AN11537

Pin FMEA for NPIC family

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Document information

Information	Content
Keywords	FMEA, NPIC
Abstract	This application note provides a Failure Modes and Effects Analysis (FMEA) for the device pins of Nexperia's NPIC shift register based LED drivers under typical failure situations

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1. Introduction

NPIC shift register based LED drivers are used in I/O expansion applications allowing the use of lower pin-count (and cost) controllers.

2. NPIC family overview

The NPIC family are n-bit serial-in/serial or parallel-out shift registers with a storage register and open-drain outputs. The serial output allows cascading providing the potential for 3 controller I/Os to control the state of 16, 24 or more LEDs. The open-drain outputs are high voltage, high continuous current extended-drain NMOS transistors designed for use in systems that require moderate load power such as LEDs. Integrated voltage clamps in the outputs provide protection against inductive transients. This feature makes the device suitable for power driver applications such as relay, solenoids and other low-current or medium-voltage loads.

NPIC shift register products are fully specified from -40 °C to +125 °C.

3. Pin FMEA

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

The individual failures are classified, according to their corresponding effects on a device and the functionality; see Table 1.

Table 1. Classification of failure effects

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

Table 2. FMEA matrix for pin short-circuit to V_{CC}

Pin	Class	Remarks
Input	B	normal operating condition, no damage to this device, no leakages, functionality may be affected
Output	C	Serial output: if output defined HIGH, no damage to this device, no leakages, no change in output level
Output	A	Serial output: if output defined LOW, short-circuits and high currents can damage device, output level changes
Output	A	Open-drain output: if output defined HIGH, voltage used for open-drain output, damages internal circuitry
Output	B	Open-drain output: if output defined LOW, no damage to this device, high leakages, output level changes, functionality may be affected
GND	B	short-circuits and high currents can damage device, functionality is affected

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

Pin	Class	Remarks
Input	B	normal operating condition, no damage to this device, no leakages, functionality may be affected
Output	A	Serial output: if output defined HIGH, short-circuits and high currents can damage device, output level changes
Output	C	Serial output: if output defined LOW, no damage to this device, no leakages, no change in output level
Output	A	Open-drain output: if output defined HIGH, voltage used for open-drain output, damages internal circuitry
Output	B	Open-drain output: if output defined LOW, no damage to this device, high leakages, output level changes, functionality may be affected
V_{CC}	B	short-circuits and high currents can damage device, functionality is affected

Table 4. FMEA matrix for pin left open

Pin	Class	Remarks
Input	B	undefined operating condition, no damage to this device, increased leakage, functionality may be affected
Output	C	normal operating condition, no damage to this device, no leakages
GND	B	undefined operating condition, no damage to this device, increased leakage, functionality is affected
V_{CC}	B	undefined operating condition, no damage to this device, increased leakage, functionality is affected

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

Pin	Class	Remarks
Input to Input	C	if inputs have same voltage levels: no damage, no leakage
	B	if inputs have different voltage levels: increased leakage, functionality is affected
Input to Output	A	if input and output have different voltage levels, can cause high current and can damage device, will affect functionality
Output to Output	C	if outputs have same voltage levels: no damage to this device, no leakage
	A	if outputs have different voltage levels: can cause high current, can damage device, functionality is affected
Input to V_{CC}	-	see Table 2
Input to GND	-	see Table 3
Output to V_{CC}	-	see Table 2
Output to GND	-	see Table 3

4. Abbreviations

Table 6. Abbreviations

Acronym	Description
FMEA	Failure Modes and Effects Analysis

5. Revision history

Table 7. Revision history

Rev	Date	Description
AN11537 v.2	20191007	AN11537, updated to latest Nexperia documentation standard
AN11537 v.1	20140428	AN11537 initial version

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