*Application Report*

# *ATL43xLI-Q1 Functional Safety FIT Rate, FMD and Pin FMA*

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## Table of Contents



## Trademarks

# 1 Overview

This document contains information for ATL43xLI-Q1 (DBZ 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 and Figure 1-2 show the device functional block diagram for reference.

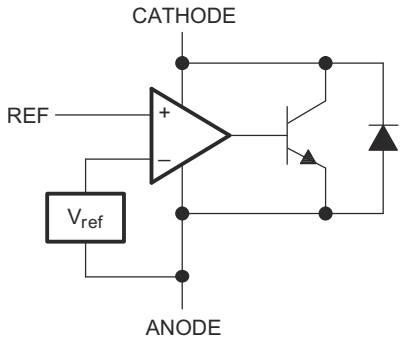


**Figure 1-1. Equivalent Schematic**

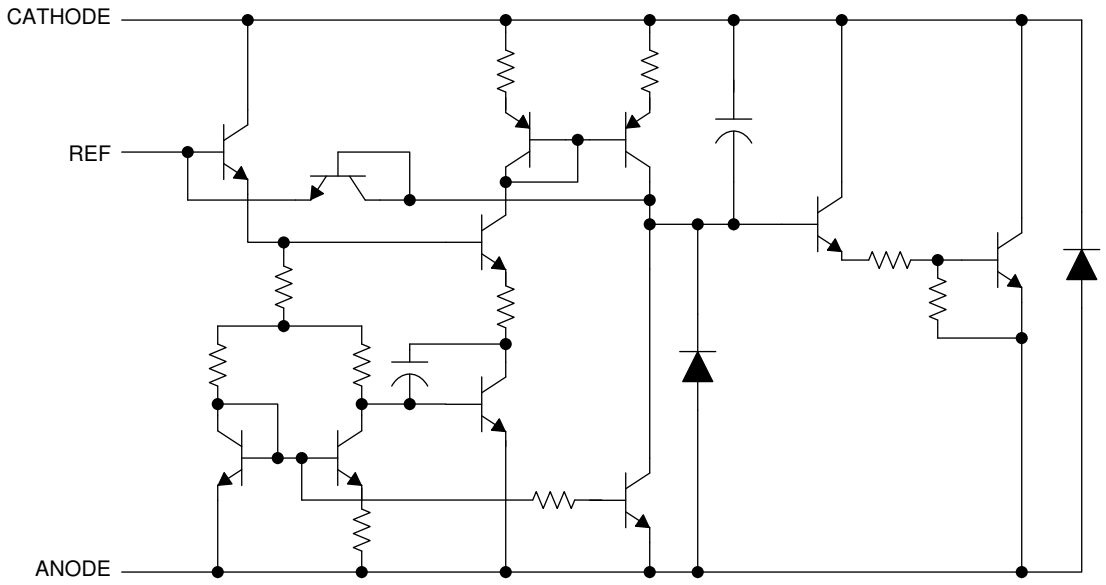


**Figure 1-2. Detailed Schematic**

ATL43xLI-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

## 2.1 DBZ Package

This section provides Functional Safety Failure In Time (FIT) rates for DBZ package of ATL43xLI-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 $10^9$ Hours) |
|---|---|
| Total Component FIT Rate | 6 |
| Die FIT Rate | 4 |
| Package FIT Rate | 2 |

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: 50 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 $T_J$ |
|---|---|---|---|
| 4 | Simple Analog / HF | 3 FIT | 55°C |

The Reference FIT Rate and Reference Virtual $T_J$ (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 ATL43xLI-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 (%) |
|---|---|
| Cathode or Anode open (HIZ) | 25% |
| Cathode or Anode short | 35% |
| Cathode not in specification voltage or current | 40% |

# 4 Pin Failure Mode Analysis (Pin FMA)

This section provides a Failure Mode Analysis (FMA) for the pins of the ATL43xLI-Q1 (DBZ package). 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 |

Assumptions of use and the device configuration assumed for the pin FMA are described by :

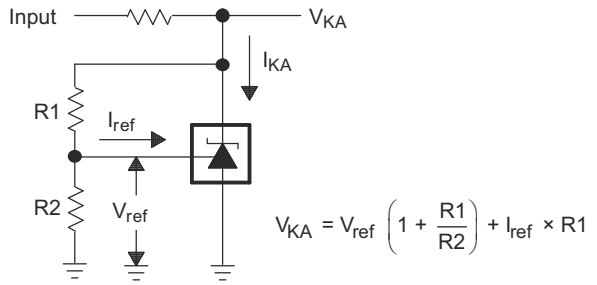


**Figure 4-1. Test Circuit for $V_{KA} > V_{ref}$**

## 4.1 DBZ Package

Figure 4-2 shows the ATL43xLI-Q1 pin diagram for the DBZ package. For a detailed description of the device pins please refer to the *Pin Configuration and Functions* section in the ATL43xLI-Q1 data sheet.

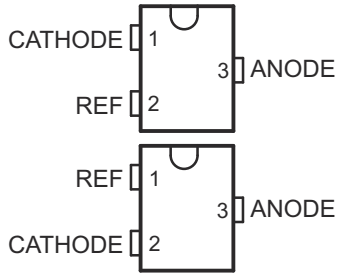


**Figure 4-2. Pin Diagram for DBZ Package**

**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 |
|---|---|---|---|
| CATHODE | 1 or 2 | No power; No Cathode voltage regulation. | C |
| REF | 1 or 2 | Cathode voltage is unregulated. | C |
| ANODE | 3 | No effect. | D |

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

| Pin Name | Pin No. | Description of Potential Failure Effect(s) | Failure Effect Class |
|---|---|---|---|
| CATHODE | 1 or 2 | No Output Voltage. | C |
| REF | 1 or 2 | Output is not regulated. | C |
| ANODE | 3 | Output voltage is not regulated. | C |

**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 |
|---|---|---|---|---|
| CATHODE | 1 or 2 | REF | Voltage might be regulated differently depending on the gain of the device. | C |
| REF | 1 or 2 | ANODE | Cathode voltage is unregulated. | C |
| ANODE | 3 | CATHODE | No damage to device, can affect application functionality. Increases leakage. | C |

**Table 4-5. Pin FMA for Device Pins Short-Circuited to VCC (For error amplifier, this is the cathode)**

| Pin Name | Pin No. | Description of Potential Failure Effect(s) | Failure Effect Class |
|---|---|---|---|
| CATHODE | 1 or 2 | No Effect. | D |
| REF | 1 or 2 | Voltage might be regulated differently depending on the gain of the device. | C |
| ANODE | 3 | No damage to device, can affect application functionality. Increases leakage. | C |

# 5 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

| DATE | REVISION | NOTES |
|---|---|---|
| September 2020 | * | Initial Release |

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