DRV5055-Q1 Functional Safety FIT Rate, FMD and Pin FMA

1 Overview

This document contains information for the DRV5055-Q1 (SOT-23 and TO-92 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 shows the device functional block diagram for reference.

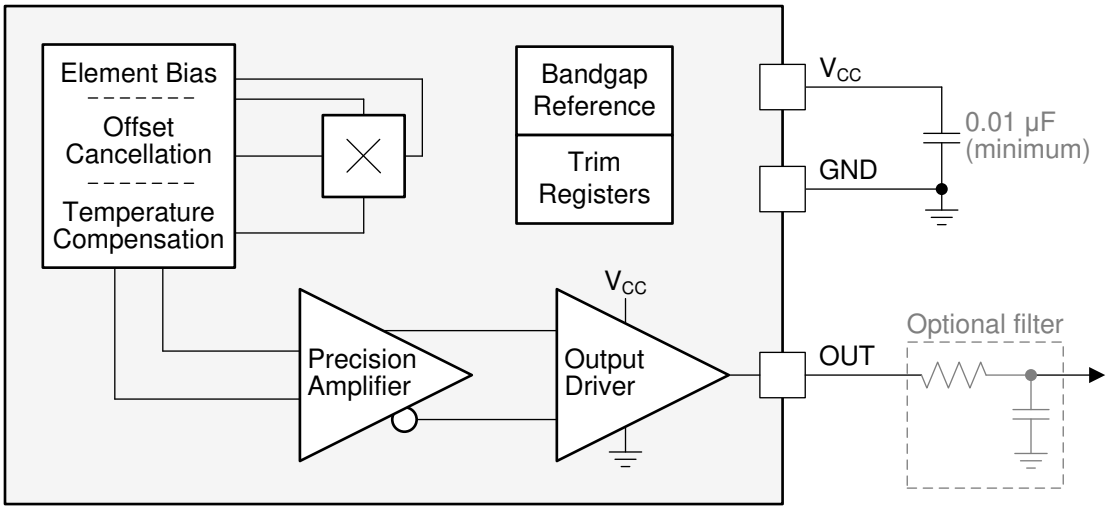

Figure 1. Functional Block Diagram

The DRV5055-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 SOT-23 Package

This section provides Functional Safety Failure In Time (FIT) rates for the SOT-23 package of the DRV5055-Q1 based on two different industry-wide used reliability standards:

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

Table 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	5
Die FIT Rate	3
Package FIT Rate	2

The failure rate and mission profile information in Table 1 comes from the Reliability data handbook IEC TR 62380 / ISO 26262 part 11:

- Mission Profile: Motor Control from Table 11
- Power dissipation: 55 mW
- Climate type: World-wide Table 8
- Package factor lambda 3 Table 17b
- Substrate Material: FR4
- EOS FIT rate assumed: 0 FIT

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

Table	Category	Reference FIT Rate	Reference Virtual T_J
5	CMOS, BICMOS Digital, analog / mixed	25 FIT	55°C

The Reference FIT Rate and Reference Virtual T_J (junction temperature) in Table 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.

2.2 TO-92 Package

This section provides Functional Safety Failure In Time (FIT) rates for the TO-92 package of the DRV5055-Q1 based on two different industry-wide used reliability standards:

- Table 3 provides FIT rates based on IEC TR 62380 / ISO 26262 part 11
- Table 4 provides FIT rates based on the Siemens Norm SN 29500-2

Table 3. 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	19
Die FIT Rate	3
Package FIT Rate	16

The failure rate and mission profile information in Table 3 comes from the Reliability data handbook IEC TR 62380 / ISO 26262 part 11:

- Mission Profile: Motor Control from Table 11
- Power dissipation: 55 mW
- Climate type: World-wide Table 8
- Package factor lambda 3 Table 17b
- Substrate Material: FR4
- EOS FIT rate assumed: 0 FIT

Table 4. Component Failure Rates per Siemens Norm SN 29500-2

Table	Category	Reference FIT Rate	Reference Virtual T_J
5	CMOS, BICMOS Digital, analog / mixed	25 FIT	55°C

The Reference FIT Rate and Reference Virtual T_J (junction temperature) in Table 4 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 DRV5055-Q1 in Table 5 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 5. Die Failure Modes and Distribution

Die Failure Modes	Failure Mode Distribution (%)
Output operation out of specification	45%
No Output	55%

4 Pin Failure Mode Analysis (Pin FMA)

This section provides a Failure Mode Analysis (FMA) for the pins of the DRV5055-Q1 (SOT-23 and TO-92 package). The failure modes covered in this document include the typical pin-by-pin failure scenarios:

- Pin short-circuited to Ground (see Table 7 and Table 10)
- Pin open-circuited (see Table 8 and Table 11)
- Pin short-circuited to V_{CC} (see Table 9 and Table 12)

Table 7 through Table 12 also indicate how these pin conditions can affect the device as per the failure effects classification in Table 6.

Table 6. 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

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

- Device is powered within published absolute maximum operating conditions

4.1 SOT-23 Package

Figure 2 shows the DRV5055-Q1 pin diagram for the SOT-23 package. For a detailed description of the device pins please refer to the '*Pin Configuration and Functions*' section in the DRV5055-Q1 datasheet.

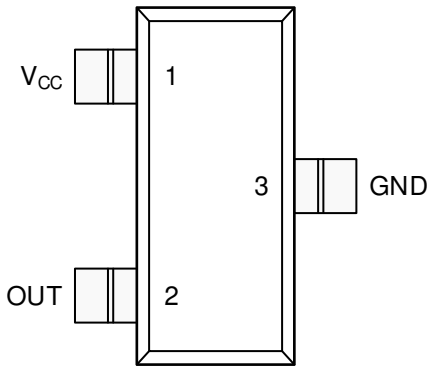

Figure 2. Pin Diagram (SOT-23 Package)

Table 7. Pin FMA for Device Pins Short-Circuited to Ground

Pin Name	Pin No.	Description of Potential Failure Effect(s)	Failure Effect Class
V_{CC}	1	Supply shorted to Ground. System will source high current as a result and may current limit. Thermal damage may result.	B
OUT	2	DRV5055-Q1 will not be damaged. Output will be pulled down by short to GND.	C
GND	3	Normal Mode of operation	D

Table 8. Pin FMA for Device Pins Open-Circuited

Pin Name	Pin No.	Description of Potential Failure Effect(s)	Failure Effect Class
V_{CC}	1	DRV5055-Q1 will not be damaged. There will be no power supply current and therefore no functionality.	B
OUT	2	DRV5055-Q1 will not be damaged. Supply current will be normal, but the output is not driving any load.	C
GND	3	DRV5055-Q1 will not be damaged. There will be no power supply current and therefore no functionality.	B

Table 9. Pin FMA for Device Pins Short-Circuited to V_{cc}

Pin Name	Pin No.	Description of Potential Failure Effect(s)	Failure Effect Class
V_{CC}	1	Normal mode of operation	D
OUT	2	DRV5055-Q1 will not be damaged. The output will sink about 14 mA (limited by overcurrent protection feature). The output signal will be pulled to V_{CC}. Any MCU monitoring the output would observe V_{CC} as an input which may result in over voltage.	B
GND	3	Supply shorted to Ground. System will source high current as a result and may current limit. Thermal damage may result.	B

4.2 TO-92 Package

Figure 3 shows the DRV5055-Q1 pin diagram for the TO-92 package. For a detailed description of the device pins please refer to the '*Pin Configuration and Functions*' section in the DRV5055-Q1 datasheet.

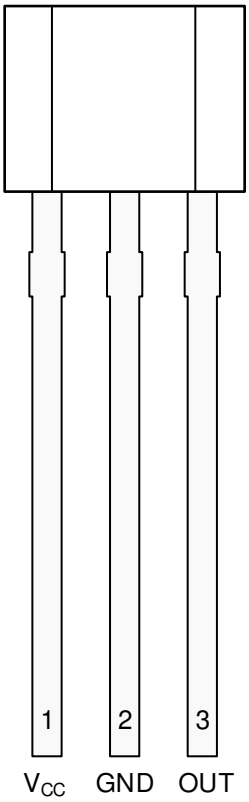

Figure 3. Pin Diagram (TO-92 Package)

Table 10. Pin FMA for Device Pins Short-Circuited to Ground

Pin Name	Pin No.	Description of Potential Failure Effect(s)	Failure Effect Class
V_{CC}	1	Supply shorted to Ground. System will source high current as a result and may current limit. Thermal damage may result.	B
GND	2	Normal Mode of operation	D
OUT	3	DRV5055-Q1 will not be damaged. Output will be pulled down by short to GND.	C

Table 11. Pin FMA for Device Pins Open-Circuited

Pin Name	Pin No.	Description of Potential Failure Effect(s)	Failure Effect Class
V_{CC}	1	DRV5055-Q1 will not be damaged. There will be no power supply current and therefore no functionality.	B
GND	2	DRV5055-Q1 will not be damaged. There will be no power supply current and therefore no functionality.	B
OUT	3	DRV5055-Q1 will not be damaged. Supply current will be normal, but the output is not driving any load.	C

Table 12. Pin FMA for Device Pins Short-Circuited to V_{CC}

Pin Name	Pin No.	Description of Potential Failure Effect(s)	Failure Effect Class
V_{CC}	1	Normal mode of operation	D
GND	2	Supply shorted to Ground. System will source high current as a result and may current limit. Thermal damage may result.	B
OUT	3	DRV5055-Q1 will not be damaged. The output will sink about 14 mA (limited by overcurrent protection feature). The output signal will be pulled to V_{CC}. Any MCU monitoring the output would observe V_{CC} as an input which may result in over voltage.	B

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Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265