS}$	$\overline{CS}$ stuck high. No SPI communication with the device is possible. SDO is Hi-Z.	B
$\overline{CS}$	11	SDO	SPI communication is corrupted. No SPI communication with the device is possible. Increase in supply current when SDO tries to drive high when $\overline{CS}$ is low. Device damage may be plausible.	A
SDO	12	—	Not considered. Corner pin.	-

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

Pin Name	Pin No.	Shorted to	Description of Potential Failure Effect(s)	Failure Effect Class
SCLK	13	SDI	SPI communication is corrupted. No SPI communication with the device is possible.	B
SDI	14	AIN0/GPIO0	AIN0/GPIO0 is configured as an analog input. The conversion result for AIN0 is undetermined.	B
			AIN0/GPIO0 is configured as a digital input: GPIO0 is stuck high. The readback value of GPI_VALUE[0] is undetermined.	B
			AIN0/GPIO0 is configured as a digital output. Increase in supply current when GPIO0 tries to drive low when SDI is high and vice versa. Device damage may be plausible.	A
AIN0/GPIO0	15	AIN1/GPIO1	AIN0/GPIO0 and AIN1/GPIO1 are configured as analog inputs. The conversion results for AIN0 and AIN1 are the same. Depending on the external circuits driving AIN0 and AIN1, the conversion results may be incorrect.	B
			AIN0/GPIO0 is configured as an analog input and AIN1/GPIO1 is configured as a digital input. The conversion result for AIN0 may be incorrect depending on the external circuit driving GPIO1. The readback value of GPI_VALUE[1] may be incorrect.	B
			AIN0/GPIO0 is configured as an analog input and AIN1/GPIO1 is configured as a digital output. The conversion result for AIN0 may be incorrect. There may be an increase in supply current when GPIO1 tries to drive high when the AIN0 voltage is low and vice versa. Device damage may be plausible.	A
			AIN0/GPIO0 is configured as a digital input and AIN1/GPIO1 is configured as an analog input. The conversion result for AIN1 may be incorrect depending on the external circuit driving GPIO0. The readback value of GPI_VALUE[0] may be incorrect.	B
			AIN0/GPIO0 and AIN1/GPIO1 are configured as digital inputs. The readback values of GPI_VALUE[0] and GPI_VALUE[1] are the same. The readback values may be incorrect depending on the external circuits driving these pins.	B
			AIN0/GPIO0 is configured as a digital input and AIN1/GPIO1 is configured as a digital output. The readback value of GPI_VALUE[0] depends on the output drive on GPIO1.	B
			AIN0/GPIO0 is configured as a digital output and AIN1/GPIO1 is configured as an analog input. The conversion result for AIN1 may be incorrect. There may be an increase in supply current when GPIO0 tries to drive high when the AIN1 voltage is low and vice versa. Device damage may be plausible.	A
			AIN0/GPIO0 is configured as a digital output and AIN1/GPIO1 is configured as a digital input. The readback value of GPI_VALUE[1] depends on the output drive on GPIO0.	B
			AIN0/GPIO0 and AIN1/GPIO1 are configured as digital outputs. Increase in supply current when GPIO0 tries to drive low and GPIO1 tries to drive high and vice versa. Device damage may be plausible.	A
AIN1/GPIO1	16	—	Not considered. Corner pin.	-
Thermal Pad	—	—	See the <a href="#">Pin FMA for Device Pins Short-Circuited to Ground</a> condition for respective device pins.	-

**Table 4-5. Pin FMA for Device Pins Short-Circuited to Supply**

Pin Name	Pin No.	Description of Potential Failure Effect(s)	Failure Effect Class
AIN2/GPIO2	1	AIN2/GPIO2 is configured as an analog input. The conversion result for this channel is close to 0xFFFF.	B
		AIN2/GPIO2 is configured as a digital input: GPIO2 is stuck high. The readback value of GPI_VALUE[2] is 1b.	B
		AIN2/GPIO2 is configured as digital output: GPIO2 is stuck high. Increase in supply current when GPIO2 tries to drive low. Device damage may be plausible.	A
AIN3/GPIO3	2	AIN3/GPIO3 is configured as an analog input. The conversion result for this channel is close to 0xFFFF.	B
		AIN3/GPIO3 is configured as a digital input: GPIO3 is stuck high. The readback value of GPI_VALUE[3] is 1b.	B
		AIN3/GPIO3 is configured as a digital output: GPIO3 is stuck high. Increase in supply current when GPIO3 tries to drive low. Device damage may be plausible.	A
AIN4/GPIO4	3	AIN4/GPIO4 is configured as an analog input. The conversion result for this channel is close to 0xFFFF.	B
		AIN4/GPIO4 is configured as a digital input: GPIO4 is stuck high. The readback value of GPI_VALUE[4] is 1b.	B
		AIN4/GPIO4 is configured as a digital output: GPIO4 is stuck high. Increase in supply current when GPIO4 tries to drive low. Device damage may be plausible.	A
AIN5/GPIO5	4	AIN5/GPIO5 is configured as an analog input. The conversion result for this channel is close to 0xFFFF.	B
		AIN5/GPIO5 is configured as a digital input: GPIO5 is stuck high. The readback value of GPI_VALUE[5] is 1b.	B
		AIN5/GPIO5 is configured as a digital output: GPIO5 is stuck high. Increase in supply current when GPIO5 tries to drive low. Device damage may be plausible.	A
AIN6/GPIO6	5	AIN6/GPIO6 is configured as an analog input. The conversion result for this channel is close to 0xFFFF.	B
		AIN6/GPIO6 is configured as a digital input: GPIO6 is stuck high. The readback value of GPI_VALUE[6] is 1b.	B
		AIN6/GPIO6 is configured as a digital output: GPIO6 is stuck high. Increase in supply current when GPIO6 tries to drive low. Device damage may be plausible.	A
AIN7/GPIO7	6	AIN7/GPIO7 is configured as an analog input. The conversion result for this channel is close to 0xFFFF.	B
		AIN7/GPIO7 is configured as a digital input: GPIO7 is stuck high. The readback value of GPI_VALUE[7] is 1b.	B
		AIN7/GPIO7 is configured as a digital output: GPIO7 is stuck high. Increase in supply current when GPIO7 tries to drive low. Device damage may be plausible.	A
AVDD	7	No effect. Normal operation.	D
DECAP	8	A voltage higher than the absolute maximum rating is applied to the pin because the minimum supply voltage is higher than the absolute maximum voltage rating of the DECAP pin. Device damage may be plausible.	A
GND	9	The device is unpowered and not functional. Observe that the absolute maximum ratings for all pins of the device are met, otherwise device damage may be plausible.	A
DVDD	10	No effect. Normal operation.	D
$\overline{CS}$	11	$\overline{CS}$ is stuck high. No SPI communication with the device is possible. SDO is Hi-Z.	B
SDO	12	SDO is stuck high. No data readback is possible from the device. Increase in supply current when device tries to drive SDO low. Device damage may be plausible.	A
SCLK	13	SCLK is stuck high. No SPI communication with the device is possible.	B
SDI	14	SDI is stuck high. Device configuration cannot be modified. The device remains in the previously configured state until a reset condition occurs. The device remains in default configuration after power-up.	B

**Table 4-5. Pin FMA for Device Pins Short-Circuited to Supply (continued)**

Pin Name	Pin No.	Description of Potential Failure Effect(s)	Failure Effect Class
AIN0/GPIO0	15	AIN0/GPIO0 is configured as an analog input. The conversion result for this channel is close to 0xFFFF.	B
		AIN0/GPIO0 is configured as a digital input: GPIO0 is stuck high. The readback value of GPI_VALUE[0] is 1b.	B
		AIN0/GPIO0 is configured as a digital output: GPIO0 is stuck high. Increase in supply current when GPIO0 tries to drive low. Device damage may be plausible.	A
AIN1/GPIO1	16	AIN1/GPIO1 is configured as an analog input. The conversion result for this channel is close to 0xFFFF.	B
		AIN1/GPIO1 is configured as a digital input: GPIO1 is stuck high. The readback value of GPI_VALUE[1] is 1b.	B
		AIN1/GPIO1 is configured as a digital output: GPIO1 is stuck high. Increase in supply current when GPIO1 tries to drive low. Device damage may be plausible.	A
Thermal Pad	—	The device unpowered and not functional. Observe that the absolute maximum ratings for all pins of the device are met, otherwise device damage may be plausible.	A

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