

AN11051

Pin FMEA for HEF4000 family

Rev. 1 — 28 April 2011

Application note

Document information

Info	Content
Keywords	FMEA, HEF4000, CMOS, wide operating supply range (3 V to 15 V)
Abstract	This application note provides a Failure Modes and Effects Analysis (FMEA) for the device pins of the NXP Semiconductors' HEF4000 family under typical failure situations



Revision history

Rev	Date	Description
v 1.0	20110428	initial version

Contact information

For more information, please visit: <http://www.nxp.com>

For sales office addresses, please send an email to: salesaddresses@nxp.com

1. Introduction

Though the HEF4000 series is one of the oldest CMOS logic families around, it is still frequently used in new designs because of its ease of design-in, wide operating supply range (3 V to 15 V), excellent noise immunity, and low power consumption. All of the standard functions are available, plus more specialized functions such as IEEE bus interfaces and PLL frequency synthesizers.

2. Pin FMEA

This application note provides a Failure Modes and Effects Analysis (FMEA) for the device pins of the NXP Semiconductor AUP family under typical failure situations such as a short-circuit to V_{DD} or V_{SS} or to a neighboring pin, or if a pin is left open.

Some HEF4000 family devices have special functions, that can have different behaviors. A failure is classified according to its effect on the HEF4000 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_{DD}

Pin	Class	Remarks
Input	B	normal operating condition, no damage, no leakage, may affect functionality
Output	C	if output defined HIGH, no damage, no leakage, no output level change
Output	A	if output defined LOW, short-circuits and high currents can damage device, output level changes
V_{SS}	B	short-circuits and high currents can damage device, will affect functionality

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

Pin	Class	Remarks
Input	B	normal operating condition, no damage, no leakage, may affect functionality
Output	C	if output defined LOW, no damage, no leakage, no output level change
Output	A	if output defined HIGH, short-circuits and high currents can damage device, output level changes
V_{DD}	B	no damage to device, will affect functionality

Table 4. FMEA matrix for pin left open

Pin	Class	Remarks
Input	B	undefined operating condition, no damage, increases leakage, may affect functionality
Output	C	normal operating condition, no damage, no leakage
V _{SS}	B	undefined operating condition, no damage, increases leakage, will affect functionality
V _{DD}	B	undefined operating condition, no damage, increases leakage (only for I/O types), will affect functionality

Table 5. FMEA matrix for pin short-circuits between neighboring 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: leakage increases, will affect functionality
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 V _{SS}	-	see Table 3
Input to V _{DD}	-	see Table 2
Output to output	C	if outputs have same voltage levels, no damage, no leakage
	A	if outputs have different voltage levels, can cause high current and can damage device, will affect functionality
Output to input	-	same effect as 'input to output' condition
Output to V _{SS}	-	see Table 3
Output to V _{DD}	-	see Table 2
V _{SS} to V _{DD}	-	not applicable, these pins are not neighbors

3. Abbreviations

Table 6. Abbreviations

Acronym	Description
CMOS	Complementary Metal-Oxide Semiconductor
FMEA	Failure Modes and Effects Analysis
PLL	Phase-Locked Loop

4. Legal information

4.1 Definitions

Draft — The document is a draft version only. The content is still under internal review and subject to formal approval, which may result in modifications or additions. NXP Semiconductors does not give any representations or warranties as to the accuracy or completeness of information included herein and shall have no liability for the consequences of use of such information.

4.2 Disclaimers

Limited warranty and liability — Information in this document is believed to be accurate and reliable. However, NXP Semiconductors does not give any representations or warranties, expressed or implied, as to the accuracy or completeness of such information and shall have no liability for the consequences of use of such information.

In no event shall NXP Semiconductors be liable for any indirect, incidental, punitive, special or consequential damages (including - without limitation - lost profits, lost savings, business interruption, costs related to the removal or replacement of any products or rework charges) whether or not such damages are based on tort (including negligence), warranty, breach of contract or any other legal theory.

Notwithstanding any damages that customer might incur for any reason whatsoever, NXP Semiconductors' aggregate and cumulative liability towards customer for the products described herein shall be limited in accordance with the *Terms and conditions of commercial sale* of NXP Semiconductors.

Right to make changes — NXP Semiconductors reserves the right to make changes to information published in this document, including without limitation specifications and product descriptions, at any time and without notice. This document supersedes and replaces all information supplied prior to the publication hereof.

Suitability for use — NXP Semiconductors products are not designed, authorized or warranted to be suitable for use in life support, life-critical or safety-critical systems or equipment, nor in applications where failure or malfunction of an NXP Semiconductors product can reasonably be expected to result in personal injury, death or severe property or environmental damage. NXP Semiconductors accepts no liability for inclusion and/or use of NXP Semiconductors products in such equipment or applications and therefore such inclusion and/or use is at the customer's own risk.

Applications — Applications that are described herein for any of these products are for illustrative purposes only. NXP Semiconductors makes no representation or warranty that such applications will be suitable for the specified use without further testing or modification.

Customers are responsible for the design and operation of their applications and products using NXP Semiconductors products, and NXP Semiconductors accepts no liability for any assistance with applications or customer product

design. It is customer's sole responsibility to determine whether the NXP Semiconductors product is suitable and fit for the customer's applications and products planned, as well as for the planned application and use of customer's third party customer(s). Customers should provide appropriate design and operating safeguards to minimize the risks associated with their applications and products.

NXP Semiconductors does not accept any liability related to any default, damage, costs or problem which is based on any weakness or default in the customer's applications or products, or the application or use by customer's third party customer(s). Customer is responsible for doing all necessary testing for the customer's applications and products using NXP Semiconductors products in order to avoid a default of the applications and the products or of the application or use by customer's third party customer(s). NXP does not accept any liability in this respect.

Export control — This document as well as the item(s) described herein may be subject to export control regulations. Export might require a prior authorization from national authorities.

Evaluation products — This product is provided on an "as is" and "with all faults" basis for evaluation purposes only. NXP Semiconductors, its affiliates and their suppliers expressly disclaim all warranties, whether express, implied or statutory, including but not limited to the implied warranties of non-infringement, merchantability and fitness for a particular purpose. The entire risk as to the quality, or arising out of the use or performance, of this product remains with customer.

In no event shall NXP Semiconductors, its affiliates or their suppliers be liable to customer for any special, indirect, consequential, punitive or incidental damages (including without limitation damages for loss of business, business interruption, loss of use, loss of data or information, and the like) arising out of the use of or inability to use the product, whether or not based on tort (including negligence), strict liability, breach of contract, breach of warranty or any other theory, even if advised of the possibility of such damages.

Notwithstanding any damages that customer might incur for any reason whatsoever (including without limitation, all damages referenced above and all direct or general damages), the entire liability of NXP Semiconductors, its affiliates and their suppliers and customer's exclusive remedy for all of the foregoing shall be limited to actual damages incurred by customer based on reasonable reliance up to the greater of the amount actually paid by customer for the product or five dollars (US\$5.00). The foregoing limitations, exclusions and disclaimers shall apply to the maximum extent permitted by applicable law, even if any remedy fails of its essential purpose.

4.3 Trademarks

Notice: All referenced brands, product names, service names and trademarks are the property of their respective owners.

5. Contents

1	Introduction	3
2	Pin FMEA	3
3	Abbreviations	4
4	Legal information	5
4.1	Definitions	5
4.2	Disclaimers	5
4.3	Trademarks.....	5
5	Contents	6

Please be aware that important notices concerning this document and the product(s) described herein, have been included in section 'Legal information'.

© NXP B.V. 2011.

All rights reserved.

For more information, please visit: <http://www.nxp.com>

For sales office addresses, please send an email to: salesaddresses@nxp.com

Date of release: 28 April 2011

Document identifier: AN11051