



AN90057

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application note

Pin FMEA for NXU family

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

Keywords: Pin FMEA, NXU, CMOS, Uni-Directional

1. Introduction

The NXU is a dual-supply level translating buffer with Schmitt-trigger inputs and 3-state outputs. It features four data inputs; four data outputs and an output enable input (OE).

Both V_{CCA} and V_{CCB} can be supplied at any voltage between 0.9 V and 5.5 V making the device suitable for translating between any of the voltage nodes (1.2 V, 1.5 V, 1.8 V, 2.5 V, 3.3 V and 5.0 V).

This device facilitates asynchronous communication between data buses. Transmit data with a fixed direction (unidirectionally) from the A bus to the B bus with given channel and from the B bus to the A bus with the other channel. The OE pin can be referenced to V_{CCA} and V_{CCB} domain and when OE pin is set LOW the outputs are disabled and enter a high-impedance OFF-state which isolates the buses. The OE pin can be left floating or externally pulled down to ground to ensure the high impedance state of the outputs during power up or power down.

No power supply sequencing is required and output glitches during power supply transitions are prevented. As a result, glitches will not appear on the outputs for supply transitions during power-up/down.

NXU family can be used for range of consumer and automotive application for voltage level translation for example general purpose I/O level translation. It also Supports push-pull voltage translation as UART, SPI and JTAG protocols.

2. NXU family overview

The NXU family comprises of following products:

- The **NXU0104** is a 4-channel fixed directional translator. It features four data inputs (An), four data outputs (YBn) and an output enable pin (OE).
- The **NXU0204** is a 4-channel fixed directional translator. It features four data inputs (A1, A2, B1, B2) four data outputs (YA3, YA4, YB1, YB2) and an output enable pin (OE).
- The **NXU0304** is a 4-channel fixed directional translator. It features four data inputs (A1, A2, A3, B4) four data outputs (YA4, YB1, YB2, YB3) and an output enable pin (OE).
- The **NXU0102** is a 2-channel fixed directional translator. It features tow data inputs (A1, A2) and tow data outputs (YB1, YB2) and an output enable pin (OE).
- The **NXU0202** is a 2-channel fixed directional translator. It features two data inputs (A1, B2) and two data outputs (YA2, YB1) and an output enable pin (OE).
- The **NXU0101** is a 1-channel fixed directional translator. It features data inputs (A) and corresponding data output (YB) and an output enable pin (OE).

Basic functional diagram is shown in [Fig. 1](#).

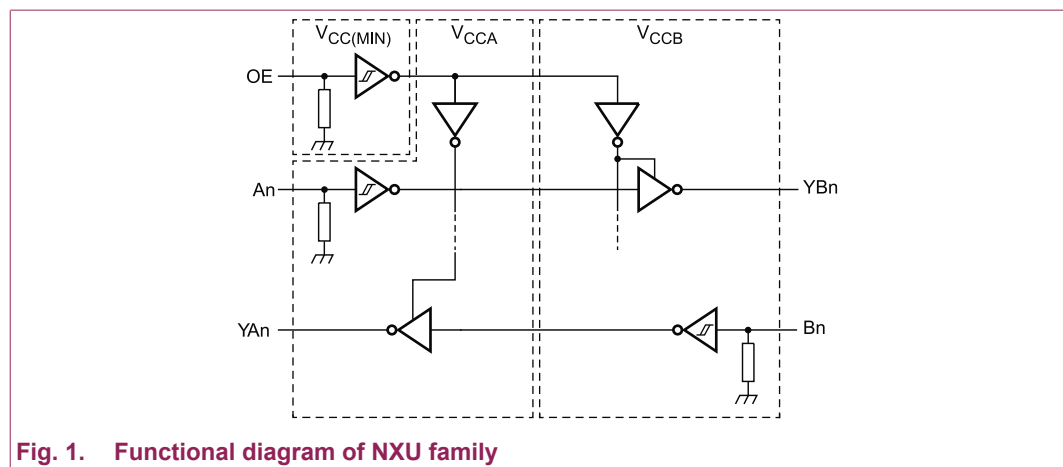


Fig. 1. Functional diagram of NXU family

3. Features and benefits

- Wide supply voltage range:
 - V_{CCA} : 0.9 V to 5.5 V
 - V_{CCB} : 0.9 V to 5.5 V
- Low power consumption for supply voltage range 1.1 V to 5.5 V
 - 3 μA ($T_{\text{amb}} = 25\text{ }^{\circ}\text{C}$)
 - 5 μA ($T_{\text{amb}} = -40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$)
- Schmitt-trigger inputs with integrated static high ohmic pull-down resistor on the input
- Maximum data rates:
 - 250 Mbps ($\geq 1.8\text{ V}$ to 5 V translation)
- High output drive 12 mA at 5 V
- Output enable (OE) allows connection to V_{CCA} or V_{CCB} domain
- Suspend mode when either one of the supply voltages is below 100 mV or disconnected (floating)
- Low noise overshoot and undershoot $<10\%$ of V_{CCO}
- I_{OFF} circuitry provides partial power-down mode operation
- Latch-up performance exceeds 100 mA per JESD78D Class II
- Complies with JEDEC standard:
 - JESD8-12 (0.9 V to 1.3 V)
 - JESD8-11 (1.4 V to 1.6 V)
 - JESD8-7 (1.65 V to 1.95 V)
 - JESD8-5 (2.3 V to 2.7 V)
 - JESD8C (2.7 V to 3.6 V)
 - JESD12-6 (4.5 V to 5.5 V)
- ESD protection:
 - HBM: ANSI/ESDA/JEDEC JS-001 class 2 exceeds 2500 V
 - CDM: ANSI/ESDA/JEDEC JS-002 class C3 exceeds 1500 V
- Specified from $-40\text{ }^{\circ}\text{C}$ to $+85\text{ }^{\circ}\text{C}$ and $-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$

4. Pin FMEA

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

A failure is classified according to its effect on the NXU 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 V_{CCA}

V_{CCA} is the supply voltage associated with the input and output ports for A side.

V_{CCB} is the supply voltage associated with the input and output ports for B side.

Pin	Class	Remarks
Input	B	Normal operating condition, the short can cause additional leakage, may affect functionality, no damage.
Output	A	If output defined LOW, short-circuits and high current can damage device, output level changes.
Output	A	If output defined HIGH short-circuits and high current can damage device, output level changes.
GND	A	Short-circuits and high currents can damage device, will affect functionality.
Supply	A	Short-circuit with supply V_{CCB} can damage device, will affect functionality.

Table 3. FMEA matrix for pin short-circuit to V_{CCB}

V_{CCA} is the supply voltage associated with the input and output ports for A side.

V_{CCB} is the supply voltage associated with the input and output ports for B side.

Pin	Class	Remarks
Input	B	Normal operating condition, the short can cause additional leakage, may affect functionality, no damage.
Output	A	If output defined LOW, short-circuits and high current can damage device, output level changes.
Output	A	If output defined HIGH short-circuits and high current can damage device, output level changes.
GND	A	Short-circuits and high currents can damage device, will affect functionality.
Supply	A	Short-circuit with supply V_{CCA} can damage device, will affect functionality.

Table 4. FMEA matrix for pin short-circuit to GND

V_{CCA} is the supply voltage associated with the input and output ports for A side.

V_{CCB} is the supply voltage associated with the input and output ports for B side.

Pin	Class	Remarks
Input	B	Normal operating condition, no additional leakage, may affect functionality, no damage.
Output	C	If output defined LOW, no leakage, no output level change.
Output	A	If output defined HIGH short-circuits and high current can damage device, output level changes.
V_{CCA}	A	Short-circuits and high currents can damage device, will affect functionality.
V_{CCB}	A	Short-circuits and high currents can damage device, will affect functionality.

Table 5. FMEA matrix for pin left open

V_{CCA} is the supply voltage associated with the input and output ports for A side.

V_{CCB} is the supply voltage associated with the input and output ports for B side.

Pin	Class	Remarks
Input	B	Normal operating condition, no damage, no additional leakage, no affect on functionality, no damage.
Output	C	Normal operating condition, no damage, no leakage.
GND	A	Undefined operating condition, can damage device, increase leakage, will affect functionality.
V_{CCA}	B	Follows functional table where outputs are disabled, no damage, no increase in leakage
V_{CCB}	B	Follows functional table where outputs are disabled, no damage, no increase in leakage

Table 6. FMEA matrix for pin short-circuits between neighbor pins

V_{CCA} is the supply voltage associated with the input and output ports for A side.

V_{CCB} is the supply voltage associated with the input and output ports for B side.

Pin	Class	Remarks
Input to input	B	If inputs have different voltage levels: leakage increases, will affect functionality
	C	If inputs have same voltage levels: no damage, no leakage
Input to output	A	If input and output have different voltage levels, can cause high current and can damage device, will affect functionality
	C	If input and output have same voltage levels, no damage, no leakage.
Input to GND	-	see Table 4
Input to V_{CCA}	-	see Table 2
Input to V_{CCB}	-	see Table 3
Output to output	A	If input and output have different voltage levels, can cause high current and can damage device, will affect functionality
	C	If input and output have same voltage levels, no damage, no leakage.
Output to input	-	Same effect as 'input to output' condition.
Output to GND	-	see Table 4
Output to V_{CCA}	-	see Table 2
Output to V_{CCB}	-	see Table 3
GND to V_{CCA}	-	see Table 2
GND to V_{CCB}	-	see Table 3

5. Revision history

Table 7. Revision history

Rev	Date	Description
AN90057 v.1	20240911	Initial version

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