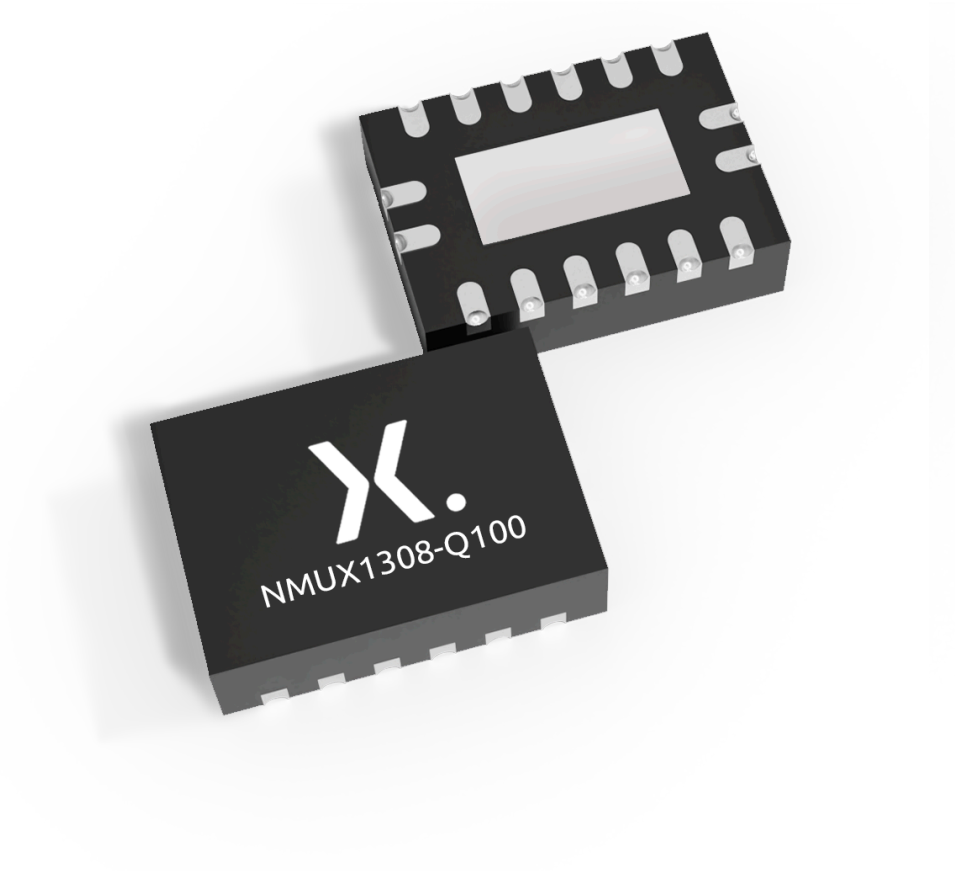
AN90051

Rev. 1 — 13 February 2024

Application note

Pin FMEA for NMUX130x family



Abstract: This application note provides a Failure Modes and Effects Analysis (FMEA) for the device pins of Nexperia's NMUX family under typical failure situations.

Keywords: Pin FMEA, NMUX, CMOS switch, Bi-directional

nexperia

1. Introduction

The NMUX130x product is a general purpose, CMOS analog switch, bi-directional, with an operating voltage range of 1.5 V to 5.5 V. The NMUX130x products extends the digital logic thresholds to be compatible with 1.8 V systems without the need for voltage translation.

All analog signal pins are bi-directional and support a voltage range from GND to V_{CC}.

All analog signal pins integrate injection current control circuitry. This control circuitry isolates overvoltage spikes on disconnected analog signal pins from coupling to the connected analog signal path, thereby preserving measurement accuracy. Additionally, this integration makes the use of external overvoltage clamp components (e.g. resistive diode network) unnecessary.

The control signal pins support 1.8 V logic thresholds across all operating voltages. In addition, these pins are 5.5 V tolerant, enabling up to 5.5 V operation independent of supply voltage.

2. NMUX130x family overview

- Automotive product qualification in accordance with AEC-Q100 (Grade 1)
  - Specified from -40 °C to +85 °C and from -40 °C to +125 °C
- Wide operating range: 1.5 V to 5.5 V
- Rail-to-Rail operation on analog signal pins
- Injection current control
- 1.8 V digital logic thresholds
  - Digital pins compatible with 1.8 V logic thresholds across full V_{CC} range
  - Removes need for up-translation device for compatibility with low voltage GPIOs
- I_{off} circuitry
  - Enables wider latitude for power sequencing considerations
  - Isolates backflow between supply rail and any biased digital/analog input when V_{CC} = 0 V
  - Prevents any biased digital/analog input from backpowering V_{CC} when V_{CC} = 0 V
  - Maintains Hi-Z state of analog switch when V_{CC} = 0 V
- 5.5 V overvoltage tolerant digital inputs
  - Supports switching of 5.5 V digital signals across full V_{CC} operating range
  - Removes need for down-translation when switching thresholds are met
- Pin compatible with industry standard 4052 and 4852 analog switch products
- ESD protection:
  - HBM: ANSI/ESDA/JEDEC JS-001 class 2 exceeds 2000 V
  - CDM: ANSI/ESDA/JEDEC JS-002 class C2b exceeds 750 V

3. Pin FMEA

This application note provides a Failure Modes and Effects Analysis (FMEA) for the device pins of Nexperia's NMUX130x family under typical failure situations such as a short-circuit to VCC or GND or to a neighboring pin, or if a pin is left open.

A failure is classified according to its effect on the LSF device and the functionality of the application; see Table 1.

Table 1. Classification of failure effects

Class	Failure effect
A	damage to device
	affects application functionality
B	no damage to device
	may affect application functionality
C	no damage to device
	no affect to application functionality

Table 2. FMEA matrix for pin short-circuit to VCC

Pin	Class	Remarks
Input/output	A	The short may cause a voltage difference across a selected switch causing high current that may result in device damage.
	B	If no voltage results observed across a selected switch, then there will be no damage. Application functionality may be affected due incorrect signal passed into Z pin.
Enable input	B	EN stuck high. Can no longer enable the device.
Ground (GND)	B	Device is not referenced to ground. Functionality will be impacted.
Select input	B	Address stuck high. Cannot control switch states.

Table 3. FMEA matrix for pin short-circuit to GND

Pin	Class	Remarks
Input/output	A	The short may cause a voltage difference across a selected switch causing high current that may result in device damage
	B	If no voltage results observed across a selected switch, then there will be no damage. Application functionality may be affected due incorrect signal passed into Z pin.
Enable input	B	EN stuck low. Can no longer disable the device without power down.
Supply (VCC)	B	Device is not powered. Device is not functional.
Select input	B	Address stuck high. Cannot control switch states.

Table 4. FMEA matrix for pin left open

Pin	Class	Remarks
Input/output	B	Input pins are in non-deterministic state, incorrect signal passed into bi-directional pins. Application functionality may be affected
Enable input	B	Control of the EN pin is lost. Cannot enable/disable switch. Will default to switches disabled.
Ground (GND)	B	Device is not referenced to ground. Functionality will be impacted.
Supply (VCC)	B	Device is not powered. Device is not functional.
Select input	B	Control of the address pin is lost. Cannot control switch.

Table 5. FMEA matrix for pin short-circuits between neighbor pins

Pin	Class	Remarks
Input/output	B	Possible incorrect signal level passed onto the input and output
Input/output to Enable	B	Possible incorrect signal passed onto the output pin. Switch state will be undefined.
Ground to Select input	B	See Table 3.
Select input to Select input	B	Control of the switch state is lost.
Select input to input/ output	B	Possible corruption of the signal passed onto the output pin. Control of the switch state is lost.
VCC to input/output	A	See Table 2.

4. Revision history

Table 6. Revision history

Rev	Date	Description
AN90051 v.1	20240213	AN90051 initial version

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